Mobility and the Costs of Congestion in New Jersey

2001 Update

Prepared for:

NEW JERSEY DEPARTMENT OF TRANSPORTATION

by:

NEW JERSEY INSTITUTE OF TECHNOLOGY

National Center for Transportation and Industrial Productivity / International Intermodal Transportation Center

In cooperation with:

The Foundation of the New Jersey Alliance for Action

New Jersey Institute of Technology

A Public Research University

July 2001

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A Final Report to

New Jersey Department of Transportation

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Newark, New Jersey

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DISCLAIMER STATEMENTS

NOTICE

ACKNOWLEDGEMENT

This research was supported by a grant from the New Jersey Department of Transportation (NJDOT). This support is gratefully acknowledged but implies no endorsement of the conclusions by the funding agency.

New Jersey Congestion Management System (NJCMS) data used in the study are provided by the New Jersey Department of Transportation (NJDOT) and the North Jersey Transportation Planning Authority (NJTPA). The research team gratefully acknowledges the provision of such a comprehensive resource. However, making the data available to the team implies no endorsement of the study results by NJDOT and NJTPA.

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EXECUTIVE SUMMARY

Congestion has a real and quantifiable cost to commuters in New Jersey.

- The first *Mobility and the Costs of Congestion in New Jersey* reported that the statewide annual cost of traffic congestion in lost time, operating cost, and wasted fuel was $4.9 billion. This update shows that the cost of congestion in New Jersey has increased to $7.3 billion, an increase of $2.4 billion, or 49 percent.
- A county-by-county analysis shows that congestion costs impact all twenty-one counties, from the most populous to the smallest (see Table A-2).
- The average annual cost of congestion for New Jersey is estimated at $1,255 per licensed driver (see Figure A-2 and Table A-4).
- Bergen County remains the most heavily congested county in the state measured by hours and the cost of congestion. Bergen County also has the highest congestion cost per driver at $4,082 per year (see Figure A-2 and Table A-4).

People traveling longer time to and from their jobs experience higher levels of stress, and this, in turn, leads to decreased labor productivity, and a reduced quality of life.

- Approximately 261 million person-hours are lost to delay in New Jersey annually. For each licensed driver in the state, the average time lost to delay was 45 hours per year (see Figure A-1, and Tables A-1 and A-3).
- The annual congestion costs to auto and bus users were $4.7 billion in lost time plus $400 million in wasted fuel.
- Bergen County has the highest total delay in the state, tallying 81.7 million hours (see Table A-1).

Congestion leads to higher costs for truck freight and service operations, these increased costs are passed on to consumers and have negative impacts on the manufacturing industry and the service sector.

- The additional operating costs to truck operators are $2.2 billion annually.

Much peak period travel throughout the state is affected by congestion.

- About 35 percent of New Jersey's peak period vehicle-miles of travel (VMT) take place under congested conditions (see Figure A-5 and Table A-7).
- Essex has the highest percentage of VMT under congested conditions at 53 percent, followed closely by Somerset County at 52 percent.

In many counties, there are more vehicles on the roads during peak periods than can be safely accommodated by the existing infrastructure.

- The Roadway Congestion Index (RCI) is a measure of the density of vehicles on a roadway. A value above 1.0 demonstrates a condition where the number of vehicles exceeds the amount of traffic that the roadways can safely handle per lane-mile. Bergen has the highest RCI at 1.32, followed by Passaic at 1.24. Essex, Middlesex, and Union Counties also have high RCI values, above 1.10 (see Figure A-7 and Table A-10).
- Non-recurring congestion, i.e. congestion directly related to accidents, construction, incidents, and other events, exacerbate New Jersey roadways that are at or approaching capacity.

Traffic volume in New Jersey will continue to grow in the future faster than both population and employment.

- New Jersey Congestion Management System (NJCMS) data indicate that there is little excess capacity in the roadway network to accommodate additional growth. Consequently, even small increases in traffic volume will result in significant increases in traffic delay and cost.
- The increase of four percent in traffic volume observed in the most recent NJCMS data (Version 2.0, Series RA) has resulted in a 38 percent increase in travel delays.
- Traffic volumes are forecast to increase an additional 8 percent by 2005 and 18 percent by 2015. If no transportation improvements are implemented, this growth will result in increases in congestion cost of 38 percent in 2005 and 103 percent in 2015 (see Table A-9).

- The impact on congestion levels is distributed unevenly across the state. Because of the forecast growth in population and employment, Ocean, Gloucester, Warren, and Burlington Counties will experience the highest traffic growth rates, and, as a result, congestion costs will increase most rapidly in these counties.

Findings and Recommendations

- The costs of congestion are real and impact virtually every resident in New Jersey. Being able to accurately identify the cost of congestion is critical and allows decision-makers to develop a more accurate estimate of benefits from mitigation of congestion.
- The true marginal costs and benefits of transportation improvements include the cost of congestion as well as secondary economic benefits. Given the quantifiable cost of congestion, investment in transportation infrastructure improvements is an offset to that cost.
- Estimation of congestion costs and benefits of mitigation should be routinely included in budgetary discussions on a state, county, and local level and as part of such process made available to both the public and to government officials. In addition, the potential benefits of proposed and programmed projects should be determined and included in decision making as well.
- To mitigate congestion, New Jersey must achieve a balance between the construction of new highway and transit facilities with the use of advanced technology such as advanced traffic control, and intelligent transportation systems. There is also a role for employer-based programs such as staggered work schedules and telecommuting to help relieve congestion. Other strategies including Smart Growth and improved land-use planning initiatives should also be considered.
- Stable transportation funding is essential to properly maintain the existing and future transportation infrastructure to move people most efficiently from their origin to destination.
- The recommendations listed above should, to some degree, mitigate the future impacts of congestion. If congestion is not mitigated, the negative consequences will be considerable: there will be a loss of attractiveness for the state to induce new businesses and employers will be unable to attract new employees. Ultimately, congestion will reduce the quality of life in New Jersey, and residents and businesses will relocate to other states.

OBJECTIVES

The objective of the *Mobility and the Costs of Congestion* study is to measure quantifiable and qualitative impacts of roadway congestion in New Jersey. The study addresses the impacts of congestion on an average traveler or affected person, as well as on area-wide levels, i.e. individual counties or statewide. The cost combines not only the direct impact of travel delay and excess fuel costs, but also the added cost of congestion on providing goods and services, i.e. the costs borne by auto, bus and truck users in terms of increased travel time and additional operating costs due to travel delay. Additional societal costs that are important to quality of life, such as the environmental impacts of congestion, are not quantified in this study.

The target audience for this research is the general public, as well as those who develop public policy on issues dealing with mobility, congestion relief, and securing stable funding sources for transportation improvements. As a result, the findings of the study are presented in clear and concise graphs and tables and in easy to understand terms.

BACKGROUND

In the past, the concerns with congestion focused mostly on its contribution to poor air quality. Congestion results in significant mobile source air pollution because of travel delays, engine idle time and unproductive fuel consumption. While the contribution of on-road mobile source emissions to air pollution remains significant, the Environmental Protection Agency (EPA) estimates that from 1989-1998 national emissions from mobile sources decreased 24 percent for carbon monoxide (CO), decreased 26 percent for volatile organic compounds (VOCs) and decreased 30 percent for particulate matter (PM) less than 10 microns in size[1]. These dramatic emission reductions occurred simultaneously with significant increases in economic growth and population – and congestion. While the air is much cleaner than in 1970, congestion is on the rise. At the national level over the past twenty-five years, vehicle miles traveled (VMT) have more than doubled, while lane miles have increased only slightly[2].

Today, congestion relief must focus on quality of life and economic issues more than just improved air quality. The general public desires livable communities, with increased mobility – they want to travel quickly and easily, with minimal interference. Traffic congestion often leads to stress, which can adversely affect quality of life. In the economic arena, the stress of congestion can adversely affect labor productivity.

The negative impacts of congestion on economic productivity have come to the forefront, since they affect the movement of both people and goods. In addition to wasted fuel costs, increased travel times can result in lost wages and decreased labor productivity. Congestion translates into higher costs of truck freight operation through driver wages, and also has a negative impact on manufacturing industry and the service sector. Congestion decreases the productivity of just-in-time manufacturing processes by forcing businesses to keep larger inventory than necessary in order to accommodate unreliable delivery schedules.

One of the first Federal reports to focus on quantifying congestion costs was *Quantification of Urban Freeway Congestion and Analysis of Remedial Measures*[3]. This research study used a FORTAN microcomputer program to calculate travel and congestion statistics for the nation's urban freeways using the Highway Performance Monitoring System (HPMS) as the basis. The report presented estimates of congested travel, user costs (area-wide), recurring congestion delay, nonrecurring (incident) congestion delay, and excess fuel consumption for 37 urban areas in 1984, as well as a future year (2005) analysis.

Additional research was done by the Texas Transportation Institute (TTI) in the early 1980s. The original study examined travel only in the urban areas of Texas, but has evolved into an extensive research effort at the National level. The *Urban Mobility Report*[4] are annual profiles that cover the period from 1982 to 1999 and analyze congestion trends in the United States. TTI assesses road congestion levels at a relatively broad scale – the urbanized area. The data is based on the HPMS database and includes statistics for 68 major urban areas. The information presented in the TTI research have evolved over the years, but the primary products are the travel rate index (TRI), user costs (individual and area-wide), congestion delay, wasted fuel consumption, and travel time index (TTI). The 2001 study found that congestion cost US travelers 4.5 billion hours of delay, 6.8 billion gallons of wasted fuel consumed and close to $77.8 billion of time and fuel cost in 1999.

Portions of New Jersey are included in two urban areas in TTI's *2001 Urban Mobility Report*. In terms of annual delay per person, "New York, NY-Northeastern, NJ" ranks 23rd (out of 68 urban areas) with 34 hours of delay per person, while "Philadelphia, PA-NJ" ranks 38th with 26 hours of delay per person.

New Jersey motorists not only have to contend with more vehicles on the road then ever before, but they are also driving on substandard roads. A study by The Road Information Program (TRIP)[5] indicates that 38 percent of New Jersey's bridges are rated as either structurally deficient or functionally obsolete because they have deteriorated or do not meet current safety standards. Approximately 17 percent of New Jersey's roads are rated in poor condition. Another 31 percent of the state's roads are rated in fair condition and have ride qualities noticeably inferior to those of new pavements. The study estimates that driving on roads in poor and fair condition costs New Jersey's motorists $889 million a year in extra vehicle repairs and operating costs — $160 per motorist.

The above studies provide critical information on both the costs of congestion on the national level, and the relationship between the transportation infrastructure and cost of transportation. However, the studies do not provide coverage of the entire state, nor do they provide county-level congestion data. This information is essential in determining public policy regarding transportation funding in New Jersey. Consequently, the first *Mobility and the Costs of Congestion in New Jersey*[6] research effort was developed by the New Jersey Institute of Technology (NJIT) to address these shortcomings.

The NJIT report used New Jersey-specific data to develop many statewide and countywide mobility measures. The results of the report were presented to the general public via coverage by several newspapers and television news programs, as well as through the NJIT website: http://www.transportation.njit.edu/. In addition, it was distributed to transportation professionals and policymakers in a written format. The authors of the report received much feedback on that first report, and have taken steps to improve the report further this year. Several new mobility measures have been added, and components of the methodology have been improved.

RESULTS

The latest New Jersey Congestion Management System (NJCMS) data was used to analyze the current conditions in the state of New Jersey. The methodology described in the Methodology section was used to compute the existing delay and cost indices for each of the twenty-one counties in New Jersey. In addition to current conditions, the NJCMS was used to estimate the future cost of congestion. The analysis estimates growth in traffic volumes on a county basis. The current and future year analyses are examined and compared with past analyses to determine differences and identify trends.

Current Conditions

All of the congestion measures: travel delay, congestion cost, percentage of peak period travel under congested conditions, travel rate index (TRI) and roadway congestion index (RCI), are summarized in graphs and tables in the Appendix. The graphs highlight current conditions while the tables include both current and future conditions. Highlights of the analysis are also discussed in this section.

Travel Delay The travel delay is determined for each roadway link and aggregated for each county. The travel delay is then divided by the number of licensed drivers and affected persons (workers plus residents) in each county. Refer to the *Subject Group* in the *Input Parameters* section for a more complete definition of affected persons.

The total person-time lost to delay in New Jersey is approximately 261 million hours annually. All counties show some travel delay during the year, from Cape May's 18,000 hours, to Bergen County's 81,673,000 hours. Bergen County ranks first in terms of total delay, representing 31 percent of the total. The county totals are shown in Table A-1.

For each licensed New Jersey driver, the average time lost to delay is 45 hours per year. This value is higher than the ones reported in the latest TTI study (using 1999 data) of 34 hours and 26 hours for the New York and Philadelphia metropolitan areas, respectively.

The highest-ranking county in terms of annual delay per licensed driver is Bergen, at 134 hours per year. The county totals are shown in Figure A-1 and Table A-3. The highest-ranking county in terms of delay per affected person is also Bergen, at 120 hours per year. The county totals are shown in Figure A-3 and Table A-5.

Based on the latest NJCMS data, traffic in New Jersey was about four percent higher than the previous NJCMS data. The majority of the traffic increase has occurred in the nine most congested counties: Bergen, Passaic, Hudson, Essex, Middlesex, Monmouth, Morris, Camden, and Somerset. As a result, this relatively small increase in traffic resulted in a 38 percent increase in travel delay statewide.

To summarize, the travel delay congestion measures indicate that:

- About 261 million person hours are lost to delay in New Jersey annually.
- For each licensed driver in the state of New Jersey, the average time lost to delay is 45 hours per year.
- Bergen County has the highest total delay in the state. Passaic, Monmouth and Essex Counties follow Bergen County in terms of total delay.
- Bergen County has the highest value of annual travel delay per licensed driver, 134 hours, followed by Passaic, Monmouth and Camden.
- Bergen County has the highest value of annual travel delay per affected person, 120 hours, followed by Passaic, Monmouth and Camden.
- Travel delay is growing significantly each year because small traffic increases in highly congested areas result in large travel delay increases. According to the most recent NJCMS data, a traffic increase of four percent has resulted in a 38 percent increase in travel delay.

Congestion Cost The cost of congestion includes the cost associated with the travel delay determined in the previous section, the truck operating costs and the wasted fuel cost. These costs are computed for each roadway link and then aggregated for each county.

The annual congestion costs of $7.3 billion are borne by auto, bus and trucks. Congestion impacts auto drivers and their passengers, commuters on transit buses, and truck operators.

The costs to auto and bus users are approximately 69 percent of the total cost of congestion. Auto/bus users incur delay at a cost of $4.7 billion in congestion costs plus wasted fuel consumed at a cost approaching $0.4 billion. The costs to truck operators are primarily due to increased labor and operating costs. These costs are approximately 31 percent of the total cost of congestion or $2.2 billion annually.

Bergen County, at $2.5 billion per year, represents approximately 34 percent of the total cost in congestion in New Jersey. In general, the northern counties experience higher congestion costs than the southern counties, but all counties suffer some degree of congestion during the year. The county totals are shown in Table A-2. Note that these costs are indicative of weekday commuter peak periods. The southern counties experience most congestion during summer weekend periods which are not part of this analysis.

The average cost of congestion is $1,255 per year for each licensed driver in New Jersey. For licensed drivers in Bergen County, the average annual cost of congestion is $4,082. The county totals are shown in Figure A-2 and Table A-4.

The average cost of congestion for New Jersey of $1,255 per licensed driver is higher than the results reported in the 2001 TTI study. The TTI study, which used 1999 data, reported average costs of congestion of $595 and $435 per licensed driver for the New York and Philadelphia metropolitan areas, respectively. In contrast to the TTI study that used an average national wage of $12.40 per hour, NJIT's 2001 Update used county-specific wage data. The average New Jersey wage rate is much higher than the national average.

Cape May County has the lowest annual congestion cost at just $6 per licensed driver. The annual congestion costs for Atlantic and Cumberland are also low, under $100 per year. Again, it is important to note here that the analyses quantifies normal peak period travel conditions, but does not quantify any congestion due to summer weekend recreational traffic, which is the source for much of the delay in these counties.

The rank of counties for annual average cost of congestion per affected person generally echoes that of cost per licensed driver. Bergen County has the highest value at $3,665 per affected person, followed by Monmouth, Passaic, Morris, Somerset and Camden Counties. The county totals are shown in Figure A-4 and Table A-6.

The average cost of congestion per weekday peak period trip is $3.36 statewide. Bergen County has the highest congestion cost at $12.10 per trip. The county totals are shown in Figure A-6 and Table A-8.

To summarize, the congestion cost measures indicate that:

- The annual cost of congestion for the State of New Jersey is approximately $7.3 billion.
- The average annual cost of congestion per licensed driver in New Jersey is $1,255.
- Bergen is the highest-ranking county in terms of annual congestion cost, accounting for about 34 percent of the total, followed by Monmouth, Essex and Passaic.

- Bergen has the highest annual congestion cost per licensed driver at $4,082, followed by Monmouth, Passaic, Morris, and Somerset. Cape May has the lowest, at $6 per licensed driver.
- Bergen has the highest annual congestion cost per affected person at $3,665, followed by Monmouth, Passaic, Morris, and Somerset. Cape May has the lowest, at $6 per affected person.
- Bergen also has the highest congestion cost per peak period trip at $12.10.
- The congestion costs to auto and bus users are 69 percent of the total. Auto and bus users incur travel delays at a cost of $4.7 billion in congestion costs plus wasted fuel consumed at a cost approaching $400 million.
- The costs to truck operators are 31 percent of the total, or about $2.2 billion annually in additional operating costs.

Percentage of Peak Travel under Congested Conditions This measure assesses the quality of traffic flow as it pertains to VMT.

About 35 percent of New Jersey's VMT takes place under congested conditions. Essex and Somerset Counties have the highest percentages of VMT under congested conditions, at 53 and 52 percent, respectively, indicating widespread congestion. Other counties' that are ranked highly in this category are Union, Passaic and Morris. Less than five percent of peak period VMT for Cumberland, Sussex and Cape May Counties takes place under congested conditions, indicating minimal congestion in these regions during weekday peak periods. The county totals are shown in Figure A-5 and Table A-7.

To summarize, VMT under congested conditions indicate that:

- About 35 percent of New Jersey's peak period VMT takes place under congested conditions.
- Essex and Somerset Counties have the highest percentage of peak period VMT under congested conditions. Cumberland, Sussex and Cap May have the lowest percentages.

Travel Rate Index (TRI) TRI is determined for each roadway link and aggregated for each county. The TRI illustrates the additional time required to complete a trip during the peak period times versus the off-peak period. The county totals are reported in Figure A-8 and Table A-11.

To summarize, the TRI measure indicates that:

- Hudson, Passaic and Bergen Counties have the highest TRI at 1.22. This indicates that a trip taken during the peak period takes 22 percent longer than during off-peak periods.
- Monmouth, Camden, Morris, Somerset, and Essex also have high values of TRI.

Roadway Congestion Index (RCI) The RCI is determined for each roadway link and aggregated for each county. The RCI measures density of cars on a roadway: the higher the RCI, the more vehicles are being accommodated by the existing infrastructure. The county totals are reported in Figure A-7 and Table A-10.

To summarize, the RCI measure indicates that:

- Bergen has the highest RCI at 1.32, followed by Passaic at 1.24. Essex, Middlesex, and Union Counties also have high RCI values, above 1.11.
- Much of South Jersey has RCI values less than 0.70, indicative of generally uncongested conditions during peak periods.

Future Conditions

Population growth is forecast to increase by ten percent statewide through 2015. Traffic is forecast to grow at a somewhat faster rate, by 18 percent through 2015. However, if no roadway improvements are made, the cost of congestion is expected to more than double during the same period. The consequence of traffic growth is clear. Given the peak period traffic conditions that currently exist throughout the state, even small increases in future traffic volumes will have significant impacts on traffic congestion, and therefore costs, on the average driver.

A comparison of statewide population growth, traffic growth, and the cost of congestion are presented in Table 2.

Table 1: Future Growths in New Jersey Population, Traffic, and Congestion Delay

	PERCENTAGE CHANGE FROM 1998 TO:	
	2005	2015
Population	3 %	10 %
Traffic	8 %	18 %
Congestion	39 %	109 %

Sources: New Jersey Department of Labor, Division of Market and Demographic Research, Occupational and Demographic Research, January 2001

New Jersey Department of Transportation New Jersey Congestion Management System Version 2.0, January 2001

METHODOLOGY

This section describes the general methodology used to compute the statistics listed in the Results section. Much of the methodology presented in this report is the result of previous research conducted by NJIT. As part of the 2000 NJIT report *Mobility and the Costs of Congestion in New Jersey* a Microsoft Access database modeling system was developed to calculate the congestion measures. This section describes the methodology, and highlights the changes in methodology between the 2000 NJIT report and this current study.

Roadway Database

Both the *Quantification of Urban Freeway Congestion and Analysis of Remedial Measures* study and the TTI *Urban Mobility Report* used the HPMS database compiled by the Federal Highway Administration (FHWA). The HPMS data is an excellent reference in that it provides a consistent set of data that allows for comparisons among urban areas nationwide. However, it does not cover the entire state roadway network, nor does it provide details necessary to determine the costs of congestion on specific roadway segments and to determine the potential benefits of implementing alternative highway improvement projects.

To address these deficiencies in the HPMS data, the New Jersey Congestion Management System (NJCMS) database was used as the basis for this study. NJIT's 2000 *Mobility and the Costs of Congestion in New Jersey* report was prepared using NJCMS data (QD Series – Version 1.5). This report has been updated using the most recent 1998 data (RA Series – Version 2.0). The NJCMS includes traffic volume and roadway geometry information for approximately 4,500 two-directional links that make up the interstate, state and major county roadway network in all 21 New Jersey counties. These 4,500 links were grouped into three classifications: freeways, principal arterials, and other arterials.

Freeways refer to roadways with limited access and egress points, generally at grade-separated interchanges. The capacity of a freeway is generally a function of the number of lanes. The interstate network, the New Jersey Turnpike and the Garden State Parkway are all examples of freeways. Principal arterials refer to major roadways with frequent access and egress points, generally at either at-grade signalized or unsignalized intersections, although some grade-separated interchanges may be present. The capacity of an arterial is generally a function of the green time allowed by the traffic signals. NJ 4 and NJ 17 in northern New Jersey and NJ 70 and NJ 73 in southern New Jersey are examples of principal arterials. The "Other arterials" category refers to the other roadways that are included in the NJCMS database. In general, these roadways were excluded from the recent TTI study. The County 500 series roadway network is generally included in the "Other arterials" category.

Minor arterials, including most of the County 600 series roadways, and local roads and streets are not included in the NJCMS database. Consequently, the congestion that may exist on these roads was not included in the calculation of the costs of congestion.

Advantages of using the CMS database are summarized below.

Traffic volumes by direction and by hour of the day: the NJCMS data includes traffic volumes by direction for each hour of the day, instead of two-directional average daily traffic volumes. Consequently, the detailed information available from the NJCMS provides an opportunity to differentiate between roadway links that have similar average daily traffic volumes, but different peaking characteristics.

Truck volumes by direction and by hour of the day: the NJCMS data includes truck volumes by direction for each hour of the day, instead of assuming an average value across all links. Again, the detailed information available from the NJCMS provides an opportunity to measure the impacts of roadways with heavy truck flows. Heavy truck flows have a significant impact on both roadway capacity and average vehicle operating costs.

Average vehicle occupancy by county and roadway group: the NJCMS data includes average vehicle occupancy (AVO) for each hour of the day, instead of assuming an average value across all links. Again, the detailed information available from the NJCMS provides an opportunity to more accurately measure the costs of congestion.

Detailed geometric information by roadway link: the NJCMS data includes information such as lane, shoulder and median widths and the location of traffic signals, so that a unique roadway capacity can be assessed for each link, instead of assuming an average capacity value for each facility type. Many freeways and expressways in New Jersey were built to older design standards with narrow lanes and shoulders and, as a result, have lower capacity. In addition, the number of traffic signals generally limits the capacity of arterials.

Congestion Measures

The methodology uses a series of congestion measures to quantify how congestion affects economic productivity and quality of life in New Jersey. The analysis can determine the cost of congestion on each link in the state. These costs could then be summed to provide costs on an area-wide (county or state) basis.

Congestion is a subjective term. Acceptable levels of congestion vary by region, by trip purpose, and by individual. What is considered congested by one person may not be considered congested by another. For this research effort, the *Highway Capacity Manual (HCM)*[78] was used to develop a standard for congestion.

There are many different types of congestion measures that can be computed. Traffic engineers use a letter-grade system that classifies quality of traffic flow as “A” though “F,” but this method is not clear to the layperson. The easiest mobility measure for non-traffic engineers to understand is travel delay – that is, “annually, 40 hours per person are wasted because of sitting in rush hour traffic.” While travel delay is an excellent measure to communicate the effects of congestion, it does not paint the whole picture. Other questions linger: How much does congestion cost to roadway users? How much travel is directly affected by some degree of congestion? How much longer will a trip take during rush hour than at other times? How well are the existing roadways capable of handling traffic during the rush hour?

To answer those and other questions, the following measures are presented in this study:

- Travel Delay (total, per licensed driver, per affected person, per vehicle-trip)
- Congestion Cost (total, per licensed driver, per affected person, per vehicle-trip)
- Percentage of Peak Period Travel under Congested Conditions
- Travel Rate Index (TRI)
- Roadway Congestion Index (RCI)

In addition to quantifying existing travel conditions, the NJCMS data could be modified to reflect a proposed highway improvement. The study methodology could be applied to determine the potential benefit of a proposed improvement of a roadway link, in terms of the reduced cost of congestion. In applying the methodology to a new or improved facility however, the traffic volume must be adjusted to reflect traffic diverted to the new facility as well as “induced” traffic that may occur because of changes in development patterns.

The congestion measures are defined and summarized below:

Travel Delay Travel delay is the measure of the time (person-hours) lost because of congestion. It is computed by comparing the peak period travel time under congested conditions to the free-flow travel time.

Congestion can be classified into two types: recurring and non-recurring congestion. Recurring congestion is typical peak period congestion that occurs every weekday morning and evening. Recurring congestion is generally predictable, and the travel delays can be quantified using the NJCMS database.

Non-recurring delay is defined as the additional travel time due to traffic incidents (vehicle breakdowns, police activity) or traffic accidents during typical peak period congestion. Congestion that occurs during due to seasonal variation (such as summer travel to recreation areas) and major entertainment or sporting events is not included as part of this study. Because of the unpredictability, non-recurring congestion is difficult to quantify. However, because it is such as large component of total travel delay, techniques are used to estimate its value.

To determine recurring travel delay, the concept of level of service (LOS) is introduced to define the threshold between “acceptable” and “unacceptable” congested conditions. Technically, there are travel delays even under acceptable traffic conditions; if there are more than a few vehicles on the road, speeds will decrease, and travel time will increase. However, the small travel delays accrued under acceptable traffic conditions should not be counted as true travel delay and added to the cost of congestion. Therefore, a process was put in place to determine the quality of traffic flow and then compute travel delay only under unacceptable traffic conditions.

For each link segment, the peak hour travel speed and level of service were computed based on the procedures of the *Highway Capacity Manual (HCM).* Level of service (LOS) refers to a quality of traffic flow with LOS = A being the best operation and LOS = F representing unsatisfactory operations. According to the *HCM*, LOS = A, B, or C are considered satisfactory operating conditions, while LOS = D, E or F are considered less than satisfactory conditions. To limit the computation to include only travel delay under less than acceptable conditions, roadway segments operating at LOS = A, B, or C could not contribute to travel delay. As LOS degraded to LOS = D, E or F, however, the subsequent increases in travel time were considered unacceptable to drivers. Therefore, the link segments that are LOS = D, E or F are considered congested, and the travel delays accrued. The recurring travel delay was then computed as the difference in the peak period travel time and the free-flow travel time.

The recurring travel delay is computed using travel time fields directly from the NJCMS. The NJCMS program calculates travel time estimates on the freeways and principal arterial streets during the peak travel periods. The travel delay was computed as the difference between the zero-volume travel time and the travel time under each hourly demand. The zero-volume travel time for arterials includes delays incurred at signalized and unsignalized intersections. The total recurring delay is the sum of the individual segment delays.

Additional travel time due to non-recurring delays during the peak travel periods was estimated using a procedure developed by TTI for their *Annual Mobility Report*. The hours lost due to non-recurring delays vary primarily as a function of roadway congestion. First, as roadways become more congested, the number of accidents generally increases. Second, the impacts of peak period accidents and incidents on delay is greater for congested roadways, as any loss in roadway capacity results in demands exceeding available capacity and long additional delays. The TTI approach used a simplified procedure where general factors were used to relate non-recurring to recurring delay based on national averages for different roadway types. Using this approach, NJIT computed that the ratio of non-recurring delay to total travel delay in this study ranged from 50 - 60 percent for each of the 21 counties in New Jersey.

Congestion Cost The cost of congestion is a function of two variables: delay cost and fuel cost. Because congestion has different economic implications for the movement of people versus goods, person-trips and truck-trips were handled differently by the delay cost analysis. Delay cost for person-trips is estimated using an average value for each hour of travel time. Average values of time were based on wage data obtained for each county (see Input Parameters). Delay costs for trucks are estimated using an average dollar-per-mile basis (see Input Parameters). Congestion causes delay to truck freight that must spend additional time in transit. This delay translates to increased operator costs (driver wage, fuel, etc.) and inventory costs, which are in turn passed onto consumers.

Fuel costs are estimated by multiplying an average fuel cost (see Input Parameters) by an estimate of wasted fuel. Computation of wasted fuel is based on the methodology[9] that TTI uses for the *Urban Mobility Report.*

Percentage of Peak Travel under Congested Conditions This measure calculates the ratio of congested VMT to total VMT. It is a region-wide indicator of the quality of traffic flow, as affected by recurring congestion. Non-recurring congestion is not included in this calculation.

VMT for link segments that operate under LOS = D, E or F are considered congested, and thus are counted towards congested VMT. This measure is a binary measure: either a link segment is congested or it is not. No differential is made among moderate, heavy and severe congestion.

Travel Rate Index (TRI) TRI is the measure of the amount of extra time it takes to travel during the peak period. The travel rate (in minutes per mile) in the peak was compared to off-peak free-flow speeds. A TRI of 1.20, for example, indicates that it will take 20 percent longer to travel to a destination during the peak period than during the off-peak period. The computation is shown in the following equation:

$$TRI = \frac{\frac{Freeway\ Travel\ Rate}{Freeflow\ Rate} \times Freeway\ Peak\ Period\ VMT + \frac{Arterial\ Travel\ Rate}{Freeflow\ Rate} \times Arterial\ Peak\ Period\ VMT}{Freeway\ Peak\ Period\ VMT + Arterial\ Peak\ Period\ VMT}$$

Roadway Congestion Index (RCI) RCI is a measure of cars per road space; a measure of vehicle travel density on major roadways in an urban area. An RCI exceeding 1.0 indicates an undesirable congestion level, on average on the freeways and principal arterial street system during the peak period.

Average daily vehicle-miles of travel (VMT) on freeways, principal arterials and other arterials are calculated by multiplying the average travel volume by the length of roadway. The resulting ratios are combined using the amount of travel on each portion of the system so that the combined index measures conditions on the freeway and arterial street systems. This variable weighting allows comparisons of areas with much freeway travel and areas with little freeway travel. The computation is shown in the following equation.

$$RCI = \frac{\frac{Freewy\,VMT}{lane\text{-}mile} \times Freewy\,VMT + \frac{Princ.\,Arter.\,VMT}{lane\text{-}mile} \times Princ.\,Art\,VMT + \frac{Oth.\,Arter.\,VMT}{lane\text{-}mile} \times Oth.\,Art\,VMT}{14000 \times Freeway\,VMT + 9000 \times Principal\ Arterial\,VMT + 5500 \times Other\ Arterial\,VMT}$$

Input Parameters

Instead of using national averages, the study uses New Jersey data where appropriate and available. Details are described below.

Analysis Period Only peak period traffic volumes are used for the recurring congestion analysis. The length of peak periods was chosen to be the four hours per day when total traffic volumes are at their maximum – two in the morning (7:00 to 9:00 AM), and two in the evening (4:00 to 6:00 PM). While there are some roadways that might experience congestion beyond those limits, the bulk of the recurring congestion occurs during this time, and using a fixed period allows a better comparison with data for the previous NJIT report.

Value of Fuel Fuel cost is estimated using an average value of $1.46 per gallon of regular gasoline for the entire state of New Jersey[10]. Data was not available for each county. A review of the American Automobile Association's *Daily Fuel Gauge Report* indicates that there is some price variation between regions of the state, but the fluctuation is generally less than 3 cents per gallon.

Value of Travel Time The average cost of a gallon of fuel is a straightforward calculation, however the value of travel time is a much more complex function. In some transportation studies, particularly toll road studies, the value of travel time is based on an average wage rate. These studies typically use a value of time between 40 and 110 percent of the average wage rate. In other studies, the use of a wage rate to determine value of time leads to bias in the study as it favors roadway improvements in higher income areas. These studies use a constant value of time, typically the minimum wage, to address these equity issues.

The 2001 TTI study used an average value of time of $12.40 per hour. For the NJIT study, the average wage rate per capita is computed separately for each county and is summarized in Table 2. The 1999 average wage data is first adjusted to 2000 by using the Consumer Price Index (CPI). The hourly wage rate is then determined by dividing the average annual salary by 2000 hours per year. These resulting adjusted wage rates vary from a low of $11.75 for Cumberland County to $26.87 for Somerset County.

Actual New Jersey county-based wage information is used by the study team so that the region's higher costs of living is accounted for in estimating the cost of congestion. It does not imply that a person that earns a lower income should be more congestion-tolerant than a person earning more.

The value of $2.85 per mile for truck delay used in the 2001 TTI study is adjusted using the CPI as well. First, the CPI is used to adjust the cost from 1999 to 2000. Second, the CPI is used to adjust the cost from an average of urban areas to a New York/North Jersey value for the NJTPA region and a Philadelphia/Atlantic City/South Jersey value for the remainder of the state. The values of $3.11 and $3.08 per mile are used for the northern and southern New Jersey counties, respectively.

Table 2: 1999 Per Capita Personal Income for New Jersey

COUNTY	RESIDENT POPULATION	WORKERS	ANNUAL INCOME (1999)	HOURLY INCOME (2000)
Atlantic	252,552	147,500	$32,086	$ 16.47
Bergen	884,118	478,700	$48,017	$ 24.77
Burlington	423,394	188,100	$30,747	$15.79
Camden	508,932	217,800	$28,035	$ 14.39
Cape May	102,326	39,800	$29,455	$ 15.12
Cumberland	146,438	60,100	$22,894	$ 11.75
Essex	793,633	385,600	$34,824	$ 17.97
Gloucester	254,673	90,700	$27,077	$ 13.90
Hudson	608,975	249,600	$27,662	$ 14.27
Hunterdon	121,989	48,300	$44,833	$ 23.13
Mercer	350,761	203,900	$39,626	$ 20.34
Middlesex	750,162	410,600	$34,267	$ 17.68
Monmouth	615,301	243,700	$37,356	$ 19.27
Morris	470,212	282,400	$49,957	$ 25.77
Ocean	510,916	135,400	$27,694	$ 14.29
Passaic	489,049	187,700	$27,559	$ 14.22
Salem	64,285	21,800	$27,178	$ 13.95
Somerset	297,490	179,200	$52,078	$ 26.87
Sussex	144,166	37,300	$30,270	$ 15.62
Union	522,541	245,300	$38,487	$ 19.86
Warren	102,437	35,900	$29,079	$ 15.00
TOTAL	8,414,350	3,889,400	$35,612	$ 18.79

Source: Resident and Worker Population: Census 2000, US Census Bureau
1999 Income: U.S. Depart. of Commerce, Bureau of Econ. Analysis, May 3 2001
Prepared By: New Jersey Department of Labor, May 2001

Subject Group Total delay and congestion costs are difficult to relate to until they are averaged for a subject group, such as per capita, per driver, or per trip. Since the NJCMS is link-based, this database cannot be used to generate subject group totals. For the purposes of this report, the research team defined three subject groups: per licensed driver, per affected persons, and per vehicle-trip.

The "licensed driver" subject group was computed in accordance with the latest FHWA *Highway Statistics Series Report*, which states that there are approximately 5.7 million licensed drivers statewide. The same proportion of driver per total population was assumed for all counties, since county-specific information was not available from the NJDOT.

To determine the "affected persons" for each county, the number of residents and workers[11] based in each county is derived from journey to work data from the *US*

Census[12]. The resident and worker data is also shown in Table 2. Congestion in a given county affects not just residents, but also workers; it affects persons who drive as well as those or rely on public buses. The equation for affected persons is below.

$$Number\ of\ \ Affected\ Persons = \frac{Total\ \mathrm{Re}\,sident\ Population + Total\,Wor\,\mathrm{ker}\ \ force}{2}$$

The licensed driver subject group allots a mobility measure to resident drivers only, and does not consider the county's non-resident workforce, which is also affected by congestion. Consequently, the affected persons subject group was devised to distribute the measures among both residents and workers. However, one group that is missing from both of these calculations is the pass-through vehicle-trips. Vehicles that neither originated in nor are destined to a county, but still use the roadway system are called pass-though trips. This group of pass-through trips is also affected by congestion, but it is difficult to measure through traffic counts alone. In order to estimate the number of pass-through trips, the study team used the New Jersey Statewide Truck Model[13]. A cordon was drawn around each of the twenty-one counties. The total traffic crossing each of the cordons was then summed. This traffic is composed of trips originating in the county, trips destined to the county, and pass-through trips, which are counted twice (once when entering the county, and once when exiting the county). The pass-through vehicle-trips are then computed as follows:

$$PassThru\,VehTrips = \frac{Total\ Cordon\,Volume - (Trips\ Originating\ in\,County + Trips\ Destined\ \ for\ County)}{2}$$

Pass-through trips are used to compute the final subject group of vehicle-trips. Total vehicle trips are computed using the equation below:

$$Total\,Veh\,Trips = Trips\,Originating\ in\,County + Trips\ Destined\ \ for\,County + PassThru\,VehTrips$$

Changes in Methodology

The most significant change is in the CMS database itself, which has been enhanced and updated by the NJDOT. Traffic counts have been updated, additional links have been added, and capacity values have been refined. The CMS documentation[14] contains a complete description of the details of the database.

NJIT's 2000 *Mobility and the Costs of Congestion in New Jersey* report was prepared using NJCMS QD Series data. This 2001 Update has been updated using the RA series data. The QD series data was one of the first attempts by NJDOT to compile traffic data for use in the federally mandated CMS. The traffic volumes included in the QD series dataset were an assemblage of various years of traffic counts, and were more reflective of traffic conditions in the early 1990's. The NJCMS is a very data-intensive effort, and NJDOT has continued efforts to improve and upgrade the database. The RA series dataset is much closer to actual 1998 traffic conditions than its predecessor.

In response to comments received on the NJIT's 2000 report, *Mobility and the Costs of Congestion in New Jersey*, several new measures of mobility were added to the 2001 update. These new measures: Congestion Cost Per Affected Person; Congestion Cost per Vehicle-Trip; and Percentage of Travel under Congested Conditions, show that there are many different ways to quantify mobility and congestion costs.

In addition, the 2001 NJIT study team incorporated AVO by county and roadway group directly from the NJCMS. The average AVO varies for each hour of the day for all roadways. In the 2000 NJIT study, an average AVO of 1.25 had been assumed for all roadways.

The formula for RCI was changed to reflect higher capacity values for New Jersey. The factor to estimate daily capacity for principal arterials was changed from 5,500 to 9,000 vehicles per lane.

For the 2001 update, the research team did not include a sample analysis of transportation corridor improvements in the report. The focus of this update is quantifying mobility and the costs of congestion. The methodology shown in this report can and should be applied to calculate the potential benefits of corridor improvement projects.

For each roadway improvement project however, the amount of traffic diverted to the new facility as well as the additional "induced" traffic due to changes in development should be included. For many projects, computing the diverted and induced traffic is a significant effort and beyond the scope of this update.

CONCLUSIONS

This report provides an overview of the cost of traffic congestion in New Jersey. From the analysis on a county basis, it is shown that the existing annual cost of congestion in New Jersey is comparable to the per driver costs reported in recent studies for the New York and Philadelphia metropolitan areas. A similar conclusion can be drawn for the hours of delay per driver. The calculated values for the Roadway Congestion Index (RCI) and the Travel Rate Index (TRI) represent a clear indication of more dense traffic conditions in the northern part of the state and in certain southern urban areas.

The relationship between traffic volume and delay is non-linear. Traffic speeds are constant and delays are minimal at low traffic volumes. However, as traffic volume on a roadway approaches and reaches capacity, traffic delays increase rapidly.

In addition to analyzing existing traffic conditions, congestion costs and potential benefits, it is important to analyze future conditions as well. Growth in traffic volume in New Jersey is likely to continue into the future as both population and employment continue to rise. Currently, many roadways in New Jersey operate at capacity or near-capacity congested conditions during the peak periods. These congested conditions lead to the large costs discussed earlier. In addition, there is little excess capacity in the roadway network to accommodate additional growth. Consequently, even small increases in traffic volume will result in significant increases in traffic delay and cost.

RECOMMENDATIONS

Transportation investments frequently must compete with other forms of government spending for scarce resources. Standard measures of effectiveness used by transportation agencies, such as traffic flow and air quality, are generally useful for comparing among different transportation alternatives. These measures fail to account for the full marginal costs and benefits of transportation investments and are therefore less than adequate for comparing transportation with other types of public investments.

The true marginal costs and benefits of transportation improvements include the cost of congestion as well as secondary economic benefits. Given the derivable and quantifiable cost of congestion, investment in transportation infrastructure improvements is an offset to that cost.

Given the existing level of congestion throughout the state coupled with the anticipated growth in population, employment and traffic, the cost of congestion can be expected to grow dramatically in the future.

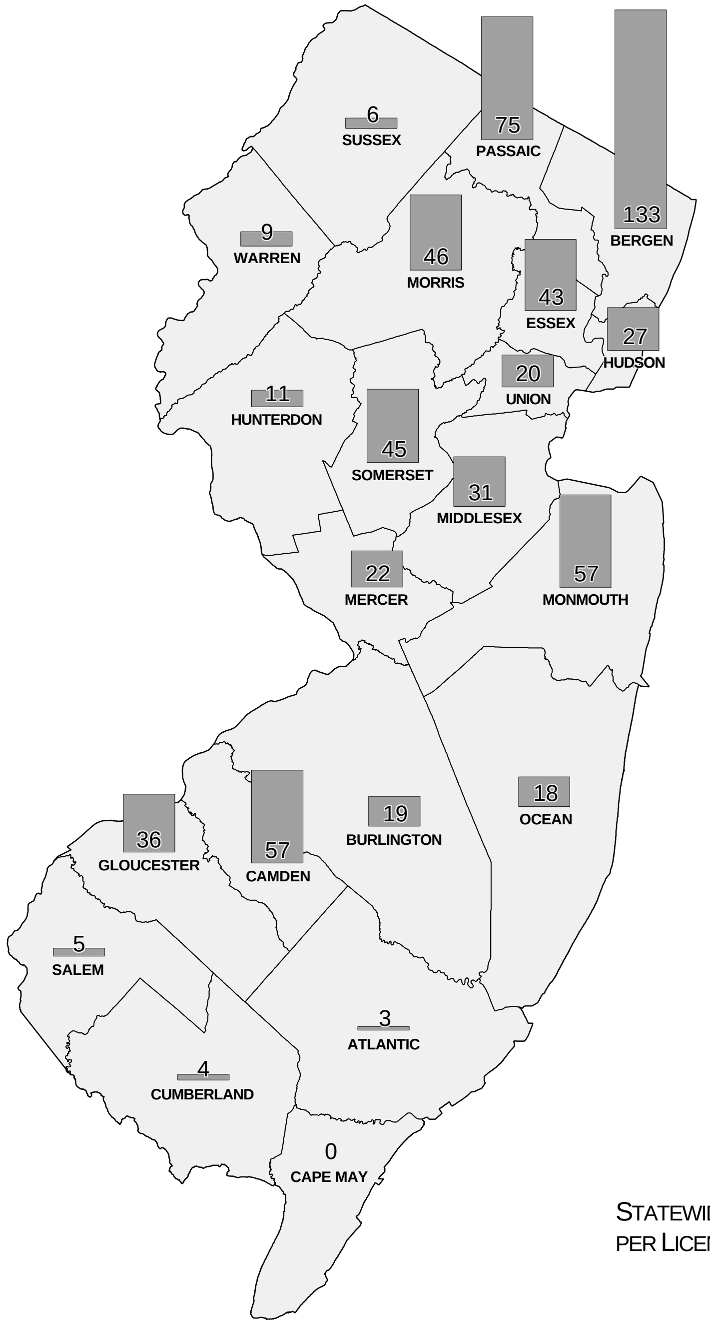
In a state that already has the highest population density, the highest density of economic activity, and very high pollution costs, there must be a deliberate and informed effort to improve the efficiency of transportation facilities in order to allow economic growth to occur with the least increase in societal cost.

This effort should include a balance between construction of new highway and transit facilities with the use of advanced technology such as advanced traffic control, and intelligent transportation systems. There is also a role for employer-based programs such as staggered work schedules and shorter workweeks to help relieve congestion. Other strategies including Smart Growth and improved land-use planning initiatives should also be considered. Stable transportation funding is essential to properly maintain the existing and future transportation infrastructure to move people most efficiently from their origin to destination.

These efforts will reduce the future impacts of congestion. If congestion is not mitigated, then there will be a loss of attractiveness for the state to induce new businesses. In addition, employers will be unable to attract new employees. Ultimately, businesses and residents may relocate to other areas.

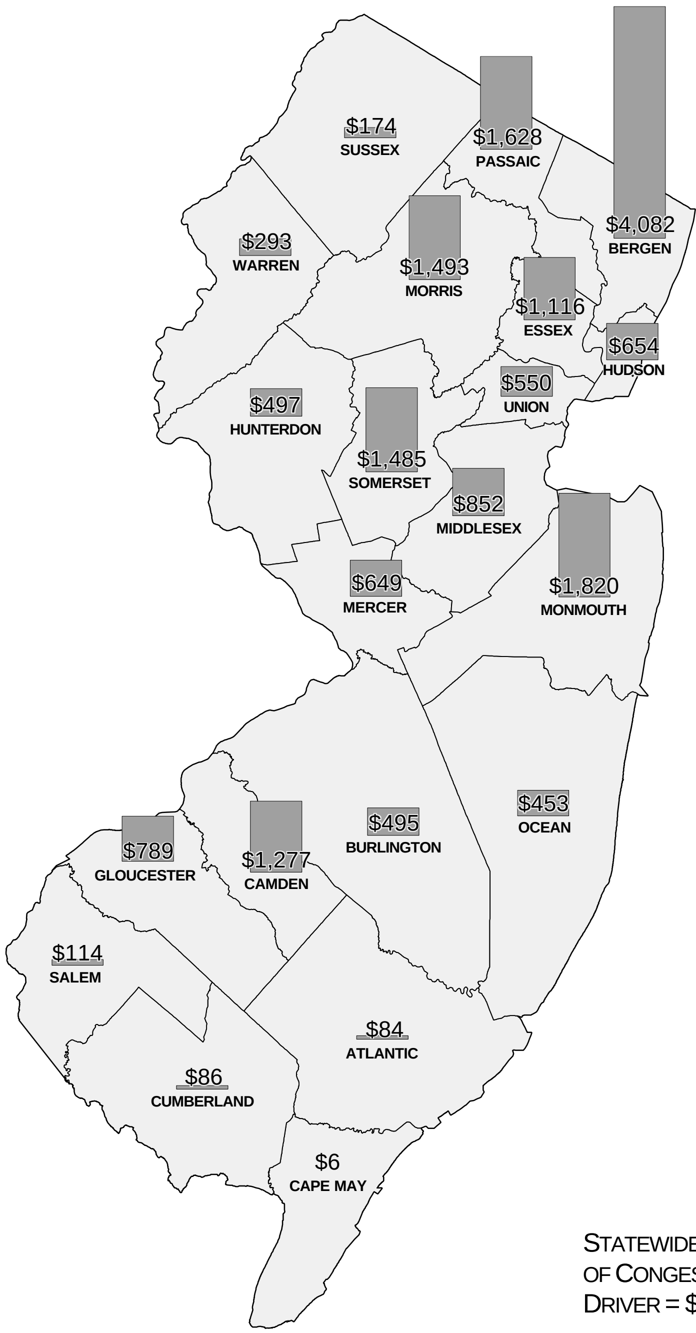
Therefore, being able to accurately identify the cost of existing and future congestion is critical and allows decision-makers to develop a more accurate estimate of the potential benefits from the mitigation of congestion. These costs and benefits should be routinely included in budgetary decision-making on a state, county, and local level and as part of such process made available to both the public and to government officials.

FIGURES



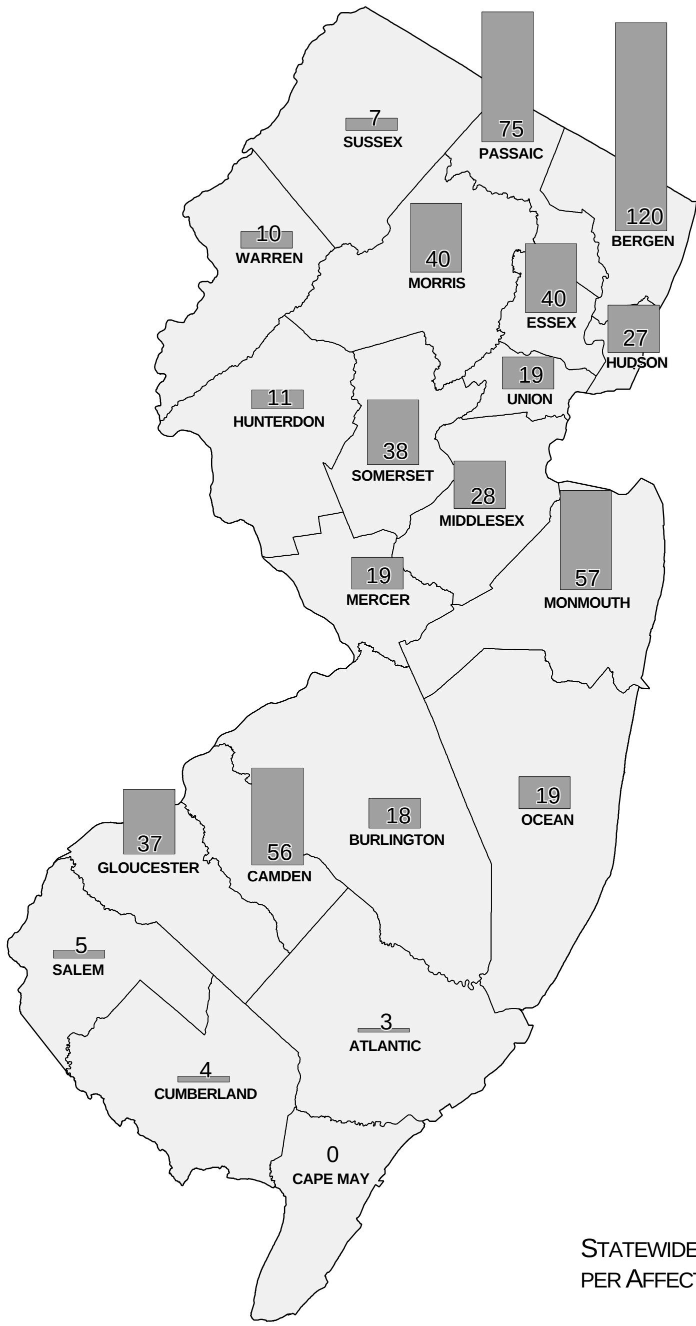
STATEWIDE AVERAGE ANNUAL DELAY PER LICENSED DRIVER = 45 HOURS.

Figure A-1
Annual Hours of Delay
Per Licensed Driver -- 1998



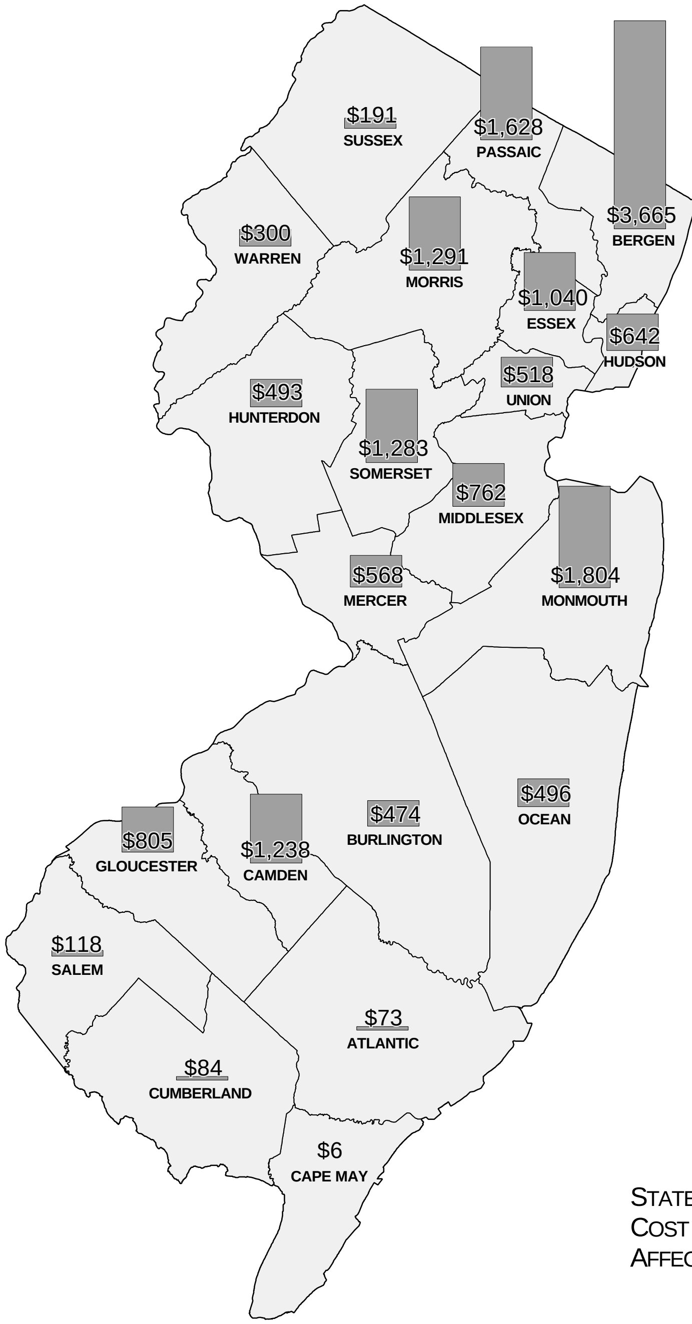
STATEWIDE AVERAGE ANNUAL COST OF CONGESTION PER LICENSED DRIVER = $1,255.

Figure A-2
Annual Cost of Congestion
Per Licensed Driver -- 1998



STATEWIDE AVERAGE ANNUAL DELAY
PER AFFECTED PERSON = 42 HOURS.

Figure A-3
Annual Hours of Delay
Per Affected Person -- 1998



STATEWIDE AVERAGE ANNUAL COST OF CONGESTION PER AFFECTED PERSON = $1,187.

Figure A-4
Annual Cost of Congestion
Per Affected Person -- 1998

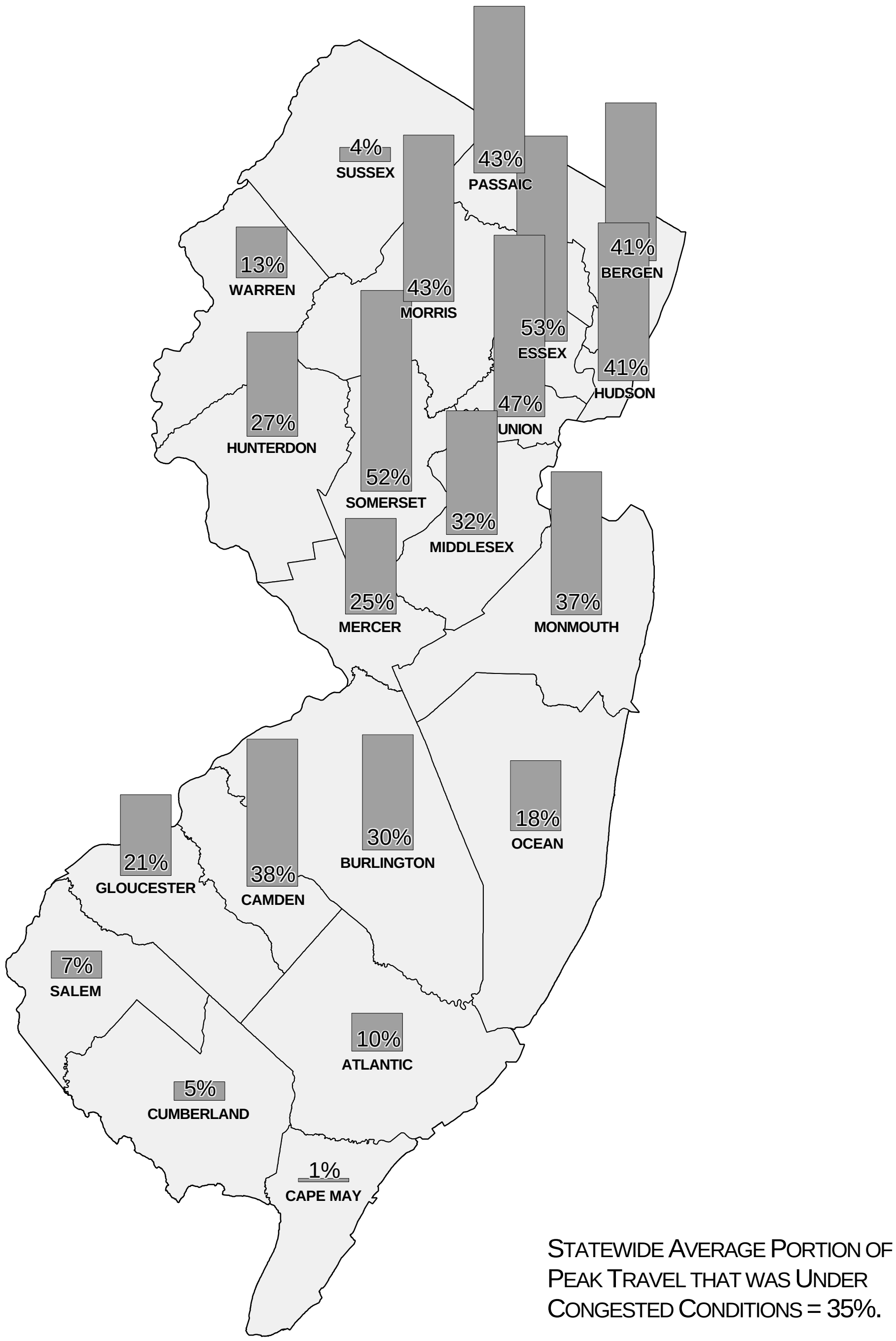


Figure A-5
Portion of Peak Travel Under
Congested Conditions -- 1998

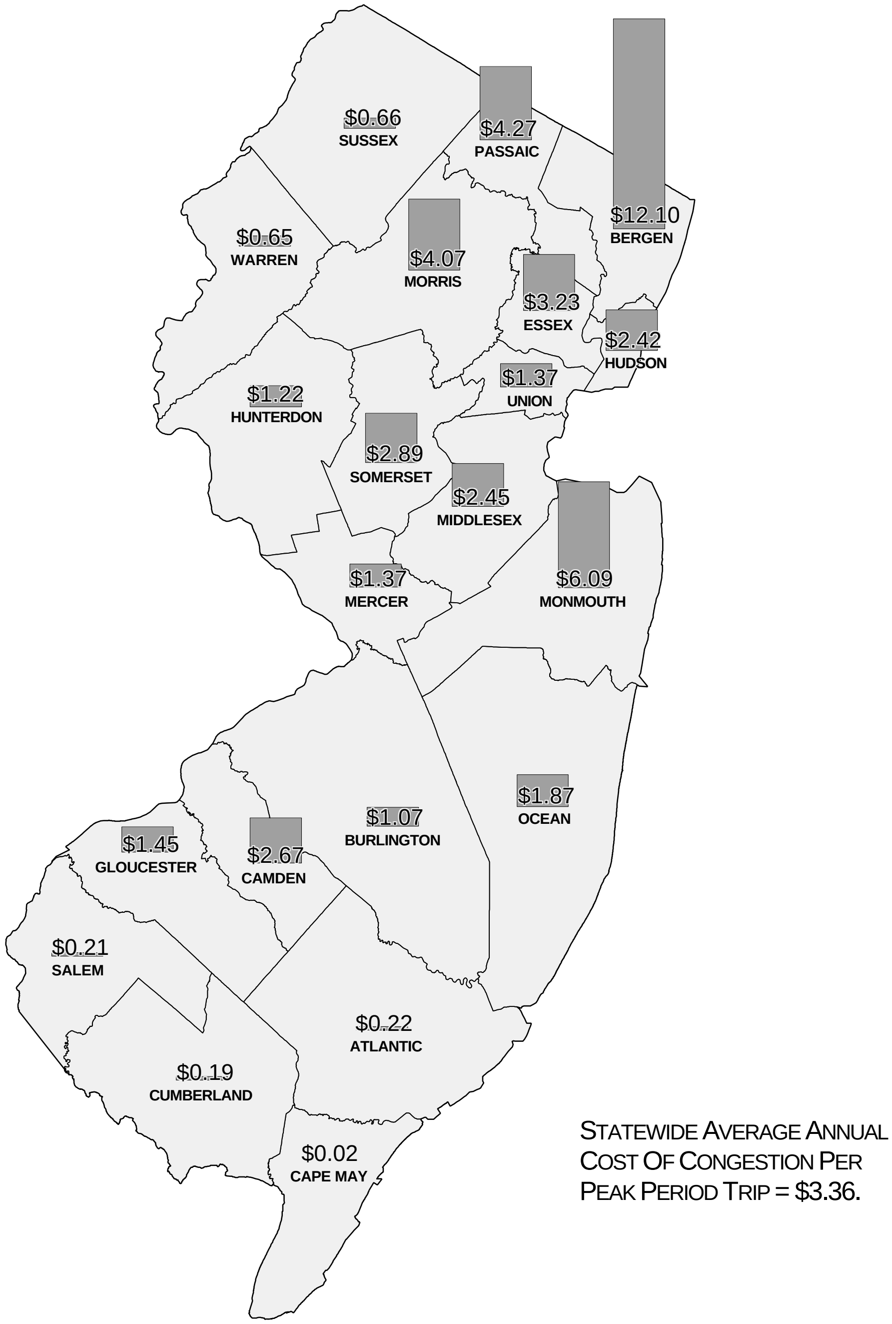
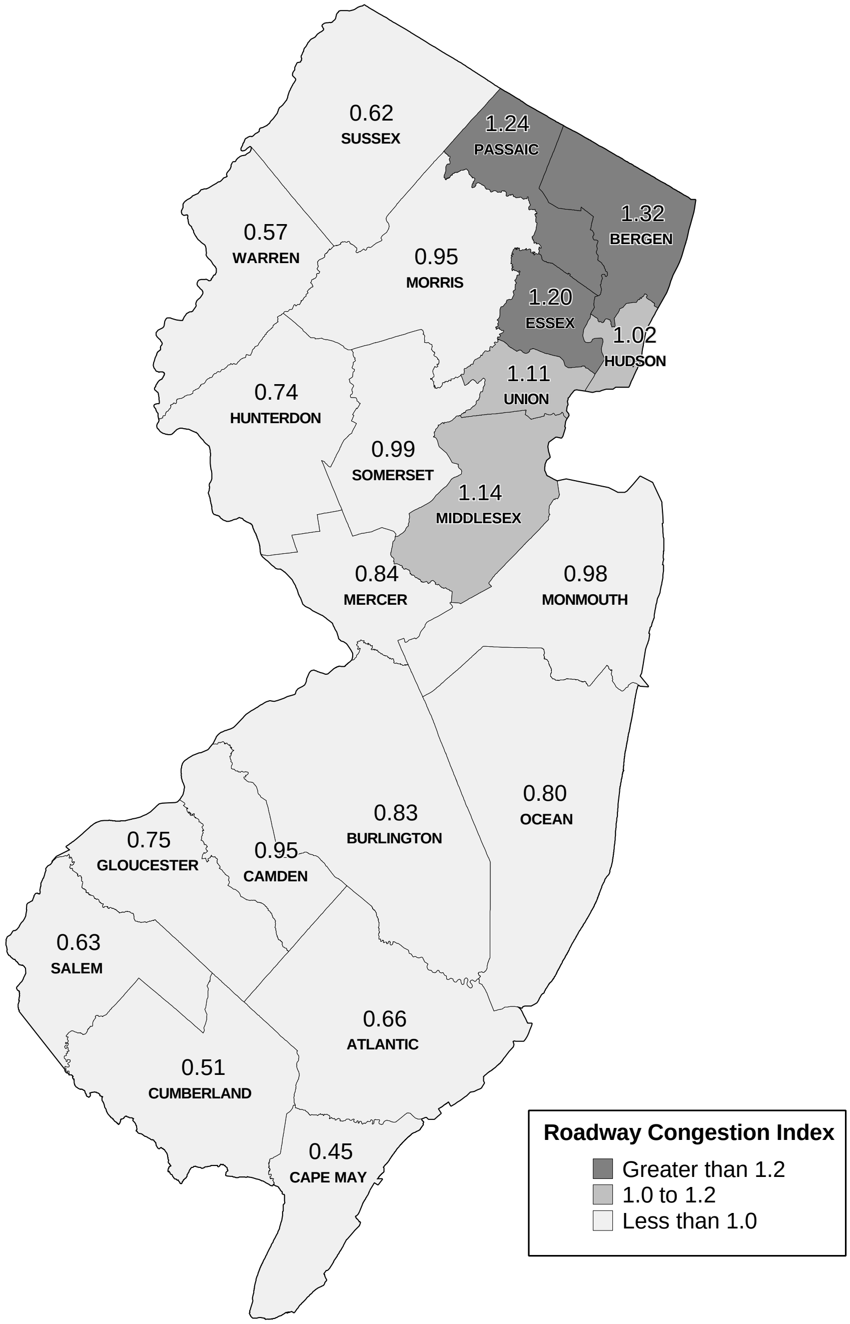
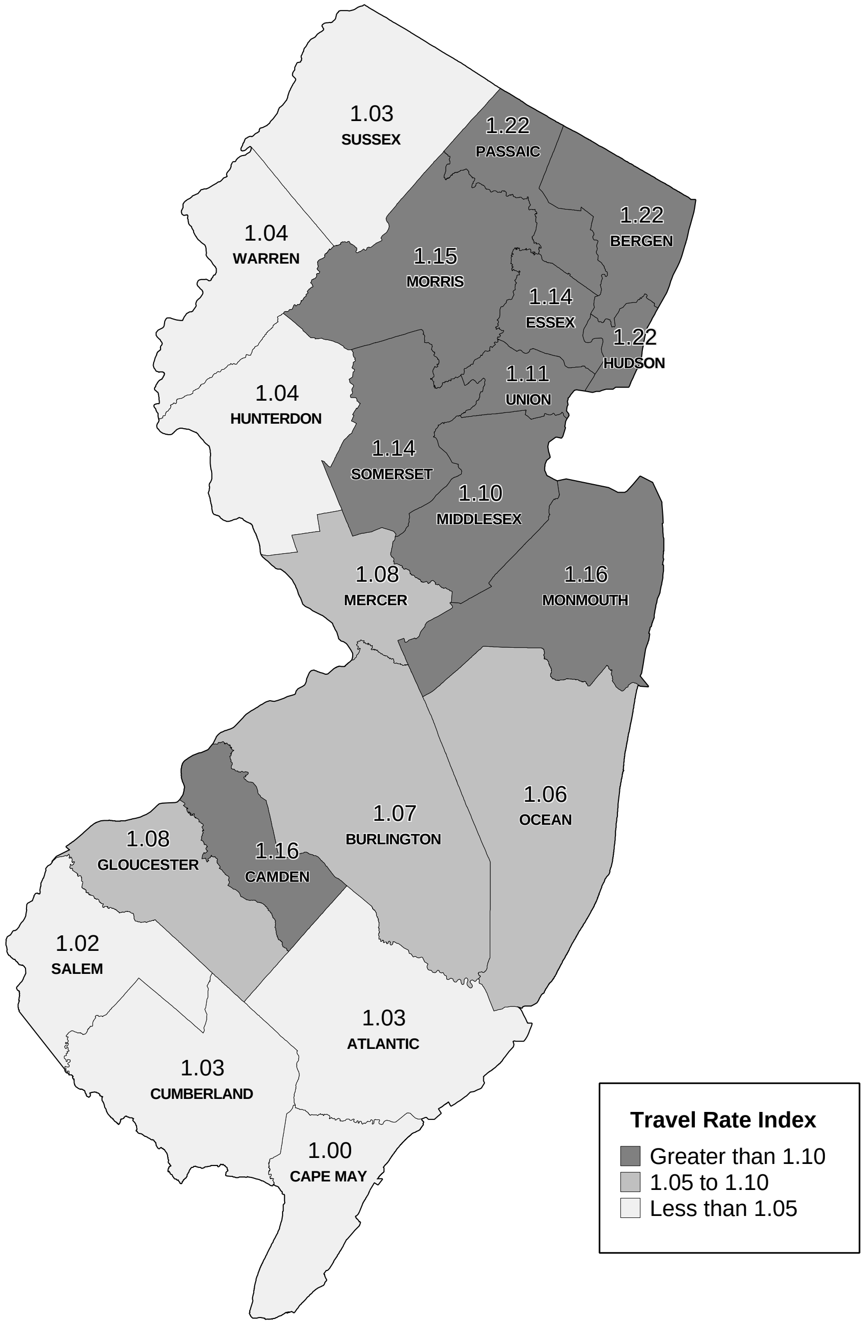


Figure A-6
Annual Cost of Congestion
Per Peak Period Trip – 1998



*A RCI VALUE OF LESS THAN 1.0 REFERS TO UNCONGESTED CONDITIONS.
A VALUE GREATER THAN 1.2 REFERS TO SEVERE CONGESTION.

Figure A-7
Roadway Congestion Index (RCI)
1998



***A TRI VALUE EQUAL TO 1.0 REFERS TO UNCONGESTED CONDITIONS. A VALUE GREATER THAN 1.1 REFERS TO SEVERE CONGESTION.**

Figure A-8
Travel Rate Index (TRI)
1998

TABLES

Table A-1: Annual Hours of Delay [thousands]

County	1998	2005	2010	2015	2020	2025
Atlantic	558	1,116	1,245	1,410	1,591	1,828
Bergen	81,673	109,867	133,052	158,260	184,269	214,555
Burlington	5,531	9,302	12,371	16,675	22,499	30,020
Camden	20,181	28,107	35,162	44,094	54,655	66,636
Cape May	18	22	25	34	39	52
Cumberland	444	580	674	790	1,021	1,170
Essex	23,854	22,349	21,071	19,690	18,252	16,955
Gloucester	6,330	13,674	21,744	32,622	47,432	67,565
Hudson	11,410	13,949	16,087	18,549	21,376	24,193
Hunterdon	965	1,439	1,960	2,585	3,444	4,472
Mercer	5,351	7,256	9,068	11,243	13,538	16,433
Middlesex	16,128	29,680	39,959	53,343	72,887	99,642
Monmouth	24,437	33,015	40,122	48,484	57,707	67,930
Morris	15,011	17,026	18,802	20,578	22,689	24,794
Ocean	6,218	12,700	21,483	34,175	51,772	77,451
Passaic	25,440	29,846	33,590	37,764	42,150	46,902
Salem	228	349	385	428	484	582
Somerset	9,163	22,593	26,384	31,455	36,599	42,777
Sussex	598	931	1,247	1,698	2,381	3,099
Union	7,253	7,979	8,743	9,675	10,860	12,350
Warren	659	1,072	1,441	1,921	2,645	3,413
Statewide Total	261,448	362,852	444,615	545,474	668,291	822,818

Table A-2: Annual Cost of Congestion [$ Million]

County	1998	2005	2010	2015	2020	2025
Atlantic	$ 15	$ 29	$ 32	$ 36	$ 41	$ 47
Bergen	$ 2,498	$ 3,336	$ 4,011	$ 4,731	$ 5,461	$ 6,314
Burlington	$ 145	$ 242	$ 319	$ 426	$ 566	$ 744
Camden	$ 450	$ 622	$ 770	$ 956	$ 1,167	$ 1,404
Cape May	$ 0	$ 1	$ 1	$ 1	$ 1	$ 1
Cumberland	$ 9	$ 11	$ 13	$ 16	$ 20	$ 23
Essex	$ 613	$ 577	$ 545	$ 511	$ 475	$ 443
Gloucester	$ 139	$ 289	$ 450	$ 663	$ 939	$ 1,309
Hudson	$ 276	$ 332	$ 380	$ 435	$ 496	$ 555
Hunterdon	$ 42	$ 64	$ 86	$ 113	$ 148	$ 188
Mercer	$ 157	$ 214	$ 267	$ 331	$ 395	$ 475
Middlesex	$ 442	$ 801	$ 1,065	$ 1,408	$ 1,907	$ 2,591
Monmouth	$ 775	$ 1,049	$ 1,277	$ 1,542	$ 1,826	$ 2,137
Morris	$ 486	$ 551	$ 607	$ 663	$ 729	$ 794
Ocean	$ 160	$ 314	$ 515	$ 796	$ 1,172	$ 1,704
Passaic	$ 551	$ 643	$ 723	$ 809	$ 901	$ 999
Salem	$ 5	$ 8	$ 9	$ 10	$ 11	$ 13
Somerset	$ 306	$ 733	$ 852	$ 1,010	$ 1,169	$ 1,357
Sussex	$ 17	$ 27	$ 36	$ 49	$ 68	$ 88
Union	$ 199	$ 221	$ 243	$ 269	$ 302	$ 342
Warren	$ 21	$ 34	$ 46	$ 61	$ 84	$ 107
Statewide Total	$ 7,305	$ 10,097	$ 12,247	$ 14,836	$ 17,880	$ 21,634

Note: Values are rounded to the nearest $millions. A value of $0 reflects a value less than $0.5 million

Table A-3: Annual Hours of Delay per Licensed Driver

County	1998	2005	2010	2015	2020	2025
Atlantic	3	6	7	7	8	8
Bergen	133	175	207	240	272	309
Burlington	19	30	38	50	64	83
Camden	57	78	96	118	144	172
Cape May	0	0	0	0	0	1
Cumberland	4	6	7	8	10	11
Essex	43	41	39	36	32	30
Gloucester	36	74	113	162	226	309
Hudson	27	34	38	43	48	53
Hunterdon	11	15	20	25	32	39
Mercer	22	30	36	44	51	60
Middlesex	31	55	72	92	120	158
Monmouth	57	72	85	98	112	127
Morris	46	49	52	55	58	60
Ocean	18	34	54	80	113	159
Passaic	75	87	96	108	120	133
Salem	5	8	8	9	10	12
Somerset	45	100	109	121	130	142
Sussex	6	9	11	14	19	24
Union	20	22	24	26	29	33
Warren	9	14	19	24	32	39
Statewide Total	45	61	72	85	101	120

Table A-4: Annual Cost of Congestion per Licensed Driver

County	1998	2005	2010	2015	2020	2025
Atlantic	$ 84	$ 161	$ 170	$ 182	$ 195	$ 214
Bergen	$ 4,082	$ 5,323	$ 6,241	$ 7,171	$ 8,068	$ 9,097
Burlington	$ 495	$ 776	$ 992	$ 1,268	$ 1,619	$ 2,048
Camden	$ 1,277	$ 1,719	$ 2,096	$ 2,556	$ 3,067	$ 3,628
Cape May	$ 6	$ 7	$ 8	$ 11	$ 12	$ 15
Cumberland	$ 86	$ 113	$ 130	$ 150	$ 191	$ 215
Essex	$ 1,116	$ 1,071	$ 1,002	$ 923	$ 844	$ 774
Gloucester	$ 789	$ 1,565	$ 2,339	$ 3,295	$ 4,478	$ 5,991
Hudson	$ 654	$ 818	$ 908	$ 1,007	$ 1,115	$ 1,213
Hunterdon	$ 497	$ 687	$ 890	$ 1,106	$ 1,368	$ 1,646
Mercer	$ 649	$ 877	$ 1,065	$ 1,283	$ 1,490	$ 1,742
Middlesex	$ 852	$ 1,498	$ 1,914	$ 2,421	$ 3,143	$ 4,100
Monmouth	$ 1,820	$ 2,303	$ 2,692	$ 3,120	$ 3,553	$ 4,003
Morris	$ 1,493	$ 1,591	$ 1,686	$ 1,757	$ 1,848	$ 1,928
Ocean	$ 453	$ 829	$ 1,292	$ 1,858	$ 2,557	$ 3,488
Passaic	$ 1,628	$ 1,864	$ 2,073	$ 2,314	$ 2,568	$ 2,839
Salem	$ 114	$ 171	$ 187	$ 208	$ 235	$ 280
Somerset	$ 1,485	$ 3,241	$ 3,530	$ 3,871	$ 4,165	$ 4,518
Sussex	$ 174	$ 250	$ 320	$ 412	$ 547	$ 672
Union	$ 550	$ 612	$ 660	$ 724	$ 807	$ 905
Warren	$ 293	$ 454	$ 588	$ 754	$ 1,005	$ 1,232
State Average	$ 1,255	$ 1,684	$ 1,980	$ 2,316	$ 2,698	$ 3,158

Table A-5: Annual Hours of Delay per Affected Person

County	1998	2005	2010	2015	2020	2025
Atlantic	3	5	6	6	6	7
Bergen	120	156	182	210	237	267
Burlington	18	29	36	47	60	77
Camden	56	75	91	112	135	160
Cape May	0	0	0	0	0	1
Cumberland	4	6	6	7	9	10
Essex	40	38	35	32	29	26
Gloucester	37	75	114	162	225	307
Hudson	27	33	36	40	45	49
Hunterdon	11	16	20	25	32	39
Mercer	19	26	31	37	43	50
Middlesex	28	49	63	80	105	137
Monmouth	57	72	84	96	110	124
Morris	40	43	45	47	49	51
Ocean	19	37	59	87	124	175
Passaic	75	86	96	106	118	130
Salem	5	8	9	9	11	13
Somerset	38	87	95	105	114	124
Sussex	7	9	12	16	21	26
Union	19	21	22	24	27	30
Warren	10	15	19	25	33	41
Statewide Total	42	57	67	79	93	110

Table A-6: Annual Cost of Congestion per Affected Person

County	1998	2005	2010	2015	2020	2025
Atlantic	$ 73	$ 138	$ 145	$ 154	$ 164	$ 178
Bergen	$ 3,665	$ 4,733	$ 5,501	$ 6,275	$ 7,011	$ 7,853
Burlington	$ 474	$ 742	$ 939	$ 1,194	$ 1,516	$ 1,909
Camden	$ 1,238	$ 1,655	$ 1,999	$ 2,417	$ 2,877	$ 3,377
Cape May	$ 6	$ 7	$ 8	$ 10	$ 11	$ 14
Cumberland	$ 84	$ 110	$ 126	$ 145	$ 184	$ 206
Essex	$ 1,040	$ 979	$ 909	$ 833	$ 757	$ 691
Gloucester	$ 805	$ 1,586	$ 2,355	$ 3,299	$ 4,463	$ 5,946
Hudson	$ 642	$ 780	$ 857	$ 944	$ 1,037	$ 1,120
Hunterdon	$ 493	$ 688	$ 887	$ 1,103	$ 1,367	$ 1,645
Mercer	$ 568	$ 753	$ 904	$ 1,079	$ 1,243	$ 1,442
Middlesex	$ 762	$ 1,324	$ 1,680	$ 2,116	$ 2,736	$ 3,556
Monmouth	$ 1,804	$ 2,287	$ 2,657	$ 3,067	$ 3,479	$ 3,905
Morris	$ 1,291	$ 1,376	$ 1,447	$ 1,502	$ 1,575	$ 1,638
Ocean	$ 496	$ 908	$ 1,411	$ 2,035	$ 2,809	$ 3,840
Passaic	$ 1,628	$ 1,860	$ 2,058	$ 2,282	$ 2,515	$ 2,763
Salem	$ 118	$ 176	$ 192	$ 212	$ 238	$ 284
Somerset	$ 1,283	$ 2,813	$ 3,055	$ 3,362	$ 3,629	$ 3,947
Sussex	$ 191	$ 275	$ 349	$ 448	$ 593	$ 727
Union	$ 518	$ 570	$ 612	$ 667	$ 739	$ 823
Warren	$ 300	$ 466	$ 605	$ 776	$ 1,035	$ 1,270
State Average	$ 1,187	$ 1,581	$ 1,846	$ 2,148	$ 2,491	$ 2,905

Table A-7: Percent of Peak Travel that is Congested

County	1998	2005	2010	2015	2020	2025
Atlantic	10%	17%	17%	17%	17%	17%
Bergen	41%	49%	54%	59%	63%	67%
Burlington	30%	36%	37%	41%	42%	46%
Camden	38%	43%	44%	47%	49%	50%
Cape May	1%	1%	1%	1%	1%	1%
Cumberland	5%	6%	6%	6%	9%	9%
Essex	53%	53%	55%	56%	56%	56%
Gloucester	21%	29%	37%	42%	45%	55%
Hudson	41%	45%	49%	54%	55%	56%
Hunterdon	27%	30%	31%	35%	38%	39%
Mercer	25%	29%	31%	33%	34%	38%
Middlesex	32%	40%	49%	54%	59%	61%
Monmouth	37%	40%	46%	49%	51%	51%
Morris	43%	46%	48%	48%	50%	50%
Ocean	18%	33%	42%	48%	56%	60%
Passaic	43%	44%	46%	48%	50%	52%
Salem	7%	12%	12%	14%	12%	13%
Somerset	52%	55%	59%	63%	65%	67%
Sussex	4%	6%	8%	9%	13%	13%
Union	47%	47%	49%	53%	56%	58%
Warren	13%	17%	19%	21%	31%	38%
State Average	35%	39%	43%	47%	49%	52%

Table A-8: Cost per Peak Period Trip

County	1998	2005	2010	2015	2020
Atlantic	$ 0.22	$ 0.41	$ 0.42	$ 0.45	$ 0.47
Bergen	$12.10	$ 15.84	$ 18.70	$ 21.67	$ 24.64
Burlington	$ 1.07	$ 1.67	$ 2.07	$ 2.60	$ 3.27
Camden	$ 2.67	$ 3.47	$ 4.06	$ 4.76	$ 5.53
Cape May	$ 0.02	$ 0.02	$ 0.02	$ 0.02	$ 0.03
Cumberland	$ 0.19	$ 0.24	$ 0.27	$ 0.30	$ 0.37
Essex	$ 3.23	$ 3.01	$ 2.82	$ 2.62	$ 2.41
Gloucester	$ 1.45	$ 2.78	$ 4.00	$ 5.48	$ 7.28
Hudson	$ 2.42	$ 2.84	$ 3.18	$ 3.55	$ 3.95
Hunterdon	$ 1.22	$ 1.69	$ 2.09	$ 2.54	$ 3.09
Mercer	$ 1.37	$ 1.74	$ 2.03	$ 2.37	$ 2.69
Middlesex	$ 2.45	$ 4.29	$ 5.52	$ 7.08	$ 9.31
Monmouth	$ 6.09	$ 7.95	$ 9.33	$ 10.91	$ 12.53
Morris	$ 4.07	$ 4.39	$ 4.62	$ 4.82	$ 5.08
Ocean	$ 1.87	$ 3.46	$ 5.39	$ 7.92	$ 11.12
Passaic	$ 4.27	$ 4.94	$ 5.49	$ 6.10	$ 6.72
Salem	$ 0.21	$ 0.31	$ 0.33	$ 0.35	$ 0.39
Somerset	$ 2.89	$ 6.50	$ 7.12	$ 7.98	$ 8.76
Sussex	$ 0.66	$ 0.95	$ 1.18	$ 1.51	$ 2.00
Union	$ 1.37	$ 1.50	$ 1.62	$ 1.76	$ 1.95
Warren	$ 0.65	$ 0.97	$ 1.20	$ 1.49	$ 1.93
State Average	$ 3.36	$ 4.45	$ 5.18	$ 6.03	$ 7.00

Table A-9: Future Growth Impact

County	Population		Traffic		Congestion Cost	
	PERCENTAGE CHANGE FROM 1998					
	2005	2015	2005	2015	2005	2015
Atlantic	3%	14%	10%	15%	98%	147%
Bergen	2%	8%	8%	19%	34%	89%
Burlington	6%	15%	11%	26%	67%	194%
Camden	3%	6%	7%	18%	38%	113%
Cape May	1%	9%	6%	14%	18%	87%
Cumberland	0%	3%	6%	15%	32%	80%
Essex	-2%	1%	0%	0%	-6%	-17%
Gloucester	5%	14%	16%	39%	108%	377%
Hudson	-4%	3%	3%	8%	20%	58%
Hunterdon	10%	21%	9%	22%	52%	170%
Mercer	0%	6%	8%	19%	36%	110%
Middlesex	3%	12%	11%	26%	81%	218%
Monmouth	7%	16%	10%	24%	35%	99%
Morris	6%	16%	2%	6%	13%	36%
Ocean	7%	21%	19%	46%	96%	397%
Passaic	2%	3%	3%	6%	17%	47%
Salem	2%	4%	8%	16%	53%	90%
Somerset	10%	27%	9%	19%	140%	231%
Sussex	8%	19%	8%	20%	56%	182%
Union	0%	3%	2%	6%	11%	35%
Warren	5%	14%	12%	28%	63%	192%
State Average	3%	10%	8%	19%	38%	103%

Table A-10: Roadway Congestion Index (RCI)

County	1998	2005	2010	2015	2020	2025
Atlantic	0.66	0.72	0.74	0.75	0.76	0.78
Bergen	1.32	1.42	1.49	1.56	1.63	1.71
Burlington	0.83	0.91	0.98	1.04	1.10	1.16
Camden	0.95	1.02	1.07	1.11	1.16	1.21
Cape May	0.45	0.47	0.49	0.51	0.53	0.55
Cumberland	0.51	0.54	0.56	0.58	0.60	0.62
Essex	1.20	1.21	1.21	1.22	1.22	1.23
Gloucester	0.75	0.87	0.95	1.05	1.14	1.23
Hudson	1.02	1.05	1.07	1.10	1.12	1.15
Hunterdon	0.74	0.81	0.86	0.91	0.96	1.01
Mercer	0.84	0.90	0.95	0.99	1.04	1.08
Middlesex	1.14	1.27	1.36	1.45	1.54	1.64
Monmouth	0.98	1.09	1.16	1.24	1.31	1.39
Morris	0.95	0.97	0.99	1.00	1.02	1.04
Ocean	0.80	0.95	1.06	1.18	1.29	1.40
Passaic	1.24	1.27	1.30	1.33	1.35	1.38
Salem	0.63	0.69	0.72	0.75	0.78	0.81
Somerset	0.99	1.08	1.13	1.17	1.22	1.27
Sussex	0.62	0.67	0.71	0.75	0.79	0.82
Union	1.11	1.14	1.16	1.19	1.21	1.24
Warren	0.57	0.63	0.68	0.73	0.77	0.82
State Average	0.92	1.00	1.05	1.10	1.16	1.21

Table A-11: Travel Rate Index (TRI)

County	1998	2005	2010	2015	2020	2025
Atlantic	1.03	1.04	1.04	1.04	1.04	1.04
Bergen	1.22	1.27	1.31	1.36	1.39	1.46
Burlington	1.07	1.10	1.12	1.14	1.17	1.20
Camden	1.16	1.20	1.22	1.26	1.29	1.32
Cape May	1.00	1.00	1.00	1.00	1.00	1.01
Cumberland	1.03	1.03	1.03	1.04	1.05	1.05
Essex	1.14	1.14	1.14	1.14	1.13	1.13
Gloucester	1.08	1.13	1.18	1.22	1.26	1.32
Hudson	1.22	1.26	1.28	1.29	1.31	1.33
Hunterdon	1.04	1.06	1.07	1.09	1.11	1.13
Mercer	1.08	1.10	1.11	1.12	1.13	1.15
Middlesex	1.10	1.14	1.17	1.21	1.26	1.32
Monmouth	1.16	1.19	1.21	1.23	1.26	1.27
Morris	1.15	1.17	1.18	1.19	1.21	1.23
Ocean	1.06	1.11	1.15	1.19	1.26	1.33
Passaic	1.22	1.23	1.25	1.27	1.29	1.32
Salem	1.02	1.03	1.03	1.03	1.03	1.04
Somerset	1.14	1.20	1.22	1.26	1.29	1.32
Sussex	1.03	1.04	1.05	1.06	1.08	1.08
Union	1.11	1.13	1.14	1.16	1.17	1.19
Warren	1.04	1.05	1.05	1.06	1.07	1.08
State Average	1.12	1.15	1.18	1.20	1.23	1.26

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NEW JERSEY INSTITUTE OF TECHNOLOGY

The New Jersey Institute of Technology (NJIT) is a public research university enrolling over 8,200 bachelor's, master's and doctoral students in more than 80 degree programs through its six colleges: Newark College of Engineering, New Jersey School of Architecture, College of Science and Liberal Arts, the School of Management, the Albert Dorman Honors College and College of Computing Sciences. Research initiatives include manufacturing, microelectronics, multimedia, transportation, computer science, solar astrophysics, environmental engineering and science, and architecture and building science.

Yahoo! Internet Life magazine has ranked NJIT the “most wired” public university in America for three consecutive years, U.S. News and World Report’s “1999 Annual Guide to America’s Best Colleges” ranked NJIT among the nation’s top universities, and Money magazine’s "Money Guide: Best College Buys 1998" rated NJIT as the 6th best value among U.S. science and technology schools.

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The Foundation of the New Jersey Alliance for Action is a tax-exempt, non-profit corporation dedicated to improving life in New Jersey through research and public education projects that will provide a better understanding of our state.

The mission of the Foundation of the New Jersey Alliance for Action is to serve as a catalyst for initiatives, which will improve the quality of life of every resident of New Jersey. It will seek to enhance the economic wellbeing, the environment, the infrastructure and all those areas that affect how the people of our State live, work, raise families and spend their leisure time.

To carry out that mission, the Foundation is committed to gain funding for sponsorship of programs and projects, which can be implemented to improve the quality of life of our citizens. It will conduct research, inform and educate the public on those issues, as well as on how specific partnerships between the public and private sectors will benefit every citizen of New Jersey.

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NATIONAL CENTER FOR TRANSPORTATION AND INDUSTRIAL PRODUCTIVITY

The National Center for Transportation and Industrial Productivity (NCTIP) at New Jersey Institute of Technology (NJIT) is one of four national centers designated by the U.S. Congress under the Intermodal Surface Transportation Efficiency Act (ISTEA) legislation of 1991. The Center was reauthorized in 1998 under the Transportation Equity Act for the 21st Century (TEA-21).

Chartered under the U.S. Department of Transportation's (USDOT) University Transportation Centers Program, NCTIP supports USDOT's strategic goals of mobility and economic growth, as well as National Transportation Science and Technology Strategy's objectives of enhancing goods and freight movement at domestic and international gateways; increasing global competitiveness; optimizing intermodal passenger and freight transportation systems; and modeling tools for transportation planning, design and operations. NCTIP is a resource for and works closely with the New Jersey Department of Transportation, which provides funding for mutually acceptable projects.

NCTIP's mission is to increase efficiency and productivity in private and public sector entities and industries through transportation improvements. Undertaking high quality, multidisciplinary, innovative education; peer-reviewed research activities; and technology transfer activities accomplish this mission.

INTERNATIONAL INTERMODAL TRANSPORTATION CENTER

Commissioner James Weinstein of the New Jersey Department of Transportation designated New Jersey Institute of Technology as the International Intermodal Transportation Center (IITC), a university-based resource program that works closely with public and private sector transportation stakeholders to facilitate economic development and quality of life improvement efforts linked to the intermodal transportation corridor.

One of IITC's primary goals is to identify common and complementary needs within the region, ensuring that a cooperative agenda is created to further economic growth from the powerful global trade assets shared by the region. Consequently, one of the early projects was the establishment of a Forum to facilitate expanded communication and collaboration among all the transportation stakeholders in the Corridor. IITC also addresses broader issues such as freight transportation, brownfields and passenger transportation. In addition, the Center identifies public and private sector investments made in the corridor communities to support mobility and advance intermodal related economic development.