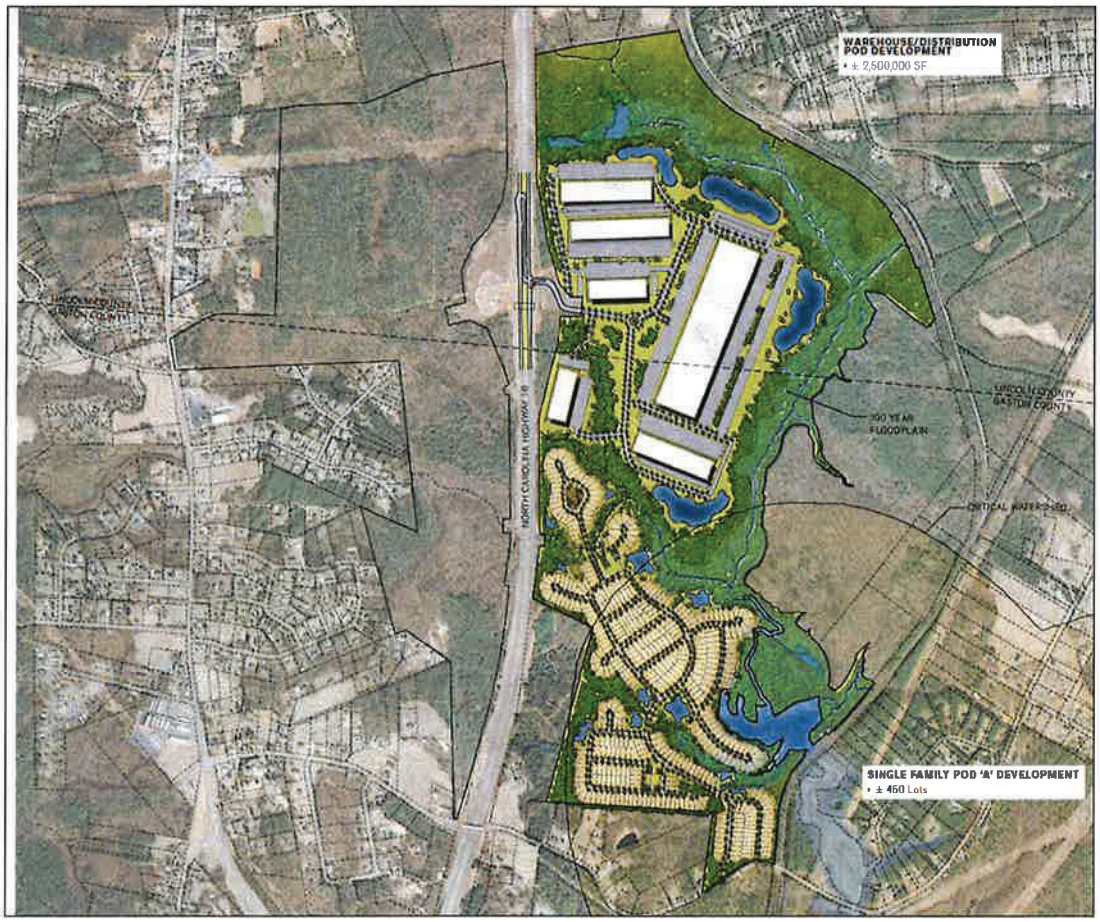
DESIGN RESOURCE GROUP

TRAFFIC IMPACT ANALYSIS

RIVERBEND PRESERVE

North of Killian Road and East of NC 16

Gaston and Lincoln County, North Carolina



for

The Shaw Tate Group

August 2019

811-001 (C-2165)

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NORTH CAROLINA PROFESSIONAL SEAL 16315 ENGINEER RANDY E. GODDARD

Randy E. Goddard

Aug. 23, 2019

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EXECUTIVE SUMMARY

The Shaw Tate Group proposes to develop a site with the following land uses:

- 2,500,000 square feet of Warehousing
- 450 Single-Family Homes

The proposed site is located north of Killian Road and east of NC 16 within both Gaston and Lincoln Counties, NC (see Figure 1). The development is expected to be completed in 2024.

NC 16 Facing north towards Proposed Site

This report provides analysis of the traffic operations within the area of influence, according to the standards set by the North Carolina Department of Transportation's (NCDOT) "Policy on Street and Driveway Access to North Carolina Highways, Chapter 4 Part C", Lincoln County Unified Development Ordinance (UDO) Section 9.8 and Gaston County's UDO Section 5.11. It provides intersection improvements needed for mitigating traffic impacts. This study evaluates the following scenarios:

- 2019 Existing Conditions
- 2024 No Build Conditions
- 2024 Build-out Conditions
- 2034 Build-out + 10 years Conditions (Lincoln Co. Requirement)

The area of influence of the site as defined by North Carolina Department of Transportation (NCDOT), Lincoln County, and Gaston County staff includes the following two existing intersections and four proposed intersections: (See Appendix 1 for the approved scoping information)

1. Killian Road & NC 16 Business (signalized)
2. Lucia Riverbend Highway & NC 16 Business (signalized)
3. NC 16 & Proposed Warehouse Access "A" (unsignalized Cross-Over)
4. Killian Road & Proposed Residential Access "B" (unsignalized)
5. Killian Road & Proposed Residential Access "C" (unsignalized)
6. NC 16 & Proposed Northbound U-Turn Bulb-Out (unsignalized)

According to the preliminary site plan (Concept Exhibit), access to the warehouse is expected to occur via one unsignalized directional cross-over (X-Over) on NC 16 (at a previously approved in control-of-access (C/A)) and access to the residential development is expected to occur via two full-movement unsignalized locations on Killian Road:

- Proposed Access "A" (X-Over): unsignalized access allowing for right-in/right-out and left-in movements located on NC 16 approximately 1 mile north of the Killian Road overpass.
- Proposed Access "B" (Full-Movement): unsignalized access allowing for full movement access located on Killian Road approximately 3,200 feet east of NC 16 overpass.
- Proposed Access "C" (Full-Movement): unsignalized access allowing for full movement located on Killian Road approximately 3,900 feet east of NC 16 overpass.

The trip generation results indicate that the development is expected to generate 652 total AM peak hour trips and 761 total PM peak hour trips.

With the results of our analyses (the specifics are described in the Traffic Analysis section of this report) we suggest the following improvements/modifications at the study intersections/ proposed accesses:

2024 Build Suggested Recommendations:

1. **Killian Road & NC 16 Business (signalized)**

- Construct a separate westbound right turn lane with 175' storage on Killian Road
- Remark the existing combined left-thru-right lane to a combined left-thru lane
- Extend southbound left turn lane storage to 125' on NC 16 Business

2. **Lucia Riverbend Highway & NC 16 Business (signalized)**

- Implement southbound right turn overlap phasing on NC 16 Business
- Extend eastbound right turn lane to 150' on Lucia Riverbend Highway

3. **NC 16 & Proposed Warehouse Access "A" (unsignalized)**

We propose the following intersection configuration:

- Convert NC 16 full median opening to a southbound directional X-over with a minimum storage of 150' (or as required to accommodate the appropriate design vehicles)
- Two ingress lanes and one egress lane (a terminating westbound right turn lane on Proposed Access "A")
- Channelized northbound right turn lane with 100' storage on NC 16
- Minimum internal protected stem of 500'

4. **Killian Road & Proposed Residential Access "B" (unsignalized)**

We propose the following intersection configuration:

- One ingress and two egress lanes (a terminating southbound right turn lane and left turn lane with 100' storage) on Proposed Access "B"
- Construct an eastbound left turn lane with 100' storage on Killian Road
- Minimum internal protected stem of 100'

5. **Killian Road & Proposed Residential Access "C" (unsignalized)**

We propose the following intersection configuration:

- One ingress and two egress lanes (a southbound right turn lane and left turn lane with 100' storage on Proposed Access "C")
- Construct an eastbound left turn lane with 100' storage on Killian Road
- Minimum internal protected stem of 100'

6. **NC 16 & Future U-Turn Bulb-Out (unsignalized)**

- Convert NC 16 full median opening to a northbound channelized U-turn lane with a minimum storage of 250' (or as required to accommodate the appropriate design vehicles)

In summary, even though the Riverbend Preserve development will increase the amount of vehicular and truck traffic on the adjacent roadways/corridors, the suggested intersection improvements/enhancements will help mitigate the additional site generated trips on the adjacent roadway network. In addition, the suggested recommendations will improve the conditions for the general traveling public as well as the users of the warehouse and the residents of the residential community.

PROPOSED DEVELOPMENT

The Shaw Tate Group proposes to develop a site with the following land uses:

- 2,500,000 square feet of Warehousing
- 450 Single-Family Homes

The proposed site is located north of Killian Road and east of NC 16 within both Gaston and Lincoln Counties, NC (see Figure 1). The development is expected to be completed in 2024.

NC 16 Facing north towards Proposed Site

According to the preliminary site plan (Concept Exhibit), access to the warehouse is expected to occur via one unsignalized directional cross-over (X-Over) on NC 16 (at a previously approved break in control-of-access (C/A)) and access to the residential development is expected to occur via two full-movement unsignalized locations on Killian Road:

- Proposed Access "A" (X-Over): unsignalized access allowing for right-in/right-out and left-in movements located on NC 16 approximately 1 mile north of the Killian Road overpass.
- Proposed Access "B" (Full-Movement): unsignalized access allowing for full movement access located on Killian Road approximately 3,200 feet east of NC 16 overpass.
- Proposed Access "C" (Full-Movement): unsignalized access allowing for full movement located on Killian Road approximately 3,900 feet east of NC 16 overpass.

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RIVERBEND PRESERVE

GASTON/ LINCOLN COUNTY, NC

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CHARLOTTE, NC 28203

AREA OF INFLUENCE

0 1,200' 2,400' N

SCALE: 1" = 2,400'

PROJECT #: 811-001
DRAWN BY: SA
CHECKED BY: MW

AUGUST 2019

REVISIONS:
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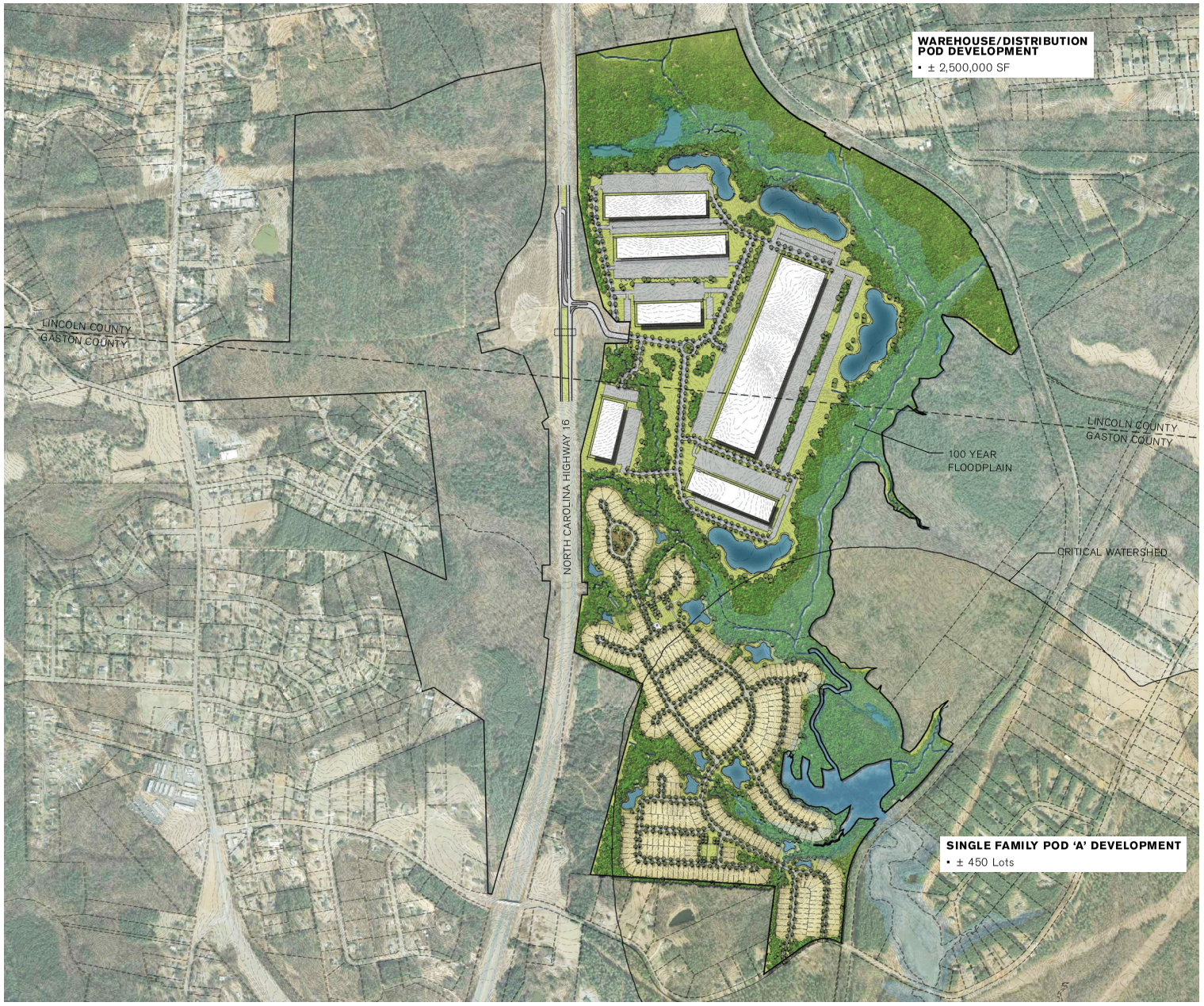
Figure 1



RIVERBEND PRESERVE GASTON/LINCOLN COUNTY, NC ▪ CONCEPT EXHIBIT

PN 1018503 | 06.13.2019

LandDesign

AREA CONDITIONS

The area of influence of the site as defined by North Carolina Department of Transportation (NCDOT) staff includes the following two existing intersections and four proposed intersections: (See Appendix 1 for the approved scoping information)

1. Killian Road & NC 16 Business (signalized)
2. Lucia Riverbend Highway & NC 16 Business (signalized)
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4. Killian Road & Proposed Residential Access “B” (unsignalized)
5. Killian Road & Proposed Residential Access “C” (unsignalized)
6. NC 16 & Proposed Northbound U-Turn Bulb-Out (unsignalized)

NC 16 Facing south towards Proposed Site

Killian Road Facing west towards Proposed Site

Morning (7:00-9:00 AM) and afternoon (4:00-6:00 PM) peak period turning movement counts (TMCs) were conducted at the existing two study intersections on Tuesday May 14, 2019. In addition, 24-hour tube counts were taken on Killian Road east of Stilwell Road, where the residential access points are anticipated. See Appendix 2 for raw count data sheets.

According to the latest NCDOT Roadway Functional Classification data, NC 16 is a Principal Arterial with a posted speed limit of 65 mph. The roadway is a two-lane median divided facility, with no bike lanes, curb/gutter, planting strip, or sidewalk present on either side of the roadway in the vicinity of the site.

Killian Road is a secondary route with a posted speed limit of 55 mph. The roadway is a one-lane undivided facility, with no bike lanes, curb/gutter, planting strip, or sidewalk present on either side of the roadway in the vicinity of the site.

In addition to the intersection TMCs, geospatial information provided by NCDOT’s ArcGIS portal (*Go! NC*), such as Annual average daily traffic (AADT) and crash data were collected.

AADT for two-way volumes on roadways within the area of influence are depicted in Table 1 based on latest 2016 data.

Table 1: Average Annual Daily Traffic Volumes (vehicles per day)

Roadway	AADT
NC 16 north of Killian Road	26,000
NC 16 Business south of NC 273	8,600
Lucia Riverbend Highway west of NC 16 Business	6,800
Killian Road east of NC 16 Business	1,100

Crash frequency per intersection is reported in Table 2 with data ranging from January 1, 2014 to December 31, 2018.

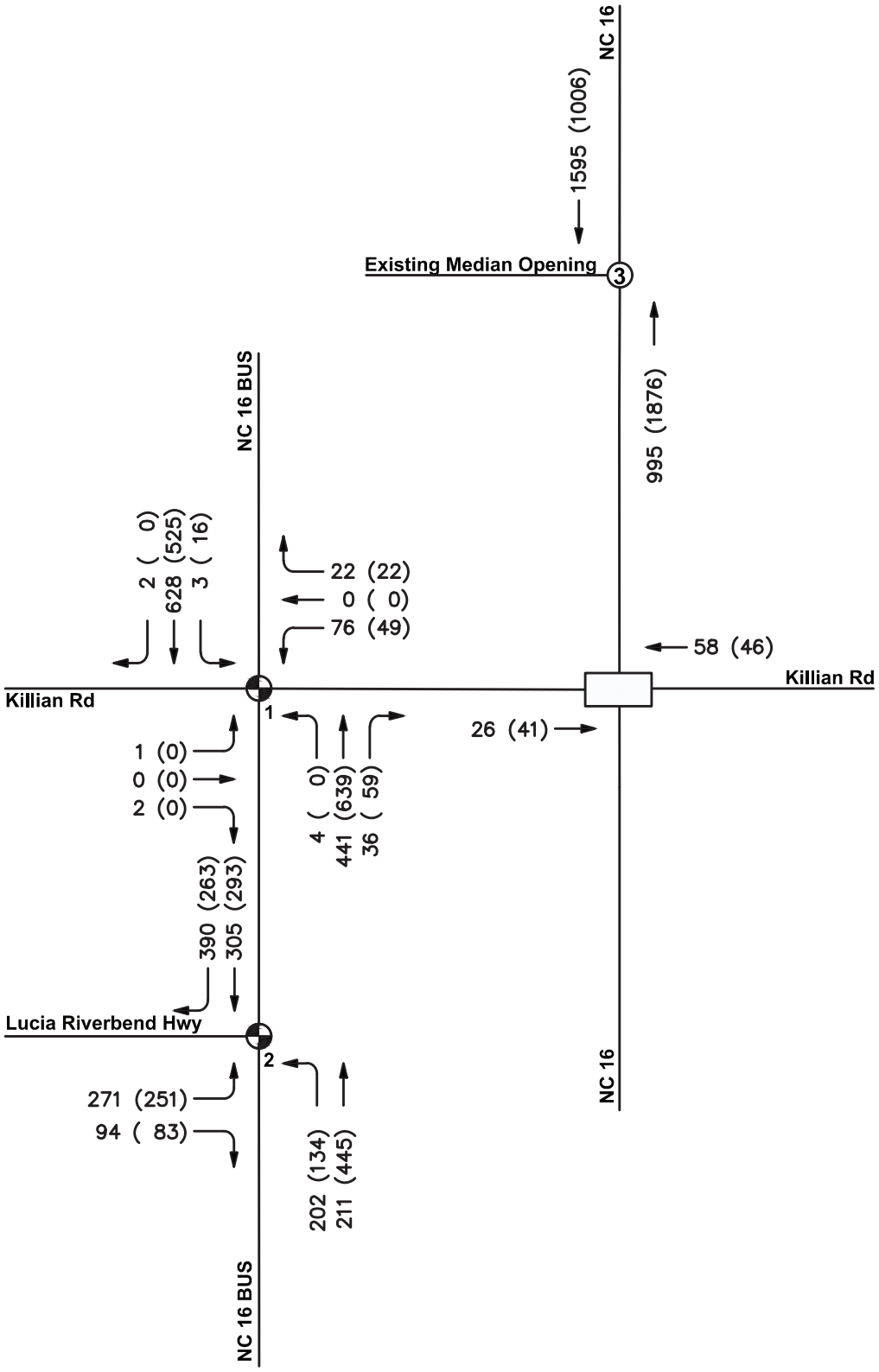
Table 2: Crash Data from 2014-2018

Intersection	Severity Type			Total Crashes
	K Injury	B & C Injury Crashes	PDO Crashes	
NC 16 Bus. & Lucia Riverbend Hwy.	**1**	**4**	**16**	**21**
Lucia Riverbend Hwy. & Stanley Lucia Rd.	**0**	**1**	**5**	**6**

Notes:
K: Fatality **B:** B injury type (evident), **C:** injury type (possible), **PDO:** Property Damage Only

Copies of the intersection investigation worksheets are in the Appendix 3 for further existing area conditions as reported in field analysis.

Figure 2 portrays the existing TMCs for the AM and PM peak hours. Figures 3A and 3B includes the directional distribution for the residential site and the warehousing site, respectively. These directional distribution percentages were approved by Division 12 District 3 and Lincoln County staff on June 4, 2019 and Gaston County staff on June 5, 2019 per existing traffic patterns.



Existing traffic volumes were collected on May 14, 2019.

VOLUMES: AM (PM)

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EXISTING PEAK HOUR TRAFFIC VOLUMES

0 NTS N

SCALE: NTS

PROJECT #: 811-001
DRAWN BY: SA
CHECKED BY: MW

AUGUST 2019

REVISIONS:
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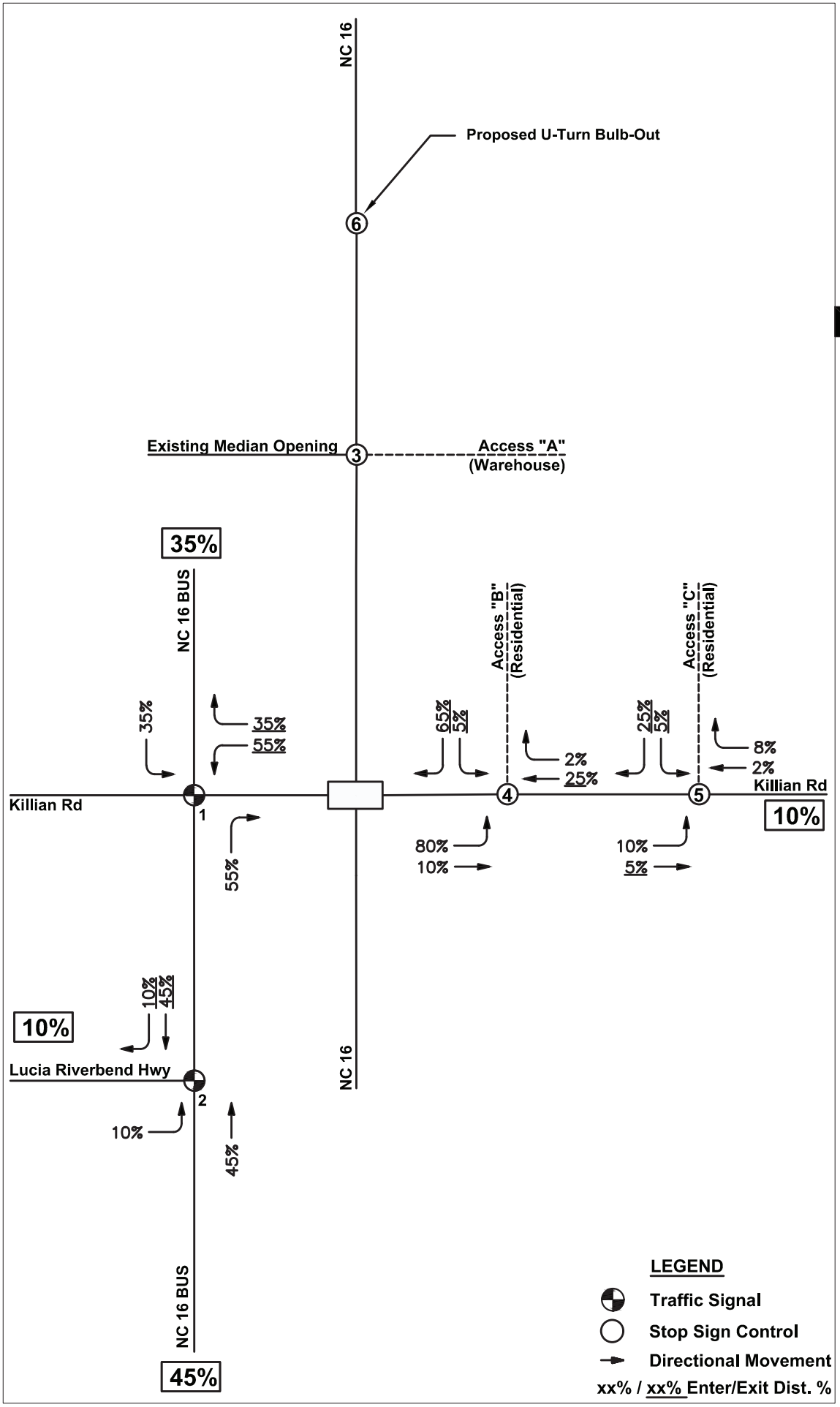
Figure 2



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RESIDENTIAL SITE DIRECTIONAL DISTRIBUTION

0 NTS
SCALE: NTS

PROJECT #: 811-001
DRAWN BY: SA
CHECKED BY: MW

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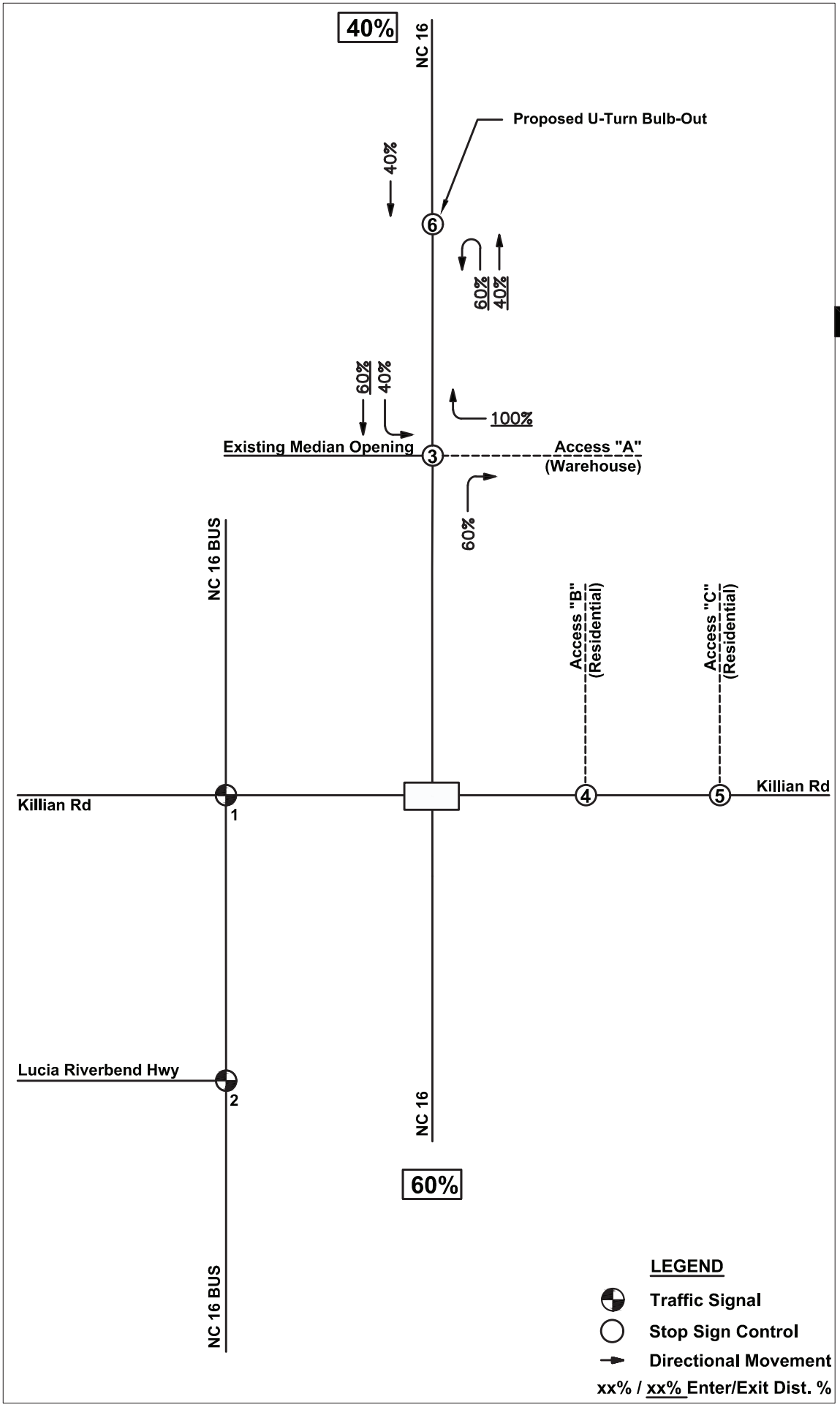
Figure 3A



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WAREHOUSE SITE DIRECTIONAL DISTRIBUTION

0 NTS
SCALE: NTS

PROJECT #: 811-001
DRAWN BY: SA
CHECKED BY: MW

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Figure 3B

PROJECTED TRAFFIC

The daily and peak-hour trip generation data for the site is presented in Table 3. Values derived for the anticipated trips generated by the site are obtained from the Institute of Transportation Engineers, Trip Generation Manual, 10th Edition, 2017.

Table 3: Trip Generation

Land Use [ITE Code]			Weekday Daily	AM Peak Hour			PM Peak Hour		
				Enter	Exit	Total	Enter	Exit	Total
Northeast									
Warehousing [150]	2,500,000	SF	3,996	251	75	326	89	240	329
Southeast									
Single Family Housing [210]	450	DU	4,149	82	244	326	272	160	432
Proposed Total			**8,145**	**333**	**319**	**652**	**361**	**400**	**761**

References:
Trip Generation, 10th Edition, Institute of Transportation Engineers, Washington, DC. 2017.

The trip generation results indicate that the development is expected to generate 652 total AM peak hour trips and 761 total PM peak hour trips.

The projected background traffic volumes used in the analyses were developed from the existing peak hour TMCs. Per NCDOT, a 1% per year growth rate was used for the 2024 background volumes. The No Build volumes for AM and PM peaks are presented in Figure 4.

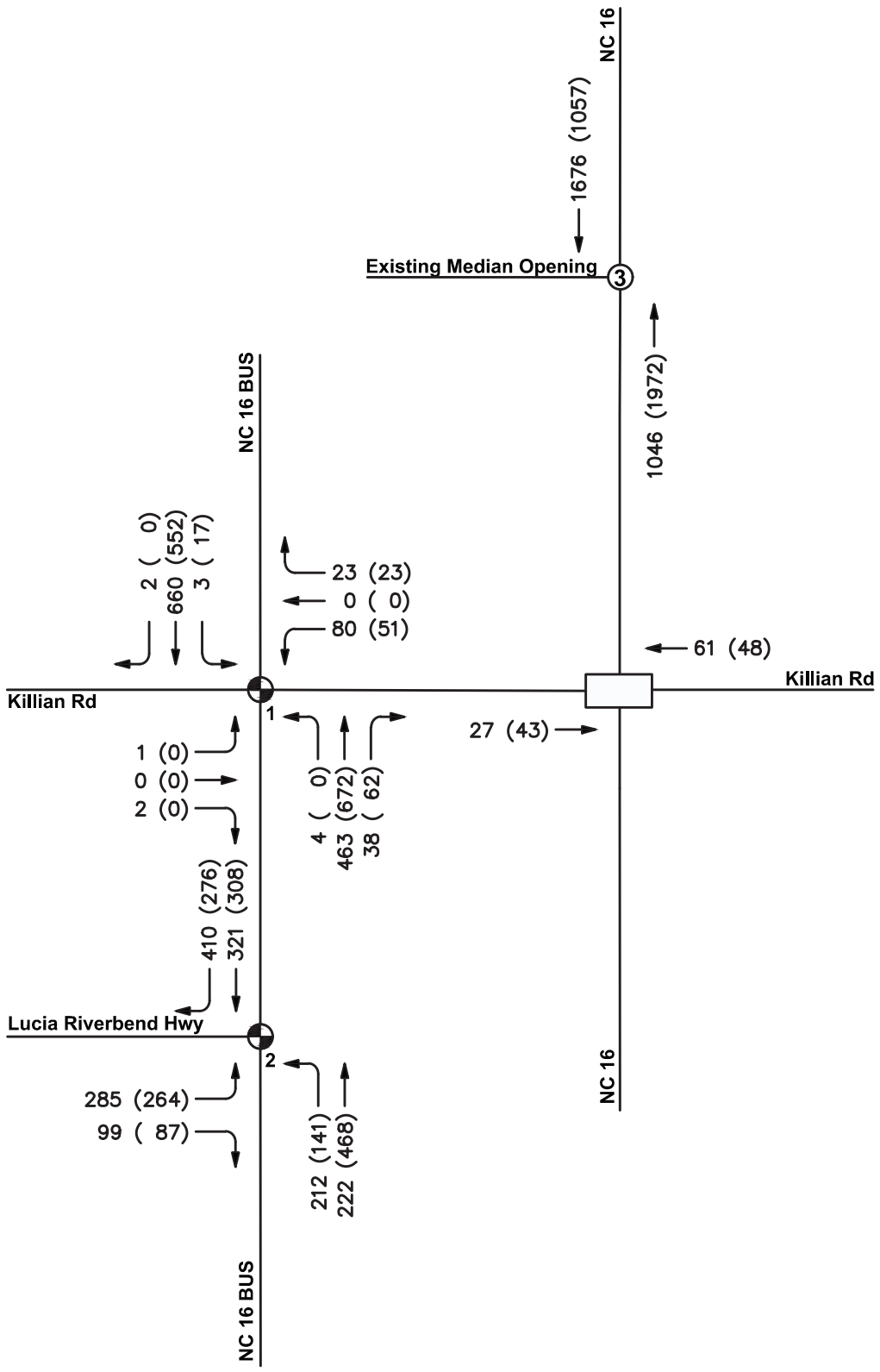
The trip assignments for the 2024 AM and PM peak hour Build traffic volumes are presented in Figures 5 and 6. The trip assignments for the 2034 (Build-out + 10 years per Lincoln County) AM and PM peak hour Build traffic volumes are presented in Figures 7 and 8, respectively. The background traffic is indicated to the far left of the movement arrows followed by the site traffic in parentheses. The two volumes are added to obtain the projected total traffic for that movement:

Background + (Site) = Total

LEGEND

- Traffic Signal
- Stop Sign Control
- Directional Movement

VOLUMES: AM (PM)



Existing count data were grown by a 1% compounded annual growth rate for No Build conditions.

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2024 NO BUILD PEAK HOUR TRAFFIC VOLUMES

0 NTS N

SCALE: NTS

PROJECT #: 811-001
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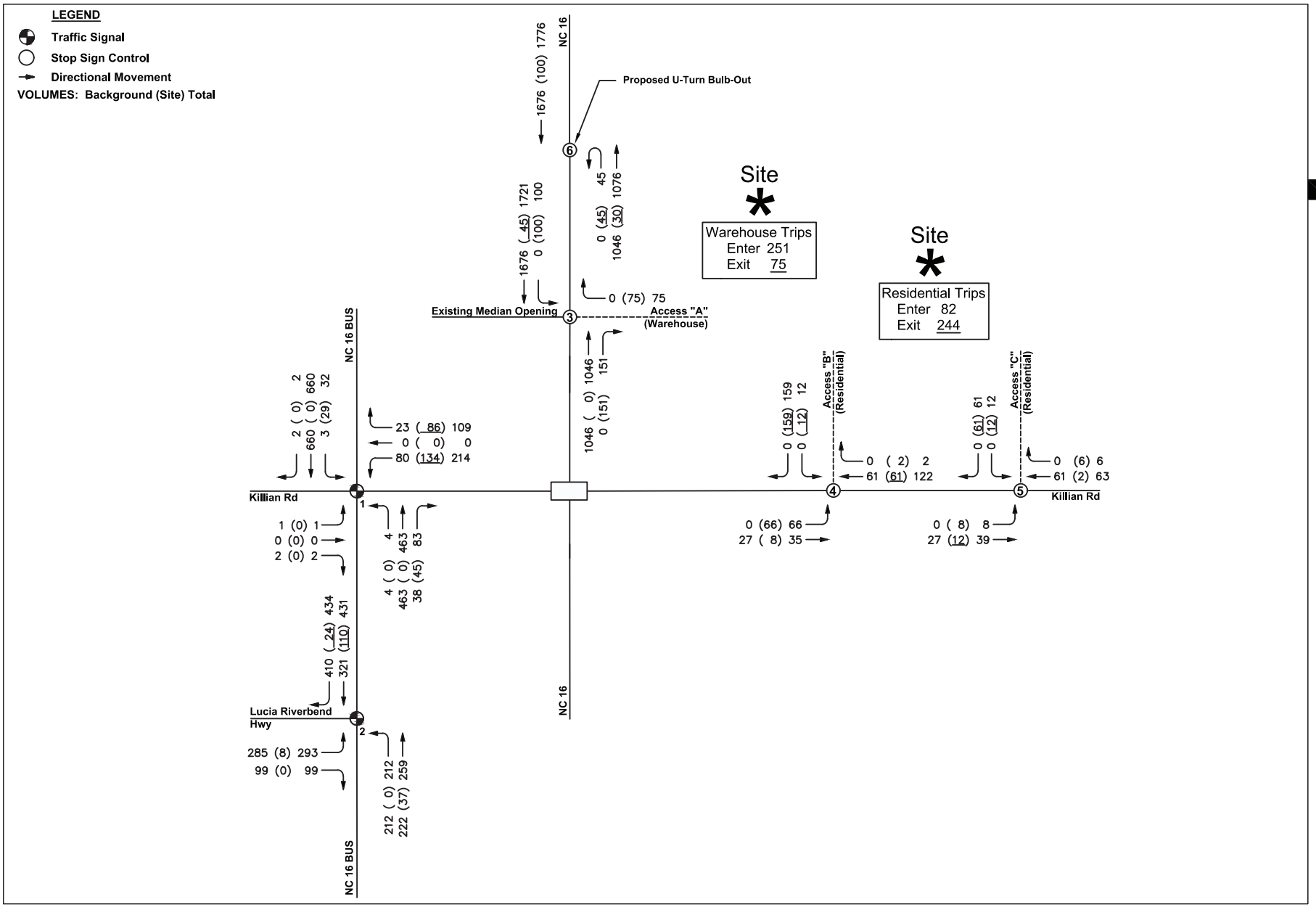
Figure 4



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2024 BUILD AM PEAK HOUR TRAFFIC VOLUMES

SCALE: NTS

PROJECT #: 811-001
DRAWN BY: PAH
CHECKED BY: MWW

AUGUST 2019

REVISIONS:
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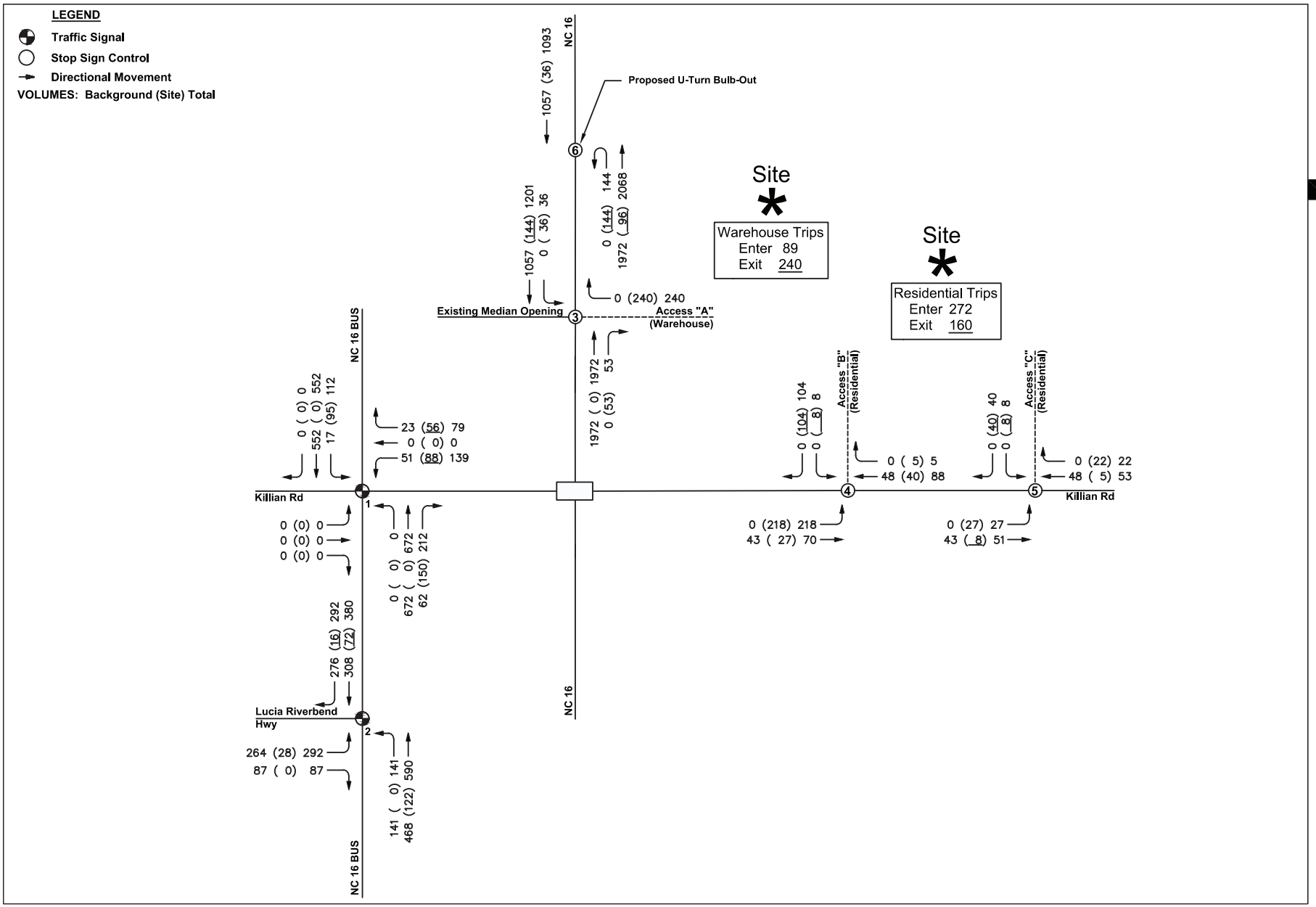
Figure 5



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2024 BUILD PM PEAK HOUR TRAFFIC VOLUMES

SCALE: NTS

PROJECT #: 811-001
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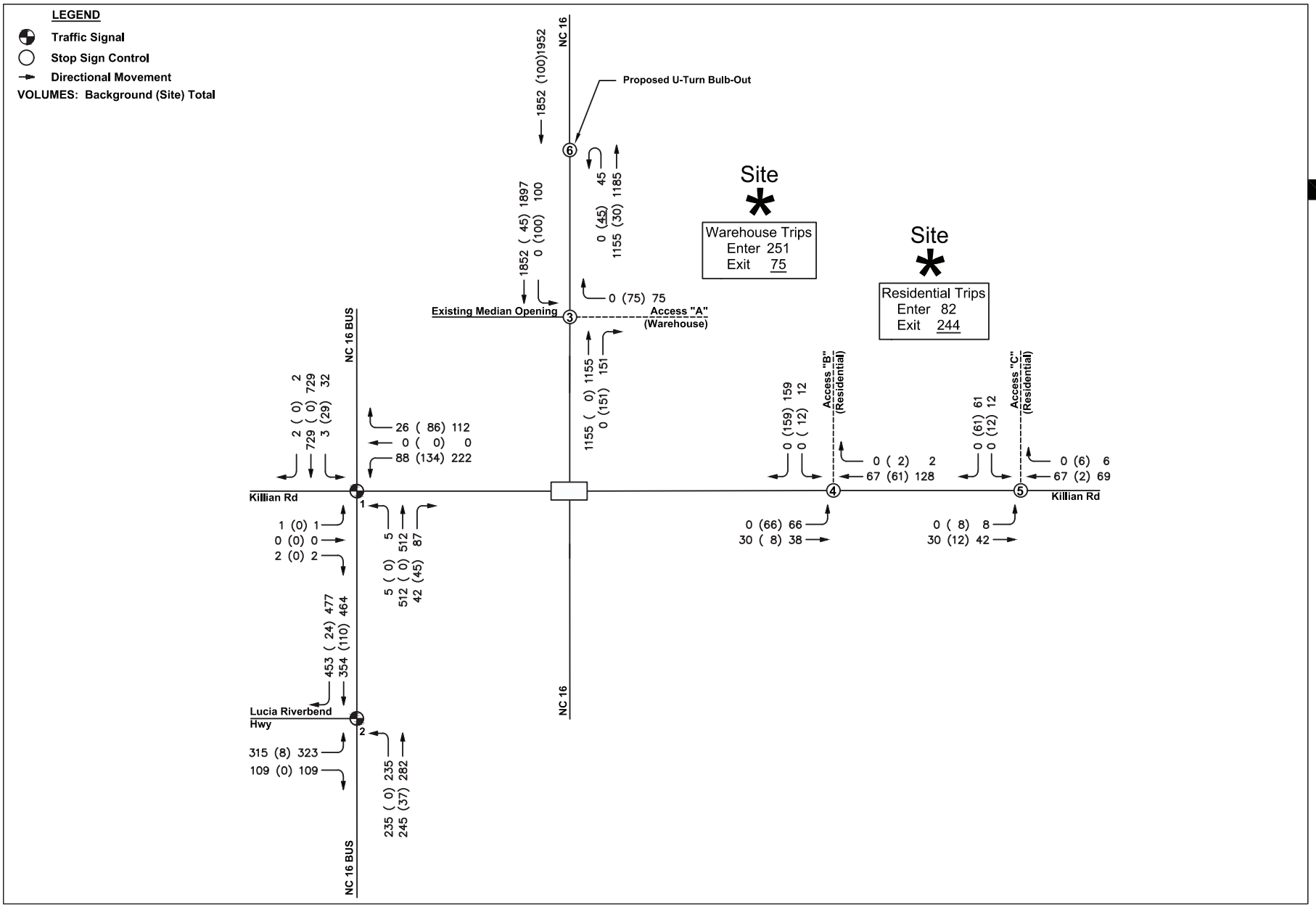
Figure 6



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2034 BUILD AM PEAK HOUR TRAFFIC VOLUMES

0 NTS N
SCALE: NTS

PROJECT #: 811-001
DRAWN BY: PAH
CHECKED BY: MWW

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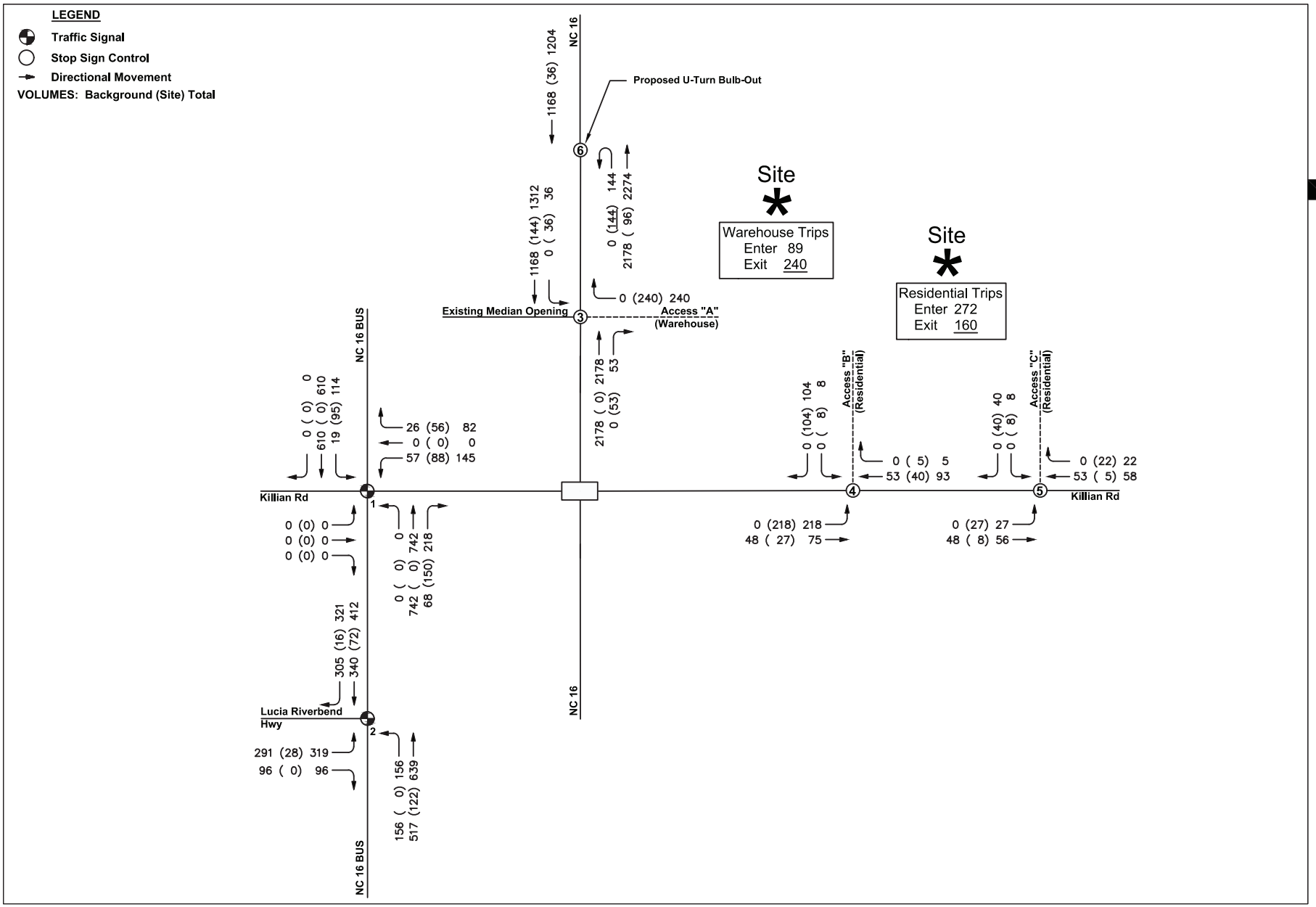
Figure 7



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2034 BUILD PM PEAK HOUR TRAFFIC VOLUMES

SCALE: NTS

PROJECT #: 811-001
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Figure 8

TRAFFIC ANALYSIS

The study intersections identified within the area of influence were analyzed to detect the traffic impact that the development has under the build-out (2024) and built-out plus 10 years (2034). The traffic analysis evaluates following measures of effectiveness' (MOEs) and their respective criteria at the intersections assuming the future year conditions of 2024 and 2034 (Build-out + 10 years per Lincoln County).

Level of service (LOS) of an intersection or approach is a qualitative MOE of traffic operations. It is a measure of average control delay in time within a peak period. The Transportation Research Board's Highway Capacity Manual[1] (HCM) defines the LOS thresholds established for signalized and unsignalized intersections per the following exhibits:

Intersection LOS	Exhibit 19-8 Signalized Intersection Control Delay per Vehicle (sec/vehicle)	Exhibit 20-2 Unsignalized Intersection Control Delay per Vehicle (sec/vehicle)
A	≤10.0	≤ 10.0
B	> 10.0 and ≤ 20.0	> 10.0 and ≤ 15.0
C	> 20.0 and ≤ 35.0	> 15.0 and ≤ 25.0
D	> 35.0 and ≤ 55.0	> 25.0 and ≤ 35.0
E	> 55.0 and ≤ 80.0	> 35.0 and ≤ 50.0
F	>80.0	> 50.0

For the analysis of unsignalized intersections, intersection LOS is defined in terms of the average control delay for each minor-street movement (or shared movement) as well as major-street left-turns. It should be noted that stop sign controlled streets/driveways intersecting major streets typically experience long delays during peak hours, while most of the traffic moving through the intersection on the major street experiences little or no delay.

This report provides analysis of the traffic operations within the area of influence, according to the standards set by the North Carolina Department of Transportation's (NCDOT) "Policy on Street and Driveway Access to North Carolina Highways, Chapter 4 Part C", Lincoln County Unified Development Ordinance (UDO) Section 9.8 and Gaston County's UDO Section 5.11. It provides intersection improvements needed for mitigating traffic impacts. This study evaluates the following scenarios:

- 2019 Existing Conditions
- 2024 No Build Conditions
- 2024 Build-out Conditions
- 2034 Build-out + 10 years Conditions (Lincoln Co. Requirement)

[1] National Research Council. Transportation Research Board. Highway Capacity Manual 6th Ed., Washington, DC. 2016.

NCDOT/LINCOLN COUNTY ANALYSIS REQUIREMENTS - In order to determine the mitigation responsibility of the developer, this study compares 2024 and 2034 Build results to the 2024 No Build results. In addition, Lincoln County UDO requires analysis of conditions 10 years after the build-out of the site.

Per Chapter 5, Section J of the *August 2003 NCDOT Policy on Street and Driveway Access to North Carolina Highways,* the applicant shall be required to identify mitigation improvements to the roadway network if at least one of the following conditions exists when comparing base network conditions to project conditions:

- *The total average delay at an intersection or an individual approach increases by 25% or greater, while maintaining the same level of service,*
- *The Level of Service (LOS) degrades by at least one level at an intersection or an individual approach,*
- *Or the Level of Service is "F" for an intersection or an individual approach.*

This section of the NCDOT access policy also states that, *mitigation improvements shall be identified when the analysis indicates that the 95th percentile queue exceeds the storage capacity of the existing lane.*

Per Lincoln County UDO Section 9.8.F the following requirements must also be met:

The County shall utilize means by which to maintain a minimum Grade "C" level of service for intersections affected by proposed developments through improvements mandated or suggested by traffic impact analyses; technical memoranda required by rezoning cases; and through adherence to level-of-service criteria described as follows:

- *Where proposed development lowers any intersection leg impacted by said development below a Grade "C", the developer will be required to provide those transportation improvements necessary to retain a Grade "C".*

- *Where an existing intersection is rated below Grade "C" prior to any proposed development, the developer will be required to maintain existing transportation levels for any/all legs impacted. Final intersection grades shall include the impact of the proposed development.*

SYNCHRO 10.3 was the software tool used in determining the delay, capacity and corresponding LOS at the study intersections. SimTraffic 10.3, a traffic simulation software application for unsignalized and signalized intersections, was used to calculate the maximum queue lengths at the study intersections. The Synchro and SimTraffic results of each scenario is displayed per intersection and are presented in Tables 4 – 15.

Base assumptions for the analysis scenarios include:

- A 1% per year background growth rate between the existing 2019 and future 2024 and 2034 conditions
- All study intersections and movements assume a 0.90 peak hour factor (PHF)
- Observed heavy vehicle percentages (from TMCs) were used in all analysis for all intersections, a minimum of 2% was applied to proposed intersections.
- 20% heavy vehicle percentages were used for the industrial Access “A” entering and exiting movements
- A minimum of 4 vehicles was assumed for all allowed movements
- Existing signal plans were used in the Existing, No Build and Build conditions, coded based on the NCDOT Congestion Management Capacity Analysis Guidelines (2015) See Appendix 4 for existing signal plans:
  - Right turn on red (RTOR) was disabled
  - Permitted-Protected phasing was adjusted to protected only in future conditions
  - Yellow and red times were adjusted to 5 seconds and 2 seconds, respectively with -2 seconds of lost time adjustment
- Signal timings as given by the signal plan were utilized and the intersections were optimized through all scenarios

1. Killian Road & NC 16 Business

Table 4: Killian Rd. & NC 16 Bus. Analysis Results

Approach	AM Peak Hour			PM Peak Hour		
	LOS	Delay (sec/veh)	Capacity (v/c)	LOS	Delay (sec/veh)	Capacity (v/c)
Existing Conditions						
Intersection	A	8.6	0.55	A	6.1	0.48
Eastbound - NC 16 Business	B	19.3	-	C	21.0	-
Westbound - Killian Road	C	26.5	-	C	24.6	-
Northbound - NC 16 Business	A	5.9	-	A	5.2	-
Southbound - NC 16 Business	A	7.7	-	A	4.6	-
2024 No Build Conditions						
Intersection	A	9.1	0.58	A	7.4	0.55
Eastbound - NC 16 Business	B	19.9	-	C	21.5	-
Westbound - Killian Road	C	26.7	-	C	26.9	-
Northbound - NC 16 Business	A	6.2	-	A	6.5	-
Southbound - NC 16 Business	A	8.3	-	A	5.6	-
2024 Build Conditions						
Intersection	D	38.3	1.21	B	18.5	1.03
Eastbound - NC 16 Business	B	20.0	-	C	22.1	-
Westbound - Killian Road	F	149.0	-	F	97.6	-
Northbound - NC 16 Business	A	7.5	-	A	7.5	-
Southbound - NC 16 Business	B	11.0	-	A	6.9	-
2024 Build Conditions with Improvements (Westbound Right Turn Lane)						
Intersection	B	16.7	0.84	B	11.4	0.73
Eastbound - NC 16 Business	B	20.0	-	C	22.2	-
Westbound - Killian Road	D	44.6	-	D	41.7	-
Northbound - NC 16 Business	A	7.4	-	A	7.2	-
Southbound - NC 16 Business	B	10.8	-	A	6.7	-
2034 Build Conditions (Build - out + 10 years per Lincoln Co. Requirement)						
Intersection	D	42.8	1.28	C	20.5	1.08
Eastbound - NC 16 Business	B	20.0	-	-	-	-
Westbound - Killian Road	F	175.6	-	F	113.8	-
Northbound - NC 16 Business	A	8.0	-	A	8.2	-
Southbound - NC 16 Business	B	12.4	-	A	7.6	-

2019 Existing Conditions

Currently the intersection operates with a LOS “A” in both peak hours.

2024 No Build Conditions

With the inclusion of the growth in the background, the intersection operates with a LOS “A” in both peak hours.

2024 Build Conditions

When comparing the impact of the 2024 Build to the 2024 No Build conditions the intersection LOS becomes a "D" in the AM peak period and a "B" in the PM peak period. The overall intersection delay increases between the No Build and Build scenarios by 320% in the AM peak hour and 150% in the PM peak hour.

2024 Build with Improvements Conditions

Based on NCDOT guidelines, the analysis results indicate the need for mitigation at the study intersection as means to improve LOS and delay.

The following improvements were tested and suggested:

- Construct a separate westbound right turn lane with 175' storage on Killian Road
- Remark the existing combined left-thru-right lane to a combined left-thru lane
- Extend southbound left turn lane storage to 125' on NC 16 Business

Assuming these improvements in place the intersection operates at a LOS "B" in both peak hours, allowed under NCDOT guidelines. Although the overall LOS decreases and delay increases, the intersection is still operating well above acceptable analysis parameters.

2034 Build Conditions (Build - out + 10 years per Lincoln Co. Requirement)

The 2034 Build conditions indicate that the intersection operates at a LOS a "D" in the AM peak period and a "B" in the PM peak period.

Table 5: Killian Rd. & NC 16 Bus. Queue Lengths

Killian Road @ NC 16 Business	Storage (Proposed)	AM PEAK		PM PEAK	
		95th % Queue	Max Queue	95th % Queue	Max Queue
2024 No Build Conditions					
Eastbound Left-Thru-Right (NC 16 Business)	TERM.	15'	25'	16'	34'
Westbound Left-Thru-Right (Killian Road)	TERM.	83'	102'	67'	83'
Northbound Left-Thru (NC 16 Business)	TERM.	135'	154'	191'	152'
Northbound Right-Turn (NC 16 Business)	175'	13'	36'	16'	40'
Southbound Left-Turn (NC 16 Business)	60'	3'	26'	7'	66'
Southbound Thru-Right (NC 16 Business)	TERM.	229'	194'	139'	227'
2024 Build Conditions with Improvements					
Eastbound Left-Thru-Right (NC 16 Business)	TERM.	15'	29'	16'	25'
Westbound Left-Thru (Killian Road)	TERM.	#209'	191'	#146'	169'
Westbound Right-Turn (Killian Road)	(175')	#88'	151'	#70'	114'
Northbound Left-Thru (NC 16 Business)	TERM.	135'	211'	191'	224'
Northbound Right-Turn (NC 16 Business)	175'	24'	103'	47'	141'
Southbound Left-Turn (NC 16 Business)	(125')	12'	57'	39'	124'
Southbound Thru-Right (NC 16 Business)	TERM.	229'	226'	139'	291'

2. Lucia Riverbend Highway & NC 16 Business

Table 6: Lucia Riverbend Hwy. & NC 16 Bus. Analysis Results

Approach	AM Peak Hour			PM Peak Hour		
	LOS	Delay (sec/veh)	Capacity (v/c)	LOS	Delay (sec/veh)	Capacity (v/c)
Existing Conditions						
Intersection	C	30.5	0.86	D	35.1	0.84
Eastbound - Lucia Riverbend Highway	D	40.5	-	D	35.9	-
Northbound - NC 16 Business	C	20.8	-	C	27.3	-
Southbound - NC 16 Business	C	31.0	-	D	42.7	-
2024 No Build Conditions						
Intersection	D	36.7	0.98	D	39.3	0.90
Eastbound - Lucia Riverbend Highway	E	63.0	-	D	49.7	-
Northbound - NC 16 Business	B	18.9	-	C	25.1	-
Southbound - NC 16 Business	C	33.5	-	D	47.8	-
2024 Build Conditions						
Intersection	D	43.1	1.02	E	63.8	1.05
Eastbound - Lucia Riverbend Highway	E	70.1	-	E	69.1	-
Northbound - NC 16 Business	C	24.5	-	D	49.4	-
Southbound - NC 16 Business	D	41.0	-	E	76.4	-
2024 Build Conditions with Improvements (Southbound Right Turn Overlap Phasing)						
Intersection	C	29.5	0.88	D	44.2	0.92
Eastbound - Lucia Riverbend Highway	D	43.2	-	E	59.6	-
Northbound - NC 16 Business	C	26.5	-	D	39.3	-
Southbound - NC 16 Business	C	24.9	-	D	41.0	-
2034 Build Conditions (Build - out + 10 years per Lincoln Co. Requirement)						
Intersection	E	57.5	1.13	F	86.5	1.14
Eastbound - Lucia Riverbend Highway	F	95.1	-	F	90.0	-
Northbound - NC 16 Business	C	28.2	-	E	69.4	-
Southbound - NC 16 Business	E	56.3	-	F	103.1	-

2019 Existing Conditions

Currently the intersection operates with a LOS “C” in the AM peak hour and LOS “D” in the PM peak hour.

2024 No Build Conditions

With the inclusion of the growth in the background, the intersection operates with a LOS “D” in the AM peak hour and a LOS “D” in the PM peak hour.

2024 Build Conditions

When comparing the impact of the 2024 Build to the 2024 No Build conditions the intersection LOS remains a “D” in the AM peak hour and becomes a “E” in the PM peak hour. The overall intersection delay increase between the No Build and Build scenario is 17% in the AM peak hour and 62% in the PM peak hour. In addition, the some of the approaches exceed the allowable parameters in both peak hours.

2024 Build with Improvements Conditions

Based on NCDOT guidelines, the analysis results indicate the need to identify mitigation at the study intersection. The following improvements were tested and are suggested:

- Implement for southbound right turn overlap phasing on NC 16 Business
- Extend eastbound right turn lane to 150' on Lucia Riverbend Highway

Assuming these improvements are in place, the intersection LOS becomes a "C" in the AM peak hour and remains a "D" in the PM peak hour (both of which are considered acceptable based on NCDOT guidelines).

2034 Build Conditions (Build - out + 10 years per Lincoln Co. Requirement)

The 2034 Build conditions indicate that the intersection operates at a LOS becomes a "E" in the AM peak period and a "F" in the PM peak period.

Table 7: Lucia Riverbend Hwy. & NC 16 Bus. Queue Lengths

Lucia Riverbend Highway at NC 16 Business	Storage (Proposed)	AM PEAK		PM PEAK	
		95th % Queue	Max Queue	95th % Queue	Max Queue
2024 No Build Conditions					
Eastbound Left-Turn (Lucia Riverbend Highway)	-	#258'	954'	#233'	512'
Eastbound Right-Turn (Lucia Riverbend Highway)	50'	78'	150'	69'	150'
Northbound Left-Turn (NC 16 Business)	-	53'	170'	36'	95'
Northbound Thru (NC 16 Business)	TERM.	#164'	217'	#314'	315'
Southbound Thru (NC 16 Business)	TERM.	186'	364'	#248'	400'
Southbound Right-Turn (NC 16 Business)	300'	#308'	365'	#238'	312'
2024 Build Conditions with Improvements					
Eastbound Left-Turn (Lucia Riverbend Highway)	-	#259'	539'	#340'	542'
Eastbound Right-Turn (Lucia Riverbend Highway)	(150')	79'	150'	93'	150'
Northbound Left-Turn (NC 16 Business)	-	72'	189'	46'	115'
Northbound Thru (NC 16 Business)	TERM.	#218'	240'	#559'	560'
Southbound Thru (NC 16 Business)	TERM.	#335'	338'	#412'	552'
Southbound Right-Turn (NC 16 Business)	300'	158'	282'	176'	399'

3. NC 16 & Proposed Warehouse Access "A"

Table 8: NC 16 & Proposed Warehouse Access "A" Analysis Results

Approach	AM Peak Hour			PM Peak Hour		
	LOS	Delay (sec/veh)	Capacity (v/c)	LOS	Delay (sec/veh)	Capacity (v/c)
2024 Build Conditions						
Westbound - Warehouse Access "A"	C	15.9	-	F	288.0	-
Northbound - NC 16	A	0.0	-	A	0.0	-
Southbound - NC 16	A	0.8	-	A	0.9	-
2034 Build Conditions (Build - out + 10 years per Lincoln Co. Requirement)						
Westbound - Warehouse Access "A"	C	17.3	-	F	427.2	-
Northbound - NC 16	A	0.0	-	A	0.0	-
Southbound - NC 16	A	0.8	-	A	1.0	-

2024 Build Conditions

We propose the following intersection configuration:

- Convert NC 16 full median opening to a southbound directional X-over with a minimum storage of 150' (or as required to accommodate the appropriate design vehicles)
- Two ingress lanes and one egress lane (a terminating westbound right turn lane on Proposed Access "A")
- Channelized northbound right turn lane with 100' storage on NC 16
- Minimum internal protected stem of 500'

Assuming this configuration, the worst leg of the intersection (westbound) operates at a LOS "C" in the AM peak period and LOS "F" in the PM peak hour. It should be noted that stop sign-controlled streets/driveways intersecting major streets typically experience long delays during peak hours, while most of the traffic moving through the intersection on the major street experiences little or no delay.

2034 Build Conditions (Build - out + 10 years per Lincoln Co. Requirement)

10 years after the build-out of the site, the worst leg of the intersection (westbound) remains at a LOS "C" in the AM peak period and LOS "F" in the PM peak hour.

Table 9: NC 16 & Proposed Warehouse Access "A" Queue Lengths

Warehouse Access "A" @ NC 16	Storage (Proposed)	AM PEAK		PM PEAK	
		95th % Queue	Max Queue	95th % Queue	Max Queue
2024 Build Conditions with Improvements					
Westbound Right-Turn (Warehouse Access "A")	TERM.	18'	101'	418'	2117'
Northbound Right-Turn (NC 16)	100'	-	65'	-	4'
Southbound Left-Turn (NC 16)	150'	20'	95'	20'	116'

4. Killian Road & Proposed Residential Access "B"

Table 10: Killian Rd. & Proposed Residential Access "B" Analysis Results

Approach	AM Peak Hour			PM Peak Hour		
	LOS	Delay (sec/veh)	Capacity (v/c)	LOS	Delay (sec/veh)	Capacity (v/c)
2024 Build Conditions						
Eastbound - Killian Road	A	5.0	-	A	6.0	-
Westbound - Killian Road	A	0.0	-	A	0.0	-
Southbound - Access "B"	B	10.0	-	A	9.7	-
2034 Build Conditions (Build - out + 10 years per Lincoln Co. Requirement)						
Eastbound - Killian Road	A	4.8	-	A	5.9	-
Westbound - Killian Road	A	0.0	-	A	0.0	-
Southbound - Access "B"	B	10.0	-	A	9.7	-

2024 Build Conditions

We propose the following intersection configuration:

- One ingress and two egress lanes (a terminating southbound right turn lane and left turn lane with 100' storage) on Proposed Access "B"
- Construct an eastbound left turn lane with 100' storage on Killian Road
- Minimum internal protected stem of 100'

Assuming this configuration, the worst leg of the intersection (southbound) operates at a LOS "B" in the AM peak period and "A" in the PM peak period. It should be noted that stop sign-controlled streets/driveways intersecting major streets typically experience long delays during peak hours, while most of the traffic moving through the intersection on the major street experiences little or no delay.

2034 Build Conditions (Build - out + 10 years per Lincoln Co. Requirement)

10 years after the build-out of the site, the worst leg of the intersection (southbound) remains at a LOS "B" in the AM peak period and "A" in the PM peak period.

Table 11: Killian Rd. & Proposed Residential Access "B" Queue Lengths

Killian Road @ Access "B"	Storage (Proposed)	AM PEAK		PM PEAK	
		95th % Queue	Max Queue	95th % Queue	Max Queue
2024 Build Conditions with Improvements					
Eastbound Left-Turn (Killian Road)	(100')	5'	52'	15'	70'
Southbound Left-Turn (Access "B")	(150')	-	23'	-	19'
Southbound Right-Turn (Access "B")	TERM.	18'	62'	10'	44'

5. Killian Road & Proposed Residential Access "C"

Table 12: Killian Rd. & Proposed Residential Access "C" Analysis Results

Approach	AM Peak Hour			PM Peak Hour		
	LOS	Delay (sec/veh)	Capacity (v/c)	LOS	Delay (sec/veh)	Capacity (v/c)
2024 Build Conditions						
Eastbound - Killian Road	A	1.3	-	A	2.6	-
Westbound - Killian Road	A	0.0	-	A	0.0	-
Southbound - Access "C"	A	9.0	-	A	8.9	-
2034 Build Conditions (Build - out + 10 years per Lincoln Co. Requirement)						
Eastbound - Killian Road	A	1.2	-	A	2.4	-
Westbound - Killian Road	A	0.0	-	A	0.0	-
Southbound - Access "C"	A	9.1	-	A	9.0	-

2024 Build Conditions

We propose the following intersection configuration:

- One ingress and two egress lanes (a southbound right turn lane and left turn lane with 100' storage on Proposed Access "C")
- Construct an eastbound left turn lane with 100' storage on Killian Road
- Minimum internal protected stem of 100'

Assuming this configuration, the worst leg of the intersection (southbound) operates at a LOS "A" in both peak hours. It should be noted that stop sign-controlled streets/driveways intersecting major streets typically experience long delays during peak hours, while most of the traffic moving through the intersection on the major street experiences little or no delay.

2034 Build Conditions (Build - out + 10 years per Lincoln Co. Requirement)

10 years after the build-out of the site, the worst leg of the intersection (southbound) operates at a LOS "A" in during both peak hours. It should be noted that stop sign-controlled streets/driveways intersecting major streets typically experience long delays during peak hours, while most of the traffic moving through the intersection on the major street experiences little or no delay.

Table 13: Killian Rd. & Proposed Residential Access "C" Queue Lengths

Killian Road @ /Access "C"	Storage (Proposed)	AM PEAK		PM PEAK	
		95th % Queue	Max Queue	95th % Queue	Max Queue
2024 Build Conditions with Improvements					
Eastbound Left-Turn (Killian Road)	(100')	0'	16'	3'	19'
Southbound Left-Turn (Access "C")	(100')	-	23'	-	23'
Southbound Right-Turn (Access "C")	TERM.	5'	53'	3'	50'

6. NC 16 & Future U-Turn Bulb-Out

We propose the following intersection configuration:

- Convert NC 16 full median opening to a northbound channelized U-turn lane with a minimum storage of 250’ (or as required to accommodate the appropriate design vehicles)

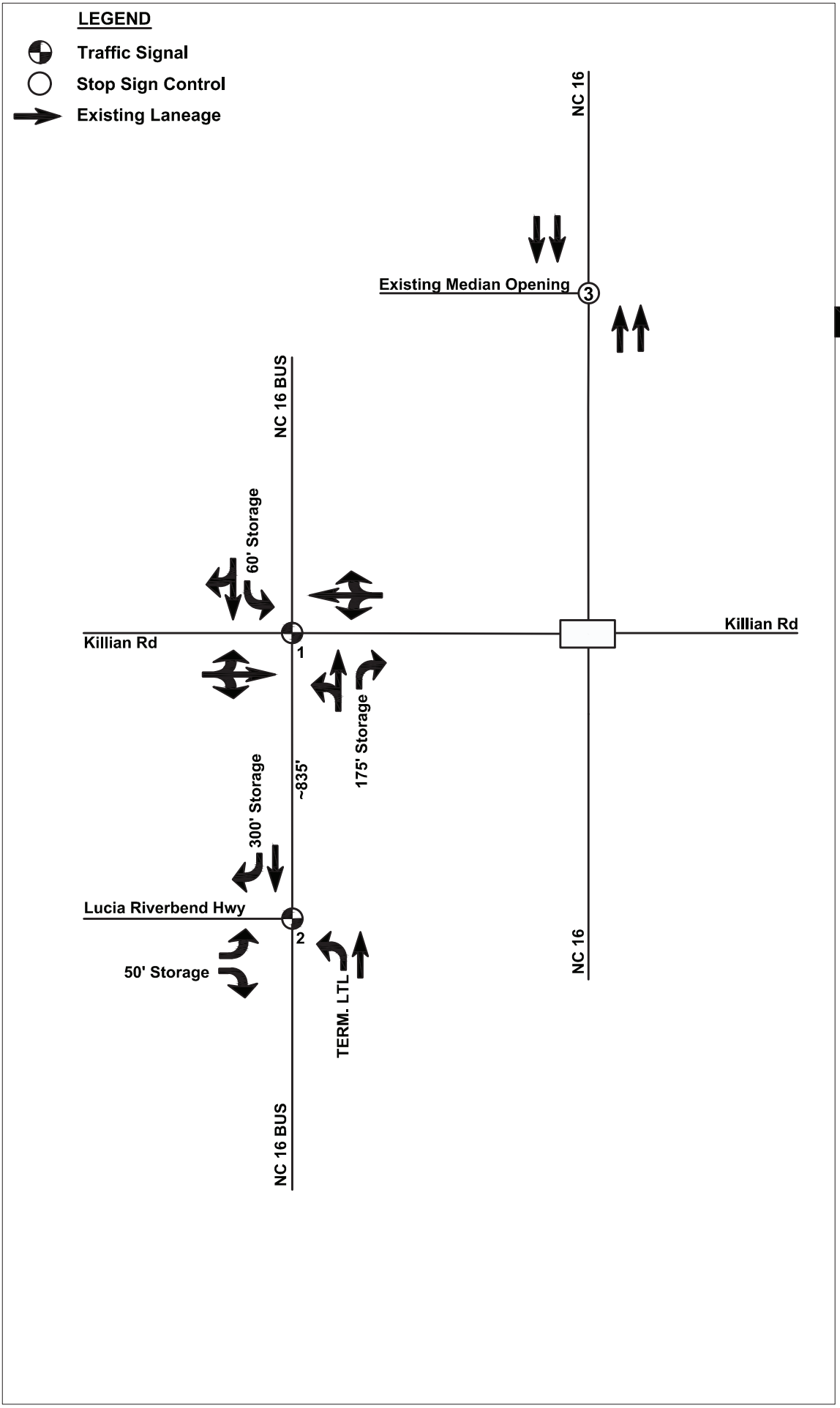
The max queues are maintained within the channelized left-turn lane in both the AM and the PM peak.

Table 15: NC 16 & Future U-Turn Bulb-Out Queue Lengths

Killian Road @ /Access “C”	Storage	AM PEAK	PM PEAK
		Max Queue	Max Queue
2024 Build Conditions with Improvements			
Northbound U-Turn (Killian Road)	(250')	218'	235’

Analysis software result reports per scenario are provided in the Appendix 5.

The existing/suggested laneage is shown on Figures 9 and 10.



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EXISTING LANEAGE

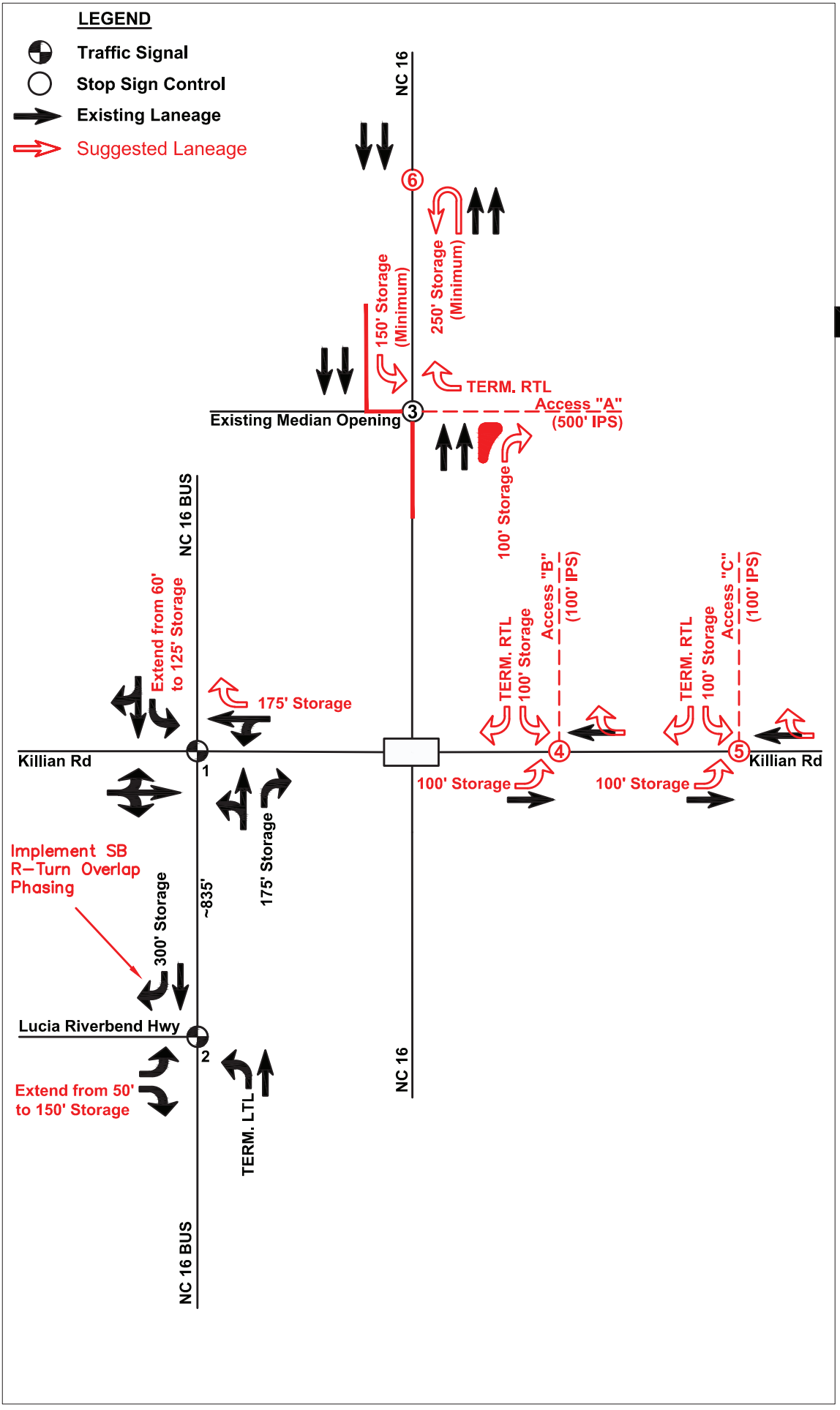
0 NTS N
SCALE: NTS

PROJECT #: 811-001
DRAWN BY: PAH
CHECKED BY: MWW

AUGUST 2019

REVISIONS:
1.

Figure 9



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SUGGESTED LANEAGE

0 NTS N
SCALE: NTS

PROJECT #: 811-001
DRAWN BY: PAH
CHECKED BY: MWW

AUGUST 2019

REVISIONS:
1.

Figure 10

CONCLUSION

In conclusion, even though the Riverbend Preserve development will increase the amount of vehicular and truck traffic on the adjacent roadways/corridors, the suggested intersection improvements/enhancements will help mitigate the additional site generated trips on the adjacent roadway network. In addition, the suggested recommendations will improve the conditions for the general traveling public as well as the users of the warehouse and the residents of the residential community.

APPENDIX