



FEASIBILITY STUDY

FS-1005A

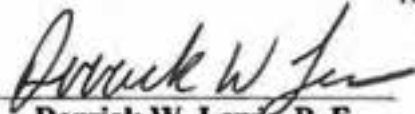
I-40 UPGRADES, MANAGED LANES

FROM WEST OF SR 1728 (WADE AVE) NEAR CARY
TO THE I-440/US 64 INTERCHANGE (EXIT 301) IN RALEIGH,
AND I-440/US 64 TO THE US 64-264 (KNIGHTDALE BYPASS) INTERCHANGE

RALEIGH, WAKE COUNTY
DIVISION 5



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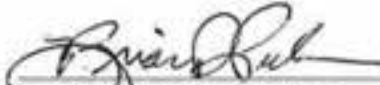

10/8/15
Date

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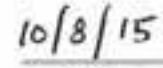



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1. GENERAL DESCRIPTION

This feasibility study addresses upgrading 17 miles of I-40 with managed lanes and interchange improvements from west of SR 1728 (Wade Avenue) near Cary to the I-440/US 64 interchange (Exit 301) in Raleigh and I-440/US 64 to the US 64-264 (Knightdale Bypass) interchange in Raleigh, Wake County. The study corridor is within the planning area of the Capital Area Metropolitan Planning Organization (CAMPO) [1]. The study includes approximately 13.5 miles of I-40 and 3.5 miles of I-440. Please refer to **Figure 1 Project Location Map** at the back of the report.

Note that a Feasibility Study is a preliminary document that is the initial step in the planning and design process for a candidate project and not the product of exhaustive environmental or design investigations. The purpose of the study is to describe the proposed project including cost, and identify potential problems that may require consideration in the planning and design phases.

Once a candidate project is identified for funding in the STIP, the Feasibility Study is followed by a rigorous planning and design process that meets the requirements of the National Environmental Policy Act (NEPA), where either an Environmental Impact Statement (EIS) or an Environmental Assessment (EA) is done.

I-40 is a vital NC corridor of statewide importance that moves high volumes of long-distance and commuter traffic. It is a Strategic Transportation Corridor (STC) in the North Carolina Transportation Network (NCTN) [2]. I-440 is also an important regional STC; a beltway for the capital city of Raleigh and neighboring town of Cary. The planning level purpose and need is to upgrade the corridor, add managed lanes and interchange improvements for the I-40 and I-440 segments described above in order to reduce congestion and provide more reliable travel times.

The **Proposed Typical Section** is an eight- to twelve-lane concrete barrier divided interstate highway with 12-foot travel lanes, 4-foot painted managed lane buffers, 12-foot full-depth inside and outside paved shoulders, and full control-of-access within a minimum state-maintained right-of-way of 300 feet. The existing right-of-way varies along I-40 and is approximately 400 feet wide; and approximately 325 feet along I-440. The posted speed limit is 65 mph along I-40 and 60 mph along I-440.



The example graphic above includes three General Purpose (GP) lanes and two Managed Lanes (ML) in each direction of travel; and would be described as a “+2 ML” section. As seen on **Figure 2 Typical Sections** at the back of the report, the Study Alternatives include +1 and +2 managed lane options.

There are six total existing GP lanes from Wade Ave. to east of Lake Wheeler Rd., and eight existing GP lanes from Lake Wheeler Rd. eastward to the end of the study corridor on I-440. Alternatives 1 and 2 add +1 and +2 ML, respectively, to the existing number of GP lanes; whereas Alternatives 3 and 4 widen the existing interstate to eight GP lanes and add +1 and +2 ML, respectively. **Section 4. Description of Alternatives** on **page 10** provides details on the alternative concepts and section costs.

The study considers concurrent-flow managed lanes that are separated by 4-foot painted buffers and have exclusive access to and from the interstate. Access in and out of the managed lanes is provided less frequently than the general purpose lanes. A concept for the managed lanes access was developed by the study team and a schematic diagram has been provided to illustrate it on **Figure 3 Managed Lane Access Schematic**. Access to and from the managed lanes will be provided by direct flyover connections, signalized drop/“Tee” ramps, and ingress/egress points at specified locations on the mainline.

EXECUTIVE SUMMARY

Based on the design concepts presented within this report, the total project costs are anticipated to range from **\$594,200,000.00** to **\$858,700,000.00**. **Table 1.1** below represents the total project costs per alternative with Drop Ramp Access at Trenton Road and Trinity Road (Section A Option 1):

TABLE 1.1 – TOTAL COSTS AND IMPACTS (W TRENTON/TRINITY ACCESS)									
ALTERNATIVE		SEC. A OPTION	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
					RES.	BUS.			
1	+1ML	A1	\$533.4 M	\$56.1 M	0	5	\$1.7 M	\$3.0 M	\$594.2 M
2	+2ML	A1	\$669.7 M	\$59.0 M	0	5	\$1.7 M	\$3.0 M	\$733.4 M
3	+1GP+1ML	A1	\$625.1 M	\$58.1 M	0	5	\$1.7 M	\$3.0 M	\$687.9 M
4	+1GP+2ML	A1	\$759.3 M	\$59.8 M	0	5	\$1.7 M	\$3.0 M	\$823.8 M

Table 1.2 below represents the total project costs per alternative with Direct Access at Wade Avenue (Section A Option 2). Section A Option 2 is estimated to cost an additional **\$32.9** to **\$34.9 M**:

TABLE 1.2 – TOTAL COSTS AND IMPACTS (W WADE DIRECT ACCESS)									
ALTERNATIVE		SEC. A OPTION	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
					RES.	BUS.			
1	+1ML	A2	\$568.3 M	\$56.1 M	0	5	\$1.7 M	\$3.0 M	\$629.1 M
2	+2ML	A2	\$704.6 M	\$57.0 M	0	5	\$1.7 M	\$3.0 M	\$766.3 M
3	+1GP+1ML	A2	\$660.0 M	\$56.1 M	0	5	\$1.7 M	\$3.0 M	\$720.8 M
4	+1GP+2ML	A2	\$794.2 M	\$59.8 M	0	5	\$1.7 M	\$3.0 M	\$858.7 M

Based on current data, estimated costs and preliminary analyses it is recommended that all the alternatives be given further consideration in the subsequent planning, design and procurement phases of the project. More information can be found in the **Section 5. Project Costs and Programming Recommendations** on **page 27**. Specific information on the I-40/440/US 1/64 Interchange (Exit 293) in Sections D and E of the Study Alternatives can be found on **page 7** and **pages 15-18**.

2. BACKGROUND

The NCDOT strives to provide “high-speed, safe, reliable highways throughout North Carolina” [2], especially on Strategic Transportation Corridors such as I-40 and I-440. Improvements considered in this study are generated by the need to relieve congestion and create more efficient, reliable travel along the interstate corridor. Managed lanes, when used in addition to general purpose lanes, provide congestion relief and promote efficient, reliable travel times. More and more state transportation departments are implementing managed lanes as a method for achieving these goals in congested metropolitan areas [3]. Design guidance for managed lanes is based on AASHTO’s Guide for HOV Facilities, FHWA Managed Lanes and HOV Facilities, and on guidance from experienced state transportation departments such as CalTrans, TxDOT and WSDOT.

ADJACENT AND COINCIDENT PROJECTS

There are numerous projects and studies in the State Transportation Improvement Program (STIP) that are on or adjacent to the FS-1005A I-40 study corridor [3]:

- **Former STIP project I-4744:** Design Build, Widened I-40 from 4 to 6 lanes from west of SR 1728 (Wade Ave) to east of SR 1319 (Jones Franklin Rd). The bridges carrying I-40 over Wade Ave and US 1/64 were widened to accommodate future eight lanes. *Project Completed in 2011.*
- **STIP project I-5311/I-5338:** Design Build, I-40/I-440 “Fortify” Rebuild Project, pavement structure reconstruction of I-40 from west of SR 1319 (Jones Franklin Rd) to I-440 north of US 64-264 (Knightdale Bypass). It is expected that the mainline typical section will be six GP lanes with concrete barrier median plus auxiliary lanes. *Under Construction; anticipated completion 2016.*
- **STIP project U-2719:** I-440/US 1 Widen to Six Lanes from Walnut Street in Cary to Wade Avenue in Raleigh, Wake County. *Planning / Design In Progress. Draft STIP: Design-Build project.*
- **STIP project I-5111:** I-40 Widening, from I-440 in Southeast Raleigh to NC 42 in Clayton, Wake and Johnston Counties. *Planning / Design In Progress. R/W FY 2016, Construction FY 2018.*
- **STIP study FS-1205A:** Construct Managed Lanes, from NC 86 in Orange County to SR 1728 (Wade Avenue) in Wake County. *Study in Progress.*
- **STIP project C-5504:** Construct Pedestrian Improvements on Buck Jones Road, Avent Ferry Road and Rock Quarry Road overpasses of I-40. *Construction 2015.*
- **Future STIP project I-5701:** Add Lanes on I-40/US 64, from I-440/US 1/US 64 to SR 1370 (Lake Wheeler Road) in Wake County. *Programmed for Planning & Environmental only.* (Correlates to Section F of the **FS-1005A Study Alternatives.**)
- **Future STIP project I-5702:** Construct Managed Lanes on I-40, US 15/501 in Durham County to I-440/US 64 in Wake County. *Programmed for Planning & Environmental only.* (Partially represented by Sections A through C of the **FS-1005A Study Alternatives.**)

- **Future STIP project I-5703:** Reconstruct Interchange of I-40/I-440/US 1/US 64 in Wake County. *Programmed for Planning & Environmental only.* (Correlate to Sections D and E of the **FS-1005A Study Alternatives.**)
- **Future STIP project I-5704:** Add Lanes & Rehab. Pavmt. on I-40, from west of SR 1728 (Wade Ave.) to east of I-440/US 1/US 64, Wake County. *Programmed for Planning & Environmental only.* (Correlate to Sections A through C of the **FS-1005A Study Alternatives.**)
- **Future STIP project I-5873:** I-40/NC54 Interchange Improvements, Wake County. (Correlates to Section B of the **FS-1005A Study Alternatives.**)

Table 2.1 below presents the correlated sections of FS-1005A with coincident STIP projects:

TABLE 2.1 – STIP CORRELATION							
STIP Project:	I-4744	I-5311/I-5338	I-5701	I-5702	I-5703	I-5704	I-5873
FS-1005A Section:	A thru D	D thru K	F	A thru C	D and E	A thru C	B

Interim I-440/US 1/US 64 (Exit 293) interchange improvements are being considered as part of the current planning for **STIP project U-2719**. Additional coordination is needed to consider how U-2719 and long-term ML and GP interchange improvements, impacts and costs correlate.

Upon completion of the **STIP I-5311/I-5338** “Fortify” project, the existing configuration and features should be incorporated into the subsequent planning and design stages of the project.

3. SAFETY, TRAFFIC AND NOISE

Based on the crash data and analysis provided by the Traffic Safety Unit, the I-40 2011 AADT was estimated at 112,500 vpd and equates to a total vehicle exposure rate of 1356.17 million vehicle miles traveled (MVMT). A total of 1,539 crashes were reported along this section of I-40 from September 1, 2008 to August 31, 2011; resulting in a crash rate of 113.48 crashes per 100 MVMT. The crash rates for the analyzed section were compared with the 2008-2010 and 2009-2011 statewide crash rates for Urban Interstate Routes with 4 or more lanes. The Total Crash Rate is about the same as the statewide crash rates; the subcategory rates are less than the statewide rates with the exception of Night Crashes.

RATE	CRASHES	CRASHES PER 100 MILLION VEHICLE MILES (MVM)	2009-2011 STATEWIDE RATE *
Total	1539	<i>113.48</i>	116.04
Fatal	5	<i>0.37</i>	0.43
Non-Fatal	336	<i>24.78</i>	30.06
Night	415	<i>30.60</i>	29.94
Wet	282	<i>20.79</i>	28.97
Property Damage Only	1198	<i>N/A</i>	<i>N/A</i>
Severity Index		<i>3.13</i>	3.50

* Statewide Accident Rates for Urban Interstate Routes with 4 or more lanes.

According to the Work Zone Safety and Mobility Policy this will be a “significant” (Level 1 Activity) project; with anticipated “adverse impacts to the traveling public... and have a high level of public interest.” [4] Analysis in the subsequent stages of the project is needed to ensure that work zone impacts are identified and traffic management strategies are initiated. The need for bicycle and pedestrian accommodations in the work zone shall be assessed during the subsequent planning stages of the project.

TRAFFIC ANALYSIS

All traffic analyses for this feasibility study were completed in a manner consistent with NCDOT Congestion Management Guidelines and the Highway Capacity Manual. Synchro and HCS software tools were used to analyze traffic components. The selection and use of traffic control devices should be based on an engineering study of traffic conditions and physical characteristics of the location and will be required in the subsequent stages of the project. These analyses are preliminary and should be examined in greater detail in the subsequent stages of the project.

Base year 2013 and future year 2040 traffic forecasts for the annual average daily traffic (AADT) were provided by the NCDOT Transportation Planning Branch (August 11, 2014 “FS-1205A” Comprehensive Forecast by Kimley-Horn) and are based on observed data as well as output from the Triangle Regional Model (TRMV5-2013). Applicable traffic forecast diagrams can be found on **Figures A.1 thru A.18** in **Appendix A**. Other prior traffic forecasts provided by the Department were also considered in the concept development (FS-1005AB dated 03/28/2014, FS-1205A I-5111 Section dated 12/11/2013, U-2719 Final dated 01/10/2013, and FS-1005A dated 11/15/2011).

The predicted AADT ranges from 141,900 to 153,700 vehicles per day (vpd) on I-440 and from 163,200 to 218,100 vpd on I-40 among the various 2040 Build Scenarios. Trucks are estimated to comprise up to 10% (4% Duals and 6% TTST's) of the total traffic. The highest volumes along the corridor occur west of Wade Ave (Exit 289), and between I-440/US 1/US 64 (Exit 293) and US 70/401 S. Saunders Street (Exit 298).

The following forecast scenarios were analyzed:

- 2013 Forecast Scenario 1 (Existing Conditions)
- 2040 Forecast Sc. 2B (+1 GP (from Wade Ave to Lake Wh Rd)) = [Appendix B General Purpose Alt]
- 2040 Forecast Scenario 3B (+1 Managed Lane) = [Study Alternative 1]
- 2040 Forecast Scenario 4B (+2 Managed Lanes) = [Study Alternative 2]
- 2040 Forecast Sc. 5B (+1 GP (from Wade Ave to Lake Wh Rd) and +1 ML) = [Study Alternative 3]
- 2040 Forecast Sc. 6B (+1 GP (from Wade Ave to Lake Wh Rd) and +2 ML) = [Study Alternative 4]

Note that the "+1 GP" options add 1 General Purpose lane per direction; widening the existing 6-lane to an 8-lane section. The "+1" and "+2" Managed Lanes options add the specified number of lanes per direction. The "B" forecast scenarios include the future southeast extension of NC 540.

The results of the preliminary analyses are presented in **Tables A.1 thru A.4** in **Appendix A**. Of particular note is the fact that mainline operations between all future year scenarios are fairly similar despite the differences in capacity. This appears to be a symptom of the forecast volumes which show that the latent demand for the facility is high enough that regardless of capacity, the volumes will increase accordingly to utilize any excess available capacity. As such, while speeds might increase in certain segments, overall LOS is unchanged for most locations when comparing alternatives. This static/deterministic analysis may not show the whole picture; there may be some improvement along side streets, and from a regional perspective more vehicles will be processed along the interstate corridor with the addition of managed lanes.

MANAGED LANES

For all managed lane scenarios, the operations of the managed lanes are expected to be acceptable (**LOS D or better**) with most of the segments operating at **LOS A (Table A.1- Managed Lanes)**. Adding 2 Managed Lanes per direction would provide a higher LOS than adding 1 ML per direction. A final determination of the number of managed lanes will be made during later planning, design and procurement phases.

I-40 MAINLINE

Consistently, along I-40, diverge, merge and weaving segments operate at unacceptable operations (**LOS E or worse**) during the AM and PM peak hours in 2040, with a few exceptions (**Tables A.2 and A.3 - Freeways**). Basic freeway segments along this section of I-40 are few but generally experience unacceptable operations during the peak hours. For all weaving segments, the basic freeway methodology was also performed to determine whether the weaving maneuvers were the cause for

reduced operations at the location or whether the volumes simply exceeded the capacity. While a stark directional split was not noticed in the operations, generally the westbound direction in the AM, and the eastbound direction in the PM, experience worse operations. This is consistent with existing travel patterns of Research Triangle Park access in the morning and work-based trips back home in the evening.

I-40/I-440/US 1/US 64 INTERCHANGE [EXIT 293]

In addition to the failing operations on the mainline, the existing cloverleaf interchange at I-40/I-440/US 1/US 64 is expected to continue exhibiting failing conditions. Among the various forecast scenarios, the I-40 GP turning movements to and from the south (US 1/64) range from 2,255 to 2,734 vph in the peak hour (41,000 to 49,700 ADT); with more vehicles turning to and from the south than remaining through on US 1/I-440. The volumes indicate that at least two-lane ramps or flyovers are needed for these movements. The GP turning movements to and from the north (I-440) are significantly lower, ranging from 220 to 644 vph (4,000 to 11,700 ADT), and could be accommodated by loop-ramps if needed. A single-lane ramp's capacity is about 2,100 pc/h at a 40-50 mph free-flow speed (HCM2010, Ch.13, p. 13-18) and a 30 mph loop-ramp's capacity is about 1,000 vph (AASHTO ch.10, p. 10-48). In addition, when cloverleaf loop-ramp weaving sections approach or exceed 1,000 vph, such as all four weaving sections in the existing cloverleaf, they cause significant deterioration in the operations (AASHTO ch.10, p. 10-48).

The proposed concept is a combination of a 4-level stack and box-diamond interchange that accommodates both GP and ML directional ramps. It will improve operations by providing high-speed directional ramps and eliminating the cloverleaf weaving sections. Whereas the cloverleaf provides low-speed loop-ramps, the "4-level stack" and "box" configurations provide high-speed directional ramps and significant operational benefits. See **Figure 7**.

RAMP TERMINAL INTERSECTIONS

All existing ramp terminal intersections within the study area were evaluated and about half are expected to operate acceptably into the future year (**Table A.4 – Ramp Intersections, Appendix A**). Those which are not (the NC 54 ramp intersections, the Cary Towne Boulevard westbound Ramp intersection, the S. Saunders Street eastbound ramp intersection, and the Rock Quarry Road eastbound Ramp intersection) tend to operate worse in the GP widening alternatives than in the Managed Lanes alternatives. This indicates the aforementioned latent demand condition where the additional GP lane attracts additional volume to the I-40 mainline and therefore degrades the ramps and ramp terminal intersections. For the alternatives containing managed lanes, some of this traffic gets shifted to the additional intersections or access points away from the GP ramp intersections. It is worth noting that the Poole Road ramp intersections are anticipated to operate equally poorly under all mainline GP and Managed scenarios without interchange improvements.

The results of the ramp terminal intersection analyses are presented in **Table A.4** in **Appendix A**. Improvements to achieve acceptable operations in 2040, where needed, are described below:

NC 54 Chapel Hill Road Interchange [Exit 290]

Based on the projected traffic volumes for the NC 54 Chapel Hill Road (Exit 290) interchange, with existing intersection configurations, the signalized westbound/northbound ramp terminal will fall to unacceptable operations (**LOS D/E**) in the 2040 AM peak hour and the signalized eastbound/southbound ramp terminal will operate at unacceptable levels (**LOS F**) in the 2040 PM peak hour.

Dual left-turns are recommended at the signalized westbound off-ramp intersection and are anticipated to achieve an **LOS C** in the design year. A channelized right-turn movement from NC 54 onto Ramp D / eastbound I-40 is recommended to achieve an acceptable **LOS B** at the signalized eastbound ramps intersection. See **Figure 6**.

Cary Towne Boulevard Interchange [Exit 291]

It is anticipated that the stop-controlled westbound/northbound ramp terminal at the Cary Towne Blvd. (Exit 291) interchange will operate at **LOS F** in the design year. If a traffic signal device is determined to be warranted, it is anticipated to achieve a **LOS B** in 2040. See **Figure 6**. The eastbound/southbound ramp intersection is anticipated to operate at **LOS B** under the existing stop-controlled configuration.

Gorman Street Interchange [Exit 295]

The Gorman Street (Exit 295) interchange ramp terminals are anticipated to operate at **LOS C/D** in the design year. No interchange improvements are included in the proposed concept and estimated costs. See **Figure 8**.

Lake Wheeler Road Interchange [Exit 297]

The Lake Wheeler Road (Exit 297) interchange ramp terminals are anticipated to operate at **LOS C or better** in the design year. See **Figure 9**.

US 70/US 401/NC 50/S. Saunders Street Interchange [Exit 298]

The S. Saunders Street (Exit 298) interchange eastbound ramp intersection is anticipated to operate at **LOS E/F** and the westbound ramp intersection at **LOS C/D/E** in the design year. The ongoing I-40/I-440 “Fortify” Rebuild Project does not alter the existing ramp or intersection configurations. Further investigations are needed at this location in subsequent planning stages, as there are constraints on any significant interchange improvements; which is likely what is needed to achieve acceptable LOS in the future. A DDI is one possible solution, and is estimated to achieve an **LOS D** at the eastbound ramps intersection and a **C** at the westbound ramps intersection. See **Figure 10**.

Hammond Road Interchange [Exit 299]

The Hammond Road (Exit 299) interchange ramp terminals are anticipated to operate at **LOS D or better** in the design year. However, some individual movements are anticipated to operate at unacceptable levels. Adding a dual right-turn to the eastbound off-ramp and a dual left-turn onto the westbound on-ramp achieves acceptable individual movements and overall intersection **LOS C** in the 2040 peak hours. See **Figure 10**.

Rock Quarry Road Interchange [Exit 300]

The Rock Quarry Road (Exit 300) interchange ramp terminals are anticipated to operate at **LOS D or better** in the design year. However, the eastbound ramp intersection in the PM peak hour is anticipated to operate at **LOS E/F** under existing timing and phasing conditions. Implementation of signal timing and phasing improvements are expected to achieve **LOS D or better** in the design year. See **Figure 10**.

One additional consideration is to construct the eastbound on-ramp in the southeast quadrant, achieving a **LOS B** and **A** at the signalized ramp intersection in the 2040 AM and PM peak hours, respectively. However, introducing this ramp reduces the weaving length to the I-40/440 split from approximately 4,500' to 3,000'. The weave is anticipated to operate at a **LOS F** under both scenarios.

Poole Road Interchange [I-440 Exit 15]

The Poole Road (I-440 Exit 15) interchange ramp terminals are anticipated to operate at **LOS F** in design year 2040. Further investigations are needed at this location in subsequent planning stages, as there are constraints on any significant interchange improvements – including a park in the northeast quadrant – which is likely what is needed to achieve acceptable LOS in the future. A DDI is one possible solution, and is estimated to achieve **LOS C** at both ramp intersections in 2040. See **Figure 12**.

NOISE ABATEMENT

Potential Noise Abatement has been included in the study based on prior NCDOT Design Noise Reports, Traffic Noise Analyses, and the current NCDOT Traffic Noise Abatement Policy (Policy). There are 23 noise study areas for which noise abatement measures have preliminarily been identified as potentially meeting Policy feasibility and reasonableness criteria, pending project final design and completion of the public involvement process.

The I-5111 Traffic Noise Analysis identified three noise study areas within the study limits of the managed lanes along I-40 south of the I-40 / I-440 interchange (Exit 301) for which traffic noise abatement preliminarily met Policy feasibility and reasonableness criteria.

Roadway widening in the vicinity of the two noise abatement measures constructed as part of the I-4744 project (2011) will require that those two noise abatement measures be replaced. Because additional residences have been permitted and constructed adjacent to the eastbound lanes of I-40 since the date of public knowledge for the I-4744 project, extension of the northern terminus of the noise abatement near Brandywine Drive (approx. -L- Sta. 199+00 to 211+50 RT) may meet NCDOT Policy feasibility and reasonableness criteria.

Expansion or replacement of the two existing traffic noise abatement measures adjacent to the eastbound and westbound lanes, respectively, of I-40 in the vicinity of Hadley Road and State Street may meet Policy feasibility and reasonableness criteria.

Traffic noise abatement measures will potentially meet Policy feasibility and reasonableness criteria for an additional 16 noise study areas in the vicinity of the project. Addition of managed lanes will constitute a “Type I” project; therefore, provision of traffic noise abatement for any of the 23 noise

study areas that meet Policy feasibility and reasonableness criteria would be subject to project final design and completion of the public involvement process.

Preliminary/Functional Design cost estimates for noise abatement in the 23 study areas have been included in the study alternatives described below.

4. DESCRIPTION OF ALTERNATIVES

As stated previously, this study considers adding concurrent-flow managed lanes (separated from the general purpose lanes by painted 4' buffers) with exclusive access to and from the interstate corridor. (See also **Figure 2 Typical Sections** and **Figure 3 Potential Managed Lane Access**.) Access to and from the managed lanes will be provided by direct connections (free-flowing flyovers or signalized drop/"Tee" ramps) and by free-flowing ingress/egress segments at specified locations. Functional Design Concepts and Cost Estimates have been developed for each of the following managed lanes study alternatives:

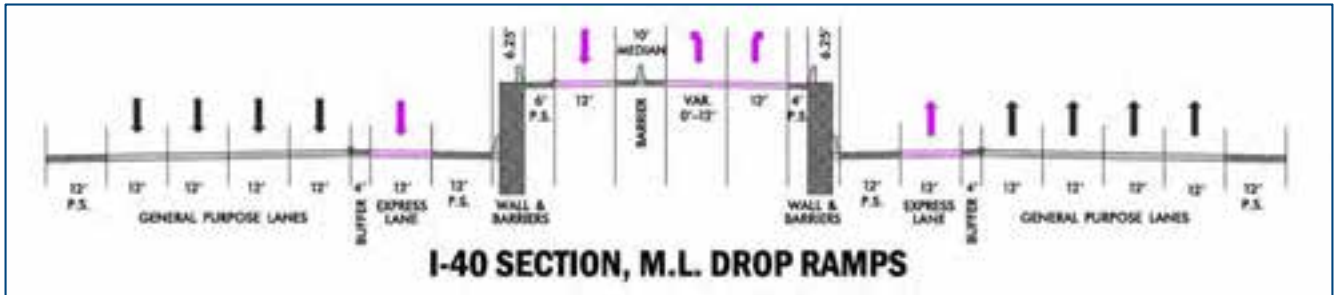
- ◆ **Study Alternative 1 (+1 Managed Lane)**
- ◆ **Study Alternative 2 (+2 Managed Lanes)**
- ◆ **Study Alternative 3 (+1 GP (from west of Wade Ave. to east of Lake Wheeler Rd.) and +1 ML)**
- ◆ **Study Alternative 4 (+1 GP (from west of Wade Ave. to east of Lake Wheeler Rd.) and +2 ML)**

One set of maps showing **Study Alternative 2 (+2ML)** improvements is included in the back of this report on **Figures 4 thru 12**. The + 2ML alternative is representative of the improvements needed for constructing each of the managed lanes options. The study corridor has been broken up into Sections A through K, as shown on **Figure 3** and **4 thru 12**. The +1GP+1ML mainline width and construction costs (from west of Wade Ave. to east of Lake Wheeler Rd.) are equal to the +2ML costs in those sections. Most of the existing bridges from Wade Ave. to Lake Wheeler Road can be retained with Alternatives 1 through 3. Note that the +1GP alternatives widen the existing six-lane I-40 to eight lanes.

NOTE: The estimated human and natural environment impacts are based on available Geographic Information System (GIS) data from Wake County/City of Raleigh/Town of Cary (2013). The NC Center for Geographic Information and Analysis (CGIA) and NC OneMap provided the statewide orthoimagery (2010, 2012, 2013). Additional information has been referenced from the former STIP I-4744 (2011) and current STIP I-5338/I-5311 projects.

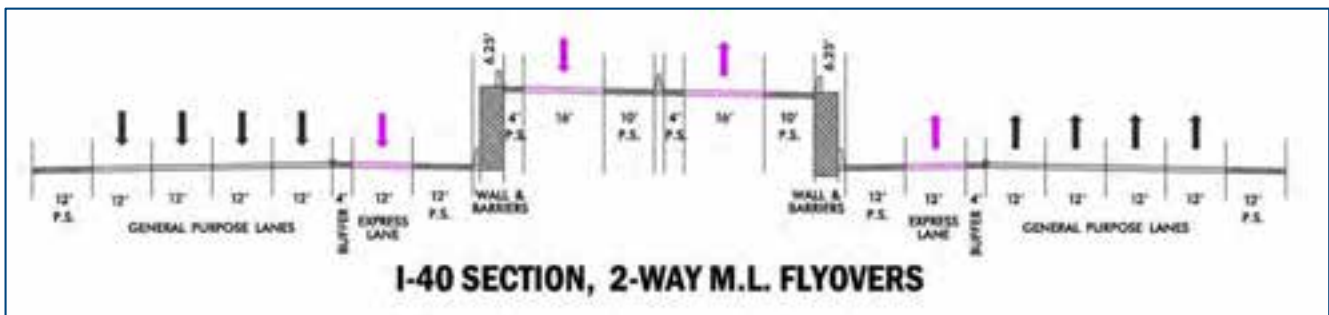
SECTION A – WADE AVENUE (EXIT 289) INTERCHANGE AREA

Section A of the study alternatives is 2.23 miles long (-L- Sta. 87+00 to 205+00) and includes the section of I-40 from west of the Trenton Road overpass to east of the Trinity Road overpass. In addition to the mainline managed lanes widening alternatives, two managed lanes access options are included in the Section A improvements. The Section A functional design concepts can be seen on **Figures 4 and 5**.



Section A Option 1 provides direct access via signalized drop or “tee” ramps at the Trenton Road and Trinity Road overpasses, such as the typical section shown above and the GoogleMap image on the left. See **Figure 4** plan view concept. The Trenton Road ramps serve the managed lane traffic to and from the west. The Trinity Road ramps serve the managed lane traffic to and from the east.

Section A Option 2 provides direct access via flyovers out of the I-40 median to and from Wade Avenue, such as the typical section below and the GoogleMap image on the right. Two-Way flyovers are utilized to and from the east; one-way flyovers to and from the west. See **Figure 5** plan view concept. Note also that GP Ramp D has been shifted west in order to move the merge further away from the managed lane ramp merge.



It is expected that the bridges on I-40 (over the eastbound ramp to Wade Avenue), Trenton Road, and Trinity Road will be replaced in conjunction with the Section A managed lanes improvements for all four alternatives. The existing 3rd-level flyover from westbound Wade Avenue to eastbound I-40 can be

retained with **Alternatives 1 through 3**. However, **Alternative 4 (+1GP+2M)** will require reconstruction of the flyover and is reflected in the costs below.

Coordination with SAS in the subsequent stages of the project will be important as the Trenton Road realignment and bridge replacement affects their property at the southeast end of SAS Campus Drive.

It is estimated that ITS deployment for Section A improvements, including replacing/relocating existing Closed Circuit Television Cameras (CCTVs), Microwave Vehicle Detectors (MVDs), and Fiber Optic Cable installation will cost \$ 300,000.00.

Potential Noise Abatement costs included below are based on noise study area investigations described on **page 9** and shown on **Figures 4 and 5**. Abatement is anticipated to cost \$ 2.2M of the total Section A construction costs.

The following costs have been determined based on the proposed improvements described herein:

SECTION A – COSTS AND IMPACTS									
ALT	OPT	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL	
				RES.	BUS.				
1	+1ML	1	\$40.9 M	\$2.43 M	0	0	\$0.27 M	\$0.3 M	\$43.9 M
		2	\$75.8 M	\$2.43 M	0	0	\$0.27 M	\$0.3 M	\$78.8 M
2	+2ML	1	\$59.1 M	\$4.38 M	0	0	\$0.27 M	\$0.3 M	\$64.1 M
		2	\$94.0 M	\$2.43 M	0	0	\$0.27 M	\$0.3 M	\$97.0 M
3	+1GP +1ML	1	\$59.1 M	\$4.38 M	0	0	\$0.27 M	\$0.3 M	\$64.1 M
		2	\$94.0 M	\$2.43 M	0	0	\$0.27 M	\$0.3 M	\$97.0 M
4	+1GP +2ML	1	\$84.3 M	\$4.38 M	0	0	\$0.27 M	\$0.3 M	\$89.3 M
		2	\$119.2 M	\$4.38 M	0	0	\$0.27 M	\$0.3 M	\$124.2 M

It is anticipated that **Section A** improvements will require 0 residential or business relocations and 0 wetland and stream impacts. The total costs range from an estimated **\$ 43,900,000.00** to **\$ 124,200,000.00**.

SECTION B – NC 54 CHAPEL HILL ROAD (EXIT 290) INTERCHANGE AREA

Section B of the study alternatives is 0.95 mile long (-L- Sta. 205+00 to 255+00) and includes the section of I-40 and the NC 54 interchange. No exclusive managed lanes access is provided at Exit 290. The **+2ML** plan view concept is on **Figure 6**.

In addition to the mainline widening for managed lanes, interchange ramp terminal improvements were considered in order to achieve acceptable levels of service in design year 2040. As stated previously in the traffic analysis results on **page 7**, dual left-turns at the signalized westbound ramps intersection and a channelized right-turn at the signalized eastbound ramps intersection (onto Ramp D) is recommended to achieve acceptable LOS in the design year.

It is expected that the bridges on NC 54 (Chapel Hill Road), the CSX/NSRR Railroad, and East Chatham Street over I-40 will accommodate the proposed managed lanes improvements for **Alternatives 1 through 3**.

However, all three overpass bridges and the interchange loops/ramps will be replaced/reconstructed with the **Alternative 4 (+1GP+2M)** scenario.

It is estimated that ITS deployment for Section B improvements, including replacing/relocating existing CCTVs, MVDs and Fiber Optic Cable will cost \$ 130,000.00.

Potential Noise Abatement costs included below are based on noise study area investigations described on **page 9** and shown on **Figure 6**; including the area along eastbound I-40 and Ramp C. Abatement is anticipated to cost \$ 1.0M of the total Section B construction costs.

The following costs have been determined based on the proposed improvements described herein:

SECTION B – COSTS AND IMPACTS								
ALT		CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
				RES.	BUS.			
1	+1ML	\$8.2 M	\$0	0	0	\$0	\$0.13 M	\$8.4 M
2	+2ML	\$9.8 M	\$0	0	0	\$0	\$0.13 M	\$10.0 M
3	+1GP+1ML	\$9.8 M	\$0	0	0	\$0	\$0.13 M	\$10.0 M
4	+1GP+2ML	\$42.3 M	\$0	0	0	\$0	\$0.13 M	\$42.5 M

It is anticipated that **Section B** improvements will require 0 residential or business relocations. Alternatives 1 through 3 are anticipated to have 0 wetland and stream impacts; Alternative 4 may have stream impacts at the crossing of the Richland Creek tributary. The total Section B costs range from **\$ 8,400,000.00** to **\$ 42,500,000.00**.

SECTION C – CARY TOWNE BLVD (EXIT 291) INTERCHANGE AREA

Section C of the study alternatives is 0.96 mile long (-L- Sta. 255+00 to 305+50) and includes the section of I-40 and the Cary Towne Blvd. interchange. No exclusive managed lanes access is provided at Exit 291. The **+2ML** functional design concept is shown on **Figure 6**.

In addition to the mainline/managed lanes widening, interchange ramp terminal improvements were considered in order to achieve acceptable levels of service in design year 2040. As stated previously in the traffic analysis results on **page 8**, if a traffic signal device is determined to be warranted at the westbound/northbound ramps intersection, it is anticipated to achieve an acceptable LOS in 2040. If a traffic signal is installed, there is enough space between the existing bridge and the intersection for left-turn lane storage without any modification to the existing structure. The eastbound/southbound ramp intersection is acceptable under existing stop-controlled conditions.

It is expected that the Cary Town Blvd. bridge over I-40 will accommodate the proposed managed lanes improvements for **Alternatives 1 through 3**. However, the overpass bridge and the loop B ramp will have to be replaced/reconstructed with the **Alternative 4 (+1GP+2M)** scenario.

It is estimated that ITS deployment for Section C improvements, including replacing/relocating an existing CCTV and Fiber Optic Cable will cost \$ 120,000.00.

Potential Noise Abatement costs included below are based on noise study area investigations described on **page 9** and shown on **Figure 6**; including areas along I-40 between Cary Towne Blvd. and Walnut Creek. Abatement is anticipated to cost \$ 1.6M of the total Section C construction costs.

The following costs have been determined based on the proposed improvements described herein:

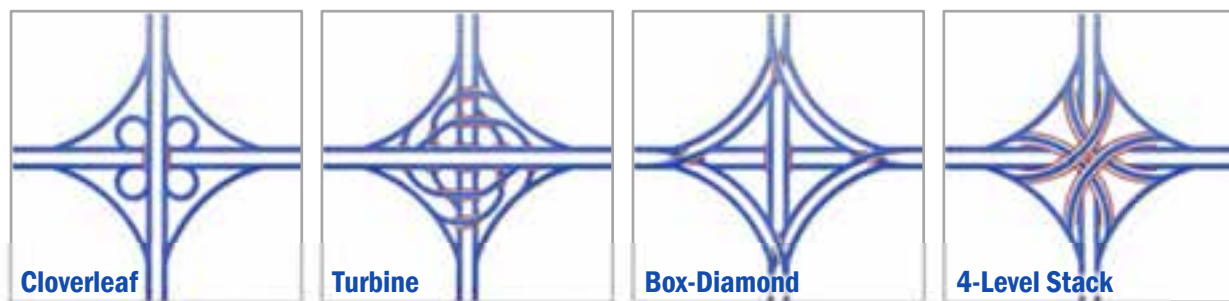
SECTION C – COSTS AND IMPACTS								
ALT		CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
				RES.	BUS.			
1	+1ML	\$6.1 M	\$0	0	0	\$0.04 M	\$0.12 M	\$6.3 M
2	+2ML	\$11.8 M	\$0	0	0	\$0.04 M	\$0.12 M	\$12.0 M
3	+1GP+1ML	\$11.8 M	\$0	0	0	\$0.04 M	\$0.12 M	\$12.0 M
4	+1GP+2ML	\$20.4 M	\$0.78 M	0	0	\$0.04 M	\$0.12 M	\$21.4 M

It is anticipated that **Section C** improvements will require 0 residential or business relocations. Alternatives 1 through 3 are anticipated to have 0 wetland and stream impacts; Alternative 4 has the potential for stream impacts at the Walnut Creek tributary crossings. The total Section C costs range from an estimated **\$ 6,300,000.00** to **\$ 21,400,000.00**.

SECTION D – I-440/US 1/US 64 (EXIT 293) INTERCHANGE AREA

Section D of the study alternatives is 1.41 miles long (-L- Sta. 305+50 to 380+00) and includes the section of I-40 from west of the Buck Jones Road overpass to the Jones Franklin Road overpass; I-440/US 1 southward to the Walnut Street/Crossroads Plaza interchange and northward up to the Jones Franklin/I-440 interchange; and the existing I-40/I-440/US 1/US 64 cloverleaf interchange. Exclusive managed lanes direct access is provided to and from the south. The **+2ML** functional design concept is shown on **Figure 7** and typical sections on **Figure 7A**.

Multiple interchange configurations were investigated in the early stages of the study, in conjunction with the GP only widening alternative. A turbine, box-diamond, 4-level stack and other variations and combinations of free-flowing directional interchanges were considered for replacing the existing full-cloverleaf, as illustrated below: ^[5]



Constructability, costs, natural resources, existing development, forecast traffic volumes and managed lanes accommodations are the main criteria that were used to develop the proposed concept. More details on the various interchanges, including a comparison matrix, are included in **Appendix B General Purpose Widening Alternative**. There are many constraints and any solution will be expensive. Other concepts may be feasible but the proposed concept meets the criteria effectively and is representative of the magnitude of costs and impacts. Note that this concept can be applied with or without managed lanes.

Some of the important features and issues identified in this study that need to be considered in the subsequent planning and design stages of the interchange project are:

- Walnut Creek (303(d) listed), FEMA floodway, Dana Drive properties (N-NW quadrant)
- Hope Community Church/Grace Christian School (N-NW quadrant)
- Buck Jones Road overpass
- South Hills Shopping Center (W quadrant)
- Crossroads Plaza/US 1 flyover
- Crossroads Plaza access:
 - Crossroads Blvd. to Walnut Street ramps,
 - Potential Caitboo Ave. extension over US 1, and
 - Potential I-40/Jones Franklin Rd. tight diamond interchange (TDI) (S and E area)
- Walnut Street bridge and interchange
- Overhead Power Line route and towers from Crossroads Shopping Center across I-40 to Situs Court business park (S and E quadrants)
- Centerview Drive office buildings (E quadrant)

Every effort has been made in the development of the proposed concept to avoid and minimize impacts to these features while providing an effective reconstruction of the multi-level interchange.

Three GP only interchange concepts were developed in the early stages of the study; a turbine, a box-diamond, and a 4-level stack (See [Appendix B General Purpose Widening Alternative](#)). With input from the NCDOT-CAMPO-Raleigh-Cary study team and based on desired planning and design criteria, one concept which combines the box-diamond (for the ML traffic) and 4-level stack (for the GP traffic) configurations was developed further and is presented herein. The GP traffic will utilize three flyovers and one loop-ramp in a 4-level stack configuration with right-hand exits and entrances. ML direct access would be provided to and from the south (US 1/64) in a box-diamond configuration with left-hand median entrances and exits.

Based on the significant size and scope of the reconstructed interchange, the Crossroads Plaza direct access ramp and flyover cannot be retained as it is today and provide adequate merging, weaving and diverging distances. Alternative access has been considered, the Town of Cary Southeast Area plan has been reviewed and the following are recommended for further consideration in the subsequent planning and design stages:

- ◆ Relocate Crossroads Blvd. to the eastern Walnut Street ramp intersection,
- ◆ Construct a Caitboo Ave. extension over US 1 to South Hills/Buck Jones Rd., and
- ◆ Construct an I-40/Jones Franklin Rd. tight diamond interchange (TDI) with braided western ramps.

In addition to costs for the main interchange and managed lanes, the costs for replacing the Buck Jones Road and Walnut Street bridges; relocating the cross-country overhead power lines; and constructing retaining walls along Walnut Creek and South Hills mall are included in the Section D estimates. Costs for the I-40/Jones Franklin Road TDI and braided ramp bridges are included in Section E below. Improvements to the I-440/US 1/Jones Franklin Road interchange are being considered under STIP U-2719 and are not included in this study. Costs for the Crossroads Blvd. and Caitboo Ave. improvements are not included in this study as they require further investigation for feasibility.

Based on the proposed interchange concept the eastbound collector-distributor bridge and Loop D ramp will be retained to provide access to northbound I-440/US 1. The other 3 bridges on I-40 over I-440/US 1 will be replaced to accommodate the managed lanes, ML flyovers, and widened I-440 median. There are 3 GP flyovers, 1 two-way M.L. flyover, and 2 one-way M.L. flyovers proposed. Maintenance of traffic and placement of bridge columns and bents has been evaluated for the proposed design concept.

It is estimated that ITS deployment for Section D improvements, including replacing/relocating existing and installing new CCTVs, MVDs and Fiber Optic Cable will cost \$ 210,000.00.

Potential Noise Abatement costs included below are based on noise study area investigations described on [page 9](#) and shown on [Figure 7](#); including areas along both sides of I-40 from Cary Towne Blvd. to Walnut Creek, between southbound I-440 and Walnut Creek, and along eastbound I-40 near Jones Franklin Road. Abatement is anticipated to cost \$ 1.7M of the total Section D construction costs.

The following costs have been determined based on the proposed improvements described herein:

SECTION D – COSTS AND IMPACTS								
ALT		CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
				RES.	BUS.			
1	+1ML	\$184.7 M	\$48.93 M*	0	4*	\$0.53 M	\$0.21 M	\$234.4 M
2	+2ML	\$203.0 M	\$48.93 M*	0	4*	\$0.53 M	\$0.21 M	\$252.7 M
3	+1GP+1ML	\$203.0 M	\$48.93 M*	0	4*	\$0.53 M	\$0.21 M	\$252.7M
4	+1GP+2ML	\$208.1 M	\$48.93 M*	0	4*	\$0.53 M	\$0.21 M	\$257.8 M

* While it is the intention of the concept to utilize retaining walls to prevent any relocations in the South Hills Shopping Center or in the Centerview Drive business park, the R/W Cost Estimate includes the cost of impacting 4 businesses.

Section D improvements are estimated to require 0 residential and 4 business relocations*. All Alternatives are anticipated to have 0 wetland impacts. No Walnut Creek stream impacts are anticipated along I-440 southbound with the use of a retaining wall. Less than 50' of stream impacts is expected from the extension of the Walnut Creek box culvert west of Buck Jones Road. The total Section D costs range from an estimated **\$ 234,400,000.00** to **\$ 257,800,000.00**.

If this interchange were to be built in stages, it is recommended that the US 1/64 south serving GP flyovers be constructed first, as they serve the heaviest volumes, replacing the existing Loop B and Loop A ramps. These can be designed in such a way as to accommodate the remaining existing cloverleaf and the future expansion with managed lanes.

Continued coordination with ongoing **STIP U-2719** (I-440/US 1 Widening) planning and design is important in providing a design that compliments future managed lanes accommodations.

SECTION E – JONES FRANKLIN ROAD (NEW EXIT) INTERCHANGE

Section E of the study alternatives is 0.45 mile long (-L- Sta. 380+00 to 403+50) and includes the section of I-40 and the proposed Jones Franklin Road tight-diamond interchange. No exclusive managed lanes access is provided. The **+2ML** plan view concept is shown on **Figure 7**.

Based on design investigations regarding how best to provide local access to Crossroads Plaza and acceptable freeway-to-freeway mobility to I-40/I-440/US 1/ US 64, this concept provides an additional GP access point off of I-40. Much like the I-540/US 1/Triangle Town Blvd. interchanges pictured to



the left, a braided ramp interchange is proposed at Jones Franklin Road to provide local access to Crossroads Blvd. An additional advantage is that the new access may relieve “pressure” on the Walnut Street interchange for those accessing Crossroads Blvd., Dillard Drive or Tryon Road. It may also improve the LOS for the

heaviest freeway-to-freeway movements at the I-440/US 1/ US 64 interchange.

As part of the TDI construction, the two-lane Jones Franklin Road bridge would be replaced with a multilane bridge with accommodations for “bikes and peds”. (This also correlates with CAMPO/Town of Cary long range plans to widen Jones Franklin south of I-40.) Retaining walls are included for the tight ramps and for minimizing and avoiding impacts to adjacent properties; including a cell tower in the northeast quadrant.

It is estimated that ITS deployment for Section E improvements, including replacing/relocating MVDs, installing a new CCTV and Fiber Optic Cable will cost \$ 80,000.00.

Potential Noise Abatement costs included below are based on noise study area investigations described on **page 9** and shown on **Figure 7**; including areas along both sides of I-40. Abatement is anticipated to cost \$ 2.4M of the total Section E construction costs.

The ramps, braided ramp bridges, coordinated traffic signals, noise abatement and retaining walls in Section E are included in the following estimated costs:

SECTION E – COSTS AND IMPACTS								
ALT		CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
				RES.	BUS.			
1	+1ML	\$18.8 M	\$0.93 M	0	0	\$0.07 M	\$0.08 M	\$19.9 M
2	+2ML	\$20.1 M	\$0.93 M	0	0	\$0.07 M	\$0.08 M	\$21.2 M
3	+1GP+1ML	\$20.1 M	\$0.93 M	0	0	\$0.07 M	\$0.08 M	\$21.2 M
4	+1GP+2ML	\$21.5 M	\$0.93 M	0	0	\$0.07 M	\$0.08 M	\$22.6 M

Section E improvements are estimated to require 0 residential or business relocations and 0 wetland and stream impacts. Alternative 4 may have stream impacts at the Walnut Creek tributary crossing. The total Section E costs range from an estimated **\$ 19,900,000.00** to **\$ 22,600,000.00**.

SECTION F – WEST OF GORMAN STREET (EXIT 295) TO EAST OF LAKE WHEELER ROAD (EXIT 297)

Section F of the study alternatives is 3.75 miles long (-L- Sta. 403+50 to 601+50). It includes the section of I-40 from west of the Gorman Street interchange to the NSRR overpass east of the Lake Wheeler Road interchange; where the general purpose lane widening ends, as noted on **Figure 1**. A managed lanes ingress/egress point is proposed in both the eastbound and westbound directions mid-way between Exits 295 and 297. The **+2ML** plan view concept is shown on **Figures 8 and 9**.

As stated previously in the traffic analysis summary on **page 8**, no ramp intersection improvements are required at the Gorman Street interchange. Based on existing bridge plans and inspection reports and on anticipated I-5311/I-5338 improvements, the **Alternative 1 (+1ML)** scenario retains the existing Gorman Street bridges. The **Alternative 2 (+2ML)** and **Alternative 3 (+1GP+1ML)** scenarios would require widening of the westbound Gorman Street bridge. The **Alternative 4 (+1GP+2ML)** scenario would require widening both of the Gorman Street bridges.

The Avent Ferry Road, Lake Dam Road, and Trailwoods Drive overpass bridges can be retained with the **Alternative 1 (+1ML)**, **Alternative 2 (+2ML)** and **Alternative 3 (+1GP+1ML)** scenarios. The **Alternative 4 (+1GP+2ML)** scenario would require replacement of each of these bridges.

SECTION F – BRIDGES							
ALT		Avent Ferry Rd bridge	Lake Dam Rd bridge	Gorman St EB bridge	Gorman St WB bridge	Trailwoods Dr bridge	Lake Wheeler Rd bridge
1	+1ML	RETAIN	RETAIN	RETAIN	RETAIN	RETAIN	RELOCATE
2	+2ML	RETAIN	RETAIN	RETAIN	WIDEN	RETAIN	RELOCATE
3	+1GP+1ML	RETAIN	RETAIN	RETAIN	WIDEN	RETAIN	RELOCATE
4	+1GP+2ML	REPLACE	REPLACE	WIDEN	WIDEN	REPLACE	RELCOATE

NCSU representatives requested including a future Centennial Campus interchange and connector road mid-way between Gorman St. and Lake Wheeler Rd., as shown on the NCSU Facilities Master Plan.^[6] A separate design concept and cost estimate has been included (see **page 32** and **Appendix C**). The introduction of a new interchange between Gorman St. and Lake Wheeler Rd. creates multiple shorter weaving segments and reduces the interchange spacing from 2 miles to 1 mile, but it improves campus access and is part of the university’s master plan. Further planning and design investigations and continued coordination with the university are needed in the subsequent stages of the project.

Based on the traffic analysis results on **page 8**, no ramp intersection improvements are required at the Lake Wheeler Road interchange. However, an idea for improved access to Centennial Campus is to realign Centennial Parkway directly to Lake Wheeler Road at I-40, creating a direct route to the campus. This also facilitates construction of the bridge over I-40, provides better skews at the ramp intersections, lengthens Ramp A, and moves west of an area of wetlands.

It is estimated that ITS deployment for Section F improvements, including replacing/relocating existing and installing new CCTVs, MVDs, Dynamic Message Signs (DMSs) and Fiber Optic Cable will cost \$ 790,000.00.

Potential Noise Abatement costs included below are based on the noise study area investigations as described on **page 9** and shown on **Figures 8 and 9**; including various areas along both sides of I-40. Abatement is anticipated to cost \$ 7.6M of the total Section F construction costs.

There is an estimated 150' of stream impacts from the relocation of Lake Wheeler Road over Walnut Creek north of I-40. There is also the potential for stream and wetland mitigation from the removal of the existing box culvert under the old roadway.

The Lake Wheeler Road/Centennial Parkway relocation also crosses the Walnut Creek greenway trail. There is an existing pedestrian tunnel next to the Walnut Creek culvert which would be relocated.

The following costs have been determined based on the proposed improvements described herein:

SECTION F – COSTS AND IMPACTS								
ALT		CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
				RES.	BUS.			
1	+1ML	\$37.6 M	\$1.18 M	0	0	\$0.21 M	\$0.79 M	\$39.8 M
2	+2ML	\$84.2 M	\$1.18 M	0	0	\$0.21 M	\$0.79 M	\$86.4 M
3	+1GP+1ML	\$84.2 M	\$1.18 M	0	0	\$0.21 M	\$0.79 M	\$86.4 M
4	+1GP+2ML	\$101.0 M	\$1.18 M	0	0	\$0.21 M	\$0.79 M	\$103.2 M

Section F improvements are anticipated to require 0 residential or business relocations, 0 wetland and approximately 150 feet of stream impacts. The total Section F costs range from **\$ 39,800,000.00** to **\$ 103,200,000.00**.

SECTION G – EAST OF LAKE WHEELER ROAD (EXIT 297) TO EAST OF HAMMOND ROAD (EXIT 299)

Section G of the study alternatives is 1.68 miles long (-L- Sta. 601+50 to 690+00) and includes the section of I-40 from the NSRR overpass east of the Lake Wheeler Road interchange to east of the Garner Road grade separation; including I-40 Exits 298 and 299. No general purpose lane additions are proposed in Sections G through K, as noted on **Figure 1**. There are two managed lanes scenarios:



Alternative 1 (+1ML) and **Alternative 2 (+2ML)**. Managed lanes access is proposed via drop ramps at Wilmington Street between Exits 298 and 299, such as that shown on the GoogleMap image from 156th Street in Surrey, BC, Canada. The typical section below also illustrates the managed lanes access concept at this location. As indicated previously in the traffic analysis summary on **page 8**, there is a

benefit to putting the managed lanes access at locations away from the GP interchanges in that it places traffic on less overcrowded corridors. The **+2ML** plan view concept is shown on **Figure 10**.



It is anticipated that the existing NSRR bridge over I-40 (west of Exit 298) will accommodate the **+1ML** managed lanes improvements. However, the remaining bridges in Section G with either **+1ML** or **+2ML** will be replaced to accommodate the managed lanes and the Wilmington Street access ramps.

SECTION G – BRIDGES							
ALT		NSRR #1 bridge	S Saunders St bridge	Wilmington St bridge	Hammond Rd bridge	NSRR #2 bridge	Garner Rd bridge
1	+1ML	RETAIN	REPLACE	REPLACE	REPLACE	REPLACE	REPLACE
2	+2ML	REPLACE	REPLACE	REPLACE	REPLACE	REPLACE	REPLACE
3	+1ML	RETAIN	REPLACE	REPLACE	REPLACE	REPLACE	REPLACE
4	+2ML	REPLACE	REPLACE	REPLACE	REPLACE	REPLACE	REPLACE

In addition to the proposed Wilmington Street ML access ramps, the study alternatives include improvements to the Hammond Road Ramp C/Loop C. The improvements in the southwest quadrant have the potential for a business relocation, box culvert extension and stream impacts.

This study does not propose any major improvements to the S. Saunders Street interchange. Further planning investigations and coordination are needed, as there are constraints on any significant improvements; which is likely what is needed to achieve acceptable LOS in the future. One possible solution that is anticipated to achieve acceptable LOS in the future, a DDI, would cost at least an additional \$ 10M to construct. Any future improvements to the S. Saunders Street interchange have the potential for wetland, stream and business impacts.

It is estimated that ITS deployment for Section G improvements, including replacing/relocating existing CCTVs and MVDs and installing new Fiber Optic Cable, will cost \$ 220,000.00.

Potential Noise Abatement costs included below are based on noise study area investigations described on **page 9** and shown on **Figure 10**; including areas along westbound I-40 near Garner Road. Abatement is anticipated to cost \$ 0.6M of the total Section G construction costs.

The following costs have been determined based on the proposed improvements described herein:

SECTION G – COSTS AND IMPACTS								
ALT		CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
				RES.	BUS.			
1	+1ML	\$82.5 M	\$1.63 M	0	1	\$0.14 M	\$0.22 M	\$84.5 M
2	+2ML	\$99.1 M	\$1.78 M	0	1	\$0.14 M	\$0.22 M	\$101.3 M
3	+1ML	\$82.50 M	\$1.63 M	0	1	\$0.14 M	\$0.22 M	\$84.5 M
4	+2ML	\$99.10 M	\$1.78 M	0	1	\$0.14 M	\$0.22 M	\$101.3 M

It is anticipated that **Section G** improvements will require 0 residential relocations, 1 business relocation, 0 wetland impacts, and 85 feet of stream impacts. The total Section G costs range from **\$ 84,500,000.00** to **\$ 101,300,000.00**.

SECTION H – WEST OF HADLEY ROAD TO EAST OF ROCK QUARRY ROAD (EXIT 300)

Section H of the study alternatives is 1.33 miles long (-L- Sta. 690+00 to 760+00) and includes the section of I-40 from west of the Hadley Road grade separation to east of the Rock Quarry Road interchange (Exit 300). No general purpose lane additions are proposed in Section H. There are two managed lanes scenarios: **Alternative 1 (+1ML)** and **Alternative 2 (+2ML)**. No managed lanes access is proposed in this section. The **+2ML** plan view concept is shown on **Figure 10**.

It is anticipated that the Hadley Road, S. State Street and Rock Quarry Road bridges will be replaced with both the **+1ML** and **+2ML** managed lanes scenarios.

The study alternatives include improvements to the Rock Quarry Road ramps; the ramps and loops have been moved outward to accommodate interstate standard loops. There are no anticipated relocations or wetland/stream impacts from the improvements.

As stated previously in the **Traffic Analysis** summary on **page 8**, both of the ramp intersections are anticipated to operate at acceptable LOS in 2040 with the exception of the eastbound ramp intersection in the PM peak hour; which is anticipated to operate at **LOS E/F**. If it is desired to improve this intersection LOS, construction of the eastbound on-ramp in the southeast quadrant would achieve an **LOS B** or better in 2040. However, introducing this ramp reduces the weaving length to the I-40/440 split from 4,500' to 3,000' approximately. It is anticipated that the weave will operate at **LOS F** under both scenarios. A new southeast quadrant on-ramp has not been included in the estimated costs below.

It is estimated that ITS deployment for Section H improvements, including replacing/relocating existing and installing new CCTVs, MVDs, a DMS and Fiber Optic Cable, will cost \$ 310,000.00.

Potential Noise Abatement costs included below are based on noise study area investigations described on **page 9** and shown on **Figure 10**; including various areas along both sides of I-40. Abatement is anticipated to cost \$ 2.4M of the total Section H construction costs.

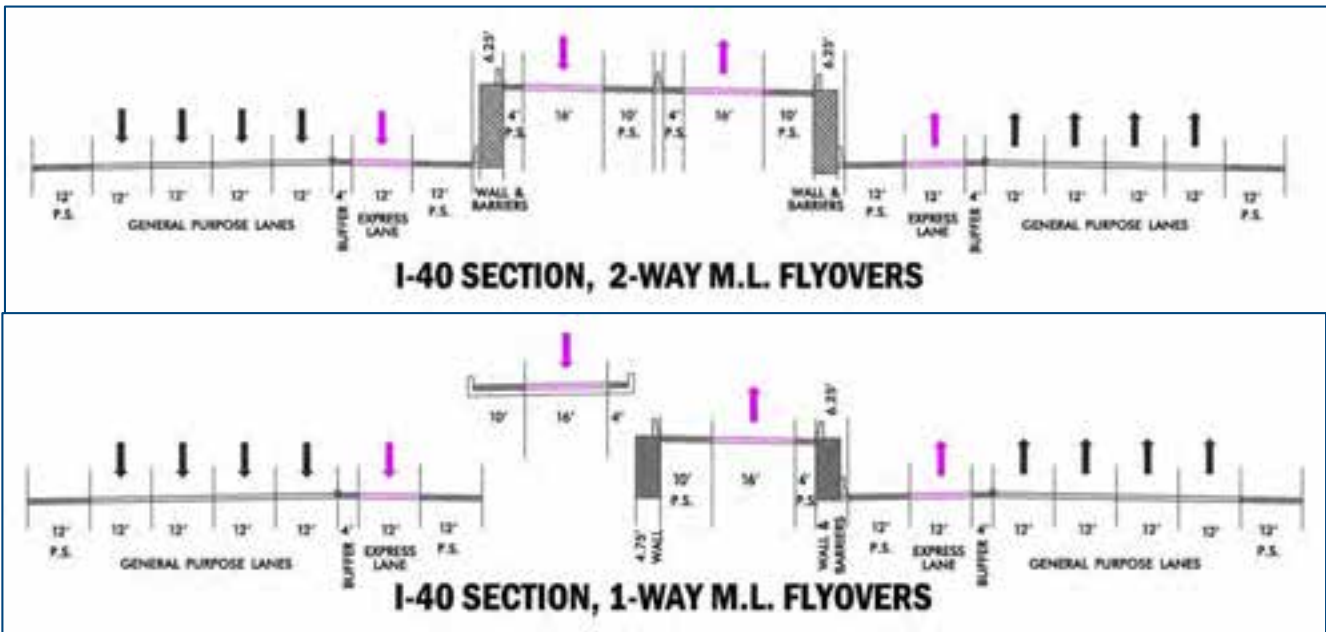
The following costs have been determined based on the proposed improvements described herein:

SECTION H – COSTS AND IMPACTS								
ALT		CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
				RES.	BUS.			
1	+1ML	\$32.6 M	\$0.78 M	0	0	\$0.16 M	\$0.31 M	\$33.9 M
2	+2ML	\$38.9 M	\$0.78 M	0	0	\$0.16 M	\$0.31 M	\$40.2 M
3	+1ML	\$32.60 M	\$0.78 M	0	0	\$0.16 M	\$0.31 M	\$33.9 M
4	+2ML	\$38.90 M	\$0.78 M	0	0	\$0.16 M	\$0.31 M	\$40.2 M

It is anticipated that **Section H** improvements will require 0 residential or business relocations, and 0 wetland or stream impacts. The total Section H costs range from \$ 33,900,000.00 to \$ 40,200,000.00.

SECTION I – I-40/I-440 SPLIT (EXIT 301)

Section I of the study alternatives is 1.52 miles long (-L- Sta. 760+00 to 840+00) and includes the section of I-40 and I-440, the Sunnybrook Road and Rock Quarry Road grade separations, and the freeway-to-freeway ramps at Exit 300. No general purpose lane additions are proposed in Section I. There are two managed lanes scenarios: **Alternative 1 (+1ML)** and **Alternative 2 (+2ML)**. Direct access is provided via flyovers out of the I-40 median to and from I-440, such as the typical sections below illustrate. Two-Way flyovers are utilized to and from the southeast leg; one-way flyovers to and from the west. The **+2ML** plan view concept is shown on **Figure 11**.



All three of the existing “Flyover AC” bridges may be retained with the **+1ML** scenario. The I-40 westbound lanes bridge over Ramp B would be replaced with the **+1ML** addition. Three of the four existing flyover structures will be replaced with the **+2ML** managed lanes scenario – one can be retained – as shown on **Figure 11**. Both scenarios include four new flyover structures to carry the managed lanes to and from I-40 and new grade separation structures at Sunnybrook Road and Rock Quarry Road.

Regarding maintenance of traffic during construction and retaining some of the existing flyover structures, the new managed lanes flyovers could be constructed first and have the GP movements placed on them temporarily while the new GP structures are built. Other staging concepts may be developed in the subsequent stages of the project.

It is estimated that ITS deployment for Section I improvements, including replacing/relocating existing and installing new CCTVs, MVDs, a DMS and Fiber Optic Cable, will cost \$ 380,000.00. Potential Noise Abatement costs included below are based on noise study area investigations described on **page 9** and shown on **Figure 11**; including areas along both sides of I-40 (to the end of the study corridor) and I-440. Abatement is anticipated to cost \$ 8.4M of the total Section I construction costs.

The following costs have been determined based on the proposed improvements described herein:

SECTION I – COSTS AND IMPACTS								
ALT		CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
				RES.	BUS.			
1	+1ML	\$70.4 M	\$0.10 M	0	0	\$0.09 M	\$0.38 M	\$71.0 M
2	+2ML	\$73.2 M	\$0.10 M	0	0	\$0.09 M	\$0.38 M	\$73.8 M
3	+1ML	\$70.40 M	\$0.10 M	0	0	\$0.09 M	\$0.38 M	\$71.0 M
4	+2ML	\$73.20 M	\$0.10 M	0	0	\$0.09 M	\$0.38 M	\$73.8 M

It is anticipated that **Section I** improvements will require 0 residential or business relocations, and 0 wetland or stream impacts. The total Section I costs range from **\$ 71,000,000.00** to **\$ 73,800,000.00**.

SECTION J – NORTH OF SUNNYBROOK ROAD TO NORTH OF POOLE ROAD (I-440 EXIT 15)

Section J of the study alternatives is 1.10 miles long (-L- Sta. 840+00 to 898+00) and includes the section of I-440 from just north of the Sunnybrook Road grade separation to north of the Poole Road interchange (I-440 Exit 15). No general purpose lane additions are proposed in Section J. There are two managed lanes scenarios: **Alternative 1 (+1ML)** and **Alternative 2 (+2ML)**. A managed lanes southbound ingress and northbound egress point is proposed mid-way between I-440 Exits 15 and 16 (providing an opportunity for Exit 15 Poole Road traffic to and from the south to enter and exit the managed lanes, respectively). The plan view design concept is shown on **Figure 12**.

A 5 cell box culvert (4 for Walnut Creek, 1 for Walnut Creek Trail pedestrians) is located under this section of I-440 near -L- Sta. 854+00 and is proposed to be extended on both ends to accommodate the **+1ML** and **+2ML** mainline improvements. Approximately 0.25 acres of wetland impacts and 80 feet of stream impacts are anticipated at the Walnut Creek/Trail quintuple box culvert extensions.

As stated previously in the traffic analysis summary on **page 9**, the Poole Road (I-440 Exit 15) interchange ramp intersections are anticipated to fail in the design year. Further investigations are needed at this location in subsequent planning stages, as there are constraints on any significant interchange improvements – including a park in the northeast quadrant – which is likely what is needed to achieve acceptable LOS in the future. A DDI is one possible solution, and is estimated to operate at

acceptable LOS in 2040. The costs for replacing the existing bridge and tying in the existing ramps have been included below.

It is estimated that ITS deployment for Section J improvements, including replacing/relocating an existing CCTV, installing a new DMS and Fiber Optic Cable, will cost \$ 270,000.00.

Potential Noise Abatement costs included below are based on noise study area investigations described on **page 9** and shown on **Figure 12**; including an area along the east side of I-440. Abatement is anticipated to cost \$ 1.5M of the total Section J construction costs.

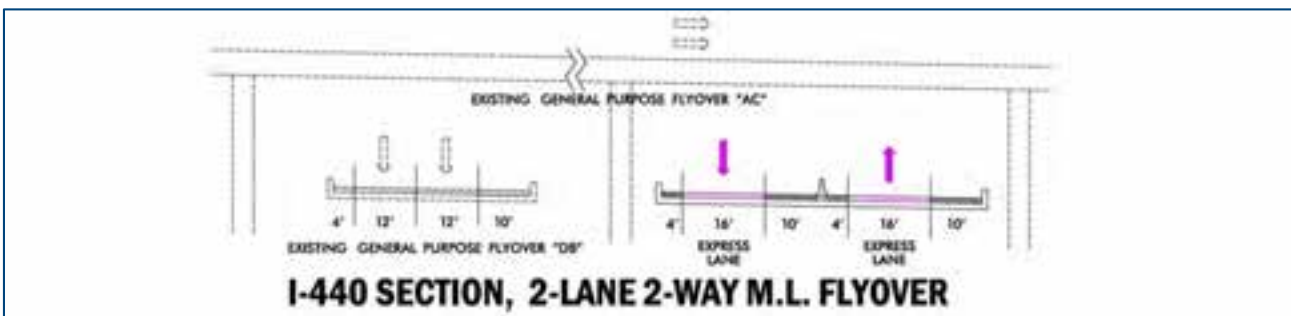
The following costs have been determined based on the proposed improvements described herein:

SECTION J – COSTS AND IMPACTS								
ALT		CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
				RES.	BUS.			
1	+1ML	\$12.7 M	\$0	0	0	\$0	\$0.27 M	\$13.0 M
2	+2ML	\$20.8 M	\$0	0	0	\$0	\$0.27 M	\$21.1 M
3	+1ML	\$12.70 M	\$0	0	0	\$0	\$0.27 M	\$13.0 M
4	+2ML	\$20.80 M	\$0	0	0	\$0	\$0.27 M	\$21.1 M

It is anticipated that **Section J** improvements will require 0 residential or business relocations, and approximately 0.25 acres of wetland impacts and 80 feet of stream impacts. The total Section J costs range from **\$ 13,000,000.00** to **\$ 21,100,000.00**.

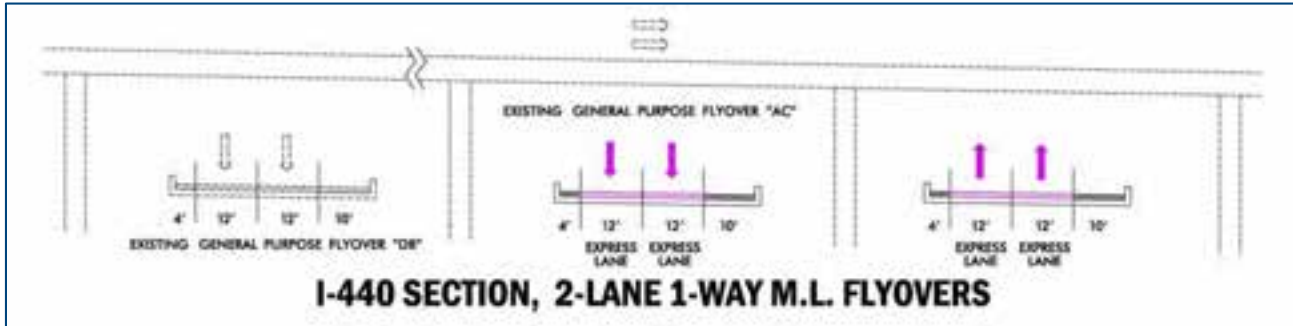
SECTION K – NORTH OF POOLE ROAD (EXIT 15) TO NORTH OF THE US 64/264 KNIGHTDALE BYPASS (EXIT 14)

Section K of the study alternatives is 1.46 miles long (-L- Sta. 898+00 to 983+00 End Study) and includes the section of I-440 from just north of Poole Road (Exit 15) to north of the US 64/264 Knightdale Bypass interchange (Exit 14). There are no general purpose lane additions proposed in Section K. There are two managed lanes scenarios: **Alternative 1 (+1ML)** and **Alternative 2 (+2ML)**. The I-440 southbound managed lanes develop and the northbound managed lanes end north of the I-440 Crabtree Creek bridges. Managed Lanes access is also provided to and from the US 64/264 Knightdale Bypass via direct access flyovers. The **+2ML** design concept is shown on **Figure 12**.



The **+1ML** managed lanes to and from the Knightdale Bypass can be built on a two-lane two-way flyover, as illustrated above, while maintaining the existing flyover bridges. In order to retain the

existing “Flyover AC” bridge with **+2ML**, the managed lanes to and from the Knightdale Bypass are built on separate two-lane one-way flyovers, as illustrated below.



In addition, the Ramp D and I-440 dual bridges over Crabtree Creek and the railroad are maintained with both **+1ML** and **+2ML**. The I-440 dual bridges require widening to accommodate the additional managed lanes. The median construction along US 64/264 extends eastward up to the New Hope Road interchange.

It is estimated that ITS deployment for Section K improvements, including replacing/relocating existing CCTVs, MVDs and Fiber Optic Cable, will cost \$ 140,000.00.

Potential Noise Abatement is based on noise study area investigations described on **page 9**; there are no anticipated areas in Section K.

The following costs have been determined based on the proposed improvements described herein:

SECTION K – COSTS AND IMPACTS								
ALT	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL	
			RES.	BUS.				
1	+1ML	\$38.9 M	\$0	0	0	\$0.06 M	\$0.14 M	\$39.1 M
2	+2ML	\$49.7 M	\$0.68 M	0	0	\$0.06 M	\$0.14 M	\$50.6 M
3	+1ML	\$38.90 M	\$0	0	0	\$0	\$0.14 M	\$39.1 M
4	+2ML	\$49.70 M	\$0.68 M	0	0	\$0.06 M	\$0.14 M	\$50.6 M

It is anticipated that **Section K** improvements will require 0 residential or business relocations, 0 wetland impacts, and some stream impacts at two Crabtree Creek tributary crossings. The total Section K costs range from **\$ 39,100,000.00** to **\$ 50,600,000.00**.

5. PROJECT COSTS AND PROGRAMMING RECOMMENDATIONS

The I-40 Upgrades and Managed Lanes Alternatives presented in this study include widening 17 miles of I-40 and I-440 and constructing interchange improvements where needed. The mainline improvements include 12-foot full-depth inside and outside paved shoulders, 4-foot painted buffers for concurrent flow managed lanes, and a 26-foot wide median with concrete barrier.

There are four Study Alternatives: **Alternative 1** and **Alternative 2** add +1 and +2 ML, respectively, to the existing number of GP lanes; **Alternative 3** and **Alternative 4** widen the existing interstate to eight GP lanes and add +1 and +2 ML, respectively.

Improvements for **Managed Lanes access** are recommended at the following locations:

- ◆ * Trenton Road/Wade Avenue (Exit 289)/Trinity Road area (**Options 1 and 2**),
- ◆ I-40/I-440/US 1/US 64 interchange (Exit 293) in Cary,
- ◆ Wilmington Street overpass,
- ◆ I-40/I-440 split interchange (Exit 301), and
- ◆ US 64-264 (Knightdale Bypass) interchange.

* Two Managed Lanes access concepts are included in Section A. There is not enough information at this time to recommend one option over the other. It is often more desirable to place managed lanes access away from other GP access locations. Also, the Trenton Road/Trinity Road drop ramps option (**Option 1**) is about \$ 34.0M less expensive, but additional studies are needed. Can the existing road network support the alternative access locations? Where are the managed lanes traffic going to and coming from? Which option is anticipated to generate more user benefit and revenue?

Improvements for **General Purpose interchanges** are recommended at the following locations:

- ◆ NC 54 Chapel Hill Road (Exit 290) ramp intersections,
- ◆ Cary Towne Blvd. (Exit 291) westbound ramp intersection,
- ◆ ** US 70/401/NC 50 S. Saunders Street (Exit 298) interchange,
- ◆ Hammond Road (Exit 299) eastbound ramp/loop intersection,
- ◆ Rock Quarry Road (Exit 300) ramp/loop intersections, and
- ◆ ** Poole Road (I-440 Exit 15) interchange.

** The improvements needed to bring the S. Saunders Street and Poole Road interchanges up to acceptable operations are outside the scope of this study. The cost for replacing the bridges is included.

A relocation of Lake Wheeler Road to Centennial Parkway is recommended on the north side of the Lake Wheeler Road (Exit 297) interchange. A new I-40/Jones Franklin Road tight-diamond interchange is recommended in conjunction with the reconstruction of the I-40/I-440/US 1/US 64 interchange (Exit 293).

The estimated costs and impacts for all alternatives and sections are presented below in **Table 5.1**:

TABLE 5.1 – PROJECT COSTS & IMPACTS

ALT.	DESCR.	SEC.	LENGTH	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
						RES.	BUS.			
1	+1ML	A1	2.23	\$40.90 M	\$2.43 M	0	0	\$0.27 M	\$0.30 M	\$43.90 M
1	+1ML	A2	2.23	\$75.80 M	\$2.43 M	0	0	\$0.27 M	\$0.30 M	\$78.80 M
1	+1ML	B	0.95	\$8.20 M	\$0	0	0	\$0	\$0.13 M	\$8.40 M
1	+1ML	C	0.96	\$6.10 M	\$0	0	0	\$0	\$0.12 M	\$6.30 M
1	+1ML	D	1.41	\$184.70 M	\$48.93 M	0	4	\$0.53 M	\$0.21 M	\$234.40 M
1	+1ML	E	0.45	\$18.80 M	\$0.93 M	0	0	\$0.07 M	\$0.08 M	\$19.90 M
1	+1ML	F	3.75	\$37.60 M	\$1.18 M	0	0	\$0.21 M	\$0.79 M	\$39.80 M
1	+1ML	G	1.68	\$82.50 M	\$1.63 M	0	1	\$0.14 M	\$0.22 M	\$84.50 M
1	+1ML	H	1.33	\$32.60 M	\$0.78 M	0	0	\$0.16 M	\$0.31 M	\$33.90 M
1	+1ML	I	1.52	\$70.40 M	\$0.10 M	0	0	\$0.09 M	\$0.38 M	\$71.00 M
1	+1ML	J	1.10	\$12.70 M	\$0	0	0	\$0	\$0.27 M	\$13.00 M
1	+1ML	K	1.46	\$38.90 M	\$0	0	0	\$0	\$0.14 M	\$39.10 M
ALT 1 with Section A Option 1:				\$533.40 M	\$56.10 M	0	5	\$1.70 M	\$3.00 M	\$594.20 M
ALT 1 with Section A Option 2:				\$568.30 M	\$56.10 M	0	5	\$1.70 M	\$3.00 M	\$629.10 M
2	+2ML	A1	2.23	\$59.10 M	\$4.38 M	0	0	\$0.27 M	\$0.30 M	\$64.10 M
2	+2ML	A2	2.23	\$94.00 M	\$2.43 M	0	0	\$0.27 M	\$0.30 M	\$97.00 M
2	+2ML	B	0.95	\$9.80 M	\$0	0	0	\$0	\$0.13 M	\$10.00 M
2	+2ML	C	0.96	\$11.80 M	\$0	0	0	\$0.04 M	\$0.12 M	\$12.00 M
2	+2ML	D	1.41	\$203.00 M	\$48.93 M	0	4	\$0.53 M	\$0.21 M	\$252.70 M
2	+2ML	E	0.45	\$20.10 M	\$0.93 M	0	0	\$0.07 M	\$0.08 M	\$21.20 M
2	+2ML	F	3.75	\$84.20 M	\$1.18 M	0	0	\$0.21 M	\$0.79 M	\$90.40 M
2	+2ML	G	1.68	\$99.10 M	\$1.78 M	0	1	\$0.14 M	\$0.22 M	\$101.30 M
2	+2ML	H	1.33	\$38.90 M	\$0.78 M	0	0	\$0.16 M	\$0.31 M	\$40.20 M
2	+2ML	I	1.52	\$73.20 M	\$0.10 M	0	0	\$0.09 M	\$0.38 M	\$73.80 M
2	+2ML	J	1.10	\$20.80 M	\$0	0	0	\$0	\$0.27 M	\$21.10 M
2	+2ML	K	1.46	\$49.70 M	\$0.68 M	0	0	\$0.06 M	\$0.14 M	\$50.60 M
ALT 2 with Section A Option 1:				\$669.70 M	\$59.00 M	0	5	\$1.70 M	\$3.00 M	\$733.40 M
ALT 2 with Section A Option 2:				\$704.60 M	\$57.00 M	0	5	\$1.70 M	\$3.00 M	\$766.30 M
3	+1GP+1ML	A1	2.23	\$59.10 M	\$4.38 M	0	0	\$0.27 M	\$0.30 M	\$64.10 M
3	+1GP+1ML	A2	2.23	\$94.00 M	\$2.43 M	0	0	\$0.27 M	\$0.30 M	\$97.00 M
3	+1GP+1ML	B	0.95	\$9.80 M	\$0	0	0	\$0	\$0.13 M	\$10.00 M
3	+1GP+1ML	C	0.96	\$11.80 M	\$0	0	0	\$0.04 M	\$0.12 M	\$12.00 M
3	+1GP+1ML	D	1.41	\$203.00 M	\$48.93 M	0	4	\$0.53 M	\$0.21 M	\$252.70 M
3	+1GP+1ML	E	0.45	\$20.10 M	\$0.93 M	0	0	\$0.07 M	\$0.08 M	\$21.20 M
3	+1GP+1ML	F	3.75	\$84.20 M	\$1.18 M	0	0	\$0.21 M	\$0.79 M	\$90.40 M
3	+1ML	G	1.68	\$82.50 M	\$1.63 M	0	1	\$0.14 M	\$0.22 M	\$84.50 M
3	+1ML	H	1.33	\$32.60 M	\$0.78 M	0	0	\$0.16 M	\$0.31 M	\$33.90 M
3	+1ML	I	1.52	\$70.40 M	\$0.10 M	0	0	\$0.09 M	\$0.38 M	\$71.00 M
3	+1ML	J	1.10	\$12.70 M	\$0	0	0	\$0	\$0.27 M	\$13.00 M
3	+1ML	K	1.46	\$38.90 M	\$0	0	0	\$0	\$0.14 M	\$39.10 M
ALT 3 with Section A Option 1:				\$625.10 M	\$58.10 M	0	5	\$1.70 M	\$3.00 M	\$687.90 M
ALT 3 with Section A Option 2:				\$660.00 M	\$56.10 M	0	5	\$1.70 M	\$3.00 M	\$720.80 M
4	+1GP+2ML	A1	2.23	\$84.30 M	\$4.38 M	0	0	\$0.27 M	\$0.30 M	\$89.30 M
4	+1GP+2ML	A2	2.23	\$119.20 M	\$4.38 M	0	0	\$0.27 M	\$0.30 M	\$124.20 M
4	+1GP+2ML	B	0.95	\$42.30 M	\$0	0	0	\$0	\$0.13 M	\$42.50 M
4	+1GP+2ML	C	0.96	\$20.40 M	\$0.78 M	0	0	\$0.04 M	\$0.12 M	\$21.40 M
4	+1GP+2ML	D	1.41	\$208.10 M	\$48.93 M	0	4	\$0.53 M	\$0.21 M	\$257.80 M
4	+1GP+2ML	E	0.45	\$21.50 M	\$0.93 M	0	0	\$0.07 M	\$0.08 M	\$22.60 M



4	+1GP+2ML	F	3.75	\$104.00 M	\$1.18 M	0	0	\$0.21 M	\$0.79 M	\$106.20 M
4	+2ML	G	1.68	\$99.10 M	\$1.78 M	0	1	\$0.14 M	\$0.22 M	\$101.30 M
4	+2ML	H	1.33	\$38.90 M	\$0.78 M	0	0	\$0.16 M	\$0.31 M	\$40.20 M
4	+2ML	I	1.52	\$73.20 M	\$0.10 M	0	0	\$0.09 M	\$0.38 M	\$73.80 M
4	+2ML	J	1.10	\$20.80 M	\$0	0	0	\$0	\$0.27 M	\$21.10 M
4	+2ML	K	1.46	\$49.70 M	\$0.68 M	0	0	\$0.06 M	\$0.14 M	\$50.60 M
ALT 4 with Section A Option 1:				\$759.30 M	\$59.80 M	0	5	\$1.70 M	\$3.00 M	\$823.80 M
ALT 4 with Section A Option 2:				\$794.20 M	\$59.80 M	0	5	\$1.70 M	\$3.00 M	\$858.70 M

The total project costs for all four alternatives are anticipated to range from **\$594.2M** to **\$858.7M**.

It is anticipated that all of the alternatives will require 0 residential relocations and up to 5 business relocations. Wetland impacts are anticipated at the Walnut Creek quintuple box culvert in Section J. There may be some wetland impacts associated with the Lake Wheeler Road/Centennial Parkway relocation in Section F. No other wetland impacts are anticipated. Stream impacts are anticipated at various creek and tributary crossings, and are expected to range from approximately 360' to 600' in total; with Alternative 4 having the highest stream impacts.

There is no significant difference between the alternatives as it relates to the latent demand and failing LOS for the I-40 mainline. The managed lanes are anticipated to achieve desirable LOS (A's, B's and C's) in 2040. The costs increase approximately 20% (or \$137M) when going from the +1ML to the +2ML alternatives. The +1GP addition increases the total project cost by approximately 15% (or \$92 M).

Based on current data, estimated costs and preliminary analyses it is recommended that all the alternatives be given further consideration in the subsequent planning, design and procurement phases of the project. The final decision on the number of managed lanes will be made during the stages of the NEPA planning process. It is premature to recommend and/or eliminate an alternative for managed lanes at this time (during this feasibility study stage). Later planning and design phases should be coordinated with the procurement phase in order to determine the best managed lanes alternative to be implemented along this corridor.

VII – ADDITIONAL CONSIDERATIONS

The following are additional items that should be considered in the subsequent stages of the project(s):

APPENDIX B – GENERAL PURPOSE WIDENING ALTERNATIVE

A General Purpose widening only alternative is included in the study, comprised of the western 10 miles of the study corridor from west of SR 1728 (Wade Avenue) to east of SR 1375 (Lake Wheeler Road). This scenario includes widening the existing six GP lanes to eight GP lanes and interchange improvements if needed. **Appendix B General Purpose Widening** provides more information on the GP only design concepts, traffic analyses, impacts and costs. Specific information on the I-40/440/US 1/64 Interchange (Exit 293) is included in Sections D and E.

APPENDIX C – CENTENNIAL CAMPUS CONNECTOR / INTERCHANGE

A Centennial Campus Connector and Interchange located between Gorman Street (Exit 295) and Lake Wheeler Road (Exit 297) was additionally considered in partnership with North Carolina State University. The design concept is based on the university’s Facilities Division - Master Plan for future development in the Centennial Campus precinct. ^[6] See **Appendix C Figure C.1**.

A preliminary traffic analysis of the I-40 mainline and Centennial Campus interchange shows that all future year scenarios are similar in despite differences in capacity and is likely a symptom of the latent demand as described in **Section III Traffic and Safety**. The I-40 merges, diverges, weaves and freeway segments between Gorman, Centennial and Lake Wheeler are all anticipated to operate at **LOS F** in future year 2040. The applicable forecast diagrams (2040 Build “A” Scenarios) and analysis results are included in **Appendix C**.

The introduction of a new interchange between Gorman Street and Lake Wheeler Road creates multiple shorter weaving segments and reduces the interchange spacing from 2 miles to 1 mile, but it improves campus access and is part of the university’s master plan.

The Centennial Interchange is not anticipated to interfere with having a managed lanes ingress/egress in the same approximate location on I-40.

Further planning, design investigations, and analyses are needed to ensure that the new interchange meets federal and state guidelines.

Potential Noise Abatement costs included below are based on the noise study area investigations as described on page 9 and shown on **Figure C.1**; including the area along eastbound I-40. Abatement is anticipated to cost \$ 0.5M of the construction costs.

The following costs have been determined based on the Centennial Campus Connector / Interchange described herein:

Construction.....	\$ 12,100,000.00
Right-of-Way.....	* \$ 5,000,000.00
Utility Relocation.....	\$ 0
Total Cost (Centennial)	\$ 17,100,000.00

The Centennial Campus Connector and Interchange has the potential to require 18 townhome relocations, 0 wetland impacts, and 475' of stream impacts. There are Walnut Creek tributary stream crossings under I-40 and through the golf course. The total cost is estimated to be **\$ 17,100,000.00**. (* Note that the R/W cost may be adjusted based on the University's master plan for this area to not be a golf course.)

GORMAN STREET (EXIT 295) INTERCHANGE

The Gorman Street (Exit 295) interchange ramp terminals are anticipated to operate at **LOS D** in the design year. However, some individual movements are anticipated to operate at unacceptable levels. One potential improvement seen below is a Diverging Diamond Interchange (DDI); which is



anticipated to achieve acceptable individual movements and overall intersection **LOS C** and **B**, respectively, in 2040. The DDI concept moves the southern ramp intersection further north of the Tryon Road signalized intersection, and can be constructed within existing right-of-way. It is estimated that the DDI interchange improvements would cost \$4.0M for construction.

**APPENDIX D – SLIP RAMP OPTION:
HARRISON AVENUE (EXIT 287) RAMP D TO I-40 EB AT WADE AVE (EXIT 289)**

The NCDOT and the City of Raleigh have developed a potential slip ramp improvement for the eastbound weave from Harrison Avenue (Exit 287) Ramp D to I-40 EB at Wade Avenue. The slip ramp eliminates the weave by providing a positive-separated auxiliary lane parallel to I-40 that ties directly into the loop-flyover ramp to EB I-40, past the EB exit to Wade Avenue. (Positive separation can be concrete barrier, bollard, or painted buffer.) Approximately 1,300 feet of the slip ramp is on new location (Station 98+00 to 111+00); the remaining 10,000 feet is widening off of existing.

It is anticipated that two box culverts would be extended to accommodate the widening, and that one retaining wall would be needed to keep the limits of construction within existing Right-of-Way.

Mr. Doumit Ishak, NCDOT Congestion Management, provided RK&K with a schematic of the concept. RK&K developed the functional design shown on **Figure D.1** and the cost estimate below:

Construction.....	\$ 9,000,000.00
Right-of-Way.....	\$ 0
Utility Relocation.....	\$ 0
Total Cost (Slip Ramp Option)	\$ 9,000,000.00

The Slip Ramp Option is anticipated to require 0 relocations, 0 wetland impacts, and 75' of stream impacts. There are three stream crossings; one of Reedy Creek and two of its tributaries. There are no anticipated ITS costs. The total Slip Ramp Option cost is estimated to be **\$ 9,000,000.00**.

RAMP METERING FEASIBILITY STUDY (M-0446)

NCDOT conducted feasibility study M-0446 in 2013 for the implementation of ramp metering in the Raleigh/Durham area and served as a pilot study statewide. The study's final recommendations included the westbound on-ramp at Gorman Street (Exit 295), denoted as site #043, as a suitable site for single lane ramp metering. Other recommended sites are outside the FS-1005A study area.

BUS ON SHOULDER SYSTEM (BOSS)

NCDOT and local public transportation systems are working to implement pilot programs for Bus on Shoulder Systems (BOSS) in the Raleigh/Durham area. BOSS allow public transportation buses to utilize interstate and primary route paved shoulders as travel lanes when traffic moves at speeds below 35 mph. Subsequent planning and design stages of the FS-1005A project should consider this program, and appropriate paved shoulder, pavement marking and signing designs. (www.ncdot.gov/nctransit/boss/)

CIRCLE FREEWAY INTERCHANGE

CAMPO representative Chris Lukasina recommended investigating the "circle" freeway interchange as a potential alternative design and a resource of ideas. The "circle" interchange at I-90/94/290 in Chicago, Illinois is being redesigned, and essentially functions like a Turbine, with very low design speeds, steep grades in an urban setting, and a grid of local streets intertwined. (See also www.circleinterchange.org, and en.wikipedia.org/wiki/Circle_Interchange.)

LOCAL-EXPRESS LANES

Former CAMPO representative Ed Johnson recommended considering a local-express lane configuration as an alternative to managed lanes. L-E lanes are similar to collector-distributor lanes in that they separate long distance through traffic from local entering and exiting traffic through one or more interchanges. The L-E lanes are often connected by slip ramps at periodic intervals. An example of this is I-270 in Montgomery County, Maryland (between Montrose Road, Rockville and I-370, Gaithersburg).

STAGING OF I-40/I-440/US 1/US 64 INTERCHANGE (EXIT 293)

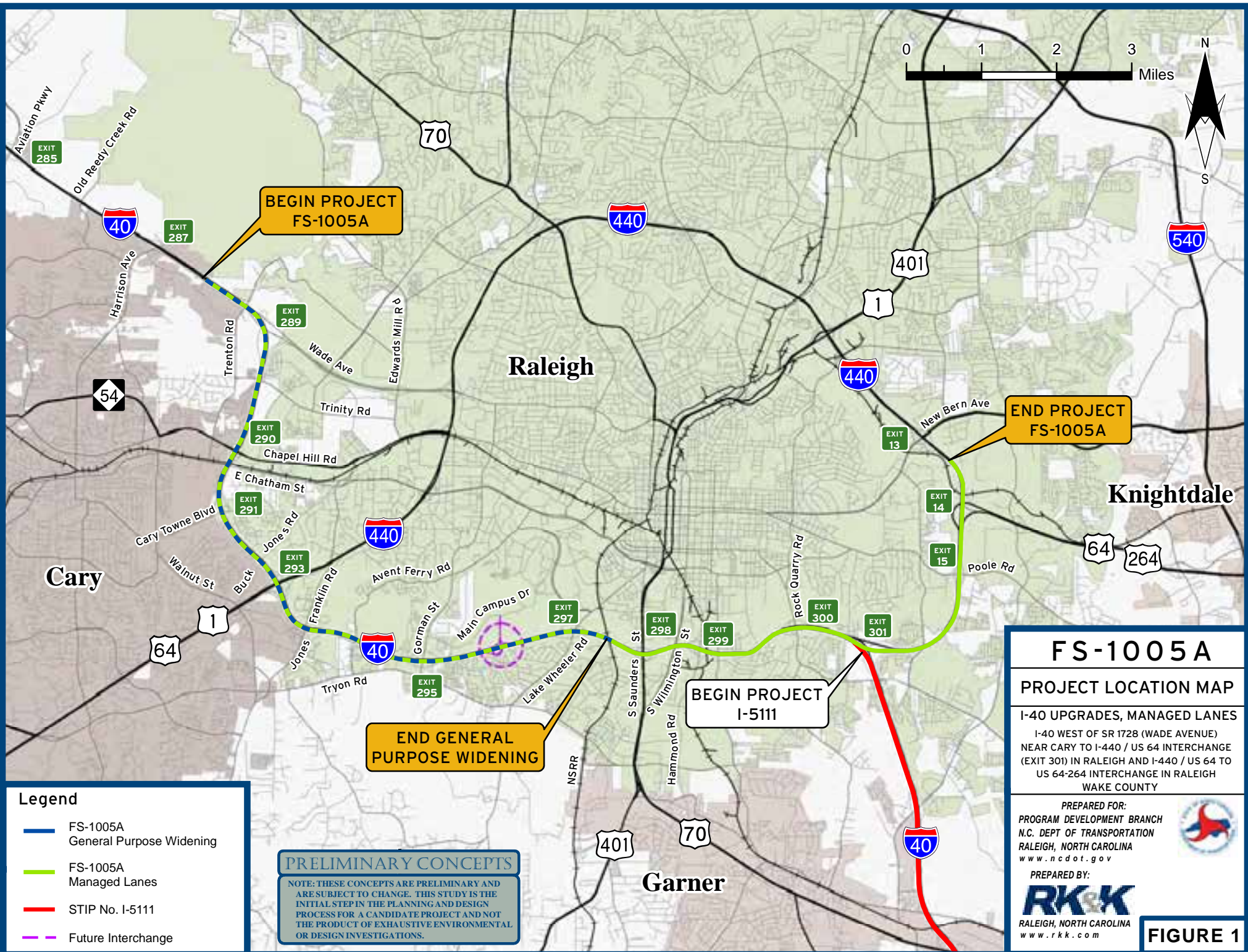
CAMPO representative Chris Lukasina recommended a staging concept for the reconstruction of the interchange: i.e. building the south-serving GP flyovers with the heaviest forecast traffic first.

FOOTNOTES

- Page 1. ^[1] Capital Area Metropolitan Planning Organization (CAMPO), <http://www.campo-nc.us>
- Page 1, 4. ^[2] NCDOT Strategic Transportation Corridors (STC) on the NC Transportation Network (NCTN), <https://connect.ncdot.gov/projects/planning/pages/NCTransportationNetwork.aspx>
- Page 4. ^[3] NCDOT Current and Draft STIP, <https://connect.ncdot.gov/projects/planning/Pages/default.aspx>.
- Page 6. ^[4] NCDOT Work Zone Safety and Mobility Policy and Guidelines (2007), <https://connect.ncdot.gov/projects/WZTC/Pages/default.aspx>.
- Page 15. ^[5] Interchange (road) article, Wikipedia. [http://en.wikipedia.org/wiki/Interchange_\(road\)](http://en.wikipedia.org/wiki/Interchange_(road)).
- Page 18, 32. ^[6] NCSU Physical Master Plan Book and Maps, http://www.ncsu.edu/facilities/physical_master_plan/index.htm.

ADDITIONAL RESOURCES

- NCDOT, HOV Lanes webpage. <http://www.ncdot.gov/projects/hov/>.
- FHWA, Managed Lanes webpage. http://ops.fhwa.dot.gov/freewaymgmt/managed_lanes.htm.
- MUTCD 2009 Edition, Chapter 3D. Markings For Preferential Lanes. <http://mutcd.fhwa.dot.gov/hdm/2009/part3/part3d.htm>.
- Experiences with Managed Lanes in the USA, Charlotte Region HOV/HOT/Managed Lanes (2007). www.charmeck.org/fastlanes/Pages/AboutFastLanes.aspx.
- SR 237 Express Lanes Project, Project Brochure, Santa Clara Valley Transportation Authority/CalTrans. <http://www.vta.org/projects-and-programs/highway/express-lanes-communications>
- Texas Transportation Institute (TTI)/Texas A&M University, Managed Lanes webpage. Handbooks, Reports and Guidance. <http://managed-lanes.tamu.edu/resources>.
- HOT Lane Buffer and Mid-Point Access Design Review Report (2006), Washington State (WS) DOT. Design Guidance. <http://www.wsdot.wa.gov/Research/Reports/600/651.1.htm>.



**BEGIN PROJECT
FS-1005A**

**END PROJECT
FS-1005A**

**BEGIN PROJECT
I-5111**

**END GENERAL
PURPOSE WIDENING**

PRELIMINARY CONCEPTS
NOTE: THESE CONCEPTS ARE PRELIMINARY AND ARE SUBJECT TO CHANGE. THIS STUDY IS THE INITIAL STEP IN THE PLANNING AND DESIGN PROCESS FOR A CANDIDATE PROJECT AND NOT THE PRODUCT OF EXHAUSTIVE ENVIRONMENTAL OR DESIGN INVESTIGATIONS.

FS-1005A
PROJECT LOCATION MAP
I-40 UPGRADES, MANAGED LANES
I-40 WEST OF SR 1728 (WADE AVENUE) NEAR CARY TO I-440 / US 64 INTERCHANGE (EXIT 301) IN RALEIGH AND I-440 / US 64 TO US 64-264 INTERCHANGE IN RALEIGH WAKE COUNTY

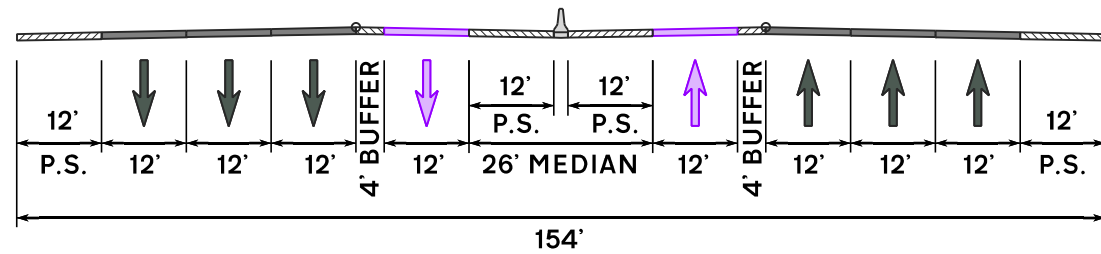
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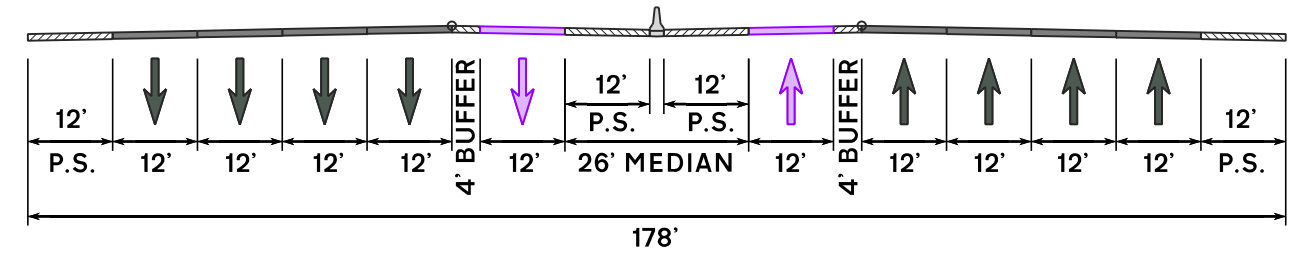
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FIGURE 1

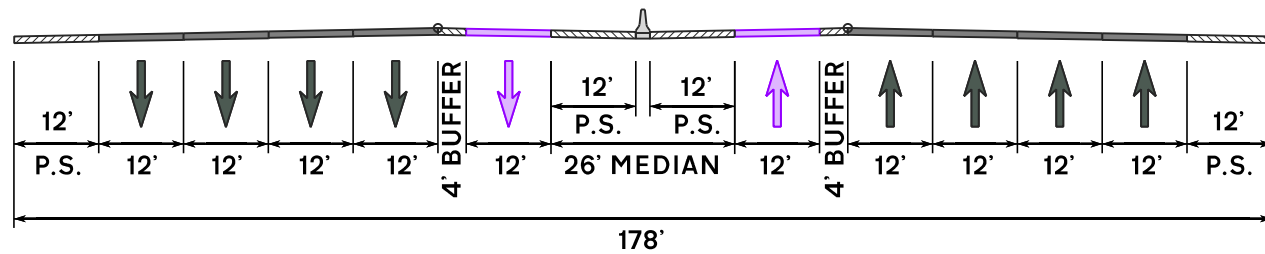
- Legend**
- FS-1005A General Purpose Widening
 - FS-1005A Managed Lanes
 - STIP No. I-5111
 - Future Interchange



ALT. 1 Typical No. 1: BEG to NSRR (-L- Sta. 601+50)
 I-40 From West of Wade Ave. to NSRR Overpass (East of Lake Wheeler Rd.)



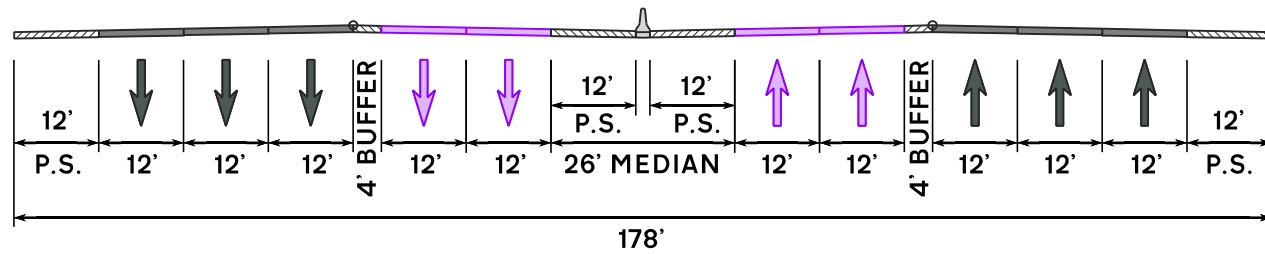
ALT. 3 Typical No. 1: BEG to END
 I-40 From West of Wade Ave. to I-440 Split, and I-440 to US 64-264 (Knightdale Bypass)



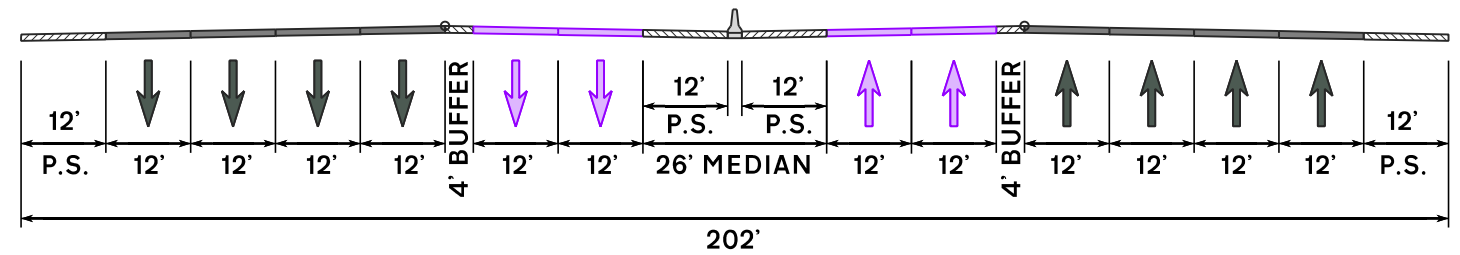
ALT. 1 Typical No. 2: NSRR (-L- Sta. 601+50) to END
 I-40 From NSRR Overpass (East of Lake Wheeler Rd.) to I-440 Split, and I-440 to US 64-264 (Knightdale Bypass)

ALT. 1 : +1ML (Existing General Purpose Lanes plus 1 Proposed Managed Lane)

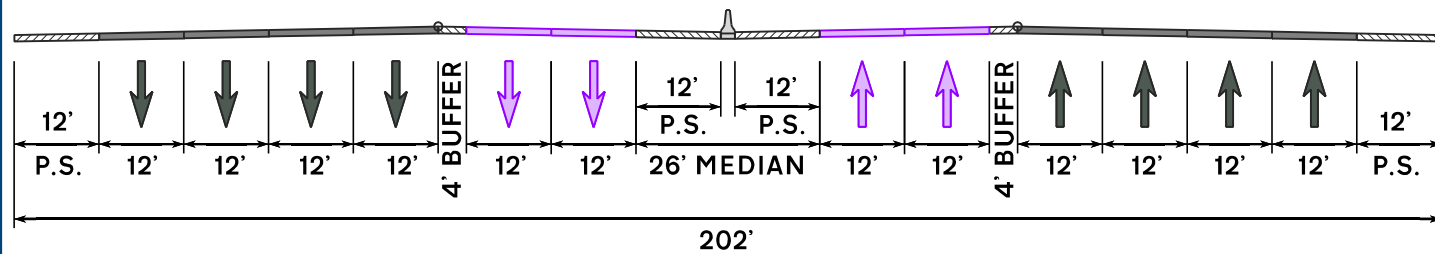
ALT. 3 : +1 GP Lane (BEG to 601+50) +1 M Lane (BEG to END)



ALT. 2 Typical No. 1: BEG (-L- Sta. 78+00) to NSRR (-L- Sta. 601+50)
 I-40 From West of Wade Ave. to NSRR Overpass (East of Lake Wheeler Rd.)



ALT. 4 Typical No. 1: BEG to END
 I-40 From West of Wade Ave. to I-440 Split, and I-440 to US 64-264 (Knightdale Bypass)



ALT. 2 Typical No. 2: NSRR (-L- Sta. 601+50) to END (-L- Sta.)
 I-40 From NSRR Overpass (East of Lake Wheeler Rd.) to I-440 Split, and I-440 to US 64-264 (Knightdale Bypass)

Note: NSRR = Norfolk Southern Railroad
 Typical Do Not Include Auxiliary Ramp Lanes

ALT. 2 : +2ML (Existing General Purpose Lanes plus 2 Proposed Managed Lane)

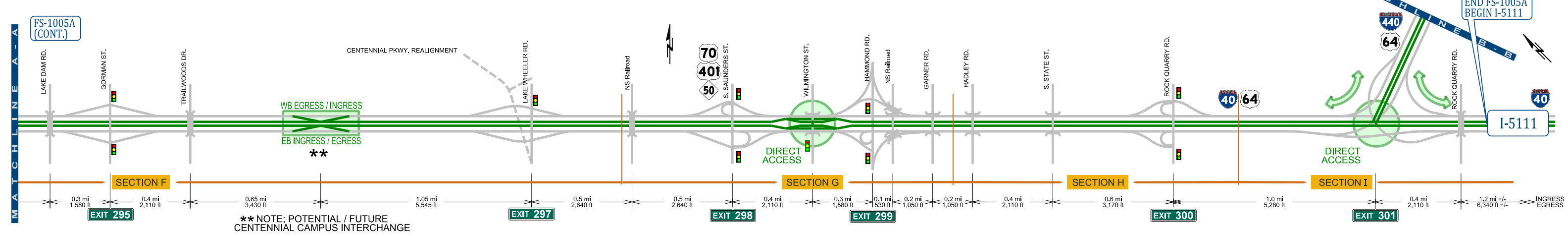
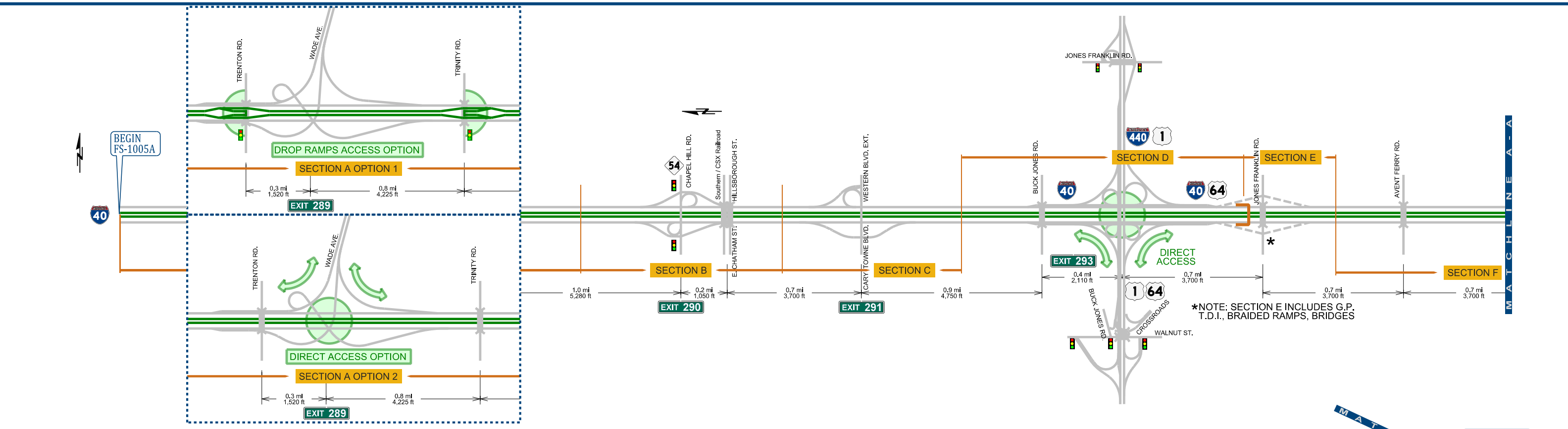
ALT. 4 : +1 GP Lane (BEG to 601+50) +2 M Lanes (BEG to END)

Typical Sections

Buffer-Separated, Concurrent Flow Managed Lanes

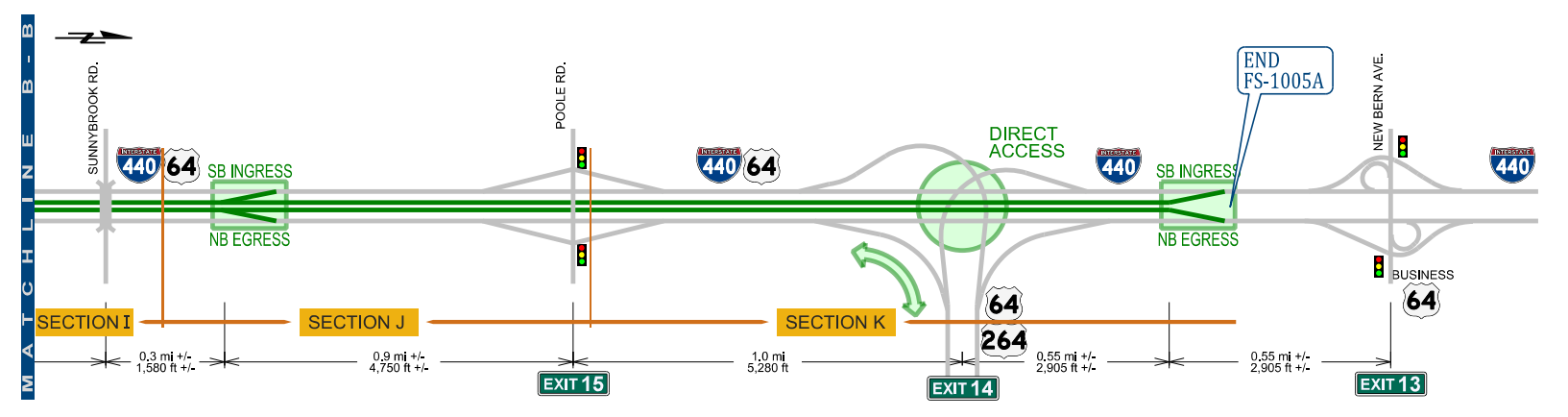
FIGURE 2
 FS-1005A
 Typical Sections

2/21/2015 Figure02.fs1005a.Local Sections.dgn



LEGEND

- GENERAL PURPOSE LANES
- MANAGED LANES
- DIRECT ACCESS : FREE-FLOWING
- DIRECT ACCESS : SIGNALIZED (DROP RAMPS)
- INGRESS / EGRESS



PRELIMINARY PLANS

NOTE: THESE PLANS ARE PRELIMINARY AND ARE SUBJECT TO CHANGE WITHOUT NOTICE. THIS STUDY IS NOT THE PRODUCT OF EXTENSIVE DESIGN OR ENVIRONMENTAL ANALYSIS.

FIGURE 3

MANAGED LANE ACCESS SCHEMATIC

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WILLIAM B. UMSTEAD PARK
(REEDY CREEK SECTION)

BEGIN FS-1005A

TRENTON RD. DROP RAMPS

RICHLAND CREEK

WADE AVE.

CITY
RALEIGH

WADE PARK BLVD.

INSIDE WADE
SUBDIVISION

INTERSTATE
40

TO HARRISON AVE.
EXIT 287

EXIT 289

SAS CAMPUS DR.

DANIEL AND VALLIE
MATTHEWS HOUSE

TOWN
CARY

TRENTON RD.

AGRICULTURAL
EXPERIMENT STATION

TRINITY RD.

BRIDGE #370 REPLACE

TRINITY RD. DROP RAMPS

INTERSTATE
40

FIGURE 4

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ALT. 2 (+2ML) FIGURE 4

FS-1005A
I-40 UPGRADES, MANAGED LANES
FROM I-40 AT WADE AVE.
TO I-440 AT US 64
WAKE COUNTY

LEGEND

PROPOSED G.P. ROADWAY	WETLANDS	COMMUNITY FEATURES
PROPOSED M.L. ROADWAY	STREAMS	CELL RADIO TOWERS
PROPOSED BRIDGES	WATER BODIES	FEMA 100 YEAR FLOODWAY
PROPOSED RIGHT-OF-WAY	STATE PARKS	SHPO HISTORIC PROPERTIES
EXISTING BRIDGES TO RETAIN	OVER-HEAD POWER LINES	POTENTIAL NOISE ABATEMENT
EXISTING BRIDGES TO REMOVE		
CITY/TOWN LIMITS		
PROPERTY LINES		

PRELIMINARY PLANS

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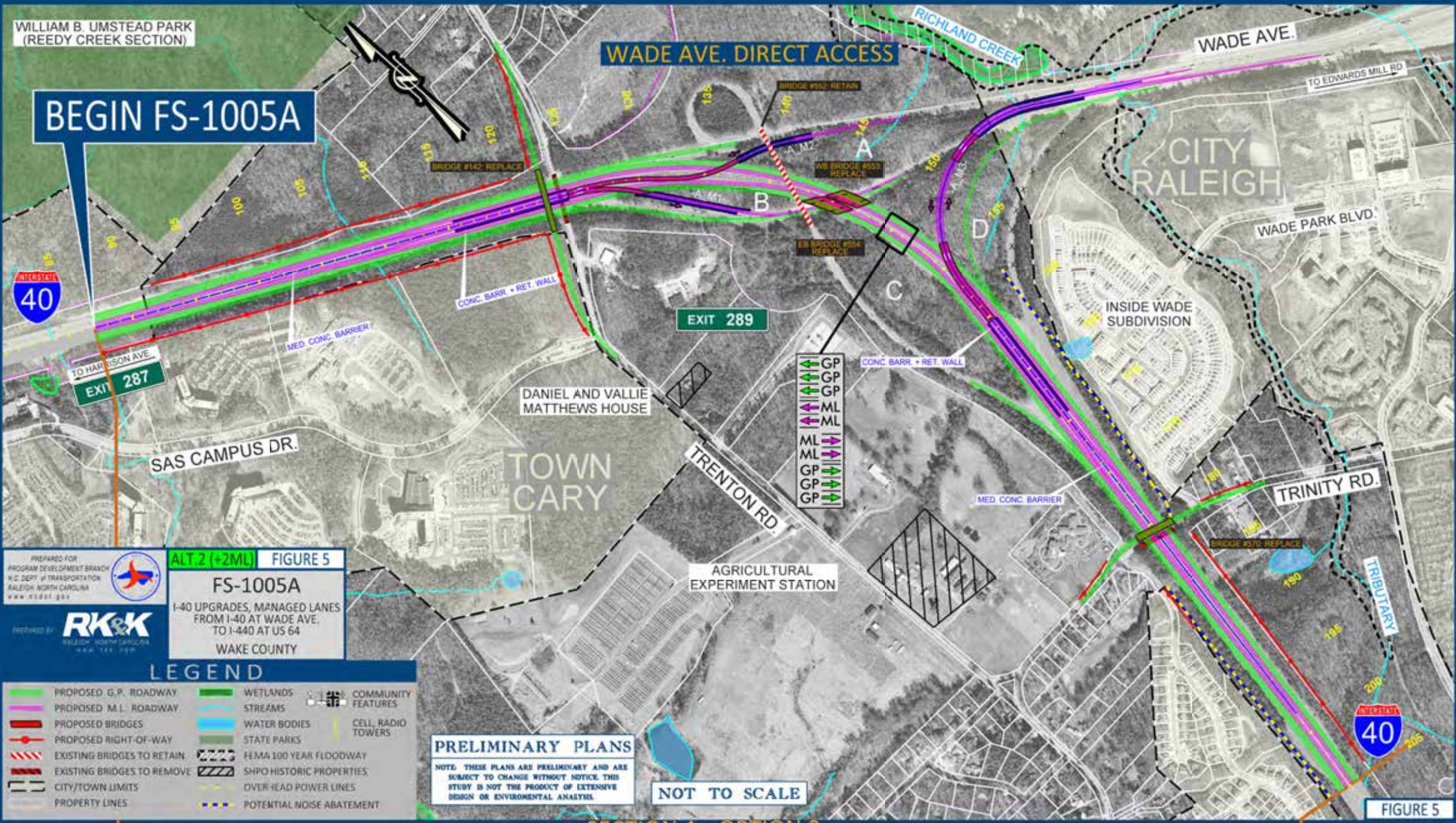
NOT TO SCALE

SECTION A - OPTION 1

WILLIAM B. UMSTEAD PARK
(REEDY CREEK SECTION)

WADE AVE. DIRECT ACCESS

BEGIN FS-1005A



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ALT. 2 (+2ML) FIGURE 5

FS-1005A
I-40 UPGRADES, MANAGED LANES
FROM I-40 AT WADE AVE.
TO I-440 AT US 64
WAKE COUNTY

LEGEND

	PROPOSED G.P. ROADWAY		WETLANDS		COMMUNITY FEATURES
	PROPOSED M.L. ROADWAY		STREAMS		CELL RADIO TOWERS
	PROPOSED BRIDGES		WATER BODIES		CITY/TOWN LIMITS
	PROPOSED RIGHT-OF-WAY		STATE PARKS		PROPERTY LINES
	EXISTING BRIDGES TO RETAIN		FEMA 100 YEAR FLOODWAY		SHPO HISTORIC PROPERTIES
	EXISTING BRIDGES TO REMOVE		OVER-HEAD POWER LINES		POTENTIAL NOISE ABATEMENT

PRELIMINARY PLANS

NOTE: THESE PLANS ARE PRELIMINARY AND ARE SUBJECT TO CHANGE WITHOUT NOTICE. THIS STUDY IS NOT THE PRODUCT OF EXTENSIVE DESIGN OR ENVIRONMENTAL ANALYSIS.

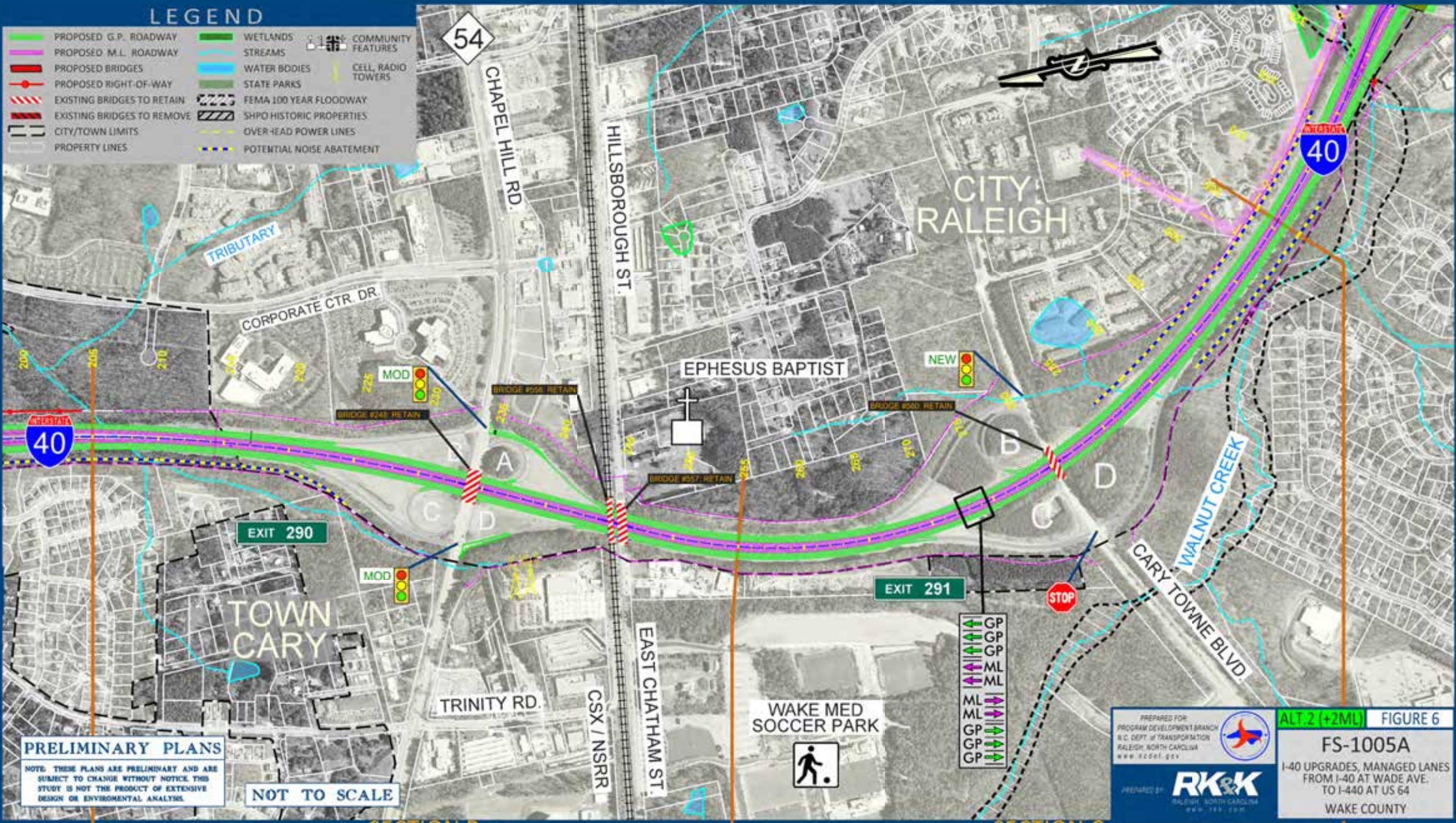
NOT TO SCALE

SECTION A - OPTION 2

FIGURE 5

LEGEND

- PROPOSED G.P. ROADWAY
- PROPOSED M.L. ROADWAY
- PROPOSED BRIDGES
- PROPOSED RIGHT-OF-WAY
- - - EXISTING BRIDGES TO RETAIN
- - - EXISTING BRIDGES TO REMOVE
- CITY/TOWN LIMITS
- PROPERTY LINES
- WETLANDS
- STREAMS
- WATER BODIES
- STATE PARKS
- FEMA 100 YEAR FLOODWAY
- SHPO HISTORIC PROPERTIES
- OVER-HEAD POWER LINES
- - - POTENTIAL NOISE ABATEMENT
- COMMUNITY FEATURES
- CELL RADIO TOWERS



PRELIMINARY PLANS
 NOTE: THESE PLANS ARE PRELIMINARY AND ARE SUBJECT TO CHANGE WITHOUT NOTICE. THIS STUDY IS NOT THE PRODUCT OF EXTENSIVE DESIGN OR ENVIRONMENTAL ANALYSIS.

NOT TO SCALE

- GP ↑
- GP ↓
- GP ↑
- GP ↓
- ML ↑
- ML ↓
- ML ↑
- ML ↓
- GP ↓
- GP ↓
- GP ↓

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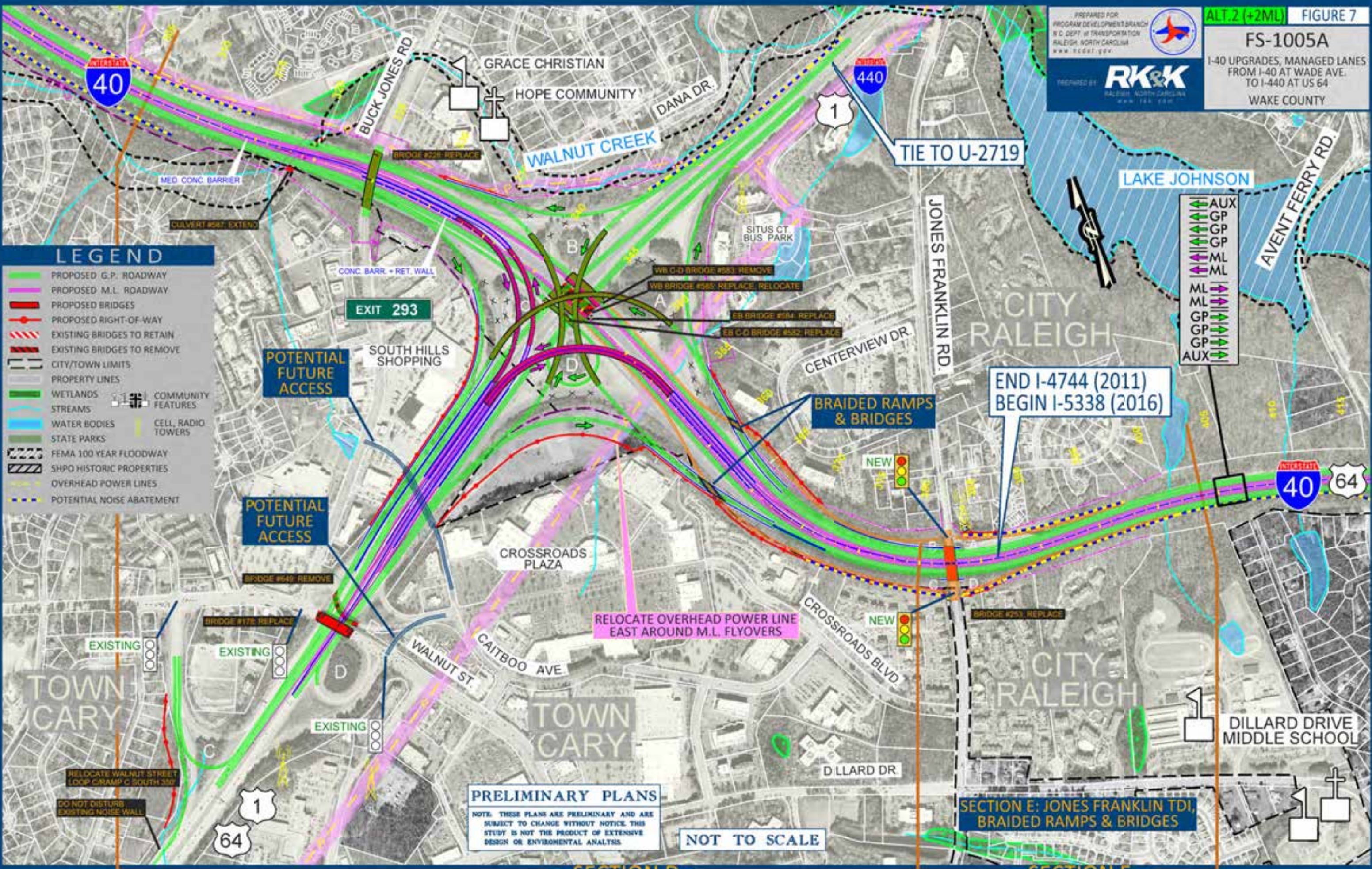
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ALT. 2 (+2MU) FIGURE 6

FS-1005A
 I-40 UPGRADES, MANAGED LANES
 FROM I-40 AT WADE AVE.
 TO I-440 AT US 64
 WAKE COUNTY

SECTION B

SECTION C



LEGEND

- PROPOSED G.P. ROADWAY
- PROPOSED M.L. ROADWAY
- PROPOSED BRIDGES
- PROPOSED RIGHT-OF-WAY
- EXISTING BRIDGES TO RETAIN
- EXISTING BRIDGES TO REMOVE
- CITY/TOWN LIMITS
- PROPERTY LINES
- WETLANDS
- STREAMS
- WATER BODIES
- STATE PARKS
- FEMA 100 YEAR FLOODWAY
- SHPO HISTORIC PROPERTIES
- OVERHEAD POWER LINES
- POTENTIAL NOISE ABATEMENT
- COMMUNITY FEATURES
- CELL, RADIO TOWERS

- AUX
- GP
- GP
- GP
- ML
- ML
- ML
- GP
- GP
- GP
- AUX

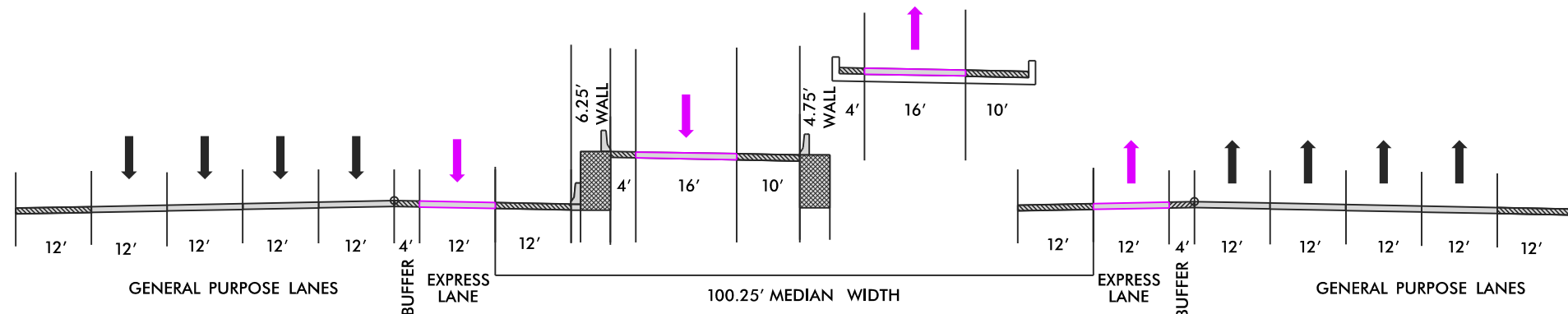
PRELIMINARY PLANS
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NOT TO SCALE

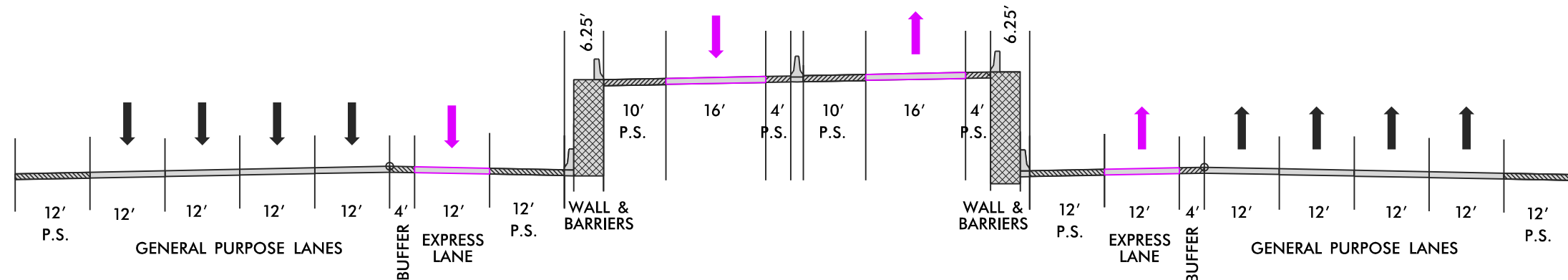
SECTION E: JONES FRANKLIN TDI, BRAIDED RAMPS & BRIDGES

SECTION D

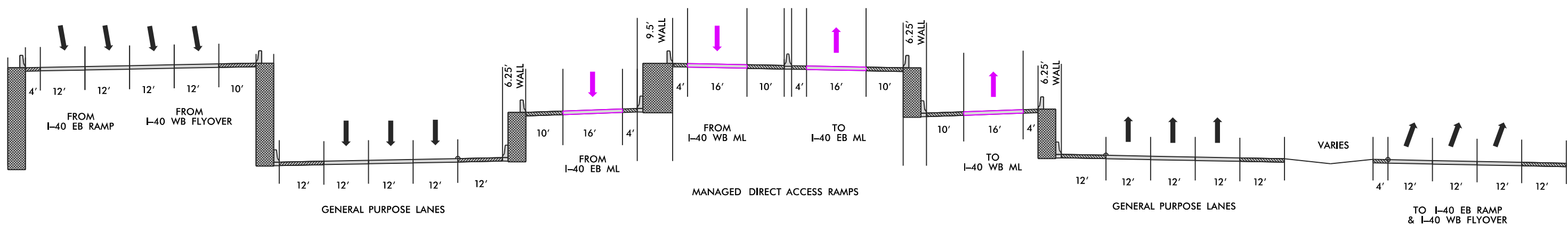
SECTION E



I-40 SECTION, 1-WAY M.L. FLYOVERS
Eastbound I-40 Approach



I-40 SECTION, 2-WAY M.L. FLYOVERS
Westbound I-40 Approach



US 1 SECTION, 1-WAY & 2-WAY FLYOVERS
Northbound US 1 Approach

LEGEND

- PROPOSED G.P. ROADWAY
- PROPOSED M.L. ROADWAY

PRELIMINARY PLANS

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ALT.2 (+2ML) FIGURE 7A

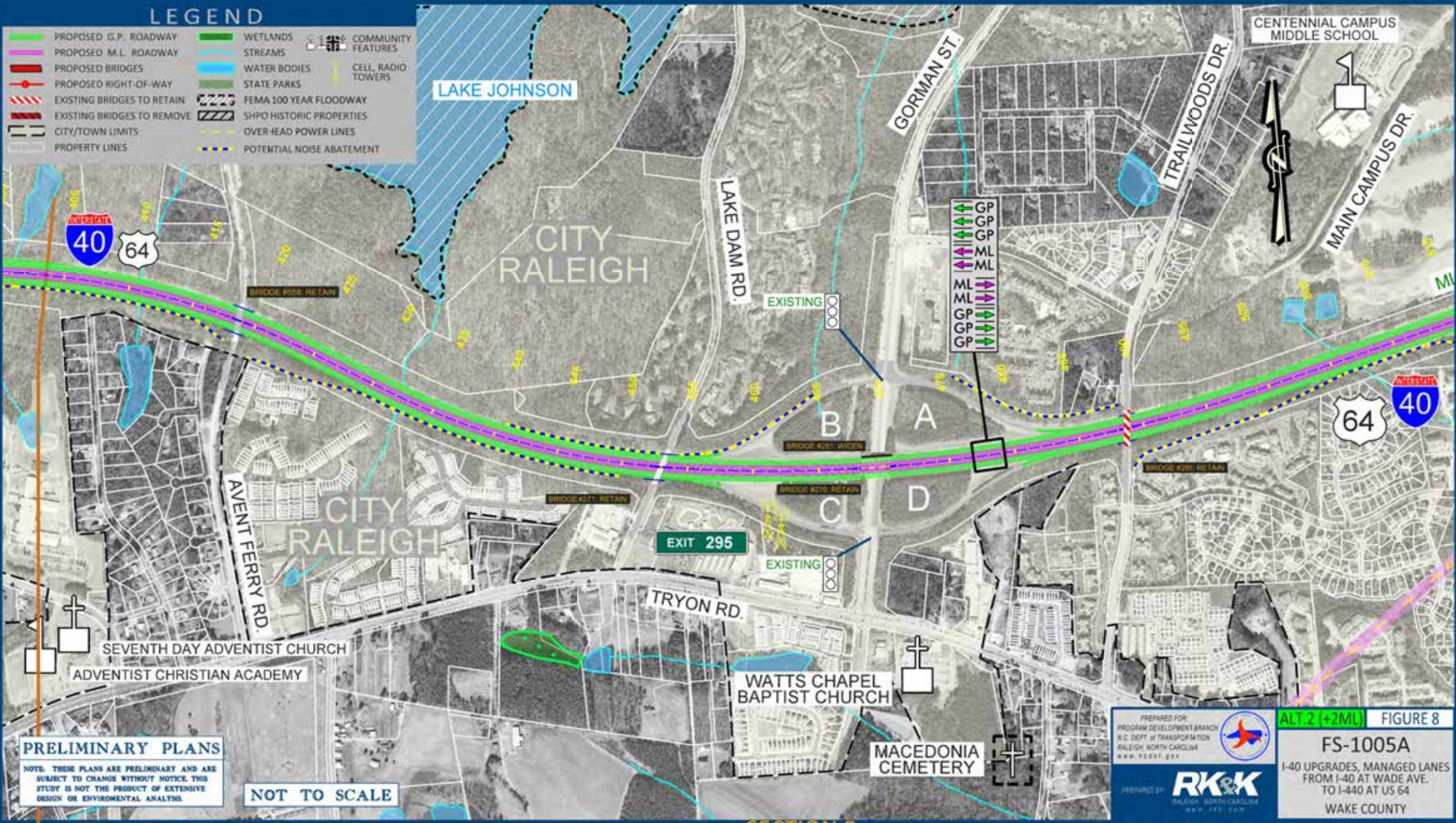
FS-1005A

I-40 UPGRADES, MANAGED LANES
 FROM I-40 AT WADE AVE.
 TO I-440 AT US 64
 WAKE COUNTY

3/13/2015 Figure 7A, FS-1005A, Roll 13, T. Ligon, dgn

LEGEND

- PROPOSED G.P. ROADWAY
- PROPOSED M.L. ROADWAY
- PROPOSED BRIDGES
- - - PROPOSED RIGHT-OF-WAY
- / - / EXISTING BRIDGES TO RETAIN
- \ - \ EXISTING BRIDGES TO REMOVE
- CITY/TOWN LIMITS
- PROPERTY LINES
- WETLANDS
- STREAMS
- WATER BODIES
- STATE PARKS
- FEMA 100 YEAR FLOODWAY
- SHPO HISTORIC PROPERTIES
- - - OVER-HEAD POWER LINES
- - - POTENTIAL NOISE ABATEMENT
- COMMUNITY FEATURES
- CELL RADIO TOWERS



PRELIMINARY PLANS

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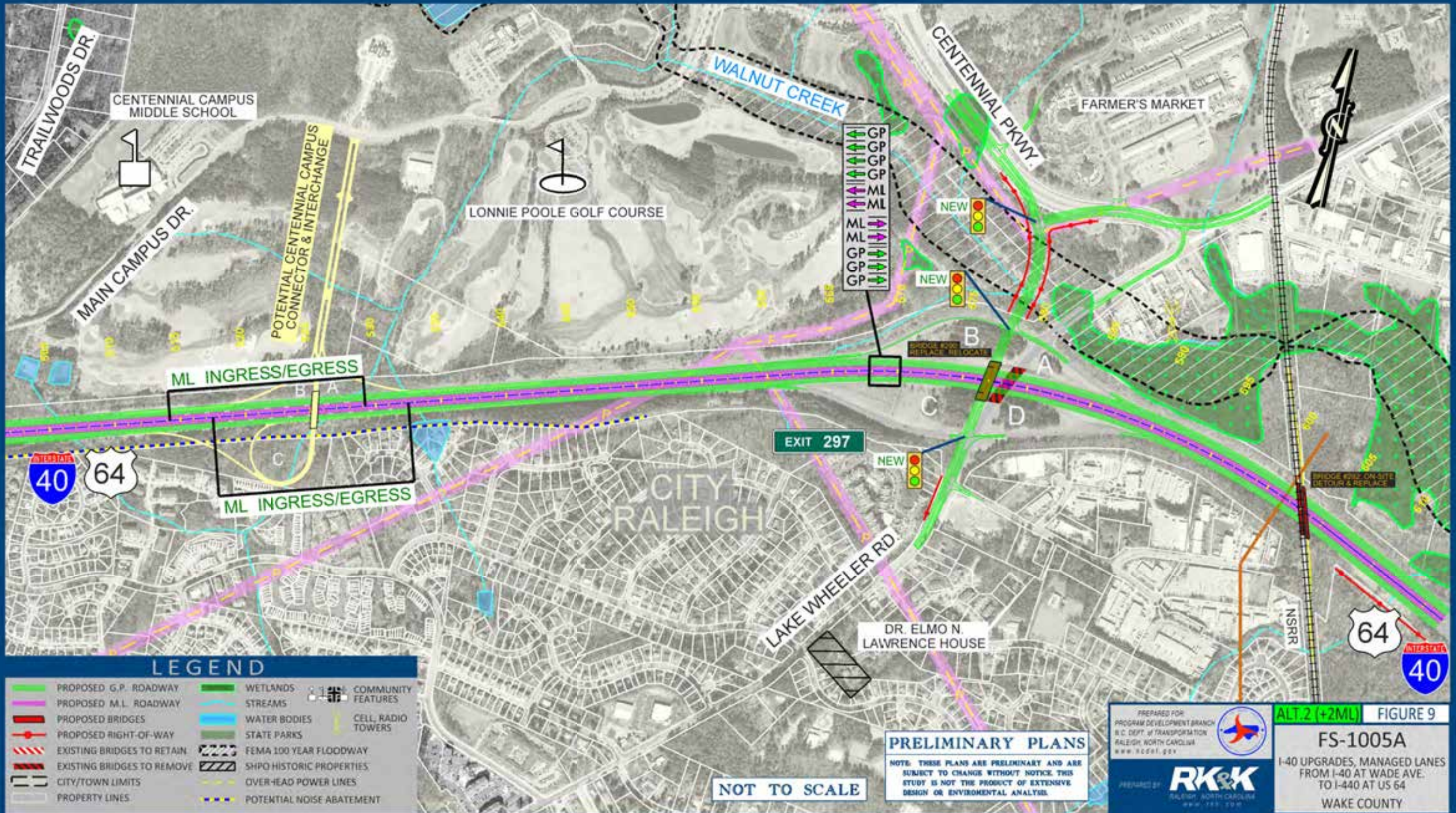
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ALT 2 (+2MU) FIGURE 8

FS-1005A
I-40 UPGRADES, MANAGED LANES
FROM I-40 AT WADE AVE.
TO I-440 AT US 64
WAKE COUNTY

SECTION F



LEGEND

- | | | | | | |
|--|----------------------------|--|-----------------------|--|---------------------------|
| | PROPOSED G.P. ROADWAY | | WETLANDS | | COMMUNITY FEATURES |
| | PROPOSED M.L. ROADWAY | | STREAMS | | CELL, RADIO TOWERS |
| | PROPOSED BRIDGES | | WATER BODIES | | FEMA 100 YEAR FLOODWAY |
| | PROPOSED RIGHT-OF-WAY | | STATE PARKS | | SHPO HISTORIC PROPERTIES |
| | EXISTING BRIDGES TO RETAIN | | OVER-HEAD POWER LINES | | POTENTIAL NOISE ABATEMENT |
| | EXISTING BRIDGES TO REMOVE | | | | |
| | CITY/TOWN LIMITS | | | | |
| | PROPERTY LINES | | | | |

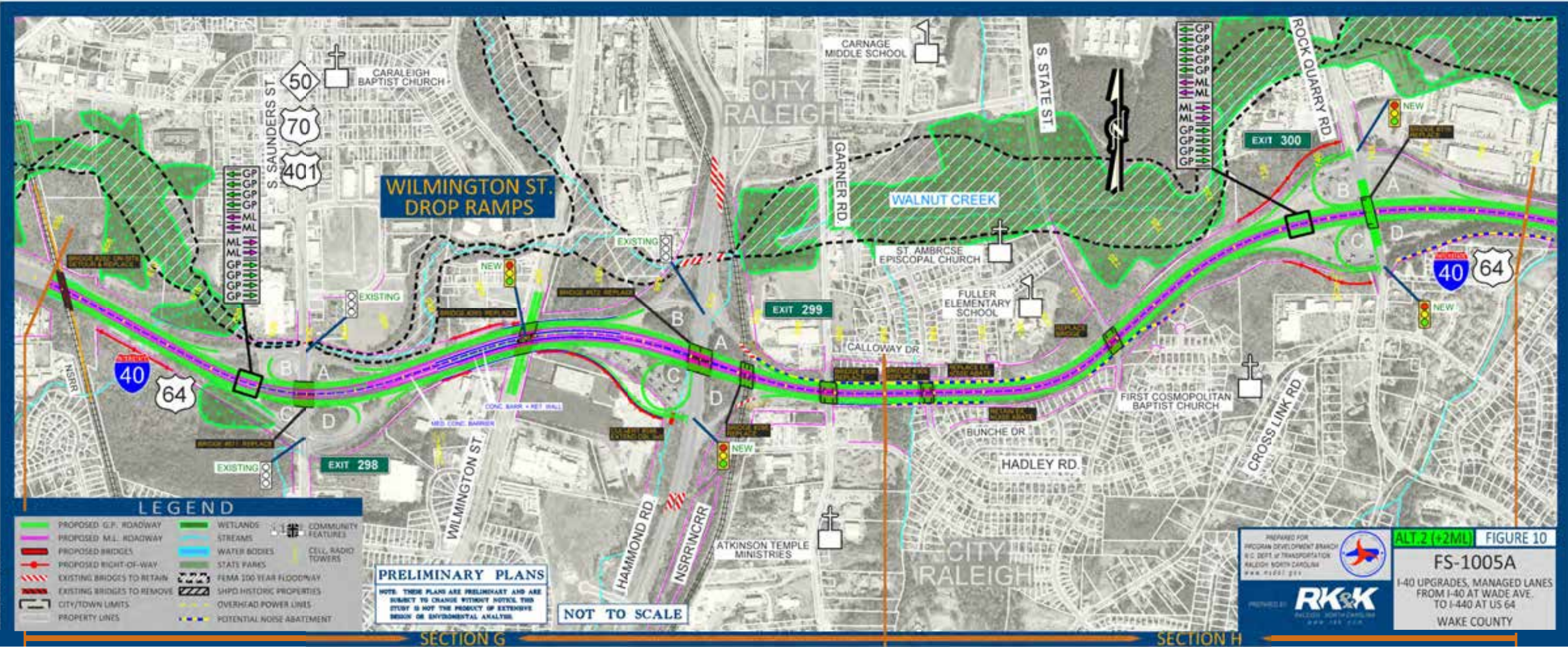
- GP
- GP
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- ML
- ML
- ML
- GP
- GP
- GP

PRELIMINARY PLANS
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ALT. 2 (+2MU) FIGURE 9
FS-1005A
 I-40 UPGRADES, MANAGED LANES
 FROM I-40 AT WADE AVE.
 TO I-440 AT US 64
 WAKE COUNTY



WILMINGTON ST. DROP RAMPS

WALNUT CREEK

PRELIMINARY PLANS

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NOT TO SCALE

AL 2 (2MI) FIGURE 10

FS-1005A
 I-40 UPGRADES, MANAGED LANES
 FROM I-40 AT WADE AVE.
 TO I-440 AT US 64
 WAKE COUNTY



SECTION G

SECTION H



PRELIMINARY PLANS

NOTE: THESE PLANS ARE PRELIMINARY AND ARE SUBJECT TO CHANGE WITHOUT NOTICE. THIS STUDY IS NOT THE PRODUCT OF EXTENSIVE DESIGN OR ENVIRONMENTAL ANALYSIS.

NOT TO SCALE

LEGEND

- | | | |
|----------------------------|---------------------------|--------------------|
| PROPOSED G.P. ROADWAY | WETLANDS | COMMUNITY FEATURES |
| PROPOSED M.L. ROADWAY | STREAMS | CELL, RADIO TOWERS |
| PROPOSED BRIDGES | WATER BODIES | |
| PROPOSED RIGHT-OF-WAY | STATE PARKS | |
| EXISTING BRIDGES TO RETAIN | FEMA 100 YEAR FLOODWAY | |
| EXISTING BRIDGES TO REMOVE | SHPO HISTORIC PROPERTIES | |
| CITY/TOWN LIMITS | OVER-HEAD POWER LINES | |
| PROPERTY LINES | POTENTIAL NOISE ABATEMENT | |

SOUTHEAST RALEIGH HIGH

END FS-1005A
BEGIN I-5111

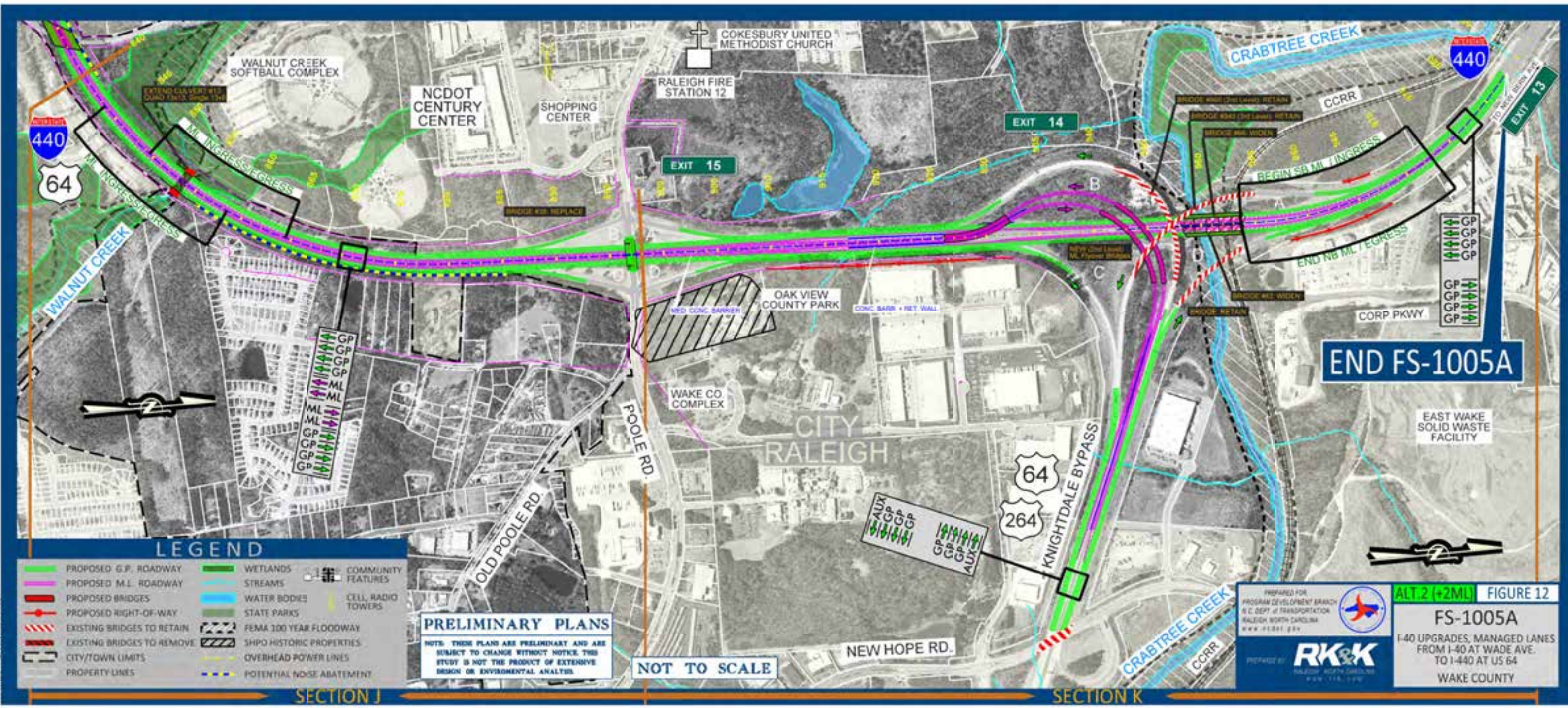
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ALT. 2 (+2MU) FIGURE 11

FS-1005A
I-40 UPGRADES, MANAGED LANES
FROM I-40 AT WADE AVE.
TO I-440 AT US 64
WAKE COUNTY

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SECTION I



LEGEND

- | | | | | | |
|--|----------------------------|--|------------------------|--|---------------------------|
| | PROPOSED G.P. ROADWAY | | WETLANDS | | COMMUNITY FEATURES |
| | PROPOSED M.L. ROADWAY | | STREAMS | | CELL, RADIO TOWERS |
| | PROPOSED BRIDGES | | WATER BODIES | | STATE PARKS |
| | PROPOSED RIGHT-OF-WAY | | FEMA 100 YEAR FLOODWAY | | SHPO HISTORIC PROPERTIES |
| | EXISTING BRIDGES TO RETAIN | | OVERHEAD POWER LINES | | POTENTIAL NOISE ABATEMENT |
| | EXISTING BRIDGES TO REMOVE | | | | |
| | CITY/TOWN LIMITS | | | | |
| | PROPERTY LINES | | | | |

PRELIMINARY PLANS

NOTE: THESE PLANS ARE PRELIMINARY AND ARE SUBJECT TO CHANGE WITHOUT NOTICE. THIS STUDY IS NOT THE PRODUCT OF EXTENSIVE DESIGN OR ENVIRONMENTAL ANALYSIS.

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END FS-1005A

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ALT 2 (+2MI) FIGURE 12

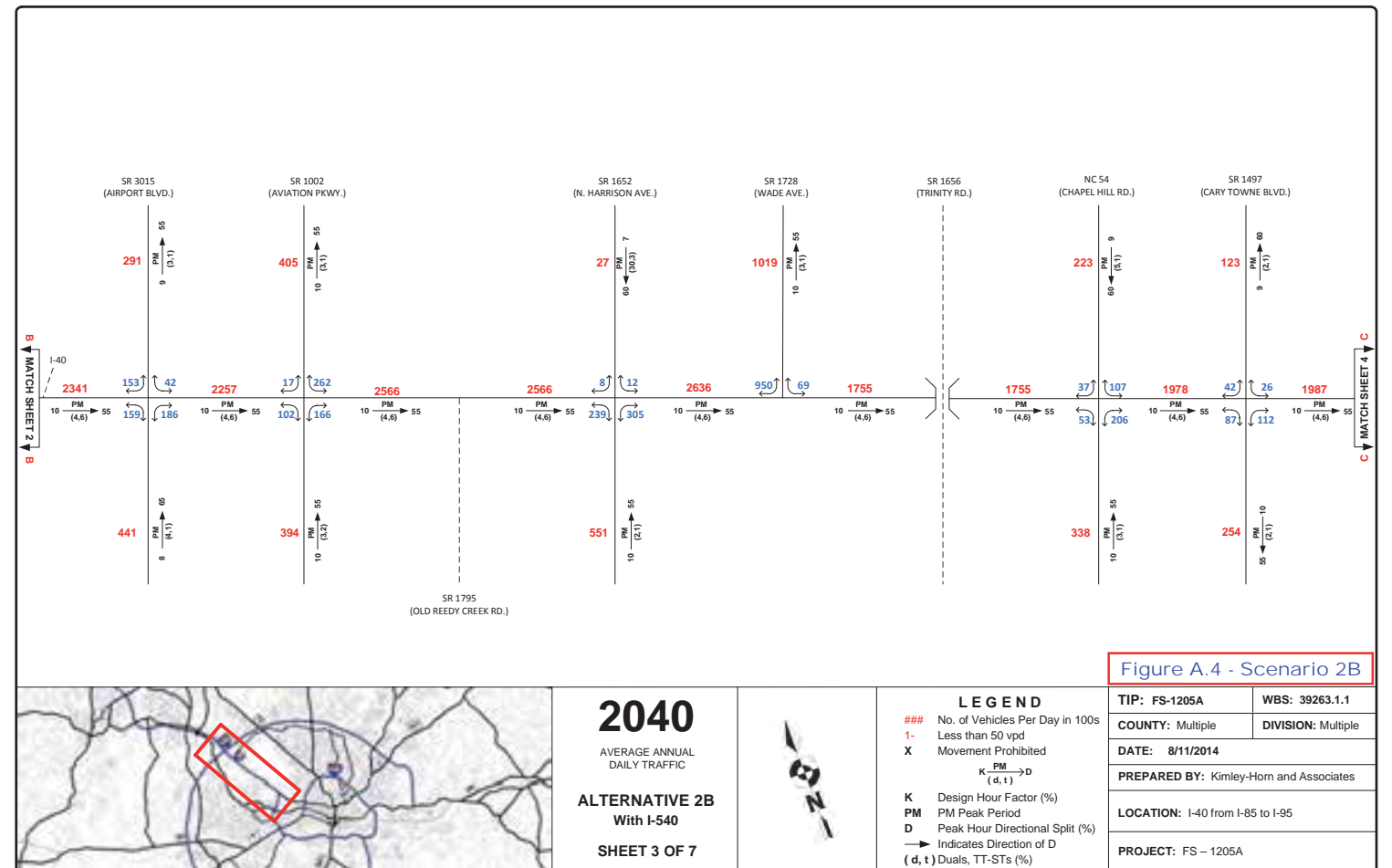
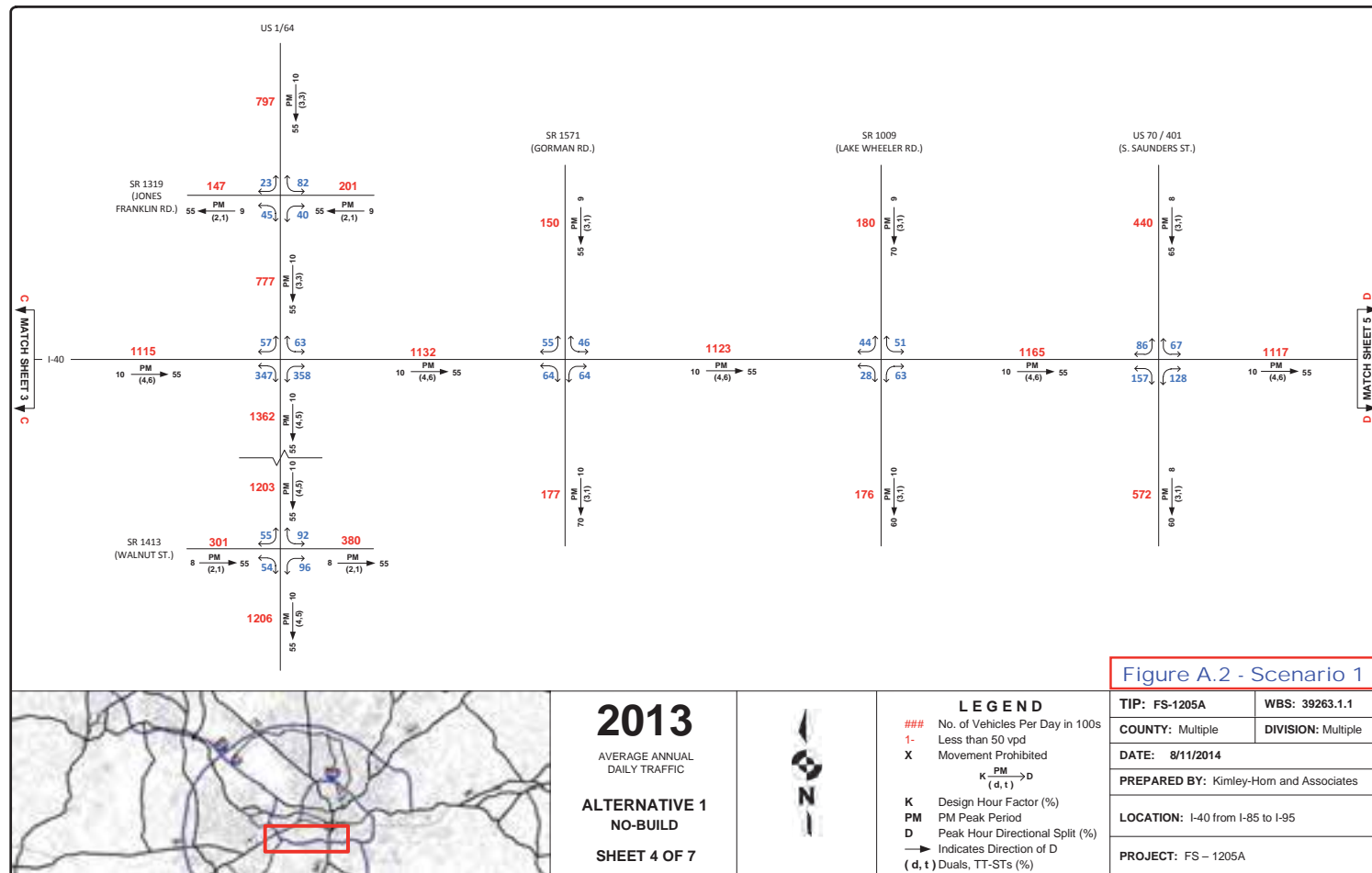
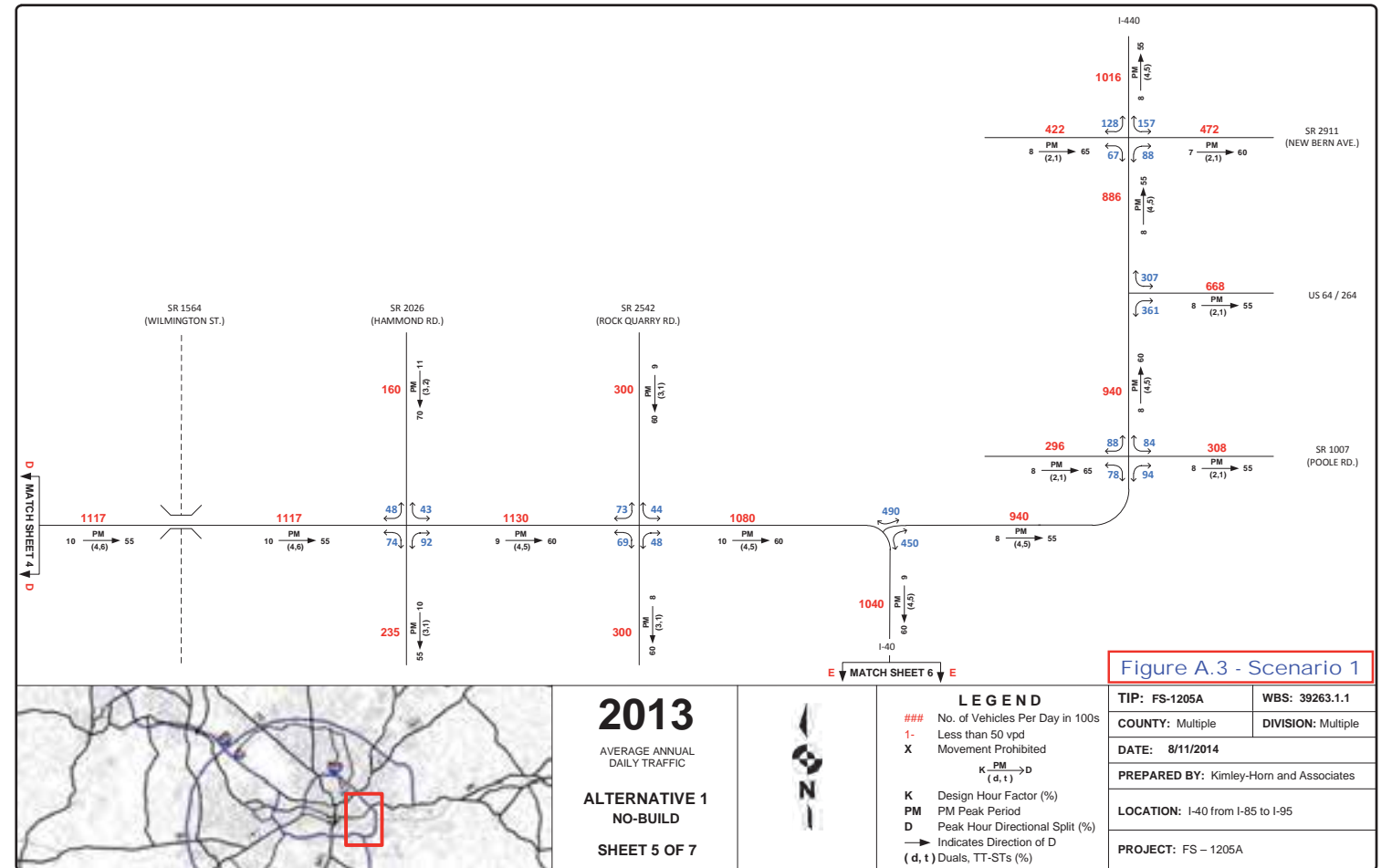
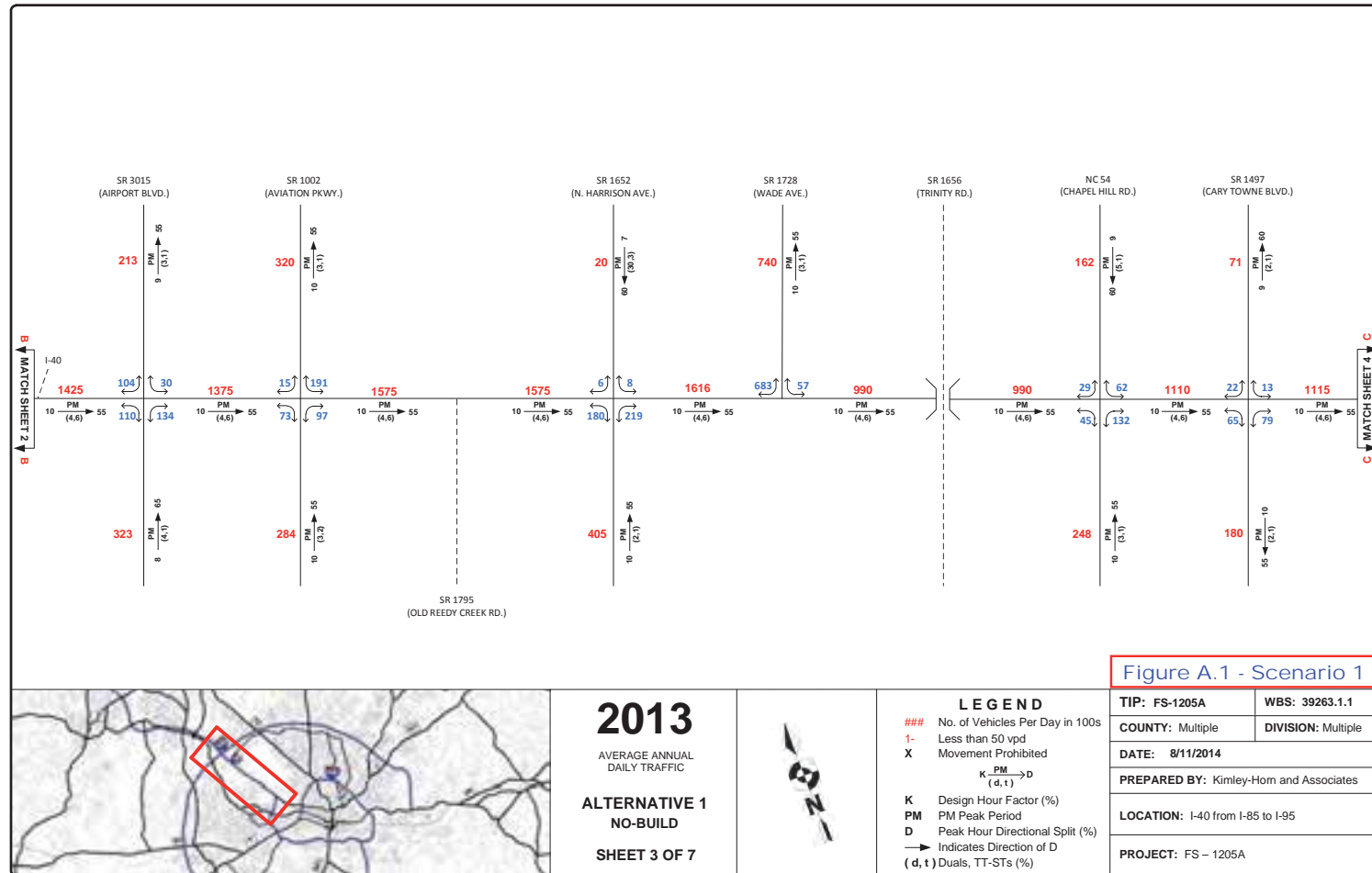
FS-1005A
I-40 UPGRADES, MANAGED LANES
FROM I-40 AT WADE AVE.
TO I-440 AT US 64
WAKE COUNTY

SECTION J

SECTION K

Appendix A:

Traffic Forecast and Preliminary Analysis



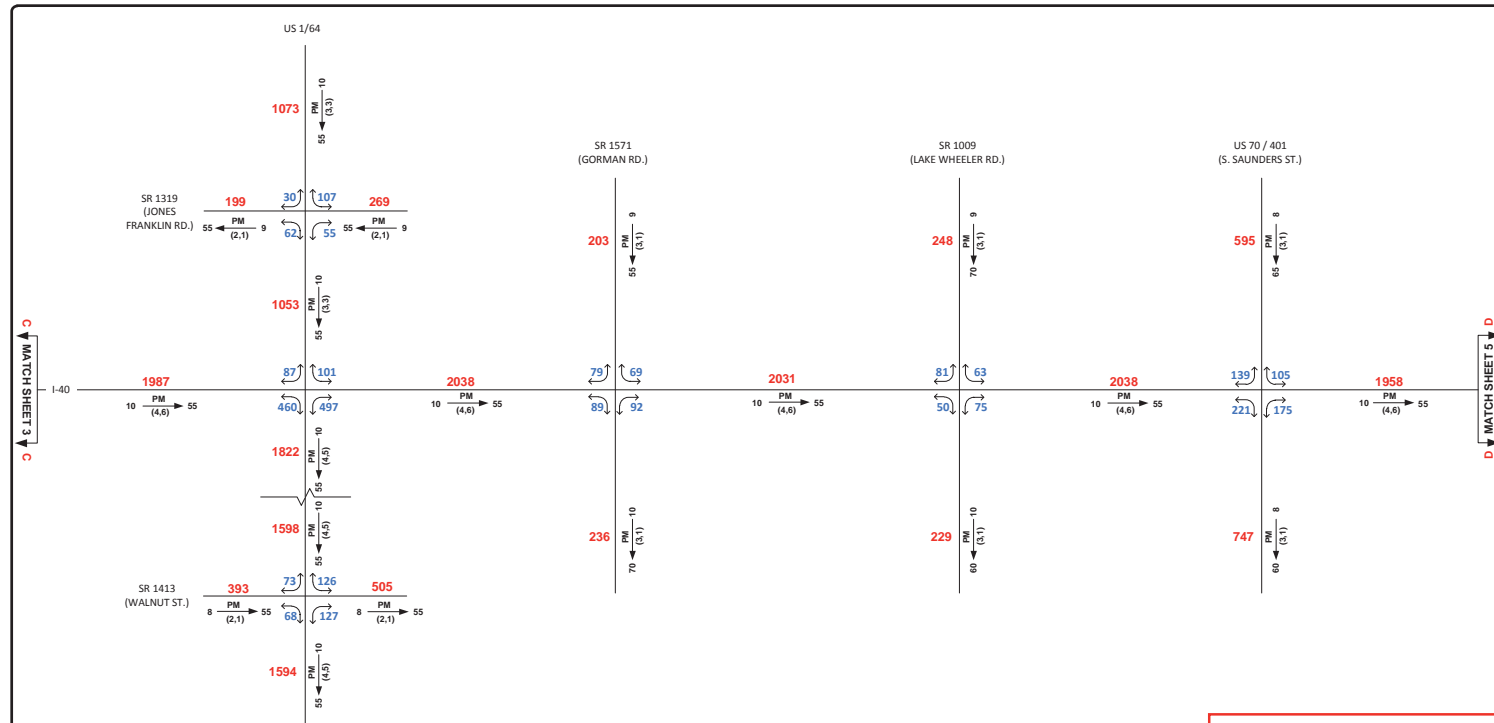


Figure A.5 - Scenario 2B

	<p>2040 AVERAGE ANNUAL DAILY TRAFFIC</p> <p>ALTERNATIVE 2B With I-540</p> <p>SHEET 4 OF 7</p>		<p>LEGEND</p> <p>### No. of Vehicles Per Day in 100s</p> <p>1- Less than 50 vpd</p> <p>X Movement Prohibited</p> <p>K-PM → D (d, t)</p> <p>K Design Hour Factor (%)</p> <p>PM PM Peak Period</p> <p>D Peak Hour Directional Split (%)</p> <p>→ Indicates Direction of D</p> <p>(d, t) Duals, TT-STs (%)</p>	<p>TIP: FS-1205A WBS: 39263.1.1</p> <p>COUNTY: Multiple DIVISION: Multiple</p> <p>DATE: 8/11/2014</p> <p>PREPARED BY: Kimley-Horn and Associates</p> <p>LOCATION: I-40 from I-85 to I-95</p> <p>PROJECT: FS - 1205A</p>
				<p>SR 1319 (JONES FRANKLIN RD.)</p> <p>SR 1413 (WALNUT ST.)</p> <p>SR 1571 (GORMAN RD.)</p> <p>SR 1009 (LAKE WHEELER RD.)</p> <p>SR 70 / 401 (S. SAUNDERS ST.)</p>

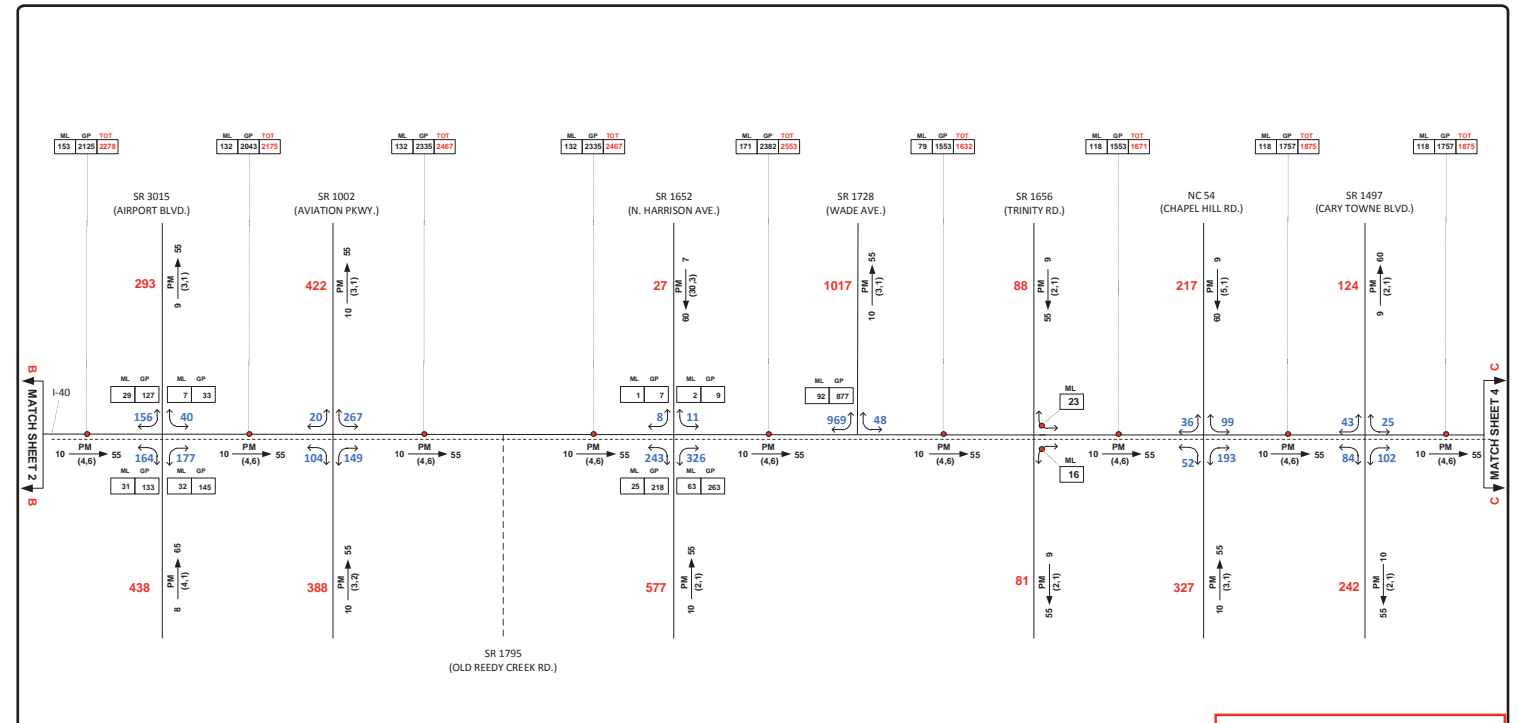


Figure A.7 - Scenario 3B

	<p>2040 AVERAGE ANNUAL DAILY TRAFFIC</p> <p>ALTERNATIVE 3B With I-540</p> <p>SHEET 3 OF 7</p>		<p>LEGEND</p> <p>### No. of Vehicles Per Day in 100s</p> <p>1- Less than 50 vpd</p> <p>X Movement Prohibited</p> <p>K-PM → D (d, t)</p> <p>K Design Hour Factor (%)</p> <p>PM PM Peak Period</p> <p>D Peak Hour Directional Split (%)</p> <p>→ Indicates Direction of D</p> <p>(d, t) Duals, TT-STs (%)</p>	<p>TIP: FS-1205A WBS: 39263.1.1</p> <p>COUNTY: Multiple DIVISION: Multiple</p> <p>DATE: 8/11/2014</p> <p>PREPARED BY: Kimley-Horn and Associates</p> <p>LOCATION: I-40 from I-85 to I-95</p> <p>PROJECT: FS - 1205A</p>
				<p>SR 3015 (AIRPORT BLVD.)</p> <p>SR 1002 (AVIATION PKWY.)</p> <p>SR 1652 (N. HARRISON AVE.)</p> <p>SR 1728 (WADE AVE.)</p> <p>SR 1656 (TRINITY RD.)</p> <p>NC 54 (CHAPEL HILL RD.)</p> <p>SR 1497 (CARY TOWNE BLVD.)</p>

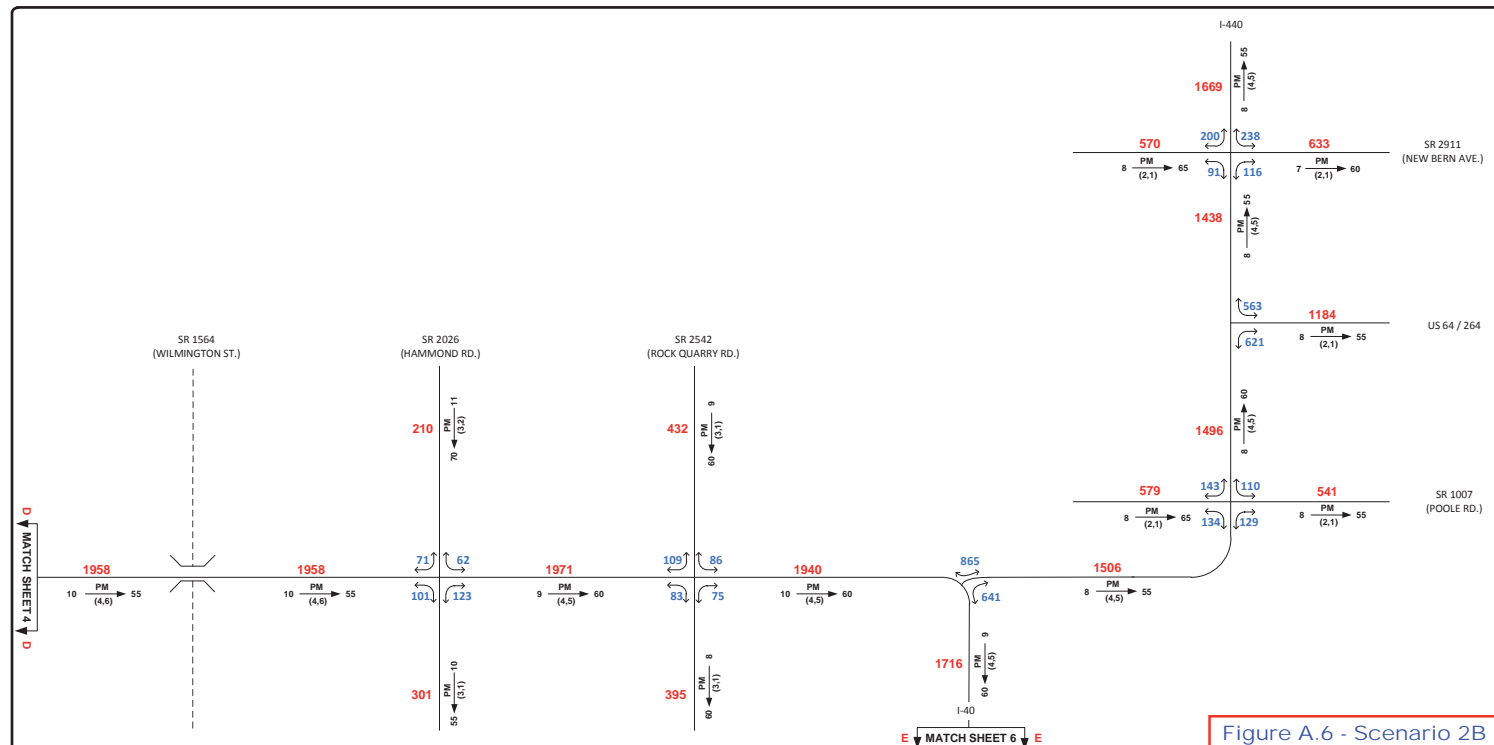


Figure A.6 - Scenario 2B

	<p>2040 AVERAGE ANNUAL DAILY TRAFFIC</p> <p>ALTERNATIVE 2B With I-540</p> <p>SHEET 5 OF 7</p>		<p>LEGEND</p> <p>### No. of Vehicles Per Day in 100s</p> <p>1- Less than 50 vpd</p> <p>X Movement Prohibited</p> <p>K-PM → D (d, t)</p> <p>K Design Hour Factor (%)</p> <p>PM PM Peak Period</p> <p>D Peak Hour Directional Split (%)</p> <p>→ Indicates Direction of D</p> <p>(d, t) Duals, TT-STs (%)</p>	<p>TIP: FS-1205A WBS: 39263.1.1</p> <p>COUNTY: Multiple DIVISION: Multiple</p> <p>DATE: 8/11/2014</p> <p>PREPARED BY: Kimley-Horn and Associates</p> <p>LOCATION: I-40 from I-85 to I-95</p> <p>PROJECT: FS - 1205A</p>
				<p>SR 1564 (WILMINGTON ST.)</p> <p>SR 2026 (HAMMOND RD.)</p> <p>SR 2542 (ROCK QUARRY RD.)</p> <p>SR 2911 (NEW BERN AVE.)</p> <p>US 64 / 264</p> <p>SR 1007 (POOLE RD.)</p>

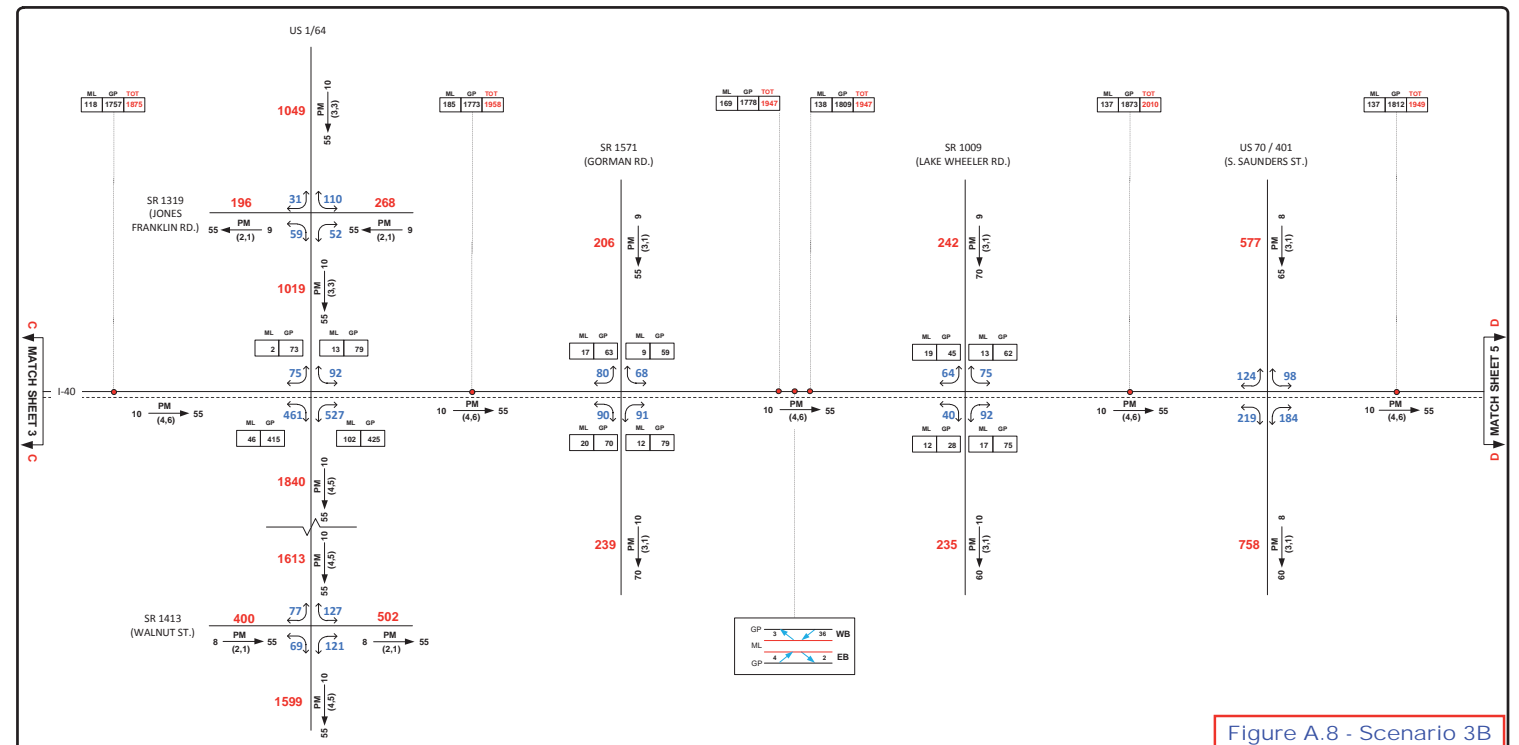


Figure A.8 - Scenario 3B

	<p>2040 AVERAGE ANNUAL DAILY TRAFFIC</p> <p>ALTERNATIVE 3B With I-540</p> <p>SHEET 4 OF 7</p>		<p>LEGEND</p> <p>### No. of Vehicles Per Day in 100s</p> <p>1- Less than 50 vpd</p> <p>X Movement Prohibited</p> <p>K-PM → D (d, t)</p> <p>K Design Hour Factor (%)</p> <p>PM PM Peak Period</p> <p>D Peak Hour Directional Split (%)</p> <p>→ Indicates Direction of D</p> <p>(d, t) Duals, TT-STs (%)</p>	<p>TIP: FS-1205A WBS: 39263.1.1</p> <p>COUNTY: Multiple DIVISION: Multiple</p> <p>DATE: 8/11/2014</p> <p>PREPARED BY: Kimley-Horn and Associates</p> <p>LOCATION: I-40 from I-85 to I-95</p> <p>PROJECT: FS - 1205A</p>
				<p>SR 1319 (JONES FRANKLIN RD.)</p> <p>SR 1413 (WALNUT ST.)</p> <p>SR 1571 (GORMAN RD.)</p> <p>SR 1009 (LAKE WHEELER RD.)</p> <p>SR 70 / 401 (S. SAUNDERS ST.)</p>

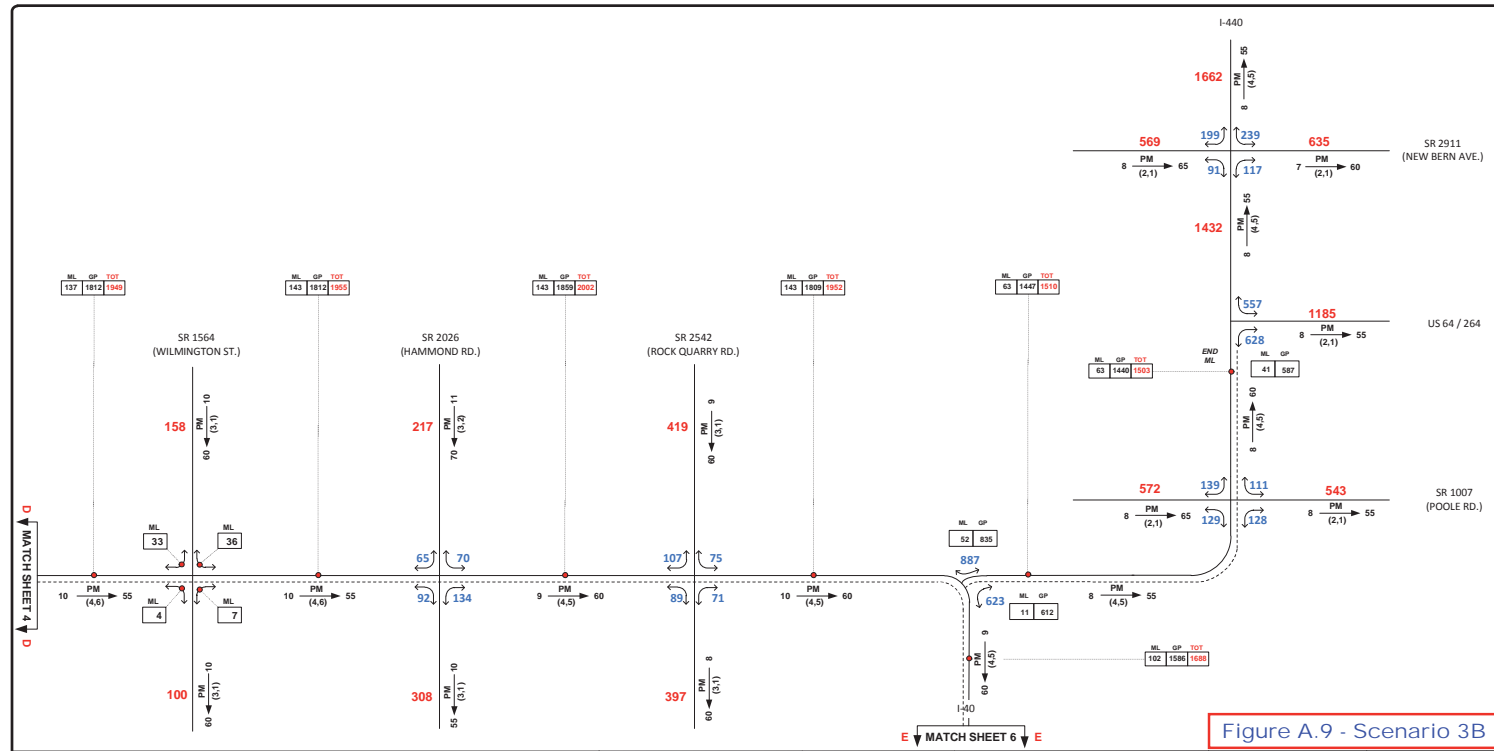


Figure A.9 - Scenario 3B

	<h2>2040</h2> <p>AVERAGE ANNUAL DAILY TRAFFIC</p>		<p>LEGEND</p> <p>### No. of Vehicles Per Day in 100s</p> <p>1- Less than 50 vpd</p> <p>X Movement Prohibited</p> <p>K-PM → D (d, t)</p> <p>K Design Hour Factor (%)</p> <p>PM PM Peak Period</p> <p>D Peak Hour Directional Split (%)</p> <p>→ Indicates Direction of D</p> <p>(d, t) Duals, TT-STs (%)</p>	<p>TIP: FS-1205A WBS: 39263.1.1</p>
	<p>ALTERNATIVE 3B With I-540</p>			<p>COUNTY: Multiple DIVISION: Multiple</p>
	<p>SHEET 5 OF 7</p>			<p>DATE: 8/11/2014</p>
				<p>PREPARED BY: Kimley-Horn and Associates</p>
				<p>LOCATION: I-40 from I-85 to I-95</p>
	<p>PROJECT: FS - 1205A</p>			

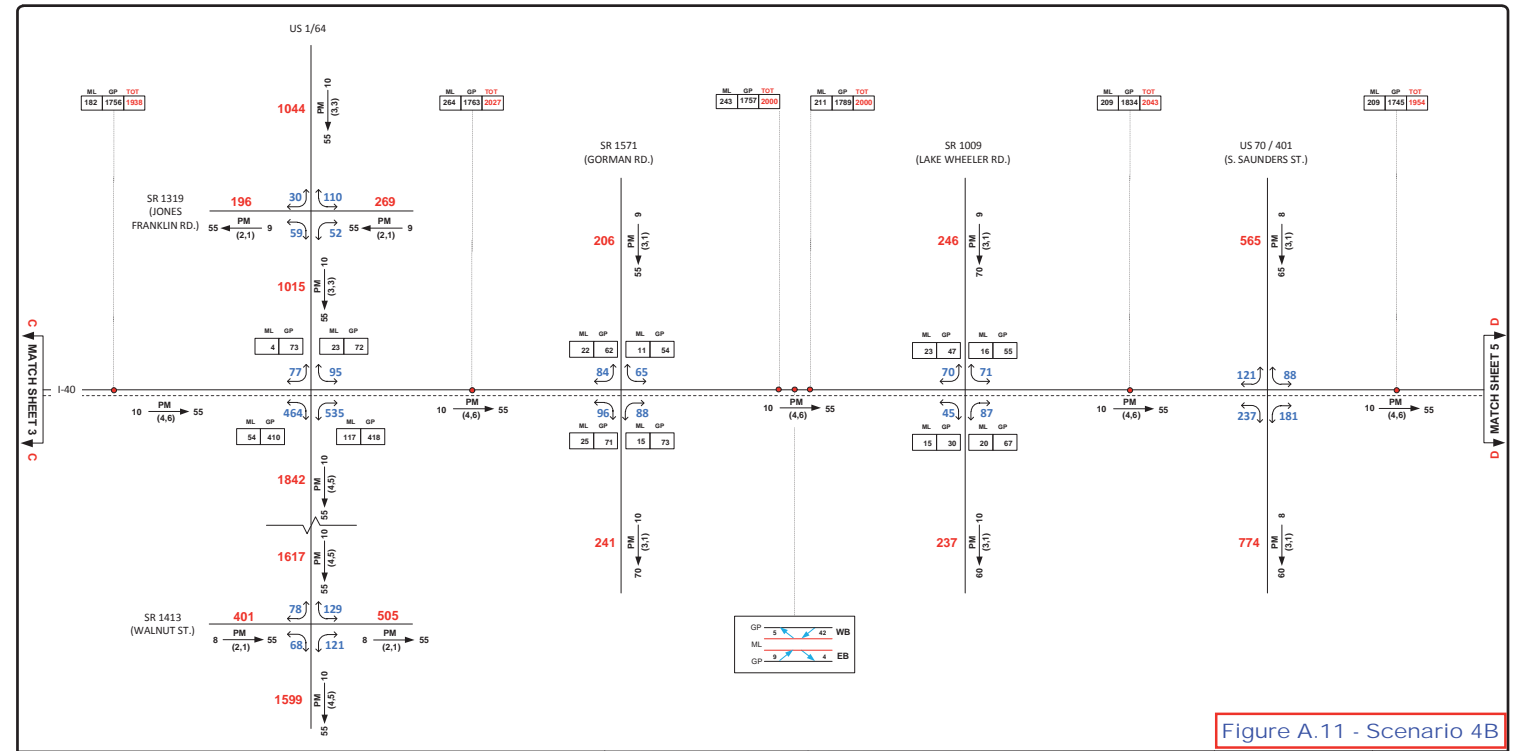


Figure A.11 - Scenario 4B

	<h2>2040</h2> <p>AVERAGE ANNUAL DAILY TRAFFIC</p>		<p>LEGEND</p> <p>### No. of Vehicles Per Day in 100s</p> <p>1- Less than 50 vpd</p> <p>X Movement Prohibited</p> <p>K-PM → D (d, t)</p> <p>K Design Hour Factor (%)</p> <p>PM PM Peak Period</p> <p>D Peak Hour Directional Split (%)</p> <p>→ Indicates Direction of D</p> <p>(d, t) Duals, TT-STs (%)</p>	<p>TIP: FS-1205A WBS: 39263.1.1</p>
	<p>ALTERNATIVE 4B With I-540</p>			<p>COUNTY: Multiple DIVISION: Multiple</p>
	<p>SHEET 4 OF 7</p>			<p>DATE: 8/11/2014</p>
				<p>PREPARED BY: Kimley-Horn and Associates</p>
				<p>LOCATION: I-40 from I-85 to I-95</p>
	<p>PROJECT: FS - 1205A</p>			

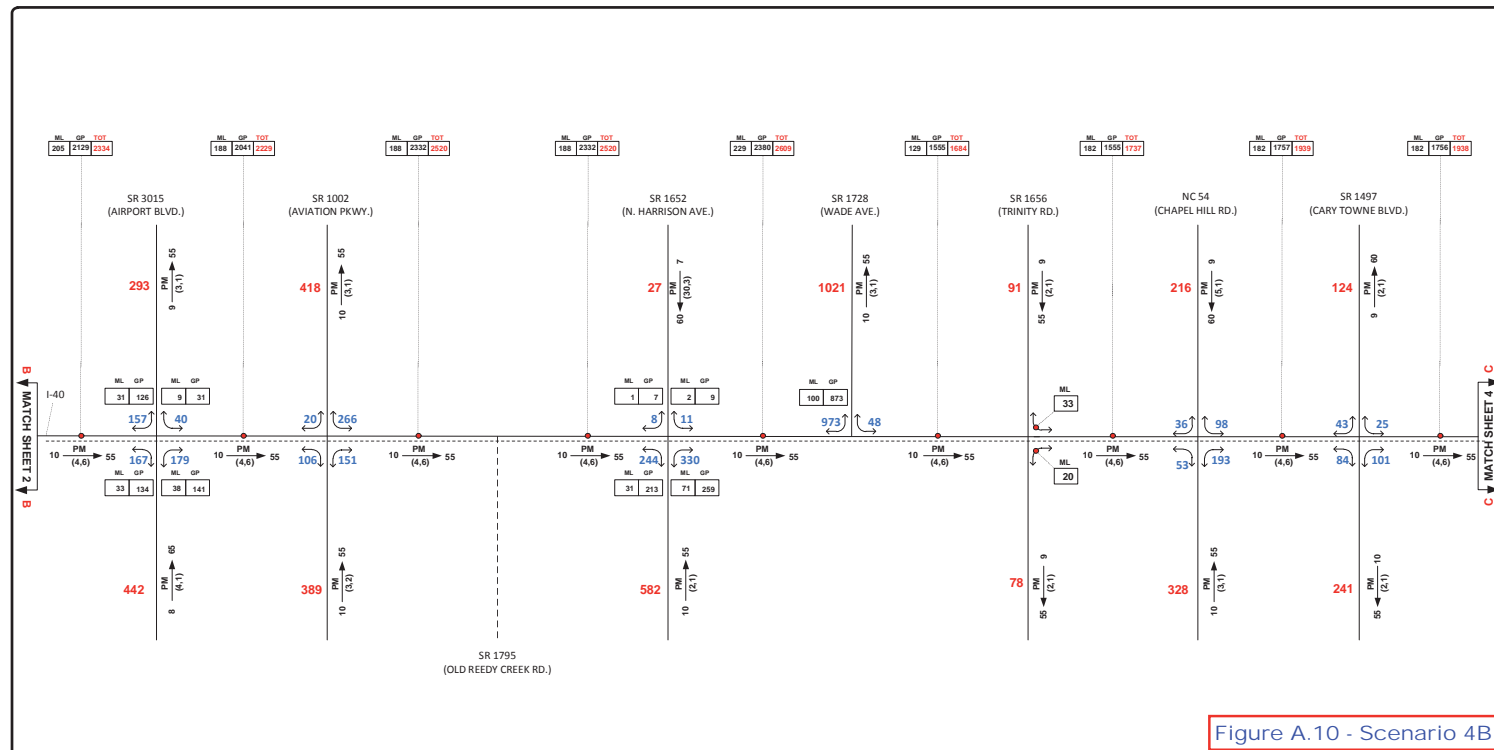


Figure A.10 - Scenario 4B

	<h2>2040</h2> <p>AVERAGE ANNUAL DAILY TRAFFIC</p>		<p>LEGEND</p> <p>### No. of Vehicles Per Day in 100s</p> <p>1- Less than 50 vpd</p> <p>X Movement Prohibited</p> <p>K-PM → D (d, t)</p> <p>K Design Hour Factor (%)</p> <p>PM PM Peak Period</p> <p>D Peak Hour Directional Split (%)</p> <p>→ Indicates Direction of D</p> <p>(d, t) Duals, TT-STs (%)</p>	<p>TIP: FS-1205A WBS: 39263.1.1</p>
	<p>ALTERNATIVE 4B With I-540</p>			<p>COUNTY: Multiple DIVISION: Multiple</p>
	<p>SHEET 3 OF 7</p>			<p>DATE: 8/11/2014</p>
				<p>PREPARED BY: Kimley-Horn and Associates</p>
				<p>LOCATION: I-40 from I-85 to I-95</p>
	<p>PROJECT: FS - 1205A</p>			

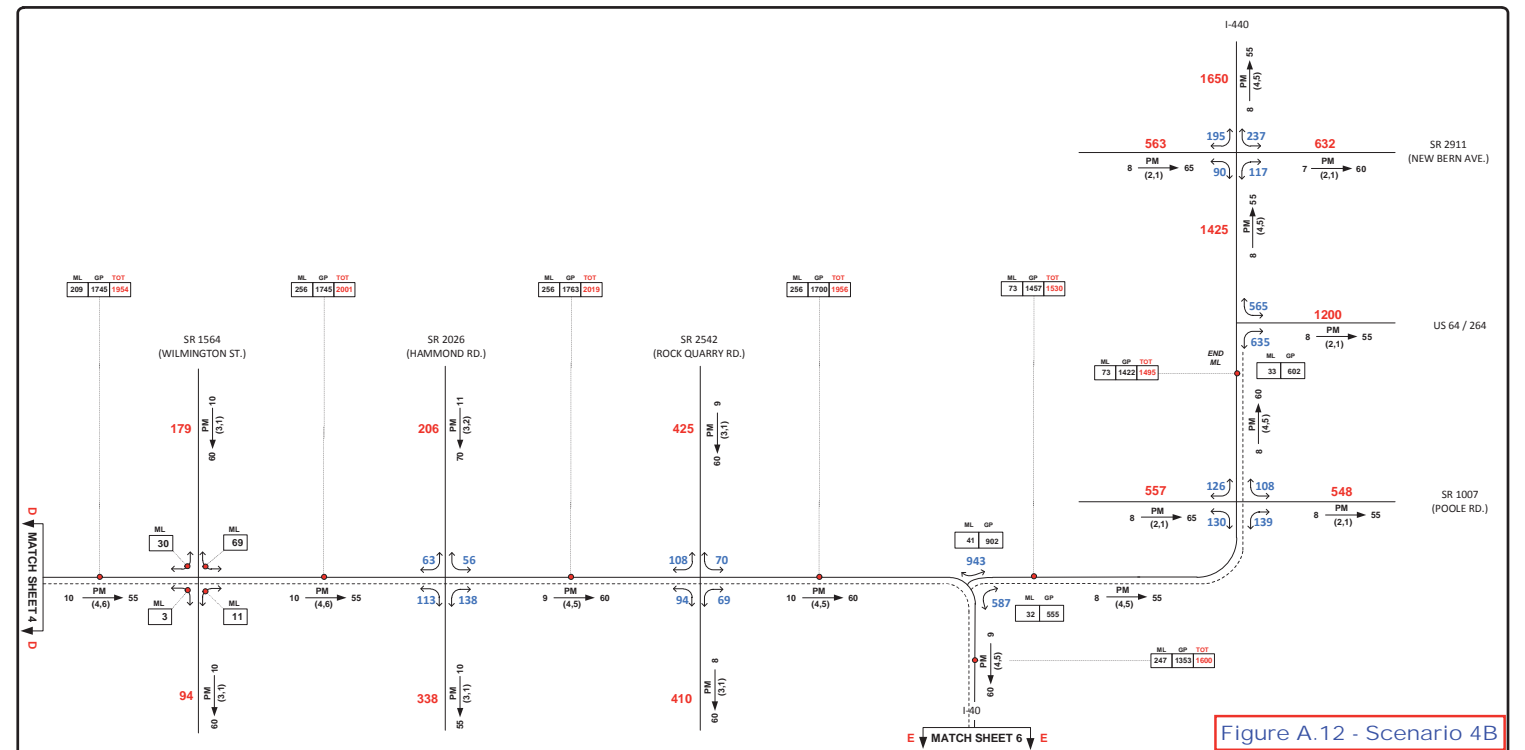


Figure A.12 - Scenario 4B

	<h2>2040</h2> <p>AVERAGE ANNUAL DAILY TRAFFIC</p>		<p>LEGEND</p> <p>### No. of Vehicles Per Day in 100s</p> <p>1- Less than 50 vpd</p> <p>X Movement Prohibited</p> <p>K-PM → D (d, t)</p> <p>K Design Hour Factor (%)</p> <p>PM PM Peak Period</p> <p>D Peak Hour Directional Split (%)</p> <p>→ Indicates Direction of D</p> <p>(d, t) Duals, TT-STs (%)</p>	<p>TIP: FS-1205A WBS: 39263.1.1</p>
	<p>ALTERNATIVE 4B With I-540</p>			<p>COUNTY: Multiple DIVISION: Multiple</p>
	<p>SHEET 5 OF 7</p>			<p>DATE: 8/11/2014</p>
				<p>PREPARED BY: Kimley-Horn and Associates</p>
				<p>LOCATION: I-40 from I-85 to I-95</p>
	<p>PROJECT: FS - 1205A</p>			

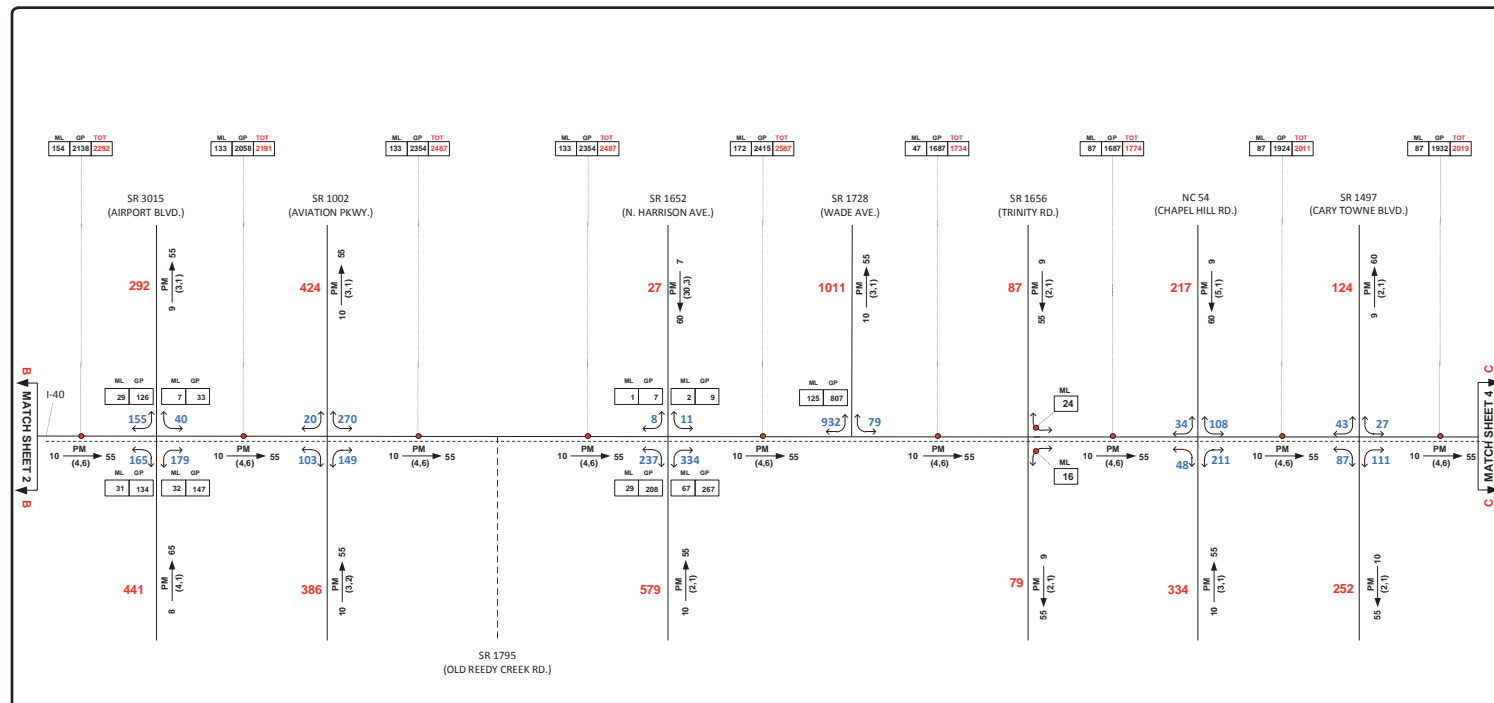
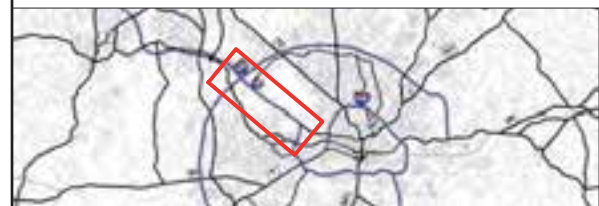


Figure A.13 - Scenario 5B



2040
AVERAGE ANNUAL DAILY TRAFFIC

ALTERNATIVE 5B
With I-540

SHEET 3 OF 7

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

TIP: FS-1205A	WBS: 39263.1.1
COUNTY: Multiple	DIVISION: Multiple
DATE: 8/11/2014	
PREPARED BY: Kimley-Horn and Associates	
LOCATION: I-40 from I-85 to I-95	
PROJECT: FS - 1205A	

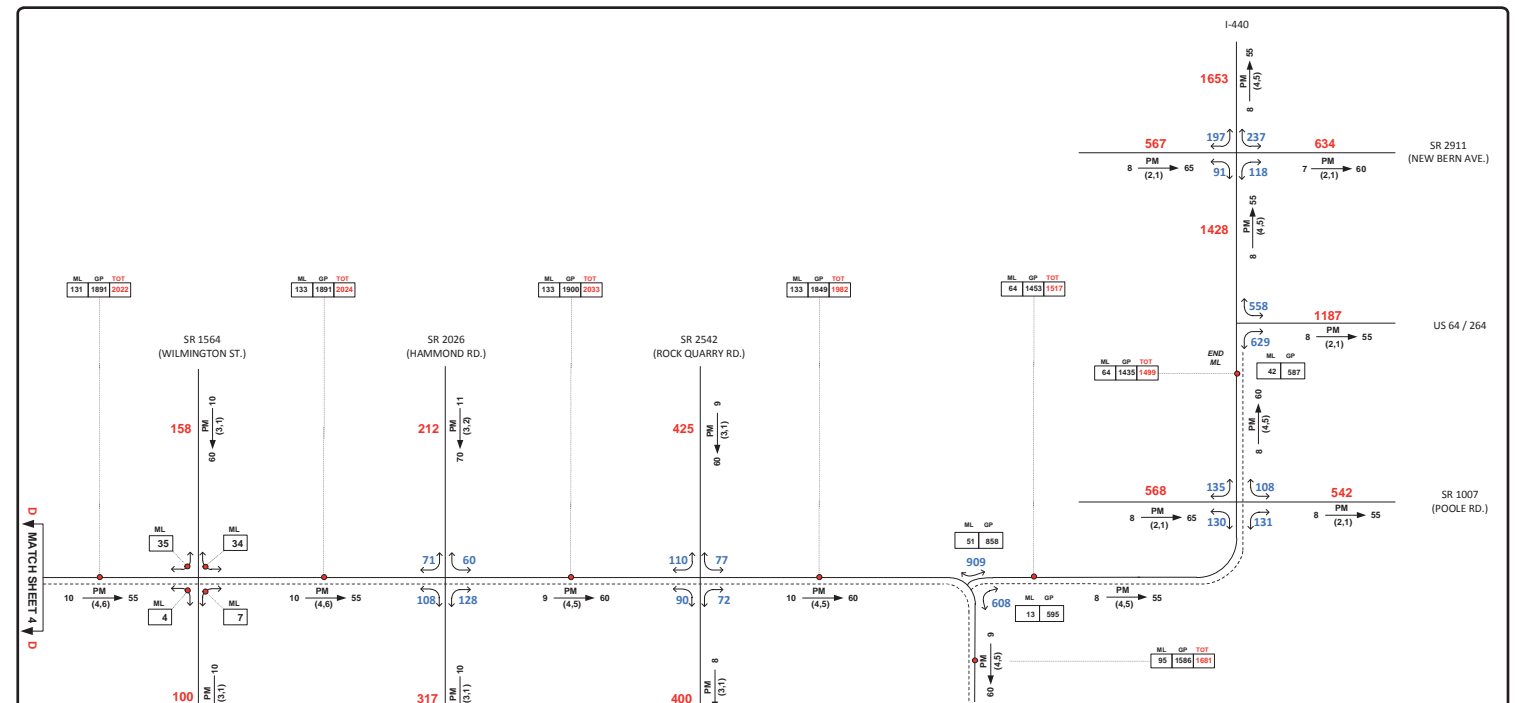


Figure A.15 - Scenario 5B



2040
AVERAGE ANNUAL DAILY TRAFFIC

ALTERNATIVE 5B
With I-540

SHEET 5 OF 7

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

TIP: FS-1205A	WBS: 39263.1.1
COUNTY: Multiple	DIVISION: Multiple
DATE: 8/11/2014	
PREPARED BY: Kimley-Horn and Associates	
LOCATION: I-40 from I-85 to I-95	
PROJECT: FS - 1205A	

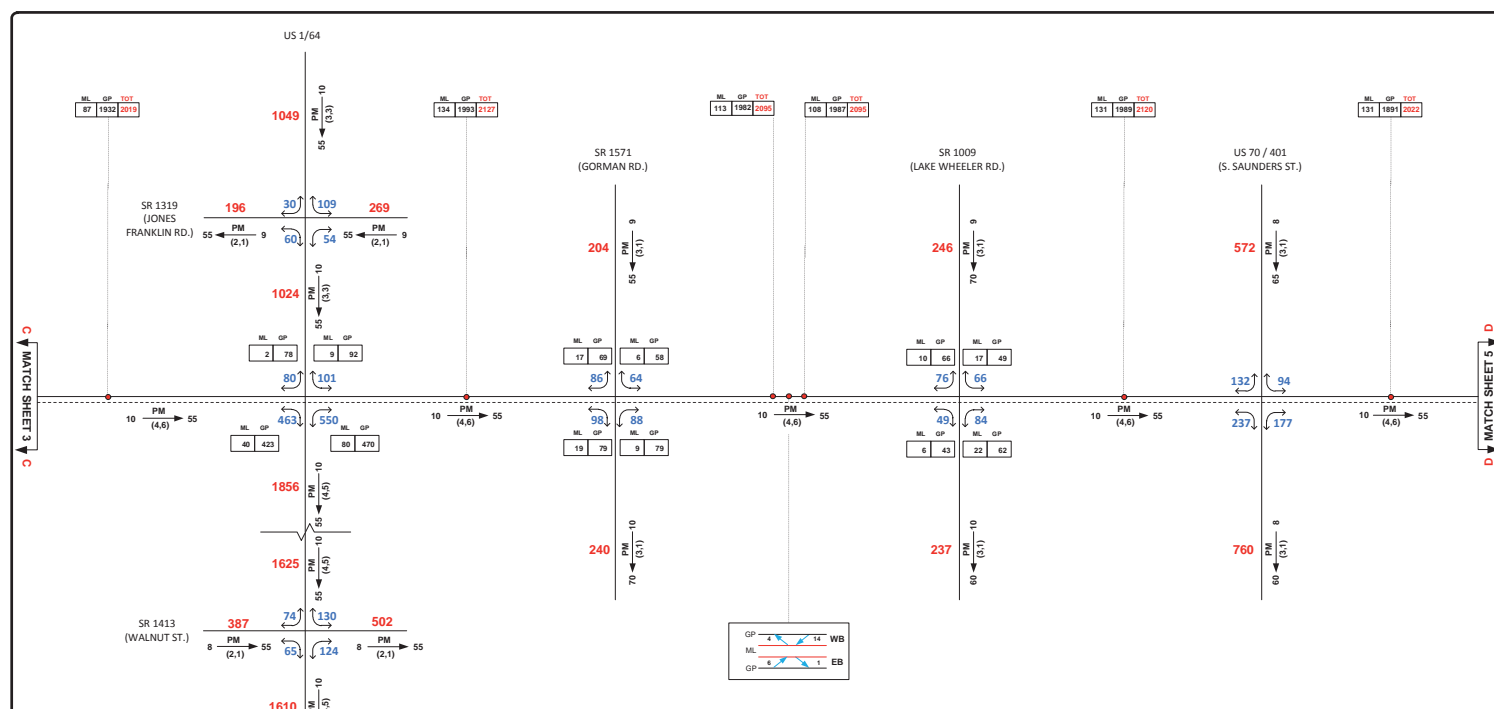


Figure A.14 - Scenario 5B



2040
AVERAGE ANNUAL DAILY TRAFFIC

ALTERNATIVE 5B
With I-540

SHEET 4 OF 7

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

TIP: FS-1205A	WBS: 39263.1.1
COUNTY: Multiple	DIVISION: Multiple
DATE: 8/11/2014	
PREPARED BY: Kimley-Horn and Associates	
LOCATION: I-40 from I-85 to I-95	
PROJECT: FS - 1205A	

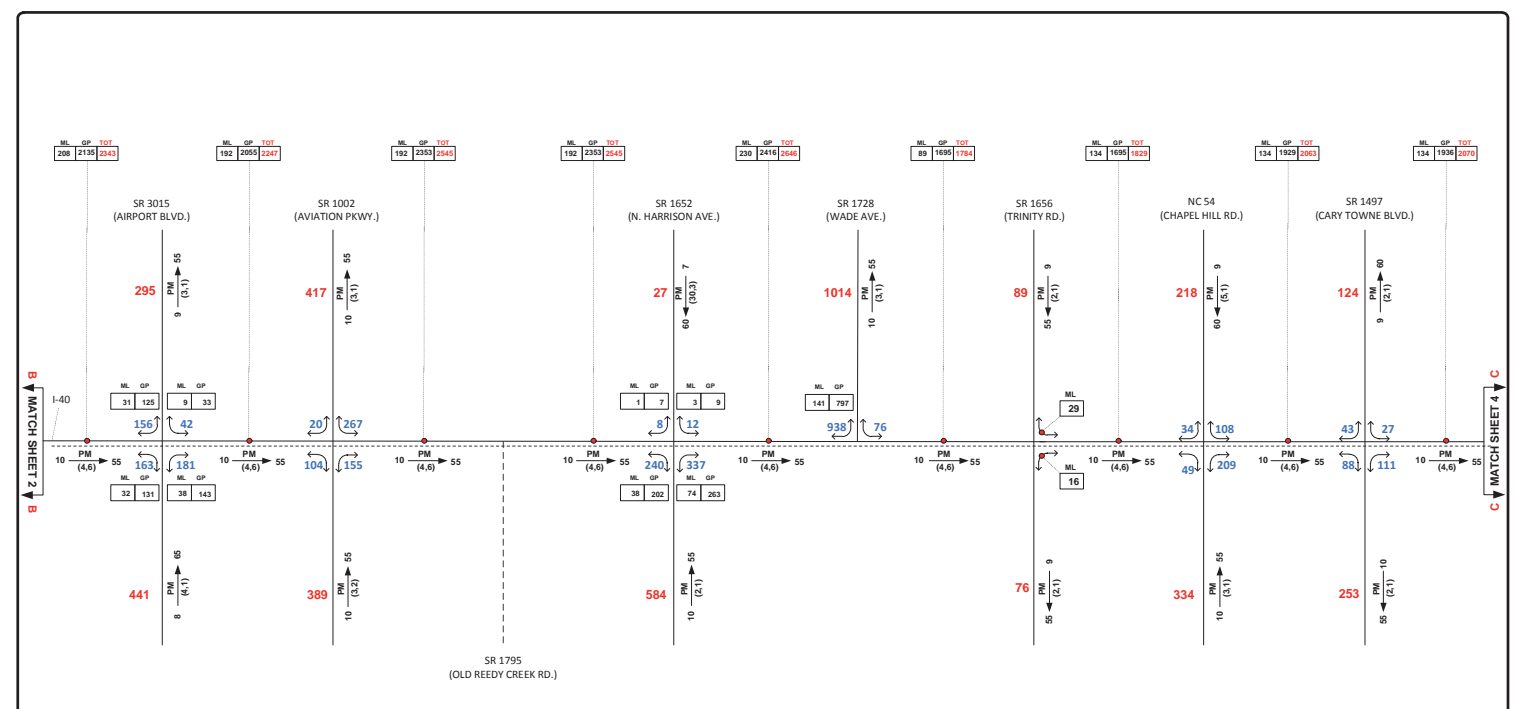
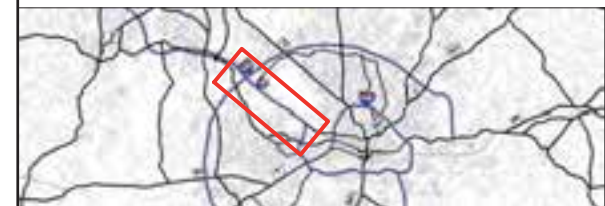


Figure A.16 - Scenario 6B



2040
AVERAGE ANNUAL DAILY TRAFFIC

ALTERNATIVE 6B
With I-540

SHEET 3 OF 7

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

TIP: FS-1205A	WBS: 39263.1.1
COUNTY: Multiple	DIVISION: Multiple
DATE: 8/11/2014	
PREPARED BY: Kimley-Horn and Associates	
LOCATION: I-40 from I-85 to I-95	
PROJECT: FS - 1205A	

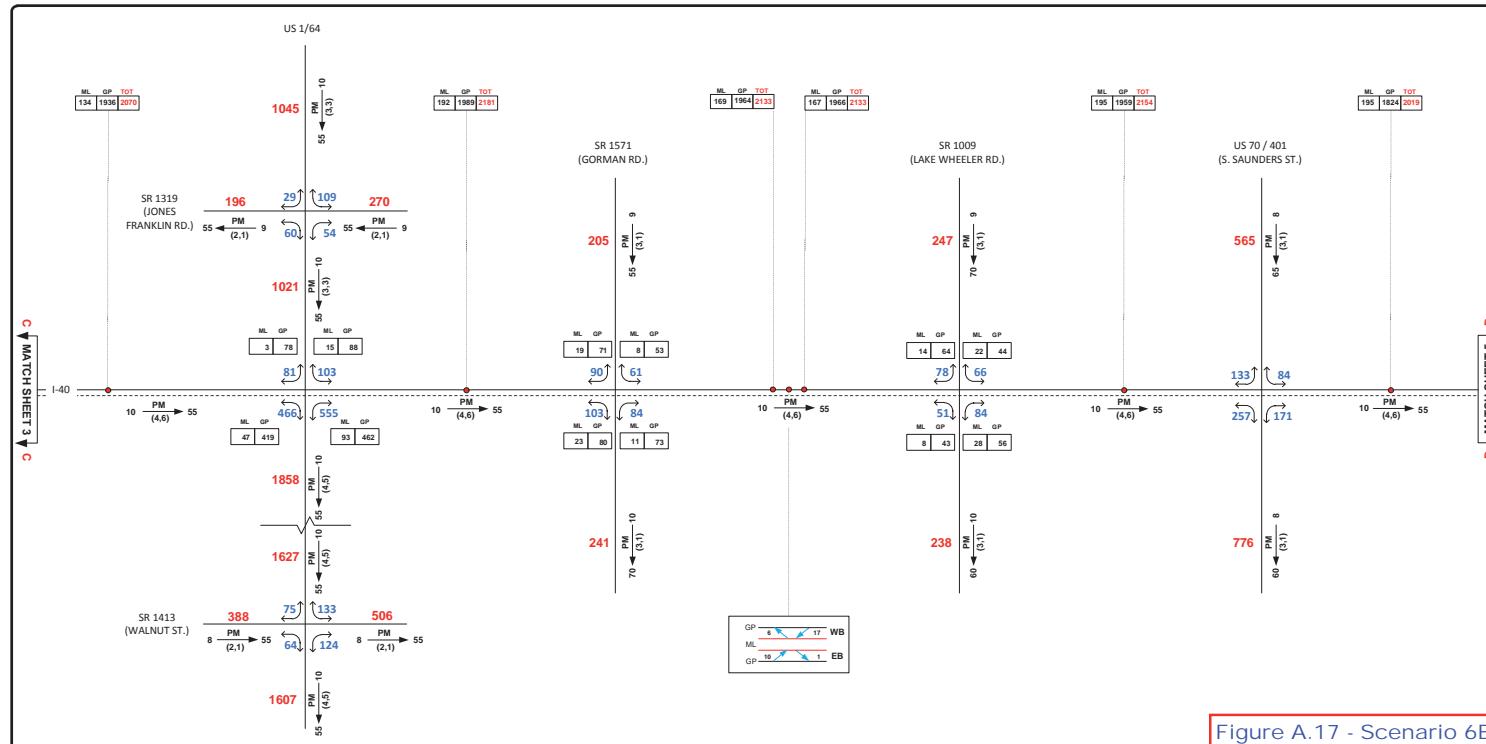


Figure A.17 - Scenario 6B

	<p>2040 AVERAGE ANNUAL DAILY TRAFFIC</p> <p>ALTERNATIVE 6B With I-540</p> <p>SHEET 4 OF 7</p>		<p>LEGEND</p> <p>### No. of Vehicles Per Day in 100s</p> <p>1- Less than 50 vpd</p> <p>X Movement Prohibited</p> <p>K $\frac{PM}{(d,t)}$ Design Hour Factor (%)</p> <p>PM PM Peak Period</p> <p>D Peak Hour Directional Split (%)</p> <p>→ Indicates Direction of D</p> <p>(d,t) Duals, TT-STs (%)</p>	<p>TIP: FS-1205A WBS: 39263.1.1</p>
				<p>COUNTY: Multiple DIVISION: Multiple</p> <p>DATE: 8/1/2014</p> <p>PREPARED BY: Kimley-Horn and Associates</p> <p>LOCATION: I-40 from I-85 to I-95</p> <p>PROJECT: FS - 1205A</p>

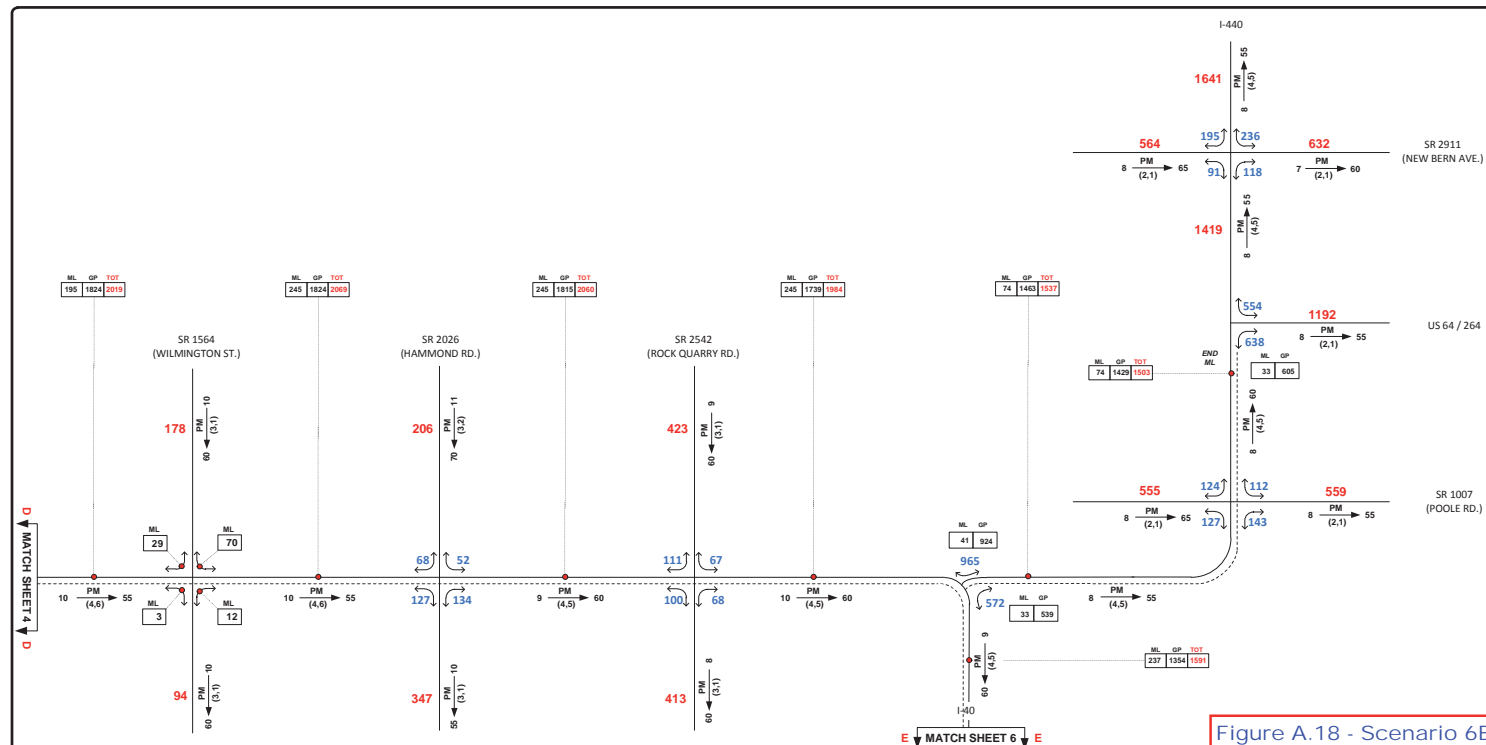


Figure A.18 - Scenario 6B

	<p>2040 AVERAGE ANNUAL DAILY TRAFFIC</p> <p>ALTERNATIVE 6B With I-540</p> <p>SHEET 5 OF 7</p>		<p>LEGEND</p> <p>### No. of Vehicles Per Day in 100s</p> <p>1- Less than 50 vpd</p> <p>X Movement Prohibited</p> <p>K $\frac{PM}{(d,t)}$ Design Hour Factor (%)</p> <p>PM PM Peak Period</p> <p>D Peak Hour Directional Split (%)</p> <p>→ Indicates Direction of D</p> <p>(d,t) Duals, TT-STs (%)</p>	<p>TIP: FS-1205A WBS: 39263.1.1</p>
				<p>COUNTY: Multiple DIVISION: Multiple</p> <p>DATE: 8/1/2014</p> <p>PREPARED BY: Kimley-Horn and Associates</p> <p>LOCATION: I-40 from I-85 to I-95</p> <p>PROJECT: FS - 1205A</p>

Table A.1 - Preliminary Traffic Analysis - Managed Lanes

Eastbound Managed Lanes Analysis (Build 2040)

Basic Freeway Segment									
Location	Peak Period	Scenario 3B		Scenario 4B		Scenario 5B		Scenario 6B	
		EB		EB		EB		EB	
		Density	LOS	Density	LOS	Density	LOS	Density	LOS
I-40 from Exit 287 to Exit 289	AM	18.7	C	8.3	A	19.5	C	8.3	A
I-40 from Exit 289 to Trinity Ave	AM	7.3	A	4.7	A	4.6	A	3.2	A
I-40 from Trinity Rd to Exit 293	AM	10.3	A	6.6	A	8.0	A	5.0	A
I-40 from Exit 293 to Exit 295	AM	15.7	B	9.5	A	11.6	B	7.0	A
I-40 from Exit 295 to Exit 297	AM	13.7	B	7.8	A	8.6	A	6.5	A
I-40 from Exit 297 to Wilmington St.	AM	10.0	A	7.5	A	9.6	A	7.0	A
I-40 from Wilmington St. to Exit 301	AM	10.2	A	-	-	9.3	A	8.6	A
I-40 from Exit 287 to Exit 289	PM	25.1	C	10.2	A	24.5	C	10.2	A
I-40 from Exit 289 to Trinity Rd	PM	12.1	B	5.7	A	7.0	A	4.0	A
I-40 from Trinity Rd to Exit 293	PM	14.5	B	8.0	A	10.2	A	5.9	A
I-40 from Exit 293 to Exit 295	PM	19.6	C	11.8	B	14.0	B	8.5	A
I-40 from Exit 295 to Exit 297	PM	16.1	B	9.2	A	10.7	A	7.3	A
I-40 from Exit 297 to Wilmington St.	PM	12.5	B	9.4	A	12.1	B	8.7	A
I-40 from Wilmington St. to Exit 301	PM	13.4	B	-	-	12.8	B	11.2	B

Merge Segment									
Location	Peak Period	Scenario 3B		Scenario 4B		Scenario 5B		Scenario 6B	
		EB		EB		EB		WB	
		Density	LOS	Density	LOS	Density	LOS	Density	LOS
Trinity On-Ramp	AM	4.7	A	7.6	A	3.6	A	5.8	A
Exit 293 On-Ramp	AM	7.1	A	10.5	B	5.2	A	5.8	A
Exit 295 On-Ramp	AM	7.5	A	10.2	B	5.1	A	7.5	A
Exit 297 On-Ramp	AM	5.9	A	8.6	A	5.3	A	8.0	A
Wilmington Street On-Ramp	AM	5.6	A	10.1	B	5.2	A	9.6	A
Trinity On-Ramp	PM	6.5	A	9.1	A	4.5	A	6.8	A
Exit 293 On-Ramp	PM	8.8	A	12.9	B	6.2	A	6.7	A
Exit 295 On-Ramp	PM	8.8	A	11.9	B	5.6	A	8.3	A
Exit 297 On-Ramp	PM	7.3	A	10.6	B	6.7	A	9.8	A
Wilmington Street On-Ramp	PM	7.6	A	12.6	B	7.0	A	12.4	B

Diverge Segment									
Location	Peak Period	Scenario 3B		Scenario 4B		Scenario 5B		Scenario 6B	
		EB		EB		EB		EB	
		Density	LOS	Density	LOS	Density	LOS	Density	LOS
Exit 287 Off-Ramp	AM	-	-	2.7	A	1.5	A	3.8	A
Exit 289 Off-Ramp	AM	0.3	A	-	-	-	-	-	-
Exit 293 Off-Ramp	AM	0.0	A	2.4	A	-1.1	A	0.9	A
Exit 295 Off-Ramp	AM	3.9	A	6.6	A	1.4	A	0.7	A
Exit 297 Off-Ramp	AM	1.9	A	4.6	A	1.0	A	3.9	A
Wilmington St. Off-Ramp	AM	1.5	A	4.6	A	1.0	A	3.4	A
Exit 301 Off-Ramp	AM	1.1	A	3.9	A	37.4	F	3.9	A
Exit 287 Off-Ramp	PM	-	-	3.9	A	2.7	A	5.2	A
Exit 289 Off-Ramp	PM	1.9	A	-	-	-	-	-	-
Exit 293 Off-Ramp	PM	1.3	A	3.7	A	-0.4	A	1.9	A
Exit 295 Off-Ramp	PM	5.5	A	8.7	A	2.4	A	1.6	A
Exit 297 Off-Ramp	PM	3.3	A	6.6	A	2.2	A	5.0	A
Wilmington St. Off-Ramp	PM	3.0	A	6.8	A	2.1	A	5.0	A
Exit 301 Off-Ramp	PM	2.7	A	6.0	A	58.3	F	6.0	A

Westbound Managed Lanes Analysis (Build 2040)

Basic Freeway Segment									
Location	Peak Period	Scenario 3B		Scenario 4B		Scenario 5B		Scenario 6B	
		WB		WB		WB		WB	
		Density	LOS	Density	LOS	Density	LOS	Density	LOS
I-40 from Exit 301 to Wilmington St.	AM	20.7	C	-	-	19.4	C	11.2	B
I-40 from Wilmington St. to Exit 297	AM	17.5	B	9.4	A	16.0	B	8.7	A
I-40 from Exit 297 to Exit 295	AM	19.0	C	10.6	A	15.0	B	7.3	A
I-40 from Exit 295 to Exit 293	AM	19.9	C	11.8	B	11.5	B	8.5	A
I-40 from Exit 293 to Trinity Rd	AM	12.1	B	8.0	A	12.3	B	5.9	A
I-40 from Trinity Rd to Exit 289	AM	7.6	A	5.7	A	7.7	A	4.0	A
I-40 from Exit 289 to Exit 287	AM	15.9	B	10.2	A	15.5	B	10.2	A
I-40 from Wilmington St. to Exit 301	PM	12.7	B	-	-	14.8	B	8.6	A
I-40 from Wilmington St. to Exit 297	PM	5.6	A	7.5	A	14.7	B	7.0	A
I-40 from Exit 297 to Exit 295	PM	9.1	A	9.0	A	12.0	B	6.5	A
I-40 from Exit 295 to Exit 293	PM	15.6	B	9.5	A	9.8	A	7.0	A
I-40 from Exit 293 to Trinity Rd	PM	16.2	B	6.6	A	11.0	B	5.0	A
I-40 from Trinity Rd to Exit 289	PM	15.5	B	4.7	A	6.4	A	3.2	A
I-40 from Exit 289 to Exit 287	PM	15.9	B	8.3	A	12.3	B	8.3	A

Merge Segment									
Location	Peak Period	Scenario 3B		Scenario 4B		Scenario 5B		Scenario 6B	
		WB		WB		WB		WB	
		Density	LOS	Density	LOS	Density	LOS	Density	LOS
Exit 301 On-Ramp	AM	7.2	A	12.4	B	89.6	F	7.5	A
Wilmington St. On-Ramp	AM	6.9	A	10.7	B	6.4	A	7.1	A
Exit 297 On-Ramp	AM	6.8	A	10.4	B	5.6	A	6.9	A
Exit 295 On-Ramp	AM	9.3	A	13.2	B	6.8	A	9.5	A
Exit 293 On-Ramp	AM	6.1	A	9.1	A	4.5	A	6.3	A
Exit 289 On-Ramp	AM	8.3	A	11.3	B	7.9	A	8.8	A
Exit 301 On-Ramp	PM	5.6	A	10.0	B	-	-	5.8	A
Wilmington St. On-Ramp	PM	5.6	A	8.6	A	5.5	A	5.7	A
Exit 297 On-Ramp	PM	5.8	A	8.9	A	4.6	A	6.0	A
Exit 295 On-Ramp	PM	7.4	A	10.7	B	5.4	A	7.6	A
Exit 293 On-Ramp	PM	4.7	A	7.6	A	3.2	A	4.9	A
Exit 289 On-Ramp	PM	6.5	A	9.3	A	6.4	A	6.9	A

Diverge Segment									
Location	Peak Period	Scenario 3B		Scenario 4B		Scenario 5B		Scenario 6B	
		WB		WB		WB		WB	
		Density	LOS	Density	LOS	Density	LOS	Density	LOS
Exit 301 On-Ramp	AM	-	-	12.4	B	-	-	-	-
Wilmington St. Off-Ramp	AM	2.6	A	10.7	B	2.1	A	2.6	A
Exit 297 Off-Ramp	AM	3.0	A	10.4	B	2.1	A	3.0	A
Exit 295 Off-Ramp	AM	5.1	A	13.2	B	2.4	A	5.1	A
Exit 293 Off-Ramp	AM	1.0	A	9.1	A	-0.4	A	1.0	A
Trinity Rd Off-Ramp	AM	1.6	A	-	-	-0.4	A	1.6	A
Exit 289 On-Ramp	AM	-	-	11.3	B	-	-	-	-
Exit 301 On-Ramp	PM	-	-	10.0	B	-	-	-	-
Wilmington St. Off-Ramp	PM	1.3	A	8.6	A	1.0	A	1.3	A
Exit 297 Off-Ramp	PM	1.7	A	8.9	A	1.0	A	1.7	A
Exit 295 Off-Ramp	PM	3.6	A	10.7	B	1.4	A	3.6	A
Exit 293 Off-Ramp	PM	0.0	A	7.6	A	-1.1	A	0.0	A
Trinity Rd Off-Ramp	PM	0.3	A	-	-	-0.9	A	0.3	A
Exit 289 On-Ramp	PM	-	-	9.3	A	-	-	-	-

Table A.2 - Preliminary Traffic Analysis - Eastbound Freeway

HCS Freeway Analysis Results																																												
No.	Segment	Segment Classification	Scenario 1 - Existing (2013)						Scenario 2B - Build (2040) [+GP]						Scenario 3B - Build (2040) [+1ML]						Scenario 4B - Build (2040) [+2ML]						Scenario 5B - Build (2040) [+GP+1ML]						Scenario 6B - Build (2040) [+GP+2ML]											
			AM			PM			AM			PM			AM			PM			AM			PM			AM			PM			AM			PM								
			speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C									
I-40 Eastbound																																												
1	Between Exit 287 and Exit 289	Basic Freeway	59	E	0.91	45	F	1.11		F	1.43		F	1.85	24	F	1.33		F	1.63	25	F	1.32		F	1.64	23	F	1.34		F	1.66	23	F	1.34		F	1.66						
2	Between Exit 287 and Exit 289	Weave		F						F			F			F			F			N/A (b)		F		F		F		F		F		F		F		F						
3	Exit 289 Off-Ramp	Diverge	56	A		54	F			F			F		53	F			F		54	F			F		52	F			F		58	F		56	F		58	F				
4	Between Exit 289 Off and On Ramps	Basic Freeway	67	C	0.70	62	D	0.85	60	E	0.90	38	F	1.19	44	F	1.12		F	1.38	45	F	1.11	19	F	1.38	60	E	0.89	46	F	1.10	60	E	0.89		F	1.10	60	E	0.89		F	1.10
5	Exit 289 On-Ramp	Merge	62	C		60	D		57	C			F		39	F			F		41	F			F		57	C		43	F		57	C		57	C		57	C		57	C	
6	Between Exit 289 and Exit 290	Basic Freeway	66	D	0.75	59	E	0.90	57	E	0.94	34	F	1.24	41	F	1.16		F	1.41	42	F	1.15		F	1.42	57	E	0.94	42	F	1.15	57	E	0.94		F	1.15	57	E	0.94		F	1.15
7	Between Exit 289 and Exit 290	Weave	59	C			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)			
8	Exit 290 Off-Ramp	Diverge	65	B		64	C		66	C		64	F		63	F		61	F		63	F		61	F		66	C		65	F		66	C		66	C		66	C		66	C	
9	Between Exit 290 Off and On Ramps	Basic Freeway	68	C	0.68	62	D	0.84	60	D	0.88	38	F	1.19	47	F	1.09	21	F	1.35	48	F	1.08	22	F	1.35	60	E	0.89	46	F	1.11	60	E	0.89		F	1.11	60	E	0.89		F	1.11
10	Exit 290 On-Ramp Loop	Merge	61	C		58	D		57	D			F		41	F			F		43	F			F		56	D		31	F		56	D		56	D		56	D		56	D	
11	Exit 290 On-Ramp	Merge	60	D		53	E		53	F		77	F			F			F			F			F		53	F		93	F		53	F		53	F		53	F		53	F	
12	Between Exit 290 and Exit 291	Basic Freeway	64	D	0.81	51	F	1.04	51	F	1.03		F	1.43	29	F	1.28		F	1.64	31	F	1.27		F	1.65	50	F	1.05	21	F	1.35	50	F	1.05		F	1.35	50	F	1.05		F	1.35
13	Between Exit 290 and Exit 291	Weave	52	C		45	E			F			F			F			F			F			F		43	F			F			F			F			F				
14	Exit 291 Off-Ramp	Diverge	65	C		64	D		66	D		63	F		62	F		59	F		62	F		59	F		65	F		63	F		65	F		65	F		65	F		65	F	
14	Between Exit 291 Off and On Ramps	Basic Freeway	66	D	0.75	56	E	0.95	56	E	0.96	24	F	1.33	37	F	1.20	2	F	1.51	39	F	1.19		F	1.53	55	E	0.98	31	F	1.26	55	E	0.98		F	1.26	55	E	0.98		F	1.26
15	Exit 291 On-Ramp	Merge	60	D		55	E		52	E		84	F			F			F			F			F		51	E		107	F		51	E		51	E		51	E		51	E	
16	Between Exit 291 and Exit 293	Basic Freeway	63	D	0.83	52	F	1.02	50	F	1.05	14	F	1.41	26	F	1.31		F	1.61	28	F	1.30		F	1.62	48	F	1.07	23	F	1.34	48	F	1.07		F	1.34	48	F	1.07		F	1.34
17	Between Exit 291 and Exit 293	Weave	58	C		57	D			F			F			F			F			F			F			F			F			F			F			F				
18	Exit 293 Off-Ramp	Diverge	59	F		59	F		60	F		59	F		60	F		58	F		60	F		58	F		61	F		61	F		61	F		61	F		61	F		61	F	
19	Between Exit 293 Off and On Ramps	Basic Freeway	70	C	0.53	68	C	0.65	66	D	0.75	51	F	1.04	58	E	0.93	39	F	1.18	57	E	0.93	39	F	1.18	64	D	0.79	54	E	0.99	64	D	0.79		E	0.99	64	D	0.79		E	0.99
20	Exit 293 On-Ramp	Merge	55	D		47	E		32	E		72	F			F			F			F			F		22	E		97	D		22	E		22	E		22	E		22	E	
21	Between Exit 293 and Exit 295	Basic Freeway	60	D	0.88	54	E	1.00	47	F	1.08		F	1.44	26	F	1.31		F	1.64	24	F	1.33		F	1.59	44	F	1.13	22	F	1.35	44	F	1.13		F	1.35	44	F	1.13		F	1.35
22	Between Exit 293 and Exit 295	Weave		N/A			N/A			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)			
23	Exit 295 Off-Ramp	Diverge	64	D		64	D		65	F		63	F		62	F		59	F		62	F		60	F		65	F		63	F		65	F		65	F		65	F		65	F	
24	Between Exit 295 Off and On Ramps	Basic Freeway	64	D	0.81	61	D	0.87	53	F	1.01	26	F	1.31	35	F	1.23		F	1.51	32	F	1.25		F	1.45	49	F	1.06	34	F	1.23	49	F	1.06		F	1.23	49	F	1.06		F	1.23
25	Exit 295 On-Ramp	Merge	58	D		58	D		47	F		88	F			F			F			F			F		41	F			F		41	F		41	F		41	F		41	F	
26	Between Exit 295 and Exit 297	Basic Freeway	59	E	0.91	57	E	0.94	45	F	1.12	17	F	1.39	22	F	1.35		F	1.60	20	F	1.37		F	1.54	41	F	1.16	27	F	1.30	41	F	1.16		F	1.30	41	F	1.16		F	1.30
27	Between Exit 295 and Exit 297	Weave	53	E		54	E			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)		N/A (b)			
28	Exit 297 Off-Ramp	Diverge	64	D		64	D		65	F		63	F		62	F		60	F		61	F		60	F		65	F		64	F		65	F		65	F		65	F		65	F	
29	Between Exit 297 Off and On Ramps	Basic Freeway	62	D	0.85	60	E	0.89	51	F	1.03	25	F	1.32	28	F	1.29		F	1.55	25	F	1.32		F	1.51	47	F	1.09	33	F	1.25	47	F	1.09		F	1.25	47	F	1.09		F	1.25
30	Exit 297 On-Ramp	Merge	58	D		56	D		50	F		82	F			F			F			F			F		44	F			F		44	F		44	F		44	F		44	F	
31	Between Exit 297 and Exit 298	Basic Freeway	57	E	0.94	54	E	0.99	46	F	1.10		F	1.42	18	F	1.38		F	1.68		F	1.40		F	1.63	42	F	1.14	24	F	1.33	42	F	1.14		F	1.33	42	F	1.14		F	1.33
32	Between Exit 297 and Exit 298	Weave	50	D		53	D		46	F			F			F			F			F			F		45	F			F		45	F		45	F		45	F		45	F	
33	Exit 298 Off-Ramp	Diverge	66	B		67	B		65	F		63	F		65	F		64	F		65	F		64	F		65	F		63	F		65	F		65	F		65	F		65	F	
34	Exit 298 Off-Ramp Loop	Diverge	62	C		63	C		61	E		60	F		61	D		61	F		61	D		61	F		61	F		60	F		61	F		61	F		61	F		61	F	
35	Between Exit 298 Off and On Ramps	Basic Freeway	70	C	0.53	68	C	0.65	59	E	0.90	35	F	1.22	61	D	0.86	47	F	1.08	61	D	0.86	51	F	1.03	57	E	0.94	44	F	1.12	57	E	0.94		F	1.12	57	E	0.94		F	1.12
36	Exit 298 On-Ramp	Merge	63	C		58	D		52	E		84	F		53	E			F		54	E		34	F		51	E		240	F		51	E		240	F		51	E		51	E	
37	Between Exit 298 and Exit 299	Basic Freeway	69	C																																								

Table A.3 - Preliminary Traffic Analysis - Westbound Freeway

HCS Freeway Analysis Results																																						
No.	Segment	Segment Classification	Scenario 1 - Existing (2013)			Scenario 2B - Build (2040) [+GP]			Scenario 3B - Build (2040) [+1ML]			Scenario 4B - Build (2040) [+2ML]			Scenario 5B - Build (2040) [+GP+1ML]			Scenario 6B - Build (2040) [+GP+2ML]																				
			AM		PM	AM		PM	AM		PM	AM		PM	AM		PM	AM		PM																		
			speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C	speed	LOS	V/C									
I-40 Westbound																																						
1	Exit 301 On-Ramp	Merge		F		68	F			F			F			F			F			F			F			F										
2	Between Exit 301 and Exit 300	Basic Freeway	68	C	0.66	70	B	0.42	39	F	1.18	65	D	0.76	51	F	1.04	66	D	0.75	47	F	1.08	66	D	0.74	50	F	1.05	66	D	0.74	50	F	1.05	66	D	0.74
3	Between Exit 301 and Exit 300	Weave	48	D		54	B			F		42	E			F		43	E			F		45	E			F		47	E			F		47	E	
4	Exit 300 Off-Ramp	Diverge	68	C		70	B		65	F		68	D		66	F		68	D		66	F		68	D		66	F		68	D		66	F		68	D	
5	Exit 300 Off-Ramp Loop	Diverge	65	F		66	F		63	F		64	F		63	F		64	F		63	F		64	F		63	F		64	F		63	F		64	F	
6	Between Exit 300 Off and On Ramps	Basic Freeway	70	C	0.59	70	B	0.36	51	F	1.03	68	C	0.65	59	E	0.91	68	C	0.65	57	E	0.95	69	C	0.65	58	E	0.93	69	C	0.65	58	E	0.93	69	C	0.65
7	Exit 300 On-Ramp	Merge	63	B		65	B		50	F		63	C		56	D		63	C		55	D		63	C		56	D		63	C		56	D		63	C	
8	Between Exit 300 and Exit 299	Basic Freeway	69	C	0.63	70	B	0.39	47	F	1.08	67	C	0.69	56	E	0.96	67	C	0.70	54	E	1.00	67	C	0.70	55	E	0.98	67	C	0.70	55	E	0.98	67	C	0.70
9	Between Exit 300 and Exit 299	Weave		N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)				
10	Exit 299 Off-Ramp	Diverge	66	B		68	A		63	F		66	C		64	F		66	C		64	F		66	C		64	F		66	C		64	F		66	C	
11	Between Exit 299 Off and On Ramps	Basic Freeway	67	C	0.71	70	B	0.46	34	F	1.23	63	D	0.83	45	F	1.11	63	D	0.82	41	F	1.16	63	D	0.83	43	F	1.13	63	D	0.83	43	F	1.13	63	D	0.83
12	Exit 299 On-Ramp	Merge	59	D		63	C		85	F		49	E			F		52	E			F		47	E			F		47	E			F		47	E	
13	Between Exit 299 and Exit 298	Basic Freeway	64	D	0.81	69	C	0.59	18	F	1.38	51	F	1.04	33	F	1.25	53	E	1.00	28	F	1.30	49	F	1.06	29	F	1.28	49	F	1.06	29	F	1.28	49	F	1.06
14	Between Exit 299 and Exit 298	Weave	49	D		54	C			F			F			F		47	E			F			F			F			F			F				
15	Exit 298 Off-Ramp	Diverge	66	C		68	B		63	F		66	D		64	F		66	D		64	F		66	F		64	F		66	F		64	F		66	F	
16	Between Exit 298 Off and On Ramps	Basic Freeway	66	D	0.75	70	C	0.57	26	F	1.31	53	E	1.00	39	F	1.18	61	D	0.86	35	F	1.22	52	F	1.02	35	F	1.22	52	F	1.02	35	F	1.22	52	F	1.02
17	Exit 298 Off-Ramp Loop	Diverge	61	C		63	C		59	F		61	E		60	F		61	E		60	F		61	E		60	F		61	E		60	F		61	E	
18	Exit 298 On-Ramp	Merge	61	C		61	C		78	F		48	E			F		51	E		102	F		45	E			F		45	E			F		45	E	
19	Between Exit 298 and Exit 297	Basic Freeway	66	D	0.74	67	C	0.70	13	F	1.42	46	F	1.10	31	F	1.26	51	F	1.04	23	F	1.34	43	F	1.14	24	F	1.33	43	F	1.13	24	F	1.33	43	F	1.13
20	Between Exit 298 and Exit 297	Weave	52	D		50	D			F		46	F			F			F			F		45	F			F		45	F			F		45	F	
21	Exit 297 Off-Ramp	Diverge	71	C		71	B		67	F		69	F		68	F		70	F		68	F		69	F		68	F		69	F		68	F		69	F	
22	Between Exit 297 Off and On Ramps	Basic Freeway	71	C	0.67	72	C	0.64	23	F	1.32	51	F	1.03	39	F	1.17	56	E	0.97	30	F	1.26	47	F	1.08	31	F	1.25	47	F	1.08	31	F	1.25	47	F	1.08
23	Exit 297 On-Ramp	Merge	66	C		66	C		98	F		50	F			F		59	D			F		42	F			F		42	F			F		42	F	
24	Between Exit 297 and Exit 295	Basic Freeway	70	C	0.70	70	C	0.69	15	F	1.39	44	F	1.12	36	F	1.20	52	F	1.02	24	F	1.31	40	F	1.16	25	F	1.30	40	F	1.16	25	F	1.30	40	F	1.16
25	Between Exit 297 and Exit 295	Weave		F			F			F			F			F			F			F			F			F			F			F				
26	Exit 295 Off-Ramp	Diverge	64	C		64	C		63	F		65	F		60	F		62	F		64	F		65	F		64	F		65	F		64	F		65	F	
27	Between Exit 295 Off and On Ramps	Basic Freeway	61	D	0.87	64	D	0.81	26	F	1.31	53	F	1.01		F	1.51	35	F	1.22	34	F	1.24	49	F	1.06	34	F	1.24	49	F	1.06	34	F	1.24	49	F	1.06
28	Exit 295 On-Ramp	Merge	55	E		60	D		78	F		50	F			F		99	F			F		46	F			F		46	F			F		46	F	
29	Between Exit 295 and Exit 293	Basic Freeway	54	E	0.99	60	D	0.88		F	1.44	47	F	1.09		F	1.65	27	F	1.30	22	F	1.35	44	F	1.13	22	F	1.35	44	F	1.13	22	F	1.35	44	F	1.13
30	Between Exit 295 and Exit 293	Weave		N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)				
31	Exit 293 Off-Ramp	Diverge	59	F		58	F		59	F		61	F		58	F		60	F		61	F		59	F		60	F		61	F		60	F		61	F	
32	Between Exit 293 Off and On Ramps	Basic Freeway	69	C	0.65	70	C	0.53	50	F	1.04	66	D	0.75	38	F	1.20	58	E	0.92	54	E	0.99	64	D	0.79	54	E	0.99	64	D	0.79	54	E	0.99	64	D	0.79
33	Exit 293 On-Ramp	Merge	44	E		58	D		75	F		42	E			F			F			F		44	E			F		43	E			F		43	E	
34	Between Exit 293 and Exit 291	Basic Freeway	52	F	1.02	63	D	0.83	13	F	1.42	49	F	1.06		F	1.61	26	F	1.31	23	F	1.34	48	F	1.07	23	F	1.34	48	F	1.07	23	F	1.34	48	F	1.07
35	Between Exit 293 and Exit 291	Weave		F		50	F			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)			N/A (b)				
36	Exit 291 Off-Ramp	Diverge	59	C		59	C		59	F		61	F		55	F		57	F		59	F		61	F		59	F		61	F		59	F		61	F	
37	Between Exit 291 Off and On Ramps	Basic Freeway	57	E	0.95	66	D	0.75	23	F	1.34	55	E	0.97		F	1.51	37	F	1.20	31	F	1.26	55	E	0.98	31	F	1.26	55	E	0.98	31	F	1.26	55	E	0.98
38	Exit 291 On-Ramp	Merge	54	E		60	D			F		53	E			F		97	F			F		52	E			F		52	E			F		52	E	
39	Between Exit 291 and Exit 290	Basic Freeway	51	F	1.04	64	D	0.81		F	1.44	51	F	1.03		F	1.65	29	F	1.28	21	F	1.36	50	F	1.05	21	F	1.36	50	F	1.05	21	F	1.36	50	F	1.05
40	Between Exit 291 and Exit 290	Weave	50	E		55	C			F		48	E			F			F			F		47	E			F		47	E			F		47	E	
41	Exit 290 Off-Ramp	Diverge	63	D		64	C		62	F		64	F		59	F		62	F		62	F		64	F		62	F		64	F		62	F		64	F	
42	Exit 290 On-Ramp Loop	Diverge	60	E		60	D		61	F		63	E		57	F		59	F		61	F		63	E		61	F		63	E		61	F		63	E	
43	Between Exit 290 Off and On Ramps	Basic Freeway	61	D	0.88	67	D	0.72	35	F	1																											

Appendix B:

General Purpose Widening Alternative

APPENDIX B - GENERAL PURPOSE WIDENING ALTERNATIVE

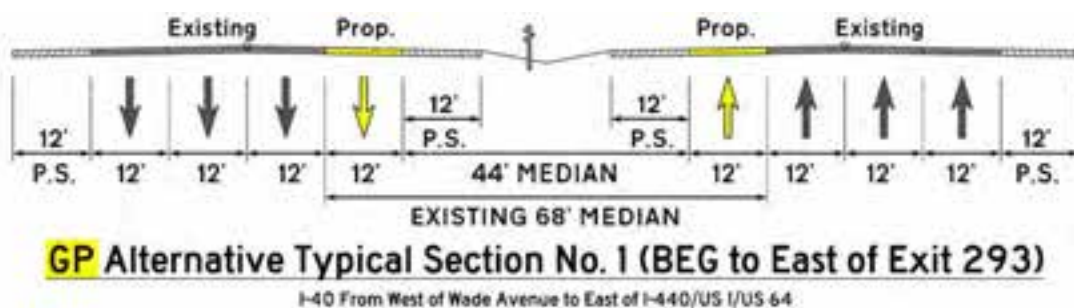
The General Purpose Widening Alternative includes the western 10 miles of the FS-1005A study corridor from west of SR 1728 (Wade Avenue) [Exit 289] near Cary to the NSRR overpass east of SR 1375 (Lake Wheeler Road) [Exit 297] in Raleigh. It includes widening the existing six GP lanes to eight GP lanes and interchange improvements where needed. The GP alternative is described herein, including cost and potential issues that may require consideration in the subsequent planning and design phases. This portion of the study is also within the CAMPO planning area. Refer to **Figure 1 Project Location Map**.

Note that a Feasibility Study is a preliminary document that is the initial step in the planning and design process for a candidate project and not the product of exhaustive environmental or design investigations. The purpose of the study is to describe the proposed project including cost, and identify potential problems that may require consideration in the planning and design phases.

Once a candidate project is identified for funding in the STIP, the Feasibility Study is followed by a rigorous planning and design process that meets the requirements of the National Environmental Policy Act (NEPA), where either an Environmental Impact Statement (EIS) or an Environmental Assessment (EA) is done.

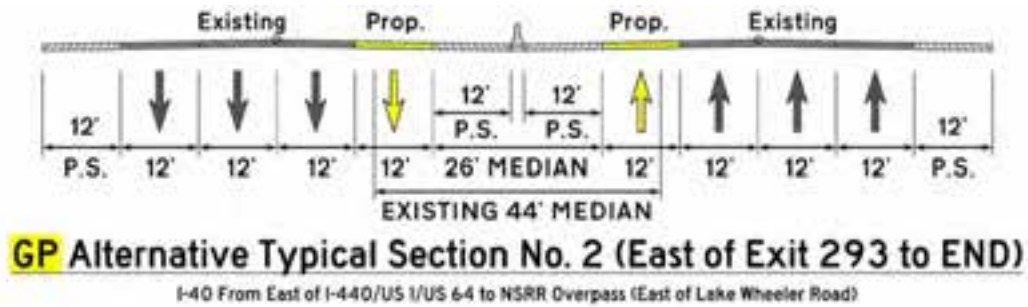
Specific information on the I-40/440/US 1/64 Interchange (Exit 293) is included in Sections D and E of the GP alternative. It should be noted that the GP design concept for reconstructing the interchange is designed to accommodate the future managed lanes and ramps presented in the ML Alternatives.

The **Proposed Typical Section** is an eight-lane divided interstate with 12-foot travel lanes, 12-foot full-depth inside and outside paved shoulders, and full control-of-access within a minimum state-maintained right-of-way of 300 feet. The existing right-of-way varies along I-40 and is



approximately 400 feet wide.

The proposed median varies through the Wade Avenue interchange and is 44 feet wide from Wade Avenue to east of the I-440/US 1/US 64 interchange (Exit 293). See **Typical Section No. 1**. Cable Guiderail is proposed for median protection.



As seen on **Typical Section No. 2**, the proposed median is 26 feet wide with concrete barrier from east of the I-440/US 1/US 64 interchange to the NSRR Overpass (East of Lake Wheeler Road, Exit 297). The posted speed limit is 65 mph throughout.

EXECUTIVE SUMMARY

Based on the design concepts presented within, widening I-40 to eight GP lanes from Wade Avenue to Lake Wheeler Road and constructing the recommended interchange improvements is estimated to cost \$234,800,000.00. It is anticipated to require 0 residential relocations, 4 business relocations, 0 wetland and 150 feet of stream impacts. See **Table B.1** below:

TABLE B.1 – COMPREHENSIVE COSTS AND IMPACTS							
SECTION	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
			RES.	BUS.			
A	\$17.1 M	\$0	0	0	\$0	\$0	\$17.1 M
B	\$6.9 M	\$0	0	0	\$0	\$0	\$6.9 M
C	\$9.7 M	\$0	0	0	\$0	\$0	\$9.7 M
D	\$94.1 M	\$48.93 M	0	4	\$0.53 M	\$0.21 M	\$143.8 M
E	\$19.2 M	\$0.93 M	0	0	\$0.07 M	\$0.08 M	\$20.3 M
F	\$34.8 M	\$1.18 M	0	0	\$0.21 M	\$0.79 M	\$37.0 M
GP Alternative Total:							\$234.8 M

ADJACENT AND COINCIDENT PROJECTS

Adjacent projects include **Former STIP project I-4744**, **Current Planning STIP U-2719**, **Current STIP Design Build I-5311/I-5338 “Fortify”**, **Future STIP’s I-5701, I-5703, I-5704 and I-5873**. See **page 3** of the **ML Report** for more information.

Interim I-440/US 1/US 64 (Exit 293) interchange improvements are being considered as part of the current planning for **STIP project U-2719**. Additional coordination is needed to consider how U-2719 and long-term GP (and ML) interchange improvements, impacts and costs correlate.

Upon completion of the **STIP I-5311/I-5338 “Fortify”** project, the existing configuration and features should be incorporated into the subsequent planning and design stages of the project.

TRAFFIC ANALYSIS

All traffic analyses for this feasibility study were completed in a manner consistent with NCDOT Congestion Management Guidelines and the Highway Capacity Manual. Synchro and HCS software tools were used to analyze traffic components. The selection and use of traffic control devices should be based on an engineering study of traffic conditions and physical characteristics of the location and will be required in the subsequent stages of the project. These analyses are preliminary and should be examined in greater detail in the subsequent stages of the project.

Base year 2013 and future year 2040 traffic forecasts for the annual average daily traffic (AADT) were provided by the NCDOT Transportation Planning Branch (August 11, 2014 “FS-1205A” Comprehensive Forecast by Kimley-Horn) and are based on observed data as well as output from the Triangle Regional Model (TRMV5-2013). Applicable traffic forecast diagrams can be found on **Figures A.1, A.2, A.4 and A.5** in **Appendix A**. Other prior traffic forecasts provided by the Department were also considered in the concept development (FS-1005AB dated 03/28/2014, FS-1205A I-5111 Section dated 12/11/2013, U-2719 Final dated 01/10/2013, and FS-1005A dated 11/15/2011).

The predicted AADT ranges from 175,500 to 203,800 vpd on I-40 in the 2040 Build Scenario. Trucks are estimated to comprise up to 10% (4% Duals and 6% TTST’s) of the total traffic. The highest volumes along the corridor occur west of Wade Ave (Exit 289), and between I-440/US 1/US 64 (Exit 293) and US 70/401/S. Saunders Street (Exit 298).

The following forecast scenarios were analyzed:

- 2013 Forecast Scenario 1 (Existing Conditions)
- 2040 Forecast Scenario 2B (+1 GP (from Wade Ave to Lake Wh Rd)) = [**GP Alternative**]

Note that the “+1 GP” options add 1 General Purpose lane per direction; widening the existing 6-lane to an 8-lane section. The “B” forecast scenarios include the future southeast extension of NC 540.

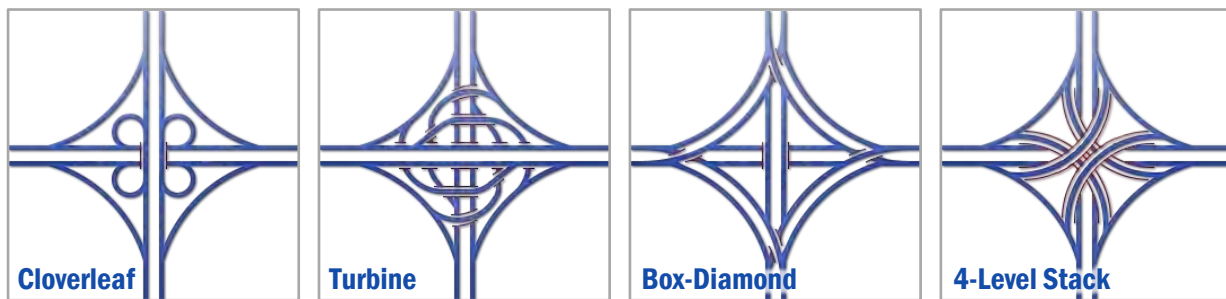
The results of the “Scenario 2B” preliminary analyses are presented in **Tables A.2 thru A.4** in **Appendix A**. Of particular note is the fact that mainline operations between all future year scenarios are fairly similar despite the differences in capacity. This appears to be a symptom of the forecast volumes which show that the latent demand for the facility is high enough that regardless of capacity, the volumes will increase accordingly to utilize any excess available capacity. As such, while speeds might increase in certain segments, overall LOS is unchanged for most locations when comparing alternatives. This static/deterministic analysis may not show the whole picture; there may be some improvement along side streets, and from a regional perspective more vehicles will be processed along the interstate corridor with the additional GP lanes.

I-40 MAINLINE

Consistently, along I-40, diverge, merge and weaving segments operate at unacceptable operations (**LOS E or worse**) during the AM and PM peak hours in 2040, with a few exceptions (**Scenario 2B, Tables A.2 and A.3 - Freeways**). Basic freeway segments along this section of I-40 are few but generally experience unacceptable operations during the peak hours. For all weaving segments, the basic freeway methodology was also performed to determine whether the weaving maneuvers were the cause for reduced operations at the location or whether the volumes simply exceeded the capacity. While a stark directional split was not noticed in the operations, generally the westbound direction in the AM, and the eastbound direction in the PM, experience worse operations. This is consistent with existing travel patterns of Research Triangle Park access in the morning and work-based trips back home in the evening.

I-40/I-440/US 1/US 64 INTERCHANGE [EXIT 293]

Based on the mainline analyses and failing conditions at the existing cloverleaf interchange, three proposed configurations were considered at the I-40/I-440US 1/US 64 interchange [Exit 293]:^[5]



The I-40 turning movements to and from the south (US 1/64) are forecast to range from 2,530 to 2,734 vph in the peak hour (46,000 to 49,700 ADT); with more vehicles turning to and from the south than remaining through on US 1/I-440. This indicates that at least two-lane ramps or flyovers are needed for these movements. The turning movements to and from the north (I-440) are significantly lower, ranging from 479 to 556 vph (8,700 to 10,100 ADT), and could be accommodated by loop-ramps if needed. A single-lane ramp's capacity is about 2,100 pc/h at a 40-50 mph free-flow speed (HCM2010, Ch.13, p. 13-18) and a 30 mph loop-ramp's capacity is about 1,000 vph (AASHTO ch.10, p. 10-48). In addition, when cloverleaf loop-ramp weaving sections approach or exceed 1,000 vph, such as all four weaving sections in the existing cloverleaf, they cause significant deterioration in the operations (AASHTO ch.10, p. 10-48).

These concepts will improve operations by providing high-speed directional ramps and eliminating the cloverleaf weaving sections. Whereas the cloverleaf provides low-speed loop-ramps, the “stack” and “box” interchanges provide high-speed directional ramps and the best operational benefits for the heaviest volumes. The turbine provides mid-range speeds and operations. A comparison matrix was developed and is presented in **Table B.2** on **page B.10**. These improvements help the interchange better operate as a regional system interchange.

RAMP TERMINAL INTERSECTIONS

All ramp terminal intersections within the study area were evaluated and most are expected to operate acceptably into the future year (**Table A.4 – Ramp Intersections**). However, those which are not tend to operate worse in the GP only widening alternative. This indicates the aforementioned latent demand condition where the additional GP lane attracts additional volume to the I-40 mainline and therefore degrades the access ramps and terminal intersections. In the alternatives containing managed lanes, some of this traffic gets shifted to the additional managed lanes intersections or access points.

Ramp terminal intersection analyses results are presented on **Scenario 2B, Table A.4 – Preliminary Traffic Analysis – Ramp Intersections** in **Appendix A**. Improvements to achieve acceptable operations in 2040, where needed, are shown on **Figures B.1 thru B.5** and are described below:

NC 54 Chapel Hill Road Interchange [Exit 290]

Based on the projected traffic volumes for the NC 54 Chapel Hill Road (Exit 290) interchange, with existing intersection configurations, the signalized westbound/northbound ramp terminal will fall to unacceptable operations (**LOS E**) in the 2040 AM peak hour and the signalized eastbound/southbound ramp terminal will operate at unacceptable levels (**LOS F**) in the 2040 PM peak hour.

Dual left-turns are recommended at the signalized westbound off-ramp intersection and are anticipated to achieve an **LOS C** in the design year. A channelized right-turn movement from NC 54 onto Ramp D / eastbound I-40 is recommended to achieve an acceptable **LOS B** at the signalized eastbound ramps intersection. See **Figure B.2** and **Appdx. A, Table A.4, Additional Analyses**.

Cary Towne Boulevard Interchange [Exit 291]

It is anticipated that the stop-controlled westbound/northbound ramp terminal at the Cary Towne Blvd. (Exit 291) interchange will operate at **LOS F** in the design year. If a traffic signal device is determined to be warranted, it is anticipated to achieve a **LOS B** in 2040 (**Appdx. A, Table A.4, Additional Analyses**). See **Figure B.2**. The eastbound/southbound stop-controlled ramp intersection is anticipated to operate at **LOS B** under the existing configuration.

Gorman Street Interchange [Exit 295]

The Gorman Street (Exit 295) interchange ramp terminals are anticipated to operate at **LOS D** in the design year. However, some individual movements are anticipated to operate at unacceptable levels.

Two potential improvements seen below are a Par-Clo Diamond Interchange and a DDI; which are anticipated to achieve acceptable individual movements and overall intersection **LOS C** and **B**, respectively, in 2040. The partial-clover interchange adds loops in the northeast and southwest quadrants. The DDI concept moves the eastbound ramp intersection further north of the Tryon Road intersection.



Since the existing Gorman St. interchange is anticipated to operate at LOS D in 2040, no interchange improvements are included in the proposed concept and estimated costs. See **Figure B.4** and **Table A.4**.

Lake Wheeler Road Interchange [Exit 297]

The Lake Wheeler Road (Exit 297) interchange ramp terminals are anticipated to operate at **LOS C or better** in the design year. See **Figure B.5** and **Table A.4**. A proposed realignment of Lake Wheeler Road to Centennial Parkway is proposed and discussed below in **Section F, page B.12**.

NOISE ABATEMENT

Potential Noise Abatement has been included in the study based on prior NCDOT Design Noise Reports, Traffic Noise Analyses, and the current NCDOT Traffic Noise Abatement Policy (Policy). There are 11 noise study areas for which noise abatement measures have preliminarily been identified as potentially meeting Policy feasibility and reasonableness criteria, pending project final design and completion of the public involvement process.

Roadway widening in the vicinity of the two noise abatement measures constructed as part of the I-4744 project (2011) will require that those two noise abatement measures be expanded. Because additional residences have been permitted and constructed adjacent to the eastbound lanes of I-40 since the date of public knowledge for the I-4744 project, extension of the northern terminus of the noise abatement near Brandywine Drive (approx. -L- Sta. 199+00 to 211+50 RT) may meet NCDOT Policy feasibility and reasonableness criteria.

Traffic noise abatement measures will potentially meet Policy feasibility and reasonableness criteria for an additional 9 noise study areas in the vicinity of the project. Addition of managed lanes will constitute a “Type I” project; therefore, provision of traffic noise abatement for any of the 11 noise study areas that meet Policy feasibility and reasonableness criteria would be subject to project final design and completion of the public involvement process.

Preliminary/Functional Design cost estimates for noise abatement in the 11 study areas have been included in the study alternative described below.

DESCRIPTION OF ALTERNATIVE

As stated previously, the GP Alternative includes widening 10 miles of I-40 to eight GP lanes and constructing interchange improvements where needed. The mainline widening will take place in the median, as illustrated on the **Proposed Typical Sections** on **pages B.1 and B.2**. Design Concepts and Cost Estimates have been developed and are described below. The study corridor is broken up into Sections A through F, as shown on **Figures B.1 thru B.5**.

NOTE: The estimated human and natural environment impacts are based on available Geographic Information System (GIS) data from Wake County/City of Raleigh/Town of Cary (2013). The NC Center for Geographic Information and Analysis (CGIA) and NC OneMap provided the statewide orthoimagery (2010, 2012, 2013). Additional information has been referenced from the former STIP I-4744 (2011) and current STIP's I-5338/I-5311 and U-2719 projects.

SECTION A – WADE AVENUE (EXIT 289) INTERCHANGE AREA

Section A of the study alternative is 2.23 miles long (-L- Sta. 87+00 to 205+00) and includes widening the section of I-40 from west of the Trenton Road overpass through the Wade Ave. interchange to east of the Trinity Road overpass. The Section A functional design concept can be seen on **Figure B.1**.

It is anticipated that I-40 can be widened to eight GP lanes through this section without impacting any existing structures. The I-40 bridges over Wade Avenue were widened under prior STIP I-4744.

It is anticipated that no ITS deployment is required for Section A improvements.

Potential Noise Abatement costs included below are based on noise study area investigations described on **page B.6** and are estimated to cost \$ 1.6M of the Section A construction costs. An existing Sound Barrier Wall along eastbound I-40 is to be retained (-L- Sta. 199+00 to 205+00 Rt.).

The following costs have been determined based on the proposed improvements described herein:

SECTION A – COSTS AND IMPACTS							
SECTION	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
			RES.	BUS.			
A	\$17.1 M	\$0	0	0	\$0	\$0	\$17.1 M

It is anticipated that **Section A** improvements will require 0 residential or business relocations and 0 wetland and stream impacts. The total Section A cost is estimated to be **\$ 17,100,000.00**.

SECTION B – NC 54 CHAPEL HILL ROAD (EXIT 290) INTERCHANGE AREA

Section B of the study alternative is 0.95 mile long (-L- Sta. 205+00 to 255+00) and includes widening the section of I-40 through the NC 54 interchange. The plan view concept is on **Figure B.2**.

In addition to the mainline widening, interchange ramp terminal improvements were considered in order to achieve acceptable levels of service in design year 2040. As stated previously in the traffic analysis results on **page B.5**, dual left-turns at the signalized westbound ramps intersection and a

channelized right-turn at the signalized eastbound ramps intersection (onto Ramp D) is recommended to achieve acceptable LOS in the design year.

It is expected that the bridges on NC 54 (Chapel Hill Road), the CSX/NSRR Railroad, and East Chatham Street over I-40 will accommodate the mainline widening.

It is anticipated that no ITS deployment is required for Section B improvements.

Potential Noise Abatement costs included below are based on noise study area investigations described on **page B.6** and are estimated to cost \$ 0.5M; including the area along eastbound I-40 and Ramp C. An existing Sound Barrier Wall along eastbound I-40 is to be retained (-L- Sta. 205+00 to 211+00 Rt.).

The following costs have been determined based on the proposed improvements described herein:

SECTION B – COSTS AND IMPACTS							
SECTION	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
			RES.	BUS.			
B	\$6.9 M	\$0	0	0	\$0	\$0	\$6.9 M

It is anticipated that **Section B** improvements will require 0 residential or business relocations and 0 wetland and stream impacts. The total Section B cost is estimated to be **\$ 6,900,000.00**.

SECTION C – CARY TOWNE BLVD (EXIT 291) INTERCHANGE AREA

Section C of the study alternative is 0.96 mile long (-L- Sta. 255+00 to 305+50) and includes widening the section of I-40 through the Cary Towne Blvd. interchange. The plan view concept is on **Figure B.2**.

In addition to the mainline widening, interchange ramp terminal improvements were considered in order to achieve acceptable levels of service in design year 2040. As stated previously in the traffic analysis results on **page B.5**, if a traffic signal device is determined to be warranted at the westbound/northbound ramps intersection, it is anticipated to achieve an acceptable LOS in 2040. The eastbound/southbound stop-controlled ramp intersection is acceptable under existing conditions.

It is expected that the Cary Town Blvd. bridge over I-40 will accommodate the proposed widening.

It is anticipated that no ITS deployment is required for Section C improvements.

Potential Noise Abatement costs included below are based on investigations described on **page B.6** and are estimated to cost \$ 1.6M; including areas along I-40 between Cary Towne Blvd. and Walnut Creek.

The following costs have been determined based on the proposed improvements described herein:

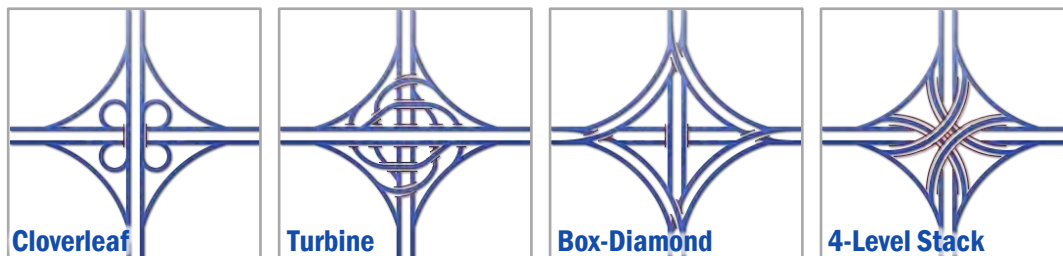
SECTION C – COSTS AND IMPACTS							
SECTION	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
			RES.	BUS.			
C	\$9.7 M	\$0	0	0	\$0	\$0	\$9.7 M

It is anticipated that **Section C** improvements will require 0 residential or business relocations and 0 wetland and stream impacts. The total Section C cost is estimated to be **\$ 9,700,000.00**.

SECTION D – I-440/US 1/US 64 (EXIT 293) INTERCHANGE AREA

Section D of the GP study alternative is 1.41 miles long (-L- Sta. 305+50 to 380+00) and includes widening the section of I-40 from west of the Buck Jones Road overpass through the I-40/I-440/US 1/US 64 cloverleaf interchange to the Jones Franklin Road overpass. The study area extends along I-440/US 1 southward to the Walnut Street/Crossroads Plaza interchange and northward up to the Jones Franklin/I-440 interchange. The proposed design concept is shown on **Figure B.3**.

Multiple interchange configurations were investigated in the early stages of the study, in conjunction with the GP only widening alternative. Turbine, box-/full-diamond, and 4-level stack directional interchanges were considered for replacing the existing full-cloverleaf.



These concepts provide high-speed directional ramps and eliminate the cloverleaf weaving sections. Whereas the cloverleaf provides low-speed loop-ramps, the “stack” and “box” interchanges provide high-speed directional ramps and operational benefits for the heaviest volumes. The turbine would provide mid-range speeds and operations. See also the traffic analysis summary on **page B.4**.

Constructability, costs, natural resources, existing development, forecast traffic volumes and managed lanes accommodations are the main criteria that were used to develop the proposed concept. There are many constraints and any solution will be expensive. Other concepts may be feasible but the proposed concept meets the criteria effectively and is representative of the magnitude of costs and impacts. Note that this concept can be applied with or without managed lanes.

Some of the important features and issues identified that need to be considered in the subsequent planning and design stages of the interchange project are:

- Walnut Creek (303(d) listed), FEMA floodway, Dana Drive properties (N-NW quadrant)
- Hope Community Church/Grace Christian School (N-NW quadrant)
- Buck Jones Road/I-40 overpass
- South Hills Shopping Center properties and access (W quadrant)
- US 1 southbound slip ramp to Buck Jones Road
- US 1 southbound flyover to Crossroads Blvd.
- Crossroads Plaza Shopping Center access
- Walnut Street bridge and interchange
- Overhead Power Line towers and routing from Crossroads Plaza across I-40 (S and E quadrants)
- Centerview Drive and Situs Court office buildings (E quadrant)

Every effort has been made in the development of the proposed concept to avoid and minimize impacts to these features while providing an effective reconstruction of the multi-level interchange.

Rough designs of the three interchange configurations were developed (as shown on **Figures B.6, B.7 and B.8**). Qualitative and quantitative data presented below in **Table B.2** were developed to assist the study team in choosing an interchange concept to carry forward for functional design and cost estimation.

TABLE B.2	TURBINE	BOX DIAMOND	STACK
Qualitative Comparisons:			
Environmental Impacts			
Right-of-Way Impacts			
Operational Issues LOS: AM(PM)	LOS E: 1(3) LOS F: 4(4)	LOS E: 4(4) LOS F: 1(2)	LOS E: 1(3) LOS F: 4(4)
Construction Costs			
Borrow			
Constructability Issues			
Score:	15	20	15
Comparative Data:			
Proposed Bridge (2nd Level)	123,000 SF	50,000 SF	26,000 SF
Proposed Bridge (3rd Level)	---	55,000 SF	101,000 SF
Proposed Bridge (4th Level)	---	88,000 SF	85,000 SF
Total Proposed Bridge	123,000 SF	193,000 SF	212,000 SF
Exist. Bridge to Retain	61,000 SF	36,000 SF	50,000 SF
Exist. Bridge to Remove	38,000 SF	51,000 SF	37,000 SF
Proposed Retaining Wall	42,000 SF	107,000 SF	65,000 SF
Ramp Design Speed (Avg.)	48 mph	51 mph	58 mph
Proposed Pavement	851,000 SF	817,000 SF	1,010,000 SF

None = 5 Low = 4 Moderate = 3 High = 2 Very High = 1

Notes: Interchange Bridges include Walnut St, Crossroads overpass, I-40 and C-D's over US 1.

Ramp Speeds based on 0.08 superelevation table, with the exception of Flyover Bridges based on 0.06 table.

This information is preliminary and subject to change. It is not the result of extensive design or environmental analysis.

Based on the information above and input from the study team, the Turbine interchange was not carried forward in this study. Constructability, maintenance of traffic, and compatibility with future managed lanes issues were the main reasons for not carrying it forward. The Turbine's lower speed ramps would also process less traffic than the stack or box interchanges. The 4-level stack and box-diamond configurations were carried forward.

If managed lanes were not being considered the "box" diamond, with some left-hand exits, could provide a context sensitive, freeway-to-freeway solution with a small footprint. If managed lanes are being considered for long-range improvements then the 4-level stack is a solution which increases the footprint somewhat but can accommodate managed lanes directional ramps in the future. The GP

interchange concept presented herein, with a 4-level stack configuration, has been designed such that managed lanes directional ramps, with a box-diamond configuration, could be added in the future. Improvements around the interchange – at Walnut Street/Crossroads Blvd., Caitboo Ave./South Hills, and at Jones Franklin Rd./I-40 – can provide local road network and service interchange type access, while improving the regional, system type function of the main freeway-to-freeway interchange.

Based on the significant size and scope of reconstructing the interchange, the Crossroads Plaza/Buck Jones Road direct access ramp and flyover can most likely not be maintained as it is today. The US 1 south-serving ramps from I-40 eastbound and westbound must each be 2-lane ramps to accommodate the forecast traffic volumes, and the distance needed to merge them onto US 1 prior to the Crossroads/Buck Jones off-ramp is not feasible. Alternative access has been considered, the Town of Cary Southeast Area plan has been reviewed and the following is recommended for further consideration:

- Relocate Crossroads Blvd. to the eastern Walnut Street ramp intersection,
- Construct a Caitboo Ave. extension over US 1 to South Hills/Buck Jones Rd., and
- Construct an I-40/Jones Franklin Rd. tight diamond interchange (TDI) with braided western ramps.

In addition to costs for the main interchange, the costs for replacing the Walnut Street bridge; relocating the cross-country overhead power lines; and constructing retaining walls along Walnut Creek and South Hills mall are included in the **Section D** estimates. Costs for the I-40/Jones Franklin Road TDI and braided ramp bridges are included in **Section E**. Improvements to the I-440/US 1/Jones Franklin Road interchange just north of FS-1005A are being considered under **STIP U-2719** and are not included in this study.

The Ramp B retaining walls are placed at the top of the existing slope, above the Walnut Creek 100-year floodplain, to avoid fill in the floodplain adjacent to the ramp. There are multiple insurable structures within the 100-year floodplain at or just upstream of the proposed wall location. Any fill within the floodplain at this location will likely cause an increase in the 100-year water surface elevation at these structures. Floodplain regulations will not allow an increase in the 100-year water surface on an insurable structure.

Based on the proposed GP interchange concept the I-40 westbound, I-40 eastbound, and eastbound collector-distributor bridges over I-440/US 1 are retained. The other westbound collector-distributor bridge over I-440/US 1 will be removed and replaced by two flyovers. There are two 3rd level GP flyovers, one 4th level flyover and one loop-ramp proposed; the Loop D ramp can be maintained and all of the cloverleaf loop weaves are eliminated.

It is estimated that ITS deployment for Section D improvements, including replacing/relocating existing and installing new CCTVs, MVDs and Fiber Optic Cable will cost \$ 210,000.00.

Potential Noise Abatement costs included below are based on noise study area investigations described on **page B.6** and are estimated to cost \$ 1.7M; including areas along both sides of I-40 from Cary Towne Blvd. to Walnut Creek, between southbound I-440 and Walnut Creek, and along eastbound I-40 near Jones Franklin Road.

The following costs have been determined based on the proposed improvements described herein:

SECTION D – COSTS AND IMPACTS							
SECTION	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
			RES.	BUS.			
D	\$94.1 M	\$48.93 M*	0	4*	\$0.53 M	\$0.21 M	\$143.8 M

* While it is the intention of the concept to utilize retaining walls to prevent any relocations in the South Hills Shopping Center or in the Centerview Drive business park, the R/W Cost Estimate includes the cost of impacting 4 businesses.

It is anticipated that **Section D** improvements will require 0 residential relocations, 4 business relocations, and 0 wetland and stream impacts. The total Section D cost is estimated to be **\$ 143,800,000.00**.

If this interchange were to be built in stages, it is recommended that the US 1/64 south serving GP flyovers be constructed first, as they serve the heaviest volumes, replacing the existing Loop B and Loop A ramps. These can be designed in such a way as to accommodate the remaining existing cloverleaf and the future expansion with managed lanes.

Further coordination with ongoing **STIP U-2719** (I-440 Improvements) planning and design is needed to provide a design that compliments the future managed lanes accommodations.

SECTION E – JONES FRANKLIN ROAD (NEW EXIT) INTERCHANGE

Section E of the study alternative is 0.45 mile long (-L- Sta. 380+00 to 403+50) and includes widening the section of I-40 and constructing the proposed Jones Franklin Road tight-diamond interchange. The proposed design concept is shown on **Figure B.3**.

Based on design investigations regarding how best to provide local access to Crossroads Plaza and freeway-to-freeway access at the I-40/I-440/US 1/ US 64 interchange, an idea developed to provide an



additional access point off of I-40. Much like the I-540/US 1/Triangle Town Blvd. interchange area pictured to the left, a braided tight-diamond interchange is proposed at Jones Franklin Road to provide local access to Crossroads Blvd. It likely improves the LOS for the heavy south-serving freeway-to-freeway

movements at the I-440/US 1/ US 64 interchange by relocating some local traffic to the new TDI. Another advantage is that the new access likely provides “relief” to the Walnut Street interchange for those accessing Crossroads Blvd., Dillard Drive or Tryon Road.

As part of the TDI construction, the two-lane Jones Franklin Road bridge would be replaced with a multilane bridge with accommodations for “bikes and peds”. (This also correlates with CAMPO/Town

of Cary’s long range plan to widen Jones Franklin to the south.) TDI ramp retaining walls help minimize and avoid impacts to adjacent properties; including a cell tower in the northeast quadrant. Noise abatement has been included along both sides of I-40 in Section E.

It is estimated that ITS deployment for Section E improvements, including replacing/relocating MVDs, installing a new CCTV and Fiber Optic Cable will cost \$ 80,000.00.

Potential Noise Abatement costs included below are based on noise study area investigations described on **page B.6** and are estimated to cost \$ 2.4M; including areas along both sides of I-40.

The ramps, braided ramp bridges, traffic signals, noise abatement and retaining walls in Section E are included in the following estimated costs:

SECTION E – COSTS AND IMPACTS							
SECTION	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
			RES.	BUS.			
E	\$19.2 M	\$0.93 M	0	0	\$0.07 M	\$0.08 M	\$20.3 M

Section E improvements are estimated to require 0 residential or business relocations and 0 wetland and stream impacts. The total Section E cost is estimated to be **\$ 20,300,000.00**.

SECTION F – WEST OF GORMAN STREET (EXIST 295) TO EAST OF LAKE WHEELER ROAD (EXIT 297)

Section F of the study alternative is 3.75 miles long (-L- Sta. 403+50 to 601+50). It includes widening the section of I-40 from west of the Gorman Street interchange to the NSRR overpass east of the Lake Wheeler Road interchange; where the general purpose lane widening ends, as noted on **Figure 1**. The proposed design concept is shown on **Figures B.4 and B.5**.

As stated previously in the traffic analysis summary on **page B.6**, no ramp intersection improvements are required at the Gorman Street interchange. The Gorman Street dual bridges can be retained with the GP Alternative. The Avent Ferry Road, Lake Dam Road, and Trailwoods Drive overpass bridges can also be retained.

NCSU representatives requested including a future Centennial Campus interchange and connector road mid-way between Gorman St. and Lake Wheeler Rd., as shown on the NCSU Facilities Master Plan.^[6] A separate design concept and cost estimate has been included (see **page 32** and **Appendix C**). The introduction of a new interchange between Gorman and Lake Wheeler creates multiple shorter weaving segments and reduces the interchange spacing from 2 miles to 1 mile, but it improves campus access and is part of the university’s master plan. Further planning and design investigations and continued coordination with the university are needed in the subsequent stages of the project.

Based on the traffic analysis results, no ramp intersection improvements are required at the Lake Wheeler Road interchange. However, an idea for improved access to Centennial Campus is to realign Centennial Parkway directly to Lake Wheeler Road at I-40, creating a direct route to the campus. This also facilitates construction of the bridge over I-40, provides better skews at the ramp intersections, lengthens Ramp A, and moves west of an area of wetlands.

It is estimated that ITS deployment for Section F improvements, including replacing/relocating existing and installing new CCTVs, MVDs, Dynamic Message Signs (DMSs) and Fiber Optic Cable will cost \$ 790,000.00.

Potential Noise Abatement costs included below are based on noise study area investigations described on **page B.6** and are estimated to cost \$ 7.6M; including various areas along both sides of I-40.

There is an estimated 150' of stream impacts from the relocation of Lake Wheeler Road over Walnut Creek north of I-40. There is also the potential for stream and wetland mitigation from the removal of the existing box culvert under the old roadway.

The Lake Wheeler Road/Centennial Parkway relocation also crosses the Walnut Creek greenway trail. There is an existing pedestrian tunnel next to the Walnut Creek culvert which would be relocated.

The following costs have been determined based on the proposed improvements described herein:

SECTION F – COSTS AND IMPACTS							
SECTION	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
			RES.	BUS.			
F	\$34.8 M	\$1.18 M	0	0	\$0.21 M	\$0.79 M	\$37.0 M

Section F improvements are anticipated to require 0 residential or business relocations, 0 wetland and approximately 150 feet of stream impacts. The total Section F cost is estimated to be **\$ 37,000,000.00**.

PROJECT COSTS & RECOMMENDATIONS

The General Purpose Widening Alternative includes widening the western 10 miles of the FS-1005A study corridor to eight GP lanes and constructing interchange improvements where needed.

The mainline improvements include 12-foot full-depth inside and outside paved shoulders. The proposed median is 44 feet wide with cable guiderail from Wade Avenue (Exit 289) to east of the I-440/US 1/US 64 interchange (Exit 293) and is 26 feet wide with concrete barrier from east of the I-440/US 1/US 64 interchange to the NSRR Overpass (East of Lake Wheeler Road, Exit 297).

Interchange improvements are recommended at the NC 54 Chapel Hill Road (Exit 290) ramp intersections and at the westbound ramp intersection of the Cary Towne Blvd. (Exit 291) interchange. A relocation of Lake Wheeler Road to Centennial Parkway is recommended on the north side of the Lake Wheeler Road (Exit 297) interchange. A reconstruction of the I-440/US 1/US 64 interchange (Exit 293) and a new I-40/Jones Franklin Road tight-diamond interchange is also recommended as part of the GP Alternative improvements.

TABLE B.1 – COMPREHENSIVE COSTS AND IMPACTS							
SECTION	CONSTR. COST	R/W COST	RELOCATIONS		UTILITY COST	ITS COST	SUBTOTAL
			RES.	BUS.			
A	\$17.1 M	\$0	0	0	\$0	\$0	\$17.1 M
B	\$6.9 M	\$0	0	0	\$0	\$0	\$6.9 M
C	\$9.7 M	\$0	0	0	\$0	\$0	\$9.7 M
D	\$94.1 M	\$48.93 M	0	4	\$0.53 M	\$0.21 M	\$143.8 M
E	\$19.2 M	\$0.93 M	0	0	\$0.07 M	\$0.08 M	\$20.3 M
F	\$34.8 M	\$1.18 M	0	0	\$0.21 M	\$0.79 M	\$37.0 M
GP Alternative Total:							\$234.8 M

It is anticipated that the GP alternative improvements will require 0 residential relocations, 4 business relocations, 0 acres of wetland impacts and 150 feet of stream impacts. The total 10-mile project is estimated to cost **\$243,800,000.00**.

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WILLIAM B. UMSTEAD PARK
(REEDY CREEK SECTION)

BEGIN FS-1005A

INTERSTATE
40

TO HARRISON AVE
EXIT 287

SAS CAMPUS DR.

DANIEL AND VALLIE
MATTHEWS HOUSE

TOWN
CARY

TRENTON RD.

AGRICULTURAL
EXPERIMENT STATION

RICHLAND CREEK

WADE AVE.

TO EDWARDS MILL RD

CITY
RALEIGH

WADE PARK BLVD.

INSIDE WADE
SUBDIVISION

TRINITY RD.

BRIDGE #370 RETAIN

TRIBUTARY

INTERSTATE
40

GP ALT.
FIGURE B.1

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GP ALT. FIGURE B.1

FS-1005A

I-40 UPGRADES
FROM WEST OF WADE AVE.
TO EAST OF LAKE WHEELER RD.
WAKE COUNTY



LEGEND

- | | | | | | |
|--|----------------------------|--|------------------------|--|---------------------------|
| | EXISTING G.P. LANES | | WETLANDS | | COMMUNITY FEATURES |
| | PROPOSED G.P. LANES | | STREAMS | | CELL, RADIO TOWERS |
| | PROPOSED BRIDGES | | WATER BODIES | | STATE PARKS |
| | PROPOSED RIGHT-OF-WAY | | FEMA 100 YEAR FLOODWAY | | SHPO HISTORIC PROPERTIES |
| | EXISTING BRIDGES TO RETAIN | | OVER-HEAD POWER LINES | | POTENTIAL NOISE ABATEMENT |
| | EXISTING BRIDGES TO REMOVE | | | | |
| | CITY/TOWN LIMITS | | | | |
| | PROPERTY LINES | | | | |

PRELIMINARY PLANS

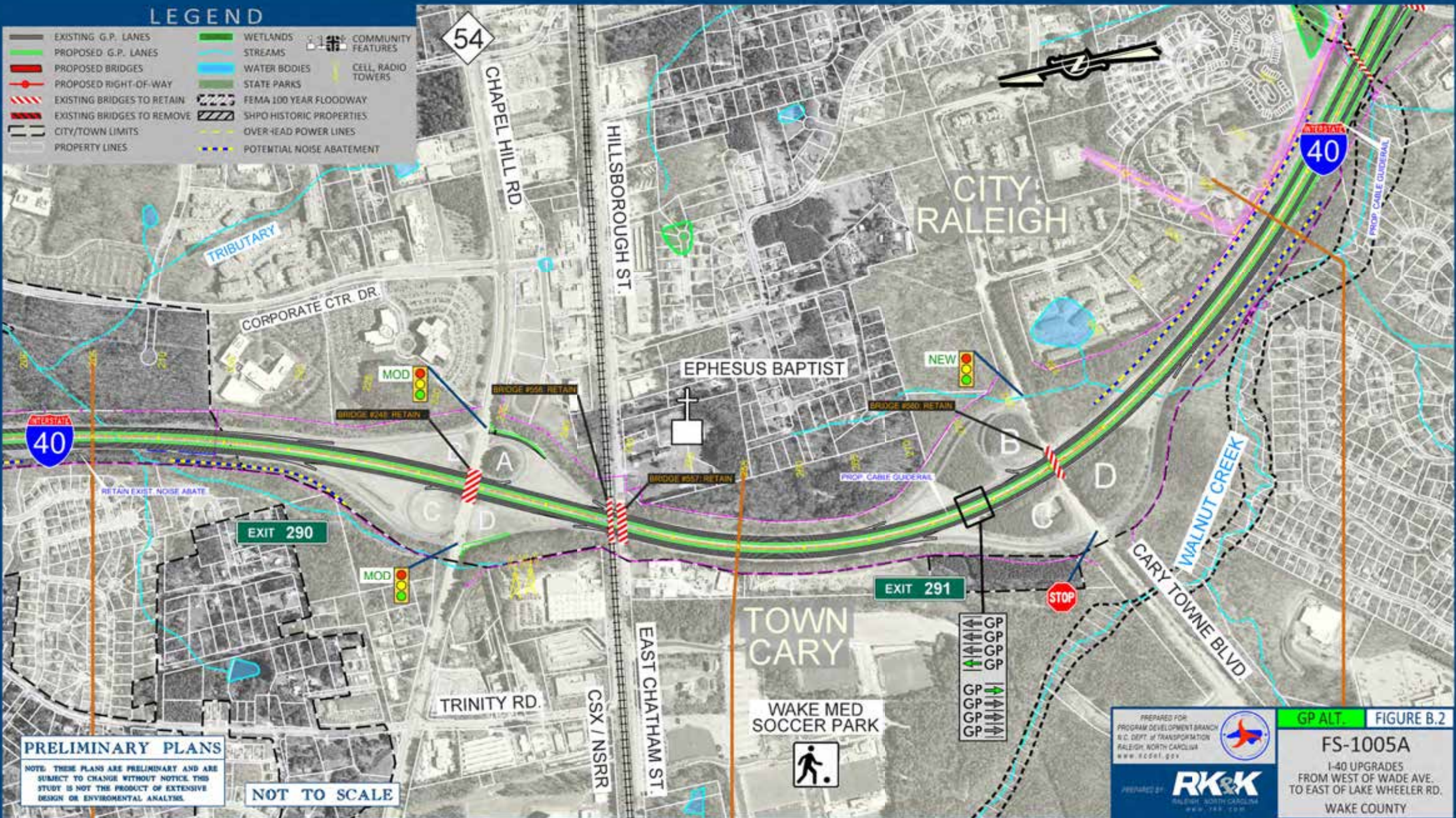
NOTE: THESE PLANS ARE PRELIMINARY AND ARE SUBJECT TO CHANGE WITHOUT NOTICE. THIS STUDY IS NOT THE PRODUCT OF EXTENSIVE DESIGN OR ENVIRONMENTAL ANALYSIS.

NOT TO SCALE

SECTION A

LEGEND

- EXISTING G.P. LANES
- PROPOSED G.P. LANES
- PROPOSED BRIDGES
- PROPOSED RIGHT-OF-WAY
- EXISTING BRIDGES TO RETAIN
- EXISTING BRIDGES TO REMOVE
- CITY/TOWN LIMITS
- PROPERTY LINES
- WETLANDS
- STREAMS
- WATER BODIES
- STATE PARKS
- FEMA 100 YEAR FLOODWAY
- SHPO HISTORIC PROPERTIES
- OVER-HEAD POWER LINES
- POTENTIAL NOISE ABATEMENT
- COMMUNITY FEATURES
- CELL RADIO TOWERS



PRELIMINARY PLANS

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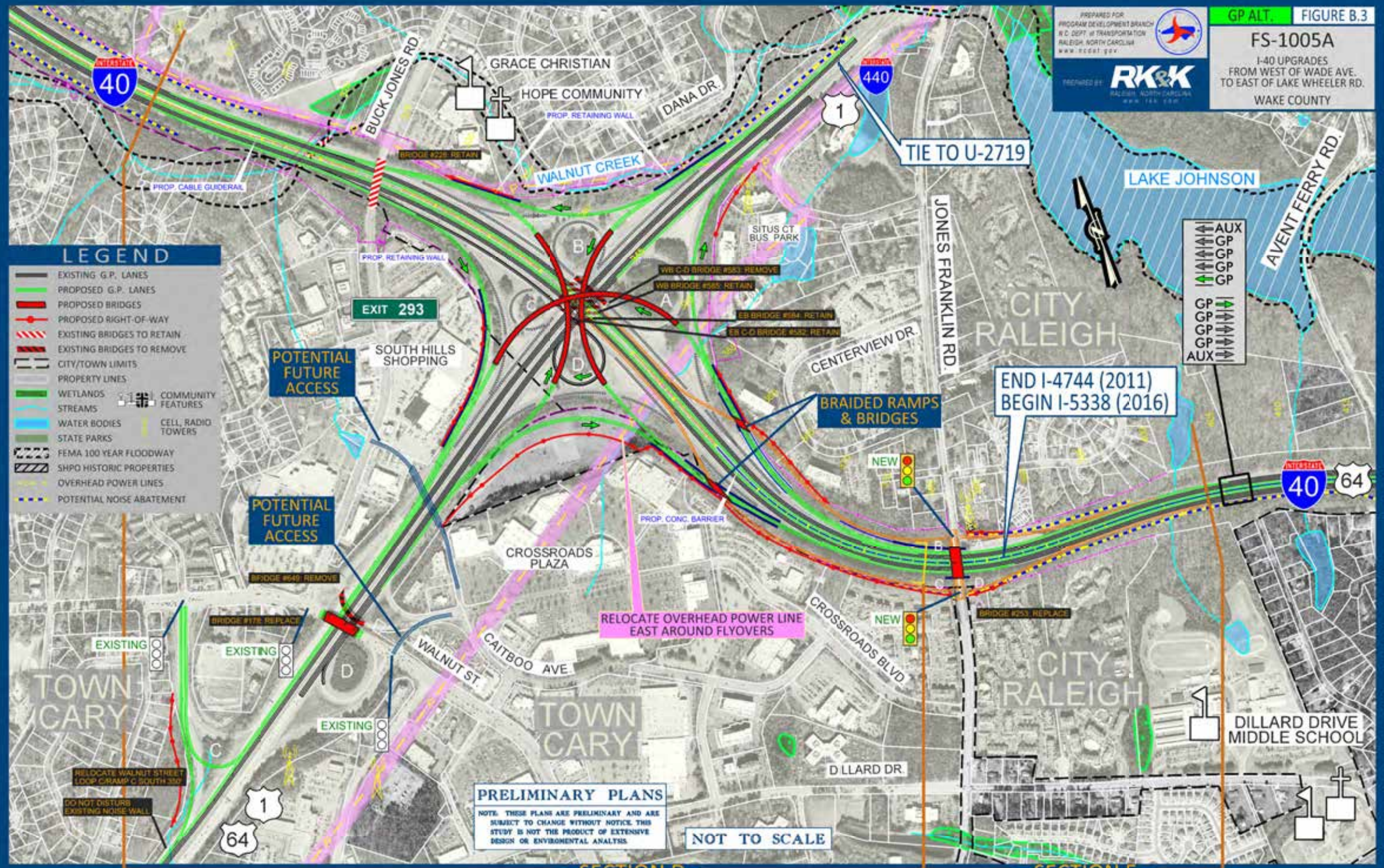
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GP ALT. FIGURE B.2

FS-1005A
I-40 UPGRADES
FROM WEST OF WADE AVE.
TO EAST OF LAKE WHEELER RD.
WAKE COUNTY

SECTION B

SECTION C



LEGEND

- EXISTING G.P. LANES
- PROPOSED G.P. LANES
- PROPOSED BRIDGES
- PROPOSED RIGHT-OF-WAY
- EXISTING BRIDGES TO RETAIN
- EXISTING BRIDGES TO REMOVE
- CITY/TOWN LIMITS
- PROPERTY LINES
- WETLANDS
- STREAMS
- WATER BODIES
- STATE PARKS
- FEMA 100 YEAR FLOODWAY
- SHPO HISTORIC PROPERTIES
- OVERHEAD POWER LINES
- POTENTIAL NOISE ABATEMENT
- COMMUNITY FEATURES
- CELL, RADIO TOWERS

	AUX
	GP
	GP
	GP
	GP
	GP
	GP
	AUX

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NOT TO SCALE

SECTION D

SECTION E

END I-4744 (2011)
BEGIN I-5338 (2016)

BRAIDED RAMPS & BRIDGES

RELOCATE OVERHEAD POWER LINE EAST AROUND FLYOVERS

POTENTIAL FUTURE ACCESS

POTENTIAL FUTURE ACCESS

EXIT 293

TIE TO U-2719

LAKE JOHNSON

AVENT FERRY RD.

JONES FRANKLIN RD.

CENTERVIEW DR.

WALNUT ST.

CAITBOO AVE.

CROSSROADS BLVD.

DILLARD DR.

DILLARD DRIVE MIDDLE SCHOOL

GRACE CHRISTIAN
HOPE COMMUNITY

SITUS CT BUS PARK

SOUTH HILLS SHOPPING

40

440

1

40

64

64

1

RELOCATE WALNUT STREET LOOP GRAMP C SOUTH 300'

DO NOT DISTURB EXISTING NOISE WALL

BRIDGE #640: REMOVE

BRIDGE #178: REPLACE

PROP. CONC. BARRIER

BRIDGE #253: REPLACE

WB C-D BRIDGE #583: REMOVE

WB BRIDGE #585: RETAIN

EB BRIDGE #584: RETAIN

EB C-D BRIDGE #582: RETAIN

BRIDGE #228: RETAIN

PROP. RETAINING WALL

PROP. CABLE GUIDERAIL

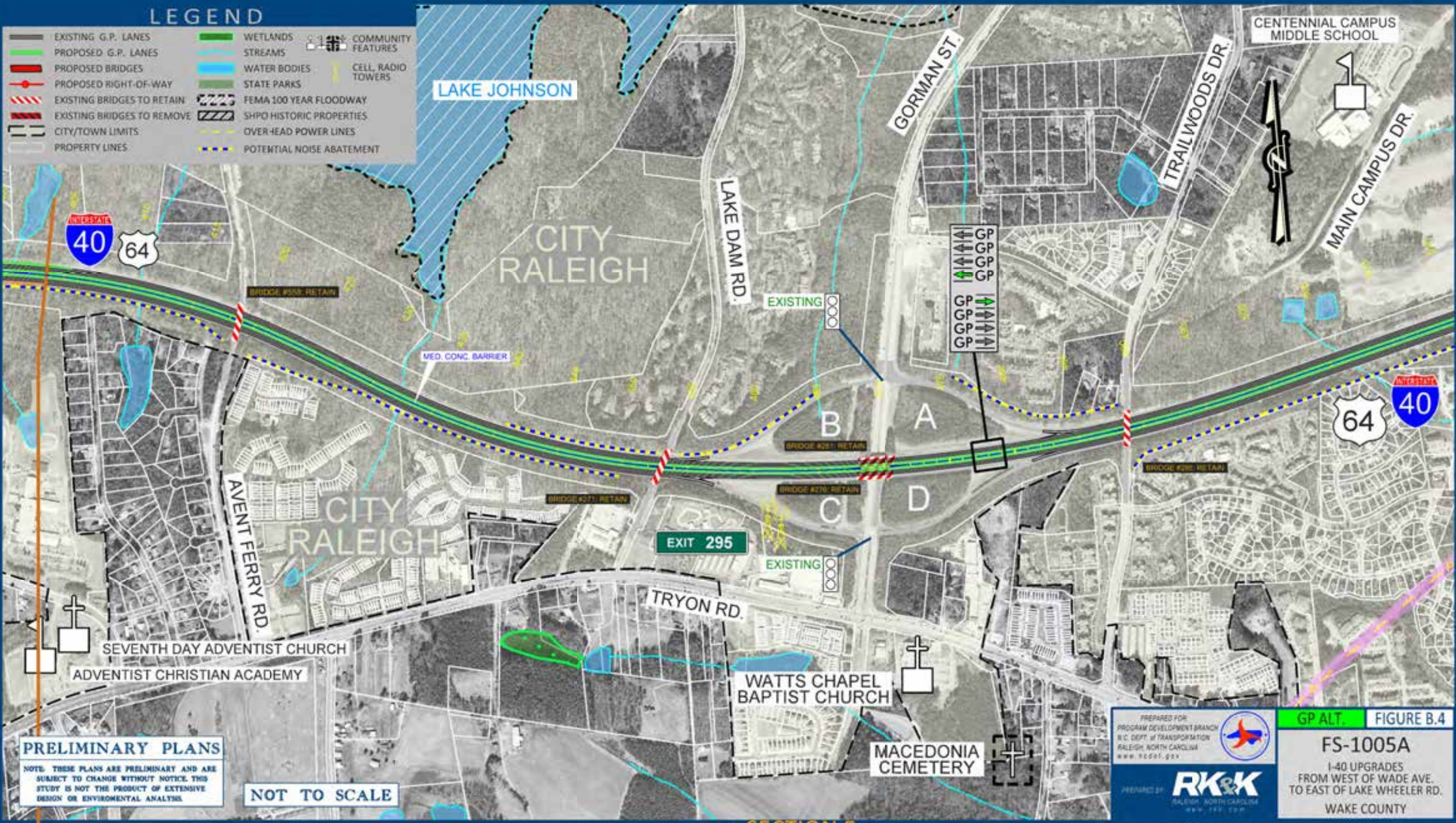
PROP. RETAINING WALL

BUCK JONES RD.

DANA DR.

LEGEND

- EXISTING G.P. LANES
- PROPOSED G.P. LANES
- PROPOSED BRIDGES
- PROPOSED RIGHT-OF-WAY
- EXISTING BRIDGES TO RETAIN
- EXISTING BRIDGES TO REMOVE
- CITY/TOWN LIMITS
- PROPERTY LINES
- WETLANDS
- STREAMS
- WATER BODIES
- STATE PARKS
- FEMA 100 YEAR FLOODWAY
- SHPO HISTORIC PROPERTIES
- OVER-HEAD POWER LINES
- POTENTIAL NOISE ABATEMENT
- COMMUNITY FEATURES
- CELL, RADIO TOWERS



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SECTION F

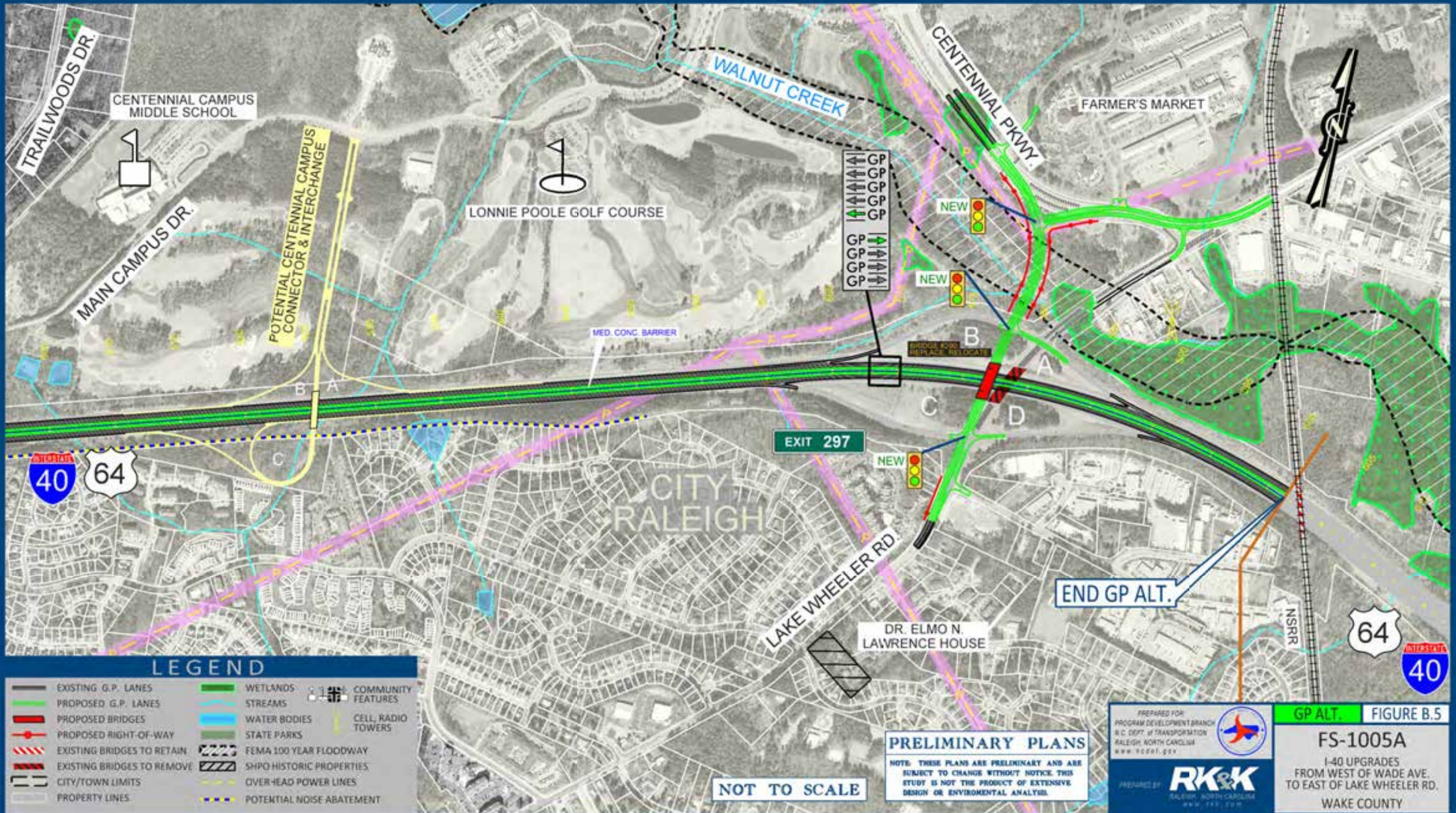
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GP ALT. FIGURE B.4

FS-1005A
I-40 UPGRADES
FROM WEST OF WADE AVE.
TO EAST OF LAKE WHEELER RD.
WAKE COUNTY



LEGEND

- | | | | | | |
|--|----------------------------|--|--------------------------|--|---------------------------|
| | EXISTING G.P. LANES | | WETLANDS | | COMMUNITY FEATURES |
| | PROPOSED G.P. LANES | | STREAMS | | CELL, RADIO TOWERS |
| | PROPOSED BRIDGES | | WATER BODIES | | POTENTIAL NOISE ABATEMENT |
| | PROPOSED RIGHT-OF-WAY | | STATE PARKS | | CITY/TOWN LIMITS |
| | EXISTING BRIDGES TO RETAIN | | FEMA 100 YEAR FLOODWAY | | PROPERTY LINES |
| | EXISTING BRIDGES TO REMOVE | | SHPO HISTORIC PROPERTIES | | |
| | | | OVER-HEAD POWER LINES | | |
| | | | | | |

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GP ALT. FIGURE B.5

FS-1005A
I-40 UPGRADES
FROM WEST OF WADE AVE.
TO EAST OF LAKE WHEELER RD.
WAKE COUNTY

SECTION F

US 1 Stack Interchange

FS-1005A

I-40 UPGRADES FROM HARRISON AVE. TO EAST OF LAKE WHEELER RD. WAKE COUNTY

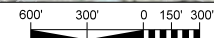
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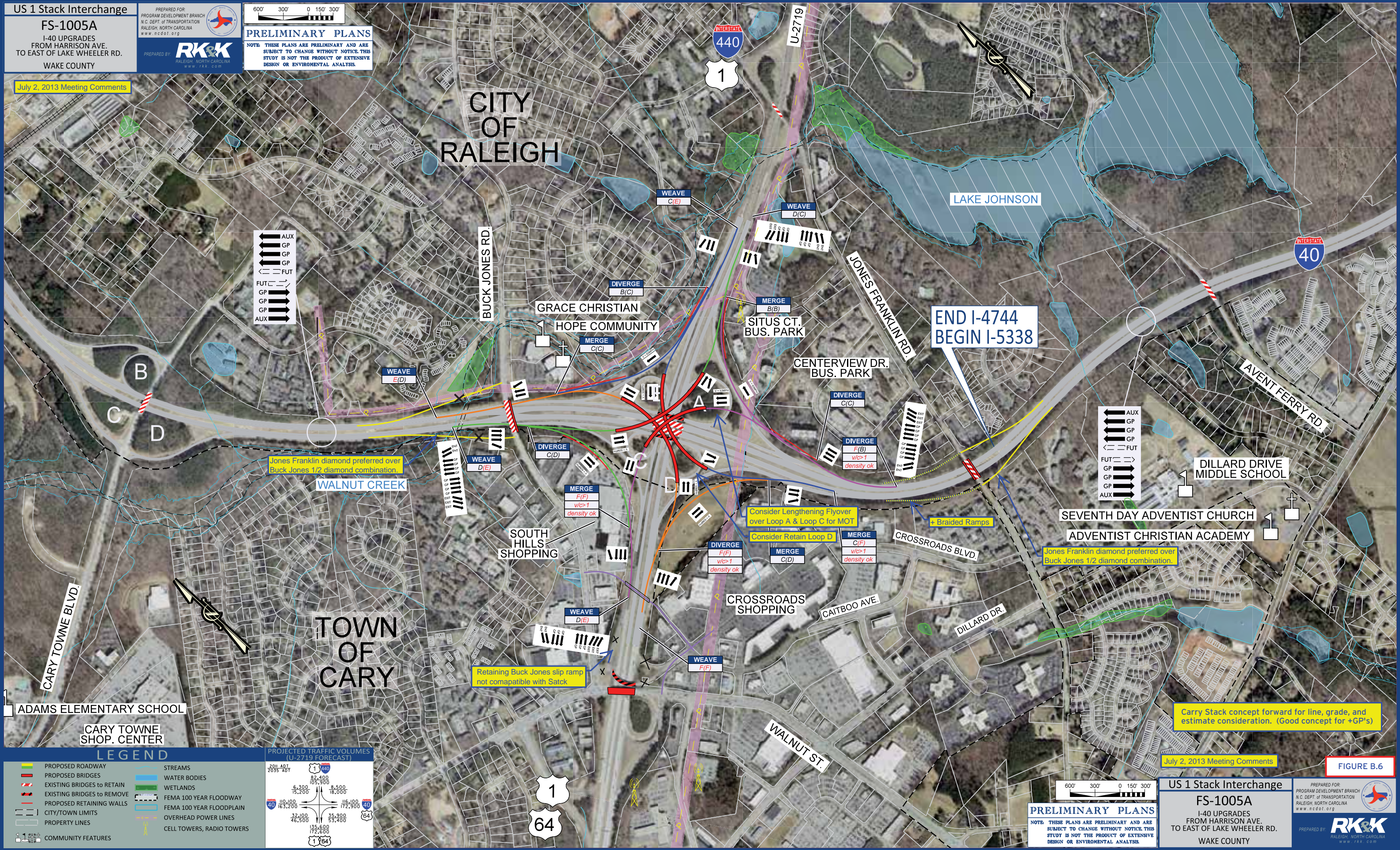
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PRELIMINARY PLANS

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July 2, 2013 Meeting Comments



AUX
GP
GP
GP
FUT
GP
GP
GP
AUX

AUX
GP
GP
GP
FUT
GP
GP
GP
AUX

Jones Franklin diamond preferred over Buck Jones 1/2 diamond combination.

Consider Lengthening Flyover over Loop A & Loop C for MOT

Consider Retain Loop D

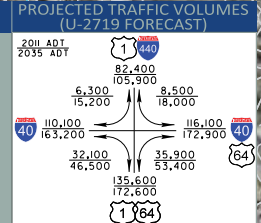
Retaining Buck Jones slip ramp not compatible with Sack

Jones Franklin diamond preferred over Buck Jones 1/2 diamond combination.

Carry Stack concept forward for line, grade, and estimate consideration. (Good concept for +GP's)

LEGEND

- PROPOSED ROADWAY
- PROPOSED BRIDGES
- EXISTING BRIDGES TO RETAIN
- EXISTING BRIDGES TO REMOVE
- PROPOSED RETAINING WALLS
- CITY/TOWN LIMITS
- PROPERTY LINES
- COMMUNITY FEATURES
- STREAMS
- WATER BODIES
- WETLANDS
- FEMA 100 YEAR FLOODWAY
- FEMA 100 YEAR FLOODPLAIN
- OVERHEAD POWER LINES
- CELL TOWERS, RADIO TOWERS



July 2, 2013 Meeting Comments

FIGURE B.6

PRELIMINARY PLANS

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US 1 Stack Interchange

FS-1005A

I-40 UPGRADES FROM HARRISON AVE. TO EAST OF LAKE WHEELER RD. WAKE COUNTY

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US 1 Box Interchange
FS-1005A
 I-40 UPGRADES
 FROM HARRISON AVE.
 TO EAST OF LAKE WHEELER RD.
 WAKE COUNTY

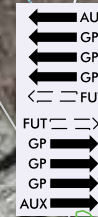
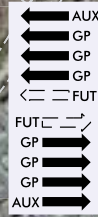
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600' 300' 0 150' 300'

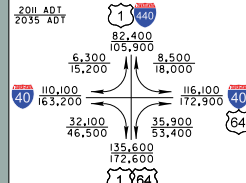
July 2, 2013 Meeting Comments



LEGEND

- PROPOSED ROADWAY
- PROPOSED BRIDGES
- EXISTING BRIDGES TO RETAIN
- EXISTING BRIDGES TO REMOVE
- PROPOSED RETAINING WALLS
- CITY/TOWN LIMITS
- PROPERTY LINES
- COMMUNITY FEATURES
- STREAMS
- WATER BODIES
- WETLANDS
- FEMA 100 YEAR FLOODWAY
- FEMA 100 YEAR FLOODPLAIN
- OVERHEAD POWER LINES
- CELL TOWERS, RADIO TOWERS

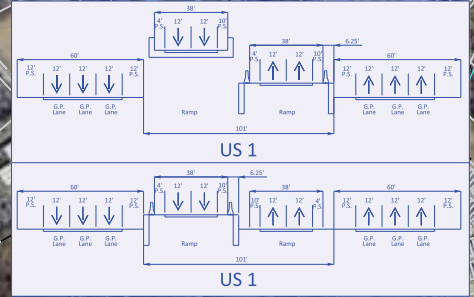
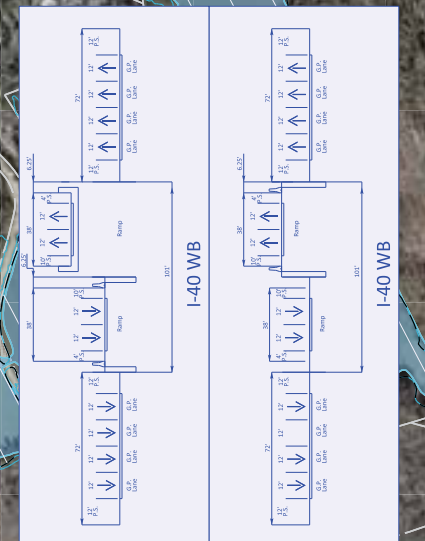
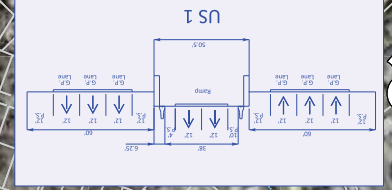
PROJECTED TRAFFIC VOLUMES
 (U-2719 FORECAST)



CITY OF RALEIGH

TOWN OF CARY

1
64



Carry Box concept forward for line, grade, and estimate consideration. (Good concept for +ML's)

July 2, 2013 Meeting Comments

FIGURE B.7

US 1 Box Interchange
FS-1005A
 I-40 UPGRADES
 FROM HARRISON AVE.
 TO EAST OF LAKE WHEELER RD.
 WAKE COUNTY

PRELIMINARY PLANS
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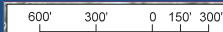
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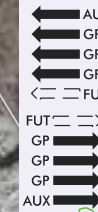
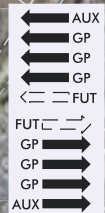
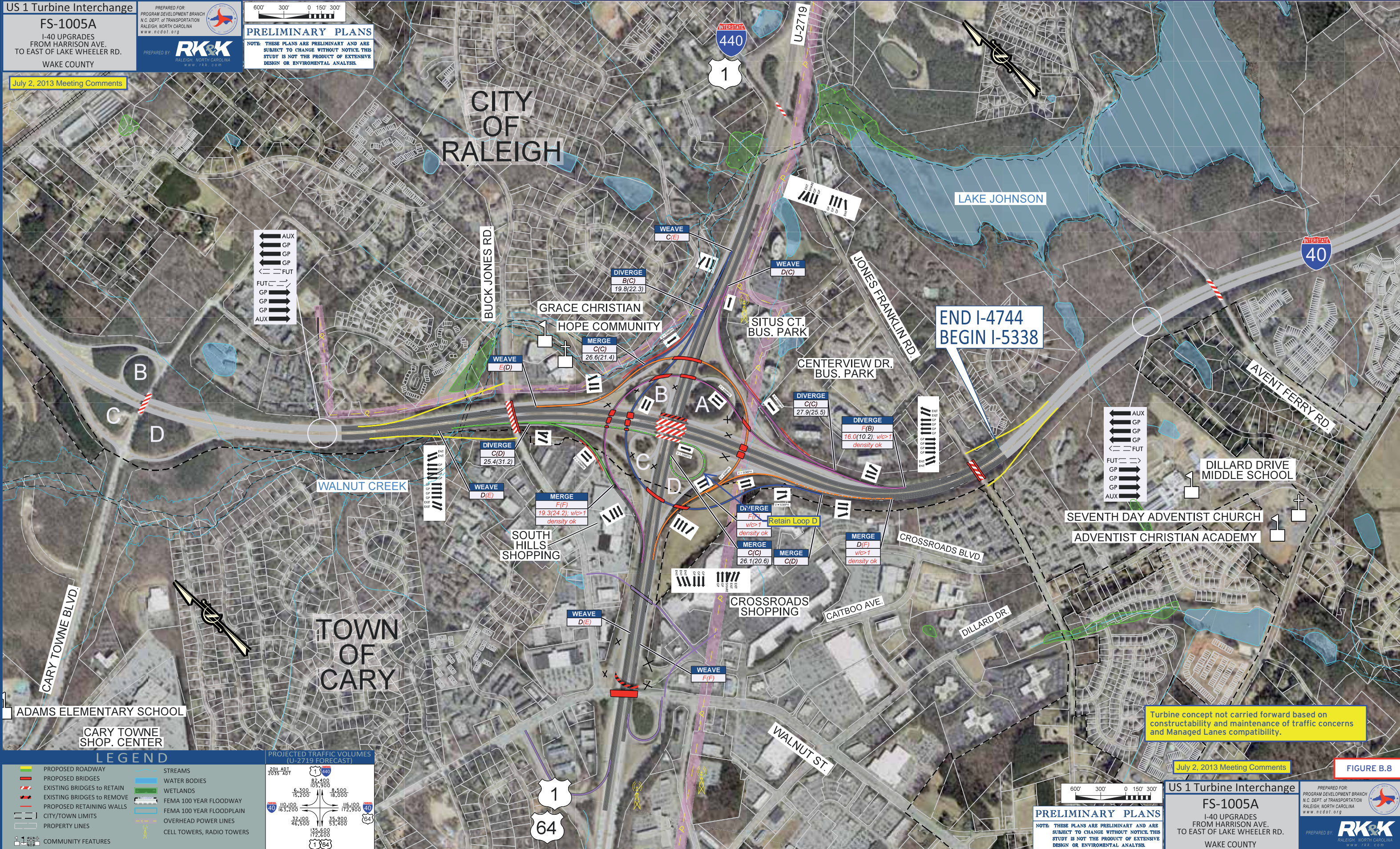
600' 300' 0 150' 300'

ENC 2 - INT - 10/11/13 - 10/11/13 - 10/11/13

FS-1005A - US 1 Box Interchange - JULY 2, 2013

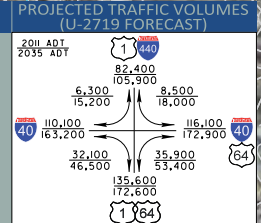


July 2, 2013 Meeting Comments



LEGEND

- PROPOSED ROADWAY
- PROPOSED BRIDGES
- EXISTING BRIDGES TO RETAIN
- EXISTING BRIDGES TO REMOVE
- PROPOSED RETAINING WALLS
- CITY/TOWN LIMITS
- PROPERTY LINES
- COMMUNITY FEATURES
- STREAMS
- WATER BODIES
- WETLANDS
- FEMA 100 YEAR FLOODWAY
- FEMA 100 YEAR FLOODPLAIN
- OVERHEAD POWER LINES
- CELL TOWERS, RADIO TOWERS



Turbine concept not carried forward based on constructability and maintenance of traffic concerns and Managed Lanes compatibility.

July 2, 2013 Meeting Comments

FIGURE B.8

Appendix C:

Centennial Campus Connector/ Interchange



CENTENNIAL CAMPUS MIDDLE SCHOOL

LONNIE POOLE GOLF COURSE

POTENTIAL CENTENNIAL CAMPUS CONNECTOR & INTERCHANGE

Walnut Creek Trib.

TRAILWOODS DR.
MAIN CAMPUS DR.

Trailwood Heights

Orchard Pointe Townhomes

Trailwood Valley Townhomes

LINEBERRY DR.

EX. BOX CULVERT

POTENTIAL NOISE ABATEMENT

PROP. RIGHT-OF-WAY

PROP. BOX CULVERTS

PRELIMINARY PLANS

NOTE: THESE PLANS ARE PRELIMINARY AND ARE SUBJECT TO CHANGE WITHOUT NOTICE. THIS STUDY IS NOT THE PRODUCT OF EXTENSIVE DESIGN OR ENVIRONMENTAL ANALYSIS.

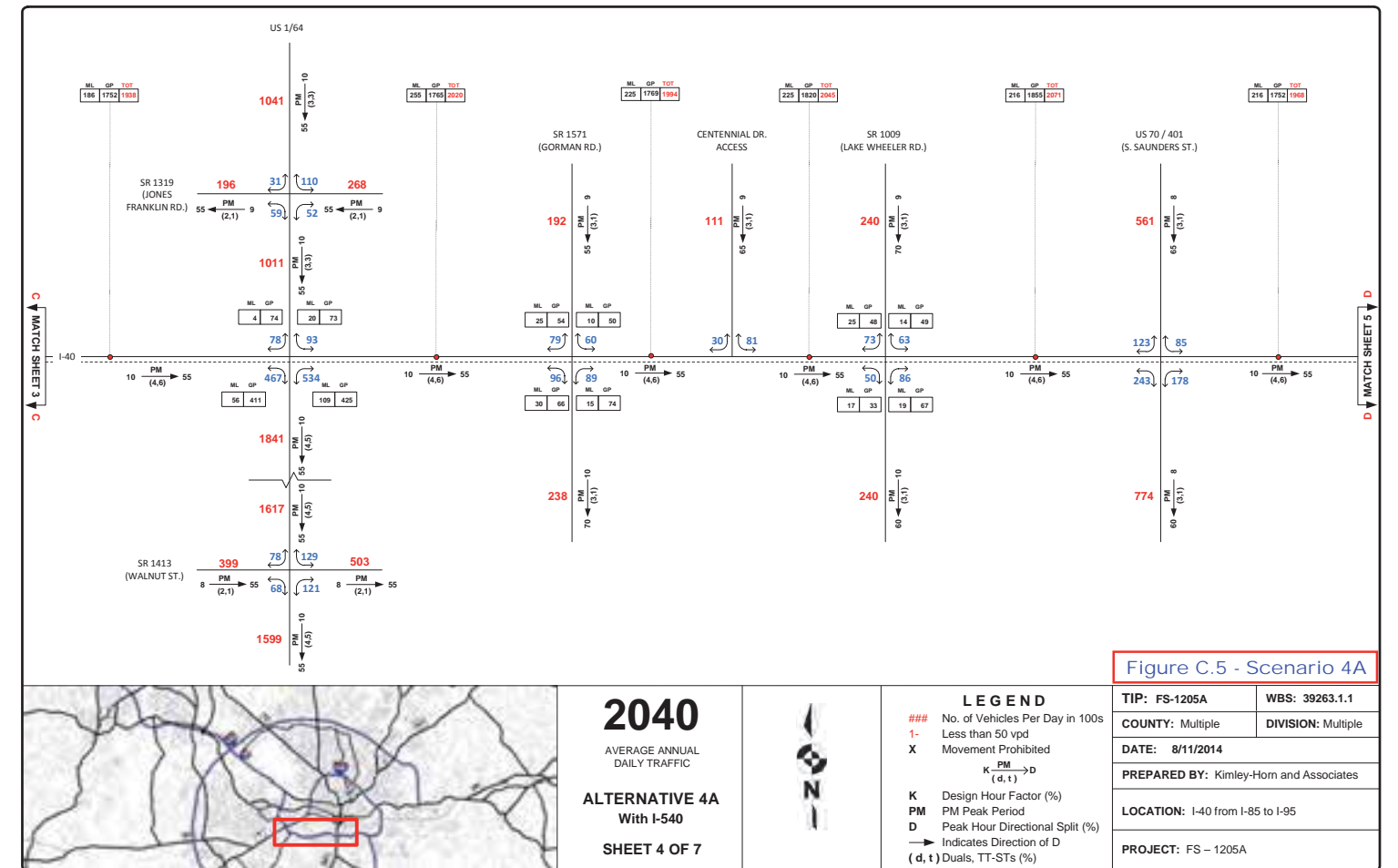
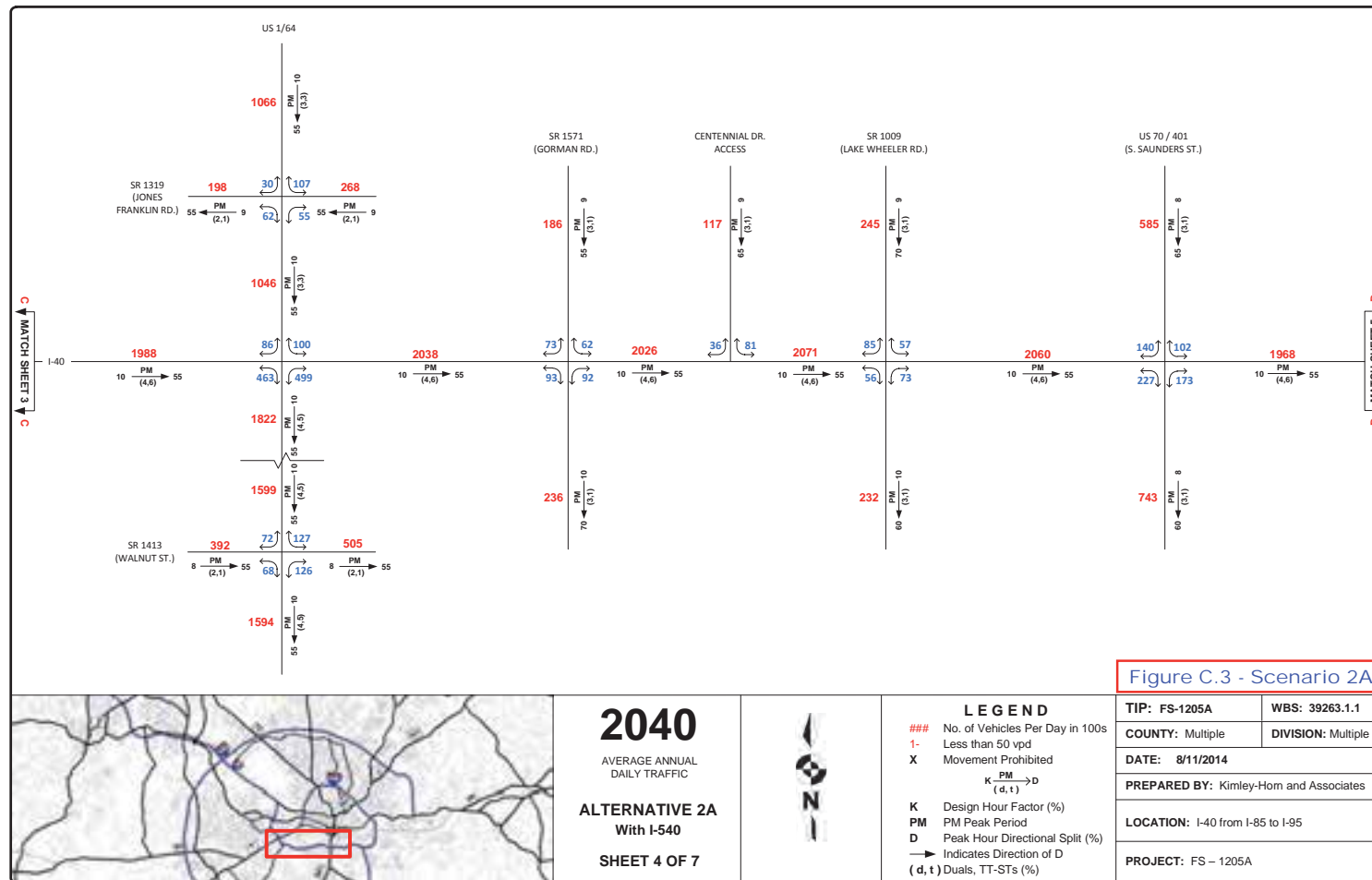
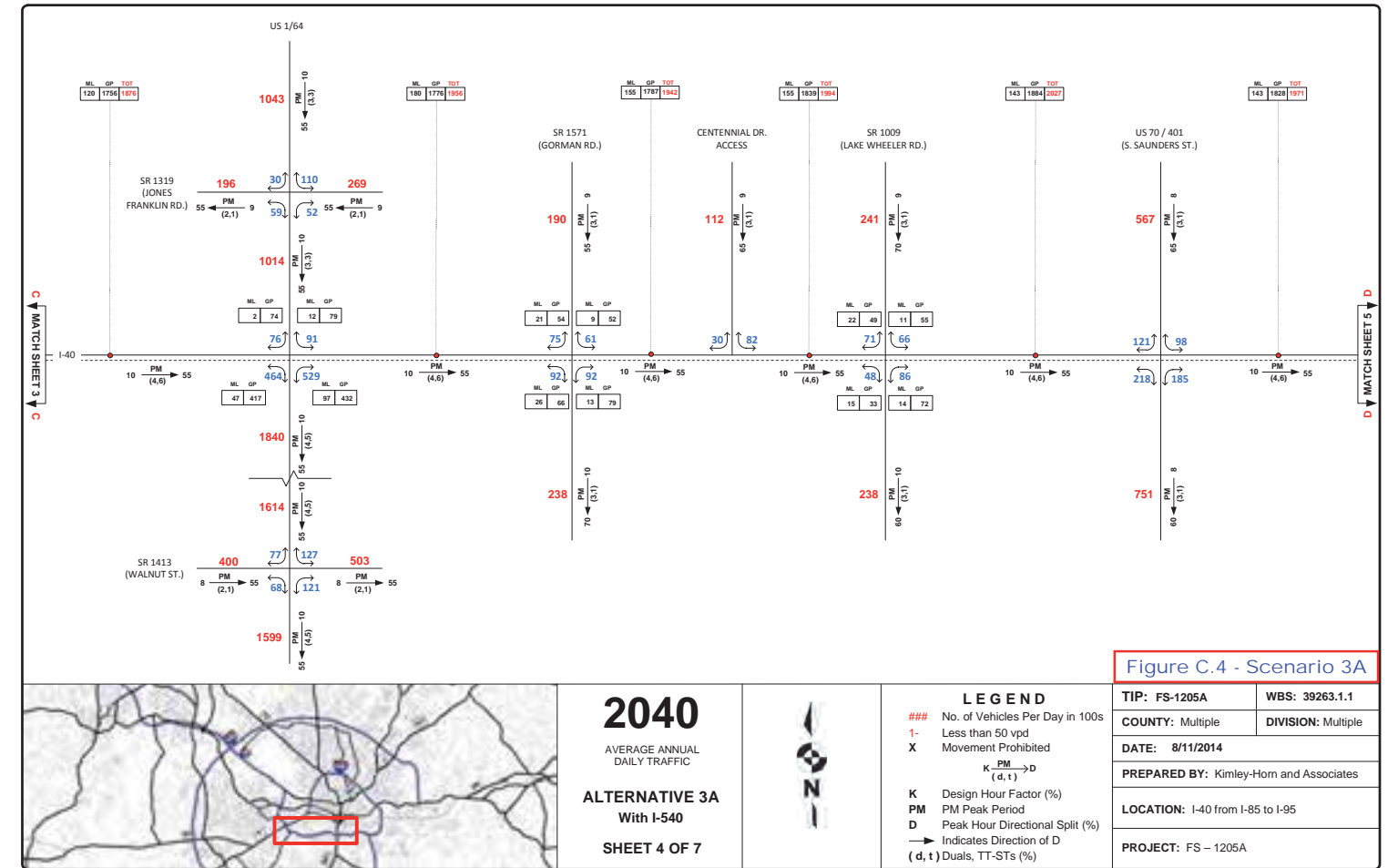
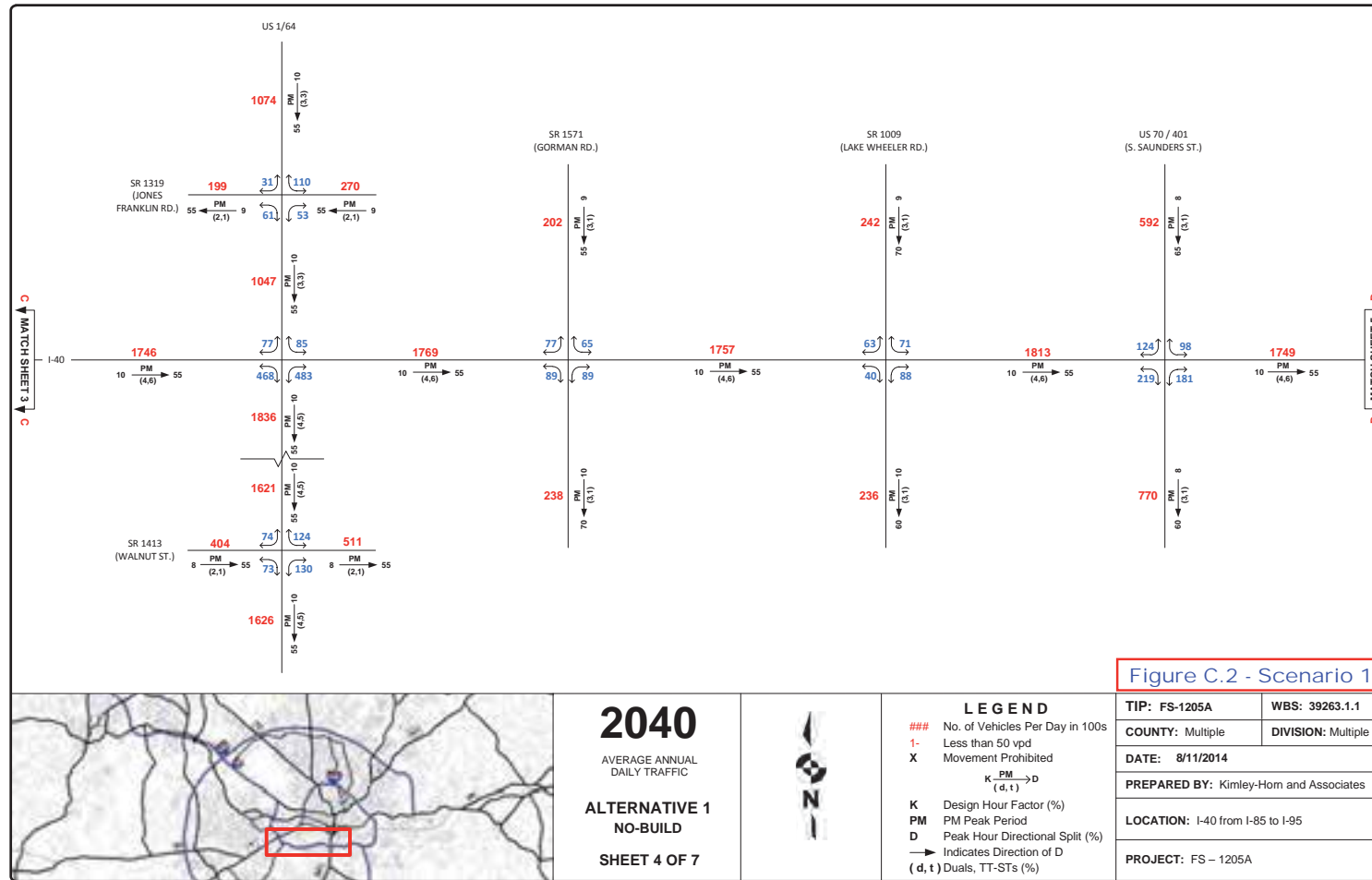
NOT TO SCALE

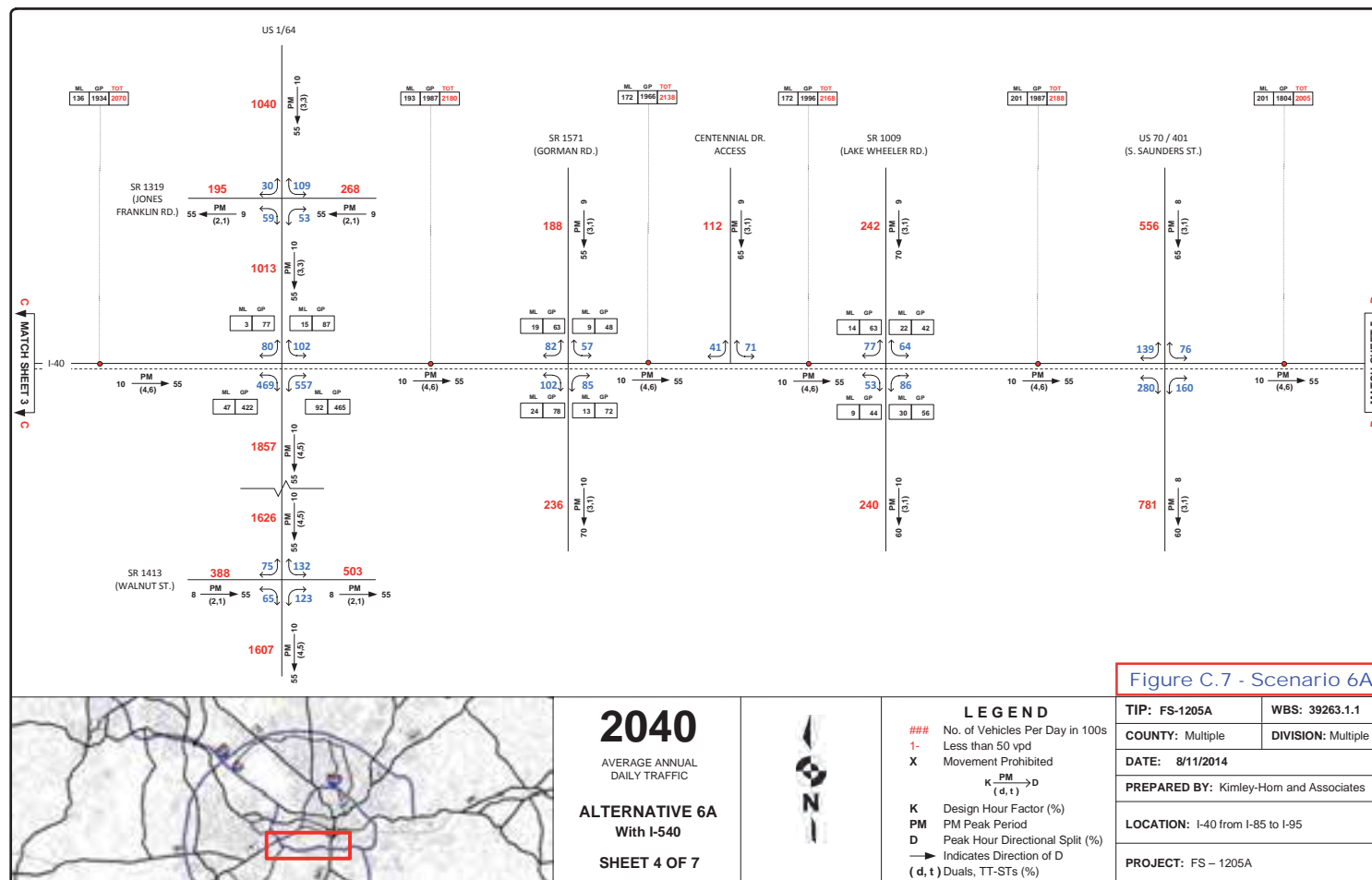
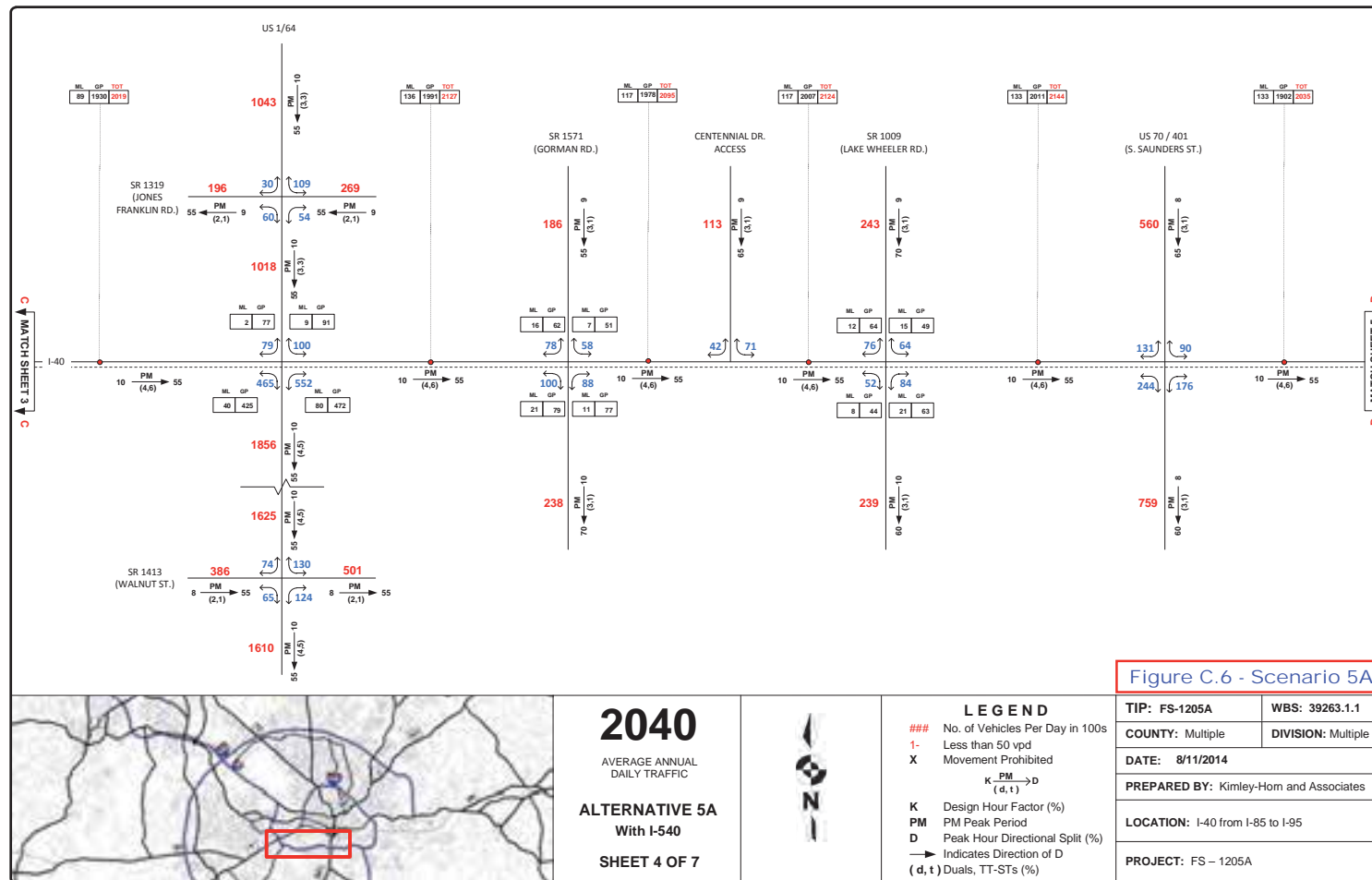
FIGURE C.1 - CENTENNIAL

FS-1005A

I-40 UPGRADES, MANAGED LANES FROM I-40 AT WADE AVE. TO I-440 AT US 64

WAKE COUNTY

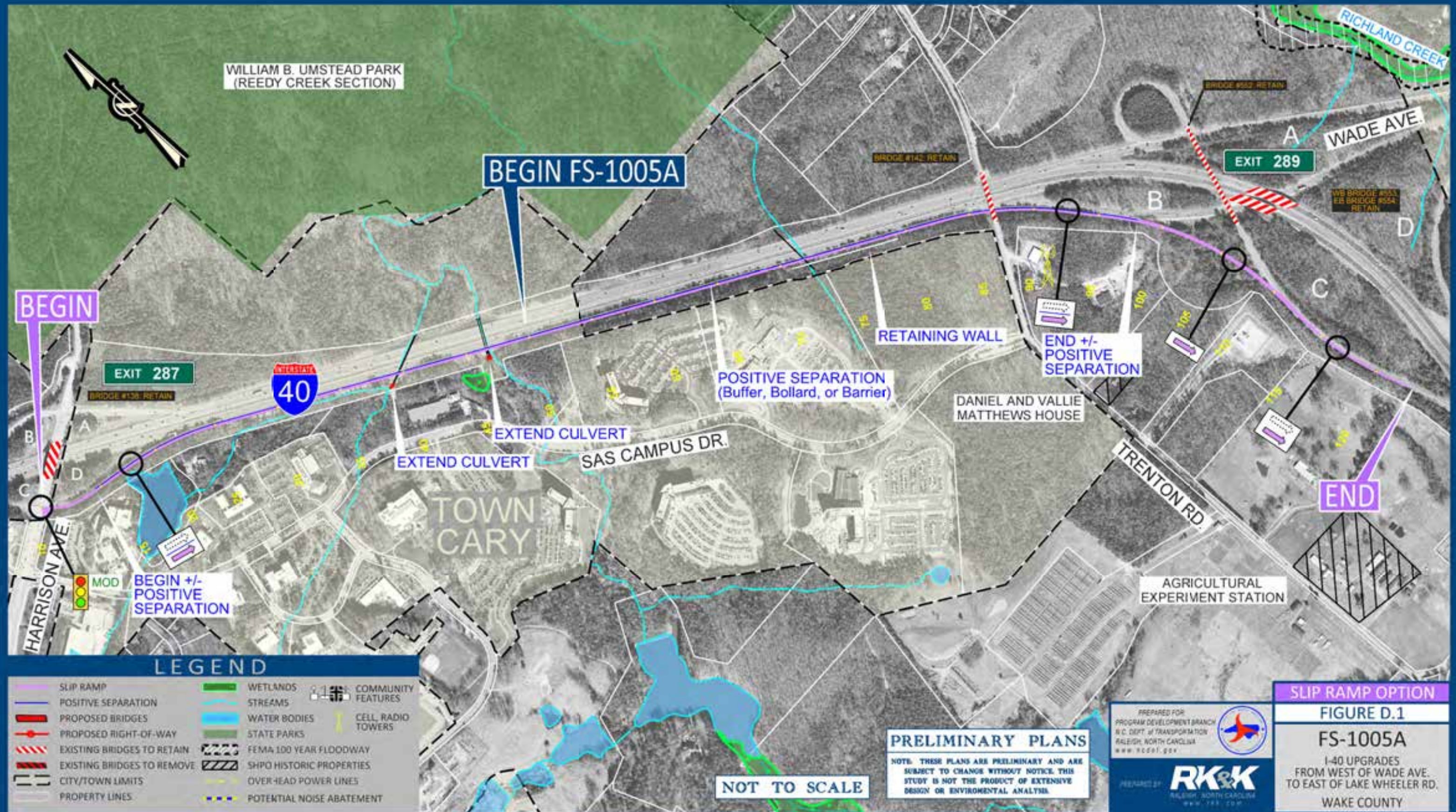




Appendix D:

Slip Ramp Option

Exit 287 to Exit 289



WILLIAM B. UMSTEAD PARK
(REEDY CREEK SECTION)

BEGIN FS-1005A

EXIT 289

WADE AVE

RICHLAND CREEK

BEGIN

EXIT 287

40

RETAINING WALL

END +/-
POSITIVE
SEPARATION

POSITIVE SEPARATION
(Buffer, Bollard, or Barrier)

DANIEL AND VALLIE
MATTHEWS HOUSE

EXTEND CULVERT

SAS CAMPUS DR.

EXTEND CULVERT

TRENTON RD.

END

AGRICULTURAL
EXPERIMENT STATION

LEGEND

- | | | |
|----------------------------|---------------------------|--------------------|
| SLIP RAMP | WETLANDS | COMMUNITY FEATURES |
| POSITIVE SEPARATION | STREAMS | CELL RADIO TOWERS |
| PROPOSED BRIDGES | WATER BODIES | |
| PROPOSED RIGHT-OF-WAY | STATE PARKS | |
| EXISTING BRIDGES TO RETAIN | FEMA 100 YEAR FLOODWAY | |
| EXISTING BRIDGES TO REMOVE | SHPO HISTORIC PROPERTIES | |
| CITY/TOWN LIMITS | OVER-HEAD POWER LINES | |
| PROPERTY LINES | POTENTIAL NOISE ABATEMENT | |

PRELIMINARY PLANS

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NOT TO SCALE

PREPARED FOR
PROGRAM DEVELOPMENT BRANCH
N.C. DEPT. OF TRANSPORTATION
RALEIGH, NORTH CAROLINA
WWW.RCDOT.GOV



SLIP RAMP OPTION

FIGURE D.1

FS-1005A

I-40 UPGRADES
FROM WEST OF WADE AVE.
TO EAST OF LAKE WHEELER RD.
WAKE COUNTY