FINAL REPORT

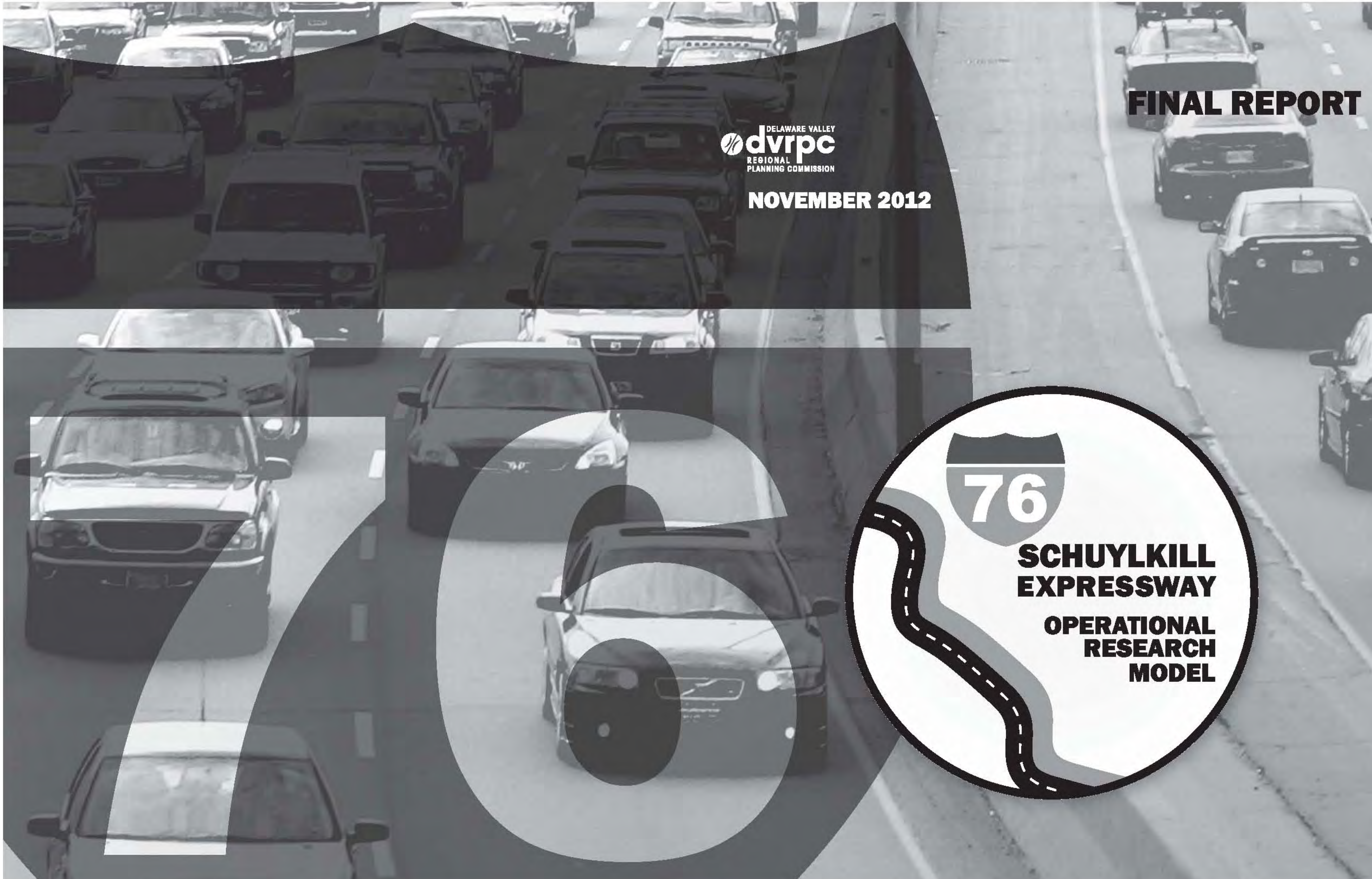
DELAWARE VALLEY REGIONAL PLANNING COMMISSION (dvrpc)

NOVEMBER 2012

76

SCHUYLKILL EXPRESSWAY

OPERATIONAL RESEARCH MODEL



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The Delaware Valley Regional Planning Commission is dedicated to uniting the region's elected officials, planning professionals, and the public with a common vision of making a great region even greater. Shaping the way we live, work, and play, DVRPC builds consensus on improving transportation, promoting smart growth, protecting the environment, and enhancing the economy. We serve a diverse region of nine counties: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey. DVRPC is the federally designated Metropolitan Planning Organization for the Greater Philadelphia Region — leading the way to a better future.

The symbol in 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 the findings and conclusions herein, 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 (www.dvrpc.org) may be translated into multiple languages. Publications and other public documents can be made available in alternative languages and formats, if requested. For more information, please call (215) 238-2871.

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EXECUTIVE SUMMARY:

The Pennsylvania Department of Transportation (PennDOT) commissioned the Delaware Valley Regional Planning Commission (DVRPC) to construct a powerful computer model capable of simulating, visualizing, and assessing traffic conditions along the Schuylkill Expressway (I-76) to use as a practical research tool. The tool can be used to determine the effects of growth, predict outcomes of changes to the Expressway's infrastructure, judge the merits of competing designs, develop maintenance and protection of traffic plans, and develop congestion management plans for improvement projects.

The Schuylkill Expressway (I-76) Operational Research Model is a mixed-traffic operations and planning tool with application for the Schuylkill Expressway proper. DVRPC prepared the operational model for the Schuylkill Expressway's mainline and interchange ramps between the Pennsylvania Turnpike at Valley Forge and the Walt Whitman Bridge—a distance of approximately 23 miles. Thirty-six (36) key intersections, at/near ramp touchdown points, that impact or may impact mainline operations were modeled in the networks.

Staff used the integrated transportation modeling suite of VISUM and VISSIM to prepare the linked regional travel forecasting and dynamic traffic modeling tool. The regional model (VISUM) was prepared and executed for Year 2010 and Year 2035 Long-Range Plan conditions. Some of its outputs served as inputs to the VISSIM operational model, thus establishing a linkage between the regional model and the operational analysis of the Expressway.

The operational model employed VISSIM to simulate the travel of individual vehicles throughout the better part of a typical weekday (7:00 AM to 6:00 PM)—for current 2010 and forecasted Year 2035 Long-Range Plan conditions. The model supplies the ability to compute and collect valuable information (volume, speed, density, throughput, travel time, stops, delay, intersection level of service, queuing, emissions, fuel consumption) for critical timeframes (15-minute, peak-hour, etc.). VISSIM also adds dimension to the performance data through its ability to animate the modeled networks. In turn, the data can be assessed for changes in performance between scenarios and/or to judge the effectiveness of conceptual improvements and strategies. Off-line database tools were developed by staff to prepare datasets and facilitate comparisons of datasets.

The delivered product is a starting point, albeit a comprehensive one, for the systematic evaluation of the Schuylkill Expressway corridor. The operational model can be used to examine and evaluate the following aspects of and/or improvements to Expressway operations:

- effects of regional growth (limited to 2010 and the 2035 Long-Range Plan scenario);
- merging and weaving sections;
- lane-changing behavior at off-ramps, lane-drops, and lane-additions;
- limited widening for auxiliary lanes;
- improved geometry or other spot improvements;
- toll plaza operations;
- ramp metering and other transportation systems management schemes; and
- incidents and work zones.

With added effort, the delivered models can be adjusted or expanded for other or wider applications that may be warranted in the future. These might involve: performing interim year analyses (i.e., Year 2015 to Year 2030), estimating the spill-over effects of incidents and emergencies, planning for and managing traffic along parallel arteries during construction projects, examining multi-modal improvement proposals within the broad I-76 planning corridor, and investigating area-based travel demand management (TDM) strategies in land use centers or related to special events.

The computer simulations and animations tell and show the complete story, but if all things come to pass in the Year 2035:

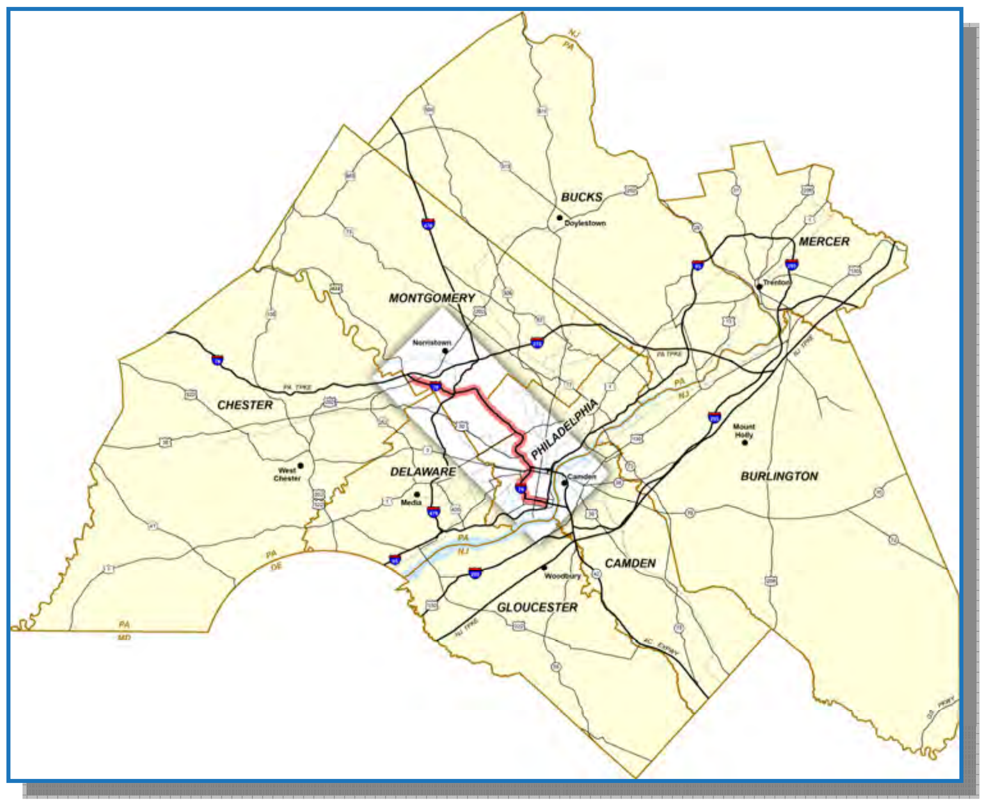
- There will be 6.1 million residents in the Delaware Valley Region (a 9-percent increase over 2010 levels).
- Daily traffic activity will rise by 13 percent along the Schuylkill Expressway. Volumes will exceed 130,000 vehicles per day in Montgomery County and 197,000 near Center City (increases on the order of 10–11 percent versus 2010 levels).
- PM Peak Hour volumes will increase at half of the daily rate because of capacity limitations along the highway.
- PM Peak Hour speeds will decline 3–4 miles per hour (mph) and, without incident, it will take two minutes longer to travel end-to-end on the Expressway than it did in 2010.

PennDOT has directed that the modeling tools be made available to member agencies for local applications and that DVRPC be responsible for administering and maintaining the models.

PURPOSE AND NEED:

The Schuylkill Expressway (I-76) is the primary highway connecting the north-western suburbs and the City of Philadelphia and serves as a gateway to Philadelphia from the rest of Pennsylvania and southern New Jersey (**Figure 1**). The Expressway is critically important to the state's and region's economies, as well as to the general well-being of local residents and businesses—when the Expressway doesn't function properly, those using the highway and nearly everyone on nearby roads are affected.

Figure 1: Regional Setting



Source: **DVRPC**

And far too frequently the Expressway does not function properly, regularly experiencing congestion due to volume, crashes, and routine maintenance activities. Sun glare slows the rush hour, and even a single abandoned car on the shoulder can snarl the Expressway in the off-peak.

The highway's original vision was well suited for scenic spaces adjacent to the Schuylkill River. However, that space was also constrained by steep grades, operating railroads, Fairmount Park, and—over time—more and more development (**Figure 2**).

Daily traffic demand has roughly doubled since the mid-1960s. Rush hour continues to confound commuters that rely on it daily, only now the "hour" lasts longer and rush hour volume peaks at incrementally different times and places, in both directions. Continually rising traffic demand and physical and institutional constraints for adding capacity have challenged engineers and planners seeking solutions since the highway first opened. History shows that PennDOT (and its predecessor, the Pennsylvania Department of Highways) has studied the highway, added connections, constructed beneficial capacity and operational improvements and re-built the highway—all at substantial financial cost. Societal costs (disruptions, delays, etc.) have also been great.

More recently, because of rising construction costs and limited funding for transportation, improvements along the highway have been practically pursued for need and through opportunity. Investments have been directed toward maintaining the highway and making it safer. Improvements at bottlenecks have been implemented in association with concurrent construction projects; and by employing electronic surveillance and communications equipment, and emergency service vehicles to detect, respond to, and clear incidents.

Still, PennDOT continues to seek opportunities regarding the Expressway's ability to stand and deliver for the future, including:

- reconstructing the highway to preserve the asset;
- providing lane and ramp widenings and operational improvements in problem spots to improve mobility; and
- adding or reconfiguring interchanges to improve accessibility.

Faced with these circumstances, PennDOT commissioned DVRPC to construct a powerful computer model capable of simulating, visualizing, and assessing traffic conditions along the Expressway to use as a practical research tool. PennDOT can use the tool to predict outcomes of changes to the Expressway's infrastructure, judge the merits of competing designs, and develop supporting maintenance and protection of traffic and congestion management plans. Linkage between the operational model and the regional travel demand forecasting model, maintained by DVRPC, provided a connection with the transportation network serving the rest of the region and a window into the long-term effects that regional growth will have on the Expressway.

Figure 2

SCHUYLKILL EXPRESSWAY TIMELINE

1930

222,000 acres developed; 3.3 million people

1932

Original vision—Riverside parkway connecting Fairmount Park & Valley Forge Park

1940

Corridor included as a component of the planned Philadelphia-Camden metro area expressway network

1947

Alignment defined—Join PA Turnpike's eastward extension at Valley Forge, serve Central Philadelphia & connect to NJ

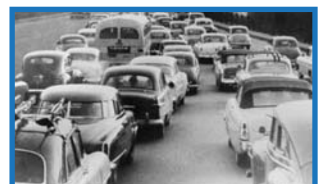
1949

Construction begins on 1st section—Turnpike to US 1

1950

Design year (1970) traffic volume estimated at 35,000 vehicles per day

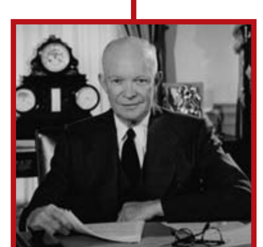
1954



1st section of the Schuylkill Expressway opened—Traffic jams reported on City Ave & in Fairmount Park

1956

Federal-Aid Highway Act established the Dwight D. Eisenhower System of Interstate and Defense Highways—Schuylkill Expressway designated I-76



1957

Walt Whitman Bridge & access roadways opened—Connects I-76 with the N-S Freeway in NJ.
- Provided relief to the Ben Franklin Bridge & improved access to Philadelphia Int'l Airport

1959

Final section of I-76 opened—rightmost westbound lane provided on structure thru Center City interchanges
- $50 million—total construction cost of the original Expressway

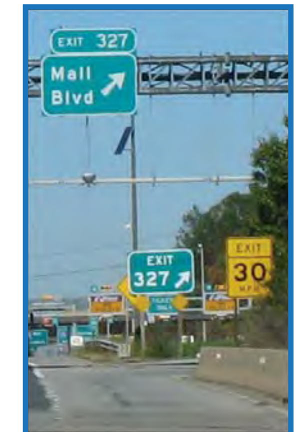
1960

1st Operational study of I-76 performed—Daily traffic volume at 70,000
- Identified safety & capacity alternatives, including parallel Manayunk Expressway & widening mainline to 8 lanes thru Center City (to accommodate the 1976 Bicentennial)

1961

Roosevelt Expressway / I-76 Interchange opened

1963



Upper Merion's edge city appears—King of Prussia Plaza opens, residents & employers follow
- Generates additional "reverse-direction" travel on the Expressway
- By 2010, the King of Prussia mall will contain nearly 3 million square feet of retail space, and Upper Merion will be host to the region's largest suburban employment levels

1967

Philadelphia R&B group The Soul Survivors release the single "Expressway to Your Heart"

1969

National Environmental Policy Act (NEPA) established federal policy, goals & procedures for protecting / enhancing the environment

1970

2nd Operational study of I-76 performed—Daily traffic volume exceeds 80,000 vehicles
- Identified need to widen mainline to a minimum 6 lanes
- Recommended acceleration & deceleration lane and shoulder improvements & ramp metering

641,000 acres developed; 5.1 million people

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

1972

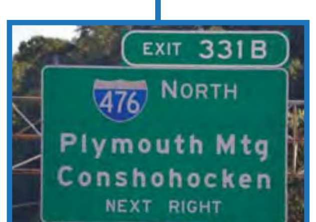
Mainline widened to 4 lanes in each direction between US 1 and Montgomery Dr & selective lane widening / operational improvements in the Lincoln Dr / Kelly Dr / US 1 Interchange

1975

Abandonment of many components of the planned urban freeway network in the region—Increased reliance on I-76 for the future

1979

I-476 opened to the north—I-76 to Ridge Pk



1981

Daily traffic volumes approach 85,000 vehicles in Montgomery County & 135,000 near Center City

1982

Schuylkill Expressway Reconstruction Project—6 year project to plan, design & rebuild mainline & bridges from the Turnpike to the University Ave viaduct [$250 million]

- Upgraded US 202 Interchange & reconfigured Vine St Interchange

1985

Final sections of I-95 completed thru Center City, I-76 & the Airport (continuous mobility thru Pennsylvania)

US 422 Expressway opened—25-mile freeway extension from US 202 / I-76 to the western edge of the region

1991

Vine Street Expressway (I-676) completed—Controlled cross-town access added between 18th St & the Ben Franklin Bridge / I-95 [$225 million]

I-476 opened to the south—I-76 to I-95 (a year later, I-476 opened between Ridge and the Turnpike to complete the highway)

1996

Schuylkill Expressway resurfaced between Valley Forge & South St

2000

Widening the Schuylkill Expressway in Montgomery County is removed from the region's Long-Range Plan in favor of the Schuylkill Valley Metro (proposed passenger rail extension & service improvements within the catchment area of US 422 & I-76)

2002

ITS: PennDOT & DRPA begin installing detectors, cameras & variable message signs along the Expressway to obtain real-time information & manage traffic

2003

US 202 (Section 400) completed

- Significantly improved connections within the I-76 / US 202 / US 422 Interchange
- 3 lanes provided in each direction south of the Schuylkill Expressway to PA 252—Mobility enhancement for Chester County

2005

960,000 acres developed; 5.5 million people

2008

South Street Bridge Replacement Project—South St Interchange is closed

- Context sensitive bridge constructed
- Left-sided interchange ramps reopened in-kind in November 2010

2010

I-76 daily traffic volumes exceeded 117,000 vehicles in Montgomery County & approached 180,000 near Center City

2011

Interchange #329 added to I-76—New westbound on- and off- ramps at Henderson Road

- More effectively serve King of Prussia / Norristown-based travelers
- Eliminate congestion on local street network

Walt Whitman Bridge Decking Replacement Project—Three-year project begins [$150 million]

2035

6.1 million residents forecasted for the Region

AND BEYOND

Primary sources: www.phillyroads.com and www.pahighways.com

OPERATIONAL MODEL OVERVIEW:

The operational research model produced for PennDOT is a mixed-traffic operations and planning tool with application for the Schuylkill Expressway. DVRPC prepared the operational model for the Schuylkill Expressway's mainline and interchange ramps between the Pennsylvania Turnpike at Valley Forge and the Walt Whitman Bridge—a distance of approximately 23 miles. Thirty-six (36) key intersections, at or near ramp touchdown points that impact or may impact mainline operations were modeled in the networks.

The model was designed to provide a wealth of information for transportation planning and decision-making purposes and required a wealth of information on existing conditions to construct and calibrate for use (including traffic volumes, roadway geometry, and signal timing plans).

DVRPC's transportation modeling platform, the Travel Improvement Model (TIM), uses PTV Vision Inc.'s integrated software products (VISUM and VISSIM) for estimating and planning multi-modal travel conditions within and beyond the Philadelphia metropolitan area. The regional model (VISUM) was prepared and executed for Year 2010 and Year 2035 Long-Range Plan conditions. Some of its outputs served as inputs to the VISSIM operational model, thus establishing a linkage between the regional model and the operational analysis of the Expressway.

The Schuylkill Expressway operational model employed VISSIM to simulate the travel of individual vehicles throughout the better part of a typical weekday (7:00 AM to 6:00 PM)—for current 2010 and forecasted Year 2035 Long-Range Plan conditions. The model supplies the ability to compute and collect valuable information (volume, speed, density, throughput, travel time, stops, delay, intersection level of service, queuing, emissions, fuel consumption) for critical timeframes (15-minute, peak-hour, etc.). In turn, the data can be assessed for changes in performance between scenarios and to judge the effectiveness of conceptual improvements and strategies. Off-line database tools were developed to prepare datasets and facilitate comparisons of datasets.

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With added effort, the models can be adjusted or expanded for other or wider applications that may be warranted in the future. These might involve: performing interim year analyses (i.e., Year 2015 to Year 2030), estimating the spill-over effects of incidents and emergencies, planning for and managing traffic along parallel arteries during construction projects, examining multi-modal improvement proposals within the broad I-76 planning corridor, and investigating area-based TDM strategies in land use centers or related to special events. (Applications and case studies for the models are listed in **Appendix A-2 and Appendix A-3**, respectively.) To accommodate these possibilities, copies of the Year 2010 and Year 2035 VISUM regional models—also containing the Nighttime Period (6:00 PM to 7:00 AM)—were supplied to PennDOT.

DVRPC's Travel Improvement Modeling (TIM) Platform:

- **VISUM** is the regional travel demand forecast modeling component. VISUM follows the four-step, trip-end-based modeling process typical of macroscopic models.

  VISUM relies on demographic and employment data, land use, and transportation network characteristics to simulate trip-making patterns throughout the region. It can be used to estimate and predict the number of trips occurring within and passing through the region, their origins and destinations, and mode of travel (highway or transit). It can be used to forecast future travel patterns and to quantify the effects of various transportation projects and policies. For highway trips, the models determine the route of each trip under prevailing congestion levels, which vary by time of day. Model outputs include highway volumes for individual facilities and transit ridership by line and station. VISUM's traffic assignment (built from regional trip tables) can be transferred to guide the VISSIM modeling.

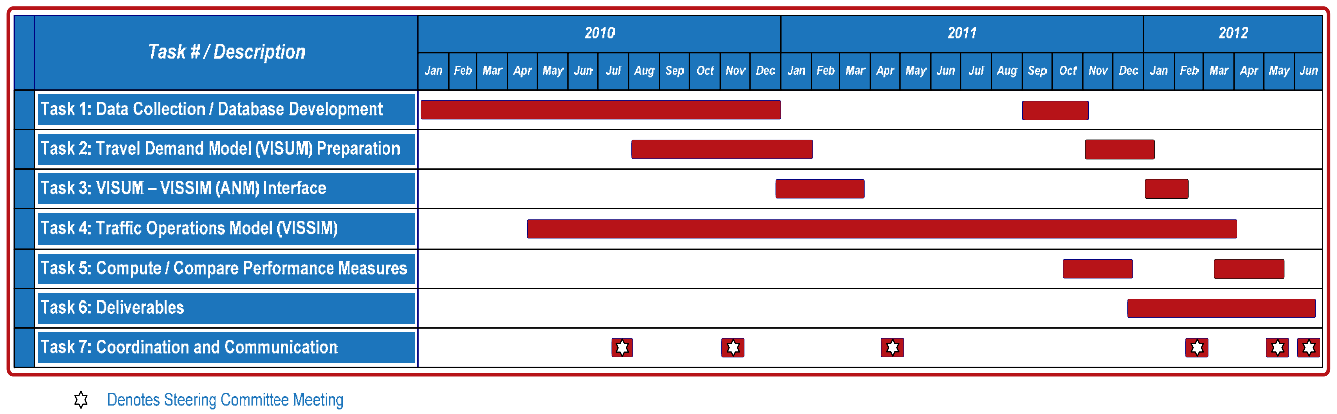
- **VISSIM** is the microscopic simulation program for multi-modal vehicular and non-vehicular flows. It is useful for computing and assessing the flow of individual vehicles for operational testing / planning of transportation facilities. Performance measures can be aggregated for selected or continuous time periods, and its animations of traffic and transportation systems add dimension to the performance data.

  The program uses actual data, and inputs and outputs from VISUM to simulate traffic operations under prevailing conditions. Ideally, outputs from VISSIM investigations can be taken back into VISUM to determine if, or how much, regional travel demands / patterns are altered by a potential improvement.

WORK PROGRAM:

A rigorous work program was completed to provide the modeling tool, including: data collection and synthesis, data management, network preparations, travel demand forecasting, operational modeling and testing, and communication. The project was completed in a 30-month time-frame (**Figure 3**).

Figure 3: Project Timeline



Source: DVRPC

TASK 1: DATA COLLECTION AND DATABASE DEVELOPMENT

Demand and supply characteristics for current 2010 conditions were established through a major traffic counting and data management program. DVRPC conducted traffic counts, performed field views, and researched other relevant information from in-house, external, and online sources, as follows:

- **a.** obtained physical, operating, and regulatory inventory for the Expressway model's mainline, ramp, and intersection network;
- **b.** created, refined, managed, and maintained database tools to store, organize, process, and analyze project data;
- **c.** gathered mainline, ramp, and intersection traffic volume and classification counts along the Expressway;
- **d.** synthesized raw count data to current 2010 typical weekday volume conditions and disaggregated volumes to 15-minute intervals (based on raw data) for the mainline, ramp, and study intersection network;
- **e.** assembled spot-speed data along the Expressway's mainline (source: Traffic.com sensor data); and
- **f.** assembled operating speed and travel-time data along the Expressway's mainline (source: INRIX Vehicle Probe Project [VPP]).

TASK 2: REGIONAL TRAVEL DEMAND FORECASTING MODEL (VISUM) PREPARATION

- **a.** focused Year 2010 regional model to the I-76 corridor by adding transportation analysis zones (TAZs) and transportation facilities as necessary;
- **b.** assembled current daily traffic count data in the broad I-76 planning corridor from activities conducted in Task 1 and other in-house sources;
- **c.** executed VISUM and compared daily traffic outputs to current travel patterns and traffic volumes;
- **d.** fine-tuned travel demand model parameters as needed until the model reasonably replicated current travel patterns and traffic volumes throughout the broad study area;
- **e.** repeated model execution and refinement for each of four time periods: the AM Peak Period (7:00 AM to 9:00 AM); the Midday Period (9:00 AM to 3:00 PM); the PM Peak Period (3:00 PM to 6:00 PM); and the Nighttime Period (6:00 PM to 7:00 AM); provided loaded networks as a deliverable;
- **f.** prepared Expressway-level sub-network (mainline and ramps) of the loaded VISUM networks for each Year 2010 time period containing complete routes for all trips from the regional model (i.e., origins, entering and exiting interchanges, and destinations); supplied Expressway and ramp link traffic forecasts to database (Task 1b); and supplied representative hourly on-ramp volumes (traffic flow rates) and routes (percentages) via ANM exports to downstream off-ramps for each ramp-pair—in each time block—to guide VISSIM (to Tasks 3b and 4d);
- **g.** added 2035 population and employment forecasts and planned transportation projects to the regional model per the region's current Transportation Improvement Program (TIP) and Long-Range Plan; and re-executed the regional VISUM model; and
- **h.** prepared Expressway-level sub-network of the loaded VISUM networks for each Year 2035 time period; supplied mainline and ramp link traffic forecasts to database (Task 1b), and representative hourly on-ramp volumes and routes for each time block for the ANM step (to Tasks 3b and 4g).

TASK 3: VISUM–VISSIM (ANM) INTERFACE

This step established an off-line connection between the VISUM and VISSIM models and the link from current traffic volumes to future-year travel demands at 15-minute intervals to use as inputs for the 2035 VISSIM operational model.

- **a.** for the AM, Midday, and PM analysis periods: developed and documented 15-minute interval relationships between current 2010 traffic volumes (Task 1d) and the calibrated Year 2010 VISSIM model's traffic volume outputs (per Task 4e) for the modeled network's mainline, ramps, and intersections;
- **b.** for the AM, Midday, and PM analysis periods: established and documented relationships between representative hourly on-ramp volumes and routes output from the Year 2010 and Year 2035 VISUM models (per Tasks 2f and 2h);
- **c.** applied forecast-year relationships (Task 3b) to current 2010 traffic volumes (Task 1d), to produce 15-minute vehicle inputs for the Year 2035 VISSIM operational model (Task 4g); and
- **d.** prepared Excel workbook file (**ANMtranslation.xls**) as a template for the interface procedure (technical documentation included in the **USER'S GUIDE**).

Task 4: Traffic Operational Model (VISSIM)

- **a.** constructed center-line model of the Schuylkill Expressway, ramps, and intersection network in VISSIM, overlaid to DVRPC's 2010 aerial photography;
- **b.** added travel and auxiliary lanes, geometry (lengths of acceleration and deceleration lanes, weaving areas, etc.), grades, and traffic control devices;
- **c.** input appropriate time-of-day traffic signal phasing and timing plans;
- **d.** input current 2010 analysis period traffic volumes at the Expressway on-ramps and intersections (from Task 1d) and applied routing decisions from VISUM (Task 2f) in 15-minute intervals;
- **e.** executed Year 2010 VISSIM model; performed integrity check, network adjustment, and parameter refinement, as necessary to calibrate the Year 2010 operational model's traffic volumes to current 2010 data for the AM Peak, Midday, and PM Peak analysis periods;
- **f.** added westbound ramps at I-76 and Henderson / South Gulph Road to the Year 2010 VISSIM modeled network to create the Year 2035 VISSIM network;
- **g.** input Year 2035 routing decisions (Task 2h) and 15-minute vehicle inputs (from Task 3c) and executed VISSIM, to yield the Year 2035 operations model for each time period; and
- **h.** performed evaluations of the Year 2010 and Year 2035 loaded networks to collect selected performance statistics (traffic volumes, spot speeds, and travel times / operating speeds) for three key operating hours: the AM Peak Hour (7:00 AM to 8:00 AM), the Midday Trough Hour (10:00 AM to 11:00 AM), and the PM Peak Hour (4:30 PM to 5:30 PM); loaded network data saved to database (Task 1b), used for analyses (Task 5), and supplied as a deliverable (Task 6).

Task 5: Compute and Compare Performance Measures

- **a.** prepared off-line performance measures change tool (**Compare.mdb**) to compare and contrast volumes and spot speeds between datasets or scenarios (technical documentation included in the **USER'S GUIDE**); and
- **b.** through the VISSIM software and its animations, and via off-line database tools: identified and quantified local trouble spots and segments along the Expressway exhibiting substantive performance changes (in traffic volumes and speeds) between current 2010 and forecasted Year 2035 conditions for the three key hours.

Task 6: Deliverables (supplied electronically)

- **a.** all baseline information: counts, aerials, condition diagrams, etc.;
- **b.** project database and **Compare.mdb** tool;
- **c.** Year 2010 and Year 2035 VISUM regional models and I-76 sub-network models (four time periods);
- **d.** ANM translation tool: **ANMtranslation.xls**;
- **e.** Year 2010 and Year 2035 VISSIM operational models (three time periods);
- **f.** **FINAL REPORT** (this document)—overview and summary of the project; and
- **g.** **USER'S GUIDE**—inventory of all supporting electronic data files, database tools, and technical documentation needed to run the models as designed or to edit for alternative applications.

Task 7: Coordination and Communication

The DVRPC project team was aided throughout by the advice and assistance of a multi-jurisdictional Steering Committee comprised of staff from PennDOT, and other transportation owners and service providers, and municipal stakeholders in the corridor (**Table 1**). Through these interactions, staff identified and inventoried potential case studies for using the models, and conducted a rudimentary application of the operational model to test the tool and document performance changes associated with an improvement.

Communication was ongoing among in-house staff and frequent with staff of the participating agencies. Formal meetings were conducted to appraise and take direction from the project's Steering Committee:

- **#1:** *Project Background & Existing Conditions* (July 20, 2010);
- **#2:** *Corridor Bus Tour (*November 3, 2010);
- **#3:** *Year 2035 Modeling Inputs & Potential Uses of the Model* (April 20, 2011);
- **#4:** *Year 2010 Calibrated Models & VISSIM Animations, Year 2035 Modeling Inputs & Potential Uses of the Model* (February 21, 2012);
- **#5:** *Year 2035 Models & VISSIM Animations, Select VISSIM Test Application* (May 4, 2012); and
- **#6:** *VISSIM Model Test Application Results, Draft - Final Report* (June 22, 2012).

The Channel 6 Zooballoon rises over the Expressway at Girard Avenue. (Photo courtesy of David Sitbon)

Table 1: Steering Committee Members

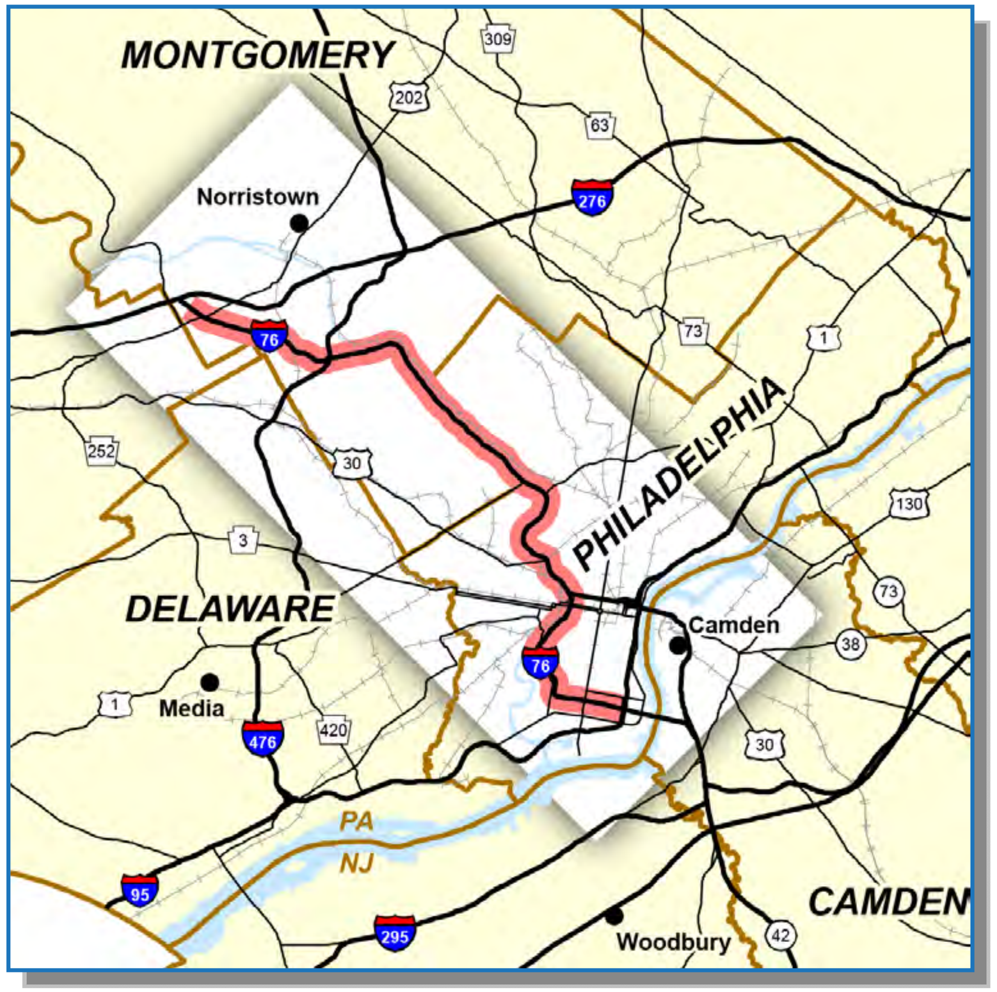
Name	Title	Organization
Mr. Manny Anastasiadis	Operations and Freeway Manager	PennDOT Engineering District 6-0
Mr. Leo Bagley	Assistant Director	Montgomery County Planning Commission
Mr. Louis Belmonte	District Traffic Engineer	PennDOT Engineering District 6-0
Mr. Stephen Buckley	Director of Policy and Planning	Philadelphia Office of Transportation and Utilities
Mr. Don Cannon	Director of Public Works	Lower Merion Township
Mr. Mark Cassel	Senior Operations Planner	SEPTA
Mr. Doug Cleland	Township Manager	Lower Merion Township
Mr. Charles Davies	Assistant District Executive, Design	PennDOT Engineering District 6-0
Mr. Charles Denny	Assistant Chief Traffic Engineer	Philadelphia Department of Streets, Traffic Engineering
Mr. Matthew Edmond	Senior Transportation Planner	Montgomery County Planning Commission
Mr. Michael English	Borough Manager	West Conshohocken Borough
Mr. Carmine Fiscina	Technology and Safety Engineer	Federal Highway Administration
Mr. Scott Fletcher	Assistant District Executive, Services	PennDOT Engineering District 6-0
Mr. Darin Gatti	Assistant Manager	Philadelphia Department of Streets
Mr. Keith Highlands	Project Development Engineer	PennDOT Bureau of Design
Mr. Ryan Jeroski	Project Manager, Schuylkill Valley Transportation Coalition	GVF (Greater Valley Forge Transportation Management Assoc.)
Mr. Brian Keaveney	Transportation Division Manager	Pennoni Associates Inc.
Mr. Francis Marabella	Borough Manager	Conshohocken Borough
Mr. Edward O'Brien	Director of Public Works	Upper Merion Township
Ms. Camille Otto	Senior Program Development Specialist	Federal Highway Administration
Mr. Ashwin Patel	Traffic Signals and Safety Manager	PennDOT Engineering District 6-0
Mr. Wesley Ratko	Transportation Planner	Montgomery County Planning Commission
Mr. A. Timothy Salvatore	Senior Engineer, Engineering Division	Delaware River Port Authority
Mr. Anthony Santaniello	Transportation Planner	Philadelphia City Planning Commission
Ms. Deborah Schaff	Senior Transportation Planner	Philadelphia City Planning Commission
Mr. Don Steele	Senior Civil Engineer	Pennsylvania Turnpike Commission
Mr. Ron Wagenmann	Township Manager	Upper Merion Township
Mr. John Ward	Deputy Planning Director	Delaware Valley Regional Planning Commission
Mr. Charles Webb	Chief Officer, Service Planning	SEPTA

Source: DVRPC

THE SCHUYLKILL EXPRESSWAY CORRIDOR:

An overview of the planning corridor (**Figure** 4) is warranted to develop the Expressway's value to the region, to introduce and establish transportation supply and demand characteristics for the modeling project, and to provide insight into potential applications of the model.

Figure 4: The Planning Corridor



Source: DVRPC

EXISTING LAND USE AND TRANSPORTATION FACILITIES

Mature suburban and urban landscapes are traversed by I-76 as it extends from Valley Forge, on the west, to New Jersey, on the east. Along the way, the Expressway serves the City of Philadelphia and provides interconnections with many of region's other expressways, including the Pennsylvania Turnpike (I-76 / I-276), US 202 / US 422, the Mid-County Expressway (I-476), the Roosevelt Expressway (US 1 North), the Vine Street Expressway (I-676), I-95, and I-295 and the North–South Freeway (NJ 42) in New Jersey.

The broad corridor is also served with a network of busy parallel and intersecting arterial highways and supportive passenger rail lines operated by the Southeastern Pennsylvania Transportation Authority (SEPTA), the Port Authority Transit Corporation (PATCO), and NJ Transit (**Figure 5**).

- SEPTA (9):
  - Paoli / Thorndale Regional Rail Line;
  - Norristown Regional Rail Line;
  - Cynwyd Regional Rail Line;
  - Chestnut Hill West Regional Rail Line;
  - Chestnut Hill East Regional Rail Line;
  - Norristown High Speed Line and Market-Frankford Line;
  - Airport Regional Rail Line; and
  - Broad Street Line.
- PATCO (1): Lindenwold High Speed Line
- NJ Transit (1): Atlantic City Rail Line

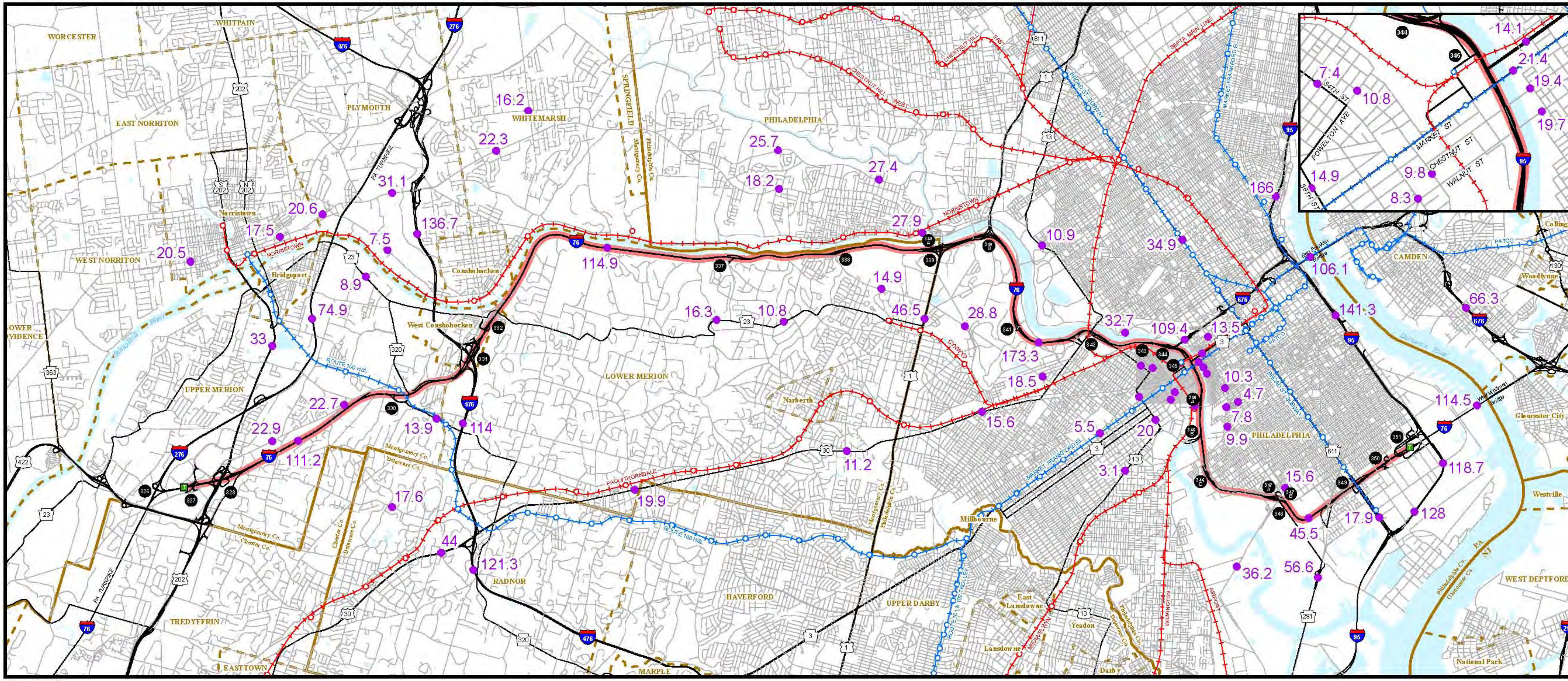
Seven regularly scheduled public bus routes operate along the Expressway:

- SEPTA—Center City and west to City Avenue (3): Routes 9, 27 and 44;
- SEPTA—Center City and west to King of Prussia (2): Routes 124 and 125;
- SEPTA—between I-476 and King of Prussia (1): Route 123; and
- NJ Transit—Broad Street and east to New Jersey (1): Route 316 (summer service only).

Nationally and locally renowned cultural sites and important commercial centers within the region rely on the accessibility and mobility supplied by the Expressway (**Figure 6**).

Principal Highways and Passenger Rail Services

Figure 5



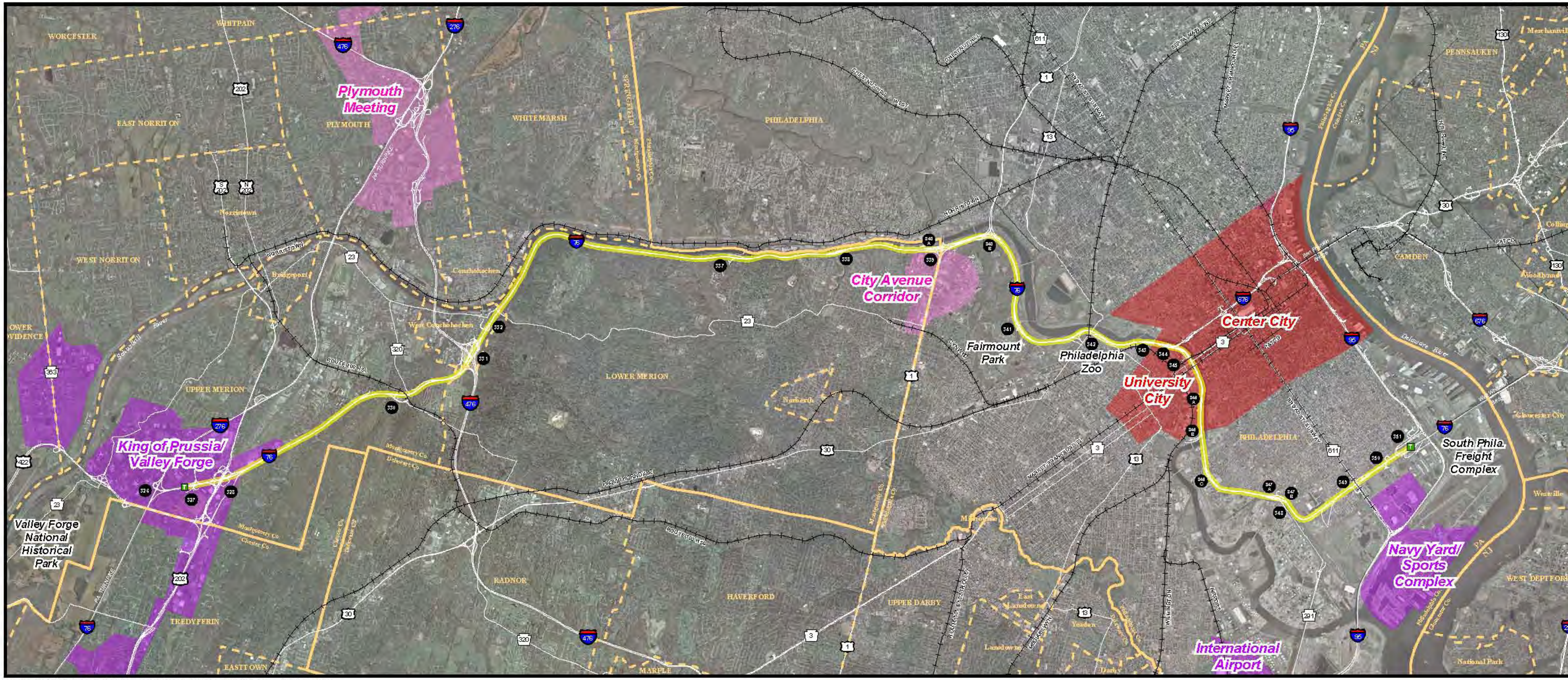
Source: DVRPC

- I-76 Schuylkill Expressway
- Toll Plaza
- Interchange Number
- Recent Daily Traffic Volume (000's)
- SEPTA Regional Rail
- Other Passenger Rail

0 1 2 Miles

Land Use Centers and Landmarks

Figure 6



Source: Land Use Centers - DVRPC Connections 2035 Plan; Aerial Imagery - DVRPC, 2010

0 1 2
Miles

- I-76 Schuylkill Expressway
- Toll Plaza
- Interchange Number
- Metropolitan Center
- Metropolitan Sub-Center
- Suburban Center

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

CURRENT 2010 TRAFFIC CONDITIONS

The detailed I-76 highway corridor is approximately 23 miles in length, extending between the toll plazas at the Pennsylvania Turnpike's Valley Forge Interchange and the Walt Whitman Bridge. There are approximately 23 interchanges with 100 ramps (50 in each direction) along the way. Institutional, regulatory, and physical conditions along the Expressway, which also define some of the modeling parameters, are illustrated on **Figure 7** (see page 17).

A comprehensive traffic count and data collection effort was conducted to establish the current traffic baseline for use in the modeling work. DVRPC staff conducted traffic counts and gathered recent traffic data from in-house and external sources. Collected items included: traffic counts, spot-speed data, and operating speed data. Data management activities were initiated alongside the data collection exercise to store, organize, and manipulate the data, and to serve in analyses. The database also served as a platform to integrate DVRPC's in-house functions that participated in the project (e.g., Travel Monitoring, Geographic Information System [GIS] Mapping, Transportation Modeling [VISUM], and Transportation Planning [VISSIM]).

Datasets were formulated to serve various needs, including: general information, inputs and outputs of the calibrated VISUM and VISSIM models, performance measurement, and further analyses. Traffic demand data elements (traffic volume, vehicle classification, and spot speeds) were collected in 15-minute increments and compiled for 24 hours along the Expressway. Operating speed and travel time data for defined segments along the mainline were collected for key hours within the morning, midday, and evening travel periods for performance measurement, but were not included in the formal project database because of their unique format.

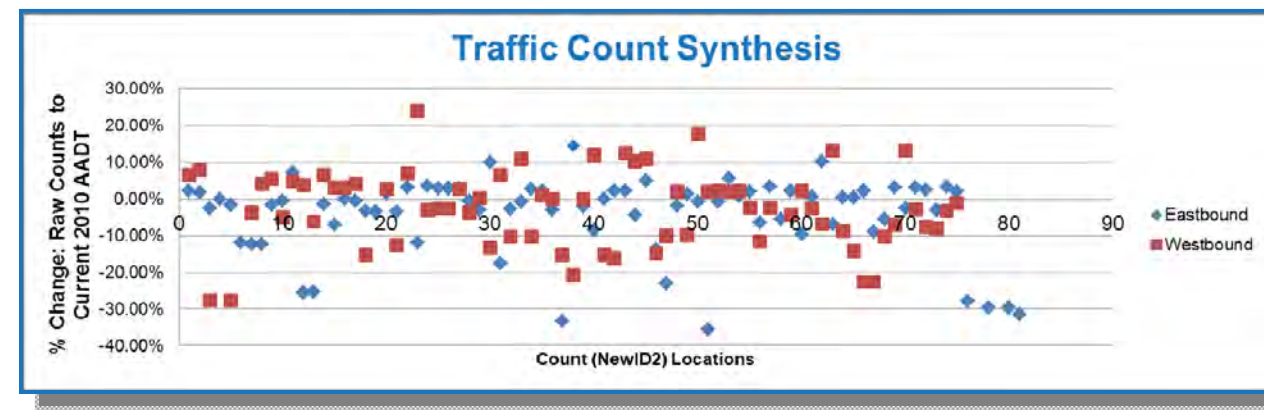
Daily traffic count data along the Expressway's mainline and on- and off-ramps was adjusted for seasonal variation and vehicle mix and synthesized to compensate for variable dates, varying count recording equipment, and missing or unreliable sensor data in both directions along the Expressway (**Figure 8**). The resultant current 2010 traffic volumes became the baseline representing typical conditions along the Schuylkill Expressway for the project.

Current 2010 daily volumes were disaggregated to 15-minute intervals, based on actual count data using data management techniques. Fifteen-minute interval traffic volumes along the mainline and ramps were re-aggregated into four time periods, or blocks, within the day for VISUM regional travel demand forecast modeling needs—because different travel characteristics (purposes, patterns, and demands) are inherent within different parts of a day:

- **AM Peak Period time block = 7:00 AM to 9:00 AM**;
- **Midday Period time block = 9:00 AM to 3:00 PM**;
- **PM Peak Period time block = 3:00 PM to 6:00 PM**; and
- **Nighttime Period time block = 6:00 PM to 7:00 AM**.

All traffic data was stored in the project database for modeling requirements, performance measurements and delivery.

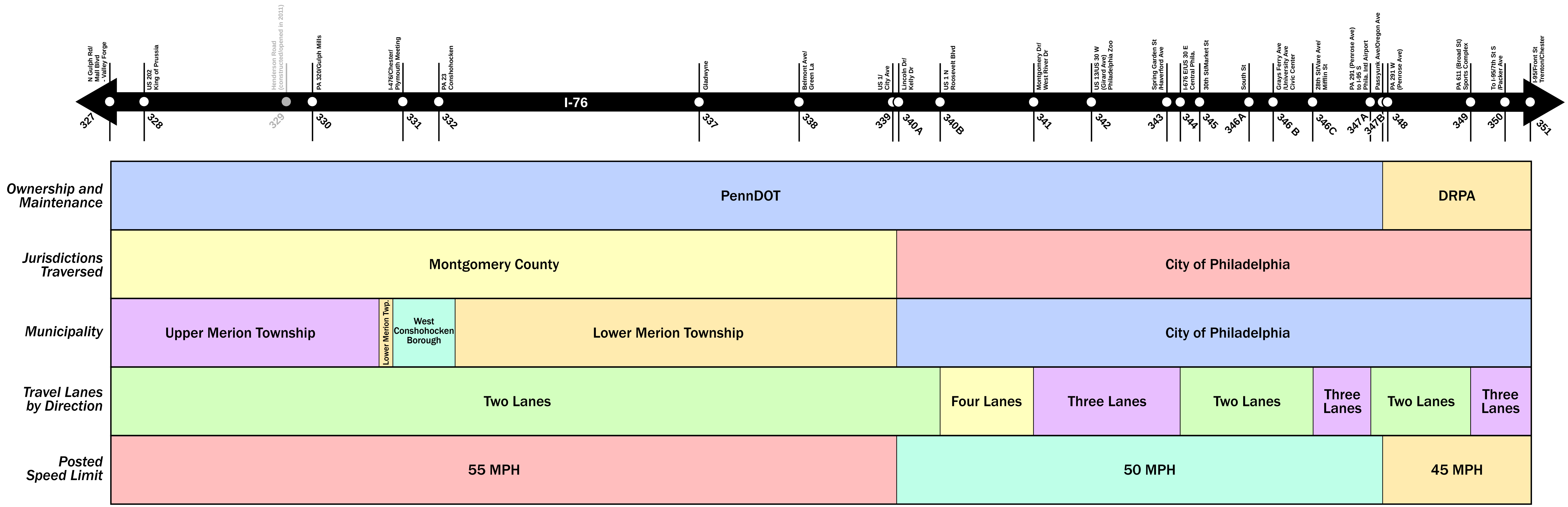
Figure 8: Daily Traffic Count Data Synthesis



Traffic counts were synthesized to flow volumes along the Expressway. System-wide (i.e., mainline and ramps), current 2010 volumes were within 5 percent of the raw traffic count data, eastbound and westbound. (DVRPC)

Institutional, Physical, and Regulatory Conditions in 2010

Figure 7



Note: Interchange numbering mimics mileage along the Expressway.

TRAFFIC DATA COLLECTION PROGRAM:

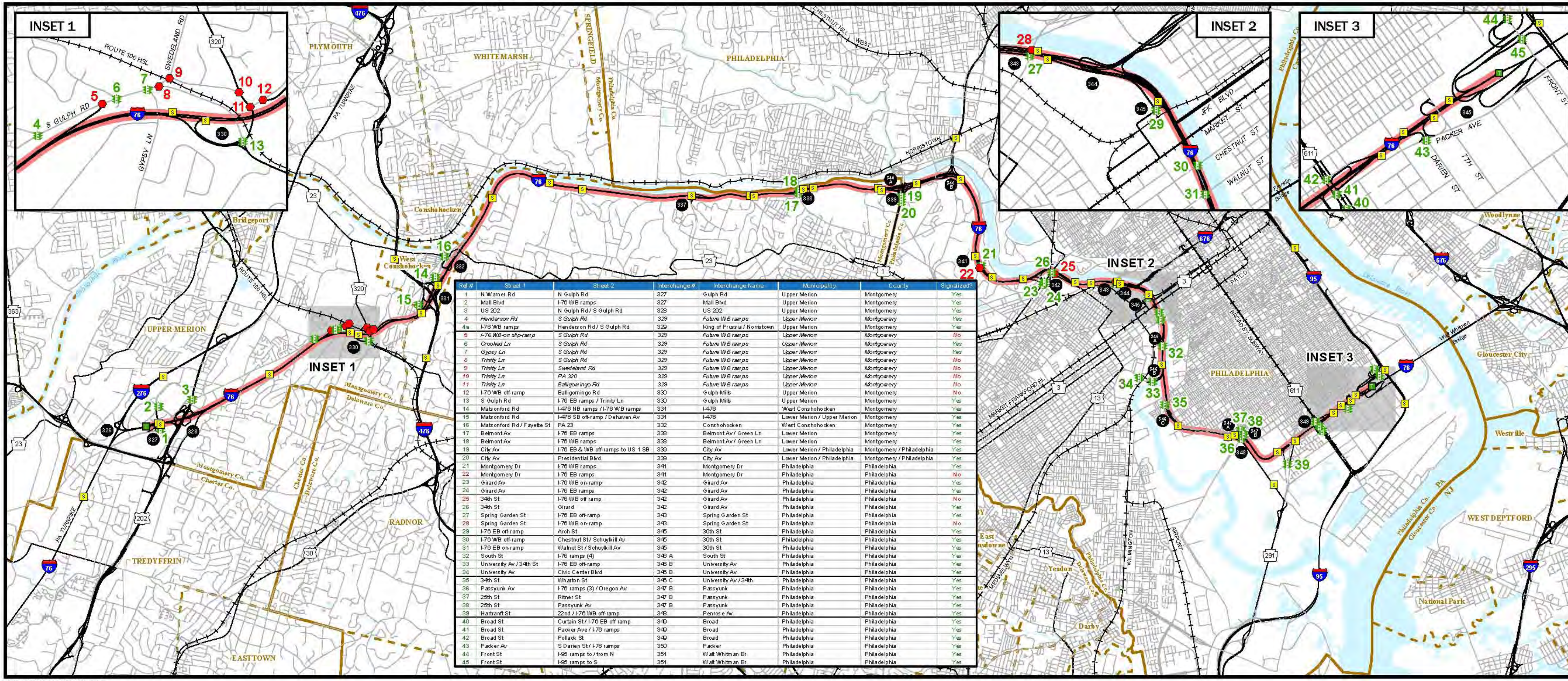
- **Expressway Traffic Characteristics**
  - 130 automatic traffic recorder (ATR) counts were conducted by DVRPC on ramps connecting with the Expressway to obtain traffic volumes in 15-minute intervals throughout the course of a typical weekday. The majority of the ATR counts were performed in winter 2009–2010.
  - The South Street Bridge Replacement and related I-76 / South Street Interchange closure (2008 through November 5, 2010) necessitated the use of historical ramp count data (conducted in 2008 before and in preparation for the bridge and interchange closure). 2008 ATR ramp count data was also used for the interchanges adjacent to South Street.
  - The I-76 count program was completed in the vicinity of the US 1 / Roosevelt Boulevard Twin Bridges Reconstruction Project prior to traffic restrictions. (The Twin Bridges reconstruction was initiated in early spring 2010 and continued through the end of the year.)
  - Mainline traffic volumes were also obtained from six ATR-traffic classification counters placed by DVRPC in late winter and early spring 2010 and from 2009 and 2010 traffic counts obtained from 26 Traffic.com sensors along the Expressway's mainline (13 eastbound and 13 westbound).
  - Year 2010 toll plaza count records, supplied by the Pennsylvania Turnpike Commission (PTC), provided traffic volumes at the western end of the Expressway at the Valley Forge Interchange.
  - Year 2009 toll plaza count records, supplied by the Delaware River Port Authority (DRPA), provided traffic volumes at the eastern end of the Expressway at the Walt Whitman Bridge.
  - Vehicle classification counts for 22 representative locations along the mainline were obtained from DVRPC's ATR counts, Traffic.com sensors, and the PTC and the DRPA count data.
  - Spot-speed data was obtained from 47 Traffic.com sensors along the Expressway's mainline (23 eastbound and 24 westbound). The data was drawn from nine "typical volume" survey days in March and April of 2009 and 2010. Each sensor's data was averaged for 15-minute interval spot speeds.
  - Average 2010 operating speeds were obtained for the defined peak hours and for 10 defined segments in each direction along the Expressway from INRIX VPP. Sampling of Tuesdays, Wednesdays, and Thursdays in April and October 2010 formed the datasets. Travel times were obtained by converting the speeds with segment lengths.

- **Intersection Traffic Conditions** (**Figure 9**)
  - Manual turning movement traffic counts (TMTCs) were conducted at 46 intersections between: 6:00 AM–9:30 AM, 11:00 AM–1:00 PM, and 3:00 PM–7:00 PM. The intersection counts were predominantly performed during the spring and summer of 2010. Turning movement traffic volumes were adjusted in proportion to ramp volumes collected from the ATRs for integration into the operational model. Ultimately, 36 locations were used in the structure of the VISSIM 2010 models (but removed from the Year 2035 models).
  - Year 2008 counts were used for the intersections most closely associated with the South Street Interchange to reflect normal operating conditions (i.e., with the South Street Bridge and Interchange open to traffic). Volumes were adjusted for integration into the operational model.
  - Traffic counts were performed at the I-76 and Henderson / South Gulph Road intersection in January 2012 to account for the addition of the King of Prussia / Norristown Interchange (#329) for the Year 2035 modeling.
  - Interim period turning movements (e.g., between 9:30 AM and 11:00 AM, etc.) were estimated in 15-minute intervals, using obtained turning volumes as a guide and ramp volumes as a control.
  - Current traffic signal permit drawings were obtained for the signalized intersections from PennDOT, the City of Philadelphia, and Pennoni Associates Inc. (the consulting traffic engineers representing the participating municipalities).

- **Spot Counts**
  - Selected ramp volume checks were performed during September and October 2011 to corroborate initial ATR / TMTC data. Adjusted traffic data in the database where required.

Intersection Turning Movement Traffic Counts

Figure 9



Ref #	Street 1	Street 2	Interchange #	Interchange Name	Municipality	County	Signalized?
1	N Warner Rd	N Gulph Rd	327	Gulph Rd	Upper Merion	Montgomery	Yes
2	Mall Blvd	I-76 WB ramps	327	Mall Blvd	Upper Merion	Montgomery	Yes
3	US 202	N Gulph Rd / S Gulph Rd	328	US 202	Upper Merion	Montgomery	Yes
4	*Henderson Rd*	*S Gulph Rd*	*329*	*Future WB ramps*	*Upper Merion*	*Montgomery*	Yes
4a	I-76 WB ramps	Henderson Rd / S Gulph Rd	329	King of Prussia / Norristown	Upper Merion	Montgomery	Yes
5	*I-76 WB-on slip-ramp*	*S Gulph Rd*	*329*	*Future WB ramps*	*Upper Merion*	*Montgomery*	*No*
6	*Crooked Ln*	*S Gulph Rd*	*329*	*Future WB ramps*	*Upper Merion*	*Montgomery*	Yes
7	*Gypsy Ln*	*S Gulph Rd*	*329*	*Future WB ramps*	*Upper Merion*	*Montgomery*	Yes
8	*Trinity Ln*	*S Gulph Rd*	*329*	*Future WB ramps*	*Upper Merion*	*Montgomery*	*No*
9	*Trinity Ln*	*Swedeland Rd*	*329*	*Future WB ramps*	*Upper Merion*	*Montgomery*	*No*
10	*Trinity Ln*	*PA 320*	*329*	*Future WB ramps*	*Upper Merion*	*Montgomery*	*No*
11	*Trinity Ln*	*Balligomingo Rd*	*329*	*Future WB ramps*	*Upper Merion*	*Montgomery*	*No*
12	I-76 WB off-ramp	Balligomingo Rd	330	Gulph Mills	Upper Merion	Montgomery	No
13	S Gulph Rd	I-76 EB ramps / Trinity Ln	330	Gulph Mills	Upper Merion	Montgomery	Yes
14	Matsonford Rd	I-476 NB ramps / I-76 WB ramps	331	I-476	West Conshohocken	Montgomery	Yes
15	Matsonford Rd	I-476 SB off-ramp / Dehaven Av	331	I-476	Lower Merion / Upper Merion	Montgomery	Yes
16	Matsonford Rd / Fayette St	PA 23	332	Conshohocken	West Conshohocken	Montgomery	Yes
17	Belmont Av	I-76 EB ramps	338	Belmont Av / Green Ln	Lower Merion	Montgomery	Yes
18	Belmont Av	I-76 WB ramps	338	Belmont Av / Green Ln	Lower Merion	Montgomery	Yes
19	City Av	I-76 EB & WB off-ramps to US 1 SB	339	City Av	Lower Merion / Philadelphia	Montgomery / Philadelphia	Yes
20	City Av	Presidential Blvd	339	City Av	Lower Merion / Philadelphia	Montgomery / Philadelphia	Yes
21	Montgomery Dr	I-76 WB ramps	341	Montgomery Dr	Philadelphia	Philadelphia	Yes
22	Montgomery Dr	I-76 EB ramps	341	Montgomery Dr	Philadelphia	Philadelphia	No
23	Girard Av	I-76 WB on-ramp	342	Girard Av	Philadelphia	Philadelphia	Yes
24	Girard Av	I-76 EB ramps	342	Girard Av	Philadelphia	Philadelphia	Yes
25	34th St	I-76 WB off ramp	342	Girard Av	Philadelphia	Philadelphia	No
26	34th St	Girard	342	Girard Av	Philadelphia	Philadelphia	Yes
27	Spring Garden St	I-76 EB off-ramp	343	Spring Garden St	Philadelphia	Philadelphia	Yes
28	Spring Garden St	I-76 WB on-ramp	343	Spring Garden St	Philadelphia	Philadelphia	No
29	I-76 EB off-ramp	Arch St	345	30th St	Philadelphia	Philadelphia	Yes
30	I-76 WB off-ramp	Chestnut St / Schuylkill Av	345	30th St	Philadelphia	Philadelphia	Yes
31	I-76 EB on-ramp	Walnut St / Schuylkill Av	345	30th St	Philadelphia	Philadelphia	Yes
32	South St	I-76 ramps (4)	346 A	South St	Philadelphia	Philadelphia	Yes
33	University Av / 34th St	I-76 EB off-ramp	346 B	University Av	Philadelphia	Philadelphia	Yes
34	University Av	Civic Center Blvd	346 B	University Av	Philadelphia	Philadelphia	Yes
35	34th St	Wharton St	346 C	University Av / 34th	Philadelphia	Philadelphia	Yes
36	Passyunk Av	I-76 ramps (3) / Oregon Av	347 B	Passyunk	Philadelphia	Philadelphia	Yes
37	25th St	Ritner St	347 B	Passyunk	Philadelphia	Philadelphia	Yes
38	25th St	Passyunk Av	347 B	Passyunk	Philadelphia	Philadelphia	Yes
39	Hartranft St	22nd / I-76 WB off-ramp	348	Penrose Av	Philadelphia	Philadelphia	Yes
40	Broad St	Curtain St / I-76 EB off ramp	349	Broad	Philadelphia	Philadelphia	Yes
41	Broad St	Packer Ave / I-76 ramps	349	Broad	Philadelphia	Philadelphia	Yes
42	Broad St	Pollack St	349	Broad	Philadelphia	Philadelphia	Yes
43	Packer Av	S Darien St / I-76 ramps	350	Packer	Philadelphia	Philadelphia	Yes
44	Front St	I-95 ramps to / from N	351	Walt Whitman Br	Philadelphia	Philadelphia	Yes
45	Front St	I-95 ramps to S	351	Walt Whitman Br	Philadelphia	Philadelphia	Yes

Source: DVRPC, Traffic.com

I-76 Schuylkill Expressway Operational Research Model Corridor

Signalized Intersection

Toll Plaza

Unsignalized Intersection

Interchange Number

Traffic Information Sensor

0 1 2

Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

76 SCHUYLKILL EXPRESSWAY OPERATIONAL RESEARCH MODEL

Current 2010 Traffic Volumes

Current 2010 traffic information was tabulated in a few straightforward ways to provide an initial overview of traffic demand conditions along the Schuylkill Expressway. Database techniques were employed to establish volumes within shorter time-frames during a typical weekday: four time blocks (for travel demand forecast modeling) and 15-minute intervals (for operational modeling).

Eastbound and westbound ramp and mainline traffic volumes are summarized in **Tables 2 and 3**, respectively (see pages 22 through 25). Over the course of a typical day, approximately 299,700 vehicles entered the Expressway eastbound and 272,000 vehicles entered westbound.

The daily volume data was assembled around ramps at the interchanges (**Table 4**) to provide a reference to the magnitude and directionality of traffic. Principal interchanges between the toll plazas are:

- Roosevelt Boulevard (US 1N) / City Avenue (US 1S);
- Mid-County Expressway (I-476) / PA 23;
- US 202 / US 422; and
- Vine Street Expressway (I-676).

Dynamic plots of traffic volumes in 15-minute intervals at traffic count checkpoints (i.e., NewID2 numbers[1]) along the mainline—shown in **Figures 10 and 11**—helped illustrate the general busyness of the highway, and the spatial and temporal variability of its traffic volume. The underlying data served as an input to the 2010 VISSIM model and was used as a basis for its calibration.

Figure 12 contains snapshots of selected traffic demand characteristics along the Expressway culled from the 15-minute interval data. Localized peaks occur at different times and in different directions along the Expressway—highlighting the value of a 15-minute operational model for the Expressway. Midday volume is only marginally lower than the peak hours. Heavy vehicles (e.g., vehicles with more than four tires touching the road, including trucks and buses) represent about seven percent of overall daily traffic volume. While congestion is not fully reflected in the spot-speed data, sluggish conditions are evident:

- eastbound in the midst of the I-476 / Conshohocken Interchange (NewID2 location #120) in the morning hours;
- eastbound approaching Montgomery Drive Interchange (NewID2 location #235) in the morning and evening periods;
- westbound on the University Avenue viaduct (NewID2 location #610) in the morning and evening;
- westbound between City Avenue and Belmont Avenue (NewID2 location #770) in the morning; and
- westbound between the Gladwynne and Conshohocken Interchanges (NewID2 location #800) in the evening period.

Tabulation of the Expressway's entering traffic volume helped isolate three important hours, within the time blocks, that ultimately would be subjected to more complete evaluation with the calibrated operational model.

#1: **AM Peak Hour = 7:00 AM–8:00 AM**;
#2: **Midday Trough Hour = 10:00 AM–11:00 AM**; and
#3: **PM Peak Hour = 4:30 PM–5:30 PM**.

Constraints present in peak traffic hours are a usual concern. Opportunities that might be present, or more measurable, because of lower overall traffic demand spurred the identification of a midday trough traffic hour. Contrasting current peak-hour conditions with the trough also supplied a range for measuring the variability of the highway's performance during the daytime hours.

[1] Checkpoints—for the mainline and ramps—were established through the data collection and modeling work. Volume and spot-speed data was saved to the database for subsequent analyses. Records in the database cite the checkpoints as "NewID2" numbers. NewID2 data points are geographically arranged along the Expressway: NewID2 numbers: 5 to 475 are eastbound, beginning at the Turnpike, and NewID2 numbers: 480 to 945 are westbound, beginning at the Walt Whitman Bridge.

Table 4: Current 2010 Interchange Ramp Traffic Volumes

Interchange #	Interchange Name / Description	Total Weekday Volume	Volume to/from West	%	Volume to/from East	%
339 & 340	US 1 (N & S)	193,200	67,100	35%	126,100	65%
331 & 332	I-476 / Conshohocken	123,600	62,400	50%	61,200	50%
328	US 202 / US 422	121,500	42,400	35%	79,100	65%
	Walt Whitman Br	114,100	--	--	--	--
344	Vine St (I-676)	107,100	76,800	72%	30,300	28%
347	26th St / Passyunk Av	87,800	78,400	89%	9,400	11%
326	PA Turnpike (I-76 / I-276)	69,400	--	--	--	--
351	I-95 / Front St	51,500	10,100	20%	41,400	80%
345	30th St / Schuylkill Av	41,100	22,100	54%	19,000	46%
341	Montgomery Dr	36,400	18,400	51%	18,000	49%
346 C	34th St / Vare Av	35,800	7,400	21%	28,400	79%
338	Belmont Av / Green La	29,000	16,900	58%	12,100	42%
330	Gulph Mills	27,500	10,500	38%	17,000	62%
342	Girard Av	26,200	11,200	43%	15,000	57%
346 A	South St	25,300	17,100	68%	8,200	32%
346 B	University Av	24,600	24,600	100%	0	0%
327	N Gulph Rd / Mall Blvd	23,300	10,500	45%	12,800	55%
349	Broad St	21,500	9,100	42%	12,400	58%
350	Packer Av / 7th St	15,000	6,700	45%	8,300	55%
348	Penrose Av	12,400	0	0%	12,400	100%
337	Gladwynne	8,700	0	0%	8,700	100%
343	Spring Garden St	7,800	7,800	100%	0	0%

Source: DVRPC

Table 2: Current 2010 Eastbound Mainline and Ramp Traffic Volumes

NewID2	EB/WB	EnterExit	Station	Interchange #	Interchange Name	EnterExitName	Weekday Total	7am-9am	9am-3pm	3pm-6pm	6pm-7am
5	EB	Enter		326	PA Turnpike (I-276)	Turnpike EB	11,692	2,352	3,800	2,180	3,360
10	EB	Enter		326	PA Turnpike (I-76)	Turnpike WB	23,596	5,876	7,256	4,312	6,152
15	EB	Mainline					35,292	8,228	11,056	6,496	9,512
20	EB	Exit		327	Gulph Road	North Gulph Rd WB	-5,349	-1,744	-1,567	-965	-1,073
25	EB	Enter		327	Gulph Road	North Gulph Road (both)	6,902	564	1,744	2,074	2,520
30	EB	Mainline	076805-7207				36,840	7,049	11,234	7,600	10,957
35	EB	Exit		328	US 202 / US 422	US 202 SB / US 422 WB (total)	-18,488	-4,559	-5,936	-3,259	-4,734
50	EB	Enter		328	US 202 / US 422	US 202 SB	4,942	293	1,498	1,096	2,055
55	EB	Exit		328	US 202 / US 422	US 202 NB	-4,241	-848	-1,673	-773	-947
60	EB	Enter	076810-7158	328	US 202 / US 422	US 202 NB / US 422 EB (total)	34,922	3,995	11,758	6,285	12,884
75	EB	Mainline	076820-7129				53,976	5,931	16,880	10,948	20,217
80	EB	Exit		330	Gulph Mills	South Gulph Road / PA 320 (both)	-6,022	-1,233	-1,999	-949	-1,841
85	EB	Enter		330	Gulph Mills	South Gulph Road / PA 320 (both)	8,480	1,173	2,510	2,334	2,463
90	EB	Mainline	076835-7236				56,459	5,871	17,392	12,333	20,863
95	EB	Exit		331	I-476 / Conshohocken	I-476 SB	-20,506	-2,470	-6,464	-4,973	-6,599
100	EB	Exit		331	I-476 / Conshohocken	I-476 NB / Conshohocken (total)	-11,944	-1,611	-3,952	-2,544	-3,837
115	EB	Enter		331	I-476 / Conshohocken	I-476 SB	16,972	1,964	6,152	2,964	5,892
120	EB	Mainline	076840-7201	331	I-476 / Conshohocken		40,990	3,754	13,128	7,784	16,324
125	EB	Enter		331	I-476 / Conshohocken	I-476 NB to I-76 EB	6,251	579	1,996	1,364	2,312
140	EB	Mainline					47,244	4,333	15,126	9,148	18,637
145	EB	Enter		332	Matsonford Rd / Conshohocken	Matsonford Rd / Conshohocken	6,725	728	2,060	1,685	2,252
150	EB	Mainline	076845-7190				53,965	5,061	17,186	10,830	20,888
155	EB	Enter		337	Gladwynne	Hollow Rd (both)	5,055	1,106	1,641	1,044	1,264
160	EB	Mainline	076870-7155				59,018	6,167	18,824	11,875	22,152
165	EB	Exit		338	Belmont Av / Green La	Belmont Av (both)	-8,630	-900	-2,328	-1,703	-3,699
170	EB	Enter		338	Belmont Av / Green La	Belmont Av (both)	6,180	797	2,082	1,000	2,301
175	EB	Mainline	076880-7125				56,571	6,064	18,579	11,174	20,754
180	EB	Exit		339	City Av	City Av NB	-7,378	-1,011	-1,759	-2,166	-2,442
185	EB	Exit		339	City Av	City Av SB	-4,069	-622	-1,617	-675	-1,155
190	EB	Enter		339	City Av	City Av SB	12,233	1,917	3,694	1,748	4,874
195	EB	Mainline	076895-7233				57,354	6,349	18,896	10,078	22,031
205	EB	Exit		340B	Roosevelt Blvd	Roosevelt Blvd NB (to service road)	-14,275	-2,480	-4,116	-3,153	-4,526
220	EB	Enter		340B	City Av	City Av NB	8,219	887	3,035	1,477	2,820
225	EB	Mainline			Roosevelt Blvd		51,293	4,755	17,812	8,403	20,323
230	EB	Enter	001450-7747	340B	Roosevelt Blvd	Roosevelt Blvd SB	40,637	5,010	12,089	7,760	15,778
235	EB	Mainline					91,934	9,766	29,902	16,163	36,103
240	EB	Exit		341	Montgomery Dr	Montgomery Dr (both)	-11,074	-1,436	-4,468	-2,310	-2,860
245	EB	Enter		341	Montgomery Dr	Montgomery Dr (both)	9,135	2,128	3,044	1,306	2,657
250	EB	Mainline					89,995	10,457	28,479	15,157	35,902
255	EB	Exit		342	Girard Av	Girard Av (both)	-6,649	-850	-1,775	-1,471	-2,553
260	EB	Enter		342	Girard Av	Girard Av (both)	6,615	1,056	1,438	1,464	2,657

Continued on next page…

Table 2: Current 2010 Eastbound Mainline and Ramp Traffic Volumes

NewID2	EB/WB	EnterExit	Station	Interchange #	Interchange Name	EnterExitName	Weekday Total	7am-9am	9am-3pm	3pm-6pm	6pm-7am
265	EB	Mainline					89,962	10,663	28,142	15,152	36,005
270	EB	Exit		343	Spring Garden St	Spring Garden St (both)	-3,610	-448	-1,220	-626	-1,316
275	EB	Mainline	076935-7123				86,353	10,217	26,922	14,526	34,688
280	EB	Exit		344	Vine St / 30th St	30th St (service road)	-6,386	-869	-2,210	-899	-2,408
290	EB	Exit		344	Vine St / 30th St	Vine St EB	-40,950	-5,547	-14,489	-6,723	-14,191
300	EB	Enter		345	Vine St / 30th St	30th St / Vine St WB (service road)	14,169	1,773	4,883	2,378	5,135
305	EB	Mainline	076940-7242				53,189	5,572	15,109	9,284	23,224
310	EB	Enter		345.5	Walnut St	Walnut St (WB) / Schuylkill Av (SB)	11,514	1,184	3,176	3,154	4,000
315	EB	Exit		346A	South St	South Street (both)	-8,964	-1,100	-3,140	-1,440	-3,284
320	EB	Enter		346A	South St	South St (both)	3,348	352	992	1,064	940
325	EB	Mainline	076945-7225				59,083	6,009	16,135	12,059	24,880
330	EB	Exit		346B	University Av	University Av / 34th St (both)	-12,723	-1,860	-4,188	-1,652	-5,023
335	EB	Mainline	076950-7137				46,360	4,147	11,948	10,409	19,856
340	EB	Enter		346C	34th St	34th St / Wharton St (both)	14,822	1,516	4,288	4,278	4,740
345	EB	Exit		346.5	Vare Av EB	Vare Av EB / 28th St	-4,621	-498	-1,477	-886	-1,760
360	EB	Enter		346.5	Vare Av EB	Vare Av EB	1,278	76	387	488	327
365	EB	Mainline					57,834	5,241	15,145	14,286	23,162
370	EB	Exit	291500-7151	347	Passyunk Av / 26th St	26th St	-20,760	-2,822	-5,754	-4,630	-7,554
375	EB	Exit		347	Passyunk Av / 26th St	Passyunk Av (both)	-16,195	-1,254	-5,703	-2,928	-6,310
380	EB	Mainline		347	Passyunk Av / 26th St		20,881	1,165	3,689	6,728	9,299
385	EB	Enter		347	Passyunk Av / 26th St	Passyunk (both)	5,336	670	1,422	1,350	1,894
390	EB	Mainline					26,219	1,836	5,112	8,079	11,192
395	EB	Enter		348	Penrose Av	Penrose Av	6,633	636	2,010	2,016	1,971
400	EB	Mainline					32,846	2,470	7,118	10,096	13,162
405	EB	Exit		349	Broad St	Broad St (both)	-3,541	-494	-954	-761	-1,332
410	EB	Enter		349	Broad St	Broad St SB	4,537	422	1,344	1,204	1,567
415	EB	Enter		349	Broad St	Broad St NB	1,238	55	324	330	529
420	EB	Mainline					35,084	2,455	7,833	10,868	13,928
425	EB	Exit		350	Packer Av	Packer Av (both) / S. Darien St	-6,659	-773	-2,333	-1,401	-2,152
430	EB	Enter		350	Packer Av	Packer Av (both) / S. Darien St	4,288	328	1,168	1,112	1,680
435	EB	Mainline	076985-7161				32,714	2,011	6,669	10,582	13,452
440	EB	Enter		351	I-95 / Front St	I-95 SB - to EB Walt Whitman Br	10,127	795	3,030	2,733	3,569
470	EB	Enter		351	I-95 / Front St	I-95 NB - to EB Walt Whitman Br	13,847	1,507	4,053	3,737	4,550
475	EB	Mainline			Walt Whitman Br	Walt Whitman Br EB	56,687	4,312	13,752	17,049	21,574

Source: DVRPC

Table 3: Current 2010 Westbound Mainline and Ramp Traffic Volumes

NewID2	EB/WB	EnterExit	Station	Interchange #	Interchange Name	EnterExitName	Weekday Total	7am-9am	9am-3pm	3pm-6pm	6pm-7am
480	WB	Mainline			Walt Whitman Br	Walt Whitman Br WB	57,406	11,478	16,596	9,228	20,104
485	WB	Exit		351	I-95 / Front St	I-95 NB / SB & Front St (both)	-27,644	-5,786	-8,538	-4,212	-9,108
510	WB	Mainline	076990-7230				29,760	5,692	8,059	5,016	10,993
515	WB	Exit		350	7th St	7th St (both)	-3,979	-663	-1,156	-700	-1,460
520	WB	Mainline					25,784	5,029	6,901	4,316	9,538
525	WB	Exit		349	Broad St	Broad St (both)	-6,663	-1,389	-1,952	-1,141	-2,181
530	WB	Enter		349	Broad St	Broad St NB	5,578	505	1,788	988	2,297
535	WB	Mainline					24,699	4,146	6,739	4,162	9,652
540	WB	Exit		348	Penrose Av	Penrose Av	-5,817	-1,145	-1,703	-932	-2,037
545	WB	Mainline					18,883	2,999	5,036	3,231	7,617
550	WB	Exit		347B	Passyunk Av	25th St SB	-4,117	-628	-1,415	-691	-1,383
555	WB	Mainline		347A	Passyunk Av		14,762	2,371	3,622	2,539	6,230
560	WB	Enter		347A	Passyunk Av	Passyunk Av (both) / Oregon Av	19,319	2,331	6,604	3,429	6,955
565	WB	Enter	291500-7151	347A	Passyunk Av	26th St	22,085	3,183	7,414	4,517	6,971
570	WB	Mainline					56,163	7,886	17,635	10,487	20,155
575	WB	Exit		346.5	Vare Av WB	Vare Av WB	-7,307	-1,715	-2,343	-1,324	-1,925
590	WB	Mainline	076950-7137				48,862	6,172	15,294	9,162	18,234
595	WB	Exit		346	34th St	34th St	-13,551	-1,584	-3,923	-2,755	-5,289
605	WB	Enter		346	34th St	34th St / Vare Av	7,430	1,449	2,241	1,230	2,510
610	WB	Mainline	076945-7225	346	University Av		42,737	6,035	13,612	7,637	15,453
615	WB	Enter		346	University Av	University Av	11,936	1,348	4,052	2,304	4,232
620	WB	Exit		346	South St	South St (both)	-4,895	-792	-2,092	-731	-1,280
625	WB	Enter		346	South St	South St (both)	8,075	1,044	2,735	1,424	2,872
630	WB	Exit		345.5	30th St / Chestnut St	Chestnut EB / Schuylkill Av	-7,485	-1,649	-2,332	-1,040	-2,464
635	WB	Exit		345	Vine St / 30th St	Vine St EB	-16,139	-2,188	-5,465	-2,933	-5,553
640	WB	Mainline		345	Vine St / 30th St		34,229	3,798	10,510	6,661	13,260
660	WB	Enter		345	Vine St / 30th St	30th St / I-76 wb service road	15,690	1,631	4,363	3,260	6,436
665	WB	Enter		344	Vine St	Vine St WB	35,760	4,341	10,257	6,307	14,855
670	WB	Mainline	076930-7171				85,685	9,771	25,134	16,229	34,551
675	WB	Enter		343	Spring Garden St	Spring Garden St (both)	4,151	468	1,491	730	1,462
680	WB	Mainline					89,836	10,239	26,624	16,958	36,015
685	WB	Exit		342	Girard Av	34th St NB / Girard Av (both)	-8,408	-1,206	-2,678	-1,144	-3,380
690	WB	Mainline		342	Girard Av		81,430	9,033	23,945	15,813	32,639
695	WB	Enter		342	Girard Av	Girard Av (both)	4,632	436	1,533	1,070	1,593
700	WB	Mainline					86,058	9,469	25,474	16,884	34,231
705	WB	Exit		341	Montgomery Dr	Montgomery Dr (both)	-8,861	-1,552	-2,365	-1,779	-3,165
710	WB	Enter		341	Montgomery Dr	Montgomery Dr (both)	7,318	893	2,332	1,448	2,645
715	WB	Mainline	076905-7142				84,512	8,810	25,439	16,553	33,710
720	WB	Exit		340B	US 1 - Roosevelt Blvd / City Av	City Av SB	-12,363	-2,098	-3,573	-3,001	-3,691
725	WB	Exit	001450-7747	340B	US 1 - Roosevelt Blvd / City Av	Roosevelt Blvd NB	-33,189	-4,328	-10,708	-5,920	-12,233
730	WB	Mainline	076900-7169	340B			38,963	2,385	11,165	7,632	17,781

Continued on next page…

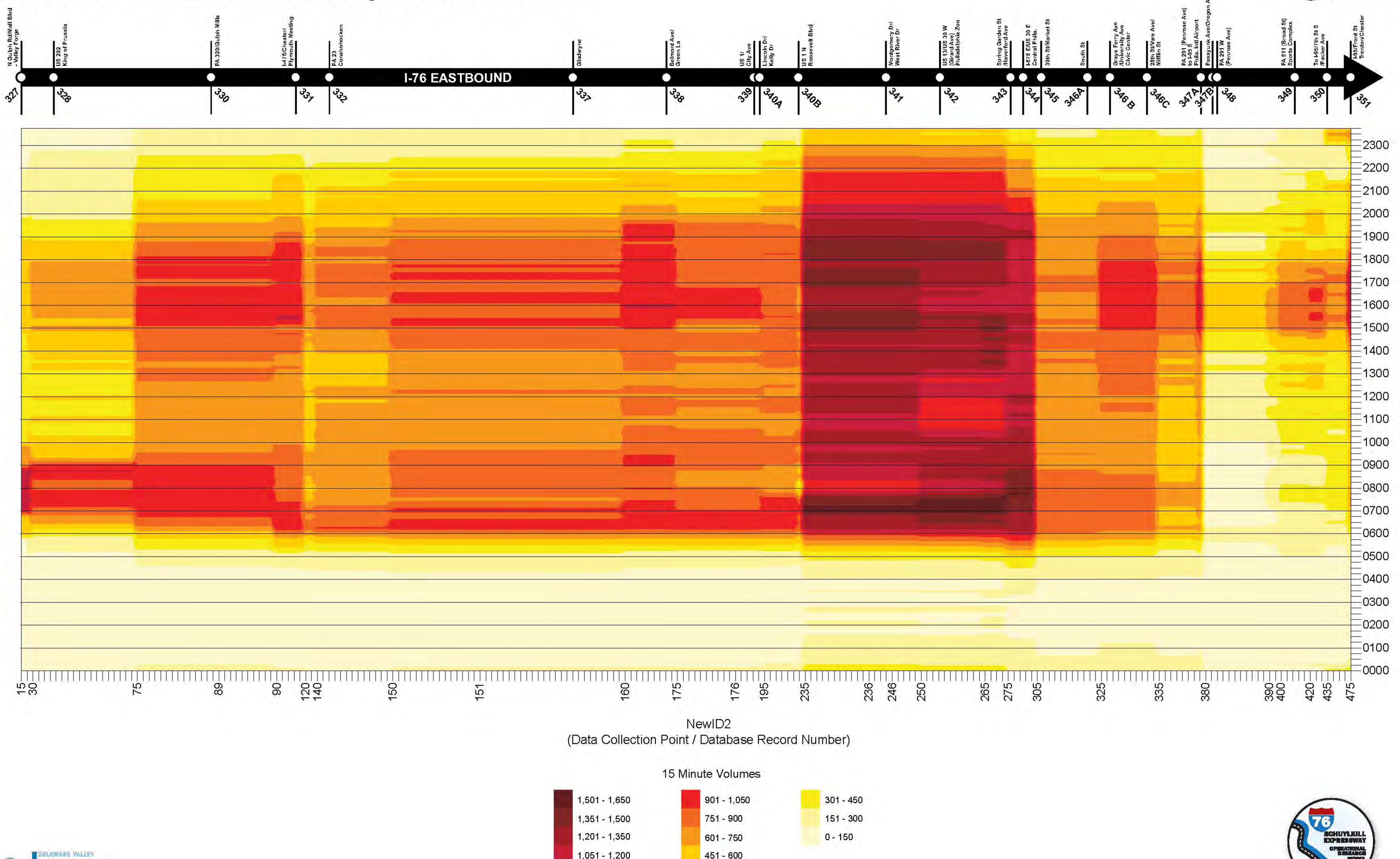
Table 3: Current 2010 Westbound Mainline and Ramp Traffic Volumes

NewID2	EB/WB	EnterExit	Station	Interchange #	Interchange Name	EnterExitName	Weekday Total	7am-9am	9am-3pm	3pm-6pm	6pm-7am
735	WB	Enter		340B	US 1 - Roosevelt Blvd / City Av	City Av SB	12,363	2,098	3,573	3,001	3,691
740	WB	Enter		340B	US 1 - Roosevelt Blvd / City Av	Roosevelt Blvd SB	29,137	3,410	9,746	5,954	10,027
745	WB	Exit		340A	US 1 - Roosevelt Blvd / City Av	City Av NB	-13,611	-1,229	-3,105	-3,240	-6,037
750	WB	Mainline		340A	US 1 - Roosevelt Blvd / City Av		66,851	6,663	21,376	13,346	25,466
755	WB	Exit		340A	US 1 - Roosevelt Blvd / City Av	City Av / US 1 SB	-18,265	-2,497	-6,114	-3,905	-5,749
760	WB	Enter		340A	US 1 - Roosevelt Blvd / City Av	City Av SB	6,987	1,851	1,910	1,473	1,753
765	WB	Enter		340A	US 1 - Roosevelt Blvd / City Av	City Av / US 1 NB	5,176	501	1,653	1,307	1,715
770	WB	Mainline	076885-7253				60,750	6,519	18,826	12,222	23,183
775	WB	Exit		338	Belmont Av / Green La	Belmont Av / Green La (both)	-5,909	-204	-1,766	-1,130	-2,809
780	WB	Mainline		338	Belmont Av / Green La		54,840	6,315	17,060	11,092	20,373
785	WB	Enter		338	Belmont Av / Green La	Belmont Av / Green La (both)	8,321	1,947	2,291	1,283	2,800
790	WB	Mainline	076865-7252				63,163	8,262	19,351	12,374	23,176
795	WB	Exit		337	Gladwynne	Hollow Rd (both)	-3,575	-274	-1,083	-823	-1,395
800	WB	Mainline	076845-7190				59,586	7,987	18,267	11,553	21,779
805	WB	Exit		332	Matsonford Rd / Conshohocken	Conshohocken - Matsonford / PA 23 (both)	-6,841	-1,009	-2,361	-972	-2,499
810	WB	Mainline					53,810	6,634	17,718	10,418	19,040
815	WB	Exit		331	I-476 / Conshohocken	I-476 NB	-18,555	-1,532	-6,417	-3,366	-7,240
820	WB	Mainline	076840-7201	331	I-476 / Conshohocken		34,193	5,447	9,492	7,213	12,041
825	WB	Exit		331	I-476 / Conshohocken	I-476 SB	-5,773	-805	-2,081	-1,038	-1,849
830	WB	Enter		331	I-476 / Conshohocken	I-476 NB / Matsonford Rd (both)	21,571	3,236	6,979	3,972	7,384
845	WB	Enter		331	I-476 / Conshohocken	I-476 SB - I-76 WB	8,396	1,444	3,010	1,546	2,396
855	WB	Mainline	076835-7236				58,384	9,322	17,397	11,695	19,970
860	WB	Exit		330	Gulph Mills	Balligomingo Rd (both)	-8,468	-1,319	-2,948	-1,351	-2,850
865	WB	Mainline	076825-7234	330	Gulph Mills		49,919	8,002	14,449	10,345	17,123
870	WB	Enter		330	Gulph Mills	South Gulph Rd (both)	4,512	630	1,635	1,157	1,090
871	*WB*	*Exit*		*329*	*King of Prussia / Norristown*	*Henderson / South Gulph Rd (both)*	*Future ramp*				
872	*WB*	*Enter*		*329*	*King of Prussia / Norristown*	*Henderson / South Gulph Rd (both)*	*Future ramp*				
875	WB	Mainline					54,432	8,632	16,085	11,502	18,213
878	WB	Exit	Express Lanes	328		Express Lanes to PA Turnpike	-8,690	-775	-2,640	-2,382	-2,893
880	WB	Exit	Collector-Distributor Lanes	328	US 202 / US 422	US 202 NB	-5,354	-740	-2,017	-1,021	-1,576
885	WB	Enter		328	US 202 / US 422	US 202 NB	15,199	2,466	2,916	5,008	4,809
890	WB	Exit		328	US 202 / US 422	US 202 SB & US 422 WB (total)	-33,887	-5,481	-9,867	-6,478	-12,061
905	WB	Enter		328	US 202 / US 422	US 202 SB / North Gulph Rd SB	4,491	476	1,232	1,403	1,380
910	WB	Collector Rd					26,195	4,580	5,712	8,033	7,870
915	WB	Exit		327	Mall Blvd	Mall Blvd	-5,886	-772	-2,230	-1,336	-1,548
918	WB	Enter	Express Lanes	327		Express Lanes to PA Turnpike	8,690	775	2,640	2,382	2,893
920	WB	Mainline	076800-7200	327	Mall Blvd		28,992	4,580	6,118	9,079	9,215
925	WB	Enter		327	Mall Blvd	Mall Blvd	4,165	413	975	1,630	1,147
930	WB	Enter		327	Pulaski Dr	Pulaski Dr (both)	974	33	103	632	206
935	WB	Mainline					34,136	5,024	7,200	11,344	10,568
940	WB	Exit		326	PA Turnpike (I-76)	Turnpike WB	-11,365	-1,164	-2,492	-4,025	-3,684
945	WB	Exit		326	PA Turnpike (I-276)	Turnpike EB	-22,771	-3,860	-4,708	-7,319	-6,884

Source: DVRPC

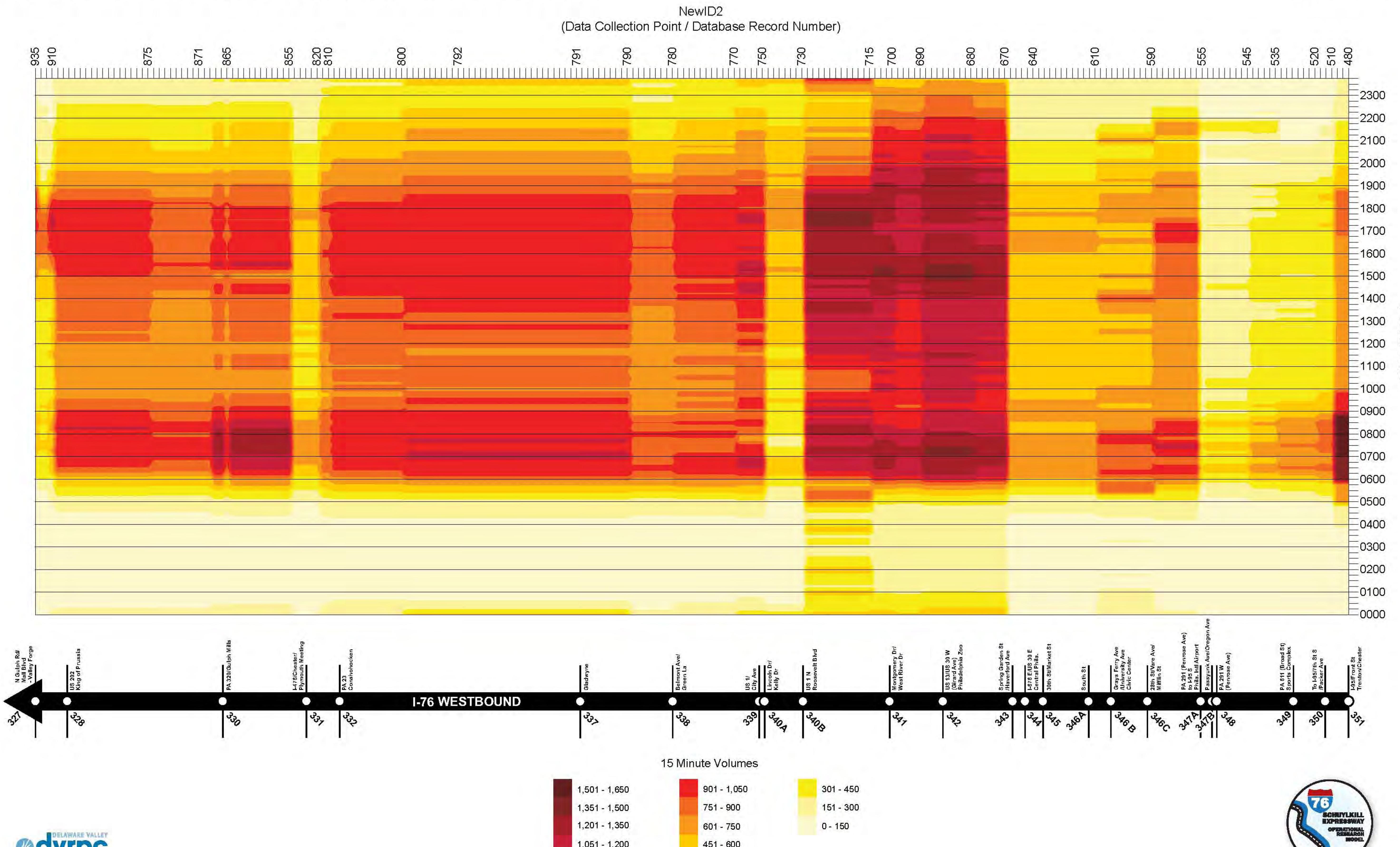
Current 2010 Eastbound Volume by Time and Location

Figure 10



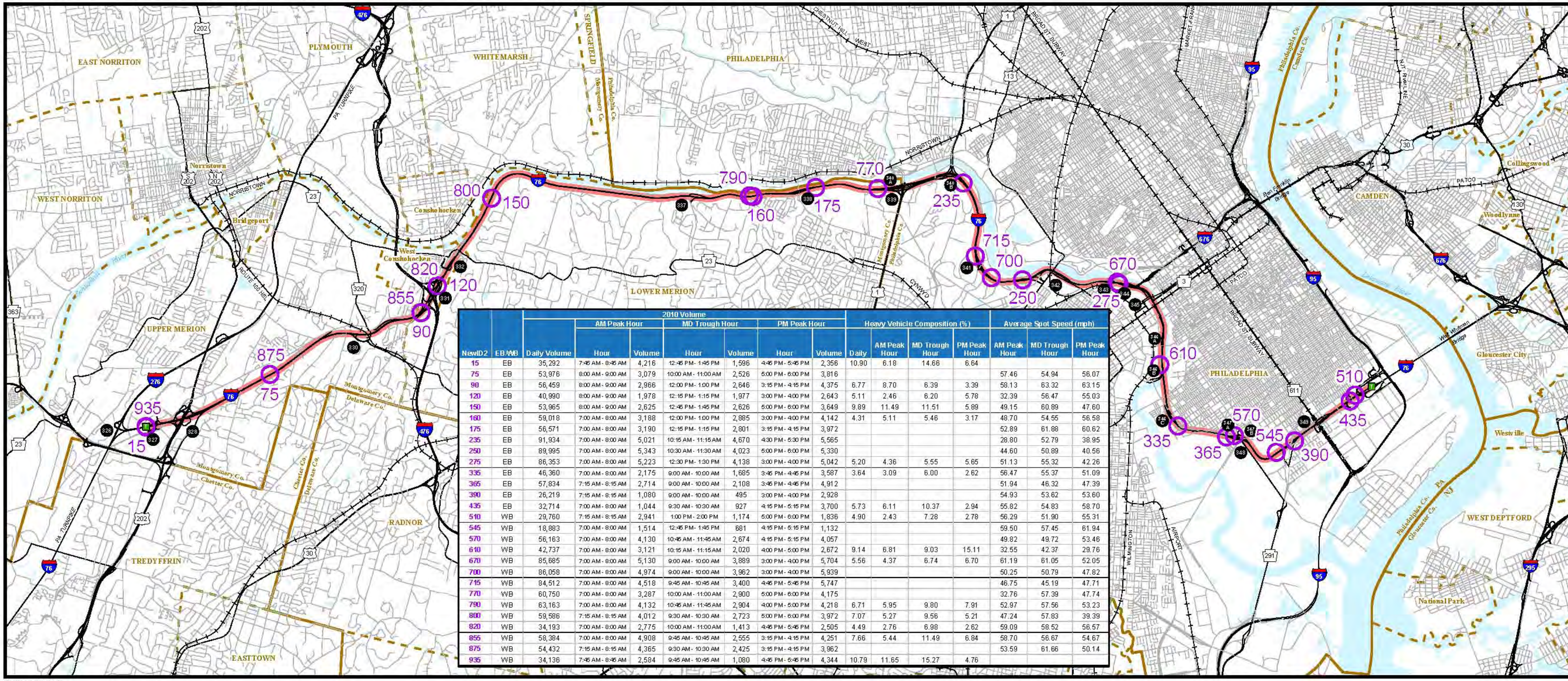
Current 2010 Westbound Volume by Time and Location

Figure 11



Selected Characteristics of Mainline Traffic Volume

Figure 12



NewID2	EB/WB	2010 Volume							Heavy Vehicle Composition (%)				Average Spot Speed (mph)		
			AM Peak Hour		MD Trough Hour		PM Peak Hour								
		Daily Volume	Hour	Volume	Hour	Volume	Hour	Volume	Daily	AM Peak Hour	MD Trough Hour	PM Peak Hour	AM Peak Hour	MD Trough Hour	PM Peak Hour
15	EB	35,292	7:45 AM - 8:45 AM	4,216	12:45 PM - 1:45 PM	1,596	4:45 PM - 5:45 PM	2,356	10.90	6.18	14.66	6.64			
75	EB	53,976	8:00 AM - 9:00 AM	3,079	10:00 AM - 11:00 AM	2,526	5:00 PM - 6:00 PM	3,816					57.46	54.94	56.07
90	EB	56,459	8:00 AM - 9:00 AM	2,966	12:00 PM - 1:00 PM	2,646	3:15 PM - 4:15 PM	4,375	6.77	8.70	6.39	3.39	58.13	63.32	63.15
120	EB	40,990	8:00 AM - 9:00 AM	1,978	12:15 PM - 1:15 PM	1,977	3:00 PM - 4:00 PM	2,643	5.11	2.46	6.20	5.78	32.39	56.47	55.03
150	EB	53,965	8:00 AM - 9:00 AM	2,625	12:45 PM - 1:45 PM	2,626	5:00 PM - 6:00 PM	3,649	9.89	11.49	11.51	5.89	49.15	60.89	47.60
160	EB	59,018	7:00 AM - 8:00 AM	3,188	12:00 PM - 1:00 PM	2,885	3:00 PM - 4:00 PM	4,142	4.31	5.11	5.46	3.17	48.70	54.55	56.58
175	EB	56,571	7:00 AM - 8:00 AM	3,190	12:15 PM - 1:15 PM	2,801	3:15 PM - 4:15 PM	3,972					52.89	61.88	60.62
235	EB	91,934	7:00 AM - 8:00 AM	5,021	10:15 AM - 11:15 AM	4,670	4:30 PM - 5:30 PM	5,565					28.80	52.79	38.95
250	EB	89,995	7:00 AM - 8:00 AM	5,343	10:30 AM - 11:30 AM	4,023	5:00 PM - 6:00 PM	5,330					44.60	50.89	40.56
275	EB	86,353	7:00 AM - 8:00 AM	5,223	12:30 PM - 1:30 PM	4,138	3:00 PM - 4:00 PM	5,042	5.20	4.36	5.55	5.65	51.13	55.32	42.26
335	EB	46,360	7:00 AM - 8:00 AM	2,175	9:00 AM - 10:00 AM	1,685	3:45 PM - 4:45 PM	3,587	3.64	3.09	6.00	2.62	56.47	55.37	51.09
365	EB	57,834	7:15 AM - 8:15 AM	2,714	9:00 AM - 10:00 AM	2,108	3:45 PM - 4:45 PM	4,912					51.94	46.32	47.39
390	EB	26,219	7:15 AM - 8:15 AM	1,080	9:00 AM - 10:00 AM	495	3:00 PM - 4:00 PM	2,928					54.93	53.62	53.60
435	EB	32,714	7:00 AM - 8:00 AM	1,044	9:30 AM - 10:30 AM	927	4:15 PM - 5:15 PM	3,700	5.73	6.11	10.37	2.94	55.82	54.83	58.70
510	WB	29,760	7:15 AM - 8:15 AM	2,941	1:00 PM - 2:00 PM	1,174	5:00 PM - 6:00 PM	1,836	4.90	2.43	7.28	2.78	56.29	51.90	55.31
545	WB	18,883	7:00 AM - 8:00 AM	1,514	12:45 PM - 1:45 PM	681	4:15 PM - 5:15 PM	1,132					59.50	57.45	61.94
570	WB	56,163	7:00 AM - 8:00 AM	4,130	10:45 AM - 11:45 AM	2,674	4:15 PM - 5:15 PM	4,057					49.82	49.72	53.46
610	WB	42,737	7:00 AM - 8:00 AM	3,121	10:15 AM - 11:15 AM	2,020	4:00 PM - 5:00 PM	2,672	9.14	6.81	9.03	15.11	32.55	42.37	29.76
670	WB	85,685	7:00 AM - 8:00 AM	5,130	9:00 AM - 10:00 AM	3,889	3:00 PM - 4:00 PM	5,704	5.56	4.37	6.74	6.70	61.19	61.05	52.05
700	WB	86,058	7:00 AM - 8:00 AM	4,974	9:00 AM - 10:00 AM	3,962	3:00 PM - 4:00 PM	5,939					50.25	50.79	47.82
715	WB	84,512	7:00 AM - 8:00 AM	4,518	9:45 AM - 10:45 AM	3,400	4:45 PM - 5:45 PM	5,747					46.75	45.19	47.71
770	WB	60,750	7:00 AM - 8:00 AM	3,287	10:00 AM - 11:00 AM	2,900	5:00 PM - 6:00 PM	4,175					32.76	57.39	47.74
790	WB	63,163	7:00 AM - 8:00 AM	4,132	10:45 AM - 11:45 AM	2,904	4:00 PM - 5:00 PM	4,218	6.71	5.95	9.80	7.91	52.97	57.56	53.23
800	WB	59,586	7:15 AM - 8:15 AM	4,012	9:30 AM - 10:30 AM	2,723	5:00 PM - 6:00 PM	3,972	7.07	5.27	9.56	5.21	47.24	57.83	39.39
820	WB	34,193	7:00 AM - 8:00 AM	2,775	10:00 AM - 11:00 AM	1,413	4:45 PM - 5:45 PM	2,505	4.49	2.76	6.98	2.62	59.09	58.52	56.57
855	WB	58,384	7:00 AM - 8:00 AM	4,908	9:45 AM - 10:45 AM	2,555	3:15 PM - 4:15 PM	4,251	7.66	5.44	11.49	6.84	58.70	56.67	54.67
875	WB	54,432	7:15 AM - 8:15 AM	4,365	9:30 AM - 10:30 AM	2,425	3:15 PM - 4:15 PM	3,962					53.59	61.66	50.14
935	WB	34,136	7:45 AM - 8:45 AM	2,584	9:45 AM - 10:45 AM	1,080	4:45 PM - 5:45 PM	4,344	10.79	11.65	15.27	4.76			

Source: DVRPC

I-76 Schuylkill Expressway

Toll Plaza

Interchange Number

NewID2 (Data Collection Point / Database Record Number)

0 1 2 Miles

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

76 SCHUYLKILL EXPRESSWAY OPERATIONAL RESEARCH MODEL

CURRENT 2010 TRAFFIC PERFORMANCE MEASURES

Speed data is more indicative of traffic congestion than are volumes alone. It can be benchmarked against posted speed limits or prevailing conditions throughout the corridor. Average spot-speed and operating speed data, obtained through the data collection effort, was tabulated within the three key hours to also establish a baseline for measuring changes in operational performance between current 2010 and Year 2035 conditions.

Average spot speeds for the defined AM Peak, Midday Trough, and PM Peak Hours were tabulated from Traffic.com sensor locations along the mainline. **Table 5** contains the data. The value of the information is for identifying where localized trouble spots may be regularly encountered along the highway.

Traffic.com sensor on I-76. (DVRPC)

Consecutive eastbound recording locations show slowing in the PM from the Roosevelt Boulevard through Center City Philadelphia. In the AM, westbound travel is slow from City Avenue into the Belmont Avenue / Green Lane Interchange. During all hours, westbound travel is slow across the University Avenue Viaduct (34th Street to University Avenue).

Representative operating speeds for each key operational hour were drawn from archived data collected by INRIX.[2] The data is stored in short, pre-defined segments in each direction of the Expressway. The data was aggregated for 10 segments in each direction in an attempt to coalesce the following characteristics: cross section, ownership and jurisdiction, locations of significant changes in traffic volume, and locations identified as opportunities for case study applications of the models. **Table 6** contains the segment data and **Figure 13** illustrates the averaged operating speeds.

Eastbound travel is indicated to be slow in the PM Peak Hour approaching Center City. Westbound operating speed is slow between the Boulevard (US 1 North) and City Avenue (US 1 South) during both the AM and PM Peaks.

Average operating speeds were also converted (weighted by distance) to overall travel times for the Expressway as a single performance indicator for the highway. During the peaks, it is a 30- to 40-minute drive end-to-end along the Expressway. In the Midday Trough Hour, travel times are about one-half hour. In each hour, eastbound travel takes marginally longer than westbound.

[2] INRIX is a private traffic information company that provides real-time and traveler information services for over 450,000 miles of roadway in twenty countries. INRIX gathers traffic data through a combination of global positioning system (GPS) enabled vehicles and mobile devices, road sensors, and other sources such as local transportation agencies. The INRIX data was made available to the project through a contract with the I-95 Corridor Coalition, with the assistance of staff at the University of Maryland's Center for Advanced Transportation Technology Laboratory.

Table 5: Hourly Spot Speed (Current 2010)

			Current 2010 (actual mph, Traffic.com)		
NewID2	EB/WB	Mainline Location	AM	MD	PM
30	EB	N Gulph Rd - US 202 / US 422	35	41	42
75	EB	US 202 / US 422 - Gulph Mills	54	55	56
90	EB	Gulph Mills - I-476 / Conshohocken	52	60	58
120	EB	Within the I-476 / Conshohocken Int.	18	54	17
150	EB	Conshohocken - Gladwynne	41	61	49
160	EB	Gladwynne - Belmont Av / Green La	49	58	54
175	EB	Belmont Av / Green La - City Av	53	59	60
195	EB	City Av - Roosevelt Blvd	46	51	50
235	EB	Roosevelt Blvd - Montgomery Dr	29	51	39
250	EB	Montgomery Dr - Girard Av	45	48	39
265	EB	Girard Av - Spring Garden St	46	52	36
275	EB	Spring Garden St - Vine St / 30th St	51	53	36
305	EB	Vine St / 30th St - Walnut St	47	48	16
325	EB	South St - University Av	62	53	49
335	EB	University Av - 34th St	56	54	52
365	EB	Vare Av - Passyunk / 26th St	53	47	48
390	EB	Passyunk Av / 26th St - Penrose Av	54	54	55
420	EB	Broad St - Packer Av	53	52	56
435	EB	Packer Av - I-95 / Front St	56	55	58
510	WB	I-95 / Front St - 7th St	57	54	56
520	WB	7th St - Broad St	56	54	56
545	WB	Penrose Av - Passyunk Av	60	57	62
570	WB	Passyunk Av - Vare Av	50	50	53
590	WB	Vare Av - 34th St	45	54	55
610	WB	34 St - University Av	33	39	29
640	WB	Vine St WB-off - 30th St WB-on	58	58	55
670	WB	Vine St - Spring Garden St	61	57	56
680	WB	Spring Garden St - Girard Av	58	55	55
690	WB	Within the Girard Av Int.	55	56	50
700	WB	Girard Av - Montgomery Dr	50	54	50
715	WB	Montgomery Dr - Roosevelt Blvd	47	44	48
730	WB	Roosevelt Blvd - City Av	49	61	48
770	WB	City Av - Belmont Av / Green La	33	57	44
780	WB	Within Belmont Av / Green La Int.	34	60	49
790	WB	Belmont Av / Green La - Gladwynne	53	58	56
800	WB	Gladwynne - Conshohocken	47	59	40
820	WB	Within I-476 Interchange	59	59	56
855	WB	I-476 - Gulph Mills	59	57	56
865	WB	Within Gulph Mills Int.	57	64	60
875	WB	Gulph Mills - US 202 / US 422	56	63	56
920	WB	Within Mall Blvd Int.	49	48	47

Source: DVRPC

Table 6: Average Operating Speed (Current 2010)

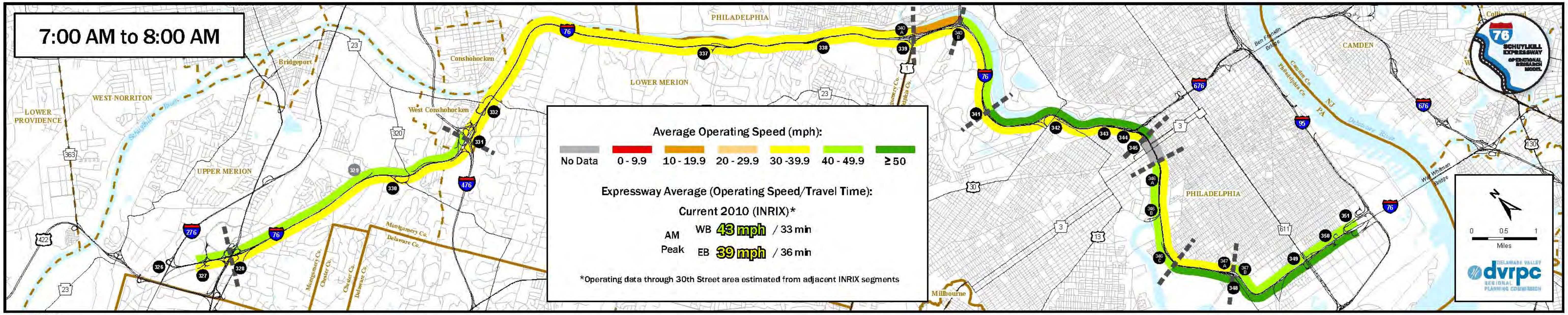
Travel Direction	Description	Length (mi)	Current 2010 Operating Speed (actual mph, INRIX)		
			AM	MD	PM
EASTBOUND	PA Turnpike Toll to US-202	0.56	30	42	33
	US 202 to I-476	4.21	38	55	31
	I-476 to US-1 South	8.00	35	51	38
	US-1 South to US-1 North	0.74	39	50	42
	US-1 North to Montgomery Dr	1.52	31	48	35
	Montgomery Dr to I-676	2.64	39	45	25
	30th St to Chestnut St	0.46	43	47	32
	Chestnut St to 34th St	1.66	47	49	39
	34th St to 26th/Passyunk	0.91	50	51	48
	26th/Passyunk to WW Br Toll	2.35	50	52	51
WESTBOUND	WW Br Toll to 26th/Passyunk	2.42	49	49	49
	26th/Passyunk to 34th St	0.93	37	46	45
	34th St. to Chestnut St	1.64	34	44	26
	Chestnut St to 30th St	0.38	43	46	34
	I-676 to Montgomery Dr	2.72	51	49	41
	Montgomery Dr to US-1 North	1.54	44	54	39
	US-1 North to US-1 South	0.74	16	50	21
	US-1 South to I-476	7.99	39	55	41
	I-476 to US 202	4.22	50	55	48
	US-202 to PA Turnpike Toll	0.52	48	48	44

Notes:
Speeds rounded to nearest whole number
Operating speed estimated from adjacent segments

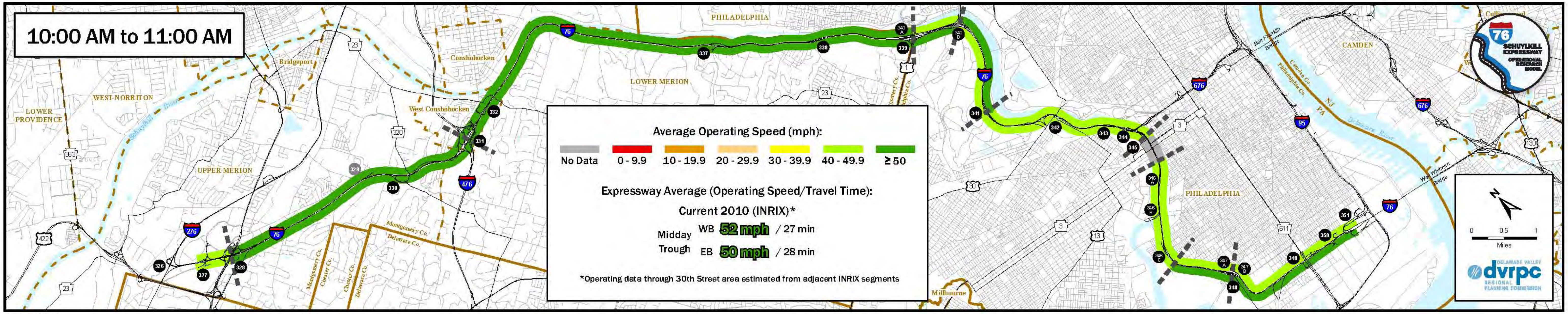
Source: DVRPC

Current 2010 Operating Speed along I-76 (AM Peak, Midday Trough, PM Peak)

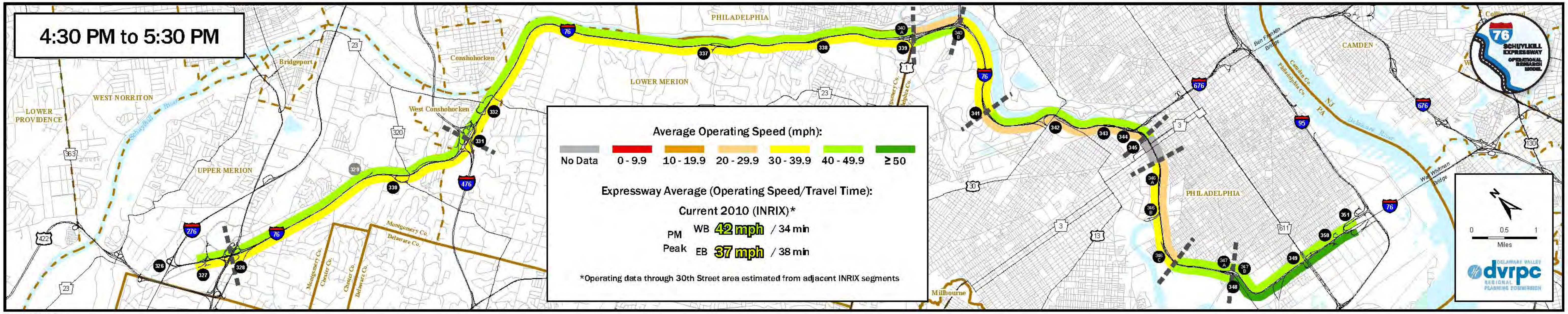
Figure 13



Source: DVRPC



Source: DVRPC



Source: DVRPC

TRANSPORTATION MODELING:

DVRPC uses PTV Vision Inc.'s software products for multi-modal transportation modeling: VISUM for regional travel demand forecasting and VISSIM for computing, assessing, and visualizing transportation operations. Three modeling functions are provided with the software:

1. VISUM—regional travel demand forecasting;
2. ANM—translating and transferring the regional model output to the operational model; and
3. VISSIM—operations modeling.

At the outset of the modeling work, the state of the regional travel demand forecasting model network and the depth of the required operational model (i.e., to supply a dynamic model operating at 15-minute intervals between 7:00 AM and 6:00 PM) were not in sync for integrating the component parts of the PTV software per its design. DVRPC staff adapted the modeling activities to fabricate an alternate off-line "ANM" interface for translating between the regional and operational models to establish 15-minute time interval relationships and to maintain linkage between VISUM's outputs and VISSIM's inputs.[3] Technical documentation for the alternative ANM translation procedure is contained in the **USER'S GUIDE**, and an electronic spreadsheet tool (**ANMtranslation.xls**) was provided in the deliverables to facilitate the process for subsequent users and applications.

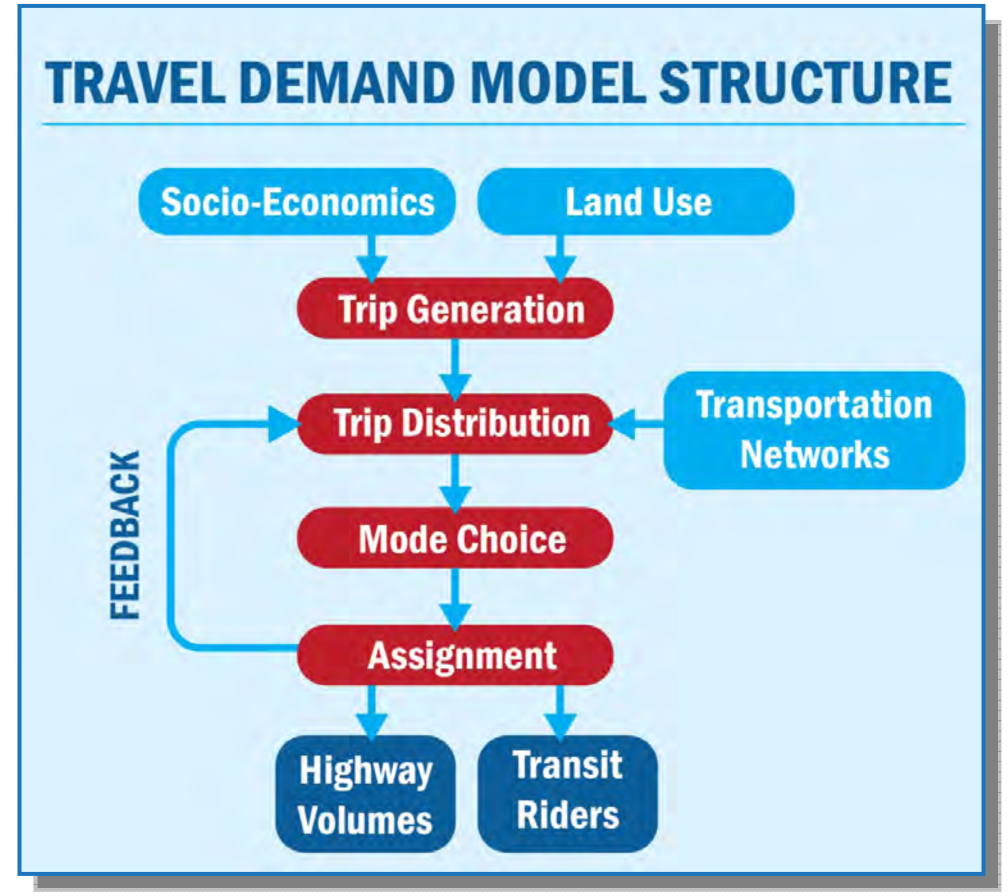
DVRPC prepared models for two planning scenarios: a Year 2010 scenario, to establish a baseline with current 2010 conditions; and a Year 2035 model, which reflects the region's future socio-economic condition and transportation network infrastructure as contained within *Connections*, DVRPC's Long-Range Plan for 2035.

YEAR 2010 REGIONAL TRAVEL DEMAND FORECASTING MODEL—PREPARATION AND EXECUTION

DVRPC maintains a personal computer-based travel simulation model that estimates travel behavior for a typical weekday and major timeframes within the day (peak, midday, nighttime) and provides related travel data for different transportation network and demographic conditions. A focused 2010 VISUM regional model was prepared for the Schuylkill Expressway.

DVRPC follows traditional 4-step procedures in its regional forecast modeling (**Figure 14**).

Figure 14: Regional Travel Simulation Process



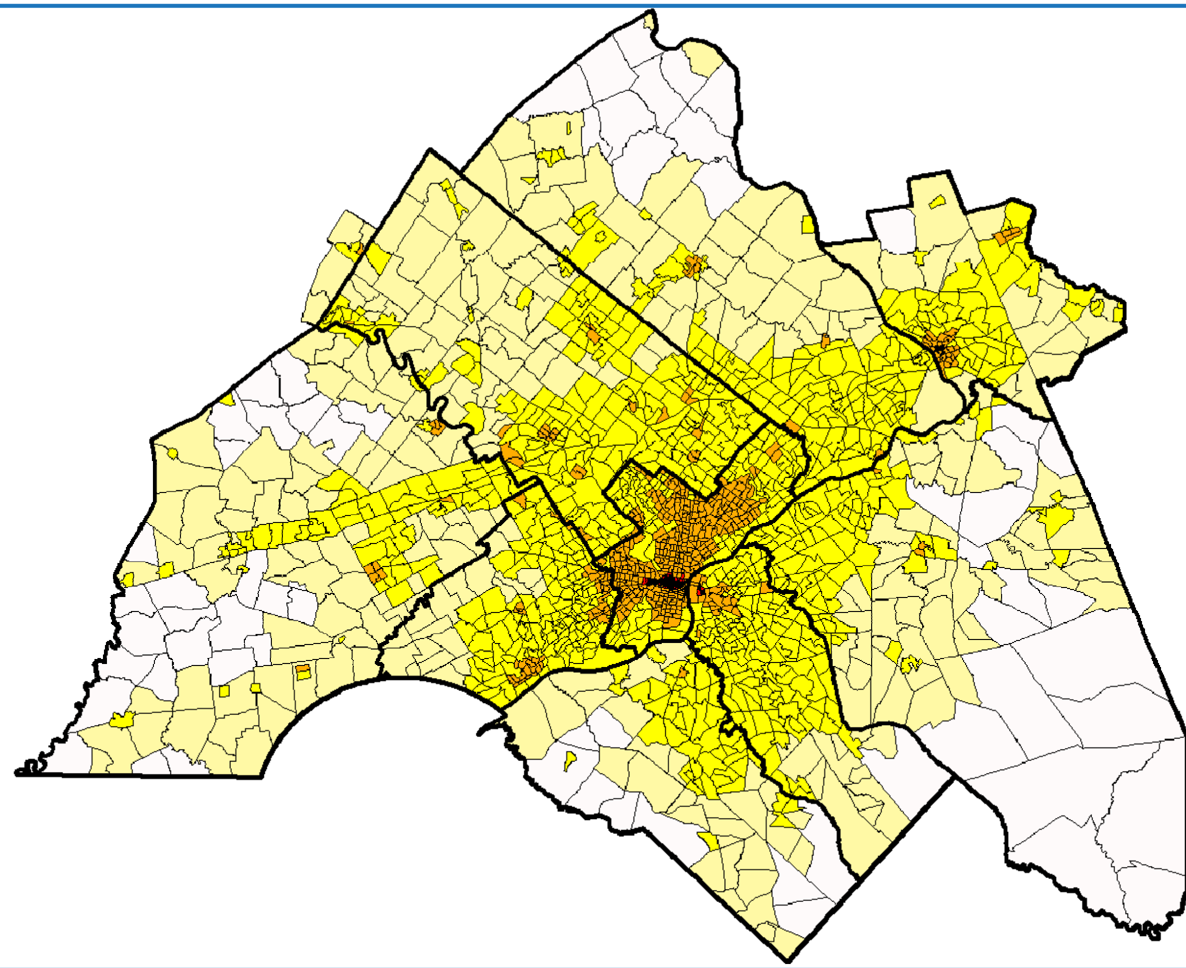
Source: DVRPC

The regional model can be used to locate problem areas, identify future trends and travel conditions, and consider various improvement strategies to address existing and emerging problems. By focusing DVRPC's regional model, enhancements are accomplished within a detailed study area while a regional level of detail is maintained elsewhere. Application of the focused modeling process provides the opportunity to obtain highway link traffic volumes (daily, or peak, midday, nighttime) and transit ridership (daily, or peak, midday, nighttime) by line or station for regularly scheduled public transportation services within the region. Other performance data available through the program is identified in **Appendix A-1**.

[3] With that action, however, the capability for two-way interaction between VISSIM and VISUM was sacrificed.

DVRPC's 2010 TAZ structure (**Figure 15**), DVRPC Board-adopted 2010 population and employment forecasts (**Table 7**), and the 2010 modeled regional transportation network (**Figure 16**) served in defining the model baseline. In focusing the I-76 model, TAZs within the broad planning corridor were "split," and their component socio-economic variables disaggregated to supply the traffic demand for the highway assignment. VISUM was subsequently executed and refined with model parameters to calibrate output to recent average daily traffic volumes recorded in the planning corridor.

Figure 15: 2010 Transportation Analysis Zones



Source: **DVRPC**

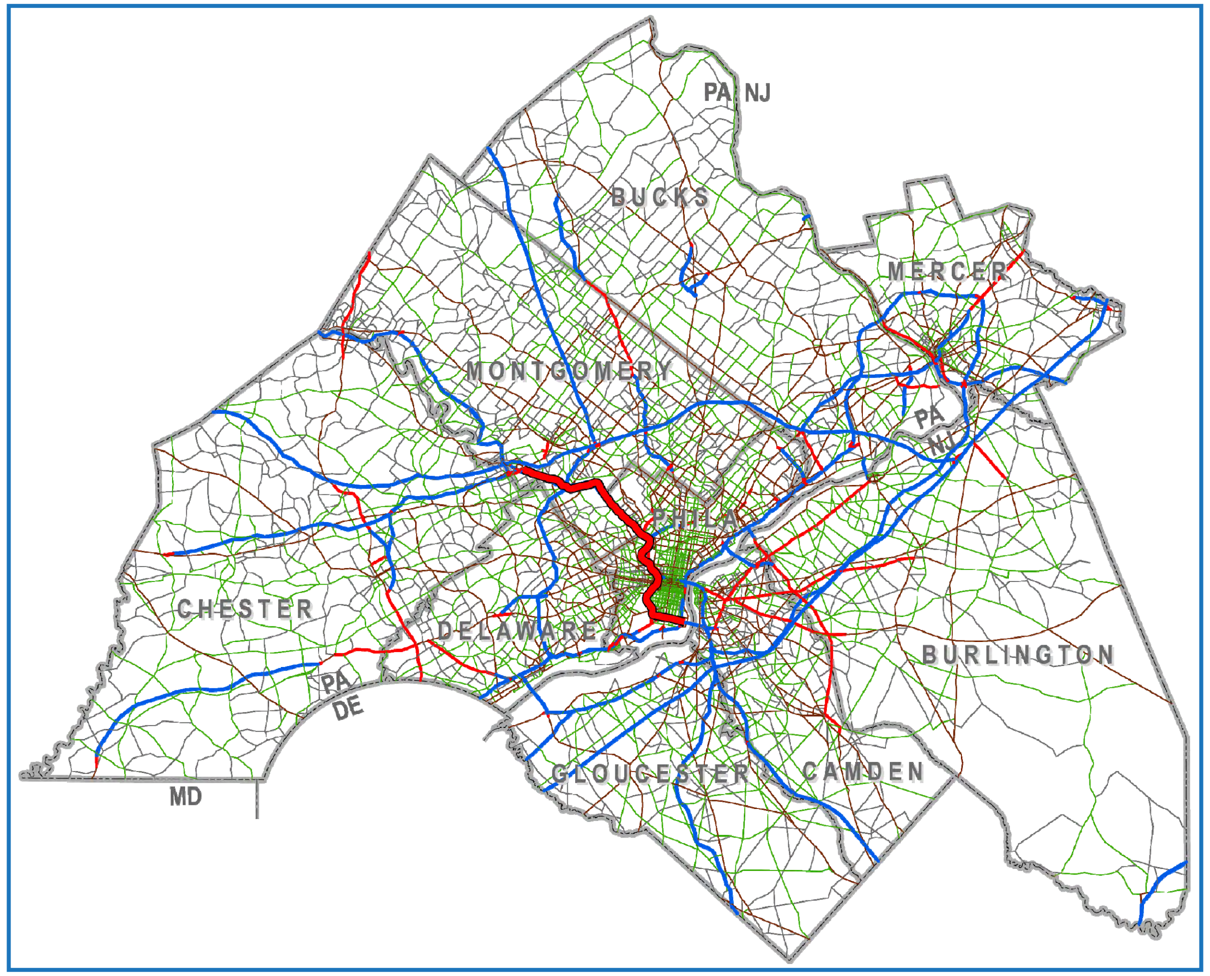
Table 7: Population and Employment Forecasts

POPULATION			Change	
Jurisdiction	2010	2035	Absolute	%
I-76 Planning Corridor				
Philadelphia	1,475,613	1,480,023	4,410	0.3%
Conshohocken	8,595	10,051	1,456	16.9%
Lower Merion	58,833	59,947	1,114	1.9%
Upper Merion	27,764	29,299	1,535	5.5%
West Conshohocken	1,558	1,716	158	10.1%
Sub-total	1,572,363	1,581,036	8,673	0.6%
Remainder of the PA Region				
Montgomery County (remaining)	705,590	793,123	87,533	12.4%
Bucks County	649,187	753,784	104,597	16.1%
Chester County	505,095	622,498	117,403	23.2%
Delaware County	556,117	559,956	3,839	0.7%
Sub-total	2,415,989	2,729,361	313,372	13.0%
NJ Counties				
Burlington County	464,968	541,203	76,235	16.4%
Camden County	516,880	524,684	7,804	1.5%
Gloucester County	292,486	369,374	76,888	26.3%
Mercer County	376,738	403,976	27,238	7.2%
Sub-total	1,651,072	1,839,237	188,165	11.4%
Region Total	5,639,424	6,149,634	510,210	9.0%

EMPLOYMENT			Change	
Jurisdiction	2010	2035	Absolute	%
I-76 Planning Corridor				
Philadelphia	722,800	736,268	13,468	1.9%
Conshohocken	7,097	8,713	1,616	22.8%
Lower Merion	44,263	45,475	1,212	2.7%
Upper Merion	55,653	62,010	6,357	11.4%
West Conshohocken	3,293	3,822	529	16.1%
Sub-total	833,106	856,288	23,182	2.8%
Remainder of the PA Region				
Montgomery County (remaining)	410,894	465,410	54,516	13.3%
Bucks County	290,233	342,236	52,003	17.9%
Chester County	270,079	337,093	67,014	24.8%
Delaware County	238,728	243,547	4,819	2.0%
Sub-total	1,209,934	1,388,286	178,352	14.7%
NJ Counties				
Burlington County	223,430	260,529	37,099	16.6%
Camden County	223,481	226,682	3,201	1.4%
Gloucester County	115,456	145,895	30,439	26.4%
Mercer County	236,358	269,446	33,088	14.0%
Sub-total	798,725	902,552	103,827	13.0%
Region Total	2,841,765	3,147,126	305,361	10.7%

Source: **DVRPC**

Figure 16: 2010 Modeled Transportation Network



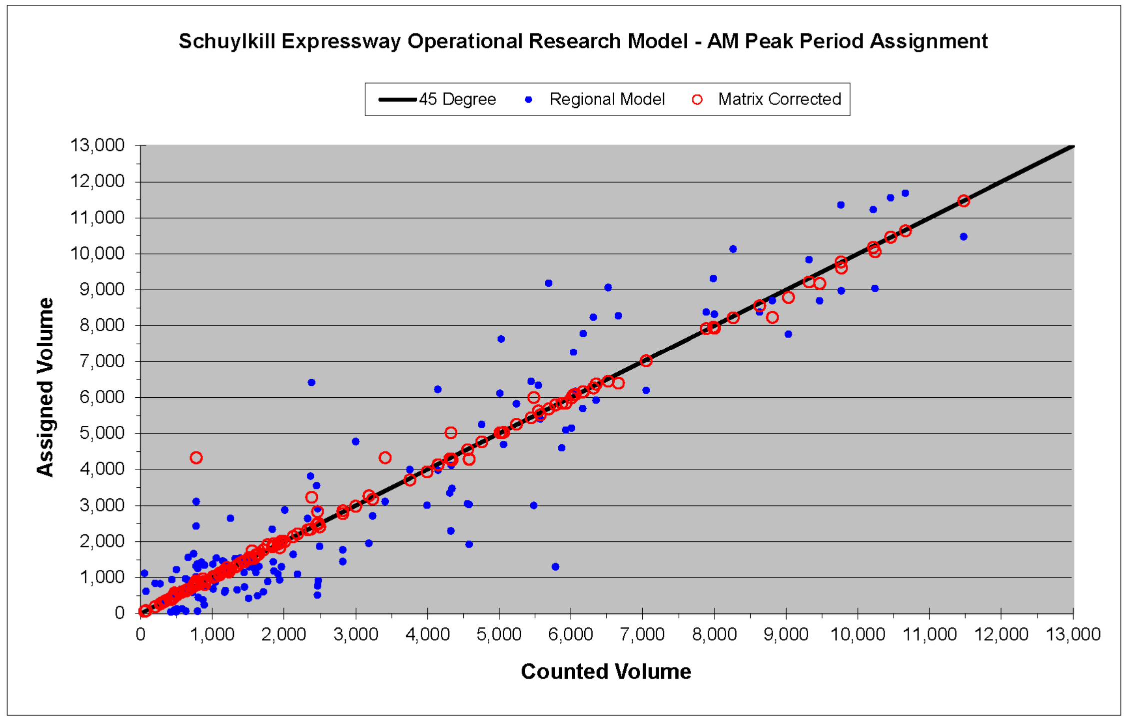
Source: DVRPC

Figure 17: Loaded Regional Model's Sub-cut for VISSIM (Representative)

Source: DVRPC

The regional model's outputs for the planning corridor included model year daily traffic forecasts and four time block forecasts (i.e., the AM Peak Period, 7:00 AM to 9:00 AM; the Midday Period, 9:00 AM to 3:00 PM; the PM Peak Period, 3:00 PM to 6:00 PM; and the Nighttime Period, 6:00 PM to 7:00 AM) for all links in the corridor, including mainline I-76 and its on- and off-ramps. Year 2010 loaded sub-networks of the VISUM model, closely reflecting the operational model's mainline and ramp network, were "clipped" from the regional model (**Figure 17**), re-run for the four time blocks, and calibrated using model parameters and matrix correction procedures provided through the software to replicate, as close as practical, the volumes contained in Tables 2 and 3. **Figure 18** displays an example of the validated assignment for the AM Peak Period.

Figure 18: Validation of VISUM Assignment – I-76 Mainline During the AM Peak Period

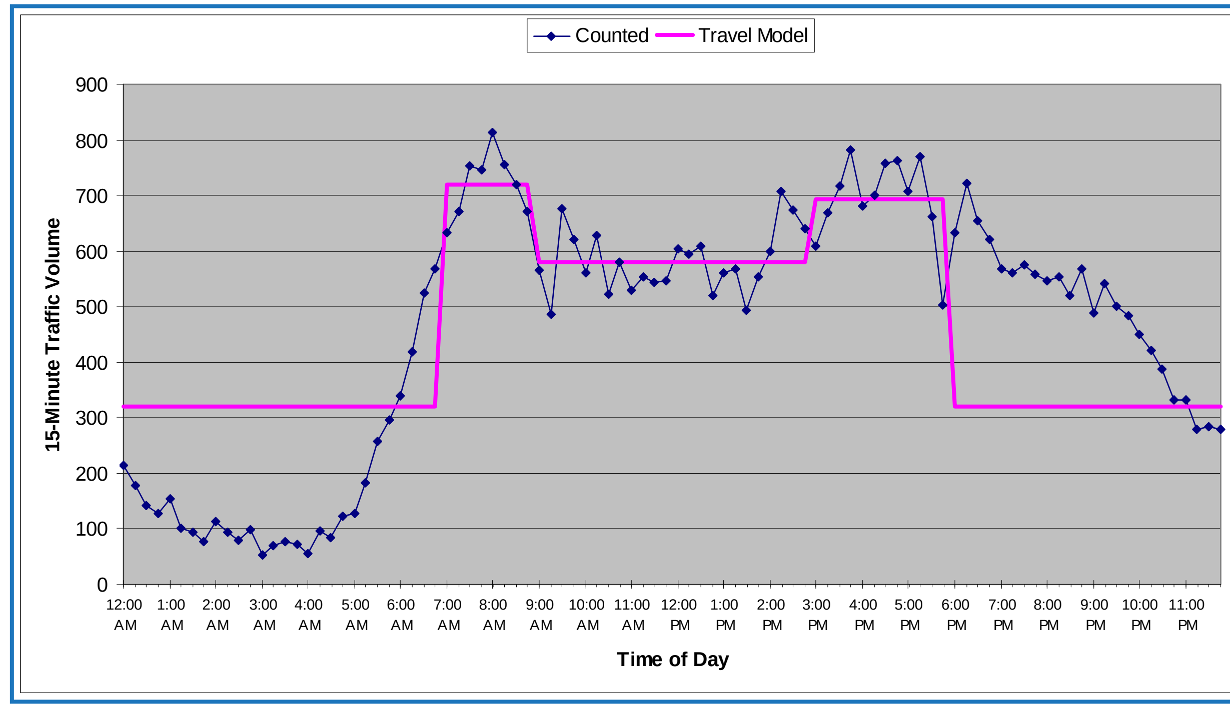


	Regional Model	Matrix Corrected
Number of Facilities	145	145
Average Counted Volume	3,138	3,138
Average Assigned Volume	3,126	3,165
Difference Between Means	-12	26
Root Mean Squared Error	1,112	332
Percent RMSE	35.4%	10.6%
Coefficient of Correlation (R)	0.93	0.99
Coefficient of Determination (R^2)	0.87	0.99

Source: **DVRPC**

Outputs from the VISUM sub-network traffic assignment served as inputs to the VISSIM operational models, including: representative hourly volumes or flow rates for each on-ramp (**Figure 19**) and “routes” or routing decisions—the paths that the entering volume takes along the Expressway (i.e., proportional distributions of each on-ramp’s hourly volume to each downstream off-ramp).

Figure 19: VISUM Output – Hourly On-Ramp Volumes for the Four Time Periods (Representative)



Source: **DVRPC**

VISUM’s volume flow rates and routes from the Year 2010 AM Peak, Midday Period and PM Peak Period models were supplied to VISSIM directly to build the Year 2010 operational model and to the ANM interface step to begin to establish relationships between the Year 2010 and Year 2035 VISUM outputs for the Year 2035 VISSIM inputs in 15-minute time intervals.

VISUM–VISSIM INTERFACE—ANM TRANSLATION

DVRPC staff formulated a special off-line tool to supply 15-minute interval data and to maintain the connection between the regional model and the Year 2035 operational model. The spreadsheet tool, **ANMtranslation.xls**, is described in greater detail in the **USER'S GUIDE** and was provided in the deliverables to facilitate the process for subsequent users and/or other applications.

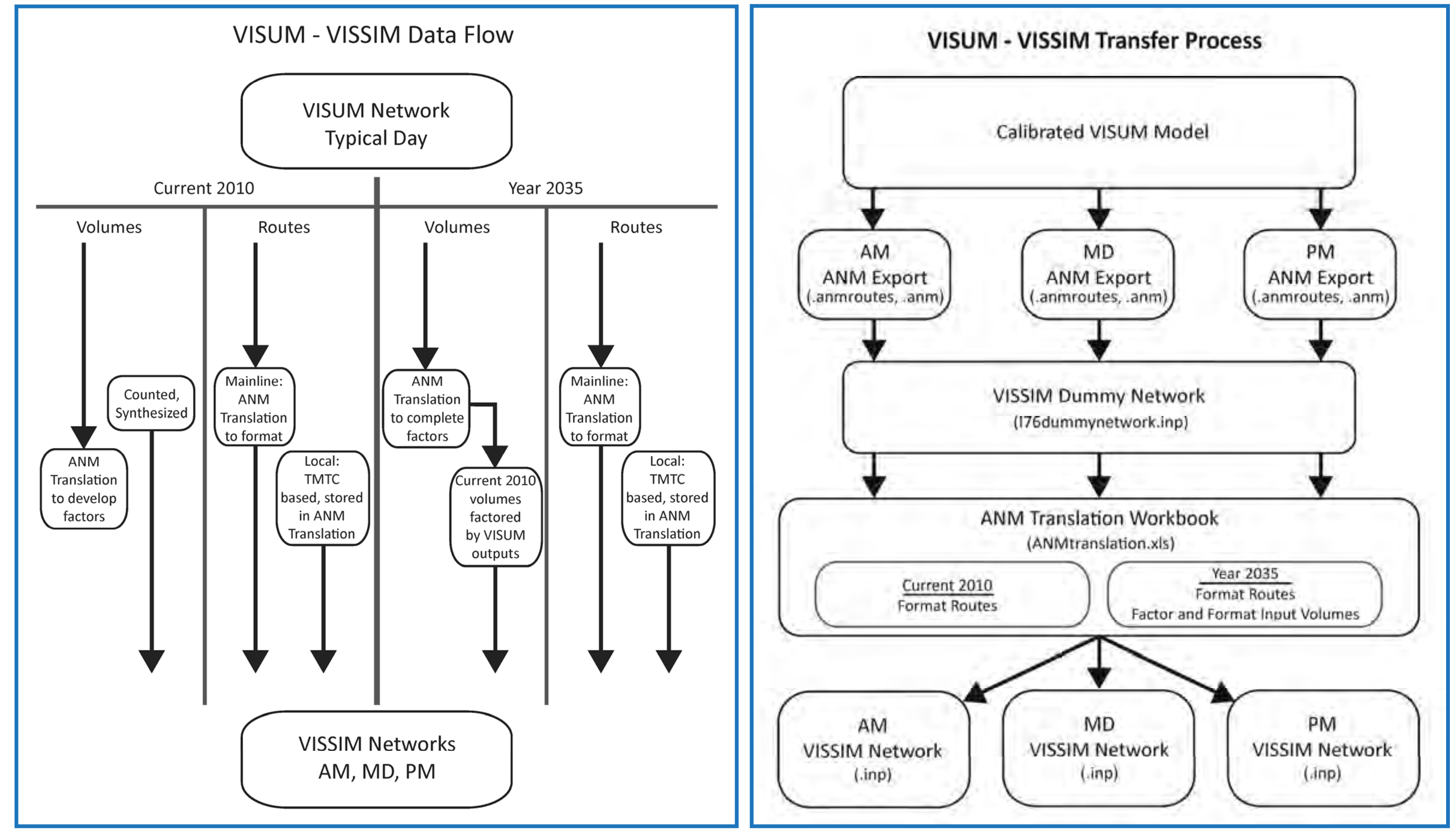
The ANM translation tool addresses volumes and routes associated with the two modeling platforms:

- Volumes: associates VISUM mainline vehicle inputs with VISSIM local network (i.e., intersection) vehicle inputs
  - records Year 2010 VISUM input volumes;
  - records Year 2035 VISUM input volumes, creates factors, applies factors to VISSIM Year 2010 volumes; and
  - prepares Year 2035 data for import into VISSIM networks.

- Routes: hosts local network (intersection-based TMTCs) routes and associates routes between the two platforms
  - accepts Year 2010 and Year 2035 mainline routes; and
  - prepares Year 2010 and Year 2035 routes for import into VISSIM networks, including local network routes.

The spreadsheet tool built and associated relationships between the Year 2010 VISUM model's volume outputs and the current 2010 VISSIM model's dynamic and static component inputs (i.e., the VISUM–VISSIM linked network and the external intersections) and then applied those relationships to the Year 2035 VISUM model outputs to formulate the vehicle inputs required for the ramp, mainline, and local intersection network components of the Year 2035 operational model at 15-minute intervals. The tool also provided a centralized file for reviewing volume and routing data, and trouble-shooting between the two platforms.

Figure 20: Schematic Diagrams of ANM Interface – Data Flow and Transfer Process

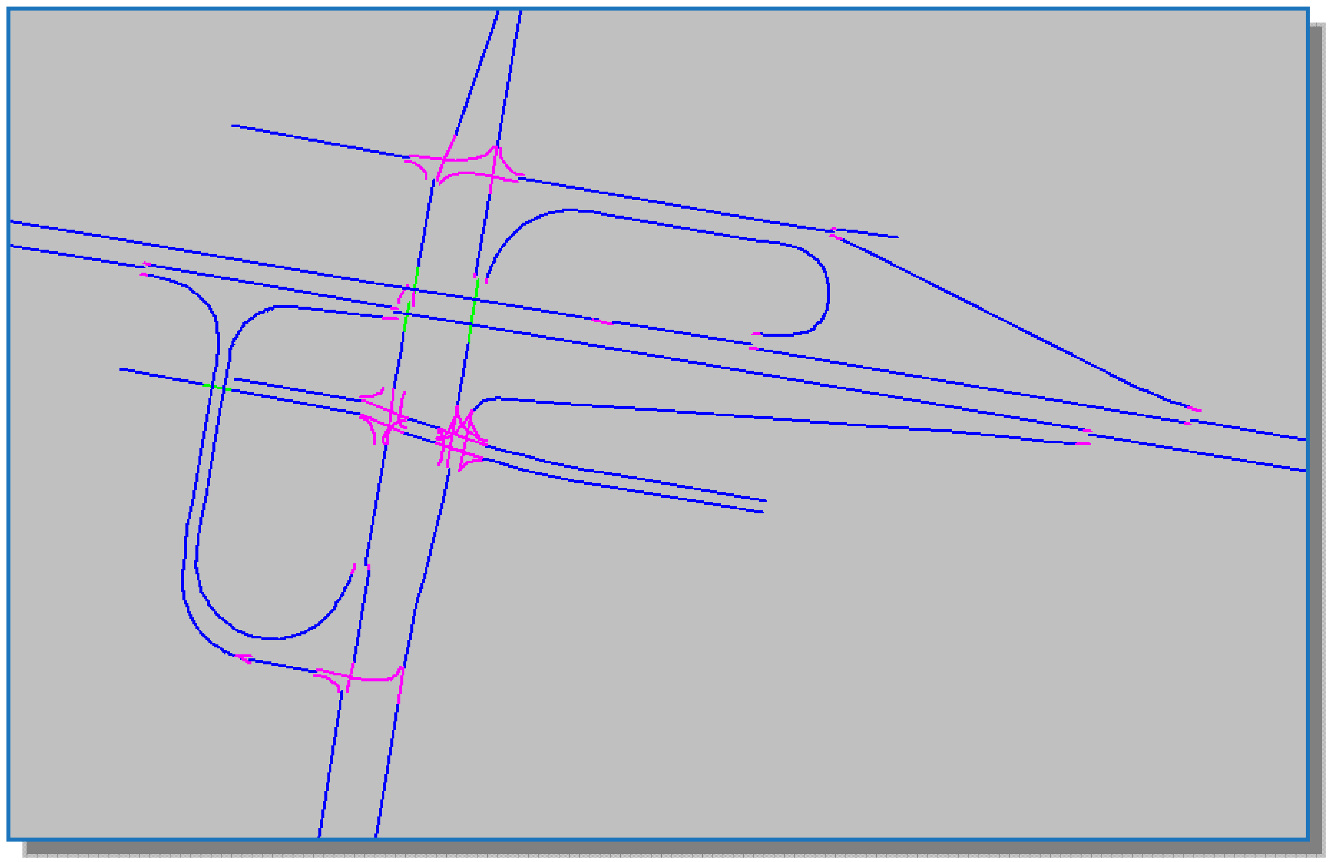


The ANM translation is actuated through an Excel workbook file. Relationships are determined between VISUM's forecasted Year 2010 and Year 2035 outputs (left diagram). Via the translation, the relationships are transferred and formatted for application to the current 2010 VISSIM model's volumes and routes—to supply the Year 2035 VISSIM model inputs (right diagram). (DVRPC)

YEAR 2010 OPERATIONAL MODEL—PREPARATION, CALIBRATION, AND PERFORMANCE MEASUREMENT

The Year 2010 VISSIM models were prepared to incorporate the physical and regulatory environment of the Schuylkill Expressway's mainline, ramp, and study intersection network for the AM Peak, Midday, and PM Peak Periods (**Figure 21**). The detail of the VISSIM models far exceeded the VISUM sub-network—with the addition of 36 at-grade intersections and the inclusion of a far more robust set of attributes attached to the network.

Figure 21: I-76 and Broad Street Interchange (VISSIM)



Source: DVRPC

Actual supply-side attributes for the VISSIM network were determined from: 2005 and 2010 aerial photography (for geometry along the centerlines of the highway's through-travel and auxiliary lanes in each direction, lengths of acceleration and deceleration lanes, merging and weaving areas, etc.), 5-foot topographic contours developed from DVRPC's 2010 aerial imagery (used to derive elevation points and establish grades along the Expressway), online "street views" (like Google maps—to corroborate control type, lane groupings, and ramp and local street speed limits), traffic signal permit drawings at the signalized intersections (for current time-of-day signal phasing and timings, actuation or detection, coordination conditions, etc.), and field views.

Current 2010 traffic demand on the Expressway's on-ramps were input to the VISSIM model for three separate simulations (AM Peak, the Midday, and the PM Peak Periods).[4] Other volume and network performance characteristics were also added, including:

- extrapolations of VISUM's representative hourly on-ramp volume and downstream routing decisions to 15-minute interval data throughout the analysis period;
- static turning movement percentages at the key intersections at or near the Expressway's on- and off-ramps in correspondence with Current 2010 TMTCs;
- traffic composition factors (5.6 percent heavy vehicles) along the Expressway for all analysis periods;[5] and
- free-flow speeds (representative thresholds computed from actual spot-speed data) on the mainline within each analysis period.

The VISSIM program was executed for each analysis period preceded by a model "seeding" interval (60 minutes for the AM and 30 minutes for the Midday and PM Periods), prior to the start of the formal analysis period. Calibration of the Year 2010 VISSIM models initially included visual and network integrity checks to replicate Current 2010 mainline and on-ramp traffic volumes as best as practical (within +/- 5 percent) for the AM Peak, the Midday, and the PM Peak Periods.

Once Year 2010 Period volumes were satisfied, then key hourly volumes, spot speeds, and operating speeds were sampled for fit. The key analytical hours were:

#1: **AM Peak Hour = 7:00 AM–8:00 AM**;
#2: **Midday Trough Hour = 10:00 AM–11:00 AM**; and
#3: **PM Peak Hour = 4:30 PM–5:30 PM**.

Based on the initial outcomes, it was necessary to adjust free-flow speed parameters along the mainline and re-run the three period assignments to reach calibration as best as practical for volume and speed. Network volumes, spot speeds, and operating speed data were obtained from these simulations to establish the modeling baseline for performance measurement.

[4] Nighttime conditions were not modeled with VISSIM.
[5] *Note*: Expediency dictated that heavy vehicle prohibitions, existing at Montgomery Drive, not be built into the operational models.

Calibration of the Year 2010 Operational Model

Modeled volumes for the AM Peak, Midday and PM Peak Periods were judged in comparison with current 2010 volumes for the same intervals as contained in Tables 2 and 3. Volumes were compared separately for the ramps and the mainline, and for the entire Expressway as a system (ramps and mainline).

Table 8 summarizes the results of the calibration effort on the ramps.

Table 8: Calibration Summary of the Expressway Ramps – Three Time Periods

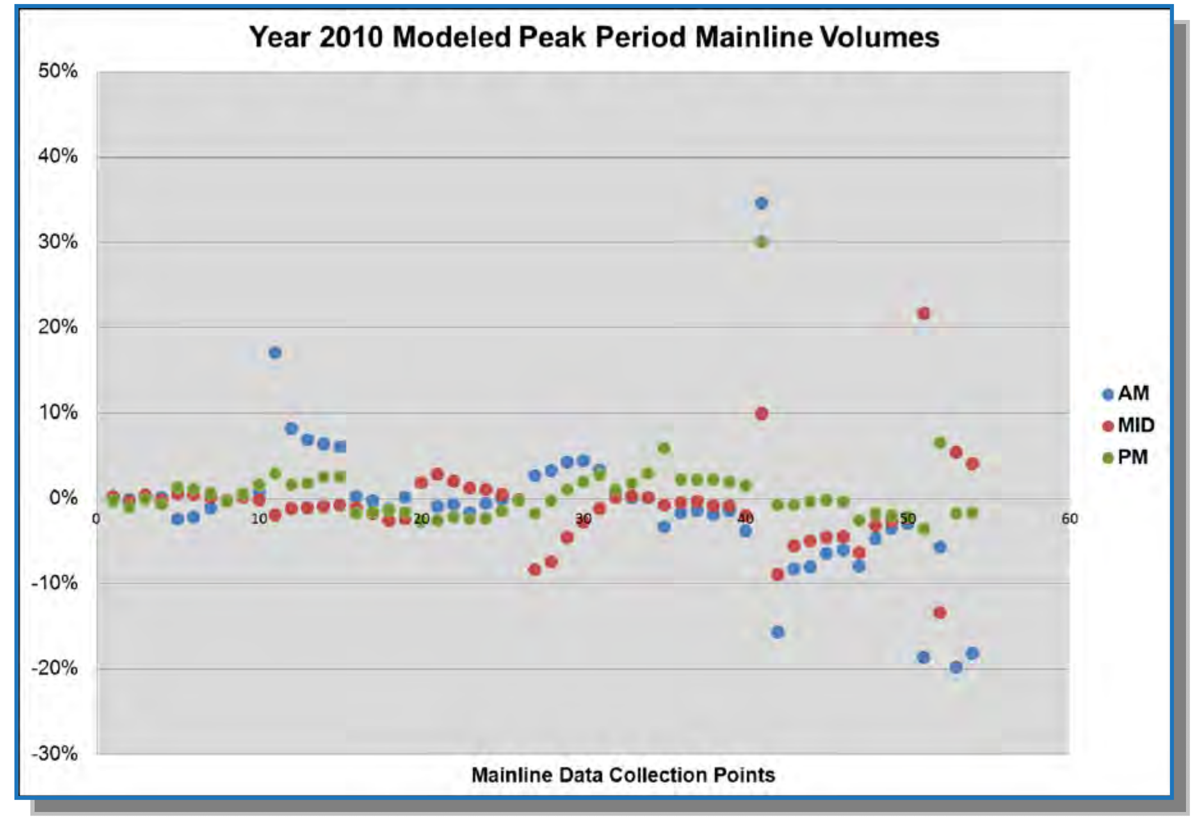
	AM Peak Period	Midday Period	PM Peak Period
Global: On- and Off-Ramps			
Year 2010 Model:	175,051	381,671	254,214
Current 2010:	174,492	382,935	256,122
Difference:	0.32%	-0.33%	-0.75%
EB On-Ramps			
Year 2010 Model:	43,051	100,731	68,634
Current 2010:	42,972	100,720	68,814
Difference:	0.18%	0.01%	-0.26%
EB Off-Ramps			
Year 2010 Model:	41,468	95,425	64,813
Current 2010:	40,812	95,908	65,385
Difference:	1.61%	-0.50%	-0.87%
WB On-Ramps			
Year 2010 Model:	45,277	93,696	60,417
Current 2010:	45,451	93,822	60,617
Difference:	-0.38%	-0.13%	-0.33%
WB Off-Ramps			
Year 2010 Model:	45,255	93,389	60,350
Current 2010:	45,670	94,052	61,306
Difference:	-0.91%	-0.70%	-1.56%

Source: DVRPC

As would be expected, modeled on-ramp volumes were very close to the targets (i.e., within +/- 0.50 percent of current volumes) because they served as original inputs to the VISSIM model. Off-ramp volumes were modeled to within +/- 2.00 percent of current volumes. Overall, on- and off-ramps were modeled to be within +/- 1.00 percent of current 2010 data.

Figure 22 presents the results of the calibration for the Expressway's mainline. Year 2010 modeled volumes were within +/- 1.50 percent of current volumes for all three time periods.

Figure 22: Calibration Summary of the Expressway Mainline – Three Time Periods



Source: DVRPC

- System-wide (ramps + mainline) modeled 2010 volume versus current 2010 volume:
  - AM Peak Period = –0.55 percent;
  - Midday Period = –0.89 percent; and
  - PM Peak Period = 0.14 percent.

Year 2010 Operational Model Performance Measures

Volume, spot-speed and operating speed data was obtained from the Year 2010 VISSIM networks through "evaluations" provided through the software for three hours of interest. Volume and spot-speed performance data collection points were established in the modeled networks to coincide with the original data collection effort and database record numbering system (i.e., the NewID2 locations). Operating speeds were gleaned from the models and compared with the INRIX data. The performance data was compared to current 2010 data for the following key operating hours:

- #1: **AM Peak Hour = 7:00 AM–8:00 AM**;
- #2: **Midday Trough Hour = 10:00 AM–11:00 AM**; and
- #3: **PM Peak Hour = 4:30 PM–5:30 PM**.

Table 9 summarizes the results of the assignment on the ramps.

Table 9: Calibration Summary of the Expressway Ramps – Three Key Hours

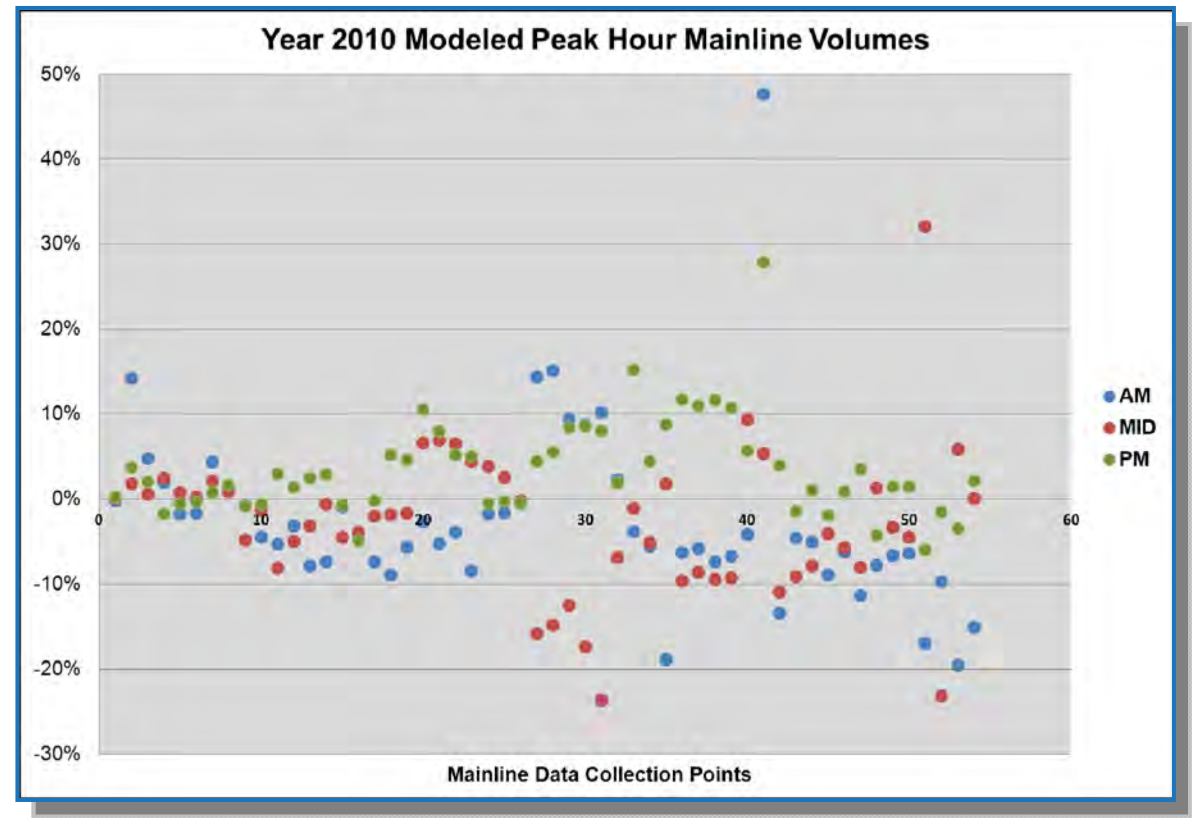
	AM Peak Hour	Midday Trough Hour	PM Peak Hour
Global: On- and Off-Ramps			
Year 2010 Model:	89,771	59,055	87,668
Current 2010:	88,015	59,723	88,732
Difference:	1.99%	-1.12%	-1.20%
EB On-Ramps			
Year 2010 Model:	22,353	15,637	23,520
Current 2010:	22,306	15,654	23,632
Difference:	0.21%	-0.11%	-0.47%
EB Off-Ramps			
Year 2010 Model:	21,090	15,012	22,230
Current 2010:	19,562	14,874	22,834
Difference:	7.81%	0.93%	-2.65%
WB On-Ramps			
Year 2010 Model:	23,335	14,201	21,150
Current 2010:	23,511	14,249	21,167
Difference:	-0.75%	-0.34%	-0.08%
WB Off-Ramps			
Year 2010 Model:	22,993	14,205	20,768
Current 2010:	22,636	14,946	21,099
Difference:	1.58%	-4.96%	-1.57%

Source: DVRPC

Modeled on-ramp volumes were very close to the targets (i.e., within +/- 1.00 percent of current volumes). Off-ramp volumes were modeled to within +/- 8.00 percent of current volumes. During the key analysis hours, overall on- and off-ramp Year 2010 modeled volumes were within +/- 2.00 percent of current 2010 conditions.

Figure 23 presents the results of the assignment for the mainline. Year 2010 modeled volumes were within +/- 3.50 percent of current volumes across all three key hours.

Figure 23: Calibration Summary of the Expressway Mainline – Three Key Hours



Source: DVRPC

- System-wide (ramps + mainline) modeled 2010 volume versus current 2010 volume:
  - AM Peak Hour = –1.61 percent;
  - Midday Trough Hour = –2.62 percent; and
  - PM Peak Hour = 1.79 percent.

Spot speeds along the modeled network were collected at 41 data collection points corresponding with Traffic.com speed sensor locations and readings recorded through the data collection effort.

Table 10 summarizes the calibrated model results in comparison with current 2010 spot speeds. Overall AM and PM Peak Hour modeled spot speeds are within 13.4 percent (+/- 6.6 mph) of current conditions. In the Midday Trough, spot speed is within 4.8 percent (2.6 mph) of actual conditions.

A Note About Compare.mdb:

DVRPC staff prepared the off-line performance measures change tool (**Compare.mdb**) to compare and contrast statistics generated through the data collection and modeling work.

The tool facilitates simple queries of current 2010, Year 2010, and/or Year 2035 for volume and/or spot-speed data without the need for access to the software and/or skill to use it. With the tool, decision makers can explore where or when significant changes take place in the Expressway's performance as a consequence of regional growth and/or in consideration of potential improvement strategies explored in future applications of the models. Summary information provided through **Compare.mdb** is easily copied to spreadsheet software for documentation or further analysis.

VISUM's forecasts are available in both daily and four time-block breakdowns. VISSIM supplies volumes and spot speeds for predetermined or self-selected time intervals (15 minutes and above) corresponding with the modeling hours (7:00 AM to 6:00 PM).

The tool may be updated by up-loading volume or spot-speed data associated with subsequent modeling applications and has been provided in the project deliverables. Technical documentation is included in the **USER'S GUIDE.**

Table 10: Hourly Spot Speed (Current 2010 and 2010 Modeled)

			Current 2010 (actual mph, Traffic.com)			2010 Modeled (modeled mph, VISSIM)			% Change (vs. actual)		
NewID2	EB/WB	Mainline Location	AM	MD	PM	AM	MD	PM	AM	MD	PM
30	EB	N Gulph Rd - US 202 / US 422	35	41	42	38	48	42	9%	16%	-1%
75	EB	US 202 / US 422 - Gulph Mills	54	55	56	52	58	55	-5%	5%	-3%
90	EB	Gulph Mills - I-476 / Conshohocken	52	60	58	56	62	55	8%	4%	-5%
120	EB	Within the I-476 / Conshohocken Int.	18	54	17	40	56	48	117%	5%	176%
150	EB	Conshohocken - Gladwynne	41	61	49	47	62	50	16%	1%	3%
160	EB	Gladwynne - Belmont Av / Green La	49	58	54	49	56	57	1%	-4%	6%
175	EB	Belmont Av / Green La - City Av	53	59	60	55	61	55	4%	2%	-8%
195	EB	City Av - Roosevelt Blvd	46	51	50	49	51	51	6%	0%	2%
235	EB	Roosevelt Blvd - Montgomery Dr	29	51	39	44	50	42	54%	-1%	7%
250	EB	Montgomery Dr - Girard Av	45	48	39	48	49	39	8%	3%	0%
265	EB	Girard Av - Spring Garden St	46	52	36	51	53	39	10%	3%	6%
275	EB	Spring Garden St - Vine St / 30th St	51	53	36	53	54	39	4%	2%	9%
305	EB	Vine St / 30th St - Walnut St	47	48	16	53	50	33	12%	3%	100%
325	EB	South St - University Av	62	53	49	57	56	47	-7%	6%	-3%
335	EB	University Av - 34th St	56	54	52	55	56	52	-3%	2%	0%
365	EB	Vare Av - Passyunk / 26th St	53	47	48	52	47	47	0%	0%	-1%
390	EB	Passyunk Av / 26th St - Penrose Av	54	54	55	53	55	55	-2%	2%	0%
420	EB	Broad St - Packer Av	53	52	56	53	54	56	0%	3%	0%
435	EB	Packer Av - I-95 / Front St	56	55	58	51	54	56	-8%	-2%	-2%
510	WB	I-95 / Front St - 7th St	57	54	56	53	54	55	-6%	0%	-1%
520	WB	7th St - Broad St	56	54	56	55	56	56	-2%	2%	1%
545	WB	Penrose Av - Passyunk Av	60	57	62	58	60	62	-3%	5%	0%
570	WB	Passyunk Av - Vare Av	50	50	53	49	51	47	-1%	1%	-11%
590	WB	Vare Av - 34th St	45	54	55	44	53	38	-2%	-2%	-32%
610	WB	34 St - University Av	33	39	29	34	42	24	4%	7%	-19%
640	WB	Vine St WB-off - 30th St WB-on	58	58	55	56	49	52	-3%	-16%	-7%
670	WB	Vine St - Spring Garden St	61	57	56	60	56	54	-2%	-3%	-4%
680	WB	Spring Garden St - Girard Av	58	55	55	56	55	55	-3%	0%	1%
690	WB	Within the Girard Av Int.	55	56	50	57	55	49	2%	-1%	-2%
700	WB	Girard Av - Montgomery Dr	50	54	50	35	54	50	-30%	1%	0%
715	WB	Montgomery Dr - Roosevelt Blvd	47	44	48	44	50	47	-6%	13%	-1%
730	WB	Roosevelt Blvd - City Av	49	61	48	49	55	43	1%	-10%	-10%
770	WB	City Av - Belmont Av / Green La	33	57	44	45	56	42	38%	-2%	-4%
780	WB	Within Belmont Av / Green La Int.	34	60	49	44	60	50	30%	1%	2%
790	WB	Belmont Av / Green La - Gladwynne	53	58	56	54	61	52	2%	4%	-6%
800	WB	Gladwynne - Conshohocken	47	59	40	51	59	45	9%	0%	13%
820	WB	Within I-476 Interchange	59	59	56	59	58	56	-1%	-1%	-1%
855	WB	I-476 - Gulph Mills	59	57	56	50	58	55	-15%	2%	-1%
865	WB	Within Gulph Mills Int.	57	64	60	57	64	59	0%	-1%	-1%
875	WB	Gulph Mills - US 202 / US 422	56	63	56	58	62	51	4%	-1%	-10%
920	WB	Within Mall Blvd Int.	49	48	47	49	50	43	-1%	4%	-7%

Source: DVRPC

Modeled Year 2010 operating speeds were obained through evaluations of the networks for the three key operational hours and compared to current 2010 data (**Table 11**). Like the current 2010 data, modeled operating speeds are marginally slower in the eastbound direction. Modeled Year 2010 Midday Trough Hour speeds are 3 mph faster than actual conditions in the eastbound direction and 5 mph faster in the westbound direction. Overall modeled AM and PM Peak Hour speeds are 7–9 mph faster.

Assessment of the Year 2010 Operational Model

- Model structures built, loaded, integrated (via special off-line "**ANM Translation**" spreadsheet tool), and functioning at 15-minute intervals.
- Performance measures baseline were established (and "**Compare**" database tool supplied for volume and spot-speed conditions).
- Reasonable parameter adjustments were applied to calibrate traffic volumes and speeds (maintains the integrity of the computer program and the models for subsequent Year 2035 scenario).
- Year 2010 forecasted volumes calibrated to within 1 percent of current 2010 volume for three Time Periods spanning 7:00 AM to 6:00 PM, and within 3 percent for the AM Peak, Midday Trough, and PM Peak Hours.
- The calibrated Year 2010 model's output for spot-speed data are on average within 7 mph of actual spot speeds during the Peak Hours and within 3 mph of actual speeds during the Midday Trough.
- Like the current data, the calibrated Year 2010 model's average operating speeds for the length of the Expressway is consistently lower (and longer to travel) in the eastbound direction than in the westbound direction. Modeled outputs are on-average 7–9 mph faster than actual data during the Peak Hours and 3–5 mph faster in the Midday Trough Hour.
- Normalize the indicators—interpolate changes between modeling scenarios (i.e., modeled 2010 outputs to modeled 2035 outputs) and apply to current 2010 spot-speed and operating speed conditions—to supply Year 2035 speeds.

Table 11: Average Operating Speed (Current 2010 and 2010 Modeled)

Travel Direction	Description	Length (mi)	Current 2010 Operating Speed (actual mph, INRIX)			2010 Modeled Operating Speed (modeled mph, VISSIM)			% Change (Current to Modeled)		
			AM	MD	PM	AM	MD	PM	AM	MD	PM
EASTBOUND	PA Turnpike Toll to US-202	0.56	30	42	33	30	37	34	-1%	-11%	5%
	US 202 to I-476	4.21	38	55	31	49	56	41	28%	2%	30%
	I-476 to US-1 South	8.00	35	51	38	45	55	49	29%	7%	28%
	US-1 South to US-1 North	0.74	39	50	42	53	54	54	34%	7%	31%
	US-1 North to Montgomery Dr	1.52	31	48	35	40	50	42	29%	3%	19%
	Montgomery Dr to I-676	2.64	39	45	25	47	49	39	21%	11%	60%
	30th St to Chestnut St	0.46	43	47	32	52	49	34	21%	6%	7%
	Chestnut St to 34th St	1.66	47	49	39	55	53	41	17%	9%	7%
	34th St to 26th/Passyunk	0.91	50	51	48	55	52	48	9%	1%	0%
	26th/Passyunk to WW Br Toll	2.35	50	52	51	54	51	53	6%	-1%	3%
WESTBOUND	WW Br Toll to 26th/Passyunk	2.42	49	49	49	53	55	56	7%	11%	12%
	26th/Passyunk to 34th St	0.93	37	46	45	48	51	53	29%	9%	17%
	34th St. to Chestnut St	1.64	34	44	26	39	47	38	14%	8%	44%
	Chestnut St to 30th St	0.38	43	46	34	46	42	38	7%	-10%	13%
	I-676 to Montgomery Dr	2.72	51	49	41	55	55	52	7%	13%	28%
	Montgomery Dr to US-1 North	1.54	44	54	39	45	51	47	3%	-6%	20%
	US-1 North to US-1 South	0.74	16	50	21	50	48	43	214%	-3%	103%
	US-1 South to I-476	7.99	39	55	41	50	60	49	28%	10%	20%
	I-476 to US 202	4.22	50	55	48	55	62	54	10%	13%	13%
	US-202 to PA Turnpike Toll	0.52	48	48	44	52	55	49	7%	13%	12%

Notes:
Speeds rounded to nearest whole number
Operating speed estimated from adjacent segments

Source: **DVRPC**

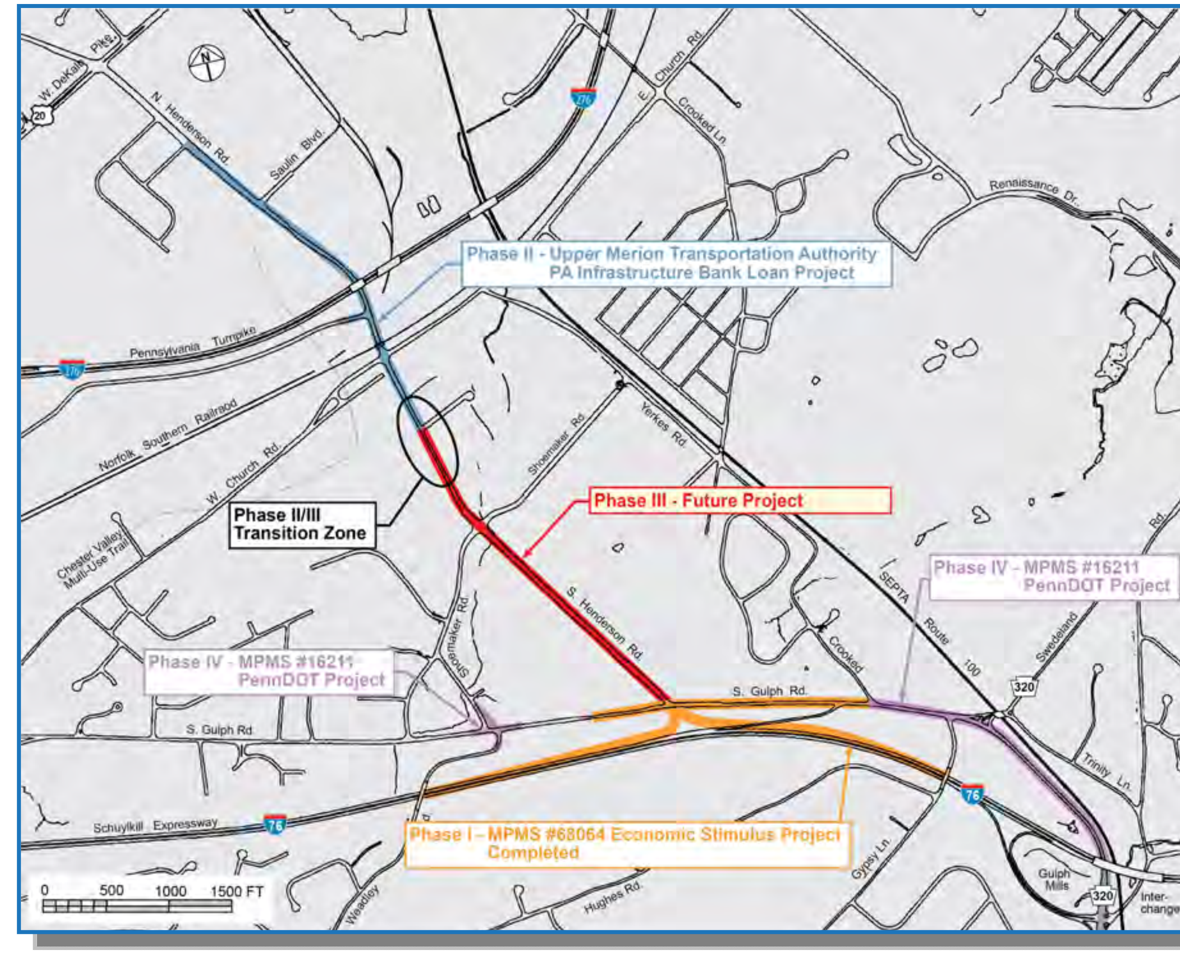
YEAR 2035 REGIONAL TRAVEL DEMAND FORECASTING MODEL

The modeled future seeks to quantify future traffic levels and operational consequences along the Expressway due to planned regional growth. Therefore, as directed by the Study Steering Committee, DVRPC staff prepared a Year 2035 VISUM model to reflect the official Long-Range Plan of the Delaware Valley Region: *Connections–The Regional Plan for a Sustainable Future*. The Plan estimates future population and employment levels and identifies the set of transportation infrastructure improvements to help accommodate the growth.

Table 7 (shown earlier) summarizes DVRPC Board-adopted population and employment forecasts used in the long-range planning effort and cites changes anticipated in the immediate corridor and beyond between 2010 and 2035. By 2035, there will be less than a 1 percent gain in corridor residents and almost a 3 percent increase in jobs. The greatest gains within the corridor for both statistics are forecasted for the City of Philadelphia and Upper Merion Township—the Expressway's bookends. These indicators alone helped point to some potential modeling exercises for the finished product (refer to **Appendix A-3**).

Multi-modal improvement projects assumed in Year 2035 travel demand forecasting conformed to the region's adopted Long-Range Plan (see **Figure 24** on page 44) and include projects throughout the region that were being constructed at the study's outset, programmed in the region's TIP or recommended in the Long-Range Plan. **Table 12** identifies some of the Long-Range Plan's projects that are in the vicinity of the planning corridor and more germane to the Schuylkill Expressway. Of those projects listed, TIP Project MPMS #68064 and LRP Project #54—the addition of I-76 westbound ramps at Henderson and South Gulph Roads (i.e., Interchange #329, signed for: King of Prussia / Norristown) and related, nearby roadway and intersection improvements—were also added to the structures of the regional model's sub-network and the operational model (**Figure 25**).

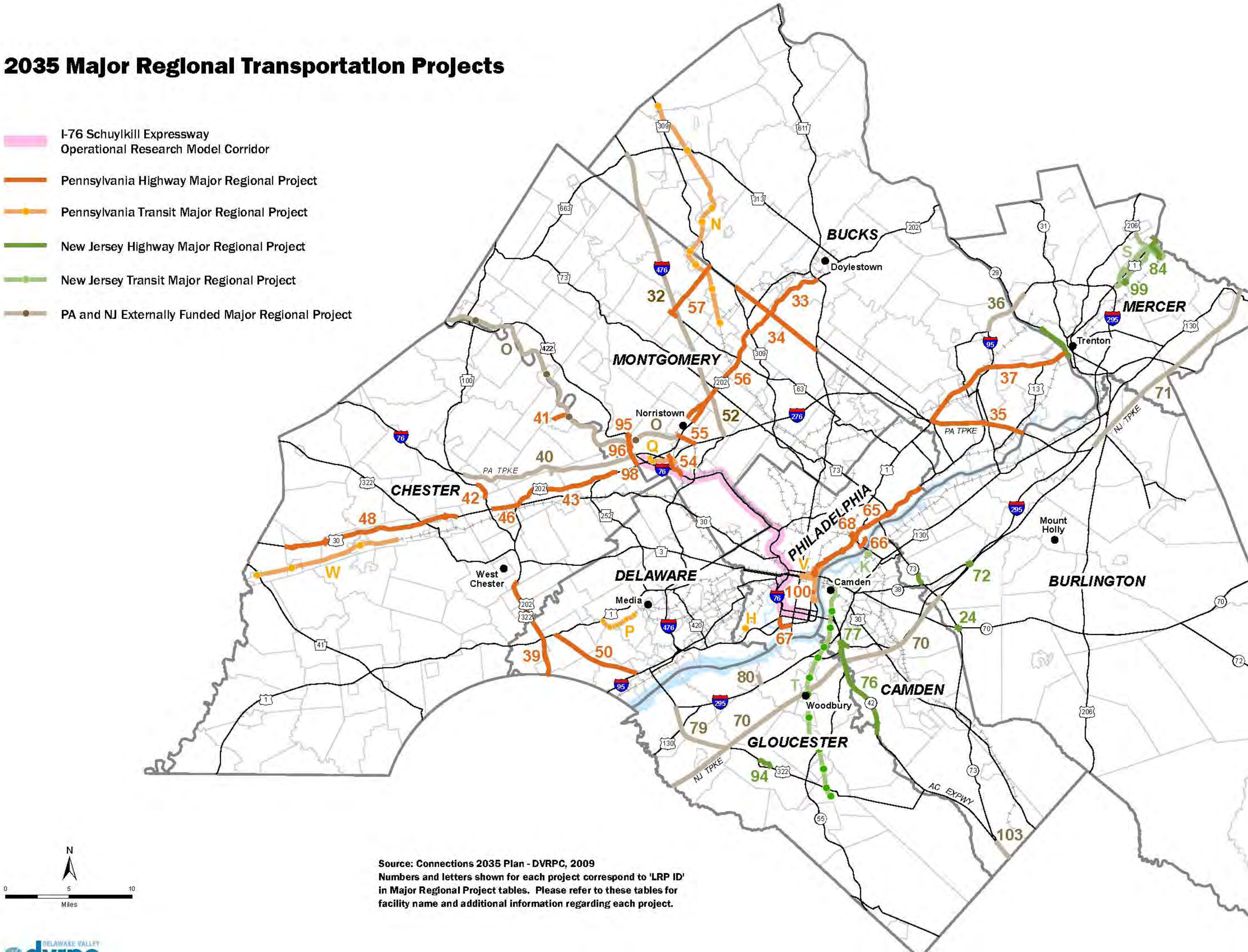
Figure 25: New I-76 Westbound Ramps at Henderson and South Gulph Roads



New, relocated westbound ramps were completed at Interchange #329 (i.e., Phase I, above) and opened to traffic in November 2011. Supportive improvements along adjacent local roadways (i.e., Phases II–IV) remain in the Long-Range Plan. The VISUM and VISSIM Year 2035 networks were updated to reflect all phases of the project. (Original graphic prepared by Boles, Smyth Associates, Inc. for Upper Merion Township. Phasing information updated by DVRPC, September 2012.)

2035 Major Regional Transportation Projects

Figure 24



Source: Connections 2035 Plan - DVRPC, 2009
Numbers and letters shown for each project correspond to 'LRP ID' in Major Regional Project tables. Please refer to these tables for facility name and additional information regarding each project.

DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

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Table 12: Programmed and Planned Transportation Projects (Representative)

Transportation Improvement Program (TIP) Projects: *PA (FY2011-2014) & NJ (FY 2010-2013)*				
MPMS #	Municipality	Project Name	Description	Expected Delivery
16688	West Conshohocken	River Road (PA 23) & Balligomingo Road	Intersection relocation, widening for turn lanes & signalization	2013
00349	Gloucester Twp.	Route 42, Grenloch-Little Gloucester Road	New interchange at NJ 42 to access College Drive	Built
16577	Springfield Twp., Whitemarsh Twp.	Ridge Pike Reconstruction	Roadway widening, intersection improvements from Philadelphia Line to Butler Pike	2019
17724	Philadelphia	South Street Bridge	Bridge replacement	Built
50931	Philadelphia	Gustine Lake Interchange	Replacement of five structures at the confluence of City Avenue, Kelly Drive, Ridge Avenue & Lincoln Drive	Built
57898	Philadelphia	Lancaster Ave Signal Modernization	Signal upgrades/ITS improvements from 45th St to City Avenue	2015
58662	Upper Merion, Bridgeport, Lower Merion & West Conshohocken	Townships-wide Closed Loop Traffic Signal Project	Interconnect 74 signals on township corridors including PA 23	Built
68064	Upper Merion Twp.	Henderson Road	New I-76 westbound off-ramp & relocated I-76 westbound on-ramp; South Gulph Road widening	Built
80479	Plymouth Twp., West Conshohocken	I-476 Roadway Reconstruction	Roadway reconstruction, shoulder widening, ramp upgrades	2012

Long-Range Plan Projects: *CONNECTIONS 2035*				
LRP ID#	County	Project Name	Description	Expected Delivery
32	Bucks, Montgomery	I-476 (NE Extension)	Widen to 6 lanes from Lansdale to Quakertown	2025
33	Bucks, Montgomery	US 202 Section 700	New two-lane parkway from Montgomeryville to Doylestown	2012
36	Bucks, Mercer	I-95 / Scudder Falls Bridge	Widen I-95 from PA 332 to NJ 29, Provide new and replacement toll bridges over the Delaware River	2015
37	Bucks	I-95 at PA Turnpike	New interchange at I-276 and I-95; Widen PA Turnpike from US 1 to New Jersey	2025
39	Chester, Delaware	US 202 Section 100	Widen from West Chester to Delaware State line	2025
40	Chester, Montgomery	I-76 (PA Turnpike)	Widen from Downingtown to Valley Forge	2025
43	Chester	US 202 Section 300	Widen from PA 252 to US 30	2025
47	Chester	PA 29 Ramps	All-electronic interchange at PA 29 and the PA Turnpike	2012
52	Montgomery	I-476 (NE Extension)	Widen to 6 lanes from Mid-County to Lansdale	2015
54	Montgomery	Henderson Road	Widen Henderson Road from Monroe Boulevard to I-76 interchange	2035
55	Montgomery	Lafayette St	Roadway extension from Barbados St. to Conshohocken Rd.; New electronic interchange at PA Turnpike	2025
56	Montgomery	US 202 Section 600	Widen from Johnson Highway to PA 309	2025
75	Camden, Gloucester	I-295 at I-76 / NJ 42	Add missing movements at interchange	2025
77	Camden, Gloucester	I-295	Direct Connection of I-295 through interchange at I-76 / NJ 42	2025
98	Montgomery	US 422 Widening	Widen from 4 to 6 lanes from US 202 to PA 363	2035
O	Chester, Montgomery, Berks	Norristown Regional Rail Line Extension	Extend rail line from Norristown to Wyomissing	2025
Q	Montgomery	Norristown High Speed Line Extension	Extend rail line from Hughes Park to King of Prussia Mall	2025
T	Camden, Gloucester	Glassboro-Camden Light Rail Line	New passenger rail service between Rand Transportation Center & Glassboro	2025

Source: DVRPC

VISUM, the regional model, was executed with the Year 2035 socio-economic variables and transportation network enhancements as inputs. Loaded Expressway-level sub-networks were prepared for the four time blocks (the AM Peak, the Midday, the PM Peak, and the Nightime Periods). **Tables 13 and 14** contain the relative changes that the Year 2035 link-level traffic forecasts represent in comparison with the Year 2010 forecasts (refer to Tables 2 and 3, presented earlier, for the current 2010 baseline volumes).

In total, the Year 2035 forecasts indicate an increase in demand of approximately 13 percent for an Average Weekday and during the AM Peak and Midday Periods. During the PM Peak Period, traffic demand increases by only half as much (6 percent) due to capacity constraints along the highway. Over the Nighttime Period, when overall activity is lowest, traffic demand will increase by 17 percent versus the Year 2010 condition.

Routing decisions output from the VISUM sub-cut's AM Peak, Midday, and PM Peak Period assignments served as direct inputs to the Year 2035 VISSIM operating model and were supplied to the ANM Translation procedure (**ANMtranslation.xls**). Hourly on-ramp flow rates, from the three time periods, were also entered into the ANM Translation step. Relationships developed between output from the Year 2010 and Year 2035 VISUM sub-network models were applied through the ANM Translation workbook to the vehicle inputs used in the Year 2010 VISSIM model to supply the Year 2035 VISSIM model's vehicle inputs in 15-minute intervals.

YEAR 2035 OPERATIONAL MODEL—PREPARATION AND PERFORMANCE MEASUREMENT

In turn, the VISSIM networks and traffic volume inputs were updated—the former with new Interchange #329 opened to traffic and the latter with the inputs from the ANM Translation step—and the program was executed for the Year 2035 AM Peak, Midday, and PM Peak Periods. After the models ran, it became clear that the intersection turning movements—which lie outside the dynamically linked models—were not reacting faithfully to the influences of the regional model. Subsequently, they were removed from the 2035 VISSIM models and animations. The models were re-run with the ramps and the mainline linked between the models. Existing service volumes on the off-ramps were modeled by setting all signal control phasing to max recall. For unsignalized locations, a reduced speed area was used to imitate current throughput on the ramps.

The VISSIM models' simulations and animations contain the full record of forecasted Year 2035 traffic conditions. Data from the three key hours (within each time period) was subsequently evaluated through the software for performance measures and compared with current 2010 conditions.

Year 2035 Operational Model Performance Measures

Performance data was collected from the Year 2035 modeled networks and contrasted with current 2010 data for three key operational hours:

- **AM Peak Hour = 7:00 AM–8:00 AM**;
- **Midday Trough Hour = 10:00 AM–11:00 AM**; and
- **PM Peak Hour = 4:30 PM–5:30 PM**.

Year 2035 volume outputs were contrasted directly with current 2010 data (via **Compare.mdb**). Speed outputs were compared with 2010 modeled output, interpolated, and judged in relation to current 2010 conditions. Spot-speed output was aggregated through the software and assembled using the **Compare.mdb** tool. Relational changes and interpolations were performed using a simple (off-line) spreadsheet (provided with the deliverables). Average operating speed data for the 20 travel-time survey segments along the Expressway was identified through the software, pivoted off 2010 modeled operating speeds for relational changes, and applied to the current 2010 average operating speeds obtained from INRIX. The latter operations were performed using a simple off-line spreadsheet (provided with the deliverables).

Significant changes (location, time, or degree) in performance were inventoried for reporting purposes and to generate potential improvement strategies or future applications for the models. Key hour traffic forecasts are contrasted with current 2010 volumes in **Table 15**. A review of the data indicates the following:

- AM Peak Hour volume increased approximately 11 percent versus 2010; the volume increases are most evident at the ends of the Expressway.
- Midday Trough Hour volume increased approximately 9 percent versus 2010; volume increases are distributed throughout the Expressway.
- PM Peak Hour volume increased approximately 7 percent versus 2010; the increases are most evident at the ends of the Expressway and westbound departing Center City.

Note that VISSIM's dynamic traffic assignment reflecting more specific highway geometry and the cumulative effects of driver behavior and accumulating demand—within a shortened timeframe (60 minutes)—results in different results than the VISUM assignment. Still, the overall results are in line between the programs.

Year 2035 spot speed is contrasted with current 2010 data in **Table 16**. Global speed readings decreased 1–2 mph versus current conditions. Noteworthy decreases include:

- AM Peak Hour = eastbound between the Roosevelt Boulevard and Montgomery Drive; and westbound between 34th Street and University Avenue; and
- PM Peak Hour = eastbound at two consecutive recording points from within the I-476 Interchange to the Gladwynne Interchange; and westbound at three consecutive recording points between the 26th Street / Passyunk Avenue Interchange and the University Avenue Interchange, and between the City Avenue and the Belmont Avenue / Green Lane interchanges.

Year 2035 average operating speeds, and changes from the current condition, are tabulated in **Table 17** and illustrated in **Figure 26** (see page 55). Noteworthy decreases include:

- AM Peak Hour = eastbound between the Turnpike toll plaza and the US 202 / US 422 Interchange, and between US 1 South (City Avenue) and Montgomery Drive; and
- PM Peak Hour = eastbound between US 202 / US 422 Interchange and I-476, and between Montgomery Drive and Vine Street (I-676); and westbound between 26th Street / Passyunk Avenue and the Chestnut Street off-ramp, and between US 1 North (the Roosevelt Boulevard) and I-476.

The net effect, in either direction, is a reduction in average peak-hour operating speeds of 1–4 mph and about two additional minutes encountered to travel the length of the Expressway in 2035.

Assessment of the Year 2035 Operational Model

- Model structures built, loaded, integrated, and functioning at 15-minute intervals:
  - Expressway on- and off-ramps and mainline are within the regional model's sub-cut and are reacting to the influences of the regional travel demand model.
  - Off-line intersections were removed from the 2035 models (not in the VISUM sub-network and not directly linked with the regional model).
  - Service volumes at off-ramp touchdown points were modeled—assuming current traffic patterns and methods of traffic control—via parameter adjustments.

- Reasonable parameter adjustments were employed, maintaining the integrity of the computer program and the models for subsequent applications and future users.

- Key operational hour traffic volumes will increase by the Year 2035, but the increases will vary by time and location along the highway:
  - During the Midday Trough Hour, mainline volume will increase at relatively strong rates throughout the length of the Expressway.
  - During the AM Peak Hour, mainline volume rises at relatively strong rates, mostly at the ends of the Expressway.
  - During the PM Peak Hour, the heaviest traffic volume hour along the facility, about half of the forecasted daily rate of traffic growth can be accommodated along the Expressway's mainline. The growth will occur at the ends of the Expressway and westbound between Center City and City Avenue.

- Summary of Year 2035 operating performance measures (normalized spot speed and average operating speeds):
  - Midday Trough Hour speed indicators will remain on par with current 2010 conditions.
  - AM and PM Peak Hour spot speeds will decline an average of 1–2 mph versus current 2010 conditions.
  - AM and PM Peak Hour average operating speeds will decline 1–4 mph versus current 2010 conditions, and it will take an extra two minutes to travel end-to-end on the Expressway.

- Compiled speed statistics served two purposes: to help calibrate the models and to describe operating conditions along the Expressway. Monitoring locations for both were established based upon the data collection effort and availability. The operating speed and travel-time sampling segments were defined to serve multiple purposes, and existing INRIX data was aggregated to match those segments. The operating speed data, particularly travel times, provide a singular performance value for the facility, but the lengths of the segments may mask localized trouble spots. The spot-speed data (obtained from existing Traffic.com sensors and gleaned from the models) can help pinpoint the trouble spots.

- Inspection of the animations tells the complete story. Simplified, the most congested locations in 2035 will be:
  - AM Peak Hour = eastbound: from City Avenue to Montgomery Drive; and
  - PM Peak Hour = westbound: from the Vare Avenue / 34th Street on-ramp to the Chestnut Street off-ramp (**Figure 27**).

- Performance tabulations and animations were assessed and used to expand the set of candidate case studies for using the VISSIM models (**Appendix A-3**).

- Evaluate and adjust models and parameters, establish additional traffic data collection locations, add density as a performance statistic with which to measure conditions along the Expressway, and re-populate intersection turning movement traffic volumes for subsequent detailed applications.

Figure 27: I-76 and University Avenue Interchange – Year 2035 PM Peak Hour (VISSIM)

Westbound PM peak hour volume to and from seven closely-spaced ramps between Vare Avenue and Chestnut Street (including the University Avenue, shown) contributes to the slowest operating speeds along I-76 in 2035. (DVRPC)

Table 13: Changes in Eastbound Mainline and Ramp Traffic Forecasts – Year 2010 to Year 2035 (VISUM)

NewID2	EB/WB	EnterExit	Station	Interchange #	Interchange Name	EnterExitName	Weekday Total		7am-9am		9am-3pm		3pm-6pm		6pm-7am	
							Abs	%	Abs	%	Abs	%	Abs	%	Abs	%
5	EB	Enter		326	PA Turnpike (I-276)	Turnpike EB	*Link not in VISUM modeled subnetwork*									
10	EB	Enter		326	PA Turnpike (I-76)	Turnpike WB	*Link not in VISUM modeled subnetwork*									
15	EB	Mainline					*Link not in VISUM modeled subnetwork*									
20	EB	Exit		327	Gulph Road	North Gulph Rd WB	*Link not in VISUM modeled subnetwork*									
25	EB	Enter		327	Gulph Road	North Gulph Road (both)	20	0%	-9	-2%	11	1%	51	2%	-33	-1%
30	EB	Mainline	076805-7207				5,633	16%	720	10%	1,295	12%	987	13%	2,631	25%
35	EB	Exit		328	US 202 / US 422	US 202 SB / US 422 WB (total)	2,824	15%	312	7%	439	7%	1,187	37%	886	18%
50	EB	Enter		328	US 202 / US 422	US 202 SB	607	13%	114	39%	107	7%	103	9%	283	14%
55	EB	Exit		328	US 202 / US 422	US 202 NB	1,609	38%	4	0%	969	58%	16	2%	620	63%
60	EB	Enter	076810-7158	328	US 202 / US 422	US 202 NB / US 422 EB (total)	4,127	12%	397	10%	1,046	9%	281	4%	2,403	20%
75	EB	Mainline	076820-7129				5,937	11%	916	16%	1,041	6%	168	2%	3,812	20%
80	EB	Exit		330	Gulph Mills	South Gulph Road / PA 320 (both)	-35	-1%	83	7%	10	1%	43	5%	-171	-8%
85	EB	Enter		330	Gulph Mills	South Gulph Road / PA 320 (both)	228	2%	30	3%	557	22%	168	7%	-527	-15%
90	EB	Mainline	076835-7236				6,197	11%	863	15%	1,587	9%	291	2%	3,456	17%
95	EB	Exit		331	I-476 / Conshohocken	I-476 SB	6,176	35%	736	29%	1,030	16%	241	5%	4,169	118%
100	EB	Exit		331	I-476 / Conshohocken	I-476 NB / Conshohocken (total)	-204	-2%	112	7%	-118	-3%	142	6%	-340	-8%
115	EB	Enter		331	I-476 / Conshohocken	I-476 SB	5,350	33%	79	4%	1,312	21%	198	7%	3,761	74%
120	EB	Mainline	076840-7201	331	I-476 / Conshohocken		5,577	13%	93	3%	1,988	15%	108	1%	3,388	20%
125	EB	Enter		331	I-476 / Conshohocken	I-476 NB to I-76 EB	993	17%	162	28%	318	16%	82	6%	431	21%
140	EB	Mainline					6,571	14%	255	6%	2,306	15%	190	2%	3,820	20%
145	EB	Enter		332	Matsonford Rd / Conshohocken	Matsonford Rd / Conshohocken	-95	-1%	34	5%	-68	-3%	-14	-1%	-47	-2%
150	EB	Mainline	076845-7190				6,476	12%	289	6%	2,238	13%	176	2%	3,773	18%
155	EB	Enter		337	Gladwynne	Hollow Rd (both)	508	10%	134	12%	33	2%	173	17%	168	14%
160	EB	Mainline	076870-7155				6,982	12%	423	7%	2,271	12%	348	3%	3,940	17%
165	EB	Exit		338	Belmont Av / Green La	Belmont Av (both)	1,186	14%	140	16%	321	14%	148	9%	577	15%
170	EB	Enter		338	Belmont Av / Green La	Belmont Av (both)	57	1%	12	1%	38	2%	25	3%	-18	-1%
175	EB	Mainline	076880-7125				5,851	10%	295	5%	1,987	11%	225	2%	3,344	16%
180	EB	Exit		339	City Av	City Av NB	779	11%	265	26%	102	6%	289	13%	123	5%
185	EB	Exit		339	City Av	City Av SB	240	6%	36	6%	49	3%	-1	0%	156	14%
190	EB	Enter		339	City Av	City Av SB	231	2%	104	5%	103	3%	170	10%	-146	-3%
195	EB	Mainline	076895-7233				5,064	9%	98	2%	1,940	10%	107	1%	2,919	13%
205	EB	Exit		340B	Roosevelt Blvd	Roosevelt Blvd NB (to service road)	744	5%	205	8%	135	3%	42	1%	362	9%
220	EB	Enter		340B	City Av	City Av NB	3,647	68%	497	56%	14	0%	136	9%	3,000	
225	EB	Mainline			Roosevelt Blvd		7,967	16%	389	8%	1,821	10%	201	2%	5,556	29%
230	EB	Enter	001450-7747	340B	Roosevelt Blvd	Roosevelt Blvd SB	-548	-1%	88	2%	16	0%	261	3%	-913	-6%
235	EB	Mainline					7,420	8%	477	5%	1,837	6%	462	3%	4,644	13%
240	EB	Exit		341	Montgomery Dr	Montgomery Dr (both)	465	4%	45	3%	71	2%	140	6%	209	7%
245	EB	Enter		341	Montgomery Dr	Montgomery Dr (both)	-47	-1%	36	2%	20	1%	94	7%	-197	-7%
250	EB	Mainline					6,909	8%	467	4%	1,787	6%	417	3%	4,238	12%
255	EB	Exit		342	Girard Av	Girard Av (both)	884	13%	23	3%	187	10%	47	3%	627	24%
260	EB	Enter		342	Girard Av	Girard Av (both)	149	2%	118	11%	-6	0%	157	11%	-120	-4%

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Table 13: Changes in Eastbound Mainline and Ramp Traffic Forecasts – Year 2010 to Year 2035 (VISUM)

NewID2	EB/WB	EnterExit	Station	Interchange #	Interchange Name	EnterExitName	Weekday Total		7am-9am		9am-3pm		3pm-6pm		6pm-7am	
							Abs	%	Abs	%	Abs	%	Abs	%	Abs	%
265	EB	Mainline					6,175	7%	563	5%	1,594	6%	527	3%	3,491	10%
270	EB	Exit		343	Spring Garden St	Spring Garden St (both)	340	9%	105	23%	80	7%	37	6%	118	9%
275	EB	Mainline	076935-7123				5,835	7%	458	5%	1,513	6%	491	3%	3,373	10%
280	EB	Exit		344	Vine St / 30th St	30th St (service road)	602	9%	-81	-8%	275	12%	179	19%	229	9%
290	EB	Exit		344	Vine St / 30th St	Vine St EB	1.933	5%	-48	-1%	678	5%	112	2%	1,191	8%
300	EB	Enter		345	Vine St / 30th St	30th St / Vine St WB (service road)	86	1%	53	3%	-2	0%	238	10%	-203	-4%
305	EB	Mainline	076940-7242				3,388	6%	640	12%	559	4%	438	5%	1,751	8%
310	EB	Enter		345.5	Walnut St	Walnut St (WB) / Schuylkill Av (SB)	972	8%	345	29%	135	4%	216	7%	276	7%
315	EB	Exit		346A	South St	South Street (both)	-18	0%	37	3%	29	1%	50	4%	-134	-4%
320	EB	Enter		346A	South St	South St (both)	558	16%	385	109%	63	6%	74	7%	36	3%
325	EB	Mainline	076945-7225				4,936	8%	1,332	22%	728	5%	679	6%	2,197	9%
330	EB	Exit		346B	University Av	University Av / 34th St (both)	-282	-2%	13	1%	43	1%	46	3%	-384	-7%
335	EB	Mainline	076950-7137				5,216	11%	1,319	32%	684	6%	633	6%	2,580	14%
340	EB	Enter		346C	34th St	34th St / Wharton St (both)	276	2%	31	2%	257	6%	202	5%	-214	-4%
345	EB	Exit		346.5	Vare Av EB	Vare Av EB / 28th St	999	35%	590	118%	201	14%	208	24%	0	
360	EB	Enter		346.5	Vare Av EB	Vare Av EB	461	49%	30	41%	140	37%	291	60%	0	
365	EB	Mainline					4,954	8%	790	15%	879	6%	918	6%	2,367	10%
370	EB	Exit	291500-7151	347	Passyunk Av / 26th St	26th St	1,452	7%	363	13%	286	5%	-113	-2%	916	11%
375	EB	Exit		347	Passyunk Av / 26th St	Passyunk Av (both)	1,070	7%	153	13%	141	2%	158	6%	618	9%
380	EB	Mainline		347	Passyunk Av / 26th St		2,432	12%	272	23%	453	12%	873	13%	834	9%
385	EB	Enter		347	Passyunk Av / 26th St	Passyunk (both)	320	6%	14	2%	354	25%	75	6%	-123	-6%
390	EB	Mainline					2,753	10%	287	16%	808	16%	948	12%	710	6%
395	EB	Enter		348	Penrose Av	Penrose Av	571	8%	4	1%	555	28%	195	10%	-183	-8%
400	EB	Mainline					3,324	10%	290	12%	1,363	19%	1,143	11%	528	4%
405	EB	Exit		349	Broad St	Broad St (both)	3,062	88%	485	98%	57	6%	301	41%	2,219	169%
410	EB	Enter		349	Broad St	Broad St SB	485	16%	607	145%	-353	-26%	231	19%	0	
415	EB	Enter		349	Broad St	Broad St NB	333	24%	14	26%	359	112%	148	45%	-188	-26%
420	EB	Mainline					1,082	3%	427	17%	1,312	17%	1,222	11%	-1,879	-14%
425	EB	Exit		350	Packer Av	Packer Av (both) / S. Darien St	-359	-5%	218	28%	226	10%	147	11%	-950	-43%
430	EB	Enter		350	Packer Av	Packer Av (both) / S. Darien St	2,753	62%	260	81%	217	19%	110	10%	2,166	117%
435	EB	Mainline	076985-7161				4,193	13%	470	24%	1,302	19%	1,184	11%	1,237	10%
440	EB	Enter		351	I-95 / Front St	I-95 SB - to EB Walt Whitman Br	15,651	156%	717	90%	4,917	163%	312	11%	9,705	278%
470	EB	Enter		351	I-95 / Front St	I-95 NB - to EB Walt Whitman Br	3,694	27%	1,638	109%	946	23%	798	21%	312	7%
475	EB	Mainline			Walt Whitman Br	Walt Whitman Br EB	23,538	42%	2,826	66%	7,164	52%	2,294	13%	11,254	54%

Source: DVRPC

Table 14: Changes in Westbound Mainline and Ramp Traffic Forecasts – Year 2010 to Year 2035 (VISUM)

NewID2	EB/WB	EnterExit	Station	Interchange #	Interchange Name	EnterExitName	Weekday Total		7am-9am		9am-3pm		3pm-6pm		6pm-7am	
							Abs	%	Abs	%	Abs	%	Abs	%	Abs	%
480	WB	Mainline			Walt Whitman Br	Walt Whitman Br WB	6,293	11%	1,431	12%	2,004	12%	911	10%	1,947	10%
485	WB	Exit		351	I-95 / Front St	I-95 NB / SB & Front St (both)	4,706	17%	750	13%	1,464	17%	624	15%	1,868	22%
510	WB	Mainline	076990-7230				1,588	5%	681	12%	541	7%	286	6%	80	1%
515	WB	Exit		350	7th St	7th St (both)	21	1%	62	9%	-29	-3%	66	9%	-78	-5%
520	WB	Mainline					1,565	6%	618	12%	570	8%	220	5%	157	2%
525	WB	Exit		349	Broad St	Broad St (both)	544	8%	77	6%	175	9%	120	11%	172	8%
530	WB	Enter		349	Broad St	Broad St NB	470	8%	96	19%	5	0%	95	10%	274	12%
535	WB	Mainline					1,492	6%	638	15%	399	6%	195	5%	260	3%
540	WB	Exit		348	Penrose Av	Penrose Av	60	1%	7	1%	92	5%	30	3%	-69	-3%
545	WB	Mainline					1,429	8%	630	21%	307	6%	164	5%	328	4%
550	WB	Exit		347B	Passyunk Av	25th St SB	256	6%	86	14%	122	9%	46	7%	2	0%
555	WB	Mainline		347A	Passyunk Av		1,174	8%	546	23%	184	5%	118	5%	326	5%
560	WB	Enter		347A	Passyunk Av	Passyunk Av (both) / Oregon Av	584	3%	68	3%	190	3%	46	1%	280	4%
565	WB	Enter	291500-7151	347A	Passyunk Av	26th St	828	4%	-71	-2%	319	4%	78	2%	502	7%
570	WB	Mainline					2,589	5%	543	7%	695	4%	242	2%	1,109	6%
575	WB	Exit		346.5	Vare Av WB	Vare Av WB	306	4%	16	1%	37	2%	67	5%	186	10%
590	WB	Mainline	076950-7137				2,281	5%	527	9%	657	4%	175	2%	922	5%
595	WB	Exit		346	34th St	34th St	182	1%	137	9%	69	2%	72	3%	-96	-2%
605	WB	Enter		346	34th St	34th St / Vare Av	574	8%	69	5%	230	10%	23	2%	252	10%
610	WB	Mainline	076945-7225	346	University Av		2,677	6%	461	8%	818	6%	126	2%	1,272	8%
615	WB	Enter		346	University Av	University Av	1,295	11%	213	16%	617	15%	80	3%	385	9%
620	WB	Exit		346	South St	South St (both)	1	0%	23	3%	10	0%	47	7%	-79	-6%
625	WB	Enter		346	South St	South St (both)	967	12%	9	1%	512	19%	180	13%	266	9%
630	WB	Exit		345.5	30th St / Chestnut St	Chestnut EB / Schuylkill Av	268	4%	177	11%	-5	0%	57	6%	39	2%
635	WB	Exit		345	Vine St / 30th St	Vine St EB	466	3%	254	11%	103	2%	116	4%	-7	0%
640	WB	Mainline		345	Vine St / 30th St		4,203	12%	228	6%	1,840	18%	166	2%	1,969	15%
660	WB	Enter		345	Vine St / 30th St	30th St / I-76 wb service road	1,549	10%	24	1%	512	12%	79	2%	934	15%
665	WB	Enter		344	Vine St	Vine St WB	6,212	18%	960	23%	1,431	14%	1,083	18%	2,738	18%
670	WB	Mainline	076930-7171				11,964	14%	1,212	13%	3,783	15%	1,328	8%	5,641	17%
675	WB	Enter		343	Spring Garden St	Spring Garden St (both)	781	19%	26	6%	345	24%	115	16%	295	21%
680	WB	Mainline					12,745	14%	1,238	12%	4,128	16%	1,443	8%	5,936	17%
685	WB	Exit		342	Girard Av	34th St NB / Girard Av (both)	91	1%	111	9%	-36	-1%	67	6%	-51	-1%
690	WB	Mainline		342	Girard Av		12,653	16%	1,126	13%	4,163	18%	1,377	9%	5,987	19%
695	WB	Enter		342	Girard Av	Girard Av (both)	1,479	33%	106	27%	696	48%	176	16%	501	32%
700	WB	Mainline					14,131	17%	1,233	13%	4,859	20%	1,552	9%	6,487	19%
705	WB	Exit		341	Montgomery Dr	Montgomery Dr (both)	-306	-3%	77	4%	-173	-7%	-37	-2%	-173	-5%
710	WB	Enter		341	Montgomery Dr	Montgomery Dr (both)	3,189	46%	104	13%	1,595	74%	368	26%	1,122	44%
715	WB	Mainline	076905-7142				17,630	21%	1,262	15%	6,627	27%	1,958	12%	7,783	24%
720	WB	Exit		340B	US 1 - Roosevelt Blvd / City Av	City Av SB	237		0		237		0		0	
725	WB	Exit	001450-7747	340B	US 1 - Roosevelt Blvd / City Av	Roosevelt Blvd NB	-717	-2%	1,302	26%	-1,115	-9%	-28	0%	-876	-7%
730	WB	Mainline	076900-7169	340B			16,341	36%	-41	-1%	7,505	59%	217	2%	8,660	44%

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Table 14: Changes in Westbound Mainline and Ramp Traffic Forecasts – Year 2010 to Year 2035 (VISUM)

NewID2	EB/WB	EnterExit	Station	Interchange #	Interchange Name	EnterExitName	Weekday Total		7am-9am		9am-3pm		3pm-6pm		6pm-7am	
							Abs	%	Abs	%	Abs	%	Abs	%	Abs	%
735	WB	Enter		340B	US 1 - Roosevelt Blvd / City Av	City Av SB	237		0		237		0		0	
740	WB	Enter		340B	US 1 - Roosevelt Blvd / City Av	Roosevelt Blvd SB	-17,201	-51%	617	14%	-8,676	-77%	-3,463	-57%	-5,679	-49%
745	WB	Exit		340A	US 1 - Roosevelt Blvd / City Av	City Av NB	353	3%	81	7%	146	5%	-385	-12%	511	8%
750	WB	Mainline		340A	US 1 - Roosevelt Blvd / City Av		790	1%	495	8%	-1,080	-5%	-1,093	-8%	2,468	10%
755	WB	Exit		340A	US 1 - Roosevelt Blvd / City Av	City Av / US 1 SB	848	5%	186	8%	310	5%	78	2%	274	5%
760	WB	Enter		340A	US 1 - Roosevelt Blvd / City Av	City Av SB	4,214	59%	364	19%	1,775	91%	821	56%	1,254	69%
765	WB	Enter		340A	US 1 - Roosevelt Blvd / City Av	City Av / US 1 NB	2,946	56%	130	25%	1,450	86%	481	37%	885	51%
770	WB	Mainline	076885-7253				7,101	12%	803	12%	1,835	10%	130	1%	4,333	19%
775	WB	Exit		338	Belmont Av / Green La	Belmont Av / Green La (both)	491	8%	134	72%	156	9%	54	5%	147	5%
780	WB	Mainline		338	Belmont Av / Green La		6,608	12%	668	11%	1,680	10%	76	1%	4,184	21%
785	WB	Enter		338	Belmont Av / Green La	Belmont Av / Green La (both)	3,334	40%	315	16%	1,426	61%	652	54%	941	33%
790	WB	Mainline	076865-7252				9,944	16%	984	12%	3,106	16%	728	6%	5,126	22%
795	WB	Exit		337	Gladwynne	Hollow Rd (both)	74	2%	14	5%	-100	-9%	61	7%	99	7%
800	WB	Mainline	076845-7190				9,870	17%	970	12%	3,206	18%	667	6%	5,027	23%
805	WB	Exit		332	Matsonford Rd / Conshohocken	Conshohocken - Matsonford / PA 23 (both)	372	5%	10	1%	145	6%	28	3%	189	7%
810	WB	Mainline					9,497	18%	960	14%	3,061	19%	639	6%	4,837	25%
815	WB	Exit		331	I-476 / Conshohocken	I-476 NB	3,812	21%	142	9%	1,476	23%	82	2%	2,112	30%
820	WB	Mainline	076840-7201	331	I-476 / Conshohocken		5,684	17%	817	15%	1,585	17%	557	8%	2,725	23%
825	WB	Exit		331	I-476 / Conshohocken	I-476 SB	173	3%	24	3%	175	8%	227	22%	-253	-14%
830	WB	Enter		331	I-476 / Conshohocken	I-476 NB / Matsonford Rd (both)	7,542	35%	463	15%	1,837	26%	377	10%	4,865	67%
845	WB	Enter		331	I-476 / Conshohocken	I-476 SB - I-76 WB	1,809	22%	345	24%	535	18%	124	8%	805	34%
855	WB	Mainline	076835-7236				14,864	26%	1,602	17%	3,781	22%	832	7%	8,649	44%
860	WB	Exit		330	Gulph Mills	Balligomingo Rd (both)	-2,812	-33%	-4	0%	-526	-18%	-715	-53%	-1,567	-53%
865	WB	Mainline	076825-7234	330	Gulph Mills		17,675	36%	1,605	20%	4,307	30%	1,547	15%	10,216	61%
							—Ramp Closed (in 2011)—									
870	*WB*	*Enter*		*330*	*Gulph Mills*	*South Gulph Rd (both)*	*-4,487*	*-100%*	*-622*	*-100%*	*-1,639*	*-100%*	*-1,148*	*-100%*	*-1,078*	*-100%*
							—Changes computed: NewID2 #860, 2010 Forecasts vs. NewID2 #860 + #871, 2035 Forecasts—									
871	WB	Exit		329	King of Prussia / Norristown	Henderson / South Gulph Rd (both)	12,964	*119%*	1,728	*134%*	4,166	*124%*	1,348	*47%*	5,722	*140%*
							—Changes computed: NewID2 #870, 2010 Forecasts vs. NewID2 #872, 2035 Forecasts—									
872	WB	Enter		329	King of Prussia / Norristown	Henderson / South Gulph Rd (both)	5,724	*28%*	949	*53%*	1,802	*10%*	1,476	*29%*	1,497	*39%*
875	WB	Mainline					5,948	11%	205	2%	303	2%	527	5%	4,913	27%
878	WB	Exit	Express Lanes	328		Express Lanes to PA Turnpike										
880	WB	Exit	Collector-Distributor Lanes	328	US 202 / US 422	US 202 NB	985	18%	143	18%	388	20%	119	12%	335	19%
885	WB	Enter		328	US 202 / US 422	US 202 NB	6,172	39%	873	31%	2,722	101%	490	10%	2,087	40%
890	WB	Exit		328	US 202 / US 422	US 202 SB & US 422 WB (total)	5,932	17%	96	2%	1,655	17%	111	2%	4,070	31%
905	WB	Enter		328	US 202 / US 422	US 202 SB / North Gulph Rd SB	4,667	101%	1,126	200%	2,671	235%	12	1%	858	57%
910	WB	Collector Rd					8,876	36%	2,015	47%	3,319	56%	597	8%	2,945	44%
915	WB	Exit		327	Mall Blvd	Mall Blvd	-1,944	-44%	34	4%	-2,073	-100%	95	7%	0	
918	WB	Enter	Express Lanes	327		Express Lanes to PA Turnpike	993	11%	-49	-6%	333	13%	201	8%	508	17%
920	WB	Mainline	076800-7200	327	Mall Blvd		11,812	40%	1,932	45%	5,724	90%	703	8%	3,453	36%
925	WB	Enter		327	Mall Blvd	Mall Blvd	*Link not in VISUM modeled subnetwork*									
930	WB	Enter		327	Pulaski Dr	Pulaski Dr (both)	*Link not in VISUM modeled subnetwork*									
935	WB	Mainline					*Link not in VISUM modeled subnetwork*									
940	WB	Exit		326	PA Turnpike (I-76)	Turnpike WB	*Link not in VISUM modeled subnetwork*									
945	WB	Exit		326	PA Turnpike (I-276)	Turnpike EB	*Link not in VISUM modeled subnetwork*									

Source: DVRPC

Table 15: Changes in Key Operating Hour Mainline Traffic Volumes (Current 2010 to Year 2035)

NewID2	EB/WB	Description	AM Peak Hour		Midday Trough Hour		PM Peak Hour	
			Abs	%	Abs	%	Abs	%
15	EB	PA Turnpike to North Gulph Rd	856	21%	222	13%	399	18%
30	EB	North Gulph Rd to US 202 / US 422	837	24%	254	15%	403	16%
75	EB	US 202 / US 422 to Gulph Mills	642	21%	209	8%	145	4%
90	EB	Gulph Mills to I-476 / Conshohocken	526	17%	339	13%	117	3%
120	EB	Within the I-476 / Conshohocken Interchange	17	1%	371	17%	68	3%
140	EB	I-476 to Conshohocken	105	5%	426	17%	57	2%
150	EB	Conshohocken to Gladwynne	270	10%	503	18%	-27	-1%
160	EB	Gladwynne to Belmont Av / Green La	234	7%	426	14%	45	1%
175	EB	Belmont Av / Green Lane to City Av	114	3%	239	8%	-120	-3%
195	EB	City Av to Roosevelt Blvd	238	6%	344	11%	-64	-2%
225	EB	Within the Roosevelt Blvd Interchange	-332	-11%	119	4%	11	0%
235	EB	Roosevelt Blvd to Montgomery Dr	-132	-2%	130	3%	93	2%
250	EB	Montgomery Dr to Girard Av	-617	-11%	246	5%	116	2%
265	EB	Girard Av to Spring Garden St	-417	-7%	292	6%	165	3%
275	EB	Spring Garden St to Vine St / 30th St	-17	0%	73	2%	-8	0%
305	EB	Vine St / 30th St to Walnut St	295	10%	10	0%	-66	-2%
325	EB	South St to University Av	1,322	43%	74	3%	61	1%
335	EB	University Av to 34th St	1,141	54%	103	6%	225	7%
365	EB	Vare Av to Passyunk Av / 26th St	1,004	38%	140	6%	406	9%
380	EB	Within the Passyunk Av / 26th St Interchange	311	56%	113	23%	471	23%
390	EB	Passyunk Av / 26th St to Penrose Av	305	33%	173	26%	492	20%
400	EB	Penrose Av to Broad St	302	24%	275	28%	539	16%
420	EB	Broad St to Packer Av	209	16%	268	24%	571	16%
435	EB	Packer Av to I-95 / Front St	223	22%	245	26%	332	9%
475	EB	To Walt Whitman Br	1,394	64%	1,117	55%	198	3%
480	WB	From Walt Whitman Br	1,110	20%	289	10%	317	10%
510	WB	I-95 / Front St to 7th St	1,362	47%	114	8%	275	16%
520	WB	7th St to Broad St	1,234	49%	107	9%	239	16%
535	WB	Broad St to Penrose Av	976	45%	84	7%	237	16%
545	WB	Penrose Av to Passyunk Av / 26th St	825	53%	-8	-1%	166	15%
555	WB	Within the Passyunk Av / 26th St Interchange	678	56%	-70	-10%	114	13%
570	WB	Passyunk Av / 26th St to Vare Av	661	16%	-61	-2%	-229	-6%
590	WB	Vare Av to 34th St	290	9%	69	3%	142	5%
610	WB	34th St to University Av	127	4%	14	1%	-47	-2%
640	WB	Within the Vine St / 30th St Interchange	-256	-11%	241	15%	164	7%
670	WB	Vine St to Spring Garden St	271	5%	72	2%	899	18%
680	WB	Spring Garden St to Girard Av	180	3%	-156	-4%	842	16%
690	WB	Within the Girard Av Interchange	133	3%	-183	-5%	769	16%
700	WB	Girard Av to Montgomery Dr	157	3%	-83	-2%	818	16%
715	WB	Montgomery Dr to Roosevelt Blvd	413	9%	842	25%	746	14%
730	WB	Within the Roosevelt Blvd Interchange	402	36%	1,041	62%	1,111	43%
750	WB	Roosevelt Blvd to City Av	-368	-11%	-580	-17%	-226	-5%
770	WB	City Av to Belmont Av / Green La	105	3%	-62	-2%	-99	-2%
780	WB	Within the Belmont Av / Green La Interchange	52	2%	-5	0%	-25	-1%
790	WB	Belmont Av / Green La to Gladwynne	-148	-3%	308	11%	102	2%
800	WB	Gladwynne to Conshohocken	4	0%	227	8%	184	5%
810	WB	Conshohocken to I-476	258	8%	-41	-2%	254	7%
820	WB	Within the I-476 / Conshohocken Interchange	-58	-2%	29	2%	237	10%
855	WB	I-476 / Conshohocken to Gulph Mills	-269	-6%	-264	-10%	-452	-11%
865	WB	Within the Gulph Mills Interchange	-88	-2%	36	2%	265	8%
875	WB	King of Prussia / Norristown to US 202 / US 422	-293	-7%	-452	-18%	-1	0%
920	WB	Within the Mall Blvd Interchange	382	17%	903	98%	167	5%
935	WB	Pulaski Dr to PA Turnpike	480	20%	867	80%	87	2%

Source: DVRPC

Table 16: Hourly Spot Speed (Current 2010 to Year 2035)

			Current 2010 (actual mph, Traffic.com)			2010 Modeled (modeled mph, VISSIM)			% Change (vs, actual)			2035 Modeled (modeled mph, VISSIM)			% Change (2010-2035 modeled)			Year 2035 (mph)		
NewID2	EB/WB	Mainline Location	AM	MD	PM	AM	MD	PM	AM	MD	PM	AM	MD	PM	AM	MD	PM	AM	MD	PM
30	EB	N Gulph Rd - US 202 / US 422	35	41	42	38	48	42	9%	16%	-1%	38	48	42	0%	0%	-1%	35	41	42
75	EB	US 202 / US 422 - Gulph Mills	54	55	56	52	58	55	-5%	5%	-3%	51	58	55	-1%	0%	0%	54	55	56
90	EB	Gulph Mills - I-476 / Conshohocken	52	60	58	56	62	55	8%	4%	-5%	54	62	55	-3%	1%	0%	50	60	57
120	EB	Within the I-476 / Conshohocken Int.	18	54	17	40	56	48	117%	5%	176%	40	56	38	0%	-1%	-20%	18	53	14
150	EB	Conshohocken - Gladwynne	41	61	49	47	62	50	16%	1%	3%	47	61	37	0%	0%	-27%	41	61	36
160	EB	Gladwynne - Belmont Av / Green La	49	58	54	49	56	57	1%	-4%	6%	49	56	57	0%	0%	0%	49	58	54
175	EB	Belmont Av / Green La - City Av	53	59	60	55	61	55	4%	2%	-8%	55	60	58	0%	0%	6%	53	59	63
195	EB	City Av - Roosevelt Blvd	46	51	50	49	51	51	6%	0%	2%	44	50	51	-10%	-1%	0%	41	50	50
235	EB	Roosevelt Blvd - Montgomery Dr	29	51	39	44	50	42	54%	-1%	7%	34	50	42	-25%	-1%	0%	22	50	39
250	EB	Montgomery Dr - Girard Av	45	48	39	48	49	39	8%	3%	0%	48	49	42	0%	0%	9%	45	48	42
265	EB	Girard Av - Spring Garden St	46	52	36	51	53	39	10%	3%	6%	51	53	37	1%	0%	-5%	47	52	34
275	EB	Spring Garden St - Vine St / 30th St	51	53	36	53	54	39	4%	2%	9%	53	54	38	-1%	-1%	-2%	51	53	35
305	EB	Vine St / 30th St - Walnut St	47	48	16	53	50	33	12%	3%	100%	52	49	33	-2%	-1%	-1%	46	48	16
325	EB	South St - University Av	62	53	49	57	56	47	-7%	6%	-3%	51	56	46	-12%	0%	-2%	54	53	48
335	EB	University Av - 34th St	56	54	52	55	56	52	-3%	2%	0%	54	56	52	-1%	0%	0%	56	54	52
365	EB	Vare Av - Passyunk / 26th St	53	47	48	52	47	47	0%	0%	-1%	52	47	47	-1%	0%	0%	52	47	48
390	EB	Passyunk Av / 26th St - Penrose Av	54	54	55	53	55	55	-2%	2%	0%	53	55	55	0%	0%	0%	54	54	55
420	EB	Broad St - Packer Av	53	52	56	53	54	56	0%	3%	0%	53	54	56	0%	0%	-1%	53	52	56
435	EB	Packer Av - I-95 / Front St	56	55	58	51	54	56	-8%	-2%	-2%	50	54	56	-2%	0%	0%	55	55	57
510	WB	I-95 / Front St - 7th St	57	54	56	53	54	55	-6%	0%	-1%	53	54	55	0%	0%	0%	57	54	56
520	WB	7th St - Broad St	56	54	56	55	56	56	-2%	2%	1%	55	56	56	0%	0%	0%	56	54	56
545	WB	Penrose Av - Passyunk Av	60	57	62	58	60	62	-3%	5%	0%	58	59	62	0%	0%	0%	59	57	62
570	WB	Passyunk Av - Vare Av	50	50	53	49	51	47	-1%	1%	-11%	50	51	37	1%	1%	-21%	50	51	42
590	WB	Vare Av - 34th St	45	54	55	44	53	38	-2%	-2%	-32%	44	54	27	-2%	2%	-29%	44	55	39
610	WB	34 St - University Av	33	39	29	34	42	24	4%	7%	-19%	29	42	19	-16%	0%	-21%	27	39	23
640	WB	Vine St WB-off - 30th St WB-on	58	58	55	56	49	52	-3%	-16%	-7%	56	49	52	0%	0%	0%	58	58	55
670	WB	Vine St - Spring Garden St	61	57	56	60	56	54	-2%	-3%	-4%	60	55	54	-1%	0%	0%	61	57	56
680	WB	Spring Garden St - Girard Av	58	55	55	56	55	55	-3%	0%	1%	56	55	55	0%	0%	0%	58	55	55
690	WB	Within the Girard Av Int.	55	56	50	57	55	49	2%	-1%	-2%	56	55	49	0%	0%	0%	55	56	50
700	WB	Girard Av - Montgomery Dr	50	54	50	35	54	50	-30%	1%	0%	38	54	50	9%	0%	0%	55	54	50
715	WB	Montgomery Dr - Roosevelt Blvd	47	44	48	44	50	47	-6%	13%	-1%	44	50	47	0%	0%	0%	47	44	48
730	WB	Roosevelt Blvd - City Av	49	61	48	49	55	43	1%	-10%	-10%	49	56	43	0%	3%	0%	49	62	48
770	WB	City Av - Belmont Av / Green La	33	57	44	45	56	42	38%	-2%	-4%	45	54	31	-1%	-3%	-27%	33	56	32
780	WB	Within Belmont Av / Green La Int.	34	60	49	44	60	50	30%	1%	2%	43	60	50	-2%	0%	0%	33	60	49
790	WB	Belmont Av / Green La - Gladwynne	53	58	56	54	61	52	2%	4%	-6%	54	61	52	0%	0%	0%	53	58	56
800	WB	Gladwynne - Conshohocken	47	59	40	51	59	45	9%	0%	13%	50	58	45	-1%	0%	0%	46	58	40
820	WB	Within I-476 Interchange	59	59	56	59	58	56	-1%	-1%	-1%	58	58	55	-1%	0%	0%	59	58	56
855	WB	I-476 - Gulph Mills	59	57	56	50	58	55	-15%	2%	-1%	50	58	55	0%	0%	0%	59	57	56
865	WB	Within Gulph Mills Int.	57	64	60	57	64	59	0%	-1%	-1%	57	64	59	0%	0%	-1%	57	64	60
875	WB	Gulph Mills - US 202 / US 422	56	63	56	58	62	51	4%	-1%	-10%	58	49	46	0%	-22%	-9%	56	49	51
920	WB	Within Mall Blvd Int.	49	48	47	49	50	43	-1%	4%	-7%	49	42	41	-1%	-17%	-4%	49	40	45

Source: DVRPC

Table 17: Average Operating Speed (Current 2010 to Year 2035)

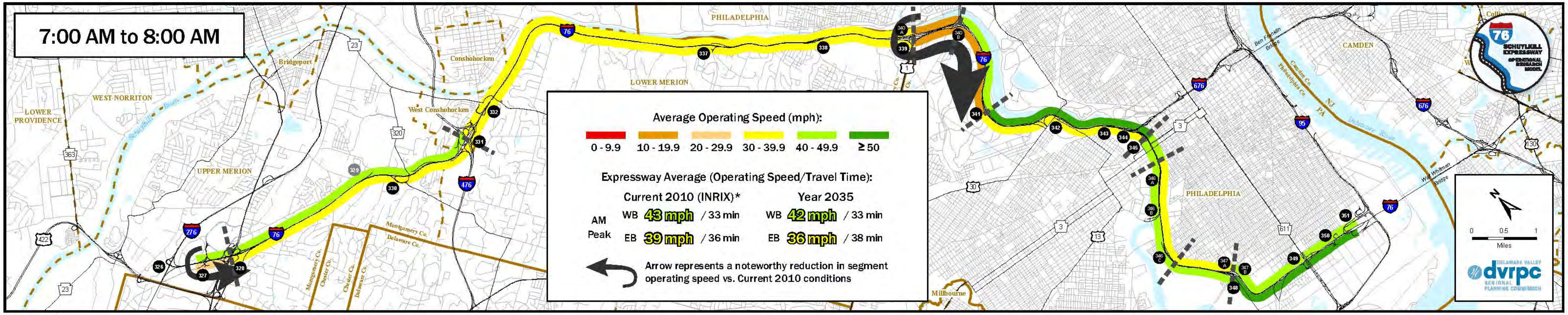
Travel Direction	Description	Length (mi)	Current 2010 Operating Speed (actual mph, INRIX)			2010 Modeled Operating Speed (modeled mph, VISSIM)			% Change (Current to Modeled)			2035 Modeled Operating Speed (modeled mph, VISSIM)			% Change (Modeled to Modeled)			Year 2035 Operating Speed (mph)		
			AM	MD	PM	AM	MD	PM	AM	MD	PM	AM	MD	PM	AM	MD	PM	AM	MD	PM
EASTBOUND	PA Turnpike Toll to US-202	0.56	30	42	33	30	37	34	-1%	-11%	5%	28	37	34	-4%	-1%	-1%	29	42	32
	US 202 to I-476	4.21	38	55	31	49	56	41	28%	2%	30%	49	56	38	-1%	0%	-8%	38	55	29
	I-476 to US-1 South	8.00	35	51	38	45	55	49	29%	7%	28%	45	54	45	0%	0%	-8%	35	51	35
	US-1 South to US-1 North	0.74	39	50	42	53	54	54	34%	7%	31%	23	54	54	-57%	0%	0%	17	50	41
	US-1 North to Montgomery Dr	1.52	31	48	35	40	50	42	29%	3%	19%	13	49	41	-67%	0%	-1%	10	48	35
	Montgomery Dr to I-676	2.64	39	45	25	47	49	39	21%	11%	60%	47	49	32	0%	-1%	-19%	39	44	20
	30th St to Chestnut St	0.46	43	47	32	52	49	34	21%	6%	7%	51	49	34	-1%	0%	0%	43	46	32
	Chestnut St to 34th St	1.66	47	49	39	55	53	41	17%	9%	7%	47	53	40	-15%	0%	-4%	40	48	37
	34th St to 26th/Passyunk	0.91	50	51	48	55	52	48	9%	1%	0%	54	52	46	-1%	0%	-4%	50	51	46
	26th/Passyunk to WW Br Toll	2.35	50	52	51	54	51	53	6%	-1%	3%	53	52	53	0%	0%	0%	50	52	51
WESTBOUND	WW Br Toll to 26th/Passyunk	2.42	49	49	49	53	55	56	7%	11%	12%	53	55	56	0%	0%	1%	49	50	50
	26th/Passyunk to 34th St	0.93	37	46	45	48	51	53	29%	9%	17%	48	51	44	-1%	0%	-17%	37	46	37
	34th St. to Chestnut St	1.64	34	44	26	39	47	38	14%	8%	44%	36	47	13	-7%	0%	-65%	32	44	9
	Chestnut St to 30th St	0.38	43	46	34	46	42	38	7%	-10%	13%	46	42	38	0%	-1%	0%	43	46	34
	I-676 to Montgomery Dr	2.72	51	49	41	55	55	52	7%	13%	28%	53	55	52	-3%	0%	0%	50	49	41
	Montgomery Dr to US-1 North	1.54	44	54	39	45	51	47	3%	-6%	20%	45	51	47	0%	0%	0%	43	54	39
	US-1 North to US-1 South	0.74	16	50	21	50	48	43	214%	-3%	103%	50	60	26	0%	23%	-40%	16	61	13
	US-1 South to I-476	7.99	39	55	41	50	60	49	28%	10%	20%	49	60	44	-1%	0%	-11%	38	55	36
	I-476 to US 202	4.22	50	55	48	55	62	54	10%	13%	13%	54	62	54	-2%	0%	1%	49	55	48
	US-202 to PA Turnpike Toll	0.52	48	48	44	52	55	49	7%	13%	12%	46	54	47	-10%	-1%	-4%	43	48	42

Notes:
Speeds rounded to nearest whole number
Operating speed estimated from adjacent segments

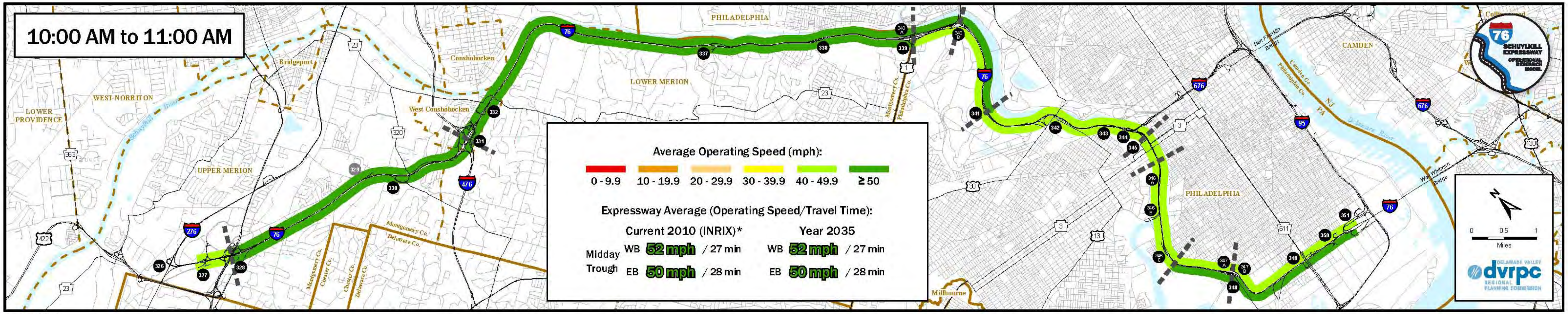
Source: DVRPC

Year 2035 Operating Speed along I-76 (AM Peak, Midday Trough, PM Peak)

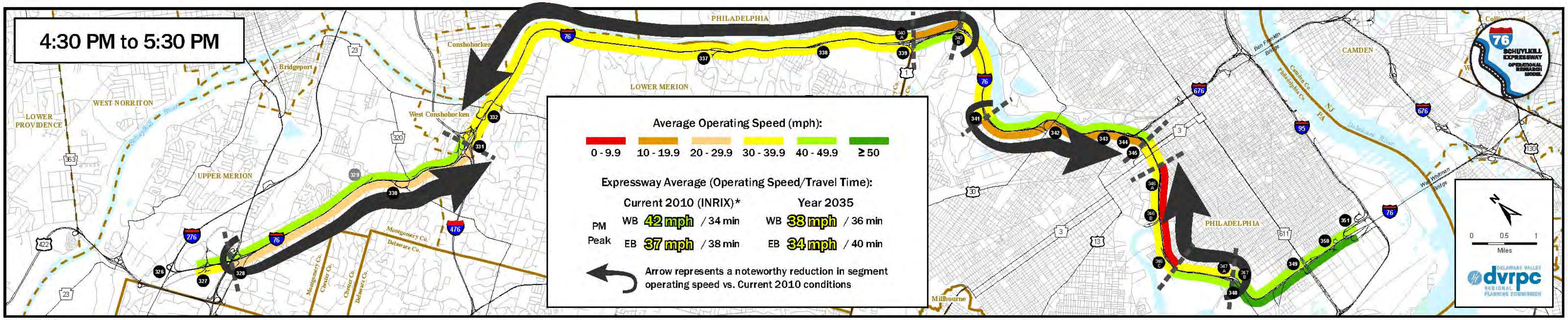
Figure 26



Source: DVRPC



Source: DVRPC



Source: DVRPC

CONCLUSION:

PennDOT commissioned DVRPC to construct a powerful computer model capable of simulating, visualizing, and assessing traffic conditions along the Schuylkill Expressway (I-76) to use as a practical research tool. The tool can be used to determine the effects of growth, predict outcomes of changes to the Expressway's infrastructure, judge the merits of competing designs, develop maintenance and protection of traffic plans, and develop congestion management plans for improvement projects.

DVRPC conducted its first application of integrated regional travel demand forecasting and traffic operations modeling. The work was prepared for the 23-mile long Schuylkill Expressway (I-76) and used DVRPC's new platform for transportation modeling, PTV Vision Inc.'s VISUM and VISSIM modeling suite. The east-west highway traverses the heart of the region and has approximately 23 interchanges and about 100 ramps (50 in each direction) en route. The modeled network replicates the existing physical and regulatory environment of the highway and incorporates 36 at-grade intersections that impact or may impact mainline traffic operations. Dedicated engagement and artistry by staff also supplied the Expressway's traffic demand elements: replicating current 2010 volumes (within +/- 5 percent) and forecasting for a Year 2035 Long-Range Plan scenario.

The 30-month long project involved a substantial data collection effort that benefitted from PennDOT's investments in electronic surveillance and data collection technologies present along the Expressway (i.e., Traffic.com sensors, *E-ZPass* detectors, cameras, and the INRIX VPP Suite). The project also benefited from a successful blending of talented DVRPC staff members to learn and master the new software, build and integrate the models, manage the data, and interpret and present the information. PennDOT District 6-0 staff was very supportive, and their direct assistance was provided in a few important circumstances. Finally, the project benefited from the insights and contributions of a set of interested stakeholders that met six times to help guide the project. All of these things were necessary to produce and deliver models with integrity and value and to meet PennDOT's specifications.

Significantly, DVRPC developed an off-line interface methodology to maintain the link between the regional model (VISUM) and the operational model (VISSIM) and accommodate continuous 15-minute interval traffic data in the dynamic operations model, between 7:00 AM and 6:00 PM. This level of specificity—requested by PennDOT and well warranted along a highway that peaks at incrementally different times and locations, in both directions—was not provided in the capability of the software's design.

Additionally, staff built an off-line querying tool to automate simple listings of actual volume and spot-speed data and modeled outputs of volume and spot-speed data without the need for the computer programs or an ability to use them. Together, the tool and the project database can help decision makers and analysts identify locations where significant performance changes are indicated as a result of regional growth or as a consequence of improvements modeled along the Expressway. Neither off-line tool was envisioned in the original work program.

In addition to PennDOT's original reasons for seeking the models, the technical and committee work helped identify other applications for the models—deriving more value from the project.

In the end, DVRPC staff built, loaded, and integrated a functioning regional demand and operational model as specified. Reasonable parameter adjustments were applied to calibrate the Year 2010 models, maintaining the integrity of the models for forecasting the project's Year 2035 scenario, and for future applications. In subsequent local studies it is recommended that parameters reflecting driver behavior characteristics be adjusted to fine-tune the models, that more data collection points be established along the modeled network, and that density (vehicles/mile/lane) be added as a modeled performance statistic for measuring change along the Expressway.

The computer simulations and animations tell and show the complete story, but if all things come to pass in the Year 2035:

- There will be 6.1 million residents in the Delaware Valley Region (a 9-percent increase over 2010 levels).
- Daily traffic activity will rise by 13 percent along the Schuylkill Expressway. Volumes will exceed 130,000 vehicles per day in Montgomery County and 197,000 near Center City (increases on the order of 10–11 percent versus 2010 levels).
- PM Peak Hour volumes will increase at half of the daily rate because of capacity limitations along the highway.
- PM Peak Hour speeds will decline 3–4 mph and, without incident, it will take two minutes longer to travel end-to-end on the Expressway than it did in 2010.

PennDOT has directed that the modeling tools be made available to member agencies for local applications, and that DVRPC be responsible for administering and maintaining the models.

APPENDICES—POTENTIAL USES OF THE MODELS:

POTENTIAL USES OF THE MODELS:

The prepared models are powerful, complex, and useful but have their limitations.

On the simplest levels, the graphic and animated products of VISUM and VISSIM can be analyzed through visual inspection. Dynamic data from the loaded models can be collected along the modeled networks to measure, contrast, and evaluate changes in performance between current conditions (2010) and modeled scenarios (Year 2010 and Year 2035), and for before and after studies.

Ideas for applying the models emanated through research, conversations with the Steering Committee, and the experiences of DVRPC staff building the models. They have been inventoried to supply PennDOT and our regional planning partners with the benefits of the information. At the conclusion of the project, DVRPC performed and reported on a rudimentary application as a test case of the delivered operational model, and PennDOT directed that the modeling tools be made available to member agencies for local applications.

Deeper applications may require broadening the modeled network, performing traffic counts and model calibration or adjusting the regional model's parameters to accommodate strategies that promote changes in travel behavior (e.g., mode choice, pricing). All necessary modules have been provided.

DVRPC is mandated to conduct Congestion Management Process (CMP) planning in the region. The CMP identifies approved strategies that should be examined in place of, or complementary with, improvement projects that promote the mobility of single-occupancy vehicles (SOVs).

A-1 PERFORMANCE MEASUREMENTS

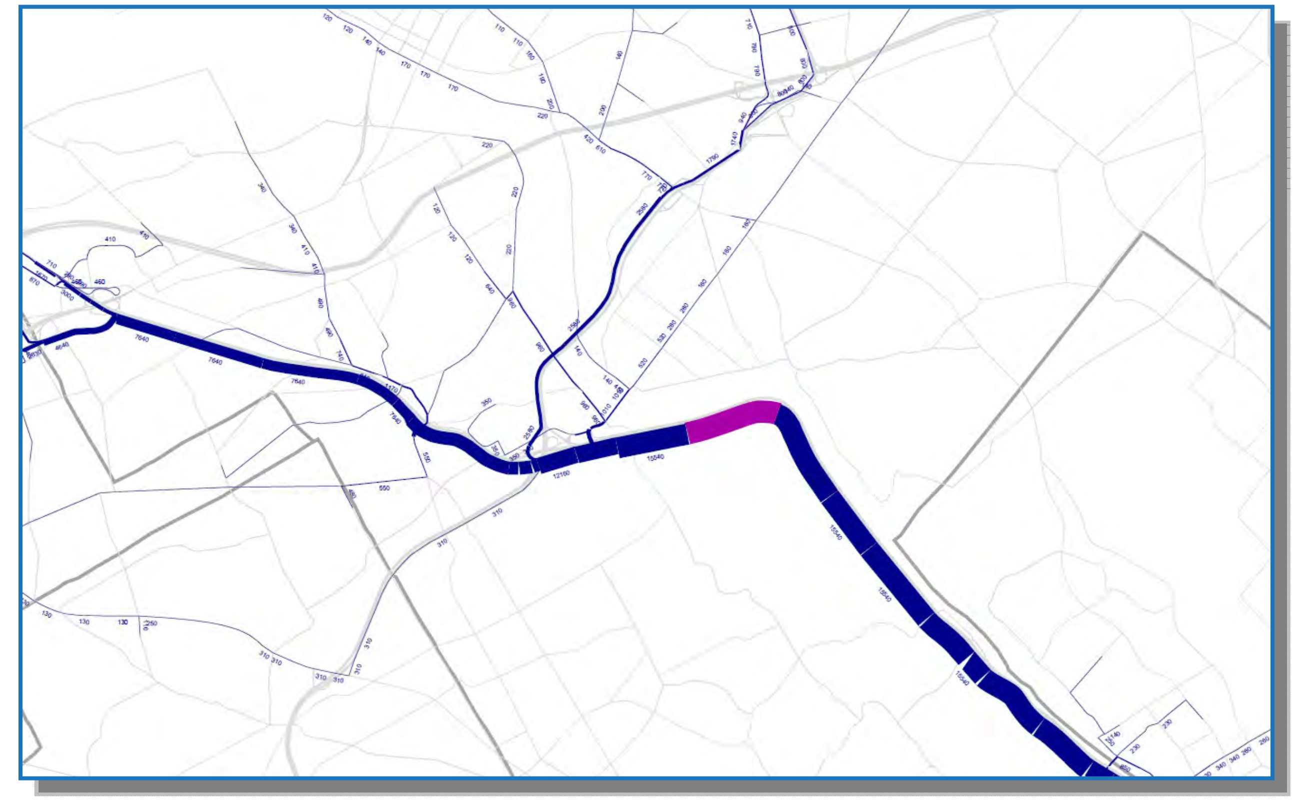
Visual inspection of the VISUM-generated graphics and VISSIM animations can supply an impression of the functionality of traffic within, or change between, scenarios. More rigorously, statistics can be gleaned through evaluations of the loaded networks provided through the software packages.

Performance statistics and measurements available through the programs include:

- VISUM
  - traffic volumes by time period (Daily, AM, Midday, PM and Nighttime);
  - vehicle miles of travel and vehicle hours of travel;
  - select link analyses: region-wide and ramp-to-ramp; and
  - origins and destinations.

- VISSIM
  - analysis period, selected hour, and 15-minute interval traffic volumes (AM / Midday / PM);
  - spot speeds;
  - travel times and operating speeds;
  - delays;
  - stops;
  - queues;
  - duration of congestion;
  - density;
  - throughput;
  - emissions;
  - intersection level of service;
  - speed and volume charts;
  - 2-D animations; and
  - 3-D animations.

As part of the project, DVRPC staff prepared a straightforward, high-level tool (**Compare.mdb**) to facilitate comparisons of data obtained through the data collection effort with datasets emanating from the delivered models. Time-period traffic volume queries are available for the VISUM networks. Traffic volume and spot-speed inquiries are available for the VISSIM networks for selected time intervals and locations. Documentation for **Compare.mdb** is provided in the **USER'S GUIDE**.



VISUM's select link procedure can be helpful in determining construction zone management practices and planning alternate routes or services for mitigation. Shown: eastbound in the AM Peak Period at the Conshohocken Curve. (DVRPC)

A-2 POTENTIAL APPLICATIONS

DVRPC staff built the VISUM and VISSIM models for a specific function: to supply a Schuylkill Expressway-level operational model consistent with current conditions (2010) and those conditions reflected in DVRPC's official Long-Range Plan for the region (2035).

The delivered model structures can serve as a tool for operational examinations or applications along the Expressway's mainline, ramps, and key intersection network (2010 only), or can be built upon for more detailed or broader-based studies that may be required in the future. To support that eventuality, all data and program files produced through the project, including the regional models and their loaded Nighttime networks, have been provided to PennDOT.

Opportunities presented by the model structures (delivered or potential) are described below:

- The following explorations can be performed with the delivered travel models:
  - effects of regional growth (limited to 2010 and the 2035 Long-Range Plan scenario);
  - merging and weaving sections;
  - lane-changing behavior at off-ramps, lane-drops, and lane-additions;
  - limited widening for auxiliary lanes;
  - improved geometry or other spot improvements;
  - toll plaza operations;
  - ramp metering and other transportation systems management schemes; and
  - incidents and work zones.

- Adjustments to the VISUM model's regional trip tables may be necessary to evaluate:
  - special events;
  - interchange relocation or reconfiguration;
  - ramp closures; and
  - minor widening along the mainline.

- Adjustments to the VISUM model's regional trip tables are necessary to evaluate:
  - toll pricing strategies;
  - enhanced transit service, ridesharing, and high-occupancy vehicle (HOV) strategies;
  - travel demand management (TDM) strategies and special events;
  - new interchange(s);
  - major land use changes or revised regional population and employment forecasts;
  - significant highway capacity changes; and
  - interim year analyses (i.e., for Year 2015, Year 2020, Year 2025, or Year 2030 forecasts).

- If broad-area corridor studies are envisioned, an expanded off-Expressway network (including multi-modal transportation options) needs to be added to the prepared VISSIM model, and VISUM-VISSIM re-executed.

- A rudimentary application using the VISSIM models (as developed) was selected by the project's Steering Committee and performed by staff as a test case. The results were reported at the final project meeting.

A-3 EXAMPLE CASE STUDIES

Candidate investigations using the VISSIM models were identified during the course of the project. The following list is representative of the ideas generated by Steering Committee members and DVRPC staff. It is not an exhaustive list. Some of the suggestions were intended expressly as test cases for the deliverable. Others were meant as serious applications of the models to explore regional interests, conditions along the Expressway where current problems were identified, or a location where a significant change in performance was forecasted by the Year 2035. Some of the studies may have been performed previously by alternate means, and some would require enhancements to the delivered models.

- Suggestions arranged by modeling level of effort within Long-Range Plan project categories:

System Maintenance

1. Re-stripe diverging westbound mainline lanes to favor the Collector-Distributor road through the US 202 / US 422 Interchange versus the Express lanes leading to the Turnpike toll plaza.
2. Minor widening at the top of the eastbound off-ramp to Arch Street (at 30th Street Station) to allow dual right-turning movements. [Case study performed and reported to Steering Committee on June 22, 2012.]
3. Signalize the Montgomery Drive Interchange eastbound ramps.
4. Close an off-ramp from the Expressway for maintenance.
5. Westbound ramp metering from 26th Street / Passyunk Avenue to South Street during the 2035 PM Peak.
6. Traffic management during the $140 million Walt Whitman Bridge re-decking project (being constructed one lane at a time, to last through 2014).
7. Traffic management and mitigation during an I-76 reconstruction project between University Avenue and Vine Street.

I-76's westbound lanes, adjacent to Center City, are built on pilings which also support the "30th Street deck." Eventual replacement is a concern to PennDOT. (DVRPC)

Concept of the westbound I-76 transition (one-quarter mile), favoring heavier US 202 / US 422 collector-distributor roadway volume versus the express lanes to the Turnpike. (DVRPC)

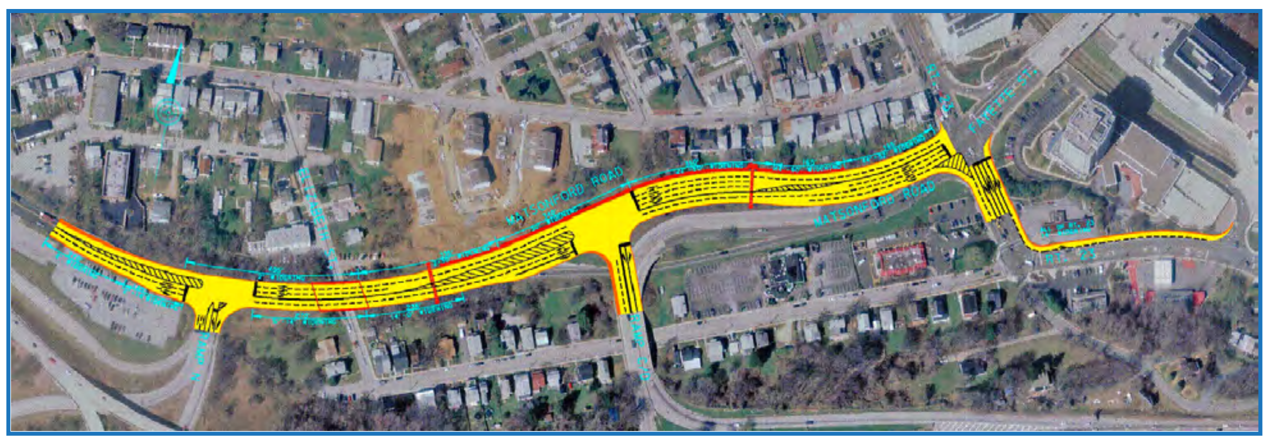
Operational Improvement

1. Transit operations: Use the model to understand work zone effects on regular travel times, for scheduling purposes; and/or to test the effects of non-recurring incidents—when, where and whether to stay on the Expressway or divert to alternate highways to provide the most reliable service.
2. Transit options in the corridor: Evaluate service and park-and-ride lot improvements along existing parallel passenger rail lines.
3. Evaluate employer trip reduction programs in jobs-rich growth centers like King of Prussia at the western end of the Expressway and the Philadelphia Naval Business Center at the eastern end.
4. Special-events planning for the redeveloping South Philadelphia Sports Complex.
5. Evaluate all electronic toll collection at the Valley Forge Interchange.
6. Evaluate converting traditional *E-ZPass* or cash lanes to EXPRESS *E-ZPass* lanes at the Walt Whitman Bridge toll plaza.
7. Evaluate tolling the Expressway.

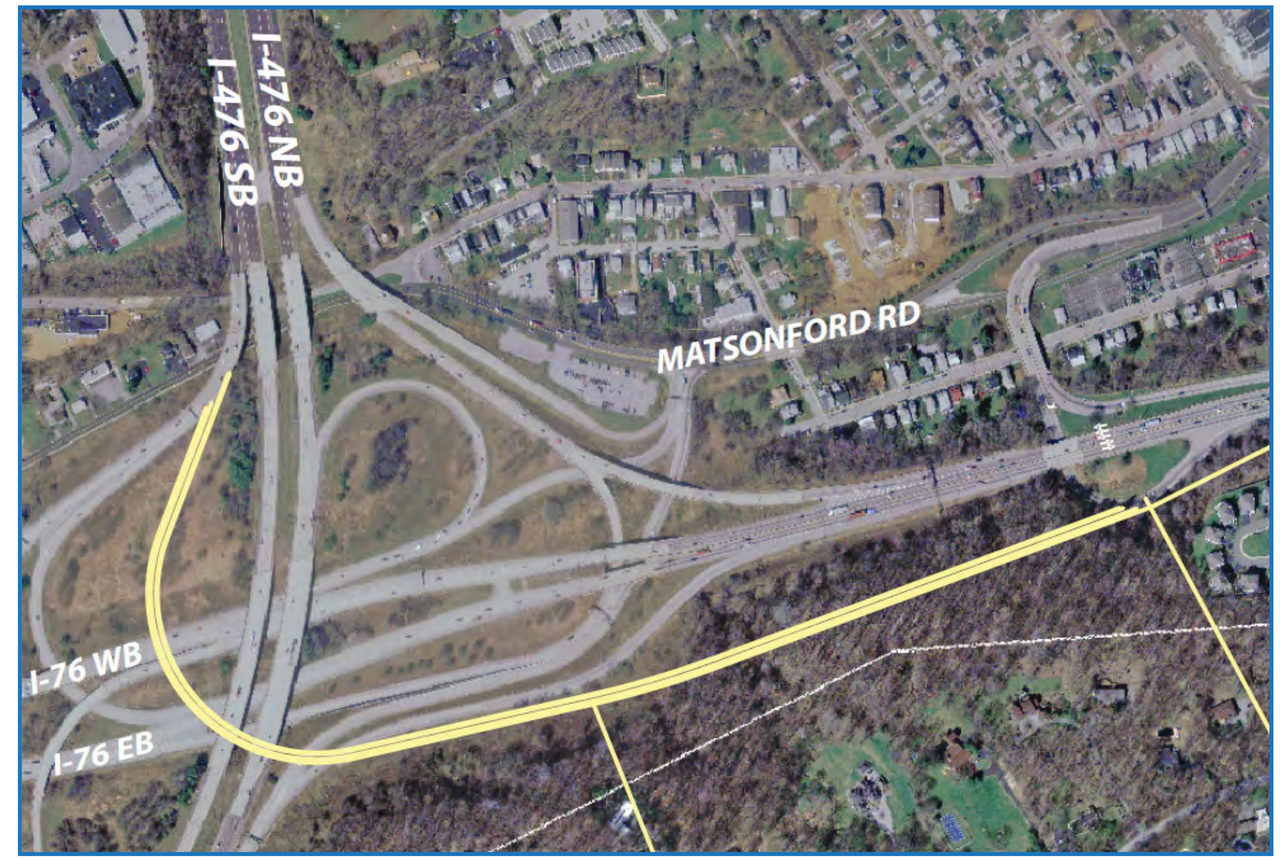
Estimating the effects of construction or incidents on scheduled travel times could be helpful for bus operations planners at SEPTA. (DVRPC)

Major Regional Projects

1. Widen the ramp descending from the 30th Street Deck to provide designated traffic lanes to I-76 westbound and I-676 eastbound.
2. Relocate I-76's ramps along Matsonford Road at the Conshohocken Interchange.
3. Right-side the merge from I-476 southbound to I-76 eastbound.
4. Complete the Gladwynne Interchange.
5. Widen the Expressway to 6 lanes from US 202 to I-476.
6. Evaluate the traffic effects of development activity and growth: in the 30th Street Station area, surrounding Drexel University, and/or within "CityAve," the City Avenue Special Services District.
7. Explore additional Schuylkill River crossings.
8. Transit options in the corridor: Evaluate the Long-Range Plan's project Q (the extension of the Norristown High Speed Line from Hughes Park Station to the King of Prussia Mall).
9. Double-deck the Expressway for general traffic, high occupancy vehicle (HOV) lane operation, or high-occupancy toll (HOT) lane operation.
10. Add the networks necessary to build and model the region's complete interstate and expressway network and supporting signed detour routes.



Concept of the relocated Conshohocken Interchange ramps along Matsonford Road. (Drawing prepared for DVRPC by the Louis Berger Group, Inc., 2008)



Concept of the right-sided ramp from I-476 southbound to I-76 eastbound. (DVRPC)

A-4 PRIMARY CMP STRATEGIES FOR I-76

- Pennsylvania Turnpike (at PA 29) to Mid-County Expressway (I-476):
  - Intelligent Transportation System (ITS), includes Traveler Information Services;
  - Integrated Corridor Management;
  - Incident Management;
  - Modifications to Existing Transit Routes or Services; and
  - Minor Road Expansions (includes major reconstruction with minor capacity, frontage or service roads, HOV lanes).

- PA 23 / Conshohocken Curve to City Avenue / US 1:
  - ITS, includes Traveler Information Services;
  - Integrated Corridor Management;
  - Incident Management;
  - Park-and-Ride Lots; and
  - Expanded Parking and Improved Access to Stations.

- City Avenue / US 1 to Center City & Walt Whitman Bridge:
  - ITS, includes Traveler Information Services;
  - Integrated Corridor Management;
  - Incident Management;
  - Expanded Parking and Improved Access to Stations;
  - Minor Road Expansions (includes major reconstruction with minor capacity, frontage or service roads, HOV lanes); and
  - Signage, Marketing, and Outreach in the Stadium Area (e.g., promote existing transit services and TDM strategies).

- Planning Corridor:
  - Install electronic controllers and fibre optic interconnections for parallel and perpendicular diversion routes.
  - Establish communications and control at the Traffic Management Center (TMC).
  - Integrate with ITS, Integrated Corridor Management for Freeways, Incident Management Operations, and Traveler Information Services.

DVRPC's Congestion Management Process (CMP):

The CMP is a systematic approach for managing congestion and enhancing the mobility of people and goods. It advances the goals of the region's Long-Range Plan to assure that modal balance is considered and provided when planning and implementing transportation improvement projects. The CMP is also a consideration in selecting projects to include for funding in the Transportation Improvement Program (TIP). Consistency with the CMP is a requirement for projects to be eligible for federal transportation funds in air quality non-attainment areas. DVRPC is responsible for conducting the region's CMP.

The CMP identifies congested travel corridors and multi-modal strategies within them to eliminate or reduce congestion. Where additional SOV capacity is appropriate, the CMP includes potential supplemental strategies to reduce travel demand, improve operations, and return the most long-term value from the investment. Where ideas for projects are developing that are not consistent with the strategies listed in the CMP, the CMP procedures detail how to advance project development—including consideration of long-term land use implications and their resulting demands for transportation investment.

The Schuylkill Expressway is the spine of an identified congested travel corridor. DVRPC's forthcoming CMP report, *Limiting Traffic Congestion and Achieving Regional Goals* (DVRPC Publication Number: 11042), identifies the set of strategies recommended for I-76. Strategies can vary by segment along the corridor but should be integrated into any studies that seek to add significant SOV capacity within the planning corridor. VISUM and VISSIM are capable of modeling most of the strategies and measuring their effects.

Publication Title: **Schuylkill Expressway (I-76) Operational Research Model – FINAL REPORT**

Publication Number: 10072

Date Published: November 2012

Geographic Area Covered: the City of Philadelphia; and Lower Merion Township, the Borough of West Conshohocken, the Borough of Conshohocken, and Upper Merion Township in Montgomery County, Pennsylvania

Key Words: Transportation Modeling, Regional Travel Demand Forecasting, Traffic Operations Modeling, VISUM, VISSIM, Performance Measures, Traffic Volume, Mean Spot Speed, Average Operating Speed, Travel Time

Abstract: The Pennsylvania Department of Transportation (PennDOT) commissioned the Delaware Valley Regional Planning Commission (DVRPC) to construct a powerful computer model capable of simulating, visualizing, and assessing traffic conditions along the Schuylkill Expressway (I-76) to use as a practical research tool. The tool can be used to determine the effects of growth, predict outcomes of changes to the Expressway's infrastructure, judge the merits of competing designs, develop maintenance and protection of traffic plans, and develop congestion management plans for improvement projects.

The Schuylkill Expressway (I-76) Operational Research Model is a mixed-traffic operations and planning tool with application for the Schuylkill Expressway proper. DVRPC prepared the operational model for the Schuylkill Expressway's mainline and interchange ramps between the Pennsylvania Turnpike at Valley Forge and the Walt Whitman Bridge—a distance of approximately 23 miles. Thirty-six (36) key intersections, at/near ramp touchdown points, that impact or may impact mainline operations were modeled in the networks.

Staff used the integrated transportation modeling suite of VISUM and VISSIM to prepare the linked regional travel forecasting and dynamic traffic modeling tool. The regional model (VISUM) was prepared and executed for Year 2010 and Year 2035 Long-Range Plan conditions. Some of its outputs served as inputs to the VISSIM operational model, thus establishing a linkage between the regional model and the operational analysis of the Expressway.

The Schuylkill Expressway operational model employed VISSIM to simulate the travel of individual vehicles throughout the better part of a typical weekday (7:00 AM to 6:00 PM)—for current 2010 and forecasted Year 2035 Long-Range Plan conditions. The model supplies the ability to compute and collect valuable information (volume, speed, density, throughput, travel time, stops, delay, intersection level of service, queuing, emissions, fuel consumption) for critical timeframes (15-minute, peak-hour, etc.). In turn, the data can be assessed for changes in performance between scenarios or to judge the effectiveness of conceptual improvements and strategies. Off-line database tools were developed to prepare datasets and facilitate comparisons of datasets.

The delivered product is a starting point, albeit a comprehensive one, for the systematic evaluation of the Schuylkill Expressway corridor. The delivered operational models can be used to examine and evaluate the following aspects of or improvements to Expressway operations:

- effects of regional growth (limited to 2010 and the 2035 Long-Range Plan scenario);
- merging and weaving sections;
- lane-changing behavior at off-ramps, lane-drops, and lane-additions;
- limited widening for auxiliary lanes;
- improved geometry or other spot improvements;
- toll plaza operations;
- ramp metering and other transportation systems management schemes; and
- incidents and work zones.

With added effort, the models can be adjusted or expanded for other or wider applications that may be warranted in the future. These might involve: performing interim year analyses (i.e., Year 2015 to Year 2030), estimating the spill-over effects of incidents and emergencies, planning for and managing traffic along parallel arteries during construction projects, examining multi-modal improvement proposals within the broad I-76 planning corridor, and investigating area-based travel demand management (TDM) strategies in land use centers or related to special events. To accommodate these possibilities, copies of the Year 2010 and Year 2035 VISUM regional models—also containing the Nighttime Period (6:00 PM to 7:00 AM)—were supplied to PennDOT. Ultimately, PennDOT directed that the modeling tools be made available to member agencies for local applications and that DVRPC be responsible for administering and maintaining the models.

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