
Presentation of Travel Demand

And

Relationships to Land Use

**Prepared for
The Delaware Transportation Institute**

By

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Executive Summary

The formulation and implementation of successful transportation policies depends on an understanding of travel demand and the transportation system (supply). The DelDOT Travel Demand Forecasting Model (TDFM), the DelDOT Household Survey, the National Personal Travel Survey (NPTS), population and employment projections, and U.S. Census data are examples of data that are available to understand travel demand in Delaware and its implications. Studying this large amount of information and presenting findings in this report was the main focus of the project and numerous views of travel demand data are available in this report. Another goal was to address the connections between land use and transportation. Residential land use was viewed in this project in terms of population density (persons per square mile) and employment density.

The Statewide figure for average trips per person for weekday travel as calculated from 5 years of data from the DelDOT Household Survey for all persons in the sample is 2.6 trips per person per weekday*For those respondents who said they made a trip in the day sampled, the figure is about 3.2 trips per person. The numbers are virtually the same for each county. No difference is seen in regards to various land use densities.

The DelDOT Household Survey showed that the average trip time over all types of week day trips for the five year sample was about 23.4 minutes. Average weekday trip time is 23.4 minutes, the median trip time is about 15 minutes. The median trip time for shopping, school, and other trips is 15 minutes, and the median trip time for work trips is 20 minutes. Over a third of all trips are 10 minutes or less and more than half of the trips are 15 minutes or less. Half of work trips are 20 minutes or less by private auto.

In general as population density decreased, average trip time increased. Trip times between rural and urban densities differ by about 50%. Average trip times for all weekday trips ranged from 29.3 minutes for rural areas to 20.9 minutes for urban densities. The most striking transportation differences related to population densities are in average trip distance. Average trip distances for all weekday trips within Delaware range from 11.5 miles for rural densities to 4.2 miles for urban densities, almost 3 times further. Differences in average trip distances in relation to density are much larger than differences in trip times because there are higher speeds in low density areas. This is in line with national results that show that trip times are not increasing at the same rate as trip distances. Average trip speeds were shown to be as much as 2 to 3 faster in lowest density areas compared to urban densities. Lower density areas offer less congestion and are more often serviced by expressways that allow more distance with less impact on trip time. On a national level, average travel speeds have been increasing.

The percentage of trips for various purposes is referred to as trip distribution. About 37% of weekday trips are work related, 21% for shopping, 6 % for school and daycare, and about another third are for other purposes. Trip distribution, and trips per person like many travel characteristics, are properties most related to life cycles and demographic factors such as age, race, income, gender, and employment status, rather than to land use type or densities.

Trip chaining, the grouping of trips(stops) for various purposes in one "outing" is a feature of travel that has been traditionally overlooked but has very significant effects. A trip that is not

* For clarification, a trip to the store and then home, is considered to be two trips.

chained is one where a person would go directly to work from home, directly to home from work, or from home to a destination and then back with no other stops. About a third of all trips involve more than one stop. Shopping, social, drop off/pickup, miscellaneous trips are those purpose that most involve a chain of trips. Non-work related travel has been increasing nationally and also non-work trip making has been growing rapidly during peak commuting times. As the private automobile provides flexibility in organizing daily activities, non-work activities can be more easily coordinated with commuting. Studies indicate that 10 to 20 percent of non-work trips are linked to the commute trip*. In regards to trip chaining, the data indicated only very slight differences in trip chaining in regards to population density.

By 1995 NPTS (that includes weekend travel) occupancy rates for all travel is 1.59 person miles per vehicle mile, ranging from a low of 1.14 for work trips to 2.17 for other social and recreational purposes. There is a general view that occupancy rates are much lower because typically the focus is on the work trip. Actually the national survey indicates that about a third of all trips are multi-occupant.

The DelDOT Household Survey 5 year sample estimates the percentage of all statewide weekday trips by transit to be about one percent, by walking 1.4%, and by private auto (passenger or driver) to be 96.4%. High density suburban and urban areas differ significantly in their use of transit, 1.6 and 5.0 percent respectively, and by walking, 2.9 and 7.9 percent. For suburban areas of medium density and below, use of other modes falls below 1% in each non-auto mode. In most of the lower density areas transit service is not available for many trips. Use of bicycles is generally 0.2 percent or lower even for urban and high density suburban areas (DelDOT Household Survey). As over a third of weekday trips in Delaware are 10 minutes, it was thought that the bicycle mode would be viable and show a higher share of trips, at least in urban areas, but the evidence suggests that the use of bicycles beyond recreation is very limited indeed.

Delaware is reaching the bulk of the transit market. When transit service guidelines used in long-range transit plans are viewed in relation to existing transit service, as they were in the WILMAPCO Regional Transit Service Needs Analysis (1996), existing transit service is in line with what guidelines would warrant. Service type guidelines warrant fixed transit in areas where there are 4 to 12 households per acre. All such areas in northern Delaware are within a quarter mile of fixed transit service. Compared to other counties in the country, New Castle County has average to above-average use of the transit system. The average transit trip is estimated to take almost twice as long as the average trip by personal auto. In models of transit ridership produced by CADSR, the most significant factor for ridership besides population density is the availability of direct service.

Practically all new population and employment growth in the future will be in suburban areas. The effect is that there are increasingly less origin-destination pairs that exist where for a particular locale there are a sufficient number of riders that can be identified to warrant direct or slightly indirect service. A previous study by CADSR showed that for medium density suburban areas such as the Pike Creek and Kirkwood Highway areas in New Castle County, a large percentage (34% to 68%) of the housing units were not within a 6 minute walking distance of bus stops located on adjoining roads, and that circulating such areas to pick up passengers involves large time costs. The effect of dispersed origins and destinations, prohibitively long travel times, the need of many for the flexibility of the private auto and to chain trips, the expense necessary to offer direct service to suburban areas, the time necessary to circulate suburban areas to collect

* James G. Strathman and Kenneth J. Dueker. "Understanding Trip Chaining", 1990 NPTS Special Reports on Trip and Vehicle Attributes, pg 1-7

passengers, and the number of areas not served, all greatly limit the market that can be served by transit. The mode share for transit in Delaware is expected to decrease.

About 90% of the journey to work market involves trips from or to suburban areas (1990 CTPP), and enhancements to the current transit system will have to better address the suburban market. Park and Ride is seen as the only effective local collection strategy for transit to reach the medium to low density suburban market. In New Castle County about 10% of transit ridership originates at Park and Rides. In many rural areas car pooling is used in place of transit for some populations. Car pooling is not addressed in this report or in the data, but given the increasingly medium to low density development trends, it may be the most successful and cost effective strategy of getting cars off the road.

Where people choose to live is determined by many factors that include quality of life, quality of schools, age, ethnicity, proximity to family and friends, jobs of other family members, and socioeconomic features of locations. A 1980 national survey sampled workers who lived more than 5 miles from work and they were asked to state the most important reason why they did not live close to their jobs. About 38% cited good schools, 24% said they liked their house, 17% said they liked their neighborhoods, and 10% said their own jobs were too far from the jobs of other family members*. A goal of most Americans is to own single-family detached homes with private open space next to each dwelling. In a Delaware survey done by CADSR that asked "Where Would You Most Like to Live?", over 70% wished to live in a suburban development or lower density area.

Travel is often less costly to the average household than land or housing. There is often a benefit to moving into the suburbs and rural areas since housing costs can be greatly reduced by increasing transportation costs somewhat. In Delaware where there is relatively low congestion and large amounts of lower cost housing and land in lower density areas, many people are willing to accept slightly longer drive times for an increased quality of life. Lifestyle preferences and economic opportunity together have driven land use patterns, and they are both in the direction of continued low density development. Raising the cost of transportation or cost or availability of suburban development such as with higher fuel costs, congestion or peak hour pricing, higher taxes, parking fees, restricted growth areas, higher land values in low density areas, and suburban impact fees would be the most promising steps to redirecting development, but such measures have low public support.

Over 80% of the State population is in medium suburban densities or less. Kent County has over a third and Sussex County has over half of the population in very low suburban and rural areas. Employment is spread in a similar way with slightly larger concentrations in higher density areas. Future growth is expected to occur in the medium suburban densities or less throughout the State. Additional urban or high density suburban areas are not expected to develop and those existing areas are for the most part showing a drop in population largely due to a continuing decline in population per household that is expected to continue over the next 20 years. Areas that are now classified as high density suburban or urban have low quantities of developable land, higher land prices, and/or low amounts of available housing stock. Location of new work places in the suburbs is a continuing trend. Declining household size will ensure that household formation will rise faster than population and put substantial pressure on new housing construction in lower

* William M. Rohe and others, Travel to Work Patterns: A Preliminary Analysis of Selected Data from the Annual Housing Survey Travel-to-Work File, University of North Carolina, Department of City and Regional Planning 1980, p 145, As seen in Stuck in Traffic, pg 1

density areas. The increasing number of single person households will tend to choose single family detached housing.

While there was not much data, the DelDOT Household Survey numbers suggest that small pockets of high density development amid otherwise low density suburban development would not be expected to have similar travel characteristics as high density development in larger areas of high density as in northern New Castle County. Rather than an area with a couple large subdivisions and commercial centers, a much larger (if not subregional) high density surrounding area would be expected to be needed to achieve travel characteristics now seen in high density suburban and urban areas of Northern Delaware. In cases of planned communities designed to have people live near where they work, some studies show that commuting behavior is not different from unplanned communities. Large percentages (80 and 90 percent) still choose to work at some distance from their homes for a large number of reasons* (SIT pg104)

As the baby boomers age, there will be an increasing need to address the mobility of elderly populations. With the baby boomers in the high earnings stages of their life cycles, they will be less likely influenced by the costs of owning a car and should be even less sensitive to increases in gasoline taxes and other costs of transportation.

* Robert B. Zehner, "Access, Travel, and Transportation in New Communities (Cambridge, Mass.: Ballinger, 1977). As seen in Stuck in Traffic by Anthony Downs, pg. 104

Introduction: Focus of the Research

There have been a number of ongoing efforts conducted by the Delaware Department of Transportation (DelDOT), the Delaware Transportation Institute, the U.S. Census Bureau, and the University of Delaware to compile information about travel demand in Delaware. This data allows an understanding of the travel needs and patterns within the State and is important to addressing appropriate policies. Due to the large amount of data available and because it is most often used for very specific applications, a large portion of the data has not been thoroughly analyzed and presented.

Travel demand is often discussed in terms of current and future housing development in Delaware. With the expected increased congestion and costs associated with new development in Delaware, there is increasing interest in the relationship of land use and transportation and the promotion of land use policies that can address the effects of ever increasing travel demand.

This research has four primary goals:

- Develop a better understanding of travel demand and the transportation system.
- Take advantage of current investments in data collection.
- Investigate the relationship between land use and transportation.
- Compilation and presentation of travel demand and travel pattern data particularly as it relates to land use.

Understanding what we know about travel demand also helps in identifying what we don't know and in seeing where data and data collection methods can be improved. The information is only as useful to the extent it can be understood, presented, and used.

Summary of Findings

The formulation and implementation of successful transportation policies depends on an understanding of travel demand and the transportation system (supply). The DelDOT Travel Demand Forecasting Model (TDFM), the DelDOT Household Survey, the National Personal Travel Survey, population and employment projections, and U.S. Census data are examples of data that are available to understand travel demand in Delaware and its implications. Some of this data has been used effectively in the past by a few planners whose job it is to work with and maintain the data. However, many people who are involved with transportation have minimal exposure to such specific data about Delaware. Among the reasons why this information has not been more readily available or understood in that past are that preparing, analyzing, and presenting these large data sets is very time consuming and challenging. Also, until this work, the DelDOT Household Survey had not been examined in detail beyond its primary function of updating models for trip generation, since the survey was started in 1995. Studying this large amount of information and presenting findings in this report was the main focus of the project. This report is not an exhaustive view of available information but seeks to take advantage of our investments in these valuable data resources.

Another goal of the project was to address the connections between land use and transportation. There are great concerns currently about urban sprawl and the low density development now seen in Delaware and how it may lead to increased congestion, poor air quality, and other social costs. Residential land use was addressed in this project in terms of population density (persons per square mile) and employment density. There are other land use factors of course, such as the connectivity and density of lane miles in an area, and the degree to which development is mixed (residential/commercial), that could have an effect on the distances or frequencies that people travel.* Population density is, however, the main indicator of the types and extent of travel in an area, and the types of transportation modes that can be successfully employed to meet the demand.

For purposes of this analysis land use densities were divided into six categories:

<u>Persons per square mile</u>	<u>Land use category</u>
0 to 100	Rural
101 to 500	Very low density suburban
501 to 1000	Low density suburban
1001 to 5000	Medium density suburban
5001 to 10,000	High density suburban
10,001 to 64,000	Urban

Whichever was greater, employment per square mile or residential population per square mile, was the figure used to classify density areas. So for instance, by this classification most areas in Brandywine Hundred and Pike Creek (New Castle County) were considered as medium density suburban. Areas such as Elsmere and Claymont fall within the high density suburban category and areas in central Newark or Wilmington make up most of the area in Delaware classified as Urban.

* Another example of where the layout of development is of concern, is "non-friendly" transit development such as those areas that feature large set backs from major transportation corridors and low connectivity between developments.

Highlights of project findings are presented below under various categories.

Travel Characteristics

The Statewide figure for average trips per person for weekday travel as calculated from 5 years of data from the DelDOT Household Survey for all persons in the sample is 2.6 trips per person per weekday* For those respondents who said they made a trip in the day sampled, the figure is about 3.2 trips per person. The numbers are virtually the same for each county. No difference is seen in regards to various land use densities. Areas classified as Rural, Suburban, and Urban showed no difference in calculated trips per person per weekday. National figures as available from the 1995 Nationwide Transportation Survey for trips per person per day are higher, in the neighborhood of 4 trips per person per day, but these figures take into account weekend travel which is not addressed in the DelDOT Household Survey.

The DelDOT Household Survey showed that the average trip time over all types of week day trips for the five year sample was about 23.4 minutes. There were no significant differences in average trip times between counties. In general as population density decreased, average trip time increased. Large differences in average trip time do exist of course in terms of trip purpose, as also shown in Figure 1. Work trips tend to take the longest time and shopping trips the shortest time.

**Figure 1. Average Trip Times for Various Purposes and Population Densities
In Delaware (in minutes, weekday travel)
Source: DelDOT Household Survey 1995 - 1999**

<u>Purpose</u>	<u>Rural</u>	<u>Very Low Suburb.</u>	<u>Low Suburb.</u>	<u>Med Suburb.</u>	<u>High Density Suburb.</u>	<u>Urban</u>	<u>All Densities</u>
All Trips	29.3	24.5	23.5	22.8	22.4	20.9	23.4
Work Trips	32.1	29.0	26.1	27.3	26.8	25.1	27.5
Shop Trips	19.1	18.8	18.2	15.8	14.9	14.8	16.5
School Trips	26.4	21.0	20.9	21.1	22.6	17.7	21.3
Other Trips	33.0	24.4	24.8	22.5	21.3	20.4	23.4

It is important to note that while the average trip time is 23.4 minutes, the median trip time is about 15 minutes. The median trip time for shopping, school, and other trips is 15 minutes, and the median trip time for work trips is 20 minutes. It can be seen from trip distributions presented later in this report that over a third of the trips are 10 minutes or less. Trip time distributions are similar for various population densities as well.

The average driving time per day for all drivers by 1995 National Personal Travel Survey is 1 hour and 13 minutes. Women drive 60 to 70 percent as many miles as men of the same age.

The percentage of trips for various purposes is referred to as trip distribution. Figures 2 and 3 provide two views, one showing distributions for each of the survey years and another showing trip distributions by county.

* For clarification, a trip to the store and then home, is considered to be two trips.

**Figure 2. Summary of Weekday Trip Distribution in Delaware
Percentage of Weekday Travel
Source: DeIDOT HH Survey 1995-1999,**

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All</u>
Work	32.5	32.1	32.2	38.6	43.7	37.0
Shop	21.8	21.9	23.1	20.7	18.2	21.2
School/Daycare	9.1	6.1	4.8	4.7	5.3	5.5
Other	36.6	40.0	39.8	36.1	32.8	36.3

Figure 2 indicates an increase in the work trip percentage of daily travel with a corresponding increase in School/Daycare percentage, and a decrease in other categories. Trip distribution is similar when the county figures are compared. Sussex County with a larger percentage of retirees, would be expected to show a lower percentage of work trips and school/daycare trips.

**Figure 3. Trip Distribution by County (percentage trips by purpose)
Source: DeIDOT Household Survey, Weekday Travel**

	<u>Kent</u>	<u>New Castle</u>	<u>Sussex</u>
Work	37.3	37.7	30.7
Shop	21.8	20.0	24.7
School/Daycare	6.5	5.7	3.9
Other	34.4	36.6	40.6

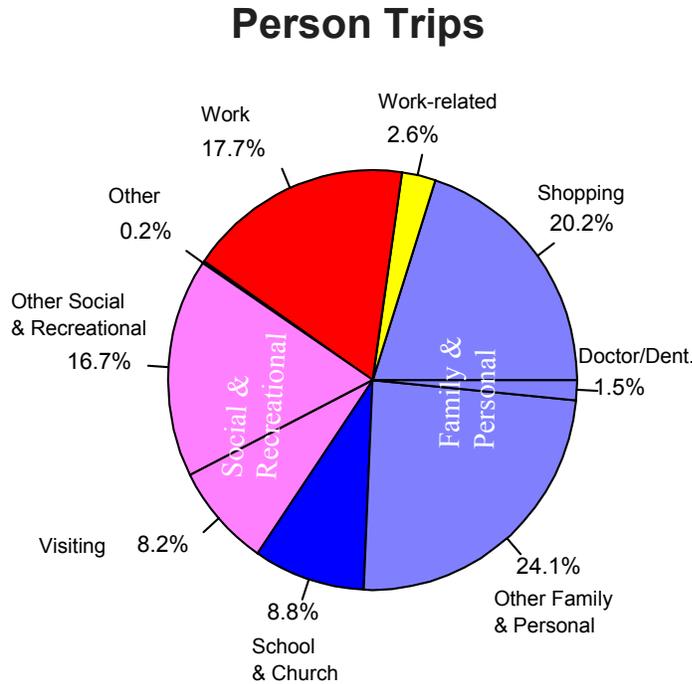
The "Other" category used in the figures above results from a grouping of destinations tabulated in the DeIDOT Household Survey. Figure 4 shows a more detailed breakdown for the 5 year sample.

**Figure 4. Percentage of Weekday Trips to Destinations in Delaware
DeIDOT Household Survey 1995-1999 (does not include Home destination)**

	<u>%</u>
Work	37
Shop	20.7
School	4.7
Drop Off./Pick Up	8.5
Social	9.7
Recreation	4.1
Eat Out	4.2
Child Care	0.7
Other	11.7

Over the entire week, work trips represent a lower percentage. The 1995 Nationwide Personal Travel Survey (NPTS) provides trip distributions for national trip distributions as shown in Figure 5.

Figure 5. Average Distribution of Trips by Purpose.
From "Our Nation's Travel:1995 NPTS Early Results Report



Trip chaining, the grouping of trips(stops) for various purposes in one "outing" is a feature of travel that has been traditionally overlooked but has very significant effects. Analysis of trip distribution, travel patterns, and average distances can be very complicated when one considers the effects of grouping trips. Typically, trip chaining is studied in terms of whether a series of trips began or ended at home or work. A trip that is not chained is one where a person would go directly to work from home, directly to home from work, or from home to a destination and then back with no other stops. Figures 6 and 7 below provide data about chaining as available from the DeIDOT Household Survey and show that almost a third of trips are part of a chain. As also shown in national data people tend to chain trips more often in the journey from work to home and make more stops than in the home to work journey.

Figure 6. Weekday Trip Chaining Types (percentage of trips)
DeIDOT Household Survey 1995-1999

	<u>Trip/Stops</u>	<u>%Trips</u> (includes incidental stops)
Home to Home Chains	4693	22.8
Home to Work Chains	1128	5.2
Work to Home Chains	1583	7.4
No Chains (Stops)	14675	68.2

Figure 7. Average number of stops in a Chain (not including incidental)
DeIDOT Household Survey 1995-1999

	<u>Stops</u>
Home to Home	1.7
Home to Work	1.2
Work to Home	1.4

Certain types of trips are more often part of trip chains as shown in Figure 8 and 9.

**Figure 8. Trip Purpose Distribution for Chained Trips
DelDOT Household Survey 1995-1999**

<u>Purpose</u>	<u>% of chained trips</u>
Child Care	1.7
School	2.9
Recreation	5.0
Eat Out	6.3
Work	6.6
Social	13.4
Drop Off / Pickup	18.0
Other	18.9
Shop	30.1

**Figure 9. Trip Purpose Distribution for Non-Chained Trips
DelDOT Household Survey 1995-1999**

<u>Purpose</u>	<u>% of non-chained trips</u>
Child Care	0.2
Eat Out	3.2
Recreation	3.7
Drop Off / Pick Up	4.0
School	5.6
Social	8.0
Other	8.4
Shop	16.3
Work	51.2

Since most of the shorter distance type trips are more likely to be taken as part of a chain, comparison of trip times and distances between chained and non-chained trips must be in terms of trip purpose, as presented in Figure 10. For the most part, the efficiencies of organizing trips in chains is reflected with trip times for chained trips being slightly lower, except for the Shop purpose.

**Figure 10. Comparison of Average Trip Times and Distances for Chained and Non-Chained Trips by Trip Purpose (minutes and miles),
DelDOT Household Survey 1995-1999**

	<u>Average Trip Time</u>		<u>Average Trip Distance</u>	
	<u>Chained</u>	<u>Non-Chained</u>	<u>Chained</u>	<u>Non-Chained</u>
Work	23.8	27.7	7.1	8.7
Shop	18.2	15.5	5.9	5.2
School-Daycare	18.8	22.0	5.5	6.8
Other	21.0	25.1	6.5	7.7

Non-work related travel has been increasing nationally and also non-work trip making has been growing rapidly during peak commuting times. As the private automobile provides flexibility in organizing daily activities, non-work activities can be more easily coordinated with commuting. Studies indicate that 10 to 20 percent of non-work trips are linked to the commute trip* The shift to single occupancy vehicles from transit contributes to congestion in the growth of vehicle trips directly, but also contributes to congestion indirectly through the stimulation of non-work based

* James G. Strathman and Kenneth J. Dueker. "Understanding Trip Chaining", 1990 NPTS Special Reports on Trip and Vehicle Attributes, pg 1-7

travel during peak periods. In terms of travel efficiency there is a benefit though in that individuals can structure their trips to minimize their travel times. There is also a benefit of trip chaining in that it has been estimated from national data that non-work trips made independent of the work trip are 10 to 20 percent longer and about 2/3 of these trips involve trips to a single destination.

Trip chaining patterns are very related to household characteristics and life cycle. A detailed study of trip chaining and its effects in Delaware was beyond the scope of this project, but it is certainly a very important issue to address in understanding travel demand and policies to address it. Figure 11 below using national data provides a good view of the extent of trip chaining.

Figure 11. Percent of Men and Women Who Make Stops¹

<u>Home to Work Trips</u>		
	<u>No Stops</u>	<u>One or more stops</u>
Women	67%	33%
Men	80.2%	18.8%

<u>Work to Home Trips</u>		
	<u>No Stops</u>	<u>One or more stops</u>
Women	38.8%	61.2%
Men	53.7%	46.4%

Figure 11 above also demonstrates an example of how travel differs depending on demographics. Differences in the travel characteristics of an area are greatly influenced by age, race, income, gender, employment status, and household structure. This report includes a number of findings related to various demographics. In particular, as Delaware's population ages, meeting the elderly's mobility needs will be an increasingly important issue.

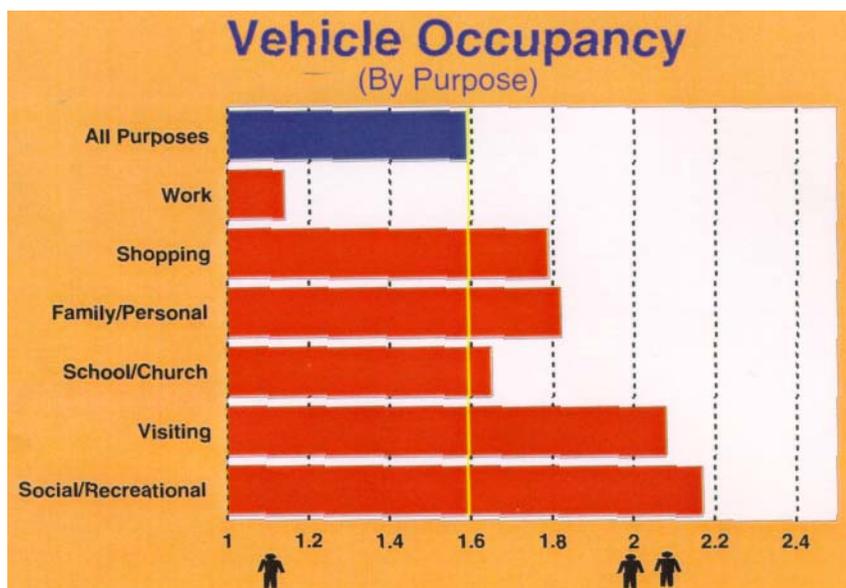
Vehicle occupancy for various trip purposes was tabulated for week day trips from the DelDOT Household Survey, and is presented in Figure 12. By 1995 NPTS (that includes weekend travel) occupancy rates for all travel is 1.59 person miles per vehicle mile, ranging from a low of 1.14 for work trips to 2.17 for other social and recreational purposes. There is a general view that occupancy rates are much lower because typically the focus is on the work trip with occupancy just over 1.0. Actually the national survey indicates that about a third of all trips are multi-occupant.

**Figure 12. Persons per Car Trip
DelDOT Household Survey**

<u>Purpose</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All Years</u>
Social	1.6	1.7	1.7	1.6	1.6	1.7
Dropoff/Pickup	2.2	2.2	2.0	2.0	2.2	2.1
Other	1.5	1.4	1.4	1.5	1.5	1.4
School	1.6	1.6	1.5	1.5	1.5	1.4
Shop	1.5	1.6	1.6	1.5	1.5	1.6
Recreation	1.5	1.9	1.8	1.9	1.5	1.9
Eat Out	1.8	2.2	2.0	1.8	2.1	2.0
Child Care	1.9	2.0	1.8	2.1	1.5	2.0
Work	1.1	1.2	1.2	1.1	1.1	1.2

¹ Nancy McGuckin, "Examining Trip-Chaining Behavior: A Comparison of Travel by Men and Women", FHWA Document on NPTS 1995 Web Site, Washington, D.C., pg. 6

Figure 13. Vehicle Occupancy² (NPTS 1995)



Travel Characteristics and Land Use

Trip time, trip distribution, and trips per person seem to be properties most related to demographic factors and life cycles rather than to land use type.

The most striking transportation differences related to population densities are in average trip distances. The DelDOT Household Survey asked each respondent how much time each trip took. The location of the trip origin and destination was located based on address, closest intersection, or residential development name. Surveyed trips were geocoded to a Modified Grid, which is a demographic unit smaller than a traffic zone used in Delaware for planning and projections. From this information, an estimated distance was calculated for each trip originating and ending in Delaware. Given this distance, and the trip time from the survey, an estimated average speed was also calculated for trips. The results are shown in Figure 14.

Figure 14. Average Trip Times for Various Purposes and Population Densities In Delaware (in minutes, weekday travel)
Source: DelDOT Household Survey 1995 - 1999

Purpose	Rural	Very Low	Low	Med	High Density	Urban	All Densities
		Suburb.	Suburb.	Suburb.	Suburb.		
All Trips	29.3	24.5	23.5	22.8	22.4	20.9	23.4
Work Trips	32.1	29.0	26.1	27.3	26.8	25.1	27.5
Shop Trips	19.1	18.8	18.2	15.8	14.9	14.8	16.5
School Trips	26.4	21.0	20.9	21.1	22.6	17.7	21.3
Other Trips	33.0	24.4	24.8	22.5	21.3	20.4	23.4

² Federal Highway Administration, "Our Nation's Travel: 1995 NPTS Early Results Report", U.S. Department of Transportation.

Figure 15. Internal Delaware Distance and Speed Estimates by Land Use Densities.
Source: 1995 - 1999 DelDOT Household Survey and GIS Road Network Model
Distance in Miles, Speed in Miles per Hour.

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>	<u>All Densities</u>
Avg Trip Distance	11.5	10.3	8.4	6.8	5.7	4.2	7.3
Avg Work Distance	13.2	12.7	9.5	8.2	6.6	5.7	8.7
Avg Shop Distance	8.7	8.2	6.2	4.8	4.1	2.6	5.5
Avg School Distance	12.5	8.5	8.5	6.9	4.1	2.7	6.5
Avg Other Distance	11.4	9.6	8.4	6.6	6.0	3.9	7.2
Avg Trip Speed	23.5	25.2	21.4	17.9	15.3	12.1	18.7
Avg Work Speed	24.7	26.3	21.8	18.0	14.8	13.6	19.0
Avg Shop Speed	27.3	26.2	20.4	18.2	16.5	10.5	20.0
Avg School Speed	28.4	24.3	24.4	19.6	10.9	9.2	18.3
Avg Other Speed	20.7	23.6	20.3	17.6	16.9	11.5	18.5

Differences in average trip distances in relation to density are much larger than differences in trip times because lower density areas allow for higher speeds. This is in line with national results that show that trip times are not increasing at the same rate as trip distances. As development is taking place more and more outside of urban areas, it would seem reasonable that these lower density areas offer less congestion and higher speeds. On a national level, average travel speeds have been increasing. Trip time is more of a driving factor as to where people locate than trip distance. Suburban development does make for more VMT but not as much an increase in travel time.

In terms of use of alternative travel modes, high density suburban and urban areas differ significantly in their use of transit, 1.6 and 5.0 percent respectively, and by walking, 2.9 and 7.9 percent. At lower densities use of other modes falls below 1% in each non-auto mode. In most of the lower density areas transit service is not available for many trips.

Figure 16. Percentage of Respondent's Mode by Population Density
Source: DelDOT Household Survey 5 year sample

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>	<u>All Densities</u>
Driver	88.9	87.2	89.0	88.1	85.7	75.0	86.7
Passenger	9.3	11.3	10.2	9.4	8.8	10.2	9.7
Public Bus	0.6	0.2	0.2	0.7	1.7	4.6	1.0
Walked	0.4	0.3	0.2	0.7	2.7	7.2	1.4
School Bus	0.2	0.6	0.3	0.6	0.7	1.6	0.6
Bike	0.1	0.2	0.1	0	0.2	0.8	0.1

In regards to trip chaining, the data indicated only very slight differences in trip chaining. Lowest density areas tended to have more Home to Home chains and less Home to Work chains.

Figure 17. Trip Chaining by Land Use Density (percentage of total trips)
DelDOT Household Survey 1995-1999

<u>Chain Type</u>	<u>Rural</u>	<u>Very Low Suburb.</u>	<u>Low Suburb.</u>	<u>Med Suburb.</u>	<u>High Density Suburb.</u>	<u>Urban</u>	<u>All Densities</u>
H - H Chain	25.5	20.9	24.9	20.8	18.7	18.6	21.0
H - W Chain	2.5	3.3	2.7	3.1	3.3	4.1	3.2
W-H Chain	5.7	6.0	4.5	5.9	5.3	4.3	5.6
No Chains	65.1	68.8	66.8	68.7	71.5	71.0	68.9
Incidental Trips H-W or W-H	3.8	2.9	2.7	3.5	3.9	3.4	3.5

Comparisons of average trip times for Chained and Non-Chained trips by the various population densities showed minor differences.

Demographic and Land Use Trends

As seen below in Figure 18 that tabulates current DelDOT population and population figures by the various land use densities, over 80% of the State population is in medium suburban densities or less. Kent County has over a third and Sussex County has over half of the population in very low suburban and rural areas. Employment is spread in a similar way with slightly larger concentrations in higher density areas.

Figure 18. Population and Employment Figures From Year 2000 DelDOT Population Projections

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>
DE Pop 2000	103513	134583	92079	280982	85661	50615
DE Pop 2000 Dist %	13.7%	17.8	12.2	37.2	11.3	6.7
KC Pop 2000 Dist %	10.3%	29.4	9.2	38.6	10.5	2.0
NC Pop 2000 Dist %	11.7%	8.8	11.8	41.5	14.5	9.9
SC Pop 2000 Dist %	23.3	38.1	16.3	21.2	1.1	0
DE Emp 2000	19396	52313	50676	171319	30857	62652
DE Emp 2000 Dist %	5.0%	13.4	12.9	43.7	7.9	16.0
KC Emp 2000 Dist %	2.9	11.5	5.5	55.1	8.9	16.3
NC Emp 2000 Dist %	3.8	10.2	14.0	41.8	9.1	19.6
SC Emp 2000 Dist %	11.9	28.8	15.0	42.6	1.7	0

Future growth is expected to occur in the medium suburban densities or less throughout the State. Additional urban or high density suburban areas are not expected to develop and those existing areas are now showing a drop in population largely due to a continuing decline in population per household that is expected to continue over the next 20 years. Areas that are now classified as high density suburban or urban have very low quantities of developable land, higher land prices, and/or low amounts of available housing stock.

Residential and employment growth continue to develop widely across the State. Destinations for all trips are spread widely.

**Figure 19. Population Estimates for the Year 2020
Year 2000 DelDOT Population Projections (CADSR)**

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>
DE Pop 2020	144374	170224	101418	284780	82593	52767
DE Dif. 2000 to 2020	40,856	35,641	9,339	3,798	-3068	2152
KC Dif. 2000 to 2020	2030	6743	2437	4871	751	234
NC Dif 2000 to 2020	21,394	16,306	3518	-1405	-3825	1918
SC Dif 2000 to 2020	17432	12592	3384	332	6	-

Figure 20. Distribution of Destinations
Source: DelDOT Household Survey 1995-1999

<u>Purpose</u>	<u>All trips</u>	<u>Work Trips</u>
Urban	11.7	13.3
High Density Suburb	16.1	17.2
Medium Suburban	45.8	41.7
Low Suburban	6.8	6.6
Very Low Suburban	9.8	9.9
Rural	5.1	5.1

Location of new work places in the suburbs has also been a trend. Figure 21 shows DelDOT projections for the year 2020 and changes in the next 20 years. In 1989, a Coldwell Banker study of office space in 50 metropolitan areas showed that the suburbs attracted 72 percent of the new office space built and 74 percent of the office space actually absorbed.

Figure 21. Employment Estimates for the Year 2020
Year 2000 DelDOT Employment Projections

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>
DE Dif. 2000 to 2020	4857	8347	7493	26810	4299	11,111
KC Dif. 2000 to 2020	144	1436	610	5075	738	2156
NC Dif 2000 to 2020	2885	3110	3595	13,291	3319	8955
SC Dif 2000 to 2020	1828	3801	3288	8444	242	-

Where people live is affected by many factors that include quality of life, quality of schools, age ethnicity, proximity to family and friends, jobs of other family members, and socioeconomic features of locations. A 1980 national survey sampled workers who lived more than 5 miles from work and they were asked to state the most important reason why they did not live close to their jobs. About 38% cited good schools, 24% said they liked their house, 17% said they liked their neighborhoods, and 10% said their own jobs were too far from the jobs of other family members³.

A goal of most Americans is to own single-family detached homes with private open space next to each dwelling. In a Delaware survey that asked "Where Would You Most Like to Live?", over 70% wished to live in a suburban development or lower density area.

Figure 22. Where Would You Most Like To Live? (% respondents)
By Survey Year⁴

	<u>City</u>	<u>Small Town</u>	<u>Suburban Dev.</u>	<u>Rural Dev.</u>	<u>Home in Country</u>
1995	3.4	17.2	20.9	10.8	47.2
1996	6.1	20.1	27.4	9.1	37.4
1997	6.0	20.4	25.0	11	37.6

³ William M. Rohe and others, Travel to Work Patterns: A Preliminary Analysis of Selected Data from the Annual Housing Survey Travel-to-Work File, University of North Carolina, Department of City and Regional Planning 1980, p 145, As seen in Stuck in Traffic, pg 17

⁴ Ratledge, Edward C., *Delawareans' Attitudes Toward Economic Growth: Survey Results*, Center for Applied Demography and Survey Research, University of Delaware

Lower housing costs, tax incentives, low fuel prices, and availability of expressways encourage suburban development as well. Travel is often less costly to the average household than land or housing. In 1990, the average household spent 16.7% of its annual income for transportation, not counting the time spent traveling, but it spent 26% for housing (Bureau of the Census, Statistical Abstract of the United States, 1990). There is often a benefit to moving into the suburbs and rural areas since housing costs can be greatly reduced by increasing transportation costs somewhat. This is of course why many households make very long commuting trips in high-housing cost metropolitan areas. In Delaware where there is relatively low congestion and large amounts of lower cost housing and land in lower density areas, many people are willing to accept slightly longer drive times for an increased quality of life.

The data certainly show that people drive larger distances in lower density areas. There has been increased support for higher density development, clustered development, mixed use development, and planned communities. There is some question as to the effect of the scale of the development and its proximity to similarly high density areas. One might think, for instance, that the residents in an isolated subdivision of high density in an otherwise low density suburban area would not have travel characteristics much different than their neighbors. There is some difficulty in investigating what travel patterns might result from a suburban pocket of high density or mixed use mostly because very few areas in Delaware would qualify as examples, and data is less available for those areas.

Average trip times for the Middletown area, the Smyrna area, and for high density suburban and urban areas in Kent County (includes Dover) were tabulated and shown below in Figure 23. The average trip times for Middletown and Smyrna areas were more in line with figures for very low density suburban areas as presented previously, particularly the figures for the work trip. Middletown and Smyrna areas both had unusual numbers of long duration trips. The Kent County high density areas mostly involve locations in Dover, and travel in general in Kent County is focused on Dover. Average trip times are more in line with previous numbers for medium density and high density suburban areas. While there was not much data, the numbers suggest that areas of high density development amid otherwise low density suburban development would not be expected to have similar travel characteristics as high density development in larger areas of high density as in northern New Castle County. In all three areas the percent of walking trips was a little more or less than one percent.

Figure 23. Average Trip Times For Higher Density Suburban Areas in Delaware

	<u>Smyrna Area</u>	<u>Middletown Area</u>	<u>Kent High Density Areas</u>
Sample Trips	109	95	255
Avg Work Time	43.7 (minutes)	34.0	24.9
Avg Shop Time	18.6	25.5	17.5
Avg Other Time	21.4	28.6	29.1

Lifestyle preferences and economic opportunity together have driven land use patterns, and they are both in the direction of continued low density development. Raising the cost of transportation or cost or availability of suburban development such as with higher fuel costs, congestion or peak hour pricing, higher taxes, parking fees, restricted growth areas, higher land values in low density areas, and suburban impact fees would be the most promising steps to redirecting development, but that is the area of least public support. People are very accustomed to low transportation costs, an effective and uncongested transportation network, and a significant public subsidy in terms of publicly financed infrastructure to support the lifestyle they desire.

The increasing number of adults in the population will generate significant new needs for "drive time" transportation capacity. As the baby boomers age, there will be an increasing need to address the mobility of elderly populations. With the baby boomers in the high earnings stages of their life cycles, they will be less likely influenced by the costs of owning a car and should be even less sensitive to increases in gasoline taxes and other costs of transportation. Declining household size will ensure that household formation will rise faster than population and put substantial pressure on new housing construction in lower density areas. The increasing number of single person households will tend to choose single family detached housing.

Transit and Other Modes of Travel

Delaware is reaching the bulk of the transit market. When transit service guidelines used in long-range transit plans are viewed in relation to existing transit service, as they were in the WILMAPCO Regional Transit Service Needs Analysis (1996), existing transit service is in line with what guidelines would warrant. Service type guidelines warrant fixed transit in areas where there are 4 to 12 households per acre. All such areas in northern Delaware are within a quarter mile of fixed transit service.

Compared to other counties in the country, New Castle County has average to above-average use of the transit system. New Castle County in 1990 was the 112th most populous county in the country and it had the 117th highest population density. In 1990, New Castle County ranked 97th in terms of the number taking public transit to work, and this was before large ridership increases were achieved through the 1990's (Bureau of Census, 1990).

The Deldot Household Survey 5 year sample estimates the percentage of all statewide week day trips by transit to be about one percent, by walking 1.4%, and by private auto (passenger or driver) to be 96.4%. The frequency of walking or using transit is much higher in urban areas where the survey estimates 4.6% of total weekday trips are by transit and 7.2% by walking.

Figure 24. Travel Mode (%) of Respondent in the DelDOT Household Survey 1995-1999

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All</u>
Driver	86.5	85.3	86.7	85.8	88.6	86.7
Passenger	8.2	10.2	9.9	10.7	8.4	9.7
Public Bus	1.0	1.2	0.9	1.1	1.1	1.0
Walked	1.4	1.8	1.6	1.4	0.9	1.4
School Bus	2.6	0.7	0.4	0.4	0.4	0.6
Bike	0.2	0.3	0.1	0.1	0.2	0.1
Other	0.2	0.5	0.3	0.4	0.3	0.4

Use of bicycles is generally 0.2 percent or lower even for urban and high density suburban areas (DelDOT Household Survey). The only tabulations that listed the bicycle travel mode as more than one percent were for the lowest income bracket in New Castle County (1.1% of weekday trips), and the Asian-Pacific Island ethnicity class (2.2% of weekday trips in a sample of 109 trips from this ethnicity). As over a third of weekday trips in Delaware are 10 minutes, it was thought that the bicycle mode would be viable and show a higher share of trips, at least in urban areas but the evidence suggests that the use of bicycles beyond recreation is very limited indeed.

Because of the many relatively short distance trips and because of the nature of transit trips (i.e. waiting for the bus, stops, and boarding) the average transit trip is estimated to take almost twice as long as the average trip by personal auto.

Figure 25. Average Trip Time By Mode (minutes)
Source: DelDOT Household Survey 1995-1999

	<u>Average Trip Time</u>
Driver	22.9
Passenger	25.2
Public Bus	38.3
Walk	12.2
School Bus	31.4
Bicycle	18.2
All modes	23.4

Figure 26, Travel Characteristics of Trips Originating and Ending in Delaware
Source: DelDOT Household Survey 1995-1999

	<u>Avg. Trip Time</u>	<u>Avg. Trip Distance</u>	<u>Avg. Trip Speed</u>
Driver	20.0	7.4	22.2
Passenger	21.1	8.0	22.7
Public Bus	35.0	6.6	11.3
Walk	11.8	.8*	4.0*
School Bus	32.2	7.5	14.0
Bicycle	18.4	3.3	10.8
All Modes	20.3	7.3	21.6

* Because of the resolution of the way the origin and destinations are geocoded, short distance trips are expected to be estimated longer than they actually are and this would be shown in higher than actual estimated average speeds.

More than half of the trips are 15 minutes or less, and over a third of all trips are 10 minutes or less. Half of work trips are 20 minutes or less by private auto. With such low travel times, and where there is relatively low or no congestion, transit will have difficulty competing for "choice" riders. In models of transit ridership produced by CADSR the most significant factor for ridership besides population density is the availability of direct service.

Origins and destinations are increasingly more dispersed throughout the State. Practically all new population and employment growth in the future will be in suburban areas. The effect is that there are increasingly less origin-destination pairs that exist where for a particular locale (an area serving several subdivisions for instance) there are a sufficient number of riders that can be identified to warrant direct or slightly indirect service. A previous study by CADSR showed that for medium density suburban areas such as the Pike Creek/ Kirkwood Highway area, a large percentage (34% to 68%) of the housing units were not within a 6 minute walking distance of bus stops located on adjoining roads, and that circulating such areas to pick up passengers involves large time costs. Two thirds of all trips are 20 minutes or less, and most origin destination pairs involving 200 or more workers have travel times by auto of 25 minutes or less.

About 90% of the journey to work market involves trips from or to suburban areas (1990 CTPP), and enhancements to the current transit system will have to better address the suburban market.

Park and Ride is seen as the only effective local collection strategy to reach the medium to low density suburban market. In New Castle County about 10% of transit ridership originates at Park and Rides.

In many rural areas car pooling is used in place of transit for some populations. Ride share is not addressed in this report or in the data, but given the increasingly medium to low density development trends, ride share programs may be the primary and most successful strategy of increasing vehicle occupancy.

The effect of dispersed origins and destinations, prohibitively long travel times, the need of many for the flexibility of the private auto and to chain trips, the expense necessary to offer direct service to suburban areas, the time necessary to circulate suburban areas to collect passengers, and the number of areas not served, all greatly limit the market that can be served by transit. The mode share for transit in Delaware is expected to decrease. Nationally, transit share has been decreasing.

As most of the markets for transit are now being reached, efforts to increase or maintain share of travel will require more intensive marketing efforts. The collection and use of travel demand data can greatly assist these efforts. In particular, origin and destination information as offered by the DelDOT Travel Demand Forecasting Model, the Census Transportation Planning Package (CTPP), and the DelDOT Household Survey, is very valuable information to help focus efforts. As an example, the 1990 CTPP for New Castle County, indicates a number of possible areas for transit development that include areas in and around western portions of Kirkwood Highway, Chestnut Hill Road, Milltown Road, northern portions around the City of New Castle, and lower portions of Route 40. Suburban destinations involving thousands of workers such as the Zeneca/Dupont, East Newark, and Newport/Boxwood areas are shown as markets that transit service may better reach.

Sources of Data

DelDOT Household Survey

The DelDOT Household Telephone Survey, as part of the Delaware Statewide Model Improvement Project, is an ongoing survey in its 6th year that gathers information about the travel behaviors and preferences of drivers, 16 years and older, across the State. It began initially to update DelDOT trip generation models and takes the place of trip diaries used by other States. In a random process, respondents are selected and asked to list the origin, destination, time, and trip method (mode) of every trip made in the preceding day. Demographic data is compiled for each respondent. Public opinion on transportation issues is also surveyed. As of January 2000, there had been 8372 people surveyed, and over 21,000 trips have been documented. This represents a continually growing body of knowledge specific to Delaware and has yet to be fully taken advantage of for planning. This research analyzes information from the DelDOT Household Survey to study the trip distributions, travel patterns, and travel time for various trip purposes and land use densities.

It is important to remember when looking at the data that only those 16 years and older were surveyed and it did not include travel on Saturday and Sunday. Before analysis the data was weighted back to Delaware demographics to account for sample bias. There is a substantial amount of information available in the survey that was not studied. This report includes highlights of travel demand and relationships to land use density.

DelDOT Travel Demand Forecasting Model

The Division of Planning at DelDOT has maintained the Travel Demand Forecasting Model for many years to predict travel demand over a 20 year projection period. This model predicts the number of trips for various purposes, trip productions and attractions, and volume to capacity ratios. It takes into account future improvements to the transportation system, projected growth, and is able to estimate the performance of the system at a general planning level for various types of growth scenarios. Model parameters are adjusted primarily to have outputs that are consistent with traffic counts and other sources of information. The model has gone through substantial improvement in the past years. The version of the model available for analysis was divided into two pieces, one for New Castle County and another for Kent and Sussex together. A new Delmarva Peninsula wide model will be available soon that includes substantial improvements to model inputs. It is a traditional 4-Step modeling approach that seeks to capture travel demand at a general planning scale rather than producing results at a subdivision level.

Census Transportation Planning Package

The 1990 Census Transportation Planning Package produced from the 14% sample of the U.S. Census provides a large amount of information about journey to work travel patterns and mode of travel in Delaware. The data for northern Delaware and Cecil County (MPO) is available for much smaller demographic units than for other areas in the state with data at a traffic zone level or smaller. It represents the most detailed origin - destination information available for Delaware.

1995 Nationwide Personal Transportation Survey

The Nationwide Personal Transportation Survey (NPTS) is a national inventory of daily passenger travel. The 1995 Survey is the fifth in a series that began in 1969 (1977, 1983, 1990). The survey is collected from a sample of U.S. households and collects information on all trips, by all modes, for all purposes, and in various types of areas (urban, rural). NPTS is a survey of travel by the civilian, non-institutionalized population of the U.S. age five and older. It does not include residents of group quarters, such as nursing homes, college dormitories, and long term medical facilities. Sample size for the 1995 NPTS was 42,033 households. Among other information the data includes:

- trip purpose
- trip mode
- trip time
- trip length
- trip time of day and day of the week
- vehicle occupancy
- driver and vehicle characteristics

The NPTS is used in this report as a comparison to local figures and also as a source for information that considers weekend travel and travel of those under 16 years of age. Numerous studies have been conducted with this information and results on some studies are included.

Year 2000 Delaware Population and Employment Projections

The Delaware Population Consortium prepares the official population projections each year in Delaware. Figures are available at the county level and include age, race, and gender distributions. The Center for Applied Demography and Survey Research at the University of Delaware uses these figures, tax assessment records, zoning information, historical development information, Department of Labor records, historical population and employment records, and a wide range of other available data to allocate county level projections to the DelDOT Traffic Zone level and for Kent and Sussex counties the Modified Grid Level (a demographic unit smaller than a traffic zone). Some figures from the projections used in this report are still being reviewed.

Travel Characteristics and Trends

Introduction

This chapter presents information available from the DelDOT Household Survey, the Census Transportation Planning Package (CTPP), the Nationwide Personal Transportation Survey, and CADSR studies concerning travel demand and characteristics.

Numbers of Trips

The DelDOT Household Survey continues to produce a large amount of information specific to Delaware travel patterns and preferences. Figure 29 on the next page summarizes what is known about the number of weekday trips for those 16 years and older. Travel from an origin to a destination is one trip, so for instance a trip to work from home and then the return trip is considered to be two trips. There is no significant difference between those living in different counties in regard to the average number of trips per day. Perhaps the most striking information shown in Figure 29 is that the number of trips per person per weekday, showed a steady decline in the five years of data analyzed. This is true for those making trips, and also there was an increased number of respondents who said they made no trips in the previous day. Declines were mostly in the "Shopping" or "Other" purposes with only small variations in Work or School/Day Care trips.

This decrease in trip taking appears to occur across all demographics. An aging population and more retirees moving into southern Delaware would tend to decrease trips. Steady increases in vehicle miles traveled (VMT), as calculated from traffic counts and the general perception by many that traffic volumes have increased, would not seem to be consistent with a drop in trip taking. Staff have considered a number of checks to verify the trend, and survey staff have been instructed to prompt respondents more as to trips that do not immediately come to mind, perhaps a shopping trip or other travel. CADSR will soon review 2000 figures and follow up with survey staff. Possible increases in travel not covered in the survey, such as commercial travel, are being considered.

It does not seem likely that respondents erroneously answered the simple question "Did you go anywhere yesterday?". Data was analyzed for those making no trips as shown in Figures 27 and 28. No major differences were seen between counties in regard to those not making trips in the preceding day. In the 1999 survey a question was added to find out the reason no trips were made (as shown in Figure 27) and hopefully this will provide some explanation and trend information about those making no trips in the future. This question also provides an estimate of those working at home.

Figure 27. Reason for No Trip. (% of no trip respondents)

Source: 1999 DelDOT Household Survey

Working at home	9.8
Sick	11.5
Vacation	7.0
Retired or unemployed	52.5
Other	17.6

Figure 28. Percentage of Those Who Made No Trips Within Different Age Groups
Source: DelDOT Household Survey 1995-1999

Age	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>Total</u>	Sample %
Under 40	29.4	37.8	35.9	34.0	32.5	33.8	46.3
40 to 64	35.8	41.1	37.0	33.0	34.5	35.0	36.9
over 65	34.9	21.1	27.1	33.0	33.0	31.2	16.2

Figure 29. State and County Trip Making Summary,
Source: DelDOT Household Survey 1995-1999

Delaware

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All</u>
Sample size	796	762	2392	2394	2375	8719
Sample no trip	108	89	355	486	596	1634
Sample w trip	688	673	2035	1908	1770	7083
%no trip	13.5	11.7	14.9	20.3	25.1	18.7
Trips	2413	2457	6894	5839	4784	22386
Trips/person	3.03	3.22	2.88	2.44	2.01	2.57
Trips/per (mt)	3.63	3.66	3.46	3.15	2.70	3.16 (of those who made trips, mt)
Avg trip time	24.40	21.62	23.10	22.44	25.26	23.37

Kent County

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All</u>
Sample size	130	124	387	380	379	1406
Trips	312	412	1063	824	703	3314
Trips/person	2.4	3.3	2.7	2.2	1.9	2.4
Sample no trip	22	14	69	90	114	309
Sample w trip	108	110	319	289	271	1097
%no trip	16.9	11.3	17.8	23.7	29.6	22.0
Trips/per (mt)	2.9	3.7	3.3	2.9	2.6	3.0 (of those who made trips, mt)
Avg trip time	25.1	22.3	22.3	22.6	23.0	22.8

Sussex

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All</u>
Sample size	143	139	440	448	449	1619
Trips	435	466	1414	1160	706	4181
Trips/person	3.0	3.4	3.2	2.6	1.57	2.6
Sample no trip	19	14	49	84	151	317
Sample w trip	124	125	391	364	298	1302
%no trip	13.2	10.1	11.1	18.8	33.6	19.6
Trips/per (mt)	3.5	3.7	3.6	3.2	2.4	3.2 (of those who made trips, mt)
Avg trip time	23.8	20.4	25.0	24.2	24.7	24.1

New Castle

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All</u>
Sample size	523	499	1564	1567	1571	5694
Trips	1664	1580	4416	3854	3378	14892
Trips/person	3.2	3.2	2.8	2.5	2.15	2.6
Sample no trip	67	62	237	312	331	1009
Sample w trip	456	438	1326	1255	1210	4685
%no trip	12.8	12.4	15.2	19.9	21.5	17.7
Trips/per (mt)	3.7	3.6	3.3	3.1	2.8	3.2 (of those who made trips, mt)
Avg trip time	24.4	21.8	22.7	21.9	25.9	23..3

Figures 30 and 31 show estimates of daily trips by county and purpose. Figure 31 clearly shows that while decreases in work trips are shown, decreases in Shopping and Other purposes are much greater. This would be inconsistent with national trends

Figure 30. Number of Daily Trips Expansion From the DelDOT Household Survey

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>
Kent	220311	307143	256094	199553	174709
New Castle	1173219	1179272	1063291	934123	840252
Sussex	306713	346549	340470	280847	174811
	1,700,243	1,832964	1659955	1414523	1189772

Figure 31. Number of Estimated Daily Trips by Purpose, DelDOT Household Survey

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>
Work	595216	647933	608928	589561	544302
Shop	370366	400931	383779	292690	217962
School/Daycare	154271	111280	79711	65975	62142
Other	622189	732316	660820	510454	390949

Comparison with other data is the best way to examine the estimated trip totals, though there is considerable difficulty in finding data with which to compare them. Work trips are the easiest, and one comparison is shown in Figure 32. It would seem that the estimated total trips, as expanded from the survey, is a little low but not necessarily since it is unknown how many people work shifts on weekends or outside of the usual Monday thru Friday work week. Since the survey only studied weekday travel, people could be reached who indicated that they made no work trip in the previous day, though they may work a full time job. If only 5% were missed in this way or in another manner that would make expected trips and estimated trips roughly the same.

Figure 32. Data Comparison of Expected and Estimated Number of Work Trips

Number of workers living in Delaware	=	385,000
Expected number of work trips	=	770,000 trips
Less sick/vacation rate (10%)	-	77,000 trips
Less carpool to work (3.6%)	-	27,700 trips
Work at home group (3% ?)	-	23,000 trips
Those working on weekend shifts	-	???
		642,300 - ??? trips expected
Estimated work trips from survey (to and from)	=	603,700 trips (five year average)

Similar comparisons for other trip purposes are much more difficult if not impossible to determine because of the lack of data. As the survey continues and additional controls are put in place, the accuracy of estimates will be better known. If declines or lower trip making is seen month after month in the future, then this would be an important finding from a public policy standpoint and contrary to national trends that show personal travel increasing. Estimated increases in VMT would then have to be a result of other sources. The types of other sources not covered in the survey include, among others, work related travel, commercial travel, delivery services, and public safety services.

Trip Time

In the DelDOT Household Survey, respondents were asked how much time (in minutes) each trip took. The figures below present a few views of that information.

Figure 33. Average Trip Time (in minutes) by Year and Purpose

DelDOT Household Survey						
Purpose	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All Years</u>
Work	30.0	26.8	27.7	26.1	28.3	27.5
Shop	16.9	15.4	16.8	15.9	17.1	16.5
School	27.4	25.3	18.0	17.3	22.3	21.2
Other	23.1	20.4	23.4	23.0	26.3	23.4
All Trips	24.4	21.6	23.1	22.4	25.3	23.3

Figure 34. Average Trip Time by County (DelDOT Household Survey 1995-1999)

	<u>Kent</u>	<u>New Castle</u>	<u>Sussex</u>
Work time	25.0	28.5	25.8
Shop	18.0	15.5	18.4
School/Daycare	23.1	21.2	19.5
Other	23.4	22.4	26.7
All Trips	22.8	23.3	24.1

Figure 35. Average Trip Time for Trips to State Destinations, (minutes)

	<u>DE</u>	<u>PA</u>	<u>MD</u>	<u>NJ</u>
	22.1	48.2	40.2	73.7

It is important to note that while the average trip time is 23.3 minutes, the median trip time is about 15 minutes. The median trip time for shopping, school, and other trips is 15 minutes and the median trip time for work trips is 20 minutes. It can be seen from trip distributions presented on the next pages that over a third of the trips are 10 minutes or less.

Figure 36

Trip Time Distribution

All Trips

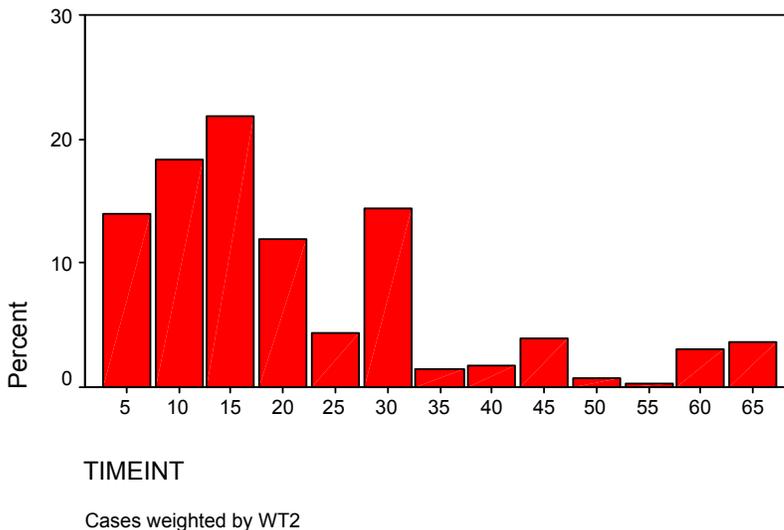
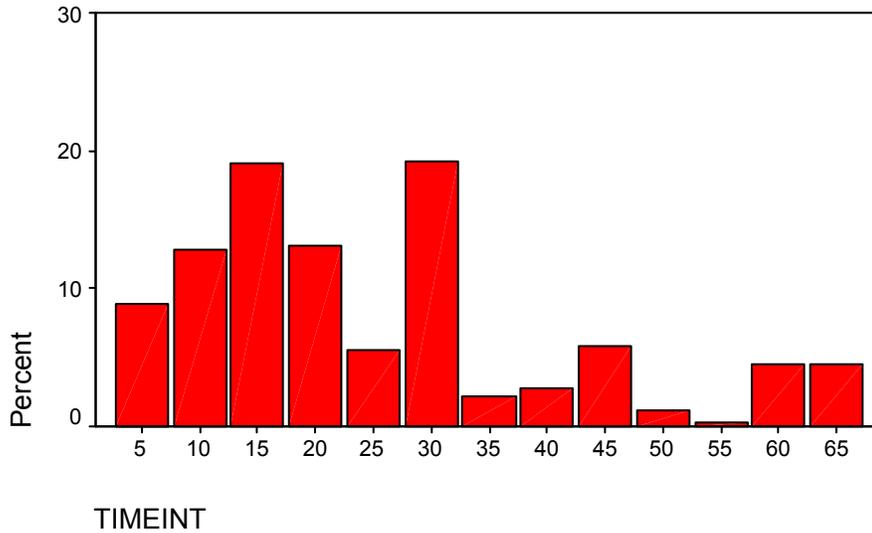


Figure 37

Trip Time Distribution

Work Trips

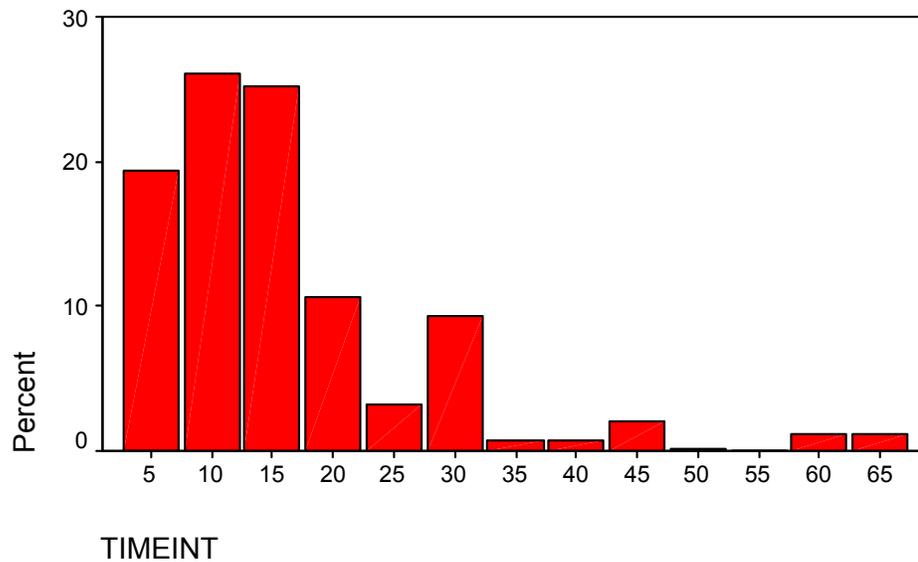


Cases weighted by WT2

Figure 38

Trip Time Distribution

Shopping Trips

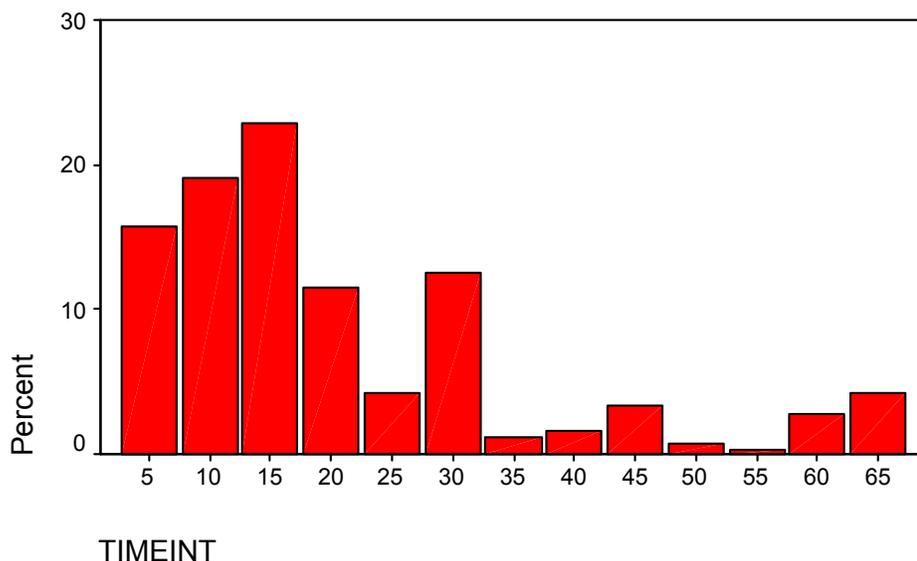


Cases weighted by WT2

Figure 39

Trip Time Distribution

Other Trips



Cases weighted by WT2

Trip Distance

The distances people travel are also of great interest. In the DelDOT Survey respondents are not asked for the distance of their trips. People generally know the time their trips take with much more accuracy than distance. In the survey, respondents provide an origin and a destination address that is then geocoded by survey staff to the Modified Grid, which is a demographic unit smaller than a traffic zone that is used by various planning groups in Delaware. To analyze trip distance in this project, geographical information system minimum path algorithms were used to estimate grid to grid distances for each trip. The path was calculated along the roads as represented in the DelDOT Center Line File. This method seemed to provide a reasonable estimate. Figures 40 thru 43 show information on distance. For travel out of the State of Delaware a distance estimate was not calculated, so that all distance estimates calculated from the DelDOT Household Survey are only for trips beginning and ending in Delaware (internal). For these trips there is some indication that average trip distances are increasing.

Figure 40. Estimated Average Distance in Miles for Trips Beginning and Ending in Delaware. DelDOT Household Survey

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All</u>
Delaware	6.9	7.0	7.2	7.4	8.0	7.3
Kent	8.8	9.0	8.5	9.3	9.4	9.0
New Castle	6.0	6.1	6.2	6.2	6.8	6.3
Sussex	8.8	8.2	9.4	9.8	11.5	9.6

**Figure 41. Average Trip Distance by Purpose in Miles (Statewide)
Internal trips. Source: DelDOT Household Survey**

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All</u>
Work	8.9	9.1	8.7	8.7	8.4	8.7
Shop	5.5	4.7	5.6	5.6	5.8	5.5
School/Daycare	6.4	9.7	5.6	5.4	7.1	6.6
Other	6.1	6.1	7.2	7.4	8.5	7.2
All	6.9	7.0	7.2	7.4	7.9	7.3

Certainly various types of trips have differing average distances. As discussed in a later section of this report that addresses transportation patterns and land use, trip distances are seen to vary in relation to land use density as show in Figure 42.

**Figure 42. Internal Delaware Distance Estimates by Land Use Densities.
Source: 1995 - 1999 DelDOT Household Survey and GIS Road Network Model
Distance in Miles, Speed in Miles per Hour.**

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>	<u>All Densities</u>
Avg Trip Distance	11.5	10.3	8.4	6.8	5.7	4.2	7.3
Avg Work Distance	13.2	12.7	9.5	8.2	6.6	5.7	8.7
Avg Shop Distance	8.7	8.2	6.2	4.8	4.1	2.6	5.5
Avg School Distance	12.5	8.5	8.5	6.9	4.1	2.7	6.5
Avg Other Distance	11.4	9.6	8.4	6.6	6.0	3.9	7.2

National data show that trip lengths over all trip purposes have not increased. However, the trip lengths for the journey to work have increased by about 26% in the years between the 1969 NPTS and 1995 NPTS. Work trips are those trips that people have the least control over, and with more and more people moving into the suburbs and with the increase in households with two or more workers, this increase is expected.

**Figure 43. Average Vehicle Trip Length (miles)
Nationwide Personal Transportation Survey⁵**

	<u>1969</u>	<u>1977</u>	<u>1983</u>	<u>1990</u>	<u>1995</u>
All Purposes	8.90	8.35	7.90	8.85	9.06
To and from work	9.40	9.02	8.55	10.97	11.80
Shopping	4.36	4.99	5.28	5.10	5.64
Other Fam. & Personal	6.51	6.72	6.68	7.43	6.93
Social and Recreational	13.12	10.27	10.55	11.80	11.24

Departure time

The following figures show the departure time for various trip purposes from the DelDOT Household Survey. Shopping and Other trips occur throughout the day. About a third of the trips that occur during the weekday morning peak are non-work related, and over half of the trips in the evening peak period are non-work.

⁵ Patricia S. Hu and Jennifer R. Young, "Summary of Travel Trends:1995 Nationwide Personal Transportation Survey". Pg. 13

Figure 44. Departure Time, All Trips, Statewide (military time)

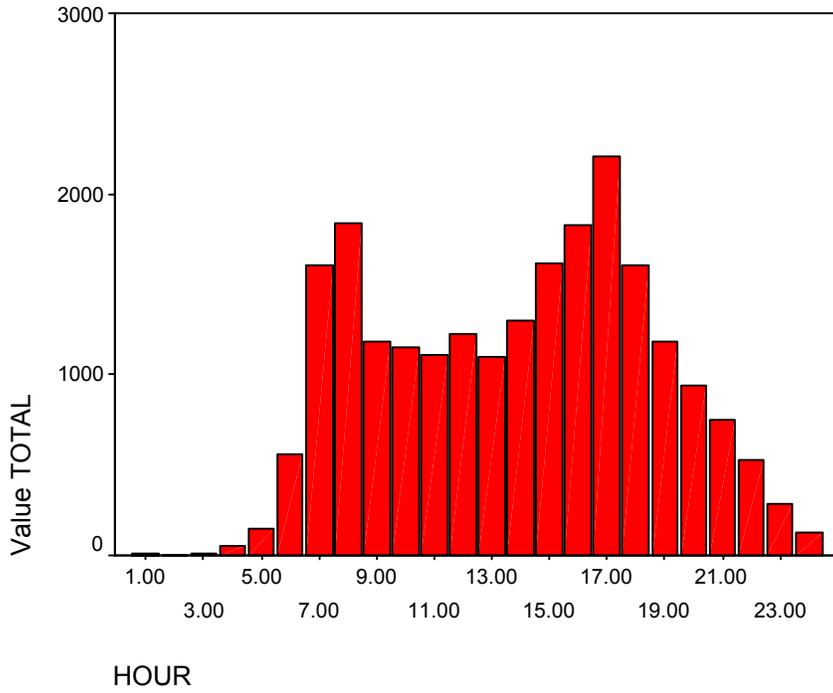


Figure 45. Departure Time, Work Trips, Statewide

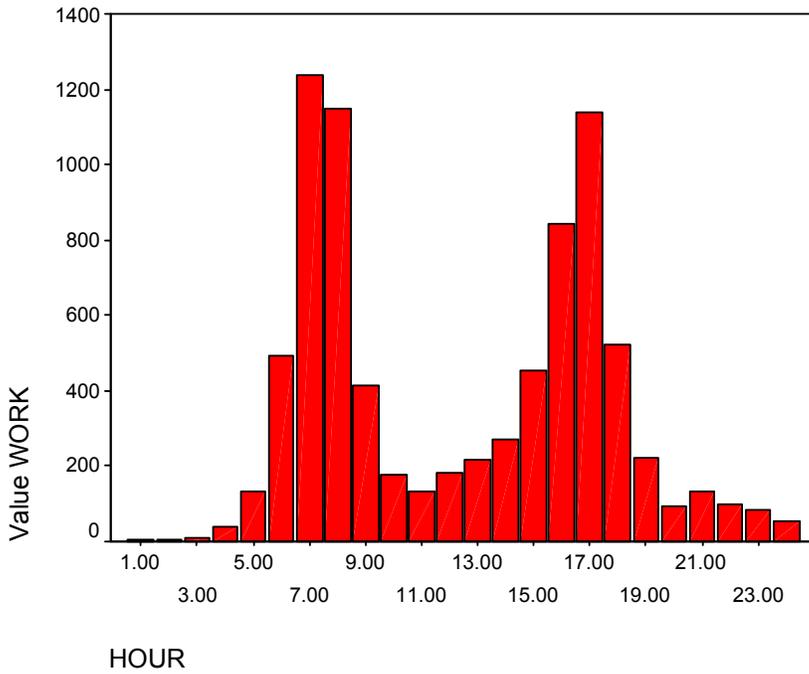


Figure 46. Trip Departure Time, Shopping Trips, Statewide

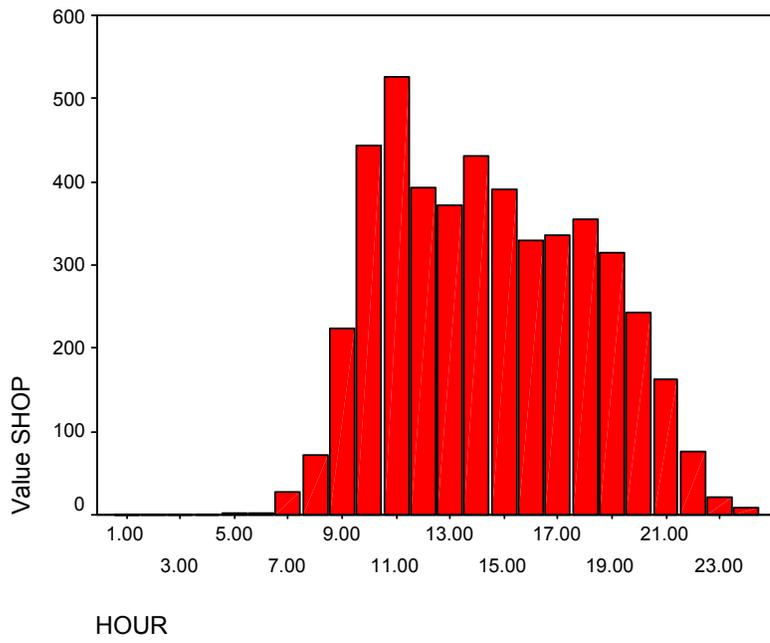


Figure 47. Departure Time, School/Daycare Trips, Statewide

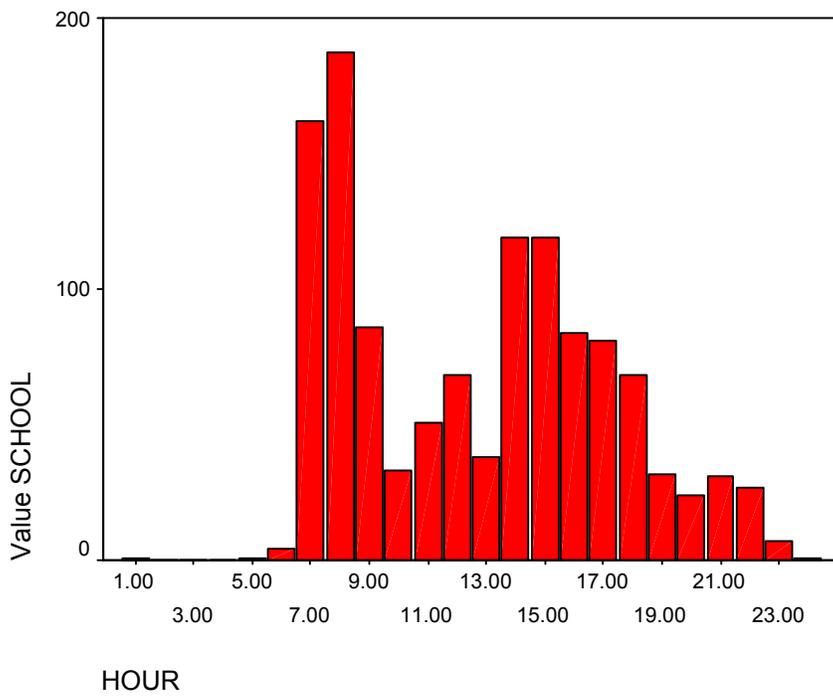
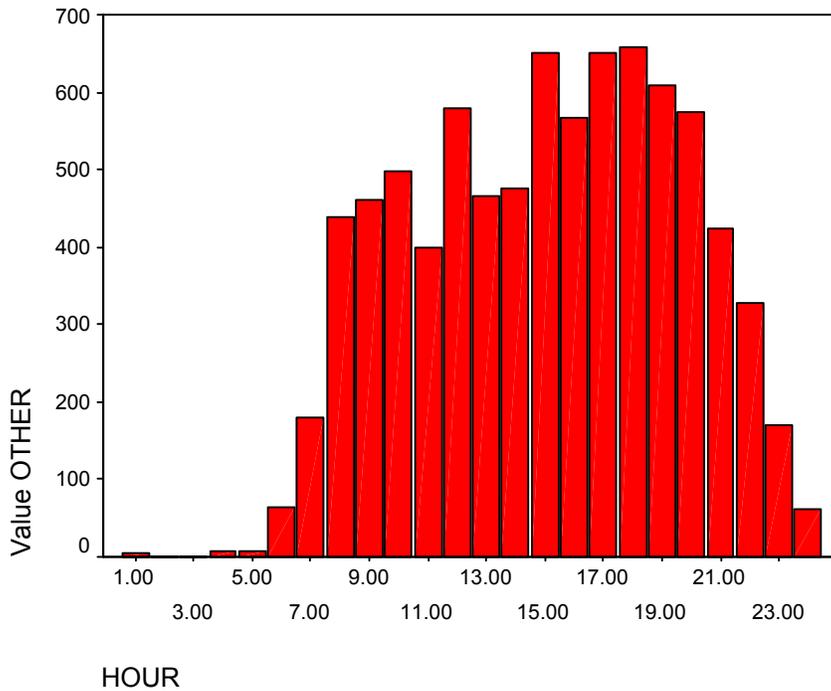


Figure 48. Departure Time, Other Trips, Statewide



Trip Distribution

The Nationwide Personal Transportation Survey (NPTS) is a national inventory of daily passenger travel and is collected from a sample of U.S. households and collects information on all trips, by all modes, for all purposes, and in various types of areas (urban, rural). Figure 50 on the next page is taken from the results of the 1995 NPTS and shows the average distribution of trips by purpose.

The most prevalent reason for travel and the area that has seen the greatest growth in the last few decades is for family and personal travel that includes shopping, running errands, dropping and picking up others, and in medical visits. Since the NPTS survey in 1969, there has been a 66% increase in average annual vehicle trips overall.

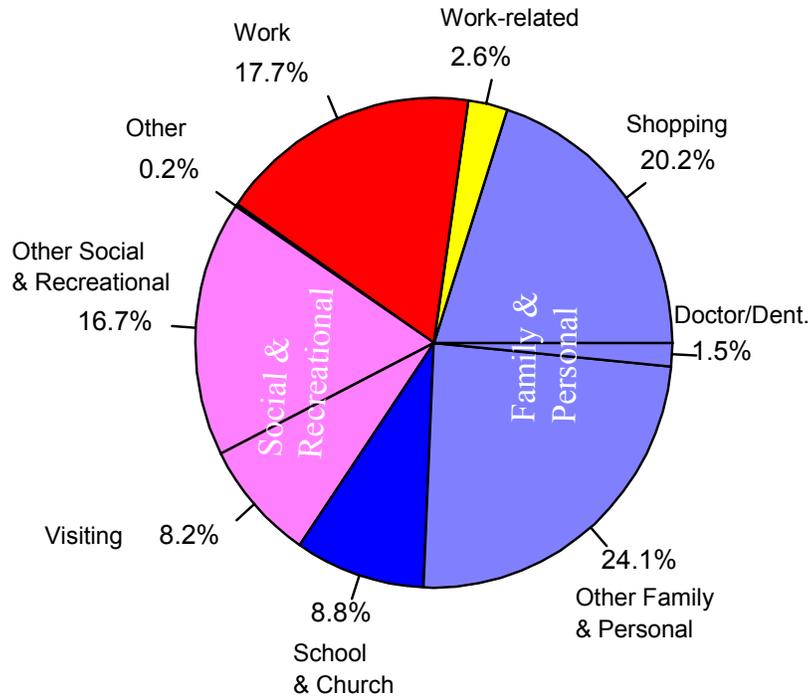
Trip distribution data available for Delaware can be derived from the DelDOT Household Survey and is presented in Figure 49. These figures only address weekday travel for those 16 years of age or older.

**Figure 49. Summary of Weekday Trip Distribution in Delaware
DelDOT HH Survey 1995-1999, Percentage of Weekday Travel**

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All</u>
Work	32.5	32.1	32.2	38.6	43.7	37.0
Shop	21.8	21.9	23.1	20.7	18.2	21.2
School/Daycare	9.1	6.1	4.8	4.7	5.3	5.5
Other	36.6	40.0	39.8	36.1	32.8	36.3

Figure 50. Person Trips, NPTS Early Results Report

Person Trips



**Figure 51, Trip Distribution by County
DelDOT Household Survey 1995 - 1999**

	Kent	New Castle	Sussex
Work	37.3	37.7	30.7
Shop	21.8	20.0	24.7
School/Daycare	6.5	5.7	3.9
Other	34.4	36.6	40.6

Survey numbers indicate an increase in the percentage of work trips and a slight increase in the percentage of School/Daycare trips in the last two years but that is because shopping and "other" types of trips declined more. As mentioned in the previous section there were declines in trips for all purposes. Figure 52 provides a more detailed look at some of the types of trips that make up the Other category in the Delaware survey.

**Figure 52, Percentage of Weekday Trips to Destinations in Delaware
DelDOT Household Survey 1995-1999**

Work	37%
Shop	20.7
Other	11.7
Social	9.7
Drop Off./Pick Up	8.5
School	4.7
Recreation	4.1
Eat Out	4.2
Child Care	0.7

Trip Chaining

Trip chaining, the grouping of trips (stops) for various purposes in one "outing" is a feature of travel that has been traditionally overlooked but has very significant effects. Analysis of trip distribution, travel patterns, and average distances can be very complicated when one considers the effects of grouping trips. Typically, trip chaining is studied in terms of whether a series of trips began or ended at home or work. A trip that is not chained is one where a person would go directly to work from home, directly to home from work, or from home to a destination and then back with no other stops. Figures 53 and 54 below provide data about chaining as available from the DelDOT Household Survey and show that almost a third of trips are part of a chain. As also shown in national data, people tend to chain trips more often in the journey from work to home and make more stops than in the home to work journey.

**Figure 53. Trip Chaining (percentage of trips)
DelDOT Household Survey 1995-1999**

	<u>Trip/Stops</u>	<u>%Trips</u> (includes incidental stops)
Home to Home Chains	4693	22.8
Home to Work Chains	1128	5.2
Work to Home Chains	1583	7.4
No Chains (Stops)	14675	68.2

**Figure 54. Average Number of Stops in a Chain (not including incidental)
DelDOT Household Survey 1995-1999**

Home to Home	1.7 stops
Home to Work	1.2
Work to Home	1.4

Certain types of trips are more often part of trip chains as shown in Figure 55 and 56.

Figure 55. Trip Purpose Distribution for Chained Trips

<u>Purpose</u>	<u>% of chained trips</u>
Child Care	1.7
School	2.9
Recreation	5.0
Eat Out	6.3
Work	6.6
Social	13.4
Drop Off / Pickup	18.0
Other	18.9
Shop	30.1

Figure 56. Trip Purpose Distribution for Non-Chained Trips

<u>Purpose</u>	<u>% of non-chained trips</u>
Child Care	0.2
Eat Out	3.2
Recreation	3.7
Drop Off / Pick Up	4.0
School	5.6
Social	8.0
Other	8.4
Shop	16.3
Work	51.2

Since most of the shorter distance type trips are more likely to be taken as part of a chain, comparison of trip times and distances between chained and non-chained trips must be in terms of trip purpose, as presented in Figures 57 and 58. For the most part, the efficiencies of organizing trips in chains is reflected with trip times for chained trips being slightly lower, except for the Shop purpose.

Figure 57. Comparison of Average Trip Times and Distances for Chained and Non-Chained Trips by Trip Purpose (minutes and miles), DelDOT Household Survey 1995-1999

	<u>Average Trip Time</u>		<u>Average Trip Distance</u>	
	<u>Chained</u>	<u>Non-Chained</u>	<u>Chained</u>	<u>Non-Chained</u>
Work	23.8	27.7	7.1	8.7
Shop	18.2	15.5	5.9	5.2
School-Daycare	18.8	22.0	5.5	6.8
Other	21.0	25.1	6.5	7.7

The DelDOT Household Survey also included a tabulation of trips called "incidental trips" for the home to work or work to home journey. These are trips considered to add little time or distance and were not coded in separate trip records as other trips. About 11% of Home to Work trips and a little over 9% of Work to Home trips involved incidental trips. The types of incidental trips and relative proportions (percentages) of the total incidental trips are shown in Figure 58. Most of these are convenience store and gas trips.

Figure 58. Percentage of Incidental Stops by Purpose. (423 stop Home-Work, 334 stops Work to Home in 5years of sampling) DelDOT Household Survey 1995-1999

	<u>Home-Work</u>	<u>Work-Home</u>
Convenience Store	38.3%	21.6%
Gas	22.5	29.3
DropOff/Pick up at Daycare	13.7	16.2
Fast Food/take out	6.6	5.7
DropOff Pick up child at school	5.0	4.8
Bank	3.8	12.9
Personal Business	2.8	5.4
Post Office	2.1	2.7
Grocery	1.9	9.9
Pickup/Dropoff person	1.7	3.0
Eat	1.4	3.9
Work Related	0.7	0
Video Store	0.2	0.3
Drug Store	0	0.6

Nationally, non-work related travel has been increasing and also non-work trip making has been growing rapidly during peak commuting times. Rather than a situation where people choose to schedule more discretionary travel during peak times, this is in part due to trip chaining. People consider their travel needs and in any outing will often structure their travel behavior around several purposes. So for instance in a commute to or from work, a person may drop their child off at school or daycare, stop by the cleaners, purchase something at the grocery store, or whatever else is convenient to their particular needs. As the private automobile provides flexibility in organizing daily activities, non-work activities can be more easily coordinated with commuting. The shift to single occupancy vehicles from transit contributes to congestion in the growth of vehicle trips directly, but also contributes to congestion indirectly through the

stimulation of non-work based travel during peak periods. National studies indicate that 10 to 20 percent of non-work trips are linked to the commute trip⁶.

Understanding the circumstances where people choose to combine various trips is important to a better understanding of travel behavior and for examining transportation policy issues. The overall effects of trip chaining on policy are often not clear. For example, while trip chaining may create more congestion in the peak travel periods by stimulating more non-work related trips there is a travel efficiency benefit that is clear to the individuals who structure their trips to minimize their travel time. It has been estimated that non-work trips made independent of the work trip are 10 to 20 percent longer, and about two thirds of these trips involve trips to a single destination.⁷ When one considers trip chaining, sometimes policies are not as clear. If trip chaining during the work trip was discouraged through more transit use, for instance, there could be more efficient use of the transportation system during peak times, but there could be increased emissions and cold starts that could result in undesirable environmental effects.

Trip chaining patterns are very related to household characteristics and life cycle. They also vary with gender, income, race, and other demographic variables. A study by McGuckin and Murakami⁸ that examined trip chaining behavior differences among men and women as indicated from the 1995 NPTS, provides a good view of the extent of trip chaining. Figures 59 - 64 below from this study (pages 31 and 32) illustrate that there are far more chained trips for the journey from work as opposed to the journey to work especially among men. On average women make fifty percent more stops on the way home from work and eighty percent more work-based tours than men.

Figure 59. Percent of Men and Women Who Make Stops Home to Work Trips, NPTS 1995 (McGuckin)

	<u>No Stops</u>	<u>One or more stops</u>
Women	67%	33%
Men	80.2%	18.8%

Figure 60 Percent of Men and Women Who Make Stops Work to Home Trips, NPTS 1995 (McGuckin)

	<u>No Stops</u>	<u>One or more stops</u>
Women	38.8%	61.2%
Men	53.7%	46.4%

Figure 61,. Mean Number of Stops By Tour Type NPTS 1995 (McGuckin)

	<u>Men</u>	<u>Women</u>
All tours	1.06	1.53
Home -Home	1.8	2.02
Work-Work	0.41	0.74
Work -Home	0.8	1.16
Home-Work	0.3	0.8

⁶ James G. Strathman and Kenneth J. Dueker. "Understanding Trip Chaining", 1990 NPTS Special Reports on Trip and Vehicle Attributes, pg 1-7

⁷ Oster, C. 1978, "Household Tripmaking to Multiple Destinations:The Overlooked Urban Travel Pattern", Traffic Quarterly, 32:511-529

⁸ Nancy McGuckin and Elaine Murakami, "Examining Trip-Chaining Behaviour - A Comparison of Travel by Men and Women", NPTS 1995 publication, available at NPTS 1995 web site

**Figure 62. Mean Number of Stops by Purpose
Work to Home Tours, NPTS 1995 (McGuckin)**

	<u>Men</u>	<u>Women</u>
Social/Recreational	1.88	2.16
Pickup / Dropoff	1.88	1.81
Shopping	1.82	2.12
Family/Personal	2.06	2.13

**Figure 63. Percentage of Trips to Take Someone Somewhere
By Tour Type -- Adult Men and Women
NPTS 1995, (McGuckin)**

	<u>Men</u>	<u>Women</u>
Home-Home	3.29	7.22
Work-Work	0.69	1.12
Work-Home	2.57	4.75
Home-Work	3.1	5.44

Strathman and Dueker's study of 1990 NPTS data found similar results with the figure below as an example. A "simple" work chain is where worker goes directly to work and from work directly home. A simple non-work trip is where a person leaves home, goes directly to a non-work destination, and then directly home again. All other chains intermediate stops and are called complex.

**Figure 64. Percentage of Work and Non-Work Trip Chains
For Men and Women That Are Complex⁹
1990 NPTS**

	<u>Men</u>	<u>Women</u>
Work Commutes	30.6	42
Non-Work Journeys	25.9	29.9
All Journeys	27.4	32.8

Findings derived from this study among others include:

- non-work stops were twice as likely to be contained in the homeward leg as in the commute to work
- trip chaining is by far more reliant on the automobile. Dispersion of work and non-work activities in metropolitan areas means that pedestrian and transit systems face a growing disadvantage in serving the mobility needs of a population that is increasingly engaging in complex trip chaining.
- Trip chaining patterns are quite distinct with respect to demographic factors.
- Higher income households are more likely to trip chain and tend to organize a larger share of trips around the commute.
- Contributions of trip chaining research have benefited an understanding of travel behavior rather than improvements in urban transportation models. Legislative and legal

⁹ Strathmore and Duecker, pg. 1-11

mandates addressing economic efficiency, land use, and environmental quality require a shift of planning focus toward travel behavior rather than traditional four step models.

- Next generation travel models would require greater ability to derive travel outcomes from household activity and transportation system conditions and research would be facilitated by activity based survey of households rather than the current trip based format.

Work Trips

Work trips are often a focus of transportation studies because they occur during the peak travel periods of the day. They involve relatively fewer destinations than other purposes and occur at more predictable times of the day, so they are markets for public transit. However, they account for only about 25% or less of all trips. While the average commute to work has increased in length, the travel time to work has not shown corresponding increases. Nationally, commute speeds have increased by more than 20 % over the past 12 years. There are three reasons most often cited for the increase in speed of travel time to work:

- the continued decentralization of metropolitan areas
- the expansion of the peak period, because of greater flexibility in hours of work
- the switch from carpool and transit to single occupancy vehicle trips, which are usually more time-efficient for the individual worker, even though less efficient for the overall transportation systems

**Figure 65. Work Trip Travel Length, Time, and Speed
From NPTS 1995**

	<u>1983</u>	<u>1990</u>	<u>1995</u>	<u>83-95%chg</u>
avg work trip length (miles)	8.5	10.6	11.6	36.5
avg work travel time (minutes)	18.2	19.7	20.7	13.7
avg work trip speed (MPH)	28	32.3	33.6	20

This is evident in data for Delaware as well. As people and employment move to the suburban areas, speeds relative to high density city areas have increased, and as restricted access highways are built such as Route 1 in Delaware, people are able to move to desirable suburban areas while not increasing drive times at the same rate as their distance increases.

**Figure 66
Median Time Commuting to Work
for Delaware Residents
(minutes)**

Year	State	Kent	New Castle	Sussex
1980	19.1	15.9	20.1	25.1
1990	19.2	17.5	19.8	18.5

Source: Center for Applied Demography and Survey Research, University of Delaware
US Bureau of Census

The trend of greater trip distances with less of an increase in travel time is contrary to the notion that suburban sprawl results in congestion. Low density settlement only causes congestion if

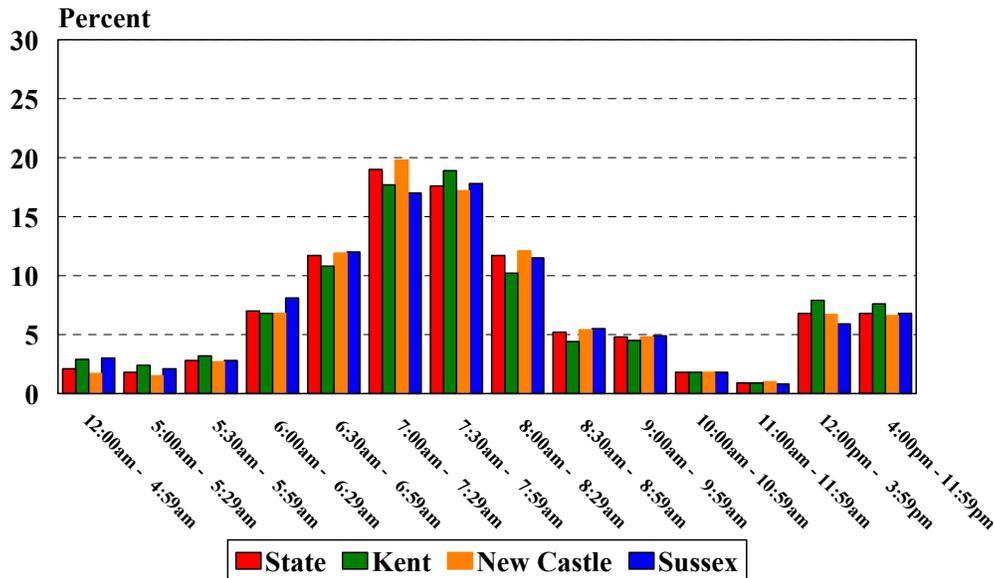
areas are not well served by expressways and other road systems, the workers have to converge on a few jobsites or bottlenecks, and/or the number of travelers greatly exceeds the capacity of the road systems¹⁰. Travel distance, time, and patterns are investigated more in a later section that describes travel characteristics in terms of density.

Figure 67
Employees by Time Leaving Home for Work:
State of Delaware - 1990

Time	State	Percent	Kent	Percent	New Castle	Percent	Sussex	Percent
12:00am - 4:59am	6,745	2.1	1,532	2.9	3,750	1.7	1,463	3.0
5:00am - 5:29am	5,820	1.8	1,274	2.4	3,481	1.5	1,065	2.1
5:30am - 5:59am	9,099	2.8	1,728	3.2	5,966	2.7	1,405	2.8
6:00am - 6:29am	22,829	7.0	3,602	6.8	15,190	6.8	4,037	8.1
6:30am - 6:59am	38,303	11.7	5,729	10.8	26,597	11.9	5,977	12.0
7:00am - 7:29am	62,020	19	9,409	17.7	44,186	19.8	8,425	17.0
7:30am - 7:59am	57,357	17.6	10,025	18.9	38,476	17.2	8,856	17.8
8:00am - 8:29am	38,001	11.7	5,401	10.2	26,896	12.1	5,704	11.5
8:30am - 8:59am	17,127	5.2	2,369	4.4	12,020	5.4	2,738	5.5
9:00am - 9:59am	15,618	4.8	2,409	4.5	10,759	4.8	2,450	4.9
10:00am - 10:59am	5,967	1.8	965	1.8	4,102	1.8	900	1.8
11:00am - 11:59am	3,035	0.9	463	0.9	2,192	1.0	380	0.8
12:00pm - 3:59pm	22,097	6.8	4,181	7.9	15,015	6.7	2,901	5.9
4:00pm - 11:59pm	22,128	6.8	4,057	7.6	14,701	6.6	3,370	6.8

Source: Center for Applied Demography and Survey Research, University of Delaware
US Bureau of Census

Figure 68
Percent of Employees by Time Leaving Home for Work:
State of Delaware - 1990



Source: Center for Applied Demography and Survey Research, University of Delaware
US Bureau of Census

¹⁰ Downs, Anthony, *Stuck in Traffic: Coping with Peak Hour Traffic Congestion*, The Brookings Institution, Washington, D.C. 1992. pg 92

Figure 69
Employees by Time Leaving Home for Work:
State of Delaware - 1990

Time	State	Percent	Kent	Percent	New Castle	Percent	Sussex	Percent
12:00am - 4:59am	6,745	2.1	1,532	2.9	3,750	1.7	1,463	3.0
5:00am - 5:29am	5,820	1.8	1,274	2.4	3,481	1.5	1,065	2.1
5:30am - 5:59am	9,099	2.8	1,728	3.2	5,966	2.7	1,405	2.8
6:00am - 6:29am	22,829	7.0	3,602	6.8	15,190	6.8	4,037	8.1
6:30am - 6:59am	38,303	11.7	5,729	10.8	26,597	11.9	5,977	12.0
7:00am - 7:29am	62,020	19	9,409	17.7	44,186	19.8	8,425	17.0
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8:30am - 8:59am	17,127	5.2	2,369	4.4	12,020	5.4	2,738	5.5
9:00am - 9:59am	15,618	4.8	2,409	4.5	10,759	4.8	2,450	4.9
10:00am - 10:59am	5,967	1.8	965	1.8	4,102	1.8	900	1.8
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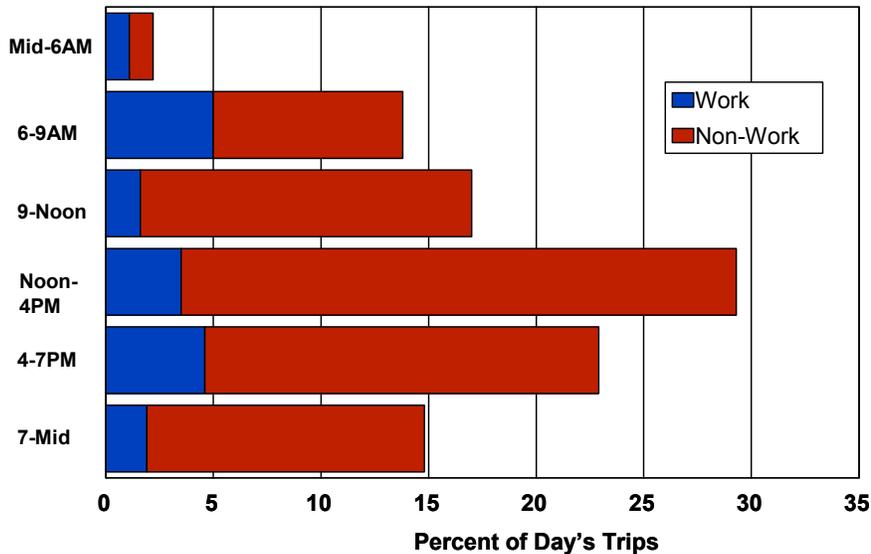
Source: Center for Applied Demography and Survey Research, University of Delaware
 US Bureau of Census

An interesting finding of the 1995 NPTS is that commute trips are in the minority even during rush hour. Approximately 37% of trips for all purposes start during the two rush hour periods, (6-9am, 4-7pm) as shown in Figure 70. This says that much of the traffic we see during rush hour is not due only to people going to work.

Figure 70¹¹

Work/Non-Work Trips

By time of Day



¹¹ Our Nations Travel:1995 NPTS Early Results Report, pg 14.

Shopping trips

Shopping trips are a continually growing segment of personal travel. Shopping trips comprise about a fifth of all person trips and one out of seven person miles traveled. Though considered by some to be more of a weekend activity, the NPTS data show that shopping trips are spread evenly throughout the week. About 62% of shopping trips take place during the week which make up 71 percent of the days of the week. The time of day shopping trips take place is shown in Figure 71.

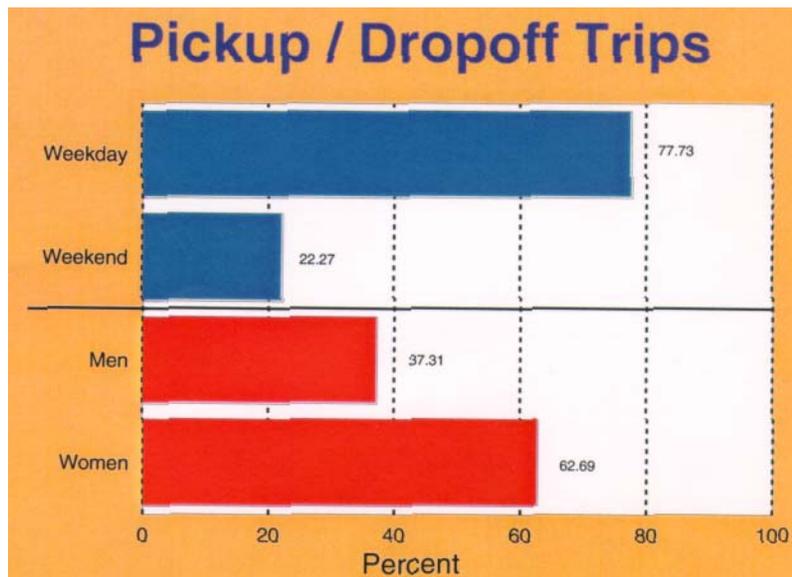
Figure 71. Percent of Shopping Trips on Weekdays and Weekends
Our Nations Travel:1995 NPTS Early Results Report

<u>Time of Day</u>	<u>% of Shopping trips Occurring Weekdays</u>	<u>% of Shopping trips Occurring Weekend</u>
Midnight to 6AM	0.5	0.5
6AM to 9AM	3	2
9AM to Noon	13	9
Noon to 4PM	22	13
4PM to 7PM	16	8
7PM to Midnight	7	6
Total percentage	61.5%	38.5%
Daily % of total trips	12%	19%

Pickup / Dropoff Trips

As would be expected, since the majority of pickup / dropoff trips involve getting children to school or to after school activities, more of these trips occur during the week, and women make about two thirds of these trips. About 11% of all trips made by women and 7% of all trips by men are pickup and dropoff trips. As a great majority of the trips involve getting children to school functions or day care , most of the trips occur during the week.

Figure 72. (From Our Nation's Travel pg. 16)



Low Income Travel

Murakami and Young examined 1995 NPTS data and 1990 Census Public Use Microdata Sample (PUMS) and reached the following conclusions:

- Persons in low incomes are much less likely to have a vehicle. About a quarter of low income households do not have a car, compared to 4% of other households. On average, low income households have 0.7 vehicles per adult compared with over 1 vehicle per adult in other households.
- Despite having fewer vehicles, people in low income households still make most of their trips by private vehicles. Trips made in private vehicles are much more likely to be in "non-household" vehicles, that is in vehicles of friends, neighbors, or relatives.
- The biggest difference in travel mode is in the proportion of walking trips. People in low income households are nearly twice as likely to walk as people in other income groups. For work related trips, low income households report 5% by walk and 5% by transit compared to 3% walk and 2% transit for other income groups. About 60% of low income household trips are three miles or less, compared to 50% for other households.
- Average travel times by private vehicle for the journey to work do not vary by income group and average between 18 and 20 minutes.
- Per person, people in low income households make about 20% fewer trips than people in other households. Differences in person miles of travel are about twice this with low income households traveling nearly 40% fewer miles.
- Walking is used for 13% of social and recreational trips and 9% of family and personal business trips, figures which are almost double for other (not low) income households.
- Social and recreation trips are significantly shorter for low income households, 8.05 miles average as compared to 10.70 for other groups.

Travel with respect to race

By NPTS 1995 results, African Americans make 95 annual transit trips per person where Caucasians average one sixth of that rate at 15 annual transit trips per person. Much of this disparity is considered to be due to lower income rates (lower vehicle ownership) and housing location patterns among African Americans. African Americans make 76% of their trips by private vehicle as compared to 88% for Caucasians. On average African Americans make 3.9 trips a day compared to 4.4 daily trips by Caucasians. Hispanics make 82% by private vehicle. Hispanics are twice as likely to use transit as non-hispanics, and make 50% more walking trips. There are certainly differing travel preferences in regard to race, but one should be cautious in generalizing, as travel is related to a number of other correlated factors such as income and housing locations.

Travel by children

Trips to and from school account for just over one fourth of the trips made by 5 to 15 year-olds. About half of America's school children aged 5-15 go to school in private vehicles. Social and recreational activities comprise 40% of their trips, and another 30% are made for family and personal business.

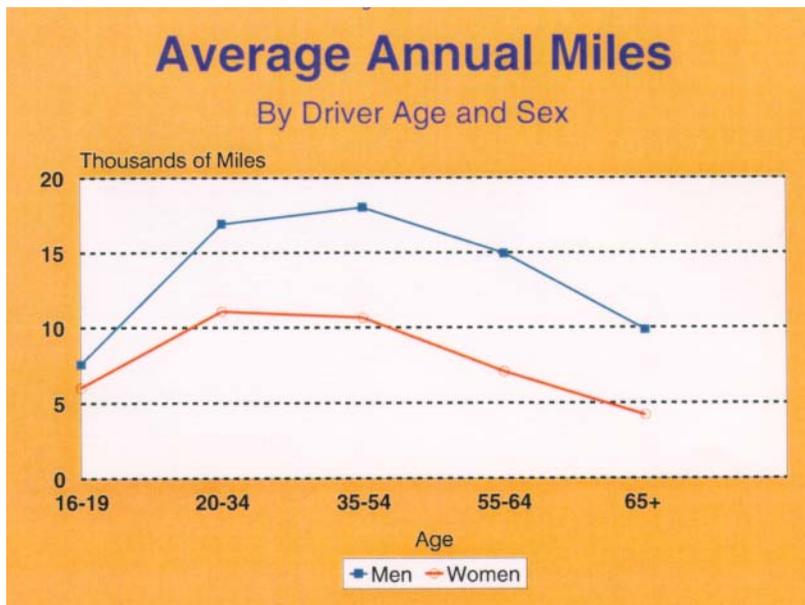
Figure 73. Travel by Children
From "Our Nation's Travel, pg. 29"

	<u>5-9 years</u>	<u>10-15 years</u>
%Trips by Trip purpose		
Social/Recreational	39.6	40.6
Family/Personal	31.3	28.5
School	26.3	26.8
Other	2.8	4.1
Annual Trips/Person		
POV passenger	1334	1366
School Bus	982	890
Walk	120	143
Transit	107	157
Other	16	22
Other	109	154
%School Trips by mode		
POV	52.8	43.5
School Bus	30.2	36
Walk	10.5	12.4
Other	6.5	8.1

Travel by the Elderly

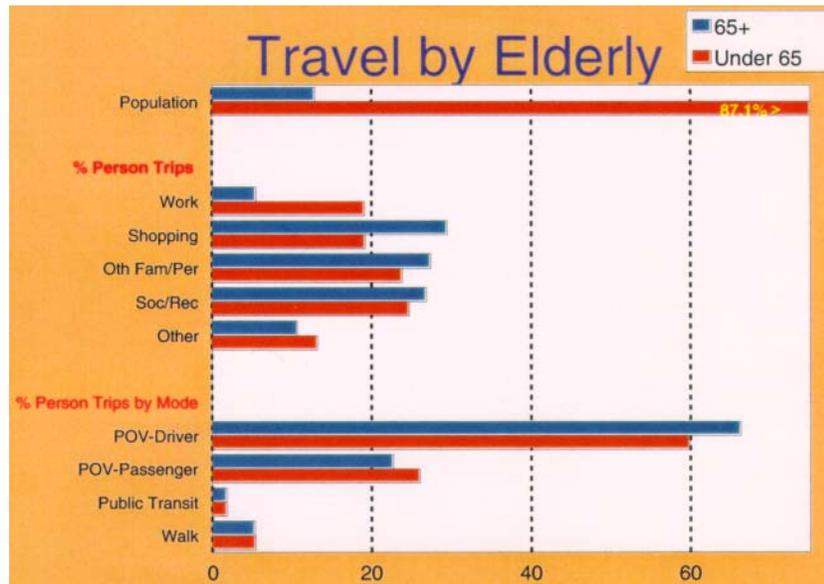
The amount of travel fluctuates with age of course as shown in Figure 74 from the Early Results Report for NPTS 1995. There are large differences in gender also.

Figure 74. (Our Nation's Travel pg. 23)



As the nation's population ages, travel patterns of the elderly are of particular interest. The NPTS provides information about this. By 1995 NPTS figures, persons 65 years or older average 3.43 trips a day. Those under 65 average 4.42 a day. The means of transport for seniors is surprisingly similar to the under 65 group. Where the number of work trips are a much lower percentage of total trips for seniors, the distribution for other trip purposes is similar.

Figure 75. (Our Nation's Travel pg. 26)



A study of travel by the elderly conducted by Rosenbloom¹² using 1990 NPTS data showed that the elderly as a group drove 20% more miles than they had in 1983, while those over 70 drove 40% more. The elderly were even less likely to use transit with no cohort using it for more than 5% of their trips, and the average was substantially less. Although walking was the second mode of choice, its importance fell by one-third in urban areas and one fourth in rural areas since 1983. Elderly men took 24% more person trips, traveled 19% more miles, and made 94% more vehicle trips than elderly women. The study showed that Caucasian's are substantially more dependent on the private car than other races. Caucasian seniors of both sexes make more vehicle and person trips and travel more miles than any other ethnic or racial grouping. The study examines a number of cultural, gender, and ethnic travel preferences among the elderly. For instance it was shown that Caucasian men make 21% more person trips than Caucasian women but African American men make almost 100% more trips than African American women. The diversity seen among younger Americans is increasingly being seen among the elderly, and this diversity is certainly expected to increase in the future. The growing diversity includes pockets of older women living alone, and men and women who are below poverty level, and those who cannot or will not drive.

Rosenbloom points out that most elderly are drivers and over three fourths live in low density suburban or non-metropolitan places-places where the use of the private car is either encouraged or absolutely necessary. Questions raised by Rosenbloom concern:

¹² Rosenbloom, Sandra, *Travel by the Elderly*, U.S. Department of Transportation, available on the NPTS 1995 web site.

- The need to know to what extent the features of elderly travel are a function of choice and to what extent necessity.
- Whether upward trends among all aspects of travel will continue and what the intensity of growth will be.
- If current sex, race, and ethnic differences in travel patterns are likely to continue.
- The need to have a comprehensive understanding of how elderly people meet their needs and the environmental constraints and barriers under which they operate in order to meet the mobility needs of seniors.

Rosenbloom presents a range of very interesting data. Figures 76 thru 79 are some examples.

Figure 76. Average Annual Miles Driven by Driver Age 1969-1990

	<u>1969</u>	<u>1977</u>	<u>1983</u>	<u>1990</u>
All Ages	8,685	10,006	10,588	13,181
60-64	8,112	8,002	8,568	10,314
65-69	5,850	6,277	6,804	8,347
70+	4,644	4,828	4,348	6,138

Figure 77. Percentage of Urban Shopping Trips Made by Alternative Modes by Cohort 1983 and 1990

<u>Age cohorts</u>	<u>Transit</u>		<u>Walking</u>		<u>Taxi</u>	
	<u>1983</u>	<u>1990</u>	<u>1983</u>	<u>1990</u>	<u>1983</u>	<u>1990</u>
60-65	2.0%	0.7%	8.3%	5.7%	---	---
65-69	1.9	1.2	13.8	6.8	---	0.1
70-74	4.9	2.7	12.1	8.7	---	0.2
75-79	0.0	3.8	14.8	7.5	---	0.6
80-84	0.0	0.5	38.8	14.7	---	0.0
85+	16.6	0.0	50.9	9.2	---	1.5

Figure 78. Annual Miles Driven by People 65+ Residing in Different Locations by Cohort, 1990

<u>Age Cohorts</u>	<u>Central City</u>		<u>Suburbs</u>		<u>Rural</u>	
	<u>Women</u>	<u>Men</u>	<u>Women</u>	<u>Men</u>	<u>Women</u>	<u>Men</u>
Total 65+	4054	8697	4630	9235	5046	9706
65-69	4683	10327	5311	11083	6464	11169
70-74	4069	8417	4819	8838	4665	10703
75-79	3485	6738	3723	8093	3916	8312
80-84	2959	5100	1843	4944	3709	6680
85+	1914	4668	1650	5630	1922	2491

Figure 79. Distribution of Urban and Rural Non-Work Vehicle Trips, by Cohort over 60, 1990

<u>Trip Purpose</u>	<u>60-64</u>		<u>65-74</u>		<u>75-79</u>		<u>80-84</u>		<u>85+</u>	
	<u>Urban</u>	<u>Rural</u>								
Shopping	32.9	32.7	33.7	34.4	32.7	32.3	39.5	39.5	36.6	32.7
Social	30.1	30.9	31.1	31.4	29.7	29.9	16.7	25.4	30.1	28.1
Family Business	26.3	26.0	25.8	24.1	23.6	23.8	11.5	16.3	9.8	13.6
School/Church	6.7	6.4	7.0	6.7	6.7	6.5	5.5	10.3	15.7	17.6
Medical	2.9	2.9	2.5	2.5	5.0	4.9	16.7	5.4	7.8	7.0
All Others	1.1	1.1	0.9	1.0	2.3	2.1	3.0	3.1	0.0	1.0

Vehicle Occupancy

By 1995 NPTS occupancy rates for all travel was 1.59 person miles per vehicle mile, ranging from a low of 1.14 for work trips to 2.17 for other social and recreational purposes. Figure 80 summarizes information for the 1995 survey. There is a general view that occupancy rates are much lower because typically the focus is on the work trip with occupancy just over 1.0. Actually about a third of all trips are multi-occupant as shown in Figure 81.

Figure 80. Vehicle Occupancy (Our Nation's Travel, pg. 24)

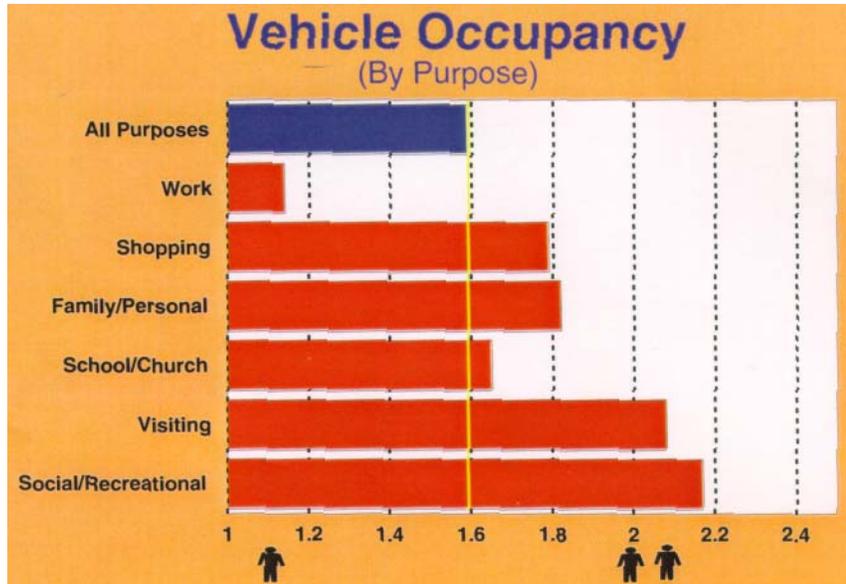
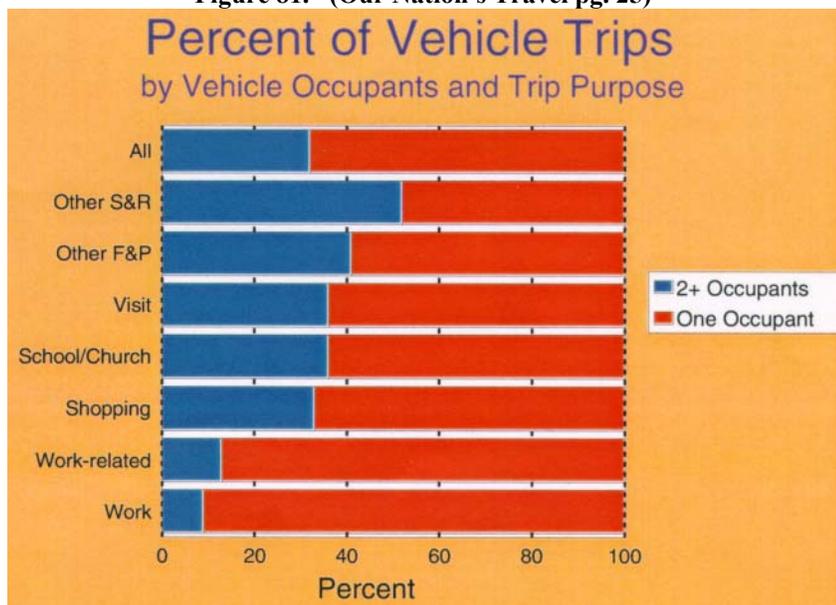


Figure 81. (Our Nation's Travel pg. 25)



Vehicle occupancy figures specific to Delaware are available for the journey to work as available in the 1990 CTPP. Figure 82 shows workers per vehicle at the county level for the journey to work during the peak travel period (6:30 to 8:30am), and the numbers are similar to national figures. Workers per vehicle for journey to and from work in the same county are equal. A major difference seems to be a higher occupancy for trips from New Castle to Sussex County.

Figure 82. Workers per Vehicle, Journey to Work During Peak Period (6:30am to 8:20am), (1990 CTPP County Level)

		<u>Place of work</u>		
		<u>New Castle</u>	<u>Kent</u>	<u>Sussex</u>
Residence	New Castle	1.08	1.13	1.28
	Kent	1.17	1.08	1.13
	Sussex	1.15	1.10	1.08

Vehicle occupancy for various trip purposes was tabulated for weekday trips from the DelDOT Household Survey, and are presented in Figure 83.

Figure 83. Persons per Car Trip DelDOT Household Survey

<u>Purpose</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All Years</u>
Dropoff/Pickup	2.2	2.2	2.0	2.0	2.2	2.1
Eat Out	1.8	2.2	2.0	1.8	2.1	2.0
Child Care	1.9	2.0	1.8	2.1	1.5	2.0
Recreation	1.5	1.9	1.8	1.9	1.5	1.9
Social	1.6	1.7	1.7	1.6	1.6	1.7
Shop	1.5	1.6	1.6	1.5	1.5	1.6
Other	1.5	1.4	1.4	1.5	1.5	1.4
School	1.6	1.6	1.5	1.5	1.5	1.4
Work	1.1	1.2	1.2	1.1	1.1	1.2

Daily Time Spent Driving

The average driving time per day for all drivers by NPTS 1995 is 1 hour and 13 minutes. Depending on age women drive 60 to 70 percent as many miles as men the same age. The difference continues to decrease as women's participation in the work force increases.

Figure 84. Daily Time Spent Driving NPTS 95, (Our Nation's Travel pg. 22)

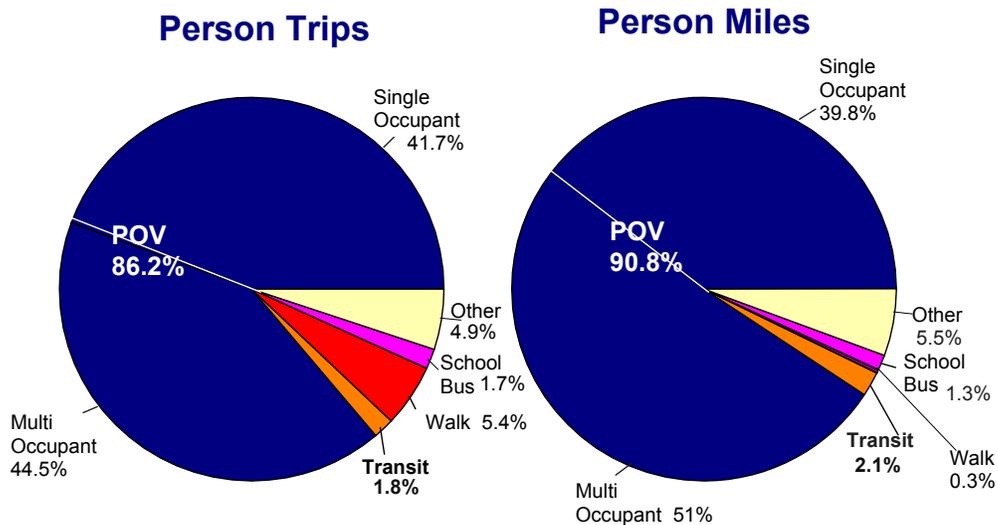
<u>Ages</u>	<u>Male</u>	<u>Female</u>
16-19	57.7	56.1
20-34	80.7	65.4
35-49	85.5	67.4
50-64	87.7	61.1
65+	73.2	54.7
All	81.3	63.6

Travel Mode - Walking, Bicycling, and Transit

Figure 85 summarizes information from the 1995 Nationwide Personal Transportation Survey for means of travel. Nationwide, travel by private auto accounts for 86% of all person trips. Walking is the next most used mode with 5.4% of all trips. Transit accounts for 1.8% of all trips. School bus trips account for 1.7% of all trips.

Figure 85. (Our Nation's Travel pg. 19)

Means of Travel



Walk accounts for 5% of trips, but less than 1% of miles. Air travel accounts for less than 1% of trips, but 3% of miles.

By NPTS, walk trips were mainly for family and personal business (43% of walk trips) and for social and recreational purposes (22% of walk trips). Seven percent of work trips were made by walking. Social and recreational purposes accounted for 60% of trips by bicycle and family, and personal business accounted for 22% of bicycle trips. Transit captured 3.1% of the trips for work, and 44% of all transit trips took place during peak times.

The DelDOT Household Survey was examined to provide information on travel mode. Figure 86 below provides mode shares for each year of the survey for all trips.

Figure 86. Travel Mode Share(%)

Source: DelDOT Household Survey

Weekday travel, age sixteen years and older

	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>All</u>
Driver	86.5	85.3	86.7	85.8	88.6	86.7
Passenger	8.2	10.2	9.9	10.7	8.4	9.7
Public Bus	1.0	1.2	0.9	1.1	1.1	1.0
Walked	1.4	1.8	1.6	1.4	0.9	1.4
School Bus	2.6	0.7	0.4	0.4	0.4	0.6
Bike	0.2	0.3	0.1	0.1	0.2	0.1
Other	0.2	0.5	0.3	0.4	0.3	0.4

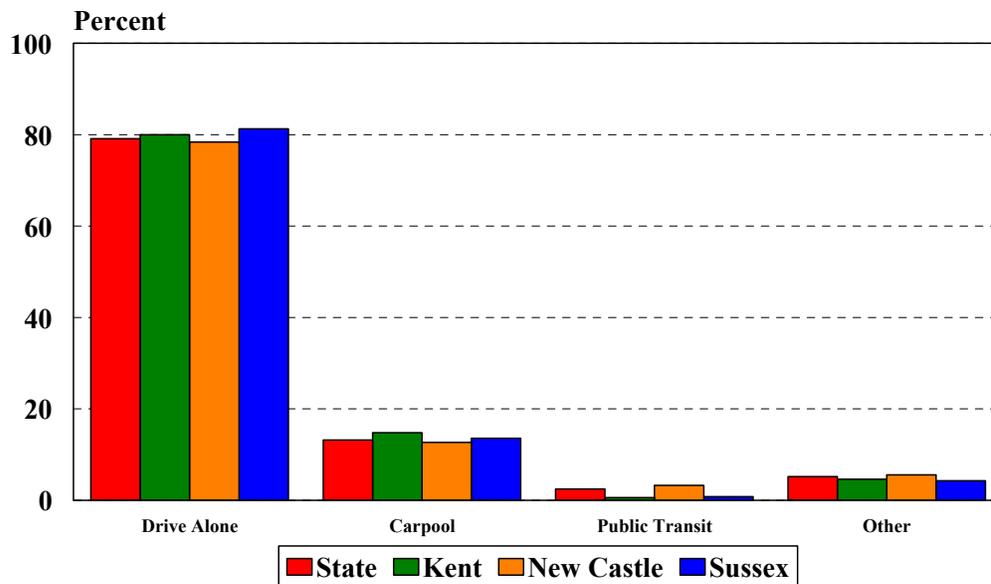
Figures from the 1990 Census for the journey to work showed travel by carpooling statewide to be 13.2% compared with transit at 2.5%. Transit in Kent and Sussex counties reaches less than one percent due to lower densities and limited service, though carpooling is slightly higher, which is consistent with national figures that show that carpooling is a substitute for dependent populations in rural areas.

Figure 87
Employees by Travel Mode
State of Delaware - 1990

Travel Mode	State	Percent	Kent	Percent	New Castle	Percent	Sussex	Percent
Drive Alone	258,087	79.1	42,492	80.0	175,198	78.4	40,397	81.3
Carpool	42,968	13.2	7,881	14.8	28,370	12.7	6,717	13.6
Public Transit	8,069	2.5	329	0.6	7,327	3.3	413	0.8
Other	17,022	5.2	2,442	4.6	12,436	5.6	2,144	4.3
Work at Home	7,980		1,553		4,313		2,114	

Source: Center for Applied Demography and Survey Research, University of Delaware
 US Bureau of Census

Figure 88
Percent of Employees by Travel Mode
State of Delaware - 1990



Source: Center for Applied Demography and Survey Research, University of Delaware
 US Bureau of Census, 1990 Census Transportation Planning Package

**Figure 89. Travel Mode by County
DelDOT Household Survey 1995-1999**

	<u>State</u>	<u>Kent</u>	<u>New Castle</u>	<u>Sussex</u>
Driver	86.7	89.0	86.5	85.7
Passenger	9.7	9.5	8.9	12.5
Public Bus	1.0	0.2	1.5	0.2
Walked	1.4	0.5	1.9	0.6
School Bus	0.6	0.7	0.7	0.3
Bike	0.1	0	0.1	0.2
Other	0.4	0.1	0.4	0.4

Certainly, mode choice is highly dependent on age, race, gender, income, and social factors. This is seen in national figures as well as those from the DelDOT Household Survey. Figures 90 thru 94 below present mode choice by some of these factors.

**Figure 90. Travel Mode by Gender
DelDOT Household Survey 1995-1999**

	<u>Males</u>	<u>Females</u>	<u>Total</u>
Driver	90.9	83.0	86.7
Passenger	5.5	13.3	9.7
Public Bus	0.8	1.3	1.0
Walked	1.7	1.2	1.4
School Bus	0.6	0.7	0.6
Bike	0.2	0.1	0.1
Other	0.3	0.4	0.4

**Figure 91. Travel Mode by Ethnicity
DelDOT Household Survey 1995-1999**

	<u>Latino Hisp/Mex</u>	<u>Black</u>	<u>White</u>	<u>Asian Pacific Island</u>	<u>Other</u>	<u>Refused</u>
Driver	79.9	78.3	88.1	83.6	87.8	86.7
Passenger	15.0	11.7	9.4	7.8	4.9	9.7
Public Bus	1.8	3.7	0.6	0	0.5	1.0
Walked	0.7	3.6	1.1	3.0	0.5	1.4
School Bus	2.0	2.0	0.4	3.4	0	0.6
Bike	0.4	0.1	0.1	2.2	0.5	0.1
Other	0	0.5	0.3	0	0.9	0.4
Sample size	192	1160	7041	109	132	84

**Figure 92. Travel Mode by Age Group
DelDOT Household Survey 1995-1999**

	<u>16 to 39</u>	<u>40 to 64</u>	<u>65 and over</u>
Driver	85.5	90.3	81.1
Passenger	9.8	7.1	16.7
Public Bus	1.1	1.0	0.7
Walked	1.9	0.9	0.8
School Bus	1.1	0.2	0
Bike	0.2	0	0.2
Other	0.3	0.3	0.5

Figure 93
Average Earnings by Travel Mode:
State of Delaware - 1990

Travel Mode	State	Kent	New Castle	Sussex
Drive Alone	\$26,351	\$21,497	\$28,771	\$20,969
Carpool	\$21,870	\$16,778	\$24,040	\$18,684
Public Transit	\$20,802	\$12,393	\$21,518	\$13,553
Other	\$15,500	\$14,075	\$15,878	\$14,961
Work at Home	\$18,743	\$17,626	\$19,576	\$17,870
All Modes	\$24,945	\$20,454	\$27,085	\$20,287

Source: Center for Applied Demography and Survey Research, University of Delaware
 US Bureau of Census

Figure 94. Travel mode by Income Statewide (%)
 Source: DeIDOT Household Survey

	0 - 29,999	30,000-39999	40,000 - 74,999	75,000 and over	Total
Driver of car	80.4	86.6	90.0	86.5	86.7
Passenger in car	12.5	9.7	8.0	9.9	9.7
Public Bus	2.4	2.1	0.6	0.8	1.0
Walked	2.9	0.9	0.7	1.6	1.4
School Bus	0.4	0.1	0.5	0.9	0.6
Bicycle	0.8	0.2	0.0	0.0	0.1
Other	0.5	0.3	0.4	0.3	0.3

Of course, travel mode selected depends on the trip purpose as well. For instance, it is more likely there will be a passenger (carpool) in an "Eat Out" trip or recreational/social trip. Walking and biking are most frequent with school related trips. Transit use is a higher percentage of commute trips. Transit is lowest for childcare, shopping, and drop-off/ pickup trips.

Figure 95. Percentage Persons Using Particular Modes by Purpose
 DeIDOT Household Survey 1995-1999

	<u>DRV</u>	<u>PASS</u>	<u>Bus</u>	<u>Walk</u>	<u>Sch Bus</u>	<u>Bike</u>	<u>Other</u>
Childcare	96.9	1.0	0	2.1	0	0	0
Work	92.6	3.6	1.9	1.3	0.1	0.1	0.4
Drop/Pick	91.9	6.0	0.4	0.6	0.4	0.0	0.7
Other	85.7	9.4	1.0	1.4	0.7	0.2	0.2
Shop	85.1	13.3	0.4	1.1	0	0.1	0.1
Social	80.7	16.1	0.6	1.8	0.0	0.4	0.3
Recreation	79.5	16.5	0.6	1.7	0.2	0	1.7
School	71.0	12.9	0.8	3.4	10.6	1.2	0.2
Eat Out	70.2	26.8	0.5	2.3	0.0	0.0	0.2

(DRV = driver, PASS = passenger)

Note: Passenger is so low for Childcare because only persons 16 years or older were surveyed in the DeIDOT Household Survey.

Transit in Terms of Service Guidelines

Service guidelines used in long-range transit plans by the local MPO, Wilmington Area Planning Council (WILMAPCO), were viewed in relation to existing transit service. Service guidelines used by WILMAPCO focus on Service Type, Service Frequency(headway), and Service Hours and are based on residential densities.

Figure 96. Service Type Guidelines¹³

<i>Residential Density (Households per acre)</i>	<i>Service Type</i>
Less than 4	Demand Response Park-n-Ride
4 to 12	Fixed Route
Over 12	Express Routes

Figure 97. Service Frequency Guidelines

<i>Residential Density (Households per acre)</i>	<i>Service Type</i>
Less than 4	2 hour advance
4 to 12	30/60*
Over 12	15/30

Existing transit service was in line with what these guidelines would warrant as suggested by the map presented in Figure 98 which shows that practically every Census Block with a housing unit density of at least 4 units per acre, is within a quarter mile of the fixed route transit system. These service guidelines of course do not reflect a level of service associated with travel time or transfers necessary for transit service of particular origin and destination pairs. While the current DART First State system provides a transit path between most major origins and destinations, the level of service of suburb-to-suburb travel is generally much less than the level of service to Wilmington in terms of trip travel time.

Markets Served

Origin/Destination (O/D) data and transit share for the journey to work in New Castle County was available for 610 subareas (CTPP zones) in the Urban Element of the 1990 Census Transportation Planning Package (CTPP). In previous work by CADSR, GIS was used to aggregate O/D data from the CTPP zone level to the Census County Division (Planning District) level to obtain a general idea of journey to work travel patterns. Examples of the results of this analysis are provided in Figures 99 and 100. Figure 99 shows where the larger markets for transit were in 1990. Transit share for those who live and work in Wilmington was approximately 11%, and represented almost a third of the total ridership for journey to work. Figure 100 shows areas that had a relatively larger number of workers but low transit share.

A June 1997 on-board passenger survey for DART First State by Ilium Associates Inc. produced some interesting statistics about transit service. A portion of this information is provided in Figures 101 thru 104. There were 3853 surveys returned in New Castle County, 240 in Kent, 18 in Sussex, and 108 for Intercounty service. (Obviously with only 18 surveys in Sussex, there is a potential for large errors in figures for Sussex). New Castle County service had a large number of frequent users with 24% riding six days a week, and an additional 59% riding four or five days a week. Nearly half were using the service for five or more years. Transit is used primarily for work trips in New Castle County (60.8%). In Kent County, 61% are riding four or five days a week, and trip purpose was more balanced with a third using transit for shopping and only a third for work.

¹³ WILMAPCO Regional Transit Service Needs Study, Working Paper Number 3

* Morning peak and midday headways in minutes

Figure 98, Housing Densities in New Castle county with 1/4 mile Buffers around transit routes. 1990 Census at the census block level.

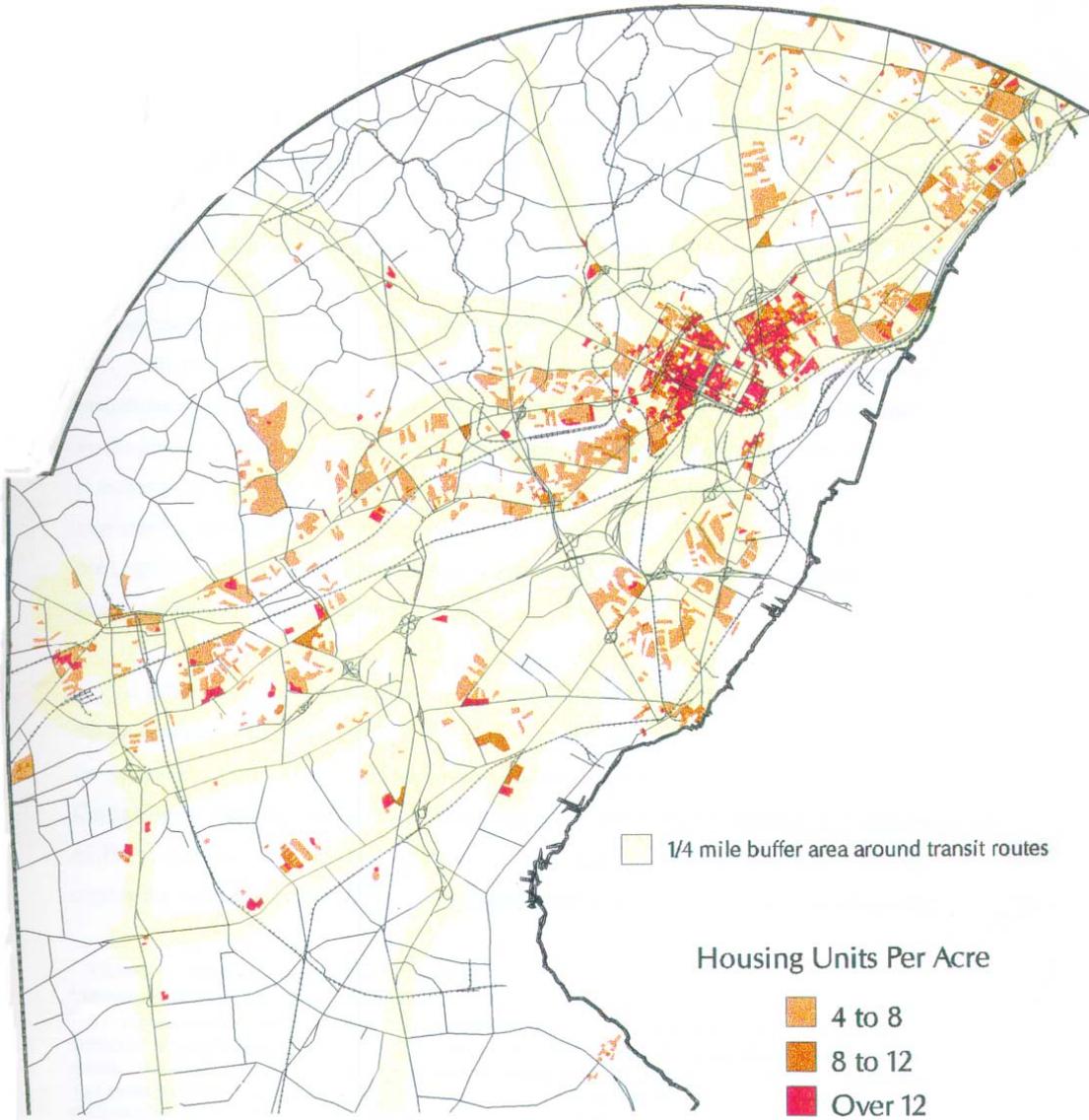


Figure 99. CCD Origin/Destination Pairs with Total Workers Greater than 500 and 2% Transit Share or Better, Workers Who Do Not Work and Live in the Same CCD.

<u>Origin name</u>	<u>Destination name</u>	<u>Total Workers</u>	<u>Transit Share (%)</u>
Kent	Wilmington	760	4.21
Wilmington	Pike Creek	798	8.77
Wilmington	Piedmont	958	8.25
Cecil	Wilmington	1277	2.98
Wilmington	Upper Christina	1390	7.27
Wilmington	Greater Newark	1510	6.89
Wilmington	New Castle	1661	5.90
New Jersey	Wilmington	1874	2.51
Upper Christina	Wilmington	2360	2.33
Wilmington	Lower Christina	2368	7.56
Piedmont	Wilmington	3473	4.95
Wilmington	Brandywine	3944	7.51
Greater Newark	Wilmington	4144	6.64
Lower Christina	Wilmington	4832	8.46
Pike Creek	Wilmington	4900	4.65
New Castle	Wilmington	7359	6.32
Brandywine	Wilmington	10799	8.51
TOTALS		54,407	6.6

Figure 100. CCD Origin/Destination Pairs, Total Workers Greater Than 2000 and Transit Share less than 2%

<u>Origin</u>	<u>Destination</u>	<u>Workers</u>	<u>Transit share (%)</u>
Greater Newark	New Castle	2010	0.4
Pike Creek	Upper Christina	2075	0.5
Central Pencader	Greater Newark	2114	0.2
Brandywine	Lower Christina	2147	0.7
Lower Christina	Brandywine	2209	0.4
Pike Creek	Greater Newark	2231	0.8
Greater Newark	Lower Christina	2260	0
Chester County	Brandywine	2290	0
Upper Christina	Greater Newark	2385	0.4
Delaware County	Wilmington	2463	0.4
Delaware	Brandywine	2507	0.2
Pike Creek	Brandywine	2524	0.8
Pike Creek	Lower Christina	2626	0.6
Greater Newark	Brandywine	2822	0
New Castle	Greater Newark	2886	0.3
Greater Newark	Upper Christina	3150	0.7
Chester County	Wilmington	3168	0.8
New Castle	Lower Christina	3185	0.7
New Castle	Upper Christina	4142	1.8

**Figure 101. How Often Do You Use DART First State Service
DART 1997 On-Board Survey, Ilium Associates, Inc.**

	<u>New Castle</u>	<u>Kent</u>	<u>Sussex</u>	<u>Intercounty</u>
6 days per week	23.9	4.2	27.8	3.7
4-5 days per week	58.8	60.8	33.3	67.6
1-3 days per week	11.2	24.2	33.3	18.5
Less than once a week	3.1	5.4	5.6	9.3

**Figure 102. What is Purpose of This Transit Trip?
DART 1997 On-Board Survey, Ilium Associates, Inc.**

	<u>New Castle</u>	<u>Kent</u>	<u>Sussex</u>	<u>Intercounty</u>
Work	60.8	33.3	50	50

Social/Recreational	4.1	7.5	16.7	7.4
Other	7.1	7.5	11.1	5.6
Shopping	5.7	15.8	5.6	1.9
School	4.4	11.7	11.1	12
Medical/Dental	3.5	5	0	3.7

**Figure 103. How Long Have You Been Using DART First State Bus Service?
DART 1997 On-Board Survey, Ilium Associates, Inc.**

	<u>New Castle</u>	<u>Kent</u>	<u>Sussex</u>	<u>Intercounty</u>
Less than 1 year	16.1	25.8	33.3	28.7
1-3 years	21.7	41.3	22.2	43.5
3-5 years	13.1	11.3	5.6	20.4
More than 5 years	46.7	17.1	38.9	5.6

**Figure 104. Time of Day For Boarding Transit
DART 1997 On-Board Survey, Ilium Associates, Inc.**

	<u>New Castle County</u>	<u>Kent County</u>
Before 6:00am	2%	1%
6:00 am to 9:00am	44%	26%
9:00 am to Noon	18%	27%
Noon to 3:00pm	11%	13%
3:00pm to 6:00 pm	19%	11%
After 6:00 pm	4%	1

The use of origin and destination information such as available in the 1990 CTPP is a valuable tool for locating markets for transit. In New Castle County, origin and destination information indicates a number of possible areas for transit development that include areas in and around western portions of Kirkwood Highway, Chestnut Hill Road south of Newark, Milltown Road, northern portions around the City of New Castle, and lower portions of Route 40. Suburban destinations involving thousands of workers such as Zeneca/Dupont, East Newark, and Newport/Boxwood are shown as areas that transit service may better reach.

Service to the suburbs

Review of CTPP data clearly showed how much of the journey to work market was based in the suburbs. Over 50% of the journey to work market is in suburb to suburb travel with a transit share on the average of less than 1%. About 90% of the journey to work market involves travel to or from a low density area.

**Figure 105. Travel Between Wilmington, New Castle County Suburbs and
Neighboring Counties For Those Who Work in New Castle County.**

<u>Origin</u>	<u>Destination</u>	<u>% who work in NCC</u>	<u>Transit Share %</u>
Neighboring Counties	Wilmington	4	1
NCC not Wilm	Wilmington	16	6

Wilmington	Wilmington	7	11
Wilmington	NCC not Wilm.	5	8
Neighboring Counties	NCC not Wilm.	14	1
NCC not Wilm.	NCC not Wilm.	54	1

Population and employment projections as presented in a later chapter of this report clearly show that practically all new development is taking place at moderate to low density suburban densities. Many higher density areas and urban areas are showing a population decline as housing stock and developable land is less available, and there is a continued decrease in persons per household.

Figure 106. Population Estimates For The Year 2020 and Population Change Between Year 2020 and 2000 (DIF.)

Source: DelDOT population projections 1999

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>
DE Pop 2020	144374	170224	101418	284780	82593	52767
DE Dif. 2000 to 2020	40,856	35,641	9,339	3,798	-3068	2152
KC Dif. 2000 to 2020	2030	6743	2437	4871	751	234
NC Dif 2000 to 2020	21,394	16,306	3518	-1405	-3825	1918
SC Dif 2000 to 2020	17432	12592	3384	332	6	-

Low density development makes it very difficult to increase the use of alternative travel modes. A literature review conducted to determine the current understanding of transit service in the suburbs showed a recurring theme that successful transit service in the suburbs demands an understanding of travel patterns. A distinguishing feature of the more successful suburban transit services has been the service of hubs. Studies conducted as part of the Transit Cooperative Research Program have identified success factors and service strategies for the suburbs through case studies of transit agencies across the country.¹⁴

Elements of success include¹⁵ :

- Develop services around focal points (hubs/park and rides).
- Serve transit's more traditional markets
- Target markets appropriately. Services targeted to choice riders succeed only if appropriately supported and if they have a role to serve.
- Economize on expenses. Costs per trip must be kept down.
- Obtain private sector support. Direct marketing via representative personal contact with employers is essential. The private sector can support new service in a number of ways.
- Plan with the community. Best services are those initiated by transit operators working closely with the local community.
- Establish realistic goals, objectives, and standards. Measure implemented services against specific service criteria.

¹⁴ TCRP B-6:Improving Transit Connections for Enhanced Suburban Mobility, Draft Report-Guidelines for Enhancing Suburban Mobility Using Public Transportation, Transit Research Program, Transportation Research Board, by Urbitran Associates Inc, January 1997 **and** TCRP Synthesis 14, Innovative Suburb-to-Suburb Transit Practices, A Synthesis of Transit Practice, Transit Cooperative Research Program, Transportation Research Board, 1995.

¹⁵ TCRP B-6, pgs 18-21 and TCRP Synthesis 14, pgs 25-27

-
- Develop supportive policies, plans, and regulations (i.e. land use policies, parking fees, mandatory auto-occupancy, etc.)
 - Adapt vehicle fleets to customer demand.
 - Distribute transit information to offset poor visibility of service in low density areas.
 - Pursue opportunities for Park and Rides.
 - Offer safe, sheltered stops.
 - Guaranteed ride home programs contribute to success.

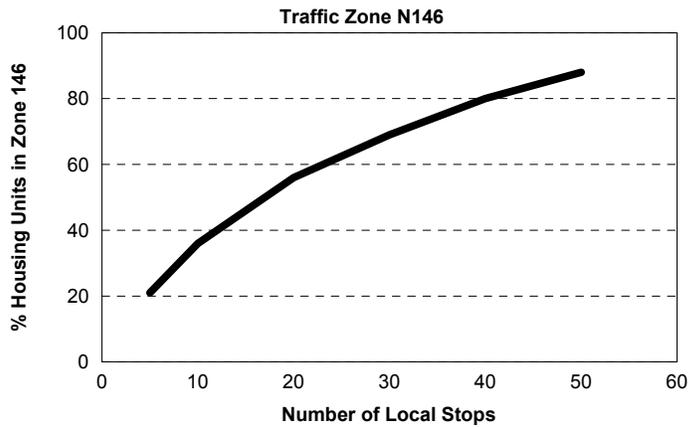
Service Within Local Neighborhoods

The analysis of origin/destination data suggested areas where there were a large number of workers and very low transit share. One such area was the Pike Creek area in New Castle County that would be classified here as a medium density suburb with a very low amount of interconnection between housing developments. To get a better understanding of the feasibility of serving such areas with fixed transit, housing units were accurately located at the tax parcel level, and optimum routing algorithms available in GIS were used to determine the length and duration of routes to reach the largest number of housing units within a 6 minute walk of potential transit stops. The results of this exercise are shown in Figures 107 and 108 for one traffic zone in the Pike Creek area. To reach only about 30% of the housing units by fixed transit, it was estimated to take at least 30 minutes of circulation time plus the time to make the stop. This would mean that a transit trip to Wilmington, for instance, would be twice as long by transit as by private auto. There are about 4,000 workers total in this area. About 800 (20%) of these work in Wilmington. If only 30% were reached by transit that would be 240 workers to be reached. If 10% would use transit (the 1990 transit share to Wilmington for the Pike Creek Planning District is just under 5%) then one would be designing the route during peak times to serve about 25 people and a percentage of these would not want to leave at the same time. These are rough (though generous) figures but they illustrate how costly and impractical direct fixed route transit service could be to reach larger numbers of workers in medium and lower suburban densities even for service to a major urban area. Four thousand workers in such an area sounds at first like a large number but by the time the number gets thinned as to how many that service can reach, the number of destinations that people desire to travel to, and the number of people that will use transit the actual market that can be reached gets rather small.

Use of park and rides and a hub based routing strategy are necessary as the circulation time to collect passengers is too long. In the Pike Creek area just mentioned, the local park and ride (Faith Baptist Church) accounts for almost 70% of the morning transit ridership. The primary route doesn't just serve Pike Creek and Wilmington, but also places in between. In areas where there is not a large percentage of workers going to the same destination, where parking is free at work, and where average trip times to work are less than 20 minutes as with most of Delaware, the situation is far worse. As development moves to lower density, less developed areas, there are not large populations that can be served within the route.

Figure 107

**% "Housing Units" Within 6 Minute Walk vs.
Number of Local Stops**



* Assumes Walking Speed of 2 MPH

DRAFT Jan 1997

Figure 108
Demand Reached and Collector Miles Traveled
By Number of Local Stops in Traffic Zone N146

Number of Stops	Housing Units Within 6 Min. Walk	Circuit Miles	Circuit Travel Time*
5	950	11.9	28 minutes + stop time
10	1750	14.3	34 minutes +
20	2650	19.9	48 minutes +
30	3300	25.2	60 minutes +
40	3800	30.6	73 minutes +
50	4200	34.1	82 minutes +

* Assumes Avg. Speed of 25MPH

Circuit Includes Stops at Poly Drummand Shopping Center and Pike Creek Office Campus (PR)

Where People Live and Travel in Delaware

Introduction

The DelDOT Travel Demand Forecasting Model (Forecasting Model) produces a number of outputs as to where people travel in Delaware and the expected volumes that result on the roads. The Forecasting Model is primarily based on gravity models but numerous adjustments over the years have been made to calibrate the model to provide outputs that are in line with measured traffic volumes, origin and destination data available from the CTPP, and knowledge of the transportation system.

The 1990 Census Transportation Planning Package (CTPP) also provides information about travel in Delaware. The Urban Element of the CTPP provides detailed information about where people in Delaware live and work at the State, County, and Planning District levels. For portions of northern Delaware, detailed travel data is available at the traffic zone level as was derived from the 14% sample (long form) of the 1990 Census. Together the Forecasting Model and the CTPP provide a wealth of information to support an understanding of travel in Delaware. This section examines origins and destinations for various purposes and what we know about the usage of the transportation system.

Journey to Work at the County Level

Figure 109 provides the 1990 CTPP estimates of county to county origins and destinations. Other figures that are available from the CTPP indicate that 13% (46,669) of the 348,428 people who worked in Delaware came into Delaware from other states. Cecil County supplied the most with 10,892 workers, but Chester County, PA, and Delaware County, PA are close with 10,354 and 7,556 workers respectively. Other large contributors in 1990 are Salem County, NJ (3,098), Philadelphia County, PA (1,158) and Gloucester County, NJ (1,029).

There were 30,225 Delawareans estimated to leave the state on the journey to work so there was estimated to be a net in-migration of 16,000 workers. Workers leaving the state are primarily headed to Pennsylvania with 6,188 headed for Delaware County, 3,514 for Chester County, and 4,697 for Philadelphia County. There were 2,142 going to Cecil County, MD, 2,630 to Wicomico County, MD, 1,716 for Worcester County, MD, and 1,724 on their way to Salem County, NJ.

In 1990 Kent County was a net exporter of workers since 7,769 go to work in New Castle or Sussex counties and only 5,773 come into Kent from elsewhere in Delaware. Sussex County is a net exporter of workers but only by about 500 with most of them going to Kent County. Mode of travel and travel times from the CTPP for the journey to work have been presented in the previous chapter.

Figure 109
1990 Journey to Work
by Origin and Destination

Place of Work							
Place of Residence	Kent	New Castle	Sussex	Cecil	Other	At Home	Total
Kent	43,512	4,307	3,462	29	1,834	1,553	54,697
New Castle	2,028	196,960	196	2,104	22,043	4,313	227,644
Sussex	3,745	362	39,207	9	6,348	2,114	51,785
Cecil	62	10,761	69	16,018	6,872	918	34,700
Outside	1,812	29,849	4,116	3,233	n/a	n/a	39,010
Work at Home	1,553	4,313	2,114	918	n/a	n/a	8,898
Total	52,712	246,552	49,164	22,311	37,097	8,898	416,734

Source: Center for Applied Demography and Survey Research, University of Delaware
US Bureau of Census

Journey to Work at the Census County Division Level

A next level of detail to examine journey to work origins and destinations is the Census County Division (CCD) sometimes referred to as Planning Districts. Summary figures by CCD for New Castle County are available through the CTPP. Figure 111 shows the total number of workers for each CCD in New Castle County and the percentage of those workers who live and work in each CCD. A similar table was produced for Kent and Sussex counties using DelDOT Travel Demand Forecasting data. The jobs per population figures give an idea as to the degree of mixed land use within the CCD. In New Castle County the urban areas of Wilmington and Newark have large numbers of jobs and a larger percentage of people who live and work in the area. The Brandywine CCD which is relatively older development has the largest population, highest density, and largest number of jobs for a suburban area in New Castle County. A little less than a third of the people in the Brandywine CCD live and work there. Other suburban CCD's have less jobs, less population, less density, and about 20% or less people who live and work in the area.

The Upper Christina CCD that includes Churchman's Crossing, the Christiana Hospital, and large financial institutions is an example of relatively new residential and employment development. While the number of jobs is roughly equal to the population, only about 16% of the people live and work there. Simply having a large number of jobs relative to population in a local area doesn't mean that large percentages of those living there will work there. The costs and styles of housing units might not be appropriate for those workers, for example.

Kent and Sussex counties show a different picture. Development is at a much lower density and activity is centered around the towns. People tend to live and work in the same local area. Figures show that 89% of the workers who live in the Dover CCD work there. In Sussex the

largest job CCD's are Lewes, Seaford, and Selbyville-Frankford, all of which have 69% or greater of the resident workers employed there.

Figure 110. New Castle County Census County Divisions

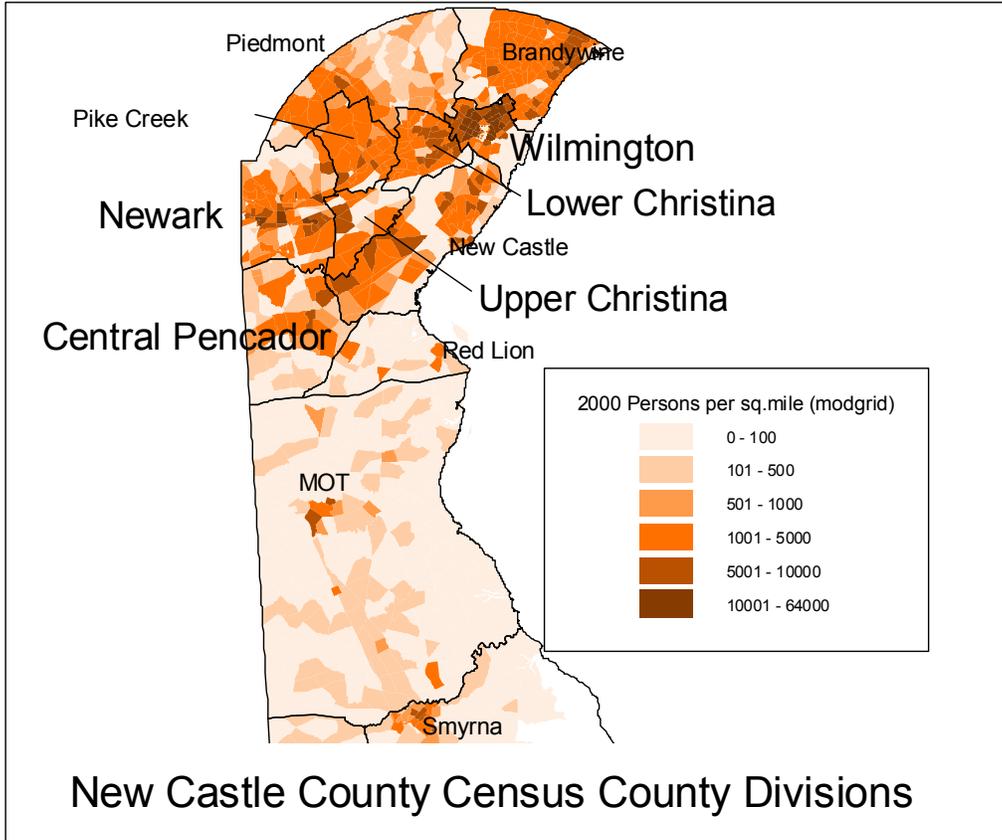


Figure 111. Total Workers by Census County Division in New Castle, Delaware and Total Workers Who Live and Work in the Same CTPP, (1990 data)

<u>CCD Destination</u>	<u>Population</u> <u>1990</u>	<u>Workers</u>	<u>jobs/Pop</u>	<u>Jobs</u>	<u>%workers</u> <u>Live and work here</u>
Red Lion	4033	1943	.42	1716	14%
Central Pencader	17719	9621	.15	2605	3
MOT	18578	8297	.15	2801	25
Piedmont	24402	11802	.25	6227	4
Pike Creek	38733	21296	.27	10547	9
Upper Christina	21177	13127	1.0	22042	16
New Castle	67798	35149	.35	23633	21
Lower Christina	36543	17995	.74	26937	20
Greater Newark	61003	31350	.61	37226	37
Brandywine	80434	40732	.51	41073	28
Wilmington	71526	31999	.95	68185	52

Figure 112. Kent County CCD's and densities

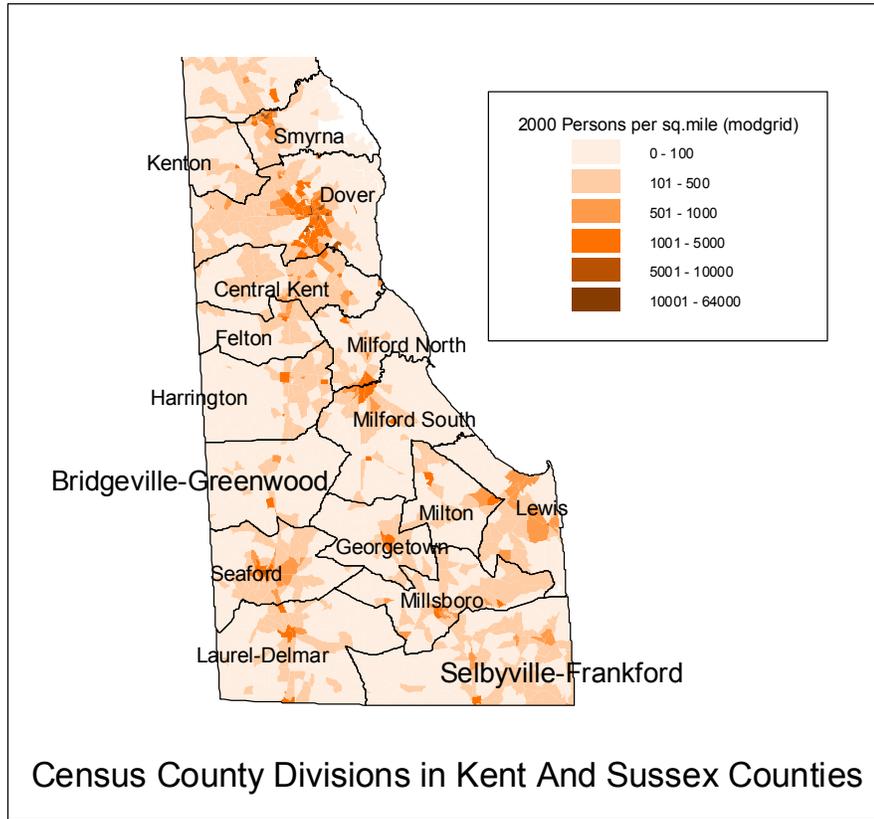
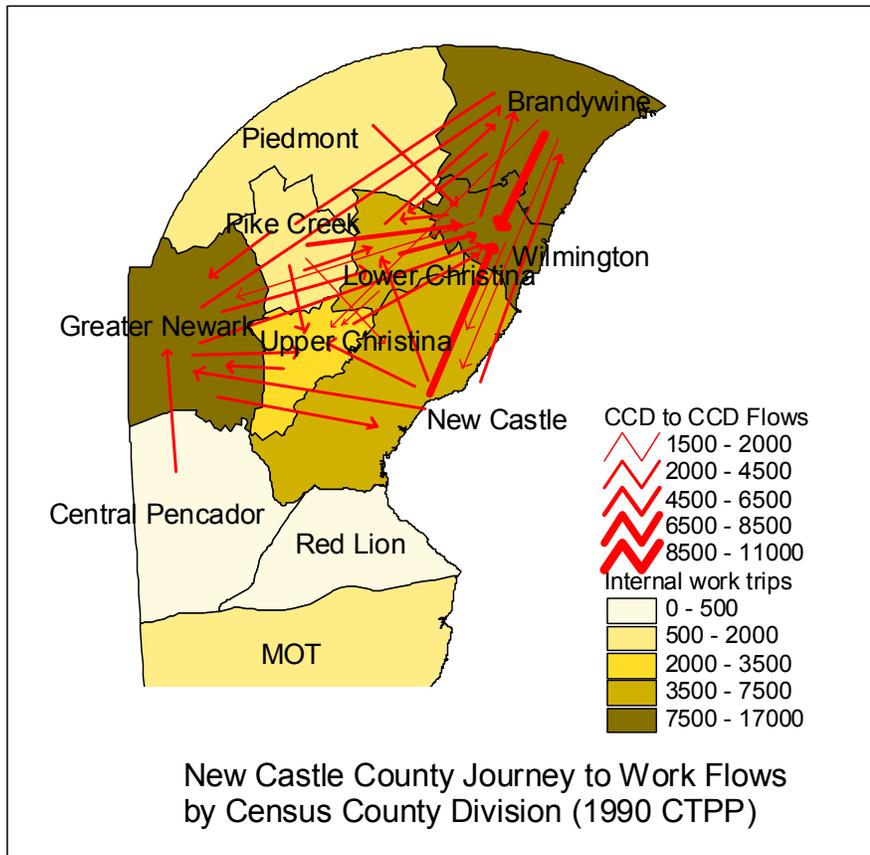


Figure 113. Total Workers by Census County Division in Kent County, Delaware And Total Workers Who Live and Work in the Same CCD, (number of workers as predicted by the DeIDOT 1998 Travel Demand Forecasting Model

CCD Destination	1990 Population	Workers	Jobs/Pop90	Jobs	%workers live and work here
KENT COUNTY					
Kenton	4429	1930	.05	219	4%
Felton	4844	2158	.16	799	7
Central Kent	15838	5115	.09	1436	7
Harrington	9018	3448	.29	2618	25
Smyrna	10633	3972	.27	2922	34
Milford North	6758	1879	.63	4269	27
Dover	59473	25017	.65	35243	89
SUSSEX COUNTY					
Milton	7671	3208	.04	322	4%
BridgevilleGreenwood	6899	2229	.07	500	7
Millsboro	12897	4622	.15	1902	18
Georgetown	7776	2936	.41	2317	27
Laurel-Delmar	15086	5373	.16	2490	32
Milford South	14044	4839	.21	2900	22
Lewes	13628	4515	.55	7473	73
Seaford	18897	5496	.44	8290	69
Selbyville-Frankford	16331	4745	.48	7774	87

Examining the journey to work flows between CCD's provides a more complete picture. Journey to work origin/destination pairs involving 1500 or more workers at the CCD level for New Castle County are presented in Figure 115 on the next page. Scanning the table it is clear that the largest flows are into Wilmington or where the origin and destination are the same. One way to picture this better is as in Figure 114 below that shows CCD flows with 1500 or greater workers. This diagram illustrates the large flows into Wilmington and to a lesser extent Brandywine.

Figure 114. New Castle County CCD Work Flows



Because of the lower populations, no CCD origin/destination pair greater than 1,500 involving travel from MOT or Red Lion, and only one (to Newark) for Central Pencader, flows from these areas are not shown in Figure 114. As there is increasing development in these areas, it is interesting to see what the numbers are. Figures 116 and 117 show journey to work destinations for MOT and Central Pencader. It is clear from these figures that those workers in these southern areas of New Castle County are spread fairly evenly across northern employment areas with slightly more going to the Newark CCD.

Figure 115. JTW Origin and Destinations at the Census Planning

**Division Level for Census County Divisions in New
Castle County. Total Workers Greater Than 1500.
(Source: 1990 CTPP)**

<u>Origin</u>	<u>Destination</u>	<u>Number of Workers</u>
Wilmington	Greater Newark	1510
Pike Creek	New Castle	1517
Lower Christina	Upper Christina	1601
Chester	Greater Newark	1636
Wilmington	New Castle	1661
Brandywine	New Castle	1781
New Jersey	Wilmington	1874
Brandywine	Upper Christina	1937
Pike Creek	Pike Creek	1954
Greater Newark	New Castle	2010
Pike Creek	Upper Christina	2075
Central Pencader	Greater Newark	2114
Upper Christina	Upper Christina	2122
Brandywine	Lower Christina	2147
Lower Christina	Brandywine	2209
Pike Creek	Greater Newark	2231
Greater Newark	Lower Christina	2260
Brandywine	Philadelphia County	2284
Chester	Brandywine	2290
Upper Christina	Wilmington	2360
Wilmington	Lower Christina	2368
Upper Christina	Greater Newark	2385
Delaware County	Wilmington	2463
Delaware County	Brandywine	2507
Pike Creek	Brandywine	2524
Pike Creek	Lower Christina	2626
Greater Newark	Brandywine	2822
New Castle	Greater Newark	2886
Greater Newark	Upper Christina	3150
Chester County	Wilmington	3168
New Castle	Lower Christina	3185
Piedmont	Wilmington	3473
Brandywine	Delaware County	3545
Lower Christina	Lower Christina	3664
Wilmington	Brandywine	3944
Cecil	Greater Newark	3984
New Castle	Upper Christina	4142
Greater Newark	Wilmington	4144
New Castle	Brandywine	4165
Lower Christina	Wilmington	4832
Pike Creek	Wilmington	4900
New Castle	New Castle	7267
New Castle	Wilmington	7359
Brandywine	Wilmington	10799
Brandywine	Brandywine	11456
Greater Newark	Greater Newark	11542
Wilmington	Wilmington	16688

Figure 116. CCD Work Destinations From the MOT Area (1990 CTPP)

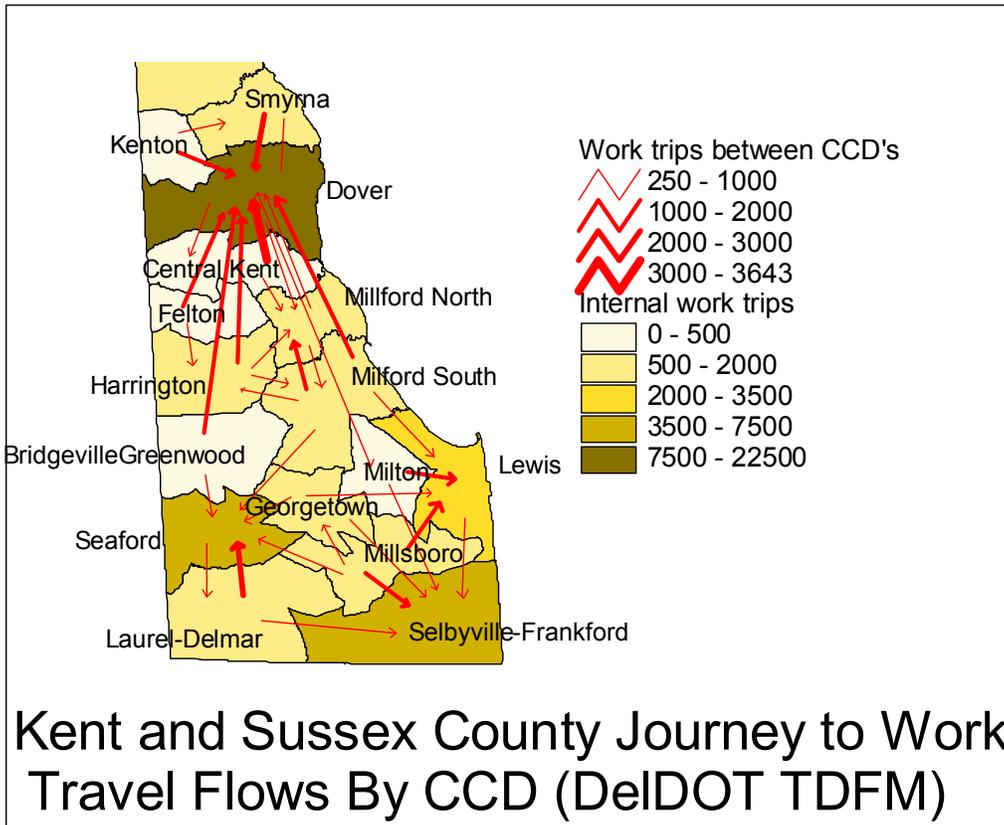
Census County Division Workers

Central Pencador	103
Red Lion	105
Pike Creek	129
New Jersey	131
Piedmont	146
Cecil County	193
Lower Christina	722
Wilmington	785
Upper Christina	807
Brandywine	855
New Castle	875
Greater Newark	938
Kent County	987
MOT	1235

Figure 117. CCD Work Destinations From the Central Pencador Area (1990 CTPP)

<u>Census County Division</u>	<u>Workers</u>
Delaware County	102
Red Lion	106
Kent	117
New Jersey	142
Philadelphia	153
Cecil County	262
Central Pencador	334
Pike Creek	340
Piedmont	410
Lower Christina	824
New Castle	851
Brandywine	1078
Upper Christina	1160
Wilmington	1389
Greater Newark	2114

Figure 118. Kent and Sussex County Journey to Work Flows



The primary source of origin and destination information in Kent and Sussex counties is the DeIDOT Travel Demand Forecasting Model (TDFM). The CTPP does not address these areas and the ongoing DeIDOT Household Survey still as yet does not have enough observations to sufficiently present travel flows. Output from this model was used to create Figure 118 above, that shows how employment is centered at Dover with over 8 times the employment of any other CCD in Kent County. Just over 70% of the workers living in Central Kent and Kenton CCD's are employed in Dover. For Smyrna, 60% of the workers work in Dover and for Felton the figure is about 54%. Large percentages of workers in northern Sussex also travel to Dover. In southern Sussex County, journey to work is focused on the CCD's with the greatest employment, Seaford, Lewes, and Selbyville-Frankford. Kenton, Felton, and Central Kent in Kent County and Milton, Bridgeville-Greenwood, Millsboro and Laurel-Delmar with their very low percentage of jobs with respect to their populations all could be considered "bedroom communities". The longer travel distances in Kent and Sussex counties all involve travel to Dover. Figures show that for employment centers in Sussex, workers tend to live closer to where they work. Tabulation of CCD origin and destination figures for the journey to work for pairs with 1000 or more workers is provided in Figure 119.

Figure 119. Kent /Sussex Journey to Work by CCD

**Daily Work Trip Estimate, Workers gt 1000
Source DelDOT TDFM 1998**

<u>ORIGIN</u>	<u>DESTINATION</u>	<u>Number of Workers</u>
Milford South	Dover	1043
Harrington	Dover	1058
Milford South	Milford South	1072
Felton	Dover	1157
Milford South	Milford North	1181
Millsboro	Selbyville-Frankford	1192
Milton	Lewes	1278
Smyrna	Smyrna	1360
Millsboro	Lewis	1378
Kenton	Dover	1397
Laurel-Delmar	Laurel-Delmar	1733
Laurel-Delmar	Seaford	2025
Smyrna	Dover	2394
Lewes	Lewes	3300
Central Kent	Dover	3643
Seaford	Seaford	3780
Selbyville-Frankford	Selbyville-Frankford	4115
Dover	Dover	22324

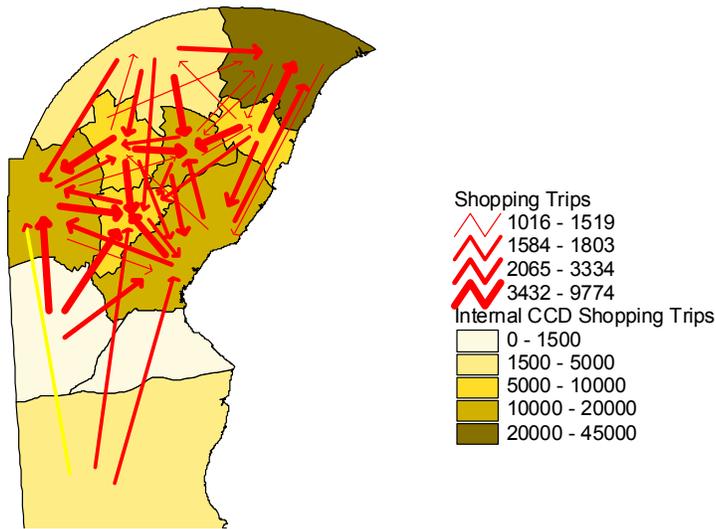
Shopping Trips at the CCD Level

The DelDOT Travel Demand Forecasting Model also predicts the number of daily trips to and from all traffic zones. Figure 120 below tabulates the number of shopping trips attracted and produced from each CCD. Brandywine is the destination of the most shopping trips, followed by Upper Christina. By looking at the ratio of attractions to productions, the general character of the areas can be seen. The Upper Christina CCD, that includes a large regional mall with over three times as many shopping trips attracted as produced is clearly a commercial center. Wilmington, while a job center and the largest, most dense urban area in Delaware, produces more than twice as many shopping trips as it attracts. Central Pencader and MOT, which are the areas that are developing the fastest over the coming years are seen as primarily residential areas with very little shopping occurring within them. This as shown earlier is also true of jobs. Central Pencader and MOT had a jobs to population ratio of only 0.15. These areas may eventually have the population to encourage commercial development, but not now. At the CCD level, development is not occurring in a mixed use fashion and it would be expected that those living in these areas would need to drive more for work and shopping. Areas of older development in Brandywine, greater Newark, and New Castle, on the other hand, attract and produce closer to the same number of shopping trips and are focuses of a large amount of commercial activity.

Figure 120. Estimates of Daily Shopping Trips, Productions and Attractions at the CCD Level in New Castle County. Source: DelDOT TDFM 1996

<u>Census County Division</u>	<u>Trips Attracted</u>	<u>Trips Produced</u>	<u>Attrac/Prod</u>
Red Lion	737	1854	0.4
Central Pencader	1639	14371	0.1
MOT	3552	10325	0.3
Piedmont	7069	15735	0.3
Wilmington	10633	27053	0.4
Pike Creek	20161	29044	0.7
Lower Christina	31531	19599	1.6
New Castle	34988	39993	0.9
Greater Newark	38501	31192	1.2
Upper Christina	41007	12555	3.3
Brandywine	59586	46551	1.3

**Figure 121. Shopping Trip Flows in New Castle County
Source: DelDOT TDF Model, 1996**



New Castle Shopping Flows

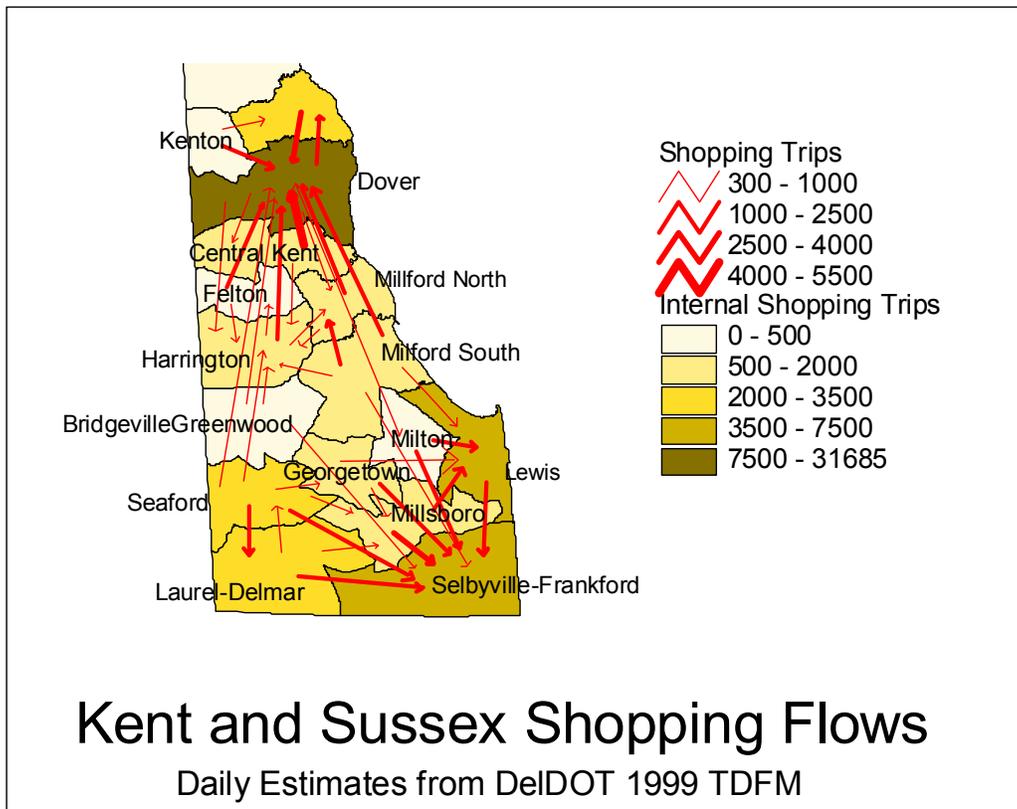
Daily Estimates from DeIDOT 1996 TDFM

In Kent and Sussex counties the shopping flows are similar to that for the journey to work, the complete dominance of the Dover area in Kent, and to a lesser extent the Selbyville-Frankford area in Sussex. Again for the most part, those areas that have the least commercial activity and jobs are those that are expected to see the fastest growth in residential development.

Figure 122. Estimates of Daily Shopping Trips, Productions and Attractions at the CCD Level in Kent and Sussex Counties
Source: DeIDOT TDFM 1996

<u>Census County Division</u>	<u>Trips Attracted</u>	<u>Trips Produced</u>	<u>Attrac/Prod (%)</u>
BridgevilleGreenwood	507	3024	0.2
Milton	511	4553	0.1
Kenton	621	2762	0.2
Felton	1662	3021	0.6
Milford South	1823	6678	0.3
Georgetown	1912	4120	0.5
Central Kent	2051	7119	0.3
Seaford	3288	7676	0.4
Millsboro	3289	6661	0.5
Milford North	3997	2514	1.6
Smyrna	5202	5291	1.0
Laurel-Delmar	5325	7460	0.7
Harrington	5383	4753	1.1
Lewes	9890	6456	1.5
Selbyville-Frankford	19397	6585	2.9
Dover	49055	35240	1.4

Figure 123. Kent and Sussex Shopping Flows
Source: DeIDOT TDF Model 1999



Home Based Other

The DeIDOT Travel Demand Forecasting Model also includes estimates of Home Based Other trips, trips that are not work or shopping related. Figures 124 thru 125 below show some of this data. Home Based Other Trips are predicted to be much more balanced across CCD's than for work or shopping. Each CCD attracts a similar share of these trips relative to their populations. This is especially true for Kent and Sussex where productions and attractions are roughly equal for all CCD's. It's also interesting to note that close to 50% of shopping and home based other trips originate and end in the same CCD. For work trips only about 25% of workers live and work in the same CCD.

Figure 124. Estimates of Daily Home Based Other Trips, Productions and Attractions at the CCD Level in New Castle County
Source: DeIDOT TDFM 1998

<u>Census County Division</u>	<u>Trips Attracted</u>	<u>Trips Produced</u>	<u>Attrac/Prod%</u>
Red Lion	3662	3996	0.9
MOT	18025	22958	0.8
Central Pencader	18394	29020	0.6
Piedmont	25334	33281	0.8
Upper Christina	36821	24724	1.5
Lower Christina	39626	38756	1.0
Pike Creek	43344	55961	0.8
New Castle	64013	78181	0.8
Greater Newark	69903	60780	1.2
Brandywine	85329	91083	0.9
Wilmington	88257	53968	1.6

Figure 125. Estimates of Daily Home Based Other Trips, Productions and Attractions at the CCD Level in Kent and Sussex Counties
Source: DelDOT TDFM 1996

<u>Census County Division</u>	<u>Trips Attracted</u>	<u>Trips Produced</u>	<u>Attrac/Prod (%)</u>
Kenton	3202	3125	1.0
BridgevilleGreenwood	3628	3710	1.0
Felton	4749	4674	1.0
Milton	4837	4922	1.0
Georgetown	7608	7780	1.0
Central Kent	9528	9343	1.0
Milford North	9537	9537	1.0
Millsboro	10343	10602	1.0
Harrington	11027	11001	1.0
Milford South	11032	11073	1.0
Smyrna	12481	12190	1.0
Laurel-Delmar	13215	13630	1.0
Seaford	16567	16989	1.0
Lewes	21660	22180	1.0
Selbyville-Frankford	29679	30534	1.0
Dover	91442	89245	1.0

Origins and destinations for smaller areas

Predicting flows between smaller areas requires much more data. The DelDOT Household Survey does not have sufficient data to estimate flows between areas as small as a traffic zone. Estimates of trips taken between traffic zones resulting from trip generation and gravity models are made using the DelDOT Travel Demand Forecasting Model, and these are useful for general planning particularly when numbers are calibrated to known traffic counts. The 1990 CTPP is based on the long form captured journey to work data for areas smaller than the DelDOT traffic zones, and provides a great resource to study transportation patterns. Using the CTPP data, total workers and transit share for the journey to work was tabulated from aggregations of DELDOT Traffic Zones for the largest 50 origins and 25 destinations using the data from the 1990 CTPP. These origins and destinations are shown in Figures 126 and 127 on the next two pages.

Figure 126. Origin Places in New Castle County

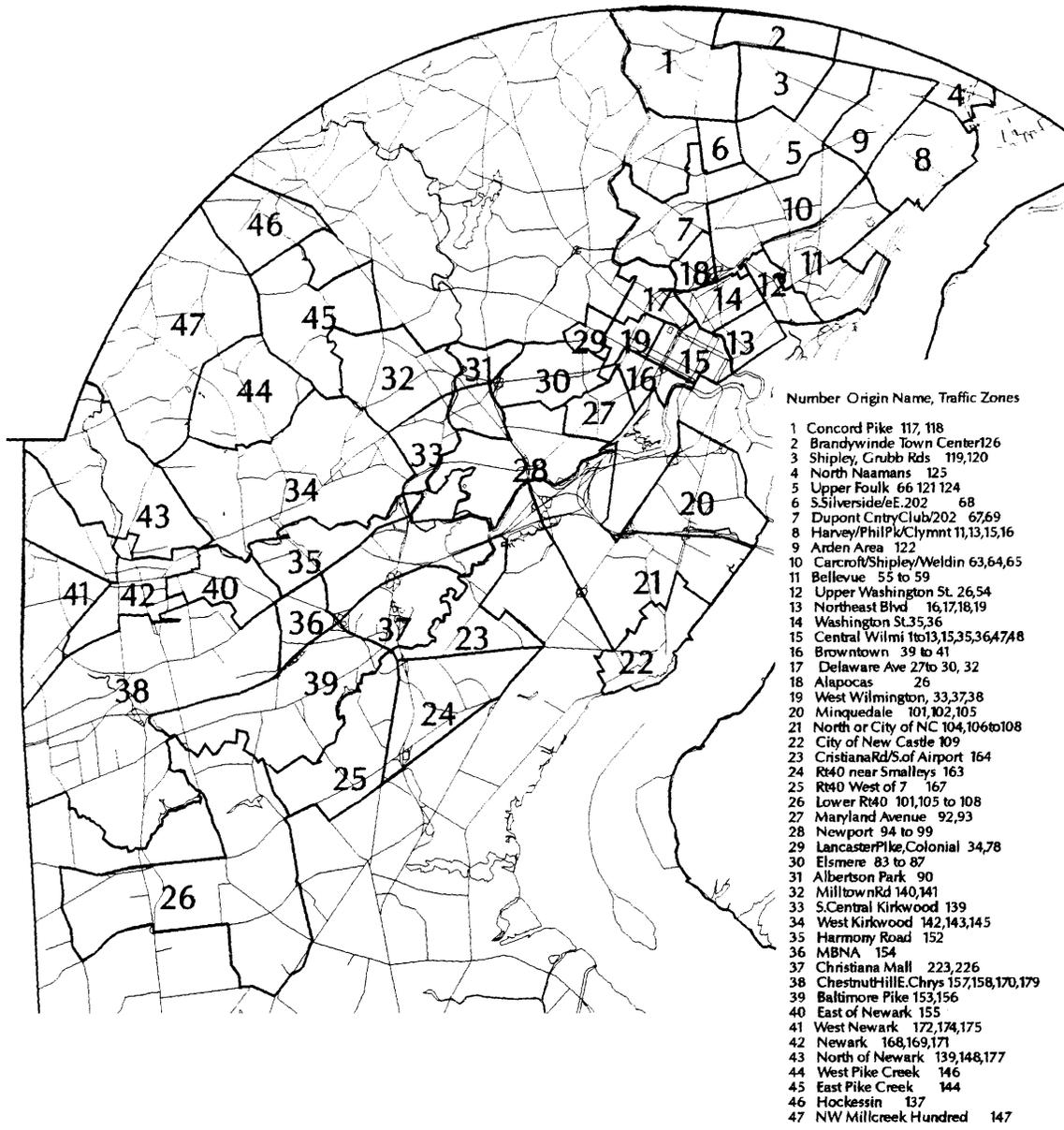
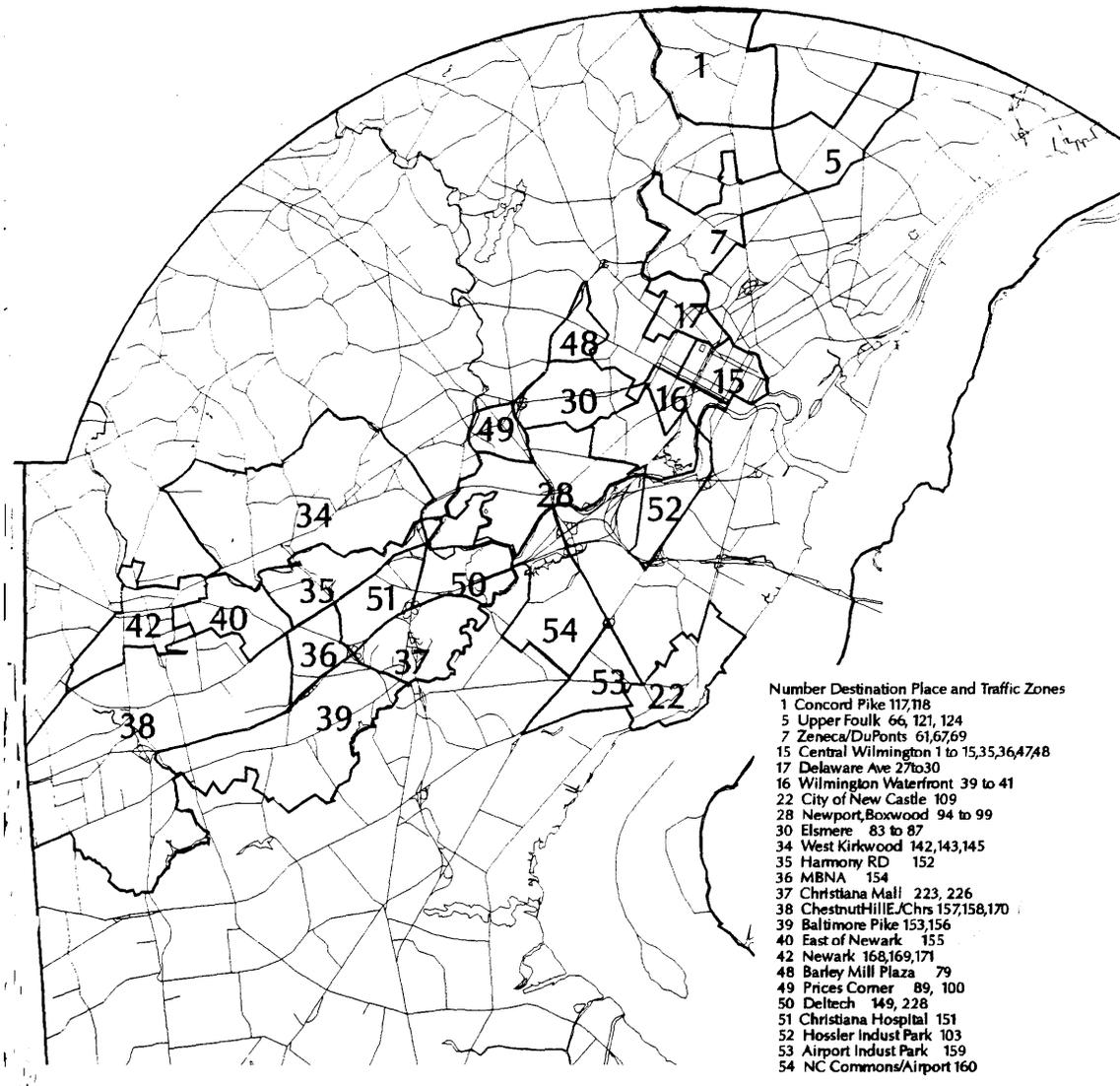


Figure 127. Destination Places in New Castle County



As seen when the data was viewed at the Census County Division level, the greatest share of transit riders involves Wilmington as a destination. Figure 128 shows where transit is most successful. Higher density and lower income areas are represented in Figure 128, but there are some lower density, more affluent areas which show a good transit share such as West Pike Creek, Arden, DuPont Country Club/ Rt202, and S. Silverside / Rt.202. Areas where transit share is between 5 and 10% mostly serve Wilmington.

**Figure 128. Total Workers Greater Than 200 and Share 10% or More
1990 CTPP**

<u>ORIGIN</u>	<u>DESTINATION</u>	<u>WORKERS</u>	<u>RIDERS</u>	<u>TRANSIT SHARE %</u>
Upper Washington St.	Wilmington	593	60	10
Washington St.	East of Newark	241	24	10
West Newark	Wilmington	404	39	10
Arden Area	Wilmington	365	40	11
Newport	Wilmington	633	68	11
West Pike Creek	Wilmington	897	110	12
Maryland Ave	Wilmington	462	55	12
DuPont CC / 202	Wilmington	390	46	12
West Wilmington	Wilmington	995	116	12
Delaware Ave	Wilmington	1205	160	13
Washington St.	Delaware Ave	412	52	13
Elsmere	Wilmington	641	90	14
Brandywine Twn Cntr	Wilmington	273	39	14
Browtown	Wilmington	875	124	14
City of New Castle	Wilmington	325	49	15
East Naamans	Wilmington	522	83	16
Bellevue	Wilmington	1230	224	18
S.Silverside/E.202	Wilmington	225	41	18
Minquedale	Wilmington	794	151	19
Washington St.	Wilmington	1886	370	20
North East Blvd.	Wilmington	950	253	27

An illustrative way of viewing New Castle County journey to work patterns is as an origin/destination table as shown in Figure 132. Numbers are shown for all pairs which involve 70 or more workers. The Wilmington Central Business District is the largest destination for almost all origins. Many of the OD pairs which involve larger numbers of workers are where the origin area and destination area are the same, or nearby.

**Figure 129. Total workers greater than 200 and 5% <= share < 10%
1990 CTPP**

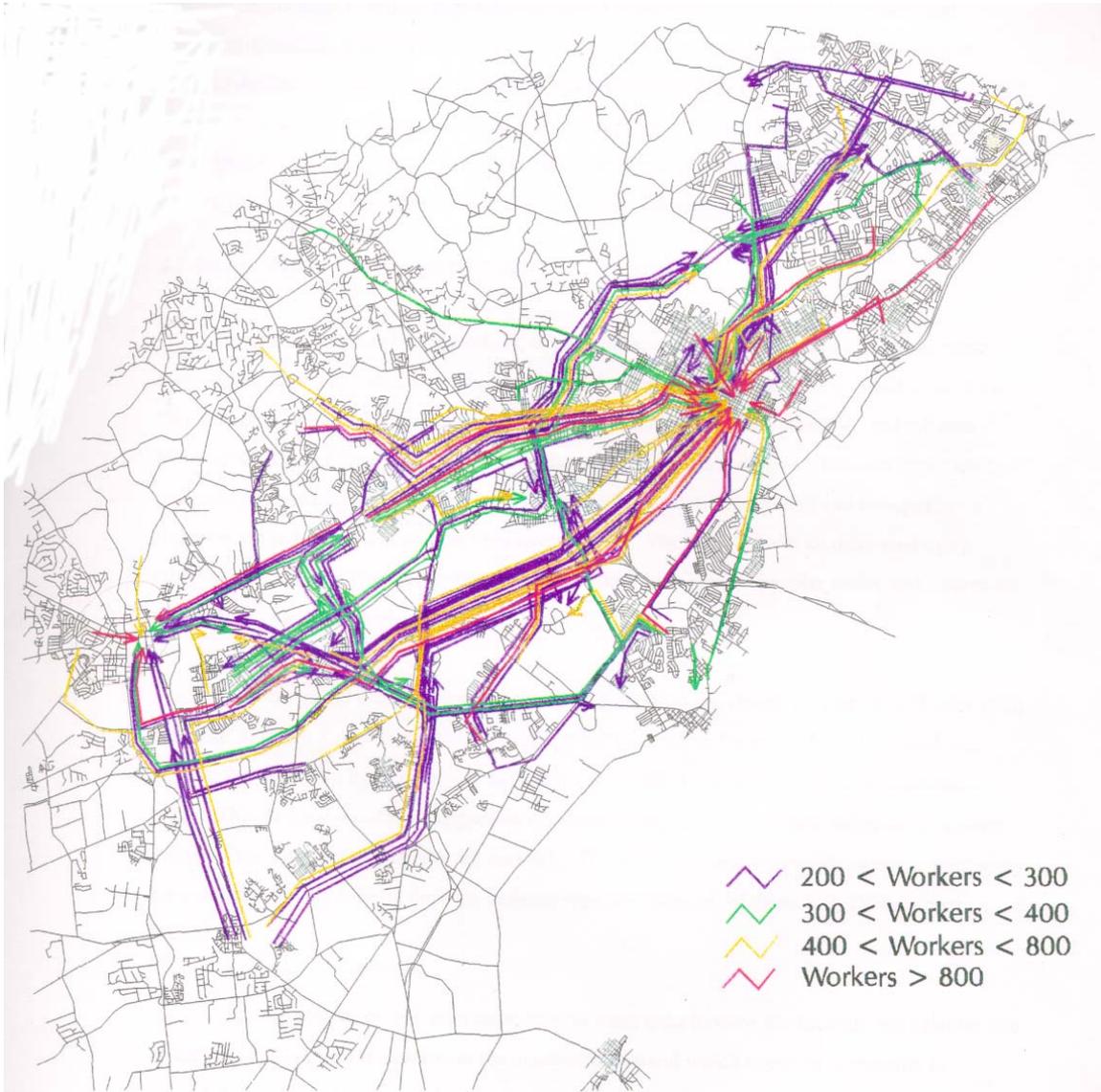
<u>ORIGIN</u>	<u>DESTINATION</u>	<u>WORKERS</u>	<u>RIDERS</u>	<u>TRANSIT SHARE</u>
Elsmere	Christiana Mall	216	14	6
Concord Pike	Wilmington	218	15	7
Central Wilmington	West Wilmington	219	15	7
Washington Street	West Wilmington	222	21	9
Washington Street	Newport/Boxwood	231	19	8
Christiana Mall	Wilmington	254	12	5
LancastePk/ColHghts	Wilmington	340	22	6
MBNA	Wilmington	445	24	5
ChristianaRD/S.Arprt	Wilmington	483	27	6
NW Millcreek Hund.	Wilmington	502	33	7
Shipley/Grubb Rds.	Wilmington	503	23	5
Upper Foulk	Wilmington	598	52	9
East Pike Creek	Wilmington	730	41	9
Harvey/PhilPK/Claymnt	Wilmington	970	67	7
Rt.40 near Smalleys	Wilmington	1054	76	7
Chestnut Hill E./Chry	Wilmington	1085	93	9
North of City of NC	Wilmington	1155	77	7
Central Wilmington	Wilmington	3185	271	9

Figure 130. Total Workers ge 300 and Share lt 5%

1990 CTPP

ORIGIN	DESTINATION	WORKERS	BUS	SHARE (%)
Sth. Central Kirkwood	Wilmington	303	11	4
W. Kirkwood	Barley Mill Plaza	303	0	0
North of City of NC	Harmony Road	307	0	0
Harmony Road	Newark	309	0	0
Albertson Park	Wilmington	316	7	2
North of City of NC	Newark	318	0	0
Chestnut Hill E./Chry	Newport/Boxwood	321	0	0
West Kirkwood	Elsmere	326	0	0
Hockessin	Wilmington	329	11	3
Newark	East of Newark	330	9	3
Chestnut Hill E./Chry	West Kirkwood Hy.	340	0	0
West Kirkwood	Christiana Mall	342	0	0
North of City of NC	Newport/Boxwood	347	0	0
Upper Foulk	Zeneca/DuPont	352	0	0
Chestnut Hill E.	Harmony Road	352	0	0
Chestnut Hill E.	Zeneca/DuPont	353	0	0
Harvey/PhilPk/Clymnt	Zeneca/DuPont	354	0	0
Chestnut Hill E.	MBNA	384	0	0
North of City of NC	City of New Castle	395	0	0
West Kirkwood	Newport/Boxwood	405	0	0
Delaware Ave	Delaware Avenue	426	11	3
North of City of NCC	Airport Indust Park	430	0	0
Newport	Newport/Boxwood	489	2	0
North of City of NCC	NC Commons/Airprt	503	9	2
Elsmere	Elsmere	504	4	1
Chestnut Hill E./Chry	East of Newark	512	7	1
West Kirkwood	Zeneca/DuPont	526	0	0
Rt.40 West of Rt 7	Wilmington	527	0	0
North of Newark	Newark	542	22	4
Lower Rt. 40	East of Newark	557	0	0
West Wilmington	West Wilmington	560	0	0
West Kirkwood	West Kirkwood	568	0	0
Baltimore Pike	Wilmington	597	8	1
Lower Rt.40	Wilmington	614	11	2
Milltown Road	Wilmington	679	23	3
ChestnutHillE.Chry	ChestnutHillE.Chry	706	0	0
WestKirkwood	Newark	918	12	1
West of Newark	Newark	1322	42	3
West Kirkwood	Wilmington	1559	67	4
ChestnutHillE.Chry	Newark	1865	0	0
Newark	Newark	1878	60	3

Figure 131. JTW Flows Between New Castle County Places



Characteristics of the Transportation System

Introduction

The transportation network representation of roads used in the DelDOT Travel Demand Forecasting Model associates information with each road segment such as the road name, number of lanes, the capacity, traffic volumes, in service date, average speed across the segment, average speed across the segment during peak travel periods, and projected volumes and volume to capacity ratios. The road segments identified in the model are combinations of roads, and any impedances within the segment such as stop signs or signalized intersections. This is not a detailed model in that it does not show subdivision roads and every access point to the road network. The main purpose is to understand at the traffic zone level what the expected volumes of traffic may be on major roads. The connectivity of roads and the allowable turns that can be made on roads is represented so that in transportation models the minimum path algorithms can be performed along the course of the road network, the time it takes between given origins and destinations can be calculated, and gravity models for travel can be employed.

It is beyond the scope of this project to address all of the features of the network and model outputs but, a few figures are included in this chapter to provide a view of information related to the road network.

Traffic Volumes

Figure 133 shows a state-wide map of traffic volumes (AADT) during peak periods as predicted by the DelDOT Travel Demand Forecasting (TDF) Model. These figures for volumes are the result of a standard four step travel demand modeling process that predicts the number of trips being taken between all traffic zones and loading these trips along road network paths. Actual traffic count data is used to compare model results with actual numbers, and alterations are made to model parameters so that model output reflects known information. For the year 2025, the model shows higher volumes on most major highways including Route 202, Route 95, Route 40, Route 896 and Route 1. In New Castle County below the Chesapeake and Delaware Canal local roads begin to show greater use similar to many of the major roads in the northern part of the county. In Sussex and Kent counties Route 13, Route 113, and Route 1 show increased use.

Volume to Capacity Ratios

A much clearer picture of the effects of increased volume is obtained by viewing the predicted volume for a portion of the road network in relation to the capacity of the road. Figure 134 shows predicted volume to capacity ratios for road segments for the years 1998 and 2025. During peak periods it is expected that portion of the road network will always have volumes greater than the capacity creating some congestion and decrease in travel times. From Figure 134, it is obvious that many more roads will have volume to capacity ratios greater than 1. In particular, Figure 134 shows the potential stress on local roads that is not seen when just looking at maps of road volumes.

FIGURE 133

Traffic Volumes from DeIDOT TDF Model

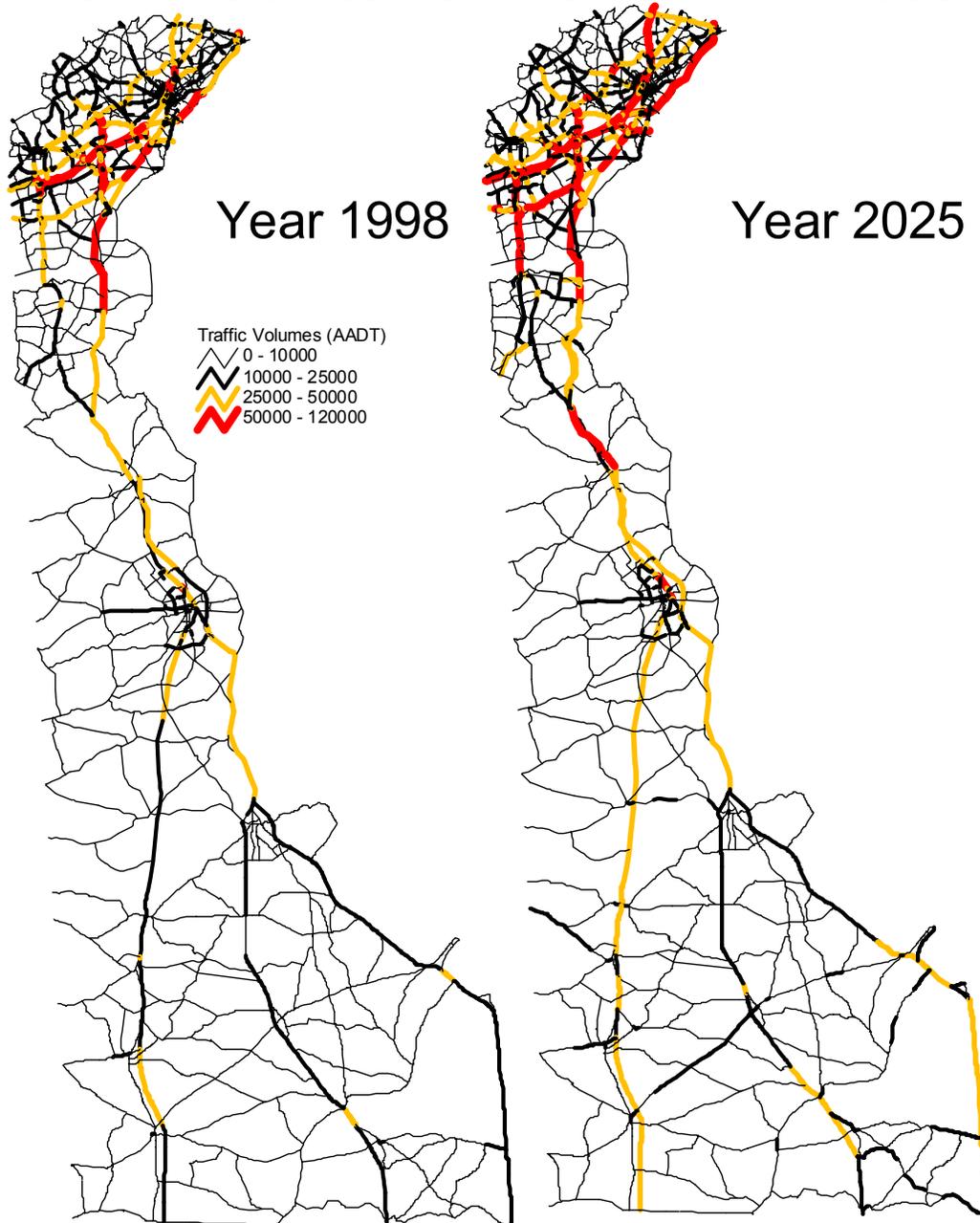
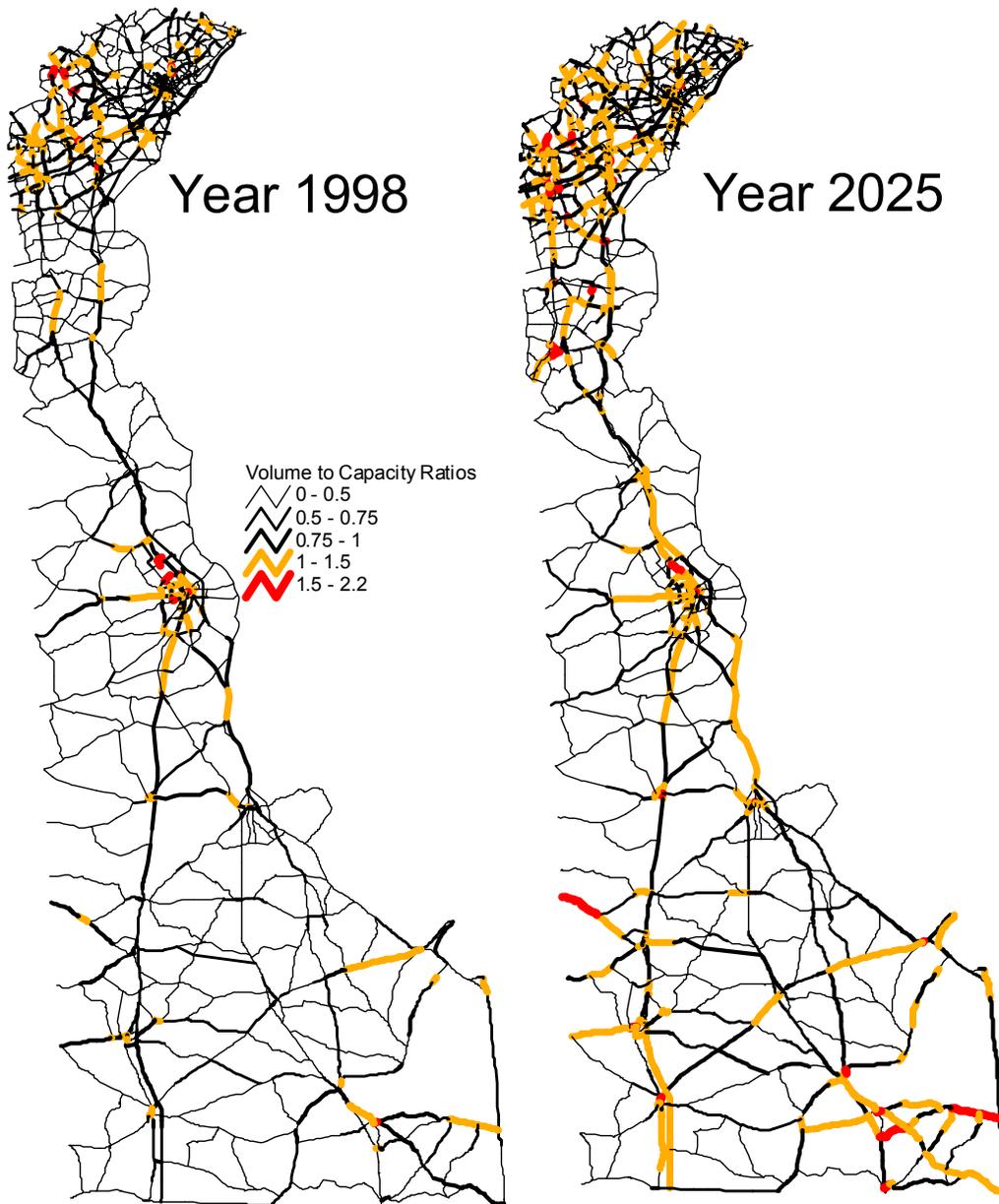


Figure 134

Volume to Capacity Ratios



Accessibility Contours

In the DelDOT Travel Demand Forecasting Model, the state is divided into hundreds of traffic zones that form the main demographic unit of analysis. The distance and the travel time measured along the road network from each zone to all other zones is calculated. This is referred

to as the distance skim table and time skim table. Distance and time between zones along with the demographic and employment makeup of each zone is used in gravity models to predict the number of trips expected between zones. The time it takes to cross a network model road segment is calculated from travel studies and is meant to include any differences in speed, average time needed to cross intersections (signals, stop signs), and other impediments. Whatever the internal features of each road segment, a travel time value is computed which is the time it takes by car in normal conditions to go from one end to the other.

So given any traffic zone, it is possible to specify the length of time to reach any other zone. The time it takes to get from point to point depends on the conditions and types of roads that connect two points. The argument has been made in many cases that the construction of a restricted highway to the suburbs, for instance, effectively makes low density suburban areas more accessible to jobs in higher density or urban areas. Zone to zone time skim tables were used to generate accessibility contours relative to various points in the state to study the effective proximity of places based on what the road network allows, and to examine time travel data within the model. For each focus area such as "the City of Newark" (made up of a few to several zones), zone to zone travel times were computed (averaged). Contouring programs available in ArcInfo geographic information system software were used to study how "close" in time various places were with respect to the focus area.

Using the data available, the effect of the highways like Interstate 95 and Route 1 is clear in the way the time contours bulge outward. This mapping method provides a way to clearly see the accessibility to various areas and is another interesting view of outputs of the travel demand forecasting model. A multi-year project by the University of Delaware Department of Civil Engineering with the Delaware Transportation Institute focuses on travel time and delay measurements, and this will improve the information on the figures that follow.

Figure 135

Brandywine Areas Time Contours

(in minutes)

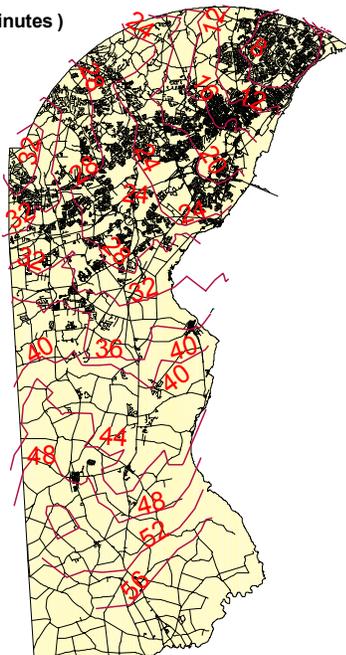


Figure 136

Wilmington Time Contours (minutes)

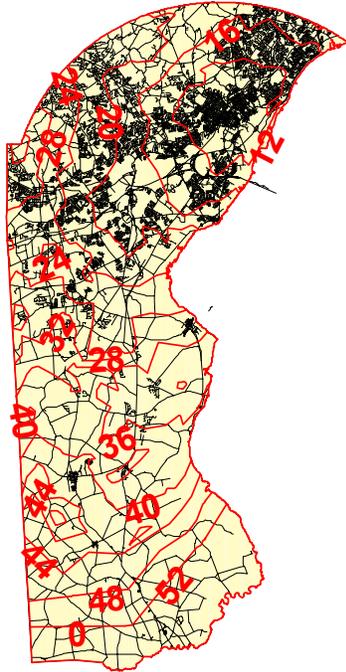


Figure 137

Middletown Time Contours (minutes)

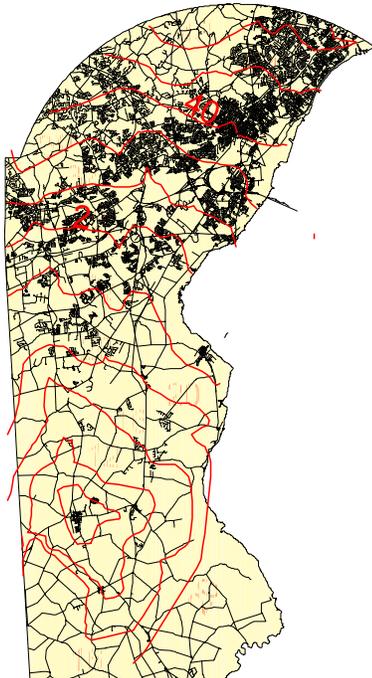


Figure 138

Dover Time Contours (minutes)

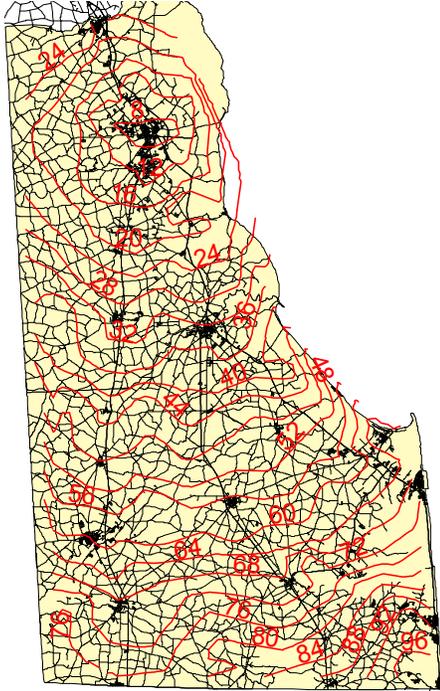
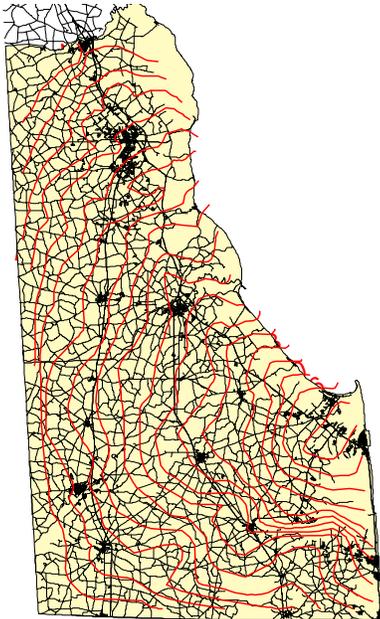


Figure 139

Lewis / Rehobeth Time Contours (minutes)



A Brief Review of the Relationship of Land Use and Transportation

Introduction

There is great concern now that our current residential and employment development patterns and densities are contributing to increased congestion and social impacts. In regard to transportation, land use is considered more in terms of the locations of populations and the destinations they go to rather than the broader environmental context. In this report land use is primarily viewed in terms of population and employment density. Before going into travel characteristics associated with various densities in the next chapter, this chapter briefly focuses on the transportation and land use relationship and various policies to address the two.

Relevance of Land Use to Transportation

Focus on Land Use to Limit Congestion and Preserve Transportation System Capacity

The focus on land use in regard to transportation is primarily directed toward limiting congestion and preserving the transportation system capacity. The greatest concern by the public is that with growing residential and commercial growth and increased travel demand (trips per person), there will be increasing congestion and a decrease in the quality of life now enjoyed. Congestion in Delaware is relatively minor at this time and is primarily a factor in the morning and evening peak commuting times along major corridors, or due to road maintenance, or seasonal demands. While it can be said that in other areas of the country things are much worse, the perception in Delaware is that each year there are increased volumes of traffic and that there is a gradual degradation of the ability of our transportation facilities to accommodate it.

Building additional roads or increasing capacity of existing facilities is an answer in some cases, but this is more difficult than it has been in the past. As in many areas in the country, Delaware is at a stage where building our way out of the problem can be very costly. Also there are many examples where increased capacity leads to increased land use development and a general response of the public to take advantage of the increased capacity by either shifting their routes, location, timing, or mode of travel until congestion levels quickly return to the levels experienced before improvements¹⁶ (sit37).

The focus then is often on land use solutions that can stop the problem before it happens by limiting development, for instance, or by promoting development patterns that least impact the transportation system.

Addressing Land Use To Minimize Costs of Developing and Maintaining The Transportation System.

Higher density development tends to reduce the costs of building infrastructure trunk lines as required for major sewer, water, highway, and utility lines. By focusing new land use development, or by directing development into existing areas with excess capacity, some savings can be realized.

¹⁶ Stuck in Traffic, pg. 37

Understanding Land Use To Predict Future Transportation Needs

A good understanding of current and projected land use and travel demand is crucial to recognizing future needs and potential problems. To this end, DelDOT maintains the DelDOT Travel Demand Forecasting Model which predicts, at a network level the volume of traffic that will be generated based on gravity models and statewide population projections that have been disaggregated to the traffic zone level. To determine local effects of new development or employment, traffic impact studies are always conducted.

Land Use To Support Alternative Modes of Travel

Decreasing the number of trips through the encouragement and support of transit, and other alternatives to the single occupancy vehicle is a goal for DelDOT and Wilmington Area Planning Council (WILMAPCO). This includes the encouragement of transit friendly development, high density development to make areas more easily served by transit, and planned communities that make pedestrian and bicycle travel more viable.

Maintaining Quality of Life or Character of a Locale

The public each year sees how agricultural and vacant land is gradually consumed by new development. They see with it the steadily increasing traffic volumes, additional access points to the system and new traffic controls, longer waits at intersections, and the inconveniences of road construction that accompany new development and projects to increase capacity and safety. There are some efforts to limit growth in certain areas, and maintain the current character of locales and the quality of life enjoyed by those living in less developed areas. In cases where natural resources are in danger from development, there are initiatives that seek to limit growth.

One example of such an effort is the Centerville (Delaware) Village Plan, conducted through a FHWA grant through the Transportation and Community and System Preservation Pilot Program. This program assists communities in solving interrelated problems involving transportation, land development, environmental protection, public safety and economic development. Centerville will work to develop a master plan to preserve the Kennett Pike named by Scenic America as one of the 12 "Last Chance Landscapes" in 1999. The area is considered one of the most scenic and historic areas in Delaware and is now seen as under threat from sprawling land development and increasing traffic. The main focus at this point is to encourage traditional village type residential and commercial development and to recommend appropriate changes to the New Castle County Unified Development Code¹⁷.

Air Quality and Land Use

The air quality impacts of transportation are most dependent on the types and characteristics of vehicles in use, vehicle miles traveled (VMT) by those vehicles, and driving habits. Considerations of land use in regard to air quality are mostly centered around development that would lead to less total VMT, either through a reduction of trip distances or a move to modes of

¹⁷ WILMAPCO TRANSPORTER, Summer 2000

travel that have less of an air quality impact (transit, bike, walk). In 1999, Delaware exceeded the Environmental Protection Agency's acceptable ozone limits for 29 days, with ground-level ozone being one of the most prevalent forms of air pollution.¹⁸

Focus on Transportation Systems to Support the Economic Growth in an Area

A transportation system that provides connections and the mobility to and from jobs supports the economic growth of an area. An overall good quality of life provided by an area that includes efficient transportation systems serves to attract new employers to the state and supports economic growth.

Land Use Policies That Affect Transportation

This section reviews the types of land use policies that most address transportation.

Promoting higher density residential development

There is a common premise that low density development leads to long distances to commute and perform daily tasks. With low density development, it is more difficult to provide public transit, and there is an expected greater cost in providing services and new infrastructure, instead of making use of existing facilities that may have excess capacity. The disadvantages to sprawl cited in WILMAPCO's MTP include an overall degradation of our quality of life, loss of traditional communities and municipalities, impediments to economic development, and environmental damage. There is a general belief that reduced sprawl will result in reduced traffic congestion, preserved open space, and improved air quality.

Concentrating jobs in large clusters

There has been a trend over the last few decades for new employment and commercial activity taking place in the suburbs. In a Coldwell Banker study of 50 metropolitan areas, it was shown that the suburbs attracted 72 percent of the new office space built and 74 percent of the office space actually absorbed.¹⁹ Zoning ordinances that prohibit high density commercial development encourage the dispersion of employment. Suburban development typically is now taking place in low-rise, work places served by their own ample free parking, or businesses located along major commercial streets.

The objective in concentrating jobs in larger clusters is to have a greater segment of the population with common destinations which makes use of transit or car pool much more feasible. Dispersed employment and low density suburban development as is seen in Delaware leads to a situation where trip destinations as well as origins are scattered, and a very low number of people wanting to take a trip to and from the same locations.

¹⁸ WILMAPCO TRANSPORTER, Summer 2000

¹⁹ Coldwell Banker Commercial Toro Wheaton Services, Coldwell Banker Commercial Office Vacancy Index of the United States, December 31, 1989, (Boston 1990)

There are some problems with concentrating jobs in large clusters though. First by having greater numbers of people converge on the same location, the potential for congestion could be worse if the transportation system does not have the capacity, transit facilities were not improved, and/or there was not a substantial change of behavior that would lead to more people using ride share or public transit. There is no evidence that concentrating jobs in large suburban clusters in itself would produce any notable changes in commuting behavior.

The existence of large job centers itself does not create conditions conducive to greater transit commuting. For transit service to be effective, the concentrations must be compact enough so that workers can walk to and from one or a few transit stops, transit service must be frequent, and transit vehicles must be able to efficiently circulate to reach points in the center. New job centers are not of the same character as traditional urban development. Typically each building is surrounded by its own parking lot and isolated from other structures. Pedestrian movement is often unattractive and inefficient. While there may be a range of employment types in these centers (office, retail, service) people still tend to drive between locations in the center.

Promoting mixed use development, planned communities, traditional towns

Increasing densities combined with the promotion of mixed use development and various types of planned communities (village concept) that include employment and commercial centers is expected to further decrease trip distances and promote the use of other travel modes (walking, bicycling) thereby lessening the impact on the transportation system. With planned mixed use development, it is expected that commercial resources within the development will meet the existing needs of the local, nearby population. To lessen the impact on the transportation system, these communities are specifically designed to be compact and to efficiently provide and encourage flows for pedestrians, bicyclists, and transit.

Promoting development conducive to transit and other modes

Promoting transit friendly development, is again an effort to lessen impacts of growing populations. Considerations of facilities that would encourage walking or biking, such as greenways, sidewalks, and bike paths are other ways considered to decrease congestion. Development that is designed to be more accessible to the transit system will hopefully reach more potential transit users. A cornerstone of the WILMAPCO Metropolitan Transportation Plan (MTP) is to shift 10% of all future trips to some other mode than driving alone. Much of this shift is to be attained by improvements to the transit system. On the land use side, the Plan's methods of reaching this goal include transit-friendly design initiatives and improved bike and pedestrian facilities, as well as increased densities and mixed use development.

Changing the jobs-housing balance

Long journeys can result from imbalances between job sites and the places people live. In theory, if more housing was located in areas where there were job surpluses, and more jobs were located in areas with housing surpluses, workers would live closer to where they worked and there would be a decrease in total travel. It is much more complicated of course because simply focusing on a balance in housing units and jobs does not take into account that the cost or styles of housing in a particular area may not be appropriate for the workers that would be employed in the jobs of that area. A greater match is necessary.

There are numerous difficulties with policies to address the jobs housing balance. First of all, tactics tend to assume people would like to live as close to their jobs as possible, but there are many factors that go into the decision of where to live. For instance, in 1990, the average household spent 16.7 % of its annual income for transportation, not counting the time spent in traveling, but spent 26% for housing. Therefore an overall benefit might result from decreasing housing costs while increasing transportation costs somewhat. This is the reason that many people have long commutes in high housing cost metropolitan areas.

A study of 15 matched pairs of both planned and unplanned communities showed no significant differences in the work and commuting behavior of their residents. In both types, more than 84% of residents chose to work at some distance from their homes with an average commuting time of 25 minutes and with an average distance around 10 miles. The distribution of workers commuting different distances were similar. In a survey of 22 San Francisco Bay area communities, a majority of workers were employed elsewhere (the average was 63%) and a majority working there lived elsewhere (the average was 62%)²⁰. The planning of these communities typically attempts to address the compatibility of jobs and housing, and these statistics suggest the difficulty of decreasing traveling distances by policies to address the jobs-housing balance or through the creation of a planned community or village.

Directed development and growth limits

There is some support for directed development and growth limits. In a 1992 WILMAPCO Public Opinion Poll, 49% of regional residents felt that development should occur in existing towns and designated growth areas. 49% felt that there should be no new development even if it improves the economy. 72% felt that farmland and open space should be preserved through tax incentives. 34% felt that growth should not be limited.²¹ Arguments around controlling growth are generally about preserving the quality of life and local character of an area, or in insuring that infrastructure will be able to support the growth now and in the future.

In theory, blocking or diverting growth will reduce the increase of traffic flows in an area. In the 1980s local growth-management policies became a widespread local government response to rising traffic congestion. There have also been programs that seek to have developers bear more of the costs for new infrastructure. Efforts to control and accommodate growth can have mixed and unexpected results. For instance, directing growth to previously developed areas could in some cases make congestion worse if extra capacity does not exist. As another example, zoning and development guidelines can often discourage or prohibit mixed use or high density development. Often county or regional level efforts or policies can be at odds with local land development goals.

Whether policies can affect future traffic congestion depends on whether traffic is generated locally or from somewhere else, whether there is an ample stock of developable land, and whether diverted growth will relocate to areas where it still generates traffic passing through the community. To the extent that today's traffic is generated by past growth already in place, growth-management policies can have little impact.

²⁰ Stuck in Traffic, pg.104

²¹ WILMAPCO 2025 MTP, pg S-22

What the data can tell us about land use and transportation

Land use and transportation concerns and the various policies to address them cannot be covered here. The focus of the research was first to understand what available information can say about the relationship of travel demand and population densities. Some of the questions covered in the next chapter are:

- How does travel demand differ with regard to different development densities?
- How do travel patterns differ between urban areas and suburban areas?
- In regard to density, do people travel more or for different purposes?
- How does the density of an area relate to use of various travel modes (transit, bike)?
- What are the travel patterns of mixed use development areas?
- What are the travel patterns of our urban areas?

In a following chapter, population projections are used to get an initial idea of where we are heading with information to help address questions such as:

- What is sprawl and its effects in Delaware?
- Where is new residential development and employment expected and what is the character of that development?
- What factors do people consider when choosing where to live?
- Are there emerging markets for transit?

The data then can help us understand the extent of the impact of current development in regard to transportation.

Delaware Trip Characteristics And The Relationship With Population Density

Introduction

This chapter discusses and presents analysis concerning what is known about travel demand and trip characteristics in Delaware for various land use densities. Figures include travel mode distributions, average trips per person, average trip times, and the distribution of trips by purpose (i.e. work, shopping). The data used comes from the DelDOT Household Survey, an ongoing survey conducted by the Center for Applied Demography and Survey Research (CADSR) at the University of Delaware for DelDOT. Five years of data (1995-1999) were studied that included information for 21,500 trips made by approximately 8700 respondents randomly sampled across the state. The survey provides travel demand data and public opinion specific to Delaware.

Many transportation and land use plans advocate increased housing densities to support the use of transit and other alternatives to the single occupancy vehicle. There is an assumption, particularly where growth occurs at higher densities and with mixed uses, that average trip distances of resident populations will be lower. There are also questions as to the differences in travel demand between those living in urban, suburban, and rural areas. Using data from the DelDOT Household Survey, potential differences in travel demand for various population densities were investigated.

Analysis with respect to respondents density class

The DelDOT Household Survey included a question that asked respondents to identify in what type of area they live, Urban, Suburban, or Rural. Maps showing the location of respondents by area are shown in Figure 142. For the most part, area type as indicated by respondents is what would be expected. Respondents in the DelDOT Survey are asked whether they made any trips in the preceding day and if so the purpose, trip time, mode, and location of origin and destination were collected for each trip made. This data is summarized for the three types of land use in the next figures.

Average trips per person were calculated by dividing the total number of trips by the total number of people in the sample. Trips per person for those who made trips on the day surveyed (have trip) is shown in Figure 140 with an average of 3.2 trips per person. There appears to be no significant difference in the number of trips per person made by each of the different land uses. The lower densities have a greater percentage of home to home chained trips, a less percentage of home to work chains, but the numbers are not that much different. There was no significant difference, in the number of trips or in the type/purpose distribution of trips. Trip times vary by a few minutes, but the greatest difference is seen in the average trip distance with those in urban areas traveling on the average almost half the distance for trips than rural areas. Rural average speeds would be estimated at almost 50% faster than Urban average speeds. The other big difference is in mode distribution. Urban trips had greater percentage of trips by walking and public bus.

**Figure 140. DelDOT Household Survey
Summary of 1995-1999 Data For Three Types of Land Use**

	<u>Urban</u>	<u>Suburban</u>	<u>Rural</u>	<u>Entire Sample</u>
Sample Size	1427	5476	1775	8717
% with trips	79.1	82.6	78.9	81.2
Trips/pers	2.5	2.6	2.4	2.6
Trips/pers (have trip)	3.2	3.2	3.1	3.2
Average Trip Distance	5.8 miles	6.7	10.6	7.3 miles
Average Trip Time	21.7 minutes	23.2	25.2	23.7minutes
Percent trips chained	29.5	31.0	32.7	30.1%
% H to H Chain	18.7	20.7	23.4	21.0
% H to W Chain	4.1	3.0	2.9	3.2
% W to H Chain	4.9	5.8	5.4	5.6
% Other Chain	1.5	1.4	1.1	1.4

**Figure 141. Summary of Trip Distribution For Three Land Use Types
(Percentage of total trips) DelDOT HH Survey 1995-1999**

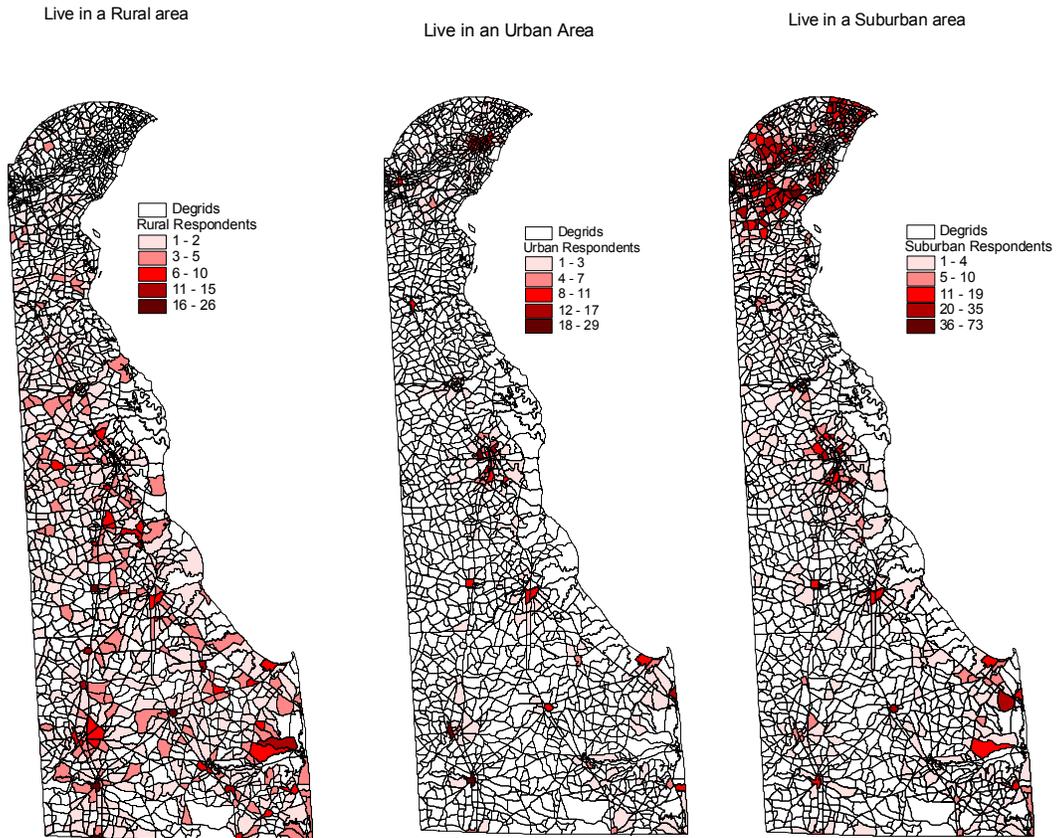
<u>Purpose</u>	<u>Urban</u>	<u>Suburban</u>	<u>Rural</u>	<u>All</u>
School/Daycare	6.6	5.5	4.3	5.5
Shopping	19.9	20.7	23.9	21.2
Work	36.3	36.4	35.8	36.3
Other	37.3	37.3	36.0	37.0

**Figure 142. Mode Distribution (%) By Land Use
DelDOT HH Survey 1995-1999**

<u>Mode</u>	<u>Urban</u>	<u>Suburban</u>	<u>Rural</u>	<u>All</u>
Driver	79.4	88.2	88.3	86.7
Passenger	11.0	9.1	10.3	9.6
Public Bus	3.1	0.8	0.2	1.0
Walked	4.9	0.9	0.2	1.4
Bicycle	0	0.2	0.1	0.1

Figure 143

**Where Respondents to DelDOT
Household Survey Said They Lived
1995 to 1999**



Since there is some question as to how consistently respondents specified their area and because of a need to better specify where respondents lived in terms of population density, data was reanalyzed in terms of persons per square mile. The population density of the modified grid (a common demographic unit used in Delaware for data) of where respondents lived was used instead to regroup the information. The six ranges of population density used are presented in a thematic map in Figure 144 and can be thought of in terms of whether they are rural, suburban, or urban as shown in Figure 145. The very low densities now in Kent and Sussex counties are very clear looking at Figure 144.

**Figure 144. Year 2000 Population Density (population per square mile)
By Delaware Modified Grid, Six Ranges Used in Further Analysis.**

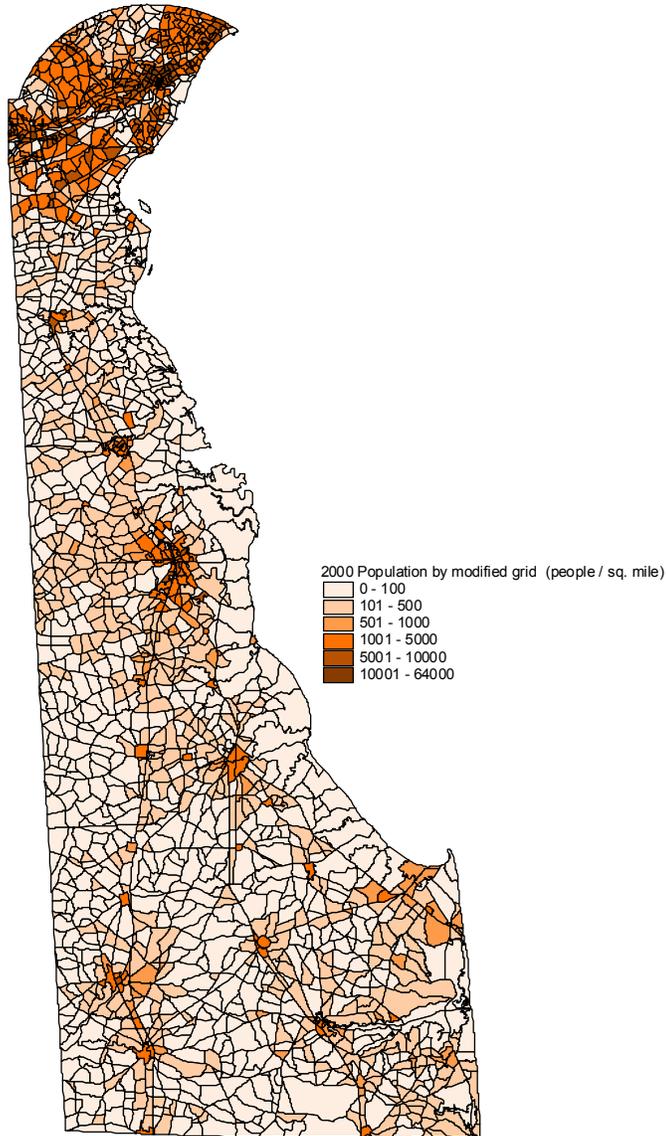


Figure 145 Descriptions Associated with Population Per Square Mile

Persons per square mile

Land use category

0 to 100

Rural

101 to 500

Very low density suburban

501 to 1000

Low density suburban

1001 to 5000

Medium density suburban

5001 to 10,000

High density suburban

10,001 to 64,000

Urban

Figures below provide a breakdown by county with respect to these density ranges. Employment was also factored in when assigning a density class. The higher figure of person per square mile or employment per square mile was used. The areas classified as urban are mostly comprised of the City of Wilmington and the City of Newark. Most higher density suburban areas are found in New Castle County and examples of areas that would be classified as High Density Suburban using these density ranges would be Elsmere and Claymont. Medium Density Suburban areas would be areas like Pike Creek, in New Castle County and the type of suburban development in northeast areas of New Castle County (Brandywine Hundred, North Wilmington). In Kent and Sussex counties, Medium and High Suburban density areas are mostly found in small pockets within or very near incorporated areas. The City of Dover in Kent County is the focus of the largest area of higher density development (mostly Medium Density Suburban) outside of New Castle County. Figures 146 thru 148 below show distributions of these classifications by county. Distributions shown in Figure 147 indicate that in New Castle County about 75% of the population lives in medium to lower density suburban areas and in the other counties its close to 90% or more. Employment is also spread in low density areas.

Figure 146. Population Living in Various Densities by County in the Year 2000

	<u>Kent</u>	<u>New Castle</u>	<u>Sussex</u>
Urban	1700	47,259	0
High Sub	12,335	69,954	1,651
Med Sub	49,043	185,828	24,995
Low Sub	11,074	84,273	25,663
Very Low Sub	38,613	40,767	56,421
Rural	13,394	50,184	34,284
All	126,159	478,265	143,014

Figure 147. Percentage Population in Various Densities by County in the Year 2000

	<u>Kent</u>	<u>New Castle</u>	<u>Sussex</u>
Urban	1.3	9.9	0
High Sub	9.8	14.6	1.1
Med Sub	38.9	38.8	17.7
Low Sub	8.8	17.6	17.9
Very Low Sub	30.6	8.5	39.4
Rural	10.6	10.5	24.0

Figure 148. Employment in Various Densities by County in the Year 2000

	<u>Kent</u>	<u>New Castle</u>	<u>Sussex</u>
Urban	3,408 (6.2%)	20,816 (7.7%)	0
High Sub	2,020 (3.7)	44,977 (16.6)	1,060 (1.7%)
Med Sub	28,483 (52.3)	82,024 (30.3)	16,617 (26.6)
Low Sub	2,438 (4.5)	60,471 (22.4)	15,722 (25.2)
Very Low Sub	11,740 (21.6)	31,708 (11.7)	20,280 (32.5)
Rural	6,349 (11.7)	30,378 (11.2)	8,722 (14.0)
All	54,438	270,374	62,401

Figures 149 thru 151 below present analysis by these density classifications. As before, there is no significant difference in average trips per person. In terms of trip distribution, there is a very slight indication that higher density areas have a higher percentage of work trips and school/daycare trips. As densities increase, average trip times are lower. As densities fall below that defined as Urban, the percentage of trips by public bus and walking falls quickly. Trip distance was estimated for the DelDOT Household Survey data for trips that originated and

ended in Delaware (internal Delaware trips). These distance estimates are presented in Figure 152 and show a very clear picture of how average trip distances vary greatly with increased population density. Average speed was calculated from the average trip time and trip distance estimate. While these speeds seem rather low, remember that this is an average speed over the trip that would include the effects of stop signs, traffic signals, getting the car started, parking, or other impediments. The higher speeds in low density areas are clearly evident.

Figure 149. Statistics for 6 Population Densities,
Source: DelDOT Household Survey 1995-1999

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>	<u>Total</u>
Sample (made a trip,mt)	498	905	537	3154	1303	471	7340
Sample % of trips	7.9	12.5	8.2	45.7	18.6	7.0	
Sample Trips	1759	2789	1826	10237	4167	1570	22387
Trips per Person (mt)	3.5	3.1	3.4	3.2	3.2	3.3	
% Trips Work	36.3	33.6	32.3	37.3	38.3	39.0	
% Trips Shop	18.0	24.3	22.7	20.8	19.0	18.0	
% Trips School/Daycar	8.1	5.4	5.9	5.1	6.3	8.1	
% Trips Other	37.5	36.6	39.0	36.9	36.3	35.0	

Figure 150. Average Trip Times for Various Purposes and Population Densities
In Delaware (in minutes, weekday travel)
Source: DelDOT Household Survey 1995 - 1999

Purpose	<u>Rural</u>	<u>Very Low Suburb.</u>	<u>Low Suburb.</u>	<u>Med Suburb.</u>	<u>High Density Suburb.</u>	<u>Urban</u>	<u>All Densities</u>
All Trips	29.3	24.5	23.5	22.8	22.4	20.9	23.4
Work Trips	32.1	29.0	26.1	27.3	26.8	25.1	27.5
Shop Trips	19.1	18.8	18.2	15.8	14.9	14.8	16.5
School Trips	26.4	21.0	20.9	21.1	22.6	17.7	21.3
Other Trips	33.0	24.4	24.8	22.5	21.3	20.4	23.4

Figure 151. Mode distribution (%) by Population Density
Source: DelDOT Household Survey 5 Year Sample

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>	<u>All densities</u>
Driver	88.9	87.2	89.0	88.1	85.7	75.0	86.7
Passenger	9.3	11.3	10.2	9.4	8.8	10.2	9.7
Public Bus	0.6	0.2	0.2	0.7	1.7	4.6	1.0
Walked	0.4	0.3	0.2	0.7	2.7	7.2	1.4
School Bus	0.2	0.6	0.3	0.6	0.7	1.6	0.6
Bike	0.1	0.2	0.1	0	0.2	0.8	0.1

Figure 152. Internal Delaware Distance and Speed Estimates by Land Use Densities.
Source: 1995 - 1999 DelDOT Household Survey and GIS Road Network Model
Distance in Miles, Speed in Miles per Hour.

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>	<u>All densities</u>
Avg Trip Distance	11.5	10.3	8.4	6.8	5.7	4.2	7.3
Avg Work Distance	13.2	12.7	9.5	8.2	6.6	5.7	8.7
Avg Shop Distance	8.7	8.2	6.2	4.8	4.1	2.6	5.5
Avg School Distance	12.5	8.5	8.5	6.9	4.1	2.7	6.5
Avg Other Distance	11.4	9.6	8.4	6.6	6.0	3.9	7.2
Avg Trip Speed	23.5	25.2	21.4	17.9	15.3	12.1	18.7
Avg Work Speed	24.7	26.3	21.8	18.0	14.8	13.6	19.0
Avg Shop Speed	27.3	26.2	20.4	18.2	16.5	10.5	20.0
Avg School Speed	28.4	24.3	24.4	19.6	10.9	9.2	18.3
Avg Other Speed	20.7	23.6	20.3	17.6	16.9	11.5	18.5

Figures 153 and 154 show similar figures by county.

Figure 153. Travel Stats, Density of Home Zone by County
Source: DelDOT Household Survey 1995-1999

New Castle

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>
Sample (made a trip)	195	225	216	2344	1185	382
Sample Trips	575	712	737	7517	3763	1232
Trips per Person (mt)	2.9	3.2	3.4	3.2	3.2	3.2
Avg Trip Time	27.8	24.7	25.0	23.3	22.1	19.9

Kent

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>
Sample (made a trip)	172	296	76	456	60	7
Sample Trips	551	843	250	1394	203	21
Trips per Person (mt)	3.2	2.8	3.3	3.0	3.8	3.0
Avg Trip Time	22.3	23.1	21.6	22.4	24.2	19.9

Sussex

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>
Sample (made a trip)	227	440	265	314	11	no data
Sample Trips	769	1358	873	1047	35	no data
Trips per Person (mt)	3.4	3.1	3.3	3.3	3.2	
Avg Trip Time	23.2	24.8	22.8	21.5	no data	

Figure 154. Internal Delaware Trips, Time, Distance, Speed by County by Density
Source: DelDOT Household Survey 1995-1999

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>	<u>Total</u>
NC Avg Trip Time	24.3	21.0	20.8	20.0	19.5	17.0	20.0
KC Avg Trip Time	20.7	22.0	19.3	20.1	19.5	15.8	20.6
SC Avg Trip Time	20.4	22.2	20.4	19.9	15.9	no data	20.9NC
NC Avg Trip Distance	11.2	9.2	7.4	6.2	5.6	3.8	6.3
KC Avg Trip Distance	10.0	10.5	9.4	7.9	7.2	2.5	9.0
SC Avg Trip Distance	10.4	10.6	9.3	8.5	4.2	no data	9.6
NC Avg Trip Speed	27.7	26.3	21.3	18.6	17.2	13.4	18.9
KC Avg Trip Speed	29.0	28.6	29.2	23.6	22.2	9.5	26.2
SC Avg Trip Speed	30.6	28.6	27.4	25.6	15.8	no data	27.6

Figures so far have been presented in terms of the land use density of the home zone of the survey respondents. To understand the types of areas that people were traveling to, destination areas were also classified according to density. Figure 155 below shows the percentage of destinations in the six density categories. The last column shows the statewide distribution of these areas. Figure 155 was created by first filtering out trip records that represent a return to home, so that the emphasis would be on where people are traveling outside of the home. Destinations for all trips to urban areas are more than twice the statewide residential distribution but for the most part destinations are very similar to the statewide distribution. Another way of saying this is that about two thirds of all trips are from and to a medium suburban or lower density area. All new development is mostly of medium suburban density or less. These are some of the reasons that transit service and increasing transit share is so difficult. Not only are the origins spread in low density areas, but the destinations are spread as well. Figure 156 shows the percentage of work trips to various densities, and while work places are much more in the higher density areas, particularly urban areas, the distribution is still very similar to the statewide residential distribution.

Figure 155. Percentage of Destinations in the Six Density Categories, All Trips, Compared to the Statewide Distribution of Densities.
Source: DelDOT Household Survey 1995-1999

	<u>% of Destinations</u>	<u>Statewide Residential Density Mix</u>
Urban	14.9	5.8
High Suburban	14.2	18.0
Medium Suburban	44.6	45.1
Low Suburban	6.0	8.4
Very Low Suburban	8.0	13.3
Rural	3.7	8.6

Figure 156. Percentage of Destinations in the Six Density Categories, WorkTrips, Compared to the Statewide Distribution of Densities.
Source: DelDOT Household Survey 1995-1999

	<u>% of Work Destinations</u>	<u>Statewide Density Mix</u>
Urban	17.8	5.8
High Suburban	15.0	18.0
Medium Suburban	38.0	45.1
Low Suburban	5.9	8.4
Very Low Suburban	8.6	13.3
Rural	3.4	8.6

There has been increased support for higher density development, clustered development, mixed use development, and planned communities. There is some question as to the effect of the scale of the development and its proximity to similarly high density areas. One might think, for instance, that the residents in an isolated subdivision of high density in an otherwise low density suburban area would not have travel characteristics much different than their neighbors. There is some difficulty in investigating what travel patterns might result from a suburban pocket of high density or mixed use mostly because very few areas would qualify as examples and data is less available for those areas.

Average trip times for the Middletown area, the Smyrna area, and for high density suburban and Urban areas in Kent County (includes Dover) were tabulated and shown below in Figure 157. The average trip times for Middletown and Smyrna areas were more in line with figures for very low density suburban areas as presented previously, particularly the figures for the work trip. Middletown and Smyrna areas both had unusual numbers of long duration trips. The Kent County high density areas mostly involve locations in Dover and travel in general in Kent County is focused on Dover. Average trip times are more in line with previous numbers for medium density and high density suburban areas. While there was not much data, the numbers suggest that areas of high density development amid otherwise low density suburban development would not be expected to have similar travel characteristics as high density development in larger areas of high density as in northern New Castle County. In all three areas the percent of walking trips was a little more or less than one percent.

Figure 157. Average Trip Times For Higher Density Suburban Areas in Delaware

	Smyrna Area	Middletown Area	Kent High Density Areas
Sample Trips	109	95	255
Avg Work Time	43.7 (minutes)	34.0	24.9
Avg Shop Time	18.6	25.5	17.5
Avg Other Time	21.4	28.6	29.1

Demographics and Trends

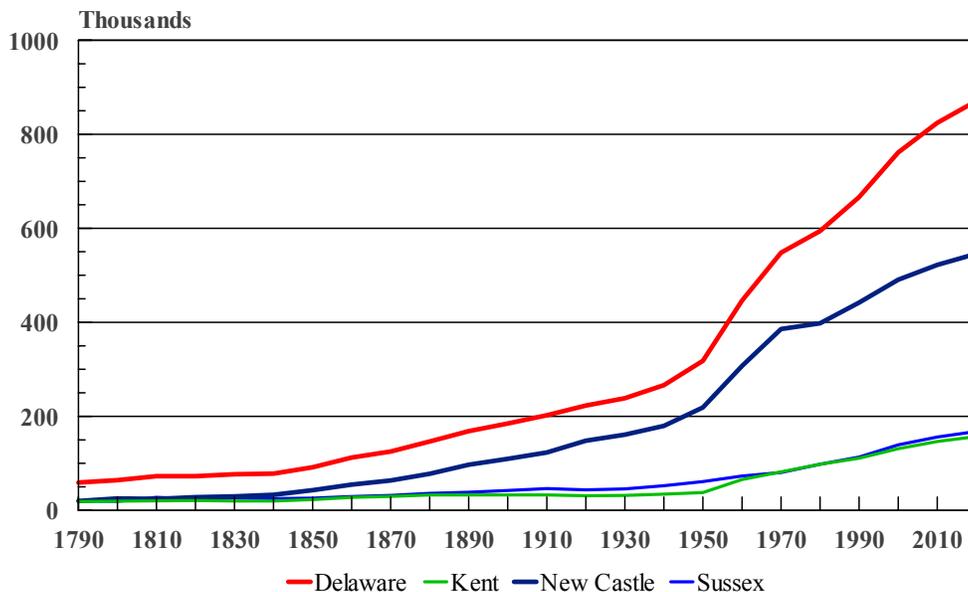
Introduction

Examining travel demand necessarily warrants an understanding of the demographics and makeup of an area, and future trends. This section includes figures for population, housing, age structure, employment, income, and projections for an understanding of Delaware's specific situation. Some of the information presented is a summary of information previously compiled by the Center for Applied Demography and Survey Research at the University of Delaware. In particular, a detailed report is available (www.cadsr.udel.edu/transportation/publications.htm) entitled "Demographic and Commuting Trends in Delaware" that discusses demographic trends that will impact the demand for travel. Some of the figures and observations of that report are included here. Also included are tables showing population and employment projections and a brief discussion of how people choose to locate.

Population

The pattern of population growth from 1790 to 2020 for the state and each county is displayed in Figure 158 below. The primary component of growth is net migration to the areas suggesting that Delaware's population growth is heavily influenced by local labor market conditions. Delaware's unemployment rate is consistently below that of the nation and the region, and has continued to generate jobs sufficient to attract net in-migration. In Sussex County, where net in-migration accounts for about 80% of population growth much of the growth can be attributed to retirees moving into the area. Those retirees then generate new economic activity and employment.

Figure 158
Population of Delaware and Counties



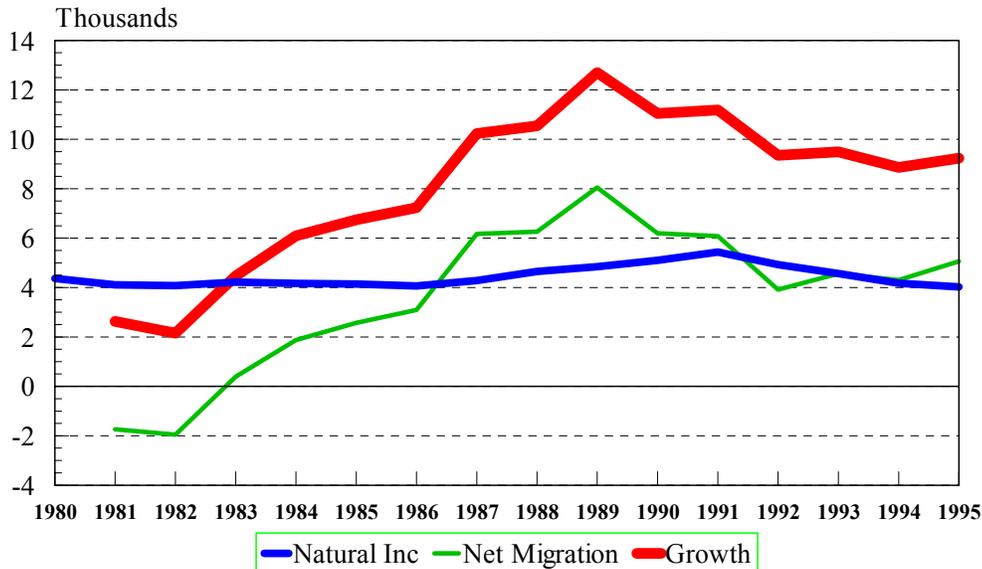
— Delaware — Kent — New Castle — Sussex
Source: Center for Applied Demography and Survey Research, University of Delaware
US Bureau of Census Decennial Census 1790-1990
Delaware Population Consortium, January 1996

Figure 159
State of Delaware and
County Populations 1790-2000

Year	State	Growth Rate	Kent	New Castle	Sussex
1790	59,096	----	18,920	19,688	20,488
1800	64,273	0.8%	19,554	25,361	19,358
1810	72,674	1.2%	20,495	24,429	27,750
1820	72,749	0.0%	20,793	27,899	24,057
1830	76,748	0.0%	19,913	29,720	27,115
1840	78,085	0.2%	19,872	33,120	25,093
1850	91,532	1.6%	22,816	42,780	25,936
1860	112,216	2.0%	27,804	54,797	29,615
1870	125,015	1.1%	29,804	63,515	31,696
1880	146,608	1.6%	32,874	77,716	36,018
1890	168,493	1.4%	32,664	97,182	38,647
1900	184,735	0.9%	32,762	109,697	42,276
1910	202,322	0.9%	32,721	123,188	46,413
1920	223,003	1.0%	31,023	148,239	43,741
1930	238,380	0.7%	31,841	161,032	45,507
1940	266,505	1.1%	34,441	179,562	52,502
1950	318,085	1.8%	37,870	218,879	61,336
1960	446,292	3.4%	65,651	307,446	73,195
1970	548,104	2.1%	81,892	385,856	80,356
1980	594,338	0.8%	98,219	398,115	98,004
1990	666,168	1.1%	110,993	441,946	113,229
2000	761,491	1.3%	131,344	490,665	139,482

Source: Center for Applied Demography and Survey Research, University of Delaware
 U.S. Bureau of Census
 Delaware Population Consortium, January 1996

Figure 160
Sources of Population Growth in Delaware



Net migration is the most dynamic force in creating population growth in Delaware. It can significantly alter the age structure of the population, and increase or decrease the supply of labor. Such factors will affect the demands for transportation infrastructure in the state. The principal features of migration in New Castle County are the strong migration in the 20-44 age groups and the net out migration in the 55-74 age groups. New Castle is the only county that shows net out-migration of older residents. In Sussex there is a net out-migration in the 15-24 age group, and a strong in migration in the 25-44 age groups. A substantial part of total net-migration in Sussex County falls into the older age groups.

Figure 161
Migration in New Castle County 1985-1990 by Age Group

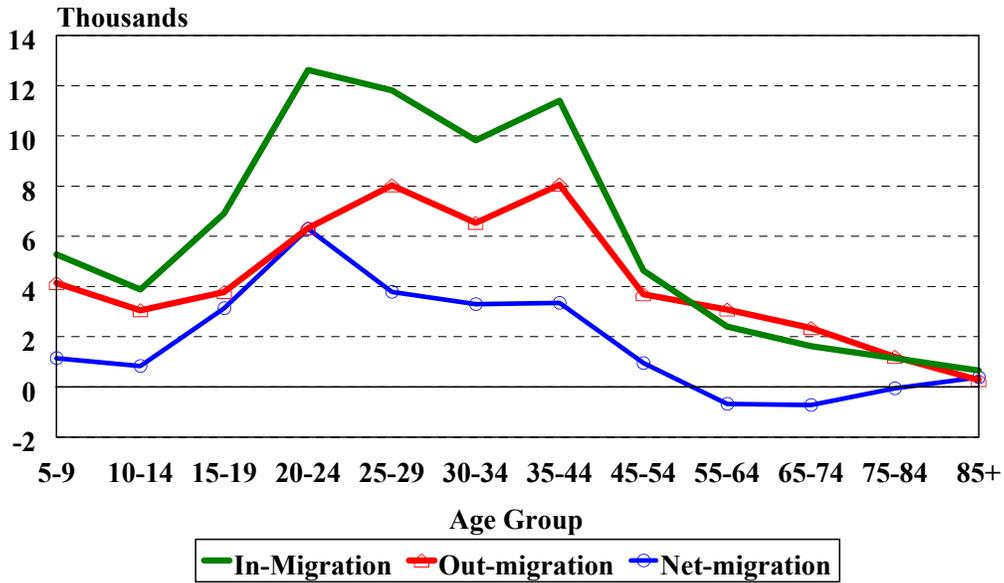
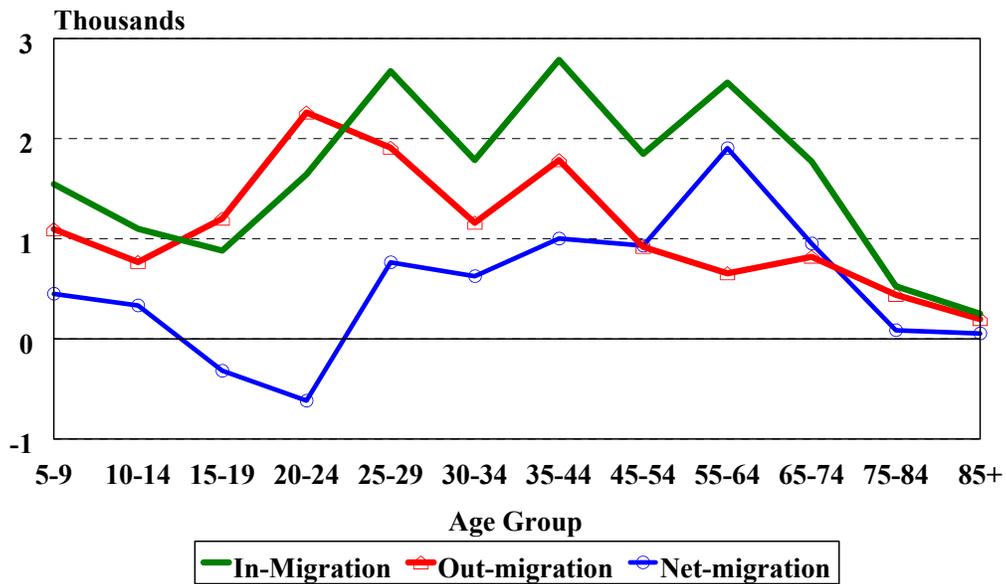


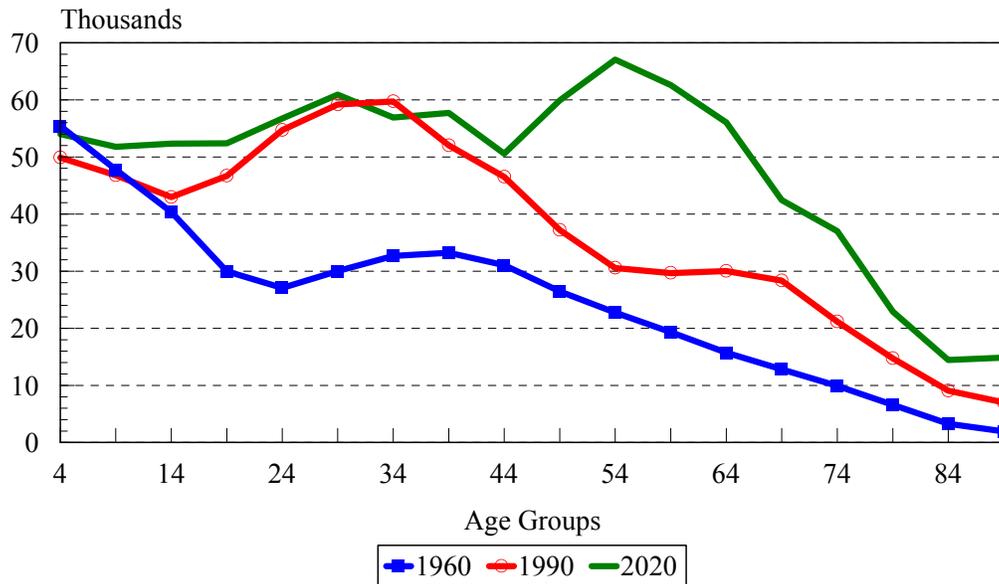
Figure 162
Migration in Sussex County 1985-1990 by Age Group



Age Structure

The age structure of a population has large impacts on travel demand and the demand for the types of services in general. Figure 163 presents the age structure in Delaware for 1960, 1990 and 2020. In 1990 the largest group is about 34 years old. In 2020 the largest group is centered at 55 years of age. Increases in the older age groups over time in Delaware are attributable to the "baby boomers" but the numbers in the older age group increase over the next 20 years largely because of the positive net in-migration.

Figure 163
Age Structure in Delaware
1960-2020

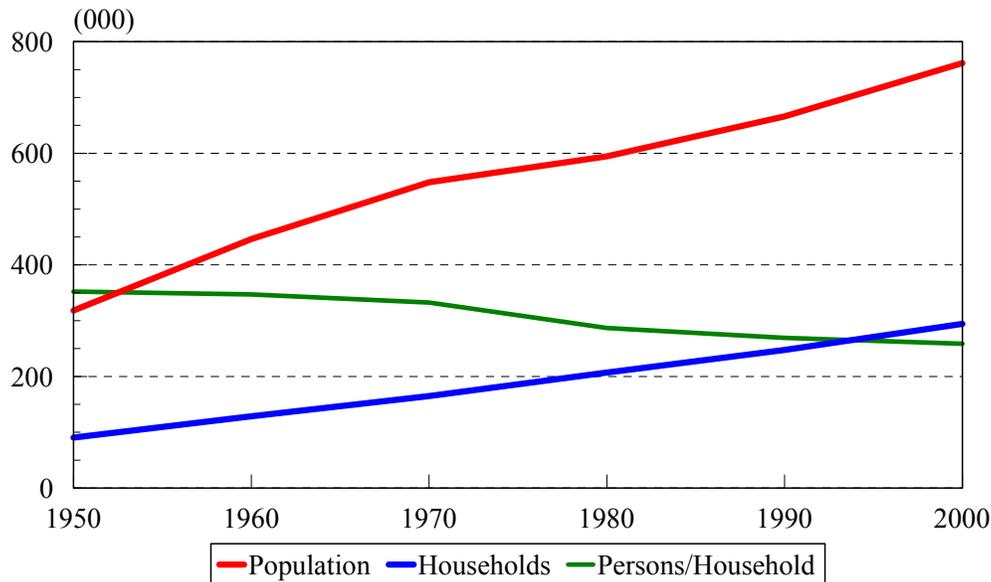


Source: Center for Applied Demography and Survey Research, University of Delaware
U.S. Bureau of Census

Household Composition

Figure 164 below illustrates several significant trends in household formation during the last 50 years. The annual growth rate in households was 2.4% while the annual rate of population growth was 1.8%. The net effect of these differential growth rates is an average household size that has declined from 3.4 persons per household, in 1950, to 2.6 persons per household expected in the year 2000. There are a few reasons for the drop in household size. The number of children that women expect to have over their lifetimes has fallen significantly. The age of first marriage and the proportion of women who never marry have increased. The number of single parent households has increased, brought about by the increase in the rate of divorce and by the increased growth rate in households headed by women who have never married and have children. Another reason is longevity. As longevity increases, the period of time when the household size is one or two (no children present) also expands.

Figure 164
Population and Households in Delaware
1950-2000



Source: Center for Applied Demography and Survey Research, University of Delaware
 U.S. Bureau of Census

Housing Stock

Figure 165 presents the distribution of housing stock in Delaware over the last 20 years. The largest majority of people still choose the single family home. Mobile homes increased in numbers and share over the last 20 years and today serve nearly 10% of the households in the State. Mobile homes are a solution to affordable housing and one chosen extensively in Kent and Sussex counties. In Sussex, where overall growth is heavily influenced by in-migration, and where many of those in-migrants move into mobile homes that were previously used for seasonal housing, growth in occupied, year round mobile homes increased at a rate 50% faster than that observed in the state overall.

There is a continuation of trends toward increased development in all three counties. Large tracts of undeveloped land are available.

Figure 165. Distribution of Land Uses (%), State of Delaware, 1997
 Source: Interpretation of 1992 Aerial Photography, as Calculated by
 Department of Food and Resource Economics, University of Delaware

	<u>State</u>	<u>KC</u>	<u>NC</u>	<u>SC</u>
Developed	16.7	11.7	37.0	10.8
Agriculture/Forest	58.14	59.2	44.7	63.5
Water	3.7	2.4	2.7	4.9
Wetlands	18.9	25.5	11.6	18.1

Figure 166
Occupied Year Round Housing Stock
in Delaware 1970-1990

State of Delaware

Structure	1990 Units	1990 Percent	1980 Units	1980 Percent	1970 Units	1970 Percent
Single Family	170,011	69.8	149,314	72.1	125,929	76.4
Multi-Family	50,554	20.8	43,950	21.2	31,156	18.9
Mobile Homes	22,906	9.4	13,817	6.7	7,719	4.7
Total	243,471	100.0	207,081	100.0	164,804	100.0

Kent County

Structure	1990 Units	1990 Percent	1980 Units	1980 Percent	1970 Units	1970 Percent
Single Family	25,582	64.5	22,952	70.1	16,393	70.1
Multi-Family	5,541	14.0	4,890	14.9	3,874	16.6
Mobile Homes	8,532	21.5	4,895	15.0	3,101	13.3
Total	39,655	100.0	32,737	100.0	23,368	100.0

New Castle County

Structure	1990 Units	1990 Percent	1980 Units	1980 Percent	1970 Units	1970 Percent
Single Family	118,847	72.4	99,435	71.6	88,075	76.1
Multi-Family	39,472	24.0	36,436	26.2	25,468	22.0
Mobile Homes	5,842	3.6	3,073	2.2	2,231	1.9
Total	164,161	100.0	138,944	100.0	115,774	100.0

Sussex County

Structure	1990 Units	1990 Percent	1980 Units	1980 Percent	1970 Units	1970 Percent
Single Family	29,673	67.9	26,927	76.1	21,461	83.6
Multi-Family	3,045	7.0	2,624	7.4	1,814	7.1
Mobile Homes	10,963	25.1	5,849	16.5	2,387	9.3
Total	43,681	100.0	35,400	100.0	25,662	100.0

Source: Center for Applied Demography and Survey Research, University of Delaware
U.S. Bureau of Census

How do people choose to locate?

Insight into how people decide to locate is important to understanding how successful land use measures may be. Those in transportation fields often look at development with a focus on the benefits of living close to work and other destinations. Where people choose to live is affected by many factors, though, that include quality of life, quality of schools, proximity to family and friends, jobs of other family members, quality of life of neighborhoods, age, ethnicity, and socioeconomic features of locations. In a 1980 national survey that sampled workers who lived more than 5 miles from work were asked to state the most important reason why they did not live close to their jobs. About 38% cited good schools, 24% said they liked their house, 17% said they liked their neighborhoods, and 10% said their own jobs were too far from the jobs of other family members.²²

"A goal of most Americans is to own single-family detached homes with private open space next to each dwelling²³. Low density to rural areas are most desirable in Delaware as shown in the results of a Delaware survey that asked "Where Would You Most Like to Live". Over 70% wished to live in a suburban development or lower density area²⁴.

**Figure 167. Where Would You Most Like To Live (% respondents)
By Survey Year**

	<u>City</u>	<u>Small Town</u>	<u>Suburban Dev.</u>	<u>Rural Dev.</u>	<u>Home in Country</u>
1995	3.4	17.2	20.9	10.8	47.2
1996	6.1	20.1	27.4	9.1	37.4
1997	6.0	20.4	25.0	11	37.6

Lower housing costs, tax incentives, low fuel prices, and availability of expressways encourage suburban development as well. In describing how some areas show an imbalance in local jobs and housing, Anthony Downs in "Stuck In Traffic" makes the point that travel has been less costly to the average household than land or housing. In 1990, the average household spent 16.7% of its annual income for transportation, not counting the cost of time spent traveling, but it spent 26% for housing.²⁵ There is often a benefit to moving into the suburbs and rural areas since housing costs can be greatly reduced by increasing transportation costs somewhat. This is of course why many households make very long commuting trips in high-housing cost metropolitan areas.²⁶

Location of new work places in the suburbs has also been a trend. In a 1989 Coldwell Banker study of office space in 50 metropolitan areas it was shown that the suburbs attracted 72 percent of the new office space built and 74 percent of the office space actually absorbed²⁷. Employment

²² William M. Rohe and others, *Travel to Work Patterns: A Preliminary Analysis of Selected Data From The Annual Housing Survey Travel-to-Work File*, University of North Carolina, Department of City and Regional Planning, 1980, p.145

²³ *Stuck in Traffic* pg 17

²⁴ Ratledge, Edward C., *Delawareans' Attitudes Toward Economic Growth: Survey Results*, Center for Applied Demography and Survey Research, University of Delaware

²⁵ Bureau of the Census, *Statistical Abstract of the United States: 1990* pp442-43

²⁶ *Stuck in Traffic* pg101

²⁷ Coldwell Banker Commercial Toro Wheaton Services, *Coldwell Banker Commercial Office Vacancy Index of the United States*, December 31, 1989, Boston 1990.

projections for Delaware clearly show expectations of continued suburban employment development.

Life style preferences and economic opportunity together have driven land use patterns and they are both in the direction of continued low density development. Economic incentives resulting from higher fuel costs, congestion pricing, higher taxes, higher land values in low density areas, suburban service user fees, or factors that raise the cost of transportation, would be the most successful at redirecting development but that is the area of least possible support. People are very accustomed to low transportation costs, an effective transportation network, and a significant public subsidy to support the life style they desire.

Population Projection and Employment Projections

As seen below in Figure 168 that tabulates current DelDOT population figures by the various land use densities, over 80% of the state population is in Medium Suburban densities or less. Kent County has over a third and Sussex County has over half of the population in very low density suburban and rural areas. Employment is spread in a similar way with slightly larger concentrations in higher density areas.

Figure 168. Population and Employment Figures from Year 2000 DelDOT Population Projections By density.

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>
DE Pop 2000	103513	134583	92079	280982	85661	50615
DE Pop 2000 Dist %	13.7%	17.8	12.2	37.2	11.3	6.7
KC Pop 2000 Dist %	10.3%	29.4	9.2	38.6	10.5	2.0
NC Pop 2000 Dist %	11.7%	8.8	11.8	41.5	14.5	9.9
SC Pop 2000 Dist %	23.3	38.1	16.3	21.2	1.1	0
DE Emp 2000	19396	52313	50676	171319	30857	62652
DE Emp 2000 Dist %	5.0%	13.4	12.9	43.7	7.9	16.0
KC Emp 2000 Dist %	2.9	11.5	5.5	55.1	8.9	16.3
NC Emp 2000 Dist %	3.8	10.2	14.0	41.8	9.1	19.6
SC Emp 2000 Dist %	11.9	28.8	15.0	42.6	1.7	0

Future growth is expected to occur in the medium suburban densities or less throughout the State. Figure 169 shows the expected changes between the year 2000 and 2020 by density and by Census County Division (CCD). Those areas showing the most rapid growth are those areas that are primarily residential areas with relatively less employment and mixed use, that are developing at medium suburban densities or less. Additional urban or high density suburban areas are not expected and those existing areas are now showing a drop in population largely due to a continuing decline in population per household that is expected to continue over the next 20 years. Areas that are now classified as high density suburban or urban have very low quantities of developable land, higher land prices, and/or low amounts of available housing stock.

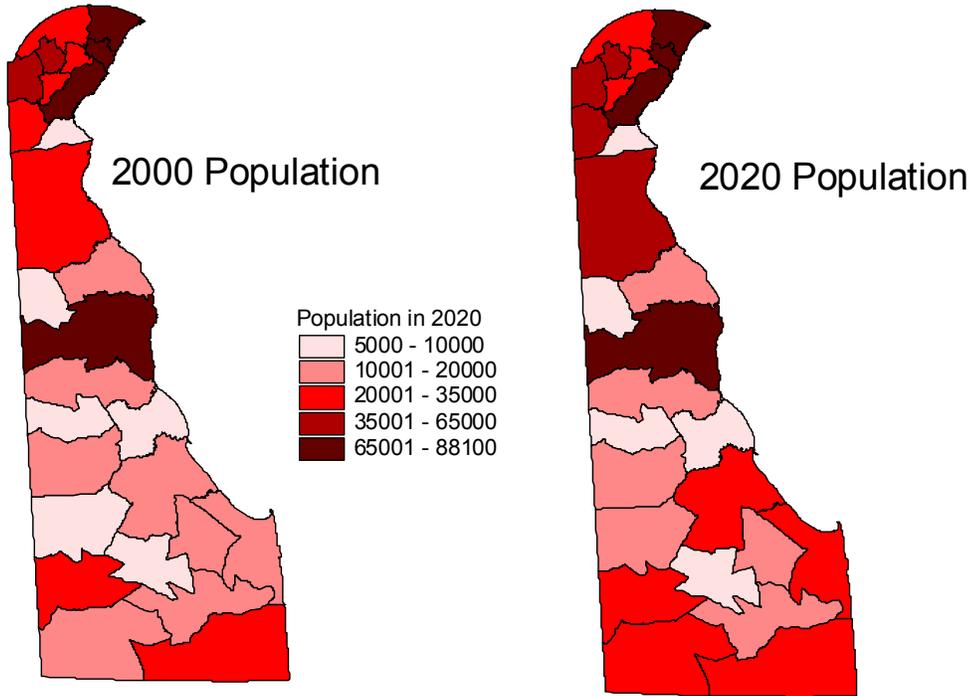
Figure 169. Population estimates for the Year 2020 by Density

	<u>Rural</u>	<u>V.Low</u>	<u>Low</u>	<u>Medium</u>	<u>H.Sub</u>	<u>Urban</u>
DE Pop 2020	144374	170224	101418	284780	82593	52767
DE Dif. 2000 to 2020	40,856	35,641	9,339	3,798	-3068	2152
KC Dif. 2000 to 2020	2030	6743	2437	4871	751	234
NC Dif 2000 to 2020	21,394	16,306	3518	-1405	-3825	1918
SC Dif 2000 to 2020	17432	12592	3384	332	6	-

*Dif = Difference, the change in population

Figure 170 below is a thematic map of population showing that growth is expected in those areas that are currently developing at the lowest densities. A tabulation of population projections by Census County Division is provided in Figure 172.

Figure 170. Maps of Year 2000 DeIDOT Population Projections



Residential and employment growth continue to develop widely across the State. Destinations for all trips are spread widely as well as shown in Figure 171 below.

Figure 171. Distribution of Destinations
Source: DeIDOT Household Survey 1995-1999

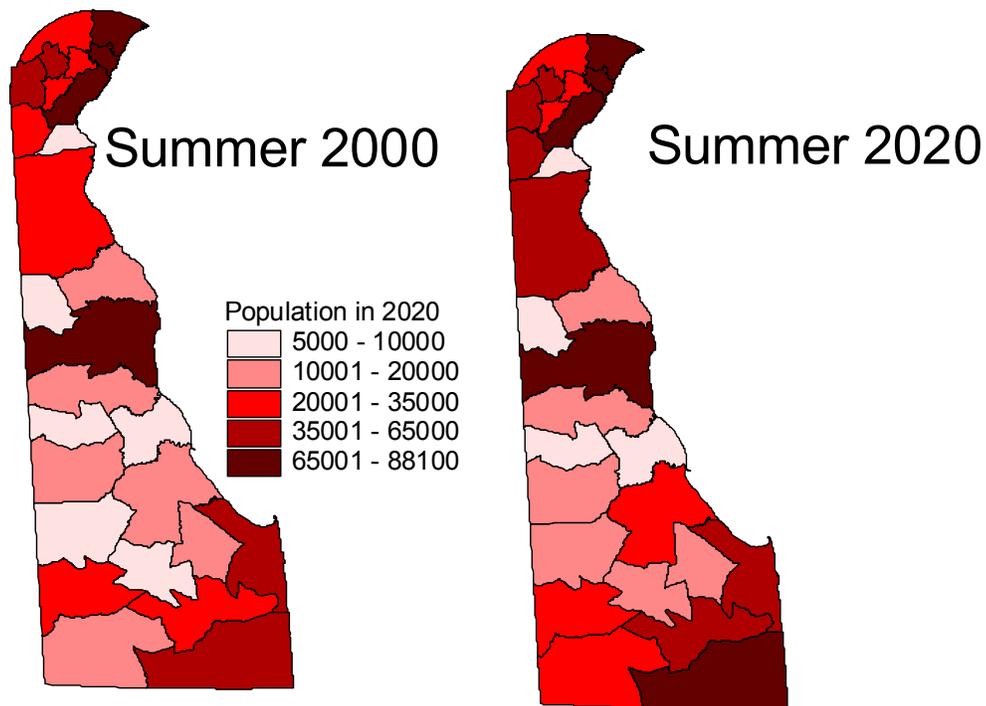
<u>Purpose</u>	<u>All trips</u>	<u>Work Trips</u>
Urban	11.7	13.3
High Density Suburb	16.1	17.2
Medium Suburban	45.8	41.7
Low Suburban	6.8	6.6
Very Low Suburban	9.8	9.9
Rural	5.1	5.1

Location of new work places in the suburbs has been a national trend. In 1989, a Coldwell Banker study of office space in 50 metropolitan areas showed that the suburbs attracted 72 percent of the new office space built and 74 percent of the office space actually absorbed.

Figure 172. Estimated Population Change by CCD

<u>CCDNAME</u>	<u>Y2000</u>	<u>Y2005</u>	<u>Y2010</u>	<u>Y2015</u>	<u>Y2020</u>	<u>Y2025</u>	<u>2000 - 2020</u>	<u>%change 2000 - 2020</u>
New Castle County								
Brandywine	79031	79302	78512	76728	74228	72072	-4803	-6.1
Central Pencader	27244	29724	32414	35463	39212	44710	11968	43.9
New Castle	78171	81864	84765	86803	88046	89485	9875	12.6
Greater Newark	53578	55127	56133	56605	56673	57060	3095	5.8
Lower Christina	33704	33716	33228	32251	30858	29421	-2846	-8.4
MOT	26220	29120	32389	36247	41115	48214	14895	56.8
Piedmont	29507	30996	32198	33070	33636	34277	4129	14.0
Pike Creek	58664	59702	59874	59148	57610	55925	-1054	-1.8
Red Lion	5101	5433	5747	6073	6493	7286	1392	27.3
Upper Christina	23278	24521	25492	26144	26472	26756	3194	13.7
Wilmington	72054	73155	73771	74082	74661	75528	2607	3.6
Kent County								
Central Kent	17637	18153	18690	19237	19805	20398	2168	12.3
Dover	67151	68578	70296	72235	74455	77047	7304	10.9
Felton	5620	5850	6089	6341	6601	6879	981	17.5
Harrington	10821	11510	12250	13050	13894	14803	3073	28.4
Kenton	5236	5536	5848	6180	6524	6893	1288	24.6
Milford North	7223	7245	7268	7323	7407	7548	184	2.5
Smyrna	12621	13110	13617	14145	14706	15286	2085	16.5
Sussex County								
BridgevilleGreenwood	7970	8572	9169	9616	10059	10478	2089	26.2
Georgetown	7597	8141	8688	8976	9285	9734	1688	22.2
Laurel-Delmar	17798	18762	19818	20453	21177	21853	3379	19.0
Lewes	19517	20732	22000	22839	23644	24556	4127	21.1
Milford South	16385	17786	19235	20173	21127	22103	4742	28.9
Millsboro	16842	17790	18771	19359	19913	20647	3071	18.2
Milton	10400	11392	12374	12941	13517	14252	3117	30.0
Seaford	22558	24149	25853	26999	28217	29363	5659	25.1
Selbyville-Frankford	23947	26131	27904	28948	29821	31445	5874	24.5
Sussex Summer Added								
BridgevilleGreenwood	776	842	1014	1087	1102	1127	326	42.0
Georgetown	787	843	1013	1091	1094	1112	307	39.0
Laurel-Delmar	1532	1538	1807	1879	1825	1795	293	19.1
Lewis	30943	32439	34164	35248	36093	37076	5150	16.6
Milford South	2438	2542	2870	3002	2999	3030	561	23.0
Millsboro	14859	16070	17446	18319	19008	19809	4149	27.9
Milton	3093	3278	3621	3789	3855	3952	762	24.6
Seaford	1641	1691	2066	2194	2141	2123	500	30.5
Selbyville-Frankford	39597	42995	46564	48942	50956	53239	11359	28.7
New Castle Total	486552	502660	514523	522614	529004	540734	42452	8.7
Kent Total	126309	129982	134058	138511	143392	148854	17083	13.5
Sussex Total	143014	153455	163812	170304	176760	184431	33746	23.6
Sussex Summer Added	95666	102238	110565	115551	119073	123263	23407	24.5
Delaware Total	755875	786097	812393	831429	849156	874019	93281	12.3
Delaware Summer Total	851541	888335	922958	946980	968229	997282	116688	13.7

Figure 173. Maps of Summer Population by CCD



Conclusions

The increasing number of adults in the population will generate significant new needs for "drive time" transportation capacity.

Declining household size will ensure that household formation will rise faster than population and put substantial pressure on new housing construction. The increasing number of single person households will tend to choose single family detached housing.

As the baby boomers age, the need for transportation to address the needs of the elderly will increase.

With the baby boomers in the high earnings stage of their life cycle, they will be less likely influenced by the costs of owning a car and should be even less sensitive to increases in gasoline taxes and other costs of transportation.

Most development will be in areas of medium to low suburban density that are primarily residential areas rather than mixed use land use. Given the densities and location of expected new development, almost all of it could be considered as sprawl. People in general prefer to live in lowest density development and there are currently incentives for this type of development.

Employment is spread and is spreading almost as much as population is.

For other conclusions and summary please refer to the Summary of Findings section of this report.

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