Scenic Conservation Plan,
Brandywine Valley National Scenic

Travel Demand Report

Delaware Greenways

June 2013

Travel Demand Report

Acknowledgements

The Board of Directors of Delaware Greenways gratefully acknowledges the assistance of the Delaware Department of Transportation in the preparation of this report. The Board especially acknowledges the assistance of the Department's Planning Division staff who ran their travel demand model and provided the results for the authors to analyze and draw conclusions relative to the future travel demand and carrying capacity of the Brandywine Valley in support of Grant SB-2009-DE-55844 – Brandywine Valley National Scenic Byway, Carrying Capacity and Preservation Plan.

Interpreting this Report

The opinions expressed, assumptions made, analysis perfromed and conclusions drawn as expressed in this report are the sole responsibility of the technical staff of Delaware Greenways who authored this report.

The analyses in the report and resulting conclusions are based on assumptions of future growth made by the authors intended to show a range of possible future travel conditions. Those assumptions are not necessarily consistent with or recommended by the policies or guidance of any agency, and are intended to explore a range of potential futures. No analysis, including this one, can predict exactly what will happen or examine all potential futures in a given study area. The authors encourage readers to keep these points in mind when interpreting the report.

"The significant problems we face cannot be solved at the same level of thinking we were at when we created them."

Albert Einstein (1879-1955)

Scenic Conservation Plan, Brandywine Valley National Scenic Byway

Travel Demand Report

Executive Summary

I'm afraid that our National Byway is becoming overrun with traffic. Am I correct? What can we do to stop it?

Fair questions. This report explains where traffic comes from, what generates it and why traffic as bad as it is. But this report is much more. It looks at how much traffic the roadways of the Brandywine Valley can accommodate and when the roadway system will congest or reach its carrying capacity. Finally, it examines the challenges we face and the opportunities we have to address the challenges.

The analysis concludes that the carrying capacity of the roadway network will be reached as early as the early to mid-years of the 2030s. But it also outlines strategies that will be explored and developed into formal recommendations in subsequent reports that can push back that day for additional years, if we have the courage to act.

The Board of Directors of Delaware Greenways believe that, other than widening the Tyler McConnell Bridge, the remaining roadways of the Brandywine Valley and especially the roadways of the Brandywine Valley National Scenic Byway should not be widened. That would irretrievably damage the scenic beauty of the Brandywine Valley and our National Byway.

Nevertheless, residents of the Valley and their community leaders and government officials must work collaboratively to preserve the beauty of the Brandywine Valley and most importantly, work to manage travel demand so that the carrying capacity of the Valley's and the National Byway roadways is not ever reached.

ES1.0 Introduction

This report is one of the Technical Reports of the Scenic Conservation Plan of the Brandywine Valley National Scenic Byway and represents the fourth report prepared by Delaware Greenways in support of the Scenic Conservation Plan. The previous reports were titled:

- Existing Conditions Report
- Viewshed Analysis Report
- Trend Scenario Report

Each report builds upon the prior reports and forms the technical basis for the Scenic Conservation Plan. This report presents the levels of vehicular travel in the study area currently and in the study year of 2040.

Understanding how much we travel enables an assessment of various alternative futures to be evaluated from the perspective of the transportation infrastructure. It is important to note that transportation infrastructure is only one of many issues to be examined in the Scenic Conservation Plan. Scenic beauty, environmental impact, land use context, and water and wastewater infrastructure are also important to the Plan and should not be secondary to the planning process.

Figure ES-1 illustrates the roadway transportation system of the Brandywine Valley. In the figure, the roads shown in purple represent the Brandywine Valley National Scenic Byway.

ES 2.0 Travel Demand in the Brandywine Valley in 2040

Travel demand is a function of human activity as well as how many of us there are and how far we have to travel for the goods and services and the

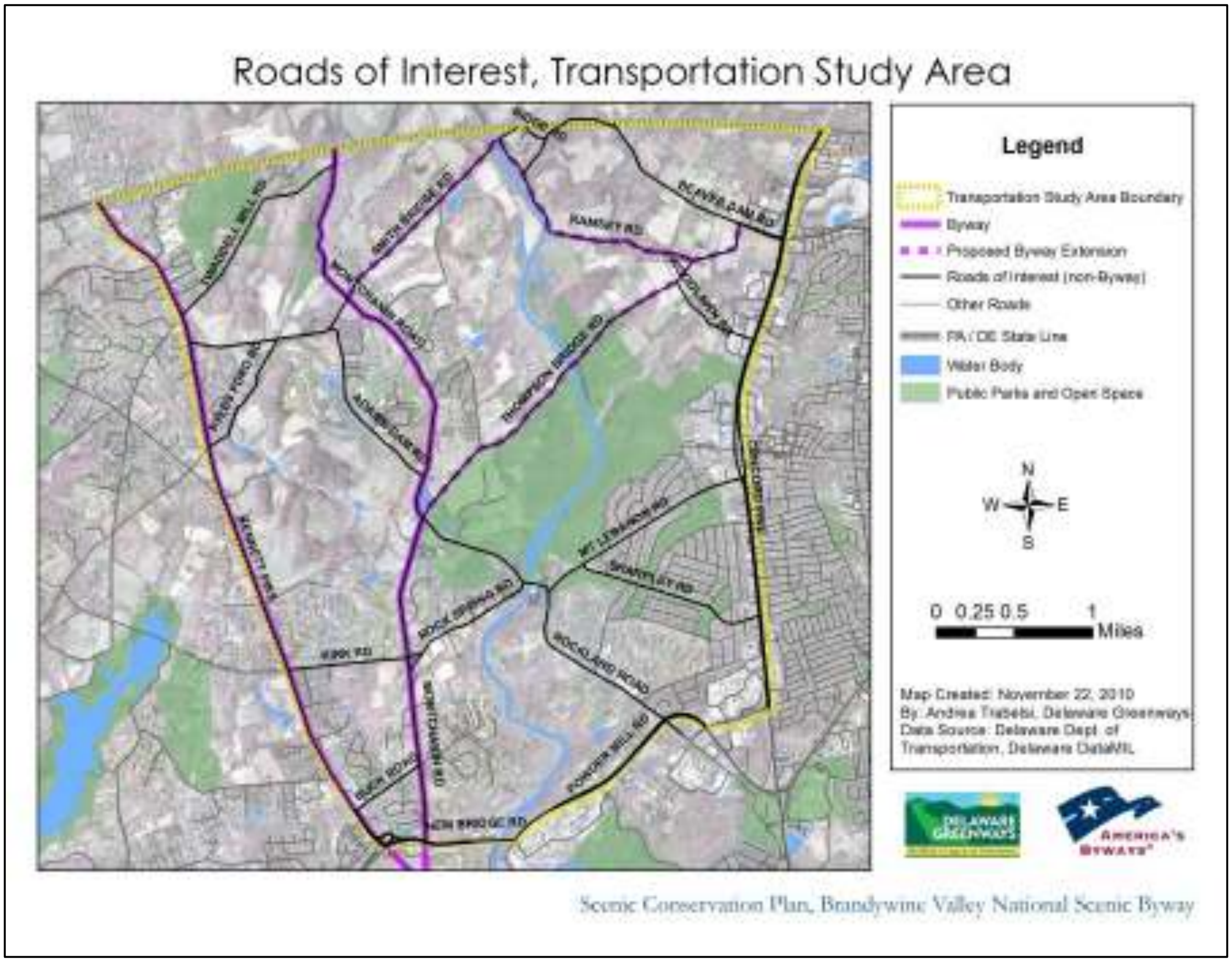

FIGURE ES-1: STUDY AREA ROADWAY NETWORK

employment opportunities we need to live our lives. Considering how many of us there will be in the year 2040, we know that the study area will undoubtedly see additional development. The region beyond the Brandywine Valley will also see increased development. Just within the Brandywine Valley, there will be an additional 1,200 people and 900 new dwelling units by the year 2040. There could be as many as 560 new jobs as well. New Castle County's population is projected to grow by over 68,000 people by the year 2040, although county-wide; the employment picture is relatively flat. In Pennsylvania, the communities surrounding the state of Delaware, Chester and Delaware Counties, are projected to grow at an annual rate 2.5 times that of New Castle County[1].

[1] Wilmington Area Planning Council for Delaware projections, Delaware Valley Regional Planning Commission for Pennsylvania projections. Delaware Greenways adjusted the population projections for the Brandywine Valley based upon the level of development activity in the counties of Pennsylvania adjacent to Delaware. For details, see the Trend Scenario Report.

But there is also good news. We are driving less, since 1990 –19% less. The recession was responsible for some of this decline but not all of it[2]. If this trend continues, even with the County population increasing by 17,000 people, we would still driving 3.6% less than we would have if didn't change our driving habits. In short, we are taking fewer trips than we did in 1990. But those trips are getting longer. According to the Delaware Department of Transportation, the number of vehicle miles traveled in the state is continuing to grow. Between 2000 and 2010, vehicle miles traveled increased by 12%.[3] Looking ahead to 2040, the travel demand model projects vehicle miles traveled to increase 10%, one third of the rate of growth in the in the first decade of this century. Still, even this much reduced rate of growth in vehicle miles of travel remains a concern.

Another trend is the commute from Chester and Delaware Counties in Pennsylvania into New Castle County. In 1990, some 12,900 residents of Chester and Delaware Counties commuted to work in New Castle County each day. This number increased by more than 21% to over 18,000 residents for the 2000 census.[4] But longstanding public policy is to strengthen New Castle County as a job center, meaning this trend should continue.

This means that we will be spending more time traveling and more time traveling on congested roadways, almost 40% more time according to this analysis. How can that be? A 10% increase in how much we travel results in a 40% increase in how much time we spend in congestion?

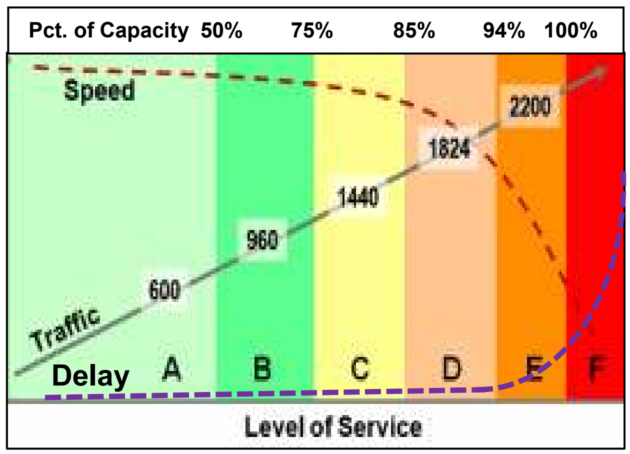

FIGURE ES-2: AS THE VOLUME TO CAPACITY RATIO INCREASES, DELAY INCREASES AT AN INCREASING RATE

The reason is simple and explained in Figure ES-2: as traffic increases and the roadways reach their capacity, traffic slows down and delays increase at an increasing rate. As a result, the system begins to congest. Transportation planners call this point the *carrying capacity* of the system.

ES 3.0 Congestion in the Brandywine Valley in 2040

The travel demand model projects average daily traffic volumes on the study area roadways to increase substantially. Looking at the three key roadways in the Valley, the north-south roads

[2] Dutzik, Tony, Baxandall, Phineas, A New Direction Our Changing Relationship with Driving and the Implications for America's Future, U.S. PIRG Education Fund and the Frontier Group, 2013.
[3] DelDOT Fact Books 2005 and 2010, Delaware Department of Transportation.
[4] US Census Bureau, Journey to Work Data, 1990 and 2000 Census.

show increases of 37% for Kennett Pike and 27% for Montchanin Road. DE Route 141 shows a substantial increase of 146%.[5]

Table ES-1: Projected Daily Traffic Volume Increases

Roadway	Average Percent Increase
DE Route 52, Kennett Pike	37
DE Route 100, Montchanin Road	27
DE Route 141, Powder Mill, New Bridge Roads	146

The travel demand model expresses congestion in terms of traffic volume in relation to the capacity of the roadway or volume to capacity ratio, making that calculation separately for each section of roadway. In the base year of 2010, during the PM Peak Period (3:00 PM to 6:00 PM), the only link congested during the entire three hour period of the PM peak was the Tyler McConnell Bridge, a two lane section of road on an otherwise four lane highway. However, by 2040, congestion spreads to other locations in the study area. Consistent congestion spreads along DE Route 141 between Barley Mill Road and Alapocas Road as not only the back-ups at the bridge begin to extend, the adjacent sections containing the signals at Alapocas Road and at Montchanin Road begin to back up on their own as traffic volume exceeds the capacity of these sections. Along DE Route 52, congestion is projected between the Pennsylvania Line and Center Meeting Road. Congestion also occurs north of the intersection of Route 82.

ES 4.0 Carrying Capacity of the Valley's Roadways

The patterns of congestion along DE Route 141 and DE Route 52 are not good news. The congestion on DE Route 141 is not unexpected; we see it today. Only by 2040, it will get worse. It is caused by a classic bottleneck or choke point in the roadway network, the Tyler McConnell Bridge. It is clear that the only solution is to widen the bridge. The congestion projected for DE Route 52 is another matter. This congestion is caused by something Delawareans cannot control: land development in Pennsylvania. But this analysis also tells us that we have time to work on preventing traffic from exceeding the carrying capacity of the Brandywine Valley National Scenic Byway. The Carrying Capacity of the Brandywine Valley will be reached sometime between 2030 and 2035. We have time but we must get to work now.

ES 5.0 Challenges and Opportunities

Clearly, there are challenges, but there are also opportunities. The following table pairs the challenges to opportunities. Subsequent reports prepared under the auspices of the Scenic Conservation Plan will set forth a path forward with specific recommendations.

[5] The Executive Summary describes the future traffic conditions projected under the Trend Scenario, one of the three development scenarios analyzed in this report. The results of the analysis for the three scenarios and how each compares to the other are presented in detail in the body of this report.

Table ES-2: Summary of Challenges and Opportunities

Challenge	Opportunity
The Tyler McConnell Bridge Bottleneck	This is a two lane bridge on a four lane highway, a choke point. Previous efforts to widen the structure have ended with no action. This analysis has shown that without action, the current situation will only worsen, affecting the Byway. The bridge must be widened.
Land Development Practices in Pennsylvania	Both WILMAPCO and the Delaware Valley Regional Planning Commission have begun to coordinate activities on their borders. With this beginning, the opportunity exists to involve Chester and Delaware Counties and their municipalities and New Castle County in a dialog. Increased coordination can only result in encouraging best land use practices.
Linking Land Use to the Carrying Capacity of the Transportation System	Both in Pennsylvania and in new Castle County, there is a substantial level of development that can occur. But in both cases, there is no link between the carrying capacity of the infrastructure and what current zoning allows to be built. Because of the rights of landowners, it is difficult to limit development. Addressing both the land use and travel demand sides of the equation, we can truly improve the situation even if we do not add capacity to the roadway system. • Considering land use, land preservation is a major opportunity; the First State National Monument is a prime example. By preserving large tracts of land, we can preserve open space and the magnificent viewshed of the Brandywine Valley. By clustering and mixing land uses, we can reduce the number of trips. • Considering travel demand, by shifting when we travel to the off peaks, we can relieve the level of congestion. By increasing walking and bicycling through eliminating barriers to the safety and comfort of walkers and cyclists, we can get folks out of their cars and onto a healthier lifestyle. Other strategies will be explored as work on the Scenic Conservation Plan continues.
Increasing Pressure to Add Roadway Capacity	For many years, the solution that is first thought of to address congestion is to add capacity to the roadway system. If we built it, our problems would go away or so we thought. But that only led to a more congestion and a never-ending cycle of congestion, roadway improvements, more congestion and more roadway improvements. While some improvements like widening the Tyler McConnell Bridge are unavoidable and clearly needed, using context sensitive solutions and flexible design guidelines as interpreted in the publication *Context Sensitive Solutions for Delaware's Byways*, new, more appropriate projects can be designed, better managing traffic flows along the roadways of the Valley.
Monitoring the Brandywine Valley	The Brandywine Valley is fortunate to be home to a public that is informed and active in civic affairs. It is also fortunate to have community leaders that are engaged. Recently approved legislation establishing a Byway Advisory Board for the Brandywine Valley National Scenic Byway is designed to bring the citizens of the Valley into closer contact with their leaders to preserve and enhance the Byway.[6]

[6] Delaware State Senate Bill 241 passed unanimously by the 146th General Assembly states, "Among other things, the Board will review and participate in the development of regulations and laws that impact the Byway; assist in securing funding to operate programs to enhance and preserve the Byway; and participate in the update and implementation of the Corridor Management Plan".

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1.0 Introduction

This report presents the levels of vehicular travel in the study area currently and in the study year of 2040. Understanding the level of vehicular travel enables an assessment of various alternative futures to be evaluated from the perspective of the transportation infrastructure. It is important to note that transportation infrastructure is only one of many parameters to be examined in the Scenic Conservation Plan. Scenic beauty, environmental impact, land use context, and water and wastewater infrastructure are also important to the Plan and should not be secondary considerations.

Delaware is one of the states that use a statewide model as the basis of estimating future travel demand. The model, called the Peninsula Model, estimates future travel demand not only for the state of Delaware but for the Eastern Shore of Maryland. The Delaware Department of Transportation is the owner of the model and has allowed it to be used for the Brandywine Valley Scenic Conservation Plan.

The travel demand modeling process uses demographic data including household travel data and physical data relative to the capacity and connectivity of the transportation system to develop future projections of travel demand. In support of the Scenic Conservation Plan, the Peninsula Model was run first with demographic and transportation system data from the year 2010 to replicate traffic volumes for that year. The model was run a second time with population and employment projections detailed in the Trend Scenario Report for the year 2040 to develop projections of travel demand for that future year.

This report consists of the following sections:

- How We Use Our Transportation System
- Travel Demand Modeling Methodology
- Analysis of Travel Demand Model Results

What is the difference between a traffic impact study and the regional travel demand model? When is the traffic impact study the best method to analyze a transportation network and when is the travel demand model the best?

A traffic impact study uses actual traffic counts on the roadway network as its base. Then it increases the existing traffic counts by a percentage factor to account for ambient or background traffic growth to the horizon year of the study (when the development is planned to be occupied) and then superimposes traffic generated from other known developments. Traffic from the development in question is then surcharged onto the roadway network. Then horizon year traffic volumes and levels of service are compared to identify the traffic impact of the proposed development and set the required mitigations.

On the other hand, a regional travel demand model is better at looking into the longer term and at a larger area. It also is better at assessing demographic and transportation trends beyond a single development and analyzing how those trends factor into how the transportation system will operate in the long run. A travel demand model can also report measures of effectiveness in addition to level of service such as vehicle miles travelled, system delay, travel speeds and air quality, an advantage when considering the long term picture.

- Carrying Capacity of the Roadway Network

As the findings of this report are weighed against all other findings, it is important to keep in mind that this travel demand model is forecasting how people who are not even born will be using the transportation system. While it is based upon industry-wide best practices and contains the rational assumptions reviewed by the transportation and land use planning communities and finally, input from the public, it is just that – a model. Even with the best judgments of demographers regarding the future, the best assessment of how current trends in how we use the transportation network will continue, we may still be surprised. Ten years ago, who would have predicted that the amount of travel we do would be going down due to the price of gas, the economy, technology and social media? Yet it is a trend that is discussed in more detail in the report. Whether the trend will continue or not should be in the back of the mind of the reader of this report. As such, the value of the model for this study is not in determining exact numbers, but in enabling comparisons, identifying patterns and considering trends.

Finally, in evaluating the findings, challenges and opportunities to successfully address the challenges emerge that, when taken together with the findings of the previous reports will provide a road map which, if followed, will lead to a future that preserves the beauty of the Brandywine Valley and a balanced transportation system.

This is the fourth report prepared by Delaware Greenways in support of the Scenic Conservation Plan. The previous reports were titled:

1. Existing Conditions Report
2. Viewshed Analysis Report
3. Trend Scenario Report

Each report builds upon the prior reports and forms the technical basis for the Scenic Conservation Plan.

2.0 How We Use Our Transportation System

When we typically think about our transportation system, we think of its faults – congestion, safety deficiencies, potholes, excessive travel times and too many big trucks. When we ask our friends and family members how their trip was, the most likely answer is, "horrible". Traffic always seems to be getting worse, public transportation is never there when you want it to be. Bicyclists ride crazy on the road and are targeted by autos. Pedestrians must have a death wish. And those developers, always overbuilding and adding to our traffic woes.

And there will be even more of us living, working and traveling to and through our Valley by the year 2040. By 2040, the population of New Castle County is projected to grow by more than 68,000, almost the current population of the City of Wilmington. While the total employment picture for the County is not expected to change, an increase of almost 4,000 jobs is projected in northern New Castle County. Further, within the study area, some 1,200 additional residents and 900 new dwelling units could be built and 560 new jobs could be located in our Valley.[7] Sounds like it couldn't get any worse.

But there is another part to this story. Our transportation system is one of the backbones of our country, giving us mobility and enabling commerce. We depend upon it as we live our lives. It binds us together as a nation and as a people. So, just how do we use our transportation system? DelDOT continually surveys its customers, the users of the state's transportation system through a telephone survey of 1,000 users per year. To date, some 15,000 users of the transportation system have been surveyed. What follows are the results of the New Castle County portion of the survey[8].

2.1 Who Makes the Trips?

There are many factors that affect the number of trips made by a person. Factors such as the overall economy, the day of the week, personal income and age, factor in how many trips are made and how the trips are made. This section of the report focuses on how many trips are made by New Castle County residents each day.

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7 For a detailed description of changes in population and employment in the region and in the study area, see the Trend Scenario Report.

8 WILMAPCO DATA REPORT #9, DelDOT's Household Survey, Selected Data for New Castle County (1995-2007, July 2009.

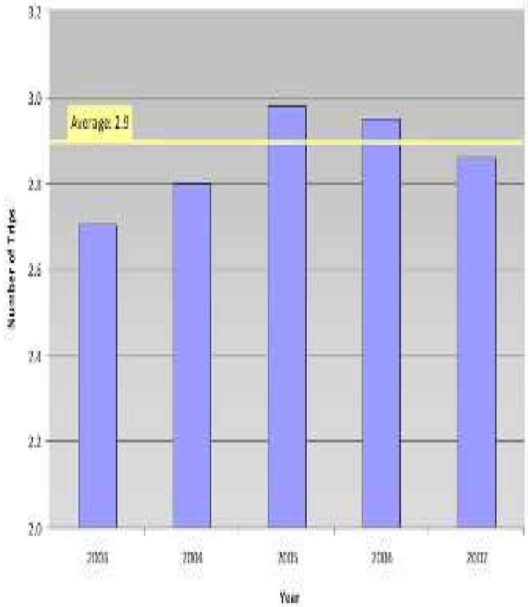

FIGURE 2.1-A: TRIPS PER YEAR, NEW CASTLE COUNTY

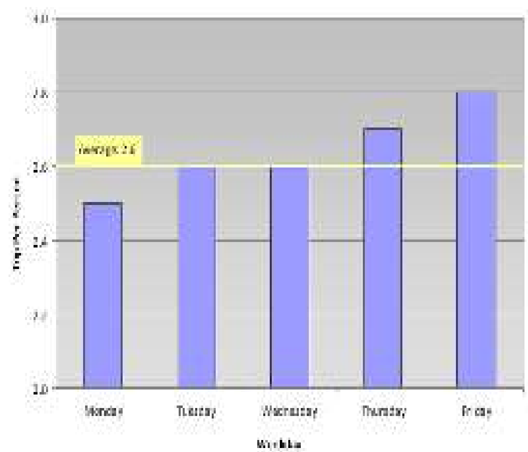

FIGURE 2.1-B: AVERAGE TRIPS PER WEEKDAY, NEW CASTLE COUNTY

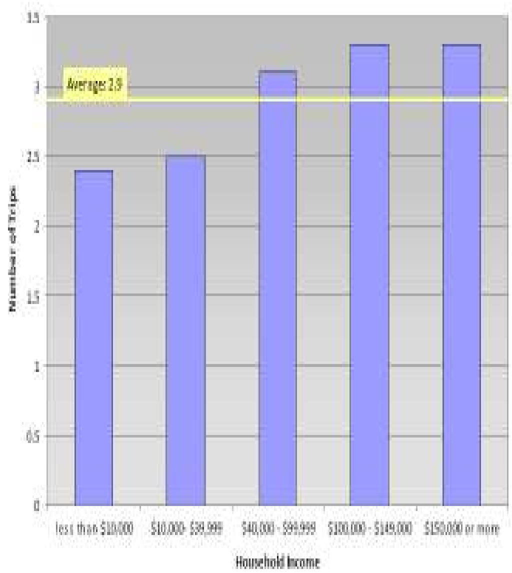

FIGURE 2.1–C: TRIPS BY HOUSEHOLD INCOME, NEW CASTLE COUNTY

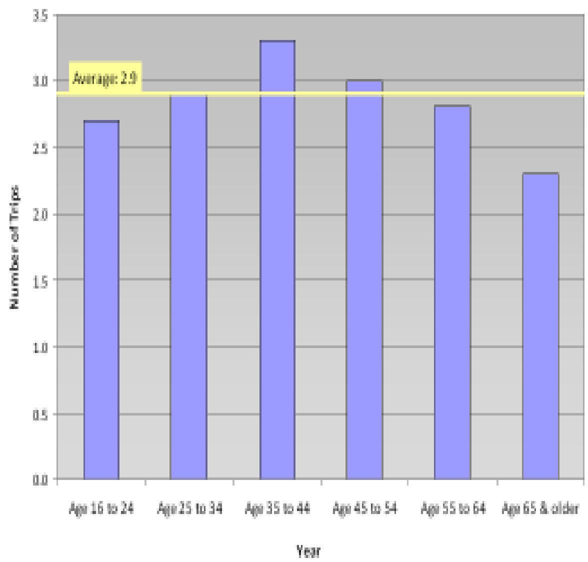

FIGURE 2.1-D: TRIPS BY AGE, NEW CASTLE COUNTY

Figure 2.1-A illustrates how trip-making by New Castle County residents has changed in the recent past. Between the years of 2003 and 2007, an average of 2.9 trips per day per person was made. But a closer inspection of the graph shows that since peaking in 2005 at almost 3.0 trips per day per person, the rate of trip making has steadily declined to almost 2.8 trips per day per person. It is interesting to note that during the 1990's more trips per person per day were

being made. During that decade, the rate was 3.2 trips per person per day. Since the 1990's the average number of trips per day per person has decreased by about 19%. Considering the population of New Castle County in 2005 which was 520,929 people, at 3.0 trips per day, there would be some 1,563,000 trips made each day. By 2010, the population of New Castle County increased to 538,170 people. If we assume that the number of trips per person per day remains at 2007 levels, the number of trips per day by Delawareans decreases to 1,507,000 trips, a decrease of 3.6%. Even with the increase in population, the decrease in number of trips per person per day still caused a decrease in the number of trips by Delawareans.

Figure 2.1-B shows the average number of trips occurring each weekday by each person. As can be seen in the graph, as the week progresses, more trips are being made with the weekday average of 2.6 trips day per person. On Monday, the rate is 2.5 trips per day per person and by Friday, the rate increases to 2.8 trips per day per person. Figure 2.1-C illustrates how income also plays a part in determining travel demand. According to the Household Travel Survey, residents with incomes in excess of $100,000 per year make 35% more trips per day than their lower income neighbors, about one trip less on average per day. A further inspection of the graph shows that there is a significant change between the $10,000 to $39,000 cohort and the $40,000 to $99,000 cohort. This dividing line relates to the Federal Poverty Level of $22,350[9] for a family of four when considering family income.

Age also makes a difference in trip making in New Castle County. Figure 2.1-D illustrates trips per day per person for different age cohorts. As shown in the graphic, the most trips are made by people between the ages of 35 and 44. After that age cohort, the number of trips per day decreases with residents over the age of 65 making the fewest trips per day per person. The age group making the second least number of trips per day is the 16 to 24 year olds, the "Millennials".

2.2 How Do We Make Our Trips?

Another way to express how we make our trips is to ask, what mode of travel do we use to make the trip? We intrinsically know that the majority of trips we make are by automobile. But as we saw above, a slight change in how many trips a person makes each day makes a big difference when considering the difference across the entire population of New Castle County.

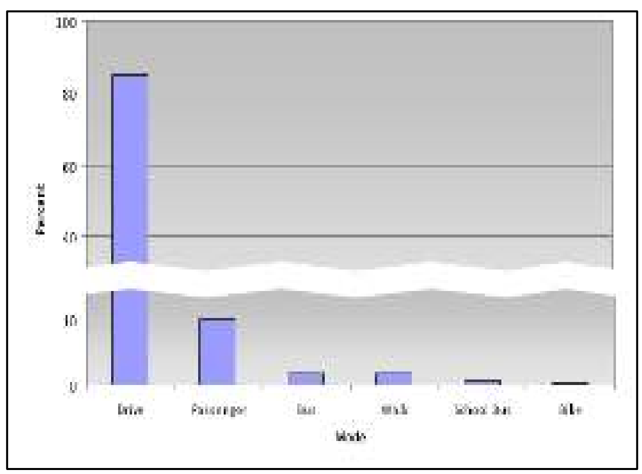

FIGURE 2.2-A: MODE OF TRAVEL IN NEW CASTLE COUNTY

Figure 2.2-A illustrates the mode of travel for the trips made by residents of New Castle County. As can be seen, when considering those who drove and those who rode as

[9] *Federal Register*, Vol. 76, No. 13, January 20, 2011, pp. 3637-3638.

passengers in an auto, some 95% of all trips were made by auto. Bus trips and walking trips represented about 2% of all trips. Travel by bicycle represented about 0.2%. However, when considering bicycle trips, the survey considered only the primary purpose of a trip such as a trip to work or a shopping trip. If the percentage of trips using public transportation was added into the auto trips, then another 30,000 trips per day would be made on the county highway system. While that addition may not make much of a difference in areas with little public transportation, it does make a difference when considering the streets and highways that serve transit hubs and along main transit corridors like US Route 202.

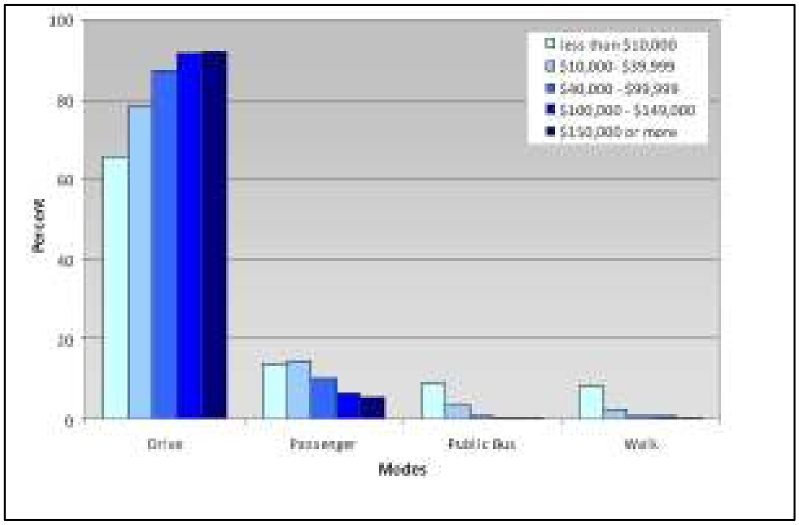

FIGURE 2.2-B: MODE OF TRAVEL IN NEW CASTLE COUNTY BY INCOME

Income also plays a role in our choice of travel mode. As can be seen in Figure 2.2-B, wealthier folks rely on their automobile at a significantly higher rate than do the less well off. Specifically, those of higher income are 38% more likely to make the trip by auto than any other method. In fact, autos were selected as the primary mode of travel by close to 98% of those who earned more than $100,000. The same was true for only 73% of those who earned less than $10,000. Using public transit and walking were more popular for lower-income people although the automobile was used by the majority of all income groups.

2.3 Our Average Trip Times and Vehicle Occupancy

Figure 2.3-A shows the average amount of time we spend in our vehicles. The average trip in New Castle County between 2000 and 2007 was nearly 28 minutes. The average trip time by auto was about 26 minutes but public transit riders trips averaged about 45 minutes. The average walking and cycling trip, for example, took

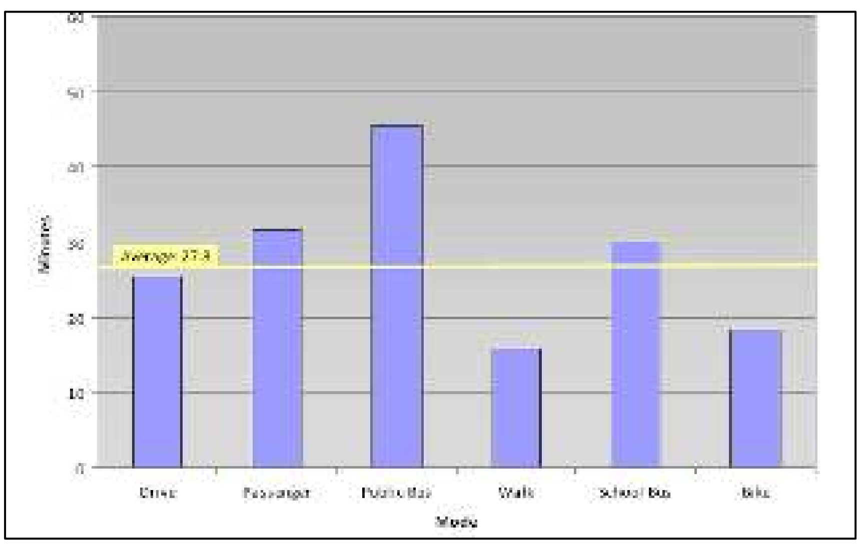

FIGURE 2.3-A: AVERAGE TRAVEL TIME BY MODE OF TRAVEL, NEW CASTLE COUNTY

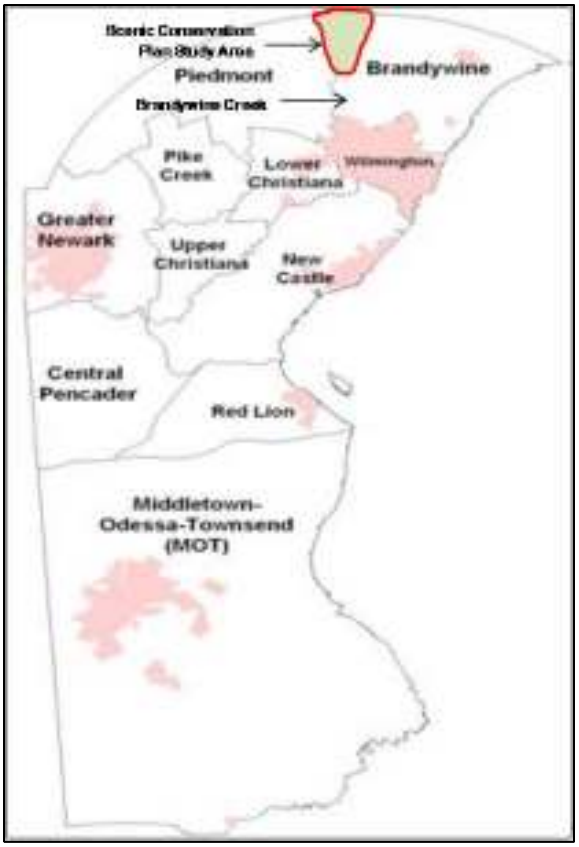

FIGURE 2.4-A: NEW CASTLE COUNTY PLANNING AREAS

just under 20 minutes during the period considered but the length of the trip was significantly shorter.

Based upon the Household Travel Survey, the less densely developed areas of the state, including the Brandywine Valley had a vehicle occupancy rate of 1.1 persons per vehicle. The more urbanized planning areas revealed vehicle occupancies of 1.2 persons per vehicle. The City of Wilmington and the major employment center of Upper Christiana had vehicle occupancies of 1.3 persons per vehicle.

2.4 Where do our Work Trips Begin and End?

New Castle County is divided into 13 Planning Areas for administration. Figure 2.4-A shows the location of each of the Planning Areas. The Household Travel Survey tracks the origin and destination of trips by Planning Area. While the Scenic Conservation Plan covers a small part of each planning area, it is still instructive to consider the origins and destinations of the two planning areas as a surrogate for the smaller study area of the Scenic Conservation Plan.

As shown in Table 2.4-A, for the Brandywine Planning Area, 57% of the trips remain in the Brandywine and Piedmont Planning areas while almost 20% travel outside the state of Delaware or the destinations are unknown. Six percent travel to Wilmington for work. The patterns are different for the Piedmont Planning Area. In this case 25% of the work trips remain in the Piedmont planning area but only 8% travel to the Brandywine planning Area. Sixteen percent travel to Wilmington and the influence of Newark is seen as 18% travel to the Newark Area for work. Within Delaware, the single highest flow of workers between their place of residence and their work location are those that remain in the Brandywine Planning Area due to the high

Table 2.4-A Trip Origins and Destinations for the Brandywine and Piedmont Planning Areas

Planning Area	Brandywine	Piedmont
Brandywine	33%	8%
Piedmont	24%	25%
Outside DE/Unknown	19%	13%
Wilmington	6%	16%
New Castle	5%	8%
Lower Christiana	4%	6%
Greater Newark	3%	18%
Upper Christiana	2%	4%
Pike Creek/Central Kirkwood	1%	5%
Central Pencader	1%	4%
Lower Delaware	1%	0%
Middletown/Odessa	1%	1%
Red Lion	0%	0%

number of residences and the large employment centers.

From US Census data, we can further examine the trips that originate in Pennsylvania and travel to and through the Brandywine and Piedmont Planning areas, many of which travel on the Byway. Table 2.4-B shows the trips originating in Delaware and Chester County, PA.

Table 2.4-B: Residents of Pennsylvania Counties adjacent to Delaware commuting to Northern New Castle County

Residence	1990 Census	2000 Census
Delaware County	7,756	12,976
Chester County	10,354	9,002
Total	18,110	21,978

As shown in the table, overall the number of residents commuting from the two Pennsylvania counties increased 21% between the 1990 and 2000 Census. This demonstrated the strength of New Castle as a job center.

2.5 How Will Our World Change Between Now and 2040?

How many times do our financial planners tell us that past performance is no guarantee of future success? But then they go on to sell us on their record of past performance as if it is a valid indicator of future success. Travel demand modeling is no different. The previous sections of Chapter 2 describe the underlying assumptions of the model. The growth of our population and its current pattern of aging affect the number of drivers of the future. Will there be another baby boom and will it affect Delaware? Will the price of gasoline increase at a rate faster than inflation? Will our cars be more efficient or use alternative fuels? Will the current trend that shows we are driving less continue? Will Delaware continue to be an attractive place for business? We just saw how global conditions in the pharmaceutical industry affect employment in the Scenic Conservation Plan study area. The answers to these questions affect how much traffic will be on the roadways. Just think how much less traffic there was on your drive to work during the depth of the recession in 2009 and how traffic seems to have increased recently. Similarly, the quality of service the transit system provides and the degree we are willing to carpool our trips and combine our trips makes a significant difference in the amount of traffic on the roads.

A good hockey player plays where the puck is. A great hockey player plays where the puck is going to be.

Wayne Gretzky

Trends and advances in technology also play a role in how we will use our transportation system in the future. Already, we are seeing vast improvements in the performance of our vehicles. They maneuver better in traffic, take curves at faster speeds, have better braking systems and are safer to drive. In the future, we will see features like adaptive cruise control, lane changing warning systems, and active parking assist where the car maneuvers into the parking space without driver intervention evolve into autonomous vehicles or vehicles that drive themselves. This means that vehicles can travel closer together increasing the capacity of our roads to accommodate travel. One measure of that is something traffic engineers measure call the saturation flow rate or the maximum number flow vehicles that can pass through a signalized intersection in one hour. In the 1980's it was measured at 1,800 vehicles per hour per lane. Now, traffic engineers recognized that it is higher, and have found it to be 1,900 vehicles per hour per lane, a 5.5% increase. This is largely due to the performance improvements in vehicles which manifest in how fast motorists accelerate and how closely they travel together.

Technology is also changing how we live our lives: video conferencing, high speed internet and cloud computing are enabling more and more of us to work from home and reduce business travel. Social media is reducing the need for face to face conversations. Online merchants are reducing the number of trips to brick and mortar stores.

A recent report titled A New Direction: Our Changing Relationship with Driving and the Implications for America's Future, prepared by the U.S. PIRG Education Fund and the Frontier Group looks into why we are driving less and concludes that the driving boom is over. No longer should we count on continued increases in traffic; rather, our own young people are leading a sea change I the way we live our lives.

Young people aged 16 to 34 drove on average 23 % in 2009 than they did in 2001—a greater decline in driving than any other age group. The severe economic recession was responsible for some of it, but not all of it.

The young who have who have left the nest are more likely to live or aspire to live in urban and walkable neighborhoods and are utilizing bicycles and public transportation than their parents and grandparents. They also communicate and relate to one another differently, embracing social media and other mobile interconnected devices. Young Americans are creating new avenues for living connected, vibrant lives that are less reliant on driving.

The uncertainty of trends and forecasts are not a reason to fail to plan and not to consider the future of our transportation system or to concentrate only on short term issues; rather, the uncertainties should inspire us to better understand our future and how we can shape it for the better.

3.0 Travel Demand Modeling Methodology

DelDOT's Peninsula Model is a travel demand model that covers a geographic area which includes all of Delaware plus Maryland's Eastern Shore. The modeled area has a population in excess of 1.2 million people within a geographic area of 5,375 square miles. Figure 3.0-A shows the area covered by the model. The model contains 908 Traffic Analysis Zones (TAZs), 28 External Stations or roadways that carry traffic outside the modeled area, and 10,047 links that represent roadway sections between intersections.[10]

FIGURE 3.0-A: MODELED AREA, PENINSULA TRAVEL DEMAND MODEL SOURCE: DELDOT

The process of estimating future travel demand is a four step process of trip generation, trip distribution, modal choice and trip assignment. These four steps are described in the following paragraphs.

3.1 Trip Generation

Trip generation, or the number of trips added to the transportation system, is based upon the Household Transportation Surveys as well as demographic data presented previously. This data is continuously updated through a telephone survey of households in Delaware and based upon more than 15,000 travel diaries recording trip frequency and trip purpose for over 29,000 trips.

The trips are characterized by type. Table 3.1-A shows the trip purposes used in the Peninsula Model. As shown in the figure, Home-Based Work trips make up 34% of all household trip-making with local shopping trips making up the third highest percentage at 17%. Based upon the household survey data, trip rates are calculated for each of the trip types based upon the survey respondent and household data. Since houses (or home as shown in the table) are defined as a *producer* of trips and employment and retail centers are *attractor*s of trips, the propensity of each residentially

Table 3.1-A Trip Purposes Tracked in the Model

Trip Purpose	Trips	Percent
Home-Based Work[11]	9,947	34
Home-Based Recreation	3,035	10
Home Based-Shop	4,780	17
Home-Based Regional Shop	1,232	4
Home-Based Other	5,090	18
Non-Home-Based Non-Work	3,202	11
Non-Home-Based Work	1,764	6
Grand Total	**29,050**	**100**

[10] A TAZ or *traffic analysis zone* is a geographically defined area, usually based upon a Census Block or blocks. This enables the model to easily use data based upon the US Census. An *external station* is a roadway that crosses the outer boundary of the modeled area and inputs the incoming and outgoing traffic volumes as well as the projected population and employment growth outside the model for the area served by the roadway.
[11] Defined as a trip beginning or ending at home with work as the main purpose. Other trip purposes are similarly defined.

Why isn't the publication 'Trip Generation" published by the Institute of Transportation Engineers (ITE) used for estimating the number of trips a given parcel generates in a regional travel demand model such as the Peninsula Model? *After all, it is the standard used across the country in the estimation of the amount of trips generated by a proposed development.*

The reason is that the ITE publication considers only trips to and from one parcel of land. If ITE trip generation rates were used to generate trips for a residential site and a retail site a few miles apart, the trips between the two sites would be double counted. For example, a trip exiting the residential parcel and going to the retail parcel would be counted twice, once as a trip exiting the residential site and one entering the retail site. It would also be counted twice in the reverse direction. ITE rates in effect double count trips so the rates must be factored downward to account for this phenomenon if used in a travel demand model.

ITE rates also do not account for multi-stop trips that the household surveys quantify. However, for small area studies and for traffic impact studies where these factors have a small impact, ITE rates are perfectly appropriate.

In short, travel demand models are person-based trip models and describe a trip made up of several links for several different purposes using different modes of travel. ITE trip generation rates are based upon vehicle trips only and describe vehicle trips on one incoming link and one outgoing link from one site.

generated trip to be attracted by a trip attractor such as an office building or a shopping center is based upon the household trip survey.

The number of residences in a given TAZ determines the trip generation rate for that TAZ. The ability of the TAZ to attract trips is a function of the number of people that work in the TAZ, whether the place of employment is an office or a retail center.

Recent enhancements to the model enable individual TAZs to be examined on a parcel by parcel basis so that different development patterns for the same parcel of land can be examined. This capability was used for the Scenic Conservation Plan. The TAZs to which future development is allocated to have been enhanced to enable parcel based examination.

Generating and attracting developments within a TAZ that existed in 2010 have already been entered into the model by DelDOT. Similarly, areas projected or planned to be developed by 2040 outside the study area have also been entered into the model by DelDOT. Delaware Greenways entered the development patterns anticipated by the three land development scenarios of the Trend Scenario Report into the model. Where the configuration of the development was known, its published site plan was used. However, in the vast number of instances, Delaware Greenways staff, with input from the Scenic Conservation Plan Committee, developed the roadway network based upon what the development might look like in accordance with existing zoning and observable physical constraints of the property in question.

3.2 Trip Distribution

Trip distribution defines where a trip begins and where it ends, independent of how it gets there. Trips are initially classed based upon whether the trip is passing through the modeled area without stopping (the trip neither begins nor ends in the modeled area), whether one trip is made entirely within the modeled area or whether only one of the trip ends is within the modeled area. The definitions of the four types of trips are shown in Table 3.2-A.

Table 3.2-A Types of Trip Ends

Trip End	Description
E to E	A trip with no trip end in the modeled area also called a through trip, ***E***xternal to ***E***xternal
I to E	A trip with its origin in a modeled area TAZ to a point outside the modeled area, ***I***nternal to ***E***xternal
E to I	A trip with its origin outside the modeled area to one of the TAZs in the modeled area, ***E***xternal to ***I***nternal.
I to I	A trip that begins and ends within the modeled area, ***I***nternal to ***I***nternal

The model chooses the TAZ that attracts the trip by applying a method that relates travel time from the trip producing TAZ to the intensity (e.g., number of square feet) of the attracting land use within the attracting TAZ[12]. The central equation of the method, called the gravity model method is:

$$\text{Attractiveness} = \frac{\text{size of the attracting zone in number of employees}}{(\text{travel time between the attracting zone and generating zone})^2}$$

The travel demand model then creates a trip table by pairing the trips generated by the trip producing land uses in one TAZ with the attracting land uses of the TAZ that attracts that trip purpose; e.g., a retail based zone attracts trips from the home based shopping trips of trip producing zones and a zone with office uses in it attracts home based work trips. The model then populates a trip table that looks like Table 3.2-B by using the gravity model to estimate the number of trips between the almost 1,000 TAZs. Because trips between TAZs are defined as one way, the return trip is also included, and timed to occur based upon the results of the household survey. The trip table represents the total number of trips in the model. They are not yet trips made by auto or transit or even placed on a specific road or transit route. That happens in the next two steps.

Table 3.2-B Sample Trip Table

		TAZ Number							
		1	2	3	4	5	6	7	…n
TAZ Number	1								
	2								
	3								
	4								
	5								
	6								
	7								
	…n								

3.3 Modal Choice

The travel demand model predicts the mode of transportation of each trip. While most all trips in Delaware are made by auto, many are made using public transit, by bicycle or simply by walking. The model makes this estimation using a series of equations that are based upon research conducted across the country, tempered by local conditions. For example, using public transit is a choice based upon availability of service (frequency of service and availability

[12] As an example of how this equation works in real life, most people go shopping at the closest shopping area they believe is most likely to have what they are looking for at the best price. Since that is most likely the largest and closest shopping area to home, the equation is designed to send a higher number of shopping trips to the largest and closest center and a smaller number of trips to a smaller nearby center, based upon the equation as applied to each pair of TAZs.

for a given trip), convenience of service (the bus stops are convenient to each trip end) and the likelihood of having a car available, measured in terms of household income. Similarly, the propensity to use a bicycle for a given trip is based upon the trip length, time of day that the trip is to be made, whether the trip can be made safely (road configuration, separate trail or bike path) and the presence of any special attractors such as parks. Pedestrian trips are similarly estimated. Trip length, time of day, location of potential generators and the availability of sidewalks and trails are the major variables considered. It should be noted that most pedestrian and bicycle trips would be internal to a TAZ or cross one or two TAZ boundaries. The model looks at each trip individually to make its assessment of the mode of transportation used.

3.4 Trip Assignment

By far, most of the trips will be assigned to the roadway network. Like a plumbing system of pipes of different sizes, lengths, and capacities to hold volumes of water, the travel demand model treats the travel system as a set of roads with varying capacities for accommodating traffic. The size or diameter of the pipe represents its capacity to move water and the length determines how long it takes the water to travel from one end to the other. Similarly, a roadway system is made up of links or lengths of roadways with a defined capacity to carry vehicles and a travel time to go from one end of the link to the other. The model then places each vehicle trip on the roadway system from its origin to its destination by following the combination of routes that provide the fastest travel time between the two points. It keeps doing that until all of the vehicle trips are routed or assigned to the roadway network. Typically, some routes reach and exceed capacity and the model calculates a reduced speed for that over-capacity link. This could make another route for that trip quicker than the first route chosen by the model, much like the GPS functions in today's automobiles. The model is run several times until all trips are assigned to their quickest route.

But not all trips are made by automobile. Some are made by public transit, some by bicycle and some by walking. There are not very many of these trips currently but the number of them is increasing every year. Travel demand models consider other factors in assigning bicycle and walking trips and public transit trips to a specific route.

Some of the key factors used in assigning non-automobile trips to a particular route are:

- Public Transit Information
    - Bus route convenience
    - Frequency of service, hours of service
    - Number of seats
    - Stop locations
    - Travel time
    - Exclusivity of route: private right of way or public street
- Bicycle Information
    - Roadway configuration related to bicycle comfort level
- Pedestrian Information
    - Location and type of pedestrian facility (sidewalk, path, trail)

3.5 Model Validation and Calibration

Because travel demand models use demographics and data on how we make our trips to estimate the number of trips in the system, and then uses physical data about the transportation system to develop a measure of the travel time of each trip so it can be routed by the quickest route, the model must be validated to insure that it reflects the traffic volumes on the roadway and the number of passengers on transit vehicles.

Validating the model means that the model results replicate actual conditions on the transportation system. Simply put, the results of the model must be compared against traffic volume data actually collected in the field. To do this, DelDOT maintains an extensive inventory of traffic count data. The traffic volumes produced by the model are then compared to the inventory of traffic counts. Differences in volumes on the roads, transit vehicles, bicycles and on foot between the model results and the actual field data are noted as are patterns of differences.

The model is then *calibrated* by adjusting the trip generation equations if the pattern of differences relates to the number of trips in the system. If the number of trips projected by the model matches the number of trips counted on the roads, but the number of trips to each of the travel modes is different, then the calibration effort centers on the mode split equations. If the model assigns traffic to two roads, transit routes, bicycle routes or pedestrian trails serving the same general origin and destination pair, then adjustments are made to the factors affecting the way the model calculates travel time of the roadway and transit links in general and for specific links if the differences are localized.

In all, the model validation and calibration process continues until the difference in volume between each roadway link, transit route, pedestrian and bicycle link produced by the model and counted in the field are so close that there is no statistically significant difference between them.

4.0 Analysis of the Travel Demand Model Results

The modeling approach for the Scenic Conservation Plan is designed to address the question of how will the study area roadway network operate in the design year of 2040 under a number of land development scenarios. The scenarios analyzed are as follows:

1. Full Build Scenario: This scenario assumes that every one of the parcels of land in the study area is built out to the limits of its current zoning potential.
2. Trend Scenario: This scenario is based upon the population and employment projections in the Trend Scenario Report assuming development occurs using conventional zoning only.
3. Open Space Scenario: This scenario is also based upon the population and employment projections in the Trend Scenario Report but the zoning option that encourages open space preservation is used by developers.

It is extremely unlikely that the Full Build Scenario will ever occur, and especially unlikely for it to occur by the plan year of 2040. It is included only as a comparison. Some combination of the Open Space and Trend Scenarios is most likely to occur based upon the population and employment projections detailed in the Trend Scenario Report. It should also be noted that the three land use scenarios do not represent the official land use policies of New Castle County. They are simply development scenarios developed for analysis.

4.1 Traffic Volume Comparison

This section compares the average daily traffic volumes (24 hour traffic volumes) for selected links of the study area roadway network. The links chosen are considered ‘barometer’ links which are indicative of the other links along the roadway. In each of the tables that follow, the projected 2040 daily traffic volumes are compared to year 2010 traffic counts. Note that no new roadway improvements that add capacity to the roadway network of the Brandywine Valley are assumed in this analysis[13].

As shown in Table 4.1 A, Kennett Pike, DE Route 52, traffic volumes are projected to increase over 2010 volumes by 37% and 39% for the Trend and Open Space Scenarios, respectively. The Full Build Scenario shows a much higher increase of 54%.

[13] The Tyler McConnell Bridge is noted in the Transportation Improvement Plan for replacement with a wider structure but the actual design and construction is not included and therefore this project is not assumed to have been implemented in any of the development scenarios studied.

Table 4.1A: Traffic Volume Comparison DE Route 52

Barometer Links			Average Daily Traffic Volume			
Roadway	From	To	2010	2040 Trend	2040 Open Space	2040 Full Build
DE Route 52	PA Line	Snuff Mill Road	10,500	19,600	19,600	19,800
DE Route 52	Twaddle Mill Road	Center Meeting Road	12,800	13,600	13,700	13,500
DE Route 52	Winterthur	Route 82	12,800	14,000	14,000	14,900
DE Route 52	Hillside Road	DE Route 82	12,800	16,800	17,400	19,500
DE Route 52	Buck Road	Hillside Road	18,400	20,400	20,900	22,900
Average Percent Increase				37%	39%	54%

Table 4.1B compares the traffic volumes for Montchanin Road, DE Route 100. Increases in traffic of about 27% and 28%, respectively for the sections of Route 100 are projected for the Trend and Open Space Scenarios, respectively. The Full Build Scenario projects an increase of 34%. Note that the section between Rotes 82 and 92 shows constant levels of traffic largely due to the lack of assumed development along Route 100. North of Route 92, the projected increases become significant due to low current traffic volumes and the potential for development in the north eastern sector of the study area.

Table 4.1B: Traffic Volume Comparison DE Route 100

Barometer Links			Traffic Volume			
Roadway	From	To	2010	2040 Trend	2040 Open Space	2040 Full Build
DE Route 100	PA Line	Twaddle Mill Road	1,700	3,900	3,900	3,900
DE Route 100	Twaddle Mill Road	Smith Bridge Road	1,700	3,500	3,500	3,600
DE Route 100	Smith Bridge Road	Adams Dam Road	7,900	10,300	10,600	10,900
DE Route 100	Route 92	Route 82	11,400	11,100	11,100	12,100
Average Percent Increase				27%	28%	34%

Routes 52 and 100 comprise the Brandywine Valley National Scenic Byway. By any measure, these increases are substantial and require further examination. However, it is also noted that the differences between the three scenarios are not significant. This is largely because the difference in the number of housing units and how the housing units are dispersed across the valley.

Route 141 shows significant increases in traffic. The increases would be higher but the constraint of the Tyler McConnell Bridge diverts the much of the added traffic to the other study area roadways.

Table 4.1C: Traffic Volume Comparison DE Route 141

Barometer Links			Traffic Volume			
Roadway	**From**	**To**	**2010**	**2040 Trend**	**2040 Open Space**	**2040 Full Build**
DE Route 141	DE Route 48	DE Route 52	32,300	71,800	72,000	72,400
DE Route 141	DE Route 100	New Bridge Road	20,300	57,100	57,300	57,500
DE Route 141	Barley Mill Road	Alapocas Drive	20,500	49,300	49,300	51,000
DE Route 141	Alapocas Drive	Children's Drive	20,500	52,100	52,000	52,310
Average Percent Increase				146%	147%	149%

4.2 Traffic Patterns

The travel demand model knows the origin and destination of each trip in the roadway system. It is instructive to use this information to examine the travel patterns in the Brandywine Valley. As shown in Section 2.4 of this report, 20% of the traffic entering the Brandywine and Piedmont Planning areas enters from Pennsylvania.

Figure 4.2-A illustrates the origin and destination patterns of traffic entering Delaware from Pennsylvania using DE Route 52. By the year 2040, the traffic volume crossing the Pennsylvania Line is projected to be in excess of 19,000 vehicles per day. Of that figure, 19% leaves at Snuff Mill Road and 27% use Owls Neck Road. Another 18% exit Route 52 at Powder Mill Road, DE Route 141. Much of this traffic travels to points along or to the south of the Route 141 Corridor. About 1,000 vehicles travel to or through the Hockessin area. The traffic remaining on DE Route 52 past Route 141 largely has a trip end in Wilmington. Surprisingly few of the trips along DE Route 52 cross the Brandywine Creek within the study area.

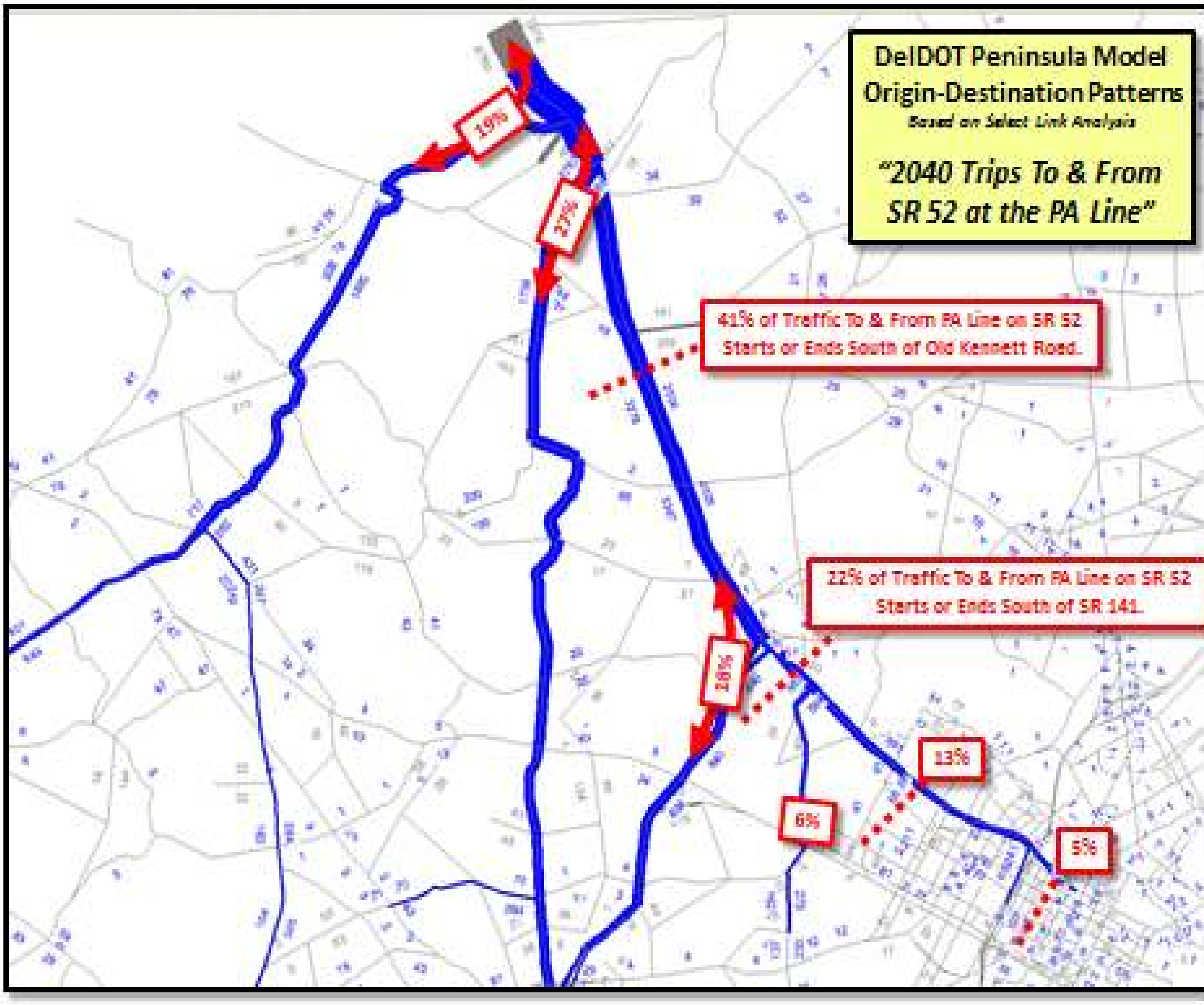

FIGURE 4.2-A: ORIGINS AND DESTINATIONS OF ROUTE 52 TRAFFIC.

As shown in Figure 4.2-B, DE Route 100 traffic shows different patterns even though a much smaller volume crosses the line compared to DE Route 52. Of the 3,900 vehicles crossing the line, 70% travel to the US Route 202 Corridor, 30% via Smith Bridge Road and 40% via Adams Dam Road. Of the remaining 30%, 10% travel into Wilmington and 10% to the Route 141 Corridor with 10% distributing elsewhere throughout the study area.

FIGURE 4.2-B: YEAR 2040 ORIGIN-DESTINATIONS OF DE ROUTE 100 TRAFFIC

US Route 202 operates with the largest traffic volumes of all of the roadways serving the study area with 54,000 vehicles per day crossing the state line. Figure 4.2-C reveals that of the 202 traffic crossing the line, 20% enters the Brandywine Valley, 10% each on DE Route 92 and on DE Route 141, Powder Mill Road. The remainder either stays on US Route 202 or uses one of the roads to the east.

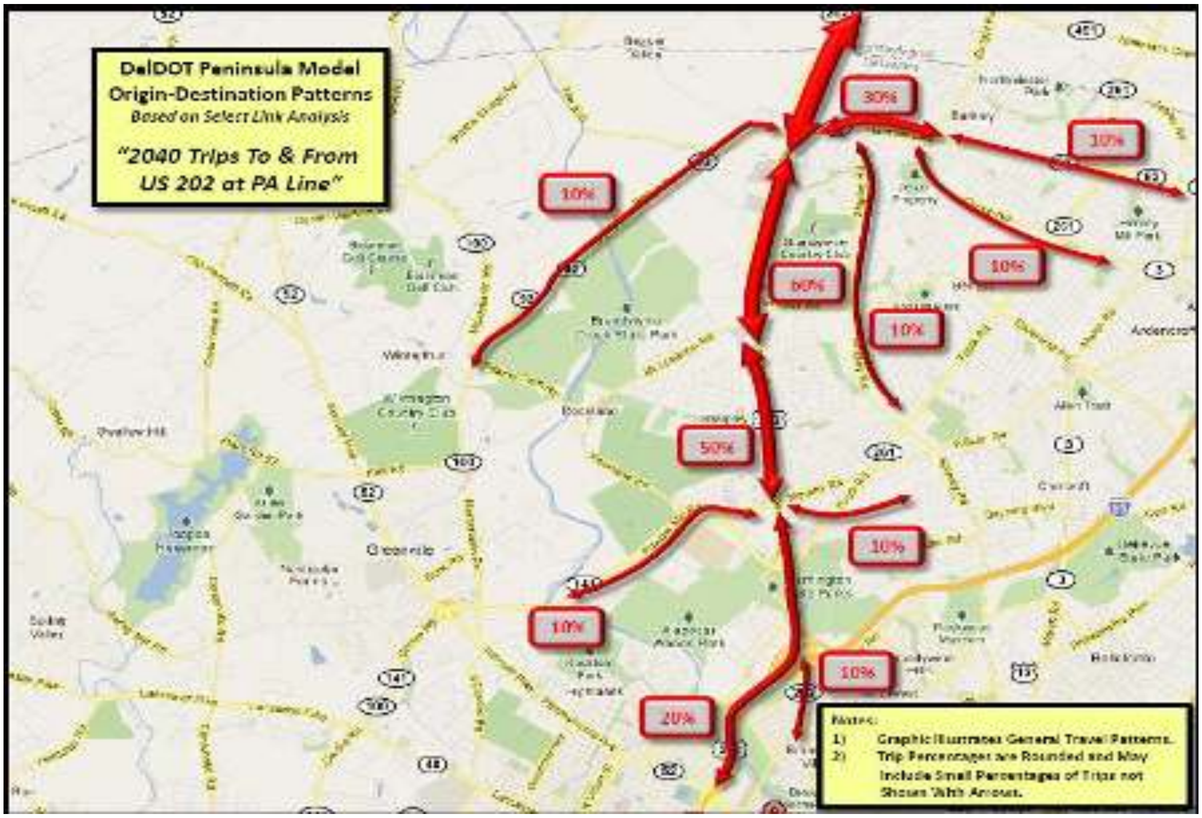

FIGURE 4.2-C: YEAR 2040 ORIGINS-DESTINATIONS OF US ROUTE 202 TRAFFIC

An important question still remains: How does traffic circulate through the Brandywine Valley? To perform that analysis, the origins and destinations of traffic using the three crossings of the Brandywine Creek, Rockland Road, Thompsons Bridge and Smith Bridge were analyzed.

Smith Bridge, projected to carry about 8,000 vehicles in 2040, is the northernmost crossing of the Brandywine Creek. As shown in Figure 4.2-D, 40% of the traffic (about 3,200 vehicles) that has a trip end in Pennsylvania on the west side of the bridge travels to the east side mostly to the US Route 202 and Naamans Road corridor. The 30% of the traffic that has a trip end in Pennsylvania on the east side of the bridge travels to the Centreville area with the largest plurality to the Route 52 corridor. Of the Delaware-based traffic, most travels between the Centreville and Naamans Road/Concord Pike areas.

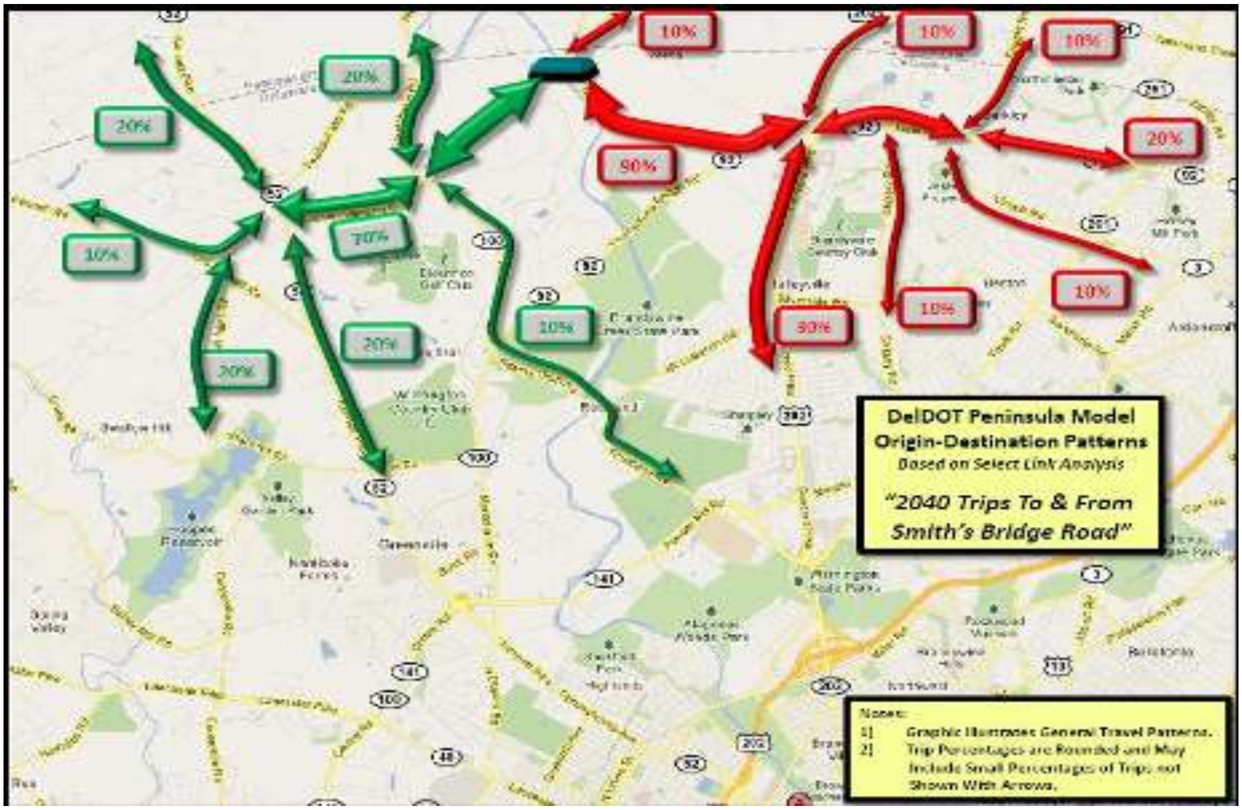

FIGURE 4.2-D: YEAR 2040 ORIGINS-DESTINATIONS OF SMITH BRIDGE TRAFFIC

By the year 2040, Thompsons Bridge on DE Route 92 will carry some 4,500 vehicles per day. Traffic on this bridge is traveling from the Naamans Road area on Concord Pike to the DE Route 100 Corridor. Some 30% of the traffic travels to Greenville and the rest into Wilmington. As can be seen in the figure, 35% of the traffic on the bridge enters Delaware from Pennsylvania on US Route 202.

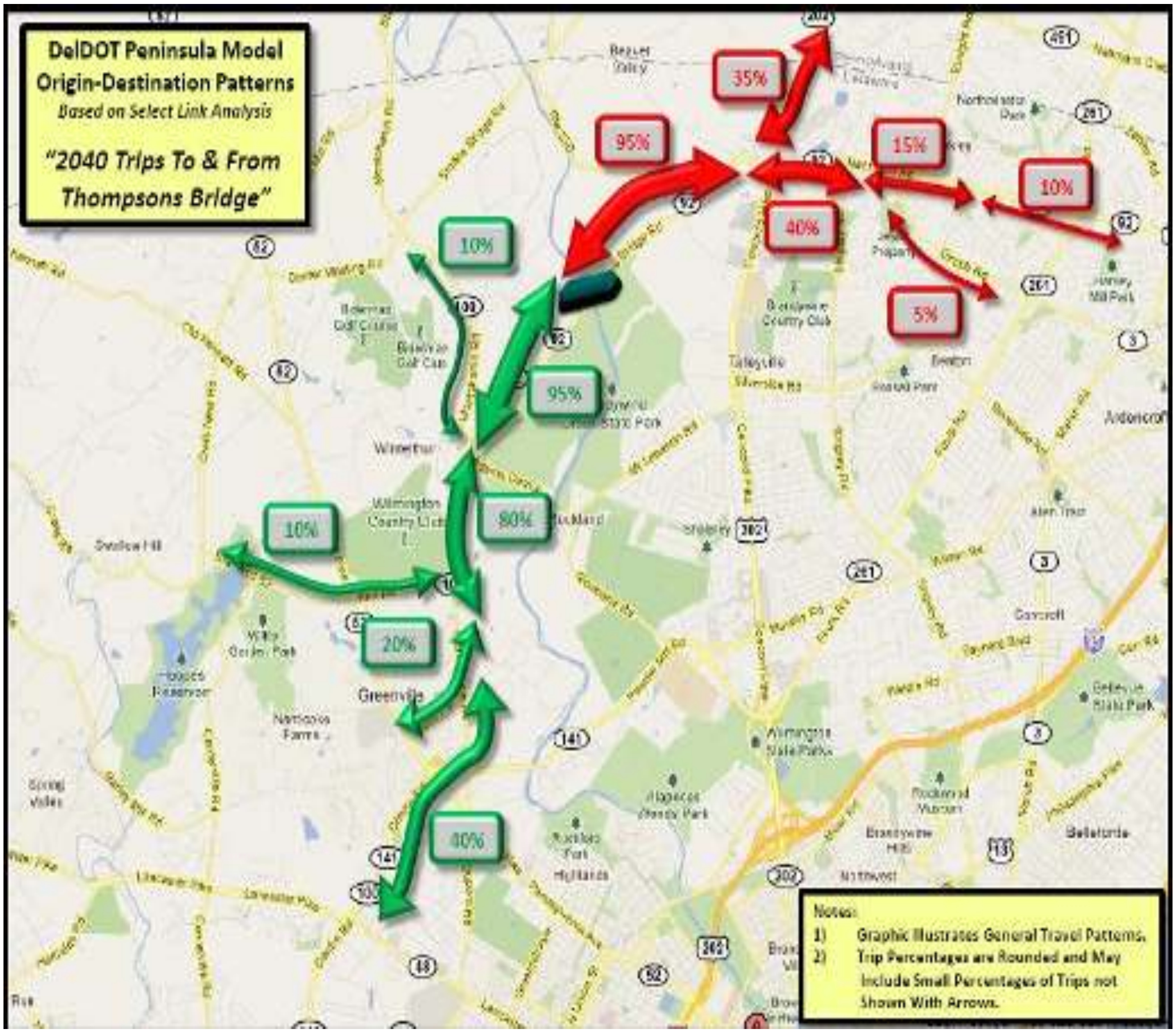

FIGURE 4.2-E: YEAR 2040 ORIGINS-DESTINATIONS OF THOMPSONS BRIDGE TRAFFIC

Rockland Road Bridge will carry about 8,300 vehicles per day. 45% of the traffic on the bridge with a trip end on the west side of the bridge is from Pennsylvania. Otherwise, it serves predominately southeast to northeast traffic.

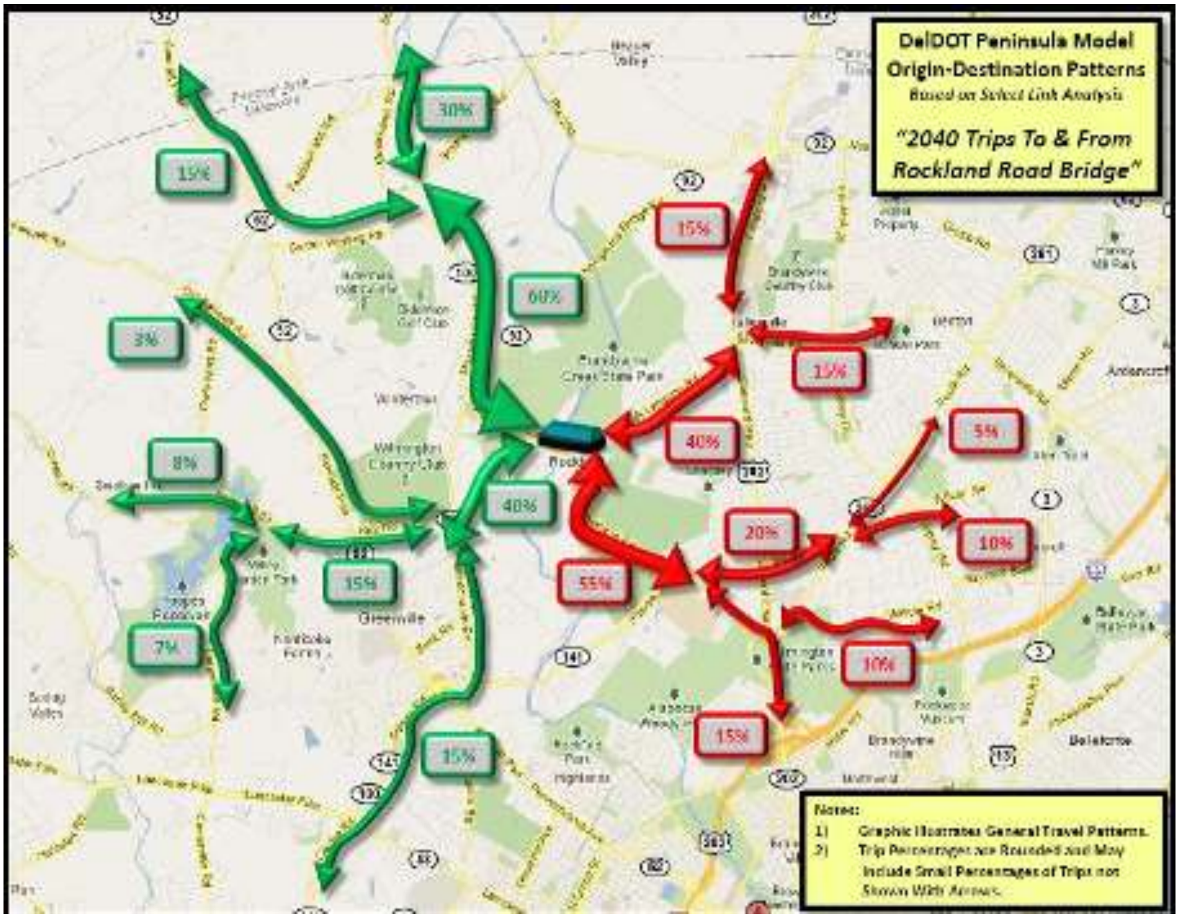

FIGURE 4.2-F: YEAR 2040 ORIGINS-DESTINATIONS OF ROCKLAND ROAD BRIDGE TRAFFIC

4.3 Assessing Future Travel Conditions

While future traffic volumes speak to the amount of travel that the transportation system must be able to accommodate, other measures describe the quality of that travel and provide a glimpse into transportation conditions by the Year 2040.

Level of Service

Most familiar to Delawareans is the concept of 'level of service'. This measure is simple to understand as it grades the ease of travel, measuring it in seconds of delay at intersections and freedom to maneuver at a desired speed between intersections. It is expressed in a letter grade, similar to a school report card. These are the definitions typically used in a traffic impact study.

The travel demand model, however, calculates level of service differently while continuing to use the same letter grades. It compares the projected traffic volumes to the capacity of the roadway, a volume to capacity ratio. This estimate of level of service is more general in nature and combines the capacities of intersections and roadway segments into a single value for each roadway link in the study area roadway network. It factors in travel speed, number of lanes, traffic signal operation, classification of the roadway and other factors such as parking, presence of shoulders and transit operations. The model then calculates a separate volume to capacity ratio for each link in the network. DelDOT has established threshold points for each of the levels of service that relate the volume to capacity ratio to what the motorist sees and experiences. Table 4.3-A illustrates the definitions of level of service used for this analysis.

The illustrations in the table, courtesy of the New Mexico Department of Transportation, graphically show each of the levels of service on a straight section of open road, much like the Byway roadways of Routes 52 and 100.

As also can be seen from the descriptions of each level of service, speeds are affected by traffic volume and as the level of service of the roadway degrades, speeds reduce. Levels D, E and F as shown in Figure 4.3-A have the greatest reductions in speeds while levels of service A to C show very little reductions in speed. Further, it should be noted that the level of service bands as shown in the figure are narrower as the letter grades increase. The reason is that smaller changes in traffic volume when the volume to capacity ratios are closing in on 100% have a significantly greater impact on the flow on traffic than a similar increase at lower volume to capacity ratios.

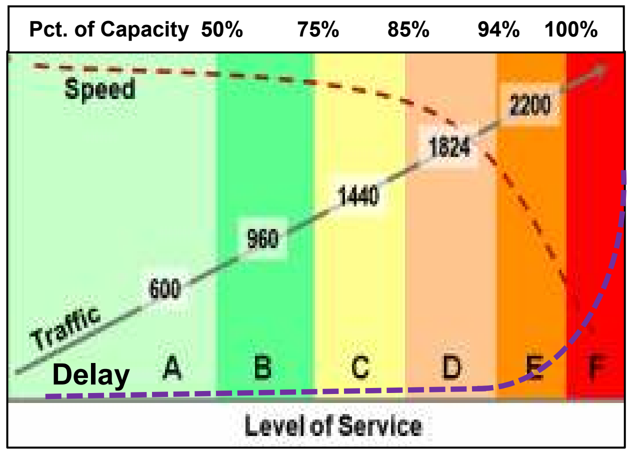

FIGURE 4.3-A: RELATIONSHIP OF LEVEL OF SERVICE TO SPEED

What is the difference in the definitions of Level of Service in Traffic Impact Studies and in Travel Demand Models?

There are many definitions of level of service: Signalized and unsignalized intersections, two lane and multi-lane roadways, roundabouts, merging and diverging ramps on freeways, downtown streets and, believe it or not, pedestrians on sidewalks. Each of these has a different measure of effectiveness. Intersections are the most common in the public discourse and are based upon seconds of vehicle delay, a very simple measurement in which equations based upon field data are used in the calculations. Measures used for roadways are based upon a motorist's freedom to maneuver and the speed of traffic relative to the posted speed, again based upon field data. Each level of service calculation requires lots of data.

Travel demand models typically contain hundreds of intersections and roadway links making level of service calculations of so many roadway intersections and configurations impractical. So a simpler, although less exacting methodology has been developed: the volume to capacity ratio. Based upon measurements, capacities are defined for each roadway and intersection based upon averages. The capacity of each is then adjusted when the travel demand model is adjusted or calibrated until the traffic volumes reported by the model closely match the traffic volumes counted in the field. With a known capacity, a volume to capacity ratio can then be calculated. Finally, the level of service boundaries between the letter grades are then set to parallel a motorist's experience traveling the roadway and the intersections in the roadway segment under analysis.

Level of Service	Percent of Capacity	What a Motorist Would See and Experience (Photos Courtesy NMDOT)
A	Less than 50%	
B	50% to 75%	
C	70% to 85%	
D	85% to 94%	
E	94% to 100%	
F	Over Capacity	

TABLE 4.3A: TRAVEL DEMAND MODEL LEVEL OF SERVICE DEFINITIONS

DelDOT's Travel Demand Model assessed traffic conditions for the year 2010 model. Figure 4.3-B illustrates the levels of service of the study area roadways in 2010 during the PM peak period. As shown in the figure, the only roadway that is of concern from a level of service perspective is Route 141. As expected, the Tyler McConnell Bridge is operating at Level of Service F with other sections operating at Levels D or E conditions.

The Trend, Open Space and Full Build Models project traffic conditions in the plan year of 2040

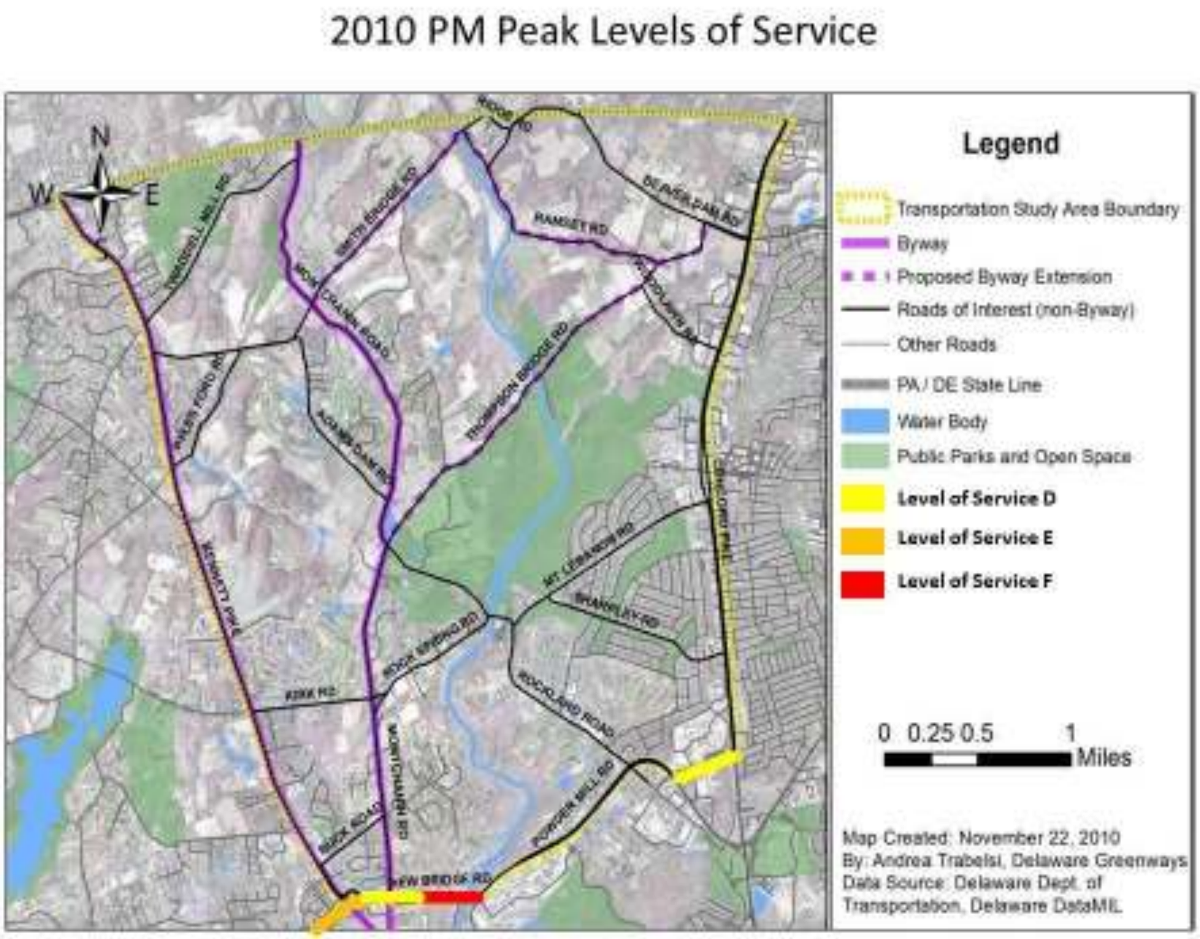

FIGURE 4.3-B YEAR 2010 LEVELS OF SERVICE

for each scenario during the PM peak period. Figures 4.3-C, 4.3-D and 4.3-E illustrate the levels of service for the study area roadway network for the Trend, open Space and Full Build Models, respectively.

Trend Scenario

Levels of service for Route 141 show Level of Service F congestion across the Tyler McConnell Bridge. Level E conditions on Route 141 exist on each side of the bridge between Barley Mill Road and Alapocas Road. Other areas of concern are on Route 52 which shows Level F

Projected 2040 PM Peak Level of Service – Trend Scenario

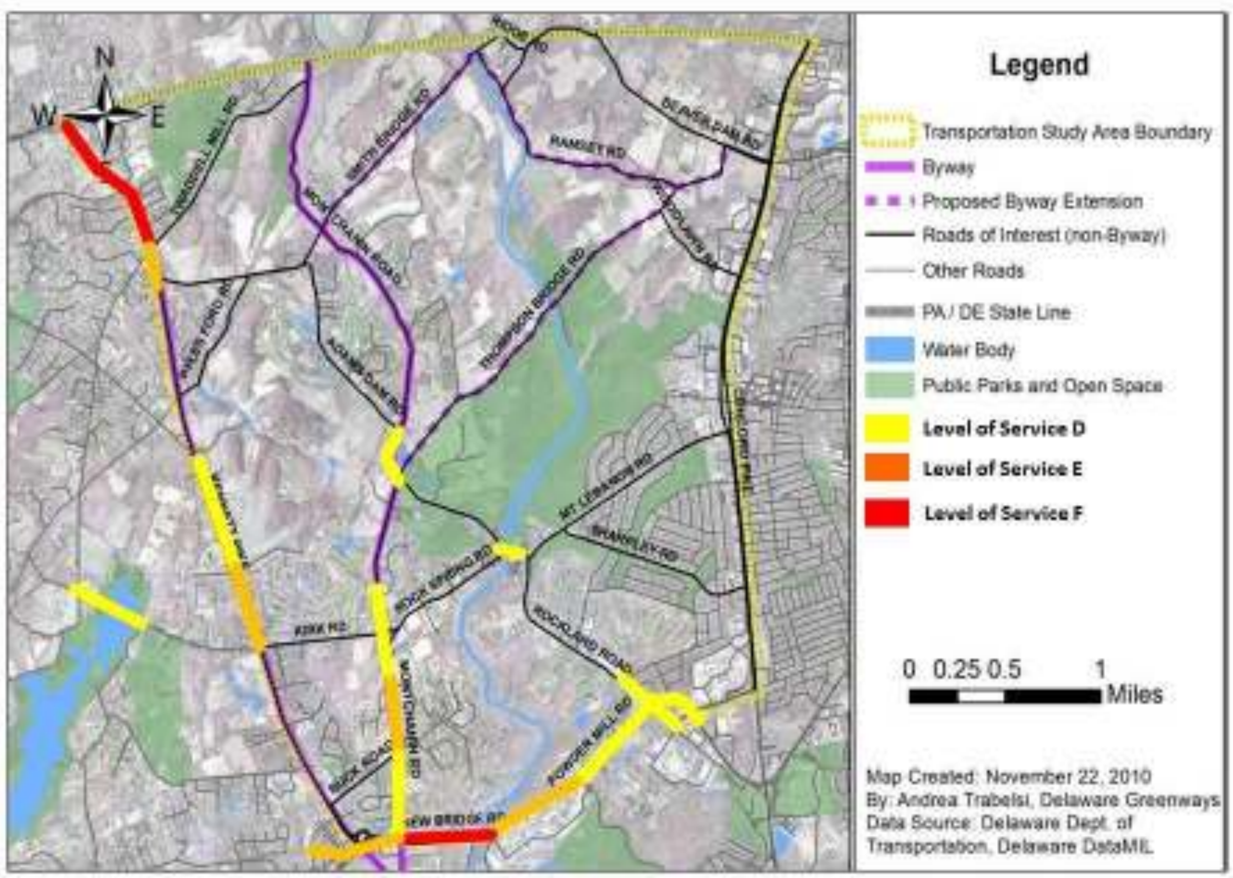

FIGURE 4.3-C: STUDY AREA LEVEL OF SERVICE, TREND SCENARIO

conditions between Centreville and the Pennsylvania Line. Level E conditions will exist south of Centreville and north of Route 82. There is a section of Route 100 that will operate at Level E conditions between Buck Road and Route 141.

Open Space Scenario

The levels of service for the Open Space Scenario closely replicate the levels of service for the Trend Scenario but add an additional Level E link between Thompson Bridge Road and Adams Dam Road. The reason for this is that the Trend Scenario assumed more development locations of less development than the Open Space Scenario which assumed fewer but denser developments. For the purposes of this study, the differences between the two scenarios are not significant to the study area in general but could be significant to a particular roadway segment. This possibility will need to be monitored as development occurs.[14]

Projected 2040 PM Peak Level of Service – Open Space Scenario

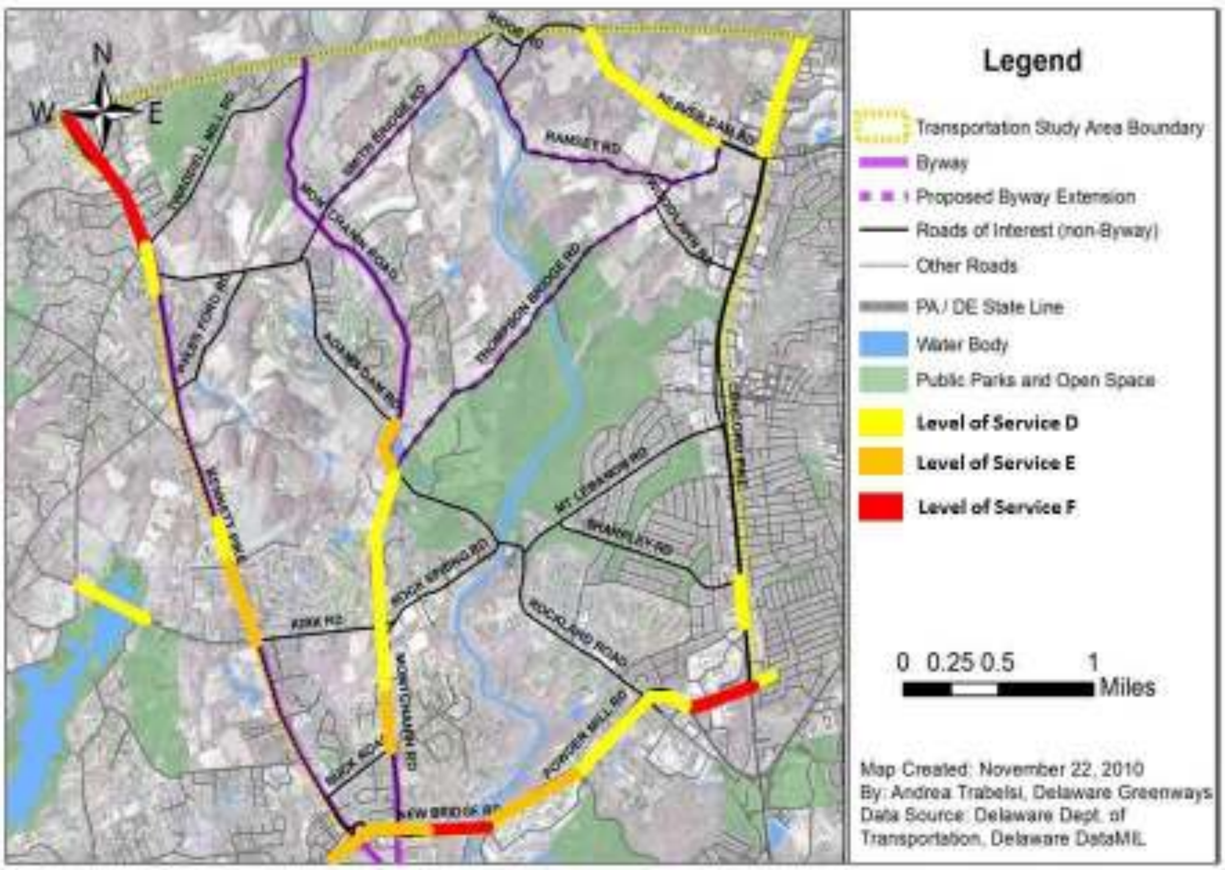

FIGURE 4.3-D: STUDY AREA LEVELS OF SERVICE, OPEN SPACE SCENARIO

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[14] It should also be noted that the locations of development assumed in the travel demand models are based upon an analysis contained in the Trend Scenario Report. As indicated in that report, development occurs when individual land owners decide over time to develop or re-develop their land. Consequently, it is unlikely that development will occur as assumed. Nor can the results of the zoning and land development process be accurately predicted. Nevertheless, it bears repeating that the results of the travel demand analysis are valid for the roadway system as a whole and that traffic conditions specific to a given development are designed to be addressed through the land development process. Recommendations to improve this process will be addressed in subsequent reports.

Full Build Scenario

The Full Build Scenario assumes all residential entitlements are built out. As shown, virtually all of Route 141 is projected to operate at Level F. Similarly, Level F conditions expand along Route 52 through Centreville. Between Winterthur and Route 82, conditions are projected to be Level E and F. Most of Route 52 will suffer some level of congestion. Further, on Route 100, Level F conditions will exist between Thompson Bridge Road and north of Buck Road with the entire length congested to varying degrees between Adams Dam Road and Route 141. Beaver Dam Road west of Thompson Bridge Road will be congested with Level F conditions between

Projected 2040 PM Peak Level of Service – Full Build Scenario

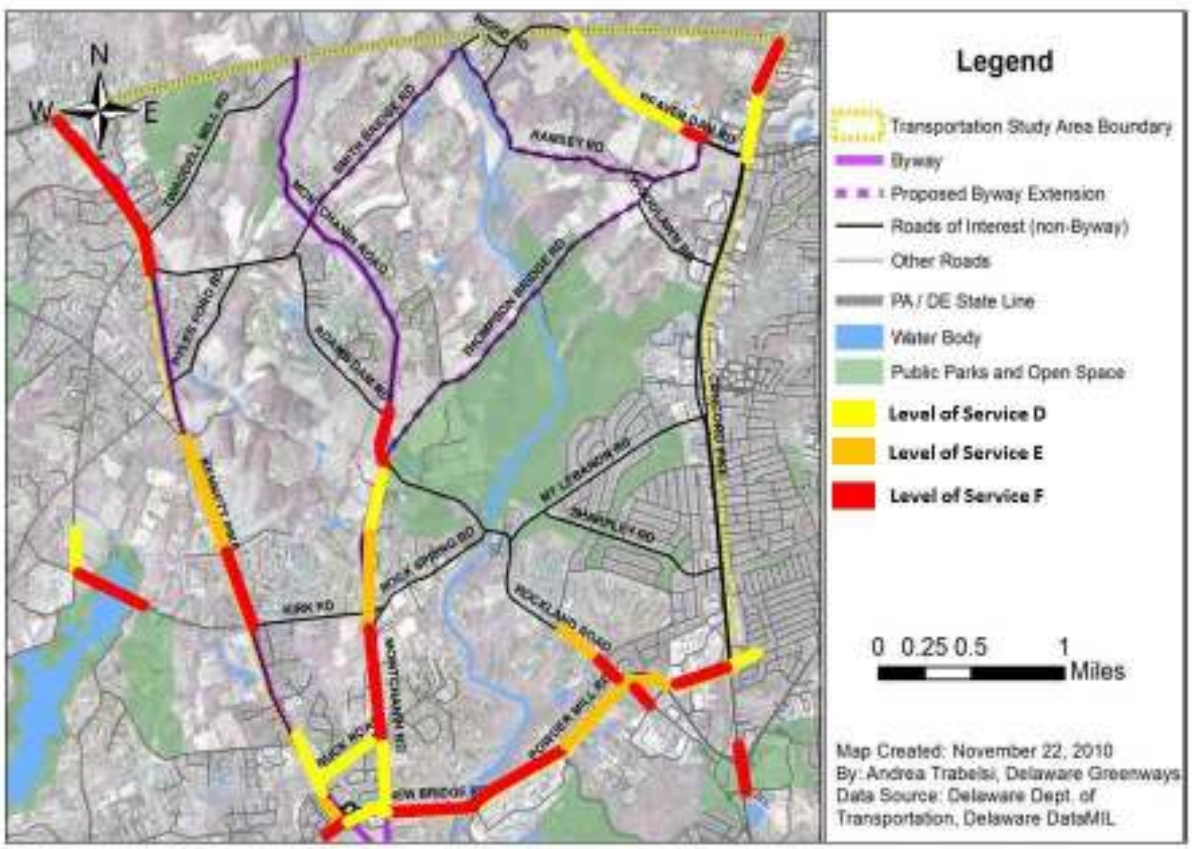

FIGURE 4.3-E: STUDY AREA LEVELS OF SERVICE, FULL BUILD SCENARIO

the dairy and Thompson Bridge Road. Further, for the first time, conditions on US Route 202 degrade to Level F approaching I-95 and approaching Pennsylvania.

Vehicle Miles Traveled

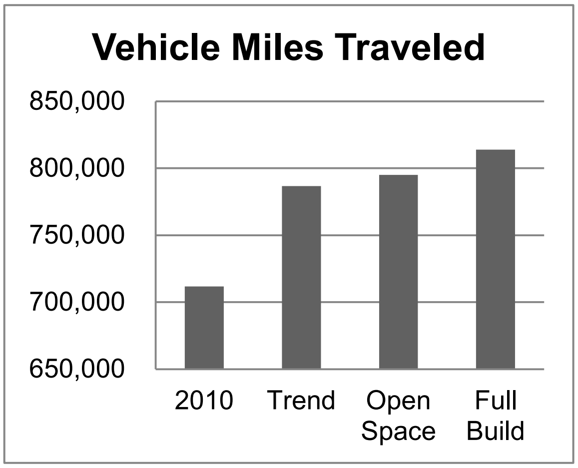

FIGURE 4.3-F: VEHICLE MILES TRAVELED COMPARISON

The amount of travel in the roadway network is estimated by calculating the number of vehicle miles traveled. Vehicle miles traveled calculates the distance between the beginning and ending points of each trip and then sums the distance of all trips in the system. We know that alternatives with the fewer vehicle miles traveled result in less vehicle emissions, less fuel consumed, more trips on foot, by bicycle or in a bus, and generate a more healthy population[15].

Figure 4.3-F illustrates the amount of vehicle miles traveled in the study area. As can be seen in the chart, in 2010, there is 712,000 vehicle miles traveled. That figure increases to about 800,000 for the three development scenarios studied. Comparing the three future scenarios to 2010, it is noted that the Trend Scenario increases travel by 10% over 2010, the Open Space Scenario by 11% and the Full Build by 14%. As this extra traffic spreads itself through the study area roadway network, it is no wonder that congestion is projected to significantly increase. It should be noted that the reason that the Open Space Scenario results in slightly higher vehicle miles traveled is because the Open Space Scenario development pattern assumes fewer developments but each contains more in the number of houses due to clustering. This is in line with the goal of the Open Space option of preserving additional open space and permitting additional housing units as an enticement for preservation of open space. The difference in vehicle miles traveled between the Trend and Open Space models is not significant and very likely would change depending upon the location of the actual development parcels and the development type chosen.

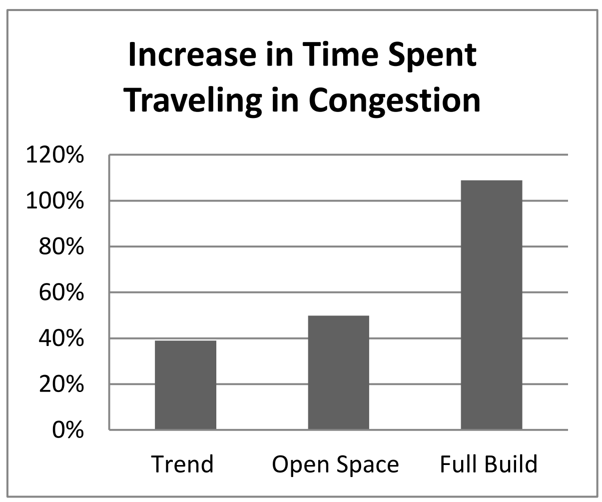

FIGURE 4.3-G: PERCENT INCREASE IN TRAVEL TIME ON CONGESTED ROADWAYS OVER 2010

Travel Time

As a model output, travel time is expressed as the aggregated travel time of all vehicles making

[15] Dill, Jennifer, PhD, et. al, Research Brief, May 2013, Active Living Research, A national program of the Robert Wood Johnson Foundation.

a trip in the study area. There were about 520,000 trips in the system for the Trend and Open Space scenarios and 540,000 trips in the system for the Full Build scenario, about 20,000 more or an increase of about 4%. Yet the travel times are substantially greater. Figure 4.3-G compares the increase in time spent for all vehicles in the system traveling in *congested conditions* (e.g., level of service E of F conditions). As shown in the graph, the Trend and Open Space scenarios show an increase of 50% but the Full Build Scenario results in an increase in excess of 100%. Figure 4.3-H illustrates travel times in the PM Peak Period. As shown in the graph, the Trend Scenario increases travel times in the PM Peak by 40% over 2010, the Open Space Scenario by 50% and the Full Build Scenario by in excess of 100%.

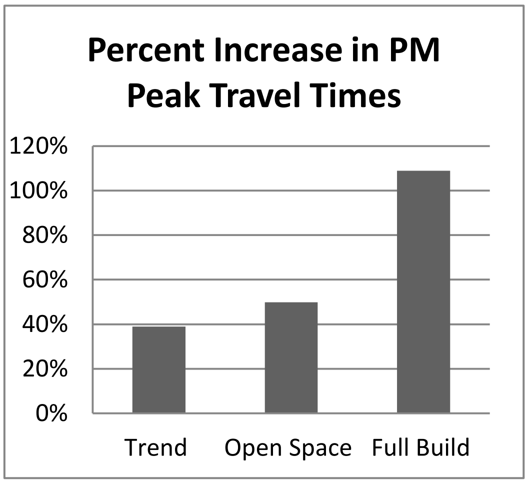

FIGURE 4.3-H: PERCENT INCREASE IN TRAVEL TIME OVER 2010

DuPont Country Club

It should be noted that the development of the office zoned portion of the DuPont Country Club has not been assumed in any of the scenarios. This site is located on the north side of Route 141 between Alapocas Road and Rockland Road. Its current zoning is office regional and could permit about 1,000,000 square feet of office space. It also has frontage on Rockland Road. Projected employment levels for the Valley can be accommodated assuming development in other non-residentially zoned tracts assumed for development. However, like any other location in the study area, development of this site might occur or might not occur. But because of its location on a major roadway that by any measure could define the carrying capacity of the system, development of this parcel has been examined separately. Appendix A provides an analysis of how traffic conditions change should the site be developed.

The conclusion of the separate analysis is that the potential development of the office portion of the DuPont Country Club will degrade traffic conditions on Route 141 and on Route 52 in Greenville beyond either the Trend of Open Space Scenarios. Further, considering Route 100, traffic conditions in the peak direction are also degraded and could get worse as traffic avoids Greenville.

5.0 Carrying Capacity of the Roadway Network

Loosely defined, *carrying capacity* is the amount of activity or use that can be handled by a system before it begins to deteriorate. Another way to describe carrying capacity is determining how much use (e.g., travel demand) a given setting (or transportation system) can absorb, before capacity is exceeded[16]. From the analysis, it is clear that even today, specific links are operating at or above their capacity. The Tyler McConnell Bridge, for example, is notorious as a point of congestion in the system. Yet it is a localized point of congestion, a classic bottleneck. Carrying capacity refers to a systemic breakdown in which the entire system begins to fail, as opposed to just a bottleneck where failure is localized.

Fixing a bottleneck like the Tyler McConnell Bridge with additional capacity could be a wise choice. But adding capacity to increase the carrying capacity of an entire transportation network is another matter. Additional capacity, to be effective in that situation, would mean widespread widening of roadways, including the Brandywine Valley National Scenic Byway if all roadway links noted as level of service D, E, or F were to be improved. Such actions would irretrievably alter the context of the Valley and especially, the Byway. This raises the question of what should the definition of carrying capacity be for the Brandywine Valley National Scenic Byway and the other roadways of the Brandywine Valley. From the assessment of level of service, it is clear that under the Open Space or Trend Development Scenarios, sections of Routes 52 and 141 will operate beyond capacity and sections of Route 100 will come close to capacity. If only level of service were used to define carrying capacity, then Route 141 is over its carrying capacity today, Kennett Pike is over capacity by 2040 and Route 100 is seriously approaching its carrying capacity sometime between now and 2040. The measure of carrying capacity must be expanded to include other parameters so that the choice and timing of any strategy whether it be managing the increase of travel demand or planning the addition of capacity to the system must reflect the desires of the affected community.

If vehicle miles traveled and travel time are considered in the definition, it is noted that 10% increases in vehicle miles traveled result in 40% and 50% increases in travel time across the entire study area, depending on the predominate development scenario. Figure 4.3-A, which shows the relationship of level of service to speed, shows the reason. Increases in traffic do not really impact speed, and as a result, travel time, until the Level of Service D-E threshold becomes widespread across the study area and not just at a few bottleneck locations. It can be concluded that between the year 2030 and 2035, the carrying capacity of the Brandywine Valley will have been reached. The exact point depends upon the development patterns, whether the rate of development and location of development follows along the demographic projections and whether growth outside the valley also stays within projections. Development in excess of that projected would speed up when the Byway and the Valley roadways reach their carrying capacity.

[16] Alternative Transportation in Parks and Public Lands (ATPPL), J.N. “Ding” Darling National Wildlife Refuge, City of Sanibel, Existing Conditions Report. Parenthesis inserted by the study team to relate the definition to this analysis.

The separate analysis of the DuPont Country Club office portion is a case in point. In addition to just accelerating the deterioration of Route 141, it adversely impacts Route 52 in Greenville and Route 100 in Montchannin.

Development in Pennsylvania is a substantial contributor to the pressures placed on the capacity of the network to accommodate its demand, adding 20% of all traffic to the roadways of northern New Castle County. Examination of Route 52 at the Pennsylvania line indicates that the traffic entering and leaving Delaware will operate at Level of Service F without a major destination in the vicinity. Traffic flow in Centreville is sensitive to development in Pennsylvania.

Finally, there is no question that the Full Build Scenario would drive travel demand well beyond the carrying capacity of the roadways of the Valley. While vehicle miles traveled increases only 14% over 2010, travel time and time spent in congestion more than doubles.

5.1 Challenges

The analysis of travel demand has shown that the issue of development within the Brandywine Valley, on the National Byway and in Pennsylvania must be addressed. Failure to do so will cause the entire network to exceed its ability to function and serve the Valley. Specific challenges are:

1. *The existing bottleneck of the Tyler McConnell Bridge*. It is the only link in the study area roadway network that operates at Level of Service F currently. It is a two lane bridge on an otherwise four lane arterial highway. Fixing the bottleneck will not be easy. DelDOT made a major attempt to widen the bridge several years ago which ended in no action. Failing to widen the Tyler McConnell Bridge will cause traffic to seek other, quicker routes across the Brandywine River, some of which are in the this study area: Rockland Road, Route 92, and Smith Bridge, especially if the DuPont Country Club tract is developed as permitted by current zoning.
2. *Development Practices in Pennsylvania*. With the Wilmington area remaining as the employment center for southern Chester County and Delaware County in Pennsylvania, continuing the pattern of development prevalent in those areas will overload the roadway network beginning with Route 52, affecting Centreville.
3. *Number of Entitlements*. If the all of development entitlements (building lots) available to landowners in the study area are built, the carrying capacity of the roadway network of the Brandywine Valley will be greatly exceeded. Even if the number of development entitlements acted upon approaches, but never exceeds, the demographic projections for the Brandywine Valley, the carrying capacity of the Brandywine Valley will be exceeded before 2040.
4. *Open Space Preservation*. The County encourages the preservation of open space by encouraging developers to cluster development and by providing additional density on tracts designed under the open space zoning provisions of the Unified Development Code. This report analyzed the differences in travel demand if developers chose traditional developments and open space developments. The results showed that open space developments increases travel demand due to the increased number of houses (entitlements). In a perfect world, open space preservation should not produce an increase in travel demand but with few other meaningful incentives to offer developers,

land use agencies are lacking the tools to effectively manage both open space and travel demand.

5. *Pressure to Add Roadway Capacity*. It can be expected that as development continues, particularly in Pennsylvania but also elsewhere, pressure to widen or substantially add capacity to the roadway system will increase, pitting neighbor against neighbor and community against community, those who are more concerned about mobility against those more concerned about the quality of life and the iconic scenery of the Valley.

But with challenges come opportunities. Each of the five challenges noted can be addressed by considering the opportunities each presents. The level of service analysis in this report paves the way. Table 4.3-A and Figure 4.3-A show that most of the degradation in traffic flow occurs in Level of Service E and F conditions. If traffic volume growth in the peak commuter periods could be restrained to 10% to 15% less than projected by the travel demand model, achieving carrying capacity could be put off for years or, at the very least, until after 2040. Further, benefits of managing peak hour traffic demand by spreading the peak period through flex time and staggered working hours, telecommuting and carpooling can be a meaningful contribution to the needed reduction in traffic.

In addition, specific opportunities exist to address the four challenges noted previously.

1. Several years ago, DelDOT made a concerted attempt to replace the Tyler McConnell Bridge with a widened structure well within the context of the area. The preliminary designs were multi-modal as connections across the Brandywine were provided for pedestrians and bicycles. But the existing 1970's designed bridge was determined to be historic, stopping all efforts. Subsequently, funding for the replacement dried up and efforts stopped. The bottleneck remains and, until the structure is replaced, will continue to exist with regional implications. It is clear, based upon this analysis that the effort should restart. The existing structure is clearly not as historic as the buildings it crosses above, nor is it unique among structures in Delaware or around the country; there are many others like it. Review of the preliminary designs that were considered in past efforts were remarkably creative and worthy of continued consideration. It is clear that an opportunity exists to reconsider the historic classification of the existing bridge as funding for a new structure is found.
2. In Pennsylvania, land use decisions are municipality based. There are over 2,500 incorporated municipalities in Pennsylvania's 67 counties. Rarely is there close coordination across municipal boundaries. Worse, Pennsylvania law specifies that each municipality provide for all potential land uses in their zoning code. It is to the municipality's advantage to encourage low density residential development across as wide an area as possible to deter undesirable land uses or force them by default to parcels on municipal boundaries. Increasing density through clustering does not mean fewer dwelling units or more publicly owned open space. Rather, it typically means the same number of units with privately owned open space. But municipalities in Pennsylvania are realizing the costs of low density development and the seeds of coordination are taking root. Recently, WILMAPCO and the Delaware Valley Regional Planning Commission (DVRPC) have published reports advocating coordination and

documenting the coordination efforts underway.[17] While the reports are regionally focused, the opportunity exists to develop a case study of cooperation between New Castle County and the counties of Chester and Delaware in Pennsylvania within the framework established by DVRPC and WILMAPCO. Focusing on encouraging best land use practices and integrating transportation into the land use planning process would go a long way to addressing the challenge. Increased coordination across state lines through peer to peer coordination and projects can shine a light on the benefit of increased coordination and cooperation.

3. Rarely is any the zoning plan tied to the carrying capacity of the infrastructure it relies upon; rather, it is an exercise of insuring the preservation of property rights. It is not reasonable or prudent to radically change the number of development entitlements; such changes are classed by the courts as takings warranting fair market based compensation. For years, however, in the Brandywine Valley, public spirited landowners have worked with non-profit conservancies and government to preserve the most treasured lands. Recently, Woodlawn Trustees, the largest landowner in the Brandywine Valley sold 1,100 acres of their holdings to create the First State National Monument, forever preserving some of the most beautiful and best viewsheds of the Brandywine Valley. Continued efforts to preserve land are clearly warranted and opportunities exist given the interest in the valley.
4. In the past, most roadway projects were planned to address capacity or level of service issues. Even if the project was driven by safety considerations, achieving Level of Service C became a project objective. Recently, DelDOT has adopted a context sensitive solution planning process for transportation projects on Delaware's Byways. The publication, *Context Sensitive Solutions for Delaware Byways* dated June 2011 provides a roadmap for transportation projects on the state's byways[18]. Incorporating the principles of flexibility in highway design promoted by the Federal Highway Administration, projects can be sized to the context of the area that surrounds the project. Flexibility is provided for level of service, lane width, shoulder width, design speed, and other factors that define the footprint of a transportation project. Each project must also meet the Department's Complete Streets Policy which provides for accommodation of all travel modes[19].

> *Let our advance worrying become advance thinking and planning.*
>
> *Winston Churchill*

Finally, as we rally to protect the intrinsic values of the Brandywine Valley National Scenic Byway, widening of any of the Byway roadways will take away the reason for Delaware's only National Byway to exist in the first place.

Recent action of the Delaware State Legislature to establish a Brandywine Valley National Scenic Byway Advisory Board at the behest of the Byway community was a major step forward and presents a new opportunity for monitoring challenges to the Byway as well as pursuing opportunities to preserve and enhance it.

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[17] Delaware Valley Regional Planning Commission, Planning at the Edge, July, 2003 and WILMAPCO, Inter-Regional Report, Making Connections Across Our Region's Borders, 2012.
[18] Delaware Department of Transportation , *Context Sensitive Solutions for Delaware Byways*, , prepared by Mahan Rykeil Associates, Inc., Whitman, Requardt & Associates, LLP, June 2011.
[19] P.I. NUMBER: O-6, Complete Streets Policy, Executive Order Number 6, by Governor Jack Markell.

APPENDIX

This analysis of the potential traffic impact of the development of a portion of the DuPont Country Club that fronts on DE Route 141 is a planning level analysis. It is NOT a formal traffic impact study that is typically prepared for a development project. If a development is proposed for this or any other tract, the traffic analysis prepared as part of the development application would be significantly more detailed. That analysis would replace and supersede this analysis.

Potential Traffic Impact of the DuPont Country Club

A1.0 Introduction

In developing the Trend, Open Space and Full Build scenarios for the Scenic Conservation Plan study, demographic and employment projections were analyzed to provide a basis to evaluate the carrying capacity of the roadways of the Brandywine Valley and especially the Routes 52 and 100, which comprise the Brandywine Valley National Scenic Byway. The development scenarios used in the travel demand modeling process did not include the development of the non-residentially zoned portion of the DuPont Country Club located on the north side of Route 141 opposite Alapocas Road. The study team was concerned that the development of

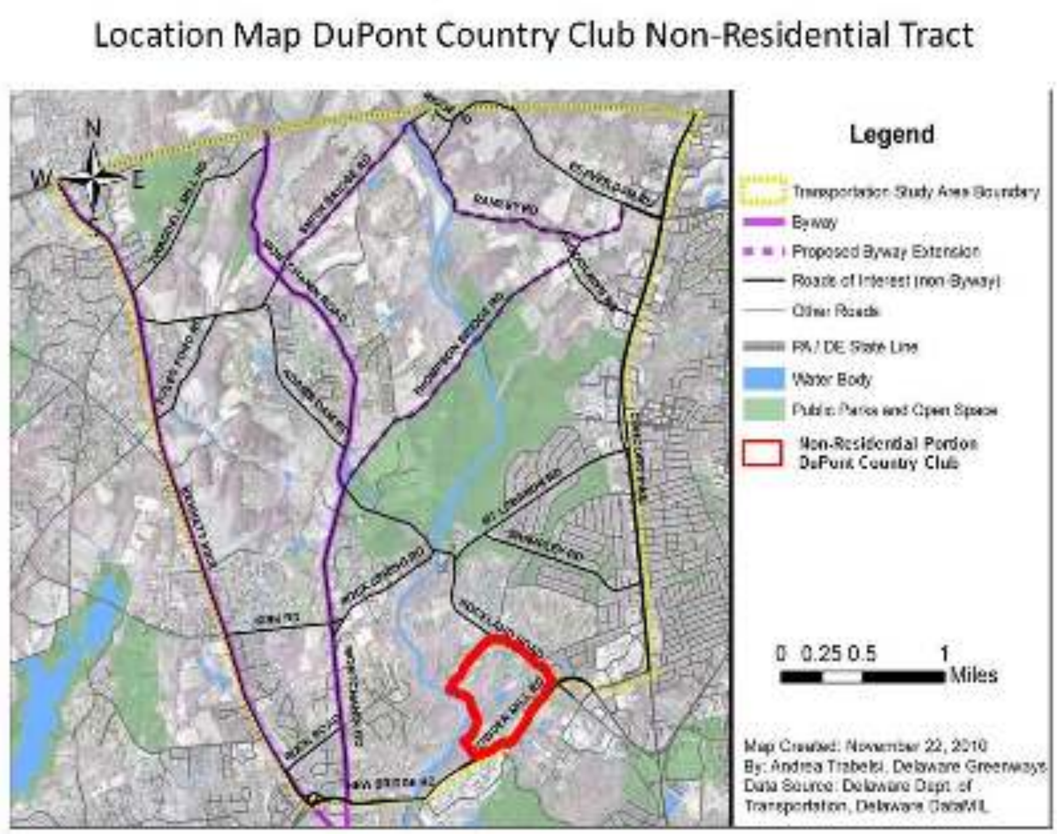

FIGURE A-1: LOCATION MAP

this tract would have an outsized impact on the roadway network of the Brandywine Valley due to its location.

Currently, this tract is zoned Office Regional under the Unified Development Code (UDC) of New Castle County. This tract also has frontage on Rockland Road. Figure A-1 illustrates the study area for the Scenic Conservation Plan and the tract in question.

Based upon an examination of the UDC, some one-million square feet of office space could be developed on that site. The UDC provides a number of options for developers to choose from in planning the site, including mixed use and clustering. No attempt was made to determine the best scenario or even the most likely development program; that is the province of the site developer, the County's Department of Land Use and the County's Planning Board under the land development process. Rather, a single use development of office was analyzed to demonstrate what the impact could be should the site be developed. Finally, it must be stated that no development proposals for the site have been submitted, none are known to be in the works and the tract could remain a golf course well beyond 2040, the time horizon of this analysis. The sole purpose of this analysis is to understand the impact of the development of this tract on the carrying capacity of the study area roadway network and the Brandywine Valley National Scenic Byway.

If and when the owners of this tract choose to develop it, any traffic analysis completed for a specific development proposal would supersede and replace this analysis. This analysis considers only the PM Peak Hour and examines traffic conditions in the year 2040 under the Trend Scenario. Trend Scenario traffic volume projections formed the base volumes upon which traffic volumes from the DuPont Country Club office portion were overlaid. Levels of

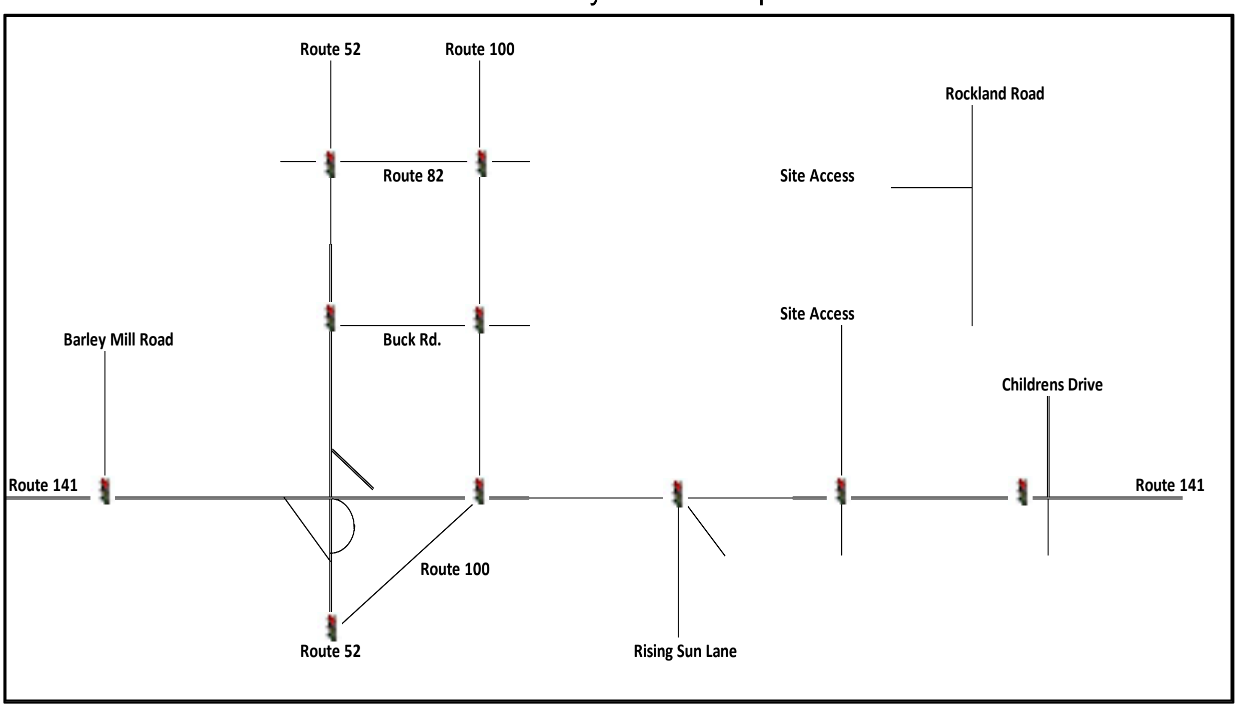

FIGURE A-2: AFFECTED ROADWAYS, DUPONT COUNTRY CLUB OFFICE PORTION

service based upon volume to capacity ratios were projected for the roadway links in a manner consistent with the DelDOT Travel Demand Model.

Figure A-2 illustrates roadways and traffic controls of the study area for this analysis. As shown, the study area includes the following roadways:

- Route 141 from Barley Mill Road to Children's Drive. This section includes the Tyler McConnell Bridge located just west of the Rising Sun Lane Intersection as well as traffic signals at Barley Mill Road, Montchanin Road, Rising Sun Lane, Alapocas Road and Children's Drive. Its junction with Route 52 is an interchange. Route 141 carries two lanes in each direction. Except for the segment between Montchanin Road and Alapocas Road, there is a landscaped median.
- Route 52 (Kennett Pike) between Route 100 and Route 82. This section includes the village of Greenville. Its entrance into the study area is just north of the Wilmington city boundary. Traffic signals are located at its intersection with Route 100, Presidential Drive, Buck Road, Hillside Road, and Route 82. Route 52 is a four lane roadway between Montchanin Road and Hillside Road. It is a two lane roadway north of Hillside Road. A landscaped median exists between Montchanin Road and just north of Hillside Road.
- Route 100 (Montchanin Road) between Route 52 and Route 82. This section includes traffic signals at Route 52, Route 141, Buck Road, Rockland Road and Route 82. It is a two lane roadway except for the section between Route 52 and Route 141.
- Rockland Road between Children's Drive and Black Gates Road. This section is a two lane roadway.

As previously noted, Routes 52 and 100, Kennett Pike and Montchanin Road, respectively, comprise the Brandywine Valley National Scenic Byway.

A1.1 Traffic Characteristics of the Office Portion of the DuPont Country Club

There are two components that comprise the traffic characteristics of any given development proposal.

- Trip generation: The amount of traffic added to the roadway network.
- Trip distribution: The arrival and departure pattern of site traffic.

Trip Generation

The amount of traffic that would be added to the roadway network by the office portion of the DuPont Country Club was determined by using the publication, Trip Generation, An ITE Informational Report, 8th Edition, 2008[20]. Land Use Code 750, Office Park, was used to estimate the amount of traffic generated by the tract. Table A-1 illustrates the amount of traffic added to the roadway network.

[20] Trip Generation, 8th Edition, An Informational Report, Institute of Transportation Engineers, Washington, D.C., 2008.

Table A-1: Trip Generation, Office Portion DuPont Country Club

Land Use Code	Description	PM Peak Hour In	Out	Total	Daily Traffic
750	Office Park	145	1,171	1,316	10, 829

Trip Distribution

The arrival/departure pattern is shown in Figure A-3. It is based upon projected future traffic patterns depicted in the Travel Demand Model. In distributing the site traffic to the roadway network, 80% of the site traffic was assumed to use an access driveway to Route 141 and the remaining 20% would use an access to Rockland Road.

Review of the arrival/departure patterns reveals that of the 80% accessing Route 141 directly, 34% arrive and depart to and from the east and 58% arrive and depart to and from the west with 31% using the Brandywine Valley National Scenic Byway.

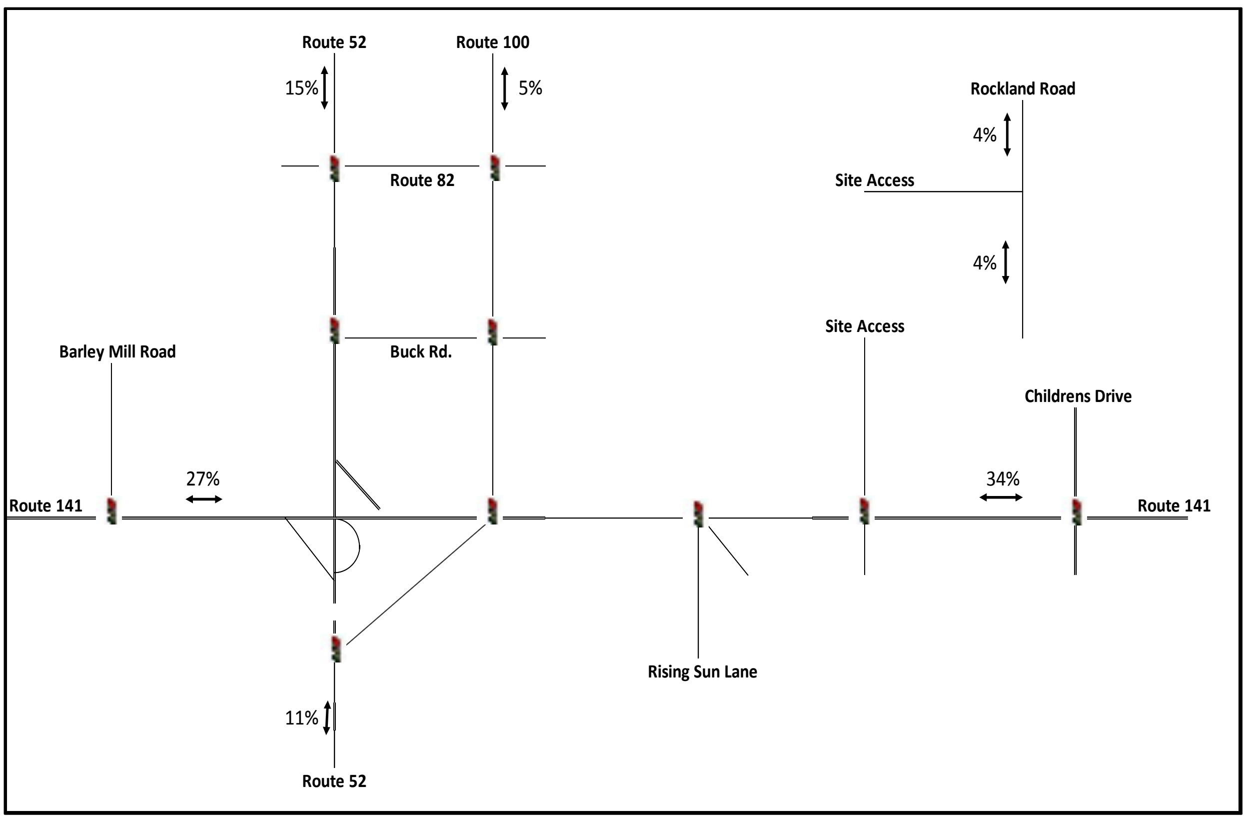

FIGURE A-3: ARRIVAL/DEPARTURE PATTERNS OF SITE TRAFFIC

Figure A-4 illustrates the site traffic on the roadway network. As shown, and as expected, Route 141 gets the bulk of the traffic generated by the site. The Tyler McConnell Bridge is projected to carry an additional 763 vehicles in the PM peak hour. In Greenville, Route 52 is projected to carry an additional 198 vehicles in the peak hour and Route 100, an additional 66 vehicles.

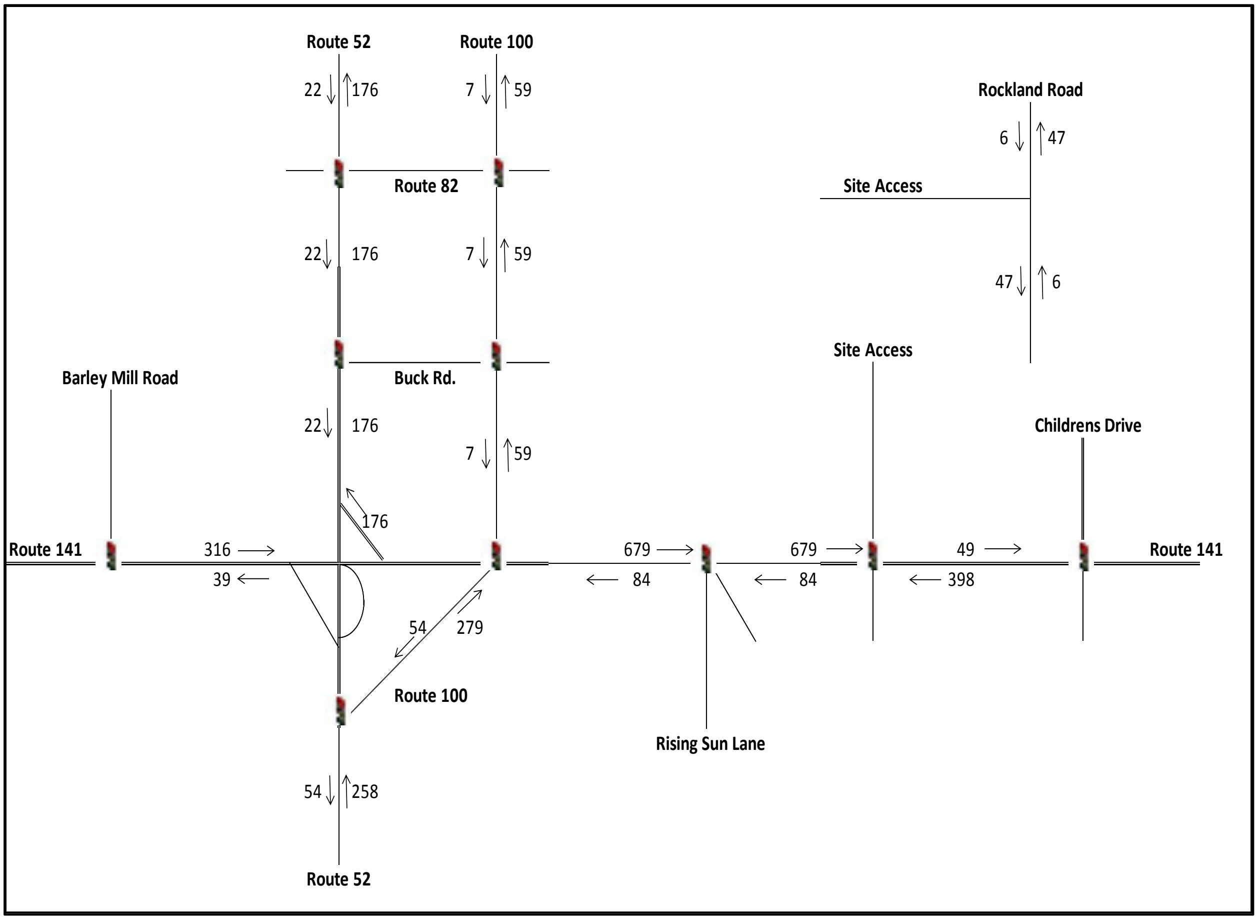

FIGURE A-4 PM PEAK HOUR SITE TRAFFIC VOLUMES

A1.2 Future PM Peak Hour Traffic Volumes

Future traffic volumes were developed by factoring the daily traffic volume projections for the Trend Scenario model by the ratio of daily traffic to peak hour traffic using the factoring methods recommended by DelDOT. In general, the PM peak hour traffic represents about 8% of daily traffic in the study area.

Figure A-5 illustrates the total future PM peak hour traffic volumes. Figure A-6 shows the percentage increase in PM peak hour traffic over the PM peak hour traffic volumes should the site not be developed(Trend Scenario).

More significantly, the Tyler McConnell Bridge will see an increase in traffic of 31% in the peak direction.

Route 52, the Brandywine Valley National Scenic Byway will see traffic increases of upwards of 30% between Route 82 and Centreville.

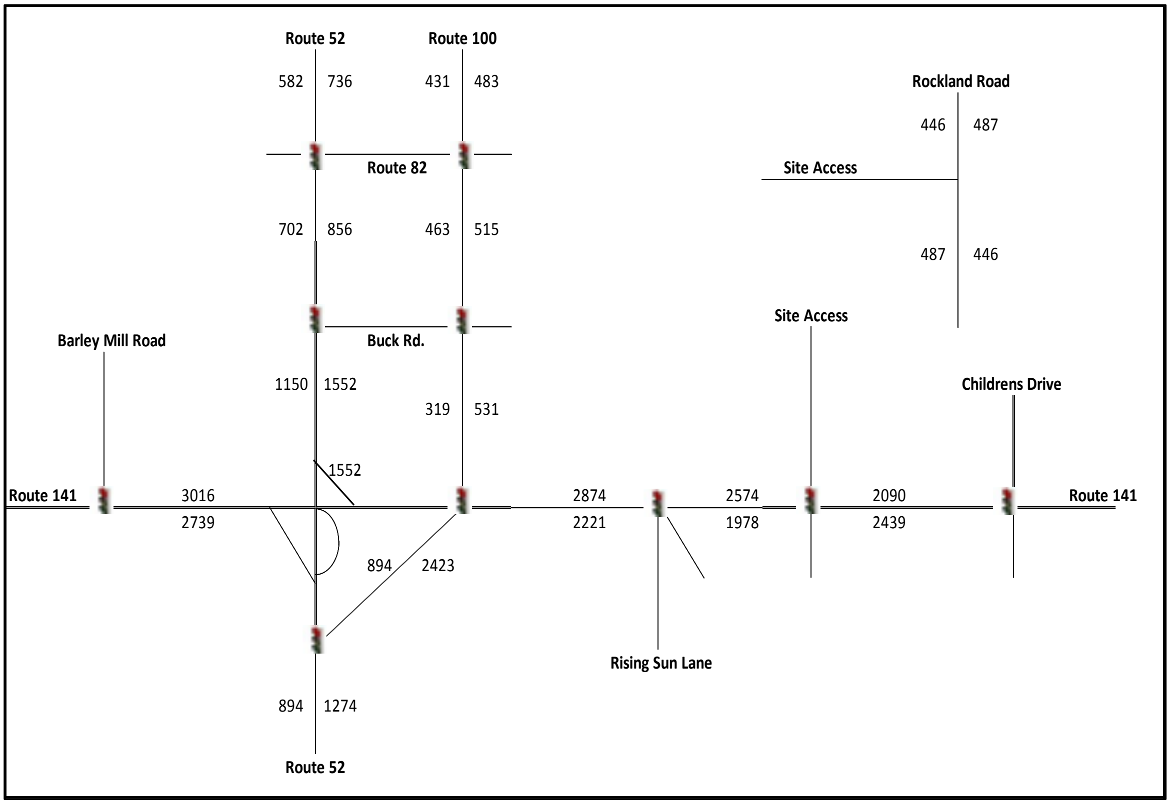

FIGURE A-5 TOTAL FUTURE PM PEAK HOUR TRAFFIC VOLUMES

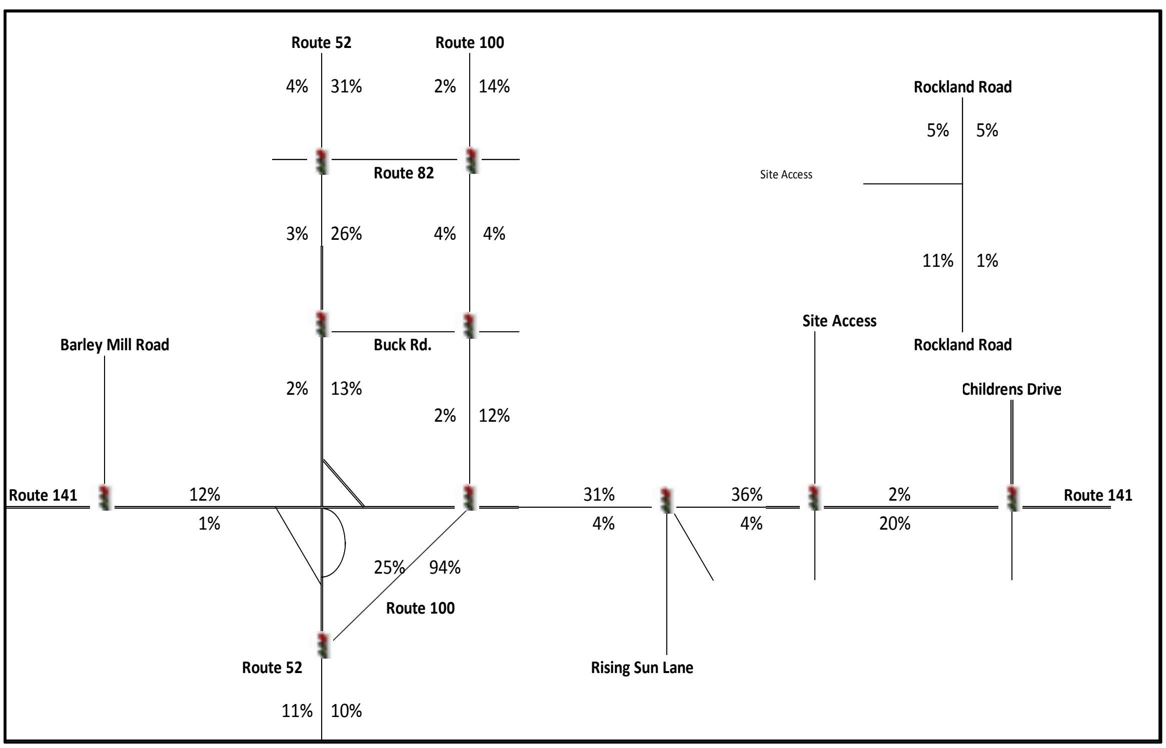

FIGURE A-6 PERCENT INCREASE IN TRAFFIC DUE TO THE OFFICE PORTION OF THE DUPONT COUNTRY CLUB

A1.3 Future Levels of Service

The level of service definitions used in this analysis are identical to those used in the Travel Demand Model and are based upon the volume to capacity ratio and not intersection delay as in a typical traffic impact study. The level of service definitions are shown previously in this report. Figure 7 illustrate the PM Peak Hour Levels of Service with the site undeveloped (the Trend Scenario) and with the site developed. The letter grades for the Trend Scenario are shown in black letters and the levels of service with the site are shown in red, in italics.

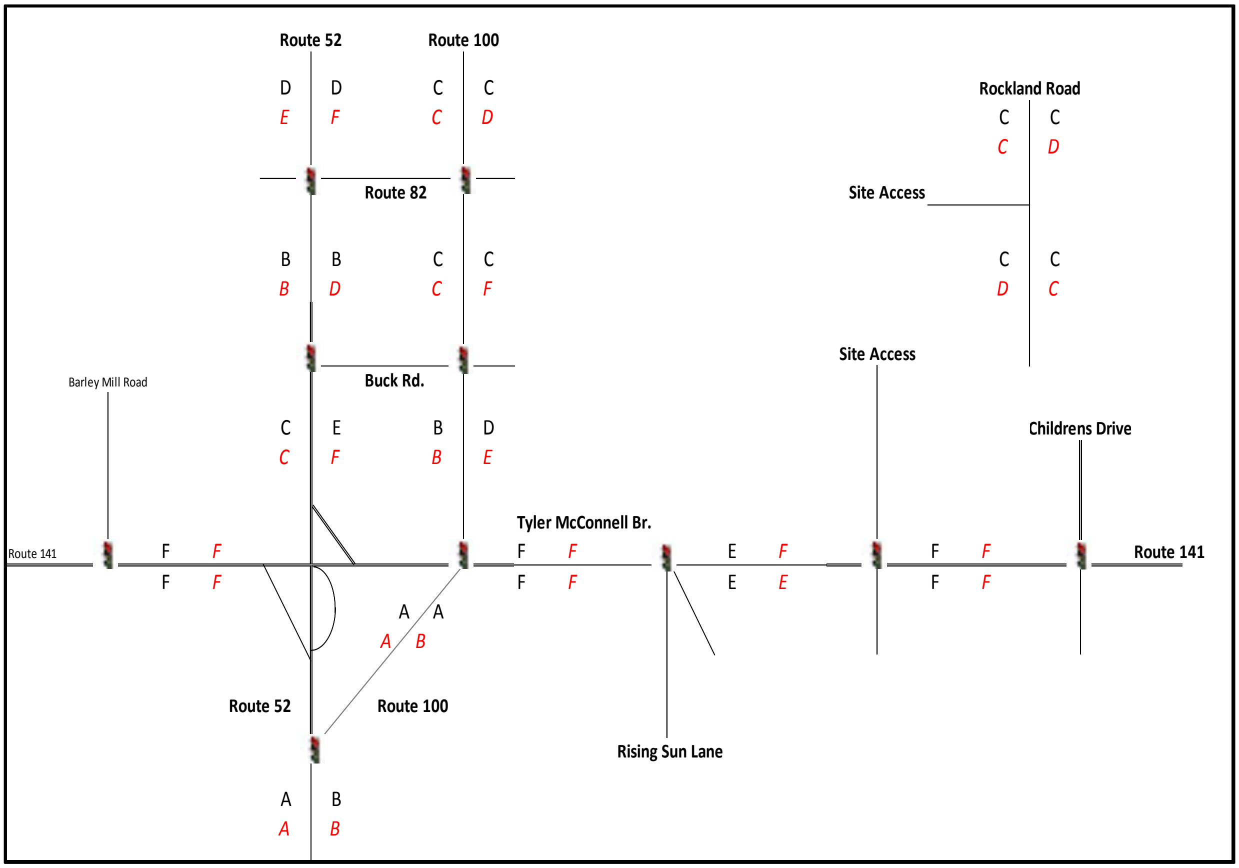

FIGURE A-7 PM PEAK LEVEL OF SERVICE COMPARISON

As show in in the figure, the levels of service on Route 141 remain at levels of E and F for this major regional travel route. The levels of service on Route 52 in Greenville and south of Centreville grow worse, to E and F north of Route 82 and become F just north of Route 141.

It is clear that the potential development of the office portion of the DuPont Country Club will degrade traffic conditions on Route 141 and on Route 52 in Greenville. Further analysis may also reveal that congested conditions on Route 141 and in Greenville may cause gridlock or system breakdown.

Considering Route 100, traffic conditions in the peak direction are also degraded and could get worse as traffic avoids Greenville.