NCDOT STIP R-2721/R-2828/R-2829

PREFERRED ALTERNATIVE - TRAFFIC ANALYSIS TECHNICAL MEMORANDUM

COMPLETE 540 TRIANGLE EXPRESSWAY SOUTHEAST EXTENSION

Wake County & Johnston County

PREPARED FOR:

North Carolina Department of Transportation (NCDOT)
Project Development & Environmental Analysis Branch

Federal Highway Administration (FHWA)

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July 2017

NCDOT STIP PROJECTS R-2721, R-2828 & R-2829
Complete 540 (Triangle Expressway Southeast Extension)

WAKE AND JOHNSTON COUNTIES

Preferred Alternative Traffic Analysis

TECHNICAL MEMORANDUM

Prepared for:

The North Carolina Department of Transportation

Congestion Management Section

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July 2017

EXECUTIVE SUMMARY

1. Introduction

The North Carolina Department of Transportation (NCDOT) is studying ways to improve regional mobility in southern and eastern Wake County. NCDOT State Transportation Improvement Program (STIP) Projects R-2721, R-2828, and R-2829, collectively known as Complete 540 – Triangle Expressway Southeast Extension form the outer loop around Raleigh and surround communities in Wake and Johnston Counties, extending from the NC 55 Holly Springs Bypass to I-40 near the US 70 Clayton Bypass (Southern Wake Freeway) and then to I-495 / US 64 / US 264 Knightdale Bypass (Eastern Wake Freeway).

Project level traffic capacity analyses for the Complete 540 project were developed by HNTB North Carolina, P.C. (HNTB) on February 23, 2015, for a No-Build alternative and 17 Detailed Study Alternatives (DSA), which included 2010 Base Year, 2012 Intermediate Year, and 2035 Future Year scenarios. Based on the analysis and the National Environmental Policy Act (NEPA) process, DSA 2 was selected as the Preferred Alternative for Complete 540.

HNTB North Carolina, P.C. has been contracted by the NCDOT to prepare project level traffic capacity analysis for the selected Complete 540 Preferred Alternative (DSA 2) using the Preferred Alternative (DSA 2) traffic forecast. The purpose of this traffic capacity analysis is to identify existing and projected roadway facility, interchange and intersection operations and any potential deficiencies for the major roadways surrounding and intersecting the Complete 540 functional designs for the Preferred Alternative (DSA 2) under 2016 Base Year and 2040 Design Year conditions. This report will refer to DSA 2 as the Preferred Alternative (PA) for simplicity. **Figure ES-1** shows the PA corridor and the project study area for the traffic analysis. ***Appendix A*** contains all figures described in this report.

Traffic volumes used in this traffic capacity analysis were based on the *Complete 540 Preferred Alternative Traffic Forecast* prepared by HNTB and approved by NCDOT Transportation Planning Branch (TPB) on August 11, 2016. The traffic capacity analysis references the following forecast volumes for the 2016 and 2040 analysis scenarios:

- 2016 Base Year No-Build,
- 2016 Base Year Build DSA 2 (PA), and
- 2040 Design Year Build DSA 2 (PA).

Complete 540 functional designs and interchange forms evaluated in this traffic capacity analysis were based on the designs and interchange form recommendations prepared by Lochner, based upon ongoing coordination, planning, analysis and design. The designs are currently being reviewed by NCDOT.

The following sections describe existing and future transportation conditions in the project study area, the capacity analysis methodology, capacity analysis results for the 2016 Base Year and 2040 Design Year, microsimulation operations analysis, and conclusions and recommendations derived from the capacity analyses related to current functional design for the Complete 540 PA.

2. Existing and Future Conditions

The Complete 540 PA corridor alignment in the project study area runs primarily east-west between the existing Triangle Expressway termini at NC 55 Bypass in Apex to I-40 near Clayton. The corridor alignment then runs primarily north-south between I-40 and the existing I-540 system interchange with I-495 / US 64 / US 264 in Knightdale. The corridor alignment crosses multiple existing freeway, arterial, and local roadway facilities. The Complete 540 PA is shown on **Figure ES-1**.

Under existing conditions, there are five major access-controlled freeways, numerous major and minor arterial facilities, nine existing interchanges, one planned future interchange (STIP Project # R-2635D), and 10 existing at-grade intersections on Y-line facilities in the traffic analysis study area.

Existing traffic control information was provided by NCDOT for all signalized intersections. Other relevant study information and analysis inputs for the existing study area facilities and corridors was collected from existing aerial photography, traffic forecast and field verified in 2014 by HNTB staff.

Under future conditions, the Complete 540 project, Triangle Expressway Southeast Extension, will complete the Raleigh 540 outer loop. Construction is currently scheduled to be completed in phases. Phase I (southern portion) is between NC 55 Bypass in Apex and I-40 near the Johnston County line. Phase II (eastern portion) continues the project at I-40 and ends at I-495 / US 64 / US 264 in Knightdale. The project is located primarily in Wake County with a small portion of the project that extends into Johnston County.

Transportation demands, social and economic demands and mobility considerations are the basis for additional transportation infrastructure in southeastern Wake County. Complete 540 will link the towns of Clayton, Garner, Fuquay-Varina, Holly Springs, Apex, Cary, Knightdale, and Raleigh. It will also connect major roadways in southern Raleigh and aid in easing congestion on the I-40, I-440 (Raleigh Beltline), NC 42, NC 55, Ten Ten Road and other arterial surface streets by providing a high-speed, reliable transportation option. The Complete 540 project would increase the overall capacity of the existing study area roadway network and be expected to divert traffic from secondary roads. The Complete 540 PA corridor is approximately 30 miles in length, beginning at the existing Toll NC 540 (Triangle Expressway) and NC 55 Bypass service interchange and terminating at the existing I-540 and I-495 / US 64 / US 264 system interchange.

With construction of Complete 540, there are nine existing interchanges, one planned future interchange (STIP Project # R-2635D) and 10 future interchanges (on and adjacent to the PA alignment), and 10 existing and 16 future at-grade intersections in the traffic analysis study area.

3. Methodology

2016 Base Year / 2040 Design Year Traffic Volume Development

Peak hour traffic volume estimates for the 2016 Base Year No-Build and Build scenarios and 2040 Design Year Build scenario were developed using daily traffic forecast information from the *Complete 540 Preferred Alternative Traffic Forecast*. Daily traffic data, such as Average Annual Daily Traffic (AADT) estimates for study area roadway segments, truck percentages, design hour volumes (DHV-factor), and peak directional flows (D-factor) were entered into NCDOT Congestion Management Section peak hour traffic volume breakout spreadsheets for each intersection and/or interchange. This traffic volume data was then entered in the capacity analysis software, as appropriate.

Capacity Analysis

Per standards for the preparation of capacity analyses for TIP projects used by the NCDOT Congestion Management Section, the Complete 540 project study area and PA were analyzed using methodologies set forth in the Highway Capacity Manual 2010 (Transportation Research Board, December 2010) and the accompanying Highway Capacity Software 2010 (HCS Version 6.60) for freeway facilities and unsignalized intersections. Signalized and unsignalized intersections were analyzed in Synchro Professional Version 9. Results for AM and PM peak hour timeframes are given as a Level-of-Service (LOS) for segments of freeway and intersections that correspond to a letter grade of LOS A through LOS F. In general, LOS D is the minimum threshold for acceptable peak hour traffic operations on the freeway segments and study area intersections, and was used as a benchmark in analyzing the PA functional design geometrics for the 2016 and 2040 analysis years. **Table ES-1** includes the details for each analysis type.

Table ES - 1 Capacity Analysis Details

Analysis Type	Details
Freeway System Analysis	Segmented the PA alignment network into separate basic freeway, weaving, merge, and diverge areas in HCS Freeway Facilities Module (Freeway Facilities). Calculated both individual segment vehicular density and LOS and overall directional system operational statistics per HCM 2010 methods.
Intersection Analysis	Created Synchro network that included individual intersections, both signalized and unsignalized, and corridors near the proposed interchange ramp terminals and incorporated signal plan information. Build network analyzed all Complete 540 interchange ramp terminal intersections as signalized intersections in the Design Year.

4. Development of Alternatives

The Build Alternative assumes construction of Complete 540 in addition other background improvements that are committed to and funded by NCDOT, local municipalities, or private development projects and would occur by the 2040 Design Year. The Complete 540 PA is shown on **Figure ES–1**. The roadway design (alignment, interchange forms, geometrics, design criteria) was provided by Lochner for use in the traffic capacity analysis.

2016 Base Year / 2040 Design Year Traffic Volume Development

Peak hour traffic volume estimates for the 2016 Base Year No-Build and Build scenarios and 2040 Design Year Build scenario were developed using daily traffic forecast information from the *Complete 540 Preferred Alternative Traffic Forecast*. Daily traffic data, such as Average Annual Daily Traffic (AADT) estimates for study area roadway segments, truck percentages, design hour volumes (DHV-factor), and peak directional flows (D-factor) were entered into NCDOT Congestion Management Section peak hour traffic volume breakout spreadsheets for each intersection and/or interchange. This traffic volume data was then entered in the capacity analysis software, as appropriate.

2040 Design Year Build Capacity Analysis Results

For Complete 540 PA operations, all freeway segments are expected to operate at LOS D or better, as shown in **Table ES-2**. For the NC 540 corridor (Triangle Expressway), between NC 55 Bypass and Veridea Parkway (formerly Old Holly Springs-Apex Road), two basic segments (OHSARI B1-D2 & D2-B3) in the eastbound PM peak are expected to operate at (LOS E) or exceeding (LOS F) peak hour capacity. For the I-40 and US 70 corridors, all segments expected to operate at LOS D or better. On the I-495 / US 64 / US 264 corridor, results indicate that four (4) eastbound and three (3) westbound segments at (LOS E) or exceeding (LOS F) peak hour capacity.

Of the 36 study area intersections analyzed at interchange ramp terminals or adjacent Y-lines, four (4) intersections are projected to experience operational deficiencies in the 2040 Design Year Build PA scenario, as shown in **Table ES-3**. Three (3) of the four (4) intersections projected to experience operational deficiencies are along the NC 55 Bypass, two (2) of which are the ramp terminal intersections. The intersection of realigned Donny Brook Road/Chandler Ridge Circle/Wake Tech Drive and US 401 is expected to operate at LOS E in the AM and LOS C in the PM peak hour.

Table ES - 2 2040 Design Year Freeway Operations Summary*

Scenario	Complete 540											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
2040 Build	12	35	16	2	0	0	10	28	23	4	0	0

*-Table shows the number of segments for each LOS

Table ES - 3 2040 Build Intersection Capacity Analysis Summary

Scenario	Number of Intersections Operating at Given LOS in at Least One AM or PM Peak Hour*					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
2040 Build	2	14	12	3	***1***	***3***

*-For signalized intersections, overall intersection LOS. For unsignalized intersections, worst-case critical movement.

5. Summary and Recommendations

The Complete 540 traffic capacity analysis was completed to evaluate 2016 Base Year No-Build and Build, and 2040 Design Year Build peak hour traffic operations for the Complete 540 Preferred Alternative and surrounding freeway facilities and nearby intersections within the traffic analysis study area.

Based on the 2016 Base Year capacity analysis, all the No-Build and Build PA freeway and intersection facilities are projected to operate at acceptable LOS D or better.

Based on the 2040 Design Year capacity analysis, the following conclusions and recommendations are presented for study area facilities and intersections:

Complete 540 Preferred Alternative Corridor

All Complete 540 PA freeway segments and interchange design configurations are projected to operate at LOS D or better in the 2040 Design Year, based on the current functional designs for Complete 540 as a six-lane, toll facility.

Of the 36 study area intersections analyzed at interchange ramp terminals or adjacent Y-lines, only 4 intersections are projected to experience operational deficiencies. Three (3) of the four (4) intersections potentially experiencing operational deficiencies are the two interchange ramp terminal intersections along NC 55 Bypass. This is due to the high vehicular volume and limited capacity along NC 55 Bypass. The intersection of realigned Donny Brook Road/Chandler Ridge Circle/Wake Tech Drive and US 401 is expected to operate at LOS E in the AM and LOS C in the PM. Reasonably feasible laneage improvements were considered and implemented at these four (4) intersection locations as part of the Complete 540 project.

NC 540 (Triangle Expressway) Corridor

Based on the 2040 Design Year Build PA analysis results, two basic segments (OHSARI B1-D2 & D2-B3) between NC 55 Bypass and Veridea Parkway (formerly Old Holly Springs-Apex Road) in the eastbound PM peak experience projected operational deficiencies. This is mainly due to the limited capacity between the eastbound off-ramp and on-ramps at Old Holly Springs-Apex Road. All the westbound segments are expected to operate at LOS D or better.

I-540 Corridor

The existing section of I-540 from I-495 / US 64 / US 264 to US 64 Business is projected to operate at acceptable LOS D or better with construction of Complete 540 and I-540 planned widening to an 8-lane facility as per 2040 MTP.

I-40 Corridor

Based on the 2040 Design Year Build PA analysis results, the existing sections of I-40 are projected to operate at acceptable LOS C or better, with construction of Complete 540 and I-40 planned widening to a 10-lane facility with eight (8) general purpose lanes and two (2) managed lanes as per the 2040 MTP. The PA proposes a five-leg system interchange with I-40 and US 70 and provides acceptable interchange spacing between US 70 and NC 42. The potential impacts of Complete 540 on I-40, US 70, US 70 Business and the system interchange operations will be re-evaluated to complete an interstate access report.

US 70 Corridor

The existing section of US 70 from I-40 to NC 42 is projected to operate at acceptable LOS D or better with construction of Complete 540 in 2040 Design Year.

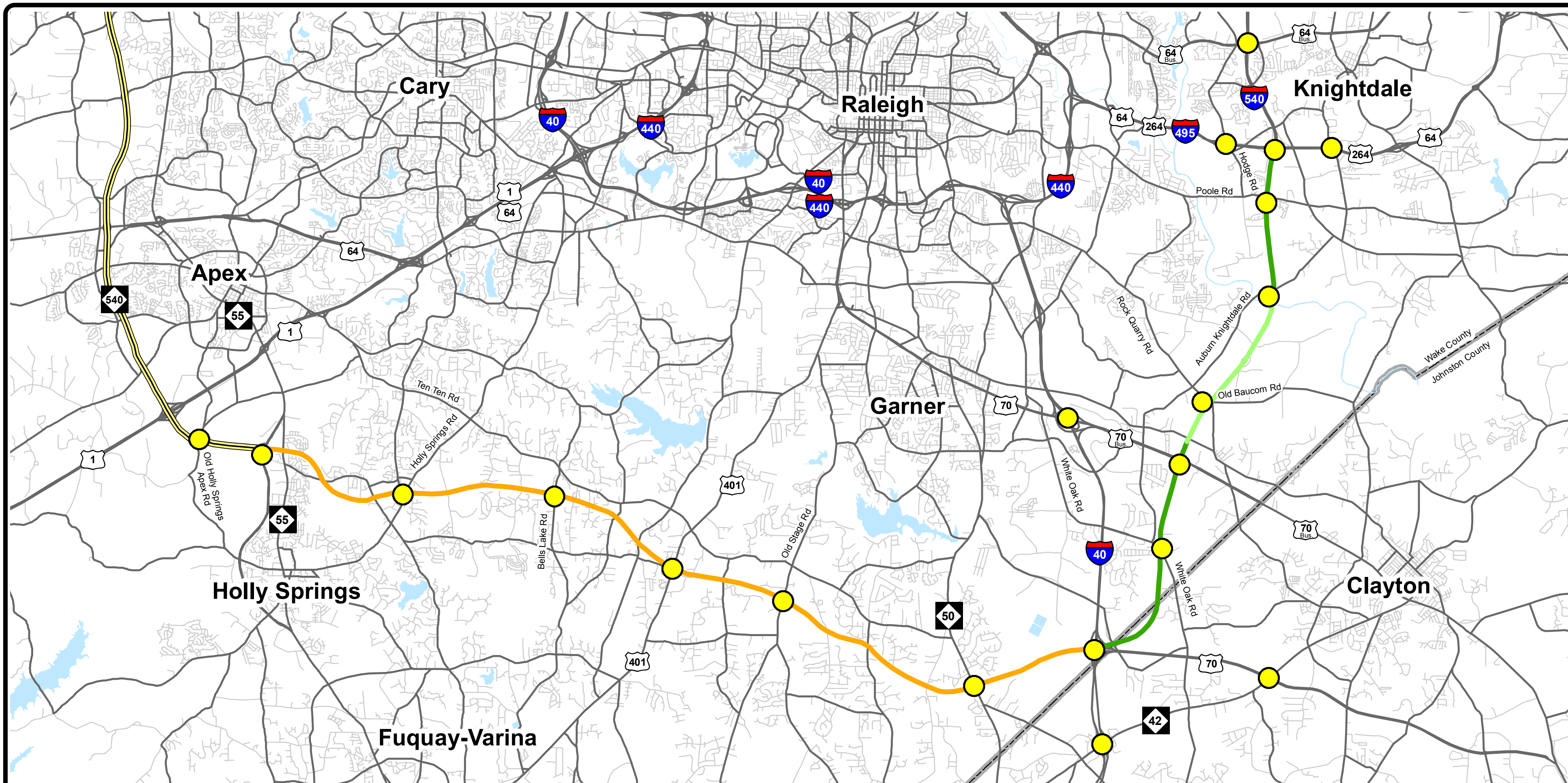
I-495 / US 64 / US 264 Corridor

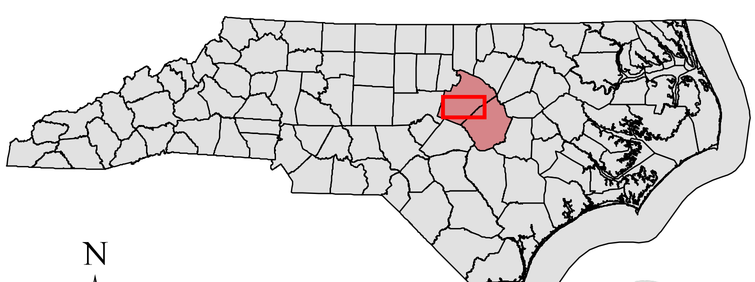
Capacity analysis results indicate that I-495 / US 64 / US 264 is operating near or over capacity with operational deficiencies in the 2040 Design Year Build AM and PM peak hours. In the 2040 Design Year Build PA scenario, I-495 / US 64 / US 264 from Hodge Road to Smithfield Road is projected to operate at LOS E or F for 4 of 13 eastbound segments and 3 of 13 westbound segments as a six-lane freeway facility. Construction of Complete 540 proposes modifying the existing directional system interchange with I-495 / US 64 / US 264 and I-540 by connecting the forth leg and constructing a flyover and a loop ramp. The system interchange was planned, designed and constructed to accommodate the future completion and connection of the 540 loop. This interchange modification would add one eastbound and one westbound freeway merge on I-495 / US 64 / US 264. The potential impacts of Complete 540 on I-495 / US 64 / US 264, I-540 and the system interchange operations will be re-evaluated to complete an interstate access report.

Ramp Demand-to-Capacity Ratios

Based on the analysis, all the ramps at the Complete 540 at I-40/US 70 Bypass system interchange are projected to operate with demand to capacity (d/C) ratios less than 1 in both the AM and PM peak hours. At the Complete 540, I-540 and I-495 / US 64 / US 264 system interchange, the ramps from westbound I-495 / US 64 / US 264 to northbound I-540 in the AM peak and the loop ramp from southbound I-540 to eastbound I-495 / US 64 / US 264 in the PM peak hour are projected to operate at d/C ratio greater than (>) 1. To operate at d/C ratio less than (<) 1, the westbound I-495 / US 64 / US 264 to northbound I-540 would require two continuous lanes to merge with the eastbound ramp and on to I-540. The loop ramp from southbound I-540 to eastbound I-495 / US 64 / US 264 (Location # 10) would require two lanes to operate at d/C ratio less than (<) 1. The ramps from eastbound and westbound I-495 / US 64

/ US 264 to northbound I-540 in the AM peak, from eastbound I-495 / US 64 / US 264 to northbound I-540 in the PM peak and from southbound I-540 to westbound I-495 / US 64 / US 264 in the AM peak hour are nearing capacity (d/C ratio > 0.85). If the demand for any of these ramps nearing capacity exceed the estimated demand in 2040, an additional lane may be necessary to operate at d/C ratio less than (<) 1. Where ramp volumes are projected to be near or exceed capacity, the feasibility of providing two lanes should be considered during the project development process.





N

Complete 540 PA Traffic Analysis Study Area

Legend

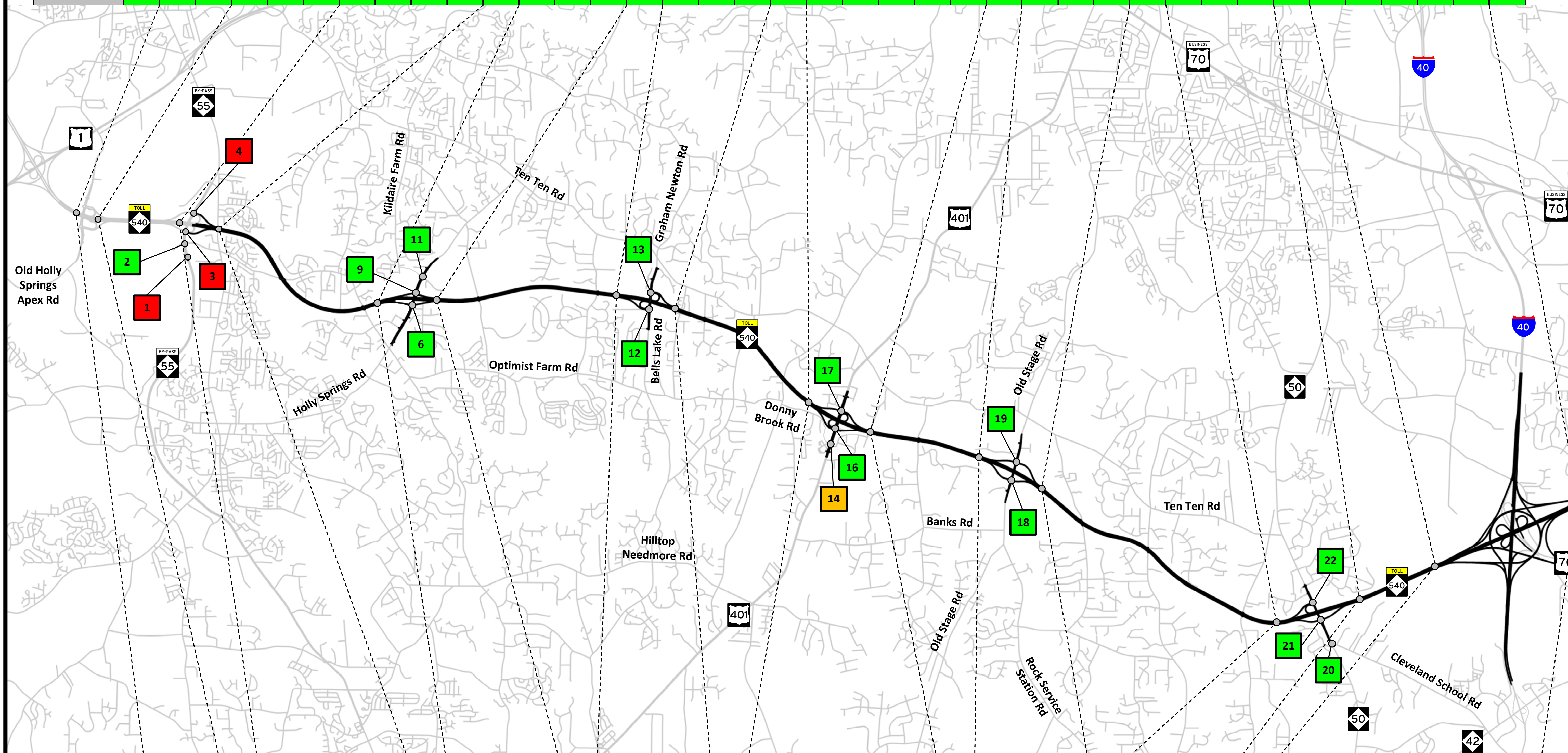
- Interchanges
- Triangle Expressway
- Major Roads
- Counties

NCDOT Preferred Alternative Corridor

- Orange
- Green
- Mint

STIP: R-2721, R-2828, R-2829	**WBS:** 37673.1.TA2, 35516.1.TA2, 35517.1.TA1
COUNTY: Wake/Johnston	**DIVISION:** 5/4
DATE: July 2017	
PREPARED BY: HNTB North Carolina, P.C. 343 E. Six Forks Rd, Suite 200 Raleigh, NC 27609	
LOCATION: NC 55 Bypass (Holly Springs) to I-495 / US 64 Bypass / US 264 (Knightdale)	
PROJECT: Complete 540 Triangle Expressway Southeast Extension	**Figure ES-1**

Facility	Complete 540																																						
Interchange		OHS-A Rd			NC 55 Bypass							Holly Springs Rd				Bells Lake Rd				US 401						Old Stage Rd				NC 50				I-40 and US 70					
Westbound	B139	M138	B137	D136	B135	M134	B133	M132	B131	D130	B129	M128	B127	D126	B125	M124	B123	D122	B121	M120	B119	M118	B117	D116	B115	M114	B113	D112	B111	M110	B109	D108	B107	M106	B105	W104	B103	D102	B101



Eastbound	B1	D2	B3	W4	B5	D6	B7	M8	B9	D10	B11	M12	B13	D14	B15	M16	B17	D18	B19	M20	B21	M22	B23	D24	B25	M26	B27	D28	B29	M30	B31	D32	B33	D34	B35	M36	B37	M38	B39
Interchange		OHS-A Rd			NC 55 Bypass					Holly Springs Rd				Bells Lake Rd				US 401						Old Stage Rd				NC 50				I-40 and US 70							
Facility	Complete 540																																						

LEGEND

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics – Time Period Demand/Capacity Ratio > 1

Intersection ID # = XX

Freeway ID # = B XX, Basic
= M XX, Merge
= D XX, Diverge
= W XX, Weave

XX = Freeway Segment Breaks
XX = Unsignalized Intersection
XX = Signalized Intersection

N

NOT TO SCALE

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540
TRIANGLE EXPRESSWAY SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

2040 DESIGN YEAR BUILD PREFERRED ALTERNATIVE

LOS & SEGMENT ID #

DATE: July 2017 | **DIVISION:** 5

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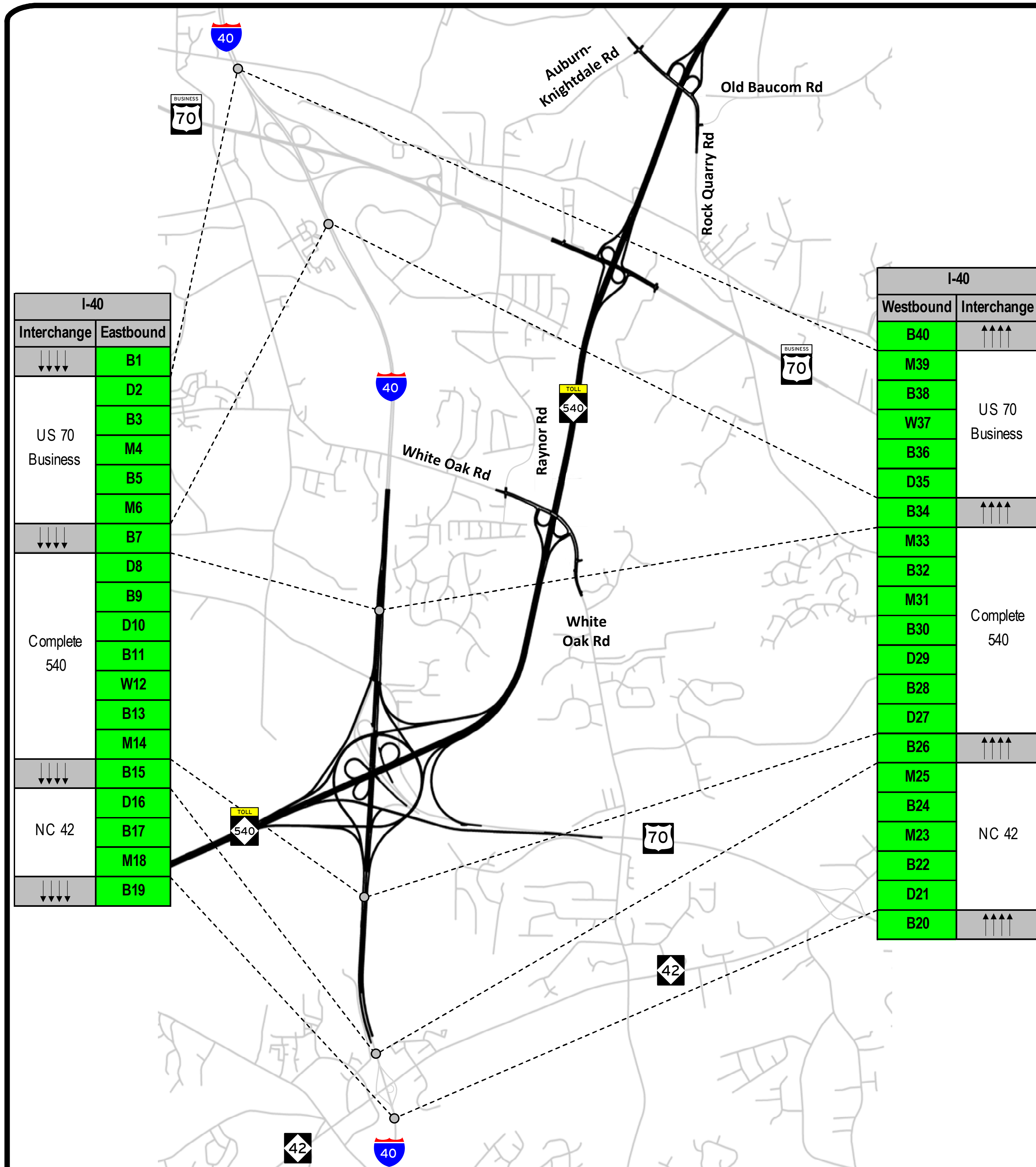
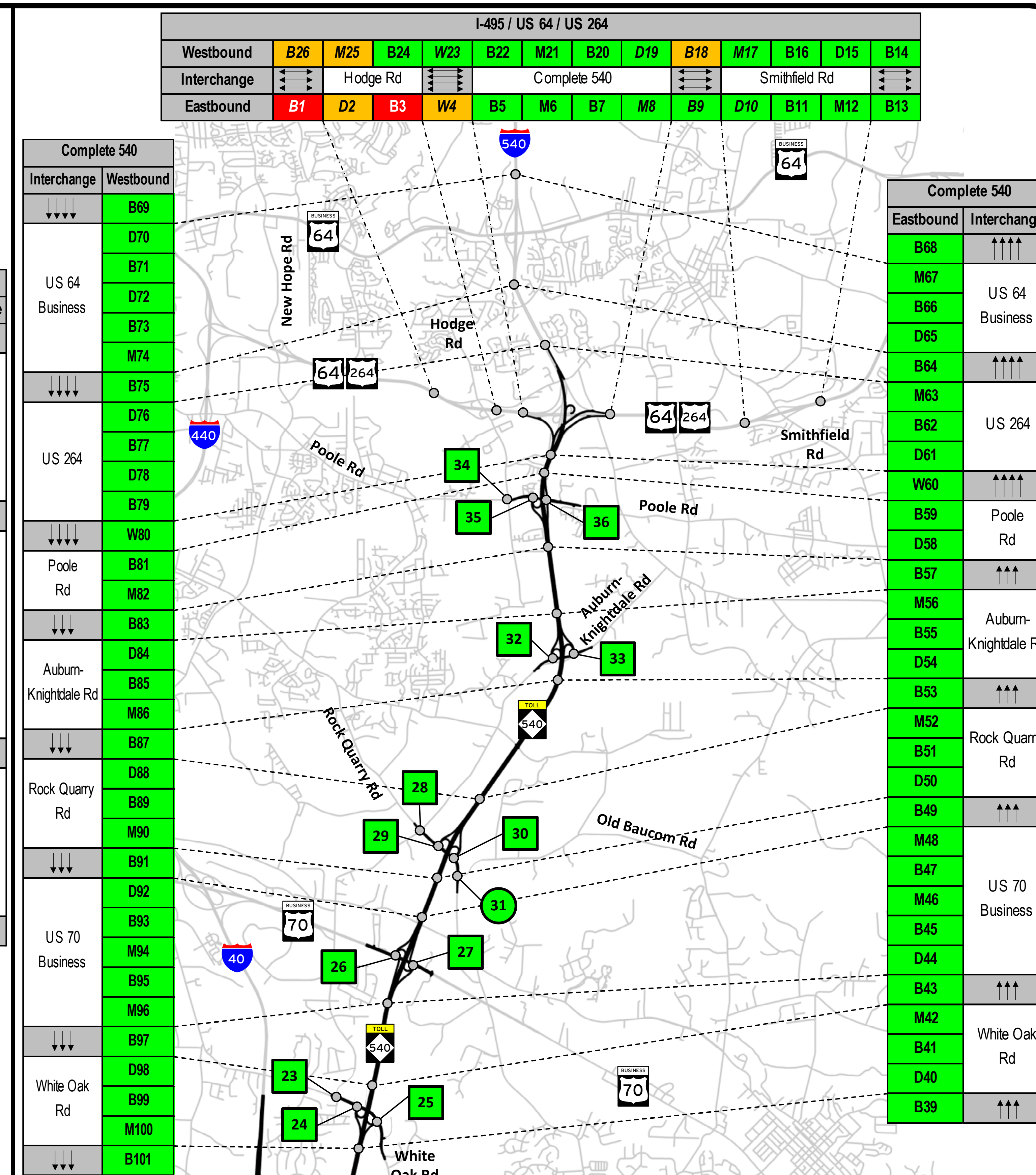
Figure ES.2



I-40	
Interchange	Eastbound
	B1
US 70 Business	D2
	B3
	M4
	B5
	M6
	B7
Complete 540	D8
	B9
	D10
	B11
	W12
	B13
	M14
	B15
NC 42	D16
	B17
	M18
	B19

I-40	
Westbound	Interchange
B40	
M39	US 70 Business
B38	
W37	
B36	
D35	
B34	
M33	Complete 540
B32	
M31	
B30	
D29	
B28	
D27	
B26	
M25	NC 42
B24	
M23	
B22	
D21	
B20	

I-495 / US 64 / US 264													
Westbound	*B26*	*M25*	B24	*W23*	B22	M21	B20	*D19*	*B18*	*M17*	B16	D15	B14
Interchange		Hodge Rd			Complete 540					Smithfield Rd			
Eastbound	*B1*	*D2*	B3	*W4*	B5	M6	B7	*M8*	*B9*	*D10*	B11	M12	B13



Complete 540	
Interchange	Westbound
	B69
US 64 Business	D70
	B71
	D72
	B73
	M74
	B75
US 264	D76
	B77
	D78
	B79
	W80
Poole Rd	B81
	M82
	B83
Auburn-Knightdale Rd	D84
	B85
	M86
	B87
Rock Quarry Rd	D88
	B89
	M90
	B91
US 70 Business	D92
	B93
	M94
	B95
	M96
	B97
White Oak Rd	D98
	B99
	M100
	B101

Complete 540	
Eastbound	Interchange
B68	
M67	US 64 Business
B66	
D65	
B64	
M63	US 264
B62	
D61	
W60	
B59	Poole Rd
D58	
B57	
M56	Auburn-Knightdale Rd
B55	
D54	
B53	
M52	Rock Quarry Rd
B51	
D50	
B49	
M48	US 70 Business
B47	
M46	
B45	
D44	
B43	
M42	White Oak Rd
B41	
D40	
B39	

LEGEND

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics – Time Period Demand/Capacity Ratio > 1

Intersection ID # = XX

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N

NOT TO SCALE

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540 TRIANGLE EXPRESSWAY SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

2040 DESIGN YEAR BUILD PREFERRED ALTERNATIVE

LOS & SEGMENT ID #

DATE: July 2017 | **DIVISION:** 5

PREPARED BY: HNTB North Carolina, P.C. 343 E. Six Forks Rd., Ste. 200 Raleigh, North Carolina 27609

Figure ES.3

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1. INTRODUCTION

The North Carolina Department of Transportation (NCDOT) is studying ways to improve regional mobility in southern and eastern Wake County. NCDOT State Transportation Improvement Program (STIP) Projects R-2721, R-2828, and R-2829, collectively known as Complete 540 – Triangle Expressway Southeast Extension form the outer loop around Raleigh and surround communities in Wake and Johnston Counties, extending from the NC 55 Holly Springs Bypass to I-40 near the US 70 Clayton Bypass (Southern Wake Freeway) and then to I-495 / US 64 / US 264 Knightdale Bypass (Eastern Wake Freeway).

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The following sections describe existing and future transportation conditions in the project study area, the capacity analysis methodology, capacity analysis results for the 2016 Base Year and 2040 Design Year, microsimulation operations analysis, and conclusions and recommendations derived from the capacity analyses related to current functional design for the Complete 540 PA.

2. EXISTING CONDITIONS

The following pages describe the context of the proposed project, the existing transportation system in the Complete 540 project study area and data collection activities conducted for the study.

2.1. Project Corridor Description

The Complete 540 PA corridor alignment in the project study area runs primarily east-west between the existing Triangle Expressway termini at NC 55 Bypass in Apex to I-40 near Clayton. The corridor alignment then runs primarily north-south between I-40 and the existing I-540 system interchange with I-495 / US 64 / US 264 in Knightdale. The corridor alignment crosses multiple existing freeway, arterial, and local roadway facilities. Most of the project study area features lower density rural/suburban development.

Future PA interchange spacing is well over one mile between interchanges, except for the segment from Poole Road to I-495 / US 64 / US 264. In addition to the proposed interchanges, the PA corridor will have numerous grade separations with natural features, railroads, and minor y-line local roadways. There are numerous existing roadway facilities, primarily surface arterial roadways, that parallel the proposed corridor alignment.

The proposed Complete 540 PA is being studied as a six-lane, toll facility and designed for a 75-mile per hour (mph) design speed, with access limited to service and system interchanges with existing y-line facilities. Similar to existing Triangle Expressway, Complete 540 is being planned for all-electronic tolling with overhead toll gantries. No toll booths or speed reductions are required with this type of toll facility. No specific lane restrictions, truck climbing lanes, transit, non-motorized transportation, or High-Occupancy Vehicle (HOV) features are planned for Complete 540.

The general project study area and the spatial relationship of the PA corridor alignment to connecting transportation facilities, municipalities and notable physical and natural features in the region is shown in **Figure 1**.

2.2. Study Area Transportation Facilities

The future location of the PA alignment in relation to existing No-Build surface street intersections and existing freeway crossings and freeway segments included in the No-Build and Build analyses is shown in **Figure 1**. General descriptions and information for selected existing study area roadways to be included in the Complete 540 intersection and freeway capacity analyses are found in **Table 1**.

Table 1 Existing Study Area Roadways

Build Corridor Interchange #	Build Corridor Analysis Intersection ID#s	SR Number / Shield	Road Name	Functional Classification*	Study Area Cross Sections	2015 AADT[#]	Speed Limit
1	10-11	55	NC 55 Bypass	Principal Arterial	4 lane divided	28,000 - 35,000	55
2	20-26	1152	Holly Springs Road	Minor Arterial	2 lane undivided	13,000	45
2	23	1300	Kildaire Farm Road	Minor Arterial	2 lane undivided	20,000	45
3	30-31	1386	Bells Lake Road	Major Collector	2 lane undivided	4,600	45
4	40-46	401	US 401	Principal Arterial	4 lane divided	33,000 - 35,000	55
4	42	1503	Donny Brook Road	Major Collector	2 lane undivided	3,000	45
4	42	2779	Old McCullers Road	Local	2 lane undivided	N/A	35
5	50-52	1006	Old Stage Road	Minor Arterial	2 lane undivided	10,000	45
6	60-67	50	NC 50 (Benson Road)	Minor Arterial	2 lane undivided	15,000 – 17,000	55
6	66	1010	Cleveland School Road	Major Collector	2 lane undivided	8,000	55
8	80-82	2700	White Oak Road	Major Collector	2 lane undivided	8,000^^	45
8	82	2555	Raynor Road	Major Collector	2 lane undivided	6,800[1]	45
9	90-91, 105	BUS 70	US 70 Business	Principal Arterial	4 lane divided	29,000 - 36,000	55
10	100-101, 103	5204	Old Baucom Road	Local	2 lane undivided	960^	55
10	100-104	2542	Rock Quarry Road	Minor Arterial	2 lane undivided	4,900	55
11	102, 110-111	2555	Auburn-Knightdale Road	Major Collector	2 lane undivided	2,800^^ - 3,700^^	45
12	120-122	1007	Poole Road	Minor Arterial	2 lane undivided	10,000	45
12	122	2516	Hodge Road	Major Collector	2 lane undivided	1,200[2] - 12,000	45
7	*N/A*	40	I-40	Interstate	4 - 6 lane divided	60,000 – 84,000	65 - 70
7, 19	*N/A*	BYPASS 70	US 70 Bypass (Clayton Bypass)	Freeway	4 lane divided	28,000	70
1-12, 20	*N/A*	540	NC 540	Freeway	6 lane divided	13,000 – 20,000	70
13-14	*N/A*	540	I-540	Interstate	6 lane divided	50,000 – 58,000	70
13, 15-16	*N/A*	495	I-495	Interstate	6 lane divided	73,000 – 78,000	70
13, 15-16	*N/A*	BYPASS 64 264	US 64 Bypass / US 264	Freeway	6 lane divided	59,000 – 70,000	70
14	*N/A*	BUSINESS 64	US 64 Business	Principal Arterial	6 lane divided	31,000 - 36,000	45

* - As defined on the *NCDOT Functional Classification Map* (http://ncdot.maps.arcgis.com/home/webmap/viewer.html?layers=029a9a9fe26e43d687d30cd3c08b1792, Accessed February 2017)
[#] - Obtained from the *NCDOT AADT Web Map* (https://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=b7a26d6d8abd419f8c27f58a607b25a1, Accessed February 2017)
^2014 AADT
^^2013 AADT (2014 AADT either not counted or an outlier)
1 – Raynor Road AADT at station (just south of US 70 BUS) likely significantly higher than actual volumes just north of White Oak Road.
2 – Low 1,200 AADT value on Hodge Road is south of Poole Road.

Study Area Roadways

There are five major access-controlled freeways within the traffic forecast study area: I-40, I-540, NC 540, I-495 / US 64 / US 264 (Knightdale Bypass), and US 70 Bypass (Clayton Bypass). The following are descriptions of the major roadways within the traffic forecast study area:

- **I-40** is the primary freeway corridor for regional connectivity between Raleigh, Research Triangle Park (RTP), Durham and Chapel Hill in the Triangle. I-40 varies from a four-lane to a six-lane freeway in the traffic analysis study area. The posted speed limit ranges from 65 to 70 miles per hour (mph) through the traffic analysis study area.

- **I-540** is an existing loop freeway around the northern portions of Wake County. It currently spans from I-40 on the western side of Wake County to I-495 / US 64 / US 264 near Knightdale in eastern Wake County. The facility features a six-lane cross section in the study area, with auxiliary lanes at interchanges and a posted speed limit of 70 mph.

- **NC 540**, also referred to as **Triangle Expressway**, is an existing freeway facility that is an extension of I-540 in western Wake County from I-40 to NC 55 Bypass near Holly Springs. The facility features a six-lane cross section with a posted speed limit of 70 mph. NC 540 from NC 54 (near RTP) to NC 55 Bypass is a toll facility.

- **I-495 / US 64 / US 264 (Knightdale Bypass)** is an existing controlled access freeway in the traffic forecast study area providing access to areas of east Wake County to I-440 and further to I-95. In the traffic forecast study area, I-495 / US 64 / US 264 features a six-lane cross-section, with auxiliary lanes at interchanges and a posted 70 mph speed limit. Currently, the route is designated I-495 from I-440 to I-540 and US 64 / US 264 east of I-540 with plans to designate the entire facility, from I-440 to I-95 in Rocky Mount, as I-495 in the future.

- **US 70 Bypass (Clayton Bypass)** is an existing controlled access freeway in the traffic forecast study area providing access to areas of Johnston County to I-40. In the traffic forecast study area, US 70 Bypass contains a four-lane cross-section, with auxiliary lanes at interchanges and a posted speed limit of 70 mph.

Other major roadways that are specifically included in the project study area include NC 55 Bypass, Holly Springs Road, Bells Lake Road, US 401, Old Stage Road, NC 50 (Benson Road), White Oak Road, US 70 Business, Rock Quarry Road, Auburn-Knightdale Road, and Poole Road. These existing thoroughfares are primarily multi-lane and two-lane facilities with 35, 45, or 55 mph speed limits in the traffic forecast study area and provide regional connectivity and access throughout Wake County, with future interchange connections to the proposed PA corridor.

Y-Lines and Grade Separated Facilities

Along the Complete 540 PA corridor, there are 17 proposed grade separations of the NC 540 freeway including railroads and intersecting minor study area roadways that have no interchange access to NC 540. These facilities within the Complete 540 project corridor are currently planned to cross NC 540 via overpasses or underpasses, per the functional designs, and are subject to change. The grade separated facilities are identified in **Table 2**, but were not studied specifically for any traffic operations impacts in this document, since they will not directly impact Complete 540 operations.

Table 2 Y-Line Grade Separated Facilities*

Y Line	Crossing Type
Old NC 55 (E. Williams St.)	Underpass
SR 1301 (Sunset Lake Road) *[western crossing]*	Overpass
SR 1301 (Sunset Lake Road) *[eastern crossing]*	Overpass
SR 1389 (Pierce-Olive Road)	Overpass
SR 1387 (West Lake Road)	Overpass
SR 1578 (Deer Meadow Road)	Overpass
SR 1404 (Johnson Pond Road)	Overpass
SR 1375 (Lake Wheeler Road)	Underpass
SR 2722 (Old McCullers Road)	Underpass
Norfolk Southern Railroad	Underpass
SR 2723 (Fanny Brown Road)	Overpass
SR 2725 (Holland Church Road)	Overpass
SR 2727 (Sauls Road)	Overpass
SR 2731 (Jordan Road)	Overpass
Southern Railway	Underpass
SR 1004 (E. Garner Road)	Underpass
SR 2552 (Battle Bridge Road)	Overpass

* Overpass and underpass locations are preliminary and subject to change.

Along the proposed NC 540 corridor, multiple Y-line facilities are impacted and re-routed/re-aligned based on proximity to the proposed NC 540 corridor and interchange ramp terminals. Below is a list of notable Y-line facilities impacted:

- SR 1300 (Kildaire Farm Road) realigned to the north, across from SR 3921 (Sancroft Drive at SR 1152 (Holly Springs Road)
- SR 1503 (Donny Brook Road) realigned to the south, joining Chandler Ridge Circle, across from Wake Tech Way at US 401
- SR 2779 (Old McCullers Road) severed from US 401 and realigned to Wake Tech internal circulation
- SR 2555 (Raynor Road) realigned to the west to be across from a realigned Tiffany Creek Drive at SR 2700 (White Oak Road)
- SR 5204 (Old Baucom Road) realigned to the south at intersection with SR 2542 (Rock Quarry Road)

2.3. Study Area Interchanges / Intersections

The following paragraphs describe existing geometrics and traffic control at all study area interchanges and intersections. Refer to **Figures 4.1** to **4.5** for additional schematic details, including laneage between intersections.

<u>Existing Study Area Interchanges</u>

NC 540 (Triangle Expressway) & NC 55 Bypass
The existing Toll NC 540 six-lane freeway facility currently terminates at the NC 55 Bypass four-lane divided facility. This service interchange is a partial cloverleaf design and features single-lane loop ramps in the northeast and southeast interchange quadrants with free-flowing entry/exit movements for each movement. This interchange is designed to accommodate future Complete 540.

I-40 & US 70 Business
The US 70 Business interchange with I-40 is a partial cloverleaf design with loop ramps in the northeast, southeast, and northwest interchange quadrants. The interchange features single and dual lane on-ramps and off-ramps with free-flowing entry/exit movements for all ramp terminals, except for one. The I-40 EB to US 70 Business Westbound ramp terminal is signalized. US 70 Business is an existing four-lane divided facility.

I-40 & US 70 (Clayton Bypass)
US 70 Bypass (Clayton Bypass), opened to traffic in 2008, terminates at a system interchange with I-40. This system interchange is a trumpet interchange design with two lanes on the I-40 eastbound off-ramp flyover and a single lane on all other ramps.

I-495 & Hodge Road
The Hodge Road service interchange with I-495 is a partial cloverleaf design with loop ramps in the northwest and southwest interchange quadrants. Signalized ramp terminals exist on both sides of the Hodge Road overpass. This study analyzes only the mainline freeway facilities at this interchange since the roadway design project limits for Complete 540 do not extend to the ramp terminals at this interchange.

I-540 & I-495 / US 264 / US 64
I-540 currently terminates at a system interchange with I-495 / US 64 / US 264. This system interchange is a trumpet interchange design with a one lane flyover and loop ramp. This interchange is designed to accommodate future Complete 540.

US 264 / US 64 (Knightdale Bypass) & Smithfield Road
The Smithfield Road service interchange with US 64 / US 264 is a traditional diamond interchange design. Signalized ramp terminals exist on both sides of the US 64 / US 264 overpass. This study analyzes only the mainline freeway facilities at this interchange since the roadway design project limits for Complete 540 do not extend to the ramp terminals at this interchange.

US 64 Business & I-540
The US 64 Business service interchange with I-540 is a diamond interchange design with a loop ramp in the southwest interchange quadrant. Signalized ramp terminals exist on both sides of the US 64 Business overpass. This study analyzes only the mainline freeway facilities at this interchange since the roadway design project limits for Complete 540 do not extend to the ramp terminals at this interchange.

I-40 & NC 42
The NC 42 interchange with I-40 is a diamond interchange design with a loop ramp in the southeast interchange quadrant. Signalized ramp terminals exist on both sides of the NC 42 overpass. This study analyzes only the mainline freeway facilities at this interchange since the roadway design project limits for Complete 540 do not extend to the ramp terminals at this interchange.

US 70 & NC 42
The NC 42 interchange with US 70 is a diamond interchange design. Signalized ramp terminals exist on both sides of the NC 42 overpass. This study analyzes only the mainline freeway facilities at this interchange since the roadway design project limits for Complete 540 do not extend to the ramp terminals at this interchange.

Existing Study Area Intersections
HNTB analyzed 12 existing at-grade intersections in the No-Build and Build scenarios, that are expected to be impacted by the Complete 540 PA alignment. **Table 3** provides a list of existing intersections and their existing traffic control details.

Table 3 Existing Study Area Intersection Details

Intersection	Study ID #	Traffic Control	Signal Phases	Signal Operation	Cross walk	Ped Signals
NC 55 Bypass and Mid-block U-turn	1	Unsignalized	N/A	N/A	No	No
NC 55 Bypass and Old Smithfield Road	2	Unsignalized	N/A	N/A	No	No
NC 55 Bypass and NC 540 EB Ramps	3	Unsignalized	N/A	N/A	No	No
NC 55 Bypass and NC 540 WB Ramps	4	Unsignalized	N/A	N/A	No	No
Holly Springs Road (SR 1152) and Kildaire Farm Road (SR 1300)	11	Signal	3	Coordinated	No	No
US 401 and Donny Brook Road (SR 1503) / Old McCullers Rd (SR 2779)	15	Signal	5	Coordinated	No	No
US 401 and Wake Tech Drive / Chandler Ridge	14	Signal	5	Coordinated	Yes	Yes
NC 50 and Cleveland Road (SR 1010) / Stevens Oaks Drive (SR 5324)	20	Signal	3	Free-Run	No	No
White Oak Road (SR 2700) and Raynor Road (SR 2555)	23	Unsignalized	N/A	N/A	No	No
Rock Quarry Road (SR 2542) and Auburn-Knightdale Road (SR 2555)	28	Signal	2	Free-Run	No	No
Rock Quarry Road (SR 2542) and Old Baucom Road (SR 5204)	31	Unsignalized	N/A	N/A	No	No
Poole Road (SR 1007) and Hodge Road (SR 2516)	34	Signal	3	Free-Run	No	No

Coordinated = Coordinated Signal Control (Closed Loop System)

2.4. Data Collection

Field verification of existing conditions and operations within the study area, including geometrics, traffic control devices, speed limits, and traffic patterns, was completed on June 16, 2016. In June 2016 HNTB received the most recent traffic signal plans in the study area from the NCDOT Transportation Mobility and Safety Division. The 2040 Metropolitan Transportation Plan (MTP) documents were obtained from Capital Area Metropolitan Planning Organization (CAMPO).

3. METHODOLOGY

The following pages describe the traffic volume development and capacity analysis methodologies used in this technical memorandum.

3.1. 2016 Base Year and 2040 Design Year Traffic Volume Development

The *Complete 540 Preferred Alternative Traffic Forecast*, prepared by HNTB North Carolina, was used to develop the AM and PM peak hour traffic volumes analyzed in this study. ***Appendix B*** contains the traffic forecast used in this report. Refer to the original traffic forecast documentation for additional details on the traffic counts conducted to support the traffic forecast.

Raw count data was not directly used in the 2016 Base Year traffic analyses for Complete 540. 2016 Base Year volumes that were analyzed in this report are a product of the final traffic forecast data that included daily traffic estimates/directional splits/design hourly volume estimates that were reduced to AM and PM peak hour information. ***Appendix C*** contains the traffic forecast breakout peak hour traffic volumes

Daily traffic flows and design data (DHV and D) were entered into the NCDOT Congestion Management Section peak hour breakout spreadsheets for conversion into peak hour volumes at each study area intersection. The peak hour breakout spreadsheet results were converted into individual AM and PM peak hour movements for the proposed Complete 540 interchange forms in a separate conversion spreadsheet developed by HNTB. Both the peak hour breakout spreadsheets and the interchange conversion spreadsheets are found in ***Appendix C***.

Traffic flows were balanced between ramp terminals at each interchange, and were balanced (through the Freeway Facilities software data entry) for mainline segments along existing and proposed Complete 540 alignments based on an entry input volume and subsequent peak hour breakout on-ramp/off-ramp volumes. In this manner, the existing freeway and proposed Complete 540 freeway systems were balanced with a different methodology (and results) than if individual interchange mainline volume breakouts were analyzed in individual HCS freeway segment analyses.

3.2. Capacity Analysis Methodology

Evaluating traffic operations on suburban arterials and uninterrupted flow freeway facilities is generally done by the determination of level of service (LOS) criteria. The level of service on a freeway segment, arterial corridor, or individual intersection correlates qualitative aspects of traffic flow to quantitative terms. This enables transportation professionals to take the qualitative issues, such as congestion and substandard geometrics, and translate them into measurable quantities, such as operating speeds, flow densities, and vehicular delays. The *2010 Highway Capacity Manual (HCM 2010)* characterizes level of service by letter designations A through F. Level of service A represents ideal low-volume traffic operations, and level of service F represents over-saturated, high-volume traffic operations.

LOS for intersections is determined by average delay per vehicle, while LOS for freeway facilities is primarily determined by vehicular density of a defined freeway segment, merge/diverge area or weaving section. Level of service letter designations and criteria for arterial intersections (seconds of delay per vehicle) and for freeway facilities (average density in passenger cars per mile per lane (pc/mi/ln)) are described in **Table 4**.

The AM and PM peak hour results of this analysis are based on the LOS and delay procedures presented in the *HCM 2010*. To obtain optimized signal timings for the future traffic conditions, the timing optimization software Synchro Professional Version 9.0 was used to evaluate an optimal cycle length and phasing for the projected peak hour traffic volumes. Existing intersection signal plans were used in the analysis to develop cycle lengths, phasing, splits and intersection coordination along the project study area's arterial facilities (where applicable). NCDOT Congestion Management Section Capacity Analysis Guidelines were used in developing all other scenario timings for Build scenarios and/or future year analyses. SimTraffic Professional was used for microsimulation.

All freeway analyses, such as basic freeway segments and ramp merges and diverges, were analyzed using the Highway Capacity Software (HCS) 2010 freeway facilities system module (Freeway Facilities). Freeway Facilities allows the integration of individual segment analyses into corridor analysis to study potential multi-segment operational issues.

To simplify the process of organizing analysis results for all No-Build Alternative and Build Alternative scenarios, an identification scheme was developed for all freeway segments and study area intersections. Build Complete 540 freeway segments were analyzed in the HCS Freeway Facilities software package in the 2016 and 2040 analysis years, for the AM and PM peak hours, and in the eastbound and westbound directions. Segments are numbered sequentially in the eastbound/northbound direction and then the westbound/southbound direction. Each identification also includes a preceding letter designation for basic freeways (B), diverge ramp areas (D), merge ramp areas (M) and weaving sections (W) in the project study area.

To aid in the organizational process for analyzing surface street at-grade intersections and to assist in individual corridor signal coordination optimization, each Y-line facility intersecting Completing 540 was separated and numbered as individual zones in Synchro (1-12). Individual signalized and unsignalized study area intersections are then numbered 1-36 moving from west to east and south to north through the study area.

Table 4 Intersection & Freeway Segment Level of Service (LOS) Characteristics

Level of Service Description	Intersection		Freeway	
	Per Vehicle Delay Signal Control (seconds)	Per Vehicle Delay Stop Control (seconds)	Basic Freeway Segment Density (pc/mi/ln)	Merge/Diverge/ Weaving Area Density (pc/mi/ln)
LOS A Free flow Freedom to select desired speed / maneuver is extremely high General level of comfort and convenience for motorists is excellent	< 10.0	< 10.0	0 – 11.0	<= 10.0
LOS B Stable flow Other vehicles in the traffic stream become noticeable Reduction in freedom to maneuver from LOS A	10.0 – 20.0	10.0 – 15.0	>11.0 – 18.0	>10.0 – 20.0
LOS C Stable flow Maneuverability/operating speed are significantly affected by other vehicles General level of comfort and convenience declines noticeably	20.0 – 35.0	15.0 – 25.0	>18.0 – 26.0	>20.0 – 28.0
LOS D High density but stable flow Speed and freedom to maneuver are severely restricted General level of comfort / convenience is poor Small increases in traffic will generally cause operational problems	35.0 – 55.0	25.0 – 35.0	>26.0 – 35.0	>28.0 – 35.0
LOS E Unstable flow Speed reduced to lower but relatively uniform value Volumes at or near capacity level Comfort and convenience are extremely poor Small flow increases/minor traffic disturbances will cause breakdowns	55.0 – 80.0	35.0 – 50.0	>35.0 – 45.0	>35.0
LOS F Forced or breakdown flow Volumes exceed roadway capacity Formation of unstable queues Stoppages for long periods of time because of traffic congestion	> 80.0	> 50.0	> 45.0	Demand exceeds capacity

Transportation Research Board, *Highway Capacity Manual*. Washington, D.C.: National Research Council, 2010.

3.2.1. Freeway Analysis Methodology

The initial procedure for freeway analysis input into the HCS 2010 freeway facilities module (Freeway Facilities) involved the segmentation of existing (NC 540, I-40, US 70, I-495 / US 64 / US 264, I-540) and the proposed freeway facility (Complete 540). The functional design file for the PA was reviewed and segmented appropriately depending on its alignment, proposed interchange forms and geometric characteristics. Segments fall into the following categories – basic freeway segments, merge areas, diverge areas, weaving segments and collector-distributor facilities.

After segmentation, geometric and traffic flow inputs were entered into Freeway Facilities for each segment. For a basic freeway segment, these inputs and typical values used in this analysis) include:

- Traffic volumes were generated from NCDOT Forecast non-adjustable peak hour breakouts for the first entering mainline segment only.
- Four 15-minute time periods with demand adjustment factors of 0.89, 1.00, 1.11 and 1.00 were applied to the hourly demand to replicate a 0.90 peak hour factor. See ***Appendix D*** for additional information.
- The number of lanes varies depending on existing geometrics, planned MTP improvements to existing freeway facilities or PA design. The standard PA design is for a six-lane divided facility in most locations, with three travel lanes in each direction. Auxiliary lanes are proposed along Complete 540 at the following locations:
    - In both eastbound and westbound directions between Veridea Parkway (Old Holly Springs-Apex Road) and NC 55 Bypass,
    - In both northbound and southbound directions between I-495 / US 64/ US 264 and Poole Road, and
    - In both northbound and southbound directions between Complete 540/US 70 Bypass and NC 42.
- The terrain type is assumed to be "Rolling" for this area per the Design Criteria.
- The Base Free Flow Speed was assumed to be 5 mph greater than posted speed limits.
- The Truck Percentages were calculated from the Traffic Forecast as being equal to the percent Duals plus the percent TTST divided by two for all the peak hour mainline study area entry segments only. The truck percentages for all other mainline segments were calculated based on on/off-ramp percentages.
- Lane Width set to 12 feet.
- Right Shoulder Lateral Clearance set to 6 feet.
- Segment Lengths were determined by aerial photography or functional designs between upstream/downstream merge/diverge points.

The Freeway Facilities inputs for merging and diverging areas contain additional input parameters beyond the basic freeway segment information. These parameters, and typical values used in this analysis, include:

- On-Ramp/Off-Ramp volumes were generated from NCDOT Forecast non-adjustable peak hour breakouts.

- The location of Ramp Relative to Freeway was set to Right for all segments, given the PA alignment.
- Acceleration/Deceleration Lane Lengths were determined from aerial photography, field measurement or functional designs.
- The Free Flow Speeds on Ramps were set 50 mph for cloverleaf/flyover on/off ramps/diamond on/off ramps and 30 mph for loop ramps
- The Truck Percentage was taken from Traffic Forecast (Duals+TTST/2) for peak hour Y-lines.

The Freeway Facilities inputs for weaving areas contain additional input parameters beyond the basic freeway segment and ramp segment information. These parameters, and typical values used in this analysis, include:

- On-Ramp/Off-Ramp volumes were generated from NCDOT Forecast non-adjustable peak hour breakouts and factored counts.
- The location of Ramp Relative to Freeway was set to Right for all segments, given the PA alignment.
- Acceleration/Deceleration Lane Lengths were determined from aerial photography, field measurement or functional designs.
- The Free Flow Speeds on Ramps were set to 30 mph for loop ramps.

After inputs were entered into Freeway Facilities and checked, output data for each segment was collected for the segment density and corresponding LOS. In addition, system-wide information (by freeway direction) from Freeway Facilities was compiled and compared for the study alternatives.

The following Freeway Facilities analysis assumptions for service interchanges were also implemented in the development of the Freeway Facilities network files:

- On-Ramp/Off-Ramp Volumes (Maximum 1-lane ramp demand of 2,200 vehicles per hour. Where ramp demands exceeded 2,200 vehicles per hour, ramp lane was increased from 1 to 2-lanes). One exception to this assumption is at the NC 55 Bypass interchange. The off-ramp from eastbound NC 540 to southbound NC 55 Bypass and the on-ramp loop from northbound NC 55 Bypass to westbound NC 540 are analyzed as single-lane ramps to adhere to the existing configuration.
- Acceleration/Deceleration Lane Lengths (Maximum input distance of 1,500 feet. All distances exceeding 1,500 feet were reduced to 1,500 feet).
- Drop Lanes (Due to Freeway Facilities analysis limitations, an off-ramp was analyzed to remove volumes from the mainline to create the effect of a drop lane).

Additionally, the demand-to-capacity (d/C) ratios for ramp roadways at the two system interchanges were checked for potential capacity issues using the method described in HCM 2010. The following parameters and assumptions were used in the analysis:

- On-Ramp/Off-Ramp volumes were generated from NCDOT Forecast non-adjustable peak hour breakouts.
- The Free Flow Speeds on the ramps were set 50 mph for cloverleaf/flyover on/off ramps/diamond on/off ramps and 30 mph for loop ramps

- The Truck Percentage was taken from Traffic Forecast (Duals+TTST/2) for peak hour Y-lines.
- The maximum capacity a single lane ramp was 2,200 passenger cars/hour (pc/h) for flyover ramps and 2,100 pc/h for loop ramps.

The capacity of each ramp roadway was determined by multiplying the number of lanes by the single-lane capacity of the ramp. The d/C ratios were calculated by dividing the demand flow rate by the overall capacity of the ramp roadway.

Detailed output from Freeway Facilities and the d/C ratio summary tables can be found in ***Appendix D***.

3.2.2. Signalized Intersection Analysis Methodology

Signalized intersection capacity analyses were performed using Synchro Professional Software Version 9.0 for all scenarios. GIS-based roadway centerline information and geo-referenced aerial photography were obtained from NCDOT and NC OneMap to establish a base map for developing the proper spatial orientation of the Synchro roadway network for the separate y-line arterial roadway corridors that have existing interchanges with I-40/US 264 or future PA interchanges with Complete 540 corridors that are being analyzed for this study. Per direction from NCDOT Congestion Management staff, no analysis of the Y-line ramp terminal intersections intersecting I-40, I-495 / US 64 / US 264 or US 64 Business beyond actual PA design footprints were made for this study.

HNTB 2016 Base Year PA traffic forecast volume data for the AM and PM peak hours was entered into the Synchro networks. Current signal plans were obtained from NCDOT and used for the 2016 No-Build Alternative inputs for signal phasing and timing (cycle length, splits, offset, and coordination). Additional signal timing details that comply with NCDOT Congestion Management practices and recommendations were also updated (lost time, no right-turn-on-red, PHF, etc.) for the AM and PM peak hours.

2016 Build analysis and 2040 Design Year Build analysis included updates to Synchro inputs and parameters as follows:

- Traffic volume updates for each alternative from traffic forecast breakouts
- Optimization of cycle lengths/splits/offsets for the 2016 Base Year Build alternative
- Further optimization checks for 2040 Build alternatives
- Updating intersection control from unsignalized to signalized between No-Build and Build and/or base and future year scenarios, if warranted based on unsignalized intersection capacity analysis results and Manual on Uniform Traffic Control Devices (MUTCD) peak hour signal warrant criteria/thresholds
- Permissible changes in signal phasing in situations where phase orders could improve performance and complied with NCDOT Congestion Management policies/guidelines
- Synchro default lane utilization factors (LUFs) were updated at intersections where dual left turns and/or downstream lane drops were present using the calculation methods outlined in the NCDOT research report titled False Capacity for Lane Drops by Lee, et al. (2005).

3.2.3. Unsignalized Intersection Analysis Methodology

Unsignalized intersection capacity analyses were performed using the HCS 2010 Unsignalized report for two-way stop-controlled intersections in Synchro Professional Software Version 9.0. There are six existing unsignalized, two-way stop-controlled intersections in the project study area that were included in this analysis:

- NC 55 Bypass and Mid-block U-turn
- NC 55 Bypass and Old Smithfield Road
- NC 55 Bypass and NC 540 Eastbound Ramps
- NC 55 Bypass and NC 540 Westbound Ramps
- White Oak Road and Raynor Road
- Rock Quarry Road and Old Baucom Road

Unsignalized intersection analysis inputs were identical to the input methodology used for the signalized intersections and complied with NCDOT Congestion Management practices.

Microsimulation runs were performed using the SimTraffic software package for 2016 Base Year No-Build, 2016 Base Year Build PA and 2040 Design Year Build PA scenarios for the AM and PM peak hour conditions. The models were run for one hour with a 15-minute seeing period where traffic was loaded onto the network. Ten (10) model runs were conducted with 1-10 number seeds. SimTraffic queuing and blocking results were compiled as a check of 95th percentile queue length results from the Synchro output and as a general visual check of individual intersection operations. No direct comparisons were made between Synchro and SimTraffic results for vehicular delay and LOS.

Summary tables showing the LOS, delay, Synchro 95th percentile queues and SimTraffic maximum queues for each of the analysis scenarios are included in ***Appendix E***. Detailed Synchro LOS and delay reports and SimTraffic queueing and blocking reports are also included in ***Appendix E***.

4. DEVELOPMENT OF ALTERNATIVES

This Complete 540 technical memorandum includes analysis of the following scenarios:

- 2016 Base Year No-Build,
- 2016 Base Year Build PA, and
- 2040 Design Year Build PA.

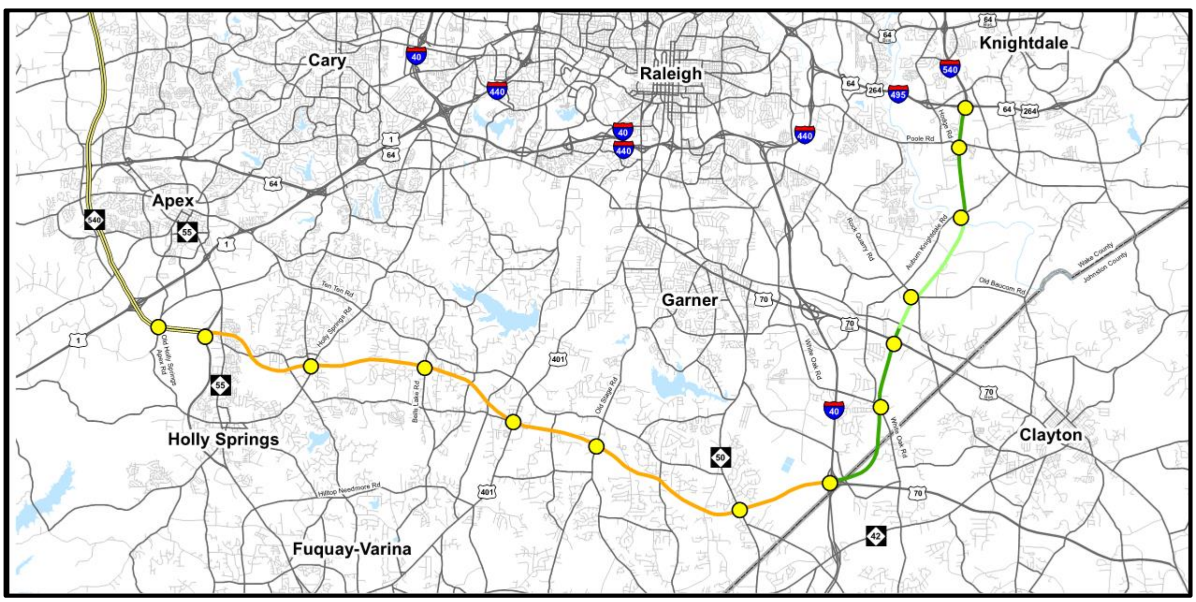
A 2040 Design Year No-Build scenario is not included. Per Section 8 of the *Complete 540 Preferred Alternative Traffic Forecast*, "The Complete 540 project team considered the preparation of a 2040 Future Year No-Build (FYNB) traffic forecast in conjunction with the preparation of the Future Year Build (FYB) traffic forecast for the preferred alternative. A 2040 FYNB traffic forecast has not been developed. Various alternative means and methods are being explored at this time to quantitatively assess FYNB and FYB traffic forecast scenarios based on traffic operations and traffic conditions."

The following section describes the Build PA alternative analyzed in the report.

4.1. Complete 540 Build Preferred Alternative Description

The Complete 540 PA corridor follows the orange, green, mint, and green segment corridors as displayed in **Exhibit 1** below and in **Figure 1** included in ***Appendix A***.

Exhibit 1 Complete 540 Preferred Alternative (PA)



The Complete 540 PA corridor is comprised of three corridor segments. The first segment is the Orange Corridor for the southern section of the project. The Orange Corridor begins at the Triangle Expressway and NC 55 Bypass interchange in Holly Springs and travels eastward to the I-40 and US 70 Bypass interchange near the border of Wake and Johnston Counties. The Orange Corridor primarily runs to the south of and parallel to SR 1010 (Ten Ten Road) for most its alignment. The Orange Corridor includes planned interchanges at NC 55 Bypass, SR 1152 (Holly Springs Road), SR 1386 (Bells Lake Road), US 401, SR 1006 (Old Stage Road), NC 50, and I-40.

The second corridor segment is the Green Corridor for the eastern section of the project. The Green Corridor begins at the I-40 and US 70 interchange and heads north/northeast to the existing I-540 and I-495 / US 64 / US 264 interchange. The Green Corridor has planned interchanges with I-40, SR 2700 (White Oak Road), US 70 Business, SR 2542 (Rock Quarry Road), SR 2555 (Auburn-Knightdale Road), SR 1007 (Poole Road), and I-495 / US 64 / US 264.

The third corridor segment is the Mint Corridor. The Mint Corridor has interchanges at the same locations as the Green Corridor. The only difference between the two alignments is that the section of the project between Rock Quarry Road and Auburn Knightdale Road has a proposed alignment slightly further to the east in the Mint Corridor option.

Table 5 summarizes the proposed interchange forms for the PA corridor along the southern and eastern sections of NC 540.

Table 5 Interchange Forms for the Preferred Alternative

Interchange	Interchange #	Proposed Interchange Form*
NC 55 Bypass & NC 540	1	6 Ramp Partial Cloverleaf with Loops in Quadrants A & D
Holly Springs Road & NC 540	2	Diverging Diamond
Bells Lake Road & NC 540	3	Partial Cloverleaf with Loops in Quadrants A & C
US 401 & NC 540	4	6 Ramp Partial Cloverleaf with Loops in Quadrants A & C
Old Stage Road & NC 540	5	Diamond
NC 50 & NC 540	6	Half Tight Diamond with Loop in Quadrant B
I-40/US 70 & NC 540	7	Dreamcatcher
White Oak Road & NC 540	8	Partial Cloverleaf with Loops in Quadrants B & C
US 70 Business & NC 540	9	6 Ramp Partial Cloverleaf with Loops in Quadrants A & C
Rock Quarry Road/Old Baucom Road & NC 540	10	Partial Cloverleaf with Loops in Quadrants A & D
Auburn-Knightdale Road & NC 540	11	Partial Cloverleaf with Loops in Quadrants A & D
Poole Road & NC 540	12	Half Tight Diamond with Loop in Quadrant B
US 64/264 & NC 540	13	Semi directional with Loops in Quadrant B & D

* - Proposed interchange forms selected by the project team are preliminary and subject to change.

4.2. 2040 Design Year Build PA Alternative Assumptions

The 2040 Design Year Build PA scenario assumes that the Complete 540 project will be constructed along with committed to and fiscally constrained 2040 MTP projects. Based on information collected to date for the Complete 540 project, the additional improvements shown in **Table 6** are currently anticipated (or approved in the 2040 CAMPO MTP) in the project study area by the 2040 Design Year. Therefore, the project assumes the additional improvements from the 2040 MTP in the 2040 Design Year.

Additionally, NCDOT STIP Project R-2635D, also referred to as Access 540, proposes to convert the existing grade separation of Veridea Parkway (formerly Old Holly Springs-Apex Road) over NC 540 (Triangle Expressway) to a partial cloverleaf interchange and construct auxiliary lanes between US 1 and NC 55 Bypass. The project is currently scheduled to be open to traffic in 2017. R-2635D functional design plans, prepared by HNTB, were reviewed and incorporated into the freeway analysis only. A partial cloverleaf, with loop ramps in the northeast and southeast quadrants, was analyzed in Freeway Facilities by inserting diverge and merge segments into the existing NC 540 (Triangle Expressway) freeway network configuration. The 2040 Design Year Build freeway analysis was updated from the 2016 Base Year to include this interchange adjacent to the Complete 540 western project termini at NC 55 Bypass. It was assumed that all existing roadway geometrics, laneage, and traffic control would remain consistent with 2016 Base Year information along all other areas.

NCDOT is currently evaluating five alternatives for reconfiguration of the I-40 and NC 42 interchange as part of STIP I-4739 project. However, a preferred alternative and interchange form is yet to be determined. Therefore, a preferred interchange form was not assumed in the Complete 540 analysis. HNTB is coordinating with the NCDOT and STIP I-4739 project team to coordinate the connectivity between the two projects.

Table 6 2040 MTP Changes to Study Area Roadways

SR Number	Road Name	Segment	Number of Lanes	
			Existing	2040 MTP
	I-40	Exit 306 (US 70 Business) to Exit 312 (NC 42)	4	10[1]
-	I-540	Exit 24 (US 64 Business) to Exit 26 (US 64/264)	6	8[1]
-	US 64 / US 264	Exit 422 (Hodge Road) to Exit 425 (Smithfield Road)	6	8
-	US 70	Exit 318 (I-40) to Exit 320 (NC 42)	4	4
-	US 401	Ten Ten Road to Tech Road	4	6
	NC 50	Ten Ten Road to Cleveland School Road	2	4
-	NC 55 Bypass	E Williams Street to Old Smithfield Road	4	6
-	US 70 Business	I-40 to NC 42	4	6
1007	Poole Road	Hodge Road to Clifton Road	2	4
1152	Holly Springs Road	Ten Ten Road to Kildaire Farm Road	2	4[2]
1152	Holly Springs Road	Kildaire Farm Road to Sunset Lake Road	2	4[2]
1006	Old Stage Road	Ten Ten Road to Banks Road	2	4
1010	Cleveland School Road	NC 50 to NC 42	2	2
2542	Rock Quarry Road	Battle Bridge Road to E. Garner Road	2	4
1386	Bells Lake Road	Ten Ten Road to Optimist Farm Road	2	2
2700	White Oak Road	Raynor Road to Carley Circle	2	4
2555	Auburn-Knightdale Road	Battle Bridge Road to Grasshopper Road	2	2
1503	Donny Brook Road	Lake Wheeler Road to US 401	2	2
2555	Raynor Road	White Oak Road to Twain Drive	2	2
5204	Old Baucom Road	Rock Quarry Road to Brown Field Road	2	2
2516	Hodge Road	US 264/64 to Poole Road	2	2
2779	Old McCullers Road	US 401 to Ten Ten Road	2	2

[1] – Includes 2 Managed Lanes.
[2] – Analyzed 6-lane section at NC 540 interchange and 4-lane section at project limits.

5. FREEWAY SEGMENT ANALYSIS

This section presents the capacity analysis for freeway facilities for 2016 Base Year No-Build and Build and 2040 Design Year Build PA scenarios within the Complete 540 project study area. AM and PM peak hour traffic volumes and existing/proposed lane geometrics were entered into the HCS 2010 Freeway Facilities software module. Detailed segment measures of effectiveness results for the worst-case AM and PM peak hour for the Complete 540 are presented in **Tables 12** and **13**.

5.1. 2016 Base Year Analysis

This analysis uses the 2016 Base Year No-Build and Build peak hour traffic volumes and existing/proposed lane geometrics to evaluate traffic operations on the Complete 540, NC 540, I-40, US 70, I-495 / US 64 / US 264 and I-540 uninterrupted flow facilities in the project study area. The analysis determines individual freeway segment and system-wide density and LOS measures of effectiveness for 2016 Build PA scenario.

5.1.1. 2016 No-Build Scenario Results

All the segments along existing freeway facilities perform at an acceptable LOS D or better in the AM and PM peak hours. **Figure 2** provides a sheet key for the No-Build freeway segment figures. **Figures 3.1 to 3.5** schematically show 2016 Base Year No-Build existing laneage and intersection traffic control for roadways in the study area, along with the scheme for freeway segment identification numbers.

5.1.2. 2016 Build PA Scenario Results

For Complete 540 PA operations, all freeway segments are expected to operate at LOS D or better. For the US 70 and I-495 / US 64 / US 264 corridors, all freeway segments are projected to operate at LOS D or better. For the I-40 corridor, the eastbound segment results indicate that corridor operations and segment densities will slightly worsen from the No-Build scenario with two (2) segments at near capacity (LOS E) to one (1) segment at near capacity and another one exceeding peak hour capacity (LOS F). The results for the westbound segments indicate that corridor operations and segment densities will slightly improve from the No-Build scenario with seven (7) segments to six (6) segments in Build scenario near (LOS E) or exceeding (LOS F) peak hour capacity in Build.

Figure 4 provides a sheet key for the Build PA freeway segment figures. **Figures 5.1 to 5.9** schematically show 2016 Base Year Build volumes, intersection traffic control, freeway segment identification numbers and LOS for the PA.

5.2. 2040 Design Year Analysis

This analysis uses the 2040 Design Year Build peak hour traffic volumes and future planned/proposed freeway geometrics to evaluate traffic operations on the Complete 540, NC 540, I-40, US 70, I-495 / US 64 / US 264 and I-540 uninterrupted flow facilities in the project study area. Like the 2016 scenario evaluations, this analysis determines individual freeway segment and system-wide density and LOS measures of effectiveness for the 2040 Build PA scenario.

5.2.1. 2040 Build PA Scenario Results

For Complete 540 PA operations, all freeway segments are expected to operate at LOS D or better. For the NC 540 corridor, between NC 55 Bypass and Veridea Parkway (formerly Old

Holly Springs-Apex Road), two basic segments (OHSARI B1-D2 & D2-B3) in the eastbound PM peak are expected to operate at (LOS E) or exceeding (LOS F) peak hour capacity. For the I-40 corridor, results indicate that corridor operations and segment densities will slightly improve from the No-Build scenario, with all segments expected to operate at LOS D or better. For the US 70 corridor, all freeway segments are projected to operate at LOS D or better. On the I-495 / US 64 / US 264 corridor, results indicate that four (4) eastbound and three (3) westbound segments at (LOS E) or exceeding (LOS F) peak hour capacity.

Figures 6.1 to **6.9** show the traffic volumes, intersection traffic control, freeway segment identification numbers and LOS for the study area intersections in the 2040 Design Year Build PA scenario. The 2040 Design Year Build PA laneage and future 2040 MTP laneage assumptions are shown in Figures **7.1** to **7.9**.

Tables 7, 8, 9, 10 and **11** provide an overall summary and comparison of LOS results for the AM and PM peak hour LOS for basic freeway sections, merges, diverges and weaves across all three scenarios. Detailed segment measures of effectiveness results for the AM and PM peak hours are presented in **Tables 12** and **13**. ***Appendix D*** contains the detailed HCS 2010 Freeway Facilities output files and corridor summary tables.

Complete 540 and I-540 will form a continuous freeway facility corridor once Complete 540 is constructed; therefore, these facilities are included in the Complete 540 corridor summary **Tables 7, 12** and **13**. NC 540 (Triangle Expressway) would also be part of the continuous freeway facility corridor but was included in a separate table as this section was analyzed separately under the R-2635D project.

Table 7 Freeway Operations Summary – Complete 540

Scenario	Complete 540											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
2016 No-Build	-	-	-	-	-	-	-	-	-	-	-	-
2016 Build	55	8	2	0	0	0	52	11	3	0	0	0
2040 Build	12	35	16	2	0	0	10	28	23	4	0	0

*-Table shows the number of segments for each LOS

Table 8 Freeway Operations Summary – NC 540

Scenario	NC 540											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
2016 No-Build	4	0	0	0	0	0	3	0	0	0	0	0
2016 Build	1	0	0	0	0	0	1	0	0	0	0	0
2040 Build	0	0	0	1	1	1	0	0	1	3	0	0

*-Table shows the number of segments for each LOS

Table 9 Freeway Operations Summary – I-40

Scenario	I-40											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
2016 No-Build	0	5	5	3	2	0	0	2	8	0	4	3
2016 Build	2	10	3	2	1	1	3	6	5	1	4	2
2040 Build	2	14	3	0	0	0	3	13	5	0	0	0

*-Table shows the number of segments for each LOS

Table 10 Freeway Operations Summary – US 70

Scenario	US 70											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
2016 No-Build	4	3	0	0	0	0	5	3	0	0	0	0
2016 Build	3	8	0	0	0	0	2	8	0	0	0	0
2040 Build	1	5	5	0	0	0	2	1	7	0	0	0

*-Table shows the number of segments for each LOS

Table 11 Freeway Operations Summary – I-495 / US 64 / US 264

Scenario	I-495 / US 64 / US 264											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
2016 No-Build	0	1	6	4	0	0	0	1	5	5	0	0
2016 Build	0	1	9	3	0	0	0	1	7	5	0	0
2040 Build	0	1	8	0	2	2	0	0	4	6	3	0

*-Table shows the number of segments for each LOS

5.3. Ramp Demand-to-Capacity Ratios

The capacity and operations of freeway ramps at system interchanges can have a major impact on roadway network and corridor operations. Deficiencies in freeway ramp capacity can cause upstream and downstream operational issues on the subject freeway facility and adjacent freeway/Y-line facilities. Therefore, the demand flow rate on the ramps at the two system interchanges were checked against the capacity of ramp roadways. Based on the analysis, all the ramps at the Complete 540 at I-40/US 70 Bypass system interchange are projected to operate with demand to capacity (d/C) ratios less than (<) 1 in both the AM and PM peak hours. At the Complete 540, I-540 and I-495 / US 64 / US 264 system interchange, the ramps from westbound I-495 / US 64 / US 264 to northbound I-540 (Location # 2) in the AM peak and the loop ramp from southbound I-540 to eastbound I-495 / US 64 / US 264 (Location # 10) in the PM peak hour are projected to operate at d/C ratio greater than (>) 1. To operate at d/C ratio less than (<) 1, the westbound I-495 / US 64 / US 264 to northbound I-540 (Location # 2) would require two continuous lanes to merge with the eastbound ramp and on to I-540. The loop ramp from southbound I-540 to eastbound I-495 / US 64 / US 264 (Location # 10) would require two lanes to operate at d/C ratio less than (<) 1. The ramps from eastbound and westbound I-495 / US 64 / US 264 to northbound I-540 (Location # 1) in the AM peak, from eastbound I-495 / US 64 / US 264 to northbound I-540 (Location # 3) in the PM peak and from southbound I-540 to westbound I-495 / US 64 / US 264 (Location # 8) in the AM peak hour are nearing capacity (d/C ratio > 0.85). If the demand for any of these ramps nearing capacity exceed the estimated demand in 2040, an additional lane may be necessary to operate at d/C ratio less than (<) 1. Where ramp volumes are projected to be near or exceed capacity, the feasibility of providing two lanes should be considered during the project development process. The d/C ratio summary tables for 2040 Build PA scenario and figures (**Figure D.1** and **Figure D.2**) showing location numbers are included in ***Appendix D***.

Table 12 Complete 540 Detailed Freeway Operations Summary – AM Peak

2040 Build Eastbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
N/A			
West of NC 55 Bypass	W4	12.3	B
NC 55 Bypass	B5	8.7	A
	D6	10.9	B
	B7	6.8	A
	M8	11.3	B
	B9	10.8	A
Holly Springs Rd	D10	11.6	B
	B11	8.8	A
	M12	14.7	B
	B13	13.8	B
Bells Lake Rd	D14	14.9	B
	B15	11.4	B
	M16	14.6	B
	B17	13.5	B
US 401	D18	14.9	B
	B19	9.4	A
	M20	10.9	B
	B21	10.2	A
	M22	13.6	B
	B23	12.8	B
Old Stage Rd	D24	14.2	B
	B25	8.3	A
	M26	9.5	A
N/A			
	B27	8.9	A
NC 50	D28	9.7	A
	B29	6.8	A
	M30	11.1	B
	B31	10.6	A
I-40	D32	11.5	B
	B33	6.0	A
	D34	6.6	A
	B35	3.4	A
	M36	6.0	A
	B37	5.8	A
	M38	9.1	A
	B39	8.8	A
White Oak Rd	D40	9.5	A
	B41	6.7	A
	M42	9.9	A
	B43	9.4	A
US 70 Business	D44	10.1	B
	B45	8.3	A
	M46	11.2	B
	B47	10.6	A
	M48	15.0	B
	B49	14.2	B
Rock Quarry Rd	D50	16.8	B
	B51	12.8	B
	M52	17.3	B
	B53	16.1	B
Auburn-Knightdale Rd	D54	18.8	B
	B55	15.0	B
	M56	17.9	B
	B57	16.6	B
Poole Rd	D58	17.4	B
	B59	15.8	B
	W60	23.4	C
US 64 / US 264	D61	25.3	C
	B62	15.3	B
	M63	30.6	D
	B64	25.7	C
US 64 Business	D65	25.3	C
	B66	18.5	C
	M67	27.9	C
North of US 64 Business	B68	28.4	D
Facility		**13.5**	**B**

2016 Build Eastbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of NC 55 Bypass	B3	4.9	A
NC 55 Bypass	D4	5.4	A
	B5	2.7	A
	D6	3.1	A
	B7	2.5	A
	M8	3.9	A
	B9	3.7	A
Holly Springs Rd	D10	4.0	A
	B11	3.0	A
	M12	5.4	A
	B13	5.2	A
Bells Lake Rd	D14	5.6	A
	B15	4.1	A
	M16	5.9	A
	B17	5.6	A
US 401	D18	6.0	A
	B19	4.1	A
	M20	5.0	A
	B21	4.7	A
	M22	7.0	A
	B23	6.7	A
Old Stage Rd	D24	7.4	A
	B25	3.9	A
	M26	4.6	A
N/A			
	B27	4.3	A
NC 50	D28	4.7	A
	B29	3.0	A
	M30	4.8	A
	B31	4.6	A
I-40	D32	4.7	A
	B33	3.8	A
	D34	4.2	A
	B35	2.1	A
	M36	4.2	A
	B37	4.1	A
	M38	7.2	A
	B39	6.9	A
White Oak Rd	D40	7.5	A
	B41	5.1	A
	M42	7.4	A
	B43	7.0	A
US 70 Business	D44	7.5	A
	B45	5.8	A
	M46	6.5	A
	B47	6.2	A
	M48	8.2	A
	B49	7.8	A
Rock Quarry Rd	D50	9.3	A
	B51	6.9	A
	M52	8.7	A
	B53	8.2	A
Auburn-Knightdale Rd	D54	9.6	A
	B55	8.0	A
	M56	8.8	A
	B57	8.3	A
Poole Rd	D58	8.7	A
	B59	7.8	A
	W60	9.4	A
US 64 / US 264	D61	11.2	B
	B62	7.0	A
	M63	18.5	B
	B64	17.5	B
US 64 Business	D65	19.7	B
	B66	12.3	B
	M67	22.4	C
North of US 64 Business	B68	21.0	C
Facility		**6.8**	**A**

2016 No-Build Eastbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of NC 55 Bypass	B3	3.7	A
NC 55 Bypass	D4	4.1	A
	B5	1.1	A
	D6	1.4	A
N/A			
South of US 64 Business	B7	13.4	B
US 64 Business	D8	14.7	B
	B9	8.9	A
	M10	17.7	B
North of US 64 Business	B11	16.4	B
Facility		**N/A**	**N/A**

Eastern Termini — COMPLETE 540 — Western Termini

2016 No-Build Westbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of NC 55 Bypass	B24	6.8	A
NC 55 Bypass	M23	7.3	A
	B22	5.6	A
N/A			
US 64 / US 264	D21	6.0	A
	B20	4.5	A
	D19	12.6	B
	B18	10.9	A
US 64 Business	M17	11.5	B
	B16	7.0	A
	D15	13.5	B
	B14	11.0	B
	D13	13.5	B
North of US 64 Business	B12	12.6	B
Facility		**N/A**	**N/A**

2016 Build Westbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of NC 55 Bypass	B135	10.4	A
NC 55 Bypass	M134	11.3	B
	B133	10.3	A
	M132	10.5	B
	B131	5.4	A
	D130	7.7	A
	B129	7.1	A
Holly Springs Rd	M128	7.5	A
	B127	5.8	A
	D126	9.6	A
	B125	8.7	A
Bells Lake Rd	M124	9.3	A
	B123	6.9	A
	D122	9.6	A
	B121	8.9	A
US 401	M120	9.5	A
	B119	8.1	A
	M118	8.5	A
	B117	6.5	A
	D116	10.8	B
	B115	9.8	A
N/A			
Old Stage Rd	M114	10.2	B
	B113	5.5	A
	D112	6.6	A
	B111	6.1	A
NC 50	M110	6.4	A
	B109	3.4	A
	D108	6.5	A
	B107	5.3	A
I-40	M106	5.5	A
	B105	4.2	A
	W104	4.9	A
	B103	3.0	A
	D102	8.1	A
	B101	7.2	A
White Oak Rd	M100	7.6	A
	B99	5.8	A
	D98	9.2	A
	B97	7.6	A
US 70 Business	M96	8.1	A
	B95	6.8	A
	M94	7.1	A
	B93	5.1	A
	D92	6.5	A
	B91	6.0	A
Rock Quarry Rd	M90	6.4	A
	B89	5.4	A
	D88	6.6	A
	B87	6.2	A
Auburn-Knightdale Rd	M86	6.6	A
	B85	5.9	A
	D84	6.6	A
Poole Rd	B83	6.2	A
	M82	6.6	A
	B81	5.9	A
	W80	7.4	A
US 64 / US 264	B79	5.2	A
	D78	11.2	B
	B77	9.2	A
	D76	15.5	B
	B75	13.9	B
US 64 Business	M74	14.8	B
	B73	9.5	A
	D72	16.3	B
	B71	13.4	B
	D70	16.7	B
North of US 64 Business	B69	15.7	B
Facility		**7.9**	**A**

2040 Build Westbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of NC 55 Bypass	B135	22.1	C
NC 55 Bypass	M134	17.6	B
	B133	19.9	C
	M132	21.0	C
	B131	15.1	B
	D130	22.7	C
	B129	21.2	C
Holly Springs Rd	M128	22.4	C
	B127	16.8	B
	D126	25.3	C
	B125	24.8	C
Bells Lake Rd	M124	25.8	C
	B123	19.3	C
	D122	23.8	C
	B121	23.6	C
US 401	M120	24.6	C
	B119	20.5	C
	M118	21.8	C
	B117	15.7	B
	D116	21.7	C
	B115	20.5	C
N/A			
Old Stage Rd	M114	21.6	C
	B113	12.7	B
	D112	14.3	B
	B111	13.5	B
NC 50	M110	14.3	B
	B109	9.1	A
	D108	16.9	B
	B107	13.4	B
I-40	M106	13.7	B
	B105	7.2	A
	W104	7.7	A
	B103	4.2	A
	D102	9.7	A
	B101	8.7	A
White Oak Rd	M100	9.1	A
	B99	6.9	A
	D98	11.7	B
	B97	9.6	A
US 70 Business	M96	10.3	B
	B95	9.3	A
	M94	9.7	A
	B93	7.3	A
	D92	11.6	B
	B91	10.6	A
Rock Quarry Rd	M90	11.3	B
	B89	9.5	A
	D88	13.0	B
	B87	12.0	B
Auburn-Knightdale Rd	M86	12.9	B
	B85	10.9	A
	D84	13.2	B
Poole Rd	B83	12.4	B
	M82	13.4	B
	B81	11.9	B
	W80	17.5	B
US 64 / US 264	B79	11.3	B
	D78	15.2	B
	B77	13.0	B
	D76	20.5	C
	B75	19.2	C
US 64 Business	M74	20.1	C
	B73	14.3	B
	D72	20.3	C
	B71	17.9	B
	D70	20.8	C
North of US 64 Business	B69	20.8	C
Facility		**32.7**	**D**

Cell Shading – Green = LOS A – D, Orange = LOS E, Red = LOS F; N/A – Analysis not applicable for comparable location or segment

Table 13 Complete 540 Detailed Freeway Operations Summary – PM Peak

COMPLETE 540 — Eastern Termini / Western Termini

2040 Build Eastbound PM				2016 Build Eastbound PM				2016 No-Build Eastbound PM			
Location	Segment ID	Density (pc/mi/ln)	LOS	Location	Segment ID	Density (pc/mi/ln)	LOS	Location	Segment ID	Density (pc/mi/ln)	LOS
N/A				West of NC 55 Bypass	B3	9.6	A	West of NC 55 Bypass	B3	6.8	A
West of NC 55 Bypass	W4	25.1	C	NC 55 Bypass	D4	10.8	B	NC 55 Bypass	D4	7.9	A
NC 55 Bypass	B5	14.4	B		B5	5.2	A		B5	1.4	A
	D6	16.5	B		D6	5.9	A		D6	1.8	A
	B7	12.0	B		B7	4.8	A	N/A			
	M8	18.7	B		M8	6.9	A				
	B9	17.7	B		B9	6.5	A				
Holly Springs Rd	D10	19.9	B	Holly Springs Rd	D10	7.1	A				
	B11	14.2	B		B11	5.3	A				
	M12	22.8	C		M12	8.9	A				
	B13	21.9	C		B13	8.4	A				
Bells Lake Rd	D14	23.5	C	Bells Lake Rd	D14	9.1	A				
	B15	17.2	B		B15	6.7	A				
	M16	22.5	C		M16	9.3	A				
	B17	21.4	C		B17	8.8	A				
US 401	D18	23.7	C	US 401	D18	9.5	A				
	B19	14.6	B		B19	6.5	A				
	M20	17.9	B		M20	8.2	A				
	B21	16.3	B		B21	7.8	A				
	M22	20.5	C		M22	10.6	B				
	B23	19.5	C		B23	10.0	A				
Old Stage Rd	D24	22.1	C	Old Stage Rd	D24	11.1	B				
	B25	12.4	B		B25	6.0	A				
	M26	14.3	B		M26	7.1	A				
N/A				N/A							
	B27	13.3	B		B27	6.6	A				
NC 50	D28	15.3	B	NC 50	D28	7.3	A				
	B29	9.1	A		B29	4.0	A				
	M30	14.1	B		M30	6.3	A				
	B31	13.9	B		B31	6.1	A				
I-40	D32	15.8	B	I-40	D32	6.3	A				
	B33	8.0	A		B33	5.0	A				
	D34	9.2	A		D34	5.6	A				
	B35	3.1	A		B35	2.2	A				
	M36	5.5	A		M36	5.2	A				
	B37	6.7	A		B37	5.2	A				
	M38	9.2	A		M38	8.1	A				
	B39	9.4	A		B39	7.7	A				
White Oak Rd	D40	10.5	B	White Oak Rd	D40	8.3	A				
	B41	7.7	A		B41	6.4	A				
	M42	10.5	B		M42	8.7	A				
	B43	10.6	A		B43	8.3	A				
US 70 Business	D44	11.9	B	US 70 Business	D44	9.0	A				
	B45	8.3	A		B45	5.9	A				
	M46	10.1	B		M46	6.5	A				
	B47	9.9	A		B47	6.1	A				
	M48	12.0	B		M48	7.2	A				
	B49	11.6	B		B49	6.8	A				
Rock Quarry Rd	D50	13.1	B	Rock Quarry Rd	D50	8.0	A				
	B51	10.6	A		B51	6.2	A				
	M52	13.7	B		M52	7.5	A				
	B53	13.3	B		B53	7.0	A				
Auburn-Knightdale Rd	D54	15.0	B	Auburn-Knightdale Rd	D54	8.3	A				
	B55	12.3	B		B55	6.8	A				
	M56	14.5	B		M56	7.5	A				
	B57	13.7	B		B57	7.1	A				
Poole Rd	D58	15.0	B	Poole Rd	D58	7.5	A				
	B59	13.1	B		B59	6.8	A				
	W60	19.7	B		W60	8.4	A				
US 64 / US 264	D61	18.4	B	US 64 / US 264	D61	8.4	A				
	B62	12.9	B		B62	5.7	A				
	M63	18.4	B		M63	15.3	B				
	B64	17.8	B		B64	14.7	B	South of US 64 Business	B7	11.1	B
US 64 Business	D65	19.4	B	US 64 Business	D65	16.5	B	US 64 Business	D8	12.2	B
	B66	13.8	B		B66	10.3	A		B9	7.3	A
	M67	20.8	C		M67	18.1	B		M10	14.1	B
North of US 64 Business	B68	20.2	C	North of US 64 Business	B68	16.9	B	North of US 64 Business	B11	13.1	B
Facility		16.5	B	Facility		7.9	A	Facility		N/A	N/A

2016 No-Build Westbound PM				2016 Build Westbound PM				2040 Build Westbound PM			
Location	Segment ID	Density (pc/mi/ln)	LOS	Location	Segment ID	Density (pc/mi/ln)	LOS	Location	Segment ID	Density (pc/mi/ln)	LOS
West of NC 55 Bypass	B24	3.7	A	West of NC 55 Bypass	B135	6.3	A	West of NC 55 Bypass	B135	12.6	B
NC 55 Bypass	M23	3.9	A	NC 55 Bypass	M134	6.8	A	NC 55 Bypass	M134	10.2	B
	B22	2.6	A		B133	6.2	A		B133	11.2	B
N/A					M132	6.3	A		M132	11.1	B
					B131	3.8	A		B131	9.6	A
					D130	5.5	A		D130	15.2	B
					B129	5.1	A		B129	13.5	B
				Holly Springs Rd	M128	5.4	A	Holly Springs Rd	M128	14.2	B
					B127	4.3	A		B127	11.5	B
					D126	6.9	A		D126	18.3	B
					B125	6.4	A		B125	16.3	B
				Bells Lake Rd	M124	6.7	A	Bells Lake Rd	M124	17.3	B
					B123	5.2	A		B123	13.6	B
					D122	7.1	A		D122	17.1	B
					B121	6.6	A		B121	15.7	B
				US 401	M120	7.0	A	US 401	M120	16.7	B
					B119	5.8	A		B119	13.8	B
					M118	6.1	A		M118	14.5	B
					B117	5.0	A		B117	11.3	B
					D116	8.2	A		D116	16.1	B
					B115	7.5	A		B115	14.5	B
				N/A				N/A			
				Old Stage Rd	M114	7.8	A	Old Stage Rd	M114	15.0	B
					B113	4.5	A		B113	9.6	A
					D112	5.3	A		D112	11.2	B
					B111	4.9	A		B111	10.3	A
				NC 50	M110	5.2	A	NC 50	M110	10.6	B
					B109	3.6	A		B109	8.1	A
					D108	6.1	A		D108	13.9	B
					B107	5.0	A		B107	11.6	B
				I-40	M106	5.2	A	I-40	M106	11.4	B
					B105	4.2	A		B105	6.9	A
					W104	4.6	A		W104	9.0	A
					B103	4.0	A		B103	6.0	A
					D102	8.0	A		D102	10.8	B
					B101	7.3	A		B101	9.5	A
				White Oak Rd	M100	7.6	A	White Oak Rd	M100	9.8	A
					B99	5.4	A		B99	7.4	A
					D98	8.6	A		D98	11.8	B
					B97	7.1	A		B97	10.0	A
				US 70 Business	M96	7.6	A	US 70 Business	M96	10.8	B
					B95	6.7	A		B95	9.8	A
					M94	7.1	A		M94	10.4	B
					B93	5.9	A		B93	8.8	A
					D92	8.5	A		D92	16.7	B
					B91	7.9	A		B91	14.6	B
				Rock Quarry Rd	M90	8.4	A	Rock Quarry Rd	M90	15.7	B
					B89	6.9	A		B89	13.0	B
					D88	8.8	A		D88	18.0	B
					B87	8.2	A		B87	16.3	B
				Auburn-Knightdale Rd	M86	8.8	A	Auburn-Knightdale Rd	M86	17.6	B
					B85	7.9	A		B85	15.0	B
					D84	8.7	A		D84	18.0	B
					B83	8.2	A		B83	16.6	B
				Poole Rd	M82	8.8	A	Poole Rd	M82	18.0	B
					B81	7.8	A		B81	15.9	B
					W80	9.4	A		W80	29.9	D
					B79	6.9	A		B79	15.0	B
US 64 / US 264	D21	11.1	B	US 64 / US 264	D78	16.6	B	US 64 / US 264	D78	22.2	C
	B20	8.0	A		B77	13.2	B		B77	18.7	C
	D19	14.8	B		D76	18.4	B		D76	25.1	C
	B18	13.1	B		B75	17.0	B		B75	24.8	C
US 64 Business	M17	13.9	B	US 64 Business	M74	18.1	B	US 64 Business	M74	25.2	C
	B16	8.6	A		B73	11.8	B		B73	17.6	B
	D15	17.9	B		D72	21.7	C		D72	25.9	C
	B14	14.3	B		B71	17.7	B		B71	24.2	C
	D13	16.6	B		D70	20.5	C		D70	25.9	C
North of US 64 Business	B12	15.7	B	North of US 64 Business	B69	19.9	C	North of US 64 Business	B69	27.3	D
Facility		N/A	N/A	Facility		7.6	A	Facility		16.3	B

Cell Shading – Green = LOS A – D, Orange = LOS E, Red = LOS F; N/A – Analysis not applicable for comparable location or segment.

6. INTERSECTION CAPACITY ANALYSIS

This section presents the capacity analysis for all the intersections for 2016 Base Year No-Build and Build and 2040 Design Year Build PA scenarios within the Complete 540 project study area. LOS results and additional intersection details for these scenarios are found in the raw Synchro/SimTraffic output sheets in ***Appendix E***. A tabular results summary across all scenarios is found in **Table 14** on the following pages.

The anticipated changes to the study area at-grade intersections between the No-Build and Build analyses are listed below:

- Ramp terminal intersections at the interchange of NC 540 and NC 55 Bypass were converted from unsignalized to signalized control. At the eastbound ramps, only the southbound left-turn, northbound through and right-turn, and westbound right-turn movements will be under signal control. The southbound through and eastbound right-turn movements will operate under free-flowing conditions. At the westbound ramps, the northbound right-turn movement will operate under free-flowing conditions while all other movements will be under signal control.
- The Old Smithfield Road and Mid-block U-turn intersections along NC 55 Bypass were converted from unsignalized to signalized control due the heavy volumes and the wide cross-section along NC 55 Bypass. At the Old Smithfield Road intersection, only the southbound through and northbound left-turn movements will operate under signal control. The northbound through will operate under free-flowing condition while the eastbound right-turn and westbound right-turn will operate under stop-control. Per the HCS Peak Hour Signal Warrants Analysis module results, this intersection meets the MUTCD peak hour signal warrant threshold in both 2016 and 2040 Build PA scenarios. At the Mid-block U-turn intersection, the southbound U-turn and northbound through will operate under the signal control while the southbound through will operate under free-flowing conditions.

6.1. 2016 Base Year Analysis

This analysis uses the 2016 Base Year No-Build and Build peak hour traffic volumes and existing and proposed geometrics to evaluate traffic operations at all the intersections in the project study area.

6.1.1. 2016 No-Build Scenario Results

For the 2016 No-Build alternative AM and PM peak hour scenarios, 8 out of the 12 analyzed intersections operate at LOS D or better in the AM and PM peak hours. The two ramp terminal intersections at the interchange of NC 540 and NC 55 Bypass were not analyzed because they currently operate under free-flow conditions with the existing geometric configuration. Intersections that experience deficient overall LOS in at least one peak hour include:

- ♦ Holly Springs Road and Kildaire Farm Road Drive in the PM (LOS E) peak hour, due to high vehicular delays for the eastbound right-turn movement from Kildaire Farm Road to Holly Springs Road.
- ♦ NC 50 and Cleveland School Road / Stevens Oaks Drive in the AM peak hour (LOS E), due to limited capacity for the westbound right-turn movement from Cleveland School Road to NC 50, southbound left-turn movement from NC 50 to Cleveland School Road and due to heavy opposing traffic for the northbound through movement along NC 50.

- White Oak Road and Raynor Road in both the AM (LOS F) and PM (LOS F) peak hours, due to the high vehicular delay for the southbound shared left and right-turn movements on Raynor Road.

6.1.2. 2016 Build PA Scenario Results

For the 2016 Build PA AM and PM peak hour scenarios, it was assumed that all existing signalized intersections in the project study area would be re-optimized, to reflect anticipated traffic volume changes that were included in the Complete 540 traffic forecast data. These changes had a positive effect on operations at the NC 50 and Cleveland School Road / Stevens Oaks Drive intersection, Rock Quarry Road and Auburn Knightdale Road intersection, and the Poole Road and Hodge Road intersection, with AM and PM peak hour LOS improving to LOS C or better. No intersections, including the new ramp terminal intersections added in the Build PA scenario, are expected to operate at an overall LOS E or LOS F in the 2016 Base Year.

At the White Oak Road and Raynor Road intersection, the southbound exclusive left and shared through/right-turn approach will operate at LOS F under stop control in both AM and PM peak hours. Per the HCS Peak Hour Signal Warrants Analysis module results, this intersection meets the MUTCD peak hour signal warrant threshold in both 2016 and 2040 Build PA scenarios, and therefore was analyzed as a signalized intersection in both scenarios. Consideration should be given to operating this intersection as unsignalized and monitor it for future signalization. With the signalization, this intersection is expected to operate at LOS B during both peaks in the 2016 Build PA scenario.

The HCS Peak Hour Signal Warrants Analysis reports are included in ***Appendix F***. Summary figures showing traffic volumes and overall intersection LOS for the 2016 No-Build (Existing) scenario can be found in **Figures 3.1** to **3.5**. **Figures 5.1** to **5.9** show the traffic volumes, intersection traffic control, freeway segment identification numbers and LOS for the study area intersections in the 2016 Base Year Build PA scenario. A 2016 Base Year Build PA Laneage figure is not provided in this report; however, the summary figures provided for the 2040 Design Year Build PA scenario shows where additional 2040 MTP laneage was added to the 2016 Base Year Build laneage.

6.2. 2040 Design Year Analysis

As mentioned in **Section 4**, a 2040 Design Year No-Build scenario was not included in this analysis. A comparison of 2040 Design Year No-Build and Build traffic conditions using the Triangle Regional Model (TRM) as a tool will be included in the Complete 540 Quantitative Indirect and Cumulative Effects (ICE) documentation.

This section presents future anticipated roadway network changes and capacity analysis results for the 2040 Design Year Build PA scenario in the AM and PM peak hours for the intersections within the Complete 540 project study area.

6.2.1. 2040 Build PA Scenario Results

Of the 36 study area intersections analyzed at interchange ramp terminals or adjacent Y-lines, four (4) intersections are projected to experience operational deficiencies, as shown in **Table 14**.

As per the 2040 MTP, NC 55 Bypass will be widened to a six-lane facility by the year 2030. Three (3) of the four (4) intersections projected to experience operational deficiencies are along NC 55 Bypass, two (2) of which are the ramp terminal intersections. The NC 55 Bypass and NC 540 westbound ramps intersection is expected to operate at LOS F in the AM peak hour. The partial signal at NC 55 Bypass and NC 540 eastbound ramps intersection is expected to operate at LOS F in the AM and LOS E in the PM peak hour. This is due to the high vehicular volume and limited capacity along NC 55 Bypass.

The intersection of realigned Donny Brook Road/Chandler Ridge Circle/Wake Tech Drive and US 401 is expected to operate at LOS E in the AM and LOS C in the PM. The addition of the eastbound Donny Brook Road traffic to the eastbound Chandler Ridge Circle traffic in the Build PA scenario resulted in increased delay at this intersection. All other intersections are expected to operate at an overall LOS D or better in the 2040 Design Year.

Figures 6.1 to **6.9** show the traffic volumes, intersection traffic control, freeway segment identification numbers and LOS for the study area intersections in the 2040 Design Year Build PA scenario. The 2040 Design Year Build PA laneage and future 2040 MTP laneage assumptions are shown in **Figures 7.1** to **7.9**.

Table 14 Detailed Intersection Capacity Analysis Results Summary

		2016 No-Build					2016 Build					2040 Build				
		Overall		Approach			Overall		Approach			Overall		Approach		
ID#	Intersection	LOS	Delay	Approach	LOS	Delay	LOS	Delay	Approach	LOS	Delay	LOS	Delay	Approach	LOS	Delay
1	NC 55 Bypass & Mid-block U-turn	-	-	Northbound	-	-	C (A)	27.5 (8.2)	Northbound	C (B)	34.1 (15.9)	F (C)	128.8 (25.2)	Northbound	F (E)	193.0 (62.0)
				Southbound	-	-			Southbound	B (A)	17.2 (4.4)			Southbound	C (A)	27.7 (7.2)
2	NC 55 Bypass & Old Smithfield Road	-	-	Eastbound	E (F)	35.0 (187.7)	A (A)	1.2 (2.4)	Eastbound	A (A)	0.1 (0.1)	C (C)	32.1 (25.7)	Eastbound	A (A)	0.2 (0.1)
				Westbound	F (D)	1028.7 (30.6)			Westbound	A (A)	0.4 (0.2)			Westbound	A (A)	1.5 (0.4)
				Northbound	-	-			Northbound	A (A)	1.5 (1.3)			Northbound	D (A)	54.1 (2.1)
				Southbound	-	-			Southbound	A (A)	0.9 (3.3)			Southbound	A (D)	2.3 (42.2)
3	NC 55 Bypass & NC 540 EB Ramps						B (A)	15.1 (5.2)	Eastbound	A (A)	0.6 (2.7)	F (E)	99.6 (79.6)	Eastbound	A (F)	3.5 (279.1)
									Westbound	F (D)	84.1 (35.3)			Westbound	F (D)	213.2 (48.3)
									Northbound	B (A)	14.4 (5.4)			Northbound	F (B)	141.8 (15.2)
									Southbound	B (A)	19.6 (5.4)			Southbound	C (B)	29.7 (10.8)
4	NC 55 Bypass & NC 540 WB Ramps						B (A)	11.0 (9.1)	Westbound	E (D)	79.4 (45.3)	F (C)	99.0 (20.2)	Westbound	E (E)	68.1 (73.1)
									Northbound	A (A)	3.1 (0.8)			Northbound	F (A)	144.2 (5.0)
									Southbound	A (B)	7.7 (10.7)			Southbound	B (C)	15.1 (20.1)
5	Holly Springs Road & NC 540 EB Off-ramp Right-turn						A (A)	1.7 (3.9)	Eastbound	A (B)	7.9 (15.9)	A (B)	4.8 (12.4)	Eastbound	B (C)	13.6 (34.5)
									Southbound	A (A)	0.8 (1.6)			Southbound	A (A)	2.7 (5.1)
6	Holly Springs Road & NC 540 EB Ramps Crossover						B (B)	14.1 (17.4)	Northbound	C (B)	21.4 (18.0)	C (C)	22.3 (21.7)	Northbound	C (B)	24.6 (18.1)
									Southbound	A (B)	9.6 (16.0)			Southbound	C (C)	20.9 (30.0)
7	Holly Springs Road & NC 540 EB Off-ramp Left-turn						A (A)	2.9 (3.9)	Eastbound	D (C)	45.1 (31.0)	A (A)	3.0 (3.7)	Eastbound	D (C)	37.0 (23.0)
									Northbound	A (A)	0.1 (0.1)			Northbound	A (A)	0.2 (0.1)
8	Holly Springs Road & NC 540 WB Off-ramp Left-turn						B (A)	11.5 (8.6)	Westbound	D (D)	40.1 (50.5)	B (B)	15.1 (12.5)	Westbound	D (D)	38.4 (50.1)
									Southbound	A (A)	0.1 (0.1)			Southbound	A (A)	0.1 (0.2)
9	Holly Springs Road & NC 540 WB Ramps Crossover						C (B)	21.0 (15.1)	Northbound	C (C)	26.8 (25.4)	B (B)	15.2 (17.2)	Northbound	B (B)	14.5 (12.8)
									Southbound	B (B)	12.1 (11.2)			Southbound	B (B)	16.1 (18.7)
10	Holly Springs Road & NC 540 WB Off-ramp Right-turn						A (A)	4.3 (2.6)	Westbound	B (A)	13.9 (8.8)	A (A)	9.1 (6.0)	Westbound	C (B)	25.0 (16.8)
									Northbound	A (A)	0.1 (0.1)			Northbound	A (A)	0.1 (0.1)
11	Holly Springs Road (SR 1152) & Kildaire Farm Road (SR 1300)/Sancroft Drive	B (E)	15.2 (60.9)	Eastbound	C (F)	20.0 (120.9)	B (C)	19.9 (26.1)	Eastbound	C (C)	25.2 (23.5)	C (D)	31.8 (36.7)	Eastbound	D (C)	38.0 (24.1)
				-	-	-			Westbound	D (D)	53.3 (52.9)			Westbound	D (E)	54.0 (58.0)
				Northbound	B (B)	11.2 (10.0)			Northbound	B (C)	13.1 (28.6)			Northbound	C (D)	23.7 (38.1)
				Southbound	C (D)	25.4 (44.7)			Southbound	C (C)	32.0 (26.8)			Southbound	D (E)	47.4 (57.7)
12	Bells Lake Road (SR 1386) & NC 540 EB Ramps						B (B)	12.2 (14.9)	Eastbound	C (C)	23.2 (20.3)	B (B)	15.9 (19.4)	Eastbound	C (C)	27.7 (23.5)
									Northbound	B (B)	10.3 (13.6)			Northbound	B (B)	12.7 (12.8)
									Southbound	A (B)	8.7 (12.1)			Southbound	B (C)	10.0 (20.4)
13	Bells Lake Road (SR 1386) & NC 540 WB Ramps						B (B)	15.1 (13.6)	Westbound	C (C)	21.4 (28.0)	B (B)	17.7 (15.2)	Westbound	B (C)	17.0 (24.7)
									Northbound	B (A)	12.9 (7.7)			Northbound	B (A)	16.8 (9.6)
									Southbound	B (A)	10.6 (9.4)			Southbound	C (B)	20.1 (14.4)
14	US 401 & Donnybrook Road (SR 1503)/Wake Tech Driveway	C (B)	20.4 (15.2)	Eastbound	D (B)	48.6 (39.9)	C (C)	31.4 (23.3)	Eastbound	E (E)	77.5 (72.2)	E (C)	63.8 (32.4)	Eastbound	F (F)	109.3 (101.8)
				Westbound	E (E)	57.0 (57.2)			Westbound	D (D)	41.3 (43.8)			Westbound	E (E)	55.7 (59.7)
				Northbound	C (B)	22.2 (20.0)			Northbound	D (B)	36.8 (19.5)			Northbound	E (C)	78.6 (29.2)
				Southbound	B (A)	10.9 (6.7)			Southbound	B (B)	15.5 (18.3)			Southbound	D (C)	39.2 (24.7)
15	US 401 & Donnybrook Road (SR 1503)/Old McCullers Road (SR 2779)	B (C)	17.6 (20.8)	Eastbound	E (D)	64.9 (53.5)										
				Westbound	E (E)	60.5 (58.9)										
				Northbound	A (A)	8.4 (8.4)										
				Southbound	B (C)	16.6 (21.1)										
16	US 401 & NC 540 EB Ramps						A (B)	7.6 (10.1)	Eastbound	E (D)	57.6 (48.3)	B (C)	13.8 (29.4)	Eastbound	E (E)	62.7 (58.3)
									Northbound	A (A)	1.3 (3.4)			Northbound	A (A)	4.0 (7.2)
									Southbound	A (A)	5.1 (5.5)			Southbound	A (C)	8.4 (34.6)
17	US 401 & NC 540 WB Ramps						B (B)	15.2 (13.2)	Westbound	D (D)	50.6 (49.1)	B (B)	18.3 (15.9)	Westbound	E (D)	59.4 (54.3)
									Northbound	A (A)	4.2 (4.0)			Northbound	A (A)	10.0 (4.7)
									Southbound	A (A)	7.7 (7.5)			Southbound	A (B)	9.1 (12.9)
18	Old Stage Road (SR 1006) & NC 540 EB Ramps						B (B)	16.2 (17.9)	Eastbound	D (C)	35.1 (28.1)	C (C)	24.4 (20.6)	Eastbound	E (C)	56.1 (28.9)
									Northbound	A (B)	7.0 (10.5)			Northbound	B (B)	11.7 (18.1)
									Southbound	A (A)	4.3 (6.5)			Southbound	A (B)	6.6 (10.1)
19	Old Stage Road (SR 1006) & NC 540 WB Ramps						B (B)	18.2 (13.7)	Westbound	D (D)	45.0 (40.2)	C (B)	28.9 (16.9)	Westbound	E (D)	68.9 (47.4)
									Northbound	B (B)	15.1 (11.8)			Northbound	C (B)	21.4 (13.4)
									Southbound	B (B)	18.6 (12.4)			Southbound	D (B)	38.6 (17.4)
20	NC 50 & Steven Oaks Road (SR 5324)/Cleveland School Road (SR 1010)	E (C)	61.1 (24.8)	Eastbound	B (C)	17.8 (20.4)	B (B)	15.2 (15.7)	Eastbound	D (D)	43.6 (41.0)	D (D)	53.6 (50.1)	Eastbound	E (E)	70.3 (60.8)
				Westbound	E (D)	69.4 (44.7)			Westbound	A (A)	2.5 (3.3)			Westbound	A (B)	6.4 (10.4)
				Northbound	E (C)	62.1 (28.7)			Northbound	C (C)	22.4 (32.1)			Northbound	F (F)	88.1 (83.9)
				Southbound	D (B)	54.4 (17.6)			Southbound	B (B)	18.9 (14.1)			Southbound	E (D)	61.1 (50.5)
21	NC 50 & NC 540 EB Ramps						B (B)	14.7 (18.5)	Eastbound	D (C)	41.7 (33.7)	C (C)	23.2 (33.8)	Eastbound	E (D)	58.8 (52.8)
									Northbound	A (B)	8.5 (16.1)			Northbound	B (C)	13.6 (29.6)
									Southbound	B (B)	13.9 (11.2)			Southbound	C (C)	24.4 (25.2)

Table 14 (Continued) Detailed Intersection Capacity Analysis Results Summary

ID#	Intersection	2016 No-Build					2016 Build					2040 Build				
		Overall		Approach			Overall		Approach			Overall		Approach		
		LOS	Delay	Approach	LOS	Delay	LOS	Delay	Approach	LOS	Delay	LOS	Delay	Approach	LOS	Delay
22	NC 50 & NC 540 WB Ramps						B (B)	16.0 (16.7)	Eastbound	C (C)	30.7 (30.9)	C (C)	26.2 (31.8)	Eastbound	D (D)	39.3 (42.7)
									Northbound	A (A)	5.6 (9.5)			Northbound	B (C)	10.4 (24.6)
									Southbound	C (B)	26.7 (16.3)			Southbound	D (C)	41.9 (29.0)
23	White Oak Road (SR 2700) & Raynor Road (SR 2555)/Tiffany Creek Drive	-	-	-	-	-	B (B)	11.4 (14.5)	Eastbound	A (B)	9.0 (12.7)	A (B)	9.8 (15.2)	Eastbound	B (B)	10.0 (14.5)
				-	-	-			Westbound	A (A)	8.9 (3.0)			Westbound	A (A)	5.2 (3.7)
				-	-	-			Northbound	D (D)	39.2 (38.7)			Northbound	D (D)	39.3 (38.8)
				Southbound	***F (F)***	***161.5 (294.7)***			Southbound	D (D)	36.3 (52.7)			Southbound	D (D)	37.9 (41.8)
24	White Oak Road (SR 2700) & NC 540 SB Ramps						B (B)	11.1 (10.9)	Eastbound	A (A)	5.6 (6.4)	B (B)	13.9 (13.9)	Eastbound	A (B)	8.7 (10.5)
									Westbound	A (A)	4.3 (1.7)			Westbound	B (A)	10.1 (3.6)
									Northbound	C (C)	30.2 (31.4)			Northbound	C (C)	27.3 (33.0)
25	White Oak Road (SR 2700) & NC 540 NB Ramps						C (C)	23.6 (20.2)	Eastbound	D (D)	35.7 (36.5)	C (C)	21.4 (20.0)	Eastbound	D (D)	37.2 (39.4)
									Northbound	B (C)	19.9 (25.2)			Northbound	B (C)	17.2 (23.3)
									Southbound	B (B)	18.0 (12.3)			Southbound	B (B)	18.1 (13.3)
26	US 70 Business & NC 540 SB Ramps						A (A)	3.9 (8.1)	Eastbound	A (A)	3.7 (7.4)	A (B)	8.0 (19.3)	Eastbound	A (C)	8.7 (21.2)
									Westbound	A (A)	1.3 (5.5)			Westbound	A (A)	3.8 (8.4)
									Southbound	C (B)	25.4 (18.3)			Southbound	B (C)	19.4 (30.8)
27	US 70 Business & NC 540 NB Ramps						A (A)	6.8 (8.9)	Eastbound	A (A)	4.1 (6.1)	A (B)	7.4 (13.2)	Eastbound	A (A)	4.0 (7.0)
									Westbound	A (A)	5.0 (6.8)			Westbound	A (A)	7.2 (4.9)
									Northbound	C (C)	33.8 (23.4)			Northbound	D ***(F)***	38.2 ***(90.1)***
28	Rock Quarry Road (SR 2542) & Auburn Knightdale Road (SR 2555)	B (B)	12.9 (12.9)	Eastbound	A (A)	6.7 (9.0)	B (B)	10.9 (11.4)	Eastbound	A (A)	3.3 (3.4)	B (B)	15.4 (16.4)	Eastbound	A (B)	7.7 (10.1)
				Westbound	A (A)	8.5 (7.7)			Westbound	A (A)	1.3 (1.0)			Westbound	A (A)	2.8 (3.5)
				Northbound	C (C)	23.4 (22.1)			Northbound	D (D)	40.6 (42.8)			Northbound	***E*** (D)	***60.1*** (47.1)
				Southbound	C (B)	21.6 (18.7)			Southbound	D (D)	44.2 (43.8)			Southbound	D (C)	38.5 (34.6)
29	Rock Quarry Road (SR 2542) & NC 540 SB Ramps						B (C)	19.4 (23.3)	Eastbound	B (B)	18.9 (17.5)	C (C)	21.3 (23.2)	Eastbound	B (B)	14.5 (17.7)
									Westbound	B (B)	10.7 (13.8)			Westbound	B (C)	19.8 (24.9)
									Southbound	D (D)	35.3 (36.0)			Southbound	C (C)	28.6 (29.2)
30	Rock Quarry Road (SR 2542) & NC 540 NB Ramps						B (A)	12.9 (9.3)	Eastbound	A (A)	2.1 (3.1)	B (B)	16.3 (13.7)	Eastbound	A (A)	8.9 (7.6)
									Westbound	A (A)	7.7 (6.6)			Westbound	B (C)	16.8 (22.8)
									Southbound	C (C)	34.9 (32.2)			Southbound	C (C)	30.0 (23.6)
31	Rock Quarry Road (SR 2542) & Old Baucom Road (SR 5204)*	-	-	Westbound	B (B)	11.2 (10.2)	-	-	Westbound	B (A)	11.3 (9.9)	-	-	Westbound	D (D)	25.9 (34.0)
32	Auburn Knightdale Road (SR 2555) & NC 540 SB Ramps						A (A)	8.4 (8.4)	Eastbound	A (A)	3.9 (3.8)	B (B)	11.0 (11.1)	Eastbound	A (A)	8.5 (7.8)
									Westbound	A (A)	1.3 (1.2)			Westbound	A (A)	2.8 (1.8)
									Southbound	C (C)	22.7 (22.6)			Southbound	C (C)	20.2 (20.7)
33	Auburn Knightdale Road (SR 2555) & NC 540 NB Ramps						A (A)	8.1 (8.1)	Eastbound	A (A)	2.6 (2.5)	B (B)	11.4 (11.3)	Eastbound	A (A)	8.2 (7.5)
									Westbound	A (A)	3.2 (3.2)			Westbound	A (A)	5.0 (5.0)
									Southbound	C (C)	23.0 (23.0)			Southbound	C (C)	23.1 (23.3)
34	Poole Road (SR 1007) & Hodge Road (SR 2516)	D (D)	45.6 (38.4)	Eastbound	D (C)	41.8 (34.2)	B (B)	15.2 (14.3)	Eastbound	B (B)	14.6 (10.9)	C (C)	28.6 (25.9)	Eastbound	C (C)	32.8 (22.8)
				Westbound	D (D)	37.2 (45.2)			Westbound	A (A)	6.4 (4.3)			Westbound	C (B)	23.5 (16.5)
				Northbound	D (B)	40.0 (16.7)			Northbound	D (D)	54.7 (54.1)			Northbound	***E*** (D)	***56.6*** (54.4)
				Southbound	***E*** (D)	***66.0*** (38.7)			Southbound	C (C)	31.1 (34.9)			Southbound	C (D)	28.6 (37.5)
35	Poole Road (SR 1007) & NC 540 SB Ramps						C (C)	22.7 (25.5)	Eastbound	A (A)	6.7 (5.6)	C (C)	27.3 (32.3)	Eastbound	C (C)	22.6 (24.0)
									Westbound	A (A)	7.5 (5.1)			Westbound	C (C)	29.5 (34.0)
									Northbound	D (D)	41.3 (49.7)			Northbound	C (D)	29.0 (38.3)
36	Poole Road (SR 1007) & NC 540 NB Ramps						B (B)	17.6 (15.8)	Eastbound	B (B)	16.4 (14.4)	C (B)	22.4 (14.3)	Eastbound	A (A)	9.4 (4.7)
									Westbound	B (B)	13.5 (13.4)			Westbound	C (C)	29.6 (27.9)
									Northbound	***E*** (D)	***55.7*** (54.6)			Northbound	***E (E)***	***72.5 (68.7)***

X (X) – AM (PM) Peak Hour Level of Service; ##.# (##.#) – AM (PM) Peak Hour Delay in Seconds Per Vehicle
Cell Shading – Green = LOS A – D, Orange = LOS E, Red = LOS F;
BOLD/ITALIC = Intersection/Approach/Movement that has Operational Deficiencies (LOS E or F)
* Unsignalized Intersection – No Overall or Approach LOS/Delay Reported by HCM Methodology

7. CONCLUSIONS AND RECOMMENDATIONS

The Complete 540 traffic capacity analysis was completed to evaluate 2016 Base Year No-Build and Build, and 2040 Design Year Build peak hour traffic operations for the Complete 540 Preferred Alternative and surrounding freeway facilities and nearby intersections within the traffic analysis study area. The recommended freeway, arterial, interchange and intersection geometrics and intersection control for the Complete 540 PA are presented in **Figures 7.1** to **7.9**. Recommended and analyzed geometrics for the PA are included in the detailed capacity analysis outputs from HCS Freeway Facilities and Synchro/SimTraffic in ***Appendices E*** and ***F***, respectively.

Based on the 2016 Base Year capacity analysis, all the No-Build and Build PA freeway and intersection facilities are projected to operate at acceptable LOS D or better.

Based on the 2040 Design Year capacity analysis, the following conclusions and recommendations are presented for study area facilities and intersections:

Complete 540 Preferred Alternative Corridor

All Complete 540 PA freeway segments and interchange design configurations are projected to operate at LOS D or better in the 2040 Design Year, based on the current functional designs for Complete 540 as a six-lane, toll facility, as shown in **Table 15**.

Of the 36 study area intersections analyzed at interchange ramp terminals or adjacent Y-lines, only 4 intersections are projected to experience operational deficiencies as shown in **Table 16**. Three (3) of the four (4) intersections potentially experiencing operational deficiencies are the two interchange ramp terminal intersections along NC 55 Bypass. This is due to the high vehicular volume and limited capacity along NC 55 Bypass. The intersection of realigned Donny Brook Road/Chandler Ridge Circle/Wake Tech Drive and US 401 is expected to operate at LOS E in the AM and LOS C in the PM. Reasonably feasible laneage improvements were considered and implemented at these four (4) intersection locations as part of the Complete 540 project.

NC 540 (Triangle Expressway) Corridor

Based on the 2040 Design Year Build PA analysis results, two basic segments (OHSARI B1-D2 & D2-B3) between NC 55 Bypass and Veridea Parkway (formerly Old Holly Springs-Apex Road) in the eastbound PM peak experience projected operational deficiencies. This is mainly due to the limited capacity between the eastbound off-ramp and on-ramps at Old Holly Springs-Apex Road. All the westbound segments are expected to operate at LOS D or better.

I-540 Corridor

The existing section of I-540 from I-495 / US 64 / US 264 to US 64 Business is projected to operate at acceptable LOS D or better with construction of Complete 540 and I-540 planned widening to an 8-lane facility as per 2040 MTP.

I-40 Corridor

Based on the 2040 Design Year Build PA analysis results, the existing sections of I-40 are projected to operate at acceptable LOS C or better, with construction of Complete 540 and I-40 planned widening to a 10-lane facility with eight (8) general purpose lanes and two (2) managed lanes as per the 2040 MTP. The PA proposes a five-leg system interchange with I-40 and US 70 and provides acceptable interchange spacing between US 70 and NC 42. The potential impacts of Complete 540 on I-40, US 70, US 70 Business and the system interchange operations will be re-evaluated to complete an interstate access report.

US 70 Corridor

The existing section of US 70 from I-40 to NC 42 is projected to operate at acceptable LOS D or better with construction of Complete 540 in 2040 Design Year.

I-495 / US 64 / US 264 Corridor

Capacity analysis results indicate that I-495 / US 64 / US 264 is operating near or over capacity with operational deficiencies in the 2040 Design Year Build AM and PM peak hours. In the 2040 Design Year Build PA scenario, I-495 / US 64 / US 264 from Hodge Road to Smithfield Road is projected to operate at LOS E or F for 4 of 13 eastbound segments and 3 of 13 westbound segments as a six-lane freeway facility. Construction of Complete 540 proposes modifying the existing directional system interchange with I-495 / US 64 / US 264 and I-540 by connecting the forth leg and constructing a flyover and a loop ramp. The system interchange was planned, designed and constructed to accommodate the future completion and connection of the 540 loop. This interchange modification would add one eastbound and one westbound freeway merge on I-495 / US 64 / US 264. The potential impacts of Complete 540 on I-495 / US 64 / US 264, I-540 and the system interchange operations will be re-evaluated to complete an interstate access report.

Ramp Demand-to-Capacity Ratios

Based on the analysis, all the ramps at the Complete 540 at I-40/US 70 Bypass system interchange are projected to operate with demand to capacity (d/C) ratios less than 1 in both the AM and PM peak hours. At the Complete 540, I-540 and I-495 / US 64 / US 264 system interchange, the ramps from westbound I-495 / US 64 / US 264 to northbound I-540 in the AM peak and the loop ramp from southbound I-540 to eastbound I-495 / US 64 / US 264 in the PM peak hour are projected to operate at d/C ratio greater than (>) 1. To operate at d/C ratio less than (<) 1, the westbound I-495 / US 64 / US 264 to northbound I-540 would require two continuous lanes to merge with the eastbound ramp and on to I-540. The loop ramp from southbound I-540 to eastbound I-495 / US 64 / US 264 (Location # 10) would require two lanes to operate at d/C ratio less than (<) 1. The ramps from eastbound and westbound I-495 / US 64 / US 264 to northbound I-540 in the AM peak, from eastbound I-495 / US 64 / US 264 to northbound I-540 in the PM peak and from southbound I-540 to westbound I-495 / US 64 / US 264 in the AM peak hour are nearing capacity (d/C ratio > 0.85). If the demand for any of these ramps nearing capacity exceed the estimated demand in 2040, an additional lane may be necessary to operate at d/C ratio less than (<) 1. Where ramps volumes are projected to be near or exceed capacity, the feasibility of providing two lanes should be considered during the project development process.

Table 15 Overall Freeway Operations Summary

Scenario	Complete 540											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
2016 No-Build	-	-	-	-	-	-	-	-	-	-	-	-
2016 Build	55	8	2	0	0	0	52	11	3	0	0	0
2040 Build	12	35	16	2	0	0	10	28	23	4	0	0

*-Table shows the number of segments for each LOS

Table 16 Overall Intersection Capacity Analysis Summary

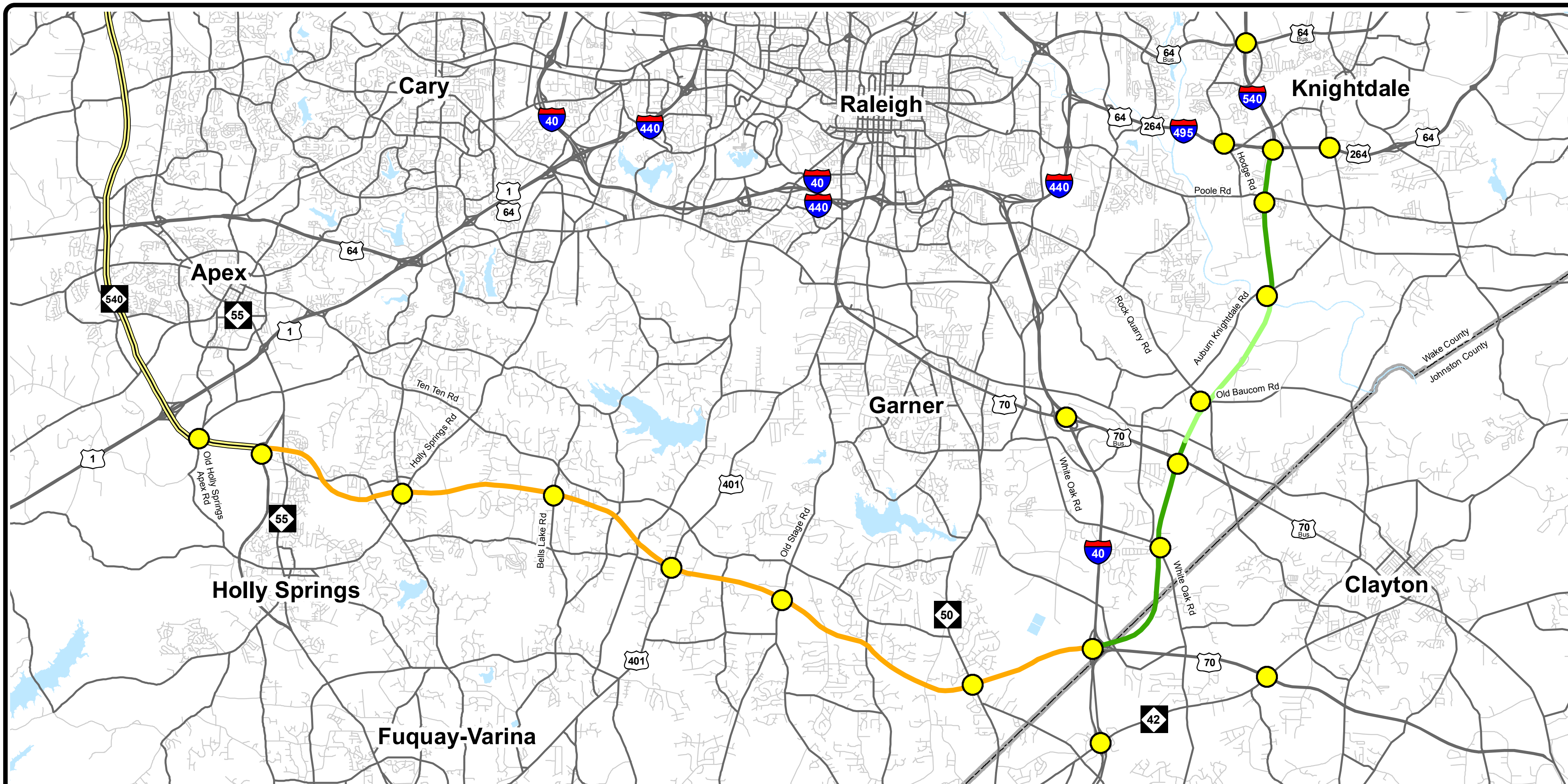
Scenario	Number of Intersections Operating at Given LOS in at Least One AM or PM Peak Hour*					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
2016 No-Build	0	2	1	1	***2***	***2***
2016 Build	8	20	7	0	***0***	***0***
2040 Build	2	14	12	3	***1***	***3***

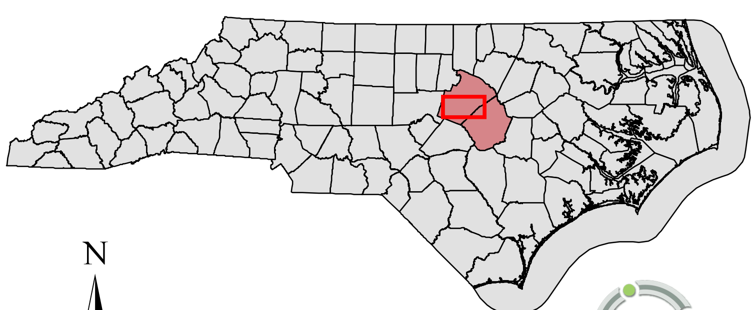
*-For signalized intersections, overall intersection LOS. For unsignalized intersections, worst-case critical movement.

APPENDIX

Appendix A – Figures

1) Traffic Analysis Study Area
2) No Build Traffic Analysis Figures Sheet Key
3) 3.1 – 3.5) 2016 No-Build Laneage, Volumes, LOS & ID
4) Build Traffic Analysis Figures Sheet Key
5) 5.1 – 5.9) 2016 Build Laneage, Volumes, LOS & ID
6) 6.1 – 6.9) 2040 Build PA Volumes, LOS & ID
7) 7.1 – 7.9) 2040 Build PA Laneage & LOS





N

Complete 540 PA Traffic Analysis Study Area

Legend

Interchanges

Triangle Expressway

Major Roads

Counties

NCDOT Preferred Alternative Corridor

Orange

Green

Mint

STIP: R-2721, R-2828, R-2829

WBS: 37673.1.TA2, 35516.1.TA2, 35517.1.TA1

COUNTY: Wake/Johnston

DIVISION: 5/4

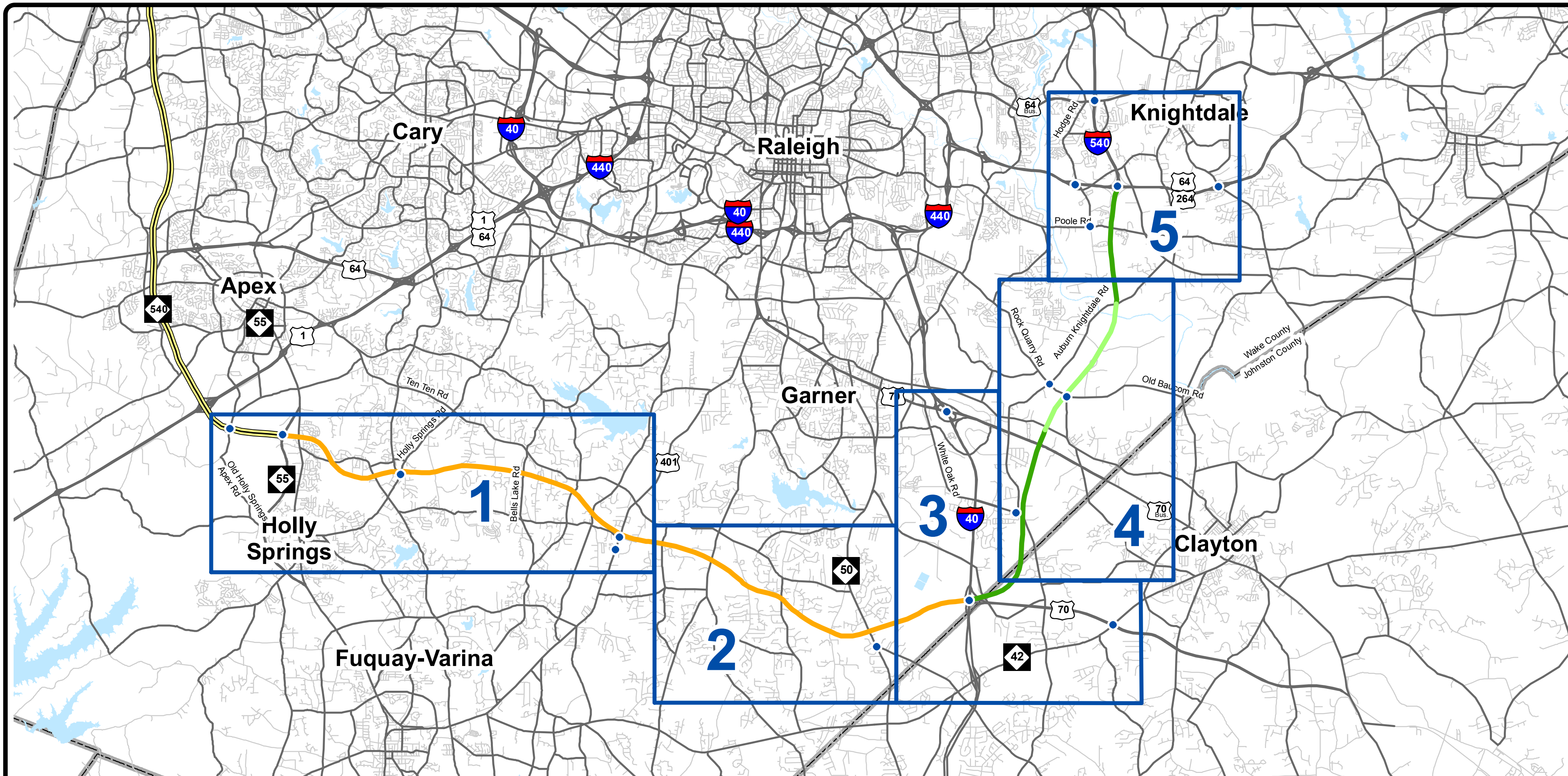
DATE: July 2017

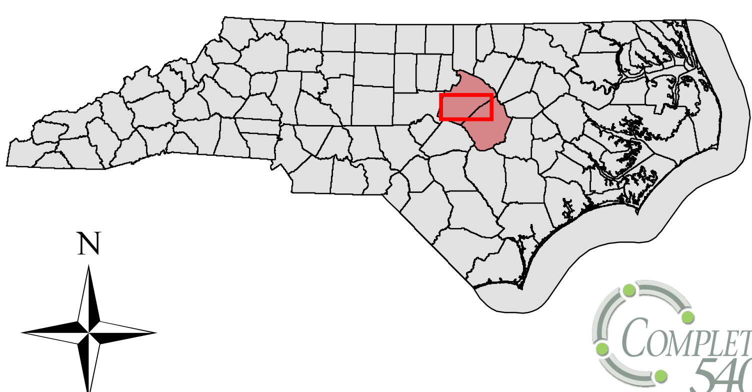
PREPARED BY: HNTB North Carolina, P.C.
343 E. Six Forks Rd, Suite 200
Raleigh, NC 27609

LOCATION: NC 55 Bypass (Holly Springs) to I-495 / US 64 Bypass / US 264 (Knightdale)

PROJECT: Complete 540 Triangle Expressway Southeast Extension

Figure 1





No Build Traffic Analysis Figures Sheet Key

Legend

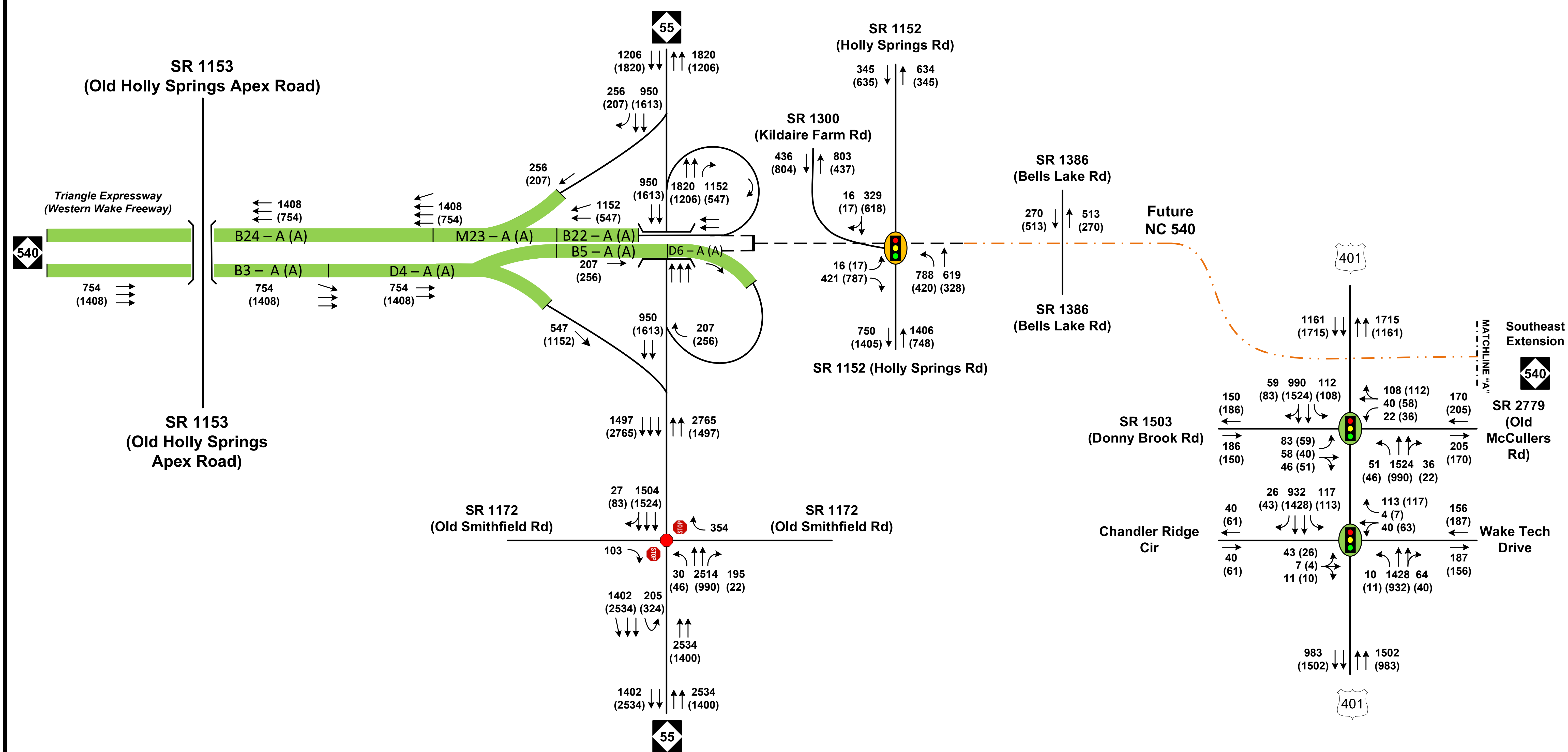
- Analyzed Intersection/Interchange
- Triangle Expressway
- Major Roads
- Counties

NCDOT PA Corridor

CORRIDOR

- Orange
- Green
- Mint

STIP: R-2721, R-2828, R-2829	**WBS:** 37673.1.TA2, 35516.1.TA1, 35517.1.TA1
COUNTY: Wake/Johnston	**DIVISION:** 5/4
DATE: July 2017	
PREPARED BY: HNTB North Carolina, P.C. 343 E. Six Forks Rd, Suite 200 Raleigh, NC 27609	
LOCATION: NC 55 Bypass (Holly Springs) to I-495 / US 64 Bypass / US 264 (Knightdale)	
PROJECT: Complete 540 Triangle Expressway Southeast Extension	**Figure 2**



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

N

NOT TO SCALE

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

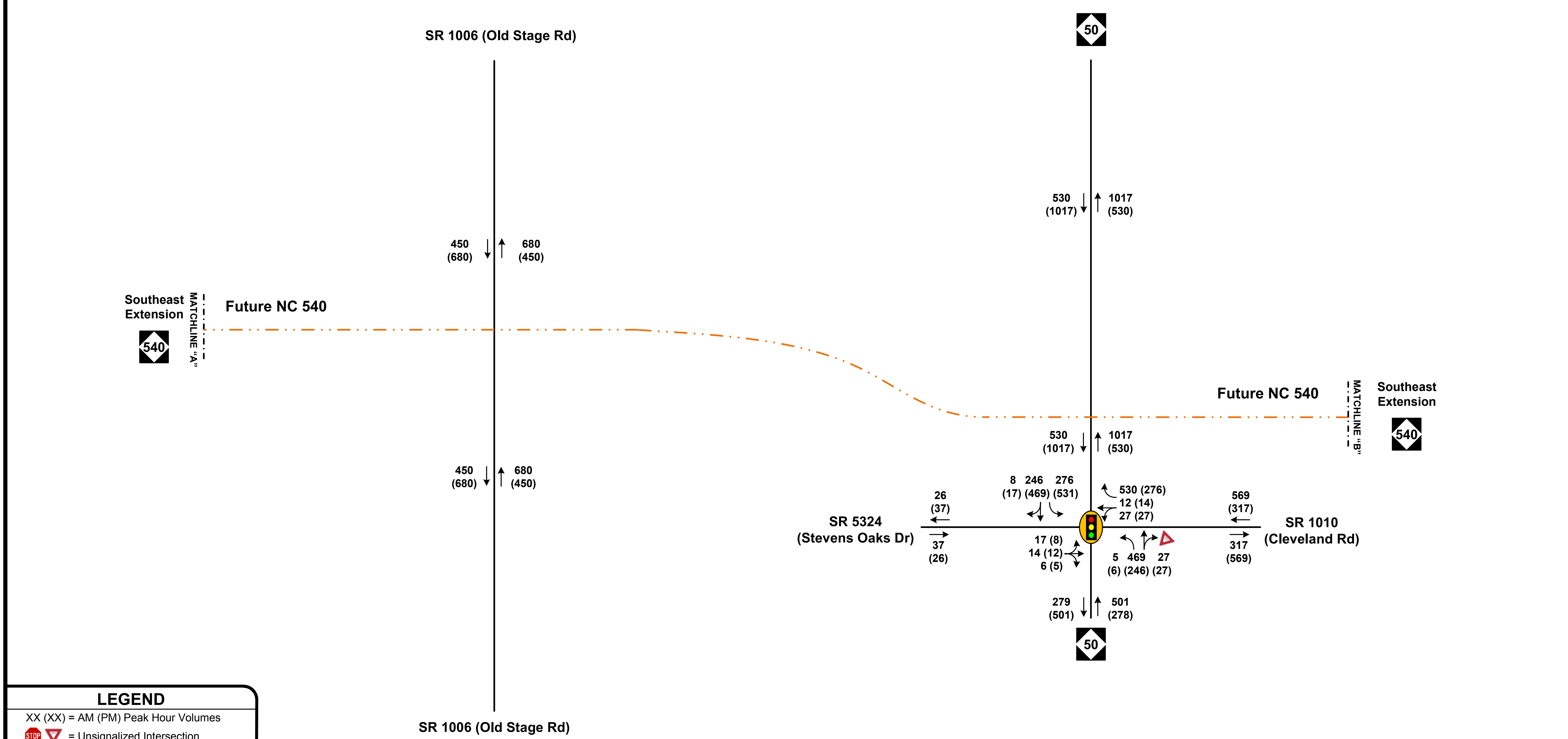
Preferred Alternative

2016 BASE YEAR NO-BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 3.1

NOT TO SCALE



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

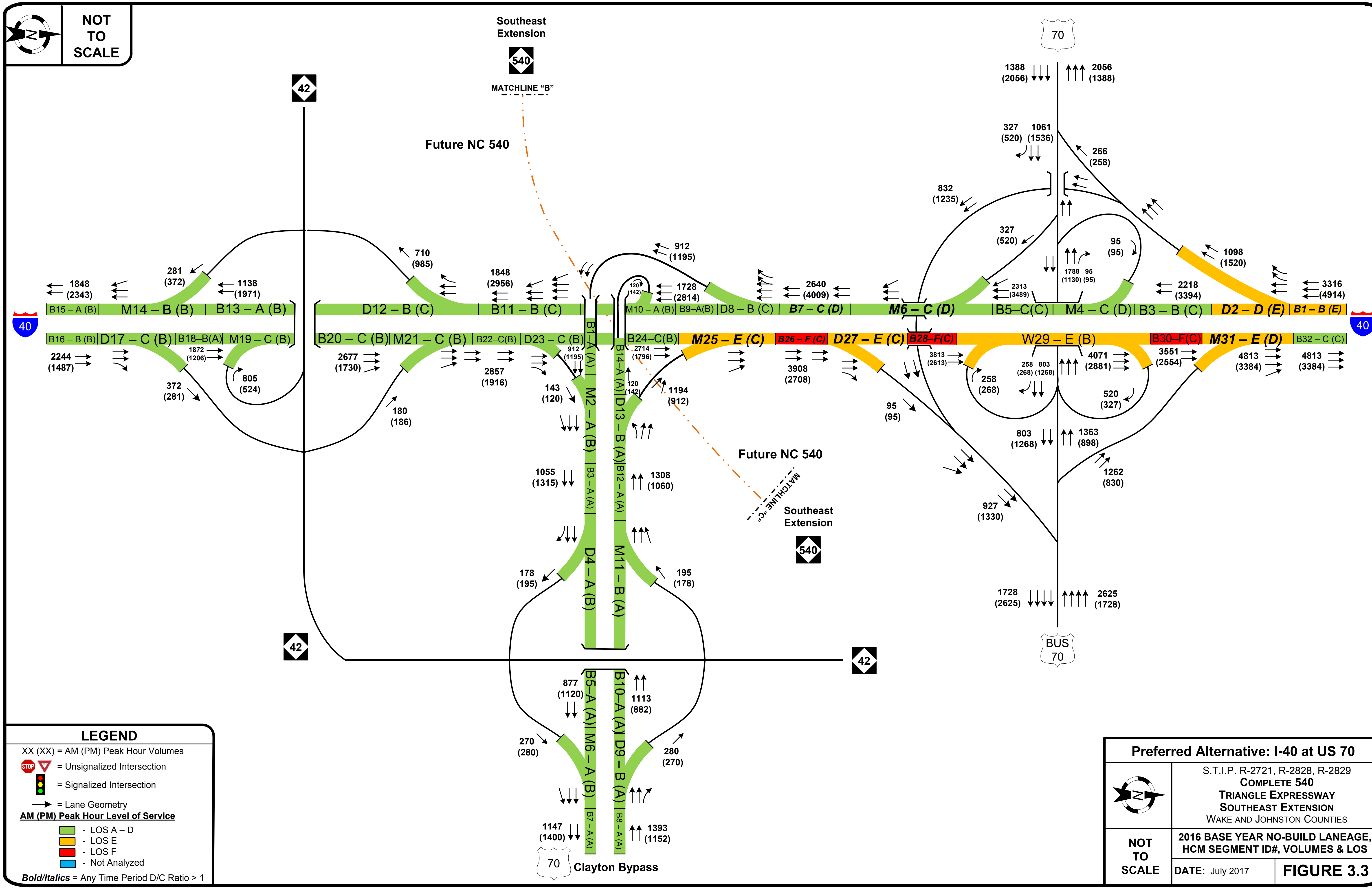
Preferred Alternative

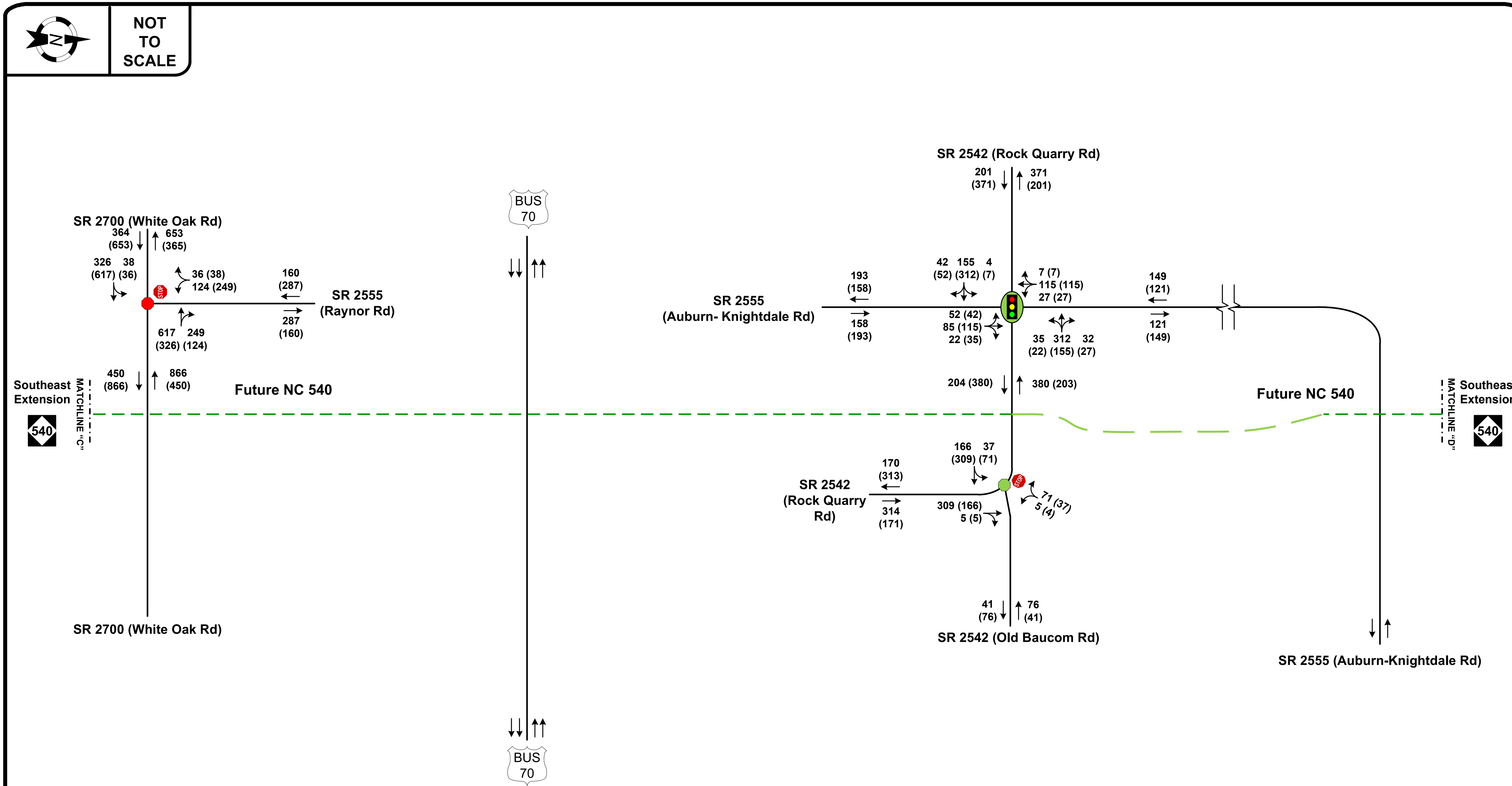
2016 BASE YEAR NO-BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 3.2

NOT TO SCALE


NOT TO SCALE
Southeast Extension
540
MATCHLINE "B"
Future NC 540
42
70
1388 (2056)
2056 (1388)
327 (520)
1061 (1536)
266 (258)
832 (1235)
327 (520)
95 (95)
1098 (1520)
912 (1195)
710 (985)
281 (372)
1848 (2343)
1138 (1971)
1848 (2956)
1728 (2814)
2640 (4009)
2313 (3489)
1788 (1130)
95 (95)
2218 (3394)
3316 (4914)
40
B15 – A (B)
M14 – B (B)
B13 – A (B)
D12 – B (C)
B11 – B (C)
M10 – A (B)
B9–A(B)
D8 – B (C)
B7 – C (D)
M6 – C (D)
B5–C(C)
M4 – C (D)
B3 – B (C)
D2 – D (E)
B1 – B (E)
B16 – B (B)
D17 – C (B)
B18–B(A)
M19 – C (B)
B20 – C (B)
M21 – C (B)
B22–C(B)
D23 – C (B)
B24–C(B)
M25 – E (C)
B26 – F (C)
D27 – E (C)
B28–F(C)
W29 – E (B)
B30–F(C)
M31 – E (D)
B32 – C (C)
2244 (1487)
1872 (1206)
372 (281)
805 (524)
2677 (1730)
180 (186)
2857 (1916)
912 (1195)
143 (120)
2714 (1796)
120 (142)
1194 (912)
3908 (2708)
3813 (2613)
95 (95)
258 (268)
258 (268)
803 (1268)
4071 (2881)
520 (327)
3551 (2554)
4813 (3384)
4813 (3384)
803 (1268)
1363 (898)
1262 (830)
927 (1330)
1728 (2625)
2625 (1728)
BUS 70
B1–A (A)
M2 – A (B)
B3 – A (A)
D4 – A (B)
B14–A (A)
D13 – B (A)
B12 – A (A)
M11 – B (A)
1055 (1315)
1308 (1060)
Future NC 540
MATCHLINE "C"
Southeast Extension
178 (195)
195 (178)
877 (1120)
1113 (882)
B5–A (A)
M6 – A (B)
B7 – A (A)
B10–A (A)
D9 – B (A)
B8 – A (A)
270 (280)
280 (270)
1147 (1400)
1393 (1152)
Clayton Bypass
LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
Bold/Italics = Any Time Period D/C Ratio > 1
Preferred Alternative: I-40 at US 70
S.T.I.P. R-2721, R-2828, R-2829
Complete 540
Triangle Expressway
Southeast Extension
Wake and Johnston Counties
NOT TO SCALE
2016 BASE YEAR NO-BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS
DATE: July 2017
FIGURE 3.3



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

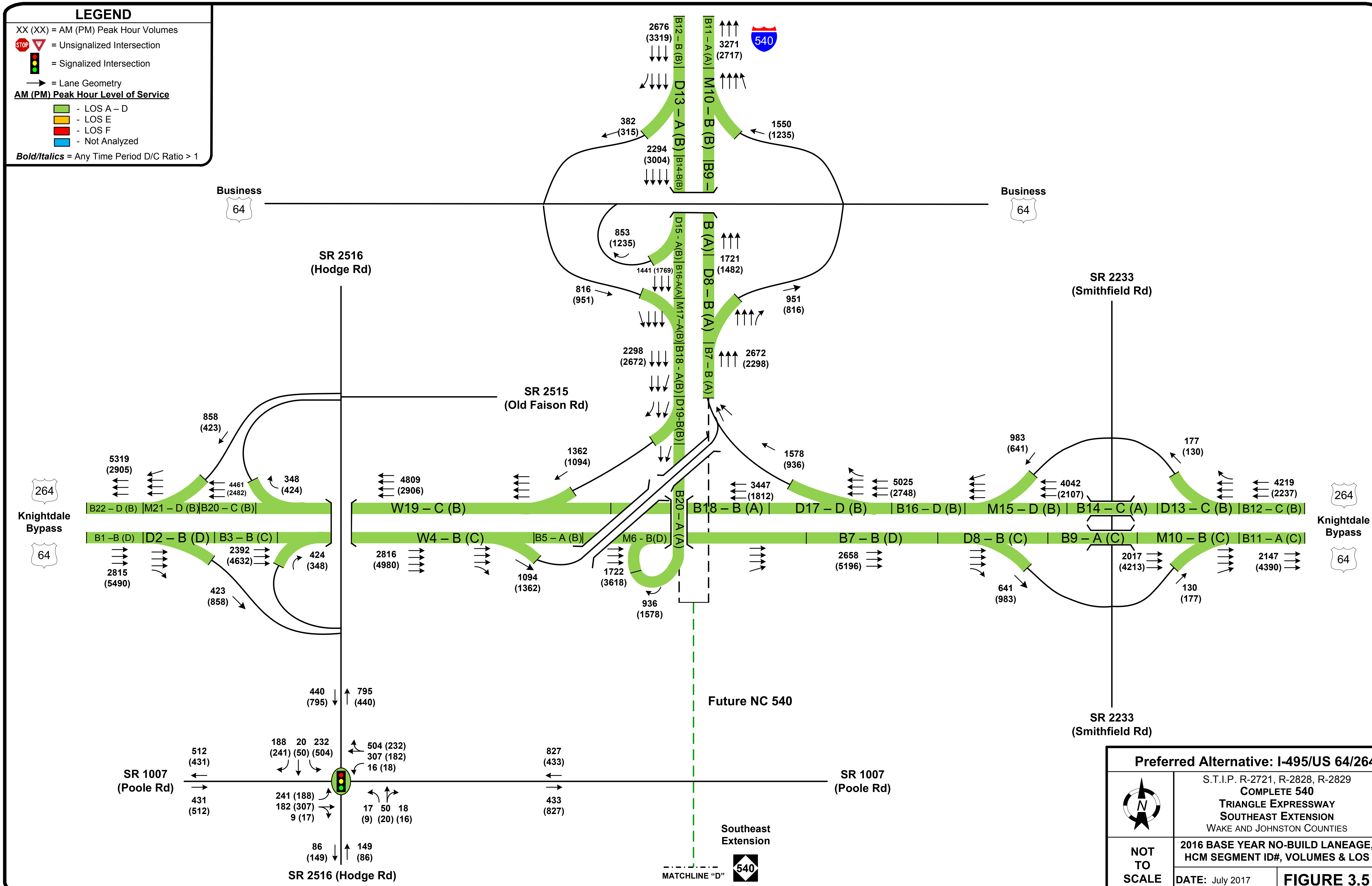
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

Preferred Alternative

2016 BASE YEAR NO-BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 3.4



Preferred Alternative: I-495/US 64/264

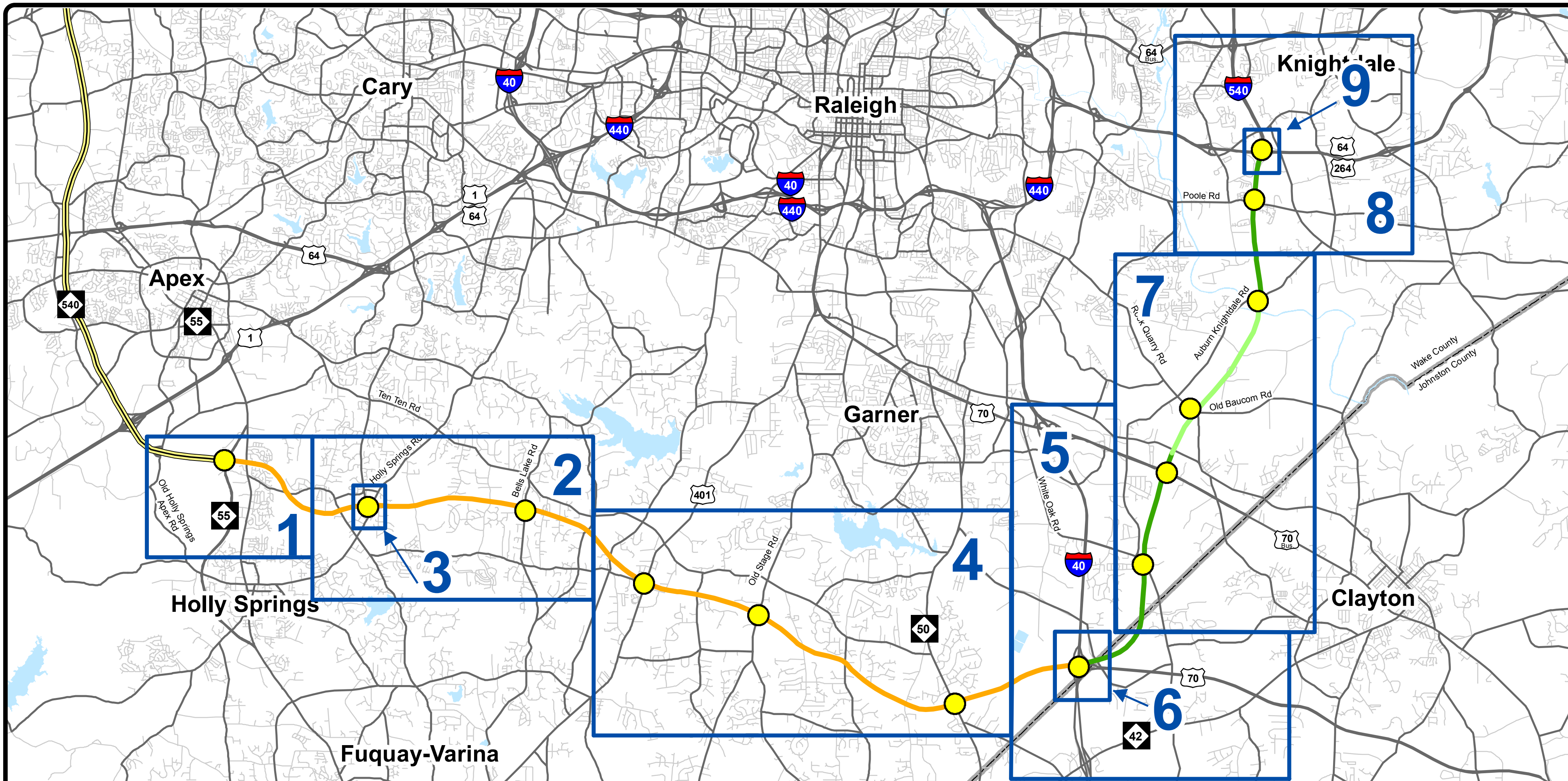
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

NOT TO SCALE

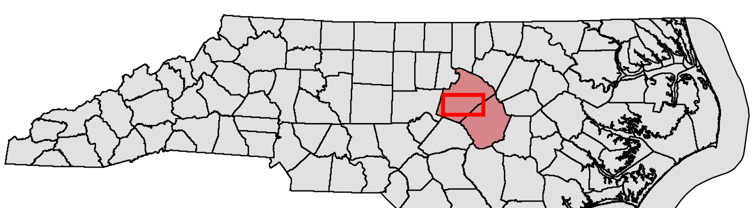
2016 BASE YEAR NO-BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 3.5



Build PA Traffic Analysis Figures Sheet Key



N

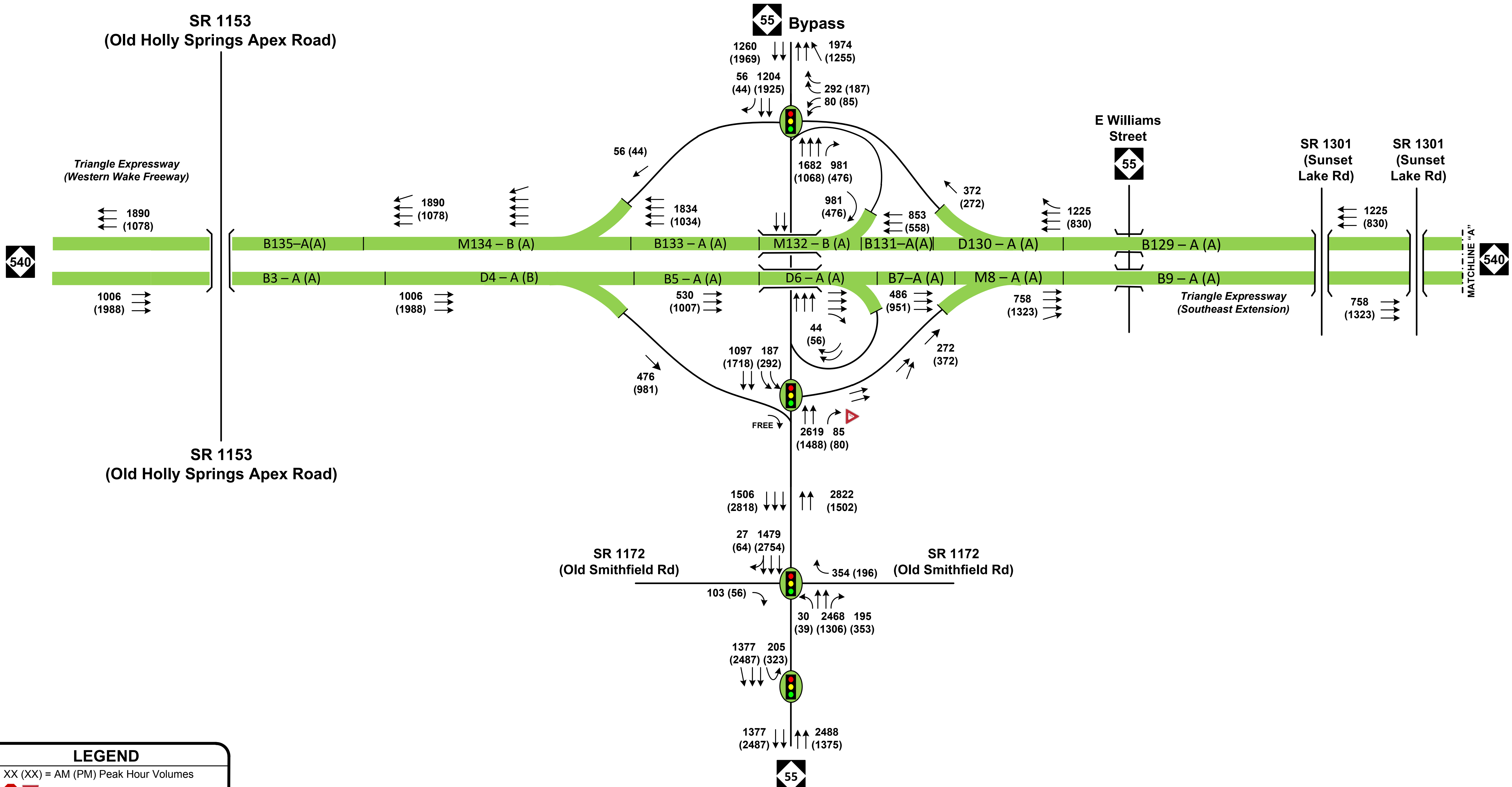
Legend

- Interchanges
- Triangle Expressway
- Major Roads
- Counties

NCDOT Preferred Alternative Corridor

- Orange
- Green
- Mint

STIP: R-2721, R-2828, R-2829	**WBS:** 37673.1.TA2, 35516.1.TA1, 35517.1.TA1
COUNTY: Wake/Johnston	**DIVISION:** 5/4
DATE: July 2017	
PREPARED BY: HNTB North Carolina, P.C. 343 E. Six Forks Rd, Suite 200 Raleigh, NC 27609	
LOCATION: NC 55 Bypass (Holly Springs) to I-495 / US 64 Bypass / US 264 (Knightdale)	
PROJECT: Complete 540 Triangle Expressway Southeast Extension	**Figure 4**



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

Preferred Alternative

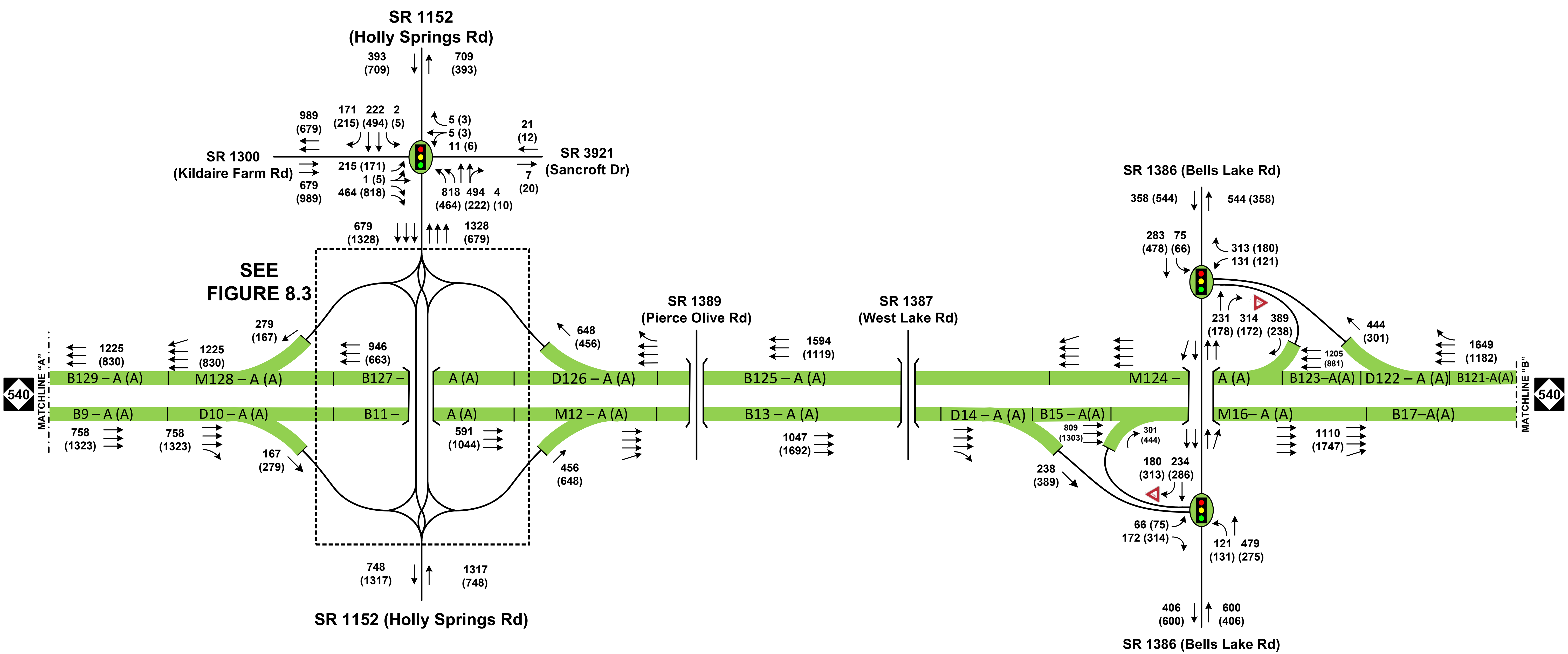
2016 BASE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 5.1

N

NOT TO SCALE



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

STOP = Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

<u>AM (PM) Peak Hour Level of Service</u>

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540

TRIANGLE EXPRESSWAY

SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

Preferred Alternative

2016 BASE YEAR BUILD

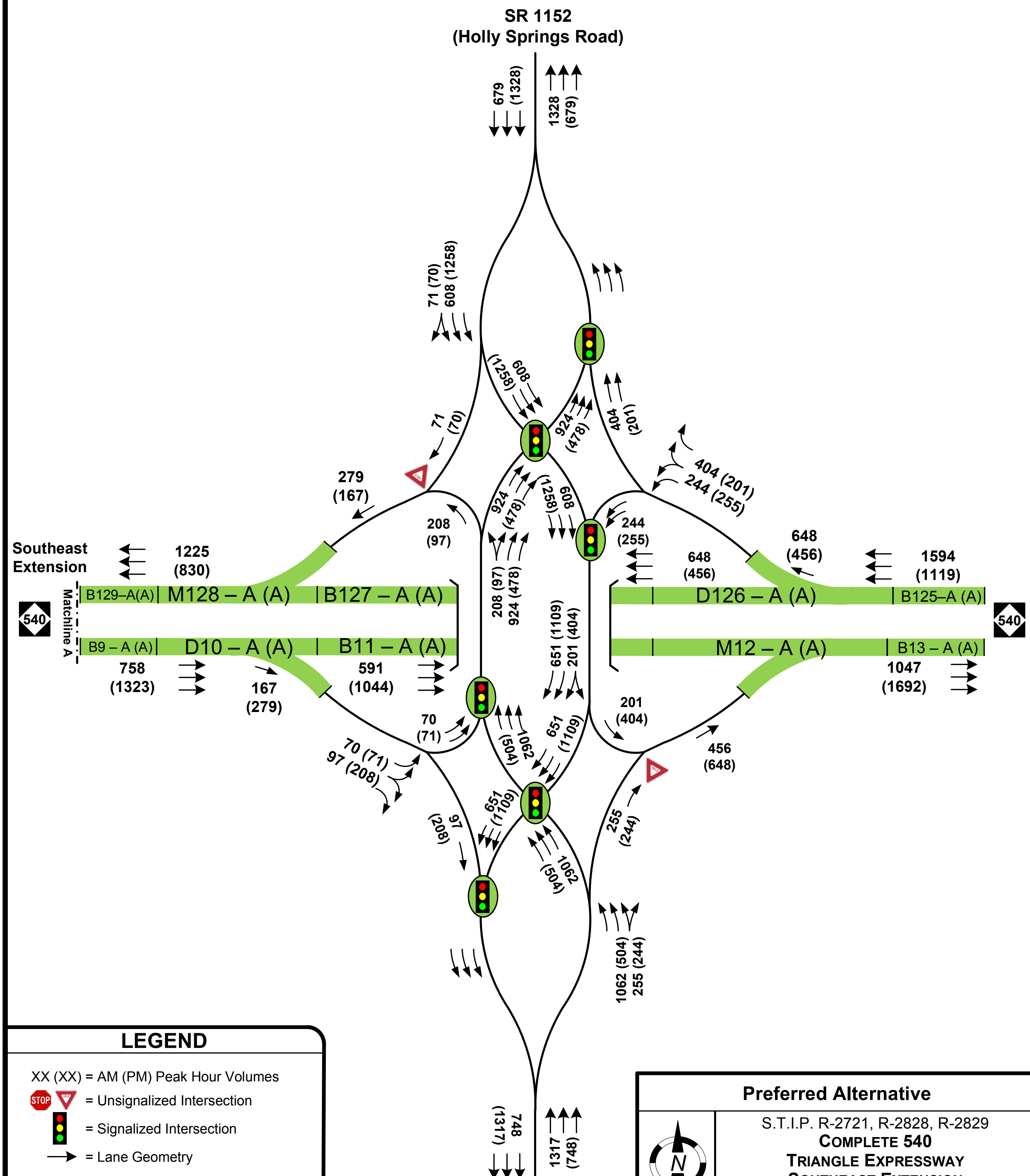
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 5.2

N

NOT TO SCALE



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

STOP = Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

Preferred Alternative

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

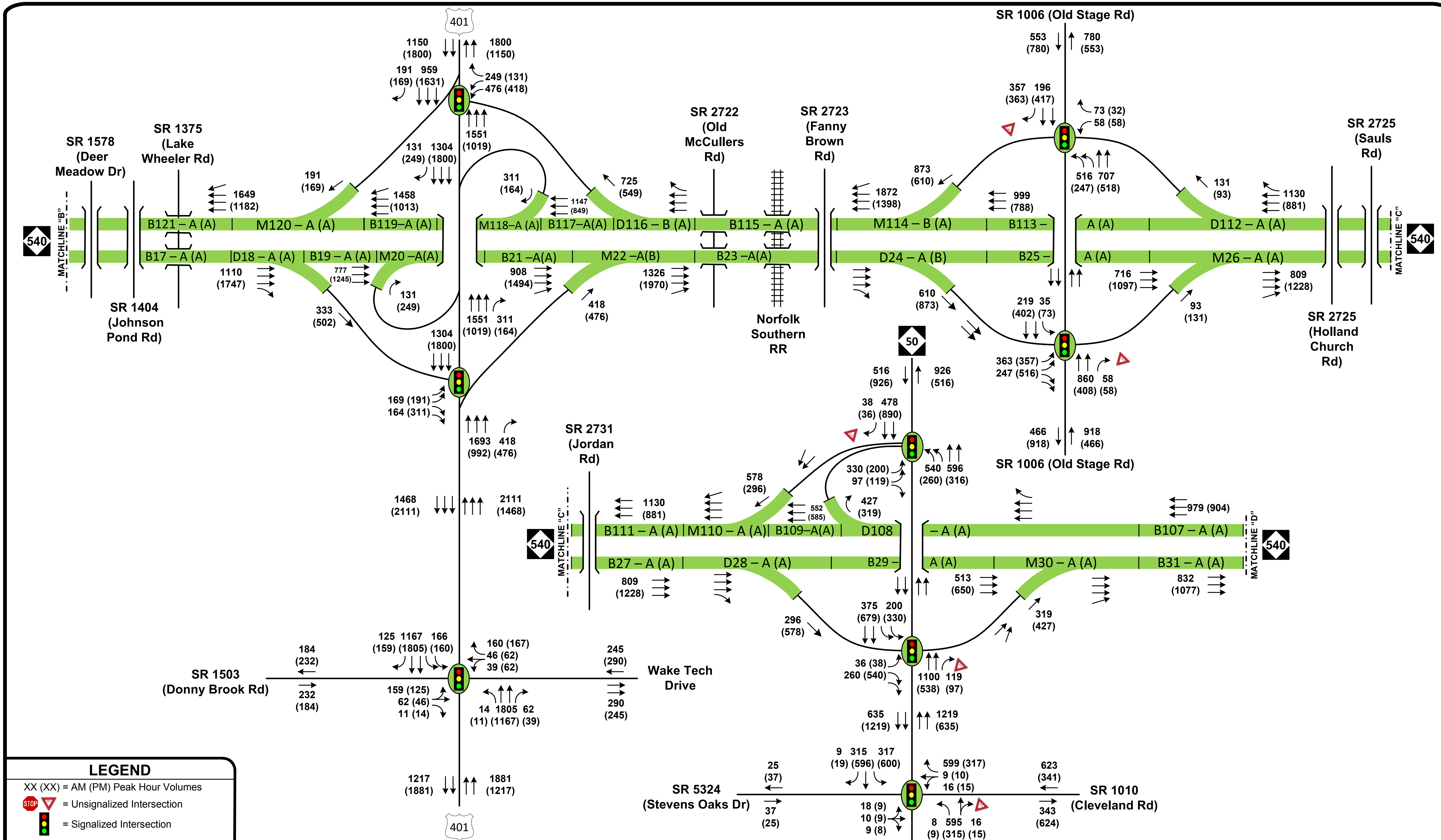
N

NOT TO SCALE

2016 BASE YEAR BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 5.3



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

STOP = Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

N

NOT TO SCALE

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540 TRIANGLE EXPRESSWAY SOUTHEAST EXTENSION

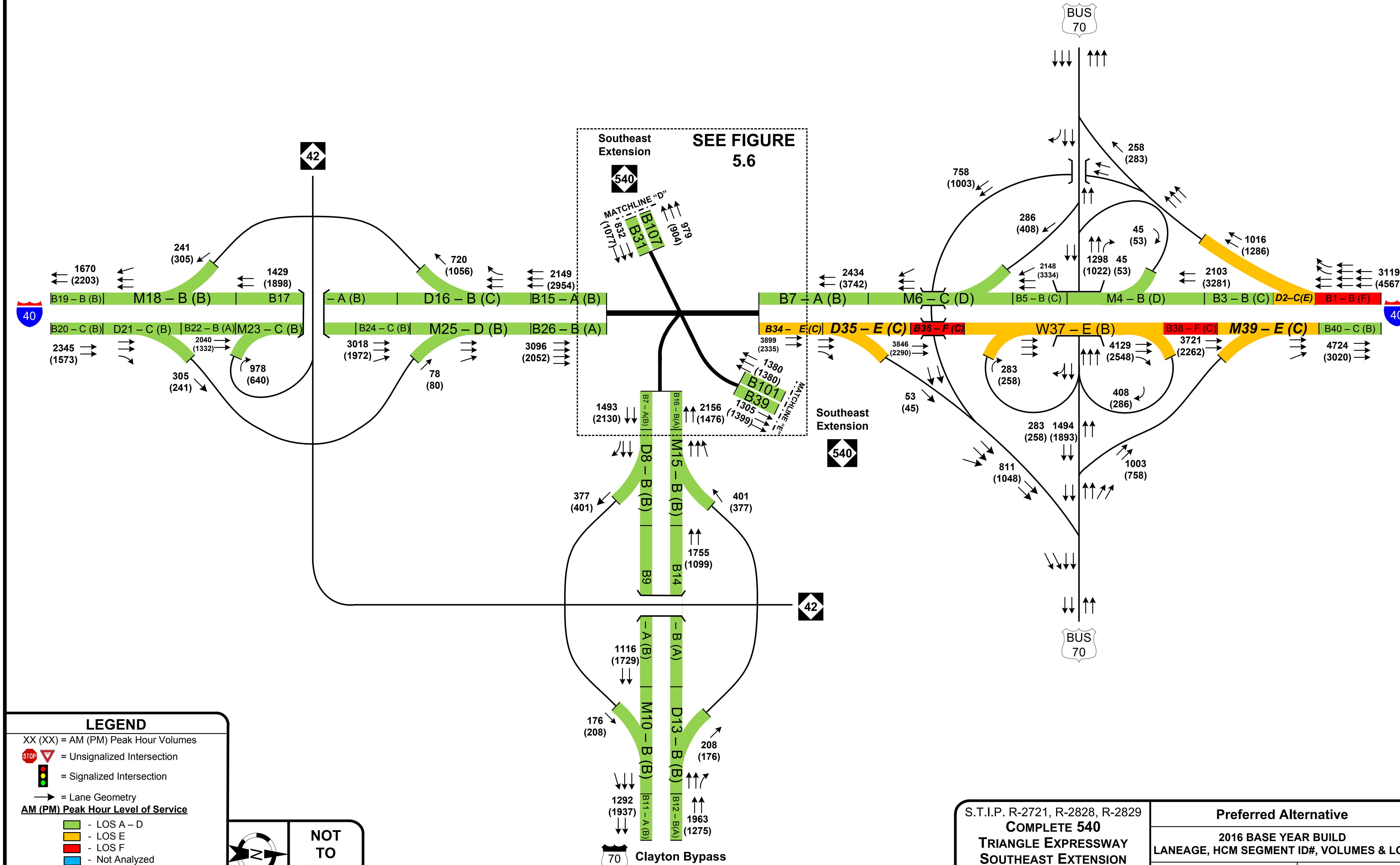
WAKE AND JOHNSTON COUNTIES

Preferred Alternative

2016 BASE YEAR BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 5.4



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

NOT TO SCALE

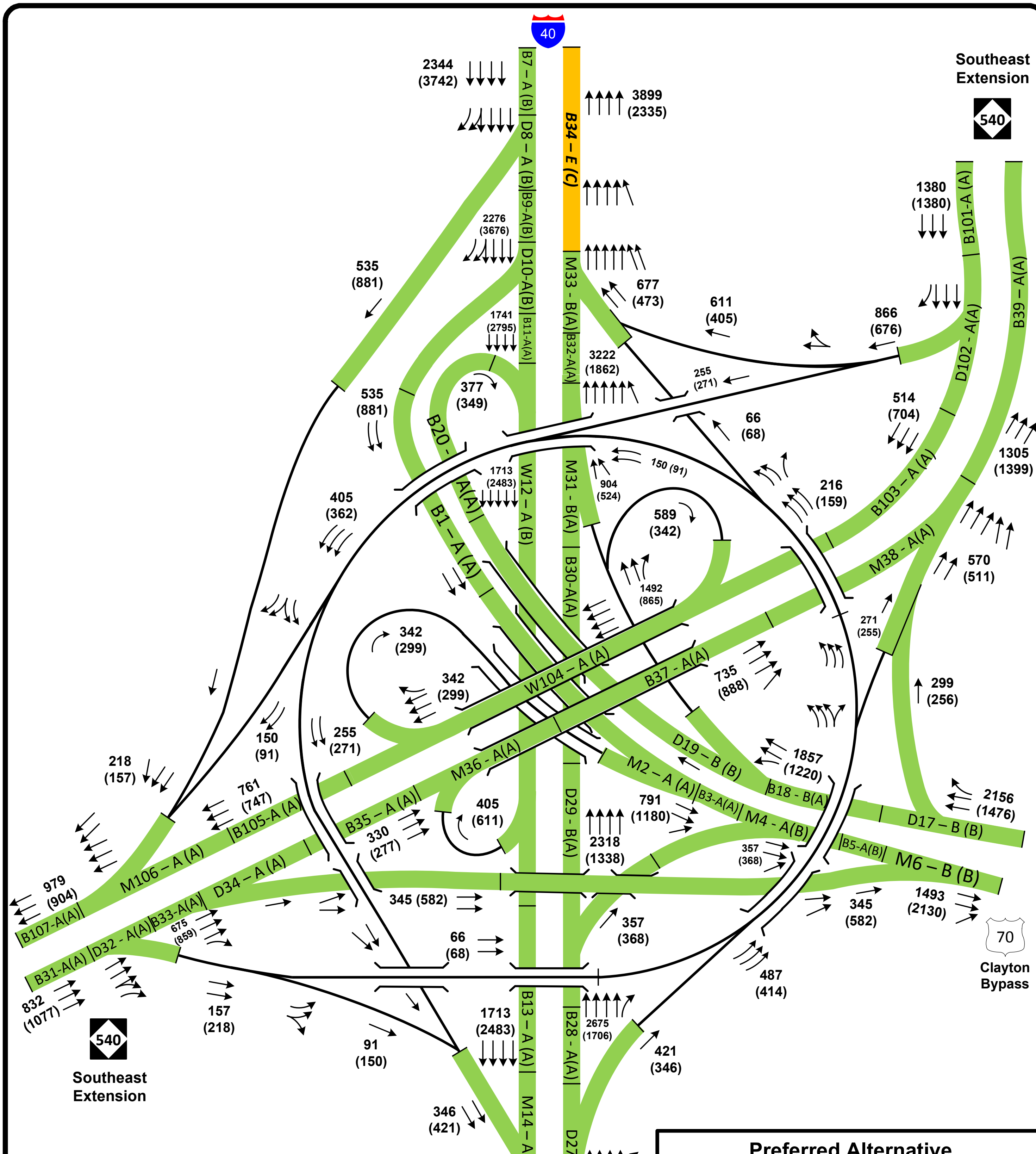
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

Preferred Alternative

2016 BASE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 5.5



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

→ = Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Preferred Alternative

S.T.I.P. R-2721, R-2828, R-2829

Complete 540
Triangle Expressway
Southeast Extension

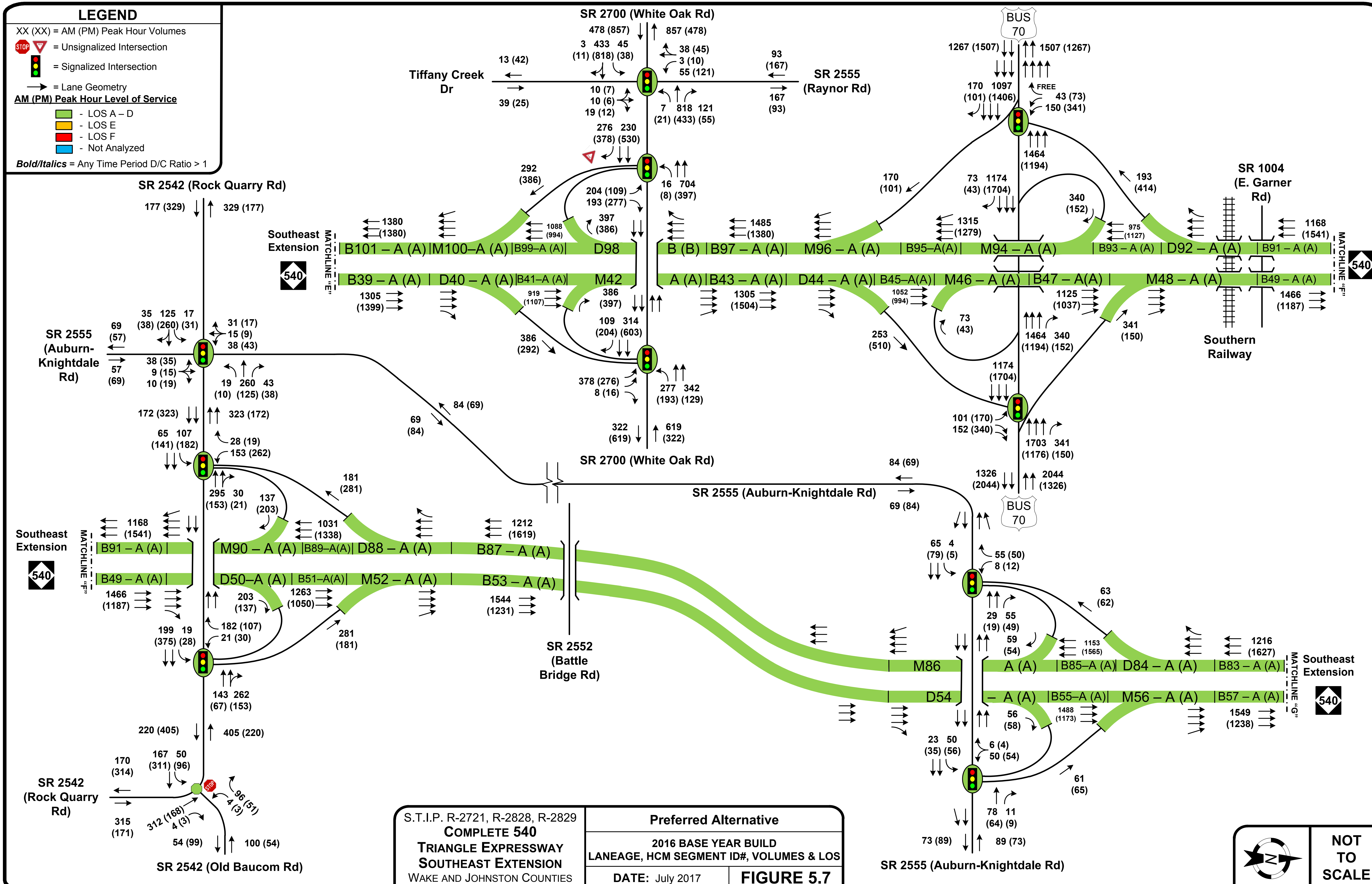
Wake and Johnston Counties

2016 BASE YEAR BUILD
LANEAGE, HCM SEGMENT ID#,
VOLUMES & LOS

NOT TO SCALE

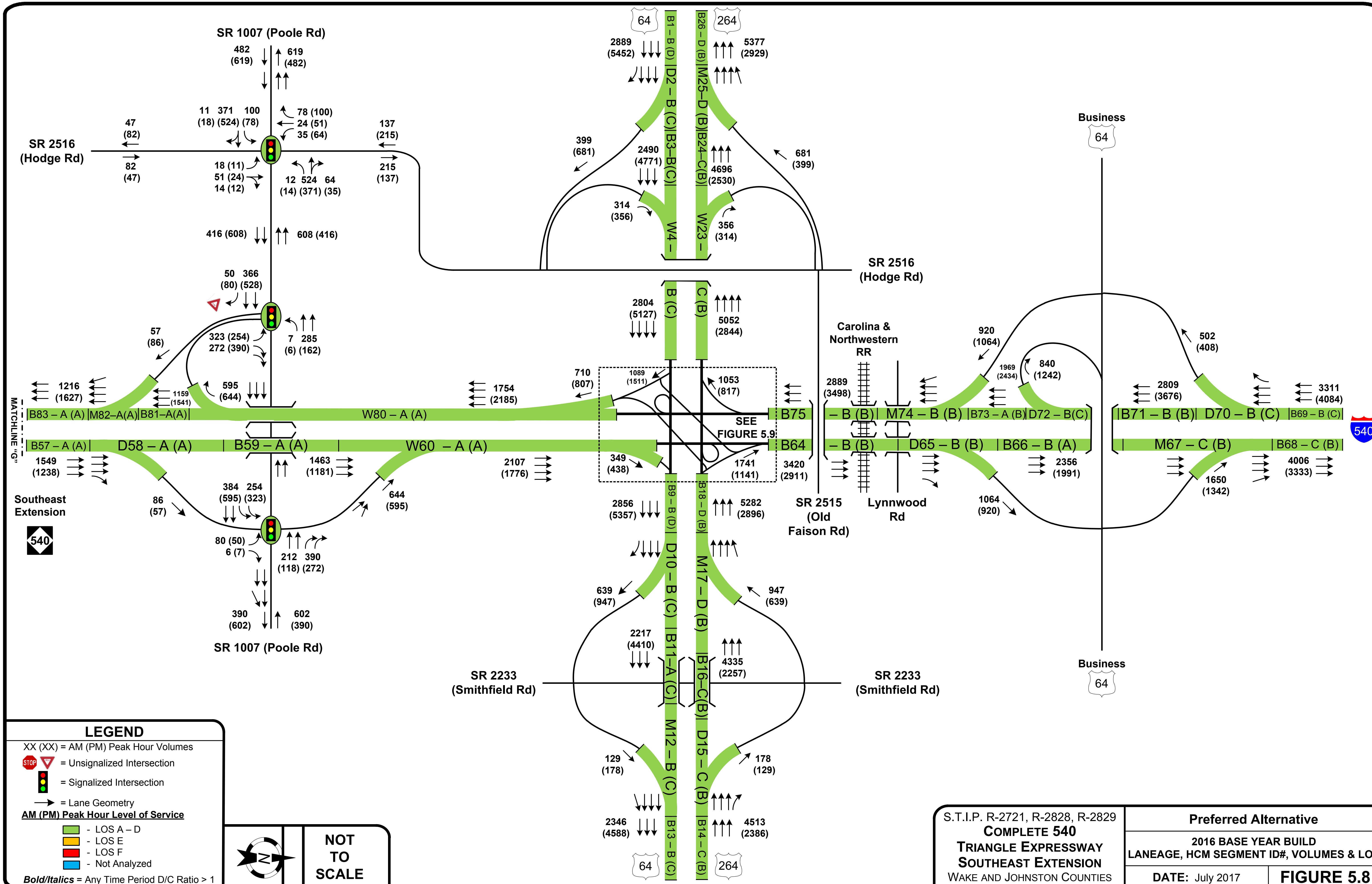
DATE: July 2017

FIGURE 5.6



S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

Preferred Alternative
2016 BASE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS
DATE: July 2017
FIGURE 5.7

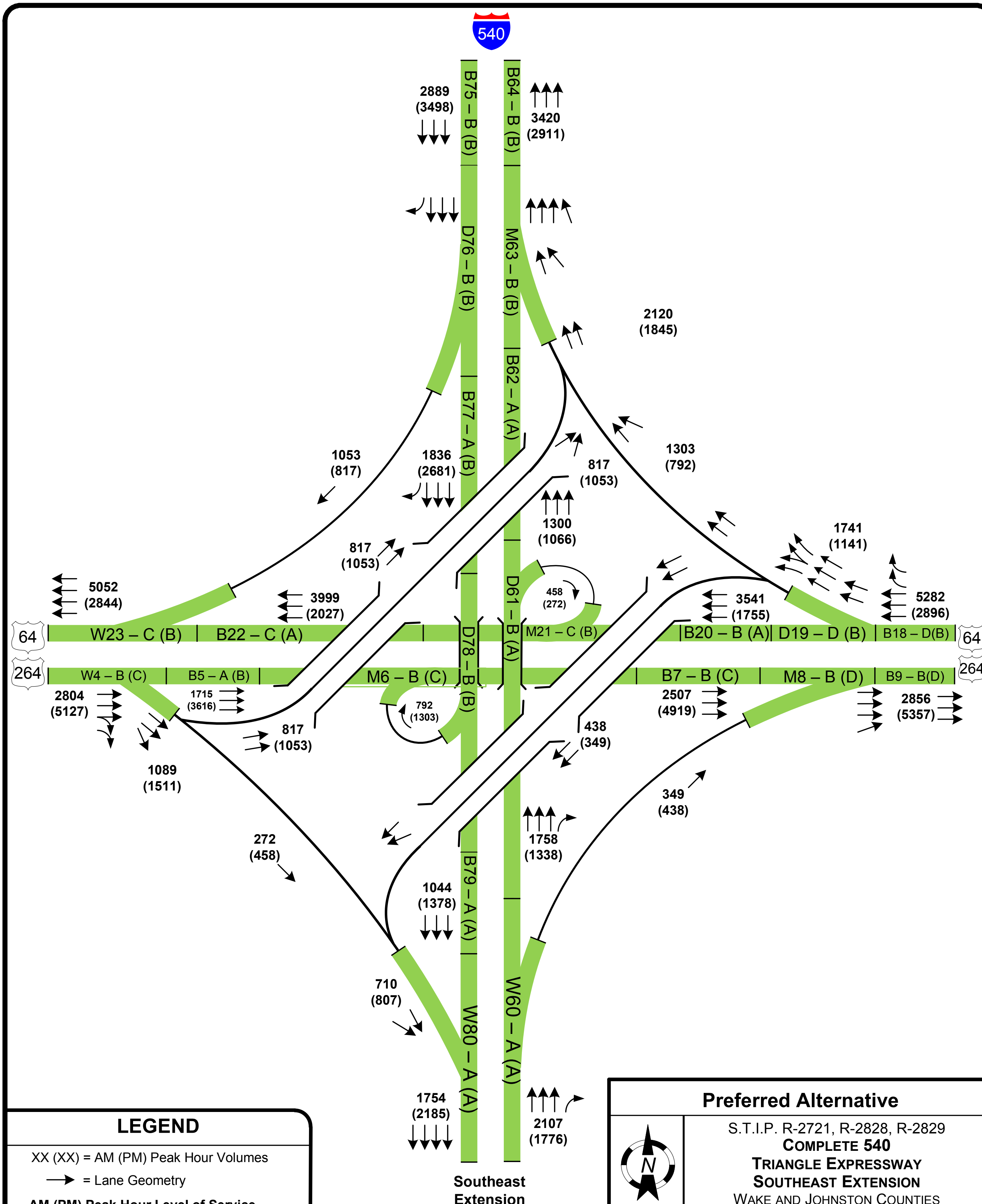


S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

Preferred Alternative
2016 BASE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 5.8



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

→ = Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Preferred Alternative

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540

TRIANGLE EXPRESSWAY

SOUTHEAST EXTENSION

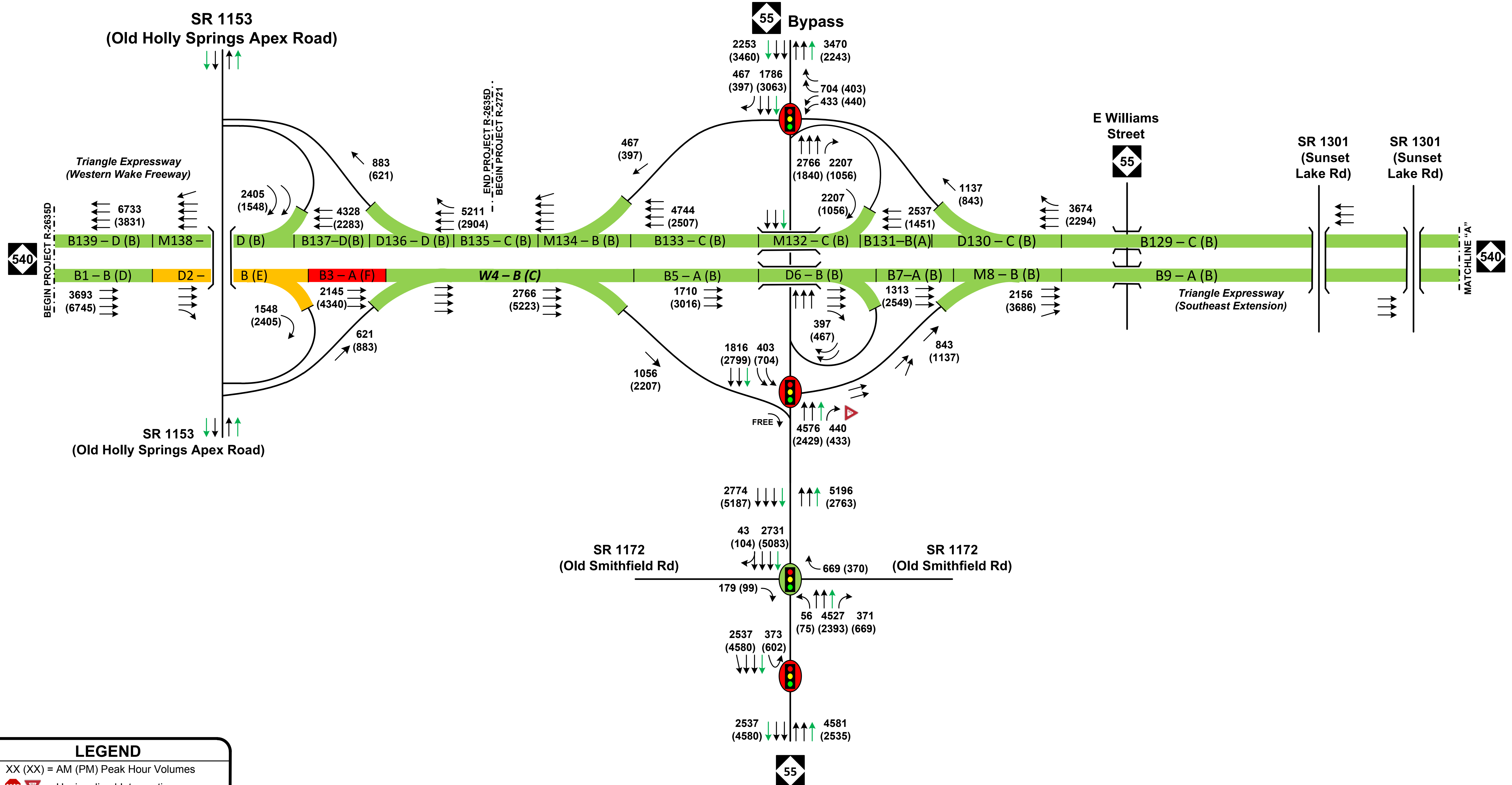
WAKE AND JOHNSTON COUNTIES

2016 BASE YEAR BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

NOT TO SCALE

DATE: July 2017

FIGURE 5.9



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

Preferred Alternative

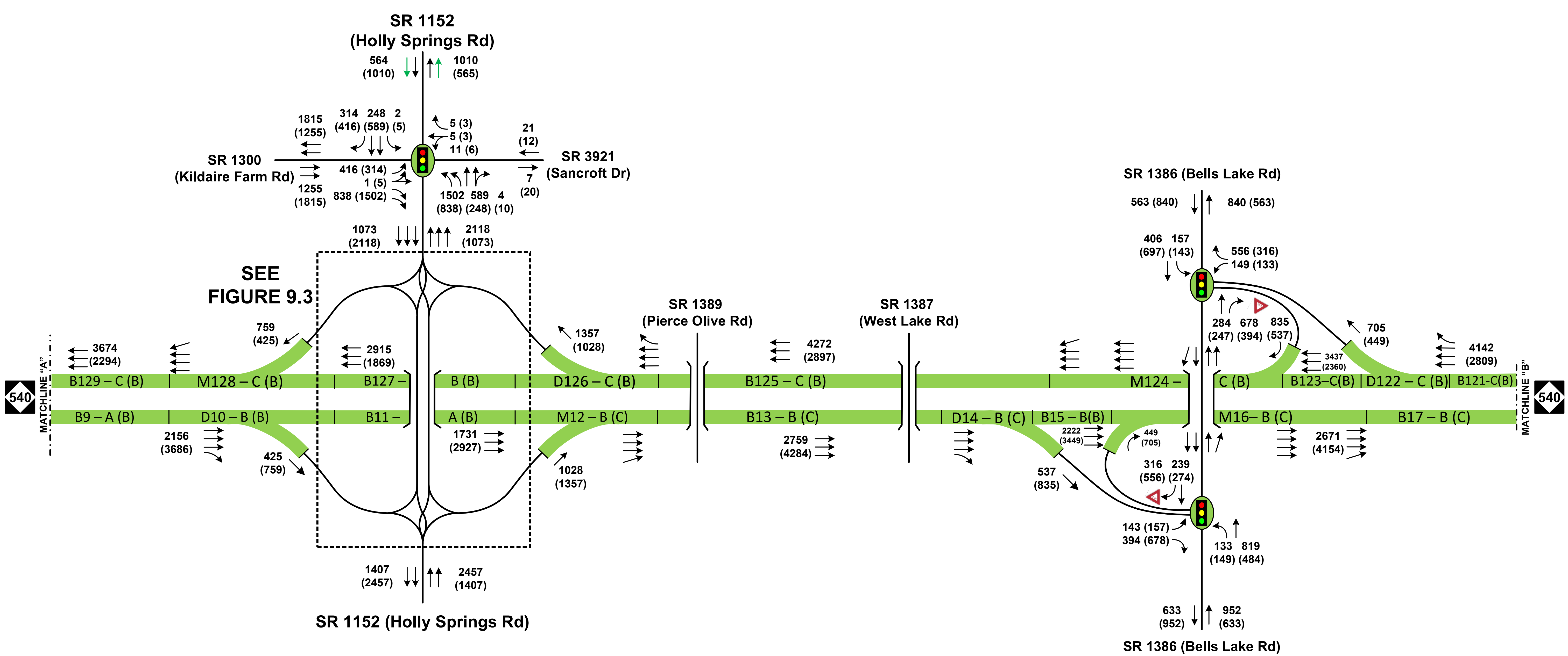
2040 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 6.1

N

NOT TO SCALE



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

Preferred Alternative

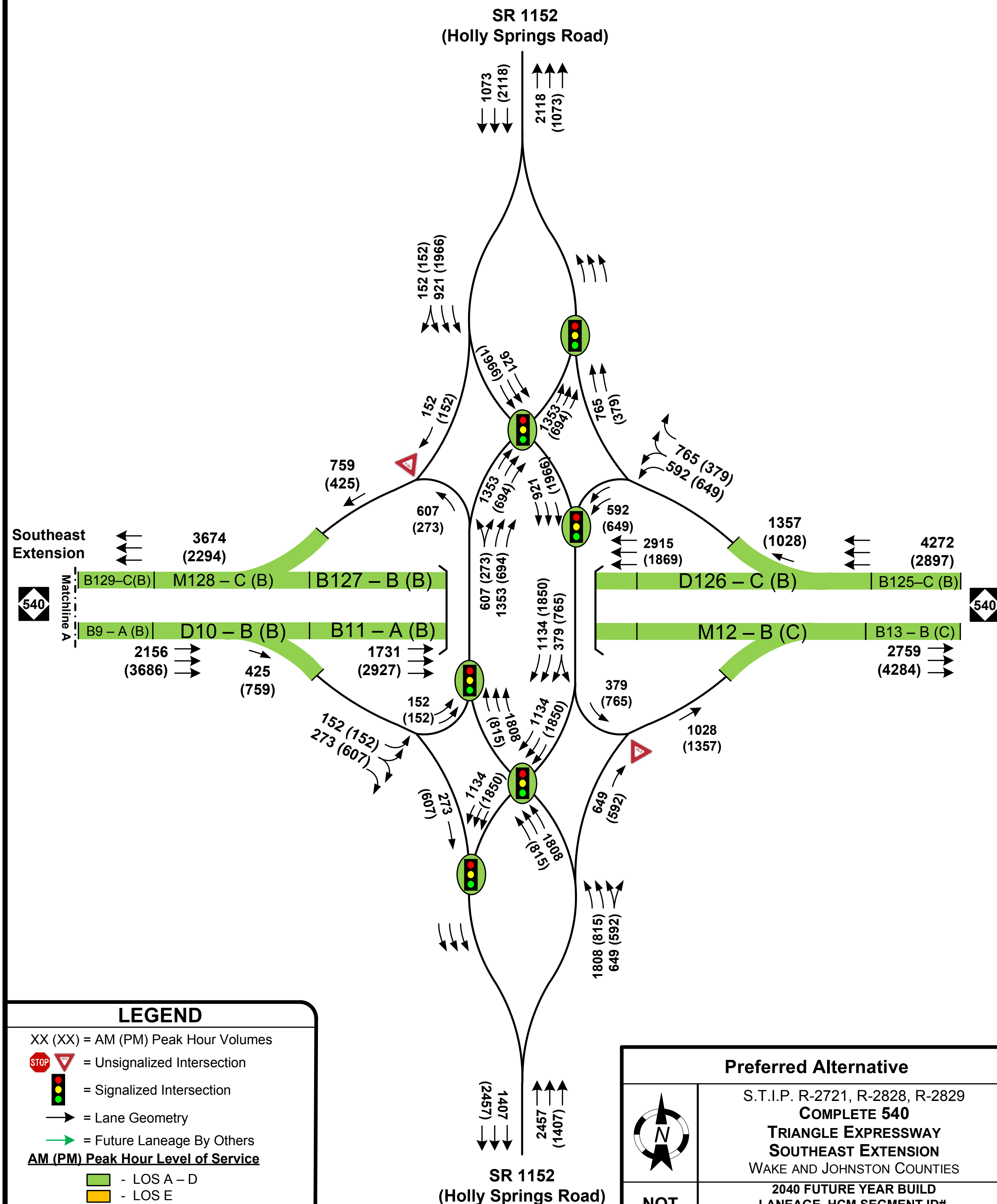
2040 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 6.2

N

NOT TO SCALE



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

STOP = Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

Preferred Alternative

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540

TRIANGLE EXPRESSWAY

SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

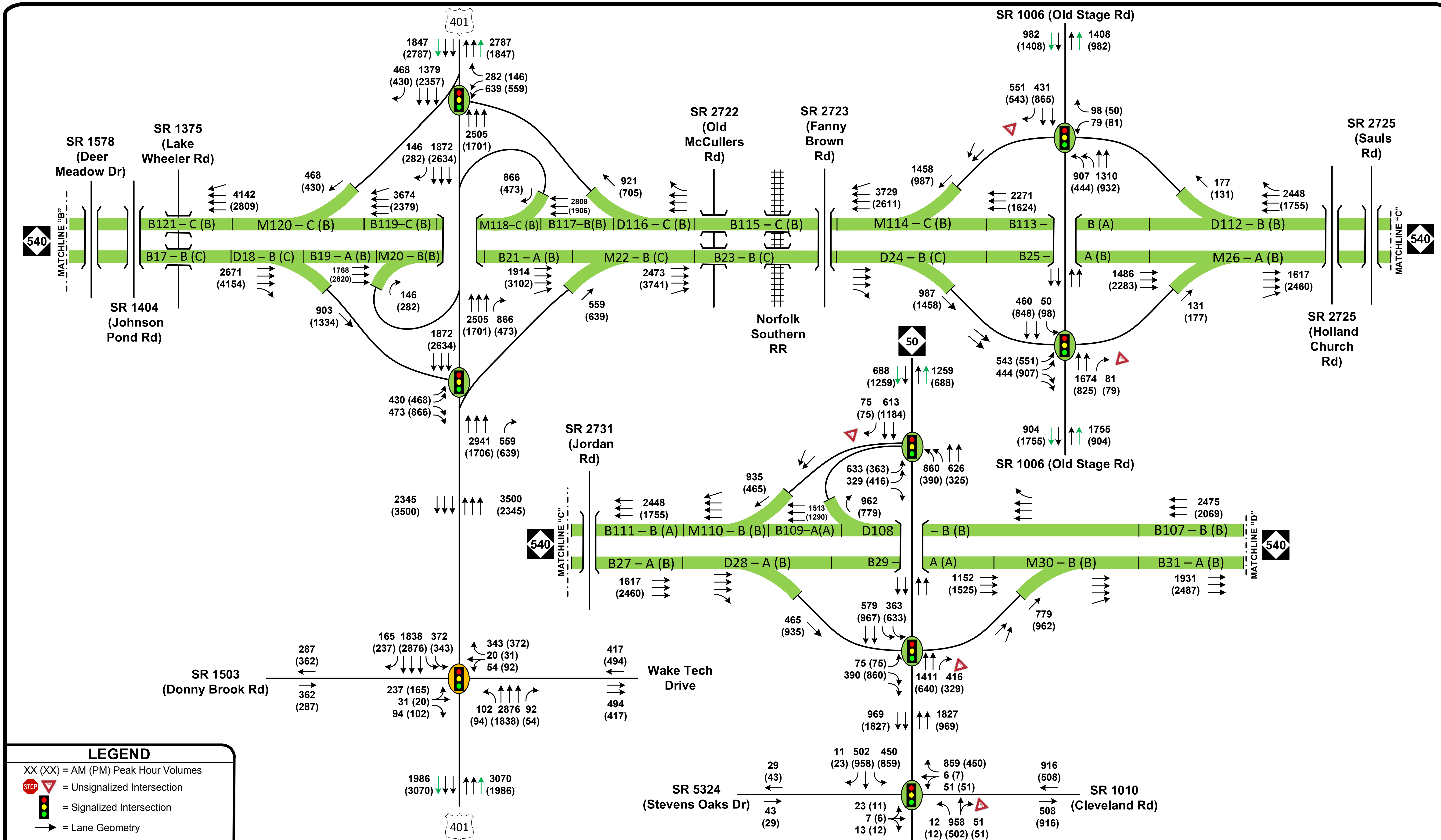
N

NOT TO SCALE

2040 FUTURE YEAR BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 6.3



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

STOP = Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

N

NOT TO SCALE

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540 TRIANGLE EXPRESSWAY SOUTHEAST EXTENSION

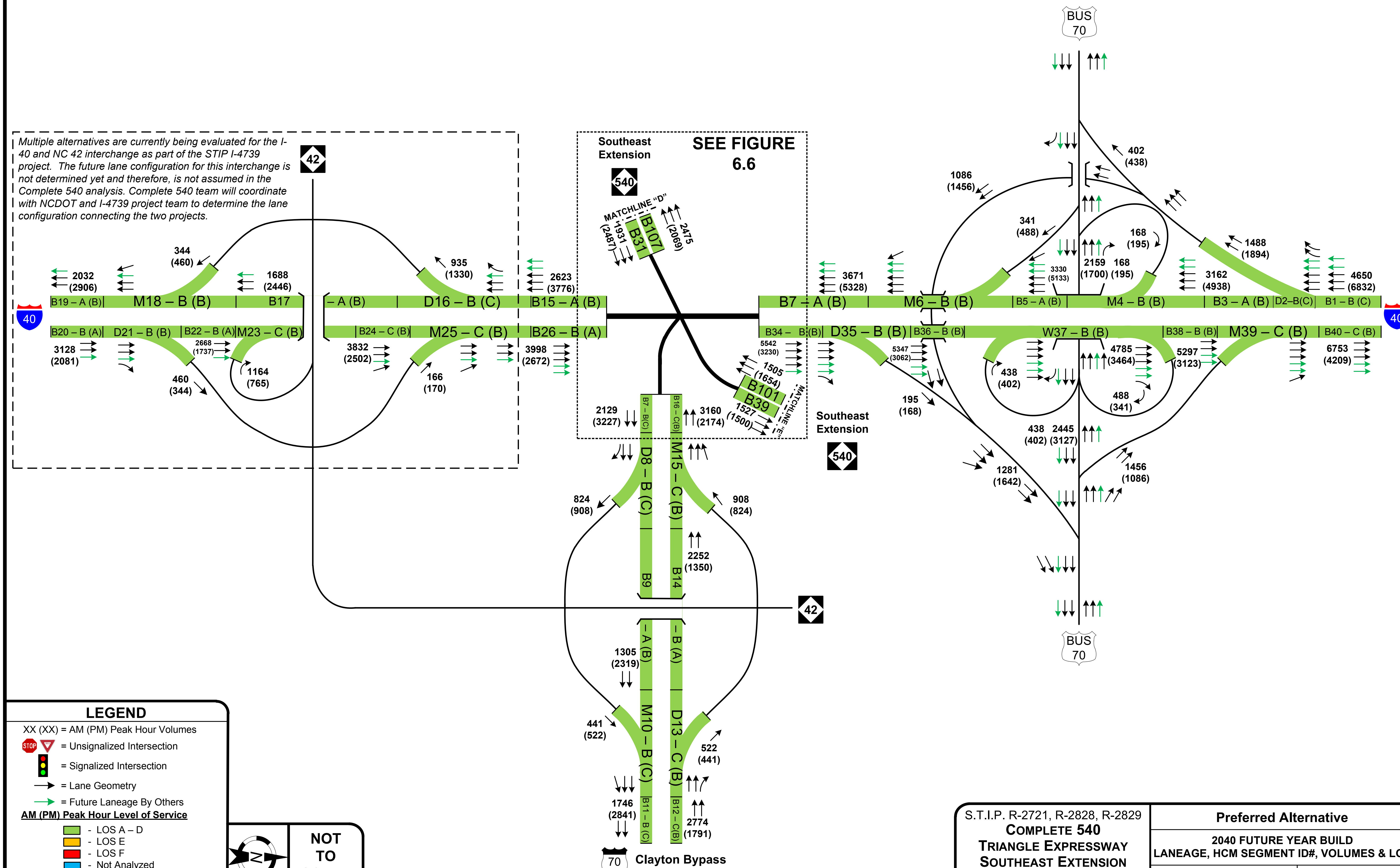
WAKE AND JOHNSTON COUNTIES

Preferred Alternative

2040 FUTURE YEAR BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 6.4



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

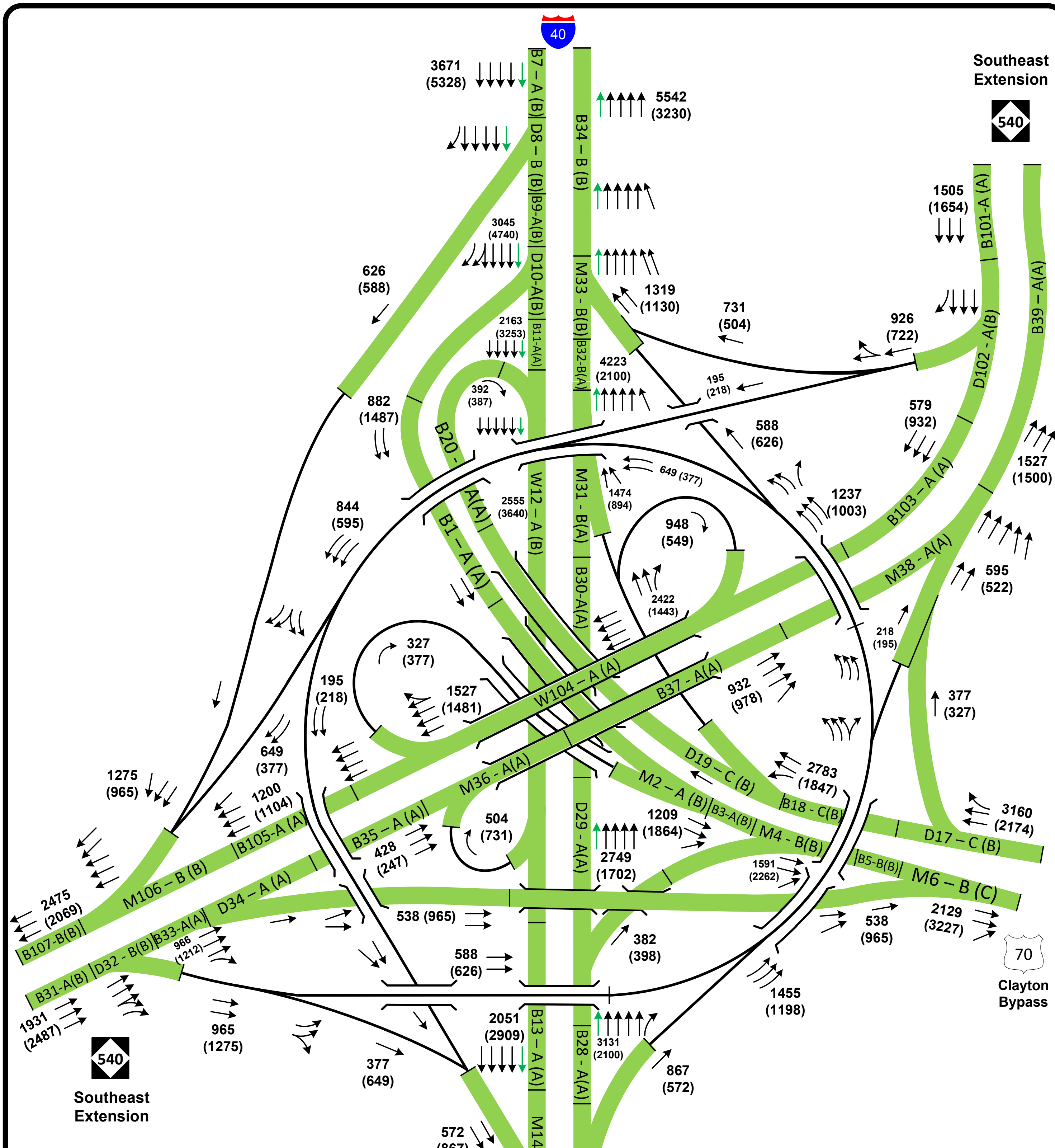
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

Preferred Alternative

2040 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 6.5



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

→ = Lane Geometry

→ = Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

Preferred Alternative

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540

TRIANGLE EXPRESSWAY

SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

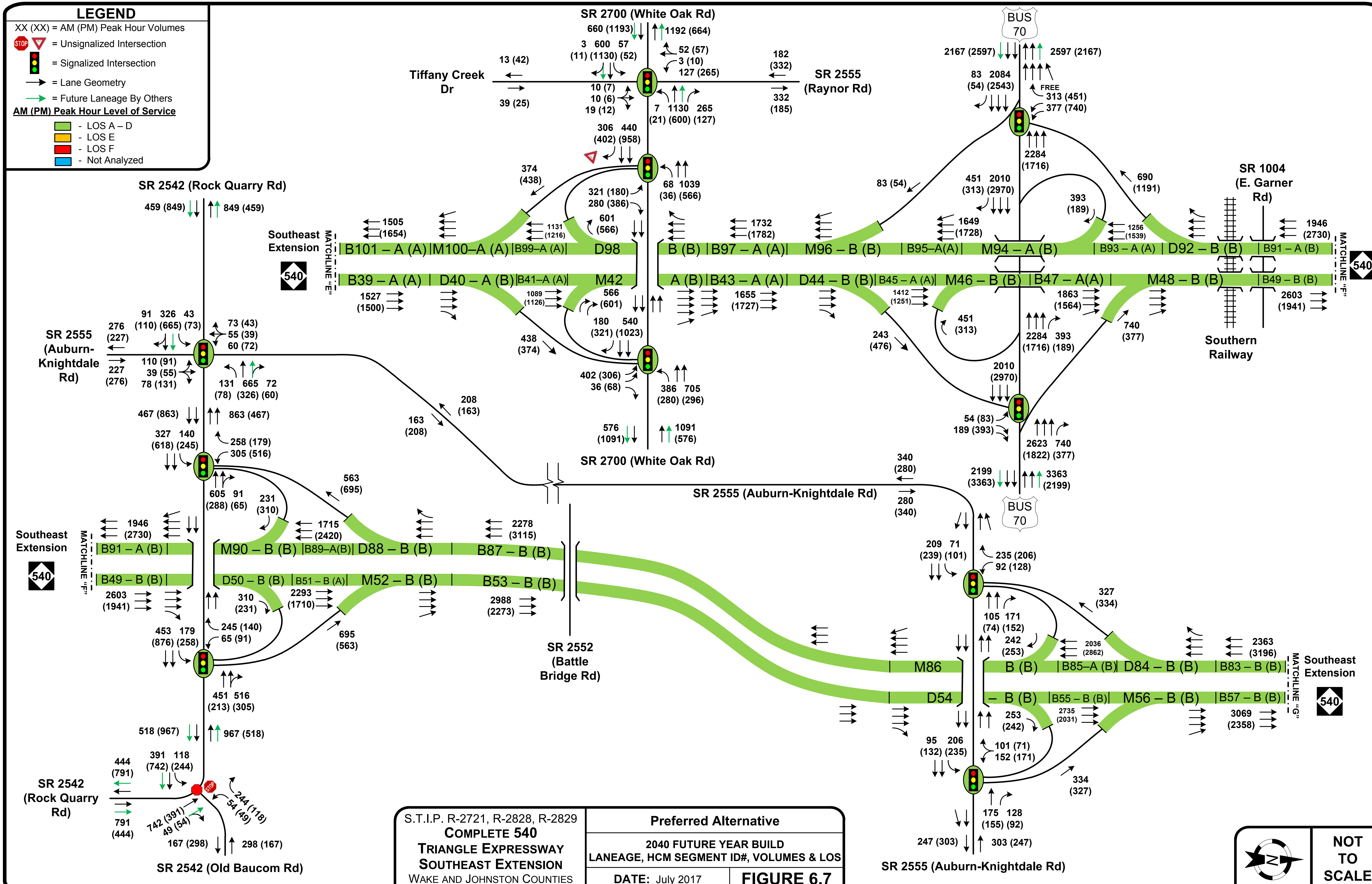
N

NOT TO SCALE

2040 FUTURE YEAR BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 6.6



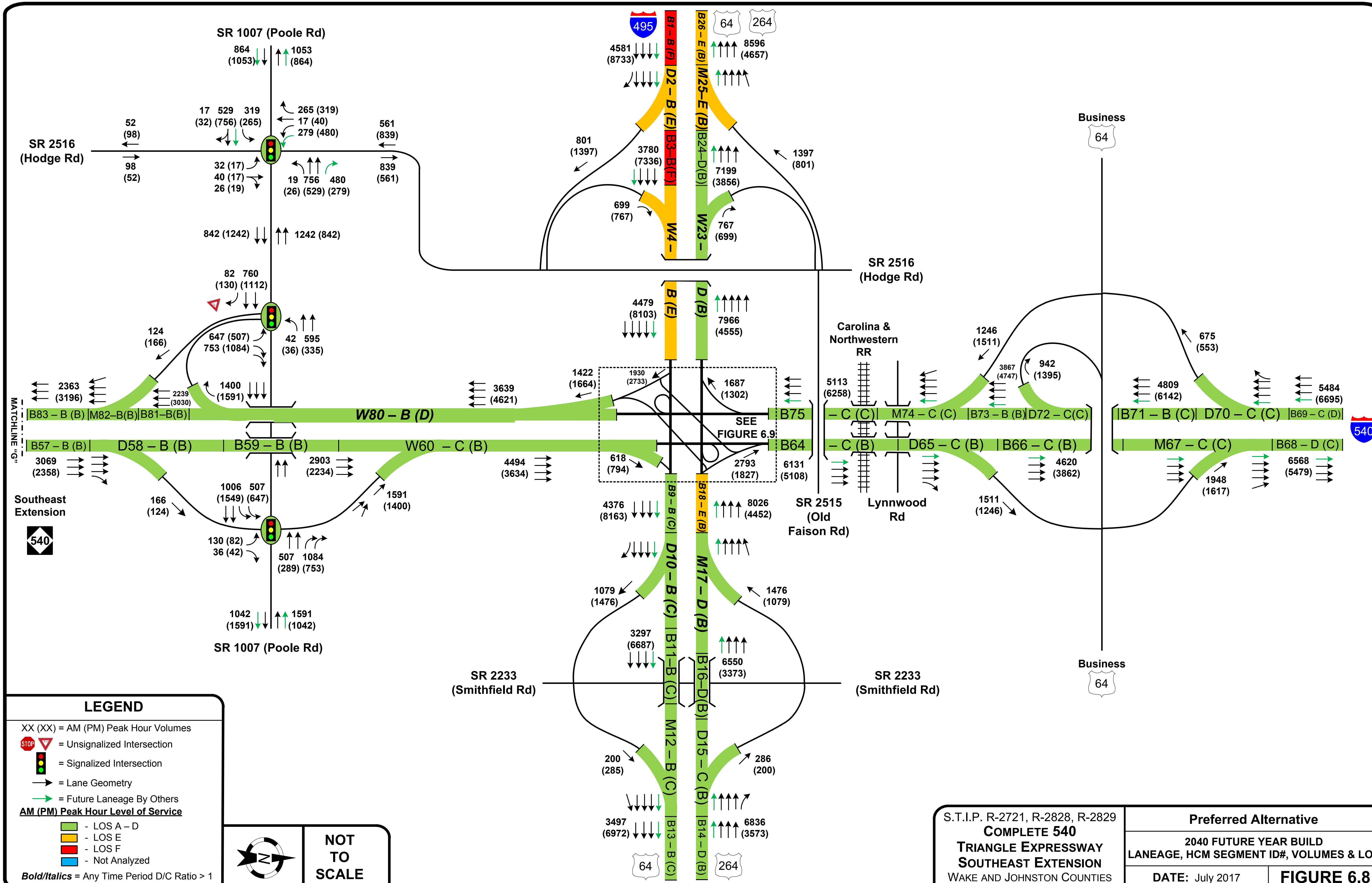
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

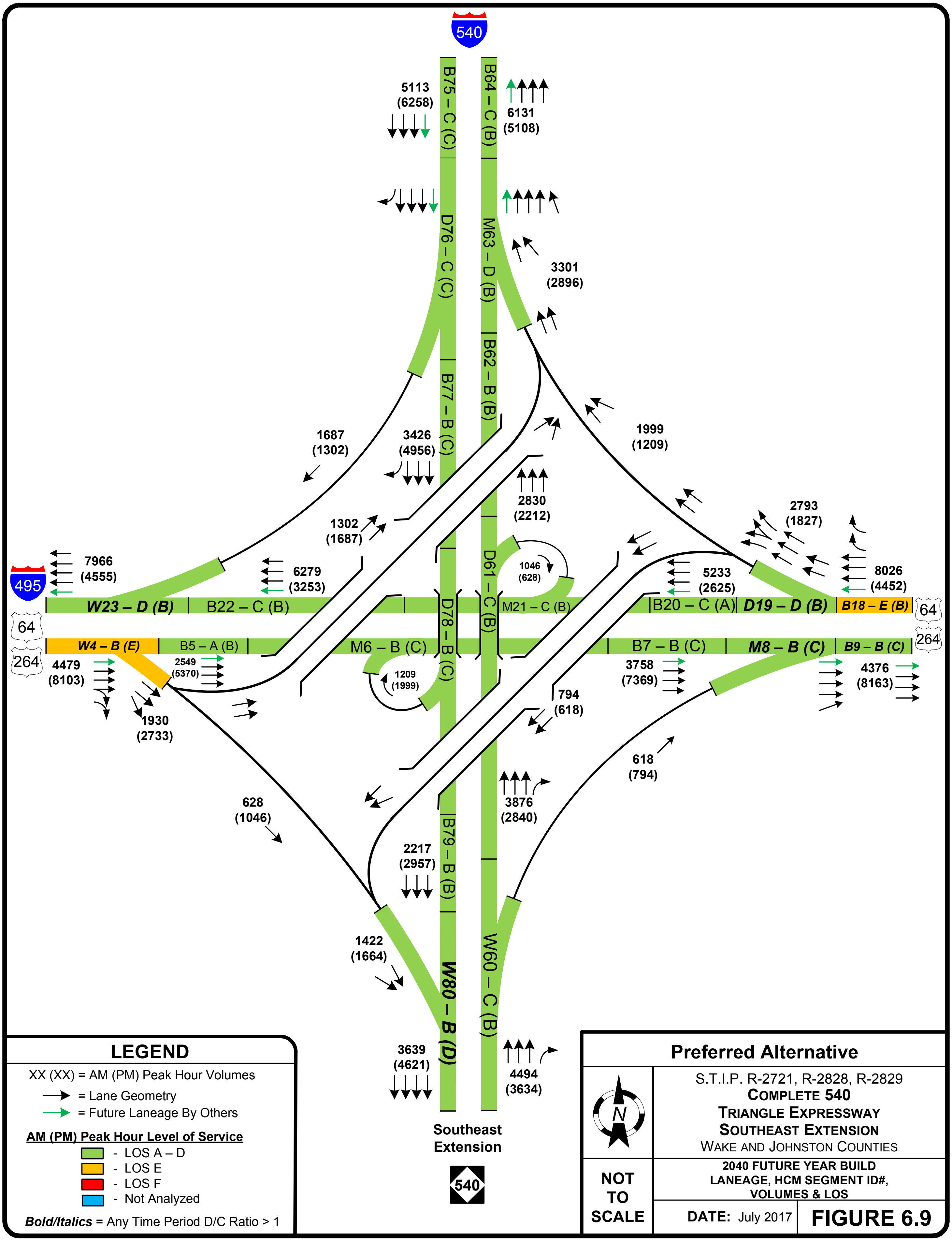
Preferred Alternative

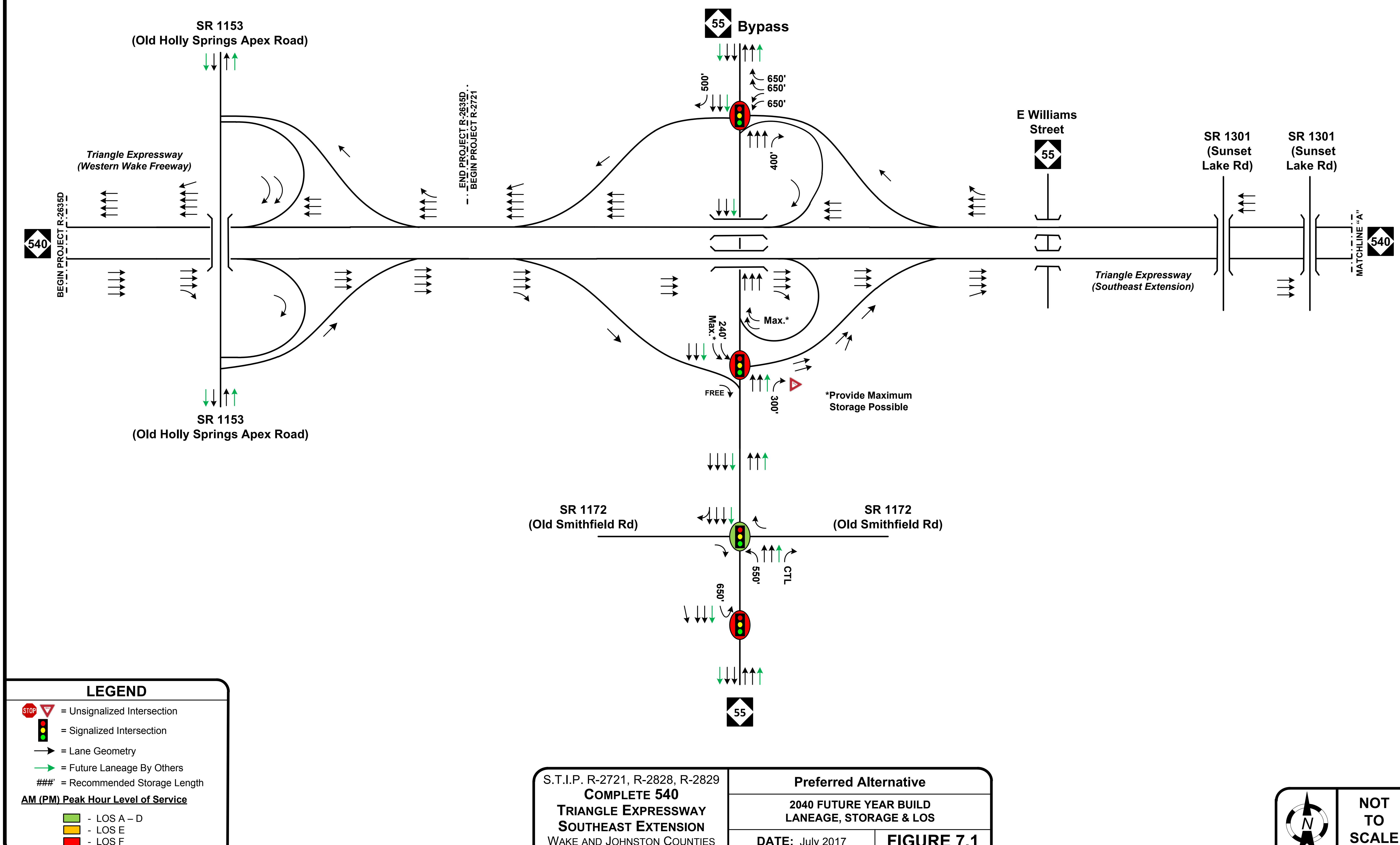
2040 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: July 2017

FIGURE 6.7


SR 1007 (Poole Rd)
SR 2516 (Hodge Rd)
SR 2516 (Hodge Rd)
SR 2515 (Old Faison Rd)
Lynnwood Rd
Carolina & Northwestern RR
Business 64
Business 64
SR 2233 (Smithfield Rd)
SR 2233 (Smithfield Rd)
Southeast Extension
540
495
64
264
MATCHLINE "G"
SEE FIGURE 6.9
B1 – B (F)
D2 – B (E)
B3 – B (F)
W4 –
B26 – E (B)
M25 – E (B)
B24 – D (B)
W23 –
B (E)
D (B)
B83 – B (B)
M82 – B (B)
B81 – B (B)
W80 – B (D)
B75
– C (C)
M74 – C (C)
B73 – B (B)
D72 – C (C)
B71 – B (C)
D70 – C (C)
B69 – C (D)
B57 – B (B)
D58 – B (B)
B59 – B (B)
W60 – C (B)
B64
– C (B)
D65 – C (B)
B66 – C (B)
M67 – C (C)
B68 – D (C)
B9 – B (C)
D10 – B (C)
B11 – B (C)
M12 – B (C)
B13 – B (C)
B18 – E (B)
M17 – D (B)
B16 – D (B)
D15 – C (B)
B14 – D (B)
LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
STOP = Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
Bold/Italics = Any Time Period D/C Ratio > 1
N
NOT TO SCALE
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
Preferred Alternative
2040 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS
DATE: July 2017
FIGURE 6.8


540
495
64
264
B75 – C (C)
B64 – C (B)
5113
(6258)
6131
(5108)
D76 – C (C)
M63 – D (B)
3301
(2896)
B77 – B (C)
B62 – B (B)
1687
(1302)
3426
(4956)
1999
(1209)
2830
(2212)
1302
(1687)
2793
(1827)
7966
(4555)
6279
(3253)
1046
(628)
5233
(2625)
8026
(4452)
W23 – D (B)
B22 – C (B)
D78 – B (C)
D61 – C (B)
M21 – C (B)
B20 – C (A)
D19 – D (B)
B18 – E (B)
W4 – B (E)
B5 – A (B)
M6 – B (C)
B7 – B (C)
M8 – B (C)
B9 – B (C)
4479
(8103)
2549
(5370)
1209
(1999)
3758
(7369)
4376
(8163)
1930
(2733)
794
(618)
618
(794)
628
(1046)
3876
(2840)
2217
(2957)
B79 – B (B)
1422
(1664)
W80 – B (D)
W60 – C (B)
3639
(4621)
4494
(3634)
Southeast
Extension
LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
Bold/Italics = Any Time Period D/C Ratio > 1
Preferred Alternative
N
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
2040 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#,
VOLUMES & LOS
NOT
TO
SCALE
DATE: July 2017
FIGURE 6.9



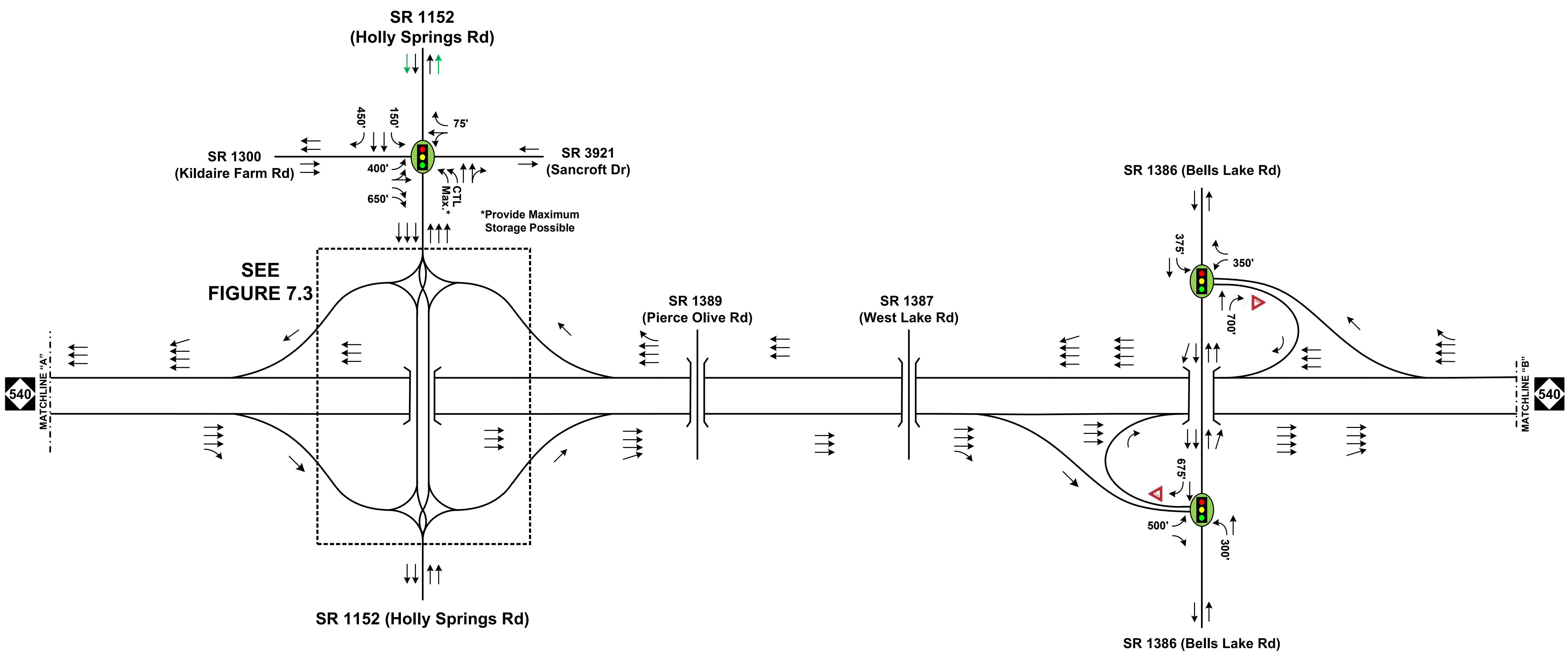
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

Preferred Alternative

2040 FUTURE YEAR BUILD
LANEAGE, STORAGE & LOS

DATE: July 2017

FIGURE 7.1



LEGEND

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

###' = Recommended Storage Length

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F

S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

Preferred Alternative

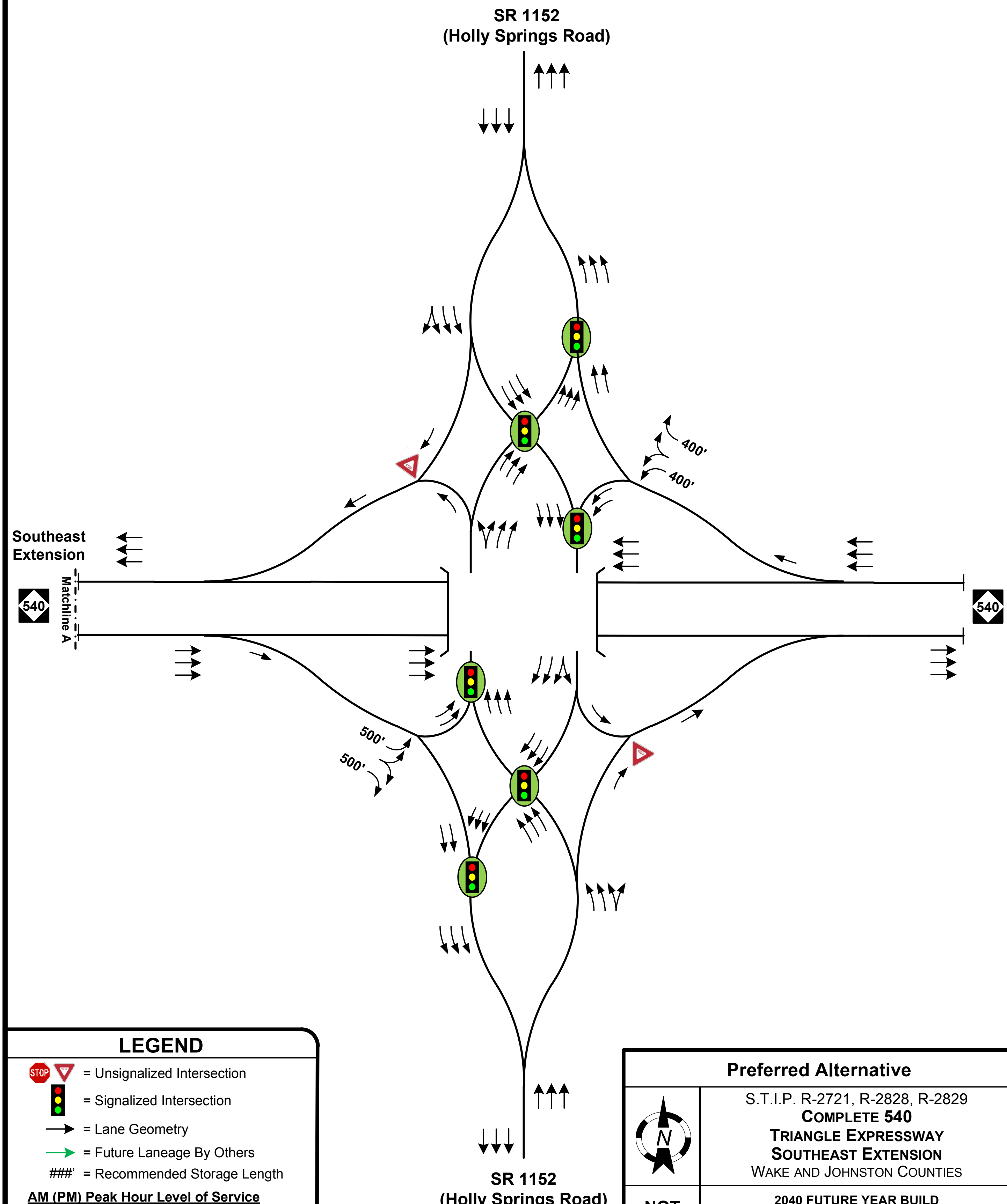
2040 FUTURE YEAR BUILD
LANEAGE, STORAGE & LOS

DATE: July 2017

FIGURE 7.2

N

NOT TO SCALE



LEGEND

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

###' = Recommended Storage Length

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F

Preferred Alternative

S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

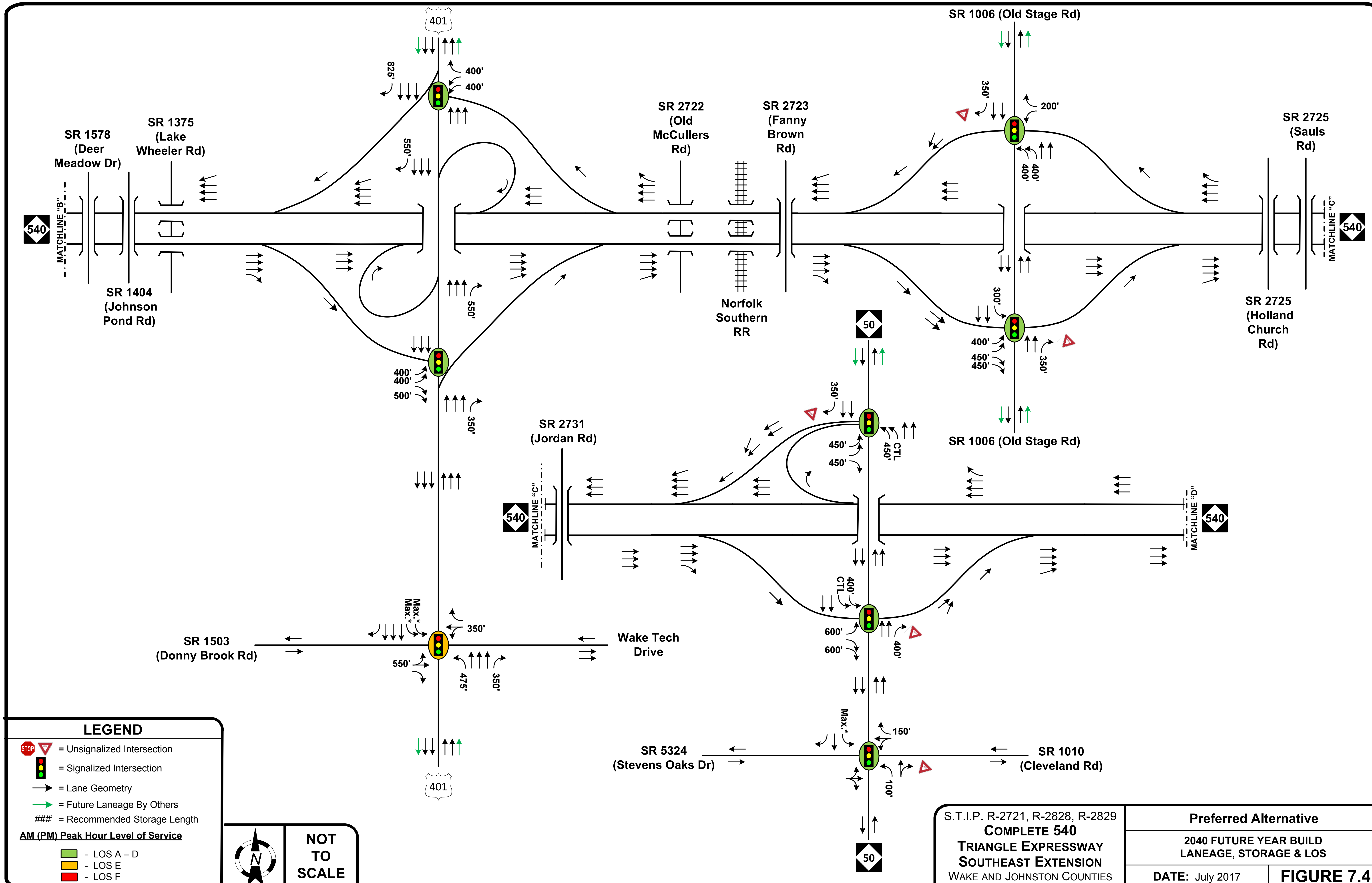
N

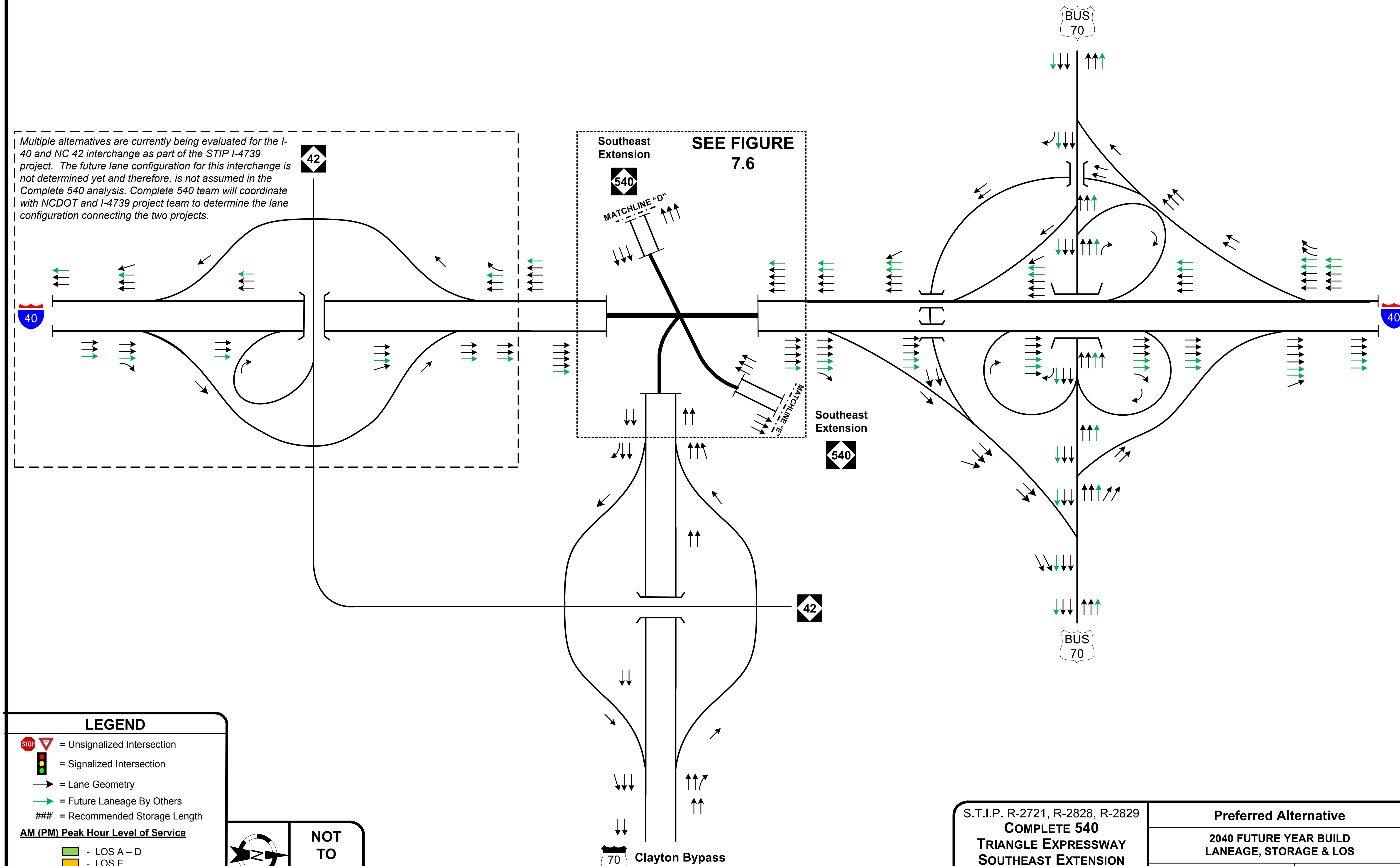
NOT TO SCALE

2040 FUTURE YEAR BUILD
LANEAGE, STORAGE & LOS

DATE: July 2017

FIGURE 7.3


401
SR 1006 (Old Stage Rd)
SR 1578 (Deer Meadow Dr)
SR 1375 (Lake Wheeler Rd)
SR 1404 (Johnson Pond Rd)
SR 2722 (Old McCullers Rd)
SR 2723 (Fanny Brown Rd)
Norfolk Southern RR
SR 2725 (Sauls Rd)
SR 2725 (Holland Church Rd)
540
MATCHLINE "B"
MATCHLINE "C"
MATCHLINE "D"
50
SR 2731 (Jordan Rd)
SR 1503 (Donny Brook Rd)
Wake Tech Drive
SR 5324 (Stevens Oaks Dr)
SR 1010 (Cleveland Rd)
825'
400'
550'
500'
350'
200'
300'
450'
600'
150'
100'
475'
CTL
Max.*
LEGEND
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others
= Recommended Storage Length
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
N
NOT TO SCALE
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
Preferred Alternative
2040 FUTURE YEAR BUILD
LANEAGE, STORAGE & LOS
DATE: July 2017
FIGURE 7.4



LEGEND

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

###' = Recommended Storage Length

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F

NOT TO SCALE

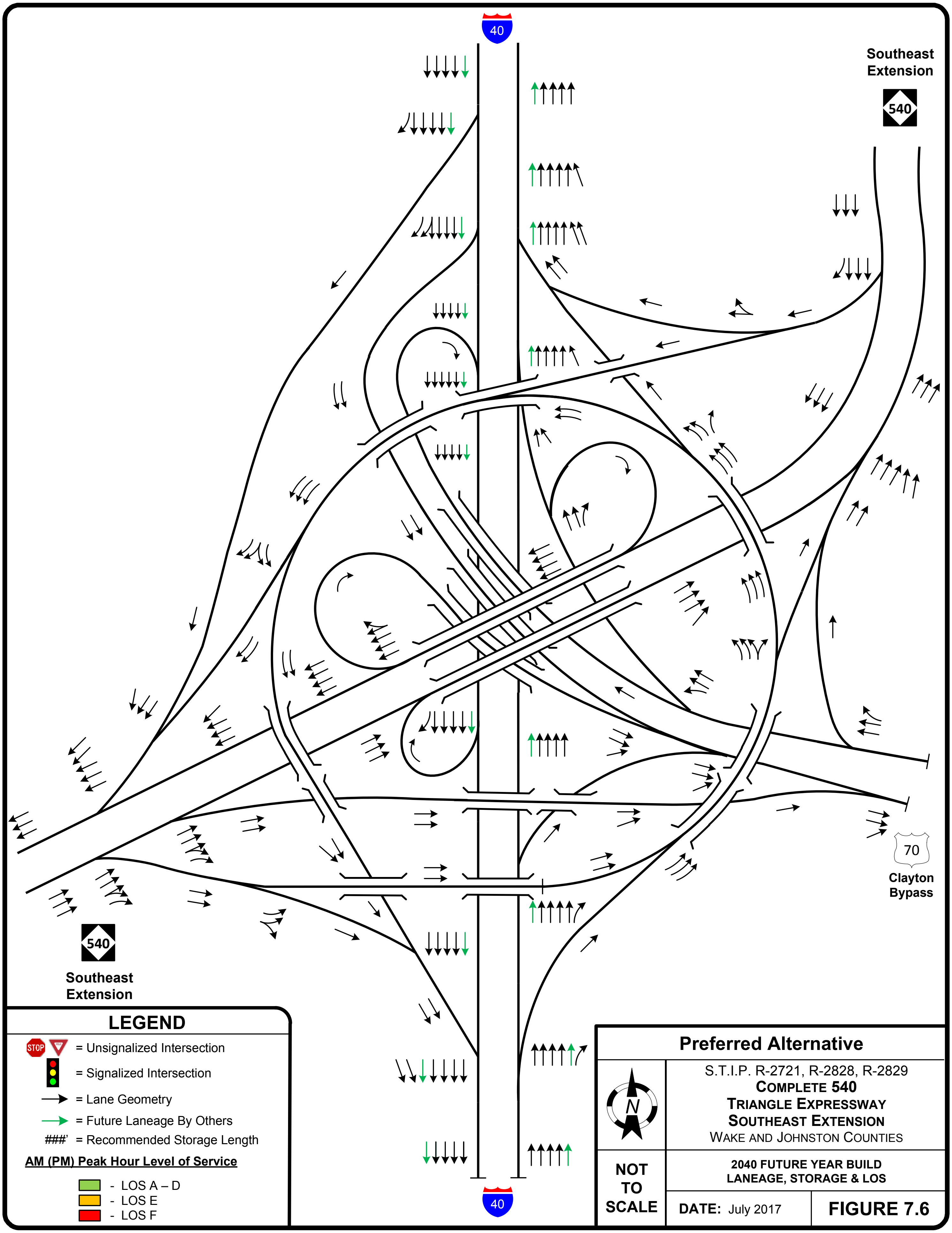
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

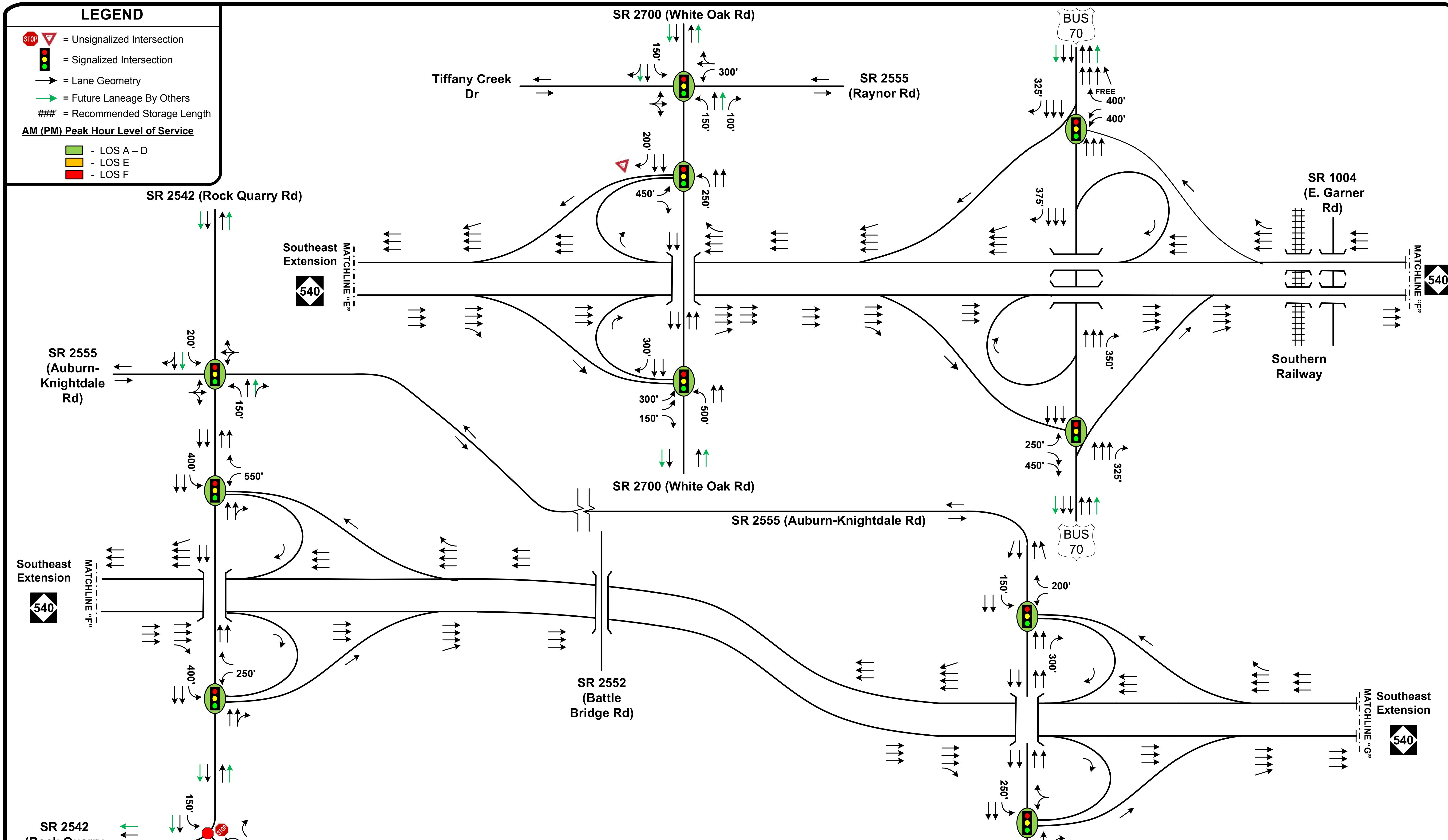
Preferred Alternative

2040 FUTURE YEAR BUILD LANEAGE, STORAGE & LOS

DATE: July 2017

FIGURE 7.5


40
Southeast
Extension
540
70
Clayton
Bypass
540
Southeast
Extension
40
LEGEND
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others
###' = Recommended Storage Length
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
Preferred Alternative
N
S.T.I.P. R-2721, R-2828, R-2829
Complete 540
Triangle Expressway
Southeast Extension
Wake and Johnston Counties
NOT
TO
SCALE
2040 FUTURE YEAR BUILD
LANEAGE, STORAGE & LOS
DATE: July 2017
FIGURE 7.6



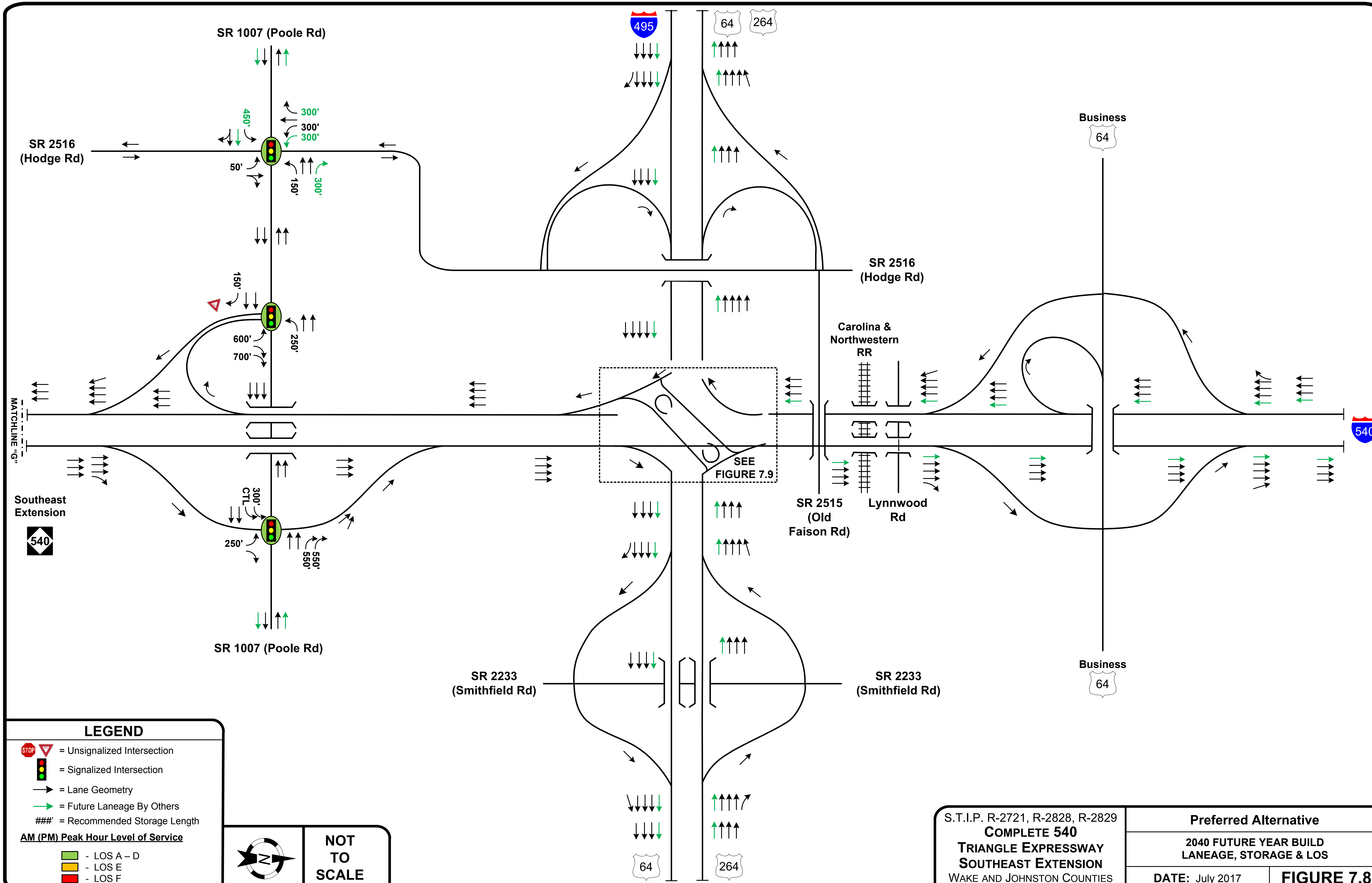
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

Preferred Alternative

2040 FUTURE YEAR BUILD
LANEAGE, STORAGE & LOS

DATE: July 2017

FIGURE 7.7



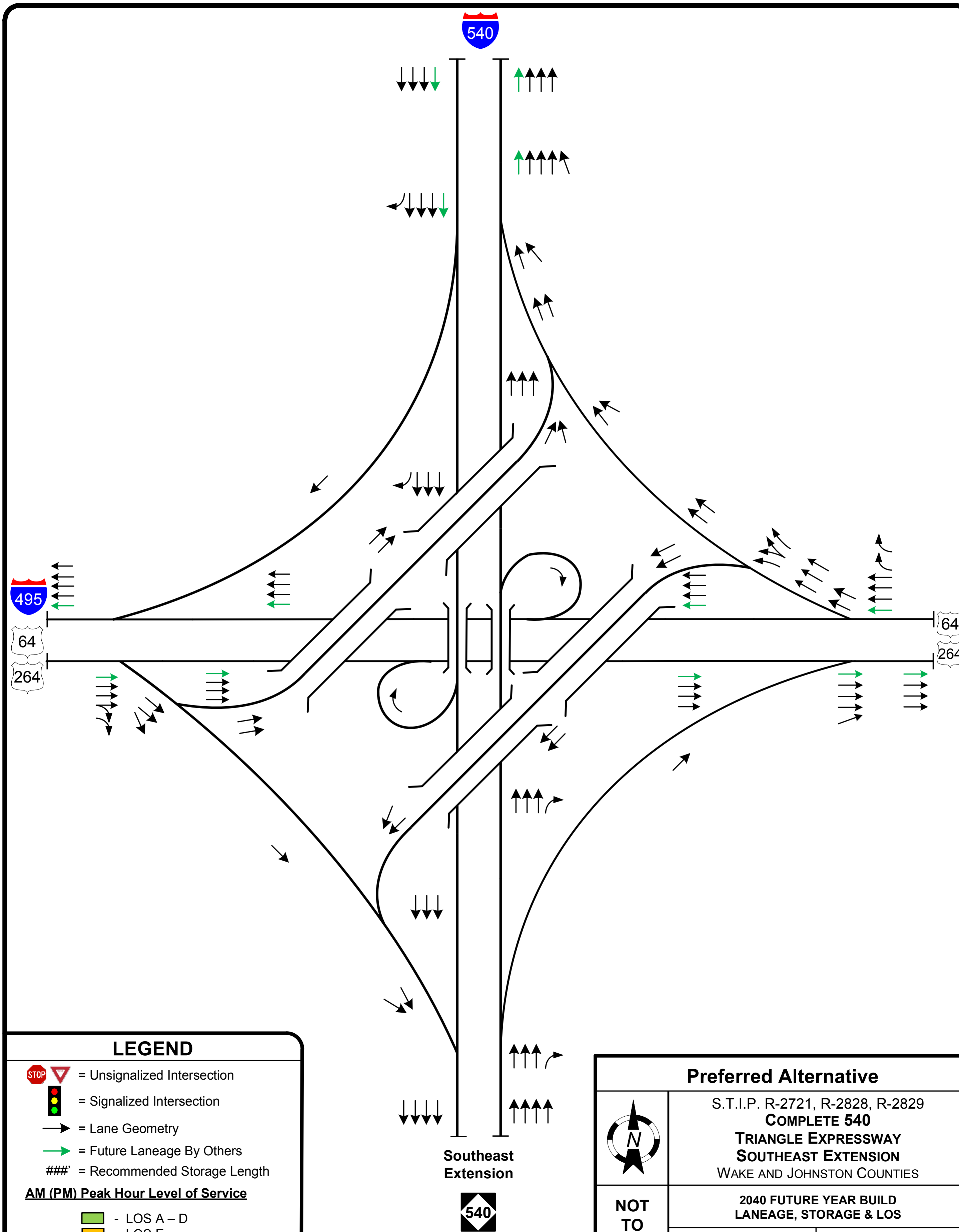
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

Preferred Alternative

2040 FUTURE YEAR BUILD LANEAGE, STORAGE & LOS

DATE: July 2017

FIGURE 7.8



LEGEND

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

###' = Recommended Storage Length

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F

Preferred Alternative

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540

TRIANGLE EXPRESSWAY

SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

N

NOT TO SCALE

2040 FUTURE YEAR BUILD
LANEAGE, STORAGE & LOS

DATE: July 2017

FIGURE 7.9