DELAWARE VALLEY
dvrpc
REGIONAL
PLANNING COMMISSION

FEBRUARY 2014

US 30
EASTERN RADNOR TOWNSHIP

TRAFFIC *and* CIRCULATION STUDY

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DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

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EXECUTIVE SUMMARY

This study examined existing, proposed, and potential pedestrian and vehicular traffic issues along the US 30 corridor in the vicinity of Villanova University (the "University"). The University currently has plans to redevelop the main parking lot on US 30 into residential student housing. The redevelopment also includes a small retail area, a parking garage, and a performing arts center. This study is an extension of the *US 30 (Lancaster Avenue) Corridor Study: Creating Linkages and Connecting Communities* (December 2011, DVRPC Publication No. 11003), as part of a follow-up effort to formalize the study's recommendation into implementation.

US 30 is a four-lane arterial, serving as the primary east-west route through Radnor Township. It provides access to the Villanova University area and interconnects with I-476 just west of the main campus. US 30 is adversely affected by high traffic volumes, peak-hour congestion, and high-volume pedestrian crossings.

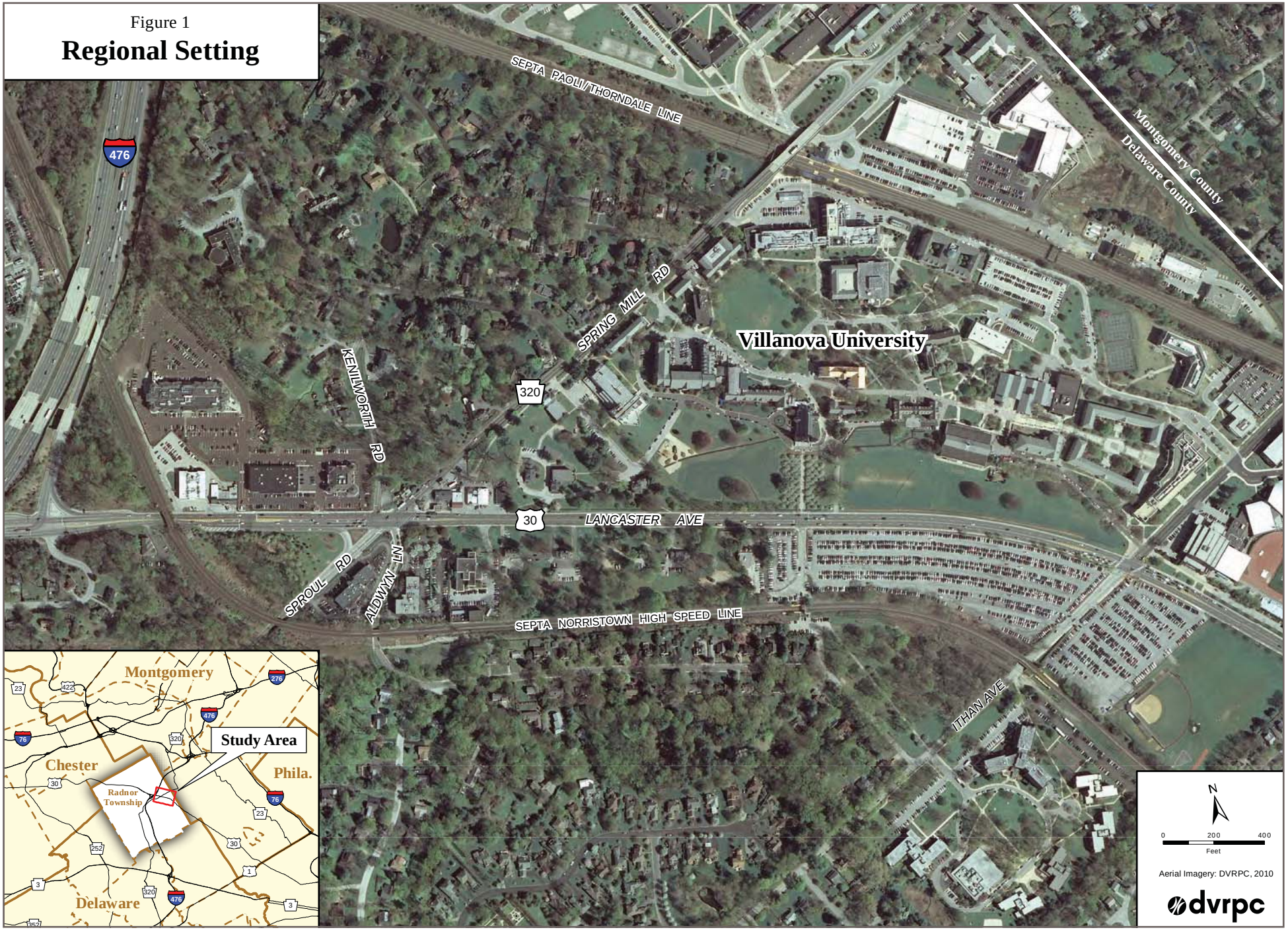
This report examines two key elements of the US 30 study area: pedestrian activity and traffic operations. The pedestrian component is comprised of two elements. The first analizes pedestrian counts crossing US 30 at Church Walk and Ithan Avenue, while the second investigates how pedestrians circulate through Villanova's main campus. For traffic operations, the study area was modeled under existing conditions and various improvement scenarios. Three future-year networks were built: a No-Build, Build 1, and Build 2.

An extensive data collection effort was undertaken, for both pedestrians and vehicles, in the form of pedestrian crossing counts and vehicular turning-movement counts. Existing roadway geometry and signal timing plans were obtained. From this, traffic operations within the study area were assessed under existing conditions, utilizing the VISSIM simulation software.

Improvement scenarios were run in the simulation software with the goal of reducing congestion, decreasing delay at signalized intersections, and creating a safer environment for motorists and pedestrians. Detailed analysis is provided for each of the four signalized intersections in the study area. Simulation output from the existing and future-year networks was tabulated and performance measures were compared across the different scenarios. ●

Figure 1

Regional Setting



CHAPTER ONE:

INTRODUCTION

This project was undertaken to advance specific recommendations of the *US 30 (Lancaster Avenue) Corridor Study: Creating Linkages and Connecting Communities* toward implementation[1]. The study area addressed in this project was highlighted for further development due to concerns that it included the corridor's most congested intersection, is subjected to high levels of pedestrian activity, and was reported to experience excessive vehicular speeds.

PROJECT SETTING

The detailed study area is US 30 (Lancaster Avenue), extending from east of I-476 (the Blue Route) through the Villanova University campus, just east of Ithan Avenue, in Radnor Township, Delaware County, Pennsylvania (**Figure 1**). US 30 is an east-west, four-lane principal arterial highway. The highway serves as a conduit to the Blue Route, Villanova University, and more remote destinations. Within the project limits, Lancaster Avenue is abutted by institutional and suburban-commercial development, surrounded by residential neighborhoods. Villanova University is the dominant institution and a major attraction and traffic generator.

1 *DVRPC Publication No. 11003, December 2011.*

SEPTA's Norristown High Speed Line is aligned along the south side of US 30 and offers two stations on the Villanova campus. SEPTA's Paoli/Thorndale Regional Rail Line also parallels US 30 on the campus's north side. The line's Villanova Station is located in the northwest corner of the campus. Other highways in the immediate area include Spring Mill Road/Sproul Road (PA 320), Ithan Avenue, and County Line Road. These provide access to Villanova's campus, area neighborhoods, and the SEPTA stations. Heavy through-traffic volumes, peaked-traffic demands—oriented to the Blue Route and Villanova University—and high volumes of University-based pedestrians crossing Lancaster Avenue are representative of a typical weekday.

SPECIFIC TRANSPORTATION ISSUES

The *US 30 (Lancaster Avenue) Corridor Study* identified the following shortcomings within the study area:

- High volume of pedestrians crossing US 30 at the Ithan Avenue and Church Walk intersections. The main parking lot for Villanova University is situated along the south side of US 30, across from the main campus. Ithan Avenue and Church Walk provide protected crosswalks controlled by traffic signals.
- Severe traffic congestion at the six-legged, signalized intersection of Lancaster Avenue and PA 320 (Spring Mill Road/Sproul Road) intersection. Complex signal phasing and long cycle lengths contribute to congestion and long queues—particularly on the PA 320 approaches.
- The intersection and surrounding area is a high crash location in the corridor, with 67 crashes between 2004 and 2008.
- The area south of the intersection consists of a large number of cul-de-sacs that are accessible only from PA 320.

More recently, Villanova University has also advanced one of the recommendations of its Master Plan (October 2008), and is pursuing land development approvals to redevelop the parking lots on the south side of Lancaster Avenue into student housing and other campus-oriented uses.

STUDY GOALS

The goals for this study were straightforward and were attained.

1. To identify and assess systemic actions addressing the project area's transportation

shortcomings.

2. To increase chances for success by working collaboratively and cooperatively with the stakeholders responsible for implementation.

Project recommendations were identified through outreach with project stakeholders, and independently by the DVRPC staff.

Implementation of transportation improvements is reliant on acceptance, approvals, and financing by governmental jurisdictions and property owners. Therefore, representatives of Radnor Township, Delaware County, PennDOT, SEPTA, and Villanova University have been directly included in the project's undertakings and fully apprised of its outcomes (See Appendix D). ●

CHAPTER TWO:

PEDESTRIAN CROSSING & CIRCULATION

This aspect of the study focuses on pedestrian activity to Villanova University's main campus from the parking lot adjacent to US 30 Lancaster Avenue. Pedestrian movements from two access points, Church Walk and Ithan Avenue, were evaluated. In addition to measuring student activity, these two count locations lead to the SEPTA Norristown High Speed Line stations on the south side of US 30.

The pedestrian experience in the study area is currently identified by several issues. A high number of pedestrians cross Lancaster Avenue throughout the day.

- There are excessive vehicular speeds (in relation to the 25 mph posted speed limit) during off-peak hours along Lancaster Avenue, which is not ideal for pedestrians.
- Traffic signals at the Church Walk and Ithan Avenue intersections provide safe access to the parking lot from the main Villanova campus. However, during peak hours, the pedestrian signal phase adds to traffic congestion along Lancaster Avenue.

Two facets of Villanova's pedestrian activity were examined and evaluated: volumes and circulation. Both data sets were collected for the purposes of a) identifying pedestrian movement across the campus from the main parking lot, b) understanding pedestrian circulation within the Villanova campus, and c) improving safety for pedestrians and motorists traveling along US 30.

PEDESTRIAN VOLUMES

Pedestrian volumes were gathered by using passive infrared pedestrian counters at the Ithan Avenue and Church Walk intersections. These counters recorded hourly pedestrian movement by direction during a typical week in January 2013, while classes were in session.

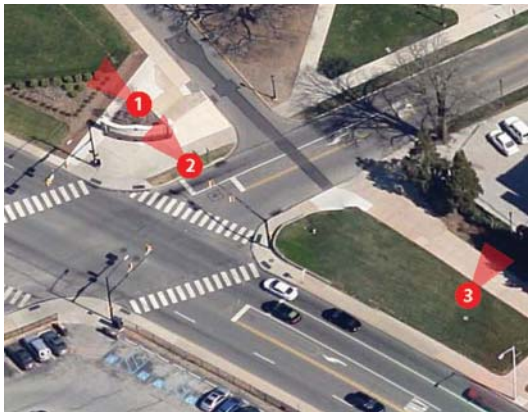
Pedestrian counts by time of day were collected at the Church Walk and Ithan Avenue intersections. A single counter was used at Church Walk, as shown in **Figure 2**. Three counters were used at Ithan Avenue, represented in **Figure 3**, to capture people accessing the campus from the different approaches.

Ithan Avenue serves as the gateway to the campus, while Church Walk is used by many students to get to classrooms in the western end of the campus. It is assumed that the majority of the students traveling from the planned dorms along Lancaster Avenue will use Church Walk to get to classes. As a result, the University has plans to construct a pedestrian overpass at Church Walk.

Figure 2: Church Walk Pedestrian Count Location

Aerial Imagery: Google

Figure 3: Ithan Avenue Pedestrian Count Locations



Aerial Imagery: Google

The pedestrian volumes, collected at Church Walk and Ithan Avenue, were tabulated into hourly totals from 6:00 AM until 10:00 PM and are shown in **Table 1** and **Table 2**. Ninety-seven percent (9,704 trips) of all pedestrians that enter and leave the main campus from Lancaster Avenue on a typical weekday do so during these hours. The northbound trips reflect pedestrians entering the main campus, while southbound volumes represent people leaving. This applies for both locations.

Church Walk accounts for 3,100 trips, while the Ithan Avenue intersection accounts for 6,604 trips. Northbound peak pedestrian activity from the two count locations occurs between 9:00 AM and 10:00 AM.

The highest PM pedestrian volumes from the campus southbound through Church Walk to Lancaster Avenue were 168 trips, recorded between 4:00 PM and 5:00 PM, while the highest total hourly volumes for both directions was 296 trips, between 2:00 PM and 3:00 PM.

Table 1: Church Walk Pedestrian Counter Hourly Totals

Time Period	Combined	Northbound Trips	Southbound Trips
6:00 AM - 7:00 AM	13	11	2
7:00 AM - 8:00 AM	28	25	3
8:00 AM - 9:00 AM	217	206	11
9:00 AM - 10:00 AM	278	239	39
10:00 AM - 11:00 AM	230	181	50
11:00 AM - 12:00 PM	294	207	87
12:00 PM - 1:00 PM	257	138	120
1:00 PM - 2:00 PM	241	127	113
2:00 PM - 3:00 PM	296	131	166
3:00 PM - 4:00 PM	222	78	144
4:00 PM - 5:00 PM	254	86	168
5:00 PM - 6:00 PM	254	104	150
6:00 PM - 7:00 PM	162	91	71
7:00 PM - 8:00 PM	136	41	95
8:00 PM - 9:00 PM	107	21	87
9:00 PM - 10:00 PM	111	39	64
	3,100	**1,724**	**1,368**

Source: DVRPC, 2013

The highest PM pedestrian volume from the campus southbound through Ithan Avenue was 447 trips, recorded between 5:00 PM and 6:00 PM. The highest hourly combined volume through Ithan Avenue for both directions was 698 trips, recorded between 5:00 PM and 6:00 PM.

Overall, the trend is for pedestrians to enter the campus from the Lancaster Avenue parking lots in the AM, with a reverse movement in the PM. There are, however, variations based on location. The predominant movement through Church Walk is northbound from 6:00 AM to 2:00 PM, while the southbound flow is generally the primary movement from 2:00 PM to 10:00 PM. At Ithan Avenue, the predominant movement is northbound from 6:00 AM to 12:00 PM, while the southbound flow is generally the prevalent movement from 12:00 PM to 10:00 PM.

There are a high number of pedestrian crossings at Church Walk. The average of 3,100 trips is significant, and this number is higher during special events.

Table 2: Ithan Avenue Pedestrian Counter Hourly Totals

Time Period	Combined	Northbound Trips	Southbound Trips
6:00 AM - 7:00 AM	36	24	12
7:00 AM - 8:00 AM	108	70	39
8:00 AM - 9:00 AM	447	316	135
9:00 AM - 10:00 AM	589	316	277
10:00 AM - 11:00 AM	367	193	177
11:00 AM - 12:00 PM	541	279	265
12:00 PM - 1:00 PM	530	231	304
1:00 PM - 2:00 PM	425	157	272
2:00 PM - 3:00 PM	577	180	398
3:00 PM - 4:00 PM	481	125	359
4:00 PM - 5:00 PM	474	157	319
5:00 PM - 6:00 PM	698	255	447
6:00 PM - 7:00 PM	370	167	209
7:00 PM - 8:00 PM	294	92	202
8:00 PM - 9:00 PM	404	80	325
9:00 PM - 10:00 PM	265	94	171
	6,604	**2,734**	**3,910**

Source: DVRPC, 2013

PEDESTRIAN CIRCULATION

Pedestrian circulation patterns were recorded with the use of BlueTOAD™ detectors. BlueTOAD™ is a device that detects anonymous MAC addresses, or wireless identifications, which are used to connect signals from Bluetooth devices, such as cell phones. BlueTOAD™ detectors were placed at the Ithan Avenue and Church Walk intersections, in addition to six key destination

points across the campus, to track pedestrian movements. These detectors have an approximate range of 150 feet. All data was analyzed for origin-destination pairs within a 30-minute window. From this, inter-campus route patterns were then plotted.

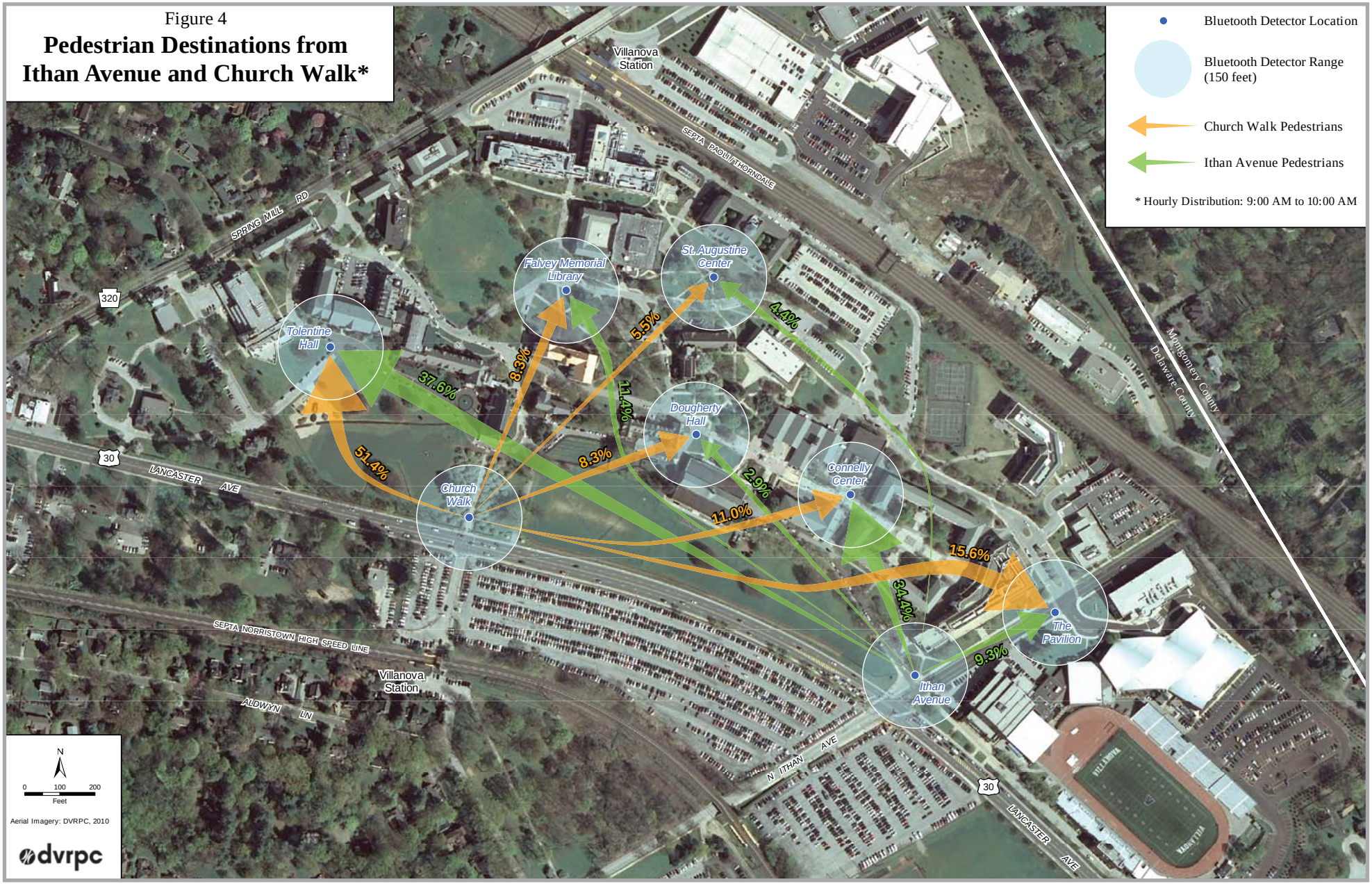
Figure 4 shows the distribution of pedestrian trips, in terms of percentage, from Ithan Avenue and Church Walk to destinations throughout the Villanova campus. The data reflects trips completed during the hour of 9:00 AM to 10:00 AM during a typical day. This hour was chosen because it represents the period of the highest combined pedestrian activity at Church Walk and Ithan Avenue. By observing pedestrian trips within the AM peak, the following patterns were detected.

- At Church Walk, the primary destination for pedestrians was Tolentine Hall, with 51.4 percent. The next major destination was in the vicinity of the athletic facilities by the Pavilion (15.6 percent). The location with the fewest trips was St. Augustine Center, with 5.5 percent.
- The primary destination for pedestrians passing through the Ithan Avenue and Lancaster Avenue intersection northbound was Tolentine Hall, with 37.6 percent of all trips. The second most popular destination from Ithan Avenue was Connelly Center (34.4 percent). The least-traveled destination from Ithan Avenue was Dougherty Hall, with only 2.9 percent of trips.

The hourly distribution of pedestrian origin and destination patterns collected from BlueTOAD™ devices can be found in **Table A-1** and **Table A-2** in the Appendix. From 6:00 AM to 10:00 PM, the northbound pedestrian volumes could be applied to the hourly distributions to determine the number of people heading to each of the destinations. ●

Figure 4

Pedestrian Destinations from Ithan Avenue and Church Walk*



CHAPTER THREE:

TRAFFIC OPERATIONS

Traffic operations were evaluated for the US 30 Lancaster Avenue corridor, extending from just east of the I-476 interchange to just east of the Ithan Avenue intersection. The one-mile long corridor is comprised of four signalized intersections, all within Radnor Township: Villanova Center, PA 320, Church Walk, and Ithan Avenue. US 30 consists of a four-lane cross-section with a 25 mph speed limit east of PA 320, and a 35 mph speed limit from PA 320 to I-476.

The study area is characterized by traffic congestion during peak hours on US 30, high-volume pedestrian crossings at Church Walk and Ithan Avenue, high vehicular speeds, and a complex, six-leg intersection at PA 320. In order to fully evaluate traffic operations, an assessment of existing conditions was performed using the VISSIM software package. This multi-modal micro-simulation allows for collecting intersection and network performance measures. Once existing peak-hour conditions were recreated and calibrated, future-year improvement scenarios were developed.

METHODOLOGY

Automatic Traffic Recorder (ATR) and Manual Turning Movement Counts (MTMC) were conducted in September 2012. The MTMCs were performed at the four key study area intersections. Counts were also taken at the unsignalized US 30 entrance of the Villanova Center, the intersection of Ashwood Road and PA 320, and the driveways serving Sovereign Bank. Additional counts within the study area and at the Villanova parking lot driveways on Ithan Avenue were acquired from F. Tavani and Associates, Inc.

The MTMC's were collected between the hours of 6:00 AM and 9:00 AM, and 3:00 PM and 6:00 PM, during a typical weekday, recording vehicles completing each movement per approach in 15-minute intervals. Via an examination of the turning counts, the network peak hours were determined to be 8:00 to 9:00 in the AM and 5:00 to 6:00 in the PM. Historic ATR counts from DVRPC's database were also used to supplement the September 2012 counts and for quality control purposes.

Speed data was also collected on US 30 between Church Walk and Ithan Avenue, for both the eastbound and westbound directions. Individual vehicle speeds were aggregated into 5 mph bins, and the 85th percentile speed was identified. The results of the speed data are found in **Table B-1** and **Table B-2** in the Appendix.

The ATR and MTMCs were aggregated onto working maps for the respective AM and PM peak-hour conditions. Because the turning movement and ATR counts were not all counted on the same day, efforts were made to keep the integrity of peak-hour conditions. However, small adjustments were made to the raw counts for balance and flow within the network.

The VISSIM software was incorporated for operations testing and to collect intersection and network-wide performance measures. In order to match the geometry on the ground, the VISSIM network was built on top of scaled 2010 aerial photos. Current traffic signal condition diagrams were acquired from PennDOT, and different timing and phasing plans were incorporated for the respective period. Stop signs, yield points, conflict areas, reduced speed areas, and desired speed decisions for the street network were all entered into VISSIM to replicate real-world conditions. It should be noted that the signal timings were verified with field visits. The cycle length and phasing were measured and compared to the timings reflected in signal plans. Isolated discrepancies were found between the two, and

where applicable, field-measured timings were entered into VISSIM.

Once all of the inputs were complete, the base-year VISSIM network was ready to be calibrated. This process involved ensuring that the simulated volumes matched the counted volumes and running the simulations to identify and amend any unusual or unrealistic conditions.

A series of data collection points were inserted on links throughout the VISSIM network. The peak-hour turning-movement counts output from VISSIM were copied into spreadsheets and compared to actual volumes. An iterative process, where slight adjustments were made in terms of volumes and routes in order to better replicate reality, was continued until a reasonable calibration was achieved.

Traffic volumes for the future scenarios were developed using an area-wide growth rate to reflect 2035 conditions. This factor was based on an examination of current and forecast traffic volumes, historical trends in traffic volumes, and DVRPC's Board-adopted population and employment forecasts in the study area. DVRPC's new traffic demand model (TIM2.0), which was recently validated against base-year conditions, was used to support this analysis. From this, a total growth rate of 5.75 percent was added to existing traffic volumes to reflect background traffic growth for the year 2035.

The following is an analysis of the traffic effects of regional growth.

- Traffic increases will be greatest during the PM peak hour.
- Regional growth will be responsible for:
  - One hundred seventy-one additional PM peak-hour vehicles (two-way, total) on US 30, west of PA 320, and 117 additional two-way vehicles on US 30, between PA 320 and Ithan Avenue;
  - Forty-five additional PM peak-hour vehicles on PA 320, north of Lancaster Avenue; and
  - Forty-three additional PM peak-hour vehicles on Ithan Avenue, south of US 30.

The redevelopment of Villanova's parking lot, located on the south side of US 30, is the key factor for creating the traffic volumes in the Build 1 and Build 2 scenarios. According to the Zoning Sketch Plan (May 2012), the main parking lot will be converted into student housing and limited retail. The Plan also outlines a 1,800-space parking garage to be located on the east side of Ithan Avenue, just south of US 30. New driveways on Ithan Avenue are provided to accommodate access points in/out of the garage.

Trip generation and trip distribution characteristics of the University's redevelopment project were based on the change in supply and shift in location of parking spaces between existing and proposed conditions. Existing peak-hour turning-movement volumes to and from the driveways serving the two parking lots were identified, increased by 16.2 percent (to reflect an overall increase from 1,726 to 2,006 parking spaces), and redistributed along current approach routes in proportion to the distribution of parking spaces per the Sketch Plan's parking layout (assuming: all parking is available on a first-come, first-served basis; and a right-in/right-out configuration for the parking garage driveway on Lancaster Avenue, east of Ithan Avenue).

Following is an analysis of the outcome of the traffic assignment procedure.

- Traffic increases will be greatest during the PM peak hour.
- The largest traffic impacts are between driveways and are attributable to vehicles changing parking locations. A maximum increase of 182 total two-way PM peak-hour vehicles will be added to US 30 between

Church Walk and the parking garage driveway, and 175 two-way PM peak-hour vehicles will be added to South Ithan Avenue between US 30 and the parking garage's exit-driveway.

- Traffic volume increases due to the expanded overall parking supply will extend beyond the campus. Immediately removed from parking facility access points, maximum total two-way PM peak-hour traffic volume increases will be 41 additional vehicles along US 30, and 26 two-way PM peak-hour vehicles along Ithan Avenue. The volumes will dissipate as distance from the campus increases.

NETWORKS

One current (2012) and three future-year scenarios were created. The existing conditions, represented as the Base-Year network, were built and calibrated in the process described above. The No-Build represents future-year conditions where no improvements are made to the network. The Build 1 and Build 2 are future-year scenarios representing different improvements throughout the corridor. For the No-Build, Build 1, and Build 2, a horizon year of 2035 was used. AM and PM peak-hour, network-wide turning movements for existing conditions and all scenarios are found in **Figure C-1** through **Figure C-8** in the Appendix.

As previously mentioned, the Base Year network represents traffic patterns and volumes from a typical weekday in 2012 and serve as the current conditions from which future scenarios can be compared. Existing AM and PM peak-hour networks were built and calibrated in VISSIM. The current lane configuration in the vicinity of the US 30 and PA 320 intersection is shown in **Figure 5**.

The No-Build scenario represents future conditions if no improvements or significant changes are made to the network. In this case, a 23-year time horizon was used, or conditions representative of 2035. A total growth rate of 5.75 percent, developed by DVRPC and endorsed by PennDOT, was applied to volumes on US 30, PA 320, and Ithan Avenue. The driveway and side-street volumes throughout the network were held constant.

The Build 1 scenario incorporates the No-Build background 2035 traffic volumes, a representation of the traffic volumes as a result of the Villanova redevelopment, in addition to several traffic-related improvements.

At Villanova Center and US 30:

- The unsignalized entrance into the Villanova Center is converted to a right-in/right-out configuration.
- To better accommodate vehicles accessing the Center, the left-turn lane entering at the western, signalized driveway was lengthened from 70 feet to 110 feet.

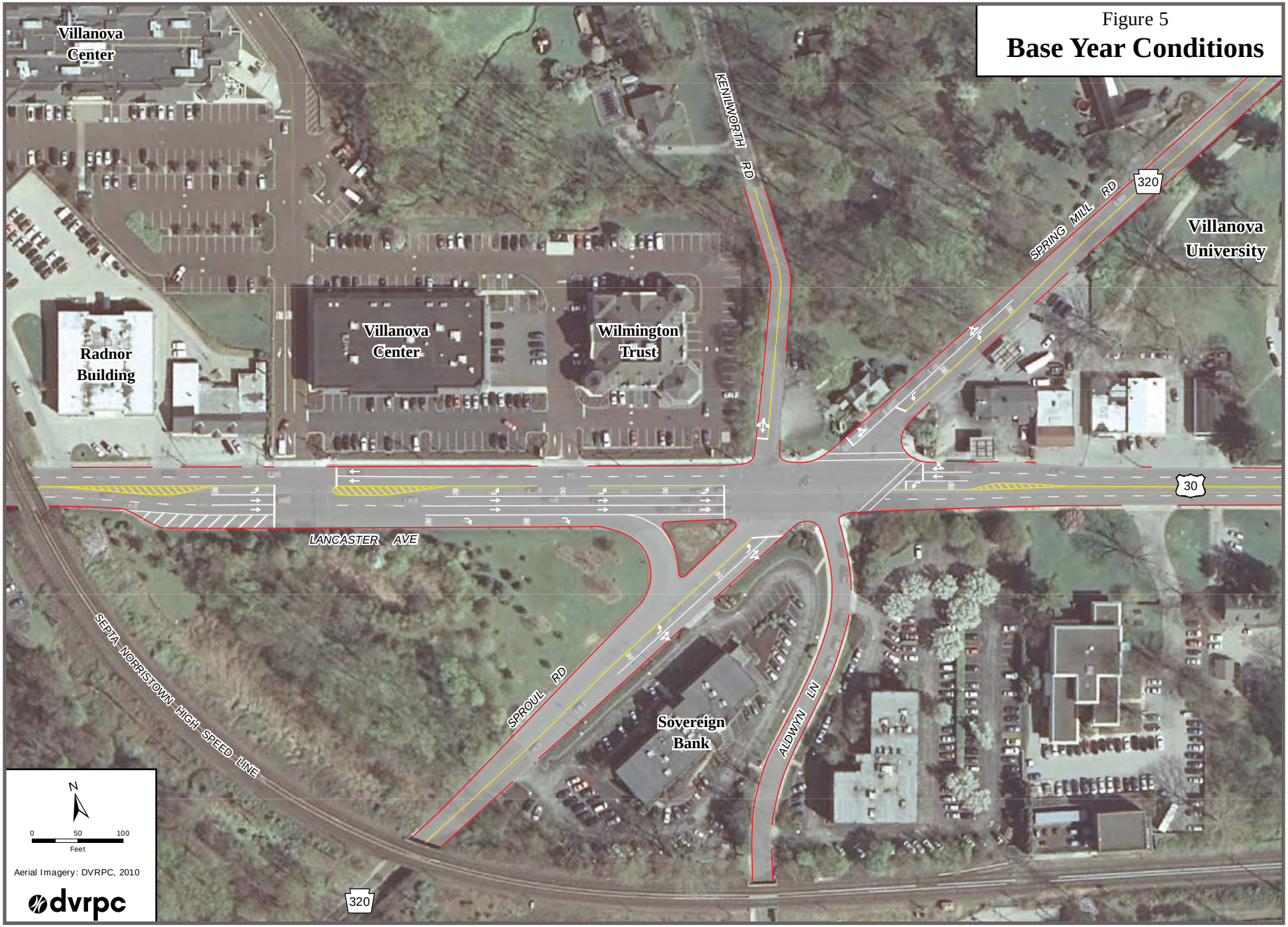


Figure 5
Base Year Conditions
Villanova Center
KENILWORTH RD
SPRING MILL RD
320
Villanova University
Radnor Building
Villanova Center
Wilmington Trust
30
LANCASTER AVE
SEPTA NORRISTOWN HIGH SPEED LINE
SPROUL RD
Sovereign Bank
ALDWYN LN
320
N
0 50 100
Feet
Aerial Imagery: DVRPC, 2010
dvrpc

At PA 320 and US 30:

- The Aldwyn Lane approach is removed from the US 30/PA 320 intersection, with new access provided onto Sproul Road via a short roadway connector.
- Sproul Road northbound is widened to accommodate an additional left-turn lane.
- A separate right-turn lane is added to the southbound approach on Spring Mill Road.
- The left turns on eastbound and westbound US 30 are given a protected-only phase.
- The signal timing has been adjusted to better facilitate traffic flow. Detailed Build 1 improvements for this intersection are summarized in **Figure 6**.

At Church Walk and US 30:

- The street-level crossing is removed in favor of a pedestrian overpass. The traffic signal will only change phases if recalled by a vehicle exiting the Villanova parking lot.

The Build 1 scenario includes the redevelopment of the large, surface Villanova parking lot on the south side of US 30 into student housing. Most of the displaced parking will be provided by a garage located on the southeast corner of Ithan and US 30. To accommodate the shifting traffic volumes, improvements are incorporated at the US 30/Ithan Avenue intersection.

At Ithan Avenue and US 30:

- The left-turn lane on US 30 westbound is lengthened from 120 feet to 200 feet.
- The northbound approach on Ithan Avenue is given a protected lead left.
- Left-turn phases on eastbound and westbound US 30 are given more protected green time.

The Build 2 scenario also includes the Villanova redevelopment. It is comprised of an iteration of the Build 1 scenario, isolating the dual left-turn lanes on northbound Sproul Road. All other lane configurations throughout the network are returned to existing conditions.

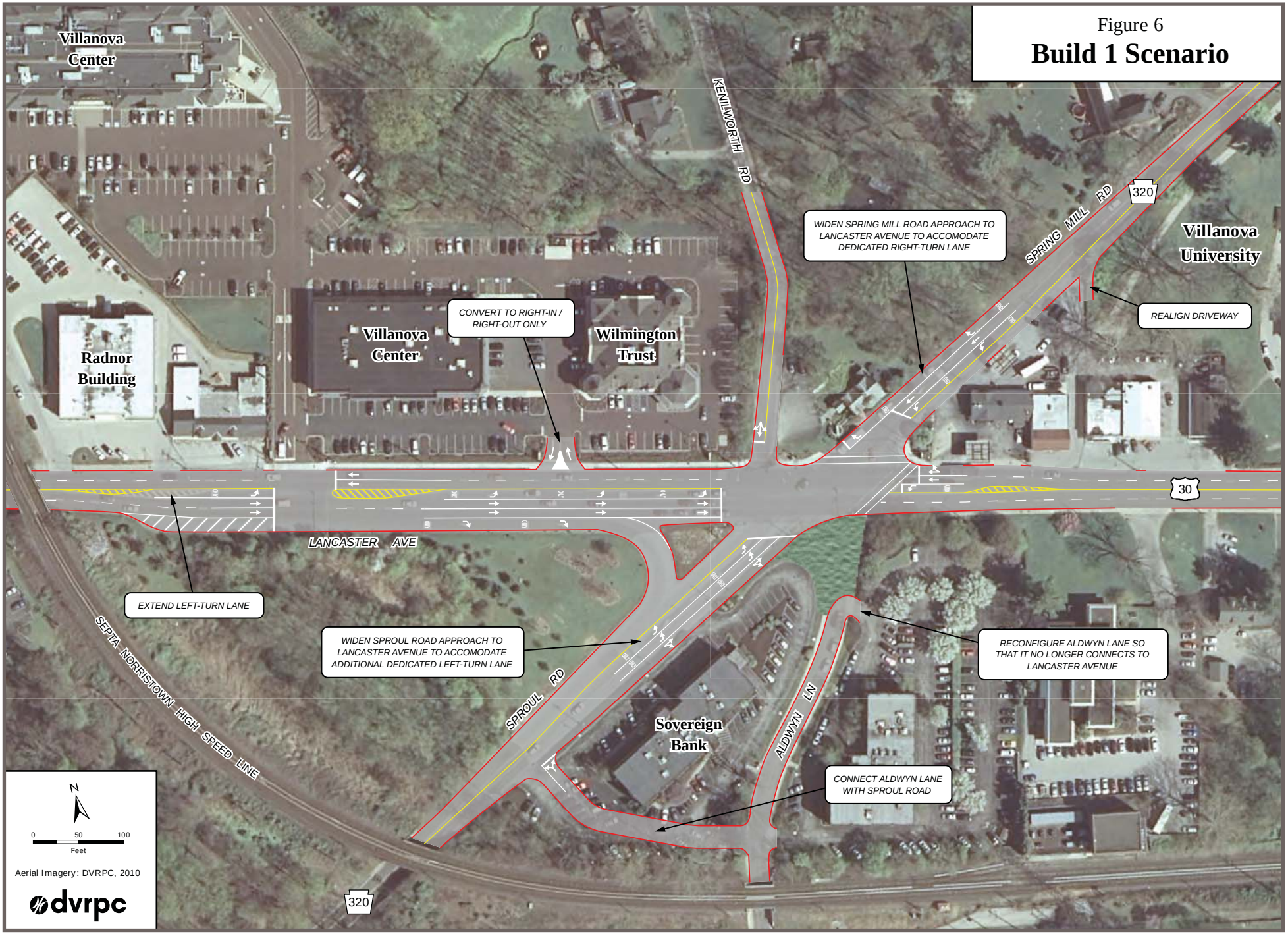
At PA 320 and US 30:

- Sproul Road northbound is widened to accommodate an additional left-turn lane.
- The protected left turns on US 30 remain in the Build 2 scenario and the signal timings are adjusted accordingly. Detailed Build 2 improvements for this intersection are summarized in **Figure 7**.

The background traffic volumes for the Villanova redevelopment are included in the Build 2 scenario. Because this scenario models a single improvement, only performance measures for the US 30/PA 320 intersection were collected. The closure of Kenilworth Road was also explored as a possible intersection improvement. However, it was not supported by the steering committee, and upon testing, was not shown to be a worthwhile improvement.

Figure 6

Build 1 Scenario



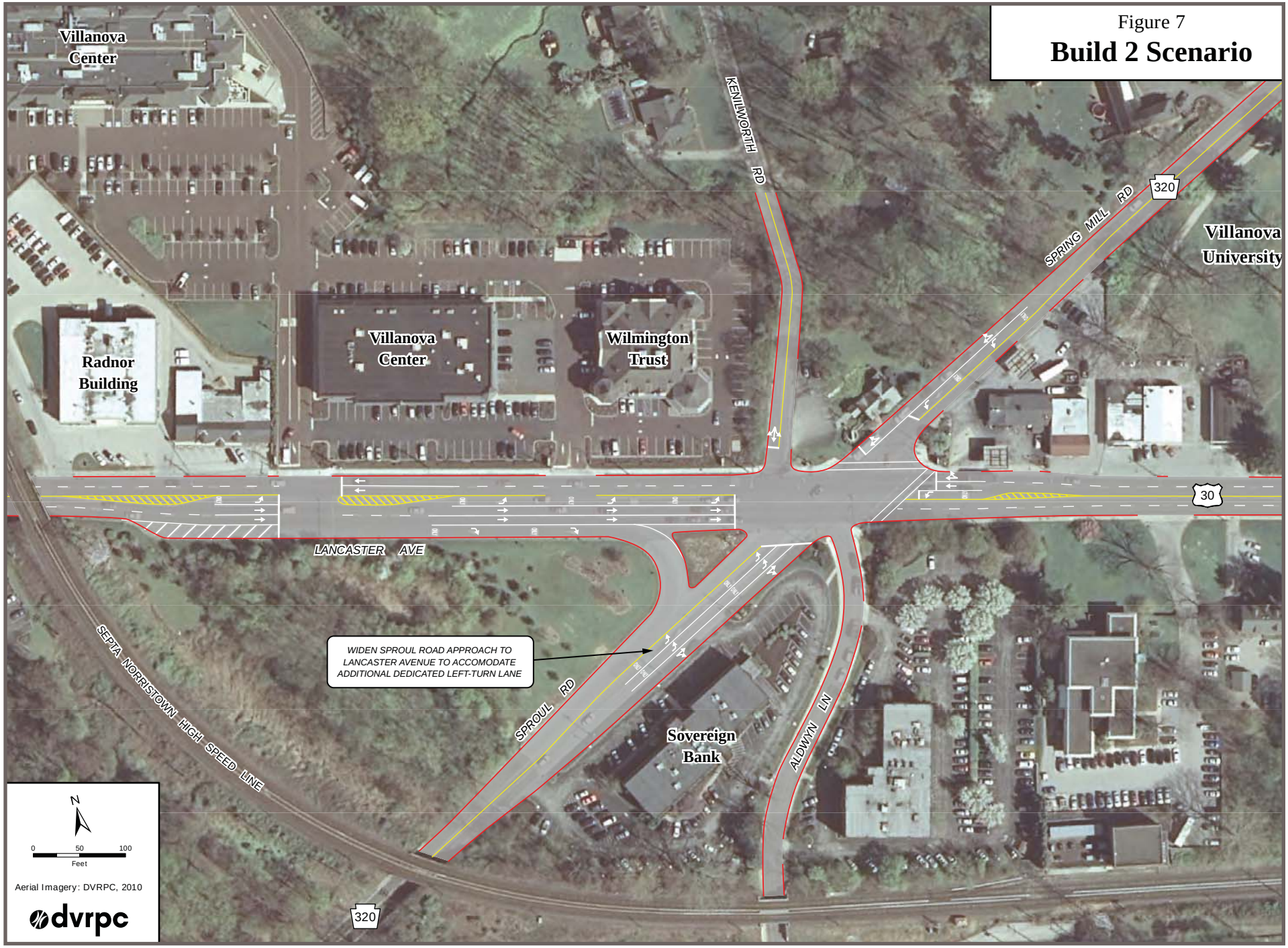


Figure 7
Build 2 Scenario
Villanova Center
KENILWORTH RD
SPRING MILL RD
320
Villanova University
Radnor Building
Villanova Center
Wilmington Trust
30
LANCASTER AVE
WIDEN SPROUL ROAD APPROACH TO LANCASTER AVENUE TO ACCOMODATE ADDITIONAL DEDICATED LEFT-TURN LANE
SEPTA NORRISTOWN HIGH SPEED LINE
SPROUL RD
Sovereign Bank
ALDWYN LN
N
0 50 100
Feet
Aerial Imagery: DVRPC, 2010
dvrpc
320

RESULTS

For each of the three scenarios for the respective AM and PM peak hour, VISSIM simulations were run for a total of 75 minutes, with the first 15 minutes functioning as the model seeding, or warm-up time. The 60 minutes following the seeding serves as the formal modeling period for evaluation.

Performance measures were collected as output from the VISSIM simulations. To replicate conditions for a usual or typical peak period, simulations for 10 random seeds in VISSIM were run and averaged. Performance measures of approach delay (seconds), average queue (feet), and maximum queue (feet) were collected for the four signalized study area intersections. Also listed is the average delay (seconds) for the intersection as a whole. Both intersection and approach delay are assigned Level of Service (LOS) based on Highway Capacity Manual 2010 standards for a signalized intersection.

US 30 & VILLANOVA CENTER

This intersection operates on a 160-second cycle length in the AM and 165-second cycle in the PM and is slightly offset from the US 30/ PA 320 intersection. There is coordination of the westbound US 30 through movement at Villanova Center with the westbound through movement at PA 320. Throughout the future-year scenarios, no changes are made to existing cycle lengths or signal phasing and timings. The intersection performs at LOS A currently and throughout all scenarios, mainly because of the low volume exiting out of the Villanova Center, allowing for longer green times on US 30. In the Build 1 scenario, the eastbound left-turn lane is lengthened by approximately 40 feet to accommodate the closure of the left-turn entrance at the unsignalized Villanova Center entrance (which has been converted to right-in/right-out). Results for the US 30/Villanova Center intersection can be found in **Table 3**.

Although there is some variation in average and maximum queue length, the Level of Service across the scenarios remains relatively unchanged for both the AM and PM peak hour.

Table 3: US 30 Lancaster Avenue & Villanova Center Traffic Performance

Approach and Performance Measure	AM						PM					
	Base Year		No-Build		Build 1		Base Year		No-Build		Build 1	
Lancaster Avenue EB												
Avg Delay (sec) | (LOS)	2.5	A	3.3	A	12.4	B	4.3	A	5.4	A	8.8	A
Avg Queue (ft)	2.2		3.2		55.2		14.2		18.5		26.8	
Max Queue (ft)	162.1		175.8		346.9		281.6		324.6		412.2	
Villanova Center SB												
Avg Delay (sec) | (LOS)	38.8	D	38.4	D	38.5	D	49.1	D	48.9	D	47.4	D
Avg Queue (ft)	3.2		3.2		3.2		27.2		26.9		26.6	
Max Queue (ft)	48.0		48.1		48.0		125.8		120.2		125.6	
Lancaster Avenue WB												
Avg Delay (sec) | (LOS)	0.8	A	0.8	A	0.9	A	2.3	A	2.2	A	3.9	A
Avg Queue (ft)	1.6		1.5		1.5		16.6		19.2		31.7	
Max Queue (ft)	235.4		226.7		204.6		401.2		425.8		555.3	
Intersection												
Avg Delay (sec) | (LOS)	2.0	A	2.4	A	3.5	A	5.1	A	5.5	A	8.0	A

Source: DVRPC, 2012

US 30 & PA 320

This intersection, in terms of volume, is the busiest in the study area. The cycle length for the AM peak is 160 seconds, while the PM is 165 seconds (field observed). The intersection currently performs at LOS D in the AM and LOS E in the PM, as shown in **Table 4** and **Table 5**. The worst delay is found in the PM, at the northbound Sproul Road and southbound Spring Mill approaches. At the Sproul Road approach, there is a high number of left-turning vehicles, occasionally resulting in queues that spill back into the through lane. Additionally, not all queued vehicles make it through the intersection during the green phase. On Spring Mill Road, there is heavy demand at this approach. Vehicles typically wait several cycles before getting through the intersection.

In the No-Build scenario, no changes to the signal timing or physical improvements are modeled, and delay for nearly all approaches and for the intersection increases.

Several modifications take place at this intersection in the Build 1 scenario.

- The Spring Mill southbound approach is widened to accommodate a right-turn-only lane.
- The Aldwyn Lane approach is removed from the intersection and reconfigured to connect into Sproul Road.
- To accommodate the additional volume on the Sproul Road approach, a second northbound left-turn lane is added.
- The cycle lengths remain the same as the Base Year for the AM and PM (160 and 165, respectively); however, the signal phasing and timings are adjusted. The removal of Aldwyn Lane allows extra time to be distributed to other phases without lengthening the cycle length.
- The signal phasing for US 30 eastbound and westbound left turns is changed from protected and permitted to protected only. This is more of a safety issue than an operational issue, as it was observed that vehicles would get 'trapped' trying to turn left as permitted green time for the phase ended.

The decrease in overall intersection delay from the No-Build to the Build 1 is dramatic, especially in the PM peak hour. The additional lanes on southbound Spring Mill Road and northbound Sproul Road reduce approach delay by two-thirds in the PM peak hour. Even with the protected left turn phase, delay on both eastbound and westbound US 30 remains relatively unchanged.

The Build 2 results are also shown in **Table 4** and **Table 5**. The goal of this scenario was to isolate the additional left-turn lane improvement on northbound Sproul Road. Aldwyn Lane is brought back into the US 30/PA 320 intersection and the right-turn-only lane on southbound Spring Mill Road is removed.

Overall, delay is most significantly reduced from the No-Build to the Build 1 scenarios on Spring Mill Road and Sproul Road approaches; delay on US 30 remains relatively stable. The relocation of Aldwyn Lane in the Build 1 scenario allows for additional green times on the other approaches.

Queue lengths along US 30 in the Build 1 scenario remains about the same as current levels. The relocated Aldwyn Lane will connect into Sproul Road approximately 360 feet south of the US 30 intersection. The average queue lengths on northbound Sproul Road are approximately 125 feet for both the AM and PM peak hour. As such, the realignment should not have a major impact on vehicles turning into and out of Aldwyn Lane.

For the Build 2 scenario, the AM results for both approach delay and overall intersection delay fare slightly worse than the Build 1 scenario. In the PM peak hour, three of the approaches fall into Level of Service F and the overall intersection delay is significantly worse. The inclusion of Aldwyn Lane in the Build 2 scenario does not

Table 4: US 30 Lancaster Avenue & PA 320 AM Traffic Performance

Approach and Performance Measure	AM							
	Base Year		No-Build		Build 1		Build 2	
Sproul Road NB								
Avg Delay (sec) | (LOS)	71.2	E	93.8	F	55.6	E	67.0	E
Avg Queue (ft)	234.6		389.5		132.2		141.9	
Max Queue (ft)	890.8		1,265.3		649.3		653.5	
Aldwyn Lane NB								
Avg Delay (sec) | (LOS)	73.3	E	73.0	E	N.A.	N.A.	80.5	F
Avg Queue (ft)	11.7		11.7		N.A.		13.0	
Max Queue (ft)	75.1		78.8		N.A.		82.7	
Kenilworth Road SB								
Avg Delay (sec) | (LOS)	78.2	E	72.1	E	78.3	E	85.4	F
Avg Queue (ft)	8.0		7.5		14.1		8.8	
Max Queue (ft)	74.0		68.4		105.9		71.0	
Spring Mill Road SB								
Avg Delay (sec) | (LOS)	61.1	E	61.8	E	53.9	D	70.3	E
Avg Queue (ft)	60.4		66.6		67.9		83.2	
Max Queue (ft)	388.2		398.2		275.3		540.9	
Lancaster Avenue EB								
Avg Delay (sec) | (LOS)	23.2	C	24.8	C	32.7	C	42.9	D
Avg Queue (ft)	28.0		36.9		75.4		131.9	
Max Queue (ft)	335.1		353.5		363.2		357.0	
Lancaster Avenue WB								
Avg Delay (sec) | (LOS)	34.5	C	36.9	D	38.3	D	45.5	D
Avg Queue (ft)	84.2		99.4		90.8		121.1	
Max Queue (ft)	467.3		597.5		436.3		559.7	
Intersection								
Avg Delay (sec) | (LOS)	39.5	D	45.0	D	36.3	D	45.5	D

Source: DVRPC, 2012

Table 5: US 30 Lancaster Avenue & PA 320 PM Traffic Performance

Approach and Performance Measure	PM							
	Base Year		No-Build		Build 1		Build 2	
Sproul Road NB								
Avg Delay (sec) | (LOS)	124.5	F	205.4	F	68.2	E	76.0	E
Avg Queue (ft)	360.6		798.6		123.1		111.2	
Max Queue (ft)	1,015.1		1,406.6		574.1		447.2	
Aldwyn Lane NB								
Avg Delay (sec) | (LOS)	112.1	F	111.3	F	N.A.	N.A.	130.5	F
Avg Queue (ft)	82.6		82.0		N.A.		106.8	
Max Queue (ft)	257.4		254.1		N.A.		311.2	
Kenilworth Road SB								
Avg Delay (sec) | (LOS)	83.5	F	83.6	F	88.4	F	100.0	F
Avg Queue (ft)	13.8		13.7		14.9		16.8	
Max Queue (ft)	76.9		77.5		85.4		88.4	
Spring Mill Road SB								
Avg Delay (sec) | (LOS)	139.4	F	152.8	F	58.7	E	139.1	F
Avg Queue (ft)	336.6		402.8		87.1		353.8	
Max Queue (ft)	1,118.6		1,188.3		479.6		1,174.5	
Lancaster Avenue EB								
Avg Delay (sec) | (LOS)	28.5	C	28.6	C	38.7	D	52.6	E
Avg Queue (ft)	51.0		56.5		104.4		167.2	
Max Queue (ft)	379.3		373.2		371.4		636.4	
Lancaster Avenue WB								
Avg Delay (sec) | (LOS)	49.4	D	50.0	D	46.3	D	65.9	E
Avg Queue (ft)	147.4		151.6		142.0		195.6	
Max Queue (ft)	644.8		641.6		611.3		704.7	
Intersection								
Avg Delay (sec) | (LOS)	64.2	E	76.1	E	48.4	D	73.6	E

Source: DVRPC, 2012

allow for this timing to be allocated to other phases. The protected lefts on US 30 also add extra time to the signal cycle length, further exacerbating intersection delay. As an alternative, the protected left turns on US 30 could remain protected plus permitted in the Build 2 scenario. The cycle length would not be lengthened, and delay would be reduced.

US 30 & CHURCH WALK

This intersection operates on a 60-second cycle length throughout the day. For both the Base Year and No-Build, this intersection operates at LOS A in the AM peak hour and LOS B in the PM peak. In the Build 1 scenario as part of the Villanova parking lot redevelopment, a pedestrian overpass is built over US 30 and the street-level crosswalks have been removed. The overpass would provide a safe crossing for Villanova students and transit riders accessing the Norristown High Speed Line. The Build 1 signal cycle length remains the same as the existing timings, though the signal would only be recalled for vehicular traffic. Due to the large parking lot being replaced with student housing, vehicular traffic entering and exiting the Villanova lot will be greatly reduced. As a result, this intersection will experience very little delay in the Build 1 scenario, as shown in **Table 6**.

The overpass would provide a safe crossing for Villanova students and transit riders accessing the Norristown High Speed Line. An attractive overpass for pedestrians has the potential to draw Speed Line passengers away from the Stadium Station to the Villanova Station. The utilization of Stadium Station over time should be evaluated to determine its relevance.

Table 6: US 30 Lancaster Avenue & Church Walk Traffic Performance

Approach and Performance Measure	AM						PM					
	Base Year		No-Build		Build 1		Base Year		No-Build		Build 1	
Villanova Parking Lot NB												
Avg Delay (sec) | (LOS)	7.2	A	7.2	A	5.4	A	11.4	B	11.2	B	8.4	A
Avg Queue (ft)	0.3		0.3		0.0		4.9		4.8		0.6	
Max Queue (ft)	26.4		26.4		21.2		83.8		81.9		25.6	
Lancaster Avenue EB												
Avg Delay (sec) | (LOS)	7.2	A	7.5	A	1.1	A	19.1	B	20.1	C	2.3	A
Avg Queue (ft)	21.8		24.9		1.2		76.9		87.0		7.3	
Max Queue (ft)	434.8		518.4		177.3		576.7		627.6		429.8	
Lancaster Avenue WB												
Avg Delay (sec) | (LOS)	5.2	A	5.9	A	1.0	A	13.1	B	13.4	B	1.7	A
Avg Queue (ft)	11.5		14.0		1.0		38.1		39.2		3.6	
Max Queue (ft)	290.4		328.5		146.3		341.8		347.9		257.9	
Intersection												
Avg Delay (sec) | (LOS)	6.4	A	6.8	A	1.1	A	16.2	B	16.9	B	2.1	A

Source: DVRPC, 2012

The pedestrian overpass will provide a significant enhancement for pedestrians and vehicular delay at this intersection. With low vehicular volumes exiting at Church Walk, the traffic signal will rarely be recalled, providing ample green time on US 30. This would improve overall travel times through the study corridor on US 30 by creating a better opportunity for interconnecting adjacent traffic signals. However, removing pedestrian traffic may also increase the speed of vehicles through this area. To prevent pedestrian/vehicle conflicts, a physical barrier should be in place to prevent pedestrians from crossing US 30 at street level once the overpass is installed.

US 30 & ITHAN AVENUE

The signal at this intersection currently operates on a 120-second cycle, incorporating a 26 second pedestrian scramble phase. The signal at Ithan Avenue did not appear to be coordinated with the signal at Church Walk. The existing intersection LOS is C in the AM and D in the PM. Most approaches experience a slight increase in delay for the No-Build. However, with the majority of the Villanova parking lot converted to student housing, and the new parking garage to be located near the southeast corner of US 30 and Ithan Avenue, much higher traffic volumes are relocated to this intersection in the Build 1 scenario.

To help accommodate the increase, several improvements are introduced.

Table 7: US 30 Lancaster Avenue & Ithan Avenue Traffic Performance

Approach and Performance Measure	AM			PM		
	Base Year	No-Build	Build 1	Base Year	No-Build	Build 1
Ithan Avenue NB						
Avg Delay (sec) | (LOS)	37.5 D	36.2 D	42.2 D	42.8 D	48.1 D	54.5 D
Avg Queue (ft)	21.5	21.6	29.4	39.7	50.0	81.1
Max Queue (ft)	153.2	158.0	175.6	211.3	273.5	416.4
Ithan Avenue SB						
Avg Delay (sec) | (LOS)	37.1 D	38.1 D	52.1 D	39.6 D	42.3 D	59.0 E
Avg Queue (ft)	24.2	27.3	39.0	52.9	63.4	92.5
Max Queue (ft)	183.1	220.0	237.6	306.7	355.3	452.6
Lancaster Avenue WB						
Avg Delay (sec) | (LOS)	25.0 C	26.5 C	30.4 C	31.8 C	34.6 C	30.3 C
Avg Queue (ft)	63.7	71.4	83.9	84.0	93.7	75.5
Max Queue (ft)	325.7	355.8	381.2	365.4	369.0	336.7
Lancaster Avenue EB						
Avg Delay (sec) | (LOS)	32.1 C	33.5 C	40.2 D	35.4 D	37.0 D	59.7 E
Avg Queue (ft)	90.7	101.2	135.9	116.0	128.8	247.8
Max Queue (ft)	521.1	578.6	669.1	573.0	633.0	875.8
Intersection						
Avg Delay (sec) | (LOS)	30.0 C	31.2 C	37.6 D	35.4 D	38.0 D	49.0 D

Source: DVRPC, 2012

- The left-turn lane on US 30 westbound is lengthened.
- The signal phasing is changed to support a protected lead left-turn on northbound Ithan Avenue.
- The cycle length in the Build 1 scenario is increased to 130 seconds in the AM, and 135 seconds in the PM.

Generally, approach delay and intersection delay in the Build 1 scenario increase, most notably on Ithan Avenue during the PM peak hour. The results for the US 30/Ithan Avenue intersection are shown in Table 7. To reduce delay, additional turn lanes may be desirable from a vehicular standpoint at this intersection. Unfortunately, this would increase the crossing distance for pedestrians, thus creating the need to lengthen the pedestrian scramble phase. Improving vehicular operational performance at Ithan Avenue would require shortening or eliminating the pedestrian scramble or further increasing the cycle length.

The queue length on the northbound Ithan Avenue should not have a major impact on the proposed driveway locations for the new parking garage in the Build scenarios. According to the Zoning Sketch Plan (May 2012), an exiting driveway is to be located approximately 250 feet south of the Ithan Avenue intersection, while the simulated average queue lengths for the PM peak hour are only around 80 feet.

It should be noted that the pedestrian overpass at Church Walk would likely shift pedestrians away from the US 30/Ithan Avenue intersection. From a pedestrian perspective, an overpass is a safer and faster way to cross US 30. A shift away from Ithan Avenue may allow for reducing the duration of the pedestrian phase, allocating more time for vehicular traffic at the intersection.

Table 8: AM Network Traffic Performance

Performance Measure	AM			
	Base Year	No-Build	Build 1	Build 2
Average Delay (sec)	62.6	68.4	62.3	77.3
Average Speed (mph)	16.0	15.4	16.5	15.0

Source: DVRPC, 2012

Table 9: PM Network Traffic Performance

Performance Measure	PM			
	Base Year	No-Build	Build 1	Build 2
Average Delay (sec)	82.4	91.8	76.9	105.2
Average Speed (mph)	13.8	13.0	13.9	12.6

Source: DVRPC, 2012

SEPTA's Routes 105 and 106 bus stops at Church Walk would likely be discontinued with the introduction of the pedestrian overpass. These stops would shift to Ithan Avenue, thus any pedestrian improvements at this location would benefit transit passengers.

NETWORK PERFORMANCE MEASURES

Performance measures were also collected for the entire network, allowing for a holistic comparison across the different scenarios. Data is collected for all vehicles across the entire VISSIM network, including the local facilities, for the duration that they are in the simulation.

Average delay in seconds and average speed in miles per hour were collected for the respective AM and PM peak hour, as shown in **Table 8** and **Table 9**. ●

CHAPTER FOUR:

CONCLUSION

Villanova University's Radnor Campus is bisected by US 30. As a result, there is a high number of pedestrians crossing US 30 on a daily basis, both at Church Walk and Ithan Avenue, as confirmed by DVRPC's data collection program. Improving the pedestrian crossing situation coincides with the school's plan to construct a pedestrian overpass at Church Walk.

A number of roadway improvements have been identified and tested within the VISSIM networks at the study area's four signalized intersections, to which varying degrees of intersection performance are realized. The most significant changes are identified at US 30/PA 320. Here, the modifications include adding additional capacity on Sproul Road and Spring Mill Road, eliminating a low-volume approach, and adjusting the signal phasing.

The greatest changes in intersection traffic volumes in the Build 1 scenario take place at US 30/Ithan Avenue. The redevelopment plan to convert the large parking lot into student housing focuses relocated traffic to the US 30/Ithan Avenue intersection. Although several improvements are introduced, increased traffic volumes and a 26-second exclusive pedestrian phase limits intersection performance from a vehicular standpoint.

Currently, the PA 320, Church Walk, and Ithan Avenue intersections all operate on different cycle lengths. From field observations, it was not apparent that signal progression has been implemented on US 30 through the study area. In the future-year Build 1 scenario, in conjunction with Villanova's redevelopment plan, there is an opportunity to coordinate the traffic signals and establish a corridor-wide cycle length. The offsets can also be adjusted to optimize traffic flow at speeds more reflective of a pedestrian-friendly environment.

According to the updated Zoning Sketch Plan (November 2012), the driveways accessing Villanova's administrative offices along the south side of US 30 are to be consolidated. A new access road to the rear of the properties will serve as the new access points for the offices. This will all but eliminate turning vehicles on US 30 between Church Walk and PA 320, reducing conflicts and improving traffic flow. Overall, the moderate traffic improvements decrease approach and intersection delay throughout much of the study area. Improvements identified accommodate the traffic effects of regional growth and Villanova's redevelopment plan. ●

Table A-1: Hourly Distribution of Pedestrian Trips from Church Walk

Time Period	Tolentine Hall	Falvey Memorial Library	St Augustine Center	Dougherty Hall	Connelly Center	Pavillion
6:00 AM - 7:00 AM	51.2%	9.8%	1.2%	13.4%	14.6%	9.8%
7:00 AM - 8:00 AM	75.3%	2.6%	3.6%	2.1%	2.6%	13.9%
8:00 AM - 9:00 AM	50.1%	5.8%	8.8%	12.9%	8.5%	13.8%
9:00 AM - 10:00 AM	51.4%	8.3%	5.5%	8.3%	11.0%	15.6%
10:00 AM - 11:00 AM	48.8%	8.2%	6.6%	11.9%	9.0%	15.6%
11:00 AM - 12:00 PM	55.1%	8.6%	6.4%	10.2%	4.8%	15.0%
12:00 PM - 1:00 PM	60.2%	10.7%	5.3%	9.7%	4.4%	9.7%
1:00 PM - 2:00 PM	55.7%	6.2%	5.2%	14.9%	6.2%	11.9%
2:00 PM - 3:00 PM	63.3%	5.0%	0.5%	15.1%	6.5%	9.5%
3:00 PM - 4:00 PM	68.4%	4.0%	1.1%	9.6%	6.8%	10.2%
4:00 PM - 5:00 PM	76.8%	2.2%	0.4%	8.9%	4.5%	7.1%
5:00 PM - 6:00 PM	61.4%	3.0%	2.0%	12.7%	5.6%	15.2%
6:00 PM - 7:00 PM	59.0%	3.7%	2.5%	16.8%	5.6%	12.4%
7:00 PM - 8:00 PM	61.1%	1.6%	2.4%	18.3%	7.9%	8.7%
8:00 PM - 9:00 PM	73.8%	0.9%	0.0%	11.2%	5.6%	8.4%
9:00 PM - 10:00 PM	74.0%	2.7%	0.0%	4.1%	6.8%	12.3%

Source: DVRPC, 2013

Table A-2: Hourly Distribution of Pedestrian Trips from Ithan Avenue

Time Period	Tolentine Hall	Falvey Memorial Library	St Augustine Center	Dougherty Hall	Connelly Center	Pavillion
6:00 AM - 7:00 AM	18.7%	10.6%	1.6%	6.5%	53.7%	8.9%
7:00 AM - 8:00 AM	30.5%	2.6%	3.6%	1.6%	58.4%	3.2%
8:00 AM - 9:00 AM	26.8%	9.9%	5.9%	1.3%	48.4%	7.8%
9:00 AM - 10:00 AM	37.6%	11.4%	4.4%	2.9%	34.4%	9.3%
10:00 AM - 11:00 AM	32.1%	12.1%	4.8%	0.9%	39.1%	10.9%
11:00 AM - 12:00 PM	38.2%	8.9%	4.6%	2.3%	42.8%	3.3%
12:00 PM - 1:00 PM	36.1%	9.3%	2.4%	1.4%	47.8%	3.1%
1:00 PM - 2:00 PM	29.6%	8.1%	1.5%	0.8%	51.9%	8.1%
2:00 PM - 3:00 PM	38.2%	6.3%	0.8%	1.7%	49.6%	3.4%
3:00 PM - 4:00 PM	42.8%	7.0%	1.6%	0.8%	43.2%	4.7%
4:00 PM - 5:00 PM	29.4%	8.0%	1.0%	1.7%	56.4%	3.5%
5:00 PM - 6:00 PM	42.1%	9.9%	0.4%	0.0%	45.2%	2.4%
6:00 PM - 7:00 PM	36.5%	6.7%	0.0%	0.6%	52.8%	3.4%
7:00 PM - 8:00 PM	29.9%	18.4%	1.4%	0.0%	45.6%	4.8%
8:00 PM - 9:00 PM	33.3%	2.9%	0.0%	0.0%	60.8%	2.9%
9:00 PM - 10:00 PM	31.0%	8.0%	0.0%	0.0%	55.2%	5.7%

Source: DVRPC, 2013

Table B-1: Speed Details: Off-Peak US 30 Eastbound between Church Walk and Ithan Avenue

RECORDNUM: 93042
COUNTDATE: 12-SEPT-12

COUNT TIME	COUNTLANE	0-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-999	TOTAL	CTDIR
12:00 AM	1	0	0	1	5	9	0	0	0	0	0	0	0	0	0	15	East
12:15 AM	1	1	0	2	1	6	3	2	0	0	0	0	0	0	0	15	East
12:30 AM	1	0	0	1	1	2	6	1	1	0	0	0	0	0	0	12	East
12:45 AM	1	0	0	0	2	0	4	1	0	0	0	0	0	0	0	7	East
1:00 AM	1	1	0	0	4	3	3	0	0	0	0	0	0	0	0	11	East
1:15 AM	1	1	0	0	0	2	3	0	0	0	0	0	0	0	0	6	East
1:30 AM	1	0	0	1	2	5	0	3	0	0	0	0	0	0	0	11	East
1:45 AM	1	0	0	0	1	0	2	0	1	0	0	0	0	0	0	4	East
2:00 AM	1	0	0	0	0	3	2	0	0	0	0	0	0	0	0	5	East
2:15 AM	1	0	0	0	1	1	1	3	0	0	0	0	0	0	0	6	East
2:30 AM	1	0	0	0	2	0	3	2	0	0	0	0	0	0	0	7	East
2:45 AM	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2	East
3:00 AM	1	1	0	0	2	0	1	0	0	0	0	0	0	0	0	4	East
3:15 AM	1	1	0	0	1	2	2	0	0	1	0	0	0	0	0	7	East
3:30 AM	1	1	0	0	0	1	1	0	1	0	0	0	0	0	0	4	East
3:45 AM	1	0	0	0	0	3	0	1	1	0	0	0	0	0	0	5	East
4:00 AM	1	0	0	0	0	3	2	0	1	0	0	0	0	0	0	6	East
4:15 AM	1	0	0	0	1	1	0	4	0	0	0	0	0	0	0	6	East
4:30 AM	1	0	0	0	0	0	2	4	0	0	0	0	0	0	0	6	East
4:45 AM	1	0	0	0	2	0	6	3	2	0	0	0	0	0	0	13	East
5:00 AM	1	0	0	0	1	6	3	3	1	1	0	0	0	0	0	15	East
5:15 AM	1	0	0	0	2	3	8	3	1	0	0	0	0	0	0	17	East
5:30 AM	1	0	0	0	2	10	17	1	2	0	0	0	0	0	0	32	East
5:45 AM	1	0	0	0	3	18	15	6	1	0	1	0	0	0	0	44	East
10:00 AM	1	19	7	22	47	75	13	1	0	1	0	0	0	0	0	185	East
10:15 AM	1	22	5	13	53	74	16	1	0	0	0	0	0	0	0	184	East
10:30 AM	1	21	0	7	48	86	23	5	0	0	0	0	0	0	0	190	East
10:45 AM	1	19	4	17	98	68	12	1	0	0	0	0	0	0	0	219	East
11:00 AM	1	21	0	10	33	78	13	6	0	0	0	0	0	0	0	161	East
11:15 AM	1	15	0	14	62	59	17	1	0	0	0	0	0	0	0	168	East
11:30 AM	1	22	3	5	61	67	20	2	0	0	0	0	0	0	0	180	East
11:45 AM	1	19	2	13	70	74	6	1	1	0	0	0	0	0	0	186	East
12:00 PM	1	12	3	20	72	83	20	6	1	0	0	0	0	0	0	217	East
12:15 PM	1	13	3	20	57	72	13	1	0	0	0	0	0	0	0	179	East
12:30 PM	1	13	0	19	83	71	14	1	0	0	0	0	0	0	0	201	East
12:45 PM	1	16	1	25	74	51	14	1	2	0	0	0	0	0	0	184	East
1:00 PM	1	19	26	28	84	49	17	1	0	0	0	0	0	0	0	224	East
1:15 PM	1	13	14	33	63	54	6	0	0	0	0	0	0	0	0	183	East
1:30 PM	1	29	20	34	59	52	5	2	0	0	0	0	0	0	0	201	East
1:45 PM	1	11	0	23	83	50	8	0	0	0	0	0	0	0	0	175	East
2:00 PM	1	18	5	26	74	61	8	0	0	0	0	0	0	0	0	192	East
2:15 PM	1	15	2	26	76	33	10	0	0	0	0	0	0	0	0	162	East
2:30 PM	1	17	0	18	62	93	19	2	0	0	0	0	0	0	0	211	East
2:45 PM	1	17	3	25	82	59	17	1	0	0	0	0	0	0	0	204	East
7:00 PM	1	12	0	4	47	62	14	2	1	0	0	0	0	0	0	142	East
7:15 PM	1	8	0	14	51	47	28	5	1	1	0	0	0	0	0	155	East
7:30 PM	1	8	0	1	44	55	17	6	0	0	0	0	0	0	0	131	East
7:45 PM	1	9	0	5	34	56	20	4	0	0	0	0	0	0	0	128	East
8:00 PM	1	8	0	6	51	39	15	0	2	0	0	0	0	0	0	121	East
8:15 PM	1	2	0	10	37	58	15	3	0	0	0	0	0	0	0	125	East
8:30 PM	1	6	1	5	53	30	14	4	3	0	0	0	0	0	0	116	East
8:45 PM	1	6	0	5	37	31	12	4	0	0	0	0	0	0	0	95	East
9:00 PM	1	4	0	13	49	62	10	0	1	0	0	0	0	0	0	139	East
9:15 PM	1	4	0	3	31	33	25	3	0	0	0	0	0	0	0	99	East
9:30 PM	1	3	0	4	21	43	15	5	1	0	0	0	0	0	0	92	East
9:45 PM	1	2	3	13	25	20	7	1	0	0	0	0	0	0	0	71	East
10:00 PM	1	0	0	6	27	26	16	5	0	0	0	0	0	0	0	80	East
10:15 PM	1	0	0	1	23	23	10	4	0	0	0	0	0	0	0	61	East
10:30 PM	1	1	0	2	9	19	16	4	0	0	0	0	0	0	0	51	East
10:45 PM	1	0	0	0	6	13	21	6	2	0	0	0	0	0	0	48	East
11:00 PM	1	1	0	0	9	19	5	3	2	0	0	0	0	0	0	39	East
11:15 PM	1	0	0	1	4	7	11	2	0	0	0	0	0	0	0	25	East
11:30 PM	1	0	0	0	10	9	6	4	1	0	0	0	0	0	0	30	East
11:45 PM	1	0	0	0	2	7	5	3	1	0	0	0	0	0	0	18	East
	f(x)	431	102	496	1944	2047	638	138	31	4	1	0	0	0	0	5832	4957.2
mean spd in range		7.5	18	23	28	33	38	43	48	53	58	63	68	73	87.5		
		3232.5	1836	11408	54432	67551	24244	5934	1488	212	58	0	0	0	0	170395.5	
	cum f(x)	431	533	1029	2973	5020	5658	5796	5827	5831	5832	5832	5832	5832	5832	29.21734	mean
						85th percentile										5832	

RECORDNUM: 93043
COUNTDATE: 12-SEPT-12

COUNTTIME	COUNTLANE	0-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-999	TOTAL	CTDIR
12:00 AM	2	0	0	1	3	10	4	2	1	0	0	0	0	0	0	21	West
12:15 AM	2	1	0	2	6	6	4	1	0	0	0	0	0	0	0	20	West
12:30 AM	2	0	0	1	4	2	4	0	0	0	0	0	0	0	0	11	West
12:45 AM	2	0	0	1	1	5	2	2	0	0	0	1	0	0	0	12	West
1:00 AM	2	0	0	0	2	2	1	2	0	0	0	0	0	0	0	7	West
1:15 AM	2	0	0	2	2	6	0	0	0	0	0	0	0	0	0	10	West
1:30 AM	2	0	0	1	2	2	2	4	0	0	0	0	0	0	0	11	West
1:45 AM	2	0	0	1	0	6	1	0	0	0	0	0	0	0	0	8	West
2:00 AM	2	0	0	0	0	3	3	2	2	0	0	0	0	0	0	10	West
2:15 AM	2	0	0	0	1	6	1	0	0	0	0	0	0	0	0	8	West
2:30 AM	2	0	0	1	0	1	2	0	0	0	0	0	0	0	0	4	West
2:45 AM	2	0	0	0	1	2	0	1	0	0	0	0	0	0	0	4	West
3:00 AM	2	0	0	0	1	3	2	0	0	0	0	0	0	0	0	6	West
3:15 AM	2	0	0	1	0	2	3	0	0	1	0	0	0	0	0	7	West
3:30 AM	2	0	0	0	2	3	0	0	0	0	0	0	0	0	0	5	West
3:45 AM	2	0	0	1	0	2	3	0	0	0	0	0	0	0	0	6	West
4:00 AM	2	0	0	1	2	1	4	2	0	0	0	0	0	0	0	10	West
4:15 AM	2	0	0	0	0	1	1	1	0	0	0	0	0	0	0	3	West
4:30 AM	2	0	0	1	2	3	1	1	2	0	0	0	0	0	0	10	West
4:45 AM	2	0	0	1	0	2	5	2	2	0	0	0	0	0	0	12	West
5:00 AM	2	0	0	0	2	4	5	4	0	0	0	0	0	0	0	15	West
5:15 AM	2	0	0	0	2	5	7	4	0	0	0	0	0	0	0	18	West
5:30 AM	2	0	0	0	2	6	10	5	0	0	0	0	0	0	0	23	West
5:45 AM	2	1	1	3	6	17	14	10	1	0	0	0	0	0	0	53	West
10:00 AM	2	60	28	23	13	8	4	0	0	0	0	0	0	0	0	136	West
10:15 AM	2	61	40	19	6	5	1	0	0	0	0	0	0	0	0	132	West
10:30 AM	2	57	32	26	14	15	6	1	0	0	0	0	0	0	0	151	West
10:45 AM	2	27	9	6	25	42	36	5	1	0	0	0	0	0	0	151	West
11:00 AM	2	51	33	28	11	27	11	1	0	0	0	0	0	0	0	162	West
11:15 AM	2	54	33	16	14	8	3	0	0	0	0	0	0	0	0	128	West
11:30 AM	2	40	11	21	24	30	14	1	0	0	0	0	0	0	0	141	West
11:45 AM	2	44	12	27	42	30	5	0	0	0	0	0	0	0	0	160	West
12:00 PM	2	40	22	32	24	20	10	4	1	0	0	0	0	0	0	153	West
12:15 PM	2	57	34	21	8	10	3	2	0	0	0	0	0	0	0	135	West
12:30 PM	2	55	15	28	21	32	7	0	0	0	0	0	0	0	0	158	West
12:45 PM	2	88	7	0	0	0	0	0	0	0	0	0	0	0	0	95	West
1:00 PM	2	92	6	8	2	0	0	0	0	0	0	0	0	0	0	108	West
1:15 PM	2	61	22	17	23	13	0	0	0	0	0	0	0	0	0	136	West
1:30 PM	2	53	23	13	28	36	19	0	0	0	0	0	0	0	0	172	West
1:45 PM	2	31	8	10	26	42	9	2	0	0	0	0	0	0	0	128	West
2:00 PM	2	44	29	29	44	20	6	1	0	0	0	0	0	0	0	173	West
2:15 PM	2	60	23	19	2	12	9	1	0	0	0	0	0	0	0	126	West
2:30 PM	2	53	30	16	28	15	3	0	0	0	0	0	0	0	0	145	West
2:45 PM	2	70	30	10	12	5	2	0	0	0	0	0	0	0	0	129	West
7:00 PM	2	54	34	21	15	14	7	2	1	0	0	0	0	0	0	148	West
7:15 PM	2	46	25	19	29	22	3	1	0	0	0	0	0	0	0	145	West
7:30 PM	2	34	23	16	37	22	7	0	0	0	0	0	0	0	0	139	West
7:45 PM	2	21	11	16	29	29	12	2	0	0	0	0	0	0	0	120	West
8:00 PM	2	27	10	9	25	27	18	1	0	0	0	0	0	0	0	117	West
8:15 PM	2	40	20	15	16	17	3	0	0	0	0	0	0	0	0	111	West
8:30 PM	2	30	14	18	26	32	4	1	1	0	0	0	0	0	0	126	West
8:45 PM	2	36	22	6	29	27	12	3	0	0	0	0	0	0	0	135	West
9:00 PM	2	35	30	21	24	18	8	0	0	0	0	0	0	0	0	136	West
9:15 PM	2	25	19	13	14	31	11	0	0	0	0	0	0	0	0	113	West
9:30 PM	2	19	18	12	18	23	6	3	0	0	0	0	0	0	0	99	West
9:45 PM	2	17	10	26	15	16	6	2	1	0	0	0	0	0	0	93	West
10:00 PM	2	8	3	7	25	21	14	1	4	0	0	0	0	0	0	83	West
10:15 PM	2	5	3	9	13	17	11	1	1	0	0	0	0	0	0	60	West
10:30 PM	2	1	5	5	5	10	11	1	0	0	0	0	0	0	0	38	West
10:45 PM	2	1	0	2	7	13	6	3	0	0	0	0	0	0	0	32	West
11:00 PM	2	0	0	1	8	9	6	2	0	0	0	0	0	0	0	26	West
11:15 PM	2	0	0	3	2	9	9	3	1	0	0	0	0	0	0	27	West
11:30 PM	2	0	0	2	8	11	6	2	0	0	0	0	0	0	0	29	West
11:45 PM	2	1	0	3	3	3	14	5	0	0	0	0	0	0	0	29	West
	f(x)	1500	695	611	756	841	401	94	19	1	0	1	0	0	0	4919	4181.15
mean spd in range		7.5	18	23	28	33	38	43	48	53	58	63	68	73	87.5		
		11250	12510	14053	21168	27753	15238	4042	912	53	0	63	0	0	0	107042	
	cum f(x)	1500	2195	2806	3562	4403	4804	4898	4917	4918	4918	4919	4919	4919	4919	21.76093	mean
						85th percentile										4919	

Table B-2: Speed Details: Off-Peak US 30 Westbound between Church Walk and Ithan Avenue

Figure C-1

Current Morning Peak Hour Traffic Volumes
8:00 AM to 9:00 AM - September, 2012

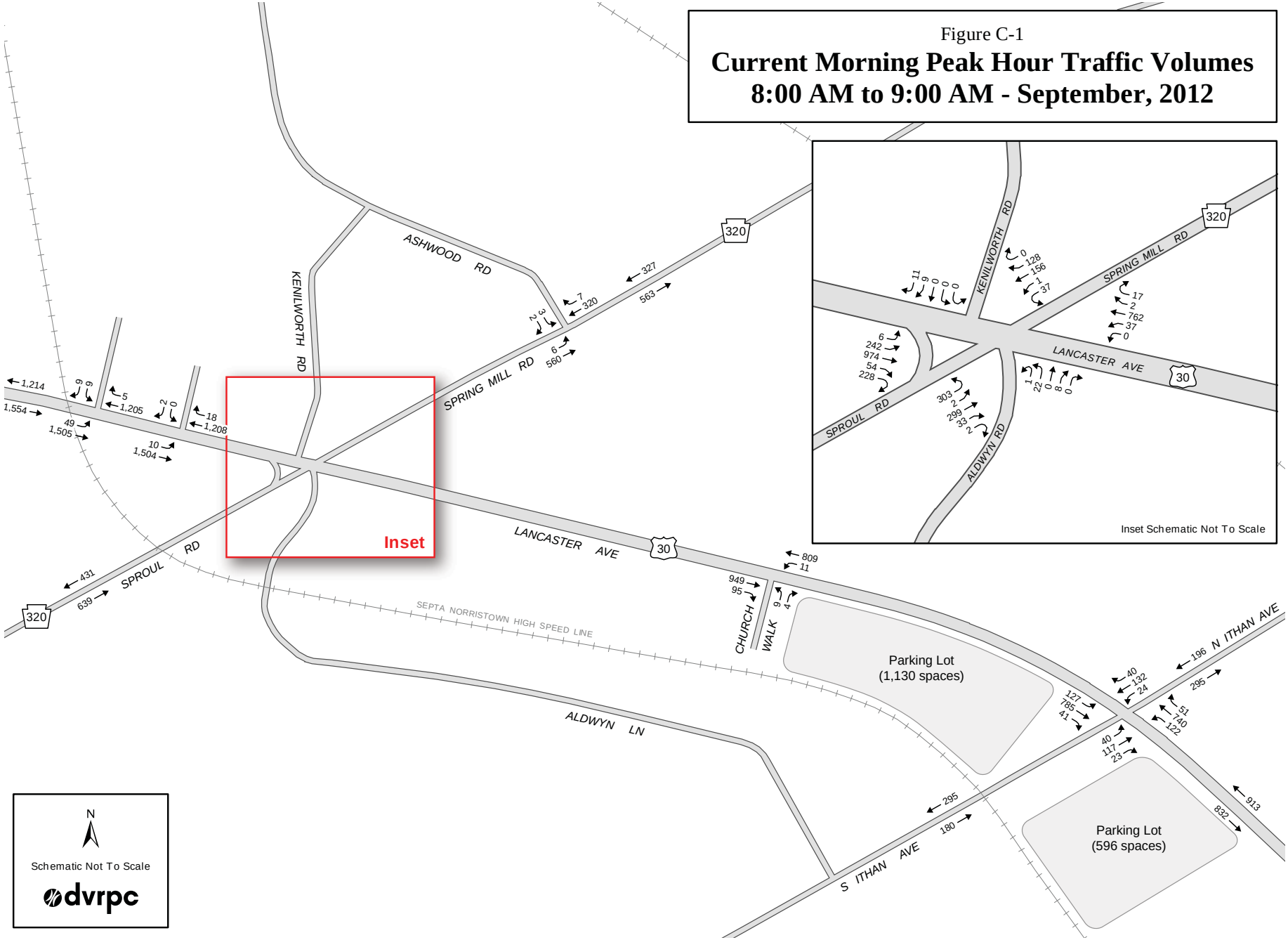


Figure C-2

Current Evening Peak Hour Traffic Volumes
5:00 PM to 6:00 PM - September, 2012

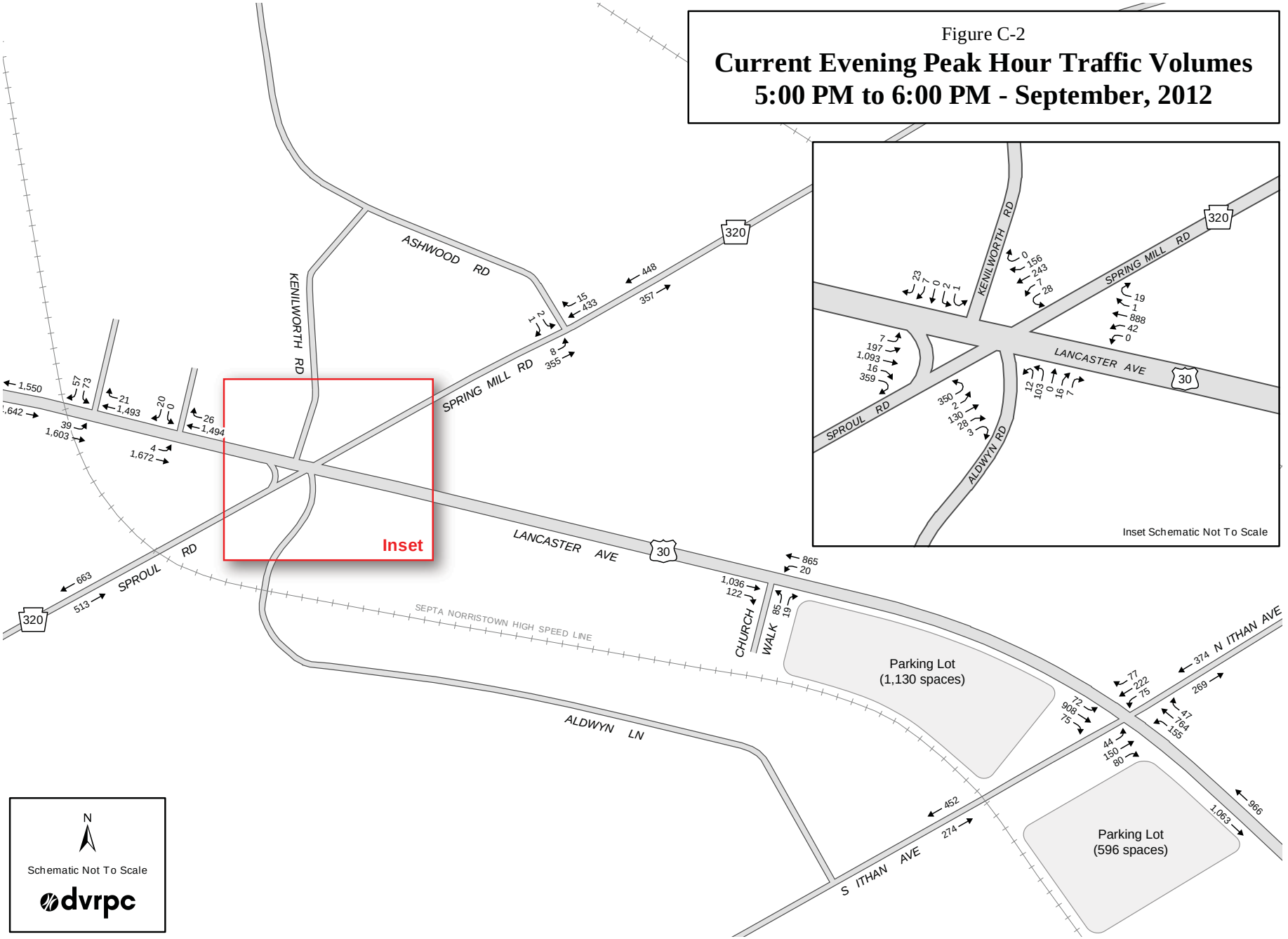


Figure C-3

No-Build Morning Peak Hour Traffic Volumes 8:00 AM to 9:00 AM - 2035

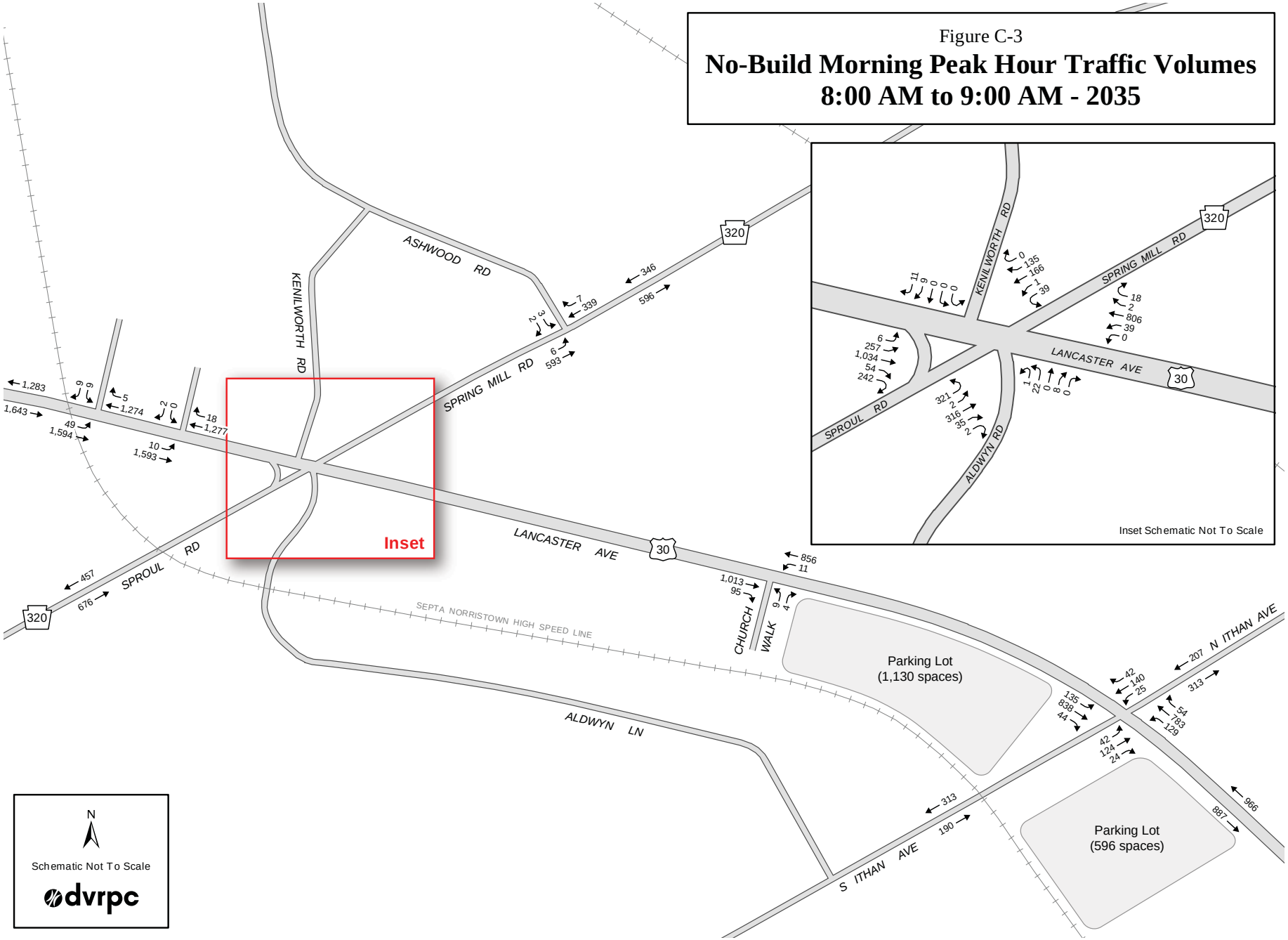


Figure C-4

No-Build Evening Peak Hour Traffic Volumes
5:00 PM to 6:00 PM - 2035

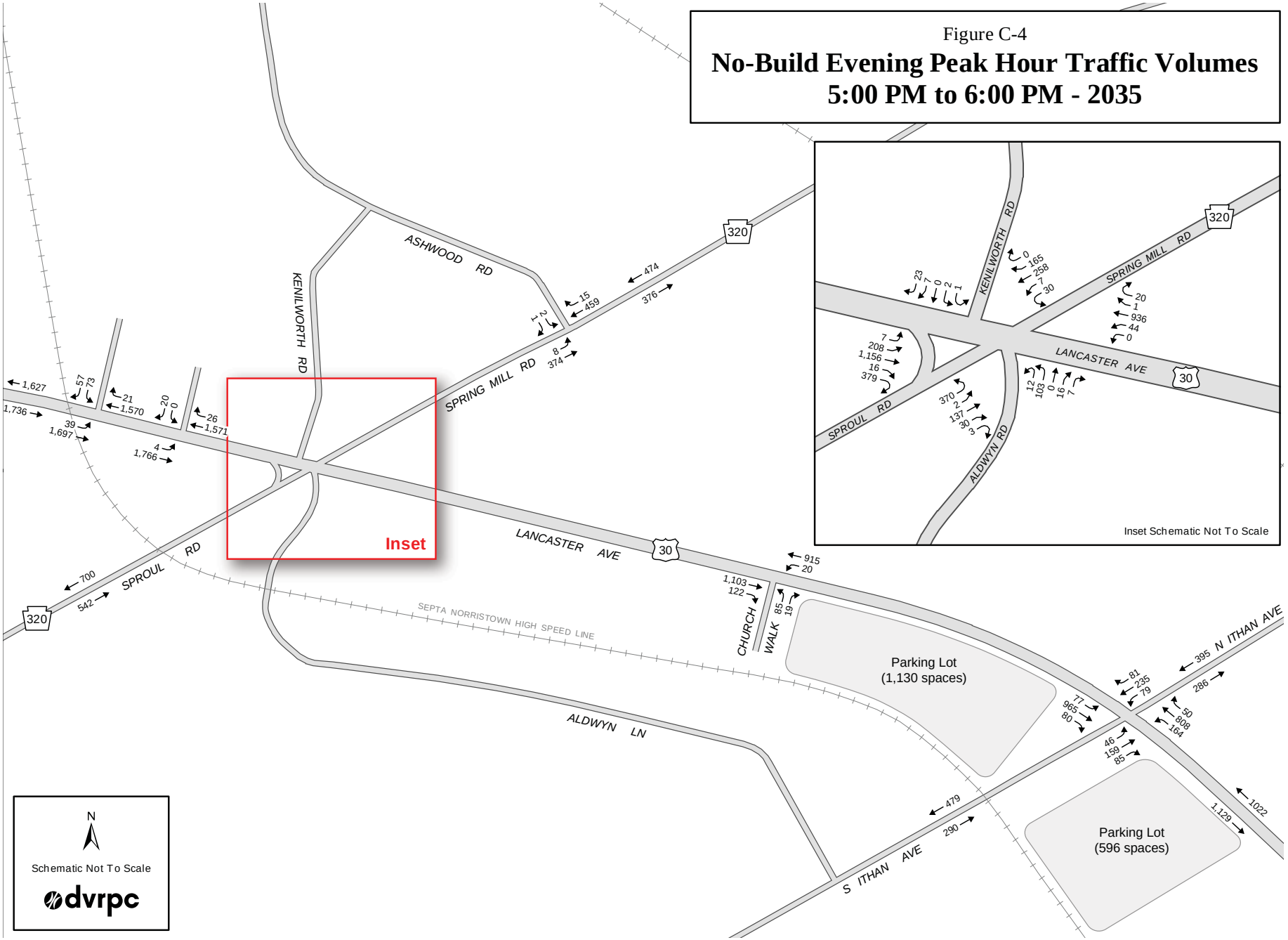


Figure C-5

Build 1 Morning Peak Hour Traffic Volumes 8:00 AM to 9:00 AM - 2035

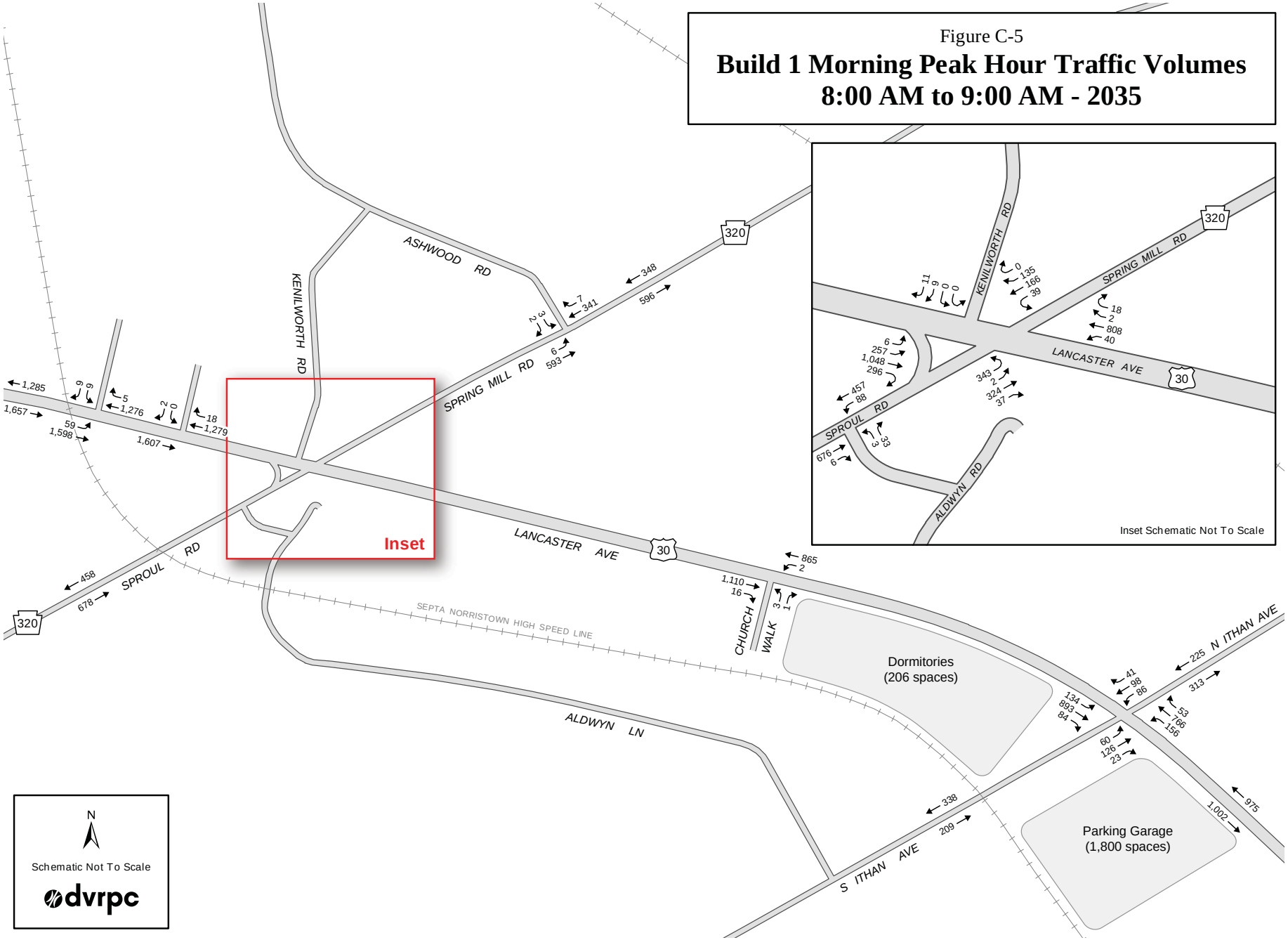


Figure C-6

Build 1 Evening Peak Hour Traffic Volumes
5:00 PM to 6:00 PM - 2035

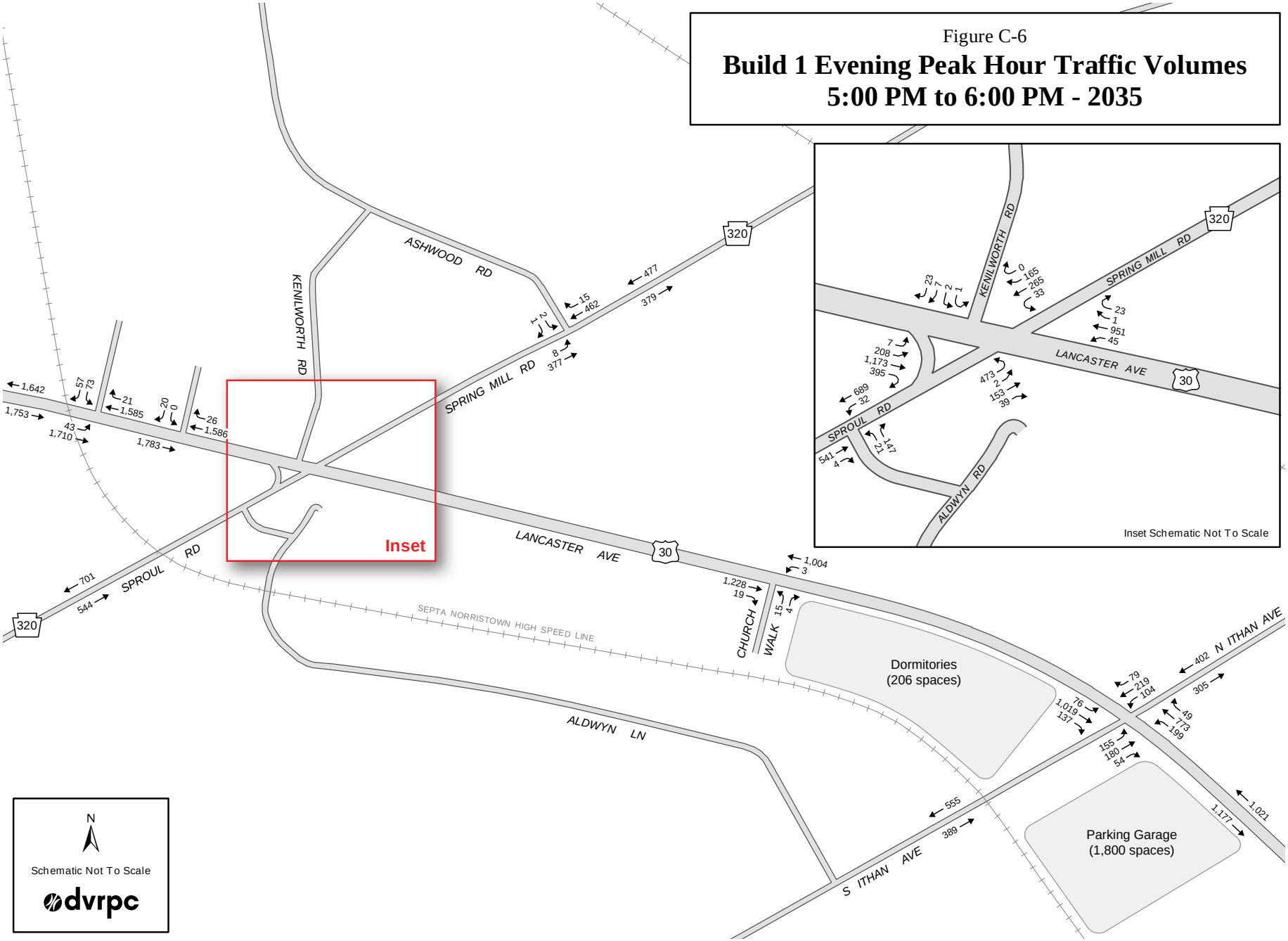


Figure C-7

Build 2 Morning Peak Hour Traffic Volumes
8:00 AM to 9:00 AM - 2035

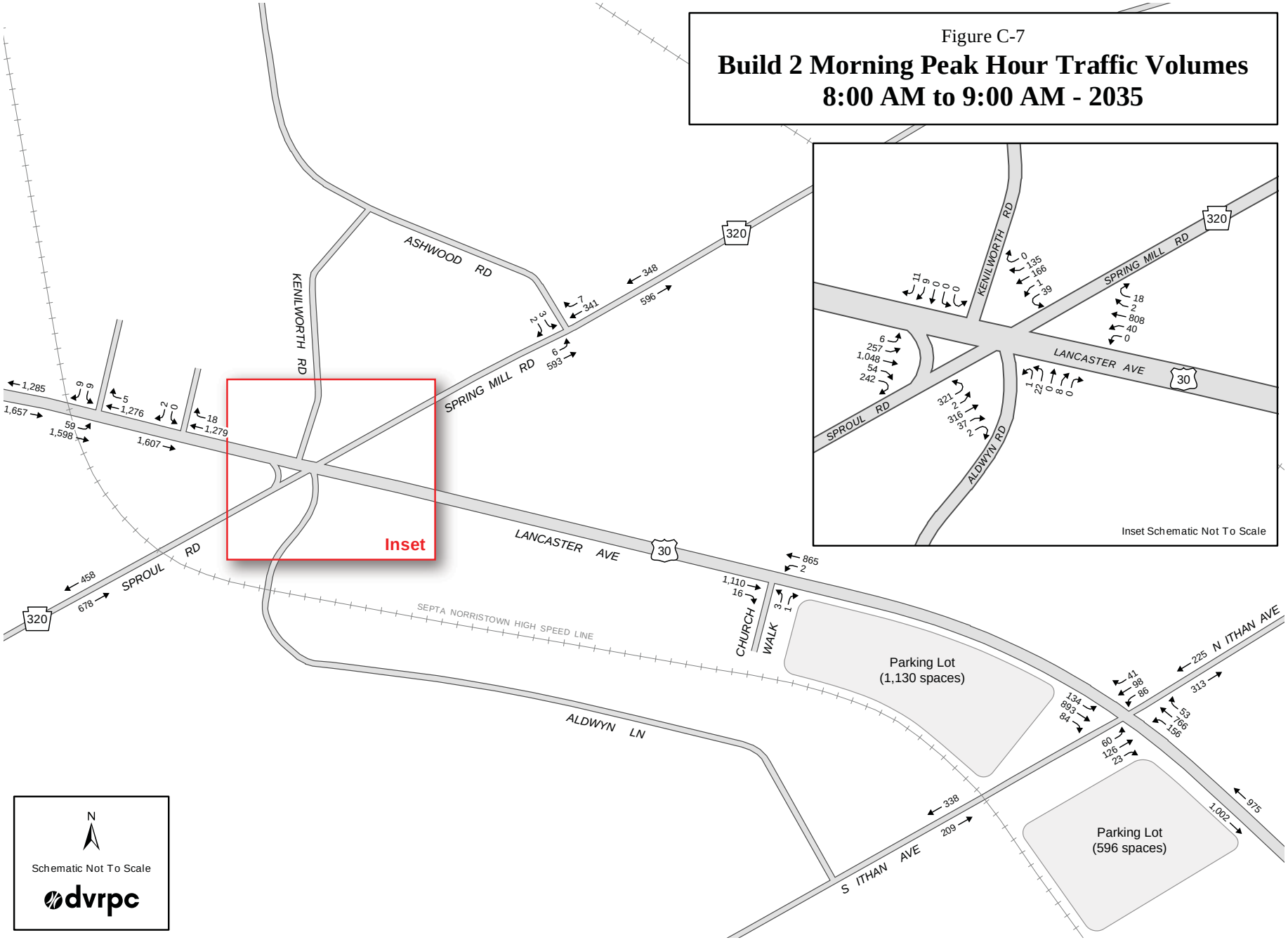
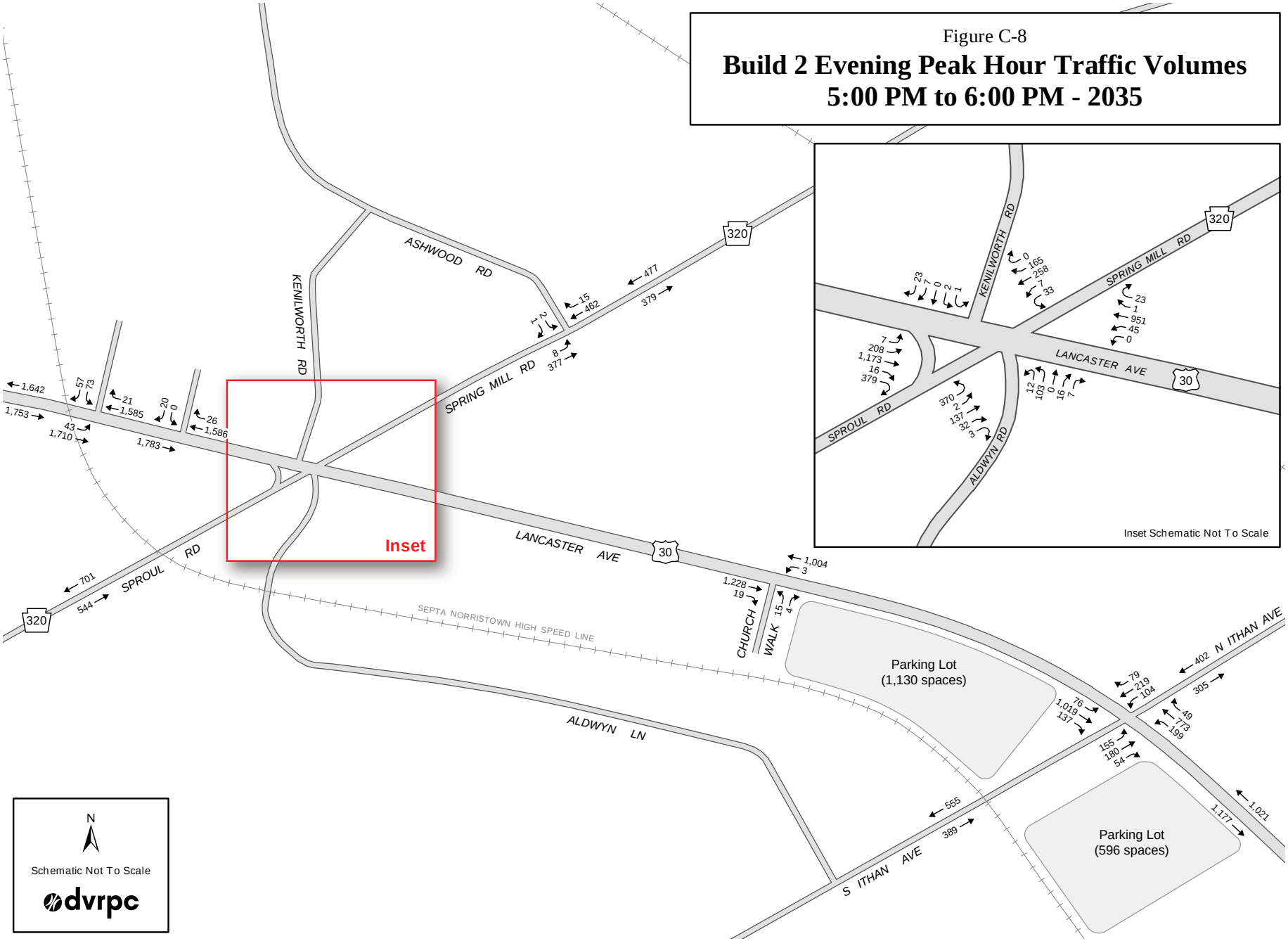


Figure C-8

Build 2 Evening Peak Hour Traffic Volumes
5:00 PM to 6:00 PM - 2035



APPENDIX D: STUDY PARTICIPANTS

TECHNICAL ADVISORY COMMITTEE

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Robert Morro, Executive Director for Facilities Management, Villanova University

Steven Hildebrand, Villanova University

Frank Tavani, Tavani and Associates, Inc.

US 30 EASTERN RADNOR TOWNSHIP TRAFFIC AND CIRCULATION STUDY

Publication Number: 13037

Date Published: February 2014

Geographic Area Covered:
Radnor Township, Delaware County, Pennsylvania

Key Words:
Lancaster Avenue, Villanova University, pedestrian counts, BlueToad, VISSIM software, Level of Service analysis, intersection delay, model calibration, microsimulation modeling

Abstract:
This study examined existing, proposed, and potential pedestrian and vehicular traffic issues along the US 30 corridor in the vicinity of Villanova University. This study is an extension of the US 30 (Lancaster Avenue) Corridor Study: Creating Linkages and Connecting Communities (December 2011, DVRPC Publication No. 11003) as part of a follow-up effort to formalize the Study's recommendation into implementation.

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