EXECUTIVE SUMMARY

Introduction

Stantec Consulting Services Inc. (Stantec) was retained by the North Jersey Transportation Planning Authority (NJTPA) to conduct the revalidation of its regional travel demand model (NJRTM-E). This revalidation project is referred as "The 2018 NJRTM-E Revalidation Project". The NJRTM-E was originally developed in 2008 and revalidated in 2011. In 2015, the model was updated to include the transit module conversion from TRNBUILD to Public Transport (PT) and to add a sub-model to better account for external trips. However, these updated model components had not been officially adopted into the model until the completion of the 2018 NJRTM-E Revalidation Project.

The tasks included in this project are as follows:

1. Data Collection (e.g., incorporation of the 2010-11 Regional Household Travel Survey (RHTS), 2010 Census data, updated traffic counts).
2. Expanded Traffic Analysis Zone structure and Network Refinement.
3. Model Component Updates, including mode choice, PT module, External Model, NJFARE2 program, Home-Based Work Strategic (HBWS), Home-Based University (HBU), truck data, income group definition, and non-motorized trips.
4. Model revalidation, including model calibration to 2015 traffic condition.
5. Sensitivity analysis.

Data Collection

Data Collection

The first step of the model revalidation project is to prepare the observed targets for various model components, including trip generation, trip distribution, mode choice, and highway and transit assignments. The observed targets for the first three model components were derived mostly from the 2010-11 Regional Household Travel Survey (RHTS). This data was supplemented with other information (mostly Census derived). For example, the 2015 PUMS data was used to determine lifecycle statistics for use in trip generation. The 2014 Census Longitudinal-Employer Household Dynamics data was used for socio-economic data work and trip distribution. Census Journey-to-work data provided trip distribution and mode choice information for the region.

Besides RHTS and Census information, data was also provided by regional agencies. Surrounding MPOs provided their latest socio-economic data. NJTPA subregions provided traffic count information.

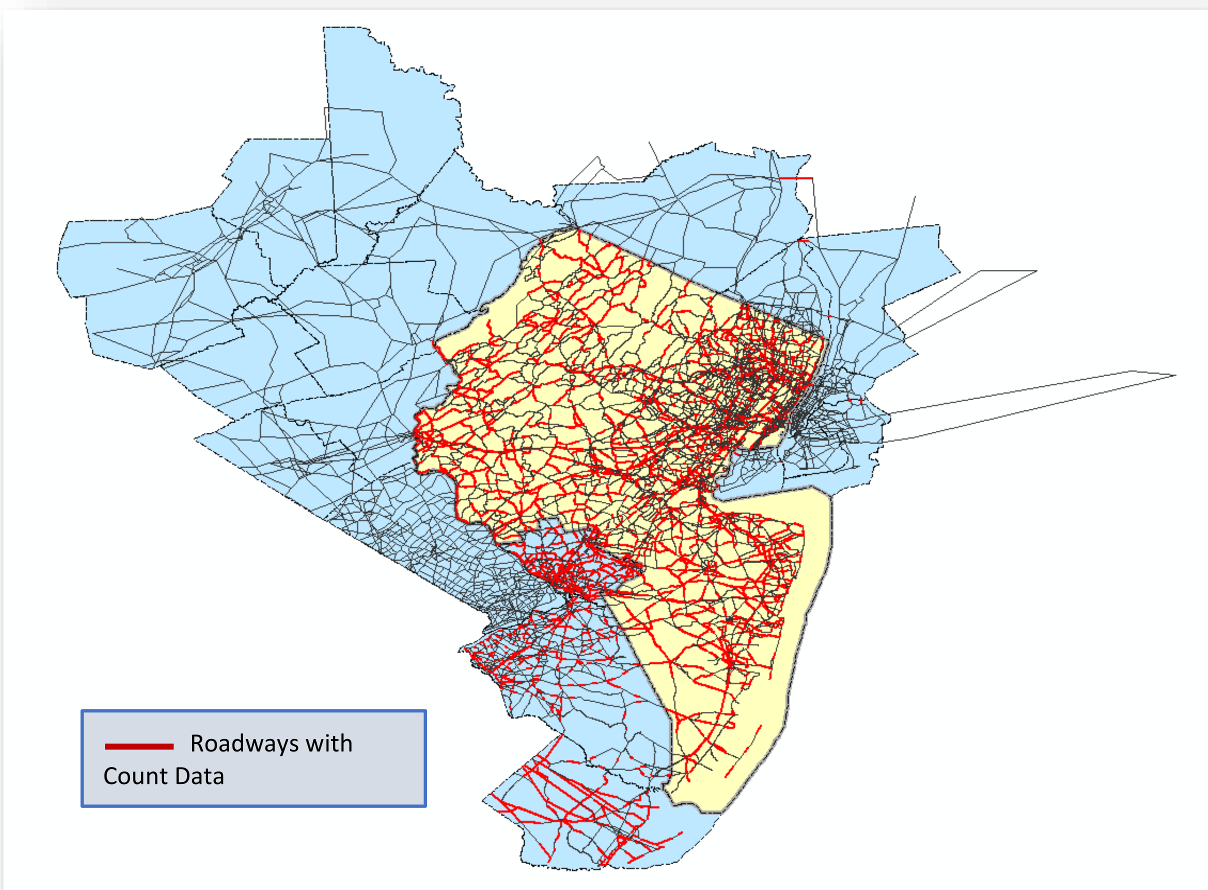
For freight, PANYNJ provided Origin-Destination data for their major facilities. These were supplemented with CoStar data that provided major warehouse facility locations and employment.

For highway and transit assignments the observed targets used for comparing speed, traffic count and transit ridership were obtained from:

- INRIX speed data
- Various traffic count sources
- Transit ridership data provided by the NJT and PANYNJ

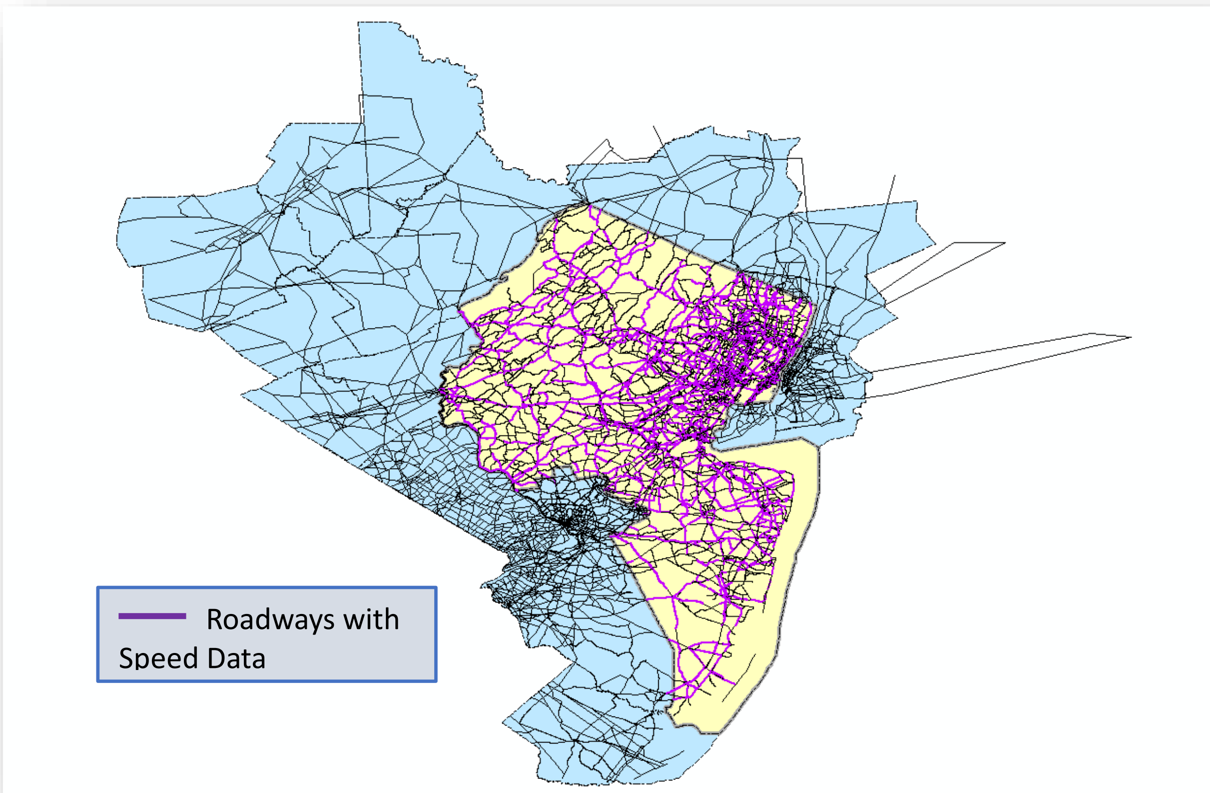
The traffic count database covers more than 6,000 highway links in the study area, which shows the wealth of data used in this revalidation project. Special emphasis for traffic count collection was given to screenline locations. Locations not available from NJDOT, PANYNJ or other governmental agency sources were collected as part of this revalidation project. Figure E-2 shows the traffic count locations.

Figure E-2 - Traffic Count Locations



The observed speed data also include most of the highway links in the NJTPA Region as shown in Figure E-3.

Figure E-3 – Observed Speed Locations



Expanded Traffic Analysis Zone structure and Network Refinements

This project provided the first chance to fully incorporate the changes to the Traffic Analysis Zone structure (TAZs) resulting from the 2010 census into the NJRTM-E. The TAZs were expanded from 2553 zones to 2900 zones, including over 180 reserved zones for future use (2,712 TAZs excluding reserved zones). Within the NJTPA region, there are over 70 new TAZs and 1,602 TAZs (excluding reserved zones). The updated zonal system:

- Follows the 2010 Census Boundary
- Considers the NJTPA, Port-Authority, and Surrounding MPO county boundaries
- Maintains municipality boundaries within the NJTPA region.
- Considers the NJ Transit's TAZ system for compatibility purposes

The updates on the zonal system also required adjustments to the centroid connectors in the highway network. The updated zonal system is shown on Table E-1 in the Model Development Manual.

Additional to centroid connector changes, both the highway and transit networks were reviewed to incorporate any necessary changes to the transportation system. Since most changes to the transportation system (both highway and transit) are incorporated annually, this more thorough review of the system only necessitated minor adjustments.

Table E-1 – Updated 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	

Model Component Updates

Mode Choice Model

The mode choice model component was converted from the Fortran-Based program to C-Based program. This new C-Based program is consistent with the updated NJ TRANSIT's Travel Demand Model (NJTDFM).

PT Module

The transit sub-model was converted from using the TRNBUILD program, a CUBE legacy program which is no longer supported, to using the Public Transport (PT) program in the NJRTM-E Refinement project. This sub-model was officially incorporated into the NJRTM-E as part of this revalidation project and was further calibrated to replicate the 2015 transit ridership data obtained from the NJ TRANSIT (NJT). The PT conversion is included in the transit path building and transit assignment sub-models.

NJFARE2 Program Conversion

NJFARE2 program is an executable file to calculate transit fares. The program was incompatible with the latest version of Cube version (Version 6.4) and therefore required NJRTM-E users to maintain the older CUBE version 6.1 for running the model. As part of this project, NJFARE2 program was converted into a series of Cube scripts and stored into a fare sub-model called "Prepare Transit Fare" thus, allowing the NJRTM-E to run using the latest CUBE Platform. This transit fare sub-model is consistent with the NJT's updated fare estimation model.

External Trip Sub-model

The external sub-model was originally developed as part of the NJRTM-E Refinement Project in 2015. The main focus of this task is to refine the modeling of external auto trips on the southern section of the NJ Turnpike with the objective of improving the estimated volume and travel patterns. The refinements 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 Turnpike's 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 2015 New Jersey Turnpike entry-exit transaction data provided by the New Jersey Turnpike Authority as part of the 2018 NJRTM-E Revalidation Project.

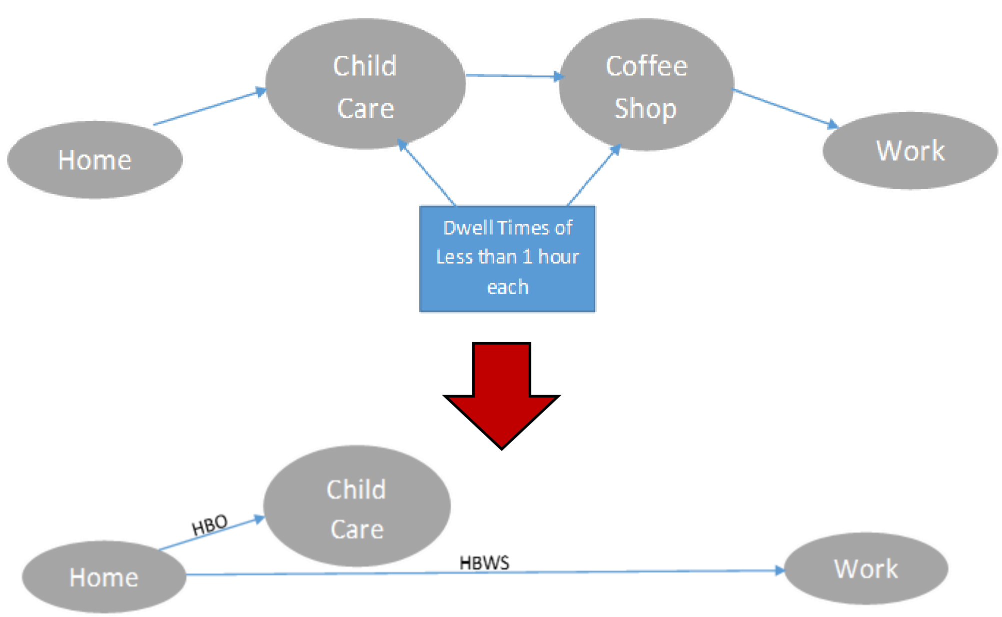
The module was designed to be flexible and easily adaptable to other NJRTM-E external gateways into the NJTPA region serving significant long-distance travel, such as the western terminus of I-80 and I-78. However, since the model has a larger buffer to the west and north of the NJTPA region, these external loading points, as well as those on the northern portion of the region, are significantly more distant from the NJTPA region and the portion of traffic from those zones that interacts with the NJTPA counties may be much lower than the percentage of traffic on the southern end of the NJ Turnpike. Detail discussion of this sub-model is presented in Section 9.10.

HBWS Review

The review of HBWS was mainly focused on determining the length of the dwell-time within the work trip chain. 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 E-1 shows the schematic diagram of the HBWS Trip.

As part of this analysis, Stantec in coordination with NJTPA, revisited the dwell-time for the HBWS purpose. The data from 2010-2011 NYMTC / NJTPA RHTS was used for this analysis. 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 was eventually 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.

Figure E-1 – S Sample of HBWS Trip



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 frequency distribution of dwell-time at intermediate stops for HBWS trip purpose was also evaluated. The results of the analysis indicated that the HBWS trip patterns among the three dwell-time categories are quite similar. Therefore, the original dwell-time criteria of 60 minutes was retained for this project. Detail discussion of HBWS analysis can be found in Appendix L of the Model Development Manual.

HBU Review and Updates

The original approach or method for estimating HBU was retained. The student enrollment data was updated and the model was recalibrated to the 2015 data derived from the 2010-2011 RHTS.

Update Truck Data

The truck model component was also revisited as part of the 2018 Revalidation Project. The special generators data such as warehouses and truck terminals were updated based on the latest data provided by Freight Division of the NJTPA.

The origin-destination (O-D) truck distribution from/to seven major truck generators, including ports and airports were obtained from Port Authority of New York and New Jersey (PANYNJ). The seven major truck generators are:

- Newark Liberty Airport
- Port Elizabeth and Port Newark
- Port Jersey
- Howland Hook
- JFK Airport
- Stewart Airport
- New York Marine Terminal

The O-D data was used for truck model calibration.

Income Group Update

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 categories. These categories which were created based on 2000 dollars were updated to 2015 dollars to be consistent with the new income data. The five income groups based on 2000 dollars were 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 used both Census household income data and the CPI data for urban areas. Due to data availability, the eight income groups from the 2010-2011 RHTS had to be incorporated as part of the NJRTM-E income groups to maintain consistency between the model and the data source. The income group from the RHTS are 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 the RHTS data to the inflation adjusted income group, it was deemed reasonable to adjust the new income group 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

Further detail on this topic can be found in Appendix M of the Model Development Manual.

Non-Motorized Model

The original approach of the non-motorized model and the utility variables for each trip purpose were retained. The utility coefficients of those variables were calibrated and updated to the 2010-2011 RHTS Data. The observed non-motorized data was very limited for certain markets and trip purposes. Therefore, deviations between observed and estimated trips are higher at the purpose-level than for the NJTPA region as a whole. At the regional-level, the estimated non-motorized trips were 0.4% lower than the observed data as shown in Table E-2.

Table E-2 – Updated NJRTM-E Zonal System

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%**

A further detail discussion of the non-motorized model is presented in Section 8.7 of the Model Development Manual.

Model Revalidation

Revalidation Results

The model was revalidated to the 2015 conditions. Starting with the first model component, Trip Generation, the estimated trip production and attraction were compared to the observed data. Table E-3 shows the trip generation summary by trip purpose. The estimated trips replicated the observed targets very well, the differences are within one percent.

Table E-3 – Trip Production and Attraction Comparison by Purpose

PURPOSE	TRIP PRODUCTION			TRIP ATTRACTION		
	OBS	EST	DIFF %	OBS	EST	DIFF %
HBWD	3,523,245	3,525,175	0.1%	3,150,196	3,150,593	0.0%
HBWS	1,250,989	1,253,265	0.2%	1,180,403	1,180,006	0.0%
HBS	2,316,321	2,316,303	0.0%	2,278,566	2,275,407	-0.1%
HBO	8,793,743	8,793,403	0.0%	8,621,691	8,620,107	0.0%
WBO	1,035,877	1,029,443	-0.6%	1,016,902	1,027,553	1.0%
NHBO	4,628,192	4,638,431	0.2%	4,633,466	4,630,850	-0.1%
TOTAL	**21,548,368**	**21,556,019**	**0.0%**	**20,881,224**	**20,884,517**	**0.0%**

The trip distribution calibration were performed by comparing the measures of the distribution, such as average travel time and distance, as well as frequency distributions and the trip flows between counties. Table E-4 shows the average travel time and distance by purpose. The estimated travel time and distance are generally well within tolerance of the observed data. The percent differences between observed and estimated values are within 5%.

Table E-4 Average Time and Distance Comparison

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%

Another important measure of the trip distribution, is the number of trips traveling between New Jersey and New York crossing the Hudson River. Table E-5 shows the trip comparison of this market. The estimated total trip is 1.5% lower than the observed value, which is within reasonable tolerance. There are more variance at purpose-level.

Table E-5 Trans-Hudson Crossing Person Trip Comparison

PURPOSE	OBSERVED (RHTS)	ESTIMATED	%DIFFERENCE
HBWD	585,714	570,551	-2.6%
HBWS	126,708	130,918	3.3%
HBS	45,159	35,517	-21.4%
HBO	221,094	242,595	9.7%
WBO	49,766	45,057	-9.5%
NHBO	95,506	82,590	-13.5%
TOTAL	**1,123,946**	**1,107,229**	**-1.5%**

Table E-6 compares mode distribution by purpose between the observed RHTS data and the NJRTM-E. The estimated mode shares are reasonably close to the observed data across all trip purposes.

In addition to regional comparison, the mode shares were also compared for trip movements between various geographic market segments. The region is subdivided into eleven different market segments to allow the model to closely replicate the observed ridership patterns. For example, the first market segment are trips originating west of the Hudson River (excluding Staten Island) into Manhattan. The model estimated results were reasonable when compared to observed data. The market segment definition and mode choice comparison by market segment are presented in Chapter 10, Mode Choice, of the Model Development Manual.

Table E-6 Mode Share Comparison by Purpose

MODE	HBWD (Person Trips)	
	2010 RHTS	Estimated
	Pct	Pct
SOV	76.1%	75.0%
HOV2	5.7%	5.8%
HOV3	0.8%	0.8%
HOV4	0.5%	0.6%
Walk-Transit	10.3%	11.1%
Drive-Transit	6.5%	6.8%
TOTAL	100.0%	100.0%
Average Car Occupancy	1.05	1.05

MODE	HBWS (Person Trips)	
	2010 RHTS	Estimated
	Pct	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	Estimated
	Pct	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%	4.9%
Drive-Transit	0.2%	0.1%
TOTAL	100.0%	100.0%
Average Car Occupancy	1.27	1.29

MODE	HBO (Person Trips)	
	2010 RHTS	Estimated
	Pct	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	Estimated
	Pct	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	Estimated
	Pct	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

For highway assignment, estimated volumes and VMT from the model were compared to the traffic counts. These results of these comparisons were aggregated to the facility type, area type, and screenline levels. Other critical locations such as the Hudson River crossings and the New Jersey Turnpike were also compared. The Root-Mean-Square Error (RMSE) was calculated by volume group, Speeds were compared to available INRIX data to assess the operational performance of the highway assignment model.

Table E-7 and E-8 show percent differences of traffic volumes by facility type and by area type compared to the FHWA and other DOT standards, respectively. The comparisons indicated that the differences between observed data and model estimates were well-within the reasonable tolerance. The other comparisons, which also compared favorably to observed data, and detail discussions pertaining to highway assignment can be found in Section 12.2 of the Model Development Manual.

Table E-7 Traffic Volume Comparison by Facility Type

FACILITY TYPE	ESTIMATED %DIFF	FHWA STANDARD
Limited-Access Facility	0.9%	+/- 7%
Expressway	-4.9%	+/- 10%
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**

Table E-8 Traffic Volume Comparison by Area Type

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**

The final calibration component is transit assignment. Rail and bus ridership were compared to the observed ridership provided by the NJT and PANYNJ. Table E-9 and E-10 show the NJT rail ridership and PABT bus ridership summaries by line. The rail ridership results are generally within a reasonable tolerance. The estimated bus ridership has more variance compared to the observed data, however observed bus ridership date was only based on one data and is, therefore, not as reliable as the rail ridership data which was collected for the full year. Table E-11 shows the PATH ridership comparison. The estimated total ridership for PATH mode is 1.4% higher than the observed data. The difference is within a reasonable tolerance. The difference is more significant at station-level.

Table E-9 Average Weekday Boarding by Rail Line

Line Name	Observed 2016	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 E-10 PABT Bus Ridership Summary - Inbound

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 E-11 PATH Ridership Summary

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%**

Chapter 14, Transit Assignment, has a more detailed discussion including additional comparison summaries.

Sensitivity Analysis

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

Increase Transit Fare by 50%

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 E-12. The results indicated that the total transit trips are down by approximately four percent, 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 E-12 – Mode Choice Comparison

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%
Drive-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%**

To assess the reasonableness of the sensitivity results, the ridership changes due to past increased transit fares were reviewed. The results of the sensitivity analysis for the 50% fare increase is approximately 4% decrease in ridership. After comparing to the historical data and discussing with technical advisory committee (TAC) members, the results are deemed to be reasonable. Section 15.2 includes a detailed discussion of this sensitivity analysis.

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 E-13. 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 E-14.

Table E-13 – 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 E-14 – 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 E-15 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.

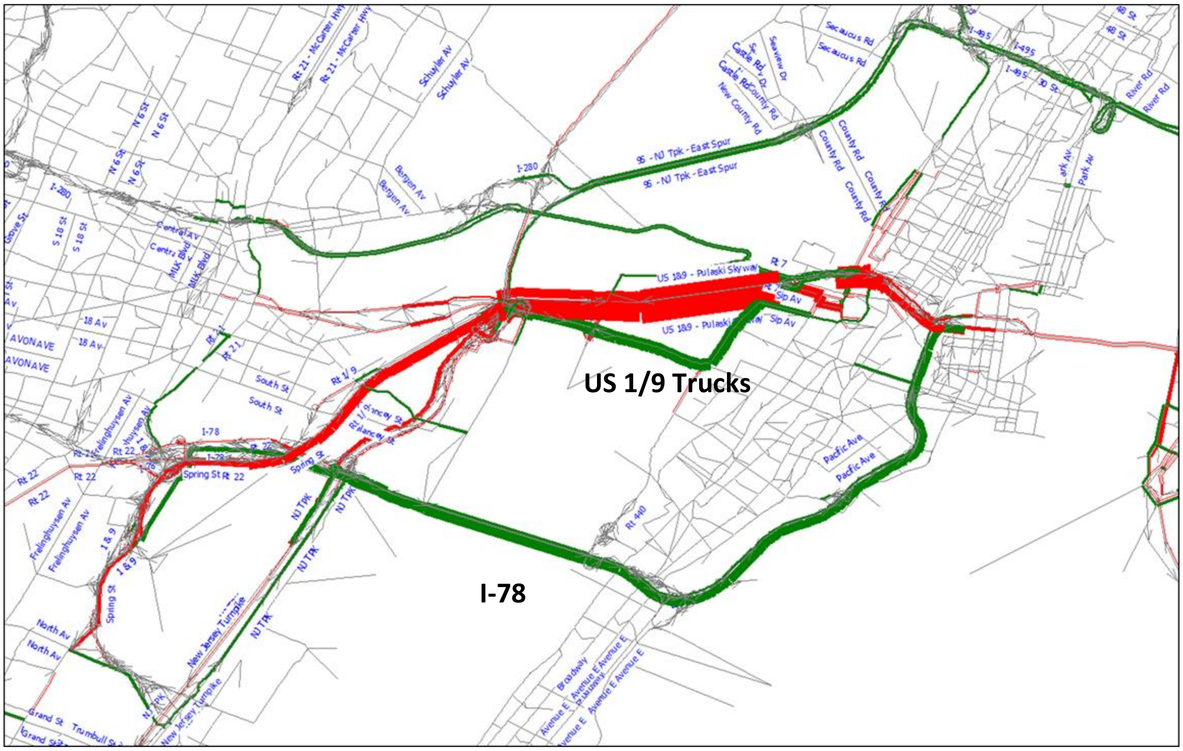
Table E-15 – Mode Choice Comparison

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%**

Pulaski Skyway Closing

The third sensitivity test assessed the 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 were closed, as well as several ramps along this corridor. The traffic counts representing before and after the closure were obtained and compared. Figure E-4 shows the estimated traffic diversion due to the closing.

Figure E-4 – The Estimated Traffic Diversion Due to Pulaski Closing



TAC members reviewed and discussed the estimated traffic diversion during the final TAC meeting and deemed that the pattern was reasonable. Table E-16 compares the Trans-Hudson traffic between the base scenario where northbound Pulaski Skyway lanes are closed, and the sensitivity scenario which correspond to the conditions prior to the closing. The positive differences on the table indicates locations where 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. Section 15.4 of the Model Development Manual includes a detailed discussion of this sensitivity analysis.

Table E-16 – Trans-Hudson Traffic Summary

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%**