

# USER'S GUIDE

DELAWARE VALLEY  
**dvrpc**  
REGIONAL  
PLANNING COMMISSION

**NOVEMBER 2012**



**SCHUYLKILL  
EXPRESSWAY**

**OPERATIONAL  
RESEARCH  
MODEL**



**USER'S GUIDE**



**NOVEMBER 2012**

A circular graphic with a thick black border. Inside the circle, at the top, is a shield-shaped road sign with the number "76" in white on a black background. Below the sign is a stylized, winding road with a dashed center line and solid outer edges. To the right of the road diagram, the text "SCHUYLKILL EXPRESSWAY" and "OPERATIONAL RESEARCH MODEL" is written in bold, uppercase letters.

**SCHUYLKILL  
EXPRESSWAY**

**OPERATIONAL  
RESEARCH  
MODEL**

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.

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**INTRODUCTION:**

The Schuylkill Expressway (I-76) Operational Research Model was produced to provide a wealth of information for transportation planning and decision-making purposes, and required a wealth of information to construct and calibrate for use. In turn, this **USER'S GUIDE** was produced to organize and document the various models, data files, applications, and reports delivered through the project.

Technical documentation is enclosed for four tools prepared to use the models and/or interpret their results:

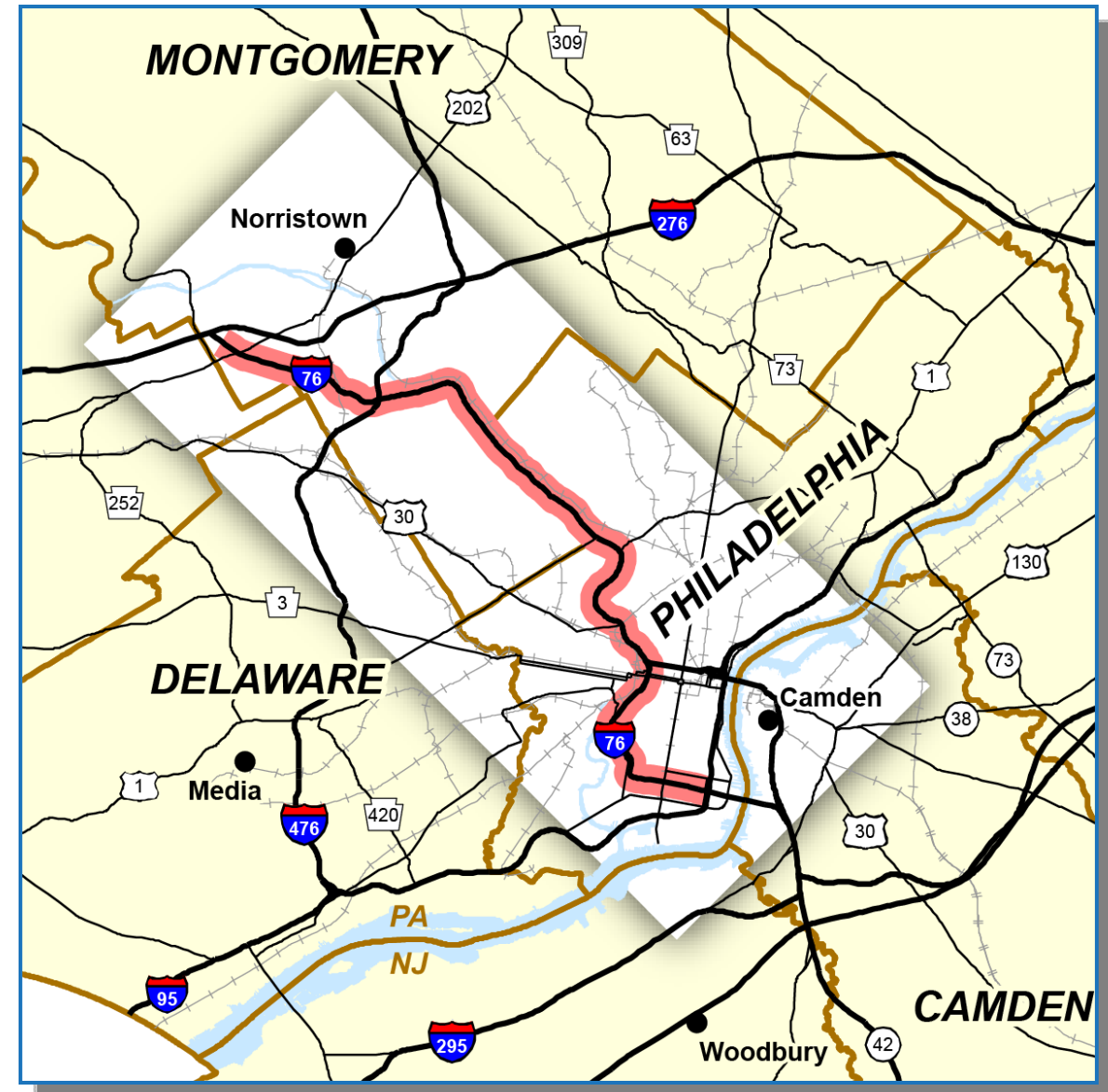
1. ANM Translation—platform for translating and transferring VISUM output to VISSIM;
2. Compare—flexible calculator for volumes and spot-speed performance measures;
3. Spot-Speed Tabulator—formatted calculator for 41 defined speed-reading locations along the Expressway; and
4. Operating Speed Tabulator—formatted calculator for 10 defined segments in each direction along the Expressway.

**RESEARCH MODEL PROJECT OVERVIEW**

The Pennsylvania Department of Transportation (PennDOT) commissioned the Delaware Valley Regional Planning Commission (DVRPC) to construct a powerful computer model capable of simulating, assessing, and visualizing traffic conditions along the Schuylkill Expressway to use as a practical research tool. Linkage between the operational model and the regional travel demand forecasting model, maintained by DVRPC, provides 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.

The model produced for PennDOT is a mixed-traffic operations and planning tool 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 (**Figure 1**). Thirty-six (36) key intersections, at/near ramp touchdown points, that impact or may impact mainline operations were modeled in the networks.

Figure 1: The Planning Corridor



Source: DVRPC



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 four time periods or blocks comprising a typical weekday, 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 facility.

VISSIM simulated the travel of individual vehicles throughout the better part of a typical weekday (7:00 AM to 6:00 PM) in three time periods, for current 2010 and forecasted Year 2035 conditions. The operational 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/or to judge the effectiveness of conceptual improvements and strategies. Off-line database tools were developed to prepare and facilitate comparisons of datasets.

### THE REPORT

The **USER'S GUIDE** provides a general background into the project, the traffic data collection effort, and the modeling steps performed. Specific modeling activities are described for the ANM Translation step and the VISSIM operational modeling so that subsequent users may understand and use the models as developed. This report also offers an inventory of the project deliverables supplied to PennDOT in electronic format. The body of the report concludes with a description of **Compare.mdb**—a special analysis tool developed to perform simple queries of the provided models as an aid to decision makers who may not have access to the software or the skills to use it.

It is assumed that the reader has proficiency in these matters and models. More information on the overall project, the results of the modeling steps, and applications of the models is provided in a companion document entitled: **SCHUYLKILL EXPRESSWAY (I-76) OPERATIONAL RESEARCH MODEL—FINAL REPORT** (DVRPC Publication Number 10072).

### DELIVERABLES

All project data and models have been provided to PennDOT in electronic formats as the deliverables, including:

- ❑ traffic counts, corridor mapping, signalized intersection condition diagrams;
- ❑ database of current 2010 Conditions—volume, vehicle composition, spot speeds;
- ❑ 2010 Operating Speed / Travel Times for 10 defined segments in each direction of the Expressway;
- ❑ Year 2010 and Year 2035 VISUM regional models with selected outputs saved to the project database;

- ❑ Year 2010 and Year 2035 VISSIM operational models with appropriate outputs saved to the project database;
- ❑ **FINAL REPORT**—overview and summary of the project; and
- ❑ **USER'S GUIDE** (this document)—inventory of all supporting electronic data files, database tools and technical documentation needed either to run the models as designed or to edit for alternative applications.

### 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.





**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 in **Figure 2** (see page 4).

A comprehensive traffic count and data collection effort was conducted to establish the current traffic baseline for use in the modeling work. Attributes needed to code the network (number of travel lanes, traffic control devices, etc.) were obtained via various means. DVRPC staff conducted traffic counts and researched / obtained recent traffic demand data for performance measurement from in-house and external sources. Collected elements included: traffic count, spot-speed, 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 Systems [GIS] Mapping, Transportation Modeling [VISUM], and Transportation Planning [VISSIM]).

Datasets were formulated to serve various needs, including: general information, inputs / 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 / travel time information, for defined segments along the mainline, was compiled for key hours within the morning, midday, and evening travel periods for performance measurement.

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 3**). The resultant current 2010 traffic volumes became the baseline representing typical conditions along the Schuylkill Expressway for the project.

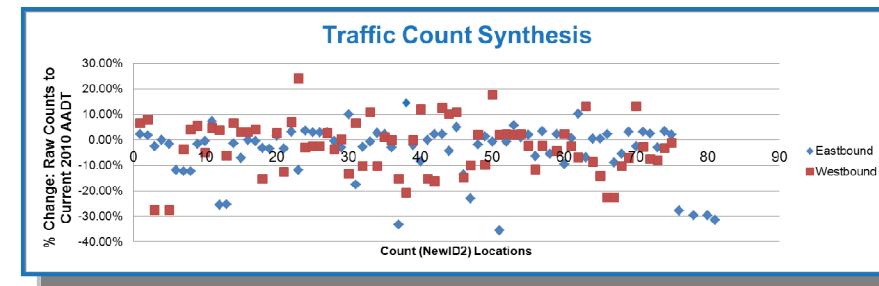
Current 2010 daily volumes were disaggregated to 15-minute intervals, based on actual count data using data management techniques. Fifteen-minute interval traffic volumes along the mainline and ramps were re-aggregated into four time periods, or blocks, within the day for VISUM regional travel demand 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 existing conditions data was added to the deliverables and, where appropriate, linked to the project database (**Compare.mdb**) for modeling requirements and performance measurement.

**Figure 3: Daily Traffic Count Data Synthesis**



*Traffic counts were synthesized to flow volumes along the Expressway. (DVRPC)*

**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 timeframes during a typical weekday: four time blocks, for travel demand forecast modeling; and 15-minute intervals, for operational modeling. 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.**

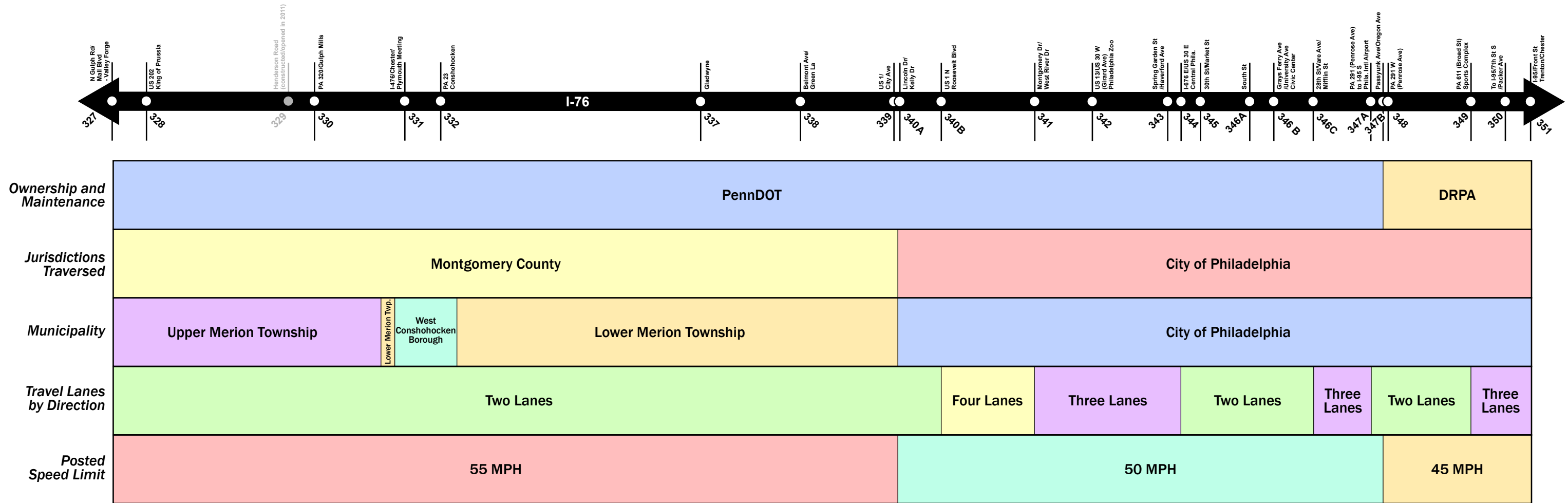
**FILE MANAGEMENT**

Current 2010 traffic data is stored in project directory folders: Deliverables\1\_Data Collection\, for Expressway mapping and traffic volume data; and linked to: Deliverables\5\_Database and VISSIM Analytical Tools\1\_Compare\Compare Tool\ (i.e., the database), for volume and spot-speed data. INRIX operating speed readings are contained in: Deliverables\5\_Database and VISSIM Analytical Tools\3\_Operating Speeds\.



# Institutional, Physical, and Regulatory Conditions in 2010

Figure 2



Note: Interchange numbering mimics mileage along the Expressway.

### TRANSPORTATION MODELING:

DVRPC used 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. While each program may be employed independently, the Operational Research Model project utilized both software products. The ability to transfer VISUM-generated data to the VISSIM model for performance measuring was central to this project's purpose and scope and remains applicable for additional modeling.

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.

The project's main deliverable is a series of VISSIM models. Operational testing and performance measurement on the Schuylkill Expressway was performed with VISSIM. However, the VISUM model played a vital role: creating trip generation, trip distribution, mode choice, and trip assignment at the regional level; providing through program integration a connection with the transportation network serving the rest of the region; and providing a window into the long-term effects that regional growth will have on the Expressway. For these reasons the models needed to be linked and all modules supplied and explained in the event of additional studies or alternative users.

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. To compensate, 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 maintain linkage between VISUM's outputs and VISSIM's inputs.<sup>1</sup> Technical documentation for the alternative ANM Translation procedure is contained in this report, and an electronic spreadsheet tool (**ANMtranslation.xls**) is provided in the deliverables to facilitate the process for subsequent users and applications.

DVRPC prepared fully loaded VISUM and VISSIM 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.

<sup>1</sup> With that action, however, the capability for two-way interaction between VISSIM and VISUM was sacrificed.



**VISUM—REGIONAL TRAVEL DEMAND MODEL:**

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.

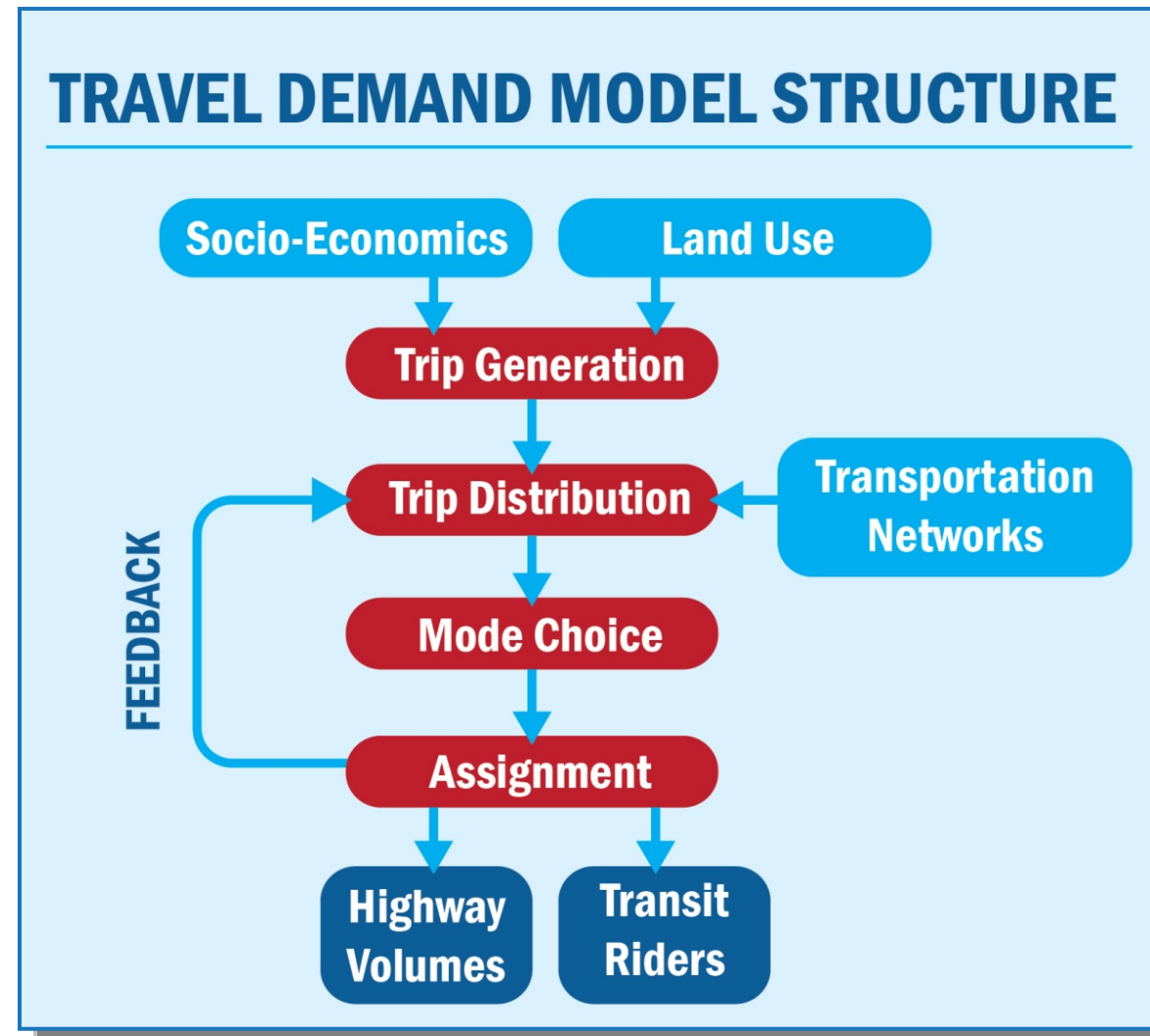
DVRPC follows traditional four-step procedures in its regional forecast modeling (Figure 4). The regional model can be used to locate problem areas, identify future trends and travel conditions, and consider various improvement strategies to address existing and emerging problems. By focusing DVRPC's 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.

DVRPC's 2010 Transportation Analysis Zone (TAZ) structure, DVRPC Board-adopted 2010 population and employment forecasts, and the 2010 modeled regional transportation network served in defining the modeling 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.

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, re-run for four time blocks (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), and calibrated using model parameters and matrix correction procedures provided through the software to replicate, as close as practical, the volumes contained in Tables 1 and 2.

Outputs from the VISUM Year 2010 sub-network traffic assignment served the project in two ways. First, outputs for the planning corridor included model year daily and four time block forecasts for all links in the corridor, including mainline I-76 and its on- and off-ramps. These were stored in the appropriate deliverables folders as products and added to the database and **Compare.mdb** tool for potential querying. Second, representative hourly volumes or flow rates for each on-ramp, and "routes" or routing decisions—the paths that the entering volume takes along the Expressway (e.g., proportional distributions of each on-ramp's hourly volume to each downstream off-ramp)—were provided as inputs to the VISSIM operational modeling work.

Figure 4: Regional Travel Simulation Process



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.

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.

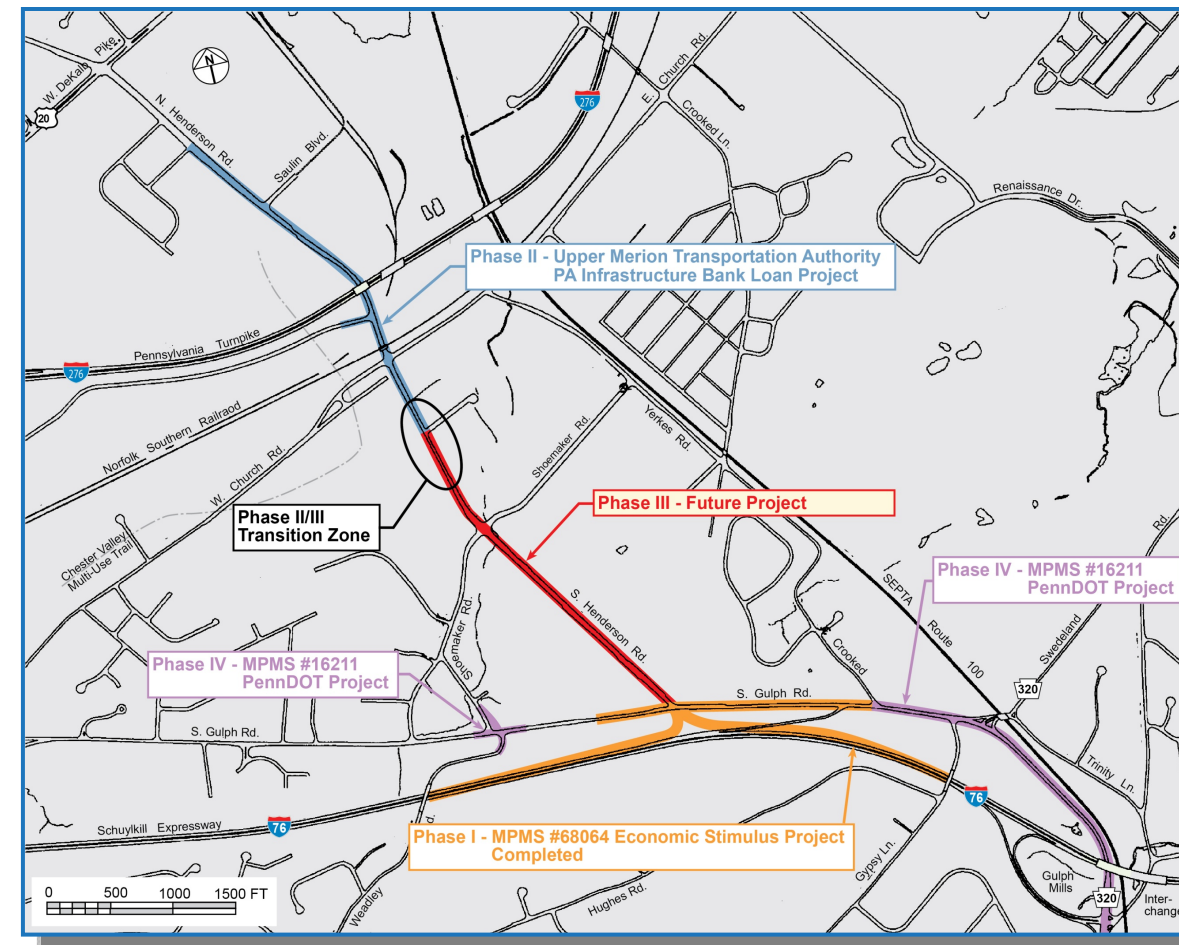
The VISUM regional model was executed with the Year 2035 socio-economic variables and transportation network enhancements as inputs. Of those projects, the new I-76 westbound ramps to/from Henderson and South Gulph Roads (i.e., Interchange #329, signed for King of Prussia / Norristown) and related, nearby roadway and intersection improvements (Figure 5) were also added to the structure of the regional model's network. The models were run, and loaded Expressway-level sub-networks were prepared for the four time blocks (the AM Peak, the Midday, the PM Peak, and the Nighttime Periods). Link-level forecasts resulting from the Expressway model's four time period assignments were stored in the deliverables and entered into the database.

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.

**FILE MANAGEMENT**

VISUM models, modules, and results are contained in project directory folders: Deliverables\2\_VISUM\ . Resulting traffic forecasts have also been linked to the database: Deliverables\5\_Database and VISSIM Analytical Tools\1\_Compare\Compare Tool\ (i.e., the database).

**Figure 5: New I-76 Westbound Ramps at Henderson and South Gulph Roads**



*The new /relocated westbound ramps at Interchange #329 (i.e., Phase I) were completed 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.)*



Table 1: 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

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**Table 1: 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 / 30 <sup>th</sup> St	30 <sup>th</sup> St (service road)	-6,386	-869	-2,210	-899	-2,408
290	EB	Exit		344	Vine St / 30 <sup>th</sup> St	Vine St EB	-40,950	-5,547	-14,489	-6,723	-14,191
300	EB	Enter		345	Vine St / 30 <sup>th</sup> St	30 <sup>th</sup> 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 / 34 <sup>th</sup> 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	34 <sup>th</sup> St	34 <sup>th</sup> 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 / 28 <sup>th</sup> 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 / 26 <sup>th</sup> St	26 <sup>th</sup> St	-20,760	-2,822	-5,754	-4,630	-7,554
375	EB	Exit		347	Passyunk Av / 26 <sup>th</sup> St	Passyunk Av (both)	-16,195	-1,254	-5,703	-2,928	-6,310
380	EB	Mainline		347	Passyunk Av / 26 <sup>th</sup> St		20,881	1,165	3,689	6,728	9,299
385	EB	Enter		347	Passyunk Av / 26 <sup>th</sup> 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 2: 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	7 <sup>th</sup> St	7 <sup>th</sup> 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	25 <sup>th</sup> 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	26 <sup>th</sup> 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	34 <sup>th</sup> St	34 <sup>th</sup> St	-13,551	-1,584	-3,923	-2,755	-5,289
605	WB	Enter		346	34 <sup>th</sup> St	34 <sup>th</sup> 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	30 <sup>th</sup> St / Chestnut St	Chestnut EB / Schuylkill Av	-7,485	-1,649	-2,332	-1,040	-2,464
635	WB	Exit		345	Vine St / 30 <sup>th</sup> St	Vine St EB	-16,139	-2,188	-5,465	-2,933	-5,553
640	WB	Mainline		345	Vine St / 30 <sup>th</sup> St		34,229	3,798	10,510	6,661	13,260
660	WB	Enter		345	Vine St / 30 <sup>th</sup> St	30 <sup>th</sup> 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	34 <sup>th</sup> 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

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**Table 2: 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
<b>750</b>	<b>WB</b>	<b>Mainline</b>		<b>340A</b>	<b>US 1 - Roosevelt Blvd / City Av</b>		<b>66,851</b>	<b>6,663</b>	<b>21,376</b>	<b>13,346</b>	<b>25,466</b>
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
<b>770</b>	<b>WB</b>	<b>Mainline</b>	<b>076885-7253</b>				<b>60,750</b>	<b>6,519</b>	<b>18,826</b>	<b>12,222</b>	<b>23,183</b>
775	WB	Exit		338	Belmont Av / Green La	Belmont Av / Green La (both)	-5,909	-204	-1,766	-1,130	-2,809
<b>780</b>	<b>WB</b>	<b>Mainline</b>		<b>338</b>	<b>Belmont Av / Green La</b>		<b>54,840</b>	<b>6,315</b>	<b>17,060</b>	<b>11,092</b>	<b>20,373</b>
785	WB	Enter		338	Belmont Av / Green La	Belmont Av / Green La (both)	8,321	1,947	2,291	1,283	2,800
<b>790</b>	<b>WB</b>	<b>Mainline</b>	<b>076865-7252</b>				<b>63,163</b>	<b>8,262</b>	<b>19,351</b>	<b>12,374</b>	<b>23,176</b>
795	WB	Exit		337	Gladwynne	Hollow Rd (both)	-3,575	-274	-1,083	-823	-1,395
<b>800</b>	<b>WB</b>	<b>Mainline</b>	<b>076845-7190</b>				<b>59,586</b>	<b>7,987</b>	<b>18,267</b>	<b>11,553</b>	<b>21,779</b>
805	WB	Exit		332	Matsonford Rd / Conshohocken	Conshohocken - Matsonford / PA 23 (both)	-6,841	-1,009	-2,361	-972	-2,499
<b>810</b>	<b>WB</b>	<b>Mainline</b>					<b>53,810</b>	<b>6,634</b>	<b>17,718</b>	<b>10,418</b>	<b>19,040</b>
815	WB	Exit		331	I-476 / Conshohocken	I-476 NB	-18,555	-1,532	-6,417	-3,366	-7,240
<b>820</b>	<b>WB</b>	<b>Mainline</b>	<b>076840-7201</b>	<b>331</b>	<b>I-476 / Conshohocken</b>		<b>34,193</b>	<b>5,447</b>	<b>9,492</b>	<b>7,213</b>	<b>12,041</b>
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
<b>855</b>	<b>WB</b>	<b>Mainline</b>	<b>076835-7236</b>				<b>58,384</b>	<b>9,322</b>	<b>17,397</b>	<b>11,695</b>	<b>19,970</b>
860	WB	Exit		330	Gulph Mills	Balligomingo Rd (both)	-8,468	-1,319	-2,948	-1,351	-2,850
<b>865</b>	<b>WB</b>	<b>Mainline</b>	<b>076825-7234</b>	<b>330</b>	<b>Gulph Mills</b>		<b>49,919</b>	<b>8,002</b>	<b>14,449</b>	<b>10,345</b>	<b>17,123</b>
870	WB	Enter		330	Gulph Mills	South Gulph Rd (both)	4,512	630	1,635	1,157	1,090
<b>871</b>	<b>WB</b>	<b>Exit</b>		<b>329</b>	<b>King of Prussia / Norristown</b>	<b>Henderson / South Gulph Rd (both)</b>					
<b>872</b>	<b>WB</b>	<b>Enter</b>		<b>329</b>	<b>King of Prussia / Norristown</b>	<b>Henderson / South Gulph Rd (both)</b>					
<b>875</b>	<b>WB</b>	<b>Mainline</b>					<b>54,432</b>	<b>8,632</b>	<b>16,085</b>	<b>11,502</b>	<b>18,213</b>
<b>878</b>	<b>WB</b>	<b>Exit</b>	<b>Express Lanes</b>	<b>328</b>		<b>Express Lanes to PA Turnpike</b>	<b>-8,690</b>	<b>-775</b>	<b>-2,640</b>	<b>-2,382</b>	<b>-2,893</b>
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
<b>918</b>	<b>WB</b>	<b>Enter</b>	<b>Express Lanes</b>	<b>327</b>		<b>Express Lanes to PA Turnpike</b>	<b>8,690</b>	<b>775</b>	<b>2,640</b>	<b>2,382</b>	<b>2,893</b>
<b>920</b>	<b>WB</b>	<b>Mainline</b>	<b>076800-7200</b>	<b>327</b>	<b>Mall Blvd</b>		<b>28,992</b>	<b>4,580</b>	<b>6,118</b>	<b>9,079</b>	<b>9,215</b>
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
<b>935</b>	<b>WB</b>	<b>Mainline</b>					<b>34,136</b>	<b>5,024</b>	<b>7,200</b>	<b>11,344</b>	<b>10,568</b>
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



**THE ANM TRANSFER—CONNECTING VISUM AND VISSIM:**

By design, PTV’s software package allows for the automated transfer of data between the two platforms. Transfer is accomplished via the ANM Import (first transfer) and the Adaptive ANM Import (subsequent transfers). **The ANM process can only be used in its intended fashion if the VISSIM network is created by a VISUM ANM export.** As was started earlier, the state of the regional travel demand forecasting model network, and the depth of the operational model’s work program (i.e., providing the capability for continuous 15-minute interval operations modeling between 7:00 AM and 6:00 PM) at the outset of the project, were not in sync for integrating the component parts of the PTV software per its design.

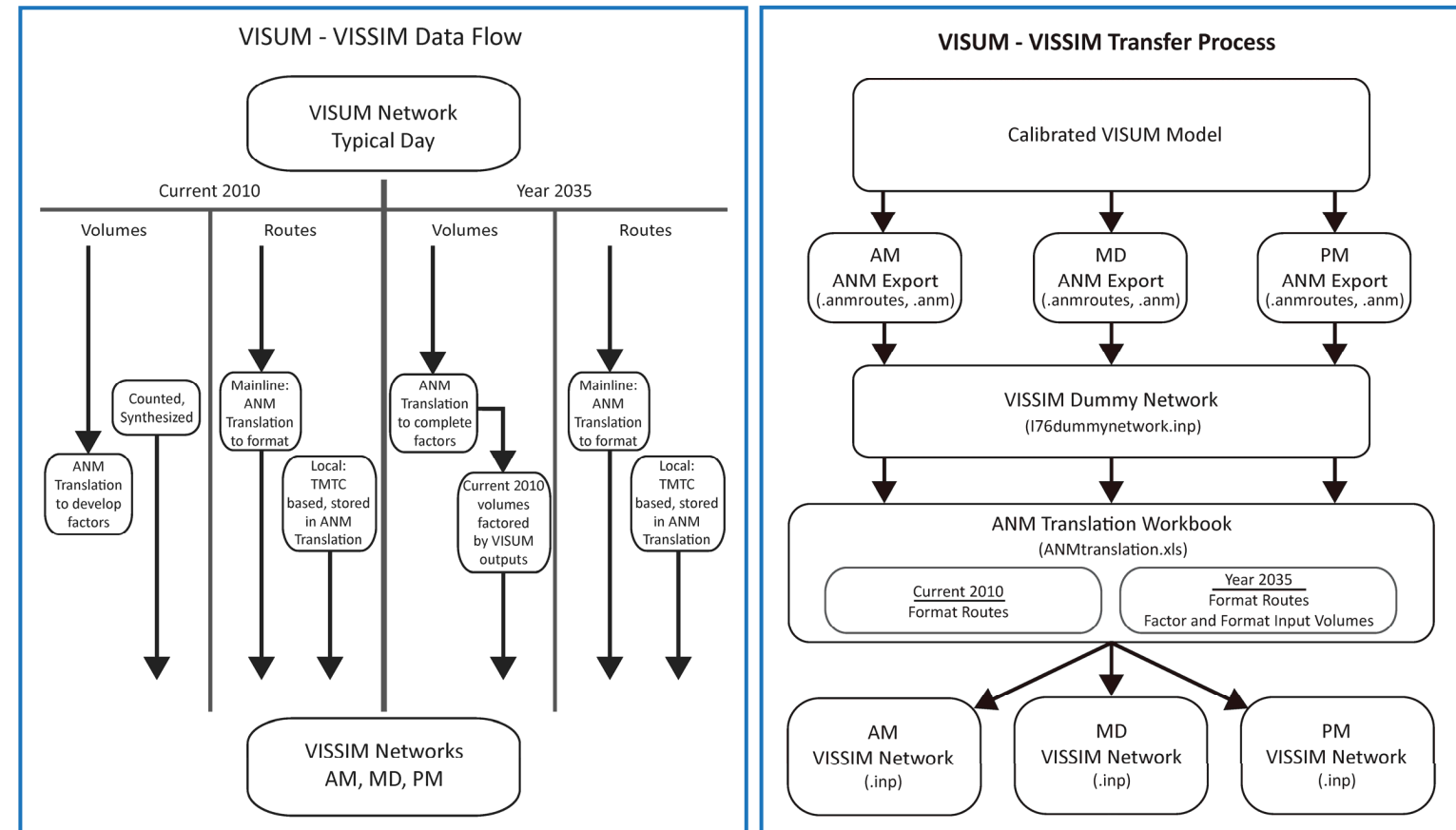
**DVRPC’S ANM TRANSLATION PROCEDURE**

DVRPC staff adapted the modeling activities and fabricated an alternative, off-line “ANM Translation” process to prepare the datasets and link VISUM’s outputs and VISSIM’s inputs (Figure 6). First, a sub-network of the Expressway, and its on- and off-ramps between the Pennsylvania Turnpike and Walt Whitman toll plazas, was clipped from the Year 2010 regional model (VISUM). Concurrently, staff prepared the structure of the Year 2010 operational model (VISSIM) to correspond with the physical and regulatory conditions of the Expressway, its ramps, and 36 key at-grade intersections at / near the ramp terminals. The intersections on the local road network lie outside of the VISUM sub-network and vehicle entry points to that network. Year 2010 turning movement traffic volumes were “manually” connected in 15-minute intervals—in relation to the turning movement patterns reflected in the current 2010 traffic volumes and the vehicle inputs and routes emanating from VISUM. Thus, a functional integration, but not a dynamically linked one, was established for the intersections in the Year 2010 VISSIM models.

Each VISSIM model, in DVRPC’s alternative translation procedure, has two primary inputs transferable from each loaded VISUM sub-network that control vehicles on its network:

1. Vehicle Inputs; and
2. Vehicle Routes.

Figure 6: 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)



### VEHICLE INPUTS

Vehicle inputs are defined locations where vehicles enter the VISSIM network. Typically, they are either at the end of on-ramps or at the stub end of links that comprise the network. VISSIM network vehicle inputs are provided in 15-minute increments. VISSIM introduces vehicles onto the network based on the vehicle input locations and the 15-minute interval traffic volumes. Though the vehicles are calculated and provided in the database files in 15-minute increments, VISSIM reads, and therefore needs, the input values as hourly flow rates. As such, the vehicle volume inputs have been multiplied by four in an off-line spreadsheet to yield the interval input values required for the VISSIM network.

The VISUM networks used for this project supply vehicle inputs at 49 locations—primarily on on-ramps but also at the Pennsylvania Turnpike and Walt Whitman Bridge toll plazas. The VISSIM networks have many more vehicle input locations. The difference is due to the VISSIM networks containing the key intersections at the ends of on- and off-ramps (and beyond the boundary of the loaded VISUM sub-network).

Automatic traffic recorder and intersection turning movement traffic counts were conducted to develop the current 2010 base year traffic volumes. In turn, these traffic volumes were used as inputs in the Year 2010 VISSIM model due to their real-world relevance for calibration and their ability to be related to other actual performance statistics and/or compared to performance data output from VISSIM.

Future Year 2035 VISSIM traffic forecast inputs were generated off base year volumes by establishing and applying unique input location volume change factors calculated between volume outputs from the Year 2010 and Year 2035 VISUM model runs within the dynamically linked portion of the model. For Year 2035 VISSIM, vehicle inputs were assigned to on-ramps, nearly all of which correspond to a Year 2035 VISUM vehicle input. The remaining vehicle inputs are assigned volumes of zero and can be populated as needed by an end user for individual analyses.

There is one VISSIM vehicle input location that is not associated with a VISUM vehicle input location. For this, the Mall Boulevard westbound on-ramp, the future year values were determined using a factor aggregated from all vehicle inputs.

### VEHICLE ROUTES

Vehicle routes are the second function that is common between VISUM and VISSIM. Vehicle routes define where vehicles that enter the dynamically linked model are destined in the network. Vehicle routes are determined in VISUM, and all calibration efforts regarding vehicle routes that are on the I-76 mainline occurred in the VISUM models.

A vehicle enters the Expressway portion of the network on an on-ramp, or at the stub end of links that comprise the network, and crosses a routing decision that assigns its destination off-ramp. The routing decision contains a routing percentage for each downstream exit. Like vehicle inputs, there are many more

vehicle routes in the VISSIM model: 977 for Year 2010 and 1,013 for Year 2035 versus 537 and 559, respectively, in the VISUM models. Again, the difference is due to the addition of intersections that are off of the I-76 mainline in the VISSIM models and beyond the boundary of the loaded VISUM sub-network. The VISUM routes each correspond to a VISSIM route. The matching routes all begin on on-ramps, or link stub ends, and end on off-ramps, the Walt Whitman Bridge, or the Pennsylvania Turnpike. Vehicle routes off the mainline and through the at-grade intersections at the ramp terminals do not have an integrated model relationship with the I-76 mainline routes.<sup>2</sup> Routing decisions at the intersections are based off of the turning movement patterns from the counts during the modeling period and are static between the Year 2010 and Year 2035 models. The ANM Translation process loads all vehicle routes into the Year 2035 VISSIM models, but routes off of the I-76 mainline are not used because the associated vehicle inputs are not populated. Routes exported from the VISUM models are given in raw numbers of vehicles that are assigned to each route by time period. The routes are aggregated to groups based on route starting point and converted to percentages before being applied to the VISSIM model. **Should additional analysis require a new assignment from the regional travel demand forecasting model, the output must be imported into the VISSIM network(s) for subsequent operational analysis.**

### ANM TRANSLATION—SET-UP FILES, APPLICATION TOOLS, AND STEPS

In DVRPC's alternative ANM Translation procedure, **two mediums are necessary to make a transfer from VISUM to VISSIM:**

1. a dummy network; and
2. the **ANMtranslation.xls** file.

The dummy network, titled **ANMtransfernetnetwork.inp**, was constructed by an ANM Import of a finalized VISUM network. The network is a generic version of the other VISSIM networks; there are no traffic signals or other traffic control devices. The purpose of this network is to allow the software to format the data in a fashion that is more easily workable.

The **ANMtranslation.xls** file was constructed to factor and format data for transfer between the networks of the two modeling platforms. The tool also supplied a centralized resource for on-the-go troubleshooting and for model calibration. Following is a summary of the **ANMtranslation.xls** "workbook," by tab.

- *Volumes* – This worksheet is for information purposes. The associations between vehicle input locations across the two platforms is made. Volume factoring is also done in this worksheet.

<sup>2</sup> DVRPC's I-76 Operational Model was calibrated to mainline, and on- and off-ramp conditions. Key intersections at the ramp touchdown points were added to the VISSIM model to facilitate more detailed studies in future / subsequent applications.



- *VISSIM Veh Inputs (2010/2035)* – These worksheets are simply reformatted versions of the *Volumes* worksheet. The formatting allows for transfer into the VISSIM network. The worksheets are self-populating, and changes should not be required. The three time periods are color coded.
- *2010VISUMINPUTS (AM/MD/PM)* – These worksheets are receivers of VISUM network data. The vehicle inputs for the 2010 VISUM model, sorted by link number, are copied and pasted into this sheet. The *Volumes* worksheet reads this data.
- *2035VISUMINPUTS (AM/MD/PM)* – This is the same as the 2010 variation, the only difference being that this is the future year.
- *VISUMRoutesKey* – This worksheet creates the associations between the VISUM routes and the corresponding VISSIM routes. Columns N through R list every on- and off-ramp along the Expressway, along with the associated link numbers. Columns A through L create every routing option that is possible, whether used or not. A link code was developed using the to- and from-link numbers for each route. The code is simply the origin link multiplied by 100,000 plus the destination link. The link codes are used in later worksheets.
- *2035RoutesKey* – This worksheet was created to account for minor differences between the Year 2010 and Year 2035 networks, such as the addition of the Henderson Road Interchange. It serves the same purpose as the *VISUMRoutesKey* tab but for Year 2035 routes.
- *VISUM Route Inputs* (one for each testing scenario's AM / Midday / PM time periods):
  - *2010VISUMRoutes* – Similar to VISUM input worksheets, this worksheet is populated by copying and pasting the VISUM routes. Subsequent spreadsheets read the data.
  - *2035VISUMRoutes* – Same as above, except for the year iteration.
- *2010VISSIMRoutes* – This worksheet is formatted to allow for the transfer of route data to the VISSIM model for the base year's AM, Midday, and PM time periods. Because there are many more routes in the VISSIM model, many are colored gray to distinguish them as not corresponding to VISUM routes. For corresponding routes, link codes are calculated and a lookup function matches them with the VISUM route link code. The lookup code then is used to look up the route data. The data is reformatted as a percentage for each route and used to populate the appropriate cells.
- *2035VISSIMRoutes* – same as above except for the year iteration.

There are a series of steps that must be undertaken in order to complete a transfer of data across the two platforms.

1. Conduct an ANM export from the VISUM sub-network. An .anmroutes file is created.
2. Using the generic VISSIM network (**ANMtransfarnetwork.inp**), conduct an Adaptive ANM Import. Import the file created in the previous step. This will overwrite the vehicle input and vehicle routes data. **Note that regardless of time period being exported, the VISUM file must be exported as an AM (i.e., morning peak period) file.** This does not affect the data in any way.
3. The first transfer goes from the generic VISSIM network to the **ANMtranslation.xls** spreadsheet. In the VISSIM user interface, select vehicle inputs, right click in the network window, right click in the vehicle inputs window and uncheck "show vehicle compositions," sort by link number, select and copy all data, and paste it into the appropriate vehicle inputs worksheet. Repeat this step for vehicle routes. Ensure all routing decisions are highlighted so that all routes can be copied and pasted. **It may be worthwhile to paste into a blank spreadsheet first, to ensure that formatting is maintained.** This allows for an additional layer of control.
4. The final step takes the reformatted data from the **ANMtranslation.xls** workbook to the VISSIM model. To accomplish this, the reverse of Step 3 is required. Copy the data from the appropriate worksheet and paste it into the appropriate window in the VISSIM network. Vehicle Inputs and Vehicle Routes need to be transferred. The workbook is formatted so that all data is in the proper format and order. Note that each VISSIM network has a seeding period: 60 minutes for the AM Peak Period, 30 minutes each for the Midday Period and the PM Peak Period. For example, the PM Peak Period's network seeds from 2:30 PM – 3:00 PM, a half-hour in front of the formal evaluation period (3:00 PM – 6:00 PM). **When transferring between the ANMtranslation.xls workbook and a VISSIM network, these seeding periods must be accounted for.**
5. **Save the VISSIM file.**

#### FILE MANAGEMENT

All files and programs needed to complete the translation / transfer procedure are contained in: Deliverables\3\_ANM Translation Tool.

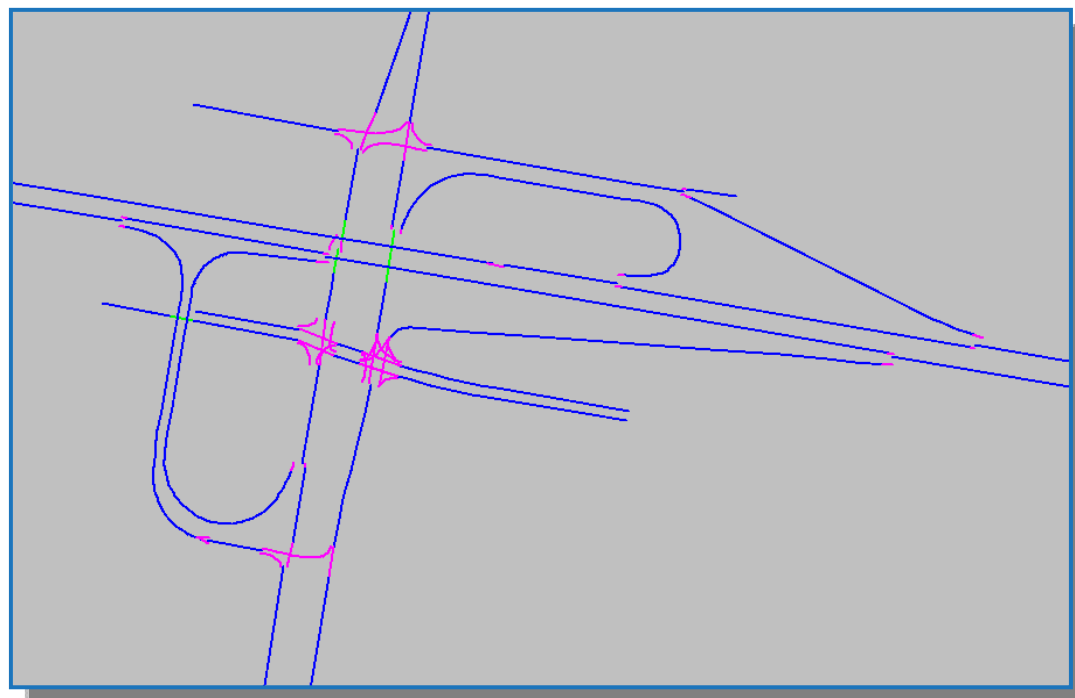


### VISSIM—OPERATIONAL MODEL:

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. 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.

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 or 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. **Figure 7** illustrates a VISSIM screen-shot of the coded network.

**Figure 7: I-76 and Broad Street Interchange (VISSIM)**



Source: DVRPC

Current 2010 traffic demand on the Expressway's on-ramps was input to the VISSIM model for three separate simulations (AM Peak, Midday, and PM Peak Periods).<sup>3</sup> Other volume and network performance inputs or 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 turning movement traffic volumes;
- traffic composition factors (5.6 percent heavy vehicles) along the Expressway for all analysis periods;<sup>4</sup> 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 Period, and 30 minutes each 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, Midday, and PM Peak Periods.

Once Year 2010 Period volumes were satisfied; 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 desired speed decision parameters along the mainline and re-run the three period assignments to reach calibration as best as practical for volume and speed. From these models, network volumes, spot speeds, and operating speed data were obtained to establish the modeling baseline for performance measurement.

Year 2035 modeling accounted for Interchange #329 (at Henderson and South Gulph Roads), along with representative on-ramp volumes and downstream routes output from the Year 2035 VISUM models (via the ANM Translation step). Data collection and performance measurement steps were repeated. It warrants mentioning here that, upon completion of the Year 2035 VISSIM modeling, it became clear that the locations beyond the boundary of the dynamically linked models (i.e., the local intersections) were not reacting faithfully to the influence of the Year 2035 VISUM assignment. Volumes were adjusting along the ramps and mainline, but traffic patterns through the terminal intersections were not. Staff was unable to rectify this situation, and

<sup>3</sup> Nighttime conditions were not modeled with VISSIM.

<sup>4</sup> Note: Expediency dictated that heavy vehicle prohibitions, existing at Montgomery Drive, were not built into the operational models.



ected to remove the intersections from the Year 2035 VISSIM models and animations. Traffic control conditions at the ramp terminal points, that might influence traffic backups on the off-ramps and into the mainline, were modeled by adjusting alternative parameters available in the software.

## MODEL CODING, CALIBRATION, AND EVALUATION STEPS

### NETWORK CODING

The VISSIM network, made up of a system of links and connectors, was built by tracing over scaled aerials. The links were coded “urban” or “freeway,” based on the roadway’s functionality. Traffic signal condition diagrams were acquired from PennDOT. Different timing and phasing plans were noted and incorporated for the respective period. *E-ZPass* data was collected from the Delaware River Port Authority and the Pennsylvania Turnpike Commission to accurately code the toll plazas. Stop signs, yield points, conflict areas, reduced-speed areas, and desired speed decisions for the local street network were all entered before running simulations.

Once the network was coded, volumes were entered at all entry points in the network at 15-minute increments. VISSIM requires input volumes in terms of an hourly flow rate; thus, all volumes were multiplied by four. The routing network’s structure was set up manually in two phases. Routes were inserted to connect vehicles through the local intersection network with the dynamic network’s entry points (i.e., the on-ramps) based on current 2010 turning movement traffic volumes. Upon entering the on-ramp, a separate set of routes was then inserted via the software to establish connections to the downstream off-ramps (i.e., take the vehicles along the mainline from the on-ramps and distribute them to the off-ramps). Once the routes structure was established, route distributions, guided by VISUM’s sub-network output, were input to the VISSIM models via the automated ANM process.

### SIMULATIONS

The AM Peak Period VISSIM network was simulated from 6:00 AM to 9:00 AM with a one-hour seeding period. The Midday Period network ran from 8:30 AM to 3:00 PM, with the first half-hour as the seeding period. The PM Peak Period network ran from 2:30 PM to 6:00 PM, also with an initial half-hour seeding period. For all networks, the simulation resolution was set to five time steps/second. *Stochastic Volumes*<sup>5</sup> were not used in the simulations due to the large number of random seeds needed for the model to achieve statistical significance. Instead, all of the 15-minute vehicle inputs for all three networks were set to *Exact Volume* (i.e., current 2010 traffic volumes).

### CALIBRATION

At the outset of the work, a practical goal for calibrating VISSIM assignments for each time period simulation was set at +/-5 percent (versus current 2010 volumes) for the on-ramps and mainline network.

The first step in the calibration process sought to ensure that all of the vehicles could enter the network and obtain measure throughput. Vehicles that cannot enter the network are tabulated in the .err file but are not accounted for in network performance measurement. To compensate, links were lengthened to accommodate the demand and get the vehicles onto the network as the current volumes suggest they are (this treatment was applied at the Vine Street Expressway’s westbound approach to I-76, among others). Related to this step was assessing how many vehicles diffused during the simulations, also tabulated by link in the .err file. Another systemic treatment was applied on multi-lane network entry points where vehicles entering the network onto a multi-lane facility immediately need to change lanes, but another vehicle is competing for the same space, causing a prolonged stall in traffic movement and inordinate backups. As a remedy, staff re-coded the entry links to individual lanes that carried similar routes onto the multi-lane cross section by inserting multiple connectors (an example of the treatment includes eastbound traffic entering the modeled network from the Pennsylvania Turnpike’s toll plaza).

At several locations, stop signs were replaced with a reduced-speed area to more accurately reflect actual conditions and eliminate unrealistic queues. Where input volumes on the local road network were approaching, or at capacity, links were split to separate turning vehicles from through vehicles. This was done to eliminate unnecessary and disruptive weaving and lane changing (and, as an example, was used at the Belmont Avenue / Green Lane Interchange). *Lane Change Distances* were also adjusted to ensure vehicles would be in the appropriate lane to follow their routes.

### DATA COLLECTION

*Data Collection Points* were inserted on links throughout the network to correspond with the data collection effort and database record numbers (i.e., the NewID2 locations) and data obtained from the INRIX Vehicle Probe Project (VPP) Suite. Data for mainline and ramp volumes, mainline spot speed, and mainline operating speeds / travel time was extracted from the networks via the software’s “evaluations” command. Spreadsheets were set up to tabulate and contrast the output with measured data utilizing the following output files: .mes (for volumes and spot speed) and .rsz (for travel times / operating speeds). The data was collected, summarized, and analyzed in 15-minute intervals for the full simulation period to help guide the calibration process. Performance measures were reported 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).

<sup>5</sup> Italicized words are VISSIM modeling terms.



### DESIRED SPEED DECISIONS

For the local streets, a small range (+/-2 miles per hour) was used for desired speed distribution around the actual speed limit, because accuracy of this measure on the local network was not essential. For mainline speeds, free-flow speeds were inserted at all of the locations corresponding to the data collection locations / Traffic.com sensor locations (for spot speeds). Initially, this speed was derived from a computed value that represented unimpeded conditions (for example, travel speeds at 3:00 AM). However, this method resulted in operating speeds that were generally too high. Subsequently, a more representative threshold—average speed, computed from actual data at each location during each modeling period—was inserted. The method improved modeled results for both spot speeds and operating speeds without adversely affecting assigned volumes.

### REFINED CALIBRATION

Default driver behavior values and parameters were adjusted in VISSIM as necessary; they were not changed arbitrarily. Each location was calibrated on an individual basis to achieve counted throughput. For more complicated lane drops, merging, and weaving areas, refined adjustments were made to the driver behavior parameters. Typically, *Headway Time (CC1)* and *Following Variation (CC2)* were reduced for “Following,” while *Minimum Headway* and the *Safety Distance Reduction Factor* were reduced for “Lane Change.”

### CALIBRATION RESULTS

Aspects of the VISSIM simulations pertaining to volumes were modified and refined. Because the on-ramp volumes were fed through the local street network, adjustments were made, as necessary, to match the on-ramp volumes in VISSIM to the current 2010 volume. Most of these adjustments involved increasing the turning speeds of vehicles, to increase vehicle throughput at the traffic signal, and decreasing the safety factor to reflect more aggressive driving.

The calibration goal (+/-5 percent) for all on-ramps and the mainline was ultimately realized. Only minor changes were made to the mainline headways and following distances for calibration purposes, mostly to replicate localized congestion. It should be noted that the off-ramp volumes, which come directly from the VISUM model's assignment, were not adjusted, and no manual changes were made to the regional travel demand forecasting model's trip tables. In the end, and in aggregate, off-ramp volumes, too, fell within 5 percent of current 2010 traffic volumes.

### 2035 NETWORK

The network was adjusted to account for the new westbound ramps at the Henderson and South Gulph Roads (i.e., Interchange #329). Time period vehicle routes and vehicle inputs, from VISUM and the **ANMtranslation.xls** workbook, were copied into the appropriate VISSIM model, and the models were re-executed.

Local street and intersection network traffic volumes were ultimately eliminated from the 2035 VISSIM networks and simulations because turning movement volumes through the intersections were not accurately reflecting the influences of the Year 2035 VISUM model. Traffic signals at the ramp termini were kept in the models and set to max recall, in order to determine if queues on off-ramps would impede mainline traffic conditions. At stop-sign-controlled ramp terminals, a reduced-speed area was inserted on the ramp to mimic current 2010 throughput.

The 2035 networks were checked for integrity and the models were re-run. Data collection steps were repeated along the mainline and ramp network. Key operating hour traffic volumes, mainline spot speed, and mainline operating speeds / travel time data were extracted from the models and tabulated for reporting purposes.

### OUTPUT DATA

VISSIM products were supplied in the deliverables.

### FILE MANAGEMENT

VISSIM inputs and products, including loaded networks and .mes and .rsz files emanating from network evaluations, were added to the appropriate sub-folder in: Deliverables\4\_VISSIM\. The .mes and .rsz files were reformatted as necessary and linked to the database for use with **Compare.mdb** and the other analytical tools in: Deliverables\5\_Database and VISSIM Analytical Tools\.



**DELIVERABLES:**

All project data and models have been provided to PennDOT in electronic formats as the deliverables, including:

- ❑ traffic counts, corridor mapping, signalized intersection condition diagrams;
- ❑ database of current 2010 Conditions: volume, vehicle composition, spot speeds;
- ❑ 2010 Operating Speed / Travel Times for 10 defined segments in each direction of the Expressway;
- ❑ Year 2010 and Year 2035 VISUM regional models with selected outputs saved to the project database;
- ❑ Year 2010 and Year 2035 VISSIM operational models with appropriate outputs saved to the project database;
- ❑ **FINAL REPORT**—overview and summary of the project; and
- ❑ **USER'S GUIDE** (this document)—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.

Year 2010 modeling output files equate with DVRPC's best and final effort at calibrating the models with current conditions. Year 2035 modeling outputs reflect the influences of regional population and employment growth, and planned and programmed transportation projects included in DVRPC's current Long-Range Plan.

Technical documentation for four DVRPC staff-developed applications is included in this report:

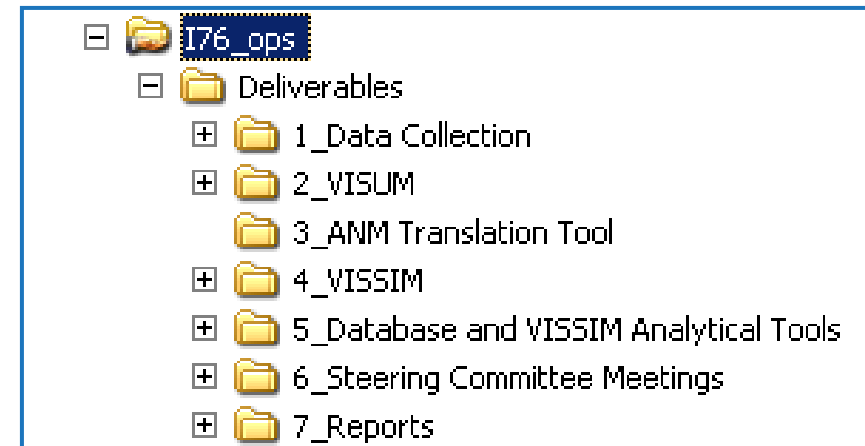
1. ANM Translation (**ANMtranslation.xls**);
2. Performance Change Calculator (**Compare.mdb**);
3. Spot-Speed Tabulator (**SpotSpeedTabulatorTool.xls**)—formatted calculator for Peak Hour speed readings at 41 defined locations along the Expressway and in the modeled operational networks; and
4. Operating Speed Tabulator (**OperatingSpeedTabulatorTool.xlsx**)—formatted calculator for Peak Hour speed readings for 10 segments in each direction along the Expressway and in the modeled operational networks (Expressway-level summary of operating speeds and travel times also supplied).

DVRPC staff will provide technical support of the models as requested by PennDOT.

**DIRECTORIES AND FILE DESCRIPTIONS**

Products were supplied in a portable flash drive, organized with an overall folder structure shown in **Figure 8**.

**Figure 8: Directory for Project Deliverables**



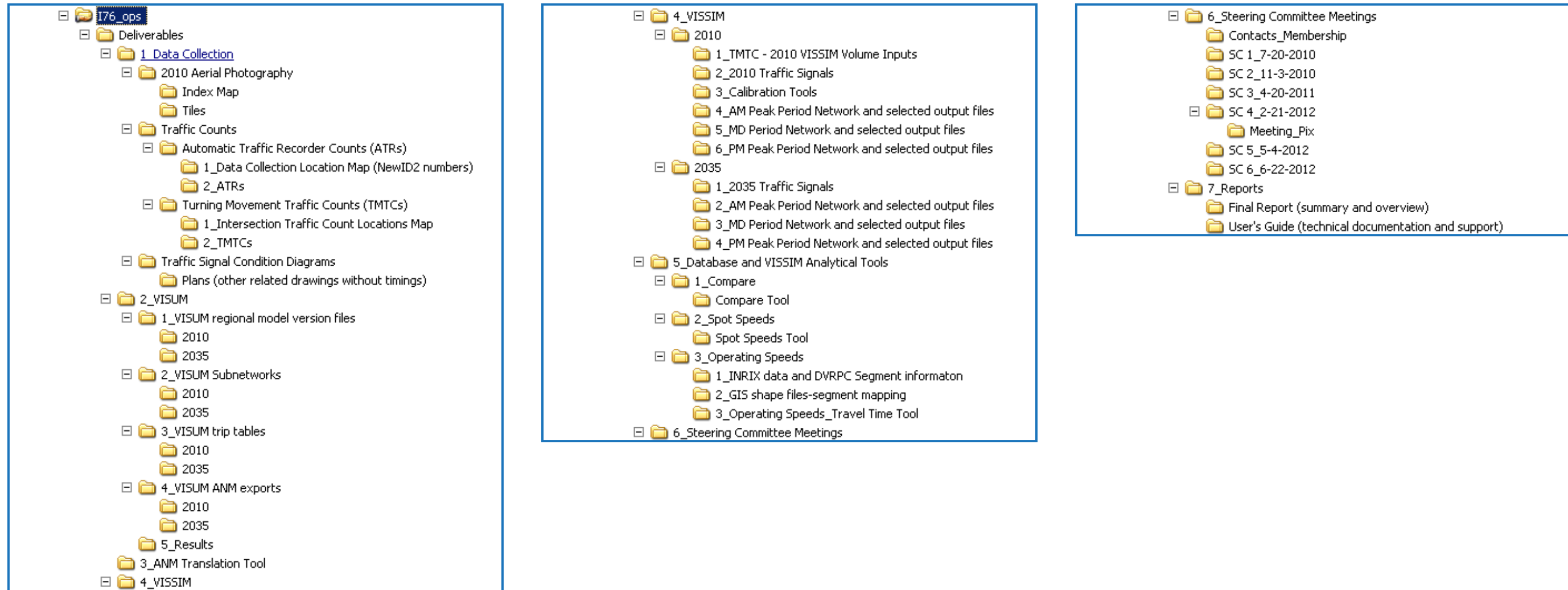
Source: DVRPC

Necessary component files were copied into sub-folders within the Deliverables file structure, to further organize the various files needed to use the models or to contain the products emanating from the project (**Figure 9**). Brief descriptions of the contents of the sub-folders (files, tools, etc.) follow.





Figure 9: Sub-directories of Project Deliverables



Source: DVRPC



## 1\_DATA COLLECTION

- **2010 Aerial Photography:**
  - Index Map—corresponding to the DVRPC aerials used in the project (.pdf); and
  - Tiles—I-76 Corridor aerials (.bgr and .sid).
- **Traffic Counts**
  - **Automatic Traffic Recorder Counts (ATRs):**
    1. 1\_Data Collection Location Map—corridor map identifying locations of NewID2 database record numbers for referencing ATRs locations (.pdf); and
    2. 2\_ATRs—referenced to NewID2 record number\_DVRPC count record number, counts summarized to clock hours (.pdf).
  - **Turning Movement Traffic Counts (TMTCs):**
    1. 1\_Intersection Traffic Count Locations Map [and locations list] (.pdf)—Figure 9 from the **FINAL REPORT**; and
    2. 2\_TMTCs—key intersection identifier number, original and extended-continuous counts in 15-minute intervals (.xls).
- **Traffic Signal Condition Diagrams:**
  1. Plans (other related drawings without timings)—permit drawings for signalized intersections, keyed to key intersection number (.pdf).

## 2\_VISUM

Regional models include the Year 2010 and forecasted Year 2035 scenarios. The files document the TAZ structure, transportation networks, and population and employment forecasts as they were employed as an influence to the operations modeling. VISUM outputs include traffic forecasts (Daily, and AM Peak, Midday, PM Peak, and Nighttime Periods) for the Expressway-level sub-network. These are saved to the database. Other VISUM outputs served as direct inputs to guide the operational modeling. These included flow rates or representative hourly volumes entering the network and routes to downstream off-ramps. The latter outputs (entering volumes and routes) were transferred to the VISSIM modeling via the ANM Translation step.<sup>6</sup>

The regional models were also supplied to support potential further studies, such as examining nighttime operations, broadening the study area, or expanding the set of strategies for investigation.

- **1\_VISUM regional model version files (2010 and 2035)**—loaded regional models for calibrated Year 2010 and Year 2035 forecasted conditions (.ver):
  - \_AM: AM Peak Period (7:00 AM–9:00 AM);
  - \_MD: Midday Period (9:00 AM–3:00 PM);
  - \_PM: PM Peak Period (3:00 PM–6:00 PM);
  - \_EV: Nighttime (6:00 PM–7:00 AM); and
  - \_PK: the combined peak period.
- **2\_VISUM Subnetworks (2010 and 2035)**—loaded network sub-cuts from the Year 2010 and Year 2035 regional models to perform Expressway-level regional modeling (.ver):
  - \_AM\_: AM Peak Period (7:00 AM–9:00 AM);
  - \_MD\_: Midday Period (9:00 AM–3:00 PM);
  - \_PM\_: PM Peak Period (3:00 PM–6:00 PM); and
  - \_EV\_: Nighttime (6:00 PM–7:00 AM).

[Note: No combined peak prepared.]
- **3\_VISUM trip tables (2010 and 2035)**—Year 2010 and Year 2035 sub-network entry point to exit point trip tables (.txt):
  - AM Peak Period (7:00 AM–9:00 AM);
  - Midday Period (9:00 AM–3:00 PM);
  - PM Peak Period (3:00 PM–6:00 PM); and
  - Nighttime (6:00 PM–7:00 AM).

[Note: No Nighttime VISSIM model prepared.]
- **4\_VISUM ANM exports (2010 and 2035)**—Year 2010 and Year 2035 sub-network entry vehicle inputs and routes; used as imports to ANM Translation step (\_Network.anm and \_Route.anmroutes):
  - AM Peak Period (7:00 AM–9:00 AM);
  - Midday Period (9:00 AM–3:00 PM);
  - PM Peak Period (3:00 PM–6:00 PM); and
  - Nighttime (6:00 PM–7:00 AM).

[Note: No Nighttime VISSIM model prepared.]
- **5\_Results**—files documenting the Year 2010 model calibration; the Year 2010 and Year 2035 models' traffic assignment results (.pdf and .xls).

<sup>6</sup> See discussions in “THE ANM TRANSFER—CONNECTING VISUM AND VISSIM” section of this report.



### 3\_ANM TRANSLATION TOOL

- five files for translating / transferring / using the ANM tool:
  - ANMtransfernetnetwork.inp—a “dummy” VISSIM network for importing finalized loaded VISUM networks, and subsequently to provide the inputs for the ANM Translation workbook;
  - **ANMtranslation.xls**—workbook for factoring, formatting, and transferring between the modeling platforms: VISUM (output) to VISSIM (input);
  - ANMtransfernetnetwork.panm—the network data file for the ANM process;
  - ANMtransfernetnetwork.panmRoutes—the routes data file for the ANM process; and
  - Vissim.ini—an initialization file that stores the program’s user display attributes.

### 4\_VISSIM

- **2010:**
  - 1\_TMTC - 2010 VISSIM Volume Inputs—factored intersection turning movement counts for Year 2010 vehicle inputs, arranged by interchange / intersection number [per Figure 9 in the **FINAL REPORT**] (.xls);
  - 2\_2010 Traffic Signals—inputs for VISSIM’s Year 2010 signal operations (phasing, timings, etc.) at individual intersections for each modeling period (.sig and .rbc);
  - 3\_Calibration Tools—spreadsheets developed and used to calibrate Year 2010 network volumes for the AM\_, MD\_, and PM\_ Periods (.xls and .xlsx); and
  - 4\_AM Peak / 5\_MD / 6\_PM Peak Period Network and selected output files—loaded, executable file for the referenced simulation (.inp), and output files for performance measurement for volumes and spot speeds (.mes) and for travel times / operating speeds (.rsz) from the referenced simulation.
- **2035:**
  - 1\_2035 Traffic Signals—inputs for VISSIM’s Year 2035 signal operations (phasing, timings, etc.) at individual intersections for each modeling period (.sig and .rbc); and
  - 2\_AM Peak / 3\_MD / 4\_PM Peak Period Network and selected output files—loaded, executable file for the referenced simulation (.inp), and output files for performance measurement for volumes and spot speeds (.mes) and for travel times / operating speeds (.rsz) from the referenced simulation.

### 5\_DATABASE AND VISSIM ANALYTICAL TOOLS

- **1\_Compare:**
  - Compare Tool—**Compare.mdb**: flexible program file for querying and comparing alternate datasets (volumes and/or spot speeds) in self-defined locations, segments and timeframes for current and modeled conditions (.mdb). More explanations follow in “THE TOOL TO COMPARE WITH” section.
- **2\_Spot Speeds:**
  - Spot Speeds Tool—**SpotSpeedTabulatorTool.xls**: formatted spreadsheet for reading / tabulating / comparing / normalizing alternate spot-speed query results (from **Compare.mdb**) at 41 defined points for the three key operating hours (.xls). The delivered spreadsheet is pre-loaded with the DVRPC modeling project data.
- **3\_Operating Speeds:**
  - 1\_INRIX data and DVRPC Segment information—full data download of April and October 2010 sampling data for operating speed / travel time data from INRIX VPP and correspondence between INRIX’ TMC\_codes (locations) and the DVRPC operational model’s reporting segments / ID numbers (.accdb);
  - 2\_GIS shape files-segment mapping—GIS shape files for mapping defined segments (.dbf, .prj, .sbn, .sbx, .shp, .xml, and .shx); and
  - 3\_Operating Speeds\_Travel Time Tool—**OperatingSpeedTabulatorTool.xlsx**: formatted spreadsheet for reading / tabulating / mapping / comparing / normalizing alternate travel time output from VISSIM (.rsz) to provide average operating speeds for defined segments and travel times in each direction along the Expressway for the three key operating hours (.xlsx). The delivered spreadsheet is pre-loaded with the DVRPC modeling project data.

### 6\_STEERING COMMITTEE MEETINGS

- Steering Committee membership and contact information (.pdf); and
- meeting hand-outs (.pdf), other meeting materials (.pdf, .ppt, and .jpg), and meeting notes (.pdf) from the project’s six formal meetings.

### 7\_REPORTS

- **Final Report (summary and overview)**—the purpose, activities, analyses, findings, and conclusions of the project (.pdf); and
- **User’s Guide (technical documentation and support)**—this document and file directory guide for the project deliverables (.pdf).





**TOOLS:**

The Schuylkill Expressway (I-76) Operational Research Model project employed VISSIM to simulate the operation of individual vehicles along the Expressway throughout the better part of a typical weekday (7:00 AM to 6:00 PM) for 2010 and forecasted Year 2035 conditions. The program's animation feature provides a visual display of operating conditions on the mainline, ramps, and at important intersections at or near the ramp touchdown points (2010 only). Alternatively, the software's "Evaluation" command supplies the ability to collect and compute a robust set of performance data contained in modeled networks—and, with that, deliver greater analytical depth. Data for specific points, nodes, links, segments, and/or the entire network can be extracted and aggregated for critical timeframes (15-minute, peak-hour, etc.) to serve as a performance indicator for evaluating some aspect of any given network.

To supply more utility, DVRPC staff created a few off-line analytical tools to facilitate simple queries and high-level data skimming for decision makers. Key among them is **Compare.mdb**, which prepares and automates comparisons between current 2010 traffic data and/or model outputs. Via the interface, the analyst can query and compare baseline data and modeled output data for most time intervals, for individual locations, or for user-defined segments. In turn, summarized performance data can be readily accessed and assessed for changes between:

- alternative scenarios – to assess the effects of forecasted growth; and/or
- alternative networks – to judge the effectiveness of conceptual improvements / strategies.

Two simple spreadsheet tools were also prepared that link and evaluate current and modeled spot-speed data, and current and modeled average operating speed / travel time data. Procedures are embedded to normalize modeled outputs with current 2010 conditions. These are:

1. [SpotSpeedTabulatorTool.xls](#); and
2. [OperatingSpeedTabulatorTool.xlsx](#).

Both spreadsheets are set up for predetermined locations and time periods. Locations correspond with the data collection effort, specified in the **FINAL REPORT**. Time periods are the three key operational hours (AM Peak Hour = 7:00 AM to 8:00 AM, Midday Trough Hour = 10:00 AM to 11:00 AM, and PM Peak Hour = 4:30 PM to 5:30 PM).

VISSIM can supply a wide range of individual performance statistics (**Table 3**). The data is accessed via evaluations performed within the software. Program output may be configured differently, depending on the performance measure being sought. Therefore, in order to be universally useful, the database tool must be uniquely formatted to accept the output for all types of evaluations—an inordinate task, given the possibilities. As such, DVRPC staff created a limited set of macros within the **Compare.mdb** performance change calculator to supply straightforward comparisons of modeled datasets that have the same format (.mes—

volumes and spot speeds), with the traffic data obtained through the data collection effort. DVRPC staff applied the tool to help calibrate the Year 2010 VISSIM models, to highlight some network performance changes, and to identify potential case study applications for the models. The latter two points are more fully described in the **FINAL REPORT** and its appendices.

**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 uploading volume or spot-speed data associated with subsequent modeling applications and has been provided in the project deliverables. Technical documentation follows in the "THE TOOL TO COMPARE WITH" section of this report.

**FILE MANAGEMENT**

Tools, and related data files, are contained in the project directory folder: Deliverables\5\_Database and VISSIM Analytical Tools\.



Table 3: VISSIM Evaluation Formats and DVRPC Tools for Modeled Performance Data

❑ **.mes**—Files provide output data for defined data collection points. **Developed directly and indirectly, and used in the Operational Research Model Project** to collect number of vehicles and mean spot speeds. [Tools to use: **Compare.mdb** for user-defined searches on volumes and spot speeds, and **SpotSpeedTabulatorTool.xls** for 41 predetermined spot-speed locations.]

- can be used to collect number of vehicles and mean spot speeds;
- can be configured for any timeframe or interval; and
- can also collect:

- Acceleration	- Occupancy rate of vehicles (passengers/vehicle)
- Total distance traveled of vehicles crossing the point	- # of persons
- Length of vehicles crossing the point	- Queued time

❑ **.rsz**—Files provide travel time outputs for defined segments. **Developed indirectly and used in the Operational Research Model Project** to collect average operating speeds for 10 predetermined segments, and travel times in each direction along the Expressway. [Tool to use: **OperatingSpeedTabulatorTool.xlsx**.]

- output may be formatted for average speeds;
- gives raw or compiled data;
- must define segments;
- can be collected in intervals; and
- standard output provides average travel time (seconds) and the number of vehicles completing the segment.

❑ **.kna**—Files provide outputs for node / intersection analyses. **Not developed for the Operational Research Model Project.**

- can supply:

- Average queue length (all approaches)	- Delay time
- To and from info	- Max queue
- Movements	- # of vehicles
- Delay per person	- # of persons
- Stopped delay	- # of stops
- Other emissions data	

❑ **.npe**—Files supply performance measures for the entire modeled network. **Not developed for the Operational Research Model Project.**

- can only collect one time span at a time; and
- can supply (aggregated / averaged):

- Average delay	- Average # of stops
- Average speed	- Distance traveled
- Travel time	- Average stopped delay
- # of active vehicles	- # of vehicles completing routes
- Other emissions data	

[Notes: All files are named the same as the network's name followed by a unique file extension (.mes, .rsz, etc.). Outputs are given as delimited text files.

Source: DVRPC

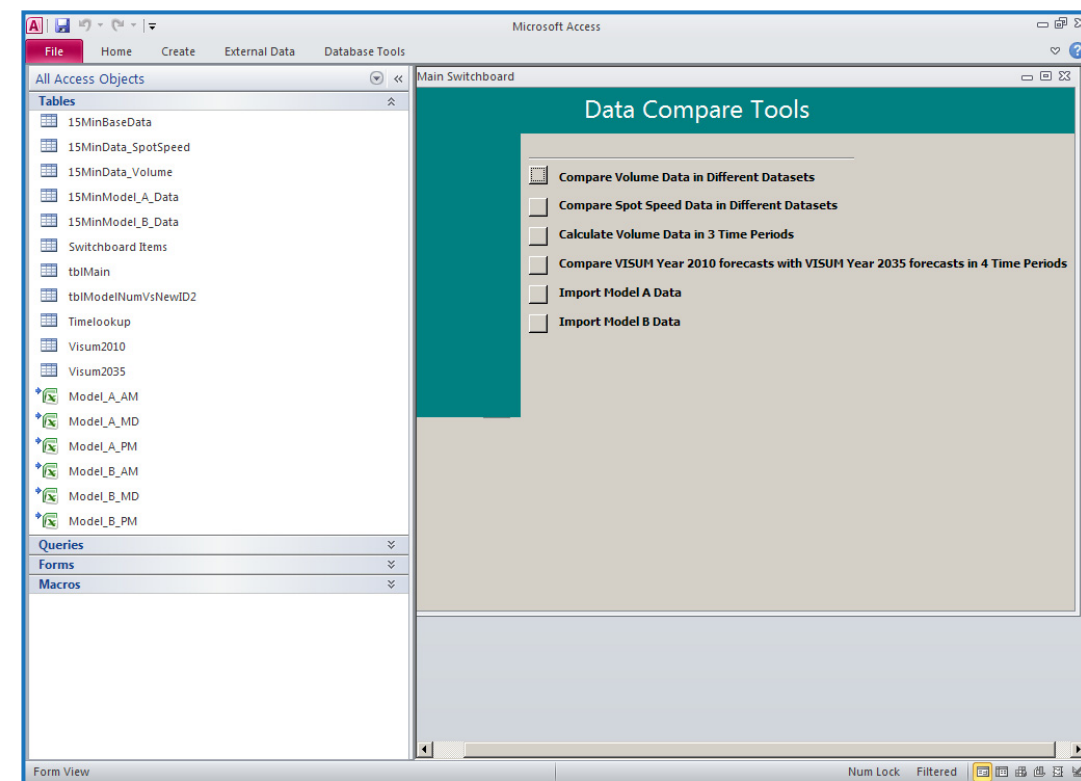


**THE TOOL TO COMPARE WITH:**

**Compare.mdb** (Figure 10) is the database tool configured to function with Microsoft Access and Excel and is formatted to use the data contained in the directory folder: 5\_Database and VISSIM Analytical Tools\1\_Compare\Compare Tool. It processes:

- files created to contain / manage the data collection effort and the current 2010 traffic dataset;
- output files from the VISUM sub-network assignments (Time Period and Daily Total traffic forecasts along I-76's mainline and ramps); and
- output files from VISSIM model evaluations, for point-specific information (total volume and mean spot speed).

**Figure 10: Main Switchboard and Tables Supporting the Compare.mdb Tool**



Source: DVRPC

**LINKED / IMPORTED DATA IN THE DATABASE**

Current 2010 traffic volume and spot-speed data have been imported in the project database (via the tables: 15MinBaseData, 15MinData\_Volume, and 15MinData\_SpotSpeed).

Modeled Year 2010 and Year 2035 data output from VISSIM was transferred from Excel into an Access table in the **Compare.mdb** database. Three steps are necessary to import the model data into the database.

Using the .mes format as the example:

1. Copy the volume and spot-speed data from the .mes format VISSIM output file to ModelDataTemp\_A/B.xls file.
2. Link all three sheets (AM, Midday, and PM) in ModelDataTemp\_A/B.xls to **Compare.mdb**.
3. Run the Import Model A/B Data function from the switchboard.

Upon completion of the above steps, modeled volume and spot-speed data was transferred into the Access table: 15MinModel\_A/B\_Data. This table has the same structure as the base year, current 2010 traffic data table: 15MinBaseData, etc., and thus allows for straight comparisons between datasets. Correspondence tables have been developed and added to the database to relate simulation time to real time (TimeLookup), and data collection point identifiers with the NewID2 record numbering system (tblModelNumVsNewID2).

Year 2010 and Year 2035 traffic assignment results from VISUM (in .xls formats) have been imported to the database (tables: Visum2010, and Visum2035) to access the four Time Period mainline and ramp traffic forecasts.

**FUNCTIONS**

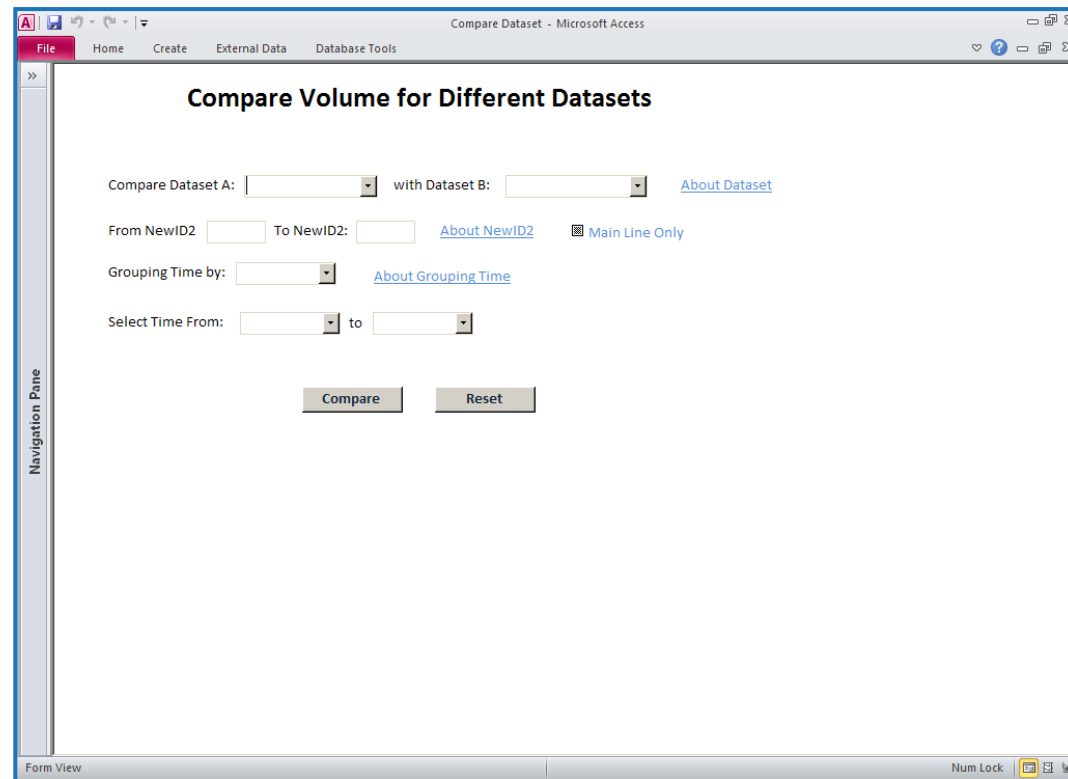
Three data query functions have been automated in the tool:

1. volume comparisons (Figure 11 and Figure 13);
2. spot-speed comparisons (Figure 12); and
3. VISUM forecast comparisons (Figure 14).

Instructions, definitions, prompts, and drop-down menus are provided in each command menu that describe or help identify datasets for selection / comparison. Query results are output in spreadsheet format for subsequent processing with Excel or Access.



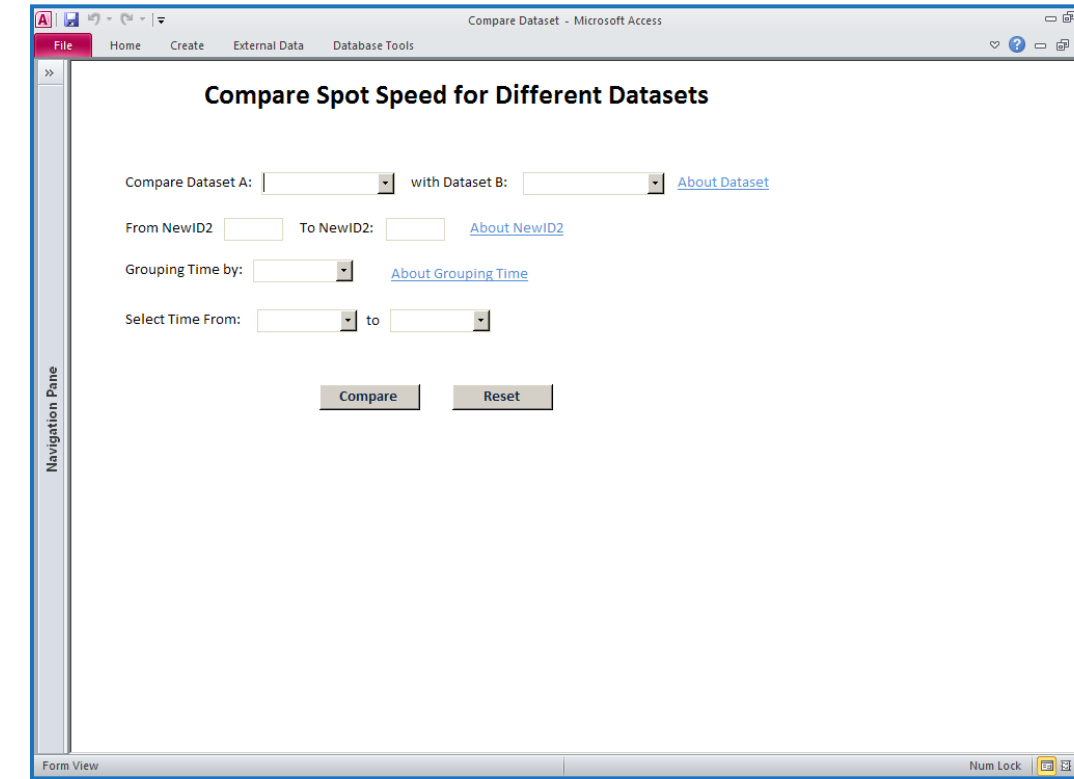
Figure 11: Menu for Volume Comparisons



Source: DVRPC

- Compares current 2010 base year traffic volume and/or one set of VISSIM modeling output volumes (e.g., Year 2010 or Year 2035) with an alternative dataset. [Note: VISUM forecasts are not available through this switchboard item.]
- Output data is referenced to data collection point / NewID2 database record number or may be requested for the mainline only.
- Time intervals are in 15-minute (minimum) increments or able to be aggregated to 30- or 60-minute periods for current 2010 and VISSIM data.
- Self-selected time interval (in 15-minute increments) is available between midnight and 11:59:59 PM for current 2010 volumes. Modeled VISSIM output is available only between 7:00 AM and 5:59:59 PM.
- Predefined aggregations (three Time Periods / four Time Periods) may be obtained via the menu. VISSIM outputs only are available for the three Time Period aggregated dataset. Current 2010 volumes may be obtained in four Time Periods (and compared to VISUM forecasts provided through a subsequent switchboard operation).

Figure 12: Menu for Spot-Speed Comparisons



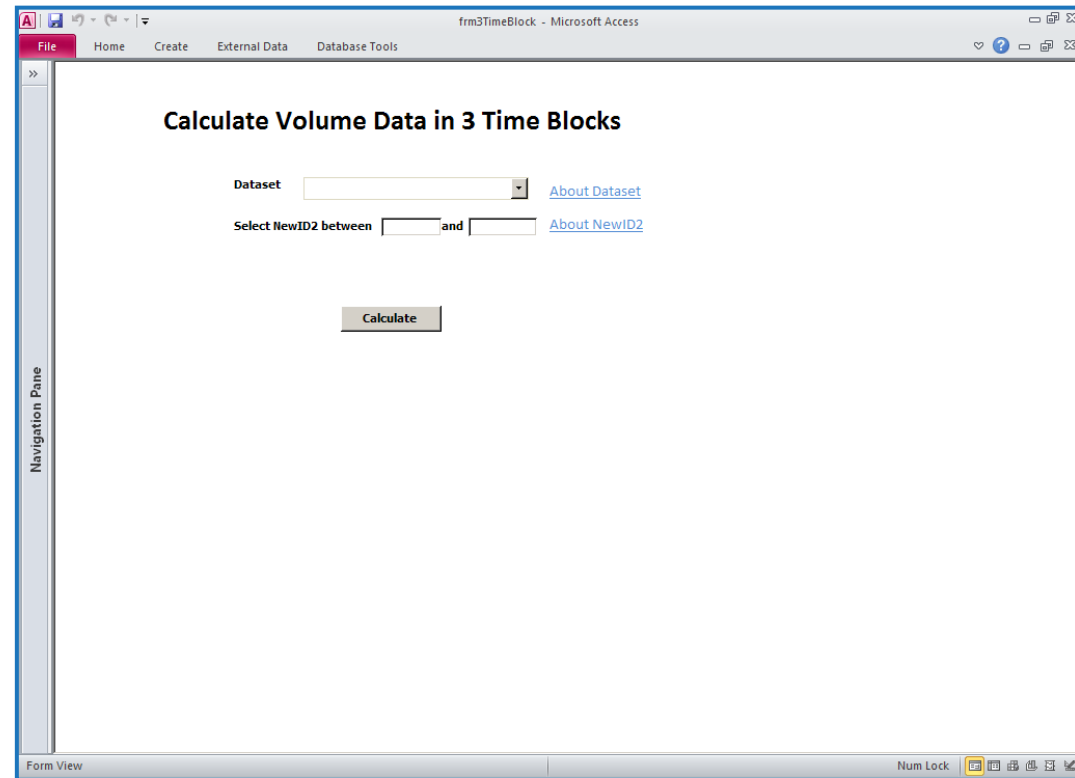
Source: DVRPC

- Compares current 2010 spot speeds and/or one set of VISSIM modeling output (e.g., Year 2010 or Year 2035) with an alternative dataset.
- Output data is referenced to data collection points / NewID2 database record number.
- Time intervals are in 15-minute (minimum) increments or aggregated to 30- or 60-minute periods.
- Self-selected time intervals (in 15-minute increments) are available between midnight and 11:59:59 PM for current 2010 spot speeds. VISSIM output is available only between 7:00 AM and 5:59:59 PM.





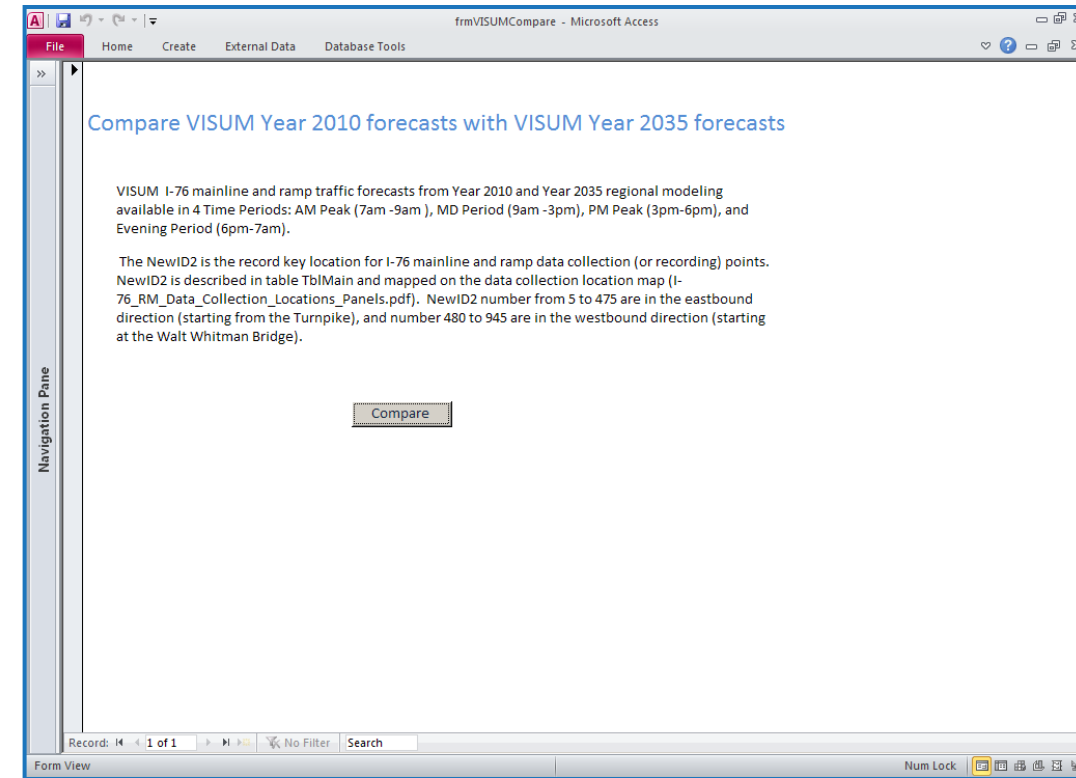
**Figure 13: Menu for Three Time Block Volume List**



Source: DVRPC

- ❑ Provides a single traffic volume dataset view of current 2010 base year or the VISSIM modeling output (i.e., Year 2010 or Year 2035) for the AM Peak / Midday / PM Peak Periods, spanning 7:00 AM to 5:59:59 PM.
- ❑ Output data is referenced to NewID2 database record number.

**Figure 14: Menu for Four Time Block Forecast Comparisons**



Source: DVRPC

- ❑ Provides a one-view comparison of VISUM's Year 2010 and Year 2035 traffic forecasts for four Time Periods (AM Peak / Midday / PM Peak / Nighttime) and supplies Daily total values. Tabulations may be compared to current 2010 volumes, tabulated to four Time Periods, available via a previous switchboard operation.
- ❑ Output data is referenced to NewID2 database record number.





**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 to:

- ❑ determine the effects of growth;
- ❑ 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 for improvement projects.

DVRPC staff complied using PTV Vision Inc.'s integrated regional travel demand forecasting (VISUM) and traffic operations modeling (VISSIM) suite. The Schuylkill Expressway (I-76) Operational Research Model produced a wealth of information for transportation planning and decision-making purposes and required a wealth of information to construct and calibrate for use. In turn, this **USER'S GUIDE** was prepared to inventory, organize, and document the various models, data files, applications, and reports delivered through the project so that subsequent users may understand and use the models as developed.

Technical documentation is enclosed for four special tools prepared to use the models and/or interpret their results:

1. ANM Translation—platform for translating and transferring VISUM output to VISSIM;
2. Compare—flexible calculator for volumes and spot-speed performance measures;
3. Spot-Speed Tabulator—formatted calculator for 41 defined speed-reading locations along the Expressway; and
4. Operating Speed Tabulator—formatted calculator for 10 defined segments in each direction along the Expressway.

All data files and models produced through the project have been supplied to PennDOT in electronic format. It is assumed that the reader has proficiency in these matters and models. More information on the overall project, the results of the modeling steps, and applications of the models is provided in a companion document entitled: **SCHUYLKILL EXPRESSWAY (I-76) OPERATIONAL RESEARCH MODEL—FINAL REPORT** (DVRPC Publication Number 10072).

**MODEL APPLICATIONS / LIMITATIONS**

The delivered product is a starting point, albeit a comprehensive one, for the systematic evaluation of the Schuylkill Expressway corridor. The delivered 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 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 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 in the deliverables to PennDOT.



**DISCLAIMER**

Project deliverables were developed and provided for the expressed use of PennDOT. PennDOT has subsequently directed that copies of the I-76 project models will be made available to member agencies for local applications. Any use of the models will be administered through DVRPC, and DVRPC staff will provide technical support for the models. The models will be treated as open-source materials, so that subsequent users can make changes / additions to the networks, inputs, parameters, etc. to the benefit of the local study, and the I-76 models. Copies of the final models will be returned to DVRPC to maintain (expand / edit) the master copy for subsequent use and/or users.

DVRPC's alternative ANM Translation procedure was developed for a specific purpose: to overcome a project work scope and scheduling challenge and maintain the link between DVRPC's regional model and the operational modeling required for the Schuylkill Expressway (I-76) Operational Research Project.

The operational models and files have been created with VISSIM (release 5.3). VISUM (release 11.5) regional travel demand forecasting models have been supplied to facilitate potential VISSIM exercises and/or other applications that may be defined by PennDOT for the Schuylkill Expressway in the future. Any other use of the VISUM models requires the written consent of DVRPC. Users will need licenses for compatible software releases from PTV Vision Inc. It is expected that the users will have proficiency in these matters and models.

Any observations, questions, or problems encountered with this documentation may be directed to DVRPC staff (**Table 4**).

**Table 4: DVRPC Project Staff Contact Directory**

Name	Subject	Contact Information	
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Source: DVRPC



**PUBLICATION TITLE: Schuylkill Expressway (I-76) Operational Research Model – USER’S GUIDE**

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**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 supporting 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 project models produced a wealth of information for transportation planning and decision-making purposes and required a wealth of information to construct and calibrate for use. In turn, this **USER’S GUIDE** was prepared to inventory, organize, and document the various models, data files, applications, and reports delivered through the project so that subsequent users may understand and use the models as developed. At the conclusion of the project, PennDOT directed that the modeling tools be made available to member agencies for local applications, and that DVRPC be responsible for administering their use.

All data files and models produced through the project have been supplied to PennDOT in electronic format. All data files and models produced through the project are being maintained and will be updated by DVRPC. It is assumed that the reader has proficiency in these matters and models. More information on the overall project, the results of the modeling steps, and applications of the models is provided in a companion document entitled: **SCHUYLKILL EXPRESSWAY (I-76) OPERATIONAL RESEARCH MODEL – FINAL REPORT** (DVRPC Publication Number 10072).

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