Rock Creek Subdivision

Traffic Impact Analysis

Lincoln County, NC

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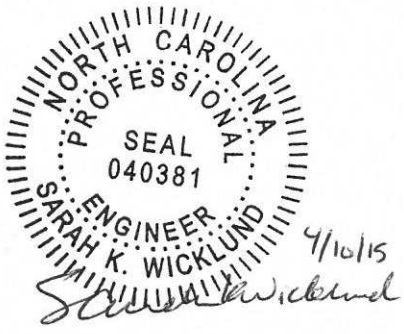
April 10, 2015



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EXECUTIVE SUMMARY

Rock Creek Subdivision is a proposed residential development to be constructed on a 64.1 acre parcel located on the west side of Campground Rd north of NC 16 in Lincoln County, NC. The existing land is currently vacant. The proposed development will consist of no more than 150 single family homes. Two full movement access points are proposed, one on Campground Rd south of the intersection at Will Proctor St, and one on Catawba Burris Rd north of the intersection at Campground Rd.

In addition to the proposed site entrance intersections, the following existing intersections are included as part of the area of influence for the proposed development.

NC 16 Bus & Campground Rd/Forney Hill Rd ..... *Signalized 4-legged intersection*
NC 16 Bus & Will Proctor St/St. James Church Rd… ..... *Signalized 4-legged intersection*
Campground Rd & Will Proctor St ..... *Unsignalized 4-legged intersection*
Campground Rd & Catawba Burris Rd ..... *Unsignalized 3-legged intersection*

The proposed development is estimated to generate 1,525 daily trips, including 115 new trips during the AM peak hour and 151 new trips during the PM peak hour.

For the purposes of the Traffic Impact Analysis (TIA), the full build-out of the site will be completed in 2020. Thus, the design year in this study is 2021, or one year past build-out.

There are a total of four (4) scenarios evaluated for the intersections potentially affected by the proposed Rock Creek development project:

1. The "**2015 Existing Conditions Analysis**" evaluates the current intersection operational performance.
2. The "**2021 No-Build Analysis**" examines the future traffic conditions where the proposed redevelopment does not occur. This analysis takes into account background traffic growth (2% per year). No other approved developments in the study area or any committed transportation improvements have been identified for the 2021 design year.
3. The "**2021 Build Analysis**" evaluates the intersection operational performance after distributing site generated trips through the study area intersections, and,
4. The "**2021 Build with Improvements Analysis**" is conducted if comparing scenarios 2 and 3 above there is any degradation in the operational performance of study area intersections as outlined by the NCDOT.

For each scenario intersection capacity analyses were performed for two weekday peak hours, namely AM peak and PM peak. Existing intersections were analyzed in all four scenarios while the proposed intersections were analyzed in the "build" scenarios only.

This study documents the intersection level-of-service (LOS) and queuing analysis for the proposed development. LOS is a letter designated by the average vehicle delay time at an approach to an intersection with "A" representing little or no delay and "F" representing high levels of congestion. LOS D or better is considered acceptable. Delay and LOS results for unsignalized intersections are reported for each approach while signalized intersections add a composite delay (based on a weighted average of the approaches) and LOS for the overall intersection. Results of the analyses are summarized below:

2015 Existing Conditions Analysis

All four of the study intersections currently operate at an overall acceptable LOS (D or better) in both peak periods. The southbound approach at the signalized intersection of NC 16 Bus and Campground Rd/Forney Hill Rd experiences approximately 48 seconds of delay (LOS D) during the PM peak hours, the highest average approach delays in the study area. The eastbound/westbound TWLT lane between the intersections of NC 16 Bus at Campground Rd/Forney Hill Rd and NC 16 Bus at Will Proctor St/St. James Church Rd provides adequate storage capacity for both intersections. The northbound right-turn lane at the intersection of NC 16 Bus at Will Proctor St/St. James Church Rd might experience storage deficiencies during peak hours. It should be noted that the analysis does not allow right turn on red (RTOR) in accordance with NCDOT's traffic analysis guidelines, which may overestimate the queue lengths.

2021 No-Build Analysis

Similar to the existing conditions, all four intersections are expected to operate at an overall acceptable LOS. The southbound approach at the intersection of NC 16 Bus and Campground Rd/Forney Hill Rd is expected to experience an increase in delays in both peak periods and operate at a LOS E with approximately 60 seconds of delay in the PM peak period. The queue lengths are expected to increase at the intersection of NC 16 Bus and Campground Rd/Forney Hill Rd compared to the 2015 Existing Condition Analysis. The eastbound left-turn queue is expected to exceed the current storage capacity during the PM peak period. The TWLT between the intersections on NC 16 Bus is expected to continue providing adequate storage lengths for both intersections. The northbound right-turn queue length may exceed the existing storage capacity, based on the conservative queue analyses.

2021 Build Analysis

Similar to the 2021 No-Build Conditions, all the study intersections including the two proposed site entrance intersections are expected to operate at an overall acceptable LOS. The intersection of NC 16 Bus and Campground Rd/Forney Hill Rd is expected to experience increased delays resulting in a drop in overall LOS (from C to D) in the PM peak period. The southbound approach LOS is expected to degrade to LOS to E and F in the AM and PM peak periods, respectively. The intersection of NC 16 Bus and Will Proctor St/St. James Church Rd is expected to maintain the No Build traffic operations performance with minimal delay increases on all four approaches.

2021 Build with Improvements Analysis

While all study intersections are expected to operate at an overall acceptable LOS after the site is constructed, when compared to the 2021 No Build Conditions, the intersection of NC 16 Bus at Campground Rd/Forney Hill Rd experiences LOS degradation on both eastbound and southbound approaches. The traffic volumes at the Site Entrance (#1) on Campground Rd also meet the left-turn lane threshold according to the NCDOT's *Policy on Street and Driveway Access to North Carolina Highway.*

With the proposed intersection improvements (see below) installed at both locations, the intersection of NC 16 Bus at Campground Rd/Forney Hill Rd is expected to maintain the No Build traffic operations performance. The site entrance on Campground Rd will benefit from the proposed left-turn lane on Campground Rd from both operations and safety perspectives.

Conclusions

The traffic analyses identified improvement needs at two intersections, one existing and one proposed, to accommodate site traffic upon full build-out. The following improvements are therefore recommended to mitigate the site traffic impacts.

Proposed Improvements by Developer:

NC 16 Bus and Campground Rd/ Forney Hill Rd

- Construct a southbound right-turn lane with 200' of storage and appropriate taper.
- Extend the eastbound left-turn lane by 90' to provide 200' of storage and appropriate taper.
- Signal upgrade to accommodate the proposed lane configurations, including an overlap phase for the southbound right-turn lane.

Campground Rd/Site Entrance #1

- Construct a northbound left-turn lane on Campground Rd with 100' of storage and appropriate taper.

The proposed turn lane improvements will help to separate the left-turn and right-turn vehicles from the through traffic streams, prevent possible through lane blockages caused by turning vehicles, and therefore improve the traffic operations and safety performance. It is concluded that the proposed improvements will provide additional capacity to accommodate the site traffic, and maintain the No Build traffic operations performance in the study area upon site build-out.

It is noted that there is no clear public right-of-way at the NC 16 Bus and Campground Rd/ Forney Hill Rd intersection. If the right-of-way for the proposed intersection improvements can not be reasonably obtained, it might be appropriate for the proposed development to contribute towards other transportation improvement measures determined by NCDOT and the County.

INTRODUCTION

Rock Creek Subdivision is a proposed residential development to be constructed on a 64.1 acre parcel located on the west side of Campground Rd north of NC 16 in Lincoln County, NC. The existing land is currently vacant. The proposed development will consist of no more than 150 single family homes. Figure 1 illustrates the location of the site and surrounding area.

The subject development is proposed to have two full access points; one on Campground Rd and one on Catawba Burris Rd. Figure 2 shows the current Site Plan.

After discussions with the County and NCDOT, the following existing intersections are included, in addition to the two proposed site entrance intersections, as part of the area of influence for the proposed development.

NC 16 Bus & Campground Rd/Forney Hill Rd ..... *Signalized 4-legged intersection*
NC 16 Bus & Will Proctor St/St. James Church Rd… ..... *Signalized 4-legged intersection*
Campground Rd & Will Proctor St ..... *Unsignalized 4-legged intersection*
Campground Rd & Catawba Burris Rd ..... *Unsignalized 3-legged intersection*

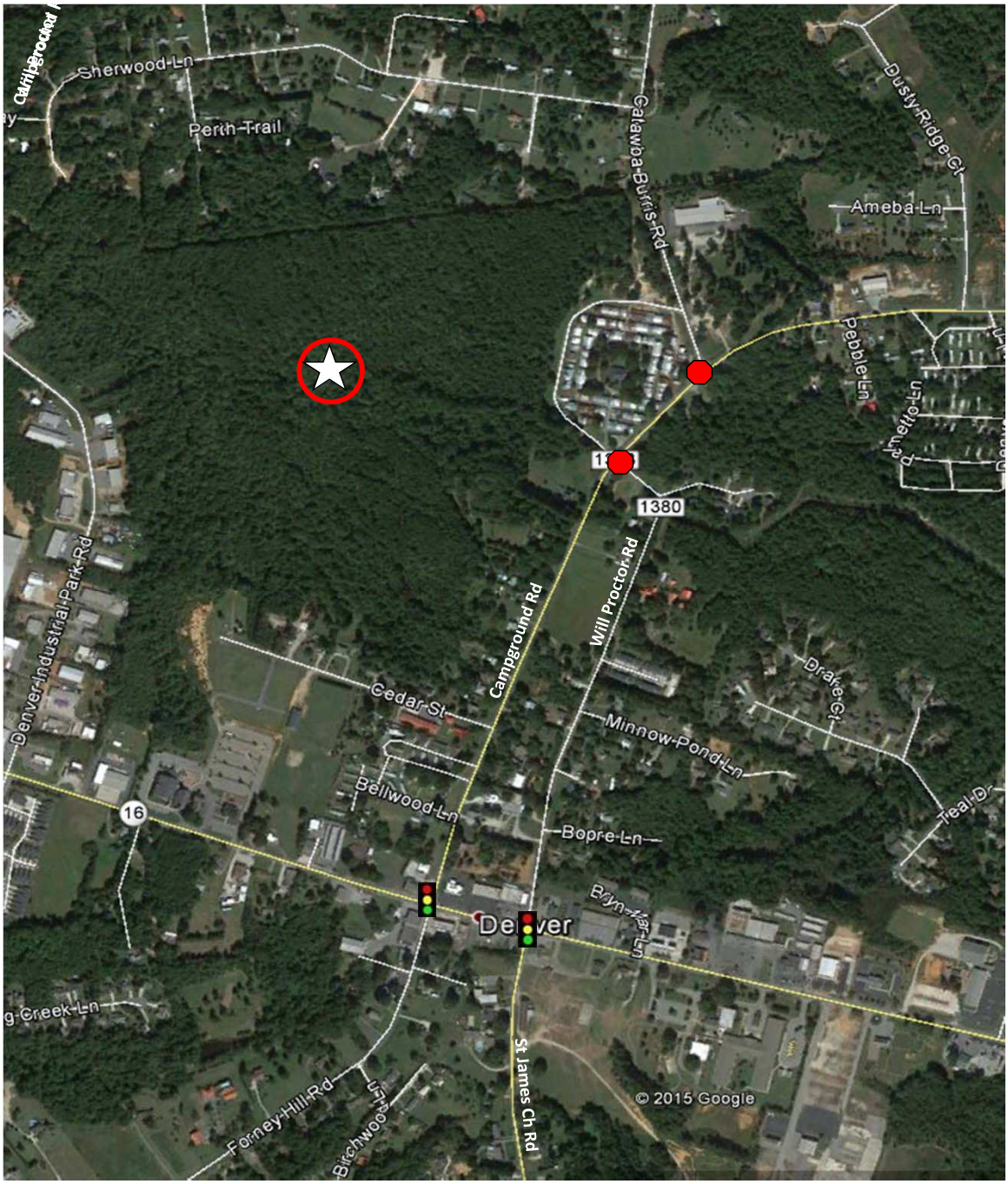
The existing intersection lane configuration is shown in Figure 3. Below is a detailed description of the existing study area roadway network. All Average Annual Daily Traffic (AADT) information provided in this description was obtained from the North Carolina Department of Transportation (NCDOT) via the following website: http://www.ncdot.gov/travel/statemapping/trafficvolumemaps/.

NC 16 Business is an east-west two-lane roadway on the south side of the study area providing access to Lake Norman to the southeast and Catawba County to the northwest. NC 16 Business has a center two-way left-turn lane between Campground Rd and the bridge over CSX railroad track approximately 6,600 feet to the east. The land use along NC 16 Bus in the study area is primarily commercial. The 2013 AADT on NC 16 Bus between Campground Rd and Will Proctor Rd was 11,000 vehicles per day (vpd). The speed limit along this road is 35 miles per hour (mph).

Campground Road is a north-south two-lane roadway connecting NC 16 Bus to NC 150 in Catawba County. The land use along this roadway is mainly residential with some commercial. The 2013 AADT on Campground Rd north of NC 16 Bus was 7,100 vpd. The posted speed limit along this road is 35 mph.

N

***Not to Scale



Intersections:
Catawba Burris Rd @ Campground Rd
Will Proctor St @ Campground Rd
NC 16 Bus @ Campground Rd/Forney Hill Rd
NC 16 Bus @ Will Proctor St/St. James Church Rd

Legend	
	Signalized Intersection
	Unsignalized Intersection
	Future Site

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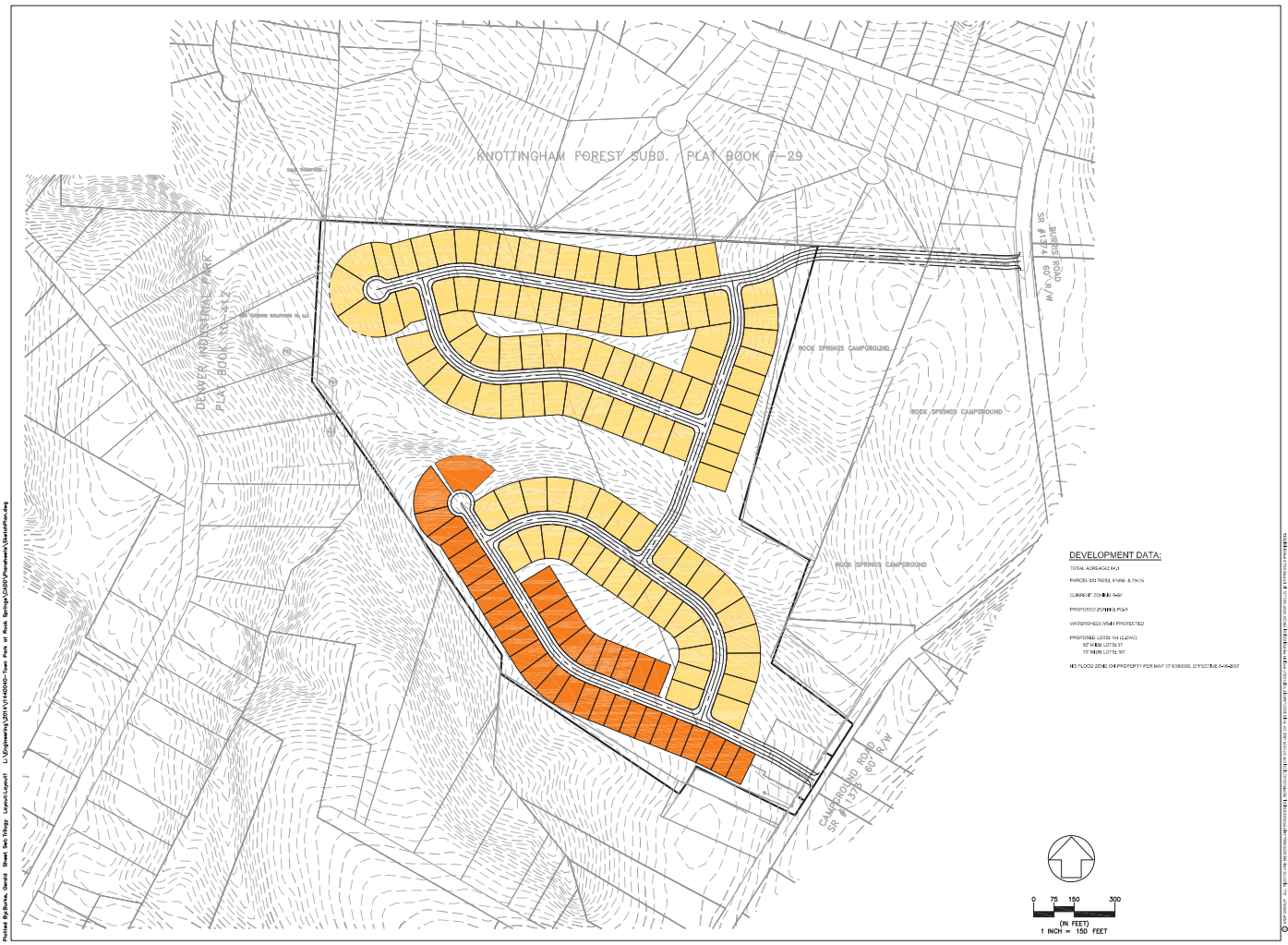
Figure 1
Study Area



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PRELIMINARY NOT RELEASED FOR CONSTRUCTION

NC LICENSE # F-0891

TOWN PARK AT ROCK SPRINGS

CAMPGROUND ROAD, DENVER, NC

NO.	BY	DATE	REVISION

PROJECT MGR: [illegible] DATE: 7.24.25

DRAWN BY: VR CHECKED BY: DR

TITLE

PRELIMINARY SKETCH PLAN

SHEET

SK-1

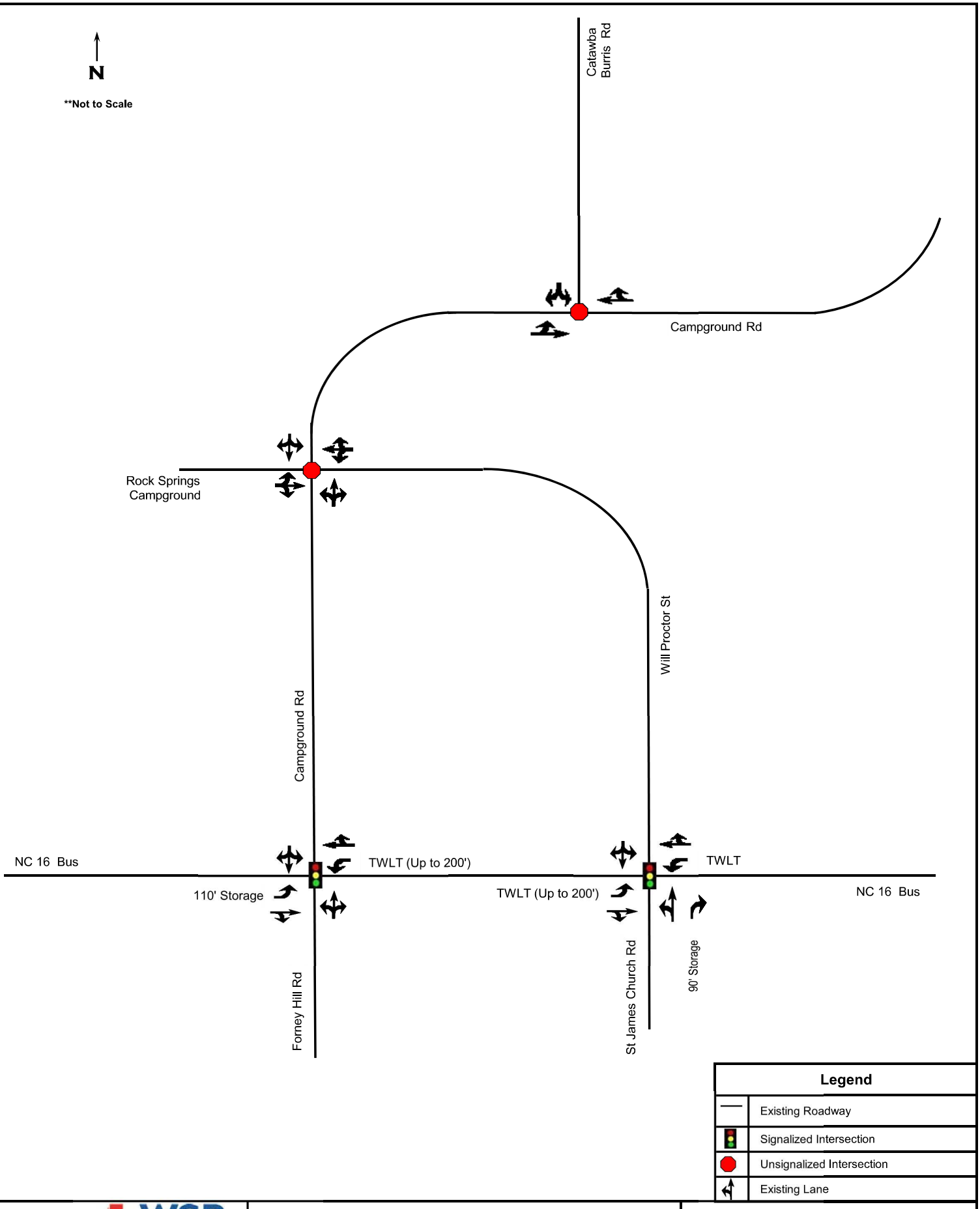

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Figure 3
Existing (2015) Lane Configuration

Will Proctor St is a north-south two-lane roadway providing an additional connection between Campground Rd and NC 16 Bus. The land use along this roadway is mainly residential. There is no AADT available for this roadway. The speed limit along this road is 35 mph.

Catawba Burris Rd is a north-south two-lane roadway connecting a residential area in Catawba County to Campground Rd. The land use along this roadway is mainly residential. There is no AADT available for this roadway. The posted speed limit on this road is 45 mph.

Forney Hill Rd is a north-south two-lane roadway in the study area connecting NC 16 Bus to NC 16 to the south. The land use along his road is primarily residential. The 2012 AADT on Forney Hill Rd south of NC 16 Bus was 3,000 vpd. The speed limit along this road is 35 mph.

St. James Church Rd is a north-south two-lane roadway providing access from NC 16 Bus to NC 16 and NC 73 to the south. The land use along this roadway is mainly residential. The 2013 AADT on St. James Church Rd south of NC 16 Bus was 5,200 vpd. The posted speed limit on this road is 35 mph.

The intersection of NC 16 Bus at Campground Rd/Forney Hill Rd is a signalized four-legged intersection. The eastbound approach on NC 16 Bus has an exclusive left-turn lane with 110' of storage and a shared through/right-turn lane. The westbound approach on NC 16 Bus has a Two-Way Left Turn (TWLT) lane and a shared through/right-turn lane. The northbound Forney Hill Rd approach and the southbound Campground Rd approach both are one-lane approaches with shared movements. There does not appear to be clear right-of-way at this intersection.

The intersection of NC 16 Bus at Will Proctor St/St. James Church St is a signalized four-legged intersection. The eastbound approach on NC 16 Bus has a TWLT lane and a shared through/right-turn lane. The westbound approach on NC 16 Bus has a TWLT lane and a shared through/right-turn lane. The northbound approach on St. James Church Rd has a shared left-turn/though lane and an exclusive right-turn lane with 90' of storage. The southbound Will Proctor St approach is a one-lane approach with shared movements. There does not appear to be clear right-of-way at this intersection.

The intersection of Campground Rd at Will Proctor St/Rock Springs Campground Driveway is a four-legged intersection with stop control on Will Proctor St and Rock Springs Campground Driveway. All four intersection approaches are one-lane approaches with shared movements.

The intersection of Campground Rd at Catawba Burris Rd is a three-legged intersection with stop control on Catawba Burris Rd. All three intersection approaches are one-lane approaches with shared movements.

The two traffic signals on NC 16 Bus are in a coordinated signal system "NC 16 Denver CLS" which currently has a cycle length of 90 seconds during both AM and PM peak hours.

For the purposes of the Traffic Impact Analysis (TIA), the full build-out of the site will be completed, opened, and fully occupied in 2020. Thus, the design year in this study is 2021, or one year past build-out. There are a total of four (4) scenarios evaluated for the intersections potentially affected by the proposed Rock Creek development project:

1. The "**2015 Existing Conditions Analysis**" evaluates the current intersection operational performance.
2. The "**2021 No-Build Analysis**" examines the future traffic conditions where the proposed redevelopment does not occur. This analysis takes into account background traffic growth (2% per year). No other approved developments in the study area or any committed transportation improvements have been identified for the 2021 design year.
3. The "**2021 Build Analysis**" evaluates the intersection operational performance after distributing site generated trips through the study area intersections, and,
4. The "**2021 Build with Improvements Analysis**" is conducted if comparing scenarios 2 and 3 above there is any degradation in the operational performance of study area intersections as outlined by the NCDOT.

The four existing study area intersections were studied in all scenarios while new intersections/site entrances were evaluated in the future year "Build" and "Build with Improvements" scenarios only. Traffic counts were conducted at all four locations to help determine site trip distribution in the analysis.

Intersection analyses were performed for two peak hours in all scenarios. For the purposes of this study, the peak hour analysis was performed for the weekday 7:00-8:00 AM (peak hour between 7:00-9:00 AM) and 5:00-6:00 PM (peak hour between 4:00-6:00PM).

In accordance with the NCDOT Capacity Analysis Guidelines, no "Right Turn on Red" (RTOR) is allowed in this study. In addition, a Peak Hour Factor (PHF) of 0.90 is used for all future analysis scenarios. The current traffic signal timing parameters provided by NCDOT were used in the analyses.

2015 EXISTING CONDITIONS ANALYSIS

Traffic counts for the study area intersections were performed during the weekday AM peak hours of 7:00 – 9:00 and weekday PM peak hours of 4:00 - 6:00 on January 15, 2015. The traffic counts are provided in Appendix B and depicted in Figure 4.

Existing volumes, traffic flow characteristics, and intersection geometrics collected during field visits were used to determine the level of service. The level of service (LOS) is a measurement of average delay incurred at an intersection for a particular movement. LOS is defined by the Transportation Research Board's Highway Capacity Manual 2010 (HCM). The following tables give the HCM criteria for both signalized (HCM Exhibit 18-4) and unsignalized intersections (HCM Exhibit 19-1).

HCM Exhibit 18-4

LOS	Control Delay (s/veh)
A	≤10
B	> 10 - 20
C	> 20 - 35
D	> 35 - 55
E	> 55 - 80
F	> 80

HCM Exhibit 19-1

LOS	Control Delay (s/veh)
A	≤10
B	> 10 - 15
C	> 15 - 25
D	> 25 - 35
E	> 35 - 50
F	> 50

The LOS analysis for signalized and unsignalized intersections was completed through the use of Synchro, version 7. The software package categorizes the LOS based on HCM methodology and criteria. According to industry standards, any signalized intersection or any approach of an unsignalized intersection is considered acceptable if the Control Delay is LOS D or better with the LOS A representing little or no delay. Any signalized intersection or approach with a LOS of E or F is considered substandard and may need mitigation to improve the operational performance.

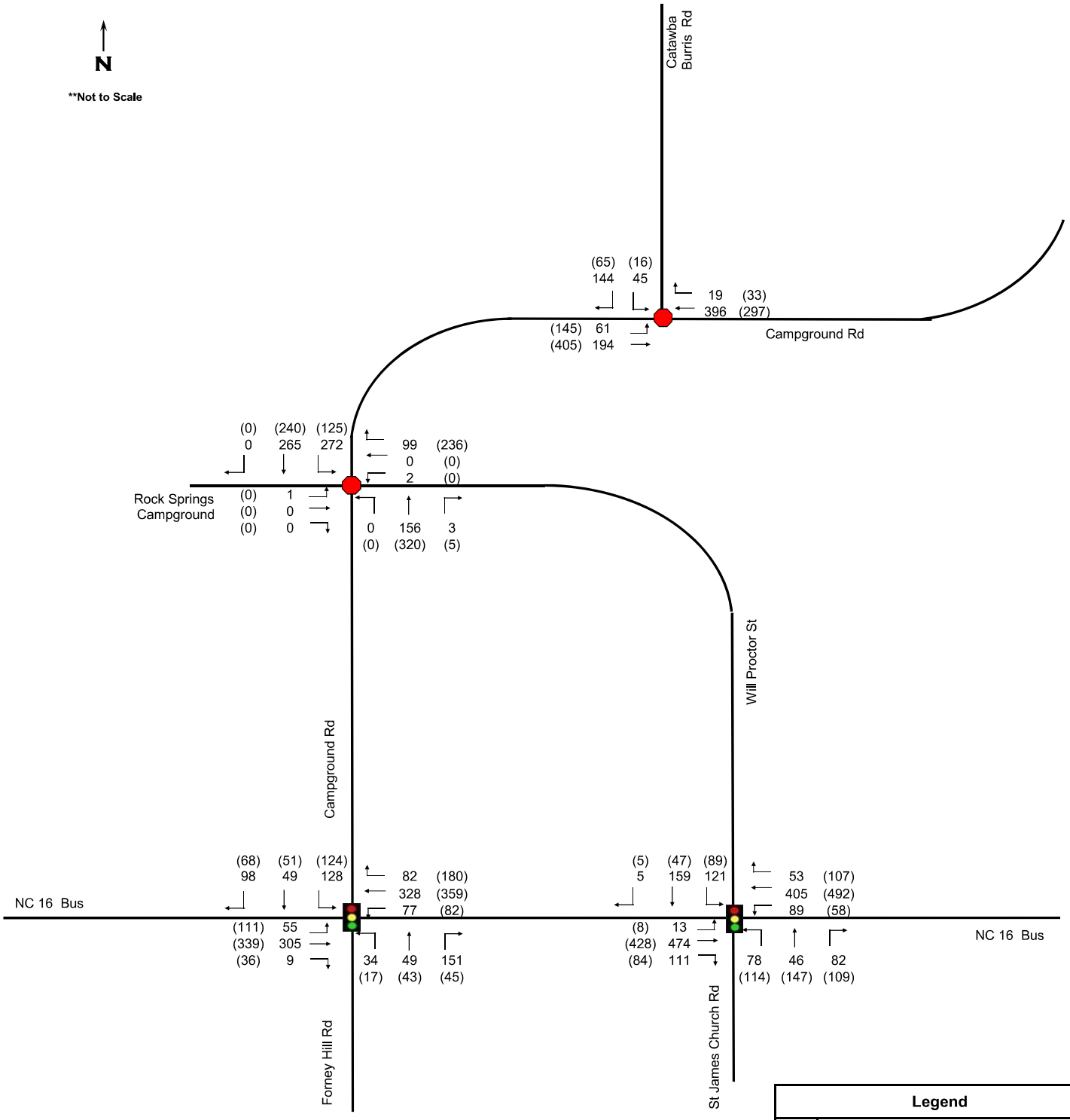

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Figure 4
2015 Existing Peak Hour Traffic Volumes

Table 1 lists the LOS results from the 2015 Existing Conditions analysis. Delay and LOS results are reported for each intersection approach. Intersection average delays (based on a weighted average of the approaches) and LOS are also reported for signalized intersections.

All four of the study intersections currently operate at an overall acceptable LOS (D or better) in both peak periods. The southbound approach at the signalized intersection of NC 16 Bus and Campground Rd/Forney Hill Rd experiences approximately 48 seconds of delay (LOS D) during the PM peak hours, the highest average approach delays in the study area.

Table 1: Level of Service Analysis – 2015 Existing Conditions

Intersection	Approach		Existing (2015)			
			AM		PM	
			Delay (sec)	LOS	Delay (sec)	LOS
NC 16 Bus @ Campground Rd/Forney Hill Rd	signalized	Intersection Average	**21.4**	**C**	**20.1**	**C**
		EB - NC 16 Bus	13.9	B	9.7	A
		WB - NC 16 Bus	19.0	B	14.8	B
		NB - Forney Hill Rd	25.6	C	28.8	C
		SB - Campground Rd	33.0	C	48.3	D
NC 16 Bus @ Will Proctor St/St James Church Rd	signalized	Intersection Average	**21.4**	**C**	**19.9**	**B**
		EB - NC 16 Bus	18.1	B	14.2	B
		WB - NC 16 Bus	12.8	B	16.5	B
		NB - St James Church Rd	28.3	C	29.1	C
		SB - Will Proctor St	39.7	D	29.9	C
Campground Rd @ Will Proctor St/Rock Spring Campground Driveway	unsignalized	EB - Driveway	33.4	D	32.2	D
		WB - Will Proctor St	11.4	B	13.8	B
		NB - Campground Rd	0.1	A	0.0	A
		SB - Campground Rd	5.5	A	3.7	A
Campground Rd @ Catawba Burris Rd	unsignalized	EB - Campground Rd	2.7	A	3.3	A
		WB - Campground Rd	0.0	A	0.0	A
		SB - Catawba Burris Rd	20.4	C	15.2	C

Unacceptable delay

A Queue Analysis was performed at the study area intersections. The purpose of the Queue Analysis is to evaluate the adequacy of turn lanes by comparing the existing turn bay storage lengths to the 95% queues predicted in the Synchro traffic model and the maximum queue predicted in the SimTraffic simulations. The eastbound/westbound TWLT lane between the intersections of NC 16 Bus at Campground Rd/Forney Hill Rd and NC 16 Bus at Will Proctor St/St. James Church Rd provides adequate storage capacity for both intersections. The northbound right-turn lane at the intersection of NC 16 Bus at Will Proctor St/St. James Church Rd might experience storage deficiencies during peak hours. It should be noted that the analysis does not allow right turn on red (RTOR) in accordance with NCDOT's traffic analysis guidelines, which may overestimate the queue lengths. Queue lengths are reported in the output files provided in Appendix E and displayed in Table 2.

Table 2: Queue Analysis – 2015 Existing Conditions

Intersection	Turn Lane {Future}		Storage Length (ft) {Future}	Existing (2015)			
				AM		PM	
				95th % Queue Length (ft)	Max Queue Length (ft)	95th % Queue Length (ft)	Max Queue Length (ft)
NC 16 Bus @ Campground Rd/Forney Hill Rd	signalized	EBL	110 {210}	30	68	41	107
		WBL	200 (TWLT)	m41	131	m32	128
NC 16 Bus @ Will Proctor St/St James Church Rd	signalized	EBL	200 (TWLT)	m11	75	m5	34
		NBR	90	81	125	101	202

Queue length greater than storage length

m: queue is metered by upstream signal

#: volume exceeds capacity

2021 NO-BUILD ANALYSIS

The proposed single family subdivision is scheduled to be completed in 2020. The No Build analysis was performed for one year past build-out (2021). This provides a fair comparison to the Build Conditions with full capacity and "normalized" traffic patterns. An annual growth rate of 2% was applied to the existing (2015) traffic volumes to estimate the future (2021) background traffic volumes. After discussions with the County and NCDOT, it was determined that no other approved developments in the vicinity area or any committed transportation improvements will affect the traffic conditions during the 2021 analysis year. Traffic volumes for the 2021 No-Build Analyses are shown in Figures 5. The results of the 2021 No-Build analyses are displayed in Table 3.

Table 3: Level of Service Analysis – 2021 No-Build

Intersection	Approach		No Build (2021)			
			AM		PM	
			Delay (sec)	LOS	Delay (sec)	LOS
NC 16 Bus @ Campground Rd/Forney Hill Rd	signalized	Intersection Average	**23.9**	**C**	**28.1**	**C**
		EB - NC 16 Bus	13.0	B	19.1	B
		WB - NC 16 Bus	16.3	B	22.0	C
		NB - Forney Hill Rd	28.6	C	30.8	C
		SB - Campground Rd	47.9	D	60.2	E
NC 16 Bus @ Will Proctor St/St James Church Rd	signalized	Intersection Average	**25.2**	**C**	**23.8**	**C**
		EB - NC 16 Bus	25.9	C	18.4	B
		WB - NC 16 Bus	17.7	B	19.5	B
		NB - St James Church Rd	26.7	C	33.8	C
		SB - Will Proctor St	36.8	D	38.1	D
Campground Rd @ Will Proctor St/Rock Spring Campground Driveway	unsignalized	EB - Driveway	37.2	E	42.9	E
		WB - Will Proctor St	11.0	B	15.6	C
		NB - Campground Rd	0.1	A	0.0	A
		SB - Campground Rd	5.6	A	3.9	A
Campground Rd @ Catawba Burris Rd	unsignalized	EB - Campground Rd	2.7	A	3.6	A
		WB - Campground Rd	0.0	A	0.0	A
		SB - Catawba Burris Rd	21.0	C	17.9	C

Unacceptable delay

Similar to the existing conditions, all four intersections are expected to operate at an overall acceptable LOS. The southbound approach at the intersection of NC 16 Bus and Campground Rd/Forney Hill Rd is expected to experience an increase in delays in both peak periods and operate at a LOS E with approximately 60 seconds of delay in the PM peak period. The eastbound approach at the intersection of Campground Rd and Will Proctor St/Rock Springs Campground driveway is expected to operate at LOS E in both peak periods. However the traffic volumes on this eastbound approach are expected to be no more than a few vehicles during typical weekday peak hours. The delay changes can be attributed to the background traffic growth as well as the PHF (0.90) changes.

A Queue Analysis was performed for 2021 No-Build Analysis. As shown in Table 4 below, the queue lengths are expected to increase at the intersection of NC 16 Bus and Campground Rd/Forney Hill Rd compared to the 2015 Existing Condition Analysis. The eastbound left-turn queue is expected to exceed the current storage capacity during the PM peak period. The TWLT between the intersections on NC 16 Bus is expected to continue providing adequate storage lengths for both intersections. The northbound right-turn queue length may exceed the existing storage capacity, based on the conservative queue analyses.

Table 4: Queue Analysis - 2021 No-Build

Intersection	Turn Lane {Future}		Storage Length (ft) {Future}	No Build (2021)			
				AM		PM	
				95th % Queue Length (ft)	Max Queue Length (ft)	95th % Queue Length (ft)	Max Queue Length (ft)
NC 16 Bus @ Campground Rd/Forney Hill Rd	signalized	EBL	110 {200}	31	109	131	194
		WBL	200 (TWLT)	m42	179	m38	224
NC 16 Bus @ Will Proctor St/St James Church Rd	signalized	EBL	200 (TWLT)	m12	71	m5	42
		NBR	90	94	133	122	204

Queue length greater than storage length
m: queue is metered by upstream signal
#: volume exceeds capacity

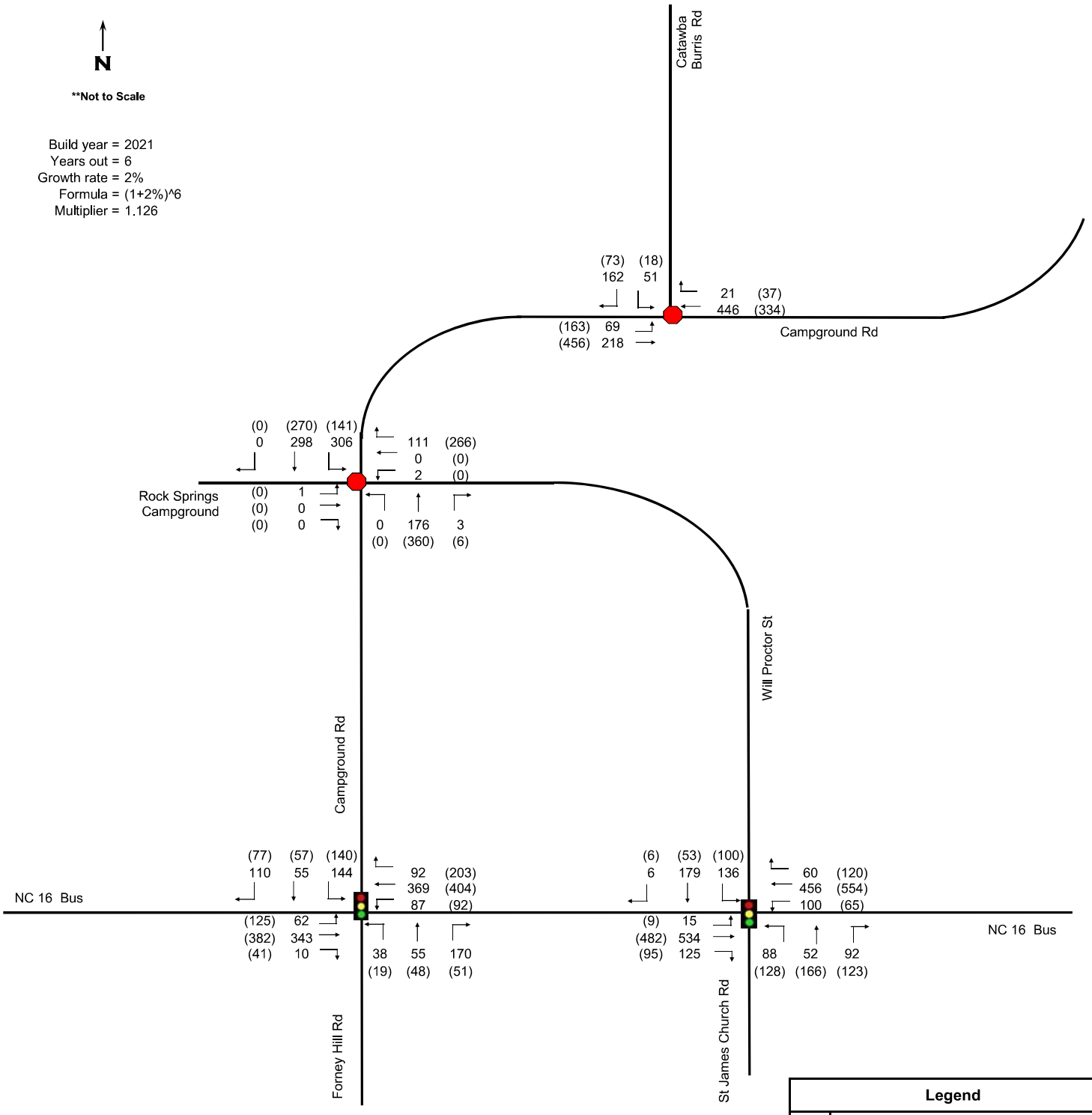

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Figure 5
2021 No Build Peak Hour Traffic Volumes

SITE TRIP GENERATION AND DISTRIBUTION

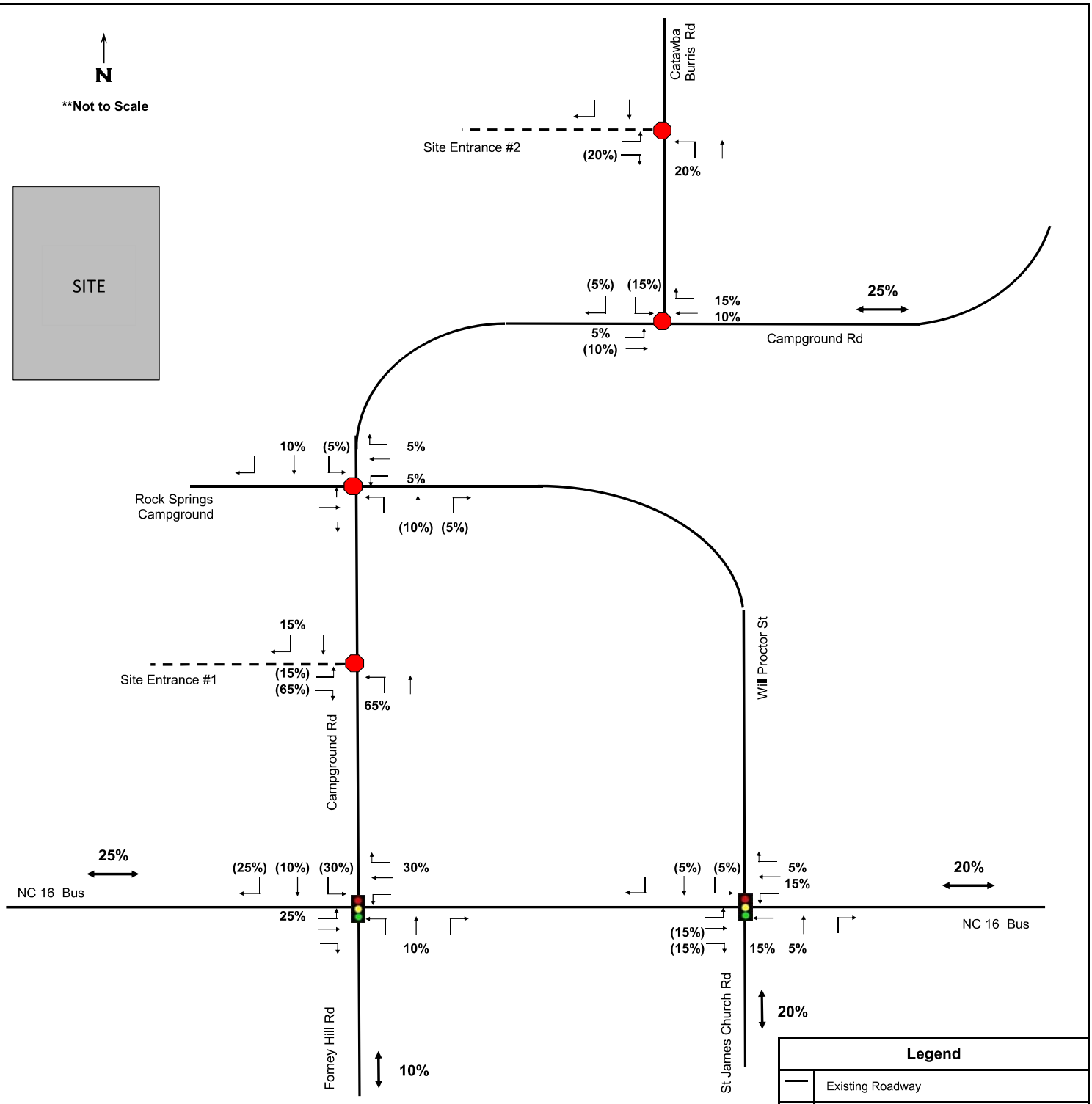
Table 5 depicts trip estimates for the proposed Rock Creek Subdivision. These values are based on calculations contained in the ITE *Trip Generation Manual*, 9th Edition, *ITE Trip Generation Handbook*, 2nd Edition, and guidance from the NCDOT Congestion Management Unit.

Table 5: Rock Creek Subdivision Trip Generation

ITE CODE	LAND USE	SIZE		Average Daily Trips (24 Hours)			AM Peak Hour (one hour between 7and 9am)			PM Peak Hour (one hour between 4 and 6pm)		
				Enter	Exit	Total	Enter	Exit	Total	Enter	Exit	Total
210	Single Family	150	DU	763	763	1,525	29	86	115	95	56	151

The proposed Rock Creek Subdivision is estimated to generate 1,525 daily trips. Out of that, 115 new trips (29 entering and 86 exiting) will be generated during the AM peak hour and 151 new trips (95 entering and 56 exiting) will be generated during the PM peak hour.

The site trips were distributed through the study area intersections based on the existing traffic patterns, traffic volumes, and engineering judgment. It is estimated that 25% of the site traffic will head north on Campground Rd, 25% will heard north on NC 16 Bus via Campground Rd, 20% will head south on NC 16 Bus via Campground Rd and Will Proctor St, 10% will head south on Forney Hill Rd towards NC 16, and the remaining 20% will head south on St James Church Rd towards NC 16. Ingress trips are expected the follow similar travel patterns. Figures 6 and 7 illustrate the site trip distribution patterns and peak hour site trips for the proposed Rock Creek Subdivision. The site trips were computed by multiplying site trip distribution percentages by the peak hour site trip estimates.



Legend	
—	Existing Roadway
- -	Proposed Roadway
	Signalized Intersection
	Unsignalized Intersection
XX	Peak Hour Ingress Site Trip Distribution
(XX)	Peak Hour Egress Site Trip Distribution

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Figure 6
Site Trip Distribution

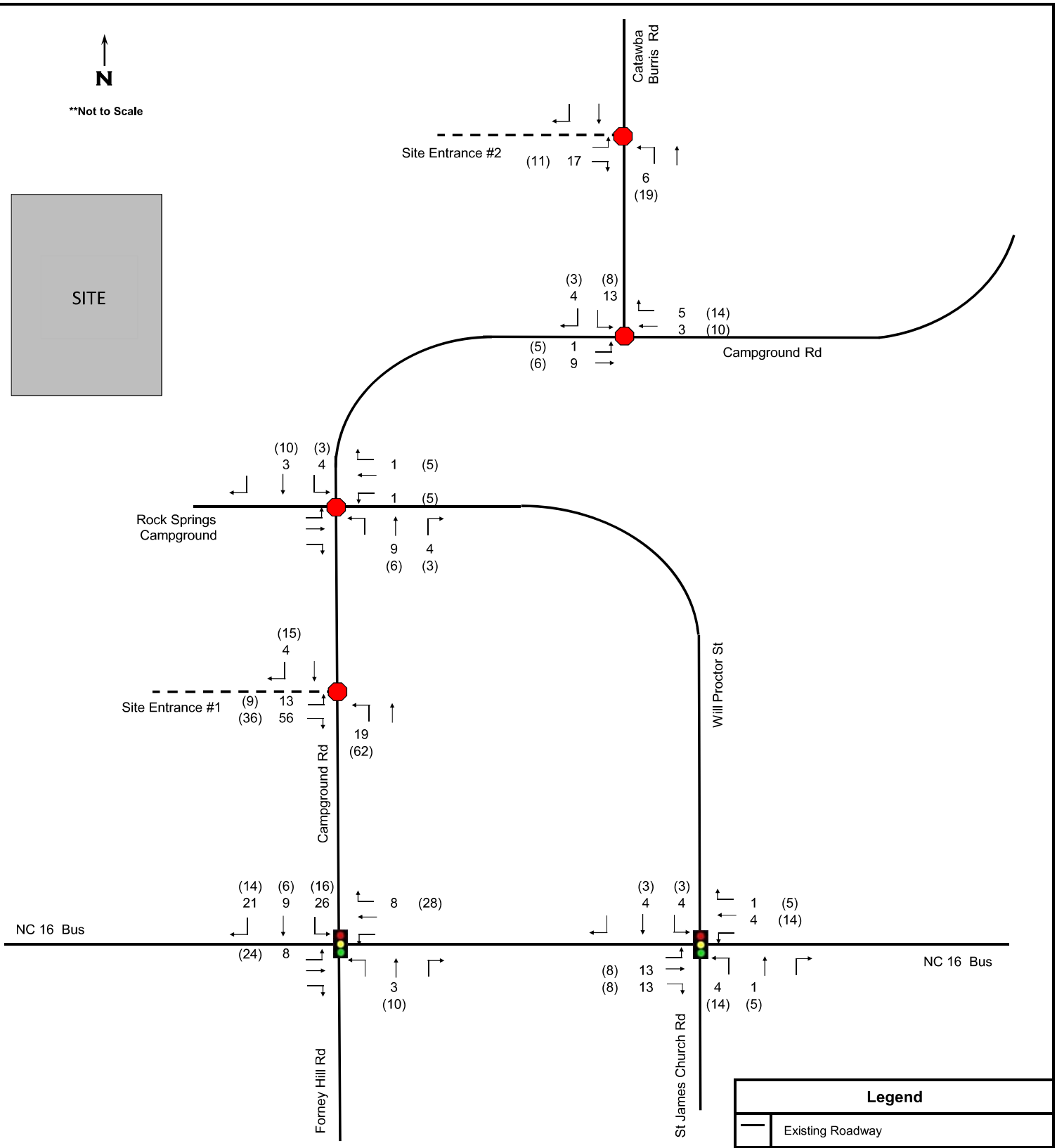

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Figure 7
Site Peak Hour Trips

SITE ACCESS

The new Rock Creek development is proposed to have two full access points, one on Campground Rd approximately 600 feet south of the intersection at Will Proctor St, and one e on Catawba Burris Rd approximately 1,000 feet north of the intersection at Campground Rd. Should these proposed access points change, additional analysis may be required.

2021 BUILD ANALYSIS

The 2021 Build Analysis adds the site trips to the background traffic used in the 2021 No-Build Analysis. Figure 8 shows the 2021 Build traffic volumes for the AM and PM peak hour conditions. LOS results for the 2021 Build Analysis are shown below in Table 6.

Table 6: Level of Service Analysis - 2021 Build

Intersection	Approach		Build (2021)			
			AM		PM	
			Delay (sec)	LOS	Delay (sec)	LOS
NC 16 Bus @ Campground Rd/Forney Hill Rd	signalized	Intersection Average	**31.8**	**C**	**37.0**	**D**
		EB - NC 16 Bus	12.7	B	21.4	C
		WB - NC 16 Bus	16.5	B	27.0	C
		NB - Forney Hill Rd	29.6	C	31.9	C
		SB - Campground Rd	79.0	E	91.5	F
NC 16 Bus @ Will Proctor St/St James Church Rd	signalized	Intersection Average	**27.5**	**C**	**25.2**	**C**
		EB - NC 16 Bus	29.7	C	18.2	B
		WB - NC 16 Bus	18.7	B	19.2	B
		NB - St James Church Rd	28.0	C	37.5	D
		SB - Will Proctor St	39.1	D	46.3	D
Campground Rd @ Will Proctor St/Rock Spring Campground Driveway	unsignalized	EB - Driveway	38.8	E	45.7	E
		WB - Will Proctor St	11.5	B	17.1	C
		NB - Campground Rd	0.1	A	0.0	A
		SB - Campground Rd	5.7	A	4.0	A
Campground Rd @ Catawba Burris Rd	unsignalized	EB - Campground Rd	2.6	A	3.8	A
		WB - Campground Rd	0.0	A	0.0	A
		SB - Catawba Burris Rd	24.2	C	22.5	C
Campground Rd @ Site Entrance #1	unsignalized	EB - Site Entrance #1	11.3	B	11.8	B
		NB - Campground Rd	0.9	A	1.7	A
		SB - Campground Rd	0.0	A	0.0	A
Catawba Burris Rd @ Site Entrance #2	unsignalized	EB - Site Entrance #2	9.7	A	9.0	A
		NB - Catawba Burris Rd	0.5	A	0.8	A
		SB - Catawba Burris Rd	0.0	A	0.0	A

Unacceptable delay

Similar to the 2021 No-Build Conditions, all the study intersections including the two proposed site entrance intersections are expected to operate at an overall acceptable LOS. The intersection of NC 16 Bus and Campground Rd/Forney Hill Rd is expected to experience increased delays resulting in a drop in overall LOS (from C to D) in the PM peak period. The eastbound approach is expected to experience a

2.3-second increase in delay resulting in a drop in LOS from a LOS B to a LOS C in the PM peak period. The southbound approach is expected to experience a 65% and 52% increase in delays in the AM and PM peak periods, respectively. This results a degradation of LOS from a LOS D to a LOS E in the AM peak period and from a LOS E to a LOS F in the PM peak period. The intersection of NC 16 Bus and Will Proctor St/St. James Church Rd is expected to maintain the No Build traffic operations performance with minimal delay increases on all four approaches.

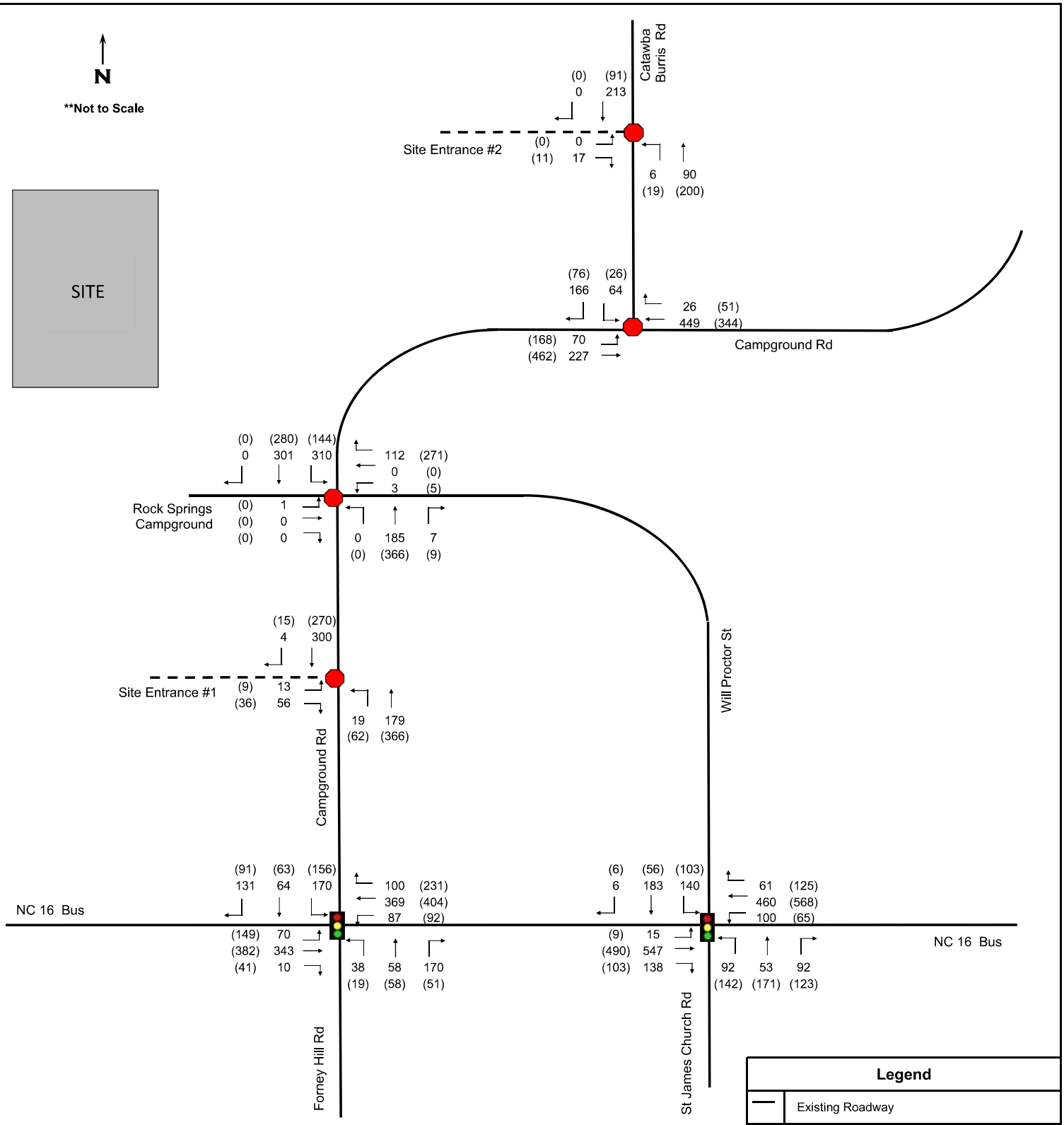
A Queue Analysis was also performed for 2021 Build Analysis. The queue lengths for the turn lanes are similar to those in the 2021 No-Build conditions.

Table 7 summarizes the 2021 Build Condition queue analysis results.

Table 7: Queue Analysis - 2021 Build

Intersection	Turn Lane {Future}		Storage Length (ft) {Future}	Build (2021)			
				AM		PM	
				95th % Queue Length (ft)	Max Queue Length (ft)	95th % Queue Length (ft)	Max Queue Length (ft)
NC 16 Bus @ Campground Rd/Forney Hill Rd	signalized	EBL	110 {200}	33	105	153	195
		WBL	200 (TWLT)	m42	215	m37	224
NC 16 Bus @ Will Proctor St/St James Church Rd	signalized	EBL	200 (TWLT)	m0	49	m5	59
		NBR	90	94	136	122	205

Queue length greater than storage length
m: queue is metered by upstream signal
#: volume exceeds capacity



Legend	
—	Existing Roadway
- -	Proposed Roadway
	Signalized Intersection
	Unsignalized Intersection
XX	AM Peak Hour Traffic Volume
(XX)	PM Peak Hour Traffic Volume

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Figure 8
2021 Build Peak Hour
Traffic Volumes

2021 BUILD WITH IMPROVEMENTS ANALYSIS

NCDOT requires improvements to the roadway network if any of the following conditions exist:

1. The average delay at an intersection or individual approach increases by 25% or greater, or:
2. The Level of Service degrades by at least one level, while comparing the 2021 No-Build results to 2021 Build results.
3. Level of Service is "F".

In addition, NCDOT's *Policy on Street and Driveway Access to North Carolina Highway* specifies left-turn and right-turn lane warrants based on conflicting traffic volumes. Based on the LOS and queue analysis results as well as the turn lane warrant guidelines, the following improvements are recommended to mitigate the degradation of traffic operations:

Proposed Improvements by Developer:

NC 16 Bus and Campground Rd/ Forney Hill Rd

- Construct a southbound right-turn lane with 200' of storage and appropriate taper.
- Extend the eastbound left-turn lane by 90' to provide 200' of storage and appropriate taper.
- Signal upgrade to accommodate the proposed lane configurations, including an overlap phase for the southbound right-turn lane.

Campground Rd/Site Entrance #1

- Construct a northbound left-turn lane on Campground Rd with 100' of storage and appropriate taper.

The proposed turn lane improvements will help to separate the left-turn and right-turn vehicles from the through traffic streams, prevent possible through lane blockages caused by turning vehicles, and therefore improve the traffic operations and safety performance. Tables 8 and 9 summarize the LOS and queue analysis of the 2021 Build with Improvements Scenario. The analysis output reports, including the queue reports, are included in Appendix E.

With the proposed improvements in place, all intersections are expected to operate at an overall acceptable LOS for both peak periods. When compared to the 2021 No Build Conditions, the intersection of NC 16 Bus at Campground Rd/Forney Hill Rd is expected to have overall similar

traffic operations performance. The southbound approach is still expected to experience a small increase in delays in the AM peak period, while the PM peak period is expected to experience a decrease in delays.

Table 8: Level of Service Analysis - 2021 Build with Improvements

Intersection	Approach		Build (2021) with Improvements			
			AM		PM	
			Delay (sec)	LOS	Delay (sec)	LOS
NC 16 Bus @ Campground Rd/Forney Hill Rd	signalized	Intersection Average	**28.1**	**C**	**29.1**	**C**
		EB - NC 16 Bus	11.6	B	23.0	C
		WB - NC 16 Bus	22.0	C	21.2	C
		NB - Forney Hill Rd	33.1	C	33.7	C
		SB - Campground Rd	52.7	D	57.0	E
NC 16 Bus @ Will Proctor St/St James Church Rd	signalized	Intersection Average	**21.7**	**C**	**24.5**	**C**
		EB - NC 16 Bus	16.5	B	15.7	B
		WB - NC 16 Bus	18.7	B	19.3	B
		NB - St James Church Rd	20.8	C	37.5	D
		SB - Will Proctor St	39.1	D	45.9	D
Campground Rd @ Will Proctor St/Rock Spring Campground Driveway	unsignalized	EB - Driveway	38.8	E	45.7	E
		WB - Will Proctor St	11.5	B	17.1	C
		NB - Campground Rd	0.1	A	0.0	A
		SB - Campground Rd	5.7	A	4.0	A
Campground Rd @ Catawba Burris Rd	unsignalized	EB - Campground Rd	2.6	A	3.8	A
		WB - Campground Rd	0.0	A	0.0	A
		SB - Catawba Burris Rd	24.2	C	22.5	C
Campground Rd @ Site Entrance #1	unsignalized	EB - Site Entrance #1	11.3	B	11.8	B
		NB - Campground Rd	0.8	A	1.2	A
		SB - Campground Rd	0.0	A	0.0	A
Catawba Burris Rd @ Site Entrance #2	unsignalized	EB - Site Entrance #2	9.7	A	9.0	A
		NB - Catawba Burris Rd	0.5	A	0.8	A
		SB - Catawba Burris Rd	0.0	A	0.0	A

Unacceptable delay

The queue analysis of the 2021 Build with improvements shows similar queues at the intersection of NC 16 Bus and Will Proctor St/St. James Church Rd when compared to the previous scenario. The TWLT between the signalized intersections on NC 16 Bus is still expected to provide adequate storage lengths for both intersections. The eastbound approach at the intersection of NC 16 Bus and Campground Rd/Forney Hill Rd is expected to experience a small increase in queue lengths, but this is unlikely to exceed the current TWLT lane storage capacity. The max queue length estimates for the southbound Campground Rd approach appear to be skewed (overestimated) by adjacent through/left-turn volumes, as the queuing and blocking report shows there are little to no queuing penalties or vehicle blockage.

Table 9: Queue Analysis - 2021 Build with Improvements

Intersection	Turn Lane {Future}		Storage Length (ft) {Future}	Build (2021) with Improvements			
				AM		PM	
				95th % Queue Length (ft)	Max Queue Length (ft)	95th % Queue Length (ft)	Max Queue Length (ft)
NC 16 Bus @ Campground Rd/Forney Hill Rd	signalized	EBL	110 {200}	41	98	#182	169
		WBL	200 (TWLT)	m86	219	m44	224
		SBR	{200}	84	223*	68	238*
NC 16 Bus @ Will Proctor St/St James Church Rd	signalized	EBL	200 (TWLT)	m3	99	m44	36
		NBR	90	40	129	122	205
Campground Rd @ Site Entrance 1	unsignalized	NBL	{100}	1	33	4	49

Queue length greater than storage length

m: queue is metered by upstream signal

#: volume exceeds capacity

*: no queuing or blocking

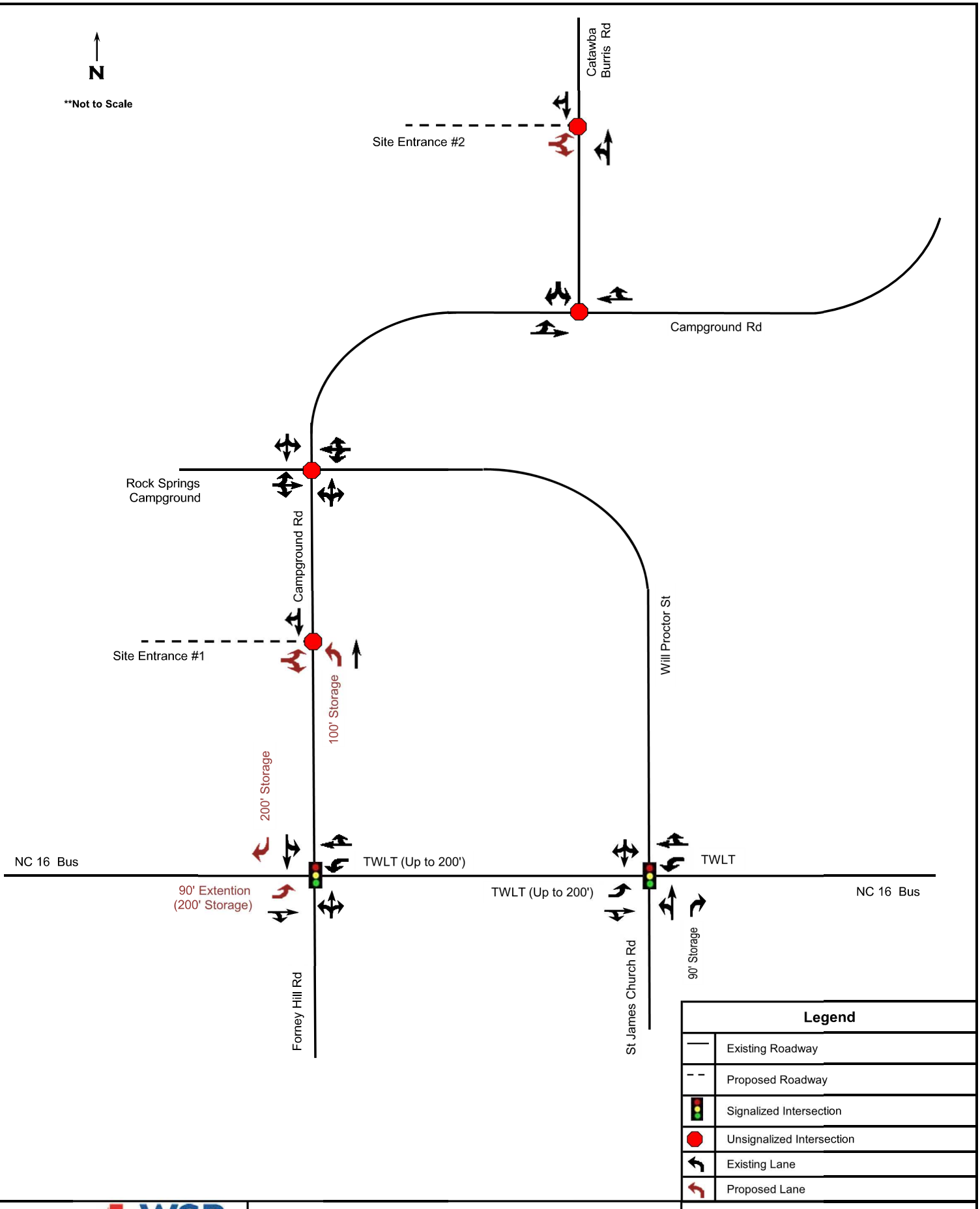

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Figure 9
2021 Build Lane Configuration

CONCLUSIONS

The proposed Rock Creek Subdivision is estimated to generate 1,525 daily trips, including 115 new trips during the AM peak hour and 151 new trips during the PM peak hour.

The existing study intersections are all operating at an overall acceptable LOS. With the completion of Rock Creek Subdivision (2021 Build conditions), some study intersections or intersection approaches will experience increased delays and a lower LOS compared to the 2021 No-Build conditions. The following improvements are recommended to be implemented upon the completion of the proposed development to provide similar or better traffic operational performance as the 2021 No Build Conditions.

Proposed Improvements by Developer:

NC 16 Bus and Campground Rd/ Forney Hill Rd

- Construct a southbound right-turn lane with 200' of storage and appropriate taper.
- Extend the eastbound left-turn lane by 90' to provide 200' of storage and appropriate taper.
- Signal upgrade to accommodate the proposed lane configurations, including an overlap phase for the southbound right-turn lane.

Campground Rd/Site Entrance #1

- Construct a northbound left-turn lane on Campground Rd with 100' of storage and appropriate taper.

The proposed turn lane improvements will help to separate the left-turn and right-turn vehicles from the through traffic streams, prevent possible through lane blockages caused by turning vehicles, and therefore improve the traffic operations and safety performance. It is concluded that the proposed improvements will provide additional capacity to accommodate the site traffic, and maintain the No Build traffic operations performance in the study area upon site build-out.

It is noted that there is no clear public right-of-way at the NC 16 Bus and Campground Rd/ Forney Hill Rd intersection. If the right-of-way for the proposed intersection improvements can not be reasonably obtained, it might be appropriate for the proposed development to contribute towards other transportation improvement measures determined by NCDOT and the County.

Table 10 summarizes the LOS and queue analysis results for this traffic impact analysis.

Table 10: Traffic Analysis Result Summary

Intersection	Approach		Existing (2015)				No Build (2021)				Build (2021)				Build (2021) with Improvements			
			AM		PM		AM		PM		AM		PM		AM		PM	
			Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS
NC 16 Bus @ Campground Rd/Forney Hill Rd	signalized	Intersection Average	**21.4**	**C**	**20.1**	**C**	**23.9**	**C**	**28.1**	**C**	**31.8**	**C**	**37.0**	**D**	**28.1**	**C**	**29.1**	**C**
		EB - NC 16 Bus	13.9	B	9.7	A	13.0	B	19.1	B	12.7	B	21.4	C	11.6	B	23.0	C
		WB - NC 16 Bus	19.0	B	14.8	B	16.3	B	22.0	C	16.5	B	27.0	C	22.0	C	21.2	C
		NB - Forney Hill Rd	25.6	C	28.8	C	28.6	C	30.8	C	29.6	C	31.9	C	33.1	C	33.7	C
		SB - Campground Rd	33.0	C	48.3	D	47.9	D	60.2	E	79.0	E	91.5	F	52.7	D	57.0	E
NC 16 Bus @ Will Proctor St/St James Church Rd	signalized	Intersection Average	**21.4**	**C**	**19.9**	**B**	**25.2**	**C**	**23.8**	**C**	**27.5**	**C**	**25.2**	**C**	**21.7**	**C**	**24.5**	**C**
		EB - NC 16 Bus	18.1	B	14.2	B	25.9	C	18.4	B	29.7	C	18.2	B	16.5	B	15.7	B
		WB - NC 16 Bus	12.8	B	16.5	B	17.7	B	19.5	B	18.7	B	19.2	B	18.7	B	19.3	B
		NB - St James Church Rd	28.3	C	29.1	C	26.7	C	33.8	C	28.0	C	37.5	D	20.8	C	37.5	D
		SB - Will Proctor St	39.7	D	29.9	C	36.8	D	38.1	D	39.1	D	46.3	D	39.1	D	45.9	D
Campground Rd @ Will Proctor St/Rock Spring Campground Driveway	unsignalized	EB - Driveway	33.4	D	32.2	D	37.2	E	42.9	E	38.8	E	45.7	E	38.8	E	45.7	E
		WB - Will Proctor St	11.4	B	13.8	B	11.0	B	15.6	C	11.5	B	17.1	C	11.5	B	17.1	C
		NB - Campground Rd	0.1	A	0.0	A	0.1	A	0.0	A	0.1	A	0.0	A	0.1	A	0.0	A
		SB - Campground Rd	5.5	A	3.7	A	5.6	A	3.9	A	5.7	A	4.0	A	5.7	A	4.0	A
Campground Rd @ Catawba Burris Rd	unsignalized	EB - Campground Rd	2.7	A	3.3	A	2.7	A	3.6	A	2.6	A	3.8	A	2.6	A	3.8	A
		WB - Campground Rd	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A	0.0	A
		SB - Catawba Burris Rd	20.4	C	15.2	C	21.0	C	17.9	C	24.2	C	22.5	C	24.2	C	22.5	C
Campground Rd @ Site Entrance #1	unsignalized	EB - Site Entrance #1									11.3	B	11.8	B	11.3	B	11.8	B
		NB - Campground Rd									0.9	A	1.7	A	0.8	A	1.2	A
		SB - Campground Rd									0.0	A	0.0	A	0.0	A	0.0	A
Catawba Burris Rd @ Site Entrance #2	unsignalized	EB - Site Entrance #2									9.7	A	9.0	A	9.7	A	9.0	A
		NB - Catawba Burris Rd									0.5	A	0.8	A	0.5	A	0.8	A
		SB - Catawba Burris Rd									0.0	A	0.0	A	0.0	A	0.0	A

Unacceptable delay

Intersection	Turn Lane {Future}		Storage Length (ft) {Future}	Existing (2015)				No Build (2021)				Build (2021)				Build (2021) with Improvements			
				AM		PM		AM		PM		AM		PM		AM		PM	
				95th % Queue Length (ft)	Max Queue Length (ft)	95th % Queue Length (ft)	Max Queue Length (ft)	95th % Queue Length (ft)	Max Queue Length (ft)	95th % Queue Length (ft)	Max Queue Length (ft)	95th % Queue Length (ft)	Max Queue Length (ft)	95th % Queue Length (ft)	Max Queue Length (ft)	95th % Queue Length (ft)	Max Queue Length (ft)	95th % Queue Length (ft)	Max Queue Length (ft)
NC 16 Bus @ Campground Rd/Forney Hill Rd	signalized	EBL	110 {200}	30	68	41	107	31	109	131	194	33	105	153	195	41	98	#182	169
		WBL	200 (TWLT)	m41	131	m32	128	m42	179	m38	224	m42	215	m37	224	m86	219	m44	224
		SBR	{200}													84	223*	68	238*
NC 16 Bus @ Will Proctor St/St James Church Rd	signalized	EBL	200 (TWLT)	m11	75	m5	34	m12	71	m5	42	m0	49	m5	59	m3	99	m44	36
		NBR	90	81	125	101	202	94	133	122	204	94	136	122	205	40	129	122	205
Campground Rd @ Site Entrance 1	unsignalized	NBL	{100}													1	33	4	49

Queue length greater than storage length
m: queue is metered by upstream signal
#: volume exceeds capacity
*: no queuing or blocking