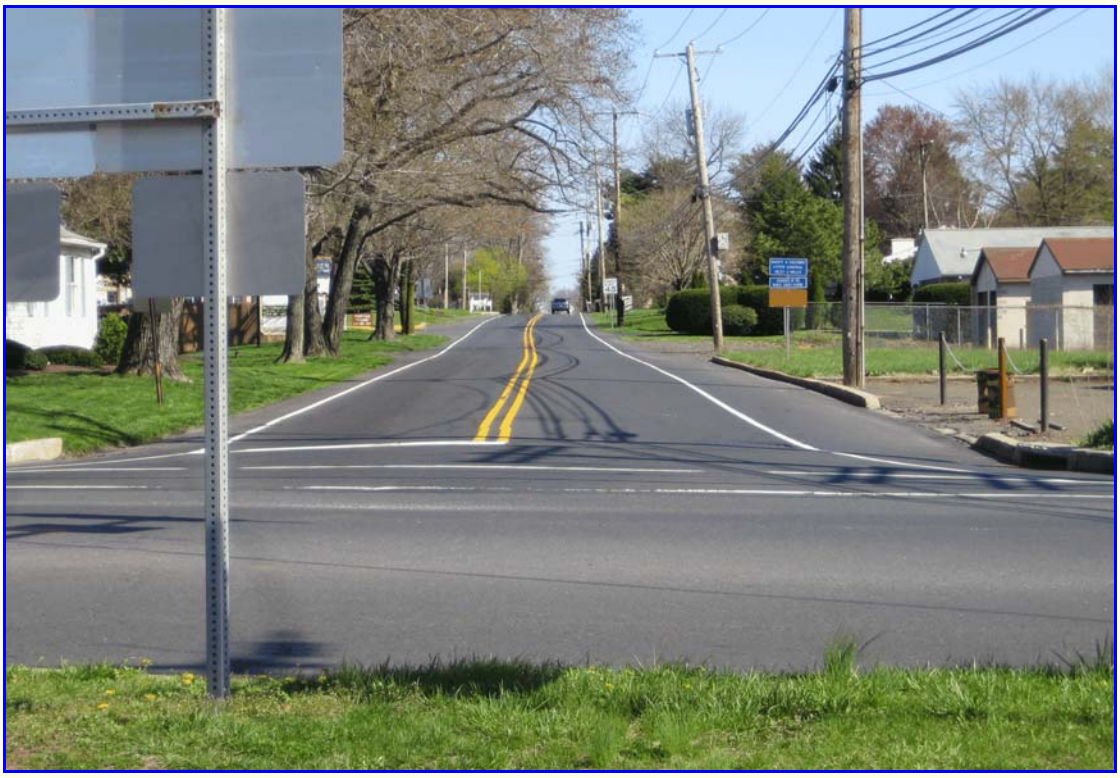
**Technical Memorandum**

# Bristol Road Extension Traffic Study



May 2008

Delaware Valley Regional Planning Commission
190 North Independence Mall West, 8th Floor
Philadelphia, PA 19106-1520

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Created in 1965, the Delaware Valley Regional Planning Commission (DVRPC) is an interstate, intercounty, and intercity agency which provides continuing, comprehensive, and coordinated planning to shape a vision for the future growth of the Delaware Valley region. The region includes Bucks, Chester, Delaware, and Montgomery counties as well as the City of Philadelphia, in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer counties in New Jersey. DVRPC provides technical assistance and services, conducts high priority studies that respond to the request and demands of member state and local governments, fosters cooperation among various constituents to forge a consensus on diverse regional issues, determines and meets the needs of the private sector, and practices public outreach efforts to promote two-way communication and public awareness of regional issues and the commission.

Our logo is adapted from the official DVRPC seal, and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

DVRPC is funded by a variety of funding sources including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey departments of transportation, as well as by DVRPC's state and local member governments. The authors, however, are solely responsible for its findings and conclusions, which may not represent the official views or policies of the funding agencies.

DVRPC fully complies with Title VI of the Civil Rights Act of 1964 and related statutes and regulations in all programs and activities. DVRPC's website may be translated into Spanish, Russian, and Traditional Chinese online by visiting www.dvrpc.org. Publications and other public documents can be made available in alternative languages or formats, if requested. For more information, please call (215) 238-2871.

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# I. INTRODUCTION

Bristol Road runs northeast/southwest along the boundary of Doylestown, Warrington, Warwick, Warminster, Northampton, and Lower Southampton townships in Bucks County, Pennsylvania. It extends from PA 513 (Hulmeville Road) near the Pennsylvania Turnpike, in Bensalem Township to US 202 (Butler Avenue) in Chalfont and New Britain boroughs, a distance of approximately 19 miles. However, a small piece of Bristol Road between PA 532 (Buck Road) and PA 213 (Bridgetown Road) in Lower Southampton Township is "missing." Bristol Road is a two-lane, urban minor arterial for its entire length, except for the section between PA 232 (Second Street Pike) and PA 532, where it is a two-lane, urban collector.

This study, requested by the Pennsylvania Department of Transportation (PENNDOT), examines the effects on traffic volumes that result from extending the terminus of Bristol Road from US 202 to Park Avenue, in Chalfont Borough, a distance of just over 2,000 feet. This Bristol Road Extension is intended to enhance the Chalfont street network by providing additional connections between US 202 and portions of Chalfont Borough and New Britain Township. Currently, the only way to access US 202 from the area of Chalfont Borough north of the SEPTA/Conrail railroad tracks is via PA 152 (North Main Street).

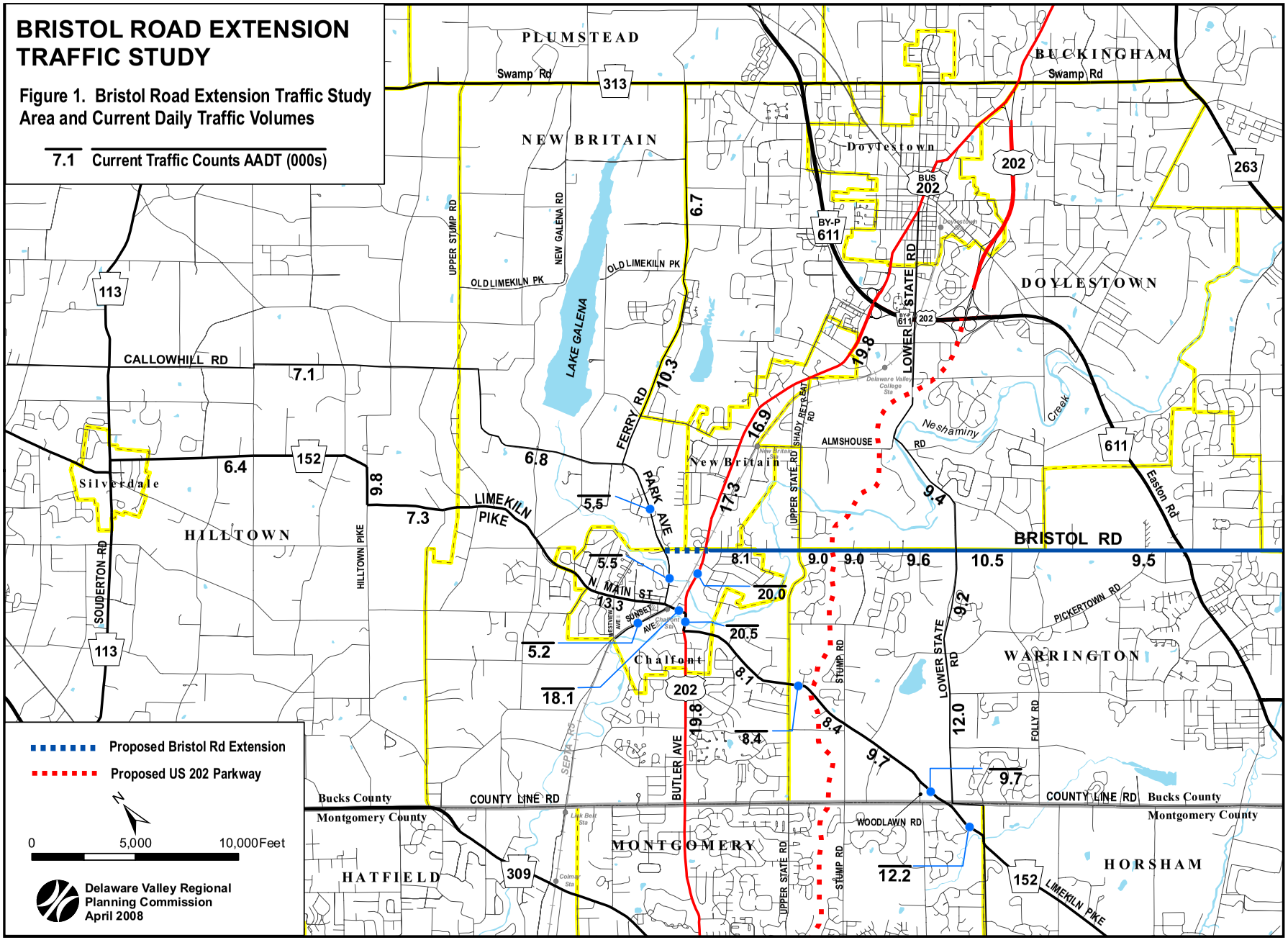
PA 152 is offset as it crosses US 202, therefore, both PA 152 and US 202 traffic must come together on a common link to cross the Neshaminy Creek. This has led to recurring congestion at both of the PA 152/US 202 intersections. The Bristol Road Extension will provide an alternative means for Chalfont area traffic to cross US 202.

This memo documents the existing traffic volumes in the study area including current daily and AM, midday, and PM peak hour traffic volumes and presents 2030 traffic forecasts with and without the proposed Bristol Road Extension. It also includes an explanation of the travel forecasting methodology and a description of the travel simulation model used to develop the traffic projections.

## A. Current Average Daily Traffic Volumes

The study area is shown in Figure 1. It is centered along Bristol Road and extends from PA 113 (Souderton Road) in Hilltown Township to PA 611 (Easton Road) in Warrington Township. Other study area municipalities include Chalfont and New Britain boroughs, New Britain Township, and Doylestown Township. Also shown in Figure 1 are current average annual daily traffic (AADT) volumes at selected locations within the study area.

Traffic volumes along Bristol Road range from 8,100 to 10,500 vehicles per day (vpd). The highest volume occurs between Lower State and Folly roads, while the lowest occurs just south of US 202. Like Bristol Road, PA 152 (named Limekiln Pike south of US 202 and North Main Street north of US 202) also provides connections between Chalfont Borough


BRISTOL ROAD EXTENSION TRAFFIC STUDY
Figure 1. Bristol Road Extension Traffic Study Area and Current Daily Traffic Volumes
7.1 Current Traffic Counts AADT (000s)
PLUMSTEAD
NEW BRITAIN
BUCKINGHAM
DOYLESTOWN
HILLTOWN
WARRINGTON
MONTGOMERY
HATFIELD
HORSHAM
Chalfont
New Britain
Doylestown
Silverdale
Swamp Rd
313
202
263
611
BY-P
BUS
113
152
309
CALLOWHILL RD
OLD LIMEKILN PK
UPPER STUMP RD
NEW GALENA RD
LAKE GALENA
FERRY RD
LOWER STATE RD
UPPER STATE RD
SHADY BEECH RD
ALMSHOUSE RD
Neshaminy Creek
Easton Rd
BRISTOL RD
LIMEKILN PIKE
PARK AVE
N MAIN ST
DIVISION AVE
WESTVIEW AVE
HILLTOWN PIKE
SOUDERTON RD
PICKERTOWN RD
STUMP RD
FOLLY RD
BUTLER AVE
SEPTA
COUNTY LINE RD
WOODLAWN RD
Bucks County
Montgomery County
Proposed Bristol Rd Extension
Proposed US 202 Parkway
N
0
5,000
10,000 Feet
Delaware Valley Regional Planning Commission
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and Upper State, Stump, and Lower State roads. South of US 202, PA 152 carries between 8,100 and 9,700 vpd. Within Chalfont Borough, however, PA 152 carries between 13,300 and 18,100 vpd. North of Chalfont, traffic volumes on PA 152 range from 6,400 to 9,800 vpd. US 202 bisects Chalfont and New Britain boroughs. Current traffic volumes on US 202 are between 16,900 and 20,500 vpd, with the highest volume occurring in Chalfont Borough, where US 202 and PA 152 come together. Other important roads that connect Chalfont and New Britain boroughs with the greater study area include Sunset and Park avenues, which carry 5,200 to 5,500 vpd, and Ferry and Callowhill roads, which carry between 6,700 and 10,300 vpd.

## B. Current AM, Midday, and PM Peak Hour Volumes

AM, midday, and PM peak hour traffic counts, including intersection turning movements, were collected at six key intersections in the study area. These include the Bristol Road intersections with Lower State Road and US 202, as well as the PA 152 intersections with Park Avenue, Sunset Avenue, and US 202. These volumes are displayed in Figure 2.

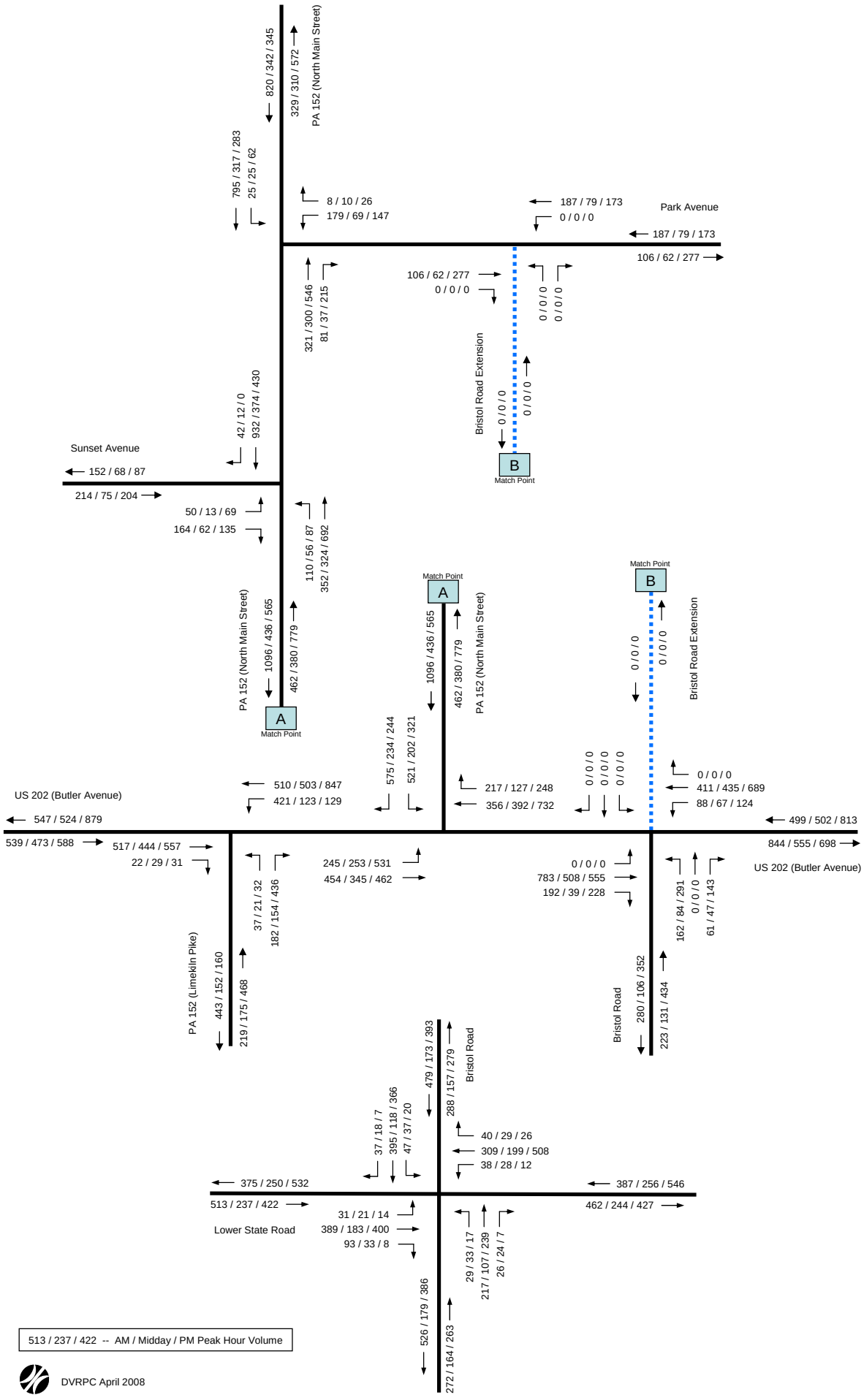
During the AM peak hour, there is a heavy volume of traffic along PA 152 in the southbound direction, crossing Park and Sunset avenues and heading towards US 202. This volume increases from 820 vehicles per hour (vph) just north of Park Avenue to 1,096 vph just north of US 202. Approximately half of this volume turns right onto US 202 southbound and half turns left onto US 202 northbound, towards Doylestown (although they cross one another, both PA 152 and US 202 are designated as north-south roadways). Northbound volumes along PA 152 in Chalfont during the AM peak hour are considerably lighter than the corresponding southbound traffic volumes. They range from 219 to 462 vph.

AM peak hour volumes along US 202 in its southbound direction range from 499 vph, just north of Bristol Road, to 931 vph, between the two PA 152 intersections. Northbound AM peak hour volumes on US 202 are heaviest north of PA 152. They reach 975 vph on the approach to the US 202/Bristol Road intersection.

Midday traffic volumes tend to be lower than both the AM and PM peak hour volumes. The highest volumes during the midday peak hour occur along US 202. In the southbound direction, these volumes are between 502 and 626 vph. Similar volumes occur in the northbound direction. These range from 473 to 598 vph.

During the PM peak hour, there are heavy traffic flows along PA 152 in the northbound direction and along US 202 in both its northbound and southbound directions. Northbound PA 152 volumes range from 468 to 779 vph, with the highest volume occurring just north of US 202. Northbound US 202 volumes range from 588 to 993 vph, while southbound US 202 carries between 813 and 980 vehicles during the PM peak hour. Both PA 152/US 202 intersections experience heavy traffic volumes during the PM peak hour.

# Figure 2. Current AM, Midday, and PM Peak Hour Intersection Turning Movement Counts



# II. TRAVEL FORECASTING PROCEDURES

Traffic forecasts are prepared and evaluated for the year 2030 under two different highway network alternatives: a No-Build and a Build alternative. For each of these alternatives, DVRPC's travel simulation model is modified to reflect the alternative under consideration and is used to prepare travel forecasts representative of that scenario. The No-Build Alternative provides a useful future-year reference against which any impacts associated with the Build alternative may be compared and quantified.

The No-Build Alternative does not include any changes to Bristol Road. This alternative does, however, include improvements to other regional facilities that are included in DVRPC's Transportation Improvement Program (TIP) and Long Range Plan and may have an impact on Bristol Road traffic volumes once they are built. These TIP and Plan projects include the two-lane US 202 Parkway along a new alignment between Upper State and Stump roads, widening County Line Road to four travel lanes between US 202 and PA 152, and intersection improvements at the US 202/PA 309 intersection. The Build Alternative includes these TIP and Plan projects, as well as a two-lane extension of Bristol Road from its present terminus at US 202 to Park Avenue in Chalfont Borough.

DVRPC's travel simulation models are used to forecast future travel patterns. These models utilize a system of traffic zones that follow Census boundaries and rely on demographic and employment data, land use, and transportation network characteristics to simulate trip making patterns throughout the region.

## A. Socioeconomic Projections

DVRPC's long-range population and employment forecasts are revised periodically to reflect changing market trends, development patterns, local and national economic conditions, and available data. The completed forecasts reflect all reasonably known current information and the best professional judgement of predicted future conditions. The revised forecasts adopted by the DVRPC Board in February 2005 are an update to municipal forecasts that were last completed in 2000.

DVRPC uses a multistep, multisource methodology to produce its forecasts at the county level. County forecasts serve as control totals for municipal forecasts, which are disaggregated from county totals. Municipal forecasts are based on an analysis of historical data trends adjusted to account for infrastructure availability, environmental constraints to development, local zoning policy, and development proposals. Municipal population forecasts are constrained using density ceilings and floors. County, and where necessary, municipal input is used throughout the process to derive the most likely population forecasts for all geographic levels.

## 1. Population Forecasting

Population forecasting at the regional level involves review and analysis of six major components: births, deaths, domestic in-migration, domestic out-migration, international immigration, and changes in group quarters populations (e.g., dormitories, military barracks, prisons, and nursing homes). DVRPC uses both the cohort survival concept to age individuals from one age group to the next, and a modified Markov transition probability model based on the most recent US Census and the US Census Bureau's Current Population Survey (CPS) research, to determine the flow of individuals between the Delaware Valley and the outside world. For movement within the region, Census and IRS migration data, coupled with CPS data, are used to determine migration rates between counties. DVRPC relies on county planning offices to provide information on any known, expected, or forecasted changes in group quarters populations. These major population components are then aggregated and the resulting population forecasts are reviewed by member governments for final adjustments based on local knowledge.

## 2. Employment Forecasting

Employment is influenced by local, national, and global political and socioeconomic factors. The US Census Bureau provides the most reasonable and consistent time series data on county employment by sector, and serves as DVRPC's primary data source for employment forecasting. Employment sectors include mining, agriculture, construction, manufacturing, transportation, wholesale, retail, finance/insurance, service, government, and military. Other supplemental sources of data include the Bureau of Economic Analysis, the Bureau of Labor Statistics, Occupational Privilege tax data, and other public and private sector forecasts. As in the population forecasts, county-level total employment is used as a control total for sector distribution and municipal level forecasts. Forecasts are then reviewed by member counties for final adjustments based on local knowledge.

## 3. Bristol Road Extension Traffic Study Area Forecasts

As part of the Bristol Road Extension Traffic Study, DVRPC staff reviewed its most recent current population and employment estimates, its long-range population and employment forecasts, and all proposed land use developments in the study area. Based on this review, DVRPC developed 2030 municipal-level population and employment forecasts for use as inputs to the traffic simulation models. Table 1 summarizes the population and employment forecasts used in the study.

Between 2005 and 2030, the total population in the greater study area is projected to increase by 27,185 residents to 97,085. This is nearly 40 percent above the current total of 69,900 residents. Doylestown, Hilltown, New Britain, and Warrington townships are all projected to add large numbers of new residents between 2005 and 2030. Doylestown, Hilltown, and New Britain townships will each add between 4,600 and 6,400 residents,

while Warrington Township's population will increase by over 10,000 people. Chalfont and New Britain boroughs, which are largely built out, will experience little or no population growth.

The study area will also add a significant number of new jobs between 2005 and 2030. The current employment total of 28,944 is projected to increase by 12,680, or 43.8 percent. The vast majority of these new jobs will be located in Doylestown, Hilltown, and Warrington townships. Table 1 provides a summary of the projected population and employment growth in the study area.

### Table 1. Population and Employment in the Study Area

| | Population | | | | | Employment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2005 - 2030 Growth | | | | | 2005 - 2030 Growth | |
| **Municipality** | **2000** | **2005** | **2030** | **Abs.** | **Pct.** | **2000** | **2005** | **2030** | **Abs.** | **Pct.** |
| Chalfont Borough | 3,900 | 4,040 | 4,600 | 560 | 13.9% | 1,963 | 1,978 | 1,874 | -104 | -5.3% |
| Doylestown Township | 17,619 | 18,570 | 23,190 | 4,620 | 24.9% | 8,026 | 8,407 | 14,986 | 6,579 | 78.3% |
| Hilltown Township | 12,100 | 13,080 | 18,515 | 5,435 | 41.6% | 4,359 | 5,024 | 6,398 | 1,374 | 27.3% |
| New Britain Borough | 3,125 | 3,150 | 3,150 | 0 | 0.0% | 1,047 | 998 | 1,521 | 523 | 52.4% |
| New Britain Township | 10,698 | 11,770 | 18,190 | 6,420 | 54.5% | 3,610 | 3,899 | 4,164 | 265 | 6.8% |
| Warrington Township | 17,580 | 19,290 | 29,440 | 10,150 | 52.6% | 7,963 | 8,638 | 12,681 | 4,043 | 46.8% |
| **Study Area Total** | **65,022** | **69,900** | **97,085** | **27,185** | **38.9%** | **26,968** | **28,944** | **41,624** | **12,680** | **43.8%** |

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## B. DVRPC's Travel Simulation Process

For the Bristol Road Extension Traffic Study, a focused simulation process was employed. A focused simulation process allows the use of DVRPC's regional simulation models, but includes a more detailed representation of the study area. Local streets not included in the regional network, but of interest in this study, are added to the highway network. Traffic zones inside the study area are subdivided so that traffic from existing and proposed land use developments may be loaded more precisely onto the network. The focusing process increases the accuracy of the travel forecasts within the detailed study area. At the same time, all existing and proposed highways throughout the region, and their impact on both regional and interregional travel patterns become an integral part of the simulation process.

DVRPC's travel models follow the traditional steps of trip generation, trip distribution, modal split, and traffic assignment. However, an iterative feedback loop is employed from traffic assignment to the trip distribution step. The feedback loop ensures that the congestion

levels used by the models when determining trip origins and destinations are equivalent to those that result from the traffic assignment step. Additionally, the iterative model structure allows trip making patterns to change in response to changes in prevailing traffic volumes, congestion levels, and improvements to the transportation system.

The DVRPC travel simulation process uses the Evans Algorithm to iterate the model. Evans reexecutes the trip distribution and modal split models based on updated highway speeds after each iteration of highway assignment and assigns a weight to each iteration. This weight is then used to prepare a convex combination of the link volumes and trip tables for the current iteration and a running weighted average of the previous iterations. This algorithm converges rapidly to the equilibrium solution on highway travel speeds and congestion levels. About seven iterations are required for the process to converge to the equilibrium state for study area travel patterns.

The DVRPC travel simulation models are disaggregated into separate peak, midday, and evening time periods. This disaggregation begins in trip generation where factors are used to separate daily trips into peak, midday, and evening travel. The enhanced process then utilizes completely separate model chains for peak, midday, and evening travel simulation runs. Time-of-day sensitive inputs to the models, such as highway capacities and transit service levels, are disaggregated to be reflective of time-period-specific conditions. Capacity factors are used to allocate daily highway capacity to each time period. Separate transit networks were used to represent the difference in transit service over the course of a day.

The enhanced model is disaggregated into separate model chains for the peak (combined AM and PM), midday (the period between the AM and PM peaks), and evening (the remainder of the day) periods for the trip distribution, modal split, and travel assignment phases of the process. The peak period is defined as 7:00 AM to 9:00 AM and 3:00 PM to 6:00 PM. Peak period and midday travel are based on a series of factors which determine the percentage of daily trips that occur during those periods. Evening travel is then defined as the residual after peak and midday travel are removed from daily travel.

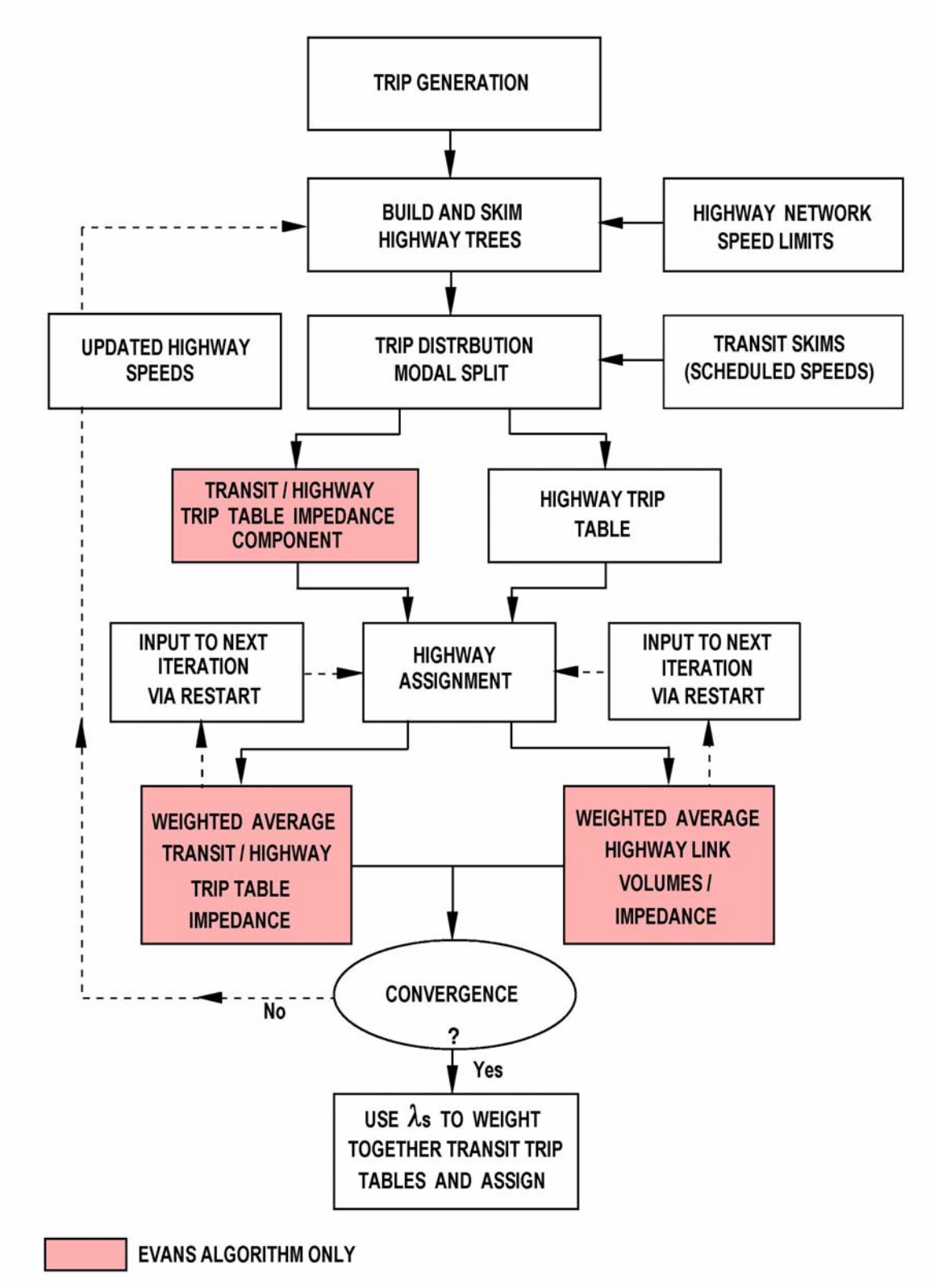
External-local productions at the nine-county cordon stations are disaggregated into peak, midday, and evening components using percentages derived from the temporal distribution of traffic counts taken at each cordon station.

Figure 3 provides a flow chart of the travel demand forecasting process. The first step in the process involves generating the number of trips that are produced by and destined for each traffic zone and cordon station throughout the nine-county region.

## 1. Trip Generation

Both internal trips (those made within the DVRPC region) and external trips (those that cross the boundary of the region) must be considered in the simulation of regional travel.

## Figure 3. DVRPC's Travel Simulation Process



For the simulation of travel demand, internal trip generation is based on zonal forecasts of population and employment, whereas external trips are estimated from cordon line traffic counts, surveys, and other sources. The latter also include trips that pass through the Delaware Valley region. Estimates of internal trip productions and attractions by zone are established for each trip purpose on the basis of trip rates applied to the zonal estimates of demographic and employment data. Trip purposes include work and nonwork trips, light and heavy truck trips, and taxi trips. This part of the DVRPC model is not iterated on highway travel speed. Rather, estimates of daily trip making by traffic zone are calculated and then disaggregated into peak, midday, and evening time periods.

## 2. Evans Iterations

The iterative portion of the Evans forecasting process involves updating the highway network restrained link travel speeds, rebuilding the minimum time paths through the network, and skimming the interzonal travel time for the minimum paths. Then the trip distribution, modal split, and highway assignment models are executed in sequence for each pass through the model chain. After convergence is reached, the transit trip tables for each iteration are weighted together and the weighted average table is assigned to the transit network. The highway trip tables are loaded onto the network during each Evans iteration. For each time period, seven iterations of the Evans process are performed to ensure that convergence on travel times is reached.

## 3. Trip Distribution

Trip distribution is the process whereby the zonal trip ends established in the trip generation analysis are linked together to form origin-destination patterns in the trip table format. Peak, midday, and evening trip ends are distributed separately. For each Evans iteration, a series of ten gravity-type distribution models are applied at the zonal level. These models follow the trip purpose and vehicle type stratifications established in trip generation.

## 4. Modal Split

The modal split model is also run separately for the peak, midday, and evening time periods. The modal split model calculates the fraction of each person-trip interchange in the trip table which should be allocated to transit, and then assigns the residual to the highway side. The choice between highway and transit usage is made on the basis of comparative cost, travel time, and frequency of service, with other aspects of modal choice being used to modify this basic relationship. In general, the better the transit service, the higher the fraction assigned to transit, although trip purpose and auto ownership also affect the allocation. The model subdivides highway trips into auto drivers and passengers. Auto driver trips are added to the truck, taxi, and external vehicle trips in preparation for assignment to the highway network.

### 5. Highway Assignment

For highway trips, the final step in the focused simulation process is the assignment of vehicle trips to the highway network representative of the alternative being modeled. For peak, midday, and evening travel, the assignment model produces the future traffic volumes for individual highway links that are required for the evaluation of each alternative. The regional nature of the highway network and trip table underlying the focused assignment process allow the diversion of travel into and through the study area to various points of entry and exit in response to the improvements made in the transportation system.

For each Evans iteration, highway trips are assigned to the network representative of a given alternative by determining the best (minimum time) route through the highway network for each zonal interchange, and then allocating the interzonal highway travel to the highway facilities along that route. This assignment model is "capacity restrained" in that congestion levels are considered when determining the best route. The Evans equilibrium assignment method is used to implement the capacity constraint. When the assignment and associated trip table reach equilibrium, no path faster than the one actually assigned for each trip can be found through the network, given the capacity restrained travel times on each link.

### 6. Transit Assignment

After equilibrium is achieved, the weighted average transit trip tables are assigned to the transit network to produce link and route passenger volumes. The transit person trips produced by the modal split model are "linked" in that they do not include any transfers that occur either between transit trips or between auto approaches and transit lines. The transit assignment procedure accomplishes two major tasks. First, the transit trips are "unlinked" to include transfers, and second, the unlinked transit trips are associated with specific transit facilities to produce link, line, and station volumes. These tasks are accomplished simultaneously within the transit assignment model, which assigns the transit trip matrix to minimum impedance paths built through the transit network. There is no capacity restraining procedure in the transit assignment model.

## C. Highway Traffic Assignment Validation

Before a focused simulation model can be used to predict future trip making patterns, its ability to replicate existing conditions is tested. The simulated highway assignment outputs are compared to current traffic counts taken on roadways serving the study area. The focused simulation model was executed with current conditions and the results were compared with recent traffic counts. Based on this analysis, the focused model produced accurate traffic volumes. The validated model was then executed for the No-Build and

Build alternatives, with socioeconomic and land use inputs reflective of future conditions, and the alternative under evaluation.

A total of 35 locations throughout the greater study area with available daily traffic counts were used for model validation. Five of these locations are along Bristol Road; 12 are on PA 152; nine are on US 202; and six are on other facilities in Chalfont Borough such as Sunset and Park avenues. The total assigned traffic on all facilities, 398,988 vehicles, is within three percent of the total counted volume of 410,005 vehicles.

# III. PROJECTED TRAFFIC VOLUMES

Year 2030 projected traffic volumes are presented and analyzed in this chapter. For both the No-Build and Build alternative, a daily traffic forecast is prepared at each location where a current count was provided in Chapter I. AM, midday, and PM peak hour intersection turning movement forecasts are also provided for each alternative at the intersections with turning movement counts.

## A. 2030 Daily Traffic Forecasts

Figure 4 displays the 2030 average daily traffic forecasts for the No-Build and Build alternatives, along with the current traffic counts for comparison. Table 2 provides these same volumes, along with comparisons between current and 2030 No-Build Alternative traffic volumes and between Build and No-Build volumes.

### 1. No-Build Alternative Traffic Forecasts

Under the No-Build Alternative, 2030 volumes on Bristol Road increase to 12,100 to 15,000 vpd. These values represent increases of between 2,500 and 6,000 vpd over current traffic volumes. In percentage terms, these increases range from 25 to as much as 67 percent. Traffic volumes along PA 152 increase by a similar amount: from 2,300 to 5,900 vpd, or 15 to 62 percent, over current daily traffic volumes.

Daily traffic volumes in 2030 on US 202 under the No-Build Alternative, however, are lower than current volumes at some locations. Between County Line Road and PA 152 (Limekiln Pike), the 2030 volume of 17,700 vpd is approximately 2,100 vpd, or 10.6 percent, lower than the current volume of 19,800 vpd. US 202 volumes between Bristol Road and Shady Retreat Road are 1,300 to 1,400 vpd lower than current volumes, which represent reductions of eight to nine percent. These reductions are due to the new US 202 Parkway, which diverts some traffic from existing US 202.

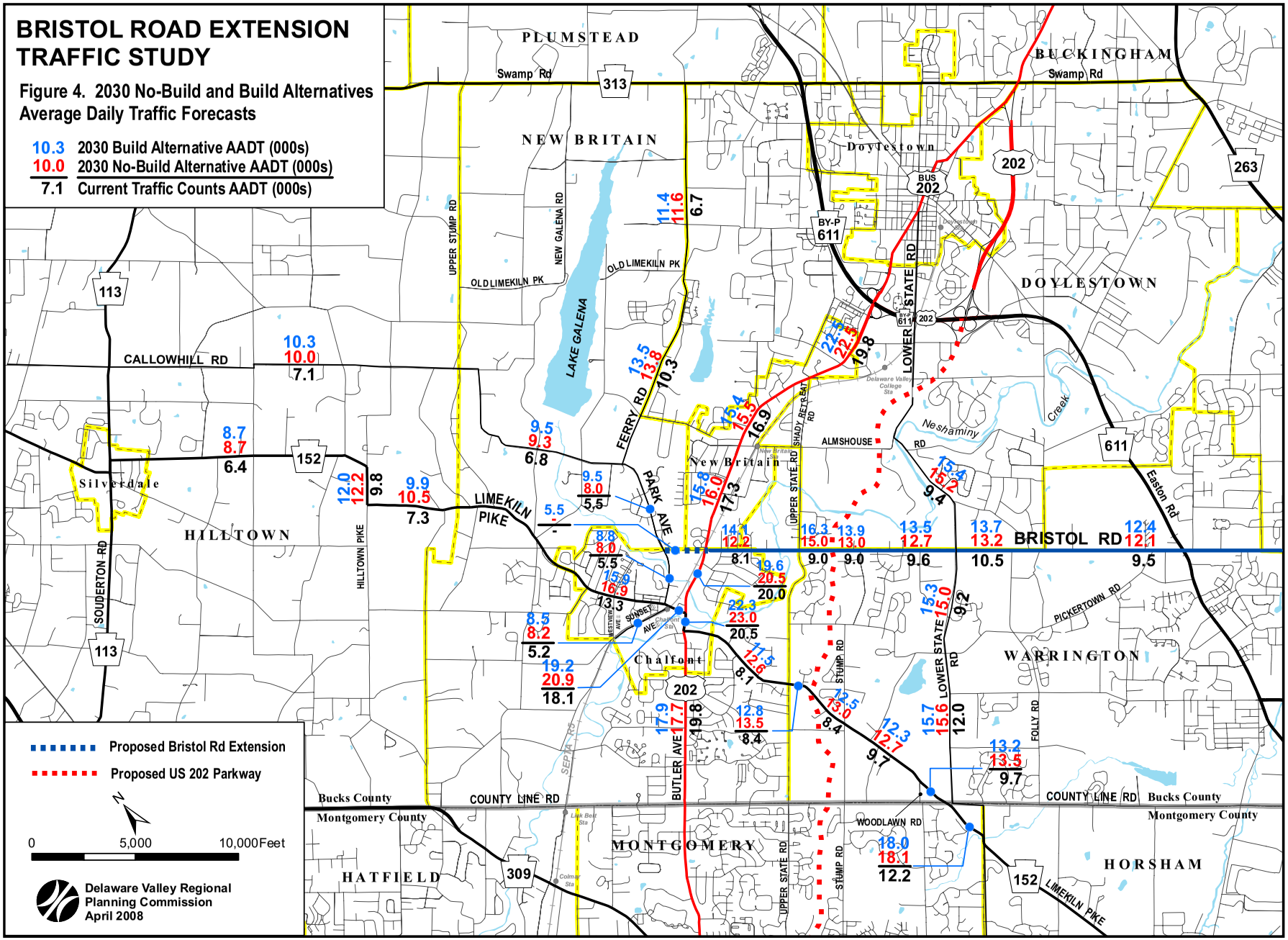
In contrast, 2030 No-Build traffic volumes on US 202 between the two PA 152 intersections are higher than current volumes. This is because the increase in PA 152 traffic in Chalfont Borough is greater than the US 202 traffic that is diverted to the new US 202 Parkway.

Traffic volumes on other Chalfont area roadways also exhibit large increases over current traffic volumes in 2030 under the No-Build Alternative. These increases range from 2,500 to 4,900 vpd. They are largely due to traffic traveling through the Chalfont area to and from the fast growing areas of Hilltown, Warrington, and surrounding townships.

# BRISTOL ROAD EXTENSION TRAFFIC STUDY

**Figure 4. 2030 No-Build and Build Alternatives Average Daily Traffic Forecasts**

10.3 2030 Build Alternative AADT (000s)
10.0 2030 No-Build Alternative AADT (000s)
7.1 Current Traffic Counts AADT (000s)

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# Table 2. 2030 No-Build and Build Alternative Average Daily Traffic Forecasts

| Location | Current Counts | 2030 No-Build | 2005-2030 Growth Absolute | 2005-2030 Growth Percent | 2030 Build | Build/No-Build Diff. Absolute | Build/No-Build Diff. Percent |
|---|---|---|---|---|---|---|---|
| *Bristol Road* | | | | | | | |
| Bristol Road Extension - Park Ave to US 202 | ------ | ------ | ------ | ------ | 5,500 | ------ | ------ |
| Bristol Road - US 202 to Upper State Road | 8,057 | 12,200 | 4,143 | 51.4% | 14,100 | 1,900 | 15.6% |
| Bristol Road - Upper State Road to US 202 Parkway | 8,961 | 15,000 | 6,039 | 67.4% | 16,300 | 1,300 | 8.7% |
| Bristol Road - US 202 Parkway to Stump Road | 8,961 | 13,000 | 4,039 | 45.1% | 13,900 | 900 | 6.9% |
| Bristol Road - Stump Road to Lower State Road | 9,587 | 12,700 | 3,113 | 32.5% | 13,500 | 800 | 6.3% |
| Bristol Road - Lower State Road to Folly Road | 10,543 | 13,200 | 2,657 | 25.2% | 13,700 | 500 | 3.8% |
| Bristol Road - Folly Road to Easton Road | 9,507 | 12,100 | 2,593 | 27.3% | 12,400 | 300 | 2.5% |
| *PA 152 (Limekiln Pike, North Main Street)* | | | | | | | |
| PA 152 - Souderton Road (PA 113) to Hilltown Pike East | 6,363 | 8,700 | 2,337 | 36.7% | 8,700 | 0 | 0.0% |
| PA 152 - Hilltown Pike East to Hilltown Pike West | 9,760 | 12,200 | 2,440 | 25.0% | 12,000 | -200 | -1.6% |
| PA 152 - Hilltown Pike West to New Galena Road | 7,288 | 10,500 | 3,212 | 44.1% | 9,900 | -600 | -5.7% |
| PA 152 - New Galena Road to Park Avenue | 13,267 | 16,900 | 3,633 | 27.4% | 15,900 | -1,000 | -5.9% |
| PA 152 - Park Avenue to US 202 (Butler Avenue) | 18,145 | 20,900 | 2,755 | 15.2% | 19,200 | -1,700 | -8.1% |
| PA 152 - US 202 (Butler Aveune) to Upper State Road | 8,120 | 12,600 | 4,480 | 55.2% | 11,500 | -1,100 | -8.7% |
| PA 152 - Upper State Road to US 202 Parkway | 8,350 | 13,500 | 5,150 | 61.7% | 12,800 | -700 | -5.2% |
| PA 152 - US 202 Parkway to Stump Road | 8,350 | 13,000 | 4,650 | 55.7% | 12,500 | -500 | -3.8% |
| PA 152 - Stump Road to Woodlawn Road | 9,655 | 12,700 | 3,045 | 31.5% | 12,300 | -400 | -3.1% |
| PA 152 - Woodlawn Road to County Line Road | 9,655 | 13,500 | 3,845 | 39.8% | 13,200 | -300 | -2.2% |
| PA 152 - County Line Road to Lower State Road | 12,178 | 18,100 | 5,922 | 48.6% | 18,000 | -100 | -0.6% |
| *US 202* | | | | | | | |
| US 202 - County Line Road to PA 152 (Limekiln Pike) | 19,791 | 17,700 | -2,091 | -10.6% | 17,900 | 200 | 1.1% |
| US 202 - PA 152 (Limekiln Pike) to PA 152 (North Main Street) | 20,512 | 23,000 | 2,488 | 12.1% | 22,300 | -700 | -3.0% |
| US 202 - PA 152 (North Main Street) to Bristol Road | 20,045 | 20,500 | 455 | 2.3% | 19,600 | -900 | -4.4% |
| US 202 - Bristol Road to Almshouse Road | 17,313 | 16,000 | -1,313 | -7.6% | 15,800 | -200 | -1.3% |
| US 202 - Almshouse Road to Shady Retreat Road | 16,942 | 15,500 | -1,442 | -8.5% | 15,400 | -100 | -0.6% |
| US 202 - Shady Retreat Road to PA 611 Bypass | 19,825 | 22,500 | 2,675 | 13.5% | 22,500 | 0 | 0.0% |
| *Lower State Road* | | | | | | | |
| Lower State Road - PA 152 to Pinkertown Road | 11,954 | 15,600 | 3,646 | 30.5% | 15,700 | 100 | 0.6% |
| Lower State Road - Pinkertown Road to Bristol Road | 9,183 | 15,000 | 5,817 | 63.3% | 15,300 | 300 | 2.0% |
| Lower State Road - Bristol Road to Almshouse Road | 9,453 | 15,200 | 5,747 | 60.8% | 15,400 | 200 | 1.3% |
| *Chalfont Area Local Roads* | | | | | | | |
| Sunset Avenue - Westview Avenue to PA 152 Main St. | 5,168 | 8,200 | 3,032 | 58.7% | 8,500 | 300 | 3.7% |
| Park Avenue - Limekiln Pike to Bristol Road Extension | 5,462 | 8,000 | 2,538 | 46.5% | 8,800 | 800 | 10.0% |
| Park Avenue - Bristol Road Extension to Ferry Road | 5,462 | 8,000 | 2,538 | 46.5% | 9,500 | 1,500 | 18.8% |
| Callowhill Road - Ferry Road to Stump Road | 6,757 | 9,300 | 2,543 | 37.6% | 9,500 | 200 | 2.2% |
| Callowhill Road - Stump Road to Hilltown Pike (Dublin Rd) | 7,074 | 10,000 | 2,926 | 41.4% | 10,300 | 300 | 3.0% |
| Ferry Road - Callowhill Road to Old Limekiln Road | 10,320 | 13,800 | 3,480 | 33.7% | 13,500 | -300 | -2.2% |
| Ferry Road - Old Limekiln Road to Swamp Road | 6,722 | 11,600 | 4,878 | 72.6% | 11,400 | -200 | -1.7% |

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## 2. Build Alternative Traffic Forecasts

The Build Alternative, which extends Bristol Road from US 202 to Park Avenue, tends to increase traffic volumes on Bristol Road and decrease volumes on PA 152, compared to the No-Build Alternative. The increases on Bristol Road range from 300 to 1,900 vpd, or 2.5 to 15.6 percent, over the corresponding No-Build volumes. The largest increases occur closest to US 202.

The new Bristol Road extension carries 5,500 vpd in 2030. This extension of Bristol Road will serve both through traffic from Chalfont and New Britain boroughs that continues along Bristol Road towards Warrington Township (and the reverse movement), as well as traffic that uses the new Bristol Road extension to access US 202 (and its reverse movements).

Some of this traffic is diverted from PA 152 to Bristol Road. PA 152 volumes are 100 to 1,700 vpd lower under the Build Alternative than under the No-Build Alternative. The largest reductions occur on either side of US 202, where they account for decreases of eight to nine percent. Traffic volumes on US 202, in the vicinity of PA 152, are also lower under the Build Alternative than the No-Build Alternative. These reductions range from 200 to 900 vpd.

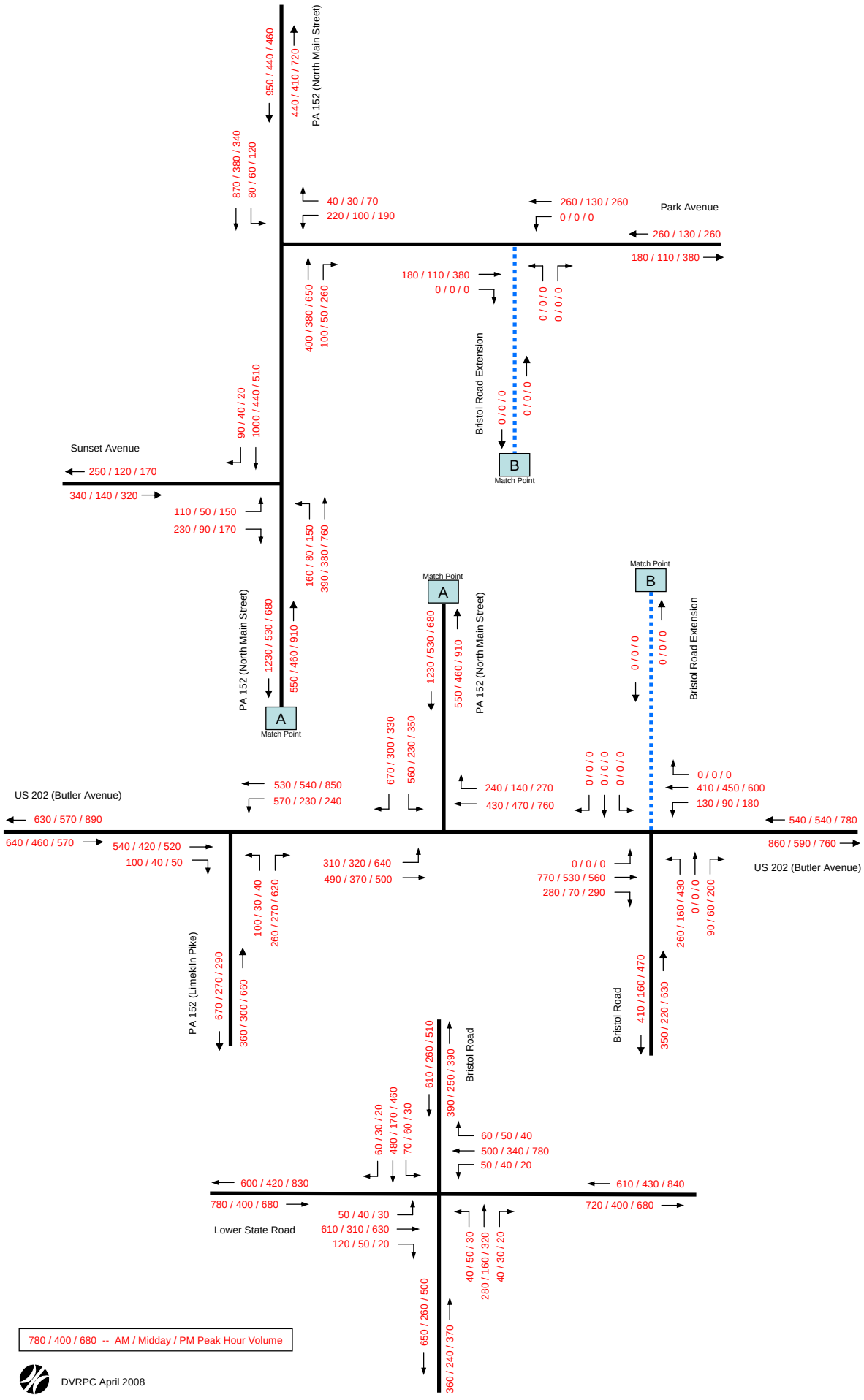
Traffic volumes on Chalfont area local roads are generally higher under the Build Alternative, although traffic on portions of Ferry Road is reduced. The largest increases occur on Park Avenue, on either side of the new intersection with the Bristol Road extension.

## B. 2030 AM, Midday, and PM Peak Hour Traffic Forecasts

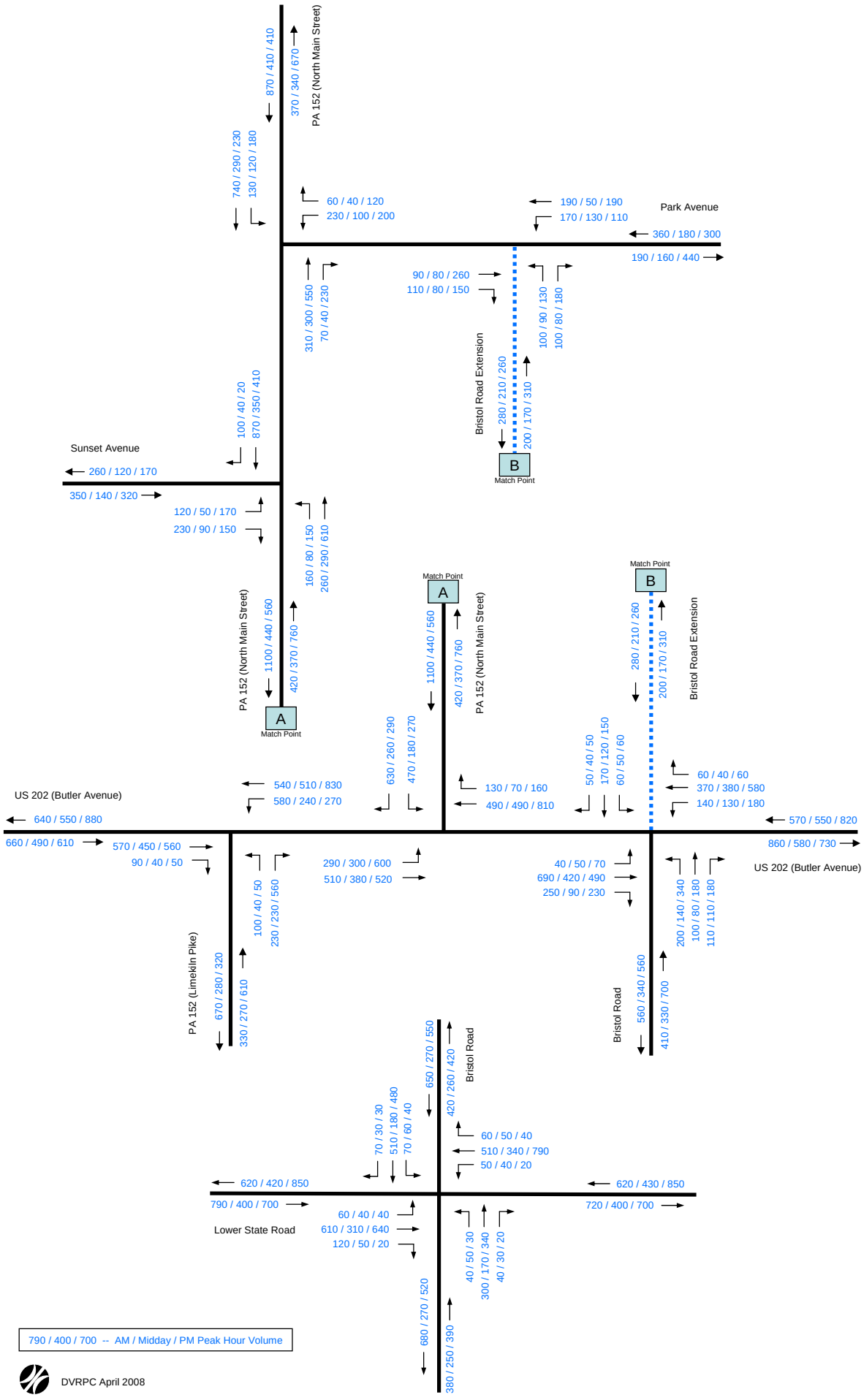
This section discusses the AM, midday, and PM peak hour intersection turning movement forecasts. Generally, the relationships between current and No-Build peak hour volumes and between the No-Build and Build alternatives follow the same patterns and trends as the daily traffic volumes. However, the percentage of daily traffic that occurs during the 2030 AM and PM peak hours may be somewhat less than the percentage under current conditions. This is consistent with the “peak spreading” that occurs as traffic volumes increase. As congestion levels rise, a greater percentage of traffic is shifted to the “shoulders” of the peak (i.e., immediately before and after the peak hour). Midday hourly volumes are not generally affected by peak spreading, due to lower congestion levels during the midday time period.

AM, midday, and PM peak hour intersection turning movement forecasts for 2030 under the No-Build Alternative are provided in Figure 5. The corresponding 2030 peak hour forecasts for the Build Alternative are shown in Figure 6.

# Figure 5. 2030 No-Build Alternative AM, Midday, and PM Peak Hour Intersection Turning Movement Forecasts



# Figure 6. 2030 Build Alternative AM, Midday, and PM Peak Hour Intersection Turning Movement Forecasts



## 1. No-Build Alternative Traffic Forecasts

Under the No-Build Alternative during the AM peak hour, southbound traffic volumes along PA 152 (North Main Street) range from 950 to 1,230 vph as they approach US 202. These volumes represent increases of approximately 130 vph over current AM peak hour volumes. AM peak hour volumes on the US 202 approaches to the PA 152/US 202 intersection also increase over current volumes. These increases are 100 vph on both the northbound and southbound approaches. The increased volumes on all approaches to this intersection result in even larger delays at this already congested intersection.

At the other PA 152/US 202 intersection, AM peak hour traffic volumes turning from US 202 to PA 152 and from PA 152 to US 202 exhibit large increases relative to current turning volumes. Through movements on US 202, however, are similar to current traffic volumes.

AM peak hour traffic volumes on Bristol Road at its US 202 and Lower State Road intersections increase by approximately 90 to 130 vph over current volumes. The largest increases among individual turning movements occur on the Bristol Road northbound left-turn onto US 202 southbound, which increases to 260 vph, and on the US 202 northbound right-turn onto Bristol Road southbound, which increases to 280 vph.

Lower State Road volumes also exhibit large increases over current traffic levels during the AM peak hour under the No-Build Alternative. However, these increases are largely confined to the through movements across Bristol Road.

Midday peak hour traffic volumes under the No-Build Alternative continue to be lower than the corresponding AM and PM peak hour volumes. On a percentage basis, the increases in midday peak hour volumes tend to be larger than the increases in AM or PM peak hour volumes, as there is less congestion during the midday hours and thus these volumes are less likely to be affected by peak spreading.

Notable increases during the midday peak hour include the northbound Bristol Road left-turn onto US 202 southbound, which nearly doubles to 160 vph, the US 202 southbound left-turn onto PA 152 (Limekiln Pike) southbound, which also nearly doubles to 230 vph, and the US 202 northbound left-turn on PA 152 (North Main Street) northbound, which increases from the current volume of 253 vph to 320 vph under the No-Build Alternative.

During the PM peak hour, there are heavy traffic flows along PA 152 in the northbound direction and along US 202 in both the northbound and southbound directions. Northbound PA 152 volumes range from 660 to 910 vph, with the highest volume occurring just north of US 202. These volumes represent increases of 130 to 190 vph over current PM peak hour traffic volumes. Northbound US 202 volumes range from 570 to 1,140 vph, while southbound US 202 carries between 780 and 1,090 vehicles during the PM peak hour. These volumes are 50 to 150 vph high than current volumes at the approaches to PA 152. However, south of PA 152 and north of Bristol Road, the 2030 No-Build Alternative volumes are similar to the current traffic volumes. In fact, the volume on the southbound US 202

approach to Bristol Road and the northbound US 202 approach to PA 152 are lower than current PM peak hour traffic volumes.

## 2. Build Alternative Traffic Forecasts

The new Bristol Road extension changes peak hour traffic patterns on US 202, PA 152, and Park Avenue in Chalfont Borough. The existing "T-intersection" of Bristol Road and US 202 becomes a four-legged intersection that allows for additional turning movements and a new intersection is created at Bristol Road and Park Avenue. The Bristol Road extension provides an alternative to PA 152 for trips between Chalfont Borough and US 202 and beyond. This results in lower left-turning volumes from PA 152 southbound onto US 202 northbound, and from US 202 northbound onto PA 152 northbound during all three peak hours. It also results in lower right-turning volumes from PA 152 northbound onto US 202 northbound and from US 202 southbound onto PA 152 northbound.

Compared to the No-Build Alternative, 2030 AM peak hour traffic volumes on PA 152 north of US 202 are reduced by 70 to 130 vph in the northbound direction and by 80 to 130 vph in the southbound direction. The largest reductions occur at the PA 152/US 202 intersection. Between Park Avenue and US 202, the Bristol Road extension carries 200 vehicles in the northbound direction during the AM peak hour and 280 in the southbound direction. Approximately half of these volumes are through movements across US 202; and half are turning movements to or from US 202. South of US 202, AM peak hour Bristol Road traffic volumes are 60 to 150 vph higher than the corresponding No-Build alternative volumes.

AM peak hour volumes on US 202 are similar between the No-Build and Build alternatives. The Build Alternative volumes are 50 to 70 vph lower than the No-Build volumes between Bristol Road and PA 152 (North Main Street) and 0 to 30 vph higher than the No-Build volumes at other locations along US 202.

The right-turn from US 202 southbound to PA 152 northbound is significantly lower under the Build Alternative (130 vph) than under the No-Build Alternative (240 vph). Part of this reduction is due to US 202 southbound traffic diverted to a right-turn onto the Bristol Road extension and part is due to Bristol Road northbound through movements across US 202 that would have made a left-turn onto US 202 southbound, followed by a right-turn onto PA 152 northbound, under the No-Build Alternative.

During the midday peak hour, the Bristol Road extension carries 170 to 210 vehicles. These volumes are only 30 to 70 vph lower than the AM peak hour volumes. Again, about half of these volumes come from or continue to existing Bristol Road on the other side of US 202, and about half are turning movements to or from US 202.

Under the Build Alternative, the highest volumes during the midday peak hour occur along US 202. In the southbound direction, these volumes are between 550 and 750 vph. In the northbound direction they range from 490 to 680 vph.

During the PM peak hour, the Bristol Road extension carries 260 vehicles in the southbound direction and 310 vehicles northbound. Compared to the No-Build Alternative, traffic volumes on PA 152 between Park Avenue and US 202, which parallels the Bristol Road extension, are reduced by 100 to 150 vph. Smaller reductions of 50 vph, occur on PA 152 north of Park Avenue. Under the Build Alternative, PM peak hour volumes on PA 152 north of US 202 will range from 410 to 560 vph in the southbound direction and from 670 to 760 vph in the northbound direction.

South of US 202, PA 152 will carry 320 vph in the southbound direction and 610 vph in the northbound direction. The PA 152 (Limekiln Pike) northbound right-turn onto US 202 northbound and the following US 202 northbound left-turn onto PA 152 (North Main Street) volumes are reduced by 40 to 60 vph, compared to the No-Build Alternative. Some traffic making these movements has the alternative of using Bristol Road and its extension, under the Build Alternative.

The heaviest PM peak hour volumes occur on US 202. They range from 820 to 1,100 vph in the southbound direction and from 610 to 1,120 vph in the northbound direction. The greatest difference in PM peak hour volumes on US 202 between the No-Build and Build alternatives occurs in the southbound direction between Bristol Road and PA 152, where the Build Alternative volume is 60 vph lower than the No-Build Alterative volume. Although the through movement is 50 vph higher than the No-Build Alternative volume, the right-turn from US 202 southbound onto PA 152 northbound is reduced by 110 vph. The Bristol Road extension provides an alternative to PA 152 for traffic heading into Chalfont Borough towards Park Avenue.

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# IV. CONCLUSIONS

The Bristol Road Extension is intended to enhance the Chalfont street network by providing additional connections between US 202 and portions of Chalfont Borough and New Britain Township. Currently, the only way to access US 202 from the area of Chalfont Borough north of the SEPTA/Conrail railroad tracks is via PA 152 (North Main Street). This has lead to high volumes of traffic and congestion at the two PA 152 intersections with US 202.

Both the population and employment in the surrounding areas are forecast to increase by significant margins. By 2030, the total population in the study area is projected to increase by nearly 40 percent, to just under 100,000 residents and the employment by over 40 percent to nearly 42,000 jobs. Largest increases in both population and employment occur in Doylestown, Hilltown, New Britain, and Warrington townships. This growth will lead to additional trips traversing the study area, further increasing congestion and delay.

Daily traffic volumes along Bristol Road currently range from 8,100 to10,500 vehicles per day. By 2030, under the No-Build Alternative, these volumes increase to 12,100 to 15,000 vpd. Large increases also occur on PA 152, which largely parallels Bristol Road in the study area, and on many of the local roads in and around Chalfont Borough.

The Build Alternative tends to increase traffic volumes on Bristol Road and decrease volumes on PA 152, compared to the No-Build Alternative. The increases on Bristol Road range from 300 to 1,900 vpd. The new Bristol Road extension carries 5,500 vpd in 2030. This extension of Bristol Road will serve both through traffic from Chalfont Borough and New Britain Township that continues along Bristol Road towards Warrington Township (and the reverse movement), as well as traffic that uses the new Bristol Road extension to access US 202 (an its reverse movements).

The peak hour traffic volumes generally follow the same trends as the daily volumes. In 2030, under the No-Build Alternative, there are significant increases in peak hour volumes along PA 152 and Bristol Road compared to the current volumes. The Build Alternative tends to decrease the PA 152 volumes by diverting some traffic to Bristol Road. The additional connection between Chalfont Borough and US 202, provided by the Bristol Road extension, results in lower volumes at the PA 152 and US 202 intersections. Notable decreases occur on the US 202 southbound right-turn onto PA 152 (North Main Street) northbound, the reverse left-turn movement from PA 152 southbound onto US 202 northbound, the PA 152 (Limekiln Pike) northbound right-turn onto US 202 northbound, and the US 202 northbound left-turn onto PA 152 (North Main Street) northbound.

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# Bristol Road Extension Traffic Study

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**Geographic Area Covered:** The municipalities of Chalfont and New Britain boroughs and Doylestown, Hilltown, New Britain, and Warrington townships in Bucks County, Pennsylvania.

**Key Words:** Bristol Road, Traffic Forecasts, Travel Simulation, AADT, Peak Hour Volumes, Intersection Turning Movements.

## ABSTRACT

This report documents 2030 traffic forecasts for the Bristol Road Extension Traffic Study area. Average daily and AM, midday, and PM peak hour forecasts are provided for a No-Build and a Build alternative and compared to current volumes. The Build Alternative extends the terminus of Bristol Road from US 202 to Park Avenue and provides additional connections between US 202 and portions of Chalfont Borough and New Britain Township.

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