I-40 Westbound Auxiliary Lane

NC 55 to NC 147

Durham County

STIP Project No. I-5707

WBS No. 50123.1.FS1

Traffic Operations and Safety Analysis Technical Memorandum

Prepared For:
North Carolina Department of Transportation
Project Development and Environmental Analysis
Prepared By:
Patriot Transportation Engineering, PLLC

July 2015

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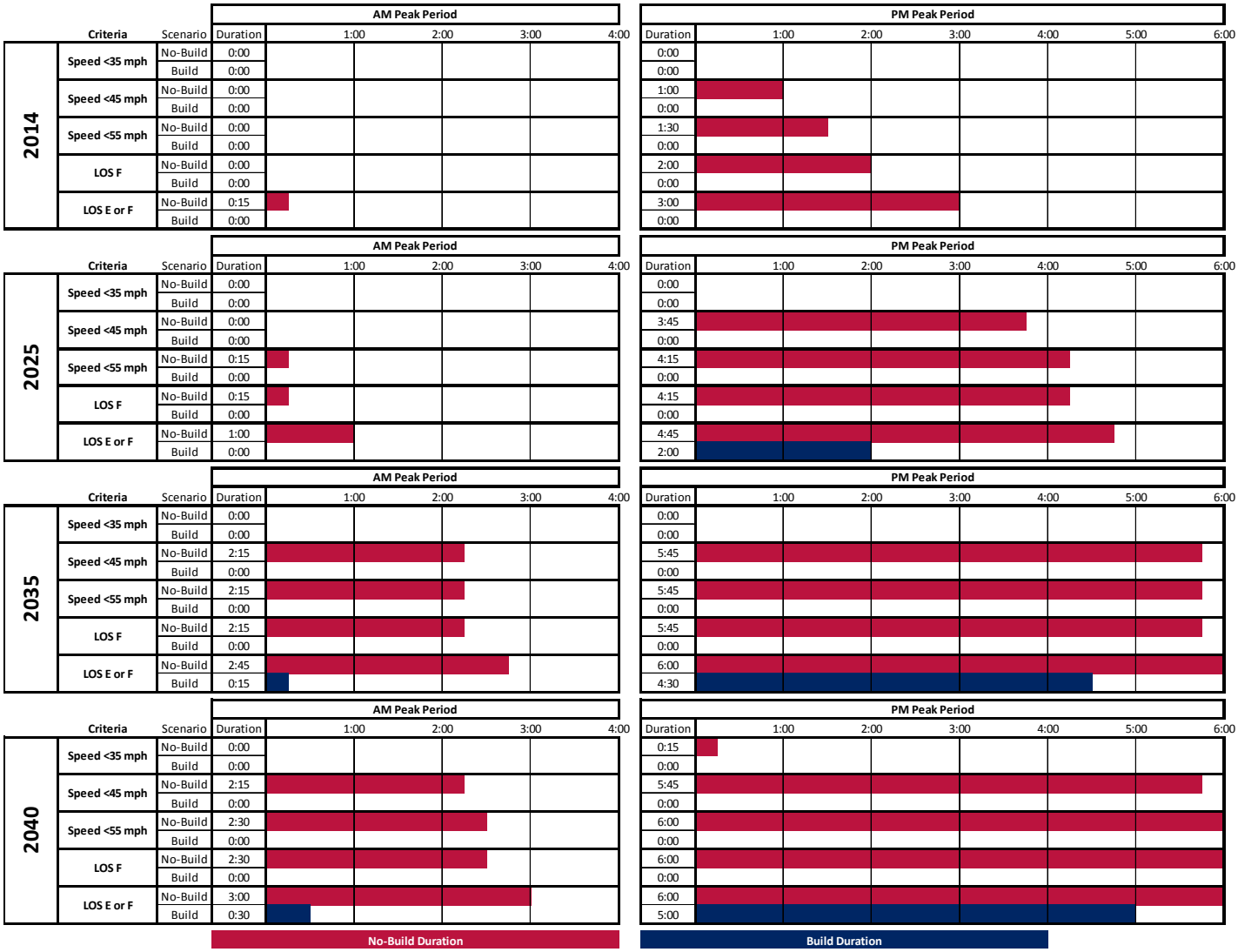
The North Carolina Department of Transportation (NCDOT) proposes to construct State Transportation Improvement Program (STIP) Project Number I-5707; which would add an auxiliary lane along I-40 Westbound from NC 147 to NC 55 in Durham County. The purpose of this technical memorandum is to analyze the traffic operations for the proposed addition of the auxiliary lane and includes the analysis of the 2014, 2025, 2035 and 2040 Scenarios for both No-Build and Build. The analysis was developed utilizing microscopic simulation of each of the scenarios in TransModeler, including the development of a calibrated base year model. The technical memorandum also includes the analysis of the crash data within the study area and a comparison to the statewide and critical crash rates.

Currently, I-40 carries approximately 125,200 vehicles per day (vpd) within the project study area. The traffic volumes are anticipated to increase to 161,500 vpd by 2030 and the 2040 volume for I-40 is forecast to be 191,400, including approximately 16,000 vpd utilizing the managed lanes that are planned for completion between 2030 and 2040.

The objective of this study is to determine if the proposed improvements will improve traffic operations within the study area and to determine both the short-term, mid-term and long-term effects of the proposed project. The scope of the project is relatively limited in nature and does not substantively change the through capacity of the I-40 corridor as it is only providing a westbound auxiliary lane between a pair of interchanges. The long-term needs for the I-40 corridor cannot be met by a project with such a limited scope; therefore, it is assumed that the proposed project will not alleviate congestion along I-40. However, it is expected that the proposed project will provide short-term and mid-term improvements in traffic operations and potentially reduce the duration of congestion along the corridor.

The results of the analysis are shown in the following figure:



Based on the speed and Level of Service (LOS) results, the proposed addition of an auxiliary lane along I-40 Westbound between NC 147 and NC 55 will result in a noticeable improvement in traffic operations, both in the interim and in the design year 2040. The analysis shows that the I-40 corridor has individual locations that are currently (2014) operating at LOS F and that have speeds as low as 25 mph. In the future, even with the currently planned improvements in the vicinity of the project, the level of congestion will become much more severe with congestion in the AM peak extending well beyond 10:00 AM and congestion in the PM peak beginning prior to 3:00 PM and extending beyond 9:00 PM. The proposed project is shown to substantially improve the traffic operations in the 2014 Base Year, essentially eliminating the LOS E or F operations within the study area. In the Interim Year analysis for 2025 and 2035 the proposed project also shows substantial improvements in the traffic operations within the study area as the network has LOS E operations with average speeds remaining in excess of 55 mph. Additionally, the proposed project will reduce the duration of congestion and improve the upstream bottleneck where I-40 Westbound reduces from four through lanes to three through lanes following the diverge to NC 147 Northbound. The 2040 Future Year Build analysis shows relatively substantial improvements in both the magnitude and duration of congestion when compared to the No-Build scenario. Overall, the proposed project will not alleviate congestion along the I-40 corridor; however it will provide substantial improvements to the traffic operations in the Base (2014), Interim (2025-2035) and Future Year (2040).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. PROJECT BACKGROUND

Patriot Transportation Engineering, PLLC (Patriot), as a Subconsultant to Mulkey, Inc., has been contracted by the North Carolina Department of Transportation (NCDOT) to develop traffic operations and safety analysis for NCDOT State Transportation Improvement Program (STIP) Project Number I-5707; I-40 Westbound Auxiliary Lane from NC 147 to NC 55 in Durham County.

1.1 PURPOSE OF TECHNICAL MEMORANDUM

The purpose of this technical memorandum is to analyze the traffic operations for the proposed addition of an auxiliary lane along I-40 Westbound from NC 147 to NC 55 (I-5707) which includes the analysis of the 2014, 2025, 2035 and 2040 Scenarios for both No-Build and Build scenarios. The analysis utilized microscopic simulation of each of the scenarios in TransModeler (Version 4, Build 5925), including the development of a calibrated base year model. The technical memorandum also includes analysis of the crash data within the study area and a comparison to the statewide and critical crash rates.

1.2 PROJECT DESCRIPTION

Interstate 40 is a six-lane facility divided by concrete barriers within the project study area. The Project Study Area, shown in Figure 2-1, includes I-40 Westbound and begins at the ramp merge from NC 147 Southbound and ends at the ramp diverge to NC 55. The I-40/NC 147 interchange is a system (freeway-to-freeway) interchange that includes, what is referred to as the Durham Freeway, north of the interchange and the Triangle Expressway Toll Road south of I-40. The I-40/NC 55 interchange is a service interchange with a partial clover design with both the ramps and loops on the west side of NC 55.

The analysis of the proposed project includes the evaluation of a single design alternative that provides an auxiliary lane between the existing merge from NC 147 Southbound to the existing diverge to NC 55.

2. DESCRIPTION OF SCENARIOS ANALYZED

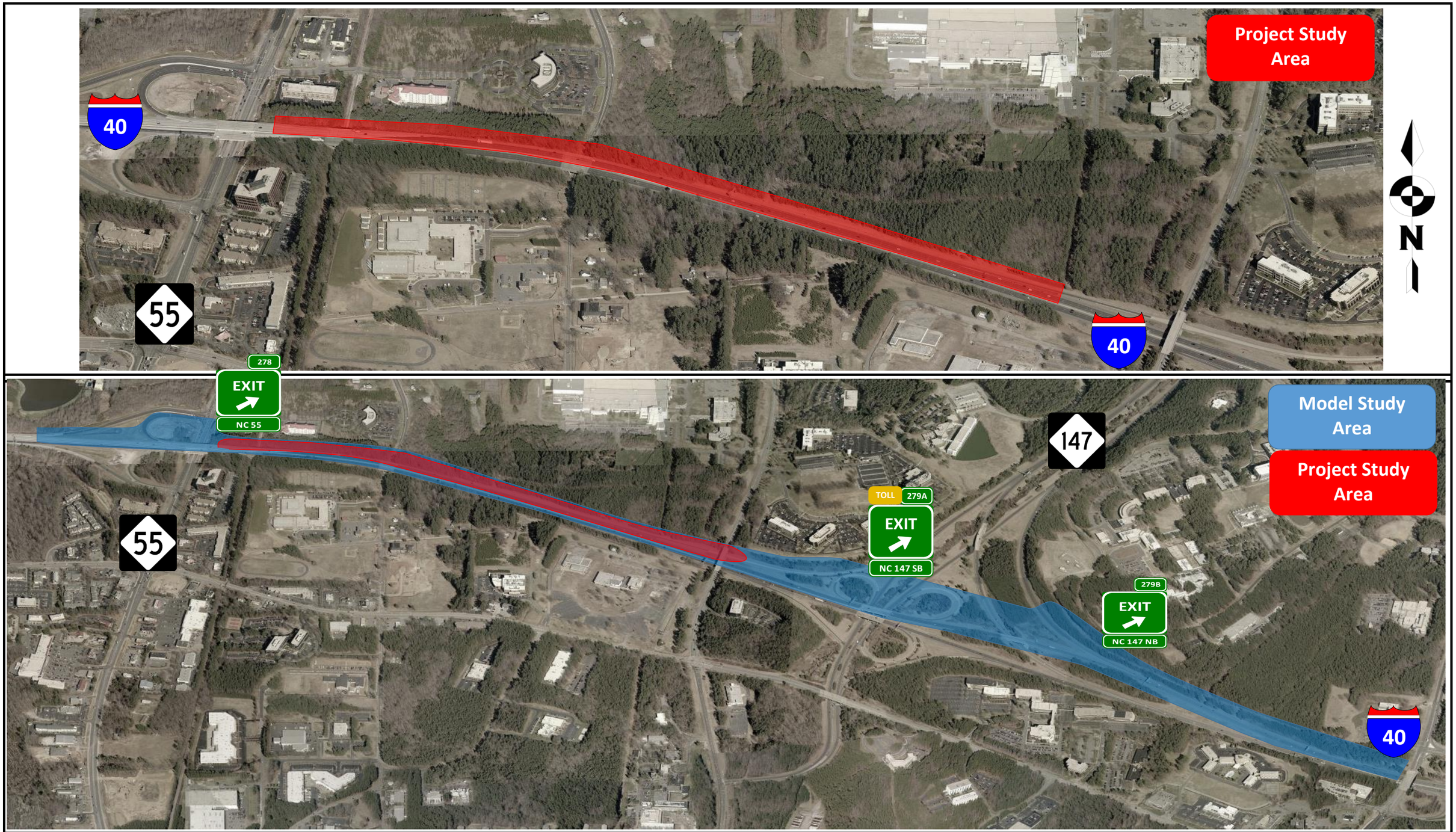
The scenarios that require analysis as a part of this study include analysis of both existing and future conditions, both with and without the project. The following scenarios were evaluated in the microscopic simulation of the traffic operations.

2.1 2014 BASE YEAR EXISTING CONDITIONS

The Existing Conditions analysis is based on the current traffic volumes and existing configuration of the transportation network within the project study area. This analysis provides a baseline for comparison against future scenarios. The 2014 Base Year Existing Conditions Model includes calibration, which is the process where the analyst checks the overall model-predicted traffic performance for a street/road system against field measurements of traffic performance, such as traffic volumes, travel times, average speeds, and average delays. The objective of model calibration is to obtain the best match possible between model performance estimates and the field measurements of performance and then utilize the parameters developed in the calibrated model to evaluate alternative scenarios including future years and/or design variations.

2.2 2014 BASE YEAR BUILD SCENARIO

Analysis of this scenario included evaluating the proposed build alternative with the 2014 base year traffic. This scenario evaluated what the traffic operations will be in the vicinity of the proposed project if the proposed project is constructed. The Build Alternative analysis was based on the preliminary design of the project.



STIP Project No. I-5707 I-40 Westbound - NC 147 to NC 55 Durham County	**Figure 1-1**	**Project Study Area** **Simulation Model Study Area**	PATRIOT TRANSPORTATION ENGINEERING, PLLC Prepared By: **Patriot Transportation Engineering, PLLC** 3008 Anderson Drive, Suite 120 Raleigh, North Carolina 27609 (919)977-9125

2.3 2025 INTERIM YEAR NO BUILD AND BUILD SCENARIOS

Both the No-Build and Build scenarios were analyzed for the interim year of 2025. The 2025 No-Build assumes the local transportation system would evolve as currently planned, but without implementation of the proposed project. With the exception of routine maintenance, no changes would take place along the existing corridor within the study area. The 2025 Build Alternative analysis is based on the preliminary design of the auxiliary lane, and with the exception of routine maintenance, no other changes would take place along the existing corridors within the study area.

2.4 2035 INTERIM YEAR NO-BUILD AND BUILD SCENARIOS

Both the No-Build and Build scenarios were also analyzed for the interim year of 2035. The 2035 No-Build assumes the local transportation system would evolve as currently planned, but without implementation of the proposed project. The 2035 Build Alternative analysis is based on the preliminary design for the project. The primary change along the I-40 corridor that is anticipated between 2030 and 2040 is the inclusion of managed lanes along I-40. The 2040 Metropolitan Transportation Plan (2040 MTP) prepared jointly by the Capital Area Metropolitan Planning Organization (CAMPO) and the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHCMPO) includes managed lanes along I-40 from NC 147 to US 15-501 (Project ID 45.2) as a project being completed between 2030 and 2040. The design details of the project have not yet been determined and the traffic forecast for the proposed project included the managed lanes as a separate facility that did not include direct access to I-40 within the limits of the proposed project; therefore, the managed lanes are not modeled as part of the evaluation of the corridor.

2.5 2040 FUTURE YEAR NO-BUILD AND BUILD SCENARIOS

This scenario evaluated what the traffic operations will be in the vicinity of the proposed project in the design year 2040 if the proposed project is or is not constructed. Similar to the 2035 scenarios the I-40 managed lanes were considered when the volumes were developed and are accounted for in the traffic forecast; however they are not included in the model as they do not have direct access to I-40 within the limits of the proposed project..

3. METHODOLOGY

The use of microscopic simulation was completed using TransModeler software (version 4.0 Build 5925), due to the complexity of the project. TransModeler is a microscopic, behavior-based multi-purpose traffic simulation program that has emerged as one of the leading simulation softwares. For many engineering disciplines, simulation has become an indispensable instrument for the optimization of complex technical systems. This is also true for transportation planning and traffic engineering, where simulation is an invaluable and cost-reducing tool. The microscopic simulation model was developed for the build and no-build alternatives for the project and was based on a calibrated base model for the area.

The methodology for microscopic simulation begins with a base model developed from data collected for the transportation network. The base model is then calibrated against the data measured in the field to arrive at a calibrated base model. Once the base model is calibrated the future year build alternatives can be developed and their results compared.

Microscopic simulation does have some limitations in evaluating alternatives. Because the model is constrained to the capacity of a given roadway, the model can only load traffic up to the capacity of a facility with the excess vehicles being denied entry into the model network. Due to this limitation, the results for facilities that exceed capacity may not be completely reliable. The primary means of overcoming this limitation is to model a long enough time period for the model to process all of the anticipated traffic demand.

4. MEASURES OF EFFECTIVENESS

Measures of Effectiveness (MOE) are system performance statistics that best characterize the degree to which a particular alternative meets the project objectives. The MOEs for microscopic simulation can be abundant due to the nature of the type of analysis. The primary MOEs for freeway facilities are typically average speed, density and Level of Service for individual segments within the network. On an overall network level MOEs such as average system speed, average system delay, and number of stops can provide overall indications of the operations of a network.

For this analysis it was recommended that the use of segment level MOEs such as average speed along prescribed segments of the network would used as a method of comparison for alternatives. As a secondary MOE, the density and corresponding LOS provided a basis for comparison between alternatives.

The objective of the study is to determine if the proposed improvements will improve traffic operations within the study area and to determine both the short-term, mid-term and long-term effects of the proposed project. The scope of the project is relatively limited in nature and does not substantively change the through capacity of the I-40 corridor as it is only providing a westbound auxiliary lane between a pair of interchanges. The long-term needs for the I-40 corridor cannot be met by a project with such a limited scope; therefore, it is assumed that the proposed project will not alleviate congestion along I-40. However, it is expected that the proposed project will provide short-term and mid-term improvements in traffic operations and potentially reduce the duration of congestion in the westbound direction along the corridor.

The anticipated growth in traffic along the I-40 corridor between 2014 and 2040 includes an increase from 125,200 vehicles per day (vpd) in 2014 to 191,400 vpd (including 16,000 vpd on the managed lanes) in 2040. Due to the limited scope of the improvements and the anticipated growth in traffic volumes along I-40, it was determined that the most appropriate use of the MOEs was the duration of time where the corridor meets certain MOE thresholds, including the following:

- Duration of time that I-40 between NC 147 and NC 55 has an average speed less than 65 mph
- Duration of time that I-40 between NC 147 and NC 55 has an average speed less than 55 mph
- Duration of time that I-40 between NC 147 and NC 55 has an average speed less than 45 mph
- Duration of time that I-40 between NC 147 and NC 55 has an average speed less than 35 mph
- Duration of time that I-40 between NC 147 and NC 55 is operating at LOS F
- Duration of time that I-40 between NC 147 and NC 55 is operating at LOS E or worse

There are no known thresholds for determining if the MOEs for an alternative are acceptable. In the absence of any known thresholds, the goal was to provide a project that would reduce the duration of reduced speed and unacceptable LOS (LOS E or F) along the corridor.

5. NETWORK DEVELOPMENT

5.1 GEOMETRY

The basis for developing the geometric data was aerial photographs and contour data. Aerial photography from NCOneMap (Durham County, 2012 imagery; http://nconemap.org/)was used as a background to digitize the network into the simulation model. The three-dimensional attributes and grades were determined based on contour data

from the NCDOT GIS Unit (Elevation Data at 20-foot Grid, Durham County; https://connect.ncdot.gov/resources/gis/pages/cont-elev_v2.aspx).

The limits of the model network, shown in Figure 2-1, include I-40 Westbound from east of the NC 147 interchange to a point slightly wast of the entrance ramp from NC 55. The model limits were selected such that they would allow for the upstream effects to be captured and to better evaluate the project study area as part of the overall transportation system.

The geometry of the Build network is based on the proposed roadway design for the project that will extend the existing acceleration lane from NC 147 to connect to the existing deceleration lane to NC 55. It is assumed that the gore locations along I-40 Westbound will not be modified under the proposed project.

5.2 SPEED DATA

The speed data for the network was developed based on INRIX speed data. The data taken from INRIX was for free flow conditions and was based on individual speed readings from the study area for every Sunday morning during 2014 from 6:00 AM to 10:00 AM, totaling nearly 100,000 readings. TransModeler utilizes a desired speed distribution to assign speeds to vehicles within the network. The variables within the model then affect the desired speed to determine the actual travel speed of vehicles, such as increasing the speed on downgrades and slightly reducing the speed on upgrades, tight horizontal curves, or where physical barriers are close enough to the roadway to affect the speed. Therefore, the data derived from INRIX is not completely comparable to the desired speed in TransModeler as the TransModeler speed is essentially what the driver would drive absent any geometric considerations or interactions with any other vehicles (essentially driving on a flat, straight roadway with no other traffic). To account for this the speed distribution was transferred upward by about 5 mph to account for the difference between the data and the actual desired speed. Table 5-1 shows the Desired Speed Distribution utilized for I-40.

Table 5-1: INRIX Speed Data and Desired Speed Distribution

Speed Measurement (mph)	No. of Measurements	Percentage of Measurements	Deviation from Speed Limit – Initial (mph)	Deviation from Speed Limit – Adjusted (mph)
≤50 mph	116	0.1%	-15	-10
51-53 mph	142	0.1%	-12	-7
54-56 mph	989	1.0%	-9	-4
57-59 mph	3,965	4.0%	-6	-1
60-62 mph	6,049	6.1%	-3	2
63-65 mph	8,707	8.7%	0	5
66-68 mph	23,788	23.9%	3	8
69-71 mph	28,916	29.1%	6	11
71-73 mph	18,378	18.5%	9	14
≥74 mph	8,465	5.1%[1]	12	17
		3.4%[1]	15	20
Total	**99,515**	**100.0%**		

Notes: 1 – INRIX Data is not reported above 75 mph; therefore, the readings above 75 mph were distributed among the two groupings based on a normal distribution.

5.3 DRIVING BEHAVIOR PARAMETERS

Driver behavior parameters are used to guide vehicles through the network during the simulation of the base model. Given a path, a vehicle's movements between the origin and destination are governed by driver behavior models. In the microscopic simulation model, driver behavior models govern the more detailed actions a driver takes in response to local conditions, including surrounding traffic, signals, signs and incidents. These driver behavior models are used to simulate a driver's acceleration, lane changing, gap acceptance, merging, yielding and other behaviors. The models and parameters are organized into the following groups:

- Acceleration
- Lane Changing
- Merging and Yielding
- Response to Traffic Controls

Initially, the default driver behavior parameters were utilized for the base year model; however, during the calibration of the model (described in Section 5.7) the Acceleration parameters were modified to better replicate driver behaviors in the study area.

5.4 VOLUME INPUT AND ORIGIN-DESTINATION MATRICES

The TransModeler model is capable of using unbalanced input volumes and using its own algorithms to balance the network; however using this method of traffic volume input can produce inaccuracies in actual processed volumes at particular locations. To accurately model the network in TransModeler the input volumes were developed into a balanced network. The traffic forecast for the proposed project is based on Average Annual Daily Traffic (AADT) with Directional Split (D) and Design Hourly Volume factor (K). The forecast volumes are balanced with regard to AADT; however, the K factor varied throughout the analysis. In order to balance the network, assumptions were made as to which volumes to hold constant to create a balanced network. The balanced volumes were developed by holding the link volume along I-40 between NC 147 and NC 55 constant and balancing outward in both directions by holding the ramp volumes constant and adjusting the I-40 volumes.

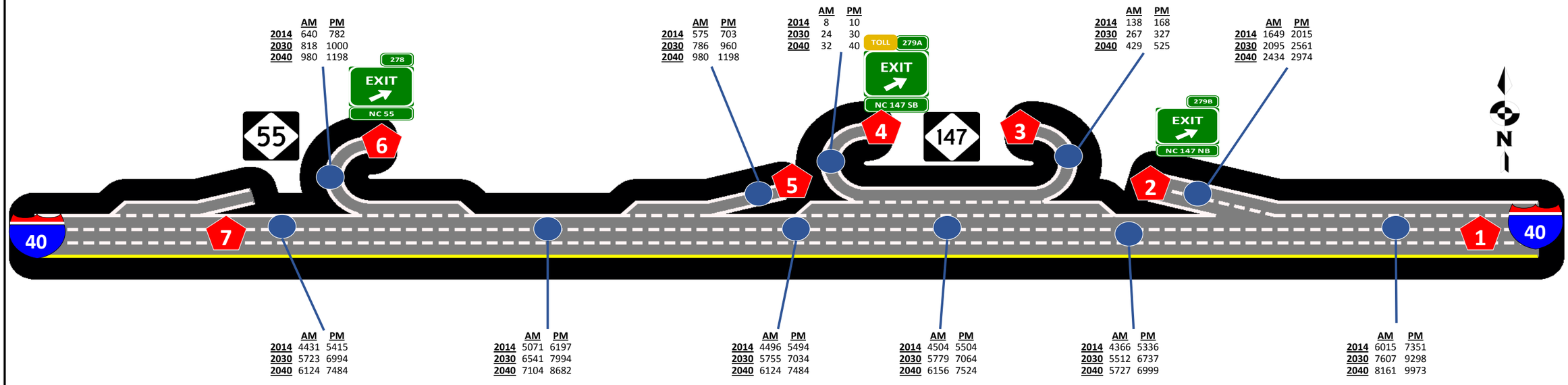
The forecast developed by the NCDOT Transportation Planning Branch was used to develop peak hour volumes and is located in Appendix A. The traffic forecast included the following scenarios:

- 2014 No-Build
- 2030 Build
- 2040 Build

The balanced peak hour volumes for each scenario are shown on Figure 5-1.

For this model, the best method of determining the origin-destination volumes was by using the peak hour forecasts and engineering judgment based on the evaluation of field conditions. The O-D data was developed into balanced matrices for each scenario model and are summarized in Figure 5-1. O-D matrices were also developed for the 2025 and 2035 Interim Years by scaling the 2030 and 2040 volumes, respectively, based on interpolating the volumes for the link between NC 147 and NC 55.

Vehicle fleet data was defined at the global level for the model as there was little variation in the truck percentages for the modeled roadways. The distribution of vehicles was based on the NCDOT default values.



AM Peak

PM Peak

Origin - Destination Matrices

2014

	2	4	6	7	Total
1	1649	8	572	3786	**6015**
3	0	0	13	125	**138**
5	0	0	55	520	**575**
Total	**1649**	**8**	**640**	**4431**	**6728**

	2	4	6	7	Total
1	2015	10	699	4627	**7351**
3	0	0	16	152	**168**
5	0	0	67	636	**703**
Total	**2015**	**10**	**782**	**5415**	**8222**

2025

	2	4	6	7	Total
1	1860	21	638	4235	**6754**
3	0	0	22	215	**237**
5	0	0	66	632	**698**
Total	**1860**	**21**	**726**	**5082**	**7689**

	2	4	6	7	Total
1	2274	27	780	5175	**8256**
3	0	0	27	263	**290**
5	0	0	81	772	**853**
Total	**2274**	**27**	**888**	**6210**	**9399**

2030

	2	4	6	7	Total
1	2095	24	719	4769	**7607**
3	0	0	25	242	**267**
5	0	0	74	712	**786**
Total	**2095**	**24**	**818**	**5723**	**8660**

	2	4	6	7	Total
1	2561	30	878	5829	**9298**
3	0	0	31	296	**327**
5	0	0	91	869	**960**
Total	**2561**	**30**	**1000**	**6994**	**10585**

2035

	2	4	6	7	Total
1	2338	31	803	4668	**7840**
3	0	0	42	370	**412**
5	0	0	96	845	**941**
Total	**2338**	**31**	**941**	**5883**	**9193**

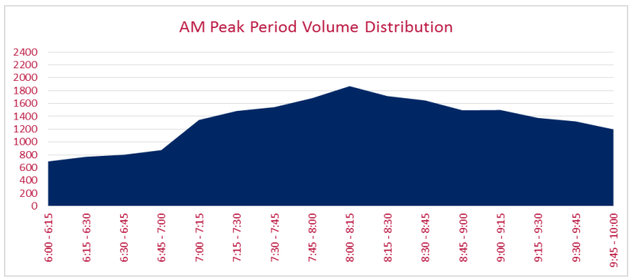
	2	4	6	7	Total
1	2857	38	981	5704	**9580**
3	0	0	52	453	**505**
5	0	0	118	1033	**1151**
Total	**2857**	**38**	**1151**	**7190**	**11236**

2040

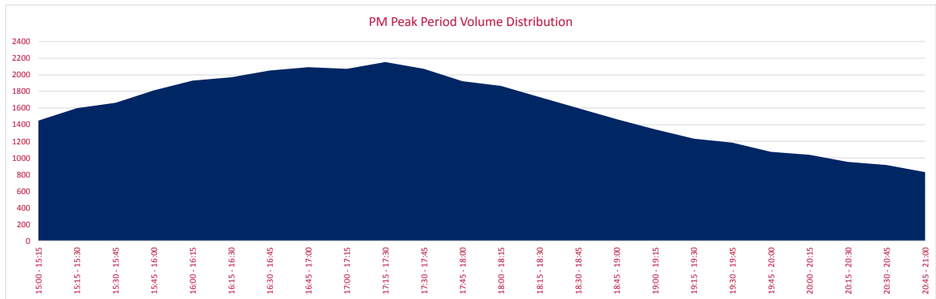
	2	4	6	7	Total
1	2434	32	836	4859	**8161**
3	0	0	44	385	**429**
5	0	0	100	880	**980**
Total	**2434**	**32**	**980**	**6124**	**9570**

	2	4	6	7	Total
1	2974	40	1022	5937	**9973**
3	0	0	54	471	**525**
5	0	0	123	1075	**1198**
Total	**2974**	**40**	**1198**	**7484**	**11696**

Hour	Matrix Scaling Factor
5:30 - 6:00	0.1599
6:00 - 7:00	0.4672
7:00 - 8:00	0.8997
8:00 - 9:00	1.0000
9:00 - 10:00	0.8016
10:00 - 10:30	0.6536



Hour	Matrix Scaling Factor
14:30 - 15:00	0.6863
15:00 - 16:00	0.7935
16:00 - 17:00	0.9786
17:00 - 18:00	1.0000
18:00 - 19:00	0.8104
19:00 - 20:00	0.5872
20:00 - 21:00	0.4536
21:00 - 21:30	0.3512



STIP Project No. I-5707

I-40 Westbound - NC 147 to NC 55

Durham County

Figure 5-1

Balance Peak Hour Volumes

Origin-Destination Matrices

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5.5 SIMULATION SETTINGS AND REPETITIONS

As one of the goals of the study is to determine the duration of congestion during the AM and PM peak periods, it was determined that multi-hour simulations would be developed. Existing data was reviewed and it was determined the following periods would be modeled for each peak:

- AM Peak Period – 6:00 AM to 10:00 AM
- PM Peak Period – 3:00 PM to 9:00 PM

Additionally, each simulation will include a warmup period that allows traffic to be present in the model prior to collecting output data, and a cool down period that will allow traffic to complete their trips and be included in the output data. The warmup and cool down periods will extend 30 minute prior to and subsequent to the periods identified above. In order to properly load the model for multiple hours, matrix scaling factors were determined based on count data taken for the project study area on the following dates:

- September 16, 2014
- September 17, 2014 (AM Peak only – PM peak had incident)
- October 21, 2014
- October 22, 2014

The traffic count data was only available in one-hour increments; therefore, engineering judgment was used to develop vehicle loading in 15-minute increments, allowing the model to incrementally build toward the peak traffic demand. The matrix scaling factors and peak period volume distributions are shown in Figure 5-1.

All simulation software contain run control parameters to enable the modeler to customize the software operation for their specific modeling needs. Multiple repetitions of the same model are required because microscopic simulation results will vary depending on the random number seed used in each run. The random number seed is used to select a sequence of random numbers that are used to make numerous decisions throughout the simulation run. The outcomes of all of these decisions will affect the simulation results. The results of each run are usually close to the average of all of the runs; however, each run will be different from the others.

The number of repetitions required for the calibrated base model is based on a statistical evaluation of the results based on a desired range and confidence interval as described in Appendix B of the FHWA Traffic Analysis Toolbox. For the calibrated base model, the selected ratio of the Confidence Interval divided by the Standard Deviation of the sample was 1.25 with a desired confidence level of 95%. This combination resulted in 16 runs to satisfy the statistical requirements for the base model. Each model was assigned a random seed between 5 and 80 in increments of 5.

5.6 OUTPUT

The output data was extracted from the TransModeler model via the Output Manager using the Flow and Travel Time Reports. The outputs were collected in 15-minute increments for the following categories:

- Average Speed (mph) by INRIX Traffic Message Channel (TMC) Segment
- Level of Service for each Segment based Highway Capacity Manual 2010 (HCM) classification
- Density (pcphpl) for each HCM Segment

5.7 BASE YEAR CALIBRATION

In order for the results of the TransModeler model to be validated, the model requires calibration. The preferred method of calibrating a model is by replicating the observed conditions in a base year model andthen using the same parameters and settings to develop the future year models.

The means of calibrating the base year model included comparing the speed modeled in TransModeler along two INRIX TMC segments with the average speed data collected by INRIX for each segment. The INRIX segment data was collected in 15-minute increments and was an average of data from the third Tuesday, Wednesday and Thursday of each month of the year during 2014. To be considered calibrated, the average speed for each hour was required to be within five miles per hour of the collected speed for each of the locations for more than 75 percent of the data points. The average speed was determined by averaging a statistically adequate number of model runs. Additionally, a secondary measure for calibration was to attempt to replicate the duration of congestion within the model for each peak period. A formal threshold was not selected for this measure, and calibration was left to the satisfaction of the analyst that it was adequately replicating the duration and intensity of the congestion during each peak period.

Calibrating the base year model to replicate the current existing conditions required the following changes to be made:

- The desired speed distribution for the model was shifted up by 5 mph from the collected INRIX data to account for the difference between INRIX data collected at low flow periods and desired speed distribution input into the model.
- The curve-based time distribution for the PM peak was adjusted to better replicate the levels of congestion. Because the count data was only in one-hour increments, the development of time distributions in 15-minute increments required engineering judgment in order to match the results collected through INRIX
- The Headway Threshold parameter populations, within the Driver Behavior/Acceleration, was shifted downward to increase the aggressiveness of drivers, as shown below:

Lower Bound (sec)	Upper Bound (sec)	Percentage – Initial	Percentage - Calibrated
0.25	1.75	5%	**10%**
0.30	2.46	20%	**25%**
0.30	3.17	50%	**50%**
0.30	3.89	20%	**10%**
0.35	4.60	5%	**5%**

The results of the Calibration effort are shown on Figure 5-2. Overall, the AM peak was able to replicate the average speed for both segments for each of the four hours, whereas the PM peak was able to replicate the average speed for Segment 1 for four of the six hours and Segment 2 for five of the six hours. Additionally, the model proved to replicate the duration and intensity of the congestion very well, with the PM peak Segment 2 data exactly replicating the duration of time (1 hour) with speeds less than 45 mph and only being 15 minutes off for the duration of time (1 hour 45 minutes vs. 1 hour 30 minutes) with speeds less than 55 mph. The PM peak data for Segment 1 also replicated the intensity of the congestion reasonably well; however, the model showed a slightly shorter duration than the INRIX data.

Overall, it was determined that the model adequately replicated the existing conditions and was suitable for use in evaluating geometric changes to the network for the existing and future years.

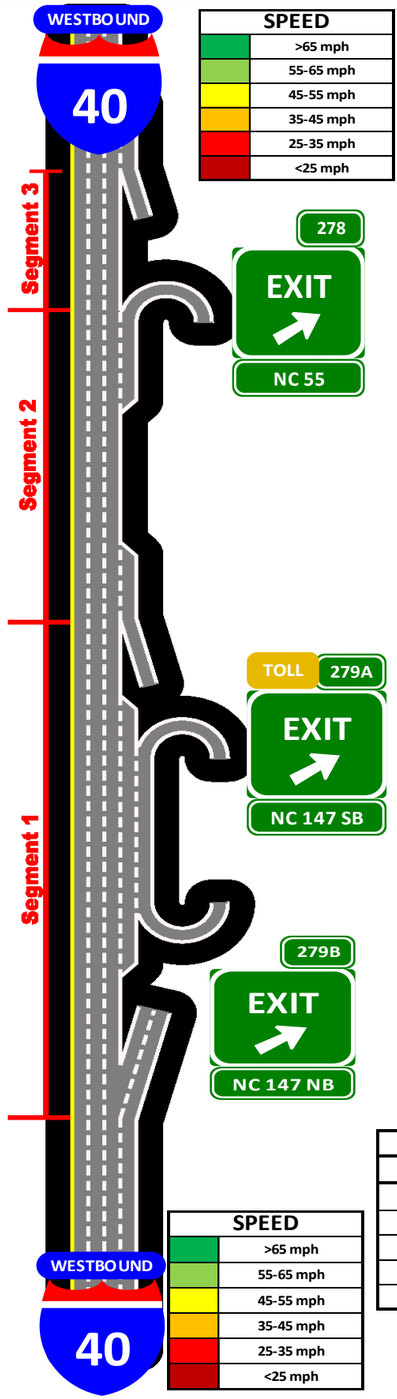
AM Peak Period (6:00 - 10:00 AM)

INRIX Speed (mph)

6:00	6:15	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45	9:00	9:15	9:30	9:45
70	71	71	71	70	70	70	70	70	70	69	69	66	67	68	70
69	69	69	69	68	68	68	68	68	67	67	67	65	65	66	68
69	68	69	69	68	68	68	68	68	66	66	67	68	66	67	69

Model Speed (mph)

6:00	6:15	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45	9:00	9:15	9:30	9:45
71	71	71	70	68	67	67	66	64	66	66	67	67	68	68	69
69	69	69	69	66	66	65	64	61	63	64	65	65	66	66	67
70	70	69	69	68	67	67	66	65	66	66	67	67	68	68	68



PM Peak Period (3:00 - 9:00 PM)

INRIX Speed (mph)

15:00	15:15	15:30	15:45	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15	18:30	18:45	19:00	19:15	19:30	19:45	20:00	20:15	20:30	20:45
64	64	65	65	65	66	67	64	59	52	46	44	46	50	52	55	63	66	69	69	69	69	69	69
63	63	63	64	63	64	65	64	57	46	40	38	39	44	47	51	60	65	69	69	70	69	68	68
63	62	64	63	63	64	65	65	57	43	32	32	31	35	43	49	58	65	68	68	69	69	69	68

Model Speed (mph)

15:00	15:15	15:30	15:45	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15	18:30	18:45	19:00	19:15	19:30	19:45	20:00	20:15	20:30	20:45
67	66	66	65	64	63	62	62	62	63	63	63	63	65	66	67	67	68	69	69	70	70	70	71
65	64	63	61	59	58	55	49	45	41	40	40	44	56	64	65	66	67	68	68	68	68	68	69
67	66	66	65	64	64	63	62	50	33	25	26	37	60	66	67	67	68	68	69	69	69	69	70

AM Peak Speed - Segment 2 (I-5707 Study Area)

Speed	Duration		
	Inrix	Model	Difference
<65 mph	0 hours 00 minutes	1 hours 00 minutes	1 hours 00 minutes
<55 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<45 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<35 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<25 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes

PM Peak Speed - Segment 2 (I-5707 Study Area)

Speed	Duration		
	Inrix	Model	Difference
<65 mph	4 hours 00 minutes	3 hours 30 minutes	0 hours 30 minutes
<55 mph	1 hours 45 minutes	1 hours 30 minutes	0 hours 15 minutes
<45 mph	1 hours 00 minutes	1 hours 00 minutes	0 hours 00 minutes
<35 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<25 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes

NUMBER OF MODEL REPETITIONS

Desired Confidence Level	95%	
Desired CI/S Ratio	1.25	
Model Statistics	**AM Peak**	**PM Peak**
Speed Sample Standard Deviation	1.0211	7.0584
Number of Samples	16	16
Mean Speed	61.20	46.05
95% Confidence Interval	1.2712	8.7873
Calculated CI/S Ratio	1.24	1.24
Adequate Number of Runs?	Yes	Yes

CALIBRATION - INRIX SPEED DATA

Time	MOE Criteira	Target	Actual	Calibrated
AM	Within Acceptable Range (+/- 5 mph)	75%	100%	Calibrated
PM	Within Acceptable Range (+/- 5 mph)	75%	75%	Calibrated

Notes:

The model does not include the merge from NC 55 to I-40 WB; therefore, the results for Segment 3 may not be fully representative of the actual operations and are shown as crosshatched.

STIP Project No. I-5707

I-40 Westbound - NC 147 to NC 55

Durham County

Figure 5-2

2014 Existing Conditions - Calibrated

Inrix Speed vs. Model Speed Comparison

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6. SIMULATION RESULTS

Based on scenarios described in Section 2, the Calibrated Base Year Model could be modified to include the Build design and run for each of the defined scenarios based on the travel demand described in Section 5.4. For each of the scenarios, as described in Section 4, the Measures of Effectiveness were extracted and reported in order to determine the change in traffic operations from the No-Build to Build scenarios.

6.1 2014 BASE YEAR NO-BUILD AND BUILD SCENARIOS

This scenario includes the evaluation of the Base Year traffic operations for both the No-Build and Build scenarios, with the results of the analysis being presented on Figure 6-1 and Figure 6-2.

The results of the analysis show the following:

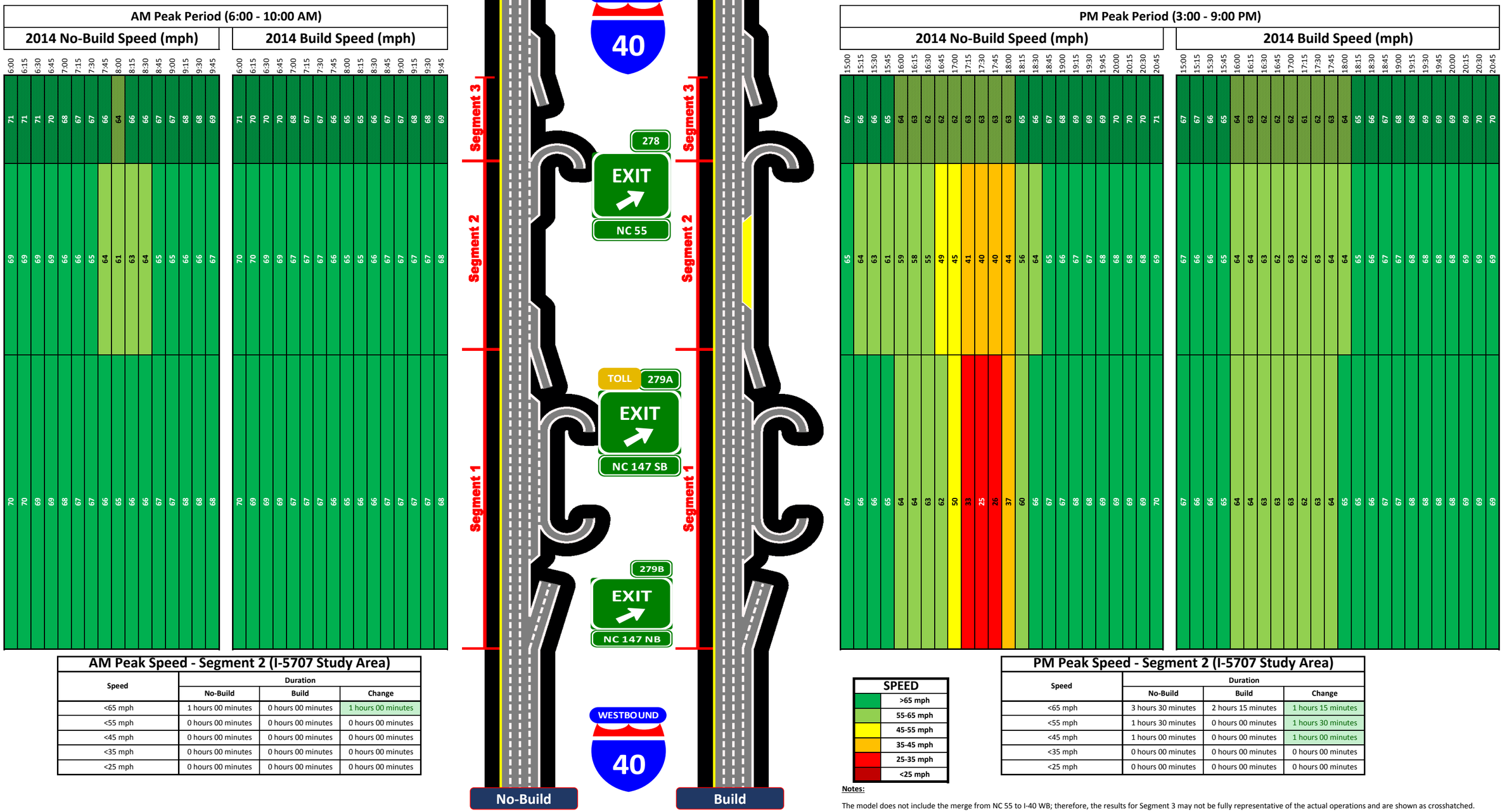
- The speed comparison for the AM peak period showed that the No-Build scenarios experienced 1 hour of speeds below 65 mph, while the Build scenario did not have any speeds below 65 mph.
- The speed comparison for the PM peak period showed substantial improvements in the speeds along Segment 1 and Segment 2 (Project Study Area). For Segment 1 the No-Build scenario shows 45 minutes with speeds less than 35 mph, 1 hour with speeds less than 45 mph and 1 hour 15 minutes with speeds less than 55 mph, while the Build scenario did not have any speeds less than 55 mph with the slowest speed being 62 mph. For Segment 2 the No-Build scenario shows 1 hour with speeds less than 45 mph and 1 hour 30 minutes with speeds less than 55 mph, while the Build scenario did not have any speeds less than 55 mph with the slowest speed being 62 mph.
- The LOS comparison for the AM peak period showed improvements in the LOS within the Project Study Area. The No-Build scenario has LOS E operations for 15 minutes and LOS D or worse operations for 1 hour 45 minutes, while the Build scenario operated at LOS C or better for the entire time AM peak period.
- The LOS comparison for the PM peak period also showed substantial improvement in the LOS within the Project Study Area. The No-Build scenario has LOS F operations for 2 hours and LOS E or worse operations for 3 hours, while the Build scenario operates at LOS D or better for the entire peak period.
- The results also show improvement in the overall I-40 corridor with a 41 percent decrease in upstream segments that are operating at LOS E or worse when comparing the PM peak No-Build and Build results.

6.2 2025 INTERIM YEAR NO BUILD AND BUILD SCENARIOS

This scenario includes the evaluation of the 2025 Interim Year traffic operations for both the No-Build and Build scenarios, with the results of the analysis being presented on Figure 6-3 and Figure 6-4.

The results of the analysis show the following:

- The speed comparison for the AM peak period showed that the No-Build scenarios experienced 15 minutes with speeds below 55 mph and 2 hours 15 minutes of speeds below 65 mph, while the Build scenario showed that it had 1 hour of speeds less than 65 mph with the slowest speed being 63 mph.
- The speed comparison for the PM peak period showed substantial improvements in the speeds along Segment 1 and Segment 2 (Project Study Area). For Segment 1 the No-Build scenario shows 3 hours 15 minutes with speeds less than 25 mph, 3 hours 45 minutes with speeds less than 35 mph, and 4 hour with speeds less than 55 mph, while the Build scenario showed only 45 minutes with speeds less than 55 mph with the slowest speed being 46 mph. For Segment 2 the No-Build scenario shows 3 hours 45 minutes with speeds less than 45 mph and 4 hours 15 minutes with speeds less than 55 mph, while the Build scenario did not have any speeds less than 55 mph with the slowest speed being 55 mph.



AM Peak Speed - Segment 2 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
<65 mph	1 hours 00 minutes	0 hours 00 minutes	1 hours 00 minutes
<55 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<45 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<35 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<25 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes

PM Peak Speed - Segment 2 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
<65 mph	3 hours 30 minutes	2 hours 15 minutes	1 hours 15 minutes
<55 mph	1 hours 30 minutes	0 hours 00 minutes	1 hours 30 minutes
<45 mph	1 hours 00 minutes	0 hours 00 minutes	1 hours 00 minutes
<35 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<25 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes

Notes:

The model does not include the merge from NC 55 to I-40 WB; therefore, the results for Segment 3 may not be fully representative of the actual operations and are shown as crosshatched.

STIP Project No. I-5707

I-40 Westbound - NC 147 to NC 55

Durham County

Figure 6-1

2014 No-Build vs. Build Comparison

Speed (mph)

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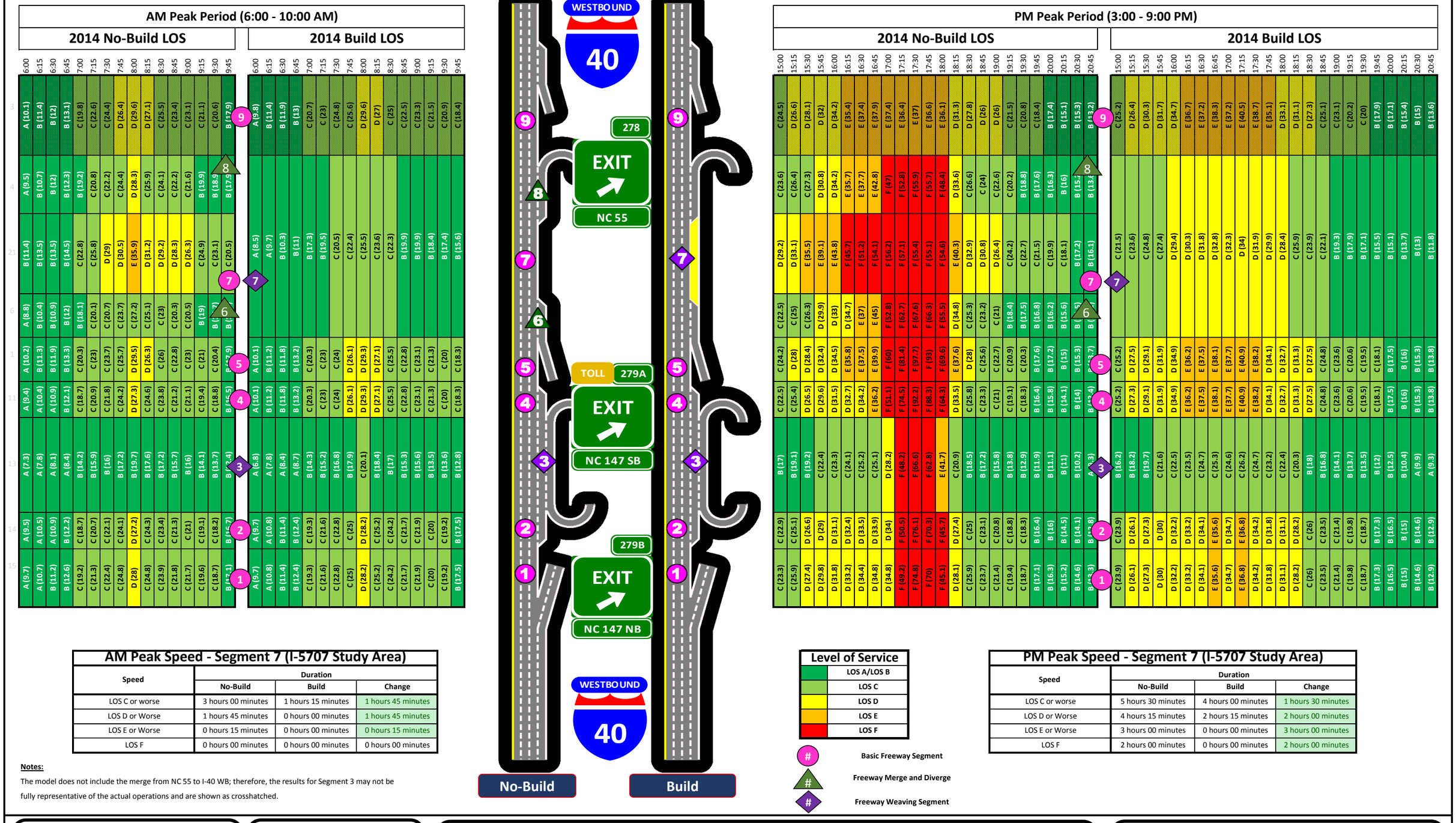

AM Peak Speed - Segment 7 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
LOS C or worse	3 hours 00 minutes	1 hours 15 minutes	1 hours 45 minutes
LOS D or Worse	1 hours 45 minutes	0 hours 00 minutes	1 hours 45 minutes
LOS E or Worse	0 hours 15 minutes	0 hours 00 minutes	0 hours 15 minutes
LOS F	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes

PM Peak Speed - Segment 7 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
LOS C or worse	5 hours 30 minutes	4 hours 00 minutes	1 hours 30 minutes
LOS D or Worse	4 hours 15 minutes	2 hours 15 minutes	2 hours 00 minutes
LOS E or Worse	3 hours 00 minutes	0 hours 00 minutes	3 hours 00 minutes
LOS F	2 hours 00 minutes	0 hours 00 minutes	2 hours 00 minutes

Level of Service

- LOS A/LOS B
- LOS C
- LOS D
- LOS E
- LOS F

- # Basic Freeway Segment
- # Freeway Merge and Diverge
- # Freeway Weaving Segment

Notes:

The model does not include the merge from NC 55 to I-40 WB; therefore, the results for Segment 3 may not be fully representative of the actual operations and are shown as crosshatched.

STIP Project No. I-5707

I-40 Westbound - NC 147 to NC 55

Durham County

Figure 6-2

2014 No-Build vs. Build Comparison

Level of Service

PATRIOT TRANSPORTATION ENGINEERING, PLLC

Prepared By:
Patriot Transportation Engineering, PLLC
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AM Peak Period (6:00 - 10:00 AM)

2025 No-Build Speed (mph)

6:00	6:15	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45	9:00	9:15	9:30	9:45
71	70	70	70	67	66	65	64	62	63	64	65	66	67	67	68
69	69	68	68	65	64	63	61	54	57	61	63	63	64	65	66
70	69	69	69	67	66	66	65	63	64	65	66	66	67	67	67

2025 Build Speed (mph)

6:00	6:15	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45	9:00	9:15	9:30	9:45
70	70	70	69	67	66	66	64	62	64	64	66	66	67	67	68
70	69	69	69	67	66	65	64	63	64	64	66	66	66	67	67
69	69	69	69	67	66	66	65	63	65	65	66	66	66	67	67

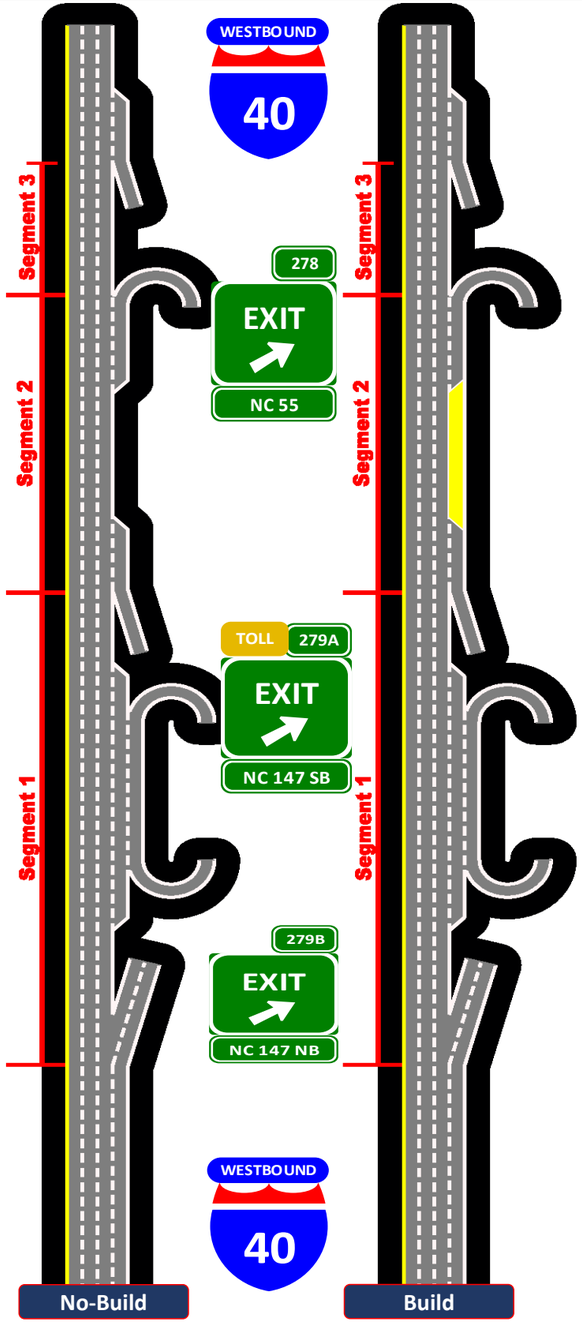
PM Peak Period (3:00 - 9:00 PM)

2025 No-Build Speed (mph)

15:00	15:15	15:30	15:45	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15	18:30	18:45	19:00	19:15	19:30	19:45	20:00	20:15	20:30	20:45
66	65	64	62	62	63	64	63	63	64	63	63	63	63	63	62	62	62	62	63	69	69	70	70
63	61	59	53	41	39	38	38	38	38	39	39	39	40	41	41	42	43	44	48	67	67	68	68
66	65	65	63	43	18	17	17	17	16	17	18	18	19	20	21	22	24	25	34	68	69	69	69

2025 Build Speed (mph)

15:00	15:15	15:30	15:45	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15	18:30	18:45	19:00	19:15	19:30	19:45	20:00	20:15	20:30	20:45
66	65	64	62	60	59	57	56	56	55	56	57	60	63	65	65	66	67	67	68	68	68	68	69
66	65	64	63	61	60	58	55	57	55	56	59	61	63	65	65	66	67	67	68	68	68	68	69
66	65	64	63	62	61	59	58	55	49	46	50	57	64	65	66	66	67	68	68	68	68	68	69



AM Peak Speed - Segment 2 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
<65 mph	2 hours 15 minutes	1 hours 00 minutes	1 hours 15 minutes
<55 mph	0 hours 15 minutes	0 hours 00 minutes	0 hours 15 minutes
<45 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<35 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<25 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes

SPEED
>65 mph
55-65 mph
45-55 mph
35-45 mph
25-35 mph
<25 mph

PM Peak Speed - Segment 2 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
<65 mph	5 hours 00 minutes	3 hours 00 minutes	2 hours 00 minutes
<55 mph	4 hours 15 minutes	0 hours 00 minutes	4 hours 15 minutes
<45 mph	3 hours 45 minutes	0 hours 00 minutes	3 hours 45 minutes
<35 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<25 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes

Notes:

The model does not include the merge from NC 55 to I-40 WB; therefore, the results for Segment 3 may not be fully representative of the actual operations and are shown as crosshatched.

STIP Project No. I-5707

I-40 Westbound - NC 147 to NC 55

Durham County

Figure 6-3

2025 No-Build vs. Build Comparison

Speed (mph)

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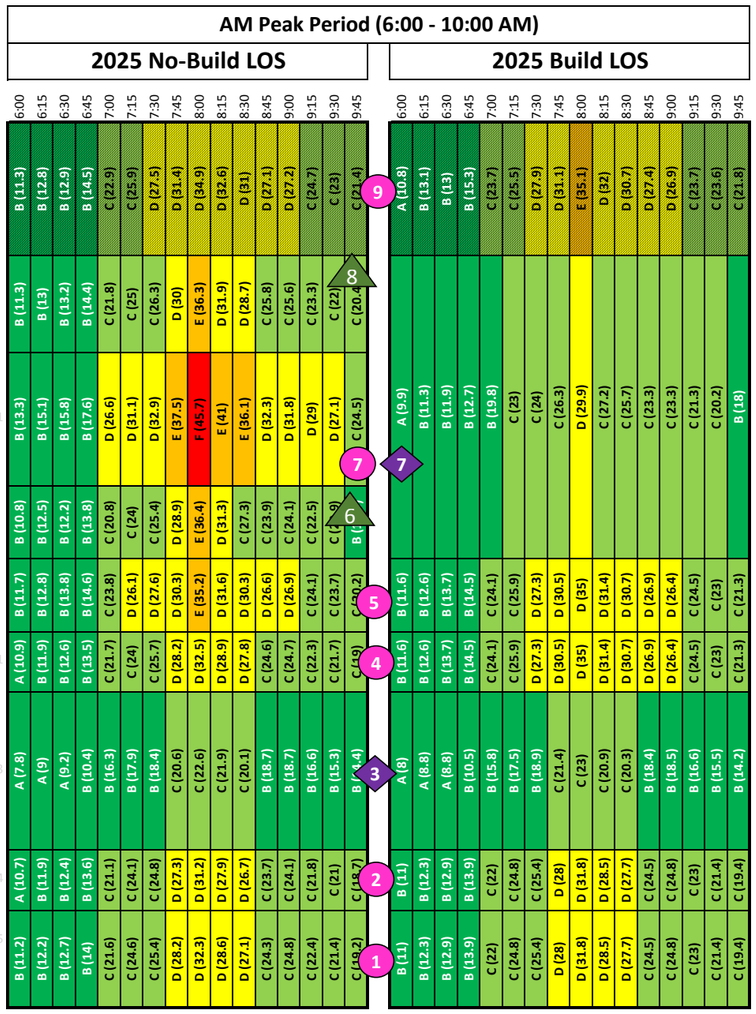

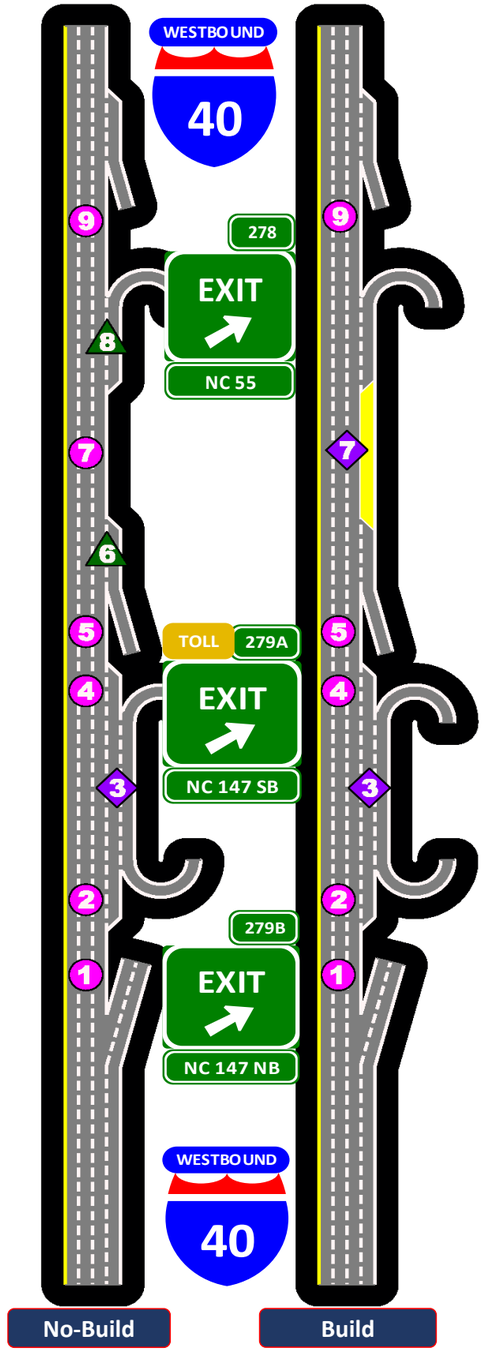

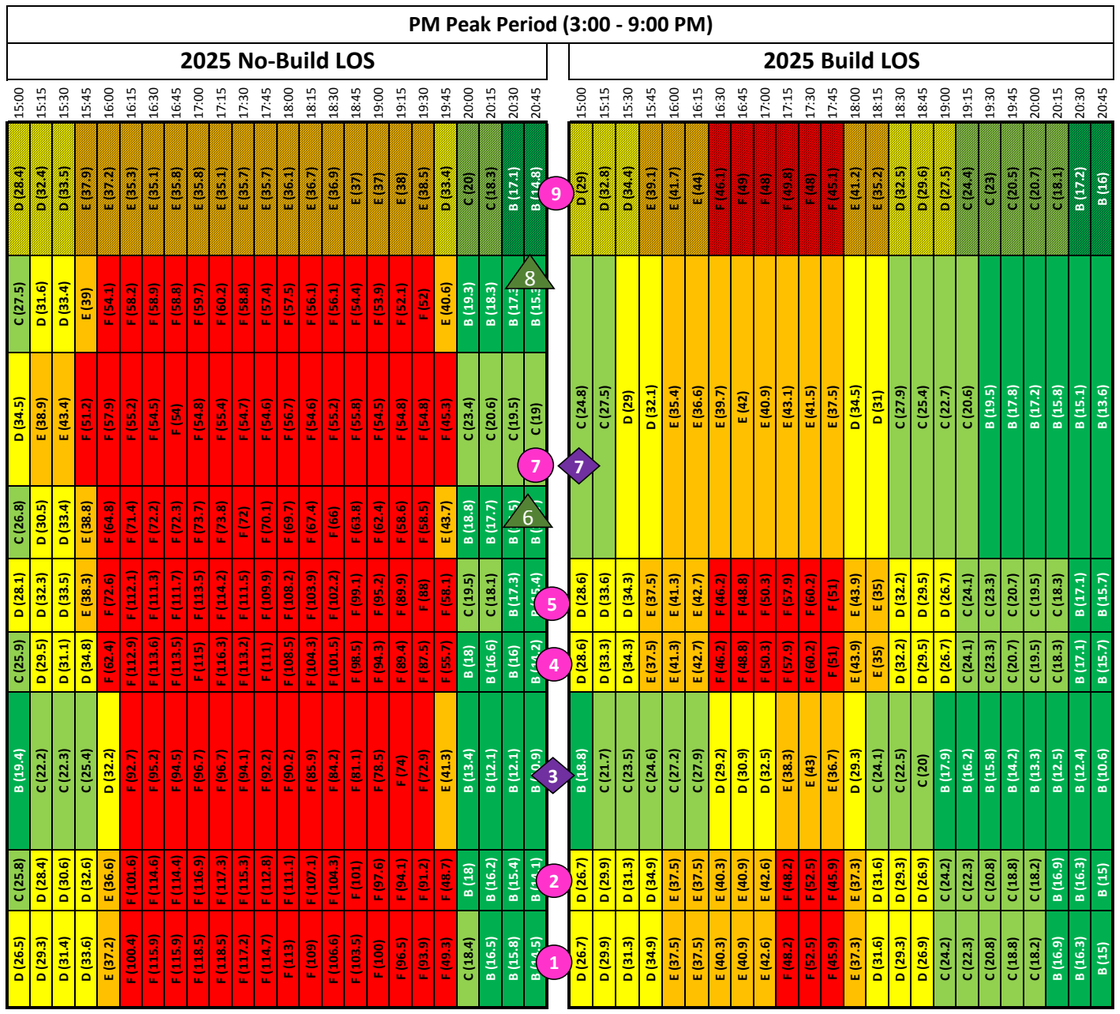

AM Peak Speed - Segment 7 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
LOS C or worse	3 hours 00 minutes	2 hours 30 minutes	0 hours 30 minutes
LOS D or Worse	2 hours 45 minutes	0 hours 15 minutes	2 hours 30 minutes
LOS E or Worse	1 hours 00 minutes	0 hours 00 minutes	1 hours 00 minutes
LOS F	0 hours 15 minutes	0 hours 00 minutes	0 hours 15 minutes

Notes:

The model does not include the merge from NC 55 to I-40 WB; therefore, the results for Segment 3 may not be fully representative of the actual operations and are shown as crosshatched.

Level of Service
LOS A/LOS B
LOS C
LOS D
LOS E
LOS F

Basic Freeway Segment

Freeway Merge and Diverge

Freeway Weaving Segment

PM Peak Speed - Segment 7 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
LOS C or worse	6 hours 00 minutes	4 hours 30 minutes	1 hours 30 minutes
LOS D or Worse	5 hours 00 minutes	3 hours 00 minutes	2 hours 00 minutes
LOS E or Worse	4 hours 45 minutes	2 hours 00 minutes	2 hours 45 minutes
LOS F	4 hours 15 minutes	0 hours 00 minutes	4 hours 15 minutes

STIP Project No. I-5707

I-40 Westbound - NC 147 to NC 55

Durham County

Figure 6-4

2025 No-Build vs. Build Comparison

Level of Service

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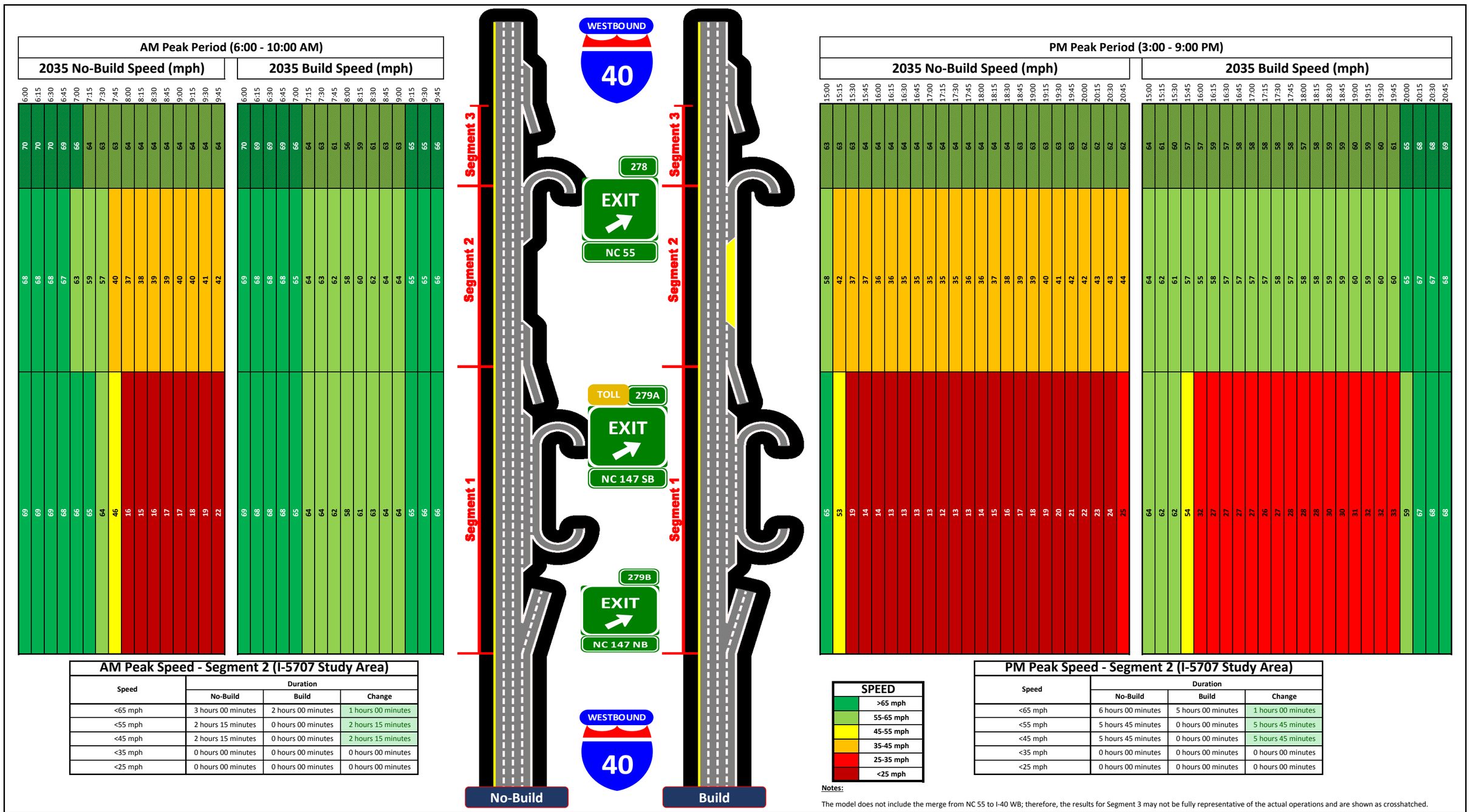
- The LOS comparison for the AM peak period showed improvements in the LOS within the Project Study Area. The No-Build scenario has LOS F operations for 15 minutes and LOS E or worse operations for 1 hour, while the Build scenario operated at LOS D or better for the entire time AM peak period.
- The LOS comparison for the PM peak period also showed substantial improvement in the LOS within the Project Study Area. The No-Build scenario has LOS F operations for 4 hours 15 minutes and LOS E or worse operations for 4 hours 45 minutes, while the Build scenario operates at LOS E for 2 hours. The Build scenario therefore reduced the duration of LOS E or worse conditions by 2 hours.
- The results also show improvement in the overall I-40 corridor with a 46 percent decrease in upstream segments that are operating at LOS E or worse when comparing the No-Build and Build results for the PM peak period.

6.3 2035 INTERIM YEAR NO-BUILD AND BUILD SCENARIOS

This scenario includes the evaluation of the 2035 Interim Year traffic operations for both the No-Build and Build scenarios, with the results of the analysis being presented on Figure 6-5 and Figure 6-6.

The results of the analysis show the following:

- The speed comparison for the AM peak period showed that the No-Build scenarios experienced at least 2 hours 15 minutes with speeds below 45 mph, with the sub -45 mph speeds extending beyond the end of the model period. The Build scenario showed that it had no speeds less than 55 mph with the slowest speed being 58 mph.
- The speed comparison for the PM peak period showed substantial improvements in the speeds along Segment 1 and Segment 2 (Project Study Area). For Segment 1 the No-Build scenario shows 5 hours 15 minutes with speeds less than 25 mph, at least 5 hours 30 minutes with speeds less than 35 mph, and 5 hours 45 minutes with speeds less than 55 mph with the speed being at 25 mph at 9:00 PM when the model ended, while the Build scenario shows 4 hours with speeds less than 35 mph and 4 hours 15 minutes with speeds less than 55 mph. Segment 1 showed a reduction in sub-45 mph speeds of at least 1 hour 30 minutes. The level of congestion in Segment 1 limits the traffic flow entering Segment 2 allowing the Project Study Area to operate better than may be anticipated. For Segment 2 the No-Build scenario shows at least 5 hours 45 minutes with speeds less than 45 mph with the speed being 44 mph at 9:00, while the Build scenario did not have any speeds less than 55 mph with the slowest speed being 57 mph.
- The LOS comparison for the AM peak period showed improvements in the LOS within the Project Study Area. The No-Build scenario has LOS F operations for at least 2 hours 15 minutes and LOS E or worse operations for at least 2 hours 45 minutes with the model being at LOS F at 10:00 when the simulation ended, while the Build scenario operated at LOS E or worse for only 15 minutes during the AM peak period.
- The LOS comparison for the PM peak period also showed improvement in the LOS within the Project Study Area. The No-Build scenario has LOS F operations for at least 5 hours 45 minutes and LOS E or worse operations for at least 6 hours with the model operating at LOS F at 9:00 when the simulation ended, while the Build scenario operates at LOS E for 4 hours 30 minutes. The Build scenario therefore reduced the duration of LOS E or worse conditions by at least 1 hour 30 minutes.
- The results also show improvement in the overall I-40 corridor with at least a 20 percent decrease in upstream segments that are operating at LOS E or worse when comparing the No-Build and Build results for the PM peak period. The percentage is likely much higher as the No-Build model is operating at LOS F for all segments when the model ends at 9:00; whereas the Build scenario is operating at LOS C or better for all segments at the end of the simulation.



AM Peak Speed - Segment 2 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
<65 mph	3 hours 00 minutes	2 hours 00 minutes	1 hours 00 minutes
<55 mph	2 hours 15 minutes	0 hours 00 minutes	2 hours 15 minutes
<45 mph	2 hours 15 minutes	0 hours 00 minutes	2 hours 15 minutes
<35 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<25 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes

SPEED	
	>65 mph
	55-65 mph
	45-55 mph
	35-45 mph
	25-35 mph
	<25 mph

PM Peak Speed - Segment 2 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
<65 mph	6 hours 00 minutes	5 hours 00 minutes	1 hours 00 minutes
<55 mph	5 hours 45 minutes	0 hours 00 minutes	5 hours 45 minutes
<45 mph	5 hours 45 minutes	0 hours 00 minutes	5 hours 45 minutes
<35 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<25 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes

Notes:

The model does not include the merge from NC 55 to I-40 WB; therefore, the results for Segment 3 may not be fully representative of the actual operations and are shown as crosshatched.

STIP Project No. I-5707

I-40 Westbound - NC 147 to NC 55

Durham County

Figure 6-5

2035 No-Build vs. Build Comparison

Speed (mph)

Prepared By:
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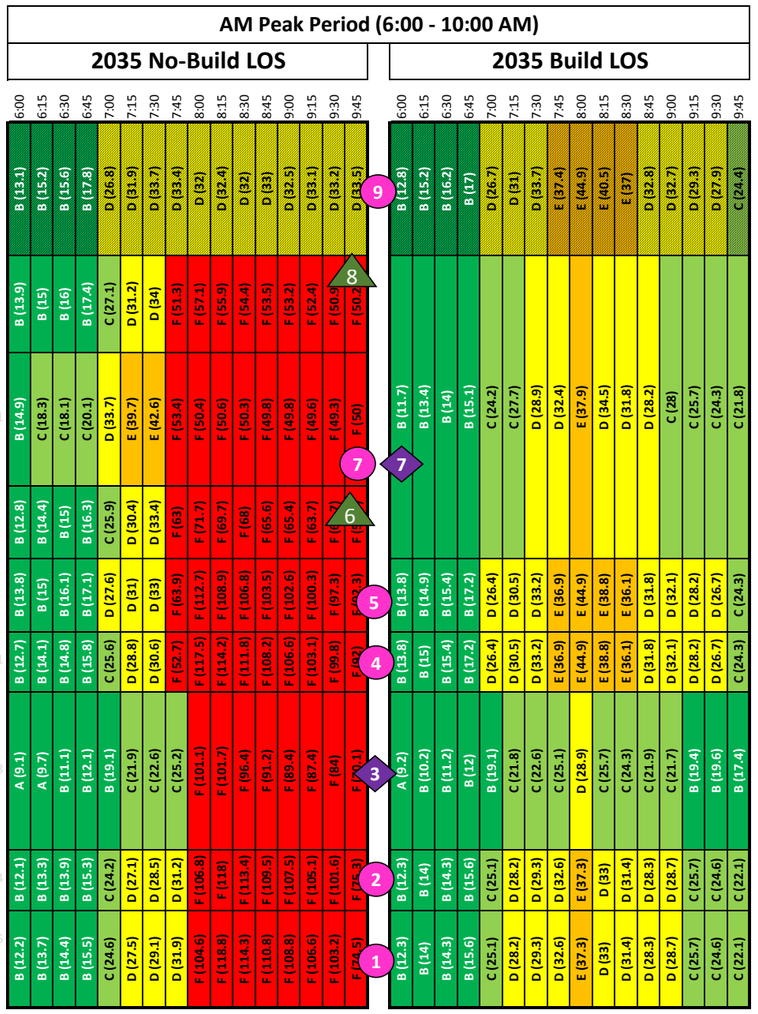

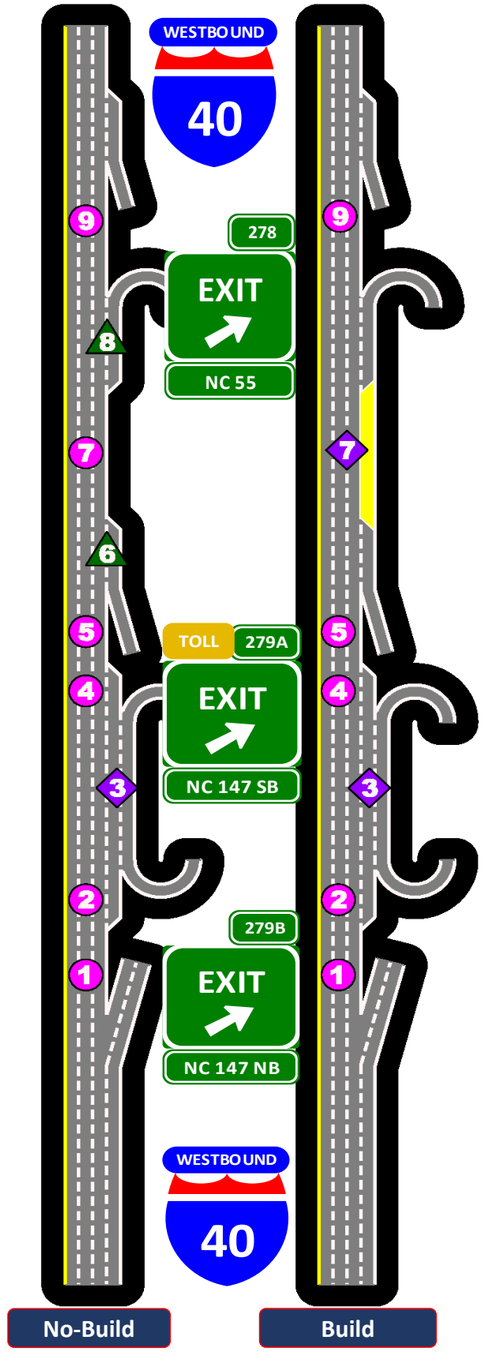

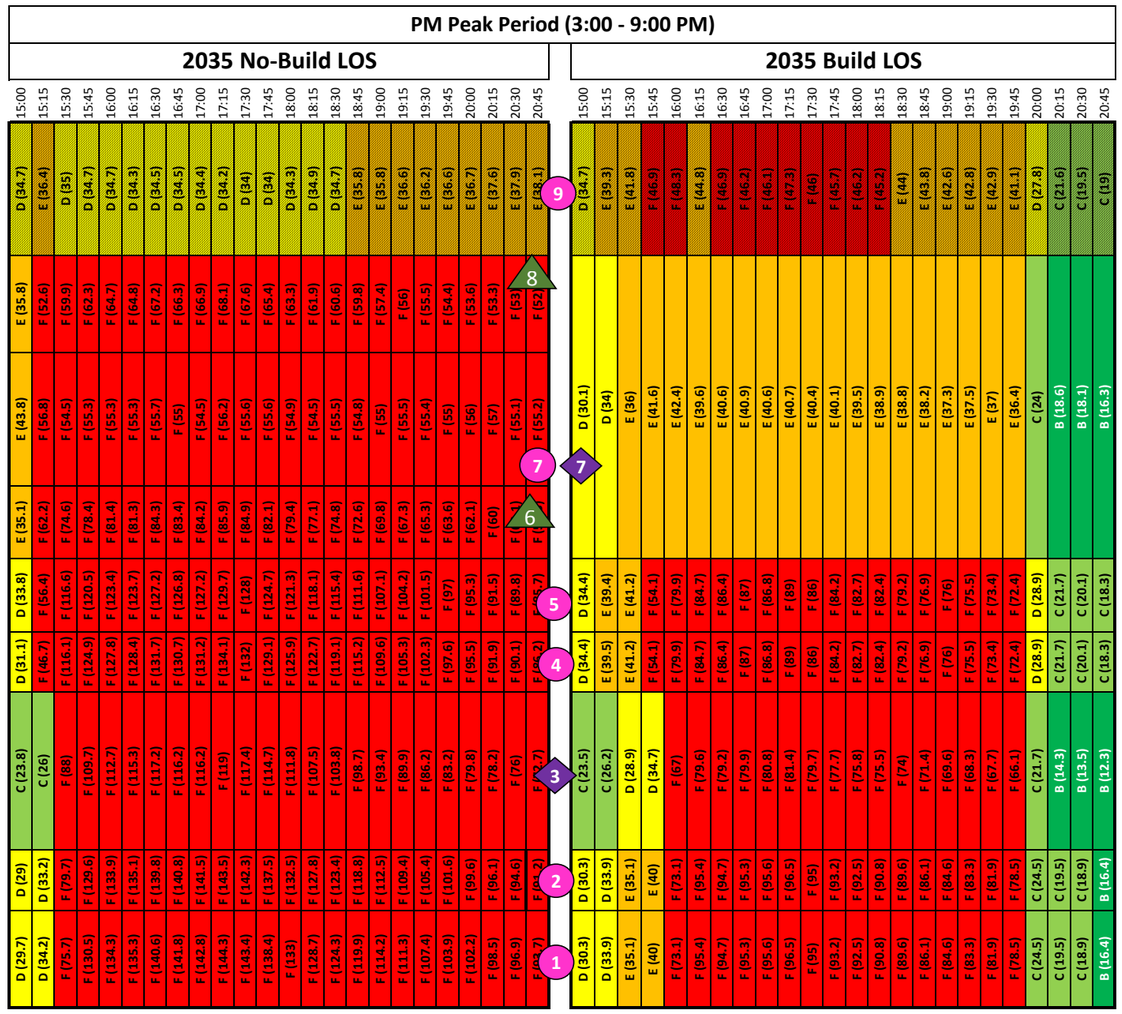

AM Peak Speed - Segment 7 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
LOS C or worse	3 hours 45 minutes	3 hours 00 minutes	0 hours 45 minutes
LOS D or Worse	3 hours 00 minutes	1 hours 30 minutes	1 hours 30 minutes
LOS E or Worse	2 hours 45 minutes	0 hours 15 minutes	2 hours 30 minutes
LOS F	2 hours 15 minutes	0 hours 00 minutes	2 hours 15 minutes

Notes:

The model does not include the merge from NC 55 to I-40 WB; therefore, the results for Segment 3 may not be fully representative of the actual operations and are shown as crosshatched.

Level of Service
LOS A/LOS B
LOS C
LOS D
LOS E
LOS F

Basic Freeway Segment

Freeway Merge and Diverge

Freeway Weaving Segment

PM Peak Speed - Segment 7 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
LOS C or worse	6 hours 00 minutes	5 hours 15 minutes	0 hours 45 minutes
LOS D or Worse	6 hours 00 minutes	5 hours 00 minutes	1 hours 00 minutes
LOS E or Worse	6 hours 00 minutes	4 hours 30 minutes	1 hours 30 minutes
LOS F	5 hours 45 minutes	0 hours 00 minutes	5 hours 45 minutes

STIP Project No. I-5707

I-40 Westbound - NC 147 to NC 55

Durham County

Figure 6-6

2035 No-Build vs. Build Comparison

Level of Service

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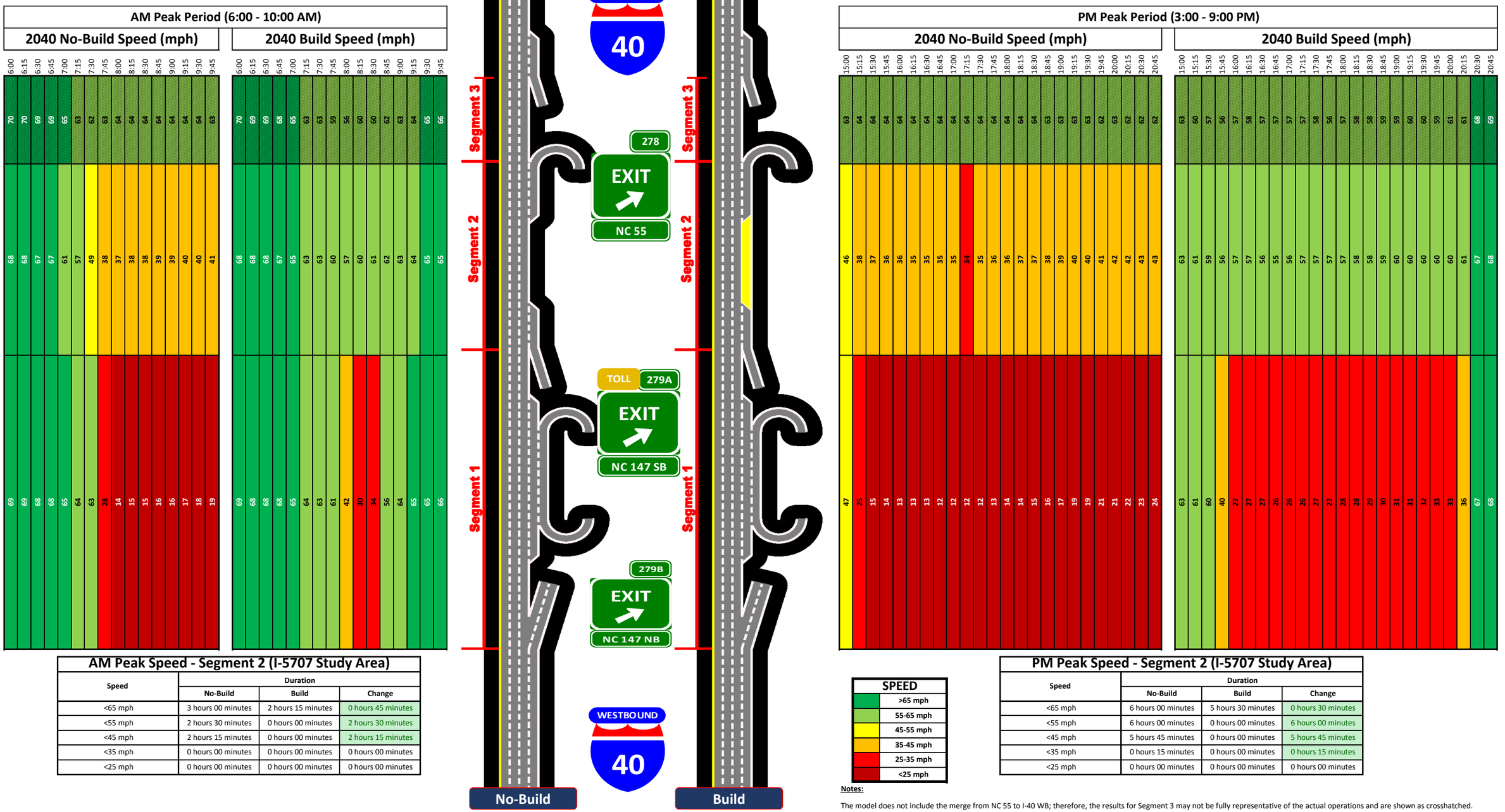
6.4 2040 FUTURE YEAR NO-BUILD AND BUILD SCENARIOS

This scenario includes the evaluation of the 2040 Future Year traffic operations for both the No-Build and Build scenarios, with the results of the analysis being presented on Figure 6-7 and Figure 6-8.

The results of the analysis show the following:

- The speed comparison for the AM peak period showed that the No-Build scenarios experienced at least 2 hours 15 minutes with speeds below 45 mph and the sub-45 mph speeds extending beyond the end of the model period, while the Build scenario showed that it had no speeds less than 55 mph with the slowest speed being 57 mph.
- The speed comparison for the PM peak period showed substantial improvements in the speeds along Segment 1 and Segment 2 (Project Study Area). For Segment 1 the No-Build scenario shows at least 5 hours 30 minutes with speeds less than 25 mph, at least 5 hours 45 minutes with speeds less than 35 mph, and at least 6 hours with speeds less than 55 mph with the speed being at 24 mph at 9:00 PM when the model ended, while the Build scenario shows 4 hours 15 minutes with speeds less than 35 mph and 4 hours 45 minutes with speeds less than 45 mph. Segment 1 showed a reduction in sub-45 mph speeds of at least 1 hour 30 minutes. The level of congestion in Segment 1 limits the traffic flow entering Segment 2 allowing the Project Study Area to operate better than may be anticipated. For Segment 2 the No-Build scenario shows 15 minutes with speeds less than 35 mph and at least 5 hours 45 minutes with speeds less than 45 mph with the speed being 43 mph at 9:00 when the model ended, while the Build scenario did not have any speeds less than 55 mph with the slowest speed being 55 mph.
- The LOS comparison for the AM peak period showed improvements in the LOS within the Project Study Area. The No-Build scenario has LOS F operations for at least 2 hours 30 minutes and LOS E or worse operations for at least 3 hours with the model being at LOS F at 10:00 when the simulation ended, while the Build scenario operated at LOS E or worse for only 30 minutes during the AM peak period.
- The LOS comparison for the PM peak period also showed improvement in the LOS within the Project Study Area. The No-Build scenario has LOS F operations for at least 6 hours with the model operating at LOS F at 9:00 when the simulation ended, while the Build scenario operates at LOS E for 5 hours. The Build scenario therefore reduced the duration of LOS E or worse conditions by at least 1 hour.
- The results also show improvement in the overall I-40 corridor with at least a 10 percent decrease in upstream segments that are operating at LOS E or worse when comparing the No-Build and Build results for the PM peak period. The percentage is likely much higher as the No-Build model is operating at LOS F for all segments when the model ends at 9:00; whereas the Build scenario is operating at LOS C or better for all segments at the end of the simulation.



AM Peak Speed - Segment 2 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
<65 mph	3 hours 00 minutes	2 hours 15 minutes	0 hours 45 minutes
<55 mph	2 hours 30 minutes	0 hours 00 minutes	2 hours 30 minutes
<45 mph	2 hours 15 minutes	0 hours 00 minutes	2 hours 15 minutes
<35 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes
<25 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes

SPEED
>65 mph
55-65 mph
45-55 mph
35-45 mph
25-35 mph
<25 mph

PM Peak Speed - Segment 2 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
<65 mph	6 hours 00 minutes	5 hours 30 minutes	0 hours 30 minutes
<55 mph	6 hours 00 minutes	0 hours 00 minutes	6 hours 00 minutes
<45 mph	5 hours 45 minutes	0 hours 00 minutes	5 hours 45 minutes
<35 mph	0 hours 15 minutes	0 hours 00 minutes	0 hours 15 minutes
<25 mph	0 hours 00 minutes	0 hours 00 minutes	0 hours 00 minutes

Notes:

The model does not include the merge from NC 55 to I-40 WB; therefore, the results for Segment 3 may not be fully representative of the actual operations and are shown as crosshatched.

STIP Project No. I-5707

I-40 Westbound - NC 147 to NC 55

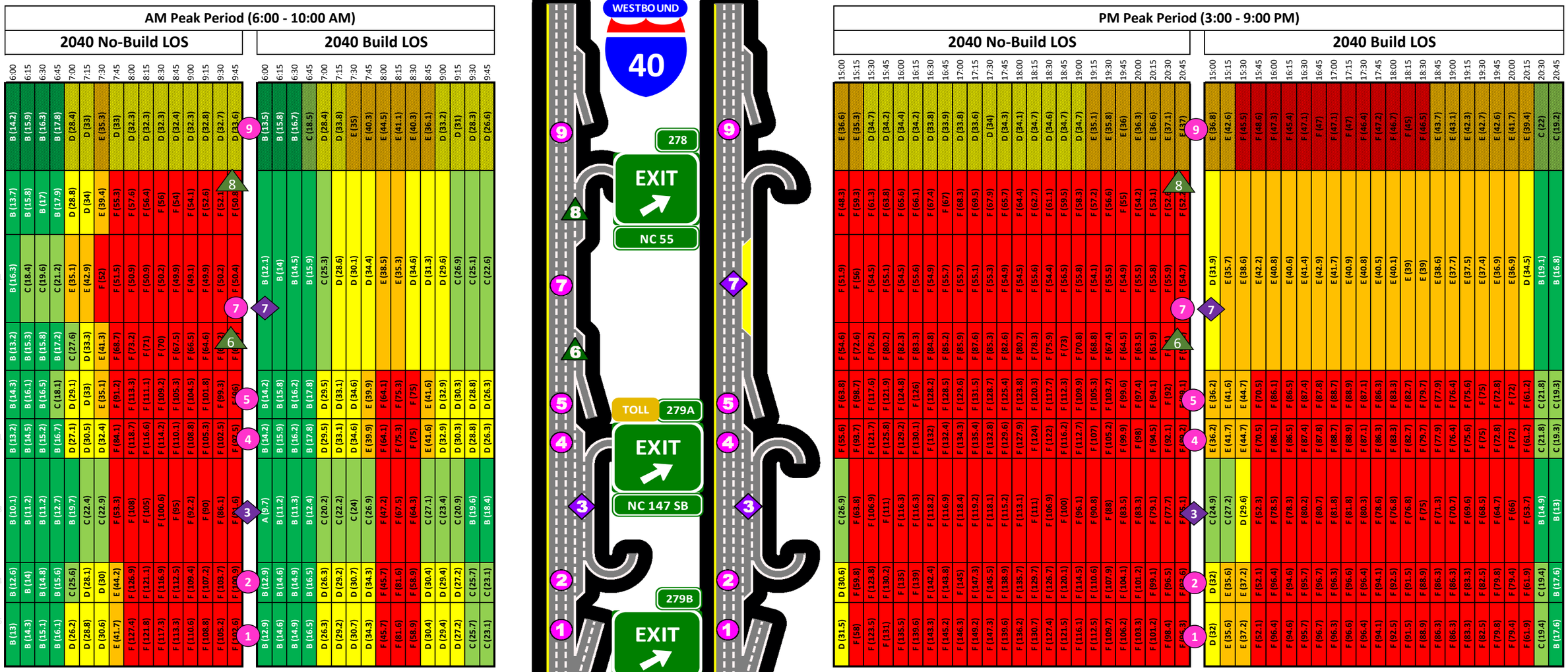
Durham County

Figure 6-7

2040 No-Build vs. Build Comparison

Speed (mph)

Prepared By:
Patriot Transportation Engineering, PLLC
3008 Anderson Drive, Suite 120
Raleigh, North Carolina 27609
(919)977-9125



AM Peak Speed - Segment 7 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
LOS C or worse	3 hours 45 minutes	3 hours 00 minutes	0 hours 45 minutes
LOS D or Worse	3 hours 00 minutes	2 hours 00 minutes	1 hours 00 minutes
LOS E or Worse	3 hours 00 minutes	0 hours 30 minutes	2 hours 30 minutes
LOS F	2 hours 30 minutes	0 hours 00 minutes	2 hours 30 minutes

Notes:

The model does not include the merge from NC 55 to I-40 WB; therefore, the results for Segment 3 may not be fully representative of the actual operations and are shown as crosshatched.

Level of Service
LOS A/LOS B
LOS C
LOS D
LOS E
LOS F

Basic Freeway Segment

Freeway Merge and Diverge

Freeway Weaving Segment

PM Peak Speed - Segment 7 (I-5707 Study Area)

Speed	Duration		
	No-Build	Build	Change
LOS C or worse	6 hours 00 minutes	5 hours 30 minutes	0 hours 30 minutes
LOS D or Worse	6 hours 00 minutes	5 hours 30 minutes	0 hours 30 minutes
LOS E or Worse	6 hours 00 minutes	5 hours 00 minutes	1 hours 00 minutes
LOS F	6 hours 00 minutes	0 hours 00 minutes	6 hours 00 minutes

STIP Project No. I-5707

I-40 Westbound - NC 147 to NC 55

Durham County

Figure 6-8

2040 No-Build vs. Build Comparison

Level of Service

Prepared By:
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3008 Anderson Drive, Suite 120
Raleigh, North Carolina 27609
(919)977-9125

7. CRASH RATE ANALYSIS

This section presents a summary of the Crash Rate Analysis for the proposed project. The analysis included the segment of I-40 Westbound from the NC 147 merge to the NC 55 diverge, a total distance of 0.391 miles. The segment analyzed for the project study area included a total of 33 crashes, of which one resulted in a fatality, for the period from April 1, 2010, to March 31, 2015. The crash rate was compared to the statewide average for similar roadway types to determine if the segment exceeded the statewide average. The simple comparison of the roadway crash rate versus the statewide average crash rate identifies nearly one-half of all locations as having a potential highway safety concern. A more appropriate method is the critical crash rate method. The critical crash rate is a statistically derived number, which is greater than the average crash rate, that can be used to identify locations where crash occurrence is higher than expected for a given facility type. Safety measures could be considered for locations identified in this manner. For planning purposes the confidence level used to calculate the critical crash rate is 95 percent. The critical crash rate is beneficial because it accounts for exposure (volumes) and varying segment lengths. If a segment has an actual crash rate higher than the critical rate, the location may have a potential highway safety deficiency and should receive additional analysis.

The results of the crash analysis are shown in Table 7-1. The NCDOT Traffic Engineering Accident Analysis System (TEAAS) Strip Analysis Report for the project study area is included in Appendix B. The analysis shows that for all crash types, with the exception of fatal crashes, the crash rate is lower than the Statewide Crash Rate. When the Critical Crash Rate is reviewed for the fatal crash type it was found to be less than the critical. Further, the lone fatal crash was a run off the road crash where the vehicle was found to be traveling 113 mph; therefore, it is likely that the design of the roadway was not the overriding factor in the crash.

Table 7-1: Crash Rate Comparison – I-40 Westbound from NC 147 to NC 55

Crash Type	Crashes	Crash Rate (per 100 MVM)	Statewide Crash Rate (per 100 MVM)[1]	Critical Crash Rate (per 100 MVM)[2]	Exceeds	
					Statewide Rate	Critical Rate
Total	33	77.68	89.93	115.04	No	No
Fatal	1	2.35	0.34	2.99	Yes	No
Non-Fatal Injury	3	7.06	22.16	35.22	No	No
Wet	7	16.48	19.94	32.39	No	No
Night	10	23.54	23.65	37.10	No	No

1 – 2010-2012 Statewide Crash rate for Urban Interstate Route

2 – Based on the statewide crash rate (95% level of confidence)

An analysis of the crash data does show that a majority of the crashes are during peak periods when congestion is highest. The PM peak period from 5:00 PM to 7:00 PM that was shown to have lower speeds accounts for 39.4 percent of the crashes. A review of the accident types also shows that a majority of the accidents (54.6 percent) were rear end collisions with a slow or stopped vehicle.

8. CONCLUSIONS

Based on the speed and LOS results of the simulation models, the proposed addition of an auxiliary lane along I-40 Westbound between NC 147 and NC 55 will result in a noticeable improvement in traffic operations, both in the interim and in the design year 2040. The analysis shows that the I-40 corridor has individual locations that are currently operating at LOS F and that have speeds as low as 25 mph. In the future, even with the currently planned improvements in the vicinity of the project, the level of congestion will become much more severe with congestion in the AM peak extending beyond 10:00 AM and congestion in the PM peak beginning prior to 3:00 PM and extending beyond 9:00 PM. The proposed project is shown to substantially improve the traffic operations in the 2014 Base Year, essentially eliminating the LOS E or F operations within the study area. In the Interim Year analysis for 2025 and 2035 the proposed project also shows substantial improvements in the traffic operations within the study area as the network has LOS E operations with average speeds remaining in excess of 55 mph. Additionally, the proposed project will reduce the duration of congestion and improve the upstream bottleneck where I-40 reduces from 4 through lanes to three through lanes following the diverge to NC 147 Northbound. The 2040 Future Year Build analysis shows relatively substantial improvements in both the magnitude and duration of congestion when compared to the No-Build scenario. Overall, the proposed project will not alleviate congestion along the I-40 corridor; however it will provide substantial improvements to the traffic operations in the Base (2014), Interim (2025-2035) and Future Year (2040).

APPENDIX A:

TRAFFIC FORECAST

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

PAT MCCRORY
GOVERNOR

ANTHONY J. TATA
SECRETARY

February 9, 2015

MEMORANDUM TO: Theresa Ellerby
Project Development and Environmental Analysis Branch

FROM: Jamie V. Moore
Transportation Planning Branch

SUBJECT: Traffic Forecast for Project I-5707
Durham County
The widening of I-40 Westbound for an auxiliary lane from West of NC147 to East of NC55

Please find attached the 2014 / 2030 / 2040 Traffic Forecast for the above mentioned project. TIP Project I-5707 is defined as the widening of I-40 westbound for an auxiliary lane from west of NC147 to east of NC55. This is the first forecast completed for this project. This project lies within the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC MPO) planning jurisdiction.

The forecasts for FS-1205A, completed 8/11/14, FS-1205C (managed lanes), completed 5/22/14, FS-1205C (widening), completed 2/21/13, and FS-1305A, completed 6/26/14, were reviewed during the development of this forecast. Julie Bollinger, PE, DCHC MPO Coordinator, Brian Wert, Transportation Engineer II with the Metrolina Planning Group, and Rupal Desai, PE, the Capital Area MPO Coordinator for the Transportation Planning Branch; Felix Nwoko, PhD, the DCHC MPO Administrator; Jason Watson, Division 5, District 2 Traffic Engineer; Bill Judge, PE, City of Durham Director of Engineering and Infrastructure; Kent Taylor, PE, State Traffic Survey Engineer with the Traffic Survey Unit; and John Stansberry, the Regional Toll Road Manager for the Turnpike Authority, were consulted during the development of this forecast. Information on current and future land development was received from these sources. The Triangle Regional Model (TRM), version 5 (TRM V5), approved April 10, 2013, was used as a tool in the development of this forecast. The model Base Year is 2010, the Interim Year is 2030, and the Future Year is 2040.

The following scenarios are provided:

- 2014 Base Year No Build
- 2030 Interim Year Build
- 2040 Future Year Build

Certain assumptions were made in the development of the forecast:

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

NCDOT TPB
TRANSPORTATION PLANNING BRANCH
https://connect.ncdot.gov/projects/planning/

LOCATION:
TRANSPORTATION BUILDING
1 SOUTH WILMINGTON STREET
RALEIGH, NC 27601
Phone: 919-707-0900
Fax: 919-733-9794

Fiscal Constraint: Within an MPO, the future year forecasts assume construction of projects as listed within the MPO's Metropolitan Transportation Plan (MTP, previously called LRTP). This forecast is consistent with the Capital Area and DCHC MPO's current 2040 MTP, adopted April 10, 2013. Projects in the MTP which affect this facility include:

For Interim Year 2030:

- FS-1205A: I-40 Managed Lanes from NC147 to Wade Avenue
- U-5324A-E: The widening of NC54 from I-40 to NC55

For Future Year 2040:

- FS-1205A: I-40 Managed Lanes from NC147 to US15-501
- FS-1205C: The widening of NC147 from I-40 to the East End Connector

Development Activity: According to information received from various planners, there are currently no planned and approved developments that will affect the project area.

Methodology: The Base Year No Build was developed primarily based upon traffic counts taken for this forecast and supplemental data provided by the Traffic Survey Group.

The Interim Year Build traffic volumes were calculated by applying the selected growth rates to the Base Year No Build volumes using a linear growth formula. The growth rate used along NC147 (Triangle Expressway) south of I-40 is higher than usual due to the economic growth and the development that is expected from Durham over the coming years. Also, as the surrounding facilities become more congested, it is expected that more drivers will opt for driving on the Triangle Expressway to save time. After speaking with Brian Wert, it was decided that this forecast would use a growth rate more closely resembling that of the model and therefore a rate of 5.7% was selected. The resulting volumes were then adjusted to refine and balance the volume estimates.

Future Year Build traffic volumes were calculated by applying the selected growth rates to the Interim Year Build volumes using a linear growth formula. The resulting volumes were then adjusted to refine and balance the volume estimates. To calculate and separate the volumes for the managed lanes along I-40, the model was used to determine the percent of traffic shift. The percent of traffic shift was applied to the Future Year Build traffic volumes. The volumes on the diagrams are shown indicating General Purpose, Managed Lanes, and a total of the two.

Interpolation: To determine any intermediate years, straight-line interpolation may be used between the Base Year No Build and Interim Year Build scenarios and also between the Interim Year Build and Future Year Build scenarios. AADT volumes may be extrapolated for up to two years immediately following 2040. If it is determined that any of these assumptions have become inconsistent with the project and surrounding area activity, please request updated projections at this location.

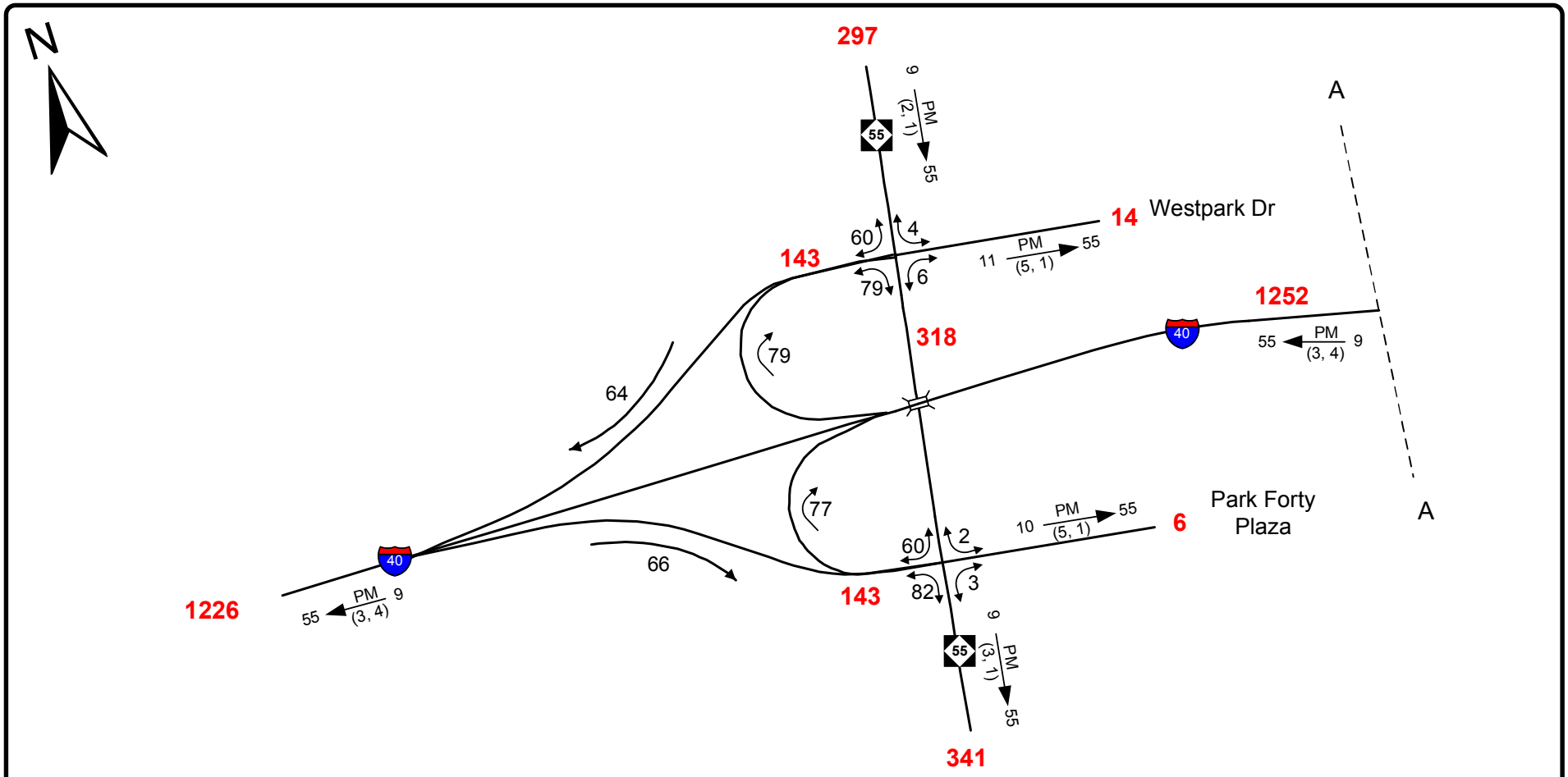
For future reference, this forecast will be saved in Project Store in the LongRangePlanning\TrafficForecasts folder, under project I5707. If you have any

questions, or if I can be of further assistance, please do not hesitate to call me at (919) 707-0937, or e-mail me at jvmoore@ncdot.gov.

cc: FILE (Durham County, Project I-5707)

cc: *Final distribution for your records via e-mail. Diagrams as PDF attachment*

State Traffic Forecast Engineer, Transportation Planning Branch
Scott Walston, PE, Transportation Planning Branch
Doumit Y. Ishak, Congestion Management Section
Don Chen, PE, Pavement Management Unit
Karen Roberson, Transportation Planning Branch
Joey Hopkins, PE, Division of Highways - Division 5
Glenn W. Mumford, PE, Roadway Design Unit
Felix Nwoko, PhD, DCHC MPO



2014 AVERAGE ANNUAL DAILY TRAFFIC

NO BUILD
SHEET 1 OF 6

LEGEND

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

TIP: I-5707 | **WBS:** 50123.1.FS1

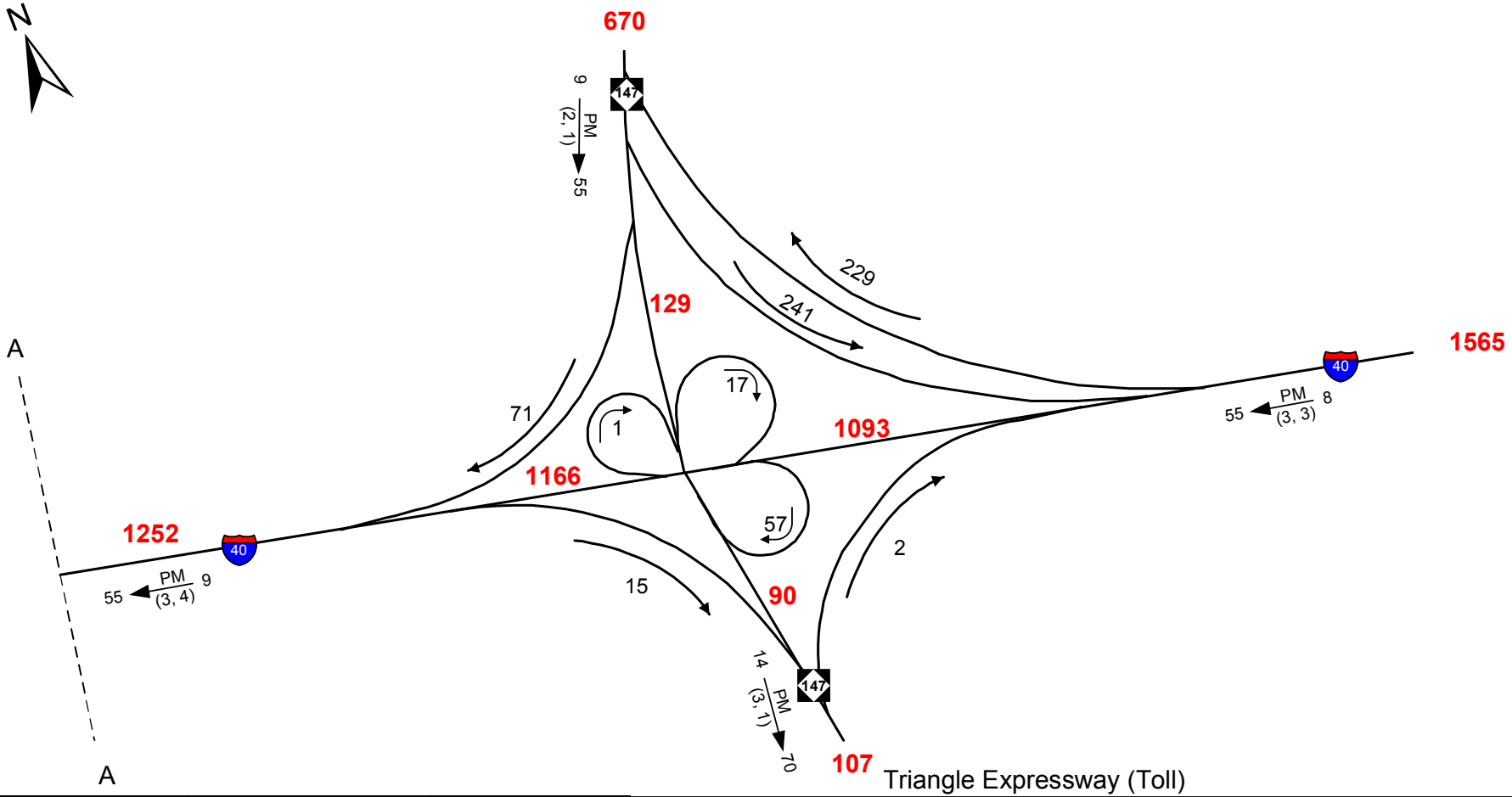
COUNTY: Durham | **DIVISION:** 5

DATE: 2-9-2015

PREPARED BY: Jamie Moore

LOCATION: I-40

PROJECT: Widen for auxiliary lane between NC55 (Exit 278) and NC147 (Exit 279)



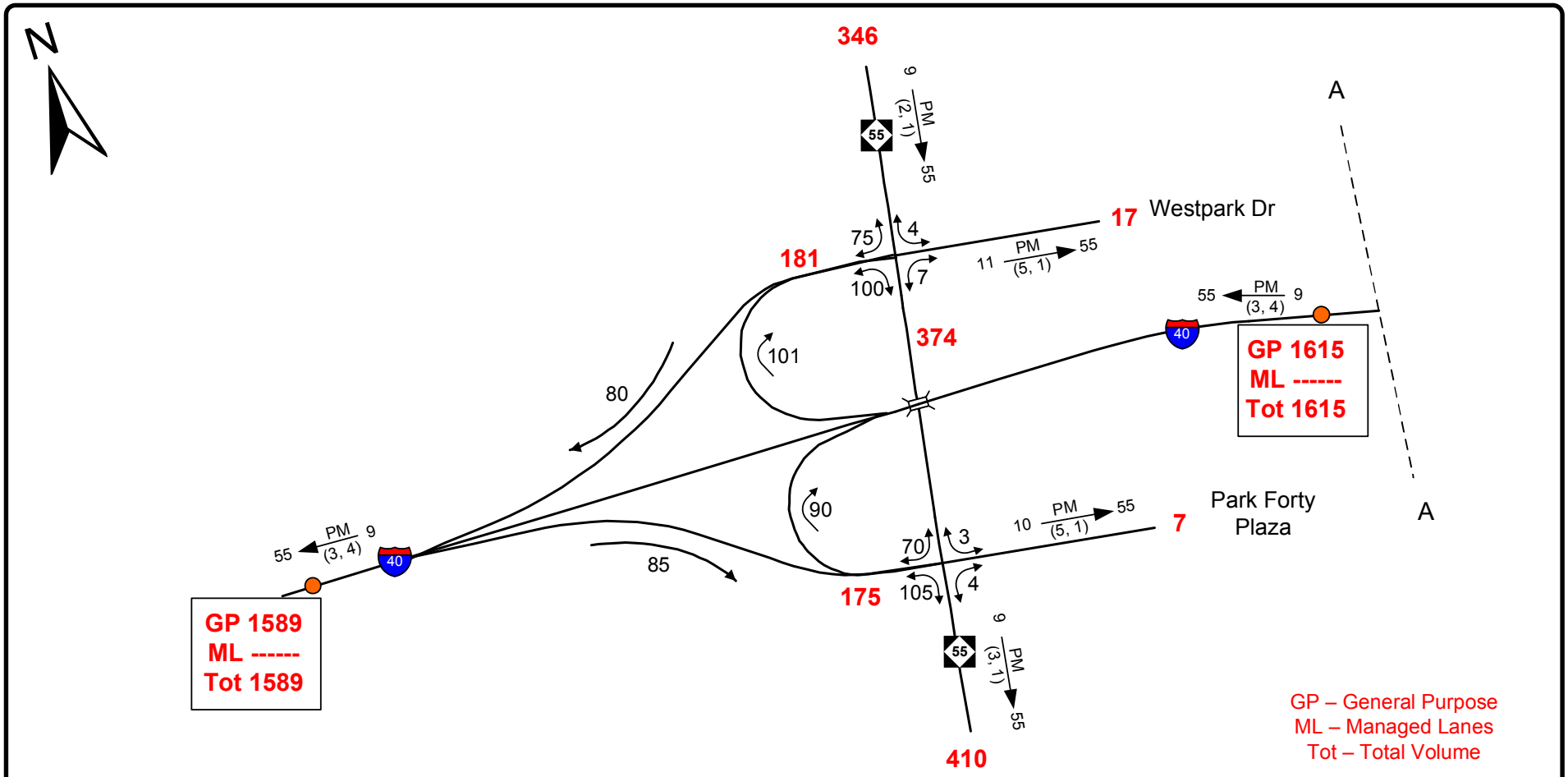
2014 AVERAGE ANNUAL DAILY TRAFFIC

NO BUILD
SHEET 2 OF 6

LEGEND

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

TIP: I-5707	**WBS:** 50123.1.FS1
COUNTY: Durham	**DIVISION:** 5
DATE: 2-9-2015	
PREPARED BY: Jamie Moore	
LOCATION: I-40	
PROJECT: Widen for auxiliary lane between NC55 (Exit 278) and NC147 (Exit 279)	



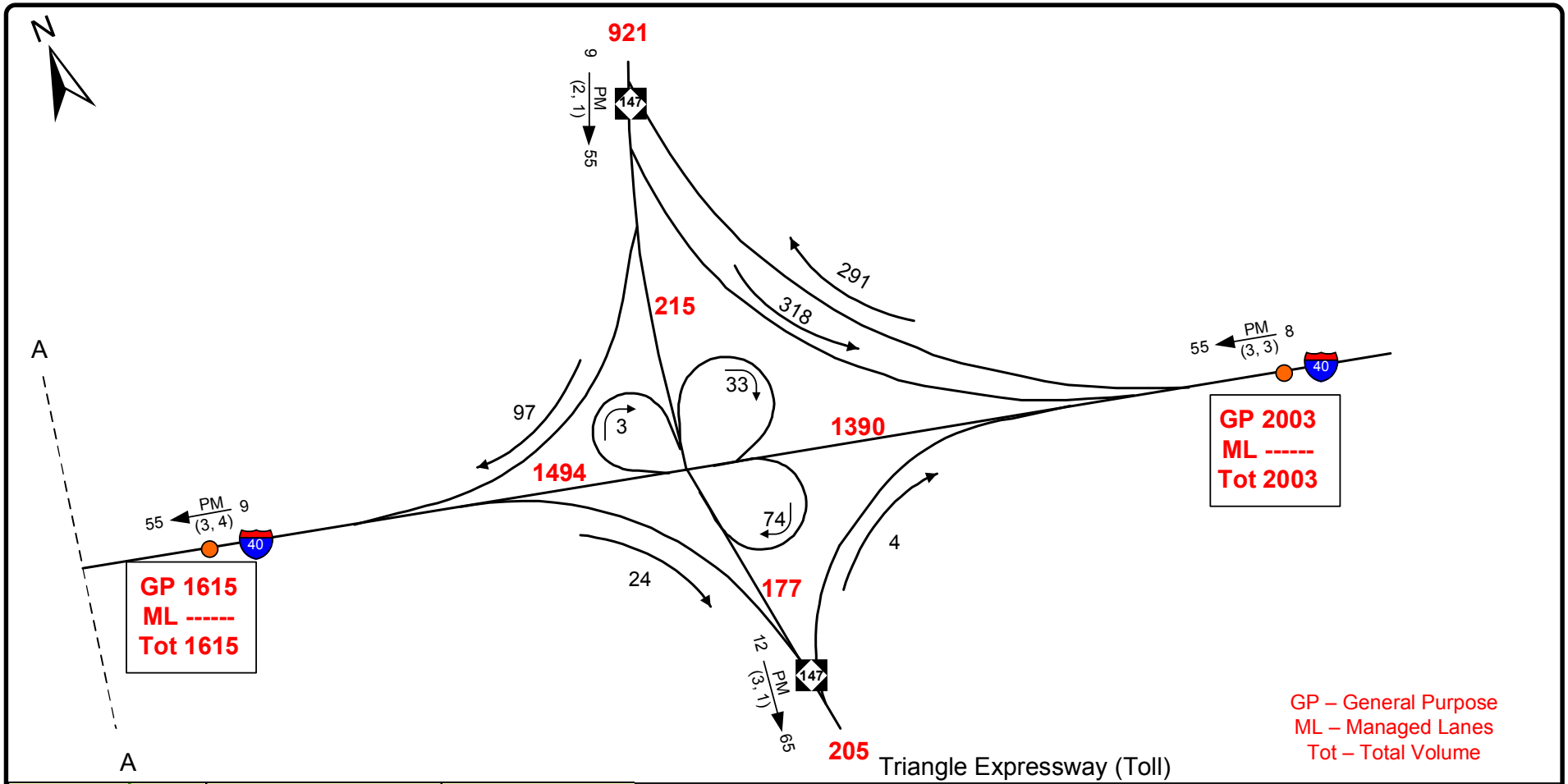
2030 AVERAGE ANNUAL DAILY TRAFFIC

BUILD
SHEET 3 OF 6

LEGEND

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

TIP: I-5707	**WBS:** 50123.1.FS1
COUNTY: Durham	**DIVISION:** 5
DATE: 2-9-2015	
PREPARED BY: Jamie Moore	
LOCATION: I-40	
PROJECT: Widen for auxiliary lane between NC55 (Exit 278) and NC147 (Exit 279)	



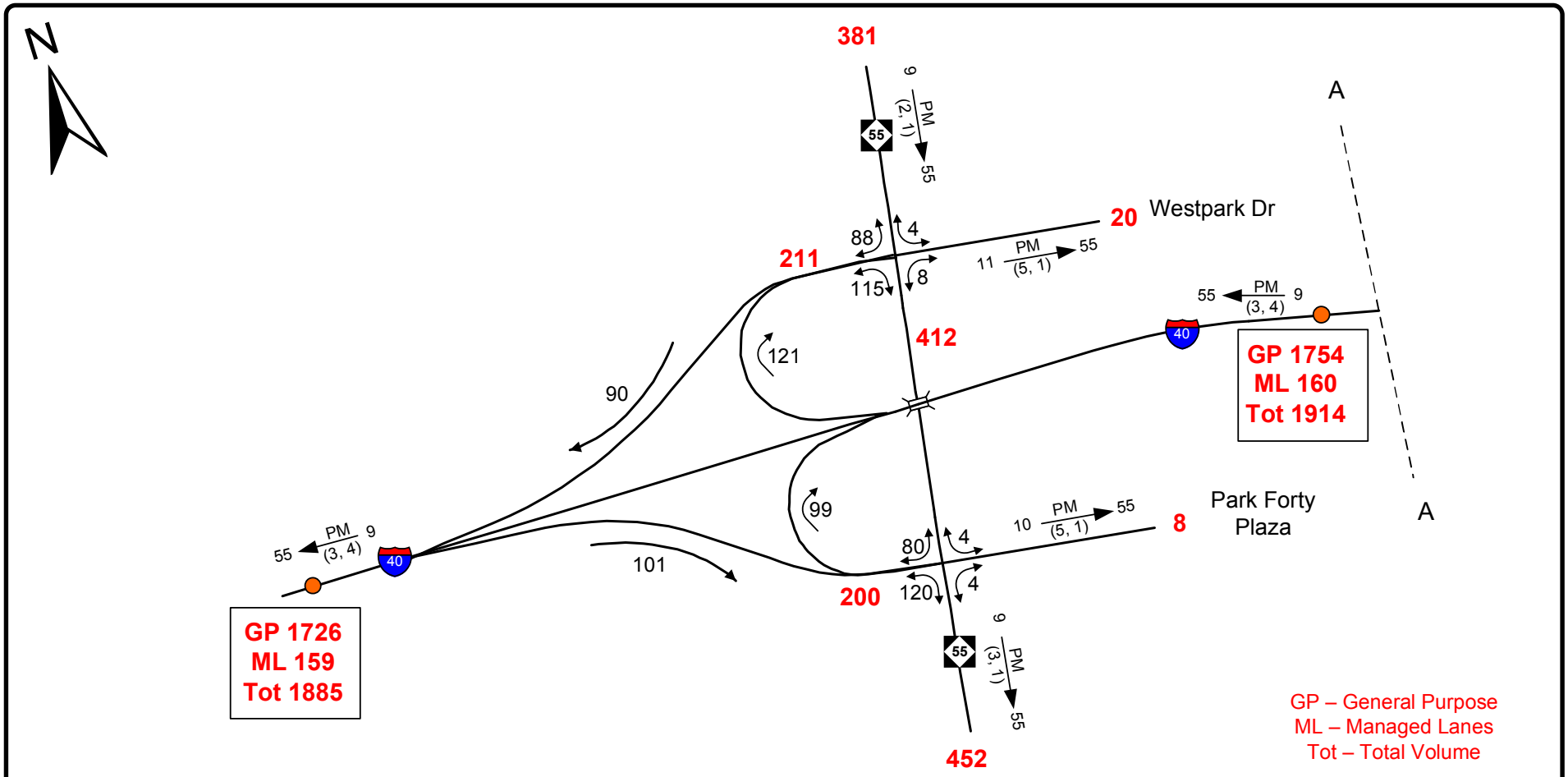
2030 AVERAGE ANNUAL DAILY TRAFFIC

BUILD
SHEET 4 OF 6

LEGEND

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

TIP: I-5707	**WBS:** 50123.1.FS1
COUNTY: Durham	**DIVISION:** 5
DATE: 2-9-2015	
PREPARED BY: Jamie Moore	
LOCATION: I-40	
PROJECT: Widen for auxiliary lane between NC55 (Exit 278) and NC147 (Exit 279)	



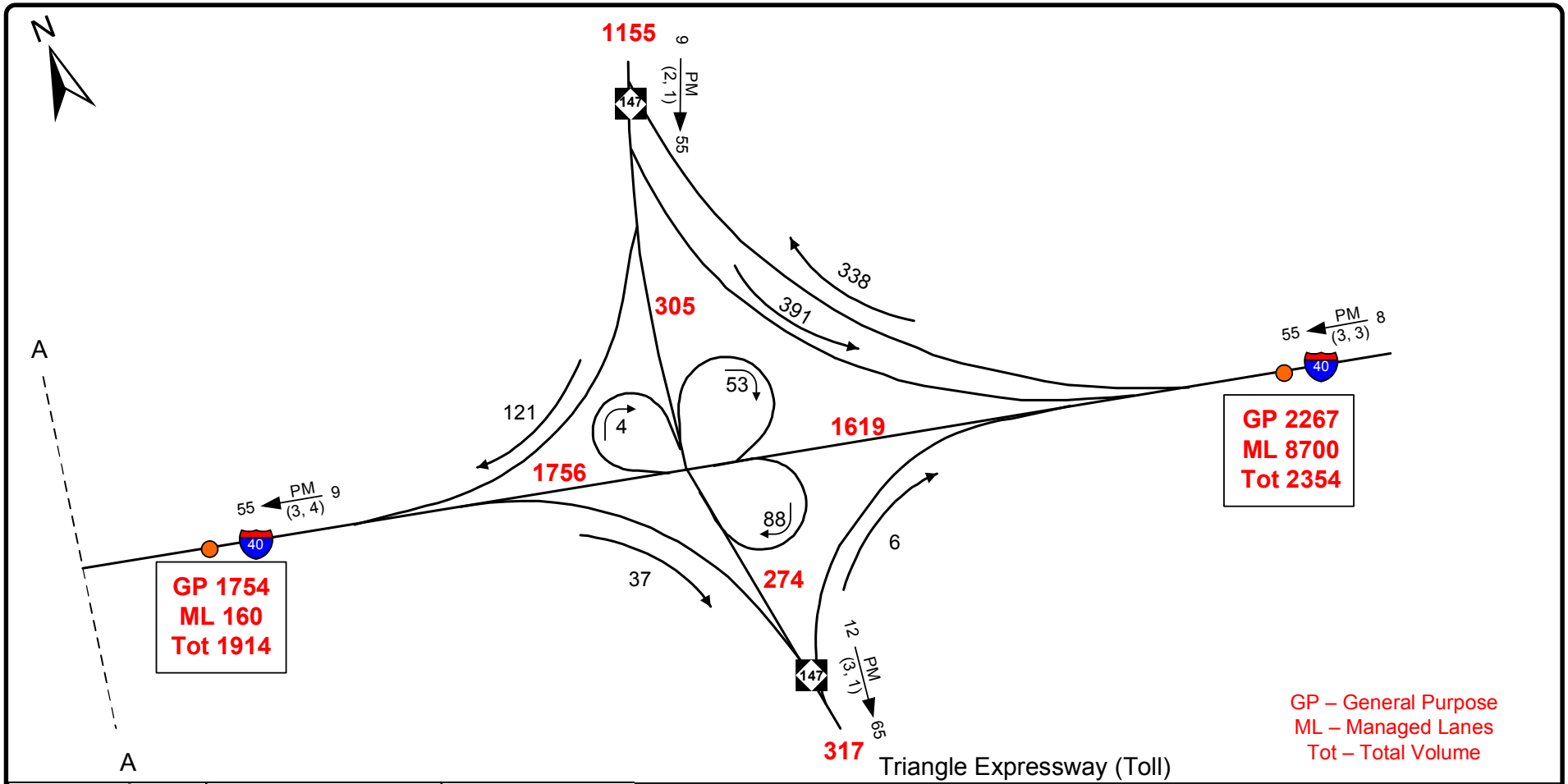
2040 AVERAGE ANNUAL DAILY TRAFFIC

BUILD
SHEET 5 OF 6

LEGEND

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

TIP: I-5707	**WBS:** 50123.1.FS1
COUNTY: Durham	**DIVISION:** 5
DATE: 2-9-2015	
PREPARED BY: Jamie Moore	
LOCATION: I-40	
PROJECT: Widen for auxiliary lane between NC55 (Exit 278) and NC147 (Exit 279)	



2040 AVERAGE ANNUAL DAILY TRAFFIC

BUILD

SHEET 6 OF 6

LEGEND

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

TIP: I-5707 **WBS:** 50123.1.FS1

COUNTY: Durham **DIVISION:** 5

DATE: 2-9-2015

PREPARED BY: Jamie Moore

LOCATION: I-40

PROJECT: Widen for auxiliary lane between NC55 (Exit 278) and NC147 (Exit 279)

APPENDIX B:

TEAAS STRIP ANALYSIS REPORT

North Carolina Department of Transportation
Traffic Engineering Accident Analysis System
Strip Analysis Report

Study Criteria Summary

County: DURHAM **City:** All and Rural
Date: 04/01/2010 **to** 03/31/2015 **Study:** MW41000035162
Location: Crash analysis on westbound lanes on I 40 from SB on-ramp to NC 55 (Apex Highway) to end of WB on ramp to I 40 from NC 147 (Durham Freeway).

Report Details

Acc No	Crash ID	Milepost	Date	Accident Type	Total Damage	Injuries F	A	B	C	Condition R	L	W	Road Ch	Ci	Trfc Ctl Dv	Op
1	**103896481**	8.290	11/08/2013 18:45	REAR END, SLOW OR STOP	$ 2000	0	0	0	0	1	2	1	1	0	0	
Unit 1 : 4	**Alchl/Drgs:** 0	**Speed:** 10 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 11	**Obj Strk:**											
Unit 2 : 1	**Alchl/Drgs:** 0	**Speed:** 15 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**											
2	**104078478**	8.290	06/11/2014 21:52	SIDESWIPE, SAME DIRECTION	$ 6000	0	0	0	0	2	1	2	1	0	0	
Unit 1 : 1	**Alchl/Drgs:** 0	**Speed:** 60 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**											
Unit 2 : 1	**Alchl/Drgs:** 0	**Speed:** 60 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 5	**Obj Strk:** 46											
3	**104104749**	8.290	06/23/2014 07:11	FIXED OBJECT	$ 2000	0	0	0	0	1	1	1	1	0		
Unit 1 : 12	**Alchl/Drgs:** 0	**Speed:** 60 MPH	**Dir:** E	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:** 33											
4	**104247051**	8.290	12/18/2014 18:51	REAR END, SLOW OR STOP	$ 1300	0	0	0	0	1	5	1	1	0	0	
Unit 1 : 1	**Alchl/Drgs:** 0	**Speed:** 0 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**											
Unit 2 : 1	**Alchl/Drgs:** 0	**Speed:** 0 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**											
Unit 3 : 1	**Alchl/Drgs:** 0	**Speed:** 0 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**											
5	**102891525**	8.300	06/18/2010 11:45	MOVABLE OBJECT	$ 800	0	0	0	0	1	1	1	1	2	0	
Unit 1 : 1	**Alchl/Drgs:** 0	**Speed:** 55 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:** 18											
6	**102891537**	8.300	06/18/2010 11:45	MOVABLE OBJECT	$ 650	0	0	0	0	1	1	1	1	2	0	
Unit 1 : 1	**Alchl/Drgs:** 0	**Speed:** 55 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:** 18											
7	**103507885**	8.300	07/27/2012 17:37	REAR END, SLOW OR STOP	$ 1500	0	0	0	0	1	1	1	1	0	0	
Unit 1 : 4	**Alchl/Drgs:** 0	**Speed:** 65 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 11	**Obj Strk:**											
Unit 2 : 1	**Alchl/Drgs:** 0	**Speed:** 65 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**											
8	**103951897**	8.300	01/13/2014 07:37	MOVABLE OBJECT	$ 2000	0	0	0	0	1	1	1	1	0	0	
Unit 1 : 1	**Alchl/Drgs:** 0	**Speed:** 40 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:** 18											
9	**103693749**	8.310	02/11/2013 00:00	REAR END, SLOW OR STOP	$ 2000	0	0	0	0	2	5	3	1	0		1
Unit 1 : 1	**Alchl/Drgs:** 0	**Speed:** 50 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 11	**Obj Strk:**											

Acc No	Crash ID	Milepost	Date	Accident Type	Total Damage	Injuries F	A	B	C	Condition R	L	W	Road Ch	Ci	Trfc Ctl Dv	Op
Unit	**2 :** 32	**Alchl/Drgs:**	7	**Speed:** 0 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				16			**Obj Strk:**			
10	**103161071**	8.370	05/20/2011 18:41	REAR END, SLOW OR STOP	$ 1000	0	0	0	0	1	1	1	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:**	0	**Speed:** 20 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**			
Unit	**2 :** 2	**Alchl/Drgs:**	0	**Speed:** 30 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**			
11	**103196498**	8.370	07/08/2011 16:06	REAR END, SLOW OR STOP	$ 3000	0	0	0	0	2	1	3	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:**	0	**Speed:** 15 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				11			**Obj Strk:**			
Unit	**2 :** 1	**Alchl/Drgs:**	0	**Speed:** 15 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**			
12	**103293768**	8.370	11/04/2011 19:21	REAR END, SLOW OR STOP	$ 3000	0	0	0	0	2	4	3	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:**	0	**Speed:** 30 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**			
Unit	**2 :** 4	**Alchl/Drgs:**	0	**Speed:** 30 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**			
13	**103369663**	8.370	01/27/2012 19:00	REAR END, SLOW OR STOP	$ 30750	0	0	0	2	1	5	1	1	0	0	
Unit	**1 :** 4	**Alchl/Drgs:**	0	**Speed:** 15 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				1			**Obj Strk:**			
Unit	**2 :** 2	**Alchl/Drgs:**	0	**Speed:** 35 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				1			**Obj Strk:**			
Unit	**3 :** 1	**Alchl/Drgs:**	0	**Speed:** 40 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**			
Unit	**4 :** 4	**Alchl/Drgs:**	0	**Speed:** 40 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**			
14	**103776400**	8.370	06/14/2013 17:01	REAR END, SLOW OR STOP	$ 6000	0	0	0	0	1	1	1	1	0	0	
Unit	**1 :** 4	**Alchl/Drgs:**	0	**Speed:** 45 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				11			**Obj Strk:**			
Unit	**2 :** 1	**Alchl/Drgs:**	0	**Speed:** 45 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**			
15	**104309802**	8.370	02/04/2015 20:30	REAR END, SLOW OR STOP	$ 8000	0	0	0	0	1	5	1	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:**	0	**Speed:** 60 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**			
Unit	**2 :** 2	**Alchl/Drgs:**	0	**Speed:** 50 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**			
16	**104050178**	8.400	01/04/2014 11:01	OTHER NON-COLLISION	$ 500	0	0	0	0	1	1	1	3	0	0	
Unit	**1 :** 1	**Alchl/Drgs:**	0	**Speed:** 65 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**			
17	**103606664**	8.415	11/20/2012 18:59	SIDESWIPE, SAME DIRECTION	$ 1000	0	0	0	0	1	2	1	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:**	0	**Speed:** 45 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**			
Unit	**2 :** 1	**Alchl/Drgs:**	7	**Speed:** 45 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				5			**Obj Strk:**			
18	**104046613**	8.450	04/30/2014 07:52	RAN OFF ROAD - LEFT	$ 4500	0	0	0	0	2	1	2	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:**	0	**Speed:** 68 MPH **Dir:** W		**Veh Mnvr/Ped Actn:**				4			**Obj Strk:**		48	

Acc No	Crash ID	Milepost	Date	Accident Type	Total Damage	Injuries F	A	B	C	Condition R	L	W	Road Ch	Ci	Trfc Ctl Dv	Op
19	**104059090**	8.453	05/13/2014 17:23	REAR END, SLOW OR STOP	$ 5000	0	0	0	0	1	1	1	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:** 0	**Speed:** 50 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**										
Unit	**2 :** 12	**Alchl/Drgs:** 7	**Speed:** 50 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**										
20	**104200270**	8.480	10/31/2014 18:07	REAR END, SLOW OR STOP	$ 600	0	0	0	0	1	4	1	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:** 0	**Speed:** 55 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 11	**Obj Strk:**										
Unit	**2 :** 1	**Alchl/Drgs:** 0	**Speed:** 55 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**										
21	**104146186**	8.500	09/04/2014 19:30	REAR END, SLOW OR STOP	$ 1400	0	0	0	0	2	1	1	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:** 0	**Speed:** 30 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 11	**Obj Strk:**										
Unit	**2 :** 1	**Alchl/Drgs:** 0	**Speed:** 30 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 11	**Obj Strk:**										
Unit	**3 :** 1	**Alchl/Drgs:** 0	**Speed:** 30 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**										
22	**104053090**	8.501	05/11/2014 14:10	REAR END, SLOW OR STOP	$ 5500	0	0	0	0	1	1	1	1	0	0	
Unit	**1 :** 4	**Alchl/Drgs:** 0	**Speed:** 65 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 11	**Obj Strk:**										
Unit	**2 :** 1	**Alchl/Drgs:** 0	**Speed:** 65 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 11	**Obj Strk:**										
23	**103009908**	8.520	11/05/2010 16:50	REAR END, SLOW OR STOP	$ 1200	0	0	0	0	1	1	1	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:** 0	**Speed:** 20 MPH	**Dir:** E	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**										
Unit	**2 :** 1	**Alchl/Drgs:** 7	**Speed:** 30 MPH	**Dir:** E	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**										
24	**102940951**	8.540	08/16/2010 18:07	REAR END, SLOW OR STOP	$ 7500	0	0	0	0	1	1	1	1	0	0	
Unit	**1 :** 4	**Alchl/Drgs:** 7	**Speed:** 0 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 2	**Obj Strk:**										
Unit	**2 :** 2	**Alchl/Drgs:** 0	**Speed:** 25 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 11	**Obj Strk:**										
Unit	**3 :** 1	**Alchl/Drgs:** 7	**Speed:** 65 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**										
25	**103936704**	8.540	12/23/2013 16:11	SIDESWIPE, SAME DIRECTION	$ 3400	0	0	0	0	2	1	3	1	0	0	
Unit	**1 :** 4	**Alchl/Drgs:** 0	**Speed:** 60 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**										
Unit	**2 :** 1	**Alchl/Drgs:** 0	**Speed:** 65 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 5	**Obj Strk:**										
Unit	**3 :** 2	**Alchl/Drgs:** 0	**Speed:** 65 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**										
26	**104016594**	8.652	03/26/2014 18:28	REAR END, SLOW OR STOP	$ 5000	0	0	0	0	1	1	1	1	0	0	
Unit	**1 :** 4	**Alchl/Drgs:** 0	**Speed:** 0 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**										
Unit	**2 :** 4	**Alchl/Drgs:** 0	**Speed:** 0 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**										
27	**103288062**	8.678	10/28/2011 07:04	MOVABLE OBJECT	$ 4000	0	0	0	1	1	1	1	1	2	0	
Unit	**1 :** 1	**Alchl/Drgs:** 0	**Speed:** 65 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 5	**Obj Strk:** 18										

North Carolina Department of Transportation
Traffic Engineering Accident Analysis System
Strip Analysis Report

Acc No	Crash ID	Milepost	Date	Accident Type	Total Damage	Injuries F	A	B	C	Condition R	L	W	Road Ch	Ci	Trfc Ctl Dv	Op
28	**102875780**	8.681	05/31/2010 22:45	MOVABLE OBJECT	$ 1000	0	0	0	0	1	5	2	1	2	0	
Unit	**1 :** 1	**Alchl/Drgs:** 0	**Speed:** 65 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:** 18										
29	**103047059**	8.681	12/11/2010 04:43	RAN OFF ROAD - RIGHT	$ 6000	1	1	1	1	1	5	1	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:** 1	**Speed:** 113 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:** 37										
30	**103326745**	8.681	12/08/2011 19:08	REAR END, SLOW OR STOP	$ 3000	0	0	0	0	1	4	1	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:** 0	**Speed:** 0 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 1	**Obj Strk:**										
Unit	**2 :** 1	**Alchl/Drgs:** 0	**Speed:** 40 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:**										
31	**103733871**	8.681	04/24/2013 08:57	FIXED OBJECT	$ 6800	0	0	0	0	1	1	1	3	0	0	
Unit	**1 :** 1	**Alchl/Drgs:** 0	**Speed:** 55 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 5	**Obj Strk:** 41										
32	**103781050**	8.681	06/15/2013 18:59	PARKED MOTOR VEHICLE	$ 4500	0	0	1	0	1	1	1	1	0	0	
Unit	**1 :** 5	**Alchl/Drgs:** 7	**Speed:** 0 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 3	**Obj Strk:** 20										
Unit	**2 :** 4	**Alchl/Drgs:** 0	**Speed:** 55 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 4	**Obj Strk:** 20										
33	**103909290**	8.681	11/22/2013 19:07	SIDESWIPE, SAME DIRECTION	$ 2000	0	0	0	0	1	5	1	1	0	0	
Unit	**1 :** 1	**Alchl/Drgs:** 0	**Speed:** 50 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 5	**Obj Strk:**										
Unit	**2 :** 12	**Alchl/Drgs:** 0	**Speed:** 50 MPH	**Dir:** W	**Veh Mnvr/Ped Actn:** 5	**Obj Strk:**										

Legend for Report Details:

Acc No - Accident Number
Injuries: F - Fatal, A - Class A, B - Class B, C - Class C
Condition: R - Road Surface, L - Ambient Light, W - Weather
Rd Ch - Road Character
Rd Ci - Roadway Contributing Circumstances
Trfc Ctl - Traffic Control: Dv - Device, Op - Operating
Alchl/Drgs - Alcohol Drugs Suspected
Veh Mnvr/Ped Actn - Vehicle Maneuver/Pedestrian Action
Obj Strk - Object Struck

Summary Statistics

High Level Crash Summary

Crash Type	Number of Crashes	Percent of Total
Total Crashes	33	100.00
Fatal Crashes	1	3.03
Non-Fatal Injury Crashes	3	9.09
Total Injury Crashes	4	12.12
Property Damage Only Crashes	29	87.88
Night Crashes	10	30.30
Wet Crashes	7	21.21
Alcohol/Drugs Involvement Crashes	1	3.03

Crash Severity Summary

Crash Type	Number of Crashes	Percent of Total
Total Crashes	33	100.00
Fatal Crashes	1	3.03
Class A Crashes	0	0.00
Class B Crashes	1	3.03
Class C Crashes	2	6.06
Property Damage Only Crashes	29	87.88

Vehicle Exposure Statistics

Annual ADT = 59500

Total Length = 0.391 (Miles) **0.629 (Kilometers)**

Total Vehicle Exposure = 42.48 (MVMT) **68.37 (MVKMT)**

Crash Rate	Crashes Per 100 Million Vehicle Miles	Crashes Per 100 Million Vehicle Kilometers
Total Crash Rate	77.68	48.27
Fatal Crash Rate	2.35	1.46
Non Fatal Crash Rate	7.06	4.39
Night Crash Rate	23.54	14.63
Wet Crash Rate	16.48	10.24
EPDO Rate	308.37	191.61

Miscellaneous Statistics

Severity Index =	3.97
EPDO Crash Index =	131.00
Estimated Property Damage Total = $	132900.00

Accident Type Summary

Accident Type	Number of Crashes	Percent of Total
FIXED OBJECT	2	6.06
MOVABLE OBJECT	5	15.15
OTHER NON-COLLISION	1	3.03
PARKED MOTOR VEHICLE	1	3.03
RAN OFF ROAD - LEFT	1	3.03
RAN OFF ROAD - RIGHT	1	3.03
REAR END, SLOW OR STOP	18	54.55
SIDESWIPE, SAME DIRECTION	4	12.12

Injury Summary

Injury Type	Number of Injuries	Percent of Total
Fatal Injuries	1	12.50
Class A Injuries	1	12.50
Class B Injuries	2	25.00
Class C Injuries	4	50.00
Total Non-Fatal Injuries	7	87.50
Total Injuries	8	100.00

Monthly Summary

Month	Number of Crashes	Percent of Total
Jan	3	9.09
Feb	2	6.06
Mar	1	3.03
Apr	2	6.06
May	4	12.12
Jun	6	18.18
Jul	2	6.06
Aug	1	3.03
Sep	1	3.03
Oct	2	6.06
Nov	5	15.15
Dec	4	12.12

Daily Summary

Day	Number of Crashes	Percent of Total
Mon	6	18.18
Tue	2	6.06
Wed	5	15.15
Thu	3	9.09
Fri	13	39.39
Sat	3	9.09
Sun	1	3.03

Hourly Summary

Hour	Number of Crashes	Percent of Total
0000-0059	1	3.03
0100-0159	0	0.00
0200-0259	0	0.00
0300-0359	0	0.00
0400-0459	1	3.03
0500-0559	0	0.00
0600-0659	0	0.00
0700-0759	4	12.12
0800-0859	1	3.03
0900-0959	0	0.00
1000-1059	0	0.00
1100-1159	3	9.09
1200-1259	0	0.00
1300-1359	0	0.00
1400-1459	1	3.03
1500-1559	0	0.00
1600-1659	3	9.09
1700-1759	3	9.09
1800-1859	8	24.24
1900-1959	5	15.15
2000-2059	1	3.03
2100-2159	1	3.03
2200-2259	1	3.03
2300-2359	0	0.00

Light and Road Conditions Summary

Condition	Dry	Wet	Other	Total
Day	16	5	0	21
Dark	8	2	0	10
Other	2	0	0	2
Total	26	7	0	33

Object Struck Summary

Object Type	Times Struck	Percent of Total
GUARDRAIL END ON SHOULDER	1	8.33
MEDIAN BARRIER FACE	1	8.33
MOVABLE OBJECT	5	41.67
OFFICIAL HIGHWAY SIGN NON-BREAKAWAY	1	8.33
PARKED MOTOR VEHICLE	2	16.67
SHOULDER BARRIER FACE	1	8.33
TREE	1	8.33

Vehicle Type Summary

Vehicle Type	Number Involved	Percent of Total
PASSENGER CAR	40	64.52
PICKUP	5	8.06
SPORT UTILITY	12	19.35
TRUCK/TRAILER	3	4.84
UNKNOWN	1	1.61
VAN	1	1.61

Yearly Totals Summary

Accident Totals

Year	Total Accidents	Fatal Accidents	Injury Accidents	Property Damage Only Accidents
2010	6	1	0	5
2011	5	0	1	4
2012	3	0	1	2
2013	7	0	1	6
2014	11	0	0	11
2015	1	0	0	1
Total	33	1	3	29

Injury Totals

Year	Fatal Injuries	Class A, B, or C Injuries
2010	1	3
2011	0	1
2012	0	2
2013	0	1
2014	0	0
2015	0	0
Total	1	7

Miscellaneous Totals

Year	Property Damage	EPDO Index
2010	$ 17150	81.80
2011	$ 14000	12.40
2012	$ 33250	10.40
2013	$ 26700	14.40
2014	$ 33800	11.00
2015	$ 8000	1.00
Total	$ 132900	131.00

Type of Accident Totals

Year	Left Turn	Right Turn	Rear End	Run Off Road & Fixed Object	Angle	Side Swipe	Other
2010	0	0	2	1	0	0	3
2011	0	0	4	0	0	0	1
2012	0	0	2	0	0	1	0

Year	Left Turn	Right Turn	Rear End	Run Off Road & Fixed Object	Angle	Side Swipe	Other
2013	0	0	3	1	0	2	1
2014	0	0	6	2	0	1	2
2015	0	0	1	0	0	0	0
Total	0	0	18	4	0	4	7

Strip Diagram

Features	Milepost	Crash IDs
WB EXIT RAMP TO NC 55 S | BEGIN	8.29	103896481 | 104078478 | 104104749 | 104247051
	8.30	102891525 | 102891537 | 103507885 | 103951897
	8.31	103693749
STRUCTURE: 310292 | STRUCTURE: 310291	8.32	
	8.33	
	8.34	
	8.35	
	8.36	
	8.37	103161071 | 103196498 | 103293768 | 103369663 | 103776400 | 104309802
	8.38	
	8.39	
	8.40	104050178
	8.41	103606664
	8.42	
	8.43	
	8.44	
	8.45	104046613 | 104059090
	8.46	
	8.47	
	8.48	104200270
	8.49	
	8.50	104146186 | 104053090
STRUCTURE: 310294 | STRUCTURE: 310293 | SR 1945 | ALSTON	8.51	
	8.52	103009908
	8.53	
	8.54	102940951 | 103936704
	8.55	
	8.56	
	8.57	
	8.58	
	8.59	
	8.60	
	8.61	
	8.62	
	8.63	
	8.64	
	8.65	104016594
	8.66	
	8.67	
WB ON-RAMP FROM NC 147 | END	8.68	103288062 | 102875780 | 103047059 | 103326745 | 103733871 | 103781050 | 103909290

Study Criteria

Study Name	Log No.	PH No.	TIP No.	K/A Cf.	B/C Cf.	ADT	ADT Route
MW41000035162	41000035162			76.8	8.4	59500	10000040

Request Date	Courier Service	Phone No.	Ext.	Fax No.
04/10/2015		919 707 6020		

County			Municipality					
Name	Code	Div.	Name	Code	Y-Line Ft.	Begin Date	End Date	Years
DURHAM	31	5	All and Rural		0	04/01/2010	03/31/2015	5.00

Location Text

Crash analysis on westbound lanes on I 40 from SB on-ramp to NC 55 (Apex Highway) to end of WB on ramp to I 40 from NC 147 (Durham Freeway).

Requestor

Theresa Ellerby
NCDOT
PDEA

Included Accidents	Old MP	New MP	Type
104309802		8.37	I
104247051		8.29	I
104200270		8.48	I
104146186		8.5	I
104104749		8.29	I
104078478		8.29	I
104059090		8.453	I
104053090		8.501	I
104050178		8.4	I
104046613		8.45	I
104016594		8.652	I
103951897		8.3	I
103936704		8.54	I
103909290		8.681	I
103896481		8.29	I
103781050		8.681	I
103776400		8.37	I
103733871		8.681	I
103693749		8.31	I
103606664		8.415	I
103507885		8.3	I
103369663		8.37	I
103326745		8.681	I
103293768		8.37	I
103288062		8.678	I
103196498		8.37	I

103161071	8.37	I
103047059	8.681	I
103009908	8.52	I
102940951	8.54	I
102891537	8.3	I
102891525	8.3	I
102875780	8.681	I

Fiche Roads

Name	Code
I 1	10000001
I 40	10000040

Strip Road

Name	Code	Begin MP	End MP	Miles	Kilometers
I 1	10000001	8.290	8.681	0.391	0.629

PATRIOT TRANSPORTATION ENGINEERING, PLLC

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NC LICENSE # P-1173

PATRIOT
TRANSPORTATION
ENGINEERING, PLLC