Princeton Community Traffic Study Final Report

Submitted To:

Town of Princeton

Submitted By:

AECOM

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I. INTRODUCTION

A. Background

Princeton is strategically located at the nexus of north-south and east-west traffic flows in Central New Jersey. Reflecting this geographic situation, the Circulation Element of the Master Plan has goals that seek to reduce or limit the volume of through traffic on Princeton streets in favor of a peripheral road system that would better serve through traffic. The Circulation Element also seeks to balance land use with the capacity of the circulation system to ensure that proposed land uses do not overload the system.

Through this circulation planning process Princeton elected to not expand street system capacity, instead working to manage existing cartway widths for optimal performance with intersection and traffic signal improvements; operational improvements such as turn lanes; roundabouts; traffic calming; and sustainable, safe pedestrian / bicycle and transit networks. The overarching theme of the Master Plan is of balance and scale, and this approach to street management is consistent with and supports that theme.

B. Purpose of the Study

The purpose of this traffic planning study was to:

1. Assess issues, constraints and opportunities related to current traffic condition within the study area,
2. Estimate the extent of future traffic growth based on both the upcoming development projects within Princeton and development potential in greater Princeton area,

3. Determine impacts due to local and regional growth,
4. Identify context sensitive and multimodal improvement concepts based on the identified traffic issues; and
5. Involve all stakeholders including general public through a collaborative process to build consensus in order to improve quality of life.

C. ASUP Task Force

Recognizing the study background and purpose, Princeton formed the Alexander Street / University Place (ASUP) Task Force with a goal to advance a study to "evaluate and make recommendations to manage the appropriate flow of traffic and transportation in the Princeton community as a result of increased development".

The ASUP Task Force included the following stakeholders:

1. Selected representatives of the general public
2. Princeton University
3. Municipality of Princeton representatives - planning and engineering divisions
4. Elected officials

II. BASIC STUDY PARAMETERS

A. Study Focus Area

The study focus area was concentrated on the key corridors and intersections within the Princeton downtown as shown in Figure 1 below. These corridors included:

Group 1: Bayard Lane Corridor

Group 2: Princeton Core (Nassau Street between Bayard Lane and University Place)

Group 3: Alexander Street Corridor

Group 4: Witherspoon Street Corridor

Group 5: Washington Road Corridor

Group 6: Harrison Street Corridor

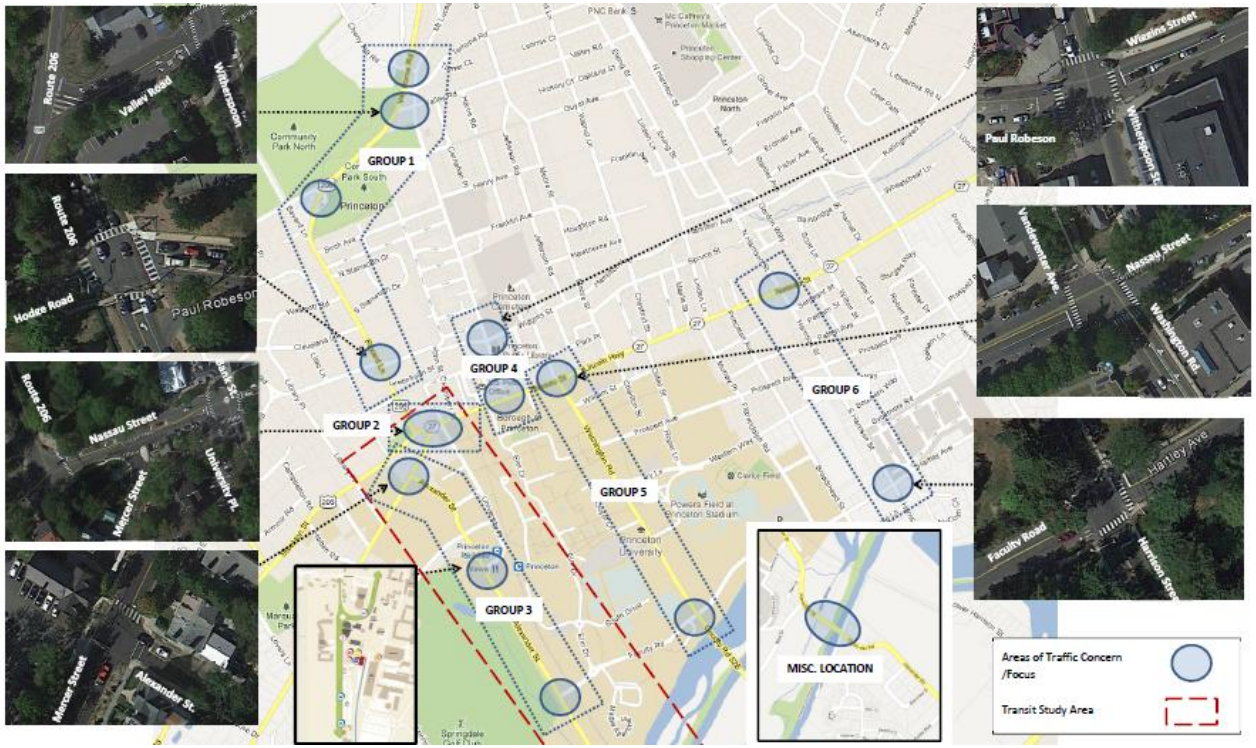


Figure 1: Traffic Focus Areas

The figure illustrates areas of concern from a traffic operations and performance perspective. These areas were identified based on the previous studies conducted in this area by AECOM and others, feedback from the Municipality of Princeton and the ASUP Task Force.

B. Traffic Data Compilation

The study did not involve any new traffic data collection efforts. For the purpose of this study the approach was to compile available traffic data from the recent studies within and near the study area. With the help of the Municipality of Princeton, AECOM compiled traffic count data from various sources including previous Princeton area studies conducted by AECOM and others, recent traffic studies including the Princeton Arts and Transit District Study and other NJDOT studies in the vicinity. Appendix 1 provides intersection turning movement traffic counts during weekday AM and PM peak hours and Appendix 2 provides ATR count information based on this traffic data compilation effort. These counts were used to refine the greater Princeton area travel demand model.

It should be noted that the available peak hour traffic counts at the beginning of this study (from the recent studies including the Princeton Arts and Transit District Study) were found to be somewhat lower in some areas of the Alexander Street corridor when data from some other resources was made available. However, even with the lower existing counts in such areas the projected impacts of future growth were significant. Thus, this only highlights the fact that with higher existing counts the extent of impacts related to projected future growth will be even worse, as such further highlighting the need to identify appropriate context sensitive solutions.

III. CURRENT TRAFFIC CONCERNS AND CONSTRAINTS

The following current traffic concerns and constraints were identified for each of the focus corridors:

Bayard Lane Corridor (Figure 2)

This corridor extends from the intersection of Cherry Hill Road to the north to the intersection of Paul Robeson Place and Hodge Road to the south. This is a 2-lane corridor with one lane in each direction with a narrow shoulder on either side.

Concerns	Constraints
• Heavy vehicle traffic impacts • Vehicular speeding • Narrow lanes • Lack of bicycle opportunities • Traffic congestion along Route 206 • Pedestrian crossing issues	• Proximity to historic structures/ monument • Varying nature of Route 206 Transect: In-town residential to civic park to rural residential

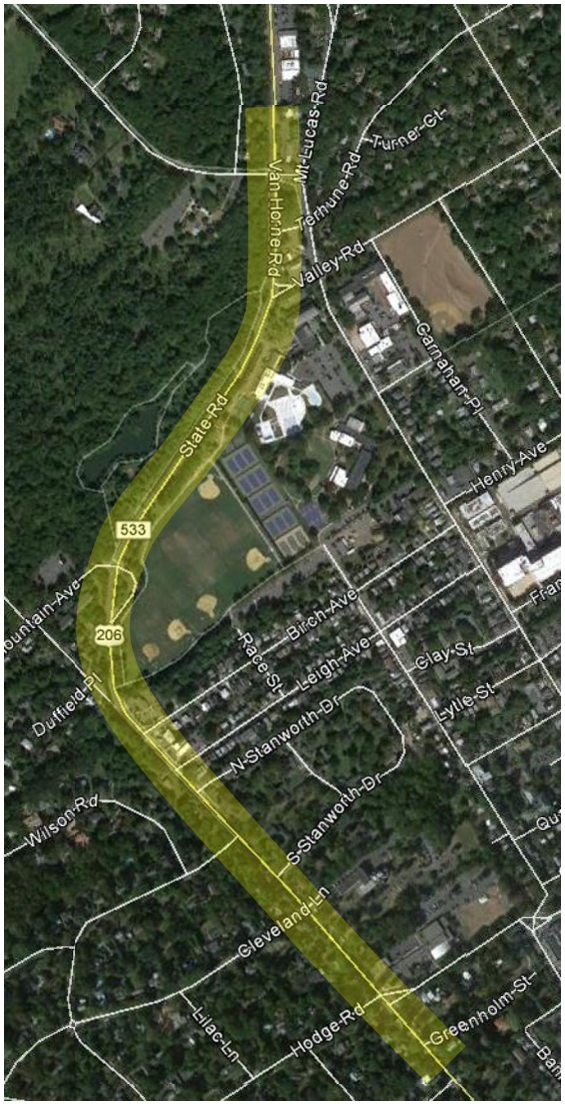


Figure 2: Bayard Lane Corridor

Nassau Street and Bayard Lane Core (Figure 3)

This small Nassau Street segment between the Bayard Lane intersection and the University Place intersection is key to the traffic operational performance during peak hours. Traffic backups from this segment spill back on other key corridors in the Princeton Downtown.

Concerns	Constraints
• Peak period traffic congestion • Confusing intersection geometry • Closely spaced intersections • Lack of signal coordination opportunities • Pedestrian safety • Extent of through traffic • Heavy vehicle/truck traffic - turning radii	• Proximity to historic structures/ monument - no room for expansion and/or for acquiring additional ROW

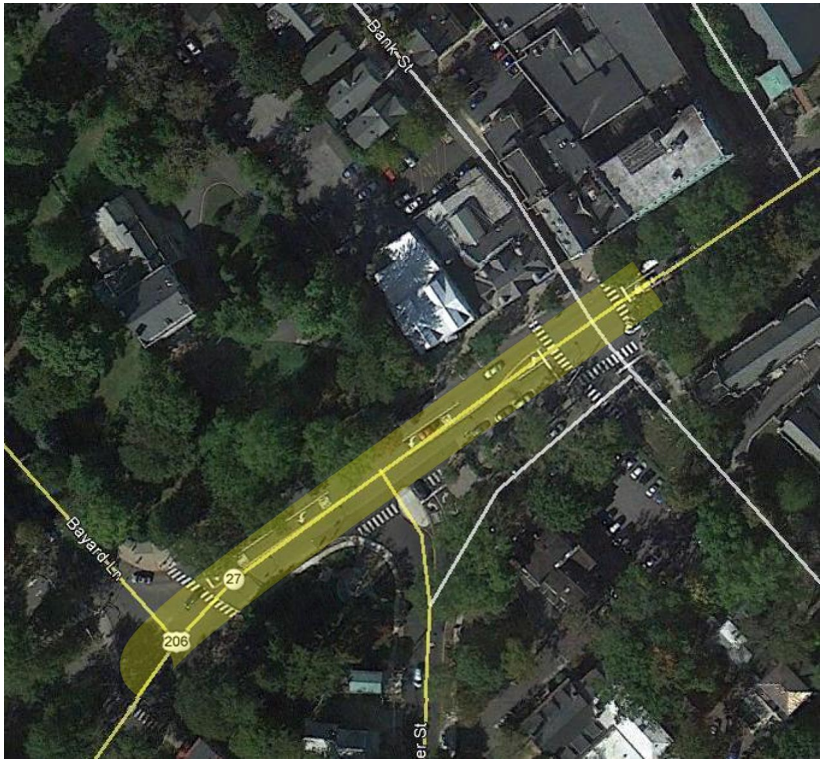


Figure 3: Nassau Street and Bayard Lane Core

Alexander Street Corridor (Figure 4)

This corridor extends from the intersection of Mercer Street to the north to the intersection of Faculty Road to the south. This is a 2-lane corridor with one lane in each direction. The corridor has various intersection controls including the newly built roundabout (University Place and Alexander Street), a signalized intersection (Faculty Rd. and Alexander Rd.) and stop-control (Mercer Street and Alexander Street). This corridor provides access to the newly relocated Princeton Station. On-street parking is available on one side along almost entire length of this corridor.

Concerns	Constraints
• Increased levels of traffic • Possible Route 1 traffic actions may further impact traffic • Vehicular speeding	• Potential ROW impacts • Proximity to historic district

Figure 4: Alexander Street Corridor

Witherspoon Street Corridor (Figure 5)

This corridor extends from the intersection of Paul Robeson Place to the north to the intersection of Nassau Street to the south. This is a 2-lane corridor with one lane in each direction and has on-street parking on both sides.

Concerns	Constraints
• Peak hour traffic congestion • Pedestrian safety issues • Vehicular-pedestrian conflicts and impacts on intersection operation	• Proximity to historic structures • On-street parking maneuvers impact traffic flow performance

Figure 5: Witherspoon Street Corridor

Washington Road Corridor (Figure 6)

This corridor extends from the intersection of Nassau Street to the north to the D&R Canal to the south. This is a 2-lane corridor with one lane in each direction and has significant pedestrian activity in the northern section of the corridor related to the Princeton University.

Concerns	Constraints
• Peak hour traffic congestion • Vehicular speeding • Pedestrian safety issues • Nassau St. & Washington Road intersection alignment • Impacts of potential Route 1 traffic actions on Washington Rd corridor	• Proximity to historic structures • Proximity to environmentally sensitive area

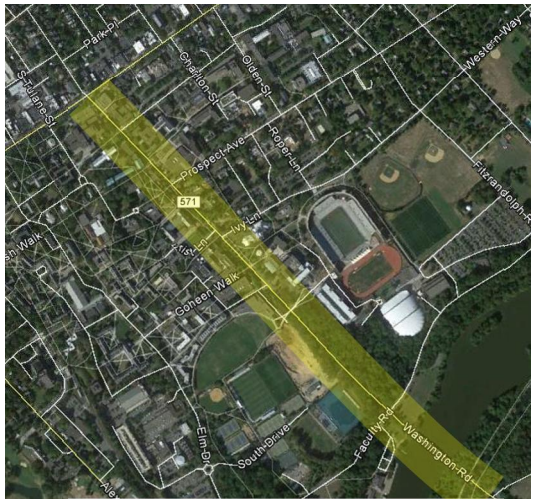


Figure 6: Washington Road Corridor

Harrison Street Corridor (Figure 7)

This corridor extends from the intersection of Nassau Street to the north to the intersection of Faculty Road to the south. This is a 2-lane corridor with one lane in each direction and is sometimes used as a corridor to bypass Princeton Downtown.

Concerns	Constraints
• Vehicular speeding • Increasing peak hour traffic volumes • Pedestrian safety issues	• No room for expansion and/or for acquiring additional ROW

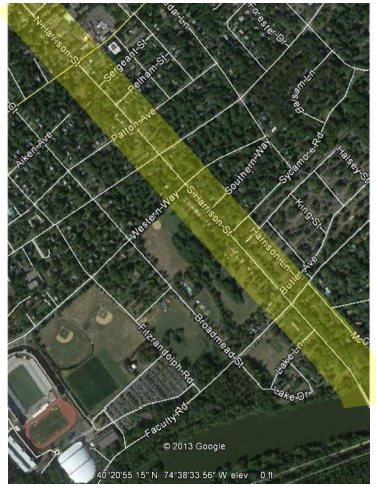


Figure 7: Harrison Street Corridor

IV. FUTURE DEVELOPMENT IMPACT ASSESSMENT

Local and regional developments and/or redevelopments have a direct relationship with the extent of additional traffic generated and assigned to the area roadway network. Thus, in turn, land use development/redevelopment activities have direct impact on the traffic operational performance of the transportation system.

In order to estimate future condition traffic volumes, AECOM used the greater Princeton area travel demand model. This model covers Princeton, West Windsor, and portions of Plainsboro, Lawrence and Montgomery Townships. A comprehensive land use and development inventory is maintained for this model on an ongoing basis and this modeling tool is applied to determine roadway assessments for Princeton and West Windsor. In addition, this modeling tool has also been used for various planning studies in the area including the NJDOT Penns Neck Study and West Windsor/Princeton Junction Redevelopment Planning Study. Figure 8 shows a screenshot of this travel demand model network.

Figure 8: Greater Princeton Area Travel Demand Model Network

A. Travel Demand Modeling Process

The following describes a typical 3-step traffic modeling process for an auto travel demand model (See Figure 9).

Trip Generation: Based on the assumed land use data, vehicular trips are generated in this step related to these land uses.

Trip Distribution: This step determines the origin and destination for each generated trip based on socioeconomic characteristics like population, employment etc.

Trip Assignment: The generated trips are assigned to the roadway network along one or more path(s) between their origin and destination.

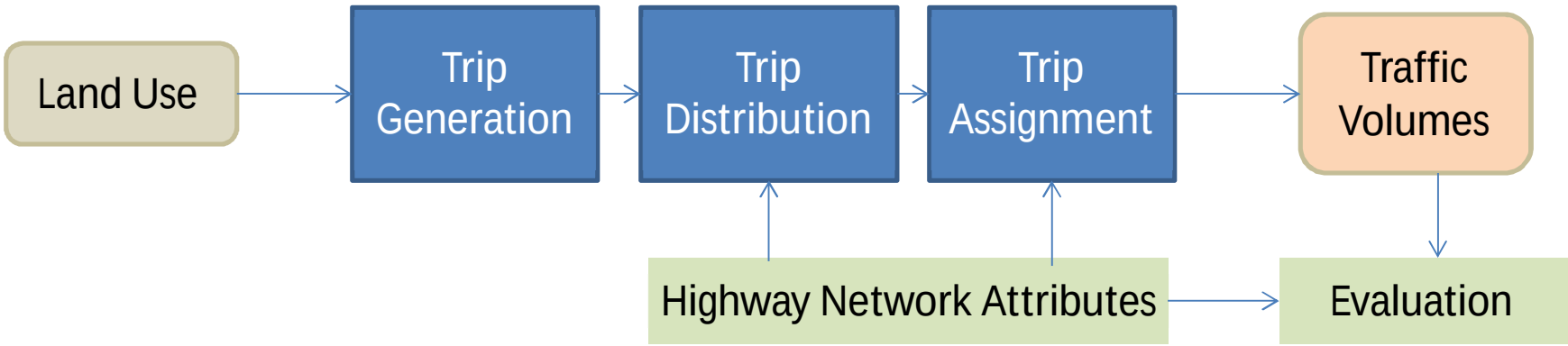


Figure 9: Travel Demand Modeling Process

B. Model Refinement

Based on the available existing condition traffic volume data, the model was calibrated for the existing condition. This calibration process ensures that the traffic volume outputs provided by the model under existing condition generally match observed traffic count data on the ground. This process validates the usefulness of the model for future condition volume projections.

Once the existing condition calibration was completed, future development/redevelopment information as well as upcoming roadway improvement projects were applied to the model before the model was used to project future condition traffic volumes.

C. Local and Regional Land Use Assumptions

The following is a list of proposed study area (local) developments/redevelopments (See Figure 10 for location and Appendix 3 for new trip generation estimates):

1. Reconstruction of Hibben Magie graduate student housing
2. Princeton University Arts and Transit Project

3. Hulfish North (Palmer Square)
4. Redevelopment of YM/YWCA
5. Redevelopment of Merwick and Stanworth
6. Redevelopment of Princeton Medical Center

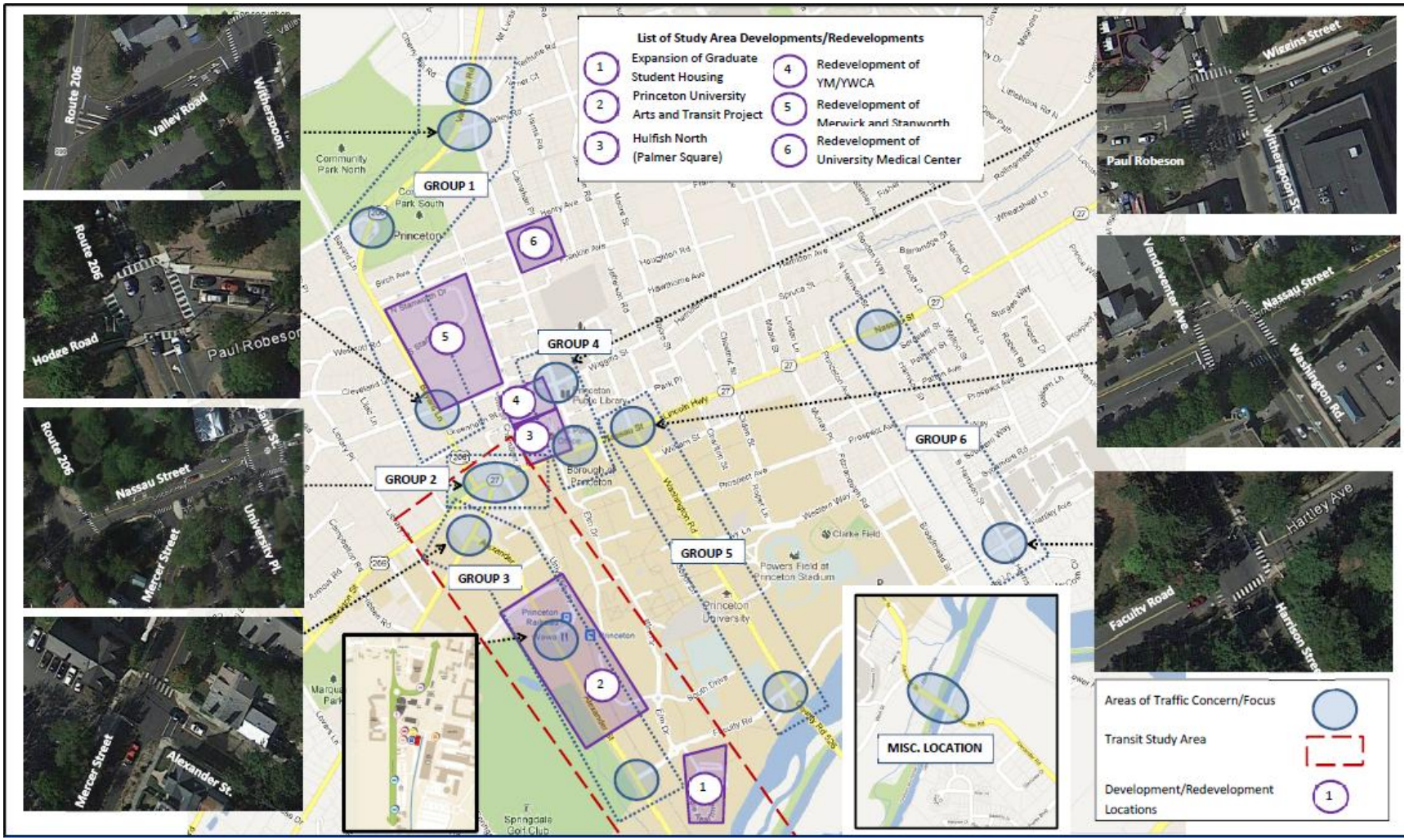


Figure 10: Study Area Developments/Redevelopments

In addition to the local or study area development/redevelopment projects, the following regional development/redevelopment potential was also considered in the model in order to determine impacts associated with these projects on Princeton roadways (See Figure 11) :

- A Princeton/Plainsboro Medical Center
- B Carnegie Center (East)
- C Carnegie Center (West)
- D Princeton Junction Redevelopment
- E Wyeth
- F Sarnoff
- G Greenview

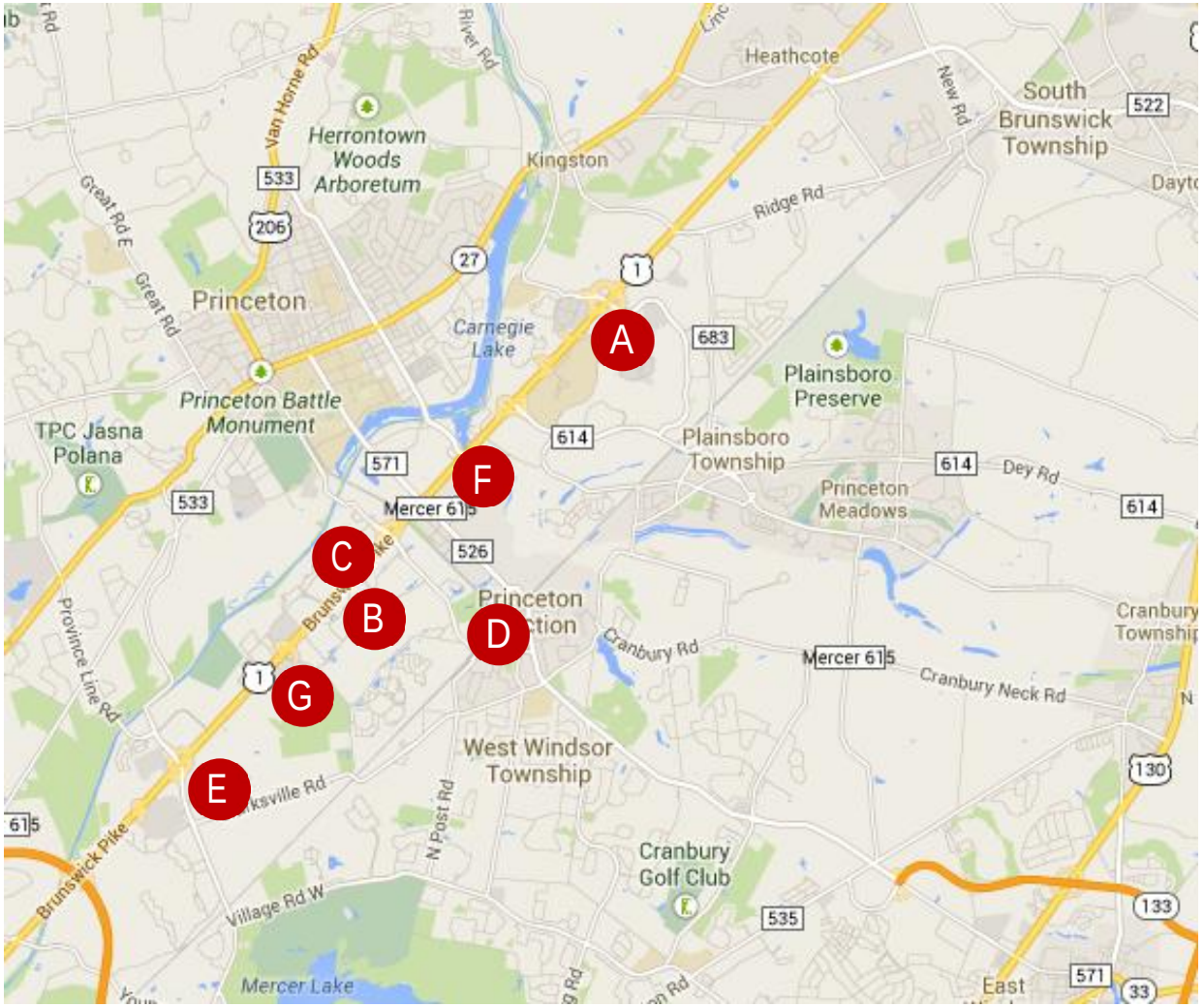


Figure 11: Regional Developments/Redevelopments

D. Travel Demand Model Outputs

The calibrated travel demand model provided projected roadway link volumes under the future condition (see Figure 12 for a sample). For the purpose of this study the future year was 2027 (15 years in the future from the base analysis year of 2012).

These projected volumes were then compared to the existing condition volumes to determine the extent of absolute and percentile traffic volume change as well as to understand likely traffic volume shift patterns during both the AM and PM peak hours.

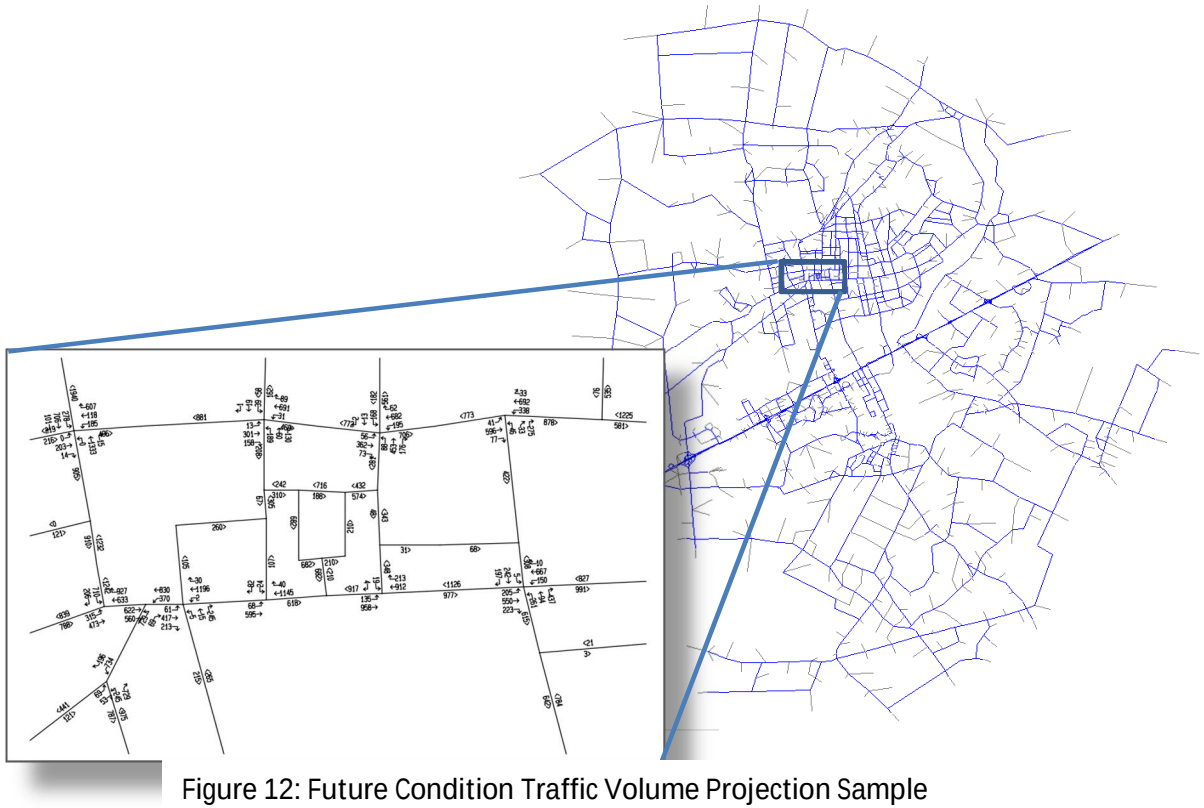


Figure 12: Future Condition Traffic Volume Projection Sample

Separate model runs were also conducted once the improvement packages were identified (discussed later in the report) with the help of the ASUP Task Force to determine how each of the improvement packages would help to improve study area traffic performance.

Figure 13 shows as an example the difference in the roadway network bi-directional volumes between the 2012 Existing Condition PM peak hour and 2027 Future No-Build Condition PM peak hour. This type of analysis can help to determine the overall impacts that can be anticipated if the anticipated regional development happens within the next 25 years. In addition, this change in anticipated traffic volumes can be linked to specific generators to determine what portion of this traffic volume change is related to local developments vs. regional developments.

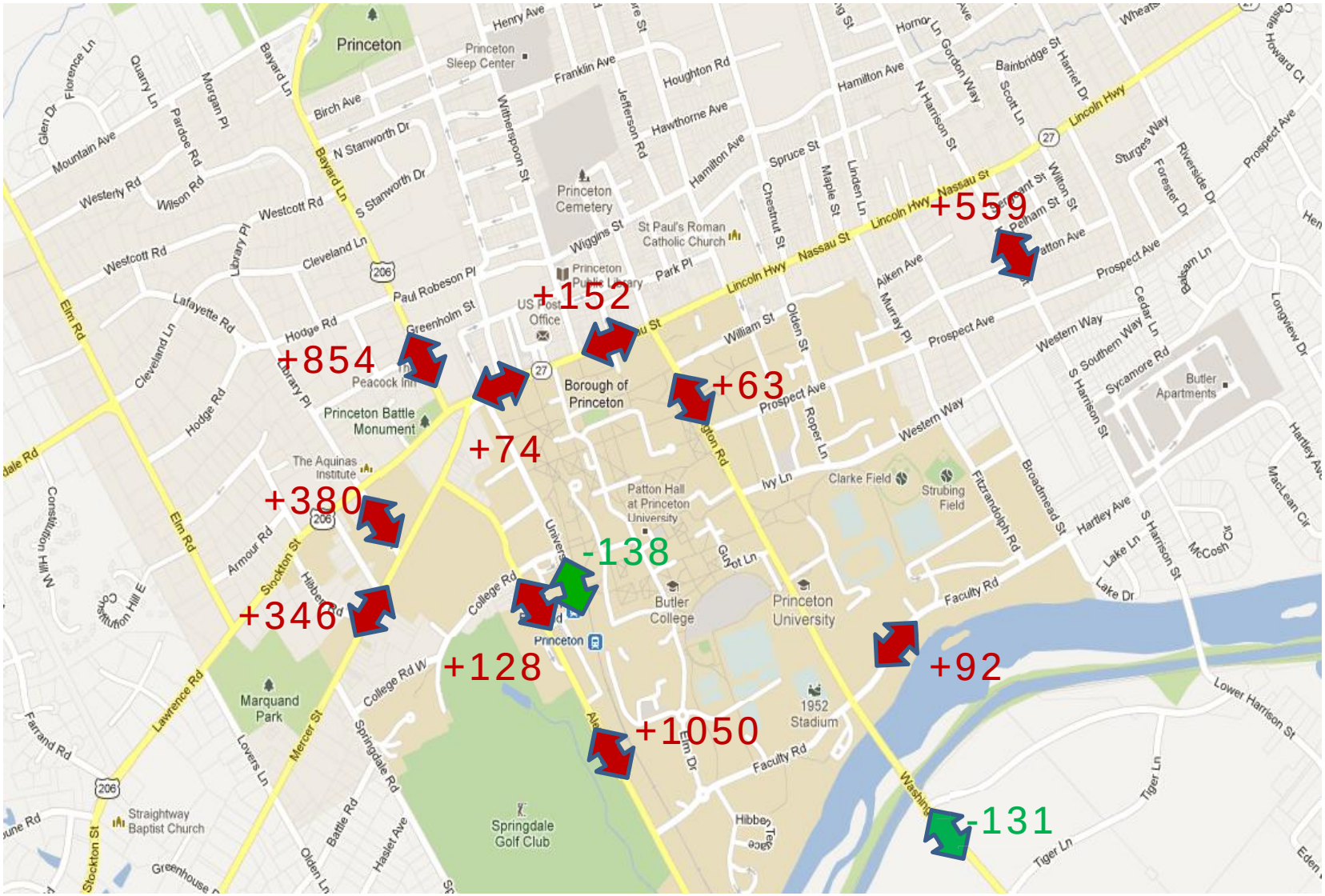


Figure 13: Projected Change in Bi-Directional Link Volumes (PM Peak Hour) between 2012 Existing Condition and 2027 Future No-Build Condition

For example, Figure 14 breaks down the projected increase in Alexander Street traffic just north of the Faculty Road intersection. It shows that a 110% traffic volume growth (additional 1050 vehicles) can be anticipated by the 2027 Future Condition PM peak hour compared to the 2012 Existing Condition PM peak hour bi-directional volume (948 vehicles). Of these additional vehicles, almost 2/3 are associated with regional growth whereas 1/3 can be linked to local Princeton area growth.

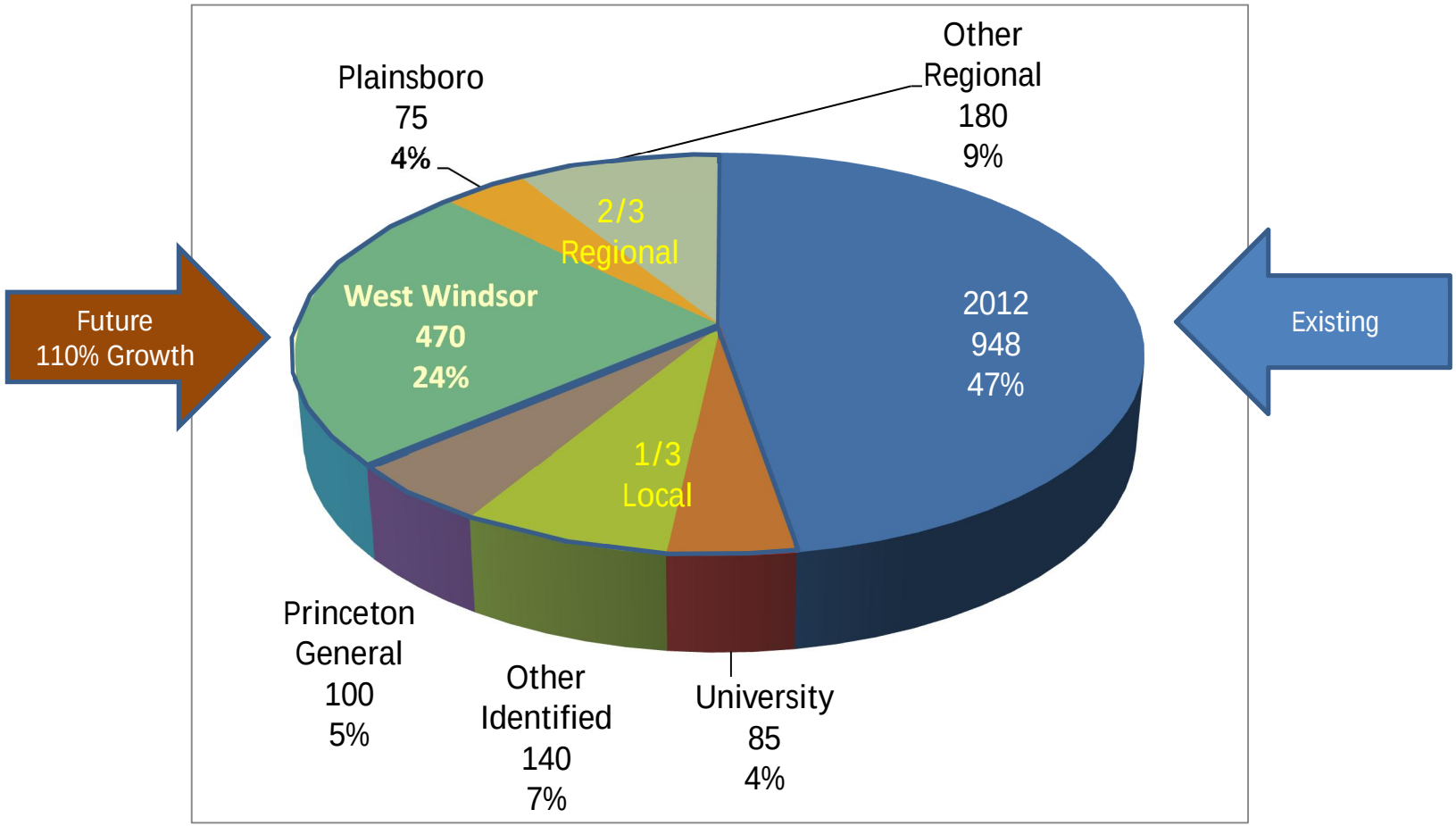


Figure 14: Example of Roadway Link Volume Growth and Contributing Components for Alexander Street Roadway Segment

(Bi-Directional Volumes during PM Peak Hour)

V. IMPROVEMENT CONCEPT DEVELOPMENT

A. Concept Development Process

As discussed earlier, through this circulation planning process of the Master Plan Princeton has elected to not expand street system capacity, instead working to manage existing cartway widths for optimal performance with intersection and traffic signal improvements; operational improvements such as turn lanes; roundabouts; traffic calming; and sustainable, safe pedestrian / bicycle and transit networks. Considering this AECOM developed and presented several improvement concepts to the ASUP Task Force. A framework was provided to the ASUP Task Force to evaluate these various improvement concepts as below:

1. Concept Evaluation Criteria

Traffic Evaluation Criteria

- Potential to reduce vehicular conflict points and improve traffic flow
- Potential to reduce congestion
- Extent of likely change in through traffic levels
- Traffic calming potential

Multimodal Evaluation Criteria

- Transit friendliness
- Bicycle friendliness
- Pedestrian friendliness

Socioeconomic/Quality of Life Evaluation Criteria

- Residential neighborhoods impacts
- Business impacts

Other Evaluation Criteria

- Ease of implementation
- Potential for ROW impacts
- Consistency with prior plans

2. Consideration for Concurrent Transit Study

Considering the concurrent Princeton Transit Study that was also underway to assess various transit options to connect Princeton Dinky Station with the Nassau Street corridor, AECOM also incorporated provisions for multimodal choices in its concept development process. The ASUP Task Force was presented with information on the potential of each improvement concept to support transit alternatives along the University Place and/or Alexander Street corridors.

B. Concept 1: Turn Restrictions

This easy to implement and low cost improvement concept was developed for the Nassau Street core area between Bayard Lane and University Place. As identified before, this core area experiences significant congestion and backups during existing condition peak hours. This congestion in turn propagates along the other key corridors in the Princeton downtown.

As a part of this improvement concept, left turns into and out of Mercer Street will be prohibited at the intersection with Nassau Street. In addition, left turn from Nassau Street onto Bank Street will also be prohibited. This will result in a significant reduction in vehicular conflict points in the core area and will help streamline traffic operation, which will result in reduced congestion and backups. This concept is illustrated in Figure 15.

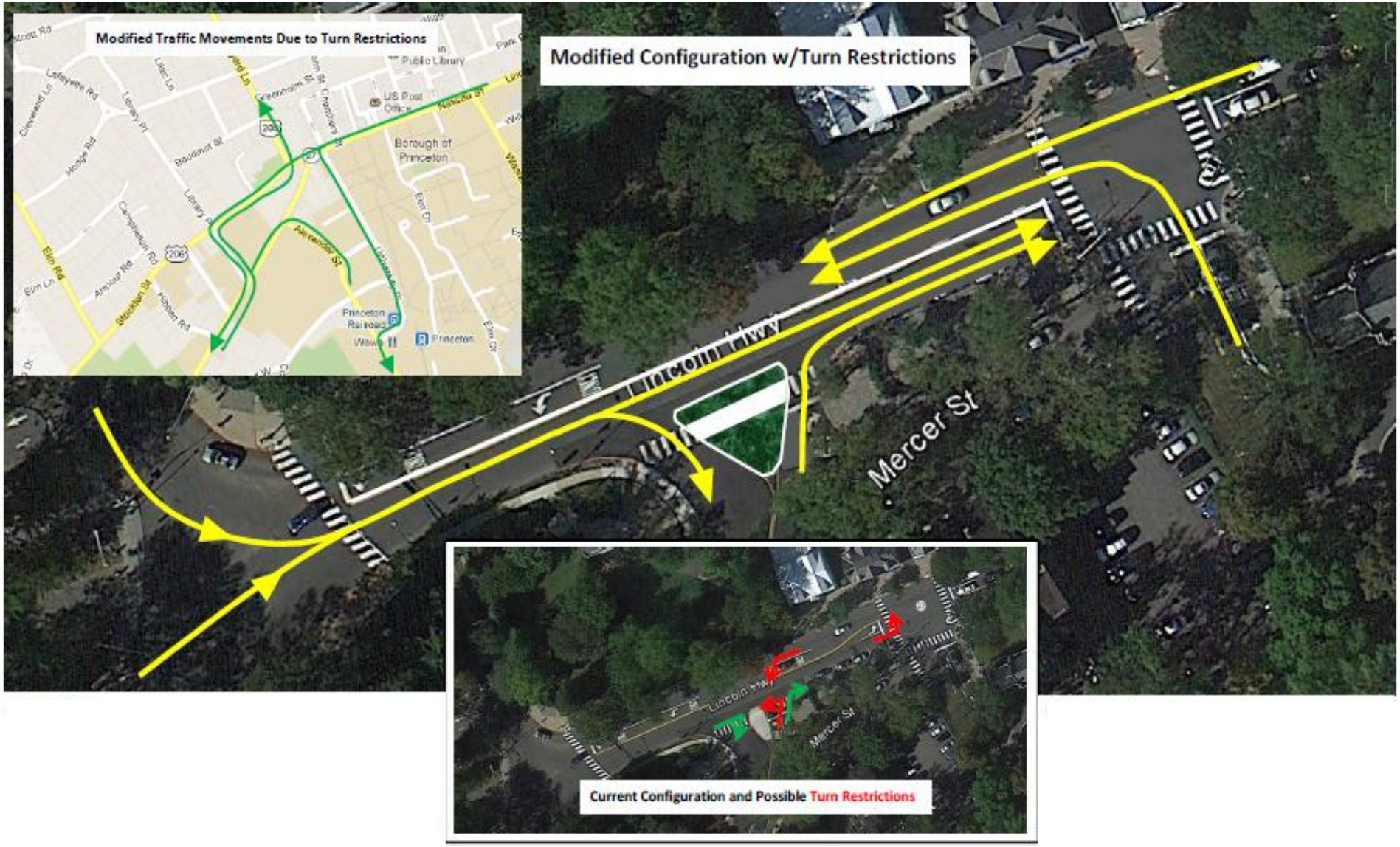


Figure 15: Concept 1: Left Turn Restrictions for Nassau Street Core Area

The following are the advantages and disadvantages of the Turn Restriction Concept:

Advantages	Disadvantages
• Fewer vehicular conflicts and improved traffic flow • Better signal coordination opportunity and reduced congestion • Fewer backups impacting closely spaced intersections • Well defined traffic movements • Wider island at Mercer Street for pedestrian crossing convenience • Easy to implement	• Modified (and slightly longer) routing for some vehicles • Elimination of a few on-street parking spaces • May have some impacts on the intersection of Route 206 & Library Place

C. Concept 2: Street Closures

This improvement concept was developed to achieve two aspects. First, by closing a roadway segment several turning movements could be eliminated, which will result in traffic performance improvement at the termini intersection of this closed segment. Second, this area can be converted into a pedestrian only plaza to further enhance the pedestrian friendly character of Princeton downtown. One of the key candidate locations for this concept is the Mercer Street segment between Alexander Street and Nassau Street. Figure 16 illustrates the street segment closure concept for the Mercer Street segment.

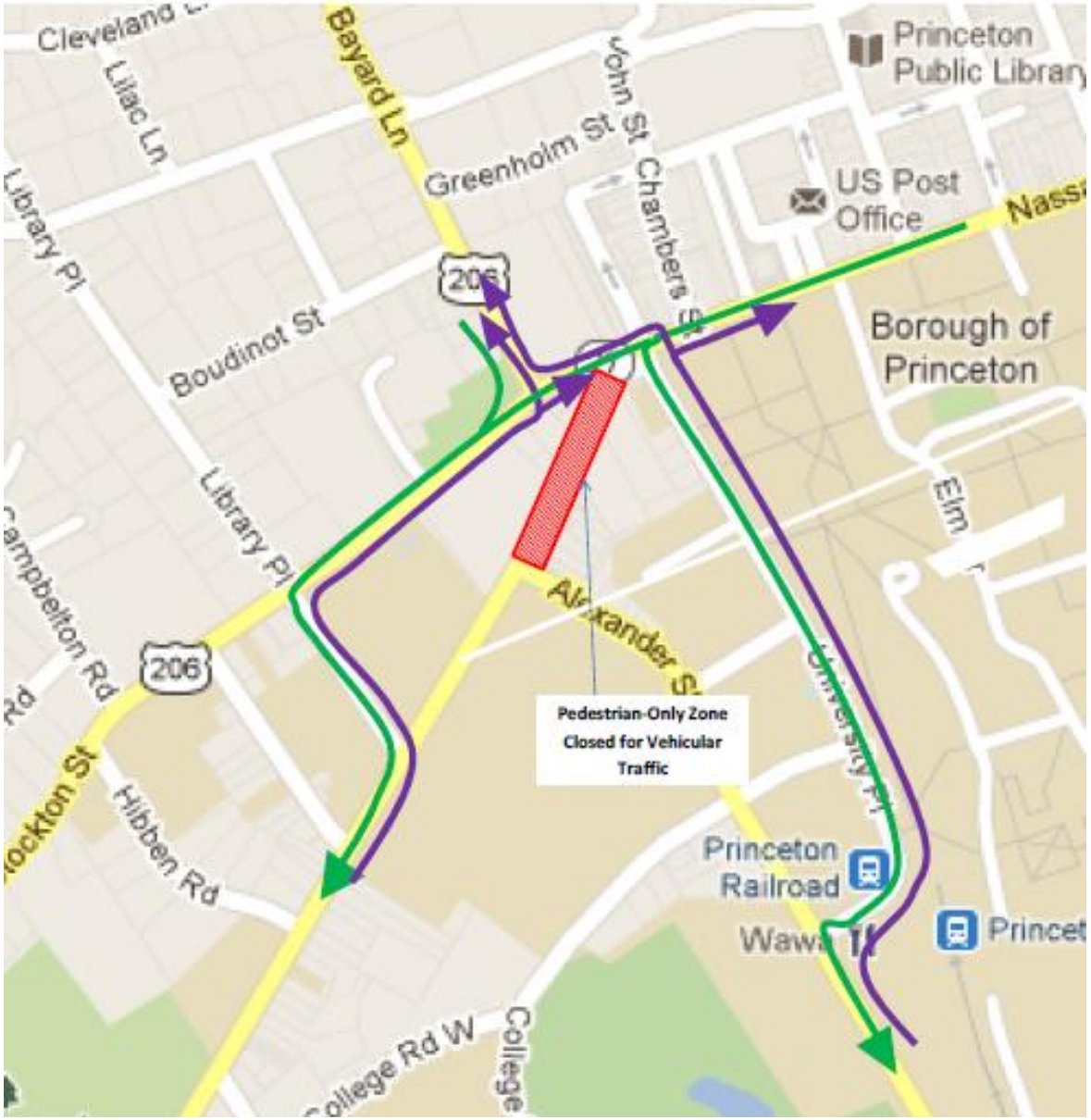


Figure 16: Concept 2: Mercer Street Closure

The following are the advantages and disadvantages of the Street Closure Concept for Mercer Street:

Advantages	Disadvantages
• Fewer vehicular conflicts and improved traffic flow on Nassau St. • Elimination of many vehicular conflict points - fewer spillback impacts at closely spaced intersections on Nassau Street • Eastbound on-street parking (3 spaces) on Nassau Street between Mercer St. and University Pl. can be replaced by a travel lane facilitating further circulation improvements • Better signal coordination opportunity for Bayard/Nassau and Nassau/University intersections and reduced congestion • Alexander St. and Mercer St. intersection becomes a control-free intersection • Minimal routing impacts for key destinations • Improved pedestrian experience along Nassau Street • Opportunity to create a pedestrian-only zone for variety of uses	• Modified routing for some vehicles • Elimination of few on-street parking spaces • May have some impacts on the intersection of Route 206 & Library Place • Access to properties along the closed section of Mercer Street needs to be resolved

D. Concept 3: One-Way Loops

These improvement concepts consider one-way pair operation with University Place and Alexander Street. The one-way loop can be in either a clockwise direction or a counterclockwise direction. The one-way loop concept can provide performance improvements for key intersections in this area. It will also have the potential for preserving a dedicated right-of-way for the transit option along University Place. Also, it can promote other multimodal choices such as provision of a bicycle lane. Figure 17 illustrates these one-way loop concepts.

Counter Clockwise One-Way Loop

Clockwise One-Way Loop

Figure 17: Concept 3: One-Way Loops

The following are the advantages and disadvantages of the clockwise one-way loop improvement concept:

Advantages	Disadvantages
• Significant traffic performance improvement potential for the core area (Nassau Street between Bayard Lane and University Place) • Potential for multimodal opportunities • Opportunity for dedicated transit lane • All right turn movements – easier from circulation point of view • Better circulation benefits during PM peak vs. AM peak	• Significant performance deterioration likely at the proposed new roundabout at University & Alexander • Reduces redundancy (conversion of 2 two-way streets into single one-way loop)

The following are the advantages and disadvantages of the counter-clockwise one-way loop improvement concept:

Advantages	Disadvantages
• Significant traffic performance improvement at the proposed new roundabout at University Place and Alexander Street • Potential for multimodal opportunities • Opportunity for dedicated transit lane • Better circulation benefits during AM peak vs. PM peak	• All left turn movements – need to yield to major opposing flows on Nassau Street • Significant performance impact on Nassau Street core area (between Bayard Lane and University Place) • Reduces redundancy (conversion of 2 two-way streets into single one-way loop)

E. Recommended Improvement Packages for Further Study

The various concepts described in the earlier section were presented to the ASUP Task Force. The Task Force reviewed them closely with a detailed discussion of pros and cons related to each of the concepts. The Task Force then recommended packaging these concepts as follows for conducting further analysis using travel demand modeling. Appendix 4 provides roadway network and land use details of the above scenarios.

1. Improvement Package 1: Street Closures
    - Mercer Street closed between Alexander Street and Nassau Street
    - Witherspoon Street closed between Nassau Street and Spring Street
    - Left turn from Nassau Street onto Bank Street prohibited

2. Improvement Package 2: Clockwise One-way Loop (University Place-Alexander Street) with one-way Witherspoon Street
    - Mercer Street one-way in eastbound direction from Alexander Street to Nassau Street
    - University Place one-way in southbound direction from Nassau Street to Alexander Street
    - Alexander Street one-way in northbound direction from University Place to Mercer Street
    - Left turns from Nassau Street onto Bank Street prohibited
    - Witherspoon Street one-way in northbound direction from Nassau Street to Spring Street
    - Signal at Nassau Street and Witherspoon Street converted to pedestrian signal only

3. Improvement Package 3: Counterclockwise One-way Loop (University Place-Alexander Street) with one-way Witherspoon Street
    - Mercer Street one-way in westbound direction from Nassau Street to Alexander Street
    - University Place one-way in northbound direction from Alexander Street to Nassau Street
    - Alexander Street one-way in southbound direction from Mercer Street to University Place
    - Left turns from Nassau Street on to Bank Street prohibited

- Witherspoon Street one-way in northbound direction from Nassau Street to Spring Street
- Signal at Nassau Street and Witherspoon Street converted to pedestrian signal only

4. Improvement Package 4: Standalone One-way Loop option for University Place and Alexander Street
    - Standalone one-way loop without any other improvement (better option between clockwise or counter-clockwise based on assessment of packages 2 and 3)

F. Travel Demand Model Key Observations

The travel demand modeling analysis conducted the following comparisons:

1. Existing 2012 Condition to 2027 No-Build Condition – this comparison was done to understand the potential impacts of future land use on Princeton roadways if no roadway improvement projects are done (see earlier Section IV. D and Figure 13 for this comparison).
2. 2027 No-Build Condition to 2027 Build Condition (individual comparison with improvement packages 1 through 4 as described earlier) – this comparison was done to understand the potential performance improvement that could be achieved through each of these improvement packages (see Appendix 5 for the estimated change in bi-directional traffic volumes during PM peak hour between the 2027 No-Build Condition and the 2027 Build Condition packages)

The following are the key observations from the travel demand modeling analysis:

1. Forecasted peak hour traffic growth is likely to be concentrated along the Alexander Street corridor (based on the comparison between 2012 Existing Condition and 2027 No-Build Condition)
2. All proposed improvement packages will help redistribute future traffic from the Alexander Street corridor to other access corridors.
3. All proposed improvement packages have more or less similar traffic volume redistribution potential from Alexander Street corridor to other corridors.

4. Closing Witherspoon Street between Nassau Street and Spring Street or converting it to northbound one-way operation will have significant impacts on the operation of Nassau Street intersections with Chambers Street and Vandeventer Avenue.

Figure 18 shows PM peak hour two-way traffic volumes on North-South corridors in the study area. It can be seen that a significant projected increase between the Base (2012 Existing) and the No-Build (2027) scenarios can be attributed to the Alexander Street corridor. All four improvement packages will reduce the projected demands on the north-south corridors compared to the No-Build scenario.

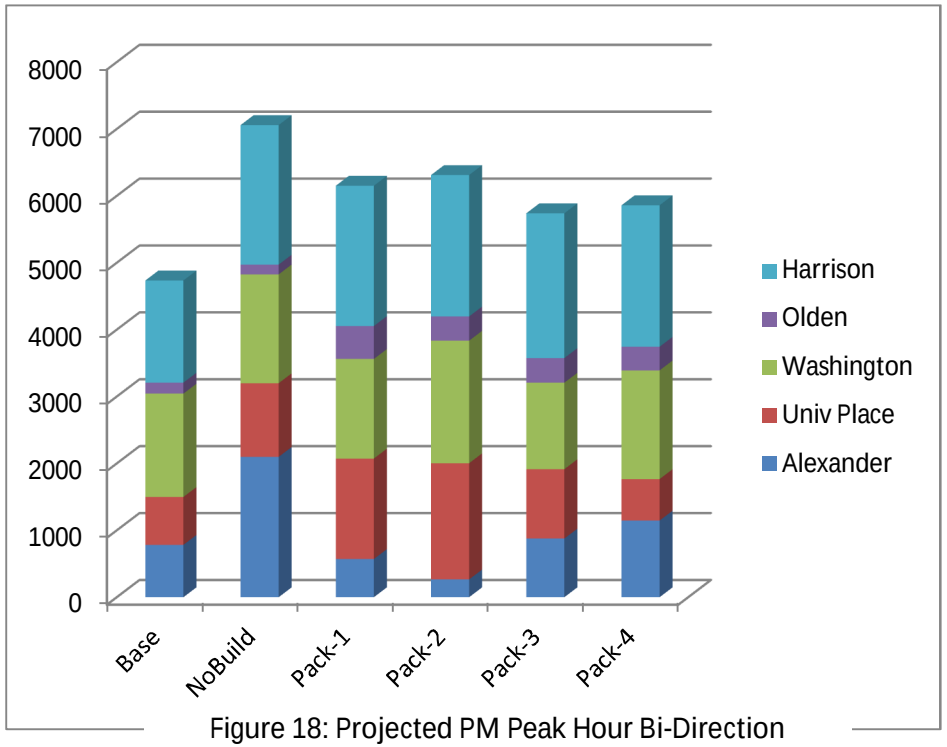


Figure 18: Projected PM Peak Hour Bi-Direction Volumes along North-South Corridors

While all the improvement packages showed potential for traffic volume redistribution helping to reduce impacts on Alexander Street corridor, it is important to note:

1. The proposed one-way loop systems lack redundancy. Under the existing condition both Alexander Street and University Place are two-way streets with collectively two travel lanes in each direction. With the proposed one-way systems, there will be one lane in each direction with the remaining cartway reserved for either on-street parking and a bicycle lane or for a dedicated transit lane.
2. Since the proposed improvement packages are not improving capacity, there will be some impacts on other locations outside of the study area boundary for this study. These impacts will need to be assessed before implementing any of the proposed improvement packages.

VI. PRELIMINARY TRAFFIC OPERATIONAL ANALYSIS

While travel demand analysis provided estimates of potential traffic volume growth and/or shifts during the weekday peak hours, it is important to understand how these projected volumes will impact operational performance for the key study area intersections. Thus, while AECOM was not scoped to conduct an operational analysis as a part of this study, AECOM undertook such analysis at the request of the ASUP Task Force and the Town of Princeton.

A. Operational Modeling Process

AECOM conducted intersection operational performance analysis using the Synchro + SimTraffic software platform. Operational performance indicators for the key study area intersections were Level of Service (LOS) and average intersection delay per vehicle. Based on the industry approved Highway Capacity Methods (HCM), the Level of Service for signalized and unsignalized intersections relates to the following ranges of control delays:

Level of Service (LOS)	Average Control Delay per Vehicle (in Sec.)	
	Signalized	Unsignalized
A (Excellent - Free Flow)	<=10	<=10
B (Very Good - Minor Adjustments)	>10 and <=20	>10 and <=15
C (Good - Stable Flow of Traffic)	>20 and <=35	>15 and <=25
D (Satisfactory Flow - Occasional Delays)	>35 and <=55	>25 and <=35
E (Capacity Flow - Significant Delays)	>55 and <=80	>35 and <=50
F (Failing - Significant Delays and Queuing)	>80	>50

B. Use of Princeton Arts and Transit Study Operational Model

AECOM used the traffic volumes from the 2017 Build Condition Synchro model from the Princeton Arts and Transit Study for establishing the Base No-Build Condition intersection operational performance without implementing any of the improvement packages described earlier in the report. While the future year assumed for travel demand analysis was 2027, for the purpose of operational analysis a near-term future year (2017) was deemed acceptable to understand impacts of various improvement packages on intersection performance. AECOM then created multiple Synchro models to determine intersection operational performance related to the various improvement packages.

Based on the specifics associated with the proposed roadway network for each improvement package, AECOM conducted traffic volume reassignment prior to conducting the intersection performance analysis for the improvement package models. The traffic volume reassignment process did not consider any reduction/shifts in traffic away from the immediate corridor, in order to conduct a worse case analysis. The following scenarios were tested during both weekday AM and PM peak hours:

1. 2017 baseline analysis
2. 2017 Improvement Package 1 analysis (Mercer Street segment closed)
3. 2017 Improvement Package 2 analysis (clockwise one-way loop for University Place and Alexander Street)
4. 2017 Updated Improvement Package 2 analysis (same as Improvement Package 2 except for traffic signal at the intersection of Nassau Street and University Place shifted to the intersection of Nassau Street and Mercer Street)
5. 2017 Improvement Package 3 (counter-clockwise one-way loop for University Place and Alexander Street)
6. 2017 Updated Improvement Package 3 (same as Improvement Package 3 except University Place to Mercer Street traffic flows bypass Nassau Street using the street parallel to and located just south of Nassau Street)

C. Intersection Performance Assessment

The following table shows results of the intersection performance assessment during the weekday AM peak hour.

AM Peak Hour Intersection Performance Assessment

Intersection	Control	AM Peak Hour										
		2017 Baseline Analysis			2017 Mercer Closed Analysis			2017 Updated Clockwise One-way Loop Analysis			2017 Updated Counterclockwise One-way Loop Analysis	
		LOS	Delay (sec)		LOS	Delay (sec)		LOS	Delay (sec)		LOS	Delay (sec)
NASSAU CORE AREA												
Nassau & Bayard	Signal	D	49.6		C	27.1		C	29.0		D	39.5
Nassau & Mercer	Stop	F	80.5		-	-		C	24.9		C	15.5
Nassau & University	Signal	C	21.7		B	14.5		C	24.6		B	12.8
ALEXANDER CORRIDOR												
Alexander & Mercer	Stop	F	434.9		A	-		D	34.4		A	-
Alexander & College	Stop	D	34.6		C	17.8		B	11.8		E	39.9
Alexander & University	Roundabout	C	-		D	-		F	-		A	-

It can be seen that by 2017 without any improvements, the stop controlled intersections of Nassau Street and Mercer Street as well as Alexander Street and Mercer Street will perform at a failing level of service with significant delays. With the Improvement Package 1 (Mercer Street Segment between Alexander Street and Nassau Street closed), intersection performance can be improved to an acceptable level of service. Similarly with the counter-clockwise one-way loop options, 2017 baseline intersection performance for the intersections with failing LOS can be improved to an acceptable LOS.

The following table shows results of the intersection performance assessment during the weekday PM peak hour. It can be seen that for the 2017 baseline condition, PM peak hour delays are worse for the stop-controlled intersections of Nassau Street and Mercer Street as well as Alexander Street and Mercer Street. Each vehicle at the stop-controlled approach of Mercer Street at Nassau Street will experience an average of 17-minute delay before it can turn onto Nassau Street. Similarly, each vehicle at the stop-controlled approach of Alexander Street at Mercer Street will experience an average of 10-minute delay before it can turn onto Mercer Street. These significant delays and associated backups will also impact performance of other intersections in the vicinity as well.

However with the proposed improvement packages, these excessive delays can be eliminated and these intersections will perform at an acceptable level of service.

It should be noted that while the improvement packages help improve the study area intersection performance to an acceptable level of service in 2017, some other intersections outside of the study area can be impacted due to changes in the traffic pattern related to these improvements. These impacts will need to be assessed before implementing any of the proposed improvement packages.

PM Peak Hour Intersection Performance Assessment

Intersection	Control	PM Peak Hour										
		2017 Baseline Analysis			2017 Mercer Closed Analysis			2017 Updated Clockwise One-way Loop Analysis			2017 Updated Counterclockwise One-way Loop Analysis	
		LOS	Delay (sec)		LOS	Delay (sec)		LOS	Delay (sec)		LOS	Delay (sec)
NASSAU CORE AREA												
Nassau & Bayard	Signal	C	28.2		C	28.8		B	17.6		C	32.0
Nassau & Mercer	Stop	F	1031		-	-		B	14.0		C	16.3
Nassau & University	Signal	B	15.4		B	18.4		B	12.5		C	28.1
ALEXANDER CORRIDOR												
Alexander & Mercer	Stop	F	600.4		A	-		C	16.4		A	-
Alexander & College	Stop	E	36.6		C	22.9		E	45.7		D	30.5
Alexander & University	Roundabout	B	-		C	-		D	-		A	-

VII. PATH FORWARD

The ASUP Task Force has also been overseeing the Princeton Transit Study, which looks into various options for providing continuation of transit service from the recently relocated Princeton Dinky Station to the Nassau Street corridor. This transit study has developed several options. The following two options have been the leading contenders and it is important to understand the traffic implications associated with these options:

Option 1[1] : Widening University Place to Accommodate 2-way In-street[2] Transit Tracks with Parking:

This option will maintain the existing number of travel lanes, two-way traffic operation and intersection controls along the University Place corridor. Thus, this transit option in its present form cannot support the one-way loop improvement packages (Packages 2, 3 and 4) of the Princeton Traffic Study. With the proposed in-street operation of transit vehicles under this option, vehicular performance along the University Place corridor will be slightly impacted compared to the existing conditions. Improvement Package 1 of the traffic study (closure of Mercer Street segment between Alexander Street and Nassau Street) can still be implemented to eliminate traffic issues in the Nassau Street core area (between University Place and Bayard Lane) as well as to improve failing intersection performance at the intersections of Mercer Street/Nassau Street and Mercer Street/Alexander Street.

If it is not suitable to implement the Traffic Study's Improvement Package 1 with this transit option, then performance of the Nassau Street core area as well as the performance of the intersection of Nassau Street and Mercer Street can still be improved by implementing the "Turn Restrictions" concept described earlier in Section V - Subsection B of this report. For improving performance of the Mercer Street and Alexander Street intersection, a signal warrants analysis should be undertaken to determine if this intersection can be signalized to improve intersection performance.

[1] Labeled as Option E in the Princeton Transit Study
[2] Shared with regular traffic lane

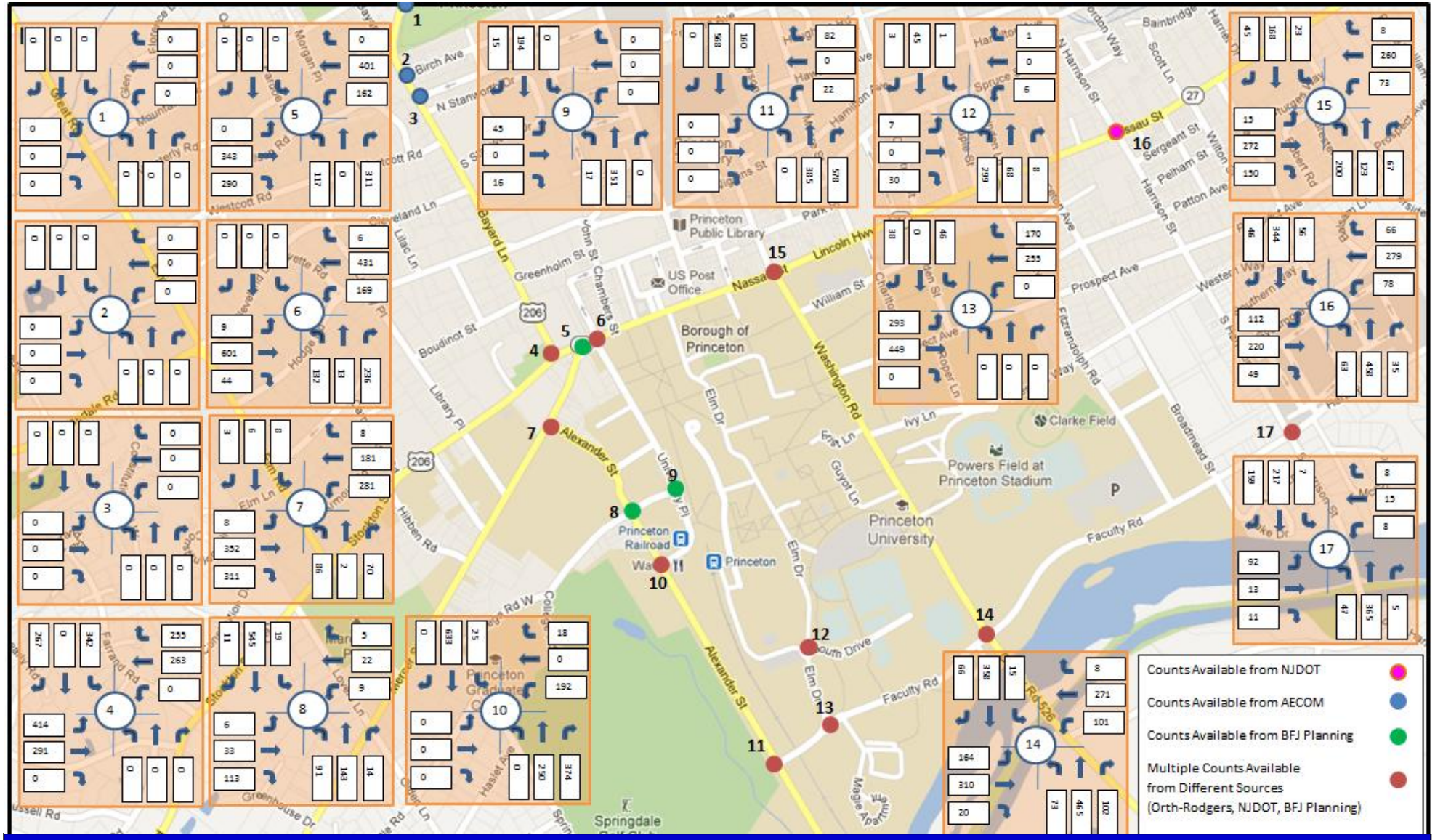
Option 2[3]: Widening University Place to accommodate dedicated transit track with two-way traffic operation:

From a traffic operations point of view this option is similar to Option 1 above except that the provision of a dedicated track for the proposed transit service will cause University Place corridor traffic operation to remain similar to the existing condition. The Traffic performance improvement options suggested above under the discussion of Option 1 apply to this option as well.

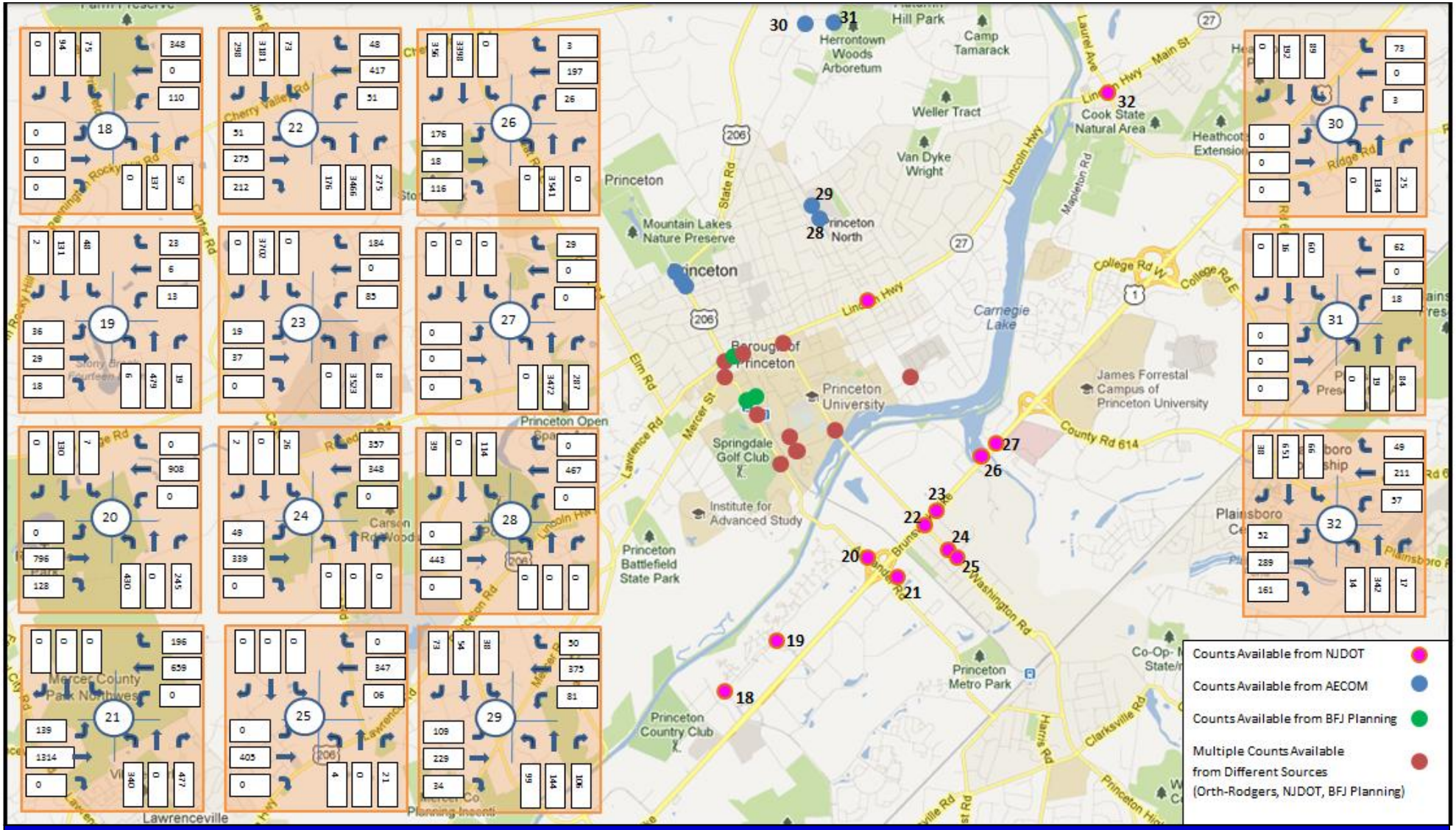
[3] Labeled as Option F in the Princeton Transit Study

APPENDIX 1

Compiled Intersection Turning Movement Traffic Counts – Weekday AM and PM Peak Hours

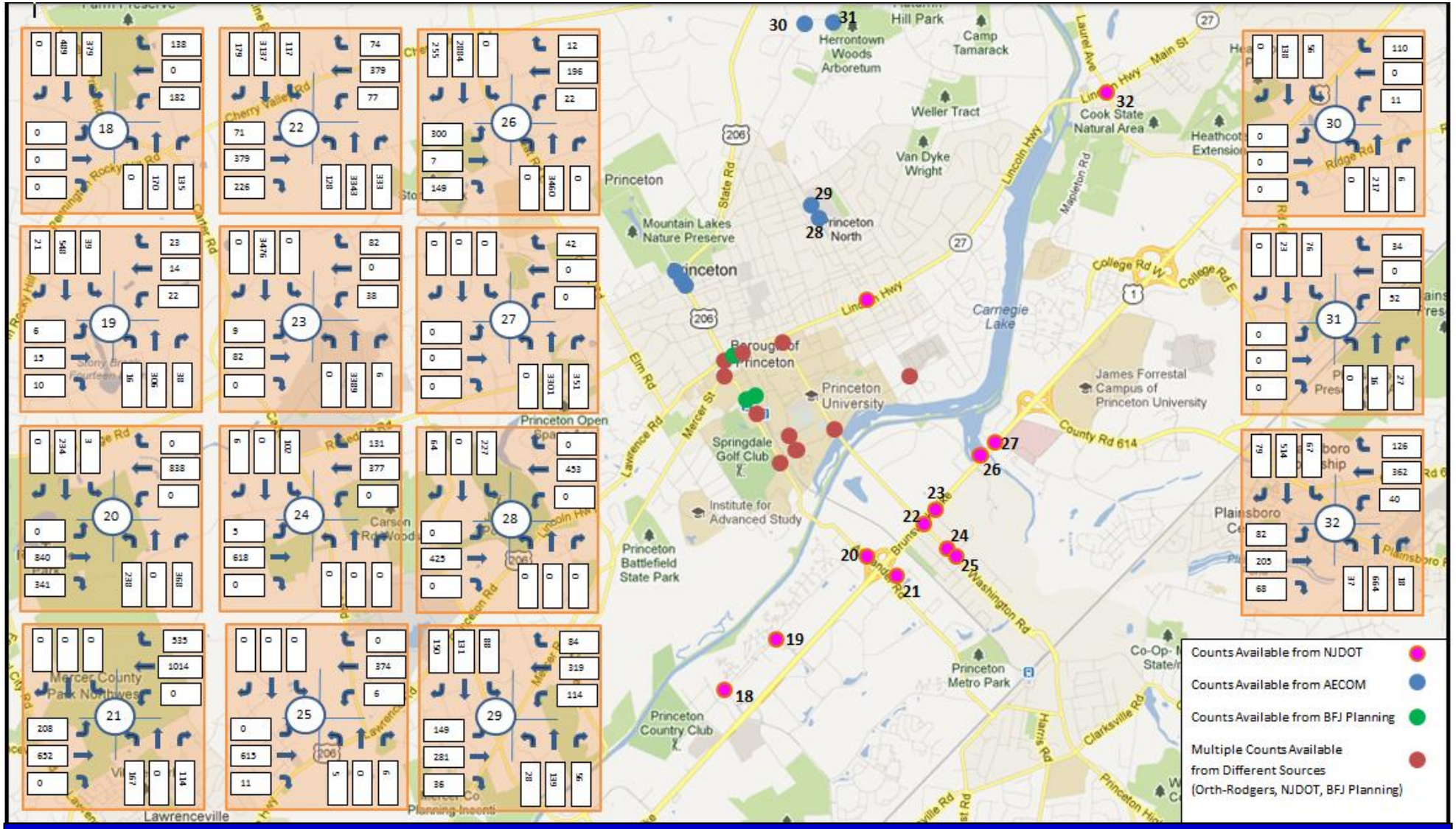


2012 AM Peak Hour Intersection Turning Movement Traffic Counts



2012 AM Peak Hour Intersection Turning Movement Traffic Counts

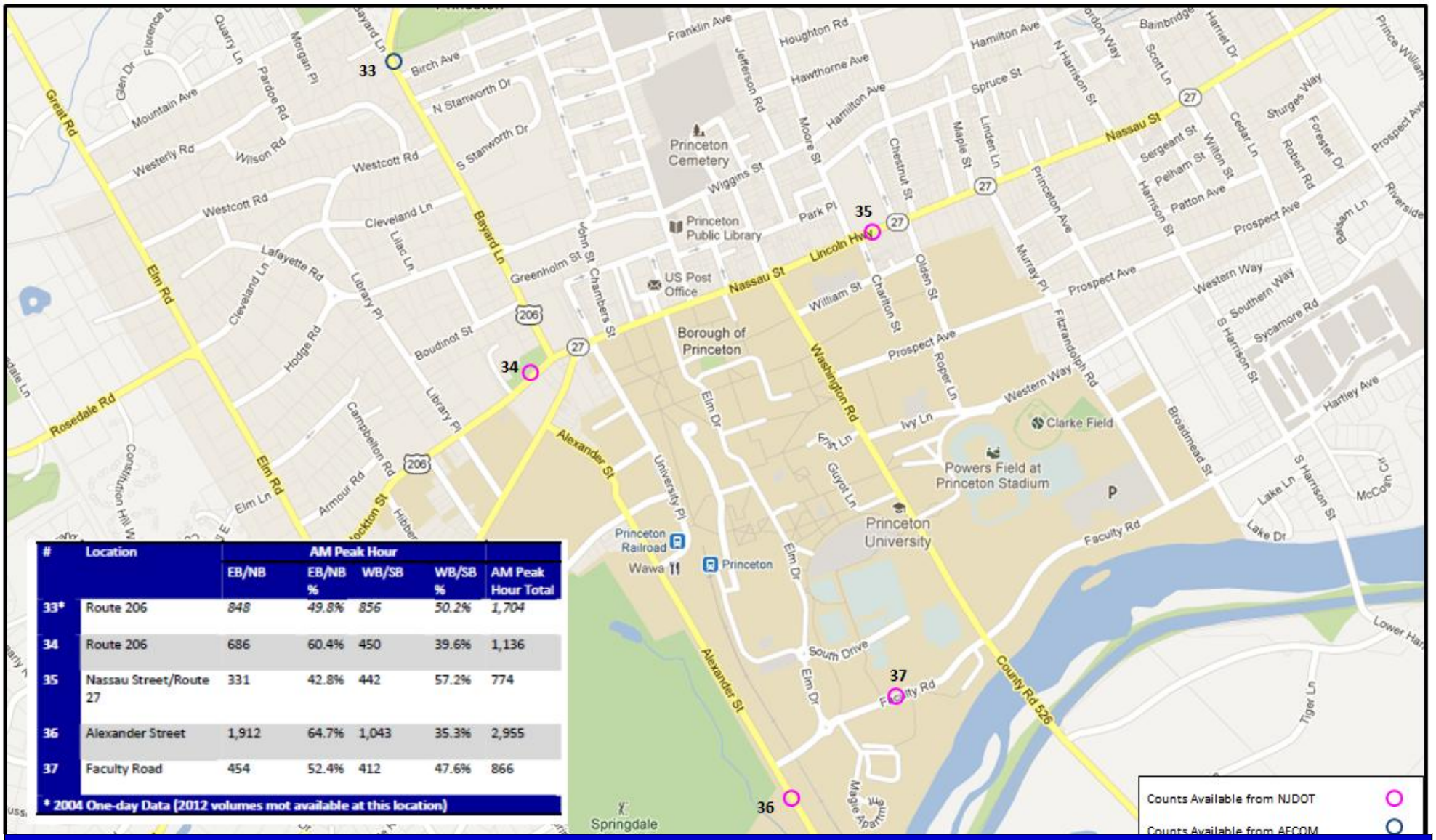
2012 PM Peak Hour Intersection Turning Movement Traffic Counts



2012 PM Peak Hour Intersection Turning Movement Traffic Counts

APPENDIX 2

Compiled Automatic Traffic Recorder (ATR) Counts



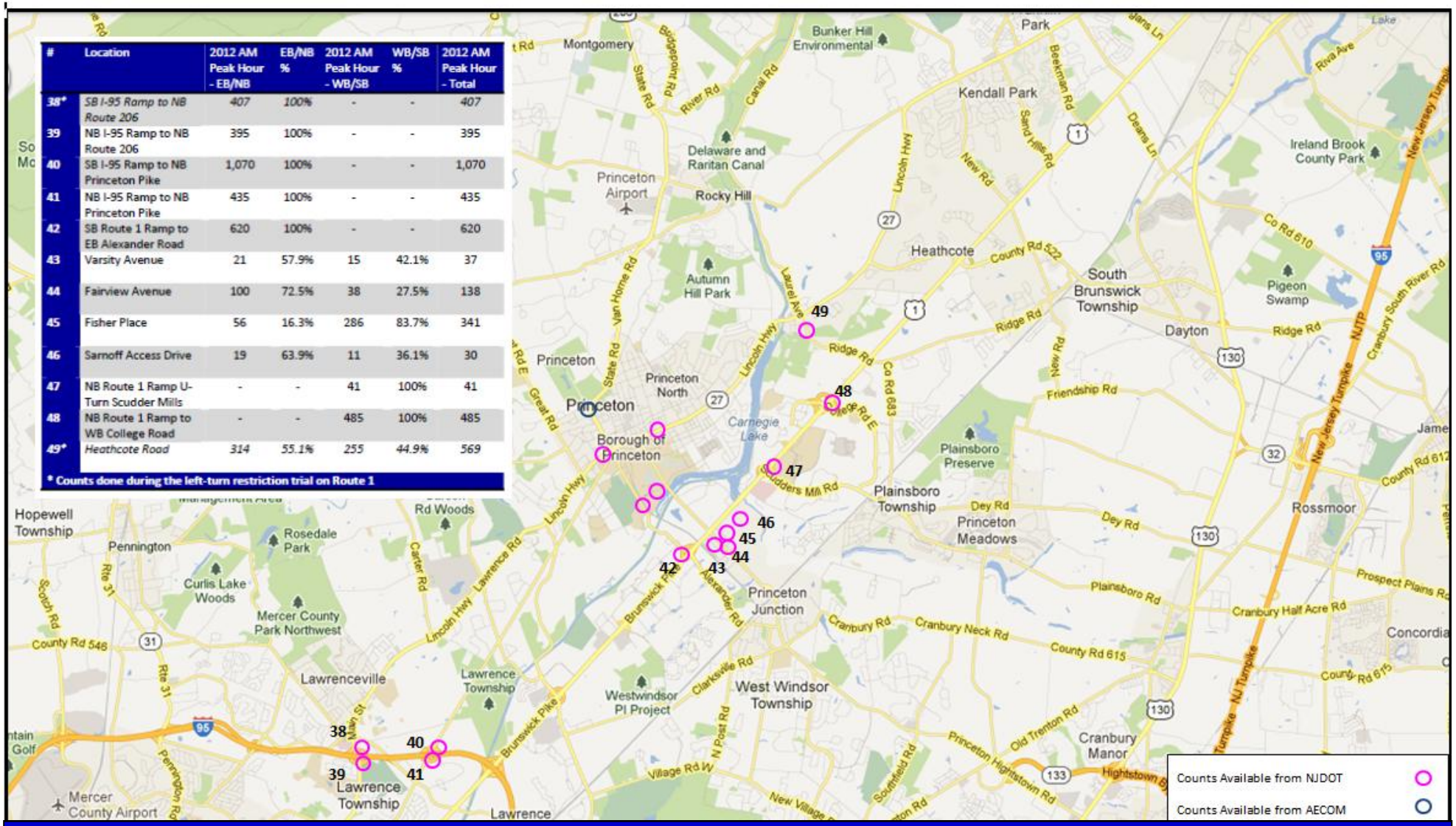
#	Location	AM Peak Hour				
		EB/NB	EB/NB %	WB/SB	WB/SB %	AM Peak Hour Total
33*	Route 206	*848*	*49.8%*	*856*	*50.2%*	*1,704*
34	Route 206	686	60.4%	450	39.6%	1,136
35	Nassau Street/Route 27	331	42.8%	442	57.2%	774
36	Alexander Street	1,912	64.7%	1,043	35.3%	2,955
37	Faculty Road	454	52.4%	412	47.6%	866

* 2004 One-day Data (2012 volumes not available at this location)

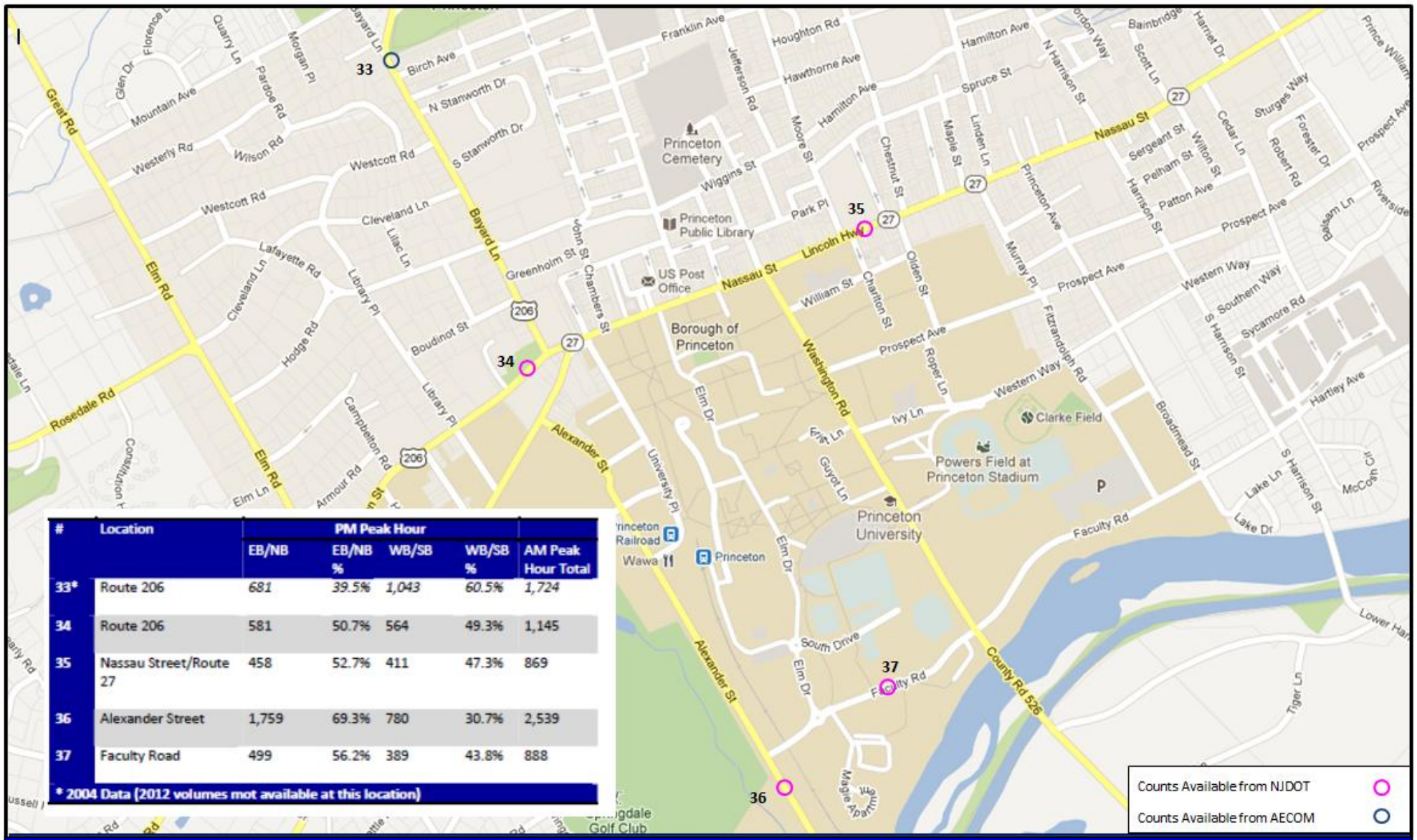
2012 AM Peak Hour ATR Counts

#	Location	2012 AM Peak Hour - EB/NB	EB/NB %	2012 AM Peak Hour - WB/SB	WB/SB %	2012 AM Peak Hour - Total
38*	*SB I-95 Ramp to NB Route 206*	*407*	*100%*	-	-	*407*
39	NB I-95 Ramp to NB Route 206	395	100%	-	-	395
40	SB I-95 Ramp to NB Princeton Pike	1,070	100%	-	-	1,070
41	NB I-95 Ramp to NB Princeton Pike	435	100%	-	-	435
42	SB Route 1 Ramp to EB Alexander Road	620	100%	-	-	620
43	Varsity Avenue	21	57.9%	15	42.1%	37
44	Fairview Avenue	100	72.5%	38	27.5%	138
45	Fisher Place	56	16.3%	286	83.7%	341
46	Sarnoff Access Drive	19	63.9%	11	36.1%	30
47	NB Route 1 Ramp U-Turn Scudder Mills	-	-	41	100%	41
48	NB Route 1 Ramp to WB College Road	-	-	485	100%	485
49*	*Heathcote Road*	*314*	*55.1%*	*255*	*44.9%*	*569*

* Counts done during the left-turn restriction trial on Route 1



2012 AM Peak Hour ATR Counts



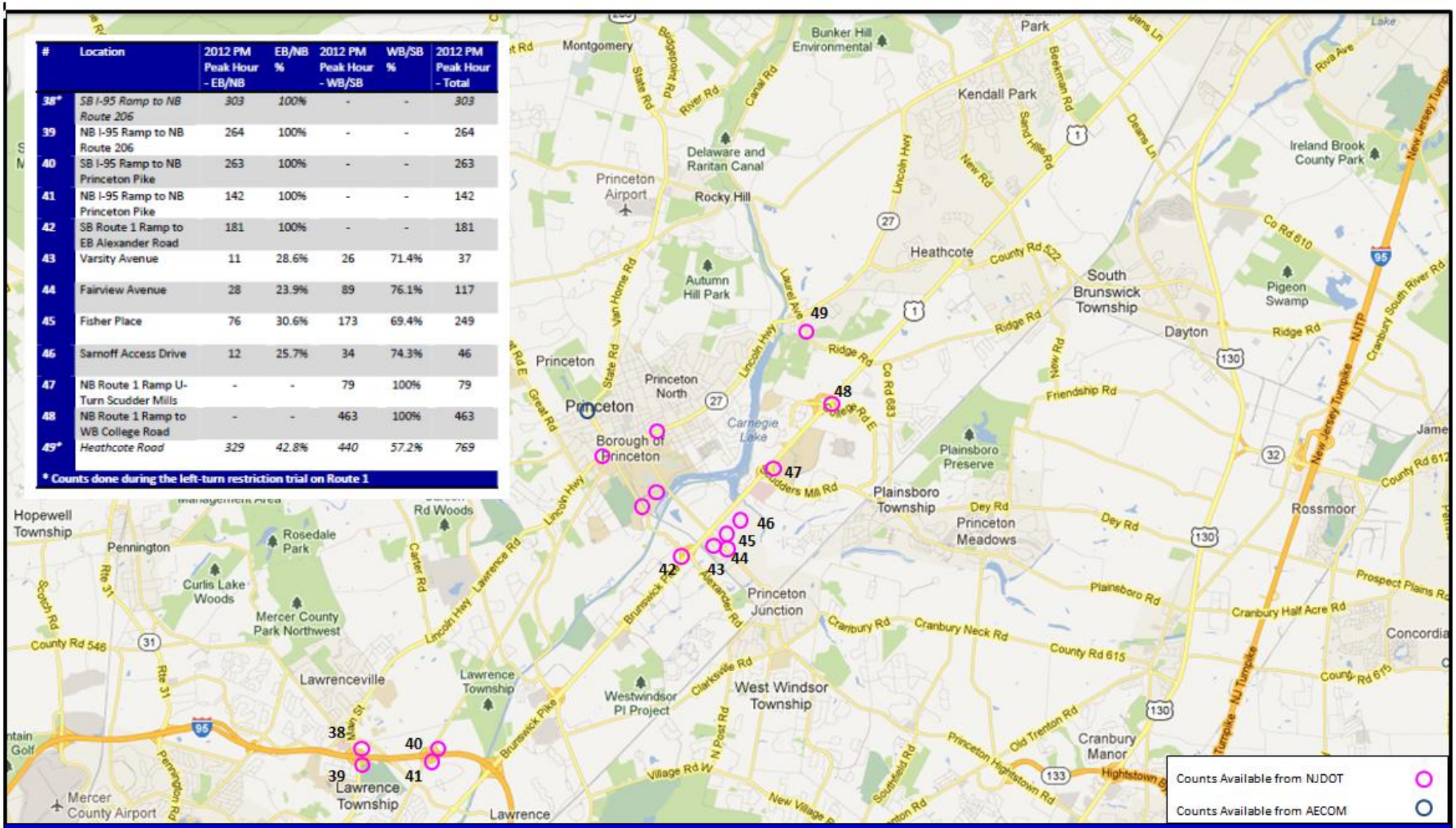
#	Location	PM Peak Hour EB/NB	EB/NB %	WB/SB	WB/SB %	AM Peak Hour Total
33*	Route 206	*681*	*39.5%*	*1,043*	*60.5%*	*1,724*
34	Route 206	581	50.7%	564	49.3%	1,145
35	Nassau Street/Route 27	458	52.7%	411	47.3%	869
36	Alexander Street	1,759	69.3%	780	30.7%	2,539
37	Faculty Road	499	56.2%	389	43.8%	888

*** 2004 Data (2012 volumes mot available at this location)**

2012 PM Peak Hour ATR Counts

#	Location	2012 PM Peak Hour - EB/NB	EB/NB %	2012 PM Peak Hour - WB/SB	WB/SB %	2012 PM Peak Hour - Total
*38**	*SB I-95 Ramp to NB Route 206*	*303*	*100%*	-	-	*303*
39	NB I-95 Ramp to NB Route 206	264	100%	-	-	264
40	SB I-95 Ramp to NB Princeton Pike	263	100%	-	-	263
41	NB I-95 Ramp to NB Princeton Pike	142	100%	-	-	142
42	SB Route 1 Ramp to EB Alexander Road	181	100%	-	-	181
43	Varsity Avenue	11	28.6%	26	71.4%	37
44	Fairview Avenue	28	23.9%	89	76.1%	117
45	Fisher Place	76	30.6%	173	69.4%	249
46	Sarnoff Access Drive	12	25.7%	34	74.3%	46
47	NB Route 1 Ramp U-Turn Scudder Mills	-	-	79	100%	79
48	NB Route 1 Ramp to WB College Road	-	-	463	100%	463
*49**	*Heathcote Road*	*329*	*42.8%*	*440*	*57.2%*	*769*

* Counts done during the left-turn restriction trial on Route 1



2012 PM Peak Hour ATR Counts

APPENDIX 3

Study Area Development/Redevelopment – New Trip Generation

FUTURE LOCAL DEVELOPMENT NEW TRIP GENERATION

	TAZ	NUMBER	TYPE	Peak Hour New Trip Generation AM In	AM Out	PM In	PM Out
Hulfish North (Palmer Square)	747	97	Townhouses	9	41	41	22
University Med Center Redevelopment	716	280	Apartments	26	118	118	64
YM/YWCA Redevelopment	749						
- Additional Residential @ 14 du/ac @ 10 a		140	Townhouses	13	59	59	32
Merewick / Stanworth Graduate Housing							
- Additional units	706	172	Apartments	16	73	73	39
Hibben Magie Graduate Housing	610	329	Dwelling Units	23	12	21	21
University Arts & Transit							
Relocated Employees (West Garage)	600			24	0	0	20
New Employees (Lots 32, 33)	694	55	Spaces	25	2	2	23
Restaurant / Café	601	10	Thousand Sq. Ft.	79	82	31	31
Total Trips				215	387	345	251

APPENDIX 4

Travel Demand Modeling Scenario Details

Modeled Scenario =	Base Model +	Network Updates +	Land Use Updates
1. 2012 Base Condition	2006 Base Model	• Available 2012 Traffic Count Data • Any roadway improvement projects completed since 2006	• Relocation of the University Medical Center
2. 2027 No-Build Condition	2012 Base Condition	• Roadway improvements related to the Princeton University Arts and Transit Project	• All new developments/redevelopments identified in the RFP o Expansion of Graduate Hosing (Hibben-Magie) o Princeton University Arts and Transit Project o Hulfish North (Palmer Square) Redevelopment o Redevelopment of YM/YWCA o Redevelopment of Merwick and Stanworth o Redevelopment of University Medical Center
3. Improvement Package 1: Street Closures	2027 No-Build Condition	• Mercer Street closed in both directions between Alexander Street and Nassau Street • Witherspoon Street closed in both directions between Nassau Street and Spring Street • Left turn from Nassau Street onto Bank Street prohibited	• None: same as in 2027 No-Build Condition
4. Improvement Package 2: One-way Loop in Clockwise Direction	2027 No-Build Condition	• Mercer Street one-way in eastbound direction from Alexander Street to Nassau Street • University Place one-way in southbound direction from Nassau Street to Alexander Street • Alexander Street one-way in northbound direction from University Place to Mercer Street • Left turns from Nassau Street on to Bank Street prohibited • Witherspoon Street one-way in northbound direction from Nassau Street to Spring Street • Signal at Nassau Street and Witherspoon Street converted to pedestrian signal only	• None: same as in 2027 No-Build Condition
5. Improvement Package 3: One-way Loop in Counterclockwise Direction	2027 No-Build Condition	• Mercer Street one-way in westbound direction from Nassau Street to Alexander Street • University Place one-way in northbound direction from Alexander Street to Nassau Street • Alexander Street one-way in southbound direction from Mercer Street to University Place • Left turns from Nassau Street on to Bank Street prohibited • Witherspoon Street one-way in northbound direction from Nassau Street to Spring Street • Signal at Nassau Street and Witherspoon Street converted to pedestrian signal only	• None: same as in 2027 No-Build Condition
6. Stand-alone Improvement Run: Either Clockwise or Counterclockwise One-Way Loop	Either Improvement Package 2 or Improvement Package 3	• Same actions as in either Package 2 or Package 3 except: o Replace Witherspoon Street one-way conversion with current two-way operation o Fully functional traffic signal at Nassau Street and Witherspoon Street intersection	• None: same as in 2027 No-Build Condition

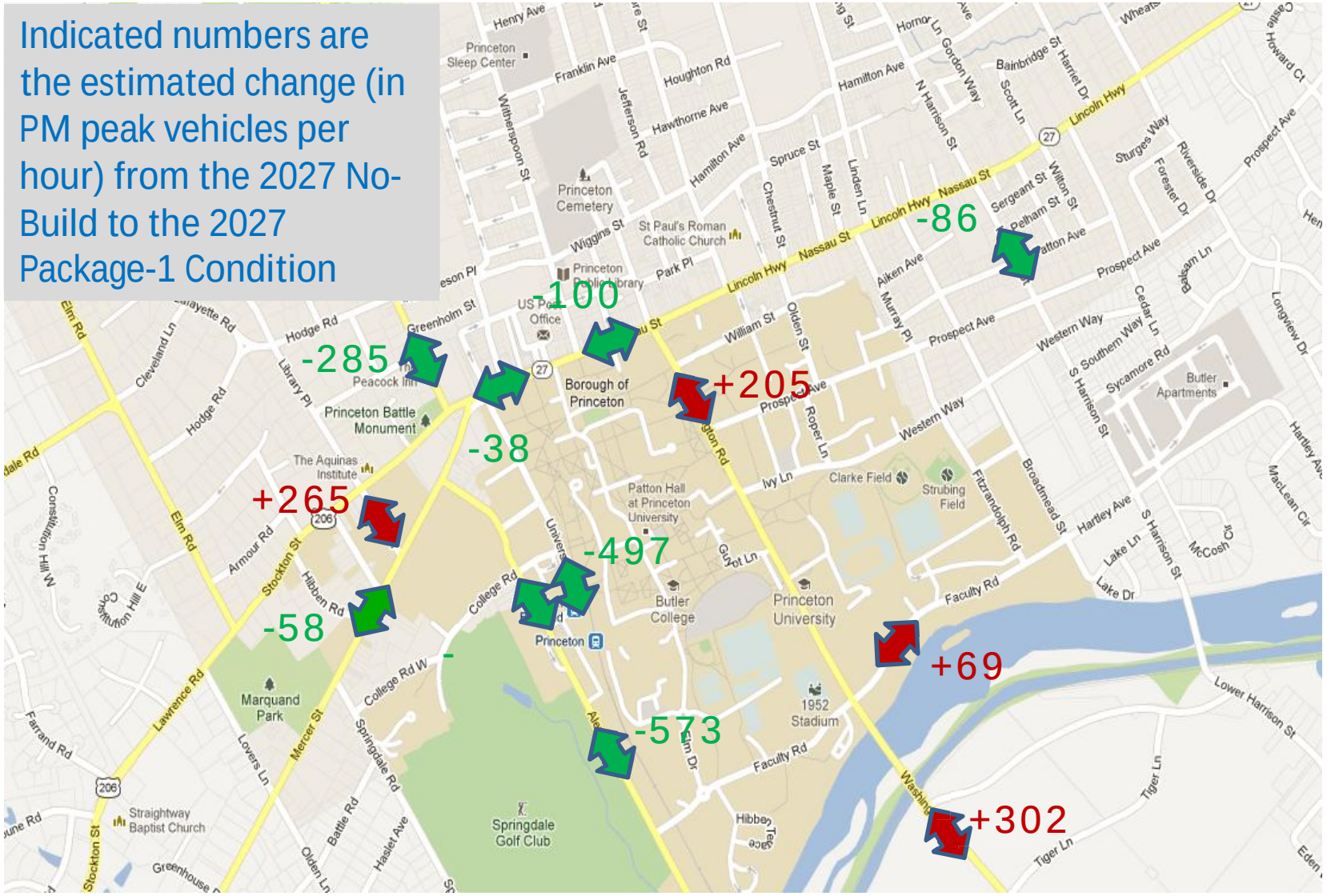
APPENDIX 5

Travel Demand Modeling Analysis for Improvement Packages

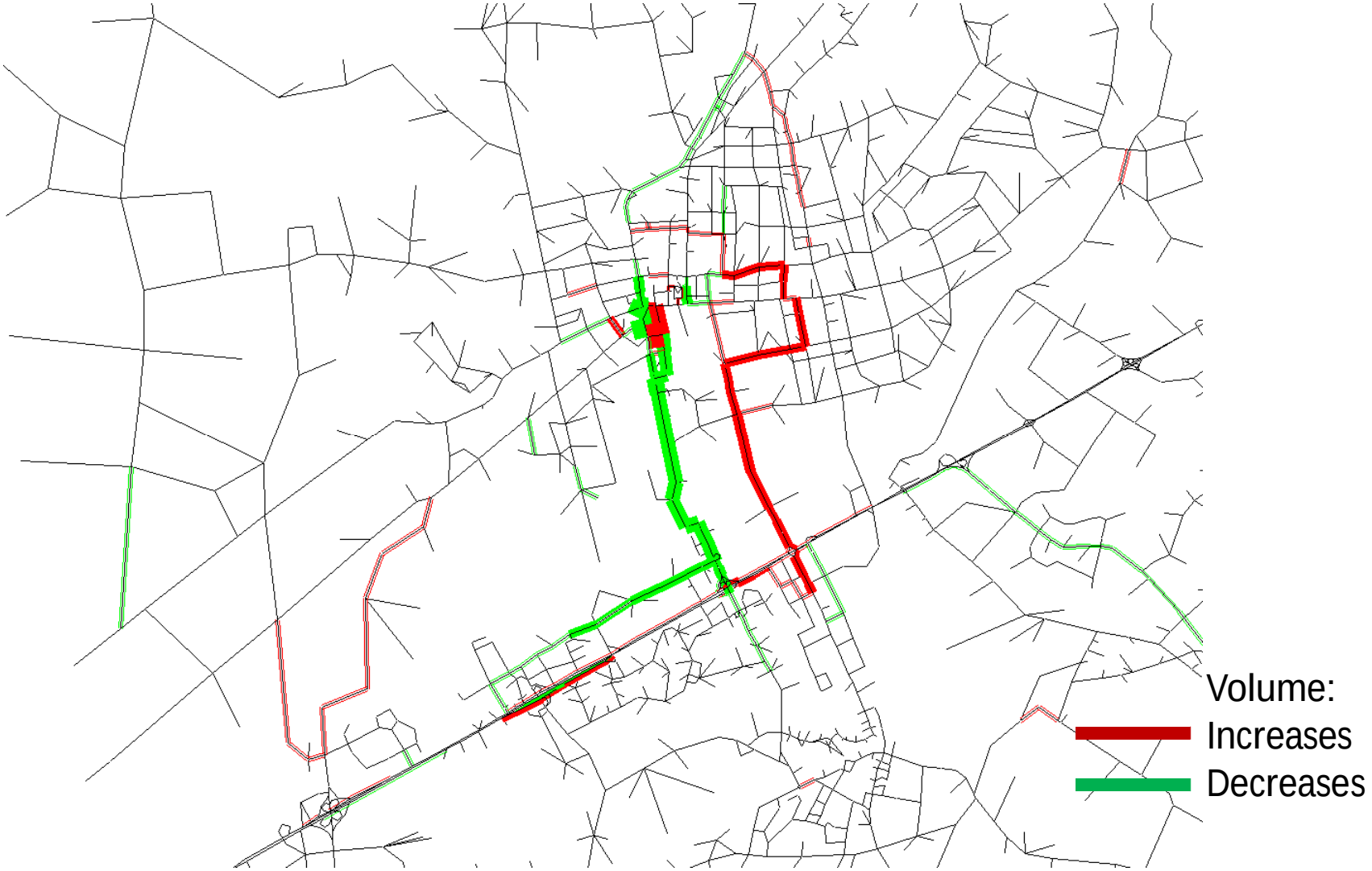
Traffic Volume Changes

Projected PM Peak Hour Traffic Volume Change: 2027 No-Build to 2027 Improvement Package 1

Indicated numbers are the estimated change (in PM peak vehicles per hour) from the 2027 No-Build to the 2027 Package-1 Condition

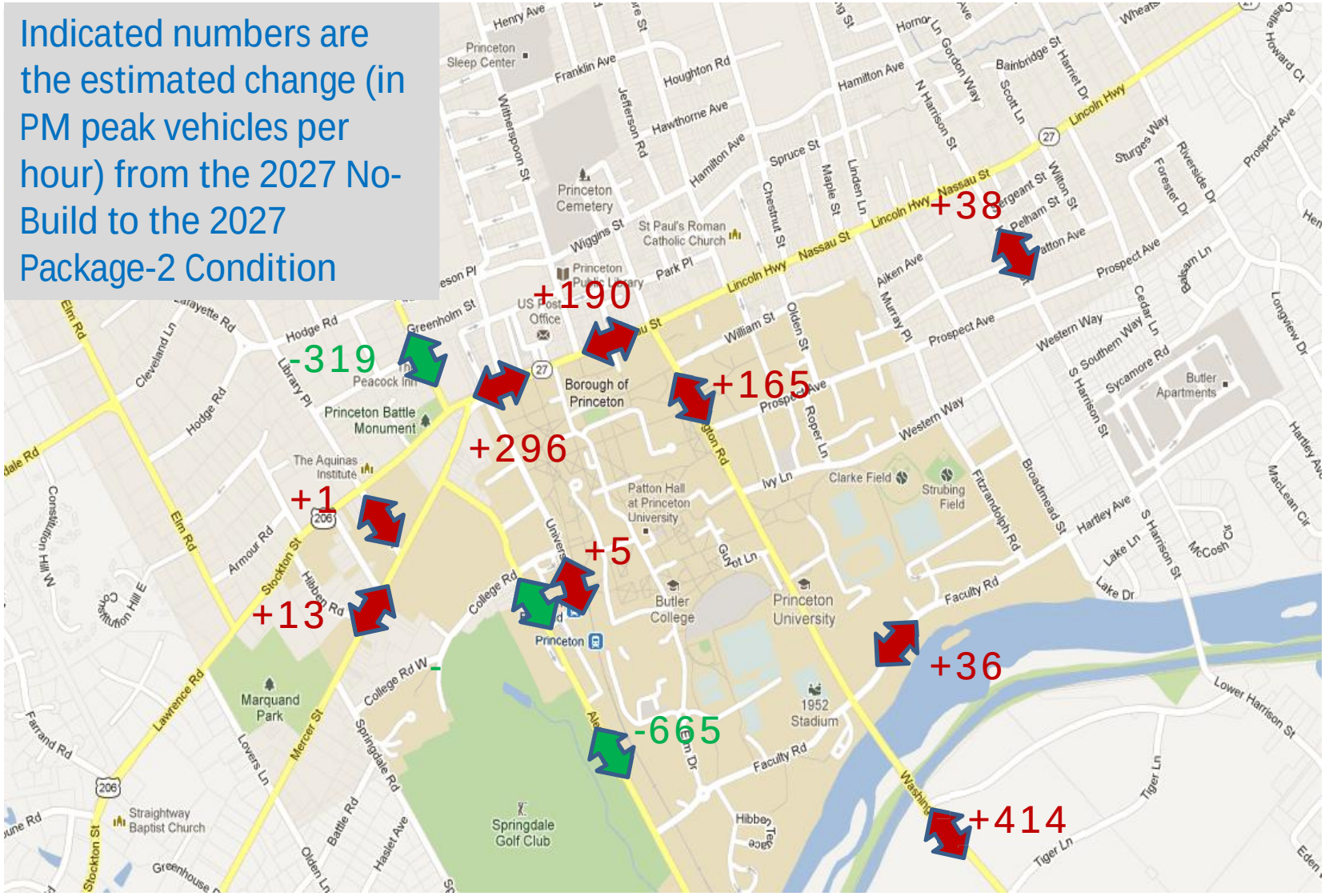


Projected PM Peak Hour Traffic Volume Shifts: 2027 No-Build to 2027 Improvement Package 1

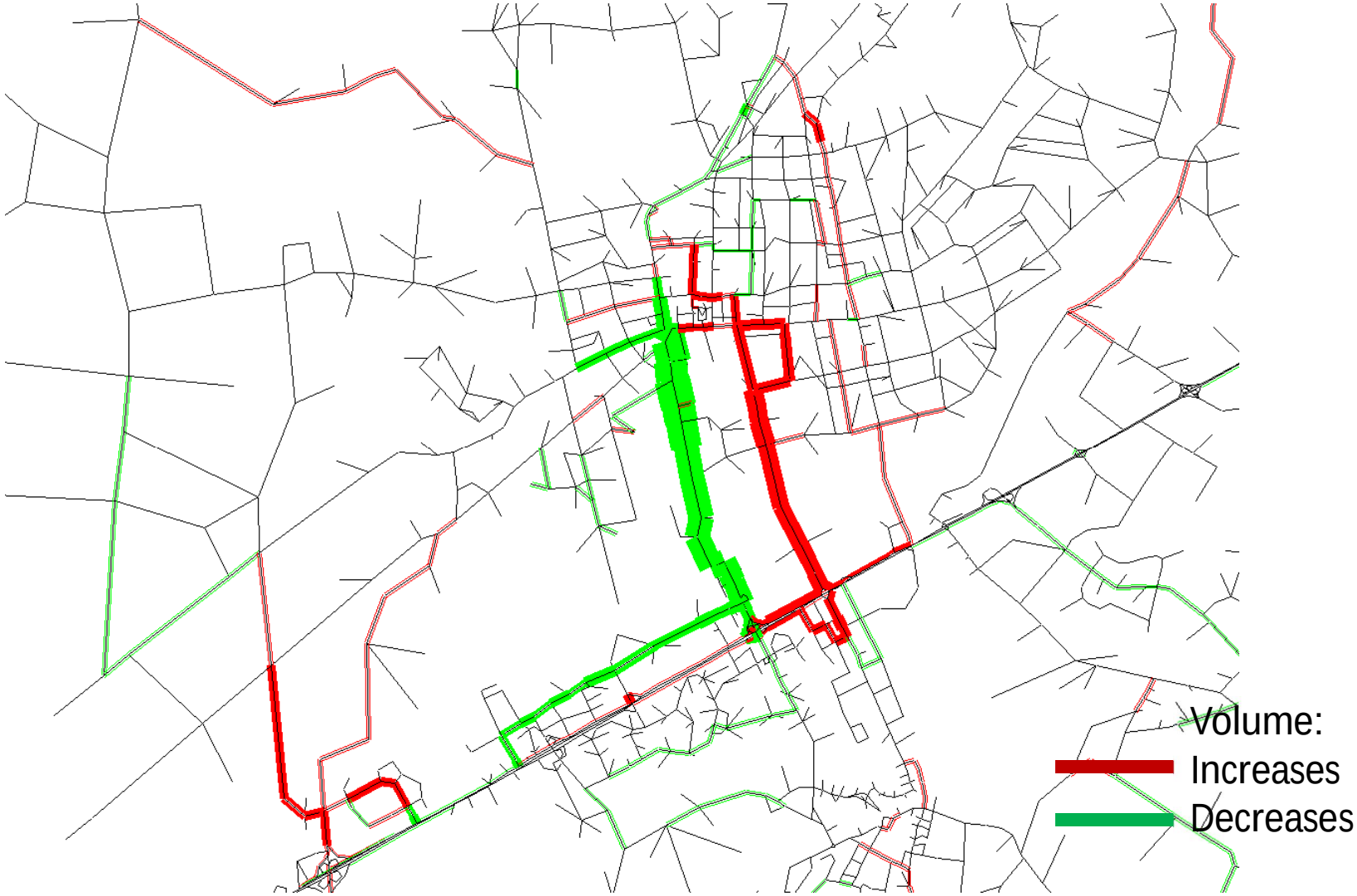


Projected PM Peak Hour Traffic Volume Change: 2027 No-Build to 2027 Improvement Package 2

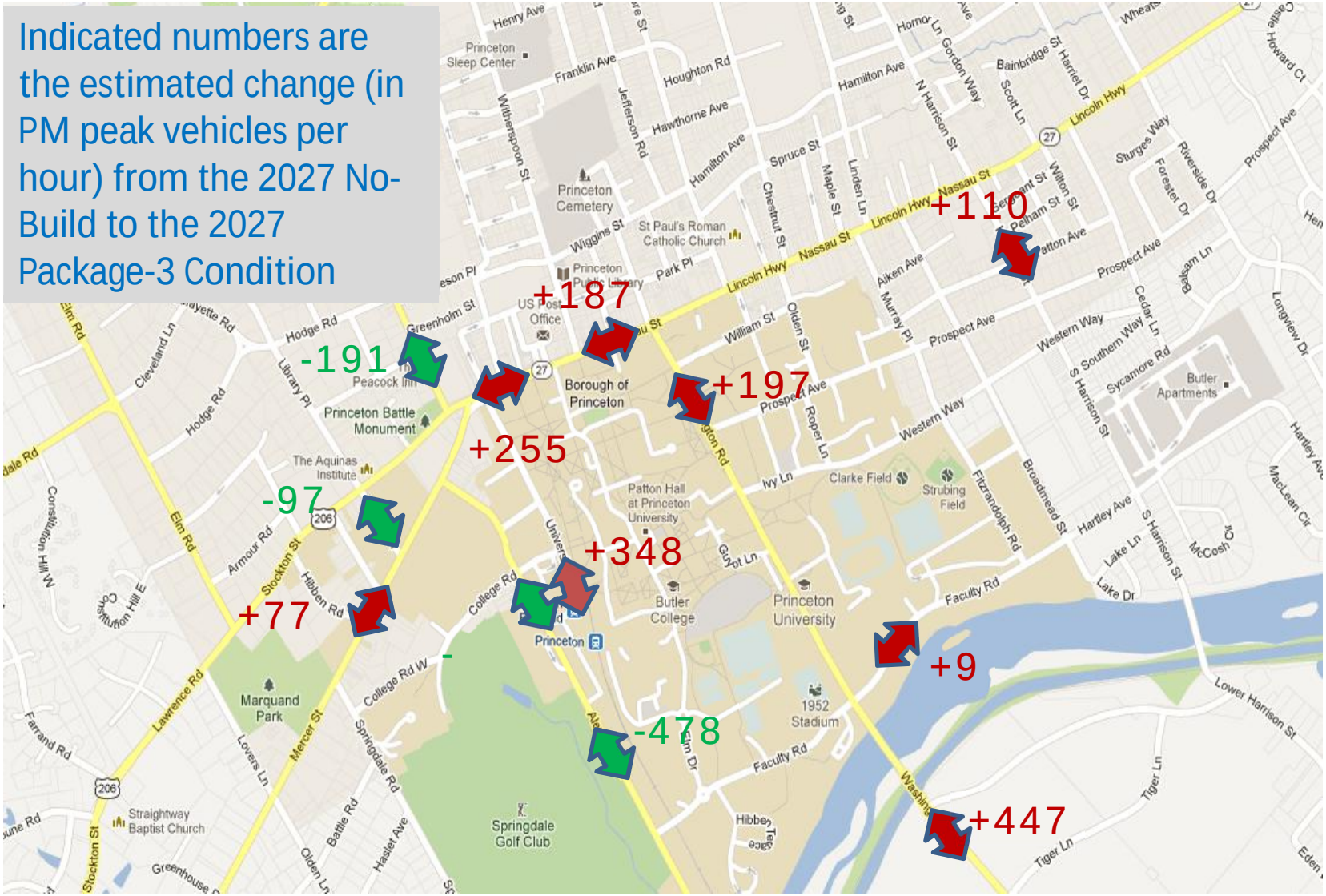
Indicated numbers are the estimated change (in PM peak vehicles per hour) from the 2027 No-Build to the 2027 Package-2 Condition



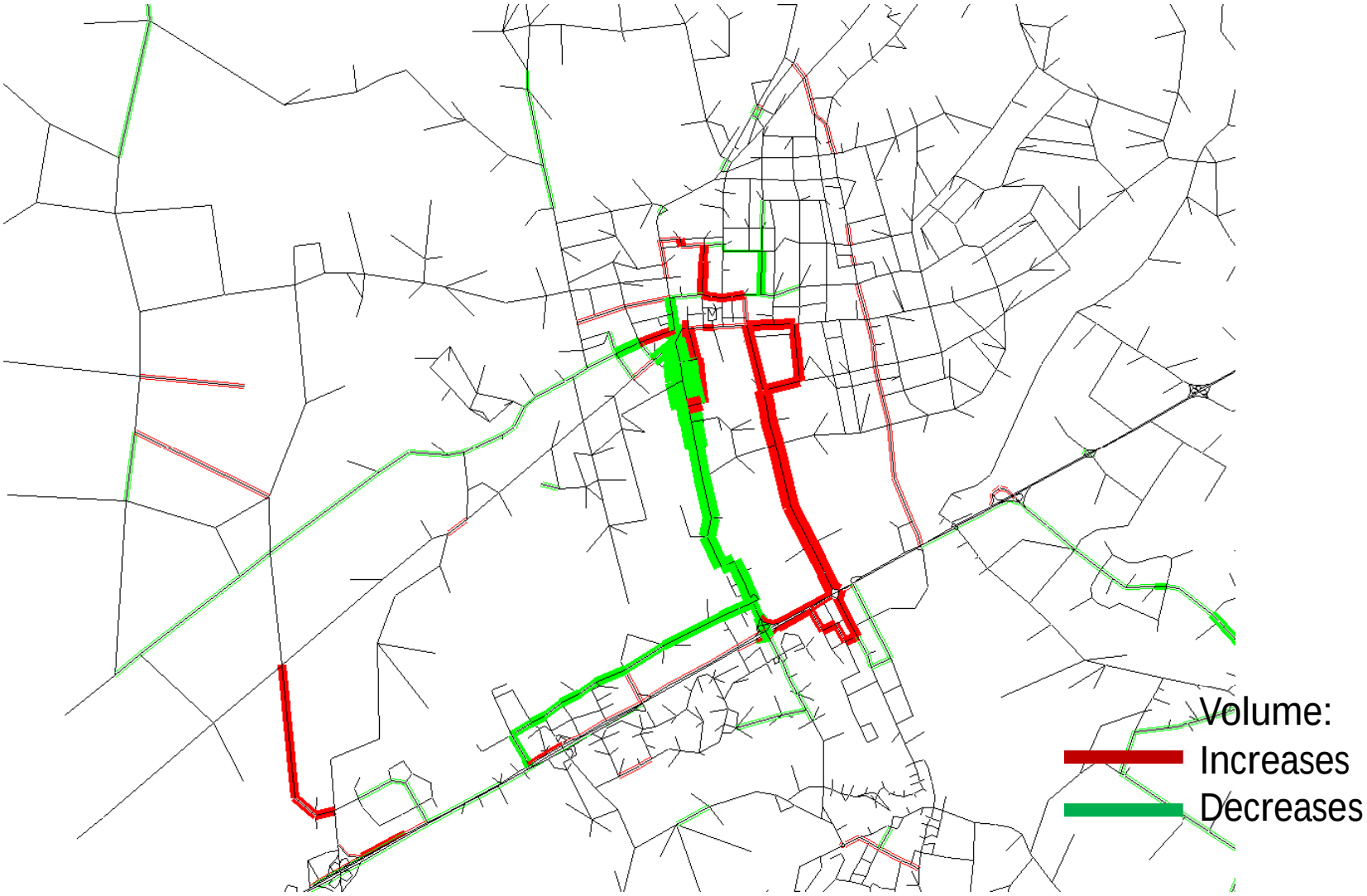
Projected PM Peak Hour Traffic Volume Shifts: 2027 No-Build to 2027 Improvement Package 2



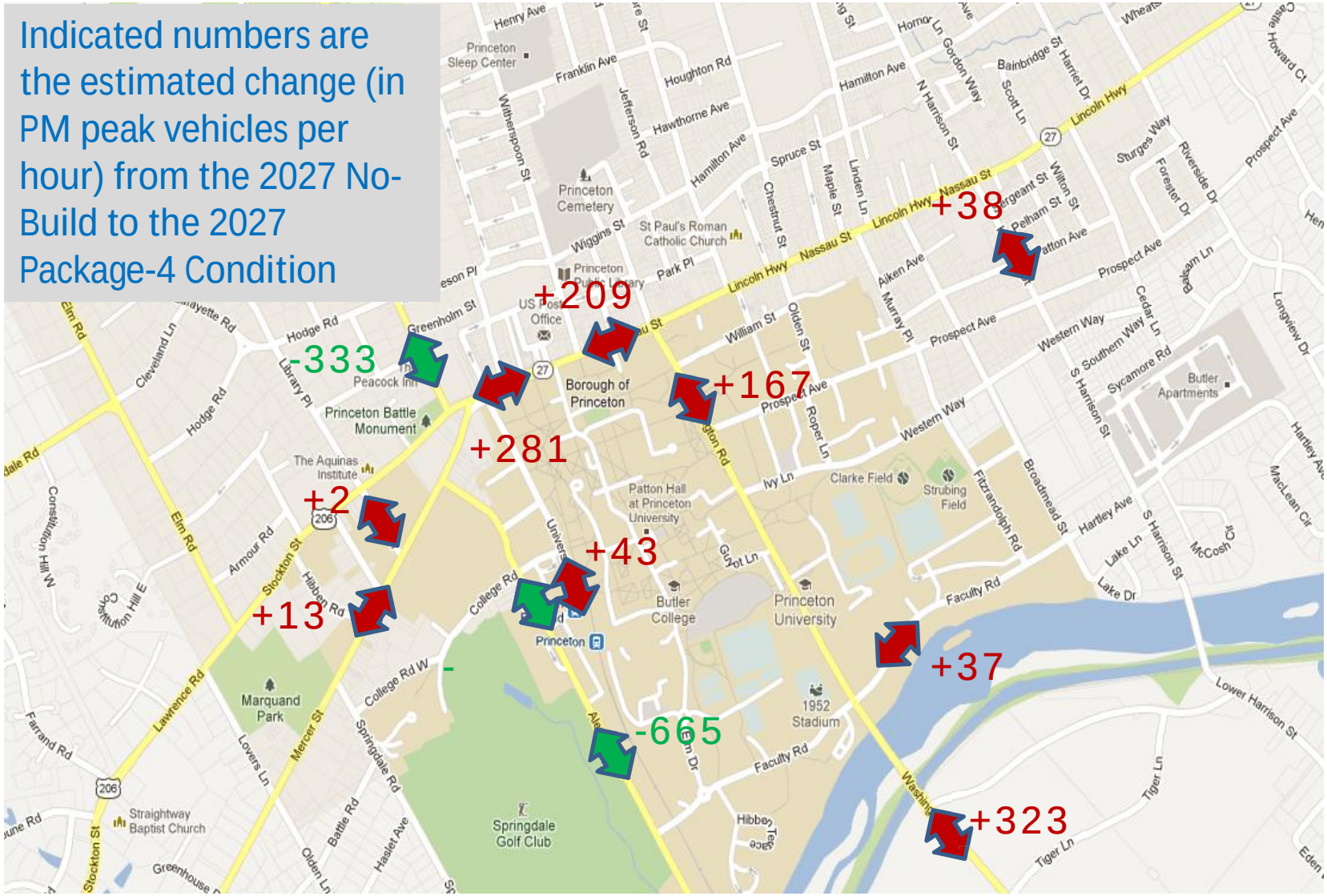
Projected PM Peak Hour Traffic Volume Change: 2027 No-Build to 2027 Improvement Package 3



Projected PM Peak Hour Traffic Volume Shifts: 2027 No-Build to 2027 Improvement Package 3



Projected PM Peak Hour Traffic Volume Change: 2027 No-Build to 2027 Improvement Package 4



Projected PM Peak Hour Traffic Volume Shifts: 2027 No-Build to 2027 Improvement Package 4