

NC 54 & MORE FEASIBILITY STUDY

NC 54

From NC 540 / I-540 to NW Maynard Road (SR 3073)
Morrisville and Cary, Wake County
FS-1005B

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List of Acronyms and Abbreviations

CAMPO	Capital Area Metropolitan Planning Organization
LOS	Level of service
MTP	Metropolitan Transportation Plan
MVMT	Million vehicle miles traveled
NC	North Carolina
NCDOT	North Carolina Department of Transportation
NCRR	North Carolina Railroad Company
NEPA	National Environmental Policy Act
PAT	Project Advisory Team
SR	Secondary Road
STIP	State Transportation Improvement Program
vpd	Vehicles per day

I. EXECUTIVE SUMMARY

A. INTRODUCTION

In partnership with the Capital Area Metropolitan Planning Organization (CAMPO), the Town of Cary, the Town of Morrisville, and Norfolk Southern, the North Carolina Department of Transportation (NCDOT) has investigated potential improvements to NC 54 from NC 540 / I-540 in Morrisville to Northwest Maynard Road (Secondary Road [SR] 3073) in Cary, a distance of approximately 5.5 miles. A vicinity map is included as **Figure 1**. The improvements described in this study can be considered as a system, or program, of projects that can be implemented in phases, as funding becomes available. Potential phases of the project are referred to as Segments throughout this Feasibility Study. A brief description of each Segment studied is provided in **Table 1**, and is shown graphically in a series of figures (**Figure 1, 2 & 3**). Detailed descriptions of each Segment are discussed in section IV.A.1 through section IV.A.3.

Table 1. Feasibility Study Segment Descriptions

Segment	Segment Type	Segment Beginning	Segment Ending	Figure References	Total Costs*
Segment 1	NC 54 Mainline Improvements and Widening	Just West of NC 540 (Finley Avenue)	Just East of Airport Boulevard	Figure 1, 2-1 & 2-2	\$ 35,900,000
Segment 1A	Interchange Modifications at NC 54 and NC 540	Ramp and Loop West of NC 540	Ramp and Loop East of NC 540	Figure 2-1	\$ 875,000
Segment 1B	Interim Intersection and Final Grade Separation at NC 54 and McCrimmon Parkway	McCrimmon Parkway Near Perimeter Park Drive	McCrimmon Parkway at Church Street	Figure 2-2 & 3-1	\$ 20,300,000
Segment 1C	Future Extension of Airport Boulevard to Church Street, with Grade Separation at NC 54 and Railroad	Airport Boulevard at NC 54	Church Street	Figure 2-2	\$ 19,900,000**
Segment 2	NC 54 Mainline Improvements and Widening	Just East of Airport Boulevard	Weston Parkway	Figure 1, 2-2, 2-3 & 2-4	\$ 72,700,000
Segment 2A	Grade Separation of Railroad and Morrisville Carpenter Road (Railroad Over Morrisville Carpenter Road)	On Railroad Corridor West of Green Drive	On Railroad Corridor West of Morrisville Parkway	Figure 2-3 & 2-4	\$ 20,600,000
Segment 3	NC 54 Mainline Improvements and Widening	Weston Parkway	NW Maynard Road	Figure 1, 2-4 & 2-5	\$ 54,400,000
Segment 3A	Grade Separation of Morrisville Parkway and NC 54, and Extend Morrisville Parkway to Connect with Weston Parkway	Weston Parkway	Morrisville Parkway	Figure 2-4 & 3-2	\$ 34,000,000

*Total Costs include Utility Relocation, Right-of-way and Construction. A full breakdown of costs can be found in section IV.B. (Table 7).

**Estimated costs for Segment 1C are based on Conceptual Design Quantities for Segment 1B.

It should be noted that this study is the initial step in the planning and design process and is not the product of exhaustive environmental or design investigations. The purpose of this study is to describe recommended improvements and associated costs for planning and programming purposes, and to identify potential design and environmental issues to be considered during subsequent phases of project development. The study also describes the purpose and need for the project(s), alternatives studied, and a summary of stakeholder and public involvement conducted to help develop the project objectives and alternatives.

B. FEASIBILITY STUDY ASSUMPTIONS & CONSTRAINTS

Several key assumptions and constraints should be noted for the review of this Feasibility Study. This report primarily focuses on optimal design and traffic operation standards, throughout the study corridor. This approach allows for the improvements to best meet the project purpose, as outlined in section III.A. of this report. However, this reports focus on optimal design standards is not intended to preclude other alternatives or design modifications from being studied in subsequent phases of the project development process. Additionally, as noted below in the study recommendations, Context Sensitive Design and philosophy should be included during future Project Development Phases, particularly during the development of the final purpose and need statements. Notable assumptions and constraints associated with this report are listed below:

- The operational goal for signalized intersection levels of service was LOS D or better in 2040
- An optimal median width of 30-foot was used throughout the NC 54 corridor
- Designs include 5-foot and 10-foot sidewalks on the west and east sides of NC 54, respectively
- 14-foot outside through lanes are provided for shared use between motorists and bicycles
- Sections of existing NC 54 within the NCRR corridor (primarily between Sunset Avenue and Weston Parkway) were relocated to the east and moved completely outside of the NCRR Right-of-way
- Grade separated designs were considered optimal at all Railroad crossings, due to operational and safety benefits

C. FEASIBILITY STUDY RECOMMENDATIONS

The following sections include brief descriptions of the Feasibility Study recommended improvements and general recommendations for future project development phases.

1. RECOMMENDED IMPROVEMENT

This Feasibility Study recommends all Segments except for Segment 3A, as previously described in **Table 1**, for improvements to the NC 54 corridor. Implementation of these recommendations will best meet the purpose and need as outlined in section III.A and III.B. Segment 3A is not recommended due to its high right-of-way cost. These recommendations do not preclude additional alternatives or context sensitive designs from being developed during future project development phases. A full description of Segment recommendations can be found is section V. of this report.

2. GENERAL RECOMMENDATIONS FOR FUTURE PROJECT DEVELOPMENT PHASES

The following is a list of project related issues that were discussed as a part of the feasibility study, but should be looked at in more detail during future project development phases.

- Possibly lower the operation goal for signalized intersection levels of service, from LOS D, to allow for a Context Sensitive Design, given the developed nature of the NC 54 corridor

- Designs should include co-ordination with applicable transit services, to incorporate appropriate transit stops and needed facilities (e.g., transit pads, shelters, lighting, and bus bays) into the project design
- The 30-foot median should be evaluated, as designs progress, to determine if a narrower median can be implemented to reduce impacts along the corridor
- The Town of Morrisville should evaluate removing recommendations from its MTP for the 5-foot sidewalk on the west side of NC 54, specifically for the portion of NC 54 located within the NCRR right-of-way
- The Alternative to widen NC 54 from the existing western edge of pavement, within the NCRR right-of-way, should be evaluated in more detail
- CAMPO's traffic model shows an absolute need for 4-lanes on Aviation Parkway and no additional lanes will be allowed at the existing railroad crossing with Morrisville-Carpenter Road
- Alternatives to the new connection located in the northwest quadrant of the NC 54 and NW Maynard Road intersection should be evaluated, since the Town of Cary does not support the connection as shown in the Feasibility Study

II. PROJECT DESCRIPTION AND OBJECTIVES

A. GENERAL PROJECT DESCRIPTION

The NC 54 & More Feasibility Study is being prepared to investigate potential improvements to NC 54 between NC 540 / I-540 and Northwest Maynard Road (SR 3073). Generally, it is recommended that NC 54 be widened to a four-lane divided facility from NC 540 / I-540 to just east of Weston Parkway. From just east of Weston Parkway to Northwest Maynard Road (SR 3073), NC 54 is recommended to be widened to a six-lane divided roadway. A 30-foot raised median is incorporated so that double left turn lanes can be accommodated at appropriate intersections. Recommended intersection and interchange designs are described in Section III.A. It is also recommended that NC 54 be realigned between Sunset Avenue and a point 600 feet west of Weston Parkway to eliminate its longitudinal encroachment onto North Carolina Railroad Company (NCRR) right-of-way, as discussed in section II.B.6. The mainline improvements can be broken into three logical project segments that then have options at individual intersections and interchanges. This study describes the improvements using the following segment limits:

- Segment 1 – NC 540 / I-540 to Airport Boulevard (SR 3015)
- Segment 2 – Southeast of Airport Boulevard (SR 3015) to Weston Parkway (SR 3090)
- Segment 3 – Weston Parkway (SR 3090) to Northwest Maynard Road (SR 3073)

The potential project segments and approximate number of through lanes for each segment are shown on the vicinity map (**Figure 1**).

B. STAKEHOLDER INVOLVEMENT AND PROJECT OBJECTIVES

A Project Advisory Team (PAT) was organized to help guide the study and consisted of representatives from the funding partners (NCDOT, CAMPO, Town of Cary, Town of Morrisville, and Norfolk Southern) as well as the NCRR and Triangle Transit (now GoTriangle). The group met six times over the life of the project to discuss project needs, potential concepts, and anticipated planning, design, and environmental issues

In addition to the Project Advisory Team, two public meetings were held to discuss project needs and potential concepts. Local officials meetings were held prior to both public meetings. The first public meeting was held on February 18, 2013, primarily to solicit information from the public on corridor transportation needs and issues. Information presented to the public included a handout summarizing the goals of the feasibility study and project development process, traffic



data, existing and future no-build capacity analyses, and displays of conceptual alternative intersection and interchange designs. Approximately 51 people attended the meeting and 13 written comments were received. The following issues and needs were identified by those providing comments:

- The need to reduce traffic congestion and improve traffic flow
- The need to improve safety along the corridor for vehicles, bicycles, and pedestrians
- The need to incorporate future transit stops
- The need to address sight distance issues along the corridor
- Concerns about anticipated business and residential relocations and impacts to the “community fabric,” particularly in the vicinity of the Town of Morrisville
- Balancing the ideal transportation facility with existing and approved development
- Project costs

A second public meeting was held on April 16, 2015. Updated traffic data, capacity analyses, and conceptual alternatives were presented. Approximately 97 people attended the meeting and 27 written comment sheets or emails were received. Ten of these comments concerned the closure of the Church Street highway-rail at-grade crossing located northwest of the proposed project. The crossing had been planned for closure for several years and was closed in May 2015, shortly after the public meeting was held for the NC 54 project. Of the Church Street comments, many requested that improvements to NC 54 and McCrimmon Parkway be completed prior to closure, or expedited to provide additional connectivity to motorists impacted by the Church Street closure. In addition to comments about the Church Street rail crossing closure (part of TIP Project U-4716 that has since been completed), the following comments were provided:

- Expedite the project to the extent practicable to help alleviate traffic congestion
- Widen NC 54 to four lanes, not six lanes
- Provide a grade-separated solution at Weston Parkway and Morrisville Parkway
- Grade-separate Morrisville Carpenter Road and the railroad
- Minimize property impacts by reducing the median or number of lanes, but do not sacrifice mobility
- Provide bicycle accommodations
- Provide a grade-separated pedestrian crossing in the vicinity of Cary Parkway
- Reconsider the use of median U-turns
- Implement other roadway improvements to the transportation system
- Implement transit solutions
- Revise signal timing at Northwest Maynard Road to favor NC 54 routing; consider a new signal at Fairbanks Road and temple
- Coordinate with the Town of Cary to rezone properties along NC 54 between Cary Parkway and Northwest Maynard Road

The comments raised by the public show general agreement that NC 54 must be widened in a manner that considers adjacent property impacts and future mobility. Bicycle and pedestrian accommodations are included in the proposed project, though a grade-separated pedestrian crossing is not. A grade-separation of the railroad is included in the project and the grade-separated solution at Weston Parkway and Morrisville Parkway was considered but not recommended due to high right-of-way impacts and costs. The project does incorporate the use of median U-turns and requires some sections of NC 54 to be widened to six lanes. The project's purpose and need and recommended improvements are discussed in more detail in the following sections.

III. PURPOSE AND NEED

A. PROJECT PURPOSE

The purposes of the NC 54 improvements are to enhance existing and future traffic operations as traffic volumes continue to grow, eliminate longitudinal highway encroachments on the NCRR right-of-way, and minimize the number of vehicles exposed to rail traffic by replacing highway-rail at-grade crossings with grade separations.

B. PROJECT NEED AND BACKGROUND INFORMATION

1. TRANSPORTATION PLANS

Improvements to NC 54 are included in the *CAMPO 2040 Metropolitan Transportation Plan* (MTP), the *Morrisville Transportation Plan*, and the *Town of Cary Comprehensive Transportation Plan Update*. Projects are also included in the *2016-2025 State Transportation Improvement Program* (STIP). Applicable information in those plans is summarized in the sub-sections below.

CAMPO 2040 Metropolitan Transportation Plan

The *CAMPO 2040 Metropolitan Transportation Plan* (MTP), adopted in June 2013, includes several projects along and in the immediate vicinity of the NC 54 corridor. These projects are listed in **Table 2**.

Table 2. Projects Included in the CAMPO MTP

ID in MTP	Location	Improvement	Notes
A222c	NC 54 between the Northern Town Limits of Morrisville and Perimeter Park Drive	Widen to six lanes	Within the limits of this feasibility study
A119	McCrimmon Parkway between NC 54 and Airport Boulevard	Widen to four lanes and grade separation over railroad and NC 54	Connects to NC 54 within the limits of this feasibility study
F13	NC 147 Toll Extension from NC 540 to McCrimmon Parkway	Construct a four lane roadway extending NC 147 to McCrimmon Parkway	Immediately west of the limits of the feasibility study
A26a	McCrimmon Parkway between Airport Boulevard and Aviation Parkway	Construct a two lane roadway connecting two completed segments	Immediately east of the limits of the feasibility study
A26b	McCrimmon Parkway between Airport Boulevard and Aviation Parkway	Widen to four lanes	Immediately east of the limits of the feasibility study
A222b	NC 54 between McCrimmon Parkway Grade Separation and Weston Parkway	Widen to four lanes	Within the limits of this feasibility study
A165a	Airport Boulevard Extension	Extend Airport Boulevard from NC 54 to Garden Square Lane as a four-lane roadway	The portion of the project between NC 54 and Church Street is within the limits of this feasibility study.
A220a	Morrisville-Carpenter Road from Page Street in Morrisville to Davis Drive	Widen to four lanes and grade separation with NC 54	Connects to NC 54 within the limits of the feasibility study, immediately west of existing at-grade highway-rail crossing
A64b	Aviation Parkway between NC 54 and Evans Road	Widen to four lanes	Connects to NC 54 within the limits of this feasibility study
A222a	NC 54 between Cary Parkway and Northwest Maynard Road	Widen to four lanes	Within the limits of this feasibility study
A221	NC 54 between Northwest Maynard Road and Wilson Street	Widen to six lanes	Within the limits of this feasibility study
A236	Chapel Hill Road from Northwest Maynard Road to Northeast Maynard Road	Widen to four lanes	Immediately southeast of the limits of the feasibility study

The MTP also includes a grade separation to carry McCrimmon Parkway over NC 54 (part of A119), shows on-roadway bicycle facilities along the entire length of NC 54, and includes commuter and/or light rail along the NCRR-owned (Norfolk Southern-operated) corridor that lies parallel to NC 54.

Morrisville Transportation Plan

The *Morrisville Transportation Plan: 2009-2035*, adopted in 2009, notes that NC 54 should be widened to either four or six lanes, depending on project segment. Between NC 540 / I-540 and McCrimmon Parkway (SR 1635), NC 54 is “planned to be four lanes in the short term. Expansion to six lanes is possible if a traffic impact analysis shows the improvement is needed and it is approved by Town Council, or if the NC 54 Corridor Study shows future need and it is approved by Town Council.” The plan also includes grade separations to carry McCrimmon Parkway (SR 1635) and Airport Boulevard (SR 3015) over NC 54 and the adjacent NCRR-owned corridor. Between McCrimmon Parkway and Cary Parkway, NC 54 is planned as a four-lane facility. Between Cary Parkway and the Cary town limits, NC 54 is planned as a six-lane boulevard.

The Morrisville Transportation Plan includes two different four lane cross-sections for NC 54. A 124-foot wide median divided cross-section (with 23-foot planted median) and a narrower 79-foot wide undivided cross-section. The narrower 79-foot wide four lane cross-section is recommended between Sunset Avenue and Keybridge Drive.

The plan notes that bicycle and pedestrian accommodations along NC 54 are of a medium priority and include 6-foot bicycle lanes, except in the Town Center of Morrisville where 4-foot bicycle lanes are recommended, a 10-foot walkway on the east side of NC 54 (the side opposite the railroad corridor), and a 5-foot sidewalk on the west side.

The plan also notes the need to continue to coordinate with local transit agencies regarding bus and potential rail stops.

Town of Cary Comprehensive Transportation Plan Update

The *Town of Cary Comprehensive Transportation Plan Update*, adopted in 2008, amended in June 2015, includes NC 54 as a six-lane median-divided facility. The plan includes an 18-foot raised planted median and 14-foot wide outside lanes (for bicycle accommodations). A 10-foot wide street-side trail is also included in the plan along the east side of NC 54 and a 5-foot sidewalk is included on the west side of NC 54.

2015-2025 State Transportation Improvement Program

The *2015-2025 State Transportation Improvement Program* identifies several projects in the project area (Table 3). The first two listed projects are those that will be informed by the utility relocation, right-of-way and construction cost estimates presented in subsequent sections of this study.

Table 3. Projects Included in the 2015-2025 STIP

TIP Number	Description	Right-of-Way Schedule	Construction Schedule
U-5750	NC 54 widening from NC 540 / I-540 to Perimeter Park Drive	2021	2023
U-5747	NC 54 and McCrimmon Parkway Grade separation	2021	2023
U-5811	Widen Aviation Parkway	2020	2022
U-5828	Construct McCrimmon Parkway between Airport Boulevard and Aviation Parkway	2020	2021

2. TRANSIT PLANS AND NEEDS

There are currently no fixed-route transit services or stops along the subject NC 54 corridor. However, the Morrisville Transportation Plan includes several recommendations for transit services throughout the NC 54 corridor. Chief among these recommendations are:

- Support to shift Triangle Transit Route 301 over to NC 54 (from its current location along I-40)
- Provide bus stops near residential neighborhoods in Morrisville
- Work closely with Cary to expand the C-Tran service in Morrisville. Cooperation with C-Tran will initially include discussions on establishing a C-Tran bus stop at Park West Village on NC 54 and at Morrisville Manor on Cary Parkway, which would allow better access for Morrisville residents to planned C-Tran service along Cary Parkway and Weston Parkway. Future

discussions with C-Tran will explore the possibility of adding future routes along NC 54 (north-south) and Airport Boulevard (east-west).

Given the recommendation for future fixed-route services on NC 54, it is recommended that future project development phases and design include co-ordination with applicable transit services, to incorporate appropriate transit stops and needed facilities (e.g., transit pads, shelters, lighting, and bus bays) into the project design. Impacts of implementing bus stops along the NC 54 corridor are anticipated to be limited to monetary and minor additional right-of-way impacts, assuming bus bays are provided. If bus bays are not provided, bus stops could potentially impact traffic operations.

3. TRAFFIC DATA

Existing traffic volumes on NC 54 vary from 14,800 vehicles per day (vpd) east of Airport Boulevard (SR 3015) to 25,600 vpd just west of Morrisville Parkway (SR 3060). In 2040, under the build scenario, traffic volumes are forecasted to vary from 22,200 vpd east of Airport Boulevard (SR 3015) to 46,100 vpd east of Morrisville Parkway (SR 3060).

The traffic forecast prepared for the project is included in the Appendix. The future year forecasts assume construction of transportation projects as listed within the CAMPO MTP, adopted in June 2013. Historical growth rates, the Triangle Regional Model (adopted in June 2013), and planned and permitted developments were used to estimate the 2040 year volumes.

4. EXISTING ROADWAY

Within the project limits, NC 54 is primarily a two-lane roadway, with turning lanes at major intersections. There are some segments of NC 54 that have been widened to multi-lanes, but these segments are generally short. NC 54 has been widened to a four-lane, median-divided facility from NC 540 / I-540 to southeast of Carrington Mill Boulevard, from just northwest of Weston Parkway to southeast of Cary Parkway, and the approach to the Northwest Maynard Road intersection. One major hydraulic structure is located along this section of NC 54. A bridge carries NC 54 over Crabtree Creek.

5. EXISTING AND FUTURE NO-BUILD CAPACITY ANALYSES; LEVELS OF SERVICE AND AVERAGE DELAY PER VEHICLE (seconds)

Existing and future no-build traffic capacity analyses were conducted for the existing roadway network using the traffic volumes described in section II.B.2. The highway capacity analyses were based on methodologies from the Highway Capacity Manual (HCM 2000), Special Report 209. Traffic modeling software used in the capacity analyses included Synchro 7.0 and SimTraffic 7.0; HCS 2010 was only used for merge/diverge and ramp analyses.

Highway and intersection performance is usually described using “level of service.” Level of service (LOS) is a qualitative measure describing operational conditions within a traffic stream and at intersections. At intersections, LOS is based on delay. Six LOS ranging from A to F represent defined

operational characteristics, with LOS A as the best operating conditions. LOS E and F are considered to be undesirable LOS associated with frequent and long delays. Typically, when possible, new roadways are designed to operate at LOS D or better in their design year.

Table 4 presents the LOS and associated average vehicle delays for signalized intersections along the corridor.

Table 4. Existing and Future No-Build Levels of Service and Average Vehicle Delays

Signalized Intersection NC 54 at:	Existing Conditions				2035 Future No-Build Conditions			
	AM Peak		PM Peak		AM Peak		PM Peak	
	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)
NC 540 SB Ramps	C	24.8	C	27.0	D	40.3	D	39.8
I-540 NB Ramps	B	19.9	B	14.1	C	22.6	B	17.2
Carrington Mill Blvd.	C	26.6	C	31.3	C	33.6	D	42.6
McCrimmon Parkway	F	155.5	F	97.7	F	426	F	292
Airport Blvd.	D	39.5	D	35.5	F	84	F	115
Morrisville-Carpenter Rd. / Aviation Parkway	D	49.7	E	71.9	F	221	F	263
Weston Parkway	C	21.0	C	27.2	C	33.5	D	36.6
Morrisville Parkway	C	29.6	D	46.2	D	46.2	D	49.2
Market Center Dr.	B*	11.8	C	20.1	A*	8.5	C	28.2
Cary Parkway	E	57.9	E	60.6	F	189	F	183
NW Maynard Rd.	D	38.6	D	42.8	E	69.3	F	93.6
LOS Summary	3 of 11 Intersections Failing or Exceeding Capacity; 6 of 11 Intersections At or Exceeding Capacity				5 of 11 Intersections Failing or Exceeding Capacity; 9 of 11 Intersections At or Exceeding Capacity			

*The increase in LOS at Market Center Drive is attributed to signal optimization within Synchro and the LOS being close to the limits between LOS A & B.

As shown in the table, in the base year, 6 of 11 signalized intersections are at LOS D or worse. In 2035, if no improvements are made, 9 of 11 signalized intersections are at LOS D or worse. It should be noted that a design year of 2040 is used for the Build Condition Analysis (see **Table 10**). During the development of this Feasibility Study the traffic forecast was updated to a design year of 2040 and it was decided that only the Build Condition Analysis would be updated at this time. An updated design year analysis of the No-Build condition will be completed as a part of future project development phases.

6. CRASH INFORMATION

A crash analysis, dated February 6, 2012, was prepared for the NC 54 & More project by the NCDOT. This analysis was reviewed along the segment of roadway between NC 540 and Northwest Maynard Road (SR 3073). The data includes crashes that occurred during the three-year time period between December 1, 2008, and November 30, 2011. The segment analysis did not include crashes on side streets.

Three hundred and ninety-two crashes occurred along the mainline of this existing stretch of NC 54 over three years. Based on a length of 5.5 miles and an average daily traffic volume of 16,800 vpd, the total crash rate along this segment of NC 54 is 388.71 crashes per 100 million vehicle miles traveled (100 MVMT).

Of the 392 crashes, there were no fatalities, 121 (31%) injury crashes, and 271 (69%) property damage only crashes. Examining the crash types, 223 (57%) are rear-end crashes with the next most frequent types of collisions being left-turn crashes (52, or 13%), run-off road/fixed object crashes (41, or 10%), and angle crashes (29, or 7%). The frequency of rear-end collisions often increases as the capacity of an intersection is neared or exceeded, which creates traffic queues.

The NC 54 crash rate and severity index was compared to 2008-2010 three year crash rates for North Carolina. The statewide average for all urban NC routes was 261.92 crashes per 100 MVMT. Thus, NC 54's rate exceeds that average. The severity index of crashes on NC 54 was 3.63 versus a statewide average for all urban NC routes of 4.08. The subject section of NC 54 has a higher frequency of crashes compared to other urban NC routes. The crash severity index on NC 54, however, is below average for urban NC routes in North Carolina.

In addition to the section or strip analysis, intersection analyses were performed to identify the number of crashes at intersections along the study area. **Table 5** presents the crashes reported at each intersection.

Table 5. Crashes on NC 54 by Intersection

Intersection	Number of Crashes
NC 54 and NC 540 WB Ramps	17
NC 54 and I-540 EB Ramps	14
NC 54 and Carrington Mill Boulevard	16
NC 54 and McCrimmon Parkway (SR 1635)	23
NC 54 and Airport Boulevard (SR 3015)	19
NC 54 and Aviation Parkway (SR 1002)/ Morrisville Carpenter Road (SR 3014)	37
NC 54 and Weston Parkway (SR 3090)	13
NC 54 and Morrisville Parkway (SR 3060)	23
NC 54 and Cary Parkway (SR 3112)	23
NC 54 and NW Maynard Road (SR 3073)	47

The intersections that experienced the highest crash frequencies all had a significant percentage of rear end crashes. The top three, Northwest Maynard Road (SR 3073), Aviation Parkway (SR 1002) / Morrisville-Carpenter Road (SR 3014), and McCrimmon Parkway (SR 1635), had rear-end crashes accounting for more than two-thirds of the total percentage of crashes.

7. HIGHWAY-RAIL CONFLICTS AND ENCROACHMENTS

Generally, within the project limits, NC 54 runs parallel to the NCRR corridor that is operated by Norfolk Southern. From NC 540 / I-540 to just east of Airport Boulevard (SR 3015), the right-of-way for NC 54 is immediately adjacent to the 200-foot wide NCRR right-of-way, but the roadway is not within railroad property. From a point approximately 1,000 feet west of Morrisville-Carpenter Road (SR 3014) to 1,000 feet west of Weston Parkway (SR 3090), NC 54 is wholly located on the NCRR right-of-way. In addition to the longitudinal constraint between NC 540 / I-540 and Airport Boulevard (SR 3015), and the longitudinal encroachment between west of Morrisville-Carpenter Road (SR 3014)

and west of Weston Parkway (SR 3090), two cross-streets that intersect with NC 54 have at-grade crossings of the NCRR corridor, operated by Norfolk Southern. These at-grade crossings are located at McCrimmon Parkway (SR 1635) and Morrisville-Carpenter Road (SR 3014), in close proximity to their intersections with NC 54.

Six intercity passenger trains and six to eight freight trains travel this section of railroad each day. The number of intercity passenger trains using this rail corridor will increase to eight in 2017 and ten in 2019. As freight volumes increase, the lengths and / or number of freight trains may also increase. It is also anticipated the corridor may carry commuter trains in the future. Additional tracks may be needed to accommodate the anticipated rail services in the railroad right-of-way. With continued increases in highway traffic volumes and the anticipated increase in train traffic, the exposure rate at the two at-grade crossings will increase. An ultimate goal of the studied projects is to replace the highway-rail at-grade crossings with grade separations and to eliminate the longitudinal encroachment of NC 54 on the NCRR right-of-way. Interim solutions, discussed in subsequent sections of this report, may include retaining an at-grade crossing, provided the number of lanes across the railroad is not increased.

IV. ALTERNATIVES CONSIDERED

Throughout the feasibility study process multiple concepts and alternatives were discussed with the PAT. Two main alternatives were considered for the mainline segments of NC 54, an alternative that widens NC 54 and relocates the roadway outside of the NCRR right-of-way and an alternative that would widen NC 54 from the existing edge of pavement on the west side. For the purposes of this report, only the alternative that widens NC 54 and relocates the roadway outside of the NCRR right-of-way is quantified for impacts and cost estimates. This alternative is considered optimal from a design perspective, but both alternatives should be carried forward for detail studies in subsequent phases of the project development process.

A. CONCEPTUAL DESIGN FEATURES AND CONSTRAINTS

All alternatives considered would widen NC 54 to a median-divided multi-lane facility. A 30-foot raised median width is used along the entire length of NC 54 in conceptual designs. The traffic capacity analyses show that double left turn lanes, and in some cases double U-turn lanes, are required at several intersections. A 30-foot median will accommodate double left turn lanes at intersections. Moreover, at this early phase in project development, intermediate left-overs and U-turn locations have not yet been determined. The 30-foot median would accommodate overlapping intermediate left-overs into properties along NC 54. If during subsequent phases of project development it is determined that long segments of NC 54 can be constructed without the need for double or overlapping turn lanes, the median could be narrowed in those locations. Traffic capacity analyses were conducted using traditional intersection designs in addition to alternative intersection designs that limit one or more left-turn and through movements. The traditional intersection analysis showed

that NC 54 would have to be widened to accommodate 6 to 10 through lanes. Concepts using alternative intersection and grade-separated designs require NC 54 to be widened to accommodate four to six through lanes. Thus, in order to reduce the anticipated footprint and improve anticipated traffic operations, concepts that use alternative intersection designs were considered in this study.

Bicycle and pedestrian accommodations are incorporated into the typical cross-sections of NC 54 used in the conceptual designs. The conceptual designs include accommodations of a 5-foot sidewalk along the west side of NC 54 and a 10-foot sidewalk along the east side of NC 54. In addition to sidewalks, the conceptual design typical sections do include 14-foot outside through lanes to help provide for shared use between motorists and bicycles. The full 6-foot bicycle lanes described in the Town of Morrisville transportation plan were not incorporated in an effort to reduce the project's footprint; however, construction cost estimates were completed to evaluate the additional cost associated with implementing the full 6-foot bicycle lanes within the Town Limits of Morrisville (see **Table 6**). The Town of Cary transportation plan matches the conceptual design typical section; therefore, the length of improvements for Segment 3, in **Table 6**, is limited to the portion within the Town Limits of Morrisville.

Table 6. Additional Construction Costs to Incorporate 6-foot Bicycle Lanes on NC 54 within the Town Limits of Morrisville

Segment	Segment Length (miles)	Additional Construction Costs (\$)
1	2.17	\$ 916,000
2	1.82	\$ 770,000
3	1.10*	\$ 464,000

*Estimate for Segment 3 is limited to the portion within the Town Limits of Morrisville.

Whether or not sidewalks or street-side bicycle facilities are constructed as part of the NC 54 projects will depend on funding agreements among the Town of Morrisville (30% share), Town of Cary (50% share), and the NCDOT (70% share and 50% share respectively), in accordance with NCDOT's *Pedestrian Policy*. The final determination of the scope and implementation of bicycle and pedestrian accommodations will be made during subsequent phases of the project development process.

Conceptual designs are presented on **Figures 2-1** through **2-5**. The number of through and turning lanes at each intersection is indicated on those figures. General features and design constraints are discussed for each segment below.

1. NC 540 / I-540 TO AIRPORT BOULEVARD

Except between NC 540/ I-540 and just southeast of Carrington Mill Boulevard, this segment of NC 54 must have two through lanes in each direction to accommodate forecasted traffic volumes. Between Carrington Mill Boulevard and the westbound ramp terminal onto NC 540, westbound NC 54 requires three through lanes. All widening for this segment of NC 54 must be achieved along the westbound lane side of NC 54, as the NCRR right-of-way is immediately adjacent to NC 54's existing right-of-way along the opposite side. It should be noted that the typical section berm widths described in the previous section must be reduced through the NC 540 / I-540 interchange area so that the existing

structures that carry NC 540 / I-540 over NC 54 and the NCRR can be retained. In addition, in order to accommodate the required lanes under these bridges, the concrete slope protection under the bridges must be removed and replaced with a retaining wall. The existing 10-foot sidewalk, on the east side of NC 54, will be reconstructed at the base of the required retaining wall.

At the eastbound I-540 ramp terminal, triple left turns are provided from eastbound NC 54 onto the ramp. Double right turns are provided for traffic turning from westbound NC 54 onto the ramp. Two left turns and one right turn lane carry traffic off of the ramp onto NC 54. Improvements on the I-540 ramps are estimated as part of Segment 1A.

Along this segment of NC 54, Lichtin Boulevard and Carrington Mill Boulevard are designed as a system of intersections. Lichtin Boulevard will function as a right-in / right-out access. Traffic coming out of Lichtin Boulevard will be directed by channelized lanes to either a lane that turns onto the eastbound I-540 ramp or a lane that proceeds through the interchange on westbound NC 54. Channelization of lanes on Lichtin Boulevard should be provided to help control weaves on NC 54 between Lichtin and the I-540 ramp. A U-Turn from the Carrington Mill Boulevard intersection is located immediately in front of Lichtin Boulevard, but no left turn traffic onto or off of Lichtin Boulevard should be allowed. Carrington Mill Boulevard is recommended to be a left-in alternative intersection design. The costs of these improvements are incorporated into the cost estimate for Segment 1.

A future campus of Wake Technical Community College will be located along the northeast side of this segment of NC 54. A new access point may be required onto NC 54. Depending on the location of that access point and other future needs, the median width between Carrington Mill Boulevard and McCrimmon Parkway (SR 1635) could be narrowed.

At McCrimmon Parkway (SR 1635), ultimately a grade-separated quadrant interchange is needed to accommodate traffic volumes (see **Figure 3-1** for Interim and Final Recommendations for this Segment). The cost of this interchange is included as Segment 1B. This interchange must be constructed while considering the location of a future, potential GoTriangle commuter rail station. Once the quadrant interchange is constructed, the existing at-grade highway-rail crossing on McCrimmon Parkway (SR 1635) will be closed.

The Town of Morrisville is currently finalizing the design and engineering of Phase I of its McCrimmon Parkway Extension project. As a part of this project the Town is planning to convert the Perimeter Park Drive intersection, with NC 54, to a right-in/right-out movement, due to its proximity to McCrimmon Parkway. The Town may also follow-up this work with a road diet on the section of Perimeter Park Drive between McCrimmon Parkway and NC 54, which may entail reducing westbound Perimeter Park Drive to one lane. However, for the purposes of this study Perimeter Park Drive remains a traditional intersection and helps supplement the quadrant movements associated with the

NC 54 and McCrimmon Parkway interchange. The costs of these improvements are incorporated into the estimate for Segment 1. The final configuration of this intersection will be determined during the project development process.

Airport Boulevard (SR 3015) is designed as a left-out alternative intersection. This design helps accommodate the heavy left-turn volumes onto eastbound NC 54. The costs of the left-out superstreet are incorporated into the estimate for Segment 1. The costs to extend Airport Boulevard (SR 3015) to Church Street and grade-separate that extension over NC 54 and the railroad are included in estimates for Segment 1C.

Detailed improvements, including the number of turning lanes at each intersection, for this segment of NC 54 (Segments 1, 1A, 1B, and 1C) are shown in **Figures 2-1** and **2-2**. An Interim and Final Recommendation for Segment 1B is shown in **Figure 3-1**.

2. SOUTHEAST OF AIRPORT BOULEVARD TO WEST OF WESTON PARKWAY

From Airport Boulevard (SR 3015) to west of Weston Parkway (SR 3090), this segment of NC 54 must have two through lanes in each direction to accommodate traffic volumes. Concepts include left-in alternative intersection designs at Southport Drive, Green Drive, and a U-Turn east of Keybridge Drive. However, the primary design feature that is included in Segment 2 is the elimination and/or minimization of highway and railroad conflicts. In order to eliminate the longitudinal encroachment of NC 54 onto the NCRR right-of-way, the roadway must be realigned from Sunset Avenue to a point approximately 600 feet west of Weston Parkway. During the study process, there had been some initial discussion of widening this section of NC 54 rather than realigning it. However, with the anticipated growth in the number of intercity passenger trains, the potential for commuter trains, and potential growth in freight volumes, the full railroad right-of-way must be preserved or restored to the extent practicable to accommodate future tracks.

In addition, the future traffic volumes at NC 54, Morrisville-Carpenter Road (SR 3014), and Aviation Parkway (SR 1002) are best-accommodated by a grade-separated interchange, rather than an at-grade intersection. The realignment of NC 54 and the grade-separated quadrant intersection at Morrisville-Carpenter Road (SR 3014) / Aviation Parkway (SR 1002) may eliminate the need for the existing at-grade highway-rail crossing on Morrisville-Carpenter Road to be widened. East of the interchange, dual bridges to carry NC 54 over Crabtree Creek must be constructed. These improvements are included in the cost estimates prepared and presented for Segment 2.

Replacing the Morrisville-Carpenter Road (SR 3014) at-grade railroad crossing with a grade separation was also studied. The costs associated with constructing a grade separation (between Morrisville-Carpenter Road (SR 3014) and Railroad) are included as Segment 2A.

The interchange (between Aviation Parkway (SR 1002) and NC 54) and grade separation (between Morrisville-Carpenter Road (SR 3014) and the Railroad) concepts would lower the grade of Aviation

Parkway (SR 1002) and Morrisville-Carpenter Road (SR 3014) so that the realigned NC 54 and railroad could be carried over them. Concepts lowered the roadways by approximately 9-10 feet. Lowering the roadway grades was limited by the presence of a tributary to Crabtree Creek. The railroad grade separation would also require the grade of the railroad to be raised by approximately 14 feet at the crossing. Raising the railroad grade would require the realignment of the railroad from horizontal and vertical curves just southeast of Truss Builders (whose siding must be maintained) and horizontal and vertical curves just west of Morrisville Parkway. The realignment would require the construction of bridges that could accommodate double tracks at Morrisville-Carpenter Road (SR 3014) and at Crabtree Creek. The NCRR is currently planning to replace the railroad bridge over Crabtree Creek close to its current grade and not at a grade that would facilitate the grade separation between Morrisville-Carpenter Road (SR 3014) and the railroad. Unless the replacement of the railroad bridge over Crabtree Creek can be constructed at the same time as the grade separation between Morrisville-Carpenter Road (SR 3014) and the railroad, the costs of the NC 54 project must include the replacement of a railroad bridge over Crabtree Creek at an appropriate grade, to allow for the grade separation of Morrisville-Carpenter Road (SR 3014) and the railroad.

Carrying Morrisville-Carpenter Road (SR 3014) and Aviation Parkway (SR 1002) over the railroad and NC 54 was discussed during the project study. The alternative would require the grade of the roads to be raised by approximately 30 feet to provide the 23-foot clearances needed over the railroad. As such the alternative's potential physical impact on historic resources and access in the town center community, and aesthetic impacts to the community may be difficult to overcome. However, this alternative would require fewer bridges to be constructed and maintained. The alternative can be considered during the project development process, if desired. Funding levels established by the alternative to carry the railroad over the highway would likely cover the costs of this potential alternative improvement.

Construction phasing of the realignment, interchange, and grade-separation will be difficult. Grade-separating the railroad may require Morrisville-Carpenter Road (SR 3014) and Aviation Parkway (SR 1002) to be closed during some phases of construction. Thus, this portion of the project should be phased after Segments 1 and 1B (the McCrimmon Parkway interchange), and potentially after Segment 1C (the extension of Airport Boulevard) are constructed. Detailed improvements, including the number of turning lanes at each intersection, for this segment of NC 54 (Segments 2 and 2A) are shown in **Figures 2-2, 2-3 and 2-4**.

3. WESTON PARKWAY TO NW MAYNARD ROAD

From just west of Weston Parkway (SR 3090) to NW Maynard Road (SR 3073), NC 54 is proposed to have three through lanes in each direction. Construction cost estimates for Segment 3 include traditional intersections at Weston Parkway (SR 3090), Morrisville Parkway (SR 3073), and Market Center Drive, an alternative intersection design at Cary Parkway (SR 3112) that utilizes U-Turns on three of four intersection approaches rather than left-turns (known as a "Michigan Left"), and an at-

grade quadrant intersection design at Northwest Maynard Road (SR 3073). These improvements are included in **Figures 2-4** and **2-5**. Heavy multi-family and commercial development is present along both sides of this segment of NC 54.

The at-grade intersections at Weston Parkway (SR 3090) and Morrisville Parkway (SR 3073) do not provide ideal traffic operations in the design year. An alternative to grade-separate Morrisville Parkway and NC 54, and extend Morrisville Parkway to intersect Weston Parkway and provide access to NC 54 was analyzed. The conceptual design for this option is included in **Figure 3-2**. The design provides more efficient traffic operations, but has much greater right-of-way costs and impacts. The costs associated with this alternative are included in the estimates for Segment 3A.

B. UTILITY RELOCATION, RIGHT-OF-WAY AND CONSTRUCTION COSTS

Estimates for utility relocation, right-of-way and construction costs for improvements to NC 54 are presented in **Table 7**. These costs are based on an optimal design which includes the assumption that a 30-foot wide median will be used throughout the project corridor, NC 54 will be moved completely outside of the NCRR right-of-way, sidewalks are included on both sides of NC 54 (10-foot on east side and 5-foot on west side) and that the existing pavement structure for NC 54 is adequate and will not require reconstruction. Additionally, right-of-way costs are based on existing conditions, and could potentially increase, in the future, as additional development occurs throughout the corridor.

Table 7. Utility Relocation, Right-of-way and Construction Costs

Segment	Utility Relocation Costs (\$)	Right-of-way Costs (\$)	Construction Costs (\$)	Total Costs (\$)
1	\$ 800,000	\$ 17,500,000	\$ 17,600,000	\$ 35,900,000
1A	\$ 50,000	\$ -0-	\$ 825,000	\$ 875,000
1B	\$ 100,000	\$ 7,800,000	\$ 12,400,000	\$ 20,300,000
1C*	\$ 100,000	\$ 7,800,000	\$ 12,000,000	\$ 19,900,000
2	\$ 1,000,000	\$ 47,400,000	\$ 24,300,000	\$ 72,700,000
2A	\$ 500,000	\$ 5,000,000	\$ 15,100,000	\$ 20,600,000
3	\$ 1,100,000	\$ 31,300,000	\$ 22,000,000	\$ 54,400,000
3A	\$ 200,000	\$ 18,700,000	\$ 15,100,000	\$ 34,000,000

*Estimated costs for Segment 1C are based on Conceptual Design Quantities for Segment 1B.

C. POTENTIAL ENVIRONMENTAL ISSUES

General environmental issues likely to influence the design and development of the NC 54 improvements are identified in this section. It should be noted that the issues and impacts are not the product of detailed surveys or technical studies. If federally-funded, a formal environmental document that complies with the National Environmental Policy Act and other applicable regulatory laws will be required. **Table 8** presents anticipated residential and business relocations, potential impacts to cultural resources, and anticipated impacts to parks and other resources.

Table 8. Potential Relocation Impacts and Environmental Issues

Segment	Relocations*		Cultural Resources	Parks	Other
	Residential	Business			
1	3	6			Access to Future Wake Technical Community College Campus
1A	0	0			
1B	0	2			Cemetery in proximity to realigned McCrimmon Parkway
1C	0	2			
2	66	23	Concept designed to avoid or minimize impacts to the Pugh House (West of NC 54 and south of Morrisville-Carpenter Road; (Listed on the National Register) and associated State Study List District	Cedar Fork District Park (Lower Soccer Fields)	Cemetery east of NC 54, south of Sunset Road; Crabtree Creek floodplain; Community cohesion in the town center section of Morrisville
2A	4	0	Concept designed to avoid or minimize impacts to the Pugh House (West of NC 54 and south of Morrisville-Carpenter Road; (Listed on the National Register) and associated State Study List District		1 Church/ Non-Profit
3	27	9	Concept designed to avoid impacts to property associated with the Nancy Jones House (Listed on the National Register)		
3A	20	0			

*The estimated number of above relocations includes those parcels where the proposed acquisition areas involve relocation of livable or business units.

In addition to potential impacts identified in Table 8, the NEPA document will need to identify any potential impacts to streams, wetlands, and threatened and endangered species. As of April, 2015, the US Fish and Wildlife Service list the red-cockaded woodpecker, dwarf wedge mussel, and Michaux's sumac as endangered species in Wake County. The northern long-eared bat is listed as a threatened species in Wake County. Several Federal Species of Concern are also identified.

Segments 2 and 2A of the project, between Airport Boulevard (SR 3015) and Weston Parkway (SR 3090), are anticipated to have the most challenging environmental issues to coordinate. The environmental document will need to demonstrate that impacts to parks and historic resources are avoided to the extent practicable and then minimized, in accordance with Section 4(f) of the US Department of Transportation Act of 1966. The state study list historic district in the Morrisville town center includes three properties on the National Register of Historic Places (the Pugh House, the Williamson Page House, and the Morrisville Christian Church). The Pugh House lies in close proximity to Morrisville-Carpenter Road (SR 3014) and could be impacted by any improvements to that road. The other National Register resources in this area are further away from construction limits, but could be impacted by any potential changes to the street network in the town center. Impact to the community and its function would be a related concern, depending on what improvements are ultimately pursued. This study considers the recommended grade separation of the railroad over the roadway to be the most palatable, but a final determination would be made during the NEPA and associated public involvement process. A cemetery is also located along the realigned portion of NC 54. The project could require the relocation of some graves, though efforts would be made in

subsequent designs to minimize potential impacts. The project would also have to consider the presence of Crabtree Creek and its associated floodplain and floodway.

Segment 3 is anticipated to have high numbers of business relocations. The Nancy Jones House, which is on the National Register of Historic Places, is located along Segment 3. The feasibility study included an alignment that widened opposite of the historic property. During project development, a best-fit alignment should be developed to minimize impacts to the historic property, but also residential and commercial properties.

If the improvements are divided into multiple transportation improvement projects, Segments 2 and 2A would be anticipated to require more complex NEPA documents than those required of Segment 1, 1A, 1B, 1C, 3, and 3A.

V. RECOMMENDATIONS

Recommendations for improvements to NC 54 are described below, based on the capacity analyses, conceptual designs, potential environmental issues, stakeholder, and public involvement conducted for this study.

A. NC 540 / I-540 TO AIRPORT BOULEVARD

- Widen NC 54 from NC 540 / I-540 to Airport Boulevard (SR 3015) to four lanes, as detailed in Segment 1. Also construct the recommended improvements to the NC 540 / I-540 ramp termini (Segment 1A).
- Construct the McCrimmon Parkway (SR 1635) interchange and close the existing at-grade railroad crossing at McCrimmon Parkway (SR 1635) as described for Segment 1B. This portion of the project should be completed prior to constructing the grade separation at Morrisville-Carpenter Road (SR 3014). If completed first, this project can help alleviate temporary traffic impacts anticipated to occur during the construction of Segment 2A. It can also help provide additional network connectivity requested by motorists impacted by the Church Street crossing closure.

If funding is available, the construction of the Airport Boulevard (SR 3015) extension (Segment 1C) should also be considered as it helps provide additional network connectivity and another grade-separated route over the railroad. The extension could further relieve temporary traffic impacts anticipated during the construction of improvements between Airport Boulevard (SR 3015) and Weston Parkway (SR 3090) (Segments 2 and 2A).

B. AIRPORT BOULEVARD TO WEST OF WESTON PARKWAY

- Widen NC 54 to four lanes and realign NC 54 as described for Segment 2.
- Construct the quadrant interchange at Aviation Parkway (SR 1002) / Morrisville-Carpenter Road (SR 3014), included as part of costs developed for Segment 2.

- Construct the grade-separation of the railroad and Morrisville-Carpenter Road (SR 3014), but only after the McCrimmon Parkway (SR 1635) interchange is completed.

C. WEST OF WESTON PARKWAY TO NW MAYNARD ROAD

- Widen NC 54 to a six-lane median divided facility, as detailed in Segment 3.

Utility relocation, right-of-way and construction costs for the recommended improvements are summarized in **Table 9**.

Table 9. Costs of Recommended Improvements

Segment	Utility Relocation Costs (\$)	Right-of-way Costs (\$)	Construction Costs ¹ (\$)	Total Costs (\$)
1	\$ 800,000	\$ 17,500,000	\$ 17,600,000	\$ 35,900,000
1A	\$ 50,000	\$ -0-	\$ 825,000	\$ 875,000
1B	\$ 100,000	\$ 7,800,000	\$ 12,400,000	\$ 20,300,000
2	\$ 1,000,000	\$ 47,400,000	\$ 24,300,000	\$ 72,700,000
2A	\$ 500,000	\$ 5,000,000	\$ 15,100,000	\$ 20,600,000
3	\$ 1,100,000	\$ 31,300,000	\$ 22,000,000	\$ 54,400,000
Totals:	\$ 3,550,000	\$ 109,000,000	\$ 92,225,000	\$ 204,775,000

¹ Construction Costs include sidewalks and 14-foot outside travel lanes (6-foot dedicated bike lanes are not included; see Table 5 for additional cost).

D. TRAFFIC CAPACITY ANALYSES OF CONCEPTUAL IMPROVEMENTS

Highway capacity analyses were conducted for the future year conceptual traffic volumes described in Section III.B.2. The highway capacity analyses were based on methodologies from the Highway Capacity Manual (HCM 2000), Special Report 209. Traffic modeling software used in the capacity analyses included Synchro 7.0 and SimTraffic 7.0; HCS 2010 was only used for merge/diverge and ramp analyses. Traffic capacity analyses were conducted using traditional intersection designs in addition to alternative intersection designs that limit one or more left-turn and through movements. The traditional intersection analysis showed that NC 54 would have to be widened to accommodate 6 to 10 through lanes. Concepts using alternative intersection and grade-separated designs require NC 54 to be widened to accommodate 4 to 6 through lanes. Multiple scenarios were considered at intersections throughout the project corridor. **Table 10** presents the levels of service and associated average vehicle delays for signalized intersections associated with the recommended improvements. The operational goal for the improvements was to provide signalized intersection levels of service of LOS D or better in 2040. As shown in the table, all intersection LOS's meet this criteria except for NC 54's intersections with Weston Parkway and Morrisville Parkway. These intersections are recommended as at-grade intersections, as the grade-separated solution (whose costs are presented as Segment 3A) are considered prohibitive.

Table 10. Build Capacity Analyses of Recommended Improvements

Signalized Intersection NC 54 at:	Movement	2040 Future Build Conditions			
		AM Peak		PM Peak	
		LOS	Delay (sec)	LOS	Delay (sec)
NC 540 SB Ramps	Signalized Traditional Intersection	C	25.3	C	20.1
I-540 NB Ramps	Signalized Traditional Intersection	C	28.1	C	22.2
Lichtin Blvd.	Signalized Right-in / Right-out	A	6.1	B	18.6
Carrington Mill Blvd.	Signalized Left-in Alternative Intersection	C	25.0	C	23.6
McCrimmon Parkway	Grade-separation with Quadrant Ramp – Ramp Intersection on NC 54	C	21.2	B	13.8
	Grade separation with Quadrant Ramp – Ramp Intersection on McCrimmon Parkway	C	22.1	B	19.4
Perimeter Park Dr.	Signalized Traditional Intersection*	C	21.1	B	17.7
Airport Blvd.	Signalized Left-Out Alternative Intersection	A	8.0	C	21.9
	Signalized Eastbound NC 54 U-Turn	B	18.3	A	7.4
Southport Drive	Signalized Left-in Alternative Intersection	C	22.5	B	18.0
Southport Drive	Signalized Westbound NC 54 U-Turn	A	9.6	B	11.0
Morrisville-Carpenter Rd. / Aviation Parkway	Grade separation with Quadrant Ramp – Ramp Intersection on NC 54	D	39.5	C	29.4
	Grade separation with Quadrant Ramp – Ramp Intersection on Aviation Parkway	C	29.9	D	36.1
Weston Parkway	Signalized traditional intersection	D	43.4	D	42.2
Morrisville Parkway	Signalized traditional intersection	D	39.5	D	37.9
Market Center Dr.	Signalized WB NC 54 Dual U-Turn at Intersection	B	16.7	C	26.6
Cary Parkway	Signalized Michigan Left – Center Intersection	C	32.3	C	23.1
	Signalized EB NC 54 U-Turn	C	25.3	B	13.4
	Signalized NB Cary Parkway U-Turn	B	20.0	B	18.8
NW Maynard Rd.	Quadrant Ramp Signal with NC 54	B	10.3	A	4.8
	At-grade intersection of NC 54 and NW Maynard	D	37.5	D	35.8
	Quadrant Ramp Signal with NW Maynard	B	18.1	C	29.4

*The Town of Morrisville plans to convert Perimeter Park Drive to a right-in/right-out movement; however, for the purposes of this study it has been analyzed as a signalized intersection.

E. ALTERNATIVES FOR DETAILED STUDY

Both of the mainline segment alternatives discussed by the PAT, an alternative that widens NC 54 and relocates the roadway outside of the NCRR right-of-way and an alternative that would widen NC 54 from the existing edge of pavement on the west side, should be carried forward to subsequent phases of the project development process for detailed studies.

VI. COMMENTS RECEIVED ON THE DRAFT FEASIBILITY STUDY REPORT

Following distribution of the Draft Feasibility Study Report, the following comments were received from the project stakeholder team. Responses to substantial comments are noted below.

A. TOWN OF MORRISVILLE COMMENTS

Comment: “We question the need for a 30-foot wide median along the entire corridor. The Morrisville Transportation Plan recommends a 24-foot planted median along much of the corridor, with no median in the section of the corridor between Keybridge Drive and Sunset Avenue, because of the adjoining railroad corridor in this area. We believe a narrower median could work throughout much of the corridor, with widening around major intersections where needed to accommodate multiple turn lanes.”

Response: For the purposes of this Feasibility Study an optimal median width of 30-foot was used throughout the corridor. The traffic capacity analyses show that double left turn lanes, and in some cases double U-turn lanes, are required at several intersections. A 30-foot median will accommodate double left turn lanes at intersections. Moreover, at this early phase in project development, intermediate left-overs and U-turn locations have not yet been determined. The 30-foot median would accommodate overlapping intermediate left-overs into properties along NC 54. If during subsequent phases of project development it is determined that long segments of NC 54 can be constructed without the need for double or overlapping turn lanes, the median could be narrowed in those locations.

Comment: “While we understand that a primary purpose of the study was to look at moving the NC 54 corridor outside of the NCRR corridor, we believe the Study could discuss widening the roadway from the existing edge of pavement without relocating the entire roadway outside of the corridor. This has been discussed at prior Technical Committee meetings, and our understanding was that a discussion of this could be included in the final study document.”

Response: A brief description of these alternatives has been added to Section III. of this report. Additionally, the recommendation to carry both alternatives forward for detailed studies has been added to Section IV. For the purposes of this report, only the alternative that widens NC 54 and relocates the roadway outside of the NCRR right-of-way is quantified for impacts and cost estimates. This alternative is considered optimal from a design perspective, but is not intended to preclude other alternatives from being studied in subsequent phases of the project development process.

Comment: “We are disappointed with the discussion about not including bicycling facilities in the study, and only including pedestrian accommodations if the Towns of Morrisville and Cary contribute funding (Page 9). **This is in direct conflict with NCDOT’s Adopted Complete Streets Policy.** At a minimum, the Study should include the recommended bicycle and pedestrian facilities shown in the local plan, and reference NCDOT’s Complete Streets Policy. If the median is narrowed, bicycle lanes can easily be accommodated without expanding the width of the facility.”

Response: The conceptual designs do provide a 10-foot sidewalk on the east side of NC 54 and a 5-foot sidewalk on the west side of NC 54. Bicycle accommodations were limited to the inclusion of wide (14-foot) outside travel lanes to minimize the project footprint; however, estimated costs for providing full 6-foot bike lanes are provided in **Table 6** of this report. The final determination of the scope and implementation of bicycle and pedestrian accommodations will be made during subsequent phases of the project development process. The NCDOT’s Adopted Complete Streets Policy requires that multimodal alternatives be considered and incorporated in the design of all appropriate transportation projects. Whether or not sidewalks or street-side bicycle facilities are constructed as part of the NC 54 projects is still dependent on funding agreements among the Town of Morrisville, Town of Cary, and the NCDOT, in accordance with NCDOT’s *Pedestrian Policy*.

Comment: “The Town would not support the construction of the horseshoe design at Morrisville Parkway/Weston Parkway.”

Response: Comment noted. The horseshoe design is not included in the recommended improvements. This alternative was intended to be an optimal solution from a traffic capacity analysis standpoint.

B. TOWN OF CARY’S COMMENTS

Comment: “Town of Cary’s Parks and Recreation Cultural Resources Master Plan identifies a street-side trail along the corridor from NE Maynard Road to the Cary Town limits. The Study should include the recommended bicycle and pedestrian facilities shown in local plans, and reference NCDOT’s Complete Streets Policy.”

Response: The conceptual designs do provide a 10-foot sidewalk on the east side of NC 54 and a 5-foot sidewalk on the west side of NC 54. Bicycle accommodations were limited to the inclusion of wide (14-foot) outside travel lanes to minimize the project footprint. The conceptual design typical section (from a bicycle and pedestrian perspective) matches the Town of Cary’s plans; however, estimated costs for providing full 6-foot bike lanes along portions of the NC 54 corridor are provided in **Table 6**, but do not include portions within the Cary Town Limits. The final determination of the scope and implementation of bicycle and pedestrian accommodations will be made during subsequent phases of the project development process.

Comment: “We would like to see the median width reduced along the entire corridor. The Town of Cary Comprehensive Transportation Plan shows an 18-foot wide median for our 6-lane cross-section improvements from NE Maynard to the Cary Town limits.”

Response: For the purposes of this Feasibility Study an optimal median width of 30-foot was used throughout the corridor. The traffic capacity analyses show that double left turn lanes, and in some cases double U-turn lanes, are required at several intersections. A 30-foot median will accommodate double left turn lanes at intersections. Moreover, at this early phase in project development, intermediate left-overs and U-turn locations have not yet been determined. The 30-foot median would accommodate overlapping intermediate left-overs into properties along NC 54. If during subsequent phases of project development it is determined that long segments of NC 54 can be constructed without the need for double or overlapping turn lanes, the median could be narrowed in those locations.

Comment: “The Town does not support the ‘horseshoe design’ [at Weston Parkway and Morrisville Parkway]”

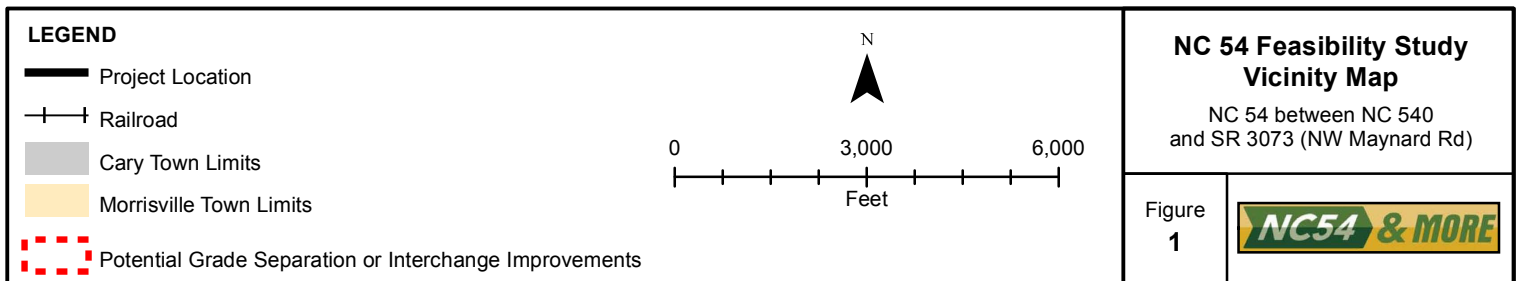
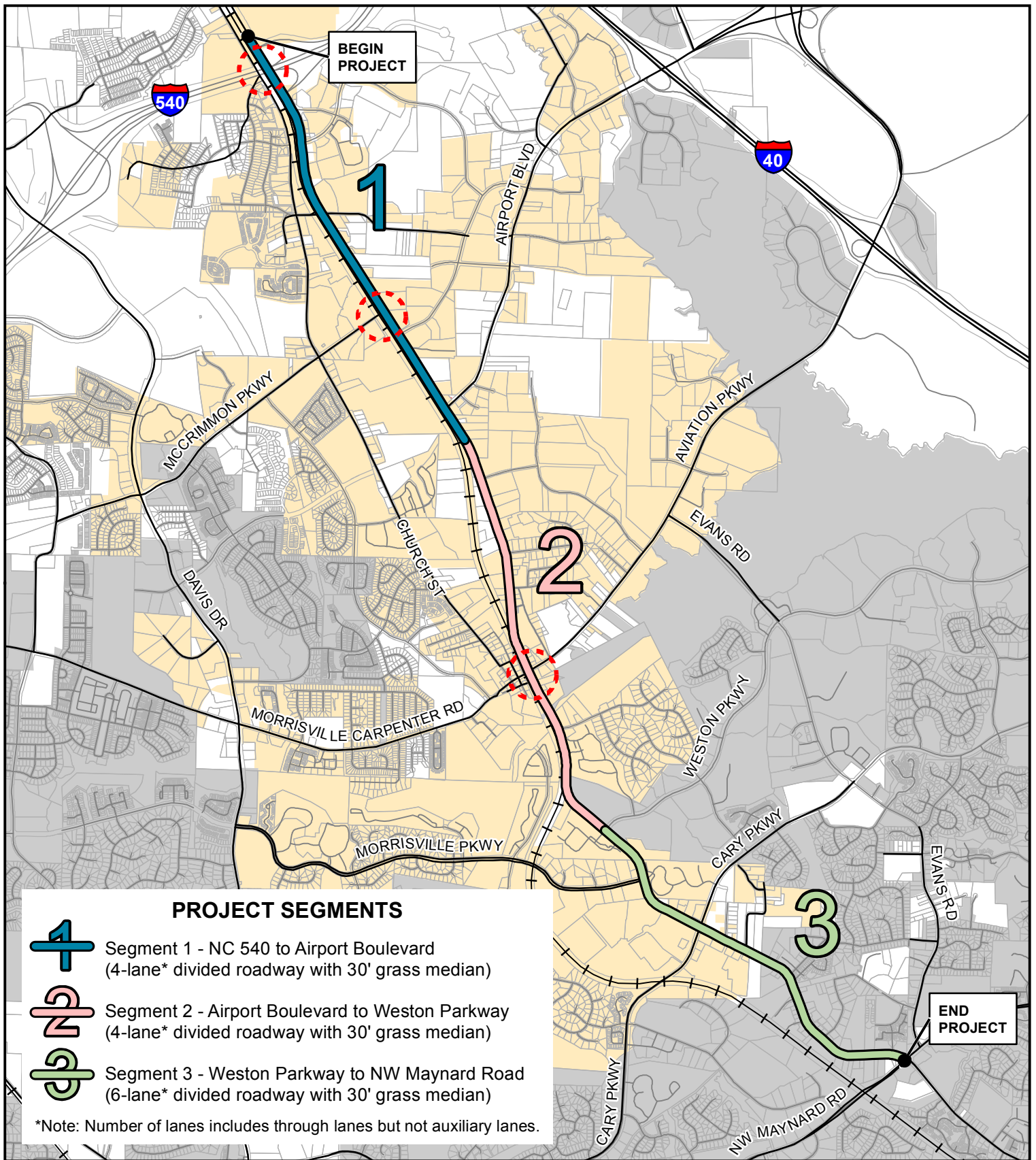
Response: The “horseshoe design” was originally placed in the recommendations section as a place holder, pending the results of the right-of-way cost estimates. Due to the high right-of-way cost

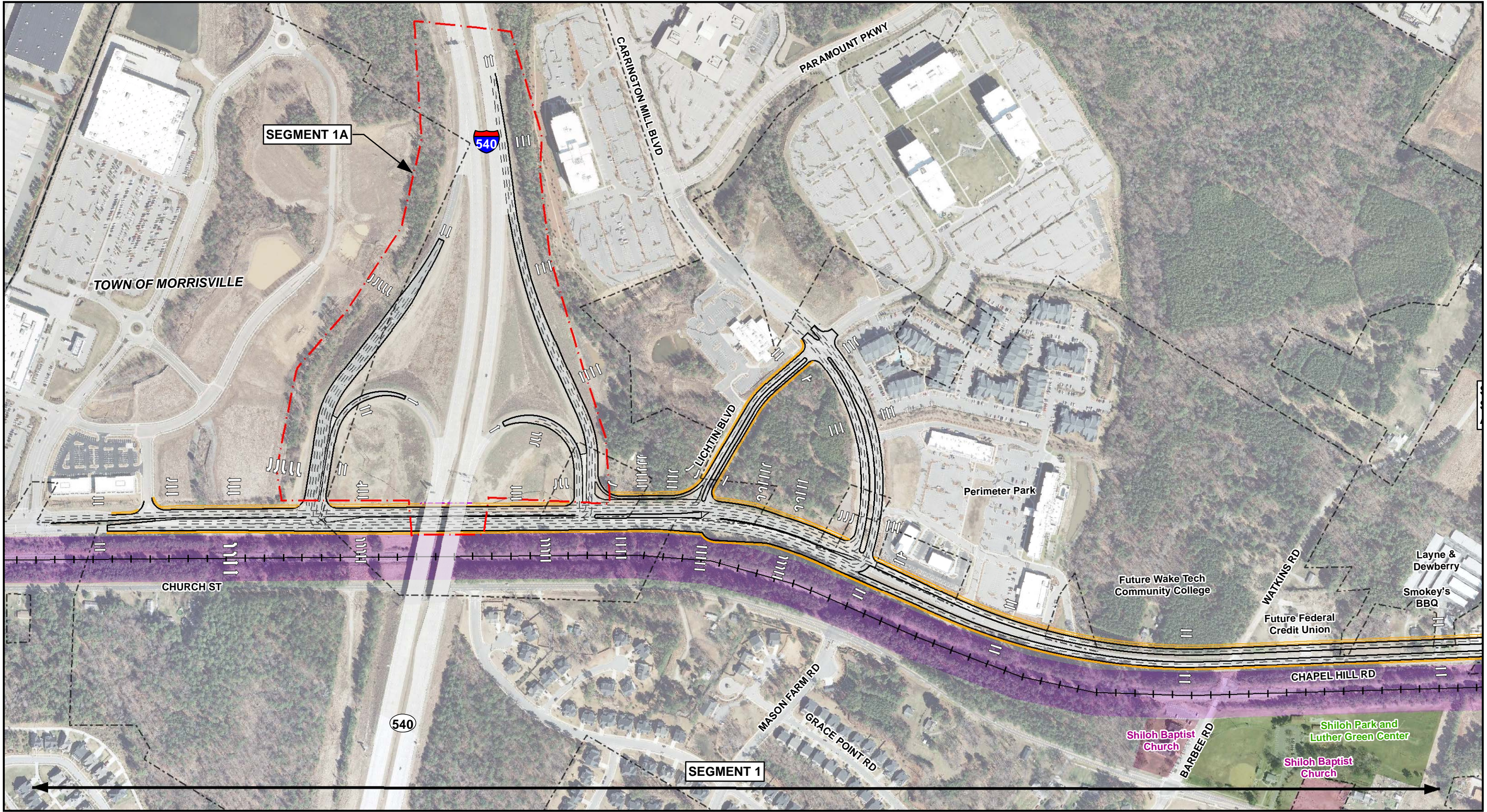
estimate (\$18,700,000) the horseshoe design (segment 3A) is not included in the final recommendations.

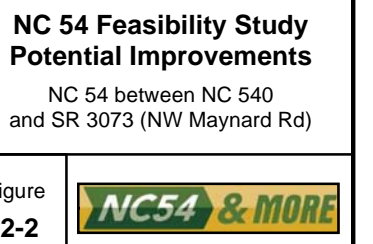
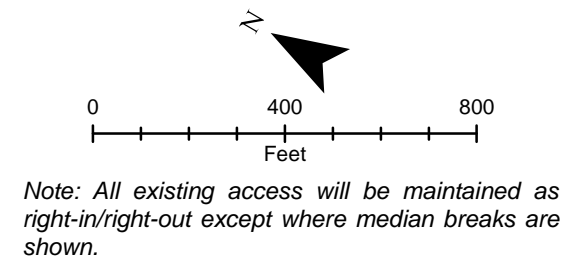
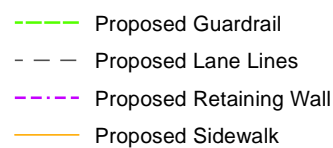
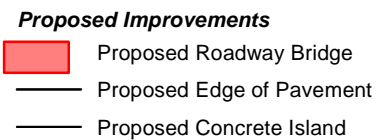
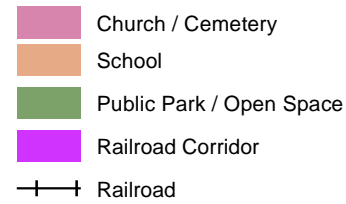
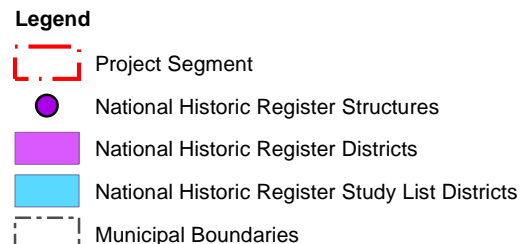
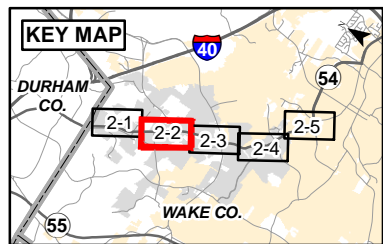
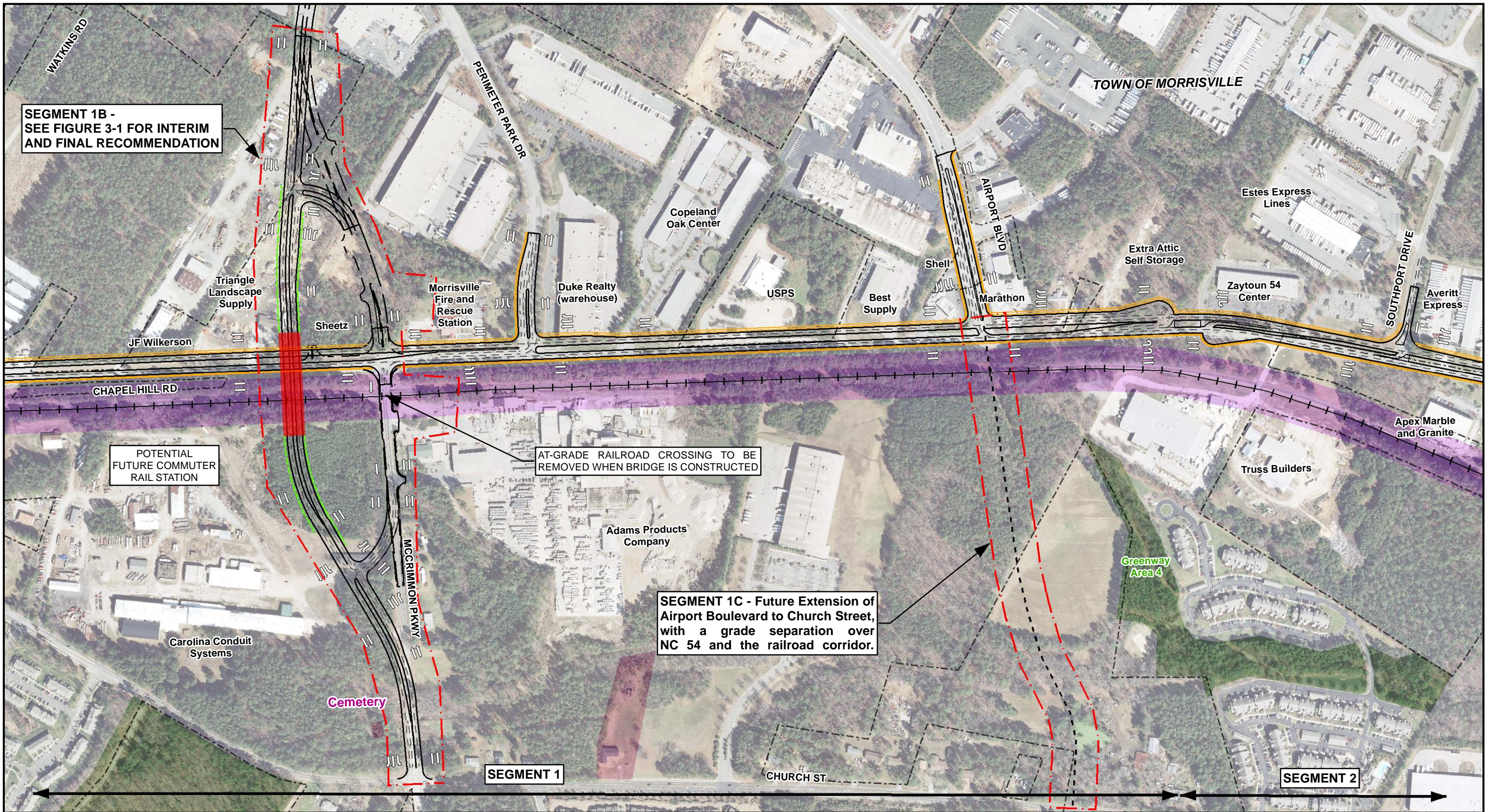
Comment: “The Town of Cary does not support the new road connection recommendation between NE Maynard and Chapel Hill Road (NC 54)”

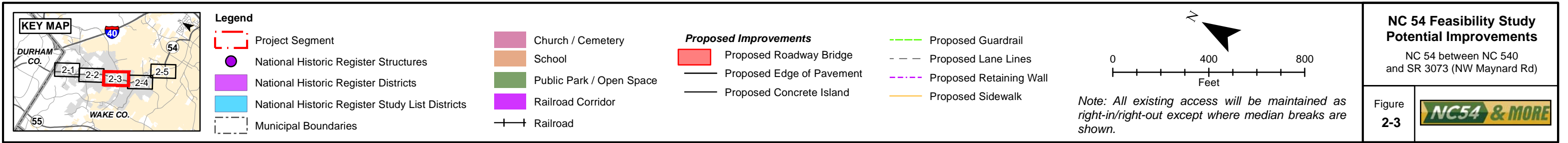
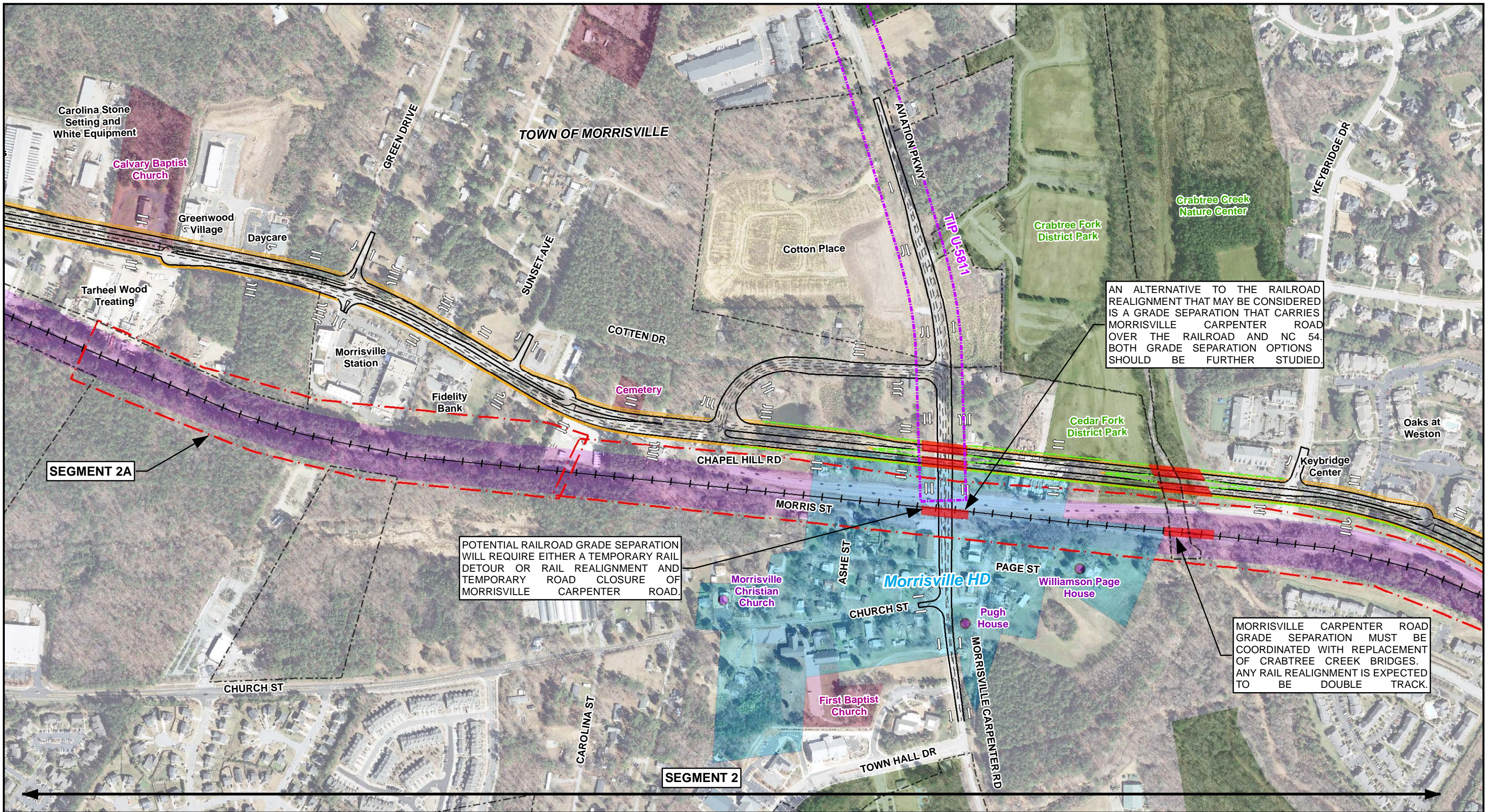
Response: Comment noted. This connection is intended to help alleviate congestion at the NE Maynard and Chapel Hill Road intersection. During later planning and design stages of project development, the ultimate configuration of all the intersections, including this one, will be determined. Additional alternative designs and subsequent capacity analysis will be required during the project development process.

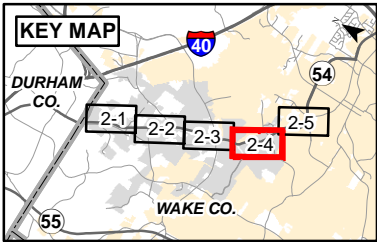
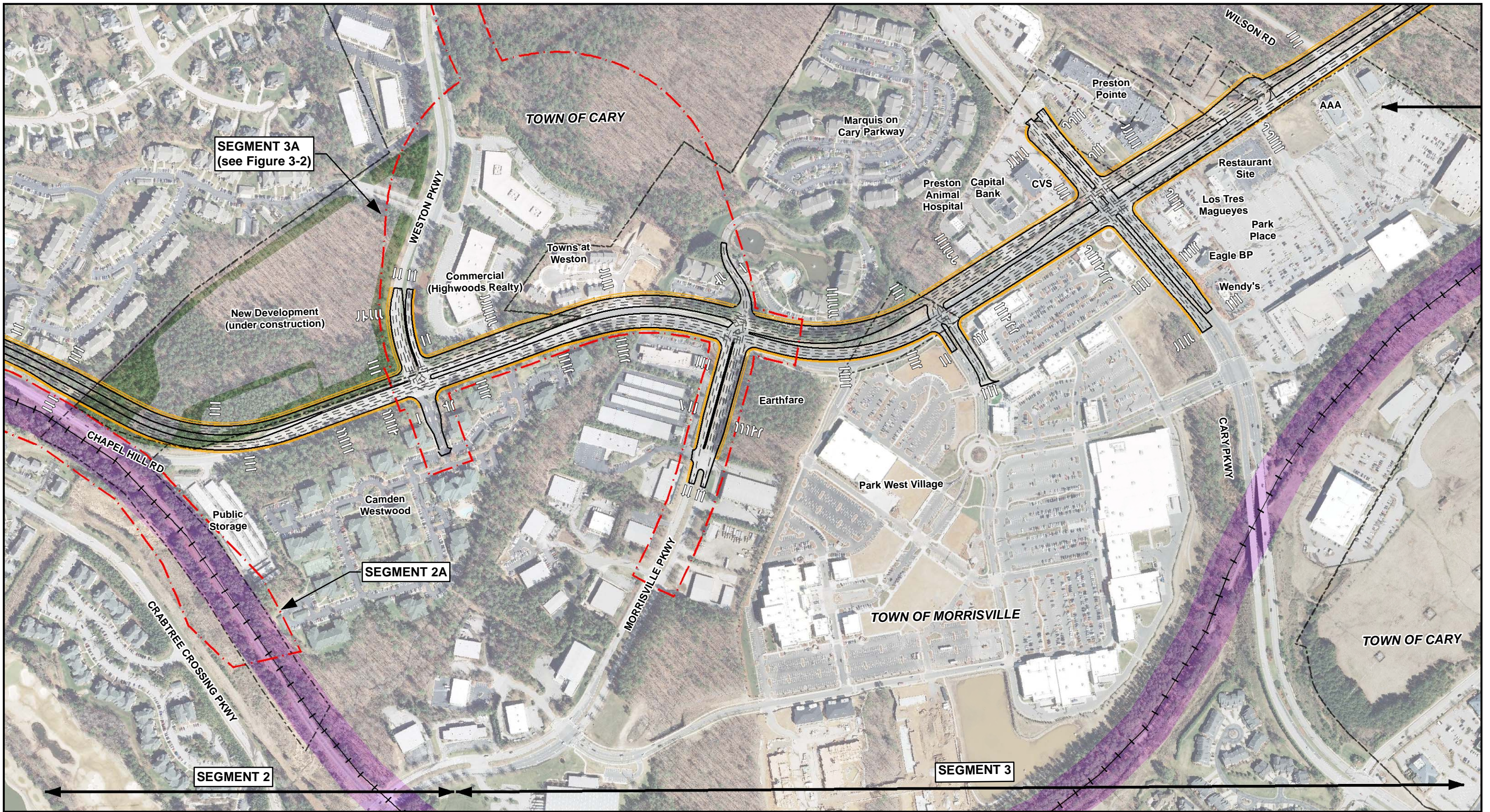
FIGURES









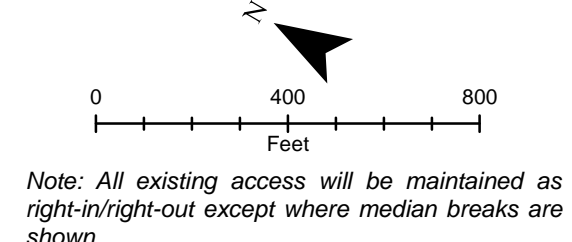


- Legend**
- Project Segment
 - National Historic Register Structures
 - National Historic Register Districts
 - National Historic Register Study List Districts
 - Municipal Boundaries

- Church / Cemetery
- School
- Public Park / Open Space
- Railroad Corridor
- + + Railroad

- Proposed Improvements**
- Proposed Roadway Bridge
 - Proposed Edge of Pavement
 - Proposed Concrete Island

- Proposed Guardrail
- Proposed Lane Lines
- Proposed Retaining Wall
- Proposed Sidewalk

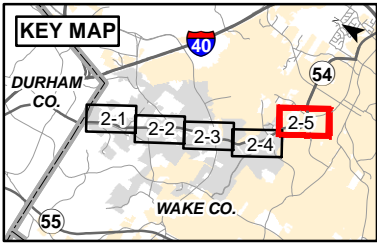
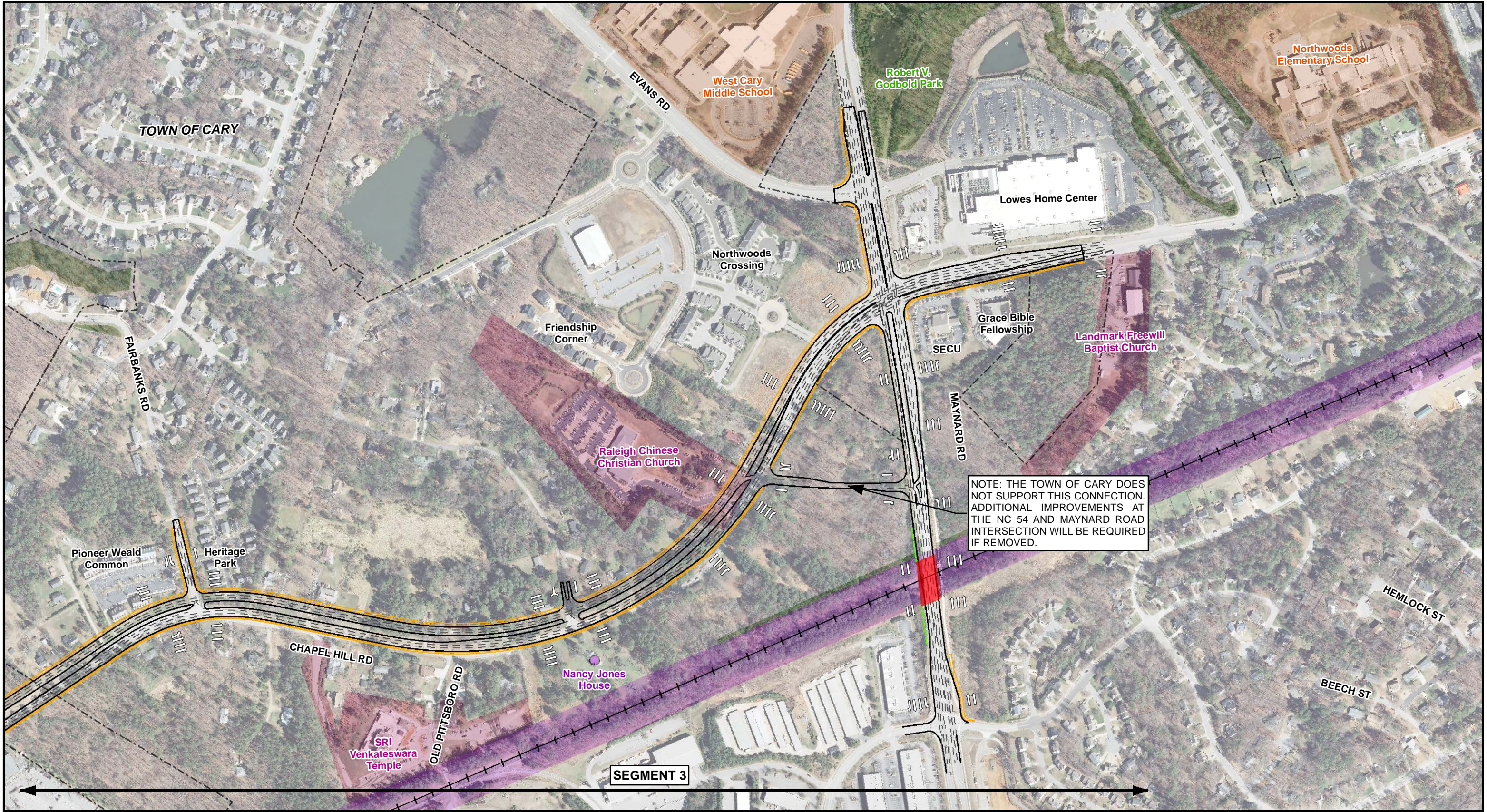


**NC 54 Feasibility Study
Potential Improvements**

NC 54 between NC 540
and SR 3073 (NW Maynard Rd)

Figure
2-4

NC54 & MORE

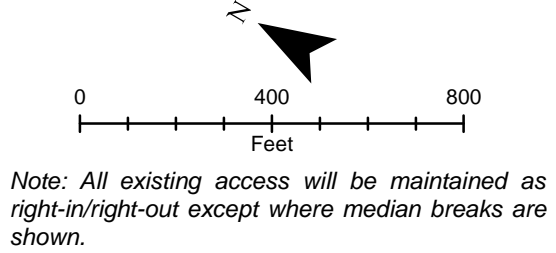


- Legend**
- Project Segment
 - National Historic Register Structures
 - National Historic Register Districts
 - National Historic Register Study List Districts
 - Municipal Boundaries

- Church / Cemetery
- School
- Public Park / Open Space
- Railroad Corridor
- Railroad

- Proposed Improvements**
- Proposed Roadway Bridge
 - Proposed Edge of Pavement
 - Proposed Concrete Island

- Proposed Guardrail
- Proposed Lane Lines
- Proposed Retaining Wall
- Proposed Sidewalk



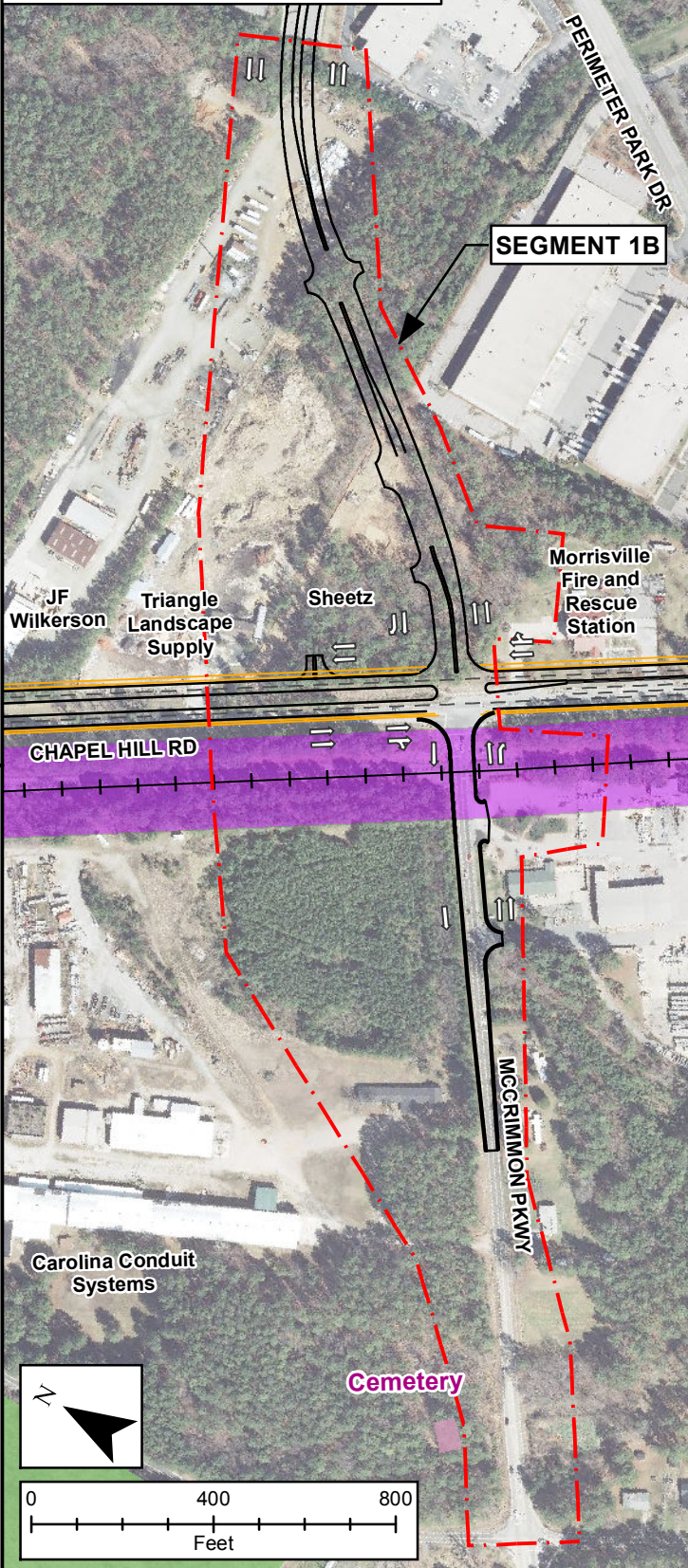
**NC 54 Feasibility Study
Potential Improvements**

NC 54 between NC 540
and SR 3073 (NW Maynard Rd)

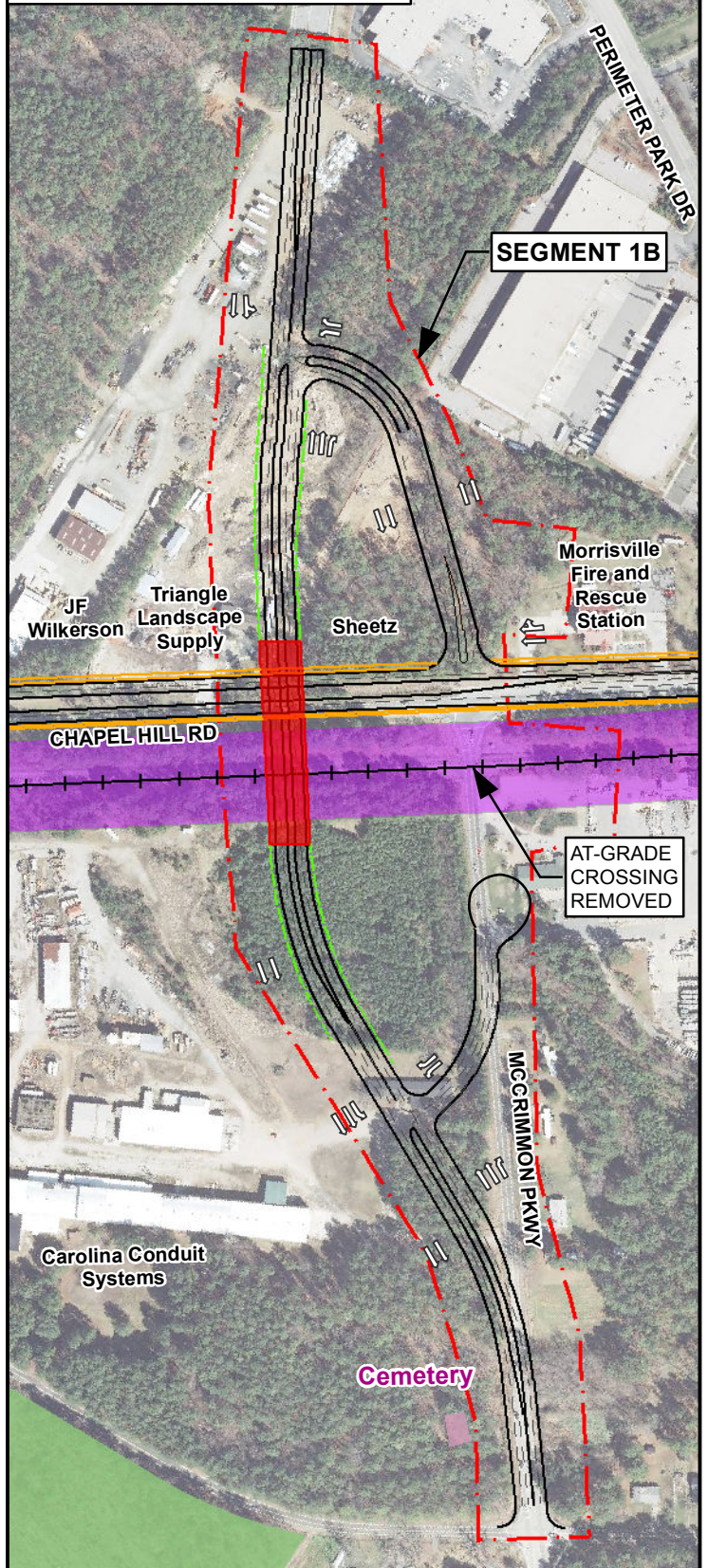
Figure
2-5



INTERIM RECOMMENDATION



FINAL RECOMMENDATION



Legend

- Project Segment
- Railroad

Proposed Improvements

- Proposed Roadway Bridge
- Proposed Edge of Pavement
- Proposed Concrete Island

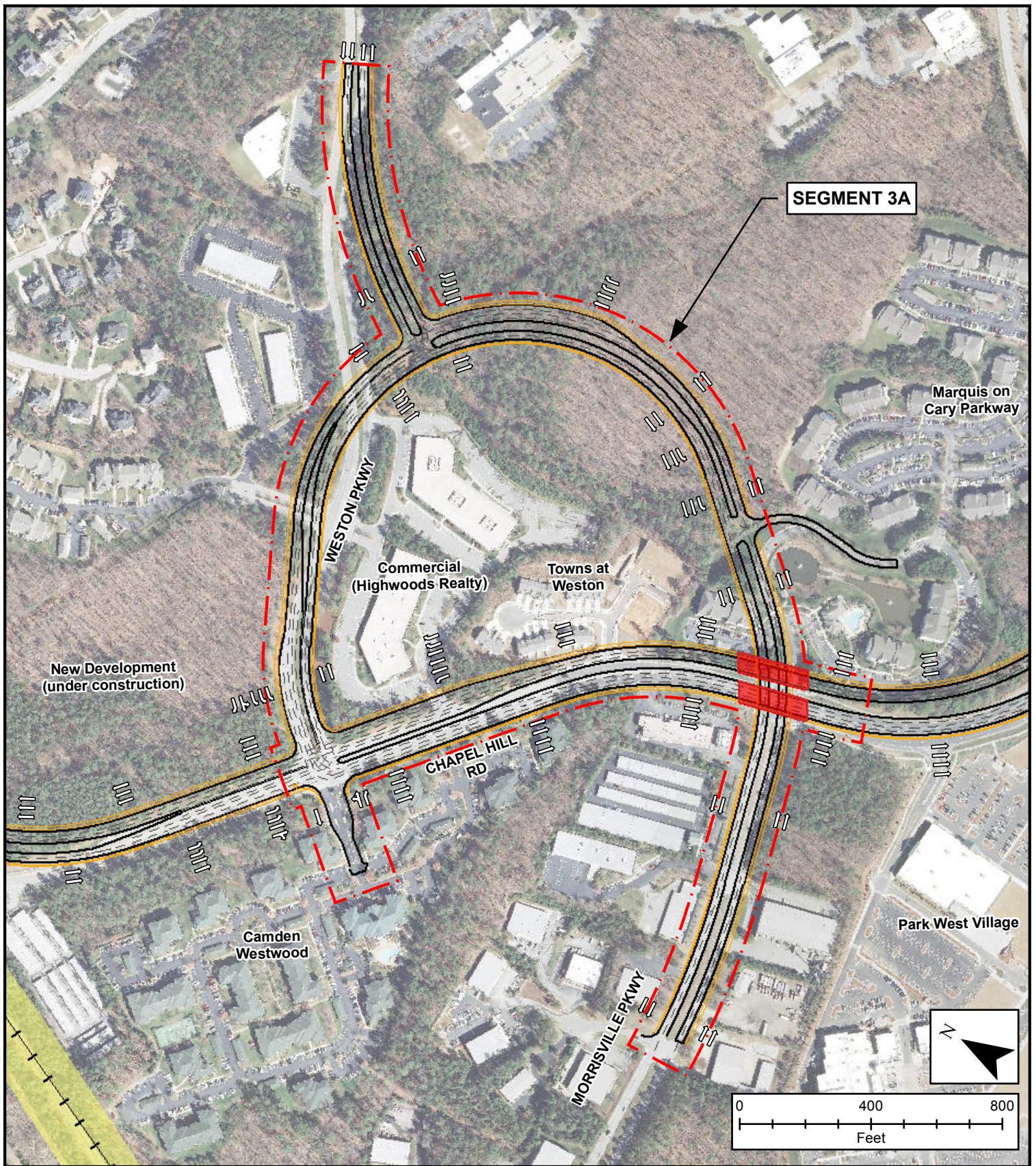
- Proposed Guardrail
- Proposed Lane Lines
- Proposed Retaining Wall
- Proposed Sidewalk

Segment 1B NC 54 Feasibility Study Potential Improvements

NC 54 between NC 540
and SR 3073 (NW Maynard Rd)

Figure
3-1





Legend

- Project Segment
- Railroad Corridor

Proposed Improvements

- Proposed Roadway Bridge
- Proposed Edge of Pavement
- Proposed Concrete Island
- Proposed Guardrail
- Proposed Lane Lines
- Proposed Retaining Wall
- Proposed Sidewalk

SEGMENT 3A

Marquis on
Cary Parkway

Commercial
(Highwoods Realty)

Towns at
Weston

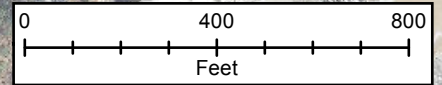
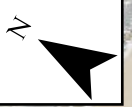
New Development
(under construction)

CHapel Hill
RD

Camden
Westwood

Park West Village

MORRISVILLE PKWY



Segment 3A
NC 54 Feasibility Study
Potential Improvements
NC 54 between NC 540
and SR 3073 (NW Maynard Rd)

Figure
3-2



APPENDIX





STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

PAT MCCRORY
GOVERNOR

ANTHONY J. TATA
SECRETARY

May 23, 2014

MEMORANDUM TO: Shane York, PE
Program Development Branch

FROM: Elisabeth R. Bray
Transportation Planning Branch

SUBJECT: Traffic Forecast for FS-1005B
Wake County
NC 54 Widening

Please find attached the 2014/2040 traffic forecast for the above mentioned project. Project FS-1005B is a feasibility study for the widening of NC 54 from NC 540 to NC 54/SR 3073 (Maynard Road). This is an update of a previous forecast completed in 2011. This project lies within the Capital Area Metropolitan Planning Organization.

A meeting to discuss the forecasting process was held on March 25, 2014. After this meeting, information pertinent to the forecast was requested from the meeting attendees. This includes Eddie McFalls-AECOM, Derrick Waller-NCDOT Div 5 District Office, Benjamin Howell-Town of Morrisville, Ben Hitchings-Town of Morrisville, Todd Delk-Town of Cary, Alex Rickard-CAMPO and Richard Adams-Kimley-Horn. Information was received from the Town of Morrisville, The Town of Cary and NCDOT Division 5 District Office. Rupal Desai, PE, NCDOT CAMPO Coordinator, also provided information, including model runs, throughout the forecasting process.

The following scenarios are provided:

- 2014 Base Year No-Build
- 2014 Base Year Build
- 2040 Future Year No-Build
- 2040 Future Year Build

Certain Assumptions were made during the development of this forecast:

Fiscal Constraint:

Within an MPO, the future year forecasts assume construction of projects as listed within the MPO's MTP. This forecast is consistent with the Capital Area MPO's current MTP, adopted June 2013.

Development Activity:

The following assumptions have been made when developing the future year 2040 traffic forecast:

MAILING ADDRESS:
NC DEPARTMENT OF TRANSPORTATION
TRANSPORTATION PLANNING BRANCH
1554 MAIL SERVICE CENTER
RALEIGH NC 27699-1554



<http://ncdot.org/doh/preconstruct/tpb/>

LOCATION:
TRANSPORTATION BUILDING
1 SOUTH WILMINGTON STREET
RALEIGH, NC 27601
Phone: 919-733-4705
Fax: 919-733-2417

According to Benjamin Howell, AICP, CZO, Town of Morrisville, the following commercial developments are planned and approved in the Town of Morrisville:

Under construction or recently constructed

- Park West Village (Cary Pkwy & NC 54)
- Sheetz Gas Station (NC 54 & McCrimmon Pkwy)
- Continuing construction in Perimeter Park (on Carrington Mill)

Approved residential developments beginning construction

- Cotton Place (Aviation Pkwy)
- Woods at Fairbanks (off Wilson Rd)
- The Birkshires (on McCrimmon Pkwy)

The Town of Morrisville is also constructing a new, large community park on Church Street just north of McCrimmon Parkway that will include a regulation-size Cricket/Multi-purpose field, and will be capable of holding competitions with spectators. There are also some planned, but not approved developments in the area. This includes a proposed Earth Fare Grocery with retail out-building to be located at Morrisville Parkway and NC 54 and a proposed Wake Tech RTP site located on NC 54 between Watkins and Carrington Mill.

According to Todd Delk, PE, Town of Cary, the following developments are planned and approved in the Town of Cary:

- Weston Corners – Apts/Retail/Townhomes – NC 54 and Weston Parkway
- Centergreen Park at Weston – Office – Weston Pkwy E of Evans Rd
- Weatherfield Townhomes – Maynard Rd W of NC 54

There are rezoning cases for two proposed townhome/residential communities. One is located on the south side of Weston Parkway just north of NC 54 and the other is on NC 54 between Cary Pkwy and NW Maynard. These are planned, but not approved.

Methodology:

The ten and twenty year historical AADT growth rates and the model growth rates were reviewed. All development mentioned in the previous section is included in the growth rate along NC 54 and the relevant y-lines. The selected growth rates were then applied to the Base Year No-Build 2014 AADTs and grown with the straight line method to forecast the Future Year No-Build 2040 volumes. Adjustments were then made to refine and balance the resulting volume estimates.

The Base Year Build AADT was determined by finding the percent difference between the volumes on the Base Year Model No-Build scenario and the Base Year Model Build scenario. The percent difference was applied to the Base Year No-Build AADTs to calculate the Base Year Build AADTs. All other Build Scenarios follow the same methodology finding the percent difference between the appropriate model scenarios. Adjustments were then made to refine and balance the resulting volume estimates. The Triangle Regional Model adopted in June 2013 was used as a tool.

Interpolation:

Interpolation between scenarios is not recommended. AADT volumes may be extrapolated for up to two years immediately following 2040. If it is determined that any of these assumptions have become inconsistent with the project and surrounding area activity, please request updated projections at this location.

If you have any questions, or I can be of any further assistance on this project, please do not hesitate to contact me at 919-707-0938, email: erbray@ncdot.gov.

cc : FILE (Wake County, TIP Project FS-1005B)

cc: (via e-mail as *PDF Attachments*):

Glenn Mumford, PE, Roadway Design Branch

Scott Walston, PE, Transportation Planning Branch

State Traffic Forecast Engineer, Transportation Planning Branch

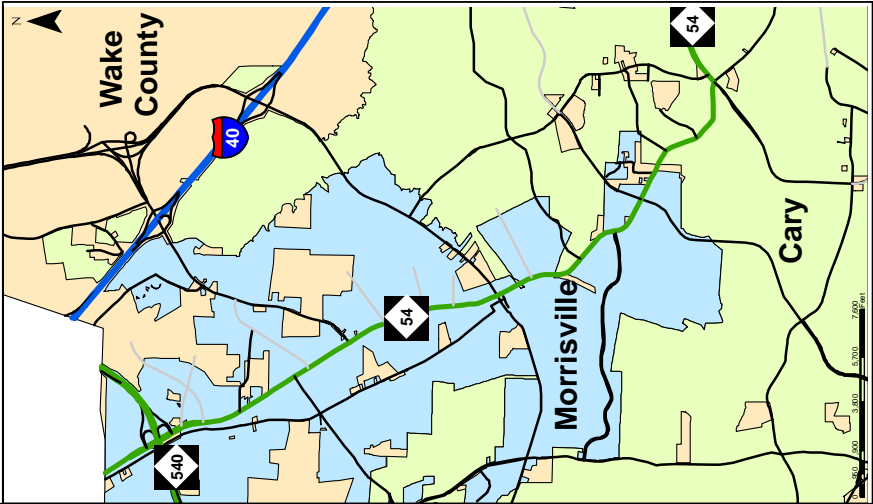
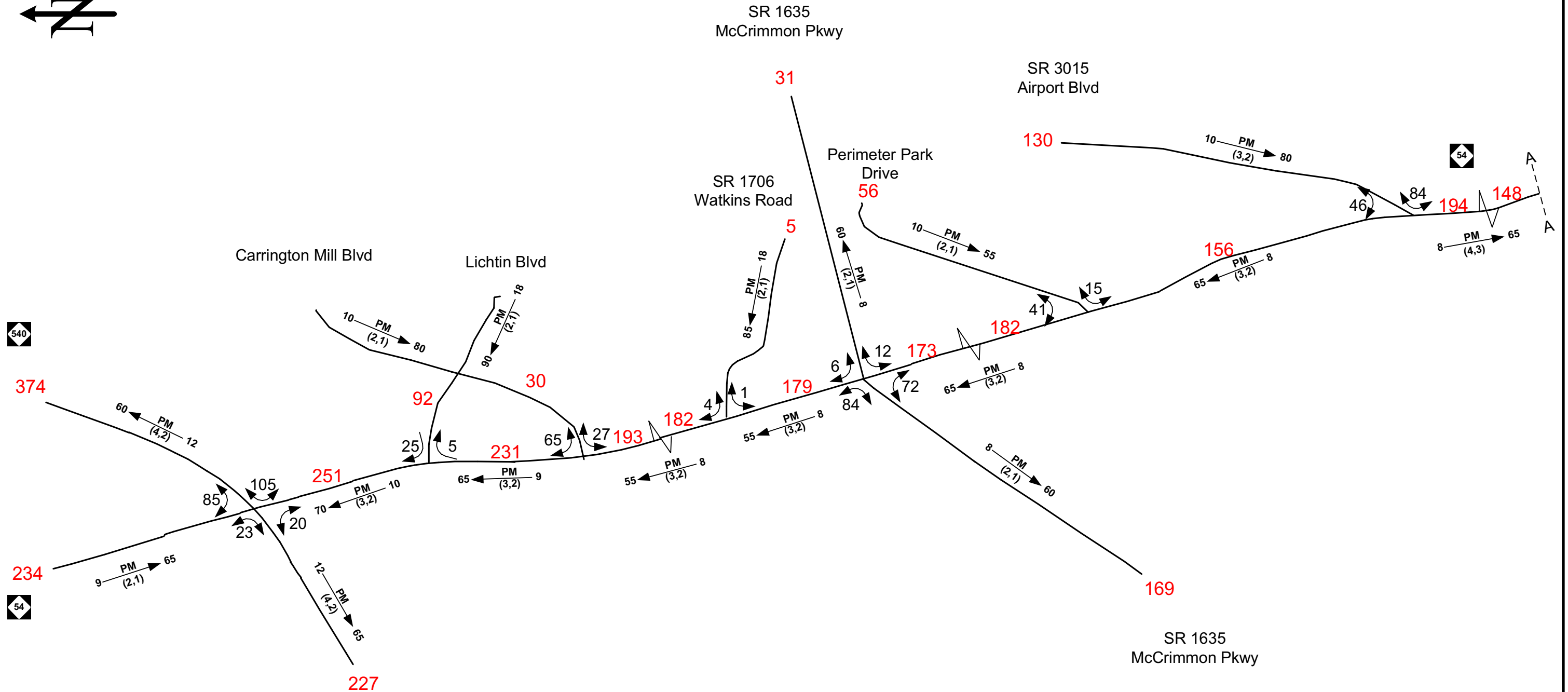
James Dunlop, PE, Congestion Management Section

Don Chen, PE, Pavement Management

Wally Bowman, PE, Division 5 Engineer

Chris Lukasina, CAMPO

Karen Roberson, Transportation Planning Branch



2014

AVERAGE ANNUAL DAILY TRAFFIC

LEGEND

No. of Vehicles Per Day (VPD) in 100s

1- Less than 50 VPD

x Movement Prohibited

..... Proposed Roadway

K Design Hour Factor (%)

PM PM Peak Period

D Peak Hour Directional Split

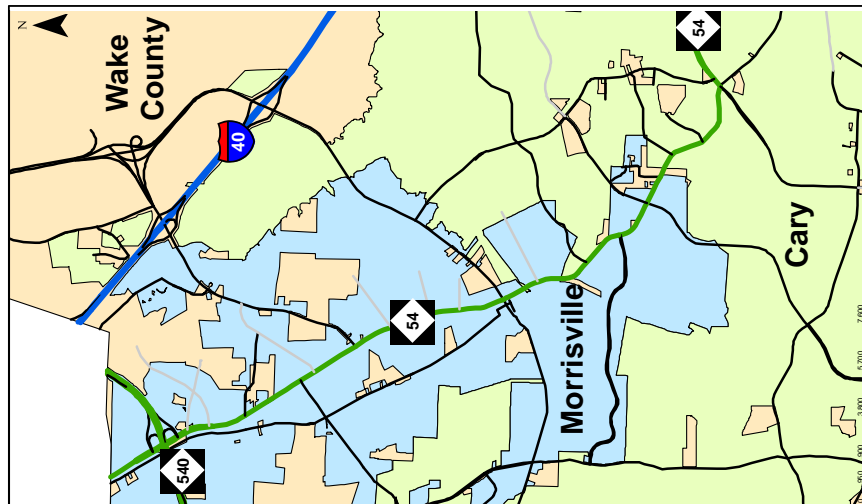
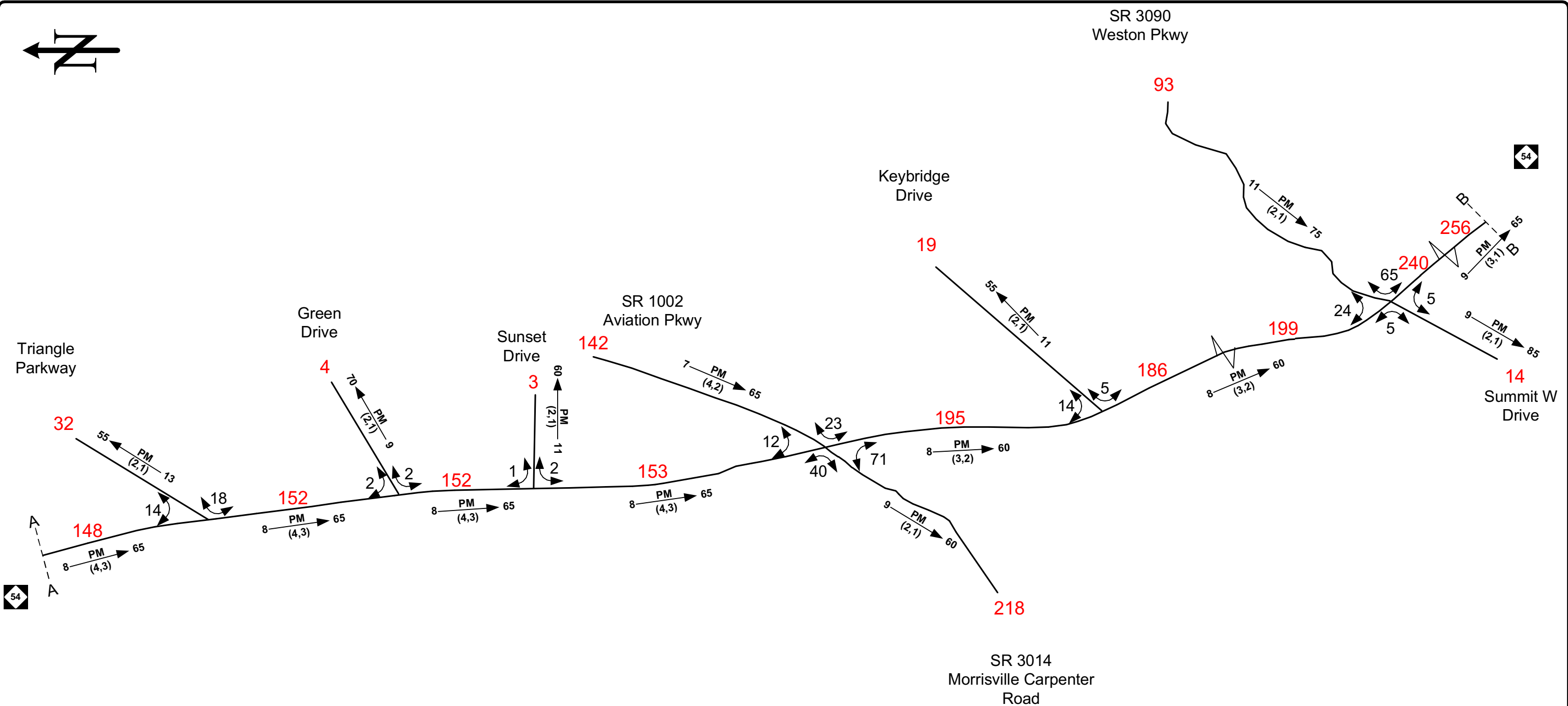
Indicates Direction of D

(d, t) Duals, TT-STs (%)

No Build

SHEET 1 OF 12

TIP: FS-1005B	WBS: 34263.1.1
COUNTY: Wake	DIVISION: 5
DATE: 05/23/2014	
PREPARED BY: Elisabeth Bray	
LOCATION: NC 54 from NC 540 to NC 54/SR 3073 (N. Maynard Road)	
PROJECT: Feasibility Study	



2014

AVERAGE ANNUAL DAILY TRAFFIC

LEGEND

No. of Vehicles Per Day (VPD) in 100s

1- Less than 50 VPD

x Movement Prohibited

..... Proposed Roadway

K Design Hour Factor (%)

PM PM Peak Period

D Peak Hour Directional Split

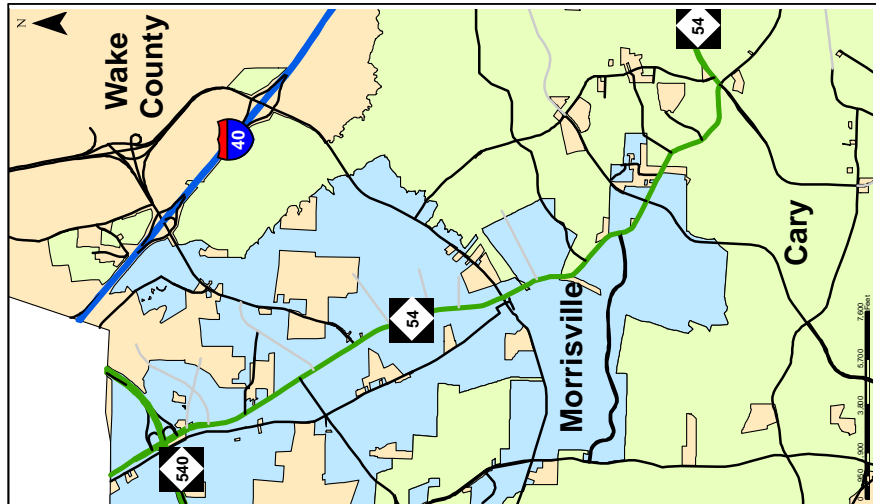
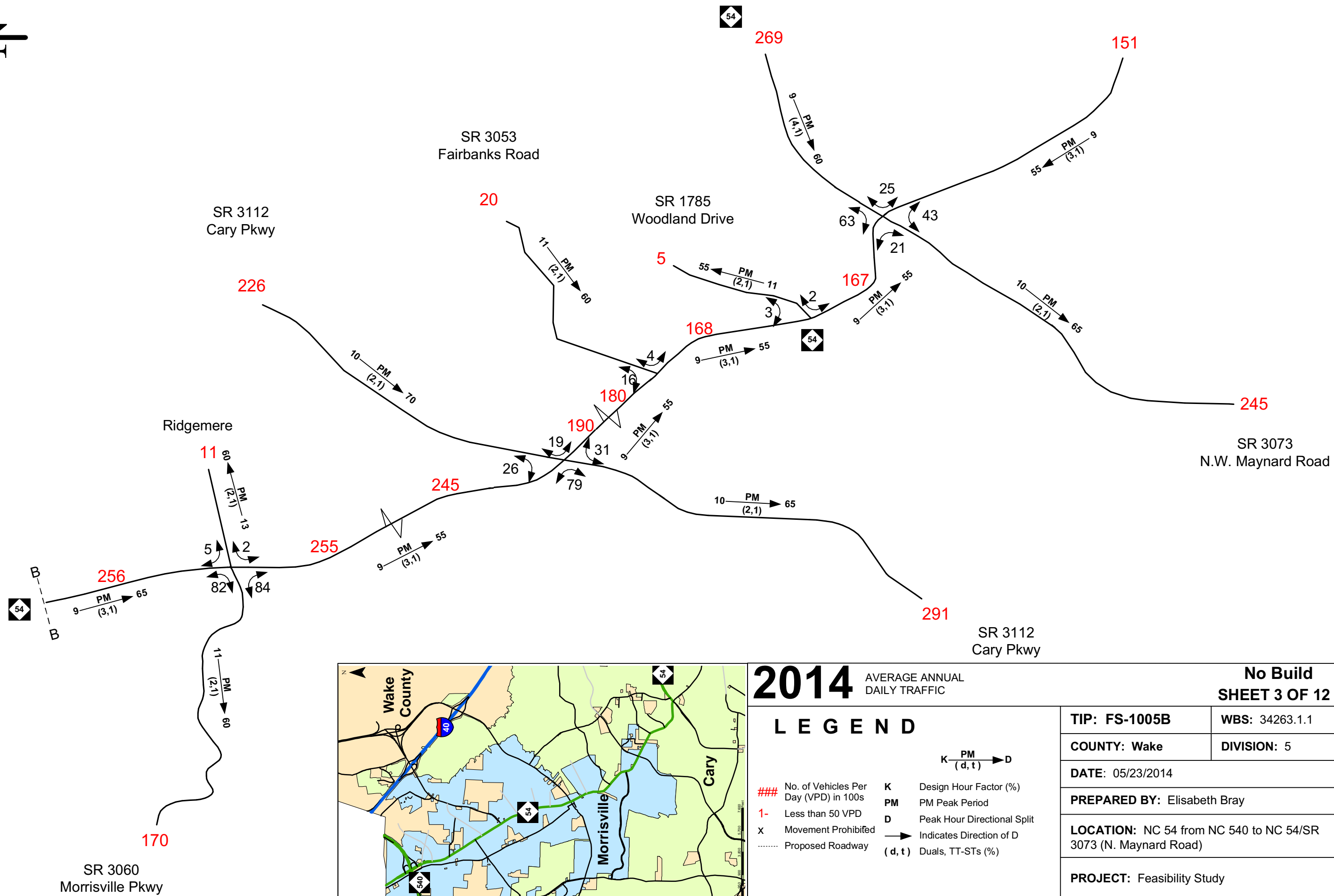
→ Indicates Direction of D

(d, t) Duals, TT-STs (%)

No Build

SHEET 2 OF 12

TIP: FS-1005B	WBS: 34263.1.1
COUNTY: Wake	DIVISION: 5
DATE: 05/23/2014	
PREPARED BY: Elisabeth Bray	
LOCATION: NC 54 from NC 540 to NC 54/SR 3073 (N. Maynard Road)	
PROJECT: Feasibility Study	



2014

AVERAGE ANNUAL DAILY TRAFFIC

LEGEND

No. of Vehicles Per Day (VPD) in 100s

1- Less than 50 VPD

x Movement Prohibited

..... Proposed Roadway

K Design Hour Factor (%)

PM PM Peak Period

D Peak Hour Directional Split

Indicates Direction of D

(d, t) Duals, TT-STs (%)

No Build

SHEET 3 OF 12

TIP: FS-1005B

COUNTY: Wake

DATE: 05/23/2014

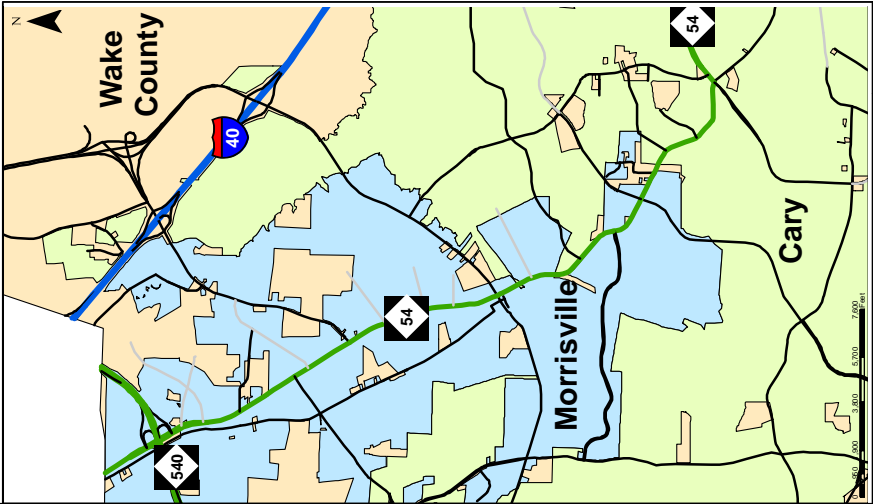
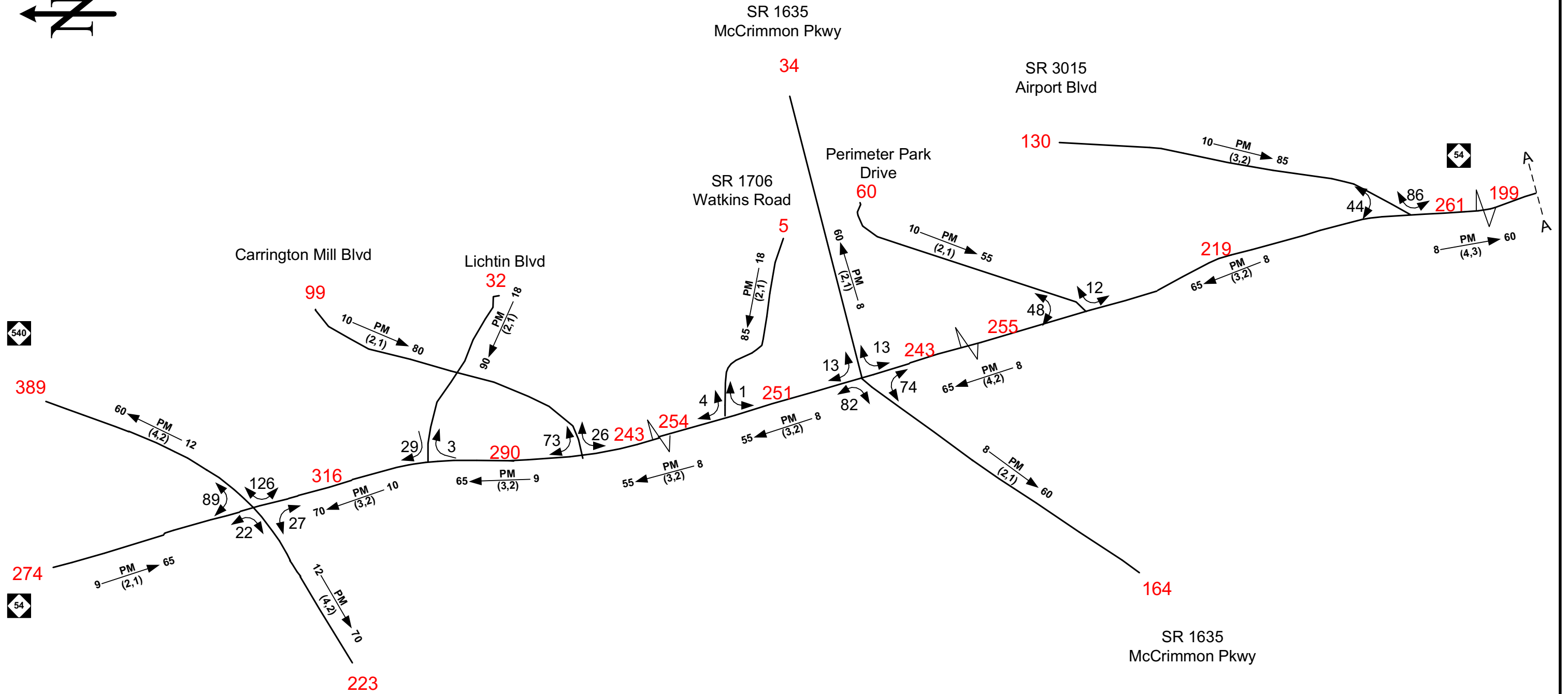
PREPARED BY: Elisabeth Bray

LOCATION: NC 54 from NC 540 to NC 54/SR 3073 (N. Maynard Road)

PROJECT: Feasibility Study

WBS: 34263.1.1

DIVISION: 5



2014

AVERAGE ANNUAL DAILY TRAFFIC

LEGEND

No. of Vehicles Per Day (VPD) in 100s

1- Less than 50 VPD

x Movement Prohibited

..... Proposed Roadway

K Design Hour Factor (%)

PM PM Peak Period

D Peak Hour Directional Split

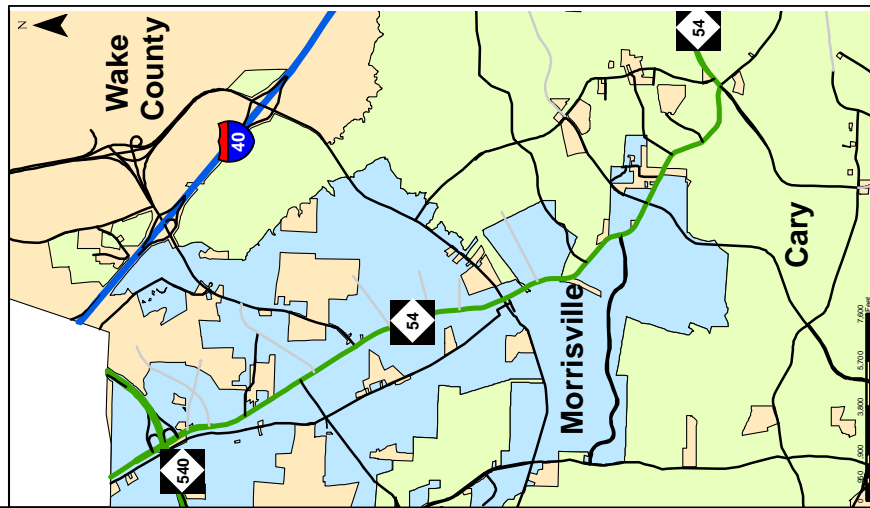
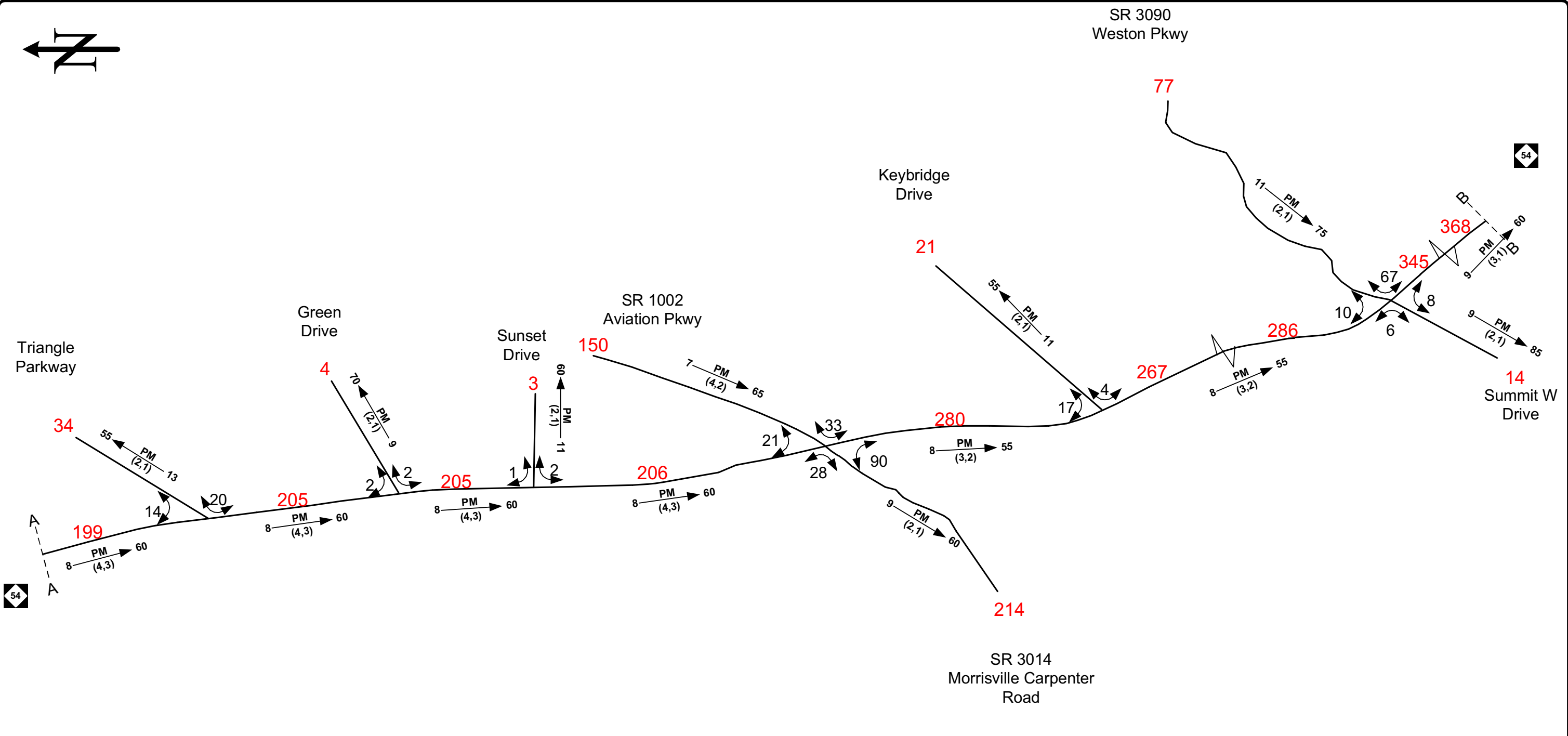
Indicates Direction of D

(d, t) Duals, TT-STs (%)

Build

SHEET 4 OF 12

TIP: FS-1005B	WBS: 34263.1.1
COUNTY: Wake	DIVISION: 5
DATE: 05/23/2014	
PREPARED BY: Elisabeth Bray	
LOCATION: NC 54 from NC 540 to NC 54/SR 3073 (N. Maynard Road)	
PROJECT: Feasibility Study	



2014

AVERAGE ANNUAL DAILY TRAFFIC

LEGEND

No. of Vehicles Per Day (VPD) in 100s

1- Less than 50 VPD

x Movement Prohibited

..... Proposed Roadway

K Design Hour Factor (%)

PM PM Peak Period

D Peak Hour Directional Split

Indicates Direction of D

(d, t) Duals, TT-STs (%)

Build SHEET 5 OF 12

TIP: FS-1005B

COUNTY: Wake

DATE: 05/23/2014

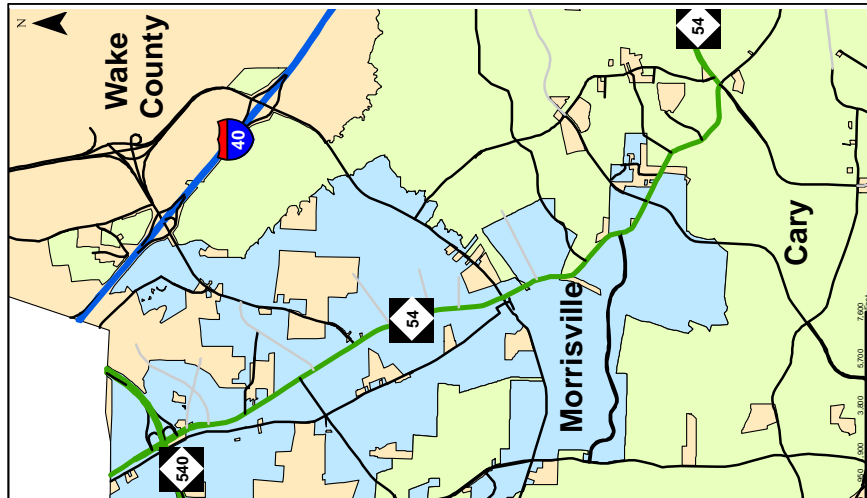
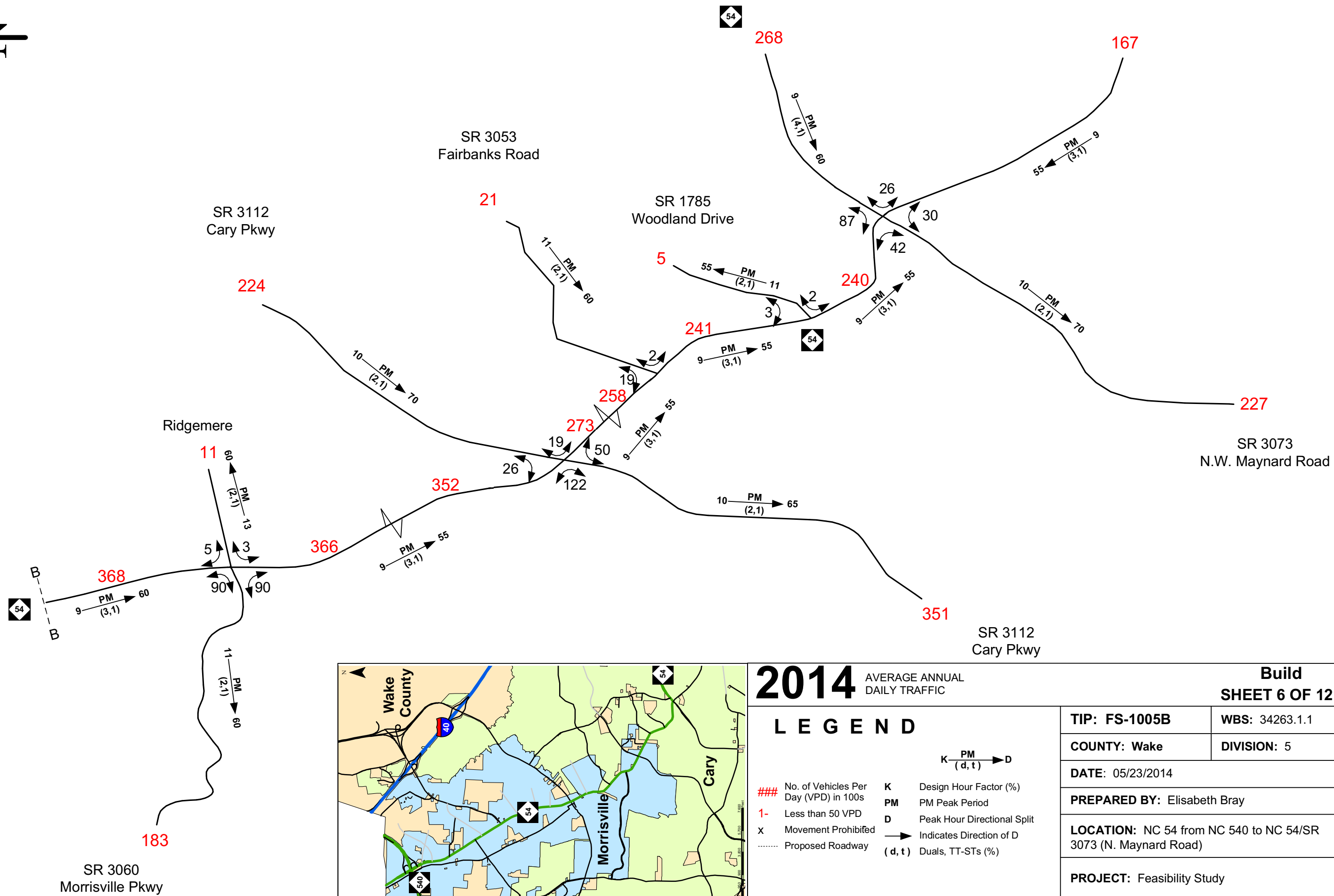
PREPARED BY: Elisabeth Bray

LOCATION: NC 54 from NC 540 to NC 54/SR 3073 (N. Maynard Road)

PROJECT: Feasibility Study

WBS: 34263.1.1

DIVISION: 5



2014

AVERAGE ANNUAL
DAILY TRAFFIC

###

No. of Vehicles Per
Day (VPD) in 100s

1-

Less than 50 VPD

x

Movement Prohibited

.....

Proposed Roadway

K

Design Hour Factor (%)

PM

PM Peak Period

D

Peak Hour Directional Split

→

Indicates Direction of D

(d, t)

Duals, TT-STs (%)

K

PM

(d, t)

→

D

Build

SHEET 6 OF 12

TIP: FS-1005B

WBS: 34263.1.1

COUNTY: Wake

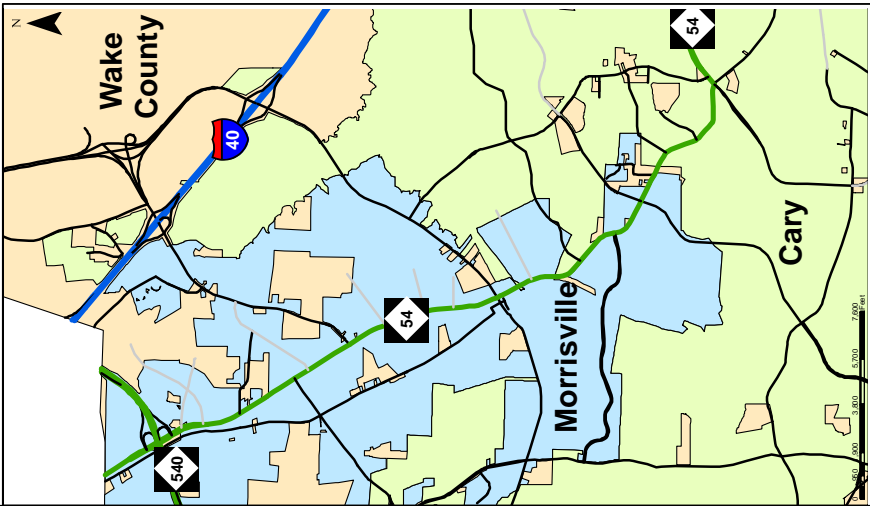
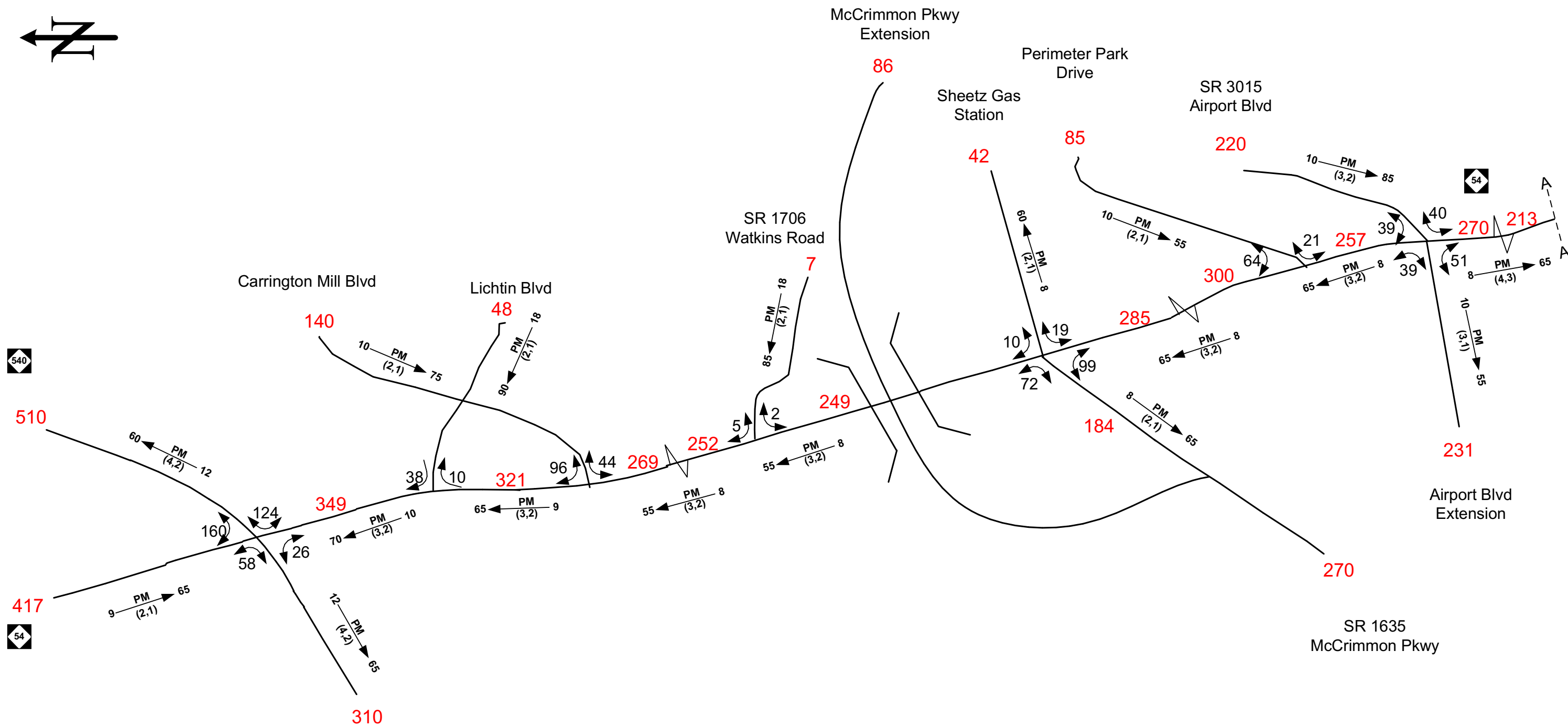
DIVISION: 5

DATE: 05/23/2014

PREPARED BY: Elisabeth Bray

LOCATION: NC 54 from NC 540 to NC 54/SR
3073 (N. Maynard Road)

PROJECT: Feasibility Study



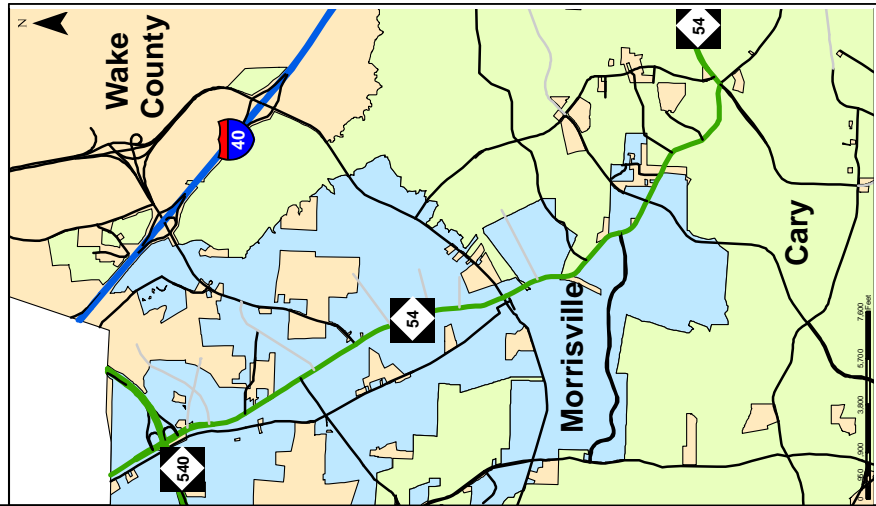
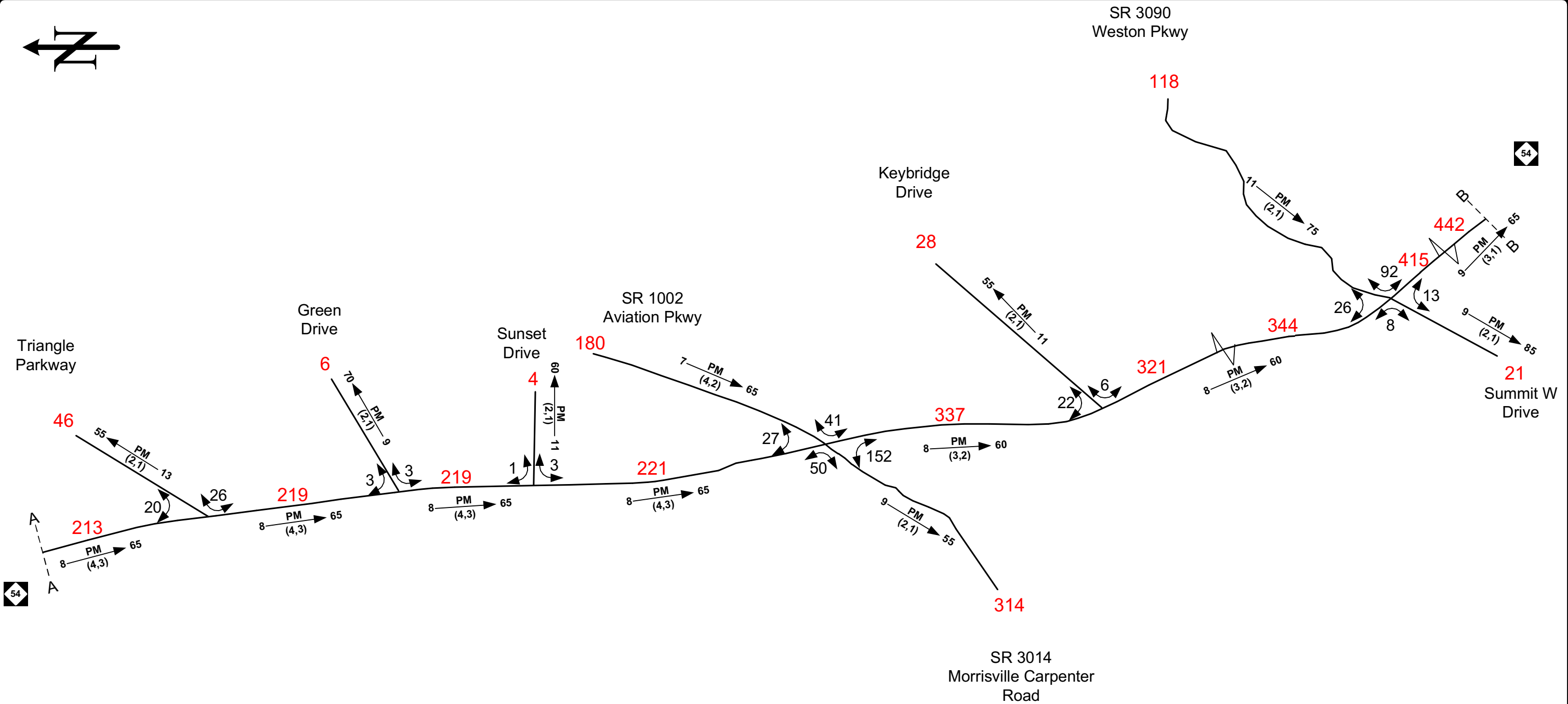
2040

AVERAGE ANNUAL DAILY TRAFFIC

LEGEND

###	No. of Vehicles Per Day (VPD) in 100s	K	Design Hour Factor (%)
1-	Less than 50 VPD	PM	PM Peak Period
X	Movement Prohibited	D	Peak Hour Directional Split
.....	Proposed Roadway	→	Indicates Direction of D
		(d, t)	Duals, TT-STs (%)

No Build	
SHEET 7 OF 12	
TIP: FS-1005B	WBS: 34263.1.1
COUNTY: Wake	DIVISION: 5
DATE: 05/23/2014	
PREPARED BY: Elisabeth Bray	
LOCATION: NC 54 from NC 540 to NC 54/SR 3073 (N. Maynard Road)	
PROJECT: Feasibility Study	



2040

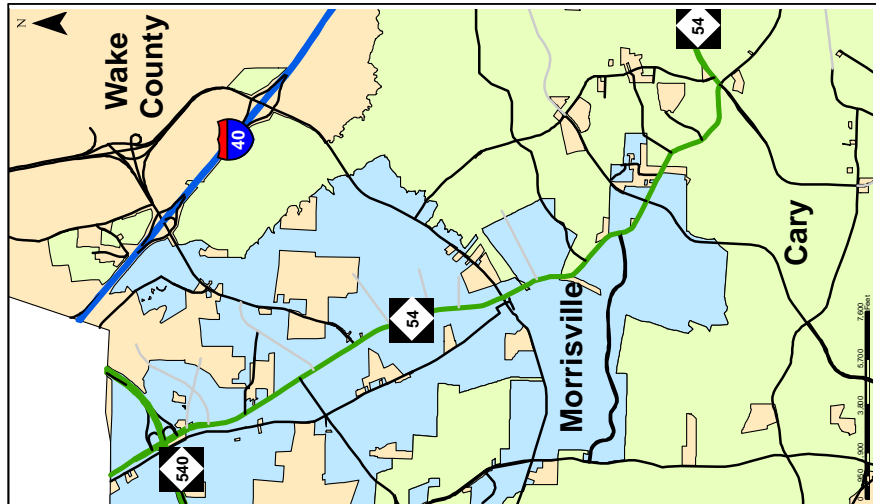
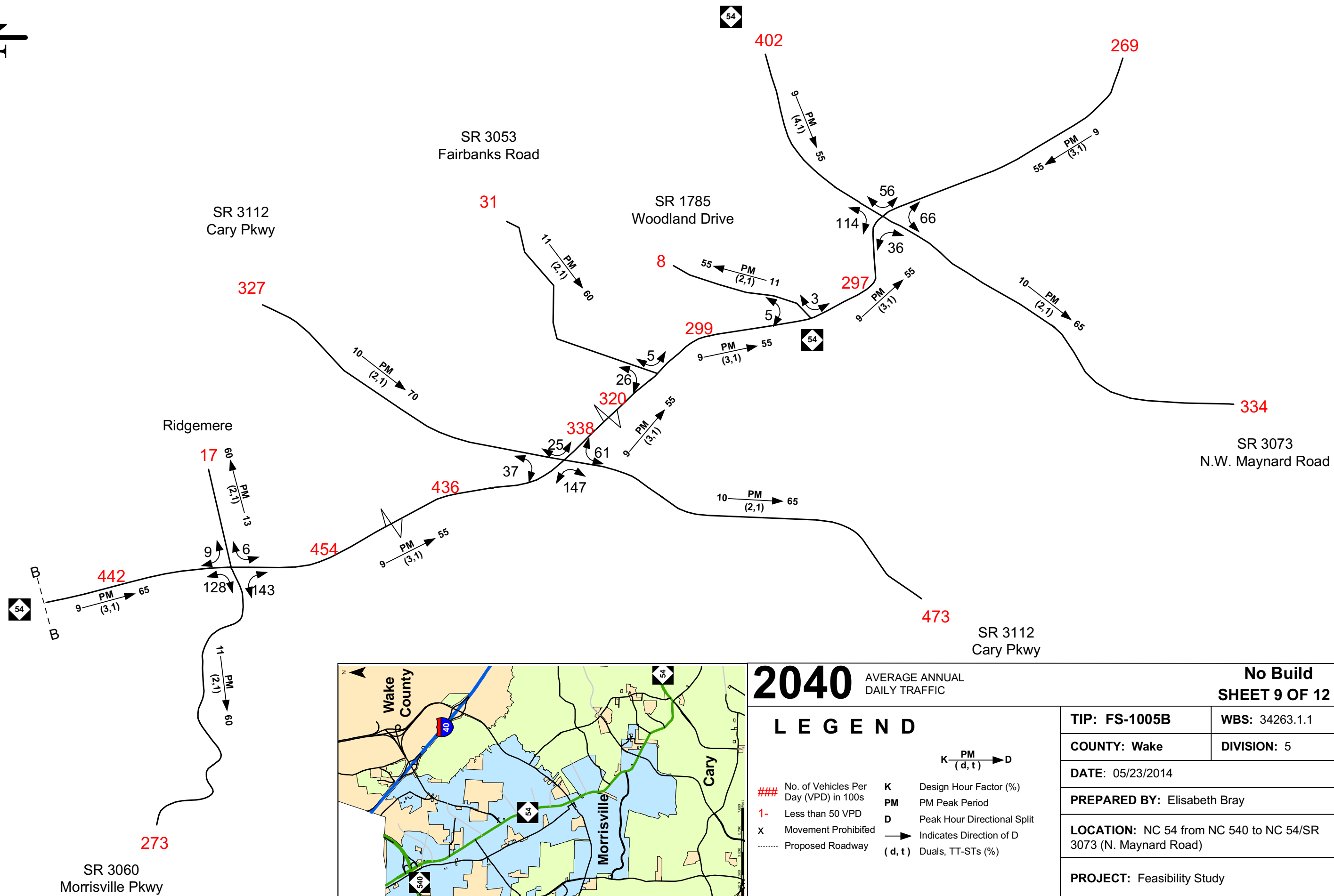
AVERAGE ANNUAL DAILY TRAFFIC

LEGEND

- ### No. of Vehicles Per Day (VPD) in 100s
- 1- Less than 50 VPD
- x Movement Prohibited
- Proposed Roadway
- K Design Hour Factor (%)
- PM PM Peak Period
- D Peak Hour Directional Split
- Indicates Direction of D
- (d, t) Duals, TT-STs (%)

No Build SHEET 8 OF 12

TIP: FS-1005B	WBS: 34263.1.1
COUNTY: Wake	DIVISION: 5
DATE: 05/23/2014	
PREPARED BY: Elisabeth Bray	
LOCATION: NC 54 from NC 540 to NC 54/SR 3073 (N. Maynard Road)	
PROJECT: Feasibility Study	



2040

AVERAGE ANNUAL DAILY TRAFFIC

###

No. of Vehicles Per Day (VPD) in 100s

1-

Less than 50 VPD

x

Movement Prohibited

.....

Proposed Roadway

K

Design Hour Factor (%)

PM

PM Peak Period

D

Peak Hour Directional Split

→

Indicates Direction of D

(d, t)

Duals, TT-STs (%)

No Build

SHEET 9 OF 12

TIP: FS-1005B

WBS: 34263.1.1

COUNTY: Wake

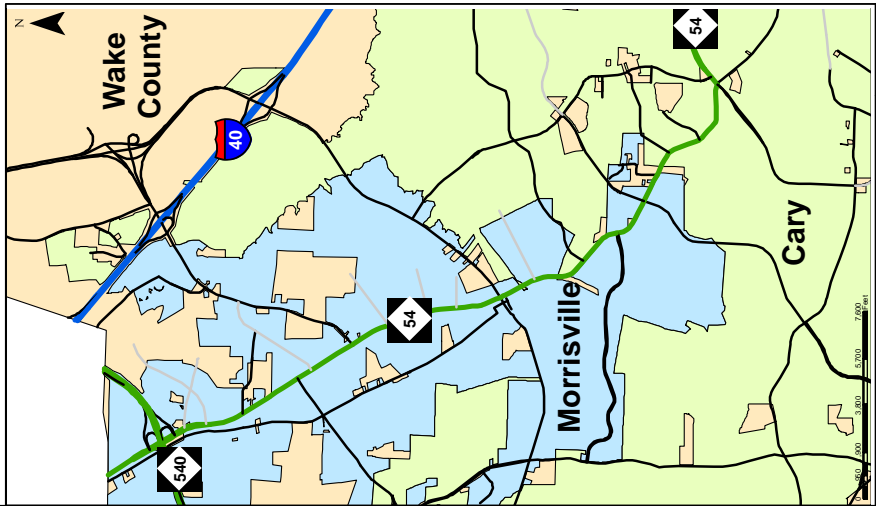
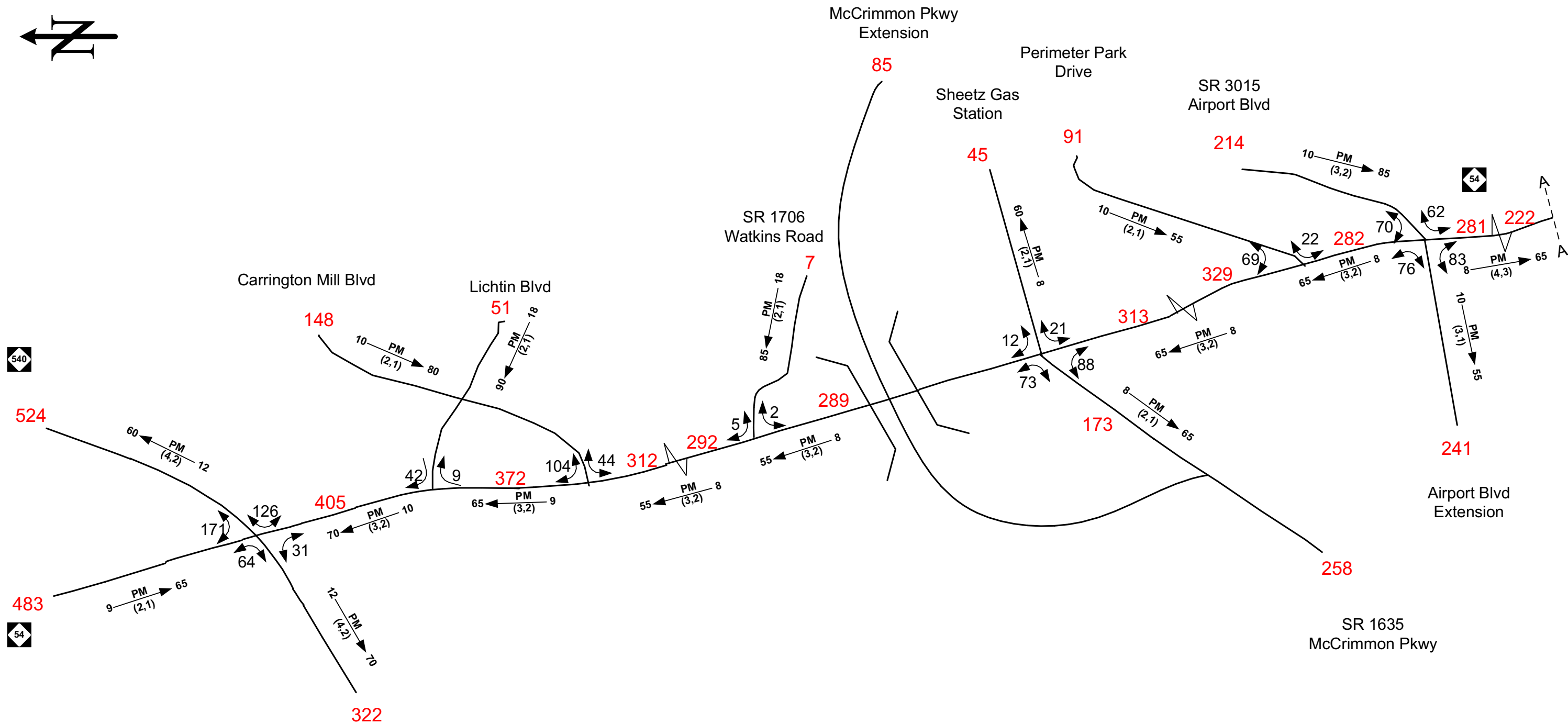
DIVISION: 5

DATE: 05/23/2014

PREPARED BY: Elisabeth Bray

LOCATION: NC 54 from NC 540 to NC 54/SR 3073 (N. Maynard Road)

PROJECT: Feasibility Study



2040

AVERAGE ANNUAL
DAILY TRAFFIC

LEGEND

No. of Vehicles Per Day (VPD) in 100s

1- Less than 50 VPD

x Movement Prohibited

..... Proposed Roadway

K Design Hour Factor (%)

PM PM Peak Period

D Peak Hour Directional Split

→ Indicates Direction of D

(d, t) Duals, TT-STs (%)

Build

SHEET 10 OF 12

TIP: FS-1005B

COUNTY: Wake

DATE: 05/23/2014

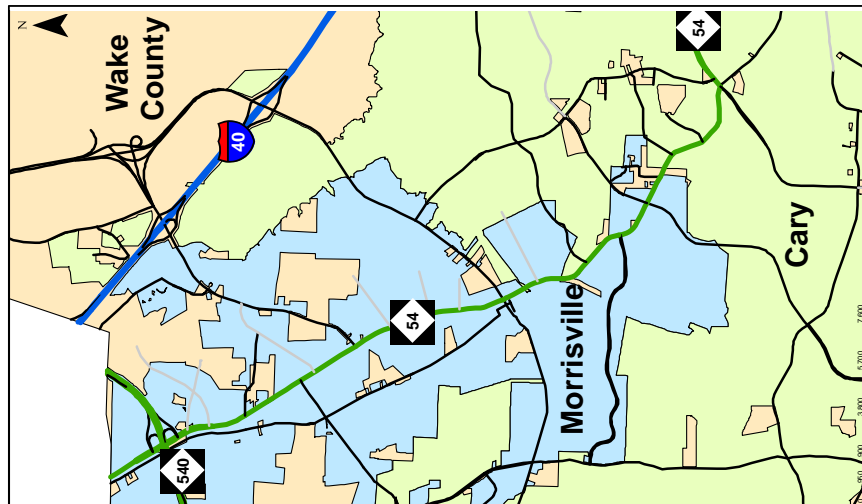
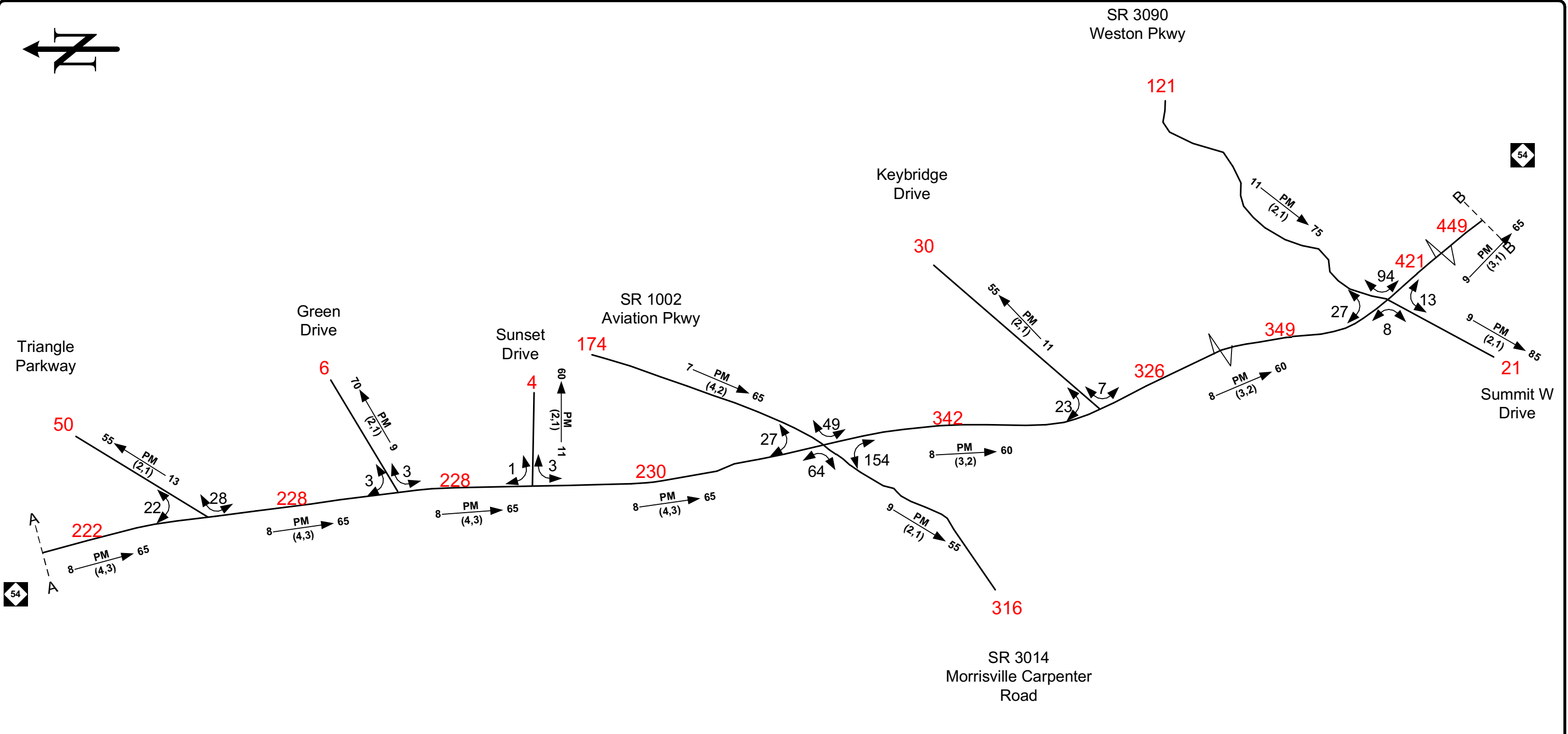
PREPARED BY: Elisabeth Bray

LOCATION: NC 54 from NC 540 to NC 54/SR 3073 (N. Maynard Road)

PROJECT: Feasibility Study

WBS: 34263.1.1

DIVISION: 5



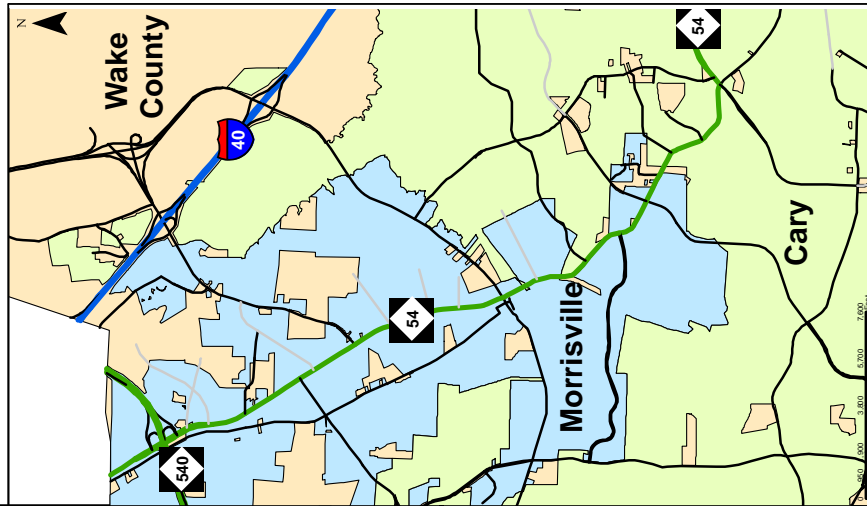
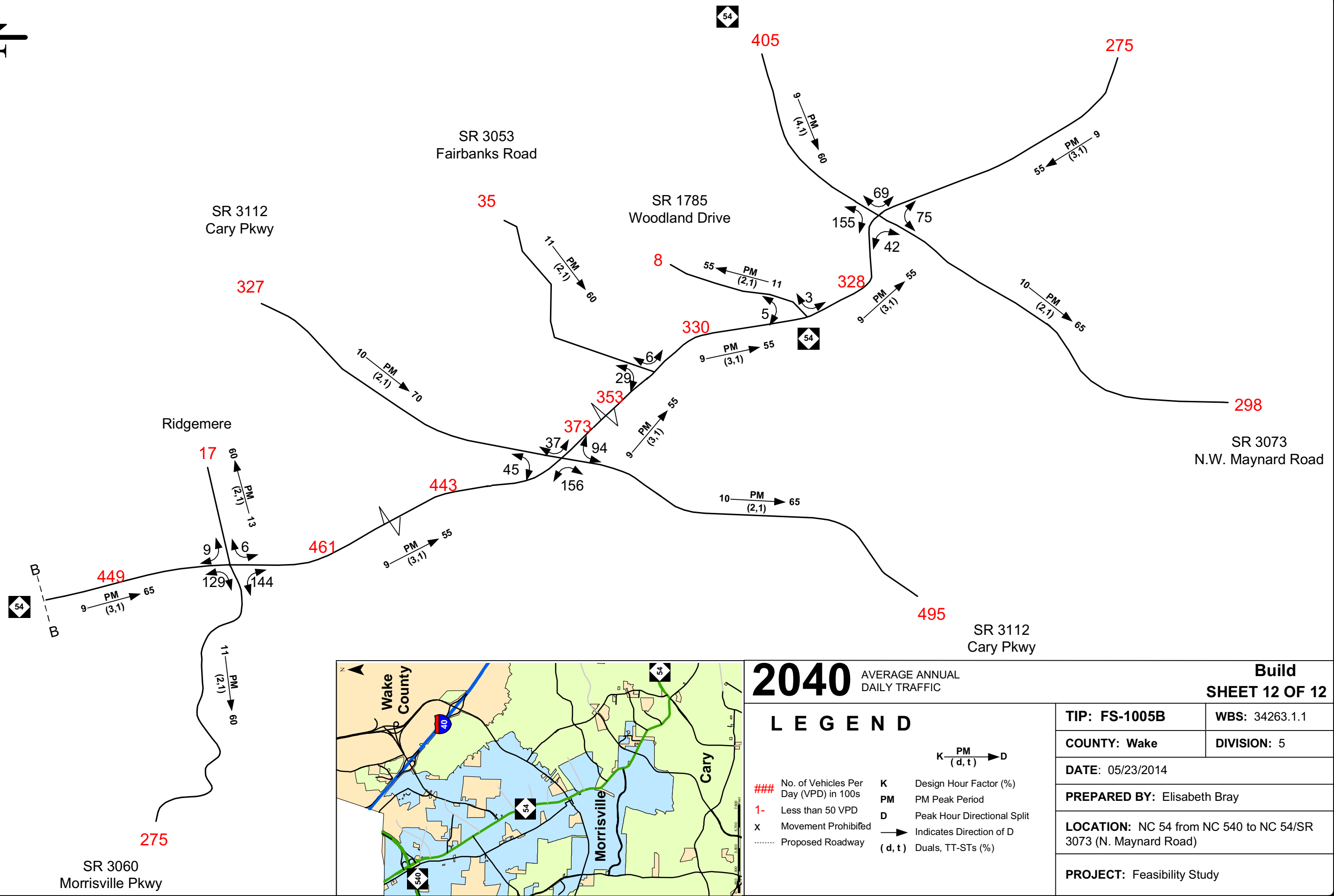
2040

AVERAGE ANNUAL DAILY TRAFFIC

LEGEND

###	No. of Vehicles Per Day (VPD) in 100s	K	Design Hour Factor (%)
1-	Less than 50 VPD	PM	PM Peak Period
X	Movement Prohibited	D	Peak Hour Directional Split
.....	Proposed Roadway	→	Indicates Direction of D
		(d, t)	Duals, TT-STs (%)

Build SHEET 11 OF 12	
TIP: FS-1005B	WBS: 34263.1.1
COUNTY: Wake	DIVISION: 5
DATE: 05/23/2014	
PREPARED BY: Elisabeth Bray	
LOCATION: NC 54 from NC 540 to NC 54/SR 3073 (N. Maynard Road)	
PROJECT: Feasibility Study	



2040 AVERAGE ANNUAL
DAILY TRAFFIC

LEGEND

- | | | | |
|-------|---------------------------------------|----------|-----------------------------|
| ### | No. of Vehicles Per Day (VPD) in 100s | K | Design Hour Factor (%) |
| 1- | Less than 50 VPD | PM | PM Peak Period |
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| ----- | Proposed Roadway | → | Indicates Direction of D |
| | | (d, t) | Duals, TT-STs (%) |

$$K \xrightarrow[(d, t)]{PM} D$$

Build
SHEET 12 OF 12

TIP: FS-1005B	WBS: 34263.1.1
COUNTY: Wake	DIVISION: 5
DATE: 05/23/2014	
PREPARED BY: Elisabeth Bray	
LOCATION: NC 54 from NC 540 to NC 54/SR 3073 (N. Maynard Road)	
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