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ALTERNATIVE PERFORMANCE MEASURES FOR EVALUATING CONGESTION

FINAL REPORT
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16. Abstract

This report summarizes the results of the work performed under the project *Alternative Performance Measures for Evaluating Congestion*. The study first outlines existing approaches to looking at congestion. It then builds on the previous work in the area of evaluating congestion by incorporating the public's perception of what they consider to be congested through the use of a web-based survey. The idea of utilizing public input is not frequently seen in studies that look at congestion and its impacts and what makes this study additionally more unique is the focus on drivers in the State of New Jersey.

The results presented are specific to the area and allow for conclusions in terms of the entire state, various classifications throughout the state (age, income, etc.) as well as more disaggregated county level findings. The major findings of this effort are that New Jersey motorists are more tolerant of congestion than what is expected according to nationally used traffic engineering principles. The study also found that although New Jersey motorists are tolerant of congestion, they experience a very significant amount of stress while driving.

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INTRODUCTION

Transportation investments frequently must compete with other forms of government spending for scarce resources. 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. Available and easy to use computer modeling systems allow the integration of congestion cost-benefit analysis within budget planning at the state, county and municipal levels.

Although there are many different ways to measure traffic conditions, in general, they fall into two broad categories – time-based and density-based. Time-based measures include variations on travel time, travel speed or travel rate (the inverse of speed). Density-based measures include volume, density (vehicles per mile), or volume to capacity (v/c) ratio. Traffic engineers tend to favor density-based measures for several reasons: the data is far less costly and time-consuming to obtain, calculations are simplified through standardized computer software packages, and comparisons are more easily made among different roadways. The traveling public, as well as public officials, favor time-based measures because they can be directly measured, i.e. how long did it take me to travel from point a to point b, what was my average speed, or how long was my wait in a toll plaza queue.

This study builds on previous work in the area of evaluating congestion by incorporating the public's perception of what they consider to be congested. The idea of utilizing public input is not frequently seen in studies that look at congestion and its impacts and what makes this study additionally more unique is the focus on drivers in the State of New Jersey. The results presented are specific to the area and allow for conclusions in terms of the entire state, various classifications throughout the state (age, income, etc.) as well as more disaggregated county level findings.

The report consists of the following parts:

- detailed overview of work previously completed in the area of studying congestion and its impacts
- presentation of the development and findings of the survey of New Jersey drivers' perceptions of congestion
- overview of the most up to date results from NJIT's Congestion Program
- summary of the major findings and possible extensions of the work completed during this study

BACKGROUND

Introduction

Measuring and evaluating congestion is becoming increasingly important for transportation agencies. Congestion mitigation, environmental assessment and congestion pricing strategies all involve the use of congestion measures. However, there are many different congestion measures that are currently used by various agencies throughout the country. Depending on the congestion measures used, the resulting analysis of congestion levels can vary drastically. It is therefore important to choose the congestion measures appropriately, depending on the use and users of the measures. This section will explore various congestion measures used throughout the country.

Defining Congestion Measures

Meyer (1994) indicates that there is no consistent congestion measure used by metropolitan planners to monitor system congestion. This is still the case today. He also maintains that based on all the information collected for congestion measures, it is difficult to discern whether congestion levels are increasing or decreasing. This is because the analysis of different congestion measures can lead to very different conclusions on the state of the roadway system.

Meyer also states “A good set of congestion measures has the potential to improve not only the quality and consistency of public transportation policy but also pubic understanding of the congestion phenomenon, leading to political support for policy improvements and more rational behavior by individual travelers.”

He lists the following characteristics of good congestion measures:

- Clear, intuitive meaning and easily understood by professionals in other fields
- Acceptable and useful to transportation professionals
- Comparable across time and between geographical areas
- Strong relationship to actual costs of congestion – can calculate direct and indirect costs of congestion from the measures
- Consistent with theoretical definition of the social cost of congestion
- Be cost effective
- Able to forecast
- Be based on statistically sound measurement techniques

A report was produced for the National Cooperative Highway Research Program titled “Quantifying Congestion” (1997). There are two parts to this report: the Final Report and the Users Guide. This report indicates how a congestion measurement program should be developed. The users guide gives detailed instructions on data collection and analysis techniques for congestion measures. A good summary of the report is provided by Turner (1996).

This report suggests the following appropriate definitions for congestion and unacceptable congestion:

- “Congestion is travel time or delay in excess of that normally incurred under light or free-flow travel conditions.”
- “Unacceptable congestion is travel time or delay in excess of an agreed upon norm. The agreed upon norm may vary by type of transportation facility, travel mode, geographic location, and time of day.”

This idea of “unacceptable” congestion allows users of the transportation system to indicate a threshold at which they consider traffic conditions to be inadequate. Not only may this threshold of unacceptable congestion depend on the values mentioned in the definition of congestion, but it may also depend on each individual’s assessment of congestion.

Lomax (1997) details the importance of identifying the use and users of the congestion measures proposed. The selection of congestion measures should also depend on the study purpose and objectives. It is important to select the geographic extent of the study (CBD/Corridor/Region) as well as the class of roads to be used. The time period used for the data collection is also important. Some locations may have peak periods which are spread out over many hours, while some areas may have sharper peaking. An alternative to peak period data collection is to consider the total daily traffic, or just a period when the system is heavily congested. Also, sampling during off-peak conditions may give a representation of free flow or uncongested conditions. Daily and seasonal traffic variation should also be considered. It may be that the congested associated with seasonal variations may be what the transportation agency is trying to capture with a congestion measure. On the other hand, seasonal variation may cause daily congestion measures to be inaccurately represented.

The users of the congestion measures must accurately be identified. As public involvement in the transportation process increases, it is very important to develop congestion measures that can be easily understood by the traveling public. Politicians, administrators as well as engineers and planners must all be able to understand and discuss congestion measures.

The uses of the congestion measures must also be considered. It may be difficult to test how new facilities improve congestion using volume to capacity ratio because the new facility may attract new demand and the ratio may remain constant. In this case, vehicle-miles traveled (VMT) might be a better measure to consider.

Travel Time Congestion Measures

Lomax (1997) proposes that travel time and speed measures are effective because they satisfy the widest range of requirements for congestion information.

The following list of recommended time based congestion measures can be found in Lomax (1997):

- Travel time or difference in travel times
- Travel rate (inverse of travel time)
- Delay rate – actual travel rate minus acceptable travel rate
- Total delay in person hours or vehicle hours
- Relative delay rate – delay rate divided by acceptable travel rate
- Delay ratio – delay rate divided by actual travel rate
- Kilometers of congested roadway
- Congested travel – person volume multiplied by congested travel distance
- Speed of person movement – person volume multiplied by speed
- Corridor mobility index – speed of person movement divided by normalizing factor.

A report dealing with congestion measures in New Jersey (D'Abadie 2002) found that time based measures show much more congestion than distance based measures. This study defined two thresholds for congestion. Roadway segments with a v/c greater or equal to 0.75 were considered congested and locations with a v/c of 0.9 or greater were considered heavily congested. The distance-based measure of congested vehicle miles was compared with the time-based measure of vehicle hours of congested travel.

The results of this study showed that the time based measure showed a much larger percentage of vehicle hours of travel occur under congested and severely congested conditions. Even small sections of roadway that were severely congestion greatly increased the travel time of the entire road network. This study concludes that time based measures of congested more accurately reflect the way the traveling public perceive congestion than distance based measures.

Boarnet (1998) expresses that a congestion index should reflect the full range of highway performance. He studied a variety of congestion measures and found that the only congestion index that measures the full range of system performance and allows comparison across different metro areas is the Texas Transportation Institute index of RCI.

RCI (Road Congestion Index) is a weighted average of vehicle-miles traveled and lane miles of freeway.

$$RCI = \frac{\left(\frac{dailyVMT_{freeway}}{lane-mile}\right) * VMT_{freeway} + \left(\frac{dailyVMT_{arterial}}{lane-mile}\right) * VMT_{arterial}}{13000 * VMT_{freeway} + 5000 VMT_{arterial}}$$

This measure assumes a capacity per lane of 13,000 vehicles per day for freeways and 5,000 vehicles per day for principal arterials. It assumes a baseline for congestion based on those capacities and does not account for daily peaking.

Development of Baseline Congestion

Many studies compare actual congestion to a baseline congestion value in determining a congestion measure. However, the literature varies quite a bit in how this baseline is determined and what the actual baseline value is.

Lindley (1987) uses an average speed of 55mph to calculate the "ideal" travel time.

(D'Abadie 2002) defined two thresholds for congestion based on volume to capacity ratios.

NJIT (2001) used the boundary between LOS C and D as the baseline for defining acceptable congestion.

Meyer (1994) quotes a 1993 FHWA study based on the HPMS that states a volume to capacity ratio greater or equal to 1.0 is the threshold for congestion on freeways or principle arterials with no signals, or with good progression. A volume to capacity ratio greater or equal to 0.85 is used for other principle arterials.

TTI's RCI index, mentioned above, uses daily capacity values (vehicles per day) for freeways and arterials.

Although each of these baseline congestion measures may have merit, they are all in a way arbitrary and in some cases the same value is used nation-wide. Baseline congestion measures could vary quite significantly by region. For example, drivers in heavily congested areas might define acceptable congestion at a considerably higher level than drivers in uncongested or rural areas. Baseline congestion might also depend on trip purpose, travel mode or even on each individual's characteristics. Although many studies agree that it is important to allow for public input when determining baseline congestion levels, it seems most have not gone through the data collection process

Other Congestion Measures

Turner (1991) suggests that a good congestion measures should describe the extent, severity and duration of congestion. He defines indicators of congestion as variables closely related to the level of congestion such as travel characteristics (VMT), facility supply characteristics (lane-miles of roadway), demographic characteristics (population density) or a combination of these variables. Descriptors of congestion are measures such as vehicle delay, congestion duration, and average travel speed. An effort is then made to develop a relationship between indicators and congestion levels. This paper also provides the following comparison among congestion measures.

Cottrell (1998) developed the lane-mile duration index to relate AADT per hourly capacity to congestion duration. This measure considers only recurring congestion.

LMDI – Lane-Mile Duration Index

$$LMDI_f = \sum_{i=1}^{m}\left[congested\ lane-mile_i * congested\ duration_i\,(hours)\right]$$

where i is an individual freeway segment and m is the total number of freeway segments.

RCI – Roadway Congestion Index is defined above, developed by TTI.

CSI – Congestion Severity Index developed by Lindley (1987).

$$CSI = \frac{total\ \ freeway\ delay\ (veh-hr)}{freeway\ VMT\ (million)} + \frac{total\ arterial\ delay}{arterial\ VMT\ (million)}$$

Lindley (1987) looked at correlations between various indicators. He found that DVMT to lane-mile (travel to supply ratio) has the highest correlation. The next highest correlation was found to be between DVMT and miles squared of urban area. The majority of transit indicators had very poor correlation.

Papacostas (2001) mentions alternatives to LOS for assessing congestion levels:

- Travel rate in minutes per mile
- Delay = actual travel time minus acceptable travel time
- Relative delay = actual travel time divided by acceptable travel time
- Total delay in vehicle hours
- Corridor mobility index = (passenger volume)*(average speed)/normalizer, where the normalizer is 25,000 for streets and 125,000 for freeways (Lomax 1999). The facility specific normalizers were obtained from empirical data.
- Accessibility = sum of objective ability to reach opportunities (e.g. jobs) where actual travel time is less than acceptable travel time. Acceptable travel time may vary with type of opportunity as well as the individual
- Average freeway operating speed, calculated as follows:

  $$Peak\ hour\ speed = 91.4 - 2.0ADT - 2.85ACCESS\ ,$$

  where ADT is annual daily traffic per line (1000's) and ACCESS is the number of access points per mile.

Cotrell (1998) developed a model to estimate the probability of recurring freeway congestion. He used the following explanatory variables: V/C, AADT/C (where C is hourly capacity), average hourly delay, access frequency (# of access points per mile between endpoints of highway study segment), K factor (ratio of the 30th highest hourly volumes to the AADT), ramp metering indicator (0 if no ramp metering, or 1 if ramp metering is present).

His definition of recurring congestion was rather subjective and not related to quantifiable roadway performance. Sections were considered congested if the transportation agency representative of the congestion monitoring in the area classified the location as a bottleneck. He found a good fit model using logistic regression model that showed that at a k-factor of 0.10 and an AADT/C of 8.5 there is a 50% probability that congestion will recur.

Although the intent of this study could provide a good model for forecasting recurring congestion, it is important to select appropriate baseline congestion measure. It is unknown how each agency used in this study determined bottleneck locations and it is quite likely they all used different methods.

A different analysis of congestion can be found in Gordon (1997) who concludes that average commute speed is increasing. He quotes a USDOT 1994 study that found that average trip length for commuting trips has increased, and so has the average travel time for commute trips, but that the trip length has increased much more than the increased travel time from 1983 to 1990 and concludes that average commute trip speed has increased. Gordon has reviewed seven separate nationwide surveys that all have similar conclusions. He also cautions against using census data for travel speed analysis as this data includes trip chained work trips in the work trip analysis. Trip chaining has increased in recent years and trip chained work trips are significantly longer in distance and duration than non-stop work trips. Therefore the trip lengths and travel times reported in the census data for work trips may be unrealistically long.

This highlights that different congestion studies can draw very different conclusions by using different congestion measures. It also brings up the importance of using good data when developing congestion measures.

Evaluating Congestion

Perhaps the first study to actually quantify congestion and apply it on a national scale was an FHWA study done by Lindley (1986). Using the HPMS (Highway Performance Monitoring System) data for freeways. He calculated total annual delay due to recurring congestion:

$$Delay = (Ideal\ travel\ time - Actual\ travel\ time) * PCT * AADT * 260$$

Using ideal travel time as average speed 55mph.
PCT is the percentage of daily traffic experiencing congested conditions
260 is the number of days per year where recurring congestion is expected (weekday).

Fuel consumption due to this excess delay was calculated using the following equation developed by Raus (1981).

Miles per gallon=8.8+0.25*Average Speed (mph)

This equation was developed using the 1980 passenger car vehicle fleet.

Lindley (1987) also estimated the costs of congestion due to non-recurring (or incident) congestion. The average duration of congestion was determined from actual data for real incidents. This included time the incident was in a traveling lane, and the time the incident was moved to shoulder, but not cleared. The time was found for seven different incident types for urban freeways. The total incident rate per million VMT was also found from national data. The number of occurrences of certain incident types was estimated and the percent of total capacity remaining by lane was found.

One of the most widely known studies which evaluates congestion is that produced annually by the Texas Transportation Institute (TTI). Since 1982, the TTI has been quantifying congestion for major urban centers in the United States. The most recent report from TTI is The 2001 Urban Mobility Report by Schrank and Lomax (2001). This report uses 1999 data to report on congestion in 68 urban centers in the United States with a range of populations above 100,000. Some conclusions for the 68 urban centers studied include:

- The average annual delay per person is 36 hours.
- The total cost of congestion is $78 billion (including lost time and wasted fuel).
- In many of the most congested areas, there is not enough money, space or public approval to add the roads required to bring congested down to “acceptable” levels.

One new congestion measure included in this Texas Transportation Institute report is the Travel Time Index (TTI). This measure is a comparison of total peak travel time to free flow travel time. This is similar to the Travel Rate Index (TRI) also developed early by TTI, but includes delay due to recurring and non-recurring (incident) congestion. One of the main conclusions TTI makes is that building new roads is not the solution to the congestion problem. These measures will be outlined in detail later in this paper.

Schrank (2002) states that the most versatile mobility measures are those based on travel time and speed because they are easy to comprehend, can be used for different users and communicated to many different users. This paper outlines a study completed in Grand Junction Colorado to estimate congestion using travel time based methods.

Data collection was done using the floating car method to determine travel time on the test section. The study used the Travel Rate Index (TRI) which compares measured travel rates (inverse of speed) to free flow conditions, weighted by passenger-miles of travel (PMT).

$$TRI = \frac{\left(\frac{FreewayTravelRate}{FreewayFreeflowRate} * FreewayPeakPMT\right) + \left(\frac{ArterialTravelRate}{ArterialFreeflowRate} * ArterialPeakPMT\right)}{\left(FreewayPeakPMT + ArterialPeakPMT\right)}$$

This result of this study was a quantifiable evaluation of the level of congestion on the test section of roadway. 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 New Jersey Institute of Technology produced “Mobility and the Costs of Congestion in New Jersey” in 2000. This report detailed the costs of congestion in New Jersey by county. The total annual cost of congestion including lost time, operating costs and fuel consumption was found to be $4.9 billion. This equals $880 per licensed driver in the state.

This was updated in 2001 and the new costs were found to be $7.3 billion annually and $1,255 per licensed driver.

Although the approach of this study was similar to the Urban Mobility Report produced by TTI, it contained the following improvements:

- Traffic volumes were provided by hour and by direction instead of two-directional daily averages.
- Actual truck volumes by direction and hour were used instead of a constant value of 5% trucks.
- Vehicle occupancy by county and roadway type
- Detailed geometric information for each roadway link, allowing for better capacity estimations.
- Sections of roadway with LOS C or better were not considered congested and the delay on these sections was not included in the costs of congestion.

Ozbay (2001) developed a method for estimating the full marginal costs of highway transportation in New Jersey. This study identified direct vs. indirect costs and could be used for congestion pricing.

Direct costs:

- vehicle operating costs
- car depreciation
- time lost in traffic
- infrastructure costs

Indirect costs:

- social or external costs
- costs of congestion
- accidents
- air pollution
- noise
- loss of open space

The value of time is included in the direct costs of time lost in traffic due to congestion. This study used the BPR function for travel time

$$Time = T_o\left(1 + 0.15\frac{v}{c}\right)^4$$

where T_o is free flow travel time

This study does not include non-recurring congestion. Although the costs of accidents are included, it does not include the costs of added congestion due to accidents.

Conclusions from this study included that the cost/trip an additional user causes is not close to what the user is charged (fuel taxes). Also, trips mostly on primary arterials have increased marginal costs compared to trips mostly on freeways. This indicates that congestion mitigation on arterials could be a primary focus for New Jersey.

Summary of Existing Congestion Measures

There are many different types of congestion measures used by various transportation agencies. Different congestion measures may be appropriate for different situations. When coming up with congestion measures it is important to consider the use for the measures as well as the users of the measures.

There has been an increased popularity in the use of time-based measures for congestion as time based measures are easily understood by a wide variety of audiences. It is also felt by many that travel time measures more accurately reflect factors the traveling public consider when evaluating congestion levels.

It is important when considering congestion to look at a baseline value of congestion. This value may vary by location, trip purpose, mode and individual. This baseline level is also important when computing the costs of congestion. Most studies calculating the costs of congestion deal with excess travel time, where existing travel time must be compared to some baseline level.

It is the users of the transportation system who are most qualified to determine what this baseline for congestion should be. This is not a value that can be calculated in the field by observing traffic conditions, but must be directly asked of the traveling public.

In general, there are three major things that one has to keep in mind when evaluating congestion and its impacts:

- Understand who will be the end users of the analysis and make sure that the findings are presented accordingly.
- Understand the limitations of the available data. Some of the approaches discussed are very data intensive where data may not be readily available. While it may be appropriate to make certain assumptions, they should be outlined clearly to the end users of the analysis.

- Consider the specific congestion baseline for your type of analysis. This may vary by location, trip type, transportation mode and individuals involved.

Obviously the above is not a complete list but, if followed, it should lead to a proper evaluation of congestion and its impacts.

WEB-BASED CONGESTION SURVEY OF NEW JERSEY DRIVERS

While the literature reviewed presented a variety of approaches to evaluating congestion, there is very little evidence of public input into deciding when roadway conditions are congested, and, when they are, what are the impacts of congestion. Incorporating the public's views into the process of establishing what is congested, evaluating congestion impacts and identifying congested location throughout New Jersey are the main components of this study. The following sections of the report present the objectives of the survey, discuss the design of the survey, cover the survey distribution process and present the major survey findings.

Survey Objectives

The main objective in designing the congestion survey was to better understand New Jerseyans' perception of congestion. Several research questions were developed as part of the design process:

1. Does a typical NJ driver perceive congestion differently from a typical U.S. driver?
2. Does the perception of congestion vary by trip type?
3. Does the perception of congestion vary by facility type?
4. Does the perception of congestion vary by any of the following: age, gender, income, education, occupation, location?

These questions served as guidance in developing the survey contents, format and order.

As the design phase progressed, two more objectives became clear. First, the survey was determined to be an ideal opportunity to ask the drivers of New Jersey to give specific examples of congested locations. Once identified, these locations may be examined by the NJDOT Congestion Buster Task Force to see if the congestion could be alleviated through their Quick Fix Initiatives program. The program identifies trouble spots on New Jersey roadways that can be significantly improved with quick and inexpensive fixes (e.g. adjustment of signal timings).

The final objective of the survey was to assess the significance of stress among New Jersey drivers and determine its main causes to see if alleviating congestion in the State would result in a decrease in stress experienced by its drivers.

Survey Design

Although the main objective of the survey was clear, the survey design process went through several stages of different delivery methods as well as a continuously evolving questionnaire.

Survey Delivery Methods

Initially the survey was to be administered in person at several focus group meetings. However, since the goal was to reach a wide range of New Jersey drivers, it was deemed more appropriate to reach those drivers through their employers. The survey would be distributed on a CD-ROM accompanied by the answer sheet to interested companies in person or via mail, which would then pass it on to their employees. Once the employees completed the survey, the answer sheet would be returned to NJIT via fax or mail for data entry and analysis. While this approach would certainly reach more New Jersey drivers, the process of distributing the survey, collecting the responses and manually entering the data would not be very time efficient and would result in a substantial expense associated with preparing the CD-ROMs for distribution.

Through the process of evaluating various survey delivery methods, it was found that the most effective and efficient way to deliver the survey was via the web. The survey would reach the most respondents out of all of the methods. Additionally, the responses would be stored electronically eliminating the need for a substantial amount of data entry.

Survey Design Process

The final web-based survey (presented in Appendix A) is a result of a continuously evolving process that involved feedback from the clients, project manager, sample surveys and internal meetings.

The survey is a combination of general questions about each person taking the survey and a series of Paramics simulation videos depicting various congestion scenarios. It is divided into eight parts. Part 1 is made up of 13 questions that are mainly used to describe the individual in terms of age, gender, education, occupation, home location, work location, primary commute mode, average home to work travel time, and average home to work travel distance. The respondents are then asked to list up to five locations where they encounter congested conditions on a regular basis. In addition to the location, the respondents identify the time (weekday AM or PM peak, weekend or other) when the congestion takes place. In order to better understand commuters' travel decisions, the survey takers are asked to select a maximum of five factors that they use when deciding on a commute path. The choices range from travel time to reliability of travel time to avoiding toll facilities. There is also an option to enter their own factor if it is not listed. Part 1 concludes with an open comment question on the clarity of the survey.

Parts 2 through 7 are a series of Paramics simulation videos that present a range of congested conditions on signalized roads (parts 2,3,and 4) and freeway sections (parts 5,6 and 7). Paramics is an advanced software package for microscopic traffic simulation. The package was selected because of its advantages is in presntation of 3-D simulations of traffic conditions. The six scenarios presented were created based on Level of Service and are as follows:

1. Part 2: Signalized Intersection Level of Service D
2. Part 3: Signalized Intersection Level of Service E
3. Part 4: Signalized Intersection Level of Service F
4. Part 5: Freeway Section Level of Service D
5. Part 6: Freeway Section Level of Service E
6. Part 7: Freeway Section Level of Service F

Each video clip is approximately 20 seconds and gives a sample of the conditions associated with the particular Level of Service. Once the respondent views the clip, he/she answers the related questions. In order to determine whether drivers perceive congestion differently based on the type of trip, three scenarios are presented to the respondents (travel to/from work, travel to/from shore and travel to/from mall). The respondent has four choices to classify the conditions in each scenario of each video clip: not at all congested, slightly congested, moderately congested or extremely congested. This range of congestion will allow for more detailed comparison of the survey responses.

Finally, part 8 consists of 6 questions that deal with stress. The respondents are asked about the frequency with which they experience stress while driving for the three types of trips discussed above: travel to/from work, travel to/from shore and travel to/from mall. Since it is important to gauge whether the issue of driving related stress is on the rise, the survey takers are asked whether they have noticed an increase over the past year or over the past five years. Finally, the respondents select the thing that they see as most responsible for stress while driving (aggressive drivers, congestion due to road construction, congestion due to accidents, people who drive too slow, or other).

Once the respondent answers all of the questions and submits his/her survey, the responses are automatically recorder in a Microsoft Access database that is directly connected to the web-based survey. This feature of the survey allows for quick and easy compiling and manipulating of the responses by eliminating the potentially time consuming data entry.

Survey Distribution

The highlight of the survey distribution was a statewide NJDOT press release announcing the survey and directing potential respondents to the survey website. The release appeared in several newspapers as well as on radio stations throughout New Jersey. This success was further supplemented by internal announcements at NJDOT, NJ Transit and NJIT as well as distribution by several of the State's TMAs. The distribution effort was very successful in not only attracting a larger than expected turnout of respondents to the survey but also making the public aware of the importance of their opinions.

Survey Results

Survey Sample Composition

In order to make conclusions based on the congestion survey, it is important to first understand the composition of the survey sample. This section will describe the 1393 survey respondents based on the responses provided in Part 1 of the survey.

Figure 1 shows the age breakdown of the survey respondents. The survey sample covers all age groups with the majority of the respondents (79%) between 25 and 54 years of age. Gender breakdown, presented in Figure 2, shows that males made up the majority of the respondents with 60%. Figure 3 shows the educational breakdown of the survey respondents that covers all education levels. The majority (37%) of the collected survey responses came from people whose highest level of education completed was a Bachelors Degree. Occupation of survey respondents is presented in Figure 4. Professionals are a clear majority of the sample at 59% with administrative employees second at 22%. As is shown in Figure 5, the majority (31%) of the survey respondents earn between $50k and $75k. However, the income distribution of the sample covers the entire range of salaries.

Tables 1 and 2 present the geographical makeup of the survey sample. The respondents were asked for their home and work locations in terms of city, county and state. In case of respondents from outside New Jersey (Pennsylvania and New York), only city and state were recorded. In terms of home county, all New Jersey counties as well as the states of New York and Pennsylvania were represented in the survey sample. Mercer, Middlesex, Burlington, Morris, Monmouth, State of Pennsylvania and Bergen counties were represented with five or more percent of the total sample. Similarly, in terms of work county, all New Jersey counties as well as the states of New York and Pennsylvania were part of the survey sample. Mercer, Morris, Essex, Middlesex, Bergen, State of New York and Hunterdon counties were represented by at least five percent of the survey sample. It is important to note the interstate movements captured in the survey sample. There is a significant number of respondents that live in Pennsylvania but work in New Jersey. There are also respondents that live in New Jersey but travel to work in New York.

Figure 6 shows the sample composition by primary commute mode. More than 80% of the total survey sample answered “drive alone” as the primary commute mode. Six percent of the sample either drives or walks to public transit and another six percent of the respondents carpools to work. The average one way travel time breakdown of the survey sample is presented in Figure 7. More than 50% of the respondents travel for 15 to 45 minutes to get to work. Interestingly, there is one percent of the sample (approximately 14 respondents) that travels for over 100 minutes each way to get to work. Figure 8 shows the average one way travel distance breakdown of the sample. Of those surveyed, 40% travel less than 15 miles to get to work. Compared with Figure 7 showing the average travel time, only 15% (less than half of those that travel under 15 miles) of the total sample have a commute that is less than 15 minutes one way.

Finally, the respondents were asked to select a maximum of five factors that they use to make travel decision for their commute trip. The decisions could involve which mode to take, which route to travel and what time to depart. Figure 9 shows the responses for this question. Overwhelmingly, the survey sample picked minimizing travel time and avoiding time spent in heavy traffic. Reliability of the travel time was also a very important decision factor among the survey respondents.

Survey Sample Perception of Congestion

Part 1 of the survey established the makeup of the survey sample. Parts 2 through 7 deal with how the survey respondents perceive congestion on two types of facilities (signalized intersections and freeway segments) and three types of trips (work, shore and shopping) based on sample Paramics simulation videos. This section will provide detail on the time based traffic properties of the simulations in the survey and present results of the perception of congestion for the following: the entire survey sample,

1. gender breakdown,
2. age group breakdown,
3. education breakdown,
4. occupation breakdown,
5. income breakdown,
6. home county breakdown, and
7. work county breakdown.

The main objective of this analysis is to show whether New Jersey drivers perceive congestion differently than what has been established with traffic engineering principles. In order to address this issue, the Paramics simulation videos in the survey were created using Level of Service (LOS) criteria. Exhibits 16-2 and 23-2 from the 2000 Highway Capacity Manual were used as a reference during the simulation development process.

For signalized intersections, the simulations are based upon the appropriate average intersection approach delays per vehicle for each LOS (D, E and F). Exhibit 16-2 gives delays in seconds per vehicle as 35 to 55, 55 to 80 and more than 80 for LOS D, E and F respectively. The average approach delays presented in the survey Paramics simulation videos for LOS D, E and F are 49.8, 70.9 and 95.6 seconds per vehicle.

For freeway sections, the simulations were created based on average speeds. The free flow speed presented in the Paramics simulation videos is 65 miles per hour. The speeds associated with this free flow speed for LOS D, E and F are given in Exhibit 23-2 of the 2000 HCM. They are (in miles per hour) 59.7 to 64.6 for LOS D, 52.2 to 59.7 for LOS E and anything lower than 52.2 signifies LOS F. The simulated scenarios have speeds of 64.2 miles per hour for LOS D, 57.7 miles per hour for LOS E and 34 miles per hour for LOS F.

In order to eliminate discrepancies in the respondents' understanding of congestion the survey has a clear definition prior to each of the simulation video clips. The definition reads as follows:

> *A roadway is considered to be congested if the conditions are so undesirable you would consider changing your travel behavior in order to avoid traffic delays. Changing your behavior includes changing your route, your departure time or your travel mode.*

The goal of the above definition is to set the stage for all respondents to think about what they see in the Paramics simulation videos using the same criteria. Once the survey respondents are clear on the definition of congestion, they proceed by watching the brief video clip illustrating a roadway scenario. Upon completion, the respondent gives his/her perception of the scenario for three different trip types: work, shore and shopping. Various trip types are a part of the scenario and may result in different perception of congestion. The survey taker has four possible answers to choose from to identify the level of congestion in the simulation video for a particular trip type:

1. Not at all congested. This response is assigned a value of 1 for the remainder of the analysis.
2. Slightly congested. This response is assigned a value of 2 for the remainder of the analysis.
3. Moderately congested. This response is assigned a value of 3 for the remainder of the analysis.

4. Extremely congested. This response is assigned a value of 4 for the remainder of the analysis.

Through the combination of various levels of congestion and the 1 to 4 rating scale, the analysis will be able to capture the public's perception of congestion more accurately.

The remainder of this section analyzes the responses in terms of aggregated average perceptions for the entire survey sample, age group breakdown, education breakdown, occupation breakdown, income breakdown, home county breakdown, and work county breakdown. The averages fall between 1 and 4 with 1 showing that the respondents did not consider the scenario to be congested and 4 showing that the scenario was extremely congested. Another way of looking at these results is through the concept of how tolerant the respondents are. In these terms, lower averages show a greater deal of tolerance than the higher averages.

Figure 10 summarizes the perception of congestion for the entire survey sample. Overall, the New Jersey drivers are more tolerant of roadway congestion than what is established using traffic engineering principles. For intersections, the survey sample considers average approach delays of 49.8 seconds per vehicle slightly congested, 70.9 seconds per vehicle moderately congested and 95.6 seconds per vehicle between moderately and extremely congested.

The level of tolerance towards congestion is even more evident when looking at the freeway scenarios with free flow speed of 65 miles per hour. The survey sample considers the average speed of 64.2 miles per hour between not at all congested and slightly congested. The average speed of 57.7 miles per hour is moderately congested and 34 miles per hour still falls between moderately and extremely congested in the opinion of the survey sample.

While Figure 10 shows some slight variation by trip type, only the worst freeway scenario is significant enough to conclude varying perception by trip type. The figure shows that the survey sample is more tolerant of the congested condition when traveling to work than they are when traveling to either shore or shopping.

Figures 11 through 16 present the perception findings by various age groups. Consistently, independent of the trip type or facility, the figures show that tolerance of congested conditions decreases with age.

Figure 17 shows the perception of congestion by gender. Females are more tolerant in all scenarios except for the worst signalized intersection scenario and worst freeway scenario.

Figures 18 through 23 present the finding in terms of the highest level of education completed by the respondents. Although there are slight variations among the groups, trip types and facility types, there is no consistent pattern leading to a conclusion that the level of education impacts an individual's perception of congestion.

Figures 24 through 29 show the perception of the survey sample by occupation. Most occupations responded similarly with two exceptions. The portion of the sample in landscaping/animal care is the least tolerant of congested conditions while precision production/craft is the most tolerant of all the occupations.

Figures 30 through 35 look at the potential impacts of income on the perception of congestion. There are slight variations in the first five figures but Figure 30 leads to two conclusions. First, tolerance of congested conditions decreases with increased incomes. Second, the tolerance for work trips is significantly higher than shore and shopping trips.

Figures 36 through 41 look at perception of congestion by home county. In general, there are very small variations among the counties and trip types. Overall, there does not appear to be the division between Northern New Jersey and Southern New Jersey. It was anticipated that due to the levels of activity associated with the two parts of the State, the drivers in the north would be significantly more tolerant of congestion that their southern counterparts. The analysis does not lead to this conclusion. While there are slight variations among the counties, they are not consistent with a clear north/south division.

Figures 42 through 47 present the perception analysis by work county. As was the case with the home county breakdown of congestion perception, there is no clear north/south division of perceptions by work county.

In conclusion, New Jersey drivers are more tolerant of congested roadway conditions than the national average based on 2000 HCM traffic engineering principles used throughout the country. When viewing the short simulation clips in the survey, the respondents do not classify the conditions that they observe to be as congested as they are according to traffic engineering guidelines used nationally. Additionally, the tolerance that New Jersey appears to have for congested roadways seems to decrease as the age of the motorists responding to the survey increases.

Survey Sample Driving Related Stress Summary

Part 8 of the survey looks at the possible psychological impacts of congestion on individuals. This section summarizes the findings of the driving related stress experienced by New Jersey drivers.

Figure 48 shows driving related stress experienced on the way to work. The majority of the survey sample (38%) experience stress sometimes while driving to work. While 58% of the respondents experience stress often very often or always, only 4% never experiences stress.

Figure 49 shows the driving related stress experienced on the way to the mall. Unlike work, the majority of the sample (65%) experiences stress sometimes or never.

Figure 50 presents the driving related stress on the way to the shore. The results fall in between the work trips and the shopping trips. A slight majority (53%) of the survey sample experience stress often, very often or always.

Figures 51 and 52 show the increase in stress over one and five years respectively. The majority (66%) of the survey sample sees an increase in driving related stress over the past year. An even greater majority (86%) of the respondents feel that there has been an increase in driving related stress over the last five years.

Finally, Figure 53 presents the factors that lead to driving related stress. The majority (35%) of the survey sample feels that aggressive drivers are the main contributor to stress while driving. The combination of congestion due to road construction (13%) and accidents (14%) is the second most common response.

Survey Sample Congested Locations

Question 11 in Part 1 of the survey asks the respondents to identify/complain about up to five locations where they encounter congestion on a regular basis. Tables 3, 4, 5 and 6 as well as Figures 54, 55 and 56 present the summary of responses to this question. Additionally, Appendix B provides the full results of this analysis.

The respondents were given a great deal of flexibility when answering this question. There were several common ways in which the survey sample identified the problem locations: route number or street name (e.g. Route 1), intersection (e.g. Route 1 and Washington Road), route in a town (e.g. Route 1 in Edison), or segment of a highway (e.g. GSP between interchange 145 and interchange 150).

Once compiled, the respondents’ raw complaints were weighted in order to balance the potential impact of the number of responses within a particular county that may have resulted from the unrestricted survey access. This process consisted of generating a weighting factor that is a combination of the number of responses within a county as a fraction of the total number of responses in New Jersey and the number of trip ends within a county as a fraction of trip ends in New Jersey. The trip end information comes directly from the U.S. Census. The final county factors that are used to weigh the raw number of complaints are calculated as follows:

$$\frac{\text{(trip ends within a NJ county / trip ends in NJ)}}{\text{(respondents that live or work in a NJ county / total respondents that live or work in NJ)}}$$

The table outlining the county weight factors as well as the data that was used to obtain them is included in Appendix B.

Table 3 lists the top ten congested locations prior to being weighted. The following locations received more than 35 complaints each: Interchange of I 287 and NJ 24 and the Interchange of US 1 and I 295. Table 4 summarizes the top ten weighted locations with the Union Toll Plaza, Interchange of I 295 and NJ 42 and the Lincoln Tunnel receiving more than 35 weighted complaints. Tables 5 and 6 show the top ten lists of non-weighted and weighted congested corridors respectively. There are no corridors that receive more than 35 complaints in either summary.

Once the congested locations identified through the survey were compiled, the next step involved creating a GIS map illustrating where the top spots are around New Jersey. Figures 54 (non-weighted) and 55 (weighted) illustrate the locations identified, both intersections and corridors, using varying sizes and colors of points and lines to show the number of complaints. Figure 56 is an overlay of the congested locations identified through the survey and locations identified in the NJDOT Congestion Buster Task Force Final Report (2002). While there is some overlapping between the different sources, there are many locations that were identified through the survey that were not listed in the previous NJDOT work.

Statistical Analysis

The above sections present the major findings of the web-based congestion survey of New Jersey motorists. Additionally, the research team completed a full statistical analysis of the results dealing with the respondents' perception of congestion as a whole and when broken down by gender, age, education, income, occupation, home county and work county. The objective of this analysis was to test the statistical significance of the findings. Appendix C is dedicated to the complete explanation of the approach (including data used) and summary of the findings of this analysis.

PROGRAM RESULTS

The New Jersey Institute of Technology produced "Mobility and the Costs of Congestion in New Jersey" in 2000. The software application that evaluates congestion in New Jersey developed for this study has been maintained, updated and improved over the years. This year especially, there are a number of small changes in the methodology as well as updated input data that result in the findings in the following section. The complete methodology behind the application is presented in Appendix D.

Travel Delay

While the NJIT Congestion Program evaluates congestion using many different measures, travel delay has been selected for this study because it was the top decision factor selected by the survey sample when it comes to route choice, mode choice and departure time choice. This is the clearest way for the public to understand congestion. What follows is a summary of current delay measures for New Jersey.

Travel delay, expressed in person-hours of delay, is calculated for each roadway link and then aggregated for each facility type in each county. The total annual travel delay due to congestion in New Jersey is estimated at 302.3 million person-hours (Table 7). On a county level, delays range from the low of 191,000 person-hours in Cape May County to the high of 83.2 million in Bergen County. Passaic County has the second highest delay at 24.7 million person-hours, closely followed by Middlesex (24.3 million) and Monmouth (22.2 million) Counties. Almost 82% of the total delay is experienced on principal arterials, while freeways contribute only about 10% to the total delay. High delays on arterials are caused by a combination of high volumes during peak hours, roadway geometric and capacity restrictions, and traffic signals. A geographic overview of total travel delay per county for year 2003 is presented in Figure 57. In an attempt to better understand the magnitude of congestion impacts, total travel delay is also reported as the amount of delay experienced per affected person[1], per person mile traveled (PMT), and per peak period trip[2].
The average travel delay per affected person in New Jersey is estimated at 34.1 hours. Bergen County has the highest delay per affected person (74.3 hours) of all New Jersey counties, followed by Passaic County (42.7 hours), Camden and Monmouth Counties (31.2 hours each). Results for travel delay per affected person are listed in Table 8 by county and facility type. The variations in the average travel delay per affected person across the state can be seen in Figure 58.

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[1] The number of affected persons of a region is defined as all residents of that region, as well as all workers who travel to work in the region but reside outside of the region. See Appendix II for more details.

[2] Peak periods are defined as from 6 AM to 10 AM and from 3 PM to 7 PM.

Travel delay per person mile traveled (PMT) (Table 9 and Figure 59) gives a standardized estimate as to how much delay one person-trip would generate during peak hours per mile traveled. Bergen County again has the highest value of average delay at 0.61 minutes per PMT, with 1.05 minutes per PMT on principal arterials and only 0.03 minutes delay per PMT on freeways (under statewide average). Hudson and Passaic Counties also have fairly high delays with 0.40, and 0.39 minutes per PMT countywide. For the entire state, the average delay per PMT is 0.21 minutes, while delays per PMT on principal arterials and freeways are 0.41 minutes and 0.04 minutes, respectively.

The calculation of the average travel delay per peak hour vehicle-trip is yet another way to quantify mobility and congestion. Values for this measure are given in Table 10 and shown in Figure 60. Results show that lost time due to congestion in New Jersey is 3.41 minutes per vehicle-trip. Again, Bergen County has the highest resulting delay of 11.99 minutes per trip, followed by Passaic and Monmouth Counties.

Generally, congestion is more prevalent in northern and central New Jersey than in southern counties. Bergen, Essex, Hudson, Middlesex, Morris, Passaic, Somerset, and Union Counties account for almost 70% of total statewide travel delay. It is important to emphasize that these estimates are based on the average weekday peak period traffic conditions (which affects mostly daily commuters) adjusted for traffic on 15 summer Fridays between Memorial Day and Labor Day to account for trips to New Jersey shore.

CONCLUSIONS

This report presented a very detailed overview of existing congestion measures as well as a discussion of the design, distribution and findings of the web-based congestion survey of New Jersey motorists done by the research team. Overall, several things became clear as a result of the extensive literature review of the existing congestion measures:

1. It is critical to identify the ultimate users of the congestion measures. As public involvement in the transportation process increases, it is very important to develop congestion measures that can be easily understood by the traveling public. Politicians, administrators as well as engineers and planners must all be able to understand and discuss congestion measures.
2. Since some of the congestion measures are very data intensive, it is important to understand the limitations of the various data sources used.
3. Since the congestion baseline may vary by location, trip type, transportation mode and individuals involved, the initial step in any congestion analysis should be to identify where the baseline is.

In addition to the overview of the existing congestion measures, this report presented a unique approach to looking at and evaluating congestion for the State of New Jersey. Incorporating the public's views into the process of establishing what is congested, evaluating congestion impacts and identifying congested location throughout New Jersey are the main components of this part of the study. Surveying the public is one of the best ways to understand congestion and its impacts because there is no better source than the people who use the State's roads on a daily basis. The successful survey distribution resulted in an extremely rich database of 1393 responses that can be used as a reference after the completion of this study. Some of the major findings of the survey analysis are:

1. New Jersey drivers are more tolerant of congested roadway conditions than the national average based on 2000 HCM traffic engineering principles used throughout the country.
2. The tolerance towards road congestion decreases as the drivers get older.
3. Critical congested locations that can be used for potential NJDOT "Quick Fix" initiatives were identified throughout the State based on the respondents experiences.
4. Although the respondents showed high tolerance for congestion, they also experience a great deal of driving stress with 58% of the respondents experiencing stress often, very often or always and only 4% never experiencing stress on their way to work

This study began an important process of looking at the potential impacts congestion and driving may have on individuals. Driving related stress and road rage are critical issues that are very common in New Jersey. This is clearly an area that deserves further study to see the extent of the problem as well as potential ways of alleviating it. Evaluating congestion in terms of delays and costs should only be a part of the process of identifying the problem. Identifying the impacts that are more difficult to quantify but are no less important to the driving public should also be factored in. The high level of tolerance should not be taken as a sign that everything is copasetic because it is very realistic that the tolerance has been built up through the years of driving on poor quality and congested roads that in turn resulted in high levels of stress leading to incidents of road rage.

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TABLES

Table 1. Sample Composition - Home County

Respondents by Home County	
County (NJ) or State	**Percentage of Total Respondents**
Mercer	11.4%
Middlesex	9.0%
Burlington	8.0%
Monmouth	7.9%
Morris	7.9%
PA	6.4%
Bergen	5.3%
Essex	5.0%
Camden	4.5%
Somerset	4.1%
Hunterdon	4.0%
Ocean	3.5%
Sussex	3.2%
Gloucester	3.1%
Union	3.1%
Atlantic	2.9%
Passaic	2.9%
Hudson	2.5%
Warren	1.8%
NY	1.3%
Cumberland	0.9%
Salem	0.4%
Undeclared	0.4%
Cape May	0.4%
Total	100.0%

Table 2. Sample Composition - Work County

Respondents by Work County	
County (NJ) or State	**Percentage of Total Respondents**
Mercer	23.8%
Monmouth	13.0%
Bergen	8.9%
Middlesex	8.2%
Cape May	6.9%
Essex	5.3%
Hudson	5.3%
NY	4.7%
Camden	4.2%
PA	3.6%
Atlantic	2.9%
Salem	2.7%
Undeclared	2.2%
Ocean	1.9%
Sussex	1.9%
Morris	1.6%
Cumberland	1.0%
Somerset	0.8%
Passaic	0.4%
Union	0.3%
Burlington	0.2%
Gloucester	0.1%
Hunterdon	0.1%
Warren	0.1%
Total	100.0%

Table 3. Top Ten Complaint Locations [All Locations, Non-Weighted]

Rank	Location	County	Location Type	Complaints
1	I 287 / NJ 24	Morris	Intersection/Point	43
2	US 1 / I 295	Mercer	Intersection/Point	39
3	NJ 29 / Tunnel	Mercer	Intersection/Point	34
4	I 295 / NJ 42	Camden	Intersection/Point	33
5	I 287 / I 80	Morris	Intersection/Point	32
6	GSP / I 280	Essex	Intersection/Point	27
6	US 1 / Nassau Park Blvd	Mercer	Intersection/Point	27
8	I 295 / Scudders Fall Bridge	Mercer	Intersection/Point	25
8	NJ 70 / NJ 73	Burlington	Intersection/Point	25
10	GSP / US 9	Middlesex	Intersection/Point	24
10	NJ 70 : Cherry Hill Twp	Camden	Corridor	24

Table 4. Top Ten Complaint Locations [All Locations, Sampling Weighted]

Top Ten Complaint Locations [All Locations, Sampling Weighted]						
Rank	Location	County	Location Type	Raw Complaints	Weight Factor	Weighted Complaints
1	GSP / Union Toll	Union	Intersection/Point	19	2.59	49.1
2	I 295 / NJ 42	Camden	Intersection/Point	33	1.38	45.6
3	NJ 495 / Lincoln Tunnel	Hudson	Intersection/Point	15	2.37	35.5
4	GSP / I 280	Essex	Intersection/Point	27	1.28	34.4
5	NJ 24 / I 78	Union	Intersection/Point	13	2.59	33.6
6	NJ 70 : Cherry Hill Twp	Camden	Corridor	24	1.38	33.1
7	I 287 / NJ 24	Morris	Intersection/Point	43	0.76	32.8
8	US 46 / NJ 3	Passaic	Intersection/Point	14	2.04	28.5
9	GSP / US 9	Middlesex	Intersection/Point	24	1.13	27.1
10	I 78 / Holland Tunnel	Hudson	Intersection/Point	11	2.37	26.0

Table 5. Top Ten Complaint Locations [Corridors, Non-Weighted]

Top Ten Complaint Locations [Corridors, Non-Weighted]				
Rank	**Location**	**County**	**Location Type**	**Complaints**
1	NJ 70 : Cherry Hill	Camden	Corridor	24
2	NJ 18 : East Brunswick	Middlesex	Corridor	15
2	I 80 : Rockaway Twp Border - Exit	Morris	Corridor	15
2	US 1 : West Windsor	Mercer	Corridor	15
5	I 80 : Exit 39 - Parsippany Twp Bo	Morris	Corridor	13
5	I 80 : Denville Twp Border - I 287	Morris	Corridor	13
7	I 80 : Rockaway Twp	Morris	Corridor	12
7	I 80 : Exit 34 - Rockaway Twp Bor	Morris	Corridor	12
9	I 287 : Exit 10-12	Somerset	Corridor	11
9	I 287 : Exit 9 -10	Middlesex	Corridor	11
9	US 1 : Princeton	Mercer	Corridor	11

Table 6. Top Ten Complaint Locations [Corridors, Sampling Weighted]

Top Ten Complaint Locations [Corridors, Sampling Weighted]						
Rank	**Location**	**County**	**Location Type**	**Raw Complaints**	**Weight Factor**	**Weighted Complaints**
1	NJ 70 : Cherry Hill	Camden	Corridor	24	1.38	33.1
2	US 22 : Union Twp	Union	Corridor	9	2.59	23.3
3	I 80 : Exit 57-60	Passaic	Corridor	9	2.04	18.3
4	NJ 17 : Paramus	Bergen	Corridor	9	1.97	17.7
5	NJ 18 : East Brunswick	Middlesex	Corridor	15	1.13	17.0
6	I 80 : Paterson	Passaic	Corridor	7	2.04	14.3
7	NJTPKE : Lincoln Tunnel	Hudson	Corridor	6	2.37	14.2
8	NJTPKE : Exit 13-13A	Union	Corridor	5	2.59	12.9
9	I 287 : Exit 10-12	Somerset	Corridor	11	1.16	12.7
10	I 287 : Exit 9 -10	Middlesex	Corridor	11	1.13	12.4

Table 7. Annual Hours of Delay by Facility Type – 2003 (Thousands)

COUNTY	Freeways	Principal Arterials	Other Arterials	All Roadways
Atlantic	878	5,149	291	6,318
Bergen	2,072	80,042	1,124	83,239
Burlington	1,100	5,443	35	6,578
Camden	1,467	16,548	1,017	19,032
Cape May	0	82	109	191
Cumberland	0	72	486	559
Essex	4,660	14,234	107	19,000
Gloucester	203	5,822	2,939	8,964
Hudson	3,221	15,982	1,653	20,855
Hunterdon	204	571	401	1,176
Mercer	242	5,893	282	6,418
Middlesex	5,181	16,616	2,491	24,289
Monmouth	2,699	16,597	2,887	22,183
Morris	2,226	10,161	1,848	14,235
Ocean	1,430	9,063	7,821	18,314
Passaic	1,360	23,309	32	24,701
Salem	2	171	145	319
Somerset	463	11,102	855	12,420
Sussex	0	882	269	1,151
Union	2,511	8,917	7	11,435
Warren	36	758	135	929
TOTAL	**29,957**	**247,415**	**24,933**	**302,305**

Table 8. Average Annual Hours of Delay per Affected Person by Facility Type – 2003

COUNTY	Freeways	Principal Arterials	Other Arterials	All Roadways
Atlantic	2.9	17.3	1.0	21.2
Bergen	1.8	71.4	1.0	74.3
Burlington	2.1	10.6	0.1	12.8
Camden	2.4	27.1	1.7	31.2
Cape May	0.0	0.7	1.0	1.7
Cumberland	0.0	0.5	3.1	3.5
Essex	4.8	14.8	0.1	19.7
Gloucester	0.7	19.5	9.8	30.0
Hudson	4.6	23.0	2.4	30.0
Hunterdon	1.3	3.6	2.6	7.5
Mercer	0.6	13.5	0.6	14.7
Middlesex	5.5	17.6	2.6	25.8
Monmouth	3.8	23.3	4.1	31.2
Morris	3.5	16.0	2.9	22.4
Ocean	2.6	16.3	14.1	33.0
Passaic	2.4	40.3	0.1	42.7
Salem	0.0	2.3	2.0	4.3
Somerset	1.1	25.8	2.0	28.8
Sussex	0.0	5.4	1.7	7.1
Union	3.9	13.9	0.0	17.8
Warren	0.3	6.2	1.1	7.6
Statewide Average	**3.4**	**27.9**	**2.8**	**34.1**

Table 9. Average Delay per Person Mile Traveled by Facility Type – 2003 (Minutes/PMT)

COUNTY	Freeways	Principal Arterials	Other Arterials	All Roadways
Atlantic	0.13	0.94	0.12	0.44
Bergen	0.14	4.22	2.49	2.43
Burlington	0.10	0.54	0.03	0.29
Camden	0.18	1.40	0.76	0.88
Cape May	0.00	0.09	0.06	0.04
Cumberland	0.00	0.09	0.29	0.16
Essex	0.40	1.99	0.45	0.99
Gloucester	0.03	1.21	0.95	0.59
Hudson	0.52	2.59	2.08	1.59
Hunterdon	0.06	0.21	0.23	0.15
Mercer	0.04	0.73	0.44	0.42
Middlesex	0.21	1.03	0.86	0.56
Monmouth	0.20	1.18	0.63	0.69
Morris	0.17	1.12	0.86	0.59
Ocean	0.17	1.45	1.93	0.99
Passaic	0.25	2.25	0.33	1.56
Salem	0.00	0.14	0.16	0.07
Somerset	0.06	1.72	0.69	0.80
Sussex	0.00	0.31	0.20	0.27
Union	0.18	1.32	0.07	0.56
Warren	0.01	0.33	0.22	0.14
Statewide Average	**0.17**	**1.62**	**0.75**	**0.85**

Table 10. Average Delay per Peak Period Vehicle Trip Due To Congestion – 2003

COUNTY	Average Delay per Peak Period Trip (minutes)
Atlantic	2.81
Bergen	11.99
Burlington	1.58
Camden	3.69
Cape May	0.22
Cumberland	0.43
Essex	3.25
Gloucester	3.05
Hudson	6.31
Hunterdon	1.03
Mercer	1.87
Middlesex	4.31
Monmouth	5.60
Morris	3.73
Ocean	6.20
Passaic	5.83
Salem	0.37
Somerset	4.54
Sussex	1.31
Union	2.54
Warren	0.88
Statewide Average	**3.41**

FIGURES

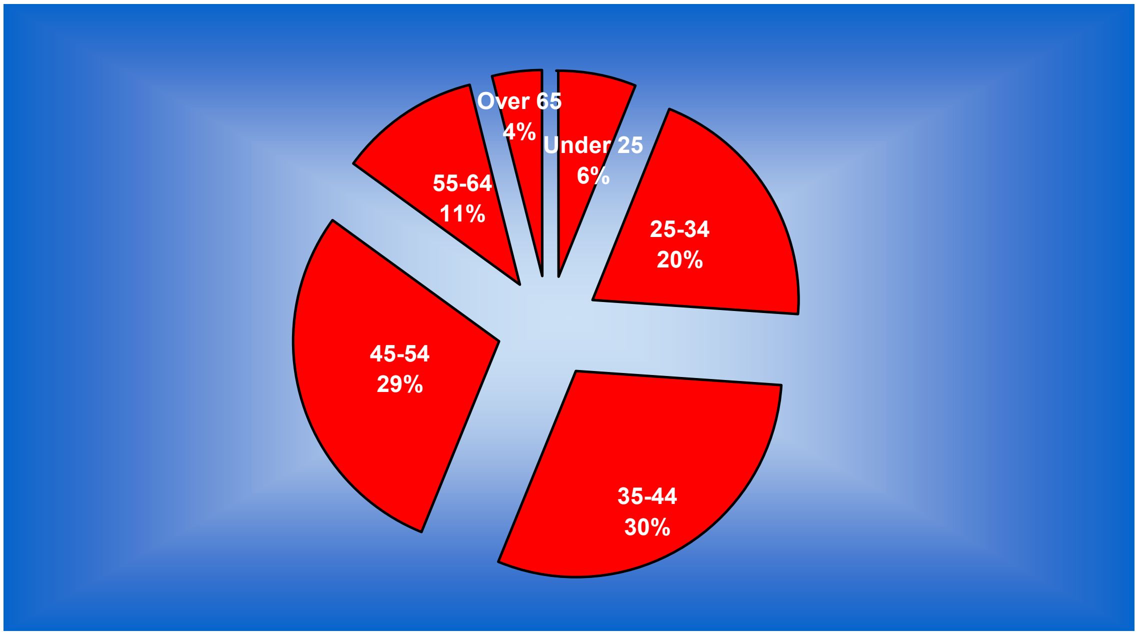


Figure 1. Sample Composition - Age

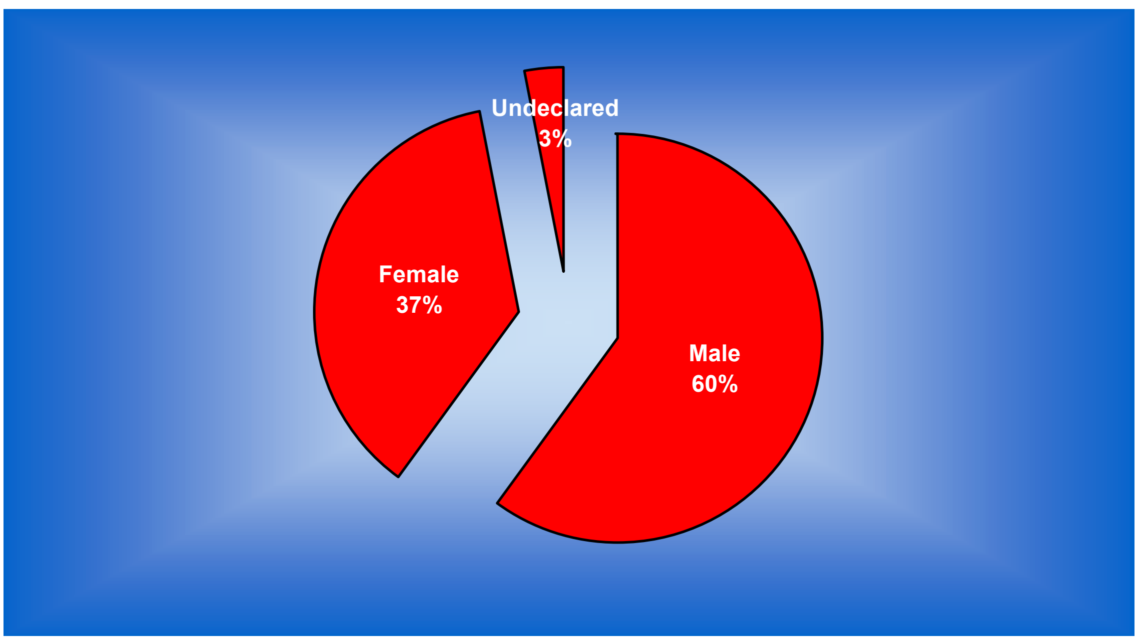


Figure 2. Sample Composition – Gender

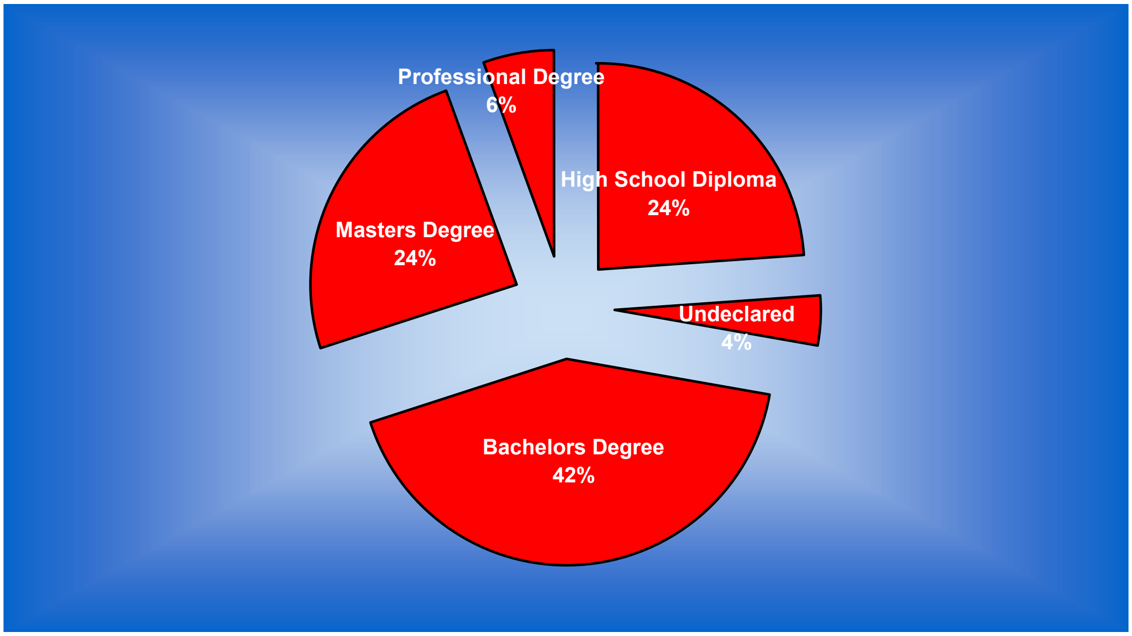


Figure 3. Sample Composition - Education

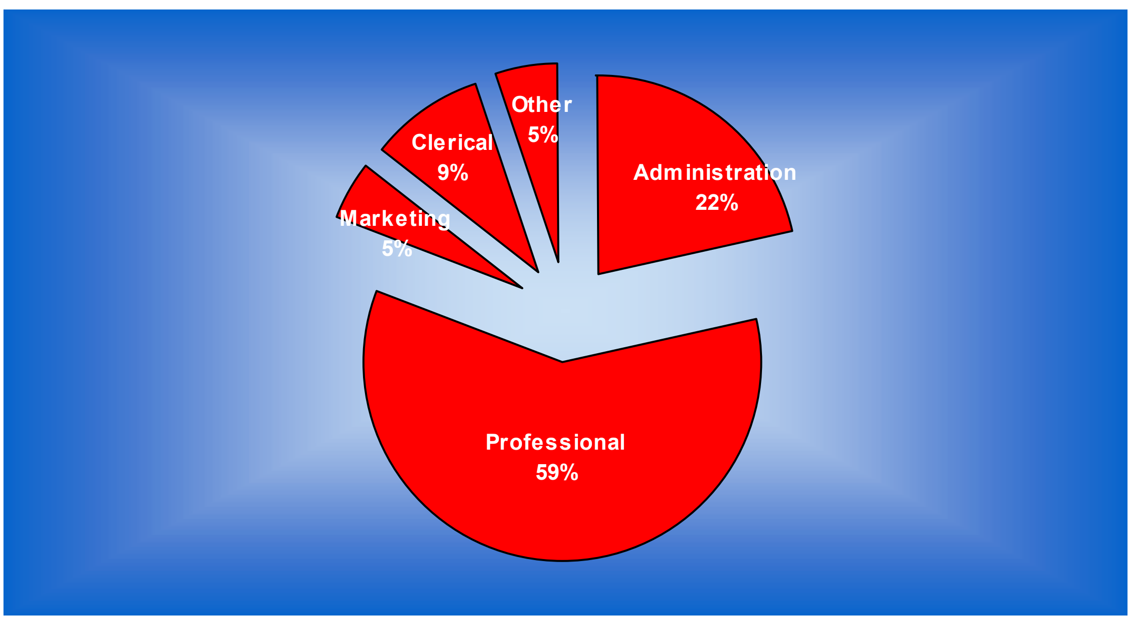


Figure 4. Sample Composition – Occupation

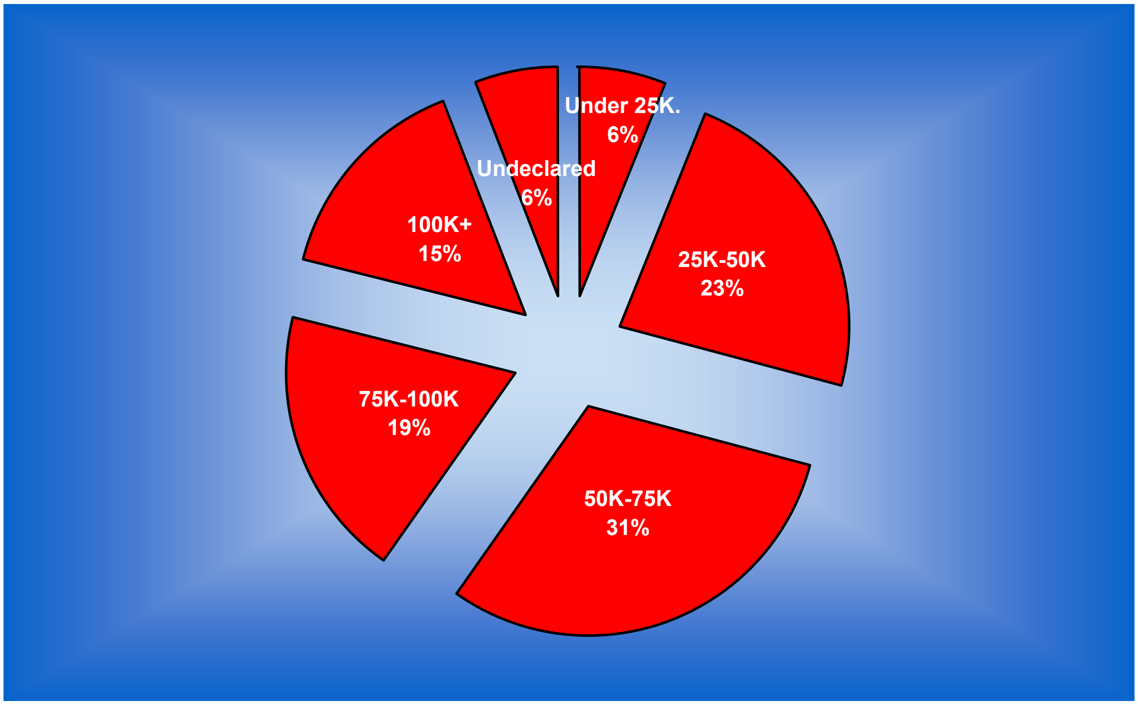


Figure 5. Sample Composition – Income

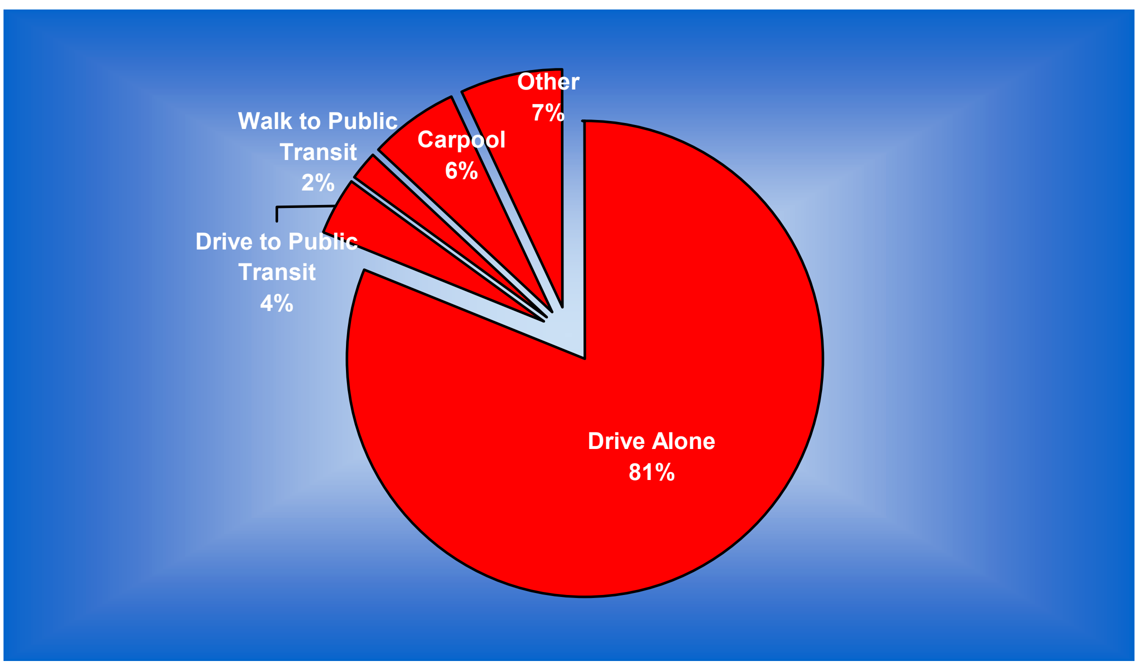


Figure 6. Sample Composition – Commute Mode

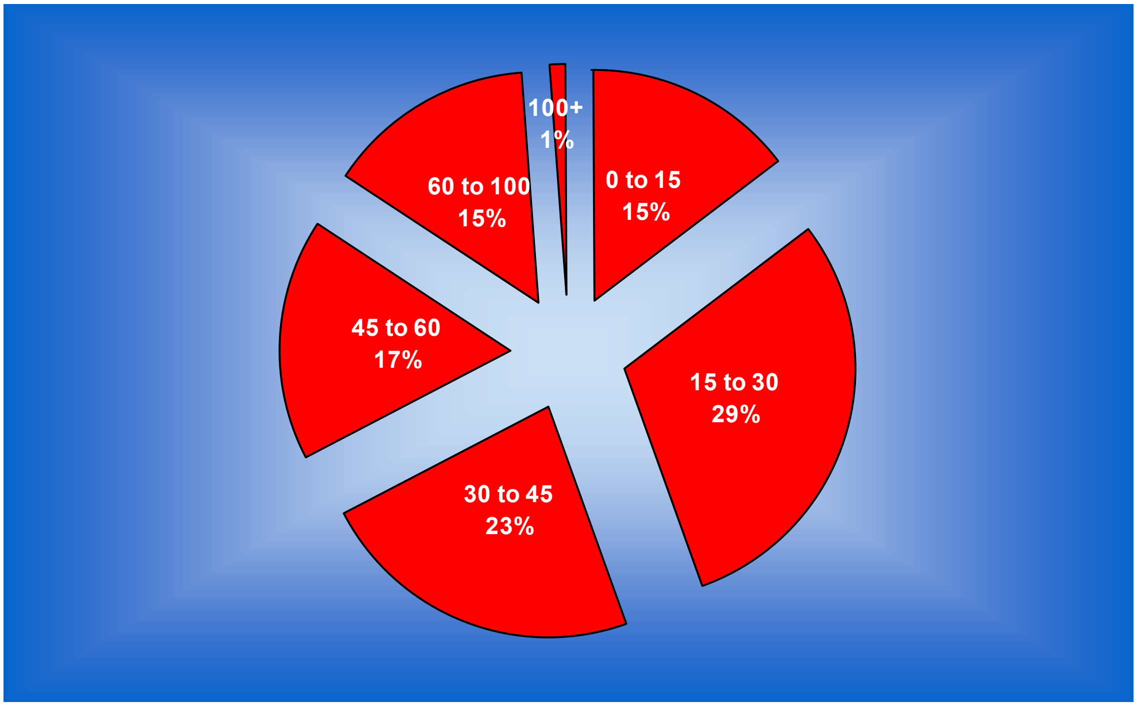


Figure 7. Sample Composition – Travel Time (minutes) Distribution

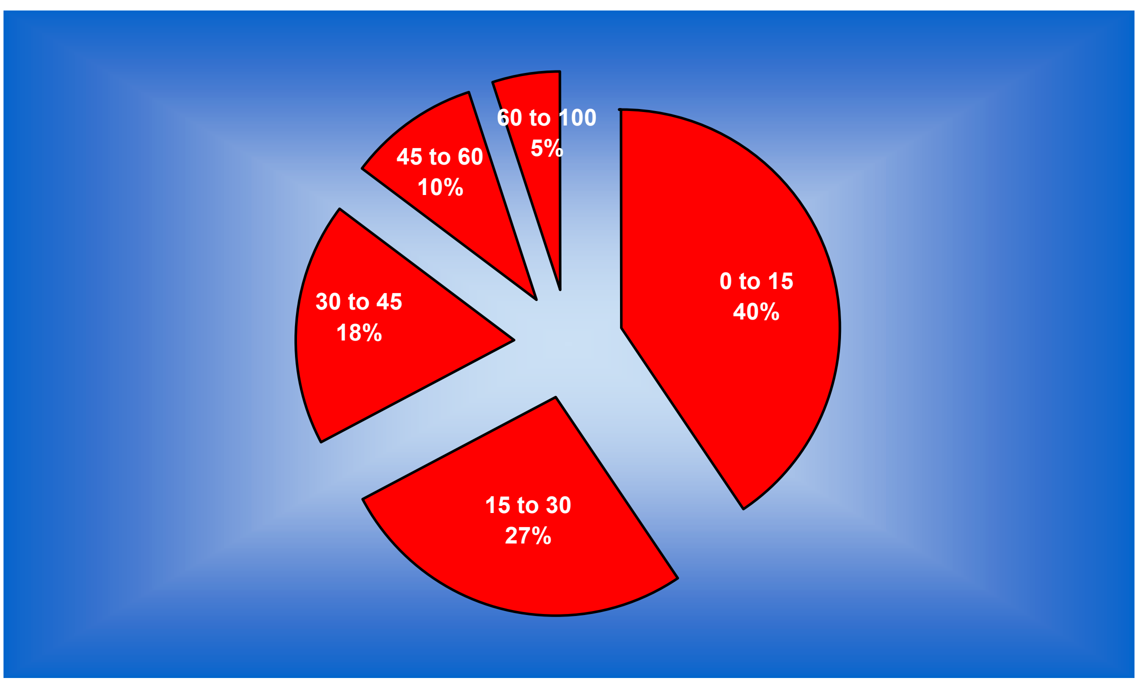


Figure 8. Sample Composition – Travel Distance (miles) Distribution

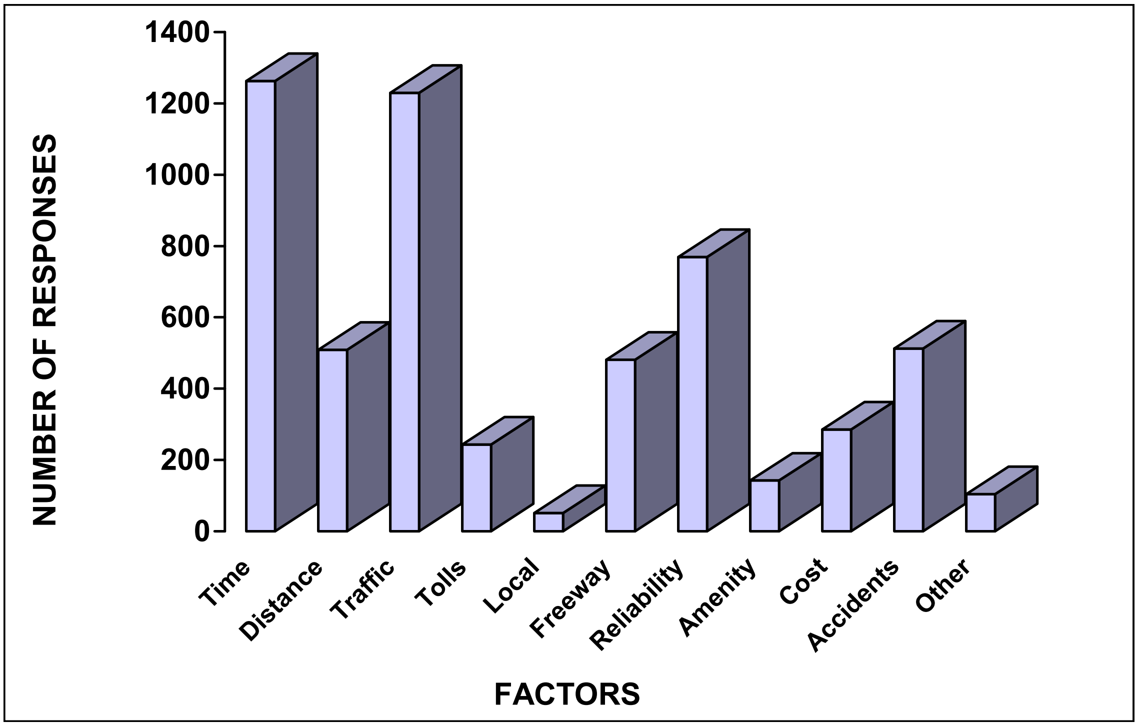


Figure 9. Sample Composition - Decisions Factors

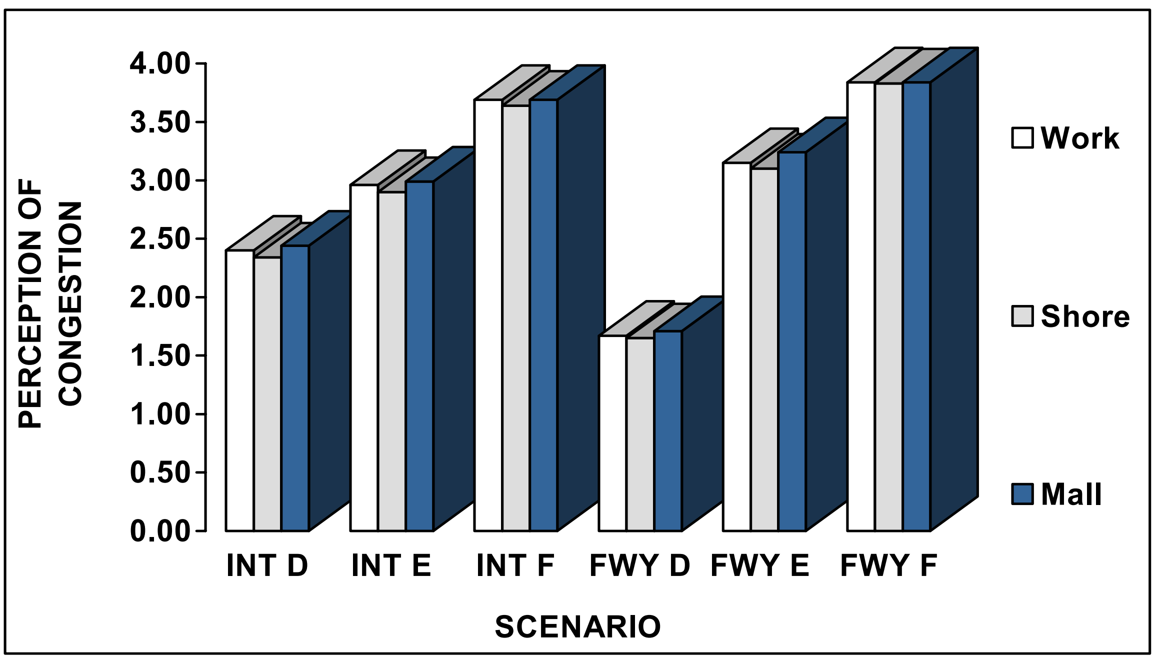


Figure 10. Sample Perception – Entire State

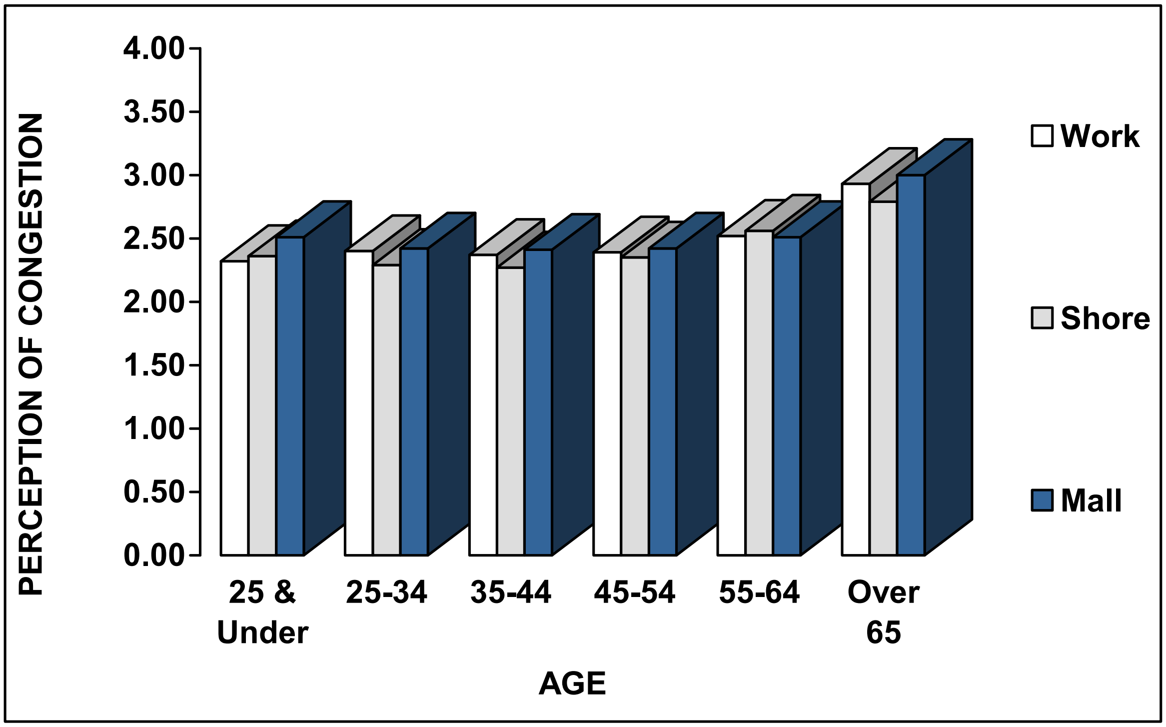


Figure 11. Sample Perception - Age Intersection D

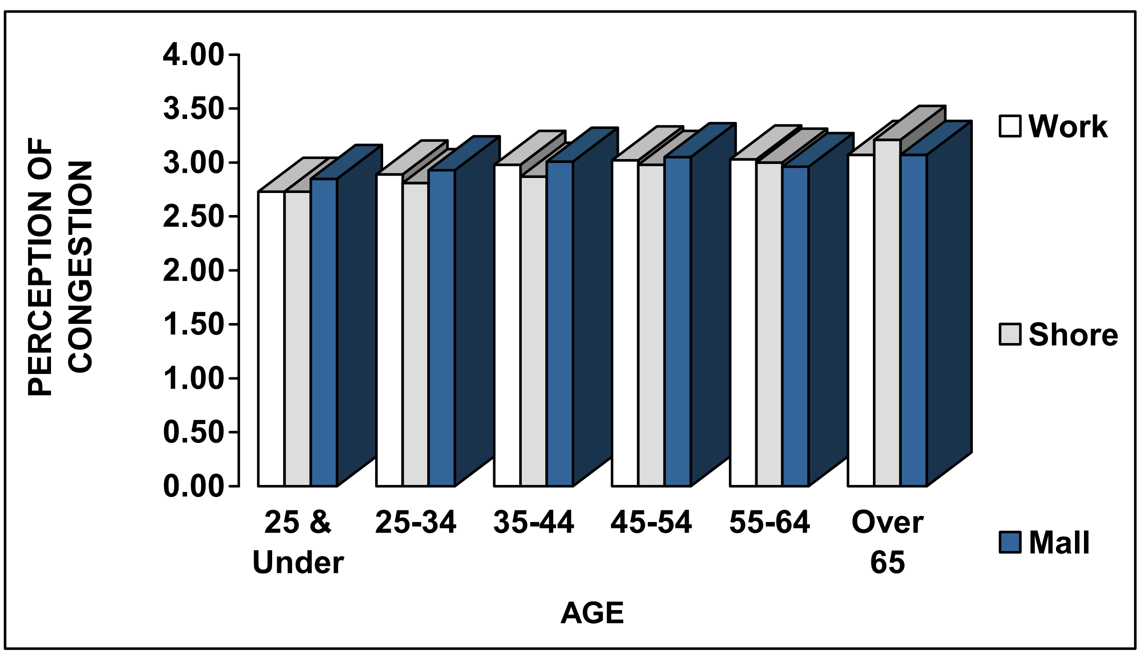


Figure 12. Sample Perception - Age Intersection E

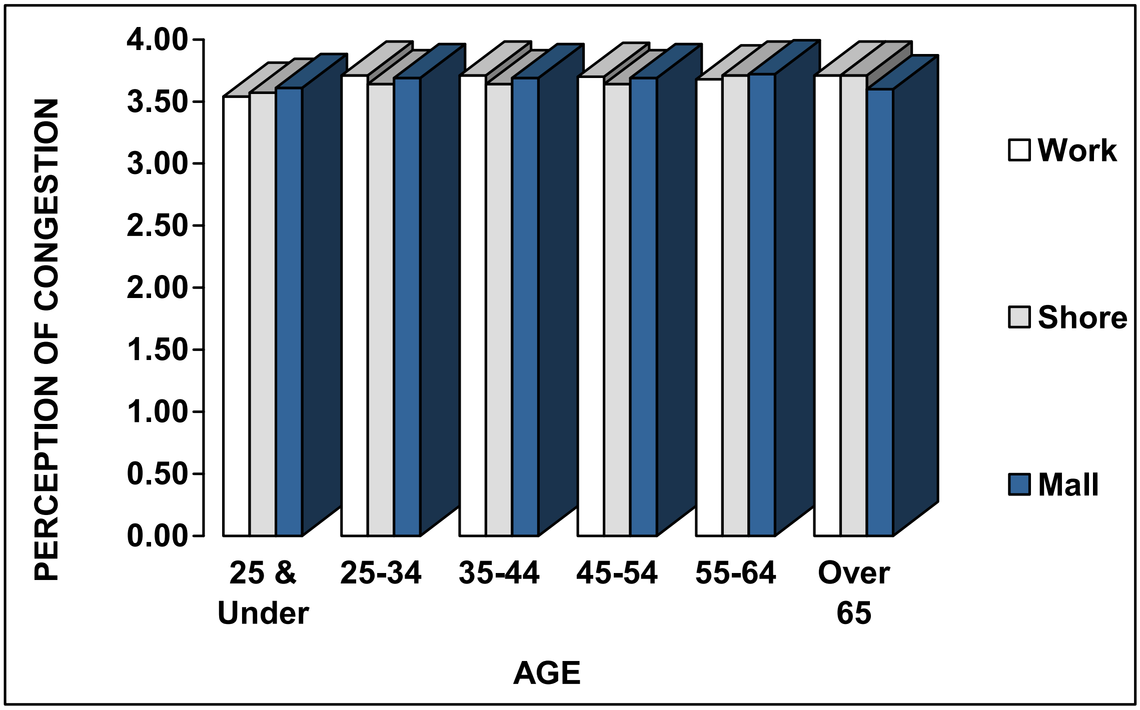


Figure 13. Sample Perception - Age Intersection F

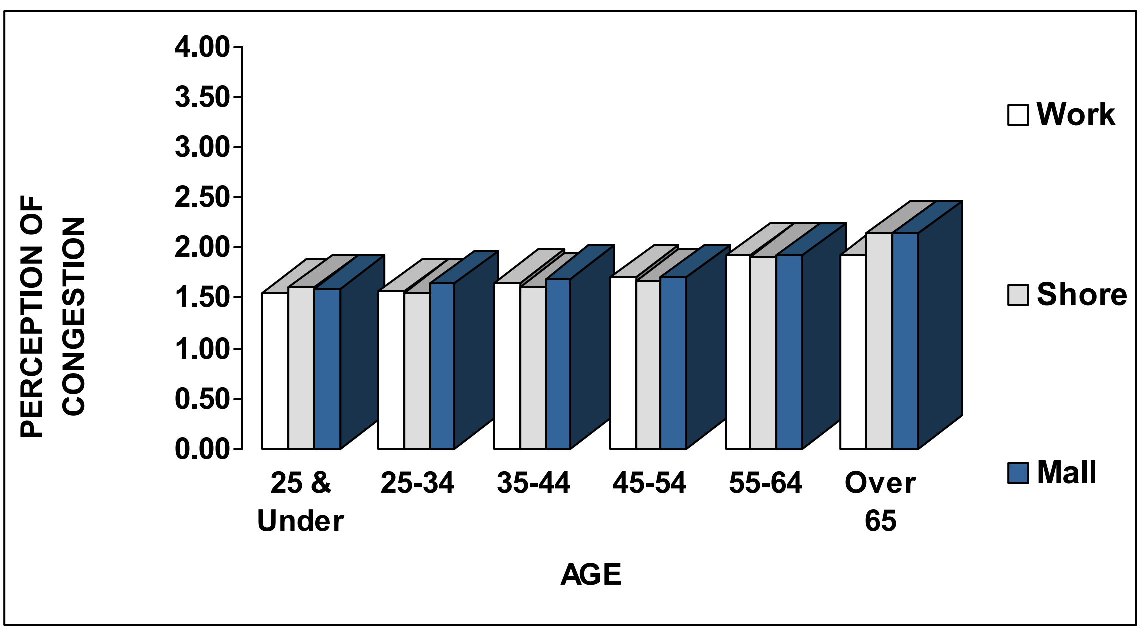


Figure 14. Sample Perception - Age Freeway D

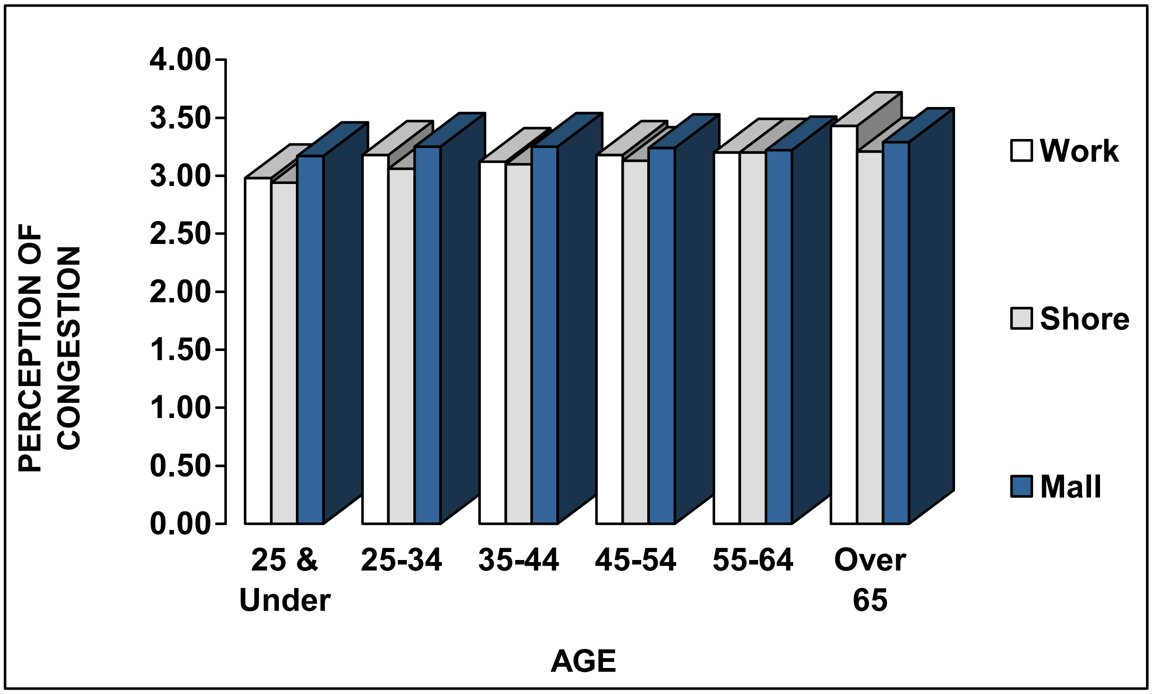


Figure 15. Sample Perception - Age Freeway E

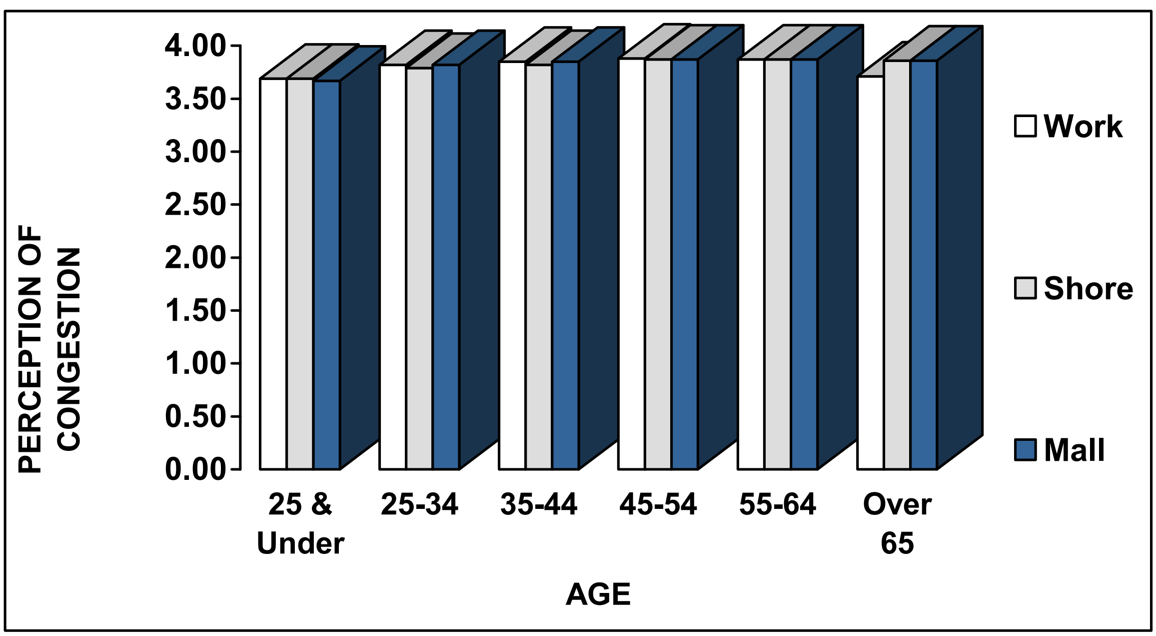


Figure 16. Sample Perception - Age Freeway F

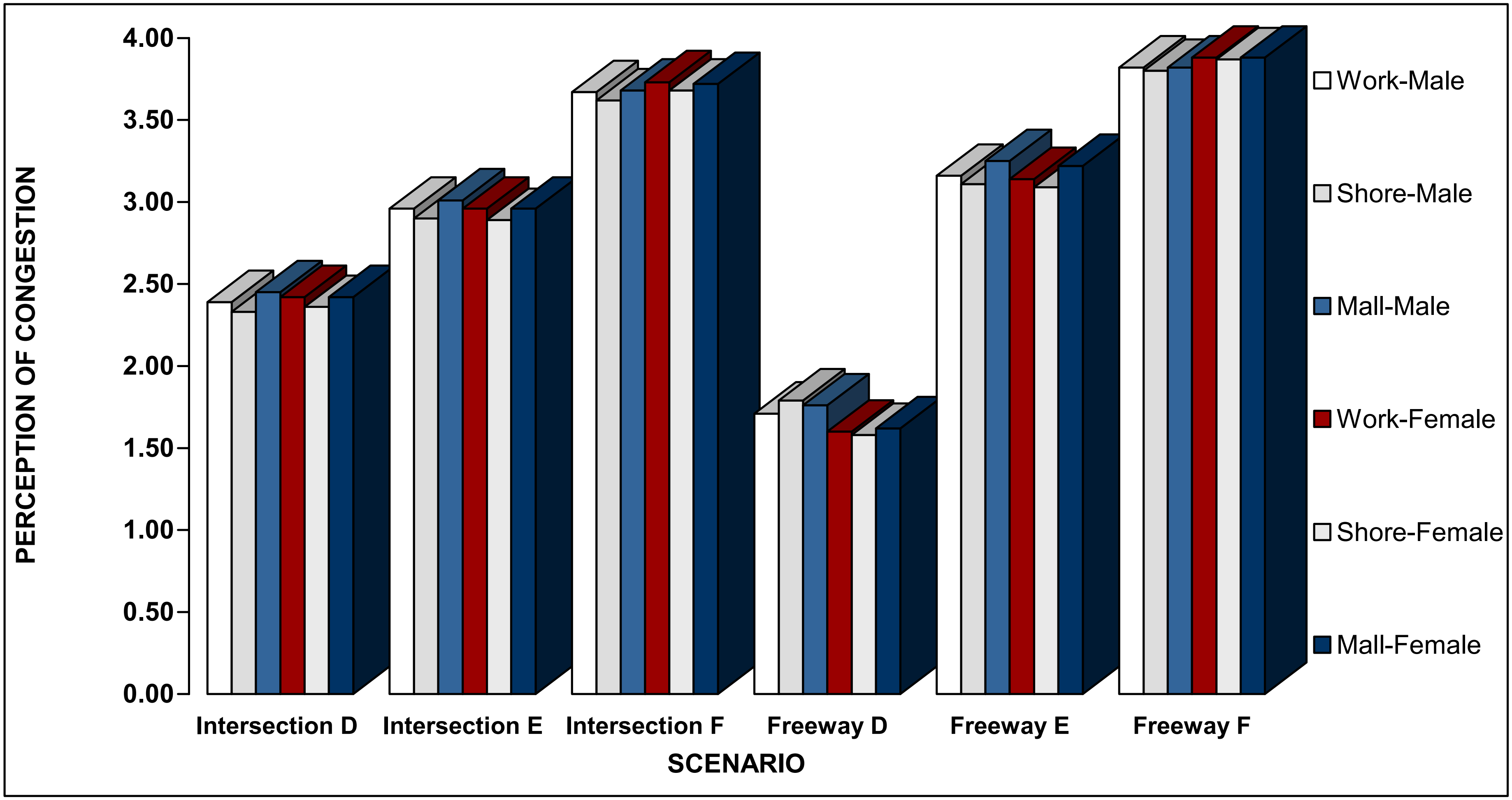


Figure 17. Sample Perception - Gender

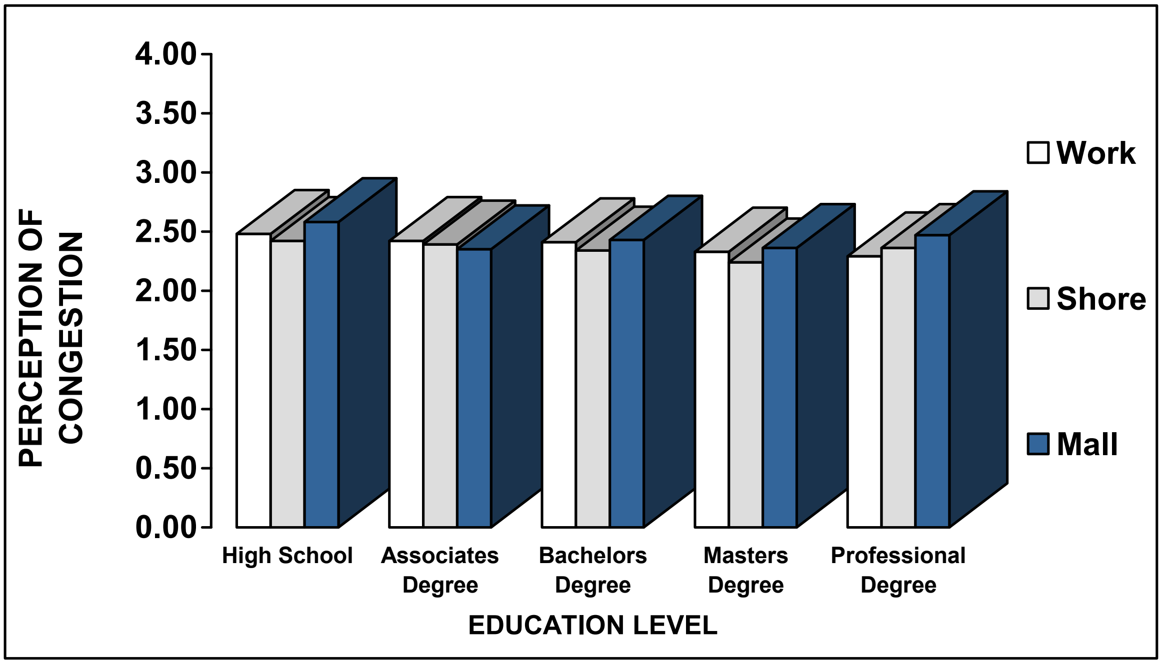


Figure 18. Sample Perception - Education Intersection D

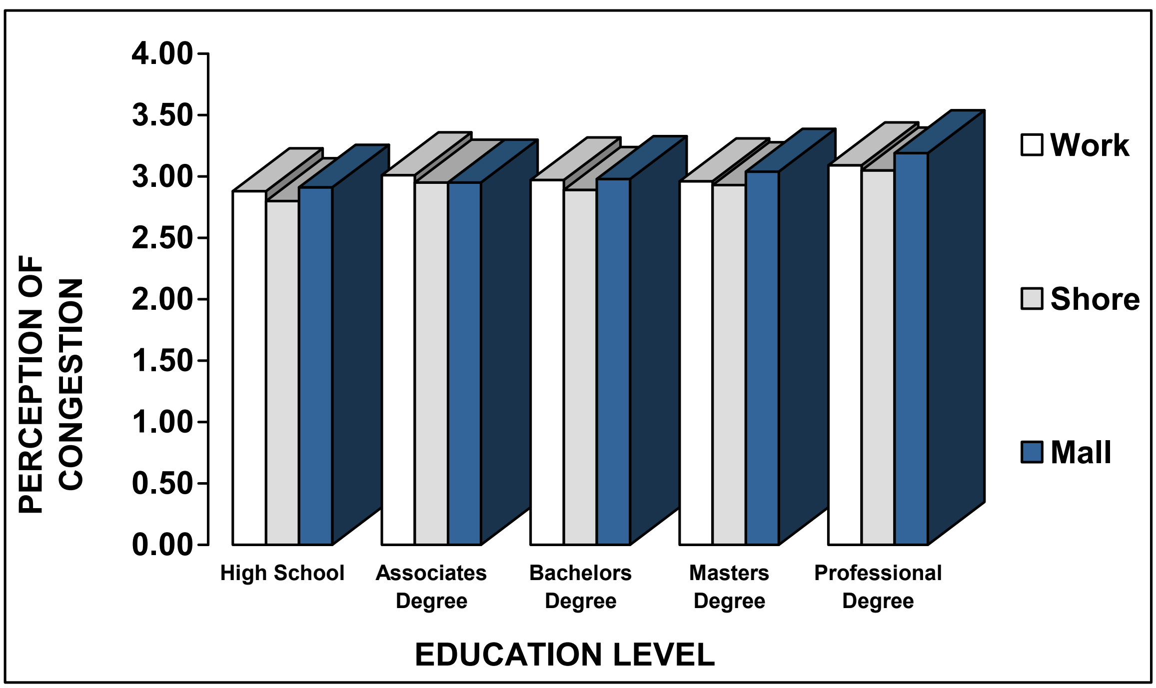


Figure 19. Sample Perception - Education Intersection E

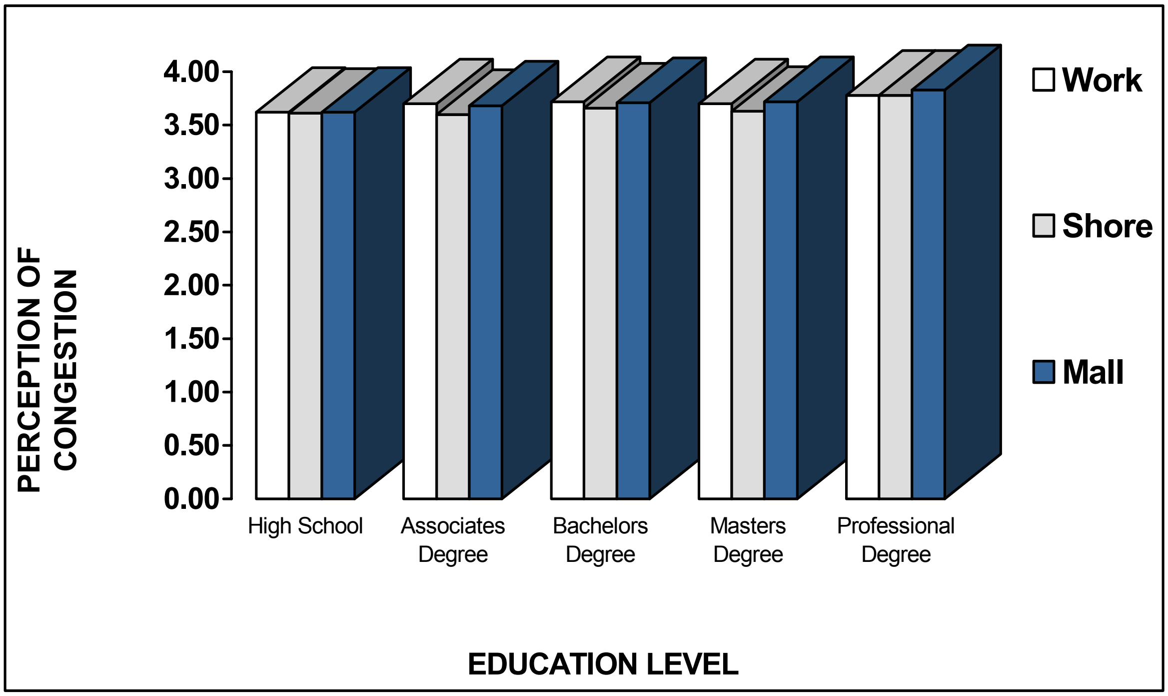


Figure 20. Sample Perception - Education Intersection F

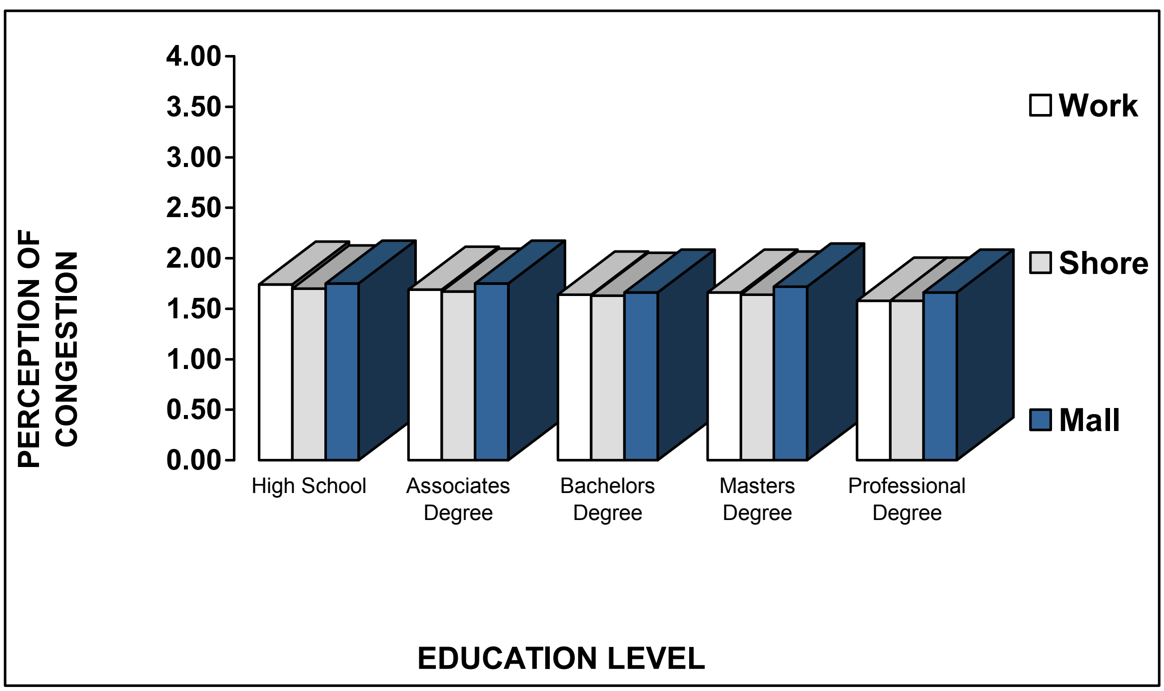


Figure 21. Sample Perception - Education Freeway D

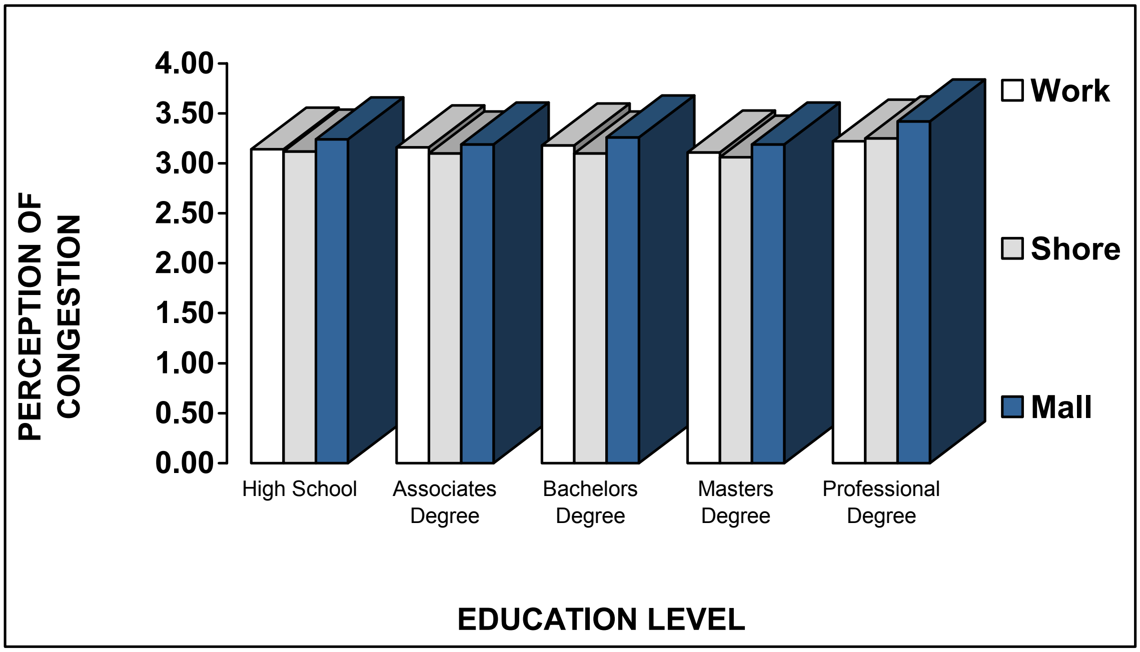


Figure 22. Sample Perception - Education Freeway E

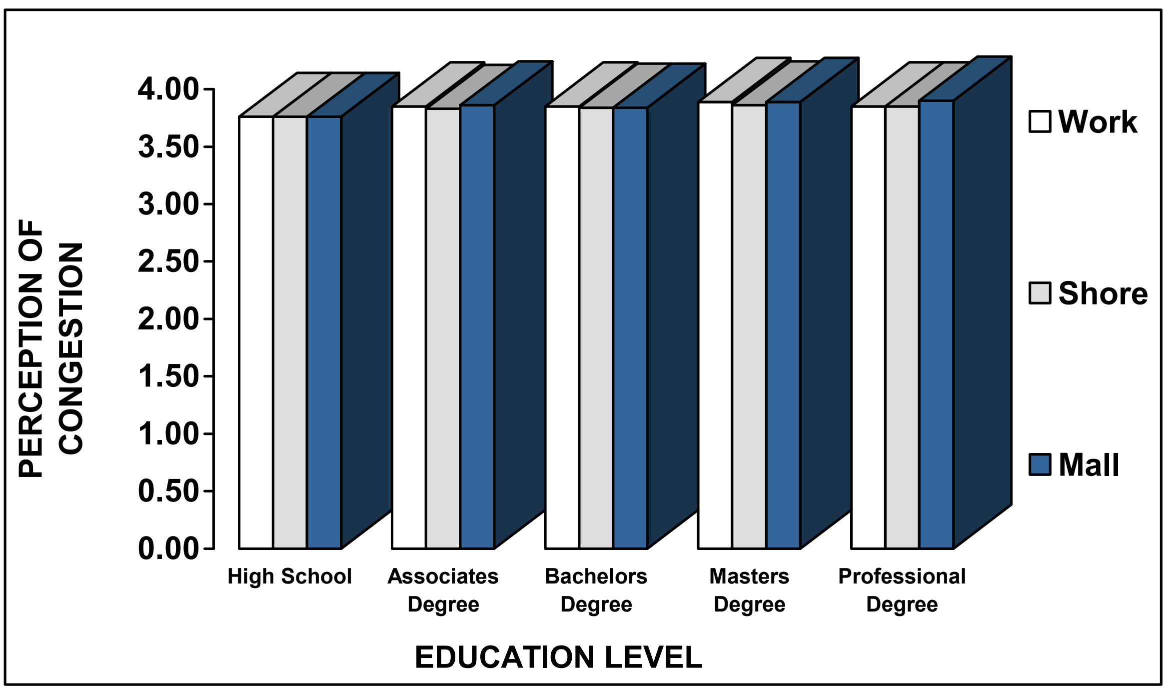


Figure 23. Sample Perception - Education Freeway F

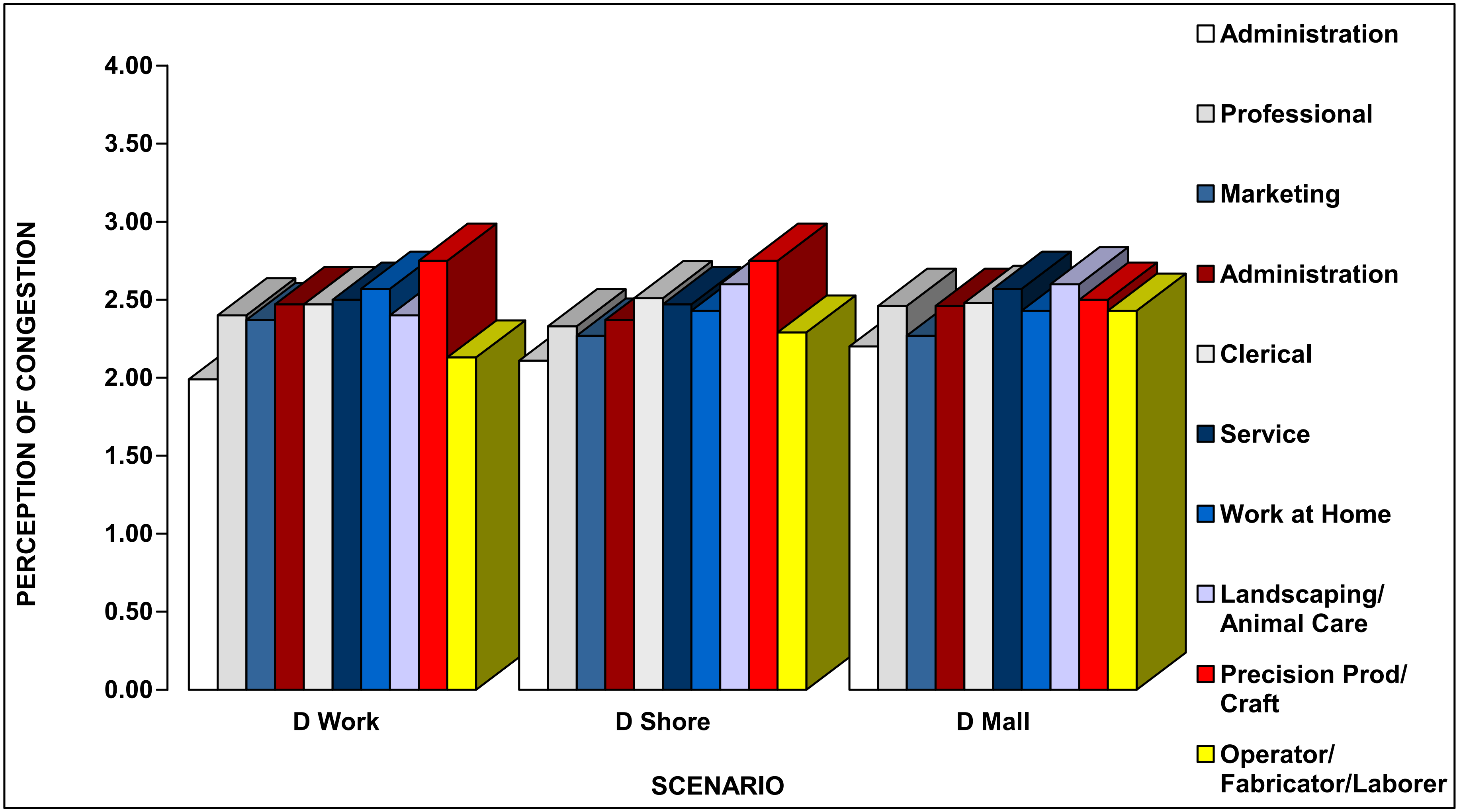


Figure 24. Sample Perception – Occupation: Intersection D Scenario

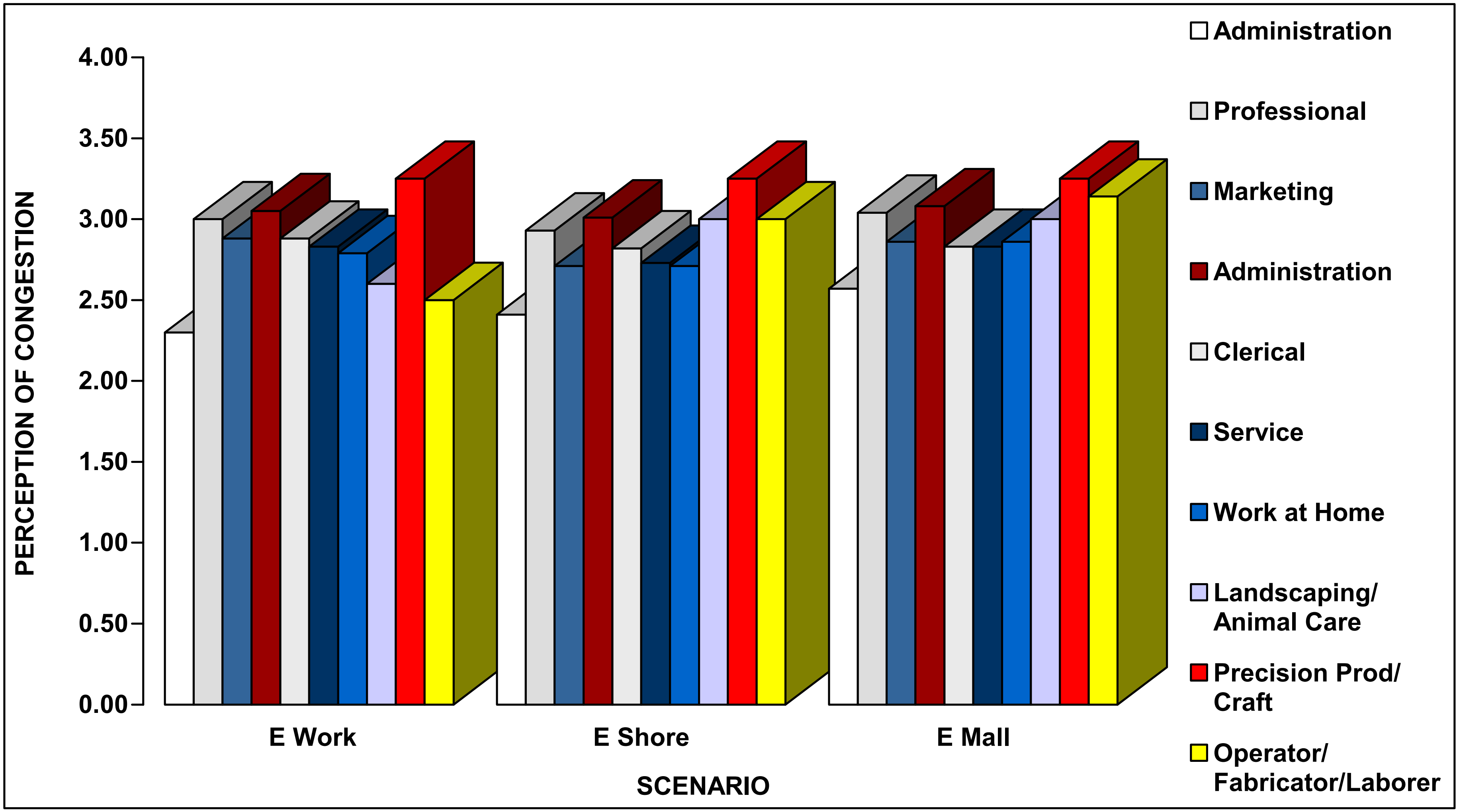


Figure 25. Sample Perception – Occupation: Intersection E Scenario

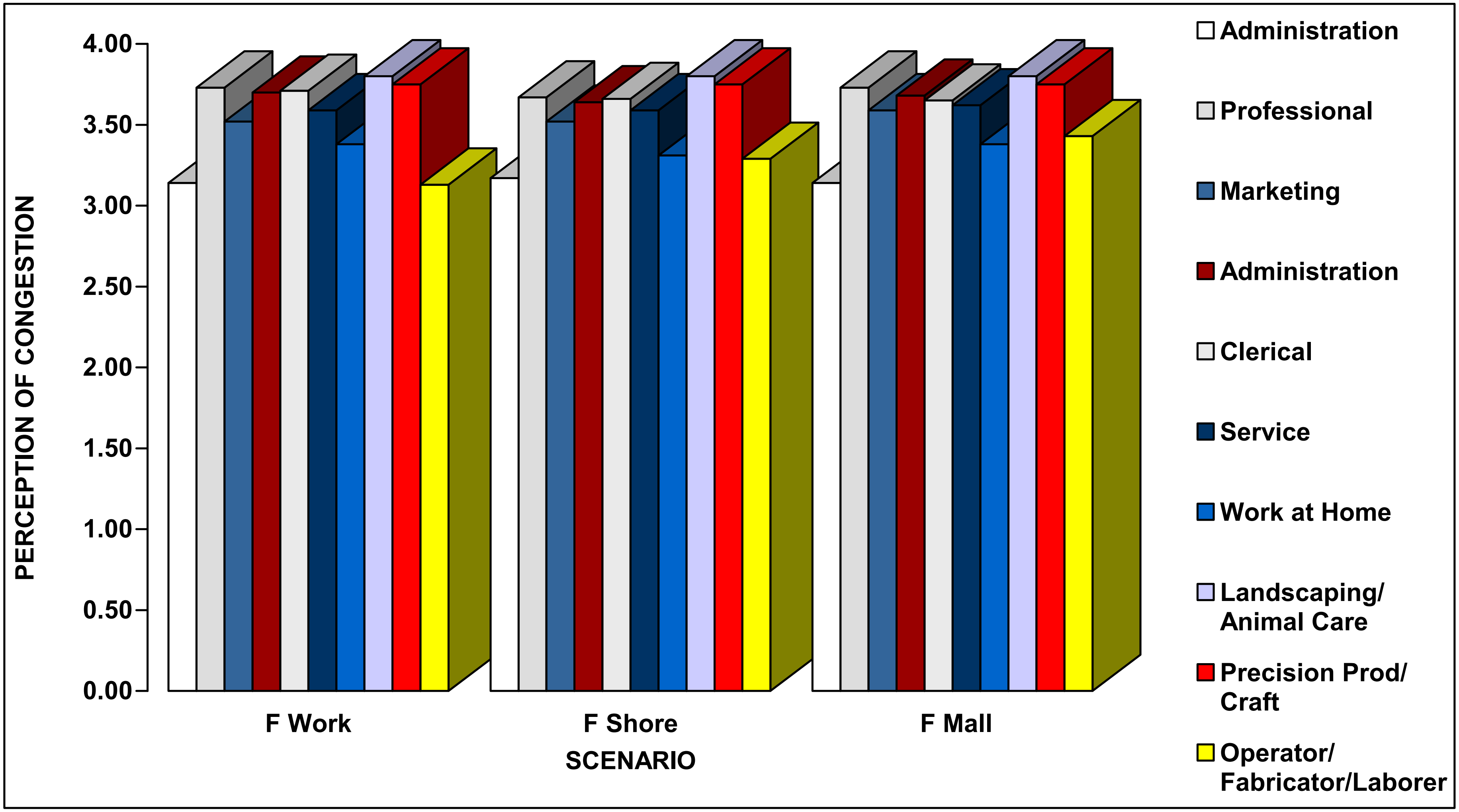


Figure 26. Sample Perception – Occupation: Intersection F Scenario

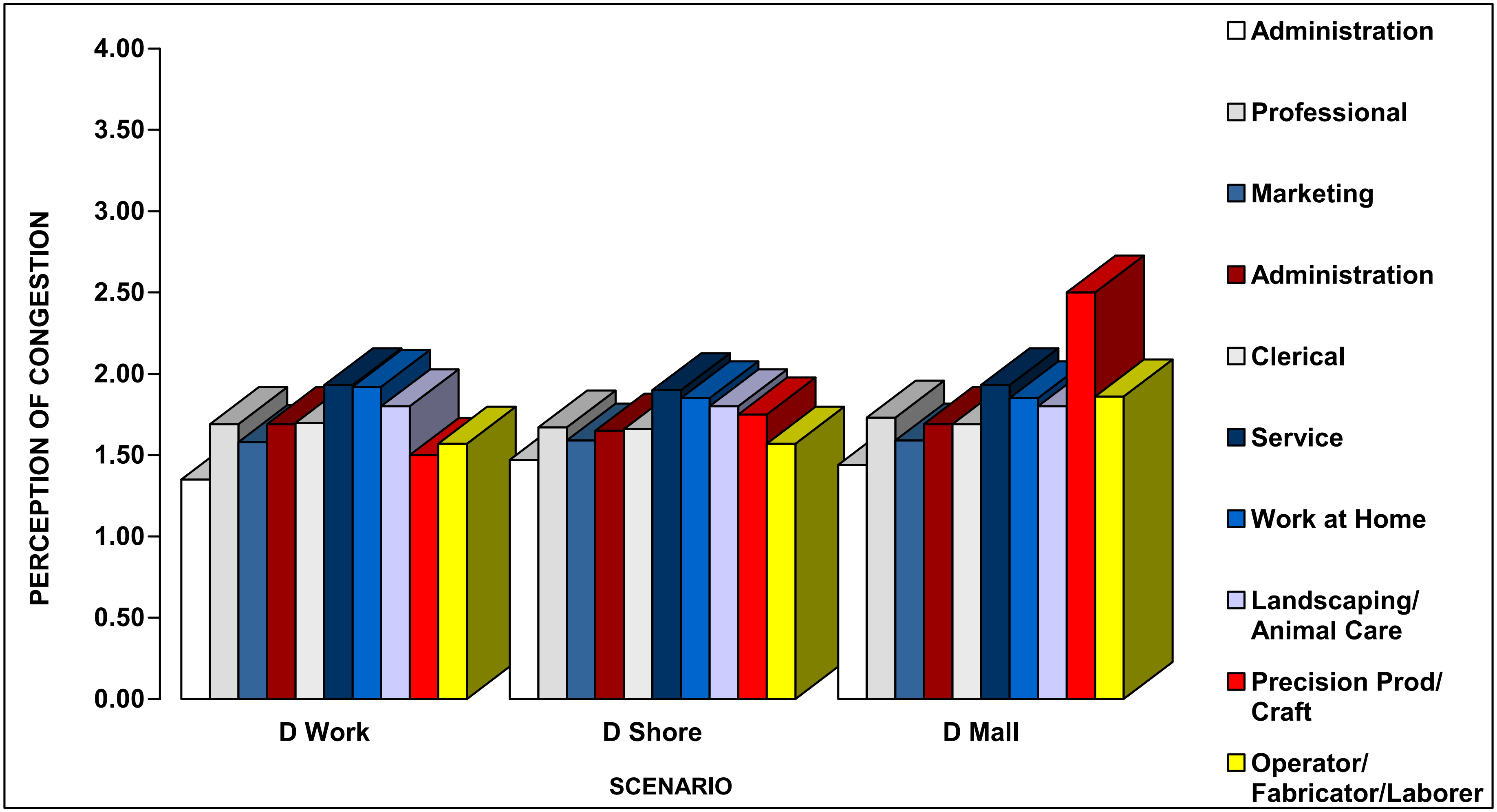


Figure 27. Sample Perception – Occupation: Freeway D Scenario

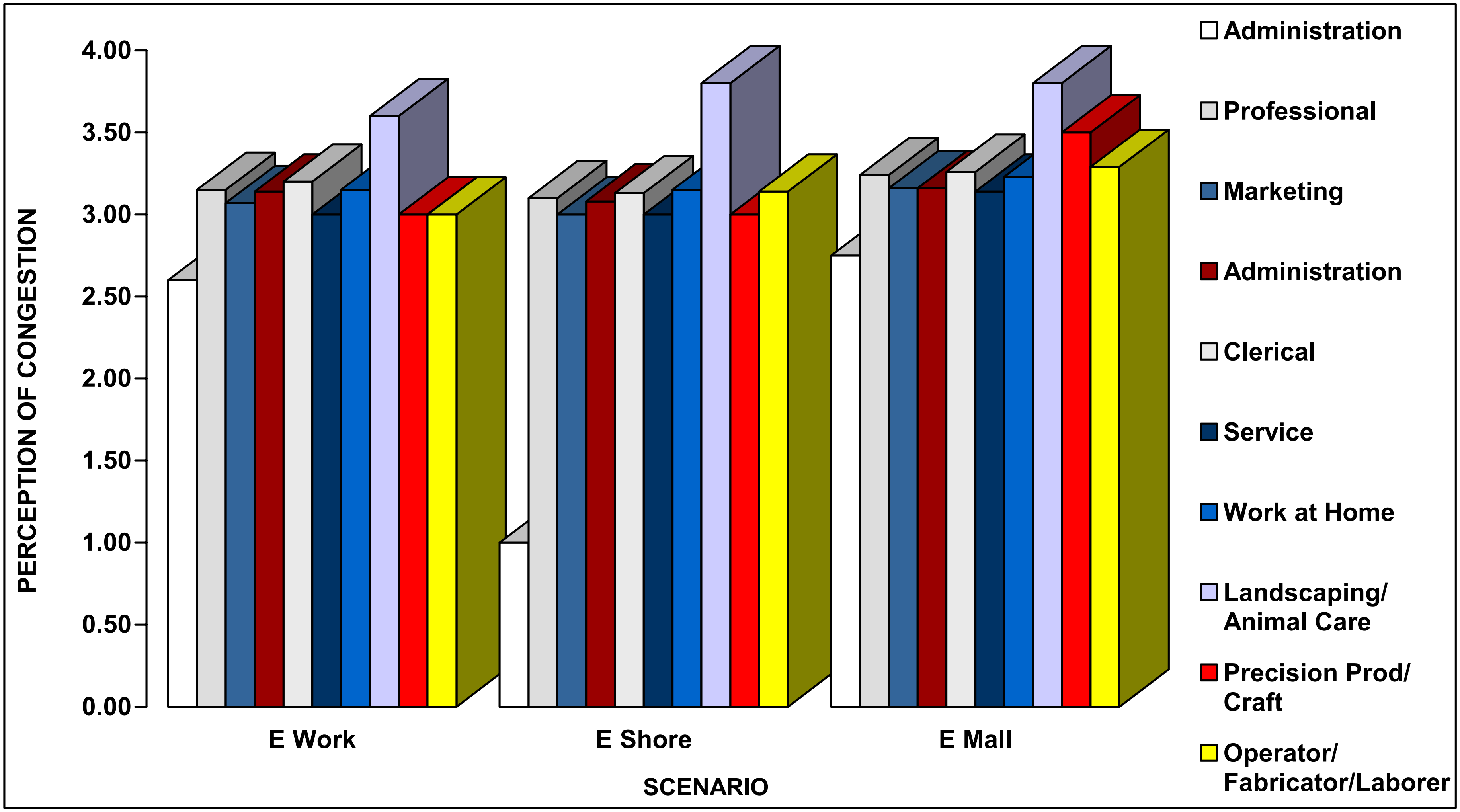


Figure 28. Sample Perception – Occupation: Freeway E Scenario

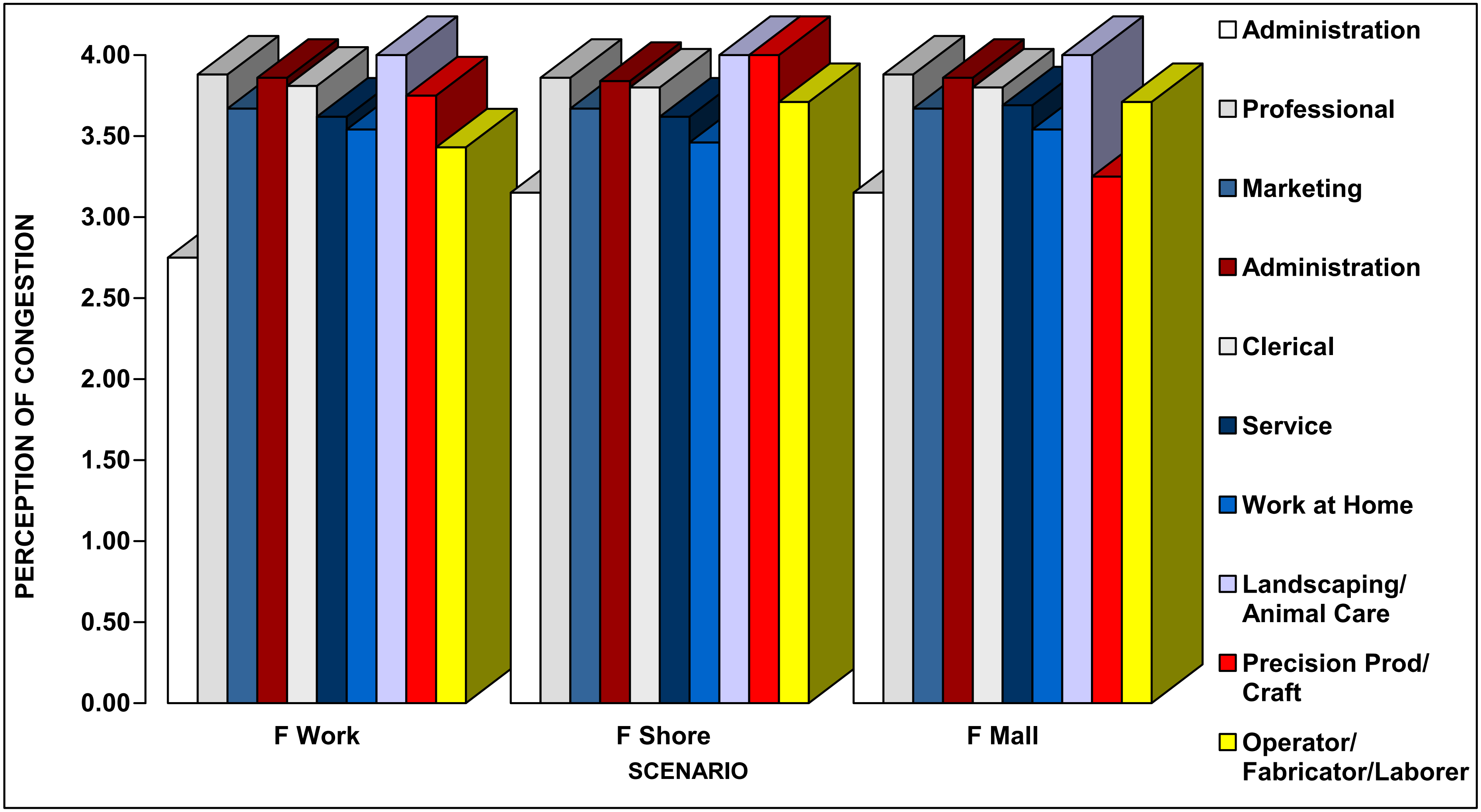


Figure 29. Sample Perception – Occupation: Freeway F Scenario

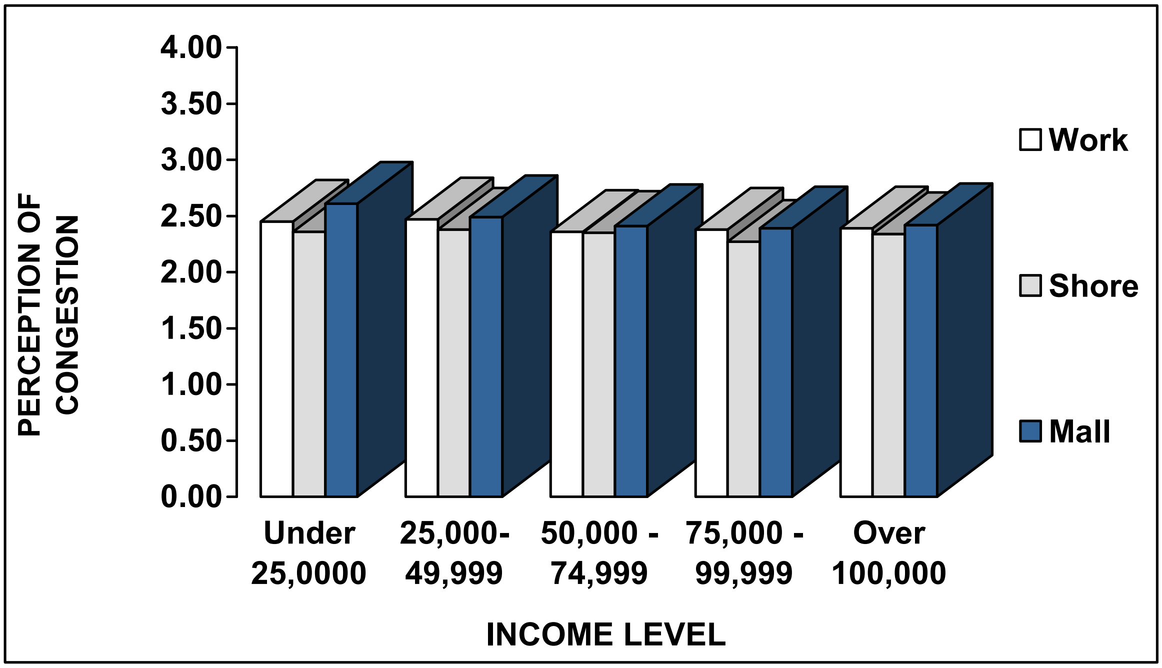


Figure 30. Sample Perception - Income Intersection D

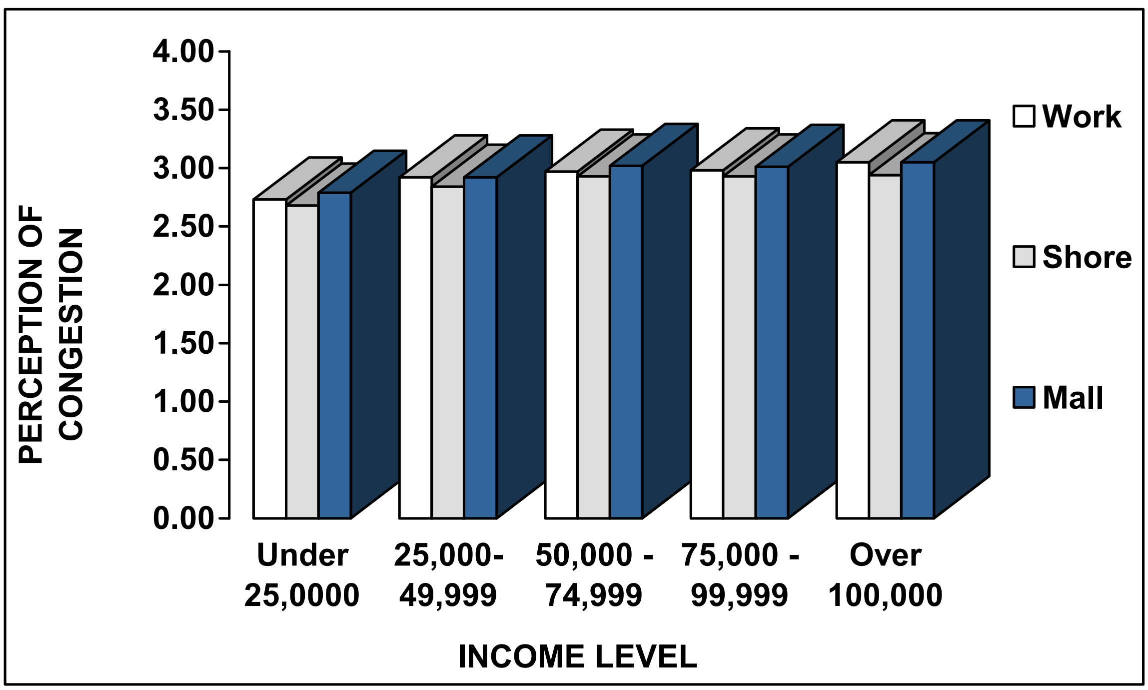


Figure 31. Sample Perception - Income Intersection E

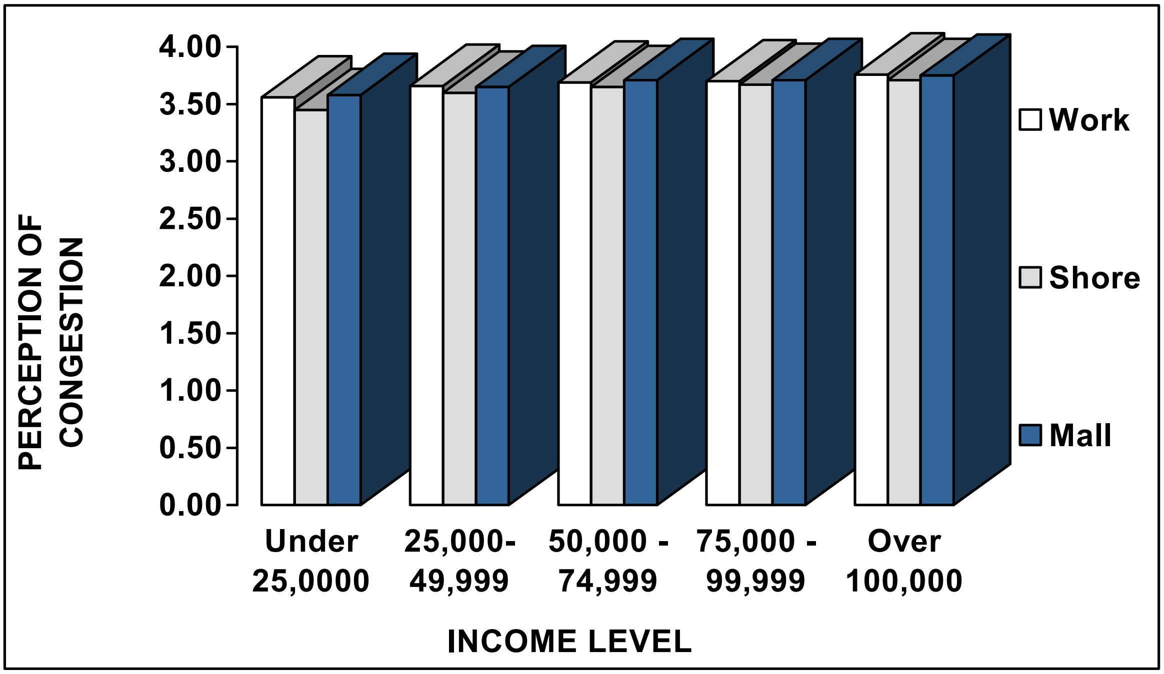


Figure 32. Sample Perception - Income Intersection F

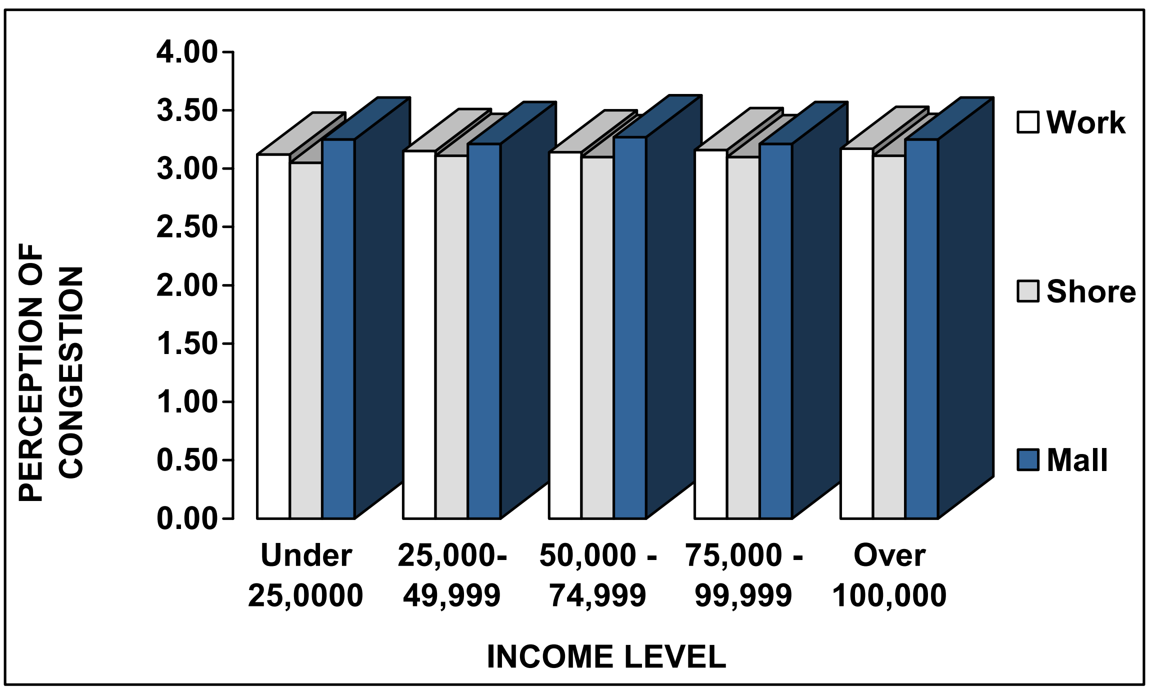


Figure 33. Sample Perception - Income Freeway D

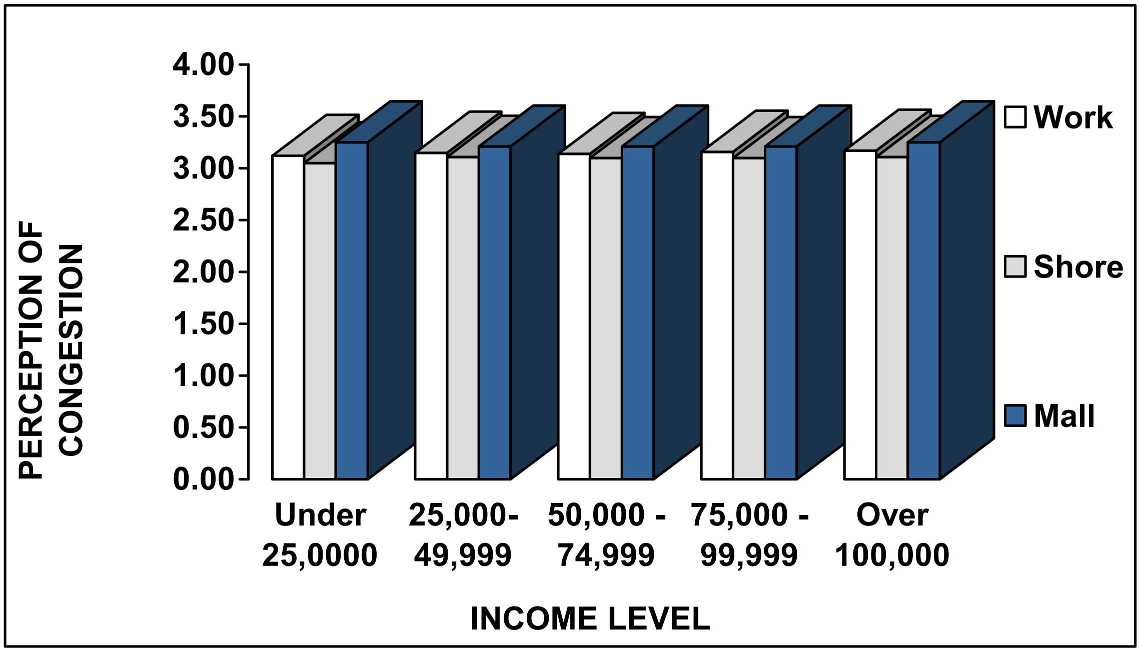


Figure 34. Sample Perception - Income Freeway E

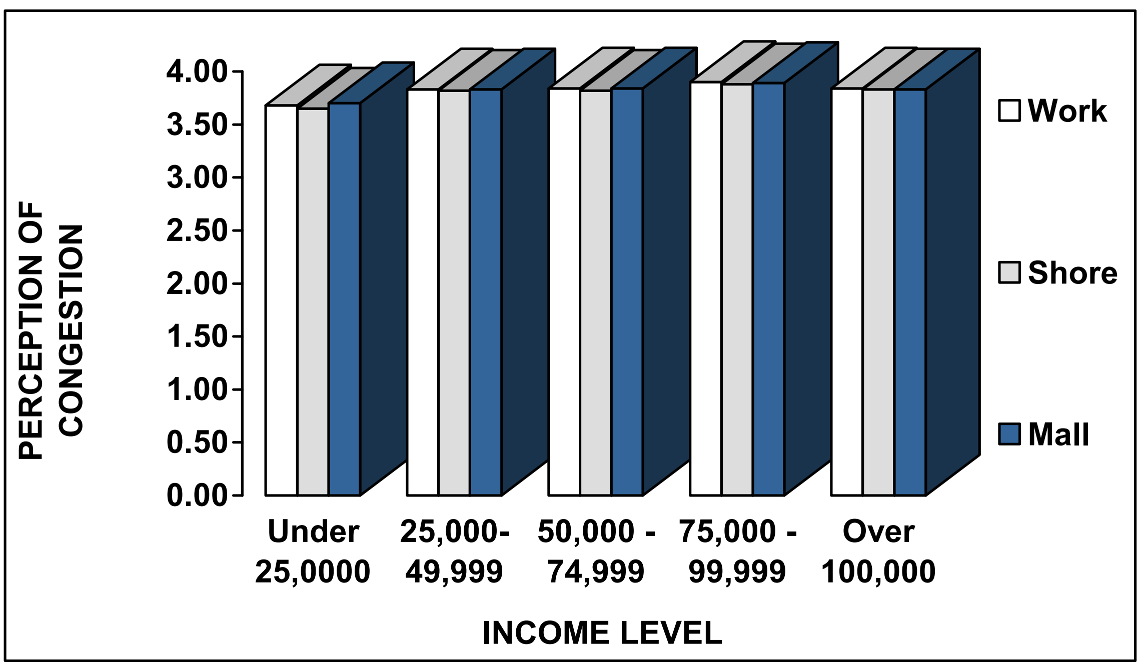


Figure 35. Sample Perception - Income Freeway F

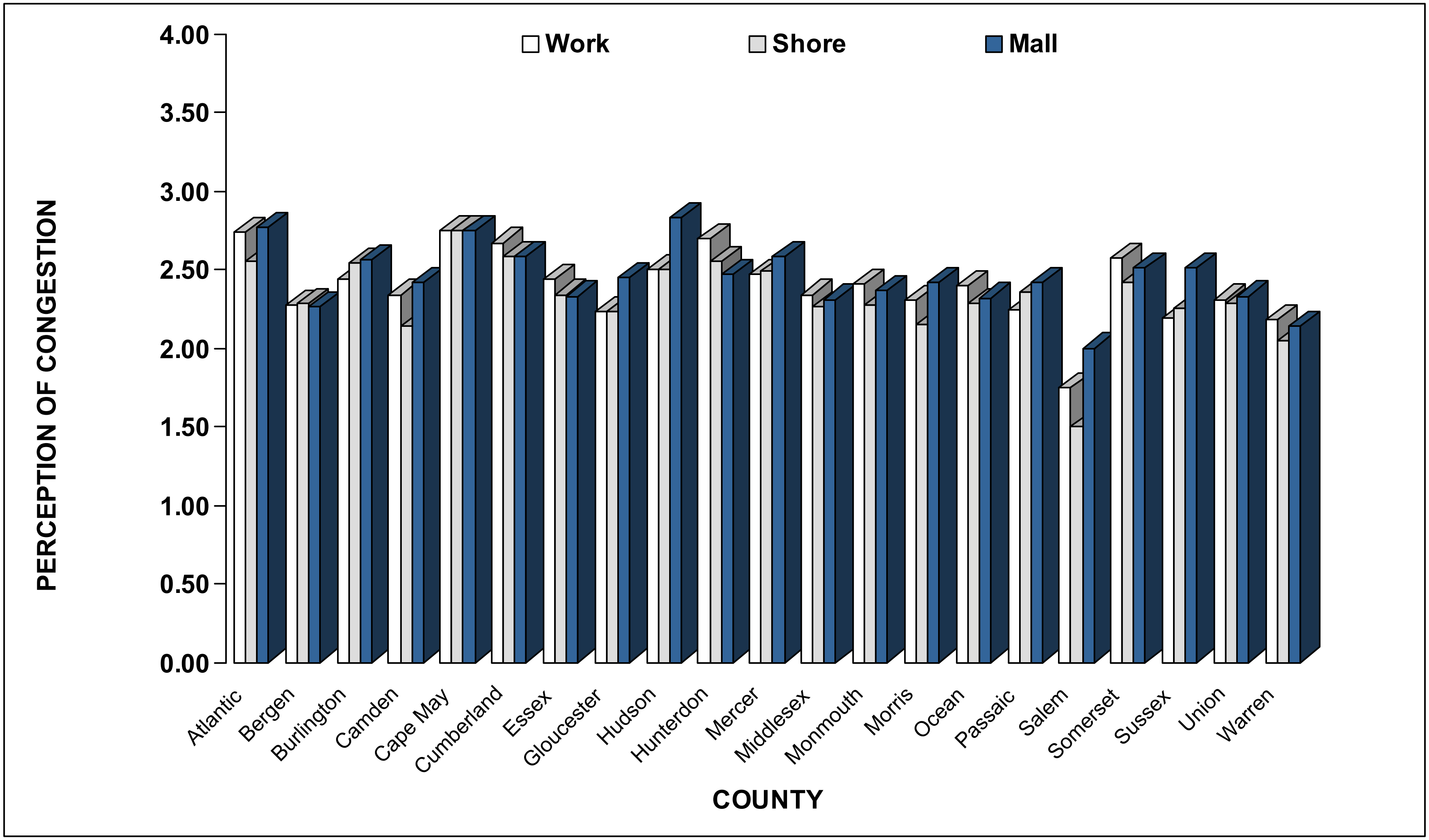


Figure 36. Sample Perception - Home County Intersection D

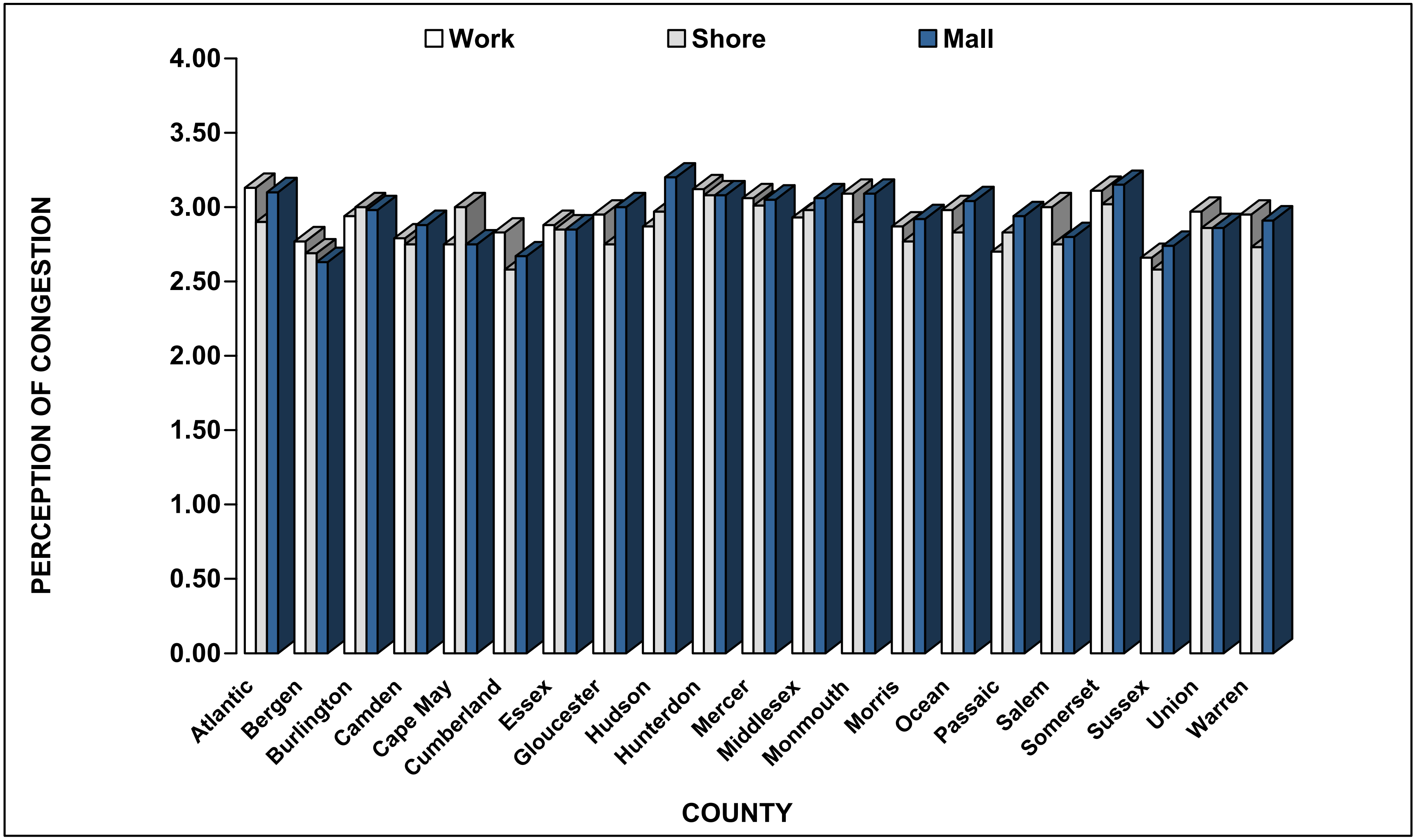


Figure 37. Sample Perception - Home County Intersection E

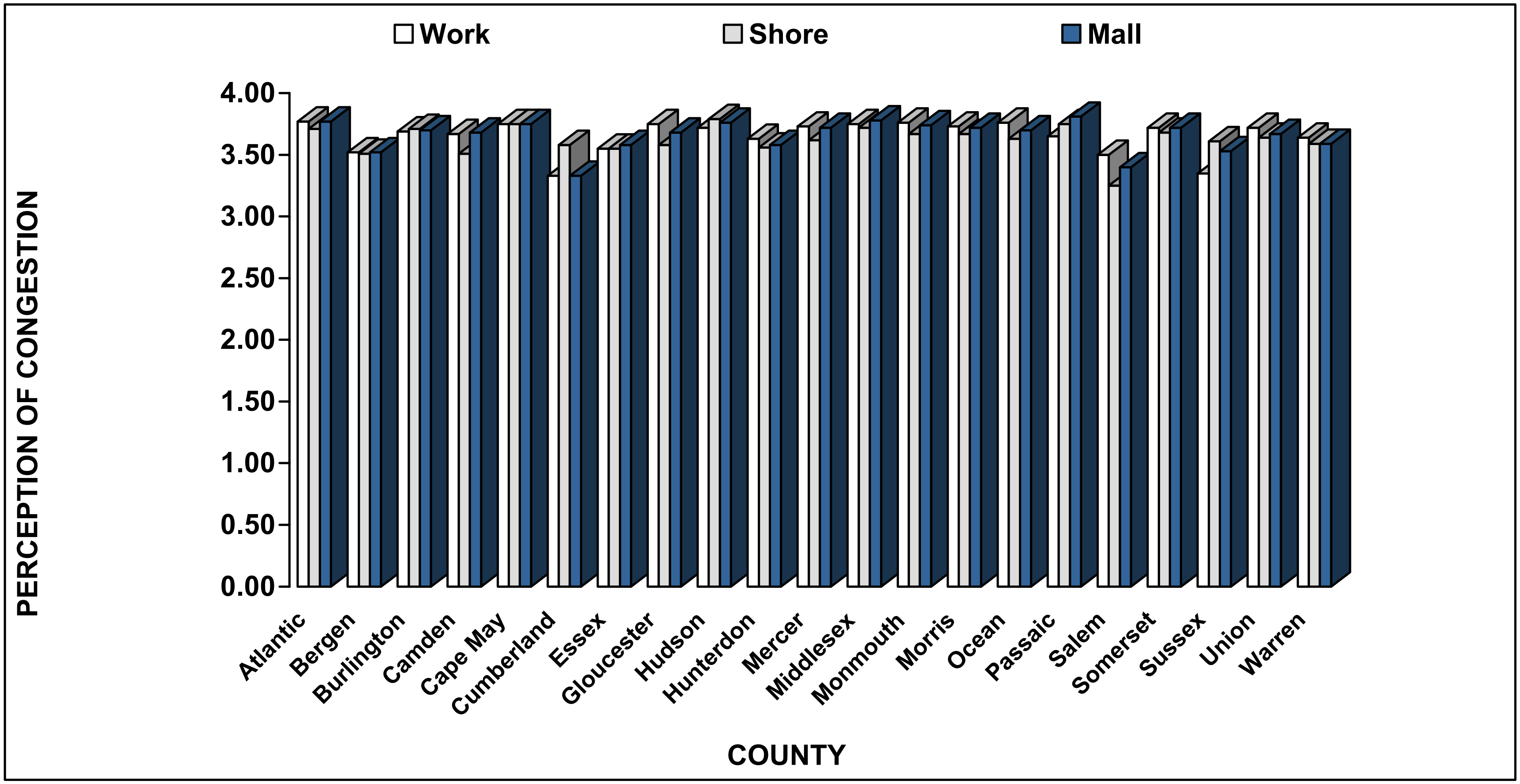


Figure 38. Sample Perception - Home County Intersection F

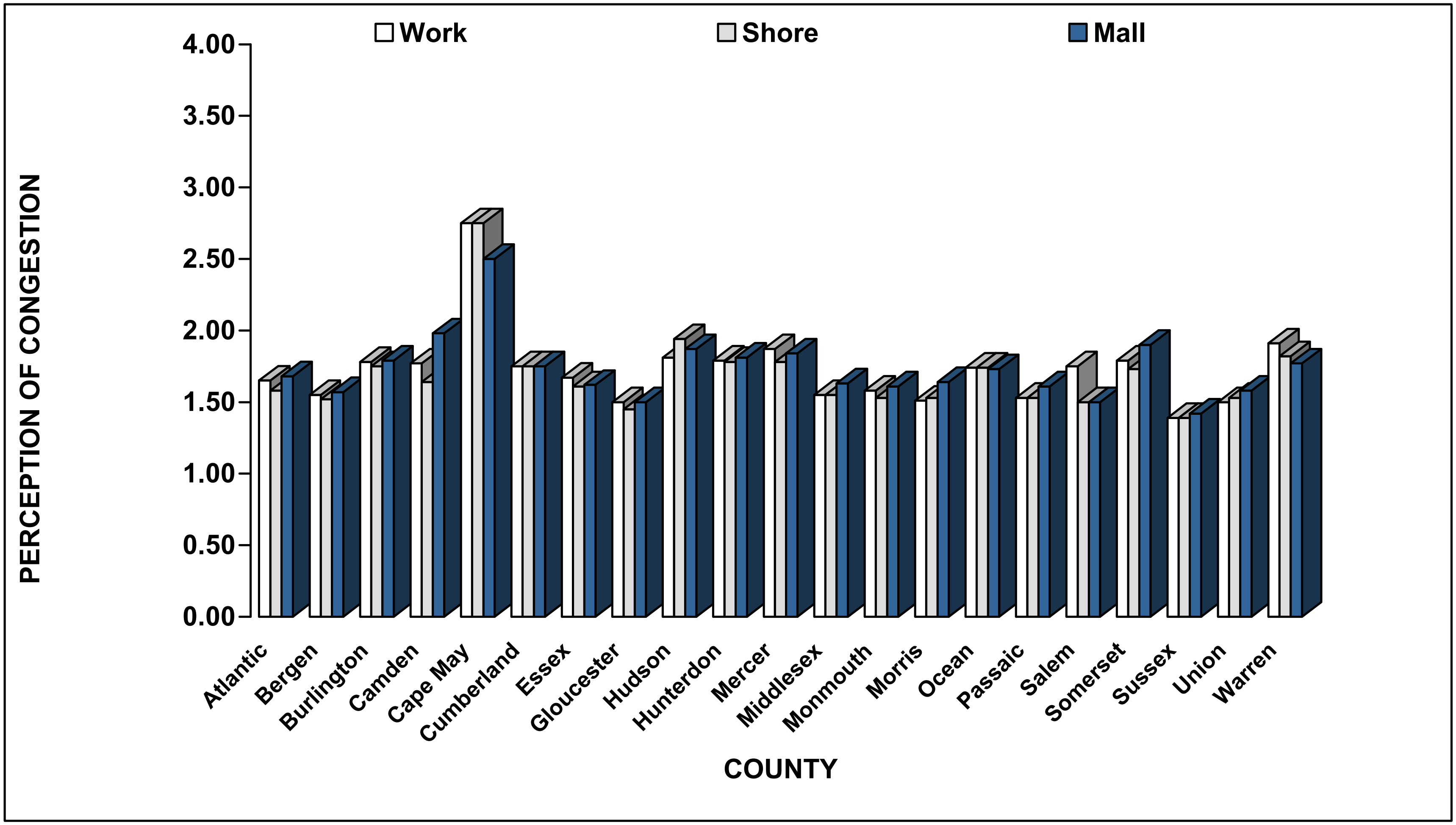


Figure 39. Sample Perception - Home County Freeway D

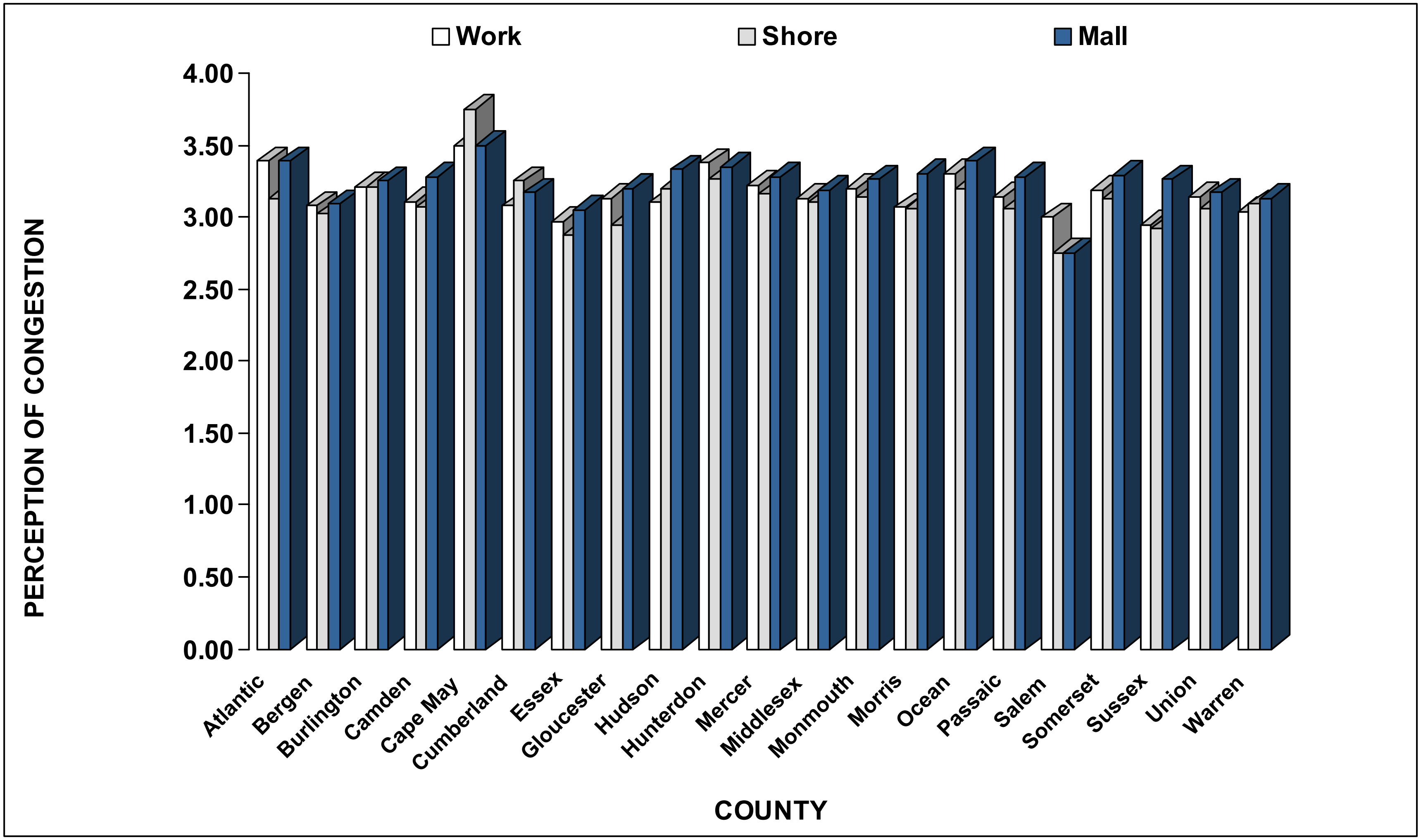


Figure 40. Sample Perception - Home County Freeway E

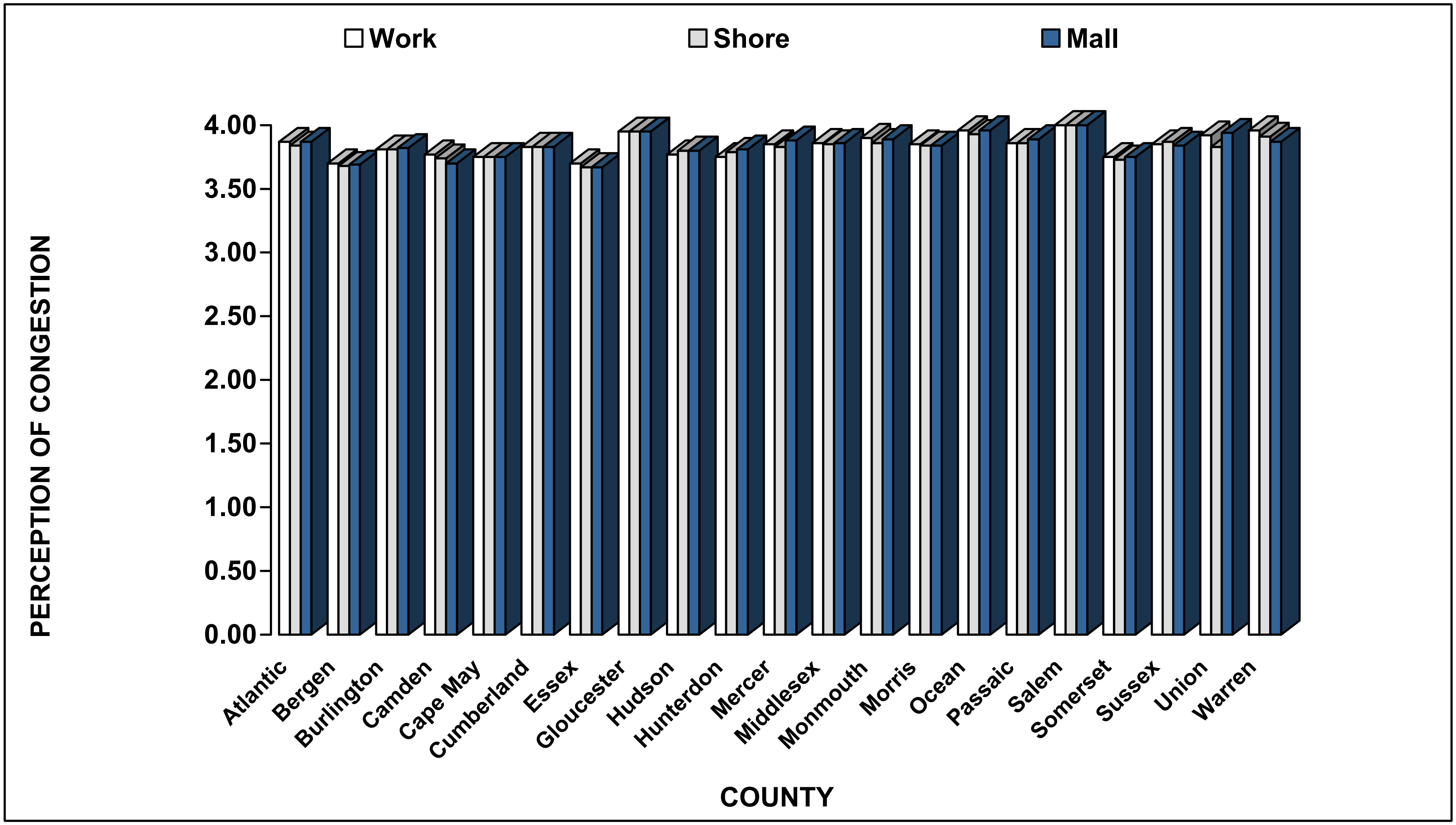


Figure 41. Sample Perception - Home County Freeway F

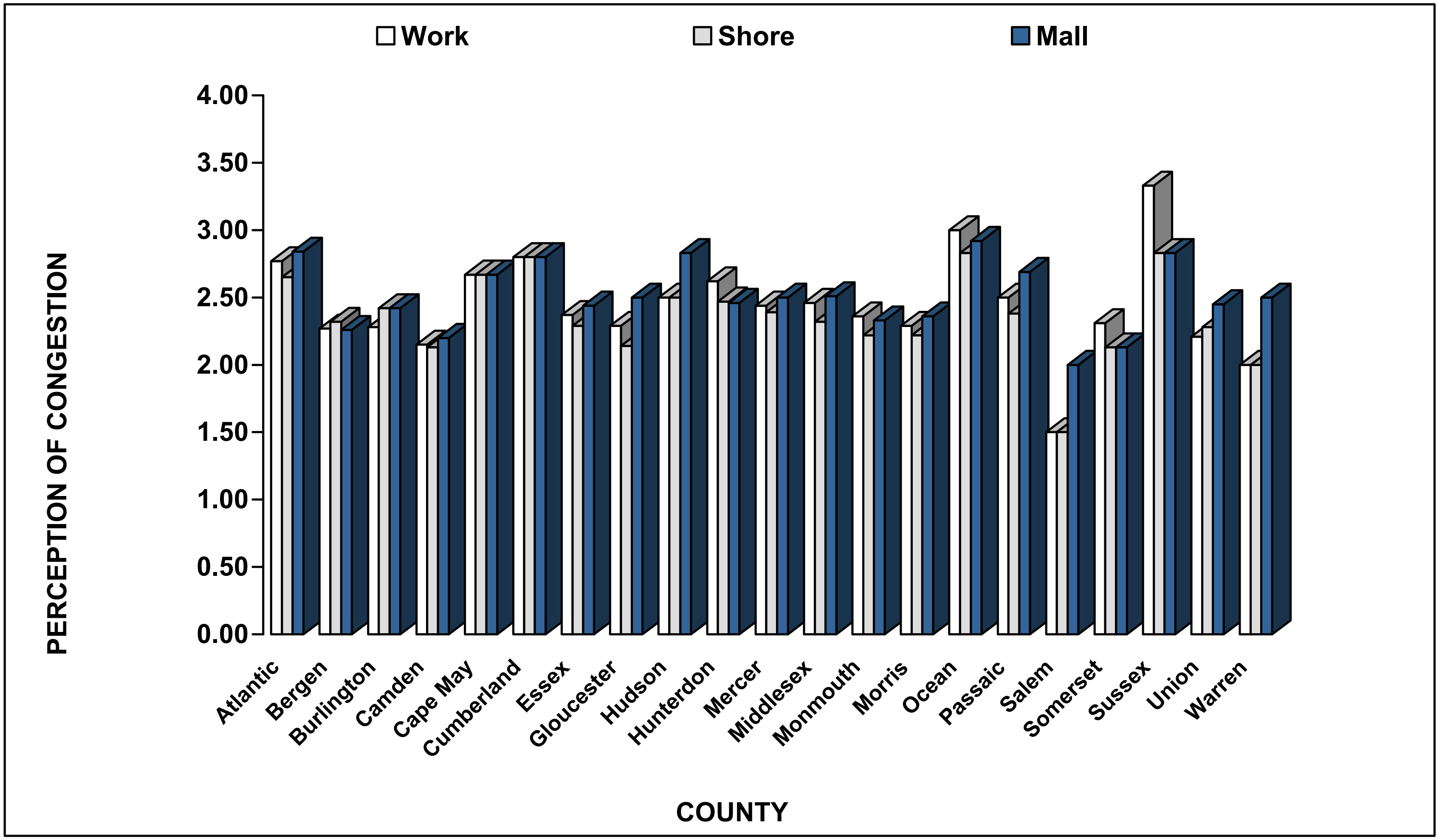


Figure 42. Sample Perception - Work County Intersection D

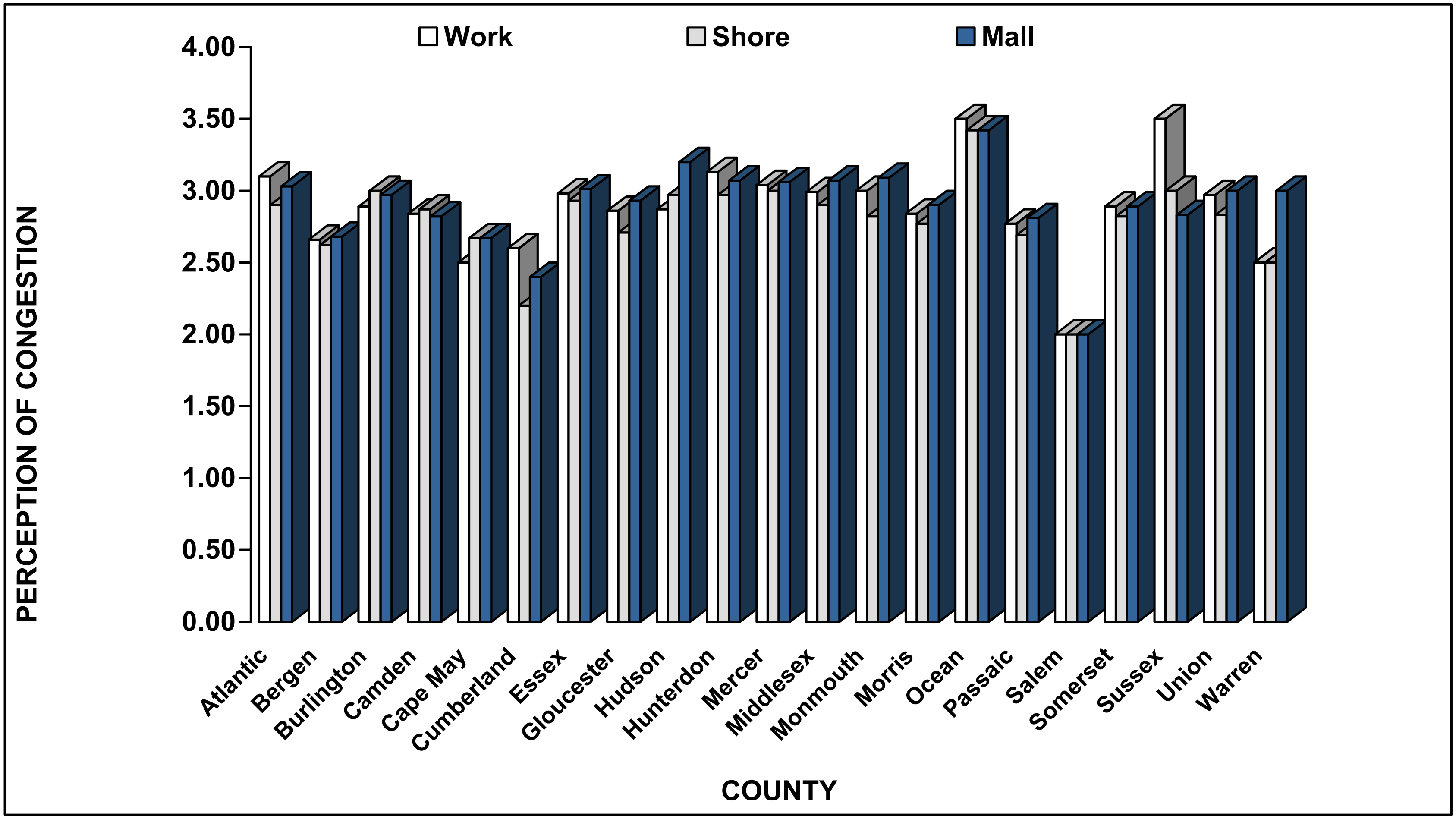


Figure 43. Sample Perception - Work County Intersection E

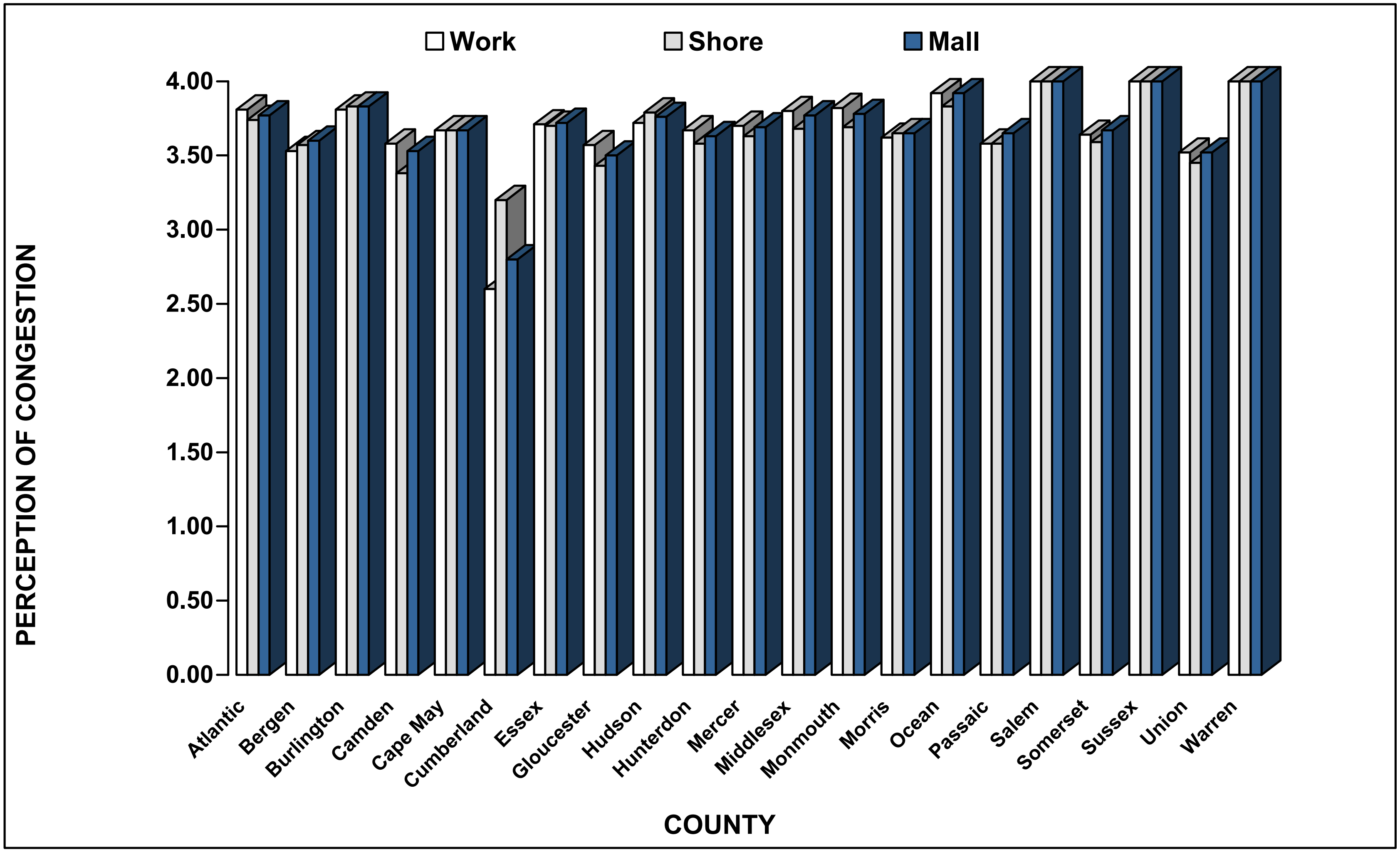


Figure 44. Sample Perception - Work County Intersection F

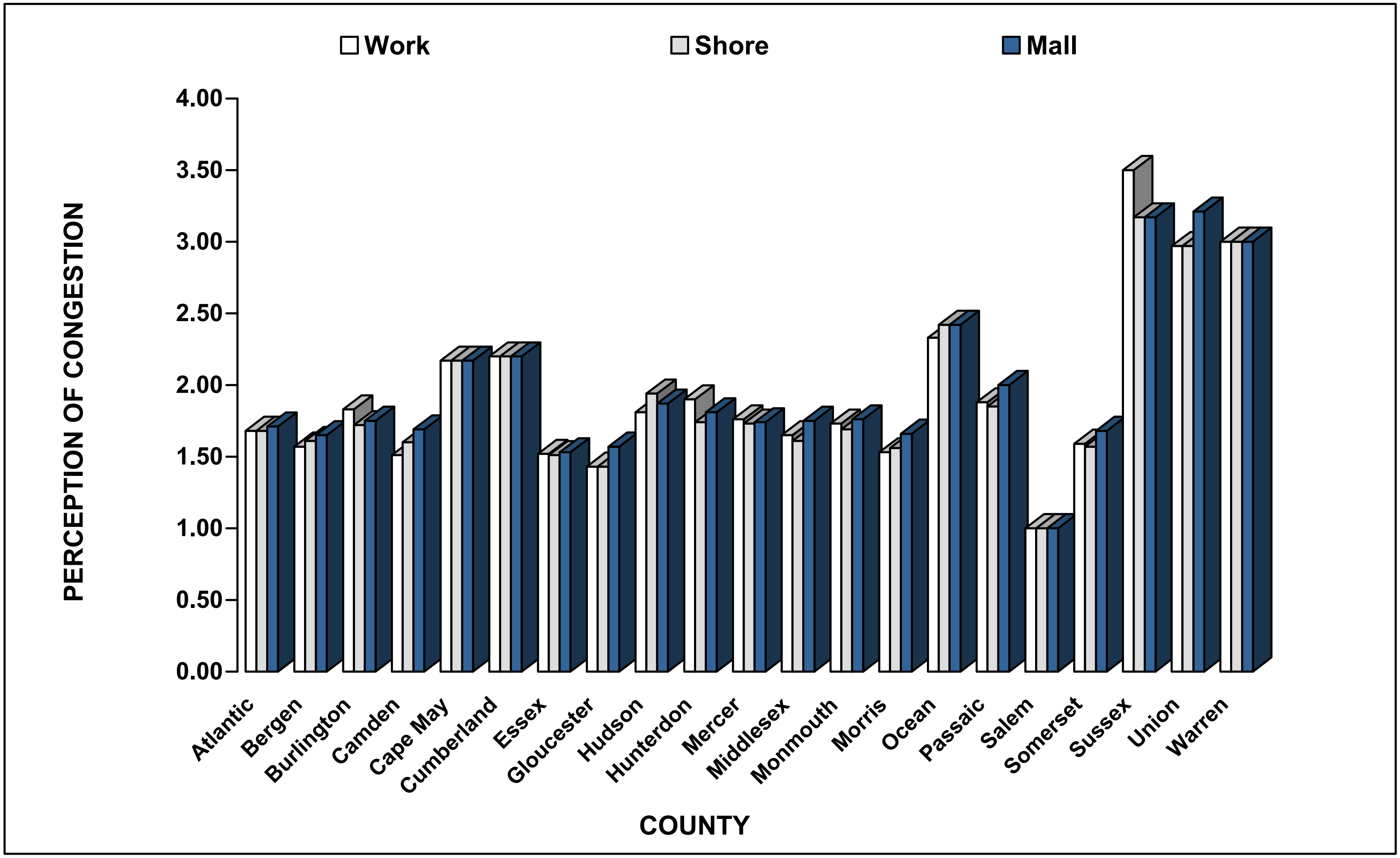


Figure 45. Sample Perception - Work County Freeway D

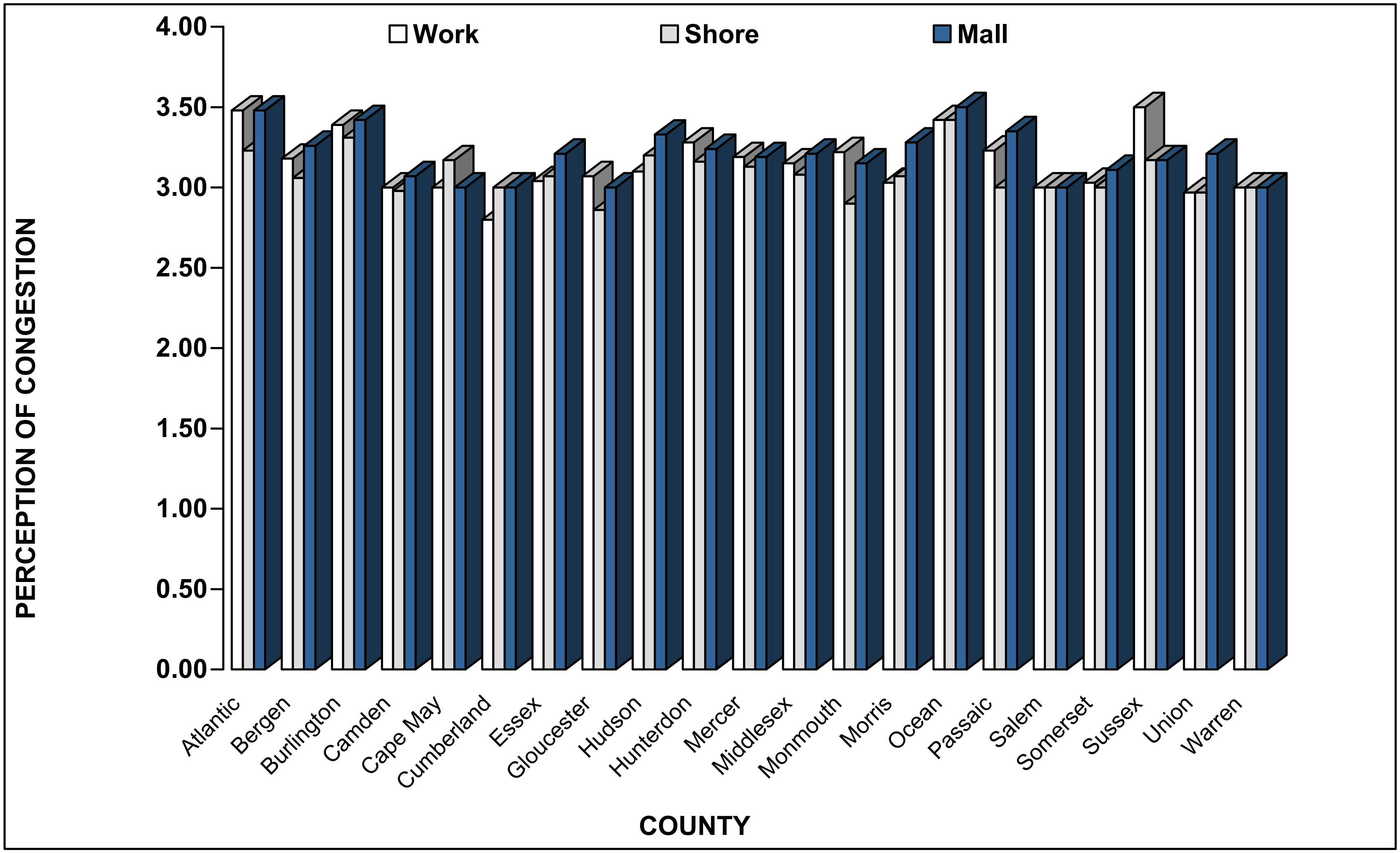


Figure 46. Sample Perception - Work County Freeway E

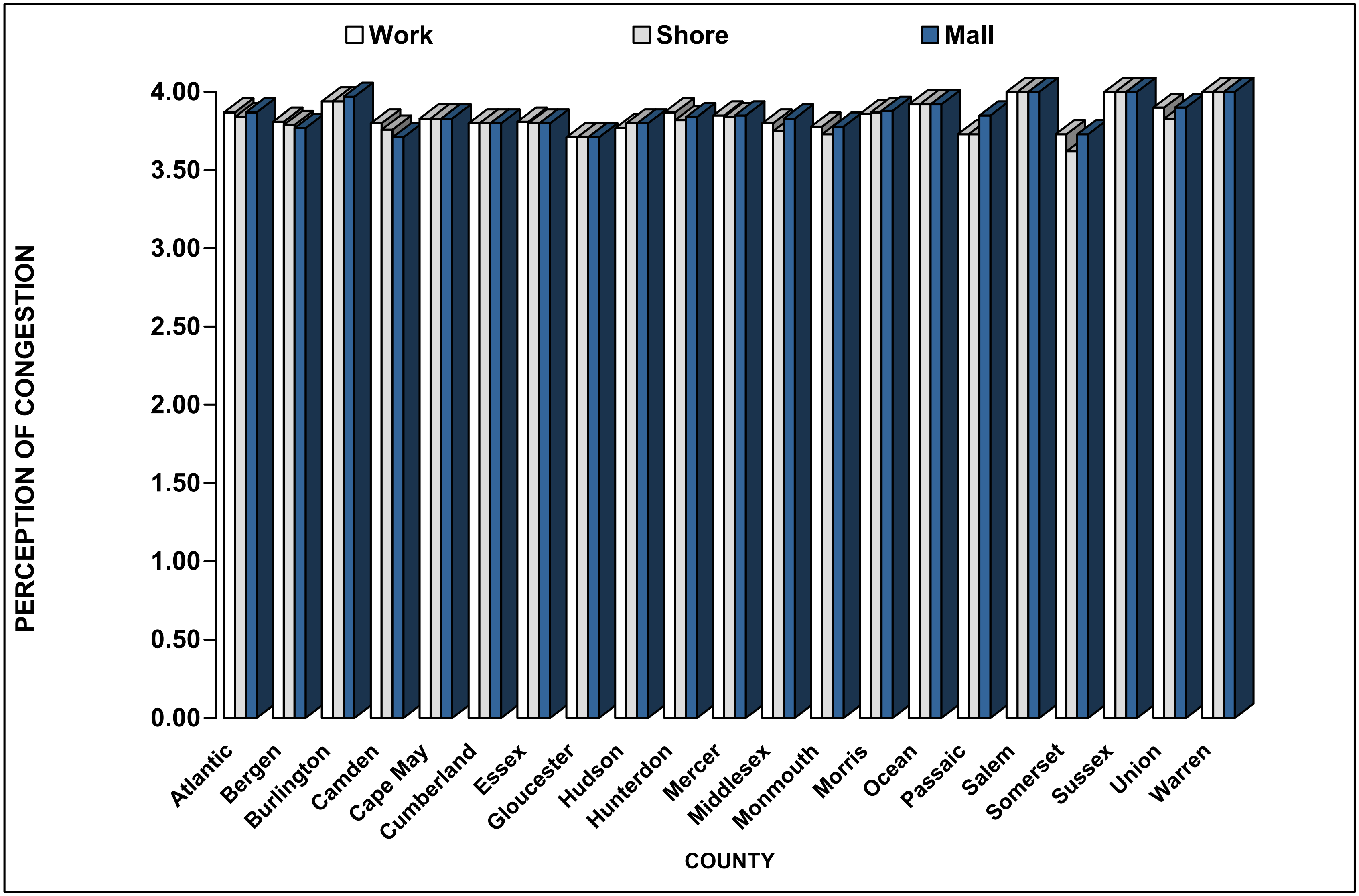


Figure 47. Sample Perception - Work County Freeway F

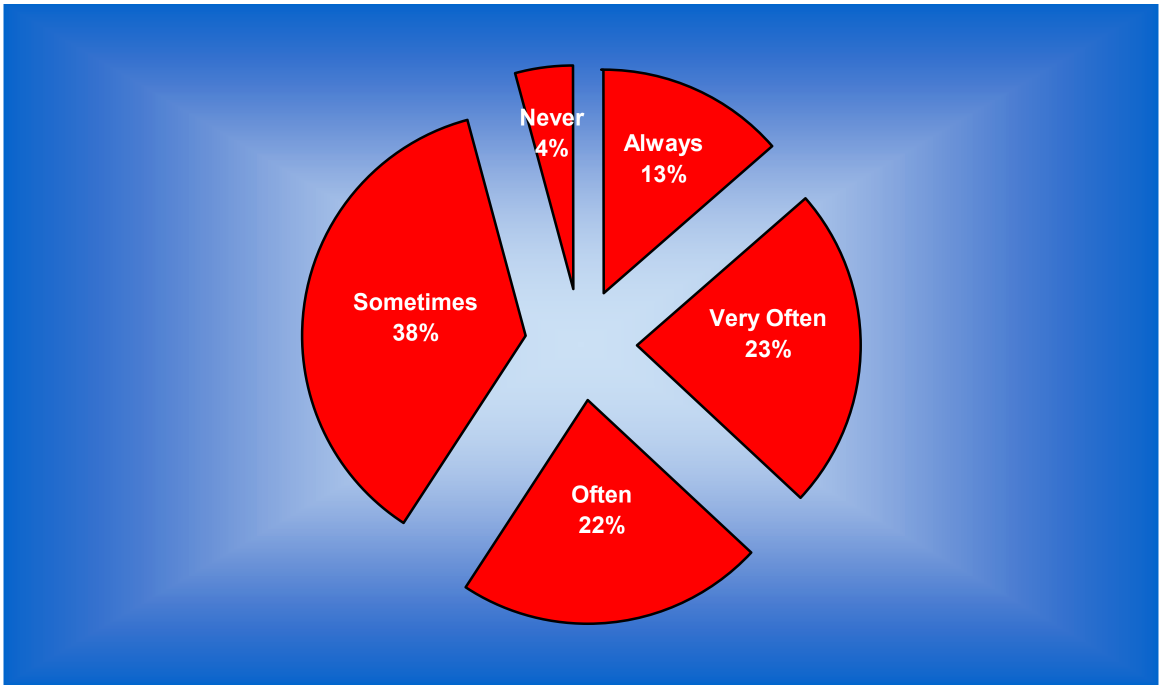


Figure 48. Stress - Driving to Work

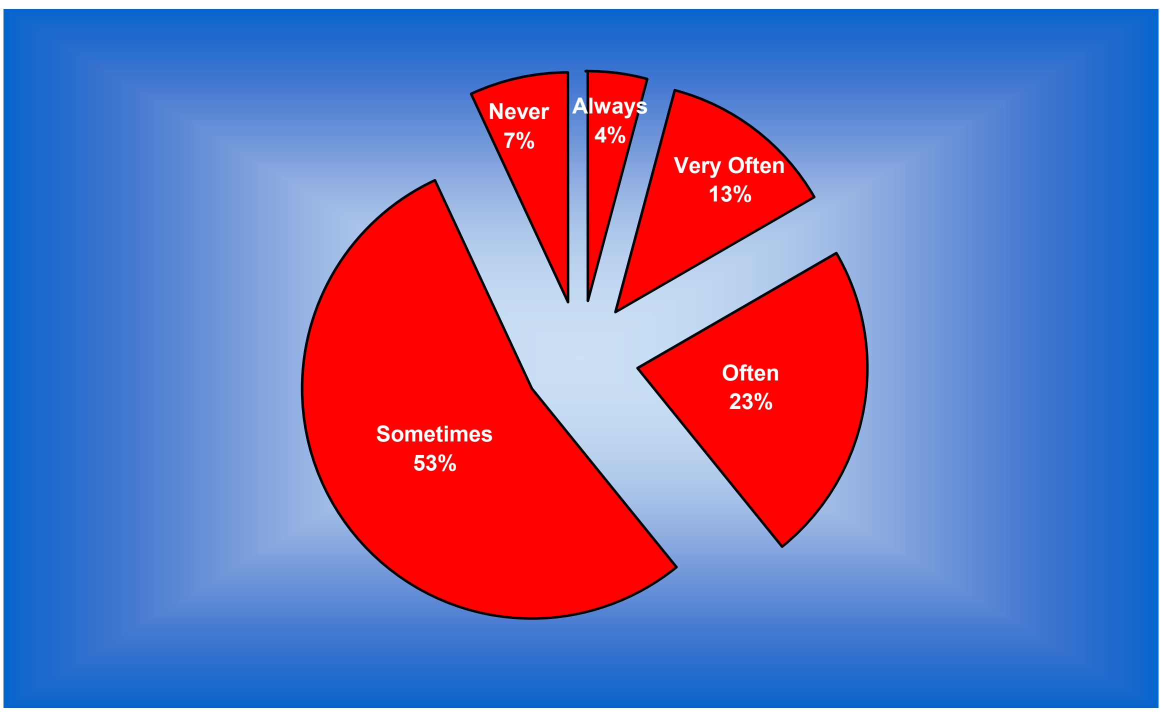


Figure 49. Stress - Driving to Shopping

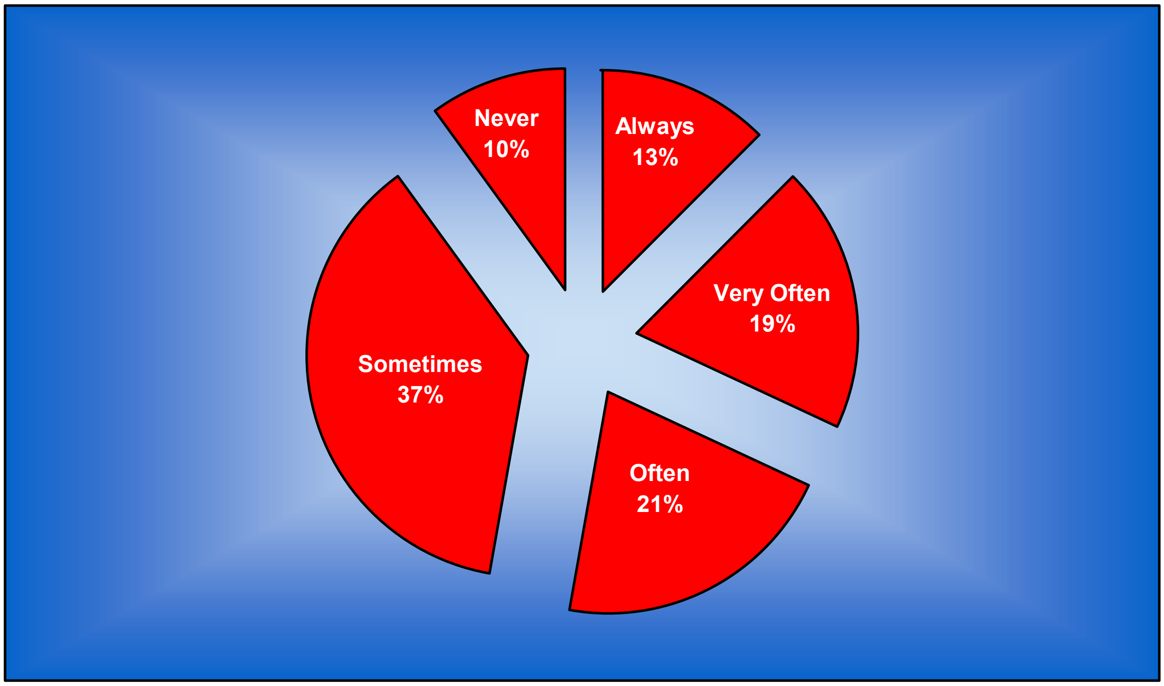


Figure 50. Stress - Driving to Shore

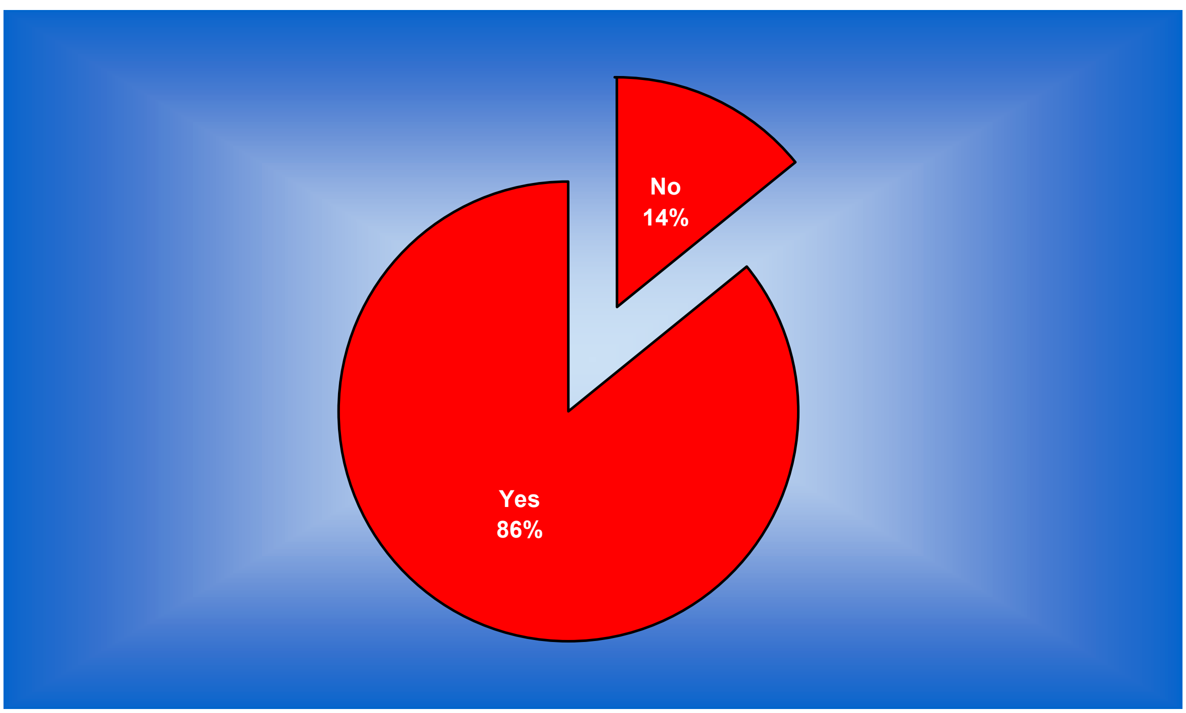


Figure 51. Stress - Stress Increase Over 1 Year

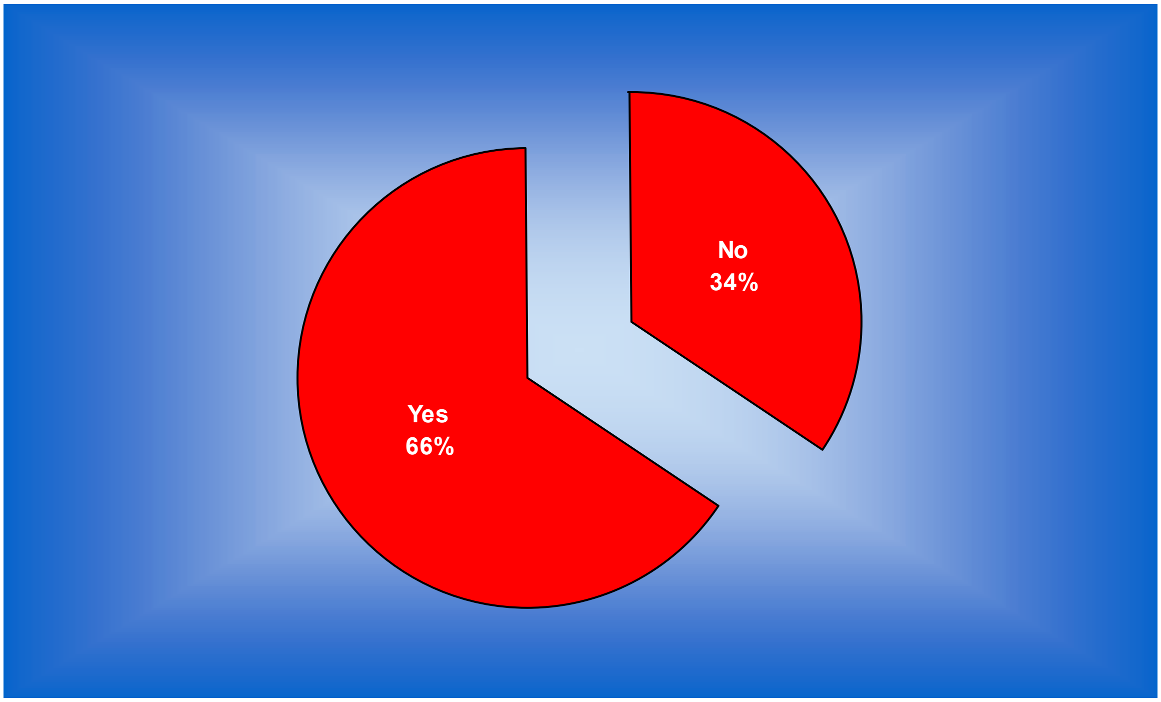


Figure 52. Stress - Stress Increase Over 5 Years

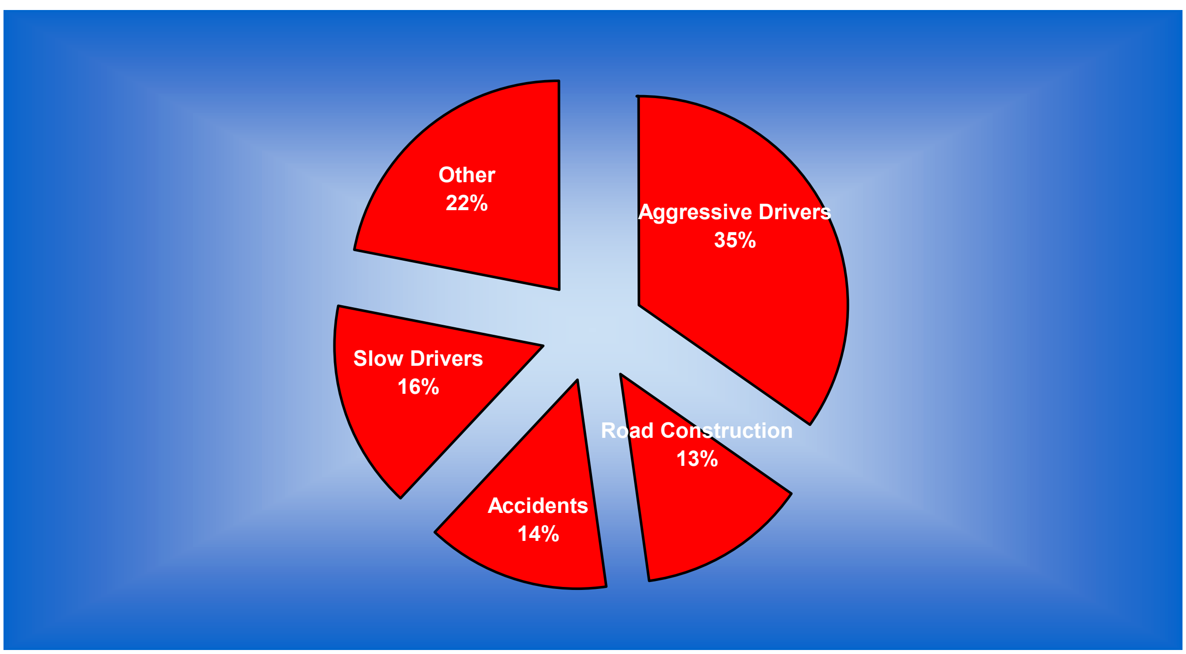


Figure 53. Stress – Contributing Factors

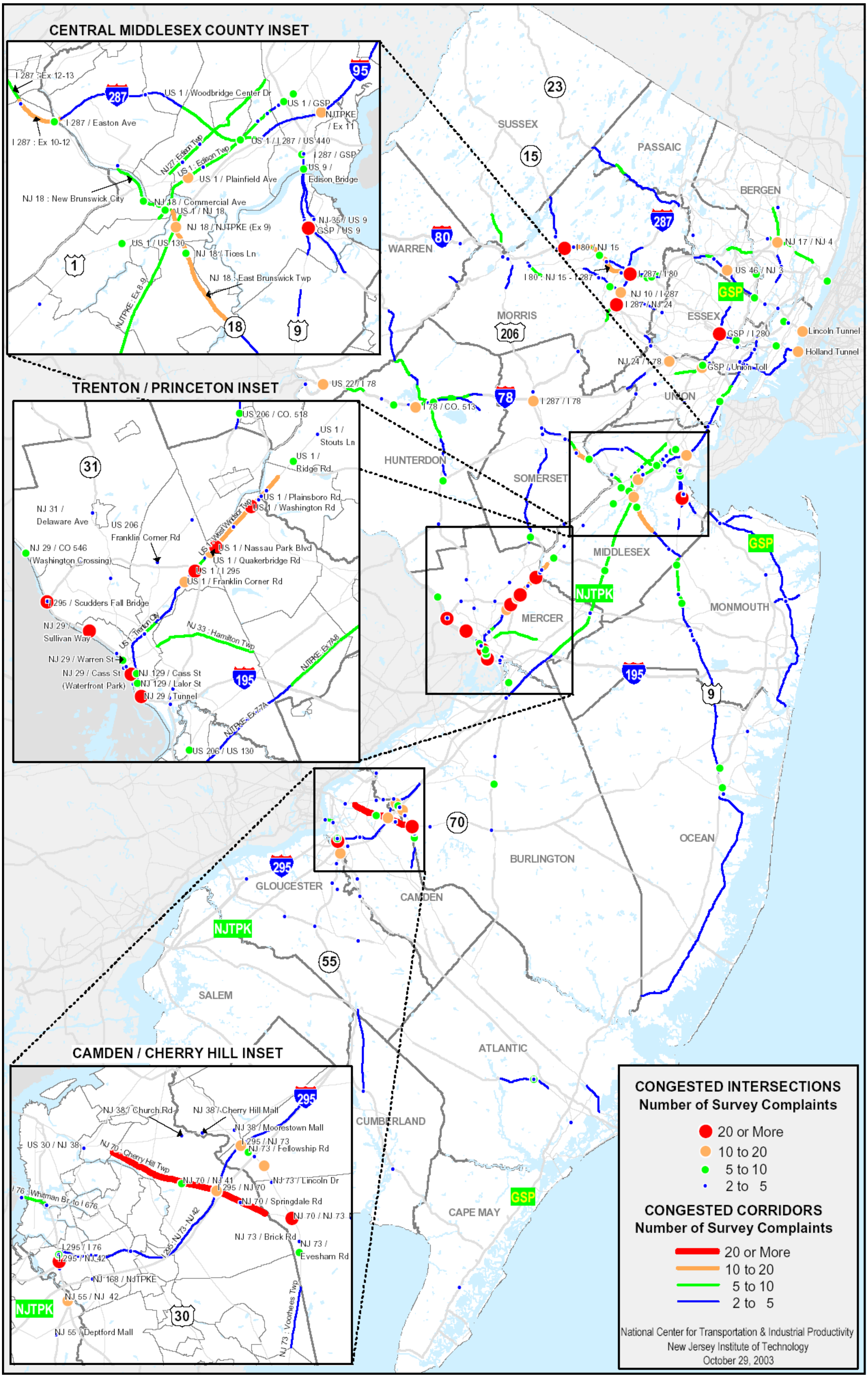


Figure 54. Congested Locations

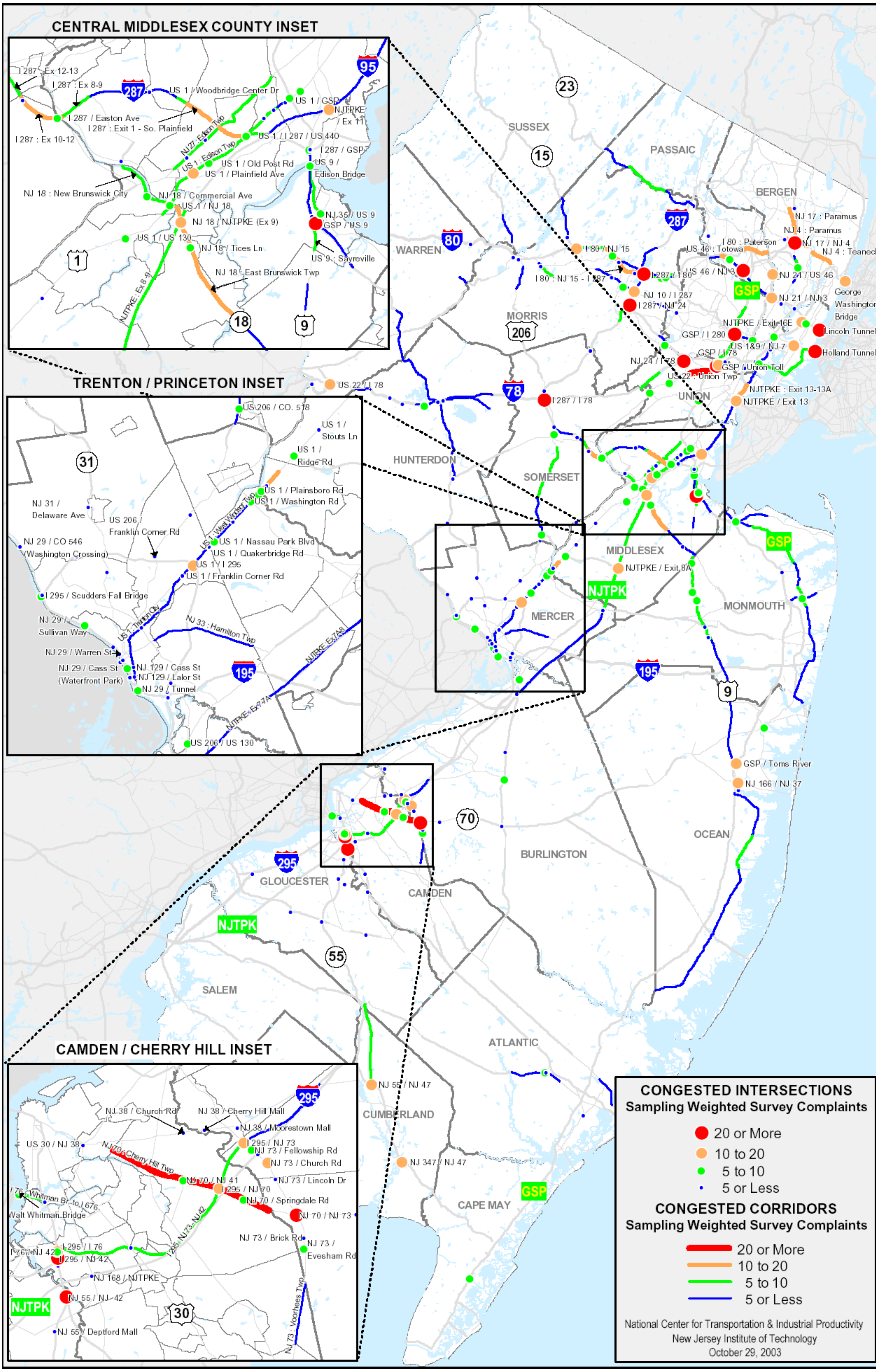


Figure 55. Weighted Congested Locations

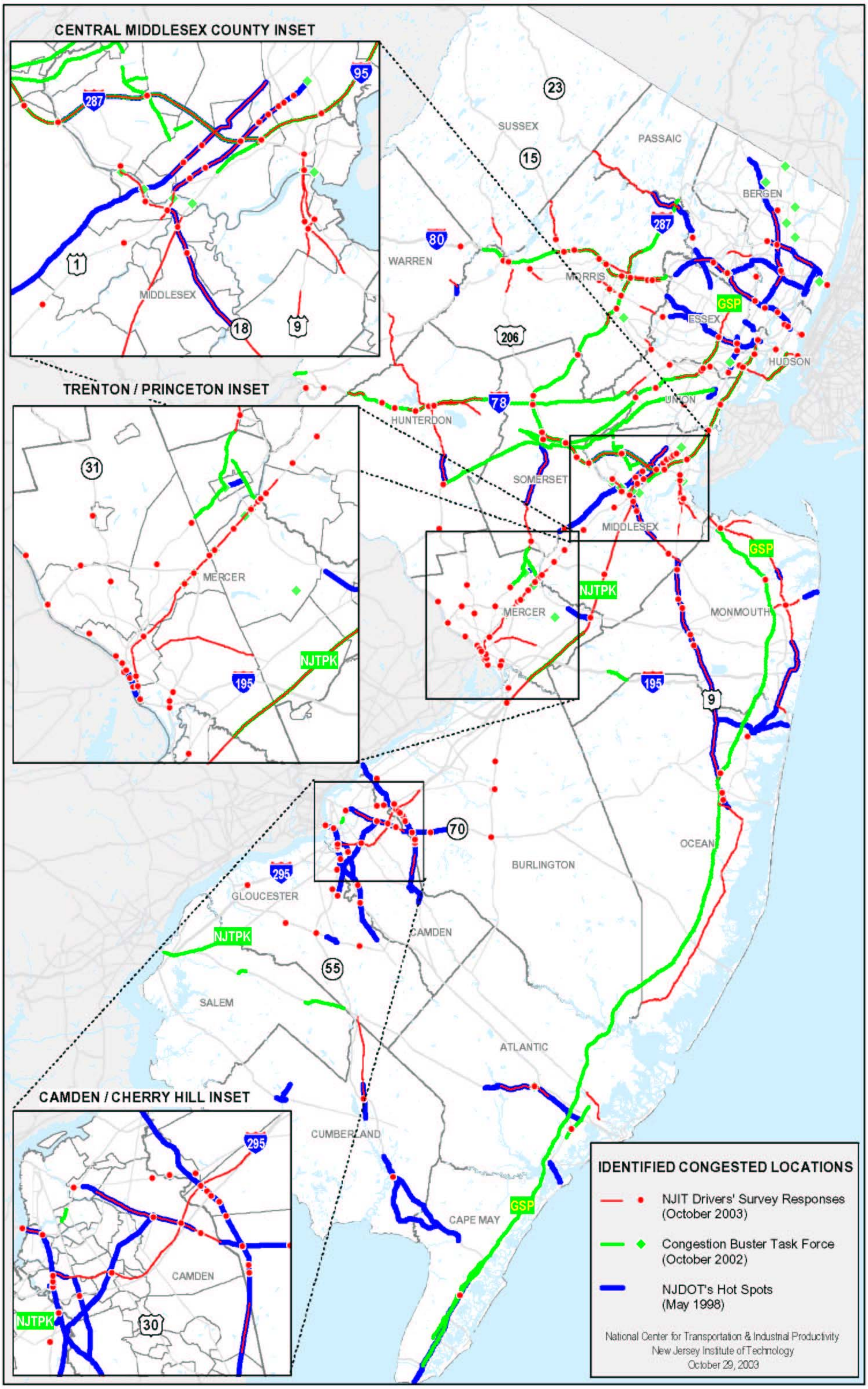


Figure 56. Comparison of Congested Locations

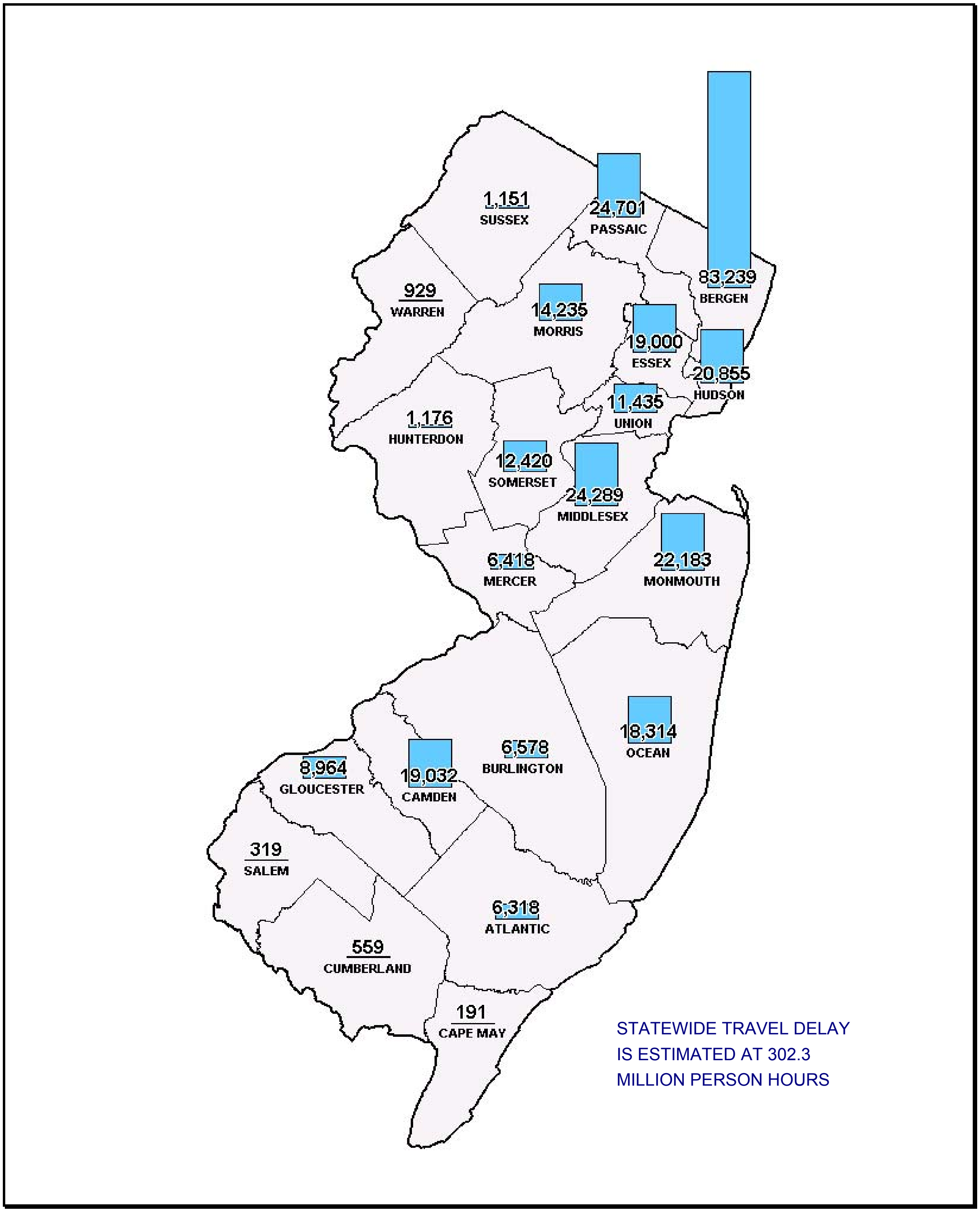


Figure 57. Annual Hours of Delay – 2003 (Thousands of Person Hours of Delay)

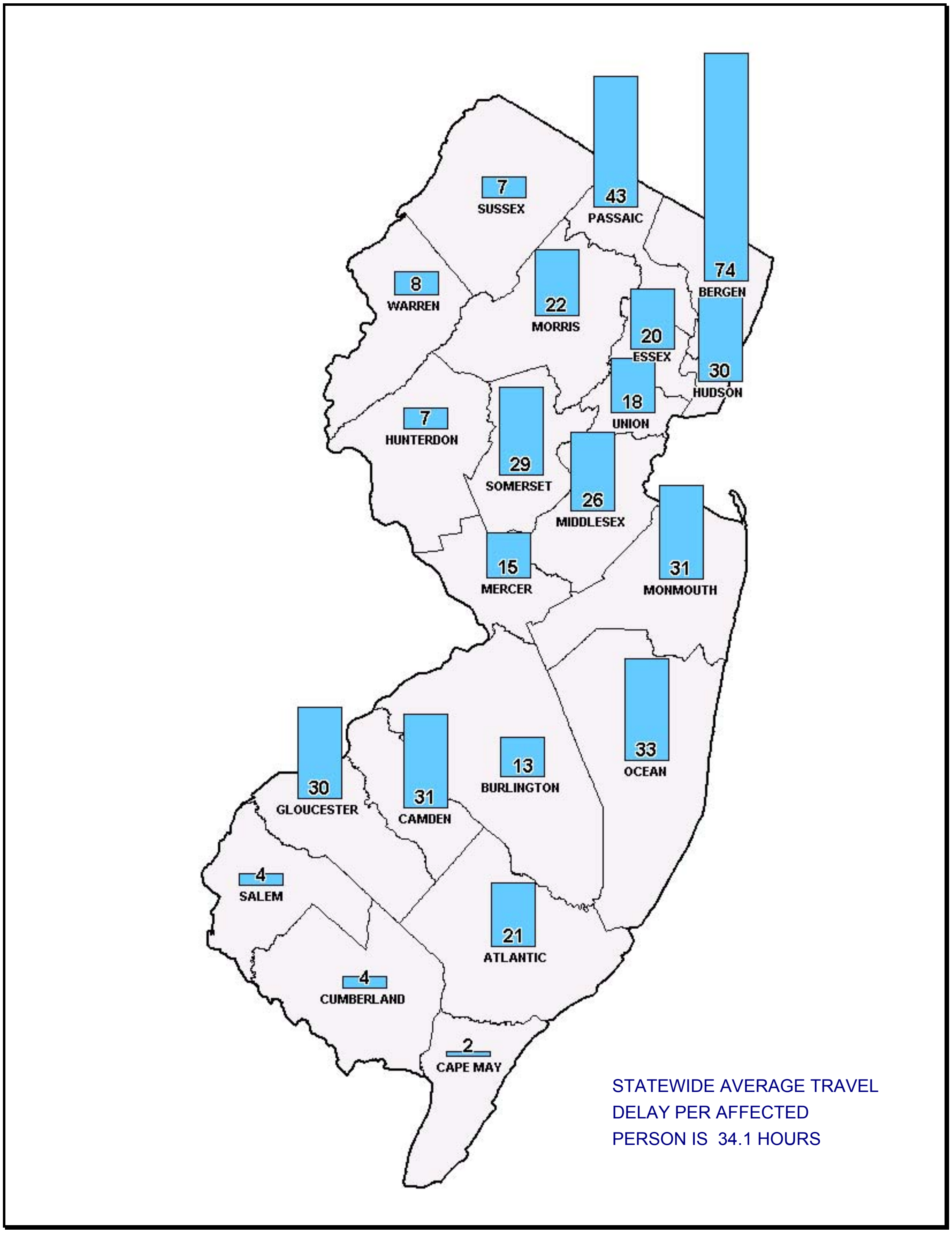


Figure 58. Average Annual Travel Delay Per Affected Person – 2003 (Hours)

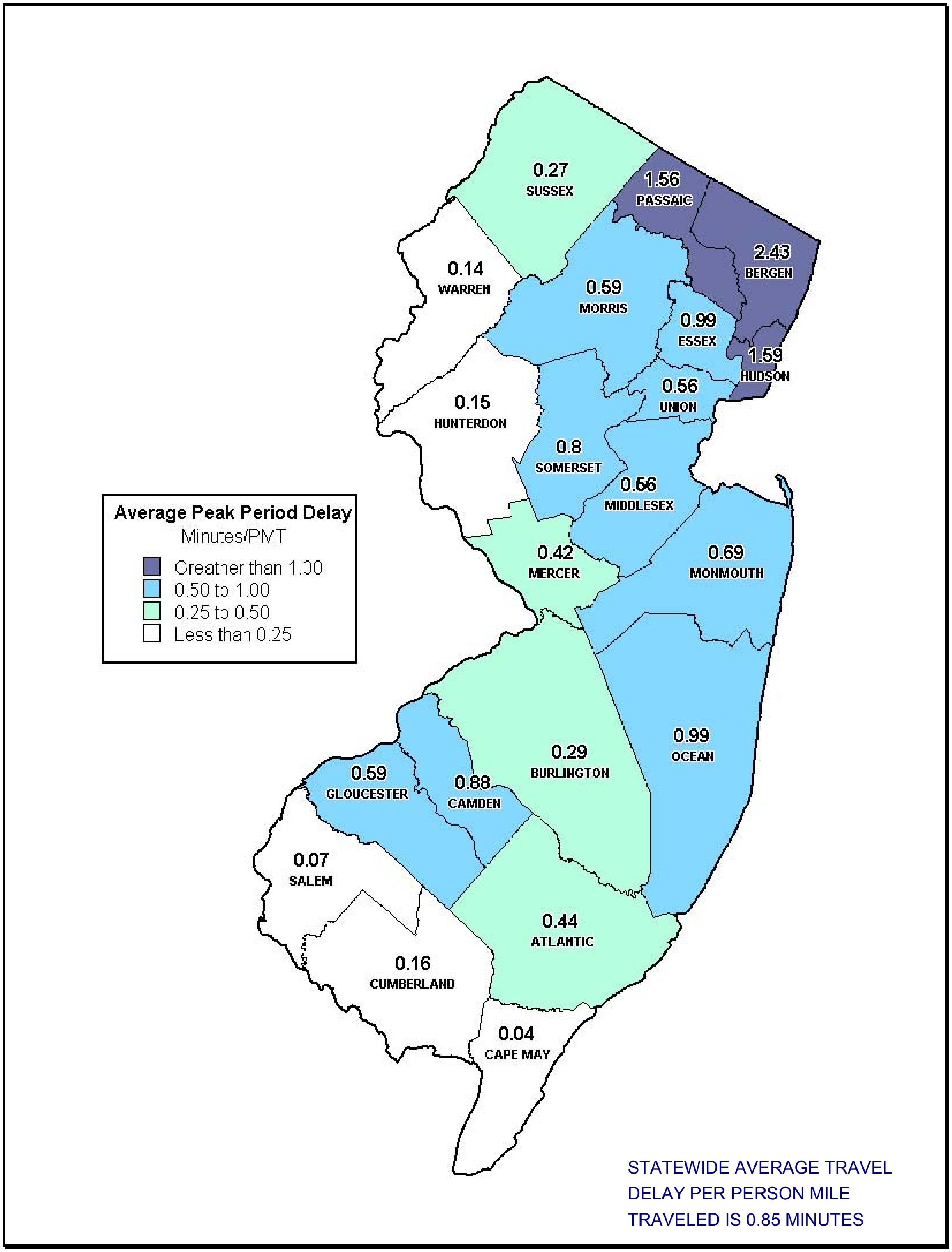


Figure 59. Average Travel Delay Per Person Mile Traveled – 2003 (Minutes per Person Mile Traveled)

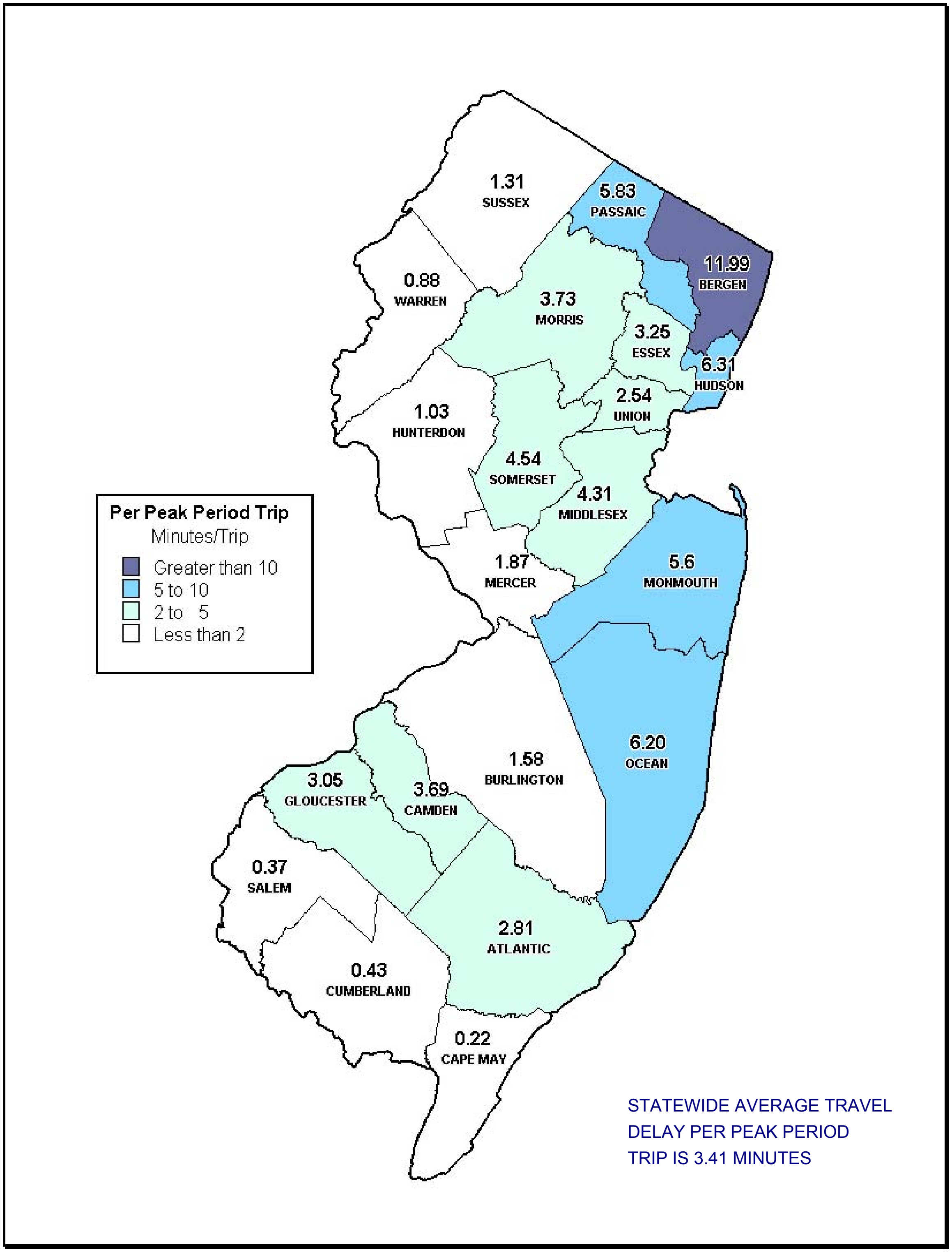


Figure 60. Average Travel Delay Per Peak Period Trip – 2003 (Minutes of Delay per Peak Period Trip)

APPENDICES

Appendix A. Traffic Congestion Survey

Please click here to proceed to the survey.

When you have answered all of the questions, click the submit button at the bottom of the survey.

ABOUT THE PROJECT

Transportation investments frequently must compete with other forms of government spending for scarce resources. Therefore, being able to accurately measure 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. The goals of this study, to be conducted by the National Center for Transportation and Industrial Productivity (NCTIP) at the New Jersey Institute of Technology (NJIT), are to develop and compute time-based measures that accurately and effectively describe congestion and mobility in New Jersey.

Principal Investigator: Dr. Lazar N. Spasovic, Director, NCTIP

Project Customer: Robert Miller, Manager, Systems Development and Analysis, NJDOT

Project Manager: Nancy Ciaruffoli, Research Project Manager, NJDOT

ABOUT NJIT

NJIT's continuing mission of instruction, research, economic growth and public service has put the institution among the leading comprehensive technological universities in the nation. With over 8,800 students, NJIT is the largest technological university in the New York metropolitan region.

ABOUT NCTIP

The National Center for Transportation and Industrial Productivity (NCTIP) at the New Jersey Institute of Technology is one of four national university centers designated under the landmark Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, which the U.S. Congress reauthorized, in 1998, as the Transportation Efficiency Act (TEA-21). Evolving from the strategic planning process of the U.S. Department of Transportation's University Transportation Centers Program, the purpose of NCTIP is to find ways to increase industrial productivity through improvements in transportation.

ABOUT THE SURVEY

The survey that follows consists of seven parts. Part 1 elicits information about you. Parts 2-7 requires that you click on the images indicated to play 6 different videos and answer questions regarding the videos. The entire survey should take approximately 15 minutes of your time. If you have questions or comments, please contact Jakub Rowinski at (973) 596-5315 or rowinski@njit.edu. Once again, thank you for your cooperation in completing this survey.

IMPORTANT NOTES:

1. THIS SURVEY WAS DESIGNED TO RUN IN INTERNET EXPLORER. IF YOU DO NOT HAVE INTERNET EXPLORER INSTALLED ON YOUR COMPUTER, PLEASE FOLLOW THE LINK BELOW TO INSTALL THE FREE VERSION.DOWNLOAD INTERNET EXPLORER

2. AS THIS SURVEY REQUIRES THE VIEWING OF SEVERAL SMALL VIDEO CLIPS, IT IS INTENDED FOR A HIGH SPEED INTERNET CONNECTION (T1, CABLE OR DSL). ADDITIONALLY, A MEDIA PLAYER (FOR EXAMPLE WINDOWS MEDIA PLAYER) IS REQUIRED TO VIEW THE VIDEO CLIP. IF YOU DO NOT HAVE A MEDIA PLAYER INSTALLED ON YOUR COMPUTER, PLEASE FOLLOW ONE OF THE LINKS BELOW TO INSTALL A FREE VERSION.

WINDOWS MEDIA   QUICKTIME

PART 1 of 8: INFORMATION ABOUT YOU

1. Please indicate your age:

Under 25 ○ 45 to 54 ○

25 to 34 ○ 55 to 64 ○

35 to 44 ○ 65 and over ○

2. Please indicate your gender:

Male ○ Female ○

3. Please indicate the highest level of education you have completed:

High School ○ Masters degree ○

Associates degree ○ Professional degree(Ph.D, J.D. etc.) ○

Bachelors degree ○

4. Please indicate your occupation (Select a maximum of 2 choices):

Executive Administrative or Management ☐ Work at Home ☐

Professional or Technical ☐ Landscaping or Animal Care ☐

Marketing or Sales ☐ Precision Production or Craft ☐

Administrative Support or Clerical ☐ Operator, Fabricator, or Laborer ☐

Service ☐ Other [ ]

5. Please indicate your annual income:

Under $25,000 ○ $ 75,000 to $ 99,999 ○

$ 25,000 to $ 49,999 ○ Over $ 100,000 ○

$ 50,000 to $ 74,999 ○

6. Home (If inside NJ, please specify county in county box)

City: [ ] State: [Select a State ▾] [Select a County ▾]

7. Work (If inside NJ, please specify county in county box)

City: ☐ State: Select a State ▾ Select a County ▾

8. Please indicate your primary commute mode:

- Drive alone ○
- Drive to ferry ○
- Drive to bus ○
- Walk ○
- Walk to rail ○
- Vanpool ○
- Bicycle ○
- Drive to rail ○
- Carpool ○
- Walk to ferry ○
- Walk to bus ○
- Other ☐

9. Please indicate your average one-way travel time from home to work:

☐ Minutes

10. Please indicate your average one-way travel distance from home to work:

☐ Miles

11. Please list a maximum of 5 locations and time of day where you experience congestion on a consistent basis.

a. Location: ☐

Time of Day: ☐ AM Peak ☐ PM Peak ☐ Weekend Other ☐

b. Location: ☐

Time of Day: ☐ AM Peak ☐ PM Peak ☐ Weekend Other ☐

c. Location: ☐

Time of Day: ☐ AM Peak ☐ PM Peak ☐ Weekend Other ☐

d. Location: ☐

Time of Day: ☐ AM Peak ☐ PM Peak ☐ Weekend Other ☐

e. Location: ______

Time of Day: ☐ AM Peak ☐ PM Peak ☐ Weekend Other ______

12.Please select up to 5 factors you consider important when making travel decisions (route choice, travel mode, departure time) for your commute trip.

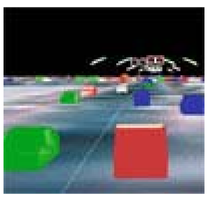
- ☐ Minimize travel time
- ☐ Minimize distance traveled
- ☐ Minimize time spent in heavy traffic
- ☐ Avoiding toll facilities
- ☐ Avoiding freeway travel
- ☐ Avoiding roads with signals
- ☐ Reliability of travel time
- ☐ Route with other amenities along the way (school, shopping)
- ☐ Minimize costs (gas, transit pass, etc.)
- ☐ Avoiding high accident locations
- ☐ Other ______

13. Please provide any comments you may have on the clarity of the survey design.

PART 2 of 8

Instructions: *Before you answer the questions for Part 2 of the survey, you need to review the videos. Imagine that you are traveling on your local roadway going into your monitor.*

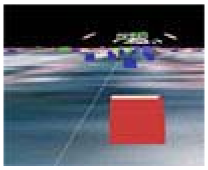
Please note: *A roadway is considered to be congested if the conditions are so undesirable you would consider changing your travel behavior in order to avoid traffic delays. Changing your behavior includes changing your route, your departure time or your travel mode.*

Signalized Intersection	Scenario 1: To what extent would you consider this signalized intersection congested if you were:		
Signalized Intersection Scenario 1	Traveling to/from work	Traveling to/from the shore	Traveling to/from the mall
Video 1			
	O Not at all Congested	O Not at all Congested	O Not at all Congested
	O Slightly Congested	O Slightly Congested	O Slightly Congested
	O Moderately Congested	O Moderately Congested	O Moderately Congested
	O Extremely Congested	O Extremely Congested	O Extremely Congested
Click on image once to play the video			

PART 3 of 8

Instructions: *Before you answer the questions for Part 3 of the survey, you need to review the videos. Imagine that you are traveling on your local roadway going into your monitor.*

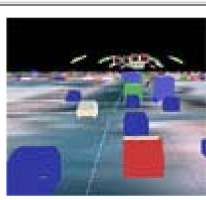
Please note: *A roadway is considered to be congested if the conditions are so undesirable you would consider changing your travel behavior in order to avoid traffic delays. Changing your behavior includes changing your route, your departure time or your travel mode.*

Signalized Intersection Signalized Intersection Scenario 2	Scenario 2: To what extent would you consider this signalized intersection congested if you were:		
	Traveling to/from work	Traveling to/from the shore	Traveling to/from the mall
Video 2			
	O Not at all Congested	O Not at all Congested	O Not at all Congested
	O Slightly Congested	O Slightly Congested	O Slightly Congested
	O Moderately Congested	O Moderately Congested	O Moderately Congested
	O Extremely Congested	O Extremely Congested	O Extremely Congested
Click on image once to play the video			

PART 4 of 8

Instructions: *Before you answer the questions for Part 4 of the survey, you need to review the videos. Imagine that you are traveling on your local roadway going into your monitor.*

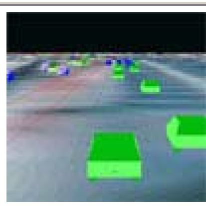
Please note: *A roadway is considered to be congested if the conditions are so undesirable you would consider changing your travel behavior in order to avoid traffic delays. Changing your behavior includes changing your route, your departure time or your travel mode.*

Signalized Intersection Signalized Intersection Scenario 3	Scenario 3: To what extent would you consider this signalized intersection congested if you were:		
	Traveling to/from work	Traveling to/from the shore	Traveling to/from the mall
Video 3			
	O Not at all Congested	O Not at all Congested	O Not at all Congested
	O Slightly Congested	O Slightly Congested	O Slightly Congested
	O Moderately Congested	O Moderately Congested	O Moderately Congested
	O Extremely Congested	O Extremely Congested	O Extremely Congested
Click on image once to play the video			

PART 5 of 8

Instructions: *Before you answer the questions for Part 5 of the survey, you need to review the videos. Imagine that you are traveling on your local roadway going into your monitor.*

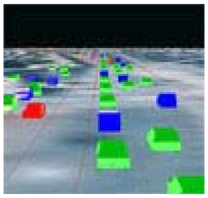
Please note: *A roadway is considered to be congested if the conditions are so undesirable you would consider changing your travel behavior in order to avoid traffic delays. Changing your behavior includes changing your route, your departure time or your travel mode.*

Freeway Section	Scenario 1: To what extent would you consider this freeway section congested if you were:		
Freeway Section Scenario 1	Traveling to/from work	Traveling to/from the shore	Traveling to/from the mall
Video 1			
	O Not at all Congested	O Not at all Congested	O Not at all Congested
	O Slightly Congested	O Slightly Congested	O Slightly Congested
	O Moderately Congested	O Moderately Congested	O Moderately Congested
	O Extremely Congested	O Extremely Congested	O Extremely Congested
Click on image once to play the video			

PART 6 of 8

Instructions: *Before you answer the questions for Part 6 of the survey, you need to review the videos. Imagine that you are traveling on your local roadway going into your monitor.*

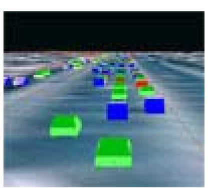
Please note: *A roadway is considered to be congested if the conditions are so undesirable you would consider changing your travel behavior in order to avoid traffic delays. Changing your behavior includes changing your route, your departure time or your travel mode.*

Freeway Section Freeway Section Scenario 2	Scenario 2: To what extent would you consider this freeway section congested if you were:		
	Traveling to/from work	Traveling to/from the shore	Traveling to/from the mall
Video 2			
	○ Not at all Congested	○ Not at all Congested	○ Not at all Congested
	○ Slightly Congested	○ Slightly Congested	○ Slightly Congested
	○ Moderately Congested	○ Moderately Congested	○ Moderately Congested
	○ Extremely Congested	○ Extremely Congested	○ Extremely Congested
Click on image once to play the video			

PART 7 of 8

Instructions: *Before you answer the questions for Part 7 of the survey, you need to review the videos. Imagine that you are traveling on your local roadway going into your monitor.*

Please note: *A roadway is considered to be congested if the conditions are so undesirable you would consider changing your travel behavior in order to avoid traffic delays. Changing your behavior includes changing your route, your departure time or your travel mode.*

Freeway Section Freeway Section Scenario 3	Scenario 3: To what extent would you consider this freeway section congested if you were:		
	Traveling to/from work	Traveling to/from the shore	Traveling to/from the mall
Video 3			
	○ Not at all Congested	○ Not at all Congested	○ Not at all Congested
	○ Slightly Congested	○ Slightly Congested	○ Slightly Congested
	○ Moderately Congested	○ Moderately Congested	○ Moderately Congested
	○ Extremely Congested	○ Extremely Congested	○ Extremely Congested
Click on image once to play the video			

PART 8 of 8: ADDITIONAL QUESTIONS

1. How often do you experience stress in your daily commute to work?

○ always ○ very often ○ often ○ sometimes ○ never

2. How often do you experience stress in your shopping trips?

○ always ○ very often ○ often ○ sometimes ○ never

3. How often do you experience stress in your summer trips to the shore?

○ always ○ very often ○ often ○ sometimes ○ never

4. Have you noticed an increase in driving related stress over the last year?
○ yes ○ no

5. Have you noticed an increase in driving related stress over the last five years? ○ yes ○ no

6. What do you see as the thing most responsible for your stress while driving?

○ aggressive drivers

○ congestion due to road construction

○ congestion due to accidents

○ people who drive too slow

○ other

Thank you very much for your assistance with this survey.

Click to submit --> Submit

Appendix B. Congested Locations

Table B-1 Complaint Weighting Factor by County

COUNTY	NUMBER OF RESPONDENTS HAVING HOME OR WORK COUNTY	% OF RESPONDENTS HAVING HOME OR WORK COUNTY	TOTAL TRIP ENDS	% OF TOTAL TRIP ENDS	FACTOR
Atlantic	81	2.91%	239,920	3.18%	**1.095**
Bergen	162	5.81%	862,060	11.44%	**1.967**
Burlington	153	5.49%	390,555	5.18%	**0.944**
Camden	114	4.09%	426,595	5.66%	**1.383**
Cape May	12	0.43%	82,332	1.09%	**2.536**
Cumberland	17	0.61%	115,255	1.53%	**2.506**
Essex	198	7.11%	682,401	9.06%	**1.274**
Gloucester	57	2.05%	211,822	2.81%	**1.374**
Hudson	77	2.76%	499,237	6.62%	**2.397**
Hunterdon	126	4.52%	112,342	1.49%	**0.330**
Mercer	490	17.59%	363,482	4.82%	**0.274**
Middlesex	239	8.58%	732,985	9.73%	**1.134**
Monmouth	160	5.74%	533,646	7.08%	**1.233**
Morris	252	9.05%	516,804	6.86%	**0.758**
Ocean	61	2.19%	349,709	4.64%	**2.119**
Passaic	70	2.51%	383,596	5.09%	**2.026**
Salem	8	0.29%	51,750	0.69%	**2.391**
Somerset	100	3.59%	313,542	4.16%	**1.159**
Sussex	50	1.79%	112,677	1.50%	**0.833**
Union	67	2.40%	467,689	6.21%	**2.581**
Warren	27	0.97%	87,774	1.16%	**1.202**

Table B-2 Congested Locations by Route

Facility	Location	County	Type	Number of Complaints	County Weight	Weighted Complaints
I 76	I 295 / I 76	Camden	Intersection/Point	7	1.38	9.7
	I 76 : Whitman Br. to I 676	Camden	Corridor	6	1.38	8.3
	I 76 / NJ 42	Camden	Intersection/Point	4	1.38	5.5
	I 76 / Walt Whitman Bridge	Camden	Intersection/Point	4	1.38	5.5
	I 76 / I 676	Camden	Intersection/Point	2	1.38	2.8
I 78	I 287 / I 78	Somerset	Intersection/Point	19	1.16	22.0
	I 78 / Co 513	Hunterdon	Intersection/Point	18	0.33	6.0
	NJ 24 / I 78	Union	Intersection/Point	13	2.59	33.6
	US 22 / I 78	Warren	Intersection/Point	12	1.17	14.0
	I 78 / Holland Tunnel	Hudson	Intersection/Point	11	2.37	26.0
	I 78 : Jugtown Mountain	Hunterdon	Corridor	7	0.33	2.3
	I 78 : Approach to Holland Tunnel	Hudson	Corridor	6	2.37	14.2
	I 78 / Exit 12	Hunterdon	Intersection/Point	6	0.33	2.0
	I 78 / Exit 18 (US 22)	Hunterdon	Intersection/Point	6	0.33	2.0
	I 78 : Clinton Twp	Hunterdon	Corridor	6	0.33	2.0
	GSP / I 78	Union	Intersection/Point	5	2.59	12.9
	I 78 / Exit 11	Hunterdon	Intersection/Point	4	0.33	1.3
	I 78 / Exit 54 (Winans Ave)	Essex	Intersection/Point	3	1.28	3.8
	I 78 / Delaware River Toll	Warren	Intersection/Point	3	1.17	3.5
	I 78 : Berkeley Heights Twp	Union	Corridor	2	2.59	5.2
	US 1&9 / I 78	Essex	Intersection/Point	2	1.28	2.6
	I 78 : Whitehouse To Clinton	Hunterdon	Corridor	2	0.33	0.7
	I 78 : Readington Twp	Hunterdon	Corridor	2	0.33	0.7
	NJ 31 / I 78	Hunterdon	Intersection/Point	2	0.33	0.7
I 80	I 287 / I 80	Morris	Intersection/Point	32	0.76	24.4
	I 80 / NJ 15	Morris	Intersection/Point	22	0.76	16.8
	I 80 : Rockaway Twp Border - Exit 39	Morris	Corridor	15	0.76	11.4
	I 80 : Exit 39 - Parsipanny Twp Border	Morris	Corridor	13	0.76	9.9
	I 80 : Denville Twp Border - I 287	Morris	Corridor	13	0.76	9.9
	I 80 : Rockaway Twp	Morris	Corridor	12	0.76	9.1
	I 80 : Exit 34 - Rockaway Twp Border	Morris	Corridor	12	0.76	9.1
	I 80 : Exit 57-60	Passaic	Corridor	9	2.04	18.3
	I 80 : Rockaway Boro - Denville Twp Border	Morris	Corridor	9	0.76	6.9
	I 80 : I 287- Montville Twp Border	Morris	Corridor	8	0.76	6.1
	I 80 : Paterson Boro	Passaic	Corridor	7	2.04	14.3
	I 80 / US 46	Morris	Intersection/Point	7	0.76	5.3
	I 280 / I 80	Morris	Intersection/Point	7	0.76	5.3
	NJ 17 / I 80	Bergen	Intersection/Point	3	1.97	5.9
	I 80 / Exit 35	Morris	Intersection/Point	3	0.76	2.3
	I 80 : Wharton Boro	Morris	Corridor	3	0.76	2.3
	I 80 / Exit 19	Warren	Intersection/Point	2	1.17	2.3
	I 80 / Exit 28	Morris	Intersection/Point	2	0.76	1.5
	I 80 / Mp 40	Morris	Intersection/Point	2	0.76	1.5
	I 80 / US 202	Morris	Intersection/Point	2	0.76	1.5
	US 206 / I 80	Morris	Intersection/Point	2	0.76	1.5
I 95	I 95 / George Washington Br	Bergen	Intersection/Point	5	1.97	9.9
I 195	I 195 / I 295	Mercer	Intersection/Point	4	0.27	1.1
	NJ 29 / I 195	Mercer	Intersection/Point	3	0.27	0.8
I 280	GSP / I 280	Essex	Intersection/Point	27	1.28	34.4
	I 280 / I 80	Morris	Intersection/Point	7	0.76	5.3
	I 280 / Stickle Bridge / NJ 21	Essex	Intersection/Point	6	1.28	7.7
	I 280 : Newark City	Essex	Corridor	3	1.28	3.8

Table B-2. Congested Locations by Route Cont'd

Facility	Location	County	Type	Number of Complaints	County Weight	Weighted Complaints
I 287	I 287 / NJ 24	Morris	Intersection/Point	43	0.76	32.8
	I 287 / I 80	Morris	Intersection/Point	32	0.76	24.4
	I 287 / I 78	Somerset	Intersection/Point	19	1.16	22.0
	NJ 10 / I 287	Morris	Intersection/Point	15	0.76	11.4
	I 287 : Exit 10-12	Somerset	Corridor	11	1.16	12.7
	I 287 : Exit 9 -10	Middlesex	Corridor	11	1.13	12.4
	I 287 : Exit 1 - South Plainfield Boro	Middlesex	Corridor	9	1.13	10.2
	I 287 : Morristown Town	Morris	Corridor	9	0.76	6.9
	I 287 / GSP	Middlesex	Intersection/Point	7	1.13	7.9
	I 287 / Easton Ave	Somerset	Intersection/Point	5	1.16	5.8
	I 287 : Exit 12-13	Somerset	Corridor	5	1.16	5.8
	I 287 : Exit 1 - NJTPKE	Middlesex	Corridor	5	1.13	5.7
	US 1 / I 287 / US 440	Middlesex	Intersection/Point	5	1.13	5.7
	I 287 : Exit 8 -9	Middlesex	Corridor	4	1.13	4.5
	I 287 : Exit 4 - Edison Twp Border	Middlesex	Corridor	4	1.13	4.5
	I 287 : Parsippany-Troy Hills	Morris	Corridor	4	0.76	3.0
	I 287 / Exit 12 (Weston Canal Rd)	Somerset	Intersection/Point	3	1.16	3.5
	I 287 : Exit 13-14	Somerset	Corridor	3	1.16	3.5
	US 206/202 / I 287	Somerset	Intersection/Point	3	1.16	3.5
	I 287 / Exit 30 (Maple Ave)	Somerset	Intersection/Point	2	1.16	2.3
	I 287 / US 202	Somerset	Intersection/Point	2	1.16	2.3
	I 287 : Somerville Boro	Somerset	Corridor	2	1.16	2.3
	US 22 / I 287	Somerset	Intersection/Point	2	1.16	2.3
	I 287 / Exit 5 (Co 529)	Middlesex	Intersection/Point	2	1.13	2.3
	I 287 / NJ 440	Middlesex	Intersection/Point	2	1.13	2.3
	I 287 : Exit 4 - 8	Middlesex	Corridor	2	1.13	2.3
	I 287 : Boonton Town	Morris	Corridor	2	0.76	1.5
I 295	US 1 / I 295	Mercer	Intersection/Point	39	0.27	10.7
	I 295 / NJ 42	Camden	Intersection/Point	33	1.38	45.6
	I 295 / Scudders Fall Bridge	Mercer	Intersection/Point	25	0.27	6.9
	I 295 / NJ 70	Camden	Intersection/Point	13	1.38	18.0
	I 295 / NJ 73	Burlington	Intersection/Point	12	0.94	11.3
	I 295 / I 76	Camden	Intersection/Point	7	1.38	9.7
	I 295 : NJ 73 - NJ 42	Camden	Corridor	4	1.38	5.5
	I 195 / I 295	Mercer	Intersection/Point	4	0.27	1.1
	US 130 / I 295	Gloucester	Intersection/Point	3	1.41	4.2
	NJ 29 / I 295	Mercer	Intersection/Point	3	0.27	0.8
	I 295 / White Horse Pike	Camden	Intersection/Point	2	1.38	2.8
	I 295 : NJ 38 - NJ 73	Burlington	Corridor	2	0.94	1.9
	I 295 / Scotch Rd	Mercer	Intersection/Point	2	0.27	0.5
	US 206 / I 295	Mercer	Intersection/Point	2	0.27	0.5
I 676	I 76 / I 676	Camden	Intersection/Point	2	1.38	2.8
New Jersey Turnpike	NJ 18 / NJTPKE (Exit 9)	Middlesex	Intersection/Point	16	1.13	18.1
	NJTPKE / Exit 11	Middlesex	Intersection/Point	13	1.13	14.7
	NJTPKE / Exit 8A (NJ 32)	Middlesex	Intersection/Point	9	1.13	10.2
	NJTPKE : Exit 7A-8	Mercer	Corridor	7	0.27	1.9
	NJTPKE / Exit 16E	Hudson	Intersection/Point	6	2.37	14.2
	NJTPKE / Exit 13	Union	Intersection/Point	5	2.59	12.9
	NJTPKE : Exit 13-13A	Union	Corridor	5	2.59	12.9
	NJTPKE : Exit 8 -9	Middlesex	Corridor	5	1.13	5.7
	NJTPKE : Newark Bay Ext	Hudson	Corridor	4	2.37	9.5
	NJTPKE / Exit 14	Essex	Intersection/Point	4	1.28	5.1
	NJ 73 / NJTPKE	Burlington	Intersection/Point	4	0.94	3.8
	NJTPKE / Exit 8	Mercer	Intersection/Point	4	0.27	1.1
	NJTPKE / Exit 15W	Hudson	Intersection/Point	3	2.37	7.1
	NJTPKE / Exit 16W	Bergen	Intersection/Point	2	1.97	3.9
	NJ 168 / NJTPKE	Camden	Intersection/Point	2	1.38	2.8
	NJTPKE / Exit 15E	Essex	Intersection/Point	2	1.28	2.6
	NJTPKE : Exit 13A-15W	Essex	Corridor	2	1.28	2.6
	NJTPKE / Exit 12	Middlesex	Intersection/Point	2	1.13	2.3
	NJTPKE : Exit 10-13	Middlesex	Corridor	2	1.13	2.3
	NJTPKE : Exit 7-7A	Mercer	Corridor	2	0.27	0.5

Table B-2. Congested Locations by Route Cont'd

Facility	Location	County	Type	Number of Complaints	County Weight	Weighted Complaints
Garden State Parkway	GSP / I 280	Essex	Intersection/Point	27	1.28	34.4
	GSP / US 9	Middlesex	Intersection/Point	24	1.13	27.1
	GSP / Union Toll	Union	Intersection/Point	19	2.59	49.1
	NJTPKE / Exit 11	Middlesex	Intersection/Point	13	1.13	14.7
	I 287 / GSP	Middlesex	Intersection/Point	7	1.13	7.9
	GSP / I 78	Union	Intersection/Point	5	2.59	12.9
	GSP / Toms River	Ocean	Intersection/Point	5	2.11	10.5
	US 1 / GSP	Middlesex	Intersection/Point	5	1.13	5.7
	GSP : Exit 142 -150	Essex	Corridor	4	1.28	5.1
	GSP / Stone Harbor Blvd	Cape May	Intersection/Point	2	2.73	5.5
	GSP / Exit 135	Union	Intersection/Point	2	2.59	5.2
	GSP : Exit 140-142	Union	Corridor	2	2.59	5.2
	GSP / Hillsdale Toll	Bergen	Intersection/Point	2	1.97	3.9
	GSP / Exit 109 (Co 520)	Monmouth	Intersection/Point	2	1.24	2.5
	GSP / Exit 123	Middlesex	Intersection/Point	2	1.13	2.3
	GSP : Exit 120 - 127	Middlesex	Corridor	2	1.13	2.3
US 1	US 1 / I 295	Mercer	Intersection/Point	39	0.27	10.7
	US 1 / Nassau Park Blvd	Mercer	Intersection/Point	27	0.27	7.4
	US 1 / Washington Rd	Mercer	Intersection/Point	21	0.27	5.8
	US 1 : West Windsor Twp	Mercer	Corridor	15	0.27	4.1
	US 1 / Franklin Corner Rd	Mercer	Intersection/Point	13	0.27	3.6
	US 1 / Quakerbridge Rd	Mercer	Intersection/Point	12	0.27	3.3
	US 1 : Princeton	Mercer	Corridor	11	0.27	3.0
	US 1 / Plainfield Ave	Middlesex	Intersection/Point	10	1.13	11.3
	US 1 : Menlo Park	Middlesex	Corridor	8	1.13	9.0
	US 1 / Ridge Rd	Middlesex	Intersection/Point	7	1.13	7.9
	US 1 / Woodbridge Center Dr	Middlesex	Intersection/Point	7	1.13	7.9
	US 1 / US 130	Middlesex	Intersection/Point	6	1.13	6.8
	US 1 : New Brunswick City	Middlesex	Corridor	6	1.13	6.8
	US 1 : Lawrenceville	Mercer	Corridor	6	0.27	1.6
	US 1 / GSP	Middlesex	Intersection/Point	5	1.13	5.7
	US 1 / I 287 / US 440	Middlesex	Intersection/Point	5	1.13	5.7
	US 1 / NJ 18	Middlesex	Intersection/Point	5	1.13	5.7
	US 1 : Edison Twp	Middlesex	Corridor	5	1.13	5.7
	US 1 : Trenton City	Mercer	Corridor	5	0.27	1.4
	US 1 : Trenton City	Mercer	Corridor	5	0.27	1.4
	US 1 / Harrison St	Middlesex	Intersection/Point	4	1.13	4.5
	US 1 / Old Post Rd	Middlesex	Intersection/Point	4	1.13	4.5
	US 1 / Plainsboro Rd	Middlesex	Intersection/Point	4	1.13	4.5
	US 1 : Lawrence	Mercer	Corridor	4	0.27	1.1
	US 1 / Ford Ave	Middlesex	Intersection/Point	3	1.13	3.4
	US 1 / Grandview Ave	Middlesex	Intersection/Point	3	1.13	3.4
	US 1 / Scudder Mill Rd	Middlesex	Intersection/Point	3	1.13	3.4
	US 1 : Menlo Park	Middlesex	Corridor	3	1.13	3.4
	US 1 / N Olden Ave	Mercer	Intersection/Point	3	0.27	0.8
	US 1 / NJ 29	Mercer	Intersection/Point	3	0.27	0.8
	US 1 : Trenton City	Mercer	Corridor	3	0.27	0.8
	US 1 / Henderson Rd	Middlesex	Intersection/Point	2	1.13	2.3
	US 1 / Parsonage Rd	Middlesex	Intersection/Point	2	1.13	2.3
	US 1 / Stouts Ln	Middlesex	Intersection/Point	2	1.13	2.3
	US 1 / Carnegie Center	Mercer	Intersection/Point	2	0.27	0.5
	US 1 / Pa/NJ Toll Bridge	Mercer	Intersection/Point	2	0.27	0.5
	US 1 : Lawrence	Mercer	Corridor	2	0.27	0.5
	US 1 : Lawrence	Mercer	Corridor	2	0.27	0.5
US 1&9	US 1&9 / Pulaski Skyway (NJ 7)	Hudson	Intersection/Point	5	2.37	11.8
	US 1&9 / I 78	Essex	Intersection/Point	2	1.28	2.6
	US 1&9 / Newark Airport	Essex	Intersection/Point	2	1.28	2.6

Table B-2. Congested Locations by Route Cont'd

Facility	Location	County	Type	Number of Complaints	County Weight	Weighted Complaints
US 9	GSP / US 9	Middlesex	Intersection/Point	24	1.13	27.1
	US 9 / Edison Bridge	Middlesex	Intersection/Point	8	1.13	9.0
	US 9 / Co 520	Monmouth	Intersection/Point	7	1.24	8.7
	US 9 / E Freehold St	Monmouth	Intersection/Point	6	1.24	7.5
	US 9 : Malboro Twp	Monmouth	Corridor	6	1.24	7.5
	US 9 : Manalapan Twp	Monmouth	Corridor	5	1.24	6.2
	US 9 : Lacey Twp	Ocean	Corridor	4	2.11	8.4
	US 9 / Taylors Mill Rd	Monmouth	Intersection/Point	4	1.24	5.0
	US 9 : Freehold Twp	Monmouth	Corridor	4	1.24	5.0
	US 9 : Sayreville Boro	Middlesex	Corridor	4	1.13	4.5
	NJ 35 / US 9	Middlesex	Intersection/Point	4	1.13	4.5
	US 9 : Little Egg Harbor To Ocean	Ocean	Corridor	2	2.11	4.2
	US 9 : Dover to Berkeley	Ocean	Corridor	2	2.11	4.2
	US 9 / Elton Adelphia Rd	Monmouth	Intersection/Point	2	1.24	2.5
	US 9 / Schanck Rd	Monmouth	Intersection/Point	2	1.24	2.5
	US 9 : Howell Twp	Monmouth	Corridor	2	1.24	2.5
	US 9 / NJ 440	Middlesex	Intersection/Point	2	1.13	2.3
	US 9 : Jakes Rd To NJ 34	Middlesex	Corridor	2	1.13	2.3
	US 9 / Tilton Rd	Atlantic	Intersection/Point	2	1.10	2.2
US 22	US 22 / I 78	Warren	Intersection/Point	12	1.17	14.0
	US 22 : Union Twp	Union	Corridor	9	2.59	23.3
	US 22 : Lebanon Boro	Hunterdon	Corridor	6	0.33	2.0
	US 206/202 / US 22	Somerset	Intersection/Point	4	1.16	4.6
	US 22 : Clinton Twp	Hunterdon	Corridor	4	0.33	1.3
	US 22 : Clinton Twp	Hunterdon	Corridor	4	0.33	1.3
	US 22 / New Providence Rd	Union	Intersection/Point	2	2.59	5.2
	US 22 / Park Ave	Union	Intersection/Point	2	2.59	5.2
	US 22 / I 287	Somerset	Intersection/Point	2	1.16	2.3
	US 22 : Whitehouse	Hunterdon	Corridor	2	0.33	0.7
US 30	US 30 / NJ 38	Camden	Intersection/Point	2	1.38	2.8
	US 30 : Absecon City	Atlantic	Corridor	2	1.10	2.2
US 40	US 322 / US 40	Atlantic	Intersection/Point	7	1.10	7.7
	US 40 : Mays Landing	Atlantic	Corridor	2	1.10	2.2
US 46	US 46 / NJ 3	Passaic	Intersection/Point	14	2.04	28.5
	US 46 / I 80 (Denville)	Morris	Intersection/Point	9	0.76	6.9
	I 80 / US 46	Morris	Intersection/Point	7	0.76	5.3
	US 46 : Totowa Boro	Passaic	Corridor	5	2.04	10.2
	NJ 21 / US 46	Passaic	Intersection/Point	5	2.04	10.2
	US 46 / NJ 10	Morris	Intersection/Point	4	0.76	3.0
	US 46 / Riverview Dr	Passaic	Intersection/Point	3	2.04	6.1
	US 46 : Hackettstown Twp	Warren	Corridor	3	1.17	3.5
	US 46 : Ledgewood	Morris	Corridor	3	0.76	2.3
	US 46 : Little Falls Twp	Passaic	Corridor	2	2.04	4.1
	US 46 : Wayne Twp	Passaic	Corridor	2	2.04	4.1
	US 46 : Parsipanny	Morris	Corridor	2	0.76	1.5
US 130	US 1 / US 130	Middlesex	Intersection/Point	6	1.13	6.8
	US 206 / US 130	Burlington	Intersection/Point	6	0.94	5.7
	US 130 / Cinnaminson Ave	Burlington	Intersection/Point	4	0.94	3.8
	US 130 / I 295	Gloucester	Intersection/Point	3	1.41	4.2

Table B-2. Congested Locations by Route Cont'd

Facility	Location	County	Type	Number of Complaints	County Weight	Weighted Complaints
US 202	NJ 10 / US 202	Morris	Intersection/Point	7	0.76	5.3
	NJ 31 / US 202	Hunterdon	Intersection/Point	5	0.33	1.7
	I 287 / US 202	Somerset	Intersection/Point	2	1.16	2.3
	I 80 / US 202	Morris	Intersection/Point	2	0.76	1.5
US 206	US 206 / NJ 38	Burlington	Intersection/Point	8	0.94	7.5
	US 206 / CO. 518	Somerset	Intersection/Point	6	1.16	6.9
	US 206 / US 130	Burlington	Intersection/Point	6	0.94	5.7
	NJ 38 / US 206	Burlington	Intersection/Point	5	0.94	4.7
	US 206 : Byram Twp	Sussex	Corridor	5	0.83	4.2
	US 206 : Hillsborough Twp	Somerset	Corridor	4	1.16	4.6
	US 206 / NJ 70	Burlington	Intersection/Point	4	0.94	3.8
	US 206 / Franklin Corner Rd	Mercer	Intersection/Point	4	0.27	1.1
	US 206 : Montgomery Twp	Somerset	Corridor	2	1.16	2.3
	US 206 / Co 537	Burlington	Intersection/Point	2	0.94	1.9
	US 206 / Old York Rd	Burlington	Intersection/Point	2	0.94	1.9
	US 206 / I 80	Morris	Intersection/Point	2	0.76	1.5
	US 206 : Flanders	Morris	Corridor	2	0.76	1.5
	US 206 / I 295	Mercer	Intersection/Point	2	0.27	0.5
	US 206 / Provinceline Rd	Mercer	Intersection/Point	2	0.27	0.5
US 206/202	US 206/202 / US 22	Somerset	Intersection/Point	4	1.16	4.6
	US 206/202 / I 287	Somerset	Intersection/Point	3	1.16	3.5
US 322	US 322 / US 40	Atlantic	Intersection/Point	7	1.10	7.7
	NJ 55 / US 322	Gloucester	Intersection/Point	3	1.41	4.2
	US 322 / Wrangleboro Rd	Atlantic	Intersection/Point	3	1.10	3.3
	US 322 / Fries Mill Rd	Gloucester	Intersection/Point	2	1.41	2.8
	US 322 / NJ 45	Gloucester	Intersection/Point	2	1.41	2.8
	US 322 : English Creek To Wrangleboro Rd	Atlantic	Corridor	2	1.10	2.2
NJ 3	US 46 / NJ 3	Passaic	Intersection/Point	14	2.04	28.5
	NJ 21 / NJ 3	Passaic	Intersection/Point	8	2.04	16.3
	NJ 3 / I 495	Hudson	Intersection/Point	3	2.37	7.1
	NJ 3 : Clifton City	Passaic	Corridor	2	2.04	4.1
	NJ 17 / NJ 3	Bergen	Intersection/Point	2	1.97	3.9
NJ 4	NJ 17 / NJ 4	Bergen	Intersection/Point	11	1.97	21.7
	NJ 4 : Teaneck Twp	Bergen	Corridor	6	1.97	11.8
	NJ 4 : Paramus Boro	Bergen	Corridor	5	1.97	9.9
	NJ 4 / NJ 208	Bergen	Intersection/Point	2	1.97	3.9
NJ 7	US 1&9 / Pulaski Skyway (NJ 7)	Hudson	Intersection/Point	5	2.37	11.8
NJ 10	NJ 10 / I 287	Morris	Intersection/Point	15	0.76	11.4
	NJ 10 : Roxbury Twp	Morris	Corridor	8	0.76	6.1
	NJ 10 / US 202	Morris	Intersection/Point	7	0.76	5.3
	US 46 / NJ 10	Morris	Intersection/Point	4	0.76	3.0
	NJ 10 / Livingston Circle	Essex	Intersection/Point	2	1.28	2.6
	NJ 10 / Powder Mill Rd	Morris	Intersection/Point	2	0.76	1.5
	NJ 10 : Denville Twp	Morris	Corridor	2	0.76	1.5
	NJ 10 : Parsippany-Troy Hills	Morris	Corridor	2	0.76	1.5
	NJ 10 : East Hanover Twp	Morris	Corridor	2	0.76	1.5
NJ 15	I 80 / NJ 15	Morris	Intersection/Point	22	0.76	16.8
	NJ 15 : Jefferson Twp	Morris	Corridor	4	0.76	3.0
	NJ 15 / Berkshire Valley Rd	Morris	Intersection/Point	3	0.76	2.3
NJ 17	NJ 17 / NJ 4	Bergen	Intersection/Point	11	1.97	21.7
	NJ 17 : Paramus Boro	Bergen	Corridor	9	1.97	17.7
	NJ 17 / I 80	Bergen	Intersection/Point	3	1.97	5.9
	NJ 17 : Lodi Boro	Bergen	Corridor	3	1.97	5.9
	NJ 17 / NJ 3	Bergen	Intersection/Point	2	1.97	3.9
	NJ 17 / Polifly Rd	Bergen	Intersection/Point	2	1.97	3.9
	NJ 17 : Hasbrouck Heights	Bergen	Corridor	2	1.97	3.9
	NJ 17 : Maywood Boro	Bergen	Corridor	2	1.97	3.9

Table B-2. Congested Locations by Route Cont'd

Facility	Location	County	Type	Number of Complaints	County Weight	Weighted Complaints
NJ 18	NJ 18 / NJTPKE (Exit 9)	Middlesex	Intersection/Point	16	1.13	18.1
	NJ 18 : East Brunswick Twp	Middlesex	Corridor	15	1.13	17.0
	NJ 18 : New Brunswick City	Middlesex	Corridor	8	1.13	9.0
	NJ 18 / Commercial Ave	Middlesex	Intersection/Point	7	1.13	7.9
	NJ 18 / Tices Ln	Middlesex	Intersection/Point	5	1.13	5.7
	US 1 / NJ 18	Middlesex	Intersection/Point	5	1.13	5.7
	NJ 18 : Old Bridge Twp	Middlesex	Corridor	3	1.13	3.4
	NJ 18 / Ferry Rd	Middlesex	Intersection/Point	2	1.13	2.3
	NJ 18 / River Rd	Middlesex	Intersection/Point	2	1.13	2.3
NJ 21	NJ 21 / NJ 3	Passaic	Intersection/Point	8	2.04	16.3
	NJ 21 / US 46	Passaic	Intersection/Point	5	2.04	10.2
	NJ 21 / Raymond Blvd	Essex	Intersection/Point	2	1.28	2.6
NJ 23	NJ 23 : West Milford Twp	Morris	Corridor	9	0.76	6.9
	NJ 23 : West Milford Twp	Passaic	Corridor	4	2.04	8.1
	NJ 23 : West Milford Twp	Passaic	Corridor	4	2.04	8.1
	NJ 23 : West Milford Twp	Morris	Corridor	4	0.76	3.0
	NJ 23 : Riverdale Boro	Morris	Corridor	4	0.76	3.0
	NJ 23 / Packanack Lake Rd	Passaic	Intersection/Point	2	2.04	4.1
	NJ 23 : Butler Boro	Morris	Corridor	2	0.76	1.5
NJ 24	I 287 / NJ 24	Morris	Intersection/Point	43	0.76	32.8
	NJ 24 / I 78	Union	Intersection/Point	13	2.59	33.6
	NJ 24 / Short Hills Mall	Union	Intersection/Point	3	2.59	7.8
	NJ 24 : Chatham Boro	Morris	Corridor	2	0.76	1.5
NJ 27	NJ 27 : Edison Twp	Middlesex	Corridor	8	1.13	9.0
	NJ 27 / Plainfield Ave	Middlesex	Intersection/Point	3	1.13	3.4
	NJ 27 / New Rd	Middlesex	Intersection/Point	2	1.13	2.3
	NJ 27 / Talmadge Rd	Middlesex	Intersection/Point	2	1.13	2.3
NJ 29	NJ 29 / Tunnel	Mercer	Intersection/Point	34	0.27	9.3
	NJ 29 / Cass St (Waterfront Park)	Mercer	Intersection/Point	21	0.27	5.8
	NJ 29 / Sullivan Way	Mercer	Intersection/Point	20	0.27	5.5
	NJ 29 / CO. 546 (Washington Crossing)	Mercer	Intersection/Point	5	0.27	1.4
	NJ 29 / Warren St	Mercer	Intersection/Point	5	0.27	1.4
	NJ 29 / Calhoun St	Mercer	Intersection/Point	3	0.27	0.8
	NJ 29 / I 195	Mercer	Intersection/Point	3	0.27	0.8
	NJ 29 / I 295	Mercer	Intersection/Point	3	0.27	0.8
	US 1 / NJ 29	Mercer	Intersection/Point	3	0.27	0.8
	NJ 29 / Lalor St	Mercer	Intersection/Point	2	0.27	0.5
NJ 31	NJ 31 : Clinton Twp	Hunterdon	Corridor	8	0.33	2.6
	NJ 31 : Glen Gardner Boro	Hunterdon	Corridor	7	0.33	2.3
	NJ 31 : Hampton Boro	Hunterdon	Corridor	6	0.33	2.0
	NJ 31 / US 202	Hunterdon	Intersection/Point	5	0.33	1.7
	NJ 31 / Delaware Ave	Mercer	Intersection/Point	4	0.27	1.1
	NJ 31 / Co 579	Hunterdon	Intersection/Point	3	0.33	1.0
	NJ 31 : Clinton - Washington	Warren	Corridor	2	1.17	2.3
	NJ 31 : Clinton - Washington	Warren	Corridor	2	1.17	2.3
	NJ 31 / I 78	Hunterdon	Intersection/Point	2	0.33	0.7
	NJ 31 : Clinton - Flemington	Hunterdon	Corridor	2	0.33	0.7
	NJ 31 : Lebanon Township	Hunterdon	Corridor	2	0.33	0.7
	NJ 31 / Ewingville Rd	Mercer	Intersection/Point	2	0.27	0.5
NJ 33	NJ 33 : Hamilton Twp	Mercer	Corridor	5	0.27	1.4

Table B-2. Congested Locations by Route Cont'd

Facility	Location	County	Type	Number of Complaints	County Weight	Weighted Complaints
NJ 35	NJ 35 / NJ 36	Monmouth	Intersection/Point	4	1.24	5.0
	NJ 35 : Holmdel Twp	Monmouth	Corridor	4	1.24	5.0
	NJ 35 : Eatontown Boro	Monmouth	Corridor	4	1.24	5.0
	NJ 35 : Middletown Twp	Monmouth	Corridor	4	1.24	5.0
	NJ 36 / NJ 35	Monmouth	Intersection/Point	4	1.24	5.0
	NJ 35 / US 9	Middlesex	Intersection/Point	4	1.13	4.5
	NJ 35 : Monmouth Cnty Excluding Holmdel	Monmouth	Corridor	2	1.24	2.5
	NJ 35 : Ocean, Neptune, & Neptune City	Monmouth	Corridor	2	1.24	2.5
	NJ 35 : Red Bank - Shrewsbury Boro	Monmouth	Corridor	2	1.24	2.5
NJ 36	NJ 36 / NJ 35	Monmouth	Intersection/Point	4	1.24	5.0
	NJ 35 / NJ 36	Monmouth	Intersection/Point	4	1.24	5.0
	NJ 36 : Hazlet Twp	Monmouth	Corridor	2	1.24	2.5
	NJ 36 : Eatontown Boro	Monmouth	Corridor	2	1.24	2.5
NJ 37	NJ 166 / NJ 37	Ocean	Intersection/Point	7	2.11	14.8
NJ 38	US 206 / NJ 38	Burlington	Intersection/Point	8	0.94	7.5
	NJ 38 / US 206	Burlington	Intersection/Point	5	0.94	4.7
	NJ 38 / Church Rd	Camden	Intersection/Point	2	1.38	2.8
	US 30 / NJ 38	Camden	Intersection/Point	2	1.38	2.8
	NJ 38 / Cherry Hill Mall	Burlington	Intersection/Point	2	0.94	1.9
	NJ 38 / Moorestown Mall	Burlington	Intersection/Point	2	0.94	1.9
NJ 41	NJ 70 / NJ 41	Camden	Intersection/Point	5	1.38	6.9
	NJ 41 / NJ 47	Gloucester	Intersection/Point	3	1.41	4.2
NJ 42	I 295 / NJ 42	Camden	Intersection/Point	33	1.38	45.6
	NJ 55 / NJ 42	Gloucester	Intersection/Point	18	1.41	25.3
	I 76 / NJ 42	Camden	Intersection/Point	4	1.38	5.5
	NJ 42 / Blackwood Clementon	Camden	Intersection/Point	2	1.38	2.8
	NJ 42 / Creek Rd	Camden	Intersection/Point	2	1.38	2.8
	NJ 42 / Woodbury Turnersville Rd	Camden	Intersection/Point	2	1.38	2.8
NJ 45	US 322 / NJ 45	Gloucester	Intersection/Point	2	1.41	2.8
NJ 47	NJ 347 / NJ 47	Cumberland	Intersection/Point	4	2.55	10.2
	NJ 55 / NJ 47	Cumberland	Intersection/Point	4	2.55	10.2
	NJ 47 / NJ 55	Gloucester	Intersection/Point	3	1.41	4.2
	NJ 41 / NJ 47	Gloucester	Intersection/Point	3	1.41	4.2
	NJ 47 : Vineland City	Cumberland	Corridor	2	2.55	5.1
NJ 55	NJ 55 / NJ 42	Gloucester	Intersection/Point	18	1.41	25.3
	NJ 55 / NJ 47	Cumberland	Intersection/Point	4	2.55	10.2
	NJ 55 / US 322	Gloucester	Intersection/Point	3	1.41	4.2
	NJ 47 / NJ 55	Gloucester	Intersection/Point	3	1.41	4.2
	NJ 55 / Deptford Mall	Gloucester	Intersection/Point	2	1.41	2.8
NJ 70	NJ 70 / NJ 73	Burlington	Intersection/Point	25	0.94	23.6
	NJ 70 : Cherry Hill Twp	Camden	Corridor	24	1.38	33.1
	I 295 / NJ 70	Camden	Intersection/Point	13	1.38	18.0
	NJ 70 / NJ 41	Camden	Intersection/Point	5	1.38	6.9
	NJ 70 / Chambersbridge Rd	Ocean	Intersection/Point	4	2.11	8.4
	NJ 70 / Springdale Rd	Camden	Intersection/Point	4	1.38	5.5
	US 206 / NJ 70	Burlington	Intersection/Point	4	0.94	3.8
	NJ 70 / N Elmwood Rd	Burlington	Intersection/Point	2	0.94	1.9
NJ 73	NJ 70 / NJ 73	Burlington	Intersection/Point	25	0.94	23.6
	NJ 73 / Church Rd	Burlington	Intersection/Point	12	0.94	11.3
	I 295 / NJ 73	Burlington	Intersection/Point	12	0.94	11.3
	NJ 73 / Evesham Rd	Burlington	Intersection/Point	7	0.94	6.6
	NJ 73 / Fellowship Rd	Burlington	Intersection/Point	6	0.94	5.7
	NJ 73 / NJTPKE	Burlington	Intersection/Point	4	0.94	3.8
	NJ 73 : Voorhees Twp	Camden	Corridor	3	1.38	4.1
	NJ 73 / Brick Rd	Burlington	Intersection/Point	2	0.94	1.9
	NJ 73 / Lincoln Dr	Burlington	Intersection/Point	2	0.94	1.9

Table B-2. Congested Locations by Route Cont'd

Facility	Location	County	Type	Number of Complaints	County Weight	Weighted Complaints
NJ 129	NJ 129 / Cass St	Mercer	Intersection/Point	7	0.27	1.9
	NJ 129 / Lalor St	Mercer	Intersection/Point	5	0.27	1.4
	NJ 129 : Trenton City	Mercer	Corridor	4	0.27	1.1
NJ 166	NJ 166 / NJ 37	Ocean	Intersection/Point	7	2.11	14.8
	NJ 166 / Water St	Ocean	Intersection/Point	2	2.11	4.2
NJ 168	NJ 168 / NJTPKE	Camden	Intersection/Point	2	1.38	2.8
NJ 208	NJ 4 / NJ 208	Bergen	Intersection/Point	2	1.97	3.9
NJ 347	NJ 347 / NJ 47	Cumberland	Intersection/Point	4	2.55	10.2
NJ 440	US 1 / I 287 / US 440	Middlesex	Intersection/Point	5	1.13	5.7
	I 287 / NJ 440	Middlesex	Intersection/Point	2	1.13	2.3
	US 9 / NJ 440	Middlesex	Intersection/Point	2	1.13	2.3
NJ 495	I 495 / Lincoln Tunnel	Hudson	Intersection/Point	15	2.37	35.5
	NJ 3 / I 495	Hudson	Intersection/Point	3	2.37	7.1
	NJ 495 : Approach to Lincoln Tunnel	Hudson	Corridor	2	2.37	4.7
CO 513	I 78 / Co 513	Hunterdon	Intersection/Point	18	0.33	6.0
CO 518	US 206 / CO. 518	Somerset	Intersection/Point	6	1.16	6.9
CO 520	US 9 / Co 520	Monmouth	Intersection/Point	7	1.24	8.7
CO 520	GSP / Exit 109 (Co 520)	Monmouth	Intersection/Point	2	1.24	2.5
CO 537	US 206 / Co 537	Burlington	Intersection/Point	2	0.94	1.9
CO 546	NJ 29 / CO. 546 (Washington Crossing)	Mercer	Intersection/Point	5	0.27	1.4
CO 579	NJ 31 / Co 579	Hunterdon	Intersection/Point	3	0.33	1.0
Berkshire Valley Rd	NJ 15 / Berkshire Valley Rd	Morris	Intersection/Point	3	0.76	2.3
Blackwood Clementon Rd	NJ 42 / Blackwood Clementon Rd	Camden	Intersection/Point	2	1.38	2.8
Brick Rd	NJ 73 / Brick Rd	Burlington	Intersection/Point	2	0.94	1.9
Calhoun St	NJ 29 / Calhoun St	Mercer	Intersection/Point	3	0.27	0.8
Carnegie Center Dr	US 1 / Carnegie Center Dr	Mercer	Intersection/Point	2	0.27	0.5
Cass St	NJ 129 / Cass St	Mercer	Intersection/Point	7	0.27	1.9
	NJ 29 / Cass St (Waterfront Park)	Mercer	Intersection/Point	21	0.27	5.8
Chambersbridge Rd	NJ 70 / Chambersbridge Rd	Ocean	Intersection/Point	4	2.11	8.4
Church Rd	NJ 73 / Church Rd	Burlington	Intersection/Point	12	0.94	11.3
	NJ 38 / Church Rd	Camden	Intersection/Point	2	1.38	2.8
Cinnaminson Ave	US 130 / Cinnaminson Ave	Burlington	Intersection/Point	4	0.94	3.8
Commercial Ave	NJ 18 / Commercial Ave	Middlesex	Intersection/Point	7	1.13	7.9
Creek Rd	NJ 42 / Creek Rd	Camden	Intersection/Point	2	1.38	2.8
Delaware Ave	NJ 31 / Delaware Ave	Mercer	Intersection/Point	4	0.27	1.1
E Freehold St	US 9 / E Freehold St	Monmouth	Intersection/Point	6	1.24	7.5
Easton Ave	I 287 / Easton Ave	Somerset	Intersection/Point	5	1.16	5.8
Elton Adelphia Rd	US 9 / Elton Adelphia Rd	Monmouth	Intersection/Point	2	1.24	2.5
Evesham Rd	NJ 73 / Evesham Rd	Burlington	Intersection/Point	7	0.94	6.6
Ewingville Rd	NJ 31 / Ewingville Rd	Mercer	Intersection/Point	2	0.27	0.5
Fellowship Rd	NJ 73 / Fellowship Rd	Burlington	Intersection/Point	6	0.94	5.7
Ferry Rd	NJ 18 / Ferry Rd	Middlesex	Intersection/Point	2	1.13	2.3
Ford Ave	US 1 / Ford Ave	Middlesex	Intersection/Point	3	1.13	3.4
Franklin Corner Rd	US 1 / Franklin Corner Rd	Mercer	Intersection/Point	13	0.27	3.6
	US 206 / Franklin Corner Rd	Mercer	Intersection/Point	4	0.27	1.1

Table B-2. Congested Locations by Route Cont'd.

Facility	Location	County	Type	Number of Complaints	County Weight	Weighted Complaints
Fries Mill Rd	US 322 / Fries Mill Rd	Gloucester	Intersection/Point	2	1.41	2.8
Grandview Ave	US 1 / Grandview Ave	Middlesex	Intersection/Point	3	1.13	3.4
Harrison St	US 1 / Harrison St	Middlesex	Intersection/Point	4	1.13	4.5
Henderson Rd	US 1 / Henderson Rd	Middlesex	Intersection/Point	2	1.13	2.3
Lalor St	NJ 129 / Lalor St	Mercer	Intersection/Point	5	0.27	1.4
	NJ 29 / Lalor St	Mercer	Intersection/Point	2	0.27	0.5
Lincoln Dr	NJ 73 / Lincoln Dr	Burlington	Intersection/Point	2	0.94	1.9
N Elmwood Rd	NJ 70 / N Elmwood Rd	Burlington	Intersection/Point	2	0.94	1.9
N Olden Ave	US 1 / N Olden Ave	Mercer	Intersection/Point	3	0.27	0.8
Nassau Park Blvd	US 1 / Nassau Park Blvd	Mercer	Intersection/Point	27	0.27	7.4
New Providence Rd	US 22 / New Providence Rd	Union	Intersection/Point	2	2.59	5.2
New Rd	NJ 27 / New Rd	Middlesex	Intersection/Point	2	1.13	2.3
Old Post Rd	US 1 / Old Post Rd	Middlesex	Intersection/Point	4	1.13	4.5
Old York Rd	US 206 / Old York Rd	Burlington	Intersection/Point	2	0.94	1.9
Packanack Lake Rd	NJ 23 / Packanack Lake Rd	Passaic	Intersection/Point	2	2.04	4.1
Park Ave	US 22 / Park Ave	Union	Intersection/Point	2	2.59	5.2
Parsonage Rd	US 1 / Parsonage Rd	Middlesex	Intersection/Point	2	1.13	2.3
Plainfield Ave	US 1 / Plainfield Ave	Middlesex	Intersection/Point	10	1.13	11.3
	NJ 27 / Plainfield Ave	Middlesex	Intersection/Point	3	1.13	3.4
Plainsboro Rd	US 1 / Plainsboro Rd	Middlesex	Intersection/Point	4	1.13	4.5
Polifly Rd	NJ 17 / Polifly Rd	Bergen	Intersection/Point	2	1.97	3.9
Powder Mill Rd	NJ 10 / Powder Mill Rd	Morris	Intersection/Point	2	0.76	1.5
Provinceline Rd	US 206 / Provinceline Rd	Mercer	Intersection/Point	2	0.27	0.5
Quakerbridge Rd	US 1 / Quakerbridge Rd	Mercer	Intersection/Point	12	0.27	3.3
Raymond Blvd	NJ 21 / Raymond Blvd	Essex	Intersection/Point	2	1.28	2.6
Ridge Rd	US 1 / Ridge Rd	Middlesex	Intersection/Point	7	1.13	7.9
River Rd	NJ 18 / River Rd	Middlesex	Intersection/Point	2	1.13	2.3
Riverview Dr	US 46 / Riverview Dr	Passaic	Intersection/Point	3	2.04	6.1
Schanck Rd	US 9 / Schanck Rd	Monmouth	Intersection/Point	2	1.24	2.5
Scotch Rd	I 295 / Scotch Rd	Mercer	Intersection/Point	2	0.27	0.5
Scudder Mill Rd	US 1 / Scudder Mill Rd	Middlesex	Intersection/Point	3	1.13	3.4
Springdale Rd	NJ 70 / Springdale Rd	Camden	Intersection/Point	4	1.38	5.5
Stone Harbor Blvd	GSP / Stone Harbor Blvd	Cape May	Intersection/Point	2	2.73	5.5
Stouts Ln	US 1 / Stouts Ln	Middlesex	Intersection/Point	2	1.13	2.3
Sullivan Way	NJ 29 / Sullivan Way	Mercer	Intersection/Point	20	0.27	5.5
Talmadge Rd	NJ 27 / Talmadge Rd	Middlesex	Intersection/Point	2	1.13	2.3
Taylors Mill Rd	US 9 / Taylors Mill Rd	Monmouth	Intersection/Point	4	1.24	5.0
Tices Ln	NJ 18 / Tices Ln	Middlesex	Intersection/Point	5	1.13	5.7
Tilton Rd	US 9 / Tilton Rd	Atlantic	Intersection/Point	2	1.10	2.2
Warren St	NJ 29 / Warren St	Mercer	Intersection/Point	5	0.27	1.4
Washington Rd	US 1 / Washington Rd	Mercer	Intersection/Point	21	0.27	5.8
Water St	NJ 166 / Water St	Ocean	Intersection/Point	2	2.11	4.2
White Horse Pike	I 295 / White Horse Pike	Camden	Intersection/Point	2	1.38	2.8
Woodbridge Center Dr	US 1 / Woodbridge Center Dr	Middlesex	Intersection/Point	7	1.13	7.9
Woodbury Turnersville Rd	NJ 42 / Woodbury Turnersville Rd	Camden	Intersection/Point	2	1.38	2.8
Wrangleboro Rd	US 322 / Wrangleboro Rd	Atlantic	Intersection/Point	3	1.10	3.3

Appendix C. Statistical Analysis

Overview of Survey Responses

The survey respondent has four possible answers to choose from to identify the level of congestion in the simulation video for a particular trip type:

1. Not at all congested. This response is assigned a value of 1 for the remainder of the analysis.
2. Slightly congested. This response is assigned a value of 2 for the remainder of the analysis.
3. Moderately congested. This response is assigned a value of 3 for the remainder of the analysis.
4. Extremely congested. This response is assigned a value of 4 for the remainder of the analysis.

Through the combination of various levels of congestion and the 1 to 4 rating scale, the analysis will be able to capture the public's perception of congestion more accurately. Throughout the remainder of this section, references are made to congestion levels in terms of values between 1 and 4. These are averages of the responses collected through the survey. All averages and the accompanying standard deviations for every breakdown examined are presented in tables at the end of this section. The summaries include the following groups:

1. the entire survey sample,
2. age group breakdown,
3. education breakdown,
4. occupation breakdown,
5. income breakdown,
6. home county breakdown, and
7. work county breakdown

Graphical summaries are included in the main body of the report.

Statistical Analysis Approach

The average responses for the intersection and freeway that operate at Level of Service (LOS) D, E, and F are most of the time different depending on the depicted LOS and trip purpose. This is true for the overall average responses as well as those of the various subgroups of responses stratified by gender, income, occupation, age, education, and county of employment or residence.

The average response reported here is the average of the subjective opinions of a group of relatively randomly chosen individuals. As such, the responses (and their averages) are subject to the laws of probability and can be analyzed using statistics. One may hypothesize, for example, that although the overall average response for work trips at intersection D (2.40) has a higher value than that for the shore trip (2.34), this may be a statistical aberration. Namely, one may try to argue that the trip purpose has nothing to do with the travelers' perception of congestion. The fact that the average response is lower for the shore trip may be just attributable to chance and there are no inherent or underlying reasons that make travelers perceive congestion differently depending on trip purpose.

There are well known statistical techniques that can test hypotheses of the type posed above. In this case, two averages are known (the responses for work and shore trips), and the question is whether the average for the shore trip is indeed lower, or the differences the numbers indicate can simply be attributable to chance. To test this hypothesis, the standard testing technique for the differences between two means can be used. This technique can be found in numerous texts used to teach engineering or business statistics, quality control, etc.

Hypothesis testing is done by assuming a null hypothesis (H_o) and its alternative (H_a) as follows:

Hypothesis: H_o: = $\mu_1 - \mu_2 = 0$ (or equivalently: $\mu_1 = \mu_2$)

H_a: = $\mu_1 - \mu_2 > 0$ (or equivalently: $\mu_1 > \mu_2$)

In this case, the null hypothesis is that there is no difference in the means (averages) of the responses ($\mu_1 = \mu_2$) between work and shore trips. If this hypothesis cannot be proven (i.e., it is wrong), then the alternative is true. The alternative in this case is that the average perception of congestion is higher for work trips than it is for shore trips ($\mu_1 > \mu_2$).

To test the hypothesis of whether the perception of congestion is higher for work than shore trips, one needs the average rates ($\overline{X}_1$ = 2.40 for the work trips and $\overline{X}_2$ = 2.34 for the shore trips), the standard deviations of the rates (S_1 = 0.84 and S_2 = 0.86 respectively), and the number of responses associated with each average (n_1 and n_2 respectively and both equal to 1393 in this case).

The standard deviation of a distribution is computed as follows:

$$S = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \overline{X})^2}{n-1}}$$

Where $\overline{X}$ is the mean (average) response, X_i are the individual response values, and n is the number of observations (responses).

To test (evaluate) the hypothesis, the value of t_o has to be computed as follows:

Test Statistic: $$t_o = \frac{(\overline{X}_1 - \overline{X}_2)}{\sqrt{S_1^2 / n_1 + S_2^2 / n_2}}$$

Where $\overline{X}_1$, S_1, n_1 and $\overline{X}_2$, S_2, n_2 are as previously indicated. When numerical values are substituted in the above equation, a t_o level of congestion value of 1.88 is obtained. This value of t_o and an associated level of confidence can be used to look up values from the t-Distribution Table (presented on the next page) to determine whether the hypothesis should be accepted or rejected.

Normally, one would set in advance the level of significance α at which the hypothesis will be tested. In most cases, α is set at the 1% - 5% range. This also means that the chances the test decision is wrong should be in the 1% - 5% range, and alternatively, the chances that the decision is right (the level of confidence or 1-α), are in the 95% - 99% range. The t-Distribution Table contains a few 1-α values listed in the top row as percentages (i.e., .99=99%, .975=97.5%, etc.). The body of the table contains $t_{1-\alpha,\nu}$ values, or (as illustrated in the figure on top of the table), how far along the distribution one has to go so that the area under it and to the left of $t_{1-\alpha,\nu}$ is 1-α. Those values are also a function of the distribution's degrees of freedom (ν) that can be computed as follows:

Degrees of freedom: $$\nu = \frac{\left(\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}\right)^2}{\frac{(s_1^2 / n_1)^2}{n_1 - 1} + \frac{(s_2^2 / n_2)^2}{n_2 - 1}} - 2$$

When neither n_1 nor n_2 is small and their sum is about 60 or above, the degrees of freedom are for all practical purposes simply $\nu = n_1 + n_2 - 2$. In this example, $\nu = 1393 + 1393 - 2 = 2784$ or ∞, since the t-Distribution table stops for all practical purposes at 120 degrees of freedom.

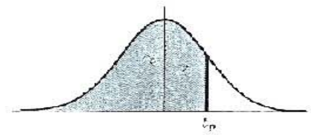
The formal decision rule for testing the hypothesis is:

Rejection Region: $t_o > t_{1-\alpha,\nu}$

If t_o is greater than $t_{1-\alpha,\nu}$, the null hypothesis (H_o) is rejected (and the alternative (H_a) is accepted) with a confidence of (1- α)%.

Table C-1. t Distribution Table

Percentile Values (t_p)
for
Student's t Distribution
with ν Degrees of Freedom
(shaded area $= p$)



ν	$t_{.995}$	$t_{.99}$	$t_{.975}$	$t_{.95}$	$t_{.90}$	$t_{.80}$	$t_{.75}$	$t_{.70}$	$t_{.60}$	$t_{.55}$
1	63.66	31.82	12.71	6.31	3.08	1.376	1.000	.727	.325	.158
2	9.92	6.96	4.30	2.92	1.89	1.061	.816	.617	.289	.142
3	5.84	4.54	3.18	2.35	1.64	.978	.765	.584	.277	.137
4	4.60	3.75	2.78	2.13	1.53	.941	.741	.569	.271	.134
5	4.03	3.36	2.57	2.02	1.48	.920	.727	.559	.267	.132
6	3.71	3.14	2.45	1.94	1.44	.906	.718	.553	.265	.131
7	3.50	3.00	2.36	1.90	1.42	.896	.711	.549	.263	.130
8	3.36	2.90	2.31	1.86	1.40	.889	.706	.546	.262	.130
9	3.25	2.82	2.26	1.83	1.38	.883	.703	.543	.261	.129
10	3.17	2.76	2.23	1.81	1.37	.879	.700	.542	.260	.129
11	3.11	2.72	2.20	1.80	1.36	.876	.697	.540	.260	.129
12	3.06	2.68	2.18	1.78	1.36	.873	.695	.539	.259	.128
13	3.01	2.65	2.16	1.77	1.35	.870	.694	.538	.259	.128
14	2.98	2.62	2.14	1.76	1.34	.868	.692	.537	.258	.128
15	2.95	2.60	2.13	1.75	1.34	.866	.691	.536	.258	.128
16	2.92	2.58	2.12	1.75	1.34	.865	.690	.535	.258	.128
17	2.90	2.57	2.11	1.74	1.33	.863	.689	.534	.257	.128
18	2.88	2.55	2.10	1.73	1.33	.862	.688	.534	.257	.127
19	2.86	2.54	2.09	1.73	1.33	.861	.688	.533	.257	.127
20	2.84	2.53	2.09	1.72	1.32	.860	.687	.533	.257	.127
21	2.83	2.52	2.08	1.72	1.32	.859	.686	.532	.257	.127
22	2.82	2.51	2.07	1.72	1.32	.858	.686	.532	.256	.127
23	2.81	2.50	2.07	1.71	1.32	.858	.685	.532	.256	.127
24	2.80	2.49	2.06	1.71	1.32	.857	.685	.531	.256	.127
25	2.79	2.48	2.06	1.71	1.32	.856	.684	.531	.256	.127
26	2.78	2.48	2.06	1.71	1.32	.856	.684	.531	.256	.127
27	2.77	2.47	2.05	1.70	1.31	.855	.684	.531	.256	.127
28	2.76	2.47	2.05	1.70	1.31	.855	.683	.530	.256	.127
29	2.76	2.46	2.04	1.70	1.31	.854	.683	.530	.256	.127
30	2.75	2.46	2.04	1.70	1.31	.854	.683	.530	.256	.127
40	2.70	2.42	2.02	1.68	1.30	.851	.681	.529	.255	.126
60	2.66	2.39	2.00	1.67	1.30	.848	.679	.527	.254	.126
120	2.62	2.36	1.98	1.66	1.29	.845	.677	.526	.254	.126
∞	2.58	2.33	1.96	1.645	1.28	.842	.674	.524	.253	.126

Source: R. A. Fisher and F. Yates, *Statistical Tables for Biological, Agricultural and Medical Research* (5th edition), Table III, Oliver and Boyd Ltd., Edinburgh, by permission of the authors and publishers.

The value of t_o indicates how far along the x-axis of the t-Distribution one should go to read a probability value that will determine whether the null hypothesis is true. One can see in the t-Distribution Table that for ∞ degrees of freedom (last line), the previously computed t_o value of 1.88 is between 1.645 and 1.96 which correspond to $t_{.95}$ and $t_{.975}$ respectively. The interpretation of the results here is that one can reject the null hypothesis at the 95% level but not the 97.5%. Another way of saying this, is that people when going to work indeed perceive intersection D as being more congested than when they are going to the shore, and this statement can me made with a relatively high probability or confidence (between 95% and 97.5%). Another way of interpreting this result is, that the chances that randomness produced different results for the two trip purposes are very small, and in the 2.5% to 5% range.

The already outlined procedure can be used to test the differences of any pair of average values representing trip purpose, intersection or freeway LOS, gender, income, occupation, age, education, and county of employment or residence. The total possible comparison pairs are for all practical purposes infinite. The following sections present some of the highlights of those comparisons.

Overall Results

All respondents collectively and as members of various subgroups, do realize without any doubt that the congestion depicted in the survey instrument is increasing as one goes from LOS D to E and F for both the Intersection and Freeway. As it can be seen from the t-Distribution Table, a t_o value of 2.58 indicates with a 99.5% confidence that the means are different. The t_o values for the differences of the average responses between the intersection operating at LOS D and E are approximately 17. This value is huge and way off the table indicating that the difference is an absolute statistical certainty. This is also true for the difference between LOS E and F for the intersection, which has an even greater to value of about 28. The differences between the LOSs for the freeway are even more significant. The t_o value for the difference between LOS D and F is about 51, and between LOS E and F about 28. These extremely strong statistical differences are true irrespective of trip purpose.

Respondents perceive collectively and as members of various subgroups freeway congestion at LOS D as being significantly less severe than intersection congestion at LOS D. The t_o value for that comparison is about 23, indicating again absolute certainty. However, at the two worst LOSs (E and F) the perceptions are reversed. Freeway congestion has higher average values than intersection congestion. In other words, survey respondents rate the two worst scenarios for freeways as more congested than the two worst scenarios for intersections. Both differences are again very significant statistically with t_o values of about 7.4.

The standard deviation of a distribution (set of observations or responses, in this case) was defined in the previous section. While the mean (average) of a distribution is a measure of its central tendency, the standard deviation is a measure of dispersion. The greater the standard deviation, the more dispersed the distribution's observations are or in this case, the more diverse the respondents' views on congestion are. If all responses are identical, then the standard deviation is zero. The response data indicate, that as the depicted congestion level increases from D to E and F the respondents are more agreeable on their perception of congestion because the standard deviations are reduced substantially. This is true for intersection as well as freeway congestion and for all trip purposes. The responses for the intersection operating at a LOS D have a standard deviation of about 0.86 and as the congestion progresses to LOS E and F the standard deviations are reduced to about 0.82 and 0.62 respectively. As congestion progresses from LOS D to E and F on the highway, the standard deviations of the responses go from about 0.81 to 0.73 and 0.52. Therefore, the greater the congestion, the more unanimous are the responders about their perception of its severity.

As mentioned earlier, the level of significance α is usually set at a relatively small value (1% - 5%), and consequently, the level of confidence 1-α at a corresponding relatively high value (95% - 99%). For the purposes of this report, if the t_o value obtained from the computation is not greater than 1.28 and therefore the difference of the means cannot be ascertained with a probability of at least 90%, then the difference will not be considered significant.

The average overall responses associated with trip purpose do differ, but not at the extraordinary confidence levels mentioned earlier for the differences between LOSs and between the intersection and freeway. For the freeway operating at LOS F, the differences are not significant for the various trip purposes. For all other scenarios presented in the survey, people going shopping perceive congestion to be worse than when they are going to the shore. For the intersection operating at LOS D or E the difference can be ascertained with a confidence of almost 100%, while for LOS F, the confidence drops slightly in the 95%-97.5% range. For the freeway operating at LOS D the confidence is in the 95%-97.5% range, while for the freeway at LOS E the confidence is almost 100%.

People going shopping perceive congestion to be worse than when they are going to work, except when the LOS is F. In that case the average congestion ratings are identical for both trip purposes and equal to 3.69 for the intersection and 3.84 for the freeway. Although the average values for the shopping trip are higher in the other cases, the differences are significant with an almost 100% confidence only for the freeway at LOS E. All other cases are not significant. Comparing the average responses between work and shopping trips, one sees that the average congestion rating for the shopping trip is always higher. For the intersection these differences are significant at the 95% to 99% level depending on the LOS. For the freeway operating at LOS E the difference is significant at the 95%-97.5% range and not significant at the other LOSs.

Gender Differences

Gender appears not to make any difference in the way people perceive congestion. There were 18 total scenarios (an intersection and freeway each of which operated at three different LOSs and each of which had three trip purposes). The average responses indicate that out of these 18 scenarios, 9 were perceived as more congested by women, 8 by men, and in one case the response was exactly identical (2.96 for the intersection operating at LOS E). Most of the differences, particularly for the intersection, were not statistically significant. However, the freeway operating at LOS D was perceived by men to be more congested with the difference being statistically significant at almost 100% for all trip purposes, while the freeway operating at LOS F was perceived by women to be more congested with also a very high statistical significance (almost 100% for the shore trip, in the 99%-99.5% range for the shopping trip, and in the 97.5%-99% range for the work trip).

Income Differences

The general observation that, as incomes increase people tend to perceive congestion as being more severe, is not statistically significant for practically all differences at LOS D for both the intersection and the freeway, and LOS E for the freeway. In addition, differences between two adjoining income groups are not significant most of the time, but when one considers the differences between a given group and the lowest income group (under $25,000 per year) then the differences become of increasing significance the higher the subgroup's income becomes. For example, for the intersection at LOS F and for the shore trip, as one compares the differences between the $25K-50K, $50K-75K, $75K-100K, and $100+K group with that of under $25K, the t_o values go from 1.65 to 2.17, 2.34 and 2.77 respectively, raising the confidence level of the significance of the differences progressively from about 90% to almost 100%. The same is generally true for shopping trips at the intersection operating under LOS F and shore trips for the intersection operating under LOS E. There is a notable exception for all trips when the depicted condition is freeway F. In this case, the group making $100+K perceives congestion as being less severe than those making $75K-100K, with the difference being statistically significant at the 90% level. Also the average responses of this high-income group are practically identical with those in the $25K-50K and $50K-75K ranges.

Education Differences

In general, the more educated one is, the more he/she makes and the response patterns associated with subgroups stratified by level of education, should not be much different from those stratified by income levels. The results of the analysis support this statement. There is also a difference between income and education level stratification at the last group. While people at the last income subgroup ($100+K) definitely have a higher income than those of the previous subgroup, those in the last education level subgroup (Professional Degree) do not necessarily make more money (or even are more educated) than those in the previous subgroup (Masters Degree). For example, a person with a BS in Engineering may be at the last group and a person with three MS degrees in the sciences or social sciences could be in the next to the last

The differences between two successive subgroups are in general not significant and not even in the same direction. For example, comparing the responses of those with a BS and those with a MS degree, for 9 of the possible 18 scenarios (as defined above in the Gender Differences section) the BS degree holders generate a higher average congestion rating, and for the remaining 9 scenarios a lower congestion rating. However, there are some instances, particularly for the intersection operating at LOSs E and F, where as education increases, so does the average perceived congestion rating. For example, for the shopping trip at the intersection operating at LOS F, if one compares the differences between those who finished high school and those having an Associates, Bachelors, Masters, and Professional Degree, the t_o values go from 0.96 to 1.71, 1.76 and 2.45, representing confidence levels of over 90%, over 95%, over 95% and over 99% respectively.

Age Differences

As a general observation, as age increases, so does the value people assign to the depicted congestion. In general the differences between successive age groups are not that great and therefore not statistically significant, although there are some notable exceptions. The 25-35 year-olds assign a significantly higher value to congestion than those under 25 for work trips at the intersection operating at LOS F, and all trip purposes for the freeway operating at LOS F with an almost 100% confidence. With the same level of confidence, 54-65 year-olds perceive congestion to be higher than 45-55 year-olds for shore trips at the intersection operating under LOS D and all trips on the freeway operating under LOS D. The t_o values generated by some comparisons among age subgroups are the highest of all subgroups considered in the analyses.

Keeping in mind that a t_o value greater than 2.58 represents almost 100% confidence that the difference is statistically significant, values up to 7.63 represent extremely strong confidences. Comparing the responses for work trips for the freeway operating at LOS F of the under 25 with those in the 25-34, 35-44, 45-54, 54-65 and over 65 age ranges, the t_o values are respectively 3.99, 6.22, 7.63, 4.39, and 0.19. The shore and shopping trips follow the same trend for the freeway operating at LOS F. The only unusual result is the behavior of the seniors who assign a slightly higher value to congestion than the under 25 individuals, but an approximately equal or slightly smaller value than the three previous (35-65 combined) age groups. Of note should be the fact that the seniors are the smallest subgroup (n=17 only), while the number of respondents in the other subgroups is in the hundreds. This small sample size is certainly contributing to the small confidence of any comparisons made with the over 65 group. This trend of increasing t_o values as one goes further away from the under 25 group is present in a number of other scenarios. For example, comparing the responses for shopping trips for the freeway operating at LOS D of the under 25 with those in the 25-34, 35-44, 45-54, 54-65 and over 65 age ranges, the t_o values are respectively 0.57, 1.27, 1.35, 3.26, and 2.40.

Occupational Differences

One major problem with the occupational stratification is that quite a few of the subgroups have sample sizes that are very small (ranging from 6 for landscaping to 17 for work at home). The results of these subgroups are not even considered here. Services and marketing are represented a little better with 35 and 65 respondents respectively. Excluding the “Other” subgroup, there are only three subgroups with substantial representation (clerical, administration and professional). People working in administration assign a lower value to congestion observed at the intersection operating at LOSs D and E than those in the professional subgroup. This is reversed for the intersection operating at LOS F and all scenarios representing the freeway where professionals assign a higher average congestion value than those working in administration. However, with the exception of the differences for the shopping trip on the freeway operating at LOS E, which is significant at the 90% - 95% range, none of the other differences are statistically significant. There were only two other places where some statistical significance was indicated among subgroups. One was for the differences between clerical and service employees for all trips on the freeway operating at LOS D, the work trips on the freeway operating at LOS E, and the work and shore trips on the freeway operating under LOS F. All differences were significant at a 90% - 95% confidence range. The other examples of statistical significance were the differences between marketing and clerical employees for the shore trip at the intersection operating at LOS D (about 97.5% confidence), the work (about 97% confidence) and shore (about 90% confidence) trips at the intersection operating at LOS F, the work trips on the freeway operating at LOS E (about 92% confidence) and the work and shore trips for the freeway operating under LOS F (both at about 90% confidence).

Work County Differences

The small sample size problem exists in this stratification also. Cape May, Cumberland, Gloucester, Ocean, Salem, Sussex and Warren Counties have sample sizes that range from 14 down to 2 and therefore no meaningful statistical analysis can be performed. An interesting case is the comparison between Bergen and Atlantic Counties presented in its entirety in the table below:

Work County	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
Atlantic	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Sam. Size	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Average	2.77	2.65	2.84	3.10	2.90	3.03	3.81	3.74	3.77	1.68	1.68	1.71	3.48	3.23	3.48	3.87	3.84	3.87
StDev	0.75	0.86	0.85	0.89	0.86	0.86	0.47	0.51	0.49	0.69	0.64	0.73	0.71	0.71	0.67	0.42	0.51	0.42
Bergen																		
Sam. Size	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86
Average	2.27	2.32	2.26	2.66	2.62	2.68	3.53	3.57	3.60	1.57	1.61	1.65	3.18	3.06	3.26	3.81	3.79	3.77
StDev	0.96	1.03	0.91	0.88	0.90	0.89	0.79	0.68	0.68	0.89	0.93	0.90	0.70	0.76	0.70	0.54	0.53	0.63
t-values	3.21	1.87	3.51	2.56	1.71	2.14	2.42	1.59	1.61	0.74	0.50	0.38	2.27	1.23	1.75	0.68	0.47	1.06
Confid(%)	100	95+	100	99	95+	98+	99+	90+	95	75+	70+	60+	95	90	95+	75+	60+	80+

People who work in Bergen County assign lower average values to congestion under all scenarios, although not all differences are significant at the level of confidence (90%) chosen for the analyses performed here. What is interesting is that the differences are much stronger for the intersection than they are for the freeway at all LOSs and for all trip purposes. The cause of this may be that people in Bergen County have to go through more intersections and are more used to congestion. Another interesting observation is that as the LOS deteriorates and goes from D to E and finally F, the perceived differences become less significant. The cause of this is probably the fact that extreme congestion is extreme congestion and it is impossible to misjudge the breakdown of a facility.

There are 23 destinations in this stratification (21 NJ Counties, NY and PA) and therefore 506 possible pair wise comparisons. Even if the 7 Counties with the small sample size are excluded, the total number of possible comparisons is 240. Obviously, that many comparisons are counterproductive and not all of them were attempted.

Besides the differences already presented, there is no obvious overall trend that can be discerned or strong conclusions that can be drawn from the data. None of the differences between Middlesex and Monmouth Counties are statistically significant at the 90% level. Comparing the Hudson and Hunterdon results, Hunterdon Co. workers assign higher average values to congestion at the 97.5% level for the shore trip at the intersection operating at LOS F, and with 99% confidence the shopping trip at the intersection operating at LOS D. The differences of all other scenarios are not statistically significant and for 8 out of the 18 scenarios, Hunterdon Co. workers assign lower values to congestion than those working in Hudson Co. In the Mercer to Hunterdon comparison there is only one statistically significant difference. Mercer workers assign a higher average congestion value at the 90%-95% level of confidence for the work trip at the intersection operating at LOS D, but assign lower values to 7 of the remaining 17 scenarios.

People working in Pennsylvania, generally assign higher values (in only two scenarios the average values are lower) to congestion than those working in New York. However, only three of the differences are statistically significant. For the work trip at the intersection operating at LOS E the difference is significant at the 95%-97.5% level. The differences for the shore trip at the intersection operating at LOS F and the highway operating at LOS E the differences are significant at the 90%-95% level.

Home County Differences

The initial comments made for the work county stratification are valid here also. Namely, there are counties with very small sample sizes (Cape May, Cumberland and Salem) and the total number of possible comparisons is large. The general comments concerning the comparisons are also applicable for this section. The Atlantic/Bergen full table is presented again to illustrate this point.

Work County	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
Atlantic	**Work**	**Shore**	**Shop**	**Work**	**Shore**	**Shop**	**Work**	**Shore**	**Shop**	**Work**	**Shore**	**Shop**	**Work**	**Shore**	**Shop**	**Work**	**Shore**	**Shop**
Sam. Size	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
Average	2.74	2.55	2.77	3.13	2.90	3.10	3.77	3.71	3.77	1.65	1.58	1.68	3.39	3.13	3.39	3.87	3.84	3.87
StDev	0.76	0.84	0.83	0.79	0.73	0.73	0.49	0.52	0.49	0.65	0.61	0.69	0.83	0.79	0.79	0.42	0.51	0.42
Bergen																		
Sam. Size	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73
Average	2.27	2.28	2.28	2.77	2.69	2.63	3.52	3.51	3.52	1.55	1.52	1.57	3.08	3.02	3.09	3.70	3.68	3.69
StDev	0.88	0.89	0.81	0.84	0.88	0.84	0.72	0.79	0.76	0.84	0.81	0.84	0.74	0.81	0.79	0.74	0.73	0.76
t-values	3.00	1.61	3.10	2.29	1.40	3.08	2.21	1.64	2.20	0.65	0.48	0.74	1.99	0.73	1.92	1.60	1.38	1.61
Confid(%)	100	95	100	99	90+	100	98+	95	98	75	60+	75+	97.5+	75+	95+	95	90+	95

Although the values in this table are different, the general discussion about it is still valid, with the only exception that the differences for the freeway operating at LOS F are now statistically significant.

With this stratification a few more comparisons are possible, since there are fewer counties with a very small sample size. For example, one now can compare Essex with Gloucester. In 6 of the 18 scenarios, Gloucester Co. residents assign lower average values to congestion, but only one of those (the work trip at the intersection operating at LOS D) is significant (at the 90%-95% level). For the 12 scenarios where Essex Co. residents assign lower average value to congestion, there are four significant differences. Three of them are all trip purposes for the freeway operating at LOS F with the level of confidence being 100%. The other, with a level of confidence in the 95%-97.5% range, is the work trip at the intersection operating at LOS F.

Here also there is no obvious overall trend that can be discerned or strong conclusions that can be drawn from the data. Of the pairs of counties tested, there is no case where residents of one county perceive congestion to be more severe for all 18 scenarios and the vast majority of the differences are not statistically significant.

An interesting result arises for the comparison between New York and Pennsylvania residents. The only statistically significant differences, and at the 100% level, are those for all three trip purposes for the freeway operating at LOS F. This is a result of the fact that all 19 New Yorkers included in the sample gave the depicted congestion the highest possible rating of 4.0.

Table C-2. Summary of Sample Composition and Perception - Total

Total	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Sample Size	1393	1393	1393	1393	1393	1393	1393	1393	1393	1393	1393	1393	1393	1393	1393	1393	1393	1393
Average	2.40	2.34	2.44	2.96	2.90	2.99	3.69	3.64	3.69	1.67	1.65	1.71	3.15	3.10	3.24	3.84	3.83	3.84
StDev	0.84	0.86	0.86	0.81	0.82	0.84	0.61	0.63	0.60	0.81	0.80	0.82	0.71	0.74	0.73	0.51	0.52	0.52

Table C-3. Summary of Sample Composition and Perception – Age

Age	% of Total Sample	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
		Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Under 25	6.5%																		
Sample Size		90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Average		2.32	2.36	2.51	2.73	2.73	2.85	3.54	3.57	3.61	1.55	1.60	1.59	2.98	2.94	3.17	3.69	3.69	3.67
StDev		0.91	0.64	0.67	0.92	0.71	0.83	0.46	0.50	0.40	0.66	0.67	0.67	0.87	0.90	0.98	0.09	0.31	0.31
25-34	20.3%																		
Sample Size		283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283	283
Average		2.40	2.29	2.42	2.89	2.81	2.93	3.71	3.64	3.69	1.56	1.55	1.64	3.18	3.06	3.25	3.82	3.79	3.82
StDev		0.83	0.85	0.86	0.82	0.80	0.86	0.58	0.64	0.59	0.75	0.78	0.81	0.71	0.75	0.74	0.54	0.59	0.55
35-44	28.6%																		
Sample Size		399	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399	399
Average		2.37	2.27	2.41	2.98	2.87	3.01	3.71	3.64	3.71	1.65	1.61	1.69	3.12	3.10	3.25	3.85	3.82	3.85
StDev		0.86	0.87	0.87	0.79	0.84	0.81	0.57	0.63	0.58	0.80	0.77	0.81	0.70	0.72	0.72	0.47	0.51	0.48
45-54	28.9%																		
Sample Size		403	403	403	403	403	403	403	403	403	403	403	403	403	403	403	403	403	403
Average		2.39	2.35	2.42	3.02	2.98	3.05	3.70	3.64	3.69	1.70	1.66	1.70	3.18	3.13	3.24	3.88	3.87	3.87
StDev		0.84	0.84	0.83	0.77	0.78	0.80	0.61	0.63	0.60	0.79	0.77	0.80	0.70	0.72	0.71	0.46	0.47	0.48
54-65	11.3%																		
Sample Size		158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158
Average		2.52	2.56	2.51	3.03	3.00	2.96	3.68	3.71	3.72	1.92	1.91	1.92	3.20	3.20	3.22	3.87	3.87	3.87
StDev		0.87	0.91	0.90	0.80	0.80	0.85	0.65	0.59	0.56	0.93	0.88	0.88	0.71	0.75	0.71	0.50	0.49	0.51
Over 65	1.2%																		
Sample Size		17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Average		2.93	2.79	3.00	3.07	3.21	3.07	3.71	3.71	3.60	1.93	2.14	2.14	3.43	3.21	3.29	3.71	3.86	3.86
StDev		0.87	0.91	0.90	0.82	0.82	0.86	0.67	0.63	0.63	0.93	0.90	0.90	0.72	0.77	0.74	0.59	0.55	0.56
Undeclared	3.1%																		
Sample Size		43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
Average		2.50	2.50	2.50	2.67	2.67	2.67	4.00	4.00	4.00	1.50	1.25	1.25	2.75	3.00	3.00	4.00	4.00	4.00
StDev		0.50	0.50	0.50	0.47	0.47	0.47	0.00	0.00	0.00	0.50	0.43	0.43	1.09	1.22	1.22	0.00	0.00	0.00

Table C-4. Summary of Sample Composition and Perception - Gender

Gender	% of Total Sample	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
		Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Male	60.1%																		
Sample Size		837	837	837	837	837	837	837	837	837	837	837	837	837	837	837	837	837	837
Average		2.39	2.33	2.45	2.96	2.90	3.01	3.67	3.62	3.68	1.71	1.70	1.76	3.16	3.11	3.25	3.82	3.80	3.82
StDev		0.85	0.86	0.86	0.81	0.83	0.85	0.63	0.65	0.61	0.83	0.81	0.84	0.72	0.75	0.74	0.53	0.56	0.57
Female	36.8%																		
Sample Size		513	513	513	513	513	513	513	513	513	513	513	513	513	513	513	513	513	513
Average		2.42	2.36	2.42	2.96	2.89	2.96	3.73	3.68	3.72	1.60	1.58	1.62	3.14	3.09	3.22	3.88	3.87	3.88
StDev		0.84	0.87	0.85	0.81	0.81	0.82	0.56	0.60	0.58	0.78	0.78	0.79	0.68	0.71	0.69	0.45	0.46	0.43
Undeclared	3.1%																		
Sample Size		43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
Average		2.50	2.50	2.50	2.67	2.67	2.67	4.00	4.00	4.00	1.50	1.25	1.25	2.75	3.00	3.00	4.00	4.00	4.00
StDev		0.50	0.50	0.50	0.47	0.47	0.47	0.00	0.00	0.00	0.50	0.43	0.43	1.09	1.22	1.22	0.00	0.00	0.00

Table C-5. Summary of Sample Composition and Perception - Education

Education	% of Total Sample	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
		Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
High School	20.5%																		
Sample Size		285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285	285
Average		2.48	2.42	2.58	2.88	2.80	2.91	3.62	3.61	3.62	1.74	1.70	1.75	3.14	3.12	3.24	3.76	3.76	3.76
StDev		0.89	0.86	0.84	0.90	0.89	0.92	0.71	0.70	0.72	0.89	0.87	0.89	0.71	0.73	0.72	0.60	0.59	0.62
Associates Degree	13.0%																		
Sample Size		181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181
Average		2.42	2.39	2.35	3.01	2.95	2.95	3.70	3.60	3.68	1.69	1.67	1.75	3.16	3.10	3.19	3.85	3.83	3.86
StDev		0.85	0.86	0.84	0.79	0.77	0.74	0.58	0.61	0.56	0.79	0.79	0.82	0.73	0.73	0.73	0.51	0.52	0.48
Bachelors Degree	36.9%																		
Sample Size		514	514	514	514	514	514	514	514	514	514	514	514	514	514	514	514	514	514
Average		2.41	2.34	2.43	2.97	2.89	2.98	3.72	3.66	3.71	1.64	1.63	1.66	3.18	3.10	3.26	3.85	3.84	3.84
StDev		0.83	0.86	0.86	0.80	0.82	0.85	0.55	0.60	0.57	0.79	0.79	0.79	0.71	0.75	0.74	0.46	0.49	0.49
Masters Degree	21.3%																		
Sample Size		297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297	297
Average		2.33	2.24	2.36	2.96	2.93	3.04	3.70	3.63	3.72	1.66	1.64	1.72	3.11	3.06	3.19	3.89	3.86	3.89
StDev		0.82	0.88	0.89	0.76	0.80	0.82	0.62	0.64	0.57	0.82	0.80	0.84	0.72	0.74	0.74	0.46	0.51	0.48
Professional Degree	5.0%																		
Sample Size		69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69
Average		2.29	2.36	2.47	3.09	3.05	3.19	3.78	3.78	3.83	1.58	1.58	1.66	3.22	3.25	3.42	3.85	3.85	3.90
StDev		0.84	0.81	0.75	0.78	0.74	0.77	0.65	0.63	0.62	0.67	0.65	0.73	0.58	0.62	0.63	0.69	0.69	0.62
Undeclared	3.4%																		
Sample Size		47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
Average		2.75	2.75	2.75	3.00	3.00	3.20	4.00	4.00	4.00	1.83	1.67	1.67	3.00	3.17	3.17	4.00	4.00	4.00
StDev		0.83	0.83	0.83	0.63	0.63	0.75	0.00	0.00	0.00	0.69	0.75	0.75	1.00	1.07	1.07	0.00	0.00	0.00

Table C-6. Summary of Sample Composition and Perception - Occupation

Occupation	% of Total Sample	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
		Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Marketing	4.3%																		
Sample Size		65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Average		2.37	2.27	2.27	2.88	2.71	2.86	3.52	3.52	3.59	1.58	1.59	1.59	3.07	3.00	3.16	3.67	3.67	3.67
StDev		0.84	0.77	0.83	0.85	0.74	0.90	0.70	0.72	0.72	0.65	0.81	0.74	0.64	0.72	0.76	0.77	0.73	0.80
Clerical	8.8%																		
Sample Size		132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132
Average		2.47	2.51	2.48	2.88	2.82	2.83	3.71	3.66	3.65	1.68	1.66	1.69	3.20	3.13	3.26	3.81	3.80	3.80
StDev		0.97	0.92	0.86	0.83	0.82	0.81	0.61	0.62	0.66	0.84	0.82	0.82	0.71	0.74	0.70	0.50	0.49	0.53
Service	2.3%																		
Sample Size		34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
Average		2.50	2.47	2.57	2.83	2.73	2.83	3.59	3.59	3.62	1.93	1.90	1.93	3.00	3.00	3.14	3.62	3.62	3.69
StDev		0.81	0.96	0.92	0.82	0.81	0.82	0.67	0.67	0.67	0.87	0.88	0.98	0.74	0.79	0.78	0.76	0.76	0.70
Work at Home	1.1%																		
Sample Size		17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Average		2.57	2.43	2.43	2.79	2.71	2.86	3.38	3.31	3.38	1.92	1.85	1.85	3.15	3.15	3.23	3.54	3.46	3.54
StDev		1.05	1.18	0.90	0.94	1.03	0.99	0.92	1.07	0.92	0.86	0.86	0.86	0.86	1.03	0.89	0.93	1.01	0.93
Landscaping	0.4%																		
Sample Size		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Average		2.40	2.60	2.60	2.60	3.00	3.00	3.80	3.80	3.80	1.80	1.80	1.80	3.60	3.80	3.80	4.00	4.00	4.00
StDev		0.80	1.02	1.02	0.80	0.63	0.63	0.40	0.40	0.40	0.75	0.75	0.75	0.49	0.40	0.40	0.00	0.00	0.00

Table C-6. Summary of Sample Composition and Perception – Occupation Cont'd

Occupation	% of Total Sample	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
		Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Production	0.5%																		
Sample Size		7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Average		2.75	2.75	2.50	3.25	3.25	3.25	3.75	3.75	3.75	1.50	1.75	2.50	3.00	3.00	3.50	3.75	4.00	3.25
StDev		0.43	0.83	0.50	0.83	0.83	0.83	0.43	0.43	0.43	0.50	0.83	0.87	0.71	0.71	0.87	0.43	0.00	1.30
Operations	0.7%																		
Sample Size		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Average		2.13	2.29	2.43	2.50	3.00	3.14	3.13	3.29	3.43	1.57	1.57	1.86	3.00	3.14	3.29	3.43	3.71	3.71
StDev		1.05	1.16	1.05	1.00	0.76	0.64	0.93	0.45	0.49	0.49	0.73	0.64	1.20	0.83	0.88	1.05	0.45	0.45
Administartion	20.1%																		
Sample Size		301	301	301	301	301	301	301	301	301	301	301	301	301	301	301	301	301	301
Average		2.47	2.37	2.46	3.05	3.01	3.08	3.70	3.64	3.68	1.69	1.65	1.69	3.14	3.08	3.16	3.86	3.84	3.86
StDev		0.84	0.87	0.86	0.73	0.78	0.79	0.58	0.60	0.59	0.81	0.78	0.80	0.73	0.75	0.76	0.45	0.47	0.48
Professional	55.0%																		
Sample Size		823	823	823	823	823	823	823	823	823	823	823	823	823	823	823	823	823	823
Average		2.40	2.33	2.46	3.00	2.93	3.04	3.73	3.67	3.73	1.69	1.67	1.73	3.15	3.10	3.24	3.88	3.86	3.88
StDev		0.84	0.85	0.85	0.79	0.80	0.82	0.56	0.59	0.55	0.82	0.80	0.83	0.70	0.73	0.72	0.42	0.47	0.43
Other	6.7%																		
Sample Size		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Average		2.43	2.30	2.56	2.73	2.70	2.75	3.71	3.59	3.70	1.57	1.54	1.58	3.23	3.16	3.26	3.82	3.80	3.82
StDev		0.81	0.91	0.88	0.89	0.86	0.90	0.51	0.68	0.56	0.85	0.82	0.84	0.61	0.68	0.67	0.47	0.58	0.52

Table C-7. Summary of Sample Composition and Perception - Income

Income	% of Total Sample	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
		Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Under 25,000	6.0%																		
Sample Size		84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84
Average		2.45	2.36	2.61	2.73	2.68	2.79	3.56	3.45	3.58	1.70	1.70	1.73	3.12	3.05	3.25	3.68	3.65	3.70
StDev		0.89	0.92	0.81	0.99	0.92	0.97	0.66	0.78	0.70	0.92	0.92	0.91	0.72	0.76	0.77	0.64	0.71	0.63
25,000- 49,999	23.1%																		
Sample Size		322	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322
Average		2.47	2.38	2.49	2.92	2.84	2.92	3.66	3.60	3.65	1.71	1.69	1.73	3.15	3.11	3.21	3.83	3.82	3.83
StDev		0.88	0.86	0.86	0.84	0.82	0.86	0.63	0.65	0.64	0.84	0.84	0.86	0.71	0.72	0.71	0.51	0.51	0.53
50,000-74,999	30.7%																		
Sample Size		427	427	427	427	427	427	427	427	427	427	427	427	427	427	427	427	427	427
Average		2.36	2.35	2.41	2.97	2.93	3.02	3.69	3.65	3.71	1.65	1.62	1.70	3.14	3.10	3.27	3.84	3.82	3.84
StDev		0.83	0.87	0.86	0.80	0.83	0.85	0.59	0.62	0.59	0.78	0.76	0.77	0.73	0.76	0.74	0.50	0.53	0.51
75,000- 99,999	19.0%																		
Sample Size		265	265	265	265	265	265	265	265	265	265	265	265	265	265	265	265	265	265
Average		2.38	2.27	2.39	2.98	2.93	3.01	3.70	3.67	3.71	1.70	1.70	1.72	3.16	3.10	3.21	3.90	3.88	3.89
StDev		0.82	0.82	0.85	0.77	0.80	0.79	0.63	0.61	0.59	0.82	0.82	0.84	0.69	0.72	0.72	0.42	0.43	0.42
Over 100,000	15.2%																		
Sample Size		212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212	212
Average		2.39	2.34	2.42	3.05	2.94	3.05	3.76	3.71	3.75	1.63	1.59	1.71	3.17	3.11	3.25	3.84	3.83	3.83
StDev		0.83	0.86	0.87	0.74	0.73	0.76	0.55	0.57	0.54	0.80	0.77	0.83	0.68	0.70	0.71	0.57	0.59	0.61
Undeclared	6.0%																		
Sample Size		83	83	83	83	83	83	83	83	83	83	83	83	83	83	83	83	83	83
Average		2.55	2.44	2.50	3.00	2.94	3.03	3.83	3.76	3.74	1.67	1.57	1.54	3.29	3.15	3.32	3.97	3.94	3.97
StDev		0.86	0.97	0.83	0.79	0.94	0.89	0.38	0.49	0.50	0.71	0.77	0.65	0.70	0.81	0.67	0.17	0.24	0.17

Table C-8. Summary of Sample Composition and Perception – Home County

Home County	% of Total Sample	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
		Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Atlantic																			
Sample Size	2.9%	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
Average		2.74	2.55	2.77	3.13	2.90	3.10	3.77	3.71	3.77	1.65	1.58	1.68	3.39	3.13	3.39	3.87	3.84	3.87
StDev		0.76	0.84	0.83	0.79	0.73	0.73	0.49	0.52	0.49	0.65	0.61	0.69	0.83	0.79	0.79	0.42	0.51	0.42
Bergen																			
Sample Size	5.2%	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73
Average		2.27	2.28	2.28	2.77	2.69	2.63	3.52	3.51	3.52	1.55	1.52	1.57	3.08	3.02	3.09	3.70	3.68	3.69
StDev		0.88	0.89	0.81	0.84	0.88	0.84	0.72	0.79	0.76	0.84	0.81	0.84	0.74	0.81	0.79	0.74	0.73	0.76
Burlington																			
Sample Size	8.0%	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112	112
Average		2.44	2.54	2.56	2.94	3.00	2.98	3.69	3.71	3.70	1.78	1.75	1.79	3.21	3.21	3.25	3.81	3.81	3.82
StDev		0.89	0.95	0.93	0.87	0.79	0.85	0.60	0.59	0.61	0.87	0.87	0.90	0.72	0.72	0.74	0.53	0.55	0.53
Camden																			
Sample Size	4.5%	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63
Average		2.34	2.14	2.42	2.79	2.75	2.86	3.67	3.51	3.68	1.77	1.84	1.98	3.11	3.07	3.28	3.77	3.74	3.70
StDev		0.84	0.90	0.81	0.85	0.86	0.87	0.63	0.84	0.65	0.82	0.85	0.87	0.69	0.75	0.77	0.59	0.69	0.77
Cape May																			
Sample Size	0.4%	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Average		2.75	2.75	2.75	2.75	3.00	2.75	3.75	3.75	3.75	2.75	2.75	2.50	3.50	3.75	3.50	3.75	3.75	3.75
StDev		1.30	1.30	1.30	1.30	1.22	1.30	0.43	0.43	0.43	0.83	0.83	1.12	0.50	0.43	0.50	0.43	0.43	0.43
Cumberland																			
Sample Size	0.9%	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Average		2.67	2.58	2.58	2.83	2.58	2.67	3.33	3.58	3.33	1.75	1.75	1.75	3.08	3.25	3.17	3.83	3.83	3.83
StDev		0.75	0.76	0.76	0.90	0.86	0.94	1.11	0.86	0.94	0.60	0.60	0.60	0.64	0.60	0.69	0.37	0.37	0.37
Essex																			
Sample Size	4.9%	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
Average		2.44	2.34	2.33	2.88	2.85	2.85	3.55	3.55	3.58	1.67	1.61	1.62	2.97	2.88	3.05	3.70	3.67	3.67
StDev		0.80	0.83	0.88	0.90	0.86	1.01	0.74	0.67	0.71	0.77	0.76	0.73	0.81	0.86	0.91	0.71	0.75	0.79
Gloucester																			
Sample Size	3.1%	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
Average		2.23	2.23	2.45	2.95	2.75	3.00	3.75	3.58	3.68	1.50	1.45	1.50	3.13	2.95	3.20	3.95	3.95	3.95
StDev		0.69	0.76	0.84	0.77	0.77	0.74	0.49	0.67	0.52	0.71	0.74	0.71	0.71	0.71	0.68	0.31	0.31	0.31

Table C-8. Summary of Sample Composition and Perception – Home County Cont'd

Home County	% of Total Sample	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
		Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Hudson																			
Sample Size	2.5%	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Average		2.50	2.50	2.83	2.87	2.97	3.20	3.72	3.79	3.76	1.81	1.94	1.87	3.10	3.20	3.33	3.77	3.80	3.80
StDev		0.76	0.72	0.78	0.81	0.71	0.87	0.74	0.48	0.57	0.93	0.98	0.87	0.87	0.70	0.65	0.67	0.48	0.48
Hunterdon																			
Sample Size	4.0%	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56
Average		2.70	2.55	2.47	3.12	3.08	3.06	3.63	3.56	3.58	1.79	1.78	1.81	3.38	3.27	3.35	3.75	3.79	3.81
StDev		0.84	0.74	0.79	0.80	0.76	0.84	0.68	0.63	0.74	0.82	0.82	0.86	0.59	0.65	0.62	0.62	0.49	0.48
Mercer																			
Sample Size	11.3%	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158	158
Average		2.47	2.48	2.57	3.06	3.01	3.05	3.73	3.62	3.72	1.87	1.78	1.84	3.22	3.16	3.28	3.85	3.83	3.88
StDev		0.78	0.81	0.80	0.71	0.83	0.82	0.55	0.66	0.57	0.79	0.76	0.80	0.70	0.71	0.68	0.45	0.51	0.40
Middlesex																			
Sample Size	9.0%	126	126	126	126	126	126	126	126	126	126	126	126	126	126	126	126	126	126
Average		2.34	2.26	2.31	2.93	2.98	3.06	3.75	3.72	3.78	1.55	1.55	1.63	3.13	3.10	3.19	3.86	3.85	3.86
StDev		0.80	0.82	0.82	0.78	0.77	0.80	0.57	0.62	0.54	0.72	0.73	0.79	0.73	0.77	0.77	0.53	0.52	0.55
Monmouth																			
Sample Size	7.8%	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108	108
Average		2.41	2.27	2.37	3.09	2.90	3.09	3.76	3.67	3.74	1.58	1.53	1.61	3.20	3.14	3.26	3.90	3.86	3.89
StDev		0.89	0.87	0.87	0.75	0.81	0.77	0.54	0.57	0.51	0.73	0.68	0.70	0.64	0.70	0.67	0.47	0.55	0.50
Morris																			
Sample Size	8.0%	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111	111
Average		2.30	2.15	2.42	2.87	2.77	2.92	3.73	3.67	3.72	1.51	1.53	1.64	3.07	3.06	3.30	3.85	3.84	3.84
StDev		0.82	0.87	0.92	0.80	0.81	0.90	0.51	0.55	0.51	0.74	0.80	0.85	0.68	0.71	0.69	0.48	0.49	0.55
Ocean																			
Sample Size	3.4%	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48
Average		2.40	2.28	2.32	2.98	2.83	3.04	3.76	3.63	3.70	1.74	1.74	1.73	3.30	3.20	3.39	3.96	3.93	3.96
StDev		0.82	0.87	0.92	0.79	0.87	0.88	0.47	0.60	0.55	0.99	0.94	0.93	0.66	0.71	0.67	0.20	0.25	0.20
Passaic																			
Sample Size	2.9%	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
Average		2.24	2.36	2.42	2.70	2.83	2.94	3.65	3.75	3.81	1.53	1.53	1.61	3.14	3.06	3.28	3.86	3.86	3.89
StDev		0.94	0.95	0.83	0.83	0.69	0.70	0.62	0.43	0.46	0.80	0.73	0.79	0.71	0.74	0.61	0.42	0.42	0.31

Table C-8. Summary of Sample Composition and Perception – Home County Cont'd

Home County	% of Total Sample	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
		Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Salem																			
Sample Size	0.4%	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Average		1.75	1.50	2.00	3.00	2.75	2.80	3.50	3.25	3.40	1.75	1.50	1.50	3.00	2.75	2.75	4.00	4.00	4.00
StDev		0.43	0.50	0.63	0.71	0.43	0.40	0.87	0.83	0.80	0.83	0.50	0.50	0.00	0.43	0.43	0.00	0.00	0.00
Somerset																			
Sample Size	4.0%	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56
Average		2.57	2.42	2.51	3.09	3.02	3.15	3.72	3.68	3.72	1.79	1.73	1.90	3.19	3.13	3.29	3.75	3.73	3.75
StDev		0.85	0.86	0.82	0.70	0.69	0.66	0.56	0.61	0.63	0.85	0.76	0.86	0.70	0.73	0.77	0.61	0.62	0.62
Sussex																			
Sample Size	3.1%	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
Average		2.19	2.25	2.51	2.66	2.58	2.74	3.35	3.61	3.53	1.39	1.39	1.42	2.95	2.92	3.26	3.85	3.87	3.84
StDev		0.80	0.76	0.89	0.95	0.96	0.94	0.94	0.59	0.75	0.63	0.54	0.54	0.55	0.66	0.71	0.43	0.34	0.43
Union																			
Sample Size	2.7%	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
Average		2.31	2.28	2.33	2.97	2.86	2.86	3.72	3.64	3.67	1.50	1.53	1.58	3.14	3.06	3.17	3.92	3.83	3.94
StDev		0.84	0.87	0.82	0.76	0.82	0.79	0.51	0.71	0.58	0.73	0.73	0.76	0.48	0.74	0.65	0.28	0.44	0.23
Warren																			
Sample Size	1.8%	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Average		2.18	2.05	2.14	2.95	2.73	2.91	3.64	3.59	3.59	1.91	1.82	1.77	3.04	3.09	3.13	3.96	3.91	3.87
StDev		0.89	0.88	0.76	0.88	1.01	1.00	0.57	0.65	0.65	1.00	1.11	1.00	0.81	0.78	0.80	0.20	0.41	0.45
New York																			
Sample Size	1.4%	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
Average		2.33	2.28	2.39	3.33	3.17	3.22	3.82	3.65	3.76	1.82	1.59	1.65	3.18	3.12	3.29	4.00	4.00	4.00
StDev		0.88	1.10	1.01	0.75	0.76	0.85	0.38	0.48	0.42	1.04	1.03	1.03	0.51	0.58	0.57	0.00	0.00	0.00
Pennsylvania																			
Sample Size	6.4%	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89	89
Average		2.42	2.37	2.40	3.11	2.98	3.10	3.81	3.69	3.78	1.67	1.69	1.70	3.13	3.08	3.13	3.93	3.90	3.92
StDev		0.87	0.81	0.77	0.69	0.73	0.71	0.39	0.51	0.44	0.85	0.83	0.86	0.69	0.68	0.71	0.26	0.33	0.32
Undeclared																			
Sample Size	1.2%	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Average		2.71	2.80	3.17	2.71	3.00	3.00	3.71	3.67	3.67	2.13	1.86	1.67	3.00	2.71	2.88	3.78	4.00	3.88
StDev		0.70	1.17	0.90	1.03	1.15	1.15	0.70	0.75	0.75	1.05	0.83	0.75	0.94	1.03	1.05	0.42	0.00	0.33

Table C-9. Summary of Sample Composition and Perception – Work County

Work County	% of Total Sample	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
		Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Atlantic	2.9%																		
Sample Size		40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Average		2.77	2.65	2.84	3.10	2.90	3.03	3.81	3.74	3.77	1.68	1.68	1.71	3.48	3.23	3.48	3.87	3.84	3.87
StDev		0.75	0.86	0.85	0.89	0.86	0.86	0.47	0.51	0.49	0.69	0.64	0.73	0.71	0.71	0.67	0.42	0.51	0.42
Bergen	6.2%																		
Sample Size		86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86
Average		2.27	2.32	2.26	2.66	2.62	2.68	3.53	3.57	3.60	1.57	1.61	1.65	3.18	3.06	3.26	3.81	3.79	3.77
StDev		0.96	1.03	0.91	0.88	0.90	0.89	0.79	0.68	0.68	0.89	0.93	0.90	0.70	0.76	0.70	0.54	0.53	0.63
Burlington	2.9%																		
Sample Size		41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
Average		2.28	2.42	2.42	2.89	3.00	2.97	3.81	3.83	3.83	1.83	1.72	1.75	3.39	3.31	3.42	3.94	3.94	3.97
StDev		0.73	0.86	0.83	0.97	0.82	0.90	0.46	0.50	0.50	0.87	0.87	0.89	0.76	0.62	0.60	0.23	0.23	0.16
Camden	3.7%																		
Sample Size		51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
Average		2.15	2.13	2.20	2.84	2.87	2.82	3.58	3.38	3.53	1.51	1.60	1.69	3.00	2.98	3.07	3.80	3.76	3.71
StDev		0.81	0.80	0.82	0.82	0.93	0.88	0.80	0.93	0.78	0.69	0.71	0.75	0.79	0.86	0.88	0.65	0.76	0.81
Cape May	0.5%																		
Sample Size		7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Average		2.67	2.67	2.67	2.50	2.67	2.67	3.67	3.67	3.67	2.17	2.17	2.17	3.00	3.17	3.00	3.83	3.83	3.83
StDev		1.11	1.11	1.11	1.12	1.11	1.11	0.47	0.47	0.47	1.07	1.07	1.07	1.00	1.07	1.00	0.37	0.37	0.37
Cumberland	0.4%																		
Sample Size		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Average		2.80	2.80	2.80	2.60	2.20	2.40	2.60	3.20	2.80	2.20	2.20	2.20	2.80	3.00	3.00	3.80	3.80	3.80
StDev		0.98	0.98	0.98	0.80	0.75	1.02	1.36	1.17	1.17	0.40	0.40	0.40	0.40	0.63	0.63	0.40	0.40	0.40
Essex	9.3%																		
Sample Size		130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
Average		2.37	2.29	2.44	2.98	2.93	3.01	3.71	3.70	3.72	1.52	1.51	1.53	3.04	3.07	3.21	3.81	3.80	3.80
StDev		0.73	0.85	0.87	0.81	0.82	0.86	0.63	0.60	0.61	0.76	0.74	0.75	0.70	0.66	0.71	0.58	0.60	0.62
Gloucester	1.0%																		
Sample Size		14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
Average		2.29	2.14	2.50	2.86	2.71	2.93	3.57	3.43	3.50	1.43	1.43	1.57	3.07	2.86	3.00	3.71	3.71	3.71
StDev		0.96	0.83	0.91	0.74	0.70	0.59	0.49	0.49	0.50	0.82	0.82	0.82	0.46	0.64	0.85	0.59	0.59	0.59

Table C-9. Summary of Sample Composition and Perception – Work County Cont'd

Work County	% of Total Sample	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
		Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Hudson	3.0%																		
Sample Size		42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
Average		2.50	2.50	2.83	2.87	2.97	3.20	3.72	3.79	3.76	1.81	1.94	1.87	3.10	3.20	3.33	3.77	3.80	3.80
StDev		0.76	0.72	0.78	0.81	0.71	0.87	0.74	0.48	0.57	0.93	0.98	0.87	0.87	0.70	0.65	0.67	0.48	0.48
Hunterdon	5.0%																		
Sample Size		70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70
Average		2.62	2.47	2.46	3.13	2.97	3.07	3.67	3.58	3.63	1.90	1.74	1.81	3.28	3.16	3.24	3.87	3.82	3.84
StDev		0.86	0.78	0.74	0.75	0.77	0.76	0.61	0.65	0.67	0.83	0.86	0.85	0.66	0.68	0.67	0.45	0.49	0.51
Mercer	23.7%																		
Sample Size		330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330
Average		2.44	2.39	2.50	3.04	3.00	3.06	3.70	3.63	3.69	1.76	1.73	1.74	3.19	3.13	3.19	3.85	3.84	3.85
StDev		0.84	0.84	0.85	0.75	0.76	0.79	0.56	0.63	0.58	0.82	0.80	0.81	0.71	0.74	0.74	0.46	0.49	0.44
Middlesex	8.1%																		
Sample Size		113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Average		2.46	2.32	2.51	2.99	2.90	3.07	3.80	3.68	3.77	1.65	1.61	1.75	3.15	3.08	3.21	3.80	3.75	3.83
StDev		0.84	0.87	0.87	0.77	0.81	0.88	0.47	0.58	0.51	0.80	0.78	0.86	0.67	0.74	0.76	0.52	0.60	0.54
Monmouth	3.6%																		
Sample Size		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Average		2.36	2.22	2.33	3.00	2.82	3.09	3.82	3.69	3.78	1.73	1.69	1.76	3.22	3.07	3.31	3.78	3.73	3.78
StDev		0.85	0.81	0.84	0.82	0.80	0.91	0.44	0.55	0.51	0.80	0.78	0.76	0.73	0.77	0.72	0.70	0.71	0.70
Morris	10.1%																		
Sample Size		141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141	141
Average		2.29	2.22	2.36	2.84	2.77	2.90	3.62	3.65	3.65	1.53	1.56	1.66	3.03	3.07	3.28	3.86	3.87	3.88
StDev		0.83	0.84	0.87	0.84	0.83	0.83	0.63	0.56	0.63	0.75	0.77	0.82	0.69	0.73	0.66	0.50	0.46	0.45
Ocean	0.9%																		
Sample Size		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Average		3.00	2.83	2.92	3.50	3.42	3.42	3.92	3.83	3.92	2.33	2.42	2.42	3.42	3.42	3.50	3.92	3.92	3.92
StDev		0.91	0.90	0.86	0.50	0.64	0.49	0.28	0.37	0.28	1.11	1.04	1.04	0.64	0.64	0.65	0.28	0.28	0.28
Passaic	2.1%																		
Sample Size		29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
Average		2.50	2.38	2.69	2.77	2.69	2.81	3.58	3.58	3.65	1.88	1.85	2.00	3.23	3.00	3.35	3.73	3.73	3.85
StDev		0.97	0.96	0.91	0.70	0.61	0.73	0.57	0.49	0.48	0.89	0.86	0.96	0.64	0.88	0.73	0.59	0.59	0.46

Table C-9. Summary of Sample Composition and Perception – Work County Cont'd

Work County	% of Total Sample	Intersection D			Intersection E			Intersection F			Freeway D			Freeway E			Freeway F		
		Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop	Work	Shore	Shop
Salem	0.1%																		
Sample Size		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Average		1.50	1.50	2.00	2.00	2.00	2.00	4.00	4.00	4.00	1.00	1.00	1.00	3.00	3.00	3.00	4.00	4.00	4.00
StDev		0.50	0.50	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Somerset	3.1%																		
Sample Size		43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
Average		2.31	2.13	2.13	2.89	2.82	2.89	3.64	3.59	3.67	1.59	1.57	1.68	3.03	3.00	3.11	3.73	3.62	3.73
StDev		0.91	0.85	0.76	0.68	0.76	0.82	0.77	0.78	0.73	0.75	0.72	0.93	0.88	0.90	0.89	0.76	0.85	0.76
Sussex	0.4%																		
Sample Size		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Average		3.33	2.83	2.83	3.50	3.00	2.83	4.00	4.00	4.00	2.33	1.83	1.83	3.50	3.17	3.17	4.00	4.00	4.00
StDev		0.75	0.69	0.69	0.50	0.58	0.69	0.00	0.00	0.00	0.75	0.69	0.69	0.50	1.07	1.07	0.00	0.00	0.00
Union	2.1%																		
Sample Size		29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
Average		2.21	2.28	2.45	2.97	2.83	3.00	3.52	3.45	3.52	1.34	1.34	1.41	2.97	2.97	3.21	3.90	3.83	3.90
StDev		0.76	0.74	0.85	0.76	0.79	0.79	0.68	0.77	0.68	0.54	0.48	0.49	0.56	0.76	0.66	0.30	0.46	0.30
Warren	0.1%																		
Sample Size		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Average		2.00	2.00	2.50	2.50	2.50	3.00	4.00	4.00	4.00	1.00	1.00	1.00	3.00	3.00	3.00	4.00	4.00	4.00
StDev		0.00	0.00	0.50	0.50	0.50	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
New York	5.0%																		
Sample Size		69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69
Average		2.28	2.28	2.33	2.87	2.89	2.90	3.63	3.59	3.62	1.67	1.64	1.69	3.10	3.05	3.23	3.94	3.92	3.92
StDev		0.83	0.84	0.73	0.81	0.84	0.82	0.60	0.69	0.61	0.86	0.85	0.80	0.61	0.61	0.66	0.30	0.33	0.33
Pennsylvania	3.5%																		
Sample Size		49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49
Average		2.35	2.22	2.35	3.13	2.85	3.15	3.78	3.67	3.80	1.71	1.64	1.80	3.22	3.20	3.44	3.98	3.96	3.98
StDev		0.73	0.93	0.87	0.74	0.83	0.72	0.46	0.63	0.45	0.81	0.82	0.83	0.55	0.58	0.54	0.15	0.21	0.15
Undeclared	2.3%																		
Sample Size		32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32
Average		2.75	2.71	2.94	2.56	2.93	2.81	3.81	3.80	3.75	1.94	1.94	1.87	3.06	3.00	3.12	3.72	3.87	3.65
StDev		0.83	1.03	0.83	1.12	1.12	1.18	0.53	0.54	0.66	0.83	0.75	0.72	0.78	0.87	0.90	0.56	0.34	0.84

Appendix D. Congestion Program Methodology

This section describes the general methodology used to compute the congestion measures for the State of New Jersey.

Roadway Database

Both the *Quantification of Urban Freeway Congestion and Analysis of Remedial Measures* study and the TTI *Urban Mobility Report* used the Highway Performance Monitoring System (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 released data (RA Series – Version 2.0, released in 2001). The NJCMS includes traffic volumes, roadway geometry, and roadway operational information for approximately 4,500 two-directional links that make up the interstate, state, and county roadway network in all 21 New Jersey counties. These 4,500 links were grouped into three classes: 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 un-signalized intersections, although some grade-separated interchanges may be present. The capacity of an arterial is generally a function of the number of lanes and 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. Other minor arterials, collectors, and local streets included in the NJCMS database are included in this category. It should be stated that some minor arterials (including some of the County 600 series roadways) and roadways with a lower functionality 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.

The NJCMS database has many advantages over the other data sources since it contains New Jersey specific traffic information:

- ***Traffic volumes by direction and by hour of the day:*** The NJCMS estimates 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 estimates 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.
- ***Detailed geometric information by roadway link:*** 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.
- ***Speed estimates by hour of the day:*** NJCMS data contains estimated free-flow speeds for each link in network. Using Volume-Density Functions (VDF) and based on estimated volumes, geometric characteristics, capacity of the roadway, and free-flow speed, the NJCMS analysis module estimates the actual speed for each hour of the day for each directional link. These speeds are then used to calculate the average travel times for each link for each direction for each hour of the day.
- ***Estimated vehicle occupancy:*** The estimated average vehicle occupancy is calculated as part of the NJCMS. These estimates, based on field data contained within the NJCMS database, are aggregated for each county by facility type as the ratio of total person-miles traveled to total vehicle-miles traveled. These calculated values were used to derive total person-hours of delay due to congestion. Table A-2.1 summarizes average vehicle occupancy per county per facility type for AM and PM peak period.
- ***Non-recurring delay:*** The NJCMS estimates the amount of non-recurring congestion occurring on a facility (link) by using lookup tables of New Jersey historical accident and incident rates and lane blockage and duration rates

in combination with the person volumes and delays experienced on the link. The probability of different incident types occurring and the additional delay that would be experienced are used to determine an annual total of non-recurring delay that can be expected. The ratios of recurring to non-recurring delay used for the analyses reported in this document are shown in Table A-1.

Table D-1: Average Vehicle Occupancy and Non-recurring/Recurring Delay Ratio

	Average Vehicle Occupancy – AM Peak		Average Vehicle Occupancy – PM Peak		Non-recurring/Recurring Delay Ratio	
COUNTY	Freeways	Arterials	Freeways	Arterials	Freeways	Arterials
Atlantic	1.34	1.31	1.47	1.49	0.40	0.18
Bergen	1.15	1.26	1.32	1.41	0.60	0.36
Burlington	1.09	1.21	1.24	1.41	0.42	0.04
Camden	1.19	1.26	1.42	1.43	0.38	0.15
Cape May	1.20	1.24	1.62	1.62	2.00	0.40
Cumberland	1.20	1.31	1.44	1.58	2.00	0.20
Essex	1.21	1.30	1.31	1.43	1.69	0.09
Gloucester	1.19	1.26	1.41	1.47	0.35	0.19
Hudson	1.41	1.64	1.16	1.78	0.69	0.65
Hunterdon	1.21	1.20	1.37	1.38	0.44	0.08
Mercer	1.09	1.25	1.22	1.40	1.62	0.24
Middlesex	1.20	1.23	1.23	1.38	0.98	0.28
Monmouth	1.33	1.23	1.42	1.43	0.18	0.15
Morris	1.21	1.22	1.25	1.37	0.24	0.15
Ocean	1.22	1.27	1.54	1.49	0.76	0.30
Passaic	1.22	1.28	1.34	1.47	0.65	0.54
Salem	1.17	1.23	1.38	1.46	2.50	0.17
Somerset	1.09	1.22	1.25	1.32	0.26	0.17
Sussex	1.31	1.29	1.56	1.41	2.00	0.39
Union	1.23	1.29	1.23	1.43	0.62	0.88
Warren	1.14	1.22	1.59	1.37	0.73	0.19
New Jersey	**1.20**	**1.26**	**1.32**	**1.44**	**0.66**	**0.30**

Source: New Jersey Congestion Management System, RA Series – Version 2.0

Congestion Analysis Model

As part of the 2000 NJIT report *Mobility and the Costs of Congestion in New Jersey,* a Microsoft Access database programming system was developed to calculate the congestion measures. This program was used in this study as well, but was updated with improved calculation procedures. NJCMS outputs and other information presented in this section were used as inputs for calculating mobility measures, as well other performance measures for the New Jersey roadways contained in NJCMS database.

Input Parameters

Instead of using national averages, the study uses New Jersey data where appropriate and available. This is done in an effort to make the delay and cost estimates more germane to New Jersey roadways and drivers.

Analysis Period

Only peak period traffic volumes are used for the recurring congestion analysis. The peak periods were chosen to be eight hours per day when the total traffic volumes are at their maximum – four hours in the morning (6:00 to 10:00 AM), and four hours in the evening (3:00 to 7:00 PM). These periods are usually referred to as “morning peak-hour” and “evening peak-hour”. While there are some roadways that might experience congestion beyond those limits, the bulk of the recurring congestion occurs during this time.

Calculated results for weekday peak hours were adjusted to account for additional traffic on Fridays during the three summer months (usually these are the 15 Fridays between Memorial Day and Labor Day). This adjustment mainly affects counties on the New Jersey shore, i.e. major roads leading towards the shore destinations.

Value of Travel Time

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.

In this study the average hourly wage rate per capita is used as a measure of value of time. It was computed separately for each county and is summarized in Table A-2.

Table D-2: Average Annual Income and Hourly Wage per Capita

COUNTY	2000 Average Annual Income per Capita	2001 Average Annual Income per Capita	2001 Average Hourly Wage per Capita
Atlantic	$ 31,396	$ 32,249	$ 16.12
Bergen	$ 50,303	$ 51,570	$ 25.79
Burlington	$ 32,860	$ 33,753	$ 16.88
Camden	$ 29,334	$ 30,131	$ 15.07
Cape May	$ 29,407	$ 30,206	$ 15.10
Cumberland	$ 23,303	$ 23,936	$ 11.97
Essex	$ 34,519	$ 35,389	$ 17.69
Gloucester	$ 28,340	$ 29,110	$ 14.56
Hudson	$ 27,522	$ 28,215	$ 14.11
Hunterdon	$ 51,018	$ 52,303	$ 26.15
Mercer	$ 40,954	$ 42,067	$ 21.03
Middlesex	$ 35,745	$ 36,645	$ 18.32
Monmouth	$ 40,123	$ 41,134	$ 20.57
Morris	$ 53,757	$ 55,111	$ 27.56
Ocean	$ 28,436	$ 29,152	$ 14.58
Passaic	$ 29,027	$ 29,758	$ 14.88
Salem	$ 29,144	$ 29,936	$ 14.97
Somerset	$ 55,596	$ 56,997	$ 28.50
Sussex	$ 33,370	$ 34,211	$ 17.11
Union	$ 39,854	$ 40,858	$ 20.43
Warren	$ 30,559	$ 31,329	$ 15.66
New Jersey	**$ 37,118**	**$ 38,139**	**$ 19.07**

Source: U.S. Department of Commerce, Bureau of Economic Analysis, May 6, 2002.
Prepared by New Jersey Department of Labor, May 2002.

At the time this report's analyses were conducted, the most recent complete source for population estimates for each county available was for the year 2001. Similarly the most recent income estimates were for the year 2000. The decision was made to have the year 2001 as a base for all population, employment, and income calculations. The 2000 average income data was first adjusted to 2001 by using the Consumer Price Index (CPI). The CPI for the Philadelphia metropolitan region was applied to Atlantic, Burlington, Camden, Cape May, Cumberland, Mercer, Ocean, and Salem Counties, while CPI for the New York metropolitan region was applied to the remaining counties. The average hourly wage rate was then determined by dividing the average annual salary by 2000 hours per year. These resulting adjusted wage rates for New Jersey vary from a low of $11.97 (Cumberland County) to a high of $28.50 (Somerset County).

Actual New Jersey county-based income information was 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.

Fuel cost

The average fuel cost was obtained through American Automobile Association's *Daily Fuel Gauge Report* prepared by the OPIS Energy Group. Since data was not available for each county, the statewide average was used in calculations. The average fuel cost was obtained for the period of January 1, 2001 – December 31, 2001 (the same base year as the calculation of the value of time). The estimated average fuel cost was $1.39 per gallon (regular gasoline).

Truck cost

Per mile truck cost was estimated using 2001 National Transportation Statistics prepared by the U.S. Bureau of Transportation Statistics. It was initially calculated for year 1999 (most recent available data) as the ratio of the total estimated annual expenditures for local and intercity trucks in the country to the total estimated annual truck miles traveled by single-unit and combination trucks nationwide. The calculated value, which represents national average, was then adjusted to 2001 dollars using the CPI for the Philadelphia and New York metropolitan regions. The final calculated values are $2.42 per truck-mile for southern New Jersey (Atlantic, Burlington, Camden, Cape May, Cumberland, Mercer, Ocean, and Salem Counties) and $2.50 for northern New Jersey (all other counties).

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 can then be summed to provide costs on an area-wide (county or state) basis.

What constitutes congestion is subjective. Acceptable levels of congestion and delay 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)*[3] was used to develop a

[3] 2000 Highway Capacity Manual. *Transportation Research Board, National Research Council, Washington, DC, 2000*

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 (e.g. 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 the 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 mobility measures are presented in this study:

- Travel Delay (total, per affected person, per vehicle-trip, per person-mile traveled)
- Congestion Cost (total, per affected person, per vehicle-trip, per person-mile traveled)
- 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 future conditions with increased travel demand or to analyze impacts of a proposed highway improvements. The 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.

Travel Delay

Travel delay is the measure of the time (person-hours) lost due to 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 and standard Volume Density Functions (VDFs).

Non-recurring delay is defined as the additional travel time due to traffic incidents (vehicle breakdowns, police activity) or traffic accidents. Congestion that occurs as a result of seasonal variations (such as summer travel to recreation areas) and major entertainment or sporting events, is not considered in this study.

Because of the unpredictability, non-recurring congestion is difficult to quantify. However, because it is such a 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, 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 delays were computed by the NJCMS, and assigned a level of service grade based on the *Highway Capacity Manual (HCM)*. Level of service (LOS) refers to a quality of traffic flow with LOS A describing the best operating conditions and LOS F representing unsatisfactory operation. According to the *HCM*, LOS A, B, and C are considered satisfactory operating conditions, while LOS D, E, and 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 do not contribute to travel delay. As LOS degraded to D, E, or F, the subsequent increases in travel time were considered unacceptable to drivers. Therefore, the link segments with LOS D, E, or F are considered congested and the recurring travel delay is accrued as the difference between the peak period travel time and the free-flow travel time.

The recurring travel delay is computed using travel time fields computed by the NJCMS. The NJCMS program calculates travel time estimates on the freeways and principal arterial streets for each hour of the day. The travel delay was computed as the difference between the zero-volume (free flow) travel time and the travel time under each hourly demand. The zero-volume travel time for arterials includes delays incurred at signalized 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 data from NJCMS. This data includes the average expected delays as the result of crashes, mechanical, electrical, or tire related vehicle beak downs and other accidents or incidents that occur on the roadway. First, the NJCMS estimates of total annual recurring and non-recurring delay were summarized for each facility type for each county. The ratio of non-recurring delay to recurring delay is then calculated. This ratio was then used as an input to the Congestion Analysis Model to compute the total non-recurring delay as a function of the recurring delay for each link. Table A-2.1 shows the non-recurring to recurring ratios for each county and facility type (the same value for principal and other arterials was assumed).

Congestion Cost

The cost of congestion is a function of both delay cost and fuel cost. As congestion has different economic implications for the movement of people versus the movement of goods, person-trips and truck-trips were handled differently by the delay cost analysis.

Delay costs for person-trips are estimated using an average monetary value for each hour of travel time delay. Average values of time are based on wage data obtained for each county (see previous Input Parameters section). Delay costs for trucks are estimated using an average dollar-per-mile basis (see Input Parameters). Congestion delays mean that truck freight 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. The computation of wasted fuel is based on the methodology[4] developed by the Federal Highway Administration (FHWA).

Percentage of Peak Travel under Congested Conditions

The percentage of peak travel under congested conditions is the calculated 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. All VMT on link segments that operate under LOS conditions D or worse are considered congested, and thusly are counted towards congested VMT. This measure is a binary measure in that either a link segment is congested or it is not. No differential is made among moderate, heavy and severe congestion under this measure.

Travel Rate Index (TRI)

The Travel Rate Index (TRI) is a measure of the amount of extra time it takes to travel during the peak period. The travel rate (in minutes per mile) during peak period was compared to the travel rate under free-flow speeds to calculate the TRI. 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 of TRI is shown in the following equation:

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[4] A Method for Estimating Fuel Consumption and Vehicle Emissions on Urban Arterials and Networks," *Rauss, J., Report No. FHWA-TS-81-210, April 1981.*

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

Roadway Congestion Index (RCI)

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

The RCI is determined by calculating the average daily vehicle-miles of travel (VMT) on freeways, principal arterials, and other arterials by multiplying the average travel volume by the length of the corresponding link and summing all the links by facility type and county. 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 different intensities of freeway travel. The computation of RCI is shown in the following equation:

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

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 database and contains no origin-destination information, it cannot be used to generate subject group totals. For the purpose of this report, the research team defined three subject groups: per affected persons, per vehicle-trip, and per person-mile traveled.

The basis of the “affected persons” subject group is that congestion in a given county affects not just residents of the county, but also those workers who commute into the county for employment. An affected person was defined as a person who lives and/or works in a region and therefore feels the impact of congestion within the region. To determine the number of affected persons for each county, estimates of the number of residents and workers based in each county were obtained from the New Jersey Department of Labor (NJDOL) and projected for horizon years. The number of persons both living and working in the county is subtracted from the sum of the resident population and employee work force to avoid double counting someone who both lives and works in the same county. Commuting patterns were taken from the 1990 Journey to Work portion of the U.S. Census (the most recent Journey to Work data available). For lack of better assumptions, the commuting patterns were assumed to remain constant for all horizon years. The equation for calculating number of affected persons is as follows:

$$Number\ of\ Affected\ Persons = Total\ Resident\ Population + Total\ Worker\ Force - Workers\ Who\ Live\ and\ Work\ In\ The\ County$$

or reformatted;

$$Number\ of\ Affected\ Persons = Total\ Resident\ Population + (1 - RW\%) \times Total\ Worker\ Force$$

where "*RW%*" represents the percentage of workers who both work and reside in the county.

The resident and worker data estimates are shown in Tables A-2.3 and A-2.4, with the intracounty commuting patterns shown in Table A-2.5.

One group that is missing from the affected persons calculation is the pass-through vehicle trips. This group accounts for vehicles that neither originate in nor are destined to a county, but still use the county's roadways. 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 research team used results from the New Jersey Statewide Truck Model (NJSTM)[5]. A cordon was drawn around each of the 21 counties and the total traffic crossing each of the cordons was summed. This traffic is composed of trips originating in the county and destined to outside the county (I-E trips), trips destined to the county originating outside the county (E-I trips), and pass-through trips (E-E trips), which are counted twice (once when entering the county, and once when exiting the county). The number of pass-through vehicle trips is then computed as follows:

$$PassThruVehTrips = \frac{Total\ CordonVolume - (OUT\_Trips + IN\_Trips)}{2}$$

where "*OUT_Trips*" denote all trips originating in the county and destined to another county, and "*IN_Trips*" denote all trips destined for the county that originate in another county

[5] *New Jersey Statewide Truck Model*, 2000 Base Model, prepared by URS Greiner Woodward Clyde for NJDOT

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

$$\text{Total Vehicle Trips} = \begin{pmatrix} \text{All Trips Originating in the County} + \text{All Trips Destined for the County} \\ \text{- Intracounty Trips} + \text{PassThru Veh. Trips} \end{pmatrix}$$

where "*Intracounty Trips*" denote trips that both originate and terminate within the subject county.

Due to the nature of the NJSTM, the calculated number of trips represents the daily total. Since the analysis deals with peak period traffic, it was necessary to calculate how many of trips occur during peak periods. The percentage of peak-hour trips could be calculated in three ways:

- As the ratio of peak period PMT to total daily PMT
- As the ratio of persons traveling during peak periods to total daily persons traveling
- As the ratio of peak period VMT to total daily VMT

Calculating and comparing these above three ratios showed less than 1% variation in the peak period travel percentage for all counties. As a result, the mean average value of three ratios was used to compute portion of daily trips that occur during the peak periods

The last subject group is person-miles traveled (PMT). This subject group was found useful as the depth of coverage of the county road networks is not consistent between all New Jersey counties. Since calculated delay and cost of congestion are additive, it could be that some counties with more extensive network coverage in NJCMS have much higher costs and delays than others as the result of incomplete or unbalanced network data. Disaggregating delays and costs per PMT can help assimilate the differences in network coverage by standardizing all counties with respect to average travel delay and average cost of congestion per person mile traveled. The assumption accompanying this subject group is that conditions on a county's road network contained within the NJCMS database are indicative of travel conditions on the remainder of the county road network. The calculation of person-miles traveled was performed directly in the NJCMS analysis model by multiplying vehicle-miles traveled with average vehicle occupancy for each link. PMT was then aggregated by county and by facility type.

Current VS. Future Conditions

Future conditions are calculated based on the same inputs and procedures as used in the calculations for current conditions. The only difference is in projected vehicle volumes. This procedure estimates congestion delays and costs in future horizon years without any improvements in the transportation infrastructure.

Projections of future volumes can be obtained from NJCMS for each county and facility type by applying built in growth factors. These volumes were then entered in calculations of the mobility measures and other network performance measures for the horizon year analyses. County population values were estimated and projected by the New Jersey Department of Labor (NJDOL) for the years of 1998, 2005, 2008, 2010, and 2015. County employment total were also obtained from the NJDOL for the years of 1998 and 2008. Estimates for years not included in the NJDOL estimates were calculated as through linear interpolation or extrapolation of the NJDOL estimates. Population and worker data is given in Tables A-3, A-4 and A-5.

Table D-3: Estimates of New Jersey Population by County, 1998-2025

COUNTY	1998	1999	2000	2001	2002	2005	2010	2015	2025
Atlantic	243,400	245,857	248,314	250,771	253,229	260,600	274,400	287,900	314,900
Bergen	875,200	879,543	883,886	888,229	892,571	905,600	928,800	953,500	1,002,900
Burlington	430,100	432,971	435,843	438,714	441,586	450,200	464,700	484,800	525,000
Camden	514,600	515,714	516,829	517,943	519,057	522,400	530,900	540,400	559,400
Cape May	100,200	100,714	101,229	101,743	102,257	103,800	106,600	111,300	120,700
Cumberland	142,900	143,429	143,957	144,486	145,014	146,600	148,900	150,800	154,600
Essex	766,400	768,114	769,829	771,543	773,257	778,400	787,000	800,600	827,800
Gloucester	253,900	255,786	257,671	259,557	261,443	267,100	278,200	290,700	315,700
Hudson	570,100	572,414	574,729	577,043	579,357	586,300	605,700	624,300	661,500
Hunterdon	125,900	127,100	128,300	129,500	130,700	134,300	139,900	148,200	164,800
Mercer	337,800	339,871	341,943	344,014	346,086	352,300	362,700	373,000	393,600
Middlesex	731,400	737,386	743,371	749,357	755,343	773,300	804,300	840,600	913,200
Monmouth	617,900	623,671	629,443	635,214	640,986	658,300	685,400	714,100	771,500
Morris	470,700	474,957	479,214	483,471	487,729	500,500	520,600	545,400	595,000
Ocean	503,200	509,400	515,600	521,800	528,000	546,600	575,700	619,100	705,900
Passaic	494,900	495,429	495,957	496,486	497,014	498,600	503,800	505,300	508,300
Salem	66,100	66,043	65,986	65,929	65,871	65,700	66,200	66,800	68,000
Somerset	291,300	296,371	301,443	306,514	311,586	326,800	348,600	377,100	434,100
Sussex	146,600	147,914	149,229	150,543	151,857	155,800	162,100	171,200	189,400
Union	509,900	511,571	513,243	514,914	516,586	521,600	530,700	536,100	546,900
Warren	101,000	101,943	102,886	103,829	104,771	107,600	111,900	116,300	125,100
New Jersey	8,293,700	8,346,329	8,398,957	8,451,586	8,504,214	8,662,100	8,937,200	9,257,500	9,898,100

Source: NJ Department of Labor, Division of Labor Market & Demographic Research, January 2001.

Table D -4: Estimates of Number of Workers by County of Employment, 1998-2025

COUNTY	1998	1999	2000	2001	2002	2005	2010	2015	2025
Atlantic	150,400	152,925	155,450	157,975	160,500	168,075	180,700	193,325	218,575
Bergen	493,750	499,070	504,390	509,710	515,030	530,990	557,590	584,190	637,390
Burlington	192,400	195,175	197,950	200,725	203,500	211,825	225,700	239,575	267,325
Camden	225,000	227,290	229,580	231,870	234,160	241,030	252,480	263,930	286,830
Cape May	40,750	41,330	41,910	42,490	43,070	44,810	47,710	50,610	56,410
Cumberland	62,700	63,060	63,420	63,780	64,140	65,220	67,020	68,820	72,420
Essex	400,350	403,275	406,200	409,125	412,050	420,825	435,450	450,075	479,325
Gloucester	92,700	94,115	95,530	96,945	98,360	102,605	109,680	116,755	130,905
Hudson	255,900	259,315	262,730	266,145	269,560	279,805	296,880	313,955	348,105
Hunterdon	49,350	50,005	50,660	51,315	51,970	53,935	57,210	60,485	67,035
Mercer	209,200	211,730	214,260	216,790	219,320	226,910	239,560	252,210	277,510
Middlesex	422,150	427,790	433,430	439,070	444,710	461,630	489,830	518,030	574,430
Monmouth	250,000	253,335	256,670	260,005	263,340	273,345	290,020	306,695	340,045
Morris	290,050	293,945	297,840	301,735	305,630	317,315	336,790	356,265	395,215
Ocean	139,000	140,920	142,840	144,760	146,680	152,440	162,040	171,640	190,840
Passaic	195,000	196,175	197,350	198,525	199,700	203,225	209,100	214,975	226,725
Salem	22,700	22,830	22,960	23,090	23,220	23,610	24,260	24,910	26,210
Somerset	182,700	185,855	189,010	192,165	195,320	204,785	220,560	236,335	267,885
Sussex	37,850	38,510	39,170	39,830	40,490	42,470	45,770	49,070	55,670
Union	255,100	256,780	258,460	260,140	261,820	266,860	275,260	283,660	300,460
Warren	37,400	37,685	37,970	38,255	38,540	39,395	40,820	42,245	45,095
New Jersey	4,004,450	4,051,115	4,097,780	4,144,445	4,191,110	4,331,105	4,564,430	4,797,755	5,264,405

Source: NJ Department of Labor, Division of Labor Market & Demographic Research, January 2001.

Table D-5: Intracounty Trips Patterns

COUNTY	Percent of employees residing within county of employment
Atlantic	73.89%
Bergen	57.03%
Burlington	67.16%
Camden	62.17%
Cape May	83.18%
Cumberland	79.01%
Essex	54.22%
Gloucester	64.77%
Hudson	58.32%
Hunterdon	52.19%
Mercer	60.12%
Middlesex	59.64%
Monmouth	75.62%
Morris	53.57%
Ocean	85.64%
Passaic	59.90%
Salem	66.59%
Somerset	42.43%
Sussex	76.91%
Union	52.74%
Warren	58.02%
Intrastate trips (New Jersey)	**92.79%**