REPORT

APRIL 2025

Capital Boulevard (US 1) Traffic and Revenue Study

Prepared for:

NORTH CAROLINA Turnpike Authority

North Carolina
Department of Transportation

CAMPO
NC Capital Area Metropolitan Planning Organization

CDM Smith

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1.0 Introduction

This report documents the ***Capital Boulevard Planning Level Traffic and Revenue Study*** conducted for the North Carolina Turnpike Authority (NCTA), North Carolina Department of Transportation (NCDOT) and the North Carolina Capital Area Metropolitan Planning Organization (CAMPO). This planning level study was designed to develop traffic and toll revenue (T&R) estimates associated with tolling Capital Boulevard (US 1) between I-540 north of Raleigh and Purnell Road in Wake Forest subsequent to planned future roadway improvements including capacity increases and conversion to a controlled access highway associated with NCDOT project U-5307. The results of the study include long-term T&R forecasts for this project under two distinct tolling methods:

1) As an expressway with all lanes tolled
2) As an express toll lanes project only tolling new capacity

The T&R forecasts presented in this study are intended for planning purposes only. A comprehensive T&R study including a more extensive independent review of socio-demographic assumptions in the regional travel demand model and stated preference surveys to assess value of time would be required for a forecast to be suitable for use in support of project financing.

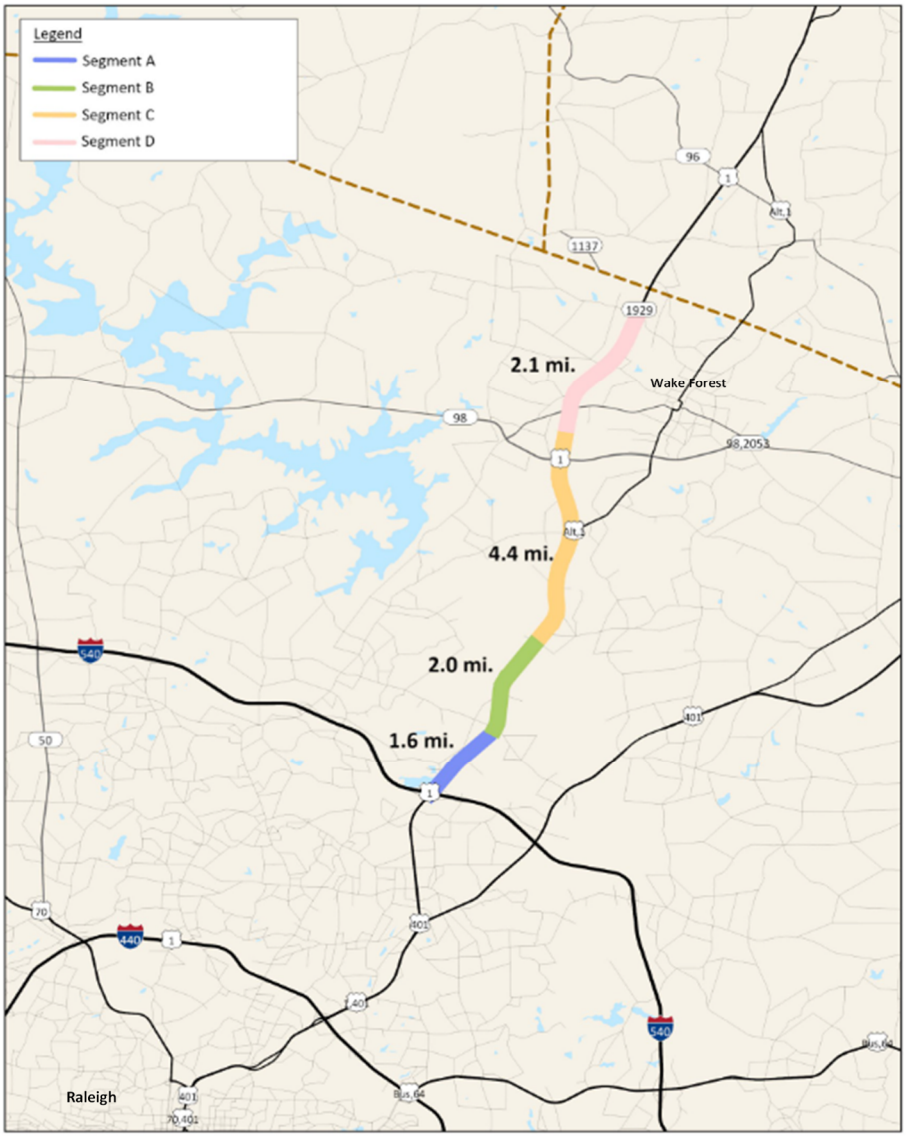
1.1 Project Description

Figure 1.1 shows the location and alignment of the existing Capital Boulevard along with the segmentation assumed for planned future improvements associated with U-5307.

- Segment A extends from I-540 to Perry Creek Road/Durant Road
- Segment B extends from Perry Creek Road/Durant Road to Burlington Mills Road
- Segment C from Burlington Mills Road to south of Durham Road
- Segment D from south of Durham Road to Purnell Road/Harris Road

Each segment is planned to have one additional lane constructed in each travel direction. Additionally, the current configuration of median-divided roadway with partial access control is planned to be converted to controlled-access highway with six new interchanges, and posted speed of 65 mph. These improvements are intended to improve congestion and travel times on Capital Boulevard and are currently listed in the NCDOT 2024-2033 State Transportation Improvement Program (STIP) and CAMPO 2050 Metropolitan Transportation Plan (MTP) as non-tolled projects. The T&R forecasts presented in this study are intended to assist NCDOT and NCTA in their evaluation of tolling as a potential way to accelerate delivery of the proposed Capital Boulevard upgrades.

Figure 1.1 Capital Boulevard Project Location Map



1.2 Report Structure

This report consists of the following five chapters.

Chapter 1: Introduction

Chapter 1 describes the purpose of the study, provides a description of the project, the work scope, and the structure of the report.

Chapter 2: Existing Conditions

Chapter 2 presents information regarding the existing conditions on Capital Boulevard and other roads in the study area. Information provided includes average weekday traffic volumes, travel patterns, travel times, and historical traffic growth in the study area.

Chapter 3: Independent Economic Review

Chapter 3 summarizes the work of the independent economist, Dr. Stephen Appold, who reviewed socioeconomic assumptions in the Triangle Regional Model Generation 2 (TRMG2), and created revised socioeconomic inputs, including population, number of households and employment, for each of the supported model years. The revised socioeconomic inputs to the TRMG2 are summarized and the changes are compared to the original inputs. In addition, Dr. Appold developed a set of socioeconomic inputs to the TRMG2 to create a base model year 2023 for calibration purposes. This chapter describes the process Dr. Appold used to develop the 2023 socioeconomic dataset. A summary of Dr. Appold's methodology is provided in his report ***How the baseline 2023 socio-economic estimates and 2030, 2040, and 2050 projections were generated for the U.S. 1 improvement project (January 2025)***, which is attached to this report as **Appendix A**.

Chapter 4: Model Development

Chapter 4 describes the TRMG2 and modifications made to the model by CDM Smith including: (1) the model calibration process and calibration metrics; (2) network refinements including planned roadway improvement assumptions; (3) updates to key modeling inputs and assumptions such as motorist value of time (VOT), vehicle operating cost (VOC) and inflation; and (4) window model adjustments for the tolled express lane scenario.

Chapter 5: Traffic and Toll Revenue Forecast

Chapter 5 presents annual traffic and gross toll revenue forecasts that were developed for the expressway and express lane scenarios. Net revenue was subsequently developed to incorporate adjustments reflecting expected toll revenue leakage and fee revenue. Estimated rates of revenue leakage and fee revenue were based on actual experience from the Triangle Expressway and Monroe Expressway.

2.0 Existing Conditions

This Chapter describes existing and historical conditions on Capital Boulevard and selected roads in the study area including lane counts, segment distances, traffic volumes, travel speeds and travel patterns. The data in this chapter was used to validate TRMG2 against observed 2023 traffic conditions.

2.1 Capital Boulevard

Figure 2.1 shows the current configuration of the 10.1-mile segment of Capital Boulevard that extends from I-540 north of Raleigh to Purnell Road in Wake Forest, including number of lanes per direction and the location of traffic signals.

There are three-lanes in each direction on Capital Boulevard, between I-540 to Perry Creed Road. The posted speed limit is 55 mph and there are 3 signalized intersections on this section of the corridor. There are 4 signalized intersections between Perry Creek Road and Falls of Neuse Road where the corridor has two lanes in each direction. The number of lanes returns to three in each direction between Falls of Neuse Road and Dr. Calvin Jones Hwy (NC 98 Business) with two signalized intersections, while maintaining the speed limit at 55 mph. The corridor then continues as a two-lane roadway in each direction between NC 98 Business and Purnell Road, with 3 signalized intersections.

2.1.1 Traffic Volume Data Collection

Traffic counts for this study were obtained primarily from the NCDOT Transportation Data Management System (TDMS) traffic count database. NCDOT TDMS counts within the study area were collected in 2021, 2022, or 2023. Counts from 2021 and 2022 were factored to estimated 2023 levels by applying growth and seasonal adjustments which were calculated using the best available continuous count station data from January 2023 to February 2024.

CDM Smith engaged The Traffic Group (TTG) as a sub-consultant to collect traffic counts at selected locations throughout the corridor where TDMS counts were not available. TTG counts were collected in Spring 2023. TTG provided count data at 19 of the 40 locations utilized in the study. Counts were collected in 15-minute increments for three consecutive weekdays (Tuesday, Wednesday, Thursday) for the screenline locations. A seven-day count including weekends was conducted for one location on US 1 north of Burlington Mills Road. Traffic count locations used for model validation are shown in **Figure 2.2** and traffic count volumes are provided in **Table 2.1**.

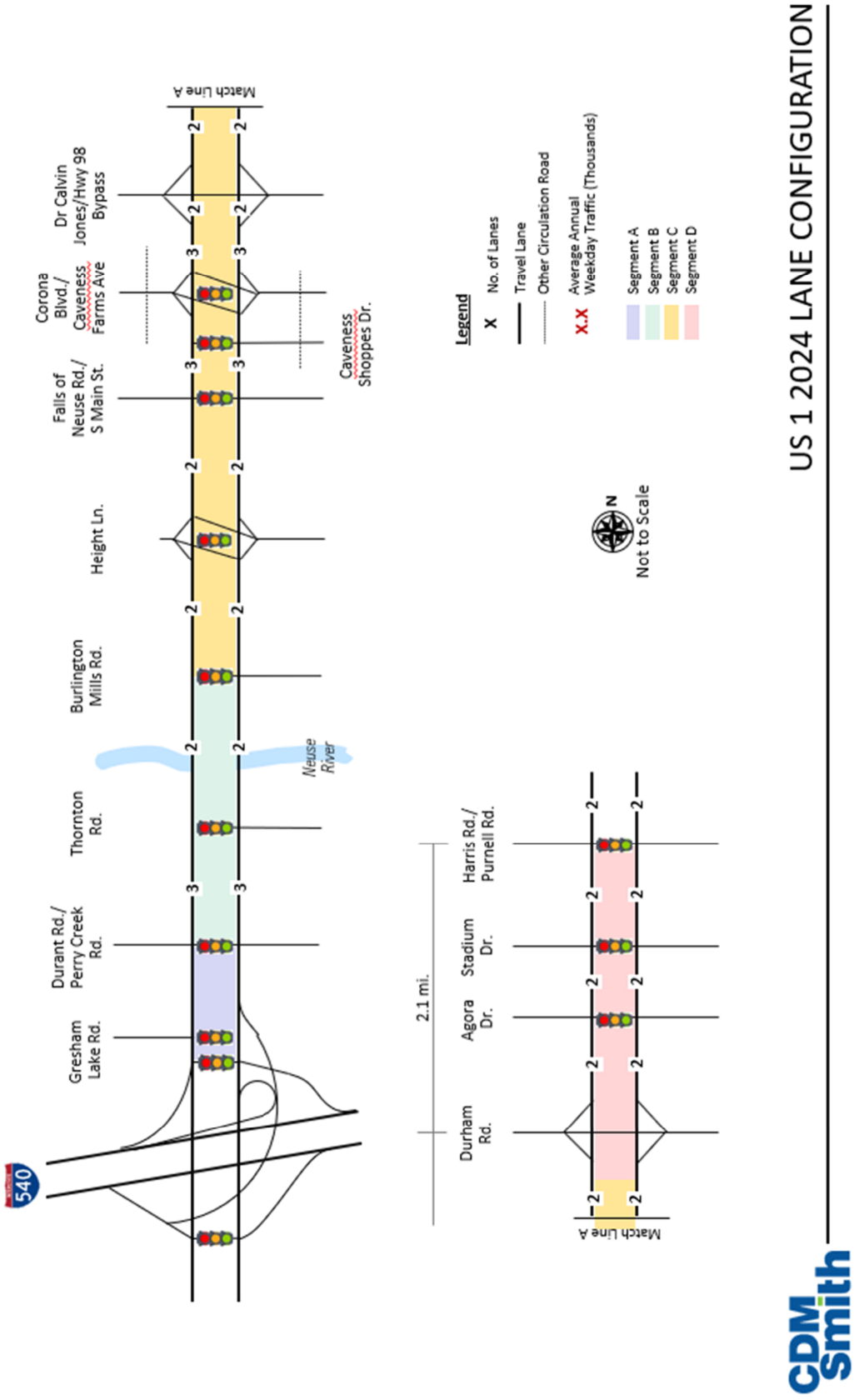


Figure 2.1 Current Configuration

Figure 2.2 Traffic Count Locations by Screenline

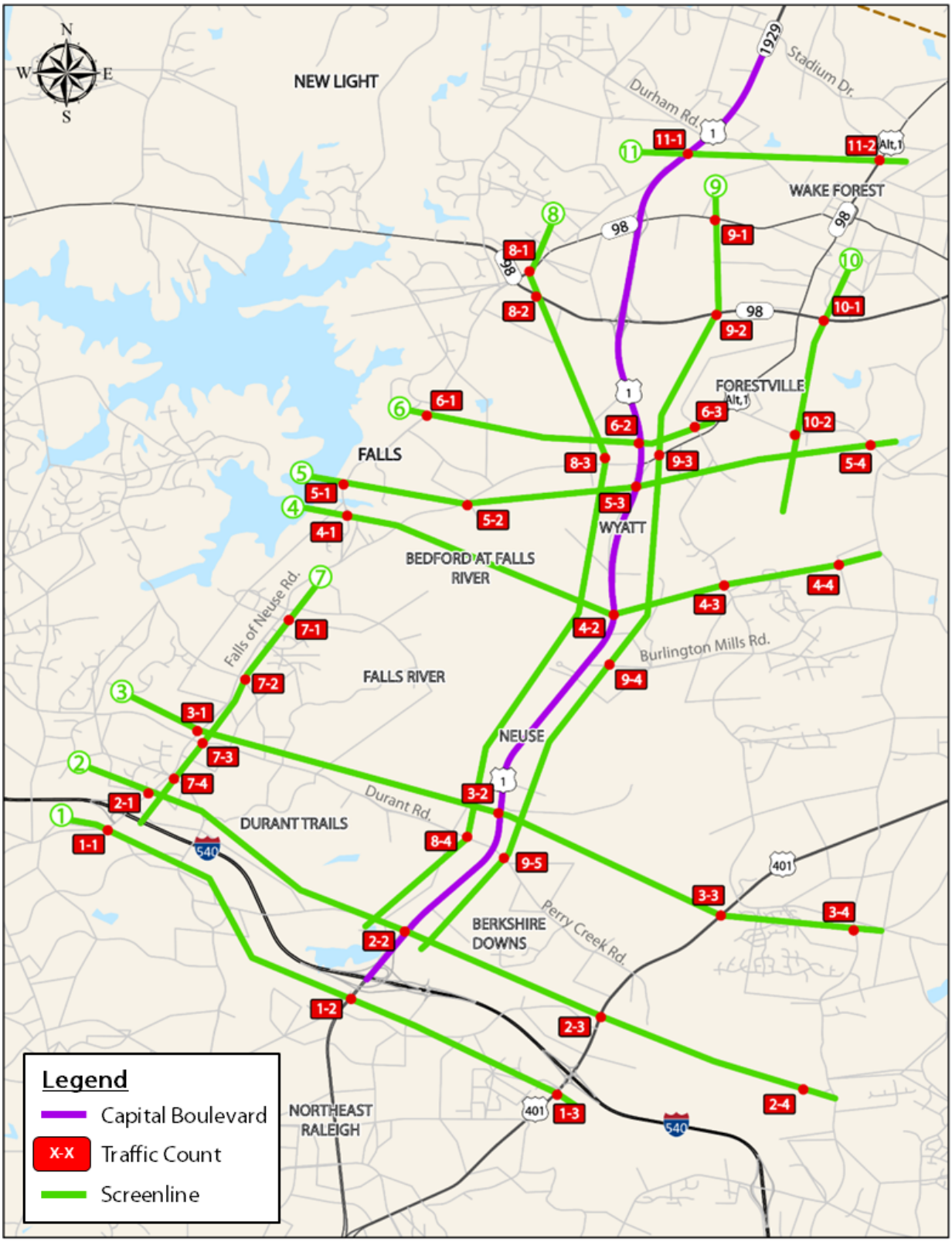


Table 2.1 Summary of 2023 Average Weekday Traffic Volumes at Screenline Locations

Location ID	Count Location	AM (7:00 AM - 9:00 AM)	MD (9:00 AM - 3:30 PM)	PM (3:30 PM - 6:30 PM)	NT (6:30 PM - 7:00 AM)	Avgerage Weekday Traffic
Screenline 1: South of I-540						
1-1	SR 2000 (Falls Of Neuse Rd)	4,500	12,700	6,900	7,900	32,000
1-2	US 1	8,700	23,100	14,100	18,400	64,300
1-3	US 401	7,300	15,500	10,800	13,900	47,500
Screenline 2: North of I-540						
2-1	SR 2000 (Falls Of Neuse Rd)	6,200	16,300	10,900	13,300	46,700
2-2	US 1 N of Gresham Lake Rd	10,600	27,900	16,700	24,000	79,200
2-3	US 401	8,700	18,100	13,400	18,300	58,500
2-4	Forestville Rd S of Granite Ridge Tr	1,700	3,400	2,800	3,500	11,400
Screenline 3: North of Durant/ Perry Creek Rd						
3-1	SR 2000 (Falls Of Neuse Rd)	5,100	12,300	8,800	10,300	36,500
3-2	US 1	8,100	19,800	11,500	14,800	54,200
3-3	US 401	8,700	17,900	13,700	17,600	57,900
3-4	SR 2049 (Forestville Rd)	1,900	3,200	3,000	3,100	11,200
Screenline 4: North of Burlington Mills Rd						
4-1	Falls of Neuse Rd At Neuse River	4,600	9,400	6,800	8,200	29,000
4-2	US 1 S of Lois Lane	7,400	20,000	11,400	16,300	55,100
4-3	Ligon Mill Rd S of Song Sparrow Dr	1,800	3,600	2,700	2,300	10,400
4-4	Forestville Rd S of Pine Valley Dr	2,800	6,800	4,700	5,000	19,300
Screenline 5: South of Falls of Neuse Rd						
5-1	NC 98 BUS	2,100	4,400	3,600	3,100	13,200
5-2	Falls of Neuse Rd W of Spruce Tree Way	4,200	9,300	6,500	8,000	28,000
5-3	US 1	6,400	15,900	9,200	12,500	44,000
5-4	Heritage Lake Rd S of Heritage Club Ave	2,600	6,600	4,400	4,100	17,700
Screenline 6: North of Falls of Neuse Rd/ Alt US 1						
6-1	SR 2000 (Old Falls Of Neuse Rd)	2,500	5,200	4,300	3,700	15,700
6-2	US 1 N of S Main St	6,900	19,000	11,000	15,700	52,600
6-3	Ligon Mill Rd N of S Main St	1,600	5,100	3,300	3,100	13,100
Screenline 7: East of Falls of Neuse Rd						
7-1	I-540 E of Falls of Neuse Rd	11,700	28,900	21,800	25,900	88,300
7-2	SR 2012 (Litchford Rd)	1,700	4,800	3,000	3,200	12,700
7-3	SR 2006 (Durant Rd)	2,500	7,200	4,400	3,700	17,800
7-4	SR 2002 (Raven Ridge Rd)	1,000	2,100	1,500	1,200	5,800
7-5	Dunn Rd E of Falls of Neuse Rd	1,300	3,200	2,200	2,800	9,500
Screenline 8: West of US 1						
8-1	SR 2006 (Durant Rd)	2,600	5,900	3,900	4,000	16,400
8-2	Falls Of Neuse Rd	3,800	9,800	5,500	6,400	25,500
8-3	NC 98 BUS	1,700	5,100	3,600	3,700	14,100
8-4	NC 98	3,400	7,700	5,600	5,500	22,200
Screenline 9: East of US 1						
9-1	SR 2006 (Perry Creek Rd)	3,500	6,900	5,900	7,100	23,400
9-2	Burlington Mills Rd E of US 1	1,900	5,200	3,100	4,200	14,400
9-3	US 1 Alt	3,600	10,300	6,000	6,700	26,600
9-4	NC 98	3,400	13,300	5,700	8,000	30,400
9-5	Durham Rd E of Hope St	1,700	4,200	2,900	2,700	11,500
Screenline 10: East of Alt US 1						
10-1	SR 2052 (Rogers Rd)	3,500	9,500	5,600	5,600	24,200
10-2	NC 98	3,900	10,500	7,200	6,200	27,800
Screenline 11: North of Durham Rd						
11-2	W Cedar Ave	1,500	3,200	2,400	2,100	9,200
11-1	US 1	6,200	17,000	9,800	13,200	46,200

2.1.2 Historical Traffic Growth in Study Area

Historical average annual daily traffic (AADT) for locations throughout the Durham and Franklin County area from the NCDOT TDMS website was used to analyze historical growth trends in the study area. **Table 2.2** provides AADT at four locations on Capital Boulevard for 2014 through 2023. **Table 2.3** provides AADT for the same years for Falls of Neuse Road, Ligon Mill Road, Forestville Road, and NC 98.

Average annual growth rates in AADT varied significantly in the study area ranging between 0.1 percent and 8.6 percent annually from 2014 through the pre-pandemic year of 2019. The highest growth was observed on NC 98 south of Durham Road and west of Salem Drive, and on Falls of Neuse Road north of Raven Ridge Road, which aligns with housing and population growth trends in the area. US 1 count locations south of US 1 Alternative and north of Durant Road grew the least over this period, at 0.1 and 0.5 percent per year, respectively, as these are in more densely populated and commercialized areas of the city with less growth potential. All locations experienced significant declines in traffic in 2020 due to the COVID-19 pandemic. Since that time, traffic on segment A and D on Capital Boulevard has recovered and exceeded 2019 AADT, while 2023 AADT on segments B and C had not yet returned to 2019 levels. For the entire ten-year period, average annual growth for all locations was in the range of -0.5 to 5.1 percent, with the highest growth on Falls of Neuse Road north of Raven Ridge Road.

Table 2.2 Average Annual Daily Traffic Volumes (In thousands) on US 1

Calendar Year	Segment A		Segment B		Segment C				Segment D	
	North of Gresham Lake Rd		North of Durant Rd		South of US 1 Alt		South of NC 98		North of Wake Union Church Rd	
	AADT	Growth	AADT	Growth	AADT	Growth	AADT	Growth	AADT	Growth
2014	-		57,055		46,839		43,967		41,105	
2015	60,788	-	55,876	-2.1	47,935	2.3	45,907	4.4	44,194	7.5
2016	62,908	3.5	57,825	3.5	49,607	3.5	47,508	3.5	45,735	3.5
2017	62,665	-0.4	53,752	-7.0	48,165	-2.9	46,555	-2.0	45,590	-0.3
2018	62,460	-0.3	53,576	-0.3	48,007	-0.3	46,403	-0.3	45,441	-0.3
2019	64,191	2.8	58,444	9.1	47,052	-2.0	48,677	4.9	46,376	2.1
2020	54,374	-15.3	49,506	-15.3	39,856	-15.3	41,784	-14.2	38,918	-16.1
2021	65,131	19.8	51,191	3.4	45,313	13.7	48,554	16.2	41,145	5.7
2022	68,974	5.9	54,211	5.9	47,986	5.9	51,419	5.9	43,573	5.9
2023	71,112	3.1	54,893	1.3	44,606	-7.0	49,050	-4.6	47,332	8.6
Compound Annual Growth Rate										
2014-2019[(1)]		1.4		0.5		0.1		2.1		2.4
2019-2023		2.6		-1.6		-1.3		0.2		0.5
2014-2023[(1)]		2.0		-0.4		-0.5		1.2		1.6

Source: https://ncdot.public.ms2soft.com/tcds/tsearch.asp?loc=Ncdot&mod=TCDS

(1) CAGR shown for segment A begins in 2015 due to data availability.

Table 2.3 – Average Annual Daily Traffic Volumes (In thousands) on Arterials

Calendar Year	Falls of Neuse Rd				Ligon Mill Rd				Forestville Rd				NC 98			
	North of Falls Valley Dr		North of Raven Ridge		South of Greenville Loop Rd		South of Wake Dr		South of Rogers Rd		North of Trentini Ave		West of Salem Dr		South of Durham Rd	
	AADT	Growth	AADT	Growth	AADT	Growth	AADT	Growth	AADT	Growth	AADT	Growth	AADT	Growth	AADT	Growth
2014	44,805		30,904		7,988		8,124		11,787		14,325		23,967		14,757	
2015	47,303	5.6	38,468	24.5	8,864	11.0	8,550	-	12,065	2.4	14,663	2.4	31,141	29.9	18,635	26.3
2016	49,037	3.7	39,878	3.7	9,188	3.7	8,863	3.5	12,507	3.7	15,200	3.7	32,227	3.5	19,285	3.5
2017	48,439	-1.2	42,036	5.4	9,696	5.5	10,628	-0.4	13,306	6.4	14,382	-5.4	29,994	-6.9	19,329	0.2
2018	48,856	0.9	42,398	0.9	9,779	0.9	10,719	-0.3	13,420	0.9	14,506	0.9	29,896	-0.3	19,265	-0.3
2019	50,340	3.0	43,774	3.2	9,480	-3.1	9,418	2.8	13,815	2.9	16,198	11.7	33,131	10.8	22,304	15.8
2020	40,073	-20.4	37,079	-15.3	8,030	-15.3	7,978	-15.3	12,784	-7.5	13,721	-15.3	26,138	-21.1	18,801	-15.7
2021	44,124	10.1	40,837	10.1	8,172	1.8	8,797	19.8	16,908	32.3	17,075	24.4	30,883	18.2	21,303	13.3
2022	46,727	5.9	43,246	5.9	8,654	5.9	9,316	5.9	17,906	5.9	18,082	5.9	32,705	5.9	22,560	5.9
2023	47,819	2.3	48,416	12.0	10,160	17.4	11,424	3.1	17,418	-2.7	15,518	-14.2	31,634	-3.3	22,478	-0.4
Compound Annual Growth Rate																
2014-2019		2.4		7.2		3.5		3.0		3.2		2.5		6.7		8.6
2019-2023		-1.3		2.6		1.7		4.9		6.0		-1.1		-1.1		0.2
2014-2023		0.7		5.1		2.7		3.9		4.4		0.9		3.1		4.8

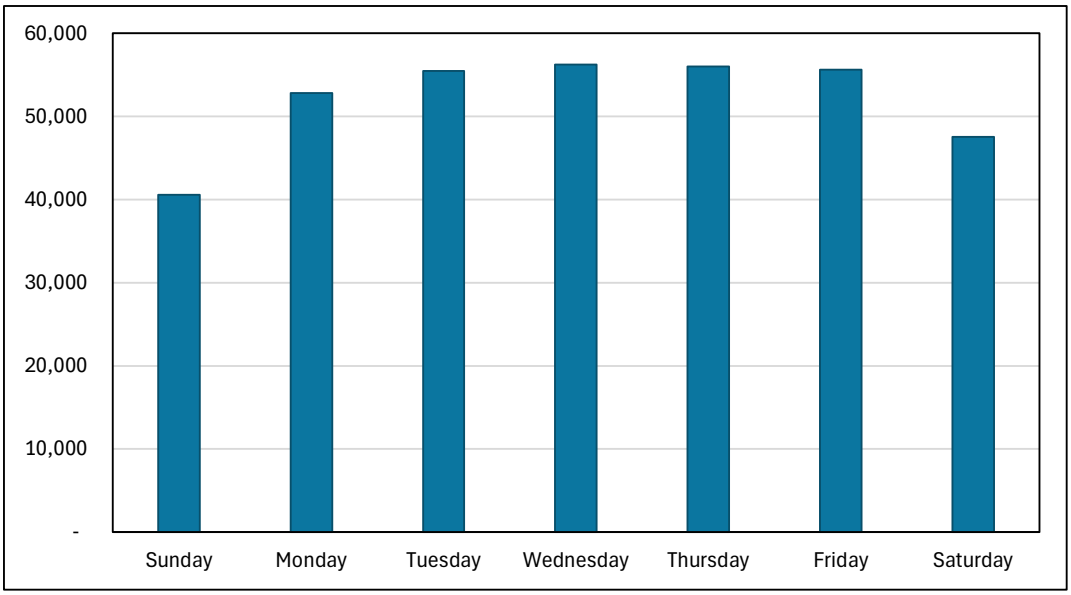
Source: https://ncdot.public.ms2soft.com/tcds/tsearch.asp?loc=Ncdot&mod=TCDS

2.2 US 1 Daily and Hourly Variation

2.2.1 Daily Variation

Figure 2.3 shows daily traffic variations on US 1 between Burlington Mills Road and Lois Lane during May 2024. Weekday traffic on US 1 at this location remains relatively stable from Monday to Friday, ranging from 52,800 to 56,200. Weekend traffic volumes are notably lower than weekday volumes due primarily to fewer work trips. Saturday was 14 percent lower than the average weekday (Monday through Friday) and Sunday was 27 percent lower.

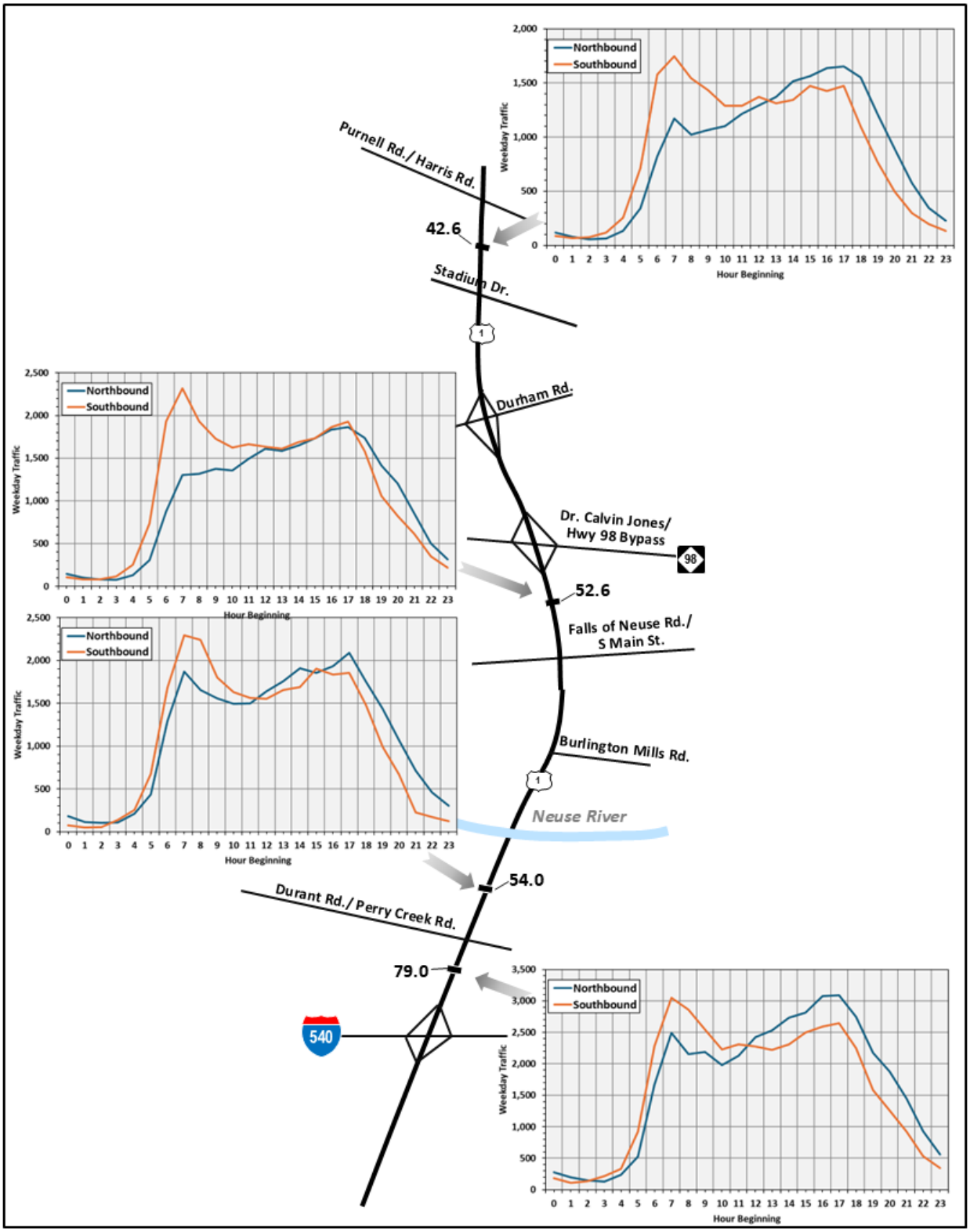
Figure 2.3 Daily Variation on US 1, North of Burlington Mills Road



2.2.2 Hourly Variation by Location

Figure 2.4 provides graphical depictions of the hourly distribution of traffic by direction on US 1 at four mainline locations. Due to the heavy shopping and business activity spread throughout the US 1 corridor, the hourly trends vary compared to a highway. On highways, there is often a clear directional difference based on the predominant direction of work trips, with one direction showing a distinct peak in the AM time period and the reciprocal peak shown in the opposite direction in the PM period. As seen in the figure, the southernmost count location north of the I-540 interchange within Segment A shows the directional pattern we anticipate when being fed by a major interstate such as I-540. The southbound AM period peaks at 7 AM as commuters travel into Raleigh and other business centers located along I-540 prior to the start of a typical workday, and the northbound direction sees a peak in the PM period from 4 – 5 PM as commuters return home. Directly to the east of this count location and south of Durant Road/Perry Creek Road are several housing communities, further reinforcing this trend is likely caused by commuting patterns.

Figure 2.4 Hourly Variation on US 1



Further north towards Wake Forest, the peaking pattern becomes less pronounced as there is more commercial development, such as Wakefield Commons and the shopping clusters around Walmart and Sam's Club north of Falls of Neuse Road/South Main Street. These shopping centers and the various car dealerships between Durant Road/Perry Creek Road and NC 98 produce less pronounced peaks compared to the those observed further south. At the count location between Falls of Neuse Road/South Main Street, located within Segment C, there is a clear AM peak around 7 AM, but the PM peak for both the northbound and southbound directions align at just under 2,000 cars per hour from 3 – 5 PM. The northernmost count location north of Stadium Drive, within Segment D, has the lowest overall volume of the count locations but still demonstrate similar, though less pronounced, directional peaking patterns.

2.3 Study Area Travel Speed Data

Travel speed data was obtained from INRIX via RITIS with permission from NCDOT. Weekday travel speed data was collected for the entire year of 2023. The data consisted of travel speeds and distance by roadway segment based on GPS data, from which travel time can be calculated.

2.3.1 Arterial Travel Times

CDM Smith compiled and summarized travel speeds for selected roads in the study area and used that information to calculate travel times which were used in base year model validation. **Figure 2.5** shows the roadway segments for which data was collected, and **Table 2.4** provides the summary of average travel times by time period and direction for a 2023 average weekday. The roads selected include arterials that run parallel to Capital Boulevard in the study area, such as Falls of Neuse Road, Ligon Mill Road, Forestville Road, and US 401. These roads would likely serve as the primary tollfree alternatives if tolling was implemented on Capital Blvd. Travel times are shown for the AM Peak (7 - 9 AM), Midday (9AM – 3PM), PM Peak (3 – 6 PM). The posted speeds and free flow travel times are also provided as reference for each roadway. It should be noted that minor differences in free flow speeds by direction on a given segment can be attributed to directional variances in INRIX segment distances.

Figure 2.5 INRIX Roadway Segment Locations

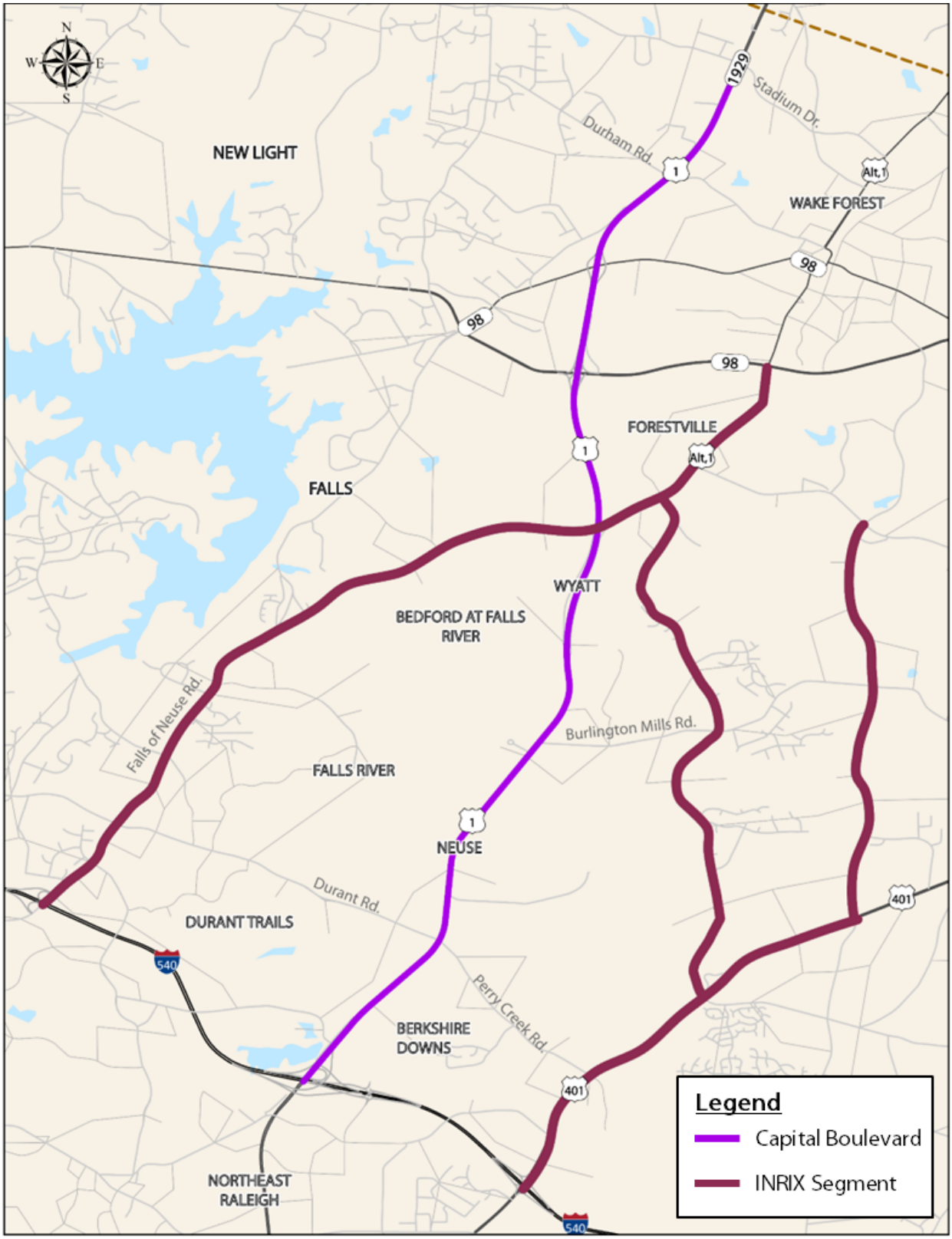


Table 2.4 Observed 2023 Arterial Travel Times and Speeds by Roadway and Direction

Roadway	Segment	Dist. (mi)	Posted Speed	Freeflow Travel Time	Dir.	AM Peak		Midday		PM Peak	
						Congested Speed	Travel Time	Congested Speed	Travel Time	Congested Speed	Travel Time
Falls of Neuse Road/ S Main Street	I-540 to Old Falls of Neuse	3.1	35	4.2	NB	40	4.6	39	4.7	32	0.0
	Old Falls of Neuse to NC98	4.3	35	7.0		33	7.7	31	8.3	27	9.5
	NC98 to Old Falls of Neuse	4.3	35	6.9	SB	32	7.9	32	8.0	31	8.3
	Old Falls of Neuse to I-540	3.1	35	4.5		25	7.5	34	5.6	34	5.5
US 401 - Ligon Mill Road	I-540 to Burlington Mills Road	4.7	45 - 50	6.1	NB	42	6.6	44	6.4	39	7.2
	Burlington Mills Road to NC98	2.2	35 - 45	3.8		38	3.5	36	3.6	36	3.7
	NC98 to Burlington Mills	2.3	35 - 45	3.7	SB	36	3.9	36	3.9	34	4.1
	Burlington Mills to I-540	4.6	45 - 50	6.4		33	8.5	42	6.6	38	7.2
US 401 - Forestville Road	I-540 to Burlington Mills Road	5.5	45 - 50	7.2	NB	42	7.9	43	7.6	36	9.1
	Burlington Mills to Rogers Road	1.5	35 - 45	2.3		31	2.8	34	2.5	31	2.8
	Rogers Road to Burlington Mills	1.5	35 - 45	2.3	SB	27	3.2	34	2.6	30	2.9
	Burlington Mills to I-540	5.4	45 - 50	7.2		32	10.3	42	7.7	39	8.4

(1) AM Peak is 7 - 9 AM, midday is 9 AM - 3 PM, PM Peak is 3 - 6 PM.

2.3.2 US 1 Travel Times

Figure 2.6 shows a travel time index by hour on Capital Blvd for each of the four segments identified in Chapter 1 for the southbound direction, and **Figure 2.7** shows the same information for the northbound direction. The travel time index is the ratio of time it takes to travel the allotted distance compared to the free-flow condition. For example, in the southbound direction during the AM peak period the highest level of delay is observed in Segment B, from Durant Road/Perry Creek Road to Burlington Mills Road, where travel time is nearly double or two times the travel time during the off peak period. In the northbound direction, Segment B still has the highest level of delay in both the AM and PM peak periods. These trends indicate a high volume of trips enter throughout the segment and exit at either Durant Road/Perry Creek Road or Burlington Mills Road. Distances shown Figure 2.6 and Figure 2.7 represent available INRIX segments that most closely align with U-5307 segment limits.

Figure 2.6 Travel Time Index on US 1 – Southbound

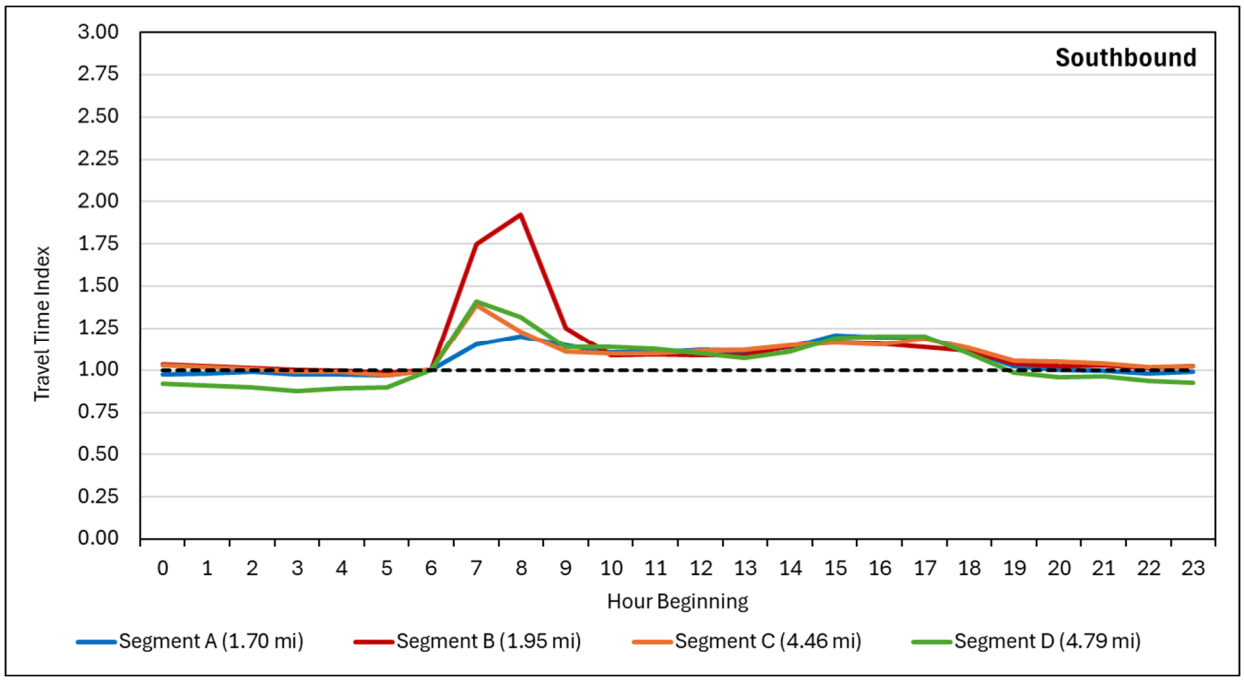
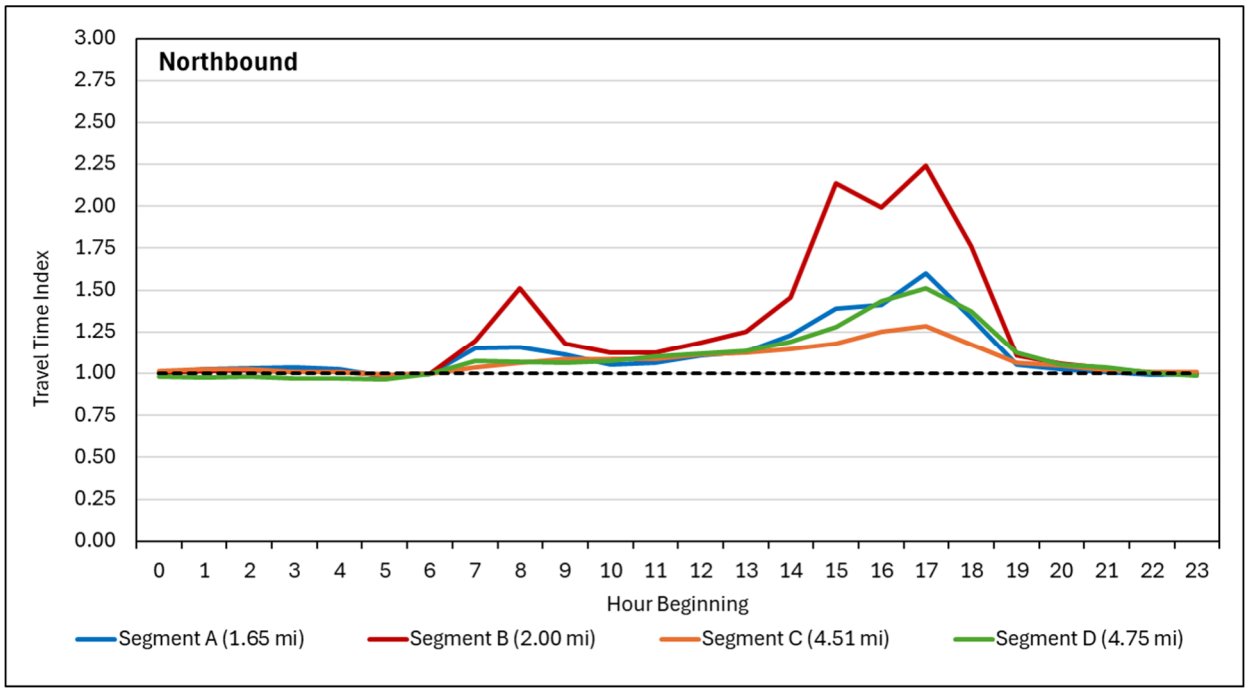


Figure 2.7 Travel Time Index on US 1 - Northbound



2.4 Travel Patterns on US 1

Streetlight Data, Inc. origin-destination data was used to identify weekday travel patterns in the study area for 2023. The data provided insights into travel patterns by time of day, which were subsequently used in validation of the travel demand model. Streetlight Data, Inc utilizes geospatial information from sources such as mobile phones, GPS devices, connected cars and commercial vehicles. Unique identifiers are used to determine individual trips. A zone system based on the TRMG2 zone system was utilized to analyze the project corridor. These zones were then aggregated to produce the trip distribution shown in **Table 2.5** which provides bi-directional trip distribution between Capital Blvd segments and notable trip generators in the area including Raleigh inside the I-540 loop, the Raleigh-Durham International Airport, and Research Triangle area. For the purposes of this dataset, the regions identified as segments A through D extend from NC 50 in the west and US 401 in the east, with northern and southern limits that align with the project corridor segments. The zone inside 540 includes areas within the I-540 loop but north of I-440, extending from I-40 in the west and NC 64 in the east. The airport zone encompasses the Raleigh-Durham International Airport limits, and the Research Triangle region extends north of I-540 to the I-885 east-west portion in southern Durham, and from NC 55 in the west and Page Road in the east.

As shown in the table, the majority of trips along the corridor start or end in Segments B and C. Segments B and C contain several commercial areas including car dealerships and shopping areas such as Walmart, Sam's Club, and several restaurants. There are also several housing communities throughout the area stretching from Falls of Neuse Road in the west to east of Forestville Road. Segment D extends from Durham Road to the end of the corridor at Purnell Road and is less densely developed compared to Segments B and C. However, Segment D along with the Franklin County region has the most potential for future development.

Table 2.5 Streetlight Origin-Destination Patterns

	Seg A	Seg B	Seg C	Seg D	Franklin County
Inside 540 (North of I-440)	16%	26%	34%	11%	13%
Airport	10%	28%	43%	9%	10%
Research Triangle	15%	29%	38%	10%	8%

3.0 Socioeconomic Review

Economic growth forecasts are a foundational component in traffic and toll revenue studies, as they provide critical insights into the potential future demand for transportation infrastructure. These forecasts form the basis for traffic demand models, which in turn support financial planning, including the feasibility of toll-backed financing.

This chapter explores the methodologies and findings of the socioeconomic forecasting process conducted for the Capital Boulevard improvement project. The analysis leverages updated regional and corridor-level socioeconomic data and employs advanced modeling techniques to generate updated projections through 2050 for the project study area. These forecasts include key variables such as population, households, employment, and income distributions, all of which are critical to understanding potential traffic growth and toll revenue generation.

The forecasting work builds on the Triangle Regional Model (TRM), a state-of-the-practice travel demand model developed collaboratively by regional planning organizations, including the Capital Area Metropolitan Planning Organization (CAMPO) and the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC MPO).[1] The transition to the updated TRM Generation 2 model (TRMG2) incorporates refined methodologies and further enhancements to networks and trip tables.

CDM Smith engaged an independent economist, Dr. Stephen J. Appold, to provide a review and update of the land use and socioeconomic growth forecasts used in this study. Such socioeconomic estimates and projections are important inputs into the assessment of the future growth in demand for the region and study corridor. A particular focus was given to the impacts from the COVID-19 pandemic, particularly telecommuting and travel pattern changes, to compute 2023 base year socioeconomic estimates. This chapter provides a summary of the understanding of the economic factors that influence the Capital Boulevard corridor, and the adjustments made to TRMG2 socioeconomic assumptions based on the analysis performed by Dr. Appold. A summary of Dr. Appold's methodology is provided in his report ***How the baseline 2023 socio-economic estimates and 2030, 2040, and 2050 projections were generated for the U.S. 1 improvement project (January 2025)***, which is attached to this report as **Appendix A**.

3.1 Socioeconomic 2023 Baseline and Data Collection

Establishing a reliable baseline is critical for accurate forecasting, as it anchors future projections to a defined and validated starting point. The baseline reflects current socioeconomic conditions and serves as a reference for evaluating growth trends and their impact on transportation demand. For this study, the baseline year was updated to 2023, replacing the TRMG2's original 2020 baseline, to incorporate the

[1] Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC MPO) has been renamed Triangle West Transportation Planning Organization (Triangle West TPO). References to DCHC MPO in this report are reflective of documentation used for this study including the ***2050 Metropolitan Transportation Plan***.

most recent data and account for changes in economic conditions, including the effects of the COVID-19 pandemic.

3.1.1 Data Sources and Methodology

Generating the 2023 socioeconomic baseline required integrating multiple data sources and methodologies to ensure accuracy and comprehensiveness. Key components include:

- Population and Household Data: The 2020 Census provided foundational population and household data, supplemented with updates from the American Community Survey (ACS) and parcel-based tax records to account for new developments.
- Employment Data: Employment figures were derived from the Longitudinal Employer-Household Dynamics (LEHD) database and commercial data sources such as DataAxle, which offered insights into workplace distribution and sectoral employment.

3.1.2 Base Year Estimation

The 2023 baseline was established by updating the TRMG2 variables to reflect current conditions. These variables fall into five subsets: two household variables, household population age distribution measures, median household income, five employment category values, and one earnings variable linked to employment location. The following subsections summarize the methodology for each subset.

3.1.2.1 Household and Household Population

The baseline household and population data were derived from the 2020 Census, augmented by housing unit additions identified through parcel-based tax records and local development data. Housing occupancy rates and average household sizes from the Census were used to estimate the household population for 2023. Data were allocated to Traffic Analysis Zones (TAZs) to ensure geographic precision.

3.1.2.2 Age Distribution Measures

Three age-related measures were calculated for the 2023 baseline: the percentage of the household population of working age, under 18, and 65 and older. These were derived using Census block-level data aggregated to TAZs. The percentage of working-age population informed projections of labor force participation and economic activity.

3.1.2.3 Household Income Estimates

Median household income was estimated using Census and ACS data, with adjustments to reflect inflation and economic changes between 2020 and 2023. These estimates were allocated to TAZs using geographic and demographic correlations observed in the baseline data.

3.1.2.4 Employment Estimates

Employment data were classified into five sectors: industrial, office, retail, high-volume service, and low-volume service. Employment density patterns and data from LEHD and DataAxle were used to spatially distribute employment across TAZs. This classification supports differentiated traffic demand modeling for each sector. Earnings data were linked to employment locations using LEHD and ACS earnings

distributions. High-wage and low-wage employment were allocated based on sectoral averages, enabling an analysis of income-driven travel patterns.

3.1.2.5 Results of Base Year Adjustments

The transition from the TRMG2 2020 Base Year to the 2023 base year developed by Dr. Appold showed modest changes in overall population and household totals, with more notable shifts in the sectorial distribution of employment. When comparing the interpolated TRMG 2023 to the adjusted 2023, population, household, and total employment estimates are no more than 3.4% different, as shown in **Table 3.1**.

Households increased by 9.7 percent from 801,157 in 2020 to 878,731 in 2023 in the revised estimates, or 3.4 percent more than interpolated 2023 TRMG2 estimates, due to a rise in housing stock and occupancy rates. Population growth estimates were minimally different between the two data sets with both reflecting an approximate six percent increase over the three-year period.

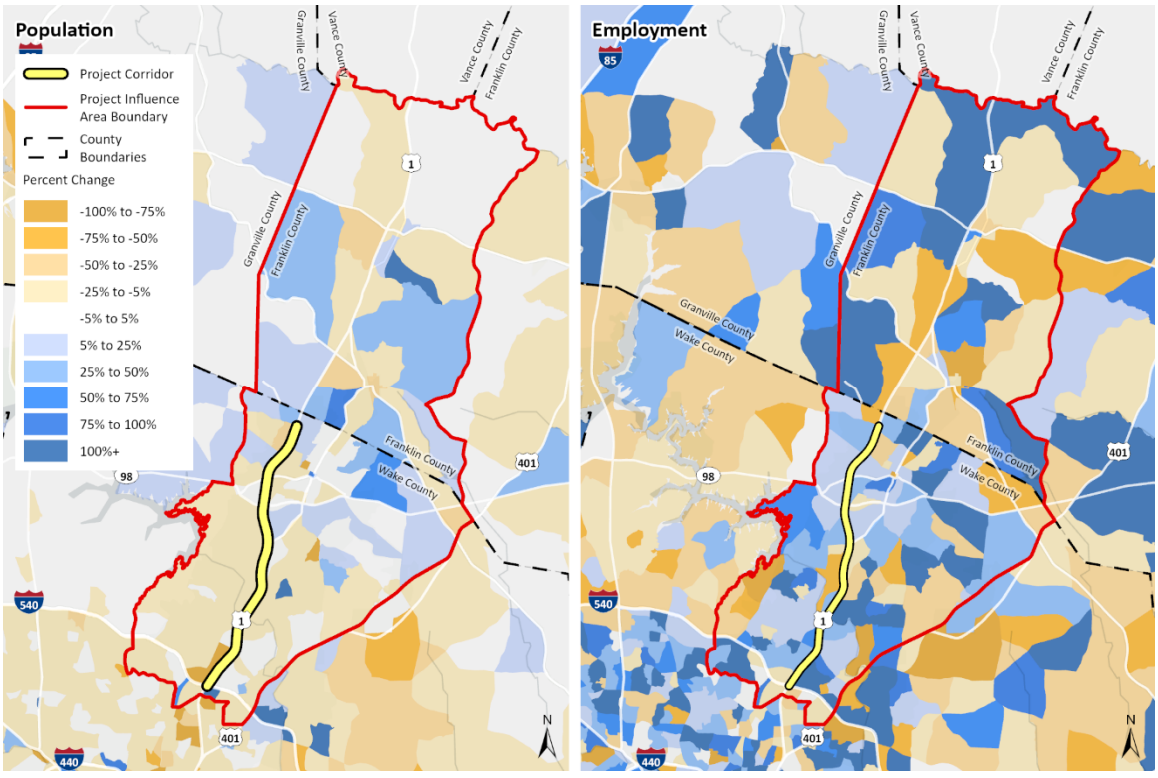
Total regional employment rose by 10.5 percent from 1,057,590 in 2020 to 1,168,585 in 2023 in the revised estimates, or 2.6 percent more than interpolated 2023 TRMG2 estimates. The notable differences between the two data sets within employment sectors is the result of Dr. Appold utilizing the latest available small-area data sources to estimate the geographical and sectoral distribution of employment, which he describes in his report. More detailed zone-level changes within the corridor are shown in **Figure 3.1**.

Median household income remained stable at approximately $75,108, reflecting adjustments for inflation and wage rises in industries experiencing high demand. Overall, these updates provide a more robust foundation for long-term socioeconomic forecasts.

Table 3.1 Socioeconomic Base Year Adjustments

Variables	TRMG2 2020	Interpolated 2023	Percent Change (TRMG2 2020 to Interpolated 2023)	Adjusted 2023	Percent Change (TRMG2 2020 to Adjusted 2023)	Percent Change (Interpolated 2023 to Adjusted 2023)
Households	801,157	849,810	6.1%	878,731	9.7%	3.4%
Household Population	2,001,649	2,125,743	6.2%	2,115,504	5.7%	-0.5%
Total Employment	1,057,590	1,138,623	7.7%	1,168,585	10.5%	2.6%
Industry	144,734	149,824	3.5%	190,221	31.4%	27.0%
Office	344,097	370,175	7.6%	312,426	-9.2%	-15.6%
Service (Low Wage)	330,250	362,309	9.7%	327,269	-0.9%	-9.7%
Service (High Wage)	63,298	70,411	11.2%	137,198	116.7%	94.9%
Retail	175,211	185,905	6.1%	201,471	15.0%	8.4%
Worker	975,886	1,035,687	6.1%	1,082,696	10.9%	4.5%
Child	480,454	510,654	6.3%	496,450	3.3%	-2.8%
Senior	247,595	262,526	6.0%	291,289	17.6%	11.0%
High Pay	441,728	473,790	7.3%	605,075	37.0%	27.7%
Median Income	75,809	75,555	-0.3%	75,108	-0.9%	-0.6%

Figure 3.1 Population and Employment Percent Change (Interpolated 2023 to Adjusted 2023)



3.2 Socioeconomic Forecasts and Adjustments

This section describes the three principal socioeconomic inputs to the TRMG2 model that drive travel demand forecasts: population, households, and employment. The forecasts assumed in the TRMG2 are outlined here, along with the adjustments and refinements applied in this study. The adopted forecasts were developed by Dr. Stephen J. Appold, whose expertise ensured that the projections align with regional growth trends and observed data.

3.2.1 Data Sources and Methodology

The socioeconomic forecasts for 2030, 2040, and 2050 were derived using a structured process based on control totals and projection year calculations. These control totals were informed by the Office of State Budget and Management (OSBM) population estimates and projections, supplemented by employment data from the Quarterly Census of Employment and Wages (QCEW). Adjustments to the 2023 baseline data were made to reflect updated trends and regional dynamics. Below, the methodology is detailed across three key variables: population, households, and employment.

3.2.1.1 Population

Population forecasts relied on county-wide control totals from OSBM, which provided projections for total population and group quarters population through 2050. Group quarters populations were assumed to remain at their 2020 proportions of total county population and grow in tandem with overall population. Age distribution changes were incorporated using data from the Joint Center for Housing Studies at Harvard, accounting for shifts in household formation and headship rates. Geographic adjustments were made for partial counties within the TRM modeling region, considering historical growth trends and the proportion of county populations residing within the region.

3.2.1.2 Households

Household projections were derived by calculating the number of households expected based on age composition changes and shifting headship rates. The Joint Center's estimates were corrected to align with the 2023 baseline, ensuring consistency. Within each county, the growth in households was allocated to Traffic Analysis Zones (TAZs) according to the proportional geographic distribution of growth projected by the MPO. These calculations incorporated updates to housing unit data to match Census Annual Estimates of Housing Units.

3.2.1.3 Employment

Employment estimates utilized QCEW data, adjusted by a factor of (100/92) to account for employment not covered by Unemployment Insurance. County employment projections were based on trends in the ratio of employment to working-age population (ages 20-64), as extracted from OSBM population data. Proportions of employment growth were allocated to TAZs based on historical patterns and planned developments, while adjustments were made for outlying counties and partial counties within the TRM region. Small area employment distributions incorporated LODES data alongside QCEW to improve sectoral accuracy.

By integrating these methodologies, the forecasts provide a detailed and localized perspective on the future socioeconomic conditions of the region. Combining county-level control totals with adjustments

for age distribution, headship rates, and employment data, the study produced refined projections grounded in regional and localized trends.

3.2.1.4 Results of Forecast Adjustments

By 2050, the number of households will increase from 878,731 in 2023 to 1,397,313, representing a 59% rise driven by urban expansion. The annual growth rate for households is projected to range between 1.5 and 2.1 percent, while population growth is projected to range between 1.4 and 2.0 percent. Due to an aging population and changes in how households are formed, the average household size is expected to decrease (**see Table 3.2**). Significant growth is forecasted for the northern part of Franklin County, highlighting development potential, whereas Wake County is anticipated to grow more slowly due to existing development (refer to **Figures 3.2 and 3.3**).

Age distribution patterns reveal an aging population, as residents aged 65 and older grow to represent a larger share of the region by 2050. However, the working-age population remains stable due to consistent regional migration trends. Median household income is expected to remain steady, hovering around $74,101 (2023 Dollars) by 2050, after adjusting for inflation and sectoral shifts.

Employment projections show varying growth rates across different sectors. Total employment is expected to reach 1,561,321 by 2050. The office and industrial sectors are projected to grow more slowly than initially anticipated, reflecting broader economic trends. High-wage service employment is forecasted to increase significantly, indicating a shift towards higher-value industries. Growth in low-wage service employment is expected to moderate, while retail employment remains relatively constant. Earnings are projected to rise, especially in high-demand sectors, contributing to overall wage growth and regional economic development. Despite changes from the original TRMG sectorial employment distribution, the adjusted 2023-2050 forecasts use the same adjusted distributions as evidenced in **Table 3.3**.

Overall, these projections provide a comprehensive view of anticipated socioeconomic trends, serving as a critical input for assessing future traffic demand and toll revenue potential on Capital Boulevard.

Table 3.2 Regional Model Socioeconomic Forecasts by Variable

	TRMG2 Values						
Variables	Interpolated 2023	CAGR 2023-2030	2030	CAGR 2030-2040	2040	CAGR 2040-2050	2050
Households	849,810	1.8%	963,334	2.2%	1,124,254	1.9%	1,286,832
Household Population	2,125,743	1.8%	2,415,297	2.3%	2,828,114	2.0%	3,243,620
Total Employment	1,138,623	2.2%	1,327,701	2.7%	1,595,604	2.6%	1,907,502
Industry	149,824	1.1%	161,699	1.4%	178,394	1.5%	198,001
Office	370,175	2.2%	431,022	2.6%	517,178	2.5%	616,468
Service (Low Wage)	362,309	2.7%	437,113	3.2%	543,638	3.0%	667,786
Service (High Wage)	70,411	3.1%	87,009	3.4%	110,243	3.2%	137,544
Retail	185,905	1.8%	210,858	2.2%	246,151	2.3%	287,703
Worker	1,035,687	1.8%	1,175,224	2.3%	1,374,150	2.0%	1,574,517
Child	510,654	1.9%	581,120	2.3%	681,609	2.0%	782,727
Senior	262,526	1.8%	297,364	2.2%	347,025	1.9%	397,006
High Pay	473,790	2.1%	548,603	2.6%	654,701	2.5%	778,080
Median Income	75,555	-0.1%	74,962	-0.1%	74,357	-0.1%	73,906
	Adopted Values						
Variables	2023	CAGR 2023-2030	2030	CAGR 2030-2040	2040	CAGR 2040-2050	2050
Households	878,731	2.1%	1,016,341	1.7%	1,205,394	1.5%	1,397,313
Household Population	2,115,504	2.0%	2,426,182	1.6%	2,839,400	1.4%	3,253,609
Total Employment	1,168,585	1.6%	1,301,452	1.0%	1,437,835	0.8%	1,561,321
Industry	190,221	1.6%	212,965	0.7%	228,801	0.5%	241,009
Office	312,426	1.5%	346,554	1.0%	382,507	0.8%	414,575
Service (Low Wage)	327,269	1.5%	363,149	1.1%	406,613	1.0%	447,969
Service (High Wage)	137,198	1.6%	152,969	1.2%	172,861	1.1%	191,994
Retail	201,471	1.6%	225,815	0.9%	247,053	0.7%	265,774
Worker	1,082,696	1.6%	1,213,690	1.1%	1,352,541	1.0%	1,489,040
Child	496,450	1.9%	567,281	1.5%	660,586	1.3%	754,023
Senior	291,289	2.0%	334,410	1.6%	391,131	1.4%	448,121
High Pay	605,075	1.4%	668,329	1.0%	735,206	0.8%	795,422
Median Income	75,108	0.0%	75,253	-0.1%	74,608	-0.1%	74,101

Figure 3.2 Population and Employment Percent Change (TRMG2 2030 to Adjusted 2030)

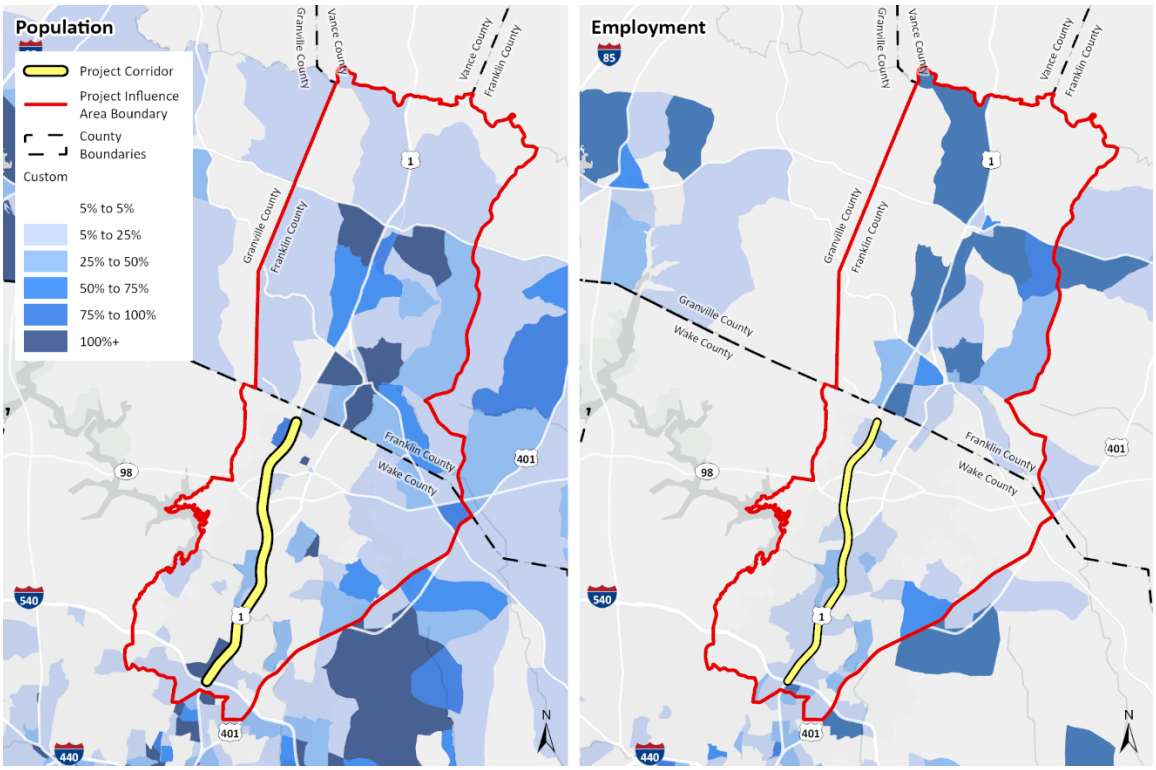


Figure 3.3 Population and Employment Percent Change (TRMG2 2050 to Adjusted 2050)

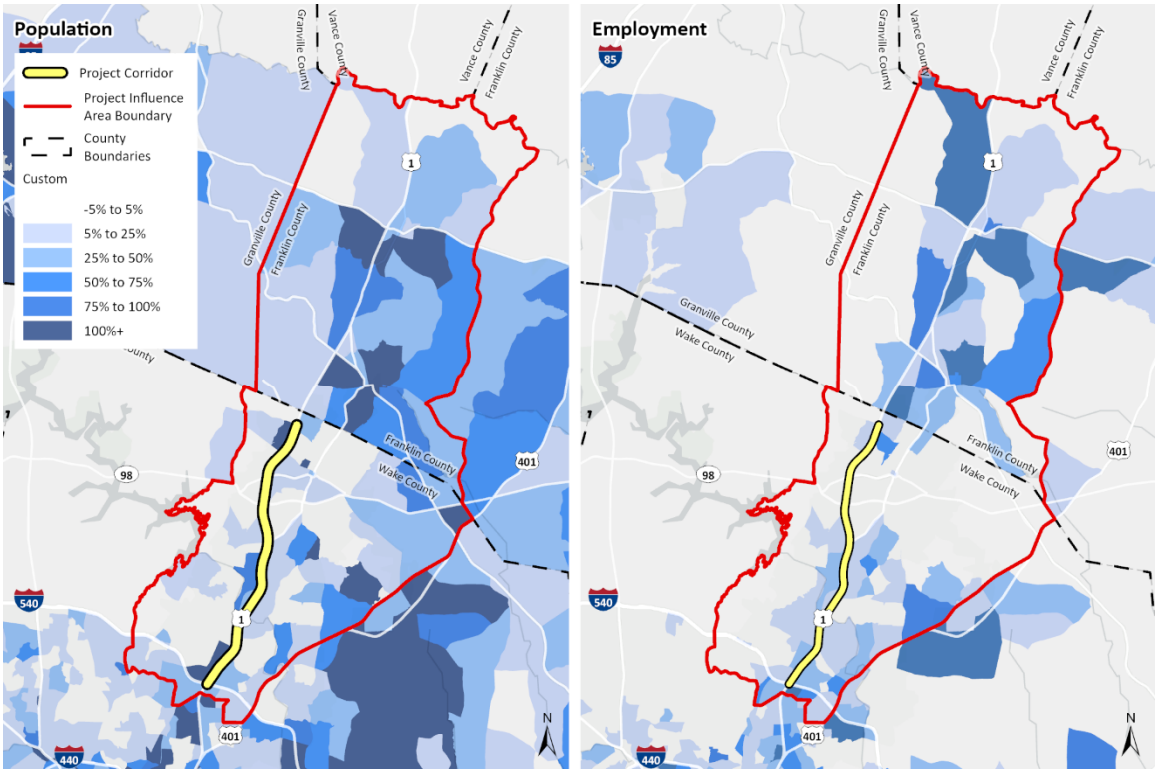


Table 3.3 Sectoral Employment Distribution

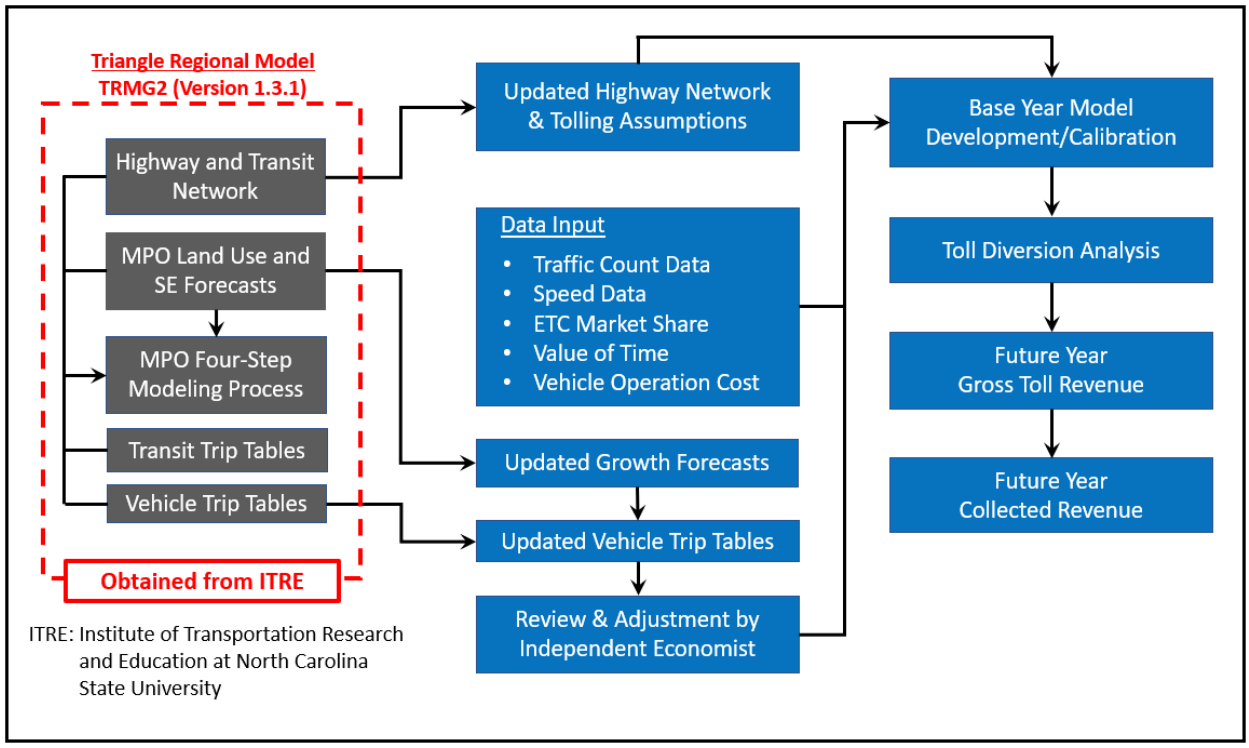
Employment Sectors	TRMG2 Values			
	Interpolated 2023	2030	2040	2050
Industry	13.2%	12.2%	11.2%	10.4%
Office	32.5%	32.5%	32.4%	32.3%
Service (Low Wage)	31.8%	32.9%	34.1%	35.0%
Service (High Wage)	6.2%	6.6%	6.9%	7.2%
Retail	16.3%	15.9%	15.4%	15.1%
Employment Sectors	**Adopted Values**			
	2023	**2030**	**2040**	**2050**
Industry	16.3%	16.4%	15.9%	15.4%
Office	26.7%	26.6%	26.6%	26.6%
Service (Low Wage)	28.0%	27.9%	28.3%	28.7%
Service (High Wage)	11.7%	11.8%	12.0%	12.3%
Retail	17.2%	17.4%	17.2%	17.0%

4.0 Regional Model Calibration and Refinement

This chapter describes the development of a 2023 base-year travel demand model and the 2030, 2040, and 2050 forecast years used for the development of traffic and revenue projections. At the onset of this study in August 2024, CDM Smith received the latest version of the Triangle Regional Model Generation 2 (TRMG2)—version 1.3.1, released in February 2024—from the Institute of Transportation Research and Education (ITRE) at North Carolina State University.

TRMG2 is a trip-based, four-step travel demand model that relies primarily on socioeconomic data and the transportation network—both roadway and transit—as inputs. Originally developed using 2018 population, housing, and employment data, the model was used to establish a 2020 base year and future-year forecasts for 2030, 2040, and 2050. For this study, CDM Smith and Dr. Steven Appold built on the TRMG2 socioeconomic data to develop an interim 2023 model for use as the new base year for this study. **Figure 4.1** outlines the steps taken to refine TRMG2 for the traffic and revenue study. The gray boxes represent the four-step modeling process, while the blue boxes highlight the specific steps CDM Smith used to adapt and run the model for this project.

Figure 4.1 Modeling Process for Toll Road Analysis



4.1 TRMG2 Regional Model Refinements

CDM Smith's toll and revenue assessments rely on a custom traffic assignment process within the Cube travel demand modeling platform. However, before the development of the Cube model, the TRMG2 regional model was leveraged to establish the initial inputs necessary for this process. Specifically, TRMG2's trip generation, trip distribution, and mode choice components were used to assess how changes in socioeconomic data (SED) and roadway network modifications would influence trip flows through the project area, ultimately shaping the trip tables used in the model.

4.1.1 Roadway Network

The TRMG2 model was developed with a 2020 base year, but to achieve a more accurate calibration for toll and revenue projections, a new base year of 2023 was introduced to better reflect current conditions. This update required refining both the SED and roadway network within the model. As part of this effort, CDM Smith reviewed the 2024 – 2033 NCDOT State Transportation Improvement Program (STIP) and the CAMPO 2050 Metropolitan Transportation Plan (MTP) to ensure that relevant projects, either near the project area or significant at a regional level, were appropriately included in the TRMG2 roadway network. Additionally, the portion of US 1 within the project area was re-coded to reflect existing conditions accurately, while future-year configurations were updated to align with the latest assumptions on how the facility will be constructed.

TRMG2 employs a master network setup where roadway improvements are tagged with unique project IDs, allowing them to be toggled or selected within a specified project list for each scenario. This system was leveraged to systematically incorporate the phased construction of US 1, ensuring that improvements were reflected in the appropriate years and scenarios.

4.1.2 Socioeconomic Data

To further enhance model accuracy, SED inputs were updated alongside roadway refinements. While TRMG2 originally included forecast years of 2030, 2040, and 2050, adjustments were made to these datasets following the introduction of the 2023 base year to improve the reliability of tolling and revenue projections. The specific changes to SED data, detailed in Chapter 3 of this report, were implemented to generate the final trip tables used in the model.

4.2 Software Conversion

Since TRMG2 was developed using the TransCAD modeling platform, while CDM Smith's toll road modeling and algorithms operate within the Cube modeling platform, the first step in model development involved converting the updated traffic assignment components of TRMG2 from TransCAD to Cube. This process included exporting and converting the network and trip matrices into Cube format, recreating additional inputs such as turn penalties, and developing a Cube Voyager model script while consulting TRMG2 documentation to preserve all key model assumptions. To ensure consistency, the model was run for the years 2023 and 2050, verifying assigned volumes aligned with those produced by TRMG2.

4.3 Base Year (2023) Model Refinements

Using the converted outputs from the TRMG2 model, the following adjustments were made to ensure the appropriate level of detail in the assumptions used for toll and revenue traffic assignments.

4.3.1 Trip Matrices

To refine the trip matrices for toll and revenue modeling, the trip tables from TRMG2 were post-processed to adjust the time frames of the AM and PM peak periods. This adjustment involved redistributing trips between matrix cores and modifying the period capacity factors during assignment to better align with the final time ranges. The AM peak period was defined as 7:00–9:00 AM, while the PM peak period covered 3:30–6:30 PM. Additionally, TRMG2 vehicle classifications were consolidated to improve efficiency in the Cube-based toll and revenue model. The final vehicle classifications used in the toll and revenue model consisted of personal vehicles and trucks. These refinements ensured that the trip matrices accurately captured peak-period demand and were appropriately structured for revenue forecasting.

4.3.2 Zone Disaggregation

In travel demand modeling, zone sizes should correspond to the level of development in the area to ensure an accurate representation of local travel behavior. Given that portions of US 1 within the study area are experiencing rapid development, a review of the traffic analysis zones (TAZs) revealed that some, particularly in the northern sections of the corridor, were relatively large. While the southern portions of the study area are more densely developed due to their proximity to the urban core, the northern segments remain more rural, necessitating refinement to zone structures. To improve the model's ability to capture localized traffic patterns, several zones in the project area were subdivided, particularly in the northern sections. This disaggregation enhanced the model's ability to load trips onto local streets feeding into and from US 1, improving the overall reliability of trip flow representation within the study area.

4.3.3 Inflation, Value of Time, and Vehicle Operating Costs

Table 4.1 provides a concise summary of modeling assumptions and inputs used in each of the assignment years; 2023, 2030, 2040 and 2050. Class 1 represents two-axle vehicles, Class 2 represents three-axle vehicles, and Class 3 represents vehicles with four or more axles.

Table 4.1 Model Inputs (VOT, VOC and CPI)

	2023	2030	2040	2050
Value Of Time ($/minute)				
Class 1	$0.34	$0.40	$0.49	$0.60
Class 2&3	$0.69	$0.82	$1.01	$1.23
Vehicle Operating Cost ($/mile)				
Class 1	$0.25	$0.24	$0.29	$0.35
Class 2&3	$0.90	$0.93	$1.17	$1.46
Annual Inflation		2023-30	2030-40	2040-50
		2.4%	2.1%	2.0%

A critical parameter in any traffic and revenue analysis relates to value of time (VOT). This is a measure of motorist's willingness to pay for time savings, and the values in Table 4.1 are shown in terms of dollars per minute. VOT information was derived from an analysis of household median income data by traffic analysis zone (TAZ) and applied on a matrix basis for model assignments. Therefore, VOT in individual traffic zones also varied from the averages shown based on median household income in each TAZ. The VOT information provided in Table 4.1 reflects weighted regionwide averages.

The VOT values derived from the 2023 baseline estimation of socioeconomic data were used as a starting point in the model calibration for this study. Values shown for subsequent years were adjusted in proportion to inflation assumptions, also shown in the table.

To develop assumptions for vehicle operating costs (VOC), CDM Smith analyzed multiple data sources to ensure accuracy and reliability. These sources included forecasts from the U.S. Energy Information Administration (EIA) for conventional gasoline, diesel fuel, and electricity prices, as well as recent trends in vehicle ownership patterns, including the distribution of sedans, SUVs, hybrids, and electric vehicles. The EIA standards reviewed for this study were adopted by the U.S. Environmental Protection Agency (EPA) as of October 2024. Additionally, trends and forecasts from the National Household Travel Survey (NHTS) were reviewed to assess expected improvements in fuel efficiency. Estimates of vehicle maintenance costs were incorporated using 2023 data from the American Automobile Association (AAA), while inflation forecasts from the Bureau of Labor Statistics (BLS) were also considered. Based on this comprehensive analysis, the VOC assumptions applied in the 2023 model were $0.25 per mile for autos and $0.90 per mile for trucks.

4.3.4 Speed and Capacity Adjustments

To ensure that model-assigned volumes and congested speeds aligned with real-world conditions, speed and capacity adjustments were made based on observed data. Hourly traffic counts and speed data collected from INRIX were carefully reviewed, with particular attention given to US 1 in its current arterial configuration, as well as nearby parallel and intersecting routes such as Falls of Neuse Road and NC 98. Volume delay functions for individual roadway links were adjusted to better reflect the observed average speeds from INRIX for each peak period (AM and PM). These refinements were primarily focused on the southern end of US 1, where congestion increases as it approaches I-540. By calibrating speeds and capacities to match observed traffic patterns, the model provided a more accurate representation of travel conditions, improving the reliability of toll and revenue projections.

4.3.5 Select Link Matrix Adjustments

To refine traffic volumes and correct directional flow imbalances during peak periods, select link analyses were conducted to adjust the associated origin-destination (O-D) pairs within the trip tables. Observed traffic patterns indicate higher southbound traffic volumes on US 1 during the AM peak period and a higher northbound traffic volumes during the PM peak period. However, initial model assignments did not fully capture this directional pattern for all segments. To address this, select link analyses were used to identify O-D pairs contributing to movements on key segments of US 1. These pairs were factored accordingly to better align modeled traffic volumes with observed directional flows. By analyzing peak period movements and making targeted adjustments, this process helped improve the

accuracy of directional flow assignments, ensuring that the model more effectively represented real-world traffic conditions on US 1.

4.4 Base Year (2023) Volume Calibration Results

Traffic volumes were the primary focus of the 2023 model calibration given the future condition change on US 1 from a signalized roadway to limited access, which would impact the travel time greatly on a segment basis. Count locations on US 1 along with the screenline locations identified in Chapter 2 were utilized during the model calibration. **Table 4.2** shows the calibration results on a total weekday basis for count locations on US 1 for both directions. **Table 4.3** shows the same information for the total count screenlines, which were shown previously in Figure 2.2.

Table 4.2 2023 Weekday Volume Calibration on US 1

Link Description	Total Weekday		
	Observed Count	Modeled Volume	Percent Difference
South of NC 540	64,353	71,891	11.7%
North of Gresham Lake	79,153	73,742	-6.8%
North of Perry Creek Rd / Durant Rd	54,064	63,025	16.6%
North of Burlington Mills Rd	55,015	53,914	-2.0%
South of Falls of Neuse Rd	43,938	49,790	13.3%
North of Falls of Neuse Rd	52,553	49,145	-6.5%
North of Durham Rd	46,128	47,987	4.0%
North of Purnell Rd / Harris Rd	41,606	40,963	-1.5%
Total	436,810	450,456	3.1%

Table 4.3 2023 Weekday Volume Calibration on Total Screenlines

Screenline	Number of Links	Total Weekday		
		Observed Count	Modeled Volume	Percent Difference
1	6	143,836	150,617	4.7%
2	8	195,669	202,398	3.4%
3	8	159,701	175,861	10.1%
4	8	113,648	110,132	-3.1%
5	8	102,662	110,640	7.8%
6	6	81,191	84,318	3.9%
7	10	134,117	155,875	16.2%
8	4	36,297	35,424	-2.4%
9	6	68,501	65,051	-5.0%
10	4	51,830	62,358	20.3%
11	2	46,128	47,987	4.0%
Total	70	1,133,580	1,200,661	5.9%

Across the US 1 corridor, modeled traffic volumes were within 3 percent of the observed counts. Model validation varied by count location due to some discrepancies between the two count sources on a daily basis. The precision of model validation at count locations in areas with more driveways and vehicle access proved difficult due to the more limited roadway coding within the model network than exists in real life. More confidence was given to the count locations at the NCDOT MS2 count locations, where model volumes were within +/- 10 percent of the observed count.

The screenlines identified for this study stretched across the network to encompass US 1 and potential alternative routes such as Falls of Neuse Road, Ligon Mill Road, and Forestville Road, along with additional smaller local roads. Screenlines 1 through 6 and 11 are east-west cutlines across the network, and screenlines 7 through 10 are north-south cutlines. The cutlines are used to pull all model links for model validation to check the trip distribution across all possible roadways, not just US 1. This ensures the share of traffic on a given roadway is in line with observed counts, and the model is not disproportionately assigning traffic to one roadway versus another.

On a total basis, the model screenlines were within six percent of the observed counts. Screenline three located north of Perry Creek Road/Durant Road was ten percent higher than the observed counts, largely due to the over assignment of traffic on the US 1 count at this location shown in Table 4.2. Screenlines seven and 10 were the north-south screenlines on the western and eastern ends of the model area and farthest away from the US 1 corridor. These locations also proved difficult to validate due to the network connectivity that existed compared to the real-life roadway network.

4.5 Future Model Adjustments and Assumptions

4.5.1 Roadway Network

Critical elements in any traffic and revenue study are assumptions regarding competing and complementary transportation improvements which may be expected to occur during the forecast period. As part of this study, CDM Smith reviewed the planned and proposed roadway improvement programs in the study area from the following sources:

1) The adopted ***2024-2033 NCDOT State Transportation Improvement Program*** (STIP) and amendments through May 2024. These are projects that have an identified funding and construction schedule. Projects in the STIP were all scored and prioritized through the NCDOT's Strategic Prioritization Office (SPOT) program, which is the methodology used to evaluate and score all transportation projects.

2) The ***2050 Metropolitan Transportation Plan*** (MTP). This is the long-range plan for transportation in the Triangle region. It includes roadway, transit, rail, bicycle, and pedestrian projects to be implemented through the year 2050. This plan is coordinated by the two Metropolitan Planning Organizations (MPOs) in the study area; the Capital Area MPO (CAMPO) and the Durham Chapel-Hill Carrboro MPO (DCHC MPO). Roadway improvements in the 2050 MTP include the current STIP projects. Future projects in the MTP, but not included in the STIP, do not have current schedules and are not financially committed but were developed recognizing overall future fiscal sources and constraints.

CDM Smith reviewed the STIP and MTP transportation projects and compared them to the projects in the TRMG2 for consistency. Roadway improvements in the STIP and the 2050 MTP generally aligned with TRMG2 networks provided in August 2024. CDM Smith coordinated with NCDOT and CAMPO personnel to verify estimated project completion dates for modeling purposes and incorporated them into the appropriate model year network as needed. **Figure 4.2** and **Table 4.4** show assumed roadway improvements included in the TRMG2 model.

Figure 4.2 Assumed Regional Transportation Plan Improvements

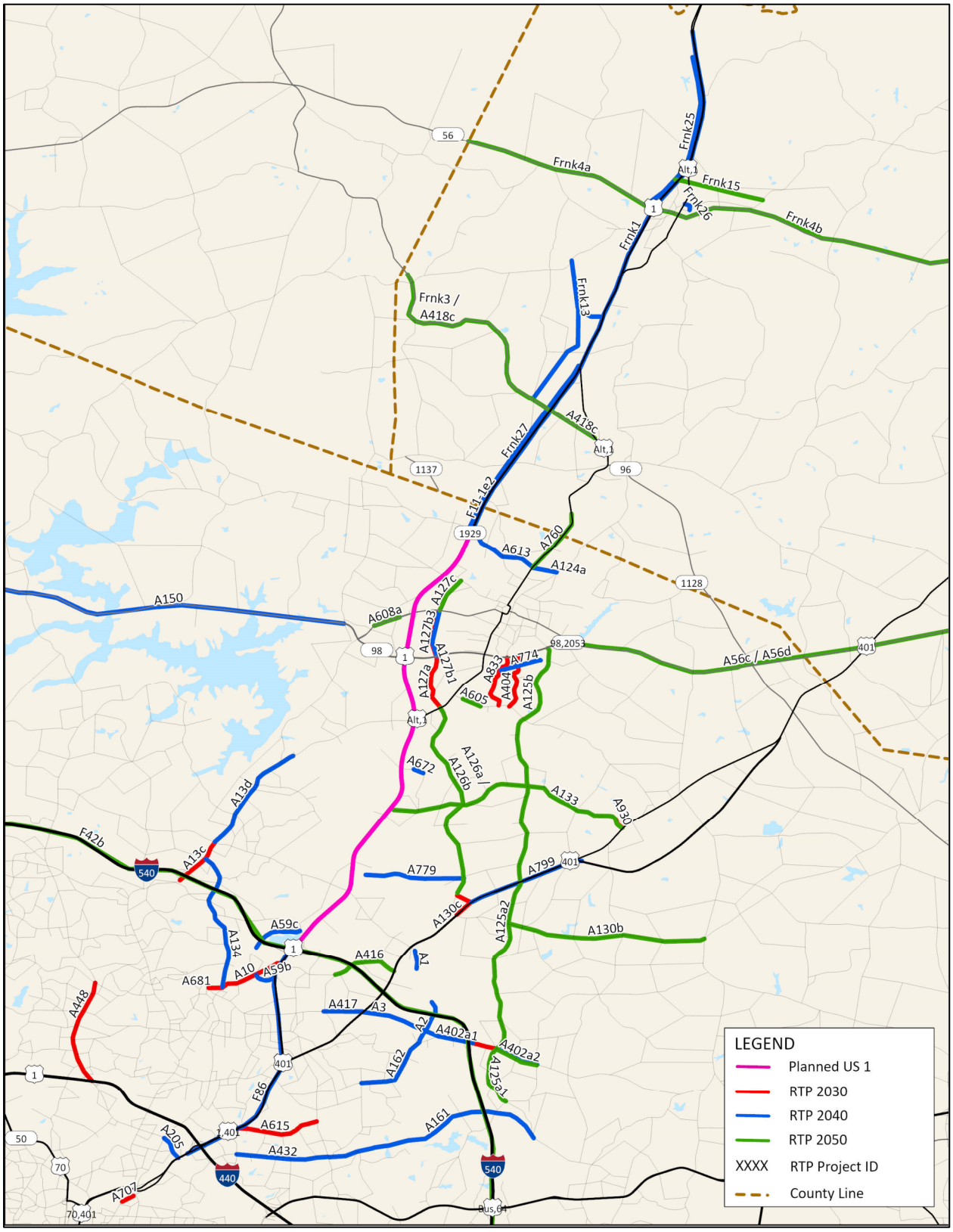


Table 4.4 Assumed Regional Transportation Plan Improvements

STIP/MTP ID	Roadway	Location	Description	Model Year		
				2030	2040	2050
A162	Buffaloe Rd	Southall Rd to Stone Station Dr	Widen from 3 to 4 lanes		X	X
A402a1	Buffaloe Rd	Spring Forest Extension to I-540	Widen from 3 to 4 lanes		X	X
A402a2	Buffaloe Rd	Forestville Rd to Old Millburnie Rd	Widen from 3 to 4 lanes		X	X
A133	Burlington Mills Rd	US 1 to US 401	Widen from 3 to 4 lanes			X
F86	Capital Blvd Corridor Upgrades	I-440 to I-540	Corridor Upgrades		X	X
A681	Dixie Forest Rd (Rd diet)	Spring Forest Rd to Litchford	widen from 2 to 3 lanes	X	X	X
A13c	Falls Of Neuse	I-540 to Durant Rd	Widen from 4 to 6 lanes		X	X
A13d	Falls of Neuse	Durant Rd to Old Falls of Neuse Rd	Widen from 4 to 6 lanes		X	X
A125a1	Forestville Rd (Franklinton - local)	Old Milburnie Rd to Buffaloe Rd	Widen from 3 to 4 lanes			X
A125a2	Forestville Rd (Franklinton - local)	Buffaloe Rd to Rogers Rd	Widen from 3 to 4 lanes			X
A416	Fox Rd	Old Wake Forest Rd to US 401	Widen from 2 to 4 lanes			X
Frnk15	Franklinton Northern Rd	W River Rd to North Main St	Construct 2 lanes on new location			X
A613	Harris Rd	US 1 to N Main St	Widen from 2 to 4 lanes		X	X
A125b	Heritage Lake Rd	Rogers Rd to NC98	Widen from 2 to 4 lanes			X
A833	Holding Village Way	Highpoint St to Friendship Chapel (Franklinton)	Construct 2 lanes on new location	X	X	X
F42b	I-540 Managed Lanes	I-40 to US 64 Bypass	Construct 2 Managed Lanes			X
A126a / A126b	Ligon Mill Rd	US 401 to US 1A	Widen from 2 to 3 lanes			X
A127a	Ligon Mill Rd	US 1A to NC98 Bypass	Widen from 2 to 4 lanes	X	X	X
A127b1	Ligon Mill Rd Connector	NC98 Bypass to Richland Creek	Construct 4 lanes on new location	X	X	X
A127b3	Ligon Mill Rd Connector	Richland Creek to NC98	Widen from 2 to 4 lanes		X	X
A127c	Ligon Mill Rd Connector	NC98 Bypass to Stadium Dr	Construct 4 lanes on new location			X
A134	Litchford Rd	Old Wake Forest Rd to Falls of Neuse Rd	Widen from 3 to 4 lanes		X	X
A130b	Mitchell Mill Rd	Forestville Rd and Rolesville Rd	Widen from 3 to 4 lanes			X
Frnk4a	NC56	W of West Sandling Rd and US 1	Widen from 2 to 4 lanes			X
Frnk4b	NC56	US 1 and Peach Orchard Rd	Widen from 2 to 4 lanes			X
Frnk3 / A418c	NC96	From Granville County to NC96 Bypass	Widen from 3 to 4 lanes			X
A150	NC98	Durham County Line to Thompson Mill Rd	Widen from 2 to 4 lanes		X	X
A56c / A56d	NC98	NC98 Bypass to NC39	Widen from 3 to 4 lanes			X
A608a	NC98	Debarmore St to Ligon Mill Rd (future connector)	Widen from 2 to 4 lanes			X
A124a	Northside Loop (Wake Forest)	N. Main St to N. White St	Construct 2 lanes on new location		X	X
A10	Old Wake Forest Rd	Litchford Rd/ Atlantic Blvd. to Capital Blvd.	Widen from 2 to 4 lanes	X	X	X
A1	Perry Creek Rd	US 401 to Fox Rd	Widen from 2 to 4 lanes		X	X
A2	Perry Creek Rd	Wallace Martin Way to Buffaloe Rd	Construct 4 lanes on new location		X	X
A404	S. Franklin St	Forestville Rd to NC98 Bypass	widen from 3 to 4 lanes	X	X	X
A205	Six Forks Rd	Atlantic Ave. to Capital Blvd.	Construct 4 lanes on new location		X	X
A161	Skycrest Rd	New Hope Rd and Forestville Rd	Construct 4 lanes on new location		X	X
A432	Skycrest Rd	Brentwood Rd and New Hope Rd	Widen from 2 to 4 lanes		X	X
A3	Spring Forest Rd	US 401 to Buffaloe Rd	Construct 4 lanes on new location		X	X
A417	Spring Forest Rd	Fox Rd to US 401	Widen from 2 to 4 lanes		X	X
HL-0119/A448	SR 1005 (Six Forks Rd)	Rowan St to SR 1827 (Lynn Rd) in Raleigh	Construct 6 lane median divided avenue	X	X	X
U-5826/A13c	SR 2000 (Falls of Neuse Rd)	I-540 to SR 2006 (Durant Rd)	Widen from 4 to 6 lanes	X	X	X
A59c	Sumner Blvd.	Ruritania St to Gresham Lake Rd	Construct 3 lanes on new location		X	X
A59b	Sumner Blvd. Extension	Old Wake Forest to Capital Blvd.	Construct 3 lanes on new location		X	X
Frnk26	Tanyard St Ext	Mason St to N Main St	Construct 2 lanes on new location		X	X
A779	Thornton Rd Extension	Thornton Rd to Ligon Mill Rd	Construct 2 lanes on new location		X	X
A615	Trawick Rd	Capital Blvd. and New Hope Rd	From 2 to 2 lanes (Median)	X	X	X
A672	Unicorn Dr Extention	Height Lane to Unicorn Dr	Construct 2 lanes on new location		X	X
Frnk1	US 1	Extend frwy project from US-1A to CAMPO MAB	Widen from 4 to 6 lanes		X	X
A760	US 1 Alt	Harris Rd to Youngsculle Southern Bypass	Widen from 3 to 4 lanes			X
Frnk27	US 1 Freeway Access Rds	Purnell Rd to Park Ave	Construct 2 lanes on new location		X	X
F11-1e2	US 1 North - Upgrade to Freeway	Harris Rd and US1A (Youngsville)	Widen from 4 and 6 lanes		X	X
A130c	US 401	Mitchell Mill Rd to Ventura Cir.	Widen from 7 to 8 lanes (CFI)	X	X	X
A799	US 401	Ligon Mill Rd to Louisburg Rd	Widen from 4 to 6 lanes		X	X
U-5748/A130c	US 401	SR 2044 (Ligon Mill Rd) and SR 2006 (Perry Creek Rd) Interchange	Intersection Improvements	X	X	X
U-6241/A930	US 401 Business (South Main St) & Burlington Mills Rd	East of Rolesville Middle School to US 401 Bus (South Main St)	Realign roadway and construct new interchange. Includes Complete Street improvements	X	X	X
Frnk25	US Access Rd	NC-56 to Swen St	Construct 2 lanes on new location		X	X
Frnk13	Western Service Rd	Bert Winston Rd to Pocomoke Rd	Construct 2 lanes on new location		X	X

5.0 Traffic and Revenue Forecast

As described in Chapters 1 and 2, this study develops long-term traffic and revenue (T&R) forecasts for Capital Boulevard when upgraded from a signalized arterial to a limited access freeway as both expressway and an express lanes configuration. This chapter details the forecasting approach and provides traffic and revenue forecasts under both tolled scenarios.

The Expressway Scenario assumed the following:

- An additional lane of capacity is added in each direction and all signals are removed, creating a limited-access toll road with an assumed posted speed of 65 mph.
- Interchanges would be provided at Durant Road/Perry Creek Road, Burlington Mills Road, Falls of Neuse Road/South Main Street, NC 98, Durham Road, and Purnell/Harris Road.
- All lanes and vehicle classes would be tolled based on a fixed toll schedule.
- The lane and toll configuration for this scenario is shown below in **Figure 5.1.**

The Express Lanes Scenario assumed the following:

- The additional lane of capacity added would be a separated single express toll lane in each direction, but all signals would still be removed, creating a limited-access toll road with an assumed posted speed of 65 mph.
- The interchanges from the general purpose lanes would align with the Expressway Scenario.
- Access from the general purpose lanes into the express lane would be provided north of Purnell/Harris Road, south of Stadium Drive, south NC 98, and south of Falls of Neuse Road. Exits from the express lanes into the general purpose lanes would be provided north of Durant Road/Perry Creek Road, north of Gresham Lake Road, and within the I-540 interchange.
- Toll rates would vary dynamically by time period based on traffic demand.
- The lane and toll configuration for this scenario is shown below in **Figure 5.2.**

5.1 Forecasting Approach

Traffic and revenue projections were developed for calendar years 2034 through 2073 and then converted to state fiscal years (FY), which extend from July 1st through June 30th. The TRMG2 was used to develop long-term forecasts, with a horizon model year of 2050. Socioeconomic data updated by Dr. Steven Appold (see Chapter 3) were input to the TRMG2 model to generate the trip tables representing travel demand for 2023, 2030, 2040, and 2050 model years. Traffic assignments for 2023 were validated to observed travel conditions and calibration adjustments were carried forward to the future year trip tables.

Traffic and revenue projections for years 2034 through 2050 were developed by interpolating the estimates between model years 2030 and 2040, and model years 2040 and 2050. Estimates for years following 2050 were based on assumed nominal growth in traffic and toll rates.

Figure 5.1 Assumed Expressway Configuration

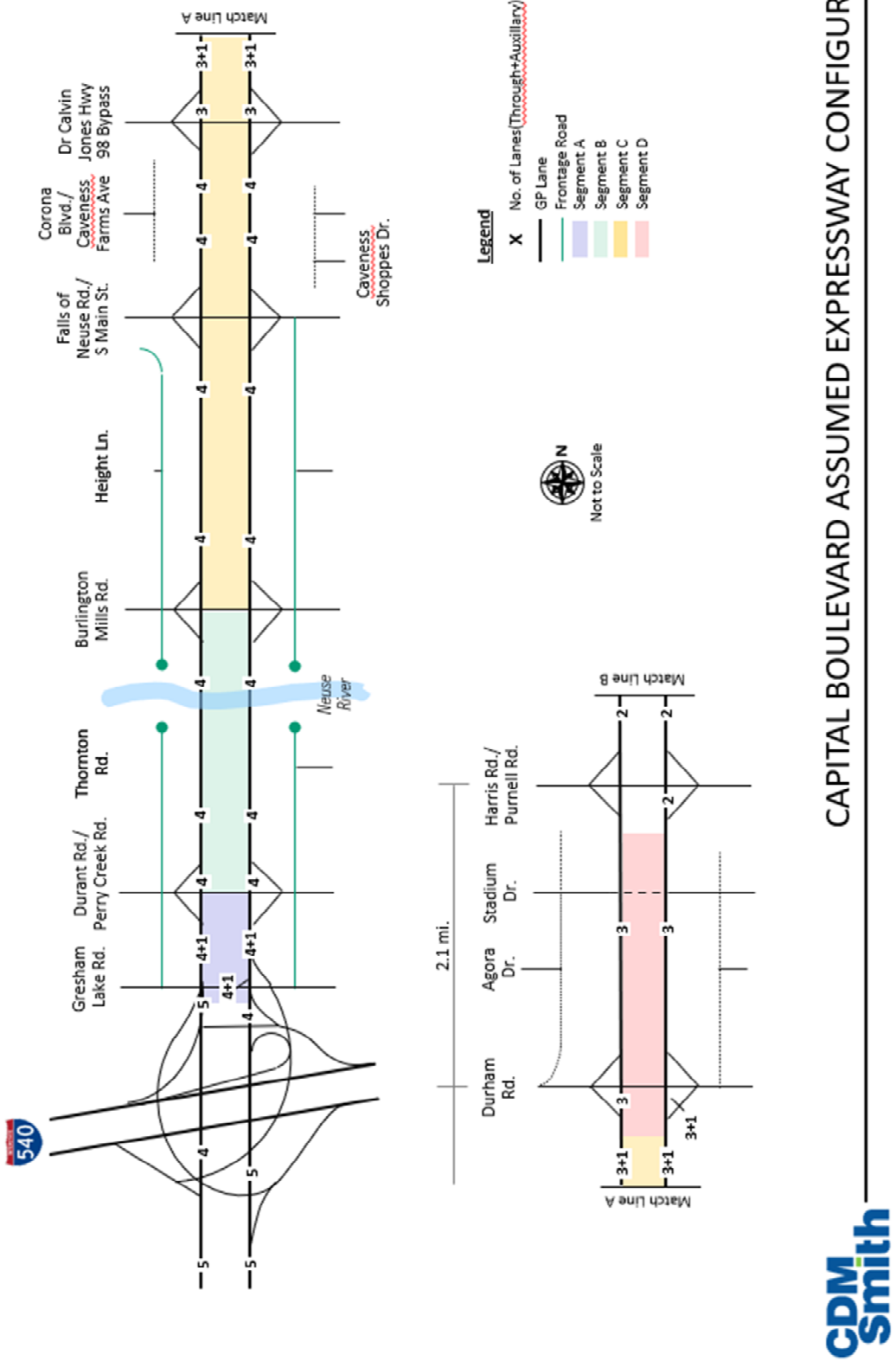
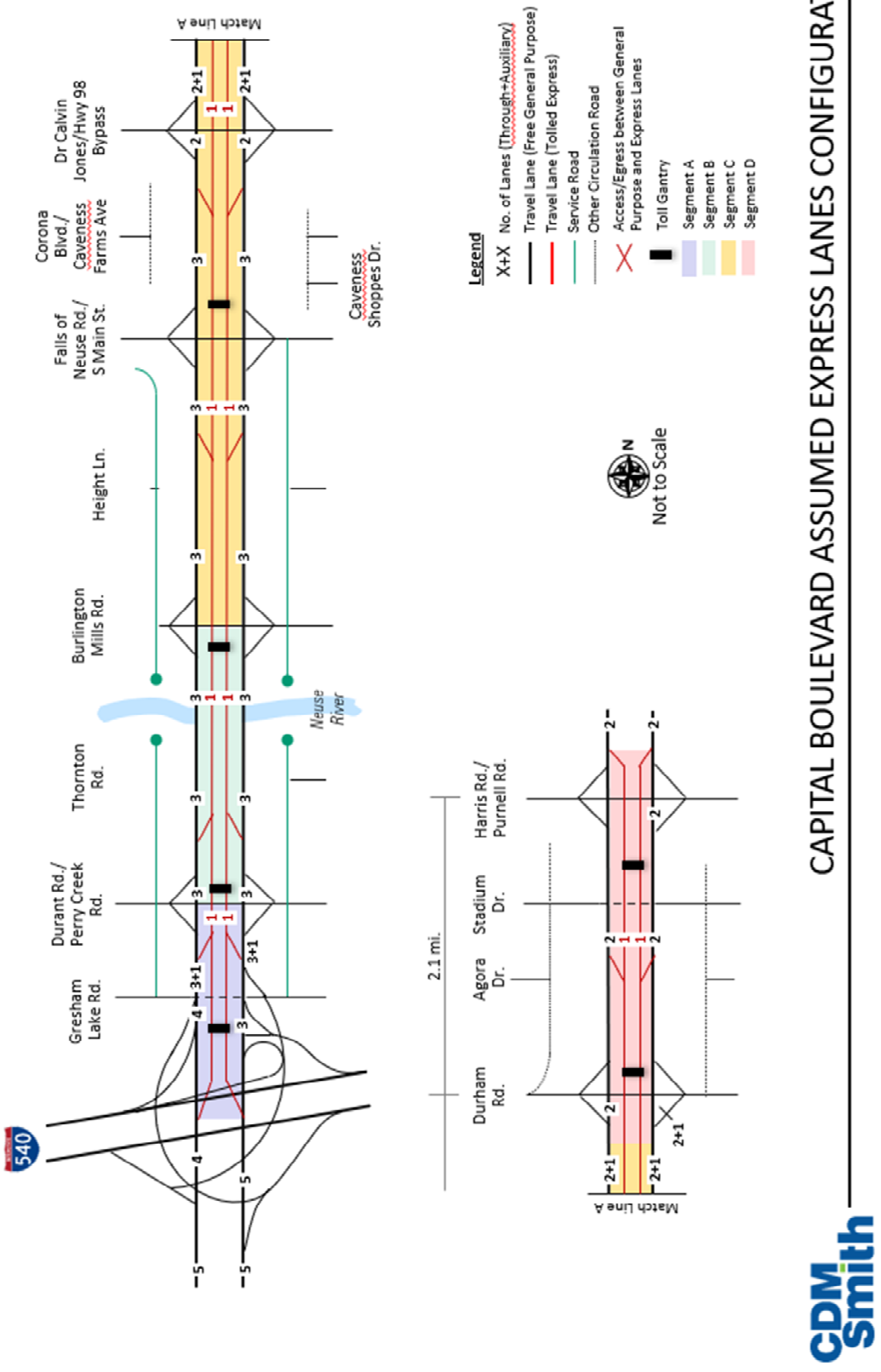


Figure 5.2 Assumed Express Lanes Configuration



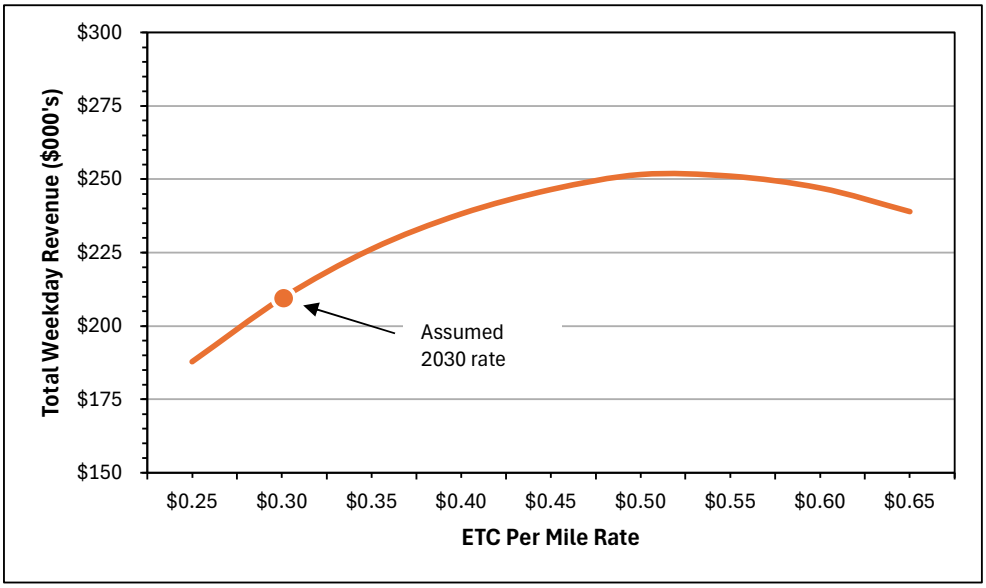
5.2 Expressway Scenario

This section covers the Expressway Scenario which assumes the conversion to a toll road where all lanes are tolled, including the existing general purpose lanes and the additional lane of new capacity, once upgraded to a limited access freeway.

5.2.1 Toll Sensitivity Assessment

As part of this traffic and revenue study, toll sensitivity analysis was conducted for the model years of 2030, 2040, and 2050. This analysis analyzes the traffic and revenue sensitivity to incremental changes in the chosen toll rate. **Figure 5.3** shows the toll sensitivity curve at 2030 levels. The horizontal scale shows the per-mile toll rate levels which were tested in the analysis for all vehicles, including both electronic toll collection via transponder (ETC) and NCTA's license plate image program named Bill by Mail (BBM). The vertical scale shows the average weekday gross toll revenue generated by the respective toll rate. The relationship assumed between ETC and BBM aligns with the policy on the Triangle Expressway, with ETC rates priced at 50 percent less than BBM rates. The ETC toll rates tested were in the range of $0.25 and $0.55 per mile, at 2030 levels. As shown in the figure, maximum revenue potential would be generated at a per mile ETC toll rate of $0.50 per mile. The forecast in this report assumes the 2030 rates would be $0.30 per mile, below the revenue maximizing toll rate.

Figure 5.3 Expressway Scenario Toll Sensitivity Curve - 2030



5.2.2 Assumed Toll Rates

Toll rates assumed in this study were established based on the toll sensitivity analysis discussed in the previous section and resulted in a rate of $0.30 per mile for Class 1 ETC customers in 2030. This is consistent with the current adopted toll schedule for Triangle Expressway for 2030. That rate was then escalated for each subsequent year based on projected rates of inflation shown previously in Table 4.1.

In keeping with toll rate policy on other NCTA facilities, tolls would be charged for three vehicle classes and two methods of payment. The following describes the three toll classes:

- Class 1 (2-axle vehicles): includes all two-axle vehicles regardless of the number of tires.
- Class 2 (3-axle vehicles): includes all three-axle vehicles including two-axle vehicles towing a single-axle trailer. Class 2 toll rates are two times the Class 1 toll rate.
- Class 3 (4-or-more axle vehicles): includes all vehicles with four or more axles (4+) including two-axle vehicles towing a dual-axle trailer. Class 3 toll rates are four times the Class 1 toll rate.

Tolls would be charged using cashless all-electronic toll collection methodology including the NCTA ETC program, NC Quick Pass, and a license plate image program named Bill by Mail (BBM). There would be no physical toll booths; all tolls would be collected via equipment located on overhead gantries. ETC transactions would require motorists to have a transponder such as NC Quick Pass or other interoperable transponders from E-ZPass, Florida SunPass, or Georgia Peach Pass. The transponder automatically deducts tolls from a pre-paid account. If a motorist did not have a transponder, high-speed cameras mounted on gantries would record the license plate and an invoice would be mailed to the registered owner through the BBM program. ETC transactions receive an automatic 50 percent discount from the BBM toll.

Table 5.1 provides toll rates assumed for each toll location for Class 1 ETC and BBM transactions, which are calculated based on the per-mile toll rate and the distance for each mainline segment. **Table 5.2** provides the same information for Classes 2 and 3. Toll rates for Classes 2 and 3 are presented as a weighted average of both classes to reflect rates that were assumed in the modeling process for this study.

Table 5.1 Assumed Class 1 Toll Rates by Year – Expressway Scenario

Year	ETC						BBM					
	NC 540 - Durant Rd/Perry Creek	Durant Rd/Perry Creek - Burlington Mills	Burlington Mills - Falls of Neuse	Falls of Neuse - Hwy 98 Bypass	Hwy 98 Bypass - Durham Rd	Durham Rd - Purnell	NC 540 - Durant Rd/Perry Creek	Durant Rd/Perry Creek - Burlington Mills	Burlington Mills - Falls of Neuse	Falls of Neuse - Hwy 98 Bypass	Hwy 98 Bypass - Durham Rd	Durham Rd - Purnell
2034	$ 0.54	$ 0.68	$ 0.68	$ 0.47	$ 0.34	$ 0.71	$ 1.08	$ 1.36	$ 1.36	$ 0.94	$ 0.68	$ 1.42
2035	0.56	0.70	0.70	0.49	0.35	0.73	1.12	1.40	1.40	0.98	0.70	1.46
2036	0.57	0.71	0.71	0.50	0.36	0.74	1.14	1.42	1.42	1.00	0.72	1.48
2037	0.58	0.72	0.72	0.51	0.37	0.76	1.16	1.44	1.44	1.02	0.74	1.52
2038	0.59	0.74	0.74	0.52	0.38	0.78	1.18	1.48	1.48	1.04	0.76	1.56
2039	0.60	0.75	0.75	0.53	0.39	0.79	1.20	1.50	1.50	1.06	0.78	1.58
2040	0.61	0.77	0.77	0.54	0.40	0.81	1.22	1.54	1.54	1.08	0.80	1.62
2041	0.63	0.78	0.78	0.55	0.41	0.82	1.26	1.56	1.56	1.10	0.82	1.64
2042	0.64	0.80	0.80	0.56	0.42	0.84	1.28	1.60	1.60	1.12	0.84	1.68
2043	0.65	0.81	0.81	0.57	0.43	0.86	1.30	1.62	1.62	1.14	0.86	1.72
2044	0.67	0.83	0.83	0.58	0.44	0.87	1.34	1.66	1.66	1.16	0.88	1.74
2045	0.68	0.85	0.85	0.59	0.45	0.89	1.36	1.70	1.70	1.18	0.90	1.78
2046	0.69	0.86	0.86	0.61	0.46	0.91	1.38	1.72	1.72	1.22	0.92	1.82
2047	0.71	0.88	0.88	0.62	0.47	0.93	1.42	1.76	1.76	1.24	0.94	1.86
2048	0.72	0.90	0.90	0.63	0.48	0.94	1.44	1.80	1.80	1.26	0.96	1.88
2049	0.73	0.92	0.92	0.64	0.49	0.96	1.46	1.84	1.84	1.28	0.98	1.92
2050	0.75	0.93	0.94	0.65	0.50	0.98	1.50	1.86	1.88	1.30	1.00	1.96
2051	0.76	0.95	0.95	0.67	0.51	1.00	1.52	1.90	1.90	1.34	1.02	2.00
2052	0.78	0.97	0.97	0.68	0.52	1.02	1.56	1.94	1.94	1.36	1.04	2.04
2053	0.79	0.99	0.99	0.70	0.53	1.04	1.58	1.98	1.98	1.40	1.06	2.08
2054	0.81	1.01	1.01	0.71	0.54	1.06	1.62	2.02	2.02	1.42	1.08	2.12
2055	0.83	1.03	1.03	0.72	0.55	1.09	1.66	2.06	2.06	1.44	1.10	2.18
2056	0.84	1.05	1.05	0.74	0.56	1.11	1.68	2.10	2.10	1.48	1.12	2.22
2057	0.86	1.08	1.08	0.75	0.57	1.13	1.72	2.16	2.16	1.50	1.14	2.26
2058	0.88	1.10	1.10	0.77	0.58	1.15	1.76	2.20	2.20	1.54	1.16	2.30
2059	0.90	1.12	1.12	0.78	0.59	1.17	1.80	2.24	2.24	1.56	1.18	2.34
2060	0.91	1.14	1.14	0.80	0.60	1.20	1.82	2.28	2.28	1.60	1.20	2.40
2061	0.93	1.16	1.16	0.81	0.61	1.22	1.86	2.32	2.32	1.62	1.22	2.44
2062	0.95	1.19	1.19	0.83	0.62	1.25	1.90	2.38	2.38	1.66	1.24	2.50
2063	0.97	1.21	1.21	0.85	0.63	1.27	1.94	2.42	2.42	1.70	1.26	2.54
2064	0.99	1.24	1.24	0.86	0.64	1.30	1.98	2.48	2.48	1.72	1.28	2.60
2065	1.01	1.26	1.26	0.88	0.65	1.32	2.02	2.52	2.52	1.76	1.30	2.64
2066	1.03	1.29	1.29	0.90	0.66	1.35	2.06	2.58	2.58	1.80	1.32	2.70
2067	1.05	1.31	1.31	0.92	0.67	1.38	2.10	2.62	2.62	1.84	1.34	2.76
2068	1.07	1.34	1.34	0.94	0.68	1.40	2.14	2.68	2.68	1.88	1.36	2.80
2069	1.09	1.36	1.36	0.95	0.69	1.43	2.18	2.72	2.72	1.90	1.38	2.86
2070	1.11	1.39	1.39	0.97	0.70	1.46	2.22	2.78	2.78	1.94	1.40	2.92
2071	1.14	1.42	1.42	0.99	0.71	1.49	2.28	2.84	2.84	1.98	1.42	2.98
2072	1.16	1.45	1.45	1.01	0.72	1.52	2.32	2.90	2.90	2.02	1.44	3.04
2073	1.18	1.48	1.48	1.03	0.73	1.55	2.36	2.96	2.96	2.06	1.46	3.10

Table 5.2 Assumed Class 2 and 3 Toll Rates by Year – Expressway Scenario

	ETC						BBM					
Year	NC 540 - Durant Rd/Perry Creek	Durant Rd/Perry Creek - Burlington Mills	Burlington Mills - Falls of Neuse	Falls of Neuse - Hwy 98 Bypass	Hwy 98 Bypass - Durham Rd	Durham Rd - Purnell	NC 540 - Durant Rd/Perry Creek	Durant Rd/Perry Creek - Burlington Mills	Burlington Mills - Falls of Neuse	Falls of Neuse - Hwy 98 Bypass	Hwy 98 Bypass - Durham Rd	Durham Rd - Purnell
2034	$ 1.84	$ 2.32	$ 2.32	$ 1.61	$ 1.16	$ 2.43	$ 3.69	$ 4.65	$ 4.65	$ 3.21	$ 2.32	$ 4.85
2035	1.91	2.39	2.39	1.67	1.20	2.49	3.83	4.78	4.78	3.35	2.39	4.99
2036	1.95	2.43	2.43	1.71	1.23	2.53	3.89	4.85	4.85	3.42	2.46	5.06
2037	1.98	2.46	2.46	1.74	1.26	2.60	3.96	4.92	4.92	3.48	2.53	5.19
2038	2.02	2.53	2.53	1.78	1.30	2.66	4.03	5.06	5.06	3.55	2.60	5.33
2039	2.05	2.56	2.56	1.81	1.33	2.70	4.10	5.12	5.12	3.62	2.66	5.40
2040	2.08	2.63	2.63	1.84	1.37	2.77	4.17	5.26	5.26	3.69	2.73	5.53
2041	2.15	2.66	2.66	1.88	1.40	2.80	4.30	5.33	5.33	3.76	2.80	5.60
2042	2.19	2.73	2.73	1.91	1.43	2.87	4.37	5.47	5.47	3.83	2.87	5.74
2043	2.22	2.77	2.77	1.95	1.47	2.94	4.44	5.53	5.53	3.89	2.94	5.88
2044	2.29	2.84	2.84	1.98	1.50	2.97	4.58	5.67	5.67	3.96	3.01	5.94
2045	2.32	2.90	2.90	2.02	1.54	3.04	4.65	5.81	5.81	4.03	3.07	6.08
2046	2.36	2.94	2.94	2.08	1.57	3.11	4.71	5.88	5.88	4.17	3.14	6.22
2047	2.43	3.01	3.01	2.12	1.61	3.18	4.85	6.01	6.01	4.24	3.21	6.35
2048	2.46	3.07	3.07	2.15	1.64	3.21	4.92	6.15	6.15	4.30	3.28	6.42
2049	2.49	3.14	3.14	2.19	1.67	3.28	4.99	6.29	6.29	4.37	3.35	6.56
2050	2.56	3.18	3.21	2.22	1.71	3.35	5.12	6.35	6.42	4.44	3.42	6.69
2051	2.60	3.25	3.25	2.29	1.74	3.42	5.19	6.49	6.49	4.58	3.48	6.83
2052	2.66	3.31	3.31	2.32	1.78	3.48	5.33	6.63	6.63	4.65	3.55	6.97
2053	2.70	3.38	3.38	2.39	1.81	3.55	5.40	6.76	6.76	4.78	3.62	7.10
2054	2.77	3.45	3.45	2.43	1.84	3.62	5.53	6.90	6.90	4.85	3.69	7.24
2055	2.84	3.52	3.52	2.46	1.88	3.72	5.67	7.04	7.04	4.92	3.76	7.45
2056	2.87	3.59	3.59	2.53	1.91	3.79	5.74	7.17	7.17	5.06	3.83	7.58
2057	2.94	3.69	3.69	2.56	1.95	3.86	5.88	7.38	7.38	5.12	3.89	7.72
2058	3.01	3.76	3.76	2.63	1.98	3.93	6.01	7.51	7.51	5.26	3.96	7.86
2059	3.07	3.83	3.83	2.66	2.02	4.00	6.15	7.65	7.65	5.33	4.03	7.99
2060	3.11	3.89	3.89	2.73	2.05	4.10	6.22	7.79	7.79	5.47	4.10	8.20
2061	3.18	3.96	3.96	2.77	2.08	4.17	6.35	7.92	7.92	5.53	4.17	8.33
2062	3.25	4.06	4.06	2.84	2.12	4.27	6.49	8.13	8.13	5.67	4.24	8.54
2063	3.31	4.13	4.13	2.90	2.15	4.34	6.63	8.27	8.27	5.81	4.30	8.68
2064	3.38	4.24	4.24	2.94	2.19	4.44	6.76	8.47	8.47	5.88	4.37	8.88
2065	3.45	4.30	4.30	3.01	2.22	4.51	6.90	8.61	8.61	6.01	4.44	9.02
2066	3.52	4.41	4.41	3.07	2.25	4.61	7.04	8.81	8.81	6.15	4.51	9.22
2067	3.59	4.47	4.47	3.14	2.29	4.71	7.17	8.95	8.95	6.29	4.58	9.43
2068	3.65	4.58	4.58	3.21	2.32	4.78	7.31	9.15	9.15	6.42	4.65	9.56
2069	3.72	4.65	4.65	3.25	2.36	4.88	7.45	9.29	9.29	6.49	4.71	9.77
2070	3.79	4.75	4.75	3.31	2.39	4.99	7.58	9.50	9.50	6.63	4.78	9.97
2071	3.89	4.85	4.85	3.38	2.43	5.09	7.79	9.70	9.70	6.76	4.85	10.18
2072	3.96	4.95	4.95	3.45	2.46	5.19	7.92	9.91	9.91	6.90	4.92	10.38
2073	4.03	5.06	5.06	3.52	2.49	5.29	8.06	10.11	10.11	7.04	4.99	10.59

5.2.3 Estimated Weekday Transactions and Revenue

This section provides theoretical average weekday traffic and revenue for opening year 2034 and model years 2040 and 2050, shown in **Table 5.3**. The information is shown by toll location for total day and total direction. As shown, the highest revenue producing toll location is located between Perry Creek Road/Durant Road and Burlington Mills Road. This toll location has toll revenue of $74,260 in 2034, nearly doubling by 2050 to $131,693. The lowest revenue producing toll locations are in the northern portion from NC 98 to Purnell Road. These toll locations double between 2034 and 2050 due to the higher growth forecast in the northern portion of the corridor near Wake Forest and Franklin County.

Table 5.3 Estimated Average Weekday Traffic and Revenue – Expressway Scenario

U-5307	Toll Location		2034 [1]		2040		2050	
Segment	From	To	Trans	Revenue	Trans	Revenue	Trans	Revenue
A	I-540	Perry Creek/Durant Rd	73,330	$ 58,009	81,997	$ 72,906	96,551	$ 103,656
B	Perry Creek/Durant Rd	Burlington Mills Rd	75,892	74,260	85,037	94,083	100,272	131,693
C	Burlington Mills Rd	Falls of Neuse Rd	65,879	64,372	74,317	82,082	87,854	116,553
C	Falls of Neuse Rd	NC 98	55,961	38,473	62,627	48,781	75,853	69,882
C	NC 98	Durham Rd	41,116	20,873	46,910	27,574	58,858	42,357
D	Durham Rd	Purnell Rd	42,430	44,703	49,538	59,069	62,519	88,152
Total	I-540	Purnell Rd	354,607	$ 300,690	400,425	$ 384,496	481,907	$ 552,292

[1] Does not include ramp-up.

5.2.4 Estimated Annual Transactions and Revenue

The weekday transaction and revenue estimates calculated at 2030, 2040, and 2050 levels based on travel demand model assumptions were used to develop fiscal year transaction and revenue forecasts over a 40-year projection period. Weekday transactions were multiplied by annualization factors of 346 for Class 1 vehicles and 274 for Classes 2 and 3. These annualization factors were developed based on historical traffic counts on Capital Boulevard. Interpolation between 2030 and 2040 estimates provided the opening year of 2034, and intermediate years were also calculated through interpolation. After the last model year of 2050, traffic growth was assumed to occur at a nominal 0.5 percent per year. Estimated annual transactions and revenue by fiscal year are presented in **Table 5.4**. The fiscal year is the 12-month period ending June 30th for each respective year. Forecasts are provided for FY 2035 through FY 2073, with an assumed opening date of July 1, 2034, which aligns with the start of FY 2035. The toll revenue shown in this table is gross revenue and does not account for adjustments due to leakage associated with BBM transactions or anticipated processing fee revenue. Additionally, ramp-up factors are applied to the first 36 months of the forecast as a net reduction factors to reflect the transition period where it takes time for motorists to become aware of the toll road policies and modify their travel habits.

Ramp-up reflects the patterns typically experienced on new toll facilities, in which transaction and revenue growth over the first several years considerably exceeds long-term averages. The factors used in the annual estimates shown in Table 5.4 were the following:

- Months 1-12: 0.618
- Months 13-24: 0.814
- Months 25-36: 0.945

Table 5.4 Estimated Annual Transactions and Gross Toll Revenue – Expressway Scenario

Fiscal Year	Estimated Annual Transactions (000)				Estimated Annual Gross Toll Revenue (000)				Average Toll Per Transaction		
	ETC	BBM	Total	% ETC	ETC	BBM	Total	% ETC	ETC	BBM	Total
2035	56,786	21,023	77,809	73.0	$ 37,300	$ 29,157	$ 66,457	56.1	$ 0.66	$ 1.39	$ 0.85
2036	73,714	26,547	100,260	73.5	49,592	37,626	87,219	56.9	0.67	1.42	0.87
2037	87,680	30,726	118,406	74.1	60,074	44,248	104,323	57.6	0.69	1.44	0.88
2038	95,643	32,605	128,248	74.6	67,005	47,897	114,901	58.3	0.70	1.47	0.90
2039	99,531	32,998	132,528	75.1	71,203	49,382	120,585	59.0	0.72	1.50	0.91
2040	102,301	32,977	135,278	75.6	74,725	50,266	124,991	59.8	0.73	1.52	0.92
2041	104,835	33,096	137,931	76.0	78,254	51,435	129,689	60.3	0.75	1.55	0.94
2042	107,120	33,353	140,473	76.3	81,669	52,819	134,488	60.7	0.76	1.58	0.96
2043	109,457	33,613	143,070	76.5	85,150	54,188	139,337	61.1	0.78	1.61	0.97
2044	111,846	33,875	145,721	76.8	88,802	55,605	144,407	61.5	0.79	1.64	0.99
2045	114,289	34,140	148,429	77.0	92,829	57,192	150,021	61.9	0.81	1.68	1.01
2046	116,786	34,407	151,194	77.2	96,791	58,674	155,465	62.3	0.83	1.71	1.03
2047	119,340	34,677	154,018	77.5	101,028	60,258	161,287	62.6	0.85	1.74	1.05
2048	121,952	34,949	156,902	77.7	105,479	61,903	167,381	63.0	0.86	1.77	1.07
2049	124,623	35,224	159,847	78.0	109,945	63,483	173,428	63.4	0.88	1.80	1.08
2050	127,354	35,502	162,855	78.2	114,650	65,136	179,786	63.8	0.90	1.83	1.10
2051	129,056	35,730	164,786	78.3	118,424	66,746	185,170	64.0	0.92	1.87	1.12
2052	129,702	35,909	165,610	78.3	121,370	68,407	189,777	64.0	0.94	1.91	1.15
2053	130,350	36,088	166,438	78.3	124,476	70,157	194,633	64.0	0.95	1.94	1.17
2054	131,002	36,269	167,271	78.3	127,610	71,923	199,532	64.0	0.97	1.98	1.19
2055	131,657	36,450	168,107	78.3	130,899	73,781	204,680	64.0	0.99	2.02	1.22
2056	132,315	36,632	168,947	78.3	134,187	75,635	209,822	64.0	1.01	2.06	1.24
2057	132,977	36,815	169,792	78.3	137,701	77,612	215,313	64.0	1.04	2.11	1.27
2058	133,642	37,000	170,641	78.3	141,395	79,695	221,090	64.0	1.06	2.15	1.30
2059	134,310	37,185	171,494	78.3	144,828	81,631	226,459	64.0	1.08	2.20	1.32
2060	134,981	37,370	172,352	78.3	148,239	83,554	231,793	64.0	1.10	2.24	1.34
2061	135,656	37,557	173,214	78.3	151,681	85,494	237,175	64.0	1.12	2.28	1.37
2062	136,334	37,745	174,080	78.3	155,607	87,708	243,315	64.0	1.14	2.32	1.40
2063	137,016	37,934	174,950	78.3	159,689	90,009	249,698	64.0	1.17	2.37	1.43
2064	137,701	38,124	175,825	78.3	163,687	92,263	255,950	64.0	1.19	2.42	1.46
2065	138,390	38,314	176,704	78.3	167,719	94,537	262,256	64.0	1.21	2.47	1.48
2066	139,082	38,506	177,587	78.3	171,913	96,901	268,814	64.0	1.24	2.52	1.51
2067	139,777	38,698	178,475	78.3	176,246	99,343	275,590	64.0	1.26	2.57	1.54
2068	140,476	38,892	179,368	78.3	180,517	101,750	282,266	64.0	1.29	2.62	1.57
2069	141,178	39,086	180,265	78.3	184,697	104,108	288,805	64.0	1.31	2.66	1.60
2070	141,884	39,282	181,166	78.3	189,022	106,547	295,569	64.0	1.33	2.71	1.63
2071	142,594	39,478	182,072	78.3	193,985	109,347	303,332	64.0	1.36	2.77	1.67
2072	143,307	39,675	182,982	78.3	198,992	112,171	311,163	64.0	1.39	2.83	1.70
2073	144,023	39,874	183,897	78.3	203,883	114,927	318,810	64.0	1.42	2.88	1.73

Annual transactions are expected to increase from 77.8 million in 2035 to 135.5 million in 2040, an average annual percent change of nearly 12 percent. This is largely due to the ramp-up applied in the first four years, and a higher rate of population and household growth during this time period. From 2040 to 2050, annual transactions are anticipated to grow to 162.9 million, an average annual percent change of just under 2.0 percent. This shows a steadying effect after ramp-up and as population and household growth stabilizes in the northern end of the corridor. In this same time period, ETC marketshare of transactions is estimated to increase from 73 percent in 2034 to 78.2 percent in 2050. After 2050, a nominal growth of 0.5 percent is assumed, making annual transactions reach 183.9 million in 2073. These transactions translate to annual gross revenue of $66.5 million in 2034 reaching $318.8 million in 2073, an average annual percent change of 4.2 percent. Gross toll revenue growth is higher than the estimated transaction growth due to the assumed inflationary increases in toll rate of 2.5 percent per year. **Figure 5.4** provides a graphical depiction of forecasted annual transactions, including the distribution of transactions between ETC and BBM. **Figure 5.5** provides the same depiction for gross toll revenue.

Figure 5.4 Estimated Annual Transactions by Payment Method - Expressway Scenario

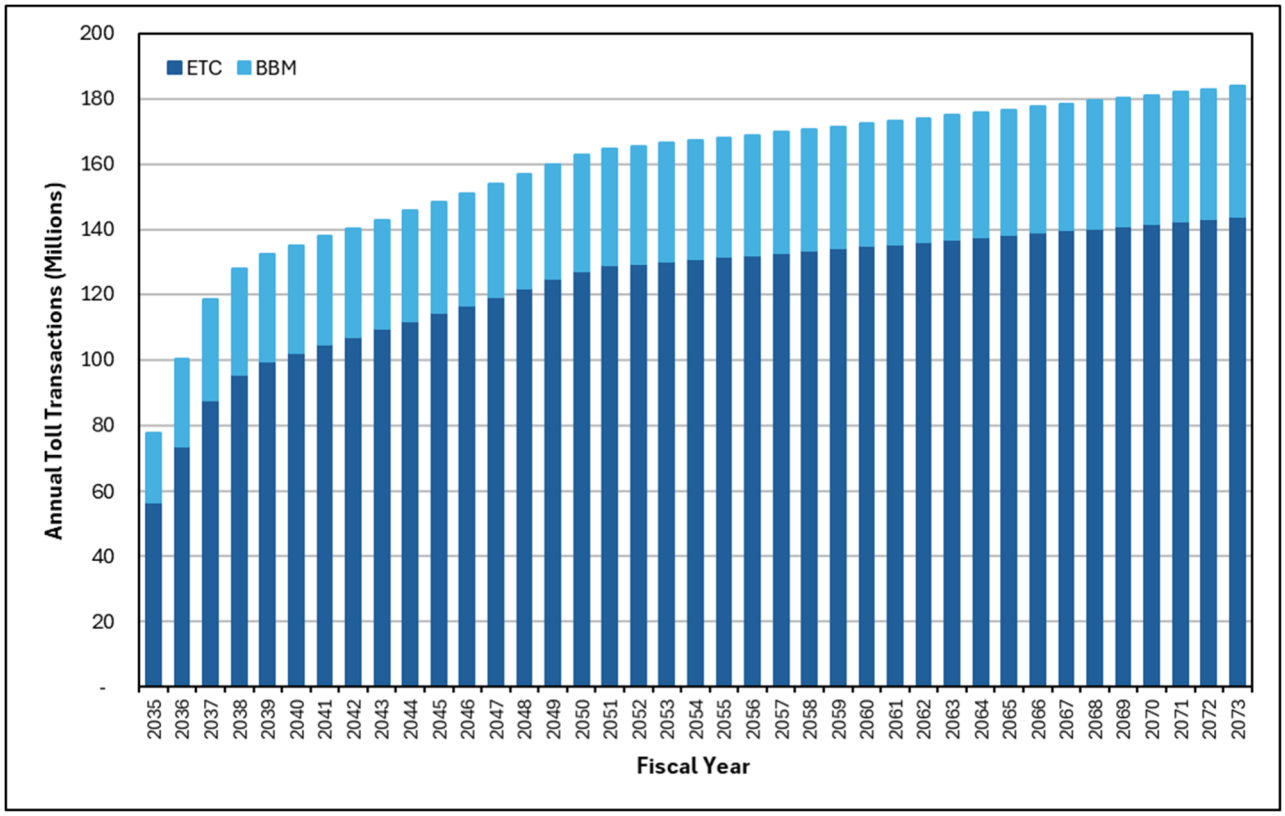
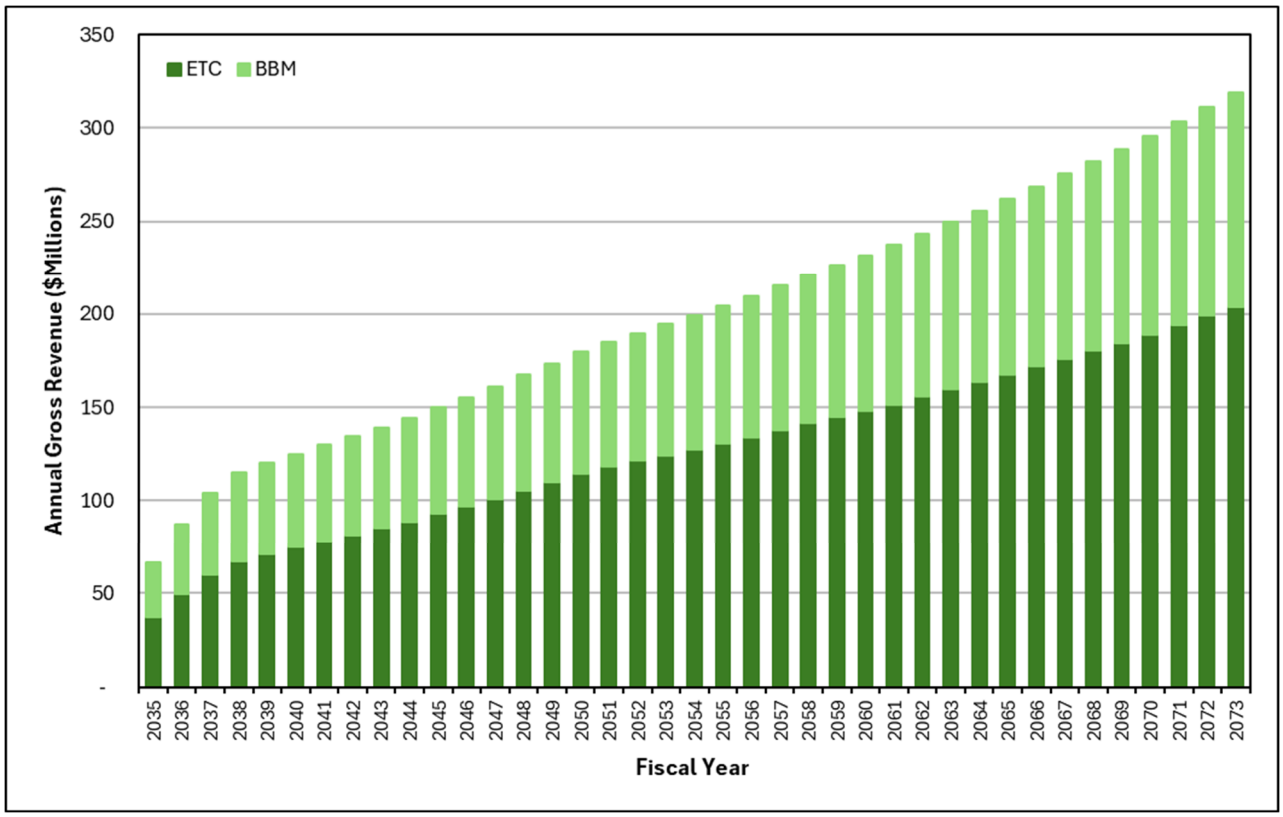


Figure 5.5 Estimated Annual Gross Toll Revenue by Payment Method - Expressway Scenario



5.2.5 Estimated Adjusted Annual Revenue

The final step in the forecast process was to adjust gross toll revenue estimates for leakage and potential additional processing fee revenue associated with the BBM collections process. The annual forecast of adjusted total revenue is provided in **Table 5.5**. Estimated gross revenue for FY 2034 is shown at $66.5 million and nearly 44 percent, or $29.2 million, is contributed from BBM transactions.

As with other all-electronic toll collection facilities in the United States, there is always some portion of BBM revenue which may not be collected. This is generally referred to as “leakage” and is a result of a variety of factors, including:

- Unreadable or obscured license plates at the time of the transaction
- Incomplete, unavailable or inaccurate information about vehicle owner name and address
- Non-payment of billed BBM transactions.

Based on actual experience on Triangle Expressway and Monroe Expressway, estimates of BBM leakage were applied for each year in **Table 5.5**. This was applied only to the BBM share of gross revenue. In FY 2034, for example, losses due to BBM leakage were estimated at $6.6 million, or 22.5 percent of expected BBM toll revenue, resulting in adjusted annual revenue of $59.9 million. The BBM leakage is estimated to reach $25.8 million by FY 2073.

Table 5.5 Estimated Annual Collected Toll and Fee Revenue - Expressway Scenario

Fiscal Year	Estimated Annual Gross Toll Revenue ($000)			BBM Leakage	Adjusted Toll Revenue	Processing Fee Revenue	Total Collected Revenue
	ETC	BBM	Total				
2035	$ 37,300	$ 29,157	$ 66,457	$ (6,555)	$ 59,902	$ 3,153	$ 63,056
2036	49,592	37,626	87,219	(8,459)	78,760	3,982	82,742
2037	60,074	44,248	104,323	(9,947)	94,375	4,609	98,984
2038	67,005	47,897	114,901	(10,767)	104,134	4,891	109,025
2039	71,203	49,382	120,585	(11,101)	109,483	4,950	114,433
2040	74,725	50,266	124,991	(11,300)	113,691	4,947	118,638
2041	78,254	51,435	129,689	(11,563)	118,126	4,964	123,090
2042	81,669	52,819	134,488	(11,874)	122,614	5,003	127,617
2043	85,150	54,188	139,337	(12,182)	127,156	5,042	132,198
2044	88,802	55,605	144,407	(12,500)	131,907	5,081	136,988
2045	92,829	57,192	150,021	(12,857)	137,164	5,121	142,285
2046	96,791	58,674	155,465	(13,190)	142,275	5,161	147,436
2047	101,028	60,258	161,287	(13,546)	147,740	5,202	152,942
2048	105,479	61,903	167,381	(13,916)	153,465	5,242	158,708
2049	109,945	63,483	173,428	(14,271)	159,157	5,284	164,441
2050	114,650	65,136	179,786	(14,643)	165,143	5,325	170,468
2051	118,424	66,746	185,170	(15,005)	170,165	5,360	175,525
2052	121,370	68,407	189,777	(15,378)	174,399	5,386	179,785
2053	124,476	70,157	194,633	(15,772)	178,861	5,413	184,274
2054	127,610	71,923	199,532	(16,168)	183,364	5,440	188,804
2055	130,899	73,781	204,680	(16,586)	188,094	5,468	193,562
2056	134,187	75,635	209,822	(17,003)	192,819	5,495	198,314
2057	137,701	77,612	215,313	(17,448)	197,866	5,522	203,388
2058	141,395	79,695	221,090	(17,916)	203,174	5,550	208,724
2059	144,828	81,631	226,459	(18,351)	208,108	5,578	213,686
2060	148,239	83,554	231,793	(18,783)	213,010	5,606	218,616
2061	151,681	85,494	237,175	(19,219)	217,955	5,634	223,589
2062	155,607	87,708	243,315	(19,717)	223,598	5,662	229,260
2063	159,689	90,009	249,698	(20,234)	229,463	5,690	235,153
2064	163,687	92,263	255,950	(20,741)	235,209	5,719	240,927
2065	167,719	94,537	262,256	(21,252)	241,004	5,747	246,751
2066	171,913	96,901	268,814	(21,784)	247,030	5,776	252,806
2067	176,246	99,343	275,590	(22,333)	253,257	5,805	259,062
2068	180,517	101,750	282,266	(22,874)	259,392	5,834	265,226
2069	184,697	104,108	288,805	(23,404)	265,401	5,863	271,264
2070	189,022	106,547	295,569	(23,952)	271,617	5,892	277,509
2071	193,985	109,347	303,332	(24,582)	278,750	5,922	284,672
2072	198,992	112,171	311,163	(25,217)	285,947	5,951	291,898
2073	203,883	114,927	318,810	(25,836)	292,974	5,981	298,955

Also shown in Table 5.4 are estimates of BBM processing fee revenue. This relates to processing fees which are added to BBM invoices which are not paid within the first payment interval. A $6.00 processing fee is assessed for each unpaid BBM invoice up to the fourth unpaid invoice, resulting in a maximum of $24 in assessed processing fees. Processing fees are estimated to generate about $3.2 million in FY 2034, increasing to about $6.0 million in FY 2073. Limited growth is anticipated in processing fee revenue after FY 2050 due to relatively stable share of BBM transactions and no annual increase in processing fees assumed in the forecast period.

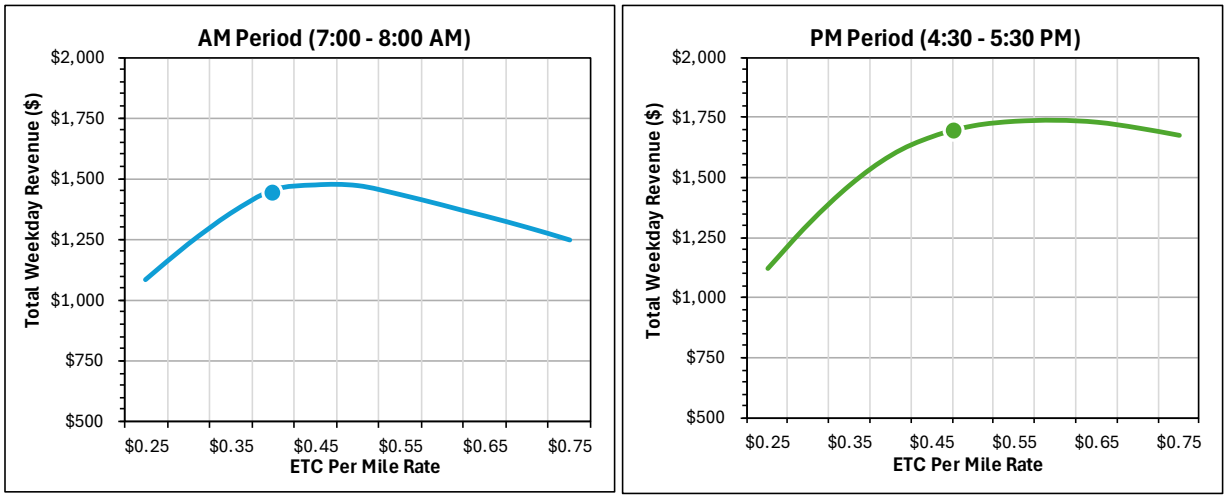
5.3 Express Lanes Scenario

The express lane scenario assumes the same total number of lanes as the Expressway Scenario, but the additional lane of capacity added to the current lane configuration is treated as a single tolled express lane. The assumption is that the express lane would operate as a dynamically priced facility, allowing toll rates to be priced at small time intervals based on current traffic conditions. The access configuration is setup in a way to filter traffic to/from the I-540 interchange, with access allowing customers to enter the lanes southbound at Purnell Road, Stadium Drive, NC 98, and Falls of Neuse and exit at Thornton Road or within the I-540 interchange. In the northbound direction the reciprocal access is allowed, with entrances at I-540 and Thornton Road, and exits at Falls of Neuse, NC 98, Stadium Drive, and Purnell Road. These access points were based on coordination with NCTA and CAMPO and informed by the Streetlight data discussed earlier in Chapter 2.

5.3.1 Toll Sensitivity Assessment

A range of per mile toll rates from $0.25 to $0.75 was tested to develop toll sensitivity curves to identify toll rates by gantry that would optimize revenue while maintaining a level of traffic that would keep the express lanes operating at speeds above 55 mph. Example toll sensitivity curves for the southbound AM peak period and northbound PM peak period for model year 2050 are shown in Figure 5.4. The sample gantry shown is for the location at Burlington Mills Road, where the peak loading within the express lanes can be found due to the access configuration. The curves show that the PM peak period generates slightly more revenue on an average weekday basis, but both curves produce optimum toll rates in the range of $0.40 to $0.45 per mile.

Figure 5.6 Sample 2050 Toll Sensitivity Curves (Toll Zone at Burlington Mills Road)



5.3.2 Estimated Weekday Traffic and Revenue

Estimated average weekday traffic and revenue for opening year 2034 and model years 2040 and 2050 is shown in **Table 5.6**. The information is shown by toll gantry for total day and combined direction. As shown, the highest revenue producing segment is located between Burlington Mills Road and Falls of Neuse Road. This segment has toll revenue of $8,060 in 2034, more than doubling by 2050 to $19,704. The lowest revenue producing segments are the end points of the corridor which generate less than $2,000 in 2034. The express lane scenario produces significantly less revenue than the Expressway Scenario due to the reduced number of tolled lanes and the limited general purpose lane congestion and modest time savings provided by the express lanes, Estimated time savings provided by the express lanes for a through trip in the peak travel direction during peak periods ranged from 0.7 to 0.9 minutes in 2040, and from 1.2 to 2.0 minutes in 2050.

Table 5.6 Estimated Weekday Traffic and Revenue - Express Lanes Scenario

U-5307	Toll Location		2034 [1]		2040		2050	
Segment	From	To	Trans	Revenue	Trans	Revenue	Trans	Revenue
A	I-540	Perry Creek/Durant Rd	8,811	$ 1,375	10,078	$ 1,821	10,958	$ 2,423
B	Perry Creek/Durant Rd	Burlington Mills Rd	14,137	5,708	15,257	7,276	17,339	11,910
C	Burlington Mills Rd	Falls of Neuse Rd	15,982	8,060	17,243	10,655	19,704	15,032
C	Falls of Neuse Rd	NC 98	11,313	4,582	12,378	5,809	14,094	9,978
C	NC 98	Durham Rd	6,402	3,537	7,618	4,891	9,218	9,068
D	Durham Rd	Purnell Rd	5,225	1,838	6,090	2,466	7,735	3,832
Total	I-540	Purnell Rd	61,869	$ 25,100	68,664	$ 32,918	79,048	$ 52,243

[1] Does not include ramp-up.

5.3.3 Estimated Annual Transactions and Revenue

The weekday transaction and revenue estimates calculated at 2030, 2040, and 2050 levels based on travel demand model assumptions were used to develop fiscal year transaction and revenue forecasts over a 40-year projection period. Weekday transactions were multiplied by annualization factors of 275 for Class 1 vehicles and 274 for Classes 2 and 3. Interpolation between 2030 and 2040 estimates provided the opening year of 2034, and intermediate years were also calculated through interpolation.

After the last model year of 2050, traffic growth was assumed to occur at a nominal 0.5 percent per year. Estimated annual transactions and revenue by fiscal year are presented in **Table 5.7**. The toll revenue shown in this table is gross revenue and does not account for adjustments due to leakage associated with BBM transactions or anticipated processing fee revenue. Additionally, ramp-up factors are applied to the first three years of the forecast as a net reduction factors to reflect the transition period where it takes time for motorists to become aware of the toll road policies and modify their travel habits.

5.3.4 Estimated Adjusted Annual Revenue

The annual forecast of adjusted total revenue, including estimates for leakage and potential additional processing fee revenue associated with the BBM collections process, is provided in **Table 5.8**.

Based on actual experience on Triangle Expressway and Monroe Expressway, estimates of BBM leakage were applied to each year in Table 5.7. This was applied only to the BBM share of gross revenue. In FY 2035, for example, losses due to BBM leakage were estimated at $0.61 million, or 22.5 percent of expected BBM toll revenue, resulting in adjusted annual revenue of $5.1 million. The BBM leakage is estimated to reach $2.4 million by FY 2073.

Table 5.7 Estimated Annual Transactions and Gross Toll Revenue - Express Lanes Scenario

Fiscal Year	Estimated Annual Transactions (000)				Estimated Annual Gross Toll Revenue ($000)				Average Toll Per Transaction		
	ETC	BBM	Total	% ETC	ETC	BBM	Total	% ETC	ETC	BBM	Total
2035	9,135	4,185	13,320	68.6	$ 2,975	$ 2,713	$ 5,689	52.3	$ 0.33	$ 0.65	$ 0.43
2036	11,196	5,013	16,208	69.1	3,762	3,352	7,114	52.9	0.34	0.67	0.44
2037	12,321	5,394	17,714	69.6	4,268	3,718	7,986	53.4	0.35	0.69	0.45
2038	12,656	5,413	18,070	70.0	4,525	3,851	8,376	54.0	0.36	0.71	0.46
2039	12,970	5,419	18,389	70.5	4,786	3,978	8,764	54.6	0.37	0.73	0.48
2040	13,291	5,426	18,717	71.0	5,062	4,110	9,172	55.2	0.38	0.76	0.49
2041	13,578	5,436	19,013	71.4	5,345	4,253	9,598	55.7	0.39	0.78	0.50
2042	13,828	5,450	19,277	71.7	5,633	4,409	10,042	56.1	0.41	0.81	0.52
2043	14,083	5,464	19,546	72.0	5,938	4,571	10,509	56.5	0.42	0.84	0.54
2044	14,343	5,478	19,821	72.4	6,260	4,741	11,001	56.9	0.44	0.87	0.56
2045	14,608	5,493	20,100	72.7	6,602	4,917	11,518	57.3	0.45	0.90	0.57
2046	14,878	5,507	20,385	73.0	6,963	5,100	12,063	57.7	0.47	0.93	0.59
2047	15,154	5,522	20,676	73.3	7,345	5,291	12,636	58.1	0.48	0.96	0.61
2048	15,435	5,537	20,972	73.6	7,749	5,491	13,240	58.5	0.50	0.99	0.63
2049	15,722	5,552	21,275	73.9	8,177	5,699	13,876	58.9	0.52	1.03	0.65
2050	16,015	5,568	21,583	74.2	8,630	5,915	14,545	59.3	0.54	1.06	0.67
2051	16,244	5,603	21,847	74.4	8,996	6,116	15,113	59.5	0.55	1.09	0.69
2052	16,406	5,659	22,065	74.4	9,266	6,300	15,566	59.5	0.56	1.11	0.71
2053	16,570	5,716	22,286	74.4	9,544	6,489	16,033	59.5	0.58	1.14	0.72
2054	16,736	5,773	22,509	74.4	9,830	6,683	16,514	59.5	0.59	1.16	0.73
2055	16,903	5,831	22,734	74.4	10,125	6,884	17,009	59.5	0.60	1.18	0.75
2056	17,030	5,874	22,904	74.4	10,403	7,073	17,476	59.5	0.61	1.20	0.76
2057	17,115	5,904	23,019	74.4	10,663	7,250	17,913	59.5	0.62	1.23	0.78
2058	17,200	5,933	23,134	74.4	10,930	7,431	18,361	59.5	0.64	1.25	0.79
2059	17,286	5,963	23,249	74.4	11,203	7,617	18,820	59.5	0.65	1.28	0.81
2060	17,373	5,993	23,366	74.4	11,483	7,807	19,291	59.5	0.66	1.30	0.83
2061	17,460	6,023	23,483	74.4	11,770	8,003	19,773	59.5	0.67	1.33	0.84
2062	17,547	6,053	23,600	74.4	12,065	8,203	20,267	59.5	0.69	1.36	0.86
2063	17,635	6,083	23,718	74.4	12,366	8,408	20,774	59.5	0.70	1.38	0.88
2064	17,723	6,114	23,837	74.4	12,676	8,618	21,293	59.5	0.72	1.41	0.89
2065	17,812	6,144	23,956	74.4	12,992	8,833	21,826	59.5	0.73	1.44	0.91
2066	17,901	6,175	24,075	74.4	13,317	9,054	22,371	59.5	0.74	1.47	0.93
2067	17,990	6,206	24,196	74.4	13,650	9,280	22,931	59.5	0.76	1.50	0.95
2068	18,080	6,237	24,317	74.4	13,991	9,512	23,504	59.5	0.77	1.53	0.97
2069	18,170	6,268	24,438	74.4	14,341	9,750	24,091	59.5	0.79	1.56	0.99
2070	18,261	6,299	24,561	74.4	14,700	9,994	24,694	59.5	0.80	1.59	1.01
2071	18,353	6,331	24,683	74.4	15,067	10,244	25,311	59.5	0.82	1.62	1.03
2072	18,444	6,362	24,807	74.4	15,444	10,500	25,944	59.5	0.84	1.65	1.05
2073	18,537	6,394	24,931	74.4	15,830	10,762	26,592	59.5	0.85	1.68	1.07

Table 5.8 Estimate Annual Collected Toll and Fee Revenue - Express Lanes Scenario

Fiscal Year	Estimated Annual Gross Toll Revenue (000)			BBM Leakage	Adjusted Toll Revenue	Processing Fee Revenue	Total Collected Revenue
	ETC	BBM	Total				
2035	$ 2,975	$ 2,713	$ 5,689	$ (610)	$ 5,079	$ 408	$ 5,487
2036	3,762	3,352	7,114	(754)	6,360	489	6,849
2037	4,268	3,718	7,986	(836)	7,150	526	7,676
2038	4,525	3,851	8,376	(866)	7,510	528	8,038
2039	4,786	3,978	8,764	(894)	7,870	528	8,398
2040	5,062	4,110	9,172	(924)	8,248	529	8,777
2041	5,345	4,253	9,598	(956)	8,642	530	9,172
2042	5,633	4,409	10,042	(991)	9,051	531	9,582
2043	5,938	4,571	10,509	(1,028)	9,482	533	10,014
2044	6,260	4,741	11,001	(1,066)	9,935	534	10,469
2045	6,602	4,917	11,518	(1,105)	10,413	536	10,948
2046	6,963	5,100	12,063	(1,147)	10,916	537	11,453
2047	7,345	5,291	12,636	(1,190)	11,446	538	11,985
2048	7,749	5,491	13,240	(1,234)	12,005	540	12,545
2049	8,177	5,699	13,876	(1,281)	12,594	541	13,136
2050	8,630	5,915	14,545	(1,330)	13,216	543	13,759
2051	8,996	6,116	15,113	(1,375)	13,738	546	14,284
2052	9,266	6,300	15,566	(1,416)	14,150	552	14,701
2053	9,544	6,489	16,033	(1,459)	14,574	557	15,131
2054	9,830	6,683	16,514	(1,502)	15,011	563	15,574
2055	10,125	6,884	17,009	(1,548)	15,462	569	16,030
2056	10,403	7,073	17,476	(1,590)	15,886	573	16,459
2057	10,663	7,250	17,913	(1,630)	16,284	576	16,859
2058	10,930	7,431	18,361	(1,671)	16,691	579	17,269
2059	11,203	7,617	18,820	(1,712)	17,108	581	17,689
2060	11,483	7,807	19,291	(1,755)	17,536	584	18,120
2061	11,770	8,003	19,773	(1,799)	17,974	587	18,561
2062	12,065	8,203	20,267	(1,844)	18,423	590	19,013
2063	12,366	8,408	20,774	(1,890)	18,884	593	19,477
2064	12,676	8,618	21,293	(1,937)	19,356	596	19,952
2065	12,992	8,833	21,826	(1,986)	19,840	599	20,439
2066	13,317	9,054	22,371	(2,035)	20,336	602	20,938
2067	13,650	9,280	22,931	(2,086)	20,844	605	21,449
2068	13,991	9,512	23,504	(2,138)	21,365	608	21,974
2069	14,341	9,750	24,091	(2,192)	21,900	611	22,511
2070	14,700	9,994	24,694	(2,247)	22,447	614	23,061
2071	15,067	10,244	25,311	(2,303)	23,008	617	23,625
2072	15,444	10,500	25,944	(2,360)	23,583	620	24,204
2073	15,830	10,762	26,592	(2,419)	24,173	623	24,796

5.4 Traffic Diversion Impacts

For purposes of this study, CDM Smith was asked to estimate the impacts of toll diversion on Capital Boulevard and the local roadway network. When a toll is added to a non-tolled facility, there will be some traffic diversion from drivers who choose not to pay the toll. The percent of traffic that is diverted due to tolling is influenced by the cost of the toll and the time savings provided by the tolled facility compared with tollfree alternatives. This section discusses estimated traffic diversion, and the impacts of toll-related traffic diversion on Capital Boulevard and the local roadway network under four conditions, including:

- No Build, which assumes the existing configuration, capacity, and posted speeds on Capital Boulevard remain unchanged
- Build Tollfree, which assumes planned capacity improvements and upgrades to Capital Boulevard associated with U-5307 but no tolls
- Expressway Scenario (see Section 5.0)
- Express Lanes Scenario (see Section 5.0)

5.4.1 Traffic Diversion

Table 5.9 shows estimated 2040 average weekday traffic across all lanes on Capital Boulevard by mainline segment for the four conditions. Improvements to Capital Boulevard draw traffic in from the local roadway network under tollfree conditions resulting in increases in AWDT ranging from 27.5 to 74.6 percent. When tolls are introduced, estimated traffic volumes decrease compared to the Build Tollfree scenario due to toll-related diversion of traffic to tollfree alternative routes. Most of the decrease shown in the Expressway Scenario is a result of traffic returning to their initial non-Capital Boulevard routings prior to diverting into the corridor via the improvements and hypothetical tollfree operations scenario. In the Expressway Scenario, AWDT is estimated to decease by 42.9 to 45.8 percent relative to Build Tollfree condition. This represents relatively high rates of toll-related diversion which are due, in part, to planned improvements to the local network by 2040 (see Section 4.5.1) which improve capacity on tollfree alternative routes, reducing the modeled time savings provided by tolled Capital Blvd. In the Express Lanes scenario, toll-related diversion compared to the Build Tollfree scenario is mitigated substantially by the majority of lanes remaining tollfree, except the one express lane in each direction.

Table 5.9 Estimated Capital Boulevard 2040 Average Weekday Traffic by Scenario

Segment	Location		Capital Boulevard AWDT (all lanes)			
	From	To	No Build	Build Tollfree	Expressway Scenario	Express Lanes Scenario
A	I-540	Perry Creek/Durant Rd	92,766	151,304	81,997	136,732
B	Perry Creek/Durant Rd	Burlington Mills Rd	90,796	148,819	85,037	140,533
C	Burlington Mills Rd	Falls of Neuse Rd	78,450	136,949	74,317	129,183
C	Falls of Neuse Rd	NC 98	73,954	114,417	62,627	112,034
C	NC 98	Durham Rd	54,717	85,358	48,651	85,937
D	Durham Rd	Purnell Rd	67,496	86,049	49,538	85,132

5.4.2 Local Roadway Network Impacts

Within the travel demand model, the local roadway network performs at similar levels with respect to traffic volumes and travel speeds when comparing the Expressway Scenario to the No Build Scenario. When comparing the Expressway Scenario with the Build Tollfree Scenario, the most notable impacts from toll-related diversion were observed in the following locations:

- Falls of Neuse Road, 2.2 miles between Durant Road and Waterwood Court
- Old Falls of Neuse Road, 0.3 miles between Wakefield Pines Drive and Wakefield Plantation Drive
- Wake Union Church Road, 0.2 miles between Durham Road/NC 98 and Kearney Road
- South Main Street/US 1 Alternative, 0.8 miles between Dr. Calvin Jones Highway/NC 98 and Forbes Road
- US 401, 1.6 miles between Fox Road and Ligon Mill Road

Traffic diversion from Capital Boulevard under the Expressway Scenario (compared with Build Tollfree) resulted in traffic increases ranging from 50 to 300 vehicles per hour in the peak direction on these segments during the AM and PM peak periods in the 2040 model. These traffic increases resulted in estimated increases in travel times ranging from 0.1 to 0.5 minutes. In all cases, modeled traffic volumes on the local roadway network remained within planned capacity despite increased traffic volumes resulting from toll diversion. In some cases, impacts were mitigated by accelerating already planned improvements. For example, widening projects on Falls of Neuse Road slated for 2040 in the MTP mitigated projected toll diversion impacts between 2034 and 2039 when the additional capacity was assumed in the 2030 model. Appendix B of this report provides a more detailed summary of these impacts by location, scenario, and model year. Please note these results are based on a regional travel demand model, and operational impacts of toll diversion to specific locations within the local roadway network may warrant further study via simulation tools or other intersection analysis methods should the project move forward as a tolled expressway.

5.5 Disclaimer

CDM Smith used currently-accepted professional practices and procedures in the development of the traffic and revenue estimates in this report. However, as with any forecast, it should be understood that differences between forecasted and actual results may occur, as caused by events and circumstances beyond the control of the forecasters. In formulating the estimates, CDM Smith reasonably relied upon the accuracy and completeness of information provided (both written and oral) by the NCTA. CDM Smith also relied upon the reasonable assurances of independent parties and is not aware of any material facts that would make such information misleading.

CDM Smith made qualitative judgments related to several key variables in the development and analysis of the traffic and revenue estimates that must be considered as a whole; therefore, selecting portions of any individual result without consideration of the intent of the whole may create a misleading or incomplete view of the results and the underlying methodologies used to obtain the results. CDM Smith gives no opinion as to the value or merit of partial information extracted from this report.

All estimates and projections reported herein are based on CDM Smith's experience and judgment and on a review of information obtained from multiple agencies, including NCTA. These estimates and projections may not be indicative of actual or future values, and are therefore subject to substantial uncertainty. Certain variables such as future developments, economic cycles, pandemics, government actions, climate change related events, or impacts related to advances in automotive technology etc. cannot be predicted with certainty and may affect the estimates or projections expressed in this report, such that CDM Smith does not specifically guarantee or warrant any estimate or projection contained within this report.

While CDM Smith believes that the projections and other forward-looking statements contained within the report are based on reasonable assumptions as of the date of the report, such forward-looking statements involve risks and uncertainties that may cause actual results to differ materially from the results predicted. Therefore, following the date of this report, CDM Smith will take no responsibility or assume any obligation to advise of changes that may affect its assumptions contained within the report, as they pertain to socioeconomic and demographic forecasts, proposed residential or commercial land use development projects and/or potential improvements to the regional transportation network.

The report and its contents are intended solely for use by the NCTA and designated parties approved by NCTA and CDM Smith. Any use by third-parties, other than as noted above, is expressly prohibited. In addition, any publication of the report without the express written consent of CDM Smith is prohibited.

CDM Smith is not, and has not been, a municipal advisor as defined in Federal law (the Dodd Frank Bill) to NCTA and does not owe a fiduciary duty pursuant to Section 15B of the Exchange Act to NCTA with respect to the information and material contained in this report. CDM Smith is not recommending and has not recommended any action to NCTA. NCTA should discuss the information and material contained in this report with any and all internal and external advisors that it deems appropriate before acting on this information.

Appendix A Independent Economist Report

How the baseline 2023 socio-economic estimates and 2030, 2040, and 2050 projections were generated for the U.S. 1 improvement project

Stephen J. Appold (10 January 2025, lightly edited 17 April 2025 – Version 1.1)

This exposition explains the methodology used in generating the "adjusted" socio-economic estimates transferred to CDM Smith for use in its initial analysis evaluating U.S. 1 improvement options.

The Triangle Regional [Travel Demand] Model was developed and is maintained by the Travel Behavior Modelling Group at North Carolina State University's Institute for Transportation Research and Education and is supported by a decentralized organization led by the Central Pines Regional Council (formerly Triangle J Council of Governments), the Capital Area Metropolitan Planning Organization (CAMPO), the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC MPO), GO Triangle (a public transit agency) and the North Carolina Department of Transportation (NCDOT). Unless more detail is needed, the responsible organizations will be referred to collectively as the MPO and the work procedures as the TRM process.

The MPO is in the process of rolling out a new version of the Triangle Regional Model (TRM G2), replacing version 6.[1] This version has been developed in collaboration with Caliper Corporation. The demand model itself has been implemented but, at present, the model relies on earlier rounds of land use visioning. With the shift to Gen 2, the area covered by the model has been slightly expanded to include a portion of Alamance County.

The TRM model builds on small area (Traffic Analysis Zones or TAZ) socio-economic estimates.[2] The estimates are generated de-centrally with the Central Pines Regional Council taking overall responsibility for growth estimates with CAMPO and DCHC MPO performing key parts of the work of establishing the baseline socio-economic data. As part of its role in developing Gen 2, Caliper Corporation provided initial 2016 calibration stage values for some variables. The creation of the MPO 2020 baseline was complicated by the Covid pandemic which both hampered Census data collection and distorted employment levels and patterns from what they otherwise would have been.

Socio-economic estimates and projections are important inputs into the assessment of the financial feasibility of toll-backed financing for improving U.S. 1 and other roadways. To support Traffic and Revenue analysis, a new, updated, 2023 vintage of the estimates was generated. In doing so, the TRM process was generally replicated using similar, but updated, sources of information and in cases where appropriate, MPO translation files.

[1] An Advanced State-of-the-Practice Hybrid Travel Demand Model for the North Carolina Research Triangle Region, Bernardin, Ward, Huntsinger, Balakrishna, and Sundaram, no date, https://www.caliper.com/pdfs/trbam-23_trm.pdf.

[2] These are different from, and more numerous than, Census TAZs.

Three main steps are needed to generate socio-economic estimates for the TRM modelling region: 1) establishing a small area (TAZ) baseline for 2023, 2) generating county-level "control" totals for 2023, 2030, 2040, and 2050, and 3) estimating future small area values of the socio-economic variables for those time points. These steps are discussed in the sections below. The final section discusses potential sources of error and the potential for difference with MPO estimates.

The establishment of a baseline is the most complex portion of the process, because doing so entails creating, gathering, and reconciling multiple datasets. The generation of the county control totals is the most straightforward because, once certain conditions are established, the procedure relies directly or indirectly on Office of State Budget and Management population projections. Estimating future socio-economic values relies on MPO small area estimates of growth patterns, which build on a distributed process of visioning, supported by CommunityViz software, and an earlier vintage of OSBM population projections. The MPO numbers were not adjusted but replicated, using the general TRM process.

Table 1 summarizes the socio-economic variables needed for analysis and transferred to CDM Smith.

1) Generating baseline socio-economic estimates

The small area baseline data includes residence-based variables and place of employment-based variables.

The primary source for the former is the 2020 decennial Census, updated by supplemental datasets: the American Community Survey, the Census Current Address Count Listing File for 2024, and parcel-based tax databases for Franklin and Wake Counties. The Census data, published by Census geographies: block, blockgroup, and PUMA, are allocated to TAZs, as are the point-based parcel data by spatial joins or spatial intersections.[3] Spatial joins are used to allocate data to TAZs because Census boundaries and TAZ boundaries do not always align. After the data was allocated to TAZs, the household and population estimates were then rounded to the nearest whole number.

The primary sources for the place of employment estimates are the Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) data which aggregates establishment data by Census block and the point-based establishment data available commercially from DataAxle, formerly known as InfoUSA and RefUSA. The LODES data are a product of the Quarterly Census of Employment and Wages (QCEW) which, itself, is a summary of the information gathered by the ES-202 (Unemployment Insurance) program. The QCEW forms the basis for county employment control tables.

[3] In the 11 counties in the TRM region, there are approximately 40,000 (40,410) Census Blocks with about 30,000 of them within the TRM model region. There are roughly 3,000 (2,965) TAZs for an average of 10 blocks per TAZ. Blocks have an average of about 24 households containing about 60 persons in households each. The median Census Block is about 11 acres (the mean is larger because rural blocks can be quite large). The 40,000 blocks combine into 1,527 Census Blockgroups with 1,244 in the model region, implying roughly 2.5 TAZs per Block Group. Less than 20 pumas are used in simulating the populations in the TAZs.

Table 2 provides an overview of the original data sources used in generating the small area 2023 baseline estimates.

The updated variables fall into five subsets: 1) two household variables, 2) household population age distribution measures, 3) median household income, 4) five employment category values, and 5) one earnings variable linked to employment location.[4]

Household and household population estimates

Two fields, representing the number of households in each TAZ and the corresponding household population were estimated. The household population plus the group quarters population sum to the total population. The basic strategy in estimating the 2023 household-related variables was to use 2020 Census data as a baseline and then add in estimates of change between the 1 April Census date and the 30 June 2023 date implicit in all TRM estimates. In this case, the period between the most thorough, detailed accounting of population and the baseline data is three years and three months, the potential for error is modest (compared to what it will be towards the end of the decade).

Two types of data were used in calculating 2023 small area household estimates: 1) 2020 Census counts of housing units, households, and household population, in each of the approximately 30,000 Census blocks in the eleven TRM region counties and 2) estimates of the number of housing units added since the 2020 Census as identified by a) analysis of the Census Master Address File block summary and new residential construction identified in the Franklin and Wake County parcel files (the U.S. 1 study area spans these counties).[5] For the remaining counties, the Census counts were simply adjusted to match the county control totals (details below).

Using the housing unit occupancy rate for each block, the number of households added was calculated from the added housing unit counts. The additional household population was estimated using 2020 block-specific average household sizes.[6] The resulting county totals were reconciled with county control totals (details below). The occupancy rates and average household sizes were calculated directly from 2020 Census data. Census block data were allocated to TAZs on the basis of a spatial join.

[4] Previous vintages included estimates for enrollment, group quarters, and earnings distributions linked to employment sectors. These are not used in the Gen 2 model. Group quarters till need to be estimated in order to obtain household population counts. A simpler measure of earnings distribution is used in Gen 2. For earlier vintage estimates, public and private school location data were obtained from the North Carolina open data portal and linked to TAZs. Enrollment information was obtained from two Department of Instruction reports: Month 2 of the Principal's Monthly Reports for the latest-available school year for public and charter school students and the North Carolina Directory of Non-Public Schools, Conventional Schools Edition, with information for the latest-available school term. The separate enrollment estimates were aggregated by TAZ and summed.

[5] Certificates of Occupancy (COs) were used in some earlier versions of the estimates, generated for previous studies, to estimate households added. Such data are not readily available for Wake County. These data are often ambiguous in any case.

[6] Some earlier versions of the estimates, generated for previous studies, used the then latest available wave of the American Community Survey to calculate the occupancy rates and average household sizes because the previous baselines were distant from Census years.

Group quarters estimates

Approximately 3 percent of the population in the eleven TRM region counties lived in group quarters in 2020. Of those, 36 percent were in institutional quarters and 64 percent not institutionalized, most in student quarters. The group quarters population is not required input to the Gen 2 model, nevertheless household population estimates require the subtraction of group quarters estimates from total population, so estimates were used internally.

Age distribution measures

The Gen 2 model requires three age-related measures: percent of the household population who are working, percent of the household population who are 18 years of age and below, and percent of the household population who are aged 65 and above. Counts for the latter two were taken from the 2020 Census block-level data and aggregated to TAZs before the percentage was calculated. The first, percent working, is closely tied to the number of those who are working age but not the same. The number of those who were employed (including the self-employed) was taken from the blockgroup data for the 2018-2022 ACS and allocated to TAZs on the basis of a spatial join before calculating the percentage.

Household income estimates

The TRM socio-economic estimates include a measure of median household income. Two alternative measures were provided. Median household income estimates were first calculated for each TAZ by aggregating the numbers of households in each of the Census household income categories in the blockgroups in the 2018-2022 ACS summary file into TAZs (based on the proportion of each blockgroup in each TAZ) and then calculating the median from the grouped data. Median income was also calculated by averaging the values of the constituent blockgroups for each TAZ. The calculated 2022 income value was not adjusted.[7]

Employment estimates

The TRM modelling process requires a high level of geographic and sectoral precision but is fraught with sources of error. Data sources are subject to varying inclusion criteria, generally focusing on wage labor while omitting those working as independent contractors or small business owners. Reporting error and confidentiality constraints implies that data may be missing for some, sometimes, important, employers. Even though the quality of geo-coded establishment data has improved immeasurably over the past decade or so, it is still not sufficiently accurate for small-area planning needs while employment is sometimes assigned to a central payroll office location.[8]

The TRM process classifies employment by five sectors: Industry, Office, two types of Service (depending upon whether they generate either a High or Low volume of customer traffic per employee), and Retail.

[7] In previous versions the then-current estimates were translated into 2013 dollars using the Consumer Price Index Research Series Using Current Methods (CPI-U-RS) -- all city average.

[8] Establishments are not required to report employment to private sector sources, such as DataAxle, and many have little motivation to do so. For example, IBM employs many high wage workers in Research Triangle Park but they refuse to reveal how many – which means DataAxle data won't have it. On the other hand, government sources are required to maintain confidentiality with the result that much information is suppressed.

Employment is separated out by sectoral category because each is thought to have different propensities to generate customer (client) traffic. Despite the relevance to estimating non-commuting traffic flows, they do not map easily onto the NAICS classifications used by most data collection efforts. The basis for categorization is not always clear. Schools, for example, are classified as Office employment. Establishments in some service sectors, such as banking, are classified as Office employment if a size threshold is reached.

As mentioned above, two small area sources are used in generating the employment estimates: the latest-available block-level Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) data and the latest available point-based establishment data available commercially from DataAxle.[9] These sources were used to estimate the geographical and sectoral distribution of employment.

The 15,245 blocks where LODES records employment were linked to TAZs using a translation file developed from a spatial intersection of shapefiles. The LODES 2-digit NAICS employment estimates were assigned to the five TRM employment categories using a translation table developed by the MPO. Corrections were made to the geographic distribution of employment in some cases. Some State employment was reallocated from a location in North Raleigh to the city center where it most likely is. One location where employment was reduced in these data lies in the 540 Turnpike Corridor near the intersection of Ten-Ten Road and U.S. 401.

The address-based DataAxle information was aggregated to TAZs using a spatial join. Establishments were assigned to the five TRM employment categories from the dataset's detailed NAICS codes by using a translation file obtained from the MPO. The establishment employment counts were corrected to meet internal reliability constraints, eliminating a number of outliers and assigning a value to most establishments with missing values. Estimates from both sources in each TRM employment sector were averaged.

2023 employment in each TRM employment category in each TAZ was estimated by the following calculation:

$$\text{Employment}_{\text{TAZ TRM sector}} = \text{Proportion of Total County Sector Employment}_{\text{County Sector TAZ}} \times \text{Sector Proportion of Total County Employment}_{\text{County Sector}}$$

[9] In earlier vintages two additional data sources were explored. The first, directly applied the 2013 TRM spatial distributions to county control totals. These data largely agreed with the two other sources but was dropped in this vintage because the data are now over a decade old. The second, was based on the number of square feet allocated to commercial uses found in county parcel files and using detailed American Planning Association Activity and Function codes for each parcel. The second was not used because the results deviated significantly from those generated by the other methods. In addition, Dun and Bradstreet/NETS also provide point-coded data but DataAxle coverage is broader. The Census Zip Business Pattern data and the CTPP publish data for relatively large sub-county areas. Government-collected point-coded data are difficult to access because of confidentiality concerns.

x Total County Employment $_{County}$

The first term was calculated by each of the two methods described above. In each case the county-level sector totals were calculated using QCEW data. The second term in the equation above was the same for each method. Data were taken from a county-level 4-digit NAICS code QCEW file translated into the TRM sectors using a translation file developed by the MPO. The third term in the equation above was taken from an adjusted county-level QCEW file including only total county covered employment. (See more in the section on Control totals.)

Earnings estimates

Along with TAZ-level estimates of employment by sector, the Gen 2 socio-economic file requires a simplified version of the earnings measures formerly used in the previous version of the model.[10] A single measure, Number of jobs with earnings greater than $3,333/month as a percentage of all jobs, is used in Gen 2, relying on the block-level LODES data mentioned above. The counts of high-paying employment were tallied, allocated to TAZs by spatial join and the percentage calculated.

2) Control totals

Household population and employment estimates for TAZs were adjusted by county to conform to county-wide control totals. The latest vintage OSBM population estimates and projections form the basis for the population control totals and, indirectly, for the employment projections for each year through 2050.[11] The OSBM estimates and projections for each of North Carolina's 100 counties are used in projecting state budgets and allocating funds.[12] Modified Quarterly Census of Employment and Wages (QCEW) data form the basis of the employment control totals. The OSBM and QCEW data have the advantage that they are used by the TRM process and are reasonable. For the base year calculations, the number of housing units (used in estimating TAZ household counts) was adjusted to match the Census Annual Estimates of Housing Units for Counties in the United States.

For each projection year, the total population found in the OSBM projections is separated into household population and group quarters population. Group quarters population is assumed to remain

[10] In the earlier generation, estimates of high and low wage employment in a combination of sectors in each TAZ. Industry and Office employment were combined for these purposes as were the two Service sectors. High and low wage employment counts are split near the median salary point for each sector.

[11] The Census Bureau is another source of annual county population estimates for North Carolina. The Census estimates are republished by the Bureau of Economic Administration and other government organizations. Despite relying on the same information sources, the Census Bureau and the OSBM sometimes slightly disagree on their estimates. In addition, both frequently revise their estimates for several years after the initial estimate.

[12] Woods and Poole's Complete Economic and Demographic Data Source (CEDDS) database is another widely available source of county population projections. The basic methodologies behind the OSBM and Woods and Poole projections are similar. The organizations perform a combination of cohort-component projections and mathematical extrapolations of population growth trends over a set window of recent years. Both need to rely on the same sources of information. The main differences would be the assumptions about the changes in the basic demographic rates of fertility, mortality, and migration. The OSBM projections are relatively conservative.

at its 2020 proportion of total county population, growing in tandem with total population. A geographic adjustment is made for the eight partial counties (details below).

As the regional population grows, along with the total U.S. population, it is expected to age. Because the Joint Center for Housing Studies at Harvard projects a changing pattern of household formation and because the OSBM projections include age information, it was possible to calculate the number of projected households in each county that took changing age composition of each county and shifting headship rates into consideration.[13] The Joint Center-based estimates were adjusted to match the 2023 baseline.

QCEW total employment estimates, adjusted by (100/92) to account for employment not covered by Unemployment Insurance, are used in creating baseline county employment totals.[14] Total employment data were used because the QCEW suppresses sectoral information in some cases. Because the Federal and State Governments do not produce county employment projections, the working age (20-64) population for each TRM county was extracted from the OSBM population estimates and projections and compared to the adjusted county employment in order to calculate trends in the ratio of employment to working age population.[15] Those (attenuated) trends are projected forward on the basis of past history to generate projected county employment totals.

Adjustments were made for the eight of the eleven regional counties which are only partially within the TRM modelling region using a combination of information on the proportion of county population within the TRM modelling region over four decades, based on constant boundary data for the 426 2010 Census tracts in the region, and proportion of employment in the TRM modelling region over a shorter period.[16] Given that the portions of those counties in the TRM region are generally growing more quickly than the remainders, those proportions have tended to increase over time. The socio-economic estimates outside the TRM modelling region in the partial counties were retained but not used. Also the TAZ employment estimates are recalculated to equal the proportion of all employment in that sector in each county. In some of the smaller outlying counties, ad hoc adjustments were made.

3) Generating projection year socio-economic estimates

Projected households, household population, and employment by category were calculated by taking the difference between the 2023 baseline and the re-calculated expectations for 2050. The number to be added in each county was allocated according to the proportional within-county geographic allocation of growth projected by the MPO. (Central Pines itself only projected the growth, using the

[13] The TRM process estimated the number of households based on the 2010 population age distribution and 2006-2010 headship rates.

[14] Estimates of total employment vary substantially, mainly because inclusion criteria vary. Bureau of Economic Analysis estimates, relying on several Federal data sources, tend to be the most broad, including self-employment. The CEDDS also aggregates Federally-collected data and tends to be somewhat less inclusive. The Bureau of Labor Statistics' (BLS) Local Area Unemployment Survey (LAUS) is based on three household and establishment surveys conducted by the BLS. The QCEW tends to be the least inclusive.

[15] The TRM process uses the employment growth rates used by Woods and Poole to project employment. However, because the CEDDS assumes a higher rate of population growth than OSBM, the results are unrealistic.

[16] These estimates have not yet been updated to include 2020 Census data.

same growth allocation proportions for each year.) The projection year growth was then added to the 2023 baseline.

The projection year values for these variables – households, population in households, and employment by category – were estimated as follows (using population as an example):

$$\text{Population}_{\text{TAZ Year}} = (\text{Proportion of County Added Population}_{\text{TAZ}} * \text{County Added Population}_{\text{Year}}) + \text{Existing Population}_{\text{TAZ 2023}}$$

where

$$\text{County Added Population}_{\text{Year}} = \text{Adjusted Projected County Population}_{\text{Year}} - \text{Existing County Population}_{2023}$$

Although population (population in households), is used in this example, the process is repeated for the number of households and each of the five employment categories. That framework implies that the distribution of growth can be different from existing development.

In this analysis, it was assumed that real incomes would remain constant over the projection period. Estimates of the percentage of high-wage employment were also assumed to remain constant.

OSBM projections expect the age distribution of the region to change over time. Projected small area values of the age composition variables were estimated by assuming that as the proportions of each group changed over time, each TAZ would retain its share of total county workers, children, and seniors over time.

4) Sources of error and differences with MPO estimates

As stated above, the estimates are not alterations of the MPO estimates but a recalculation based on newer vintages of the data sources used by the MPO and, in the case of employment, somewhat different data sources. The largest sources of error are in the underlying data used. Although the data are generally assumed to be correct for modelling purposes, there are significant errors built into the data.

The Census Bureau has evaluated the accuracy of the 2020 Census, which is estimated to have cost $13.7 billion, household population[17] and housing unit tallies.[18] Whatever the faults, it is unrealistic to believe that those estimates can be improved upon. The conclusion from this discussion is that the best

[17] Census Coverage Estimates for People in the United States by State and Census Operations 2020 Post-Enumeration Survey Estimation Report, Courtney Hill, Krista Heim, Jinhee Hong, and Nam Phan, Issued June 2022, PES20-G-02RV.

[18] Census Coverage Estimates for Housing Units in the United States 2020 Post-Enumeration Survey Estimation Report, James B. Lawrence and Jinhee Hong, Issued August 2022, PES20-G-03.

available data sources have been compiled at great expense and that they are well-suited for the required analysis but significant sources of error remain.

The Census analysis estimated a net national undercount of 782,000 people in the 2020 Census, which reflects approximately 18 million erroneous enumerations plus whole-person imputations counter-balanced by 18.8 million omissions. For North Carolina, the net undercount appears to have tripled compared to the 2010 Census, largely due to the Covid pandemic's interference with data collection. For the State as a whole, an estimated 94.0 percent of the population were enumerated in the correct county of residence. Statewide, approximately 96 percent of housing units were correctly enumerated with some units being double-counted, some mis-classified as residences, and some omitted. No estimates have yet been made available for sub-state areas. Therefore, we have little information on the accuracy of the small area (block and blockgroup) data but it so likely that the under- and over-counts identified by the Census are not evenly distributed.

Similarly, the American Community Survey is subject to both sampling and non-sampling error. While estimates of the standard errors of many values are provided by the Census, these have not been used in the analysis. Population estimates are often revised for several years after they are initially published.

The major sources of error in the employment data were discussed above. It is also known that self-employment has a different sectoral distribution than paid employment.

The revised estimates can differ from those of the MPO for several reasons.

The baseline data differs. The MPO-based data for 2023 is an interpolation. Population and employment growth may have been faster or slower than anticipated. Housing construction and employment expansion may also have occurred in somewhat different locations than had been anticipated.

Each year, the OSBM produces a new set of estimates and projections which incorporate new information and therefore often vary somewhat previous vintages. Moreover, past estimates are often revised. In the revised estimates, intermediate years are not interpolated; growth is matched to the projected control totals.

As noted above, the MPO relies on DataAxle for its small area estimates of employment location. These are subject to reporting biases, sectoral misclassification, and inaccurate employment estimates. In the revisions, these have been complemented with LODES data (the source for some data in Gen 2 and used by the MPO in other contexts). The LODES data are subject to confidentiality constraints and have less detailed NAICS coding at the block level. Combining these sources will result in somewhat different small area distribution of employment and different sectoral distributions.

Table 1: Overview of variables transmitted to CDM Smith

		variable (field) names			
Long Title of Variable	Measurement Location	baseline 2023	projected 2030	projected 2040	projected 2050
identifier		taz			
identifier		county			
identifier		stcnty			
count of households	at place of residence	HH23	valHH2030	valHH2040	valHH2050
household population	at place of residence	HH_pop23	valHH_pop2030	valHH_pop2040	valHH_pop2050
median income #1	at place of residence	median_inc23_calc			
median income #2	at place of residence	median_inc23_ave			
percent of HH pop who are working	at place of residence	pct_worker23	pctworker2030	pctworker2040	pctworker2050
percent of HH pop who below 18	at place of residence	pct_child23	pctchild2030	pctchild2040	pctchild2050
percent of HH pop who are above 65	at place of residence	pct_senior23	pctsenior2030	pctsenior2040	pctsenior2050
TRM employment category: industry	at place of employment	industry23	Industryval30	Industryval40	Industryval50
TRM employment category: industry	at place of employment	office23	Officeval30	Officeval40	Officeval50
TRM employment category: industry	at place of employment	Service_RateLow23	Service_RateLowval30	Service_RateLowval40	Service_RateLowval50
TRM employment category: industry	at place of employment	Service_RateHigh23	Service_RateHighval30	Service_RateHighval40	Service_RateHighval50
TRM employment category: industry	at place of employment	Reatail23	Retailval30	Retailval40	Retailval50
percent of employment which is high-paying	at place of employment	PctHighPay23			

Table 2: Overview of variable data sources

Long Title of Variable	Measurement Location	Small Area Data Sources	Control Total Data Sources
taz	identifier		
county	identifier		
stcnty	identifier		
count of households	at place of residence	Census 2020, MARF summary, County parcel files	Census HU estimates (adjusted)
household population	at place of residence	Census 2020 (base)	OSBM estimates (adjusted)
median income #1	at place of residence	ACS	(no county control)
median income #2	at place of residence		
percent of HH pop who are working	at place of residence	Census 2020, ACS	(no county control)
percent of HH pop who below 18	at place of residence		
percent of HH pop who are above 65	at place of residence		
TRM employment category: industry	at place of employment	LODES, Data Axle (RefUSA), MPO naics crosswalk	QCEW (adjusted)
TRM employment category: industry	at place of employment		
TRM employment category: industry	at place of employment		
TRM employment category: industry	at place of employment		
TRM employment category: industry	at place of employment		
percent of employment which is high-paying	at place of employment	LODES	(no county control)

Appendix B Notable Modeled Traffic Diversion Impacts to the Local Roadway Network by Location, Model Year, and Scenario

Modeled Traffic Diversion Impacts to the Local Roadway – 2030

Falls of Neuse Road between Durant Road and Waterwood Court

Time Period		AM (7 - 9A)		PM (3:30 - 6:30P)	
Direction		Southbound		Northbound	
Value		Value	Delta	Value	Delta
Capacity		4344		6516	
Freeflow Speed (mph)		45			
Distance (mi)		2.16			
Volume	No Build	3675	-	5759	-
	Build TF	3081	-594	4655	-1104
	Expressway	3927	252	6025	266
Travel Time (min)	No Build	3.74	-	4.28	-
	Build TF	3.07	-0.67	3.32	-0.95
	Expressway	4.09	0.35	4.59	0.32
Congested Speed (mph)	No Build	35	-	30	-
	Build TF	42	8	39	9
	Expressway	32	-3	28	-2

US 401 between Fox Road and Ligon Mill Road

Time Period		AM (7 - 9A)		PM (3:30 - 6:30P)	
Direction		Southbound		Northbound	
Value		Value	Delta	Value	Delta
Capacity		7800		11700	
Freeflow Speed (mph)		43			
Distance (mi)		1.55			
Volume	No Build	5253	-	9126	-
	Build TF	5044	-209	8800	-327
	Expressway	5955	702	9978	851
Travel Time (min)	No Build	2.40	-	2.64	-
	Build TF	2.35	-0.05	2.55	-0.09
	Expressway	2.61	0.21	2.92	0.28
Congested Speed (mph)	No Build	39	-	35	-
	Build TF	40	1	37	1
	Expressway	36	-3	32	-3

Wake Union Church Road between Durham Road/NC 98 and Kearney Road

Time Period		AM (7 - 9A)		PM (3:30 - 6:30P)	
Direction		Southbound		Northbound	
Value		Value	Delta	Value	Delta
Capacity		1560		2340	
Freeflow Speed (mph)		43			
Distance (mi)		0.32			
Volume	No Build	820	-	1406	-
	Build TF	860	40	1485	80
	Expressway	1362	542	2139	733
Travel Time (min)	No Build	0.51	-	0.55	-
	Build TF	0.52	0.01	0.58	0.02
	Expressway	0.93	0.41	1.01	0.46
Congested Speed (mph)	No Build	38	-	35	-
	Build TF	37	-1	34	-1
	Expressway	21	-17	19	-16

Modeled Traffic Diversion Impacts to the Local Roadway – 2040

US 401 between Fox Road and Ligon Mill Road

Time Period		AM (7 - 9A)		PM (3:30 - 6:30P)	
Direction		Southbound		Northbound	
Value		Value	Delta	Value	Delta
Capacity		7800		11700	
Freeflow Speed (mph)		43			
Distance (mi)		1.55			
Volume	No Build	5204	-	8721	-
	Build TF	4418	-786	7763	-958
	Expressway	5337	133	9005	285
Travel Time (min)	No Build	2.48	-	2.69	-
	Build TF	2.30	-0.18	2.44	-0.25
	Expressway	2.54	0.06	2.81	0.11
Congested Speed (mph)	No Build	38	-	35	-
	Build TF	40	3	38	4
	Expressway	37	-1	33	-1

Wake Union Church Road between Durham Road/NC 98 and Kearney Road

Time Period		AM (7 - 9A)		PM (3:30 - 6:30P)	
Direction		Southbound		Northbound	
Value		Value	Delta	Value	Delta
Capacity		1560		2340	
Freeflow Speed (mph)		43			
Distance (mi)		0.32			
Volume	No Build	824	-	1591	-
	Build TF	923	99	1565	-26
	Expressway	1444	620	2229	638
Travel Time (min)	No Build	0.51	-	0.62	-
	Build TF	0.55	0.04	0.61	-0.01
	Expressway	1.05	0.54	1.13	0.51
Congested Speed (mph)	No Build	38	-	31	-
	Build TF	35	-2	32	1
	Expressway	18	-19	17	-14

South Main Street between NC 98 and Forbes Road

Time Period		AM (7 - 9A)		PM (3:30 - 6:30P)	
Direction		Southbound		Northbound	
Value		Value	Delta	Value	Delta
Capacity		2376		3564	
Freeflow Speed (mph)		35			
Distance (mi)		0.80			
Volume	No Build	1850	-	2755	-
	Build TF	1515	-335	2308	-447
	Expressway	1945	95	2846	91
Travel Time (min)	No Build	1.72	-	1.79	-
	Build TF	1.52	-0.20	1.56	-0.24
	Expressway	1.83	0.11	1.88	0.09
Congested Speed (mph)	No Build	28	-	27	-
	Build TF	32	4	31	4
	Expressway	26	-2	26	-1

Modeled Traffic Diversion Impacts to the Local Roadway – 2050

US 401 between Fox Road and Ligon Mill Road

Time Period		AM (7 - 9A)		PM (3:30 - 6:30P)	
Direction		Southbound		Northbound	
Value		Value	Delta	Value	Delta
Capacity		7800		11700	
Freeflow Speed (mph)		43			
Distance (mi)		1.55			
Volume	No Build	5488	-	9120	-
	Build TF	4848	-640	7938	-1182
	Expressway	5497	9	9243	123
Travel Time (min)	No Build	2.57	-	2.84	-
	Build TF	2.39	-0.19	2.47	-0.37
	Expressway	2.59	0.02	2.90	0.06
Congested Speed (mph)	No Build	36	-	33	-
	Build TF	39	3	38	5
	Expressway	36	0	32	-1

Wake Union Church Road between Durham Road/NC 98 and Kearney Road

Time Period		AM (7 - 9A)		PM (3:30 - 6:30P)	
Direction		Southbound		Northbound	
Value		Value	Delta	Value	Delta
Capacity		1560		2340	
Freeflow Speed (mph)		43			
Distance (mi)		0.32			
Volume	No Build	1094	-	1896	-
	Build TF	901	-192	1514	-382
	Expressway	1306	212	2042	146
Travel Time (min)	No Build	0.64	-	0.79	-
	Build TF	0.54	-0.11	0.59	-0.21
	Expressway	0.85	0.21	0.92	0.13
Congested Speed (mph)	No Build	30	-	24	-
	Build TF	36	6	33	9
	Expressway	23	-7	21	-4

South Main Street between NC 98 and Forbes Road

Time Period		AM (7 - 9A)		PM (3:30 - 6:30P)	
Direction		Southbound		Northbound	
Value		Value	Delta	Value	Delta
Capacity		2376		3564	
Freeflow Speed (mph)		35			
Distance (mi)		0.80			
Volume	No Build	1810	-	2769	-
	Build TF	1488	-322	2484	-285
	Expressway	1824	14	2779	9
Travel Time (min)	No Build	1.75	-	1.81	-
	Build TF	1.52	-0.23	1.61	-0.20
	Expressway	1.78	0.03	1.80	0.00
Congested Speed (mph)	No Build	28	-	27	-
	Build TF	32	4	30	3
	Expressway	27	0	27	0

Modeled Traffic Diversion Impacts to the Local Roadway – 2050 (continued)

Old Falls of Neuse Road between Wakefield Pines Drive and Wakefield Plantation Drive

Time Period		AM (7 - 9A)		PM (3:30 - 6:30P)	
Direction		Southbound		Northbound	
Value		Value	Delta	Value	Delta
Capacity		2376		3564	
Freeflow Speed (mph)		45			
Distance (mi)		0.67			
Volume	No Build	1892	-	2873	-
	Build TF	1137	-755	1619	-1254
	Expressway	1930	37	2840	-34
Travel Time (min)	No Build	1.19	-	1.21	-
	Build TF	0.92	-0.27	0.92	-0.30
	Expressway	1.28	0.08	1.23	0.02
Congested Speed (mph)	No Build	34	-	33	-
	Build TF	44	10	44	11
	Expressway	32	-2	33	0

Travel Demand Model Network Plot of Roadway Segments with Notable Modeled Traffic Diversion Impacts to the Local Roadway