Jersey City 2035

The Impact of Growth on Road Infrastructure

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Executive Summary

This paper examines the effects of variability of growth in Jersey City, New Jersey on its road network using the North Jersey Transportation Planning Authority's travel demand model. The model's depiction of the road network in 2035 is compared with several alternative projections with different levels of population and job growth. The results show some predictable variations in travel demand based on growth, and some that are difficult to explain. A conclusion is reached based on the different versions of the model that in most cases, roads that are congested today will remain or become increasingly so, while those that are not will see increased volumes but for the most part will not exceed free flow capacity. Finally, it is suggested that focusing growth in a more organized fashion would allow travel demand to be better predicted and alternative transportation methods to be more effectively used to relieve congestion.

Goldman Sachs tower in Jersey City as viewed from One World Trade Center

Introduction

In recent years, Jersey City has become perhaps the greatest municipal success story in the state of New Jersey. Smart Growth America recently ranked the city the second least sprawling metro area in the country, only behind New York City, and according to USA Today Jersey City in recent decades has added more jobs, residents, and office space than the downtowns of Atlanta, Phoenix, and Miami. With its proximity to New York and access to mass transit being its primary forces of attraction, Jersey City has stood counter to low growth trends of other New Jersey municipalities, and is primed to continue growing (Hampson).

With that growth, however, comes additional stress on the basic infrastructure and services of the city, including transportation. The purpose of this project was to determine how much of a strain varying levels of growth may place on the area's road network in the year 2035, thereby identifying needs for investment in additional capacity and investment in alternatives such as mass transit and improved bicycle and pedestrian facilities.

Jersey City sits across the Hudson River from Manhattan, and is a major player in the financial industry, home to such companies as Goldman Sachs, Chase Manhattan Bank, Lehman Brothers, Merrill Lynch, and Charles Schwab. New Jersey City University, Saint Peter's College, and Hudson County Community College are located in Jersey City, as well as campuses for Rutgers and the University of Phoenix. Education wise, the city also has the top rated high school in New Jersey, McNair Academic. These factors, combined with the city's infrastructure and cultural offerings, make Jersey City one of the most attractive New Jersey cities to live in (About Jersey).

Jersey City is well served by highways and mass transit. Major roads running through or in close proximity to the city include US-1/9 (the Pulaski Skyway), NJ-440, NJ-7, Interstate 78, Interstate 95 (the New Jersey Turnpike), and within the city County Rd 612, John F Kennedy Blvd, Sip Ave, Newark Ave, and Montgomery St. Jersey City is served by the Hudson Bergen Light Rail system, and the Port Authority's PATH subway line, which connects to Newark Penn Station as well as midtown and downtown Manhattan. Additionally, the city is served by NJ Transit buses, and the NY Waterway crosses the Hudson by ferry.

Surveys put Jersey City's commuter mode share for public transportation at around 50%, making it second in the nation only behind New York City. The Circulation Element of the Jersey City Master Plan has objectives of continuing to increase mass transit ridership and regional carpooling options. As

the city grows in the coming decades, a strain will be put on the transit network. While the creation and improvement of transportation alternatives to the automobile could help relieve current congestion on the roads, it would also allow future growth to be better accommodated (Jersey City).

Literature Review

A preliminary component of this project involved researching prior publications on population growth projections and travel demand modeling.

James Reilly of the New Jersey Office of State Planning and Paul Gottlieb of Princeton University published a report in 1993 entitled "Projecting Costs for Roads Under Various Growth Scenarios." The subject of the report was a spreadsheet based model developed by the State of New Jersey Office of State Planning that would allocate growth projections and then project local road needs based on that growth. The primary conclusion of this paper was that the model was successful in showing that counties could save significantly on capital costs on road construction if growth was distributed into denser and more urban areas (Reilly, and Gottlieb).

In Norway, Morten Welde of the Norwegian Public Roads Administration and Norwegian University of Science and Technology and James Odeck of the Norwegian University of Science and Technology drafted a paper for the European Journal of Transport and Infrastructure Research entitled "Do Planners Get it Right? The Accuracy of Travel Demand Forecasting in Norway." While the 2011 publication is not geographically relevant, much of the concepts discussed are universal amongst transportation planners. The paper suggests that road infrastructure projects are often influenced by deliberately skewed forecasting. In their study of Norwegian roads, the authors found that traffic forecasts for tolled roads were fairly accurate, possibly due to more careful scrutiny from planners because of the financial implications. For roads without tolls, however, traffic was typically underestimated, with induced demand being a possible contributing factor (Welde, and Odeck 80-95).

In 2007 ESRI published a white paper called "Evaluating Population Projections – The Importance of Accurate Forecasting." The paper discusses why it is important to have good population projection methods since the United States Census only occurs every 10 years. Results of several Censuses are compared with ESRI's own forecasts, and the evaluation results in a number of recommendations for improvement. ESRI was able to reduce their error rate of 14.5% in 1990 to 6.8% in 2000 at the tract level. They were also able to begin forecasting at the block level with an error rate

of less than 10%. Finally, they were able to anticipate how population would change at the block level based on immigration ("ESRI").

For a much older snapshot of this longstanding issue, The Journal of the American Statistical Organization published an article by Michael Stoto in 1983 entitled “The Accuracy of Population Projections.” In it, Stoto lamented the inherent inaccuracies of population projections. By studying errors in past projections, Stoto was able to construct a confidence interval for future projections. Using that, he created a confidence interval for United States population through the year 2000. While the actual national population in 2000 did fall within Stoto’s confidence interval, the interval had a range of 78 million, making it of little use. Finally, Stoto concluded that simple projection techniques were more accurate than complex ones at predicting total population size (Stoto 13-20).

In 2004, the Federal Highway Administration’s *Public Roads* magazine featured an article by John S. Miller on “The Uncertainty of Forecasts.” Miller chose to investigate the subject after working on development of Virginia’s long range transportation plan. He contends that predictions of socioeconomic factors are more reliable than such things as mode share, technological improvements, and public support of capital investments. Making socioeconomic and travel demand predictions is challenging and many factors simply cannot be foreseen. One of Miller’s recommendations for improving long range plans was to use ranges for estimates compiled from a variety of sources. This would account for discrepancies between forecasting methods and allow scenarios to be analyzed using numbers across the range to show how those changes would affect the outcome (Miller).

Problem Description

New Jersey is often viewed as a region of stagnated growth and decline, and in many cases this would not necessarily be inaccurate. Jersey City seems to counter this trend. The 2000 United States Census listed Jersey City at a population of 240,055, and the 2006 population estimate was 241,789, a growth of only 0.7%. But with the city’s recent emergence, NJTPA believes growth rates have and will continue to rise. The organization estimated in 2009 that the 2010 population of the city would be 265,610, a 9.9% growth from 2000, and a 9.1% growth from the estimated 2006 population.

	2010	2015	2020	2025	2030	Percent Change
Jersey City						
Population	265,610	281,630	296,340	302,690	308,180	16.0
Households	101,180	109,600	117,360	120,940	124,330	22.9
Employment	130,780	137,640	144,790	148,480	155,570	19.0
Hudson County						
Population	667,000	694,000	720,800	740,600	760,700	14.0
Households	257,100	271,300	285,700	297,100	309,100	20.2
Employment	297,000	311,200	328,300	339,900	361,600	21.8

Source: NJTPA

NJTPA projections have Jersey City growing in population by 16% between 2010 and 2030, with a 22.9% increase in households, and a 19% increase in employment. Since NJTPA does not estimate population growth beyond 2030, Jersey City conducted its own independent analysis for growth up until 2050. They concluded that redevelopment efforts would result in the addition of 80,330 new residential units by that time, and a May 2050 population of 475,193. This would mark an 82.3% increase from the city's May 2008 population (Jersey City).

These numbers are somewhat problematic. The 2010 Census data released in February of 2011 revealed Jersey City's population to be 247,597, a growth of 3.1%, well below the 9.9% expected by the city. Therefore it stands to reason that Jersey City and the NJTPA may have overestimated the growth potential of the Jersey City region. Contrarily, just as Jersey City's recent revival may not have been expected a decade or two ago, it is certainly conceivable that population growth in the city over the next several decades could exceed expectations for reasons that cannot be foreseen at this time. Therefore, in addition to exploring the effects of population growth on travel demand based on NJTPA's estimates, this project will examine the effects based on lower than expected (10% less than default 2035 numbers in the model) and higher than expected (10% and 65% more than default 2035 numbers) growth models (U.S. Census).

Methodology

This project used the North Jersey Transportation Planning Authority's demand model, called the North Jersey Regional Transportation Model-Enhancement (NJRTM-E) to examine the effects of changes in various socioeconomic data on road network congestion in Jersey City in 2035. The four step model uses Citilabs' Cube and Voyager software with additional FORTRAN code for mode share modeling. There are 2,245 traffic analysis zones in the model, which in addition to the NJTPA region includes New York City, Long Island, portions of southern New Jersey, portions of southern New York,

and portions of eastern Pennsylvania. The model includes most arterial roads, with eight trip purposes modeled: Home-based work direct, home-based work strategic, home based shopping, home based other, work based other, non-home-non-work, airport trips, and university trips. Modes available are trucks, SOV (single occupancy vehicle), HOV-2 (high occupancy vehicle; 2 occupants), HOV-3, HOV-4+, transit-walk access, and transit-drive access (Travel Demand).

Five iterations of the model were necessary in order to gather the needed data: the base 2010 and 2035 runs, as well as new runs with various 2035 socioeconomic statistics modified by -10%, +10%, and +65%. Copies of the base 2010 and 2035 output were already provided, so three new runs were conducted using modified socioeconomic data. Jersey City is split into 72 traffic analysis zones in the model , and socioeconomic data was modified at across the board rates of -10%, 10%, and 65%, with the exception of the 65% case, in which number of households was only increased by 50%. Variations in specific zones were not taken into account. The following variables were modified by the aforementioned rates for each of the 72 zones:

POP	Population
HH	Households
INCOME	Income
CONST	Construction Employment
MFG	Manufacturing Employment
TRANS	Transportation Employment
WHLS	Wholesale Employment
RETAIL	Retail Employment
FIRE	Fire Service Employment
SERVICE	Service Employment
GOV	Government Employment
TOTAL	Total Employment
EMPBASIC	Total Basic Employment
EMPRETAIL	Total Retail Employment
EMPSERVICE	Total Service Employment

Socioeconomic data for the NJTRM-E model is contained in a dBase file which was edited in Microsoft Excel then converted back into the appropriate dBase format in Microsoft Access. Each run of the model was done with four iterations, resulting in a run time of 20-24 hours for each run. More iterations may have yielded better accuracy, but at a higher time cost.

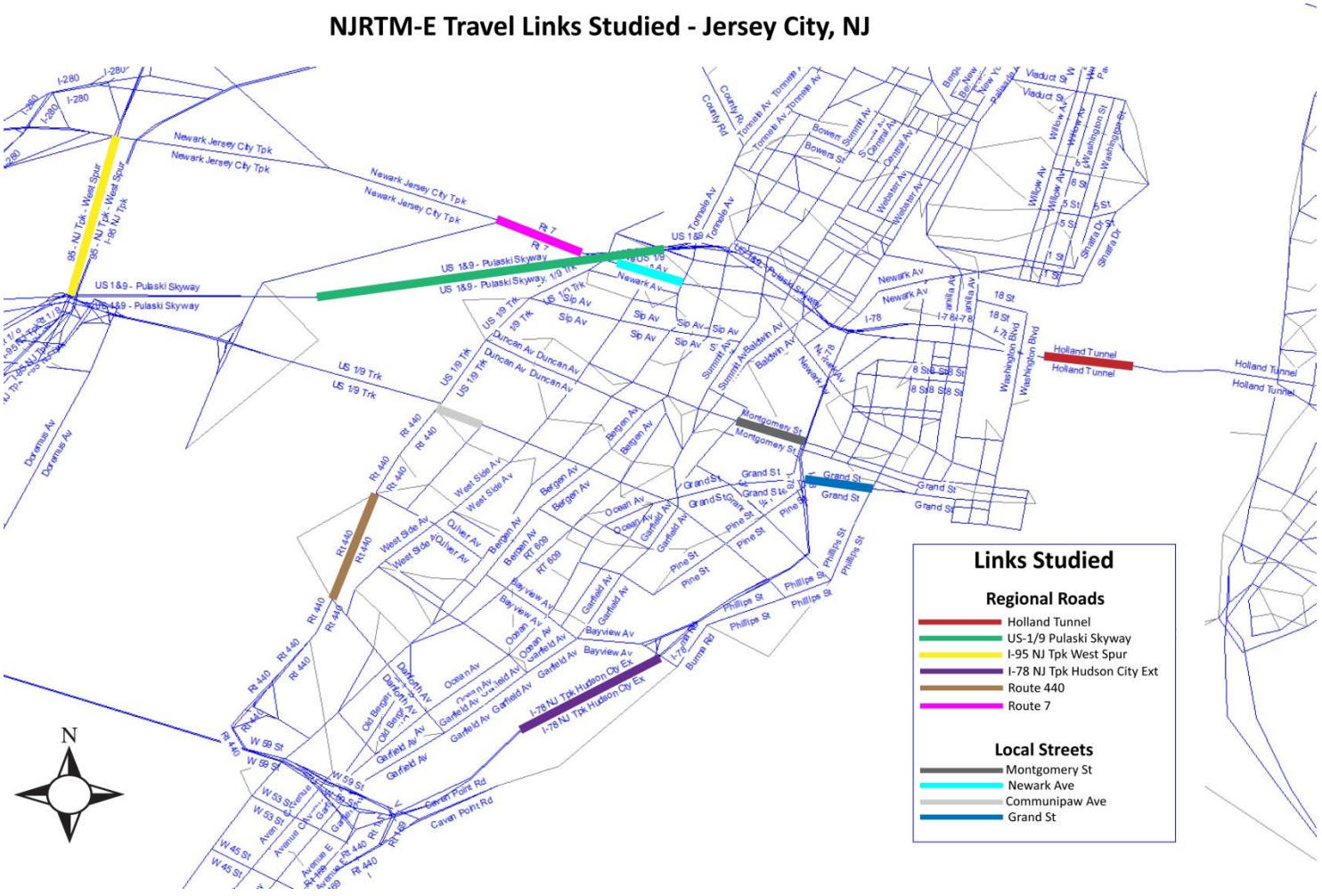
The total population and household figures for each run of the model are as follows:

Jersey City

Version	Population	Households
2010 Original	266,971	100,665
2035 Original	327,499	135,810
2035 -10%	294,749	122,229
2035 +10%	360,249	149,391
2035 +65%	540,378	203,715

Upon completion of the different runs of the model, ten road links were selected to be analyzed. The links included short (0.25 to 2 miles) segments of major roads in Jersey City; six regional roads were selected, and four local streets. The regional roads were the Holland Tunnel, US-1/9 (Pulaski Skyway), I-95 NJ Turnpike West Spur, I-78 NJ Turnpike Hudson City Extension, Route 440, and Route 7. The local streets were Montgomery Street, Newark Avenue, Communipaw Avenue, and Grand Street. The specific segments of these roads studied are mapped below (larger map in Appendix).

NJRTM-E Travel Links Studied - Jersey City, NJ



In the Cube interface, link data can be viewed via a master table (which is quite cumbersome given that there are 55,523 links) or by clicking on individual links in a graphical GIS interface. The graphical interface was used for this study, and 6 data points were recorded from each link:

A	Link Origin
B	Link Destination
DISTANCE	Length of Link (miles)
V_1	Link Vehicles Per Hour
TIME_1	Link Travel Time (minutes)
VC_1	Link Congestion Ratio (Volume/Capacity)

Generally a congestion ratio greater than 1 is defined as congested, as above 1 the traffic volume exceeds the free flow capacity. Compilation of this data for each link and each run of the model into a Microsoft Excel spreadsheet allowed the results to be analyzed and interpreted.

Analysis and Results

The model produced the following results based on AM peak demand.

Original 2035 Model

The original 2035 run showed an across the board increase in volume and congestion on the studied links, with one exception: The studied southbound link of the I-95 NJ Turnpike West Spur actually showed a slight decrease in demand despite the 22.67% population increase. Volume decreased from 13,914 vehicles per hour to 13,130, with the congestion ratio dropping from 0.80 to 0.76. The northbound link, meanwhile, slightly increased from 20,715 vehicles per hour to 22,909. The northbound piece of this link would be taken by morning commuters heading into Manhattan via the Holland Tunnel, and the southbound by commuters from the north going into Newark or Jersey City via the Pulaski Skyway or Communipaw Ave. Possible explanations for this drop in usage could be a lack of job growth in Newark and other areas accessed by the southbound link of the West Spur, or a decrease in attractiveness of routes accessed by that link. For example, Communipaw Ave eastbound increases from a congestion level of 0.97 to 1.11, thereby slowing travel time dramatically (from 0.59 minutes across this particular 0.25 mile link to 2.86 minutes). Users who in the past continued along the southbound section of the West Spur to Communipaw Ave may find it beneficial to exit earlier and take an alternative route into Jersey City.

While all other links saw usage increases, for two local streets this resulted in volume exceeding free flow capacity, making them congested. The following chart shows each link and its status in 2010 and 2035.

Link	2010	2035 Projection	Change
Holland Tunnel (East)	Congested	Congested	
Holland Tunnel (West)	Congested	Congested	
US-1/ 9 Pulaski Skyway (East)	Congested	Congested	
US-1/ 9 Pulaski Skyway (West)	Uncongested	Uncongested	
I-95 NJ Tpk West Spur (North)	Congested	Congested	
I-95 NJ Tpk West Spur (South)	Uncongested	Uncongested	
I-78 NJ Tpk Hudson City Ext (East)	Congested	Congested	
I-78 NJ Tpk Hudson City Ext (West)	Uncongested	Uncongested	
Route 440 (North)	Uncongested	Uncongested	
Route 440 (South)	Uncongested	Uncongested	
Route 7 (East)	Congested	Congested	
Route 7 (West)	Uncongested	Uncongested	
Montgomery St (East)	Congested	Congested	
Montgomery St (West)	Uncongested	Uncongested	
Newark Ave (East)	Congested	Congested	
Newark Ave (West)	Uncongested	Uncongested	
Communipaw Ave (West)	Uncongested	Uncongested	
Communipaw Ave (East)	Uncongested	Congested	Became Congested
Grand St (East)	Uncongested	Congested	Became Congested
Grand St (West)	Uncongested	Uncongested	

2035 Model with 10% Decrease in Socioeconomic Variables

As noted in the Problem Description, both the city and NJTPA overestimated growth for 2010. This run of the model was used to see what the effects would be if socioeconomic values for 2035 were overestimated by 10%. Comparing the results to the original 2035 results was intriguing, as 10 of the segments studied displayed a drop in volume while 10 showed an increase.

Holland Tunnel traffic into Manhattan increased, while traffic from Manhattan decreased. This is likely due to a lower projection of job growth in Jersey City. The Pulaski Skyway, however, showed a slight increase in volume in both directions despite the lower population and job projections. As it is a major route connecting Newark to the Holland Tunnel, a potential explanation is that more commuters had to drive to Newark and Manhattan with fewer jobs available in Jersey City. The I-78 NJ Turnpike Extension displayed slightly higher demand in the eastbound direction, yet nearly 6% less going westbound. Again, this could be explained by more commuters needing to go into New York to work.

Route 440 and Route 7 were interesting cases, as Route 440 showed an increase in demand in both directions and Route 7 a decrease in both directions. No obvious possible explanation could be deduced regarding the Route 440 increase, whereas Route 7 may have decreased because it is used to commute to jobs inside Jersey City, and there are now 10% less jobs. The same can be said of Newark Ave, which is an extension of Route 7 and saw by far the largest change, with a 27% reduction in

demand going east, but a 10% increase going west, possibly due to Jersey City residents commuting out of the city to jobs in Newark and other areas.

Grand Street perhaps was the greatest example of the impact lower growth could have on local streets. Used primarily for those traveling within Jersey City itself, the model showed a reduction in demand both ways, -10.11% eastbound and -5.55% westbound.

Despite all of these notable changes, the 10% lower growth projection did not result in a change in status of any link between congested and uncongested.

Link	2035 Original	2035 -10% Projection	Change
Holland Tunnel (East)	Congested	Congested	
Holland Tunnel (West)	Congested	Congested	
US-1/ 9 Pulaski Skyway (East)	Congested	Congested	
US-1/ 9 Pulaski Skyway (West)	Uncongested	Uncongested	
I-95 NJ Tpk West Spur (North)	Congested	Congested	
I-95 NJ Tpk West Spur (South)	Uncongested	Uncongested	
I-78 NJ Tpk Hudson City Ext (East)	Congested	Congested	
I-78 NJ Tpk Hudson City Ext (West)	Uncongested	Uncongested	
Route 440 (North)	Uncongested	Uncongested	
Route 440 (South)	Uncongested	Uncongested	
Route 7 (East)	Congested	Congested	
Route 7 (West)	Uncongested	Uncongested	
Montgomery St (East)	Congested	Congested	
Montgomery St (West)	Uncongested	Uncongested	
Newark Ave (East)	Congested	Congested	
Newark Ave (West)	Uncongested	Uncongested	
Communipaw Ave (West)	Uncongested	Uncongested	
Communipaw Ave (East)	Congested	Congested	
Grand St (East)	Congested	Congested	
Grand St (West)	Uncongested	Uncongested	

2035 Model with 10% Increase in Socioeconomic Variables

The next run of the model examined the possibility of Jersey City experiencing 10% higher growth than expected. Like the 10% decrease model, the results showed some interesting shifts, with 11 segments increasing in volume as would be predicted, but 9 segments dropping despite the higher population and jobs.

The Holland Tunnel displayed a 3.99% increase in volume entering Jersey City, but actually showed a slight drop of 0.24% in the New York bound lanes. This is more than likely explained by the growth of employment within Jersey City, attracting some additional commuters from across the Hudson and allowing New Jersey residents to avoid the tunnel by working in Jersey City. The Pulaski

Skyway, meanwhile, showed a very slight drop in eastbound traffic and an increase in westbound traffic. This change is difficult to explain, and was also exhibited by Route 7.

Other regional roads, such as the I-95 Turnpike West Spur, I-78 NJ Turnpike Extension, and Route 440 showed demand increases going both directions, which is more consistent with what was originally expected when running this model. Increased population and job activity would result in a greater strain on the road network.

Local streets showed the most dramatic changes, displaying significantly decreased use despite the higher population. This again is difficult to interpret. While one possible explanation is that the increased number of jobs within Jersey City allowed more residents to walk or take public transportation to work, it may be expected that an increased population would counteract that effect.

The effects on congestion were as followed, with only one change, as Montgomery St. eastbound changed from a congestion ratio of 1.02 to 0.97.

Link	2035 Original	2035 +10% Projection	Change
Holland Tunnel (East)	Congested	Congested	
Holland Tunnel (West)	Congested	Congested	
US-1/ 9 Pulaski Skyway (East)	Congested	Congested	
US-1/ 9 Pulaski Skyway (West)	Uncongested	Uncongested	
I-95 NJ Tpk West Spur (North)	Congested	Congested	
I-95 NJ Tpk West Spur (South)	Uncongested	Uncongested	
I-78 NJ Tpk Hudson City Ext (East)	Congested	Congested	
I-78 NJ Tpk Hudson City Ext (West)	Uncongested	Uncongested	
Route 440 (North)	Uncongested	Uncongested	
Route 440 (South)	Uncongested	Uncongested	
Route 7 (East)	Congested	Congested	
Route 7 (West)	Uncongested	Uncongested	
Montgomery St (East)	Congested	Uncongested	Became Uncongested
Montgomery St (West)	Uncongested	Uncongested	
Newark Ave (East)	Congested	Congested	
Newark Ave (West)	Uncongested	Uncongested	
Communipaw Ave (West)	Uncongested	Uncongested	
Communipaw Ave (East)	Congested	Congested	
Grand St (East)	Congested	Congested	
Grand St (West)	Uncongested	Uncongested	

2035 Model with 65% Increase in Socioeconomic Variables

Although outside the scope of the original proposal, an experimental run of the model was made with all socioeconomic values for 2035 increasing by 65%, with the exception of number of households, which was increased by 50%. This scenario, while unrealistic, can still be useful in understanding the potential impacts of growth.

With such a drastic population and job explosion, it would be expected that all 20 segments would show substantially higher demand, but in fact only 16 actually increased. The Holland Tunnel again displayed a drop in demand to access Manhattan, consistent with what was found in the 2035 +10% run. Westbound traffic into Jersey City exploded, however, with an 18.46% growth from the original 2035 run. The I-95 West Spur saw a drastic increase in southbound traffic, yet an unexplained drop in northbound usage.

The other unexpected drops were a very slight unexplained decrease on Route 440 going north, and a massive 38.77% decrease in eastbound traffic on Newark Ave. It is difficult to explain this occurrence. Finally, despite this enormous 65% socioeconomic growth, the congestion status of the roads from the original 2035 run remained steady.

Link	2035 Original	2035 +65% Projection	Change
Holland Tunnel (East)	Congested	Congested	
Holland Tunnel (West)	Congested	Congested	
US-1/ 9 Pulaski Skyway (East)	Congested	Congested	
US-1/ 9 Pulaski Skyway (West)	Uncongested	Uncongested	
I-95 NJ Tpk West Spur (North)	Congested	Congested	
I-95 NJ Tpk West Spur (South)	Uncongested	Uncongested	
I-78 NJ Tpk Hudson City Ext (East)	Congested	Congested	
I-78 NJ Tpk Hudson City Ext (West)	Uncongested	Uncongested	
Route 440 (North)	Uncongested	Uncongested	
Route 440 (South)	Uncongested	Uncongested	
Route 7 (East)	Congested	Congested	
Route 7 (West)	Uncongested	Uncongested	
Montgomery St (East)	Congested	Congested	
Montgomery St (West)	Uncongested	Uncongested	
Newark Ave (East)	Congested	Congested	
Newark Ave (West)	Uncongested	Uncongested	
Communipaw Ave (West)	Uncongested	Uncongested	
Communipaw Ave (East)	Congested	Congested	
Grand St (East)	Congested	Congested	
Grand St (West)	Uncongested	Uncongested	

Conclusions

The various model runs showed some unexplained demand shifts that may only be accounted for by carefully examining traffic flows at a micro level, or could simply be due to errors or inefficiencies in the NJRTM-E model, which as a regional model is more useful at a macro level. However, the one constant across the 10% less growth, 10% more growth, and 65% more growth runs is that roads that are congested will generally remain congested, and those that are uncongested will generally remain so. Even when viewing changes between 2010 and the original 2035 model, only two local streets had a change in congestion status. The fundamental structure of travel within the network remained the same, and the roads that are problems today will be the ones that are problems in 2035. The unpredictability of local travel within the city itself across the different iterations of the model shows the benefits that could be reaped from focusing growth into key areas, thereby making travel patterns more predictable and able to be serviced by alternative modes. This is something that Jersey City already does successfully with transit oriented development, height and density, and that foundation will need to be built upon moving forward.

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Appendix

Table 1: Jersey City Model Zones with Original and New Population and Households

Zone	2010 Pop	2010 HH	2035 -10 Pop	2035 -10 HH	2035 Pop	2035 HH	2035 +10 Pop	2035 +10 HH	2035 +65 Pop	2035 +65 HH
572	6,263	2,185	5,815	2,062	6,462	2,291	7,108	2,521	10,662	3,437
573	6,745	2,286	6,120	2,078	6,800	2,308	7,480	2,539	11,220	3,463
574	4,901	1,711	4,679	1,668	5,199	1,853	5,719	2,038	8,579	2,780
575	4,371	1,487	3,983	1,365	4,425	1,516	4,868	1,668	7,302	2,274
576	4,749	1,630	4,322	1,492	4,802	1,658	5,283	1,824	7,925	2,487
577	6,559	2,375	6,090	2,220	6,766	2,467	7,443	2,713	11,165	3,700
578	4,365	1,547	4,065	1,475	4,517	1,638	4,969	1,802	7,454	2,458
579	4,385	1,655	5,362	2,060	5,958	2,289	6,554	2,518	9,831	3,434
580	124	45	709	342	787	380	866	418	1,299	570
581	6,674	3,011	6,156	2,813	6,840	3,126	7,524	3,438	11,286	4,688
582	2,189	841	1,965	768	2,184	854	2,402	939	3,603	1,280
583	6,378	2,196	5,630	1,939	6,256	2,154	6,881	2,370	10,322	3,231
584	2,457	902	2,171	813	2,412	904	2,653	994	3,980	1,355
585	1,766	674	1,817	734	2,019	815	2,221	897	3,332	1,223
586	3,848	1,333	3,535	1,255	3,928	1,395	4,321	1,534	6,482	2,092
587	4,538	1,565	4,131	1,438	4,590	1,598	5,049	1,758	7,574	2,397
588	1,909	671	2,027	765	2,253	850	2,478	935	3,717	1,275
589	251	108	601	335	668	372	734	409	1,101	558
590	7,993	4,247	9,810	5,672	10,900	6,302	11,990	6,933	17,985	9,453
591	823	303	767	302	852	335	938	369	1,407	503
592	2,891	1,047	2,558	944	2,842	1,048	3,127	1,153	4,691	1,573
593	4,965	1,802	5,660	2,164	6,289	2,405	6,918	2,645	10,377	3,607
594	1,949	850	2,518	1,246	2,798	1,384	3,077	1,523	4,616	2,077
595	5,121	2,315	7,617	3,980	8,464	4,423	9,310	4,865	13,965	6,634
596	4,670	1,803	4,626	1,866	5,139	2,074	5,653	2,281	8,480	3,111
597	1,734	823	1,618	799	1,798	887	1,978	976	2,967	1,331
598	2,607	1,170	2,411	1,117	2,679	1,242	2,946	1,366	4,419	1,862
599	2,717	1,401	2,465	1,300	2,739	1,445	3,013	1,589	4,520	2,167
600	3,100	1,345	2,874	1,287	3,193	1,430	3,513	1,573	5,270	2,145
601	3,076	1,448	4,896	2,711	5,440	3,012	5,984	3,313	8,976	4,518
602	6,782	2,138	6,181	1,962	6,868	2,180	7,555	2,398	11,333	3,270
603	3	2	3	2	3	2	3	3	5	4
604	6,858	2,563	6,234	2,352	6,927	2,614	7,620	2,875	11,430	3,921
605	4,823	1,817	5,659	2,274	6,287	2,527	6,916	2,780	10,374	3,790
606	3,530	1,272	3,267	1,212	3,630	1,347	3,993	1,482	5,990	2,020
607	4,600	1,498	4,470	1,514	4,967	1,682	5,464	1,850	8,196	2,523
608	2,020	498	1,871	476	2,079	529	2,287	582	3,431	794
609	4,555	1,642	4,193	1,548	4,659	1,720	5,125	1,892	7,688	2,579
610	2,136	937	2,013	920	2,236	1,022	2,460	1,124	3,690	1,533
611	2,782	1,354	2,448	1,215	2,720	1,350	2,993	1,485	4,490	2,024
612	1,588	829	1,668	927	1,853	1,030	2,038	1,134	3,057	1,546
613	2,185	951	1,912	856	2,125	951	2,337	1,047	3,506	1,427
614	4,603	2,430	4,270	2,311	4,744	2,568	5,219	2,824	7,829	3,851
615	3,585	1,975	14,362	10,101	15,958	11,223	17,553	12,346	26,330	16,835
616	770	238	665	209	738	232	812	256	1,218	349
617	4,786	1,598	5,267	1,868	5,853	2,075	6,438	2,283	9,657	3,113
618	7,639	2,849	7,025	2,662	7,805	2,958	8,586	3,254	12,879	4,437
619	2,978	1,045	2,747	990	3,052	1,100	3,357	1,211	5,036	1,651
620	4,917	1,635	5,154	1,809	5,726	2,010	6,299	2,211	9,449	3,016
621	2,501	955	2,315	912	2,573	1,013	2,830	1,114	4,245	1,519
622	2,427	995	2,205	926	2,450	1,029	2,695	1,132	4,043	1,544
623	4,033	1,281	3,694	1,190	4,104	1,322	4,515	1,454	6,773	1,983
624	2,522	819	2,355	792	2,617	880	2,879	968	4,319	1,320
625	2,588	827	2,974	1,016	3,304	1,129	3,634	1,242	5,451	1,693
626	2,683	918	14,364	6,285	15,960	6,984	17,556	7,682	26,334	10,476
627	2,487	840	3,940	1,505	4,378	1,673	4,816	1,840	7,224	2,509
628	4,669	1,554	7,811	3,074	8,678	3,415	9,546	3,757	14,319	5,123
629	1,231	445	1,146	433	1,274	481	1,401	530	2,102	722
630	2,309	787	2,054	715	2,282	795	2,510	874	3,765	1,192
631	4,502	1,607	4,752	1,794	5,280	1,993	5,808	2,192	8,712	2,990
632	2,875	945	2,630	888	2,923	987	3,215	1,086	4,823	1,481
633	2,033	930	4,342	2,378	4,824	2,642	5,307	2,907	7,961	3,964
634	3,685	1,228	4,214	1,511	4,682	1,679	5,150	1,847	7,725	2,518
635	2,786	875	2,478	795	2,753	883	3,029	971	4,544	1,324
636	3,960	1,287	3,947	1,334	4,385	1,482	4,824	1,630	7,236	2,223
637	5,201	1,777	4,894	1,720	5,438	1,911	5,982	2,102	8,973	2,866
638	1,067	523	2,167	1,256	2,407	1,395	2,648	1,535	3,972	2,093
639	7,371	2,603	6,676	2,389	7,417	2,654	8,159	2,920	12,239	3,981
640	4,683	1,553	4,384	1,494	4,871	1,660	5,359	1,826	8,039	2,491
641	7,261	2,545	6,733	2,414	7,482	2,682	8,230	2,951	12,345	4,024
642	3,936	1,506	3,596	1,406	3,996	1,562	4,395	1,718	6,593	2,343
643	4,901	1,814	4,671	1,782	5,190	1,980	5,709	2,178	8,564	2,970
TOTAL:	**266,971**	**100,665**	**294,749**	**122,229**	**327,499**	**135,810**	**360,249**	**149,391**	**540,378**	**203,715**

Table 2: Volume, Time, and Congestion Results

				Original 2010			2035 Minus 10%				Original 2035			2035 Plus 10%				2035 Plus 65%			
Road	Link A	Link B	DISTANCE	V_1	TIME_1	VC_1	V_1	TIME_1	VC_1	Change	V_1	TIME_1	VC_1	V_1	TIME_1	VC_1	Change	V_1	TIME_1	VC_1	Change
Holland Tunnel (East)	9635	13646	0.50	15,942	4.22	1.87	17,713	5.99	2.08	0.28%	17,664	5.99	2.07	17,622	5.94	2.07	-0.24%	16,696	4.93	1.96	-5.48%
Holland Tunnel (West)	13646	9635	0.50	8,831	1.08	1.04	10,590	1.43	1.24	-0.42%	10,635	1.44	1.25	11,059	1.55	1.30	3.99%	12,598	2.10	1.48	18.46%
US-1/ 9 Pulaski Skyway (East)	9671	39073	2.00	15,887	6.66	1.73	17,539	8.13	1.91	0.58%	17,438	8.03	1.90	17,430	8.02	1.90	-0.04%	19,072	9.77	2.08	9.37%
US-1/ 9 Pulaski Skyway (West)	39074	39075	2.00	7,224	2.80	0.79	7,514	2.85	0.82	0.97%	7,441	2.84	0.81	7,517	2.85	0.82	1.02%	7,799	2.90	0.85	4.81%
I-95 NJ Tpk West Spur (North)	39338	9640	1.05	20,715	2.30	1.19	22,416	3.72	1.29	-2.15%	22,909	4.18	1.32	23,364	4.18	1.35	1.99%	22,225	3.52	1.28	-2.99%
I-95 NJ Tpk West Spur (South)	35927	39339	1.05	13,914	0.98	0.80	13,292	0.97	0.77	1.24%	13,130	0.96	0.76	13,628	0.97	0.78	3.80%	14,499	1.00	0.83	10.44%
I-78 NJ Tpk Hudson City Ext (East)	36616	36618	0.85	12,148	2.08	1.15	14,666	3.41	1.39	1.11%	14,505	3.41	1.38	14,590	3.41	1.39	0.60%	16,573	3.41	1.57	14.26%
I-78 NJ Tpk Hudson City Ext (West)	9723	9713	0.84	2,030	0.90	0.19	2,947	0.90	0.28	-5.79%	3,129	0.90	0.30	3,134	0.90	0.30	0.17%	3,976	0.90	0.38	27.05%
Route 440 (North)	9994	9683	0.65	3,838	0.98	0.55	5,359	1.08	0.77	2.54%	5,226	1.06	0.75	5,304	1.07	0.76	1.48%	5,214	1.06	0.75	-0.24%
Route 440 (South)	9683	9994	0.65	3,438	0.97	0.49	4,035	0.99	0.58	10.70%	3,645	0.98	0.52	3,770	0.98	0.54	3.46%	4,028	0.99	0.58	10.55%
Route 7 (East)	9706	13758	0.55	12,027	6.60	2.10	15,092	6.60	2.63	-3.84%	15,695	6.60	2.74	15,504	6.60	2.70	-1.21%	19,082	6.60	3.33	21.58%
Route 7 (West)	13758	9706	0.55	4,877	0.75	0.51	5,396	0.76	0.57	-0.84%	5,440	0.76	0.57	5,728	0.77	0.60	5.28%	6,522	0.80	0.69	19.87%
Montgomery St (East)	9936	9937	0.36	3,553	1.03	1.00	3,846	2.77	1.08	5.67%	3,639	1.56	1.02	3,434	0.98	0.97	-5.65%	3,978	3.48	1.12	9.28%
Montgomery St (West)	9937	9936	0.36	708	0.62	0.07	1,325	0.62	0.14	-8.08%	1,442	0.62	0.15	1,403	0.62	0.15	-2.76%	1,814	0.62	0.19	25.76%
Newark Ave (East)	9718	9853	0.42	1,936	3.06	1.09	2,354	7.29	1.33	-27.23%	3,236	12.45	1.82	2,166	5.47	1.22	-33.04%	1,981	3.55	1.12	-38.77%
Newark Ave (West)	9853	9718	0.42	692	1.05	0.56	985	1.15	0.79	10.39%	892	1.10	0.72	1,001	1.16	0.80	12.17%	992	1.16	0.80	11.27%
Communipaw Ave (East)	6023	9700	0.25	1,920	0.51	0.40	2,451	0.51	0.51	-11.67%	2,775	0.52	0.58	2,608	0.52	0.55	-6.01%	4,010	0.59	0.84	44.49%
Communipaw Ave (West)	9700	6023	0.25	5,883	0.59	0.97	7,537	5.12	1.25	12.13%	6,721	2.86	1.11	6,506	2.19	1.08	-3.20%	7,590	5.26	1.26	12.92%
Grand St (East)	9765	9778	0.27	3,344	0.75	0.94	3,565	0.89	1.00	-10.11%	3,966	3.16	1.12	3,617	1.20	1.02	-8.81%	4,573	6.06	1.29	15.31%
Grand St (West)	9778	9765	0.27	1,533	0.52	0.33	2,077	0.53	0.45	-5.55%	2,198	2198.47	0.48	2,294	0.53	0.50	4.37%	2,339	0.53	0.51	6.39%

Figure 1: Map of Travel Links Studied