



NJRTM-E Model Development Manual

Version 4

2023 Revalidation – Executive Summary

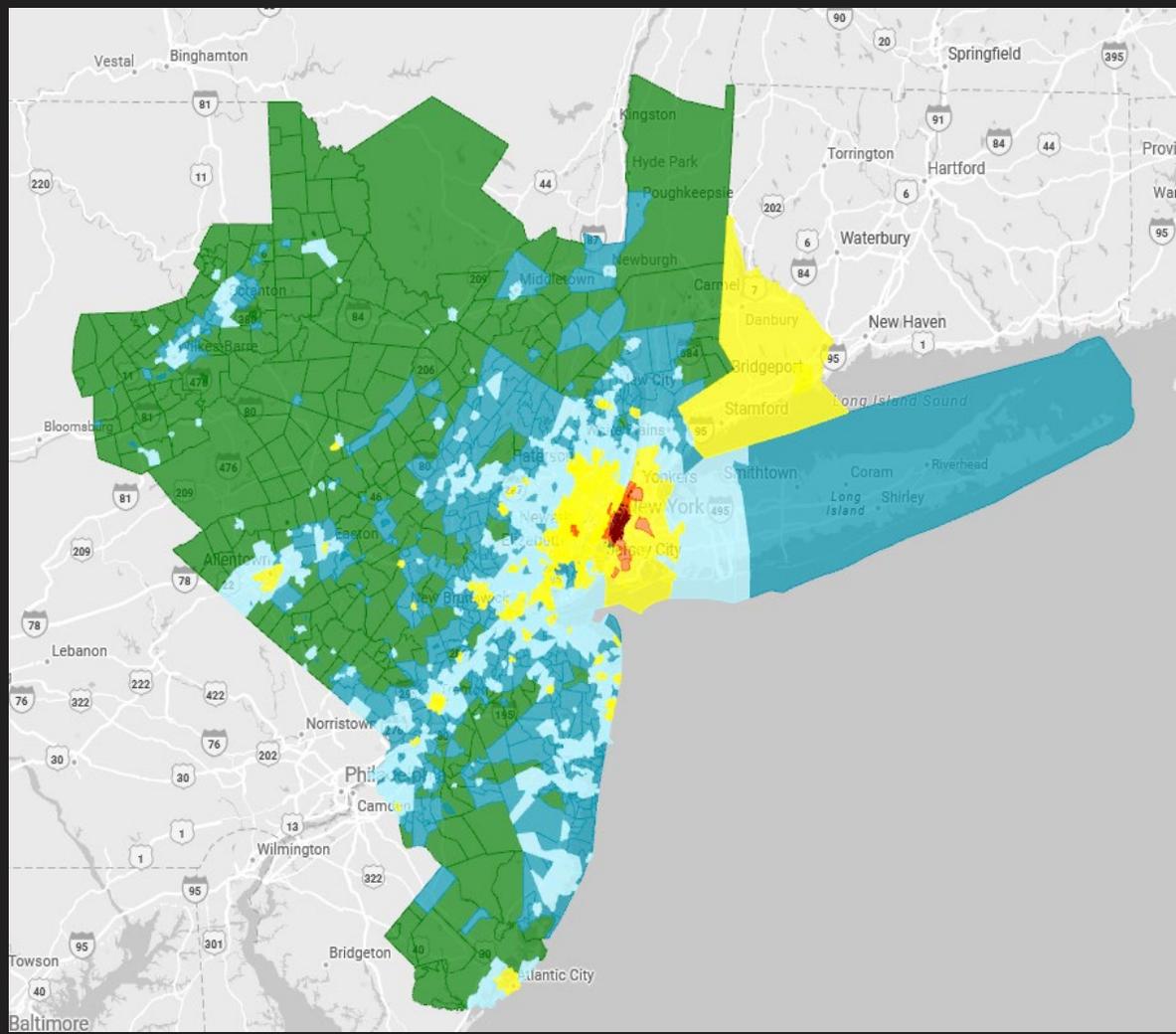
Prepared by:



In Association With:

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- Gallop Corporation
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June 30th, 2023



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EXECUTIVE SUMMARY

Introduction

From September 2021 to June 2023, the NJTPA with a consultant team led by Stantec Consulting Services, Inc. and supported by AECOM, Sobers, Gallop, and T.Y. Lin International validated the NJTPA's transportation model. The NJRTM-E is used by the NJTPA and its partners to forecast future travel impacts including analysis for air quality conformity, the congestion management process, the long range transportation plan, and other regional studies and performances analyses. Model validation is performed periodically to improve forecasting capabilities, calibrating the model to base year data.

This revalidation project is referred as "The 2023 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 previous model revalidation project, the 2018 NJRTM-E Revalidation Project.

In this validation project, The NJRTM-E was validated using 2019 and pre-pandemic 2020 data, lacking sufficient post-pandemic information. The model was also expanded to include scenario tools for various adjustments (e.g., number of work trips generated), providing flexibility for studies to incorporate post-pandemic conditions or other potential travel pattern changes. The model now incorporates Census 2020 data and geography.

The tasks included in this project are as follows:

1. Data Collection (e.g., incorporation of the 2010-11 Regional Household Travel Survey (RHTS), 2020 Census data, updated traffic counts and speed data).
2. Expanded Traffic Analysis Zone system to be consistent with the 2020 Census Boundary, and additional Network Refinement.
3. Model validation and calibration to the 2019 pre-pandemic traffic condition.
4. Sensitivity analysis.
5. Model Conversion to Cube 2023.

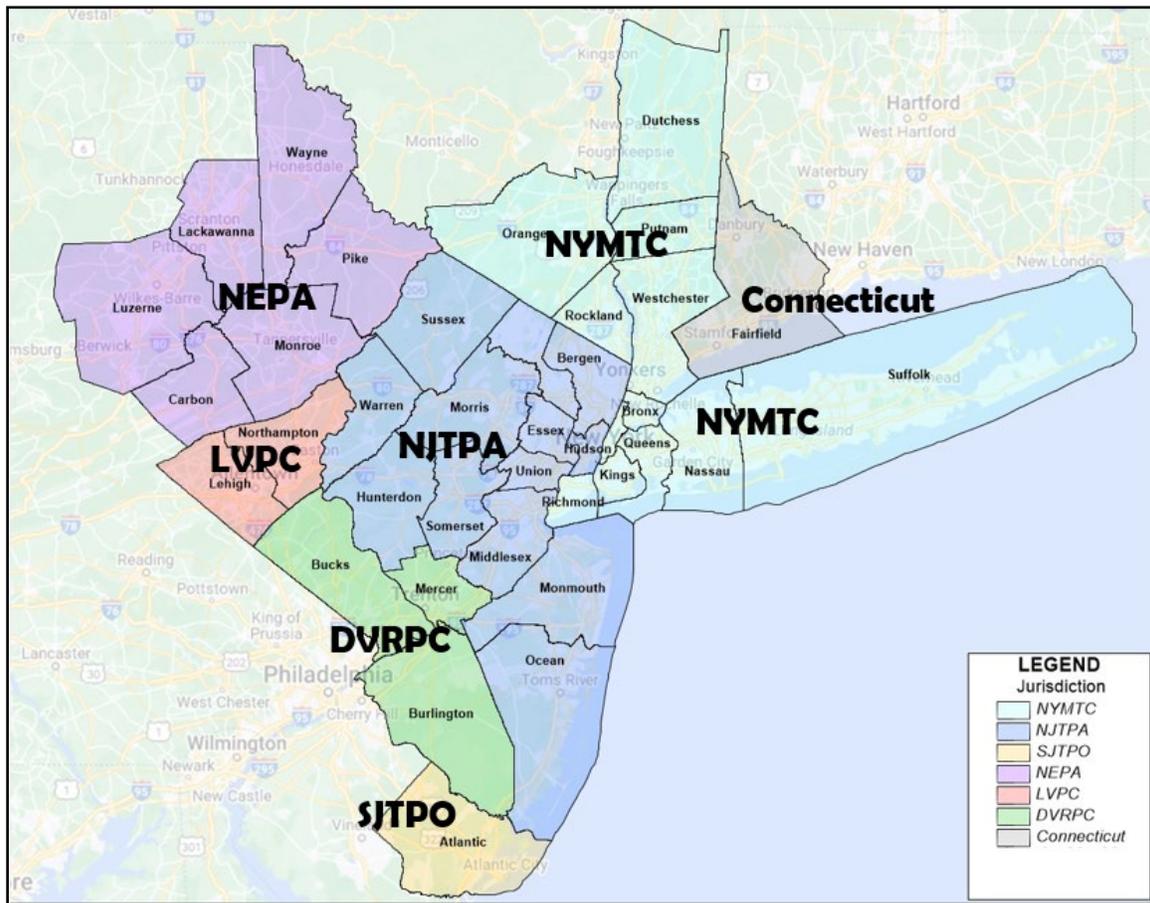
The model extends the coverage area to a total of 40 counties including the 13 NJTPA counties, encompassing areas from six Metropolitan Planning Organizations (MPOs) or planning areas in New Jersey, New York and Pennsylvania and Connecticut. Those regional planning organizations are:

- 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 E-1.

The project included discussions about model validation processes and results with the Technical Advisory Committee (TAC), which included representatives from NJTPA staff, NJDOT, NJ TRANSIT, the PANYNJ, NYMTC and NJTPA subregions. The final results of the validation are consistent with recognized modeling standards and the NJRTM-E will continue to be a valuable resource for the NJTPA and partner agencies. The validated model includes a version to function in the updated Bentley CUBE 2023 modeling software platform. The validation results are being incorporated in fully updated documentation that will be available through the travel demand modeling page (<http://www.njtpa.org/Data-Maps/Modeling-Surveys/Travel-Demand-Model.aspx>) on the NJTPA website.

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



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), the same survey data used in the

2018 NJRTM-E Revalidation Project, adjusted to the 2019 conditions. The adjustment factors were developed based on socioeconomic data growth in the study region between 2015, the previous calibration year model, and 2019, the new calibration year model. This data was supplemented with other information (mostly Census derived). For example, the 2015-2019 PUMS data was used to determine lifecycle statistics for use in trip generation. Besides RHTS and Census information, data was also provided by regional agencies. Surrounding MPOs provided the list of regionally significant 2019 projects in their region to be included in the highway network. NJDOT provided traffic count information from its traffic count database. As part of this project, the updated socioeconomic data for the whole region was prepared by NJTPA using the newly released 2020 Census Data.

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

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

Figure E-2 – Traffic Count Locations

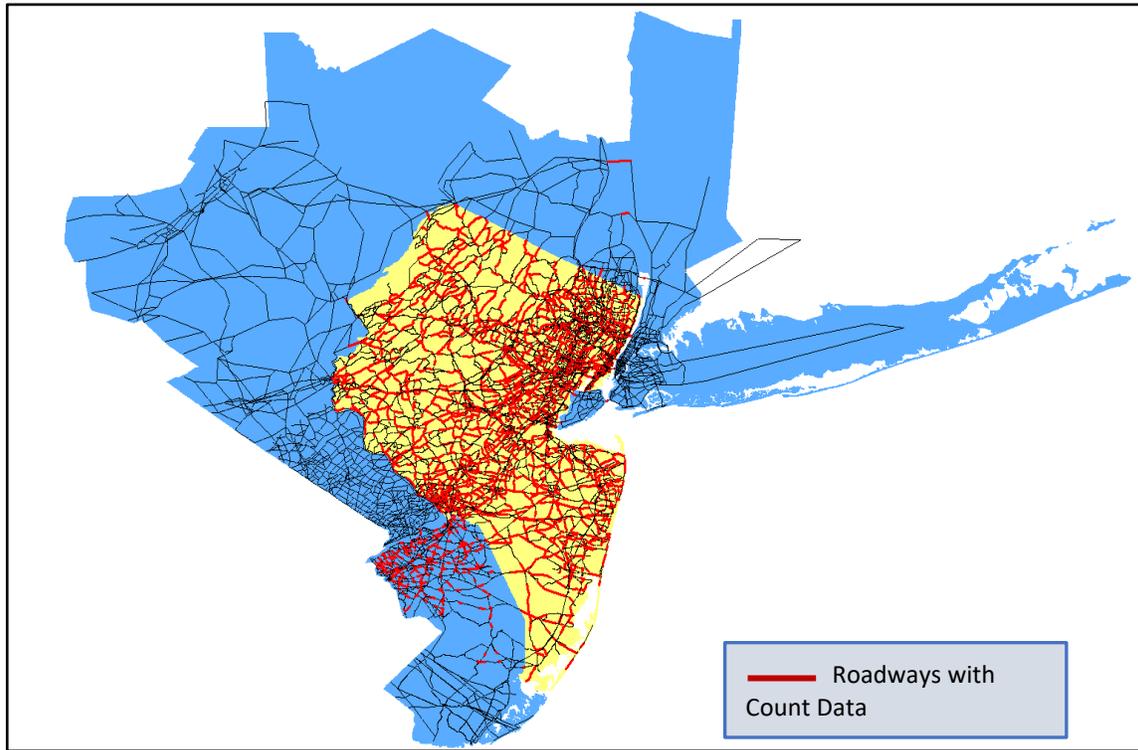
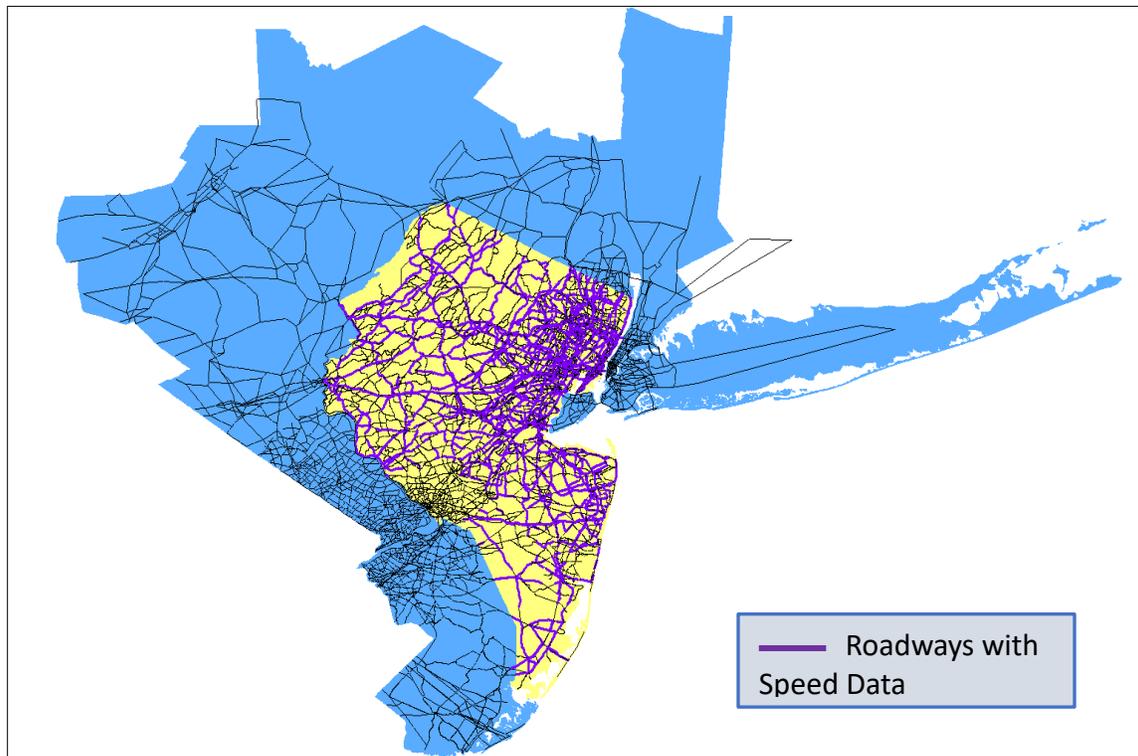


Figure E-3 – Observed Speed Locations



Expanded Traffic Analysis Zone structure and Network Refinements

This project provided the first chance to incorporate the changes to the Traffic Analysis Zone structure (TAZs) resulting from the 2020 census into the NJRTM-E. The TAZs were expanded from 2900 zones to 3028 zones, including 180 reserved zones for future use (2,848 TAZs excluding reserved zones). Within the NJTPA region, there are over 130 new TAZs and 1,732 TAZs (excluding reserved zones). The updated zonal system:

- Follows the 2020 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 periodically as part of the regional conformity analysis, this more thorough review of the system only necessitated minor adjustments.

Table E-1 – The NJRTM-E Updated Zonal System

Region	County	Zone Type (Majority of TAZs)	NJRTM-E TAZs		RESERVED TAZs	
			Zone Numbers	No. of Zones	Zone Numbers	No. of Zones
New Jersey	Atlantic	MCD	1 - 25	25		0
	Bergen	Census Tract+Block Group	26 - 236	211	237 - 246	10
	Burlington	MCD+Census Tract	247 - 387	141	388 - 389	2
	Essex	Census Tract+Block Group	391 - 620	230	623 - 632	10
	Hudson	Census Tract+Block Group	633 - 829	197	830 - 863	34
	Hunterdon	Census Tract+Block Group	864 - 899	36	900 - 909	10
	Mercer	Census Tract+Block Group	910 - 1033	124	1034 - 1042	9
	Middlesex	Census Tract+Block Group	1043 - 1262	220	1263 - 1272	10
	Monmouth	Census Tract+Block Group	1273 - 1437	165	1438 - 1447	10
	Morris	Census Tract	1448 - 1559	112	1560 - 1569	10
	Ocean	Census Tract+Block Group	1570 - 1725	156	1726 - 1735	10
	Passaic	Census Tract	1736 - 1856	121	1857 - 1866	10
	Somerset	Census Tract+Block Group	1867 - 1952	86	1953 - 1962	10
	Sussex	Census Tract+Block Group	1963 - 2007	45	2008 - 2017	10
	Union	Census Tract+Block Group	2018 - 2143	126	2145 - 2160	16
Warren	Census Tract+Block Group	2161 - 2187	27	2188 - 2197	10	
New York	Bronx	District	2198 - 2203	6	-	0
	Dutchess	District	2204 - 2205	2	-	0
	Kings	District	2206 - 2223	18	-	0
	Nassau	District	2224 - 2225	2	-	0
	New York (Manhattan)	Census Tract	2226 - 2515	290	-	0
	Orange	District	2516 - 2543	28	-	0
	Putnam	District	2544 - 2544	1	-	0
	Queens	District	2545 - 2555	11	-	0
	Richmond	District	2556 - 2606	51	2607 - 2615	9
	Rockland	Census Tract	2616 - 2680	65	-	0
	Suffolk	County	2681 - 2681	1	-	0
	Sullivan	District	2682 - 2682	1	-	0
	Westchester	District	2683 - 2709	27	-	0
Pennsylvania	Bucks	Multiple Block Groups	2710 - 2780	71	-	0
	Carbon	County	2781 - 2781	1	-	0
	Lackawanna	MCD	2782 - 2822	41	-	0
	Lehigh	MCD	2823 - 2849	27	-	0
	Luzerne	MCD	2850 - 2925	76	-	0
	Monroe	MCD	2926 - 2945	20	-	0
	Northampton	MCD	2946 - 2983	38	-	0
	Pike	MCD	2984 - 2996	13	-	0
Wayne	MCD	2997 - 3024	28	-	0	
Connecticut	Bridgeport	MCD	3025 - 3025	1	-	0
	Fairfield Co. Other	District	3026 - 3026	1	-	0
Special Generators / Externals	EWR (Essex County)		621	1		
	Port Newark (Essex County)		622	1		
	Port Elizabeth (Union County)		2144	1		
	NJTPK Southern Terminus		390	1		
	I-78 Western Terminus (PA)		3027	1		
	I-80 Western Terminus (PA)		3028	1		
Total				2848		180
				Total Zones		3028

Model Validation

Model Calibration and Validation

The there is no major update to the model components in this project. Most of the model structures and components were retained from the previous 2018 validation project, while model parameters from various model components were calibrated to replicate the new observed targets.

Revalidation Results

The model was revalidated to the 2019 conditions. Starting with the first model component, Trip Generation, the estimated trip production and attraction were compared to the observed data. Table E-2 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-2 – Trip Production and Attraction Comparison by Purpose

Purpose	Trip Production			Trip Attraction		
	Observed	Estimated	% Diff.	Observed	Estimated	% Diff.
HBWD	3,679,861	3,676,249	-0.1%	3,277,556	3,269,852	-0.2%
HBWS	1,307,010	1,306,962	0.0%	1,232,915	1,229,348	-0.3%
HBS	2,410,305	2,408,777	-0.1%	2,372,028	2,366,487	-0.2%
HBO	9,181,478	9,177,177	0.0%	8,993,250	8,971,553	-0.2%
WBO	1,085,096	1,085,194	0.0%	1,069,197	1,063,521	-0.5%
NHBO	4,892,449	4,900,099	0.2%	4,900,624	4,908,426	0.2%
TOTAL	22,556,200	22,554,459	0.0%	21,845,571	21,809,186	-0.2%

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-3 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 4%.

Table E-3 – 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	16.6	17.7	6.9%	42.6	44.2	3.6%	23.3	24.1	3.1%
HBWS	16.8	16.9	0.8%	40.5	40.6	0.5%	24.9	25.0	0.3%
HBS	5.3	5.1	-2.2%	17.9	17.5	-2.1%	17.6	17.6	-0.1%
HBO	6.2	6.2	-0.2%	19.1	20.1	5.7%	19.6	18.5	-5.6%
NHBW	9.8	9.3	-5.3%	24.6	23.7	-3.5%	23.9	23.4	-1.9%
NHBO	5.7	5.5	-4.0%	18.2	18.1	-0.5%	18.9	18.2	-3.6%

The comparisons between observed and estimated origin-destination trip flows by county by purpose can be found in Appendix I, while the frequency distribution graphs can be found in Section 9.6 of the Model Development Manual.

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-4 shows the trip comparison of this market. The estimated total trip is approximately 2% higher than the observed value, which is within reasonable tolerance. There are more variances at purpose-level.

Table E-4 – Trans-Hudson Crossing Person Trip Comparison

Purpose	Observed (RHTS)	Estimated	% Difference
HBWD	630,423	670,789	6.4%
HBWS	131,519	136,107	3.5%
HBS	46,111	47,212	2.4%
HBO	235,854	219,396	-7.0%
NHBW	55,354	53,142	-4.0%
NHBO	101,274	96,035	-5.2%
Total	1,200,534	1,222,682	1.8%

Table E-5 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-5 – Mode Share Comparison by Purpose

Mode	HBWD (Person Trips)		Mode	HBWS (Person Trips)	
	2010 RHTS (Pct)	Estimated (Pct)		2010 RHTS (Pct)	Estimated (Pct)
SOV	75.8%	75.5%	SOV	86.1%	85.3%
HOV2	5.7%	5.6%	HOV2	8.3%	8.7%
HOV3	0.8%	0.7%	HOV3	2.1%	2.1%
HOV4	0.6%	0.6%	HOV4	0.6%	0.4%
Walk-Transit	10.7%	11.1%	Walk-Transit	2.5%	2.7%
Drive-Transit	6.5%	6.5%	Drive-Transit	0.4%	0.9%
TOTAL	100.0%	100.0%	TOTAL	100.0%	100.0%
Average Car Occupancy	1.05	1.05	Average Car Occupancy	1.07	1.07

Mode	HBS (Person Trips)		Mode	HBO (Person Trips)	
	2010 RHTS (Pct)	Estimated (Pct)		2010 RHTS (Pct)	Estimated (Pct)
SOV	59.2%	58.1%	SOV	40.6%	40.2%
HOV2	25.8%	24.5%	HOV2	32.0%	31.9%
HOV3	6.9%	8.6%	HOV3	14.7%	15.1%
HOV4	3.6%	4.2%	HOV4	9.0%	9.2%
Walk-Transit	4.3%	4.5%	Walk-Transit	3.1%	3.2%
Drive-Transit	0.2%	0.1%	Drive-Transit	0.6%	0.4%
TOTAL	100.0%	100.0%	TOTAL	100.0%	100.0%
Average Car Occupancy	1.27	1.29	Average Car Occupancy	1.51	1.52

Mode	NHBW (Person Trips)		Mode	NHBO (Person Trips)	
	2010 RHTS (Pct)	Estimated (Pct)		2010 RHTS (Pct)	Estimated (Pct)
SOV	81.8%	83.6%	SOV	45.6%	44.5%
HOV2	11.8%	10.7%	HOV2	32.4%	31.9%
HOV3	2.1%	1.9%	HOV3	12.8%	13.9%
HOV4	1.5%	1.4%	HOV4	7.2%	8.1%
Walk-Transit	2.1%	2.0%	Walk-Transit	1.6%	1.5%
Drive-Transit	0.7%	0.4%	Drive-Transit	0.3%	0.1%
TOTAL	100.0%	100.0%	TOTAL	100.0%	100.0%
Average Car Occupancy	1.10	1.09	Average Car Occupancy	1.45	1.47

Mode	All Purposes (Person Trips)	
	2010 RHTS (Pct)	Estimated (Pct)
SOV	54.0%	53.7%
HOV2	24.8%	24.3%
HOV3	9.9%	10.3%
HOV4	5.8%	6.1%
Walk-Transit	4.1%	4.2%
Drive-Transit	1.4%	1.4%
TOTAL	100.0%	100.0%
Average Car Occupancy	1.41	1.41
Total Transit	5.5%	5.6%

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-5 and Table E-5 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-6 – Traffic Volume Comparison by Facility Type

Facility Type	Estimated %Difference	FHWA Standard
Limited-Access Facility	0.1%	+/- 7%
Expressway	4.0%	+/- 10%
Principal Arterial Divided	1.7%	+/- 10%
Principal Arterial Undivided	0.2%	+/- 10%
Major Arterial Divided	1.5%	+/- 15%
Major Arterial Undivided	-0.4%	+/- 15%
Minor Arterials	-1.8%	+/- 15%
Collector/Local	-2.9%	+/- 20%
TOTAL	0.1%	N/A

Table E-7 – Traffic Volume Comparison by Area Type

Area Type	Estimated %Difference	Ohio DOT	Florida DOT
CBD	-0.8%	+/- 10%	+/- 15%
Urban	3.3%	+/- 10%	+/- 15%
Suburban	-1.3%	+/- 10%	+/- 15%
Rural	-0.4%	+/- 10%	+/- 15%
TOTAL	0.1%	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-5 and Table E-5 show the NJT rail ridership and PABT bus ridership summaries by line. The at the system-level both rail ridership and bus ridership results are generally within a reasonable tolerance, at 1.2% and 1.1%, respectively. The ridership has more variance at the transit-line level compared to the observed data. Table E-5 shows the PATH ridership comparison. The estimated total ridership for PATH mode is 4% lower than the observed data. The difference is within a reasonable tolerance. The difference is more significant at individual stations.

Table E-8 – Average Weekday Boarding by Rail Line

Station Name	Observed	Estimated	Diff	% Diff
	2019			
Main/Bergen/Port Jervis Line	15,688	10,734	(4,954)	-31.6%
North Jersey Coastline/Northeast Corridor Line	62,404	76,603	14,199	22.8%
Pascack Valley Line	4,446	6,804	2,358	53.0%
Boonton Line	9,630	9,446	(184)	-1.9%
Morris/Essex Line	28,777	24,191	(4,586)	-15.9%
Raritan Valley Line	11,825	9,302	(2,523)	-21.3%
Newark City Subway	19,176	17,268	(1,908)	-9.9%
Hudson-Bergen Light Rail	46,728	46,714	(14)	0.0%
TOTAL	198,674	201,064	2,390	1.2%

Table E-9 – PABT Bus Ridership Summary - Inbound

Bus Line	2019 Observed	NJRTME Revalidation	
		Estimated	Pct Diff
BERGEN PABT ROUTES	30,777	25,502	-17.1%
ROUTE 9 PABT	8,514	7,683	-9.8%
PABT SHORT DISTANCE	33,663	29,955	-11.0%
PARK & RIDE	3,423	7,258	112.0%
MIDDLESEX/UNION PABT	8,220	11,295	37.4%
PASSAIC PABT	13,023	16,955	30.2%
GW BRIDGE	5,388	5,518	2.4%
PABT Total	103,008	104,166	1.1%

Table E-10 – PATH Ridership Summary - Inbound

Station Name	Observed	Estimated	Diff	% Diff
	2019			
33rd St	34,966	36,488	1,522	4.4%
23rd St	9,682	8,748	(934)	-9.6%
14th St	9,121	9,133	12	0.1%
9th St	5,067	6,365	1,298	25.6%
Christopher St	5,199	15,405	10,206	196.3%
SUBTOTAL	64,035	76,139	12,104	18.9%
WTC	64,048	33,253	(30,795)	-48.1%
Hoboken	29,915	30,337	422	1.4%
Pavonia/Newport	19,351	15,862	(3,489)	-18.0%
Exchange Place	18,262	1,920	(16,342)	-89.5%
Grove St	22,191	25,268	3,077	13.9%
Journal Square	27,250	26,967	(283)	-1.0%
Harrison	9,143	12,088	2,945	32.2%
Newark (Path)	30,186	51,254	21,068	69.8%
SUBTOTAL	220,346	196,948	(23,398)	-10.6%
TOTAL	284,381	273,088	(11,293)	-4.0%

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
- The new normal condition
- NYC CBD Tolling

The results of these three sensitivity analyses are presented in a separate memorandum titled “NJRTM-E Model Development Manual Version 4 – Sensitivity Analysis”.

Model Conversion to Cube 2023

The Cube Software package, the platform of the NJRTM-E, is currently undergoing a major software upgrade. The new and improved features in the new Cube, known as Cube 2023 version, include the following:

- CubePy – Users can easily integrate Python-based programs to their existing model applications.
- Improved User Interfaces – allows zoom, pan, and other features on the application manager.
- Introduces a new relational database network format with support for shape networks and data synchronization across network components.
- More responsive GIS Window for mapping and network editing.
- No longer requires ArcGIS engine.
- New Table Editor.
- New and more stable cluster implementation.
- Multi-version installation support.

There are some incompatibilities between Cube 2023 and the current Cube 6.5 version, in such that the model developed using the Cube 6.5 version will not be operable within Cube 2023 platform without any additional conversion and scripting adjustments efforts. The current NJRTM-E validation was performed mainly using the Cube 6.5 version. As part of this project, the newly validated model will be converted into the Cube 2023 platform. The NJTPA will maintain two versions of the validated NJRTM-E model, the Cube 6.5 version and Cube 2023 version.