



Appendix 3 |

Socioeconomic and Demographic Forecasts

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Passengers Getting on Barclay Center Shuttle Bus
Photo Source: MTA

1. BACKGROUND

The travel demand forecasts that are a foundation of *Plan 2045* are built from consensus socioeconomic and demographic (SED) forecasts developed by NYMTC through the Plan's horizon year. These employment, population, labor force, and household forecasts are produced in response to federal planning regulations that require the preparation of long-range population and economic forecasts for use in transportation planning. NYMTC prepared and adopted SED forecasts through the year 2050. The forecasts are an essential part of predicting the travel patterns and commercial/freight transportation needs of the multi-state metropolitan region.

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NYMTC's SED forecasts were prepared for a 31 county forecast area in the multi-state metropolitan region. The forecasts are broken down into the following five subregions:

- > New York City: five boroughs
- > Long Island: Nassau and Suffolk counties
- > Mid-Hudson: Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster, and Westchester
- > New Jersey: Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Somerset, Sussex, Union, and Warren
- > Connecticut: Fairfield, Litchfield, and New Haven

In preparing the 2050 SED forecasts, the New York City Department of City Planning's Population Division produced the population and household forecasts for each of the City's five boroughs. NYMTC's Forecasting Working Group, assisted by NYMTC staff and by a professional services contact, produced the employment and labor force forecasts for all 31-counties, as well as the population and household forecasts for the counties outside of New York City.

As described in Chapter 1, NYMTC's planning area is a subset of the larger multi-state metropolitan region. In this appendix, the full 31-County forecast area will be discussed first and then a separate analysis of trends in the NYMTC planning area will be presented. To distinguish the subset of the Mid-Hudson subregion that falls within the NYMTC planning area (Putnam, Rockland, and Westchester Counties), the subset will be referred to as the Lower Hudson Valley.

2. METHODOLOGY

Employment, population, labor force, and household forecast models were created for the 31-County forecast area. Historical rates were used to inform each model's assumptions to project the socioeconomic and demographic variables from 2010 to 2050. All analyses herein are from 2015 to 2045. Initial projections for each forecast were balanced to accord with land use constraints and development opportunities within each county.

In the following sections, each model's methodology will be explained along with the prevailing trends for the forecast horizon. The following variables were forecast at the region, subregion, and county level:

- > Employment: Total Employment (Wage & Salary Employment and Self-Employment)
- > Population: Total Population, Household Population, Group Quarters Population
- > Labor Force: Total Civilian Labor Force, Employed Civilian Labor Force
- > Households: Total Households, Average Household Size

A. EMPLOYMENT MODEL

The Wage and Salary Employment (number of jobs by location) Model used an averaging process that combined independent forecasts from three sources: IHS-Global Insight, Moody's Analytics, and the Bureau of Labor Statistics. These third-party forecasts use various econometric models to project employment based on labor market conditions, policies, and trade, among other factors. Each level of geography's share of employment growth, by industry, was calculated using each of the third-party forecasts. Further adjustments were made by the Forecasting Working Group.

To calculate figures for total employment, self-employment forecasts were added to the wage and salary employment forecasts. Self-employment rates, the ratio of self-employment to wage and salary employment, for each industry and county, were held constant throughout the forecast horizon. These rates

were applied to the related wage and salary employment forecast to produce the self-employment forecasts. Finally, the total employment forecasts were reconciled with the employed labor force forecasts based on the unemployment rate, in-commuting and out-commuting, multiple job holding rate, and journey-to-work flows.

The employment forecasts are critical to travel demand forecasting; the number of jobs by place-of-work location provides the number of potential work trips and their destination location. The employment model interacts with the population and labor force models in that employment opportunities influence migration rates and implies the level of employment demand for each subregion and county.

B. POPULATION AND LABOR FORCE MODELS

The Population and Labor Force models informed each other's outputs. Population by age and sex, the main output of the population model, was used to determine the working age population and the labor force model helps predict the number of migrants who will move to the region to fill positions in basic (export-oriented) industries. As mentioned earlier, these models were influenced by the employment model that forecasts the implied employment demand in each level of geography.

The population model yielded three outputs: total population, population in households, and population in group quarters. Household population (those not in group quarters) was projected using a cohort-component (CC) model. The group quarters population in New York City were held constant, while the group quarters population outside of NYC were held at a constant share of the total population over the projection horizon. This is because the factors of population change affect such populations differently.

The CC model divided the population into age and sex cohorts of five-year intervals and used histor-

ical birth and death rates to estimate the net natural change in population and net migration which, in combination, yielded an initial population projection. The CC model projections were then adjusted based on known changes in each New York City borough's land-use, zoning, and constrained by the predicted 2045 housing supply. The model for the counties outside of New York City used the CC method approach with inputs from the labor force model and employment demand to determine migration and thus a final population projection.

Labor force is the resident population of a place that is 16 years of age or older, employed, or if not employed actively looking for work. Stemming from the population model, the labor force model applied age/sex specific civilian labor force participation rates to the age/sex population projections. In this forecast a broad set of historical labor force participation rates were included to smooth out major changes in the labor force participation that may have resulted from the 2008 economic recession. Labor force or labor supply was calculated by totaling the civilian working age population and then applying projected labor force participation rates to that population. The civilian labor force was divided into non-basic

and basic employment, then the unemployment rate was applied, and finally net commuters were also accounted for to yield the total labor supply.

Labor-induced migration adjustments were calculated by subtracting the labor supply for basic (non-local serving) sectors from the implied labor demand for basic sectors (from the employment model output) but limited to those ages 20 through 64; individuals outside those ages are not typically migrating for labor reasons. The volume of total economic migrants (workers and their dependents) that could not be housed in New York City, due to housing supply constraints, were reallocated to the surrounding commuting shed, to be compatible with commuting patterns observed in the data.

C. HOUSEHOLD FORMATION MODEL

The household is a key unit of analysis in demographic and travel demand forecasting. The Household Formation Model forecasts the average household size and number of households for each geography. Like the previous models, separate projections were generated for New York City and the rest of the 26 counties. This was done in keeping with the clear distinction of household formation patterns that exists within the City of New York and the surrounding, more suburban counties.

New York City's average household size has been stable since 1990. Therefore, the 2010 average household size of 2.57 was held constant during the forecast horizon. The household formation model for the remaining 26 counties was conducted differently. Due to differing trends in these counties, such as declining household size and increasing number of single person households, the model for these subregions was based on age specific headship rates from the previous three decennial census years. A headship rate is the ratio of household-heads (self-identified classification by census respondents) to the corresponding household population. Headship rates were then used to forecast the projected number of households, given the projected age-distribution of the population. Household population divided by households yields the average household size.





Fulton Center, New York
Photo Source: MTA

D. NATIONAL ASSUMPTIONS FOR 2045 FORECASTS

The SED forecasts used three third party employment forecasting sources to inform the models with an indexed baseline and create an understanding of trends for the future: Moody's Analytics, IHS Global Insight, and the Bureau of Labor Statistics all provide national forecasts for wage and salary employment by industry. During the course of the projection horizon the national economy is predicted to stabilize and proceed toward recovery, albeit at a modest pace.

In the near term, as the economy continues to recover, the labor force participation rate is expected to increase as those who left the labor force, during the recession, may choose to reenter it. However, over the longer term, the labor force participation rate is expected to decline mostly due to the retirement of the Baby Boom generation.

National wage and salary employment growth between 2015 and 2045 is predicted to be 25.2 percent. The period between 2015 and 2020 will see the strongest growth, averaging around 1.1 percent per year, followed by a span of more modest growth,

between 2020 and 2025, at 0.6 percent per year. Thereafter, growth will increase slightly and then level off at approximately 0.8 percent per year.

Certain employment sectors do better than others in the forecast period. Significant employment growth is expected in both the Health Care and Construction industries. The construction sector, which suffered a significant decline during the Recession, has been recovering since 2010, and is forecasted to grow by 2.6 percent annually, an increase from a previous projection in Plan 2040. The Health Care and Social Assistance industry experienced growth during the last recession and growth is predicted to continue at 2.6 percent annually. The increase in this sector is related to the aging of the US population. Employment declines at the national level, are forecasted for Federal Government, Manufacturing, Agricultural/Fishing, Information, and Utilities sectors.

3. 2045 31-COUNTY FORECASTS

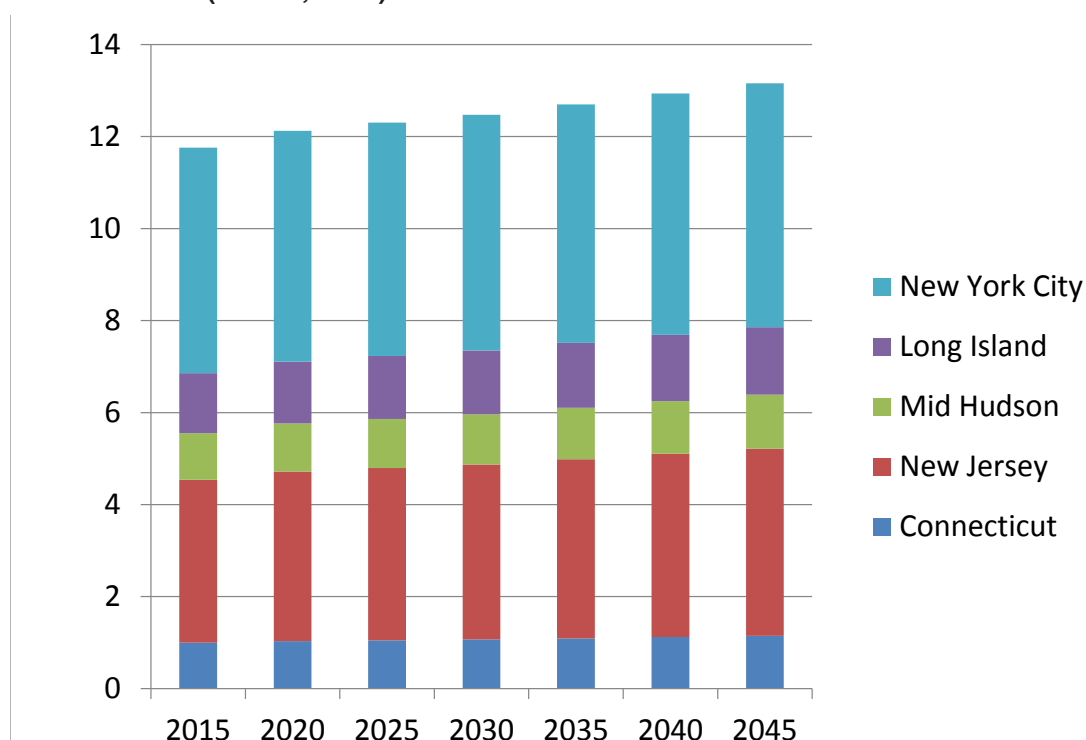
A. EMPLOYMENT

I. REGIONAL SHARE OF U.S. TOTAL EMPLOYMENT GROWTH

Over the 2015-2045 forecasting period, total employment (wage and salary and self-employment) in the 31-county forecasting area is expected to grow approximately 11.9 percent or 0.38 percent annually (compound annual growth). This growth rate equates to a net gain of 1.4 million jobs between 2015 (11.8 million) and 2045 (13.2 million). Previous NYMTC SED forecasts through 2040 predicted a higher rate of growth (32 percent from 2010 to 2040) and larger total employment figure (about 16.2 million in 2040) than the 2045 forecasts, which have more modest total employment figures for 2015 and 2045 as well as a slower rate of growth, reflecting, in part, the slow recovery from the 2008 recession and revised employment data from previous years.

From 2015 to 2020, the compound annual growth rate will be 0.6 percent. During the 2020 to 2030 period, employment is projected to grow much slower, 0.28 percent per year. During the following decade (2030-2040), the pace will increase to 0.36 percent per year. In the last period of analysis, 2040-2045, the compound annual growth in total employment will be approximately 0.34 percent. The predicted changes in total employment growth show fluctuations in growth leading toward recovery and an eventual leveling off of growth. 31-county wage and salary employment is forecast to account for about 6.7 percent of national wage and salary employment in 2045, 1.0 percentage points below the 31-county forecasting area's projected 2015 share of wage and salary employment. This minimal decrease in share of national employment could be related to aging population and other fiscal and employment policies.

FIGURE A3.1 - 31-COUNTY REGION, TOTAL EMPLOYMENT BY SUBREGION, 2015 TO 2045 (IN 000,000S)

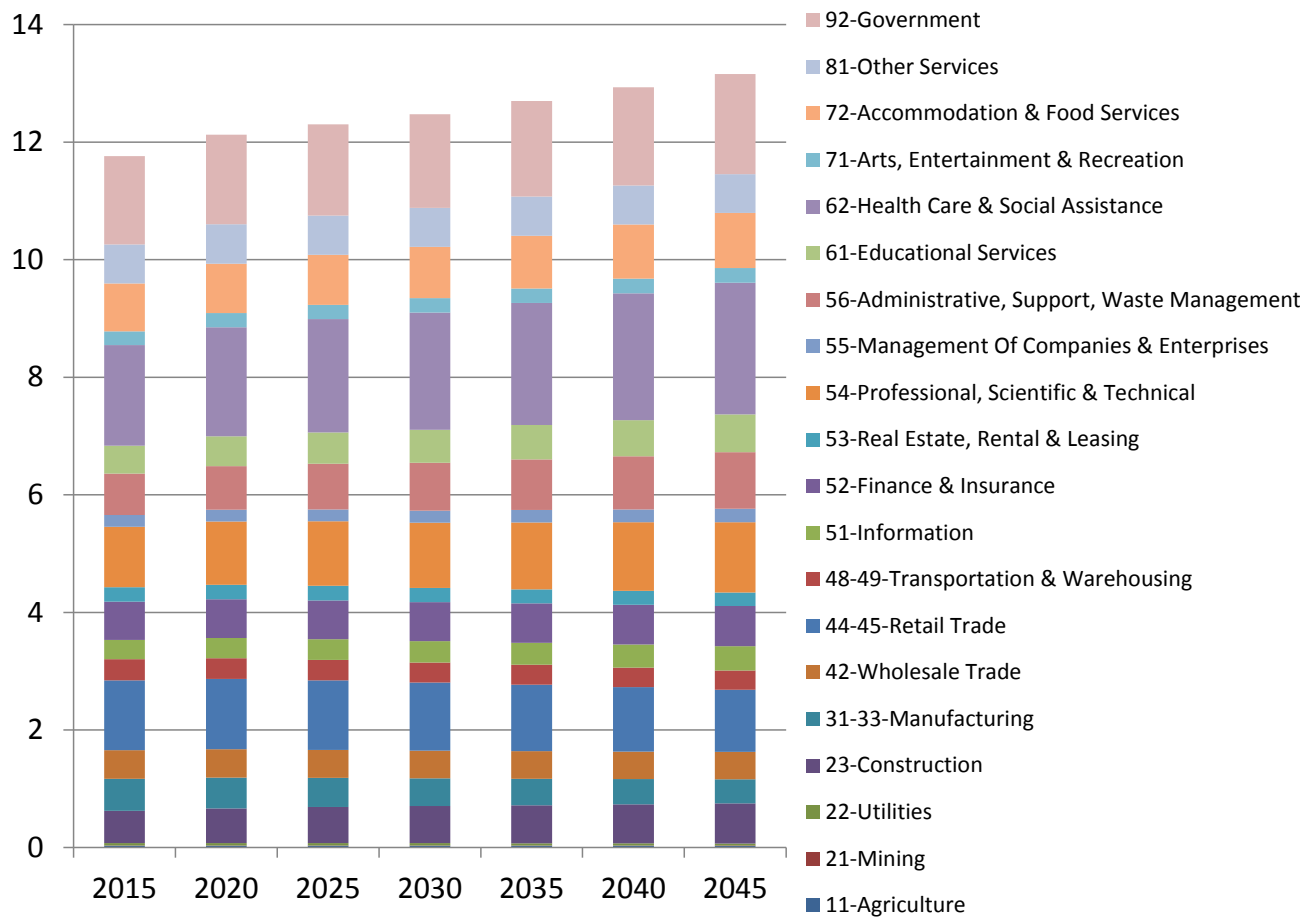


Source: NYMTC

TABLE A3.1 - 31-COUNTY REGION, TOTAL EMPLOYMENT BY SUBREGION, 2015 TO 2045 (IN 000S)

	2015	2020	2025	2030	2035	2040	2045
New York City	4,904.8	5,017.0	5,074.5	5,124.2	5,182.5	5,245.0	5,303.2
Long Island	1,304.9	1,343.8	1,365.5	1,386.6	1,413.3	1,440.4	1,468.4
Mid Hudson	1,012.3	1,045.4	1,069.1	1,091.9	1,118.1	1,144.7	1,172.3
New Jersey	3,541.9	3,687.6	3,746.7	3,800.5	3,891.9	3,983.5	4,066.1
Connecticut	996.5	1,031.7	1,047.9	1,069.8	1,093.9	1,121.4	1,149.1
31-County Region	11,760.4	12,125.6	12,303.6	12,473.0	12,699.7	12,934.9	13,159.1

Source: NYMTC

FIGURE A3.2 - 31-COUNTY REGION, TOTAL EMPLOYMENT BY INDUSTRY, 2015 TO 2045 (IN 000,000S)

Note: Employment numbers for Mining and Agriculture are very low, and are thus not represented in the bar graph above.

Source: NYMTC

II. REGIONAL EMPLOYMENT BY INDUSTRY

Certain industries are projected to see significant growth in the 31-county forecasting area, including Professional, Scientific, & Technical (16.2 percent), Construction (24.1 percent growth), Information (26.9 percent), Health Care & Social Assistance sector (30.7 percent), Educational, and the highest growth is predicted to be in Administrative, Support & Waste Management (36.4 percent). Generally, the growth in these industries relates to recovery from the 2008 recession and a strengthening of growth trends. The strong growth in the Health Care and Social Assistance may relate to the significant aging of the population, as the Baby Boom generation gets older, older residents of the region may require more health services. Growth in Health Care and Construction industries were predicted at the national level, though regionally the growth is higher. Unlike the nation, the region's information sector is predicted to increase.

There are predicted declines in several industries by 2045. Manufacturing is predicted to decline 24.7 percent, 0.9 percent each year. The decline of this industry is a continuation of a trend identified in earlier forecasts. Other industries are also predicted to experience declines. Utilities, Retail Trade and Transportation & Warehousing are forecasted to decline by 20.2 percent, 10.8 percent, and 9.7 percent, respectively. Declines in Manufacturing and Utilities are also occurring at the national level. Smaller declines from 2015 to 2045 are expected in Real Estate, Rental & Leasing and Wholesale Trade.

Self-Employment rates, by industry and region, were held constant during the forecast period. As wage and salary employment grows the number of those self-employed will also grow at the same rate; by 2045 self-employment will increase by over 191,000 jobs, or 11.9 percent (self-employment is included in the total employment growth and the per sector forecasts).

TABLE A3.2 - 31-COUNTY REGION, TOTAL EMPLOYMENT BY INDUSTRY, 2015 – 2045 (INCLUDES SELF-EMPLOYMENT)

	2015	2020	2025	2030	2035	2040	2045
11-Agriculture	28.5	29.5	29.5	29.5	28.9	28.5	27.7
21-Mining	5.3	6.2	6.4	6.5	6.5	6.6	6.6
22-Utilities	41.7	40.4	38.5	37.5	36.6	35.0	33.3
23-Construction	549.7	588.5	612.8	633.1	646.1	665.7	682.1
31-33-Manufacturing	543.0	524.1	496.3	471.6	450.1	428.9	408.7
42-Wholesale Trade	487.5	481.6	475.0	468.5	469.6	468.3	467.8
44-45-Retail Trade	1,187.0	1,198.9	1,185.3	1,161.1	1,132.5	1,095.7	1,058.1
48-49-Transportation & Warehousing	361.2	351.3	345.8	339.5	337.4	332.9	325.6
51-Information	326.3	342.2	354.1	361.5	375.6	393.0	414.2
52-Finance & Insurance	650.4	658.6	660.7	663.6	670.2	676.4	684.9
53-Real Estate, Rental & Leasing	249.2	247.8	246.1	242.5	239.6	235.7	230.8
54-Professional, Scientific & Technical	1,027.9	1,075.1	1,098.1	1,110.5	1,137.0	1,165.6	1,194.0
55-Management Of Companies & Enterprises	198.1	200.6	203.1	205.8	211.5	218.4	228.9
56-Administrative, Support, Waste Management	706.6	744.8	777.3	813.0	859.8	906.2	963.5
61-Educational Services	472.4	507.1	533.6	559.8	585.3	613.1	640.9
62-Health Care & Social Assistance	1,713.4	1,853.9	1,927.8	1,997.5	2,077.1	2,159.6	2,239.5
71-Arts, Entertainment & Recreation	233.7	239.5	242.8	245.0	247.7	249.8	251.6
72-Accommodation & Food Services	815.2	839.7	850.6	870.1	896.1	918.4	938.4
81-Other Services	660.3	671.7	666.7	664.7	666.1	664.3	657.9
92-Government	1,503.1	1,524.3	1,553.2	1,591.4	1,625.8	1,672.8	1,704.7
Total Employment - 31 County Region	11,760.4	12,125.6	12,303.6	12,473.0	12,699.7	12,934.9	13,159.1

Source: NYMTC

B. POPULATION

I. REGIONAL SHARE OF U.S. POPULATION GROWTH

The 31-county forecast area population is expected to increase by 3.0 million people between 2015 and 2045 to reach nearly 25.7 million people. The compound annual growth rate of population is 0.4 percent. This is a slower growth rate and more modest total expected population than in earlier forecasts (2040 SED forecast for year 2040 is 26.4 million and the 2045 projection is 25.2 million). The 31-county forecast area compound annual growth rate (0.4 percent) is similar to that of the nation, 0.64 percent, for the same forecast period (2015-2045). However, the total growth rate for the 31-county forecast area is slower than for the nation, 13.2 percent compared to 21.2 percent.

It should also be noted that in the 2045 forecasts, detailed population projections by race were not made. Instead, based on historical data, immigration patterns, and national projections, a race “overlay” was provided to project the portion of the population by race/ethnicity for future years. This decision was made based on the available data and due to challenges caused by the recent changes to reporting of race and ethnicity data on the Census. The racial and ethnic shares of the regional population were projected for 2015 through 2045 and compared to national race and ethnicity projections. The projections use five race/ethnicity categories: White Non-Hispanic, Black Non-Hispanic, Asian Non-Hispanic, Hispanics, and Other Non-Hispanic.

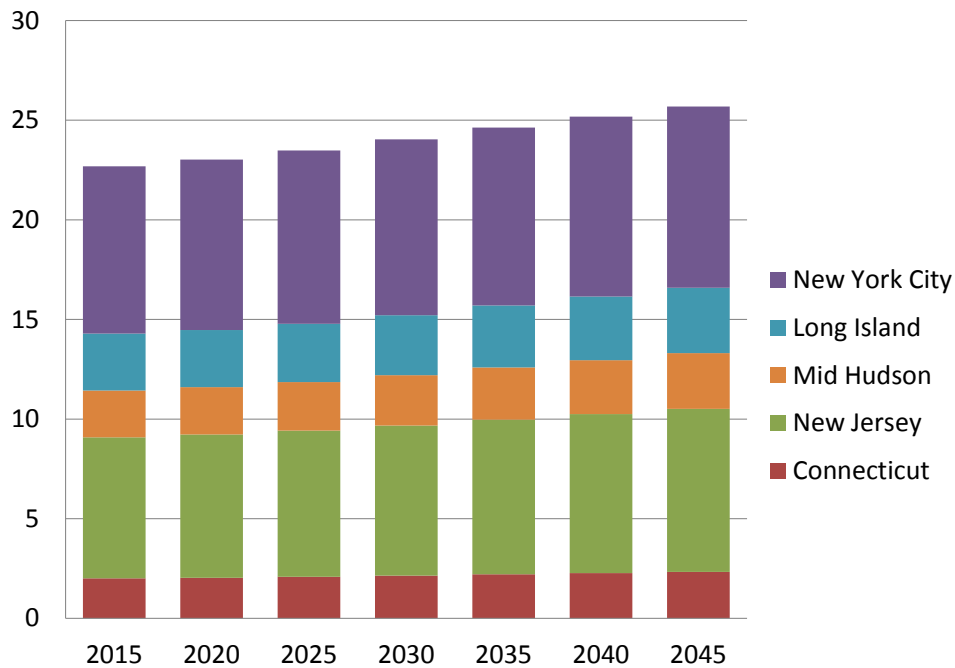
At the national level, according to the US Census 2012 National Population Projections, the Black Non-Hispanic population is projected to increase slightly from 12 to 13 percent of the total population. Asian Non-Hispanic population is projected to increase from 5 to 7 percent and similarly, the Other Non-Hispanic population is anticipated to increase from 3 to 5 percent. The Hispanic population is forecasted to increase 8 percentage points, from 18 percent in 2015 to 26 percent by 2045. By 2045 there will be a decrease in the White Non-Hispanic population, from 62 percent in 2015 to 49 percent. In the 31-county forecast area, the population by

race and ethnicity will experience the same directionality of trends throughout the forecast period, at a slightly different magnitude. For the region, the projected share of the population that identifies as White Non-Hispanic will drop to 36 percent from 50 percent in 2015; this is a slightly larger decline than the nation is expected to experience. The Black Non-Hispanic population will decline from 15 percent to 12 percent between 2015 and 2045. The Asian Non-Hispanic population will increase from 10 percent to 17 percent by 2045. The Hispanic population is estimated to increase 10 percent, from 23 percent to 33 percent. In the future the Hispanic population in the region will be nearing equality with the White Non-Hispanic population. The 31-county race and ethnicity shares were forecasted using historical Census and PUMS data as a base and estimating the future values using a combination of log and linear growth trends.

TABLE A3.3 - 31-COUNTY REGION, POPULATION, 2015 TO 2045 (IN 000S)

	2015	2020	2025	2030	2035	2040	2045
New York City	8,397.1	8,551.0	8,700.0	8,821.0	8,931.0	9,025.1	9,093.5
Long Island	2,856.2	2,868.5	2,921.6	3,010.9	3,105.6	3,195.8	3,277.0
Mid Hudson	2,347.3	2,374.8	2,435.5	2,524.4	2,621.2	2,711.7	2,800.5
New Jersey	7,077.1	7,189.7	7,340.5	7,532.6	7,761.9	7,976.1	8,185.1
Connecticut	2,009.4	2,037.9	2,083.3	2,146.9	2,211.4	2,270.3	2,326.1
31-County Region	22,687.2	23,021.9	23,480.9	24,035.9	24,631.2	25,179.1	25,682.2

Source: NYMTC

FIGURE A3.3 - 31-COUNTY REGION, POPULATION BY SUBREGION, 2015 TO 2045 (IN 000.000S)

Source: NYMTC

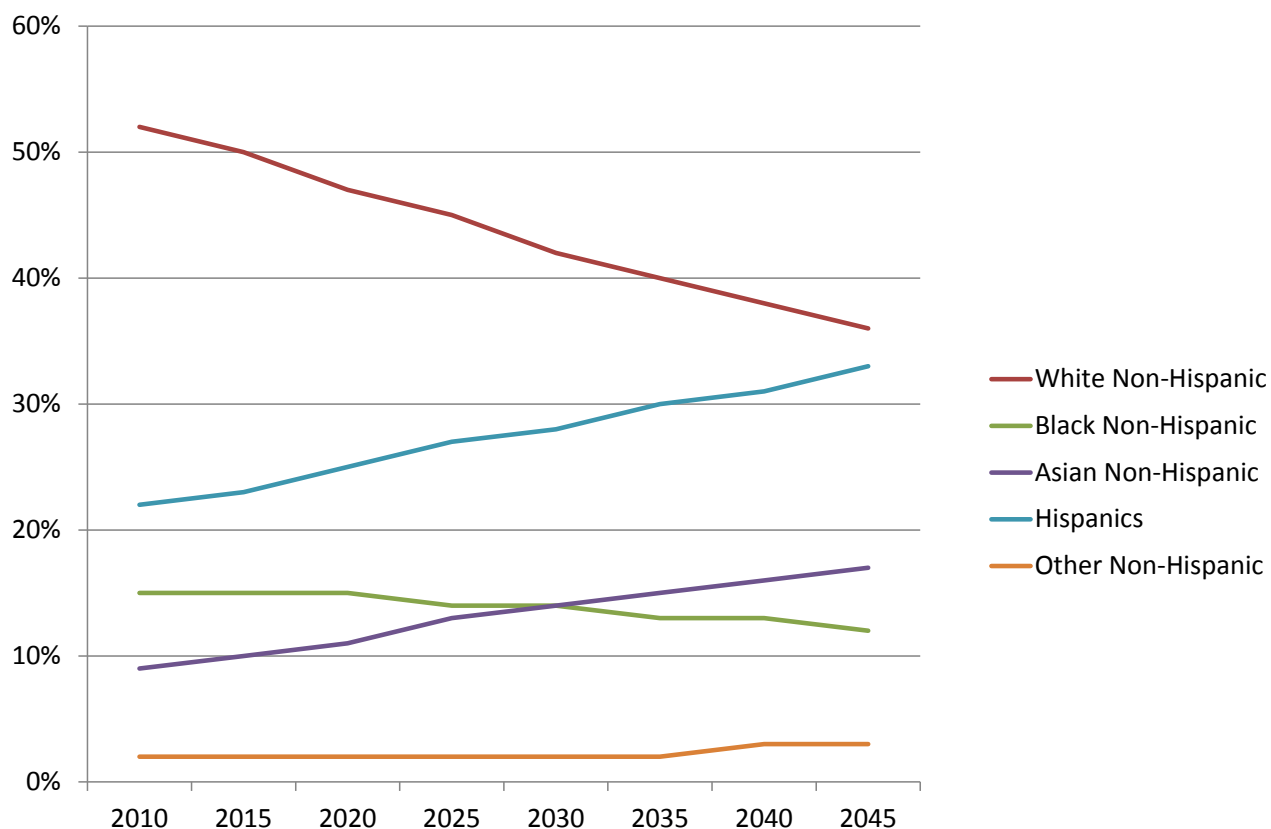
TABLE A3.4 - POPULATION BY RACE/ETHNICITY SHARES, 2015 TO 2045

National	2010	2015	2020	2025	2030	2035	2040	2045
White Non-Hispanic	64%	62%	60%	58%	55%	53%	51%	49%
Black Non-Hispanic	12%	12%	13%	13%	13%	13%	13%	13%
Asian Non-Hispanic	5%	5%	5%	6%	6%	6%	7%	7%
Hispanics	16%	18%	19%	20%	22%	23%	25%	26%
Other Non-Hispanic	3%	3%	3%	3%	4%	4%	4%	5%

31-County Region	2010	2015	2020	2025	2030	2035	2040	2045
White Non-Hispanic	52%	50%	47%	45%	42%	40%	38%	36%
Black Non-Hispanic	15%	15%	15%	14%	14%	13%	13%	12%
Asian Non-Hispanic	9%	10%	11%	13%	14%	15%	16%	17%
Hispanics	22%	23%	25%	27%	28%	30%	31%	33%
Other Non-Hispanic	2%	2%	2%	2%	2%	2%	3%	3%

Source: NYMTC

FIGURE A3.4 - 31-COUNTY REGION, POPULATION BY RACE/ETHNICITY, 2015 TO 2045



Source: NYMTC

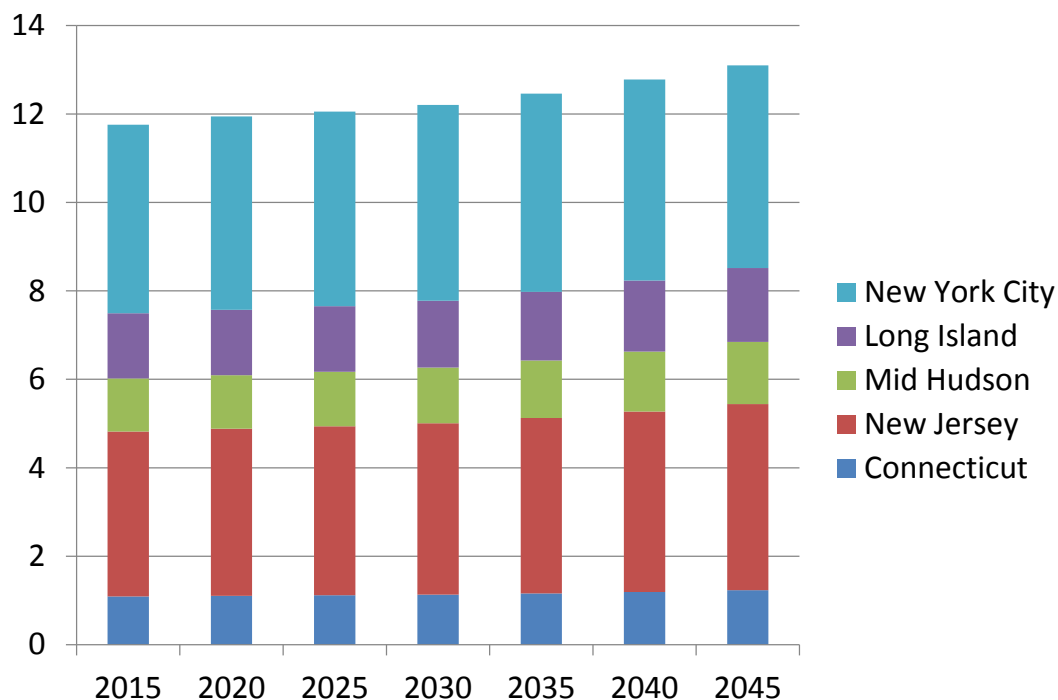
C. LABOR FORCE

I. REGIONAL SHARE OF U.S. CIVILIAN LABOR FORCE GROWTH

Labor Force refers to the residents of a location that are over the age of 16, civilians, and are attached to the labor force (employed or unemployed and actively searching for work). In the 31-county forecast area as a whole, more than 1.3 million labor force participants are expected to be added by 2045. This addition will yield a labor force total of over 13.1 million participants.

In all subregions and thus for the region as a whole, the increase in employed residents will be higher than the increase in labor force participants. This growth reflects the recovery of the labor market following the 2008 recession. Due to the improving economy and forecasted improvements in the unemployment rate, the additional employed residents (from 2015 to 2045) will be larger number than additional labor force participants (from 2015 to 2045).

FIGURE A3.5 -31-COUNTY REGION, CIVILIAN LABOR FORCE, 2015 TO 2045 (IN 000,000S)



Source: NYMTC

TABLE A3.5 - 31-COUNTY REGION, CIVILIAN LABOR FORCE, 2015 TO 2045 (IN 000S)

	2015	2020	2025	2030	2035	2040	2045
New York City	4,263.5	4,374.0	4,398.9	4,425.9	4,482.1	4,545.1	4,582.8
Long Island	1,472.5	1,475.8	1,487.6	1,511.6	1,553.1	1,609.1	1,666.1
Mid Hudson	1,202.7	1,211.9	1,230.8	1,259.5	1,302.3	1,353.5	1,409.7
New Jersey	3,727.1	3,777.2	3,820.5	3,870.8	3,966.1	4,079.6	4,206.1
Connecticut	1,092.8	1,106.3	1,117.6	1,134.8	1,158.4	1,193.6	1,232.8
31-County Region	11,758.5	11,945.1	12,055.5	12,202.5	12,462.0	12,780.8	13,097.6

Source: NYMTC

TABLE A3.6 - 31-COUNTY REGION, EMPLOYED RESIDENTS & CIVILIAN LABOR FORCE COMPARISON (IN 000S)

	Employed Residents				Total Labor Force			
	2015	2045	Additional Employed Residents (2015-2045)	% Change	2015	2045	Additional Labor Force Participants (2015-2045)	% Change
New York City	3,884.1	4,255.8	371.7	9.6	4,263.5	4,582.8	319.3	7.5
Long Island	1,385.0	1,595.9	210.9	15.2	1,472.5	1,666.1	193.6	13.2
Mid Hudson	1,115.1	1,335.9	220.7	19.8	1,202.7	1,409.7	207.0	17.2
New Jersey	3,440.5	3,979.2	538.7	15.7	3,727.1	4,206.1	479.0	12.9
Connecticut	1,004.6	1,162.5	157.9	15.7	1,092.8	1,232.8	140.1	12.8
31-County Region	10,829.3	12,329.3	1,500.0	13.9	11,758.5	13,097.6	1,339.1	11.4

Source: NYMTC

D. HOUSEHOLDS

I. REGIONAL SHARE OF HOUSEHOLD GROWTH

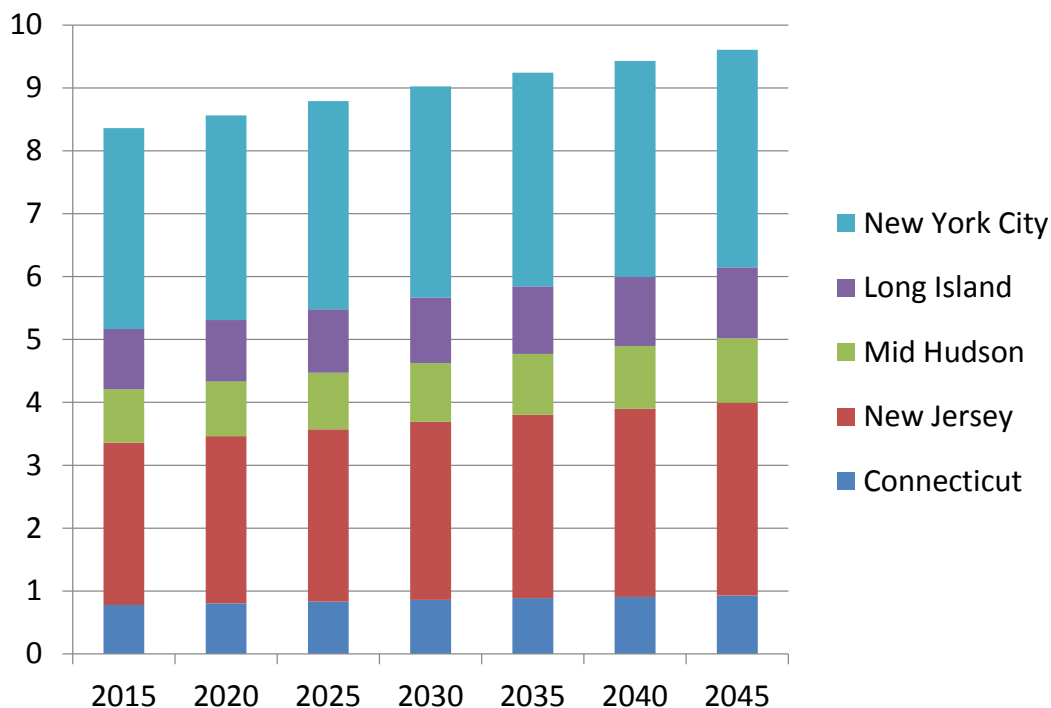
In the 31-county forecast area, the number of households is predicted to increase by over 1.2 million, yielding a total of 9.6 million households. The assumptions for the models hold the NYC counties at a constant household size but the other subregions' household size is forecasted to decline. For the 31-county forecast area as a whole, the average household size declines from 2.65 to 2.61 people.

TABLE A3.7 - 31-COUNTY REGION, NUMBER OF HOUSEHOLDS BY SUBREGION, 2015 TO 2045 (IN 000S)

	2015	2020	2025	2030	2035	2040	2045
New York City	3194.6	3254.3	3311.8	3358.0	3399.4	3434.5	3459.9
Long Island	959.4	979.5	1009.8	1043.0	1072.6	1100.1	1125.9
Mid Hudson	847.0	869.2	899.0	934.6	968.0	997.1	1025.8
New Jersey	2584.0	2659.6	2741.5	2829.0	2917.5	2991.7	3066.5
Connecticut	777.0	801.9	830.2	860.5	886.1	907.2	928.6
31-County Region	8,362.1	8,564.5	8,792.4	9,025.0	9,243.7	9,430.6	9,606.7

Source: NYMTC

FIGURE A3.6 -31-COUNTY REGION, NUMBER OF HOUSEHOLDS BY SUBREGION, 2015 TO 2045 (IN 000,000S)

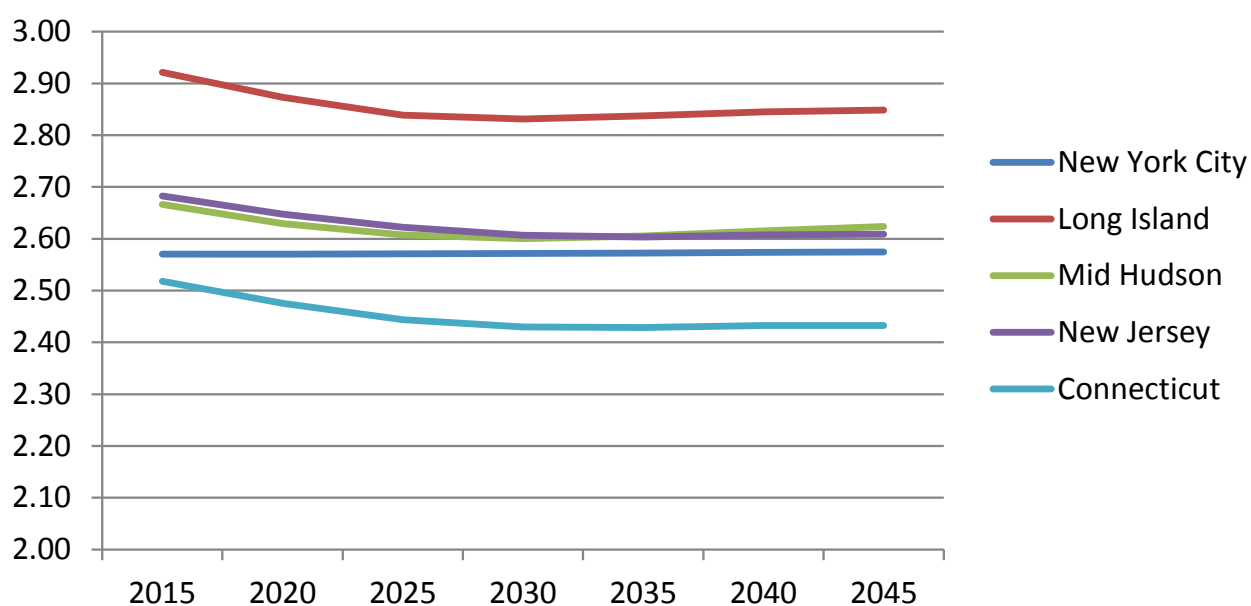


Source: NYMTC

TABLE A3.8 - 31-COUNTY REGION, AVERAGE HOUSEHOLD SIZE BY SUBREGION, 2015 TO 2045

	2015	2020	2025	2030	2035	2040	2045
New York City	2.57	2.57	2.57	2.57	2.57	2.57	2.57
Long Island	2.92	2.87	2.84	2.83	2.84	2.85	2.85
Mid Hudson	2.67	2.63	2.61	2.60	2.61	2.62	2.62
New Jersey	2.68	2.65	2.62	2.61	2.60	2.61	2.61
Connecticut	2.52	2.48	2.44	2.43	2.43	2.43	2.43
31-County Region	2.65	2.63	2.61	2.60	2.60	2.61	2.61

Source: NYMTC

FIGURE A3.7 -31-COUNTY REGION, AVERAGE HOUSEHOLD SIZE BY SUBREGION, 2015 TO 2045

Source: NYMTC

4. 2045 NYMTC PLANNING AREA FORECASTS

As discussed earlier, the Planning Area is the 10-County region that includes New York City, Long Island and the Lower Hudson Valley.

A. PLANNING AREA EMPLOYMENT

Each subregion in the planning area is forecasted to experience overall growth in total employment. As with the 31-County Region, the most significant growth for all subregions is forecasted to occur between 2015 and 2020; following that period growth will continue at a more modest pace.

New York City is expected to have an increase in total employment by approximately 390,000 by 2045, which equates to about 8.1 percent overall growth and a compound annual growth of 0.27 percent. The additional total employment by 2045 in the New York City subregion represents about 28 percent of additional total employment in the 31-county forecast area and 62 percent of additional total employment in the NYMTC planning area. In 2045, employment in New York City will represent approximately 71 percent of total employment for the planning area. Manhattan will represent 34.5 percent of the additional total employment, from 2015 to 2045.

The Long Island and Lower Hudson Valley subregions are predicted to have 164,000 and 77,000 in additional total employment, respectively, by 2045. Both subregions are expected to grow about 12 percent between 2015 and 2045. Suffolk County and Nassau County are projected to add 100,000 and 63,000, respectively, in total employment by the end of the forecast period.

B. PLANNING AREA POPULATION

The NYMTC planning area will add over 1.3 million persons by 2045. New York City will experience the most absolute growth, with a prospective addition of about 690,000 people, for a growth rate of 8.3 percent (0.27 percent annually). The Lower Hudson Valley is projected to add just over 450,000 people, for a growth rate of 19.3 percent (0.6 percent annually). Long Island is expected to grow at a rate of 14.7 percent (0.5 percent annually), increasing by over 420,000 people.

TABLE A3.9 - PLANNING AREA, TOTAL EMPLOYMENT, 2015 TO 2045 (IN 000S)

	2015	2020	2025	2030	2035	2040	2045
10 County Planning Area	6,841.4	7,011.4	7,102.3	7,182.9	7,279.9	7,381.2	7,479.8
New York City	4,904.8	5,017.0	5,074.5	5,124.2	5,182.5	5,245.0	5,303.2
Bronx County	414.7	425.4	432.4	438.6	444.8	452.1	458.6
Kings County	924.6	945.8	959.1	969.8	983.6	998.4	1,012.4
New York County	2,646.6	2,711.8	2,742.4	2,770.0	2,801.6	2,833.1	2,866.6
Queens County	771.9	784.7	788.8	792.5	797.7	804.8	807.7
Richmond County	147.1	149.3	151.7	153.3	154.8	156.4	157.9
Long Island	1,304.9	1,343.8	1,365.5	1,386.6	1,413.3	1,440.4	1,468.4
Nassau County	627.6	643.9	650.0	657.1	668.1	679.3	690.9
Suffolk County	677.2	700.0	715.5	729.4	745.2	761.1	777.4
Lower Hudson Valley	631.7	650.6	662.4	672.1	684.1	695.8	708.2
Putnam County	30.2	30.7	30.9	30.9	31.0	31.1	31.2
Rockland County	125.6	131.2	135.3	139.2	143.4	147.3	151.5
Westchester County	475.8	488.8	496.2	501.9	509.8	517.4	525.5

Source: NYMTC

TABLE A3.10 - PLANNING AREA, POPULATION, 2015 TO 2045 (IN 000S)

	2015	2020	2025	2030	2035	2040	2045
10 County Planning Area	12,650.1	12,826.0	13,059.0	13,318.2	13,580.1	13,819.0	14,022.7
New York City	8,397.1	8,551.0	8,700.0	8,821.0	8,931.0	9,025.1	9,093.5
Bronx County	1,415.7	1,446.8	1,485.3	1,519.0	1,550.5	1,579.2	1,599.6
Kings County	2,602.8	2,648.5	2,706.2	2,754.0	2,799.3	2,840.5	2,870.3
New York County	1,610.7	1,638.3	1,661.6	1,676.7	1,686.3	1,691.6	1,695.5
Queens County	2,289.5	2,330.3	2,353.4	2,373.6	2,394.4	2,412.6	2,425.6
Richmond County	478.4	487.2	493.4	497.7	500.5	501.1	502.5
Long Island	2,856.2	2,868.5	2,921.6	3,010.9	3,105.6	3,195.8	3,277.0
Nassau County	1,354.0	1,355.5	1,379.3	1,423.1	1,475.3	1,530.1	1,579.4
Suffolk County	1,502.2	1,513.0	1,542.3	1,587.9	1,630.3	1,665.7	1,697.5
Lower Hudson Valley	1,396.7	1,406.5	1,437.4	1,486.2	1,543.4	1,598.1	1,652.2
Putnam County	100.1	100.5	101.6	103.7	106.2	108.3	109.9
Rockland County	323.6	327.8	337.5	351.1	365.3	380.1	393.9
Westchester County	973.0	978.1	998.3	1,031.4	1,071.9	1,109.7	1,148.3

Source: NYMTC

C. PLANNING AREA CIVILIAN LABOR FORCE AND EMPLOYED LABOR FORCE

New York City will add about 319,000 labor force participants (residents 16 years or older who are employed or actively seeking employment) for a total percent change of 7.5 percent. Long Island will add just under 200,000 participants. The Lower Hudson Valley is expected to add approximately 127,000 participants. In total, the NYMTC planning area is expected to have over 7 million labor force participants, a growth rate of approximately 9.9 percent and an increase of approximately 640,000.

Employed Labor Force refers to residents of a place who are employed regardless of employment location. For the NYMTC planning area in 2045, the employed labor force is projected to total 6.7 million, an increase of over 700,000 employed participants. This total accounts for 47.4 percent of the total population. Like the 31-county forecast area, the increase in employed participants outpaces the increase in Civilian Labor Force participants, signaling an improvement in the economy for the planning area.

New York City will add approximately 370,000 employed participants. Long Island and the Lower Hudson Valley are expected to add 210,000 and 135,000 employed participants, respectively. The Lower Hudson Valley, which has the smallest increase in number, is projected to experience the most growth relative to 2015, with 20 percent increase over the forecast period. Long Island is projected to experience 15 percent growth while 9.6 percent growth is expected for New York City. Overall, expected growth of employed labor force over the forecast horizon is 12 percent.

A comparison of Employed Residents and Employment (employed people by residence v. jobs by place of work location) shows where in-commuting and out-commuting for work will occur at the sub-regional level. Long Island and Mid-Hudson South have more employed participants than employment, meaning many employed residents commute outside of their subregion for work. New York City has fewer employed participants than employment; therefore in-commuting from other areas occurs to fill those jobs.

TABLE A3.11 - PLANNING AREA, CIVILIAN LABOR FORCE, 2015 TO 2045 (IN 000S)

	2015	2020	2025	2030	2035	2040	2045
10 County Planning Area	6,451.5	6,571.2	6,621.0	6,689.7	6,814.2	6,963.7	7,091.6
New York City	4,263.5	4,374.0	4,398.9	4,425.9	4,482.1	4,545.1	4,582.8
Bronx County	639.6	658.9	667.9	675.4	688.0	704.0	715.5
Kings County	1,268.6	1,298.9	1,313.3	1,331.0	1,357.9	1,383.1	1,394.6
New York County	939.4	963.7	967.3	968.7	976.1	985.3	990.7
Queens County	1,192.2	1,223.4	1,222.3	1,223.5	1,232.2	1,243.3	1,250.3
Richmond County	223.7	229.0	228.2	227.2	227.8	229.4	231.7
Long Island	1,472.5	1,475.8	1,487.6	1,511.6	1,553.1	1,609.1	1,666.1
Nassau County	695.2	695.1	702.8	718.7	744.8	778.8	812.3
Suffolk County	777.2	780.7	784.8	792.9	808.4	830.3	853.8
Lower Hudson Valley	715.5	721.4	734.5	752.2	778.9	809.6	842.7
Putnam County	53.9	54.0	53.5	52.9	53.5	54.7	56.3
Rockland County	159.8	160.8	164.8	170.9	178.3	187.2	195.4
Westchester County	501.9	506.7	516.2	528.3	547.2	567.7	591.1

Source: NYMTC

TABLE A3.12 - PLANNING AREA, EMPLOYED LABOR FORCE, 2015 TO 2045 (IN 000S)

	2015	2020	2025	2030	2035	2040	2045
10 County Planning Area	5,935.6	6,108.1	6,187.7	6,273.4	6,391.0	6,531.9	6,652.9
New York City	3,884.1	4,026.8	4,071.7	4,110.5	4,162.8	4,221.0	4,255.8
Bronx County	559.1	585.8	599.0	609.1	620.5	634.9	645.3
Kings County	1,152.2	1,193.8	1,214.4	1,235.6	1,260.6	1,284.0	1,294.7
New York County	867.7	896.4	903.1	906.5	913.5	922.0	927.1
Queens County	1,095.2	1,134.1	1,138.5	1,143.0	1,151.3	1,161.7	1,168.2
Richmond County	210.0	216.6	216.6	216.3	216.8	218.3	220.6
Long Island	1,385.0	1,401.8	1,420.2	1,447.7	1,487.6	1,541.2	1,595.9
Nassau County	654.2	660.7	671.5	689.0	714.0	746.7	778.8
Suffolk County	730.8	741.1	748.7	758.8	773.6	794.6	817.1
Lower Hudson Valley	666.5	679.5	695.8	715.1	740.6	769.7	801.3
Putnam County	50.0	50.9	50.8	50.5	51.0	52.2	53.7
Rockland County	149.7	152.8	157.8	164.3	171.5	180.0	187.9
Westchester County	466.8	475.9	487.3	500.3	518.1	537.5	559.7

Source: NYMTC

TABLE A3.13 - PLANNING AREA, EMPLOYED RESIDENTS AND EMPLOYMENT COMPARISON (IN 000S)

	Employed Participants 2045	Employment 2045	Employed Participants: Employment Ratio*
10 County Planning Area	6,652.9	7,479.8	88.9
New York City	4,255.8	5,303.2	80.2
Bronx County	645.3	458.6	140.7
Kings County	1,294.7	1,012.4	127.9
New York County	927.1	2,866.6	32.3
Queens County	1,168.2	807.7	144.6
Richmond County	220.6	157.9	139.7
Long Island	1,595.9	1,468.4	108.7
Nassau County	778.8	690.9	112.7
Suffolk County	817.1	777.4	105.1
Lower Hudson Valley	801.3	708.2	113.1
Putnam County	53.7	31.2	172.2
Rockland County	187.9	151.5	124.0
Westchester County	559.7	525.5	106.5

* A ratio above 100 means that some employed participants commute outside their county or subregion for their job because there are more employed participants than employment. A ratio below 100 means that employment is higher than employed participants. Employed participants of other counties commute in to fill jobs.

Source: NYMTC

D. PLANNING AREA HOUSEHOLDS AND AVERAGE HOUSEHOLD SIZE

The NYMTC planning area is projected to add over 525,000 households by 2045. The majority of the growth will occur in New York City, especially in Brooklyn. Long Island is expected to add approximately 166,500 households, of which more than 90,000 will be in Suffolk County. The Lower Hudson Valley is forecast to add slightly under 94,000 by 2045, with approximately 67,000 of the increase occurring in Westchester County.

Average Household Size was held constant for each county in New York City. For the suburban counties, a slight decrease is projected by 2045. Long Island's average household size will decrease from 2.92 to 2.85 people but it remains the highest of the subregions. The Lower Hudson Valley's average household size is expected to decline slightly from 2.74 to 2.72.

TABLE A3.14 - PLANNING AREA, HOUSEHOLDS AND AVERAGE HOUSEHOLD SIZE (IN 000S)

	2015	2020	2025	2030	2035	2040	2045	Average Household Size 2015	Average Household Size 2045
10 County Planning Area	4651.0	4739.4	4841.6	4939.5	5029.0	5108.2	5176.4	2.66	2.65
New York City	3194.6	3254.3	3311.8	3358.0	3399.4	3434.5	3459.9	2.57	2.57
Bronx County	494.5	505.7	519.6	531.8	543.2	553.6	560.9	2.77	2.77
Kings County	953.5	970.4	991.9	1009.6	1026.5	1041.8	1052.8	2.69	2.69
New York County	776.3	790.2	801.9	809.5	814.4	817.0	819.0	1.99	1.99
Queens County	801.3	815.8	824.0	831.1	838.5	845.0	849.6	2.82	2.82
Richmond County	169.0	172.1	174.4	175.9	176.9	177.1	177.7	2.78	2.78
Long Island	959.4	979.5	1009.8	1043.0	1072.6	1100.1	1125.9	2.92	2.85
Nassau County	450.9	456.4	468.2	482.4	497.0	511.9	526.2	2.95	2.95
Suffolk County	508.5	523.1	541.6	560.5	575.6	588.2	599.7	2.89	2.76
Lower Hudson Valley	496.9	505.7	520.0	538.5	556.9	573.6	590.6	2.74	2.72
Putnam County	36.2	37.3	38.2	39.1	39.8	40.3	40.7	2.69	2.62
Rockland County	104.0	105.8	108.9	113.3	117.7	121.9	126.0	3.04	3.04
Westchester County	356.8	362.6	372.9	386.2	399.4	411.4	423.9	2.64	2.62

Source: NYMTC

5. OVERVIEW OF THE NEW YORK BEST PRACTICE MODEL (NYBPM)

The NYBPM study area covers 28 counties in New York, New Jersey, and Connecticut. It is comprised of 4,629 Transportation Analysis Zones (TAZs) and includes 21,000 miles of highway network. The transit system includes all forms of public transportation at the individual level in the transit network database. The development of the NYBPM travel forecasting model was based on the statistical analysis of data specifically collected for the 28-County New York metropolitan region, primarily the 1997/1998 Household Interview Survey (HIS) and it has been updated, recalibrated and validated continuously upon new traffic flow data. The focus of the planning, application, and calibration of the model is geared toward the 10 counties that comprise the NYMTC planning jurisdiction.

The NYBPM is representative of the more advanced set of travel demand forecasting models known as activity/tour-based models that are characterized by the following key features:

- > Comprehensive coverage of all modes and vehicle types in detailed highway and transit simulations;
- > Use of “tours” (or paired journeys) as the basic unit of modeling, instead of “trips” that are used in conventional demand models of the previous generation;
- > Use of a micro-simulation approach to generate forecasts that are discrete choices for individuals, as opposed to probabilities that represent market segment shares in conventional models; and
- > Use of the contemporary conceptual framework of the daily activity agenda of individuals accounting for intra-household interactions between members and constraints on people’s travel in terms of both time and space.

The county level employment, population, labor force, and household variables were applied to TAZ level socioeconomic forecasts for the 28-county NYBPM region for Plan 2045. These TAZ level forecasts cover the following 16 variables:

Residence-based variables include Total Population, Household Population, Group Quarters Population – Total, Group Quarters Population – In Institutions, Group Quarters Population – Homeless/Streets, Group Quarters Population – Other, Number of Households – Total, Average Household Size, Mean Household Income, and Employed Labor Force.

Workplace-based variables are Employment – Total, Employment – Office, Employment – Retail, and Mean Earnings per Worker. School enrollment variables are as follows: K-12 Enrollment and University Enrollment.

HIGHLIGHTS OF THE NYBPM

The NYBPM is a complex simulation model used for predicting the future travel of the residents of the study area based on their travel behavior for a designated base year. The NYBPM is representative of the emerging set of activity / tour-based models of regional travel demand models that are characterized by the following main features (which separate these travel-demand models from others):

- > Comprehensive coverage of all modes and vehicle types in detailed highway and transit simulations
- > Use of tour (or paired journeys) as the basic unit of modeling, instead of trip that is used in conventional demand models of the previous generation
- > Use of micro-simulation approach to generate forecasts that are discrete choices for individuals as opposed to probabilities that represent market segment shares in conventional models

- Using the contemporary conceptual framework of daily activity agenda of individuals with accounting for intra-household interactions between members and constraints on peoples travel in terms of both time and space.

The NYBPM is among the first of activity / tour-based models developed in the country and was the first activity-based model used for air quality conformity determination in the nation. At the time of this writing NYMTC was one of five MPOs with an operational activity/tour-based model. Some of the main features are described in this sub-section.

A. JOURNEY-BASED MODELS

The NYBPM uses the concept of “journeys” rather than the traditional concept of “trips.” The journey, defined as travel between two principal locations, identifies anchor points in an individual’s travel pattern, such as home, work, or school. Travel between these anchor points represents one journey which may be made up of several individual trips. Thus, use of the journey helps planners form a more realistic analysis that is based on the various decisions made by travelers between these locations, such as mode, purpose, destination, frequency and location of intermediate stops, as well as time of day of travel.

i. The Highway Network

The NYBPM highway network contains more than 79,000 links, including most minor arterial and above roadway facilities. The database includes information on number of lanes, functional class, speed, parking restriction, and truck-usage. As inputs to the NYBPM core models, the networks are used to estimate travel times and distances between Transportation Analysis Zones. The trip tables are assigned to the networks to forecast travel demand by producing expected volumes by vehicle class with congested speeds and travel delays at the link level.

ii. The Transit Network

The transit network representation integrates the many diverse transit services in New York City, Long Island, northern New Jersey, and five Lower Hudson Valley counties. The services include: Commuter rail

lines (LIRR, MNR, and New Jersey Transit rail); Rapid transit lines (NYCT and Port Authority Trans-Hudson (PATH), and the Newark City Subway); Express bus and local bus routes (more than 20 operators); and ferry routes and an aerial tramway

iii. Model Estimation, Calibration, and Validation

The estimation data sets for the original model were constructed from various data sources in a format specific to each model and to the requirements of the ALOGIT software. The Regional Travel – Household Interview Survey (RT-HIS) constitutes the primary data source for the model estimation. The RT-HIS was also the primary basis for the calibration of the NYBPM, supplemented by U. S. Census data, such as the Public Use Micro-Sample (PUMS) data and the American Community Survey (ACS) data. The present NYBPM is updated based on 2010 Census data and the most recently available traffic counts. Highway volume assignments were calibrated based on the 2010 Screenline Count database.

iv. Micro-Simulation Approach

Where traditional models operate at the zone level, with matrix tables of aggregate flows, the NYBPM uses the micro-simulation method to simulate the travel pattern of each person and each individual journey in the region. The micro-simulation method provides many advantages, and a finer level of detail which, when combined with the NYBPM’s use of the journey, increases the accuracy and usefulness of the travel demand forecasting.

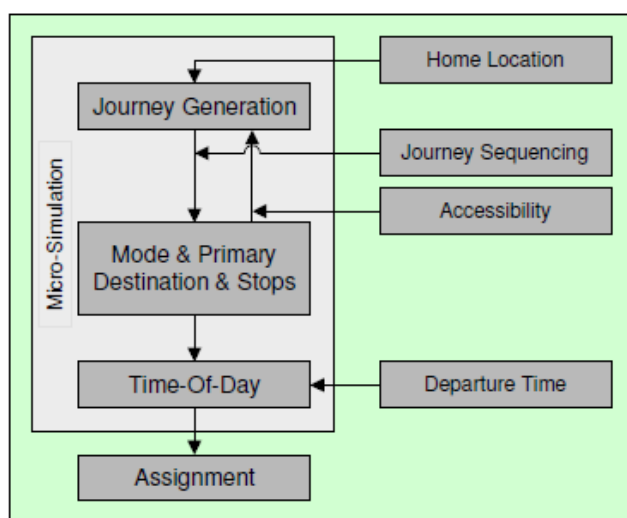
v. Application Software

The NYBPM was developed using a combination of customized programs and TransCAD software. The NYBPM is a regional model and the highway network does not contain all the local streets and intersections. A Post Processor Software (PPS) was developed to provide an interface between the NYBPM and the application tools for Congestion Management Process (CMP) and Conformity Air Quality analysis (PPS-AQ). Post-processing is the process by which traffic flows from the NYBPM output are smoothed out with HPMS data from NYSDOT, to account for the traffic flow in the local streets of the region. It addition, it also takes into account the signalized projects and ITS projects that cannot be coded into the NYBPM.

B. STRUCTURE OF THE NYBPM

The overall structure of the models and procedures that comprise the NYBPM is shown in the highly simplified schematic found in Figure A3.9. While in many respects, the data flow of the NYMTC model is similar to that of conventional “Four-Step” travel forecasting models (travel production, distribution, mode choice, and assignment), the following general modeling structure of the NYBPM represents the typical features of an activity-based travel demand model.

FIGURE A3.8 -GENERAL MODELING STRUCTURE OF THE NYBPM



Source: NYMTC

i. Household, Auto-Ownership and Journey-Frequency (HAJ) Models

The NYBPM is comprised of a set of sub-models applied in sequence: 1) the household-synthesizing model, 2) the auto-ownership model, and 3) the journey production (frequency) model.

Household Model - This model forecasts the number and distribution of households in each zone. Using Census data, the model calculates the probability of each possible combination of household characteristics, including income; size; and number of workers, nonworking adults, and children. These probabilities are then used in combination with the aggregate demographic forecasts in order to produce the number of households for each category, for each zone, for the target years.

Auto-Ownership Model - The Auto Ownership model determines the number of automobiles available in each household. The model considers the influence of household income and composition, vehicle-maintenance cost, parking availability, transit and highway accessibility, density and residential area type.

Journey-Frequency Model - The Journey-Frequency model determines the daily number of paired journeys (outbound and inbound) each person in each household makes for every travel purpose. Each person is categorized as a worker, non-working adult, or child. This model evaluates transit accessibility, auto availability, and intra-household relationships to come up with the journey frequency for each person. Linkage of journey-frequency models across different household members allows for the forecasting of a realistic set of journeys made by each household.

Mode, Destination and Stop Choice - This model comprises pre-mode choice, destination and mode choice, intermediate stop frequency, and stop location choice modeled in sequence. This model combines the destination and the mode choice model and also introduces the concept of intermediate stops in a journey. Explicitly modeling the number and location of the stops on a journey allows for a realistic representation of the interrelated decisions made by the traveler regarding all destinations (primary and secondary) and modes.

- > **Pre-Mode Choice Model** - This model distinguishes between motorized and non-motorized travel based on the person, his or her household characteristics, and land-use densities around the journey origin.
- > **Destination-Choice Model** - Different destination-choice models are applied to motorized and non-motorized subsets of journeys. They take into account available attractions for each zone in retail, office, and other employment categories, along with school and university enrollments, and then distribute journeys to the destination zones.

- > **Motorized Mode-Choice Model** - The Motorized Mode-Choice model predicts traveler decisions based on various time and cost factors as well as person and household characteristics. This model includes eight motorized modes as follows:
 - Drive alone;
 - Shared ride – 2+ (driver and passenger);
 - Shared ride – 3+ (driver and two passengers);
 - Taxi;
 - Transit (including bus, subway, and ferry) with walk access;
 - Transit with drive access;
 - Commuter rail with transfer feeder lines) with walk access;
 - Commuter rail with drive access; and
 - School bus (for journeys to schools only)
- > **Stop-Frequency Choice Model** - The Stop-Frequency Model calculates if there are any stops in a journey. There can be four combinations for stops in a journey: 1) direct journeys without stops, 2) stop on the inbound journey only, 3) stop on the outbound journey only, and 4) stops on both inbound and outbound journeys.
- > **Stop-Location Choice Model** - The Stop-Location Choice model predicts a location zone for each modeled stop based on the density of potential attractions along the journey route from origin to destination and the deviation (relative additional impedance) from the base journey route that is associated with visiting the stop zone.

Time of Day Model - Time of day models are used to convert the daily journeys into traditional trips categorized by four time periods for the traffic assignments process. These time periods are AM (6 AM to 10 AM), PM (4 PM to 8 PM), Midday (10 AM to 4 PM), and Night (8 PM to 6 AM).

Other Models - In addition to the main NYBPM model, some auxiliary models are also used, including:

- > **Truck and Commercial Vehicle Trip Tables** - Truck and commercial vehicle trip tables are estimated outside the main model using the traditional gravity model and creating forecasts for the future years.
- > **External Model** - To account for autos coming into the study area, leaving the study area, or passing through the study area, external trip tables are forecast based on data collected at the cordon line.

ii. Assignment

The trip tables from the time of day model are combined with truck and commercial trip tables, and external trip tables to create the highway and transit trip tables by time period. These trips are loaded or assigned to the highway and transit networks to forecast vehicular traffic flows on roadway segments and transit ridership by routes respectively.

C. NYBPM UPDATES

The NYBPM, which was originally estimated with 1996/1997 data, was updated, calibrated and validated several times. The latest update of NYBPM was completed recently and the model base year was updated to reflect the 2010 transportation system.

As part of NYBPM 2010 Base Update, all regional data and networks were updated and additional procedures were developed. With this update, the highway and transit networks have been improved significantly including the update of highway attributes and complete conflation of highway system. Several NYBPM computer application procedures have also been improved or added to the existing procedures that comprise the NYBPM modeling system. These included a major improvement in the Truck and Commercial model as well as substantial improvement in External model. Other major improvements and updates are:

- > Development of a new Census-based TAZ system
- > Update of Socioeconomic and Demographic Data (SED)
- > Update of Traffic Counts
- > Update of Classification Counts
- > Update of Truck Routes in highway network
- > Update of all highway tolls and parking costs
- > Update of transit service and fares
- > Implementation of Journey-to-work flow data at county level from American Community Survey (ACS) 2006-2010 and 2010 Census data.