NJTPA

NORTH JERSEY TRANSPORTATION PLANNING AUTHORITY

NJRTM-E
MODEL DEVELOPMENT MANUAL

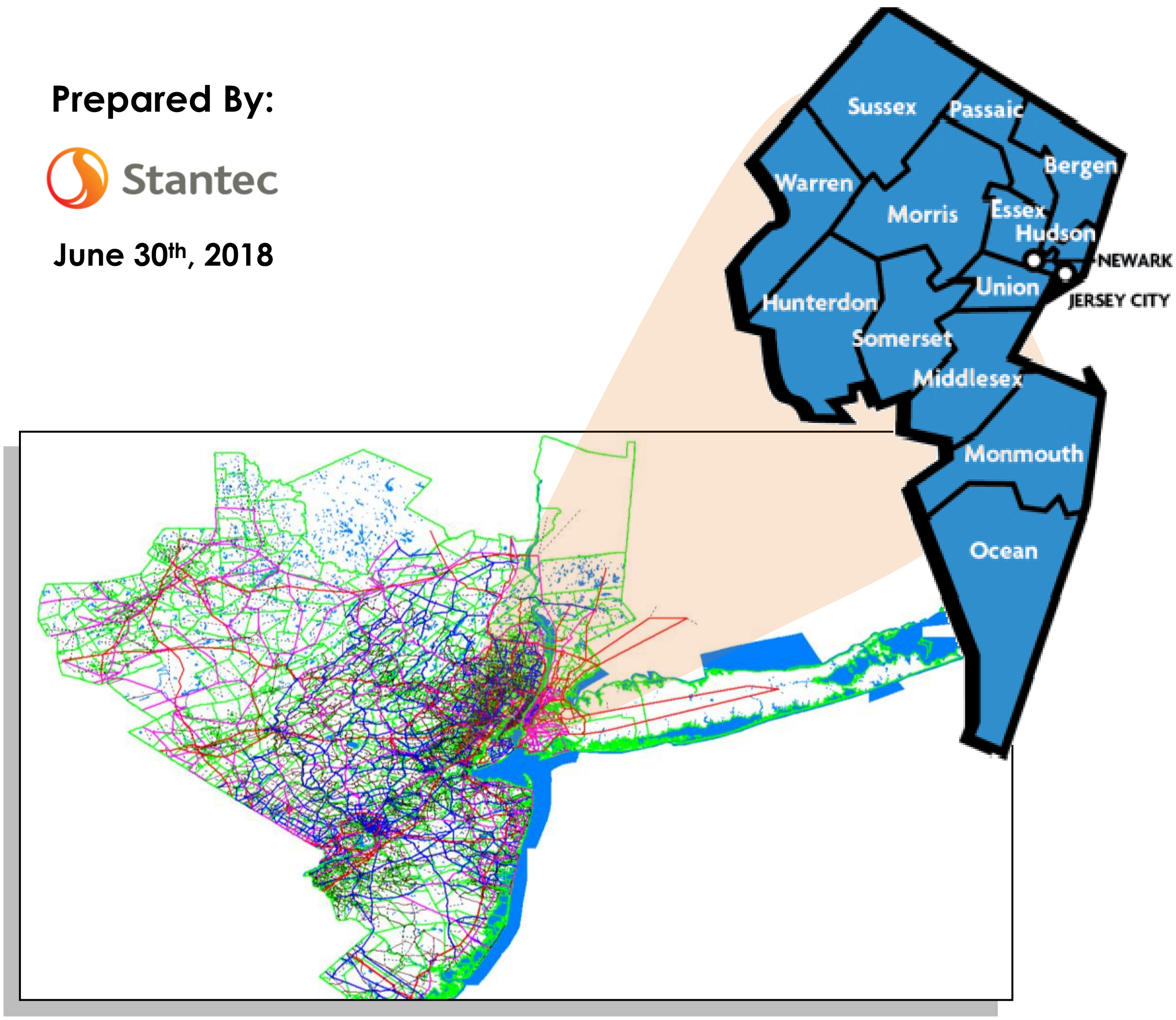
Version 3

2018 Revalidation

Prepared By:

Stantec

June 30th, 2018



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1. INTRODUCTION

The purpose of this document is to summarize the development effort of the North Jersey Regional Transportation Model “Enhanced” (NJRTM-E) Project. This model was developed to provide a common modeling process that was suitable for the planning needs for the North Jersey Transportation Planning Authority (NJTPA), New Jersey Transit (NJT), and the New Jersey Department of Transportation (NJDOT). The model was initially developed in 2008, revalidated in 2011, refined in 2015 and revalidated again in 2018. This new model has several prominent features including an enlarged modeled region encompassing the NJTPA as well as eastern Pennsylvania and metropolitan area of New York City. The NJRTM-E also features the inclusion of the customized NJT mode choice model as the basis for estimation of auto and transit mode shares. It is envisioned that this model will become the principal travel demand forecasting process for planning analysis in Northern New Jersey.

This document includes a complete description of the model development and the latest calibration of each model component. In addition, the document includes a summary of selected sensitivity tests used to validate the model. A Users Guide, developed as a separate document, is provided to describe the use of the model and its many features. The Users Guide also includes a series of appendices which contain additional technical information related to the operation of the model and supporting features.

The development report includes separate sections on each major model component. These sections are as follows:

- Zonal System and Socioeconomic Data
- Highway Network
- Transit Network
- Highway Path Building
- Transit Path Building
- Composite Impedance
- Trip Generation
- Trip Distribution
- Mode Choice
- Time of Day Trip Estimation
- Highway Assignment
- Model Convergence
- Transit Assignment

Additional documentation for specific model elements, such as mode choice, is also referenced in this report. References to those documents are provided in the relevant sections of this report.

1.1 PROJECT OVERVIEW

As mentioned briefly above, the primary objective of this project was the creation of a unified travel demand model suitable for the needs of multiple agencies performing regional and project-specific planning studies in Northern New Jersey. To accomplish this goal, the needs of each of the sponsoring agencies (NJTPA, NJ Transit and NJDOT) were identified and a series of recommendations were generated for discussion with the technical committee overseeing the project. The resulting work plan was structured as a hybrid approach where some model components, such as NJ Transit’s mode choice model, were adopted without modification, while other components, such as trip generation were replaced with new versions developed as part of this project. A summary of the key model revisions by component are provided as follows:

- Zonal System and Socioeconomic Data – The zonal system was expanded to cover a region of 40 counties covering all of northern New Jersey, eastern Pennsylvania, southern New York and the western area of Connecticut. Unified socioeconomic data estimates were also prepared based on the latest available forecasts.

- Highway Network – The highway network was expanded and geo-referenced within the northern New Jersey region. A significant amount of new variables were incorporated into the network to permit enhanced estimation of capacity and speeds, as well as advanced toll modeling techniques.

- Transit Network – The transit network from the NJ Transit Model was incorporated into the final model and a series of refinements were implemented to support the modeling of transit specific facilities such as express bus lanes.

- Highway Path Building – Highway path-building and impedance estimation were updated to account for the NJ Transit mode choice model and the toll diversion modeling.

- Transit Path Building – Transit path-building and impedance estimation were adopted from the NJ Transit regional model and revisions to support the estimation of transit specific facilities were implemented.

- Composite Impedance – Due to the complex structure of the NJ Transit mode choice model geographic segmentation, an alternative method of estimating composite impedance was developed. The new procedure is based on the parallel conductance formula and is sensitive to all time and cost elements of the highway and transit networks.

- Trip Generation – The trip generation procedures were redesigned to incorporate several new features. These new features include the introduction of several new trip purposes and the estimation of non-motorized travel, along with other modifications required to support the distribution of trips by income category.

- Trip Distribution – The trip distribution process was restructured to allocate trips by income for each trip purpose using the income groups established for the mode choice model. The distribution process as also modified to utilize the new composite impedance term developed as part of this project.

- Mode Choice – The existing mode choice model was replaced by the more robust NJ Transit mode choice model. This model also performed mode choice for each purpose in both the peak and off-peak periods.

- Time of Day Trip Estimation - This component received minor modifications as a result of redefining the peak period durations and the introduction of new trip purposes.

- Highway Assignment – The highway assignment process was restructured to provide enhanced capabilities to model additional delay related to queuing as well as to incorporate enhanced modeling of toll diversion by payment type.

- Model Convergence – The new model was structured to replace the previous naïve iteration convergence process with specific procedures to determine model convergence within acceptable closure criteria.

- Transit Assignment – The transit assignment procedures were adopted to be consistent with the NJ Transit Regional Transit Model.

In addition to the structural changes to the model, another key aspect of the project was the need to increase the model's usability by analysts at each of the agencies. Towards the end, the model interface was structured as a "flowchart" where the users can easily identify the location and contents of input files as well as review and summarize output data. The model development effort also included the development of specific "support" applications that created specific input data for the model as well as summarized output data and specific files for post-processors such as PPSUITE and SUMMIT.

1.2 MODEL IMPLEMENTATION

Because of the funding constraints and other software development issues, the implementation of the new model was implemented in several phases that were initiated in 2004. The first phase of the model development was focused on resolving any technical issues related to conversion of the models from TRANPLAN to CUBE Voyager. This element of the project was conducted during 2004 and 2005. The second phase of the model development was initiated in 2005 and included an independent peer review of the proposed work program developed for the new model. The results from the peer review process were reviewed by the stakeholder agencies and specific recommendations were incorporated into the final model. The peer review effort was summarized in a report entitled "Summary Report of the Peer Review Panel for the North Jersey Transportation Planning Authority Travel Model Improvement Effort" that was completed in January of 2006.

The final phase of the model development was completed in the Winter of 2008. Following the completion of the model, a Users Guide was prepared and training for agency staff and subregion planning staff was provided in the Spring of 2008. The training included several introductory sessions for senior agency staff and consultants and was followed by a three-day training course for agency staff and interested subregion staff.

Subsequent to initial development the model has been updated and refined:

2010-11 Revalidation: The NJRTM-E was revalidated in 2011 with a 2008 base year. Some improvements to output reporting were also added during this project

2014-2015 Refinement: The NJRTM-E was refined in 2015 with three major changes.

- The transit path building routine was converted from using CUBE's legacy TRNBUILD program to CUBE's updated PT program.
- Transit boarding and volume output were improved to take advantage of PT and provide the user with GIS based output.
- Improvements were made to the external-to-external and external-to internal trip generation and distribution by adding an application to provide the ability to increase trips coming into the modeling region using three major external locations: the NJ Turnpike, I-80, and I-78.

The updated model also supports the Cube Cluster feature. Cube cluster allows certain model components to be processed using multiple processors concurrently, hence, reducing the model's runtime. It should be noted that the results may vary slightly depending on the number of processors used during the execution of the NJRTM-E.

2. ZONAL SYSTEM AND SOCIOECONOMIC DATA

2.1 INTRODUCTION

One of the critical limitations of the previous regional model was the area encompassed in the model and its location with respect to the major regional trip generators. Most regional models are centered about the dense urban core that is the major trip attractor in the region. In contrast, the previous regional model' eastern boundary terminated at the Hudson River just to the west of New York City. Similarly, other nearby generators adjacent to the region (Atlantic City, Trenton, and Easton, PA) were not included in the previous model. This limitation caused significant problems with forecasting trips that interacted with these adjacent generators, particularly those trips destined to the heavily congested New York City area that is a critical market for transit trips.

As part of the new NJRTM-E, the modeled area includes the 13 NJTPA counties as well as the several layers of counties surrounding the NJTPA region that will serve as a buffer area for estimating travel into and out of the detailed core area. These adjacent counties include areas from southern New Jersey, eastern Pennsylvania, southern New York and Connecticut.

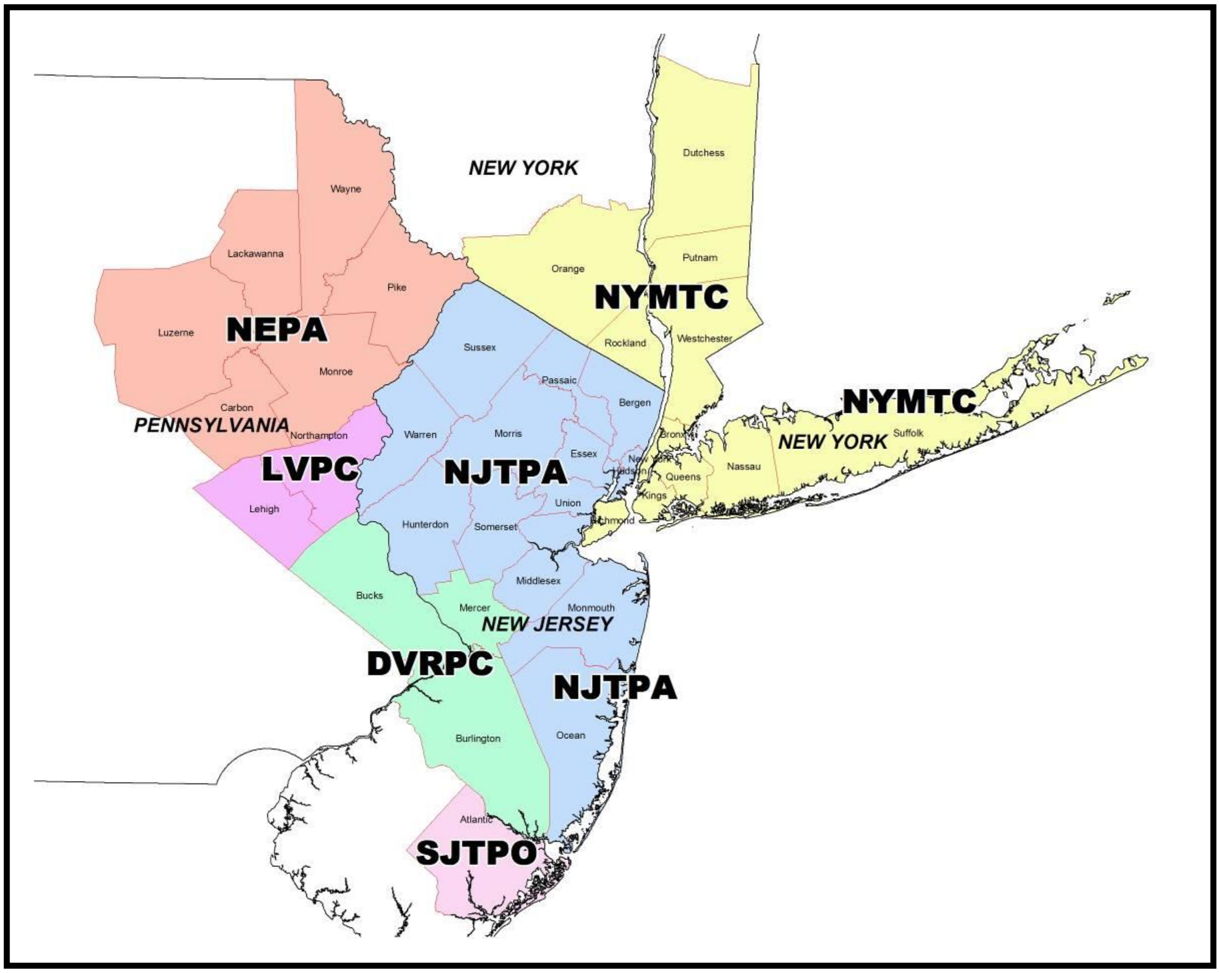
The objectives of including these surrounding counties are twofold. First, it is anticipated that this model will be used to forecast transit facilities that extend beyond the 13-county, such as the Lackawanna Cutoff rail line or reactivation of the West Trenton rail line. Extending the NJRTM-E modeled area will permit the model to estimate several key markets for transit usage outside the North Jersey Region such as Trenton and New York City. Second, since the existing 13 county region is rapidly developing, many of the NJTPA counties at the edge of the region have significant interaction with developing areas in Pennsylvania and southern New Jersey. The expanded study area enabled the modeling process to be sensitive to both development and network improvements outside of the NJTPA region. As an example, the planned interchange with I-95 and the Pennsylvania Turnpike in Bucks County Pennsylvania will potentially alter the orientation of trips destined to areas of central New Jersey.

The model extends the coverage area from the 13 NJTPA counties to a total of 40 counties, encompassing areas from six Metropolitan Planning Organizations (MPO's) or planning areas in New Jersey, New York and Pennsylvania and Connecticut. Those regional planning organizations are:

- North Jersey Transportation Planning Agency (NJTPA)
- South Jersey Transportation Planning Organization (SJTPO)
- New York Metropolitan Transportation Council (NYMTC)
- Delaware Valley Regional Planning Commission (DVRPC)
- Northeastern Pennsylvania Alliance (NEPA)
- Lehigh Valley Planning Commission (LVPC)

The geographical coverage of the model is depicted in Figure 1. It should be noted that the resulting boundary for the enlarged model area is extensive and there are numerous roadways entering the region. Using traditional modeling techniques, each of these roadways would be represented as an external zone. However, it was recognized early on that obtaining traffic counts and future year estimates for each of these roadways would be a difficult and time-consuming process. Therefore, a decision was made to ignore the trips entering at the far edge of regional model since few, if any of these trips would enter into the NJTPA 13-county region. Specific exceptions to this process were made for long-haul truck trips assumed to access the region at specific interstate roadways along the extended boundary. Other issues associated with this particular modeling technique are discussed in subsequent sections of this document.

Figure 1 – NJRTM-E Modeled Area & Regional Planning Agencies



2.2 MODEL ZONAL SYSTEM

The NJRTM-E zonal system was developed to support the forecasting of regional traffic flows. The zonal system was provided in several different geographic sizes, most of which are 2010-census based. The smallest division is a census block group. The second unit is a group of block groups and above that is a census tract. The next unit is minor civil division (which is usually a municipality) and then followed by districts which are arbitrary geographic boundaries. The largest geographic entity in this model is at the county level. The NJRTM-E consists of 2900 zones, including 188 reserved zones, as shown in Table 1.

It is anticipated that the socioeconomic data will need to be updated as new regional estimates are developed. It was anticipated that updates to the zonal data for regions outside of NJTPA would be provided on a periodic basis by the adjacent MPOs. In order to facilitate this process and ease the transferability of socioeconomic data from other MPO's to the NJRTM-E zonal system, the NJRTM-E generally honored the zonal system of other MPO's models, especially the large MPO's such as NYMTC and DVRPC. In some situations, an aggregation process was required to combine several zones from other models into a larger zone in the NJRTM-E system. APPENDIX A – ZONAL EQUIVALENCY lists the zonal equivalency between NJRTM-E and NYMTC models, as well as NJRTM-E and DVRPC models.

Table 1 – NJRTM-E Zonal System

REGION	COUNTY	ZONE TYPE	NJRTM-E - 2010 CENSUS		RESERVED ZONE		NOTES
			Zone Numbers	No. of Zones	Zone Numbers	No. of Zones	
New Jersey	Atlantic	MCD	1 - 25	25		0	
	Bergen	Census Tract+ Block Group	26 - 213	188	214 - 225	12	Zone 214 - prepared for special generator for HMDC1 Zone 215 - prepared for special generator for HMDC2
	Burlington		226 - 366	141	367 369	3	
	Essex	Census Tract+ Block Group	370 - 598	229	599 - 610	12	Zone 599 - special generator for airport Zone 600 - special generator for Port Newark
	Hudson	Census Tract+ Block Group	611 - 796	186	797 - 831	35	
	Hunterdon	Census Tract+ Block Group	832 - 863	32	864 - 873	10	
	Mercer	Census Tract+ Block Group	874 - 997	124	998 - 1007	10	
	Middlesex	Census Tract+ Block Group	1008 - 1216	209	1217 - 1226	10	
	Monmouth	Census Tract+ Block Group	1227 - 1379	153	1380 - 1389	10	
	Morris	Census Tract	1390 - 1490	101	1491 - 1500	10	
	Ocean	Census Tract+ Block Group	1501 - 1636	136	1637 - 1646	10	
	Passaic	Census Tract	1647 - 1747	101	1748 - 1757	10	
	Somerset	Census Tract+ Block Group	1758 - 1838	81	1839 - 1847	9	
	Sussex	Census Tract+ Block Group	1848 - 1891	44	1892 - 1901	10	
	Union	Census Tract+ Block Group	1902 - 2016	115	2017 - 2034	18	Zone 2017 - special generator for Port Elizabeth
	Warren	Census Tract+ Block Group	2035 - 2061	27	2062 - 2071	10	
New York	Bronx	District	2072 - 2077	6	-	0	
	Dutches	District	2078 - 2079	2	-	0	
	Kings	District	2080 - 2097	18	-	0	
	Nassau	District	2098 - 2099	2	-	0	
	Manhattan	Census Tract	2100 - 2389	290	-	0	
	Orange	District	2390 - 2417	28	-	0	Zone 2489 - reserved for Stewart Airport
	Putnam	District	2418 - 2418	1	-	0	
	Queens	District	2419 - 2429	11	-	0	
	Richmond	District	2430 - 2480	51	2481 - 2489	9	
	Rockland	Census Tract	2490 - 2554	65	-	0	
	Suffolk	District	2555 - 2555	1	-	0	
	Sullivan	District	2556 - 2556	1	-	0	
	Westchester	District	2557 - 2583	27	-	0	
Pennsylvania	Bucks	Multiple Block Groups	2584 - 2654	71	-	0	
	Carbon	County	2655 - 2655	1	-	0	
	Lackawanna	MCD	2656 - 2696	41	-	0	
	Lehigh	MCD	2697 - 2723	27	-	0	
	Luzerne	MCD	2724 - 2799	76	-	0	
	Monroe	MCD	2800 - 2819	20	-	0	
	Northampton	MCD	2820 - 2857	38	-	0	
	Pike	MCD	2858 - 2870	13	-	0	
	Wayne	MCD	2871 - 2898	28	-	0	
Connecticut	Bridgeport		2899 - 2899	1	-	0	
	Fairfield Co. Other		2900 - 2900	1	-	0	
Total				2712		188	

2.3 AREA TYPE

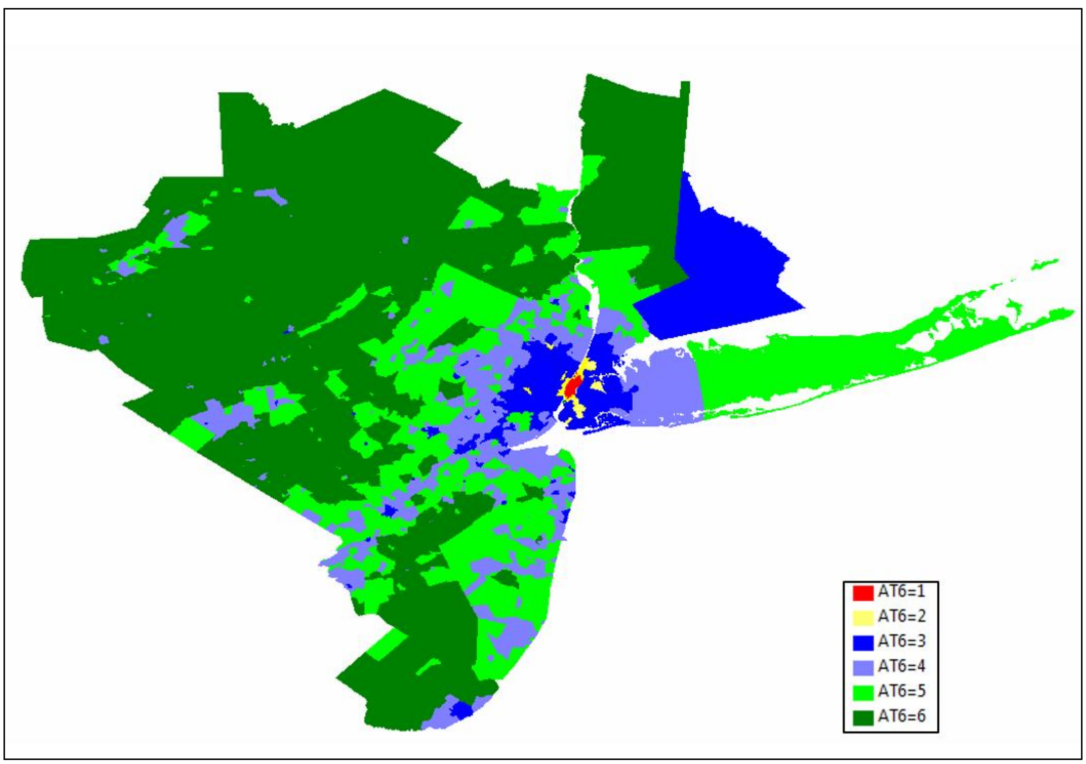
As part of the model development, each of the zones was categorized into a series of area types based on density of existing development and other characteristics. The categorization was accomplished by assigning each of the zones with one of six available area types. The definitions of the six area types are listed in Table 2. This series of area types was used to estimate non-motorized trips as part of the trip generation procedure. The model also maintained a four-category definition of area type: CBD, Urban, Suburban and Rural. This condensed area type system was used to control the estimation of network capacities and speeds developed during Phase 1 of the project. In this definition, the “Manhattan CBD” and “CBD/Urban High Density” in Table 2 were combined into CBD category. And “Suburban High” and “Suburban” were combined into Suburban category.

Table 2 – Six-Category "Trip Generation" Area Type System

AREA TYPE CATEGORY	AREA TYPE DESCRIPTION	CHARACTERISTICS
1	Manhattan CBD	Designated for typical Manhattan area
2	CBD/Urban High Density	Very high employment density or very high population density
3	Urban	High residential densities, small lots for single family dwelling units, many apartments, mostly through streets. Employment interspersed throughout the residential areas.
4	Suburban High	Medium to high residential densities, mixed developments.
5	Suburban	Low to medium residential densities, medium to large lots for single family dwelling units, homogenous land uses, restricted traffic flows (some cul-de-sacs) on residential areas.
6	Rural	Very low residential densities and much undeveloped or agricultural land, relatively few roads

The initial determination of area type was performed in an automated fashion using relationships developed from population and employment densities using a floating zone technique that evaluated the density characteristics of a given zone as function of all zones within a certain radius of the current zone. The area type designations assigned to each zone were then reviewed and adjusted by NJTPA staff as necessary. The adjustments were made by NJTPA based on knowledge of local conditions. Figure 2 shows the area type designation for the NJRTM-E Region.

Figure 2 – Area Type Designation for the NJRTM-E Region



As part of this analysis, layers of reserved land uses were obtained, such as parks, water bodies and wetlands, as well as military bases along with an inventory of developable land from NJTPA for use in the density calculations. Refinements to the calculated area types were discussed with NJTPA staff and implemented as necessary to provide reasonable designation in situations where area types varied significantly between adjacent zones.

2.4 SOCIOECONOMIC DATA

The socioeconomic data was gathered, developed, and processed from the latest MPO-approved socioeconomic data, as well as census data and other sources. The methodology used to develop the socioeconomic inputs is discussed in the following sections for each MPO. These sections will also describe the data inputs, sources by region and methods used to develop the NJRTM-E Traffic Analysis Zone (TAZ) level socioeconomic data forecasts at five-year intervals from 2015 to the year 2045.

Table 3 lists various geographic units used for traffic analysis zones in the NJRTM-E. For purposes of simplifying aggregation and ease of transferring data, the zones were established with geographic definitions consistent with census topography. While the general definition of zones within the 13-county NJTPA region was consistent with census tracts, there were situations where zones were disaggregated into block groups and sets of block groups. The definitions used by county were listed previously in Table 1.

Table 3 – Zone Geographic Scale Codes

NJRTME ZONE GEOGRAPHY	
CODE	**TYPE**
BG	Block Group
BGS	Multiple Block Group
TR	Tract
MCD	Minor Civil Division
DST	District
CO	County

The socioeconomic data are supplied in several categories by TAZ. A brief description of the categories is presented in Table 4. Population and Households are fairly common data inputs. Employment was supplied in 10 sectors corresponding to the North American Industry Classification System (NAICS). Employment was also supplied in an aggregated format of three categories: Basic, Service and Retail. Basic employment is the aggregation of the first five categories (agriculture/ mining (AGMINE), construction (CONST), manufacturing (MFG) transportation (TRANS), and wholesale (WHLSE). Retail covers Retail Trade (RET). The service category includes FIRE through Military (Finance/Insurance/Real Estate (FIRE), Service (SER), government (GOV), and Information (INFO).

Table 4 – Socioeconomic Variables

SOCIOECONOMIC VARIABLES		
CODE	DATA DESCRIPTION	EMPLOYMENT NAICS CODES
POP	Number of persons living within TAZ	
HH	Number of households contained in TAZ	
AGMINE	Agriculture, Forestry, Fishing Employment, and Mining	11,21
CONST	Construction Employment	22-23
MFG	Manufacturing Employment	31-33
TRANS	Transportation, Communications, Electric, Gas, And Sanitary Services Employment	48-49
WHLSE	Wholesale Trade Employment	42
RET	Retail Trade Employment	44-45
FIRE	Finance, Insurance and Real Estate Employment	52-53
SER	Services Employment	54-56,61-62,71-72,81
GOV	Government - Public Administration Employment	92
INFO	Information and cultural industries	51
BASIC	AGMINE + CONST + MFG + TRANS + WHLSE Employment	11,21-23,31-33,42,48-49
RETAIL	RET Employment	44-45
SERVICE	FIRE + SER + GOV + INFO Employement	51-56,61-62,71-72,81,92
TOTAL	Total Employment = BASIC + RETAIL + SERVICE	
INCOME	Average Household Income within TAZ	

Beyond the socioeconomic variables listed in Table 4, the model contains several other files with data linked to the TAZs. As an example, zonal data related to the percentage of households by lifecycle, and parking costs are also utilized by the model. These variables are described in subsequent sections of this report.

2.5 SOCIOECONOMIC DATA BY SUBREGION

Since each of the various MPOs and planning agencies maintain individual socioeconomic data files it was necessary to convert the base year and horizon years to a common format with common horizon years. The adopted assumptions and employed procedures employed for each individual region are provided in the following subsections.

2.5.1 North Jersey Transportation Planning Authority (NJTPA)

Figure 3 depicts the NJTPA portion of the NJRTM-E region. This region covers the 13 northern counties in New Jersey. Socioeconomic data was provided by NJTPA for the 13-county region in 5-year intervals from 2015 to 2045. Data by TAZ includes total population and employment; employment by aggregate category of Basic, Retail and Service; and average household income.

Data for population, households and average household income were incorporated directly into the zonal files for each horizon year. Employment was also provided by NJTPA in three and ten categories. Table 5 displays the socioeconomic data summary provided for this region.

Figure 3 – NJTPA Region

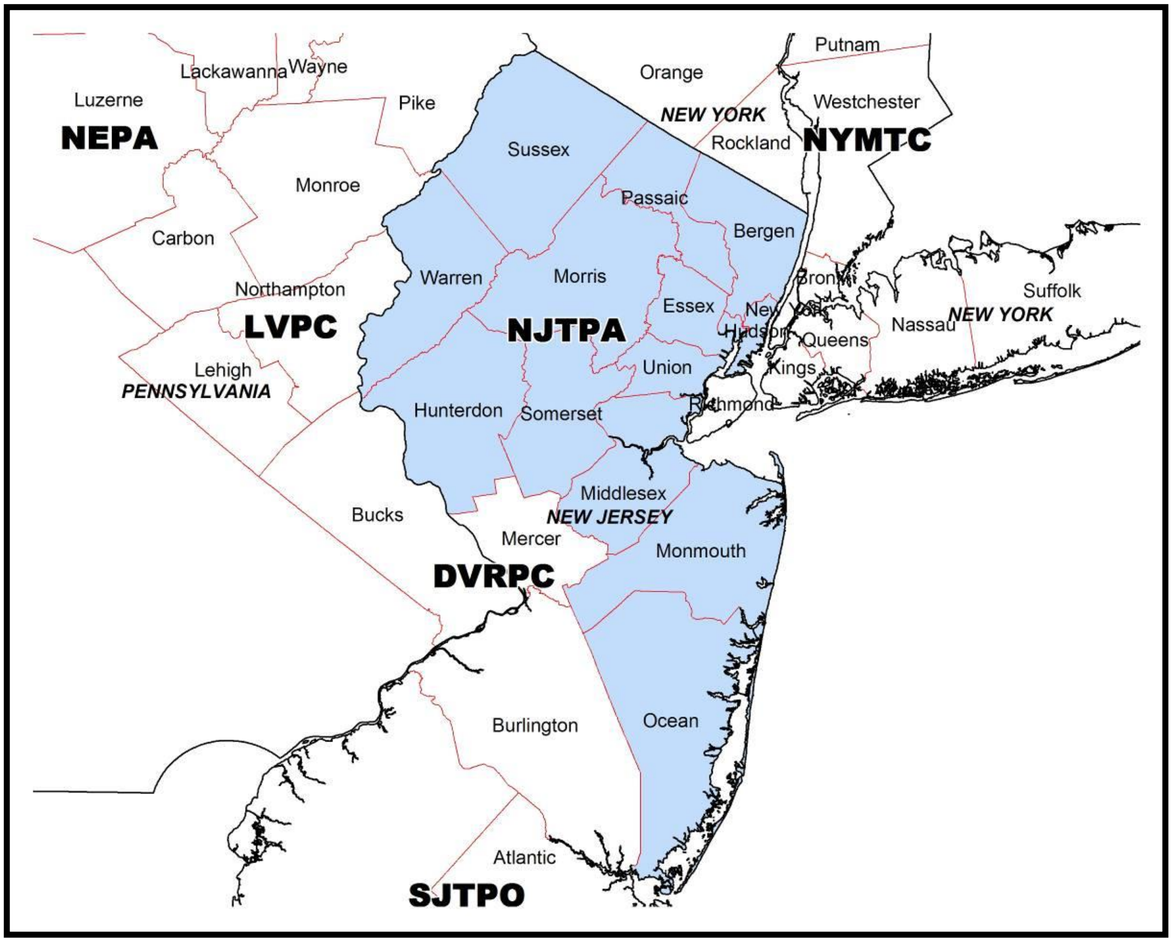


Table 5 – Socioeconomic Data Summary for the NJTPA Region

Counties Covered
Bergen, Essex, Hudson, Hunterdon, Middlesex, Monmouth, Morris, Ocean, Passaic,
Somerset, Sussex, Union, Warren
Data Source
NJTPA socioeconomic data received in 2016
Geography
NJRTME TAZs 26 to 225, 370 to 873, 1008-2071
Categories
Total Population, Total Employment, Basic, Service, and Retail Employment,
Households, Average Household Income
Years Provided
2015, 2020, 2025, 2030, 2035, 2040, 2045

2.5.2 South Jersey Transportation Planning Organization (SJTPO)

The NJRTM-E only includes one county from the SJTPO Region, which is Atlantic County (shown in Figure 4). The socioeconomic data for this region was provided by SJTPO in 2016. The data was provided in SJTPO traffic analysis zones which are based primarily on census tracts and census block groups outside of Atlantic City. In Atlantic City, the TAZ's are not based on census geography but rather a system that accommodates a model specific to Atlantic City.

Population and household estimates were obtained directly from the SJTPO data sets. The employment data was not maintained in NAICS classification format. Percentages allocations by generic classifications (Basic, Service, Retail) were calculated and then subsequent allocations to the detailed classifications were derived using base year data set developed from 2014 LEHD data. Data was provided by SJTPO for 2015 and 2040. The socioeconomic data for 2020, 2025, 2030, 2035 were estimated using linear interpolation between 2015 and 2040. The socioeconomic data for 2045 were extrapolated from 2015 and 2040 data. Table 6 shows the socioeconomic data summary for this region.

Figure 4 – SJTPO Region

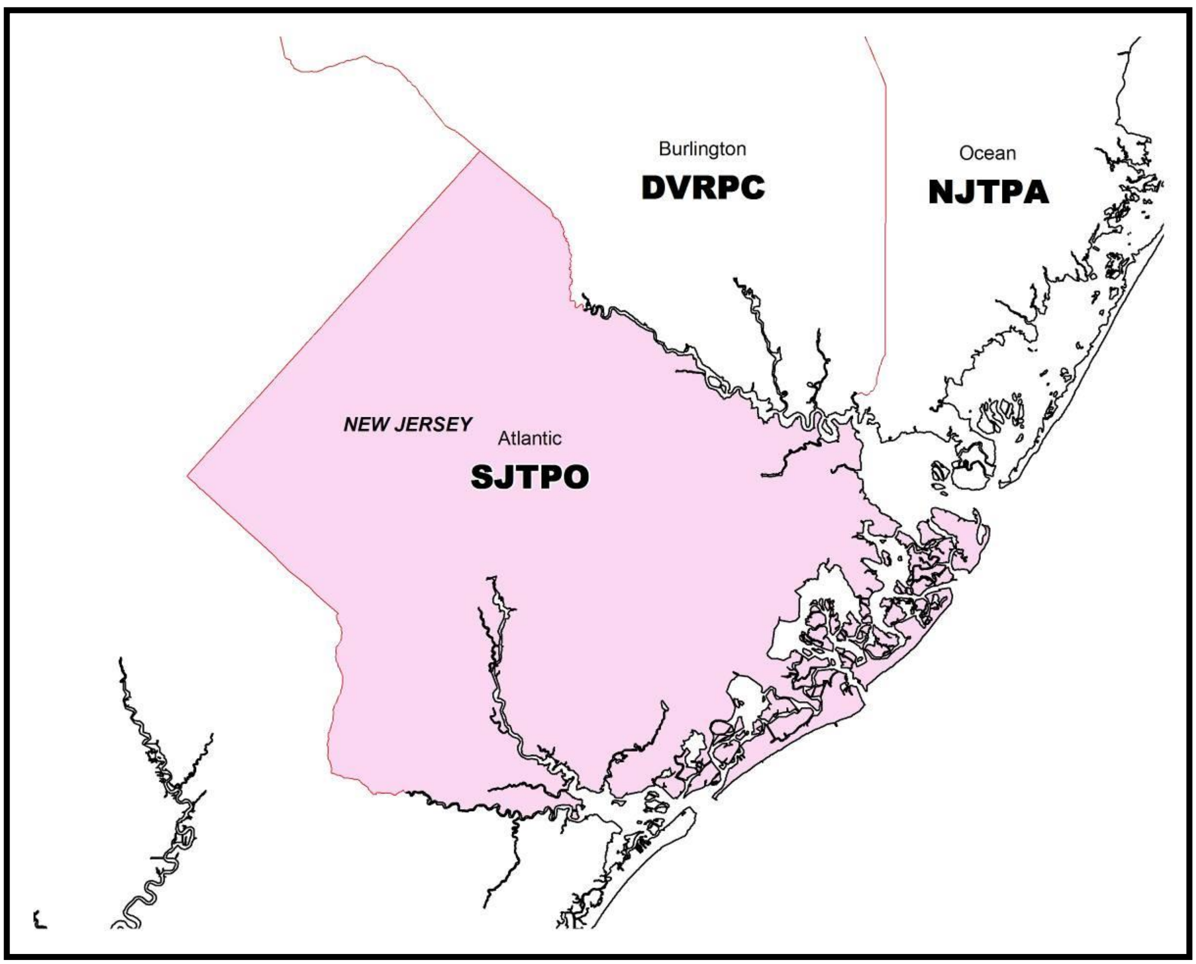


Table 6 – Socioeconomic Data Summary for the SJTPO Region

Counties Covered
Atlantic
Data Source
SJTPO socioeconomic data received in 2016
Geography
SJTPO TAZ Level
Categories
The SJTPO socioeconomic data set contains the following categories: Household Population, Group Quarters Population, Total Population, Households, Total Employment, Industrial, Retail, Office, Other and Seasonal Employment and Average Household Income.
Years Provided
2015, 2040

2.5.3 Delaware Valley Regional Planning Commissions (DVRPC)

The NJRTM-E included three DVRPC counties, Burlington NJ, Mercer NJ, and Bucks PA, as shown in Figure 5. The socioeconomic data of this region was obtained from DVRPC in 2016. The data is available in 5-year intervals from 2015 to 2045. Table 7 shows the socioeconomic data summary for the DVRPC Region.

Figure 5 – DVRPC Region

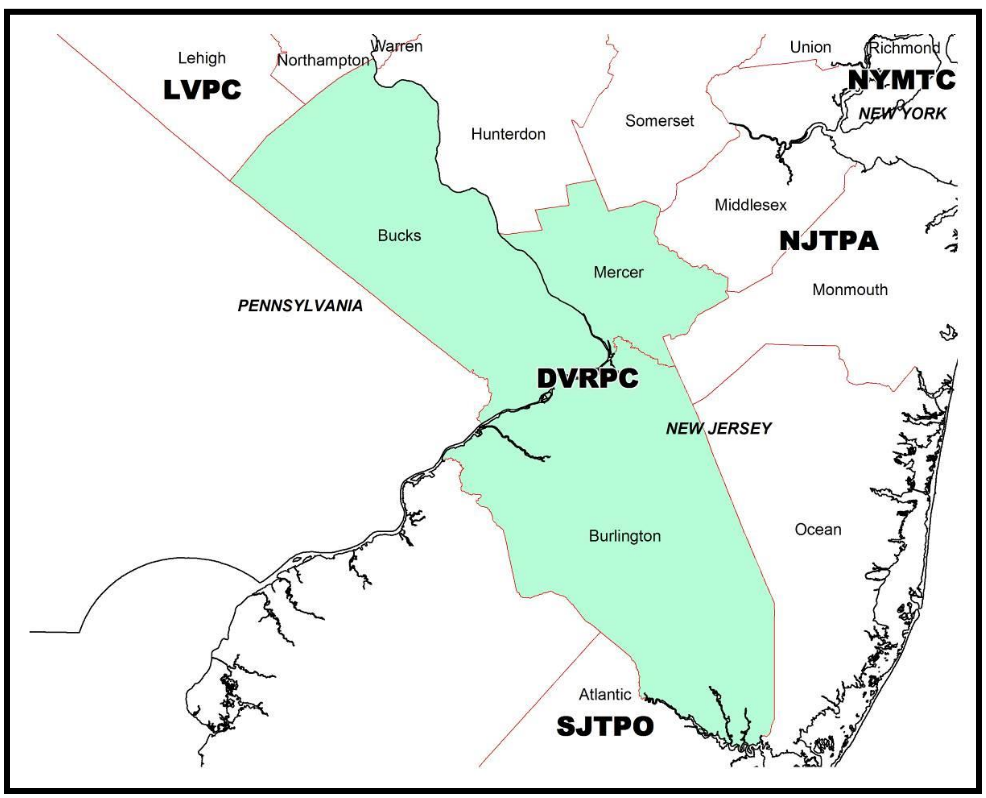


Table 7 – Socioeconomic Data Summary for the DVRPC Region

Counties Covered
Burlington, Mercer, Bucks
Data Source
DVRPC socioeconomic data received in 2016
Geography
DVRPC TAZ Level
Years Provided
2015, 2020, 2025, 2030, 2035, 2040, 2045

2.5.4 New York Metropolitan Transportation Council (NYMTC)

The NYMTC Region included in the NJRTM-E is shown in Figure 6. NYMTC provided all necessary data at the NYMTC TAZ level in 2016. The data was then transferred to the NJRTM-E zones using an equivalency table developed by Stantec. **Table 8** shows the socioeconomic information for the NYMTC Region.

Figure 6 – NYMTC Region

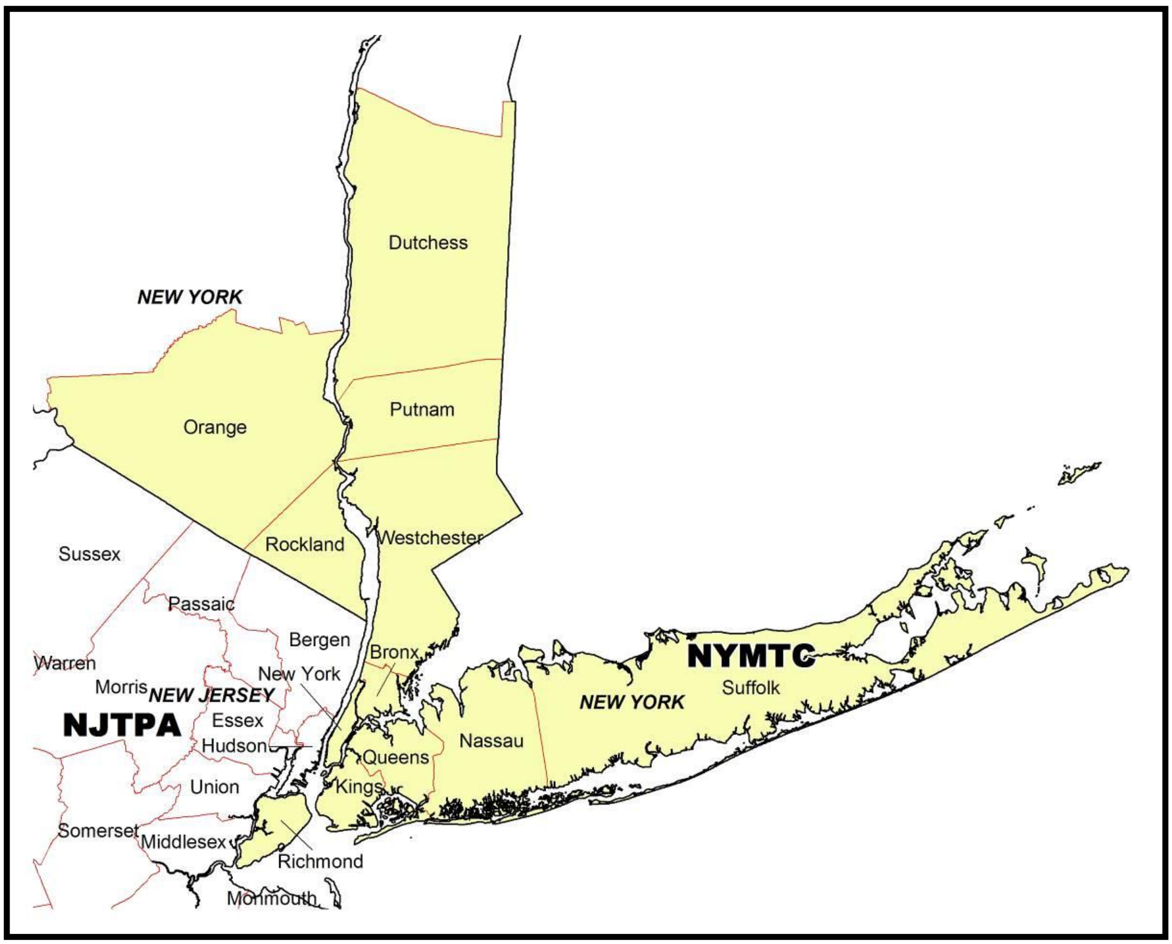


Table 8 – Socioeconomic Data Summary for the NYMTC Region

Counties Covered
Bronx, Dutchess, Kings, Nassau, New York, Orange, Putnam, Queens, Richmond, Rockland, Suffolk, Westchester
Data Source
NYMTC socioeconomic data received in 2016
Geography
NYMTC TAZ Level
Years Provided
2015, 2020, 2025, 2030, 2035, 2040, 2045

2.5.5 Lehigh Valley Planning Commission (LVPC)

Lehigh and Northampton Counties belong to the Lehigh Valley Planning Commission MPO, as shown in **Figure 7**. The LVPC socioeconomic data was obtained from Lehigh Valley Planning Commission in 2016. Data was provided by LVPC for 2010 and 2040. Socioeconomic data for intermediate years, such as 2015, 2025, and 2035 were interpolated, from 2010 and 2040, while the socioeconomic data for 2045 was extrapolated from 2010 and 2040 data. The socioeconomic summary of LVPC is shown in **Table 9**.

Figure 7 – LVPC Region

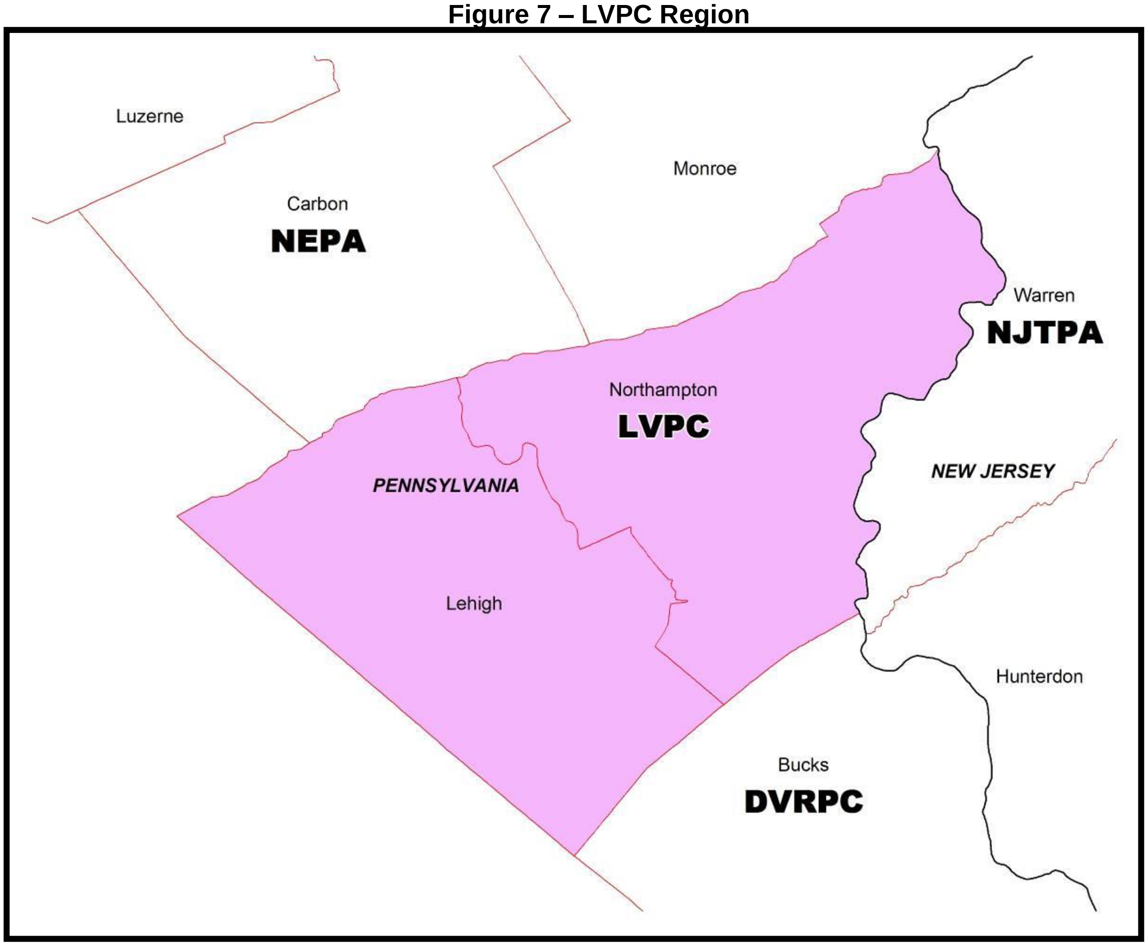


Table 9 – Socioeconomic Data Summary for the LVPC Region

Counties Covered
Lehigh, Northampton
Data Source
LVPC socioeconomic data received in 2016
Years Provided
2010, 2040

2.5.6 Northeastern Pennsylvania Alliance (NEPA)

The NEPA counties included in the NJRTM-E are Lackawanna, Luzerne, Monroe, Wayne, Pike, and Carbon Counties as shown in **Figure 8**. NEPA did not provide the SED Update during the 2018 revalidation process. Therefore, population, households, and income data were obtained from the NJTPA's FY 2015 Conformity SED Data, the latest SED available at the time of the analysis. The SED was provided from 2015 to 2045 with five-year increment. **Table 10** shows the socioeconomic summary for this region.

Figure 8 – NEPA Counties

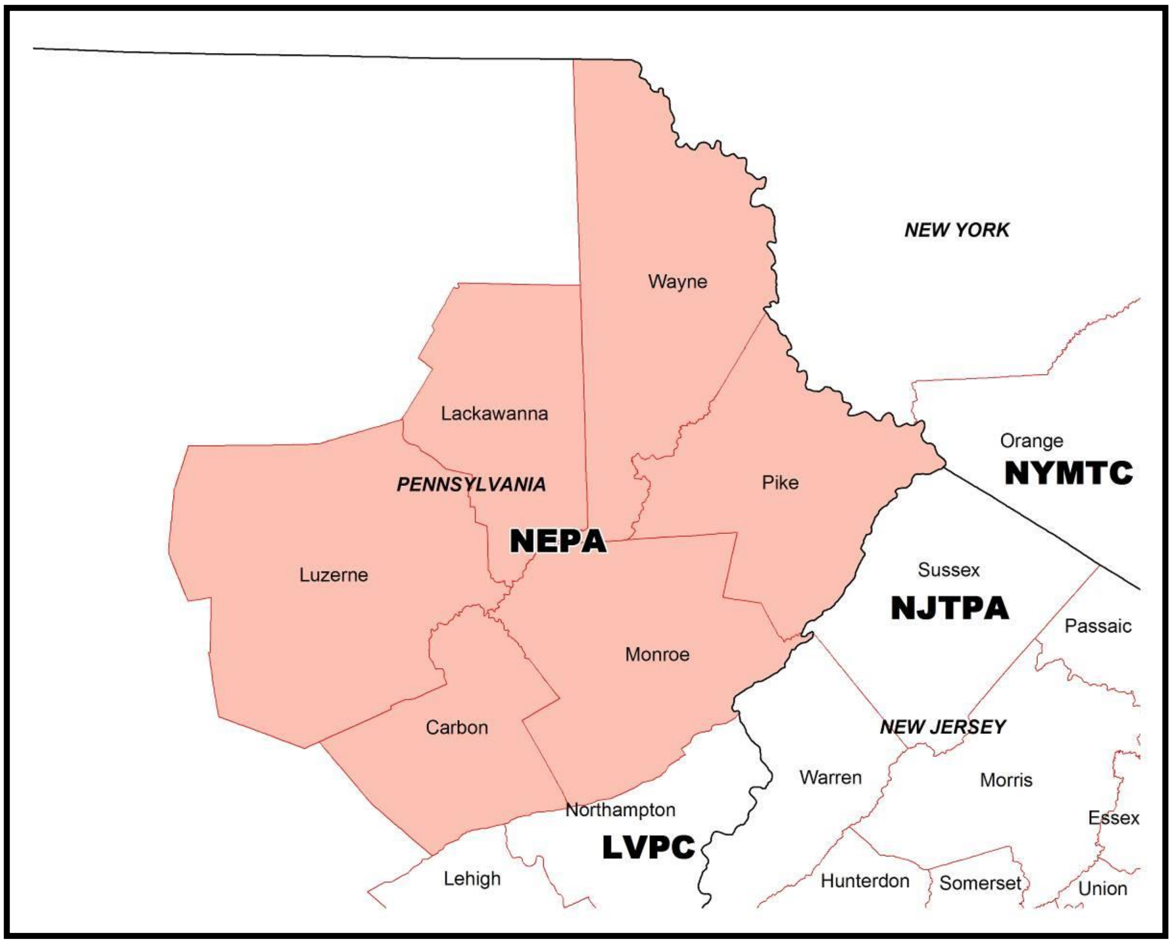


Table 10 – Socioeconomic Data Summary for the NEPA Region

Counties Covered
Carbon, Lackawanna, Luzerne, Monroe, Pike, Wayne
Data Source
NJTPA - FY2015 Conformity SED
Geography
MCD for Lackawana, Luzerne, Monroe, Pike, and Wayne; County for Carbon
Years Provided
2015, 2020, 2025, 2030, 2040, 2045

Lastly, data projections were prepared for the remaining two counties (Sullivan County, New York and Fairfield County, Connecticut) represented in the model that were not part of the individual MPOs or planning authorities. For these two counties, census data was used to provide initial estimates of population and households as well as various classifications of employment. Future year projections were established via adopted growth rates from the adjacent NYMTC counties.

2.6 SOCIOECONOMIC DATA FORECAST SUMMARY

Data used in these forecasts are provided at various geographic levels, from various sources and in various categories. Socioeconomic data was either provided, aggregated or interpolated to generate regional MPO totals. As part of our Quality Assurance (QA) process, after the socioeconomic data were distributed to the NJRTM-E TAZs, the estimates were summed by county for population and employment categories separately. A comparison was done by county to ensure that population and employment totals were maintained throughout the distribution process for all forecast years.

2.6.1 NJRTM-E Socioeconomic Data Version 1 Control Total

The regional socioeconomic data used for the 2018 revalidation is referenced as the NJRTM-E SE Data Version 4. Table 11 (a) to (c) show the control total for population, households, and total employment by county and region, and by year.

Table 11 – NJRTM-E SE Data Version 1 Control Total

(a) Population

REGION	POPULATION						
	2015	2020	2025	2030	2035	2040	2045
Bergen	928,736	936,513	951,196	970,411	994,340	1,011,159	1,030,502
Essex	790,286	801,211	818,044	838,992	861,438	885,615	909,020
Hudson	664,766	678,229	696,939	725,532	755,258	784,871	815,684
Hunterdon	127,964	128,043	128,443	129,636	132,065	133,892	135,431
Middlesex	829,266	845,251	862,805	886,904	914,559	942,881	965,760
Monmouth	631,442	635,267	639,231	645,133	655,030	662,606	671,946
Morris	500,519	510,334	515,015	520,708	524,756	527,355	530,198
Ocean	585,735	603,675	629,601	656,592	699,435	727,411	755,963
Passaic	505,892	515,359	528,416	545,994	561,209	584,980	607,568
Somerset	331,195	334,507	339,637	344,461	352,125	359,896	367,010
Sussex	149,798	151,005	151,373	152,028	154,194	156,225	157,703
Union	549,162	557,963	572,196	590,331	611,245	633,168	653,837
Warren	109,881	110,760	112,152	113,764	115,164	117,200	118,165
NJTPA	**6,704,640**	**6,808,117**	**6,945,048**	**7,120,487**	**7,330,817**	**7,527,259**	**7,718,785**
Burlington	450,912	459,344	468,428	475,978	482,560	488,026	492,709
Mercer	367,662	377,328	383,227	389,219	394,407	398,669	402,283
Bucks	634,887	640,495	654,792	669,299	681,273	691,111	699,498
DVRPC	**1,453,461**	**1,477,167**	**1,506,447**	**1,534,496**	**1,558,240**	**1,577,806**	**1,594,490**
Atlantic	269,939	278,380	286,821	295,262	303,703	312,144	320,585
SJTPO	**269,939**	**278,380**	**286,821**	**295,262**	**303,703**	**312,144**	**320,585**
Bronx	1,369,017	1,400,078	1,438,559	1,472,285	1,503,791	1,532,536	1,552,880
Dutchess	281,430	284,854	291,719	300,681	308,693	314,973	320,790
Kings	2,567,223	2,612,845	2,670,642	2,718,394	2,763,755	2,804,914	2,834,712
New York	1,543,334	1,570,909	1,594,211	1,609,350	1,618,926	1,624,236	1,628,114
Nassau	1,331,352	1,332,778	1,356,323	1,399,300	1,450,217	1,503,550	1,551,627
Orange	373,355	385,510	404,327	428,043	452,618	476,678	500,283
Putnam	97,432	97,785	98,824	100,792	103,171	105,090	106,618
Queens	2,261,478	2,302,289	2,325,428	2,345,546	2,366,354	2,384,645	2,397,622
Richmond	470,523	479,322	485,599	489,909	492,682	493,266	494,682
Rockland	315,895	319,788	328,990	342,086	355,814	370,167	383,610
Suffolk	1,471,420	1,481,632	1,509,850	1,553,567	1,593,292	1,626,165	1,655,242
Westchester	942,765	947,619	967,338	999,467	1,038,243	1,074,537	1,111,160
NYMTC	**13,025,224**	**13,215,409**	**13,471,810**	**13,759,420**	**14,047,556**	**14,310,757**	**14,537,340**
Lehigh	367,603	385,710	406,436	427,162	448,568	469,975	491,382
Northampton	313,625	329,516	347,641	365,766	384,872	403,979	423,085
LVPC	**681,229**	**715,226**	**754,077**	**792,928**	**833,441**	**873,954**	**914,466**
Carbon	62,839	64,024	64,062	64,099	64,137	64,174	64,211
Lackawanna	212,771	210,570	210,447	210,324	210,205	210,086	209,967
Luzerne	301,158	296,183	296,045	295,911	295,786	295,655	295,524
Monroe	201,799	224,341	245,644	266,942	291,435	318,350	345,265
Pike	80,304	92,693	106,075	119,453	135,603	153,938	172,273
Wayne	57,110	60,773	60,697	60,628	60,556	60,485	60,414
NEPA	**915,981**	**948,584**	**982,970**	**1,017,357**	**1,057,722**	**1,102,688**	**1,147,654**
Sullivan	76,892	77,299	78,442	79,469	80,196	80,574	80,676
Connecticut	934,215	972,336	995,273	1,017,047	1,035,250	1,049,161	1,059,596
TOTAL	**24,061,581**	**24,492,518**	**25,020,888**	**25,616,467**	**26,246,925**	**26,834,342**	**27,373,592**

(b) Households

REGION	HOUSEHOLD						
	2015	2020	2025	2030	2035	2040	2045
Bergen	339,860	346,982	356,064	364,940	372,493	375,917	380,925
Essex	289,757	297,143	306,636	317,134	326,688	335,761	344,629
Hudson	259,460	267,536	277,029	289,731	303,485	317,032	331,067
Hunterdon	48,489	49,824	51,016	51,821	52,362	52,722	52,989
Middlesex	284,658	293,238	302,001	312,684	323,181	333,200	340,819
Monmouth	238,584	245,710	251,386	256,009	260,096	262,238	265,293
Morris	186,604	193,466	197,862	201,578	202,821	203,040	204,076
Ocean	225,056	232,550	243,084	254,431	272,266	282,784	293,124
Passaic	170,877	175,941	181,445	187,674	193,112	201,022	209,472
Somerset	118,200	122,203	126,293	129,499	132,228	134,632	136,926
Sussex	56,688	58,583	59,351	59,830	60,722	61,624	62,252
Union	189,424	193,719	199,433	206,126	213,256	220,062	226,636
Warren	42,989	44,423	45,655	46,875	47,641	48,541	49,020
NJTPA	**2,450,644**	**2,521,316**	**2,597,253**	**2,678,334**	**2,760,353**	**2,828,575**	**2,897,227**
Burlington	168,000	166,927	170,336	173,170	175,641	177,693	179,451
Mercer	134,065	129,998	132,021	134,076	135,855	137,316	138,555
Bucks	240,202	239,036	244,339	249,719	254,159	257,807	260,917
DVRPC	**542,267**	**535,961**	**546,696**	**556,965**	**565,655**	**572,816**	**578,923**
Atlantic	102,250	105,447	108,644	111,841	115,038	118,236	121,433
SJTPO	**102,250**	**105,447**	**108,644**	**111,841**	**115,038**	**118,236**	**121,433**
Bronx	494,510	505,729	519,622	531,813	543,188	553,571	560,937
Dutchess	112,123	115,717	119,799	124,013	127,307	129,718	131,897
Kings	953,490	970,413	991,903	1,009,637	1,026,465	1,041,777	1,052,813
New York	776,333	790,222	801,935	809,540	814,361	817,044	818,979
Nassau	450,947	456,379	468,171	482,429	497,021	511,890	526,168
Orange	132,785	139,423	147,608	156,780	165,940	174,450	182,701
Putnam	36,187	37,258	38,231	39,112	39,814	40,290	40,685
Queens	801,323	815,767	823,972	831,108	838,476	844,957	849,561
Richmond	168,976	172,137	174,385	175,937	176,934	177,146	177,650
Rockland	103,962	105,774	108,891	113,273	117,721	121,928	126,020
Suffolk	508,497	523,076	541,575	560,511	575,632	588,165	599,739
Westchester	356,763	362,624	372,890	386,163	399,388	411,415	423,894
NYMTC	**4,895,896**	**4,994,519**	**5,108,982**	**5,220,316**	**5,322,247**	**5,412,351**	**5,491,044**
Lehigh	143,340	152,696	161,139	169,582	177,578	185,574	193,570
Northampton	121,003	128,440	135,626	142,811	149,757	156,703	163,649
LVPC	**264,342**	**281,136**	**296,765**	**312,393**	**327,335**	**342,277**	**357,219**
Carbon	25,140	25,614	25,629	25,644	25,659	25,674	25,689
Lackawanna	85,927	85,080	85,028	84,974	84,915	84,863	84,811
Luzerne	122,422	120,073	120,009	119,944	119,882	119,819	119,756
Monroe	71,603	79,511	86,985	94,455	103,041	112,471	121,901
Pike	30,024	34,656	39,659	44,661	50,699	57,554	64,409
Wayne	21,801	23,142	23,113	23,091	23,064	23,038	23,012
NEPA	**356,917**	**368,076**	**380,423**	**392,769**	**407,260**	**423,419**	**439,578**
Sullivan	28,954	32,083	32,511	32,658	32,573	32,588	32,838
Connecticut	333,502	363,818	369,071	371,112	370,504	370,974	374,110
TOTAL	**8,974,772**	**9,202,355**	**9,440,345**	**9,676,388**	**9,900,965**	**10,101,236**	**10,292,372**

(c) Total Employment

REGION	EMPLOYMENT						
	2015	2020	2025	2030	2035	2040	2045
Bergen	444,410	458,708	469,825	475,874	485,755	495,158	503,449
Essex	372,712	388,706	392,071	396,620	406,606	417,641	428,333
Hudson	292,804	312,545	320,252	327,429	337,248	347,051	356,051
Hunterdon	55,827	57,052	57,304	57,649	59,127	60,638	62,147
Middlesex	397,998	413,015	418,521	425,216	436,775	447,748	456,487
Monmouth	265,560	272,874	273,814	274,944	280,998	287,830	295,002
Morris	303,983	314,233	316,741	318,787	322,848	326,097	328,696
Ocean	169,467	178,359	183,536	188,091	194,604	201,414	208,314
Passaic	189,774	196,664	200,796	204,325	209,106	213,823	218,540
Somerset	192,717	200,047	203,308	206,495	211,498	216,146	219,555
Sussex	43,621	44,750	45,340	45,780	46,502	47,252	48,055
Union	245,932	255,326	257,616	261,032	267,183	273,198	278,871
Warren	36,043	37,163	37,630	38,154	38,678	39,270	39,659
NJTPA	**3,010,848**	**3,129,443**	**3,176,755**	**3,220,398**	**3,296,926**	**3,373,265**	**3,443,161**
Burlington	218,492	246,351	251,368	255,562	258,363	261,195	261,195
Mercer	267,528	290,864	295,408	300,025	304,021	307,302	307,302
Bucks	296,107	329,645	337,203	344,859	351,310	356,671	356,671
DVRPC	**782,127**	**866,860**	**883,979**	**900,446**	**913,694**	**925,168**	**925,168**
Atlantic	164,953	166,107	167,260	168,414	169,567	170,721	171,874
SJTPO	**164,953**	**166,107**	**167,260**	**168,414**	**169,567**	**170,721**	**171,874**
Bronx	386,605	395,988	402,695	408,925	415,450	424,011	431,896
Dutchess	118,868	122,892	126,343	129,477	133,045	137,069	141,309
Kings	865,022	882,855	895,593	906,795	921,291	939,005	956,442
New York	2,385,359	2,434,262	2,463,108	2,493,473	2,529,500	2,576,985	2,628,748
Nassau	578,075	591,116	596,938	604,594	616,325	630,461	645,515
Orange	145,299	150,704	155,842	160,785	166,118	172,119	178,321
Putnam	28,529	28,890	29,090	29,147	29,231	29,393	29,610
Queens	727,389	737,818	741,692	745,772	751,481	760,688	766,020
Richmond	138,588	140,333	142,688	144,283	145,928	148,033	150,055
Rockland	118,415	123,411	127,409	131,386	135,532	139,808	144,295
Suffolk	637,685	658,290	673,361	687,521	703,697	721,640	740,247
Westchester	439,406	450,241	457,380	463,393	471,659	481,197	491,419
NYMTC	**6,569,240**	**6,716,800**	**6,812,139**	**6,905,551**	**7,019,257**	**7,160,409**	**7,303,877**
Lehigh	234,009	249,511	262,324	275,136	288,954	302,771	316,588
Northampton	139,093	148,575	155,148	161,722	169,241	176,761	184,281
LVPC	**373,102**	**398,086**	**417,472**	**436,858**	**458,195**	**479,532**	**500,869**
Carbon	18,063	18,070	18,076	18,082	18,089	18,095	18,101
Lackawanna	97,399	96,971	96,540	96,114	95,688	95,268	94,848
Luzerne	143,073	141,654	140,251	138,855	137,480	136,112	134,744
Monroe	71,616	79,115	87,839	96,561	106,675	117,848	129,021
Pike	12,100	13,797	15,864	17,929	20,439	23,303	26,167
Wayne	18,272	18,495	18,728	18,958	19,193	19,433	19,673
NEPA	**360,523**	**368,102**	**377,298**	**386,499**	**397,564**	**410,059**	**422,554**
Sullivan	24,205	37,317	39,112	40,685	42,003	43,107	44,024
Connecticut	426,273	691,507	730,946	767,194	799,535	828,592	855,133
TOTAL	**11,711,272**	**12,374,222**	**12,604,962**	**12,826,045**	**13,096,741**	**13,390,853**	**13,666,661**

3. HIGHWAY NETWORK DEVELOPMENT

3.1 INTRODUCTION

This section provides a detailed description of the highway network development task for the NJRTM-E project. The highway network process is used to abstract the actual roadway network as a representative network for subsequent processing. The highway network is used as the basis for estimating various impedance variables such as travel times and costs used by the trip distribution and mode choice models. The highway network is also used as input to the highway assignment process.

The highway network is developed as a series of links and nodes, with the links representing roadway segments and the nodes representing their point of intersection. Nodes are also used as shaping points to align highway network links to the corresponding street configuration. The highway network also includes of zone centroids which serve as the terminal points for trips in the modeling process. These zone centroids also represent a proxy location for the socioeconomic data (population and employment) contained within the traffic analysis zones that generate trips in the NJRTM-E. The centroids are attached to the highway network via hypothetical links called centroid connectors.

Each highway link contains various data that define the operational and physical characteristics of the given facility along with fields used to provide identification data, such as roadway names. In general these parameters are categorized into three groups:

- Physical/operational variables
- Identification variables
- Performance variables

The complete list of these variables is given in Appendix F of the NJRTM-E User's Guide.

3.2 PHYSICAL/OPERATIONAL VARIABLES

These variables describe the physical and operational attributes of highway network and define the type of highway links in the network, for example, links for freeways, arterial, etc., which in turn will affect the capacity and speed of the links. The techniques used to estimate speed and capacity are based on the 2000 HCM procedures and were implemented in order to provide sensitivity to a wider range of potential improvement types, such as signalization and intersection improvements, with the objective of providing more realistic estimates of capacity suitable for operational analysis. Several key variables will be discussed in the following sections include:

- Facility Type
- Area Type
- Link Type
- Number of Lanes by time period
- Traffic Control Devices (TCD) variables
- Toll variables

During the course of setting capacity and speeds for the links, the model will review the coded values and will generate a series of information statements, warnings, and fatal messages, based on the logic of these variables. Note also that there are other variables that influence the calculation of speed and capacity, such as shoulder conditions and parking conditions, but these variables have limited coding options which require less description.

3.2.1 Facility Type

The NJRTM-E recognizes twelve different facility types that are stored in the "FT" variable. The twelve facility categories are as follows:

1. Freeways (Facility Type 1) – limited access roadway facilities, including toll facilities, with no at-grade intersections, and no traffic signals on the main lanes.

2. Expressways (Facility Type 2) – partially limited access roadway facilities with generally high speed limits, grade separated interchanges with other major facilities, and at-grade intersections with minor facilities.

3. Principal Arterial Divided (Facility Type 3) – arterials with moderately high speed limits (e.g., 35-50 mph), raised center medians with turning bays at intersections, parking restrictions, mainly serving through traffic rather than local property access.

4. Principal Arterial Undivided (Facility Type 4) – same as principal arterial divided except that there are no raised center medians and, generally, no bays for left turns.

5. Major Arterials Divided (Facility Type 5) – arterials with moderate speed limits (e.g., 30-45 mph), raised center medians with turning bays at intersections, some parking restrictions, mainly serving through traffic although some local property access is permitted.

6. Major Arterials Undivided (Facility Type 6) – same as major arterials divided except that there are no raised center medians and, generally, no bays for left turns.

7. Minor Arterials (Facility Type 7) – arterials with moderately low speed limits (e.g., 25-35 mph) and few parking restrictions that serve some through traffic, some distribution of traffic from principal and major facilities to local streets and local property access.

8. Collectors/Locals (Facility Type 8) – roadways with moderately low speed limits (e.g., 25-35 mph) and few parking restrictions that serve mainly to collect and distribute traffic from principal, major, and minor facilities to local streets and local property access.

9. High-Speed Ramps (Facility Type 9) – ramps that generally connect freeway to freeway facilities, or also known as direct connectors, have some relatively high speed limits, e.g., 50-60 mph.

10. Medium-Speed Ramps (Facility Type 10) – ramps that have moderately high turning radius and typically with speed limit approximately 40 mph.

11. Low-Speed Ramps (Facility Type 11) – ramps with low turning radius and low speed limit, e.g., 25 mph, includes jughandles.

12. Centroid Connectors (Facility Type 12) – "dummy" roadway links with unlimited capacity that serve solely to connect transportation analysis zones to the roadway network.

3.2.2 Area Type

Six separate area types were identified for the NJRTM-E region for the purposes of estimating non-motorized travel during Phase2 of the project. These six area types were compressed into 4 categories that were created during Phase 1 for the purposes of estimating highway capacity and speeds. These area types are stored in the "AT" variable, are listed below:

1. CBD (Area Type 1) – this area type is designated particularly to Manhattan Region, where population and employment densities are typically very high, such as downtown Newark and Jersey City.

2. Urban (Area Type 2) – characterized by high residential densities, small lots for single family dwelling units, many apartments, mostly through streets, Employment interspersed throughout the residential areas.

3. Suburban (Area Type 3) – characterized by low to medium residential densities, medium to large lots for single family dwelling units, homogenous land uses, restricted traffic flow restrictions such as cul-de-sacs, dead ends, traffic circles, and frequent stop signs.

4. Rural (Area Type 4) – characterized by very low residential densities and much undeveloped or agricultural land, relatively few roads.

3.2.3 Link Type

This variable is created to serve as a permission code to utilize the highway link based on vehicle type mode and toll facility type. This variable is used in highway path building and highway assignment procedures to exclude links that are not illegible for paths being developed for certain trip markets, such as "SOV-Cash". There are sixteen (16) link types defined in the NJRTM-E and they are listed below:

1. Free All (Link Type 1) – non-tolled links designated for all modes.

2. Free Auto Only (Link Type 2) – non-tolled links designated for auto mode only.

3. Free Truck Only (Link Type 3) – non-tolled links designated for truck mode only.

4. Urban Toll All (Link Type 4) – Urban tolled links designated for all trip modes (auto and trucks). Urban links are defined as links with Area Type 3 or higher (Area Types 1 to 3). The toll links are assumed to accommodate all types of toll payments, such as cash or electronic toll collection (ETC or EZ-Pass).

5. Urban Toll Auto Only (Link Type 5) – Urban tolled links designated for auto mode only.

6. Urban Toll Truck Only (Link Type 6) – Urban tolled links designated for truck mode only.

7. Rural Toll All (Link Type 7) – Rural tolled links designated for all trip modes (auto and trucks). Rural links are defined as links with area type 4. (the four-category version of the area types)

8. Rural Toll Auto Only (Link Type 8) – Rural tolled links designated for auto mode only.

9. Rural Toll Truck Only (link Type 9) – Rural tolled links designated for truck mode only.

10. Urban Free HOV Only (Link Type 10) – Urban free links for all HOV modes. This is a typical HOV link.

11. Urban Toll HOV Only (Link Type 11) – Urban tolled HOV Only. This link type is prepared for a scenario where the HOV links are now tolled.

12. Urban Toll SOV, Free HOV (Link Type 12) – Urban tolled links for SOV mode only, HOV mode is free. This is a typical use for HOT Lane scenarios.

13. Urban Toll Non-HOV vehicles (Link Type 13) – Urban toll links, all vehicles except HOVs

14. ETC Only All (Link Type 14) – Toll links dedicated for ETC patrons only (patrons with EZ-pass) for all modes. This link type is typical for congestion pricing or HOT lane scenarios where all payments are done electronically.

15. ETC Only Auto Only (Link Type 15) – Toll links dedicated for ETC patrons and Auto mode only. Truck trips are not eligible to use this type of links.

16. ETC Only SOV and Truck Toll, HOV Free (Link Type 16) – Toll links dedicated for all ETC patrons; however, only SOV and truck trips have to pay. HOV mode is free.

Note that the NJRTM-E creates a total of nine different path sets based on mode (SOV,HOV, Truck) and toll usage (Free, Cash Payment, ETC Payment). It is important to note that the Link Type variable does not assess the toll cost. It is only used to determine if a path set can use the link in question. The following example is presented to describe the use of this variable in the path sets. The path-building and highway assignment process for an SOV cash "path" without EZ-Pass should exclude all links with link types:

- 3, 6, 9 because these links are limited to trucks only
- 10, 11 because these links are limited to HOVs only
- 14, 15, and 16 because these links are limited to vehicles with transponders (ETC).

3.2.4 Number of Lanes

The NJRTM-E provides three number of lane variables by time of day:

- LanesAM – number of lanes for AM Peak period
- LanesPM – number of lanes for PM Peak period
- LanesOP – number of lanes for Midday and Night periods

The purpose of having different variables for each time period is to accommodate the situations where the configuration of the roadway varies by time of day, such as a period-specific HOV lane or a roadway with a reversible lane. Typically, an HOV lane is usually applied to the peak direction reducing one lane from the available general-purpose lanes. During the off-peak period, this lane is usually converted back into a general-purpose lane. Having separate lane variables for each time period within a master network for each model year reduces the model complexity by providing a consistent network suitable for several different time-of-day analyses.

3.2.5 Traffic Control Devices

The traffic control device (TCD) parameters were added to the model to improve the representation of capacity, speed and intersection delay. The NJRTM-E provides 13 TCD categories, defined as follows:

1. Two-way stop (TCD 1)
2. All-way stop (TCD 2)
3. Yield (TCD 3)
4. Ramp-meter (TCD 4)
5. Signalized-uncoordinated-actuated (TCD 5)
6. Signalized-uncoordinated-fixed (TCD 6)
7. Signalized-coordinated-restricted progression (TCD 7)
8. Signalized-coordinated-favorable progression (TCD 8)
9. Signalized-coordinated-maximum progression (TCD 9)
10. Freeway diverge point (TCD 10)
11. Freeway merge point (TCD 11)
12. No controls (TCD 12)
13. Unknown (TCD 99)

As mentioned previously, the techniques to estimate speed and capacity utilize this variable as part of the 2000 HCM procedures. Note that while a TCD for ramp metering has been established in the model, procedures to implement this function are not in the current model. Similarly delay estimation for Freeway merge point TCD is not implemented in the current model. In addition to TCD variable, the model also includes additional signal-related variables that adjust time and capacity. These variables include:

- NSIG – number of signals in the link
- SIGCYC – Signal cycle in seconds
- SIGCOR – Signal coordination type
    - 0 = uncoordinated signal (default)
    - 1 = coordinated-unfavorable
    - 2 = coordinated-favorable
    - 3 = coordinated-maximum progression
- GC – green time per cycle ratio

Originally, the number signals and type signals (signalized or non-signalized) were compared to the signal data from the New Jersey Congestion Management System (CMS) database version 3.1 (November 3, 2003). The comparison, however, was only performed for the North Jersey Region (NJTPA Region). It should be noted that the comparison is only limited to whether or not an intersection is signalized. All other complimentary variables were defined based on default values assumed by the model. The detailed data for the TCD and its complimentary variables can be updated in the future as more comprehensive databases become available. The TCD data was then regularly reviewed and updated as part of the NJTPA's regional conformity projects.

3.2.6 Toll Variables

The NJRTM-E requires several toll variables for different toll applications. The toll variables are listed below:

- TOLL – the toll cost values in dollars.
- MCTOLL – the scaled toll values to balance by direction especially for one-way toll, prepared for mode choice process. MCTOLL will be explained further following this list.
- TOLLAPC – a flag to identify the type of toll links, for example, HOV free toll links, truck-free toll links, etc. The TOLLAPC has thee values, with default value of 0. The default value indicates that toll is applicable to all modes (SOV, HOV, and truck). TOLLAPC of 1 indicates that toll is applied to all modes, except HOV. TOLLAPC of 2 indicates that toll is applied to all modes, except trucks.
- TOLLCLASS – toll class for lookup system. This variable provides flexibility to use toll values either directly from values coded in the link or values defined in a look-up table. The default value of TOLLCLASS is zero which is applied to all links without any toll values. TOLLCLASS between 1 and 98 indicates that the toll cost will be obtained from a look-up table. TOLLCLASS of 99 indicates that toll value is coded directly on the link. A detailed discussion about the toll look-up table will be given following this list.
- TOLLFACAM, TOLLFACPM, TOLLFACMD, TOLLFACNT – base toll factor for each time period (AM, PM, MD, and NT). This variable provides flexibility to have variable tolls for different time period. The default values of these variables are one (1), i.e., tolls are the same for all time periods and they are the same as the values coded in the toll links.
- FIXTOLL – this variable provides whether or not the toll cost is fixed through all assignment iterations or can be adjusted for each assignment iteration such as for congestion pricing scenarios. The FIXTOLL variable has two values, a value 0 for variable tolls and a value of 1 for fixed toll rates. The default is fixed tolls.

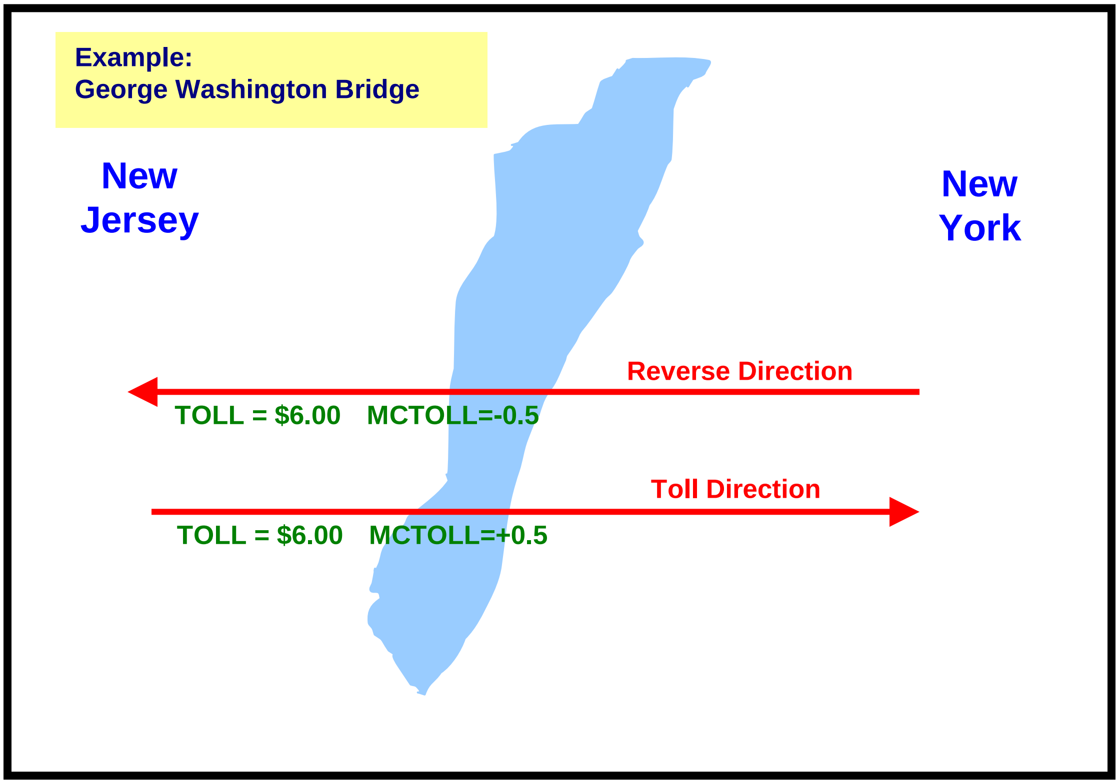
MCTOLL variable is used to control cost allocation in mode choice and traffic diversion in highway assignment with facilities employing one-way tolling schemes. For mode choice, trips are provided in a production-attraction format, so the cost of each direction of an assumed round trip should be 50% of a one-directional toll and must be presented on both directions of facility since round trips originating on either side of the toll plaza will encounter the toll at some time of the day. However, for the purposes of traffic assignment, the full cost of the toll is posted in the direction that the toll is assessed, so that the diversion process can seek differing paths (free vs. toll) if such options are present. An example of this is directional tolling schemes employed at the Holland Tunnel and the Verrazano-Narrows Bridge. In this situation, certain travelers can enter New York eastbound in the morning via the Verrazano-Narrows bridge (paying a lower toll than the eastbound Holland Tunnel) and return back to New Jersey via the non-tolled westbound Holland Tunnel.

The default value for MCTOLL is zero (0) which indicates that the toll does not exist in the link. For links with toll values, there are two sets of MCTOLL values:

- MCTOLL=1 for links with toll in both directions
- MCTOLL=+0.5 and -0.5 for links with one-way toll. The positive value (+0.5) is posted on link in the direction where the one-way toll is assessed, while the negative value (-0.5) is posted on the reverse, non-toll direction.

Figure 9 and **Figure 10** display the application of MCTOLL variable under differing conditions. These figures indicate what values should be input to TOLL and MCTOLL variables when representing either one-way or two-way toll collection plans.

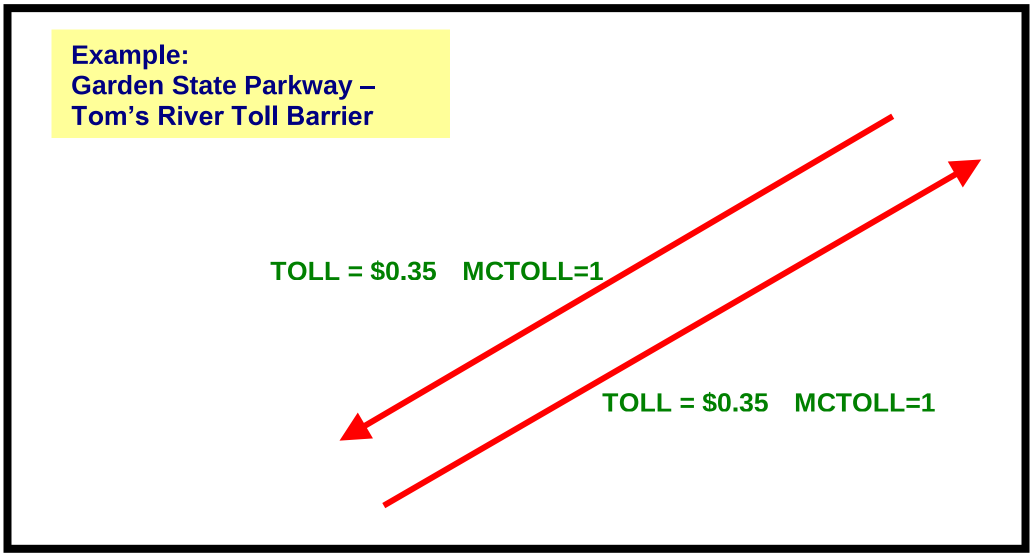
Figure 9 – MCTOLL for One-Way Toll Collection



For one-way toll collection plan, the toll values for mode choice are the absolute values of the TOLL multiplied by MCTOLL. In the example above, both directions will have toll values of $3.00. In the assignment process, the assigned toll values will be the TOLL multiplied by a “factor”. The “factor” is defined as one (1) if MCTOLL is greater than zero and defined as zero (0) if MCTOLL is less or equal to zero. In the example above, the TOLL value for the toll direction (from New Jersey to New York) is $6.00, while the TOLL value for the reverse direction is $0.00.

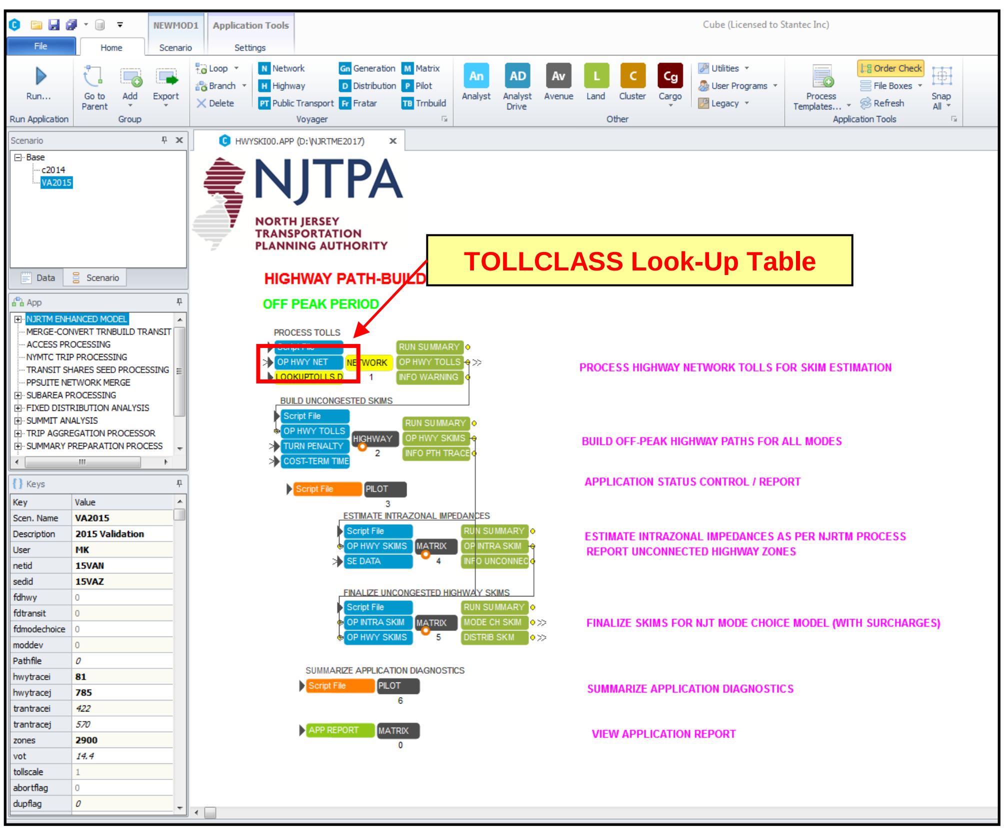
In contrast to the one-way toll collection plan at the George Washington Bridge, the MCTOLL variable is coded differently to represent the two-way toll collection situation for the Garden State Parkway toll plaza at Toms River, New Jersey. As shown in Figure 10, the MCTOLL variable is coded as 1.0 in direction which enables the toll to be properly assessed for both mode choice and the highway assignment procedures. Note that an equal toll cost (in this case $0.35) is applied to each direction of the link, just as was the case with the one-directional toll scheme. It should also be noted that the MCTOLL variable can be used to control the display of true tolling locations in CUBE. When displaying toll costs for links, the posting process can be controlled by limiting the display of TOLL on links where MCTOLL is greater than zero. This will display the actual toll in the direction that it is assessed.

Figure 10 – MCTOLL for Two-Way Toll Collection



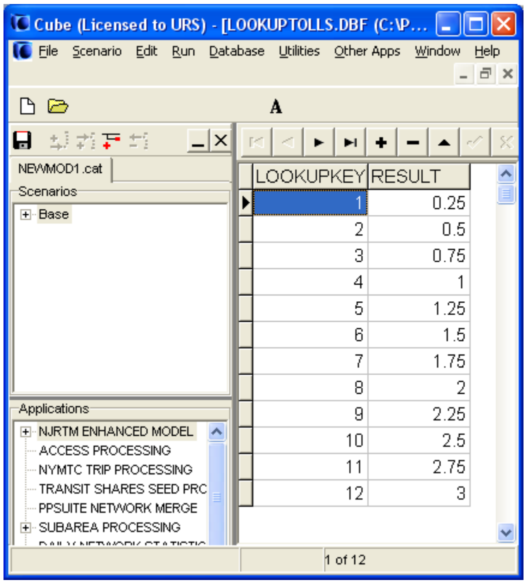
TOLLCLASS, as explained previously, is a variable to allow the use of toll rates either directly coded on the link or toll rates defined from the look-up table. The look-up table that contains the toll rate is stored in "LOOKUPTOLLS.DBF" file in the "Highway Path-Building and Skim Estimation" module, as shown in Figure 11.

Figure 11 – Toll Class Look-Up Table



The NJRTM-E model reserves 98 keys (TOLLCLASS=1-98) to be used for different toll rates. Currently, all toll rates coded in the highway network are actual toll rates. Figure 12 shows the sample of the toll class look-up table. Note that TOLLCLASS code 99 is used to indicate that the lookup table is not applied and that the toll posted on the link is the actual value.

Figure 12 – Current Toll Class Table



3.2.7 Additional Network Variables

Other pertinent highway network variables including FIXCAP, FIXTIME and LWCAPACITY.

FIXTIME is a variable to control whether travel time on a roadway link is calculated by a Volume Delay Function based on the Volume-Capacity Ratio (V/C ratio) or whether travel time is assumed to be based on free flow. FIXTIME can be defined as '0' or '1'.

- FIXTIME=0: the congested travel time is calculated using the appropriate corresponding volume-delay function.
- FIXTIME=1: the travel time on the corresponding link will always be kept constant at free-flow time (T0). This is usually applied to links outside New Jersey Region where the highway network links are under-represented. Therefore, most of links can be overloaded during the highway assignments due to lack of roadway capacity to accept the travel demand. It is also applied to the park and lot links (small triangles).

FIXCAP is a variable that determines whether a roadway link's capacity will be adjusted using the dynamic capacity approach to model peak spreading during the peak or off-peak periods. This approach allows an adjustment to the capacity when the V/C ratio reaches 0.9 or higher. While the NJRTM-E stores estimated hourly capacities, each period's capacity usually lower than the number of hours in the period. For example, the AM Peak period is defined as a three-hour period, while the AM Peak capacity factor is defined as 2.632 times the hourly capacity, or slightly lower than 3 hours. For a link that has a V/C ratio equal to or greater than 0.9, the period capacity will be dynamically and proportionally adjusted from 2.632 * capacity to 3.000 * capacity when the V/C ratio equals 1.00 or greater. FIXCAP can be defined as '0' or '1'.

- FIXCAP=0: the dynamic capacity approach is used for the link. All links will normally use a value of 0.
- FIXCAP=1: the capacity for a link is not adjusted to use the dynamic capacity approach

The LWCAPACITY variable stores the adjusted capacity resulting from the dynamic capacity approach calculation.

3.2.8 Speed and Capacity Estimation

Speeds and capacity variables for the NJRTM-E were developed by using relationships between facility type and area type. The recommended "ideal" uncongested speeds (off-peak speed), which are used as input to the highway path building process, are presented in Table 12. Note that these speeds represent theoretical upper limits or "ideal" values prior to considering other factors as number of lanes, grade, shoulder conditions, and traffic control devices that reduce these initial values. Initial estimates of congested speeds (peak speeds), which are used as input to first iteration of the highway path building process were assumed to be approximately 20% lower than the uncongested speed.

Table 12 – Uncongested Speed by Facility Type and Area Type

Facility Type	Area Type					
	Manhattan CBD	CBD	Urban	Suburban High	Suburban	Rural
Freeways	50	55	63	65	78	78
Expressways	40	45	50	55	65	65
Principal Arterials Divided	25	38	43	48	60	60
Principal Arterials Undivided	20	29	36	45	55	55
Major Arterials Divided	18	25	34	43	50	50
Major Arterials Undivided	18	24	32	40	50	50
Minor Arterials	15	22	30	37	45	45
Collectors/Locals	15	20	22	35	35	35
High-Speed Ramps	45	50	55	55	55	55
Medium-Speed Ramps	20	28	35	35	40	40
Low-Speed Ramps	15	25	25	25	25	25
Centroid Connectors	10	10	10	10	10	10

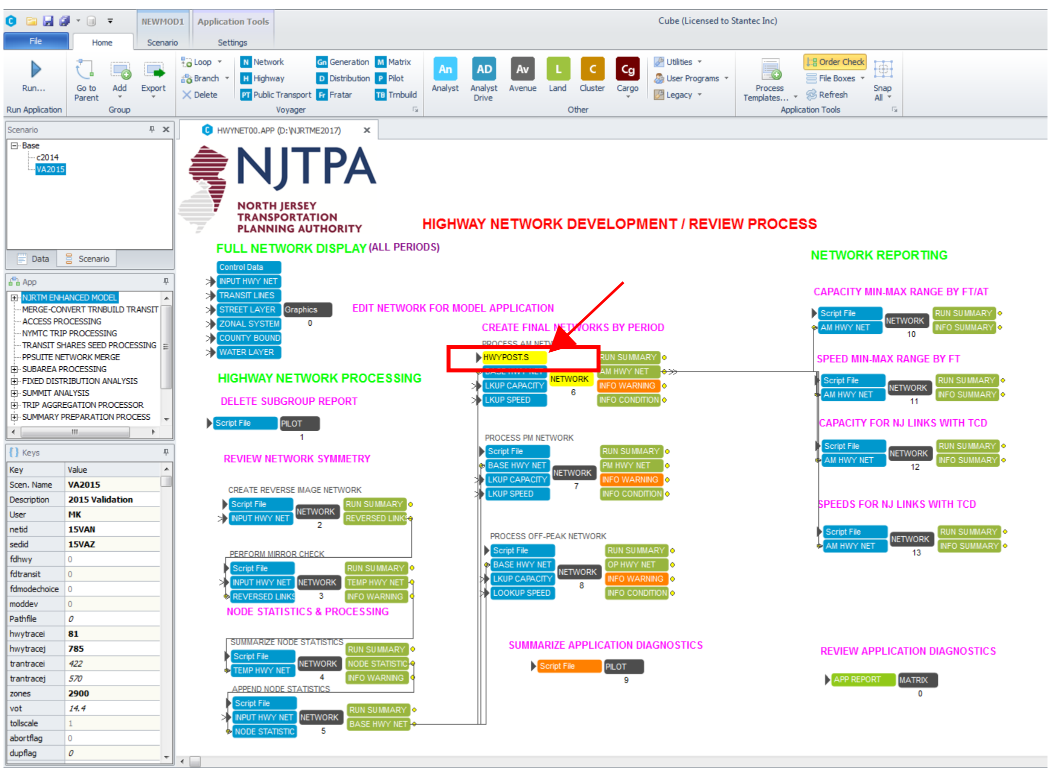
The "ideal" capacities were also assumed to be a function of facility type and area type. These initial hourly capacities per lane are listed in Table 13. The initial capacity values for each link were adjusted to take into account for geometric constraints or other impedances along the link, such as parking availability, traffic control devices, green time/cycle ratio, signal cycle length, etc.

Table 13 – Initial Hourly Capacity per Lane by Facility Type and Area Type

Facility Type	Area Type					
	Manhattan CBD	CBD	Urban	Suburban High	Suburban	Rural
Freeways	2000	2100	2200	2300	2300	2300
Expressways	1800	1850	1950	1950	2100	2100
Principal Arterials Divided	1650	1750	1800	1900	2000	2000
Principal Arterials Undivided	1600	1675	1750	1850	2000	2000
Major Arterials Divided	1550	1650	1700	1750	1900	1900
Major Arterials Undivided	1500	1625	1675	1700	1850	1850
Minor Arterials	1450	1600	1650	1675	1800	1800
Collectors/Locals	1100	1250	1300	1350	1350	1350
High-Speed Ramps	1760	1760	1760	1760	1760	1760
Medium-Speed Ramps	1500	1500	1500	1500	1500	1500
Low-Speed Ramps	1200	1200	1200	1200	1200	1200
Centroid Connectors	9000	9000	9000	9000	9000	9000

The adjustments to speed and capacity are implemented during creation of period-specific networks and the procedures can be viewed in the control files in the "Highway Network Development Module" as shown in Figure 13.

Figure 13 – Highway Network Development Module



3.3 IDENTIFICATION AND PERFORMANCE VARIABLES

The identification variables, as their name implies, contain information for identification purposes only and are used as part of the network display. The variables include roadway name, SRI, Milepost, NHS (National Highway System), county where the links are located, conformity-based project ID number, and the zone where the links reside.

The NHS variable was added as part of the 2018 NJRTM-E Revalidation Project. The NHS codes are as follows:

- 0 – Not on NHS
- 1 – Interstate
- 2 – Not Used
- 3 – Non-Interstate STRAHNET (Strategic Highway Network)
- 4 – STRAHNET Connector
- 5 – Not Used
- 6 – Not Used
- 7 – Other NHS
- 8 – Approved Intermodal
- 9 – Segment is dual designated as both an Approved Intermodal Connector and STRAHNET
- 10 – Principal arterial added to the NHS under MAP-21

The performance variables contain mainly the performance information such as traffic counts and the year those traffic counts were gathered. These variables are used primarily for reference purposes when comparing traffic forecasts to base year conditions. Note that provisions were made to permit three traffic count data sets, each with a separate reference year. It was envisioned that peak period counts, seasonal counts, or data sets with conflicting estimates could be stored in these fields as part of a future effort.

3.4 HIGHWAY NETWORK DEVELOPMENT

The NJRTM-E highway network was originally obtained from the New Jersey Transit Highway Network which includes the NJTPA Region, NYMTC region, and a portion of DVRPC region (Mercer County, NJ and Bucks County, PA). This highway network was later expanded to include more counties in Pennsylvania and South Jersey to form the current NJRTM-E highway network. Several highway network sources from adjacent MPO's, such as DVRPC and SJTPO were used as references in the initial expansion effort.

The current NJRTM-E consists of 2900 zones, expanded from 2553 zones in 2018. The NJRTM-E node numbering system, including the reserved transit nodes, is listed in Appendix G of the "User's Guide" manual. The node numbering system reserved the first 4299 nodes for use as zones. With the current 2900 NJRTM-E zones, the reserved zones and remaining 1399 unallocated zones are available for future use.

After the completion of node numbering system, the expansion of networks into Atlantic Counties, Lehigh Valley Counties, and Northeast Pennsylvania Counties was performed. The relevant segments included in the highway network and their attributes were identified from the state maps, street layers, or other on-line electronic maps. As part of this effort, the network within NJTPA region and Mercer County were refined. Those refinements include:

- Bifurcation of freeways in New Jersey Counties
- Detailed interchange coding of all limited-access facilities within New Jersey Counties

- Inclusion of all 500-series routes in New Jersey Counties
- Inclusion of the majority of 600-series routes in New Jersey Counties
- Conflation of highway network to street layer to permit true-shape display
- Zonal connector refinements to reflect proper connection from zones to highway network.
- Identified traffic signal locations within the NJTPA Region using CMS data.
- The placement of toll codes and toll costs on the appropriate network links, including the all toll bridges along the Delaware and Hudson Rivers.
- Additional layers of background features such as jurisdictional boundaries (TAZ, MCD, County); local street layer, and water layer.
- Enhancement of the facility type grouping from 9 to 12, which includes the introduction of different ramps type as discussed in the previous section.
- Introduction of coding procedures to permit modeling of various types of toll facilities, such as ETC-only toll links, HOT-Lanes, and one-way toll plans.

As a final step, the network was inspected to ensure that all recently-constructed facilities were properly coded in the network. Extensive checks for each of the key link variables were performed along with extensive network connectivity analysis to ensure that the network was configured correctly.

3.5 REVISED TOLL ESTIMATION PROCESS

The toll estimation system was also enhanced in the new model. Included in this effort is the updated toll costs for the New Jersey Turnpike, Garden State Parkway, and the addition of all bridge crossing tolls, such as bridges along the Hudson and Delaware Rivers, as well as toll bridges in the other New York counties. The toll rates were collected from several different agencies or readily available toll schedules including:

- Delaware River Joint Toll Bridge Commission (DRJTBC)
- Metropolitan Transportation Authority (MTA) Bridges and Tunnels in New York City
- Garden State Parkway
- New Jersey Turnpike Authority
- Burlington County Bridge Commission
- New York State Thruway Authority

In most cases, toll schedules were obtained directly from the respective agency's website and additional phone conversations with the agency staff when necessary.

Updates to the Garden State Parkway, toll bridges and tunnels, were relatively straightforward. Since these facilities use ramp-barrier system, tolls were directly represented by the costs posted on specific links. Each toll location was checked and modified as appropriate to reflect as closely as possible the year 2015 toll conditions. The coding process for the New Jersey Turnpike is based on an entrance/exit system in which toll charges accumulate as travel accumulates. Within the original NJRTM, the New Jersey Turnpike toll was based on a series of per mile charges that varied for each section of the Turnpike. However, since the Turnpike does not have a uniform toll rate for the entire system, the NJRTM-E provides an approximation of actual cost for each interchange to interchange movement. To develop an accurate but simple system to represent tolls, it was decided to represent each toll cost as a series of link specific charges between each interchange. This is consistent with the approach used in the original NJRTM. APPENDIX B – TOLL RATE SCHEDULE shows the toll cost posted between interchanges in the New Jersey Turnpike as well as the scheduled toll rates from NJ Turnpike Authority.

4. TRANSIT NETWORK DEVELOPMENT

4.1 INTRODUCTION

The NJRTM-E adopted existing transit networks from the NJ Transit Regional Transit Model. The primary purpose of the transit network was to develop estimates of the time and cost variables for peak and off-peak periods as required for the mode choice model. The transit network was also used as the basis to load trips within the transit assignment process. In the NJRTM-E, transit path-building and assignment are performed using CUBE's Public Transit (PT) routine. The original transit path-building and assignment were performed using the TRNBUILD routine, in order to be consistent with the adoption of the NJ Transit mode choice component. However, in the recent model refinement effort, the TRNBUILD routine was converted into PT routine, since TRNBUILD is no longer supported by its developer. The transit path results were compared between the TRNBUILD routine and PT routine during the Model Refinement Project that was completed in 2015, and the results were reasonably close. A sample comparison of TRNBUILD and PT transit skims for bus and rail modes and for both walk and drive access is shown in APPENDIX L – HOME-BASED WORK STRATEGIC (HBWS).

The difference of the resulting skims between the two routines is mainly due to the improvements of the PT module. PT is designed to model the transit path building and assignment more realistically than TRNBUILD. For example, in TRNBUILD the drive access travel time was generated using transit time which is generally lower than highway time, meanwhile, in PT the drive access travel time was generated using highway time, which is more realistic.

It should be noted that the NJ Transit Regional Transit Model covered a larger region than the original NJRTM. The adoption of this larger region facilitated estimation of transit demand for major transit hubs in the system, such as New York City, and permitted the estimation of transit services into adjacent regions in Pennsylvania and southern New Jersey. Note that during the course of the original model development, the client team elected not to extend the detailed representation of all transit services into the regions east of the Hudson River, but rather retain the existing coding of high capacity routes in Manhattan embedded in the NJT Model. This topic is discussed in further detail in Chapter 10 which describes the mode choice model development.

4.2 TRANSIT NETWORK COMPONENTS

4.2.1 Transit Network Modes

The transit network was developed based on the original network provided by New Jersey Transit. The network included those services that were present in the year 2015. As a result, the fares, headways, and travel times were all based on the conditions that existed in 2015. The network included all transit services provided in the North Jersey Region as well as some services in New York City (either operated by New Jersey Transit or the Port Authority of New York/New Jersey, MTA NYC Subway), Trenton, and long-haul transit lines that served the northwestern portion of New Jersey and Eastern Pennsylvania.

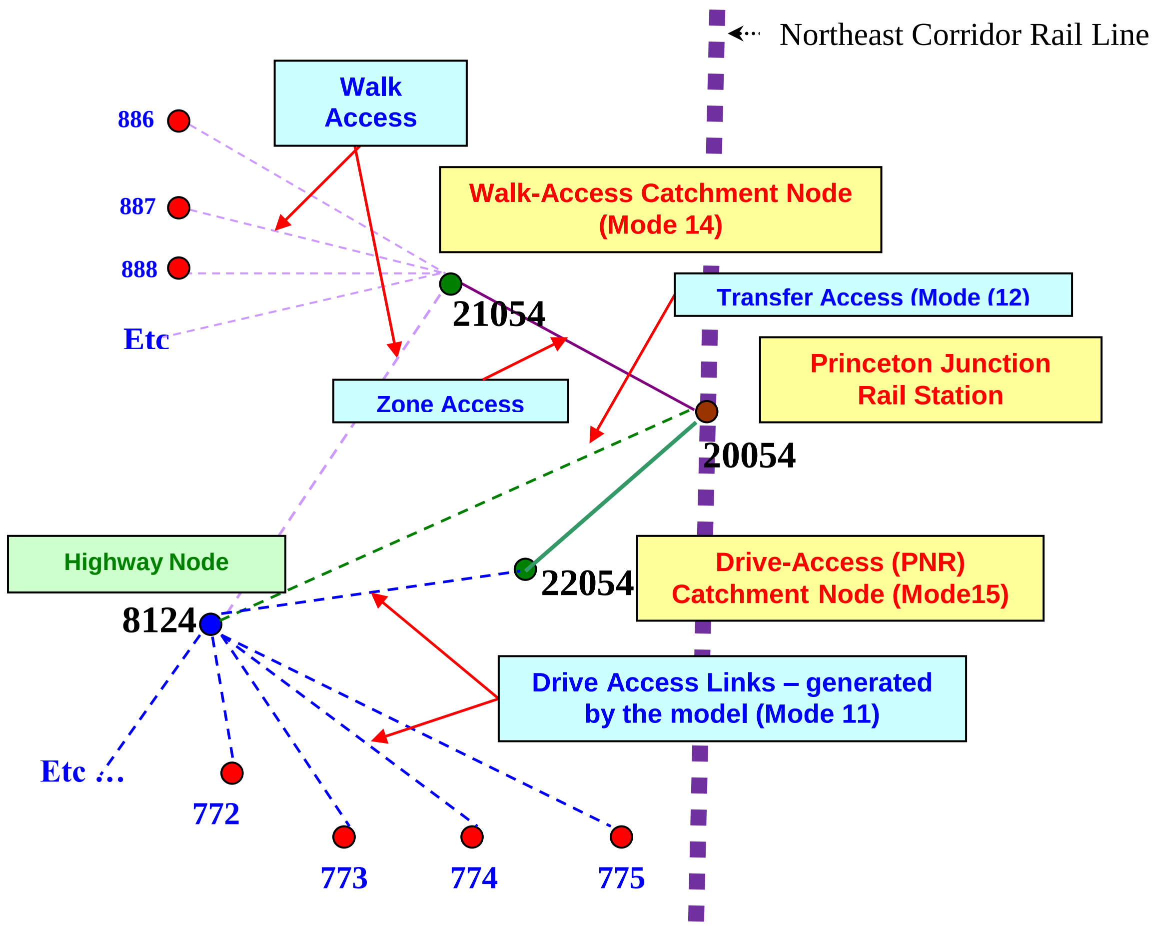
Similar to the highway network with the various types of facilities, the transit network was represented as a series of different "services". These services are abstracted as a series of "modes", reflecting the specific operating characteristics, such as use of shared right-of-ways in the case of bus services or the use of exclusive guide ways for the various rail services. Stratifying the network by mode is necessary since each type of transit service has different performance characteristics. For example, the performance characteristics of the commuter rail lines are significantly different than the local bus lines. The transit network was constructed by incorporating all of these "modes" representing the different type of transit services along with the necessary access and transfer connections. In the transit networks, modes represent actual transit routes, as well as walk/auto access connectors and "sidewalk" systems used to transfer in the CBD. It is common practice to refer to modes as being either "transit" or "non-transit" modes.

The various modes used in the NJRTM-E transit network are listed in Table 14. As shown in the table, the first 10 modes represent the actual transit services provided in the region. Note that Long distance ferry (mode 10) represents ferry lines from Monmouth County to Manhattan, while Ferry (mode 8) represents the remaining ferry lines. Modes 11-15 are the non-transit modes which provide access and transfer linkages for the network. There are two different auto-access related modes (modes 11 and 15) used in the NJRTM-E. Mode 11 includes the links connecting zones to gathering nodes at the major transit boarding points, such as PNR lots for express bus and rail lines. Mode 12 represent walk transfer links between different transit services (e.g., between a transfer between a bus and a train). Mode 15 is used to provide a common "catchment" link between the PNR lot and the station and serves a single reference link to summarize all drive access trips using the station. Walk access to transit service is provided via Mode 14 links and includes a catchment link at major transit station. A schematic representation of this coding process is provided in Figure 14.

Table 14 – NJRTM-E Transit Network Modes

MODE NUMBER	MODE DESIGNATION	TYPE OF SERVICE
1	Transit	COMMUTER RAIL
2	Transit	PATH
3	Transit	NYC SUBWAY
4	Transit	NEWARK CITY SUBWAY
5	Transit	LOCAL BUS
6	Transit	PABT BUS
7	Transit	PNR BUS
8	Transit	FERRY
9	Transit	LIGHT RAIL TRANSIT
10	Transit	LONG DISTANCE FERRY
11	Non-Transit	PNR CONNECTORS
12	Non-Transit	WALK TRANSFER
14	Non-Transit	WALK ACCESS - ZONE TO STATION
15	Non-Transit	PNR LOT TO STATION CONNECTOR

Figure 14 – Sample Access Coding from Princeton Junction Station



4.2.2 Transit Network Elements

The transit network consists of several elements that are maintained as separate files which are used as input to the PT routine. The description of the coding structure and requirements for these elements is provided within the CUBE/VOYAGER documentation. The transit system includes:

- Transit routes for each transit mode.
- Non-transit access or transfer links for both walk and drive access.
- Transit nodes for the non-highway transit facilities such as stations for commuter rail lines, ferry terminals, and the subway system.
- Transit links for all non-highway transit lines as well as special connection links for the Hudson River XBL service, and PNR links.
- Park and Ride catchment zones for each station that define the zones that can utilize certain park and ride lots.

4.2.3 Transit Route Coding

In accordance with the NJ Transit Regional Transit Model requirements, the NJRTM-E transit network coding was structured as a non-integrated procedure. As a non-integrated procedure, the transit network is created during the model execution process as part of the transit path-building and assignment procedures. The transit network uses the underlying highway network as the basis for the transit routes. The transit network was coded to be consistent with the format required by the PT module. Although many line variables are available within PT to abstract transit routes, only certain variables were used in the NJ Transit Regional Transit Model. The variables utilized are listed as follows:

- Name – Route Name
- Mode – Transit Mode
- Oneway – Flag to indicated one-way or two-way routes
- Headway[1] – peak period headways in minutes
- Headway[2] – off peak period in minutes
- N - List of nodes identifying the orientation of a transit route through the network.

The detailed descriptions of these parameters can be found in the CUBE/VOYAGER documentation under the PT routine.

4.2.4 Transit Access Coding

The transit access coding in the NJRTM-E was designed as a two-tier process. One tier represented auto access to the transit network. Each zone was assumed to be eligible for the auto-access, with connections to a predefined set of Park and Ride (PNR) lots. These access links were built using the existing highway links. In addition, PNR lots were also assumed to be accessible from certain zones. These zones were defined in the PNR Catchment Zones module and could be revised as necessary. The auto access mode was coded as mode 11 as discussed previously and listed in Table 14.

The auto-access links only connect zones to the node representing the PNR lots. To advance the travel from the PNR lots to the stations or express bus stops, a “catchment” link was utilized as a means of summarizing all trips accessing the station. These links were coded as mode 15.

The second tier represented walk access. Each zone has transit access automatically generated to available transit stops and the number of access links to each transit mode is controlled by the PT path-building process. The automated walk access links were created using the underlying highway network and an assumed speed of three (3) mph walk speed. A maximum distance of 1 mile through the network grid was assumed for all modes except commuter rail (at 1.25 miles) and the Newark Subway (at 0.75 miles). In addition, certain zones in the immediate proximity of major transit stations had user-defined walk access links.

The mode choice model also requires that percentage of each zone within walk distance be calculated. This task was performed as part of the Transit Walk Access Coverage Application discussed in section 5.15 of the User Guide. The procedure estimated the area percentage of each zone that is within ½ mile from transit service.

4.2.5 Transit Use Codes

As part of the highway network refinement effort, a new coding process was developed to represent “special use” transit facilities so as to minimize the coding of additional “parallel” transit only links. This new approach facilitates the coding of highway-based “special use” transit facilities such as exclusive bus lanes adjacent to general-purpose highway lanes (XBL) and preferential treatment such as queue jumps at traffic signals. This coding system also permits the coding of exclusive bus facilities such as those associated with a BRT-type system to be incorporated directly into the highway network, yet it restricts the use of these links to the designated transit lines.

This coding system was implemented within the existing transit speed calculation process. The coding system contains three variables, each provided for the a.m. peak period and the off-peak period. The first variable (TCODExx, where xx is the period designation) is an index describing the type of special use transit facility. The second variable (TSCALExx) provides a time multiplier that enables the analyst to scale the transit time against the free flow or congested time highway time. The third variable (TADDxx) provides a time surcharge, either positive or negative, for transit vehicles on the link. The index variable TCODE is described in Table 15.

Table 15 – TCODE Variable Description

TCODE	DESCRIPTION	EXAMPLE / NOTES
0	Standard Roadway	Local street - use standard time factoring
1	Exclusive Bus Lane	XBL
2	Queue Jump Lane	US 22
3	Reserved	
4	Reserved	
5	Reserved	
6	Reserved	
7	Reserved	
8	Reserved	
9	Exclusive Bus ROW	BRT System - use hard coded time

The primary benefit of this coding approach is that the bus routes that utilized these special facilities can still reference to the existing highway network without resorting to coding transit-only links that would need to be maintained in separate files. With this coding process, an exclusive bus-only roadway and be incorporated into the highway network with TCODE=9. This system can also be used to incorporate other transit only links, such as rail lines, in the network, since all TCODES greater than 8 are not available for highway path-building and assignment.

Some examples of how this coding system can be applied are provided for the users review. For the XBL system, the user would code the relevant highway links with a TCODE value of 1.0. All links with this code utilize free flow travel time, which could then be scaled by the user (say 1.05) with the TSCALE variable, based on actual observed speeds. If the current XBL system encounters a ten-minute delay at the approach of the Lincoln Tunnel, that link would have a value of 10.0 in the TADD variable. Note that this process is independent of the level of congestion on the adjacent general use lanes. Hypothetically, if an alternative XBL system added a new lane and mitigated the delay at the Lincoln Tunnel approach, then TSCALE could be set to 1.0 and TADD set to 0.0.

In the case of a queue jump (TCODE=2) or some other shoulder treatment, the bus runtime would be scaled using congested travel time. The analyst has the option with the TSCALE variable to adjust the runtime to reflect conditions in the field. The TADD variable could then have an additional surcharge (positive or negative) to address any minor differences. Note in this case that the bus travel time in the future year would be affected by the general increase in level of congestion although the analyst could still refine this further if necessary.

In the case of an HOV lane that is available for express bus service, it would not be necessary to utilize the new coding procedure. Buses utilizing this lane, as well as all buses in the general use lanes would have travel times automatically adjusted in response to the congestion levels as part of the normal transit travel time estimation process.

4.2.6 Transit Network/Highway Network Integration

The NJRTM-E was designed so that the bus service in the transit network is referenced to the highway network in order to estimate travel time. This process ensures that the highway and transit times are estimated on a consistent basis. With this process, increases in highway congestion will results in increased bus travel time. The linkage between the travel time on the networks was performed with a distance-based approach, i.e., the highway travel time was amplified by a distance factored by speed adjustment constant, following formula below:

*Transit Time = Highway Time + distance * speed factor*

Where:

Transit Time = defined transit time for each highway link
Highway Time = estimated highway time in each network link
Distance = link distance
Speed Factor = Speed factor based on facility type and area type.

The speed adjustment factors are varied between peak and off-peak periods. Table 16 and Table 17 list the factors for peak and off-peak periods, respectively.

Table 16 – Speed Adjustment Factors for Peak Period

FT	AT1	AT2	AT3	AT4	AT5	AT6
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00
3	1.00	0.85	0.70	0.60	0.00	0.00
4	1.20	1.20	1.00	0.60	0.00	0.00
5	1.70	2.50	2.20	0.70	0.00	0.00
6	1.70	2.80	2.50	0.70	0.00	0.00
7	1.90	2.80	2.50	1.25	0.00	0.00
8	2.00	2.80	2.50	2.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00

Table 17 – Speed Adjustment Factors for Off-Peak Period

FT	AT1	AT2	AT3	AT4	AT5	AT6
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00
3	0.50	0.35	0.25	0.10	0.00	0.00
4	1.00	0.35	0.35	0.25	0.00	0.00
5	1.50	0.50	0.30	0.25	0.00	0.00
6	1.50	1.50	0.30	0.50	0.00	0.00
7	1.50	1.50	1.00	1.45	0.00	0.00
8	2.20	2.00	1.50	2.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00	0.00

The distance-based approach was used primarily to minimize the impact of highway time changes during the calibration process. Because the highway network congested time oscillated frequently and sometimes quite significantly for some links during the calibration process, this caused a significant change of transit time as well. To provide more stable transit time for the calibration effort, the distance-based approach was used. It is recommended that the more common approach of scaling travel time be considered as a future enhancement.

4.3 TRANSIT FARE

The fare estimation procedure from the NJ Transit Regional Transit Model was adopted for use by the NJRTM-E to calculate the fares for each of the transit modes. The following fare systems exist among the different transit modes in use:

- A distance-based fare system based on the distance traveled between boarding and alighting location
- A zonal fare system based on the boarding and the alighting station
- A flat fare system where a boarding fare is collected for all passengers on a given route or mode
- Costs for specific Park and Ride (PNR) lots

Table 18 lists the fare systems used in the NJRTM-E.

Table 18 – NJRTM-E Fare Types

Mode	Fare Type
Commuter Rail	Zonal Fare
Local Bus	Distance based fare system
LRT*	Fixed fare system
NYC Subway	Fixed fare system
Newark Subway	Zonal Fare
Ferry	Zonal Fare
Express Buses	Distance based fare system
PATH*	Fixed fare system
PNR lots	Station specific fares

*At present, the PATH and LRT modes have a fixed fare system, but the fare files have been coded with a zone based fare system for flexibility in case of future fare policy changes.

The file name specification used to store the fare files is as follows:

PP_MMMM.far
Where:

- PP is the time of day (PK for peak and OP for off-peak)*
- MMMM is the mode name (rail, bus, ferry, bus etc.)
- *The 'PP' part of the filename does not exist for the Bus modes.

Note that the model provides period-specific fares for modes except the bus modes. The transit path-building routines require the following files:

- Bus.far (Bus)
- Xbus.far (Express Bus)
- OP_Rail.far (Off Peak Commuter Rail)
- PK_Rail.far (Peak Commuter Rail)
- OP_Ferry.far (Off Peak Ferry)
- PK_Ferry.far (Peak Ferry)
- OP_Ncs.far (Off Peak Newark City Subway)
- PK_Ncs.far (Peak Newark City Subway)
- OP_Path.far (Peak PATH)
- Pk_Path.far (Off Peak PATH)
- OP_LRT.far (Off Peak LRT)
- PK_LRT.far (Peak LRT)

In addition to the above transit mode fare files, the following fare files are also defined:

- PNR.far (PNR lot fare file)
- Special.far (Fare adjustments to distance-based fare system at specific locations)
- Usage.far (Flat fares and fare adjustments for various inter/inter-modal transfer combinations)

4.3.1 Distance Based Fare System

The file format for the distance-based fare system file is shown in Table 19 and a sample distance-based fare file is shown in Figure 15. Note that both the bus modes, local and express, utilize the distance-based fare system.

Table 19 – File Structure for 'Distance Based Fare' Files

Field Number	Variable
1	Fare in cents
2	Distance range in hundredths of miles separated by a hyphen "-"

Figure 15 – Sample 'Distance Based' Fare File

Bus.FAR

```
;---- Local Bus Distance Fares ----
 125     1-399
 165     400-799
 195     800-1199
 210     1200-1599
 230     1600-1999
 260     2000-2399
 290     2400-2799
 310     2800-3199
 340     3200-3599
 365     3600-3999
 390     4000-4399
 420     4400-4799
 450     4800-5199
 480     5200-5599
 500     5600
```

Ln : 1 Col : 1 Sel : 0 | 0 Windows (CR LF) UTF-8 INS

Regular and Express Bus Fares

Both peak period and off-peak period buses use the identical distance-based fare system. The Year 2015 fares (in dollars) for the regular buses are shown in Table 20.

Table 20 – Bus Fares by Mode and Distance Range

Distance range (miles)	Bus Fare ($)	
	Local	Express
1-3.99	1.25	1.95
4.00-7.99	1.65	2.70
8.00-11.99	1.95	3.00
12.00-15.99	2.10	3.65
16.00-19.99	2.30	4.30
20.00-23.99	2.60	4.60
24.00-27.99	2.90	4.90
28.00-31.99	3.10	5.20
32.00-35.99	3.40	5.55
36.00-39.99	3.65	6.00
40.00-43.99	3.90	6.50
44.00-47.99	4.20	6.90
48.00-51.99	4.50	7.35
52.00-55.99	4.80	7.70
56.00-69.99	5.00	8.25
70.00-89.99	5.00	8.60
90.00 and above	5.00	9.10

4.3.2 Zone-Based Fare System

The zone-based fare method uses a field associated with the boarding station and alighting station as an index to a fare matrix look up table that contains the appropriate station-to-station fare. The fare file for a Zone based fare system should be set up with the following information:

Name: This record type is identified with the keyword “NAME” appearing in columns 1-4. The remainder of this line contains a descriptive comment that identifies the file and serves as a heading for any printed reports.

Comment: Comments are identified with an exclamation point (!) in Column 1 and are used to provide descriptions in the file that are not read or processed by the fare matrix building program

Pivot Location: This record type is identified with the keyword “PIVOT” in columns 1-5, followed by a pivot fare zone identification number columns 9-10. The Pivot fare zone is used for trips that involve travel on more than one line. The commuter railroads in the North New Jersey area generally allow a monthly pass user to travel on any line or branch within the zone range stated on the pass. As a practical manner, this means that for travel between stations on different branches, the traveler needs to buy a pass from the higher fare zone for the boarding station or alighting station to the transfer station.

Fare Zone Definition: This record type is identified with the keyword “ZNST” in columns 1-4. Each defined fare zone appears as a separate record. The fare zone identification appears in columns 9-10 followed by a descriptive label in columns 12-25

Station Fare Zone Identification: This record type is identified with the keyword “STAT” in columns 1-4 followed by the Transit Station Node number in columns 6-10. Each station must appear at least once as a separate record in the appropriate zone fare definition file. If a station serves multiple lines, then it can appear multiple times with a separate record for each branch that it serves. Hoboken is one station that must appear multiple times in the file. The station name appears in columns 14-40. The line appears in columns 43-45 and the branch appears in column 47. The fare zone for this station appears in columns 49-51. The lines and branches are used to determine whether the station-to-station fare is calculated as a direct trip or as a trip to or from the pivot zone. If both the line and branch for the boarding station and the alighting station are the same or if the line is the same and either branch is left blank, the fare is based on the direct fare between the two fare zones. If the lines or branches are not the same, then the fare is the maximum of the boarding station to the pivot zone and the alighting station to the pivot zone.

Fare Heading: This record type is identified with the keyword “FHDG” in columns 1-4. Columns 11-15 contains the “to” fare zone number for the first column, Columns 16-20 contains the “to” fare zone number for the second column and so on for each fare zone identified with the ZNST records.

Fare: This record type is identified with the keyword “FARE” in columns 1-4. Columns 6-10 define the “from” fare zone for this record. A separate Fare Record is defined for each fare zone identified with the ZNST records. Column 11-15 defines the fare (in cents) for travel from the fare zone identified in Columns 11-15 to the fare zone identified for the first column in the FHDG record. Columns 16-20 define the fare for the second column and so on. It should be noted that the user need only code the upper right half of the fare zone matrix. The network building programs assume that the lower left half of the fare zone matrix is a mirror image of the upper right half of the matrix.

A sample ‘zone based’ fare file is shown in Figure 16.

Figure 16 – Sample 'Zone Based' Fare File

```
NAME:NJDTFM PK NCS FARE-STATION EQUIVALENCE AND FARE TABLES
! PIVOT RECORD INDICATES THAT TRIPS THAT CANNOT MATCH LINES
! AND BRANCHES MUST TRAVEL TO/FROM THAT FARE ZONE.  THE HIGHEST
! FARE TO/FROM THE PIVOT IS THE ASSIGNED FARE.
PIVOT    1
!    FZONE NAME STATIONS (NOT CURRENTLY USED EXCEPT AS COMMENTS)
ZNST:    1 Non-Downtown Nwk Stations
ZNST:    2 Downtown Nwk Stations
!  STAT RECORDS INDICATE THE FARE ZONE ASSIGNMENT
!  A BLANK LINE OR BRANCH MEANS THAT ANY LINE OR BRANCH QUALIFIES.
!    NODE    NAME FOR INFORMATION         LIN B  FZ PNR$ (B=BRANCH, FZ= FAREZONE)
STAT:20600 - Grove Street                 NCS 1   1
STAT:20601 - Franklin Avenue              NCS 1   1
STAT:20602 - Heller Parkway               NCS 1   1
STAT:20603 - Davenport Avenue             NCS 1   1
STAT:20604 - Bloomfield Avenue            NCS 1   1
STAT:20605 - Park Avenue                  NCS 1   1
STAT:20606 - Orange Street                NCS 1   1
STAT:20607 - Norfolk Street               NCS 1   1
! Intra-Downtown Travel Half Price per T. Marchwinski Meeting 7/14/04
! By Jeff Roux
STAT:20608 - Warren Street                NCS 1   2
STAT:20609 - Washington Street            NCS 1   2
STAT:20610 - Broad Street (Military Park) NCS 1   2
STAT:20621 - Newark Broad Street          NCS 1   2
STAT:20622 - Washington Park              NCS 1   2
STAT:20623 - Stadium                      NCS 1   2
STAT:20624 - Atlantic Street              NCS 1   2
STAT:20625 - NJPAC                        NCS 1   2
STAT:20649 - Newark Penn Station          NCS 1   2
!
!
FHDG:         1    2
FARE:    1 110. 110.
FARE:    2    .  55.
```

The commuter rail, ferry and Newark city subway modes use a zone-based fare system. Each of these systems are described below.

Commuter Rail Fares

Each individual commuter rail station is assigned to a fare zone. The commuter rail fare zones are shown in Table 21 below.

Table 21 – NJRTM-E Commuter Rail Fare Zones

ZONE NO.	ZONE NAME
1	NEW YORK NEC/NJC
2	NEW YORK M&E
3	NEW YORK MAIN/BERGEN/PAS
4	HOBOKEN NEC
5	NEWARK/ HOBOKEN OTHER
6	SECAUCUS
21	ELIZABETH
22	LINDEN
31	CRANFORD
32	RAHWAY
41	AVENEL
42	MET PK/WDBRG
51	METUCHEN
52	PERTH AMBOY
61	EDSN/S AMBY
62	NEW BRUNSWICK
71	S BRUNSWICK/MATAWAN
72	HAZLET
81	MIDDLETOWN
91	RED BANK
101	PRNTN/LTTL SL
111	LONG BRANCH
121	HAMILTON/ASB
131	TRENTON/BELMAR
141	PT PLEASANT
151	BAY HEAD
161	SALISBURY MILLS
171	CAMPBELL HALL
181	MIDDLETOWN
191	OTISVILLE
201	PORT JERVIS-CORNWALL HEIGHTS (SEPTA)
202	EDDINGTON-BRISTOL (SEPTA)
203	LEVITTOWN (SEPTA)
204	TRENTON (SEPTA)

The stations, the commuter rail lines are associated with, and their corresponding zone numbers are shown in Table 22 below.

Table 22 – NJRTM-E Station Fare Zone Numbers

STATION	LINE	ZONE	STATION	LINE	ZONE	STATION	LINE	ZONE	STATION	LINE	ZONE
NY Penn Station	NEC	1	Rahway	NEC	32	Morris Plain	ME	91	Lyndhurst	BER	22
NY Penn Station	RAR	1	Linden	NEC	31	Morristown	ME	81	Kingsland	BER	22
NY Penn Station	ME	2	Elizabeth	NEC	21	Convent Station	ME	72	Glen Rock(Bergen)	BER	52
NY Penn Station	BER	3	N. Elizabeth	NEC	21	Madison	ME	71	Radburn	BER	42
NY Penn Station	PAS	3	High Bridge	RAR	121	Chatham	ME	62	Broadway	BER	42
Secaucus	NEC	7	Annandale	RAR	111	Gladstone	ME	111	Plauderville	BER	41
Secaucus	BER	6	Lebanon	RAR	111	Peapack	ME	111	Garfield	BER	32
Secaucus	PAS	6	White House	RAR	101	Far Hills	ME	101	Rutherford	BER	31
Newark Penn Station	NEC	5	N. Branch	RAR	91	Bernardsville	ME	91	Harmon Cove	PAS	21
Newark Penn Station	RAR	5	Raritan	RAR	81	Basking Ridge	ME	91	Spring Valley	PAS	72
Hoboken Terminal	NEC	4	Somerville	RAR	81	Lyons	ME	81	Nanuet	PAS	71
Hoboken Terminal	BTN	5	Bridgewater	RAR	71	Millington	ME	81	Pearl River	PAS	71
Hoboken Terminal (Morr)	ME	5	Bound Brook	RAR	62	Stirling	ME	81	Montvale	PAS	62
Hoboken Terminal (Glad)	ME	5	Dunnellen	RAR	52	Gillette	ME	72	Park Ridge	PAS	62
Hoboken Terminal	MAI	5	Plainfield	RAR	51	Berkeley Heights	ME	71	Woodcliff Lake	PAS	62
Hoboken Terminal	BER	5	Netherwood	RAR	42	Murray Hill	ME	62	Hillsdale	PAS	61
Hoboken Terminal	PAS	5	Fanwood	RAR	41	New Providence	ME	61	Westwood	PAS	61
MNR Grand Central	MNR	3	Westfield	RAR	32	Summit	ME	61	Emerson	PAS	52
Bayhead Station	NEC	141	Garwood	RAR	32	Short Hills	ME	51	Oradell	PAS	51
Pt. Pleasant Beach	NEC	141	Cranford	RAR	31	Millburn	ME	51	River Edge	PAS	42
Manasquan	NEC	141	Roselle Park	RAR	22	Maplewood	ME	42	N. Hackensack	PAS	42
Spring Lake	NEC	131	Hackettstown	BNT	131	South Orange	ME	41	Anderson St	PAS	41
Belmar	NEC	131	Mount Olive	BNT	131	Mountain Station	ME	41	Essex St	PAS	41
Bradley Beach	NEC	121	Netcong	BNT	121	Highland Avenue	ME	41	Teterboro	PAS	32
Asbury Park	NEC	121	Lake Hopatcong	BNT	121	Orange	ME	32	Woodridge	PAS	31
Allenhurst	NEC	121	Howard Blvd	BNT	111	Brick Church	ME	32	Cornwall Heights	SR7	201
Elberon	NEC	111	Dover	BNT	101	East Orange	ME	32	Eddington	SR7	202
Long Branch	NEC	111	Denville	BNT	91	Nwk Broad St	ME	22	Croydon	SR7	202
Little Silver	NEC	101	Mountain Lakes	BNT	81	Port Jervis	BER	201	Bristol	SR7	202
Red Bank	NEC	91	Boonton	BNT	81	Otisville	BER	191	Levittown	SR7	203
Middletown	NEC	81	Towaco	BNT	71	Middleton	BER	181	Trenton (SEPTA)	SR7	204
Hazlet	NEC	72	Lincoln Park	BNT	62	Campbell Hall	BER	171	MNR Beacon	MNR	91
Matawan	NEC	71	Mountain View (Wayne)	BNT	61	Salisbury Mills	BER	161	MNR Peakskill	MNR	72
South Amboy	NEC	61	Little Falls	BNT	52	Harriman	BER	121	MNR Ossinning	MNR	61
Perth Amboy	NEC	52	Great Notch	BNT	51	Tuxedo	BER	91	MNR Tarrytown	MNR	61
Woodbridge	NEC	42	Montclair State Univ.	BNT	42	Sloatsburg	BER	91	Wattessing Avenue	ME	32
Avenel	NEC	41	Montclair Heights	BNT	42	Suffern	BER	81	Mount Tabor	ME	91
Trenton	NEC	131	Mountain Ave	BNT	42	Mahwah	BER	81	Clifton	BER	41
Hamilton	NEC	101	Upper Montclair	BNT	41	Route 17	BER	72	Passaic	BER	32
Princeton	NEC	101	Watchung Ave	BNT	41	Ramsey	BER	72	Delwanna	BER	31
Princeton Jct. (shuttle)	NEC	101	Walnut St	BNT	41	Allendale	BER	71	Glen Rock (Main)	BER	52
Princeton Jct.	NEC	101	Benson St	BNT	32	Waldwick	BER	62	Hawthorne	BER	51
Jersey Avenue	NEC	62	Rowe St	BNT	31	Ho-Ho-Kus	BER	62	Paterson	BER	42
New Brunswick	NEC	62	Arlington	BNT	22	Ridgewood	BER	61	Glen Ridge	ME	32
Edison	NEC	61	Metropark	NEC	42	Bay Street	ME	41	Bloomfield	ME	32
Metuchen	NEC	51									

The NJRTM-E adopted the two commuter rail fare systems for the peak and off-peak periods. Table 23 below summarizes the Year 2015 peak period rail fare matrix, while Table 24 below summarizes the off-peak period rail fare matrix.

Table 23 – Year 2015 NJ Transit Peak Period Commuter Rail Fares

ZONE	1	2	3	4	5	6	7	8	21	22	31	32	41	42	51	52	53	61	62	63	71	72	81	91	101	111	121	131	141	151	161	171	181	191	201	202	203	204
1	1.38	1.38	1.38	2.13	2.53	2.13	2.13	2.13	3.50	3.78	4.23	4.50	4.95	5.18	5.60	5.88	5.88	6.35	6.58	6.58	7.00	7.28	7.43	5.65	7.53	7.73	7.73	8.00	8.00	8.00	6.75	6.98	7.20	7.63	8.20	8.20	8.20	820
2		1.38	1.38	2.13	2.53	2.13	2.13	2.13	2.33	2.53	2.85	3.08	3.50	3.78	4.23	4.50	4.50	4.95	5.18	5.18	5.60	5.88	6.58	7.28	7.43	7.53	7.53	7.53	8.00	8.00	6.75	6.98	7.20	7.63	8.20	8.20	8.20	820
3			1.38	2.13	2.53	2.13	2.13	2.13	2.33	2.53	2.85	3.08	3.50	3.78	4.23	4.50	4.50	4.95	5.18	5.18	5.60	5.88	6.58	7.28	7.43	7.53	7.53	7.53	8.00	8.00	6.75	6.98	7.20	7.63	8.20	8.20	8.20	820
4				1.38	1.38	1.38	1.38	1.38	1.38	1.63	2.13	2.40	2.85	3.05	3.50	3.78	3.78	4.23	4.50	4.50	4.95	5.18	5.30	5.43	5.43	5.60	5.60	5.88	5.88	5.88	5.48	5.70	5.93	6.35	6.93	6.93	6.93	693
5					1.38	1.38	1.38	1.38	1.38	1.63	2.13	2.40	2.85	3.05	3.50	3.78	3.78	4.20	4.50	4.50	4.95	5.18	5.30	5.43	5.43	5.60	5.60	5.88	5.88	5.88	6.88	7.10	7.33	7.75	8.33	8.33	8.33	833
6						1.38	1.38	1.38	1.63	2.13	2.38	2.75	3.05	3.50	4.13	4.38	4.38	4.63	4.88	4.88	4.95	5.18	5.30	5.43	5.43	5.60	5.28	5.88	5.88	5.88	5.48	5.70	5.93	6.35	6.93	6.93	6.93	693
7							1.38	1.38	3.50	3.78	4.23	4.50	4.95	5.18	5.60	5.88	5.88	6.35	6.58	6.58	7.00	7.28	7.43	5.65	7.53	7.73	7.73	8.00	8.00	8.00	5.48	5.70	5.93	6.35	6.93	6.93	6.93	693
8								1.38	2.33	2.53	2.85	3.08	3.50	3.78	4.23	4.50	4.50	4.95	5.18	5.18	5.60	5.88	6.58	7.28	7.43	7.53	7.53	7.53	8.00	8.00	5.48	5.70	5.93	6.35	6.93	6.93	6.93	693
21									1.00	1.00	1.00	1.00	1.38	1.63	2.13	2.40	2.40	2.85	3.05	3.05	3.50	3.78	4.45	4.50	4.70	4.70	4.95	4.95	5.18	5.18	4.48	4.88	5.13	5.33	5.78	5.78	5.78	578
22										1.00	1.00	1.00	1.00	1.38	1.73	2.13	2.13	2.40	2.85	2.85	3.08	3.50	4.23	4.45	4.50	4.70	4.70	4.70	4.95	4.95	4.48	4.88	5.13	5.33	5.78	5.78	5.78	578
31											1.00	1.00	1.00	1.00	1.38	1.63	1.63	2.13	2.40	2.40	2.85	3.05	3.78	4.45	4.50	4.70	4.70	4.95	4.95	4.95	4.33	4.75	5.03	5.25	5.73	5.73	5.73	573
32												1.00	1.00	1.00	1.00	1.38	1.38	1.73	2.13	2.13	2.40	2.85	3.50	4.23	4.45	4.50	4.70	4.70	4.95	4.95	4.18	4.70	4.93	5.23	5.60	5.60	5.60	560
41													1.00	1.00	1.00	1.00	1.00	1.38	1.63	1.63	2.13	2.40	3.05	3.78	4.45	4.50	4.70	4.70	4.95	4.95	4.03	4.48	4.73	5.08	5.48	5.48	5.48	548
42														1.00	1.00	1.00	1.00	1.00	1.38	1.38	1.63	2.13	2.85	3.50	4.23	4.45	4.50	4.70	4.70	4.70	3.83	4.33	4.63	5.00	5.38	5.38	5.38	538
51															1.00	1.00	1.00	1.00	1.00	1.00	1.38	1.63	2.40	3.05	3.78	4.45	4.50	4.70	4.70	4.70	3.70	4.20	4.43	4.88	5.33	5.33	5.33	533
52																1.00	1.00	1.00	1.00	1.00	1.00	1.38	2.13	2.85	3.50	4.23	4.45	4.50	4.70	4.70	3.50	4.03	4.30	4.70	5.25	5.25	5.25	525
53																	1.00	1.00	1.00	1.00	1.00	1.00	1.38	2.13	2.85	3.50	4.23	4.45	4.50	4.70	4.70	3.50	4.03	4.30	4.70	4.70	4.70	470
61																		1.00	1.00	1.00	1.00	1.00	1.63	2.40	3.05	3.78	4.45	4.50	4.70	4.70	3.30	3.88	4.18	4.60	5.08	5.08	5.08	508
62																			1.00	1.00	1.00	1.00	1.38	2.13	2.85	3.50	4.23	4.45	4.50	4.50	3.10	3.68	3.98	4.48	5.00	5.00	5.00	500
63																				1.00	1.00	1.00	1.38	2.13	2.85	3.50	4.23	4.45	4.50	4.50	3.10	3.68	3.98	4.48	5.00	5.00	5.00	500
71																					1.00	1.00	1.00	1.63	2.40	3.05	3.78	4.45	4.50	4.50	2.93	3.50	3.80	4.28	4.68	4.68	4.68	468
72																						1.00	1.00	1.38	2.13	2.85	3.50	4.23	4.45	4.45	2.73	3.35	3.68	4.15	4.58	4.58	4.58	458
81																							1.00	1.00	1.63	2.40	3.05	3.78	4.45	4.45	2.45	2.65	3.10	3.30	3.70	3.70	3.70	370
91																								1.00	1.00	1.63	2.40	3.05	3.78	3.78	2.05	2.25	2.83	3.10	3.50	3.50	3.50	350
101																									1.00	1.00	1.63	2.40	3.05	3.05	1.75	2.00	2.25	2.75	3.25	3.25	3.25	325
111																										1.00	1.00	1.63	2.40	2.40	3.05	1.63	1.88	2.13	2.88	2.88	2.88	288
121																											1.00	1.00	1.63	1.63	1.08	1.53	2.18	2.70	3.18	3.18	3.18	318
131																												1.00	1.00	1.00	0.88	1.53	2.18	2.45	3.00	3.00	3.00	300
141																													1.00	1.00	1.00	0.88	1.53	2.18	2.83	2.83	2.83	283
151																														1.00	1.00	0.88	1.53	2.18	2.83	2.83	2.83	283
161																															1.00	0.88	1.53	2.18	2.83	2.83	2.83	283
171																																1.00	1.08	1.73	2.60	2.60	2.60	260
181																																	1.00	1.28	2.23	2.23	2.23	223
191																																		1.00	1.60	1.60	1.60	160
201																																			2.10	2.10	2.45	245
202																																				2.10	2.10	245
203																																					2.10	210
204																																						210

Table 24 – Year 2015 NJ Transit Off-Peak Period Commuter Rail Fares

ZONE	1	2	3	4	5	6	7	8	21	22	31	32	41	42	51	52	53	61	62	63	71	72	81	91	101	111	121	131	141	151	161	171	181	191	201	202	203	204
1	2.00	2.00	2.00	3.05	3.65	3.05	3.05	3.05	5.05	5.45	6.05	6.45	7.10	7.45	8.05	8.45	8.45	9.10	9.45	9.45	10.05	10.45	10.65	8.10	10.80	11.10	11.10	11.45	11.45	11.45	9.70	10.00	10.30	10.95	11.75	11.75	11.75	820
2		2.00	2.00	3.05	3.65	3.05	3.05	3.05	3.35	3.65	4.10	4.45	5.05	5.45	6.05	6.45	6.45	7.10	7.45	7.45	8.05	8.45	9.45	10.45	10.65	10.80	10.80	10.80	11.45	11.45	9.70	10.00	10.30	10.95	11.75	11.75	11.75	820
3			2.00	3.05	3.65	3.05	3.05	3.05	3.35	3.65	4.10	4.45	5.05	5.45	6.05	6.45	6.45	7.10	7.45	7.45	8.05	8.45	9.45	10.45	10.65	10.80	10.80	10.80	11.45	11.45	9.70	10.00	10.30	10.95	11.75	11.75	11.75	820
4				2.00	2.00	2.00	2.00	2.00	2.00	2.35	3.05	3.45	4.10	4.40	5.05	5.45	5.45	6.05	6.45	6.45	7.10	7.45	7.60	7.80	7.80	8.05	8.05	8.45	8.45	8.45	7.85	8.20	8.50	9.10	9.95	9.95	9.95	693
5					2.00	2.00	2.00	2.00	2.00	2.35	3.05	3.45	4.10	4.40	5.05	5.45	5.45	6.05	6.45	6.45	7.10	7.45	7.60	7.80	7.80	8.05	8.05	8.45	8.45	8.45	9.85	10.20	10.50	11.10	11.95	11.95	11.95	833
6						2.00	2.00	2.00	2.35	3.05	3.45	3.95	4.40	5.05	5.95	6.30	6.30	6.65	7.00	7.00	7.10	7.45	7.60	7.80	7.80	8.05	7.60	8.45	8.45	8.45	7.85	8.20	8.50	9.10	9.95	9.95	9.95	693
7							2.00	2.00	5.05	5.45	6.05	6.45	7.10	7.45	8.05	8.45	8.45	9.10	9.45	9.45	10.05	10.45	10.65	8.10	10.80	11.10	11.10	11.45	11.45	11.45	7.85	8.20	8.50	9.10	9.95	9.95	9.95	693
8								2.00	3.35	3.65	4.10	4.45	5.05	5.45	6.05	6.45	6.45	7.10	7.45	7.45	8.05	8.45	9.45	10.45	10.65	10.80	10.80	10.80	11.45	11.45	7.85	8.20	8.50	9.10	9.95	9.95	9.95	693
21									1.45	1.45	1.45	1.45	2.00	2.35	3.05	3.45	3.45	4.10	4.40	4.40	5.05	5.45	6.40	6.45	6.75	6.75	7.10	7.10	7.45	7.45	6.45	7.00	7.35	7.65	8.30	8.30	8.30	578
22										1.45	1.45	1.45	1.45	2.00	2.50	3.05	3.05	3.45	4.10	4.10	4.45	5.05	6.05	6.40	6.45	6.75	6.75	6.75	7.10	7.10	6.45	7.00	7.35	7.65	8.30	8.30	8.30	578
31											1.45	1.45	1.45	1.45	2.00	2.35	2.35	3.05	3.45	3.45	4.10	4.40	5.45	6.40	6.45	6.75	6.75	7.10	7.10	7.10	6.20	6.80	7.20	7.55	8.20	8.20	8.20	573
32												1.45	1.45	1.45	1.45	2.00	2.00	2.50	3.05	3.05	3.45	4.10	5.05	6.05	6.40	6.45	6.75	6.75	7.10	7.10	6.00	6.75	7.05	7.50	8.05	8.05	8.05	560
41													1.45	1.45	1.45	1.45	1.45	2.00	2.35	2.35	3.05	3.45	4.40	5.45	6.40	6.45	6.75	6.75	7.10	7.10	5.80	6.45	6.80	7.30	7.85	7.85	7.85	548
42														1.45	1.45	1.45	1.45	1.45	2.00	2.00	2.35	3.05	4.10	5.05	6.05	6.40	6.45	6.75	6.75	6.75	5.50	6.20	6.65	7.15	7.70	7.70	7.70	538
51															1.45	1.45	1.45	1.45	1.45	1.45	2.00	2.35	3.45	4.40	5.45	6.40	6.45	6.75	6.75	6.75	5.30	6.05	6.35	7.00	7.65	7.65	7.65	533
52																1.45	1.45	1.45	1.45	1.45	1.45	2.00	3.05	4.10	5.05	6.05	6.40	6.45	6.75	6.75	5.05	5.80	6.15	6.75	7.55	7.55	7.55	525
53																	1.45	1.45	1.45	1.45	1.45	1.45	2.00	3.05	4.10	5.05	6.05	6.40	6.45	6.75	6.75	5.05	5.80	6.15	6.75	6.75	6.75	470
61																		1.45	1.45	1.45	1.45	1.45	2.35	3.45	4.40	5.45	6.40	6.45	6.75	6.75	4.75	5.55	6.00	6.60	7.30	7.30	7.30	508
62																			1.45	1.45	1.45	1.45	2.00	3.05	4.10	5.05	6.05	6.40	6.45	6.45	4.45	5.30	5.70	6.45	7.15	7.15	7.15	500
63																				1.45	1.45	1.45	2.00	3.05	4.10	5.05	6.05	6.40	6.45	6.45	4.45	5.30	5.70	6.45	7.15	7.15	7.15	500
71																					1.45	1.45	1.45	2.35	3.45	4.40	5.45	6.40	6.45	6.45	4.20	5.05	5.45	6.15	6.70	6.70	6.70	468
72																						1.45	1.45	2.00	3.05	4.10	5.05	6.05	6.40	6.40	3.95	4.80	5.30	5.95	6.55	6.55	6.55	458
81																							1.45	1.45	2.35	3.45	4.40	5.45	6.40	6.40	3.55	3.80	4.45	4.75	5.30	5.30	5.30	370
91																								1.45	1.45	2.35	3.45	4.40	5.45	5.45	2.95	3.25	4.05	4.45	5.05	5.05	5.05	350
101																									1.45	1.45	2.35	3.45	4.40	4.40	2.55	2.90	3.25	3.95	4.65	4.65	4.65	325
111																										1.45	1.45	2.35	3.45	3.45	4.40	2.35	2.70	3.05	4.15	4.15	4.15	288
121																											1.45	1.45	2.35	2.35	1.55	2.20	3.15	3.90	4.55	4.55	4.55	318
131																												1.45	1.45	1.45	1.30	2.20	3.15	3.55	4.30	4.30	4.30	300
141																													1.45	1.45	1.45	1.30	2.20	3.15	4.05	4.05	4.05	283
151																														1.45	1.45	1.30	2.20	3.15	4.05	4.05	4.05	283
161																															1.45	1.30	2.20	3.15	4.05	4.05	4.05	283
171																																1.45	1.55	2.50	3.75	3.75	3.75	260
181																																	1.45	1.85	3.20	3.20	3.20	223
191																																		1.45	2.30	2.30	2.30	160
201																																			3.00	3.00	3.50	245
202																																				3.00	3.00	245
203																																					3.00	210
204																																						210

Ferry Fares

The fare policy for the ferry and long-distance ferry modes is similar to the commuter rail mode in that it is a zone-based fare system and there is a peak and an off-peak fare calculation in place. The zone classification for the ferry mode is shown in Table 25. The station-to-zone mapping for the ferry system is shown in Table 26.

Table 25 – Zone Classification for Ferry Mode

Zone	Zone #
Midtown Manhattan	1
Lower Manhattan	2
Staten Island	3
Port Imperial	4
Hoboken	5
Highlands/Atlantic Highlands	6
South Amboy	7
Colgate	8
West Haverstraw/Ossining	9
Harborside	10
Port Liberte	11
Belford	12
Newport	13
Liberty Harbor	14
North Hoboken	15
Lincoln Harbor	16

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Table 26 – Station-to-Zone Mapping for Ferry Zone

Ferry Station	Zone #
East 34th Street	1
West 38th Street	1
Fulton Ferry Terminal	2
Pier 11	2
Pier 11	2
South Ferry	2
World Financial Center	2
St. Georges (SI)	3
Port Imperial	4
Hoboken	5
Atlantic Highlands	6
Highlands	6
South Amboy	7
Colgate	8
Ossining	9
West Haverstraw	9
Harborside	10
Port Liberte	11
Belford	12
Newport	13
Liberty Harbor	14
North Hoboken	15
Lincoln Harbor	16

The peak-period ferry fare matrix and the off-peak period ferry fare matrix are shown in Table 27 and Table 28 respectively. Note that all values are expressed in dollars.

Table 27 – Year 2000 NJ TRANSIT Peak Period Ferry Fares

ZONE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	99.99	99.99	99.99	5.28	6.00	14.83	14.83	5.25	99.99	5.25	99.99	14.83	5.73	5.25	6.00	5.28
2		4.88	0.00	5.29	4.56	14.83	14.83	4.56	99.99	4.56	6.75	14.83	99.99	4.56	4.56	99.99
3			99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4				99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5					99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6						99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7							99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8								99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
9									2.50	99.99	99.99	99.99	99.99	99.99	99.99	99.99
10										99.99	99.99	99.99	99.99	99.99	99.99	99.99
11											99.99	99.99	99.99	99.99	99.99	99.99
12												99.99	99.99	99.99	99.99	99.99
13													99.99	99.99	99.99	99.99
14														99.99	99.99	99.99
15															99.99	99.99
16																99.99

Table 28 – Year 2000 NJ TRANSIT Off-Peak Period Ferry Fares

ZONE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	99.99	99.99	99.99	5.28	6.00	14.83	14.83	5.25	99.99	5.25	99.99	14.83	5.73	5.25	6.00	5.28
2		4.88	0.00	5.29	4.56	14.83	14.83	4.56	99.99	4.56	6.75	14.83	99.99	4.56	4.56	99.99
3			99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4				99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5					99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6						99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7							99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8								99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
9									2.50	99.99	99.99	99.99	99.99	99.99	99.99	99.99
10										99.99	99.99	99.99	99.99	99.99	99.99	99.99
11											99.99	99.99	99.99	99.99	99.99	99.99
12												99.99	99.99	99.99	99.99	99.99
13													99.99	99.99	99.99	99.99
14														99.99	99.99	99.99
15															99.99	99.99
16																99.99

Newark City Subway Fares

The Newark City Subway fare system has three zone classifications. At present, a constant fare rate is maintained for all zone-to-zone travel except for the intra-downtown travel for which half price of the regular fare is charged. The zone classification for the Newark City Subway system is shown in Table 29 and the station-to-zone mapping is shown in Table 30.

Table 29 – Zone Classification for Newark City Subway Mode

Zone	Zone #
Non-Downtown Nwk Stations	1
Downtown Nwk Stations	2
Broad Street Extention	3

Table 30 – Station-to-Zone Mapping for Newark City Subway Mode

NCS Station Name	Zone #
Bloomfield Avenue	1
Branch Brook Park	1
Davenport Avenue	1
Grove Street	1
Norfolk Street	1
Orange Street	1
Park Avenue	1
Silver Lake	1
Broad Street Downtown	2
Newark Penn Grove Inbound	2
Newark Penn Grove Outbound	2
Warren Street	2
Washington Street	2
Atlantic Street	3
Broad Street Station	3
Newark Penn Broad Inbound	3
Newark Penn Broad Outobound	3
NJPAC	3
Stadium	3
Washington Park	3

The year 2015 peak and off-peak fare matrix for the Newark Subway is shown in Table 31.

Table 31 – Year 2000 Fare Matrix for Newark City Subway Mode

ZONE	1	2
1	1.10	1.10
2		0.55

4.3.3 Station Specific Fare System

The file format for the station-specific fare system used for the PNR charges and special bus stations is listed in Table 32. Figure 17 shows a 'Station Specific' Fare file. The PNR parking cost is calculated by dividing the monthly PNR cost for that station by 40.

Table 32 – File Structure for 'Station Specific Fare' Files

Field Number	Variable
1	Fare in cents
2	Transit Node number

Figure 17 – Sample 'Station Specific' Fare File

PNR.FAR

```
; RAIL PARK RIDES
    00 22000 ;--- Bayhead
    00 22001 ;--- Point Pleasant
    00 22002 ;--- Manasquan
    00 22003 ;--- Spring Lake
    00 22004 ;--- Belmar
    00 22005 ;--- Bradley Beach
    00 22006 ;--- Asbury Park
    00 22007 ;--- Allenhurst
    00 22008 ;--- Elberon
   250 22009 ;--- Long Branch
   250 22010 ;--- Long Branch
    95 22011 ;--- Little Silver
   125 22012 ;--- Red Bank
   190 22013 ;--- Middletown
   250 22014 ;--- Hazlet
   250 22015 ;--- Matawan
   250 22016 ;--- South Amboy
    00 22017 ;--- Perth Amboy
    00 22018 ;--- Woodbridge
    00 22019 ;--- Avenel
; Published monthly ($135 at Trenton)
   475 22050 ;--- Trenton
   425 22051 ;--- Hamilton (1990 $)
    00 22052 ;--- Princeton
    00 22053 ;--- Princeton Junction Dinky
   180 22054 ;--- Princeton Junction
   225 22055 ;--- Jersey Avenue
```

length : 11,358 Ln : 1 Col : 1 Sel : 0 | 0 Windows (CR LF) UTF-8 INS

4.3.4 Special Bus Station Premiums

The transit stations and the corresponding add-on fares are listed in Table 33. These added costs to the distance-based fares are included to estimate the total costs from the regional PNR lots.

Table 33 – Premium Bus Stations and Add-On Fares

Premium Fares (in cents)	Node Number
-25.00	9863
550.00	8926
25.00	5005

4.3.5 Fixed Fare System

The LRT, New York City Subway and PATH systems use a fixed fare system. The PATH and LRT fare systems have been coded as "zone-based" fare systems to accommodate future changes in the fare calculation methodology. All the fares are in Year 2015 dollars.

Light Rail Transit

The peak period fare in the model for LRT travel is $ 1.35 while for the off-peak period it is $1.50. The peak period fare is calculated by dividing the monthly pass fare by 40 and the off-peak period fare is the cost of a one-way trip.

New York City Subway

All trips are charged the equivalent of the monthly pass fare divided by 40 ($2.00) upon entering the system.

PATH Line

The model uses a fare of $1.20 during the peak period, while in the off-peak period the fare is $1.50. The peak period fare is calculated by dividing the monthly pass fare by 40 and the off-peak period fare is the cost of one-way trip.

4.3.6 Transfer Costs

Inter/Intra modal transfer costs, in addition to the flat fares for modes including New York City Subway and PABT Local Bus are input to the model through the "Usage.far" file. The file format for 'Usage.far' is listed in Table 34 and Table 35 lists fares in the usage.far file.

Table 34 – File Structure for 'Usage Fare' Files

Field Number	Variable
1	Fare Adjustment in cents
2	Mode/Transfer combination (MTC) Number

Table 35 – Transfer Fare Costs

Fare Adjustment	MTC Number	Mode / Transfer Combination
120	1	PATH Fare
200	2	Subway Fare
110	3	NCS Fare
240	4	Mode 7 Fare
50	5	Ferry Fare
70	6	PABT Local Bus
-102	7	LRT to Port Imperial Ferry Adjustment
122	8	SEPTA Station Add-on
-58	9	Rail to LRT Discount
-50	10	Rail to NCS Discount
-100	11	Bus to Port Imperial Ferry Adjustment
-200	12	RVL - JCL/NEC Transfer Adjustment Fare (PK)
-275	13	RVL - JCL/NEC Transfer Adjustment Fare (OP)
528	14	Pt Imperial Fare to 38th Street (Arthur's PK)
487	15	Pt Imperial Fare to 38th Street (Arthur's OP)
600	16	Other Waterfront to 38th Street (Arthur's PK)
487	17	Pt Imperial Fare to 38th Street (Arthur's OP)

The PATH, Ferry and NCS fares listed in the “Usage.far” file are ignored by the model. MTC Numbers 7 and 9 through 11 are used for the various inter-modal transfer combinations, while MTC numbers 12 through 17 are used for special cases of intra-modal transfers (commuter rail-to-commuter rail and ferry-to-ferry). A sample “Usage.far” is shown in Figure 18.

Figure 18 – Sample “Usage.far” File

Usage.FAR

```
; PATH, NCS and LRT Fare Not Done Here, Use Fare Matrix
 120  1 ;---- PATH Fare ----
 200  2       ;---- Subway Fare ----
 110  3 ;---- NCS Fare ----
 240  4 ;---- Mode 7 Fare ----
  50  5       ;---- Ferry Fare ----
  70  6 ;---- PABT Local Bus ----
-102  7 ;---- LRT to Port Imperial Ferry Adjustment
 122  8 ;---- SEPTA Station Add-on
-058  9       ;---- Rail to LRT Discount
-050 10       ;---- Rail to NCS Discount
-100 11       ;---- Bus to Port Imperial Ferry Adjustment
; J. Roux here. Transfers between RVL and JCL/NEC do not pay the max
; of NYPS fare but rather Nwk Penn Station fare. #12 and #13 below represent
; the difference between fares to NYPS (pivot) and actual.
; This ensures the proper fare is charged for suburban RVL to suburban
; JCL/NEC and vica-versa.
-200 12       ;---- RVL - JCL/NEC Transfer Adjustment Fare (Peak)
-275 13       ;---- RVL - JCL/NEC Transfer Adjustment Fare (Off-Peak)
 528 14       ;---- Pt Imperial Fare to 38th Street (Arthur's Peak)
 487 15       ;---- Pt Imperial Fare to 38th Street (Arthur's OP)
 600 16       ;---- Other Waterfront to 38th Street (Arthur's Peak)
 487 17       ;---- Pt Imperial Fare to 38th Street (Arthur's OP)
```

length : 1,208 | Ln : 1 Col : 2 Sel : 0 | 0 | Windows (CR LF) | UTF-8 | INS

5. HIGHWAY PATH-BUILDING

5.1 INTRODUCTION

The highway path-building procedure is used to accumulate impedances for use by the trip generation, trip distribution, and the mode choice model components. The impedances include auto travel time, terminal time, and tolls for each origin-destination zonal pair. These impedance values are stored as a series of matrix files, often referred to as "skim" files. The content of each skim table is structured for use by one or more of the model components referenced above.

5.2 HIGHWAY PATH BUILDING PROCESS

The highway path-building process was developed to provide necessary travel time estimates for several model components. The trip generation component uses uncongested travel time as an accessibility variable for the allocation of attractions by income level. Highway travel times are used as part of the composite impedance terms that provides a measure of spatial separation for the trip distribution process. Lastly, the highway skims for time, distance, and toll costs are used as impedances for the mode choice model. The selection of the minimum path for each zonal pair was based solely on the highway travel time, since time is the primary component influencing travel determination. The path-building routine accumulates all the remaining impedance variables as the minimum path for each zonal pair was processed.

The path-building process is performed for peak and off-peak periods. The off-peak path building process was performed only during the first iteration of the model, while the peak period skims are accumulated during each iteration of the model. Table 36 lists the skim variables for each time-period.

Table 36 – Highway Path-Building Impedance Variables

Time Period	Table No	Impedance Variables
Peak	1	congested time - SOV
	2	congested tolls (dollars) - SOV
	3	congested distance - SOV
	4	congested tolls (cents) - SOV
	5	congested time - HOV
	6	congested tolls (dollars) - HOV
	7	congested distance - HOV
	8	congested tolls (cents) - HOV
	9	terminal time (total access and egress time for i-j pairs)
	10	SOV time + terminal time
	11	HOV time + terminal time
Off-Peak	1	uncongested time - SOV
	2	uncongested tolls (dollars) - SOV
	3	uncongested distance - SOV
	4	uncongested toll (cents) - SOV
	5	uncongested time - HOV
	6	uncongested tolls (dollars) - HOV
	7	uncongested distance - HOV
	8	uncongested tolls (cents) - HOV
	9	terminal time (total access and egress time for i-j pairs)
	10	SOV time + terminal time
	11	HOV time + terminal time
	12	uncongested time - Truck
	13	uncongested tolls (dollars) - Truck
	14	uncongested distance - Truck
	15	Truck time + terminal time

The access and egress terminal times are defined at the area type of zone and the total terminal time for a given origin-destination zonal pair is the summation of egress time at the origin and the access time at the destination zone. The terminal times for each zone range between 1 and 7 minutes and are stored in the ZONECOSTTIME.DBF file.

5.3 MODE SPECIFIC PATH BUILDING

In the path-building process, the NJRTM-E estimates paths for three different vehicle types or "modes": those being SOV, HOV, and Truck. The inclusion or exclusion of highway links for each mode-specific path is controlled by the "LINKTYPE" variable as described previously in the highway network development section of this document. This variable serves as a "permission" code to utilize the individual highway links based on travel mode and, during the highway assignment process, both mode and toll condition.

5.4 INTRAZONAL TIME ESTIMATION

The intrazonal time was estimated in the final step of the highway path-building process. This time was necessary for the trip distribution process. Intrazonal time was calculated based on the zonal size as follows:

- For zones in the detailed study area, the intrazonal time was calculated using half of the sum of time from two (2) closest "nonzero" zones, and then multiplied it by 0.60. The 0.60 value was obtained to replicate the intrazonal times in the original NJRTM.

- For zones in the more aggregated outlying regions (usually reflected by the zonal size of district level or higher), the intrazonal time was calculated using the time from the nearest zone multiplied by 0.6.

5.5 SKIM FILES FOR MODE CHOICE

As a final step in the highway path-building process, the skim files were formatted to be consistent with requirements for the NJ Transit mode choice model. The mode choice model was developed using a customized C-Based program that required matrix data to be provided in MINUTP format. To accommodate this requirement, the Voyager routines stored the output in this format as opposed to the standard matrix format. Table 37 lists the variables by time period.

Table 37 – Skim File Structure for Mode Choice

Time Period/Mode	Table No	Impedance Variables
Peak/SOV	1	time (minutes)
	2	distance (1/100 of miles)
	3	time (1/100 of minutes)
	4	costs (cents)
Peak/HOV	1	time (minutes)
	2	distance (1/100 of miles)
	3	time (1/100 of minutes)
	4	costs (cents)
Off-Peak/All modes	1	time (minutes)
	2	distance (1/100 of miles)
	3	time (1/100 of minutes)
	4	costs (cents)

6. TRANSIT PATH-BUILDING

6.1 INTRODUCTION

The transit path-building procedure is used to accumulate impedances for the transit modes that are available within the mode choice model. The impedances include transit in-vehicle time and various out-of-vehicle time measures such as walk time and wait time. These impedance values are accumulated in matrix files based on definition of the mode choice model variables. It should be noted that transit paths are established by time-period for each “access submode/line-haul mode combination” and that paths are developed based on minimum travel times weighted by time component.

6.2 MODE HIERARCHY

Since travel through the transit networks often requires transfers between various transit modes, such as transfer from a NJ Transit commuter rail line to the PATH system, it is necessary to establish a hierarchy between the modes to define which mode is the “primary mode” and which modes act as secondary transfer modes. The NJRTM-E model adopted the hierarchical system developed for the NJ Transit Mode Choice Model, which is based solely on the use of particular modes at any point during the travel path. The hierarchical system is defined as follows:

- A path is defined as the commuter rail mode if it contains time on the commuter rail lines.
- A path is defined as the “LRT mode” if includes time on the LRT lines, but not time on commuter rail lines
- A path is defined as the “PATH mode” if it includes time on PATH, but not the commuter rail mode or the LRT mode.
- A path is defined as the “bus mode” if it includes bus time or Newark Subway time but no other transit modes other than ferry time
- A path is defined as the “long haul ferry mode” if it includes only long-haul ferry time.
- A path is defined as the “ferry mode” if it includes only local ferry time.

6.3 PATH-BUILDING PARAMETERS

The path-building process was done separately for each walk-access and drive-access transit path mode options. A total of 12 transit path building processes were performed for each time period, consistent with the NJ Transit Mode Choice Model requirements. These access/line-haul mode combinations include:

- Walk-access and auto-access for bus
- Walk-access and auto-access for rail
- Walk-access and auto-access for PATH
- Walk-access and auto-access for LRT
- Walk-access and auto-access for ferry
- Walk-access and auto-access for long-haul ferry

In the transit path-building procedures, various time components were introduced and each time component was normally weighted to reflect how onerous that time component is to the user. For example, time spent waiting for a transit vehicle is perceived as more onerous or burdensome than the time spent in-vehicle traveling towards destination. The NJRTM-E defined the values of out-of-vehicle time factors, which include wait and transfer times, in the range of 1.5 to 2.0. The list of path-building parameters is shown in Table 38.

Table 38 – Path Building Parameters

Parameters	Values
Number of zone access links to:	
Rail, NYC Subway, Bus, Ferry, and Long Haul Ferry	8
PATH	4
Newark Subway, LRT	3
Maximum walk distance (miles) to:	
Commuter Rail and Long Haul Ferry	1.25
Newark Subway	0.75
All other modes	1.00
Assigned walk speed (mph)	3.0
Transfer Penalty (minutes) for:	
First Transfer	5.3
Second Transfer	6.9
Third Transfer	7.6
Fourth Transfer	8.2
Fifth Transfer and up	8.6
Initial wait factor for:	
Commuter Rail and Long Haul Ferry	2.0
All other modes	1.5
Transfer wait factor for:	
Commuter Rail and Long Haul Ferry	2.0
All other modes	1.5
Maximum impedance	655

In the path-building process, two sets of skim files by time-of-day were prepared: the peak and off-peak transit skims. The off-peak transit skim files were performed only in the first model iteration. The peak period transit skim files were performed during each model iteration in order to reflect changes in congested highway travel time and the resultant impact on highway- based transit run times.

As mentioned at the beginning of this section, the skim files were prepared for each "preferred" line-haul mode for each access mode. To obtain the desired paths for the preferred access/line-haul mode combinations, the times of individual modes are weighted to influence the creation of paths. To discourage the use of particular modes, weights in excess of 1.0 were applied. It should be noted that paths being created for a particular mode, even when weighted favorably may not result in the use of the required line-haul mode. If this condition exists for a given line-haul mode on a particular origin-destination zonal pair, that mode is rejected during the fare estimation process and the mode will not be an eligible option in the subsequent mode choice processing. Table 39 lists the in-vehicle time weights applied to each mode as part of path-building for a particular access/line-haul mode combination. Note that the weights by mode are identical by time period.

Table 39 – Path-Building Mode Weights

Path (Favored Mode)	COMMUTER RAIL	PATH	NYC SUBWAY	NEWARK CITY SUBWAY	LOCAL BUS	EXPRESS BUS	PNR BUS	FERRY	LIGHT RAIL	LONG DISTANCE FERRY	PNR CONNECTORS	TRANSFER CONNECTORS	WALK ACCESS CONNECTOR	PNR LOT TO STATION CONNECTOR	PNR CONNECTORS TO BUS
Peak Walk-to-Rail	1.0	1.2	1.5	1.0	2.5	6.0	6.0	1.2	1.2	1.2	1.8	2.0	2.0	2.0	1.8
Peak Walk-to-PATH	4.0	1.0	2.0	1.0	1.5	4.0	4.0	4.0	4.0	4.0	1.3	1.5	1.5	1.5	1.3
Peak Walk-to-Bus	4.0	4.0	1.5	1.0	1.0	1.2	1.2	2.0	4.0	4.0	1.3	1.5	1.5	1.5	1.3
Peak Walk-to-Ferry	4.0	4.0	1.5	1.0	2.0	4.0	4.0	1.0	1.2	4.0	1.3	1.5	1.5	1.5	1.3
Peak Walk-to-LRT	4.0	1.2	1.5	1.0	2.0	4.0	4.0	1.5	1.0	4.0	1.3	1.5	1.5	1.5	1.3
Peak Walk-to-Long Dist. Ferry	1.2	4.0	1.5	1.0	2.0	4.0	4.0	1.0	1.2	1.0	1.8	2.0	2.0	2.0	1.8
Peak Drive-to-Rail	1.0	1.0	1.5	1.0	3.0	6.0	6.0	1.2	1.2	1.2	1.8	2.0	2.0	2.0	1.8
Peak Drive-to-PATH	4.0	1.0	2.0	1.0	2.0	4.0	4.0	4.0	4.0	4.0	1.3	1.5	1.5	1.5	1.3
Peak Drive-to-Bus	4.0	4.0	1.5	1.0	1.0	1.2	1.2	2.0	4.0	4.0	1.3	1.5	1.5	1.5	1.3
Peak Drive-to-Ferry	4.0	4.0	1.5	1.0	2.0	4.0	4.0	1.0	1.2	4.0	1.3	1.5	1.5	1.5	1.3
Peak Drive-to-LRT	4.0	1.2	1.5	1.0	2.0	4.0	4.0	1.5	1.0	4.0	1.3	1.5	1.5	1.5	1.3
Peak Drive-to-Long Dist Ferry	1.2	4.0	1.5	1.0	2.0	4.0	4.0	1.0	1.2	1.0	1.8	2.0	2.0	2.0	1.8
Off-peak Walk-to-Rail	1.0	1.2	1.5	1.0	2.5	6.0	6.0	1.2	1.2	1.2	1.8	2.0	2.0	2.0	1.8
Off-peak Walk-to-PATH	4.0	1.0	2.0	1.0	1.5	4.0	4.0	4.0	4.0	4.0	1.3	1.5	1.5	1.5	1.3
Off-peak Walk-to-Bus	4.0	4.0	1.5	1.0	1.0	1.2	1.2	2.0	4.0	4.0	1.3	1.5	1.5	1.5	1.3
Off-peak Walk-to-Ferry	4.0	4.0	1.5	1.0	2.0	4.0	4.0	1.0	1.2	4.0	1.3	1.5	1.5	1.5	1.3
Off-peak Walk-to-LRT	4.0	1.2	1.5	1.0	2.0	4.0	4.0	1.5	1.0	4.0	1.3	1.5	1.5	1.5	1.3
Off-peak Walk-to-Long Dist. Ferry	1.2	4.0	1.5	1.0	2.0	4.0	4.0	1.0	1.2	1.0	1.8	2.0	2.0	2.0	1.8
Off-peak Drive-to-Rail	1.0	1.0	1.5	1.0	3.0	6.0	6.0	1.2	1.2	1.2	1.8	2.0	2.0	2.0	1.8
Off-peak Drive-to-PATH	4.0	1.0	2.0	1.0	2.0	4.0	4.0	4.0	4.0	4.0	1.3	1.5	1.5	1.5	1.3
Off-peak Drive-to-Bus	4.0	4.0	1.5	1.0	1.0	1.2	1.2	2.0	4.0	4.0	1.3	1.5	1.5	1.5	1.3
Off-peak Drive to Ferry	4.0	4.0	1.5	1.0	2.0	4.0	4.0	1.0	1.2	4.0	1.3	1.5	1.5	1.5	1.3
Off-peak Drive to LRT	4.0	1.2	1.5	1.0	2.0	4.0	4.0	1.5	1.0	4.0	1.3	1.5	1.5	1.5	1.3
Off-peak Drive to Long Dist. Ferry	1.2	4.0	1.5	1.0	2.0	4.0	4.0	1.0	1.2	1.0	1.8	2.0	2.0	2.0	1.8

Skim matrices were prepared based on the mode choice requirements. Twelve skim files were prepared consistent with the path building processes performed, as mentioned above. Extensive information was stored in each skim file for use in the mode choice process. Table 40 shows the list of tables stored in a typical skim file.

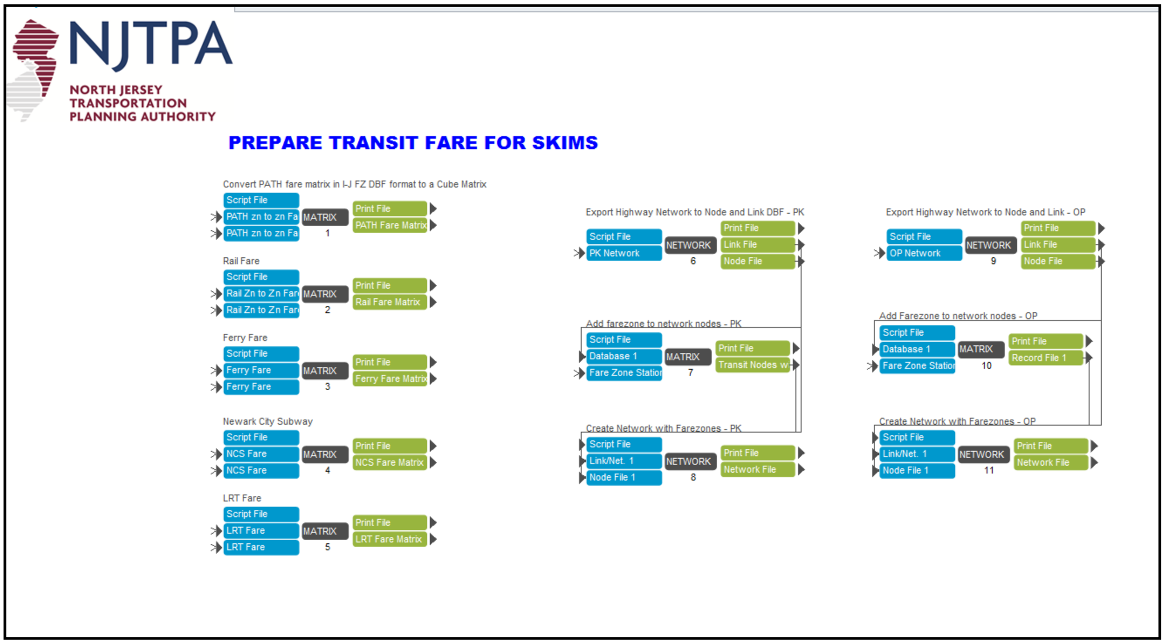
Table 40 – Skim File Table Format

Tables No.	Description	Tables No.	Description
1	In-vehicle time (IVTT) - Rail	27	Total Bus Time - PATH
2	In-vehicle time (IVTT) - PATH	28	PATH Time - Rail
3	In-vehicle time (IVTT) - Bus	29	Distance - Rail
4	In-vehicle time (IVTT) - Ferry	30	Distance - PATH
5	In-vehicle time (IVTT) - Light Rail	31	Distance - Bus
6	Total wait time - Rail	32	Distance - Ferry
7	Total wait time - PATH	33	Distance - Light Rail
8	Total wait time - Bus	34	Rail Time - Rail
9	Total wait time - Ferry	35	Subway Time - Rail
10	Total wait time - Light Rail	36	Subway Time - PATH
11	Walk time - Rail	37	Subway Time - Bus
12	Walk time - PATH	38	Subway Time - Ferry
13	Walk time - Bus	39	Subway Time - Light Rail
14	Walk time - Ferry	40	Bus Time - Lighr Rail
15	Walk time - Light Rail	41	Light Rail Time - Light Rail
16	Fare - Rail	42	In-vehicle time (IVTT) - Long Distance Ferry
17	Fare - PATH	43	Wait Time - Long Distance Ferry
18	Fare - Bus	44	Walk Time - Long Distance Ferry
19	Fare - Ferry	45	Fare - Long Distance Ferry
20	Fare - Light Rail	46	Number of Transfers - Long Distance Ferry
21	Number of Transfer - Rail	47	Bus Time - Long Distance Ferry
22	Number of Transfer - PATH	48	PATH Time - Long Distance Ferry
23	Number of Transfer - Bus	49	Distance - Long Distance Ferry
24	Number of Transfer - Ferry	50	Long Distance Ferry Time - Long Distance Ferry
25	Number of Transfer - Light Rail	51	Subway Time - Long Distance Ferry
26	Total Bus Time - Rail	52	Long Distance Ferry Time - Rail

6.4 TRANSIT FARE ESTIMATION

Within the path-building step, transit fares are calculated for each access model/line-haul mode combination. The fares calculated in the NJRTM-E reflect the 2015 dollar values. The transit fare module was converted from the Customized C+ program (NJFARE2 program) to a cube module. The new transit fare estimation module is shown in Figure 19.

Figure 19 – The New Transit Fare Module



In summary, those fare systems are described as follows:

- Distance-based fare system for bus modes
- Zone-based fare system for commuter rail, ferry, and Newark City subway modes
- Station-specific fare system for special bus station premiums
- Fixed fare system for LRT, NYC subway, and PATH

The transit fare for each origin-destination zonal pair is a function of the path selection. It is important to note, however, that the fare values do not influence the path selection process. Rather, it is based purely on the weighted travel times, as discussed earlier.

7. COMPOSITE IMPEDANCE ESTIMATION

7.1 COMPOSITE IMPEDANCE TERM DEVELOPMENT

The objective of utilizing a composite impedance term in the trip distribution process is to enable the routine to be sensitive to not only the highway travel time, but rather a more complete representation of the travel choices and costs between various origin-destination zonal pairs. Several methods have been investigated in the past and generally there is a strong preference to use the logsum term of the mode choice model since it is properly structured to represent the impedances offered by all modes and weighted to reflect the actual usage of these modes. The logsum term includes not only cost and time elements, but also the mode bias constants which account for nonmeasurable traveler preferences, such as safety and comfort. Initially, the use of the logsum term from NJ Transit Mode Choice Model was reviewed and investigated. However, this particular model has mode bias terms that vary by geographic market segment. This variation causes significant discontinuous impedance values when trips are being allocated across competing destinations. This level of variation was assumed to provide significant problems with the use of this term during the trip distribution and was therefore removed from consideration as the impedance term for this project.

An alternative impedance term was adopted for this project using a structure known as the "parallel conductance" formula. This particular formulation is flexible enough to incorporate most of the impedance terms in the traditional mode choice logsum term and can be structured to be sensitive to the actual mode choice of the zonal pair or subregions. The formula is structured as follows:

$$I_C = 1.0 / (1.0/I_H + MS_T/I_T)$$

Where:

I_C = Composite impedance for zonal pair i-j
I_H = Highway impedance for zonal pair i-j for the "representative" auto mode
MS_T = Regional transit mode share
I_T = Transit impedance for zonal pair i-j for the "representative" transit mode

Note that the highway and transit impedance terms would represent all elements of travel times and costs, by structuring the impedance for each mode as a generalized cost. With this approach, the composite impedance term would reflect all of the costs (fare, tolls, auto operating costs & parking) and the various time components (in-vehicle, waiting/walking) that are incorporated in the logsum term. For the NJTPA integrated model, the generalized costs would be based on the values of time for each trip purpose obtained from the New Jersey Transit Mode Choice Model, which was based on the stated preference survey conducted by RSG in the early 1990s.

The modal share term provides a mechanism that effectively "weighs" the impact of the transit impedance into the composite term. Note that if transit mode share is zero, then the term defaults back to the highway-based impedance. If transit share is nonzero, the composite term is reduced in value in order to represent the aspect of having multiple services available between a given origin and destination. The transit modal share term in many applications is derived from a general "regional" transit share as opposed to the specific transit mode share of a given origin-destination zonal pair. The NJRTM-E used the mode shares for each I-J zonal pair rather than a regional share value in order to more properly reflect within the composite term the degree of competiveness provided by the transit service for individual zonal pairs.

7.2 COMPOSITE IMPEDANCE VARIABLES

As part of developing the composite impedance estimates, it was necessary to adopt both the "representative" mode for the various auto modes and transit modes as well as the cost and time components that are included for mode choice. While the SOV auto mode would be the likely mode representing all auto modes due to its dominance and uniform characteristics, the selection of the representative transit mode was more complex. There are multiple line-haul modes available coupled with both walk access and drive access submodes. The "best" transit mode being used was defined as the "reference" mode, as being the transit mode with the minimum travel time, appropriately weighted for in-vehicle and out-of-vehicle elements as well as transfer surcharges. The time and cost variables for each representative mode are as follows:

Auto Mode:

$$I_H = Time_{SOV} + Tolls_{SOV} /100.0 * 60.0/14.4$$

Transit Mode

$$I_T = Time_{TIVT} + Time_{TOVT}*2.5 + Cost_{TRAN} /100.0 * 60.0/14.4$$

where:

I_H = Highway impedance for zonal pair i-j for the auto mode
I_T = Transit impedance
$Time_{SOV}$ = Time for the SOV mode in minutes
$Tolls_{SOV}$ = Toll costs for the SOV mode in cents
$Time_{TIVT}$ = In-vehicle time (in-vehicle and drive access) for best transit mode in minutes
$Time_{TOVT}$ = Out-of-vehicle time (walk and wait) for best transit mode in minutes
$Cost_{TRAN}$ = Transit fare and PNR cost for best transit mode in cents

Note that the highway costs did not include parking costs since uniform data was not available for the entire study area as part of this project. Also, auto operating costs were not included since it was believed that these estimates should be determined based on speed rather than just distance and adequate information on fuel costs by speed were not available for this analysis. As such the SOV time variable serves as a proxy for the influence of both auto time and the cost of fuel on the distribution of trips. In contrast, the transit cost variable reflects both transit fares and parking costs at stations since this data is readily-available and is estimated with specificity as part of the transit networks.

7.3 COMPOSITE IMPEDANCE APPLICATION ISSUES

There are several implementation issues that need to be addressed when implementing the proposed composite impedance structure. The first issue is related to the inability of the impedance term to reflect the appropriate weight that should be applied to each mode that is represented in the composite term. When using the logsum term, the weighted effect of each mode's contribution to the overall "utility" is directly incorporated into the composite impedance value. Therefore, the introduction of a new mode or any reduction in service is properly reflected as part of the change in the overall impedance. In contrast, the parallel conductance formula includes only one representative mode for auto and transit. Potential inconsistencies can occur if changes in the mode representing the "best" path have offsetting characteristics. For example, consider a situation where the introduction of a new transit service that provides a better travel time, but at higher cost. In such cases, the new service, as the "best" transit mode, may have a marginally lower travel time, but a higher fare, that leads to a higher transit impedance term. The higher transit impedance term, if not properly controlled, would lead to a higher composite impedance value, causing trip distribution to allocate fewer trips between a given zonal pair in response to the introduction of an "additional" mode with better service. For several reasons, this is counter-intuitive. Most relevant is the fact that the previous transit mode deemed "best" prior to the new mode might still exist, so the overall service should not have a higher impedance value than the value prior to the new mode. To address this possible issue, specific i-j zonal pair transit mode shares were utilized, rather than the regional transit modal shares as a means of offsetting this concern. Note, however, this condition would only be possible in situations where the travel time gains for the new mode are minimal and differential fare for the new mode is significant.

The second implementation issue is the need to establish transit shares by zonal pair for use in the calculation as weighing mechanism. As mentioned above, the logsum value reflects the appropriate weighting of all modes as a function of their "utility". If the logsum approach is used, by simply executing the mode choice model prior to trip distribution, the "logsum" composite impedance term and share percentages for each mode are established simultaneously prior to trip distribution. Distribution is then performed and the percentages shares are applied to resulting person trips to create the final trips by mode for each zonal pair.

In contrast, the parallel conductive technique requires the transit share in order to form the composite impedance value. Prior applications of this technique simply specified a "regional" transit share to be used to weigh the transit contribution for the combined term, but this approach limits the sensitivity since each zonal pair would have the same transit weighting, even though transit level of service may vary significantly between certain origin-destination zonal pairs. The model elected to use a separate weighing approach with the specific transit share for each zonal pair. This necessitated the creation of transit shares prior to the execution of the mode choice model.

In order to prepare transit shares for the initial model iteration, a support application was developed that establishes shares based on a previous model run. These initial shares are applied only during the first model iteration, with all subsequent iterations using shares developed from the previous iteration of the current execution.

8. TRIP GENERATION

8.1 INTRODUCTION

This section describes the development of new trip generation process for the NJRTM-E. The new trip generation procedure incorporated several significant enhancements into the regional modeling process. These enhancements include several new trip purposes and the estimation of non-motorized trips. The development of the generation model is based on the statistical analysis of data available for the 39-county region with NJTPA as the core, along with other data sets obtained for special generators such as the Newark Airport. The Regional Household Travel Survey (RHTS) conducted in 2010 and 2011 constitutes the primary data source. 2014 LEHD (Longitudinal Employer-Household Dynamics data) and 2015 PUMS (Public Use Microdata Sample) form the supplemental/secondary sources for the estimation and calibration.

The NJRTM-E included the several new trip purposes that were created by subdividing existing purposes as well as the estimation of trips for particular generators that were modeled with limited accuracy in the previous model. As an example, the previous home-based work purpose has been partitioned into two purposes, home-based work “direct” and home-based work “strategic”. In 2017, the method for determining HBWS was reviewed to determine whether it should be changed. The detail review and analysis of the HBWS trip purpose are presented in APPENDIX L – HOME-BASED WORK STRATEGIC (HBWS) The final recommendation was to retain the original definition of the dwell-time. Several new trip purposes, such university trips and airport trips, were incorporated into the new model in order to more accurately predict trip activity from these unique generators. While trips from these sites were previously abstracted as part of the home-based other trip purpose, their unique characteristics could not be fully modeled as part of this generic purpose. The following list summarizes the trip purposes included in the NJRTM-E, along with brief description of each purpose:

- Home-based Work Direct (HBWD) – includes work trips that travel directly between home and work, without any intermediate stops.
- Home-based Work Strategic (HBWS) – includes “strategic” work trips that have intermediate stops of limited duration, usually to serve another passenger, which may influence mode choice.
- Home-based Shop (HBSH) – defined as trips with one trip end at home and the other at a retail location.
- Home-based Other (HBO) - defined as trips with one trip end at home and the other at a non-retail location other than a college/university or airport.
- Home-based University (HBU) - defined as trips with one trip end at home and the other at a college or university.
- Work-based Other (WBO) – defined as a non-home-based trip with one trip end at work
- Non-Home Non-Work (NHNW) – defined as a non-home based trip with neither trip end at work
- Airport - defined as trips with one trip at Newark Airport.
- Truck Trip Purposes (Heavy, Medium, and Commercial)

The NJRTM-E also structured the estimation of trips by income. The previous 5 income groups which based on the 2000 Census data, were updated based on the average household income of the 2010 Census data. The adjustments process is discussed in APPENDIX M – INCOME GROUP ADJUSTMENTS. The adjusted five income groups are as follows:

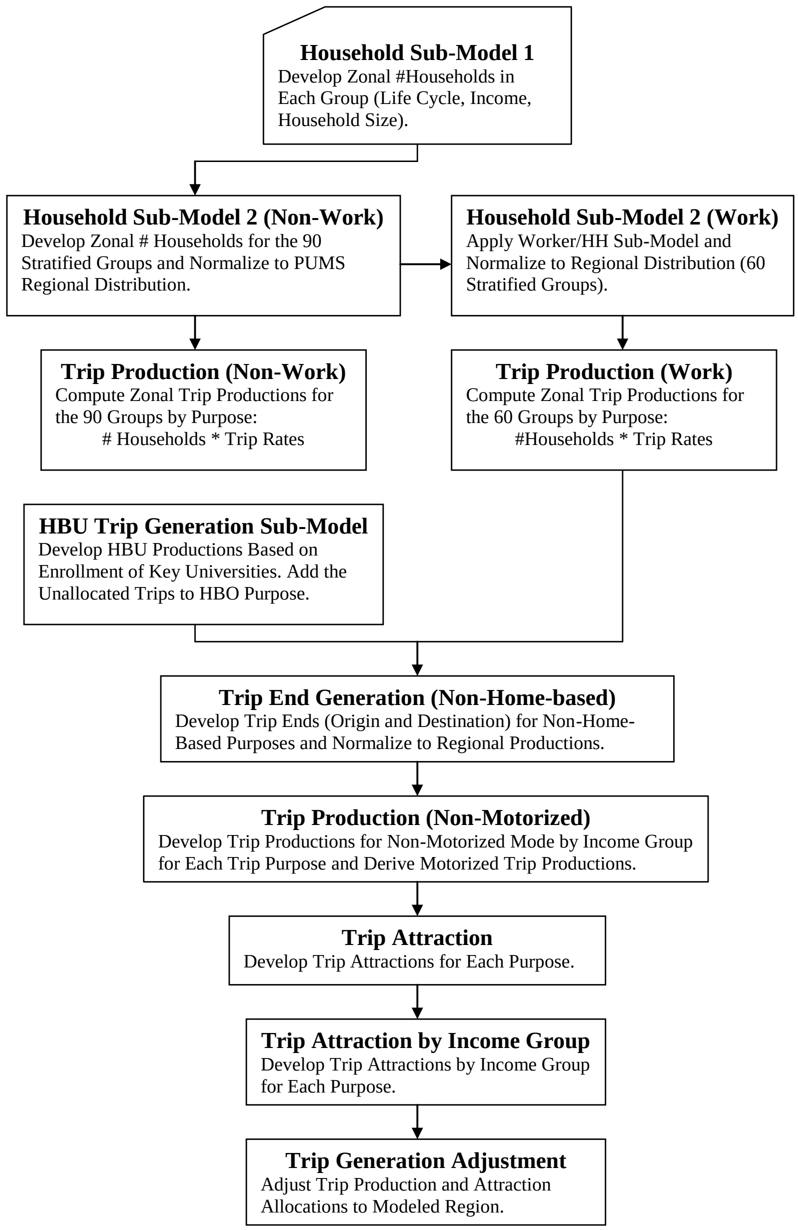
- Group 1 – equal or less than $15,000
- Group 2 – between $15,000 and $50,000
- Group 3 – between $50,000 and $100,000
- Group 4 – between $100,000 and $200,000

- Group 5 – higher than $200,000

8.2 STRUCTURE OVERVIEW

The NJRTM-E trip generation component was developed using standard techniques commonly found within four-step urban travel demand models. These techniques include a cross-classification process for trip productions and linear equations for trip attractions. The flowchart in Figure 20 depicts the general process of this trip generation model:

Figure 20 – Trip Generation Structure Overview



The trip generation component includes several procedures used to prepare the necessary zonal variables and apply the trip estimation techniques, each of which is briefly defined below:

- **Household Sub-models.** In this step, households are stratified into 90 groups (6 by household size * 5 by income group * 3 by life cycle) and then 60 groups (4 by number of workers * 5 by income group * 3 by life cycle).

- **Trip Production Estimation.** This step applies the **t**rip production rates derived from household survey to each household group. The resulting trip productions are then aggregated to 15 groups (5 by income group and 3 by life cycle).

- **HBU Trip Generation Sub-model.** This routine applies a customized technique to estimate home-based trip generation at colleges and universities. Special procedures are applied to estimate this purpose due to the limitations in the enrollment database used to control the estimation of trips for the HBU trip purpose.

- **NHB Trip End Estimation.** Trip ends are estimated for non-home-based trip purposes and normalized to the regional total derived from cross-classification process.

- **Non-motorized Sub-model.** Total person trips are partitioned into Non-motorized trips and motorized trip productions by trip purpose.

- **Trip Attraction Estimation.** Motorized trip attractions are estimated for home-based purposes and stratified by income group.

- **Regional Adjustment.** The resulting productions and attractions are adjusted at the county level for the modeled region. These adjustments are applied primarily to counties in the buffer region near the edge of the modeled area to account for trips destined to areas outside of the modeled area.

The development of these procedures is described in further detail in the following sections.

8.3 HOUSEHOLD SUBMODELS

8.3.1 Introduction

The purpose of the household submodels is to stratify households in each zone by associated socioeconomic attributes. These allocations are controlled by the aggregate average zonal values and seed distributions of households observed in PUMS data from the Census and CTPP data.

The procedure of this model contains the following four main steps:

1. Create 1-dimensional distribution of households by household size or workers
2. Create 1-dimensional distribution of households by income
3. Create 3-dimensional distribution of households by household size, income and life cycle
4. Create 3-dimensional distribution of households by number of workers, income and life cycle

The process utilized in each of these steps is provided in detail in the following sections.

8.3.2 One-dimensional Distribution of Households by Size

This step stratifies households by household size (1,2,3,4,5,6+ persons per household) at zonal level so to provide initial estimates of trips at the zonal level as well as a regional control totals for the joint distribution of households by household size, income and life cycle. A set of percentage allocations that relate a zone's average household size to the probable distribution of households by size was developed from census data. These percentage allocations were developed by computing the percentages of households by size for each census tract and then averaging the percentages by grouped average household size, as shown in Table 41.

Table 41 – Household Distribution by Size Lookup Table

PPHH	HH1	HH2	HH3	HH4	HH5	HH6
10	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
11	93.8%	5.7%	0.3%	0.2%	0.0%	0.0%
12	87.6%	10.7%	0.8%	0.6%	0.1%	0.2%
13	81.2%	15.6%	1.3%	1.1%	0.3%	0.6%
14	75.1%	19.9%	2.1%	1.7%	0.5%	0.7%
15	68.8%	24.0%	3.1%	2.5%	0.8%	0.8%
16	62.7%	27.4%	4.4%	3.5%	1.1%	0.9%
17	56.5%	30.2%	6.0%	4.7%	1.5%	1.1%
18	50.3%	32.8%	7.6%	5.9%	2.0%	1.4%
19	45.2%	34.5%	9.0%	7.1%	2.4%	1.8%
20	41.3%	35.2%	10.2%	8.2%	2.9%	2.2%
21	38.4%	34.7%	11.5%	9.4%	3.4%	2.6%
22	35.9%	33.9%	12.5%	10.6%	3.9%	3.2%
23	33.9%	32.5%	13.7%	11.8%	4.4%	3.7%
24	31.4%	32.2%	14.5%	12.8%	4.9%	4.2%
25	29.3%	31.3%	15.1%	13.9%	5.4%	5.0%
26	27.4%	30.5%	15.7%	14.8%	5.9%	5.7%
27	25.5%	29.6%	16.2%	15.7%	6.5%	6.5%
28	23.8%	28.7%	16.6%	16.4%	7.0%	7.5%
29	22.2%	28.0%	17.0%	16.9%	7.4%	8.5%
30	20.6%	27.2%	17.1%	17.5%	7.8%	9.8%
31	19.3%	26.4%	17.3%	17.8%	8.2%	11.0%
32	18.0%	25.7%	17.1%	17.9%	8.7%	12.6%
33	16.7%	24.8%	17.3%	18.1%	8.9%	14.2%
34	15.7%	23.9%	16.8%	18.1%	9.5%	16.0%
35	14.9%	22.8%	16.9%	18.0%	10.2%	17.2%
36	14.0%	21.6%	16.8%	17.7%	10.6%	19.3%
37	12.9%	20.3%	16.4%	17.1%	11.0%	22.3%
38	12.0%	19.2%	16.0%	16.7%	11.1%	25.0%
39	11.3%	18.2%	15.8%	16.2%	11.1%	27.4%
40	10.5%	16.8%	15.4%	15.3%	11.0%	31.0%
41	11.0%	15.7%	14.3%	14.6%	10.7%	33.7%
42	9.0%	15.1%	14.0%	14.1%	10.8%	37.0%
43	8.5%	14.4%	13.9%	13.7%	10.7%	38.8%
44	8.0%	13.5%	13.6%	13.5%	10.4%	41.0%
45	7.6%	12.7%	13.0%	13.1%	9.8%	43.8%

Note that the first column (PPHH) is an index field, which is the persons per household, multiplied by 10.0 to create integer values for the lookup table. The final range of average household sizes was expanded from the sample data to cover a range of 1.0 to 4.5.

The initial distributions were smoothed statistically using log-linear regression analysis to produce a set of percentages that vary logically across the full expected range of zonal average values. In addition, the percentage allocations were normalized at each average household size value such that the sum of all six percentages equals 100 percent and the resulting computed "output" average household size equals the "input" average household size. The look-up procedure was then employed to provide an initial distribution of households by size in each zone and to establish initial estimated totals by household size for the joint distribution process.

8.3.3 One-dimensional Distribution of Households by Income

This process stratifies households by household income at zonal level so as to provide an initial allocation of households by income group in each zone and initial regional totals for use in the joint distribution process of households by household size, income and life cycle. The same approach as described for household distribution by size was applied for the household distribution by income. Table 42 provides a listing of the allocation percentages for each ratio increment.

Note that the first column labeled "INCRATIO" is the index pointer for the lookup function. Since incomes may increase in magnitude over time, the index pointer controlling the lookup procedure was developed as the zonal average income divided by the regional average income. To establish the percentage allocation by income for the ratio index, census income categories were re-grouped into five defined income categories, and a corresponding look-up table that gives a household distribution by income group for each income ratio (in increments of 0.1 from 0.0 to 5.8) was developed from the 2010 Census data. The index was then calculated as 1.0+ the ratio increment.

8.3.4 Joint Distribution of Households by Size, Income and Life Cycle

In this step, an iterative proportional fitting (IPF) algorithm was used to estimate the joint distribution of households by size, income and life cycle in each zone. As part of this process, the resulting zonal estimates are normalized for each dimension to ensure that the aggregate summary of each segment matches the regional control totals. The IPF algorithm requires a "seed" distribution representing the regional control totals for the joint distribution categories as well as initial summary totals estimated by the submodels and the zone-specific one-dimensional marginal distributions by size, income and life cycle that were created in the previous steps.

The number of households by household size, income group and life cycle used for the seed distribution was summarized from PUMS as shown in Table 43. A seed distribution was then derived as in Table 44.

Table 42 – Household Distribution by Income Group Lookup Table

INCRATIO	INC1	INC2	INC3	INC4	INC5
10	100.0%	0.0%	0.0%	0.0%	0.0%
11	76.0%	17.9%	6.1%	0.0%	0.0%
12	48.1%	35.8%	12.3%	3.1%	0.7%
13	34.7%	43.8%	15.3%	5.5%	0.6%
14	25.1%	45.5%	21.3%	7.0%	1.1%
15	18.9%	45.3%	24.7%	9.9%	1.3%
16	15.7%	40.4%	28.4%	13.3%	2.1%
17	12.1%	37.6%	30.8%	16.7%	2.8%
18	9.6%	32.9%	33.3%	20.6%	3.7%
19	8.9%	28.6%	34.9%	23.0%	4.5%
20	7.1%	25.5%	34.3%	26.9%	6.1%
21	6.4%	22.9%	33.3%	29.3%	8.1%
22	5.3%	21.0%	31.8%	32.3%	9.5%
23	5.0%	18.9%	30.3%	35.2%	10.6%
24	4.7%	17.2%	27.5%	37.0%	13.6%
25	4.4%	16.0%	25.5%	38.8%	15.4%
26	4.1%	14.8%	24.4%	38.5%	18.3%
27	3.9%	13.7%	23.2%	38.2%	20.9%
28	3.7%	12.4%	22.0%	38.1%	23.7%
29	3.5%	11.8%	21.0%	37.1%	26.6%
30	3.4%	11.2%	19.9%	36.1%	29.4%
31	3.3%	10.7%	18.8%	34.8%	32.4%
32	3.3%	10.3%	17.8%	33.5%	35.1%
33	3.1%	9.8%	16.8%	32.0%	38.3%
34	3.0%	9.4%	15.7%	30.5%	41.3%
35	2.9%	9.1%	14.8%	29.0%	44.2%
36	3.0%	8.7%	13.8%	27.3%	47.2%
37	2.8%	8.4%	12.9%	27.0%	48.8%
38	2.7%	8.1%	11.9%	26.7%	50.6%
39	2.7%	7.8%	11.0%	26.4%	52.1%
40	2.7%	7.5%	10.1%	26.0%	53.7%
41	2.6%	7.3%	9.2%	25.6%	55.4%
42	2.5%	7.0%	8.3%	25.2%	57.0%
43	2.5%	6.8%	7.4%	24.8%	58.5%
44	2.4%	6.6%	6.6%	24.4%	60.0%
45	2.4%	6.3%	5.7%	23.9%	61.7%
46	2.3%	6.1%	4.9%	23.5%	63.2%
47	2.3%	6.0%	4.0%	23.0%	64.6%
48	2.3%	5.8%	3.3%	22.5%	66.2%
49	2.2%	5.6%	2.5%	22.1%	67.6%
50	2.1%	5.4%	1.7%	21.6%	69.1%
51	2.2%	5.3%	1.0%	21.1%	70.5%
52	2.1%	5.1%	0.2%	20.7%	71.9%
53	2.0%	5.0%	0.0%	20.2%	72.8%
54	2.0%	4.9%	0.0%	19.7%	73.4%
55	1.9%	4.7%	0.0%	19.3%	74.1%
56	1.9%	4.6%	0.0%	18.8%	74.7%
57	1.9%	4.5%	0.0%	18.4%	75.2%
58	1.9%	4.4%	0.0%	17.9%	75.8%
59	1.8%	4.2%	0.0%	17.5%	76.5%
60	1.8%	4.1%	0.0%	17.1%	77.0%
61	1.7%	4.0%	0.0%	16.6%	77.7%
62	1.7%	3.9%	0.0%	16.2%	78.2%
63	1.7%	3.8%	0.0%	15.8%	78.7%
64	1.6%	3.8%	0.0%	15.4%	79.2%
65	1.6%	3.7%	0.0%	15.0%	79.7%
66	1.6%	3.6%	0.0%	14.6%	80.2%
67	1.5%	3.5%	0.0%	14.2%	80.8%
68	1.6%	3.4%	0.0%	13.8%	81.3%

Table 43 – Household Distribution by Household Size/Income /Life Cycle

2015 PUMS Household Distribution by Household Size/Income Group (Retiree Group)

HH Size	Income Group					
	1	2	3	4	5	Total
1	75,250	134,896	36,500	8,691	3,755	259,092
2	14,615	94,285	103,215	61,247	23,184	296,546
3	2,579	15,625	28,511	27,486	8,785	82,986
4	1,254	6,217	12,762	16,978	6,356	43,567
5	397	3,384	8,479	11,292	4,768	28,320
6+	229	1,945	6,118	9,481	5,508	23,281
Total	**94,324**	**256,352**	**195,585**	**135,175**	**52,356**	**733,792**

2015 PUMS Household Distribution by Household Size/Income Group (With Children No Retiree)

HH Size	Income Group					
	1	2	3	4	5	Total
1	0	0	0	0	0	0
2	13,853	24,276	12,801	4,142	1,276	56,348
3	18,767	51,879	61,483	68,028	28,512	228,669
4	12,436	54,201	74,964	105,458	53,889	300,948
5	5,100	25,478	35,680	41,644	22,730	130,632
6+	3,676	16,644	20,323	19,471	8,991	69,105
Total	**53,832**	**172,478**	**205,251**	**238,743**	**115,398**	**785,702**

2015 PUMS Household Distribution by Household Size/Income Group (No Children No Retiree)

HH Size	Income Group					
	1	2	3	4	5	Total
1	66,798	132,901	124,004	48,282	11,308	383,293
2	18,087	73,318	124,955	135,316	55,966	407,642
3	3,022	20,137	38,090	49,148	21,960	132,357
4	673	6,022	15,361	25,322	11,682	59,060
5	123	1,091	2,892	5,633	2,546	12,285
6+	90	417	468	1,304	1,097	3,376
Total	**88,793**	**233,886**	**305,770**	**265,005**	**104,559**	**998,013**

With zonal-level one-dimensional household distribution by life cycle provided by NJTPA, household distribution by size and income derived above and this seed distribution, a joint distribution of households by size, income and life cycle was developed through iterative fitting. As the iterative fitting was performed at zonal level, the resulting regional total of each household group will deviate from the control values, thereby requiring the resulting zonal-level joint distribution to be normalized against the control totals by group.

Table 44 – Household Distribution by Life Cycle/Income /Household Size

Income Group/Household Size	Households with Retirees		Households with Children		Households with No Child or Retiree	
	Index	Percent	Index	Percentage	Index	Percentage
Income Group 1 - HH Group 1	1	4.3666%	31	0.0046%	61	2.6152%
Income Group 1 - HH Group 2	2	0.9005%	32	0.5300%	62	0.7594%
Income Group 1 - HH Group 3	3	0.1124%	33	0.8302%	63	0.1243%
Income Group 1 - HH Group 4	4	0.0429%	34	0.6471%	64	0.0347%
Income Group 1 - HH Group 5	5	0.0279%	35	0.3742%	65	0.0100%
Income Group 1 - HH Group 6	6	0.0206%	36	0.2198%	66	0.0019%
Income Group 2 - HH Group 1	7	3.4701%	37	0.0009%	67	4.1206%
Income Group 2 - HH Group 2	8	3.1891%	38	0.6761%	68	1.8561%
Income Group 2 - HH Group 3	9	0.4065%	39	1.5978%	69	0.3785%
Income Group 2 - HH Group 4	10	0.1534%	40	1.4671%	70	0.1056%
Income Group 2 - HH Group 5	11	0.0962%	41	0.7021%	71	0.0220%
Income Group 2 - HH Group 6	12	0.0661%	42	0.4337%	72	0.0085%
Income Group 3 - HH Group 1	13	1.1653%	43	0.0017%	73	6.0804%
Income Group 3 - HH Group 2	14	3.9883%	44	0.6050%	74	6.1486%
Income Group 3 - HH Group 3	15	1.0961%	45	3.3641%	75	1.4065%
Income Group 3 - HH Group 4	16	0.4321%	46	4.3432%	76	0.4243%
Income Group 3 - HH Group 5	17	0.3204%	47	2.1183%	77	0.0936%
Income Group 3 - HH Group 6	18	0.2869%	48	1.1071%	78	0.0301%
Income Group 4 - HH Group 1	19	0.3524%	49	0.0001%	79	1.7795%
Income Group 4 - HH Group 2	20	1.4514%	50	0.1206%	80	6.6653%
Income Group 4 - HH Group 3	21	0.8349%	51	3.0225%	81	2.1043%
Income Group 4 - HH Group 4	22	0.4794%	52	4.5797%	82	0.9491%
Income Group 4 - HH Group 5	23	0.4144%	53	2.1181%	83	0.2014%
Income Group 4 - HH Group 6	24	0.4240%	54	1.0518%	84	0.0744%
Income Group 5 - HH Group 1	25	0.0955%	55	0.0001%	85	0.4259%
Income Group 5 - HH Group 2	26	0.6350%	56	0.0276%	86	2.5109%
Income Group 5 - HH Group 3	27	0.2200%	57	1.0710%	87	0.7683%
Income Group 5 - HH Group 4	28	0.1697%	58	1.8624%	88	0.3918%
Income Group 5 - HH Group 5	29	0.1514%	59	0.9439%	89	0.1107%
Income Group 5 - HH Group 6	30	0.1627%	60	0.4103%	90	0.0348%
Total		**25.5322%**		**34.2311%**		**40.2367%**

8.3.5 Joint Distribution of Households by Number of Workers, Income and Life Cycle

For the work-based trip purposes, the production cross-classification process utilizes the number of workers as a predictive variable. In order to estimate households by number of workers, a submodel was used to disaggregate households into several worker categories. These estimates are derived using the zonal joint distribution of households by household size, income group and life cycle previously calculated. Note that the resulting joint distribution of workers per household was also normalized against regional control totals derived from PUMS.

A discrete choice worker per household submodel was developed to obtain the joint distribution of households by number of workers, income and life cycle. The worker per household submodel was estimated based on the RHTS data, which has nearly 11000 samples. The primary modeling technique was a multinomial logit structure with the alternative “households with 3+ workers” as the reference alternative (with a zero utility). Thus all variables and corresponding coefficients can be interpreted as relative contributions to having less than 3 workers in the households. The multinomial logit model for workers per household model is defined in the following formula:

$$P_i = \frac{\exp(V_i)}{\sum_{j=0}^{3} \exp(V_j)}, \; for \quad i = 0,1,2,3$$

Where:

$i, j = 0,1,2,3$	Choice alternatives (number of workers in the household)
P_i	Probability of alternative i
V_i	Utility function for alternative i

The utility function of the worker per household sub-model has the following general form:

$$V_i = \alpha_i X + \sum_{k=1}^{3} \beta_i^k Y^k + \sum_{l=1}^{4} \gamma_i^l Z^l$$

Where:

$k = 1,2,3$ Life cycle group

$l = 1,2,3,4$ Income group from 1 to 4 with income group 5 serving as the reference group

α_i	Alternative-specific coefficients for household size
X	Household size as a continuous variable
β_i^k	Alternative-specific constants for life cycle category k
Y^k	Binary variable for life cycle category k
γ_i^l	Alternative-specific constant for income group l
Z^l	Binary variable for Income group l

With the binary variables being 1 or 0, the associated coefficients actually function as alternative-specific constants. As both the lifecycle variable and the income group variable were treated as binary values and there can only be one constant in the utility function, income group 5 was chosen as the base "reference" group so that solutions for the remaining constants could be estimated by ALOGIT.

The estimated coefficients and t-statistics are listed below in Table 45. Note that the 3+ Worker Household is the reference alternative.

Table 45 – Workers per Household Sub-Model Coefficients and Constants

Workers/ HH	HH Size	Retiree	With Children	No Children	Inc_Grp1	Inc_Grp2	Inc_Grp3	Inc_Grp4
0	-1.844	6.973	4.996	-1.329	5.271	2.38	0.2993	-1.413
	(-12.7)	(-13.4)	-15.6	-13.6	-6.3	0	-6.3	0
1	-0.8222	3.911	4.673	0.4245	3.228	1.796	0.6452	-0.5227
	(-7.7)	(-8.6)	-9.9	-11.5	-5.8	-0.6	-5.8	-0.6
2	-0.6018	2.619	4.34	1.419	1.188	0.6782	0.472	-0.2749
	(-5.9)	(-3.3)	-5.9	-9.1	-5.1	(-0.5)	-5.1	(-0.5)

Note:
"Rho-Squared" w.r.t. Zero = .4048
"Rho-Squared" w.r.t. Constants = .3870

The T-statistics generated by ALOGIT log-likelihood maximization technique indicated that the household size variable and most of the group specific constants were significant above the 95% confidence level. The Rho-squared values indicate that the model shows a significant improvement over the assumption of equal market shares model, but only a limited improvement against a model which include only the constant terms.

The estimated coefficient of the household size variable becomes less negative for the higher workers per household groups. This indicates that, other aspects being equal, the number of workers is likely to increase as household size increases. The negative signs are consistent with the positive correlation between household size and number of workers per household in that, as household size increases, it's less likely that the household has either zero workers or workers in other categories less than 3 workers.

The decreasing magnitude of constants for Retiree group and With Children group with the increase of number of workers per household indicates that number of workers per household is negatively correlated to these life cycle groups. Given a household with retiree(s), other things equal, the household tends to have fewer workers than other households. Similarly, for a household with children and no retiree(s), the household may be forced to have fewer workers as one of the parents (or the only parent) may have to stay home with their children. In contrast, for households with no children or retirees, more workers are expected, which is consistent with the increasing pattern of the coefficient for No Children group.

In terms of the contribution of life cycle to the various worker alternatives, the retiree group has the largest estimated coefficient for 0 worker/HH alternative, reflecting the fact that "elderly" households tend to have no workers. The with children group has the largest estimated constants other worker alternatives, which reflects the likelihood of 1 or 2 worker households versus the 3+ worker category since these households need to balance working and staying home with children. The constants for the no children group are lower than the other life cycle groups for the lower worker alternatives and therefore have greater share 2 or 3+ worker households.

The constants for the income group constant logically decline for each worker group as income increases. This is logical as more income tends be produced by household with more workers, therefore the lower work categories become less likely alternatives as income increases.

With the application of the estimated worker per household model, households were stratified by number of workers, income and life cycle at the zonal level. To establish control totals for the joint distribution process, the number of households by number of workers, income and life cycle were summarized and cross-tabulated from PUMS as listed in Table 46.

Table 46 – Household Distribution by Number of Workers/Income /Life Cycle

2015 PUMS Household Distribution by Number of Workers/Income Group (Retire Group)

Workers	Income Group					
	1	2	3	4	5	Total
0	91,763	214,825	95,302	29,292	11,329	442,511
1	2,378	37,205	72,603	54,253	16,966	183,405
2	183	3,588	23,804	38,246	15,969	81,790
3+	0	734	3,876	13,384	8,092	26,086
Total	**94,324**	**256,352**	**195,585**	**135,175**	**52,356**	**733,792**

2015 PUMS Household Distribution by Number of Workers/Income Group (With Children No Retiree)

Workers	Income Group					
	1	2	3	4	5	Total
0	31,828	13,760	2,065	696	436	48,785
1	20,708	113,206	97,591	74,046	37,074	342,625
2	1,256	40,857	86,142	137,091	66,812	332,158
3+	40	4,655	19,453	26,910	11,076	62,134
Total	**53,832**	**172,478**	**205,251**	**238,743**	**115,398**	**785,702**

2015 PUMS Household Distribution by Number of Workers/Income Group (No Children No Retiree)

Workers	Income Group					
	1	2	3	4	5	Total
0	64,001	31,241	4,815	1,130	1,335	102,522
1	23,168	162,058	174,829	78,320	25,648	464,023
2	1,506	36,099	103,650	137,537	54,229	333,021
3+	118	4,488	22,476	48,018	23,347	98,447
Total	**88,793**	**233,886**	**305,770**	**265,005**	**104,559**	**998,013**

The 2015 PUMS data were then compared with the original 2000 PUMS data for reasonableness check as shown in Table 47. The percent distribution of both PUMS data was also compared. The comparisons indicate that the overall distributions are similar and reasonable.

Table 47 – Household Distribution by Number of Workers/Income group

2000 PUMS Household Distribution by Number of Workers/Income Group

Workers	Income Group					
	1	2	3	4	5	Total
0	203,116	196,647	136,011	41,039	16,079	592,892
1	67,159	196,221	357,078	174,637	71,998	867,093
2	10,068	53,472	254,497	319,894	112,472	750,403
3+	1,324	8,078	52,471	109,653	41,606	213,132
Total	**281,667**	**454,418**	**800,057**	**645,223**	**242,155**	**2,423,520**

2015 PUMS Household Distribution by Number of Workers/Income Group

Workers	Income Group					
	1	2	3	4	5	Total
0	187,592	259,826	102,182	31,118	13,100	593,818
1	46,254	312,469	345,023	206,619	79,688	990,053
2	2,945	80,544	213,596	312,874	137,010	746,969
3+	158	9,877	45,805	88,312	42,515	186,667
Total	**236,949**	**662,716**	**706,606**	**638,923**	**272,313**	**2,517,507**

2000 PUMS Percent Household Distribution

Workers	Income Group					
	1	2	3	4	5	Total
0	8.4%	8.1%	5.6%	1.7%	0.7%	24.5%
1	2.8%	8.1%	14.7%	7.2%	3.0%	35.8%
2	0.4%	2.2%	10.5%	13.2%	4.6%	31.0%
3+	0.1%	0.3%	2.2%	4.5%	1.7%	8.8%
Total	**11.6%**	**18.8%**	**33.0%**	**26.6%**	**10.0%**	**100.0%**

2015 PUMS Percent Household Distribution

Workers	Income Group					
	1	2	3	4	5	Total
0	7.5%	10.3%	4.1%	1.2%	0.5%	23.6%
1	1.8%	12.4%	13.7%	8.2%	3.2%	39.3%
2	0.1%	3.2%	8.5%	12.4%	5.4%	29.7%
3+	0.0%	0.4%	1.8%	3.5%	1.7%	7.4%
Total	**9.4%**	**26.3%**	**28.1%**	**25.4%**	**10.8%**	**100.0%**

Using this information, a regional joint distribution of households by number of workers, income and life cycle was created. This joint distribution derived from PUMS is listed in Table 48. As the discrete choice worker per household model was performed at zonal level, the resulting regional total of each household group will deviate from the control values, requiring the normalization of the zonal-level joint distribution against the control totals by group obtained from the PUMS data.

Table 48 – Household Distribution by Number of Workers/Income /Life Cycle

Income Group/No of Workers	Households with Retirees		Households with Children		Households with No Child or Retiree	
	Index	Percent	Index	Percentage	Index	Percentage
Income Group 1 - 0 Workers	1	5.274394%	21	1.246204%	41	1.860434%
Income Group 1 - 1 Worker	2	0.173302%	22	1.099021%	42	1.498812%
Income Group 1 - 2 Workers	3	0.020177%	23	0.233627%	43	0.161624%
Income Group 1 - 3+ Workers	4	0.003012%	24	0.027068%	44	0.024551%
Income Group 2 - 0 Workers	5	6.293573%	25	0.766984%	45	1.053550%
Income Group 2 - 1 Workers	6	0.964589%	26	2.733875%	46	4.398066%
Income Group 2 - 2 Workers	7	0.109304%	27	1.191861%	47	0.905212%
Income Group 2 - 3+ Workers	8	0.013864%	28	0.184938%	48	0.134515%
Income Group 3 - 0 Workers	9	3.997120%	29	0.676083%	49	0.938924%
Income Group 3 - 1 Workers	10	2.481349%	30	4.484964%	50	7.767545%
Income Group 3 - 2 Workers	11	0.647282%	31	5.210025%	51	4.643824%
Income Group 3 - 3+ Workers	12	0.163440%	32	1.168424%	52	0.833210%
Income Group 4 - 0 Workers	13	1.136034%	33	0.229542%	53	0.327788%
Income Group 4 - 1 Workers	14	1.380636%	34	2.821640%	54	3.003648%
Income Group 4 - 2 Workers	15	1.024502%	35	5.949157%	55	6.225903%
Income Group 4 - 3+ Workers	16	0.415429%	36	1.892371%	56	2.216734%
Income Group 5 - 0 Workers	17	0.482521%	37	0.079554%	57	0.101381%
Income Group 5 - 1 Workers	18	0.450708%	38	1.482431%	58	1.037664%
Income Group 5 - 2 Workers	19	0.291394%	39	2.170314%	59	2.179144%
Income Group 5 - 3+ Workers	20	0.209612%	40	0.582954%	60	0.924193%
Total		25.532242%		34.231037%		40.236722%

8.4 TRIP PRODUCTION ESTIMATION

8.4.1 Introduction

The household survey data was used as the basis of estimating trip generation rates for all purposes except the Newark Airport Trips and truck trips. The trip production rates from the revised and re-weighted household survey formed the base rates and were reviewed for reasonableness and adjusted as necessary. For the home-based work purpose, other comparisons to trip rates from the Census/PUMS were performed as well. The production rates are cross-tabulated for each of the household group, both by household size, income group and life cycle for the nonwork-related purposes, while the work-related purposes were stratified by number of workers, income group, and life cycle. The resulting trip generation rates, together with the households by category generated by household submodels, were used to generate zonal-level trip productions for each household group by trip purpose.

8.4.2 Trip Production Rate by Trip Purpose by Household Group

As anticipated due to the limited samples and weighing of the household survey, the original production rates from survey contained some illogical variations and were smoothed / adjusted as deemed necessary. It was generally expected that increasing household size, incomes, and workers should have higher trip generation rates. Trips from the survey made by New Jersey households and New York households were included in the summation for the purpose of increasing the sample size for the various categories.

As part of the review of the trip generation rates, the aggregate HBW rates were compared to the values derived from other regional models as well as the original NJRTM-E rates. The HBW total trip generation rate appears to be generally consistent with the original rates and other regional models, as shown in Table **49**. There is a slight increase in the WBO trip generation rates.

Table 49 – Home-Based Work Trip Rate Comparison

The 2018 NJRTM-E Revalidation Trip Rates by Work Purpose

Household Category	TRIP PURPOSE			TOTAL
	HBWD	HBWS	WBO	
RETIRED	0.59	0.16	0.25	1.00
CHILDREN	2.21	1.10	1.38	4.69
NO CHILD/RETIRED	1.70	0.46	1.28	3.44
WEIGHTED	1.53	0.56	1.02	
HBW COMBINED	2.09			
TOTAL WORK-RELATED =	3.11			

The Original Rates from 2000 Model Development Manual.

Household Category	**TRIP PURPOSE**			**TOTAL**
	HBWD	**HBWS**	**WBO**	
RETIRED	0.67	0.16	0.21	1.04
CHILDREN	1.76	0.76	0.93	3.45
NO CHILD/RETIRED	1.90	0.55	0.94	3.39
WEIGHTED	1.54	0.52	0.75	
HBW COMBINED	20.60			
TOTAL WORK-RELATED =	2.81			

Total HBW Trip Rates by Region

REGION	**RATE**	**YEAR**
BALTIMORE	1.74	1993
LOS ANGELES	1.78	
PORTLAND	1.79	
HOUSTON	1.79	
WILMINGTON	1.82	
PHOENIX	1.86	
DALLAS	1.94	
SAN ANTONIO	1.95	
SAN FRANCISCO	2.03	
READING	2.04	
NJTPA	2.06	1986
NJTPA	2.06	1998
SEATTLE	2.27	
DVRPC	2.42	2001

The NJRTM-E trip generation process stratifies the generic HBW trip purpose into two separate purposes, “direct” and “strategic”. The HBWS trip rate is approximately 24% of the total HBW purpose trips. From a limited literature review, it appears reasonable. Austin Texas has HBWS trip rates that are 31% of the HBW Purpose. For models recently developed for Memphis and Los Angeles, the HBWS trip rate was approximately 30 percent and 23 percent respectively. It should be noted that other studies from unreferenced regions have percentages as low as 5%. It is likely that differing survey techniques and variation in the definitions used to establish "strategic" trips in each region would explain most of this variation. The development of the HBWS is discussed in APPENDIX M – INCOME GROUP ADJUSTMENTS.

For the nonwork purposes, the aggregate trip generation rates for each life cycle category are listed in Table 50. As expected the home-based other trip purpose generates most of the nonwork trips and clearly increases for households that do not have retirees, with highest rates for households with children. Similarly, households with retirees have the lowest number of home-based university trips. For home-based shopping trips, the retiree households have a higher rate, but this is most likely attributed to their ability to conduct separate, dedicated trips, rather than chaining trips (including shopping trips) together as households with working individuals and family obligations must do.

Table 50 – Nonwork-Based Trip Rates

The 2018 NJRTM-E Revalidation Trip Rates by Non-Work Purpose

Household Category	TRIP PURPOSE			
	HBS	HBO	HBU	NHNW
RETIRE	1.15	3.22	0.05	2.10
CHILDREN	1.01	7.94	0.20	3.38
NO CHILD/RETIRED	0.70	1.95	0.16	0.93
WEIGHTED	0.91	4.00	0.14	1.95

The Original Rates from 2000 Model Development Manual.

Household Category	TRIP PURPOSE			
	HBS	HBO	HBU	NHNW
RETIRE	1.09	2.33	0.05	1.11
CHILDREN	0.94	6.00	0.16	1.55
NO CHILD/RETIRED	0.56	1.50	0.15	0.55
WEIGHTED	0.83	3.25	0.13	1.03

Table 51 and Table 52 list the final trip production rates by household group for the work purposes and non-work purposes respectively.

Table 51 – Production Rates - Work Related Trips by Household Group

Household Group	Households with Retirees			Households with Children			Households with No Children or		
	HBWD	HBWS	WBO	HBWD	HBWS	WBO	HBWD	HBWS	WBO
Income Group 1 - No worker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Income Group 1 - 1 worker	1.05	0.05	1.89	0.73	0.12	0.61	0.53	0.05	1.82
Income Group 1 - 2 workers	1.74	0.22	0.47	1.90	0.82	2.75	2.69	0.03	5.89
Income Group 1 - 3+ workers	2.30	0.27	0.55	4.13	0.45	2.75	5.37	0.56	8.09
Income Group 2 - No worker	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Income Group 2 - 1 worker	1.10	0.23	0.14	1.31	0.77	0.43	1.19	0.27	0.26
Income Group 2 - 2 workers	3.31	0.39	0.16	2.02	0.89	0.62	2.27	0.33	0.31
Income Group 2 - 3+ workers	3.15	0.82	0.18	3.83	0.52	1.08	3.67	0.48	0.60
Income Group 3 - No worker	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Income Group 3 - 1 worker	1.36	0.26	0.41	0.99	1.03	0.85	1.22	0.36	0.89
Income Group 3 - 2 workers	2.53	0.50	0.36	2.16	0.81	0.54	2.62	0.63	1.09
Income Group 3 - 3+ workers	3.97	1.33	0.80	3.33	0.77	0.46	4.42	0.70	0.53
Income Group 4 - No worker	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Income Group 4 - 1 worker	1.26	0.31	0.15	1.72	0.39	0.54	1.23	0.42	0.19
Income Group 4 - 2 workers	2.33	1.15	0.42	2.08	1.35	0.41	2.35	0.74	0.30
Income Group 4 - 3+ workers	3.50	0.80	0.27	3.39	1.21	0.56	4.07	0.79	0.29
Income Group 5 - No worker	0.28	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Income Group 5 - 1 worker	1.16	0.17	0.51	1.25	0.32	2.22	0.70	0.50	1.59
Income Group 5 - 2 workers	2.16	0.74	0.68	2.17	1.38	1.60	2.44	0.81	0.74
Income Group 5 - 3+ workers	5.57	1.50	3.25	2.87	1.84	2.40	3.67	1.22	1.43

Table 52 – Production Rates - Non-Work Trip Purposes by Household Group

Household Group	Households with Retirees				Households with Children				Households with No Children or Retirees			
	HBSH	HBO	HBU	NHNW	HBSH	HBO	HBU	NHNW	HBSH	HBO	HBU	NHNW
Income Group 1 - HH Group 1	0.69	1.78	0.01	1.31	0.00	0.00	0.00	0.00	0.47	1.36	0.23	0.87
Income Group 1 - HH Group 2	1.01	2.43	0.01	0.62	1.27	3.73	0.04	6.43	0.20	0.70	0.82	0.21
Income Group 1 - HH Group 3	1.61	4.13	0.16	1.03	0.40	4.25	0.02	0.29	0.55	2.04	0.49	0.38
Income Group 1 - HH Group 4	1.36	5.22	0.04	1.62	0.39	9.33	0.08	2.24	0.57	2.04	0.71	0.42
Income Group 1 - HH Group 5	1.63	9.44	0.33	0.58	1.63	6.85	0.21	1.58	0.53	2.41	1.52	0.25
Income Group 1 - HH Group 6	4.56	10.81	0.33	4.79	2.18	30.47	0.37	21.62	0.53	2.41	1.52	0.38
Income Group 2 - HH Group 1	1.15	1.89	0.01	2.24	0.00	0.00	0.00	0.00	0.69	1.27	0.05	1.07
Income Group 2 - HH Group 2	1.37	3.18	0.01	3.04	0.92	2.73	0.04	5.27	1.35	2.26	0.14	2.20
Income Group 2 - HH Group 3	1.51	3.82	0.14	2.05	0.38	4.66	0.17	1.38	0.40	2.55	0.26	1.27
Income Group 2 - HH Group 4	1.17	5.05	0.04	3.12	0.72	5.62	0.16	1.53	1.30	2.70	0.42	0.80
Income Group 2 - HH Group 5	1.55	6.29	0.23	2.75	0.88	5.41	0.33	1.90	0.58	2.13	1.02	3.75
Income Group 2 - HH Group 6	0.70	7.92	0.23	1.66	1.45	11.37	0.33	12.63	0.58	4.54	1.02	0.74
Income Group 3 - HH Group 1	0.77	2.21	0.01	1.60	0.00	0.00	0.00	0.00	0.60	1.47	0.03	0.72
Income Group 3 - HH Group 2	1.18	3.87	0.02	2.34	0.78	2.98	0.03	0.73	0.71	2.57	0.11	0.87
Income Group 3 - HH Group 3	1.05	3.26	0.14	1.08	0.70	4.13	0.14	0.96	1.17	5.02	0.11	2.10
Income Group 3 - HH Group 4	1.59	6.61	0.04	2.55	0.74	6.58	0.11	2.15	1.88	1.21	0.41	1.59
Income Group 3 - HH Group 5	1.59	8.15	0.32	1.45	0.92	7.27	0.32	2.07	1.97	10.70	1.28	0.38
Income Group 3 - HH Group 6	1.59	12.15	0.29	4.74	1.31	14.07	0.36	7.68	0.55	4.98	1.28	0.58
Income Group 4 - HH Group 1	1.19	3.01	0.00	2.30	0.00	0.00	0.00	0.00	0.38	1.45	0.02	0.65
Income Group 4 - HH Group 2	1.62	3.36	0.00	3.12	5.03	3.43	0.03	6.65	0.75	2.57	0.03	1.30
Income Group 4 - HH Group 3	1.58	4.47	0.09	2.28	0.82	4.04	0.03	1.95	0.96	2.51	0.31	1.42
Income Group 4 - HH Group 4	1.29	8.27	0.03	3.03	0.97	8.50	0.21	2.96	0.78	4.12	0.96	0.70
Income Group 4 - HH Group 5	2.27	9.02	0.44	5.55	0.87	9.97	0.17	4.21	1.48	8.92	1.84	1.89
Income Group 4 - HH Group 6	1.43	8.56	0.39	3.30	0.69	8.13	0.26	1.35	0.69	5.70	1.84	1.01
Income Group 5 - HH Group 1	0.65	1.12	0.00	2.60	0.00	0.00	0.00	0.00	0.96	0.71	0.00	0.95
Income Group 5 - HH Group 2	1.53	2.36	0.00	3.18	0.50	1.67	0.01	0.27	0.58	1.17	0.01	0.71
Income Group 5 - HH Group 3	1.53	2.63	0.03	2.15	0.63	2.83	0.02	2.55	1.62	1.03	0.12	0.62
Income Group 5 - HH Group 4	1.32	4.14	0.03	3.69	0.31	3.22	0.04	1.68	0.29	0.25	0.69	0.16
Income Group 5 - HH Group 5	2.35	3.01	0.47	3.44	0.93	7.63	0.07	5.09	0.45	2.19	1.37	0.68
Income Group 5 - HH Group 6	3.41	6.46	0.47	3.87	0.45	4.59	0.18	6.58	0.63	2.71	1.37	1.05

8.4.3 Trip Production Calibration and Adjustment

As income group and area type are two important dimensions throughout the modeling process, a decision was made to calibrate the initial trip production estimates to match targets stratified by these two variables by trip purpose. These adjustments effectively factored base trip rates produced by the generic production rate table for all regions. Note that area is not a variable used on the production cross-classification procedures so these factors were introduced to scale trip productions by area type. The adjustment factors are listed in Table 53. These same adjustments were also adopted in the 2018 model revalidation project.

Table 53 – Production Adjustment Factors by Area Type & Trip Purpose

AREA TYPE	HBWD	HBWS	HBSH	HBO	HBU	WBO	NHB
CBD/URBAN HIGH	1.20	0.95	1.40	1.10	1.60	0.75	1.12
URBAN	0.90	0.86	0.74	0.83	0.95	0.83	0.85
SUBURBAN HIGH	1.10	1.03	1.17	1.08	1.00	1.07	1.00
SUBURBAN	1.07	1.20	1.13	1.17	1.50	1.17	1.13
RURAL	0.85	1.08	0.98	1.00	0.90	1.04	1.08

Within the core calibration region that is defined as the NJTPA counties and Mercer County, adjustment factors by income group and county were also implemented. These factors are listed as part of APPENDIX C – COUNTY PRODUCTION ADJUSTMENT FACTORS BY INCOME.

Table 54 provides a comparison of the estimated and observed trip productions at the county level. Note that that the aggregate county estimates are within 3 percent of the observed total for all counties, with most counties within 2 of the target values. For the estimates by individual trip purposes nearly all other estimates are within one percent. The Trip production comparison by county and by income group is provided in APPENDIX D – TRIP PRODUCTIONS BY COUNTY & INCOME GROUP.

Table 54 – Trip Productions by County

Trip Productions from Model by County

COUNTY	HBWD	HBWS	HBSH	HBO	HBU	WBO	NHNW	TOTAL
Bergen	493,855	220,883	402,341	1,457,072	43,804	144,912	747,569	3,510,435
Essex	346,575	106,695	191,977	841,782	17,608	120,276	423,914	2,048,826
Hudson	331,659	63,603	113,565	398,210	24,775	63,661	198,785	1,194,259
Hunterdon	56,597	15,881	37,507	144,354	2,436	8,509	56,257	321,540
Mercer	178,117	71,372	125,120	409,258	7,671	61,345	264,462	1,117,345
Middlesex	451,791	150,443	274,490	1,049,472	26,547	120,069	468,359	2,541,172
Monmouth	310,359	104,818	250,383	958,771	11,823	117,418	568,347	2,321,918
Morris	267,914	85,509	151,378	676,283	6,733	102,743	396,298	1,686,859
Ocean	259,279	98,512	235,498	766,162	20,668	72,811	450,468	1,903,398
Passaic	238,111	79,246	192,426	640,839	18,277	55,116	404,259	1,628,274
Somerset	177,822	68,003	106,493	381,418	12,776	59,417	197,783	1,003,712
Sussex	78,484	43,074	41,873	184,088	2,948	24,180	73,587	448,233
Union	284,305	128,365	144,668	733,199	9,698	71,711	336,000	1,707,947
Warren	50,308	16,860	48,583	152,495	2,341	7,275	52,344	330,206
TOTAL	**3,525,175**	**1,253,265**	**2,316,303**	**8,793,403**	**208,104**	**1,029,443**	**4,638,431**	**21,764,123**

Trip Productions from Household Survey by County

COUNTY	HBWD	HBWS	HBSH	HBO	HBU	WBO	NHNW	TOTAL
Bergen	493,865	220,883	402,337	1,457,199	43,805	145,897	745,986	3,509,973
Essex	346,582	105,356	191,966	841,777	17,607	121,202	422,479	2,046,969
Hudson	331,663	63,600	113,566	398,452	24,775	63,818	198,411	1,194,284
Hunterdon	56,450	15,859	37,507	144,362	2,435	8,547	56,184	321,345
Mercer	177,029	71,223	125,119	409,340	7,672	61,654	263,954	1,115,991
Middlesex	451,789	149,855	274,532	1,049,292	26,547	120,817	467,098	2,539,929
Monmouth	310,357	104,816	250,383	958,633	11,823	118,198	567,055	2,321,265
Morris	267,195	85,411	151,371	676,231	6,733	103,338	395,341	1,685,621
Ocean	259,280	98,512	235,494	766,114	20,667	73,256	449,706	1,903,030
Passaic	238,114	79,246	192,427	640,947	18,277	55,532	403,661	1,628,205
Somerset	177,823	67,928	106,494	381,385	12,775	59,821	197,164	1,003,390
Sussex	78,483	43,074	41,873	184,109	2,948	24,239	73,429	448,156
Union	284,307	128,365	144,668	733,392	9,698	72,202	335,176	1,707,809
Warren	50,307	16,860	48,583	152,509	2,341	7,355	52,549	330,504
TOTAL	**3,523,245**	**1,250,989**	**2,316,321**	**8,793,743**	**208,103**	**1,035,877**	**4,628,192**	**21,756,472**

Percent Ratio of Trip Productions by County (Model vs. Household Survey)

COUNTY	HBWD	HBWS	HBSH	HBO	HBU	WBO	NHNW	TOTAL
Bergen	100.0%	100.0%	100.0%	100.0%	100.0%	99.3%	100.2%	100.0%
Essex	100.0%	101.3%	100.0%	100.0%	100.0%	99.2%	100.3%	100.1%
Hudson	100.0%	100.0%	100.0%	99.9%	100.0%	99.8%	100.2%	100.0%
Hunterdon	100.3%	100.1%	100.0%	100.0%	100.0%	99.6%	100.1%	100.1%
Mercer	100.6%	100.2%	100.0%	100.0%	100.0%	99.5%	100.2%	100.1%
Middlesex	100.0%	100.4%	100.0%	100.0%	100.0%	99.4%	100.3%	100.0%
Monmouth	100.0%	100.0%	100.0%	100.0%	100.0%	99.3%	100.2%	100.0%
Morris	100.3%	100.1%	100.0%	100.0%	100.0%	99.4%	100.2%	100.1%
Ocean	100.0%	100.0%	100.0%	100.0%	100.0%	99.4%	100.2%	100.0%
Passaic	100.0%	100.0%	100.0%	100.0%	100.0%	99.3%	100.1%	100.0%
Somerset	100.0%	100.1%	100.0%	100.0%	100.0%	99.3%	100.3%	100.0%
Sussex	100.0%	100.0%	100.0%	100.0%	100.0%	99.8%	100.2%	100.0%
Union	100.0%	100.0%	100.0%	100.0%	100.0%	99.3%	100.2%	100.0%
Warren	100.0%	100.0%	100.0%	100.0%	100.0%	98.9%	99.6%	99.9%
TOTAL	**100.1%**	**100.2%**	**100.0%**	**100.0%**	**100.0%**	**99.4%**	**100.2%**	**100.0%**

The trip productions for New York Counties were also calibrated to match the targets stratified by income group. The original trip production adjustment factors for Manhattan and Other New York Counties were adopted for the 2018 Revalidation as shown in Table 55 and Table 56, respectively.

Table 55 – Production Adjustment Factors by Income Group for Manhattan

INCGRP	HBWD	HBWS	HBSH	HBO	WBO	NHB
1	0.27	0.17	0.2	1.05	1.96	1.25
2	0.32	0.71	0.43	1.13	1.07	1.07
3	0.46	0.62	0.74	0.79	0.84	0.78
4	0.52	0.69	1.35	1.07	1.21	0.76
5	0.92	1.62	1.65	1.61	1.56	1.27

Table 56 – Production Adjustment Factors by Income - Other NY Counties

INCGRP	HBWD	HBWS	HBSH	HBO	WBO	NHB
1	0.49	0.30	0.8	1.05	0.44	1.00
2	0.62	0.72	0.88	0.92	1.02	0.91
3	0.61	0.61	0.73	0.83	0.84	0.93
4	1.00	1.12	1.18	1.24	1.00	1.16
5	1.14	1.02	1.54	0.95	0.81	0.81

8.5 HOME-BASED UNIVERSITY MODEL

8.5.1 Methodology Overview

The approach adopted for home-based-university (HBU) purpose utilized trip generation rates from the household survey and enrollment information for major universities located in the detailed New Jersey region and New York City region. The definition of this purpose includes any home based trip made by individuals aged 18 or older that lists school as the other trip end. Due to the limited nature of observed trip generation data for the HBU purpose, this approach focused on using the university enrollment data, including statistics about students residing off-campus to control the overall estimation process. Note that while the enrollment data base includes many of the universities, it is not an exhaustive listing of all post-secondary schools. However, the process is flexible so that if and when other data is obtained for any additional universities, the new sites can be easily integrated into the process.

The process is basically a balanced approach that utilizes data from both the household survey and the university enrollment. The household survey provided trip rates and trip length distribution data for which to calibrate the trip distribution. The university enrollment data quantifying off-campus students were used as control totals for the purpose as well as the location of the trip attractions for this purpose.

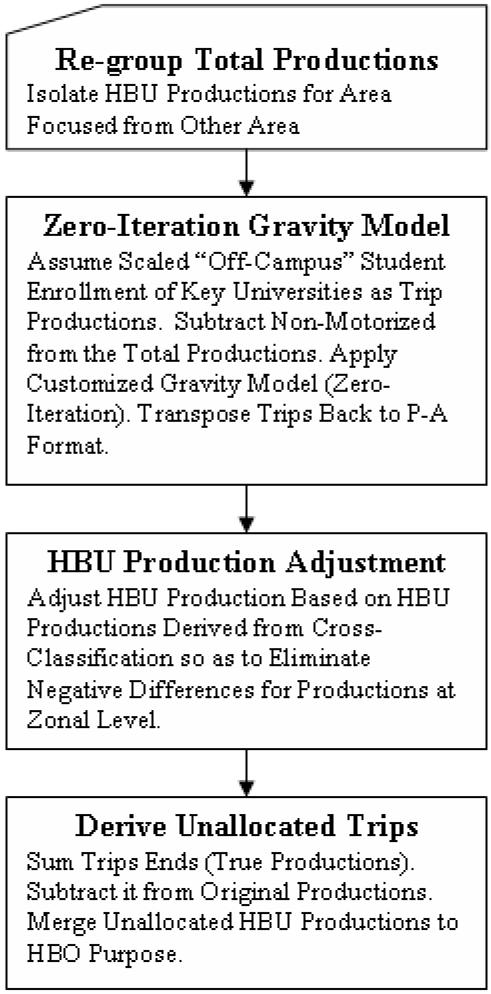
The flow chart in Figure 21 depicts the process. Note that during the initial steps of the process, the HBU trip ends are estimated with the cross-classification process for the entire region and that these trip ends represent all post-secondary school trips, even to schools such as technical schools, that are not currently included in the university database. Therefore, the number of HBU trips produced will exceed the number of trip attractions in the university database. In the final stages of the process described below, any remaining unallocated HBU trip productions are merged back into the home-based other purpose.

Since the process uses the university enrollment data base as the controlling estimate of total HBU trips, it is necessary to temporarily invert the typical “production-attraction” designations so that trips are “produced” at the university end and “attracted” to households. Trip ends at the household level estimated from cross-classification for the modeled region were designated as attractions. Estimates of trip ends associated with off-campus residents at each university were treated as productions. A zero-iteration gravity model technique was used to allocate trip ends to the proportionate trip lengths observed from the survey data, but the model does not attempt to balance the unused “attractions” at the home end.

After converting the trip end orientation back to the traditional home-based production–attraction format, the procedure quantifies any differences between the zonal level HBU trip productions from the cross-classification process and the HBU trip productions allocated by the zero iteration gravity model. Note The HBU productions from cross-classifications were expected to be greater than the HBU productions allocated by the gravity model since cross-classification estimates would, in-theory, include all home-based post secondary school trips. However, it was necessary to implement an adjustment step to eliminate the negative differences in individual zones where the gravity model allocated more trip ends than were estimated by the cross-classification process. In all the other zones where unallocated trip ends occurred, these trip ends were removed from the HBU trip purpose and added to the home-based-other trip purpose.

Note that this process is dynamic, so that as additional enrollment information is provided about any remaining universities or post-secondary education institutions, the amount of unallocated trip ends would automatically be reduced. Since enrollment information for the remote areas of Pennsylvania and Connecticut were not included in the database, HBU trip ends from these regions were converted directly to home-based other trips.

Figure 21 – HBU Sub-Model Process



8.5.2 University Enrollment

The enrollment data of universities in New Jersey region were provided by NJTPA and verified against the enrollment summary on the website of "New Jersey Commission on Higher Education". The enrollment data for universities in New York City were obtained from the website of "New York State Education Department (Office of Higher Education)". Information on the number of off-campus students was obtained from each institution either by phone calls or website search. Table 57 and Table 58 list the detailed enrollment by college by state, together with a calculated university student related "productions" by assuming "off-campus" full-time students go to universities 4 out of 5 days a week and part-time students go to universities 2 out of 5 days a week. It should be noted that these trip ends relate the initial arrival and final departure of students each day and that these trip ends could be trips that are home-based as well as trips that are non-home based. Note also that these trip ends do not account for other non-home-based trips that students make during the course of the day. As an example, a student may leave the campus for lunch or some other activity and return to campus the same day before finally leaving campus for the day.

Table 57 – University Enrollment for New Jersey Institutions

Institutions	County	Area Type	Zone	Enrollment	Full Time	Part Time	On Campus
Stockton University	Atlantic	4	13	8,674	7,715	959	2,577
Atlantic Cape Community College	Atlantic	4	14	6,361	2,920	3,441	-
Felician College	Bergen	2	87	1,957	1,429	528	487
Ramapo College of New Jersey	Bergen	3	118	6,026	5,041	985	2,739
Bergen Community College	Bergen	2	146	14,585	8,347	6,238	-
Fairleigh Dickinson University (FDU)-Metro	Bergen	2	180	8,652	3,915	4,737	850
Burlington County College	Burlington	3	279	8,762	4,289	4,473	-
New Jersey Institute of Technology	Essex	1	355	11,325	8,233	3,092	1,991
UMDNJ (Newark Campus)	Essex	2	358	3,227	2,746	513	-
Essex County College	Essex	2	426	10,954	5,628	5,326	-
Rutgers University (Newark Campus)	Essex	1	430	14,305	11,563	2,731	1,796
Bloomfield College	Essex	2	500	1,980	1,757	223	229
Montclair State University	Essex	3	507	20,465	15,876	4,589	2,748
Seton Hall University	Essex	3	538	9,824	7,168	2,656	2,114
Caldwell College	Essex	3	564	2,138	1,532	606	315
Hudson County Community College	Hudson	2	595	9,051	5,876	3,175	-
Saint Peter's College	Hudson	2	604	3,406	2,450	956	832
New Jersey City University	Hudson	2	631	8,237	5,232	3,005	3,707
Stevens Institute of Technology	Hudson	2	736	6,359	5,092	1,267	1,774
Thomas Edison State College	Mercer	2	797	13,093	84	13,009	-
Rider University	Mercer	3	840	5,069	4,022	1,047	1,843
The College of New Jersey	Mercer	3	850	7,406	6,711	695	3,903
Princeton University	Mercer	3	866	8,138	8,013	125	7,732
Mercer County Community College	Mercer	4	887	7,979	3,077	4,902	-
Rutgers University (New Brunswick Campus)	Middlesex	3	917	48,096	38,873	9,183	19,339
UMDNJ (Piscataway Campus)	Middlesex	2	919	1,928	1,641	307	-
Middlesex County College	Middlesex	3	950	11,662	5,753	5,909	-
Monmouth University	Monouth	3	1186	6,394	5,187	1,207	1,768
Brookdale Community College	Monouth	4	1233	13,835	6,554	7,281	-
College of Saint Elizabeth	Morris	3	1304	1,247	628	619	233
Fairleigh Dickinson University (FDU)-Florham	Morris	3	1307	3,394	2,993	401	1,198
Drew University	Morris	3	1310	2,082	1,691	391	1,023
County College of Morris	Morris	3	1348	8,026	3,946	4,080	-
Georgian Court College	Ocean	2	1394	2,122	1,406	716	192
Ocean County College	Ocean	3	1431	8,663	4,611	4,052	-
Passaic County Community College	Passaic	2	1536	8,389	3,481	4,908	-
William Paterson University of New Jersey	Passaic	3	1557	10,862	8,031	2,831	2,571
Raritan Valley Community College	Somerset	3	1635	8,099	3,361	4,738	-
Sussex County Community College	Sussex	3	1680	2,732	1,505	1,227	-
Kean University	Union	2	1732	14,112	10,045	4,067	1,313
Union County College	Union	3	1769	11,220	4,853	6,367	-
Centenary College	Warren	3	1814	2,284	1,817	467	1,142
Warren County Community College	Warren	4	1823	2,822	741	2,081	-
NJTPA+Mercer Total				342,145	220,908	121,237	61,837
New Jersey Total				365,942	235,832	130,110	64,414
New York Total				489,320	339,370	149,950	47,644
Grand Total				855,262	575,202	280,060	112,058

Table 58 – University Enrollment for New York Institutions

Institutions	County	Area Type	Zone	Enrollment	Full Time	Part Time	Off-Campus	Productions
Barnard College	New York	1	2045	2,359	2,298	61	236	329
Bernard Baruch College	New York	1	1920	15,756	10,582	5,174	15,756	21,070
Borough-Manhattan Community College	New York	1	1894	18,776	10,809	7,967	18,776	23,668
City College	New York	1	2049	12,360	6,957	5,403	11,760	14,494
Columbia University	New York	1	2045	23,862	19,311	4,551	16,614	22,942
Fashion Institute of Technology	New York	1	1950	10,381	6,769	3,612	9,131	11,720
Grad School and University Center	New York	1	1930	4,313	3,771	542	4,313	6,467
Hunter College	New York	1	1977	20,843	11,417	9,426	20,231	24,829
John Jay College	New York	1	2000	14,295	9,739	4,556	14,295	19,227
Katharine Gibbs-NYC	New York	1	1940	2,047	1,841	206	2,047	3,110
Marymount Manhattan College	New York	1	1984	2,007	1,603	404	1,307	1,768
New School University	New York	1	1919	9,130	6,882	2,248	8,030	11,050
New York University	New York	1	1915	40,004	30,157	9,847	29,004	38,529
Pace University	New York	1	1884	8,860	4,899	3,961	7,560	8,927
School of Visual Arts	New York	1	1924	3,575	3,317	258	2,610	3,969
Teachers College	New York	1	2045	5,007	2,746	2,261	4,257	5,002
Technical Career Institute	New York	1	1965	2,994	2,801	193	2,994	4,636
Touro College	New York	1	1914	15,718	9,374	6,344	15,580	19,853
Yeshiva University	New York	1	2072	6,367	5,612	755	5,367	7,983
College of Staten Island	Staten Island	2	2143	12,083	7,391	4,692	12,083	15,579
Wagner College	Staten Island	2	2135	2,287	2,055	232	457	546
St John's University-Staten Island	Staten Island	2	2135	2,952	1,902	1,050	2,452	3,083
Bronx Community College	Bronx	1	1830	8,470	5,088	3,382	8,470	10,846
Fordham University-Rose Hill	Bronx	2	1832	6,284	5,395	889	3,141	4,314
Fordham University-Lincoln Center	New York	1	1999	7,667	4,467	3,200	6,814	8,342
Herbert Lehman College	Bronx	2	1832	10,615	5,239	5,376	10,615	12,683
Hostos Community College	Bronx	2	1828	4,477	2,757	1,720	4,477	5,787
Manhattan College	Bronx	2	1832	3,522	3,038	484	1,706	2,343
Monroe College	Bronx	1	1830	6,070	5,269	801	5,870	8,751
ASA Institute of Bus/Comp Technology	Kings	1	1836	2,977	2,901	76	2,977	4,702
Brooklyn College	Kings	1	1852	15,281	8,515	6,766	15,281	19,037
Kingsborough Community College	Kings	2	1850	15,265	7,968	7,297	15,265	18,586
Liu-Brooklyn Campus	Kings	1	1836	8,144	5,675	2,469	7,506	10,034
Medgar Evers College	Kings	1	1842	5,211	3,134	2,077	5,211	6,676
NYC College of Technology	Kings	1	1836	12,439	7,106	5,333	12,439	15,636
Polytechnic University	Kings	1	1836	2,801	2,089	712	2,401	3,272
Pratt Institute	Kings	1	1836	4,798	4,246	552	3,298	4,835
St Francis College	Kings	1	1836	2,336	2,019	317	2,336	3,484
Laguardia Comnunity College	Queens	2	2122	13,489	7,453	6,036	13,489	16,754
Queens College	Queens	2	2128	17,638	9,185	8,453	17,638	21,458
Queensborough Community College	Queens	3	2132	12,838	6,317	6,521	12,838	15,324
St John's University -Queens	Queens	2	2128	16,889	11,965	4,924	14,432	19,152
York College	Queens	2	2124	5,899	3,878	2,021	5,899	7,822
Manhattan Total				226,321	155,352	70,969	196,682	257,915
NY Total				419,086	275,937	143,149	376,963	488,619

The original approach to estimate HBU trips was also used in the 2018 revalidation project. Additionally, county adjustment factors were applied as shown in APPENDIX C – COUNTY PRODUCTION ADJUSTMENT FACTORS BY INCOME. For revalidation purposes, the estimated HBU by County were compared with observed data from the 2010 Household Survey, and the results are shown in the Table 59.

Table 59 – HBU Trips Comparison

COUNTY	TRIPS		
	OBSERVED	ESTIMATED	%DIFF
Bergen	43,805	43,804	0.0%
Essex	17,607	17,608	0.0%
Hudson	24,775	24,775	0.0%
Hunterdon	2,435	2,436	0.0%
Mercer	7,672	7,671	0.0%
Middlesex	26,547	26,547	0.0%
Monmouth	11,823	11,823	0.0%
Morris	6,733	6,733	0.0%
Ocean	20,667	20,668	0.0%
Passaic	18,277	18,277	0.0%
Somerset	12,775	12,776	0.0%
Sussex	2,948	2,948	0.0%
Union	9,698	9,698	0.0%
Warren	2,341	2,341	0.0%
TOTAL	**208,103**	**208,104**	**0.0%**

8.6 NON-HOME-BASED TRIP ENDS ESTIMATION

The NJRTM-E provides a more detailed treatment of non-home based trips than was provided by the NJRTM. The aggregate non-home-based (NHB) trips from the NJRTM was partitioned into two purposes, work-based other (WBO) and non-home non-work (NHNW). The WBO purpose contains non-home-based trips that have at least one trip end at work while the NHNW purpose includes all other non-home-based trips. The productions of non-home-based purposes from the cross-classification process represent the trips that are "produced" by households within the region. These productions are based on the characteristics of the households although the trips are not linked to the home zone. The technique employed for estimating the non-home based trip purposes, is to use the cross-classification procedure to estimate total regional non-home-based trips and to use standard attraction equations to allocate the trips ends to individual zones. Note that the region totals by income group from cross-classification will serve as control totals that govern the overall amount of non-home-based trip ends.

The linear regression estimation method was used for non-home-based trip ends, similar to trip attractions for home-based purposes. For convenience, the methodology and results are all stated together with the trip attraction model in the following section of this report. The regression equations with the estimated coefficients for each purpose were applied then at the zonal level, providing an initial estimate of total trip ends that occur in each zone. As the estimated trip ends here represent both "origins and destinations" of the non-home-based trips, the zonal estimates are divided in half to provide both trip origins and destinations.

As all non-home-based trips occur in zones other than the home zone, the income of trip maker for the individual trips is not known. Since the NJT mode choice model that was adopted for the NJRTM-E requires trips by income group, it was necessary to create a process to estimate the income of the non-home-based trips. The method adopted assumed that the distribution of WBO trip ends by income group was related to the home-based work trips that were attracted to the zone. To estimate these percentages, trips by income for both of the HBW purposes (both Direct and Strategic) attracted to each zone were summed together to create percentage shares. Similarly, the distribution of NHNW trip ends by income group was assumed to be the same as the distribution by income group for home-based non-work purposes (HBSH and HBO) attracted to each zone. As part of this process, it was necessary to ensure that the zonal level estimates by income group matched the regional control totals. After the stratification by income group at the zonal level, the trip ends were then summed and normalized against control totals by income group from cross-classification process.

It should be noted that the trip ends estimated here are total trips including both non-motorized and motorized modes, since these trip ends were initially estimated from the household survey in the same method as the home-based trips. It was therefore necessary to partition these trips into motorized and non-motorized share, since only the motorized trips are retained in the remaining model components.

The total trip ends here were adjusted by region (NJTPA+MERCER, NEW YORK, OTHER REGION) to match the total origins and destinations from household survey by region. Since the household survey only includes NJTPA+MERCER and 12 New York counties, the adjustment factors for the OTHER REGION were derived based on the production control total from cross-classification process. As the non-motorized share model is applied prior to the attraction model, the final trip ends are not partitioned by income in this step. Rather, there is a temporary "placeholder" income stratification to maintain a common modeling structure during the estimation of the motorized trip ends. As part of the trip attraction model component, the motorized trip ends are stratified by income group using the process stated above. As part of this process, the total NHB trip ends in NJTPA+MERCER region were adjusted to match the stratified targets by income group from household survey, in order to maintain both the total trip ends as well as the motorized trip ends in this region predicted by the non-motorized model.

Table 60 lists the regional NHB adjustment factors by trip purpose and by region. These adjustments were relatively minor with all factors altering the initial model estimates by less than 10 percent.

Table 60 – Regional NHB Adjustment Factors by Purpose

REGION	WBO	NHNW
NJTPA+MERCER	0.993	1.086
New York Counties (Less Sullivan)	0.984	0.935
Other Region	1.084	1.092

8.7 NON-MOTORIZED MODEL

8.7.1 Introduction

The purpose of the non-motorized model is to separate productions of non-motorized mode from those of motorized mode. For the NJRTM-E the modeling of non-motorized trips was focused primarily on estimating the probability of non-motorized trips as a function of land use and network characteristics that could be investigated as part of potential policy initiatives. Therefore, the non-motorized trips were estimated directly as part of the trip generation process and were not advanced through the remaining model components.

The estimation dataset for each trip purpose consists of observed trips for households in NJTPA region and Mercer County, defined with a choice (motorized or non-motorized) field and a weight field, and zonal level variables that are used to describe the likelihood of selecting a non-motorized mode. For home-based purposes, the household residence zones were chosen as the basis for the zonal level variables. For non-home-based purposes, the origin zones were instead chosen as the basis.

The estimation dataset included a series of density-related variables such as area type, population/employment density and intersection/network density, a variable describing the portion of the total roadway network that is defined as “pedestrian restrictive”, as well as a variable describing the availability of autos to the traveler. The home-based purpose models included the use of the auto availability term, since home-based trips can reference the variables associated with the home zone during model application. In contrast, the models for non-home-based purposes did not include the auto availability term since the non-home-based trips cannot be linked to the characteristics of the trip makers during the application of the model.

8.7.2 Methodology

The model developed for this process predicts the percentage share of trips that will utilize non-motorized modes. The binary logit model was utilized as the model structure for the share estimation. In the transformed structure listed below, the motorized mode is assumed as a “reference” or base mode, in which case the utility for the motorized mode is set equal to zero. As a result, the coefficients and constant terms in the models apply only to the non-motorized mode. The structure of the model is as follows:

$$p_{nm} = \frac{1.0}{1.0 + e^{-U_{nm}}}$$

Where:

p_{nm} = percentage share for non-motorized mode

U_{nm} = utility of the non-motorized mode.

The utility function in the model estimation is as follows:

$$U_{nm} = \beta_1 * (PopDen) + \beta_2 * (EmpDen) + \beta_3 * (IntDen) + \beta_4 * (NetConn)$$
$$+ \beta_5 * (Net\,\mathrm{Re}\,strict) + \beta_6 * (AutoPP) + ATConst$$

Where:

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ = estimated coefficients

$PopDen$ =population density (Population /“Developable” Area)

$EmpDen$ = employment density (Employment /“Developable” Area)

$IntDen$ = intersection density (Number of intersections/“Developable” Area)

$NetConn$ = street network connectivity (Number intersections/distance of polylines)

$Net\,\mathrm{Re}\,strict$ = network restrictiveness (share of roadway network in each zone that is defined as "pedestrian restrictive")

$AutoPP$ = number of autos available per person

$ATConst$ = area-type specific constant

As part of the 2018 Model Revalidation process, the same utility functions from the 2000 NJRTM-E model were adopted, and the updated regression analyses were performed for each trip purposes using the new 2010 Household Survey Data. The updated coefficients by purpose for the non-motorized trips are listed in Table 61.

The non-motorized trip comparison by trip purpose is shown in Table 62. At the system level, the estimated non-motorized trips replicated the observed data very well, and the difference is within one percent of the observed data. As expected, there is more variations at the purpose-level. The non-motorized trip comparison by county is presented in Table 63. The estimated non-motorized trips replicated the observed data reasonably well at county-level.

Table 61 – The 2018 NJRTM-E Revalidation Utility Coefficients for the Non-Motorized Trips

Table. Logistic Regression Results in R - HBWD

Variable	Coefficient	Std. Error	z value	Pr (>|z|)	
POP_DEN	7.39E-06	1.75E-06	4.227	2.36E-05	***
EMP_DEN	4.94E-06	1.16E-06	4.265	2.00E-05	***
ST_CONN	7.12E-02	1.39E-02	5.126	2.95E-07	***
AUTOPP	-2.44E+00	1.88E-01	-13.001	<2e-16	***
AT1	NA	NA	NA	NA	
AT7	-2.85E+00	1.43E-01	-19.888	<2e-16	***
AT4	-2.79E+00	1.55E-01	-17.961	<2e-16	***
AT8	-3.85E+00	1.81E-01	-21.222	<2e-16	***

Table. Logistic Regression Results in R - HBWS

Variable	Coefficient	Std. Error	z value	Pr (>|z|)	
POP_DEN	4.40E-05	2.29E-06	19.208	<2e-16	***
EMP_DEN	2.63E-05	2.25E-06	11.66	<2e-16	***
AUTOPP	-1.85E+00	2.78E-01	-6.649	2.94E-11	***
AT1	NA	NA	NA	NA	
AT7	-2.901	0.169	-17.169	<2e-16	***
AT4	-3.66E+00	2.10E-01	-17.484	<2e-16	***
AT8	-4.59E+00	2.99E-01	-15.375	<2e-16	***

Table. Logistic Regression Results in R - HBSH

Variable	Coefficient	Std. Error	z value	Pr (>|z|)	
POP_DEN	2.22E-05	1.23E-06	18.12	<2e-16	***
ST_CONN	1.47E-01	9.13E-03	16.07	<2e-16	***
RESRATIO	1.13E+00	1.13E-01	9.98	<2e-16	***
AUTOPP	-3.26E+00	1.10E-01	-29.69	<2e-16	***
AT1	NA	NA	NA	NA	
AT7	-1.692	0.09677	-17.49	<2e-16	***
AT4	-2.09E+00	1.02E-01	-20.47	<2e-16	***
AT8	-1.75E+00	1.02E-01	-17.15	<2e-16	***

Table. Logistic Regression Results in R - HBO

Variable	Coefficient	Std. Error	z value	Pr (>|z|)	
POP_DEN	2.51E-05	6.22E-07	40.264	<2e-16	***
EMP_DEN	5.45E-06	5.63E-07	9.685	<2e-16	***
AUTOPP	-1.68E+00	5.03E-02	-33.348	<2e-16	***
RESRATIO	-1.72E+00	5.51E-02	-31.285	<2e-16	***
AT1	NA	NA	NA	NA	
AT7	-0.9894	0.03404	-29.069	<2e-16	***
AT4	-1.28E+00	3.76E-02	-34.02	<2e-16	***
AT8	-1.62E+00	4.15E-02	-39.016	<2e-16	***

Table. Logistic Regression Results in R - NHBW

Variable	Coefficient	Std. Error	z value	Pr (>|z|)	
EMP_DEN	1.33E-05	7.78E-07	17.13	<2e-16	***
ST_CONN	2.93E-01	1.56E-02	18.82	<2e-16	***
AUTOPP	-2.34E+00	1.80E-01	-12.98	<2e-16	***
AT1	NA	NA	NA	NA	
AT7	-4.05E+00	1.49E-01	-27.13	<2e-16	***
AT4	-2.83	0.165	-17.15	<2e-16	***
AT8	-3.17E+00	1.78E-01	-17.83	<2e-16	***

Table. Logistic Regression Results in R - NHNW

Variable	Coefficient	Std. Error	z value	Pr (>|z|)	
POP_DEN	3.52E-05	1.05E-06	33.57	<2e-16	***
RESRATIO	-1.60E+00	9.91E-02	-16.12	<2e-16	***
AUTOPP	-1.89E+00	8.11E-02	-23.25	<2e-16	***
AT1	NA	NA	NA	NA	
AT7	-1.70E+00	5.25E-02	-32.45	<2e-16	***
AT4	-1.715	0.05906	-29.03	<2e-16	***
AT8	-2.80E+00	7.71E-02	-36.36	<2e-16	***

Note: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 62 – Non-Motorized Trips by Purpose Comparison for NJRTM-E Counties + Mercer

TRIP PURPOSE	OBSERVED	ESTIMATED	% DIFFERENCE
HBWD	83,967	83,713	-0.3%
HBWS	39,519	44,888	13.6%
HBS	218,574	223,982	2.5%
HBO	1,167,242	1,092,058	-6.4%
WBO	90,576	104,171	15.0%
NHBO	348,931	392,554	12.5%
Total	**1,948,810**	**1,941,366**	**-0.4%**

Table 63 – Non-Motorized Trips by County Comparison for NJRTM-E Counties + Mercer

County	OBSERVED	ESTIMATED	Pct Diff%
Bergen	240,811	240,113	-0.3%
Essex	373,813	371,563	-0.6%
Hudson	450,206	447,650	-0.6%
Hunterdon	18,524	18,801	1.5%
Mercer	85,181	85,721	0.6%
Middlesex	111,451	110,167	-1.2%
Monmouth	55,247	59,947	8.5%
Morris	80,803	81,296	0.6%
Ocean	115,761	113,816	-1.7%
Passaic	194,037	192,515	-0.8%
Somerset	39,279	39,390	0.3%
Sussex	11,509	11,550	0.4%
Union	162,419	158,960	-2.1%
Warren	9,769	9,877	1.1%
Total	**1,948,810**	**1,941,366**	**-0.4%**

8.8 TRIP ATTRACTION ESTIMATION

8.8.1 Introduction

The trip attraction models were updated to account for the new trip distribution process that allocates trips by income group. These models were estimated as linear functions via standard regression techniques. The model includes separate equations for each trip purpose, including the non-home-based purposes. For the home-based purposes, attraction equations were estimated for motorized trip ends, since the non-motorized trips were estimated separately after trip production calculations. For the non-home-based trips, trip ends at the zonal level are controlled by the attraction estimation process. It was therefore necessary to estimate total trip attractions and then apply a separate process to calculate the motorized trips for these purposes.

The estimation dataset for each purpose consists of district level observed attractions, summarized from RHTS survey (motorized trips only for home-based purposes, and total trip ends, i.e. total at origin ends and destination ends for non-home-based purposes), and district level characteristics including household-related demographics, employment-related statistics and land use density related features. The 158 districts in NJTPA region adopted from previous analysis and the zones in Mercer County were aggregated into 54 districts based on the related socioeconomic characteristics and the county boundaries. Manhattan as an additional district was included initially for testing purposes, but the magnitude of activity in this district provided an inordinate influence on the model estimation and it was therefore excluded from the final estimation analysis. Since a significant part of trips attracted to Sussex, Warren, Hunterdon and Mercer could have origins outside of the surveyed region, such as Pennsylvania, districts in these counties were excluded from the regression analysis as well.

The attraction rates were slightly adjusted as part of the 2008 revalidation project, and the adjusted rates were also adopted for the 2018 revalidation project. These attractions rates generated trip attraction estimates reasonably well compared to the new observed target derived from the 2010 Household Survey Data, as shown in the calibration / validation summaries later in this chapter.

8.8.2 Methodology

The model developed for this process predicts trips attracted to each district based on district level characteristics. Linear regression model was utilized for model selection and estimation. Different combinations of district level characteristics were tested in the selection phase including total households, total employment, employment by type, area type, employment density, household size, household density, etc. The coefficients, t-statistics, R-squared values as well as the F-statistics were estimated for each model specification. These values were provided directly by linear regression analysis performed within Excel.

The appropriate dataset of independent variables varies by trip purpose. For work-related purposes, employment-related data are expected to play an important role in the estimation and household-related demographics are irrelevant. For non-work-related purposes, it was anticipated that both household-related data and employment-related data could be used as predictive variables. Density-related terms, which incorporate developable area, such as employment density, household density and area type, could influence the magnitude of trips: therefore, these terms were included in the estimation data set.

Employment data was provided in several categories: 1-category (total employment), 2-catergory (Retail and Non-Retail), 3-category (Basic, Retail and Service) and 10-categroy (Agriculture & Mining, Construction, Manufacturing, Transportation, Wholesale, Retail, F.I.R.E, Service, Government and Military/Info). The "Military/Info" group was excluded from analysis as it's too scarce to have an influence.

As part of the regression analysis, the initial review was focused on the reasonableness of the model, in terms of the logic and magnitude of the estimated coefficients. Variables that would tend to encourage trip attractions should have positive signs in general. In contrast, variables that would tend to inhibit trip attractions should have negative signs. Another check is that the t-statistics shall be statistically significant at the 90 percent confidence level (|t-statistics|>1.64).

In order to interpret the model's ability to explain the observed data, the R-Squared term is used. The value of R-Square ranges from 0.0 (model does not "fit" the data") to 1.0 (model fits the data perfectly). In addition, F-statistics from the linear regression analysis were assessed to compare the model to the "constant-only" model structure. The larger the F-statistics value, the more likely the model is both correct in its structure and efficient in predictive capacity. F-statistics indicate the goodness of fit of the model and simultaneously account for the normal predictive "benefit" from using additional independent variables. As such, it provides a "compromise" statistic that can be used to balance the model's goodness of fit and model parsimony in terms of the number of independent variables required to achieve that level of replication. The combination use of R-Square and F-statistics provide general guidance on model selection. Finally, the constant term is expected to be small in terms of its absolute value and should contribute less to the overall R-square term in a "good" model.

Table 64 summarizes the final trip attraction models for each purpose. In these models, the constant terms have been set to zero prior to the final calibration adjustments.

Table 64 – Coefficients for Attraction Models by Trip Purpose

CODE	HBWD	HBWS	HBSH	HBO	WBO	NHNW	VAR
1							POP
2			0.2848	1.13280		1.4623	HH
3	1.1618	0.4167					Total EMP
4				-0.04467	0.9329		EMPBASIC
5					2.0937		EMPRETAIL
6					1.1482		EMPSERVICE
7			1.8239				RETAIL
8							NON_RETAIL
9							AGRICULTURE&MINING
10						42.3760	CONSTRUCTION
11							MANUFACTURING
12							TRANSPORTATION
13						-19.2090	WHOLESALE
14				2.72877		4.9286	RETAIL
15				-6.77490			F.I.R.E
16				3.13670		1.9825	SERVICE
17				-9.82502			GOVERNMENT
18							MILITARY/OTHER
19							AREA TYPE
20			-0.0096				VICINITY DENSITY
21							HHSIZE
22							HH WITH RETIREE
23							HH WITH CHILDREN
24							HH WITH NO CHILDREN
25							HH Density
26							% HH RETIRED
27							% RETAIL
28	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	CONSTANT

8.8.3 Comparison/Validation

The model estimated trip attractions by trip purpose and by county is shown in Table 65. The estimated trip attractions replicated the observed data very well. Most of the differences between the model estimated and the observed data were below one percent.

Table 65 – Attractions by County by Income Group

HBWD - ATTRACTION

COUNTY	INCOME 1			INCOME 2			INCOME 3			INCOME 4			INCOME 5		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
Bergen	5,289	5,288	0.0%	85,449	85,466	0.0%	148,117	148,139	0.0%	149,132	149,144	0.0%	55,014	55,022	0.0%
Essex	14,282	14,279	0.0%	76,760	76,776	0.0%	120,740	120,757	0.0%	127,767	127,778	0.0%	34,246	34,251	0.0%
Hudson	12,046	12,044	0.0%	58,323	58,335	0.0%	87,476	87,489	0.0%	102,062	102,070	0.0%	22,815	22,819	0.0%
Hunterdon	0	0	0.0%	8,853	8,854	0.0%	6,579	6,580	0.0%	28,567	28,569	0.0%	9,449	9,450	0.0%
Mercer	0	0	0.0%	31,421	31,427	0.0%	59,533	59,542	0.0%	80,214	80,221	0.0%	12,623	12,624	0.0%
Middlesex	7,650	7,649	0.0%	77,577	77,593	0.0%	136,035	136,054	0.0%	132,532	132,544	0.0%	22,049	22,052	0.0%
Monmouth	2,960	2,960	0.0%	59,945	59,957	0.0%	92,180	92,194	0.0%	74,025	74,032	0.0%	25,705	25,709	0.0%
Morris	258	258	0.0%	58,006	58,018	0.0%	98,222	98,236	0.0%	103,300	103,309	0.0%	37,624	37,630	0.0%
Ocean	4,088	4,087	0.0%	52,842	52,853	0.0%	72,060	72,070	0.0%	63,118	63,123	0.0%	4,982	4,983	0.0%
Passaic	13,734	13,732	0.0%	43,118	43,127	0.0%	85,946	85,959	0.0%	53,715	53,720	0.0%	5,677	5,678	0.0%
Somerset	201	201	0.0%	16,800	16,803	0.0%	62,516	62,525	0.0%	94,233	94,241	0.0%	19,321	19,323	0.0%
Sussex	1,064	1,064	0.0%	9,601	9,603	0.0%	16,759	16,761	0.0%	18,967	18,969	0.0%	1,780	1,780	0.0%
Union	1,148	1,148	0.0%	42,264	42,273	0.0%	76,601	76,612	0.0%	81,346	81,352	0.0%	17,663	17,665	0.0%
Warren	519	519	0.0%	7,781	7,782	0.0%	8,022	8,023	0.0%	8,988	8,989	0.0%	514	514	0.0%
TOTAL	**63,241**	**63,228**	**0.0%**	**628,740**	**628,867**	**0.0%**	**1,070,787**	**1,070,940**	**0.0%**	**1,117,967**	**1,118,060**	**0.0%**	**269,462**	**269,499**	**0.0%**

HBWS - ATTRACTION

COUNTY	INCOME 1			INCOME 2			INCOME 3			INCOME 4			INCOME 5		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
Bergen	446	448	0.4%	33,349	33,334	0.0%	42,734	42,716	0.0%	84,092	84,070	0.0%	22,891	22,881	0.0%
Essex	2,206	2,214	0.4%	24,019	24,008	0.0%	45,790	45,770	0.0%	42,075	42,065	0.0%	9,618	9,614	0.0%
Hudson	646	648	0.4%	10,777	10,773	0.0%	31,807	31,793	0.0%	30,339	30,331	0.0%	13,130	13,124	0.0%
Hunterdon	0	0	0.0%	9,196	9,192	0.0%	2,550	2,548	0.0%	5,616	5,615	0.0%	7,845	7,841	0.0%
Mercer	0	0	0.0%	2,289	2,288	0.0%	24,408	24,398	0.0%	41,468	41,458	0.0%	14,542	14,535	0.0%
Middlesex	0	0	0.0%	24,773	24,762	0.0%	53,931	53,908	0.0%	43,264	43,253	0.0%	10,260	10,256	0.0%
Monmouth	1,449	1,455	0.4%	15,607	15,600	0.0%	27,889	27,877	0.0%	24,613	24,606	0.0%	12,431	12,426	0.0%
Morris	0	0	0.0%	11,372	11,367	0.0%	27,977	27,964	0.0%	45,265	45,254	0.0%	18,393	18,385	0.0%
Ocean	1,361	1,366	0.4%	15,615	15,608	0.0%	30,756	30,743	0.0%	19,762	19,757	0.0%	1,552	1,551	0.0%
Passaic	1,724	1,731	0.4%	9,905	9,901	0.0%	32,081	32,067	0.0%	35,660	35,651	0.0%	3,557	3,556	0.0%
Somerset	0	0	0.0%	12,776	12,771	0.0%	18,233	18,225	0.0%	35,886	35,877	0.0%	15,779	15,772	0.0%
Sussex	514	516	0.4%	1,665	1,664	0.0%	5,069	5,067	0.0%	4,971	4,970	0.0%	718	718	-0.1%
Union	410	411	0.4%	15,394	15,387	0.0%	51,211	51,188	0.0%	28,540	28,533	0.0%	11,234	11,229	0.0%
Warren	238	239	0.4%	602	602	-0.1%	1,661	1,661	0.0%	3,665	3,664	0.0%	807	807	0.0%
TOTAL	**8,994**	**9,028**	**0.4%**	**187,341**	**187,257**	**0.0%**	**396,096**	**395,923**	**0.0%**	**445,215**	**445,103**	**0.0%**	**142,757**	**142,695**	**0.0%**

HBS - ATTRACTION

COUNTY	INCOME 1			INCOME 2			INCOME 3			INCOME 4			INCOME 5		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
Bergen	16,255	16,192	-0.4%	115,779	115,414	-0.3%	120,950	120,857	-0.1%	123,790	123,892	0.1%	35,403	35,513	0.3%
Essex	9,433	9,401	-0.3%	52,044	51,955	-0.2%	38,669	38,645	-0.1%	33,124	33,164	0.1%	17,050	17,111	0.4%
Hudson	9,554	9,472	-0.9%	37,920	37,731	-0.5%	26,812	26,715	-0.4%	19,475	19,493	0.1%	2,796	2,818	0.8%
Hunterdon	525	524	-0.3%	4,955	4,946	-0.2%	9,585	9,581	0.0%	13,627	13,642	0.1%	2,756	2,764	0.3%
Mercer	4,040	4,024	-0.4%	35,233	35,121	-0.3%	46,309	46,285	-0.1%	37,810	37,884	0.2%	11,721	11,778	0.5%
Middlesex	10,224	10,199	-0.3%	59,392	59,288	-0.2%	92,360	92,325	0.0%	72,851	72,854	0.0%	6,206	6,217	0.2%
Monmouth	19,587	19,533	-0.3%	41,626	41,566	-0.1%	63,810	63,781	0.0%	109,821	109,900	0.1%	30,881	30,978	0.3%
Morris	3,860	3,847	-0.3%	43,683	43,615	-0.2%	52,428	52,418	0.0%	53,664	53,711	0.1%	23,534	23,570	0.2%
Ocean	14,427	14,383	-0.3%	69,944	69,835	-0.2%	64,389	64,363	0.0%	67,780	67,840	0.1%	10,344	10,368	0.2%
Passaic	17,345	17,276	-0.4%	70,224	70,073	-0.2%	67,419	67,400	0.0%	46,965	47,024	0.1%	3,048	3,057	0.3%
Somerset	13,519	13,477	-0.3%	21,465	21,424	-0.2%	38,144	38,131	0.0%	44,504	44,549	0.1%	18,199	18,264	0.4%
Sussex	2,092	2,086	-0.3%	8,459	8,445	-0.2%	13,773	13,767	0.0%	11,732	11,744	0.1%	1,066	1,069	0.3%
Union	3,090	3,061	-0.9%	39,755	39,678	-0.2%	46,941	46,908	-0.1%	25,974	26,098	0.5%	8,394	8,462	0.8%
Warren	933	930	-0.4%	13,221	11,069	-16.3%	8,941	8,935	-0.1%	15,594	15,616	0.1%	1,345	1,350	0.4%
TOTAL	**124,884**	**124,403**	**-0.4%**	**613,699**	**610,162**	**-0.6%**	**690,530**	**690,111**	**-0.1%**	**676,712**	**677,413**	**0.1%**	**172,741**	**173,318**	**0.3%**

HBO - ATTRACTION

COUNTY	INCOME 1			INCOME 2			INCOME 3			INCOME 4			INCOME 5		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
Bergen	29,044	28,970	-0.3%	244,207	243,722	-0.2%	469,119	468,551	-0.1%	576,159	576,877	0.1%	146,831	147,268	0.3%
Essex	57,750	57,475	-0.5%	194,331	193,702	-0.3%	257,161	256,787	-0.1%	228,994	229,505	0.2%	106,856	107,382	0.5%
Hudson	49,008	48,675	-0.7%	97,195	96,874	-0.3%	124,871	124,503	-0.3%	75,481	75,754	0.4%	33,383	34,106	2.2%
Hunterdon	2,321	2,312	-0.4%	19,521	19,459	-0.3%	30,084	30,051	-0.1%	67,036	67,145	0.2%	14,802	14,853	0.3%
Mercer	10,403	10,344	-0.6%	72,424	72,043	-0.5%	117,316	117,169	-0.1%	156,779	157,172	0.3%	44,781	45,016	0.5%
Middlesex	29,050	29,862	2.8%	163,611	163,091	-0.3%	349,524	349,392	0.0%	420,421	420,750	0.1%	44,664	44,717	0.1%
Monmouth	45,574	45,451	-0.3%	113,961	113,590	-0.3%	315,543	315,125	-0.1%	307,511	307,925	0.1%	205,991	207,142	0.6%
Morris	8,607	8,527	-0.9%	110,269	109,906	-0.3%	196,071	195,990	0.0%	264,625	265,095	0.2%	134,674	134,920	0.2%
Ocean	38,257	38,129	-0.3%	228,228	227,562	-0.3%	281,047	280,772	-0.1%	154,449	154,660	0.1%	12,396	10,709	-13.6%
Passaic	42,359	42,138	-0.5%	161,966	161,330	-0.4%	171,024	170,910	-0.1%	189,475	189,899	0.2%	36,089	36,094	0.0%
Somerset	20,216	20,124	-0.5%	67,859	67,600	-0.4%	110,101	109,983	-0.1%	141,321	141,531	0.1%	57,426	57,692	0.5%
Sussex	4,838	4,821	-0.4%	22,609	22,539	-0.3%	65,278	65,209	-0.1%	58,006	58,098	0.2%	8,215	8,227	0.1%
Union	17,466	17,311	-0.9%	126,697	126,278	-0.3%	204,087	203,647	-0.2%	293,062	294,129	0.4%	56,590	56,887	0.5%
Warren	1,852	1,843	-0.5%	23,036	22,958	-0.3%	45,268	45,216	-0.1%	43,500	43,588	0.2%	3,021	3,030	0.3%
TOTAL	**356,746**	**355,980**	**-0.2%**	**1,645,914**	**1,640,653**	**-0.3%**	**2,736,494**	**2,733,305**	**-0.1%**	**2,976,819**	**2,982,127**	**0.2%**	**905,719**	**908,043**	**0.3%**

NHBW - ATTRACTION

COUNTY	INCOME 1			INCOME 2			INCOME 3			INCOME 4			INCOME 5		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
Bergen	2,558	2,587	1.1%	13,163	13,317	1.2%	59,938	60,554	1.0%	50,060	50,566	1.0%	17,506	17,693	1.1%
Essex	3,274	3,312	1.1%	17,411	17,614	1.2%	44,124	44,578	1.0%	40,423	40,831	1.0%	13,750	13,896	1.1%
Hudson	2,620	2,650	1.1%	6,667	6,745	1.2%	33,636	33,982	1.0%	15,682	15,841	1.0%	4,044	4,087	1.1%
Hunterdon	0	0	0.0%	1,550	1,568	1.2%	2,596	2,623	1.0%	3,248	3,281	1.0%	997	1,008	1.1%
Mercer	0	0	0.0%	15,907	16,093	1.2%	24,522	24,774	1.0%	16,127	16,290	1.0%	3,969	4,011	1.1%
Middlesex	1,727	1,747	1.1%	17,853	18,061	1.2%	48,256	48,753	1.0%	42,619	43,049	1.0%	8,149	8,236	1.1%
Monmouth	5,180	5,239	1.1%	16,986	17,184	1.2%	30,893	31,211	1.0%	39,208	39,604	1.0%	23,765	24,019	1.1%
Morris	0	0	0.0%	11,392	11,525	1.2%	31,405	31,728	1.0%	42,024	42,448	1.0%	16,624	16,802	1.1%
Ocean	590	597	1.1%	14,886	15,059	1.2%	31,456	31,779	1.0%	20,981	21,193	1.0%	4,001	4,044	1.1%
Passaic	2,820	2,852	1.1%	6,859	6,939	1.2%	27,796	28,082	1.0%	13,814	13,953	1.0%	3,226	3,261	1.1%
Somerset	0	0	0.0%	2,532	2,562	1.2%	20,138	20,345	1.0%	27,265	27,540	1.0%	8,790	8,884	1.1%
Sussex	1,552	1,569	1.1%	3,481	3,522	1.2%	11,140	11,255	1.0%	5,719	5,777	1.0%	1,903	1,923	1.1%
Union	0	0	0.0%	6,643	6,720	1.2%	25,862	26,128	1.0%	31,678	31,998	1.0%	6,697	6,769	1.1%
Warren	0	0	0.0%	588	594	1.2%	1,327	1,340	1.0%	5,158	5,210	1.0%	148	150	1.1%
TOTAL	**20,322**	**20,553**	**1.1%**	**135,916**	**137,503**	**1.2%**	**393,089**	**397,132**	**1.0%**	**354,006**	**357,581**	**1.0%**	**113,570**	**114,783**	**1.1%**

NHBO - ATTRACTION

COUNTY	INCOME 1			INCOME 2			INCOME 3			INCOME 4			INCOME 5		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
Bergen	14,909	14,851	-0.4%	153,450	153,040	-0.3%	235,818	235,613	-0.1%	287,540	287,773	0.1%	55,120	55,262	0.3%
Essex	24,756	24,330	-1.7%	107,080	105,902	-1.1%	146,037	145,777	-0.2%	109,331	110,621	1.2%	35,757	36,292	1.5%
Hudson	24,491	25,236	3.0%	71,325	72,810	2.1%	55,901	56,760	1.5%	35,945	35,318	-1.7%	10,975	9,417	-14.2%
Hunterdon	2,506	2,511	0.2%	9,271	9,221	-0.5%	10,987	11,020	0.3%	29,954	29,958	0.0%	3,531	3,434	-2.8%
Mercer	12,673	12,812	1.1%	56,533	56,061	-0.8%	104,003	104,373	0.4%	69,937	69,918	0.0%	21,108	20,789	-1.5%
Middlesex	10,484	10,574	0.9%	92,347	92,623	0.3%	179,092	178,950	-0.1%	160,350	159,760	-0.4%	25,357	25,692	1.3%
Monmouth	26,290	26,058	-0.9%	82,703	82,300	-0.5%	184,142	183,717	-0.2%	212,486	212,872	0.2%	62,080	62,527	0.7%
Morris	12,023	11,869	-1.3%	107,874	107,365	-0.5%	84,796	84,680	-0.1%	139,583	139,729	0.1%	51,515	51,573	0.1%
Ocean	28,353	28,295	-0.2%	193,665	193,904	0.1%	129,012	129,028	0.0%	87,261	87,210	-0.1%	11,928	11,700	-1.9%
Passaic	31,158	30,609	-1.8%	150,988	149,843	-0.8%	115,281	115,101	-0.2%	93,870	94,576	0.8%	12,823	13,197	2.9%
Somerset	19,535	19,068	-2.4%	24,704	24,344	-1.5%	49,122	48,869	-0.5%	76,992	77,329	0.4%	27,035	27,390	1.3%
Sussex	8,752	8,817	0.7%	13,312	13,230	-0.6%	25,203	25,257	0.2%	23,918	23,956	0.2%	2,327	2,140	-8.0%
Union	9,649	9,567	-0.9%	86,905	86,373	-0.6%	119,594	119,652	0.0%	93,209	93,279	0.1%	26,202	26,476	1.0%
Warren	696	673	-3.3%	9,985	9,723	-2.6%	13,980	14,115	1.0%	24,351	24,550	0.8%	3,597	3,195	-11.2%
TOTAL	**226,276**	**225,268**	**-0.4%**	**1,160,141**	**1,156,739**	**-0.3%**	**1,452,968**	**1,452,911**	**0.0%**	**1,444,726**	**1,446,850**	**0.1%**	**349,355**	**349,083**	**-0.1%**

8.9 TRUCK TRIPS GENERATION

8.9.1 Trip Generation

The methodology of truck trip estimation was adopted from the procedures developed for the NJDOT Statewide Truck Model back in the early 1990s. This earlier process estimated truck trips by either of two types, Medium and Heavy. Medium trucks were categorized as 2-axle, 6-tire vehicles and heavy trucks as any 3+ axle vehicles. Trucks are allowed to use the entire NJTPA highway network except those roadways with truck restrictions and prohibitions (e.g., the Garden State Parkway). The commercial vehicle trips, defined as 2-axle four tire vehicles, were estimated based on the procedures adopted from NYMTC's Best Practices Model.

Internally, trip generation is performed at the zonal level using employment, households and truck terminals as the independent variables. Employment by type was used primarily for internal trip generation. Special generators, in the form of truck terminals, warehouses and pipeline terminals are utilized for conditions where the typical employment relationships would poorly estimate the truck trips. In addition, the truck terminals serve as attractors for a portion of the long-haul truck trips entering the study area from the adjacent region. For trips generated outside the region, a series of external zones were developed that represent entry points into the region. These entry points of "external zones" include major highways at the study area border as well as intermodal terminals located inside the region such as Port Elizabeth/ Newark and the various intermodal rail terminals.

8.9.2 External Trip Generation

Since the NJRTM-E employs a large buffered area around the NJTPA region, most locally-oriented truck trips would be encompassed within the modeled region. However it was recognized that there would still be some extremely long-distance truck trips that would most likely approach the modeled region along the major interstate roadways. Therefore a decision was made to reference these external gateways into the modeled region solely for the use of modeling long-haul truck movements. Dummy links with a restriction for truck usage only were created and connected from the external truck zones to the nearby highway links. Note that the intermodal truck facilities are also included as "external gateways" in the model. The source data used in the model was obtained from the original NJ Statewide Model. The data was updated as part of the 2018 Revalidation Process using the observed truck data provided by Port Authority of New York and New Jersey and NJTPA. The updated data is listed in Table 66.

Truck trips generated from the external regions were obtained from the original NJRTM-E and was updated as part of the 2018 Revalidation Project. Total external trip travel was partitioned into four categories: EI (highway based external to internal), EIMC (intermodal facility external to internal), EIE (external-internal-external) and EE (external to external). The resulting external trips are listed for medium and heavy truck respectively in Table 67.

Note that there are several externally-related truck trip categories. Through trucks are designated as EE movements and includes movements from intermodal facilities and the external "gateway" zones, A second category (EIE) refers to truck trips that are essentially external–external movements, but are routed through an intermediate truck terminal where loads are combined or transferred among vehicles, before the truck trip continues out of the region to a final destination. For external – internal trips, there are two categories. The EIMC represents truck trips that are going between an internal zone and intermodal facility such as Port Newark or an intermodal rail facility. The remaining EI category represents trips to and from internal zones and the external "gateway" zones.

Table 66 – External Truck Stations

External Station	Location	E-E Percentage	EIE Percentage	E-I Percentage
5	US 206 @ Wescoatville	0.00%	0.00%	100.00%
23	GSP/US9 @ Somers Point	0.00%	0.00%	100.00%
123	MILL POND RD.	0.00%	0.00%	100.00%
198	NJ 94	0.00%	0.00%	100.00%
231	US 130	0.00%	0.00%	100.00%
241	I - 295	0.00%	0.00%	100.00%
367	NJTPK	22.26%	5.59%	72.16%
565	OAK ISLAND	0.00%	0.00%	100.00%
599	NEWARK AIRPORT	3.88%	0.00%	96.12%
600	PORT NEWARK	15.10%	0.00%	84.90%
627	Port Jersey	6.72%	0.00%	93.28%
662	CROXTON	0.00%	0.00%	100.00%
735	S. KEARNY	0.00%	0.00%	100.00%
752	N. BER. L-FERRY	18.89%	0.00%	81.11%
1882	CR 517	0.00%	0.00%	100.00%
1884	CR 515	0.00%	0.00%	100.00%
1915	E-RAIL	0.00%	0.00%	100.00%
2017	PORT ELIZABETH	17.09%	0.00%	82.91%
2081	BROOKLYN	9.85%	0.00%	90.15%
2099	LIE N	40.01%	9.98%	50.01%
2098	South Pkwy	0.00%	0.00%	0.00%
2399	NY 17	0.94%	0.00%	99.06%
2391	CR 521	0.00%	0.00%	100.00%
2410	I-87	31.44%	7.86%	60.70%
2422	LA GUARDIA	0.00%	0.00%	100.00%
2428	JFK	16.35%	0.00%	83.65%
2430	HOWLAND HOOK	9.10%	0.00%	90.90%
2530	CR 511	0.00%	0.00%	100.00%
2572	I-684	22.56%	5.63%	71.81%
2565	NY 100	0.00%	0.00%	0.00%
2566	TACONIC CMB	0.00%	0.00%	0.00%
2567	US 9	0.94%	0.00%	99.06%
2574	I-95 CONN	24.00%	6.00%	70.00%
2642	MORRISVILLE	19.82%	0.00%	80.18%
2584	PA TPK NE	17.97%	4.49%	77.53%
2591	CR 627	0.00%	0.00%	100.00%
2626	PATPK	22.89%	5.71%	71.40%
2650	I-95 PA	24.97%	6.24%	68.79%
2649	US 1	9.99%	0.00%	90.01%
2722	PA 309/PA412	0.00%	0.00%	100.00%
2702	US 22	5.00%	0.00%	95.00%
2703	I-78	25.80%	6.45%	67.75%
2730	I-80	17.51%	4.37%	78.12%
2832	Columbia	0.91%	0.00%	99.09%
2823	PA 611	0.00%	0.00%	100.00%
2860	CR 560	0.00%	0.00%	100.00%
2870	US 206	0.92%	0.00%	99.08%

Table 67 – External Truck Traffic by Type

ZONE	LOCATION	Medium Truck				Heavy Truck			
		EI	EIMC	EIE	EE	EI	EIMC	EIE	EE
5	US 206 @ Wescoatville	595	-	-	-	1,364	-	-	-
23	GSP/US9 @ Somers Point	464	-	-	-	1,797	-	-	-
123	MILL POND RD.	977	-	-	-	418	-	-	-
198	NJ 94	505	-	-	-	216	-	-	-
231	US 130	1,005	-	-	-	2,303	-	-	-
241	I - 295	375	-	-	-	13,758	-	-	-
367	NJTPK	1,866	-	-	-	5,562	-	575	2,291
565	OAK ISLAND	-	-	-	-	-	63	-	-
599	NEWARK AIRPORT	-	331	-	9	-	487	-	24
600	PORT NEWARK	-	2,061	-	122	-	5,024	-	1,138
627	Port Jersey	-	-	-	-	-	3,636	-	262
662	CROXTON	-	-	-	-	-	879	-	-
735	S. KEARNY	-	-	-	-	-	1,355	-	-
752	N. BER. L-FERRY	-	-	-	-	-	614	-	143
1882	CR 517	88	-	-	-	37	-	-	-
1884	CR 515	142	-	-	-	61	-	-	-
1915	E-RAIL	-	-	-	-	-	330	-	-
2017	PORT ELIZABETH	-	2,061	-	122	-	14,866	-	3,366
2081	BROOKLYN	-	-	-	-	-	119	-	13
2099	LIE N	1,649	-	125	506	2,031	-	609	2,438
2098	South Pkwy	-	-	-	-	-	-	-	-
2399	NY 17	796	-	-	3	1,845	-	-	22
2391	CR 521	267	-	-	-	267	-	-	-
2410	I-87	632	-	-	-	6,108	-	873	3,491
2422	LA GUARDIA	-	29	-	-	-	63	-	-
2428	JFK	-	300	-	141	-	897	-	93
2430	HOWLAND HOOK	-	-	-	-	-	3,898	-	390
2530	CR 511	163	-	-	-	69	-	-	-
2572	I-684	2,656	-	117	472	3,818	-	391	1,562
2565	NY 100	-	-	-	-	-	-	-	-
2566	TACONIC CMB	-	-	-	-	-	-	-	-
2567	US 9	279	-	-	1	562	-	-	7
2574	I-95 CONN	2,376	-	-	-	11,484	-	1,188	4,751
2642	MORRISVILLE	-	-	-	-	-	267	-	66
2584	PA TPK NE	724	-	6	21	2,313	-	170	683
2591	CR 627	146	-	-	-	-	-	-	-
2626	PATPK	1,629	-	24	95	4,357	-	455	1,824
2650	I-95 PA	2,100	-	21	87	5,775	-	693	2,772
2649	US 1	1,601	-	-	66	4,419	-	-	602
2722	PA 309/PA412	1,115	-	-	-	1,115	-	-	-
2702	US 22	2,012	-	-	-	11,611	-	-	717
2703	I-78	1,691	-	-	-	10,927	-	1,201	4,806
2730	I-80	1,340	-	-	-	8,703	-	562	2,251
2832	Columbia	184	-	-	1	359	-	-	4
2823	PA 611	75	-	-	-	75	-	-	-
2860	CR 560	221	-	-	-	221	-	-	-
2870	US 206	161	-	-	1	162	-	-	2

8.9.3 Internal Trip Generation

Employment by type (retail, industrial, public, office and other) and the number of households were used to estimate truck trip ends. Trip generation rates by truck type, as listed in Table 68, were obtained from the NJDOT Statewide Model.

Table 68 – I/I Truck Trip Generation Rates

Variable	Medium Trucks	Heavy Trucks
Household	0.0240	0.0202
Retail Employment	0.1264	0.0590
Industrial Employment	0.0523	0.0800
Public Employment	0.0032	0.0384
Office Employment	0.0202	0.0051
Other Employment	0.0553	0.1207

As part of this project, the generation rates from the adopted truck model were compared to those rates for recently developed truck models in other MPO regional models. While it was not the intent to alter the adopted model, the trip generation rates were checked for reasonableness for use in the NJRTM-E. It should be noted that the variables utilized for the NYMTC regional model are similar and coefficient values are nearly identical. This indicates that truck trips in the adjacent regional model were successfully estimated using similar procedures. Table 69 provides the comparison of the truck generation rates for both heavy and medium trucks.

Table 69 – Internal Truck Trip Generation Rates

INTERNAL TRUCK TRIP GENERATION RATE

Equations and Coefficients for Heavy Truck

Variable	COEFFICIENTS UTILIZED BY RECENT MPO MODELS								Statewide Model (1990)	Reference Range
	Phoenix (1991)	Washington D.C.	Vancouver	San Francisco (1993)	BMC Model (1996)	Revised BMC Interim Model (2002)	ARC Model	NYBPM (2005)		
Household	0.0210					0.0680		0.0202	0.0202	0.0202 -0.0680
Population							0.0147			
Resident Labor Force					0.02065 [2]					
Retail Employment	0.0615	0.0300		0.0001	0.33395 [1]	0.1410	0.2463	0.0590	0.0590	0.0001 - 0.2463
Industrial Employment	0.0833	0.0300	0.0665	0.0293		0.1990	0.1439		0.0800	0.0293 - 0.1990
Public Employment	0.0400	0.0200		0.0220					0.0384	0.0200 - 0.0400
Office Employment	0.0053	0.0200		0.0027		0.0290	0.0829	0.0051	0.0051	0.0027 - 0.0829
Other Employment	0.1257	0.0200	0.1640	0.0220				0.0860	0.1207	0.0200 - 0.1640
Non-Retail Employment					0.01077 [2]					
Total Employment				0.0112						

Equations and Coefficients for Medium Truck

Variable	COEFFICIENTS UTILIZED BY RECENT MPO MODELS								Statewide Model (1990)	Reference Range
	Phoenix (1991)	Washington D.C.	Vancouver	San Francisco (1993)	BMC Model (1996)	Revised BMC Interim Model (2002)	ARC Model	NYBPM (2005)		
Household	0.1145	0.0400	0.0041			0.0690		0.0240	0.0240	0.0041 - 0.1145
Population					0.17588[2] / 0.10086[1]					
Resident Labor Force										
Retail Employment	0.2213	0.1700	0.0212	0.0140	1.55434 [1]	0.1770		0.1264	0.1264	0.0140 - 0.2213
Industrial Employment	0.1665	0.1400	0.0212	0.0110		0.1780			0.0523	0.0110 - 0.1780
Public Employment	0.0100	0.0400	0.0212	0.0460					0.0032	0.0032 - 0.0460
Office Employment	0.0354	0.0100	0.0212	0.0105		0.0480		0.0202	0.0202	0.0100 - 0.0480
Other Employment	0.1765	0.0400	0.3270	0.0460				0.0402	0.0553	0.0400 - 0.3270
Non-Retail Employment					0.07504 [2]					
Total Employment				0.0324						

Notes:

[1] Coefficients are applied to zones which percent development is less than 40% in BMC96 Model.

[2] Coefficients are applied to zones which percent development is greater than 40% in BMC96 Model.

For commercial vehicle estimation, a decision was made to adopt the generation rates from the recently completed NYBPM model. Those rates were stratified by area type (in the form of specific counties) as listed in Table 70. Note that the rates from the NYBPM model were established from recent model development efforts in Atlanta and Baltimore.

Table 70 – Commercial Vehicle Trip Model Coefficients

Equations and Coefficients for Commercial Vehicle Trips

Variable	COEFFICIENTS UTILIZED BY RECENT MPO MODELS					Reference Range
	ARC Model (1998) [1]	BMC Model (2002) [2]	NYBPM Model (2005) [3]			
			Manhattan	Other NYC	Suburbs	
Household		0.1460	0.0407	0.0234	0.0116	0.0116 - 0.1460
Population	0.0559					
Retail Employment	0.6426	0.5010	0.1241	0.0709	0.0355	0.0355 - 0.6426
Office Employment	0.2315	0.4540	0.0630	0.0360	0.0180	0.0180 - 0.4540
Industrial Employment	0.4823	0.4540				0.4540 - 0.4823
Other Employment			0.1470	0.0840	0.0420	0.0420 - 0.1470

Notes:

1. Coefficients for ARC Model were applied to light-duty trucks including pickups and commercial automobiles. Source: Matthew Thornton et al., "Development of Urban Commercial Vehicle Travel Demand Model and Heavy-Duty Vehicle Emissions Model for Atlanta Region", 1998. Commercial vehicles in ARC Model represents the light-duty truck including pickups and commercial automobiles.

2. Source of coefficients for BMC Model: William Allen, "Development of Commercial Vehicle Travel Model", 2002, The coefficient for Other Employment are blended by Industrial Employment, Public Employment and other Employment. The commercial vehicle in BMC Model is defined as "any vehicle that displays any text, logo, or trademark, or that is transporting equipment of an obviously commercial nature". These vehicles are restricted to be used for business purposes only.

3. Source of coefficients for NYBPM Model: Transportation Models and Data Initiative General Final Report, New York Best Practice Model (NYBPM), 2005. Commercial vehicle in MYBPM Model "consists of commercial delivery vehicles, sometimes also referred to as vans".

8.9.4 Special Truck Generators

Special generators include truck terminals, warehouse, and pipeline terminals. Truck terminals will serve as attractors for a portion of the long-haul trucks entering the study region. The special generator inventory was updated using the information provided by NJTPA, as shown Table 71.

Table 71 – Special Truck Generators

Special Generator Category	Number of Records for NJTPA Model	Number of Records for Statewide Model	Growth
Warehouse	726	107	619
Truck Terminal	614	296	318
Pipelines	10	-	10
Total	1,350	403	947

Trip generation rates from the NJ Statewide Model were adopted for the NJRTM-E. These rates are listed in Table 72.

Table 72 – Trip Generation Rate for Special Generators

Type	Rates	Medium Truck%	Heavy Truck%
Truck Terminals	55	0.45	0.55
Warehouses	275	0.36	0.64
Pipelines	220	0.20	0.80
Other Generators	1	1	1

8.9.5 Truck Trip Production – Attraction Balancing

The balancing process from the NJ Statewide Model was adopted. Essentially, the attractions were scaled to ensure that at least one attraction is available for each truck trip production. From model simulation purposes, all externally-related trips were assumed to be “produced” at the external zone and “attracted” at the internal zones. Since several of the externally-related trip purposes used similar attraction variables, the attraction balancing is performed with a hierarchical process to insure that the attractions were properly accounted within the scaling calculations.

First, EIE attractions estimated at the truck terminals were scaled to match the external station EIE productions. The difference between the initial, calculated truck terminal attractions and the scaled truck terminal attractions were then utilized for the EI intermodal truck trip purposes. The intermodal EI trip attractions were estimated as a “weighted” value of the facility-based attractions (truck terminals and warehouses) and industrial employment attractions.

After the calculation of the final weighted attraction term for the EI intermodal trip purpose, the attractions were scaled to equal the total EI intermodal productions by truck type. The unused EI intermodal attractions from this calculation were then combined as appropriate with the internal trip attractions generated from the standard equations and the pipeline special generators. Note that since industrial employment is also used to generate attractions in the standard equations, the portion of industrial employment attractions used to satisfy EI intermodal trips was subtracted from the total industrial employment attractions. This was done in order to prevent any double-counting of trip attractions.

Finally, the highway-based EI trip attractions are estimated based on accessibility percentages. The accessibility function is as follows:

$$EITRKP_i = \alpha \sum_j \frac{EITRK_j}{TIME_{ij}^{\beta}}$$

Where

$EITRKP_i$ ----Percentage of truck trip ends at internal zone i that are EI

α , β ------------Coefficient

$EITRK_j$ -----Volume of external-internal truck trips at external station j

$TIME_{ij}$ ------Travel time from internal zone i to external zone j

These attractions are then scaled to match the total EI highway-based trip productions by trip type. The final EI attractions are then subtracted from the internal trip attractions.

After the subtraction process is completed, the remaining attractions are designated as “internal trip ends” and the internal productions for each zone are set equal to these internal attractions in each zone. This infers that for every truck entering a site on a daily basis, that truck or another leaves the site. As a result, the internal productions and attractions by truck type are automatically balanced.

9. TRIP DISTRIBUTION

9.1 INTRODUCTION

This chapter focuses on calibration and application aspects of the trip distribution model. The calibration process is developed using various data sources available for the 39-county region with NJTPA as the core region. The primary data source is the Regional Household Travel Survey (RHTS) conducted in 2010 and 2011. Additional data sources include the 2015 LEHD data and 2015 traffic counts.

9.2 METHODOLOGY

Trip distribution links trip productions in the model region with trip attractions to create matrices of inter and intra-zonal travel flows. The results of trip distribution will be input to mode choice, and later assigned to highway and/or public transportation systems to determine the travel demand constrained by the supply capacities of the underlying facilities.

9.2.1 Gravity Distribution Model

The basic “Gravity Model” procedure was adopted to perform the trip distribution process. The gravity model theory states that the number of trips between two zones is directly proportional to the number of productions and attractions in those zones, and inversely proportional to the spatial separation between the zones. The formula is as follows.

$$Trip_{i->j} = \frac{P_i \times A_j \times f(\mathrm{Im}\,p_{i->j}) \times k_{i->j}}{\sum_{r=1}^{zones} A_r \times f(\mathrm{Im}\,p_{i->r}) \times k_{i->r}}$$

Where

P_i The number of trips produced from zone i

A_j The number of trips attracted to zone j

$\mathrm{Im}\,p_{i->j}$ The travel impedance from zone i to zone j

$f(\mathrm{Im}\,p_{i->j})$ The friction factor, which is a function of travel impedance

$k_{i->j}$ The specific zone-to-zone adjustment factor

The matrix of inter-zonal and intra-zonal travel impedances reflects the spatial separation between zones. Friction factors and k-factors are determined during the calibration process and their values will be used in the application process. The trip distribution model will be performed for each income group and each purpose, except HBU. The income stratification is retained in the distribution process so that trips by income group can applied to the mode choice model.

9.2.2 Calibration Overview

The purpose of trip distribution calibration is to develop friction-factors and k-factors that properly replicate the observed average trip length and also maintain the observed trip flow pattern. Prior to the calibration process, skim tables containing composite impedances for all zonal pairs need to be prepared. Congested skims were used for home-based-work trips since these trips normally occur during the peak period. Uncongested skims were used for non-home-based-work trips as they are more evenly distributed during the course of the day and tend to occur during off-peak period.

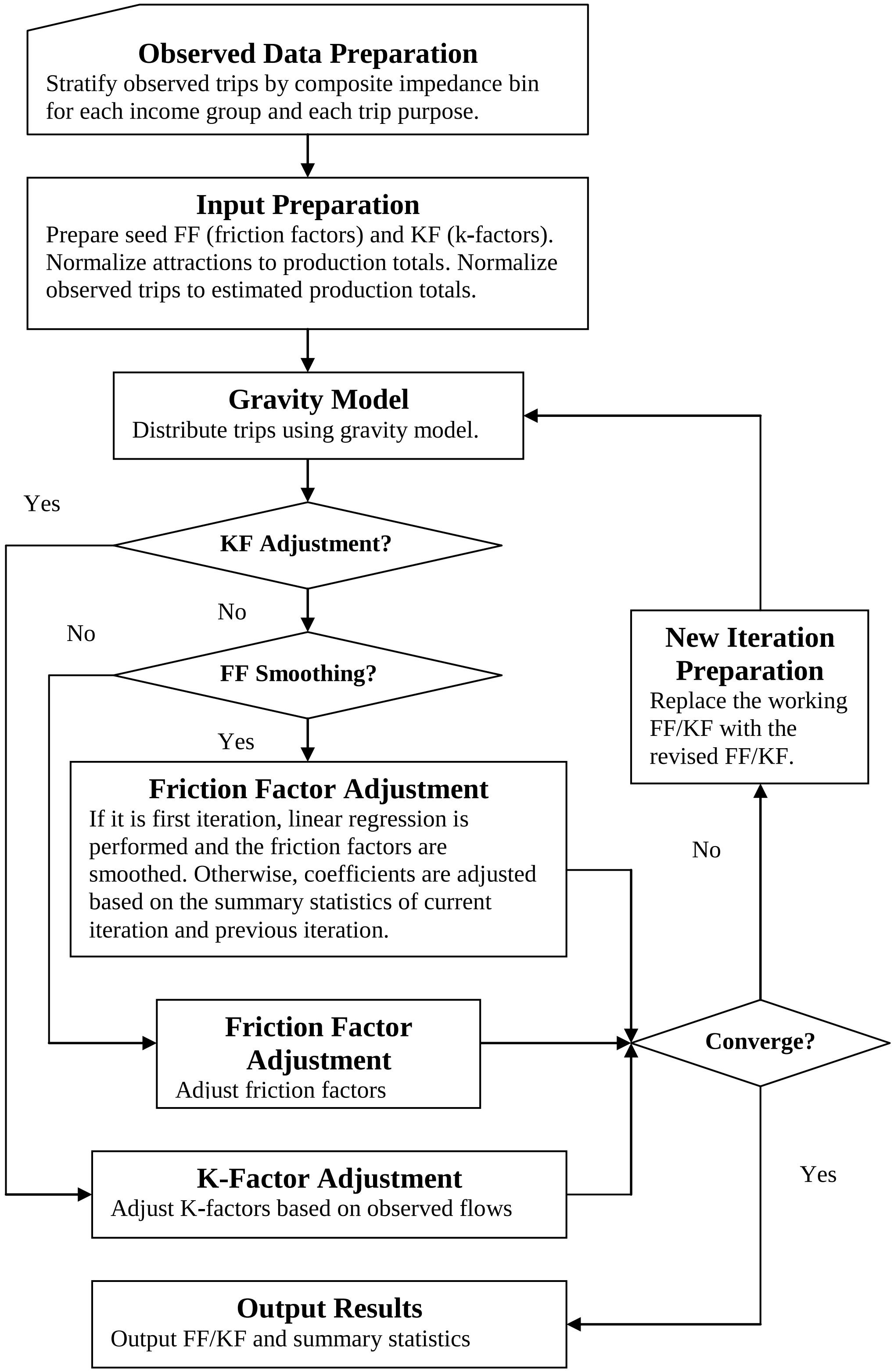
Uncongested skims were obtained from the uncongested network using free-flow time. A factor of 1.1 was applied to free-flow time to account for minor delay to the free-flow traffic condition. For the initial model iteration, congested skims were obtained from the congested networks with congested speed assumed to be 1.2 of the free-flow speed. In the successive feedback iterations, the congested speed was obtained directly from the loaded am peak period highway network of the previous iteration.

The congested skims used in the calibration phase are results of several feedback iterations. Model convergence is influential to the estimation of the congested travel time values. In the case where the congested travel times from a given model iteration underestimate the true congestion level in the network, the trips will be distributed further, hence increasing congestion for the next iteration run. In contrast, if the congested time is overestimated, then the trips will be distributed with shorter average trips lengths in the next iteration run reducing congestion level. As part of the overall model calibration effort, it was necessary to recalibrate distribution in a sequential process as the entire model progressed towards convergence.

The general calibration process is depicted in Figure 22. Observed trip flows by trip purpose and income group are organized to be stratified by composite impedance interval and normalized against estimated total trips for the calibration region which includes NJTPA, Mercer and Manhattan. The gravity model requires input data that include composite impedance skim tables, zonal trip ends (productions and attractions), friction factors, and k-factors. Pattern seed for friction factors and k-factors were also generated for the initial calibration phase. Trip production totals, assumed to be more accurate than attraction totals, were used to normalize attractions. Following the input data preparation, the gravity model was then executed using a 15-iteration closure criterion.

Separate trip distribution models will be developed for each purpose and income group combination. In order to simplify the process, friction factors by trip purpose using all income groups combined were developed as the initial model. These friction factors were used as the seed for friction factor calibration for each corresponding purpose-income group combination. This approach will ensure that the friction-factors across income group for each purpose can retain similar common base and deviate from that accordingly. It can also accelerate the calibration process as the friction-factors for combined income groups, should provide a reasonable baseline to estimate factors for each income group, given there should be a certain similarity to distribution of trips by purpose regardless of income level.

Figure 22 – Trip Distribution Calibration Process



The friction factors from the calibration process, when plotted against time (or composite impedance), tend to form a discontinuous pattern due to variation in the observed data by impedance interval. The friction factor smoothing phase was intended to smooth this irregular shape in order to provide a logical continuous function with declining factors as impedance is increased. This function normally takes the form of a specific mathematical function, such as gamma function. The impact of smoothing process was a deviation of friction factors from the previously well-calibrated results. Further adjustments, including K-factor adjustments, were required to ensure the model convergence as well as to eliminate potential distortion caused by the smoothing process. The calibration process was terminated after either the convergence or maximum iteration was reached. The friction factors and K-factors from this final calibration will be used in the application.

9.2.3 Calibration Method

The trips produced by the gravity model were then aggregated by composite impedance bin. The normalized observed trips in each bin may be different from the estimated trips hence a revised friction factor is needed to compensate for the difference. The revised friction-factor for that specific bin was calculated as follows:

$$FF_{revised} = FF_{current} * \frac{Observed\ \ Trips}{Estimated\ \ Trips}$$

Where

$FF_{current}$ - represents the friction factor of the current iteration

$FF_{revised}$ - represents the revised friction factor which will be used in the next iteration

If the estimated trips are lower than the observed trips in the current iteration, the adjustment would have the corresponding friction-factor increased. The gravity model formula shows that if the friction factor for certain zonal pairs increase, the resulting trips between the zonal pairs will increase as well.

If the estimated trips are higher than the observed trips in the current iteration, the adjustment would decrease the corresponding friction-factor in such that the estimated trips in the next iteration would also decrease. The friction-factor adjustment is an iterative process. After several iterations, the friction factors are anticipated to converge and the estimated trips for every composite impedance interval are close to replicating the observed trips. The Root Mean Square of Errors (RMSE) and the difference between observed and estimated trip length are used as two indicators for converge. The RMSE is calculated as follows:

$$RMSE = \frac{\sqrt{\frac{\sum_{i=1}^{n}(EstTrips_i - ObsTrips_i)^2}{n-1}}}{\frac{\sum_{i=1}^{n} ObsTrips_i}{n}}$$

In the friction-factor smoothing process, the gamma function is utilized to define the relationship between composite impedance and friction-factors. The following formula defines the gamma function:

$$FF(IMP) = \alpha(IMP)^{\beta} e^{\gamma(IMP)}$$

The exponential format can be converted into a linear format by multiplying each side with natural logarithm:

$$Ln(FF(IMP)) = Ln(\alpha) + \beta Ln(IMP) + \gamma(IMP)$$

A log-linear regression is then utilized to estimate the three parameters of the gamma function. The parameter estimation of the gamma function would only occur at the first iteration of the friction-factor smoothing phase. For the latter iterations, the values of the coefficients are adjusted empirically based on the comparison of observed average trip length, average trip length of the current iteration and the average trip length from the last iteration.

In the K-factor adjustment phase, trips produced by the gravity model are aggregated to county-level. K-factors are adjusted to make estimated trips match observed trips at county level. Normally, the use of K-factors is required to capture certain characteristics that influence travel that are not, or cannot be, directly modeled. Examples would include such items as tax policies that inhibit or support travel to certain regions or travel time reliability that may influence the likelihood of travel. Other geographic features such as travel across large water bodies or reserved/restricted areas where intermediate stops are not possible, can act as barriers to travel. Topographical features such mountain ranges also can inhibit travel. Lastly, given that transit networks and impedances were not fully abstracted in areas east of the Hudson River, the composite impedance terms for those areas reflect only the auto-related costs and times. This limitation introduces an inconsistency into the distribution process and may further justify the use of K-factors for some situations. A discussion regarding the limited transit network representation east of the Hudson River is provided in the Chapter 10 Introduction section of the mode choice model development.

It is preferable to have as few K-factor adjustments as possible. K-factors are adjusted based on the ratio of observed trips and estimated trips:

$$KF_{revised} = KF_{current} * \frac{Observed \quad Trips}{Estimated \quad Trips}$$

The 40 counties in the model form 1600 county pairs. It is unrealistic and undesirable to adjust all of them. The strategy here is to apply as few K-factors for Intra-NJTPA trips as possible and to apply common K-factors for other trips based on geographical proximity and jurisdiction.

A final assessment of the trip distribution process between the NJTPA region and the outlying areas focused on evaluating the pattern of trips entering and exiting the region by major roadways or transit facilities, a cordon line around the combined NJTPA and Mercer Counties was established to isolate trips between selected regions. The cordon line has the following “intercept” components:

- the land boundary between NJTPA and NY Other West,
- the Hudson River between NJTPA and New York,
- the land boundary between NJTPA + Mercer and NJ Other, and

- the Delaware River between PA and New Jersey.

Trip volumes for all facilities that cross these intercept boundaries were summarized and compared against count data that was gathered by various agencies, such as the Port Authority of New York / New Jersey and NJ Transit. These comparisons were used to identify any potential differences between the modeled trip distribution and known travel volumes.

9.3 OBSERVED DATA PREPARATION

Observed data were obtained from several sources, such as:

- 2010 / 2011 RHTS Household Survey
- New Jersey Transit Survey
- Traffic Counts Collected from Various Sources
- 2010 Census Data

As part of the calibration process, the observed trip frequencies for each trip purpose were grouped by impedance intervals. These trip frequencies were developed using the model's highway skims and observed trip tables. Note that the plot of observed trip frequency by impedance interval forms an irregular, discrete, non-smooth pattern due to the limited sampling process of the survey. Additional steps were taken to smooth the frequency pattern.

9.4 CALIBRATION PROCESS

The calibration process consists of three stages:

- Stage 1: Derive Common Friction-factors for Each Trip Purpose
- Stage 2: Derive Un-smoothed Friction-factors and K-factors for Each Income Group of Each Trip Purpose
- Stage 3: Derive Smoothed Friction-factors and Adjusted K-factors for Each Income Group of Each Trip Purpose

Each income group of each purpose has its own friction-factor lookup table and needs to be developed individually. The first stage is to develop a common friction-factor lookup table for each purpose with all income groups combined as described in the previous section. The common characteristics of travel behavior for trips from the same trip purpose were maintained with this approach. In this stage, K-factors were assumed to be the same for all income groups of the same trip purpose.

The common friction-factor lookup table for each trip purpose derived in the first stage would then be used as the seed friction-factors for each income group in the second stage. The friction factors for each income group would deviate from the common factors indicating behavior differences among different income groups. An iterative approach of friction-factor and K-factor calibration was adopted. County level K-factors were derived first for the trips between NJTPA + Mercer and Manhattan. And K-factors for other region-pairs were derived later based on the comparison of observed trips and estimated trips.

The un-smoothed friction-factors derived in the second stage were smoothed using linear regression method in the first iteration of the third stage. Gamma function was used in the regression analysis. It was anticipated that the smoothing process would affect the calibration results of the second stage. A similar iterative approach of friction factor and K-factor calibration process was also applied. Note that the smoothing process via regression analysis would only be performed at the first iteration of this stage. In the following iterations, the coefficients of the gamma function will be adjusted empirically based on the average trip lengths from the current iteration, and from the observed data. After all friction-factors and K-factors were derived, friction factors for home-based work purposes and other purposes were grouped separately as the input for the application of the trip distribution.

9.5 APPLICATION

The calibrated friction-factors and K-factors were applied to the gravity model of the trip distribution component. It generally takes several iterations of full model run in order to achieve reasonable or appropriate congestion level in the loaded highway network. The calibrated friction-factors are listed in APPENDIX G – FRICTION-FACTORS FOR WBO AND NHNW PURPOSES, and APPENDIX H – K-FACTORS FOR ALL TRIP PURPOSES, and I by purpose and income group. APPENDIX E – FRICTION-FACTORS FOR HBWD AND HBWS PURPOSES contains the HBWD and HBWS friction factors while APPENDIX F – FRICTION-FACTORS FOR HBSH AND HBO PURPOSES contains HBSH and HBO friction factors. APPENDIX G – FRICTION-FACTORS FOR WBO AND NHNW PURPOSES includes the friction-factors for WBO and NHNW by income group.

K-factors are provided at county level for each trip purpose with composite impedance ranges from 1 to 300, which covers almost all possible impedances within the model region. The final K-factors are listed in APPENDIX H – K-FACTORS FOR ALL TRIP PURPOSES. K-factors within NJTPA and Mercer County Region are in most cases set to a value of 1.0, indicating no adjustment was implemented. This indicates that the basic distribution process was able to allocate trips in a manner that replicates observed travel patterns with no additional adjustments. In contrast, K factors were required for many patterns between New Jersey and New York. The need for these adjustments is most likely related to the institutional issues, such as tax policies and other features, such as the level of network abstraction in the model for outlying areas,

9.6 CALIBRATON RESULTS

The outputs of trip distribution from the full-model run were summarized for various measures and the results were compared to targets derived from observed data, such as RHTS Household Survey Data, etc. The summaries include the regional movement between New Jersey and New York City captured along the Hudson River crossings.

The estimated trips of the Trans-Hudson movements by trip purpose were close to their targets, this indicates that the NJRTM-E model performed well at regional level. The summary of the movements by trip purpose in PA was listed in
Table 73 and the results showed that the NJRTM-E model performed well at regional level.

Table 73 – Hudson River Crossing Person Trips by Trip Purpose

	PA Format			
	West -> East		East -> West	
	OBS	EST	OBS	EST
HBWD	478,266	491,942	107,447	78,609
HBWS	94,371	104,551	32,337	26,367
HBS	38,374	28,347	6,785	7,170
HBO	158,231	147,451	62,863	95,144
WBO	29,718	25,338	20,048	19,720
NHNW	44,864	36,352	50,642	46,238
TOTAL	**843,825**	**833,980**	**280,122**	**273,249**

The percentages of intra-zonal trips from the previous and updated models are summarized for all purposes in Table 74. The comparison shows that the model results are generally reasonable but note WBO has slightly lower intrazonal trips compared to the previous model.

Table 74 – Intra-Zonal Comparison by Purpose

HBWD					
REGION	**SOURCE**	**INTRAZONAL**	**TOTAL**	**%INTRAZONAL**	**%INTRAZONAL (2010)**
NJTPA+MERCER	SURVEY	126,600	2,970,069	4.3%	7.9%
	MODEL	34,635	2,976,027	1.2%	2.1%
MANHATTAN	SURVEY	1,342	544,026	0.2%	1.9%
	MODEL	2,793	548,821	0.5%	0.6%
HBWS					
REGION	**SOURCE**	**INTRAZONAL**	**TOTAL**	**%INTRAZONAL**	**%INTRAZONAL (2010)**
NJTPA+MERCER	SURVEY	26,483	1,122,127	2.4%	6.2%
	MODEL	10,004	1,125,849	0.9%	4.1%
MANHATTAN	SURVEY	978	102,745	1.0%	0.8%
	MODEL	1,620	274,906	0.6%	1.1%
HBSH					
REGION	**SOURCE**	**INTRAZONAL**	**TOTAL**	**%INTRAZONAL**	**%INTRAZONAL (2010)**
NJTPA+MERCER	SURVEY	281,028	2,254,732	12.5%	16.4%
	MODEL	278,321	2,264,152	12.3%	17.8%
MANHATTAN	SURVEY	3,484	146,319	2.4%	1.5%
	MODEL	1,056	73,216	1.4%	3.0%
HBO					
REGION	**SOURCE**	**INTRAZONAL**	**TOTAL**	**%INTRAZONAL**	**%INTRAZONAL (2010)**
NJTPA+MERCER	SURVEY	1,685,641	8,512,173	19.8%	23.0%
	MODEL	1,477,075	8,494,695	17.4%	24.8%
MANHATTAN	SURVEY	28,387	635,407	4.5%	2.1%
	MODEL	30,804	1,048,503	2.9%	4.5%
WBO					
REGION	**SOURCE**	**INTRAZONAL**	**TOTAL**	**%INTRAZONAL**	**%INTRAZONAL (2010)**
NJTPA+MERCER	SURVEY	158,790	991,317	16.0%	11.7%
	MODEL	83,651	973,765	8.6%	9.4%
MANHATTAN	SURVEY	3,087	358,773	0.9%	1.2%
	MODEL	4,862	189,715	2.6%	2.3%
NHNW					
REGION	**SOURCE**	**INTRAZONAL**	**TOTAL**	**%INTRAZONAL**	**%INTRAZONAL (2010)**
NJTPA+MERCER	SURVEY	894,817	4,504,041	19.9%	17.8%
	MODEL	915,649	4,559,024	20.1%	17.0%
MANHATTAN	SURVEY	12,460	375,191	3.3%	3.1%
	MODEL	95,605	579,654	16.5%	7.5%

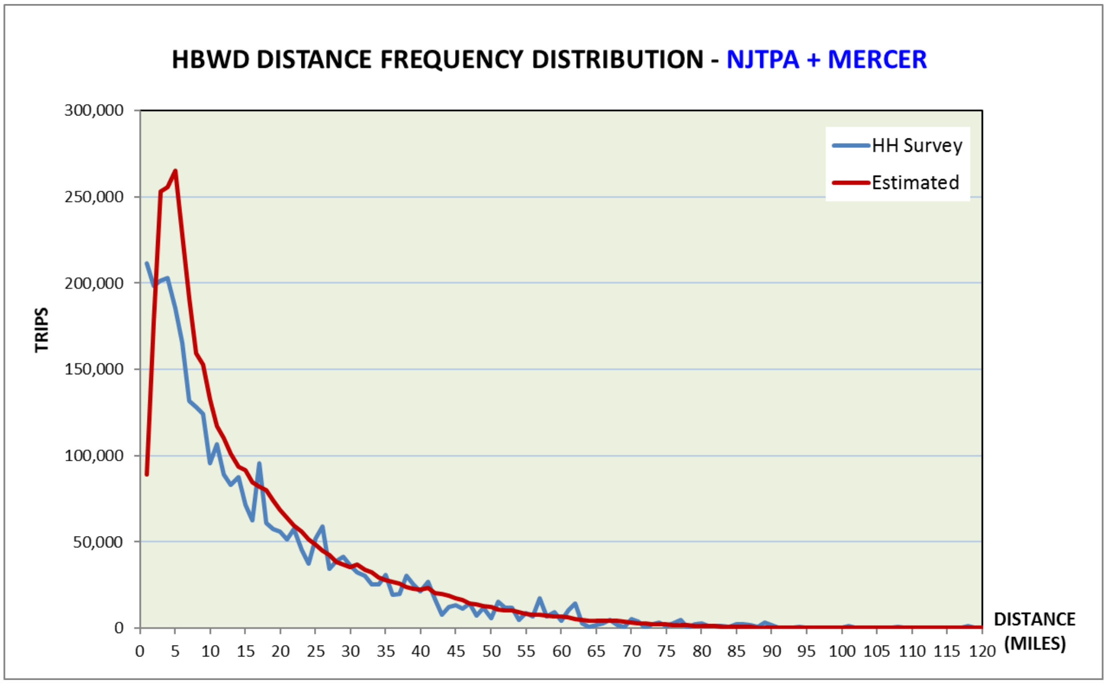
Average trip length is an important measure of trip spread or distribution. The average trip length was summarized with respect to distance and travel time from both model estimates and household survey data. The average trip length for trips from and to NJTPA and Mercer counties, the regions used in trip distribution calibration, were summarized in Table 75. The average trip lengths of the estimated trips are very close to those from household survey data, indicating that the model has a reasonable spread of trips across the region. Comparison against time and distance variables listed in Table 75 indicates that model provides an excellent replication with respect to both variables.

Table 75 – Average Trip Length Comparisons by Purpose

TRIP PURPOSE	AVERAGE DISTANCE (MILES)			AVERAGE TRAVEL TIME (MINUTES)			AVERAGE SPEED (MPH)		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
HBWD	16.8	16.2	-3.4%	38.9	38.3	-1.4%	25.9	25.4	-2.0%
HBWS	17.2	16.5	-4.1%	38.1	37.5	-1.5%	27.0	26.3	-2.6%
HBS	5.3	5.4	3.0%	17.7	18.0	2.0%	17.9	18.1	0.9%
HBO	6.2	6.3	1.5%	18.7	19.1	2.3%	20.0	19.9	-0.7%
NHBW	9.7	9.6	-0.7%	23.7	24.4	3.0%	24.6	23.7	-3.6%
NHNW	5.8	5.7	-1.8%	17.9	18.1	1.2%	19.4	18.8	-3.0%

Beyond the aggregate measures of travel time and distance discussed above, comparisons were also performed for the distribution of trips by impedance units. Figure 23 to Figure 28 depict the travel time and distance frequency distribution of each trip purpose.

Figure 23 – Frequency Distribution for HBW Purpose



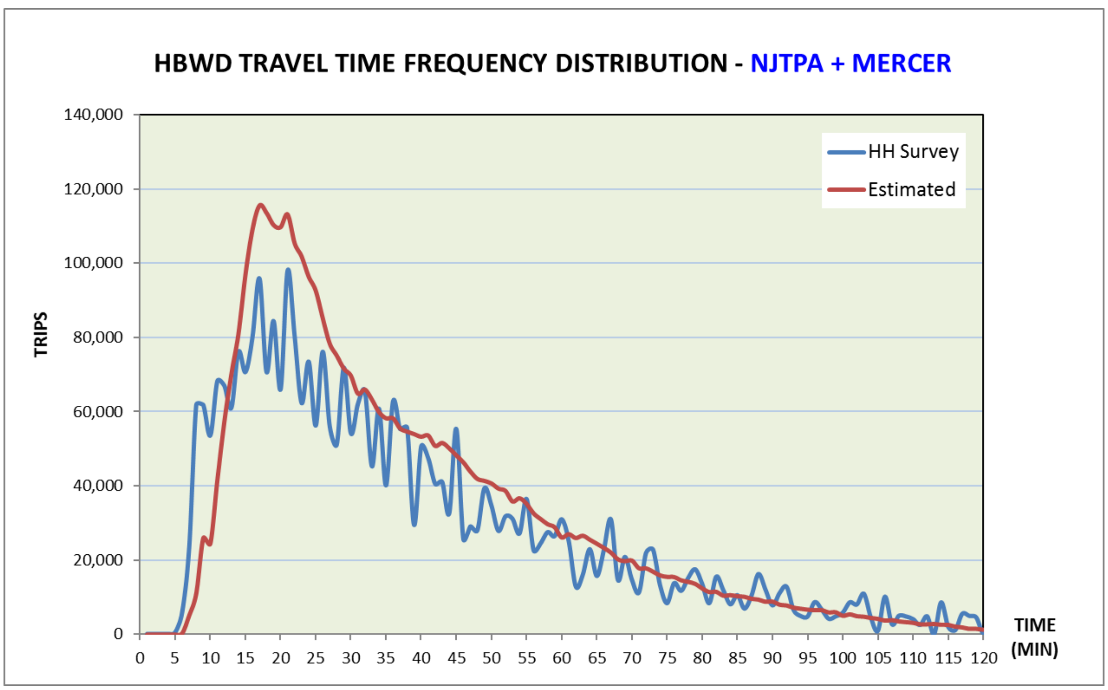
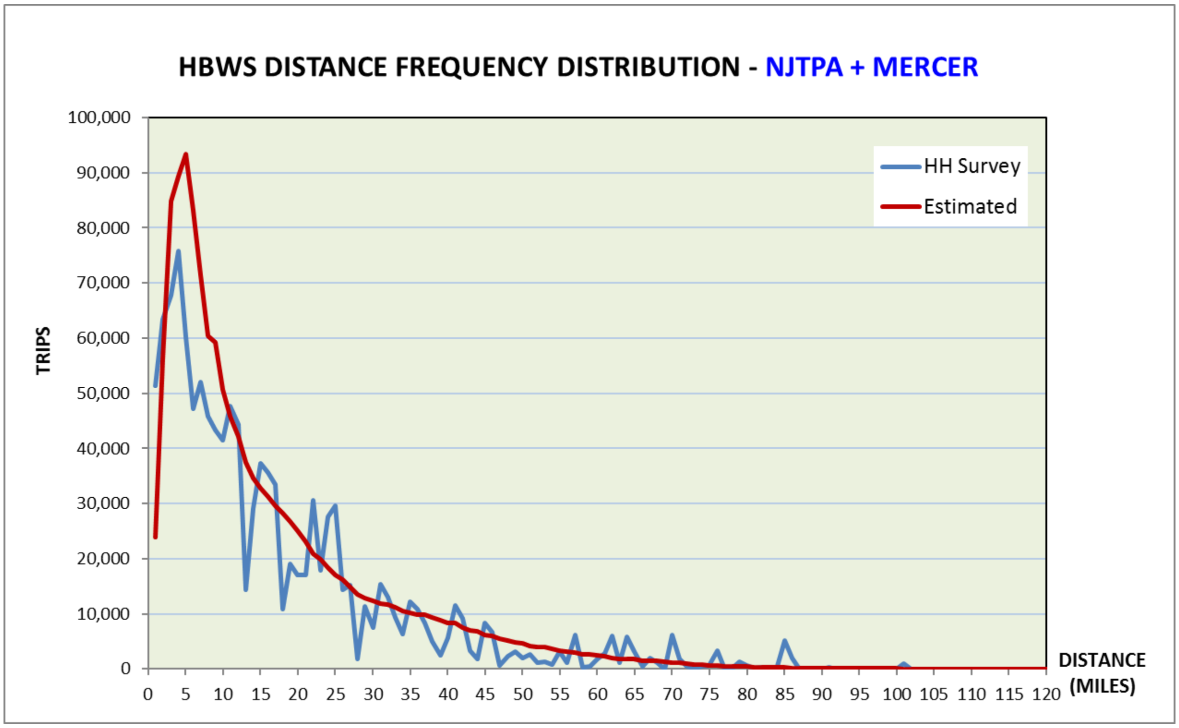


Figure 24 – Frequency Distribution for HBWS Purpose



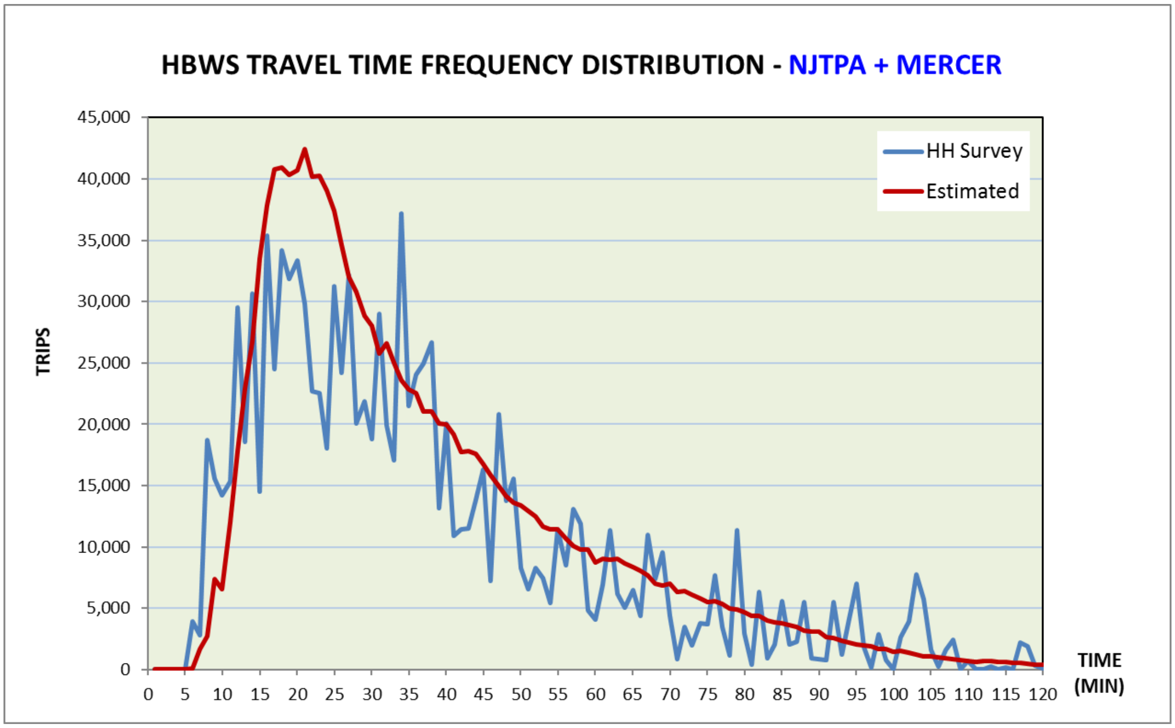
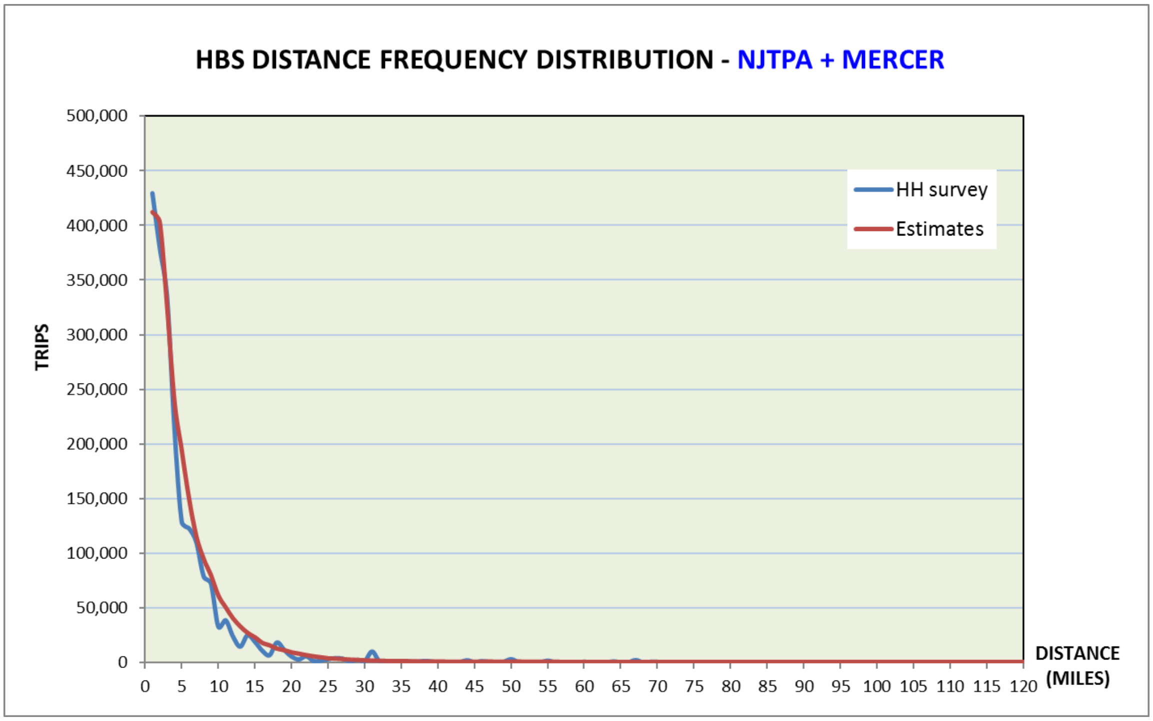


Figure 25 – Frequency Distribution for HBS Purpose



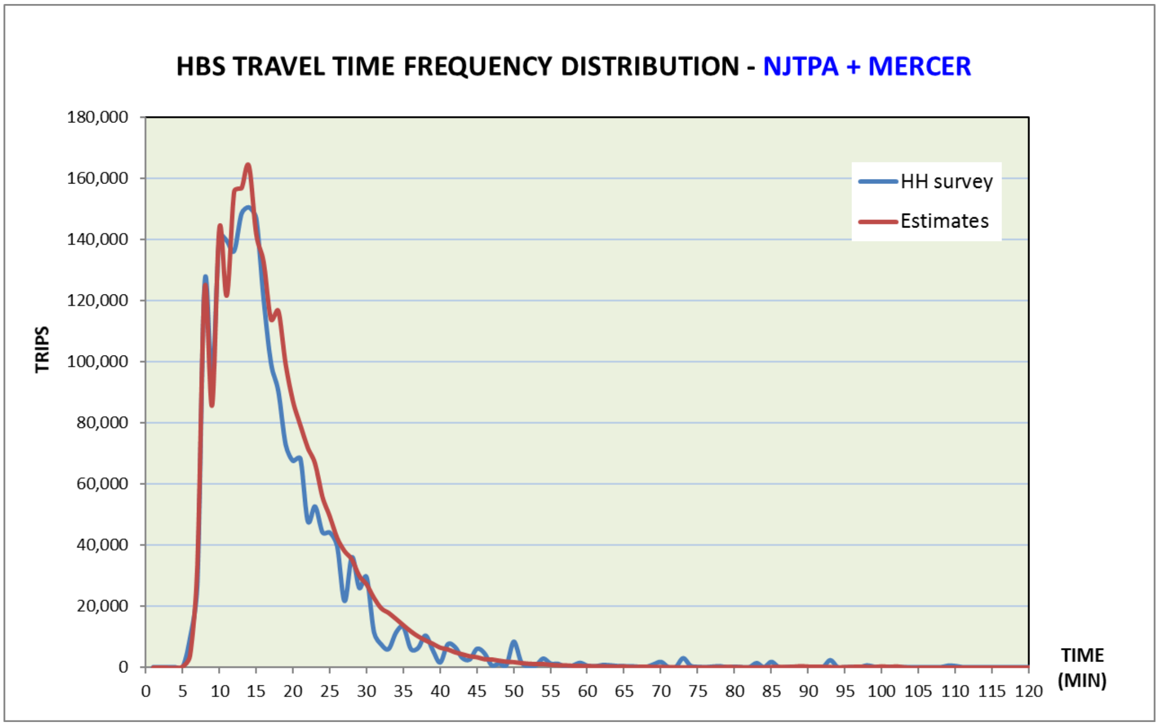
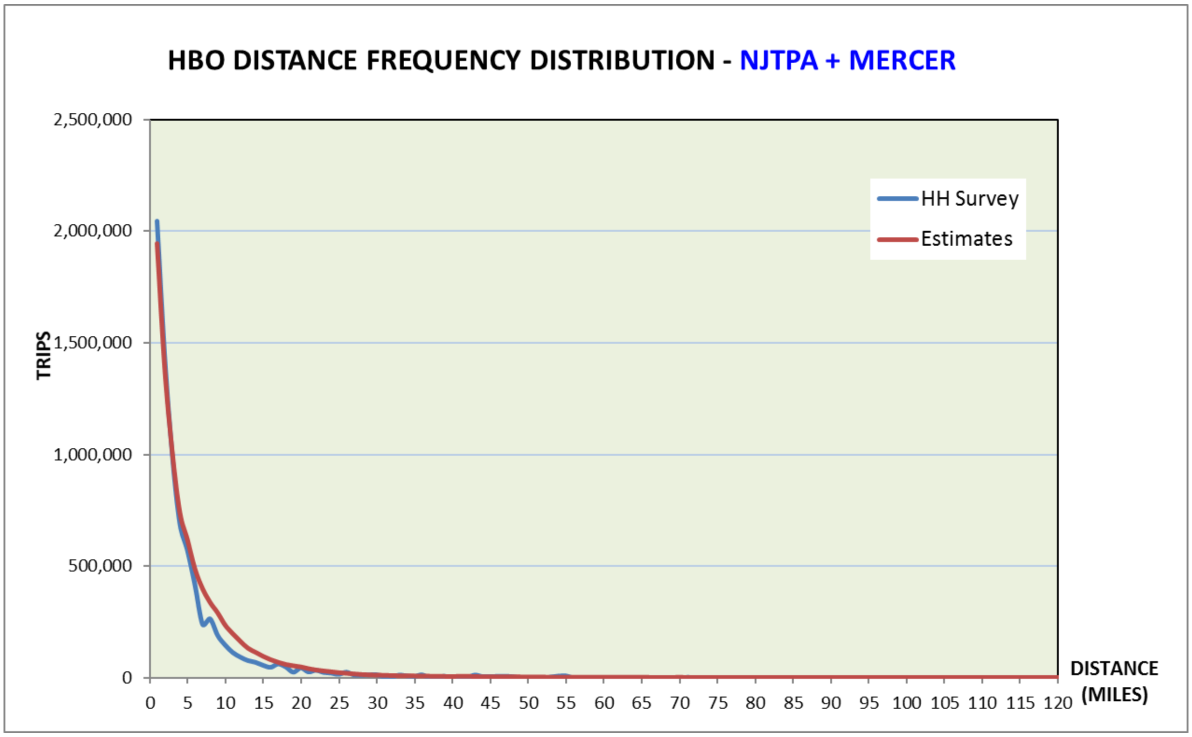


Figure 26 – Frequency Distribution for HBO Purpose



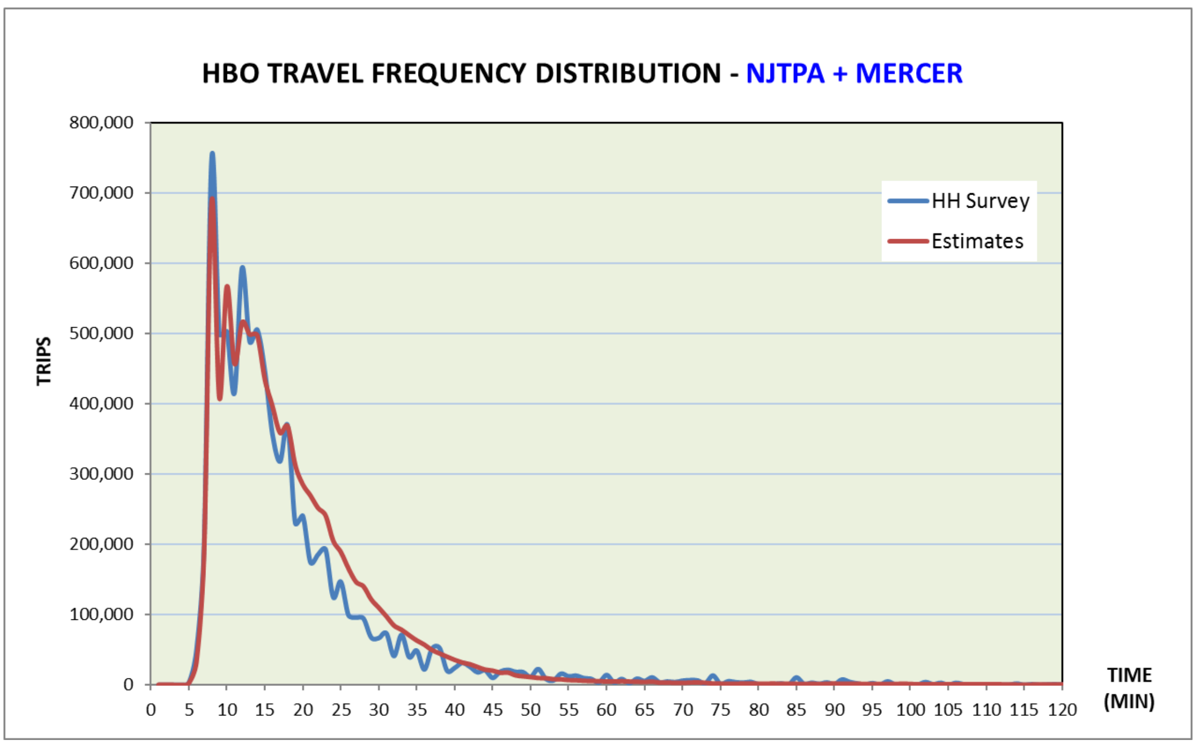
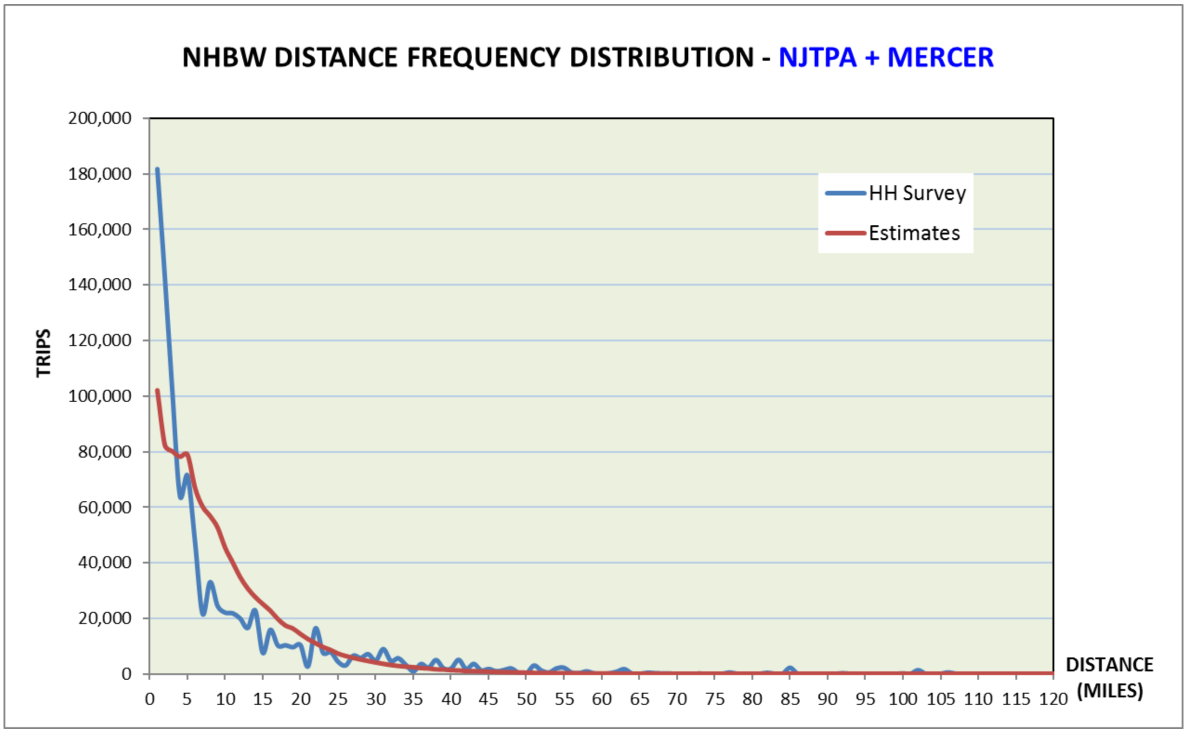


Figure 27 – Frequency Distribution for NHBW Purpose



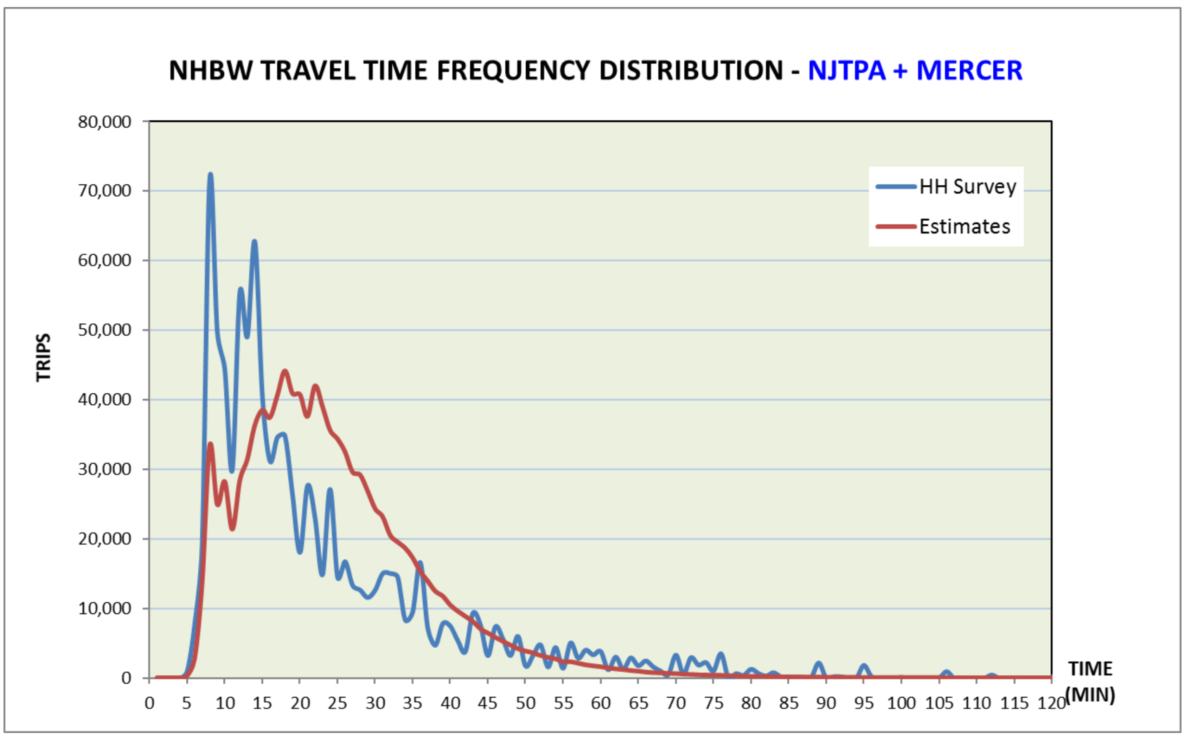
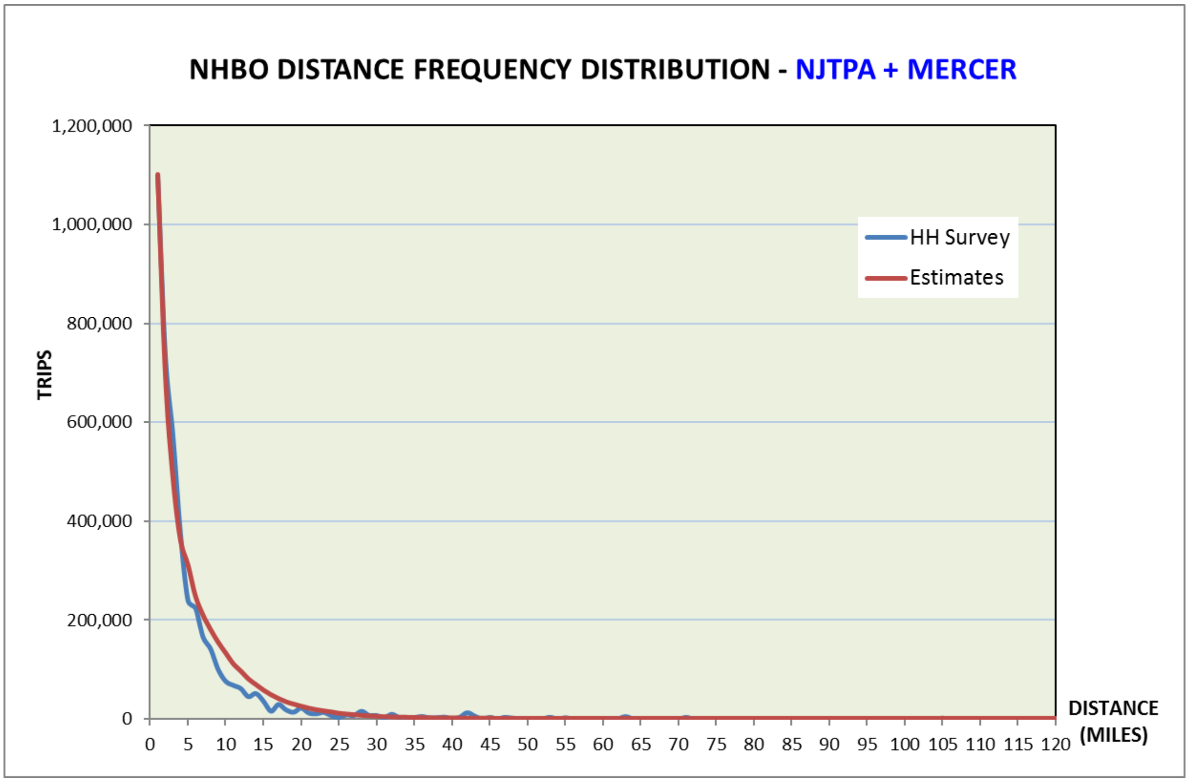
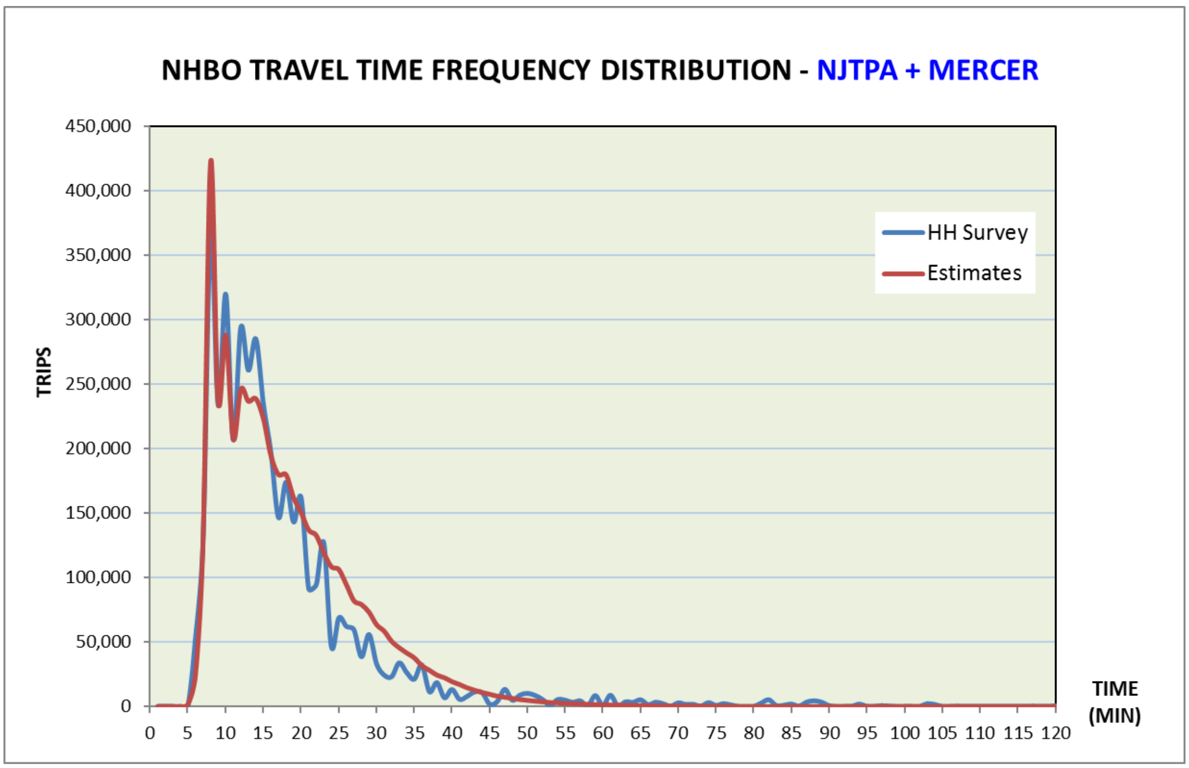


Figure 28 – Frequency Distribution for NHBO Purpose





The county-to-county person trips from both the household survey and NJRTM-E model were summarized, compared, and listed in APPENDIX I – COUNTY LEVEL TRIP INTERCHANGE COMPARISONS. These counties are the primary focus of the NJRTM-E model but have trip interactions with NJTPA core area. The trips originated from or destined to these areas are aggregated together by region and checked against available data.

9.7 PRE-MODE CHOICE TIME-OF-DAY PARTITION

Prior to mode choice step, the trips in the NJT controlled region have to be partitioned into peak and off-peak trips. Table 76 shows the time-of-day partition percentages for the peak and off-peak period by trip purpose. These percentages were developed based on the 2010-2011 NYMTC/NJTPA Regional Household Travel Survey Data. The partitioned trips were used as inputs to the NJRTM-E's mode choice model which was adopted from the NJT model.

Table 76 – Time-of-Day Partition Percentages

Period/Purpose	HBWD	HBWS	HBU	HBSH	HBO	WBO	NHNW
Peak	0.72	0.73	0.53	0.48	0.57	0.39	0.43
Off-Peak	0.28	0.27	0.47	0.52	0.43	0.61	0.57

9.8 TRUCK TRIP DISTRIBUTION CALIBRATION

9.8.1 External to External Trip Distribution

External to external trips were developed by utilizing the survey data. It was structured to have two layers of EE travel patterns, a method adopted from the New Jersey Statewide Truck Model. These patterns form the basis of simulating external truck trips across the region. The first layer, referred to as primary EE patterns, included EE movements obtained from all survey-related information. The second layer, referred to as secondary EE patterns, provides movements that were based on professional judgment. The primary patterns would govern the secondary patterns in the case where movements occurred in both patterns.

9.8.2 EI, EIE, EIMC, II Trip Distribution

A standard gravity model was utilized for truck's Internal-Internal (II), External-Internal (EI), External-Internal-External (EIE) trip distribution analyses. This method was also adopted from the New Jersey Statewide Truck Model. The gravity model distributes trips proportionally to the magnitude of productions and attractions at the origin and destination zones, and inversely to the distance or "spatial separation" between these zones. Off-peak highway skims were used to represent the spatial separation between zones. Commercial vehicle trips were distributed using the same travel times as medium trucks.

9.8.3 Trip Distribution Validation

The truck trip distribution model was validated to the recent traffic counts available for the trans-Delaware river and trans-Hudson river trips, as well as to the Origin-Destination (O-D) truck trips from / to various important truck generators, such as Ports and Airports. Table 77 shows the truck distribution comparison between various ports / Airports and Counties in the study regions.

Table 77 – Truck Trips Distribution From / To Airport

COUNTY	FROM EWR		FROM HH		FROM JFK		FROM NYMT		FROM PEPN		FROM PJ		FROM SWF	
	OBS	EST	OBS	EST	OBS	EST	OBS	EST	OBS	EST	OBS	EST	OBS	EST
Bergen	5.1%	33.6%	0.0%	25.5%	1.0%	6.6%	1.7%	0.9%	2.5%	0.0%	0.3%	0.0%	1.0%	0.4%
Essex	20.8%	6.1%	10.7%	4.1%	6.9%	5.6%	3.4%	4.5%	27.3%	8.3%	22.9%	5.6%	5.3%	7.3%
Hudson	7.9%	3.3%	12.5%	5.1%	4.2%	0.9%	18.5%	8.0%	13.2%	8.6%	41.9%	9.8%	0.3%	6.0%
Hunterdon	3.2%	0.5%	3.6%	0.4%	0.4%	0.0%	0.0%	0.0%	3.5%	1.0%	1.1%	0.2%	0.3%	0.0%
Mercer	0.2%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.8%	0.3%	0.3%	2.3%	0.0%	0.0%
Middlesex	9.4%	7.1%	33.9%	23.7%	1.5%	1.0%	12.6%	0.0%	19.7%	19.7%	16.1%	16.0%	7.6%	0.0%
Monmouth	0.0%	2.7%	0.0%	4.1%	0.0%	0.1%	0.0%	0.0%	0.1%	2.5%	0.3%	7.0%	0.2%	0.0%
Morris	1.9%	4.7%	0.0%	2.7%	0.2%	0.3%	0.0%	0.0%	0.9%	4.4%	0.0%	12.2%	0.0%	0.0%
Ocean	0.2%	1.6%	0.0%	2.6%	0.0%	0.1%	0.0%	0.0%	0.1%	1.4%	0.0%	4.1%	0.0%	0.0%
Passaic	0.2%	2.7%	0.0%	1.9%	0.1%	0.4%	0.0%	0.0%	0.1%	2.8%	0.0%	7.9%	0.0%	0.0%
Somerset	0.2%	0.2%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.7%	4.2%	0.0%	0.1%	0.0%	0.0%
Sussex	0.0%	0.5%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	1.3%	0.7%	0.3%
Union	22.5%	6.8%	10.7%	4.1%	1.2%	0.8%	0.8%	2.8%	15.3%	12.1%	10.4%	8.2%	0.0%	0.0%
Warren	0.7%	0.5%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	2.5%	1.8%	1.7%	1.2%	0.0%	0.0%
NJTPA+MERCER	**72.1%**	**70.3%**	**71.4%**	**74.7%**	**16.1%**	**15.9%**	**37.0%**	**16.2%**	**86.8%**	**67.7%**	**95.3%**	**75.9%**	**15.5%**	**14.0%**
NY (West)	0.2%	1.3%	1.8%	1.2%	0.4%	1.9%	2.5%	0.1%	1.6%	5.3%	1.1%	3.0%	80.4%	76.2%
NY (East)	21.0%	22.5%	25.0%	22.5%	82.2%	76.8%	55.5%	60.9%	2.4%	11.3%	3.6%	14.0%	0.3%	1.4%
NJ Other	1.1%	1.5%	1.8%	0.0%	0.9%	1.2%	0.8%	0.4%	1.3%	1.4%	0.0%	0.2%	0.7%	0.0%
Penn.	5.6%	4.4%	0.0%	1.7%	0.3%	4.2%	3.4%	22.4%	6.8%	13.0%	0.0%	6.9%	2.6%	8.4%
CT	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.8%	0.0%	1.0%	1.3%	0.0%	0.0%	0.5%	0.0%
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Note 1

NY (West): Orange, Rockland, and Sullivan
NY (East): Bronx, Dutchess, Kings, Nassau, Manhattan, Putnam, Queens, Richmond, Suffolk, and Westchester
NJ Other: Atlantic and Burlington
Penn.: Bucks, Carbon, Lackawanna, Lehigh, Luzerne, Monroe, Northampton, Pike, and Wayne

Note 2

EWR: Newark Liberty Airport
HH: Howland Hook
JFK: JFK Airport
NYMT: Marine Terminal
PEPN: Port Elizabeth/Port Newark
PJ: Port Jersey
SWF: Stewart Airport

COUNTY	TO EWR		TO HH		TO JFK		TO NYMT		TO PEPN		TO PJ		TO SWF	
	OBS	EST	OBS	EST	OBS	EST	OBS	EST	OBS	EST	OBS	EST	OBS	EST
Bergen	5.0%	33.6%	0.0%	25.5%	1.7%	6.6%	0.9%	0.9%	2.9%	0.0%	0.8%	0.0%	0.5%	0.4%
Essex	21.6%	6.1%	24.1%	4.1%	5.8%	5.7%	6.2%	4.5%	24.6%	8.3%	26.5%	5.6%	4.9%	7.3%
Hudson	8.5%	3.3%	17.2%	5.1%	1.3%	0.9%	15.0%	8.0%	14.7%	8.6%	43.2%	9.8%	3.0%	6.0%
Hunterdon	2.3%	0.5%	3.4%	0.4%	0.1%	0.0%	1.8%	0.0%	1.2%	1.0%	0.3%	0.2%	0.0%	0.0%
Mercer	0.4%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.2%	0.3%	0.2%	2.3%	0.3%	0.0%
Middlesex	8.7%	7.1%	17.2%	23.7%	1.9%	1.0%	11.5%	0.0%	25.5%	19.7%	13.0%	16.0%	2.4%	0.0%
Monmouth	0.0%	2.7%	0.0%	4.1%	0.0%	0.1%	0.0%	0.0%	0.2%	2.5%	0.5%	7.0%	0.2%	0.0%
Morris	0.6%	4.7%	0.0%	2.7%	0.9%	0.3%	0.0%	0.0%	1.0%	4.4%	0.2%	12.2%	3.2%	0.0%
Ocean	0.0%	1.6%	0.0%	2.6%	0.0%	0.1%	0.0%	0.0%	0.9%	1.4%	0.0%	4.1%	0.0%	0.0%
Passaic	1.0%	2.7%	0.0%	1.9%	0.1%	0.4%	0.0%	0.0%	0.2%	2.8%	0.2%	7.9%	0.0%	0.0%
Somerset	0.4%	0.2%	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	4.2%	0.0%	0.1%	0.0%	0.0%
Sussex	0.0%	0.5%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	1.3%	0.3%	0.3%
Union	20.0%	6.8%	10.3%	4.1%	1.3%	0.8%	0.9%	2.8%	14.4%	12.1%	9.3%	8.2%	0.0%	0.0%
Warren	1.9%	0.5%	0.0%	0.0%	0.8%	0.0%	0.9%	0.0%	0.9%	1.8%	1.1%	1.2%	0.0%	0.0%
NJTPA+MERCER	**70.5%**	**70.3%**	**74.1%**	**74.6%**	**13.9%**	**15.9%**	**37.2%**	**16.2%**	**87.1%**	**67.8%**	**95.3%**	**76.0%**	**14.8%**	**14.0%**
NY (West)	1.0%	1.3%	0.0%	1.2%	0.8%	1.9%	0.0%	0.1%	1.7%	5.3%	0.3%	3.0%	76.0%	76.2%
NY (East)	24.3%	22.5%	25.9%	22.5%	82.3%	76.8%	57.5%	60.9%	3.9%	11.3%	3.6%	14.0%	3.3%	1.4%
NJ Other	2.3%	1.5%	0.0%	0.0%	1.1%	1.2%	0.0%	0.4%	2.5%	1.4%	0.5%	0.2%	0.2%	0.0%
Penn.	1.7%	4.4%	0.0%	1.7%	1.7%	4.2%	5.3%	22.4%	3.9%	13.0%	0.3%	6.9%	5.2%	8.4%
CT	0.2%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	1.0%	1.3%	0.0%	0.0%	0.5%	0.0%
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

9.9 AIRPORT TRIP GENERATION AND DISTRIBUTION

9.9.1 General Information

The base year (2000) air passenger trips were developed using trip tables derived from survey data provided by NJ Transit. However, NJT did not provide any estimation method to project future air passenger trips. In an effort to include a capability to estimate future air trips, a regression model was developed for airport trips using socioeconomic data and the 2000 air-passenger trips as the basis of the model estimation and calibration. There are four types of air passenger trips introduced in the model for each time period, peak and off-peak:

- AIR1 : Business Trip from Residence
- AIR2 : Business Trip from Non-Residence
- AIR3 : Non-Business Trip from Residence
- AIR4 : Non-Business Trip from Non-Residence

9.9.2 Model Estimation Using Linear Regression Method

The passenger trip table was constructed with an assumption that only trips destined to the airport were included, the reverse-direction trips (trips originated from the airport) were not. In other words, the air-passenger model only estimated the zonal trip production but not the zonal trip attraction. Other techniques are employed to represent the directional distribution of trips to and from the airport. In the NJRTM-E, the air-passenger trip tables include trips originating from all the NJRTM-E zones (2900 zones) and destined to the Newark airport zone (zone 599). As such, the model can be described as a very simple combined generation – distribution model, or a direct demand model, with a single destination.

The air passenger trip model for each purpose was estimated using a linear regression method. The base year air passenger trips (2000) were used as the observed data or the dependent variable. The independent variables were selected among the zonal socioeconomic data that include:

- POP : zonal population
- EMP : zonal total population
- INCOME : zonal median income
- DIST_NEWARK: distance from each zone to Newark airport
- DIST_NEAR : distance from each zone to nearest airport (JFK, Laguardia, Lehigh Valley, or Philadelphia) except Newark Airport

The linear regression models were developed on a daily basis using MCD or district level data, even though the final model will be applied at the zonal level. The main reason of using the MCD level data, instead of zonal level data, is because the zonal level observed data were limited in many areas. It should be noted that the observed air-passenger data was available only for selected regions. These selected regions were New Jersey and Manhattan, NY which have significant air passenger trips to Newark Airport. In the New Jersey region, the observed data was prepared at MCD level, while for Manhattan, the observed data was prepared at district level. Manhattan was divided into three districts: Upper Manhattan, Mid-Manhattan, and Lower Manhattan. The air passenger trips from Bucks County, PA and other counties in NY were also available. However, they were not used because the data was a very limited sample for that region.

9.9.3 Model Estimation

The SPSS software was used to perform the linear regression. The zero trip observations were excluded from the analysis using the SPSS data selection option. The best models were selected using the "Step-Wise" method. This method was executed by including all five independent variables and the following regression models (with R-squared terms listed) were selected for each air-passenger type:

i) AIR1 (Business, Resident) Passenger Trip Model
AIR1_Trip = -2.119 + 0.000488*POP + 0.0005478*EMP + 0.00043*INCOME - 0.533*DIST_NEWARK + 0.303*DIST_NEAR (R2=0.769)

ii) AIR2 (Business, Non-Resident) Passenger Trip Model
AIR2_Trip = 7.318 + 0.0002798*POP + 0.001458*EMP - 0.521*DIST_NEWARK + 0.519*DIST_NEAR (R2=0.752)

iii) AIR3 (Non-Business, Resident) Passenger Trip Model
AIR3_Trip = 12.267 + 0.0009773*POP + 0.0004697*EMP + 0.0003516*INCOME - 0.705*DIST_NEWARK + 0.263*DIST_NEAR (R2=0.841)

iv) AIR4 (Non-Business, Non-Resident) Passenger Trip Model
AIR4_Trip = -25.881 + 0.0003883*POP + 0.001874*EMP + 0.0000648*INCOME - 0.429*DIST_NEWARK + 0.349*DIST_NEAR (R2=0.843)

The independent variable, "DIST_NEWARK", has negative impact on the air-passenger trips. The longer distance for a zone to Newark Airport results in less passenger trips produced by the zone being destined to Newark airport. The other independent variables have a positive relationship to the air passenger trips production.

9.9.4 Calibration of Constants

The regression models were developed using MCD level or district level data points and will be used to estimate zonal-level air-passenger trip productions in the final model application. As such, there is an inconsistency pertaining to geographical sizes used during model estimation and the model application. The constants were recalibrated and adjusted for various model regions to reduce the inconsistency. Table 78 shows regression constants for the four air passenger types and for various regions.

Table 78 – Constants of Regression for Airport Trips

State & County		Calibrated Constant Value			
		AIR1	AIR2	AIR3	AIR4
New Jersey		-28.8343	-5.4775	-14.7265	-7.873
New York	Bronx	-139.4302	-184.3404	-205.4723	-116.0245
	Kings	-107.6452	-155.6539	-162.2311	-153.7849
	New York	-45.8975	3.9224	-27.5394	-1.9437
	Queens	-216.0321	-202.05	-267.9113	-215.8475
	Richmond	-27.6106	-20.527	-14.61	-16.9003
	Westchester	-88.8921	-82.6934	-74.6079	-119.8549
	Other Counties	-31.2129	-2.7077	-10.0467	-8.3078
Pennsylvania		-38.142	2.9272	-32.6916	-7.7643

There were a few cases where negative trips were generated for zones far from Newark Airport. The high distance values and negative coefficient of "DIST_NEWARK" variable contributed to this problem. In the final model application, any cells with negative values were set equal to zero correct this problem.

9.9.5 Trip Scale Factors

The model also introduced trip scale factors to adjust the air-passenger trip tables when necessary. For example, if in the future Newark Airport is expanded and the air-trips are projected to increase by ten percent, a factor of 1.1 can be applied to the estimated air-trips to reflect the change. This factor provides flexibility and quick adjustments to model any future changes to airport facilities without recalibrating the model.

9.9.6 Time-of-Day Factors

The estimated daily air-passenger trips were then stratified into peak and off-peak trips using time-of-day factors shown in Table 79. The factors were developed for different regions using the 2000 observed air-trips provided by NJ TRANSIT. The same factors are applied to the four different air-passenger types.

Table 79 – Time of Day Distribution of Airport Trips

STATE	COUNTY	PEAK	OFF-PEAK
New Jersey	Bergen	36.71%	63.29%
	Essex	41.87%	58.13%
	Hudson	38.38%	61.62%
	Hunterdon	37.40%	62.60%
	Mercer	39.40%	60.60%
	Middlesex	37.67%	62.33%
	Monmouth	39.09%	60.91%
	Morris	38.02%	61.98%
	Ocean	43.47%	56.53%
	Passaic	40.05%	59.95%
	Somerset	41.97%	58.03%
	Sussex	46.49%	53.51%
	Union	43.49%	56.51%
	Warren	36.04%	63.96%
New Jersey Total		39.56%	60.44%
New York	Bronx	26.71%	73.29%
	Kings	34.87%	65.13%
	New York	29.46%	70.54%
	Orange	31.87%	68.13%
	Queens	32.35%	67.65%
	Richmond	40.71%	59.29%
	Rockland	28.48%	71.52%
	Westchester	53.16%	46.84%
New York Total		33.50%	66.50%
Pennsylvania		32.33%	67.67%
Default for Other Counties		37.76%	62.64%

9.10 EXTERNAL TRIP DISTRIBUTION

9.10.1 Introduction

Although the NJTPA region is surrounded by a large buffered area of additional counties from which external traffic is generated, the magnitude and trip length of external traffic on the southern section of the New Jersey Turnpike (NJTPK) tended to be much lower than the observed traffic counts and the patterns were inconsistent with the patterns from entry-exit transaction data. The differences were predominantly related to auto trips as described in the latest NJRTM-E Revalidation Report (2011). While the buffer area surrounding the NJTPA region is providing a reasonable external trip process for most of the modeled area, the magnitude of external traffic on the Turnpike and relatively long-distance characteristics of these trips due to the Turnpike's function as a gateway for travel into the Northeast Corridor required a more detailed approach for modeling external auto travel.

As part of the 2015 NJRTM-E Refinement project, the external auto trips on the southern section of the NJ Turnpike were adjusted with the objective of improving the estimated volume and travel patterns. The adjustments were implemented as a separate external traffic estimation module that is embedded into the NJRTM-E model framework. The external traffic distribution is performed using a gravity model distributing trips from the NJ Turnpikes southern terminus modeled at the Camden – Burlington County Line to the remaining internal zones within the NJRTM-E. The revised external modeling process was calibrated using the New Jersey Turnpike entry-exit transaction data provided by the New Jersey Turnpike Authority.

The module was designed to be flexible and easily adaptable to other NJRTM-E external gateways serving significant long-distance travel, such as western terminus of I-80 and I-78. It should be noted that since the model has a larger buffer to the west and north of the NJTPA region these external loading points, as well as those on the northern side of the region are significantly more distant from the NJTPA region and the portion of traffic from those zones that reaches the NJTPA counties may be much lower than the percentage of traffic on the southern end of the NJ Turnpike.

9.10.2 Process Overview

The refined external forecasting process has four basic elements. The first element is a referencing process to tie the external trips to the external gateway point. The second element is the estimation of internal EI trip attractions within the NJRTM-E region. The third element is a gravity model process to distribute the EI vehicle trips and the final element converts the trips to O-D flows for each of the assignment periods and merges the trips into the final vehicle trip tables.

The external application was added in the Trip Distribution module of the NJRTM-E as shown in Figure 29 and. As part of the external model application, the analyst has to provide the traffic volumes at the three external locations, including New Jersey Turnpike, I-78, and I-80, for each model year. The volumes are stored in the "External.DBF" file in the network related input folder, as mentioned above.

Figure 29 – External Trip Model in the Trip Distribution Model

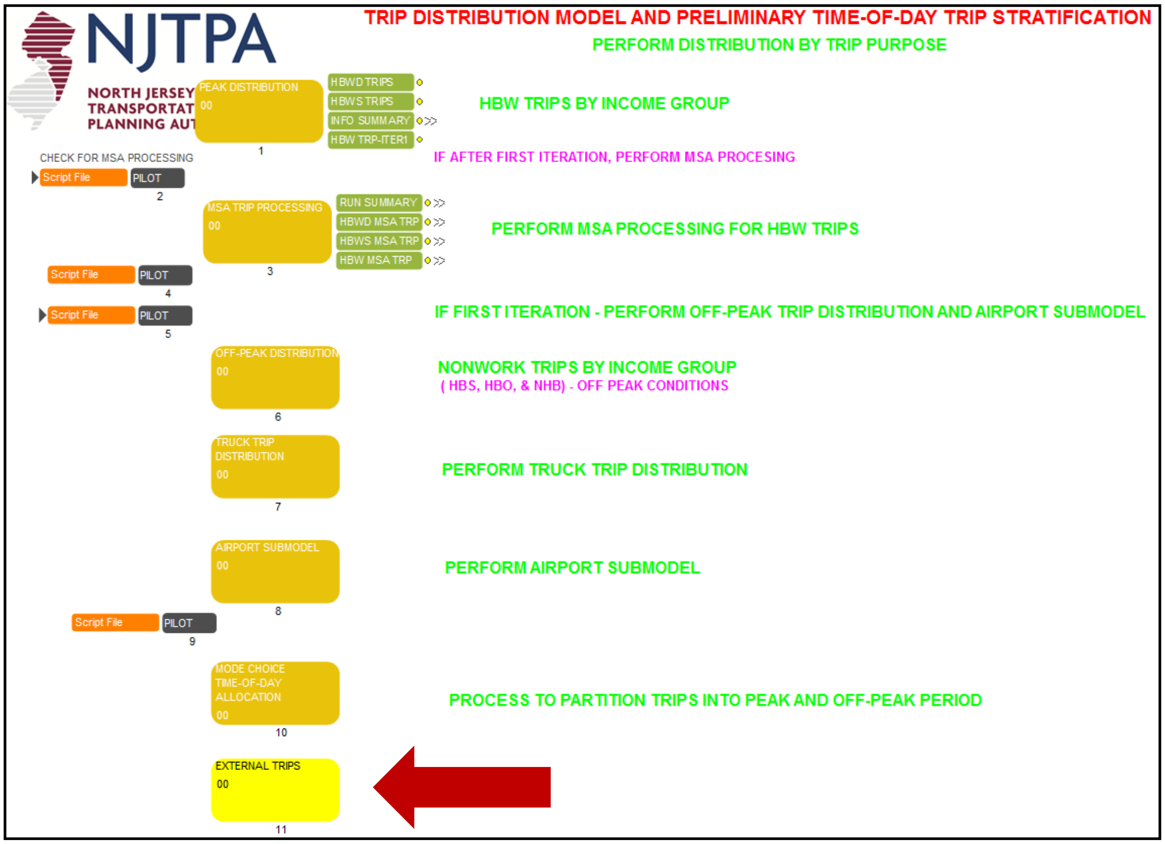
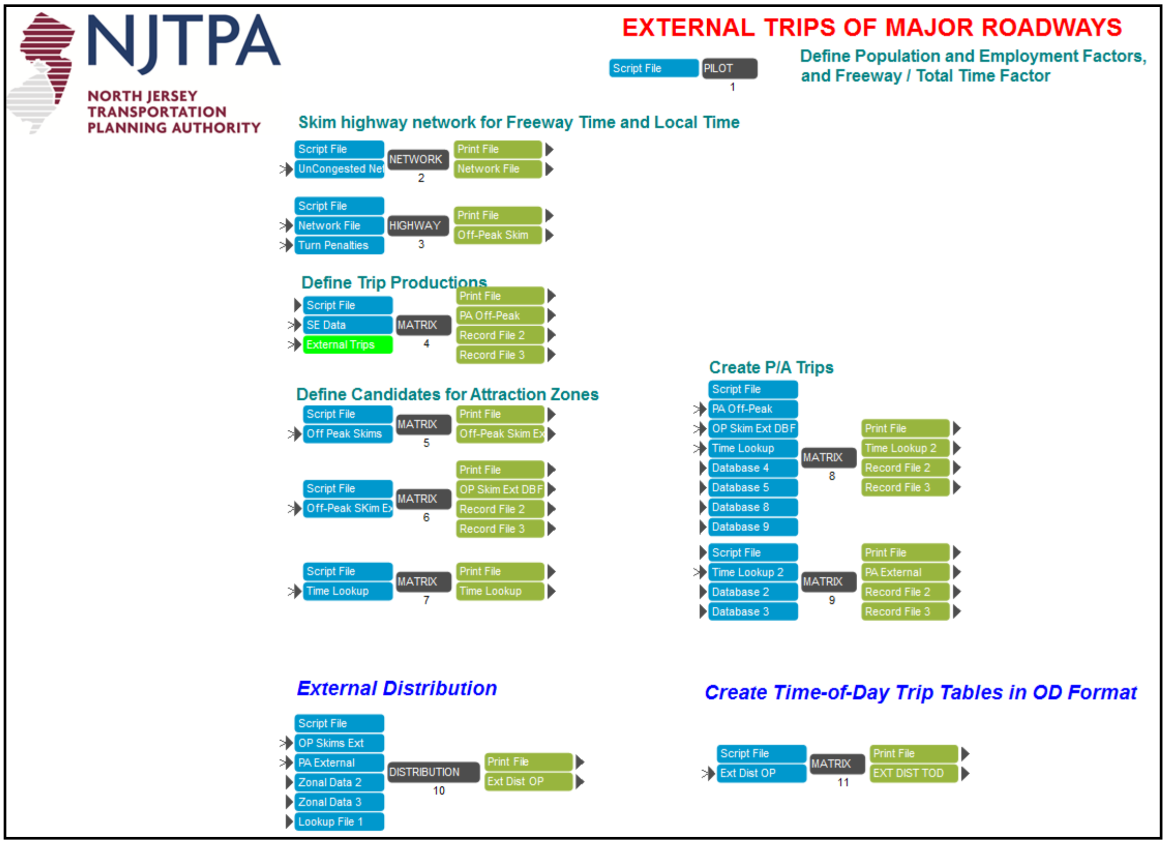


Figure 30 – External Trip Model Application



9.10.3 External-Internal Trip Generation

The daily observed auto vehicle trips from/to the southern terminus of the NJTPK is used as the production control total for the NJ Turnpike southern external with zone 367 as its surrogate zone. The trips will then be distributed to other zones (attraction zones).

The attraction zones were defined by using a two-tier process. The first tier is to locate the candidate attraction zones. A zone is defined as a candidate attraction zone if the time spent traversing limited-access facilities (such as New Jersey Turnpike) to this zone is at least half of the total trip time from the external production zone. This condition was adopted to reflect the general orientation of traffic entering the modeled region via the NJ Turnpike. As an example, it is assumed that traffic from the NJ Turnpike external gateway would be more likely to seek destination zones in core areas along the limited access facilities interconnected to the Turnpike as opposed to seek destinations in the far northwestern section of New Jersey. For those destinations, it would be more likely that travelers from south of the region would have used other limited access roadways in Pennsylvania to reach that general area. This assumption is logically supported by the magnitude of entry-exit patterns from the NJ Turnpike at its interchanges with other interstate roadways, although the final zonal destinations are not known. This assumption can be further refined in the next revalidation effort with additional route-specific survey data, such as cell phone-based O-D data.

In the second step, the trip attractions for all selected zones are estimated. Attractions are calculated as a function of 'zonal activity', which is defined as population + 0.50 * total employment, and travel time from the southern external to each attraction zone. Zones with greater activity will attract proportionally more trips.

9.10.4 Gravity Model

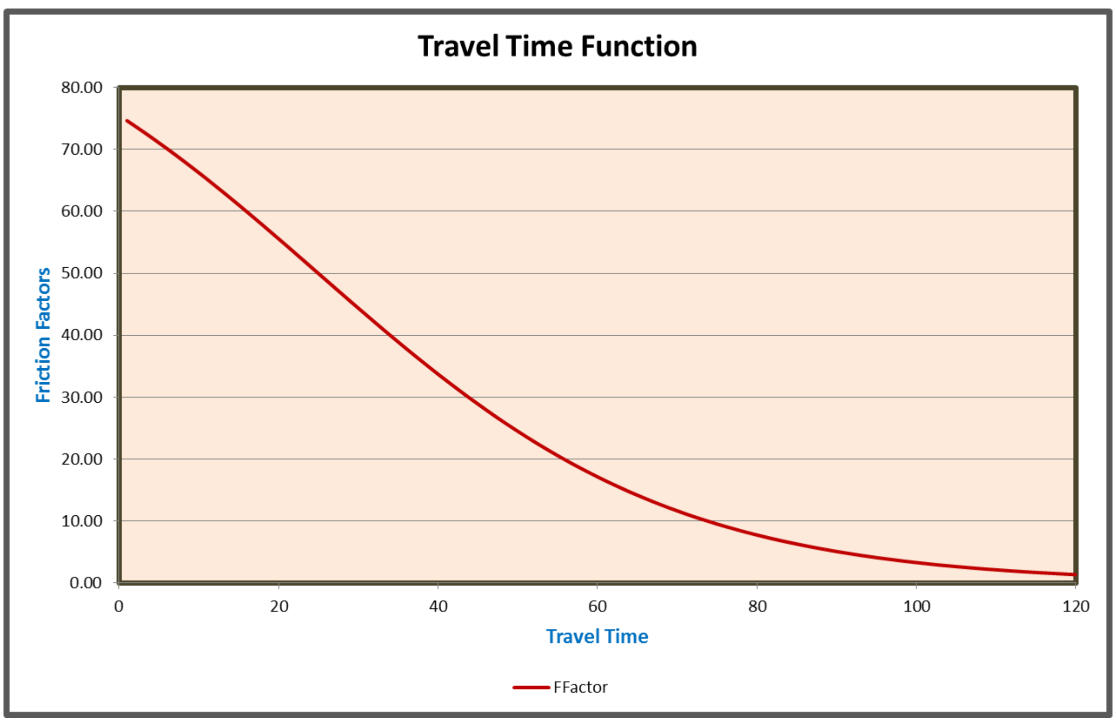
The external trip distribution is performed using a typical Gravity Model, defined as follows:

$$T_{ij} = \frac{A_j F_{ij} K_{ij}}{\sum_{allzones} A_x F_{ij} K_{ix}} x P_i$$

Where: Tij = Trip produced at zone i and attracted to zone j
Pi = Total trip production at zone i
Aj = Total attraction at zone j
Fij = Friction Factor between zones i and j
Kij = K-Factor, socioeconomic adjustment factor for interchange ij

To facilitate the transferability of this model to other major external gateways within the NJRTM-E region such as I-80 and I-78, K-factors were not utilized. The friction factors were adjusted as part of the calibration process. Figure 31 shows the friction factors as a function of travel time.

Figure 31 – Friction Factor



9.10.5 Time-Of-Day Trip Table

The daily production/attraction (P/A) external auto trip table stratified into four time-of-day (TOD) trip tables thus being converted to a final origin-destination (O-D) trip table. The time of day allocations were developed using the non-home-based (NHB) TOD factors with some directional scaling assumptions for the two peak periods. It was assumed that there would be a pronounced directional flow northbound (inbound) in the am peak period and a smaller directional imbalance in the pm peak period. These factors were defined as follows:

AM Peak = 0.121 * Daily Trip (Inbound 65% / outbound 35%)
PM Peak = 0.223 * Daily Trip (inbound 45% / outbound 55%)
MD = 0.462 * Daily trip (inbound 50% / outbound 50%)
NT = 0.194 * Daily Trip (inbound 50% / outbound 50%)

The TOD external trip tables were combined with the NHB trips prior to the highway assignment process.

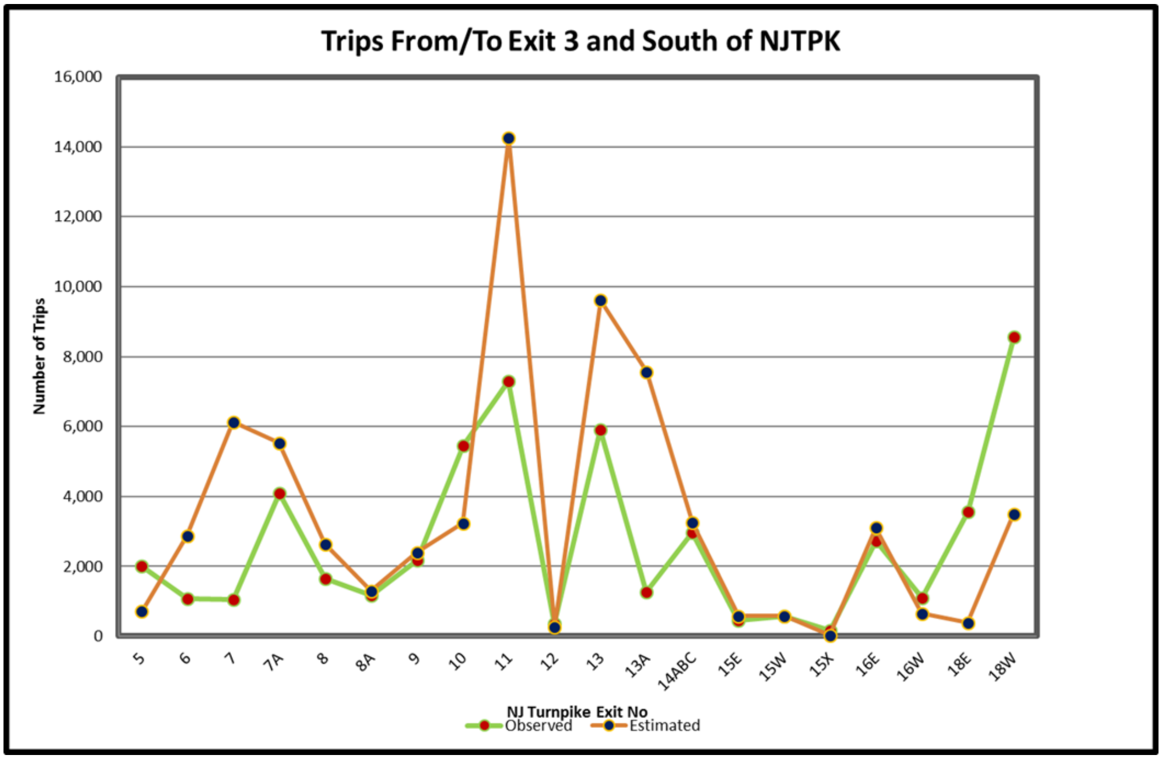
9.10.6 Highway Assignment Results

Upon the completion of the highway assignment the estimated trips by entry-exit combination from the NJ Turnpike southern external to other northern interchanges are compared to the observed data. Table 80 shows the comparison of the observed data and estimated trips. The comparison is displayed graphically in Figure 32.

Table 80 – Observed and Estimated O-D Trip Comparison

Interchange	From South(1)		To South(1)		Total	
	Observed	Estimated	Observed	Estimated	Observed	Estimated
5	1,001	317	1,011	392	2,012	709
6	506	1,567	568	1,314	1,074	2,881
7	517	3,069	537	3,056	1,054	6,124
7A	1,953	2,750	2,146	2,780	4,099	5,530
8	798	1,422	854	1,212	1,652	2,634
8A	559	596	624	700	1,183	1,296
9	1,063	1,197	1,107	1,202	2,170	2,399
10	2,755	2,232	2,709	1,004	5,464	3,236
11	3,448	7,182	3,853	7,075	7,301	14,257
12	177	133	173	139	350	271
13	2,827	4,342	3,085	5,269	5,912	9,611
13A	526	4,173	731	3,389	1,257	7,561
14ABC	1,311	1,598	1,660	1,646	2,971	3,243
15E	218	276	228	297	446	574
15W	271	279	304	296	575	575
15X	96	17	75	13	171	30
16E	1,256	1,775	1,482	1,328	2,738	3,104
16W	539	335	561	313	1,100	648
18E	1,188	164	2,384	221	3,572	385
18W	4,457	2,322	4,115	1,172	8,572	3,494
TOTAL	25,466	35,746	28,207	32,816	53,673	68,562

Figure 32 – Observed and Estimated O-D Trip From/To Interchange 3 and South



9.10.7 Other External Gateways

The New Jersey Turnpike external model was also applied to other major externals within the NJRTM-E's geographical coverage, such as I-78 and I-80 on the western edge of the model. The analyst needs to provide the external trips for these externals, including the southern external of the New Jersey Turnpike, for each model year. The estimated external trips can be developed from base year traffic counts in the vicinity of these external zones, and assumed growth factors to project the corresponding future year traffic at these locations. The traffic has to be input manually by the analyst to external.DBF file in the network related input folder, for example, "modeldata\15VAN" folder.

Currently, there is no-observed data available for I-78 and I-80 externals. Therefore, the model was not calibrated for these two locations.

10. MODE CHOICE

10.1 INTRODUCTION

The mode choice model process for the NJRTM-E was created specifically to address several objectives identified by the client team. The objectives can be generally described as the desire to retain the existing NJT mode choice model process, both in terms of its structure and the software routines used to perform the mode choice model. For the existing model structure, the NJT mode choice model provides a robust and well-specified nested logit model that has been designed specifically to address the complex and competitive transit choice environment that exists in Northern New Jersey. With respect to the software, the existing process uses a C-Based program to perform mode choice and the transit skims are generated with the PT Routine. In the older version of the model, the transit skims were generated by TRNBUILD routine. Recently, the TRNBUILD routines were converted into PT routines, as part of the NJRTM-E Refinement Project.

It should be noted that the NJT Mode Choice Model transit networks provide extensive detail regarding the lines and services within New Jersey and a segment of the high capacity transit services offered by MTA in Manhattan. During the development effort for the mode choice process, it was recognized that it would be desirable to retain this model structure for the entire expanded region. However, there were some concerns related to the ability of the older versions of TRNBUILD to handle a more extensive transit network that would result from coding all of the transit services in detail for the region east of the Hudson River. At this point the client team was unwilling to investigate converting the transit path-building process to the new Voyager Public Transport (PT) routine, given concerns that it might require an in-depth recalibration of the existing mode choice model. Furthermore it was acknowledged that maintaining the coding for the additional transit services east of the Hudson River would also place addition burdens on the client staff tasked with this requirement.

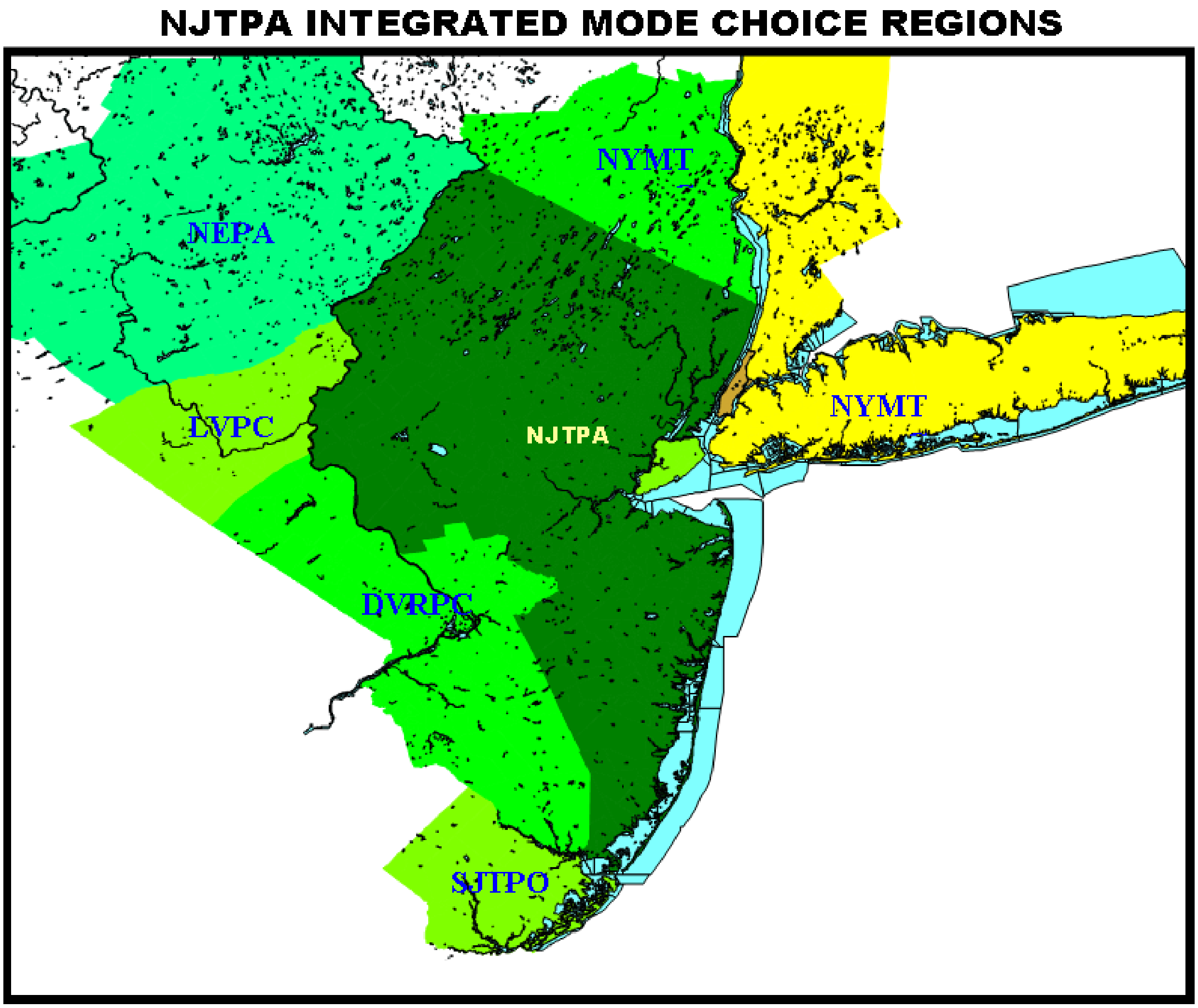
As a result of these concerns, a decision was made to partition the region into two "choice-based" sub-regions. This decision introduced a level of complexity into the model process, but enabled the final model to utilize the existing NJT mode choice model without significant modification. Figure 33 provides a representation of these two choice regions. The "NJT-Controlled" region is depicted in various shades of green and is primarily west of the Hudson River. All trips "produced" in this region utilize the NJT mode choice model process. Trips originating in the yellow-shaded areas east of the Hudson River are controlled by another process that utilizes mode shares obtained from the NYMTC Best-Practices Model (BPM). The remaining area in orange is Manhattan and trips originating from Manhattan with destinations west of the Hudson River use the NJT mode choice model to estimate mode shares, while trips from Manhattan to areas east of the Hudson rely on shares derived from the NYMTC BPM.

10.2 NJTPA REGION

10.2.1 Methodology Overview

The mode choice model for the NJRTM-E is adopted from the NJ TRANSIT North Jersey Travel Demand Forecasting Model (NJTDFM) referred to in this report as the NJT Model. The mode choice is a typical step within a traditional 4-step travel forecasting model. In this step, trips in each zone-to-zone cell of the person trip table are divided among the different available travel modes. The selection of travel mode is a function of the characteristics of each mode that is available for that particular origin-destination zonal pair and the characteristics of the traveler, the production zone, and the attraction zone.

Figure 33 – NJRTM-E Choice-Based Regions



The mathematical function used in the NJT Model to perform this split is known as a nested logit model. The logit model is structured so that, for each zone interchange, the percentage (or share) of trips choosing a given mode "a" from a choice of "m" modes is equal to the exponentiated utility associated with mode "a" divided by the sum of the exponentiated utility for all "m" modes. The equation is:

$$P_a = \frac{e^{U_a}}{\sum_{i=1}^{m} e^{U_i}}$$

where,

P_a is the probability of a traveler choosing mode a;
U_a is the utility (or attractiveness) of mode a; and
ΣU_i is the sum of the utilities for all m modes.

The utility equation, Ua, is mode-specific and can be represented in the following general form:

$$U_a = c_1 \times Distance_a + c_2 \times Fare_a + c_3 \times InVehicleTime_a + \ldots + C_a$$

where,

U_a is the utility (or attractiveness) of mode a;

$Distance_a$
$Fare_a$
In-Vehicle $Time_a$
$\ldots_a$ are level of service variables of mode a for this trip

c1,c2,.. are coefficients estimated for each of the terms based on survey results

c_a is the constant for mode a – obtained through calibration

The models are structured as a series of choices, or "nests", such as "transit vs. auto" or "walk access vs. drive access to transit". The nested logit structure implies that the share of trips choosing a particular mode b is dependent upon the logarithm of the sum ("logsum") of the exponentiated modal utilities of those sub-modes nesting below mode b. This is computed as:

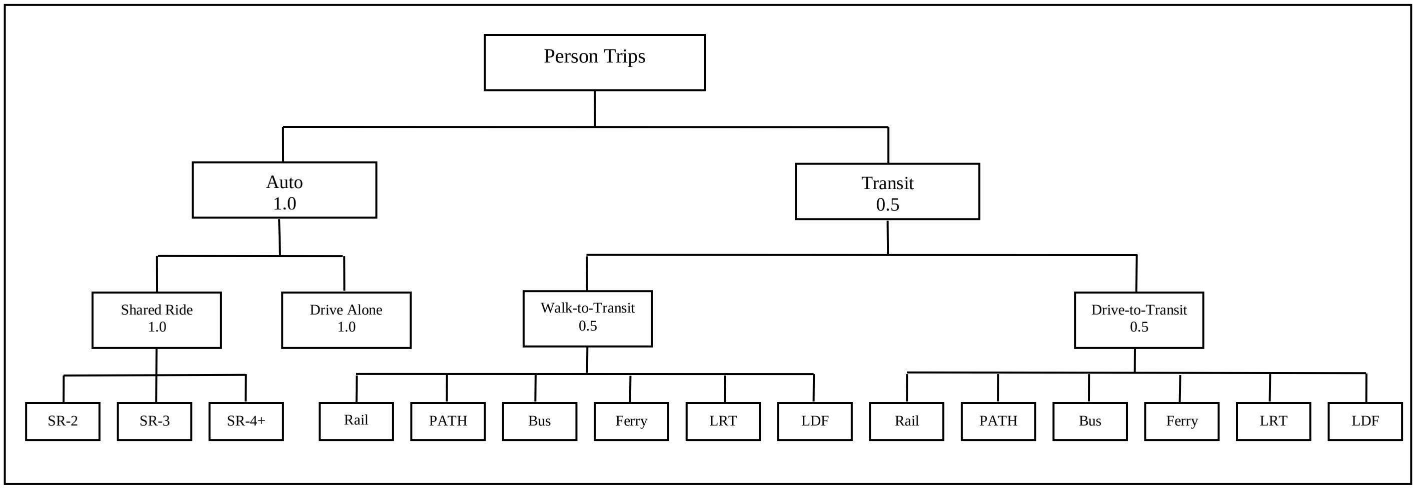
$$U_b = c_{nest} \times \ln\left(\sum_{i=1}^{n} e^{U_i}\right) + C_b$$

where:

U_b it the utility for nest b
C_{nest} is a coefficient called the nesting coefficient, or theta; and
C_b is a nest level constant for nest b– obtained through calibration.

The nesting structure for the model is presented as Figure 34 below. The nesting coefficients (thetas) were estimated from research completed by Resource Systems Group (RSG) and were set at 0.5 for the transit, walk-access, and drive-access nests.

Figure 34 – Nesting Structure for Mode Choice Model

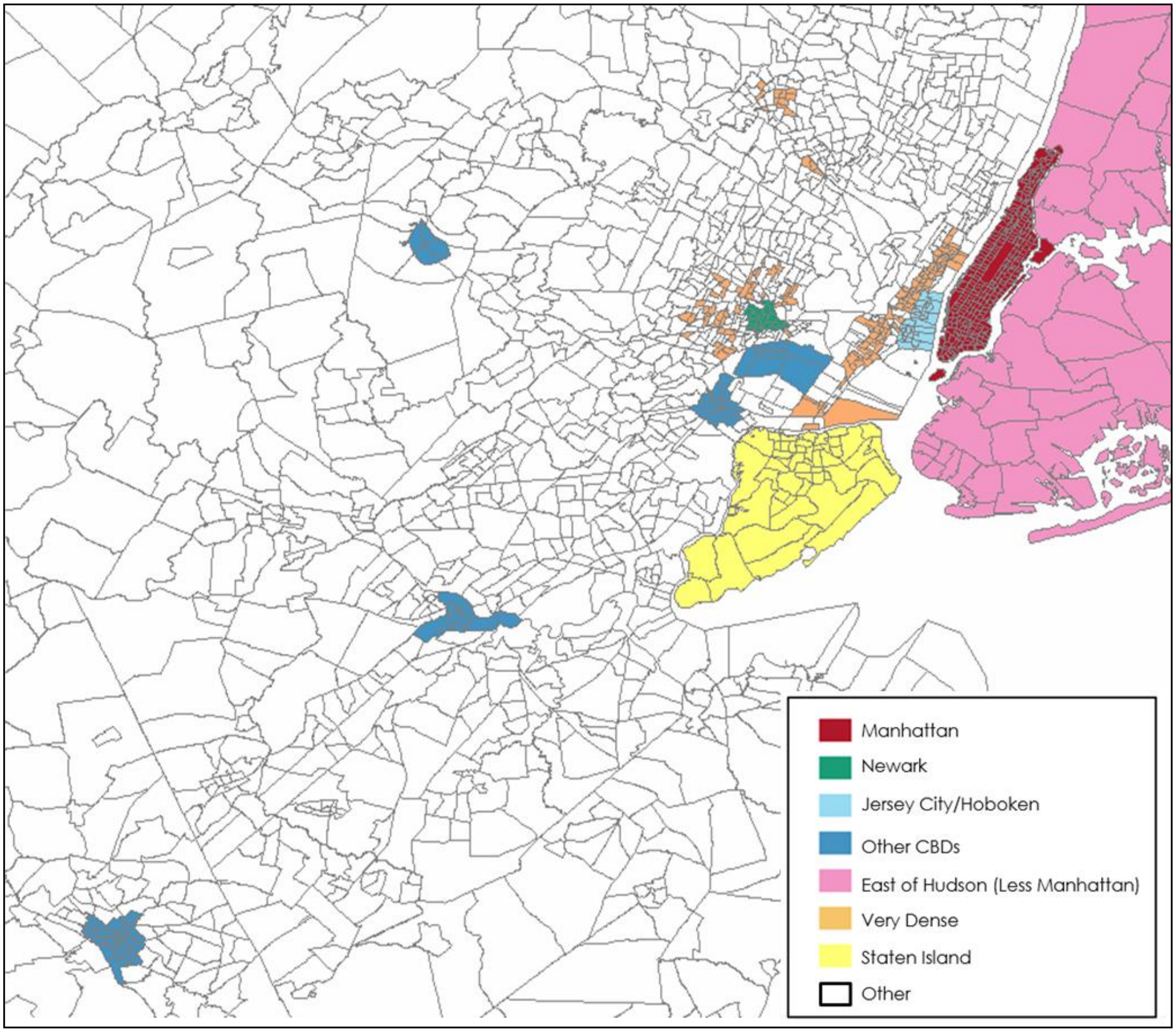


To allow the model to closely replicate observed ridership patterns, the region is subdivided into 11 different market segments. Each market segment has its own set of mode-specific constants. The market segments are described in Table 81 below and are pictured in Figure 35.

Table 81 – Market Segment Definitions

Market Segment	New Definition
1	West of Hudson (Less Staten Island) to Manhattan
2	(Less Staten Island) to Newark
3	(Less Staten Island) to Jersey City/Hoboken
4	(Less Staten Island) to Other CBD's
5	West of Hudson (Less Staten Island) to Other East of Hudson (Other than Manhattan)
6	Non-dense P's to Non-dense A's
7	Manhattan to West of Hudson
8	From Staten Island/From West of Hudson to Staten Island
9	Dense P's to Non-dense A's
10	Non-dense P's to Dense A's
11	Dense P's to Dense A's

Figure 35 – Market Segment Definition



These market segments are designed to represent:

- Key destination areas in the region that are unique and exhibit higher levels of transit ridership. These include:
    1. Manhattan,
    2. Newark Super CBD,
    3. Jersey City/Hoboken Core,
    4. Other CBDs (Morristown, New Brunswick, Elizabeth, and Trenton). These were defined by NJ TRANSIT based on employment and a presence of all-day, two-way rail service.

- Travel to or from Staten Island exhibits different behavior from travel elsewhere in the region

- Reverse commute travel from Manhattan to suburban locations attracts a higher transit share than travel from suburban origins to suburban destinations.
- Travel produced in or attracted to densely populated areas (25,000 or more persons per square mile) are more likely to use transit than persons in less densely populated areas.

10.2.2 Home-Based Work (HBW) Mode Choice Model

Coefficients for the HBW mode choice model were originally estimated for the previous version of NJTDFM (for base year 1990) using ALOGIT and the HBW trans-Hudson survey trip data. This earlier version of the NJTDFM used the results of the model estimation directly. The earlier NJTDFM was calibrated using different modal weights for path-building and the mode choice models. Experience has shown that inconsistent weights between the path-builder and mode choice models will typically cause spurious Transportation System User Benefits estimates.

As part of the 2018 Revalidation Process, the mode choice coefficients were adjusted to be consistent with the most recent NJTDFM Model. Table 82 shows the adjusted HBW mode choice coefficients.

Table 82 – Final HBW Mode Choice Model Coefficients

Parameter	Coefficient
AUTO IVTT (minutes)	-0.04000
WALK (minutes)	-0.06444
WAIT (minutes)	-0.06444
XFERS 1)5.3min 2)6.9 3)7.6 4)8.2 5+)8.6	-0.04310
DRIVE ACCESS TIME - PK (minutes)	-0.06444
DRIVE ACCESS TIME - OP (minutes)	-0.05640
TERMINAL TIME (minutes)	-0.10490
PENALTY TIME (minutes)	-0.40000

In addition, the original mode choice estimation included transportation costs (fares, tolls, parking and automobile operation costs) in Year 1990 cents. In order to maintain consistency with the original model estimation, it was necessary to represent future transportation costs within the updated NJTDFM mode choice models. Current year 2015 costs are coded (in cents) into the highway and transit networks. Within the mode choice model, the coded fares are deflated from Year 2015 (coded) to Year 1990 cents. This is done by using the annual New York-Northern New Jersey-Long Island Consumer Price Index (CPI) data from the U.S. Department of Labor for 2015 (260.558) and 1990 (138.5). Thus, the coded Year 2015 transportation costs are multiplied by 0.5316 to deflate to Year 1990 costs. The final Home-Based Work income constants are summarized below in Table 83.

Table 83 – HBW Income Constants

Income Group	Auto	Transit - Rail/Long Ferry Constant	Transit - Non Rail/Long Ferry Constant
1	0	-1.1240	0.0000
2	0	0.0000	-0.8076
3	0	-0.4734	-1.2400
4	0	-0.5383	-1.5430
5	0	-0.5534	-2.0670

10.2.3 Non-Work (HBS,HBO,NHB) Mode Choice Models

The non-work mode choice models are similar in structure to the HBW model. The non-work mode choice models have the same nesting structure and market segments. Table 84 summarizes the updated non-work mode choice coefficients and

Table 85 summarizes the non-work income group constants.

Table 84 – Estimated Non-Work Mode Choice Coefficients

Parameter	Coefficient
AUTO IVTT (minutes)	-0.04000
WALK (minutes)	-0.05230
WAIT (minutes)	-0.05230
XFERS 1)5.3min 2)6.9 3)7.6 4)8.2 5+)8.6	-0.03490
DRIVE ACCESS TIME (minutes)	-0.04580
TERMINAL TIME (minutes)	-0.01970
PENALTY TIME (minutes)	-0.40000

Table 85 – Non-Work Purpose Income Constants

Income Group	Auto	Transit - Rail/Long Ferry Constant	Transit - Non Rail/Long Ferry Constant
1	0	0.0000	0.0000
2	0	-0.4617	-0.8225
3	0	-1.5250	-1.2090
4	0	-1.4090	-1.7070
5	0	-1.4940	-1.8650

10.2.4 Aggregate Model Calibration Process

Mode-specific constants were defined so that the aggregate mode shares for each market segment matched observed shares. This was done by iteratively running the mode choice model, comparing observed and modeled results, and adjusting constants accordingly. The set of constants for each market segment and purpose are shown at level of application and the top nest level are listed in APPENDIX J – CONSTANTS-EXPRESSED AT NEST LEVEL OF APPLICATION and APPENDIX K – MODEL CONSTANTS-EXPRESSED AT TOP NEST LEVEL, respectively. The results of the calibration are discussed in Section 10.4.

10.3 NON-NJTPA REGION

10.3.1 Methodology Overview

For regions outside of NJTPA as described in the introduction above, the mode choice was estimated using share information from the NYMTC "Best Practice" Model. As a secondary control, the model assumptions regarding mode share (and overall traffic into the region) were governed by flows across the NJTPA cordon lines, many of which are "portals" across the Hudson and Delaware Rivers. These "assumed mode shares" are held constant in the basic model structure, but could be altered or refined periodically, based on new assumptions and/or refined NYMTC trip tables that would be available in the future. For particular studies, alternative assumptions could be adopted, if required. The mode shares are then applied to the estimated person trips from distribution for those regions not controlled by the NJRTM-E mode choice model.

10.3.2 NYMTC Base Year Trip Table Processing

Several processing steps were required to obtain the necessary share information for the NYMTC region. Initially, the trips from NYMTC BPM model trip tables (year 2000) were compressed into county-county matrices. Next, NYMTC staff provided output trip files by mode and traditional "4-step" trip purpose designations. Since this data was not available in a production-attraction format, it was necessary to establish mode shares using the origin-destination trips by mode. It was assumed that this was adequate for predicting mode choice in the NYMTC region.

The mode choice regions are shown in Figure 33, as discussed previously in Section 10.1. For all trips with origins west of the Hudson River (whether New Jersey, New York (Orange/ Rockland/ Sullivan), or Pennsylvania), trips by mode were calculated from the NJT mode choice model that was embedded in the NJRTM-E as the primary mode choice routine. Also, all movements from Manhattan westward into New Jersey, Pennsylvania or the three New York counties listed above were estimated by the NJT mode choice process.
For all other trips originating in Manhattan with destinations to locations east of the Hudson River, mode share and the resulting vehicle trips are calculated using percentage shares from the

NYMTC model. These mode shares are applied to the person trips generated by the NJRTM-E for the regions east of the Hudson River. The general processing of this data is as follows:

- Use the total person trips generated by the integrated model trip distribution. Zero out all regions to be estimated via the NJT Mode Choice Model, as described above. This process is part of the standard distribution procedure and has internal auditing to ensure its proper application.

- Calculate the transit percentage shares from the NYMTC mode shares and factor the base trip table from the above step to remove transit-related person trips. This process provides controls and limited summaries to ensure proper application.

- Convert remaining person trips into vehicle trips using the percentage shares for the auto-based trip purposes. Note that the process summarizes both the person trips and vehicle trips by mode. The final model uses a 3+ auto occupancy mode for autos while the NJT model provides an additional 4+ auto occupancy mode. Since few vehicle trips exist in the 4+ category and most of these trips would not enter the NJTPA region a decision was made not to further stratify the 3+ autos into two separate modes.

It should be noted that the mode shares created from the NYMTC BPM were obtained as vehicle trips for the auto modes and therefore were converted back to person trips to establish “person-trip” based shares. As part of the process, certain thresholds were established since the version of the BPM mode available at the time of this model development had some illogical share conditions for particular county-county movements. The support application developed for the NJRTM-E overrides any illogical mode shares and these thresholds can be adjusted if deemed necessary at some point in the future.

10.4 RESULTS OF NJT MODE CHOICE MODEL

As discussed previously, the NJT mode choice model performs the choice process separately for market segments defined by geographic locations and density. The 11 segments of regional movements were pre-defined by the NJT model and are listed in Table 81.

According to the definition, the area to the west of Hudson River was partitioned into six main parts: Newark, Jersey City/Hoboken, Other CBD's, Staten Island, Dense and Non-Dense area. And the area to the east of Hudson River was partitioned into two parts: Manhattan and other east of Hudson River.

The results from the NJRTM-E model were summarized by purpose as shown in Table 86. A more disaggregated summary by market segment and travel mode was also prepared and compared against AECOM mode choice model targets, the NJT model and the household survey. Auto occupancies were also calculated and checked. In the following tables, market segments 1,5 and 7 formed the trans-Hudson region, and market segments 4,6,9,10 and11 formed the intra-west of Hudson region with the exception of trips to Newark and Jersey City/Hoboken CBDs. Each of these eleven market segments is summarized within the multi-page Table 87. The first set of tables compares the mode choice results for all 11 regions.

Table 86 – Comparison of Mode Choice Results by Trip Purpose

MODE	HBWD (Person Trips)	
	2010 RHTS Pct	Estimated Pct
SOV	76.1%	75.2%
HOV2	5.7%	5.8%
HOV3	0.8%	0.8%
HOV4	0.5%	0.6%
Walk-Transit	10.3%	11.0%
Drive-Transit	6.5%	6.7%
TOTAL	100.0%	100.0%
Average Car Occupancy	1.05	1.05

MODE	HBWS (Person Trips)	
	2010 RHTS Pct	Estimated Pct
SOV	86.2%	85.1%
HOV2	8.3%	8.9%
HOV3	2.1%	2.2%
HOV4	0.6%	0.5%
Walk-Transit	2.4%	2.6%
Drive-Transit	0.4%	0.7%
TOTAL	100.0%	100.0%
Average Car Occupancy	1.07	1.07

MODE	HBS (Person Trips)	
	2010 RHTS Pct	Estimated Pct
SOV	59.2%	57.9%
HOV2	25.8%	24.4%
HOV3	7.0%	8.5%
HOV4	3.6%	4.2%
Walk-Transit	4.2%	4.8%
Drive-Transit	0.2%	0.1%
TOTAL	100.0%	100.0%
Average Car Occupancy	1.27	1.29

MODE	HBO (Person Trips)	
	2010 RHTS Pct	Estimated Pct
SOV	40.6%	39.9%
HOV2	32.1%	31.7%
HOV3	14.8%	14.8%
HOV4	8.9%	9.1%
Walk-Transit	3.0%	3.8%
Drive-Transit	0.6%	0.8%
TOTAL	100.0%	100.0%
Average Car Occupancy	1.51	1.52

MODE	NHBW (Person Trips)	
	2010 RHTS Pct	Estimated Pct
SOV	81.9%	83.3%
HOV2	11.8%	10.6%
HOV3	2.0%	1.9%
HOV4	1.5%	1.4%
Walk-Transit	2.0%	2.2%
Drive-Transit	0.7%	0.6%
TOTAL	100.0%	100.0%
Average Car Occupancy	1.09	1.09

MODE	NHBO (Person Trips)	
	2010 RHTS Pct	Estimated Pct
SOV	45.7%	44.1%
HOV2	32.4%	31.6%
HOV3	12.9%	13.8%
HOV4	7.2%	8.0%
Walk-Transit	1.6%	2.3%
Drive-Transit	0.2%	0.2%
TOTAL	100.0%	100.0%
Average Car Occupancy	1.45	1.47

Table 87 – Comparison of Mode Choice Results by Market Segment

Market Segment 1

MODE	HBWD			HBWS			HBS			HBO			NHBW			NHNW		
	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL
SOV	10.5%	10.5%	11.1%	61.6%	61.6%	63.9%	18.4%	18.4%	19.7%	16.5%	16.5%	18.5%	52.1%	52.1%	54.7%	28.0%	28.0%	30.4%
HOV2	1.5%	1.5%	1.6%	5.7%	5.7%	5.8%	6.8%	6.8%	7.3%	12.7%	12.7%	14.2%	7.7%	7.7%	8.1%	3.1%	3.1%	3.4%
HOV3	0.4%	0.4%	0.4%	1.6%	1.6%	1.6%	--	0.0%	0.0%	1.8%	1.8%	2.0%	--	0.0%	0.0%	14.1%	14.1%	15.4%
HOV4	0.2%	0.2%	0.2%	0.4%	0.4%	0.4%	0.3%	0.3%	0.3%	0.6%	0.6%	0.7%	--	0.0%	0.0%	--	0.0%	0.0%
AUTO	**12.6%**	**12.6%**	**13.4%**	**69.3%**	**69.3%**	**71.7%**	**25.5%**	**25.5%**	**27.3%**	**31.6%**	**31.6%**	**35.4%**	**59.9%**	**59.9%**	**62.9%**	**45.2%**	**45.2%**	**49.2%**
CRW	9.1%	6.6%	6.8%	4.5%	2.8%	2.8%	26.9%	4.1%	5.3%	2.9%	4.1%	4.4%	3.3%	1.8%	2.2%	1.3%	3.9%	3.9%
CRR	26.8%	20.9%	18.2%	10.0%	2.8%	2.5%	1.6%	1.5%	0.7%	9.2%	16.6%	16.8%	--	7.3%	7.5%	4.7%	13.0%	13.5%
SUBW	10.6%	22.1%	17.9%	4.0%	11.8%	9.0%	31.7%	37.6%	35.7%	15.3%	17.0%	13.0%	19.3%	17.5%	13.9%	20.4%	15.8%	13.3%
SUBR	4.7%	7.4%	3.3%	0.4%	4.6%	2.0%	6.6%	1.7%	0.3%	2.3%	2.4%	1.0%	15.1%	4.6%	2.9%	8.5%	5.4%	3.0%
BUSW	18.9%	7.4%	9.5%	8.8%	1.5%	2.2%	7.4%	17.0%	17.0%	18.0%	11.8%	11.9%	0.2%	0.9%	1.1%	4.8%	3.1%	2.4%
BUSR	14.5%	6.6%	8.9%	3.1%	1.6%	1.8%	0.4%	0.5%	0.1%	18.4%	10.3%	10.1%	1.3%	0.1%	0.2%	15.0%	1.2%	0.5%
FRYW	1.5%	2.6%	4.1%	--	1.0%	1.8%	--	6.8%	9.4%	1.1%	4.0%	4.5%	0.9%	2.9%	3.6%	--	3.8%	4.5%
FRYR	1.3%	11.3%	15.6%	--	4.0%	5.6%	--	4.8%	3.4%	1.2%	1.9%	2.3%	--	4.2%	5.1%	--	8.4%	9.6%
LRTW	--	1.3%	1.3%	--	0.1%	0.2%	--	0.6%	0.7%	--	0.4%	0.5%	--	0.6%	0.5%	--	0.1%	0.1%
LRTR	--	1.1%	1.2%	--	0.4%	0.4%	--	0.1%	0.0%	--	0.0%	0.2%	--	0.3%	0.2%	--	0.2%	0.1%
TRANSIT	**87.4%**	**87.4%**	**86.6%**	**30.7%**	**30.7%**	**28.3%**	**74.5%**	**74.5%**	**72.7%**	**68.4%**	**68.4%**	**64.6%**	**40.1%**	**40.1%**	**37.1%**	**54.8%**	**54.8%**	**50.8%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Market Segment 2

MODE	HBWD			HBWS			HBS			HBO			NHBW			NHNW		
	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL
SOV	54.2%	54.2%	58.0%	81.3%	81.3%	81.4%	--	0.0%	7.7%	29.4%	29.4%	30.4%	85.8%	85.8%	85.9%	24.0%	24.0%	24.4%
HOV2	16.2%	16.2%	17.3%	16.7%	16.7%	16.6%	--	0.0%	8.1%	25.5%	25.5%	26.3%	11.1%	11.1%	11.1%	28.8%	28.8%	29.4%
HOV3	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	8.3%	3.2%	3.2%	3.3%	--	0.0%	0.0%	15.5%	15.5%	15.8%
HOV4	0.4%	0.4%	0.4%	--	0.0%	0.0%	--	0.0%	8.3%	1.9%	1.9%	2.0%	1.3%	1.3%	1.3%	4.6%	4.6%	4.7%
AUTO	**70.8%**	**70.8%**	**75.7%**	**97.9%**	**97.9%**	**98.1%**	**0.0%**	**0.0%**	**32.4%**	**60.0%**	**60.0%**	**62.0%**	**98.2%**	**98.2%**	**98.3%**	**73.0%**	**73.0%**	**74.3%**
CRW	2.6%	4.2%	3.1%	--	0.3%	0.2%	--	1.4%	0.6%	1.0%	2.0%	1.1%	--	0.2%	0.1%	0.7%	2.9%	1.8%
CRR	10.9%	10.4%	6.4%	--	0.0%	0.0%	--	0.0%	0.4%	0.1%	0.1%	0.1%	--	0.0%	0.0%	--	0.0%	0.0%
SUBW	8.4%	1.2%	0.6%	0.2%	0.1%	0.0%	--	1.2%	0.3%	0.3%	0.9%	0.4%	1.8%	0.0%	0.0%	--	0.1%	0.0%
SUBR	--	0.3%	0.1%	--	0.0%	0.0%	--	0.0%	1.1%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
BUSW	7.3%	12.8%	13.8%	1.9%	1.7%	1.6%	100.0%	97.4%	64.5%	37.8%	36.9%	36.2%	--	1.6%	1.5%	26.3%	24.0%	23.7%
BUSR	--	0.2%	0.3%	--	0.0%	0.0%	--	0.0%	0.7%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
FRYW	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
FRYR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
LRTW	--	0.2%	0.1%	--	0.0%	0.0%	--	0.0%	0.0%	0.8%	0.1%	0.1%	--	0.0%	0.0%	--	0.0%	0.0%
LRTR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
TRANSIT	**29.2%**	**29.2%**	**24.3%**	**2.1%**	**2.1%**	**1.9%**	**100.0%**	**100.0%**	**67.6%**	**40.0%**	**40.0%**	**38.0%**	**1.8%**	**1.8%**	**1.7%**	**27.0%**	**27.0%**	**25.7%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Market Segment 3

MODE	HBWD			HBWS			HBS			HBO			NHBW			NHNW		
	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL
SOV	31.9%	31.9%	34.9%	78.5%	78.5%	79.9%	54.2%	54.2%	55.5%	27.4%	27.4%	28.5%	75.1%	75.1%	77.9%	30.7%	30.7%	31.8%
HOV2	3.0%	3.0%	3.3%	6.4%	6.4%	6.4%	15.2%	15.2%	15.5%	24.0%	24.0%	25.0%	5.0%	5.0%	5.2%	30.1%	30.1%	31.2%
HOV3	--	0.0%	0.0%	--	0.0%	0.0%	8.1%	8.1%	8.3%	11.5%	11.5%	12.0%	--	0.0%	0.0%	9.6%	9.6%	9.9%
HOV4	--	0.0%	0.0%	3.9%	3.9%	3.9%	--	0.0%	0.0%	13.5%	13.5%	14.0%	1.6%	1.6%	1.6%	14.5%	14.5%	15.0%
AUTO	**34.8%**	**34.8%**	**38.2%**	**88.7%**	**88.7%**	**90.2%**	**77.5%**	**77.5%**	**79.3%**	**76.3%**	**76.3%**	**79.5%**	**81.6%**	**81.6%**	**84.7%**	**84.9%**	**84.9%**	**87.9%**
CRW	13.1%	2.3%	2.2%	--	0.9%	0.7%	1.1%	0.2%	0.3%	1.2%	0.7%	0.7%	11.3%	1.2%	1.3%	1.1%	0.5%	0.4%
CRR	15.9%	12.6%	10.7%	--	0.0%	0.1%	--	0.0%	0.0%	--	0.6%	1.0%	--	0.5%	0.6%	--	0.0%	0.0%
SUBW	15.0%	12.3%	7.0%	7.6%	2.2%	0.9%	6.9%	7.0%	4.1%	4.0%	8.1%	3.1%	3.1%	4.9%	2.9%	3.0%	4.1%	2.3%
SUBR	4.6%	1.4%	1.2%	--	0.0%	0.0%	--	0.0%	0.0%	0.9%	0.3%	0.3%	0.9%	0.2%	0.1%	--	0.0%	0.0%
BUSW	5.3%	11.3%	17.7%	1.5%	3.6%	5.6%	7.3%	9.5%	13.9%	10.0%	7.0%	7.7%	1.2%	3.7%	5.3%	7.4%	4.2%	5.7%
BUSR	0.3%	1.3%	2.0%	--	0.0%	0.0%	--	0.0%	0.0%	0.3%	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
FRYW	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
FRYR	--	0.2%	0.2%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
LRTW	8.6%	16.2%	13.6%	2.2%	4.6%	2.5%	7.1%	5.7%	2.4%	7.3%	6.6%	7.4%	1.9%	7.6%	4.8%	3.6%	6.4%	3.7%
LRTR	2.2%	7.6%	7.2%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.3%	0.3%	--	0.2%	0.2%	--	0.0%	0.0%
TRANSIT	**65.2%**	**65.2%**	**61.8%**	**11.3%**	**11.3%**	**9.8%**	**22.5%**	**22.5%**	**20.7%**	**23.7%**	**23.7%**	**20.5%**	**18.4%**	**18.4%**	**15.3%**	**15.1%**	**15.1%**	**12.1%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Market Segment 4

MODE	HBWD			HBWS			HBS			HBO			NHBW			NHNW		
	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL
SOV	86.9%	86.9%	87.1%	72.1%	72.1%	72.6%	67.0%	67.0%	66.9%	37.8%	37.8%	38.2%	78.2%	78.2%	78.5%	32.7%	32.7%	32.9%
HOV2	3.0%	3.0%	3.0%	8.7%	8.7%	8.8%	10.3%	10.3%	10.7%	31.6%	31.6%	32.0%	16.1%	16.1%	16.1%	40.9%	40.9%	40.7%
HOV3	0.7%	0.7%	0.7%	14.3%	14.3%	14.2%	8.0%	8.0%	8.1%	15.9%	15.9%	16.1%	0.9%	0.9%	0.9%	10.0%	10.0%	10.1%
HOV4	0.1%	0.1%	0.1%	--	0.0%	0.0%	6.6%	6.6%	6.5%	4.1%	4.1%	4.2%	2.3%	2.3%	2.2%	12.7%	12.7%	12.6%
AUTO	**90.7%**	**90.7%**	**91.0%**	**95.1%**	**95.1%**	**95.6%**	**91.9%**	**91.9%**	**92.2%**	**89.4%**	**89.4%**	**90.4%**	**97.5%**	**97.5%**	**97.8%**	**96.3%**	**96.3%**	**96.3%**
CRW	2.8%	1.7%	1.3%	--	1.0%	0.7%	--	0.3%	0.2%	4.7%	1.1%	0.7%	0.8%	0.0%	0.0%	--	0.2%	0.1%
CRR	1.5%	0.2%	0.2%	--	0.0%	0.1%	--	0.9%	0.5%	1.6%	1.4%	1.0%	--	0.0%	0.0%	--	0.0%	0.0%
SUBW	0.5%	0.1%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	0.4%	0.1%	0.0%	1.2%	0.0%	0.0%	--	0.0%	0.0%
SUBR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
BUSW	4.2%	5.7%	6.0%	4.9%	3.8%	3.5%	5.5%	5.2%	5.4%	3.6%	7.5%	7.3%	0.6%	2.5%	2.2%	3.7%	3.5%	3.6%
BUSR	0.4%	0.2%	0.2%	--	0.0%	0.0%	2.6%	1.5%	1.4%	0.3%	0.4%	0.4%	--	0.0%	0.0%	--	0.0%	0.0%
FRYW	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
FRYR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
LRTW	--	0.1%	0.1%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
LRTR	--	1.4%	1.3%	--	0.0%	0.1%	--	0.3%	0.3%	--	0.1%	0.1%	--	0.0%	0.0%	--	0.0%	0.0%
TRANSIT	**9.3%**	**9.3%**	**9.0%**	**4.9%**	**4.9%**	**4.4%**	**8.1%**	**8.1%**	**7.8%**	**10.6%**	**10.6%**	**9.6%**	**2.5%**	**2.5%**	**2.2%**	**3.7%**	**3.7%**	**3.7%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Market Segment 5

MODE	HBWD			HBWS			HBS			HBO			NHBW			NHNW		
	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL
SOV	69.5%	69.5%	74.6%	82.9%	82.9%	84.7%	42.3%	42.3%	43.7%	22.5%	22.5%	24.1%	76.9%	76.9%	74.2%	53.2%	53.2%	48.9%
HOV2	4.2%	4.2%	4.1%	4.7%	4.7%	4.8%	18.9%	18.9%	19.5%	20.7%	20.7%	22.1%	13.7%	13.7%	13.4%	27.1%	27.1%	25.0%
HOV3	0.8%	0.8%	0.8%	2.0%	2.0%	2.1%	--	0.0%	0.0%	23.8%	23.8%	25.4%	--	0.0%	0.0%	3.9%	3.9%	3.6%
HOV4	0.9%	0.9%	0.9%	2.8%	2.8%	3.0%	--	0.0%	0.0%	23.5%	23.5%	25.2%	--	0.0%	0.0%	11.8%	11.8%	10.9%
AUTO	**75.5%**	**75.5%**	**80.4%**	**92.4%**	**92.4%**	**94.6%**	**61.2%**	**61.2%**	**63.2%**	**90.4%**	**90.4%**	**96.8%**	**90.6%**	**90.6%**	**87.7%**	**96.0%**	**96.0%**	**88.4%**
CRW	3.8%	1.6%	0.8%	--	1.2%	0.8%	26.1%	5.5%	6.2%	0.2%	0.6%	0.2%	--	0.3%	0.5%	--	0.2%	0.2%
CRR	4.8%	3.4%	1.2%	--	0.1%	0.1%	--	0.0%	0.5%	4.8%	4.0%	1.4%	--	0.0%	0.1%	--	0.0%	0.0%
SUBW	1.4%	6.4%	5.7%	0.6%	4.3%	2.6%	0.5%	6.7%	5.2%	2.2%	2.7%	0.9%	--	7.0%	9.2%	4.0%	3.3%	10.9%
SUBR	1.8%	5.0%	2.3%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.6%	0.1%	--	0.0%	0.0%	--	0.0%	0.0%
BUSW	5.5%	2.5%	2.3%	6.9%	2.0%	1.8%	12.1%	24.5%	19.5%	2.3%	1.1%	0.3%	9.4%	1.8%	2.1%	--	0.5%	0.2%
BUSR	7.3%	1.2%	0.9%	0.1%	0.0%	0.0%	--	0.0%	1.7%	0.1%	0.3%	0.1%	--	0.0%	0.1%	--	0.0%	0.0%
FRYW	--	0.1%	0.1%	--	0.0%	0.1%	--	0.5%	0.4%	--	0.1%	0.1%	--	0.2%	0.2%	--	0.1%	0.2%
FRYR	--	3.8%	5.9%	--	0.0%	0.0%	--	0.0%	2.1%	--	0.1%	0.0%	--	0.0%	0.1%	--	0.0%	0.0%
LRTW	--	0.0%	0.0%	--	0.0%	0.0%	--	1.4%	1.3%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
LRTR	--	0.5%	0.4%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
TRANSIT	**24.5%**	**24.5%**	**19.6%**	**7.6%**	**7.6%**	**5.4%**	**38.8%**	**38.8%**	**36.8%**	**9.6%**	**9.6%**	**3.2%**	**9.4%**	**9.4%**	**12.3%**	**4.0%**	**4.0%**	**11.6%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Market Segment 6

MODE	HBWD			HBWS			HBS			HBO			NHBW			NHNW		
	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL
SOV	89.2%	89.2%	89.7%	88.9%	88.9%	88.9%	59.5%	59.5%	59.7%	41.3%	41.3%	41.3%	85.5%	85.5%	85.6%	45.2%	45.2%	45.2%
HOV2	6.2%	6.2%	6.2%	8.8%	8.8%	8.7%	25.1%	25.1%	25.1%	32.6%	32.6%	32.7%	10.4%	10.4%	10.4%	32.0%	32.0%	32.1%
HOV3	0.8%	0.8%	0.8%	1.5%	1.5%	1.5%	8.7%	8.7%	8.8%	15.2%	15.2%	15.3%	2.0%	2.0%	2.0%	14.1%	14.1%	14.1%
HOV4	0.6%	0.6%	0.6%	0.3%	0.3%	0.3%	4.5%	4.5%	4.5%	9.5%	9.5%	9.5%	1.4%	1.4%	1.4%	7.6%	7.6%	7.7%
AUTO	**96.8%**	**96.8%**	**97.2%**	**99.5%**	**99.5%**	**99.5%**	**97.8%**	**97.8%**	**98.0%**	**98.6%**	**98.6%**	**98.8%**	**99.3%**	**99.3%**	**99.4%**	**98.9%**	**98.9%**	**99.0%**
CRW	0.2%	0.3%	0.2%	0.0%	0.1%	0.1%	0.0%	0.1%	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
CRR	0.3%	0.2%	0.1%	--	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
SUBW	0.0%	0.1%	0.1%	--	0.0%	0.0%	0.2%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SUBR	0.0%	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%	0.0%
BUSW	2.4%	2.2%	2.1%	0.5%	0.4%	0.4%	1.9%	2.1%	1.9%	1.0%	1.1%	1.0%	0.4%	0.5%	0.5%	0.9%	0.9%	0.9%
BUSR	0.1%	0.2%	0.2%	--	0.0%	0.0%	--	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%
FRYW	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%	0.0%	0.1%	0.0%	0.0%
FRYR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
LRTW	0.1%	0.1%	0.1%	--	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
LRTR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
TRANSIT	**3.2%**	**3.2%**	**2.8%**	**0.5%**	**0.5%**	**0.5%**	**2.2%**	**2.2%**	**2.0%**	**1.4%**	**1.4%**	**1.2%**	**0.7%**	**0.7%**	**0.6%**	**1.1%**	**1.1%**	**1.0%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Market Segment 7

MODE	HBWD			HBWS			HBS			HBO			NHBW			NHNW		
	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL
SOV	32.5%	34.8%	38.1%	28.7%	53.3%	55.4%	60.3%	60.3%	62.6%	47.6%	63.1%	63.4%	24.9%	36.5%	39.5%	36.1%	44.6%	41.8%
HOV2	0.1%	0.2%	0.2%	13.2%	24.6%	25.3%	--	0.0%	0.0%	14.4%	19.1%	19.2%	11.5%	16.9%	18.2%	8.4%	10.4%	9.8%
HOV3	--	0.0%	0.0%	--	0.0%	0.0%	31.7%	31.7%	33.0%	2.3%	3.1%	3.1%	--	0.0%	0.0%	5.9%	7.4%	6.9%
HOV4	6.3%	6.7%	7.2%	--	0.0%	0.0%	--	0.0%	0.0%	9.3%	12.3%	12.4%	10.1%	14.8%	16.0%	10.1%	12.5%	11.8%
AUTO	**38.9%**	**41.7%**	**45.5%**	**41.9%**	**77.9%**	**80.8%**	**92.0%**	**92.0%**	**95.6%**	**73.7%**	**97.6%**	**98.1%**	**46.6%**	**68.2%**	**73.7%**	**60.6%**	**74.9%**	**70.3%**
CRW	7.7%	2.7%	2.5%	2.0%	1.4%	1.3%	--	0.0%	0.0%	--	0.0%	0.1%	13.4%	0.8%	0.9%	--	1.3%	1.8%
CRR	6.5%	0.0%	0.0%	46.2%	0.0%	0.0%	--	0.0%	0.0%	22.3%	0.0%	0.0%	7.8%	0.0%	0.0%	0.7%	0.0%	0.0%
SUBW	8.6%	25.7%	24.3%	9.2%	10.0%	7.4%	8.0%	0.2%	0.4%	1.2%	1.3%	1.3%	5.0%	26.2%	20.9%	12.3%	15.4%	20.6%
SUBR	0.3%	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	0.4%	0.0%	0.0%	1.6%	0.0%	0.0%	4.4%	0.0%	0.0%
BUSW	20.6%	26.9%	24.9%	0.8%	10.6%	10.2%	--	7.8%	3.9%	0.6%	0.9%	0.5%	1.9%	3.5%	3.3%	5.7%	7.3%	5.8%
BUSR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	0.7%	0.0%	0.0%	19.6%	0.0%	0.0%	12.7%	0.0%	0.0%
FRYW	17.4%	2.8%	2.7%	--	0.1%	0.2%	--	0.0%	0.1%	--	0.1%	0.1%	1.4%	0.5%	0.4%	2.3%	0.5%	0.7%
FRYR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	1.2%	0.0%	0.0%	2.7%	0.0%	0.0%	1.4%	0.0%	0.0%
LRTW	--	0.2%	0.1%	--	0.1%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.7%	0.7%	--	0.6%	0.7%
LRTR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
TRANSIT	**61.1%**	**58.3%**	**54.5%**	**58.1%**	**22.1%**	**19.2%**	**8.0%**	**8.0%**	**4.4%**	**26.3%**	**2.4%**	**1.9%**	**53.4%**	**31.8%**	**26.3%**	**39.4%**	**25.1%**	**29.7%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Market Segment 8

MODE	HBWD			HBWS			HBS			HBO			NHBW			NHNW		
	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL
SOV	63.1%	63.1%	62.1%	66.9%	66.9%	66.5%	51.1%	51.1%	51.0%	39.4%	39.4%	39.3%	90.7%	90.7%	91.0%	39.7%	39.7%	39.7%
HOV2	4.5%	4.5%	4.5%	27.5%	27.5%	27.6%	25.6%	25.6%	25.6%	31.2%	31.2%	31.2%	4.5%	4.5%	4.5%	29.6%	29.6%	29.5%
HOV3	1.5%	1.5%	1.5%	1.1%	1.1%	1.1%	2.0%	2.0%	2.0%	11.8%	11.8%	11.8%	0.5%	0.5%	0.5%	14.3%	14.3%	14.2%
HOV4	0.4%	0.4%	0.4%	1.2%	1.2%	1.2%	12.2%	12.2%	12.2%	9.8%	9.8%	9.8%	--	0.0%	0.0%	10.3%	10.3%	10.2%
AUTO	**69.5%**	**69.5%**	**68.5%**	**96.7%**	**96.7%**	**96.5%**	**91.0%**	**91.0%**	**90.9%**	**92.2%**	**92.2%**	**92.0%**	**95.7%**	**95.7%**	**96.1%**	**93.8%**	**93.8%**	**93.7%**
CRW	--	0.2%	0.2%	--	0.0%	0.0%	--	0.0%	0.0%	0.0%	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
CRR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	0.1%	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
SUBW	4.7%	0.8%	0.6%	--	0.1%	0.0%	0.5%	0.0%	0.0%	0.4%	0.1%	0.0%	--	0.0%	0.0%	0.2%	0.0%	0.0%
SUBR	0.4%	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
BUSW	12.6%	1.7%	1.8%	1.4%	0.1%	0.1%	5.2%	0.6%	0.6%	3.8%	0.5%	0.5%	2.4%	0.1%	0.1%	4.8%	0.1%	0.1%
BUSR	4.9%	0.0%	0.0%	0.7%	0.0%	0.0%	0.2%	0.0%	0.0%	0.4%	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
FRYW	5.4%	20.0%	20.9%	1.0%	2.3%	2.4%	3.1%	8.2%	8.3%	2.9%	6.5%	6.6%	2.0%	4.2%	3.8%	0.6%	5.6%	5.7%
FRYR	2.4%	6.7%	7.6%	0.1%	0.7%	0.9%	--	0.2%	0.2%	0.3%	0.7%	0.7%	--	0.0%	0.0%	0.6%	0.5%	0.5%
LRTW	--	0.1%	0.1%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
LRTR	0.0%	1.0%	0.5%	--	0.2%	0.1%	--	0.0%	0.0%	--	0.1%	0.1%	--	0.0%	0.0%	--	0.0%	0.0%
TRANSIT	**30.5%**	**30.5%**	**31.5%**	**3.3%**	**3.3%**	**3.5%**	**9.0%**	**9.0%**	**9.1%**	**7.8%**	**7.8%**	**8.0%**	**4.3%**	**4.3%**	**3.9%**	**6.2%**	**6.2%**	**6.3%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Market Segment 9

MODE	HBWD			HBWS			HBS			HBO			NHBW			NHNW		
	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL
SOV	66.4%	66.4%	67.6%	64.7%	64.7%	65.4%	37.9%	37.9%	38.6%	33.4%	33.4%	33.7%	68.4%	68.4%	69.3%	31.1%	31.1%	31.3%
HOV2	9.7%	9.7%	9.8%	16.8%	16.8%	16.8%	26.7%	26.7%	27.3%	33.5%	33.5%	33.8%	12.3%	12.3%	12.5%	16.0%	16.0%	16.1%
HOV3	0.5%	0.5%	0.5%	3.7%	3.7%	3.9%	17.3%	17.3%	17.5%	3.4%	3.4%	3.5%	1.7%	1.7%	1.7%	19.3%	19.3%	19.3%
HOV4	1.4%	1.4%	1.4%	--	0.0%	0.0%	--	0.0%	0.0%	19.9%	19.9%	20.0%	1.2%	1.2%	1.2%	27.9%	27.9%	27.9%
AUTO	**77.9%**	**77.9%**	**79.2%**	**85.2%**	**85.2%**	**86.1%**	**81.9%**	**81.9%**	**83.4%**	**90.1%**	**90.1%**	**91.0%**	**83.5%**	**83.5%**	**84.6%**	**94.3%**	**94.3%**	**94.7%**
CRW	1.9%	0.4%	0.3%	3.0%	0.5%	0.4%	0.6%	0.0%	0.0%	--	0.2%	0.1%	--	0.1%	0.0%	--	0.0%	0.0%
CRR	0.5%	0.9%	0.7%	--	0.0%	0.0%	0.2%	0.1%	0.1%	0.2%	0.1%	0.1%	--	0.0%	0.0%	0.6%	0.0%	0.0%
SUBW	0.7%	1.8%	0.6%	3.2%	1.1%	0.4%	0.4%	0.5%	0.1%	0.3%	0.6%	0.2%	--	0.5%	0.1%	--	0.1%	0.0%
SUBR	--	0.2%	0.1%	--	0.0%	0.0%	--	0.1%	0.0%	--	0.2%	0.1%	--	0.0%	0.0%	--	0.0%	0.0%
BUSW	13.6%	14.8%	15.6%	8.5%	12.7%	12.8%	16.4%	15.7%	15.3%	8.8%	8.3%	8.1%	16.5%	15.5%	15.0%	5.1%	4.9%	4.6%
BUSR	3.6%	2.4%	2.5%	--	0.0%	0.0%	0.1%	0.1%	0.1%	0.4%	0.3%	0.4%	--	0.0%	0.0%	--	0.5%	0.6%
FRYW	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
FRYR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
LRTW	1.8%	0.9%	0.5%	--	0.5%	0.3%	0.4%	1.6%	0.9%	0.2%	0.2%	0.1%	--	0.4%	0.2%	--	0.1%	0.0%
LRTR	--	0.6%	0.6%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
TRANSIT	**22.1%**	**22.1%**	**20.8%**	**14.8%**	**14.8%**	**13.9%**	**18.1%**	**18.1%**	**16.6%**	**9.9%**	**9.9%**	**9.0%**	**16.5%**	**16.5%**	**15.4%**	**5.7%**	**5.7%**	**5.3%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Market Segment 10

MODE	HBWD			HBWS			HBS			HBO			NHBW			NHNW		
	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL
SOV	77.5%	77.5%	79.2%	88.8%	88.8%	88.7%	62.5%	62.5%	63.4%	33.0%	33.0%	33.3%	69.3%	69.3%	69.8%	58.8%	58.8%	58.9%
HOV2	7.7%	7.7%	7.9%	5.7%	5.7%	5.8%	22.5%	22.5%	22.9%	25.2%	25.2%	25.5%	16.9%	16.9%	17.0%	24.0%	24.0%	24.1%
HOV3	--	0.0%	0.0%	5.5%	5.5%	5.6%	--	0.0%	0.0%	33.2%	33.2%	33.5%	--	0.0%	0.0%	13.0%	13.0%	13.0%
HOV4	0.1%	0.1%	0.1%	--	0.0%	0.0%	2.3%	2.3%	2.3%	1.5%	1.5%	1.5%	2.2%	2.2%	2.2%	0.8%	0.8%	0.8%
AUTO	**85.3%**	**85.3%**	**87.2%**	**100.0%**	**100.0%**	**100.0%**	**87.3%**	**87.3%**	**88.6%**	**92.9%**	**92.9%**	**93.7%**	**88.4%**	**88.4%**	**89.1%**	**96.6%**	**96.6%**	**96.8%**
CRW	--	0.3%	0.2%	--	0.0%	0.0%	--	0.2%	0.2%	0.5%	0.2%	0.1%	--	0.2%	0.1%	--	0.1%	0.0%
CRR	6.1%	2.0%	1.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
SUBW	--	0.9%	0.3%	--	0.0%	0.0%	9.3%	1.0%	0.4%	--	0.9%	0.4%	2.1%	1.1%	0.5%	0.1%	0.3%	0.1%
SUBR	--	0.7%	0.2%	--	0.0%	0.0%	--	0.0%	0.0%	0.2%	0.1%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
BUSW	8.6%	6.9%	7.5%	--	0.0%	0.0%	3.4%	10.0%	9.7%	6.1%	5.6%	5.5%	8.2%	10.0%	10.1%	1.3%	3.1%	3.0%
BUSR	--	2.9%	2.9%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.1%	0.1%	--	0.0%	0.0%	--	0.0%	0.0%
FRYW	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
FRYR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
LRTW	--	0.5%	0.3%	--	0.0%	0.0%	--	1.6%	1.1%	0.3%	0.2%	0.1%	1.2%	0.2%	0.1%	2.0%	0.0%	0.0%
LRTR	--	0.4%	0.3%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
TRANSIT	**14.7%**	**14.7%**	**12.8%**	**0.0%**	**0.0%**	**0.0%**	**12.7%**	**12.7%**	**11.4%**	**7.1%**	**7.1%**	**6.3%**	**11.6%**	**11.6%**	**10.9%**	**3.4%**	**3.4%**	**3.2%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Market Segment 11

MODE	HBWD			HBWS			HBS			HBO			NHBW			NHNW		
	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL	SURVEY	AECOM	MODEL
SOV	47.6%	47.6%	48.0%	78.5%	78.5%	78.5%	51.3%	51.3%	51.5%	36.1%	36.1%	36.4%	60.2%	60.2%	60.9%	56.4%	56.4%	56.4%
HOV2	8.5%	8.5%	8.6%	11.5%	11.5%	11.5%	38.4%	38.4%	38.6%	27.5%	27.5%	27.8%	4.3%	4.3%	4.3%	31.0%	31.0%	31.0%
HOV3	8.7%	8.7%	8.8%	--	0.0%	0.0%	1.5%	1.5%	1.5%	8.6%	8.6%	8.7%	20.2%	20.2%	20.5%	0.8%	0.8%	0.8%
HOV4	4.6%	4.6%	4.7%	--	0.0%	0.0%	--	0.0%	0.0%	7.5%	7.5%	7.6%	--	0.0%	0.0%	1.4%	1.4%	1.4%
AUTO	**69.5%**	**69.5%**	**70.0%**	**90.0%**	**90.0%**	**90.1%**	**91.3%**	**91.3%**	**91.6%**	**79.7%**	**79.7%**	**80.5%**	**84.7%**	**84.7%**	**85.7%**	**89.6%**	**89.6%**	**89.7%**
CRW	7.4%	0.2%	0.1%	--	0.0%	0.0%	--	0.0%	0.0%	0.2%	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
CRR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
SUBW	2.2%	2.1%	0.5%	--	0.2%	0.0%	--	0.2%	0.0%	0.2%	1.0%	0.3%	--	1.5%	0.4%	0.4%	0.8%	0.3%
SUBR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	0.5%	0.0%	0.0%
BUSW	20.3%	26.1%	28.0%	10.0%	9.4%	9.7%	8.7%	7.6%	7.7%	19.8%	17.6%	18.1%	15.3%	13.0%	13.4%	8.6%	8.9%	9.4%
BUSR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.2%	0.3%
FRYW	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
FRYR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%
LRTW	0.6%	2.1%	1.3%	--	0.3%	0.2%	--	0.9%	0.6%	0.1%	1.7%	1.1%	--	0.7%	0.4%	1.0%	0.2%	0.1%
LRTR	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.0%	0.0%	--	0.2%	0.2%
TRANSIT	**30.5%**	**30.5%**	**30.0%**	**10.0%**	**10.0%**	**9.9%**	**8.7%**	**8.7%**	**8.4%**	**20.3%**	**20.3%**	**19.5%**	**15.3%**	**15.3%**	**14.3%**	**10.4%**	**10.4%**	**10.3%**
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

11. TIME OF DAY TRIP ALLOCATION

11.1 INTRODUCTION

The trip generation process was developed on a 24-hour basis. Similarly the trip distribution process used one condition, either peak or off-peak, to control the distribution of trips. Prior to mode choice, the daily trips were partitioned into peak and off-peak periods consistent with the requirements of the NJT mode choice model adopted by the NJRTM-E. The transit trips predicted by the model were retained in these two designations for purposes of assignment, but the peak and off-peak auto trips were merged together to create the specific peak and off-peak period trip tables. The final highway trip assignment was performed by time-of-day for four periods covering the a.m. and p.m. peaks, the midday period, and the other off-peak periods. Highway assignment is performed by time-of-day to account for congestion effects and the subsequent diversion of trips caused by that congestion. Transit assignment was performed by time-of-day or period-specific to account for differences in the amount of transit services available for different time of day.

The daily trip tables generated following the mode split process were in production/attraction (P/A) format, except for the non-home based trip purposes. These non-home-based daily trip tables were estimated in an origin/destination (O/D) format. The daily P/A trip tables were converted to period-specific O/D trip tables using time-of-day and direction split factors. The daily O/D trip tables were converted into period-specific O/D trip tables using only time-of-day factors.

In the highway assignment process, peak periods could comprise of timeframes of multiple hours of instead of a one-hour timeframe. Since link capacity is normally defined as hourly capacity, peak period capacity factors were developed to convert hourly capacities to multiple hour capacities.

11.2 METHODOLOGY

11.2.1 Data Sources and Preparation

Data from the 2010 / 2011 RHTS (Regional Household Travel Survey) were used as the primary source of data for the development of time-of-day and direction split factors. The survey data were expanded to represent total trip making in the survey area. The weighted trip data were then summarized into a table stratified by purpose, time-of-day, and direction of the trip. The reported starting time of the trip was used to determine time-of-day of the trip. The time-of-day was stratified into 48 one-half hour time periods starting on the hour or half-hour and ending at 29 or 59 minutes after the hour.

The direction of the trip could be determined whether a trip originated from home to a non-home location (i.e., a production zone to attraction zone trip) or a trip originated from a non-home location to the home of the trip maker (i.e., an attraction zone to production zone trip). For non-home-based trips, the direction of trips was derived from actual origins and destinations to form an observed O/D trip table.

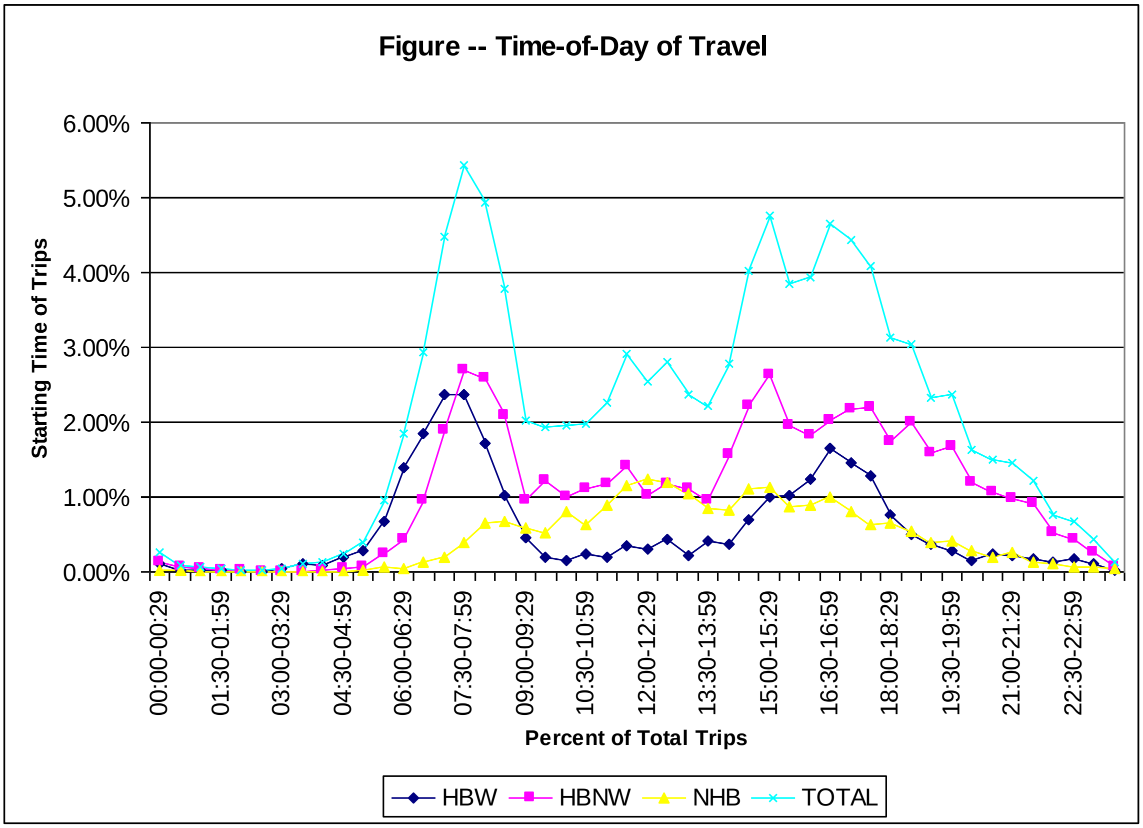
The motorized trips generated by the NJTPA counties and Mercer County households were divided into three major trip purposes: home-based work, home-based non-work, and non-home-based. In addition, home-based work trips were stratified further into home-based work direct and home-based work strategic. Home-based non-work trips were stratified into home-based shop and home-based other. Finally, the total trips were summarized.

11.2.2 Analysis of Trips by Time-of-Day

Table 88 summarizes the percentages of trips, in half-hour intervals, for a period of a day based on the survey records. The percentages were provided for all the three purposes, i.e., home-based work, home-based non-work, and non-home based, so that the total percentages of these three purposes equaled 100%. This data was then used to establish the duration of the two peak periods and to identify the maximum demand in any single hour of each period for the purposes of scaling the network capacities to reflect peaking characteristics.

The data listed in Table 88 were plotted to depict daily travel trends as shown in Figure 36. The daily travel pattern shows that the AM peak period is prominently visible and the largest component of the AM peak period is the home-based work trips. There are also a substantial number of home-based non-work trips that take place during the morning peak period.

Figure 36 – Time-of-Day Travel Pattern



The peak activity of the p.m. peak period is also clearly depicted, although the duration or spread of these trips is evident as well. The afternoon peak is longer than the morning peak period since a substantial amount of home-based non-work and non-home-based travel also occurs during the afternoon peak period. The pattern also shows a minor spike of trip activities at midday. A major component of this midday peak is non-home-based travel. These activities are typically related to midday errands and lunch trips with one trip end at the place of work. Generally, the traditional PM peak period can be seen from about 3:00 to 6:00 p.m. The afternoon peak period has a large percentage of home-based work trips as well. Table 88 shows the peak periods (in green) and peak hours of each period (in yellow for peak periods and blue for Midday and Night periods).

Table 88 – Household Survey Trip Distribution by Time-of-Day

Starting Time	HBW	HBNW	NHB	TOTAL
00:00-00:29	0.10%	0.13%	0.02%	0.26%
00:30-00:59	0.02%	0.07%	0.01%	0.10%
01:00-01:29	0.03%	0.04%	0.00%	0.07%
01:30-01:59	0.03%	0.02%	0.00%	0.05%
02:00-02:29	0.00%	0.02%	0.01%	0.02%
02:30-02:59	0.01%	0.00%	0.00%	0.01%
03:00-03:29	0.03%	0.01%	0.00%	0.04%
03:30-03:59	0.10%	0.01%	0.00%	0.12%
04:00-04:29	0.10%	0.03%	0.00%	0.12%
04:30-04:59	0.19%	0.04%	0.01%	0.24%
05:00-05:29	0.29%	0.07%	0.02%	0.39%
05:30-05:59	0.67%	0.23%	0.06%	0.96%
06:00-06:29	1.38%	0.43%	0.04%	1.86%
06:30-06:59	1.85%	0.97%	0.12%	2.94%
07:00-07:29	2.37%	1.90%	0.20%	4.47%
07:30-07:59	2.36%	2.69%	0.38%	5.43%
08:00-08:29	1.71%	2.58%	0.65%	4.94%
08:30-08:59	1.03%	2.08%	0.68%	3.79%
09:00-09:29	0.46%	0.96%	0.59%	2.02%
09:30-09:59	0.19%	1.22%	0.53%	1.94%
10:00-10:29	0.15%	0.99%	0.81%	1.95%
10:30-10:59	0.24%	1.11%	0.63%	1.98%
11:00-11:29	0.19%	1.17%	0.89%	2.26%
11:30-11:59	0.36%	1.41%	1.15%	2.92%
12:00-12:29	0.30%	1.01%	1.23%	2.54%
12:30-12:59	0.42%	1.18%	1.20%	2.80%
13:00-13:29	0.22%	1.11%	1.04%	2.37%
13:30-13:59	0.42%	0.96%	0.84%	2.22%
14:00-14:29	0.38%	1.57%	0.84%	2.79%
14:30-14:59	0.69%	2.22%	1.10%	4.01%
15:00-15:29	1.00%	2.64%	1.12%	4.76%
15:30-15:59	1.02%	1.96%	0.87%	3.85%
16:00-16:29	1.23%	1.83%	0.89%	3.95%
16:30-16:59	1.64%	2.01%	1.00%	4.66%
17:00-17:29	1.45%	2.17%	0.81%	4.42%
17:30-17:59	1.27%	2.19%	0.62%	4.09%
18:00-18:29	0.75%	1.73%	0.64%	3.13%
18:30-18:59	0.51%	1.99%	0.55%	3.04%
19:00-19:29	0.36%	1.58%	0.39%	2.33%
19:30-19:59	0.28%	1.68%	0.41%	2.37%
20:00-20:29	0.15%	1.20%	0.29%	1.63%
20:30-20:59	0.23%	1.07%	0.19%	1.49%
21:00-21:29	0.22%	0.97%	0.26%	1.46%
21:30-21:59	0.17%	0.92%	0.13%	1.22%
22:00-22:29	0.13%	0.51%	0.11%	0.75%
22:30-22:59	0.18%	0.43%	0.06%	0.67%
23:00-23:29	0.11%	0.27%	0.06%	0.43%
23:30-23:59	0.02%	0.07%	0.05%	0.14%
Total	**27.02%**	**51.45%**	**21.53%**	**100.00%**

11.2.3 Determination of Peak Periods

The highway assignment process utilizes four time-of-day periods, i.e., the morning peak period, the midday period, the afternoon peak period, and the night period. The length of each period was defined based on travel trends shown in Table 88 and Figure 36 as follows:

- Morning peak period is from 6:00 to 9:00 a.m.
- Midday period is from is from 9:00 a.m. to 3:00 p.m.
- Afternoon period is from 3:00 p.m. to 6:00 p.m.
- Night period is from 6:00 p.m. to 6:00 a.m.

11.2.4 Time-of-Day and Direction Split Factors

Time–of-day and direction factors were determined using the survey data and the definition of peak and off-peak periods. The data were simply summarized into the four time-periods by direction of travel and trip purpose. Table 89 shows the time-of-day and direction factors for each trip purpose. Each factor represents the proportion of trips in that market segment to the total daily trips. For example, 38.9 percent of daily HBW trips are made in the direction of home to work during the morning peak period. In contrast, only 0.7 percent of the daily HBW trips are made in the direction of work to home during the same morning peak period. These percentages imply that 98.3 percent of the home-based work trips made during morning peak period are from home to work while only 1.7 percent of the trips are from work to home. A similar directionality split for home-based work trips can also be seen in the afternoon peak period except that the major direction is from work to home. In the off-peak period, the directionality split is more balanced. The summation of direction and time-of-day factors for each purpose should equal to 1.0.

On an average day, 55.1 percent of the work trips are from home to work and 44.9 percent of the work trips are from work to home. This does not mean that some workers do not return home from work each day. Instead, it shows the effect of trip chaining on daily travel patterns. These percentages show that more travelers stop at intermediate points on their journey home from work each day than on their journey from home to work. The effect of trip chaining is more evident if the daily split of home-based non-work trips is also reviewed. The home-based non-work have more trips (56.3 percent) made from non-home location to home than the reversed direction (43.7 percent).

The household survey data were available to estimate time-of-day/direction split factors for home-based and non-home-based trips. However, primary data were not available for other trips that must be included in the travel modeling process which includes truck trips and airport trips. The allocation of truck trips for the heavy and medium vehicle types by time of day was retained from the NJRTM while the commercial truck trips were allocated from data obtained from the NYMTC BPM Model, as shown in Table 90. The airport trips allocated to the auto mode were converted to vehicle trips using assumed auto occupancy rates and then allocated into the time of day periods based on data obtained from the survey and discussions with AECOM. The allocation by time of day for airport trips is provided in Table 91.

Table 89 – Time-of-Day Distribution by Purpose

P->A (From Home to Other)

Period	HBWD	HBWS	HBW	HBSH	HBO
AM	0.353	0.496	0.389	0.067	0.210
MD	0.066	0.096	0.074	0.202	0.113
PM	0.020	0.030	0.022	0.073	0.099
NT	0.062	0.074	0.065	0.094	0.086
TOTAL	**0.501**	**0.696**	**0.550**	**0.436**	**0.508**

A->P (From Other to Home)

Period	HBWD	HBWS	HBW	HBSH	HBO
AM	0.004	0.016	0.007	0.011	0.030
MD	0.079	0.064	0.075	0.222	0.141
PM	0.296	0.153	0.259	0.165	0.155
NT	0.120	0.071	0.109	0.166	0.166
TOTAL	**0.499**	**0.304**	**0.450**	**0.564**	**0.492**

Non-Home-Based

Period	HBWD	HBWS	HBW
AM	0.062	0.121	0.097
MD	0.562	0.463	0.504
PM	0.282	0.223	0.247
NT	0.094	0.193	0.152
TOTAL	**1.000**	**1.000**	**1.000**

Table 90 – Truck Trip Time-of-Day Distribution

Period	Truck Type		
	Medium	Heavy	Commercial
AM	20.0%	17.0%	6.2%
Midday	24.0%	17.0%	28.2%
PM	34.0%	42.0%	56.2%
Night	22.0%	24.0%	9.4%
Total	**100.0%**	**100.0%**	**100.0%**

Table 91 – Airport Trip Time of Day Distribution

Period	Airport Trips		
	P--> A	A-->P	Total
AM	9.4%	3.5%	12.9%
Midday	11.5%	12.1%	23.7%
PM	15.0%	13.8%	28.8%
Night	14.1%	20.6%	34.7%
Total	**50.0%**	**50.0%**	**100.0%**

11.3 ESTIMATION OF CAPACITY FACTORS FOR ASSIGNMENT

The capacity factors were needed to convert hourly link capacity to period-specific link capacity during the highway assignment process. These factors were developed from the 2010-2011 RHTS. The capacity factor provides the ratio of peak-hour traffic in a specific period to the total traffic in that period. Table 92 lists the capacity factor by time-of-day periods.

Table 92 – Time Period Split and Capacity Factors

Period	Length	Duration	Peak Hour	Total%	Peak Hour%	Capacity Factor
AM	3 Hours	6:00 AM-9:00 AM	7:30 AM-8:30 AM	23.43%	10.38%	0.4430
MD	6 Hours	9:00 AM-3:00 PM	11:30 AM-12:30 AM	29.79%	5.46%	0.1833
PM	3 Hours	3:00 PM-6:00 PM	4:30 PM-5:30 PM	25.73%	9.08%	0.3529
NT	12 Hours	6:00 PM-6:00 AM	7:00 PM-8:00 PM	21.05%	4.70%	0.2233
TOTAL	**24 Hours**			**100.00%**		

11.4 APPLICATION METHODOLOGY

The time-of-day and directional split factors developed in the previous section will be applied to the vehicle trip tables generated by the mode choice model. The factors are applied prior to the highway assignment process so that the highway assignment can be performed on a time-of-day basis. These factors should be used for future assignments as well unless new factors are developed using up-to-date observed data.

Each period-specific highway assignment should use the appropriate capacity factors to scale the link capacity into period capacity. The capacity factors shown in Table 92 were used as an initial point for this process. The capacity factor adjustments are used to reflect the spreading of the "peak hour" within the peak period due to capacity restraints and can be modified as needed based on future analysis.

12. HIGHWAY ASSIGNMENT

12.1 INTRODUCTION

The purpose of this section is to summarize the development of the volume-delay functions (VDF) adopted for the NJRTM-E Model. The discussion includes a description of the VDF general structure as well as the characteristics that should be incorporated into the final functions. This section also discusses the proposed VDF calibration by facility type and area type, and anticipated adjustments that may be required. Lastly, it provides an overview of the highway assignment calibration strategy and the role of the preliminary assignment calibration.

12.1.1 Development of Volume Delay Functions (VDF)

During the initial development of the NJRTM-E, a review was performed on the readily-available literature and general modeling practice as a means of summarizing the trends regarding highway assignment and volume-delay functions. The following list of objectives was developed as a result of this review:

- Variation in Volume-Delay Functions – Many of the assignment procedures developed for large regional models contain separate volume-delay functions by facility type. Previous practice was to permit a single volume delay function, such as the BPR, but to vary the starting speeds and per lane capacity values by facility type and area type. The use of a single function in older models probably reflects several conditions including the limits of older packages and/or built-in defaults included in the major modeling packages. The flexibility available in the current generation of modeling software removes these types of limitations. It is recommended that the volume-delay functions be structured as facility-type specific, so that variation observed traffic characteristics can be modeled more accurately.

- Capacity Definition – In many previous models there was some level of uncertainty as to what level of service was being represented with the "stated" per- lane capacities. The original BPR model assumed capacity was the value that provided level-of-service "C" or the "practical capacity" of a roadway. This approach was consistent with general planning policy, in that links with volumes in excess of level of service "C" would be identified as potential needs for future capacity increases. However, the level-of-service "C" definition is not precise and, for certain facilities such as freeways, the speeds and delays exhibit very little variation at this level of service. For these reasons, the capacity was defined as the theoretical maximum capacity associated with level-of-service "E".

- The volume-delay functions should specifically estimate delay as separate from time since the delay is normally associated with queuing that occurs at a single location controlling by the link capacity. The volume delay function should be an additive term, reflecting the queuing point, rather than a scaling factor that increases time in proportion to the link's overall travel time.

- The representation of trucks in the volume-delay functions should be incorporated to reflect the disproportionate impacts of trucks on link capacity. This is relatively straightforward with the CUBE Voyager software. Note that the model must still report the trucks as a separate mode without the scaling adjustments used to modify the volume/capacity ratio calculations.

- The procedure should establish a minimum speed for each facility type. This "floor" will help insure that equilibrium does not encounter any "delay spikes" associated with links operating at exceptionally high volume/capacity ratios.

- The adopted volume-delay function should be computationally-efficient and should not result in excessive execution times.

Limits of Standard BPR Equation

The BPR formula has several limitations that will restrict its ability to meet the objectives listed previously. The formula is structured as a multiplicative function which essentially scales the initial time for the entire link, rather than just adding a surcharge representing a single queuing location. Since the network links in the NJRTM-E model are basically short segments with only one controlling location that limits capacity, the use of a scaling function is not recommended. Table 93 provides a simple example of the problem with volume-delay functions, such as the BPR, that apply a multiplicative factor:

Table 93 – BPR Function Example

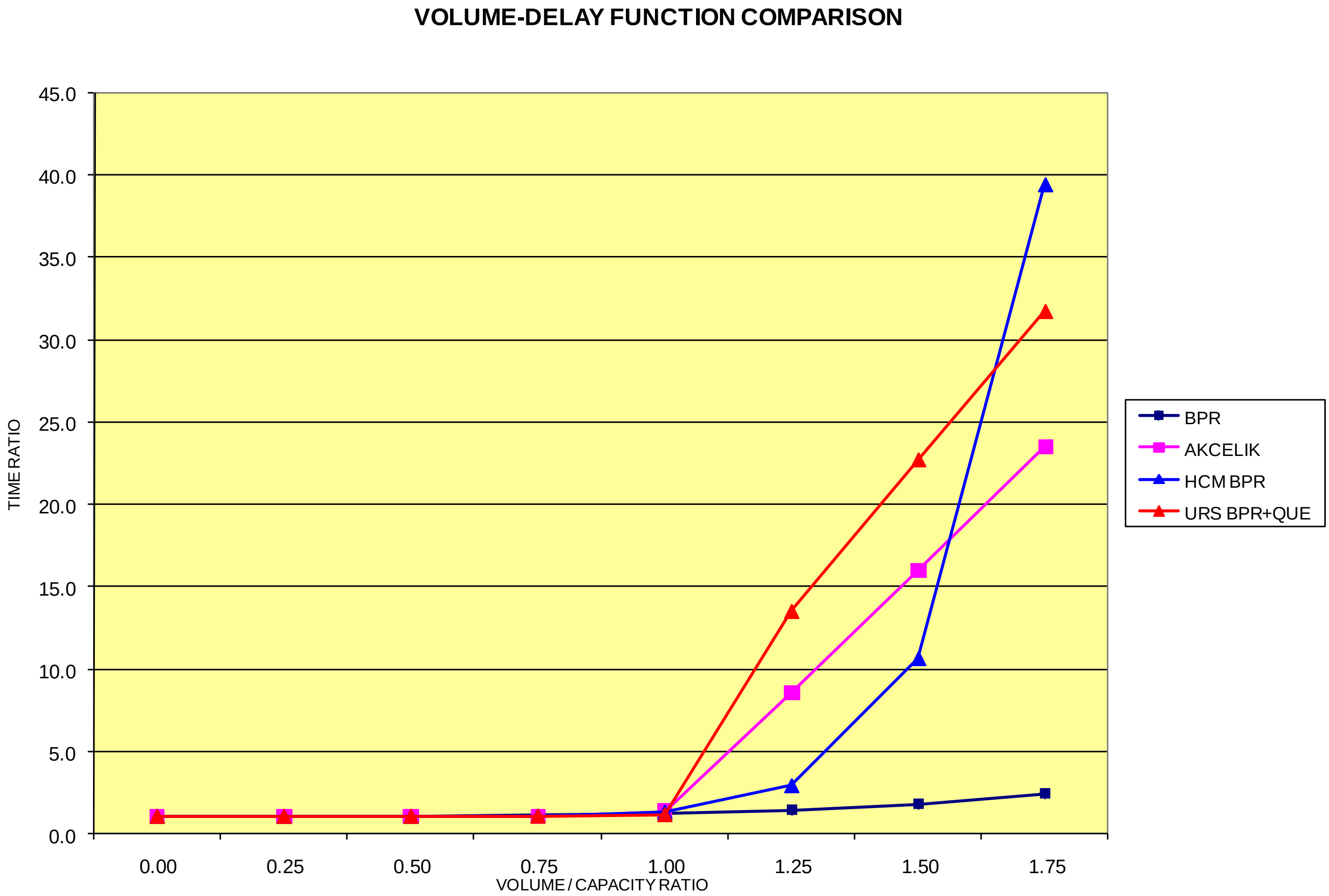
Miles	FF Speed	FF Time (minutes)	V/C Ratio	BPR Time	Delta Time	Implied Speed
1.00	60.00	1.00	1.00	1.15	0.15	52.2
2.00	60.00	2.00	1.00	2.30	0.30	52.2

These two links in the example have the same congestion (queuing) problems at one location: however, since the BPR equation uses a scaling function rather than a surcharge calculation, the longer segment suffers twice as long a delta time as compared to the shorter segment (0.30 compared to 0.15)

The second limitation is related to the estimation of congested travel times. The basic BPR function ($T_F=T_O$ * $(1.0+0.15*V/C^4)$) generally underestimates travel time for links with volumes greater than their capacity. Some more recent literature and the latest Highway Capacity Manual have suggested the use of higher exponential terms to increase the congested travel time estimates. However at these points, the revised travel times increase significantly and become increasingly asymptotic. This may cause the equilibrium function to have significant problems adjusting between iterations and achieving the proper closure.

Figure 37 displays the standard BPR function along with three volume-delay functions that were considered. Note that the Y-axis is the time ratio, defined as the revised time divided by the freeflow time. The graphs are listed for the freeway category and it should be noted that all of the curves provide similar estimates of revised time for volume/capacity ratios less than 1.0. The asymptotic nature of the HCM BPR function is evident. Both the Akcelik and "BPR & Queuing" Model result in much higher revised travel times immediately after the volume capacity ratio exceeds 1.0. It is anticipated that these increased travel times would have the effect of restraining the model from assigning many links with traffic volumes that would result in illogically high volume/capacity ratios. This approach should provide for assignment results that are more "operational" in nature, as opposed to results from a typical planning model.

Figure 37 – Volume Delay Function Comparison



Recommended Volume-Delay Function

The highway assignment module provides three different volume-delay functions (VDF) to choose. Those three VDFs are:

- Standard BPR formula
- A hybrid of the 2000 HCM (BPR) volume-delay functions and a simplified queuing formula from the Transportation and Traffic Engineering Handbook. This formula is defined as follows:
  - $T_F = T_O * (1.0 + a * (V/C)^b) + (120/2) * (1 - (C/V))$

  Note that this option is structured so that the “a” and “b” coefficients can vary by facility type, as is current practice in more recent models.

- the "Akcelik / Davidson Formula" which appears to have been implemented successfully in several research papers. This formula is structured as follows:

  $S_F = S_O + 0.25 * [T*(V/C-1) + \{(V/C-1)^2 + 8.0*J*(V/C) / (C*T)\}^{0.5}]$

  Where:

  S_F, S_O = Final and initial speeds, stated as "hours/mile"
  T = Queuing Period (assumed 1 hour)
  J = Calibration Parameter which varies by Facility Type

  Note that time (in minutes) is then calculated as follows:

  $\text{Time} = (\text{Distance} / S_F) * 60.0$

From the above three VDFs, the hybrid formula had the best fit compared to the observed data in the original model calibration / validation. Therefore, it was selected as the default VDF for this model. As part of the 2018 Revalidation project, the VDF was again reviewed and compared to the INRIX speed data. The hybrid VDF replicated the observed data well. This VDF is retained as the default VDF of this model.

Calibration Data Set

The calibration data set was developed for use in the highway assignment calibration tasks. The data contained the following items:

- Traffic Count Data as provided from the NJDOT Counts Database, the New Jersey Turnpike Authority (NJTA), the Delaware River Joint Toll Bridge Commission, and traffic counts from NJTPA subregions.
- INRIX speed data provided by NJTPA.

Assignment Calibration

The assignment calibration focused both on the standard comparisons of volumes and VMT by various classifications and statistical measures of fit such as Root Mean Squared Errors (RMSE) by volume group. The assignment calibration also focused on replicating delay at major trans-Hudson Crossing points, such as the Lincoln Tunnel, that heavily influence mode choice. The assignment calibration provided summaries of the following comparisons:

- Volumes and VMT by Facility Type, Area Type and sub-regions
- RMSE by Volume Group
- Comparison of Modeled Speeds / Observed Speeds

12.2 CALIBRATION RESULTS

The outputs of highway assignments were validated and compared to the observed data. The validation efforts were focused mainly on the NJTPA counties and Mercer County. The validation results were summarized in various tables to depict different aspects and levels of comparison. Table 94 shows the comparison of VMT and volume by facility type and area type between NJRTM-E model and observed traffic count data. The estimated VMT and volume are within 5% of the observed data at a regional level. In a more disaggregate level, the variations between estimated and observed data are more pronounced. For example, comparison by area type or by facility type is generally within ten percent range with the exception of a few facility types, such as minor arterial undivided and ramps. In general, the NJRTM-E's estimated VMT and volume replicate the observed data reasonably well. Table 95 shows the comparison of percent differences of traffic volumes by facility type and area type to the FHWA standard or standards used by other DOTs. The comparison shows that the calibration results are generally well below the standards.

The VMT and volume comparison by facility type and area type between the estimated and observed heavy trucks is shown in Table 96. The results indicated that the difference between the estimated and observed heavy trucks is approximately one percent at regional level. The difference is more pronounced at a disaggregate-level, such as by facility type and area type. The limited-access facility has the best fit compared to other facilities, and this facility has the highest number of observed data. The heavy truck counts were available only on 98 locations, while the total traffic counts were available on 6,073 locations.

Table 97 compares the regional RMSE by volume group of the NJRTM-E's volume estimates to FHWA standard for most volume groups, except for the two lowest volume groups as expected At a regional level, an RMSE of 37% is within the range of the FHWA standard.

Table 94 – VMT and Volume by FT/AT (NJTPA+Mercer)

Observed Volume vs. Estimated Volume by FT/AT

OBSERVED VOLUME

FACILITY TYPE	AREA TYPE				
	CBD	Urban	Suburban	Rural	TOTAL
Limited-Access Facility	88,420	8,286,587	16,397,877	11,720,880	36,493,764
Expressway	--	3,221,548	2,885,610	175,772	6,282,930
Principal Arterial Divided	--	2,066,506	5,041,928	343,395	7,451,829
Principal Arterial Undivided	134,688	1,221,728	3,307,911	821,719	5,486,046
Major Arterial Divided	--	16,584	346,360	--	362,944
Major Arterial Undivided	49,853	2,043,934	5,803,960	1,195,763	9,093,510
Minor Arterials	99,590	1,936,530	4,770,399	476,862	7,283,381
Collector/Local	9,642	65,226	120,749	73,811	269,428
TOTAL	**427,971**	**21,621,104**	**40,825,127**	**15,378,276**	**78,252,478**

ESTIMATED VOLUME

FACILITY TYPE	AREA TYPE				
	CBD	Urban	Suburban	Rural	TOTAL
Limited-Access Facility	111,273	8,794,875	16,463,361	10,792,992	36,162,501
Expressway	--	3,398,925	3,021,672	173,296	6,593,893
Principal Arterial Divided	--	1,797,987	4,942,577	293,767	7,034,331
Principal Arterial Undivided	112,682	1,435,167	3,042,808	675,411	5,266,068
Major Arterial Divided	--	13,004	354,787	--	367,791
Major Arterial Undivided	37,700	1,659,259	5,191,248	1,129,492	8,017,699
Minor Arterials	61,736	1,723,999	4,601,688	456,606	6,844,029
Collector/Local	8,587	68,198	100,893	77,845	255,523
High-Speed Ramp	--	239,038	169,144	--	408,182
Medium-Speed Ramp	69,797	2,734,157	2,470,836	702,155	5,976,945
TOTAL	**401,775**	**21,864,609**	**40,359,014**	**14,301,564**	**76,926,962**

ESTIMATED VOLUME/OBSERVED VOLUME

FACILITY TYPE	AREA TYPE				
	CBD	Urban	Suburban	Rural	TOTAL
Limited-Access Facility	1.26	1.06	1.00	0.92	0.99
Expressway	--	1.06	1.05	0.99	1.05
Principal Arterial Divided	--	0.87	0.98	0.86	0.94
Principal Arterial Undivided	0.84	1.17	0.92	0.82	0.96
Major Arterial Divided	--	0.78	1.02	--	1.01
Major Arterial Undivided	0.76	0.81	0.89	0.94	0.88
Minor Arterials	0.62	0.89	0.96	0.96	0.94
Collector/Local	0.89	1.05	0.84	1.05	0.95
High-Speed Ramp	--	1.13	1.23	--	1.17
Medium-Speed Ramp	1.52	1.07	1.23	1.23	1.15
TOTAL	**0.94**	**1.01**	**0.99**	**0.93**	**0.98**

Table 94- Continued

Observed VMT vs. Estimated VMT by FT/AT

OBSERVED VMT

FACILITY TYPE	AREA TYPE				
	CBD	Urban	Suburban	Rural	TOTAL
Limited-Access Facility	24,021	4,056,383	11,056,481	12,913,384	28,050,269
Expressway	--	1,387,709	1,545,784	225,036	3,158,529
Principal Arterial Divided	--	905,005	3,482,398	423,560	4,810,963
Principal Arterial Undivided	32,930	619,563	2,793,410	864,996	4,310,899
Major Arterial Divided	--	11,860	179,593	--	191,453
Major Arterial Undivided	6,687	805,686	4,440,092	1,581,430	6,833,895
Minor Arterials	23,875	807,243	3,833,153	639,650	5,303,921
Collector/Local	2,377	19,026	80,486	51,560	153,449
High-Speed Ramp	--	65,320	66,337	--	131,657
Medium-Speed Ramp	8,466	603,195	548,701	204,660	1,363,805
TOTAL	**98,356**	**9,280,990**	**28,026,435**	**16,904,276**	**54,308,840**

ESTIMATED VMT

FACILITY TYPE	AREA TYPE				
	CBD	Urban	Suburban	Rural	TOTAL
Limited-Access Facility	30,368	4,302,634	11,302,942	12,030,808	27,666,752
Expressway	--	1,410,547	1,613,789	211,865	3,236,201
Principal Arterial Divided	--	795,982	3,324,421	392,569	4,512,972
Principal Arterial Undivided	28,208	675,625	2,452,695	710,280	3,866,808
Major Arterial Divided	--	6,676	186,318	--	192,994
Major Arterial Undivided	5,183	646,163	3,828,409	1,398,237	5,877,992
Minor Arterials	12,698	631,645	3,394,708	552,265	4,591,316
Collector/Local	2,117	19,156	73,742	57,675	152,690
High-Speed Ramp	--	74,676	79,176	--	153,852
Medium-Speed Ramp	13,516	652,227	658,673	253,004	1,576,215
TOTAL	**92,090**	**9,215,331**	**26,914,873**	**15,606,703**	**51,827,792**

ESTIMATED VOLUME/OBSERVED VMT

FACILITY TYPE	AREA TYPE				
	CBD	Urban	Suburban	Rural	TOTAL
Limited-Access Facility	1.26	1.06	1.02	0.93	0.99
Expressway	--	1.02	1.04	0.94	1.02
Principal Arterial Divided	--	0.88	0.95	0.93	0.94
Principal Arterial Undivided	0.86	1.09	0.88	0.82	0.90
Major Arterial Divided	--	0.56	1.04	--	1.01
Major Arterial Undivided	0.78	0.80	0.86	0.88	0.86
Minor Arterials	0.53	0.78	0.89	0.86	0.87
Collector/Local	0.89	1.01	0.92	1.12	1.00
High-Speed Ramp	--	1.14	1.19	--	1.17
Medium-Speed Ramp	1.60	1.08	1.20	1.24	1.16
TOTAL	**0.94**	**0.99**	**0.96**	**0.92**	**0.95**

Table 95 – Percent Differences Compared to FHWA and Other Standards

FACILITY TYPE	ESTIMATED %DIFF	FHWA STANDARD
Limited-Access Facility	0.9%	+/- 7%
Expressway	-4.9%	+/- 7%
Principal Arterial Divided	5.6%	+/- 10%
Principal Arterial Undivided	4.0%	+/- 10%
Major Arterial Divided	-1.3%	+/- 15%
Major Arterial Undivided	11.8%	+/- 15%
Minor Arterials	6.0%	+/- 15%
Collector/Local	5.2%	+/- 20%
High-Speed Ramp	-16.8%	N/A
Medium-Speed Ramp	-15.4%	N/A
TOTAL	**1.7%**	**N/A**

AREA TYPE	ESTIMATED %DIFF	OHIO DOT	FLORIDA DOT
CBD	6.1%	+/- 10%	+/- 15%
Urban	-1.1%	+/- 10%	+/- 15%
Suburban	1.1%	+/- 10%	+/- 15%
Rural	7.0%	+/- 10%	+/- 15%
TOTAL	**1.7%**	**N/A**	**N/A**

TOTAL COUNTS

FACILITY TYPE	AREA TYPE				
	CBD	Urban	Suburban	Rural	TOTAL
Limited-Access Facility	2	160	262	221	645
Expressway	--	96	103	20	219
Principal Arterial Divided	--	72	227	22	321
Principal Arterial Undivided	6	115	354	145	620
Major Arterial Divided	--	4	27	--	31
Major Arterial Undivided	6	277	901	298	1,482
Minor Arterials	14	351	1,140	278	1,783
Collector/Local	2	16	48	50	116
High-Speed Ramp	--	7	5	--	12
Medium-Speed Ramp	8	351	385	100	844
TOTAL	**38**	**1,449**	**3,452**	**1,134**	**6,073**

Table 96 – Heavy Truck Volume by FT/AT (NJTPA+Mercer)

OBSERVED VOLUME

FACILITY TYPE	AREA TYPE				
	CBD	Urban	Suburban	Rural	TOTAL
Limited-Access Facility	--	90,303	142,988	397,103	630,394
Expressway	--	11,540	8,733	726	20,999
Principal Arterial Divided	--	--	1,998	--	1,998
Principal Arterial Undivided	--	482	--	198	680
Major Arterial Divided	--	--	--	--	--
Major Arterial Undivided	--	--	--	616	616
Minor Arterials	--	--	--	--	--
Collector/Local	--	--	--	--	--
TOTAL	**0**	**102,325**	**158,605**	**398,643**	**659,573**

ESTIMATED VOLUME

FACILITY TYPE	AREA TYPE				
	CBD	Urban	Suburban	Rural	TOTAL
Limited-Access Facility	--	83,748	126,031	409,672	619,451
Expressway	--	17,489	15,964	1,307	34,760
Principal Arterial Divided	--	--	3,008	--	3,008
Principal Arterial Undivided	--	604	--	220	824
Major Arterial Divided	--	--	--	--	--
Major Arterial Undivided	--	--	--	1,156	1,156
Minor Arterials	--	--	--	--	--
Collector/Local	--	--	--	--	--
High-Speed Ramp	--	--	--	--	--
Medium-Speed Ramp	--	--	3,880	--	3,880
TOTAL	**0**	**101,841**	**148,883**	**412,355**	**663,079**

ESTIMATED VOLUME/OBSERVED VOLUME

FACILITY TYPE	AREA TYPE				
	CBD	Urban	Suburban	Rural	TOTAL
Limited-Access Facility	--	0.93	0.88	1.03	0.98
Expressway	--	1.52	1.83	1.80	1.66
Principal Arterial Divided	--	--	1.51	--	1.51
Principal Arterial Undivided	--	1.25	--	1.11	1.21
Major Arterial Divided	--	--	--	--	--
Major Arterial Undivided	--	--	--	1.88	1.88
Minor Arterials	--	--	--	--	--
Collector/Local	--	--	--	--	--
High-Speed Ramp	--	--	--	--	--
Medium-Speed Ramp	--	--	0.79	--	0.79
TOTAL	**--**	**1.00**	**0.94**	**1.03**	**1.01**

TOTAL COUNTS

FACILITY TYPE	AREA TYPE				
	CBD	Urban	Suburban	Rural	TOTAL
Limited-Access Facility	--	18	17	41	76
Expressway	--	6	2	2	10
Principal Arterial Divided	--	--	2	--	2
Principal Arterial Undivided	--	2	--	2	4
Major Arterial Divided	--	--	--	--	--
Major Arterial Undivided	--	--	--	2	2
Minor Arterials	--	--	--	--	--
Collector/Local	--	--	--	--	--
High-Speed Ramp	--	--	--	--	--
Medium-Speed Ramp	--	--	4	--	4
TOTAL	**-**	**26**	**25**	**47**	**98**

Table 97 – RMSE Summary by Volume Group

VOLUME GROUP	MODEL'S RMSE	FHWA RMSE	No. Of Counts
>100,000	9.68	15.0	57
90,000-100,000	13.39	15.0	31
80,000-90,000	14.11	16.0	23
70,000-80,000	16.14	16.0	62
60,000-70,000	12.98	18.0	85
50,000-60,000	16.32	20.0	135
40,000-50,000	18.99	21.0	150
30,000-40,000	21.08	23.0	204
20,000-30,000	24.56	25.0	254
10,000-20,000	42.74	27.0	735
0-10,000	70.45	40-60	4,337
TOTAL	**37.1**	**35-40**	**6,073**

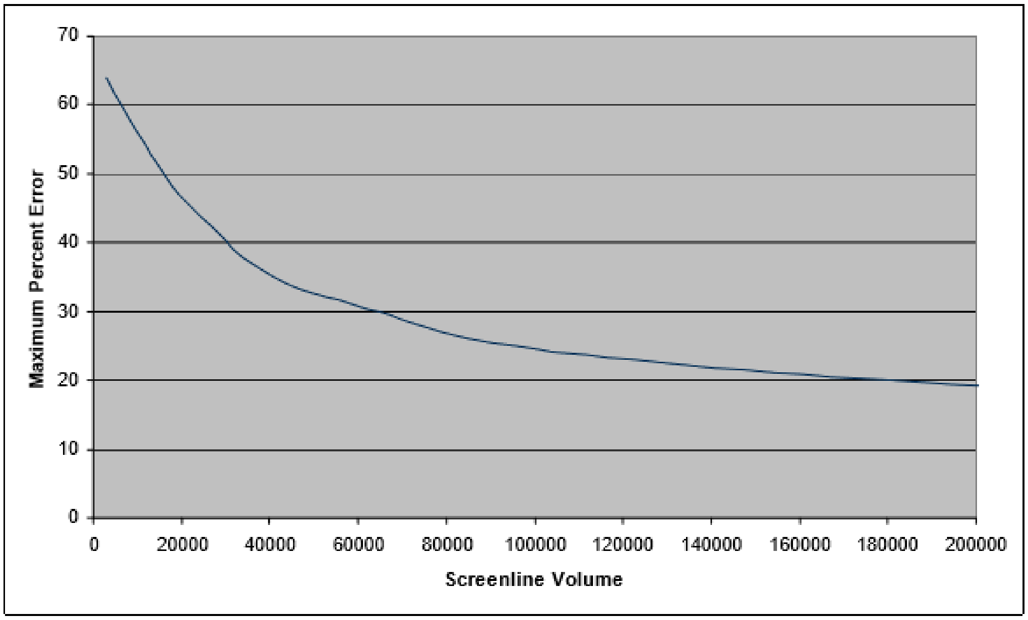
Figure 38 depicts the locations of the various screenlines used for model validation. Figure ***39*** shows the FHWA standards in a graphical form for various total screenline volumes. Table 98 summarizes model performance in respect to estimated and observed volumes at screenline crossings. The ratios of model volumes and observed counts are mostly within tolerance of the FHWA Standards. The detail screenline summary is shown in Table 104.

The model estimated speed was also compared to the observed speed from HERE data. Table 99 shows the average speed comparison by facility type and area type for each time period. The average speeds by facility type and area type for the night time period are generally within reasonable tolerance indicating that free-flow speed assumption is reasonable. The average speeds for other periods are also within reasonable tolerance indicating that the volume-delay-functions used in the model are reasonable as well. Table 100 shows the number of highway network links with observed speed data. A total of more than 9,500 links in the network have observed speed data.

Table 101 summarizes the heavy trucks and total traffic by freeway segment for New Jersey Turnpike and Garden State Parkway. In the system level, the heavy truck percentages estimated for the NJTPK and GSP are close to the observed percentages. This summary is repeated for the traffic along the Delaware River crossings as shown in Table 102. The system level comparison is again reasonable.

Figure 38 – Screenline Map

Figure 39 – Desirable Deviation in Total Screenline Volume Guidelines



Source: Calibration and Adjustment of System Planning Models, FHWA, December 1990.

Table 98 – Screenline Summary

Screenline No	Observed Counts	Estimated Volumes	Percent Difference	FHWA Standard
Screenline 1	781,068	758,068	-2.9%	+/- 19%
Screenline 2	402,372	346,798	-13.8%	+/- 19%
Screenline 3	534,530	536,794	0.4%	+/- 19%
Screenline 4	811,217	786,848	-3.0%	+/- 19%
Screenline 5	329,049	307,178	-6.6%	+/- 19%
Screenline 6	479,066	484,789	1.2%	+/- 19%
Screenline 7	516,946	532,728	3.1%	+/- 19%
Screenline 8	430,680	459,589	6.7%	+/- 19%
Screenline 9	209,507	183,229	-12.5%	+/- 19%
Screenline 10	274,275	235,005	-14.3%	+/- 19%
Screenline 11	218,926	231,358	5.7%	+/- 19%
Screenline 12	195,271	204,099	4.5%	+/- 19%
Screenline 13	349,916	337,639	-3.5%	+/- 19%
Screenline 14	337,167	322,863	-4.2%	+/- 19%
Screenline 15	644,879	661,074	2.5%	+/- 19%
Screenline 16	227,554	225,061	-1.1%	+/- 19%
Screenline 17	348,192	324,557	-6.8%	+/- 19%
Screenline 18	188,594	149,114	-20.9%	+/- 20%
Screenline 19	325,591	282,505	-13.2%	+/- 19%
Total	**7,604,800**	**7,369,296**	**-3.1%**	**+/- 19%**

Table 99 – Average Speed Comparison by Facility Type and Area Type

AM Peak Period

FACILITY TYPE	AREA TYPE											
	CBD			Urban			Suburban			Rural		
	Obs.	Est.	Ratio	Obs.	Est.	Ratio	Obs.	Est.	Ratio	Obs.	Est.	Ratio
Freeway	33.4	27.9	0.84	42.1	40.6	0.96	58.8	53.7	0.91	64.2	59.5	0.93
Expressway		37.0		38.6	37.1	0.96	45.6	41.7	0.91	51.7	51.1	0.99
Principal Arterial Divided	16.1	24.0	1.5	32.4	32.0	0.99	37.7	36.9	0.98	40.7	44.3	1.09
Principal Arterial Undivided	15.4	14.4	0.9	21.4	24.7	1.16	32.9	32.9	1.00	41.7	41.7	1.00
Major Arterial Divided					21.3		27.6	27.5	1.00			
Major Arterial Undivided	14.5	8.2	0.6	20.1	16.8	0.84	29.4	24.6	0.83	38.1	37.3	0.98
Minor Arterial	12.4	9.5	0.8	18.0	15.6	0.86	27.7	23.6	0.85	34.7	35.4	1.02
Collector / Local		10.8		12.6	14.1	1.11	18.9	16.7	0.88		33.2	
High-Speed Ramp				53.0	44.8	0.84	39.9	46.7	1.17		52.9	
Medium-Speed Ramp	16.0	16.6	1.0	22.1	25.1	1.14	29.7	32.1	1.08	34.5	32.4	0.94
Low-Speed Ramp					14.8			25.0				
Centroid Connector												

PM Peak Period

FACILITY TYPE	AREA TYPE											
	CBD			Urban			Suburban			Rural		
	Obs.	Est.	Ratio	Obs.	Est.	Ratio	Obs.	Est.	Ratio	Obs.	Est.	Ratio
Freeway	27.9	24.5	0.88	43.1	39.8	0.92	54.3	52.7	0.97	64.4	59.6	0.93
Expressway		37.1		35.2	37.3	1.06	41.1	41.4	1.01	51.2	51.3	1.00
Principal Arterial Divided	12.2	23.9	2.0	27.5	30.9	1.12	34.4	35.6	1.04	41.3	44.0	1.07
Principal Arterial Undivided	11.1	13.1	1.2	19.4	23.8	1.23	30.4	32.5	1.07	41.1	41.7	1.01
Major Arterial Divided					20.8		26.5	27.5	1.03			
Major Arterial Undivided	13.1	6.5	0.5	18.5	15.6	0.84	28.3	23.3	0.82	38.4	37.0	0.96
Minor Arterial	11.4	8.7	0.8	16.9	14.0	0.83	27.1	22.7	0.84	35.2	35.1	1.00
Collector / Local		9.1		11.8	11.8	1.00	17.2	16.5	0.96		33.2	
High-Speed Ramp				52.7	44.0	0.84	38.4	46.3	1.21		52.4	
Medium-Speed Ramp	14.2	16.7	1.2	21.0	24.5	1.16	29.3	30.9	1.05	31.9	32.0	1.00
Low-Speed Ramp					13.3			25.0				
Centroid Connector												

Table 99 - Continued

MD Period

FACILITY TYPE	AREA TYPE											
	CBD			Urban			Suburban			Rural		
	Obs.	Est.	Ratio	Obs.	Est.	Ratio	Obs.	Est.	Ratio	Obs.	Est.	Ratio
Freeway	44.6	36.6	0.82	52.2	47.7	0.91	63.1	57.8	0.92	65.2	61.3	0.94
Expressway		39.2		40.3	42.9	1.07	46.9	47.5	1.01	51.2	51.4	1.00
Principal Arterial Divided	17.0	24.0	1.4	32.3	34.9	1.08	36.8	39.9	1.08	42.1	44.7	1.06
Principal Arterial Undivided	15.0	16.6	1.1	21.5	27.0	1.26	32.1	34.3	1.07	41.6	42.2	1.02
Major Arterial Divided					21.7		28.7	31.5	1.10			
Major Arterial Undivided	14.3	10.1	0.7	20.1	20.7	1.03	29.6	29.0	0.98	38.3	38.9	1.02
Minor Arterial	12.6	11.5	0.9	18.1	18.4	1.02	28.3	27.5	0.97	34.8	36.0	1.03
Collector / Local		12.7		13.2	16.5	1.25	17.6	20.7	1.18		34.1	
High-Speed Ramp				52.6	49.5	0.94	39.1	52.4	1.34		54.9	
Medium-Speed Ramp	15.7	17.2	1.1	22.9	26.6	1.17	30.1	33.7	1.12	32.7	33.8	1.03
Low-Speed Ramp					15.1			25.0				
Centroid Connector												

NT Period

FACILITY TYPE	AREA TYPE											
	CBD			Urban			Suburban			Rural		
	Obs.	Est.	Ratio	Obs.	Est.	Ratio	Obs.	Est.	Ratio	Obs.	Est.	Ratio
Freeway	47.6	37.6	0.79	53.6	49.8	0.93	62.6	58.9	0.94	64.6	61.3	0.95
Expressway		40.0		43.8	44.5	1.02	49.3	48.6	0.99	52.7	51.4	0.98
Principal Arterial Divided	23.2	24.0	1.0	37.0	35.5	0.96	41.1	40.3	0.98	45.7	44.8	0.98
Principal Arterial Undivided	18.5	17.7	1.0	25.1	27.7	1.10	35.6	34.6	0.97	42.9	42.3	0.99
Major Arterial Divided					21.8		31.5	32.0	1.02			
Major Arterial Undivided	16.6	13.4	0.8	22.6	21.9	0.97	31.8	30.4	0.96	39.8	39.4	0.99
Minor Arterial	14.5	12.2	0.8	20.0	19.1	0.96	29.9	28.3	0.95	35.9	36.1	1.01
Collector / Local		12.8		14.8	17.3	1.17	20.5	21.1	1.03		34.1	
High-Speed Ramp				52.8	49.6	0.94	41.4	54.0	1.30		54.9	
Medium-Speed Ramp	17.3	17.6	1.0	25.7	26.9	1.05	32.1	33.9	1.06	37.7	33.8	0.90
Low-Speed Ramp					15.2			25.0				
Centroid Connector												

Table 100 – Number of Highway Network Links with Speed Data

FACILITY TYPE	AREA TYPE				Total
	CBD	Urban	Suburban	Rural	
Freeway	7	418	788	324	1,537
Expressway		401	306	30	737
Principal Arterial Divided	19	192	564	39	814
Principal Arterial Undivided	14	319	743	242	1,318
Major Arterial Divided			34		34
Major Arterial Undivided	23	1,023	1,267	368	2,681
Minor Arterial	44	960	1,237	66	2,307
Collector / Local		15	2		17
High-Speed Ramp		5	2		7
Medium-Speed Ramp	1	32	64	13	110
Low-Speed Ramp					-
Centroid Connector					-
ToTal	**108**	**3,365**	**5,007**	**1,082**	**9,562**

Table 101 – New Jersey Toll Road Volume by Vehicle Type

New Jersey Turnpike

Interchanges	Reference	2015 Count Total			Model Estimates Total			Pct Difference	
		Truck	Total	%Heavy	Truck	Total	%Heavy	Truck	Total
4 - 5	tpk01	9,543	78,689	12.1%	17,723	89,086	19.9%	86%	13.2%
5 - JCT	tpk02	10,061	83,526	12.0%	17,729	95,433	18.6%	76%	14.3%
JCT - 6	tpk03	5,782	38,420	15.0%	2,647	20,646	12.8%	-54%	-46.3%
BRIDGE	tpk04	6,645	42,548	15.6%	4,807	57,533	8.4%	-28%	35.2%
JCT - 7	tpk05	14,703	113,529	13.0%	17,985	104,171	17.3%	22%	-8.2%
7 - 7A	tpk06	17,152	124,624	13.8%	22,436	117,476	19.1%	31%	-5.7%
7A - 8	tpk07	20,044	137,374	14.6%	25,901	138,571	18.7%	29%	0.9%
8 - 8A	tpk08	19,919	141,465	14.1%	25,711	134,504	19.1%	29%	-4.9%
8A - 9	tpk09	22,756	161,146	14.1%	28,048	147,230	19.1%	23%	-8.6%
9 - 10	tpk10	25,313	193,196	13.1%	28,672	195,207	14.7%	13%	1.0%
10 - 11	tpk11	24,390	182,250	13.4%	24,707	203,806	12.1%	1%	11.8%
11 - 12	tpk12	30,534	220,378	13.9%	26,836	213,065	12.6%	-12%	-3.3%
12 - 13	tpk13	33,346	234,116	14.2%	29,842	221,542	13.5%	-11%	-5.4%
13 - 13A	tpk14	37,276	254,159	14.7%	28,541	258,978	11.0%	-23%	1.9%
13A - 14	tpk15	32,378	217,831	14.9%	25,028	205,422	12.2%	-23%	-5.7%
14 - 14A	tpk16	8,113	101,176	8.0%	4,748	86,542	5.5%	-41%	-14.5%
14A - 14B	tpk17	3,836	78,331	4.9%	1,857	64,972	2.9%	-52%	-17.1%
14B - 14C	tpk18	3,364	74,908	4.5%	1,732	69,087	2.5%	-49%	-7.8%
14 - M	tpk19	18,087	117,365	15.4%	19,957	177,453	11.2%	10%	51.2%
15E - JE	tpk21	7,356	55,261	13.3%	2,259	48,922	4.6%	-69%	-11.5%
JE - 15X	tpk22	16,729	128,443	13.0%	5,395	128,938	4.2%	-68%	0.4%
15X - 16E	tpk23	15,089	119,253	12.7%	4,506	123,940	3.6%	-70%	3.9%
16E - 17	tpk24	2,326	15,854	14.7%	2,323	11,538	20.1%	0%	-27.2%
JW - 15W	tpk27	11,235	68,318	16.4%	14,648	65,192	22.5%	30%	-4.6%
15W - 16W	tpk28	20,198	126,976	15.9%	25,224	117,658	21.4%	25%	-7.3%
16W - 18W	tpk29	15,202	91,631	16.6%	23,240	122,856	18.9%	53%	34.1%
Total		**431,377**	**3,200,767**	**13.5%**	**432,500**	**3,219,769**	**13.4%**	**0%**	**0.6%**
Total in NJTPA Area		**347,447**	**2,582,057**	**13.5%**	**323,272**	**2,596,853**	**12.4%**	**-7%**	**0.6%**

Garden State Parkway

Toll Plaza	Reference	2015 Count			Model			Pct Diff
		NB	SB	TOTAL	NB	SB	TOTAL	Total
Raritan River	gsp05	130,726	112,597	243,323	131,543	122,698	254,241	4.5%
Asbury	gsp04	76,968	78,507	155,475	70,629	68,880	139,509	-10.3%
Toms River	gsp03	46,060	66,430	112,490	37,659	64,075	101,734	-9.6%
Barnegat	gsp02	33,773	31,712	65,485	23,886	22,819	46,705	-28.7%
New Gretna	gsp01	18,801	21,134	39,935	13,873	14,270	28,144	-29.5%
TOTAL		**306,328**	**310,380**	**616,708**	**277,591**	**292,742**	**570,333**	**-7.5%**

Table 102 – Delaware River Crossing Summary

Name	Total Volume			
	Observed	Estimated	Difference	%Diff
Trenton-Morrisville Toll Bridge (US-1)	28,100	29,779	1,679	6.0%
	28,100	33,169	5,069	18.0%
New Hope-Lambertville Bridge	6,050	5,243	(807)	-13.3%
	6,050	5,967	(83)	-1.4%
Interstate 78 Toll Bridge	38,721	43,788	5,067	13.1%
	40,990	46,224	5,234	12.8%
Easton-Phillipsburg Toll Bridge (US 22)	16,650	16,300	(350)	-2.1%
	16,650	18,494	1,844	11.1%
Portland-Columbia Toll Bridge	3,850	7,110	3,260	84.7%
	3,850	7,589	3,739	97.1%
Delaware Water Gap Toll Bridge	33,744	30,160	(3,584)	-10.6%
	33,571	30,966	(2,605)	-7.8%
Milford-Montague Toll Bridge (US 206)	3,300	2,594	(706)	-21.4%
	3,300	3,160	(140)	-4.2%
Toll Bridge Total	**262,926**	**280,543**	**17,617**	**6.7%**

Name	Total Volume			
	Observed	Estimated	Difference	%Diff
Lower Trenton	8,000	6,909	(1,091)	-13.6%
	8,000	5,523	(2,477)	-31.0%
Calhoun Street	8,800	9,385	585	6.6%
	8,800	9,619	819	9.3%
Scudder Falls (I-95)	29,600	30,257	657	2.2%
	29,600	27,750	(1,850)	-6.2%
Washington Crossing (Rt 532)	3,650	4,007	357	9.8%
	3,650	3,760	110	3.0%
New Hope-Lambertville	5,868	7,050	1,182	20.1%
	5,203	6,917	1,714	32.9%
Center Bridge-Stockton	2,350	3,723	1,373	58.4%
	2,350	3,766	1,416	60.3%
Frenchtown-Uhterstown	2,000	3,026	1,026	51.3%
	2,000	2,663	663	33.1%
Milford-Upper Black Eddy	1,850	1,739	(111)	-6.0%
	1,850	2,128	278	15.0%
Riegelsville	1,700	947	(753)	-44.3%
	1,700	774	(926)	-54.5%
Northampton	9,950	12,542	2,592	26.1%
	9,950	9,612	(338)	-3.4%
Belvidere-Riverton	2,200	1,681	(519)	-23.6%
	2,200	1,136	(1,064)	-48.3%
Non-Toll Bridges	**151,271**	**154,914**	**3,643**	**2.4%**
Grand Total	**414,197**	**435,457**	**21,260**	**5.1%**

The estimated Trans-Hudson vehicular traffic was compared to the observed data in Table 103. At the system level, the comparison indicates that the model was slightly over-assigned on the westbound and slightly under-assigned on the eastbound but both are still within tolerable range. While the traffic comparison of northern bridges, between Verrazano and Newburgh-Beacon bridges are generally within reasonable range. The directional volume split on Holland Tunnel are more significant than the observed counts indicated.

Table 103 – Trans-Hudson Vehicular Traffic Summary

LOCATION	DIRECTION	Observation			Model			Pct. Difference	
		Auto	Truck	TOTAL	Auto	Truck	TOTAL	Auto	TOTAL
Newburgh-Beacon Bridge	EB	29,466	4,831	34,297	29,881	4,655	34,536	1.4%	0.7%
	WB	29,466	4,831	34,297	31,687	4,260	35,948	7.5%	4.8%
Bear Mountain Bridge	EB	9,946	241	10,187	9,445	267	9,712	-5.0%	-4.7%
	WB	9,946	241	10,187	10,267	337	10,605	3.2%	4.1%
Tappan Zee Bridge	EB	63,609	9,017	72,626	63,128	5,673	68,801	-0.8%	-5.3%
	WB	57,771	8,189	65,960	60,263	5,196	65,459	4.3%	-0.8%
George Washington Bridge	EB	126,355	13,193	139,548	120,926	14,961	135,886	-4.3%	-2.6%
	WB	122,317	16,646	138,963	125,434	16,360	141,794	2.5%	2.0%
Lincoln Tunnel	EB	50,345	3,917	54,262	49,312	3,658	52,970	-2.1%	-2.4%
	WB	56,335	3,186	59,521	51,281	4,699	55,980	-9.0%	-5.9%
Holland Tunnel	EB	43,049	-	43,049	39,510	-	39,510	-8.2%	-8.2%
	WB	46,318	-	46,318	52,913	-	52,913	14.2%	14.2%
Verrazano-Narrows Bridge	EB	96,405	7,213	103,618	80,846	12,986	93,832	-16.1%	-9.4%
	WB	89,350	5,155	94,505	84,109	11,320	95,429	-5.9%	1.0%
Total	**EB**	**419,175**	**38,412**	**457,587**	**393,048**	**42,200**	**435,248**	**-6.2%**	**-4.9%**
	WB	**411,503**	**38,248**	**449,751**	**415,955**	**42,173**	**458,128**	**1.1%**	**1.9%**
Goethals Bridge	EB	37,009	4,474	41,483	42,017	5,590	47,607	13.5%	14.8%
	WB	32,863	4,259	37,122	36,632	10,375	47,007	11.5%	26.6%
Outerbridge Crossing	EB	36,381	2,900	39,281	29,185	9,966	39,151	-19.8%	-0.3%
	WB	32,233	2,259	34,492	31,965	3,473	35,438	-0.8%	2.7%
Bayonne Bridge	SB	5,697	335	6,032	5,806	1,146	6,952	1.9%	15.2%
	NB	4,640	168	4,808	4,684	1,181	5,866	0.9%	22.0%
Total	**EB/NB**	**79,087**	**7,709**	**86,796**	**77,008**	**16,701**	**93,710**	**-2.6%**	**8.0%**
	WB/SB	**69,736**	**6,686**	**76,422**	**73,281**	**15,029**	**88,310**	**5.1%**	**15.6%**
Total All Bridges	**EB/NB**	**498,262**	**46,121**	**544,383**	**470,056**	**58,902**	**528,958**	**-5.7%**	**-2.8%**
	WB/SB	**481,239**	**44,934**	**526,173**	**489,236**	**57,202**	**546,438**	**1.7%**	**3.9%**

Table 104 – Detail Screenline Summary

ScreenLine	Location	Observed Counts	Distribution	Estimated Volumes	Distribution	Ratio
Screenline 1	CR_613 Passaic Ave	23,732	3.0%	8,844	1.2%	0.37
	NJ-23	18,214	2.3%	26,426	3.5%	1.45
	US-46	128,888	16.5%	135,220	17.8%	1.05
	NJ-19	35,278	4.5%	37,919	5.0%	1.07
	Main St	11,471	1.5%	8,674	1.1%	0.76
	SR-20/McLean Blvd	74,998	9.6%	71,853	9.5%	0.96
	River Dr	18,885	2.4%	19,684	2.6%	1.04
	GSP	53,148	6.8%	78,278	10.3%	1.47
	NJ-17	90,344	11.6%	87,068	11.5%	0.96
	S River St	14,258	1.8%	4,149	0.5%	0.29
	Teaneck Rd	6,788	0.9%	8,767	1.2%	1.29
	NJ Turnpike	210,883	27.0%	167,805	22.1%	0.80
	Rte 93/Grand Ave	23,331	3.0%	26,819	3.5%	1.15
	US 46/Bergen Blvd	19,657	2.5%	15,025	2.0%	0.76
	Palisade Ave	25,181	3.2%	35,554	4.7%	1.41
	River Rd	26,012	3.3%	25,983	3.4%	1.00
	TOTAL	**781,068**	**100.0%**	**758,068**	**100.0%**	**0.97**
Screenline 2	I-95	128,443	31.9%	128,938	37.2%	1.00
	CR-508 (Newark-Jersey City Turnpike)	56,092	13.9%	33,068	9.5%	0.59
	US-1/9 (Pulaski Skyway)	39,373	9.8%	28,588	8.2%	0.73
	US-1/9 (Truck)	77,288	19.2%	69,661	20.1%	0.90
	I-78 (NJ Turnpike Ext)	101,176	25.1%	86,542	25.0%	0.86
	TOTAL	**402,372**	**100.0%**	**346,798**	**100.0%**	**0.86**
Screenline 3	NJ-3	106,321	19.9%	127,059	23.7%	1.20
	Rte 510/S Orange Ave	17,065	3.2%	8,127	1.5%	0.48
	Chancellor Ave	8,056	1.5%	16,300	3.0%	2.02
	US 22	66,124	12.4%	61,895	11.5%	0.94
	NJ-27/Newark Ave	13,410	2.5%	14,605	2.7%	1.09
	US-9	69,395	13.0%	64,453	12.0%	0.93
	I-95	254,159	47.5%	244,356	45.5%	0.96
	TOTAL	**534,530**	**100.0%**	**536,794**	**100.0%**	**1.00**
Screenline 4	Rte 10/W Mt Pleasant Ave	30,773	3.8%	30,793	3.9%	1.00
	Old Short Hills Rd	12,239	1.5%	15,544	2.0%	1.27
	Millburn Ave	19,303	2.4%	16,914	2.1%	0.88
	I-78 Express (W of Vauxhall Rd)	162,681	20.1%	163,340	20.8%	1.00
	Morris Ave	38,080	4.7%	49,517	6.3%	1.30
	Garden State Pkwy	187,621	23.1%	169,100	21.5%	0.90
	Rte 509/Salem Rd	6,332	0.8%	7,231	0.9%	1.14
	E 1st Ave	10,120	1.2%	12,689	1.6%	1.25
	Rte 27/E St Georges Ave	20,871	2.6%	24,027	3.1%	1.15
	E Elizabeth Ave	13,078	1.6%	12,259	1.6%	0.94
	US-9	76,003	9.4%	74,000	9.4%	0.97
	NJ Turnpike	234,116	28.9%	211,435	26.9%	0.90
	TOTAL	**811,217**	**100.0%**	**786,848**	**100.0%**	**0.97**
Screenline 5	NJ-27 (N of Cortelyous Ln)	22,414	6.8%	22,371	7.3%	1.00
	US-1 (N of Finnegans Ln)	68,243	20.7%	60,598	19.7%	0.89
	US 130 (N of Davidson Mill Rd)	38,865	11.8%	41,021	13.4%	1.06
	NJ Turnpike	161,146	49.0%	147,230	47.9%	0.91
	CR-535/Cranbury South River Rd (N of Docks	19,138	5.8%	19,085	6.2%	1.00
	Spotswood Englishtown Rd	9,577	2.9%	7,093	2.3%	0.74
	CR-527/Old Bridge-Englishtown Rd	9,666	2.9%	9,780	3.2%	1.01
	TOTAL	**329,049**	**100.0%**	**307,178**	**100.0%**	**0.93**
Screenline 6	I-80 (W of Exit 38)	152,068	31.7%	158,937	32.8%	1.05
	US-46	7,456	1.6%	5,120	1.1%	0.69
	Cooper Rd	2,774	0.6%	2,040	0.4%	0.74
	Mendham Rd (E of Whitehead Rd)	11,347	2.4%	11,653	2.4%	1.03
	US-202 (Mt Kemble Ave)	8,226	1.7%	4,921	1.0%	0.60
	I-287 (W of Sand Spring Rd)	96,661	20.2%	96,531	19.9%	1.00
	Blue Mill Rd	8,492	1.8%	7,542	1.6%	0.89
	Springfield Ave (E of Snyder Ave)	13,978	2.9%	12,431	2.6%	0.89
	Mountain Ave (E of Snyder Ave)	17,606	3.7%	20,825	4.3%	1.18
	I-78 (Exit 43)	94,416	19.7%	109,163	22.5%	1.16
	US-22 (S of Park Ave)	66,042	13.8%	55,626	11.5%	0.84
	TOTAL	**479,066**	**100.0%**	**484,789**	**100.0%**	**1.01**

Table 104 - Continued

ScreenLine	Location	Observed Counts	Distribution	Estimated Volumes	Distribution	Ratio
Screenline 7	I-78 (W of Exit 43)	94,416	18.3%	109,163	20.5%	1.16
	Valley Rd	6,782	1.3%	7,784	1.5%	1.15
	US-22	52,189	10.1%	50,092	9.4%	0.96
	CR-531/Park Ave	12,948	2.5%	16,784	3.2%	1.30
	West End Ave	9,417	1.8%	13,532	2.5%	1.44
	N Washington Ave	18,081	3.5%	20,337	3.8%	1.12
	I-287 (Delaware & River Canal)	110,975	21.5%	117,891	22.1%	1.06
	Landing Ln	28,555	5.5%	15,239	2.9%	0.53
	George St (N of Livingston Ave)	8,732	1.7%	19,436	3.6%	2.23
	New St	13,705	2.7%	15,242	2.9%	1.11
	NJ Turnpike	161,146	31.2%	147,230	27.6%	0.91
	TOTAL	**516,946**	**100.0%**	**532,728**	**100.0%**	**1.03**
Screenline 8	I-80 (W of CR 637/Reynolds Ave)	187,394	43.5%	243,091	52.9%	1.30
	US-202	17,379	4.0%	19,779	4.3%	1.14
	NJ-23	66,237	15.4%	63,080	13.7%	0.95
	Riverdale Rd	7,935	1.8%	7,285	1.6%	0.92
	Hamburg Turnpike	17,216	4.0%	10,129	2.2%	0.59
	Ringwood Ave	13,964	3.2%	8,651	1.9%	0.62
	US-202	14,385	3.3%	8,585	1.9%	0.60
	Colonial Rd	8,325	1.9%	580	0.1%	0.07
	NJ-208	48,225	11.2%	64,040	13.9%	1.33
	Franklin Ave	13,608	3.2%	11,847	2.6%	0.87
	Pulis Ave	7,807	1.8%	6,968	1.5%	0.89
	Darlington Ave	4,191	1.0%	2,672	0.6%	0.64
	N Central Ave	4,284	1.0%	520	0.1%	0.12
	E Franklin Turnpike	19,730	4.6%	12,363	2.7%	0.63
	TOTAL	**430,680**	**100.0%**	**459,589**	**100.0%**	**1.07**
Screenline 9	NJ 27/ Middlesex Ave (N of Green St)	13,187	6.3%	19,058	10.4%	1.45
	Green St	13,668	6.5%	9,942	5.4%	0.73
	US 1	67,717	32.3%	38,412	21.0%	0.57
	Woodbridge Center Dr	16,584	7.9%	13,004	7.1%	0.78
	CR 514/Main St	18,394	8.8%	1,206	0.7%	0.07
	CR 611/State St	6,184	3.0%	27,018	14.7%	4.37
	Outerbridge Crossing	73,773	35.2%	74,589	40.7%	1.01
	TOTAL	**209,507**	**100.0%**	**183,229**	**100.0%**	**0.87**
Screenline 10	CR 521/River Rd	6,600	2.4%	5,754	2.4%	0.87
	NJ 23/CR 443	2,676	1.0%	2,660	1.1%	0.99
	CR 519/Mountain Rd	1,001	0.4%	3,000	1.3%	3.00
	CR 651/Unionville Rd	454	0.2%	426	0.2%	0.94
	CR 284	1,628	0.6%	2,988	1.3%	1.84
	McAfee Glenwood Rd	2,608	1.0%	4,714	2.0%	1.81
	CR 515	251	0.1%	243	0.1%	0.97
	CR 511/Lakeside Rd	3,711	1.4%	1,106	0.5%	0.30
	I-287 (NJ-NJ State Border)	148,880	54.3%	97,002	41.3%	0.65
	E Saddle River Rd	6,556	2.4%	5,235	2.2%	0.80
	Garden State Pkwy	48,971	17.9%	40,592	17.3%	0.83
	Palisades Interstate Pkwy	40,888	14.9%	59,107	25.2%	1.45
	US-9 W	10,051	3.7%	12,178	5.2%	1.21
	TOTAL	**274,275**	**100.0%**	**235,005**	**100.0%**	**0.86**
Screenline 11	I-78	79,711	36.4%	90,013	38.9%	1.13
	Northampton St Bridge	19,900	9.1%	22,155	9.6%	1.11
	US 22 (Easton-Phillipsburg Toll Bridge)	33,300	15.2%	34,794	15.0%	1.04
	Riverton - Belvidere Bridge	4,400	2.0%	2,818	1.2%	0.64
	CR 94 (Portland-Columbia Toll Bridge)	7,700	3.5%	14,699	6.4%	1.91
	I-80 (Delaware Water Gap Toll Bridge)	67,315	30.7%	61,126	26.4%	0.91
	US 206 (Milford-Montague Toll Bridge)	6,600	3.0%	5,754	2.5%	0.87
	TOTAL	**218,926**	**100.0%**	**231,358**	**100.0%**	**1.06**
Screenline 12	CR 627 (Riegelsville Bridge)	3,400	1.7%	1,721	0.8%	0.51
	Upper Black Eddy-Milford Bridge	3,700	1.9%	3,867	1.9%	1.05
	Uhlerstown-Frenchtown Bridge	4,000	2.0%	5,689	2.8%	1.42
	Centre Bridge-Stockton Bridge	4,700	2.4%	7,489	3.7%	1.59
	US 202 (New Hope-Lambertville Toll Bridge)	12,100	6.2%	11,210	5.5%	0.93
	New Hope-Lambertville Bridge	11,071	5.7%	13,966	6.8%	1.26
	Washington Crossing Bridge	7,300	3.7%	7,768	3.8%	1.06
	I-95 (Scudder Falls Bridge)	59,200	30.3%	58,007	28.4%	0.98
	Calhoun Street Bridge	17,600	9.0%	19,003	9.3%	1.08
	Lower Trenton Bridge	16,000	8.2%	12,431	6.1%	0.78
	US-1 (Trenton-Morrisville Toll Bridge)	56,200	28.8%	62,948	30.8%	1.12
	TOTAL	**195,271**	**100.0%**	**204,099**	**100.0%**	**1.05**

Table 104 - Continued

ScreenLine	Location	Observed Counts	Distribution	Estimated Volumes	Distribution	Ratio
Screenline 13	CR-522/Freehold Rd-Tennent Ave	12,107	3.5%	5,802	1.7%	0.48
	CR-3/Tennent Rd	11,746	3.4%	12,756	3.8%	1.09
	US-18 (Under Wyncrest Rd Overpass)	48,404	13.8%	41,251	12.2%	0.85
	NJ-79 (S of Newton St)	16,246	4.6%	27,540	8.2%	1.70
	NJ-34 (N of Conover Rd)	14,478	4.1%	16,326	4.8%	1.13
	CR-50/Swimming River Rd	9,804	2.8%	7,145	2.1%	0.73
	GSP (S of Newman Springs Rd/CR 520)	164,039	46.9%	125,398	37.1%	0.76
	NJ-13/Shrewsbury Ave	17,291	4.9%	19,761	5.9%	1.14
	NJ-35/Broad St	21,083	6.0%	37,688	11.2%	1.79
	Branch Ave	11,164	3.2%	19,242	5.7%	1.72
	Seven Bridges Rd (N of Silverside Ave)	10,012	2.9%	10,539	3.1%	1.05
	NJ-36 (Ocean Ave N of Beach Rd)	13,542	3.9%	14,191	4.2%	1.05
	TOTAL	**349,916**	**100.0%**	**337,639**	**100.0%**	**0.96**
Screenline 14	GSP (Alfred E. Driscoll Bridge)	236,459	70.1%	234,006	72.5%	0.99
	US-9 (Ellis S Vieser Memorial Bridge)	80,654	23.9%	68,201	21.1%	0.85
	NJ-35	20,054	5.9%	20,657	6.4%	1.03
	TOTAL	**337,167**	**100.0%**	**322,863**	**100.0%**	**0.96**
Screenline 15	Goethal's Bridge (I-278)	78,605	12.2%	94,614	14.3%	1.20
	Bayonne Bridge	10,840	1.7%	12,817	1.9%	1.18
	I-78 (Holland Tunnel)	89,367	13.9%	92,423	14.0%	1.03
	Lincoln Tunnel (NJ/NY-495)	113,783	17.6%	108,950	16.5%	0.96
	I-95 (NJ Turnpike)	278,511	43.2%	277,681	42.0%	1.00
	Outerbrigde Crossing	73,773	11.4%	74,589	11.3%	1.01
	TOTAL	**644,879**	**100.0%**	**661,074**	**100.0%**	**1.03**
Screenline 16	Tappan Zee Bridge (I-287)	138,586	60.9%	134,261	59.7%	0.97
	US-202(Bear Mountain Bridge)	20,374	9.0%	20,316	9.0%	1.00
	I-84 (Newburgh-Beacon Bridge)	68,594	30.1%	70,484	31.3%	1.03
	TOTAL	**227,554**	**100.0%**	**225,061**	**100.0%**	**0.99**
Screenline 17	Newark Jersey City Tpk	16,198	4.7%	23,028	7.1%	1.42
	I-280	73,869	21.2%	83,052	25.6%	1.12
	Raymond Blvd	21,804	6.3%	11,867	3.7%	0.54
	I-95	236,321	67.9%	206,610	63.7%	0.87
	TOTAL	**348,192**	**100.0%**	**324,557**	**100.0%**	**0.93**
Screenline 18	I-78 (NJ Turnpike Ext)	101,176	53.6%	86,542	58.0%	0.86
	US-1/US-9 (Pulaski Skyway)	39,373	20.9%	28,588	19.2%	0.73
	NJ-7	48,045	25.5%	33,984	22.8%	0.71
	TOTAL	**188,594**	**100.0%**	**149,114**	**100.0%**	**0.79**
Screenline 19	I-295 (N of W Burlington St)	67,121	20.6%	60,156	21.3%	0.90
	US-206	20,659	6.3%	5,817	2.1%	0.28
	US-130	25,889	8.0%	18,256	6.5%	0.71
	Ward Ave	3,564	1.1%	3,092	1.1%	0.87
	NJ Turnpike	124,624	38.3%	117,476	41.6%	0.94
	Crosswicks Chesterfield Rd	3,376	1.0%	6,152	2.2%	1.82
	Jacobstown Rd	4,305	1.3%	5,576	2.0%	1.30
	Cookstown New Egypt Rd	5,526	1.7%	6,141	2.2%	1.11
	NJ-70	12,930	4.0%	15,932	5.6%	1.23
	NJ-72	8,498	2.6%	8,542	3.0%	1.01
	GSP	39,935	12.3%	28,144	10.0%	0.70
	US-9	9,164	2.8%	7,221	2.6%	0.79
	TOTAL	**325,591**	**100.0%**	**282,505**	**100.0%**	**0.87**

13. MODEL CONVERGENCE

13.1 INTRODUCTION

This section describes the convergence functions for the feedback process that has been implemented in NJRTM-E in line with the 4-step demand modeling process. In this sequential process, the convergence functions control the model iterations as the iterative process approaches an optimal solution. The convergence process monitors statistics from trip distribution and highway assignment in order to determine when both the travel patterns and highway volumes have achieved consistency between model iterations. When the variation of both of these model components is within the limits of the adopted tolerances, the model converge process will be satisfied and feedback process will be terminated. Note that future year applications of the model may require more feedback iterations than the calibration year as overall demand and congestion levels may increase causing the model to process additional iterations to meet the convergence criteria.

13.2 TRIP DISTRIBUTION CONVERGENCE

The convergence of the trip distribution process ensures that the allocation of travel patterns for the home-based work purpose fully reflects the impact of congestion generated as part of the highway assignment. The convergence functions are based on the trips and the travel impedance represented with the multimodal composite impedance term discussed in Chapter 7. The convergence criteria are focused on only HBW trip purposes because these two purposes (direct and strategic) are the only ones distributed based on peak period travel conditions which are subject to the feedback conditions. The convergence function measures the variation between successive iterations with a standard statistical test known as the coincidence ratio.

<u>Coincidence Ratio</u>

The coincidence ratio is commonly used as a measure to determine the degree of replication between two distributions that are assumed to be similar, such as an observed and estimated trip table. In the case of a model convergence process, the coincidence ratio is measuring the similarity between successive iterations of the trip table. If the ratio's value is 0.0, the two distributions are completely disjointed while a value of 1.0 indicates identical distributions. As the trip tables become increasingly similar following the progressing of model iterations, the coincidence ratio approaches a value of 1.0. The equation is defined as follows:

$$coincidence \quad ratio = \frac{\sum_{t=1}^{T} \min\left\{ \frac{f^m(t)}{F^m}, \frac{f^0(t)}{F^0} \right\}}{\sum_{t=1}^{T} \max\left\{ \frac{f^m(t)}{F^m}, \frac{f^0(t)}{F^0} \right\}}$$

Where:

$f^m(t)$	=	frequency of trips for time interval t in iteration n
$f^0(t)$	=	frequency of trips for time interval t in iteration n-1
F^m	=	total O-D trips in iteration n
F^0	=	total O-D trips in iteration n-1

T = number of time interval

13.3 HIGHWAY ASSIGNMENT CONVERGENCE

The convergence of the highway assignment process indicates that the amount of traffic and hence congestion on the individual network links is nearly identical between iterations. This convergence is a critical feature of the model, as the congestion is fed back to the prior model components that rebuild highway and transit paths/skims, which in turn influences both trip distribution and mode choice. Once the highway assignment convergence is achieved and the resulting trip distribution and mode choice estimates are nearly identical between successful iterations, the overall model convergence is complete. The method used to determine the degree of convergence between two networks is a statistical measure known as the route mean square error (RMSE). When the differences are expressed on a percentage basis, the term is referred to as the percent RMSE. This term is also commonly employed to test the degree of similarity between traffic estimated by model and observed traffic counts.

<u>Percent RMSE (Root Mean Square Error)</u>

The percent RMSE is commonly used to determine how closely estimated volumes replicate observed count data. In the iterative model process, the percent RMSE will be used as the convergence criterion for the highway assignment, essentially measuring the difference in the link volumes between successive model assignments. The percent RMSE will be measured using the assigned traffic on the links between the current iteration (iteration "n") and the previous iteration (n-1). As the assigned traffic volumes on the links in the current iteration approach the values from the previous iteration, the percent RMSE term approaches zero. The formula for the RMSE term is as follows:

$$\%RMSE = \frac{\sqrt{\dfrac{\sum_i \left(f_i^n - f_i^{n-1}\right)^2}{k-1}}}{\dfrac{\sum_i f_i^{n-1}}{k}} \times 100$$

Where:

f_i^n = estimated link volume at link i for iteration n

k = number of total links

13.4 COMPARISON OF FEEDBACK METHODS

A critical element in the model convergence process is the method used to establish the trip table for each subsequent model iteration. It is necessary to "blend" the trips estimated in the current model iteration with the trips with the prior iteration in order to allow both distribution estimates to influence the subsequent mode choice and assignment processes. This blending also helps minimize the model's tendency to oscillate back and forth between iterations. Two types of MSA methods were tested for model feedback: 1/k MSA and ½ MSA. The formula for the MSA Method is as follows:

$$Trips_{adjusted} = (1-\alpha)\times Trips_{previous} + \alpha \times Trips_{current}$$

Where:

$Trips_{adjusted}$ = Adjusted trips (after trip distribution and before mode choice)

α = Weight factor, 1/(Number of Iterations) for 1/k MSA and ½ for ½ MSA

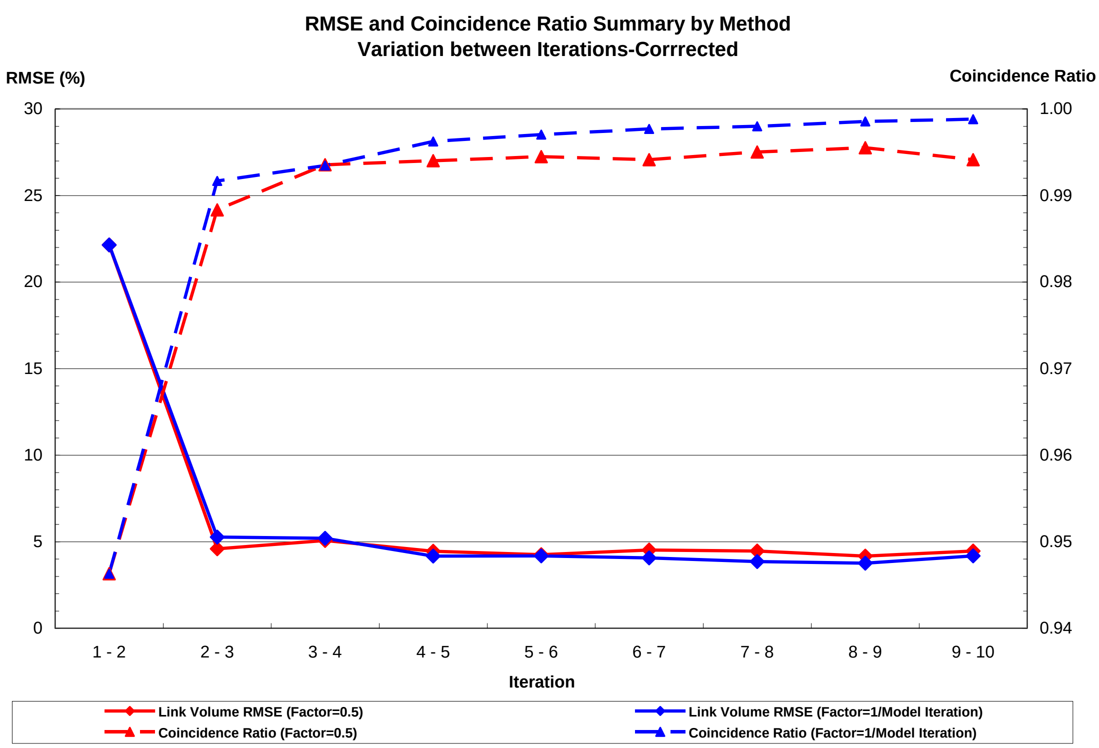
$Trips_{previous}$ = Trips from previous iteration

$Trips_{current}$ = Trips from gravity trip distribution model

As both equations show, the trips from the previous iteration and trips from the current trip distribution are weighted to form the adjusted trips which are used for the subsequent mode choice and assignment procedures. Note that only home-based-work trips use peak skims and are therefore subject to the MSA process. As such the two Home-Based work purposes are adjusted every iteration after the first iteration.

For 1/K MSA Method, α is 1/(current iteration index). For instance, it is 1/3 when it is at the 3rd iteration. For ½ MSA Method, α is always 0.5. As the number of iterations increases, 1/K MSA Method puts less weight on the current iteration while the ½ MSA Method always uses ½ as the weight for the current iteration. To determine which method provided a superior process for the NJRTM-E model, a 10-iteration trial was performed for each method. The results of these trials are shown in Figure 40. Although the ½ MSA Method generates a better RMSE value of less than 5% by the third model iteration, the 1/k Method provides a superior coincidence ratio value which is more stable in subsequent iterations. Note also that either technique appears to generate RMSE values of less than 5% after the fourth model iteration. On this basis the 1/k Method was adopted for the NJRTM-E convergence process.

Figure 40 – RMSE & Coincidence Ratio Summary by MSA Method



13.5 FEEDBACK WITHIN CUBE ENVIRONMENT

For reference purposes, this section summarizes the processing of files within the iterative model structure. This includes filenames and copy procedures performed during each model iteration, as well as the CUBE naming process that stores output files by iteration.

Iteration-Dependent Files

Two files exist that need to be stored for analysis governing model convergence. The first file (HBWPTRP.TRP) will be copied into a file (HBWPTRP.TRP-PREVIOUS) so that it will be available for both model convergence testing and the iteration weighing of trips via the MSA process. It should be noted that this file is created during the first iteration in a separate portion of the peak period distribution. For all iterations after the first iteration, the HBWPRTP.TRP file is generated directly within the MSA process.

During the testing of model convergence, this file is compared to the existing “previous” version and then copied into the previous version in preparation for the next convergence test. This copy step immediately follows convergence testing (within the HWYASSC2.S PILOT step).

The second file (HWYFBNET.NET) is generated following the AM peak highway assignment. For the first iteration, the model copies this file into a separate file (HWYFBNET-PREVOUS.NET) so that it is available for the second iteration when the convergence processing is initially performed. For all subsequent iterations, the current feedback network is copied following the convergence analysis in the HWYASSC2.S PILOT step.

Highway Path Building

During the first iteration of the highway peak period skims, congested travel time is set at 1.20 * T0. For all iterations afterwards congested time is obtained directly from T0 updated following the am peak period loading of each iteration.

Transit Network and Speed Processing

Note that the transit network speed processing script is now iteration dependent, so that the first iteration copies the T0 field into TR. All exclusive transit lane options (TCODE controlled) will use the original freeflow time in the TR field, while other links will have T0 updated following the am peak period loading of each iteration.

Trip Distribution

Note that the MSA step provides the composite file HBWPTRP.TRP for the convergence testing as well as the MSA “weighted files” for each HBW trip purpose. These weighted files are copied into the standard HBWxPTRP.TRP files as part of the TRIPDISTMSA5.S PILOT script within the MSA component. This copy step is performed for each iteration after the first iteration. Note that the MSA process is only initiated during the second iteration, so the TRIPDISTMSA5.S script does not test for iteration.

Mode Choice

Following the peak period mode share calculations, it was necessary to establish the transit shares for each zonal pair for the next iteration of trip distribution. Since the composite impedance calculation uses zonal transit shares, prior to mode choice, it is necessary to establish the shares for the first model iteration via a seed process. The seed process generates shares for both the peak and off-peak periods in a "support application" called TRANSIT SHARES SEED PROCESSING. This process uses inputs from a previous "baseline" condition as a means of providing shares for the first iteration transit shares.

Note that these shares also use the NYMTC baseline mode shares for estimating transit shares in the NYMTC region. However, since the coded transit network within the NYMTC-controlled mode choice region is minimal, these shares are not currently used in the composite impedance calculations. If/When the transit network is extended into the NYMTC-controlled region, the shares can be applied to estimate/influence the composite impedance term.

The peak period seed file is called REGION_PKSHR.TAB. Since the off-peak period is not carried through the feedback loop, this file (REGION_OPSHR.TAB) is calculated as part of the seed process. Both of these files are stored in the {SEDID} data directory since the transit shares are a combination of both network and socioeconomic conditions. These files should be able to approximate transit shares well enough for the initial model iteration.

The FB_PKSHR.TAB file is used to store the transit shares for each subsequent model iteration. Within the model loop control, this file is denoted as the CURRPKSHR.MAT and is used as input into the peak period composite impedance calculation

Highway Assignment

Note that the conditional testing of model convergence controls the copying of the current combined HBW trips and AM feedback network into the "previous" versions. Therefore if a model converges before the maximum number of iterations, the previous versions will be retained rather than being overwritten by the copy step.

Cube Naming Convention / Output Files by Iteration

Selected files are copied into iteration-specific versions and are stored with an extended filename (xxxx_Iter0y.ext) where "y" is the model iteration of the file. These files are identified on the application flowchart

14. TRANSIT ASSIGNMENT

14.1 INTRODUCTION

The transit assignment process is used to distribute transit passengers to transit lines in both peak and off-peak period. The different trip tables from the mode choice model are combined into four trip tables (combination of two time-periods and two access sub-modes). For each time period, the assignment process was performed separately for each walk-access and drive-access transit modes resulting in 12 assignment processes were performed for each time period:

- Walk-access and auto-access for bus
- Walk-access and auto-access for rail
- Walk-access and auto-access for PATH
- Walk-access and auto-access for LRT
- Walk-access and auto-access for ferry
- Walk-access and auto-access for long-haul ferry

The parameters used for controlling the assignment process are identical to those used in the transit path-building process. The only difference is that in the path-building process, skims are set as the outputs, while in the assignment process, transit trips are added as inputs, and transit volumes by link by line are added as output.

Two executable programs coded in C-Based program are used to generate the ridership summary. These custom programs were developed for the NJT Model and are structured to summarize ridership by the major transit system components. These components include the major line-haul transit routes by mode and summaries of transit activity and the major transit stations served by NJ Transit. The first series of tables summarize the ridership and station activity of the individual commuter rail lines. These tables are followed by several other tables that summarize the ridership for the PATH system and the ferry lines serving New York City. Tables summarizing the ridership for the Newark City Subway line, as well as the station activity for the major rail and bus stations serving New York City are also provided. Lastly, a summary of bus ridership by line is provided,

14.2 RESULTS

Table 105 shows the NJ TRANSIT commuter rail ridership by line group. Table 106 – Table 111 summarize the NJT commuter rail ridership for each line. The ridership listed for the Bergen Main / Port Jervis Line is summarized in Table 106, by station and line segment. The observed ridership provided by NJ Transit indicates a daily ridership of approximately 15,950, while the model estimates ridership of approximately 16,700. This is approximately 5 percent lower than the observed value.

Table 105 – Average Weekday Boarding by Rail Line

Station Name	Observed 2015	Estimated	Diff	% Diff
Main/Bergen/Port Jervis Line	15,946	16,760	814	5.1%
North Jersey Coastline/Northeast Corridor Line	65,398	65,491	93	0.1%
Pascack Valley Line	4,273	4,724	451	10.6%
Boonton Line	8,977	8,968	(9)	-0.1%
Morris/Essex Line	31,456	31,564	108	0.3%
Raritan Valley Line	12,417	12,421	4	0.0%
Newark City Subway	19,249	19,484	235	1.2%
Hudson-Bergen Light Rail	40,232	42,945	2,713	6.7%
TOTAL	**197,948**	**202,356**	**4,408**	**2.2%**

Table 106 – Weekday Station Utilization - Main/Bergen/Port Line Stations

Station Name	Observed 2015	Estimated	Diff	% Diff
Suffern	718	916	198	27.6%
Mahwah	177	78	(99)	-55.9%
Route 17	845	1,074	229	27.1%
Ramsey (Main)	610	489	(121)	-19.8%
Allendale	423	281	(143)	-33.7%
Waldwick	504	492	(12)	-2.4%
Ho-Ho-Kus	478	265	(214)	-44.7%
RidgeWood	1,735	1,568	(167)	-9.6%
Glen Rock (Main) Glen Rock (Bergen)	1,217	1,424	207	17.0%
SUBTOTAL	**6,707**	**6,586**	**(122)**	**-1.8%**
Hawthorne	532	1,035	503	94.5%
Paterson	717	1,236	519	72.3%
Clifton	934	1,114	180	19.2%
Passaic	661	796	135	20.3%
Delawanna	723	728	5	0.7%
Lyndhurst	983	1,109	126	12.8%
Kingsland	561	642	81	14.3%
SUBTOTAL	**5,111**	**6,658**	**1,547**	**30.3%**
Radburn	1,552	1,179	(373)	-24.0%
Broadway	319	419	100	31.3%
Plauderville	633	693	60	9.4%
Garfield	179	138	(41)	-22.9%
Rutherford	1,445	1,088	(357)	-24.7%
SUBTOTAL	**4,128**	**3,517**	**(612)**	**-14.8%**
TOTAL	**15,946**	**16,760**	**814**	**5.1%**

Table 107 lists the ridership for the Pascack Valley Line stations. The observed ridership for Pascack Valley lines is approximately 4,300, while the estimated ridership is approximately 4,700. This suggests that the model has estimated approximately 10% higher than the observed data, which is reasonably well for the purpose of this calibration.

Table 107 – Weekday Station Utilization - Pascack Valley Line Stations

Station Name	Observed 2015	Estimated	Diff	% Diff
Montvale	182	311	129	70.9%
Park Ridge	188	270	82	43.6%
Woodcliff Lake	102	235	133	130.4%
Hillsdale	390	304	(86)	-22.1%
Westwood	445	458	13	2.9%
Emerson	243	208	(36)	-14.6%
Oradell	391	381	(11)	-2.7%
River Edge	573	768	195	34.0%
SUBTOTAL	**2,514**	**2,934**	**420**	**16.7%**
New Bridge Landing	540	554	14	2.6%
Anderson St.	440	467	27	6.0%
Essex St.	364	357	(7)	-1.9%
Teterboro/Williams Ave	59	139	80	135.6%
Woodridge	356	274	(83)	-23.2%
SUBTOTAL	**1,759**	**1,790**	**31**	**1.8%**
TOTAL	**4,273**	**4,724**	**451**	**10.6%**

Table 108 summarizes the ridership on the Boonton Line. As shown in the table, the estimated ridership replicated the observed data very well. The difference between observed and estimated ridership is well-bellow one percent.

Table 108 – Weekday Station Utilization - Boonton Line Stations

Station Name	Observed 2015	Estimated	Diff	% Diff
Hackettstown	128	15	(114)	-88.7%
Mount Olive	20	4	(17)	-82.5%
Netcong (Both Lines)	106	28	(79)	-74.1%
Lake Hopatcong (Both Lines)	58	159	101	173.3%
SUBTOTAL	**312**	**204**	**(108)**	**-34.6%**
Mountain Lakes	17	73	56	329.4%
Boonton	80	183	103	128.8%
Towaco	82	108	26	31.7%
Lincoln Park	104	271	167	160.1%
Mountain View	121	112	(10)	-7.9%
SUBTOTAL	**404**	**746**	**342**	**84.7%**
Little Falls	169	267	98	57.7%
Montclair State University	610	607	(4)	-0.6%
Montclair Heights	386	93	(294)	-76.0%
Mountain Ave	149	431	282	188.9%
Upper Montclair	609	608	(2)	-0.2%
Watchung Ave	821	769	(52)	-6.3%
Walnut St	1,210	1,153	(58)	-4.8%
SUBTOTAL	**3,954**	**3,925**	**(29)**	**-0.7%**
Montclair-Bay St	1,340	1,181	(159)	-11.9%
Glen Ridge	1,302	1,203	(100)	-7.6%
Bloomfield	1,352	839	(514)	-38.0%
Watsessing Ave	313	871	558	178.3%
SUBTOTAL	**4,307**	**4,093**	**(214)**	**-5.0%**
TOTAL	**8,977**	**8,968**	**(9)**	**-0.1%**

Ridership for the Morris / Essex Line is summarized in Table 109. At the system-level, the estimated ridership replicated the observed data very well. The difference between the observed and estimated ridership is approximately 0.3%, well-below one percent.

Table 109 – Weekday Station Utilization - Morris/Essex Line Stations

Station Name	Observed 2015	Estimated	Diff	% Diff
Morris Plains	655	816	161	24.5%
Morristown	1,951	2,135	184	9.4%
Convent Station	1,088	1,061	(27)	-2.5%
Madison	1,604	1,604	(1)	0.0%
Chatham	1,637	1,494	(144)	-8.8%
SUBTOTAL	**6,935**	**7,109**	**174**	**2.5%**
Gladstone	153	200	47	30.7%
Peapack	45	99	54	120.0%
Far Hills	130	90	(41)	-31.2%
Bernardsville	192	190	(2)	-1.0%
Basking Ridge	90	113	23	25.6%
Lyons	423	419	(5)	-1.1%
Millington	162	203	41	25.3%
Stirling	113	183	70	61.5%
Gillette	153	173	20	12.7%
Berkeley Heights	508	429	(80)	-15.6%
Murray Hill	585	579	(6)	-1.0%
New Providence	559	619	60	10.7%
SUBTOTAL	**3,113**	**3,295**	**182**	**5.8%**
Summit	3,933	4,053	120	3.0%
Short Hills	1,629	1,150	(479)	-29.4%
Millburn	1,754	1,908	154	8.8%
Maplewood	3,402	3,190	(213)	-6.2%
South Orange	3,970	4,098	128	3.2%
Mountain Station	347	109	(238)	-68.6%
Highland Avenue	229	411	182	79.5%
Orange	1,343	1,198	(146)	-10.8%
Brick Church	1,975	1,783	(193)	-9.7%
East Orange	447	374	(73)	-16.3%
SUBTOTAL	**19,029**	**18,271**	**(758)**	**-4.0%**
NEWARK BROAD ST	2,379	2,890	511	21.5%
TOTAL	**31,456**	**31,564**	**108**	**0.3%**

Table 110 summarizes the Raritan Valley Line ridership. As shown in the table, the estimated ridership replicated the observed data extremely. The difference between observed and estimated data is close to 0%.

Table 110 – Weekday Station Utilization - Raritan Valley Line Stations

Station Name	Observed 2015	Estimated	Diff	% Diff
High Bridge	56	137	81	143.8%
Annandale	71	57	(15)	-20.4%
Lebanon	22	88	66	297.7%
White House	103	155	52	50.5%
North Branch	67	113	46	68.7%
Raritan	580	823	243	41.8%
Somerville	711	928	217	30.5%
Bridgewater	315	361	46	14.6%
SUBTOTAL	**1,925**	**2,660**	**735**	**38.2%**
Bound Brook	614	665	51	8.3%
Dunellen	924	1,047	123	13.3%
Plainfield	845	977	132	15.6%
Netherwood	516	484	(32)	-6.2%
Fanwood	1,053	828	(226)	-21.4%
Westfield	2,638	1,642	(997)	-37.8%
Garwood	118	164	46	38.6%
Cranford	1,412	1,359	(54)	-3.8%
Roselle Park	892	1,019	127	14.2%
Union	1,480	1,580	100	6.7%
SUBTOTAL	**10,492**	**9,762**	**(731)**	**-7.0%**
TOTAL	**12,417**	**12,421**	**4**	**0.0%**

Table 111 provides a summary of the ridership for the both the Northeast Corridor and North Jersey Coastline rail services. Overall, the estimated ridership replicated the observed values extremely well. The difference between the observed and estimated ridership is merely 0.1%.

Table 111 – Weekday Station Utilization - NJ Coastline/Northeast Corridor Line

Station Name	Observed 2015	Estimated	Diff	% Diff
Bay Head	160	78	(82)	-51.3%
Pt Pleasant Beach	304	444	140	45.9%
Manasquan	177	250	73	41.0%
Spring Lake	149	209	60	40.3%
Belmar	267	291	24	9.0%
Bradley Beach	223	292	69	30.9%
Asbury Park	543	513	(31)	-5.6%
Allenhurst	126	157	31	24.2%
Elberon	110	175	65	58.6%
SUBTOTAL	**2,059**	**2,407**	**348**	**16.9%**
Long Branch	1,119	1,452	333	29.7%
Little Silver	744	765	21	2.8%
Red Bank	1,182	1,128	(55)	-4.6%
Middletown	1,351	1,327	(24)	-1.8%
Hazlet	874	951	77	8.8%
Matawan	2,509	1,949	(561)	-22.3%
South Amboy	1,053	1,112	59	5.6%
Perth Amboy	887	910	23	2.6%
Woodbridge	1,759	1,865	106	6.0%
Avenel	181	300	119	65.5%
SUBTOTAL	**11,659**	**11,756**	**97**	**0.8%**
Trenton	4,422	5,597	1,175	26.6%
Hamilton	5,339	3,938	(1,401)	-26.2%
Princeton Junction	6,968	5,930	(1,038)	-14.9%
Jersey Ave	1,433	1,379	(55)	-3.8%
New Brunswick	5,147	5,531	384	7.5%
Edison	3,197	3,339	142	4.4%
Metuchen	3,674	3,858	184	5.0%
Metropark	7,745	7,037	(708)	-9.1%
SUBTOTAL	**37,925**	**36,608**	**(1,318)**	**-3.5%**
Rahway	3,368	3,896	528	15.7%
Linden	2,247	2,638	391	17.4%
Elizabeth	3,816	4,127	311	8.1%
North Elizabeth	599	1,146	547	91.2%
Newark International Airport	3,725	2,916	(810)	-21.7%
SUBTOTAL	**13,755**	**14,721**	**966**	**7.0%**
TOTAL	**65,398**	**65,491**	**93**	**0.1%**

Table 112 provides a summary of the ridership for the PATH service for stations both in New Jersey and Manhattan. Overall ridership at these stations is approximately 1.4% over the observed values. Within Manhattan, the ridership for the 33rd Street Branch is approximately 7% under the observed value. The estimated ridership on 33rd and 23rd street station are reasonably close to the observed data, while there is more variation on the rest of the stations. Ridership for the New Jersey stations and the World Trade Station overall is within 4 percent of the observed value, however there is more variation on each individual station.

Table 112 – Weekday Station Utilization - PATH System

Station Name	Observed 2015	Estimated	Diff	% Diff
33rd St	36,410	33,608	(2,803)	-7.7%
23rd St	8,956	9,030	74	0.8%
14th St	9,153	2,735	(6,418)	-70.1%
9th St	5,034	8,075	3,041	60.4%
Christopher St	4,735	6,406	1,671	35.3%
SUBTOTAL	**64,288**	**59,853**	**(4,436)**	**-6.9%**
WTC	49,490	44,376	(5,115)	-10.3%
Hoboken	27,785	25,439	(2,346)	-8.4%
Pavonia/Newport	19,054	17,835	(1,219)	-6.4%
Exchange Place	16,077	16,881	804	5.0%
Grove St	18,098	27,410	9,312	51.5%
Journal Square	26,467	28,582	2,115	8.0%
Harrison	7,887	7,030	(857)	-10.9%
Newark (Path)	28,719	33,978	5,259	18.3%
SUBTOTAL	**193,577**	**201,530**	**7,953**	**4.1%**
TOTAL	**257,865**	**261,382**	**3,517**	**1.4%**

The ridership for the Newark Subway Line Stations is listed in Table 113. Ridership for the stations where observed data is available is approximately one percent above the observed values. As expected, the variation is more pronounced at each station.

Table 113 – Weekday Station Utilization - Newark City Subway Line Stations

Station Name	Observed 2015	Estimated	Diff	% Diff
Grove Street	748	1,448	700	93.6%
Silver Lake	546	1,327	781	143.0%
Branch Brook Park / Heller Parkway	2,315	835	(1,480)	-63.9%
Davenport Ave	540	573	33	6.0%
Bloomfield Ave	1,239	800	(440)	-35.5%
Park Ave	1,277	1,402	125	9.7%
Orange St	911	824	(87)	-9.5%
Norfolk St	677	722	45	6.6%
Warren St	1,156	1,168	12	1.0%
Washington St	1,304	447	(857)	-65.7%
Millitary Park	1,463	443	(1,020)	-69.7%
NJ PAC/Center St	61	353	292	478.7%
Atlantic St	7	-	(7)	-100.0%
Washington Park	338	553	215	63.5%
Broad Street	488	1,044	556	113.9%
Newak Penn Station - Broad Inbound	6,179	7,547	1,368	22.1%
TOTAL	**19,249**	**19,484**	**235**	**1.2%**

Ridership for the Hudson Bergen LRT Stations is listed in Table 114. At system-level, the estimated ridership is approximately 7% above the observed ridership.

Table 114 – Weekday Station Utilization - Hudson-Bergen LRT Stations

Station Name	Observed 2015	Estimated	Diff	% Diff
West Side Avenue	1,580	1,686	106	6.7%
MLK Drive	1,260	1,725	465	36.9%
Garfield Avenue	675	427	(249)	-36.8%
SUBTOTAL	**3,515**	**3,838**	**323**	**9.2%**
22nd Street	1,943	1,052	(891)	-45.9%
34th St., Bayonne	1,680	1,929	249	14.8%
45th St., Bayonne	1,056	1,420	364	34.5%
Danforth Avenue	896	1,391	495	55.2%
Richard St., JC	820	739	(82)	-9.9%
SUBTOTAL	**6,395**	**6,530**	**135**	**2.1%**
Liberty State Park	2,916	3,600	684	23.5%
Jersey Av	1,110	985	(126)	-11.3%
Marin Blvd	775	382	(393)	-50.7%
Essex Street	1,214	2,512	1,298	106.9%
Exchange Place	4,751	4,594	(157)	-3.3%
Harborside	1,647	579	(1,069)	-64.9%
Harsimus Cove	1,159	2,433	1,274	109.9%
Newport Mall (Pavonia/Newport)	6,304	6,966	662	10.5%
SUBTOTAL	**19,876**	**22,050**	**2,174**	**10.9%**
2nd Street	1,292	1,313	21	1.6%
9th Street	2,706	1,915	(791)	-29.2%
Lincoln Harbor	862	737	(125)	-14.5%
Port Imperial	1,087	1,257	170	15.6%
Bergenline Ave	3,258	3,891	633	19.4%
Tonnelle Ave	1,241	1,415	174	14.0%
SUBTOTAL	**10,446**	**10,527**	**81**	**0.8%**
TOTAL	**40,232**	**42,945**	**2,713**	**6.7%**

Table 115 and Table 116 summarize the PABT bus ridership, aggregated and by line for the various service types in the region. Note that while there is some variation in the difference by line group, and in some instances, the differences can be quite significant such as PABT short distance, and PABT GWB, the overall PABT ridership is within 7 percent of the observed riderships. It should also be noted that the bus ridership data was only collected for one day on November 18, 2015.

Table 115 – PABT Bus Ridership

Bus Line	2015 Observed	NJRTME Revalidation	
		EST	Pct Diff
BERGEN PABT ROUTES	30,755	30,296	-1.5%
ROUTE 9 PABT	9,124	10,195	11.7%
PABT SHORT DISTANCE	34,095	20,713	-39.2%
PARK & RIDE	3,224	3,699	14.7%
MIDDLESEX/UNION PABT	8,699	10,154	16.7%
PASSAIC PABT	12,285	13,431	9.3%
GW BRIDGE	4,882	7,983	63.5%
PABT TOTAL	**103,064**	**96,469**	**-6.4%**

Table 116 – PABT Bus Ridership

Bus Line	2015 Observed	NJRTME Revalidation	
		EST	Pct Diff
BERGEN PABT ROUTES			
160	1,271	1,136	-10.7%
161/162	4,272	5,240	22.6%
163/164	5,395	4,137	-23.3%
165	6,436	6,514	1.2%
166	7,019	7,054	0.5%
167	3,517	3,397	-3.4%
155	266	152	-42.9%
157	155	113	-27.4%
168	1,663	2,318	39.4%
144/148	761	237	-68.9%
Subtotal	**30,755**	**30,296**	**-1.5%**
ROUTE 9 PABT			
131	555	40	-92.8%
133	617	380	-38.5%
135	359	324	-9.9%
137	1,017	1,495	47.0%
138	449	133	-70.5%
139	6,127	7,825	27.7%
Subtotal	**9,124**	**10,195**	**11.7%**
PABT SHORT DISTANCE			
107	1,737	1,643	-5.4%
108	873	350	-59.9%
111	739	35	-95.3%
121	94	-	--
123	1,499	881	-41.3%
126	8,712	3,599	-58.7%
127	1,237	1,043	-15.7%
128	4,260	1,963	-53.9%
129	1,454	727	-50.0%
154	1,366	1,050	-23.2%
156	3,801	2,740	-27.9%
158	3,223	1,676	-48.0%
159	5,100	5,010	-1.8%
Subtotal	**34,095**	**20,713**	**-39.2%**
PARK & RIDE			
320	2,671	2,911	9.0%
321	553	788	42.5%
Subtotal	**3,224**	**3,699**	**14.7%**
MIDDLESEX/UNION PABT			
112	1,077	1,085	0.7%
113	2,377	2,703	13.7%
114	3,068	3,615	17.8%
115	659	1,055	60.1%
116	1,518	1,696	11.7%
Subtotal	**8,699**	**10,154**	**16.7%**
PASSAIC PABT			
190	5,263	4,854	-7.8%
191	576	276	-52.1%
192	2,332	4,019	72.3%
193	1,061	101	-90.5%
194	1,001	2,052	104.9%
195	505	401	-20.6%
196	428	88	-79.6%
197	1,119	1,641	46.6%
Subtotal	**12,285**	**13,431**	**9.3%**
GW BRIDGE			
171	785	1,539	96%
175	907	1,645	81%
178	920	1,097	19%
181	231	376	63%
182	524	1,233	135%
186	1,132	1,394	23%
188	383	700	83%
Subtotal	**4,882**	**7,983**	**64%**

15. SENSITIVITY ANALYSIS

15.1 INTRODUCTION

Three sensitivity analyses were performed as part of the model validation. The three sensitivity analyses are:

- Increase Transit Fare by 50%, excluding NYC Subways
- Hypothetical Reduced Rail Services
- Pulaski Skyway Closing

15.2 Increase Transit Fare by 50% (excluding NYC Subways)

In the first sensitivity scenario, all transit fares were assumed to increase by 50%, except for the New York City Subway. The impact of this scenario on the mode choice results is shown in Table 117. The results indicated that the total transit trips are down by approximately four percent, and while the auto trips gain approximately 0.1%. While the percentages of the trip changes are different for these two main modes, auto and transit, the number of trips is almost identical.

Table 117 – Mode Choice Summary (NJTPA+Mercer)

MODE	PERSON TRIPS		DIFF	% DIFF
	BASE	SENSITIVITY		
SOV	11,637,015	11,676,774	39,759	0.3%
HOV2	5,250,797	5,261,235	10,437	0.2%
HOV3	2,211,558	2,215,041	3,484	0.2%
HOV4	1,309,009	1,310,970	1,961	0.1%
Total Auto	**20,408,379**	**20,464,020**	**55,641**	**0.3%**
Walk-Transit	1,027,115	987,291	-39,824	-3.9%
Driv e-Transit	349,159	333,569	-15,591	-4.5%
Total Transit	**1,376,275**	**1,320,860**	**-55,415**	**-4.0%**
TOTAL	**21,784,654**	**21,784,880**	**226**	**0.0%**

In order to assess if this reaction is reasonable, the ridership changes due to increased transit fares were reviewed. Table 118 shows the historical data of the 4th quarter transit ridership between 2009 and 2017 provided by the New Jersey Transit. During this period, transit fares were increased twice. The first increase in April 2010, where the transit fares were escalated by 25%. The second fare increase occurred in October 2015, where the transit fares were increased by 9%. Figure 41 depicts the graphical trends of the transit ridership. The first fare increase occurred during the recession period. Therefore, the changes of the ridership may be impacted by the recessions as well as by the fare increase. The second fare increase occurred in 2015 during a stable economic condition. Due to this reason, the ridership trend from the second fare increase is used for reasonableness check.

The New Jersey Transit informed us that the transit ridership decreased in 2016 was also partly impacted by the lower gasoline cost, which encouraged the trip makers to use auto instead of transit. In order to measure the impact of the 2015 fare increase, the 2015 ridership data was projected to 2016 assuming that the fare increased did not occur. The growth was assumed to be a normal annual growth. The compounded annual growth rates (CAGR) of transit ridership were estimated for several different periods, as shown in Table 119, using the historical data listed in Table 120. The 2011-2015 CAGR was assumed to be a reasonable assumption due to the stability of various economic conditions and transit fares. Assuming that there was no transit fare increase between 2015 and 2016, the projected 2016 transit ridership data would have been 1.9% higher than the 2015 transit ridership of 70M, and this would have resulted in 71.3M ridership. The 2016 ridership after the fare increase were 68.4M as shown in Table 118. Therefore, the impact of the 9% fare increase in 2015 was an approximate decrease of 4% in transit ridership ((68.4M/71.3M-1).

Table 118 – Historical Data – 4th Quarter Transit Ridership

MODE	RIDERSHIP (million)					
	2009	2010	2011	2015	2016	2017
BUS	41.1	41.1	39.9	41.7	40.1	39.3
RAIL	19.8	20.2	19.6	22.3	22.1	21.4
LIGHT RAIL	5.4	5.5	5.5	6.0	6.2	6.0
TOTAL	**66.3**	**66.7**	**65.0**	**70.0**	**68.4**	**66.7**

*Fare increased 9% on Oct 1,2015

Fare increased 25% on May 1,2010

*4Q: April through Jun

Figure 41 – Historical Data – 4th Quarter Transit Ridership

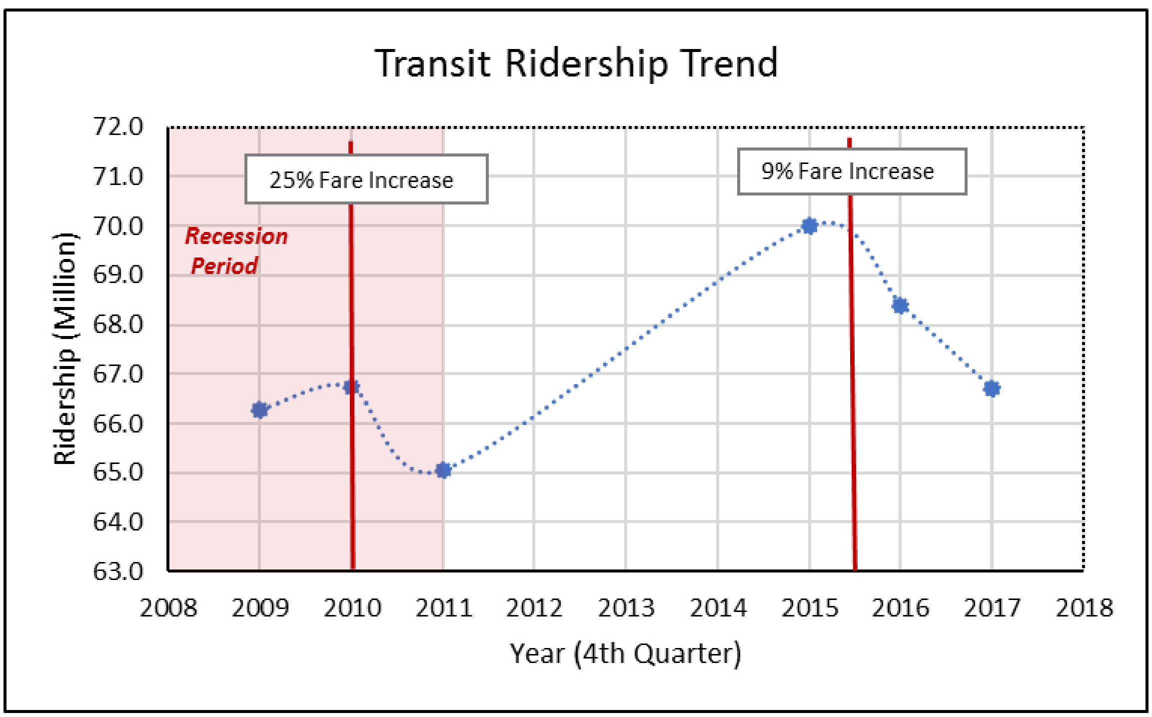


Table 119 – Compounded Annual Growth Rates (CAGR) – Based on 4th Quarter Data

MODE	CAGR				
	2009 - 2017	2009 - 2015	2011-2015	2011-2017	2015-2017
BUS	-0.6%	0.3%	1.1%	-0.3%	-2.9%
RAIL	1.0%	2.0%	3.2%	1.4%	-2.0%
LIGHT RAIL	1.2%	1.7%	2.4%	1.6%	0.0%
TOTAL	**0.1%**	**0.9%**	**1.9%**	**0.4%**	**-2.4%**

As mentioned earlier, part of the actual decrease in 2016 was partially caused by the lower gasoline cost. Therefore, the impact of the transit fare increase alone would be a lower decrease than 4%. The results of the sensitivity analysis for the 50% fare increase is approximately 4% decrease in ridership as indicated previously in Table 117. Considering that the demand responsiveness of transit fare increases in the New Jersey – New York market are believed to be inelastic due to limited transit alternatives and high cost (toll and parking) for competing modes, the sensitivity results are deemed to be reasonable during a discussion with the technical advisory committee (TAC) members.

The changes in auto vehicles along the Trans-Hudson Crossing were presented in Table 120. In general, the impact on the crossings are minimal, the highest impact was the reduction of traffic volumes on George Washington Bridge and Holland Tunnel.

Table 120 – Trans-Hudson Crossing Summary (Fare Increase 50%)

LOCATION	DIR	BASE	SENSITIVITY	DIFFERENCE	%DIFF
Newburgh-Beacon Bridge	EB	34,536	34,526	(10)	0.0%
	WB	35,948	36,064	116	0.3%
Bear Mountain Bridge	EB	9,712	9,679	(33)	-0.3%
	WB	10,605	10,611	6	0.1%
Tappan Zee Bridge	EB	68,801	68,610	(192)	-0.3%
	WB	65,459	65,325	(134)	-0.2%
George Washington Bridge	EB	135,886	133,540	(2,346)	-1.7%
	WB	141,794	139,844	(1,951)	-1.4%
Lincoln Tunnel	EB	52,970	53,050	80	0.2%
	WB	55,980	56,004	24	0.0%
Holland Tunnel	EB	39,510	38,681	(830)	-2.1%
	WB	52,913	51,070	(1,842)	-3.5%
Verrazano-Narrows Bridge	EB	93,832	93,083	(748)	-0.8%
	WB	95,429	95,105	(324)	-0.3%
Total	**EB**	**435,248**	**431,169**	**(4,079)**	**-0.9%**
	WB	**458,128**	**454,022**	**(4,105)**	**-0.9%**
Goethals Bridge	EB	47,607	47,385	(223)	-0.5%
	WB	47,007	46,875	(132)	-0.3%
Outerbridge Crossing	EB	39,151	39,069	(82)	-0.2%
	WB	35,438	35,488	50	0.1%
Bayonne Bridge	SB	6,952	6,827	(125)	-1.8%
	NB	5,866	5,943	77	1.3%
Total	**EB/NB**	**93,710**	**93,280**	**(429)**	**-0.5%**
	WB/SB	**88,310**	**88,306**	**(4)**	**0.0%**

15.3 Hypothetical Reduced Rail Services

The second sensitivity test is to reduce the Trans-Hudson Rail Tunnel capacity. In this sensitivity test, it is assumed that the maximum number of rail services using the Hudson River transit tunnels is limited to six train per hour, and these rail services will be allocated mainly to the Northeast Corridor trains. All other trains will be terminated at either Newark or Hoboken.

In the base scenario, there are nine in-bound Northeast Corridor train services per hour during peak period, and four out-bound services. During the off-peak period, there are approximately two to three services per hour as shown in Table 121. For the sensitivity analysis, the in-bound peak Northeast Corridor train services were reduced from nine to six. Services for other periods and directions remained the same. The services for other rail lines are defined in Table 122.

Table 121 – Rail Service Assumptions

NORTHEAST CORRIDOR LINE (Service per hour) - Base

SERVICE	PEAK		OFF-PEAK	
	INBOUND	OUTBOUND	INBOUND	OUTBOUND
Jersey Avenue Service	3	1	0.3	0
Local Service	1	1.5	1.5	2.05
Express (from Princeton Junction)	3	0	0	0
Semi-express	2	1.5	0.9	0
TOTAL	**9**	**4**	**2.7**	**2.05**

NORTHEAST CORRIDOR LINE (Service per hour) - Sensitivity Test

SERVICE	PEAK		OFF-PEAK	
	INBOUND	OUTBOUND	INBOUND	OUTBOUND
Jersey Avenue Service	1	1	0.3	0
Local Service	1	1.5	1.5	2.05
Express (from Princeton Junction)	2	0	0	0
Semi-express	2	1.5	0.9	0
TOTAL	**6**	**4**	**2.7**	**2.05**

Table 122 – Rail Service Assumptions by Line

Name	Comment
Northeast Corridor Line	Reduce # of service for PK Inbound only. Terminate other PK Inbound services at Newark.
Main/Bergen/Port Jervis Line	No change (Terminated at Hoboken)
North Jersey Coastline	Terminate either at Hoboken or Newark. No change in service frequencies
Pascack Valley Line	No change (Terminated at Hoboken)
Boonton Line	Terminate either at Hoboken or Newark. No change in service frequencies
Morris/Essex Line	Terminate either at Hoboken or Newark. No change in service frequencies
Raritan Valley Line	Terminate either at Hoboken or Newark. No change in service frequencies

The mode choice results indicated that the commuter rail transit trips were reduced by approximately 23.5%, as shown in Table 123 Those rail transit trips were mostly diverted to PATH, Bus, or auto. Other transit modes are marginally changed. There was no historical data that can be used to check the reasonableness of this sensitivity test. A discussion with TAC members concluded that the rail ridership changes and diversion to other modes were deemed reasonable for this level of study.

Table 123 – Mode Choice Comparison (NJTPA / Mercer)

MODE	BASE		SENSITIVITY		DIFF	% DIFF
	TRIPS	SHARE	TRIPS	SHARE		
SOV	11,637,015	53.42%	11,652,493	53.49%	15,477	0.1%
HOV2	5,250,797	24.10%	5,253,779	24.12%	2,982	0.1%
HOV3	2,211,558	10.15%	2,212,229	10.16%	671	0.0%
HOV4	1,309,009	6.01%	1,309,284	6.01%	276	0.0%
Total Auto	**20,408,379**	**93.68%**	**20,427,785**	**93.77%**	**19,406**	**0.1%**
Commuter Rail	225,869	1.04%	172,741	0.79%	-53,128	-23.5%
PATH	183,107	0.84%	193,590	0.89%	10,482	5.7%
Bus / Newark City Subway	799,971	3.67%	817,791	3.75%	17,820	2.2%
Ferry	118,937	0.55%	122,166	0.56%	3,229	2.7%
Light Rail (HBLRT / River Line)	48,390	0.22%	50,386	0.23%	1,997	4.1%
Total Transit	**1,376,275**	**6.32%**	**1,356,675**	**6.23%**	**-19,600**	**-1.4%**
TOTAL	**21,784,654**	**100.00%**	**21,784,460**	**100.00%**	**-194**	**0.0%**

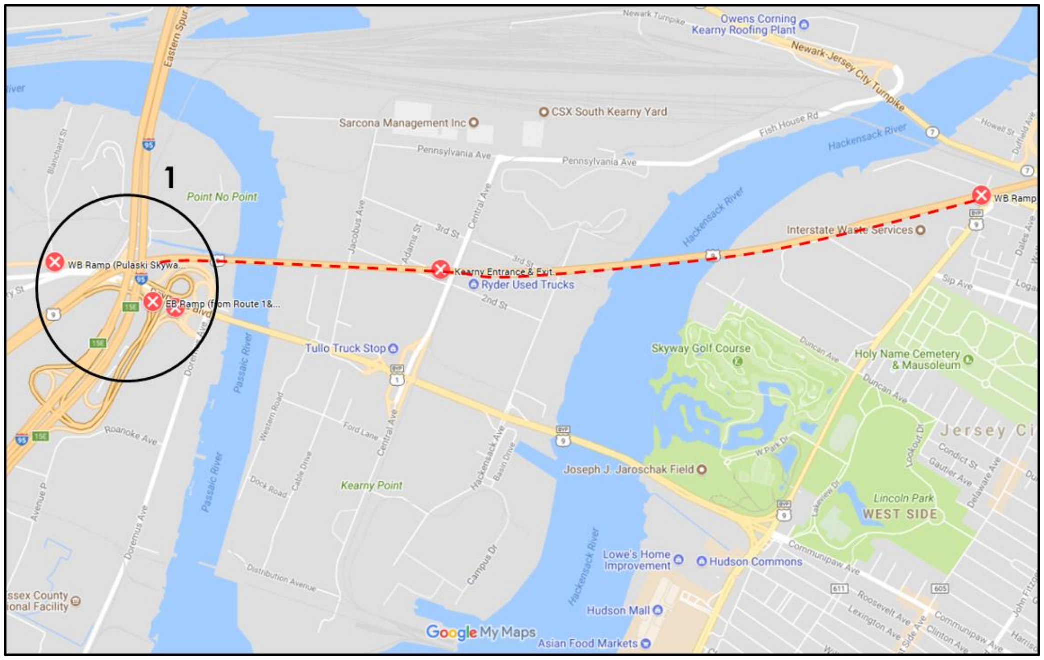
15.4 Pulaski Skyway Closing

The third sensitivity test is to assess to impact of the Pulaski Skyway closing, and the diversion of traffic due to the closing. This sensitivity test attempted to mimic the current Pulaski Skyway closure. The east-bound Pulaski Skyway between New Jersey Turnpike and Route 9 truck is closed, as well as several ramps along this corridor. Figure 42 displays the locations of these ramp closures.

The traffic counts representing before and after the closure were obtained and compared. Figure 43 shows the locations where the traffic counts for both before and after the closure are available. The traffic counts and model estimated traffic volumes before and after the closing were compared and listed in Table 122. In general, the trend of traffic change is consistent between the observed and estimated volumes, even though the estimated values can be significantly different from the traffic counts. The initial NJRTM-E estimated traffic volumes are different from the counts taken for the Pulaski Skyway project which could be due to a number of reasons related to timing of counts and attempts to replicate corridor counts in an area heavily influenced by the elimination of a major traffic movement.

Figure 44 to Figure 46 display the traffic diversion comparison at locations where the traffic counts are available. The green links show an increase in traffic after the closing, conversely, the red links indicate a decrease in traffic. In general, the estimated traffic diversion pattern is consistent with the observed pattern, except for Route 7 as shown in Figure 44. It was expected that the traffic along this corridor would increase in response to the closing of the east-bound Pulaski Skyway. However, the observed pattern shows a decrease in traffic volumes. Upon further investigation, the decrease in traffic was most likely caused by the construction on the Wittpenn Bridge, which likely discouraged travelers to use this roadway.

Figure 42 – Locations of Pulaski Skyway Ramp Closure



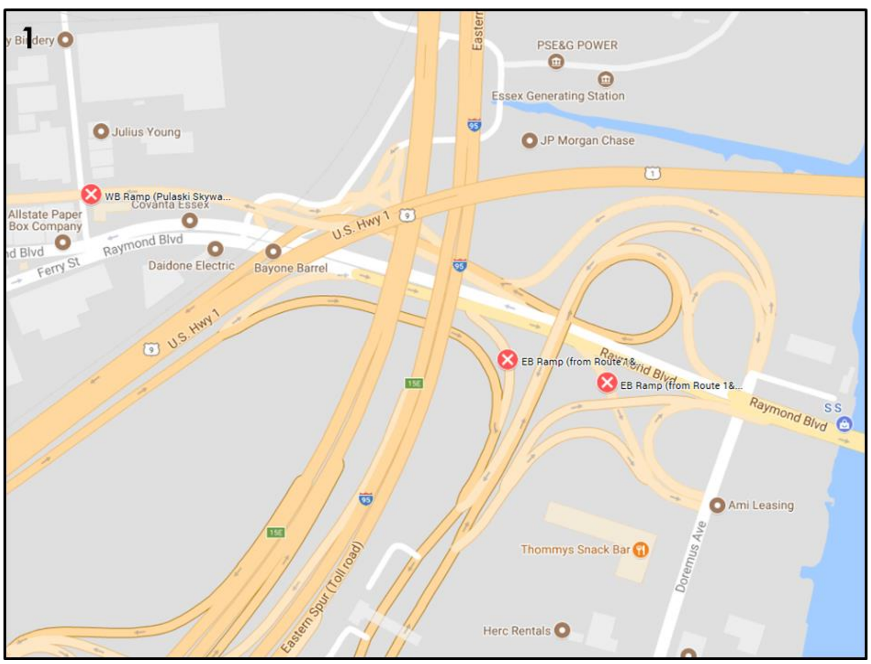


Figure 43 – Pulaski Skyway Count Locations

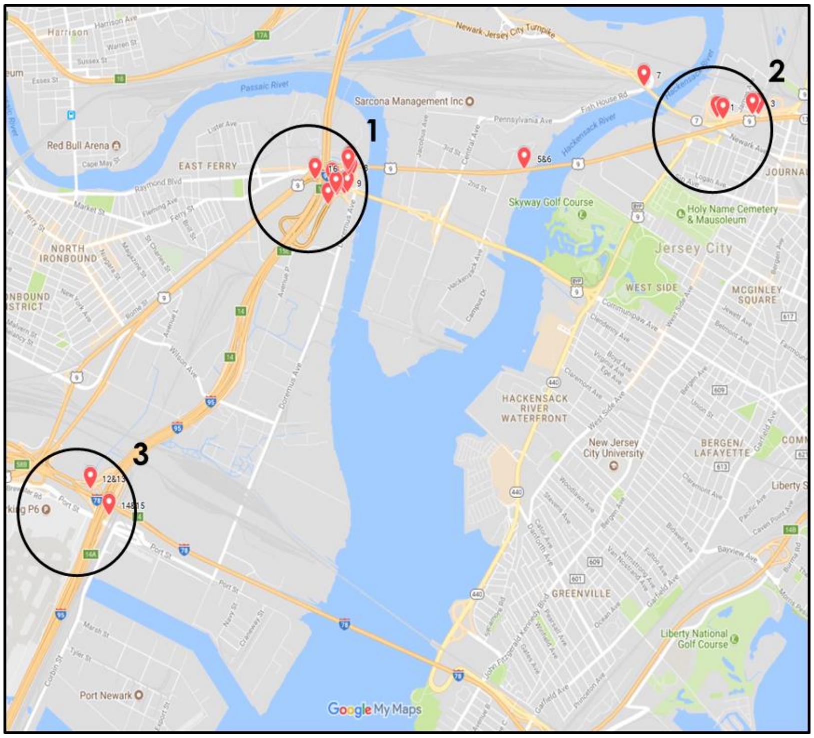
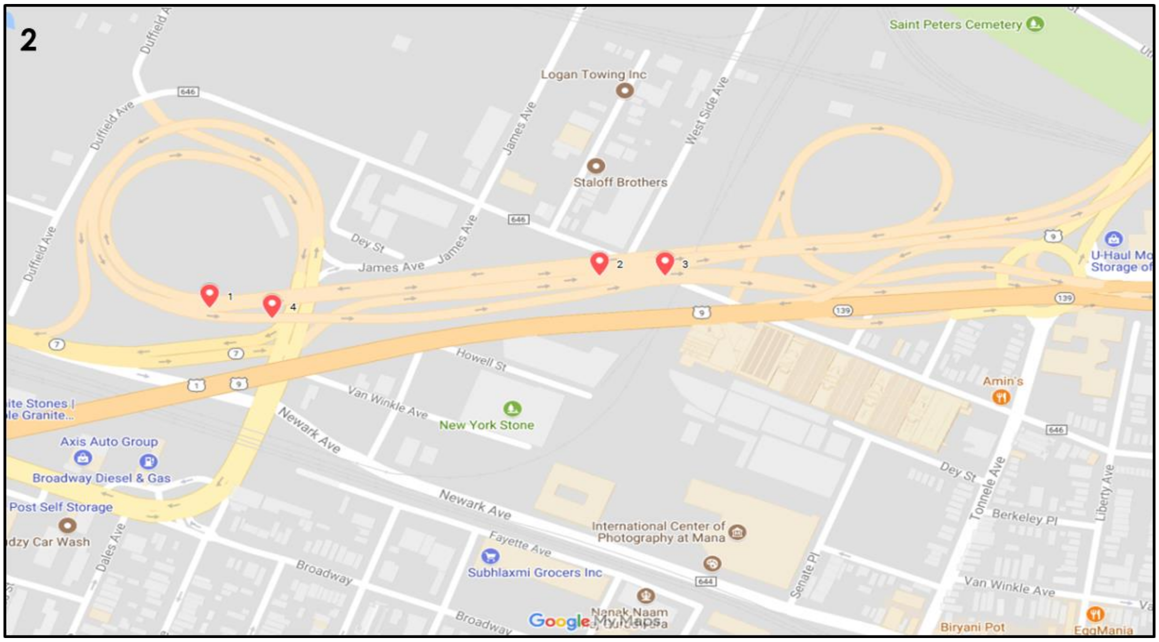


Figure 43 - Continued



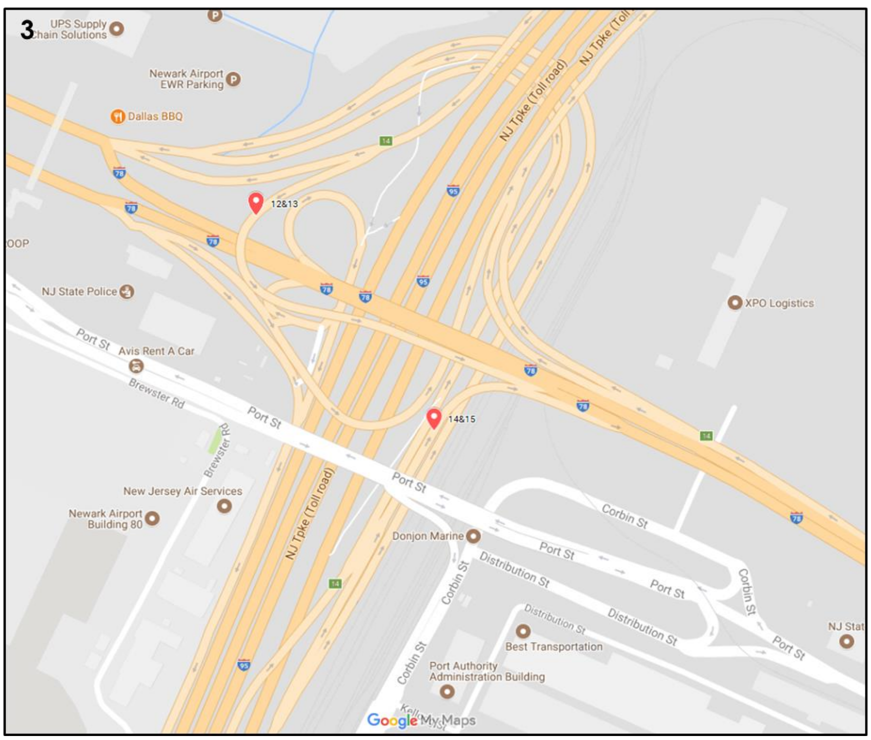


Table 124 – Traffic Volume Comparison Before and After Closing

Loc ID	Location	Dir	Pre-Closure OBS (2014)	After-Closure OBS (2015)	% Different	Pre-Closure EST	After-Closure EST	% Different
1	Rt 1&9T Loop Ramp to Rt 1&9 NB via flyover	NB	14,867	24,865	67.2%	9,022	11,741	30.1%
2	Rt 1&9T NB & Rt 7 EB to Rt 1&9 NB	NB						
3	Rt 1&9T NB & Rt 7 EB to Tonnele Circle	EB	9,584	13,961	45.7%	8,364	11,876	42.0%
4	Loop ramp to Tonnele Circle (Local)	EB						
5	PulaskiNB @ Btwn Adams&Broadway Ramps	NB	26,007	CLOSE		34,110	CLOSE	
6	PulaskiSB @ Btwn Adams&Broadway Ramps	SB	32,581	35,290	8.3%	45,179	28,588	-36.7%
7	Route 7EB @ east of Fish House	EB	10,993	20,889	90.0%	14,859	17,034	14.6%
8	Rt 1&9T WB @ to Doremus	WB	2,573	2,356	-8.4%	1,852	1,794	-3.1%
9	Rt 1&9T EB @ to Doremus	EB	4,173	CLOSE		2,211	CLOSE	
10	Doremus NB @ to Raymond WB	WB	2,971	2,117	-28.7%	963	200	-79.2%
11	Doremus NB @ to Rt 1&9T EB	EB	3,573	3,217	-10.0%	829	1,447	74.5%
12	NJTPK Int14 NH.Ramp @ from north to NBHCE	EB	32,109	37,320	16.2%	2,859	3,187	11.5%
13	NJTPK Int14 TH.Ramp @ from toll to NBHCE	EB						
14	NJTPK Int14 SIH.Ramp @ from south inner to NBCHE	EB	11,386	24,743	117.3%	14,790	16,984	14.8%
15	NJTPK Int14 SOH.Ramp @ from south outter to NBCHE	EB						
16	NJTPK Int15 AV.Ramp @ Rt 1&9NB to 15E	NB	6,997	10,924	56.1%	9,695	16,900	74.3%
17	NJTPK Int15 WT.Ramp @ RaymondEB to 15E	EB	4,254	CLOSE		12,012	CLOSE	
18	NJTPK Int15 TW.Ramp @ TPK to RaymondWB	WB	6,094	9,757	60.1%	4,923	5,950	20.9%
19	NJTPK Int15 TL.Ramp @ TPK to Doremus	NB	4,381	4,719	7.7%	3,161	3,490	10.4%
20	NJTPK Int15 TE.Ramp @ TPK to Rt 1&9TEB	EB	12,558	11,028	-12.2%	16,516	13,420	-18.7%
21	NJTPK Int15 ET.Ramp @ Rt 1&9TWB to TPK	WB	11,316	12,318	8.9%	13,752	15,339	11.5%
22	NJTPK Int15 LT.Ramp @ Doremus to TPK	NB	3,304	4,397	33.1%	1,308	1,401	7.1%

Figure 44 – Traffic Volume Comparison Before and After Closing – Location 1

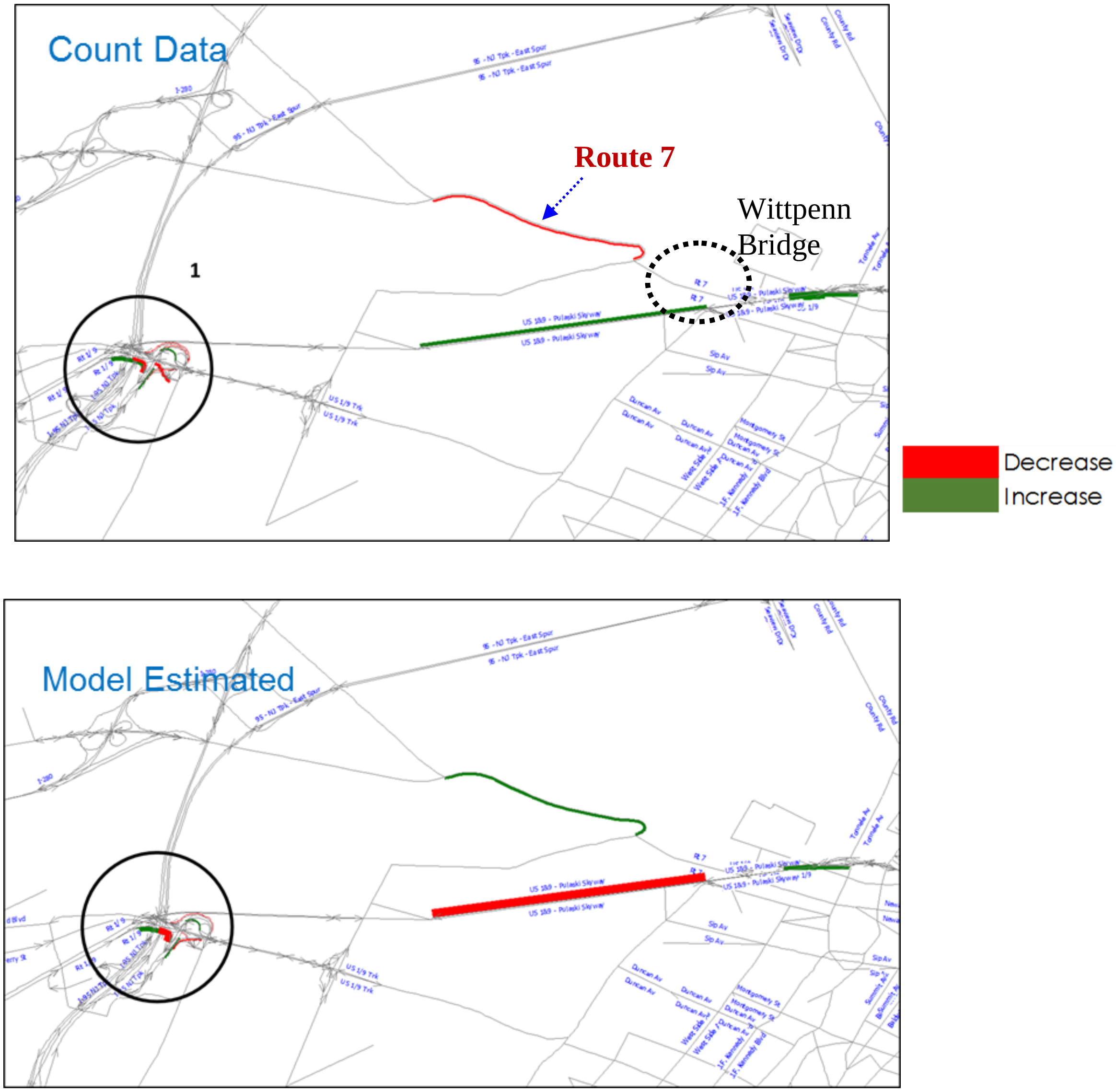


Figure 45 – Traffic Volume Comparison Before and After Closing – Location 2

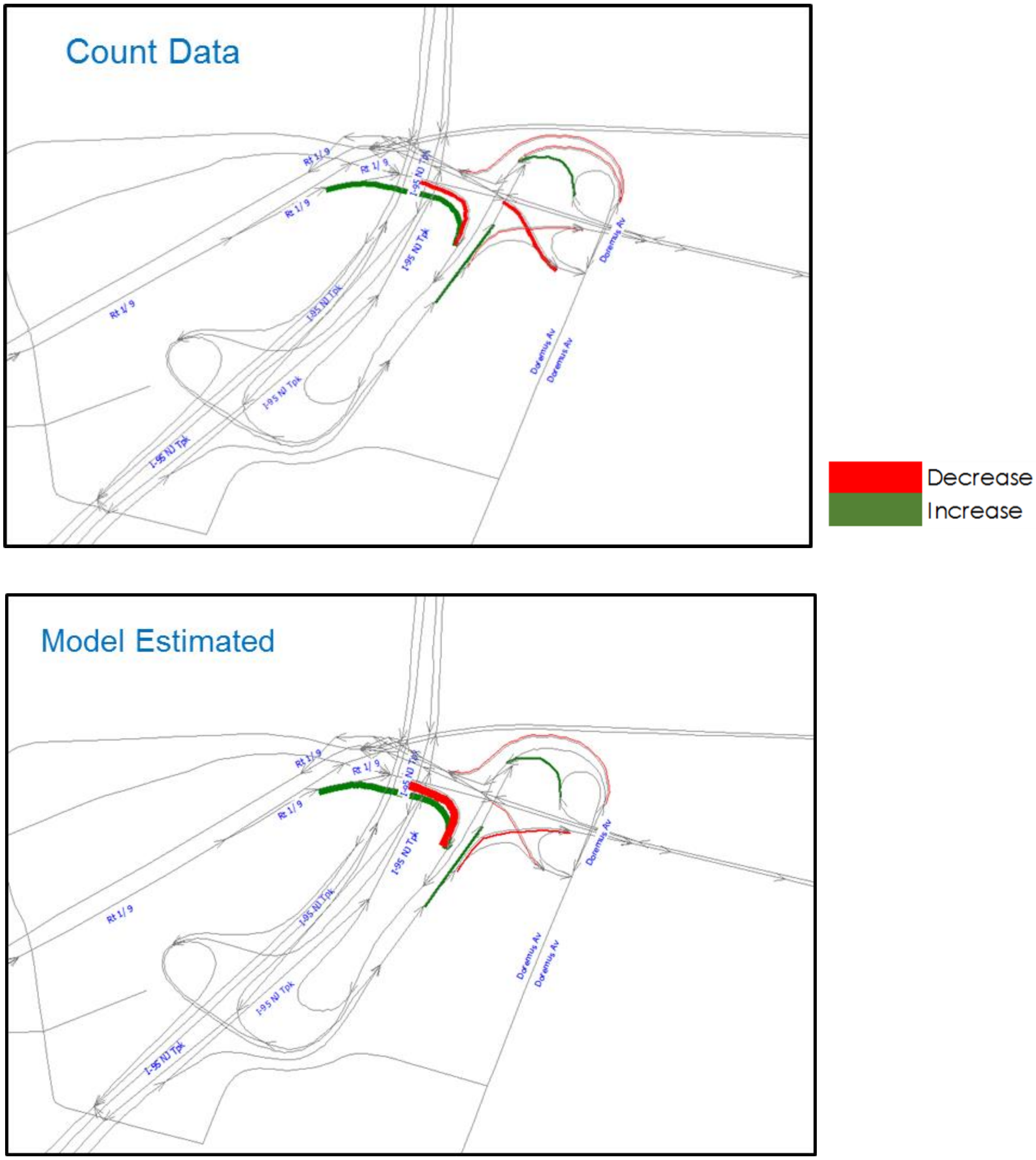
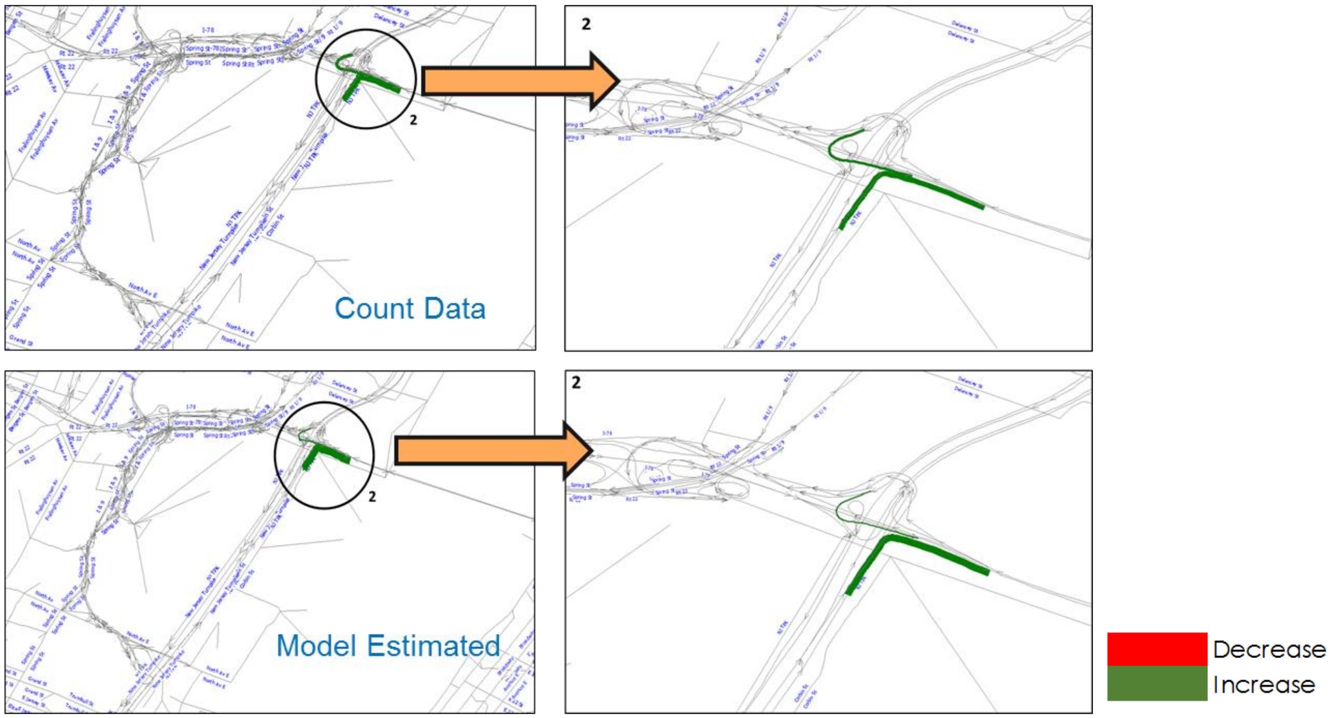


Figure 46 – Traffic Volume Comparison Before and After Closing – Location 3



The model estimated traffic diversion in the vicinity of Pulaski Skyway is shown in Figure 47. The diversion pattern shows that the Pulaski Skyway traffic was diverted to one of the following roadways:

- I-78
- US 1/9 Truck Routes
- New Jersey Turnpike

TAC members reviewed and discussed the estimated traffic diversion during the final TAC meeting and deemed that the pattern was reasonable. The impact of the closing on the Trans-Hudson crossing was presented in Table 124. The base scenario indicates the closing of the Pulaski Skyway, while the sensitivity scenario indicates the condition prior to the closing. Positive difference indicates that the traffic volumes decrease after the closing. As expected, the Holland Tunnel was impacted most by the closing and saw a three to four percent decrease in traffic.

Figure 47 – The Estimated Traffic Diversion Due to Closing

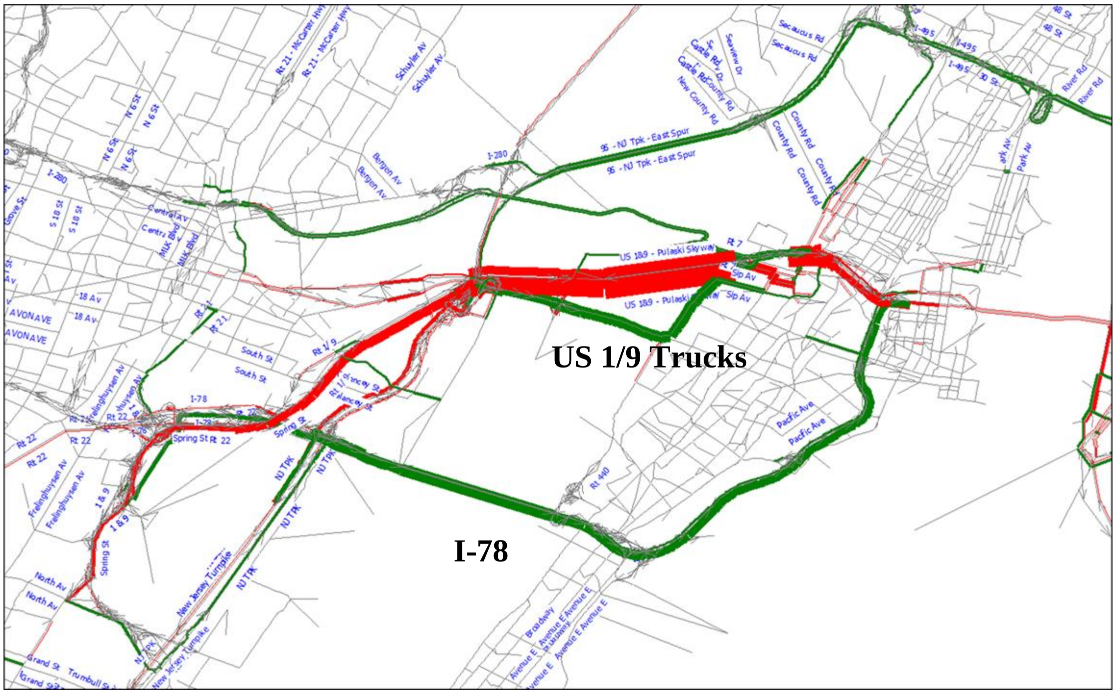


Table 125 – Trans-Hudson Vehicular Traffic Summary (Pulaski Skyway EB Closure)

LOCATION	DIR	BASE	SENSITIVITY	%DIFF
Newburgh-Beacon Bridge	EB	34,536	34,628	0.3%
	WB	35,948	36,167	0.6%
Bear Mountain Bridge	EB	9,712	9,855	1.5%
	WB	10,605	10,559	-0.4%
Tappan Zee Bridge	EB	68,801	68,856	0.1%
	WB	65,459	65,498	0.1%
George Washington Bridge	EB	135,886	135,791	-0.1%
	WB	141,794	141,947	0.1%
Lincoln Tunnel	EB	52,970	52,930	-0.1%
	WB	55,980	55,465	-0.9%
Holland Tunnel	EB	39,510	40,846	3.4%
	WB	52,913	54,897	3.7%
Verrazano-Narrows Bridge	EB	93,832	92,867	-1.0%
	WB	95,429	94,533	-0.9%
Total	**EB**	**435,248**	**435,772**	**0.1%**
	WB	**458,128**	**459,066**	**0.2%**
Goethals Bridge	EB	47,607	47,821	0.4%
	WB	47,007	47,011	0.0%
Outerbridge Crossing	EB	39,151	39,210	0.2%
	WB	35,438	35,594	0.4%
Bayonne Bridge	SB	6,952	6,861	-1.3%
	NB	5,866	5,918	0.9%
Total	**EB/NB**	**93,710**	**93,892**	**0.2%**
	WB/SB	**88,310**	**88,523**	**0.2%**

APPENDIX A – ZONAL EQUIVALENCY

1. NJRTME – NYMTC BPM EQUIVALENCY

COUNTY	NJRTME ZONE	BPM	
		TAZ_ID	NUMBER OF ZONES
Bronx	2072	1139,1142-1189,1327-1330,1339	54
	2073	1233-1234,1256-1275,1296-1326,1331-1338,1340-1341	63
	2074	1036,1038,1040-1042,1044-1045,1047-1060,1063-1078,1080-1138,1140-1141	98
	2075	1005-1035,1037,1039,1043,1046,1061-1062,1079,1343	39
	2076	1190-1232,1240,1245-1249,1276-1282,1286-1294,1342	66
	2077	1235-1239,1240-1244,1250-1255,1283-1285,1295	19
Dutches	2078	3223-3230,3240-3247,3249	17
	2079	3201-3222,3231-3239,3248,3250-3279	62
Kings	2080	1344-1368,1371-1372,1374-1391,1426-1428,1431,1434-1507,1512-1515,1525-1528,1947-1951	136
	2081	1369-1370,1373,1392-1394,1396-1403,1408-1425,1429-1430,1432-1433,2103	37
	2082	1395,1404-1407,1552-1566,1569-1570,1573-1585,1589	36
	2083	1586-1588,1590,1597-1621,1771-1783,1785-1806,1815-1820,1887,1889,2102	73
	2084	1694-1702,1720	10
	2085	1686-1688,1690-1693	7
	2086	1677-1685,1689	10
	2087	1674-1676	3
	2088	1703-1709,1712-1714,1717-1719	13
	2089	1710-1711,1715-1716,1721-1726,1755-1759	15
	2090	1727-1734,1740-1754,1828	24
	2091	1735,1821-1834,1846-1847	15
	2092	1736-1739,1760-1770,1811-1814,1829,1839-1840,1908-1915,1920,1934-1939,2100-2101	39
	2093	1835-1838,1841-1845,1873-1875,1890-1907,1916-1919,1921-1933,1940-1942,2021-2032	62
	2094	1784,1807-1810,1851-1856,1858-1872,1876-1886,1888,1976-1989,1995-1997,2034-2041	63
	2095	1567-1568,1571-1572,1591-1596,1622-1638,1648-1670,1672,1848-1850,1857,1968-1975	63
	2096	1508-1511,1516-1519,1532-1551,1639-1647,1671,1673,1943-1946,1952-1967,2006-2012	65
	2097	1520-1524,1529-1531,1545-1546,1990-1994,1998-2005,2014-2020,2033,2042-2099	89

COUNTY	NJRTME ZONE	BPM	
		TAZ_ID	NUMBER OF ZONES
Nassau	2098	2263-2420	158
	2099	2213-2262,2421-2491	121
Manhattan	2100	303	1
	2101	299	1
	2102	335	1
	2103	302	1
	2104	301	1
	2105	329	1
	2106	300	1
	2107	328	1
	2108	325	1
	2109	324	1
	2110	315	1
	2111	323	1
	2112	320	1
	2113	321	1
	2114	322	1
	2115	317	1
	2116	316	1
	2117	318	1
	2118	304	1
	2119	319	1
	2120	326	1
	2121	314	1
	2122	313	1
	2123	327	1
	2124	312	1
	2125	310	1
	2126	309	1
	2127	307	1
	2128	308	1
	2129	311	1
	2130	275	1
	2131	305	1
	2132	306	1
	2133	272	1
	2134	248	1
	2135	274	1
	2136	273	1
	2137	270	1
	2138	247	1
	2139	271	1
	2140	246	1
	2141	245	1
	2142	241	1
	2143	269	1

COUNTY	NJRTME ZONE	BPM	
		TAZ_ID	NUMBER OF ZONES
Manhattan	2144	261	1
	2145	297	1
	2146	260	1
	2147	267	1
	2148	268	1
	2149	240	1
	2150	244	1
	2151	243	1
	2152	242	1
	2153	265	1
	2154	239	1
	2155	264	1
	2156	262	1
	2157	263	1
	2158	259	1
	2159	296	1
	2160	293	1
	2161	238	1
	2162	235	1
	2163	257	1
	2164	266	1
	2165	197	1
	2166	237	1
	2167	234	1
	2168	233	1
	2169	232	1
	2170	258	1
	2171	252	1
	2172	251	1
	2173	256	1
	2174	254	1
	2175	250	1
	2176	255	1
	2177	253	1
	2178	249	1
	2179	295	1
	2180	286	1
	2181	287	1
	2182	294	1
	2183	285	1
	2184	283	1
	2185	292	1
	2186	289	1
	2187	288	1
	2188	291	1
	2189	290	1

COUNTY	NJRTME ZONE	BPM	
		TAZ_ID	NUMBER OF ZONES
Manhattan	2190	236	1
	2191	194	1
	2192	193	1
	2193	332	1
	2194	196	1
	2195	195	1
	2196	190	1
	2197	284	1
	2198	282	1
	2199	281	1
	2200	280	1
	2201	279	1
	2202	276	1
	2203	192	1
	2204	191	1
	2205	185	1
	2206	184	1
	2207	179	1
	2208	178	1
	2209	173	1
	2210	188-189	2
	2211	186-187	2
	2212	182-183	2
	2213	180-181	2
	2214	176-177	2
	2215	174-175	2
	2216	171-172	2
	2217	198	1
	2218	231	1
	2219	229	1
	2220	278	1
	2221	220	1
	2222	230	1
	2223	228	1
	2224	226	1
	2225	224	1
	2226	222	1
	2227	227	1
	2228	277	1
	2229	225	1
	2230	217	1
	2231	223	1
	2232	216	1
	2233	221	1
	2234	218	1
	2235	219	1

COUNTY	NJRTME ZONE	BPM	
		TAZ_ID	NUMBER OF ZONES
Manhattan	2236	298	1
	2237	168	1
	2238	215	1
	2239	214	1
	2240	213	1
	2241	212	1
	2242	209	1
	2243	208	1
	2244	211	1
	2245	210	1
	2246	206	1
	2247	205	1
	2248	207	1
	2249	199-200	2
	2250	201	1
	2251	333	1
	2252	334	1
	2253	202	1
	2254	204	1
	2255	203	1
	2256	162	1
	2257	159-160	2
	2258	143	1
	2259	142	1
	2260	140	1
	2261	138-139	2
	2262	166	1
	2263	167	1
	2264	165	1
	2265	164	1
	2266	169-170	2
	2267	93	1
	2268	94,96	2
	2269	92,95	2
	2270	136-137	2
	2271	135141	2
	2272	130-131,133-134	4
	2273	129132	2
	2274	157-158	2
	2275	156	1
	2276	161	1
	2277	154-155	2
	2278	153	1
	2279	151	1
	2280	146	1
	2281	150	1

COUNTY	NJRTME ZONE	BPM	
		TAZ_ID	NUMBER OF ZONES
Manhattan	2282	149	1
	2283	331	1
	2284	148	1
	2285	144	1
	2286	145	1
	2287	147	1
	2288	118-119	2
	2289	120-121	2
	2290	122-123	2
	2291	126-127	2
	2292	90-91	2
	2293	87,89	2
	2294	124-125	2
	2295	85	1
	2296	152	1
	2297	110-111	2
	2298	112	1
	2299	114-115	2
	2300	82	1
	2301	84	1
	2302	32,78-80,83	5
	2303	86	1
	2304	23	1
	2305	24	1
	2306	3	1
	2307	81	1
	2308	77	1
	2309	75	1
	2310	74	1
	2311	128	1
	2312	76	1
	2313	73	1
	2314	72	1
	2315	107113	2
	2316	103	1
	2317	330	1
	2318	105-106	2
	2319	101-102	2
	2320	98-99	2
	2321	104	1
	2322	100	1
	2323	97	1
	2324	88	1
	2325	116-117	2
	2326	108	1
	2327	42	1

COUNTY	NJRTME ZONE	BPM	
		TAZ_ID	NUMBER OF ZONES
Manhattan	2328	40	1
	2329	31	1
	2330	28-29	2
	2331	13	1
	2332	2	1
	2333	1	1
	2334	5	1
	2335	41	1
	2336	38	1
	2337	39	1
	2338	30	1
	2339	19-20	2
	2340	11-12	2
	2341	10	1
	2342	8	1
	2343	4	1
	2344	6-7	2
	2345	9	1
	2346	14	1
	2347	17-18	2
	2348	15-16	2
	2349	44	1
	2350	43	1
	2351	45	1
	2352	46	1
	2353	47	1
	2354	48	1
	2355	49	1
	2356	50	1
	2357	55	1
	2358	56	1
	2359	59	1
	2360	57	1
	2361	58	1
	2362	51	1
	2363	61	1
	2364	62	1
	2365	54	1
	2366	53	1
	2367	52	1
	2368	60	1
	2369	64	1
	2370	71	1
	2371	70	1
	2372	63	1
	2373	68	1

COUNTY	NJRTME ZONE	BPM	
		TAZ_ID	NUMBER OF ZONES
Manhattan	2374	66	1
	2375	67	1
	2376	65	1
	2377	69	1
	2378	37	1
	2379	36	1
	2380	26	1
	2381	35	1
	2382	33	1
	2383	27	1
	2384	34	1
	2385	25	1
	2386	21	1
	2387	22	1
	2388	109	1
	2389	163	1
Orange	2390	3134-3136	3
	2391	3156-3157	2
	2392	3155	1
	2393	3158	1
	2394	3159	1
	2395	3161	1
	2396	3160	1
	2397	3128-3133	6
	2398	3149-3154	6
	2399	3147-3148	2
	2400	3143-3146	4
	2401	3165	1
	2402	3162-3164	3
	2403	3189-3190	2
	2404	3191	1
	2405	3188	1
	2406	3192	1
	2407	3186-3187	2
	2408	3173-3176	4
	2409	3166-3169,3199	5
	2410	3137-3142,3200	7
	2411	3121-3127	7
	2412	3170-3172	3
	2413	3178-3180	3
	2414	3177,3181	2
	2415	3182-3185	8
	2416	3194	1
	2417	3193	1
Putnam	2418	3102-3120	19

COUNTY	NJRTME ZONE	BPM	
		TAZ_ID	NUMBER OF ZONES
Queens	2419	336-360.362-368,372-409,421,992-994	74
	2420	415,419,420,422,482,485,486,494-523,529-554,564-581,995-996	83
	2421	361,369-371,410-414,416-418,423-481,483,484,487-491,561-563,582-591	91
	2422	1004	1
	2423	492,493,592-646,651-665,682-691,785-797,999-1000	97
	2424	647-650,692,780-784,798-817	30
	2425	666-681,818-964,998,1001	165
	2426	524-528,555-560,693-755,758-779,997	97
	2427	756-757,977-991	17
	2428	1002-1003	2
	2429	965-976	12
Richmond	2430	2212	1
	2431	2150	1
	2432	2128	1
	2433	2132	1
	2434	2129	1
	2435	2130	1
	2436	2131	1
	2437	2133	1
	2438	2134	1
	2439	2135	1
	2440	2127	1
	2441	2126	1
	2442	2125	1
	2443	2120	1
	2444	2121	1
	2445	2117	1
	2446	2118	1
	2447	2119	1
	2448	2123	1
	2449	2122	1
	2450	2137	1
	2451	2107-2111	5
	2452	2104-2106,2145	4
	2453	2138	1
	2454	2136	1
	2455	2139	1
	2456	2124	1
	2457	2112-2115,2141-2142	6
	2458	2144,2146	2
	2459	2143,2147-2149,2159,2162-2163,2165	8
	2460	2151	1
	2461	2152	1
	2462	2209	1
	2463	2153	1
	2464	2166,2168	2

COUNTY	NJRTME ZONE	BPM	
		TAZ_ID	NUMBER OF ZONES
Richmond	2465	2167	1
	2466	2169	1
	2467	2171	1
	2468	2154	1
	2469	2155	1
	2470	2156	1
	2471	2157	1
	2472	2160-2161,2170,2179-2184	9
	2473	2164,2172-2178	8
	2474	2187-2191,2211	6
	2475	2185-2186,2192-2201	12
	2476	2202-2204,2208	4
	2477	2205-2207	3
	2478	2210	1
	2479	2116,2158	2
	2480	2140	1
Rockland	2490	3080	1
	2491	3085	1
	2492	3081	1
	2493	3083	1
	2494	3082	1
	2495	3084	1
	2496	3087	1
	2497	3086	1
	2498	3067	1
	2499	3066	1
	2500	3100	1
	2501	3101	1
	2502	3068	1
	2503	3070	1
	2504	3069	1
	2505	3071	1
	2506	3077	1
	2507	3079	1
	2508	3078	1
	2509	3073	1
	2510	3072	1
	2511	3076	1
	2512	3075	1
	2513	3074	1
	2514	3088	1
	2515	3089	1
	2516	3090	1
	2517	3091	1
	2518	3092	1
	2519	3098	1

COUNTY	NJRTME ZONE	BPM	
		TAZ_ID	NUMBER OF ZONES
Rockland	2520	3093	1
	2521	3095	1
	2522	3096	1
	2523	3097	1
	2524	3094	1
	2525	3055	1
	2526	3054	1
	2527	3099	1
	2528	3057	1
	2529	3058	1
	2530	3059	1
	2531	3060	1
	2532	3061	1
	2533	3065	1
	2534	3064	1
	2535	3062	1
	2536	3048	1
	2537	3053	1
	2538	3056	1
	2539	3052	1
	2540	3050	1
	2541	3051	1
	2542	3063	1
	2543	3049	1
	2544	3045	1
	2545	3047	1
	2546	3046	1
	2547	3043	1
	2548	3044	1
	2549	3041	1
	2550	3042	1
	2551	3040	1
	2552	3037	1
	2553	3038	1
	2554	3039	1
Suffolk	2555	2492-2813	322

COUNTY	NJRTME ZONE	BPM	
		TAZ_ID	NUMBER OF ZONES
Westchester	2557	2985-2986,3010,3012,3013	5
	2558	2984,3007-3009,3011,3014-3019	11
	2559	2994,3000,3001,3003-3006	7
	2560	2993,2997-2999,3002	5
	2561	2995	1
	2562	2987,2996,3028	3
	2563	2989	1
	2564	2939-2940,2988,2990	4
	2565	2991-2992	2
	2566	2983,3029,3035	3
	2567	2794-2982	9
	2568	2966,2968-2973,3030,3034	9
	2569	2967,3026-3027	3
	2570	2895-2904,2959-2965,3025,3032-3033	20
	2571	2881-2890,3020-3022	13
	2572	2875-2880,3036	7
	2573	2868-2874	7
	2574	2859-2860,2864	3
	2575	2857-2858	2
	2576	2852-2856	5
	2577	2837-2841,2843-2851,3031	15
	2578	2842	1
	2579	2814-2816	3
	2580	2817-2836	20
	2581	2861-2867,3023-3024	8
	2582	2891-2894	4
	2583	2905-2938,2941-2958	52

2. NJRTM-E – DVRPC EQUIVALENCY

COUNTY	NJRTME ZONE	DVRPC Model	
		TAZ_ID	NUMBER OF ZONES
Burlington	226	20067, 20069, 20070	3
	227	20071	1
	228	20066, 20068	2
	229	20077	1
	230	20036, 20037, 20038, 20039	4
	231	20033	1
	232	20031, 20032	2
	233	20035	1
	234	20034	1
	235	20229	1
	236	20230	1
	237	20226, 20228	2
	238	20225	1
	239	20224	1
	240	20227	1
	241	20223	1
	242	20252, 20255	2
	243	20256, 20257, 20258, 20259, 20260	5
	244	20254	1
	245	20249	1
	246	20247, 20248	2
	247	20250	1
	248	20251, 20253	2
	249	20261, 20262, 20266, 20270, 20272	5
	250	20264, 20267	2
	251	20271, 20275	2
	252	20265	1
	253	20263, 20269	2
	254	20268, 20274, 20276, 20279, 20280	5
	255	20281, 20282, 20283	3
	256	20273, 20277, 20278	3
	257	20218, 20219	2
	258	20214, 20217	2
	259	20221, 20222	2
	260	20216	1
	261	20220	1
	262	20215	1
	263	20207, 20212	2
	264	20210	1
	265	20213	1

COUNTY	NJRTME ZONE	DVRPC Model	
		TAZ_ID	NUMBER OF ZONES
Burlington	266	20205, 20208, 20209	3
	267	20206, 20211	2
	268	20203, 20204	2
	269	20201, 20202	2
	270	20245, 20246	2
	271	20231, 20232, 20234	3
	272	20233	1
	273	20236, 20242, 20244	3
	274	20235	1
	275	20237	1
	276	20238-20241, 20243	5
	277	20411, 20412	2
	278	20413, 20415	2
	279	20414, 20416	2
	280	20406-20410	5
	281	20438, 20441, 20442	3
	282	20436, 20437, 20439, 20440	4
	283	20078	1
	284	20079, 20083	2
	285	20086	1
	286	20087	1
	287	20080	1
	288	20081, 20084	2
	289	20089, 20090	2
	290	20091	1
	291	20085	1
	292	20088	1
	293	20082	1
	294	20051	1
	295	20052, 20053	2
	296	20001, 20002	2
	297	20041, 20042	2
	298	20040	1
	299	20075, 20076	2
	300	20072, 20074	2
	301	20073	1
	302	20049	1
	303	20048, 20050	2
	304	20043	1
	305	20044	1
	306	20045	1
	307	20046, 20047	2
	308	20017, 20020	2
	309	20013, 20014, 20016	3
	310	20015, 20018, 20019	3
	311	20024, 20027, 20029, 20030	4

COUNTY	NJRTME ZONE	DVRPC Model	
		TAZ_ID	NUMBER OF ZONES
Burlington	312	20028	1
	313	20021	1
	314	20023, 20025	2
	315	20026	1
	316	20022	1
	317	20063, 20064	2
	318	20062, 20065	2
	319	20055-20061	7
	320	20003, 20004, 20005	3
	321	20006	1
	322	20010, 20011, 20012	3
	323	20007, 20008, 20009	3
	324	20054	1
	325	20822-20831	10
	326	20608, 20611	2
	327	20609, 20610, 20612-20614	5
	328	20607	1
	329	20651, 20653, 20655	3
	330	20650, 20652, 20654	3
	331	20649	1
	332	20624, 20625, 20626, 20627	4
	333	20623	1
	334	20622	1
	335	20615, 20616, 20619	3
	336	20618, 20620	2
	337	20617	1
	338	20621	1
	339	20657	1
	340	20656	1
	341	20640	1
	342	20647	1
	343	20642, 20644, 20648	3
	344	20628, 20634, 20635	3
	345	20637	1
	346	20629-20633, 20636	6
	347	20638, 20639	2
	348	20641, 20646	2
	349	20643	1
	350	20645	1
	351	20424, 20426, 20428, 20430, 20431, 20433, 20435	7
	352	20432, 20434	2
	353	20423, 20429	2
	354	20425, 20427	2
	355	20808-20815	8
	356	20816-20821	6
	357	20832-20842	11

COUNTY	NJRTME ZONE	DVRPC Model	
		TAZ_ID	NUMBER OF ZONES
Burlington	358	20601, 20602, 20603, 20604, 20605	5
	359	20606	1
	360	20401, 20404, 20405	3
	361	20402, 20403	2
	362	20421, 20422	2
	363	20420	1
	364	20417, 20418	2
	365	20419	1
	366	20801-20807	7
Mercer	874	18001	1
	875	18002	1
	876	18003	1
	877	18004, 18007	2
	878	18008	1
	879	18006, 18010	2
	880	18015	1
	881	18013	1
	882	18011	1
	883	18009	1
	884	18012	1
	885	18022	1
	886	18019	1
	887	18016	1
	888	18023	1
	889	18014, 18018, 18021, 18024	4
	890	18017, 18020, 18025	3
	891	18034, 18035	2
	892	18030	1
	893	18029	1
	894	18027	1
	895	18026	1
	896	18028	1
	897	18032	1
	898	18038, 18040	2
	899	18031, 18036	2
	900	18037	1
	901	18033	1
	902	18039	1
	903	18041	1
	904	18801	1
	905	18806	1
	906	18810	1
	907	18812, 18815	2
	908	18808	1
	909	18802, 18803, 18807	3
	910	18804, 18805	2

COUNTY	NJRTME ZONE	DVRPC Model	
		TAZ_ID	NUMBER OF ZONES
Mercer	911	18809, 18811, 18814, 18816	4
	912	18813, 18818	2
	913	18817	1
	914	19001, 19005, 19006, 19009	4
	915	19002, 19003, 19007, 19008	4
	916	19004, 19010	2
	917	19011, 19013, 19015, 19017, 19018	5
	918	19012, 19016, 19019, 19020, 19022, 19023	6
	919	19014	1
	920	19024	1
	921	19021	1
	922	18832, 18834	2
	923	18827, 18830, 18831, 18833	4
	924	18824, 18828, 18829	3
	925	18821, 18823, 18825	3
	926	18826	1
	927	18822	1
	928	18819, 18820	2
	929	18240, 18242	2
	930	18241	1
	931	18236, 18238	2
	932	18239	1
	933	18230, 18233	2
	934	18231	1
	935	18237	1
	936	18235	1
	937	18232	1
	938	18229, 18234	2
	939	18228	1
	940	18225	1
	941	18221, 18222	2
	942	18212, 18216	2
	943	18203, 18206, 18210	3
	944	18214, 18219	2
	945	18220	1
	946	18215, 18218	2
	947	18223, 18227	2
	948	18226	1
	949	18224	1
	950	18213	1
	951	18207, 18211	2
	952	18204, 18208	2
	953	18201, 18202, 18205, 18209, 18217	5
	954	18418, 18419	2
	955	18420, 18422, 18423, 18426	4
	956	18421	1

COUNTY	NJRTME ZONE	DVRPC Model	
		TAZ_ID	NUMBER OF ZONES
Mercer	957	18424, 18428, 18431	3
	958	18425, 18427, 18429, 18430	4
	959	18401, 18402	2
	960	18406, 18407	2
	961	18411, 18412	2
	962	18409, 18413	2
	963	18403, 18404	2
	964	18405	1
	965	18410	1
	966	18414	1
	967	18415	1
	968	18408	1
	969	18416	1
	970	18417	1
	971	18623, 18628, 18630	3
	972	18621, 18624	2
	973	18620	1
	974	18622	1
	975	18625	1
	976	18627	1
	977	18633	1
	978	18634, 18636	2
	979	18626, 18631	2
	980	18629, 18632, 18635	3
	981	18601	1
	982	18602	1
	983	18604	1
	984	18610	1
	985	18607	1
	986	18605	1
	987	18606	1
	988	18603	1
	989	18613, 18616	2
	990	18608	1
	991	18609	1
	992	18611	1
	993	18612	1
	994	18615	1
	995	18618, 18619	2
	996	18614	1
	997	18617	1

COUNTY	NJRTME ZONE	DVRPC Model	
		TAZ_ID	NUMBER OF ZONES
Bucks	2584	14005-14013	9
	2585	14032	1
	2586	14018, 14020-14023, 14025-14030	11
	2587	14014, 14015, 14016, 14017	4
	2588	14031	1
	2589	14211-14216	6
	2590	14203, 14204	2
	2591	14210	1
	2592	14201, 14202	2
	2593	14205-14209	5
	2594	14001-14004	4
	2595	14409-14413	5
	2596	14425, 14426, 14427	3
	2597	14428, 14429, 14434	3
	2598	14432, 14433, 14435-14440	8
	2599	14431	1
	2600	14414-14424	11
	2601	14430	1
	2602	14408	1
	2603	14401-14407	7
	2604	14217-14222	6
	2605	14811-14816	6
	2606	14621-14624, 14627, 14628	6
	2607	14601, 14602	2
	2608	14625, 14626	2
	2609	14629-14638	10
	2610	14603-14610, 14612, 14615, 14620	11
	2611	14611, 14613, 14614, 14616, 14617, 14618	6
	2612	14801-14810	10
	2613	15005, 15007	2
	2614	15006	1
	2615	15004	1
	2616	15003	1
	2617	15002	1
	2618	15001	1
	2619	15414, 15415, 15417	3
	2620	15412, 15413	2
	2621	15416	1
	2622	15418, 15419	2
	2623	15244-15249	6
	2624	15229-15243	15
	2625	15201	1
	2626	15223-15228	6
	2627	15202-15222	21
	2628	15401-15404, 15406-15411	10
	2629	15405	1

COUNTY	NJRTME ZONE	DVRPC Model	
		TAZ_ID	NUMBER OF ZONES
Bucks	2630	16035, 16036, 16038, 16039	4
	2631	16037	1
	2632	16023-16029, 16031, 16032, 16034	10
	2633	16030, 16033	2
	2634	16047, 16048	2
	2635	16040, 16041, 16042, 16043	4
	2636	16022	1
	2637	16001, 16002, 16006, 16007, 16017	5
	2638	16003, 16004, 16005, 16008, 16009-16016, 16018-16021	16
	2639	16044, 16045, 16046	3
	2640	16216-16228	13
	2641	16215	1
	2642	15804-15808, 15810-15812, 15814-15816, 15818, 15819-15827	21
	2643	15802	1
	2644	15803	1
	2645	15828	1
	2646	15801	1
	2647	15809, 15813, 15817	3
	2648	15630-15637	8
	2649	15603, 15606, 15608-15629	24
	2650	15601, 15602, 15604, 15605, 15607	5
	2651	16201, 16202, 16203	3
	2652	16204, 16207, 16208, 16211-16214	7
	2653	16205, 16206, 16209, 16210	4
	2654	14619	1

APPENDIX B – TOLL RATE SCHEDULE

Cash Only Toll Rate Schedule – Class 1 Passenger Cars (2 Axles) from New Jersey Turnpike Authority

Entry	4	5	6	7	7A	8	8A	9	10	11	12	13	13A	14	14A	14B	14C	15E	15W	15X	16E	16W	18E	18W
4		0.90	2.90	1.45	1.65	2.45	3.00	3.60	4.00	4.35	5.15	6.50	6.50	7.55	9.55	9.70	10.25	8.80	9.05	9.55	9.70	9.70	11.25	11.25
5	0.90		2.15	0.90	1.35	1.65	2.45	2.90	3.00	3.60	4.60	5.45	5.45	7.25	9.05	9.10	9.55	7.55	8.05	8.65	9.10	9.10	10.65	10.65
6	2.90	2.15		1.65	2.15	2.90	3.60	4.00	4.35	4.60	5.45	6.65	6.65	8.05	9.70	10.25	10.65	9.05	9.10	9.95	10.25	10.25	11.80	11.80
7	1.45	0.90	1.65		0.90	1.35	1.65	2.15	2.45	2.90	4.00	4.75	4.75	6.50	8.05	8.80	9.05	7.25	7.40	8.35	8.80	8.80	9.70	9.70
7A	1.65	1.35	2.15	0.90		0.90	1.45	1.65	2.15	2.45	3.60	4.60	4.60	6.10	7.55	8.05	8.80	6.65	7.25	7.55	8.05	8.05	9.55	9.55
8	2.45	1.65	2.90	1.35	0.90		0.90	1.35	1.45	1.65	2.90	4.00	4.00	5.15	7.25	7.40	7.55	6.10	6.50	7.05	7.40	7.40	9.05	9.05
8A	3.00	2.45	3.60	1.65	1.45	0.90		0.90	1.35	1.45	2.45	3.60	3.60	4.75	6.65	7.25	7.40	5.45	6.10	6.75	7.25	7.25	8.80	8.80
9	3.60	2.90	4.00	2.15	1.65	1.35	0.90		0.90	0.90	1.65	2.90	2.90	4.35	6.10	6.50	6.65	4.75	5.15	5.95	6.50	6.50	7.55	7.55
10	4.00	3.00	4.35	2.45	2.15	1.45	1.35	0.90		0.90	1.45	2.45	2.45	4.00	5.45	6.10	6.50	4.60	4.75	5.65	6.10	6.10	7.40	7.40
11	4.35	3.60	4.60	2.90	2.45	1.65	1.45	0.90	0.90		0.90	1.65	1.65	3.00	4.75	5.15	5.45	4.00	4.35	4.80	5.15	5.15	6.65	6.65
12	5.15	4.60	5.45	4.00	3.60	2.90	2.45	1.65	1.45	0.90		1.20	1.20	2.45	4.35	4.60	4.75	3.00	3.60	4.15	4.60	4.60	6.10	6.10
13	6.50	5.45	6.65	4.75	4.60	4.00	3.60	2.90	2.45	1.65	1.20		0.90	1.45	3.00	3.60	4.00	2.15	2.45	3.20	3.60	3.60	4.75	4.75
13A	6.50	5.45	6.65	4.75	4.60	4.00	3.60	2.90	2.45	1.65	1.20	0.90		0.90	3.00	3.60	4.00	2.15	2.45	3.20	3.60	3.60	4.75	4.75
14	7.55	7.25	8.05	6.50	6.10	5.15	4.75	4.35	4.00	3.00	2.45	1.45	0.90		1.65	2.15	2.45	0.90	1.35	1.75	2.15	2.15	3.60	3.60
14A	9.55	9.05	9.70	8.05	7.55	7.25	6.65	6.10	5.45	4.75	4.35	3.00	3.00	1.65		0.90	1.35	2.45	2.90	3.50	4.00	4.00	5.15	5.15
14B	9.70	9.10	10.25	8.80	8.05	7.40	7.25	6.50	6.10	5.15	4.60	3.60	3.60	2.15	0.90		0.90	2.90	3.00	4.00	4.35	4.35	5.45	5.45
14C	10.25	9.55	10.65	9.05	8.80	7.55	7.40	6.65	6.50	5.45	4.75	4.00	4.00	2.45	1.35	0.90		3.00	3.60	4.15	4.60	4.60	6.10	6.10
15E	8.80	7.55	9.05	7.25	6.65	6.10	5.45	4.75	4.60	4.00	3.00	2.15	2.15	0.90	2.45	2.90	3.00		0.90	1.05	1.45	1.45	2.90	2.90
15W	9.05	8.05	9.10	7.40	7.25	6.50	6.10	5.15	4.75	4.35	3.60	2.45	2.45	1.35	2.90	3.00	3.60	0.90		1.20	1.35	1.35	2.45	2.45
15X	9.55	8.65	9.95	8.35	7.55	7.05	6.75	5.95	5.65	4.80	4.15	3.20	3.20	1.75	3.50	4.00	4.15	1.05	1.20		0.35		0.80	
16E	9.70	9.10	10.25	8.80	8.05	7.40	7.25	6.50	6.10	5.15	4.60	3.60	3.60	2.15	4.00	4.35	4.60	1.45	1.35	0.35				
16W	9.70	9.10	10.25	8.80	8.05	7.40	7.25	6.50	6.10	5.15	4.60	3.60	3.60	2.15	4.00	4.35	4.60	1.45	1.35					1.45
18E	11.25	10.65	11.80	9.70	9.55	9.05	8.80	7.55	7.40	6.65	6.10	4.75	4.75	3.60	5.15	5.45	6.10	2.90	2.45	0.80				
18W	11.25	10.65	11.80	9.70	9.55	9.05	8.80	7.55	7.40	6.65	6.10	4.75	4.75	3.60	5.15	5.45	6.10	2.90	2.45			1.45		

Cash Only Toll Rate Schedule – Class 1 Passenger Cars (2 Axles) assumed in the NJRTM-E

	4	5	6	7	7A	8	8A	9	10	11	12	13	13A	14	14A	14B	14C	15E	15W	15X	16E	16W	18E	18W
4	0.00	0.53	1.6	1.43	1.96	2.49	3.02	3.73	4.26	4.79	5.50	6.30	6.83	7.48	8.98	9.88	10.58	8.03	8.73	9.58	9.93	9.93	11.00	11.38
5	0.53	0.00	1.07	0.90	1.43	1.96	2.49	3.20	3.73	4.26	4.97	5.77	6.30	6.95	8.45	9.35	10.05	7.50	8.20	9.05	9.40	9.40	10.47	10.85
6	1.60	1.07	0.00	1.97	2.50	3.03	3.56	4.27	4.80	5.33	6.04	6.84	7.37	8.02	9.52	10.42	11.12	8.57	9.27	10.12	10.47	10.47	11.54	11.92
7	1.43	0.90	1.97	0.00	0.53	1.06	1.59	2.30	2.83	3.36	4.07	4.87	5.40	6.05	7.55	8.45	9.15	6.60	7.30	8.15	8.50	8.50	9.57	9.95
7A	1.96	1.43	2.50	0.53	0.00	0.53	1.06	1.77	2.30	2.83	3.54	4.34	4.87	5.52	7.02	7.92	8.62	6.07	6.77	7.62	7.97	7.97	9.04	9.42
8	2.49	1.96	3.03	1.06	0.53	0.00	0.53	1.24	1.77	2.30	3.01	3.81	4.34	4.99	6.49	7.39	8.09	5.54	6.24	7.09	7.44	7.44	8.51	8.89
8A	3.02	2.49	3.56	1.59	1.06	0.53	0.00	0.71	1.24	1.77	2.48	3.28	3.81	4.46	5.96	6.86	7.56	5.01	5.71	6.56	6.91	6.91	7.98	8.36
9	3.73	3.20	4.27	2.30	1.77	1.24	0.71	0.00	0.53	1.06	1.77	2.57	3.10	3.75	5.25	6.15	6.85	4.30	5.00	5.85	6.20	6.20	7.27	7.65
10	4.26	3.73	4.80	2.83	2.30	1.77	1.24	0.53	0.00	0.53	1.24	2.04	2.57	3.22	4.72	5.62	6.32	3.77	4.47	5.32	5.67	5.67	6.74	7.12
11	4.79	4.26	5.33	3.36	2.83	2.30	1.77	1.06	0.53	0.00	0.71	1.51	2.04	2.69	4.19	5.09	5.79	3.24	3.94	4.79	5.14	5.14	6.21	6.59
12	5.50	4.97	6.04	4.07	3.54	3.01	2.48	1.77	1.24	0.71	0.00	0.80	1.33	1.98	3.48	4.38	5.08	2.53	3.23	4.08	4.43	4.43	5.50	5.88
13	6.30	5.77	6.84	4.87	4.34	3.81	3.28	2.57	2.04	1.51	0.80	0.00	0.53	1.18	2.68	3.58	4.28	1.73	2.43	3.28	3.63	3.63	4.70	5.08
13A	6.83	6.30	7.37	5.40	4.87	4.34	3.81	3.10	2.57	2.04	1.33	0.53	0.00	0.65	2.15	3.05	3.75	1.20	1.90	2.75	3.10	3.10	4.17	4.55
14	7.48	6.95	8.02	6.05	5.52	4.99	4.46	3.75	3.22	2.69	1.98	1.18	0.65	0.00	1.50	2.40	3.10	0.55	1.25	2.10	2.45	2.45	3.52	3.90
14A	8.98	8.45	9.52	7.55	7.02	6.49	5.96	5.25	4.72	4.19	3.48	2.68	2.15	1.50	0.00	0.90	1.60	2.05	2.75	3.60	3.95	3.95	5.02	5.40
14B	9.88	9.35	10.42	8.45	7.92	7.39	6.86	6.15	5.62	5.09	4.38	3.58	3.05	2.40	0.90	0.00	0.70	2.95	3.65	4.50	4.85	4.85	5.92	6.30
14C	10.58	10.05	11.12	9.15	8.62	8.09	7.56	6.85	6.32	5.79	5.08	4.28	3.75	3.10	1.60	0.70	0.00	3.65	4.35	5.20	5.55	5.55	6.62	7.00
15E	8.03	7.50	8.57	6.60	6.07	5.54	5.01	4.30	3.77	3.24	2.53	1.73	1.20	0.55	2.05	2.95	3.65	0.00	0.70	1.55	1.90	1.90	2.97	3.35
15W	8.73	8.20	9.27	7.30	6.77	6.24	5.71	5.00	4.47	3.94	3.23	2.43	1.90	1.25	2.75	3.65	4.35	0.70	0.00	0.85	1.20	1.20	2.27	2.65
15X	9.58	9.05	10.12	8.15	7.62	7.09	6.56	5.85	5.32	4.79	4.08	3.28	2.75	2.10	3.60	4.50	5.20	1.55	0.85	0.00	0.35	0.00	1.42	
16E	9.93	9.40	10.47	8.50	7.97	7.44	6.91	6.20	5.67	5.14	4.43	3.63	3.10	2.45	3.95	4.85	5.55	1.90	1.20	0.35	0.00	0.00	1.07	
16W	9.93	9.40	10.47	8.50	7.97	7.44	6.91	6.20	5.67	5.14	4.43	3.63	3.10	2.45	3.95	4.85	5.55	1.90	1.20		0.00	0.00		1.45
18E	11.00	10.47	11.54	9.57	9.04	8.51	7.98	7.27	6.74	6.21	5.50	4.70	4.17	3.52	5.02	5.92	6.62	2.97	2.27	1.42	1.07	0.00	0.00	0.00
18W	11.38	10.85	11.92	9.95	9.42	8.89	8.36	7.65	7.12	6.59	5.88	5.08	4.55	3.90	5.40	6.30	7.00	3.35	2.65			1.45	0.00	0.00

APPENDIX C – COUNTY PRODUCTION ADJUSTMENT FACTORS BY INCOME

PURPOSE	COUNTY	INC1	INC2	INC3	INC4	INC5
HBWD	BERGEN	0.9538	0.8554	1.0049	0.8943	1.0722
HBWD	ESSEX	1.2781	0.9960	1.0585	0.9793	0.9893
HBWD	HUDSON	1.1307	1.0981	1.0745	1.0410	0.9824
HBWD	HUNTERDON	1.0000	0.7378	1.0635	1.1616	1.3087
HBWD	MERCER	1.0000	1.0064	0.9201	1.0016	0.9106
HBWD	MIDDLESEX	1.2946	0.9327	1.0092	1.0606	0.8884
HBWD	MONMOUTH	1.0439	1.0237	0.9934	1.0305	1.0355
HBWD	MORRIS	1.0000	1.1617	1.0665	0.9926	0.9941
HBWD	OCEAN	0.7411	1.0487	0.9621	0.9342	0.9999
HBWD	PASSAIC	0.9859	1.0340	0.9991	0.9598	1.0682
HBWD	SOMERSET	0.3847	0.9431	1.0407	1.0733	0.8261
HBWD	SUSSEX	0.7447	0.9348	0.7666	1.0567	0.8330
HBWD	UNION	0.4666	1.0618	0.8442	0.9527	0.8504
HBWD	WARREN	0.8367	1.0603	1.0392	1.0415	1.0448
HBWS	BERGEN	1.3491	1.9974	0.9853	1.2920	0.8269
HBWS	ESSEX	1.0000	1.0155	0.8209	1.0589	1.0260
HBWS	HUDSON	0.6578	0.6355	0.7446	0.8707	1.0663
HBWS	HUNTERDON	1.0000	1.7421	0.8371	0.6287	0.3845
HBWS	MERCER	1.0000	0.9791	1.2421	0.9958	1.2019
HBWS	MIDDLESEX	1.0000	1.2118	0.9729	0.8328	1.2683
HBWS	MONMOUTH	0.6654	0.9225	1.0196	0.9182	0.9185
HBWS	MORRIS	1.0000	0.4873	0.8072	1.0194	1.0133
HBWS	OCEAN	2.8215	0.8450	1.1140	1.1789	1.0003
HBWS	PASSAIC	1.0934	0.8962	1.0028	1.1104	0.8352
HBWS	SOMERSET	1.0000	1.1706	0.8873	0.8164	1.3749
HBWS	SUSSEX	2.8130	1.1957	1.6344	0.8592	1.3593
HBWS	UNION	4.5330	0.8102	1.4592	1.1306	1.3587
HBWS	WARREN	2.1103	0.8258	0.8980	0.9025	0.9096
HBSH	BERGEN	1.0000	1.1750	1.0000	1.0000	1.0000
HBSH	ESSEX	1.0000	1.0000	1.0000	1.0000	1.0000
HBSH	HUDSON	1.0000	1.0000	1.0000	1.0000	1.0000
HBSH	HUNTERDON	0.8259	1.0000	1.0000	1.0000	1.0000
HBSH	MERCER	1.0000	1.0000	1.0000	1.0000	1.0000
HBSH	MIDDLESEX	1.0000	1.0000	1.0000	1.0000	1.0000
HBSH	MONMOUTH	1.0000	1.0000	1.0000	1.0000	1.0000
HBSH	MORRIS	1.0000	1.0000	1.0000	1.0000	1.0000
HBSH	OCEAN	1.0000	1.0000	1.0000	1.0000	1.0000
HBSH	PASSAIC	1.0000	1.0000	1.0000	1.0000	1.0000
HBSH	SOMERSET	1.0000	1.0000	1.0000	1.0000	1.0000
HBSH	SUSSEX	0.5516	1.0000	1.0000	1.0000	1.0000
HBSH	UNION	1.0000	1.0000	1.0000	1.0000	1.0000
HBSH	WARREN	1.0000	1.0000	1.0000	1.0000	1.0000
HBO	BERGEN	1.0107	1.0105	1.0102	1.0095	1.0095
HBO	ESSEX	1.0079	1.0078	1.0072	1.0060	1.0060
HBO	HUDSON	1.0235	1.0229	1.0219	1.0220	0.2807
HBO	HUNTERDON	0.9878	0.9879	0.9878	0.9877	0.1798
HBO	MERCER	0.9195	1.0021	1.0016	1.0008	0.7920
HBO	MIDDLESEX	0.9857	1.0049	1.0048	1.0046	0.3981
HBO	MONMOUTH	0.9989	0.9992	0.9996	1.0002	1.0002
HBO	MORRIS	0.7607	0.9969	0.9969	0.9969	0.9969
HBO	OCEAN	0.9932	0.9928	0.9916	0.9914	0.1083
HBO	PASSAIC	1.0100	1.0079	1.0055	1.0031	0.3624
HBO	SOMERSET	0.9977	0.9977	0.9975	0.9968	0.9968
HBO	SUSSEX	0.9792	0.9789	0.9780	0.9777	0.1856
HBO	UNION	0.9865	0.9872	0.9880	0.9893	0.9893
HBO	WARREN	0.7844	0.9894	0.9884	0.9878	0.1235

PURPOSE	COUNTY	INC1	INC2	INC3	INC4	INC5
HBU	BERGEN	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	ESSEX	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	HUDSON	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	HUNTERDON	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	MERCER	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	MIDDLESEX	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	MONMOUTH	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	MORRIS	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	OCEAN	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	PASSAIC	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	SOMERSET	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	SUSSEX	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	UNION	1.0000	1.0000	1.0000	1.0000	1.0000
HBU	WARREN	1.0000	1.0000	1.0000	1.0000	1.0000
WBO	BERGEN	12.5075	0.6795	1.1239	0.5032	0.7632
WBO	ESSEX	9.6621	3.3291	1.9446	1.5272	0.9746
WBO	HUDSON	3.6702	0.7498	3.9450	2.0318	1.0770
WBO	HUNTERDON	0.0000	1.0328	0.8047	0.2980	0.8961
WBO	MERCER	0.0000	6.5816	1.0672	0.7127	0.3409
WBO	MIDDLESEX	5.5934	2.0602	1.2388	0.8467	0.5267
WBO	MONMOUTH	8.1483	3.4677	1.0251	1.1085	1.8670
WBO	MORRIS	0.0000	0.7971	1.7398	1.1978	0.8620
WBO	OCEAN	0.9969	1.4060	2.6983	1.6881	1.0046
WBO	PASSAIC	11.4489	0.3381	1.5462	0.4637	0.4953
WBO	SOMERSET	0.0000	0.6358	2.1486	1.2758	0.6796
WBO	SUSSEX	10.9962	5.1614	3.8548	1.6386	4.4230
WBO	UNION	0.0000	0.8134	1.3988	1.9908	0.7092
WBO	WARREN	0.0000	0.4469	0.2376	0.9431	0.0239
NHNW	BERGEN	0.7871	1.0343	0.9495	1.1668	1.0688
NHNW	ESSEX	0.8237	0.8504	0.7948	0.8279	0.9479
NHNW	HUDSON	0.8782	1.0166	0.5254	0.7713	1.1512
NHNW	HUNTERDON	1.2383	1.0127	1.0500	1.2184	1.6938
NHNW	MERCER	1.1768	0.7205	0.9822	1.1199	1.4623
NHNW	MIDDLESEX	0.8000	0.8571	0.8831	1.0051	1.6766
NHNW	MONMOUTH	0.7899	0.8428	0.9804	0.9706	0.7849
NHNW	MORRIS	1.5453	1.4869	0.8149	0.9363	1.0148
NHNW	OCEAN	0.9976	1.0370	0.7927	0.8680	2.2468
NHNW	PASSAIC	0.8720	1.1774	0.8713	1.1439	1.5110
NHNW	SOMERSET	1.2947	1.2490	0.8789	1.0744	1.3665
NHNW	SUSSEX	1.2841	0.8703	0.7553	1.0539	0.9210
NHNW	UNION	0.9660	1.1543	0.9987	0.8795	1.1967
NHNW	WARREN	0.7279	1.3410	1.5829	1.2934	3.6649

APPENDIX D – TRIP PRODUCTIONS BY COUNTY & INCOME GROUP

HBWD - PRODUCTION

COUNTY	INCOME 1			INCOME 2			INCOME 3			INCOME 4			INCOME 5			TOTAL		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
Bergen	4,561	4,561	0.0%	70,273	70,274	0.0%	151,105	151,102	0.0%	176,525	176,519	0.0%	91,401	91,399	0.0%	493,865	493,855	0.0%
Essex	13,064	13,064	0.0%	77,885	77,882	0.0%	112,713	112,709	0.0%	107,079	107,078	0.0%	35,842	35,842	0.0%	346,582	346,575	0.0%
Hudson	20,608	20,608	0.0%	81,862	81,860	0.0%	108,628	108,625	0.0%	95,347	95,349	0.0%	25,219	25,218	0.0%	331,663	331,659	0.0%
Hunterdon	0	146	0.0%	4,322	4,322	0.0%	14,567	14,568	0.0%	24,629	24,629	0.0%	12,932	12,932	0.0%	56,450	56,597	0.3%
Mercer	0	1,087	0.0%	29,070	29,070	0.0%	56,553	56,555	0.0%	76,216	76,216	0.0%	15,190	15,189	0.0%	177,029	178,117	0.6%
Middlesex	5,198	5,198	0.0%	66,712	66,710	0.0%	171,050	171,055	0.0%	187,739	187,737	0.0%	21,090	21,091	0.0%	451,789	451,791	0.0%
Monmouth	2,959	2,959	0.0%	38,118	38,119	0.0%	107,262	107,258	0.0%	109,509	109,512	0.0%	52,509	52,511	0.0%	310,357	310,359	0.0%
Morris	0	722	0.0%	44,593	44,592	0.0%	84,479	84,479	0.0%	100,899	100,897	0.0%	37,224	37,223	0.0%	267,195	267,914	0.3%
Ocean	4,654	4,654	0.0%	75,667	75,666	0.0%	91,849	91,850	0.0%	78,231	78,229	0.0%	8,880	8,880	0.0%	259,280	259,279	0.0%
Passaic	15,000	15,000	0.0%	53,762	53,761	0.0%	83,661	83,662	0.0%	67,434	67,431	0.0%	18,256	18,256	0.0%	238,114	238,111	0.0%
Somerset	201	201	0.0%	18,797	18,796	0.0%	54,960	54,961	0.0%	79,914	79,912	0.0%	23,952	23,952	0.0%	177,823	177,822	0.0%
Sussex	671	671	0.0%	11,176	11,177	0.0%	30,659	30,657	0.0%	30,847	30,848	0.0%	5,131	5,131	0.0%	78,483	78,484	0.0%
Union	1,189	1,189	0.0%	61,151	61,150	0.0%	85,954	85,951	0.0%	114,920	114,922	0.0%	21,093	21,093	0.0%	284,307	284,305	0.0%
Warren	1,065	1,065	0.0%	10,108	10,108	0.0%	21,035	21,036	0.0%	16,606	16,606	0.0%	1,493	1,493	0.0%	50,307	50,308	0.0%
TOTAL	**69,170**	**71,124**	**2.8%**	**643,495**	**643,487**	**0.0%**	**1,174,475**	**1,174,467**	**0.0%**	**1,265,894**	**1,265,886**	**0.0%**	**370,212**	**370,211**	**0.0%**	**3,523,245**	**3,525,175**	**0.1%**

HBWS - PRODUCTION

COUNTY	INCOME 1			INCOME 2			INCOME 3			INCOME 4			INCOME 5			TOTAL		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
Bergen	846	846	0.0%	49,597	49,596	0.0%	48,452	48,451	0.0%	92,330	92,333	0.0%	29,658	29,657	0.0%	220,883	220,883	0.0%
Essex	0	1,337	0.0%	22,975	22,975	0.0%	27,188	27,189	0.0%	39,939	39,940	0.0%	15,254	15,253	0.0%	105,356	106,695	1.3%
Hudson	1,318	1,318	0.0%	11,814	11,815	0.0%	20,163	20,164	0.0%	22,035	22,036	0.0%	8,270	8,270	0.0%	63,600	63,603	0.0%
Hunterdon	0	22	0.0%	3,621	3,621	0.0%	4,495	4,495	0.0%	5,829	5,829	0.0%	1,914	1,914	0.0%	15,859	15,881	0.1%
Mercer	0	147	0.0%	8,628	8,628	0.0%	25,391	25,391	0.0%	28,221	28,222	0.0%	8,984	8,984	0.0%	71,223	71,372	0.2%
Middlesex	0	588	0.0%	27,604	27,604	0.0%	55,781	55,782	0.0%	53,830	53,829	0.0%	12,640	12,639	0.0%	149,855	150,443	0.4%
Monmouth	249	249	0.0%	10,545	10,545	0.0%	36,957	36,958	0.0%	36,638	36,639	0.0%	20,427	20,427	0.0%	104,816	104,818	0.0%
Morris	0	98	0.0%	5,969	5,969	0.0%	22,264	22,265	0.0%	40,090	40,089	0.0%	17,088	17,089	0.0%	85,411	85,509	0.1%
Ocean	2,564	2,564	0.0%	19,434	19,435	0.0%	35,941	35,940	0.0%	36,814	36,815	0.0%	3,759	3,759	0.0%	98,512	98,512	0.0%
Passaic	2,447	2,447	0.0%	14,547	14,547	0.0%	27,921	27,921	0.0%	28,395	28,395	0.0%	5,936	5,936	0.0%	79,246	79,246	0.0%
Somerset	0	77	0.0%	7,841	7,841	0.0%	17,059	17,058	0.0%	24,431	24,430	0.0%	18,597	18,597	0.0%	67,928	68,003	0.1%
Sussex	356	356	0.0%	4,757	4,757	0.0%	23,994	23,995	0.0%	10,081	10,081	0.0%	3,885	3,885	0.0%	43,074	43,074	0.0%
Union	1,672	1,672	0.0%	14,601	14,602	0.0%	49,218	49,219	0.0%	48,858	48,856	0.0%	14,016	14,016	0.0%	128,365	128,365	0.0%
Warren	397	397	0.0%	2,730	2,730	0.0%	6,975	6,975	0.0%	6,115	6,115	0.0%	644	644	0.0%	16,860	16,860	0.0%
TOTAL	**9,850**	**12,119**	**23.0%**	**204,664**	**204,666**	**0.0%**	**401,798**	**401,801**	**0.0%**	**473,607**	**473,610**	**0.0%**	**161,071**	**161,069**	**0.0%**	**1,250,989**	**1,253,265**	**0.2%**

HBS - PRODUCTION

COUNTY	INCOME 1			INCOME 2			INCOME 3			INCOME 4			INCOME 5			TOTAL		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
Bergen	6,941	6,941	0.0%	113,787	113,788	0.0%	121,747	121,748	0.0%	123,015	123,017	0.0%	36,845	36,846	0.0%	402,337	402,341	0.0%
Essex	9,638	9,641	0.0%	66,880	66,894	0.0%	54,047	54,049	0.0%	45,409	45,402	0.0%	15,993	15,990	0.0%	191,966	191,977	0.0%
Hudson	9,944	9,944	0.0%	44,449	44,448	0.0%	33,194	33,193	0.0%	22,020	22,020	0.0%	3,960	3,960	0.0%	113,566	113,565	0.0%
Hunterdon	525	525	0.0%	6,313	6,313	0.0%	11,897	11,897	0.0%	15,417	15,417	0.0%	3,355	3,355	0.0%	37,507	37,507	0.0%
Mercer	4,040	4,040	0.0%	30,829	30,829	0.0%	46,297	46,297	0.0%	34,131	34,131	0.0%	9,823	9,823	0.0%	125,119	125,120	0.0%
Middlesex	9,462	9,461	0.0%	75,197	75,187	0.0%	103,301	103,287	0.0%	75,915	75,902	0.0%	10,656	10,653	0.0%	274,532	274,490	0.0%
Monmouth	18,238	18,238	0.0%	39,055	39,055	0.0%	59,120	59,120	0.0%	107,625	107,625	0.0%	26,345	26,345	0.0%	250,383	250,383	0.0%
Morris	3,860	3,860	0.0%	38,760	38,764	0.0%	37,674	37,676	0.0%	47,550	47,550	0.0%	23,527	23,528	0.0%	151,371	151,378	0.0%
Ocean	15,773	15,773	0.0%	74,768	74,769	0.0%	62,480	62,481	0.0%	72,833	72,835	0.0%	9,640	9,640	0.0%	235,494	235,498	0.0%
Passaic	25,407	25,407	0.0%	63,415	63,415	0.0%	59,423	59,423	0.0%	40,153	40,153	0.0%	4,029	4,029	0.0%	192,427	192,426	0.0%
Somerset	14,037	14,037	0.0%	11,271	11,271	0.0%	29,255	29,254	0.0%	34,728	34,728	0.0%	17,203	17,203	0.0%	106,494	106,493	0.0%
Sussex	537	537	0.0%	7,188	7,188	0.0%	17,384	17,384	0.0%	14,881	14,881	0.0%	1,883	1,883	0.0%	41,873	41,873	0.0%
Union	4,307	4,307	0.0%	44,350	44,350	0.0%	52,860	52,860	0.0%	30,219	30,219	0.0%	12,932	12,932	0.0%	144,668	144,668	0.0%
Warren	933	933	0.0%	16,244	16,244	0.0%	12,678	12,678	0.0%	17,383	17,383	0.0%	1,344	1,344	0.0%	48,583	48,583	0.0%
TOTAL	**123,643**	**123,645**	**0.0%**	**632,507**	**632,516**	**0.0%**	**701,357**	**701,349**	**0.0%**	**681,278**	**681,262**	**0.0%**	**177,536**	**177,533**	**0.0%**	**2,316,321**	**2,316,303**	**0.0%**

HBO - PRODUCTION

COUNTY	INCOME 1			INCOME 2			INCOME 3			INCOME 4			INCOME 5			TOTAL		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
Bergen	28,409	28,407	0.0%	221,638	221,623	0.0%	449,247	449,213	0.0%	599,539	599,479	0.0%	158,366	158,350	0.0%	1,457,199	1,457,072	0.0%
Essex	66,181	66,185	0.0%	191,084	191,093	0.0%	243,917	243,923	0.0%	242,222	242,212	0.0%	98,373	98,369	0.0%	841,777	841,782	0.0%
Hudson	55,708	55,682	0.0%	109,666	109,612	0.0%	127,068	126,995	-0.1%	79,695	79,629	-0.1%	26,314	26,293	-0.1%	398,452	398,210	-0.1%
Hunterdon	3,692	3,692	0.0%	14,796	14,795	0.0%	37,485	37,483	0.0%	77,919	77,914	0.0%	10,470	10,470	0.0%	144,362	144,354	0.0%
Mercer	11,324	11,323	0.0%	67,270	67,265	0.0%	125,962	125,944	0.0%	161,997	161,952	0.0%	42,787	42,775	0.0%	409,340	409,258	0.0%
Middlesex	24,154	24,165	0.0%	176,616	176,669	0.0%	363,437	363,507	0.0%	413,350	413,389	0.0%	71,736	71,742	0.0%	1,049,292	1,049,472	0.0%
Monmouth	44,879	44,894	0.0%	107,759	107,790	0.0%	306,693	306,754	0.0%	317,049	317,070	0.0%	182,253	182,265	0.0%	958,633	958,771	0.0%
Morris	7,779	7,779	0.0%	102,563	102,567	0.0%	171,365	171,375	0.0%	268,835	268,861	0.0%	125,689	125,701	0.0%	676,231	676,283	0.0%
Ocean	42,893	42,895	0.0%	234,989	235,001	0.0%	304,761	304,780	0.0%	159,445	159,458	0.0%	24,026	24,028	0.0%	766,114	766,162	0.0%
Passaic	40,200	40,199	0.0%	192,502	192,483	0.0%	182,754	182,723	0.0%	194,229	194,181	0.0%	31,263	31,255	0.0%	640,947	640,839	0.0%
Somerset	19,162	19,163	0.0%	69,590	69,595	0.0%	92,608	92,613	0.0%	134,369	134,383	0.0%	65,657	65,664	0.0%	381,385	381,418	0.0%
Sussex	4,610	4,609	0.0%	24,773	24,770	0.0%	85,948	85,939	0.0%	58,370	58,362	0.0%	10,409	10,408	0.0%	184,109	184,088	0.0%
Union	16,216	16,209	0.0%	142,632	142,584	0.0%	236,515	236,449	0.0%	270,084	270,026	0.0%	67,945	67,930	0.0%	733,392	733,199	0.0%
Warren	2,737	2,740	0.1%	29,498	29,494	0.0%	58,374	58,368	0.0%	56,330	56,323	0.0%	5,570	5,570	0.0%	152,509	152,495	0.0%
TOTAL	**367,944**	**367,941**	**0.0%**	**1,685,374**	**1,685,339**	**0.0%**	**2,786,135**	**2,786,066**	**0.0%**	**3,033,432**	**3,033,239**	**0.0%**	**920,858**	**920,818**	**0.0%**	**8,793,743**	**8,793,403**	**0.0%**

NHBW - PRODUCTION

COUNTY	INCOME 1			INCOME 2			INCOME 3			INCOME 4			INCOME 5			TOTAL		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
Bergen	2,605	2,601	-0.2%	13,409	13,362	-0.4%	61,056	60,705	-0.6%	50,995	50,558	-0.9%	17,832	17,686	-0.8%	145,897	144,912	-0.7%
Essex	3,336	3,364	0.9%	17,736	17,799	0.4%	44,948	44,725	-0.5%	41,177	40,595	-1.4%	14,006	13,792	-1.5%	121,202	120,276	-0.8%
Hudson	2,669	2,572	-3.6%	6,791	6,617	-2.6%	34,263	33,761	-1.5%	15,975	16,108	0.8%	4,119	4,603	11.7%	63,818	63,661	-0.2%
Hunterdon	0	0	0.0%	1,579	1,576	-0.1%	2,644	2,620	-0.9%	3,309	3,281	-0.8%	1,015	1,031	1.6%	8,547	8,509	-0.4%
Mercer	0	0	0.0%	16,204	16,198	0.0%	24,979	24,739	-1.0%	16,428	16,333	-0.6%	4,043	4,075	0.8%	61,654	61,345	-0.5%
Middlesex	1,760	1,740	-1.1%	18,186	18,046	-0.8%	49,157	48,899	-0.5%	43,414	43,219	-0.4%	8,301	8,166	-1.6%	120,817	120,069	-0.6%
Monmouth	5,277	5,291	0.3%	17,303	17,278	-0.1%	31,470	31,300	-0.5%	39,939	39,567	-0.9%	24,209	23,982	-0.9%	118,198	117,418	-0.7%
Morris	0	0	0.0%	11,604	11,576	-0.2%	31,991	31,861	-0.4%	42,808	42,503	-0.7%	16,935	16,803	-0.8%	103,338	102,743	-0.6%
Ocean	601	598	-0.5%	15,163	15,047	-0.8%	32,043	31,834	-0.7%	21,373	21,228	-0.7%	4,076	4,104	0.7%	73,256	72,811	-0.6%
Passaic	2,873	2,898	0.9%	6,987	6,986	0.0%	28,315	28,174	-0.5%	14,072	13,874	-1.4%	3,286	3,185	-3.1%	55,532	55,116	-0.7%
Somerset	0	0	0.0%	2,579	2,594	0.6%	20,514	20,478	-0.2%	27,773	27,518	-0.9%	8,954	8,827	-1.4%	59,821	59,417	-0.7%
Sussex	1,581	1,562	-1.2%	3,546	3,545	0.0%	11,348	11,275	-0.6%	5,826	5,778	-0.8%	1,939	2,021	4.2%	24,239	24,180	-0.2%
Union	0	0	0.0%	6,767	6,760	-0.1%	26,345	26,141	-0.8%	32,269	32,079	-0.6%	6,822	6,731	-1.3%	72,202	71,711	-0.7%
Warren	0	0	0.0%	599	609	1.8%	1,351	1,329	-1.7%	5,254	5,183	-1.4%	151	153	1.6%	7,355	7,275	-1.1%
TOTAL	**20,701**	**20,625**	**-0.4%**	**138,452**	**137,993**	**-0.3%**	**400,424**	**397,841**	**-0.6%**	**360,612**	**357,824**	**-0.8%**	**115,689**	**115,159**	**-0.5%**	**1,035,877**	**1,029,443**	**-0.6%**

NHBO - PRODUCTION

COUNTY	INCOME 1			INCOME 2			INCOME 3			INCOME 4			INCOME 5			TOTAL		
	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF	OBSERVED	ESTIMATED	%DIFF
Bergen	14,892	14,920	0.2%	153,275	153,503	0.1%	235,550	236,136	0.2%	287,213	287,760	0.2%	55,057	55,250	0.4%	745,986	747,569	0.2%
Essex	24,728	24,699	-0.1%	106,959	106,979	0.0%	145,870	146,218	0.2%	109,206	109,993	0.7%	35,716	36,024	0.9%	422,479	423,914	0.3%
Hudson	24,463	24,482	0.1%	71,243	71,403	0.2%	55,838	56,376	1.0%	35,904	35,917	0.0%	10,963	10,608	-3.2%	198,411	198,785	0.2%
Hunterdon	2,503	2,502	0.0%	9,261	9,269	0.1%	10,974	11,009	0.3%	29,920	29,962	0.1%	3,527	3,516	-0.3%	56,184	56,257	0.1%
Mercer	12,659	12,626	-0.3%	56,469	56,408	-0.1%	103,884	104,198	0.3%	69,857	70,110	0.4%	21,084	21,120	0.2%	263,954	264,462	0.2%
Middlesex	10,472	10,522	0.5%	92,242	92,512	0.3%	178,888	179,440	0.3%	160,168	160,409	0.2%	25,328	25,476	0.6%	467,098	468,359	0.3%
Monmouth	26,260	26,299	0.2%	82,608	82,717	0.1%	183,933	184,190	0.1%	212,244	212,700	0.2%	62,010	62,441	0.7%	567,055	568,347	0.2%
Morris	12,009	11,966	-0.4%	107,751	107,811	0.1%	84,700	85,012	0.4%	139,424	139,924	0.4%	51,456	51,585	0.2%	395,341	396,298	0.2%
Ocean	28,321	28,337	0.1%	193,444	193,676	0.1%	128,865	129,216	0.3%	87,162	87,363	0.2%	11,914	11,876	-0.3%	449,706	450,468	0.2%
Passaic	31,123	31,079	-0.1%	150,816	150,794	0.0%	115,150	115,449	0.3%	93,763	94,046	0.3%	12,809	12,891	0.6%	403,661	404,259	0.1%
Somerset	19,513	19,470	-0.2%	24,676	24,642	-0.1%	49,066	49,176	0.2%	76,904	77,277	0.5%	27,004	27,218	0.8%	197,164	197,783	0.3%
Sussex	8,742	8,768	0.3%	13,297	13,313	0.1%	25,174	25,295	0.5%	23,891	23,963	0.3%	2,325	2,249	-3.3%	73,429	73,587	0.2%
Union	9,638	9,607	-0.3%	86,806	86,854	0.1%	119,458	119,681	0.2%	93,103	93,525	0.5%	26,172	26,333	0.6%	335,176	336,000	0.2%
Warren	695	694	-0.1%	9,974	9,963	-0.1%	13,964	13,991	0.2%	24,323	24,425	0.4%	3,593	3,272	-8.9%	52,549	52,344	-0.4%
TOTAL	**226,018**	**225,971**	**0.0%**	**1,158,821**	**1,159,843**	**0.1%**	**1,451,314**	**1,455,385**	**0.3%**	**1,443,082**	**1,447,372**	**0.3%**	**348,957**	**349,860**	**0.3%**	**4,628,192**	**4,638,431**	**0.2%**

APPENDIX E – FRICTION-FACTORS FOR HBWD AND HBWS PURPOSES

CI	HBWD					HBWS				
	INC1	INC2	INC3	INC4	INC5	INC1	INC2	INC3	INC4	INC5
1	8533	90	192	1	1342	3762	282	407	1	696
2	377713	1567	3240	542	28054	175101	3123	5594	510	17724
3	2322270	7827	15918	19129	146593	1115651	12205	24400	17473	103685
4	6363168	23483	47168	190982	434262	3148961	31152	66540	171707	332122
5	11197234	53295	105942	954867	942619	5689217	62963	140285	850941	764824
6	14890167	101377	199697	3082602	1680716	7751479	109790	251334	2735029	1429460
7	16320740	170718	333540	7358532	2616380	8692482	172898	402446	6520073	2313252
8	15528703	262958	509890	14083394	3687725	8452811	252716	593552	12489889	3368874
9	13261748	378364	728517	22768483	4817929	7371906	348931	822126	20245034	4526623
10	10400340	515939	986825	32221758	5928796	5900167	460611	1083695	28764249	5707910
11	7612803	673608	1280267	40944195	6950895	4405308	586331	1372371	36735829	6836930
12	5263946	848453	1602826	47600843	7829762	3105805	724298	1681378	42963288	7849030
13	3469858	1036951	1947505	51357788	8528515	2086658	872460	2003510	46666303	8695520
14	2195971	1235208	2306771	51997090	9027739	1345586	1028614	2331530	47595995	9345356
15	1341834	1439175	2672962	49836464	9323533	837559	1190489	2658476	45980563	9784464
16	795238	1644826	3038612	45539248	9424550	505530	1355819	2977906	42370033	10013512
17	458809	1848306	3396720	39903414	9348682	296980	1522406	3284064	37455329	10044869
18	258486	2046053	3740942	33690178	9119826	170335	1688166	3571988	31915455	9899304
19	142571	2234875	4065729	27517617	8765041	95631	1851162	3837563	26317742	9602858
20	77154	2412009	4366400	21817707	8312211	52670	2009634	4077532	21072588	9184092
21	41042	2575150	4639179	16840631	7788269	28511	2162010	4289481	16430707	8671881
22	21495	2722461	4881191	12686531	7217965	15193	2306921	4471785	12506534	8093736
23	11099	2852567	5090424	9347644	6623087	7981	2443201	4623551	9313011	7474666
24	5657	2964528	5265673	6749255	6022080	4138	2569886	4744536	6797151	6836482
25	2849	3057816	5406471	4783249	5429957	2120	2686205	4835071	4870340	6197475
26	1419	3132269	5513000	3332255	4858424	1074	2791575	4895974	3430956	5572383
27	700	3188057	5586012	2284883	4316149	539	2885588	4928466	2379312	4972556
28	342	3225629	5626730	1543837	3809122	268	2967995	4934094	1626164	4406259
29	166	3245678	5636772	1028962	3341047	132	3038698	4914654	1096473	3879056
30	80	3249087	5618060	677112	2913737	64	3097726	4872122	730047	3394220
31	38	3236898	5572747	440299	2527504	31	3145229	4808595	480377	2953147
32	18	3210265	5503145	283133	2181496	15	3181459	4726236	312620	2555749
33	8	3170425	5411663	180171	1874013	7	3206755	4627226	201350	2200805
34	4	3118663	5300753	113528	1602759	3	3221531	4513725	128426	1886274
35	2	3056283	5172859	70876	1365063	2	3226261	4387841	81165	1609556
36	1	2984591	5030382	43862	1158053	1	3221469	4251601	50854	1367710
37	0	2904865	4875644	26921	978788	0	3207716	4106931	31603	1157624
38	0	2818347	4710863	16394	824365	0	3185593	3955641	19487	976154
39	0	2726225	4538133	9910	691992	0	3155705	3799416	11929	820221
40	0	2629623	4359409	5948	579037	0	3118671	3639803	7251	686883
41	0	2529594	4176498	3546	483062	0	3075111	3478214	4379	573385
42	0	2427115	3991052	2101	401841	0	3025641	3315921	2627	477187
43	0	2323083	3804566	1237	333365	0	2970867	3154062	1567	395979
44	0	2218314	3618379	724	275837	0	2911384	2993639	929	327683
45	0	2113541	3433679	422	227669	0	2847765	2835528	548	270450
46	0	2009419	3251504	244	187466	0	2780564	2680483	322	222651
47	0	1906524	3072752	141	154011	0	2710312	2529144	188	182857
48	0	1805359	2898187	81	126250	0	2637512	2382046	109	149829
49	0	1706355	2728449	46	103277	0	2562641	2239623	63	122493
50	0	1609877	2564061	26	84315	0	2486147	2102220	36	99932
51	0	1516228	2405443	15	68702	0	2408449	1970103	21	81360
52	0	1425653	2252914	8	55876	0	2329936	1843459	12	66109
53	0	1338346	2106709	5	45364	0	2250970	1722414	7	53615
54	0	1254452	1966983	3	36767	0	2171881	1607034	4	43404
55	0	1174074	1833821	1	29749	0	2092973	1497334	2	35076
56	0	1097276	1707249	1	24033	0	2014522	1393285	1	28297
57	0	1024088	1587238	0	19385	0	1936776	1294818	1	22792
58	0	954509	1473715	0	15613	0	1859958	1201834	0	18329
59	0	888515	1366565	0	12557	0	1784268	1114205	0	14717
60	0	826056	1265644	0	10085	0	1709880	1031783	0	11800

CI	HBWD					HBWS				
	INC1	INC2	INC3	INC4	INC5	INC1	INC2	INC3	INC4	INC5
61	0	767066	1170778	0	8089	0	1636948	954401	0	9447
62	0	711460	1081774	0	6480	0	1565605	881876	0	7554
63	0	659143	998420	0	5184	0	1495962	814018	0	6031
64	0	610008	920492	0	4142	0	1428115	750626	0	4810
65	0	563940	847758	0	3306	0	1362142	691498	0	3831
66	0	520818	779977	0	2636	0	1298104	636426	0	3047
67	0	480515	716909	0	2099	0	1236051	585205	0	2421
68	0	442905	658311	0	1670	0	1176016	537627	0	1922
69	0	407856	603941	0	1327	0	1118021	493493	0	1523
70	0	375240	553562	0	1053	0	1062080	452602	0	1206
71	0	344927	506941	0	835	0	1008193	414761	0	954
72	0	316791	463851	0	662	0	956354	379784	0	754
73	0	290708	424072	0	524	0	906548	347489	0	595
74	0	266556	387393	0	414	0	858752	317703	0	470
75	0	244217	353609	0	327	0	812939	290258	0	370
76	0	223578	322524	0	258	0	769076	264996	0	291
77	0	204531	293954	0	204	0	727123	241766	0	229
78	0	186969	267720	0	161	0	687040	220424	0	180
79	0	170794	243656	0	127	0	648781	200834	0	141
80	0	155910	221602	0	100	0	612297	182868	0	111
81	0	142228	201409	0	78	0	577539	166406	0	87
82	0	129660	182936	0	62	0	544453	151334	0	68
83	0	118127	166052	0	48	0	512987	137545	0	53
84	0	107552	150632	0	38	0	483086	124940	0	42
85	0	97864	136561	0	30	0	454694	113427	0	33
86	0	88995	123731	0	23	0	427757	102917	0	25
87	0	80883	112041	0	18	0	402219	93331	0	20
88	0	73468	101398	0	14	0	378025	84593	0	16
89	0	66696	91715	0	11	0	355120	76634	0	12
90	0	60514	82912	0	9	0	333451	69389	0	9
91	0	54877	74914	0	7	0	312964	62798	0	7
92	0	49738	67652	0	5	0	293608	56805	0	6
93	0	45058	61064	0	4	0	275331	51360	0	4
94	0	40798	55089	0	3	0	258084	46416	0	3
95	0	36922	49675	0	3	0	241818	41929	0	3
96	0	33399	44772	0	2	0	226487	37858	0	2
97	0	30198	40334	0	2	0	212044	34169	0	2
98	0	27291	36320	0	1	0	198447	30825	0	1
99	0	24652	32690	0	1	0	185651	27797	0	1
100	0	22259	29410	0	1	0	173616	25057	0	1
101	0	20090	26448	0	1	0	162303	22578	0	1
102	0	18124	23774	0	0	0	151673	20336	0	0
103	0	16344	21362	0	0	0	141690	18309	0	0
104	0	14732	19186	0	0	0	132319	16479	0	0
105	0	13275	17226	0	0	0	123526	14826	0	0
106	0	11957	15460	0	0	0	115280	13334	0	0
107	0	10765	13869	0	0	0	107550	11987	0	0
108	0	9689	12438	0	0	0	100306	10773	0	0
109	0	8717	11150	0	0	0	93521	9679	0	0
110	0	7839	9992	0	0	0	87169	8693	0	0
111	0	7048	8951	0	0	0	81224	7805	0	0
112	0	6334	8015	0	0	0	75662	7005	0	0
113	0	5690	7175	0	0	0	70460	6285	0	0
114	0	5111	6421	0	0	0	65598	5638	0	0
115	0	4588	5744	0	0	0	61054	5055	0	0
116	0	4118	5137	0	0	0	56810	4532	0	0
117	0	3695	4593	0	0	0	52846	4061	0	0
118	0	3314	4105	0	0	0	49146	3638	0	0
119	0	2971	3667	0	0	0	45693	3259	0	0
120	0	2664	3276	0	0	0	42472	2918	0	0

CI	HBWD					HBWS				
	INC1	INC2	INC3	INC4	INC5	INC1	INC2	INC3	INC4	INC5
121	0	2387	2925	0	0	0	39468	2612	0	0
122	0	2138	2611	0	0	0	36667	2337	0	0
123	0	1915	2330	0	0	0	34057	2091	0	0
124	0	1715	2079	0	0	0	31625	1870	0	0
125	0	1535	1854	0	0	0	29360	1672	0	0
126	0	1373	1653	0	0	0	27250	1495	0	0
127	0	1228	1474	0	0	0	25287	1336	0	0
128	0	1099	1313	0	0	0	23460	1194	0	0
129	0	982	1170	0	0	0	21760	1066	0	0
130	0	878	1042	0	0	0	20179	952	0	0
131	0	785	928	0	0	0	18708	850	0	0
132	0	701	826	0	0	0	17341	759	0	0
133	0	626	735	0	0	0	16071	677	0	0
134	0	559	654	0	0	0	14891	604	0	0
135	0	499	582	0	0	0	13794	539	0	0
136	0	446	518	0	0	0	12776	481	0	0
137	0	398	460	0	0	0	11831	429	0	0
138	0	355	409	0	0	0	10953	382	0	0
139	0	316	364	0	0	0	10139	341	0	0
140	0	282	323	0	0	0	9383	304	0	0
141	0	252	287	0	0	0	8683	271	0	0
142	0	224	255	0	0	0	8033	241	0	0
143	0	200	227	0	0	0	7430	215	0	0
144	0	178	201	0	0	0	6871	191	0	0
145	0	159	179	0	0	0	6353	170	0	0
146	0	141	158	0	0	0	5874	151	0	0
147	0	126	141	0	0	0	5429	135	0	0
148	0	112	125	0	0	0	5018	120	0	0
149	0	100	111	0	0	0	4636	107	0	0
150	0	89	98	0	0	0	4283	95	0	0
151	0	79	87	0	0	0	3957	84	0	0
152	0	70	77	0	0	0	3654	75	0	0
153	0	62	68	0	0	0	3375	67	0	0
154	0	56	61	0	0	0	3116	59	0	0
155	0	49	54	0	0	0	2876	53	0	0
156	0	44	48	0	0	0	2655	47	0	0
157	0	39	42	0	0	0	2450	42	0	0
158	0	35	37	0	0	0	2261	37	0	0
159	0	31	33	0	0	0	2086	33	0	0
160	0	27	29	0	0	0	1924	29	0	0
161	0	24	26	0	0	0	1775	26	0	0
162	0	22	23	0	0	0	1637	23	0	0
163	0	19	20	0	0	0	1509	20	0	0
164	0	17	18	0	0	0	1391	18	0	0
165	0	15	16	0	0	0	1283	16	0	0
166	0	13	14	0	0	0	1182	14	0	0
167	0	12	12	0	0	0	1090	13	0	0
168	0	11	11	0	0	0	1004	11	0	0
169	0	9	10	0	0	0	925	10	0	0
170	0	8	9	0	0	0	852	9	0	0
171	0	7	8	0	0	0	785	8	0	0
172	0	7	7	0	0	0	723	7	0	0
173	0	6	6	0	0	0	666	6	0	0
174	0	5	5	0	0	0	613	5	0	0
175	0	5	5	0	0	0	564	5	0	0
176	0	4	4	0	0	0	520	4	0	0
177	0	4	4	0	0	0	478	4	0	0
178	0	3	3	0	0	0	440	3	0	0
179	0	3	3	0	0	0	405	3	0	0
180	0	2	2	0	0	0	373	3	0	0

CI	HBWD					HBWS				
	INC1	INC2	INC3	INC4	INC5	INC1	INC2	INC3	INC4	INC5
181	0	2	2	0	0	0	343	2	0	0
182	0	2	2	0	0	0	315	2	0	0
183	0	2	2	0	0	0	290	2	0	0
184	0	2	1	0	0	0	267	2	0	0
185	0	1	1	0	0	0	245	1	0	0
186	0	1	1	0	0	0	226	1	0	0
187	0	1	1	0	0	0	208	1	0	0
188	0	1	1	0	0	0	191	1	0	0
189	0	1	1	0	0	0	175	1	0	0
190	0	1	1	0	0	0	161	1	0	0
191	0	1	1	0	0	0	148	1	0	0
192	0	1	1	0	0	0	136	1	0	0
193	0	1	0	0	0	0	125	1	0	0
194	0	0	0	0	0	0	115	0	0	0
195	0	0	0	0	0	0	106	0	0	0
196	0	0	0	0	0	0	97	0	0	0
197	0	0	0	0	0	0	89	0	0	0
198	0	0	0	0	0	0	82	0	0	0
199	0	0	0	0	0	0	75	0	0	0
200	0	0	0	0	0	0	69	0	0	0
201	0	0	0	0	0	0	63	0	0	0
202	0	0	0	0	0	0	58	0	0	0
203	0	0	0	0	0	0	53	0	0	0
204	0	0	0	0	0	0	49	0	0	0
205	0	0	0	0	0	0	45	0	0	0
206	0	0	0	0	0	0	41	0	0	0
207	0	0	0	0	0	0	38	0	0	0
208	0	0	0	0	0	0	35	0	0	0
209	0	0	0	0	0	0	32	0	0	0
210	0	0	0	0	0	0	29	0	0	0
211	0	0	0	0	0	0	27	0	0	0
212	0	0	0	0	0	0	25	0	0	0
213	0	0	0	0	0	0	23	0	0	0
214	0	0	0	0	0	0	21	0	0	0
215	0	0	0	0	0	0	19	0	0	0
216	0	0	0	0	0	0	17	0	0	0
217	0	0	0	0	0	0	16	0	0	0
218	0	0	0	0	0	0	15	0	0	0
219	0	0	0	0	0	0	13	0	0	0
220	0	0	0	0	0	0	12	0	0	0
221	0	0	0	0	0	0	11	0	0	0
222	0	0	0	0	0	0	10	0	0	0
223	0	0	0	0	0	0	9	0	0	0
224	0	0	0	0	0	0	9	0	0	0
225	0	0	0	0	0	0	8	0	0	0
226	0	0	0	0	0	0	7	0	0	0
227	0	0	0	0	0	0	7	0	0	0
228	0	0	0	0	0	0	6	0	0	0
229	0	0	0	0	0	0	6	0	0	0
230	0	0	0	0	0	0	5	0	0	0
231	0	0	0	0	0	0	5	0	0	0
232	0	0	0	0	0	0	4	0	0	0
233	0	0	0	0	0	0	4	0	0	0
234	0	0	0	0	0	0	4	0	0	0
235	0	0	0	0	0	0	3	0	0	0
236	0	0	0	0	0	0	3	0	0	0
237	0	0	0	0	0	0	3	0	0	0
238	0	0	0	0	0	0	3	0	0	0
239	0	0	0	0	0	0	2	0	0	0
240	0	0	0	0	0	0	2	0	0	0

CI	HBWD					HBWS				
	INC1	INC2	INC3	INC4	INC5	INC1	INC2	INC3	INC4	INC5
241	0	0	0	0	0	0	2	0	0	0
242	0	0	0	0	0	0	2	0	0	0
243	0	0	0	0	0	0	2	0	0	0
244	0	0	0	0	0	0	1	0	0	0
245	0	0	0	0	0	0	1	0	0	0
246	0	0	0	0	0	0	1	0	0	0
247	0	0	0	0	0	0	1	0	0	0
248	0	0	0	0	0	0	1	0	0	0
249	0	0	0	0	0	0	1	0	0	0
250	0	0	0	0	0	0	1	0	0	0
251	0	0	0	0	0	0	1	0	0	0
252	0	0	0	0	0	0	1	0	0	0
253	0	0	0	0	0	0	1	0	0	0
254	0	0	0	0	0	0	1	0	0	0
255	0	0	0	0	0	0	1	0	0	0
256	0	0	0	0	0	0	1	0	0	0
257	0	0	0	0	0	0	0	0	0	0
258	0	0	0	0	0	0	0	0	0	0
259	0	0	0	0	0	0	0	0	0	0
260	0	0	0	0	0	0	0	0	0	0
261	0	0	0	0	0	0	0	0	0	0
262	0	0	0	0	0	0	0	0	0	0
263	0	0	0	0	0	0	0	0	0	0
264	0	0	0	0	0	0	0	0	0	0
265	0	0	0	0	0	0	0	0	0	0
266	0	0	0	0	0	0	0	0	0	0
267	0	0	0	0	0	0	0	0	0	0
268	0	0	0	0	0	0	0	0	0	0
269	0	0	0	0	0	0	0	0	0	0
270	0	0	0	0	0	0	0	0	0	0
271	0	0	0	0	0	0	0	0	0	0
272	0	0	0	0	0	0	0	0	0	0
273	0	0	0	0	0	0	0	0	0	0
274	0	0	0	0	0	0	0	0	0	0
275	0	0	0	0	0	0	0	0	0	0
276	0	0	0	0	0	0	0	0	0	0
277	0	0	0	0	0	0	0	0	0	0
278	0	0	0	0	0	0	0	0	0	0
279	0	0	0	0	0	0	0	0	0	0
280	0	0	0	0	0	0	0	0	0	0
281	0	0	0	0	0	0	0	0	0	0
282	0	0	0	0	0	0	0	0	0	0
283	0	0	0	0	0	0	0	0	0	0
284	0	0	0	0	0	0	0	0	0	0
285	0	0	0	0	0	0	0	0	0	0
286	0	0	0	0	0	0	0	0	0	0
287	0	0	0	0	0	0	0	0	0	0
288	0	0	0	0	0	0	0	0	0	0
289	0	0	0	0	0	0	0	0	0	0
290	0	0	0	0	0	0	0	0	0	0
291	0	0	0	0	0	0	0	0	0	0
292	0	0	0	0	0	0	0	0	0	0
293	0	0	0	0	0	0	0	0	0	0
294	0	0	0	0	0	0	0	0	0	0
295	0	0	0	0	0	0	0	0	0	0
296	0	0	0	0	0	0	0	0	0	0
297	0	0	0	0	0	0	0	0	0	0
298	0	0	0	0	0	0	0	0	0	0
299	0	0	0	0	0	0	0	0	0	0
300	0	0	0	0	0	0	0	0	0	0

APPENDIX F – FRICTION-FACTORS FOR HBSH AND HBO PURPOSES

CI	HBSH					HBO				
	INC1	INC2	INC3	INC4	INC5	INC1	INC2	INC3	INC4	INC5
1	1064050	148622	95344	1990286	1990286	4530218347	743575494	309363350	12302891	12302891
2	3960840	2236266	683602	7888124	7888124	907969204	740118924	142361244	27510585	27510585
3	6775914	8005816	1738485	16029898	16029898	313381438	585561227	79890511	40640622	40640622
4	8431598	15921744	2892280	24780744	24780744	135119888	421717428	48627587	50665457	50665457
5	8812615	22944950	3813508	32977420	32977420	65814368	288471457	30945960	57553962	57553962
6	8248749	26971249	4340439	39916620	39916620	34627218	191001136	20256023	61644166	61644166
7	7154973	27545715	4463370	45256720	45256720	19214513	123653244	13518967	63398552	63398552
8	5869859	25381326	4261167	48912485	48912485	11085615	78746051	9151868	63294081	63294081
9	4614917	21619202	3843725	50965417	50965417	6588888	49521518	6263163	61771976	61771976
10	3508489	17307684	3315418	51594626	51594626	4009197	30835691	4323137	59216925	59216925
11	2595856	13178134	2758025	51026820	51026820	2486276	19047156	3004797	55951365	55951365
12	1878023	9626781	2226756	49502137	49502137	1566212	11687736	2100474	52237466	52237466
13	1333345	6792091	1753247	47252210	47252210	999700	7132067	1475391	48282807	48282807
14	931576	4652242	1351224	44487260	44487260	645295	4331552	1040578	44247522	44247522
15	641935	3106232	1022370	41389586	41389586	420576	2619986	736503	40251712	40251712
16	437055	2028386	761235	38111383	38111383	276430	1579103	522888	36382472	36382472
17	294433	1298925	558863	34775350	34775350	183036	948780	372234	32700224	32700224
18	196503	817531	405199	31476973	31476973	121993	568485	265620	29244224	29244224
19	130054	506669	290532	28287673	28287673	81784	339783	189947	26037242	26037242
20	85433	309693	206243	25258307	25258307	55116	202639	136093	23089469	23089469
21	55742	186945	145094	22422657	22422657	37320	120608	97676	20401704	20401704
22	36148	111577	101243	19800706	19800706	25378	71654	70213	17967939	17967939
23	23311	65910	70121	17401578	17401578	17326	42500	50544	15777413	15777413
24	14955	38568	48235	15226094	15226094	11870	25170	36433	13816218	13816218
25	9550	22374	32974	13268938	13268938	8160	14886	26292	12068552	12068552
26	6072	12876	22411	11520441	11520441	5626	8793	18995	10517659	10517659
27	3845	7356	15151	9968026	9968026	3890	5187	13738	9146534	9146534
28	2426	4173	10192	8597358	8597358	2696	3057	9945	7938437	7938437
29	1525	2353	6825	7393223	7393223	1874	1800	7205	6877249	6877249
30	956	1319	4551	6340198	6340198	1305	1059	5225	5947712	5947712
31	597	735	3022	5423140	5423140	911	622	3791	5135578	5135578
32	372	407	2000	4627526	4627526	637	365	2753	4427691	4427691
33	231	225	1318	3939687	3939687	446	214	2001	3812007	3812007
34	143	123	866	3346941	3346941	313	126	1455	3277595	3277595
35	89	68	567	2837669	2837669	220	74	1059	2814591	2814591
36	55	37	371	2401330	2401330	155	43	771	2414149	2414149
37	34	20	241	2028447	2028447	109	25	561	2068378	2068378
38	21	11	157	1710561	1710561	77	15	409	1770266	1770266
39	13	6	102	1440174	1440174	55	9	298	1513608	1513608
40	8	3	66	1210676	1210676	39	5	218	1292936	1292936
41	5	2	42	1016274	1016274	27	3	159	1103441	1103441
42	3	1	27	851909	851909	19	2	116	940912	940912
43	2	1	18	713188	713188	14	1	85	801667	801667
44	1	1	11	596306	596306	10	1	62	682496	682496
45	1	1	7	497982	497982	7	1	45	580609	580609
46	1	1	5	415393	415393	5	1	33	493580	493580
47	1	1	3	346122	346122	4	1	24	419310	419310
48	1	1	2	288099	288099	3	1	18	355984	355984
49	1	1	1	239561	239561	2	1	13	302032	302032
50	1	1	1	199009	199009	1	1	10	256104	256104
51	1	1	1	165167	165167	1	1	7	217034	217034
52	1	1	1	136958	136958	1	1	5	183823	183823
53	1	1	1	113469	113469	1	1	4	155611	155611
54	1	1	1	93931	93931	1	1	3	131661	131661
55	1	1	1	77695	77695	1	1	2	111342	111342
56	1	1	1	64217	64217	1	1	2	94114	94114
57	1	1	1	53037	53037	1	1	1	79515	79515
58	1	1	1	43772	43772	1	1	1	67151	67151
59	1	1	1	36101	36101	1	1	1	56685	56685
60	1	1	1	29754	29754	1	1	1	47831	47831

CI	HBSH					HBO				
	INC1	INC2	INC3	INC4	INC5	INC1	INC2	INC3	INC4	INC5
61	1	1	1	24508	24508	1	1	1	40343	40343
62	1	1	1	20174	20174	1	1	1	34015	34015
63	1	1	1	16596	16596	1	1	1	28668	28668
64	1	1	1	13645	13645	1	1	1	24153	24153
65	1	1	1	11212	11212	1	1	1	20342	20342
66	0	0	0	9208	9208	1	1	1	17127	17127
67	1	1	1	7558	7558	1	1	1	14415	14415
68	1	1	1	6201	6201	1	1	1	12128	12128
69	1	1	1	5084	5084	1	1	1	10201	10201
70	1	1	1	4167	4167	1	1	1	8578	8578
71	1	1	1	3414	3414	1	1	1	7211	7211
72	0	0	0	2795	2795	1	1	1	6060	6060
73	0	0	0	2288	2288	1	1	1	5091	5091
74	0	0	0	1872	1872	1	1	1	4276	4276
75	0	0	0	1530	1530	1	1	1	3590	3590
76	0	0	0	1251	1251	1	1	1	3014	3014
77	0	0	0	1022	1022	1	1	1	2530	2530
78	0	0	0	835	835	1	1	1	2123	2123
79	1	1	1	682	682	1	1	1	1781	1781
80	1	1	1	556	556	1	1	1	1493	1493
81	1	1	1	454	454	1	1	1	1252	1252
82	0	0	0	370	370	1	1	1	1050	1050
83	0	0	0	302	302	1	1	1	880	880
84	0	0	0	246	246	1	1	1	737	737
85	0	0	0	200	200	1	1	1	618	618
86	0	0	0	163	163	1	1	1	517	517
87	0	0	0	133	133	1	1	1	433	433
88	1	1	1	108	108	1	1	1	363	363
89	1	1	1	88	88	1	1	1	304	304
90	1	1	1	72	72	1	1	1	254	254
91	1	1	1	58	58	1	1	1	213	213
92	1	1	1	47	47	1	1	1	178	178
93	1	1	1	39	39	1	1	1	149	149
94	0	0	0	31	31	1	1	1	125	125
95	0	0	0	25	25	1	1	1	104	104
96	0	0	0	21	21	0	0	0	87	87
97	0	0	0	17	17	1	1	1	73	73
98	0	0	0	14	14	1	1	1	61	61
99	0	0	0	11	11	1	1	1	51	51
100	1	1	1	9	9	1	1	1	43	43
101	1	1	1	7	7	1	1	1	36	36
102	1	1	1	6	6	1	1	1	30	30
103	0	0	0	5	5	1	1	1	25	25
104	0	0	0	4	4	1	1	1	21	21
105	0	0	0	3	3	1	1	1	17	17
106	0	0	0	3	3	1	1	1	14	14
107	0	0	0	2	2	1	1	1	12	12
108	0	0	0	2	2	0	0	0	10	10
109	0	0	0	1	1	1	1	1	8	8
110	0	0	0	1	1	1	1	1	7	7
111	0	0	0	1	1	1	1	1	6	6
112	0	0	0	1	1	1	1	1	5	5
113	0	0	0	1	1	0	0	0	4	4
114	0	0	0	1	1	0	0	0	3	3
115	0	0	0	0	0	0	0	0	3	3
116	0	0	0	0	0	0	0	0	2	2
117	0	0	0	0	0	0	0	0	2	2
118	0	0	0	0	0	0	0	0	2	2
119	0	0	0	0	0	1	1	1	1	1
120	0	0	0	0	0	1	1	1	1	1

CI	HBSH					HBO				
	INC1	INC2	INC3	INC4	INC5	INC1	INC2	INC3	INC4	INC5
121	0	0	0	0	0	1	1	1	1	1
122	0	0	0	0	0	0	0	0	1	1
123	0	0	0	0	0	0	0	0	1	1
124	0	0	0	0	0	0	0	0	1	1
125	0	0	0	0	0	0	0	0	1	1
126	0	0	0	0	0	0	0	0	0	0
127	0	0	0	0	0	0	0	0	0	0
128	0	0	0	0	0	0	0	0	0	0
129	0	0	0	0	0	0	0	0	0	0
130	0	0	0	0	0	0	0	0	0	0
131	0	0	0	0	0	0	0	0	0	0
132	0	0	0	0	0	0	0	0	0	0
133	0	0	0	0	0	0	0	0	0	0
134	0	0	0	0	0	0	0	0	0	0
135	0	0	0	0	0	1	1	1	1	1
136	0	0	0	0	0	1	1	1	1	1
137	0	0	0	0	0	1	1	1	1	1
138	0	0	0	0	0	0	0	0	0	0
139	0	0	0	0	0	0	0	0	0	0
140	0	0	0	0	0	0	0	0	0	0
141	0	0	0	0	0	0	0	0	0	0
142	0	0	0	0	0	0	0	0	0	0
143	0	0	0	0	0	0	0	0	0	0
144	0	0	0	0	0	0	0	0	0	0
145	0	0	0	0	0	0	0	0	0	0
146	0	0	0	0	0	0	0	0	0	0
147	0	0	0	0	0	0	0	0	0	0
148	0	0	0	0	0	0	0	0	0	0
149	0	0	0	0	0	0	0	0	0	0
150	0	0	0	0	0	0	0	0	0	0
151	0	0	0	0	0	0	0	0	0	0
152	0	0	0	0	0	0	0	0	0	0
153	0	0	0	0	0	1	1	1	1	1
154	0	0	0	0	0	1	1	1	1	1
155	0	0	0	0	0	1	1	1	1	1
156	0	0	0	0	0	0	0	0	0	0
157	0	0	0	0	0	0	0	0	0	0
158	0	0	0	0	0	0	0	0	0	0
159	0	0	0	0	0	0	0	0	0	0
160	0	0	0	0	0	0	0	0	0	0
161	0	0	0	0	0	0	0	0	0	0
162	0	0	0	0	0	0	0	0	0	0
163	0	0	0	0	0	0	0	0	0	0
164	0	0	0	0	0	0	0	0	0	0
165	0	0	0	0	0	0	0	0	0	0
166	0	0	0	0	0	0	0	0	0	0
167	0	0	0	0	0	0	0	0	0	0
168	0	0	0	0	0	0	0	0	0	0
169	0	0	0	0	0	0	0	0	0	0
170	0	0	0	0	0	0	0	0	0	0
171	0	0	0	0	0	0	0	0	0	0
172	0	0	0	0	0	0	0	0	0	0
173	0	0	0	0	0	0	0	0	0	0
174	0	0	0	0	0	0	0	0	0	0
175	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0
177	0	0	0	0	0	0	0	0	0	0
178	0	0	0	0	0	0	0	0	0	0
179	0	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0	0

APPENDIX G – FRICTION-FACTORS FOR WBO AND NHNW PURPOSES

CI	WBO					NHNW				
	INC1	INC2	INC3	INC4	INC5	INC1	INC2	INC3	INC4	INC5
1	7518976	20549091	8637666	2432460	2432460	1275360146	318645178	415385946	916310	916310
2	3519275	6758685	3584823	7048643	7048643	405901207	334745006	126871644	3696965	3696965
3	2172516	3452512	2067785	12314109	12314109	185581075	286466417	59899066	7701117	7701117
4	1502074	2111986	1364824	17487399	17487399	98414594	225411239	33799829	12238259	12238259
5	1105067	1426071	969887	22168995	22168995	56608255	169395006	21030092	16767906	16767906
6	845561	1024998	722192	26156679	26156679	34278713	123648792	13918971	20917001	20917001
7	664772	769181	555371	29369684	29369684	21506769	88462525	9613790	24457195	24457195
8	533110	595714	437282	31802753	31802753	13848477	62365791	6850760	27273238	27273238
9	434052	472623	350563	33496535	33496535	9095806	43476932	4999619	29332600	29332600
10	357650	382162	285065	34517983	34517983	6068396	30041815	3717942	30659655	30659655
11	297560	313805	234486	34947283	34947283	4100180	20610216	2807217	31315126	31315126
12	249550	260969	194721	34869194	34869194	2799435	14056272	2146376	31380453	31380453
13	210695	219356	162994	34367424	34367424	1928185	9538953	1658506	30946377	30946377
14	178908	186060	137367	33521116	33521116	1338051	6446060	1293095	30104943	30104943
15	152666	159059	116448	32402797	32402797	934531	4340149	1016030	28944173	28944173
16	130833	136906	99220	31077338	31077338	656374	2912971	803733	27544774	27544774
17	112545	118546	84920	29601606	29601606	463286	1949648	639573	25978340	25978340
18	97137	103195	72969	28024565	28024565	328429	1301677	511619	24306613	24306613
19	84088	90257	62923	26387674	26387674	233736	867149	411184	22581491	22581491
20	72987	79277	54432	24725456	24725456	166927	576534	331856	20845509	20845509
21	63504	69901	47222	23066162	23066162	119590	382633	268849	19132618	19132618
22	55374	61847	41074	21432469	21432469	85923	253534	218555	17469110	17469110
23	48381	54896	35811	19842167	19842167	61894	167745	178226	15874612	15874612
24	42348	48866	31290	18308830	18308830	44692	110835	145756	14363067	14363067
25	37129	43615	27394	16842428	16842428	32341	73142	119516	12943662	12943662
26	32604	39024	24027	15449896	15449896	23451	48213	98237	11621686	11621686
27	28671	34995	21110	14135643	14135643	17036	31747	80928	10399292	10399292
28	25246	31448	18576	12901997	12901997	12397	20884	66808	9276166	9276166
29	22257	28316	16370	11749607	11749607	9036	13726	55258	8250106	8250106
30	19645	25542	14446	10677778	10677778	6596	9013	45787	7317508	7317508
31	17358	23079	12764	9684766	9684766	4822	5914	38003	6473772	6473772
32	15352	20887	11291	8768031	8768031	3530	3878	31592	5713637	5713637
33	13591	18932	10000	7924442	7924442	2587	2541	26302	5031446	5031446
34	12043	17183	8865	7150451	7150451	1898	1664	21928	4421363	4421363
35	10680	15617	7867	6442243	6442243	1394	1089	18305	3877536	3877536
36	9478	14211	6988	5795848	5795848	1025	712	15300	3394225	3394225
37	8418	12947	6213	5207234	5207234	754	465	12803	2965889	2965889
38	7482	11809	5528	4672390	4672390	556	304	10726	2587260	2587260
39	6654	10782	4923	4187375	4187375	410	199	8995	2253377	2253377
40	5922	9855	4387	3748368	3748368	302	130	7550	1959618	1959618
41	5274	9016	3912	3351698	3351698	223	85	6344	1701708	1701708
42	4699	8255	3491	2993871	2993871	165	55	5335	1475722	1475722
43	4189	7566	3118	2671580	2671580	122	36	4491	1278081	1278081
44	3736	6940	2786	2381715	2381715	90	23	3783	1105535	1105535
45	3334	6370	2491	2121373	2121373	67	15	3189	955148	955148
46	2977	5852	2228	1887847	1887847	50	10	2691	824282	824282
47	2659	5380	1994	1678631	1678631	37	7	2272	710575	710575
48	2376	4949	1786	1491413	1491413	27	4	1920	611916	611916
49	2124	4556	1600	1324065	1324065	20	3	1623	526429	526429
50	1900	4197	1434	1174633	1174633	15	3	1373	452452	452452
51	1700	3868	1286	1041332	1041332	11	3	1162	388514	388514
52	1521	3568	1154	922535	922535	8	1	984	333316	333316
53	1362	3292	1036	816759	816759	6	3	834	285718	285718
54	1220	3040	930	722658	722658	5	3	707	244716	244716
55	1093	2808	836	639013	639013	3	0	600	209433	209433
56	979	2595	751	564721	564721	3	3	509	179101	179101
57	878	2400	675	498787	498787	3	3	433	153050	153050
58	787	2220	607	440312	440312	3	3	367	130696	130696
59	706	2055	546	388489	388489	3	3	312	111530	111530
60	634	1903	491	342592	342592	3	3	266	95112	95112

CI	HBSH					HBO				
	INC1	INC2	INC3	INC4	INC5	INC1	INC2	INC3	INC4	INC5
61	569	1762	442	301971	301971	3	3	226	81059	81059
62	511	1633	398	266039	266039	3	3	192	69040	69040
63	459	1514	359	234276	234276	3	3	164	58768	58768
64	412	1404	323	206214	206214	3	3	139	49995	49995
65	370	1303	291	181436	181436	3	3	119	42508	42508
66	333	1209	263	159568	159568	3	3	101	36123	36123
67	299	1123	237	140279	140279	3	3	86	30680	30680
68	269	1043	214	123274	123274	3	3	74	26044	26044
69	242	969	193	108288	108288	3	3	63	22098	22098
70	217	901	174	95090	95090	3	3	54	18741	18741
71	195	837	157	83470	83470	3	3	46	15886	15886
72	176	779	142	73244	73244	0	0	39	13460	13460
73	158	724	128	64250	64250	3	3	33	11399	11399
74	142	674	116	56341	56341	3	3	29	9650	9650
75	128	627	104	49390	49390	3	3	24	8166	8166
76	115	584	94	43283	43283	0	0	21	6907	6907
77	104	544	85	37919	37919	3	3	18	5840	5840
78	94	507	77	33211	33211	0	0	15	4936	4936
79	84	472	70	29078	29078	0	0	13	4170	4170
80	76	440	63	25453	25453	0	0	11	3522	3522
81	68	410	57	22274	22274	0	0	10	2973	2973
82	62	382	52	19486	19486	0	0	8	2509	2509
83	56	357	47	17043	17043	0	0	7	2117	2117
84	50	333	42	14902	14902	0	0	6	1785	1785
85	45	310	38	13027	13027	0	0	5	1505	1505
86	41	290	35	11385	11385	0	0	4	1269	1269
87	37	270	31	9948	9948	0	0	4	1069	1069
88	33	252	28	8690	8690	0	0	3	900	900
89	30	236	26	7590	7590	0	0	3	758	758
90	27	220	23	6627	6627	0	0	2	638	638
91	24	206	21	5785	5785	0	0	2	537	537
92	22	192	19	5049	5049	0	0	2	452	452
93	20	180	17	4406	4406	3	3	3	380	380
94	18	168	16	3844	3844	0	0	1	320	320
95	16	157	14	3353	3353	3	3	3	269	269
96	15	147	13	2924	2924	0	0	1	226	226
97	13	137	12	2550	2550	0	0	1	190	190
98	12	128	11	2223	2223	0	0	1	159	159
99	11	120	10	1937	1937	0	0	1	134	134
100	10	112	9	1688	1688	0	0	1	112	112
101	9	105	8	1471	1471	0	0	0	94	94
102	8	98	7	1281	1281	0	0	0	79	79
103	7	92	7	1116	1116	0	0	0	67	67
104	7	86	6	972	972	3	3	3	56	56
105	6	81	5	846	846	3	3	3	47	47
106	5	76	5	737	737	0	0	0	39	39
107	5	71	4	641	641	3	3	3	33	33
108	4	66	4	558	558	0	0	0	28	28
109	4	62	4	486	486	0	0	0	23	23
110	4	58	3	423	423	0	0	0	19	19
111	3	55	3	368	368	0	0	0	16	16
112	3	51	3	320	320	0	0	0	14	14
113	3	48	3	278	278	0	0	0	11	11
114	2	45	2	242	242	3	3	3	10	10
115	2	42	2	210	210	0	0	0	8	8
116	2	39	2	183	183	0	0	0	7	7
117	2	37	2	159	159	0	0	0	6	6
118	2	35	2	138	138	3	3	3	5	5
119	1	33	1	120	120	3	3	3	4	4
120	1	31	1	104	104	0	0	0	3	3

CI	HBSH					HBO				
	INC1	INC2	INC3	INC4	INC5	INC1	INC2	INC3	INC4	INC5
121	1	29	1	91	91	3	3	3	3	3
122	1	27	1	79	79	0	0	0	2	2
123	1	25	1	68	68	0	0	0	2	2
124	1	24	1	59	59	0	0	0	2	2
125	1	22	1	52	52	0	0	0	1	1
126	1	21	1	45	45	0	0	0	1	1
127	1	20	1	39	39	0	0	0	1	1
128	1	18	1	34	34	3	3	3	3	3
129	1	17	1	29	29	3	3	3	3	3
130	1	16	1	25	25	0	0	0	1	1
131	0	15	0	22	22	0	0	0	1	1
132	0	14	0	19	19	0	0	0	0	0
133	0	13	0	17	17	0	0	0	0	0
134	0	13	0	14	14	0	0	0	0	0
135	0	12	0	13	13	0	0	0	0	0
136	0	11	0	11	11	0	0	0	0	0
137	0	10	0	9	9	0	0	0	0	0
138	0	10	0	8	8	0	0	0	0	0
139	0	9	0	7	7	0	0	0	0	0
140	0	9	0	6	6	0	0	0	0	0
141	0	8	0	5	5	0	0	0	0	0
142	0	8	0	5	5	0	0	0	0	0
143	3	7	3	4	4	0	0	0	0	0
144	0	7	0	4	4	0	0	0	0	0
145	0	6	0	3	3	0	0	0	0	0
146	0	6	0	3	3	0	0	0	0	0
147	0	6	0	2	2	0	0	0	0	0
148	0	5	0	2	2	0	0	0	0	0
149	0	5	0	2	2	0	0	0	0	0
150	0	5	0	2	2	0	0	0	0	0
151	0	4	0	1	1	0	0	0	0	0
152	0	4	0	1	1	0	0	0	0	0
153	0	4	0	1	1	0	0	0	0	0
154	0	4	0	1	1	0	0	0	0	0
155	0	3	0	1	1	0	0	0	0	0
156	0	3	0	1	1	0	0	0	0	0
157	0	3	0	1	1	0	0	0	0	0
158	0	3	0	1	1	0	0	0	0	0
159	0	3	0	0	0	0	0	0	0	0
160	0	3	0	0	0	0	0	0	0	0
161	0	2	0	0	0	0	0	0	0	0
162	0	2	0	0	0	0	0	0	0	0
163	0	2	0	0	0	0	0	0	0	0
164	0	2	0	0	0	0	0	0	0	0
165	0	2	0	0	0	0	0	0	0	0
166	0	2	0	0	0	0	0	0	0	0
167	0	2	0	0	0	0	0	0	0	0
168	0	2	0	0	0	0	0	0	0	0
169	0	2	0	0	0	0	0	0	0	0
170	0	1	0	0	0	0	0	0	0	0
171	0	1	0	0	0	0	0	0	0	0
172	0	1	0	0	0	0	0	0	0	0
173	0	1	0	0	0	0	0	0	0	0
174	0	1	0	0	0	0	0	0	0	0
175	0	1	0	0	0	0	0	0	0	0
176	0	1	0	0	0	0	0	0	0	0
177	0	1	0	0	0	0	0	0	0	0
178	0	1	0	0	0	0	0	0	0	0
179	0	1	0	0	0	0	0	0	0	0
180	0	1	0	0	0	0	0	0	0	0

CI	HBSH					HBO				
	INC1	INC2	INC3	INC4	INC5	INC1	INC2	INC3	INC4	INC5
181	0	1	0	0	0	0	0	0	0	0
182	0	1	0	0	0	0	0	0	0	0
183	0	1	0	0	0	0	0	0	0	0
184	0	1	0	0	0	0	0	0	0	0
185	0	1	0	0	0	0	0	0	0	0
186	0	1	0	0	0	0	0	0	0	0
187	0	1	0	0	0	0	0	0	0	0
188	0	1	0	0	0	0	0	0	0	0
189	0	0	0	0	0	0	0	0	0	0
190	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0
192	0	0	0	0	0	0	0	0	0	0
193	0	0	0	0	0	0	0	0	0	0
194	0	0	0	0	0	0	0	0	0	0
195	0	0	0	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	0	0	0
197	0	0	0	0	0	0	0	0	0	0
198	0	0	0	0	0	0	0	0	0	0
199	0	0	0	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0
202	0	0	0	0	0	0	0	0	0	0
203	0	0	0	0	0	0	0	0	0	0
204	0	0	0	0	0	0	0	0	0	0
205	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0
207	0	0	0	0	0	0	0	0	0	0
208	0	0	0	0	0	0	0	0	0	0
209	0	0	0	0	0	0	0	0	0	0
210	0	0	0	0	0	0	0	0	0	0
211	0	0	0	0	0	0	0	0	0	0
212	0	0	0	0	0	0	0	0	0	0
213	0	0	0	0	0	0	0	0	0	0
214	0	0	0	0	0	0	0	0	0	0
215	0	0	0	0	0	0	0	0	0	0
216	0	0	0	0	0	0	0	0	0	0
217	0	0	0	0	0	0	0	0	0	0
218	0	0	0	0	0	0	0	0	0	0
219	0	0	0	0	0	0	0	0	0	0
220	0	0	0	0	0	0	0	0	0	0
221	0	0	0	0	0	0	0	0	0	0
222	0	0	0	0	0	0	0	0	0	0
223	0	0	0	0	0	0	0	0	0	0
224	0	0	0	0	0	0	0	0	0	0
225	0	0	0	0	0	0	0	0	0	0
226	0	0	0	0	0	0	0	0	0	0
227	0	0	0	0	0	0	0	0	0	0
228	0	0	0	0	0	0	0	0	0	0
229	0	0	0	0	0	0	0	0	0	0
230	0	0	0	0	0	0	0	0	0	0
231	0	0	0	0	0	0	0	0	0	0
232	0	0	0	0	0	0	0	0	0	0
233	0	0	0	0	0	0	0	0	0	0
234	0	0	0	0	0	0	0	0	0	0
235	0	0	0	0	0	0	0	0	0	0
236	0	0	0	0	0	0	0	0	0	0
237	0	0	0	0	0	0	0	0	0	0
238	0	0	0	0	0	0	0	0	0	0
239	0	0	0	0	0	0	0	0	0	0
240	0	0	0	0	0	0	0	0	0	0

APPENDIX H – K-FACTORS FOR ALL TRIP PURPOSES

K-Factors for HBWD Trip Purpose

COUNTY	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	Bronx	Kings	Manhattan	Queens	Richmond
Bergen	1.89	1.17	0.52	10.00	10.00	5.43	4.29	1.06	10.00	0.91	10.00	3.12	1.59	10.00	7.49	7.56	0.71	3.63	2.15
Essex	0.49	1.50	0.31	10.00	2.78	0.25	0.25	1.69	1.40	0.56	0.77	0.25	0.66	0.25	2.03	0.25	0.35	3.06	0.46
Hudson	1.57	0.67	1.64	0.25	10.00	2.98	0.83	2.73	0.25	0.57	6.44	3.40	0.42	0.25	2.34	0.49	0.32	2.67	0.25
Hunterdon	0.45	0.89	6.45	0.62	10.00	2.14	1.05	0.85	10.00	0.36	0.67	0.25	2.02	10.00	0.25	0.25	3.15	50.00	0.25
Mercer	0.25	0.25	0.82	0.25	10.00	0.37	0.25	5.59	0.27	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.20	0.25	0.25
Middlesex	2.10	0.63	0.78	2.53	8.08	1.06	0.25	1.42	2.45	1.26	1.78	0.25	0.59	0.25	50.00	11.14	1.36	15.57	0.25
Monmouth	8.11	2.19	5.07	10.00	1.39	0.48	0.63	10.00	0.48	0.79	6.39	0.25	0.69	0.25	0.25	17.89	2.01	50.00	0.90
Morris	0.55	0.73	0.25	3.95	10.00	0.50	0.25	1.75	0.25	0.78	1.38	2.75	1.31	10.00	15.16	4.07	0.61	0.25	1.99
Ocean	10.00	6.45	10.00	4.59	3.80	0.74	0.82	10.00	1.24	1.80	9.22	0.25	0.25	0.25	50.00	50.00	11.24	0.25	6.38
Passaic	1.38	0.82	0.52	10.00	0.25	0.25	0.25	2.45	0.25	4.76	5.76	1.27	0.48	0.25	1.27	4.66	0.28	4.67	0.25
Somerset	0.69	0.70	2.03	1.93	10.00	0.49	0.25	0.61	0.25	0.25	0.55	0.25	0.91	0.25	0.25	4.35	0.90	50.00	3.54
Sussex	8.12	4.81	10.00	0.25	10.00	10.00	0.25	3.96	0.25	3.25	10.00	3.01	3.22	10.00	50.00	0.25	0.98	0.25	0.25
Union	0.61	0.35	1.28	4.83	10.00	0.78	0.25	1.15	0.25	0.27	1.18	0.25	1.80	10.00	10.34	4.95	0.65	0.25	0.25
Warren	0.53	0.25	0.25	0.34	1.33	0.25	1.14	0.53	0.25	0.54	0.48	0.47	0.38	7.19	0.25	0.25	0.87	0.25	0.25
Bronx	0.29	0.25	0.50	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.27	0.25	5.28	0.85	0.33	1.66	0.10
Kings	50.00	50.00	6.74	50.00	0.25	7.82	50.00	50.00	0.25	0.25	0.25	0.25	0.25	30.00	1.43	0.33	0.33	0.28	0.48
Manhattan	3.21	1.95	2.60	10.00	10.00	50.00	50.00	5.75	10.00	0.49	0.25	0.25	2.53	0.25	8.32	1.18	0.30	2.42	10.00
Queens	23.57	50.00	4.71	0.25	1.00	50.00	50.00	50.00	0.25	28.83	0.25	0.25	50.00	0.25	3.11	0.35	0.33	10.00	0.58
Richmond	1.92	0.57	0.54	0.25	0.25	0.25	0.25	0.25	32.79	2.56	4.58	0.25	0.36	0.25	10.00	0.38	1.17	3.65	0.10

K-Factors for HBWS Trip Purpose

COUNTY	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	Bronx	Kings	Manhattan	Queens	Richmond
Bergen	1.99	1.51	0.87	10.00	0.25	2.88	0.25	0.70	0.25	1.18	0.25	5.13	1.07	10.00	18.37	7.93	0.25	0.25	1.10
Essex	0.36	3.29	0.25	0.25	10.00	0.65	0.25	3.20	0.25	0.35	10.00	0.25	0.89	0.25	0.25	0.25	0.25	1.38	0.25
Hudson	1.67	1.19	0.59	0.25	0.25	0.80	0.81	4.79	0.25	0.92	10.00	0.25	0.87	0.25	7.59	0.25	0.25	0.54	0.25
Hunterdon	0.25	0.25	0.25	8.24	4.14	0.59	0.25	0.58	3.58	0.25	0.43	0.25	0.52	2.03	0.25	0.25	0.25	0.25	0.25
Mercer	0.25	0.25	0.37	0.25	6.68	0.44	0.25	1.20	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.31	0.25	0.25
Middlesex	0.60	0.40	0.25	0.25	10.00	1.40	0.25	1.78	0.25	0.25	0.75	0.25	0.32	10.00	14.16	0.25	0.48	3.51	0.50
Monmouth	8.34	2.86	5.64	0.25	1.52	0.51	0.61	3.67	0.29	2.20	10.00	0.25	0.25	0.25	39.66	2.51	0.25	0.25	1.48
Morris	0.72	1.74	0.25	2.78	10.00	0.25	0.25	0.48	0.25	4.64	1.20	5.36	0.48	0.25	50.00	50.00	0.25	0.25	0.25
Ocean	0.25	6.53	0.25	0.25	10.00	1.32	0.26	0.25	0.47	2.48	9.12	0.25	1.27	0.25	0.25	50.00	2.34	0.25	10.31
Passaic	2.05	4.61	2.14	0.25	0.25	0.25	5.63	1.47	0.25	2.84	2.32	6.18	0.41	0.25	1.94	4.98	0.25	0.25	0.25
Somerset	2.89	2.80	1.28	10.00	7.63	0.53	0.37	0.55	0.25	1.37	0.73	0.25	0.52	0.25	0.25	0.25	0.28	0.25	0.25
Sussex	4.73	8.76	10.00	0.25	10.00	0.25	0.25	1.11	0.25	10.00	5.26	1.03	5.89	10.00	50.00	50.00	0.25	0.25	0.25
Union	0.25	0.71	3.53	0.25	0.25	3.82	0.25	2.92	0.25	7.09	1.97	0.25	1.52	0.25	50.00	21.11	0.47	0.25	2.69
Warren	0.25	0.52	0.25	5.36	0.25	0.25	0.25	0.94	0.25	2.21	1.66	1.78	0.53	0.69	0.25	0.25	0.47	0.25	0.25
Bronx	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	10.00	0.25	0.23	0.68	0.10
Kings	0.25	7.62	2.70	0.25	0.25	3.30	50.00	0.25	50.00	0.25	0.25	0.25	50.00	0.25	0.10	0.62	0.18	0.33	0.10
Manhattan	0.25	0.77	0.43	0.25	10.00	7.43	0.25	2.78	0.25	0.25	0.25	0.25	0.25	0.25	1.26	0.16	0.10	0.10	0.10
Queens	0.25	19.09	5.96	1.00	1.00	0.25	0.25	0.25	0.25	0.25	0.25	1.00	0.25	1.00	3.45	0.49	0.17	10.00	0.10
Richmond	0.60	0.25	0.25	0.25	0.25	0.25	0.35	39.70	0.25	0.25	0.48	0.25	0.25	0.25	0.10	0.29	0.19	1.99	0.10

K-Factors for HBSH Trip Purpose

COUNTY	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	Bronx	Kings	Manhattan	Queens	Richmond
Bergen	1.60	0.26	0.26	0.25	0.25	0.25	0.25	0.25	0.25	1.21	0.25	10.00	0.92	0.25	2.52	11.96	5.44	0.25	0.25
Essex	0.41	1.40	0.74	0.25	0.25	0.39	0.25	1.50	0.25	1.45	0.25	0.25	0.25	0.25	0.25	0.25	50.00	0.25	0.25
Hudson	0.31	0.30	0.90	0.25	0.25	10.00	0.25	0.25	0.25	0.67	10.00	0.25	1.67	0.25	0.25	0.25	46.46	50.00	0.25
Hunterdon	0.25	2.33	0.25	2.68	0.25	2.18	0.25	0.25	0.25	0.25	0.28	0.25	10.00	0.89	0.25	0.25	0.25	0.25	0.25
Mercer	0.25	0.25	0.25	0.25	1.13	0.25	0.25	0.25	0.25	0.25	0.25	0.25	7.82	0.25	0.25	4.91	11.32	0.25	0.25
Middlesex	0.25	0.26	0.25	3.39	7.56	0.64	0.48	0.43	0.25	6.96	0.44	0.25	0.25	0.25	0.25	0.25	50.00	0.25	0.25
Monmouth	0.25	0.25	0.25	0.25	5.20	0.25	1.08	0.25	0.26	0.25	0.25	0.25	0.53	0.25	0.25	0.25	0.25	0.25	50.00
Morris	0.58	0.25	0.25	0.69	10.00	2.00	0.25	1.36	0.25	0.25	0.72	0.25	1.08	0.33	0.25	0.25	21.24	0.25	0.25
Ocean	0.25	0.25	0.25	0.25	10.00	0.25	0.76	10.00	0.93	0.25	0.25	0.25	10.00	0.25	0.25	0.25	0.25	0.25	0.25
Passaic	1.41	1.33	1.79	0.25	0.25	0.25	0.25	4.33	0.25	1.76	0.25	0.25	3.11	0.25	0.25	0.25	0.25	50.00	0.25
Somerset	0.25	0.25	5.91	0.25	2.94	0.25	0.25	0.25	0.25	0.25	1.59	0.25	0.87	0.25	0.25	0.25	50.00	0.25	0.25
Sussex	0.25	0.25	10.00	0.25	0.25	0.25	0.25	6.40	0.25	10.00	0.25	1.13	0.25	1.54	0.25	0.25	0.25	0.25	0.25
Union	0.72	0.45	0.32	10.00	0.25	0.99	0.25	0.58	0.25	3.73	1.33	0.25	1.72	0.25	0.25	0.25	50.00	0.25	0.25
Warren	0.25	0.25	0.25	6.65	0.25	0.25	0.25	7.24	0.25	0.25	0.25	2.38	0.25	4.30	0.25	0.25	0.25	0.25	0.25
Bronx	38.39	0.25	0.25	0.25	1.00	0.25	0.25	0.25	1.00	0.25	0.25	0.25	0.25	0.25	4.91	0.25	10.00	10.00	0.25
Kings	0.25	0.25	50.00	0.25	1.00	0.25	0.25	0.25	1.00	0.25	0.25	0.25	0.25	1.00	0.25	0.80	10.00	10.00	10.00
Manhattan	13.54	0.25	9.21	0.25	0.25	0.25	0.25	0.25	1.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.10	5.30	0.25
Queens	50.00	0.25	0.25	0.25	0.25	0.25	30.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25	10.00	0.25	10.00	10.00	0.25
Richmond	0.25	0.25	0.25	0.25	0.25	11.73	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	1.80	10.00	10.00	0.48

K-Factors for HBO Trip Purpose

COUNTY	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	Bronx	Kings	Manhattan	Queens	Richmond
Bergen	2.61	1.37	0.25	0.25	10.00	0.95	10.00	0.26	0.25	0.25	2.96	0.25	2.54	0.25	0.45	1.63	0.52	50.00	0.25
Essex	1.08	1.62	0.25	10.00	10.00	0.25	10.00	0.67	0.25	0.32	0.71	0.25	0.67	9.15	1.35	8.57	6.25	50.00	0.25
Hudson	5.89	1.77	0.95	0.25	10.00	1.53	10.00	5.02	10.00	1.45	10.00	0.25	0.56	0.25	1.29	14.27	11.43	50.00	11.93
Hunterdon	0.25	3.65	10.00	1.44	0.25	0.47	9.47	0.39	10.00	0.25	0.43	0.25	7.43	0.37	0.25	0.25	50.00	0.25	0.25
Mercer	0.25	10.00	10.00	2.89	4.32	3.62	3.21	0.25	10.00	0.25	4.47	0.25	10.00	0.25	0.25	0.25	50.00	50.00	0.25
Middlesex	10.00	1.48	1.02	6.26	0.33	1.05	0.38	1.01	0.66	0.43	1.74	10.00	0.33	10.00	0.25	50.00	17.81	50.00	0.25
Monmouth	10.00	4.87	10.00	0.25	0.25	0.36	0.97	10.00	0.25	10.00	6.03	10.00	1.05	10.00	0.25	0.25	32.53	0.25	50.00
Morris	0.43	0.54	0.25	0.25	1.25	0.25	9.70	2.17	10.00	0.25	0.70	0.57	1.31	0.25	0.25	50.00	0.25	50.00	0.25
Ocean	0.25	10.00	10.00	0.25	0.69	10.00	2.22	3.21	0.73	0.25	3.62	0.25	10.00	0.25	0.25	50.00	0.25	0.25	43.49
Passaic	1.53	2.06	0.37	10.00	0.25	0.25	0.25	0.47	0.25	1.98	7.59	3.49	0.59	0.25	0.25	0.25	4.01	50.00	0.25
Somerset	3.45	3.51	5.07	0.68	0.25	0.25	2.41	1.87	0.25	0.25	2.06	0.25	1.24	2.44	0.25	0.25	50.00	0.25	0.25
Sussex	7.19	1.75	1.87	0.25	0.25	0.25	3.53	2.88	0.25	1.20	0.25	1.05	0.50	0.25	0.25	0.25	1.13	0.25	11.56
Union	0.95	1.62	7.01	0.25	0.25	0.25	0.25	0.57	10.00	0.25	0.33	0.25	2.56	0.25	0.25	0.25	21.85	50.00	8.11
Warren	10.00	3.93	0.25	0.74	0.25	5.90	0.25	3.10	0.25	6.29	0.72	2.11	0.25	2.37	0.25	0.25	3.55	0.25	0.25
Bronx	7.61	0.25	0.25	0.25	0.25	50.00	50.00	0.25	0.25	50.00	0.25	0.25	0.25	0.25	0.10	10.00	0.10	10.00	10.00
Kings	0.25	50.00	15.10	0.25	0.25	50.00	50.00	0.25	0.25	0.25	0.25	0.25	50.00	0.25	1.08	0.10	0.10	0.10	4.45
Manhattan	12.30	50.00	1.52	0.25	50.00	0.25	0.25	50.00	0.25	0.25	0.25	0.25	50.00	10.00	0.11	0.25	0.10	0.45	10.00
Queens	48.50	44.50	2.69	0.25	0.25	50.00	0.25	0.25	0.25	0.25	0.25	0.25	12.20	0.25	0.12	0.10	0.10	0.15	10.00
Richmond	0.96	0.66	0.25	0.25	0.25	0.25	0.37	0.25	27.00	0.25	0.25	0.25	0.25	0.25	10.00	0.28	0.70	2.27	0.10

K-Factors for WBO Trip Purpose

COUNTY	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	Bronx	Kings	Manhattan	Queens	Richmond
Bergen	2.58	1.40	1.33	0.25	0.25	10.00	10.00	0.34	0.25	1.61	0.25	1.17	9.23	10.00	0.27	7.11	2.48	12.65	0.25
Essex	2.25	3.93	1.71	0.25	10.00	8.67	0.25	2.08	0.25	6.22	0.25	10.00	10.00	10.00	0.25	27.86	50.00	0.25	0.25
Hudson	0.73	0.42	1.47	0.25	0.25	3.78	10.00	0.25	0.25	1.02	10.00	0.25	1.64	0.25	30.71	0.47	30.57	6.11	0.25
Hunterdon	0.25	0.25	10.00	7.13	0.25	0.25	0.25	0.84	0.25	10.00	10.00	0.25	9.00	4.25	0.25	0.25	0.25	0.25	0.25
Mercer	0.25	0.25	0.25	0.25	3.12	0.52	0.25	0.25	4.84	0.25	0.72	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Middlesex	0.39	0.25	0.76	0.62	3.92	1.98	0.25	0.25	10.00	4.29	2.08	0.25	2.89	0.25	0.25	50.00	50.00	0.25	0.25
Monmouth	1.29	0.25	0.25	0.25	0.40	0.25	1.63	0.98	3.31	0.25	0.25	0.25	0.69	0.25	0.25	0.25	0.25	0.25	0.25
Morris	3.21	1.40	0.25	2.49	0.25	4.02	10.00	2.24	0.25	4.55	3.25	0.30	4.73	10.00	50.00	0.25	50.00	0.25	0.25
Ocean	10.00	0.25	0.25	0.25	2.27	4.92	0.30	0.25	1.19	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Passaic	4.24	7.55	0.27	10.00	0.25	10.00	0.25	5.53	0.25	10.00	6.44	0.25	4.13	0.25	0.25	50.00	9.97	50.00	0.25
Somerset	0.25	0.25	0.25	0.51	1.33	0.51	0.25	0.25	10.00	0.79	3.30	0.41	0.65	3.93	0.25	0.25	0.25	0.25	0.25
Sussex	0.25	10.00	0.25	0.25	0.25	0.25	0.25	2.99	0.25	0.25	10.00	1.97	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Union	0.25	0.25	0.25	0.58	8.56	0.60	0.37	0.25	10.00	0.25	2.22	0.25	5.83	0.25	0.25	10.78	38.46	0.25	0.25
Warren	0.25	10.00	0.25	0.79	0.25	0.25	0.25	0.83	0.25	0.25	0.25	0.25	0.25	4.49	0.25	0.25	0.25	0.25	0.25
Bronx	0.83	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	3.70	10.00	4.39	10.00	10.00
Kings	3.63	0.25	0.25	0.25	0.25	0.25	0.25	50.00	0.25	0.25	0.25	0.25	0.25	0.25	3.21	0.10	8.00	3.08	2.68
Manhattan	2.51	34.00	3.41	0.25	0.25	0.25	0.25	50.00	0.25	0.25	0.25	0.25	50.00	0.25	6.16	3.89	3.70	6.78	10.00
Queens	0.25	50.00	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	10.00	0.10	0.80	0.10	5.50
Richmond	0.25	10.99	3.27	0.25	0.25	0.25	3.65	0.25	0.25	0.25	0.25	0.25	3.25	0.25	0.25	3.48	10.00	1.99	0.25

K-Factors for NHNW Trip Purpose

COUNTY	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	Bronx	Kings	Manhattan	Queens	Richmond
Bergen	1.74	0.25	1.22	0.25	0.25	0.47	10.00	0.62	10.00	0.56	5.91	0.25	0.31	0.25	2.73	0.25	1.17	11.09	0.25
Essex	2.69	2.20	2.92	10.00	10.00	5.07	10.00	6.39	0.25	6.88	10.00	10.00	10.00	0.25	18.73	50.00	47.00	0.25	5.19
Hudson	0.42	0.25	1.61	0.25	0.25	3.00	0.25	0.51	10.00	0.75	10.00	0.25	0.52	0.25	0.25	21.93	3.29	0.25	5.77
Hunterdon	0.25	10.00	0.25	0.71	0.72	0.26	0.25	0.33	0.25	0.25	0.27	0.25	0.25	0.43	0.25	0.25	0.25	0.25	0.25
Mercer	0.25	0.25	0.25	0.25	2.77	0.79	0.76	0.25	0.42	10.00	0.53	0.25	10.00	0.25	0.25	0.25	0.25	0.25	0.25
Middlesex	3.03	0.25	1.09	0.25	1.18	1.23	0.34	0.60	1.10	0.25	1.39	10.00	0.25	0.25	50.00	50.00	50.00	0.25	0.44
Monmouth	0.25	0.25	0.25	0.25	1.07	0.62	0.95	0.25	0.25	10.00	2.73	0.25	0.70	0.25	0.25	50.00	50.00	0.25	10.93
Morris	0.65	0.25	0.25	0.25	0.25	0.25	10.00	1.47	0.25	1.08	0.74	1.47	0.33	0.96	0.25	0.25	0.25	0.25	0.25
Ocean	0.25	10.00	10.00	0.25	10.00	5.04	2.57	10.00	0.80	0.25	0.25	1.00	0.25	1.00	0.25	0.25	0.25	0.25	0.25
Passaic	0.32	0.25	0.64	10.00	0.25	0.25	0.25	0.86	0.25	1.61	0.25	2.55	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Somerset	0.38	0.25	0.25	0.25	1.85	0.25	1.71	0.25	0.25	0.25	1.54	10.00	0.31	0.25	0.25	0.25	35.50	0.25	0.25
Sussex	4.23	0.25	0.25	10.00	0.25	10.00	0.25	0.49	1.00	0.25	0.25	1.18	0.25	0.25	0.25	0.25	0.25	0.25	50.00
Union	0.25	0.25	1.45	10.00	0.25	0.63	0.25	0.45	0.25	0.60	5.09	0.25	1.73	0.25	0.25	50.00	15.64	50.00	2.06
Warren	0.25	0.25	0.25	0.25	0.25	10.00	0.25	1.17	1.00	0.25	0.25	1.46	0.25	3.51	0.25	1.00	0.25	0.25	0.25
Bronx	1.25	0.25	0.25	1.00	1.00	50.00	1.00	0.25	0.25	0.25	0.25	50.00	0.25	0.25	0.20	10.00	0.10	10.00	10.00
Kings	1.16	0.25	50.00	1.00	1.00	50.00	1.00	0.25	0.25	0.25	0.25	1.00	0.25	1.00	0.82	0.10	0.11	0.10	0.40
Manhattan	1.89	6.16	13.93	1.00	1.00	50.00	50.00	50.00	30.00	6.10	50.00	0.25	5.99	0.25	0.27	0.10	0.10	0.10	10.00
Queens	0.25	0.25	0.25	0.25	1.00	0.25	1.00	0.25	0.25	0.25	1.00	1.00	0.25	1.00	0.49	0.10	0.10	0.10	2.58
Richmond	0.25	0.25	32.09	0.25	0.25	12.69	30.61	0.25	50.00	0.25	0.25	1.00	6.51	1.00	0.25	2.52	10.00	6.32	0.10

APPENDIX I – COUNTY LEVEL TRIP INTERCHANGE COMPARISONS

All Person Trips County-to-County Comparison

REGION	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	NJTPA+Mercer	Bronx	Kings	Manhattan	Queens	Richmond	New York City	TOTAL
Bergen	2,795,415	75,782	76,038	9,118	1,143	13,128	7,102	18,063	360	141,197	9,142	1,049	18,580	1,112	3,167,230	35,510	14,027	134,595	4,426	1,274	189,831	3,357,061
	2,781,385	87,571	81,233	805	4	12,467	1,334	18,979	43	142,322	4,038	1,083	20,694	84	3,152,044	35,801	13,928	155,470	1,387	1,238	207,823	3,359,867
Essex	71,406	1,407,208	53,286	12,645	4,008	13,689	3,109	123,585	223	111,078	14,157	3,559	127,277	928	1,946,158	2,400	1,564	93,192	3,429	2,197	102,782	2,048,939
	68,737	1,406,590	57,548	1,129	107	14,724	3,304	122,387	246	107,560	11,493	1,601	122,922	250	1,918,598	1,625	2,805	103,258	1,311	2,966	111,965	2,030,563
Hudson	94,820	50,760	737,886	0	3,841	14,137	1,902	13,995	3,836	18,523	9,703	121	12,597	0	962,120	6,387	9,935	171,203	8,659	1,322	197,507	1,159,627
	92,204	57,514	729,095	2	94	11,575	847	13,358	14	17,599	5,074	134	12,918	0	940,430	4,850	11,664	202,074	6,796	3,204	228,588	1,169,018
Hunterdon	85	9,257	2,448	222,904	5,426	9,268	407	5,227	1,205	222	32,405	0	8,018	6,319	303,191	0	0	3,723	119	0	3,842	307,033
	153	4,650	2,204	221,187	5,941	9,585	421	5,748	557	244	33,554	59	8,900	6,537	299,739	0	0	4,169	12	16	4,198	303,937
Mercer	0	283	1,451	2,600	952,279	49,399	10,173	2,653	12,097	3,089	12,300	0	2,399	0	1,048,725	0	2,203	16,343	258	0	18,804	1,067,529
	33	1,117	1,452	3,513	919,694	54,857	17,332	2,987	10,556	21	17,237	0	3,252	1	1,032,050	0	1	12,571	5	214	12,791	1,044,842
Middlesex	15,420	29,305	11,553	2,971	85,009	1,923,283	69,380	14,131	13,394	7,834	143,433	1,033	70,137	1,113	2,387,997	7,672	16,808	71,567	3,334	6,164	105,546	2,493,543
	12,287	32,694	12,971	3,092	79,648	1,946,943	72,955	14,657	12,252	7,252	143,651	37	83,118	159	2,421,717	1,867	4,801	74,413	851	7,913	89,846	2,511,563
Monmouth	6,740	19,046	15,266	323	13,312	73,364	1,979,734	7,111	85,335	2,130	17,096	1,133	14,273	1,121	2,235,984	41	4,282	41,869	1,973	11,085	59,249	2,295,233
	5,840	17,113	15,358	212	17,143	74,665	1,983,462	6,029	91,847	1,595	15,266	1	16,938	0	2,245,470	32	890	45,518	549	8,232	55,220	2,300,691
Morris	31,643	85,403	2,560	5,788	657	5,893	2,543	1,309,294	258	76,935	38,461	23,951	46,347	11,564	1,641,295	7,467	2,204	17,158	800	587	28,215	1,669,510
	30,762	90,658	4,783	6,814	209	6,821	1,447	1,297,905	10	80,649	39,950	26,220	51,104	11,780	1,649,112	2,971	1,818	19,439	33	777	25,039	1,674,151
Ocean	1,957	9,455	8,996	50	19,279	23,473	171,075	1,702	1,592,104	200	3,106	0	3,552	0	1,834,947	523	2,064	9,565	0	3,227	15,379	1,850,326
	404	5,516	2,084	74	14,601	18,041	174,209	764	1,610,866	185	3,372	0	3,106	0	1,833,221	7	213	10,799	0	4,080	15,099	1,848,320
Passaic	190,281	102,599	24,619	1,019	0	663	1,444	83,300	0	1,141,414	4,931	3,912	4,375	0	1,558,557	970	4,176	21,616	2,177	0	28,938	1,587,495
	187,639	110,138	24,500	458	4	1,082	1,568	81,468	3	1,142,550	4,858	4,543	5,048	5	1,563,864	1,031	3,853	25,464	438	67	30,854	1,594,718
Somerset	4,175	23,342	9,834	22,585	32,081	75,122	4,899	36,453	782	1,948	713,710	572	37,119	577	963,200	0	572	11,421	2,288	4,369	18,649	981,849
	4,537	27,442	10,320	22,443	29,483	83,969	4,702	37,337	181	2,293	710,355	613	40,091	709	974,477	1	141	8,504	226	5,218	14,091	988,567
Sussex	14,958	10,889	6,108	521	1,706	1,210	276	67,853	0	15,171	3,449	296,823	2,479	3,738	425,179	615	390	1,144	0	269	2,417	427,597
	14,818	11,721	3,773	545	2	979	69	70,728	0	14,403	2,283	304,070	3,304	3,356	430,050	431	42	779	0	45	1,297	431,347
Union	7,187	114,797	78,614	3,001	1,861	98,116	880	46,911	1,381	12,674	57,951	0	1,188,934	1,133	1,613,440	2,219	8,297	49,110	3,699	7,441	70,766	1,684,206
	8,785	130,577	81,057	2,346	889	104,758	3,633	47,661	342	13,441	57,814	40	1,178,627	62	1,630,032	1,238	7,205	49,652	154	10,594	68,843	1,698,875
Warren	3,477	2,208	0	16,013	242	1,254	303	31,390	0	2,551	6,798	8,659	1,333	217,929	292,158	0	0	1,901	0	0	1,901	294,059
	1,491	2,509	256	18,140	327	2,474	264	33,532	1	2,499	7,241	10,117	1,596	222,262	302,710	3	2	2,197	0	12	2,214	304,923
NJTPA+Mercer	3,237,564	1,940,333	1,028,658	299,538	1,120,844	2,302,000	2,253,226	1,761,668	1,710,975	1,534,967	1,066,641	340,813	1,537,420	245,534	20,380,182	63,804	66,521	644,406	31,160	37,934	843,825	21,224,007
	3,209,076	1,985,811	1,026,634	280,759	1,068,146	2,342,939	2,265,547	1,753,541	1,726,920	1,532,615	1,056,185	348,518	1,551,618	245,205	20,393,515	49,858	47,363	714,309	11,761	44,576	867,866	21,261,380
Bronx	8,457	115	1,055	0	0	3,428	234	0	0	6,987	0	158	221	0	20,655							20,655
	9,041	366	1,033	0	0	90	32	78	0	4,333	3	3	262	0	15,242							15,242
Kings	9,532	13,430	18,931	537	0	8,004	6,222	3,375	1,078	0	0	0	12,218	118	73,443							73,443
	16,183	20,010	27,406	0	0	578	1,526	895	182	45	1	0	6,940	0	73,766							73,766
Manhattan	29,190	11,490	19,729	3,829	4,353	7,239	5,902	4,544	353	1,561	108	152	2,731	1,137	92,318							92,318
	33,432	13,719	21,688	0	3	1,931	37	3,895	0	1,833	17	0	1,800	0	78,354							78,354
Queens	6,402	8,916	3,966	0	0	9,084	6,445	1,139	0	849	0	0	2,184	0	38,986							38,986
	4,888	9,104	6,228	0	0	3,082	7	77	0	619	0	0	811	0	24,815							24,815
Richmond	1,981	8,122	8,769	0	0	14,178	5,761	4,344	3,405	955	1,738	0	5,466	0	54,718							54,718
	2,023	13,623	13,317	5	77	22,714	11,922	3,865	3,199	859	1,572	0	21,046	0	94,224							94,224
New York City	55,562	42,074	52,450	4,365	4,353	41,932	24,564	13,402	4,835	10,352	1,847	310	22,820	1,255	280,122							280,122
	65,567	56,822	69,673	6	80	28,394	13,523	8,810	3,381	7,689	1,593	3	30,861	0	286,401							286,401
TOTAL	3,293,126	1,982,406	1,081,109	303,903	1,125,197	2,343,932	2,277,790	1,775,071	1,715,810	1,545,319	1,068,488	341,123	1,560,241	246,789	20,660,303	63,804	66,521	644,406	31,160	37,934	843,825	21,504,128
ATTRACTION	3,274,643	2,042,633	1,096,307	280,765	1,068,226	2,371,333	2,279,070	1,762,351	1,730,301	1,540,304	1,057,779	348,521	1,582,479	245,205	20,679,916	49,858	47,363	714,309	11,761	44,576	867,866	21,547,782

TEXT	Observed
TEXT	Estimated

Home-Based-Work Direct County-to-County Comparison

REGION	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	NJTPA+Mercer	Bronx	Kings	Manhattan	Queens	Richmond	New York City	TOTAL
Bergen	258,790	26,757	22,707	4,543	811	8,302	1,095	8,060	139	26,951	8,562	382	6,455	487	374,041	12,748	5,010	80,279	1,439	674	100,150	474,191
	263,809	27,509	22,851	78	0	7,897	1,013	8,520	35	26,466	3,368	456	7,056	20	369,078	14,530	5,384	91,618	626	838	112,995	482,073
Essex	19,415	173,669	18,081	5,192	40	3,448	265	32,769	223	17,564	1,733	0	15,509	0	287,910	1,929	666	49,102	684	1,971	54,352	342,261
	19,726	172,874	17,754	733	26	3,821	1,067	32,870	181	17,405	1,746	57	15,253	0	283,513	1,199	1,153	58,731	793	2,478	64,354	347,867
Hudson	34,099	18,320	129,573	0	1,619	10,011	504	9,251	0	6,716	2,730	121	3,755	0	216,698	3,374	6,367	94,724	5,484	305	110,253	326,951
	31,703	18,653	125,805	0	7	9,008	396	8,594	0	6,231	2,654	132	3,869	0	207,053	2,724	5,300	111,730	4,998	1,195	125,948	333,001
Hunterdon	85	1,081	1,846	22,733	2,972	6,297	178	2,280	348	138	11,810	0	1,919	788	52,476	0	0	2,114	119	0	2,233	54,709
	89	1,098	1,906	22,993	3,064	6,520	169	2,476	184	141	12,744	15	2,295	873	54,568	0	0	1,948	11	8	1,967	56,535
Mercer	0	0	1,001	259	135,341	15,329	1,913	2,302	1,629	0	3,708	0	561	0	162,043	0	0	9,522	0	0	9,522	171,566
	11	745	1,136	519	126,708	16,783	4,484	2,589	1,840	14	4,444	0	923	0	160,196	0	0	10,309	1	138	10,448	170,645
Middlesex	6,578	16,279	7,874	574	17,847	241,340	11,807	6,557	8,182	5,862	39,823	0	25,150	0	387,874	5,842	10,937	41,507	343	2,515	61,143	449,017
	6,961	15,345	8,996	626	18,546	242,280	12,333	6,934	7,980	5,062	41,066	3	28,829	0	394,962	1,510	3,880	49,350	566	3,648	58,954	453,916
Monmouth	3,462	12,456	9,128	323	3,188	22,494	171,634	5,096	19,540	561	7,183	0	6,579	0	261,645	0	3,052	37,249	1,973	1,842	44,116	305,761
	3,399	10,934	9,675	206	3,095	23,397	176,956	4,421	19,416	545	7,389	0	8,082	0	267,515	0	804	39,733	547	2,709	43,794	311,309
Morris	10,726	28,531	1,823	3,741	197	3,007	0	142,890	0	17,719	12,132	6,166	12,661	3,896	243,491	2,251	390	15,232	0	587	18,461	261,952
	10,985	29,554	2,815	3,514	146	3,023	141	143,161	0	17,943	12,358	7,093	14,403	1,946	247,082	1,925	492	16,665	3	766	19,851	266,934
Ocean	1,818	3,306	3,064	50	3,655	5,926	58,341	1,159	164,402	100	1,525	0	0	0	243,346	523	188	7,336	0	1,222	9,270	252,616
	326	3,214	1,850	59	3,757	6,173	59,397	416	163,231	87	1,686	0	329	0	240,526	7	34	8,731	0	1,840	10,613	251,139
Passaic	41,592	19,721	9,520	356	0	312	0	26,206	0	111,674	3,017	379	2,041	0	214,817	779	2,773	11,728	732	0	16,013	230,829
	41,970	20,335	9,446	169	0	536	85	25,558	0	113,222	2,958	437	2,164	0	216,880	745	2,598	14,103	300	54	17,801	234,681
Somerset	1,623	9,324	7,145	6,122	13,111	24,126	1,033	9,807	0	894	78,687	0	10,793	0	162,667	0	572	7,330	2,288	4,369	14,558	177,224
	1,822	9,756	7,625	6,410	9,397	26,054	1,166	10,710	36	1,033	79,792	31	12,983	7	166,821	1	138	6,014	225	5,094	11,471	178,293
Sussex	6,850	3,857	1,960	0	1,628	1,047	0	16,494	0	3,882	2,165	36,364	367	1,027	75,641	306	0	255	0	0	561	76,202
	8,167	4,539	1,781	1	0	909	0	17,933	0	4,372	1,374	34,592	571	503	74,743	225	0	245	0	0	469	75,212
Union	5,693	28,980	25,950	504	1,586	24,466	153	14,679	0	2,602	12,497	0	126,759	1,133	245,001	1,154	3,952	29,570	0	1,660	36,335	281,336
	6,305	30,874	28,784	586	622	23,887	2,088	15,618	69	2,737	13,083	10	121,414	59	246,135	711	3,545	32,340	12	2,853	39,461	285,596
Warren	717	499	0	4,613	242	268	303	9,254	0	1,287	4,108	1,920	844	18,363	42,418	0	0	1,300	0	0	1,300	43,718
	767	1,163	219	5,242	298	1,385	252	10,201	0	1,318	4,243	2,343	999	18,526	46,955	1	1	1,368	0	10	1,380	48,335
NJTPA+Mercer	391,447	342,781	239,674	49,011	182,238	366,371	247,226	286,804	194,464	195,950	189,680	45,332	213,392	25,694	2,970,066	28,907	33,906	387,248	13,061	15,145	478,266	3,448,332
	396,040	346,594	240,644	41,135	165,667	371,670	259,546	290,002	192,971	196,575	188,907	45,170	219,170	21,935	2,976,027	23,578	23,330	442,886	8,083	21,631	519,508	3,495,535
Bronx	2,746	115	1,055	0	0	0	0	0	0	0	0	0	221	0	4,137							4,137
	2,187	236	841	0	0	5	0	45	0	435	0	0	211	0	3,959							3,959
Kings	9,038	8,994	10,607	537	0	511	2,567	3,092	0	0	0	0	0	118	35,464							35,464
	15,315	16,845	12,593	0	0	247	246	457	0	22	0	0	16	0	45,742							45,742
Manhattan	9,879	1,861	7,307	3,829	1,474	4,880	642	434	224	469	0	0	359	0	31,358							31,358
	7,869	1,246	5,872	0	0	1,029	25	286	0	268	0	0	282	0	16,877							16,877
Queens	4,037	4,242	2,652	0	0	1,151	3,900	1,139	0	849	0	0	1,768	0	19,737							19,737
	2,160	2,498	3,452	0	0	71	6	67	0	588	0	0	524	0	9,367							9,367
Richmond	1,010	2,599	4,723	0	0	592	419	0	2,326	955	1,650	0	2,477	0	16,751							16,751
	608	1,499	3,491	0	0	1,912	436	25	1,769	579	1,107	0	1,834	0	13,259							13,259
New York City	26,710	17,811	26,345	4,365	1,474	7,134	7,529	4,666	2,550	2,272	1,650	0	4,824	118	107,447							107,447
	28,139	22,325	26,249	0	0	3,264	713	879	1,769	1,891	1,108	0	2,866	0	89,204							89,204
TOTAL	418,157	360,592	266,018	53,376	183,712	373,505	254,755	291,470	197,014	198,222	191,330	45,332	218,217	25,812	3,077,513	28,907	33,906	387,248	13,061	15,145	478,266	3,555,779
ATTRACTION	424,178	368,919	266,893	41,136	165,667	374,934	260,260	290,881	194,740	198,466	190,015	45,170	222,036	21,935	3,065,231	23,578	23,330	442,886	8,083	21,631	519,508	3,584,739

TEXT	Observed
TEXT	Estimated

Home-Based-Work Strategic County-to-County Comparison

REGION	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	NJTPA+Mercer	Bronx	Kings	Manhattan	Queens	Richmond	New York City	TOTAL
Bergen	129,222	9,519	14,117	4,575	0	3,340	0	2,928	0	17,324	0	385	5,098	491	186,998	10,306	5,568	8,448	0	371	24,693	**211,691**
	128,332	9,857	14,517	726	0	3,166	76	3,127	8	17,011	56	422	5,510	49	182,858	10,622	4,675	15,768	67	397	31,530	**214,388**
Essex	4,089	50,598	4,085	0	323	1,677	267	17,395	0	3,724	8,435	0	8,303	0	98,897	0	315	5,815	239	0	6,369	**105,266**
	4,181	49,991	4,075	22	16	1,651	363	17,272	65	3,482	7,083	3	8,325	0	96,530	25	297	10,231	198	258	11,009	**107,539**
Hudson	7,775	3,554	23,683	0	0	460	187	2,754	0	1,274	1,781	0	3,120	0	44,588	1,213	487	12,688	278	0	14,666	**59,253**
	7,499	3,838	22,920	1	0	402	154	2,676	2	1,237	1,357	0	3,160	0	43,245	866	389	19,413	212	178	21,058	**64,303**
Hunterdon	0	155	54	8,279	721	1,103	0	775	351	0	2,619	0	989	180	15,226	0	0	128	0	0	128	**15,354**
	62	167	53	8,127	734	1,069	60	801	350	54	2,689	7	1,072	198	15,442	0	0	211	0	8	219	**15,661**
Mercer	0	0	294	0	49,400	7,119	826	351	1,907	0	763	0	271	0	60,931	0	0	1,864	0	0	1,864	**62,795**
	22	357	312	297	48,184	7,552	2,740	391	2,190	6	2,133	0	1,366	0	65,549	0	1	1,720	1	74	1,795	**67,344**
Middlesex	1,553	3,516	1,020	0	14,227	81,610	2,263	3,778	1,112	0	9,843	0	12,763	615	132,297	881	0	12,161	183	2,172	15,397	**147,694**
	1,678	3,533	1,484	113	9,424	83,165	5,874	4,081	1,357	368	10,204	1	14,426	129	135,835	326	97	12,440	202	2,591	15,657	**151,492**
Monmouth	2,265	4,722	4,710	0	2,749	8,905	62,308	684	5,346	469	7,028	0	2,500	0	101,685	41	269	1,553	0	1,023	2,886	**104,571**
	2,282	4,342	4,990	3	2,797	8,983	63,276	715	5,481	456	5,596	0	3,169	0	102,090	32	82	1,774	1	1,271	3,159	**105,249**
Morris	2,467	9,168	90	1,163	199	0	0	40,013	0	14,954	6,762	1,616	2,912	0	79,344	2,975	1,503	526	0	0	5,005	**84,349**
	2,554	9,826	598	1,112	16	210	15	39,879	1	15,175	6,913	1,992	3,421	260	81,971	722	1,223	1,460	1	7	3,413	**85,384**
Ocean	0	2,008	0	0	10,272	4,420	11,163	0	59,305	100	1,395	0	2,088	0	90,751	0	727	2,045	0	1,441	4,213	**94,963**
	5	2,037	14	7	5,784	4,490	11,728	2	59,835	92	1,521	0	2,559	0	88,073	0	178	2,060	0	1,859	4,097	**92,171**
Passaic	16,052	12,977	7,548	0	0	0	1,444	6,452	0	27,149	491	420	941	0	73,475	191	1,018	2,311	0	0	3,519	**76,994**
	16,042	13,479	7,695	4	0	101	1,480	6,417	3	27,071	495	488	1,001	0	74,275	177	820	3,323	10	13	4,343	**78,617**
Somerset	2,126	5,933	1,265	7,627	2,753	5,238	587	2,899	0	860	33,681	0	3,986	0	66,956	0	0	971	0	0	971	**67,928**
	2,283	6,116	1,302	6,337	2,962	5,411	617	3,004	63	873	33,834	2	4,656	1	67,462	0	3	726	0	81	812	**68,273**
Sussex	4,134	4,743	3,767	0	78	0	0	7,120	0	8,221	739	9,123	2,043	1,855	41,824	308	390	49	0	0	747	**42,571**
	4,388	5,161	1,867	5	0	12	0	7,466	0	7,115	814	8,875	2,680	1,643	40,026	204	41	85	0	0	331	**40,356**
Union	83	10,631	13,740	0	0	16,677	54	9,735	0	7,622	7,016	0	49,105	0	114,663	1,065	4,133	5,821	0	2,643	13,662	**128,325**
	502	10,674	16,366	11	0	16,205	375	10,112	48	7,946	7,194	0	47,116	0	116,548	525	3,282	5,283	3	3,571	12,664	**129,213**
Warren	0	259	0	3,591	0	0	0	2,949	0	585	2,041	740	489	3,841	14,495	0	0	252	0	0	252	**14,747**
	69	280	33	3,942	2	160	7	3,335	0	601	2,188	986	581	3,760	15,946	0	0	234	0	1	235	**16,180**
NJTPA+Mercer	169,767	117,782	74,371	25,235	80,723	130,548	79,098	97,834	68,021	82,282	82,594	12,284	94,610	6,981	1,122,131	16,980	14,410	54,632	700	7,650	94,371	**1,216,502**
	169,899	119,658	76,225	20,704	69,919	132,578	86,765	99,278	69,402	81,486	82,076	12,777	99,043	6,040	1,125,849	13,498	11,091	74,728	695	10,309	110,322	**1,236,171**
Bronx	482	0	0	0	0	0	0	0	0	0	0	0	0	0	482							**482**
	897	107	142	0	0	9	2	27	0	130	2	0	52	0	1,369							**1,369**
Kings	0	679	1,333	0	0	238	2,506	0	1,078	0	0	0	11,497	0	17,331							**17,331**
	98	1,563	1,998	0	0	151	1,072	2	182	14	0	0	6,177	0	11,257							**11,257**
Manhattan	0	1,292	1,981	0	2,031	1,162	0	626	0	0	0	0	0	0	7,092							**7,092**
	1,291	868	1,431	0	0	837	0	435	0	164	0	0	106	0	5,132							**5,132**
Queens	0	482	975	0	0	0	0	0	0	0	0	0	0	0	1,457							**1,457**
	39	706	1,710	0	0	0	0	0	0	3	0	0	3	0	2,462							**2,462**
Richmond	274	0	859	0	0	0	409	4,344	0	0	89	0	0	0	5,975							**5,975**
	211	292	1,488	2	0	722	387	3,581	35	21	72	0	1,576	0	8,386							**8,386**
New York City	756	2,454	5,148	0	2,031	1,399	2,915	4,970	1,078	0	89	0	11,497	0	32,337							**32,337**
	2,536	3,536	6,770	2	0	1,719	1,461	4,045	218	332	75	0	7,914	0	28,607							**28,607**
TOTAL	**170,523**	**120,236**	**79,519**	**25,235**	**82,754**	**131,948**	**82,014**	**102,805**	**69,099**	**82,282**	**82,682**	**12,284**	**106,107**	**6,981**	**1,154,468**	**16,980**	**14,410**	**54,632**	**700**	**7,650**	**94,371**	**1,248,839**
ATTRACTION	**172,436**	**123,194**	**82,995**	**20,706**	**69,919**	**134,297**	**88,226**	**103,322**	**69,620**	**81,818**	**82,150**	**12,777**	**106,956**	**6,040**	**1,154,456**	**13,498**	**11,091**	**74,728**	**695**	**10,309**	**110,322**	**1,264,778**

TEXT	Observed
TEXT	Estimated

Home-Based-Shop County-to-County Comparison

REGION	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	NJTPA+Mercer	Bronx	Kings	Manhattan	Queens	Richmond	New York City	TOTAL
Bergen	350,078	892	1,872	0	0	0	0	0	0	29,848	0	158	97	0	382,945	1,745	2,154	5,506	0	0	9,404	**392,350**
	344,460	930	2,141	0	0	1	0	289	0	29,899	1	79	132	0	377,931	1,383	1,950	7,752	0	0	11,085	**389,016**
Essex	5,469	133,851	6,328	0	0	257	0	12,172	0	24,340	0	0	5,540	0	187,957	0	0	4,010	0	0	4,010	**191,966**
	4,846	135,004	7,113	0	0	248	1	12,223	0	23,298	92	5	6,499	1	189,330	1	3	2,237	0	0	2,241	**191,571**
Hudson	8,899	1,603	84,612	0	0	1,803	0	0	0	2,213	754	0	2,002	0	101,886	0	0	11,080	506	0	11,586	**113,472**
	8,218	1,416	85,693	0	0	447	0	9	0	1,665	153	0	1,952	0	99,552	4	28	13,423	175	0	13,630	**113,182**
Hunterdon	0	96	0	29,254	96	448	0	169	0	0	3,945	0	629	2,134	36,772	0	0	0	0	0	0	**36,772**
	0	100	0	28,758	175	468	0	510	0	1	4,189	8	569	2,145	36,922	0	0	0	0	0	0	**36,922**
Mercer	0	0	0	182	114,534	2,696	0	0	0	0	983	0	273	0	118,668	0	2,203	855	0	0	3,058	**121,726**
	0	0	0	292	111,092	5,217	2,470	0	443	0	3,568	0	336	0	123,418	0	0	0	0	0	0	**123,418**
Middlesex	0	536	0	166	15,333	216,158	13,354	260	0	638	16,350	0	2,388	0	265,183	0	0	8,410	0	0	8,410	**273,593**
	18	506	58	155	15,653	221,512	13,558	242	30	541	16,614	0	4,585	0	273,470	0	0	688	0	10	699	**274,169**
Monmouth	0	0	0	0	2,981	2,640	238,783	0	5,035	0	0	0	245	0	249,684	0	0	0	0	256	256	**249,940**
	0	8	0	0	2,985	3,437	238,334	0	4,969	0	20	0	278	0	250,031	0	0	0	0	217	217	**250,248**
Morris	2,271	1,926	0	145	200	762	0	131,556	0	5,281	2,927	1,587	2,845	1,051	150,551	0	0	126	0	0	126	**150,677**
	2,095	3,455	193	145	0	764	1	128,979	0	5,639	3,127	2,157	3,172	1,029	150,757	0	0	199	0	0	199	**150,956**
Ocean	0	0	0	0	780	0	12,112	142	221,836	0	0	0	251	0	235,120	0	0	0	0	0	0	**235,120**
	0	0	0	0	840	26	12,728	0	221,768	0	2	0	9	0	235,373	0	0	0	0	0	0	**235,373**
Passaic	29,636	5,120	1,862	0	0	0	0	14,759	0	140,222	0	0	338	0	191,937	0	0	0	270	0	270	**192,207**
	27,798	5,295	2,105	0	0	3	0	14,211	0	141,089	5	204	377	0	191,086	8	2	5	2	0	16	**191,103**
Somerset	0	0	379	0	1,179	1,893	0	1,114	0	0	100,014	0	1,690	0	106,269	0	0	225	0	0	225	**106,494**
	8	361	409	156	1,175	3,579	23	1,125	0	13	97,678	3	1,805	8	106,344	0	0	38	0	0	38	**106,382**
Sussex	0	0	103	0	0	0	0	7,666	0	1,342	0	30,936	0	402	40,449	0	0	0	0	0	0	**40,449**
	1	3	10	0	0	0	0	8,011	0	1,072	1	31,765	0	440	41,303	0	0	0	0	0	0	**41,303**
Union	298	6,062	301	178	0	12,786	0	4,313	0	1,002	10,850	0	107,848	0	143,637	0	0	1,031	0	0	1,031	**144,668**
	288	6,236	351	137	0	12,985	90	4,157	0	1,024	10,695	1	108,149	0	144,113	0	0	336	0	0	337	**144,450**
Warren	0	0	0	1,521	0	0	0	4,676	0	0	0	1,031	0	36,444	43,671	0	0	0	0	0	0	**43,671**
	0	0	0	1,758	0	0	0	4,936	0	1	41	1,317	0	36,469	44,523	0	0	0	0	0	0	**44,523**
NJTPA+Mercer	396,651	150,087	95,457	31,446	135,105	239,442	264,249	176,826	226,870	204,885	135,823	33,711	124,147	40,031	2,254,731	1,745	4,357	31,241	776	256	38,374	**2,293,106**
	387,732	153,313	98,071	31,401	131,919	248,686	267,205	174,692	227,210	204,242	136,189	35,538	127,862	40,092	2,264,153	1,396	1,983	24,679	176	228	28,462	**2,292,615**
Bronx	172	0	0	0	0	0	0	0	0	0	0	0	0	0	172							**172**
	152	0	0	0	0	0	0	0	0	0	0	0	0	0	152							**152**
Kings	0	0	901	0	0	0	0	0	0	0	0	0	0	0	901							**901**
	0	0	17	0	0	0	0	0	0	0	0	0	0	0	17							**17**
Manhattan	2,086	0	199	0	0	0	0	0	0	0	0	0	0	0	2,285							**2,285**
	4,742	0	808	0	0	0	0	0	0	0	0	0	0	0	5,550							**5,550**
Queens	374	0	0	0	0	0	1,468	0	0	0	0	0	0	0	1,841							**1,841**
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							**0**
Richmond	0	0	0	0	0	1,585	0	0	0	0	0	0	0	0	1,585							**1,585**
	0	0	5	0	0	1,471	1	0	0	0	0	0	13	0	1,490							**1,490**
New York City	2,632	0	1,100	0	0	1,585	1,468	0	0	0	0	0	0	0	6,785							**6,785**
	4,895	0	829	0	0	1,471	1	0	0	0	0	0	13	0	7,209							**7,209**
TOTAL	**399,283**	**150,087**	**96,557**	**31,446**	**135,105**	**241,027**	**265,717**	**176,826**	**226,870**	**204,885**	**135,823**	**33,711**	**124,147**	**40,031**	**2,261,516**	**1,745**	**4,357**	**31,241**	**776**	**256**	**38,374**	**2,299,890**
ATTRACTION	**392,627**	**153,313**	**98,900**	**31,401**	**131,919**	**250,157**	**267,206**	**174,692**	**227,210**	**204,242**	**136,189**	**35,538**	**127,875**	**40,092**	**2,271,362**	**1,396**	**1,983**	**24,679**	**176**	**228**	**28,462**	**2,299,823**

TEXT	Observed
TEXT	Estimated

Home-Based-Other County-to-County Comparison

REGION	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	NJTPA+Mercer	Bronx	Kings	Manhattan	Queens	Richmond	New York City	TOTAL
Bergen	1,282,712	25,958	17,778	0	333	353	5,577	1,968	0	33,882	290	0	5,362	0	1,374,213	6,095	600	30,922	2,796	229	40,641	**1,414,855**
	1,272,398	27,564	22,222	0	4	355	38	1,891	0	34,831	303	9	6,296	0	1,365,911	5,540	603	32,530	414	0	39,087	**1,404,998**
Essex	23,150	668,253	9,362	7,323	3,210	1,555	2,261	29,127	0	27,820	1,242	0	39,359	204	812,864	357	121	25,183	2,506	0	28,167	**841,031**
	21,832	677,727	13,402	295	50	1,918	1,537	28,086	0	26,457	1,340	33	40,926	214	813,817	320	159	26,224	320	0	27,023	**840,839**
Hudson	31,410	16,343	297,649	0	484	470	960	1,554	1,819	4,763	2,371	0	1,736	0	359,559	204	938	34,740	2,200	118	38,201	**397,760**
	31,973	17,113	297,406	1	88	443	74	1,538	13	4,774	323	0	1,859	0	355,603	183	1,014	39,379	1,139	198	41,913	**397,516**
Hunterdon	0	591	413	111,893	842	1,256	229	1,137	506	0	9,934	0	4,385	1,515	132,699	0	0	1,481	0	0	1,481	**134,180**
	1	587	192	109,674	1,126	1,340	191	1,099	23	10	10,454	21	4,802	1,544	131,065	0	0	2,010	0	0	2,011	**133,076**
Mercer	0	283	156	1,943	364,351	14,465	4,724	0	6,741	0	4,611	0	335	0	397,609	0	0	1,873	258	0	2,131	**399,740**
	0	10	3	1,807	350,821	15,136	4,624	0	4,221	0	4,767	0	163	0	381,553	0	0	543	3	0	546	**382,099**
Middlesex	5,612	8,100	1,450	2,086	23,506	891,839	28,539	1,778	727	281	49,506	871	15,950	499	1,030,744	0	4,110	6,049	2,808	0	12,968	**1,043,712**
	2,216	7,797	1,322	1,897	22,565	902,882	28,245	1,632	691	250	48,525	10	16,534	26	1,034,592	1	88	10,872	83	18	11,062	**1,045,654**
Monmouth	973	1,565	1,427	0	884	20,856	885,848	1,172	27,408	612	2,228	1,133	3,235	1,121	948,463	0	0	2,253	0	4,747	7,001	**955,463**
	131	1,503	682	1	4,838	20,828	880,875	753	30,160	409	1,756	1	3,595	0	945,533	0	0	3,944	0	804	4,748	**950,281**
Morris	4,217	15,736	608	66	60	688	356	597,681	174	11,846	10,750	8,109	20,711	1,544	672,546	0	310	236	800	0	1,346	**673,891**
	4,142	16,697	871	1,220	46	840	324	588,021	10	15,147	11,358	8,109	22,558	3,536	672,879	29	102	341	30	0	502	**673,381**
Ocean	0	3,934	5,719	0	877	9,377	54,140	295	675,599	0	186	0	1,214	0	751,340	0	1,149	0	0	564	1,713	**753,053**
	1	256	219	7	862	3,553	54,271	345	690,061	6	163	0	208	0	749,952	0	0	8	0	378	386	**750,339**
Passaic	66,042	31,605	3,012	290	0	0	0	10,635	0	509,960	1,371	2,500	799	0	626,214	0	0	7,489	337	0	7,826	**634,041**
	65,512	33,900	2,857	150	4	66	1	10,265	0	508,062	1,321	2,644	856	1	625,640	68	2	7,791	83	0	7,943	**633,583**
Somerset	275	6,379	1,044	4,563	6,688	25,048	1,654	15,021	0	0	305,154	0	11,753	136	377,716	0	0	2,746	0	0	2,746	**380,461**
	240	6,383	870	4,403	7,703	28,654	1,441	14,012	2	75	302,113	4	11,970	140	378,010	0	0	1,642	0	0	1,642	**379,652**
Sussex	3,385	1,001	278	0	0	0	276	27,227	0	1,726	0	138,793	69	230	172,985	0	0	840	0	135	974	**173,959**
	1,649	691	114	7	2	5	69	27,851	0	1,632	31	145,494	40	369	177,951	2	0	449	0	39	491	**178,442**
Union	717	50,059	34,181	0	0	23,004	231	11,051	604	330	8,575	0	590,834	0	719,587	0	0	10,500	1,851	336	12,687	**732,274**
	743	50,708	31,099	24	8	30,415	275	10,347	73	579	7,797	2	590,983	1	723,054	2	0	9,398	44	280	9,723	**732,777**
Warren	2,760	726	0	5,581	0	698	0	9,867	0	679	649	4,423	0	110,287	135,671	0	0	350	0	0	350	**136,020**
	654	553	5	6,165	26	799	5	10,244	1	577	734	4,691	14	114,667	139,135	2	1	595	0	1	599	**139,733**
NJTPA+Mercer	1,421,253	830,533	373,078	133,743	401,235	989,610	984,793	708,514	713,579	591,899	396,866	155,828	695,741	115,537	8,512,209	6,656	7,229	124,661	13,555	6,129	158,231	**8,670,440**
	1,401,491	841,489	371,264	125,651	388,142	1,007,235	971,972	696,084	725,255	592,809	390,983	161,018	700,804	120,498	8,494,695	6,147	1,969	135,726	2,115	1,718	147,675	**8,642,370**
Bronx	2,928	0	0	0	0	2,477	234	0	0	6,987	0	0	0	0	12,626							**12,626**
	3,391	1	25	0	0	60	29	1	0	3,743	0	0	0	0	7,251							**7,251**
Kings	0	3,757	2,910	0	0	821	188	0	0	0	0	0	721	0	8,398							**8,398**
	45	1,573	7,928	0	0	167	207	4	0	6	1	0	746	0	10,676							**10,676**
Manhattan	8,681	1,667	901	0	415	0	0	490	0	0	0	0	390	1,137	13,681							**13,681**
	8,731	1,386	929	0	3	0	0	256	0	12	0	0	755	0	12,072							**12,072**
Queens	1,992	1,166	339	0	0	7,933	0	0	0	0	0	0	417	0	11,847							**11,847**
	2,666	1,894	896	0	0	3,010	0	8	0	25	0	0	284	0	8,783							**8,783**
Richmond	697	4,097	1,496	0	0	5,789	3,261	0	701	0	0	0	270	0	16,312							**16,312**
	1,204	10,313	6,066	3	77	12,783	9,386	259	1,337	260	392	0	14,376	0	56,456							**56,456**
New York City	14,298	10,687	5,646	0	415	17,020	3,684	490	701	6,987	0	0	1,798	1,137	62,863							**62,863**
	16,037	15,167	15,843	3	80	16,020	9,622	529	1,337	4,046	393	0	16,161	0	95,238							**95,238**
TOTAL	**1,435,551**	**841,220**	**378,723**	**133,743**	**401,650**	**1,006,629**	**988,477**	**709,004**	**714,280**	**598,886**	**396,866**	**155,828**	**697,540**	**116,674**	**8,575,072**	**6,656**	**7,229**	**124,661**	**13,555**	**6,129**	**158,231**	**8,733,302**
ATTRACTION	**1,417,528**	**856,656**	**387,107**	**125,655**	**388,222**	**1,023,255**	**981,594**	**696,612**	**726,592**	**596,854**	**391,376**	**161,018**	**716,964**	**120,498**	**8,589,933**	**6,147**	**1,969**	**135,726**	**2,115**	**1,718**	**147,675**	**8,737,608**

TEXT	Observed
TEXT	Estimated

Work-Based-Other County-to-County Comparison

REGION	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	NJTPA+Mercer	Bronx	Kings	Manhattan	Queens	Richmond	New York City	TOTAL
Bergen	108,117	7,506	7,620	0	0	1,080	160	1,067	0	8,153	0	124	1,256	134	135,218	77	695	854	84	0	1,710	136,927
	103,922	7,025	8,180	0	0	993	131	1,014	0	8,193	1	112	1,316	14	130,902	57	1,250	1,111	128	1	2,547	133,449
Essex	5,686	64,875	6,814	0	319	4,248	0	11,191	0	10,384	0	2,391	9,949	723	116,580	0	280	4,698	0	0	4,978	121,559
	5,512	65,303	7,633	2	15	4,658	4	11,430	0	10,889	19	1,377	8,496	36	115,375	1	921	3,025	0	12	3,959	119,333
Hudson	3,973	3,012	41,382	0	1,738	707	251	111	1,416	1,147	1,487	0	618	0	55,842	1,595	40	9,728	192	0	11,555	67,396
	3,689	2,672	40,357	0	0	634	222	183	0	1,114	233	2	563	0	49,669	1,053	82	11,577	245	20	12,977	62,646
Hunterdon	0	0	136	5,575	0	0	0	209	0	84	2,730	0	96	286	9,115	0	0	0	0	0	0	9,115
	0	5	53	5,555	10	12	0	197	0	38	2,016	2	94	276	8,259	0	0	0	0	0	0	8,259
Mercer	0	0	0	54	48,796	2,707	230	0	1,214	0	679	0	0	0	53,680	0	0	2,228	0	0	2,228	55,909
	0	4	1	109	48,078	2,811	451	6	1,198	0	704	0	1	0	53,364	0	0	0	0	1	1	53,365
Middlesex	98	235	734	144	5,737	89,732	1,528	305	2,278	1,053	7,002	0	7,733	0	116,579	0	1,654	1,244	0	0	2,897	119,476
	83	942	739	136	5,423	91,384	1,518	432	1,129	957	6,927	4	7,507	1	117,183	0	705	755	0	241	1,701	118,884
Monmouth	40	40	0	0	229	1,353	106,200	158	9,299	0	0	0	180	0	117,499	0	0	0	0	0	0	117,499
	28	85	11	1	219	1,323	105,503	130	9,020	1	14	0	174	0	116,506	0	0	0	0	36	36	116,543
Morris	5,439	10,600	39	392	0	1,380	1,056	68,019	84	7,315	1,860	721	2,621	1,504	101,030	2,240	0	1,038	0	0	3,279	104,308
	5,024	10,734	167	412	0	1,515	367	68,411	0	7,340	2,000	715	2,731	1,422	100,837	293	1	772	0	1	1,067	101,904
Ocean	139	0	0	0	1,103	3,199	6,199	0	58,704	0	0	0	0	0	69,344	0	0	184	0	0	184	69,528
	72	3	1	0	1,052	3,233	6,526	1	59,479	0	0	0	1	0	70,368	0	0	0	0	2	2	70,371
Passaic	9,684	12,783	167	84	0	351	0	7,018	0	24,941	52	0	133	0	55,214	0	385	88	837	0	1,310	56,524
	9,295	12,522	181	17	0	315	0	6,741	0	24,622	52	11	133	0	53,890	1	427	140	43	0	611	54,501
Somerset	0	202	0	1,251	1,346	6,249	58	2,018	782	194	43,427	87	914	442	56,970	0	0	0	0	0	0	56,970
	48	856	86	1,246	1,306	6,347	94	2,857	79	181	44,195	82	895	446	58,719	0	0	0	0	18	18	58,737
Sussex	0	1,288	0	0	0	0	0	3,246	0	0	545	19,043	0	0	24,121	0	0	0	0	0	0	24,121
	3	1,087	1	0	0	0	0	3,244	0	12	56	19,343	0	8	23,754	0	0	0	0	0	0	23,754
Union	267	5,667	461	65	275	5,167	355	2,276	776	177	2,798	0	48,334	0	66,618	0	105	1,473	0	0	1,578	68,195
	401	5,855	1,422	68	258	5,463	405	2,650	151	220	2,937	25	48,737	1	68,591	1	304	1,900	1	289	2,494	71,086
Warren	0	723	0	255	0	0	0	980	0	0	0	0	0	4,363	6,322	0	0	0	0	0	0	6,322
	0	492	0	281	0	2	0	1,008	0	1	11	150	0	4,401	6,346	0	0	0	0	0	0	6,346
NJTPA+Mercer	133,444	106,931	57,352	7,821	59,544	116,173	116,036	96,598	74,553	53,450	60,578	22,366	71,833	7,452	984,132	3,912	3,159	21,535	1,113	0	29,718	1,013,850
	128,077	107,587	58,831	7,826	56,360	118,690	115,222	98,304	71,056	53,567	59,165	21,824	70,648	6,605	973,765	1,405	3,691	19,279	417	622	25,413	999,178
Bronx	436	0	0	0	0	0	0	0	0	0	0	0	0	0	436							436
	413	7	19	0	0	0	0	4	0	8	0	0	0	0	450							450
Kings	188	0	0	0	0	2,642	0	282	0	0	0	0	0	0	3,112							3,112
	380	7	40	0	0	0	0	431	0	1	0	0	0	0	860							860
Manhattan	1,154	3,528	1,354	0	433	617	558	1,821	0	0	0	152	1,910	0	11,528							11,528
	1,557	5,626	2,587	0	0	0	0	1,730	0	1	0	0	448	0	11,948							11,948
Queens	0	3,027	0	0	0	0	0	0	0	0	0	0	0	0	3,027							3,027
	19	3,997	156	0	0	1	0	2	0	3	0	0	1	0	4,178							4,178
Richmond	0	1,425	214	0	0	0	123	0	0	0	0	0	183	0	1,946							1,946
	0	1,479	443	0	0	41	160	1	0	0	0	0	217	0	2,341							2,341
New York City	1,778	7,979	1,569	0	433	3,258	681	2,103	0	0	0	152	2,093	0	20,048							20,048
	2,370	11,116	3,244	0	0	42	160	2,167	0	13	0	0	665	0	19,777							19,777
TOTAL	135,222	114,910	58,921	7,821	59,978	119,432	116,717	98,702	74,553	53,450	60,578	22,518	73,927	7,452	1,004,180	3,912	3,159	21,535	1,113	0	29,718	1,033,898
ATTRACTION	130,447	118,703	62,075	7,826	56,360	118,732	115,383	100,471	71,056	53,580	59,165	21,824	71,313	6,605	993,542	1,405	3,691	19,279	417	622	25,413	1,018,956

TEXT	Observed
TEXT	Estimated

Non-Home-Non_Work County-to-County Comparison

REGION	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	NJTPA+Mercer	Bronx	Kings	Manhattan	Queens	Richmond	New York City	TOTAL
Bergen	666,495	5,151	11,944	0	0	54	269	4,040	220	25,040	290	0	312	0	713,815	4,540	0	8,586	107	0	13,233	727,047
	668,464	14,686	11,322	0	0	55	76	4,139	0	25,923	309	5	383	1	725,363	3,670	66	6,689	152	2	10,579	735,942
Essex	13,598	315,961	8,616	130	116	2,505	316	20,931	0	27,246	2,747	1,168	48,616	0	441,950	115	182	4,384	0	226	4,907	446,857
	12,640	305,692	7,571	78	0	2,428	332	20,506	0	26,028	1,212	124	43,423	0	420,034	80	271	2,811	0	217	3,379	423,413
Hudson	8,663	7,928	160,988	0	0	687	0	325	601	2,409	581	0	1,366	0	183,548	0	2,103	8,243	0	900	11,246	194,794
	9,122	13,822	156,915	0	0	642	0	358	0	2,579	354	0	1,516	0	185,308	20	4,849	6,553	27	1,613	13,062	198,370
Hunterdon	0	7,334	0	45,170	794	164	0	658	0	0	1,368	0	0	1,415	56,903	0	0	0	0	0	0	56,903
	0	2,692	0	46,080	832	176	1	665	0	1	1,461	5	68	1,501	53,484	0	0	0	0	0	0	53,484
Mercer	0	0	0	162	239,856	7,083	2,480	0	607	3,089	1,556	0	960	0	255,793	0	0	0	0	0	0	255,793
	0	1	0	490	234,812	7,358	2,563	1	663	1	1,620	0	463	0	247,971	0	0	0	0	0	0	247,971
Middlesex	1,579	640	476	0	8,359	402,605	11,890	1,453	1,094	0	20,910	163	6,153	0	455,320	950	108	2,197	0	1,476	4,731	460,051
	1,331	4,571	371	166	8,037	405,720	11,427	1,337	1,065	74	20,315	20	11,238	3	465,674	30	31	308	0	1,405	1,774	467,448
Monmouth	0	262	0	0	3,281	17,118	514,961	0	18,707	488	658	0	1,534	0	557,008	0	960	814	0	3,216	4,990	561,998
	1	241	0	1	3,208	16,697	518,518	9	22,802	184	491	0	1,642	0	563,795	0	3	68	0	3,196	3,266	567,061
Morris	6,522	19,441	0	281	0	56	1,131	329,135	0	19,820	4,030	5,752	4,597	3,569	394,333	0	0	0	0	0	0	394,333
	5,962	20,392	139	412	0	469	599	329,454	0	19,405	4,193	6,154	4,819	3,586	395,585	2	0	3	0	3	7	395,592
Ocean	0	207	213	0	2,591	551	29,121	106	412,258	0	0	0	0	0	445,047	0	0	0	0	0	0	445,047
	0	6	0	0	2,307	566	29,558	0	416,492	0	0	0	0	0	448,929	0	0	0	0	0	0	448,929
Passaic	27,276	20,393	2,509	289	0	0	0	18,229	0	327,468	0	613	123	0	396,900	0	0	0	0	0	0	396,900
	27,023	24,607	2,217	119	0	61	2	18,276	0	328,484	27	759	517	3	402,093	32	5	102	1	0	139	402,232
Somerset	151	1,504	0	3,022	7,002	12,568	1,567	5,593	0	0	152,746	485	7,982	0	192,621	0	0	149	0	0	149	192,771
	136	3,969	29	3,891	6,940	13,924	1,360	5,629	2	119	152,744	489	7,782	108	197,121	0	0	84	0	25	109	197,230
Sussex	590	0	0	521	0	163	0	6,099	0	0	0	62,564	0	224	70,160	0	0	0	0	134	134	70,295
	610	240	0	532	0	53	0	6,224	0	201	7	64,000	12	393	72,274	0	0	0	0	6	6	72,280
Union	129	13,399	3,981	2,253	0	16,015	87	4,857	0	941	16,216	0	266,055	0	323,934	0	108	716	1,848	2,801	5,474	329,408
	546	26,231	3,035	1,520	1	15,804	401	4,777	1	935	16,108	2	262,228	1	331,590	0	73	395	94	3,601	4,163	335,753
Warren	0	0	0	453	0	288	0	3,664	0	0	0	546	0	44,630	49,581	0	0	0	0	0	0	49,581
	1	20	0	752	0	128	0	3,808	0	2	24	631	2	44,438	49,805	0	0	0	0	0	0	49,805
NJTPA+Mercer	725,003	392,219	188,727	52,281	261,999	459,855	561,823	395,092	433,487	406,500	201,100	71,291	337,697	49,838	4,536,913	5,604	3,461	25,089	1,955	8,754	44,864	4,581,777
	725,837	417,170	181,598	54,040	256,138	464,080	564,836	395,182	441,026	403,936	198,865	72,190	334,092	50,035	4,559,026	3,833	5,298	17,011	275	10,069	36,486	4,595,511
Bronx	1,693	0	0	0	0	951	0	0	0	0	0	158	0	0	2,802							2,802
	2,001	15	7	0	0	16	0	1	0	17	0	3	0	0	2,061							2,061
Kings	306	0	3,179	0	0	3,793	961	0	0	0	0	0	0	0	8,238							8,238
	344	22	4,831	0	0	13	0	0	0	2	0	0	1	0	5,214							5,214
Manhattan	7,389	3,142	7,987	0	0	580	4,702	1,172	129	1,093	108	0	72	0	26,375							26,375
	9,241	4,593	10,060	0	0	64	12	1,188	0	1,387	17	0	210	0	26,774							26,774
Queens	0	0	0	0	0	0	1,077	0	0	0	0	0	0	0	1,077							1,077
	3	8	14	0	0	0	0	0	0	1	0	0	0	0	26							26
Richmond	0	0	1,477	0	0	6,212	1,547	0	377	0	0	0	2,536	0	12,150							12,150
	0	40	1,825	0	0	5,785	1,553	0	57	0	0	0	3,031	0	12,291							12,291
New York City	9,388	3,142	12,643	0	0	11,536	8,288	1,172	506	1,093	108	158	2,608	0	50,642							50,642
	11,590	4,678	16,738	0	0	5,879	1,565	1,190	57	1,407	18	3	3,242	0	46,366							46,366
TOTAL	734,391	395,361	201,370	52,281	261,999	471,391	570,110	396,264	433,993	407,593	201,209	71,449	340,305	49,838	4,587,555	5,604	3,461	25,089	1,955	8,754	44,864	4,632,419
ATTRACTION	737,427	421,848	198,336	54,040	256,138	469,958	566,401	396,372	441,083	405,344	198,883	72,193	337,334	50,035	4,605,392	3,833	5,298	17,011	275	10,069	36,486	4,641,878

TEXT	Observed
TEXT	Estimated

All HBW County-to-County Comparison with Adjusted Observed Data for NJTPA, Mercer, and NYC

	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	NJTPA+Mercer	Bronx	Kings	Manhattan	Queens	Richmond	New York City	TOTAL
Bergen	388,013	36,276	36,824	9,118	811	11,641	1,095	10,988	139	44,275	8,562	767	11,553	978	561,039	23,054	10,578	88,726	1,439	1,045	124,843	685,882
	390,876	37,768	35,912	797	0	10,656	1,049	11,264	41	42,783	3,384	864	12,441	67	547,902	25,807	9,405	110,638	680	1,186	147,715	695,617
Essex	23,504	224,267	22,165	5,192	363	5,125	533	50,164	223	21,288	10,169	0	23,812	0	386,807	1,929	980	54,917	923	1,971	60,721	447,527
	23,939	226,803	21,683	758	43	5,387	1,406	50,788	248	21,148	8,826	61	23,678	0	384,766	1,273	1,306	64,286	948	2,680	70,492	455,258
Hudson	41,874	21,874	153,255	0	1,619	10,470	691	12,005	0	7,991	4,510	121	6,875	0	261,285	4,588	6,854	107,412	5,761	305	124,919	386,204
	41,325	24,617	161,732	1	7	9,476	561	11,567	2	7,764	4,098	134	7,337	0	268,622	3,490	4,948	114,169	4,489	1,438	128,533	397,155
Hunterdon	85	1,236	1,900	31,013	3,694	7,400	178	3,054	699	138	14,428	0	2,908	968	67,702	0	0	2,242	119	0	2,361	70,063
	150	1,309	1,691	31,371	3,853	7,624	227	3,318	530	194	15,532	23	3,375	1,080	70,279	0	0	1,861	19	16	1,896	72,175
Mercer	0	0	1,295	259	184,741	22,449	2,739	2,653	3,536	0	4,471	0	832	0	222,975	0	0	11,386	0	0	11,386	234,361
	34	1,099	1,258	836	175,579	24,732	7,262	2,976	3,981	18	6,627	0	2,349	0	226,753	0	1	10,818	2	208	11,029	237,782
Middlesex	8,131	19,795	8,893	574	32,074	322,949	14,070	10,335	9,294	5,862	49,666	0	37,913	615	520,171	6,722	10,937	53,668	526	4,687	76,540	596,711
	9,592	19,366	10,585	755	28,007	326,260	18,459	11,118	9,410	5,166	51,544	4	43,911	130	534,307	2,344	3,405	58,044	781	6,433	71,006	605,312
Monmouth	5,727	17,179	13,838	323	5,938	31,399	233,941	5,780	24,886	1,030	14,210	0	9,080	0	363,330	41	3,321	38,802	1,973	2,865	47,002	410,332
	6,442	15,005	13,992	210	5,862	31,656	240,323	5,107	24,850	949	12,702	0	11,072	0	368,170	39	886	42,923	553	4,007	48,407	416,577
Morris	13,194	37,699	1,913	4,904	396	3,007	0	182,903	0	32,674	18,894	7,782	15,574	3,896	322,835	5,226	1,893	15,759	0	587	23,465	346,301
	13,472	39,963	3,423	4,697	157	3,155	148	184,342	1	33,333	19,407	9,068	17,490	2,223	330,879	2,702	1,630	16,149	3	753	21,237	352,115
Ocean	1,818	5,314	3,064	50	13,927	10,346	69,503	1,159	223,708	200	2,920	0	2,088	0	334,097	523	915	9,382	0	2,663	13,483	347,579
	365	5,138	1,777	67	9,368	10,344	71,448	411	223,681	166	3,022	0	2,886	0	328,673	9	204	10,683	0	3,645	14,541	343,214
Passaic	57,644	32,697	17,069	356	0	312	1,444	32,658	0	138,823	3,508	799	2,982	0	288,292	970	3,791	14,039	732	0	19,532	307,824
	57,775	34,288	17,304	170	0	614	1,532	31,923	3	141,664	3,436	925	3,124	0	292,757	949	2,752	16,188	285	64	20,237	312,994
Somerset	3,749	15,257	8,411	13,749	15,864	29,364	1,620	12,706	0	1,754	112,369	0	14,780	0	229,623	0	572	8,301	2,288	4,369	15,529	245,152
	4,131	16,179	8,674	12,862	12,690	31,179	1,774	13,913	97	1,889	113,836	34	17,326	8	234,592	1	118	6,360	282	5,186	11,948	246,540
Sussex	10,984	8,600	5,727	0	1,706	1,047	0	23,614	0	12,103	2,904	45,488	2,410	2,882	117,464	615	390	304	0	0	1,309	118,773
	12,430	9,640	3,720	6	0	911	0	24,949	0	11,616	2,219	43,833	3,029	2,179	114,533	467	45	340	0	0	852	115,385
Union	5,776	39,611	39,690	504	1,586	41,143	207	24,414	0	10,224	19,513	0	175,863	1,133	359,664	2,219	8,085	35,390	0	4,303	49,997	409,661
	7,072	41,514	44,563	627	664	42,006	2,560	25,384	125	10,554	21,101	11	170,910	61	367,152	1,535	5,477	34,055	15	6,553	47,635	414,787
Warren	717	759	0	8,204	242	268	303	12,203	0	1,871	6,149	2,659	1,333	22,204	56,913	0	0	1,551	0	0	1,551	58,465
	863	1,491	257	9,229	304	1,529	258	13,615	0	1,988	6,558	3,372	1,545	22,240	63,251	1	1	953	0	11	965	64,216
NJTPA+Mercer	561,214	460,563	314,045	74,246	262,961	496,920	326,325	384,638	262,485	278,232	272,274	57,616	308,002	32,676	4,092,197	45,886	48,316	441,880	13,761	22,795	572,638	4,664,834
	568,466	474,181	326,572	62,389	236,534	505,527	347,006	390,675	262,969	279,231	272,291	58,331	320,475	27,989	4,132,634	38,616	30,178	487,465	8,056	32,179	596,493	4,729,127
Bronx	3,228	115	1,055	0	0	0	0	0	0	0	0	0	221	0	4,619							4,619
	2,693	328	890	0	0	12	2	65	0	515	2	0	240	0	4,748							4,748
Kings	9,038	9,673	11,940	537	0	748	5,073	3,092	1,078	0	0	0	11,497	118	52,794							52,794
	17,317	14,215	12,314	0	0	387	1,297	489	181	33	0	0	6,036	0	52,269							52,269
Manhattan	9,879	3,153	9,288	3,829	3,505	6,042	642	1,060	224	469	0	0	359	0	38,450							38,450
	8,398	1,956	6,493	0	0	1,724	23	662	0	391	0	0	347	0	19,994							19,994
Queens	4,037	4,724	3,627	0	0	1,151	3,900	1,139	0	849	0	0	1,768	0	21,194							21,194
	2,063	1,482	3,684	0	0	31	2	55	0	448	0	0	192	0	7,957							7,957
Richmond	1,284	2,599	5,581	0	0	592	829	4,344	2,326	955	1,738	0	2,477	0	22,726							22,726
	873	1,658	4,100	2	0	2,456	771	3,544	1,701	540	1,119	0	3,245	0	20,009							20,009
New York City	27,466	20,265	31,492	4,365	3,505	8,533	10,444	9,636	3,628	2,272	1,738	0	16,321	118	139,784							139,784
	31,343	19,639	27,481	2	0	4,611	2,096	4,815	1,882	1,927	1,122	0	10,060	0	104,976							104,976
TOTAL	588,680	480,828	345,537	78,611	266,466	505,453	336,769	394,274	266,113	280,505	274,012	57,616	324,323	32,794	4,231,981	45,886	48,316	441,880	13,761	22,795	572,638	4,804,618
ATTRACTION	599,809	493,820	354,052	62,391	236,534	510,138	349,101	395,489	264,850	281,158	273,412	58,332	330,535	27,989	4,237,611	38,616	30,178	487,465	8,056	32,179	596,493	4,834,104

TEXT	Observed
TEXT	Estimated

All Non-HBW County-to-County Comparison with Adjusted Observed Data for NJTPA, Mercer, and NYC

	Bergen	Essex	Hudson	Hunterdon	Mercer	Middlesex	Monmouth	Morris	Ocean	Passaic	Somerset	Sussex	Union	Warren	NJTPA+Mercer	Bronx	Kings	Manhattan	Queens	Richmond	New York City	TOTAL
Bergen	2,407,402	39,507	39,215	0	333	1,487	6,006	7,075	220	96,922	580	282	7,028	134	2,606,191	12,456	3,448	45,869	2,986	229	64,988	2,671,179
	2,389,229	50,210	43,821	0	4	1,404	246	7,332	0	98,841	614	206	8,128	16	2,600,051	10,655	3,875	48,109	694	2	63,335	2,663,386
Essex	47,902	1,182,940	31,120	7,453	3,645	8,564	2,576	73,421	0	89,790	3,988	3,559	103,464	928	1,559,351	471	584	38,274	2,506	226	42,061	1,601,412
	44,825	1,183,690	35,656	374	65	9,254	1,874	72,246	0	86,673	2,664	1,540	99,337	250	1,538,447	401	1,356	34,402	322	229	36,710	1,575,157
Hudson	52,946	28,886	584,631	0	2,222	3,667	1,211	1,990	3,836	10,532	5,192	0	5,722	0	700,835	1,799	3,082	63,791	2,898	1,018	72,588	773,422
	53,098	35,064	580,849	1	88	2,173	297	2,094	13	10,161	1,067	2	5,915	0	690,820	1,263	5,939	70,258	1,597	1,833	80,890	771,710
Hunterdon	0	8,021	549	191,892	1,732	1,868	229	2,173	506	84	17,976	0	5,110	5,350	235,489	0	0	1,481	0	0	1,481	236,970
	2	3,384	245	190,071	2,142	1,995	192	2,471	23	50	18,120	37	5,530	5,467	229,728	0	0	2,010	0	0	2,011	231,739
Mercer	0	283	156	2,341	767,538	26,951	7,434	0	8,562	3,089	7,829	0	1,568	0	825,750	0	2,203	4,956	258	0	7,417	833,168
	0	15	4	2,697	744,804	30,519	10,108	7	6,526	1	10,658	0	962	0	806,302	0	0	544	3	1	548	806,851
Middlesex	7,289	9,510	2,659	2,397	52,935	1,600,334	55,311	3,795	4,100	1,972	93,767	1,033	32,224	499	1,867,826	950	5,872	17,899	2,808	1,476	29,006	1,896,832
	3,648	13,817	2,487	2,354	51,680	1,621,505	54,751	3,644	2,916	1,822	92,382	33	39,859	30	1,890,928	31	824	12,613	83	1,675	15,226	1,906,153
Monmouth	1,013	1,867	1,427	0	7,375	41,966	1,745,793	1,331	60,449	1,100	2,885	1,133	5,193	1,121	1,872,653	0	960	3,067	0	8,220	12,247	1,884,901
	160	1,836	692	3	11,250	42,282	1,743,236	892	66,951	594	2,281	1	5,685	0	1,875,862	0	3	4,014	0	4,253	8,270	1,884,132
Morris	18,449	47,704	647	883	261	2,886	2,543	1,126,391	258	44,261	19,567	16,169	30,773	7,668	1,318,460	2,240	310	1,400	800	0	4,750	1,323,210
	17,222	51,276	1,367	2,188	47	3,588	1,291	1,114,874	10	47,529	20,679	17,136	33,274	9,574	1,320,057	325	103	1,314	30	4	1,776	1,321,832
Ocean	139	4,141	5,932	0	5,351	13,127	101,572	543	1,368,396	0	186	0	1,465	0	1,500,851	0	1,149	184	0	564	1,896	1,502,747
	73	266	219	8	5,060	7,376	103,083	346	1,387,801	6	165	0	217	0	1,504,622	0	0	8	0	380	389	1,505,010
Passaic	132,638	69,901	7,550	663	0	351	0	50,642	0	1,002,591	1,423	3,113	1,393	0	1,270,266	0	385	7,577	1,444	0	9,406	1,279,672
	129,630	76,326	7,347	286	4	445	3	49,496	0	1,002,257	1,405	3,619	1,883	5	1,272,706	108	435	8,040	129	1	8,713	1,281,419
Somerset	426	8,085	1,423	8,836	16,216	45,758	3,279	23,746	782	194	601,341	572	22,340	577	733,577	0	0	3,120	0	0	3,120	736,697
	431	11,570	1,389	9,696	17,125	52,506	2,919	23,623	83	387	596,732	579	22,449	702	740,192	0	0	1,765	0	43	1,808	742,000
Sussex	3,974	2,289	381	521	0	163	276	44,239	0	3,068	545	251,336	69	856	307,715	0	0	840	0	269	1,109	308,824
	2,262	2,021	124	539	2	59	69	45,328	0	2,916	95	260,604	52	1,210	315,281	2	0	449	0	45	497	315,778
Union	1,411	75,186	38,924	2,497	275	56,973	673	22,497	1,381	2,451	38,438	0	1,013,071	0	1,253,777	0	212	13,720	3,699	3,138	20,769	1,274,545
	1,978	89,047	35,854	1,749	267	64,675	1,171	21,930	225	2,758	37,538	30	1,010,120	3	1,267,347	2	378	12,028	138	4,171	16,717	1,284,064
Warren	2,760	1,449	0	7,809	0	985	0	19,187	0	679	649	6,000	0	195,725	235,244	0	0	350	0	0	350	235,594
	655	1,066	5	8,955	27	929	5	19,994	1	580	811	6,789	16	199,977	239,809	2	1	596	0	1	599	240,408
NJTPA+Mercer	2,676,350	1,479,769	714,614	225,292	857,883	1,805,081	1,926,901	1,377,030	1,448,489	1,256,735	794,367	283,197	1,229,418	212,858	16,287,985	17,917	18,205	202,526	17,399	15,139	271,187	16,559,172
	2,643,212	1,519,588	710,058	218,923	832,565	1,838,709	1,919,245	1,364,278	1,464,549	1,254,576	785,210	290,575	1,233,428	217,235	16,292,151	12,790	12,914	196,149	2,996	12,639	237,488	16,529,639
Bronx	5,229	0	0	0	0	3,428	234	0	0	6,987	0	158	0	0	16,036							16,036
	5,952	23	50	0	0	76	29	7	0	3,764	0	3	0	0	9,905							9,905
Kings	494	3,757	6,990	0	0	7,255	1,149	282	0	0	0	0	721	0	20,649							20,649
	769	1,599	12,782	0	0	180	207	436	0	9	1	0	746	0	16,729							16,729
Manhattan	19,311	8,337	10,441	0	848	1,197	5,260	3,484	129	1,093	108	152	2,372	1,137	53,869							53,869
	24,251	11,589	14,180	0	3	64	12	3,173	0	1,400	17	0	1,411	0	56,100							56,100
Queens	2,366	4,192	339	0	0	7,933	2,545	0	0	0	0	0	417	0	17,792							17,792
	2,688	5,896	1,058	0	0	3,011	0	10	0	28	0	0	284	0	12,976							12,976
Richmond	697	5,523	3,187	0	0	13,586	4,932	0	1,078	0	0	0	2,989	0	31,992							31,992
	1,205	11,835	8,329	3	77	20,074	11,100	260	1,394	260	393	0	17,632	0	72,562							72,562
New York City	28,096	21,809	20,958	0	848	33,399	14,120	3,766	1,207	8,080	108	310	6,499	1,137	140,338							140,338
	34,865	30,943	36,400	4	80	23,405	11,349	3,885	1,394	5,461	411	3	20,073	0	168,272							168,272
TOTAL	2,704,447	1,501,578	735,572	225,292	858,731	1,838,479	1,941,021	1,380,796	1,449,697	1,264,814	794,476	283,507	1,235,918	213,996	16,428,323	17,917	18,205	202,526	17,399	15,139	271,187	16,699,510
ATTRACTION	2,678,078	1,550,530	746,458	218,926	832,645	1,862,114	1,930,594	1,368,162	1,465,944	1,260,037	785,621	290,578	1,253,501	217,235	16,460,424	12,790	12,914	196,149	2,996	12,639	237,488	16,697,911

TEXT	Observed
TEXT	Estimated

APPENDIX J – CONSTANTS-EXPRESSED AT NEST LEVEL OF APPLICATION

1. From Everywhere (except Staten Island) to Manhattan

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	2.88739	3.13620	1.67808	2.94974	7.68656	7.90375	6.09863	7.64087	4.13200	5.32317	4.61332	5.66382
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-0.77007	-2.13753	-3.18114	-3.80638	-3.02093	-2.34052	-1.76945	-2.70615	-0.66500	-1.27021	-0.62376	-1.35171
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	4.93698	2.62688	6.99367	3.47112	3.63726	-3.48318	1.31981	-4.09306	-8.88108	-7.72020	-10.68170	-8.68310
WK-BUS	3.74709	4.61803	2.06145	2.14523	3.05455	-6.88441	-1.88482	-5.71107	-2.77714	-6.75685	-6.62568	-10.37791
WK-FERRY	19.77449	18.71363	14.01282	14.46680	17.53849	35.02491	6.79732	16.88561	14.77946	10.21908	24.26004	20.39109
WK-LRT	1.87577	1.24868	3.08727	1.17869	1.43497	0.28678	-1.25953	-5.74971	3.93037	-3.48301	2.22230	-6.76961
WK-LNGFRY	2.47766	7.72426	-2.39123	6.75149	21.97721	11.09655	11.13792	5.14019	16.74193	-4.33817	14.18417	-3.45046
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	7.70010	4.27825	12.91752	7.43464	4.06343	0.09682	3.12804	-1.48280	-5.91509	-5.00892	-7.22518	-5.67265
DR-BUS	4.81209	6.98456	7.59376	8.24983	1.72405	-1.34676	0.09649	-1.97205	-0.44643	-2.64994	-5.35432	-7.11017
DR-FERRY	-1.39688	-2.32355	4.88588	1.87702	7.95218	-6.27478	-5.07524	-11.28444	-1.24640	-9.80246	-4.66022	-12.35452
DR-LRT	1.02118	-1.12285	6.28812	1.81246	2.42864	-0.61812	-3.42707	-6.08547	-7.46654	-6.67559	-9.34991	-8.55374
DR-LNGFRY	-2.32057	2.38885	1.76705	4.06447	19.03387	-2.25052	5.08735	5.54506	9.55068	-2.74284	0.20667	-3.82787
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-1.37971	-1.96169	-1.65095	-2.19972	-0.77006	0.67520	0.15710	0.24832	-0.21166	-0.59403	-0.17893	-0.56029
SR3	-3.32052	-3.28301	-1.83786	-1.75565	-1.00478	-1.12350	-1.10085	-1.36310	-1.87126	-1.13673	-1.82655	-1.09177
SR4	-3.16549	-4.23776	-4.02127	-5.04436	-3.44992	0.86337	-1.82418	-0.86665	-1.24882	-1.15573	-1.19973	-1.10513

2. From Everywhere (except Staten Island and Manhattan) to Newark Super CBD

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	1.71069	3.15071	1.38791	2.66670	1.93766	4.66217	6.28843	7.95276	2.85482	3.11634	2.62884	3.23819
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-0.98740	-5.40607	-0.59116	-4.40803	-5.74224	-9.29161	-3.33865	-7.58437	-3.30713	-3.40553	-4.36319	-4.58205
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	5.75313	-2.09521	8.98289	1.73079	0.00002	1.59907	19.99231	7.01744	-4.94043	-7.02595	-4.96246	-8.21177
WK-BUS	0.86376	-4.57249	6.64892	2.29899	2.85540	-2.37806	-2.04816	-12.64417	1.40385	-2.08067	0.32445	-4.49277
WK-FERRY	1.08254	-4.20676	3.84147	1.31451	0.00002	-2.39445	4.91737	-11.17568	-4.94043	-7.02595	-4.96246	-8.21177
WK-LRT	4.00536	-2.66011	7.40681	1.62416	0.00002	-2.39445	4.91737	-11.17568	-4.94043	-7.02595	-4.96246	-8.21177
WK-LNGFRY	1.08254	-4.20676	3.84147	1.31451	0.00002	-2.39445	4.91737	-11.17568	-4.94043	-7.02595	-4.96246	-8.21177
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	-0.95348	-1.38286	0.28100	-0.45841	0.00002	-7.25829	-5.90384	-6.20922	-6.88582	-5.39881	-6.88242	-5.19547
DR-BUS	-3.91635	-5.95971	7.54793	7.52613	0.00002	6.48784	-6.63902	-5.65288	6.66197	1.59670	7.64854	1.72358
DR-FERRY	-6.43354	-8.55073	-0.02603	1.64188	0.00002	-7.25829	-2.37182	-3.04488	-6.88582	-2.11736	-6.88242	-1.30138
DR-LRT	-6.43354	-8.55073	-0.02603	1.64188	0.00002	-7.25829	-1.00522	-1.70874	-6.88582	-2.11736	-6.88242	-1.30138
DR-LNGFRY	-6.43354	-8.55073	-0.02603	1.64188	0.00002	-7.25829	-2.37182	-3.04488	-6.88582	-2.11736	-6.88242	-1.30138
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-1.41027	-1.39214	-1.82980	-1.82151	0.52540	0.51828	1.10330	1.11755	-0.73583	-2.08132	-2.34693	-1.84764
SR3	-3.52741	-3.51764	-4.24233	-4.23576	-0.94603	-0.95100	0.31771	0.32371	-1.38603	-1.80354	-5.92239	-4.48568
SR4	-4.11067	-4.09523	-4.21135	-4.20962	-0.95647	-0.96376	0.30578	0.30944	-0.31971	-1.75355	-5.70904	-5.29139

3. From Everywhere (except Staten Island and Manhattan) to Jersey City/Hoboken Core

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	1.01341	0.67833	18.82039	1.46953	1.93521	2.30021	3.19683	4.76391	1.18088	1.89291	1.34779	1.92708
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-0.44570	-0.30186	-31.90695	-0.59009	-1.25138	-4.71716	-0.58357	-3.45600	0.17055	-1.99493	0.17527	-2.06015
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	10.92915	6.56908	27.57442	10.40317	-1.91988	3.98275	-1.08294	-5.51923	-6.77245	-1.43046	-10.63498	-4.90614
WK-BUS	6.30732	3.83173	20.00898	8.28773	-1.12958	-7.61204	-8.82244	-16.84401	0.46681	-7.11878	-4.54847	-12.31643
WK-FERRY	9.74906	8.55816	27.46520	19.06484	10.27758	0.00002	-1.66979	-1.11609	8.39323	-3.60585	12.66034	-6.53737
WK-LRT	17.03273	15.08311	26.64728	18.10677	8.97651	10.75604	1.08684	-2.26580	7.79658	2.13239	6.46244	0.36059
WK-LNGFRY	10.99522	12.55816	25.16678	19.06484	0.00002	0.00002	-9.38668	-12.71930	-6.77245	-3.60585	-10.63498	-6.53737
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	6.87400	2.80232	8.30582	4.00074	1.40118	0.00002	-4.08638	-4.91363	-0.97427	-3.87471	-4.80309	-7.68548
DR-BUS	6.67197	9.46848	6.49258	9.78572	1.99540	0.00002	-3.32605	0.79795	-0.97427	-3.87471	-4.80309	-7.68548
DR-FERRY	11.40230	7.24961	11.94887	7.53650	4.98796	0.00002	-7.03528	-4.18086	8.00865	-3.87471	0.73218	-7.68548
DR-LRT	6.70285	0.94492	9.57014	1.62345	1.99540	5.69208	-4.19947	-7.40621	-1.39636	-6.29176	-4.69821	-10.03871
DR-LNGFRY	3.92257	7.24961	4.40290	7.53650	1.99540	0.00002	-3.32605	-4.18086	-0.97427	-3.87471	-4.80309	-7.68548
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-1.95100	-2.10062	-1.98000	-2.14823	-0.22957	-0.23020	0.29694	0.32578	-2.53255	-2.07469	-0.15360	-0.10554
SR3	-4.11189	-3.30562	-4.16127	-3.36622	-1.83523	-1.78529	-0.54553	-0.52964	-3.99945	-2.27817	-1.21214	-0.30562
SR4	-3.52115	-3.60134	-3.57432	-3.67282	-1.84795	-1.84321	-0.56436	-0.55082	-4.30957	-3.32491	-1.22394	-1.34978

4. From Everywhere (except Staten Island and Manhattan) to Other CBD's

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	0.89832	3.71640	0.91363	3.98675	2.75061	4.35706	5.55252	6.67703	2.62440	3.21694	2.06114	3.11786
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-2.11538	-5.27398	-2.21537	-5.80272	-8.88594	-12.15159	-4.13359	-5.12210	-3.89473	-4.30223	-3.67145	-4.19427
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	4.89510	6.19619	5.26654	6.58711	0.00002	-3.07960	7.27208	5.35022	0.00002	-0.28245	0.00002	-2.43178
WK-BUS	3.56495	-5.76507	3.58913	-6.76539	3.29760	-1.20087	-0.41272	-7.58173	7.37440	3.48914	4.89178	0.32391
WK-FERRY	3.33397	-4.71302	3.34089	-5.20656	0.00002	-3.07960	0.25998	-8.65652	0.00002	-0.28245	0.00002	-2.43178
WK-LRT	6.77390	5.63347	6.80995	5.99203	0.00002	25.19345	9.27404	8.63915	0.00002	-0.28245	0.00002	-2.43178
WK-LNGFRY	3.33397	-4.71302	3.34089	-5.20656	0.00002	-3.07960	0.25998	-8.65652	0.00002	-0.28245	0.00002	-2.43178
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	5.53059	6.67111	5.63413	6.31275	0.00002	0.00002	1.25809	-1.74043	5.66697	-1.80384	3.86483	-2.88322
DR-BUS	4.29543	-1.32117	4.43221	-1.15731	14.66614	14.71051	-1.86688	-2.45753	7.19439	5.23559	4.91407	2.81812
DR-FERRY	2.20095	0.91328	2.13196	0.73952	0.00002	0.00002	-1.46140	-0.88633	5.66697	-1.80384	3.86483	-2.88322
DR-LRT	2.20095	0.91328	2.13196	0.73952	0.00002	0.00002	-1.46140	-0.88633	5.66697	-1.80384	3.86483	-2.88322
DR-LNGFRY	2.20095	0.91328	2.13196	0.73952	0.00002	0.00002	-1.46140	-0.88633	5.66697	-1.80384	3.86483	-2.88322
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-2.01043	-2.14359	-1.99849	-2.13267	-0.10578	-0.11235	0.43417	0.47756	-2.22498	-1.68268	-0.18220	0.61325
SR3	-3.93894	-4.08791	-3.92349	-4.06956	-1.69554	-1.69838	-0.42891	-0.41447	-3.83170	-2.15699	-1.37663	0.14408
SR4	-4.17498	-4.37856	-4.15725	-4.35956	-1.69780	-1.70313	-0.36718	-0.34407	-4.12332	-3.27091	-1.37996	-0.96775

5. From Everywhere (except Staten Island and Manhattan) to East of Hudson (except Manhattan)

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	1.68578	2.30139	13.19832	7.26471	11.05317	8.60415	7.37397	9.84321	0.87159	4.71683	2.56019	5.60432
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-0.44076	-1.28929	-12.85722	-4.58293	-3.42307	-0.16125	-2.60804	-5.86397	3.24612	-1.75072	4.20275	-1.43188
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	6.08655	5.09751	29.11610	18.47775	0.00002	0.00002	19.21801	3.19964	7.86298	-10.48139	3.51820	-15.81145
WK-BUS	5.85920	5.73463	-2.28631	3.65188	-13.94409	-8.56129	-0.46725	-11.55523	-0.88473	-11.25265	-2.65950	-15.95041
WK-FERRY	8.24602	15.10933	32.56365	19.41718	70.27708	0.00002	8.03818	-7.85646	9.45103	-4.96163	4.32780	-10.33214
WK-LRT	3.01564	1.66005	25.52314	15.47488	0.00002	15.33272	14.64409	7.20683	0.00002	-10.36624	0.00002	-15.26368
WK-LNGFRY	4.69948	5.40055	13.99274	7.90390	0.00002	0.00002	8.03818	-7.85646	0.00002	-11.05993	0.00002	-13.72316
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	9.00379	4.06493	14.94336	5.44413	1.04945	-16.23485	6.63619	-1.06147	-9.54265	-3.53696	-10.83733	-7.85637
DR-BUS	8.23898	7.50290	1.32888	4.85183	-8.42320	-8.40996	0.12517	-3.69202	3.37147	-13.82157	-0.14581	-17.72755
DR-FERRY	2.10205	-0.06291	2.41906	-1.74650	-5.96765	-16.23485	-9.58017	-11.86614	-5.01941	-13.82157	-11.21208	-17.72755
DR-LRT	1.63975	1.39811	10.89182	-0.23098	-10.30654	-16.23485	-9.58017	-0.99197	-9.54265	-13.82157	-10.83733	-17.72755
DR-LNGFRY	6.47057	1.39811	-5.02276	-0.23098	-10.30654	-16.23485	-9.58017	-11.86614	-9.54265	-13.82157	-10.83733	-17.72755
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-1.51401	-0.85542	-1.39676	-0.77634	-0.56069	0.83643	-0.11031	0.43470	-2.27281	-1.36151	-0.14141	-0.46735
SR3	-2.59193	-2.83761	-2.43968	-2.73298	-3.26352	-2.00975	-1.32856	-0.71794	-2.68065	-2.51182	-0.53785	-1.60617
SR4	-2.88264	-2.96664	-2.71251	-2.84973	-1.49329	-2.05077	-1.26386	0.18747	-1.88723	-2.76057	0.26256	-1.84951

6. From Non-Dense to Non-Dense (except non-dense zones in Newark, Jersey City, Hoboken and Other CBDs)

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	0.65238	2.32105	0.69859	2.44993	1.65042	2.45124	3.52568	4.41154	1.76097	2.97427	1.07074	2.66697
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-1.26492	-3.74351	-1.40849	-3.98572	-3.96311	-3.60337	-1.99245	-3.74098	-2.80428	-3.41185	-2.79504	-3.29883
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	6.88132	-0.55397	6.76928	-1.20745	0.00002	0.00002	1.12203	-7.49716	7.62053	-1.63872	4.34109	-2.70550
WK-BUS	4.85264	-2.25781	4.86079	-2.47563	4.19893	2.92027	2.33088	-5.42723	9.83000	2.47942	6.84062	0.04741
WK-FERRY	11.64666	15.61728	7.49747	-2.71488	0.00002	0.00002	0.57154	-6.75961	9.61784	-1.63872	4.34109	-2.70550
WK-LRT	2.53150	-9.50047	2.51900	-9.82260	3.35762	0.82928	-4.08748	-8.13701	2.92345	-1.63872	1.79757	-2.70550
WK-LNGFRY	4.49980	-2.58324	4.51489	-2.71488	0.00002	0.00002	0.57154	-6.75961	7.62053	-1.63872	4.34109	-2.70550
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	3.63865	3.14284	3.56032	2.99714	-2.91413	-6.63473	-6.01531	-7.91519	3.71793	-3.18090	1.20880	-4.30360
DR-BUS	4.18503	-0.92553	4.20975	-0.99066	3.05867	-2.17281	-2.62815	-7.53738	8.91076	2.32587	6.34093	-0.09786
DR-FERRY	5.59314	16.28931	5.93909	0.17681	-2.91413	-6.63473	-0.78724	-6.17509	10.45843	14.18861	7.93528	-4.30360
DR-LRT	-8.22437	-12.89047	-8.99166	-13.64568	-2.91413	-6.63473	-9.84517	-15.29295	5.17031	-8.64454	1.43190	-9.48440
DR-LNGFRY	2.17957	0.08684	2.26926	0.17681	-2.91413	-6.63473	-6.01531	-6.17509	3.71793	-3.18090	1.20880	-4.30360
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-2.28616	-2.25196	-2.26862	-2.23574	-0.14020	-0.14397	0.13648	-0.57967	-1.51639	-1.62680	-0.21594	0.59861
SR3	-4.26098	-4.23661	-4.23619	-4.21359	-1.74246	-1.74630	-0.73178	-1.85337	-2.69757	-2.11899	-1.39456	0.10890
SR4	-4.55391	-4.51889	-4.52517	-4.49220	-1.74474	-1.75025	-0.73279	-2.14614	-2.70434	-3.29074	-1.40000	-1.06131

7. From Manhattan to Everywhere (except Manhattan)

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	1.42972	11.16072	1.18287	8.77464	3.10792	8.10516	4.85322	14.91016	4.18056	4.83296	1.69898	3.69957
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	15.44454	38.46076	17.67517	12.15516	4.25867	0.00002	20.47042	26.62980	8.73774	7.13765	7.88082	5.51833
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	15.47814	-18.16336	12.41953	-12.48398	2.54110	3.29708	6.77565	-16.99285	-6.87274	0.27190	-3.50094	-2.10024
WK-BUS	12.24711	-25.70220	9.79223	-18.90155	6.25671	-18.32013	5.49876	-23.03723	8.00056	6.06975	12.56898	5.36477
WK-FERRY	12.66419	-29.26073	9.52090	-18.00868	5.29048	0.00002	0.00002	-18.52964	-2.38724	1.69734	1.90984	-1.36416
WK-LRT	9.11588	-25.43005	7.17092	-18.13084	0.00002	17.73586	0.00002	-22.44527	-0.27212	0.50919	6.18118	0.68339
WK-LNGFRY	12.93355	-15.87104	11.82565	-9.67230	0.00002	0.00002	0.00002	-18.52964	0.00002	0.00002	0.00002	0.00002
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
DR-BUS	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
DR-FERRY	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
DR-LRT	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
DR-LNGFRY	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-3.16021	-1.92807	-3.13471	-1.89965	-6.28932	-6.07941	-1.25690	-1.23711	-0.02331	-0.36345	-0.00436	-0.37166
SR3	-3.39298	-3.97909	-3.36317	-3.93341	-6.28932	-6.07941	-3.32057	-3.58646	-0.09406	0.50510	-0.07708	0.50302
SR4	-4.62880	-3.19077	-4.59363	-3.14668	-6.28932	-6.07941	-5.16329	-5.83515	-2.75544	-3.91608	-2.76340	-3.67842

8. To or From Staten Island

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	3.36222	6.56573	4.12691	7.84652	-1.06134	10.54168	2.17582	2.12761	2.68717	1.57575	0.54452	-0.92869
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-2.52908	-5.00802	-0.66526	-4.10340	2.72577	-21.57199	9.20503	2.87068	-3.92448	-2.45877	-2.05221	0.37191
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	1.07861	-17.84559	-1.79879	-15.07494	0.00002	-19.56734	14.97464	6.15827	0.00002	0.00002	0.00002	0.00002
WK-BUS	-10.48335	-28.00272	-13.03939	-23.01667	0.00002	-19.01403	-1.06618	-2.59338	9.20220	11.68896	7.89724	11.90057
WK-FERRY	-4.82689	-10.40435	-7.43799	-15.13788	7.28694	-20.79691	5.35656	4.53404	0.96497	2.37787	-0.60759	2.67524
WK-LRT	4.51977	-12.90617	0.33036	-12.54400	0.00002	-20.15375	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
WK-LNGFRY	-10.65306	-11.68309	-14.71328	-17.36230	0.00002	-21.15373	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	12.27944	-2.97779	15.50441	-2.00076	0.00002	0.00002	-14.48987	-4.39051	0.00002	0.00002	0.00002	0.00002
DR-BUS	22.60441	-0.04933	25.06461	-0.86153	0.00002	0.00002	0.80174	-2.62331	0.00002	0.00002	0.00002	0.00002
DR-FERRY	-3.59986	-5.51688	-9.86922	-12.20116	11.37662	12.29915	-13.79882	-1.52270	10.13465	10.68225	11.35834	11.58238
DR-LRT	-7.33766	-22.02511	-15.40428	-31.46359	0.00002	0.00002	-21.91695	-12.52049	0.00002	0.00002	0.00002	0.00002
DR-LNGFRY	0.30622	-5.97225	-6.69604	-12.82056	0.00002	0.00002	-12.48987	-6.39051	0.00002	0.00002	0.00002	0.00002
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-2.50712	-2.71023	-2.44301	-2.65524	2.11993	1.44323	0.00654	-0.21030	-0.74250	-0.61894	-0.72697	-0.60454
SR3	-4.16994	-4.22724	-4.08434	-4.15388	0.19556	-0.41551	-1.73655	-1.21014	-1.47543	-2.14516	-1.45661	-2.12660
SR4	-4.54136	-5.46289	-4.44598	-5.37623	0.42620	-3.08996	-1.25060	-2.27531	-1.07371	-7.81864	-1.04997	-8.01327

9. From Dense to Non-Dense (except non-dense zones in Newark, Jersey City, Hobokem, Other CBD's or East of Hudson)

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	1.22858	4.29107	1.73779	5.10931	2.01004	2.47058	4.74497	7.39603	4.86474	2.59969	2.95753	1.06831
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-1.03928	-3.13625	-1.52731	-4.48038	-4.35261	-5.22718	-7.95232	-5.46376	-4.11532	-2.57411	-4.78636	-3.28304
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	7.37173	-5.26229	4.57920	-9.45869	0.00002	0.00002	1.52666	-13.25307	-1.25724	0.00002	-2.35399	0.00002
WK-BUS	7.46552	-6.72237	5.48900	-9.80839	3.79015	3.44695	-0.53601	-13.93391	4.49432	7.50628	2.24973	5.01406
WK-FERRY	7.12638	-6.50678	8.33572	-9.54246	0.00002	0.00002	-1.24371	-10.44151	0.00002	0.00002	0.00002	0.00002
WK-LRT	1.67429	-11.68061	-0.35709	-14.77475	1.11404	2.98961	-6.25170	-18.58411	-0.46942	3.48481	-1.16728	1.71594
WK-LNGFRY	5.33841	-6.50678	7.14590	-9.54246	0.00002	0.00002	-1.24371	-9.44151	0.00002	0.00002	0.00002	0.00002
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	7.14431	-3.72486	5.00748	-5.33941	0.00002	9.34003	10.21935	-7.19307	0.00002	5.65346	0.00002	5.04573
DR-BUS	9.47156	-1.30478	8.31210	-1.98688	0.00002	11.33167	12.82937	-6.37715	15.33871	14.40558	12.05163	11.64865
DR-FERRY	2.29962	34.11398	1.92016	-3.00661	0.00002	0.00002	2.86724	-7.43683	10.85176	0.00002	6.21209	0.00002
DR-LRT	-4.55228	-18.56903	-7.17933	-19.46596	0.00002	0.00002	0.00002	-15.68302	-3.53722	0.00002	0.98172	0.00002
DR-LNGFRY	10.61174	-2.07816	10.16076	-3.00661	0.00002	0.00002	0.00002	-9.43684	0.00002	0.00002	0.00002	0.00002
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-0.80507	-0.74207	-0.78960	-0.72964	-0.10377	-0.12234	0.46037	0.46399	-1.59361	-1.64760	-0.18755	-0.29848
SR3	-2.47232	-2.61916	-2.45156	-2.60394	-1.71785	-1.71868	-0.40357	-0.39384	-2.70742	-2.10552	-1.35883	-0.75484
SR4	-2.61177	-2.97054	-2.58808	-2.95163	-1.72078	-1.72167	-0.40396	-0.40237	-2.71151	-3.27461	-1.36369	-1.92046

10. From Non-Dense to Dense (except non-dense zones in Newark, Jersey City, Hobokem, Other CBD's or East of Hudson)

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	1.43969	1.75382	1.32094	1.67269	1.05527	1.81339	3.99562	4.97740	2.68949	4.16236	1.53474	3.00226
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-1.35013	-2.41322	-1.35713	-2.33967	-3.17862	-0.40968	-2.53043	-4.16347	-1.37188	-2.31540	-1.21030	-2.01955
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	4.43464	2.46711	5.56831	3.25685	0.00002	0.00002	-0.64037	-4.99056	2.83345	-5.68179	0.57020	-7.71033
WK-BUS	4.60584	3.15935	5.55684	4.01614	4.96547	5.57639	1.18270	-4.93789	7.58024	-0.80358	2.91824	-4.12637
WK-FERRY	13.88655	11.87644	11.18923	12.50204	0.00002	0.00002	58.82324	-6.21550	2.83345	0.48388	0.57020	-2.76524
WK-LRT	0.37027	13.76613	1.34053	15.55815	12.44250	16.56178	-0.95465	-7.33435	3.04085	-4.01356	-0.60714	-6.74509
WK-LNGFRY	18.98271	11.87644	13.03617	12.50204	0.00002	0.00002	-0.42102	-6.21550	2.83345	0.48388	0.57020	-2.76524
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	1.48567	4.54860	2.11227	4.95364	0.00002	-7.48608	3.03585	-4.12972	-4.71675	-11.64632	-9.16226	-14.25473
DR-BUS	5.06678	5.07962	5.91308	5.62216	12.46699	0.17520	1.75225	-2.18727	8.38583	0.62036	5.29683	-2.15906
DR-FERRY	26.96956	21.93431	23.35260	20.97671	0.00002	24.98859	-7.60713	-9.64469	18.42003	1.87111	8.53170	1.06527
DR-LRT	-6.02503	-7.36570	-6.39589	-6.64721	5.30251	-5.06299	-7.60713	-8.46671	-4.71675	-11.64632	-9.16226	-14.25473
DR-LNGFRY	3.45324	4.12411	3.31673	4.85642	0.00002	-7.48608	-7.60713	-9.64469	-4.71675	-11.64632	-9.16226	-14.25473
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-1.70113	-1.76192	-1.69328	-1.75665	-0.06266	-0.07343	0.50239	0.51388	-1.54631	-1.75706	-0.09980	0.02394
SR3	-3.77865	-3.76919	-3.76917	-3.76037	-1.61674	-1.62191	-0.32798	-0.31880	-2.68751	-2.12520	-1.23794	-0.34204
SR4	-4.09578	-4.09240	-4.08713	-4.08349	-1.62130	-1.62740	-0.33566	-0.33084	-2.69221	-3.25616	-1.24230	-1.47155

11. From Dense to Dense (except non-dense zones in Newark, Jersey City, Hobokem, Other CBD's or East of Hudson)

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	4.01445	4.56407	4.39411	5.01617	2.23805	2.92499	3.55058	2.95765	11.43715	5.03184	1.80794	1.16143
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-5.20467	-4.18892	-5.32686	-4.92470	-5.11271	-1.65320	-4.16073	0.66393	-19.43308	-6.84171	-5.22713	-5.61102
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	-3.83434	-4.34160	-4.53279	-5.66557	1.02438	-1.46242	7.35850	6.31010	0.00002	-2.61769	0.00002	-0.75867
WK-BUS	-0.66723	-3.89428	-0.67543	-4.07520	-0.09694	-1.40073	3.54556	2.34535	6.49653	1.92739	2.59846	0.30451
WK-FERRY	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
WK-LRT	-1.82019	16.00871	-1.87270	17.85731	15.67791	20.09305	7.15066	9.39063	15.12103	-0.70112	3.51505	-1.25699
WK-LNGFRY	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002	0.00002
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	-2.20979	-4.66639	-4.73822	-6.14217	0.00002	1.62685	5.98375	-5.87801	0.00002	0.00002	0.00002	0.00002
DR-BUS	24.97442	12.27075	23.84533	12.46800	0.00002	2.11812	10.53678	-4.99370	19.96972	20.12862	18.70355	14.71454
DR-FERRY	12.63030	10.64512	11.93719	12.31315	0.00002	0.00002	0.00002	-10.46237	10.08597	0.00002	11.12264	0.00002
DR-LRT	-6.14361	-13.63337	-8.73735	-15.20286	0.00002	-3.48948	-2.73030	-9.45345	-7.49058	9.74330	-4.47548	6.47146
DR-LNGFRY	22.61570	0.00002	17.78737	0.00002	0.00002	0.00002	0.00002	-10.46237	0.00002	0.00002	0.00002	0.00002
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-0.85649	-0.87757	-0.84883	-0.87176	-0.10881	-0.11280	0.46716	0.47938	-1.51702	-1.62399	-0.19739	-0.67952
SR3	-2.56979	-2.09786	-2.56234	-2.08762	-1.70999	-1.70883	-0.39002	-0.39105	-2.72966	-2.09503	-1.38797	-1.14998
SR4	-3.02396	-3.00981	-3.00834	-3.01683	-1.71183	-1.71287	-0.39329	-0.39498	-2.73226	-3.28147	-1.39311	-2.33791

APPENDIX K – MODEL CONSTANTS-EXPRESSED AT TOP NEST LEVEL

1. From Everywhere (except Staten Island) to Manhattan

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	2.88739	3.13620	1.67808	2.94974	7.68656	7.90375	6.09863	7.64087	4.13200	5.32317	4.61332	5.66382
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-0.38504	-1.06877	-1.59057	-1.90319	-1.51047	-1.17026	-0.88473	-1.35308	-0.33250	-0.63511	-0.31188	-0.67586
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	1.23425	0.65672	1.74842	0.86778	0.90932	-0.87080	0.32995	-1.02327	-2.22027	-1.93005	-2.67043	-2.17078
WK-BUS	0.93677	1.15451	0.51536	0.53631	0.76364	-1.72110	-0.47121	-1.42777	-0.69429	-1.68921	-1.65642	-2.59448
WK-FERRY	4.94362	4.67841	3.50321	3.61670	4.38462	8.75623	1.69933	4.22140	3.69487	2.55477	6.06501	5.09777
WK-LRT	0.46894	0.31217	0.77182	0.29467	0.35874	0.07170	-0.31488	-1.43743	0.98259	-0.87075	0.55558	-1.69240
WK-LNGFRY	0.61942	1.93107	-0.59781	1.68787	5.49430	2.77414	2.78448	1.28505	4.18548	-1.08454	3.54604	-0.86262
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	1.92503	1.06956	3.22938	1.85866	1.01586	0.02421	0.78201	-0.37070	-1.47877	-1.25223	-1.80630	-1.41816
DR-BUS	1.20302	1.74614	1.89844	2.06246	0.43101	-0.33669	0.02412	-0.49301	-0.11161	-0.66249	-1.33858	-1.77754
DR-FERRY	-0.34922	-0.58089	1.22147	0.46926	1.98805	-1.56870	-1.26881	-2.82111	-0.31160	-2.45062	-1.16506	-3.08863
DR-LRT	0.25530	-0.28071	1.57203	0.45312	0.60716	-0.15453	-0.85677	-1.52137	-1.86664	-1.66890	-2.33748	-2.13844
DR-LNGFRY	-0.58014	0.59721	0.44176	1.01612	4.75847	-0.56263	1.27184	1.38627	2.38767	-0.68571	0.05167	-0.95697
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-1.37971	-1.96169	-1.65095	-2.19972	-0.77006	0.67520	0.15710	0.24832	-0.21166	-0.59403	-0.17893	-0.56029
SR3	-3.32052	-3.28301	-1.83786	-1.75565	-1.00478	-1.12350	-1.10085	-1.36310	-1.87126	-1.13673	-1.82655	-1.09177
SR4	-3.16549	-4.23776	-4.02127	-5.04436	-3.44992	0.86337	-1.82418	-0.86665	-1.24882	-1.15573	-1.19973	-1.10513

2. From Everywhere (except Staten Island and Manhattan) to Newark Super CBD

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	1.71069	3.15071	1.38791	2.66670	1.93766	4.66217	6.28843	7.95276	2.85482	3.11634	2.62884	3.23819
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-0.49370	-2.70304	-0.29558	-2.20402	-2.87112	-4.64581	-1.66933	-3.79219	-1.65357	-1.70277	-2.18160	-2.29103
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	1.43828	-0.52380	2.24572	0.43270	0.00001	0.39977	4.99808	1.75436	-1.23511	-1.75649	-1.24062	-2.05294
WK-BUS	0.21594	-1.14312	1.66223	0.57475	0.71385	-0.59452	-0.51204	-3.16104	0.35096	-0.52017	0.08111	-1.12319
WK-FERRY	0.27064	-1.05169	0.96037	0.32863	0.00001	-0.59861	1.22934	-2.79392	-1.23511	-1.75649	-1.24062	-2.05294
WK-LRT	1.00134	-0.66503	1.85170	0.40604	0.00001	-0.59861	1.22934	-2.79392	-1.23511	-1.75649	-1.24062	-2.05294
WK-LNGFRY	0.27064	-1.05169	0.96037	0.32863	0.00001	-0.59861	1.22934	-2.79392	-1.23511	-1.75649	-1.24062	-2.05294
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	-0.23837	-0.34572	0.07025	-0.11460	0.00001	-1.81457	-1.47596	-1.55231	-1.72146	-1.34970	-1.72061	-1.29887
DR-BUS	-0.97909	-1.48993	1.88698	1.88153	0.00001	1.62196	-1.65976	-1.41322	1.66549	0.39918	1.91214	0.43090
DR-FERRY	-1.60839	-2.13768	-0.00651	0.41047	0.00001	-1.81457	-0.59296	-0.76122	-1.72146	-0.52934	-1.72061	-0.32535
DR-LRT	-1.60839	-2.13768	-0.00651	0.41047	0.00001	-1.81457	-0.25131	-0.42719	-1.72146	-0.52934	-1.72061	-0.32535
DR-LNGFRY	-1.60839	-2.13768	-0.00651	0.41047	0.00001	-1.81457	-0.59296	-0.76122	-1.72146	-0.52934	-1.72061	-0.32535
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-1.41027	-1.39214	-1.82980	-1.82151	0.52540	0.51828	1.10330	1.11755	-0.73583	-2.08132	-2.34693	-1.84764
SR3	-3.52741	-3.51764	-4.24233	-4.23576	-0.94603	-0.95100	0.31771	0.32371	-1.38603	-1.80354	-5.92239	-4.48568
SR4	-4.11067	-4.09523	-4.21135	-4.20962	-0.95647	-0.96376	0.30578	0.30944	-0.31971	-1.75355	-5.70904	-5.29139

3. From Everywhere (except Staten Island and Manhattan) to Jersey City/Hoboken Core

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	1.01341	0.67833	18.82039	1.46953	1.93521	2.30021	3.19683	4.76391	1.18088	1.89291	1.34779	1.92708
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-0.22285	-0.15093	-15.95348	-0.29505	-0.62569	-2.35858	-0.29179	-1.72800	0.08528	-0.99747	0.08764	-1.03008
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	2.73229	1.64227	6.89361	2.60079	-0.47997	0.99569	-0.27074	-1.37981	-1.69311	-0.35762	-2.65875	-1.22654
WK-BUS	1.57683	0.95793	5.00225	2.07193	-0.28240	-1.90301	-2.20561	-4.21100	0.11670	-1.77970	-1.13712	-3.07911
WK-FERRY	2.43727	2.13954	6.86630	4.76621	2.56940	0.00001	-0.41745	-0.27902	2.09831	-0.90146	3.16509	-1.63434
WK-LRT	4.25818	3.77078	6.66182	4.52669	2.24413	2.68901	0.27171	-0.56645	1.94915	0.53310	1.61561	0.09015
WK-LNGFRY	2.74881	3.13954	6.29170	4.76621	0.00001	0.00001	-2.34667	-3.17983	-1.69311	-0.90146	-2.65875	-1.63434
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	1.71850	0.70058	2.07646	1.00019	0.35030	0.00001	-1.02160	-1.22841	-0.24357	-0.96868	-1.20077	-1.92137
DR-BUS	1.66799	2.36712	1.62315	2.44643	0.49885	0.00001	-0.83151	0.19949	-0.24357	-0.96868	-1.20077	-1.92137
DR-FERRY	2.85058	1.81240	2.98722	1.88413	1.24699	0.00001	-1.75882	-1.04522	2.00216	-0.96868	0.18305	-1.92137
DR-LRT	1.67571	0.23623	2.39254	0.40586	0.49885	1.42302	-1.04987	-1.85155	-0.34909	-1.57294	-1.17455	-2.50968
DR-LNGFRY	0.98064	1.81240	1.10073	1.88413	0.49885	0.00001	-0.83151	-1.04522	-0.24357	-0.96868	-1.20077	-1.92137
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-1.95100	-2.10062	-1.98000	-2.14823	-0.22957	-0.23020	0.29694	0.32578	-2.53255	-2.07469	-0.15360	-0.10554
SR3	-4.11189	-3.30562	-4.16127	-3.36622	-1.83523	-1.78529	-0.54553	-0.52964	-3.99945	-2.27817	-1.21214	-0.30562
SR4	-3.52115	-3.60134	-3.57432	-3.67282	-1.84795	-1.84321	-0.56436	-0.55082	-4.30957	-3.32491	-1.22394	-1.34978

4. From Everywhere (except Staten Island and Manhattan) to Other CBD's

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	0.89832	3.71640	0.91363	3.98675	2.75061	4.35706	5.55252	6.67703	2.62440	3.21694	2.06114	3.11786
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-1.05769	-2.63699	-1.10769	-2.90136	-4.44297	-6.07580	-2.06680	-2.56105	-1.94737	-2.15112	-1.83573	-2.09714
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	1.22378	1.54905	1.31664	1.64678	0.00001	-0.76990	1.81802	1.33756	0.00001	-0.07061	0.00001	-0.60795
WK-BUS	0.89124	-1.44127	0.89728	-1.69135	0.82440	-0.30022	-0.10318	-1.89543	1.84360	0.87229	1.22295	0.08098
WK-FERRY	0.83349	-1.17826	0.83522	-1.30164	0.00001	-0.76990	0.06500	-2.16413	0.00001	-0.07061	0.00001	-0.60795
WK-LRT	1.69348	1.40837	1.70249	1.49801	0.00001	6.29836	2.31851	2.15979	0.00001	-0.07061	0.00001	-0.60795
WK-LNGFRY	0.83349	-1.17826	0.83522	-1.30164	0.00001	-0.76990	0.06500	-2.16413	0.00001	-0.07061	0.00001	-0.60795
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	1.38265	1.66778	1.40853	1.57819	0.00001	0.00001	0.31452	-0.43511	1.41674	-0.45096	0.96621	-0.72081
DR-BUS	1.07386	-0.33029	1.10805	-0.28933	3.66654	3.67763	-0.46672	-0.61438	1.79860	1.30890	1.22852	0.70453
DR-FERRY	0.55024	0.22832	0.53299	0.18488	0.00001	0.00001	-0.36535	-0.22158	1.41674	-0.45096	0.96621	-0.72081
DR-LRT	0.55024	0.22832	0.53299	0.18488	0.00001	0.00001	-0.36535	-0.22158	1.41674	-0.45096	0.96621	-0.72081
DR-LNGFRY	0.55024	0.22832	0.53299	0.18488	0.00001	0.00001	-0.36535	-0.22158	1.41674	-0.45096	0.96621	-0.72081
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-2.01043	-2.14359	-1.99849	-2.13267	-0.10578	-0.11235	0.43417	0.47756	-2.22498	-1.68268	-0.18220	0.61325
SR3	-3.93894	-4.08791	-3.92349	-4.06956	-1.69554	-1.69838	-0.42891	-0.41447	-3.83170	-2.15699	-1.37663	0.14408
SR4	-4.17498	-4.37856	-4.15725	-4.35956	-1.69780	-1.70313	-0.36718	-0.34407	-4.12332	-3.27091	-1.37996	-0.96775

5. From Everywhere (except Staten Island and Manhattan) to East of Hudson (except Manhattan)

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	1.68578	2.30139	13.19832	7.26471	11.05317	8.60415	7.37397	9.84321	0.87159	4.71683	2.56019	5.60432
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-0.22038	-0.64465	-6.42861	-2.29147	-1.71154	-0.08063	-1.30402	-2.93199	1.62306	-0.87536	2.10138	-0.71594
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	1.52164	1.27438	7.27903	4.61944	0.00001	0.00001	4.80450	0.79991	1.96575	-2.62035	0.87955	-3.95286
WK-BUS	1.46480	1.43366	-0.57158	0.91297	-3.48602	-2.14032	-0.11681	-2.88881	-0.22118	-2.81316	-0.66488	-3.98760
WK-FERRY	2.06151	3.77733	8.14091	4.85430	17.56927	0.00001	2.00955	-1.96412	2.36276	-1.24041	1.08195	-2.58304
WK-LRT	0.75391	0.41501	6.38079	3.86872	0.00001	3.83318	3.66102	1.80171	0.00001	-2.59156	0.00001	-3.81592
WK-LNGFRY	1.17487	1.35014	3.49819	1.97598	0.00001	0.00001	2.00955	-1.96412	0.00001	-2.76498	0.00001	-3.43079
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	2.25095	1.01623	3.73584	1.36103	0.26236	-4.05871	1.65905	-0.26537	-2.38566	-0.88424	-2.70933	-1.96409
DR-BUS	2.05975	1.87573	0.33222	1.21296	-2.10580	-2.10249	0.03129	-0.92301	0.84287	-3.45539	-0.03645	-4.43189
DR-FERRY	0.52551	-0.01573	0.60477	-0.43663	-1.49191	-4.05871	-2.39504	-2.96654	-1.25485	-3.45539	-2.80302	-4.43189
DR-LRT	0.40994	0.34953	2.72296	-0.05775	-2.57664	-4.05871	-2.39504	-0.24799	-2.38566	-3.45539	-2.70933	-4.43189
DR-LNGFRY	1.61764	0.34953	-1.25569	-0.05775	-2.57664	-4.05871	-2.39504	-2.96654	-2.38566	-3.45539	-2.70933	-4.43189
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-1.51401	-0.85542	-1.39676	-0.77634	-0.56069	0.83643	-0.11031	0.43470	-2.27281	-1.36151	-0.14141	-0.46735
SR3	-2.59193	-2.83761	-2.43968	-2.73298	-3.26352	-2.00975	-1.32856	-0.71794	-2.68065	-2.51182	-0.53785	-1.60617
SR4	-2.88264	-2.96664	-2.71251	-2.84973	-1.49329	-2.05077	-1.26386	0.18747	-1.88723	-2.76057	0.26256	-1.84951

6. From Non-Dense to Non-Dense (except non-dense zones in Newark, Jersey City, Hoboken and Other CBDs)

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	0.65238	2.32105	0.69859	2.44993	1.65042	2.45124	3.52568	4.41154	1.76097	2.97427	1.07074	2.66697
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-0.63246	-1.87176	-0.70425	-1.99286	-1.98156	-1.80169	-0.99623	-1.87049	-1.40214	-1.70593	-1.39752	-1.64942
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	1.72033	-0.13849	1.69232	-0.30186	0.00001	0.00001	0.28051	-1.87429	1.90513	-0.40968	1.08527	-0.67638
WK-BUS	1.21316	-0.56445	1.21520	-0.61891	1.04973	0.73007	0.58272	-1.35681	2.45750	0.61986	1.71016	0.01185
WK-FERRY	2.91167	3.90432	1.87437	-0.67872	0.00001	0.00001	0.14289	-1.68990	2.40446	-0.40968	1.08527	-0.67638
WK-LRT	0.63288	-2.37512	0.62975	-2.45565	0.83941	0.20732	-1.02187	-2.03425	0.73086	-0.40968	0.44939	-0.67638
WK-LNGFRY	1.12495	-0.64581	1.12872	-0.67872	0.00001	0.00001	0.14289	-1.68990	1.90513	-0.40968	1.08527	-0.67638
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	0.90966	0.78571	0.89008	0.74929	-0.72853	-1.65868	-1.50383	-1.97880	0.92948	-0.79523	0.30220	-1.07590
DR-BUS	1.04626	-0.23138	1.05244	-0.24767	0.76467	-0.54320	-0.65704	-1.88435	2.22769	0.58147	1.58523	-0.02447
DR-FERRY	1.39829	4.07233	1.48477	0.04420	-0.72853	-1.65868	-0.19681	-1.54377	2.61461	3.54715	1.98382	-1.07590
DR-LRT	-2.05609	-3.22262	-2.24792	-3.41142	-0.72853	-1.65868	-2.46129	-3.82324	1.29258	-2.16114	0.35798	-2.37110
DR-LNGFRY	0.54489	0.02171	0.56732	0.04420	-0.72853	-1.65868	-1.50383	-1.54377	0.92948	-0.79523	0.30220	-1.07590
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-2.28616	-2.25196	-2.26862	-2.23574	-0.14020	-0.14397	0.13648	-0.57967	-1.51639	-1.62680	-0.21594	0.59861
SR3	-4.26098	-4.23661	-4.23619	-4.21359	-1.74246	-1.74630	-0.73178	-1.85337	-2.69757	-2.11899	-1.39456	0.10890
SR4	-4.55391	-4.51889	-4.52517	-4.49220	-1.74474	-1.75025	-0.73279	-2.14614	-2.70434	-3.29074	-1.40000	-1.06131

7. From Manhattan to Everywhere (except Manhattan)

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	1.42972	11.16072	1.18287	8.77464	3.10792	8.10516	4.85322	14.91016	4.18056	4.83296	1.69898	3.69957
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	7.72227	19.23038	8.83759	6.07758	2.12934	0.00001	10.23521	13.31490	4.36887	3.56883	3.94041	2.75917
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	3.86954	-4.54084	3.10488	-3.12100	0.63528	0.82427	1.69391	-4.24821	-1.71819	0.06798	-0.87524	-0.52506
WK-BUS	3.06178	-6.42555	2.44806	-4.72539	1.56418	-4.58003	1.37469	-5.75931	2.00014	1.51744	3.14225	1.34119
WK-FERRY	3.16605	-7.31518	2.38023	-4.50217	1.32262	0.00001	0.00001	-4.63241	-0.59681	0.42434	0.47746	-0.34104
WK-LRT	2.27897	-6.35751	1.79273	-4.53271	0.00001	4.43397	0.00001	-5.61132	-0.06803	0.12730	1.54530	0.17085
WK-LNGFRY	3.23339	-3.96776	2.95641	-2.41808	0.00001	0.00001	0.00001	-4.63241	0.00001	0.00001	0.00001	0.00001
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
DR-BUS	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
DR-FERRY	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
DR-LRT	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
DR-LNGFRY	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-3.16021	-1.92807	-3.13471	-1.89965	-6.28932	-6.07941	-1.25690	-1.23711	-0.02331	-0.36345	-0.00436	-0.37166
SR3	-3.39298	-3.97909	-3.36317	-3.93341	-6.28932	-6.07941	-3.32057	-3.58646	-0.09406	0.50510	-0.07708	0.50302
SR4	-4.62880	-3.19077	-4.59363	-3.14668	-6.28932	-6.07941	-5.16329	-5.83515	-2.75544	-3.91608	-2.76340	-3.67842

8. To or From Staten Island

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	3.36222	6.56573	4.12691	7.84652	-1.06134	10.54168	2.17582	2.12761	2.68717	1.57575	0.54452	-0.92869
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-1.26454	-2.50401	-0.33263	-2.05170	1.36289	-10.78600	4.60252	1.43534	-1.96224	-1.22939	-1.02611	0.18596
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	0.26965	-4.46140	-0.44970	-3.76874	0.00001	-4.89184	3.74366	1.53957	0.00001	0.00001	0.00001	0.00001
WK-BUS	-2.62084	-7.00068	-3.25985	-5.75417	0.00001	-4.75351	-0.26655	-0.64835	2.30055	2.92224	1.97431	2.97514
WK-FERRY	-1.20672	-2.60109	-1.85950	-3.78447	1.82174	-5.19923	1.33914	1.13351	0.24124	0.59447	-0.15190	0.66881
WK-LRT	1.12994	-3.22654	0.08259	-3.13600	0.00001	-5.03844	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
WK-LNGFRY	-2.66327	-2.92077	-3.67832	-4.34058	0.00001	-5.28843	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	3.06986	-0.74445	3.87610	-0.50019	0.00001	0.00001	-3.62247	-1.09763	0.00001	0.00001	0.00001	0.00001
DR-BUS	5.65110	-0.01233	6.26615	-0.21538	0.00001	0.00001	0.20044	-0.65583	0.00001	0.00001	0.00001	0.00001
DR-FERRY	-0.89997	-1.37922	-2.46731	-3.05029	2.84416	3.07479	-3.44971	-0.38068	2.53366	2.67056	2.83959	2.89560
DR-LRT	-1.83442	-5.50628	-3.85107	-7.86590	0.00001	0.00001	-5.47924	-3.13012	0.00001	0.00001	0.00001	0.00001
DR-LNGFRY	0.07656	-1.49306	-1.67401	-3.20514	0.00001	0.00001	-3.12247	-1.59763	0.00001	0.00001	0.00001	0.00001
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-2.50712	-2.71023	-2.44301	-2.65524	2.11993	1.44323	0.00654	-0.21030	-0.74250	-0.61894	-0.72697	-0.60454
SR3	-4.16994	-4.22724	-4.08434	-4.15388	0.19556	-0.41551	-1.73655	-1.21014	-1.47543	-2.14516	-1.45661	-2.12660
SR4	-4.54136	-5.46289	-4.44598	-5.37623	0.42620	-3.08996	-1.25060	-2.27531	-1.07371	-7.81864	-1.04997	-8.01327

9. From Dense to Non-Dense (except non-dense zones in Newark, Jersey City, Hobokem, Other CBD's or East of Hudson)

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	1.22858	4.29107	1.73779	5.10931	2.01004	2.47058	4.74497	7.39603	4.86474	2.59969	2.95753	1.06831
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-0.51964	-1.56813	-0.76366	-2.24019	-2.17631	-2.61359	-3.97616	-2.73188	-2.05766	-1.28706	-2.39318	-1.64152
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	1.84293	-1.31557	1.14480	-2.36467	0.00001	0.00001	0.38167	-3.31327	-0.31431	0.00001	-0.58850	0.00001
WK-BUS	1.86638	-1.68059	1.37225	-2.45210	0.94754	0.86174	-0.13400	-3.48348	1.12358	1.87657	0.56243	1.25352
WK-FERRY	1.78160	-1.62670	2.08393	-2.38562	0.00001	0.00001	-0.31093	-2.61038	0.00001	0.00001	0.00001	0.00001
WK-LRT	0.41857	-2.92015	-0.08927	-3.69369	0.27851	0.74740	-1.56293	-4.64603	-0.11736	0.87120	-0.29182	0.42899
WK-LNGFRY	1.33460	-1.62670	1.78648	-2.38562	0.00001	0.00001	-0.31093	-2.36038	0.00001	0.00001	0.00001	0.00001
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	1.78608	-0.93122	1.25187	-1.33485	0.00001	2.33501	2.55484	-1.79827	0.00001	1.41337	0.00001	1.26143
DR-BUS	2.36789	-0.32620	2.07803	-0.49672	0.00001	2.83292	3.20734	-1.59429	3.83468	3.60140	3.01291	2.91216
DR-FERRY	0.57491	8.52850	0.48004	-0.75165	0.00001	0.00001	0.71681	-1.85921	2.71294	0.00001	1.55302	0.00001
DR-LRT	-1.13807	-4.64226	-1.79483	-4.86649	0.00001	0.00001	0.00001	-3.92076	-0.88431	0.00001	0.24543	0.00001
DR-LNGFRY	2.65294	-0.51954	2.54019	-0.75165	0.00001	0.00001	0.00001	-2.35921	0.00001	0.00001	0.00001	0.00001
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-0.80507	-0.74207	-0.78960	-0.72964	-0.10377	-0.12234	0.46037	0.46399	-1.59361	-1.64760	-0.18755	-0.29848
SR3	-2.47232	-2.61916	-2.45156	-2.60394	-1.71785	-1.71868	-0.40357	-0.39384	-2.70742	-2.10552	-1.35883	-0.75484
SR4	-2.61177	-2.97054	-2.58808	-2.95163	-1.72078	-1.72167	-0.40396	-0.40237	-2.71151	-3.27461	-1.36369	-1.92046

10. From Non-Dense to Dense (except non-dense zones in Newark, Jersey City, Hobokem, Other CBD's or East of Hudson)

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	1.43969	1.75382	1.32094	1.67269	1.05527	1.81339	3.99562	4.97740	2.68949	4.16236	1.53474	3.00226
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-0.67507	-1.20661	-0.67857	-1.16984	-1.58931	-0.20484	-1.26522	-2.08174	-0.68594	-1.15770	-0.60515	-1.00978
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	1.10866	0.61678	1.39208	0.81421	0.00001	0.00001	-0.16009	-1.24764	0.70836	-1.42045	0.14255	-1.92758
WK-BUS	1.15146	0.78984	1.38921	1.00404	1.24137	1.39410	0.29568	-1.23447	1.89506	-0.20090	0.72956	-1.03159
WK-FERRY	3.47164	2.96911	2.79731	3.12551	0.00001	0.00001	14.70581	-1.55388	0.70836	0.12097	0.14255	-0.69131
WK-LRT	0.09257	3.44153	0.33513	3.88954	3.11063	4.14045	-0.23866	-1.83359	0.76021	-1.00339	-0.15179	-1.68627
WK-LNGFRY	4.74568	2.96911	3.25904	3.12551	0.00001	0.00001	-0.10526	-1.55388	0.70836	0.12097	0.14255	-0.69131
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	0.37142	1.13715	0.52807	1.23841	0.00001	-1.87152	0.75896	-1.03243	-1.17919	-2.91158	-2.29057	-3.56368
DR-BUS	1.26670	1.26991	1.47827	1.40554	3.11675	0.04380	0.43806	-0.54682	2.09646	0.15509	1.32421	-0.53977
DR-FERRY	6.74239	5.48358	5.83815	5.24418	0.00001	6.24715	-1.90178	-2.41117	4.60501	0.46778	2.13293	0.26632
DR-LRT	-1.50626	-1.84143	-1.59897	-1.66180	1.32563	-1.26575	-1.90178	-2.11668	-1.17919	-2.91158	-2.29057	-3.56368
DR-LNGFRY	0.86331	1.03103	0.82918	1.21411	0.00001	-1.87152	-1.90178	-2.41117	-1.17919	-2.91158	-2.29057	-3.56368
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-1.70113	-1.76192	-1.69328	-1.75665	-0.06266	-0.07343	0.50239	0.51388	-1.54631	-1.75706	-0.09980	0.02394
SR3	-3.77865	-3.76919	-3.76917	-3.76037	-1.61674	-1.62191	-0.32798	-0.31880	-2.68751	-2.12520	-1.23794	-0.34204
SR4	-4.09578	-4.09240	-4.08713	-4.08349	-1.62130	-1.62740	-0.33566	-0.33084	-2.69221	-3.25616	-1.24230	-1.47155

11. From Dense to Dense (except non-dense zones in Newark, Jersey City, Hobokem, Other CBD's or East of Hudson)

	Peak HBWD	Off-Peak HBWD	Peak HBWS	Off-Peak HBWS	Peak HBS	Off-Peak HBS	Peak HBO	Off-Peak HBO	Peak WBO	Off-Peak WBO	Peak NHNW	Off-Peak NHNW
DRIVE	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
TRANSIT	4.01445	4.56407	4.39411	5.01617	2.23805	2.92499	3.55058	2.95765	11.43715	5.03184	1.80794	1.16143
WK-TRN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-TRN	-2.60234	-2.09446	-2.66343	-2.46235	-2.55636	-0.82660	-2.08037	0.33197	-9.71654	-3.42086	-2.61357	-2.80551
WK-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
WK-PATH	-0.95859	-1.08540	-1.13320	-1.41639	0.25610	-0.36561	1.83963	1.57753	0.00001	-0.65442	0.00001	-0.18967
WK-BUS	-0.16681	-0.97357	-0.16886	-1.01880	-0.02424	-0.35018	0.88639	0.58634	1.62413	0.48185	0.64962	0.07613
WK-FERRY	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
WK-LRT	-0.45505	4.00218	-0.46818	4.46433	3.91948	5.02326	1.78767	2.34766	3.78026	-0.17528	0.87876	-0.31425
WK-LNGFRY	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001
DR-RAIL	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
DR-PATH	-0.55245	-1.16660	-1.18456	-1.53554	0.00001	0.40671	1.49594	-1.46950	0.00001	0.00001	0.00001	0.00001
DR-BUS	6.24361	3.06769	5.96133	3.11700	0.00001	0.52953	2.63420	-1.24843	4.99243	5.03216	4.67589	3.67864
DR-FERRY	3.15758	2.66128	2.98430	3.07829	0.00001	0.00001	0.00001	-2.61559	2.52149	0.00001	2.78066	0.00001
DR-LRT	-1.53590	-3.40834	-2.18434	-3.80072	0.00001	-0.87237	-0.68258	-2.36336	-1.87265	2.43583	-1.11887	1.61787
DR-LNGFRY	5.65393	0.00001	4.44684	0.00001	0.00001	0.00001	0.00001	-2.61559	0.00001	0.00001	0.00001	0.00001
DRVALN	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
SR2	-0.85649	-0.87757	-0.84883	-0.87176	-0.10881	-0.11280	0.46716	0.47938	-1.51702	-1.62399	-0.19739	-0.67952
SR3	-2.56979	-2.09786	-2.56234	-2.08762	-1.70999	-1.70883	-0.39002	-0.39105	-2.72966	-2.09503	-1.38797	-1.14998
SR4	-3.02396	-3.00981	-3.00834	-3.01683	-1.71183	-1.71287	-0.39329	-0.39498	-2.73226	-3.28147	-1.39311	-2.33791

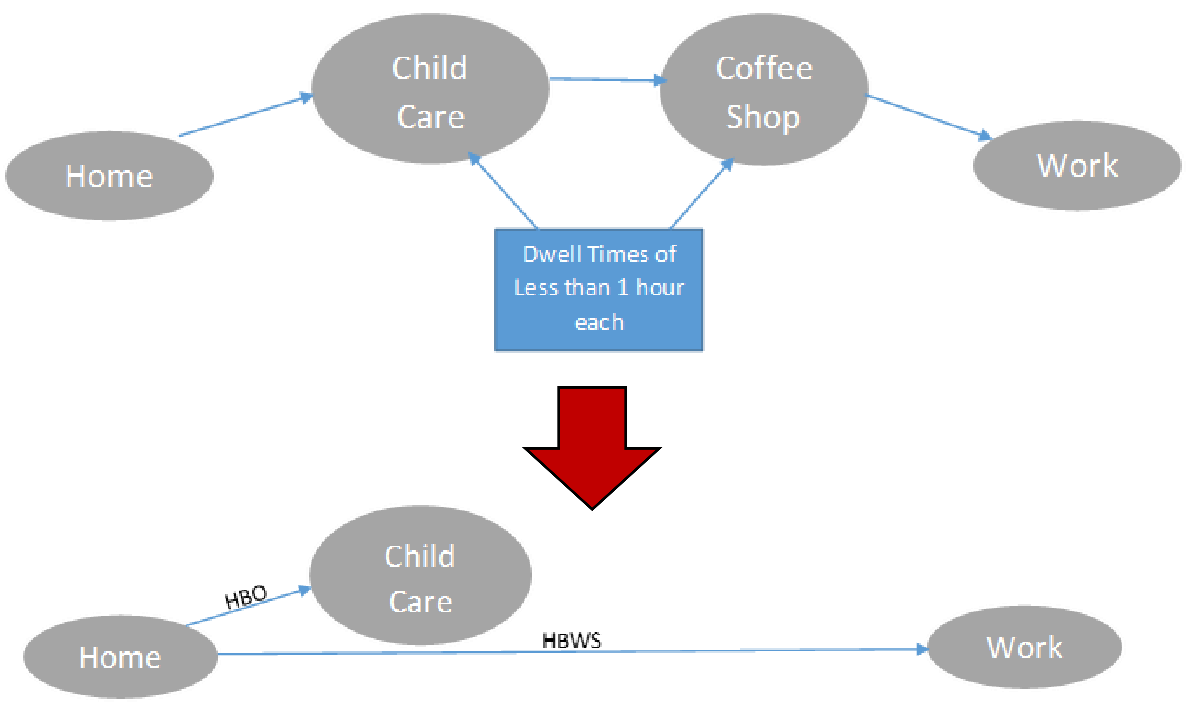
APPENDIX L – HOME-BASED WORK STRATEGIC (HBWS)

INTRODUCTION

This memo describes the process of developing the Home-Based Work Strategic (HBWS) data from the 2010-2011 NYMTC/NJTPA Household Survey Data. The HBWS is defined as a trip from home to work (or vice versa) with intermediate stops in between (chain trips). In the current definition, HBWS trips only consider any intermediate stops with activity duration (dwell-time) less than an hour at each stop. The HBWS chained trip is converted into a single Home-to-Work Strategic trip, while keeping the first leg of the chained trip and assigning it into another Home-Based trip purpose. The first leg of the trip was included as a proxy for the added Vehicle Miles Travelled (VMT) that normally occurs during trip chaining.

NJTPA expressed concerns about whether the manner in which HBWS trips were calculated for the NJRTM-E might cause the exclusion of too many lost (or misapplied) trips in the model; therefore, Stantec analyzed the characteristics of these trips as calculated and applied by the model. Figure 48 shows the schematic diagram of the HBWS Trip.

Figure 48 – A Sample of HBWS Trip



As part of this analysis, Stantec in coordination with NJTPA, revisited the dwell-time for the HBWS purpose. Setting too short a dwell time cutoff might result in too many trips where the home-to-work connection, including the income connection used in trip generation, is lost while using too long a dwell time cutoff might exclude important intermediate trips in the analysis. Review from various travel demand models indicated that the dwell-time used by those models varied significantly. For example, the CAMPO Austin's model used a 5-minute cut-off instead of 60 minutes. Therefore, NJTPA and Stantec deemed that it would be useful to assess the impacts of the maximum dwell-time on the development of the HBWS trips.
Three dwell-time categories were tested in this review: 60 minutes, 30 minutes, and 15 minutes. The impact of the duration criteria on the HBWS generation was evaluated. This will eventually be used to decide if the current criteria need to be adjusted in this NJRTM-E Revalidation Project. Additionally, Stantec also developed the frequency distribution and average trip length of the first leg, and the frequency distribution of the activity duration. The impact of the first leg of the HBWS trip chain on the VMT was also reviewed.

THE PROCESS TO CREATE THE HBWS TRIPS

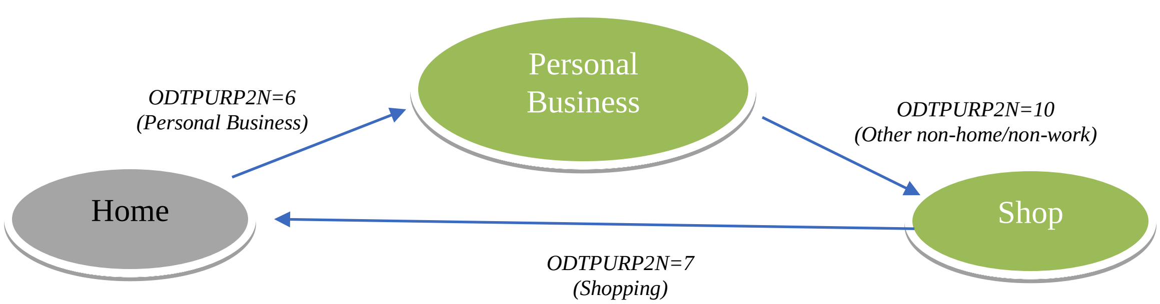
The HBWS trips were created from the 2010-2011 HH Survey Data as follow:

1. Stantec used the LINKED TRIP database and developed a Python program to summarize the HBWS trips.

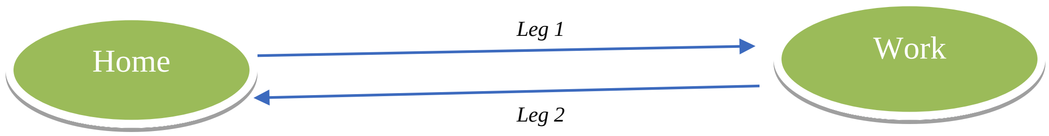
2. Each tour by each person (on the same day) was analyzed. If a tour did not include any "between work and non-work" trips based on using the OD primary trip purpose field (ODTPURP2N), it was excluded from HBWS consideration. Additionally, if the tour was less than three legs, it was also excluded. Figure 49 shows a sample of the tours that were excluded from the HBWS consideration.

Figure 49 – Samples of Excluded Tours Data from HBWS Consideration

a. Does not include "Between Work and Non-Work" OD primary purpose

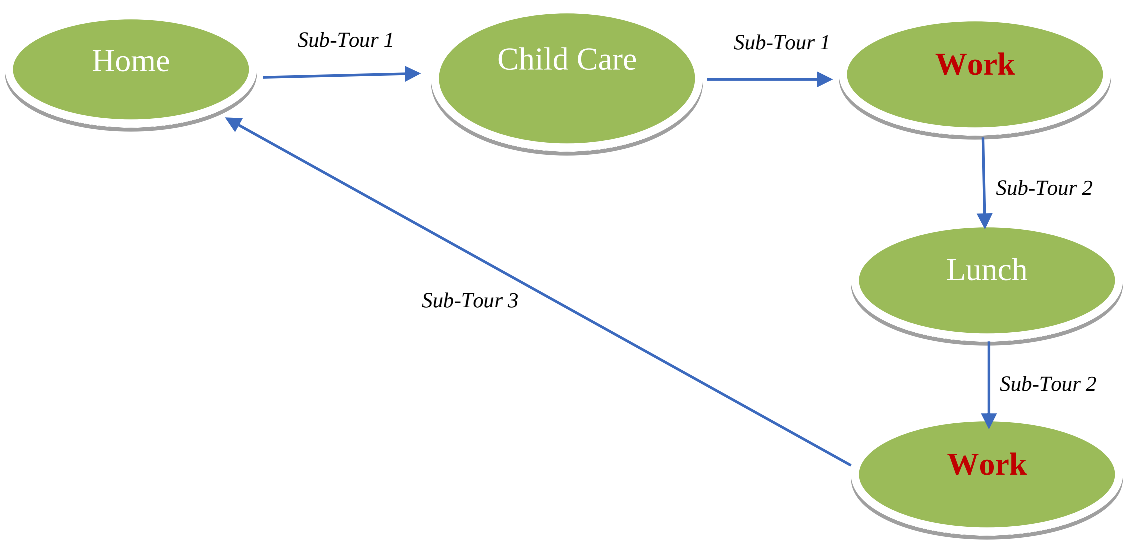


b. Less than three legs



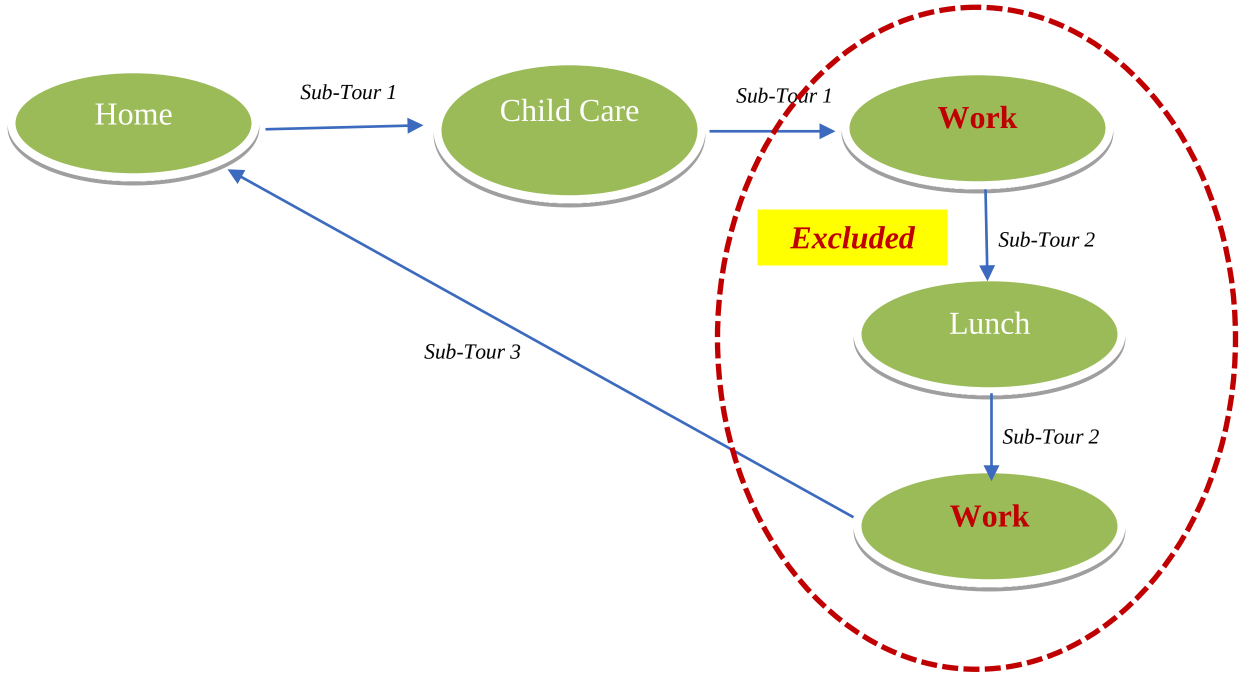
3. Each tour was partitioned into several sub-tours. The sub-tour number for each tour starts at 1, and every time a leg has a work-related "origin trip purpose" (OTPURP=1, 9, 10, 14) the sub-tour number was increased. Figure 50 shows a sample of tour disaggregation process.

Figure 50 – A Sample of Tour Partition to Sub-Tour



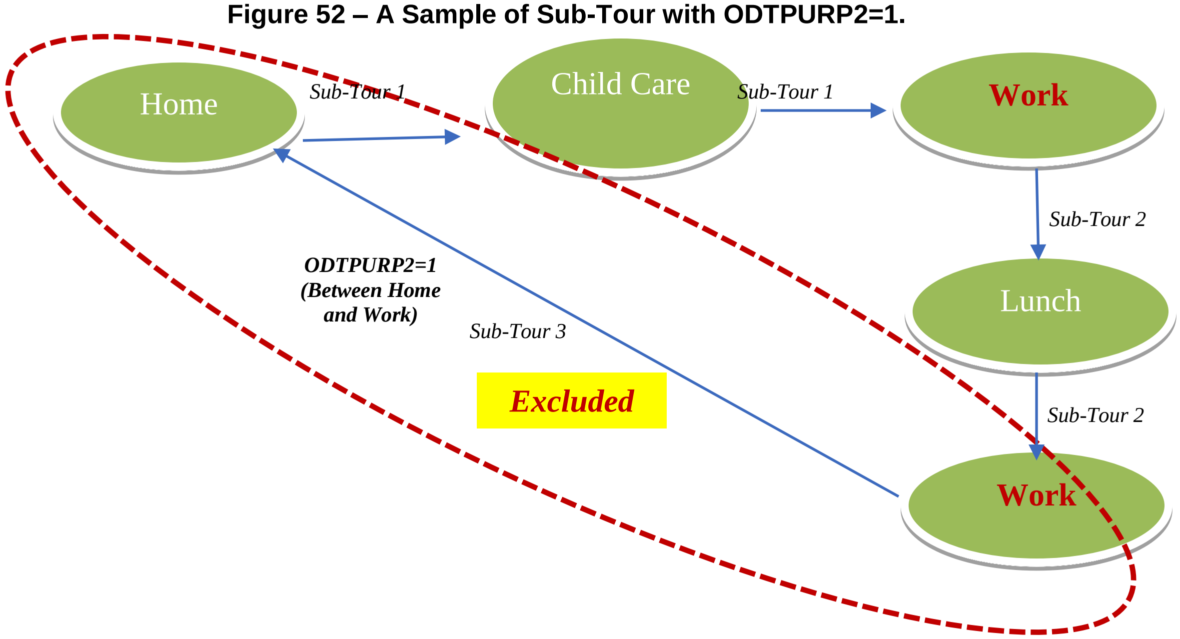
4. Any legs of the sub-tours that do not have origin (ORIG_HOME) = home or destination (DEST_HOME) = home were excluded from consideration. As shown in Figure 51.

Figure 51 – A Sample of Sub-Tour Without Origin or Destination Home.



5. Any sub-tours with ODTPURP2=1 (between Home and Work or HBWD) were also excluded as shown in Figure 52.

Figure 52 – A Sample of Sub-Tour with ODTPURP2=1.



6. To check the impacts of using different dwell times as a cutoff for inclusion as an HBWS trip, the number of trips was calculated using maximum dwell-times of 60, 30, and 15 minutes at the intermediate stops. The summary of HBWD and HBWS trips for each dwell-time limit is presented in Table 126. The comparison was performed for all records (trips), as well as for trips with at-least one end in NJTPA counties. Note that the number of trips were calculated using WHT_FAC3 (Level 3 Weights – a final weight that combines the Level-2 Weights and the correction for under-reporting non-GPS sample trips). The results indicated that the HBW trips purpose is dominated by HBW-Direct trips which comprise approximately 80% of the total HBW trips. The HBWS trips are approximately between 17% and 23% of total HBW trips, and between 19% and 24% of HBW trips that start or end in NJTPA counties.

Table 126 – HBWD and HBWS Comparison from 2010 HH Survey Data.

Max Dwell-Time	Trip Purpose	All-Trips			At-Least One End in NJTPA Counties		
		Number of Records	Trips	Percent Trips	Number of Records	Trips	Percent Trips
60 Minutes	HBWD	28,926	11,718,152	77.3%	12,936	3,934,978	75.7%
	HBWS	5,346	3,433,014	22.7%	2,526	1,263,441	24.3%
	Total HBW	**34,272**	**15,151,166**	**100.0%**	**15,462**	**5,198,418**	**100.0%**
30 Minutes	HBWD	28,926	11,718,152	79.9%	12,936	3,934,978	78.2%
	HBWS	4,371	2,939,135	20.1%	2,094	1,095,293	21.8%
	Total HBW	**33,297**	**14,657,287**	**100.0%**	**15,030**	**5,030,270**	**100.0%**
15 Minutes	HBWD	28,926	11,718,152	82.8%	12,936	3,934,978	81.3%
	HBWS	3,531	2,431,372	17.2%	1,691	905,989	18.7%
	Total HBW	**32,457**	**14,149,524**	**100.0%**	**14,627**	**4,840,966**	**100.0%**

Stantec also reviewed the time-of-day pattern of the HBWS for trips that start or end in NJTPA Counties as shown in Table 127. This analysis was performed to ascertain whether time-of-day splits required any major adjustments. The comparison indicates that the majority of work trips happened during the normal office hours, i.e., leaving for work in the AM and coming home in the PM. The split between Home-to-Work trips and Work-to-Home trips is similar across the maximum dwell-time categories.

Table 127 – HBWS Pattern By Time-of-Day.

Max Dwell-Time Limit (Minutes)	Time-of-Day	Direction of Trips	Trips	Pct. Trips
60 Minutes	AM	Home-to-Work	543,941	93.1%
		Work-to-Home	40,060	6.9%
		Total	**584,001**	**100.0%**
	PM	Home-to-Work	19,741	2.9%
		Work-to-Home	659,699	97.1%
		Total	**679,440**	**100.0%**
	Total		**1,263,441**	
30 Minutes	AM	Home-to-Work	519,989	94.3%
		Work-to-Home	31,498	5.7%
		Total	**551,487**	**100.0%**
	PM	Home-to-Work	16,886	3.1%
		Work-to-Home	526,920	96.9%
		Total	**543,806**	**100.0%**
	Total		**1,095,293**	
15 Minutes	AM	Home-to-Work	490,774	94.9%
		Work-to-Home	26,352	5.1%
		Total	**517,126**	**100.0%**
	PM	Home-to-Work	14,464	3.7%
		Work-to-Home	374,399	96.3%
		Total	**388,863**	**100.0%**
	Total		**905,989**	

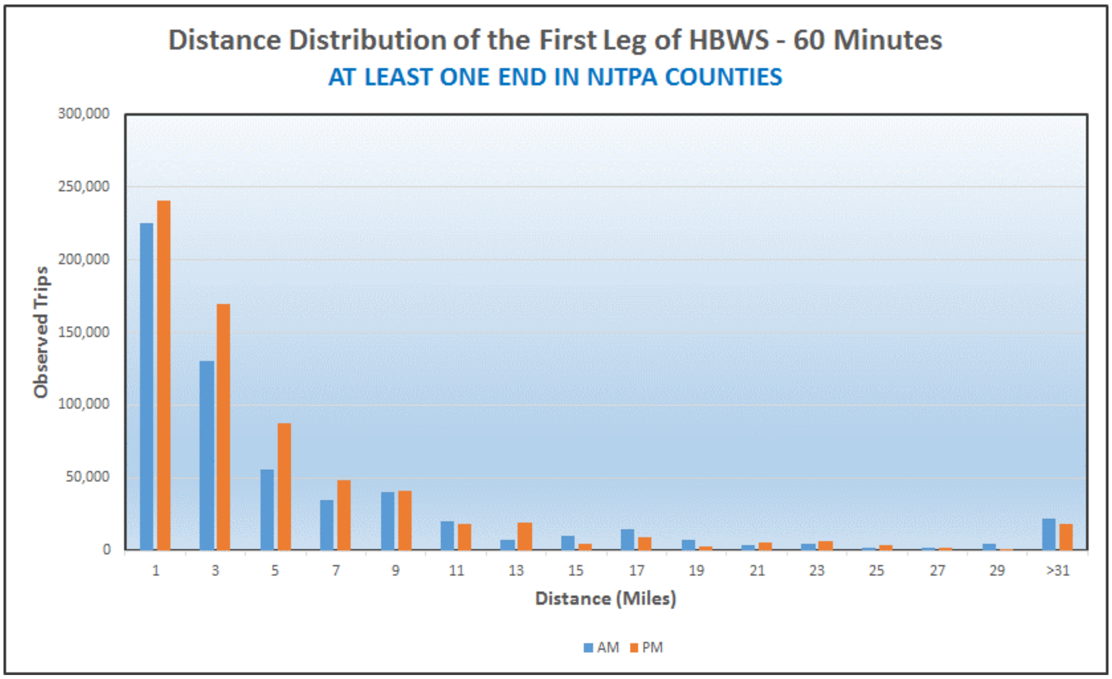
DISTANCE DISTRIBUTION FOR THE FIRST LEG OF HBWS TRIPS

The frequency distribution of the first leg's average distance were calculated to help determine the trip characteristics of the first trip leg and the added VMT from including the first trip chaining leg as compared to the actual VMT by the survey participant The average distance of the HBWS first leg trip by time-of-day (AM or PM) is shown in Table 128. The average distance is higher for the trips that start or end in the 13 NJTPA Counties than the overall average. This is reasonable since the overall average is skewed by significantly shorter trips that occur in Manhattan. The average distance for AM and PM periods is similar for both sample sets. The average distance among the three dwell-time categories is also comparable. The distance distribution of the first leg for the 60-minute dwell-time is shown in Figure 53.

Table 128 – Average Distance of the First Leg of HBWS Trips

MaxDwell-Time (Minutes)	Description	Average Distance for all trips (Miles)	Average Distance for Only if O or D within the 13 NJTPA Counties
60 Minutes	AM (Home-to-Work)	4.41	5.83
	PM (Work-to-Home)	4.26	5.75
	Total	**4.35**	**5.86**
30 Minutes	AM (Home-to-Work)	4.44	5.85
	PM (Work-to-Home)	4.09	5.42
	Total	**4.28**	**5.69**
15 Minutes	AM (Home-to-Work)	4.26	5.40
	PM (Work-to-Home)	3.75	5.08
	Total	**4.06**	**5.31**

Figure 53 – Distance Distribution of the HBWS' First Leg for 60-Minutes Activity Duration.



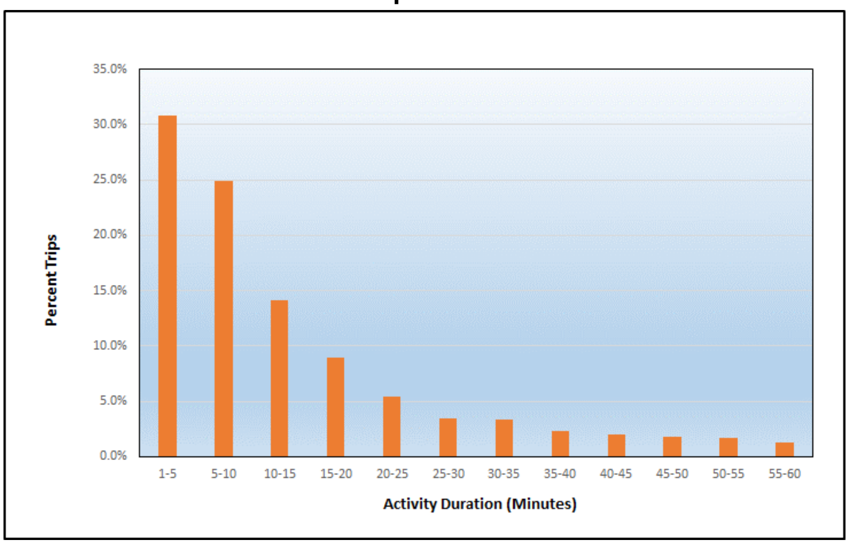
FREQUENCY DISTRIBUTION OF DWELL-TIME FOR HBWS

The frequency distribution of dwell-time at intermediate stops for HBWS trip purpose was also evaluated. Table 129 and Figure 54 show the dwell-time percent frequency distribution with a 60-minute cut off. Using 60-minute dwell-time as the base, the frequency distribution table shows that the 15-minute dwell-time category only captured approximately 70% of HBWS trips, while the 30-minute dwell-time category captured approximately 88% of the trips.

Table 129 – Dwell-Time Percent Distribution.

Dwell-Time Range	Percent Trips	Cummulative Percent
1-5	30.8%	69.8%
5-10	24.9%	
10-15	14.1%	
15-20	9.0%	87.7%
20-25	5.4%	
25-30	3.5%	
30-35	3.3%	100.0%
35-40	2.3%	
40-45	2.0%	
45-50	1.8%	
50-55	1.6%	
55-60	1.3%	

Figure 54 – Dwell-Time Percent Trip Distribution for all Intermediate Legs.



CONCLUSION

Based on the observations above, it was concluded that the HBWS trip patterns among the three dwell-time categories are quite similar. While most first leg trips occurred during the first 30 minutes, NJTPA and Stantec decided to retain the original dwell-time criteria of 60 minutes for this project. Additionally, Stantec in coordination of NJTPA, also reviewed the impact of adding the first of the HBWS trips on the VMT estimates. Table 130 shows the comparison of the HBWS tour distance (real distance) with the modeled distance (direct distance + first leg).

Table 130 – Average HBWS Distance Comparison – Real vs. Modeled

	Average Distance (Miles)
HBWS Tour Distance to Work	20.04
HBWS Direct Distance to Work	16.14
First Leg Distance	5.86
Total	22.00
% Difference	**9.8%**

Considering that the HBWS trips are approximately 5.6% of the total trips, the impact of the modeled distance on the regional VMT is approximately 0.5% higher than the real VMT, as shown in Table 131. This impact is reasonably small and on the higher side, which is acceptable for the Conformity Analysis.

Table 131 – The Impact of Modeled HBWS Distance on Regional VMT

% HBWS Trips (of Total trips)	5.6%
% difference attributable to the HBWS distance variation	**9.8%**
% VMT Change at Regional Level	**0.5%**

While the current treatment of HBWS trips by the NJRTM-E is inexact, both NJTPA and Stantec concluded that the benefits of keeping the HBWS definition unchanged was the best alternative. Using a HBWS provides a better accounting of all trips where the primary purpose is the work destination while keeping the first leg of the trip helps the model retain the VMT lost from excluding intermediate trips from the model.

APPENDIX M – INCOME GROUP ADJUSTMENTS

Since, as part of the NJRTM-E Revalidation Project, the new income data was collected using the five-year 2011-2015 American Community Survey and is based on 2015 dollars (calibration year), Stantec analyzed the need to update the current income group definition. This definition which was created based on 2000 dollars needs updating to 2015 dollars to be consistent with the new income data. Currently, the NJRTM-E uses five income groups as follows:

- Group 1 – equal or less than $14,999
- Group 2 – between $15,000 and $34,999
- Group 3 – between $35,000 and $74,999
- Group 4 – between $75,000 and $149,999
- Group 5 - $150,000 and higher

In order to build the income adjustment factor, Stantec reviewed the historical household income data in New Jersey, obtained from the Census Data, and the CPI for urban areas. Table 132 shows the historical income data and CPI from 2000 to 2015. The income and CPI factors were normalized to 2000 values.

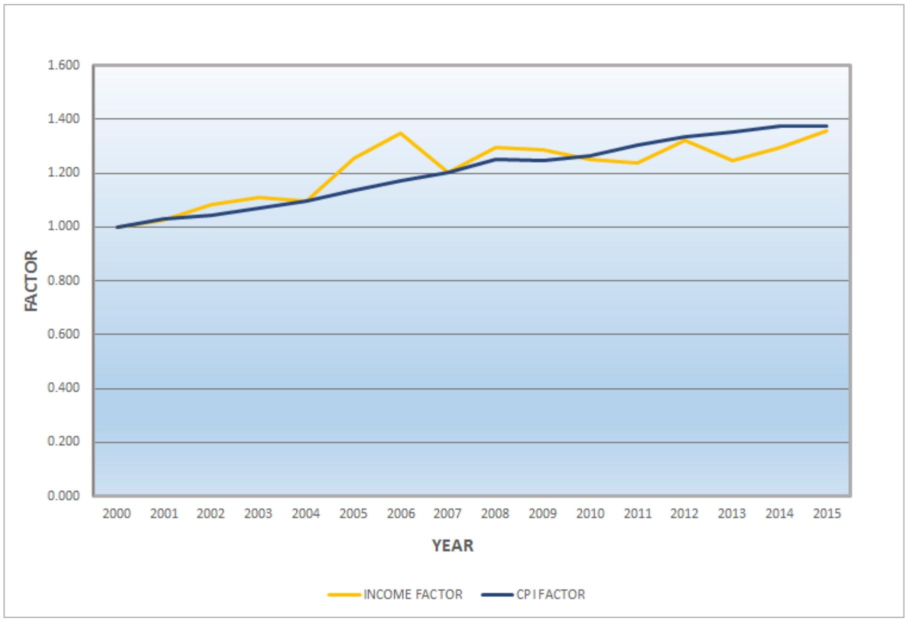
Table 132 – Historical Income and CPI Data

YEAR	INCOME		CPI	
	VALUE	FACTOR	VALUE	FACTOR
2000	$50,405	1.000	172.2	1.000
2001	$51,771	1.027	177.1	1.028
2002	$54,568	1.083	179.9	1.045
2003	$56,045	1.112	184.0	1.069
2004	$55,275	1.097	188.9	1.097
2005	$63,368	1.257	195.3	1.134
2006	$68,059	1.350	201.6	1.171
2007	$60,508	1.200	207.3	1.204
2008	$65,306	1.296	215.3	1.250
2009	$64,777	1.285	214.5	1.246
2010	$62,968	1.249	218.1	1.267
2011	$62,338	1.237	224.9	1.306
2012	$66,692	1.323	229.6	1.333
2013	$62,768	1.245	233.0	1.353
2014	$65,243	1.294	236.7	1.375
2015	$68,357	1.356	237.0	1.376

Note:
Income = NJ Median Income from US Census Bureau
CPI = CPI-U for All-Urban Consumers

Figure 55 shows the plot of Income and CPI Factors from 2000 to 2015. The figure indicates that income and CPI grew at an almost similar trend. CPIs increased steadily every year except between 2008 and 2009 or at the start of the recent recession, while income data have slightly more variations over the years.

Figure 55 – Income and CPI Growth Trend



Income and CPI grew at 35.6% and 37.6%, respectively, from 2000 to 2015 as shown in Table 132. Table 133 shows the adjusted income group definition using CPI-Based and Income-Based factors.

Table 133 – Adjusted Income Group Definition Using CPI-Based and Income-Based Factors

Income Group	Year 2000		Year 2015 - CPI Based		Year 2015 - Income Based	
	From	To	From	To	From	To
1	$0	$15,000	$0	$20,646	$0	$20,342
2	$15,000	$35,000	$20,646	$48,174	$20,342	$47,465
3	$35,000	$75,000	$48,174	$103,230	$47,465	$101,712
4	$75,000	$150,000	$103,230	$206,461	$101,712	$203,423
5	$150,000		$206,461	$0	$203,423	$0

For calibration purposes, it is pertinent to create an income group definition that is consistent with the income group from the 2010-2011 Household Travel Survey Data. The income group from the Household Survey Data is defined as follows:

- Group 1 – equal or less than $15,000
- Group 2 – between $15,000 and $30,000
- Group 3 – between $30,000 and $50,000
- Group 4 – between $50,000 and $75,000
- Group 5 – between $75,000 and $100,000
- Group 6 – between $100,000 and $150,000
- Group 7 – between $150,000 and $200,000
- Group 8 – higher than $200,000

Comparing the income group definition from household survey data to the adjusted income group shown in Table 133, it was deemed reasonable that income groups 3 to 5 will be adjusted to the new definition as follows:

- Group 3 – between $50,000 and $100,000
- Group 4 – between $100,000 and $200,000
- Group 5 – higher than $200,000

Additionally, the household distribution for the updated income groups 3 to 5 was compared to the original 2000 income groups, as shown in Table 134. The household distribution of these three income groups (Group 3-5) is similar to the household distribution of the same income groups from the original 2000 data.

Table 134 – Household Distribution by Income Group Comparisons

Updated Income Group	2010 HH Survey (Weighted)	Income Group	NJRTM-E 2000 Validation	
			PUMS Data	Census Data
- - 15,000	8.2%	1	11.6%	11.6%
15,000 - 30,000	13.7%	2	18.8%	18.6%
30,000 - 50,000	14.6%			
50,000 - 100,000	29.6%	3	33.0%	33.1%
100,000 - 200,000	26.0%	4	26.6%	27.0%
>200000	7.9%	5	10.0%	9.7%

The grouping of the first two income categories, however, is not as simple and easy as the last three income categories. To analyze the grouping of the first two categories, Stantec compared the travel patterns among three income categories derived from the household survey data (0-15K, 15-30K, and 30-50K), including:

- Trip rates by income by trip purpose
- Mode share by income and by purpose

Table 135 shows the trip rates per household by income group and trip purpose, and Table 136 compares the percent mode shares by income group and trip purpose. The yellow-shaded values in these two tables indicate the values that are similar among the first three income categories.

Table 135 – Trip Rates Per Household by Income Group and Trip Purpose

Purpose	Income						Total
	0-15k	15k-30k	30k-50k	50k-100k	100k-200k	200k+	
HBWD	0.42	0.87	1.21	1.86	2.15	2.17	1.61
HBWS	0.06	0.19	0.20	0.40	0.51	0.54	0.35
HBS	0.85	1.00	1.04	0.97	1.09	1.00	1.01
HBO	2.74	2.99	3.00	4.16	5.11	5.09	4.03
NHBW	0.10	0.17	0.33	0.51	0.67	0.72	0.46
NHBO	1.40	1.88	1.99	2.10	2.45	1.92	2.07
Total	5.57	7.11	7.77	10.00	11.98	11.45	9.54

Table 136 – Mode Shares by Income and by Trip Purpose

HBWD

MODE	INC-1	PCT	INC-2	PCT	INC-3	PCT
SOV	27,480	39.8%	162,207	68.1%	286,872	76.9%
HOV2	8,629	12.5%	14,551	6.1%	25,922	6.9%
HOV3	3,446	5.0%	2,172	0.9%	2,602	0.7%
HOV4	2,487	3.6%	5,663	2.4%	3,453	0.9%
Walk Transit	22,726	32.9%	49,794	20.9%	51,987	13.9%
Drive Transit	4,235	6.1%	3,747	1.6%	2,229	0.6%
Total	69,003	100.0%	238,134	100.0%	373,065	100.0%

HBWS

MODE	INC-1	PCT	INC-2	PCT	INC-3	PCT
SOV	4,760	67.8%	47,568	88.5%	58,859	92.6%
HOV2	1,481	21.1%	4,375	8.1%	2,358	3.7%
HOV3	-	0.0%	880	1.6%	50	0.1%
HOV4	-	0.0%	-	0.0%	-	0.0%
Walk Transit	196	2.8%	924	1.7%	2,324	3.7%
Drive Transit	587	8.4%	-	0.0%	-	0.0%
Total	7,024	100.0%	53,746	100.0%	63,591	100.0%

Table 136 **- Continued**

HBS

MODE	INC-1	PCT	INC-2	PCT	INC-3	PCT
SOV	45,817	41.6%	111,630	46.7%	211,839	68.0%
HOV2	34,095	30.9%	63,933	26.8%	60,788	19.5%
HOV3	3,619	3.3%	24,955	10.4%	14,515	4.7%
HOV4	8,914	8.1%	731	0.3%	4,941	1.6%
Walk Transit	17,565	15.9%	35,674	14.9%	18,549	6.0%
Drive Transit	172	0.2%	1,998	0.8%	729	0.2%
Total	110,182	100.0%	238,922	100.0%	311,360	100.0%

HBO

MODE	INC-1	PCT	INC-2	PCT	INC-3	PCT
SOV	122,129	36.7%	292,798	41.9%	392,784	49.1%
HOV2	68,801	20.7%	239,515	34.3%	226,051	28.3%
HOV3	31,045	9.3%	57,502	8.2%	90,198	11.3%
HOV4	33,789	10.2%	44,799	6.4%	42,633	5.3%
Walk Transit	61,681	18.6%	60,413	8.6%	41,165	5.1%
Drive Transit	15,063	4.5%	3,888	0.6%	6,531	0.8%
Total	332,507	100.0%	698,914	100.0%	799,362	100.0%

NHBW

MODE	INC-1	PCT	INC-2	PCT	INC-3	PCT
SOV	12,807	75.8%	25,590	75.2%	72,319	79.1%
HOV2	1,161	6.9%	4,748	14.0%	6,312	6.9%
HOV3	-	0.0%	978	2.9%	5,140	5.6%
HOV4	-	0.0%	-	0.0%	3,125	3.4%
Walk Transit	2,924	17.3%	2,694	7.9%	4,110	4.5%
Drive Transit	-	0.0%	-	0.0%	366	0.4%
Total	16,892	100.0%	34,011	100.0%	91,372	100.0%

NHBO

MODE	INC-1	PCT	INC-2	PCT	INC-3	PCT
SOV	84,386	42.4%	219,056	48.3%	376,917	63.9%
HOV2	71,044	35.7%	118,789	26.2%	146,449	24.8%
HOV3	20,095	10.1%	63,207	13.9%	32,248	5.5%
HOV4	10,716	5.4%	20,451	4.5%	21,334	3.6%
Walk Transit	12,775	6.4%	29,562	6.5%	10,197	1.7%
Drive Transit	-	0.0%	2,817	0.6%	3,132	0.5%
Total	199,015	100.0%	453,883	100.0%	590,277	100.0%

Using these comparisons and after discussing with NJTPA, it was deemed logical to define the first two income groups as 0-15K and 15-50K. The final updated income group definition is as follows:

- Group 1 – equal or less than $15,000
- Group 2 – between $15,000 and $50,000
- Group 3 – between $50,000 and $100,000
- Group 4 – between $100,000 and $200,000
- Group 5 – higher than $200,000