

**Traffic Impact Analysis for  
Harrisburg Town Center  
Harrisburg, North Carolina**

**Prepared for:**

**Town of Harrisburg  
Harrisburg, North Carolina**

**Prepared by:**

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018536029**



*Laura N Reid  
4/3/19*

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## 1.0 Executive Summary

The purpose of this Traffic Impact Analysis (TIA) is to evaluate the vehicular traffic impacts on the surrounding transportation infrastructure as a result of the proposed Harrisburg Town Center development. The primary objectives of the study are:

- To estimate trip generation and distribution for the proposed development.
- To perform intersection capacity analyses for the identified study area.
- To determine the potential traffic impacts of the proposed development.
- To identify improvements to mitigate the proposed development's traffic impacts.

The proposed Harrisburg Town Center development is located north of NC 49 and east of Roberta Road in Harrisburg, North Carolina. Based on the site plan provided by the applicant, the proposed development is currently envisioned to consist of approximately:

- 148,000 square feet (sf) of general office space
- 176,300 sf of retail
- 333 multifamily housing units

For the purposes of this TIA, a build-out year of 2023 was considered at the direction of the Town. Based on the provided site plan and information provided by the applicant, the proposed development will utilize existing on-street parking and surface lots to access the project site and provide internal connectivity.

A TIA scoping meeting was held with the Town of Harrisburg and representatives of the applicant in Harrisburg on December 18, 2018, to obtain background information and to ascertain the scope and parameters to be included in this TIA. A Memorandum of Understanding (MOU) was developed based on discussions from this meeting that documented all scoping parameters to be used for the TIA and was reviewed and agreed upon by the Town of Harrisburg and the applicant. Additionally, North Carolina Department of Transportation (NCDOT) reviewed and approved the MOU, which is included in the **Appendix**.

The following AM and PM peak-hour scenarios were analyzed to determine the proposed development's transportation impacts on the surrounding network:

- 2019 Existing Conditions
- 2023 Background Conditions
- 2023 Build-out Conditions

Based on coordination with the Town, NCDOT and the applicant, this TIA evaluated operations under each of the AM and PM peak-hour scenarios above for the following study area intersections:

1. Roberta Road and Rocky River Crossing
2. Roberta Road and Main Street
3. Roberta Road and Parallel Drive
4. Roberta Road and Physicians Boulevard
5. Roberta Road and NC 49
6. Harrisburg Veterans Road and Stallings Road
7. Morehead Road / Alexander Avenue and NC 49
8. Kee Lane and NC 49
9. Main Street and NC 49
10. Main Street and Kee Lane

Kimley-Horn was retained to determine the potential traffic impacts of this development (in accordance with the traffic study guidelines in the *NCDOT Policy on Street and Driveway Access to North Carolina Highways* and set forth by the *Town of Harrisburg Unified Development Ordinance – Appendix F*), and to identify transportation improvements that may be required to mitigate these impacts. This report presents trip generation, distribution, capacity analyses, and identified transportation improvements required to mitigate anticipated traffic demands produced by the subject development.

Based on the capacity analyses performed at each of the identified study intersections, along with review of the auxiliary turn-lane warrants contained herein, the following improvements have been identified to mitigate the impact of the proposed development on the adjacent street network:

***Roberta Road and Rocky River Crossing Road***

- Construction of a southbound right-turn lane with a minimum of 100 feet of storage.

***Roberta Road and Main Street***

- Installation of a traffic signal.
- Installation of fiber connection to the signal at Roberta Road and NC 49
- Construction of a westbound right-turn lane with a minimum of 450 feet of storage.

***Roberta Road and Parallel Drive***

- Construction of an eastbound right-turn lane with a minimum of 50 feet of storage.

***Roberta Road and NC 49***

- Construction of a southbound right-turn lane with 325 feet of storage and permitted-overlap phasing.

***Harrisburg Veterans Road and Stallings Road\****

- Restripe the eastbound through lane to provide a shared through-left lane.
- Implementation of split phasing on the eastbound and westbound approaches.
- Installation of a traffic signal at the intersection of Stallings Road and Hickory Ridge Road to operate on the existing signal cabinet

*\*These improvements are currently the responsibility of the Camellia Gardens development. However, if the proposed Harrisburg Town Center is constructed prior to Camellia Gardens, the Harrisburg Town Center will be responsible for this improvement.*

***Morehead Road / Alexander Avenue and NC 49***

- Construction of a southbound left-turn lane with a minimum of 425 feet of storage

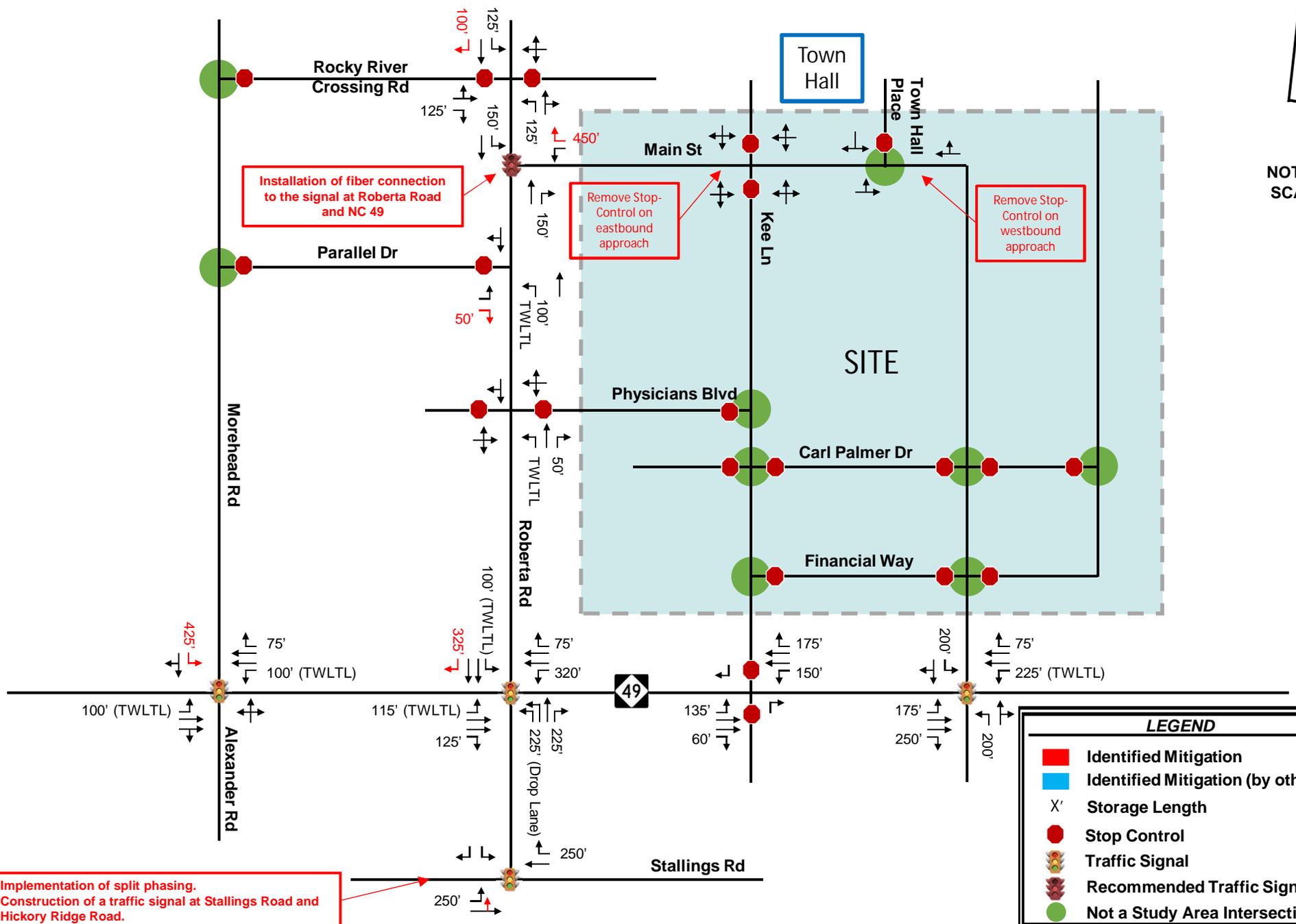
***Main Street and Kee Lane***

- Remove eastbound stop-control to allow intersection to operate as two-way stop-control (northbound and southbound approaches remain stop-controlled).

**Main Street and Town Hall Place**

- Remove westbound stop-control to allow intersection to operate as two-way stop-control (southbound approach remains stop-controlled).

The mitigation improvements identified within the study area are shown in **Figure 1.1**. The improvements shown on this figure are subject to approval by NCDOT and the Town of Harrisburg. All additions and attachments to the State and Town roadway system shall be properly permitted, designed and constructed in conformance to standards maintained by the agencies.



NOT TO SCALE

LEGEND	
<span style="color: red;">■</span>	Identified Mitigation
<span style="color: blue;">■</span>	Identified Mitigation (by others)
X'	Storage Length
●	Stop Control
	Traffic Signal
	Recommended Traffic Signal
●	Not a Study Area Intersection

## 2.0 Introduction

The proposed Harrisburg Town Center development is located north of NC 49 and east of Roberta Road in Harrisburg, North Carolina. Based on the site plan provided by the applicant, the proposed development is currently envisioned to consist of approximately:

- 148,000 sf of general office space
- 176,300 sf of retail
- 333 multifamily housing units

For the purposes of this TIA, a build-out year of 2023 was considered at the direction of the Town. Based on the provided site plan and information provided by the applicant, the proposed development will utilize existing on-street parking and surface lots to access the project site and provide internal connectivity.

A TIA scoping meeting was held with the Town of Harrisburg and representatives of the applicant in Harrisburg on December 18, 2018, to obtain background information and to ascertain the scope and parameters to be included in this TIA. A Memorandum of Understanding (MOU) was developed based on discussions from this meeting that documented all scoping parameters to be used for the TIA and was reviewed and agreed upon by the Town of Harrisburg and the applicant. Additionally, North Carolina Department of Transportation (NCDOT) reviewed and approved the MOU, which is included in the **Appendix**.

Kimley-Horn was retained to determine the potential traffic impacts of this development (in accordance with the traffic study guidelines in the *NCDOT Policy on Street and Driveway Access to North Carolina Highways* and set forth by *Town of Harrisburg Unified Development Ordinance – Appendix F*), and to identify transportation improvements that may be required to mitigate these impacts. This report presents trip generation, distribution, capacity analyses, crash analyses and identified transportation improvements required to mitigate anticipated traffic demands produced by the subject development.

### 3.0 Existing Traffic Conditions

Existing traffic conditions were coordinated with Town of Harrisburg and NCDOT staff and collected through field observations and turning-movement counts to establish the existing conditions baseline analysis.

#### 3.1 STUDY AREA

Based on coordination with the Town, NCDOT and the applicant, the study area for this TIA includes the following existing intersections:

1. Roberta Road and Rocky River Crossing
2. Roberta Road and Main Street
3. Roberta Road and Parallel Drive
4. Roberta Road and Physicians Boulevard
5. Roberta Road and NC 49
6. Harrisburg Veterans Road and Stallings Road
7. Morehead Road / Alexander Avenue and NC 49
8. Kee Lane and NC 49
9. Main Street and NC 49
10. Main Street and Kee Lane

**Figure 3.1** shows the study area intersections and the site location, **Figure 3.2** shows the proposed site plan for the development as provided by the applicant and **Figure 3.3** shows the existing roadway geometry at the study intersections.

The primary roadways in the vicinity of the site are Roberta Road, Harrisburg Veterans Road, NC 49, Morehead Road, and Stallings Road.

Roberta Road is currently a three-lane, major collector (one lane in each direction with a two-way left-turn lane) with a posted speed limit of 35 miles per hour (mph) in the vicinity of the project site. Roberta Road carries an annual average daily traffic (AADT) volume of 14,000 vehicles per day (vpd) north of NC 49 based on 2016 NCDOT AADT data.

Harrisburg Veterans Road is currently a four-lane, undivided major collector with a posted speed limit of 35 mph. Harrisburg Veterans Road does not have a posted NCDOT AADT.

NC 49 is currently a four-lane, divided principal arterial with a posted speed limit of 35 mph. NC 49 carries an AADT volume of 35,000 vpd west of Morehead Road, 37,000 vpd between Morehead Road and Roberta Road, 30,000 vpd between Roberta Road and Main Street, and 26,000 vpd east of Main Street based on 2016 NCDOT AADT data.

Morehead Road is currently a two-lane, undivided minor arterial with a posted speed limit of 35 mph. Morehead Road carries an AADT volume of 9,600 vpd north of NC 49 based on 2016 NCDOT AADT data.

Stallings Road is currently a two-lane, undivided local road with a posted speed limit of 35 mph. Stallings Road carries an AADT volume of 6,100 vpd east of Harrisburg Veterans Road and 9,000 vpd west of Harrisburg Veterans Road based on 2012 and 2014 NCDOT AADT data, respectively.

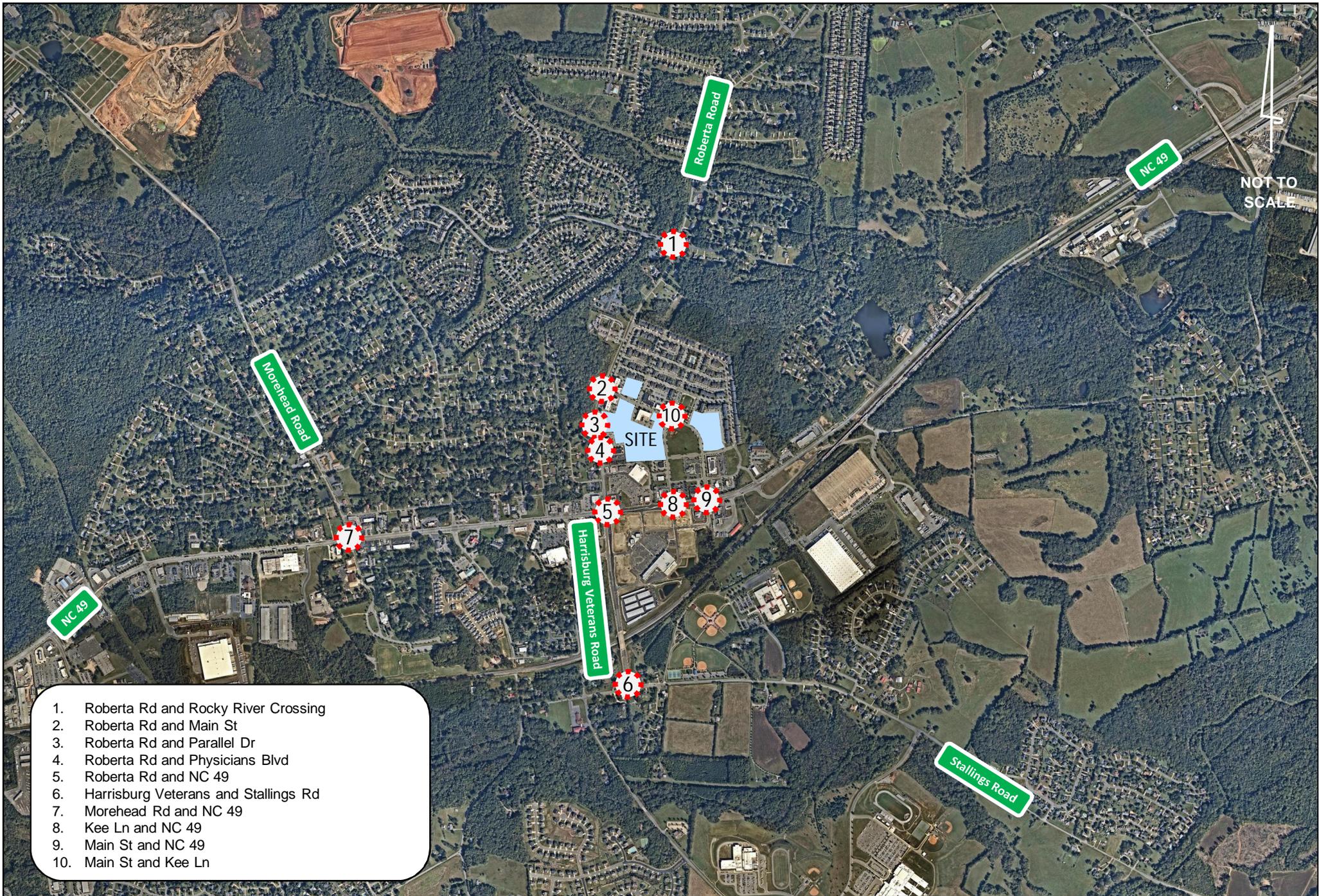
### 3.2 EXISTING TRAFFIC VOLUME DEVELOPMENT

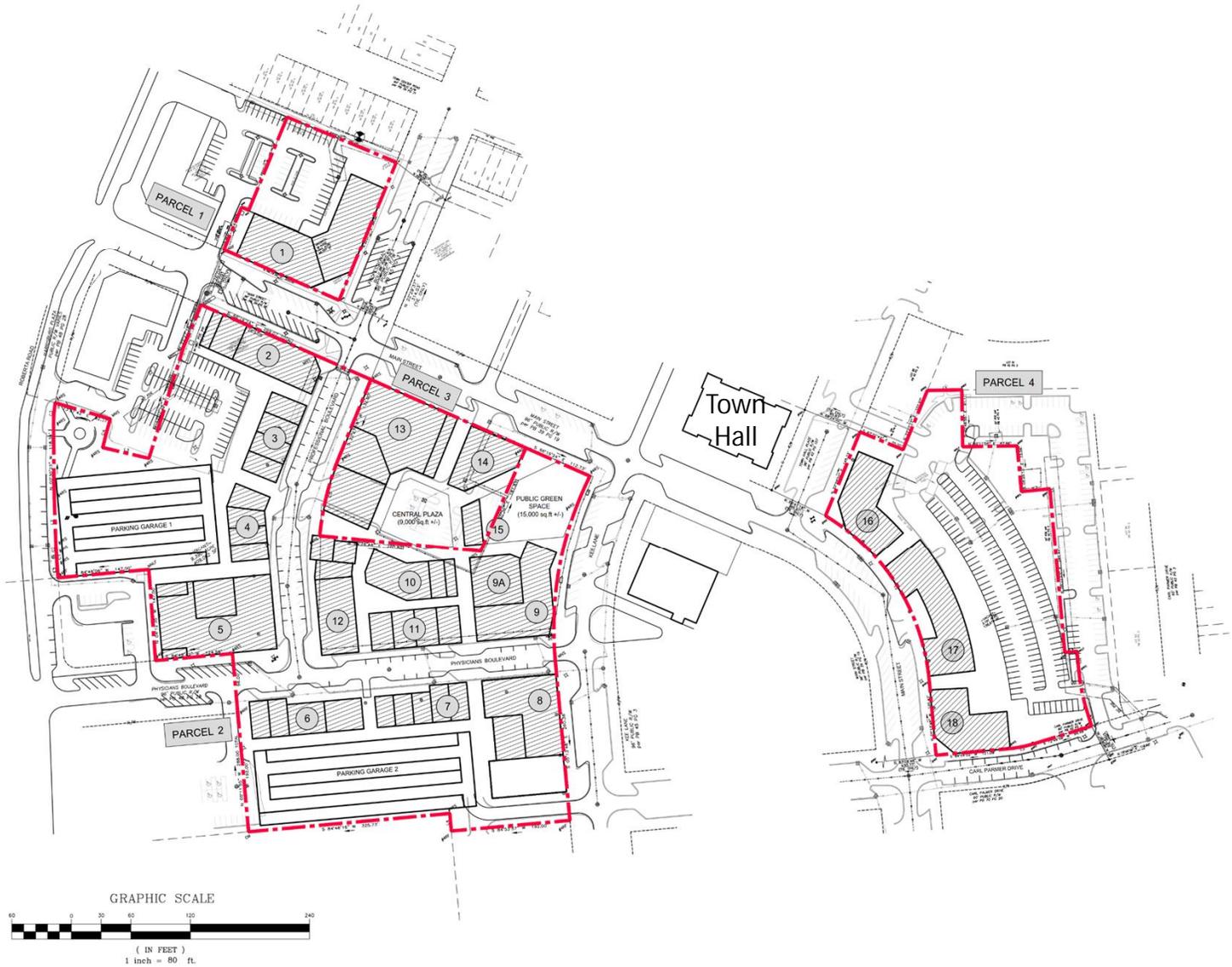
AM (7:00-9:00 AM) and PM (4:00-6:00 PM) intersection turning-movement, heavy-vehicle, pedestrian and bicycle counts were performed by National Data & Surveying Services on Tuesday, January 8, 2019, at the following intersections:

1. Roberta Road and Rocky River Crossing
2. Roberta Road and Main Street
3. Roberta Road and Parallel Drive
4. Roberta Road and Physicians Boulevard
5. Roberta Road and NC 49
6. Harrisburg Veterans Road and Stallings Road
7. Morehead Road / Alexander Avenue and NC 49
8. Kee Lane and NC 49
9. Main Street and NC 49
10. Main Street and Kee Lane

Volume balancing was performed along Roberta Road between Main Street and Physicians Boulevard, but was not performed between the remaining study area intersections due to the presence of driveways and distance between the intersections. Peak-hour intersection turning-movement count data is provided in the **Appendix**.

**Figure 3.4** illustrates the 2019 existing AM and PM peak-hour traffic volumes.





**PROGRAM:**

Parcel Number	Acres	SqF	Building Area(SqF)
1	1.909	46,572	76,000
2	5.990	409,062	514,000
3	1.380	60,113	88,200
4	1.911	138,979	151,300
<b>Total</b>	<b>11.03</b>	<b>654,724</b>	<b>829,500</b>

Land Use Information	
Site Area	15.03 Acres
Gross Building Area	829,000 Sq Feet
Total Dwelling Units	333 Units
Total Parking Spaces	1,155 Spaces

Overall (Parcel 1-4)						
Uses	Building Area(SqF)	Percentage (%)	Housing Units	Parcel Area (acres)	FAR	Area/Parcel Area (Ratio/Acres)
Retail/Commercial	176,300	21%				
Office	148,000	18%				
Art Center	35,500	7%	333	15.03	1.27	22.2
Residential	469,200	56%				
<b>Total Mixed-Use Area:</b>	<b>829,000</b>	<b>100%</b>				
Open Space				196,300		
Percentage of Open Space				30.0%		
Parking Space				1,155 Spaces, including 525 off-street parking and 520 on-street parking		
Dwelling Space				24		

- SURVEY:**
- LEGEND**
- PARCEL BOUNDARY
  - RF REBAR FOUND
  - RS REBAR SET
  - R/W RIGHT-OF-WAY
  - SF SQUARE FEET
  - MB MAP BOOK
  - DB DEED BOOK
  - PG PAGE
  - FS FRONT SETBACK
  - RY REAR YARD
  - SY SIDE YARD
  - PDE PUBLIC DRAINAGE EASEMENT
  - SD STORM DRAIN EASEMENT
  - MNLF MAG NAIL FOUND
  - CM CONCRETE MONUMENT
  - CP COMPUTED POINT
  - MNS MAG NAIL SET
  - CHAINLINK FENCE
  - ⊕ FIRE HYDRANT
  - ⊕ WATER VALVE
  - ⊕ LIGHT POLE
  - ⊕ SANITARY SEWER MANHOLE
  - ⊕ CATCH BASIN
  - ⊕ CLEAN OUT
  - ⊕ HANDICAPPED PARKING
  - ⊕ DROP INLET
  - ⊕ STORM DRAIN MANHOLE
- NOTES**
- AREA CALCULATED BY COORDINATE COMPUTATION.
  - ADJOINING PROPERTY OWNERS NAMES WERE TAKEN FROM CABARRUS COUNTY TAX OFFICE RECORDS, AND ARE CONSIDERED AS NOW OF FORMERLY.
  - IRON RODS AT ALL CORNERS UNLESS NOTED.
  - THIS MAP IS SUBJECT TO ANY AND ALL APPLICABLE DEED RESTRICTIONS, EASEMENTS, RIGHT-OF-WAY, UTILITIES AN RESTRICTIVE COVENANTS AND PRELIMINARY PLAN WHICH MAY BE OF RECORD.
  - ALL DISTANCES ARE HORIZONTAL GROUND DISTANCES MEASURED WITH ELECTRONIC MEASURING DEVICES.
  - LOT SUBJECT TO ALL ZONING ORDINANCES OF THE TOWN OF HARRISBURG. BUILDER/OWNER MUST VERIFY THAT LOT IS IN COMPLIANCE WITH ALL COUNTY AND HOMEOWNERS ASSOCIATION ZONING ORDINANCES PRIOR TO ANY LAND DISTURBANCE OR CONSTRUCTION.
  - THIS SURVEY WAS PERFORMED WITHOUT THE BENEFIT OF A TITLE SEARCH.
  - NO ICCS MONUMENT FOUND WITHIN 2000 FEET.
  - SEBARS SHOWN ARE PER CURRENT ZONING ORDINANCES UNLESS OTHERWISE NOTED.
  - SUBJECT PROPERTY ZONED PUD.

**SITE NOTES:**

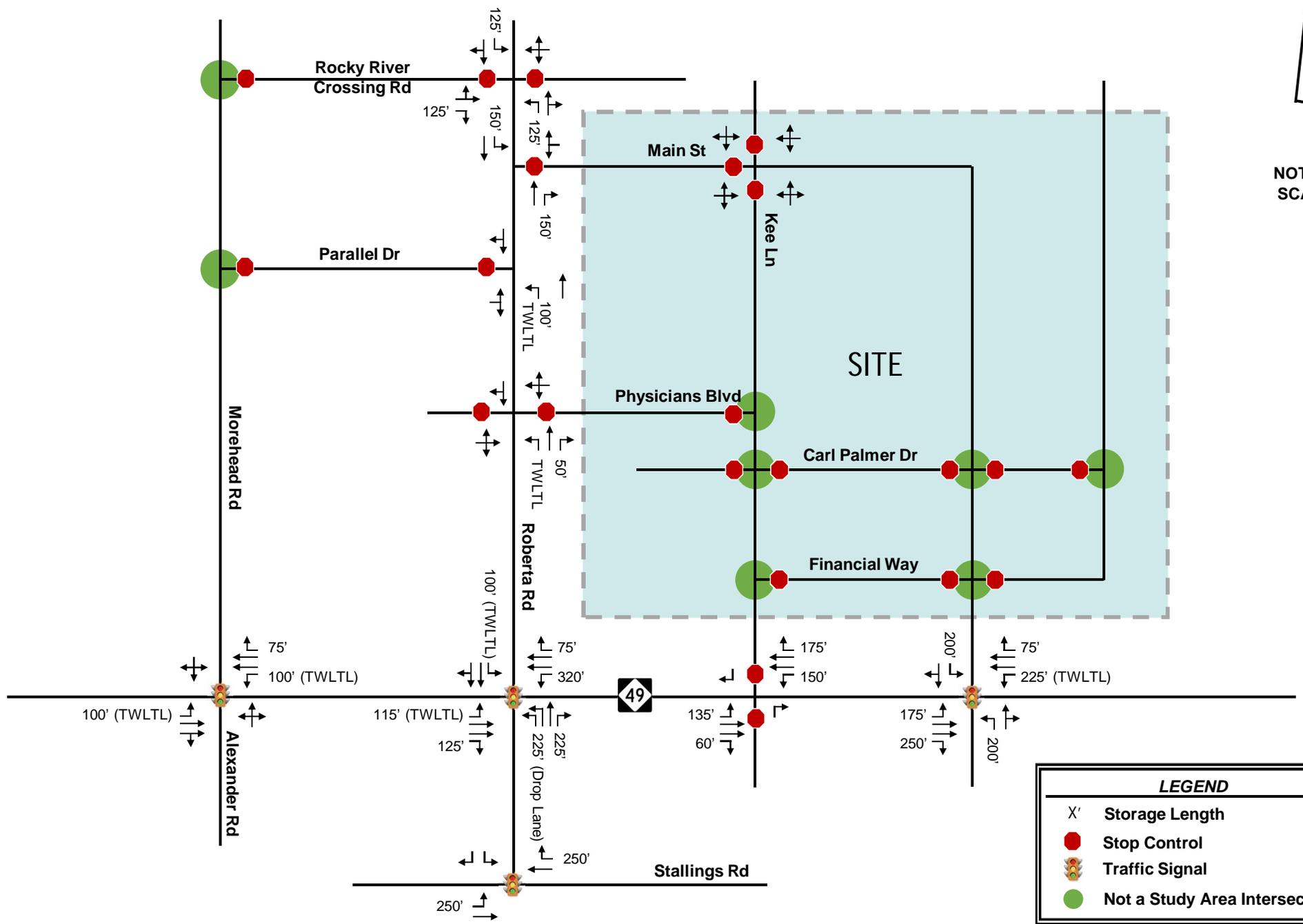
BUILDING SETBACK REQUIREMENTS (MINIMUM) ZONED PUD:  
 FRONT: 10 FEET  
 SIDE YARD: 5 FEET  
 REAR YARD: 5 FEET

**FLOOD NOTE:**  
 NO PORTION OF THE SUBJECT PROPERTY SHOWN HEREON LIES WITHIN A SPECIAL FLOOD HAZARD AREA PER FEMA FLOOD INSURANCE RATE MAP, COMMUNITY PANEL 371055700A, DATED NOVEMBER 9, 2008.

PHYSICAL SURVEY AT PROPERTY KNOWN AS  
 # 4350 MAIN STREET  
 PARCEL # 507970360000  
 BEING THE REMAINING PORTION OF 08-9479 PG 195  
 TOWN OF HARRISBURG, CABARRUS COUNTY, NC  
 DATE: OCTOBER 9, 2018

**PHOENIX LAND SURVEYING, INC.**  
 1216 1/2 AVENUE ROAD  
 CHARLOTTE, NORTH CAROLINA 28203  
 TEL: 770-335-1855  
 FAX: 770-335-1856  
 EMAIL: INFO@PHOENIXLANDSURVEYING.COM  
 WWW.PHOENIXLANDSURVEYING.COM

<b>KEY PLAN</b> 	<b>SITE PLANNER:</b> <b>International Place Design, LLC</b> Land Planning and Landscape Architecture 50 Behamell Street, Concord, MA 01742, USA Tel: 1-978-287-0500 Cell: 1-617-281-9445 Fax: 1-978-369-2731	<b>CLIENT:</b> CapitalNexus LLC, Redtown Investment LLC	<b>ARCHITECTS:</b>  <b>CIVIL ENGINEERS:</b>  <b>TRAFFIC ENGINEERS:</b>	<b>REVISION</b> <table border="1"> <thead> <tr> <th>No.</th> <th>DATE</th> <th>DESCRIPTION</th> </tr> </thead> <tbody> <tr> <td>1</td> <td></td> <td></td> </tr> <tr> <td>2</td> <td></td> <td></td> </tr> <tr> <td>3</td> <td></td> <td></td> </tr> <tr> <td>4</td> <td></td> <td></td> </tr> </tbody> </table>	No.	DATE	DESCRIPTION	1			2			3			4			<b>NOTE:</b> DATE: March 12, 2019 DRAWING TITLE: <b>REZONING OVERALL SITE PLAN</b> SCALE: 1" = 80' NOTE:	<b>DRAWING No.:</b> <b>FIG.1</b> TOTAL:
		No.		DATE	DESCRIPTION																
		1																			
		2																			
3																					
4																					
<b>PROJECT:</b> <b>HARRISBURG TOWN CENTER</b> Harrisburg, North Carolina	<b>REZONING</b>	<b>DATE:</b> March 12, 2019 <b>DESIGN BY:</b> <b>DRAWN BY:</b> <b>CHECKED BY:</b> <b>APPROVED BY:</b> <b>NOTE:</b>																			
<b>REZONING</b>	<b>TRAFFIC ENGINEERS:</b>	<b>DATE:</b> March 12, 2019 <b>DESIGN BY:</b> <b>DRAWN BY:</b> <b>CHECKED BY:</b> <b>APPROVED BY:</b> <b>NOTE:</b>																			
<b>REZONING</b>	<b>TRAFFIC ENGINEERS:</b>	<b>DATE:</b> March 12, 2019 <b>DESIGN BY:</b> <b>DRAWN BY:</b> <b>CHECKED BY:</b> <b>APPROVED BY:</b> <b>NOTE:</b>																			



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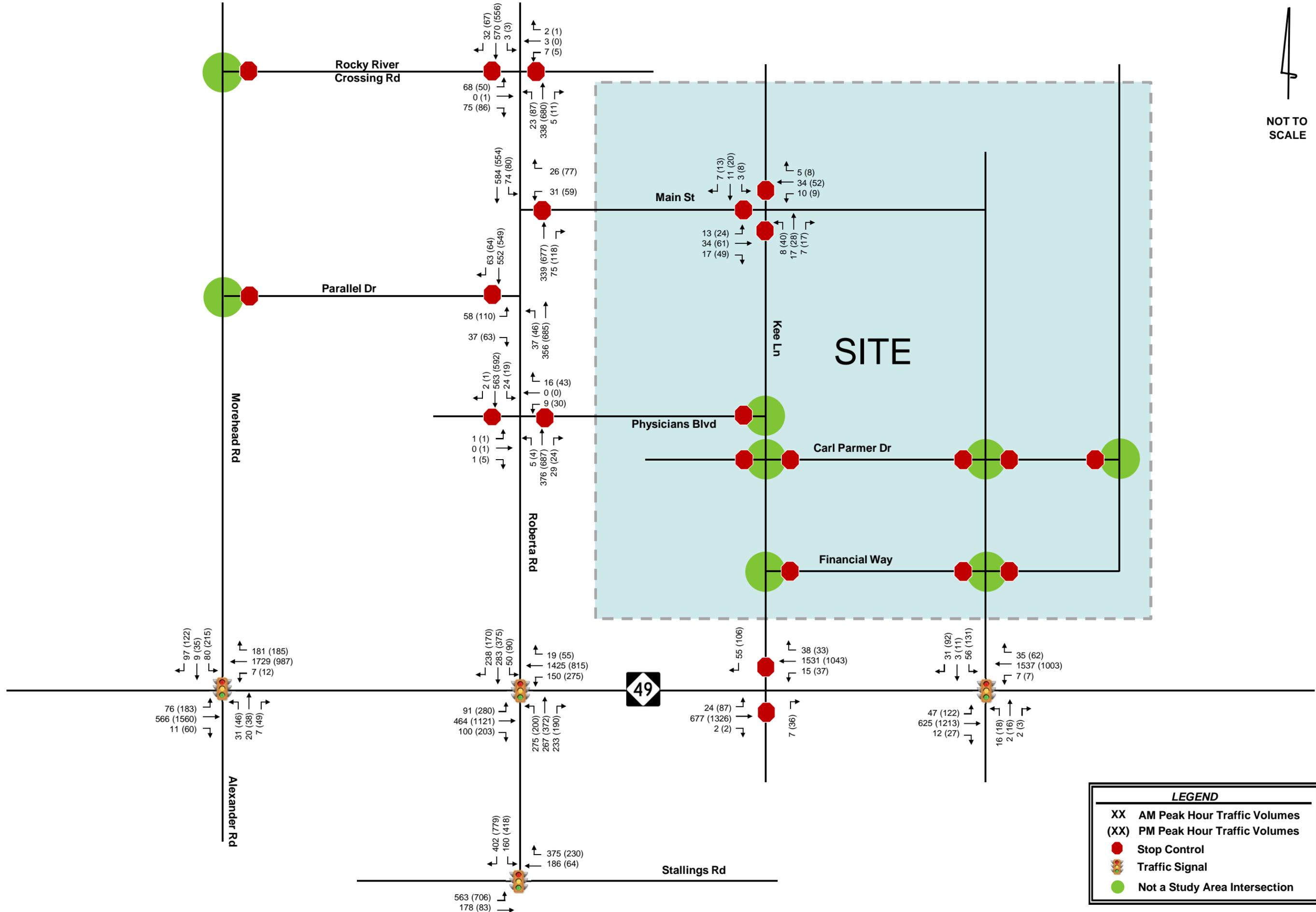


Figure 3.4

2019 Existing Traffic Volumes

Harrisburg Town Center Traffic Impact Analysis

## 4.0 Background Traffic Volume Development

Projected background (non-project) traffic is defined as the expected growth or change in traffic volumes on the surrounding roadway network between the year the existing counts were collected and the expected build-out year absent the construction and opening of the proposed project. This includes both non-specific general growth based on historical increase in local traffic volumes (historical background growth), along with specific growth and/or change in traffic volumes caused by either approved, but not yet fully-constructed, off-site developments and/or planned transportation projects specifically identified within the vicinity of the proposed development.

### 4.1 HISTORICAL BACKGROUND GROWTH TRAFFIC

Historical background growth is the increase in existing traffic volumes due to usage increases and non-specific growth throughout the area, and accounts for growth that is independent of specific off-site developments or planned transportation projects. Historical background growth traffic is calculated using an annual growth rate, which is applied to the existing traffic volumes up to the future horizon years. For this analysis, an annual growth rate of 2.0% was applied to the 2019 existing peak-hour traffic volumes to calculate base 2023 background traffic volumes. This methodology was determined based on coordination with Town of Harrisburg and NCDOT staff.

### 4.2 APPROVED DEVELOPMENTS

At the direction of the Town of Harrisburg and NCDOT staff, four approved developments that are expected to impact traffic volumes within the study area were included in the background traffic volumes for this TIA, including:

- Harris Square
- Harrisburg Village
- Stallings Road Subdivision
- Novant Phase 1

Per coordination with the Town, the Harris Square site was assumed to be 40% built-out. All other developments were assumed to be 0% built-out.

Volumes for the approved developments were obtained from the following sources:

- Harris Square TIA (Kimley-Horn, April 2016)
- Harrisburg Village TIA (WSP | Parsons Brinckerhoff, July 2016)
- Stallings Road Subdivision TIA (Kimley-Horn, October 2018)

It should be noted that a TIA was not performed for the Novant Phase 1 development. Therefore, trip generation was performed for this site and project trips associated with this development were distributed throughout the study area using the methodology discussed in *Section 5.3 (Site Traffic Distribution and Assignment)*.

The following laneage improvements were include in all future year conditions at the intersection of Roberta Road and NC 49 based on the identified mitigation in the *Harrisburg Village TIA*:

- Extension of the southbound through-right lane to provide 375 feet of storage
- Extension of the westbound right-turn lane to provide 150 feet of storage

**Figures 4.1** and **4.2** show the 2023 background AM and PM peak-hour traffic volumes, respectively, that include the historical growth traffic and approved development trips.

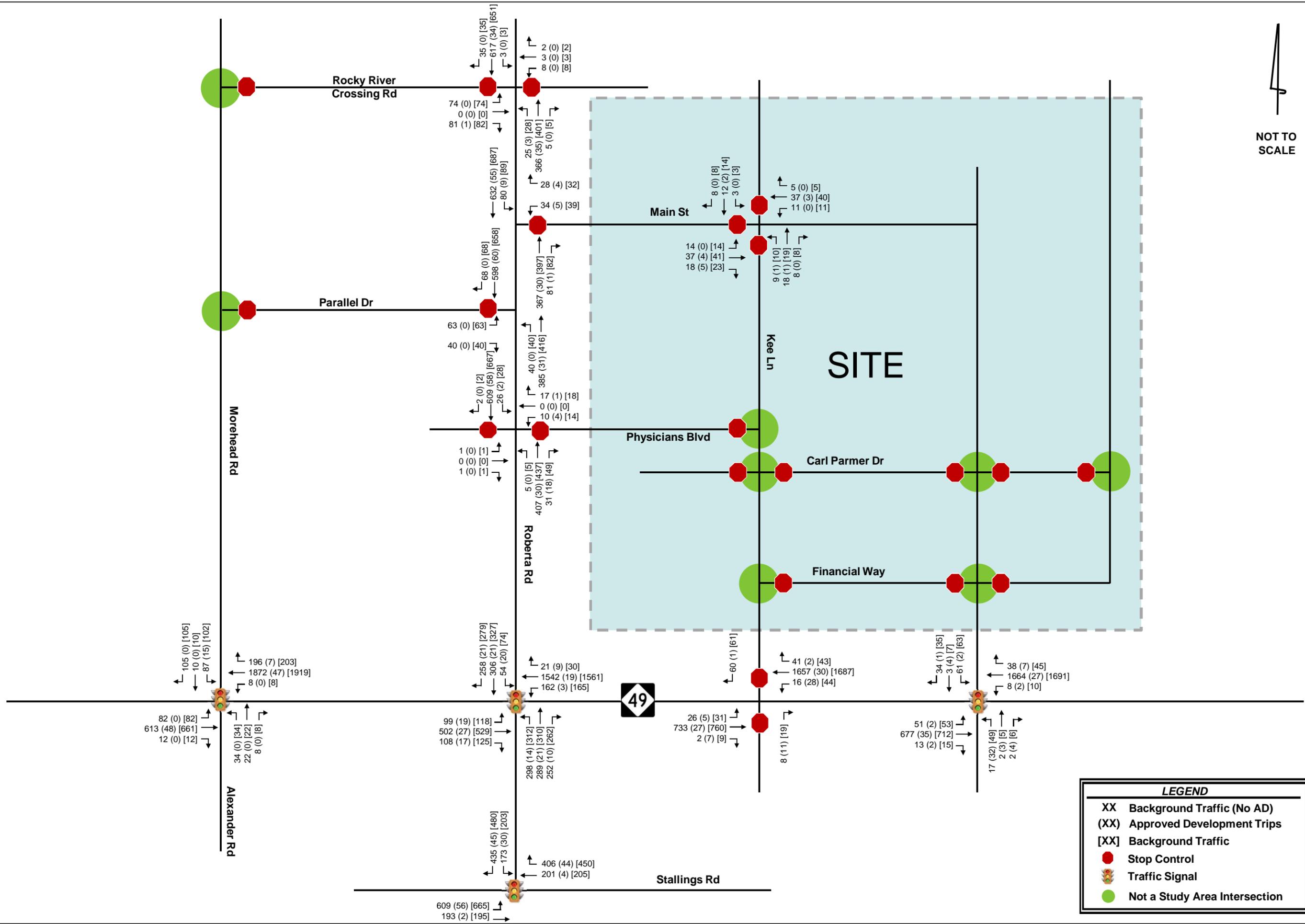


Figure 4.1

2023 Background AM Peak-Hour Traffic Volumes

Harrisburg Town Center Traffic Impact Analysis

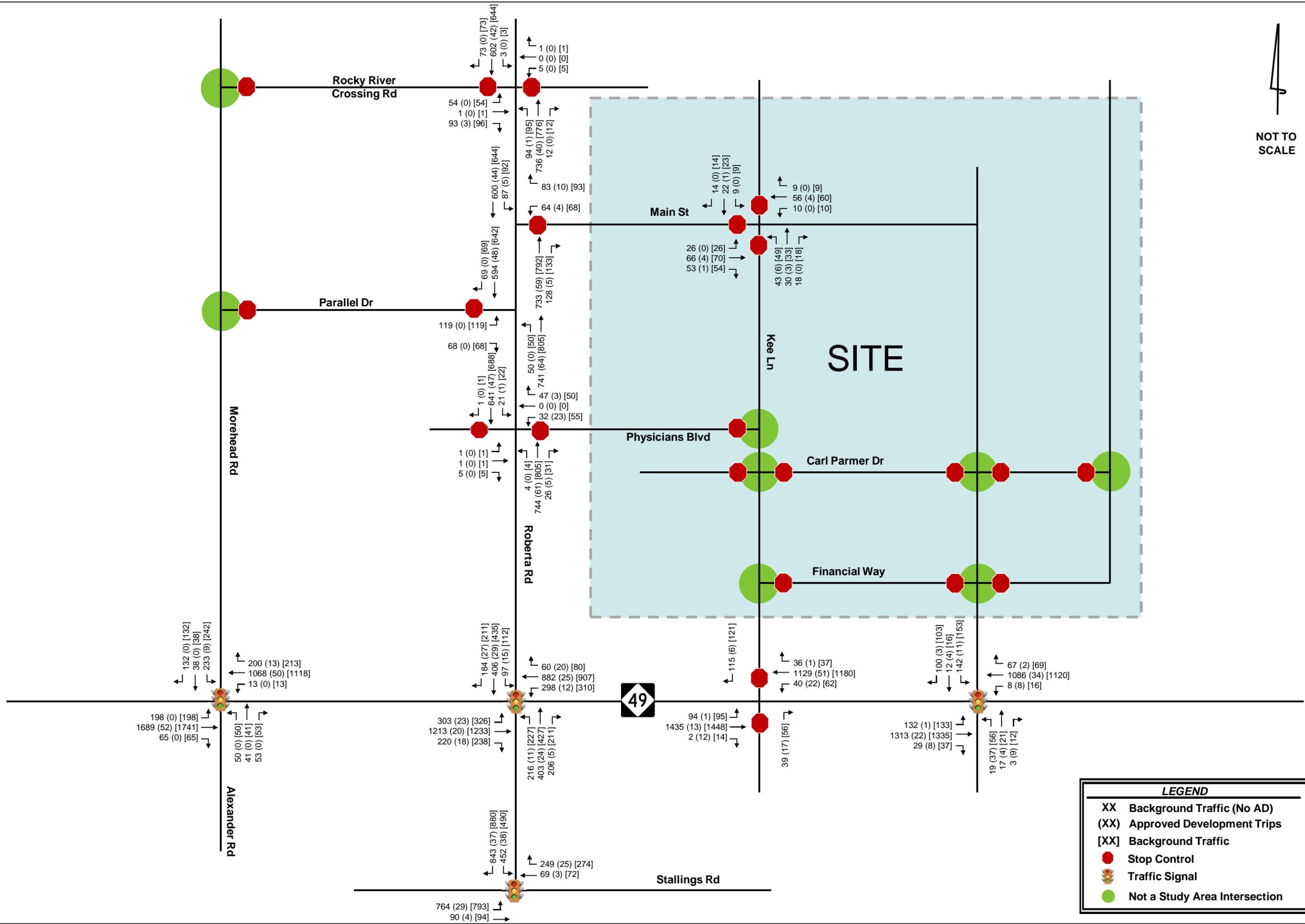


Figure 4.2

2023 Background PM Peak-Hour Traffic Volumes

Harrisburg Town Center Traffic Impact Analysis

## 5.0 Site Traffic Volume Development

Site traffic developed for this TIA is defined as the vehicle trips expected to be generated and added to the study area by construction of the proposed development, and the distribution and assignment of that traffic throughout the surrounding network.

### 5.1 SITE ACCESS

Based on the provided site plan and information provided by the applicant, the proposed development access will utilize existing on-street parking and surface lots to access the project site and provide internal connectivity.

### 5.2 TRAFFIC GENERATION

The traffic generation potential of the proposed development was determined using the trip generation rates published in *Trip Generation* (Institute of Transportation Engineers, Tenth Edition, 2017).

Based on the site plan provided by the applicant, the proposed development is envisioned to consist of approximately 148,000 square feet of general office space, 176,300 square feet of retail and 333 units of multifamily housing.

**Table 5.1** summarizes the projected trip generation for the proposed mixed-use development. During a typical weekday, the proposed development has the potential to generate 470 and 815 net new external trips during the AM and PM peak hours, respectively.

Table 5.1 - Trip Generation								
Land Use	Intensity	Daily	AM Peak Hour			PM Peak Hour		
			Total	In	Out	Total	In	Out
General Office	148,000 SF	1,552	235	207	28	228	41	187
Shopping Center	176,300 SF	8,840	240	149	91	827	397	430
Multifamily Housing Mid-Rise - (Condos/Apartments)	333 DU	1,813	111	29	82	141	86	55
<b>Subtotal</b>		<b>12,205</b>	<b>586</b>	<b>385</b>	<b>201</b>	<b>1,196</b>	<b>524</b>	<b>672</b>
<b>Internal Capture</b>		<b>1,548</b>	<b>40</b>	<b>20</b>	<b>20</b>	<b>52</b>	<b>26</b>	<b>26</b>
<i>ITE 820 Pass-By - 0% AM / 34% PM</i>		266	0	0	0	266	133	133
<b>Pass-By</b>		<b>266</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>266</b>	<b>133</b>	<b>133</b>
<b>Net New External Trips</b>		<b>10,391</b>	<b>546</b>	<b>365</b>	<b>181</b>	<b>878</b>	<b>365</b>	<b>513</b>

### 5.3 SITE TRAFFIC DISTRIBUTION AND ASSIGNMENT

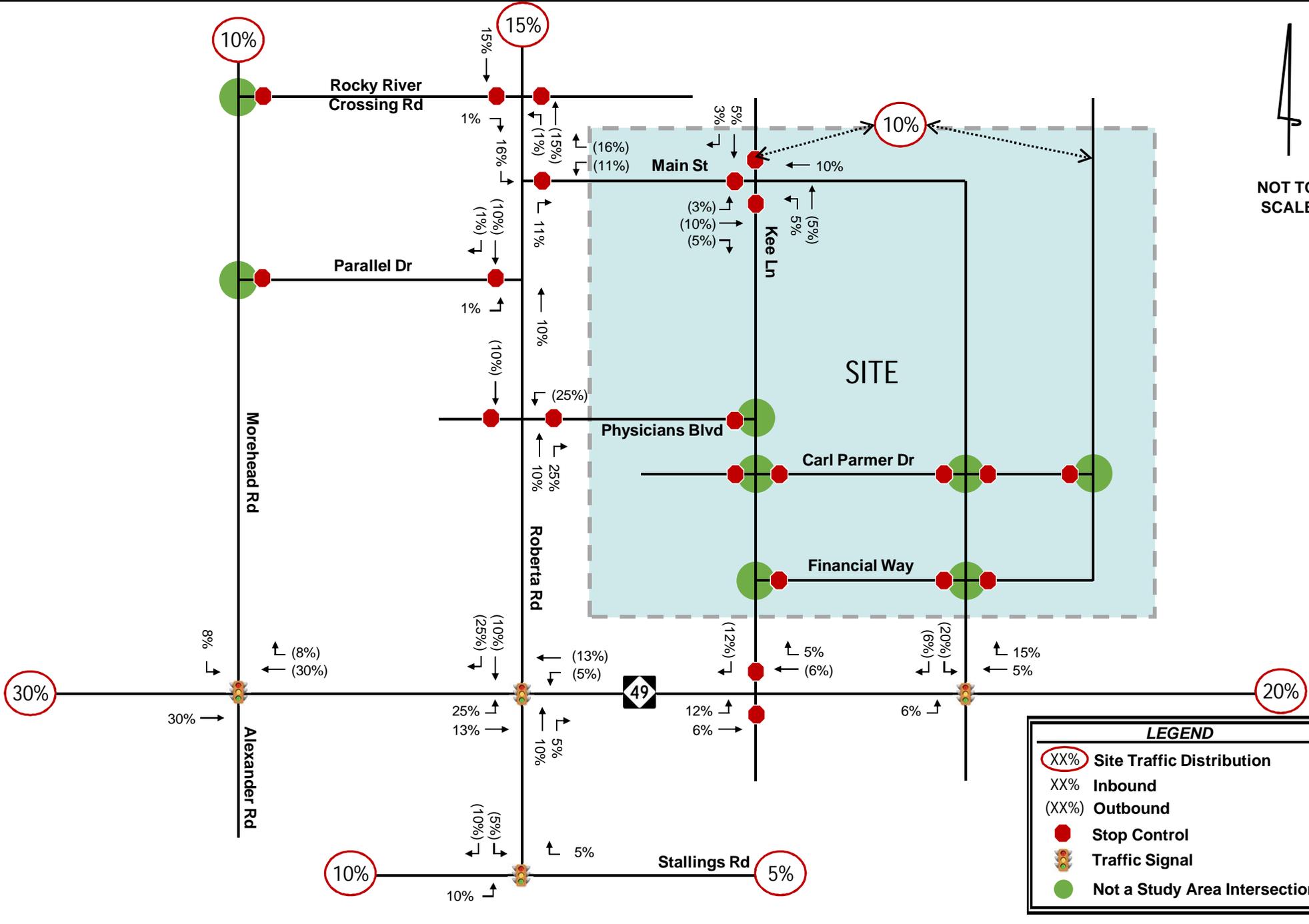
The proposed development's trips were assigned to the surrounding network based on existing peak-hour turning movements, surrounding land uses, locations of similar land use and population densities in the area. The following site traffic distribution was reviewed and approved as part of the MOU by the Town of Harrisburg, NCDOT and the applicant:

- 30% to/from the west along NC 49
- 20% to/from the east along NC 49
- 10% to/from the north along Morehead Road
- 15% to/from the north along Roberta Road
- 10% to/from the north along Kee Lane and Carl Parmer Drive
- 10% to/from the southwest along Stallings Road
- 5% to/from the southeast along Stallings Road

The overall site traffic distribution and assignment are shown in **Figure 5.1**.

### 5.4 BUILD-OUT TRAFFIC VOLUMES

The 2023 build-out traffic volumes include the assignment of the projected site traffic generation added to the 2023 background traffic volumes. **Figures 5.2** and **5.3** show the projected 2023 build-out traffic volumes for the AM and PM peak hours, respectively. Intersection volume development worksheets for all intersections within the study network are provided in the **Appendix**.



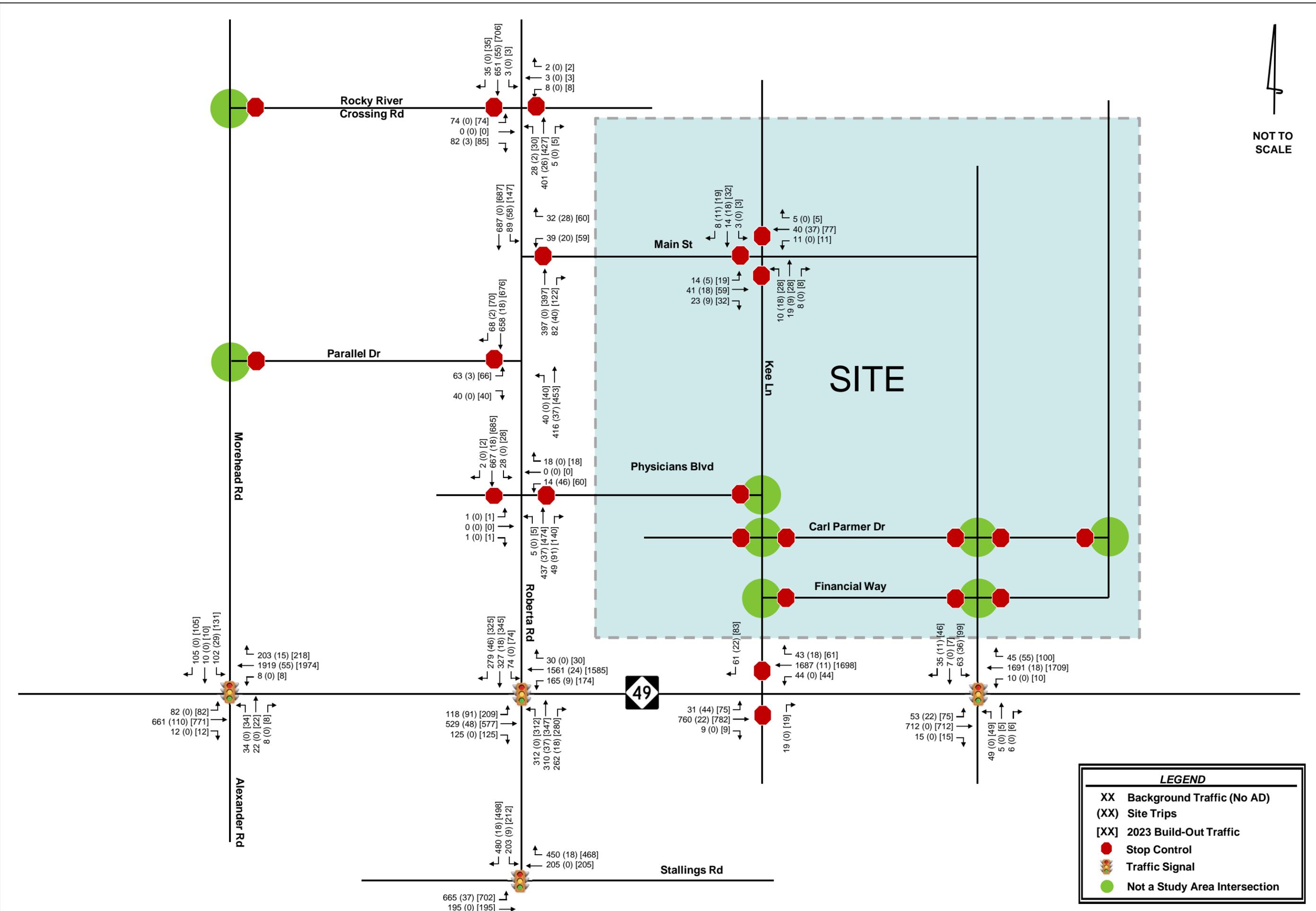


Figure 5.2

2023 Build-Out AM Peak-Hour Traffic Volumes

Harrisburg Town Center Traffic Impact Analysis

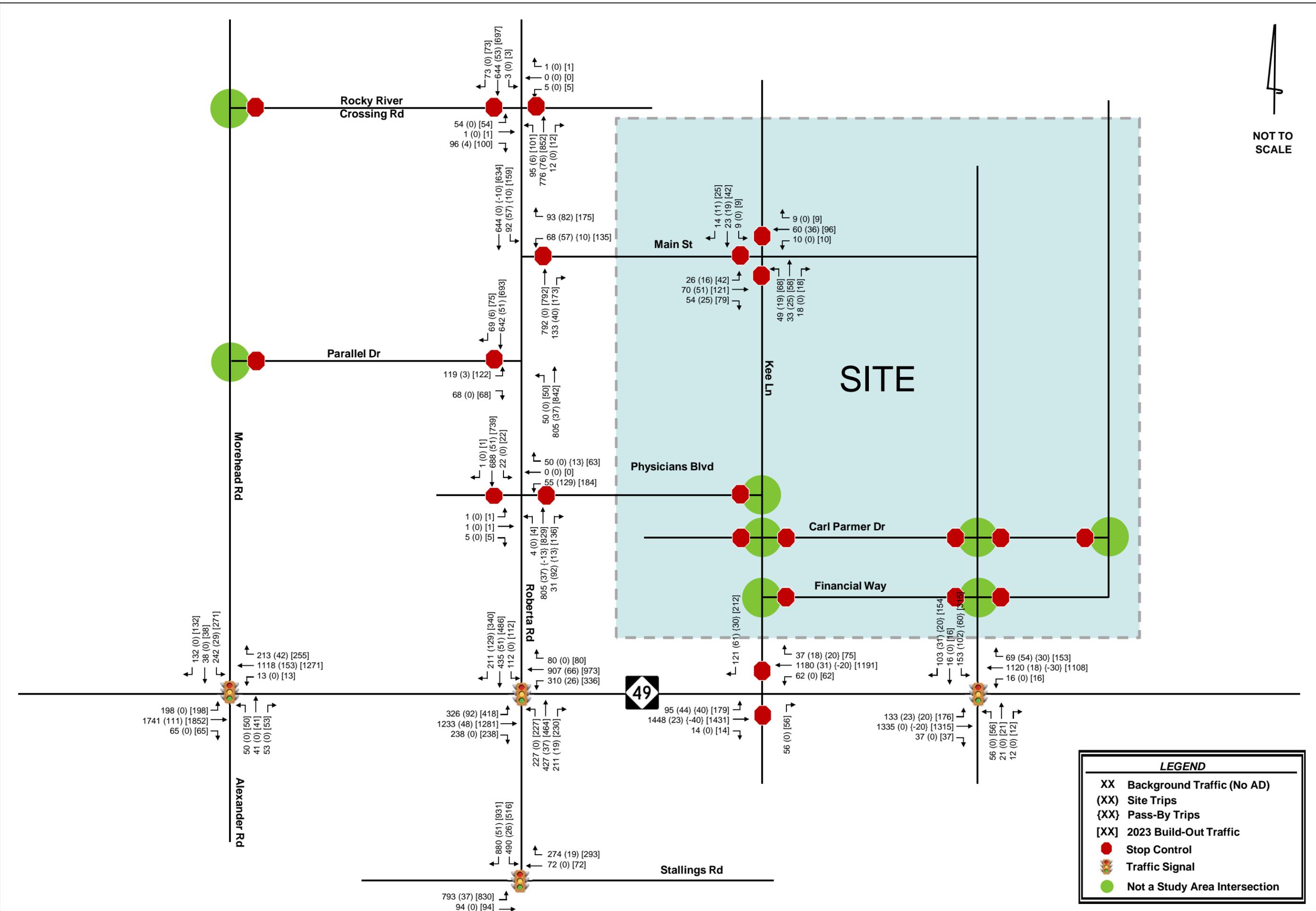


Figure 5.3

2023 Build-Out PM Peak-Hour Traffic Volumes

Harrisburg Town Center Traffic Impact Analysis

## 6.0 Capacity Analysis

Based on the requirements set forth by the *Town of Harrisburg Unified Development Ordinance – Appendix F* and in accordance with the traffic study guidelines in the *NCDOT Policy on Street and Driveway Access to North Carolina Highways*, capacity analyses were performed at the study area intersections for each of the following AM and PM peak-hour scenarios:

- 2019 Existing Conditions
- 2023 Background Conditions
- 2023 Build-out Conditions

Capacity analyses were performed for the AM and PM peak hours using the Synchro Version 10 software to determine the operating characteristics at the signalized and stop-controlled intersections of the adjacent street network and to evaluate the impacts of the proposed development. Capacity is defined as the maximum number of vehicles that can pass over a particular road segment, or through a particular intersection, within a specified period of time under prevailing operational, geometric and controlling conditions within a set time duration. This software program uses methodologies contained in the *Highway Capacity Manual (HCM)* to determine the operating characteristics of an intersection.

The *Highway Capacity Manual (HCM)* defines LOS as a “quantitative stratification of a performance measure or measures representing quality of service”, and is used to “translate complex numerical performance results into a simple A-F system representative of travelers’ perceptions of the quality of service provided by a facility or service”. The HCM defines six levels of service, LOS A through LOS F, with A having the best operating conditions from the traveler’s perspective and F having the worst. However, it must be understood that “the LOS letter result hides much of the complexity of facility performance”, and that “the appropriate LOS for a given system element in the community is a decision for local policy makers”. According to the HCM, “for cost, environmental impact, and other reasons, roadways are typically designed not to provide LOS A conditions during peak periods but instead to provide some lower LOS that balances individual travelers’ desires against society’s desires and financial resources. Nevertheless, during low-volume periods of the day, a system element may operate at LOS A.”

LOS for a two-way stop-controlled (TWSC) intersection is determined by the control delay at the side-street approaches, typically during the highest volume periods of the day, the AM and PM peak periods. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. With respect to field measurements, control delay is defined as the total elapsed time from the time a vehicle stops at the end of the queue to the time the vehicle departs from the stop line. It is typical for stop sign-controlled side streets and driveways intersecting major streets to experience long delays during peak hours, particularly for left-turn movements. The majority of the traffic moving through the intersection on the major street experiences little or no delay.

LOS for a three-way stop-controlled intersection is reported by approach and overall intersection. It should be noted that Synchro does not report results for three-way stop-controlled intersections; results for the intersection of Main Street and Kee Lane were obtained from SimTraffic.

LOS for signalized intersections is reported for the intersection as a whole, and typically during the highest volume periods of the day, the AM and PM peak periods. One or more movements at an

intersection may experience a low level-of-service, while the intersection as a whole may operate acceptably.

LOS for roundabout intersections is also reported for the intersection as a whole, but uses the same control delay thresholds as the stop-controlled intersections. However, if the volume-to-capacity ratio on an approach of the intersection is greater than 1.0, that approach or intersection is reported as LOS F regardless of the reported control delay.

**Table 6.0-A** and **6.0-B** list the LOS control delay thresholds published in the HCM for unsignalized and signalized intersections, respectively, as well as the unsignalized operational descriptions assumed herein.

Table 6.0-A Vehicular LOS Control Delay Thresholds for Unsignalized Intersections		
Level-of-Service	Average Control Delay per Vehicle [sec/veh]	
A	≤ 10	Short Delays
B	> 10 – 15	
C	> 15 – 25	
D	> 25 – 35	Moderate Delays
E	> 35 – 50	
F	> 50	Long Delays

Table 6.0-B Vehicular LOS Control Delay Thresholds for Signalized Intersections	
Level-of-Service	Average Control Delay per Vehicle [sec/veh]
A	≤ 10
B	> 10 – 20
C	> 20 – 35
D	> 35 – 55
E	> 55 – 80
F	> 80

Using the signal timing plans, cycle lengths, offsets, and splits were optimized for the existing conditions analyses and carried through all scenarios. The Congestion Management (CM) cycle of 120 seconds based on the phasing of the signalized intersections was also utilized. A lost time of 5 seconds was used in all scenarios and no right turn on red (RTOR) were utilized in all scenarios as well. Permitted-protected phasing was only allowed at existing signals under existing 2019 conditions to reflect field conditions. All existing permitted-protected phasing was converted to protected phasing under all future scenarios. Intersection splits were optimized in background conditions and utilized in build-out conditions.

In the existing condition, the observed peak hour factor (PHF) was used in the analysis. A 0.9 PHF was used for all future conditions during the AM and PM peak hours.

Capacity analysis reports generated by Synchro Version 10 software are included in the **Appendix**.

## 6.1 ROBERTA ROAD AT ROCKY RIVER CROSSING ROAD

**Table 6.1** summarizes the LOS, control delay and 95<sup>th</sup> percentile queue lengths at the unsignalized intersection of Roberta Road at Rocky River Crossing Road.

Table 6.1 - Roberta Road and Rocky River Crossing							
Condition	Measure	EB	WB	NB		SB	
		EBLTR	WBLTR	NBL	NBTR	SBL	SBTR
<b>AM Peak Hour</b>							
2019 Existing	LOS (Delay)	E (38.2)	D (27.6)	A (0.9)		A (0.1)	
	Synchro 95th Q	112'	11'	4'	0'	1'	0'
2023 Background	LOS (Delay)	E (41.2)	E (37.8)	A (0.6)		A (0.0)	
	Synchro 95th Q	98'	9'	3'	0'	0'	0'
2023 Build-out	LOS (Delay)	F (53.4)	E (45.2)	A (0.6)		A (0.0)	
	Synchro 95th Q	127'	11'	3'	0'	0'	0'
2023 Build-out IMP	LOS (Delay)	F (50.4)	E (44.9)	A (0.6)		A (0.0)	
	Synchro 95th Q	121'	11'	3'	0'	0'	0'
<b>PM Peak Hour</b>							
2019 Existing	LOS (Delay)	F (246.0)	F (75.6)	A (1.2)		A (0.1)	
	Synchro 95th Q	272'	26'	11'	0'	1'	0'
2023 Background	LOS (Delay)	F (241.6)	F (101.6)	A (1.1)		A (0.0)	
	Synchro 95th Q	267'	19'	11'	0'	0'	0'
2023 Build-out	LOS (Delay)	F (453.7)	F (145.9)	A (1.1)		A (0.0)	
	Synchro 95th Q	348'	25'	12'	0'	0'	0'
2023 Build-out IMP	LOS (Delay)	F (394.1)	F (142.9)	A (1.1)		A (0.0)	
	Synchro 95th Q	330'	25'	12'	0'	0'	0'

As shown in **Table 6.1**, the eastbound and westbound approaches are expected to operate with long delays in both peak hours both with and without site traffic. It should be noted that at unsignalized intersections, it is not uncommon for a stop controlled, side-street approach to experience long delays in peak hours.

The eastbound approach is expected to experience significant increases in delay in the PM peak hour. This approach already has a dedicated right-turn lane and minimal through volumes; therefore, the addition of turn lanes on this approach would offer minimal benefit to the intersection. Further, due to the low side-street volumes, a signal would not be warranted at this intersection.

To reduce delay at this intersection, a southbound right-turn lane with a minimum of 100 feet of storage should be constructed. It should be noted that this turn lane is warranted in background and build-out conditions as shown in **Section 7.0**. A northbound right-turn is not warranted at this intersection and would be expected to not significantly reduce side-street delays.

## 6.2 ROBERTA ROAD AND MAIN STREET

**Table 6.2** summarizes the LOS, control delay and 95<sup>th</sup> percentile queue lengths at the unsignalized intersection of Roberta Road and Main Street.

Table 6.2 - Roberta Road and Main Street									
Condition	Measure	WB			NB		SB		Intersection
		WBL	WBT	WBR	NBT	NBR	SBL	SBT	LOS (Delay)
AM Peak Hour									
2019 Existing	LOS (Delay)	C (15.1)			A (0.0)		A (1.0)		-
	Synchro 95th Q	-	18'	-	0'	0'	6'	0'	
2023 Background	LOS (Delay)	C (16.2)			A (0.0)		A (1.0)		-
	Synchro 95th Q	-	18'	-	0'	0'	8'	0'	
2023 Build-out	LOS (Delay)	C (20.8)			A (0.0)		A (1.6)		-
	Synchro 95th Q	-	42'	-	0'	0'	15'	0'	
2023 Build-out IMP	LOS (Delay)	E (63.7)			A (1.4)		A (4.6)		A (8.2)
	Synchro 95th Q	m92'	-	m94'	m41'	m13'	49'	257'	
2023 Build-out IMP RIRO @ Physicians	LOS (Delay)	E (60.6)			A (2.0)		A (6.6)		B (11.3)
	Synchro 95th Q	160'	-	m90'	m50'	m16'	75'	319'	
PM Peak Hour									
2019 Existing	LOS (Delay)	C (23.9)			A (0.0)		B (1.5)		-
	Synchro 95th Q	-	61'	-	0'	0'	12'	0'	
2023 Background	LOS (Delay)	D (32.7)			A (0.0)		A (1.4)		-
	Synchro 95th Q	-	88'	-	0'	0'	13'	0'	
2023 Build-out	LOS (Delay)	F (190.7)			A (0.0)		A (2.5)		-
	Synchro 95th Q	-	426'	-	0'	0'	28'	0'	
2023 Build-out IMP	LOS (Delay)	D (52.9)			B (10.6)		A (9.5)		B (16.5)
	Synchro 95th Q	m173'	-	m224'	m110'	m23'	125'	303'	
2023 Build-out IMP RIRO @ Physicians	LOS (Delay)	E (57.3)			A (8.9)		B (17.2)		C (22.4)
	Synchro 95th Q	#429'	-	m211'	m115'	m25'	#265'	329'	

# 95th percentile volume exceeds capacity, queue may be longer

m Volume for 95th percentile queue is metered by upstream signal

As shown in **Table 6.2**, all approaches of the study intersection currently operate at an acceptable level during both the AM and PM peak hours, and are expected to continue operating acceptably under 2023 background conditions. The westbound approach is expected to drop by two levels of service during the PM peak hour upon build-out of the site.

Because the site is expected to increase delays at this intersection, the installation of a traffic signal with fiber connection to Roberta Road and NC 49 is recommended to mitigate the site impacts to the intersection. A detailed Traffic Signal Warrant Analysis can be found in **Section 7.0**. It is also recommended that the two lanes be provided on the westbound approach; a right-turn lane and a left-turn lane. Implementation of this laneage may require restriction of on-street parking along the north side of Main Street, but some of this existing pavement could be utilized to provide the right-turn lane.

As noted in **Section 6.4**, the intersection of Roberta Road and Physicians Boulevard may be converted to a right-in/right-out in the future. If that happens, the left-turns in and out of that intersection would be expected to utilize the proposed signal at Roberta Road and Main Street. In **Table 6.2**, LOS, delays, and queues are reported for this scenario. The overall intersection is still expected to operate acceptably under this scenario. Based on the anticipated queues with the addition of the Physicians Boulevard traffic, approximately 450 feet of storage should be provided for the westbound right-turn lane.

### 6.3 ROBERTA ROAD AND PARALLEL DRIVE

**Table 6.3** summarizes the LOS, control delay and 95<sup>th</sup> percentile queue lengths at the unsignalized intersection of Roberta Road and Parallel Drive.

Table 6.3 - Roberta Road and Parallel Drive					
Condition	Measure	EB	NB		SB
		EBT	NBL	NBT	SBTR
<b>AM Peak Hour</b>					
2019 Existing	LOS (Delay)	C (16.4)	A (0.8)		A (0.0)
	Synchro 95th Q	32'	4'	0'	0'
2023 Background	LOS (Delay)	C (18.4)	A (0.8)		A (0.0)
	Synchro 95th Q	31'	4'	0'	0'
2023 Build-out	LOS (Delay)	C (19.3)	A (0.8)		A (0.0)
	Synchro 95th Q	33'	4'	0'	0'
2023 Build-out IMP	LOS (Delay)	C (16.3)	A (0.8)		A (0.0)
	Synchro 95th Q	18'	5'	0'	0'
<b>PM Peak Hour</b>					
2019 Existing	LOS (Delay)	D (29.7)	A (0.8)		A (0.0)
	Synchro 95th Q	86'	7'	0'	0'
2023 Background	LOS (Delay)	E (43.2)	A (0.6)		A (0.0)
	Synchro 95th Q	126'	5'	0'	0'
2023 Build-out	LOS (Delay)	F (54.5)	A (0.6)		A (0.0)
	Synchro 95th Q	151'	6'	0'	0'
2023 Build-out IMP	LOS (Delay)	D (34.9)	A (0.6)		A (0.0)
	Synchro 95th Q	109'	6'	0'	0'

As shown in **Table 6.3**, the eastbound approach of Parallel Drive is expected to operate with long delays under background and build-out conditions in the PM peak hour. It should be noted that at unsignalized intersections, it is not uncommon for a stop controlled, side-street approach to experience long delays in peak hours.

In the PM peak hour, the stop-controlled eastbound approach is expected to drop from LOS E to LOS F with the addition of site traffic. To mitigate the impact of the site, a dedicated eastbound right-turn lane with 50 feet of storage should be constructed. There is approximately 75 feet between Roberta Road and the first driveway on Parallel Drive; turn-lane storage should be accommodated within this distance. With this improvement in place, the stop-controlled approach is expected to operate with less delay than the background condition.

Because the site is not expected to significantly impact delay at this intersection, no improvements are recommended at this intersection for capacity purposes.

## 6.4 ROBERTA ROAD AND PHYSICIANS BOULEVARD

**Table 6.4** summarizes the LOS, control delay and 95<sup>th</sup> percentile queue lengths at the unsignalized intersection of Roberta Road and Physicians Boulevard.

Table 6.4 - Roberta Road and Physicians Boulevard							
Condition	Measure	EB	WB	NB			SB
		EBLTR	WBLTR	NBL	NBT	NBR	SBTR
<b>AM Peak Hour</b>							
2019 Existing	LOS (Delay)	B (14.0)	B (12.2)	A (0.2)			A (0.8)
	Synchro 95th Q	1'	6'	1'	0'	0'	2'
2023 Background	LOS (Delay)	C (15.2)	B (14.0)	A (0.1)			A (0.8)
	Synchro 95th Q	0'	7'	1'	0'	0'	2'
2023 Build-out	LOS (Delay)	C (15.6)	C (19.2)	A (0.1)			A (0.8)
	Synchro 95th Q	0'	25'	1'	0'	0'	2'
<b>PM Peak Hour</b>							
2019 Existing	LOS (Delay)	C (16.2)	C (20.1)	A (0.1)			A (1.2)
	Synchro 95th Q	5'	34'	1'	0'	0'	3'
2023 Background	LOS (Delay)	C (16.3)	D (28.1)	A (0.0)			A (1.0)
	Synchro 95th Q	2'	52'	0'	0'	0'	3'
2023 Build-out	LOS (Delay)	C (17.4)	F (155.3)	A (0.0)			A (1.0)
	Synchro 95th Q	2'	322'	0'	0'	0'	3'

As shown in **Table 6.4**, all approaches of the study intersection currently operate at an acceptable level of service during both the AM and PM peak hours and are expected to continue operating acceptably under 2023 background conditions. The westbound approach is expected to drop by two levels of service during the PM peak hour upon build-out of the site. It should be noted that at unsignalized intersections, it is not uncommon for a stop controlled, side-street approach to experience long delays in peak hours.

Should a dedicated left- and right-turn lane be provided on the westbound approach, the delay on that approach is expected to drop to about 55 seconds. Implementation of this approach would likely require removal of the existing on-street parking on the north side of Physicians Boulevard. However, it should be noted that due to the existing pavement width, some vehicles may be utilizing this pavement to make right-turns. Further, this intersection would likely not meet signal warrants and is located less than 1,000 feet to the adjacent signal at NC 49.

Based on discussion with the Town, the westbound approach to this intersection may be converted to a right-in/right-out intersection in the future. With this configuration in place, the westbound approach is expected to operate at LOS B and LOS C in the AM and PM peak-hours, respectively. Impact of this access configuration to the proposed signal at Roberta Road and Main Street can be found in **Section 6.2**. Capacity analysis results for this scenario can be found in the **Appendix**.

Therefore, no improvements are recommended at this intersection for capacity purposes.

## 6.5 ROBERTA ROAD AND NC 49

**Table 6.5** summarizes the LOS, control delay and 95<sup>th</sup> percentile queue lengths at the signalized intersection of Roberta Road and NC 49.

Table 6.5 - Roberta Road and NC 49														
Condition	Measure	EB			WB			NB			SB			Intersection LOS (Delay)
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
<b>AM Peak Hour</b>														
2019 Existing	LOS (Delay)	C (24.7)			E (71.1)			E (55.1)			D (54.6)			E (56.2)
	Synchro 95th Q	m#87'	m#143'	m#55'	148'	#872'	m#20'	#207'	286'	203'	82'	235'	-	
2023 Background	LOS (Delay)	D (35.4)			F (146.1)			E (55.5)			E (57.0)			F (90.8)
	Synchro 95th Q	m#218'	m#194'	m#79'	m#183'	#1049'	m#22'	m#205'	m#294'	m#151'	#133'	328'	-	
2023 Build-out	LOS (Delay)	F (100.3)			F (153.7)			D (53.3)			E (60.5)			F (105.3)
	Synchro 95th Q	m#406'	m#209'	m#77'	m#175'	#1071'	m#21'	m#194'	m#318'	m#154'	#133'	#396'	-	
2023 Build-out IMP	LOS (Delay)	C (31.5)			F (166.2)			E (70.6)			D (43.4)			F (96.9)
	Synchro 95th Q	m#305'	m#216'	m#84'	m#93'	#1120'	m#23'	m#248'	m#399'	m#222'	#135'	195'	324'	
2023 Build-out IMP Superstreet	LOS (Delay)	C (22.5)			E (72.6)			F (82.0)			D (46.6)			E (60.3)
	Synchro 95th Q	-	m#237'	m#308'	-	#952'	m#92'	#198'	#790'	318'	m#122'	311'	#413'	
<b>PM Peak Hour</b>														
2019 Existing	LOS (Delay)	D (53.6)			D (53.0)			E (55.7)			E (59.1)			D (54.7)
	Synchro 95th Q	m#301'	m#631'	m#180'	#371'	#462'	76'	m#123'	m#362'	m#125'	#157'	294'	-	
2023 Background	LOS (Delay)	F (100.8)			F (113.1)			E (56.0)			E (60.5)			F (89.5)
	Synchro 95th Q	m#302'	m#656'	m#159'	#537'	#589'	m#91'	m#91'	m#313'	m#88'	#218'	347'	-	
2023 Build-out	LOS (Delay)	F (140.1)			F (144.1)			E (59.1)			F (87.8)			F (117.3)
	Synchro 95th Q	m#419'	m#629'	m#147'	#591'	#651'	m#83'	m#89'	m#333'	m#94'	#218'	#534'	-	
2023 Build-out IMP	LOS (Delay)	F (123.1)			F (92.2)			D (50.7)			D (43.3)			F (87.5)
	Synchro 95th Q	m#447'	m#750'	m#152'	#500'	#614'	m#78'	m#109'	m#488'	m#63'	#220'	247'	291'	
2023 Build-out IMP Superstreet	LOS (Delay)	F (100.2)			D (39.4)			F (153.2)			D (39.6)			F (84.9)
	Synchro 95th Q	-	m#778'	#830'	-	545'	#521'	#173'	#1348'	139'	m#160'	447'	m#297'	

# 95th percentile volume exceeds capacity, queue may be longer  
 m Volume for 95th percentile queue is metered by upstream signal

As shown in **Table 6.5**, this intersection currently operates at LOS E and LOS D during the AM and PM peak hours, respectively. Under both the 2023 background conditions and the 2023 build-out conditions, the intersection is expected to drop one level of service (LOS F) during the AM peak hour and two levels of service (LOS F) during the PM peak hour.

To mitigate the site impact at this intersection, the construction of a southbound right-turn lane with 325 feet of storage and permitted-overlap phasing is recommended.

It should be noted that approximately 170 feet of storage is currently available on this approach between the stop bar and the CVS driveway. The current southbound through-right lane extends its storage across this driveway, but installation of this turn lane across the driveway should be discussed with NCDOT and the Town relative to potential safety concerns. With the installation of this improvement, eastbound U-turns should be prohibited.

At the direction of the Town, this intersection was also analyzed as a superstreet for planning purposes. Under this scenario, it was assumed that left-turns would be prohibited from NC 49 but permitted from Roberta Road/Harrisburg Veterans Road; left-turns from the mainline will be accommodated in U-turn bulbs on Roberta Road/Harrisburg Veterans Road. Under this laneage configuration, the superstreet would improve overall intersection operations in both peak-hours. To better improve operations at this intersection, side street left-turns and throughs may need to be restricted. If these movements are restricted, u-turn bulbs would need to be located along NC 49.

## 6.6 HARRISBURG VETERANS ROAD AND STALLINGS ROAD

**Table 6.6** summarizes the LOS, control delay and 95<sup>th</sup> percentile queue lengths at the signalized intersection of Harrisburg Veterans Road and Stallings Road.

Table 6.6 - Harrisburg Veterans Road and Stallings Road								
Condition	Measure	EB		WB		SB		Intersection LOS (Delay)
		EBL	EBT	WBT	WBR	SBL	SBR	
AM Peak Hour								
2019 Existing	LOS (Delay)	B (11.0)		B (17.0)		C (24.5)		B (16.4)
	Synchro 95th Q	256'	57'	182'	275'	m170'	331'	
2023 Background	LOS (Delay)	D (36.6)		D (40.1)		B (18.7)		C (32.1)
	Synchro 95th Q	#846'	81'	241'	401'	m218'	311'	
2023 Build-out	LOS (Delay)	D (37.0)		D (46.7)		B (17.6)		C (33.8)
	Synchro 95th Q	#915'	81'	241'	426'	m215'	m310'	
2023 Build-out IMP	LOS (Delay)	C (28.7)		D (46.1)		C (26.2)		C (33.0)
	Synchro 95th Q	487'	506'	241'	405'	275'	173'	
PM Peak Hour								
2019 Existing	LOS (Delay)	C (25.6)		C (22.7)		C (26.5)		C (25.7)
	Synchro 95th Q	#595'	56'	99'	172'	m431'	m385'	
2023 Background	LOS (Delay)	F (234.0)		C (23.4)		B (16.5)		F (91.5)
	Synchro 95th Q	#1188'	73'	109'	177'	m352'	m666'	
2023 Build-out	LOS (Delay)	F (261.5)		C (23.2)		B (17.2)		F (100.5)
	Synchro 95th Q	#1257'	73'	109'	192'	m301'	m651'	
2023 Build-out IMP	LOS (Delay)	E (79.8)		C (21.7)		C (23.4)		D (42.2)
	Synchro 95th Q	#671'	#688'	109'	168'	m429'	m329'	

# 95th percentile volume exceeds capacity, queue may be longer

m Volume for 95th percentile queue is metered by upstream signal

As shown in **Table 6.6**, under 2023 background conditions, the overall intersection is expected to operate at LOS C and LOS F in the AM and PM peak hours, respectively. The overall intersection and its approaches are expected to continue to operate at the same levels of service with the addition of site traffic.

Per the previous improvements considered at this intersection in the *Camellia Gardens TIA* (Kimley-Horn, January 2019) the 2023 Build-out Improved conditions include the following improvements:

- Restriping of the eastbound through lane to provide a shared through-left lane
- Implementation of split phasing on the eastbound and westbound approaches
- Installation of a traffic signal at the intersection of Stallings Road and Hickory Ridge Road to operate on the existing signal cabinet

If this improvement is not in place when the proposed Harrisburg Town Center is constructed, the Harrisburg Town Center is responsible for this improvement. Implementation of these improvements by the Camellia Gardens development should be confirmed with the Town.

With these improvements in place, the intersection is projected to operate with minimal increases in delay in the AM peak-hour and decreases in delay in the PM peak-hour compared to the background condition.

## 6.7 MOREHEAD ROAD/ALEXANDER AVENUE AND NC 49

**Table 6.7** summarizes the LOS, control delay and 95<sup>th</sup> percentile queue lengths at the signalized intersection of Morehead Road/Alexander Avenue and NC 49.

Table 6.7 - Morehead Road / Alexander Avenue and NC 49										
Condition	Measure	EB		WB			NB	SB		Intersection LOS (Delay)
		EBL	EBT	WBL	WBT	WBR	NBT	SBL	SBT	
<b>AM Peak Hour</b>										
2019 Existing	LOS (Delay)	A (8.5)		B (19.9)			D (44.7)	F (82.4)		C (23.0)
	Synchro 95th Q	66'	112'	m4'	m735'	m80'	84'	-	166'	
2023 Background	LOS (Delay)	B (12.5)		C (27.3)			D (47.6)	F (109.0)		C (29.8)
	Synchro 95th Q	#133'	111'	m2'	m726'	m61'	95'	-	#359'	
2023 Build-out	LOS (Delay)	B (11.9)		D (35.2)			D (47.2)	F (151.4)		D (37.9)
	Synchro 95th Q	#133'	133'	m2'	m733'	m64'	95'	-	#423'	
2023 Build-out IMP	LOS (Delay)	A (5.7)		B (17.9)			E (59.7)	F (85.5)		C (20.5)
	Synchro 95th Q	72'	101'	m1'	m705'	m37'	102'	#243'	#180'	
<b>PM Peak Hour</b>										
2019 Existing	LOS (Delay)	C (31.8)		C (26.7)			C (28.5)	E (70.2)		C (34.6)
	Synchro 95th Q	151'	#728'	m18'	472'	m177'	125'	-	302'	
2023 Background	LOS (Delay)	E (59.3)		C (31.8)			C (30.1)	F (88.3)		D (51.8)
	Synchro 95th Q	#324'	#1013'	m9'	m516'	m164'	148'	-	#585'	
2023 Build-out	LOS (Delay)	E (79.7)		D (49.6)			C (30.1)	F (112.6)		E (70.5)
	Synchro 95th Q	#324'	#1117'	m8'	m538'	m170'	148'	-	#643'	
2023 Build-out IMP	LOS (Delay)	C (34.1)		C (24.2)			D (38.4)	E (70.8)		C (34.5)
	Synchro 95th Q	#233'	#1006'	m9'	m567'	m180'	166'	#410'	190'	

# 95th percentile volume exceeds capacity, queue may be longer

m Volume for 95th percentile queue is metered by upstream signal

As shown in **Table 6.7**, the study intersection currently operates at an acceptable level of service during the AM and PM peak hours and is expected to continue operating acceptably under the 2023 background conditions during both the AM and PM peak hours. Under the 2023 Build-out conditions, the intersection is expected to drop to LOS D and LOS E during the AM and PM peak hours, respectively.

To mitigate the impact of the site traffic, it is recommended that the southbound approach be reconfigured to provide one southbound left-turn lane with 425 feet of storage and one shared through/right-turn lane. Based on a review of available aerial imagery, the existing cross-section of Morehead Road is approximately 35 feet and tapers back to 24 feet approximately 300 feet from the intersection at Morris Drive. The cemetery to the west of Morehead Road could limit the ability to accommodate widening to the west. Available pavement widths and required turning radii should be reviewed to determine if this improvement could be accommodated without widening.

## 6.8 KEE LANE AND NC 49

**Table 6.8** summarizes the LOS, control delay and 95<sup>th</sup> percentile queue lengths at the unsignalized intersection of Kee Lane and NC 49.

Table 6.8 - Kee Lane and NC 49									
Condition	Measure	EB			WB			NB	SB
		EBL	EBT	EBR	WBL	WBT	WBR	NBR	SBR
AM Peak Hour									
2019 Existing	LOS (Delay)	A (0.7)			A (0.1)			A (9.6)	B (10.9)
	Synchro 95th Q	8'	0'	0'	2'	0'	0'	1'	11'
2023 Background	LOS (Delay)	A (0.7)			A (0.2)			A (9.5)	B (10.6)
	Synchro 95th Q	9'	0'	0'	4'	0'	0'	2'	8'
2023 Build-out	LOS (Delay)	A (1.7)			A (0.2)			A (9.4)	B (11.5)
	Synchro 95th Q	24'	0'	0'	4'	0'	0'	2'	12'
PM Peak Hour									
2019 Existing	LOS (Delay)	A (0.9)			A (0.4)			B (10.2)	B (11.0)
	Synchro 95th Q	15'	0'	0'	6'	0'	0'	6'	21'
2023 Background	LOS (Delay)	A (0.8)			A (0.7)			B (10.3)	B (10.2)
	Synchro 95th Q	16'	0'	0'	13'	0'	0'	7'	14'
2023 Build-out	LOS (Delay)	A (1.5)			A (0.6)			B (10.3)	B (11.9)
	Synchro 95th Q	35'	0'	0'	12'	0'	0'	7'	33'

As shown in **Table 6.8**, all approaches of the study intersection currently operate at an acceptable level during both the AM and PM peak hours and are expected to continue operating acceptably under 2023 background conditions and 2023 build-out conditions. Therefore, no improvements are recommended at this intersection for capacity purposes.

## 6.9 MAIN STREET AND NC 49

**Table 6.9** summarizes the LOS, control delay and 95<sup>th</sup> percentile queue lengths at the signalized intersection of Main Street and NC 49.

Table 6.9 - Main Street and NC 49												
Condition	Measure	EB			WB			NB		SB		Intersection LOS (Delay)
		EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT	
<b>AM Peak Hour</b>												
2019 Existing	LOS (Delay)	A (2.5)			A (10.0)			D (52.9)		E (60.0)		B (10.8)
	Synchro 95th Q	6'	27'	2'	6'	448'	19'	30'	12'	85'	33'	
2023 Background	LOS (Delay)	A (6.8)			B (12.5)			E (63.9)		E (61.6)		B (13.9)
	Synchro 95th Q	m91'	31'	m2'	9'	585'	25'	83'	29'	100'	72'	
2023 Build-out	LOS (Delay)	A (9.7)			B (15.9)			E (59.3)		E (69.9)		B (18.0)
	Synchro 95th Q	m#131'	31'	m2'	9'	598'	47'	83'	29'	#165'	86'	
<b>PM Peak Hour</b>												
2019 Existing	LOS (Delay)	A (2.2)			B (12.9)			D (42.3)		E (59.5)		B (12.8)
	Synchro 95th Q	m8'	m35'	m2'	9'	335'	42'	33'	38'	164'	152'	
2023 Background	LOS (Delay)	A (9.7)			B (19.0)			D (46.8)		E (60.1)		B (18.9)
	Synchro 95th Q	m79'	m498'	m5'	23'	471'	58'	83'	52'	194'	149'	
2023 Build-out	LOS (Delay)	B (15.4)			C (30.7)			D (39.4)		E (60.1)		C (28.2)
	Synchro 95th Q	m111'	m477'	m5'	23'	463'	116'	84'	52'	#513'	209'	

# 95th percentile volume exceeds capacity, queue may be longer

m Volume for 95th percentile queue is metered by upstream signal

As shown in **Table 6.9**, under 2019 existing and 2023 background conditions, the overall intersection is expected to operate at LOS B during both the AM and PM peak hours. With the addition of site traffic, the overall intersection is expected to drop from LOS B to LOS C in the PM peak hour. Therefore, no capacity improvements are recommended at this intersection due to the proposed site.

## 6.10 MAIN STREET AND KEE LANE

**Table 6.10** summarizes the LOS, control delay and 95<sup>th</sup> percentile queue lengths at the unsignalized intersection of Main Street and Kee Lane.

Table 6.10 - Main Street and Kee Lane						
Condition	Measure	EB	WB	NB	SB	Intersection
		EBLTR	WBLTR	NBLTR	SBLTR	LOS (Delay)
<b>AM Peak Hour</b>						
2019 Existing	SimTraffic LOS (Delay)	A (2.0)	A (0.9)	A (2.6)	A (3.8)	A (2.0)
	SimTraffic 95th Q	47'	0'	41'	37'	
2023 Background	SimTraffic LOS (Delay)	A (2.1)	A (1.0)	A (2.6)	A (4.1)	A (2.0)
	SimTraffic 95th Q	45'	0'	39'	37'	
2023 Build-out	SimTraffic LOS (Delay)	A (4.2)	A (0.9)	A (2.8)	A (4.6)	A (3.1)
	SimTraffic 95th Q	81'	0'	50'	46'	
2023 Build-out IMP	LOS (Delay)	A (1.4)	A (0.9)	B (11.1)	B (10.4)	-
	Synchro 95th Q	1'	1'	9'	7'	
<b>PM Peak Hour</b>						
2019 Existing	SimTraffic LOS (Delay)	A (3.5)	A (1.0)	A (4.1)	A (4.5)	A (2.8)
	SimTraffic 95th Q	58'	0'	58'	44'	
2023 Background	SimTraffic LOS (Delay)	A (3.5)	A (1.2)	A (4.2)	A (4.7)	A (2.9)
	SimTraffic 95th Q	58'	0'	56'	47'	
2023 Build-out	SimTraffic LOS (Delay)	F (68.2)	B (13.1)	A (3.7)	F (92.8)	E (35.9)
	SimTraffic 95th Q	613'	198'	60'	228'	
2023 Build-out IMP	LOS (Delay)	A (1.5)	A (0.7)	C (15.5)	B (12.5)	-
	Synchro 95th Q	2'	1'	34'	13'	

As shown in **Table 6.10**, under 2023 background conditions, the overall intersection is expected to operate at LOS A during the AM and PM peak hours. The overall intersection and its approaches are expected to continue to operate at LOS A during the AM peak hour and LOS F during the PM peak hour with the addition of site traffic. Therefore, it is recommended that the eastbound stop-control be removed to allow for the intersection to operate as a conventional two-way stop-controlled intersection. With this improvement implemented, the northbound and southbound approaches are expected to operate at an acceptable level of service during both the AM and PM peak hours with the east/west traffic operating under uninterrupted flow.

It should be noted that a single-lane roundabout was also considered and analyzed at this intersection. The results yielded an overall LOS A during both the AM and PM peak hour with minimal queuing. These results can be found in the **Appendix**.

## 7.0 Auxiliary Turn Lane Warrants

Warrants for additional turn-lane improvements for unsignalized intersection beyond those necessary for capacity were determined based on a review of the figure titled 'Warrant for Left and Right-Turn Lanes' found on page 80 in the *NCDOT Policy On Street And Driveway Access to North Carolina Highways*. The results of the warrants for left and right-turn lanes under 2023 build-out conditions are summarized by intersection below and included in the **Appendix**.

### Roberta Road at Rocky River Crossing Road

#### 2023 Background Conditions

- Southbound right-turn lane along Roberta Road with a minimum storage length of 75

#### 2023 Build-out Conditions

- Southbound right-turn lane along Roberta Road with a minimum storage length of 75

Although warranted in the background and build-out conditions, it is recommended that the proposed site build the southbound right-turn lane to mitigate anticipated increases in side-street delay. Per NCDOT guideline, a minimum of 100 feet of storage will be required for the warranted turn lane.

## 8.0 Traffic Signal Warrant Analysis

Based on the approved MOU, a 13- hour traffic signal warrant analysis was performed for the 2023 build-out year for the intersection of Roberta Road and Main Street, based on the guidelines published by the Federal Highway Administration (FHWA) in the *Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition*.

For signal warrant analysis, the MUTCD provides the following standards:

- An engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location.
- The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following signal warrants:
  - Warrant 1, Eight-Hour Vehicular Volume
  - Warrant 2, Four-Hour Vehicular Volume
  - Warrant 3, Peak Hour
  - Warrant 4, Pedestrian Volume
  - Warrant 5, School Crossing
  - Warrant 6, Coordinated Signal System
  - Warrant 7, Crash Experience
  - Warrant 8, Roadway Network
  - Warrant 9, Intersection Near a Grade Crossing

Warrant 1 Condition A is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic signal. Warrant 1 Condition B is intended for application where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or

crossing the major street. If a combination of Condition A and Condition B are not satisfied, Warrant 1 may be satisfied by Condition C.

Warrant 2 is intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic signal.

Warrant 3 is intended for use at a location where traffic conditions are such that for a minimum of one hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

A traffic control signal should not be installed unless one or more of the above warrants are met. However, the satisfaction of a traffic signal warrant or warrants should not in itself require the installation of a traffic control signal.

**Table 8.1** shows the results of the signal warrant analyses for the intersection of Roberta Road and Main Street under both 2023 background and build-out conditions, along with number of hours satisfied against the number of hours required.

<b>Table 8.1 – Traffic Signal Warrant Analysis Results</b> <b>Roberta Road and Main Street</b> Criteria satisfied/not satisfied (hours satisfied/required)		
Intersection	2023 Background	2023 Build-Out
Warrant 1A	0/8	5/8
Warrant 1B	8/8	11/8
Warrant 1C	0/8	8/8
Warrant 2	5/4	8/4
Warrant 3	0/1	5/1

Based on results shown in **Table 8.1**, signal warrants 1, 2 and 3 are met in both background and build conditions at the intersection of Roberta Road and Main Street, with the exception of warrant 3 for background conditions. It should be noted that this signal warrant analysis was performed based the assumption that the minor street (Main Street) consists of two approach lanes per the recommendation of this TIA.

To mitigate the impact of the site, a signal at Roberta Road and Main Street is recommended. Signal warrant calculations are included in the **Appendix**.

## 9.0 Crash Data Analysis

Crash data was obtained at study intersections for crashes that occurred between January 1, 2016, and December 31, 2018. No crash data was available for two of the study area intersections: Roberta Road at Rocky River Crossing Road and Roberta Road at Main Street. Over this three-year period, 158 total crashes were reported at the eight existing study intersections. The breakdown of crashes at these eight study intersections by severity, frequency and accident type can be seen the tables below.

**Table 9.1 – Crash Severity Summary**

Crash Type	Number of Crashes
Fatal Crashes	0
Class A	0
Class B	7
Class C	27
Property Damage Only	124
<b>Total</b>	<b>158</b>

**Table 9.1** above displays the total number of crashes by severity type from most to least severe. As shown, there were no fatal or Class A crashes reported in the study area intersections over the past three years. ‘Class A’ incidents are crashes in which serious injury is suspected, which can include significant loss of blood or broken bones. ‘Class B’ incidents are crashes in which minor injury is suspected, such as bruises or minor cuts. There were seven of these crash types within the study area reported over the three years. There were 27 ‘Class C’ crashes reported, which are defined as crashes wherein possible injuries occur. Possible injuries are injuries reported by the person or indicated by his/her behavior, but no wounds or injuries are physically present, such as limping or complaint of neck pain. There were 124 crashes in which only property damage occurred, meaning no injury was reported in 78% of the recorded crashes at the study intersections.

**Table 9.2 – Accident Frequency Summary**

Location	Crashes/100 MEV
Roberta Road and Parallel Drive (Int #3)	17.54
Roberta Road and Physicians Boulevard (Int #4)	17.10
Roberta Road and NC 49 (Int #5)	54.25
Harrisburg Veterans Road and Stallings Road (Int #6)	9.54
Morehead Road and NC 49 (Int #7)	46.69
Kee Lane and NC 49 (Int #8)	38.91
Main Street and NC 49 (Int #9)	33.21
Main Street and Kee Lane (Int #10)	1.42
<b>Average</b>	<b>38.57</b>

Shown in **Table 9.2** are the accident frequency rates for each study intersection, reported in crashes per 100 million entering vehicles (MEV). Their rates resulted in a weighted average crash rate of 38.57 crashes per 100 MEV, with the highest rate occurring at the intersection of Roberta Road and NC 49.

**Table 9.3 – Accident Type Summary**

Accident Type	Int #3	Int #4	Int #5	Int #6	Int #7	Int #8	Int #9	Int #10
Angle	0	0	8	0	2	0	1	2
Backing Up	0	0	1	0	0	0	0	0
Left-Turn, Different Roadways	2	0	4	1	2	5	1	1
Left-Turn, Same Roadway	0	0	9	4	5	0	3	0
Moveable Object	0	0	0	0	1	0	0	0
Other Collisions with Vehicle	0	0	0	1	0	0	0	0
Overturn/Rollover	0	0	0	1	0	0	0	0
Ran off Road - Left	1	0	1	0	0	0	1	0
Ran off Road - Right	2	1	1	1	0	0	0	0
Rear End, Slow or Stop	2	1	30	5	14	6	7	0
Rear End, Turn	0	0	1	2	0	0	0	0
Right-Turn, Different Roadways	0	0	2	1	0	3	3	0
Right-Turn, Same Roadway	1	0	0	1	0	0	0	0
Sideswipe Opposite Direction	0	0	0	0	1	0	0	0
Sideswipe Same Direction	0	0	10	0	4	2	0	0
<b>Total</b>	<b>8</b>	<b>2</b>	<b>67</b>	<b>17</b>	<b>29</b>	<b>16</b>	<b>16</b>	<b>3</b>

As seen in **Table 9.3**, at the eight study intersections, the most common crash type was a rear-end collision caused by slowing or stopping, with 41% of crashes. This crash type is often associated with mainline traffic along a corridor with unsignalized turning movements with the lack of turn lanes onto side-streets. The second most common crash type was a left-turn collision from the same roadway.

## 10.0 Mitigation Improvements

Based on the capacity analyses performed at each of the identified study intersections, the following improvements have been identified to mitigate the impact of the proposed development on the adjacent street network:

### ***Roberta Road and Rocky River Crossing Road***

- Construction of a southbound right-turn lane with a minimum of 100 feet of storage.

### ***Roberta Road and Main Street***

- Installation of a traffic signal.
- Installation of fiber connection to the signal at Roberta Road and NC 49
- Construction of a westbound right-turn lane with a minimum of 450 feet of storage.

### ***Roberta Road and Parallel Drive***

- Construction of an eastbound right-turn lane with a minimum of 50 feet of storage.

### ***Roberta Road and NC 49***

- Construction of a southbound right-turn lane with 325 feet of storage and permitted-overlap phasing.

### ***Harrisburg Veterans Road and Stallings Road\****

- Restripe the eastbound through lane to provide a shared through-left lane.
- Implementation of split phasing on the eastbound and westbound approaches.
- Installation of a traffic signal at the intersection of Stallings Road and Hickory Ridge Road to operate on the existing signal cabinet

*\*These improvements are currently the responsibility of the Camellia Gardens development. However, if the proposed Harrisburg Town Center is constructed prior to Camellia Gardens, the Harrisburg Town Center will be responsible for this improvement.*

### ***Morehead Road / Alexander Avenue and NC 49***

- Construction of a southbound left-turn lane with a minimum of 425 feet of storage

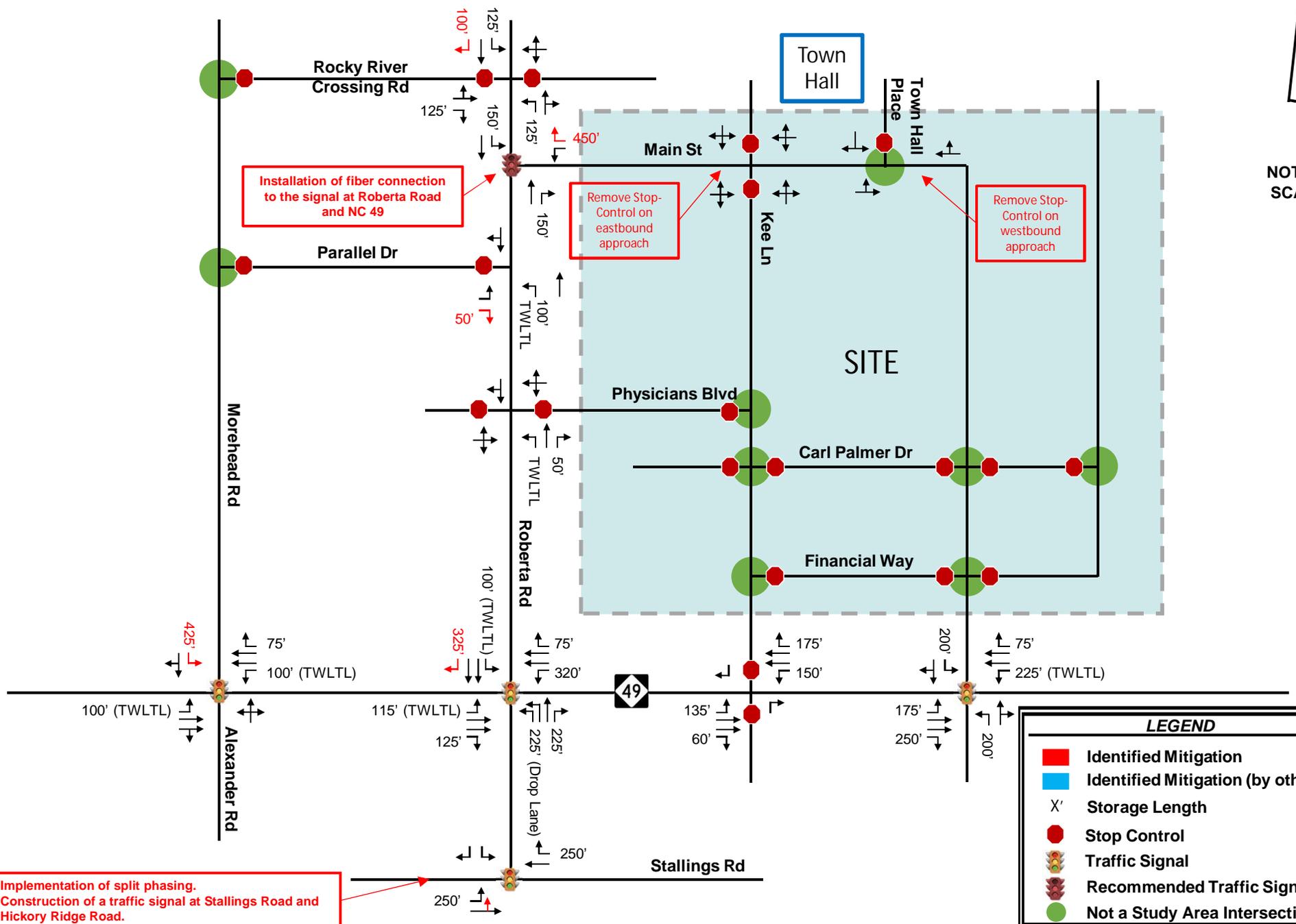
### ***Main Street and Kee Lane***

- Remove eastbound stop-control to allow intersection to operate as two-way stop-control (northbound and southbound approaches remain stop-controlled).

### ***Main Street and Town Hall Place***

- Remove westbound stop-control to allow intersection to operate as two-way stop-control (southbound approach remains stop-controlled).

The mitigation improvements identified within the study area are shown in **Figure 10.1**. The improvements shown on this figure are subject to approval by NCDOT and the Town of Harrisburg. All additions and attachments to the State and Town roadway system shall be properly permitted, designed and constructed in conformance to standards maintained by the agencies.



Installation of fiber connection to the signal at Roberta Road and NC 49

Remove Stop-Control on eastbound approach

Remove Stop-Control on westbound approach

- Implementation of split phasing.
- Construction of a traffic signal at Stallings Road and Hickory Ridge Road.

LEGEND	
<span style="color: red;">■</span>	Identified Mitigation
<span style="color: blue;">■</span>	Identified Mitigation (by others)
X'	Storage Length
●	Stop Control
	Traffic Signal
	Recommended Traffic Signal
●	Not a Study Area Intersection

**APPENDIX**