E-470 Comprehensive Traffic and Revenue Study

Final Report

May 2020

E470

CDM Smith

Table of Contents

List of Figures

List of Tables

Appendices

Chapter 1
Introduction

The E-470 Public Highway Authority (Authority) has requested CDM Smith perform a comprehensive traffic and revenue study, culminating in the development of updated long-term traffic and revenue forecasts for the Authority. This study will serve to update prior forecasts. Those include studies developed as part of the last investment-grade traffic and revenue study prepared in 2014 and the latest forecasts developed in the study titled, *E-470 Traffic and Revenue Forecasts, New Toll Structure* dated January 5, 2018, and updated in the 2018 Traffic and Toll Revenue "Bring-Down" Letter dated December 20, 2018 (referred to in this report as the "2018 Update"). This current study and the associated forecasts of transactions and revenue include the collection of significant amounts of original traffic data, an independent review of the Region's underlying socioeconomic forecasts by Economic & Planning Systems (EPS), and culminating in a detailed traffic and revenue evaluation. All standard due-diligence data review and analyses for this study were performed as noted in this report. The study was conducted at a level of detail to meet the typical requirements of an Investment Grade Traffic and Revenue Study for the financial community for major bond issues.

This chapter provides a summary of the E-470 system including its current configuration, planned interchange improvements, toll collection and toll rates, and recent historical transaction and revenue trends. Also presented is the study team and report structure.

E-470 Description

As shown in **Figure 1-1**, E-470 is a 47-mile toll road running along the eastern perimeter of the Denver Metro area, forming the eastern half of the originally conceived I-470, the outer circumferential highway around Denver. E-470 extends from C-470 at I-25 in Douglas County south of Denver to the east and north through Aurora and then passes along the western edge of Denver International Airport (DIA). The road then turns westward, terminating at the Northwest Parkway at I-25 just south of 160th Avenue north of Denver in Thornton.

E-470 Configuration

E-470 was built in four phases beginning at the south end with a 5-mile segment between I-25 in Lone Tree and Parker Road that opened to traffic on June 1, 1991. The final 12-mile segment in the north between 120th Avenue and I-25 in Thornton opened to traffic on January 3, 2003, less than a year before the 8.7-mile Northwest Parkway toll road opened on November 24, 2003. The Northwest Parkway extends west and south from I-25 to U.S. 36 and constitutes the northwest quadrant of the outer beltway. With the soon-to-be-completed widening of E-470 from Quincy Avenue to I-70, 21 miles of E-470 from I-25 (south) to I-70 will be six-lane limited access. The remaining 26 miles are currently four lanes with future capital plans to widen based on demand.

Existing and Planned Interchanges

A total of 24 interchanges exist along the E-470 alignment. In addition, four completely new interchanges have been programmed for construction.

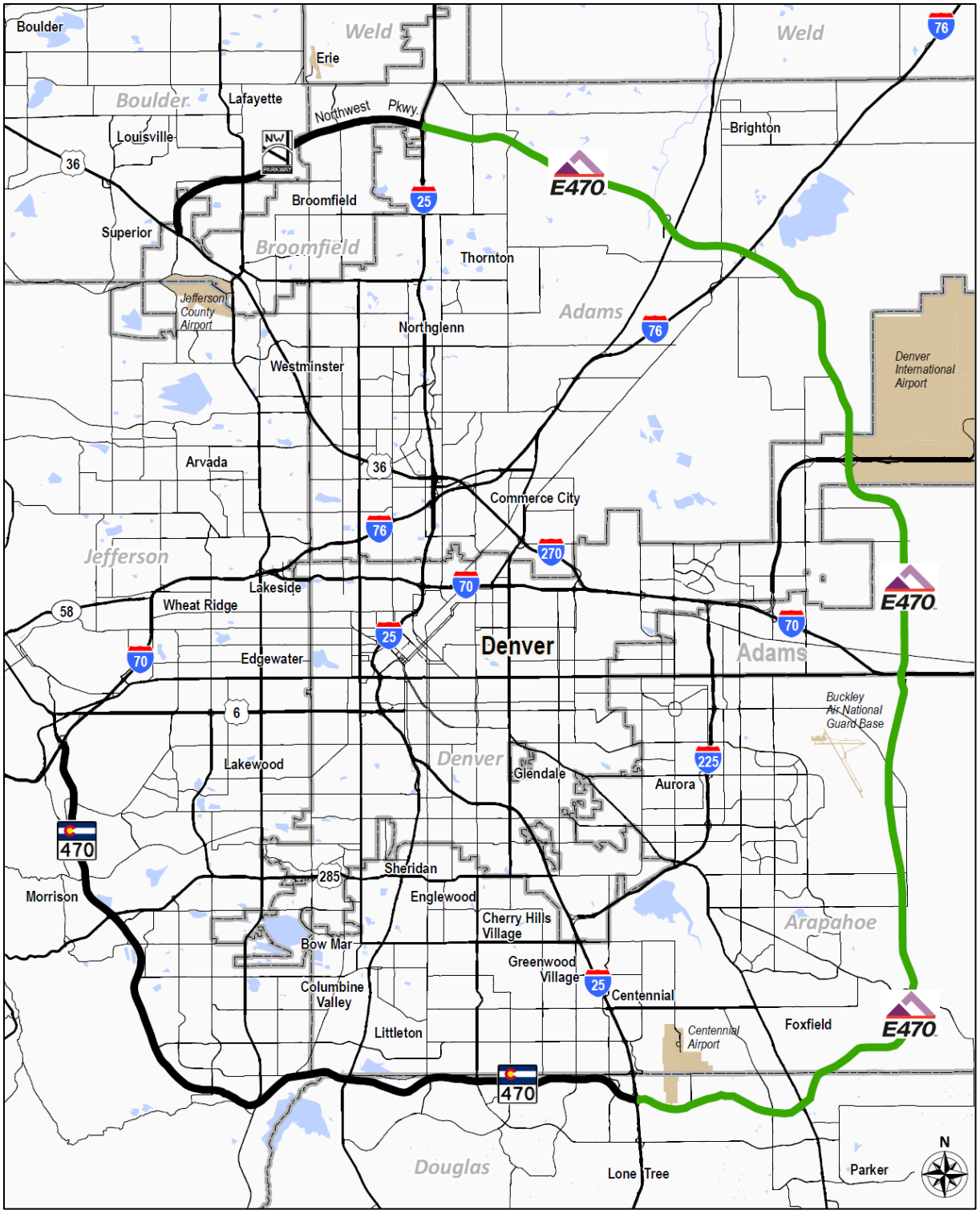


Figure 1-1
Location Map

Chronologically, the next planned construction will be two new full-access interchanges, one at 38th Avenue and the other at 88th Avenue are currently planned to open by 2024 and 2026, respectively. This will be followed by additional new full-access interchanges at 112th Avenue and Potomac Avenue are scheduled to open by 2031 and 2036, respectively.

New ramps are also planned at the I-70 and I-76 interchanges. At I-70, construction of an eastbound I-70 to southbound E-470 ramp is scheduled to open by 2023, while the remaining ramps, creating a full-access interchange with I-70, are scheduled to open to traffic by 2030. At I-76, ramps from northbound E-470 to westbound I-76 and westbound I-76 to northbound E-470 are scheduled to open to traffic by 2035 and 2040, respectively. Since the need for these new interchanges is driven by the pace of land development in their influence areas, market conditions could accelerate, or delay planned opening dates. These 28 interchanges are described in **Table 1-1**.

Toll Collection and Toll Rates

E-470 operates an all-electronic, closed-barrier system of toll collection, wherein no toll-free passage is permitted. All motorists pass through at least one mainline or ramp toll plaza where tolls are paid either by the ExpressToll or License Plate Toll (LPT) methods of toll payment. Under the all-electronic tolled (AET) system, customer vehicles not equipped with an ExpressToll transponder pay their toll via the LPT method. However, ExpressToll customers are charged a discounted toll compared to LPT customers. And, while neither the ExpressToll nor the LPT toll is the same at each of the five mainline gantries (refer to **Table 1-2**), the discount for an ExpressToll transaction of 37 percent is the same at each. In 2020 for example, passenger car ExpressToll customers pay a toll of $12.90 for a full-length, 47-mile trip which is $8.30, or 37 percent less than the $20.45 toll made by LPT customers for a comparable trip. Table 1-2 presents historical and current passenger car ExpressToll and LPT tolls from 2018 through 2020. As shown, mainline gantry tolls for ExpressToll customers remained unchanged, while LPT tolls increased by $0.15 in 2019. A $0.15 toll increase planned for LPT customers in 2020 was not made and tolls were retained at 2019 levels. Based on the ExpressToll versus LPT toll differential, the ExpressToll discount has risen modestly from 35 percent in 2018 to 37 percent in 2020. Prior to 2018, the ExpressToll discount was 20 percent.

The current toll collection system consists of 5 mainline toll gantries and 34 ramp toll gantries, along with 8 additional planned ramp toll gantries. Based on 2020 rates, an ExpressToll customer in a passenger car making a full-length trip pays $14.25, or approximately $0.30 per mile. However, as with any closed-barrier system of toll collection, motorists making relatively short trips will usually pay a higher per-mile toll because of the placement of the mainline and ramp toll gantries.

Figure 1-2 presents the passenger car per-mile toll rates for 57 U.S. all-electronic tolled (AET) highways, including E-470. The figure places the E-470 toll rate, shaded in dark green, into context by comparing it with toll rates charged on the other AET tolled highways. E-470's ExpressToll toll rate ranks among the highest 25 percent of the AET roads shown. However, while most toll facilities have increased toll rates, in November 2019, E-470's Board of Directors voted to reaffirm a freeze on the ExpressToll rate at 2017 levels through 2020. In addition to freezing ExpressToll rates, 2020 LPT tolls were also frozen at 2019 levels.

Table 1-1
Existing and Planned E-470 Interchanges

Interchange Number	Interchange Location	Milepost	Type (Toll/No Toll) and Tolled Direction (North/South)	Opening Year	
1	I-25 (South)	0.0	No Toll	1991	
2	Jamaica	0.5	No Toll	2004	
3	Peoria	1.7	Toll T/F South	1991	
	Toll Gantry A	2.5	**Mainline**	1991	
4	Chambers	3.5	Toll T/F North	2002/2004	(1)
5	Jordan	4.4	Toll T/F North	1991	
6	Parker	5.2	No Toll	1991/1998	(1)
7	Gartrell	8.6	Toll T/F South	2000	
8	Smoky Hill	10.4	Toll T/F South	1998/1999	(1)
9	Quincy	13.2	Toll T/F South	1999	
	Toll Gantry B	15.0	**Mainline**	1999	
10	Jewell	16.2	Toll T/F North	1999	
11	6th Parkway	19.0	Toll T/F North	1999	
12	I-70	20.3	No Toll	1999/2007/2023/2030	(2)
	Toll Gantry C	22.5	**Mainline**	1999	
13	38th Avenue	23.5	Toll T/F North	2024	
14	56th Avenue	24.3	Toll T/F North	1998/1999	(1)
15	64th Avenue	25.3	Toll T/F North	1998	
16	Pena Boulevard	27.6	No Toll	1998	
17	88th Avenue	28.7	Toll T/F South	2026	
	Toll Gantry D	30.0	**Mainline**	1998	
18	96th Avenue	30.2	Toll T/F North	1998	
19	104th Avenue	31.3	Toll T/F North	1998	
20	112th Avenue	32.3	Toll T/F North	2031	
21	120th Avenue	33.8	Toll T/F North	1998/2002	(1)
22	I-76	35.3	No Toll	2002/2035/2040	(1)
23	Potomac Street	36.7	Toll T/F South	2036	
24	U.S. 85	38.1	Toll T/F South	2002	
	Toll Gantry E	39.6	**Mainline**	2003	
25	Quebec	41.8	Toll T/F North	2014	
26	Colorado	43.5	Toll T/F North	2003	
27	York	44.5	Toll T/F North	2003	
28	I-25 (North)	46.1	No Toll	2003	

(1) Half of the interchange is opened in the first year indicated, with the additional movements completed and opened during the subsequent years shown.

(2) At-grade interchange constructed and opened in the first year indicated; an improved grade-separated "fly-by" interchange opened during the second year shown, including a new northbound E-470 to westbound I-70 fly-over ramp; a new eastbound I-70 to southbound E-470 ramp to be opened in the third year shown; and, direct connect ramps between I-70 and E-470 for all movements (interchange complete) in the fourth year shown.

T/F = to/from

Table 1-2
Historic and Current Roll Rates
Passenger Car Toll Rates

Interchange			Type (Toll/No Toll) and Tolled Direction	Passenger Car Toll Rates					
				2018		2019		2020	
Number	Location	Milepost	(North/South)	ExpressToll	LPT	ExpressToll	LPT	ExpressToll	LPT
1	I-25 (South)	0.0	No Toll	-	-	-	-	-	-
2	Jamaica	0.5	No Toll	-	-	-	-	-	-
3	Peoria	1.7	Toll T/F South	$ 1.25	$ 1.95	$ 1.25	$ 2.05	$ 1.25	$ 2.05
	Toll Gantry A	**2.5**	**Mainline**	**2.70**	**4.15**	**2.70**	**4.30**	**2.70**	**4.30**
4	Chambers	3.5	Toll T/F North	1.25	1.95	1.25	2.05	1.25	2.05
5	Jordan	4.4	Toll T/F North	1.25	1.95	1.25	2.05	1.25	2.05
6	Parker	5.2	No Toll	-	-	-	-	-	-
7	Gartrell	8.6	Toll T/F South	1.25	1.95	1.25	2.05	1.25	2.05
8	Smoky Hill	10.4	Toll T/F South	1.25	1.95	1.25	2.05	1.25	2.05
9	Quincy	13.2	Toll T/F South	1.25	1.95	1.25	2.05	1.25	2.05
	Toll Gantry B	**15.0**	**Mainline**	**2.95**	**4.50**	**2.95**	**4.65**	**2.95**	**4.65**
10	Jewell	16.2	Toll T/F North	1.25	1.95	1.25	2.05	1.25	2.05
11	6th Parkway	19.0	Toll T/F North	1.25	1.95	1.25	2.05	1.25	2.05
12	I-70	20.3	No Toll	-	-	-	-	-	-
	Toll Gantry C	**22.5**	**Mainline**	**2.70**	**4.15**	**2.70**	**4.30**	**2.70**	**4.30**
13	38th Avenue	23.5	Toll T/F North	-	-	-	-	-	-
14	56th Avenue	24.3	Toll T/F North	1.25	1.95	1.25	2.05	1.25	2.05
15	64th Avenue	25.3	Toll T/F North	1.25	1.95	1.25	2.05	1.25	2.05
16	Pena Boulevard	27.6	No Toll	-	-	-	-	-	-
17	88th Avenue	28.7	Toll T/F South	-	-	-	-	-	-
	Toll Gantry D	**30.0**	**Mainline**	**2.95**	**4.50**	**2.95**	**4.65**	**2.95**	**4.65**
18	96th Avenue	30.2	Toll T/F North	1.25	1.95	1.25	2.05	1.25	2.05
19	104th Avenue	31.3	Toll T/F North	1.25	1.95	1.25	2.05	1.25	2.05
20	112th Avenue	32.3	Toll T/F North	-	-	-	-	-	-
21	120th Avenue	33.8	Toll T/F North	1.25	1.95	1.25	2.05	1.25	2.05
22	I-76	35.3	No Toll	-	-	-	-	-	-
23	Potomac Street	36.7	Toll T/F South	-	-	-	-	-	-
24	U.S. 85	38.1	Toll T/F South	1.25	1.95	1.25	2.05	1.25	2.05
	Toll Gantry E	**39.6**	**Mainline**	**2.95**	**4.50**	**2.95**	**4.65**	**2.95**	**4.65**
25	Quebec	41.8	Toll T/F North	1.25	1.95	1.25	2.05	1.25	2.05
26	Colorado	43.5	Toll T/F North	1.25	1.95	1.25	2.05	1.25	2.05
27	York	44.5	Toll T/F North	1.25	1.95	1.25	2.05	1.25	2.05
28	I-25 (North)	46.1	No Toll	-	-	-	-	-	-

(1) Toll increases are assumed to be implemented on January 1.

T/F = to/from

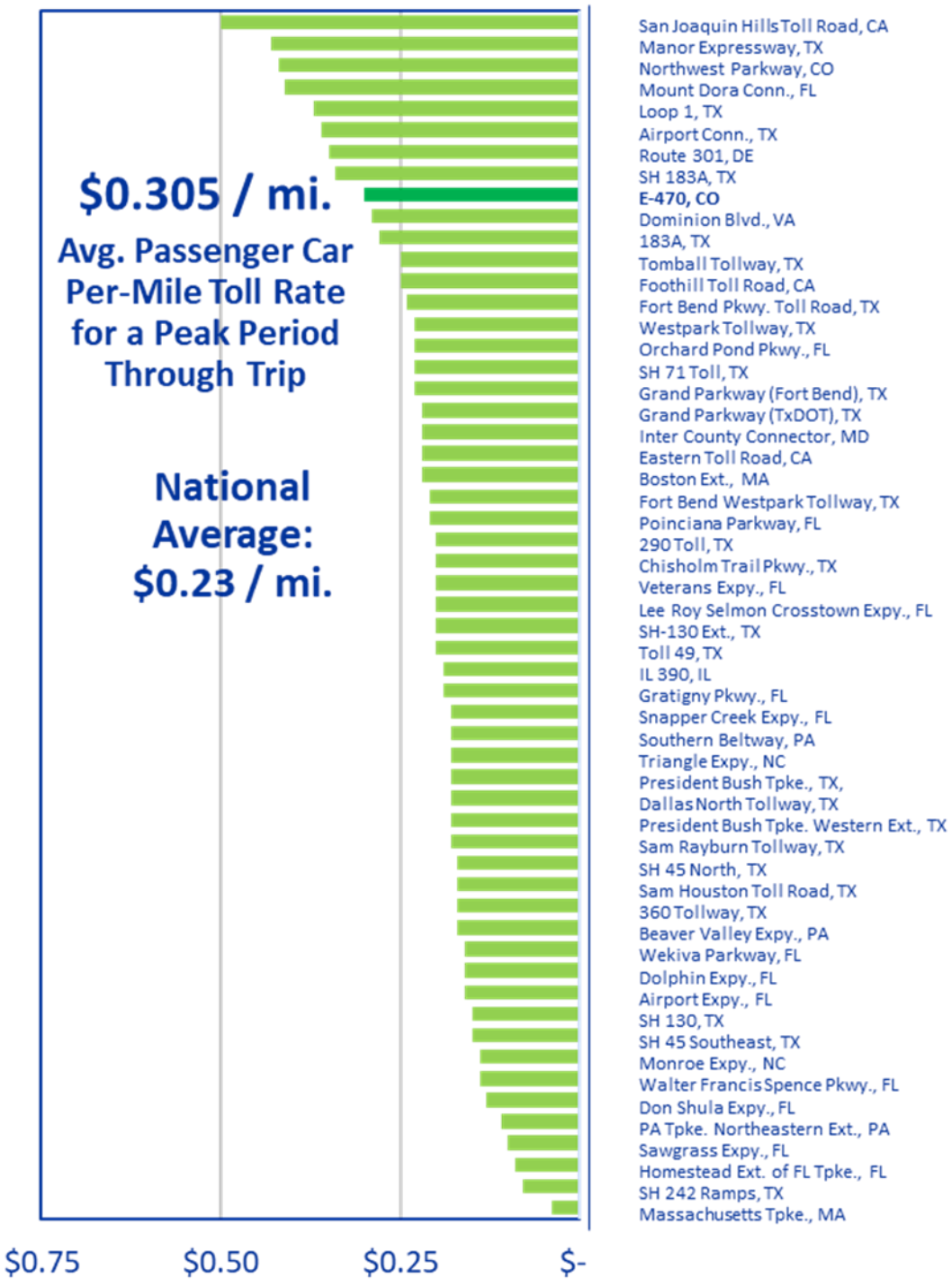


Figure 1-2
All Electronic Toll Facilities Toll Rate Comparison

Although ExpressToll rates have not increased since 2017, the historical toll rate increases of approximately 2.4 percent per annum for ExpressToll and 5.5 percent per annum for LPT between 2011 and 2019, coupled with traffic growth of more than 7.0 percent per annum during the same period, has resulted in revenue growth of 11.5 percent per annum. As a result of this growth in revenue and the potential for level-debt after 2020, the Authority's current plan is to retain the current toll rate structure through 2024, with a 2 percent rate increase in 2025 and every fifth year thereafter throughout the current forecast period ending in 2050. However, as is the prerogative of the Board, the toll rate structure may be reviewed annually. Given the likelihood of the implementation of this toll rate structure, the traffic and revenue forecasts developed in this study have been referred to as the "Preferred Toll Rate Scenario".

Study Team

CDM Smith (CDM) was the prime consultant with overall responsibility for successful completion of the study. In addition to overall project management and Study Team coordination responsibilities, CDM personnel were responsible for all traffic and revenue analyses, including modifications to the travel demand models, estimates of future toll transactions and revenue, and the preparation of all study documentation. CDM was assisted by three firms during the conduct of the current assignment. These three Study Team members were:

- **Economic & Planning Systems (EPS)** – EPS was responsible for performing a corridor growth assessment, specifically reviewing land development and socioeconomic/demographic growth assumptions made by the Denver Regional Council of Governments (DRCOG). EPS then prepared an alternative socioeconomic/demographic forecast based on their independent assessment of growth within the region at a Traffic Analysis Zone (TAZ) level used to adjust estimates of future trip-making in the regional travel demand model.

- **Felsburg Holt & Ullevig (FHU)** – FHU was responsible for working with the trip matrices developed by the DRCOG and checking them for reasonableness. FHU provided the EPS socioeconomic/demographic forecasts to the DRCOG and coordinated the DRCOG effort to develop updated future year trip matrices using their UrbanSim model. They were also tasked with updating traffic networks to reflect future-year improvements which were included in the fiscally constrained highway improvement program.

- **All Traffic Data Services (ATDS)** – ATDS was responsible for conducting 48-hour automatic traffic recorder counts at all non-tolled interchange ramps along E-470. The counts were conducted during internal weekdays (Tuesday through Thursday). Combined with traffic data at its mainline and ramp gantry locations, these counts permitted a traffic profile of existing conditions to be prepared. These were used as an aid in the traffic model calibration.

Report Structure

Chapter 2, **Traffic and Revenue Trends** provides a profile of historical trends and variations of traffic and revenue on E-470. The chapter also presents recent trends in transactions by method of toll payment, along with E-470 customer trip characteristics such as trip frequency and trip movements.

Chapter 3, **Corridor Growth Analysis** provides a summary of the methodology and forecasts developed by EPS which reflect local growth expectations and recent development activity. A copy of the EPS full report is included in Appendix A of this report.

Chapter 4, **Traffic and Revenue Analysis** provides a summary of the modeling methodology, future-year highway network assumptions and the underlying basic assumptions used in the modeling process. The chapter also includes documentation of the toll rate sensitivity analyses along with a 30-year forecasts of traffic and revenue for the Preferred Toll Rate Scenario.

Chapter 2

Traffic and Revenue Trends and Conditions

Annual and monthly toll transaction and revenue trends from January 2007 through March 2020 were assembled and reviewed. These trends are important in understanding driver reactions to construction activities on and off E-470, toll rate changes, motor fuel price increases, recessions, and non-recurring, one-time events such as inclement weather, accidents, sporting events, etc. Average daily and weekday traffic volume trends, hourly traffic variations, and trends in ExpressToll participation rates, along with data related to customer trip characteristics were also reviewed.

Annual and Monthly Transaction Trends

Transaction growth on E-470 over the past 10-year period from 2009 to 2019 is presented in **Table 2-1**, while more recent monthly trends for January 2017 through March 2020 are provided in **Table 2-2**. These trends are also depicted graphically on an average daily basis, which accounts for leap days, by mainline toll gantry in **Figure 2-1**.

Following a decline in transactions of 7.9 percent in 2009, influenced primarily by impacts of the Great Recession, transactions returned to consistent positive growth in 2010, increasing by 6.9 percent, even though weather-related events in January and February 2010 tempered the final annual increase. Continued growth occurred throughout 2011 and 2012, with total system-wide transactions increasing by 1.5 percent over 2010 and then by 3.6 percent over 2011. The 54.0 million transactions in 2012 fell only 176,000 transactions short of the 2007 pre-recession high of 54.1 million. Transactions in 2013 grew by 8.2 percent. This acceleration in growth compared to the 3.6 percent growth a year prior, actually began in July 2013. From July through December 2013, growth accelerated, averaging 10.6 percent. This double-digit, year-over-year transaction growth continued through 2015, likely due to continued economic recovery from the Great Recession and significant reductions in gasoline prices. Average gasoline prices decreased from $3.39 per gallon in 2014 to $2.40 in 2015, a drop of almost 30 percent. Based largely on these events, annual transaction growth in 2014 and 2015 was 13.6 percent and 12.4 percent, respectively. Transactions increased at a lower, but still robust 7.2 percent in 2016, reaching 80.0 million. Since 2015, monthly transaction growth has remained robust, although generally at slightly lower, single-digit rates. Annual transaction growth in 2016 and 2017 was 7.2 percent and 4.0 percent respectively.

Considering monthly trends moving forward, September 2017 represented the first year-over-year decrease in transactions in almost seven years on E-470 for a single month. In addition to an additional weekend day in September 2017 when compared to the prior year, the decrease was likely the result of gas price shocks resulting from the impacts of Hurricanes Harvey and Irma, both of which occurred that month. This is most evident at Gantry D, where months of robust double-digit growth related to ongoing development in the area were interrupted in September 2017 and the months that followed by the increased gas prices that followed Hurricanes Harvey and Irma. As gas prices stabilized and employment levels grew between 2017 and 2019, strong

Table 2-1
Annual Toll Transaction Trends by Mainline Toll Gantry
2009 - 2019

	Toll Gantry A		Toll Gantry B		Toll Gantry C		Toll Gantry D		Toll Gantry E		Ramp Gantries		Total	
Year	Transactions	Percent of Total E-470	Transactions	Percent of Total E-470	Transactions	Percent of Total E-470	Transactions	Percent of Total E-470	Transactions	Percent of Total E-470	Transactions	Percent of Total E-470	Transactions	Percent of Total E-470
2009 (2)(3)	12,540,655	26.1	7,722,296	16.1	5,259,855	11.0	6,638,569	13.8	5,225,893	10.9	10,585,445	22.1	47,972,713	100.0
AAPC	6.3		8.7		10.2		7.5		8.0		3.9		6.9	
2010	13,331,374	26.0	8,394,057	16.4	5,797,063	11.3	7,136,412	13.9	5,644,401	11.0	10,994,634	21.4	51,297,941	100.0
AAPC	(3.5)		4.1		4.8		4.3		4.2		0.8		1.5	
2011 (4)	12,863,902	24.7	8,738,007	16.8	6,075,209	11.7	7,440,510	14.3	5,878,725	11.3	11,084,033	21.3	52,080,386	100.0
AAPC	1.4		5.0		5.3		5.3		5.3		2.1		3.6	
2012 (1)(5)	13,048,995	24.2	9,176,916	17.0	6,395,155	11.9	7,838,432	14.5	6,188,263	11.5	11,318,055	21.0	53,965,816	100.0
AAPC	5.2		9.9		11.1		10.5		9.2		6.6		8.2	
2013 (6)	13,722,771	23.5	10,084,744	17.3	7,104,817	12.2	8,665,141	14.8	6,759,547	11.6	12,065,712	20.7	58,402,732	100.0
AAPC	11.9		10.1		16.4		17.9		16.5		12.3		13.6	
2014 (7)	15,355,232	23.1	11,105,675	16.7	8,266,721	12.5	10,218,284	15.4	7,873,978	11.9	13,545,148	20.4	66,365,038	100.0
AAPC	10.3		8.4		10.2		17.5		14.8		14.3		12.4	
2015 (8)	16,935,141	22.7	12,034,972	16.1	9,109,646	12.2	12,007,555	16.1	9,039,236	12.1	15,482,497	20.8	74,609,047	100.0
AAPC	3.2		7.7		5.6		11.5		7.4		8.7		7.2	
2016 (1)(9)(10)	17,475,732	21.9	12,964,435	16.2	9,618,852	12.0	13,384,776	16.7	9,704,115	12.1	16,827,325	21.0	79,975,235	100.0
AAPC	(0.4)		1.4		3.4		12.6		8.3		1.6		4.0	
2017 (11)(12)(13)	17,401,797	20.9	13,147,947	15.8	9,941,687	12.0	15,071,870	18.1	10,512,371	12.6	17,099,498	20.6	83,175,170	100.0
AAPC	0.0		9.0		7.2		4.1		7.7		4.8		5.0	
2018 (14)	17,407,286	19.9	14,329,661	16.4	10,659,821	12.2	15,694,590	18.0	11,324,130	13.0	17,923,312	20.5	87,338,800	100.0
AAPC	(0.6)		4.0		6.1		3.4		7.3		2.6		3.4	
2019 (15)	17,304,686	19.2	14,898,208	16.5	11,311,613	12.5	16,224,973	18.0	12,149,520	13.5	18,390,570	20.4	90,279,570	100.0
AVERAGE ANNUAL PERCENT CHANGE (AAPC)														
2009 - 2014	4.1		7.5		9.5		9.0		8.5		5.1		6.7	
2014 - 2019	2.4		6.1		6.5		9.7		9.1		6.3		6.3	
2009 - 2019	3.3		6.8		8.0		9.3		8.8		5.7		6.5	

Source: E-470 Public Highway Authority.

(1) Leap Year.

(2) On January 1, 2009, License Plate Tolling was introduced on the E-470 system, with a $0.25 toll differential over ExpressToll tolls at mainline toll gantries and $0.10 at ramp toll gantries. Cash toll collections continued until July 4, 2009, at which point the entire E-470 was converted to All-Electronic Tolling.

(3) ExpressToll tolls increased at Toll Gantry A from $1.75 to $2.00 and at Toll Gantries B, C, D and E from $2.00 to $2.25 on January 1, 2009. Ramp toll gantries increased to $0.90. Additionally, a toll differential of $0.25 between ExpressToll and License Plate Toll was introduced at all mainline toll gantries.

(4) Tolls increased at Toll Gantry A from $2.00 to $2.15 and at Toll Gantries B, C, D and E from $2.25 to $2.40 on January 1, 2011. Ramp toll gantries increased to $0.95. Additionally, the toll differential between ExpressToll and License Plate Toll was increased from $0.25 to 25 percent.

(5) Tolls increased at Toll Gantry A from $2.15 to $2.25 and at Toll Gantries B, C, D and E from $2.40 to $2.50 on January 1, 2012. Ramp toll gantries increased to $1.00.

(6) Tolls increased at Toll Gantry A from $2.25 to $2.35 and at Toll Gantries B, C, D and E from $2.50 to $2.60 on January 1, 2013. Ramp toll gantries increased to $1.05.

(7) Tolls increased at Toll Gantry A from $2.35 to $2.45 and at Toll Gantries B, C, D and E from $2.60 to $2.70 on January 1, 2014. Ramp toll gantries increased to $1.10.

(8) Tolls increased at Toll Gantry A from $2.45 to $2.50 and at Toll Gantries B, C, D and E from $2.70 to $2.75 on January 1, 2015. Ramp toll gantries increased to $1.15.

(9) Tolls increased at Toll Gantry A from $2.50 to $2.60 and at Toll Gantries B, C, D and E from $2.75 to $2.85 on January 1, 2016. Ramp toll gantries increased to $1.20.

(10) Construction began in spring of 2016 to add a third lane in each direction along an eight-mile stretch from Parker Road and Quincy Avenue.

(11) Tolls increased at Toll Gantry A from $2.60 to $2.70 and at Toll Gantries B, C, D and E from $2.85 to $2.95 on January 1, 2017. Ramp toll gantries increased to $1.25.

(12) Hurricane Harvey occurred in August 2017 and Hurricane Irma occurred in September 2017, leading to gasoline shortages and other national travel disruptions.

(13) Construction on the C-470 Express Lanes began September 2017.

(14) ExpressToll rates decreased at Toll Gantry C from $2.85 to $2.70 on January 1, 2018. Additionally, the toll differential between ExpressToll and License Plate Toll was increased to 53 percent.

(15) The toll differential between ExpressToll and License Plate Toll was increased to 58 percent on January 1, 2019.

Table 2-2
Monthly Toll Transaction Trends by Mainline Toll Gantry
2017 - 2020

Year	Month		Gantry A Monthly Transactions	Gantry A Year/Year Pct. Change	Gantry B Monthly Transactions	Gantry B Year/Year Pct. Change	Gantry C Monthly Transactions	Gantry C Year/Year Pct. Change	Gantry D Monthly Transactions	Gantry D Year/Year Pct. Change	Gantry E Monthly Transactions	Gantry E Year/Year Pct. Change	Toll Ramps Monthly Transactions	Toll Ramps Year/Year Pct. Change	Total Monthly Transactions	Total Year/Year Pct. Change
2017	January	(1)	1,307,354	(1.4)	941,371	4.6	665,510	2.6	1,041,823	17.6	693,664	5.9	1,281,342	1.7	5,931,064	4.5
	February		1,246,855	(3.6)	896,191	1.3	631,238	0.4	996,626	17.0	664,934	3.6	1,244,436	2.1	5,680,280	2.9
	March		1,439,931	2.4	1,064,097	5.2	773,076	4.5	1,200,206	19.8	816,517	9.9	1,412,324	5.5	6,706,151	7.5
	April		1,399,660	0.2	1,024,054	3.5	745,084	3.7	1,138,824	16.1	792,053	8.0	1,364,496	2.7	6,464,171	5.1
	May		1,565,948	1.5	1,202,699	5.5	899,249	6.6	1,329,915	17.6	931,081	9.7	1,494,193	2.4	7,423,085	6.6
	June		1,588,671	(0.7)	1,121,395	(7.8)	970,333	5.5	1,441,999	17.1	1,011,896	11.3	1,526,353	2.5	7,660,647	4.0
	July		1,508,731	(2.8)	1,174,800	(1.8)	950,609	2.3	1,427,498	14.3	993,547	8.7	1,454,150	(0.7)	7,509,335	2.8
	August		1,603,779	(1.3)	1,254,883	2.8	962,159	5.9	1,497,451	19.6	1,040,524	11.4	1,564,874	0.7	7,923,670	5.7
	September		1,462,082	(5.2)	1,129,027	(2.1)	851,442	(0.9)	1,248,555	4.4	912,173	6.7	1,455,066	(1.2)	7,058,345	(0.3)
	October		1,480,572	4.0	1,168,021	1.8	875,620	2.1	1,337,607	4.9	939,761	7.5	1,481,548	0.5	7,283,129	3.3
	November		1,400,457	2.8	1,108,146	4.1	830,635	4.8	1,259,233	5.1	884,687	8.4	1,413,249	2.6	6,896,407	4.3
	December		1,397,757	(0.6)	1,063,263	2.1	786,732	1.9	1,152,133	1.9	831,534	6.7	1,407,467	1.3	6,638,886	1.9
	Total		**17,401,797**	**(0.4)**	**13,147,947**	**1.4**	**9,941,687**	**3.4**	**15,071,870**	**12.6**	**10,512,371**	**8.3**	**17,099,498**	**1.6**	**83,175,170**	**4.0**
2018	January		1,328,637	1.6	1,008,755	7.2	710,202	6.7	1,078,011	3.5	762,886	10.0	1,335,902	4.3	6,224,393	4.9
	February		1,231,391	(1.2)	940,023	4.9	660,794	4.7	997,727	0.1	712,886	7.2	1,250,270	0.5	5,793,091	2.0
	March		1,457,267	1.2	1,141,403	7.3	832,305	7.7	1,246,651	3.9	888,797	8.9	1,463,940	3.7	7,030,363	4.8
	April		1,446,085	3.3	1,125,620	9.9	816,034	9.5	1,200,451	5.4	864,931	9.2	1,448,708	6.2	6,901,829	6.8
	May		1,598,880	2.1	1,299,850	8.1	959,520	6.7	1,401,794	5.4	1,014,858	9.0	1,604,768	7.4	7,879,670	6.2
	June		1,583,432	(0.3)	1,331,564	18.7	1,020,304	5.1	1,471,504	2.0	1,063,007	5.1	1,578,910	3.4	8,048,721	5.1
	July		1,537,290	1.9	1,312,155	11.7	1,028,633	8.2	1,492,665	4.6	1,078,164	8.5	1,559,077	7.2	8,007,984	6.6
	August		1,631,897	1.8	1,368,970	9.1	1,038,750	8.0	1,554,494	3.8	1,116,802	7.3	1,675,797	7.1	8,386,710	5.8
	September		1,469,662	0.5	1,224,553	8.5	919,249	8.0	1,369,313	9.7	979,194	7.3	1,523,504	4.7	7,485,475	6.1
	October		1,357,009	(8.3)	1,283,081	9.9	966,072	10.3	1,423,232	6.4	1,027,823	9.4	1,571,857	6.1	7,629,074	4.7
	November		1,402,552	0.1	1,186,796	7.1	887,606	6.9	1,287,474	2.2	945,001	6.8	1,460,644	3.4	7,170,073	4.0
	December		1,363,184	(2.5)	1,106,891	4.1	820,352	4.3	1,171,274	1.7	869,781	4.6	1,449,935	3.0	6,781,417	2.1
	Total		**17,407,286**	**0.0**	**14,329,661**	**9.0**	**10,659,821**	**7.2**	**15,694,590**	**4.1**	**11,324,130**	**7.7**	**17,923,312**	**4.8**	**87,338,800**	**5.0**
2019	January		1,306,004	(1.7)	1,054,974	4.6	749,281	5.5	1,090,431	1.2	801,596	5.1	1,367,363	2.4	6,369,649	2.3
	February		1,258,160	2.2	1,012,012	7.7	722,505	9.3	1,041,245	4.4	765,914	7.4	1,303,797	4.3	6,103,633	5.4
	March		1,344,394	(7.7)	1,133,409	(0.7)	845,978	1.6	1,219,135	(2.2)	907,664	2.1	1,416,968	(3.2)	6,867,548	(2.3)
	April		1,462,501	1.1	1,206,313	7.2	882,999	8.2	1,279,975	6.6	953,867	10.3	1,531,255	5.7	7,316,910	6.0
	May		1,568,042	(1.9)	1,355,541	4.3	1,026,142	6.9	1,456,005	3.9	1,091,564	7.6	1,639,318	2.2	8,136,612	3.3
	June		1,501,484	(5.2)	1,341,551	0.8	1,056,247	3.5	1,492,875	1.5	1,112,042	4.6	1,580,298	0.1	8,084,497	0.4
	July		1,559,410	1.4	1,419,918	8.2	1,133,688	10.2	1,613,417	8.1	1,202,532	11.5	1,652,307	6.0	8,581,272	7.2
	August		1,596,703	(2.2)	1,406,999	2.8	1,085,945	4.5	1,574,558	1.3	1,181,192	5.8	1,703,541	1.7	8,548,938	1.9
	September		1,489,578	1.4	1,285,948	5.0	993,434	8.1	1,441,267	5.3	1,080,021	10.3	1,594,472	4.7	7,884,720	5.3
	October		1,479,394	9.0	1,297,625	1.1	1,007,764	4.3	1,444,440	1.5	1,094,205	6.5	1,586,588	0.9	7,910,016	3.7
	November		1,338,399	(4.6)	1,174,461	(1.0)	890,402	0.3	1,273,992	(1.0)	966,403	2.3	1,471,657	0.8	7,115,314	(0.8)
	December		1,400,617	2.7	1,209,457	9.3	917,228	11.8	1,297,633	10.8	992,520	14.1	1,543,006	6.4	7,360,461	8.5
	Total		**17,304,686**	**(0.6)**	**14,898,208**	**4.0**	**11,311,613**	**6.1**	**16,224,973**	**3.4**	**12,149,520**	**7.3**	**18,390,570**	**2.6**	**90,279,570**	**3.4**
2020	January		1,339,565	2.6	1,110,907	5.3	794,646	6.1	1,156,677	6.1	869,143	8.4	1,482,808	8.4	6,753,746	6.0
	February		1,228,859	(2.3)	1,019,296	0.7	735,864	1.8	1,059,938	1.8	790,395	3.2	1,356,796	4.1	6,191,148	1.4
	March	(2)	918,543	(31.7)	764,282	(32.6)	537,017	(36.5)	786,942	(35.5)	572,292	(36.9)	1,086,954	(23.3)	4,666,030	(32.1)
	Year-to-Date		**3,486,967**	**(10.8)**	**2,894,485**	**(9.6)**	**2,067,527**	**(10.8)**	**3,003,557**	**(10.4)**	**2,231,830**	**(9.8)**	**3,926,558**	**(4.0)**	**17,610,924**	**(8.9)**

(1) Tolls increased at Toll Gantry A from $2.60 to $2.70 and at Toll Gantries B, C, D and E from $2.85 to $2.95 on January 1, 2017. Ramp toll gantries increased to $1.25.

(2) Travel reductions, closure of public spaces and activites, and reduced economic activity resulting from the COVID-19 outbreak began in mid-March 2020.

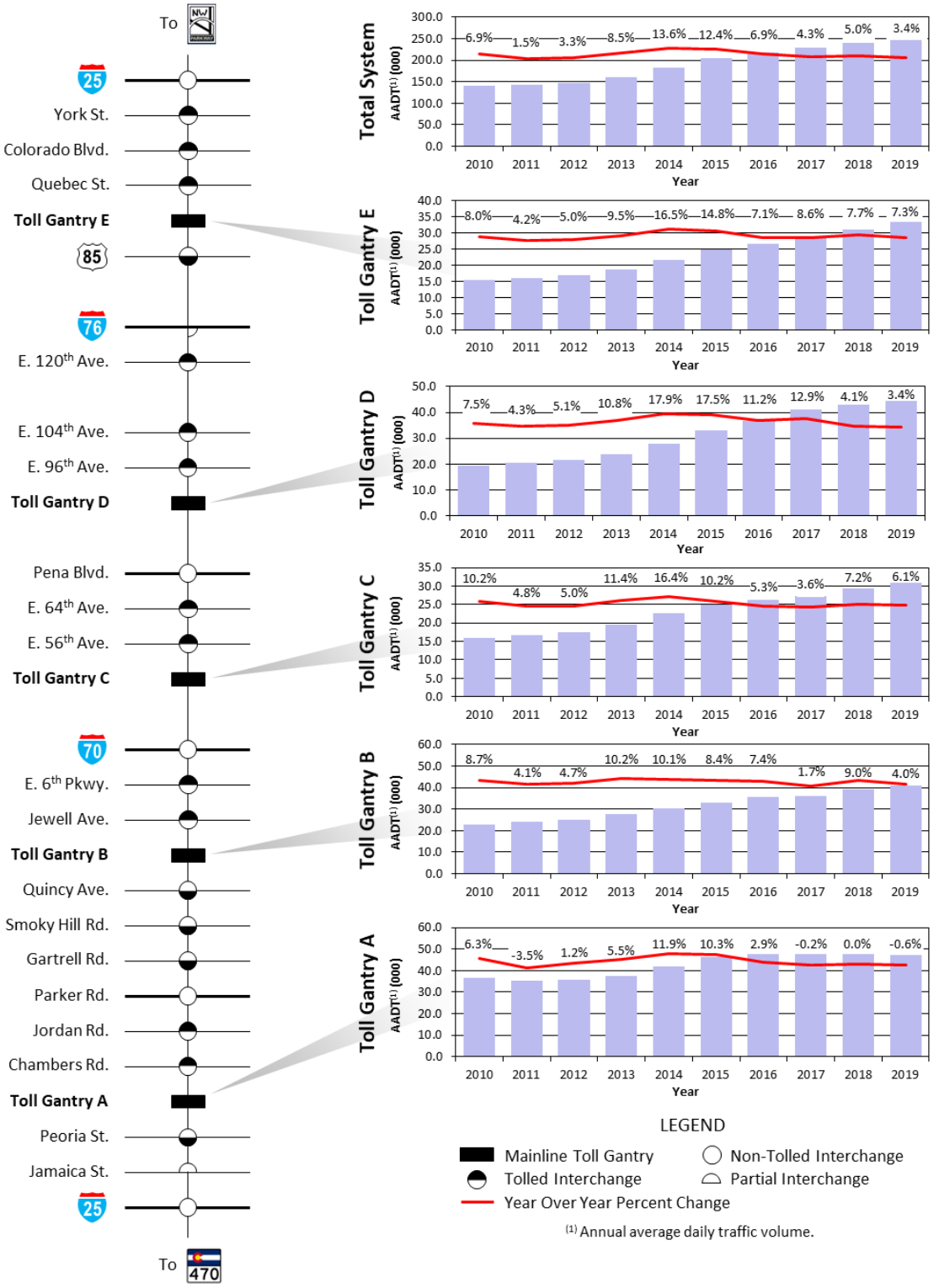


Figure 2-1
Historical Annual Average Daily Traffic by Mainline Toll Locations

transaction growth continued on E-470. Year-over year growth rates in 2018 and 2019 were 5.0 percent and 3.4 percent, respectively, with year-over-year growth rates by month falling relatively close to the annual average. Monthly transaction trends are also presented in **Figure 2-2**.

Comparing the gantries one against the other, transaction growth at Toll Gantry A has fallen significantly behind other E-470 toll locations, with a number of years of zero or negative transaction growth. This is due to the ongoing impacts related to construction of the C-470 Express Lanes. Prior to construction on C-470, Gantry A transactions were growing year-over-year at rates of 11.9 percent (2014), 10.3 percent (2015) and 3.2 percent (2016 thru beginning of C-470 construction in Oct.). C-470 construction began in late 2016, meaning 2017 was the first full "year over year" impact, with Gantry A transactions coming in 0.4 percent lower that year than in 2016. Based on historical growth trends, normal growth at Gantry A was likely about 3.5 percent in 2017, meaning that the negative impact of the C-470 Express Lane construction at Gantry A was likely around 4.0 percent. As the project continued into 2018, actual growth at Toll Gantry A was 0.0 percent, representing a level of normal growth constrained by the ongoing construction. In 2019, there was a ramp up in construction activity, leading to an increase in impacts at Toll Gantry A. Assuming a 1.0 percent normal growth rate under the constrained construction conditions, it is likely that the construction impacts increased at Gantry A in 2019 an additional 2.25 percent. Thus, the estimated the total construction impact currently being experienced at Toll Gantry A is roughly 6.25 percent or 3,400 transactions per weekday. It is anticipated that when construction on C-470 ends in Spring 2020, the facility will experience a return of some of that traffic, plus an extra bump from the impacts of the project itself.

Lastly, it is worth noting the significant year-over-year decrease in transactions in March 2020. This is due to the public space closures, event cancellations, stay-at-home orders, and reduced economic activity resulting from the COVID-19 outbreak, which began mid-month. CDM Smith continues to monitor these impacts on a daily basis to assess the short-term and potential long-term impacts. The effects of COVID-19 to E-470 traffic are discussed later in this chapter and their potential impacts on future traffic and revenue are discussed in greater detail in **Chapter 4** of this report.

Annual Revenue Trends

Annual system-wide revenue trends from 2009 through 2019 by method of payment are presented in **Table 2-3**. Despite lower transactions in 2009 due to the Great Recession, the conversion to AET in 2009 and the increase in toll rates led to an increase in toll revenue over 2008 (not shown). ExpressToll revenue increased by 11.4 percent, the result of the $0.25 toll differential between ExpressToll and License Plate Toll rates at mainline gantry locations. The share of toll revenue resulting from ExpressToll transactions increased as well from 70 percent in 2008 to 72.3 percent in 2009. Net toll revenues, which include adjustments for unbillable and unpaid toll transactions, differed from gross toll revenues in 2009 by 1.2 percent as a result of the new License Plate Toll payment option. The shift to ExpressToll continued into 2010, as License Plate Toll revenues decreased by 8.0 percent over the prior year. As a result, the ExpressToll market share peaked at 75.6 percent of total revenue.

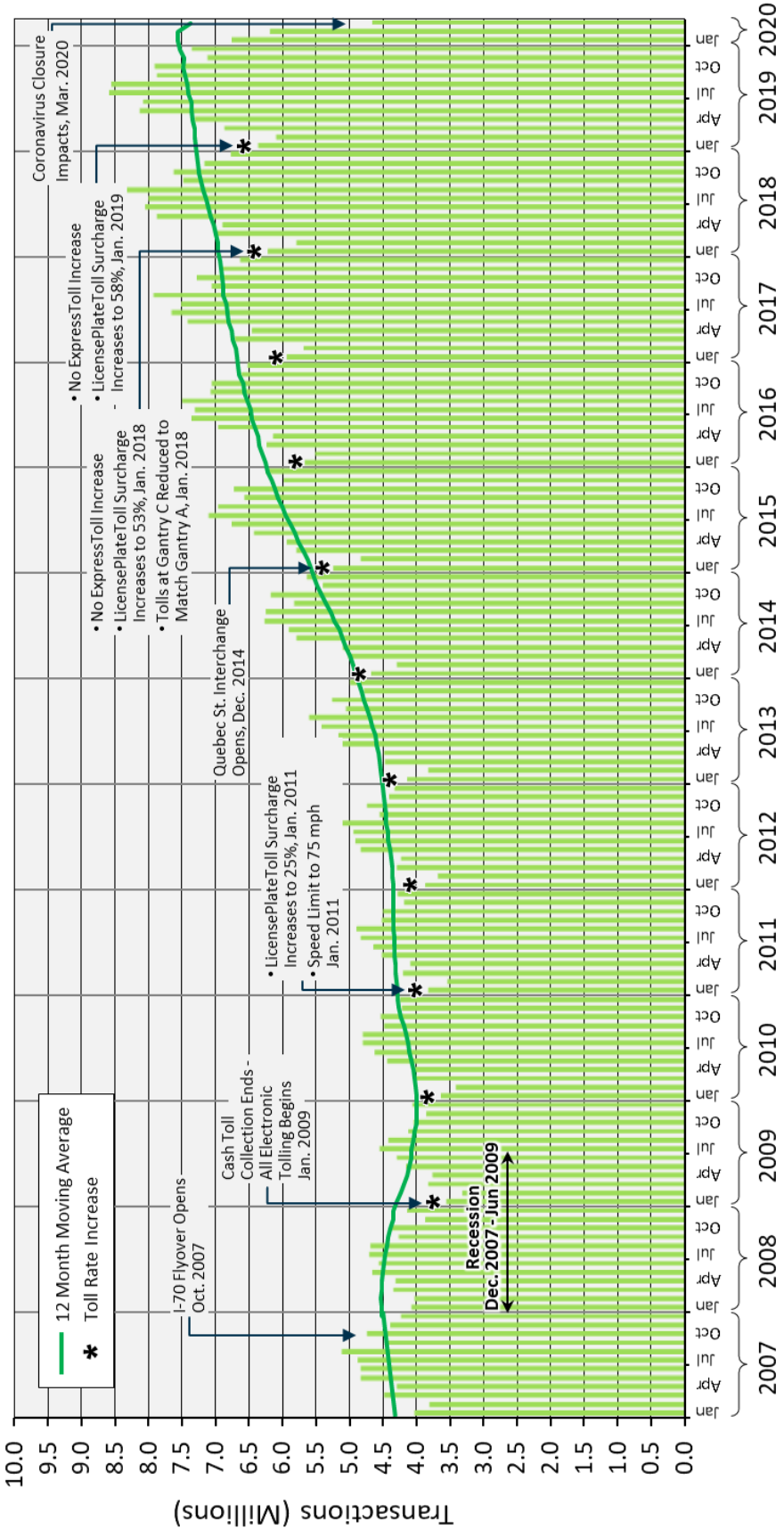


Figure 2-2
Monthly Transaction Trends

Table 2-3
Annual Systemwide Toll Revenue Trends
2009 - 2019

Year	Gross Toll Revenues (1)									Net Toll Revenues (2)	
	ExpressToll			Cash / License Plate Toll			Total				
	Revenue	Average Toll	Percent of Total E-470	Revenue	Average Toll	Percent of Total E-470	Revenue	Average Toll	Percent of Total E-470	Revenue	Average Toll
2009 (5)(6)	$ 67,712,188	$ 1.95	72.3	$ 25,887,184	$ 3.13	27.7	$ 93,599,372	$ 1.95	100.0	$ 92,442,683	$ 1.93
AAPC	8.9			(8.0)			4.2			2.0	
2010	$ 73,708,570	$ 1.98	75.6	$ 23,815,212	$ 1.69	24.4	$ 97,523,782	$ 1.90	100.0	$ 94,309,891	$ 1.84
AAPC	7.5			32.1			13.5			14.2	
2011 (7)	$ 79,209,778	$ 2.10	71.6	$ 31,459,634	$ 2.20	28.4	$ 110,669,412	$ 2.12	100.0	$ 107,722,486	$ 2.07
AAPC	8.2			9.9			8.7			8.4	
2012 (3)(8)	$ 85,693,927	$ 2.21	71.3	$ 34,567,673	$ 2.26	28.7	$ 120,261,600	$ 2.23	100.0	$ 116,744,889	$ 2.16
AAPC	11.3			14.1			12.1			10.7	
2013 (9)	$ 95,367,587	$ 2.32	70.8	$ 39,425,861	$ 2.28	29.2	$ 134,793,448	$ 2.31	100.0	$ 129,181,918	$ 2.21
AAPC	15.4			20.1			16.8			16.4	
2014 (10)	$ 110,080,820	$ 2.44	69.9	$ 47,364,845	$ 2.23	30.1	$ 157,445,664	$ 2.37	100.0	$ 150,404,512	$ 2.27
AAPC	14.5			16.0			15.0			15.0	
2015 (11)	$ 126,058,057	$ 2.51	69.6	$ 54,933,992	$ 2.26	30.4	$ 180,992,049	$ 2.43	100.0	$ 173,039,512	$ 2.32
AAPC	15.1			6.7			12.5			11.4	
2016 (3)(12)(13)	$ 145,091,716	$ 2.62	71.2	$ 58,609,418	$ 2.38	28.8	$ 203,701,135	$ 2.55	100.0	$ 192,810,649	$ 2.41
AAPC	12.5			9.0			11.5			10.9	
2017 (14)(15)(16)	$ 163,299,992	$ 2.75	71.9	$ 63,896,754	$ 2.70	28.1	$ 227,196,746	$ 2.73	100.0	$ 213,765,649	$ 2.57
AAPC	7.7			15.7			9.9			9.0	
2018 (17)	$ 175,816,969	$ 2.74	70.4	$ 73,956,549	$ 3.20	29.6	$ 249,773,518	$ 2.86	100.0	$ 233,088,327	$ 2.67
AAPC	3.2			13.1			6.1			6.8	
2019 (18)	$ 181,436,249	$ 2.76	68.4	$ 83,634,020	$ 3.42	31.6	$ 265,070,269	$ 2.94	100.0	$ 249,013,096	$ 2.76
AVERAGE ANNUAL PERCENT CHANGE (AAPC)											
2009 - 2014	10.2			12.8			11.0	4.0		10.2	
2014 - 2019	10.5			12.0			11.0	4.4		10.6	
2009 - 2019	10.4			12.4			11.0	4.2		10.4	

Source: E-470 Public Highway Authority, 2017.

(1) Gross Toll Revenues do not include adjustments for uncollectible revenues (non-revenue vehicles, bad license plate images, etc...) or unpaid transactions.

(2) Net Toll Revenues include adjustments for uncollectible revenues (non-revenue vehicles, bad license plate images, etc...) and unpaid transactions.

(3) Leap Year.

(4) Tolls increased at Toll Gantry A from $1.50 to $1.75 and at Toll Gantry B, C, D and E from $1.75 to $2.00 on January 1, 2006. Increases of $0.25 at several ramp plazas.

(5) On January 1, 2009, License Plate Tolling was introduced on the E-470 system, with a $0.25 toll differential over ExpressToll tolls at mainline toll gantries and $0.10 at ramp toll gantries. Cash toll collections continued until July 4, 2009, at which point the entire E-470 was converted to All-Electronic Tolling.

(6) ExpressToll tolls increased at Toll Gantry A from $1.75 to $2.00 and at Toll Gantries B, C, D and E from $2.00 to $2.25 on January 1, 2009. Ramp toll gantries increased to $0.90. Additionally, a toll differential of $0.25 between ExpressToll and License Plate Toll was introduced.

(7) Tolls increased at Toll Gantry A from $2.00 to $2.15 and at Toll Gantries B, C, D and E from $2.25 to $2.40 on January 1, 2011. Ramp toll gantries increased to $0.95. Additionally, the toll differential between ExpressToll and License Plate Toll was increased from $0.25 to 25 percent.

(8) Tolls increased at Toll Gantry A from $2.15 to $2.25 and at Toll Gantries B, C, D and E from $2.40 to $2.50 on January 1, 2012. Ramp toll gantries increased to $1.00.

(9) Tolls increased at Toll Gantry A from $2.25 to $2.35 and at Toll Gantries B, C, D and E from $2.50 to $2.60 on January 1, 2013. Ramp toll gantries increased to $1.05.

(10) Tolls increased at Toll Gantry A from $2.35 to $2.45 and at Toll Gantries B, C, D and E from $2.60 to $2.70 on January 1, 2014. Ramp toll gantries increased to $1.10.

(11) Tolls increased at Toll Gantry A from $2.45 to $2.50 and at Toll Gantries B, C, D and E from $2.70 to $2.75 on January 1, 2015. Ramp toll gantries increased to $1.15.

(12) Tolls increased at Toll Gantry A from $2.50 to $2.60 and at Toll Gantries B, C, D and E from $2.75 to $2.85 on January 1, 2016. Ramp toll gantries increased to $1.20.

(13) Construction began in spring of 2016 to add a third lane in each direction along an eight-mile stretch from Parker Road and Quincy Avenue.

(14) Tolls increased at Toll Gantry A from $2.60 to $2.70 and at Toll Gantries B, C, D and E from $2.85 to $2.95 on January 1, 2017. Ramp toll gantries increased to $1.25.

(15) Hurricane Harvey occurred in August 2017 and Hurricane Irma occurred in September 2017, leading to gasoline shortages and other national travel disruptions.

(16) Construction on the C-470 Express Lanes began September 2017.

(17) ExpressToll rates decreased at Toll Gantry C from $2.85 to $2.70 on January 1, 2018. Additionally, the toll differential between ExpressToll and License Plate Toll was increased to 53 percent.

(18) The toll differential between ExpressToll and License Plate Toll was increased to 58 percent on January 1, 2019.

In 2011, the Authority increased toll rates for ExpressToll transactions at the mainline toll gantries by $0.15 and at the toll ramps by $0.05 and increased the toll differential between ExpressToll and License Plate Toll. This increased the average toll rate by 11.8 percent in 2011, as compared to 2010. As a result of the toll increase and normal growth, gross toll revenue increased by 13.5 percent in 2011 over 2010. Much of this increase was the result of the increased toll rate differential between ExpressToll and License Plate Toll transactions. The toll rate differential between the two payment methods was increased from $0.25 to 25 percent, effectively doubling the differential between ExpressToll and License Plate Toll methods of payment. Due to this change, toll revenues collected from License Plate Toll transactions increased by 32.1 percent in 2011.

From 2011 through 2017, the Authority has implemented annual toll increases. Despite the resultant traffic diversions from E-470 following these increases, gross toll revenue increased by 8.7 percent in 2012 and 12.1 percent in 2013. These increases were led by growth in License Plate Toll revenue, which grew an average of 12.0 percent per year between 2011 and 2013. Moreover, while License Plate Toll revenue represented only about 29 percent of total gross toll revenue between 2011 and 2013, the growth in License Plate Toll revenue represented 33 percent of the total growth during that period. This may have been the result of new system users coming from the developing areas in Aurora and Adams County who had yet to register for ExpressToll, in addition to the return of some of the less frequent non-resident, recreational or discretionary customers lost during the recession.

Coupled with annual toll increases and robust traffic growth, gross toll revenue increased by 16.8 percent, 15.0 percent, and 12.5 percent in 2014, 2015 and 2016, respectively. These systemwide increases were the product of comparable average revenue growth rates for both ExpressToll and LicensePlateToll between 2013 and 2016. ExpressToll revenue grew at an average rate of 13.7 percent over the three-year period, while License Plate Toll revenue grew by 16.7 percent.

While annual growth in gross ExpressToll revenue fell to 7.7 percent in 2018 and 3.2 percent in 2019, annual growth in gross LicensePlateToll revenue increased back to double digits (15.7 percent in 2018 and 13.1 percent in 2019). As a result, the share of ExpressToll revenue fell below 69 percent in 2019, for the first time in over 10 years. Likely, the increase in LicensePlateToll customers was due to new residents in the region using E-470 infrequently and who had not yet registered for an ExpressToll account. Total annual gross toll revenues grew in 2018 by 9.9 percent and in 2019 by 6.1 percent. Due to modest gains in toll collection rates, 2019 net toll revenues grew slightly more, by 6.8 percent.

Overall growth in systemwide gross toll revenues between 2009 and 2019 has averaged 11.0 percent per year, while net toll revenues have increased by 10.4 percent over the same 10-year period. During that time, system-wide gross toll revenue has more than doubled, from $93.6 million to $265.1 million. This is largely due to an average annual toll rate increase of 4.2 percent over that 10-year period. Total net toll revenue was $249.0 million in 2019, representing a leakage rate of 6.1 percent.

2019 Average Weekday Traffic Volumes

The regional travel demand model used in the traffic and revenue forecasting process is based on annual average weekday traffic (AWDT) volumes. As an aid in the model calibration process, traffic counts were obtained from Colorado Department of Transportation (CDOT) and from the Denver Regional Council of Governments (DRCOG) for major arterial roadways within the project corridor along five screenlines. These screenlines were developed to intercept traffic flows along major east and west or north and south roadways parallel to the mainline tolling locations on E-470. Additional traffic counts were collected along these screenlines in September 2019 by All Traffic Data Services (ATDS). The screenline counts and cross-street counts were useful to calculating the total volume of traffic potential to E-470, to estimate the current E-470 market share of traffic and to aid in the calibration of the regional travel demand model.

In addition, a balanced traffic profile of 2019 AWDT volumes for each E-470 ramp and mainline section was developed as part of the model calibration process in order to compare the model's traffic assignment output with actual traffic volumes. The complete mainline and ramp traffic profile was developed using count data at the existing toll locations provided by the Authority in conjunction with 48-hour machine counts of traffic conducted on internal weekdays in September 2019 by ATDS at all non-tolled ramp locations.

Project Screenlines

One assessment of the reasonableness of the results of the tolled traffic assignments is whether the total volume crossing a group of parallel routes, called a screenline, compares well with actual traffic volumes. The variation in the traffic assignments from the travel demand model versus the actual traffic counts may differ on individual roads; however, if the total assigned volumes crossing the screenlines are reasonably close to the counts, then this is an indication that volumes, congestion levels, and travel patterns are being reasonably simulated by the model.

CDM Smith developed five screenlines to assist in the calibration of the travel demand model, illustrated in **Figure 2-3**. CDM Smith obtained available traffic counts for the roadways along these screenlines from CDOT, DRCOG and ATDS. These counts were generally conducted between 2016 and 2019. Based on historical traffic growth trends and monthly factors developed from the data provided by the Authority and from continuous counter information obtained from CDOT, the traffic counts were adjusted to 2019 AWDT levels. The resulting 2019 AWDT volumes along the five screenlines are provided in **Table 2-4**.

As expected, based on the available count data, the share of screenline traffic on E-470 varies by location. The share of traffic using E-470 at Screenline A is 7.6 percent. The share of traffic on E-470 at screenlines B and C are 6.9 percent and 4.7 percent, respectively. These shares would probably be higher were it not for the proximity of several major competing toll-free parallel roads, including I-25, I-225, Pena Boulevard and Tower Road. Of the five screenlines, Screenlines D and E have the greatest share of traffic using E-470, with market shares of 13.2 percent and 11.4 percent, respectively. It should be noted that the overall E-470 market share at Screenline D and E are a minimum of 50 percent greater than those of Screenlines A, B and C. This may be due to the lack of competing parallel facilities at these locations. For example, E-470 serves as one of only seven crossings of the South Platt River in the ten miles between E 160th Avenue and E 88th Avenue.

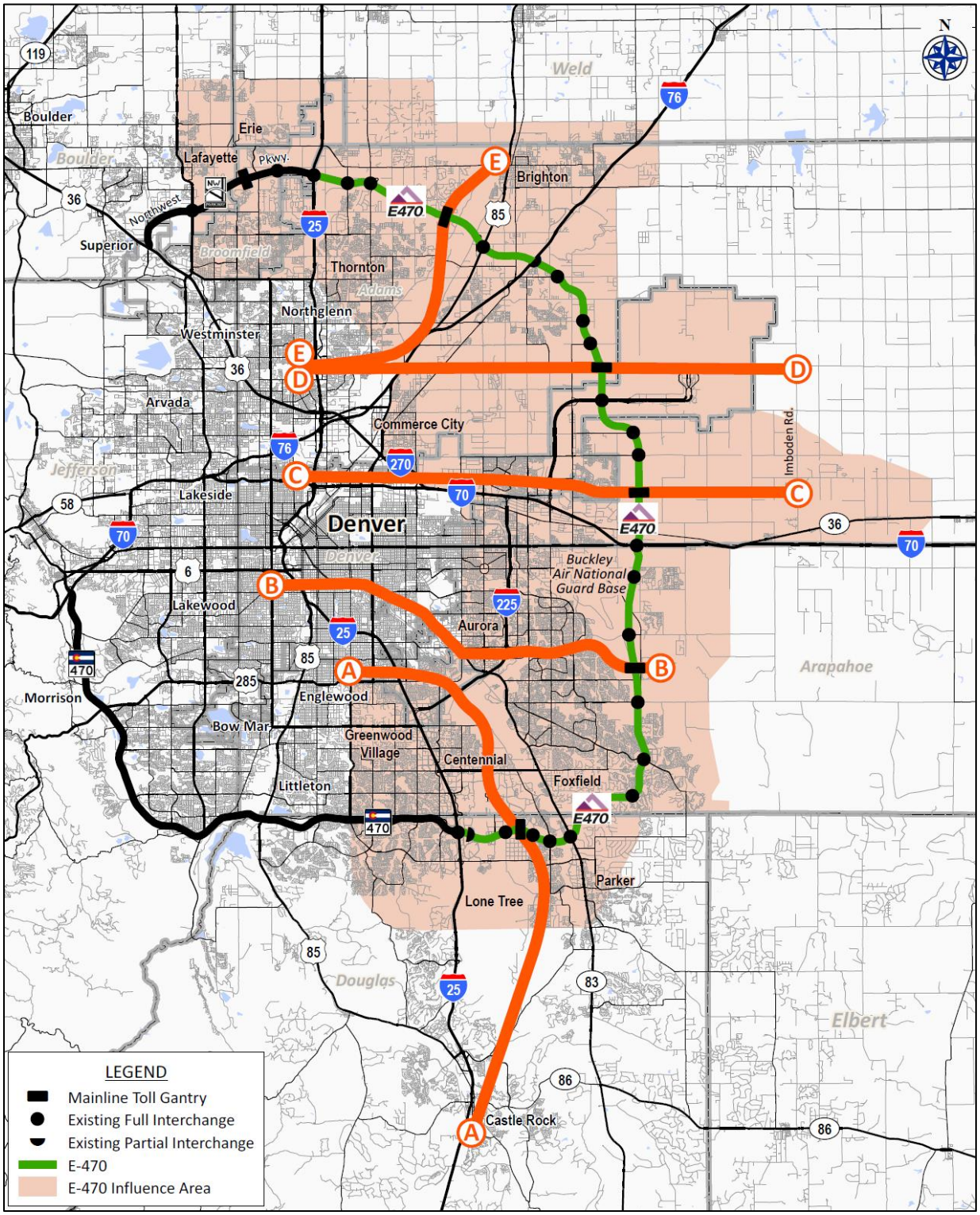


Figure 2-3
Project Screenlines

Table 2-4
2019 Annual Average Weekday Traffic Volumes at Screenline Locations

Street Name	Location	Annual Average Weekday Traffic (AWDT) Northbound	Southbound	Total
Screenline A				
I-25	North of SH 30 / E Hampden Ave.	125,480	132,770	258,250
SH 30	South of E Dartmouth Ave.	22,920	23,070	45,990
I-225	Southwest of SH 83 / Parker Rd.	78,520	76,810	155,330
Dam Rd.	Southwest of SH 83 / Parker Rd.	6,070	4,890	10,960
SH 88 / E Arapahoe Rd.	East of S Peroia St.	36,280	37,650	73,930
E Broncos Pkwy.	West of S Potomac St.	12,620	12,180	24,800
E County Line Rd.	East of Concord Center Dr.	4,870	5,400	10,270
Compark Blvd.	East of Concord Center Dr.	3,230	3,360	6,590
E-470	**Toll Gantry A**	**25,780**	**28,070**	**53,850**
E Lincoln Ave.	East of S Peoria St.	21,520	20,720	42,240
Ridgegate Pkwy.	East of S Peoria St.	9,440	9,650	19,090
Hess Rd.	East of S Havana St.	5,060	4,670	9,730
Total Screenline Traffic Volumes		**351,790**	**359,240**	**711,030**
Percent E-470 Market Share for Screeline		7.3	7.8	7.6
Screenline B				
I-25	South of SH 6 / 6th Ave.	117,260	127,460	244,720
SH 2 / S Colorado Blvd.	South of E 1st Ave.	28,360	27,500	55,860
SH 30 / S Havana St.	North of SH 83 / S Parker Rd.	16,550	16,940	33,490
S Peoria St.	South of E Iliff Ave.	12,500	12,070	24,570
I-225	North of SH 83 / S Parker Rd.	76,050	69,330	145,380
S Chambers Blvd.	South of E Iliff Ave.	16,650	18,320	34,970
S Buckley Rd.	South of E Iliff Ave.	15,480	15,370	30,850
S Tower Rd.	South of E Iliff Ave.	14,400	13,890	28,290
S Dunkirk St.	South of E Iliff Ave.	2,780	2,430	5,210
E-470	**Toll Gantry B**	**22,800**	**23,470**	**46,270**
SH 30 / S Gun Club Rd.	South of E Jewell Ave.	11,400	10,700	22,100
Total Screenline Traffic Volumes		**334,230**	**337,480**	**671,710**
Percent E-470 Market Share for Screeline		6.8	7.0	6.9
Screenline C				
I-25	North of I-70	120,000	114,850	234,850
SH 265 / Brighton Blvd.	South of York St.	3,670	3,460	7,130
SH 6 / Vasquez Blvd.	North of I-70	9,560	13,950	23,510
SH 2 / Colorado Blvd.	North of I-70	18,330	17,090	35,420
I-270	North of I-70	44,430	45,430	89,860
Central Park Blvd.	North of I-70	17,440	14,550	31,990
Havana St.	North of I-70	16,760	14,660	31,420
Peoria St.	North of I-70	24,380	18,170	42,550
Chambers Rd.	North of E 40th Ave.	18,210	20,910	39,120
Pena Blvd.	North of E 40th Ave.	65,760	60,860	126,620
Tower Rd.	South of Green Valley Ranch Blvd.	12,190	13,470	25,660
Picadilly Rd.	South of Green Valley Ranch Blvd.	2,320	2,520	4,840
E-470	**Toll Gantry C**	**17,500**	**16,750**	**34,250**
Mohegan Rd.	South of E 56th Ave	450	490	940
Total Screenline Traffic Volumes		**371,000**	**357,160**	**728,160**
Percent E-470 Market Share for Screeline		4.7	4.7	4.7
Screenline D				
I-25	South of E 88th Ave.	85,150	90,160	175,310
I-76	South of E 88th Ave.	46,610	45,240	91,850
Brighton Rd.	South of E 88th Ave.	2,370	2,430	4,800
Rosemary St.	South of E 88th Ave.	6,080	6,840	12,920
SH 2	South of E 88th Ave.	550	950	1,500
Tower Rd.	South of E 88th Ave.	18,370	18,160	36,530
E-470	**Toll Gantry D**	**24,330**	**25,230**	**49,560**
Total Screenline Traffic Volumes		**183,460**	**189,010**	**372,470**
Percent E-470 Market Share for Screeline		13.3	13.3	13.3
Screenline E				
I-25	South of E 88th Ave.	85,150	90,160	175,310
E 88th Ave.	at South Platte River	12,190	11,530	23,720
McKay Rd.	at South Platte River	9,230	9,320	18,550
SH 44 / E 104th Ave.	at South Platte River	8,230	8,070	16,300
E 120th Ave.	at South Platte River	9,860	10,450	20,310
Henderson Rd.	at South Platte River	3,610	4,070	7,680
E-470	**Toll Gantry E**	**18,310**	**18,480**	**36,790**
SH 7 / E 160th Ave.	at South Platte River	8,680	8,850	17,530
E 168th Ave.	at South Platte River	2,840	2,630	5,470
Total Screenline Traffic Volumes		**158,100**	**163,560**	**321,660**
Percent E-470 Market Share for Screeline		11.6	11.3	11.4

Balanced E-470 Traffic Profile

A complete profile of 2019 AWDT volumes on E-470 is provided in **Figure 2-4**. Actual average weekday traffic at the mainline and ramp toll gantries was obtained from count information provided by the Authority. To develop the complete mainline and ramp traffic profile, CDM Smith subcontracted with ATDS to obtain 48-hour machine traffic counts at all non-tolled ramp locations. The counts were conducted on internal weekdays (Tuesday – Thursday) in September 2019. Based on historical traffic growth trends and monthly factors developed from the data provided by the Authority, these counts were adjusted to 2019 AWDT levels. Together with control volumes at the mainline toll gantries, balanced AWDT volumes from I-25 south to I-25 north were estimated.

This data was an important basic input to the traffic and revenue forecasting process, as it was used as an aid in the calibration of the regional travel demand model. It also provided a firm basis for estimating when future widening might be required, since peak mainline traffic load points occur at locations other than mainline toll gantries.

At the south end of E-470, immediately north of I-25, the 2019 AWDT volume was 52,440. The peak load point was, however, one interchange north, between Jamaica Street and Peoria Street ramps. Traffic at this location reached 57,030. Volumes remained in excess of 50,000 over the entire 8.6-mile section of E-470 between I-25 and Gartrell Road. Growth along this segment of roadway has been low in recent years, relative to the rest of E-470, primarily due to ongoing construction activities associated with the C-470 Express Lanes. North of Gartrell Road, weekday volumes gradually drop from less than 48,000 to less than 45,000 between Gartrell Road and I-70. Between I-70 and Pena Boulevard, AWDT volumes are generally in the range of 33,000 to 34,000. North of Pena Boulevard to I-76, AWDT's range between 46,000 to just under 50,000. North of I-76 to the I-25 interchange, the AWDT's are in the range of 37,000 to 38,000 vehicles.

The heaviest interchange volumes include Parker Road, Smoky Hill Road, Pena Boulevard and I-70. The original ramps constructed along the southern most portion of E-470 all carry relatively high volumes of traffic. Parker Road also has relatively high ramp volumes in both travel directions, with 15,200 vehicles per day entering and exiting to and from the south and 14,500 vehicles per day entering and exiting to/from the north. At the I-70 Interchange, traffic tends to be much heavier to and from the south with AWDTs in excess of 15,200. At Pena Boulevard, the combined ramps to/from the south average 15,000 vehicles per weekday, while the combined ramp volumes to/from the north average 31,100 vehicles per weekday. Based on these volumes, over 46,000 vehicles per day used E-470 to access Pena Boulevard, with the roughly two thirds of these oriented to/from Denver International Airport (DIA). Based on the ramp volumes in the balanced profile, 29.7 percent of E-470 trips are to/from the Pena Boulevard Interchange and 21.8 percent of all E-470 trips are to/from DIA.

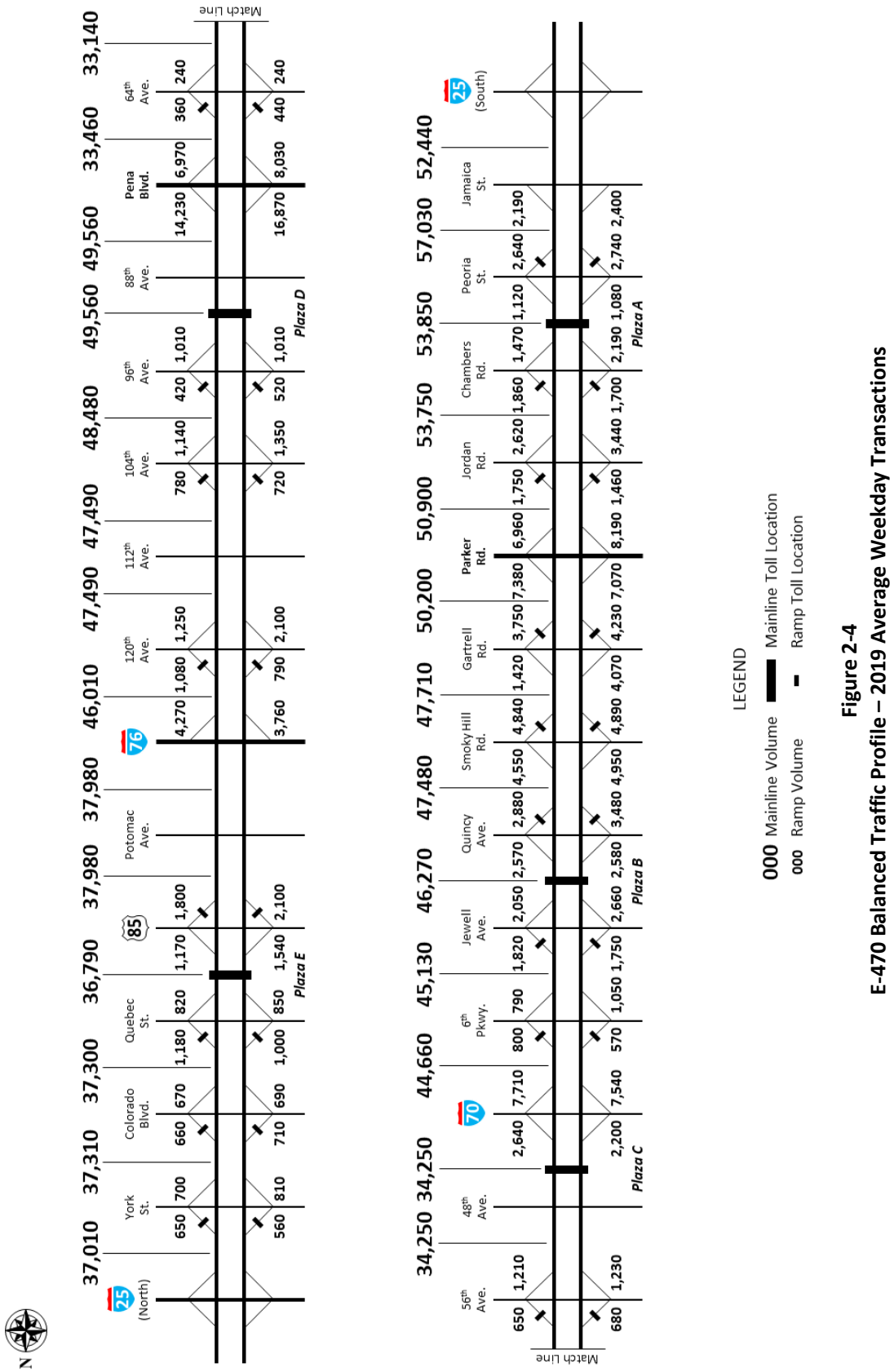


Figure 2-4
E-470 Balanced Traffic Profile – 2019 Average Weekday Transactions

Several of the interchanges have relatively low volumes. Many of these were constructed in areas that have yet to experience significant local development, but for which future development is planned. Examples of this include 6th Parkway, 56th Avenue, 64th Avenue, 96th Avenue and 104th Avenue.

Based on the actual ramp and mainline traffic volumes presented in **Figure 2-4**, it was estimated that on an average weekday in 2019, 155,390 trips were made. Dividing the 276,980 transactions which occurred on an average weekday in 2019, the average number of transactions per trip was estimated at 1.8. The average number of transactions per trip on E-470 has historically remained relatively constant, with 1.8 transactions per trip observed during in the prior 2017 and 2013 balanced profiles.

Monthly Traffic Variations

Figure 2-5 provides an index of 2019 monthly traffic variations by mainline toll location and for the total system. The dashed horizontal line reflects a typical average month, or an index value of 1.00. In general, average December through April traffic volumes were below the average month, while May through November were above the average. For all toll locations, January represented the lowest month in terms of average traffic volumes, about 17 percent below the average month, while July and August represented the highest months with traffic approximately 12 percent above the average month, respectively.

Daily Traffic Variations

Figure 2-6 provides a summary of 2019 daily traffic variations at each mainline toll location and for the total system for a typical week. The index value of 1.0 represents an average day. As with most urban toll facilities, weekend traffic tends to be considerably lower than weekday volumes. All five weekdays produce traffic volumes above the average at all mainline tolling locations, while Saturday and Sunday volumes are generally in the range of 60 to 75 percent of the average day, depending on tolling location. The peak days are Thursday and Friday, based on the sample data provided by the Authority. These patterns are consistent for all five mainline toll locations.

Hourly Traffic Variations

Table 2-5 provides a summary of typical hourly traffic volumes at the five mainline toll gantry locations based on an average of hourly data for a typical week in 2019. The data is also shown graphically in **Figure 2-7**.

Considerable peaking occurred at Toll Gantries A and D, where peak hour, peak direction volumes come closest to reaching Level-of-Service (LOS) C capacity. At Toll Gantry A, the peak hour directional volume exceeded 4,000 vehicles in the morning and over 3,450 in the evening. This was substantially higher than midday and off-peak hours, most of which tended to average between 1,000 to 1,500 vehicles or less per direction per hour. Peak hour, peak direction volumes at Toll Gantry D approached 2,750 vehicles in the morning and 2,800 in the evening. Toll Gantry B exhibited similar peak hour volumes, ranging between 2,500 to 2,900 vehicles per hour per direction. Peak-hour volumes at Toll Gantries C and E were generally lower than at the other three mainline toll gantries.

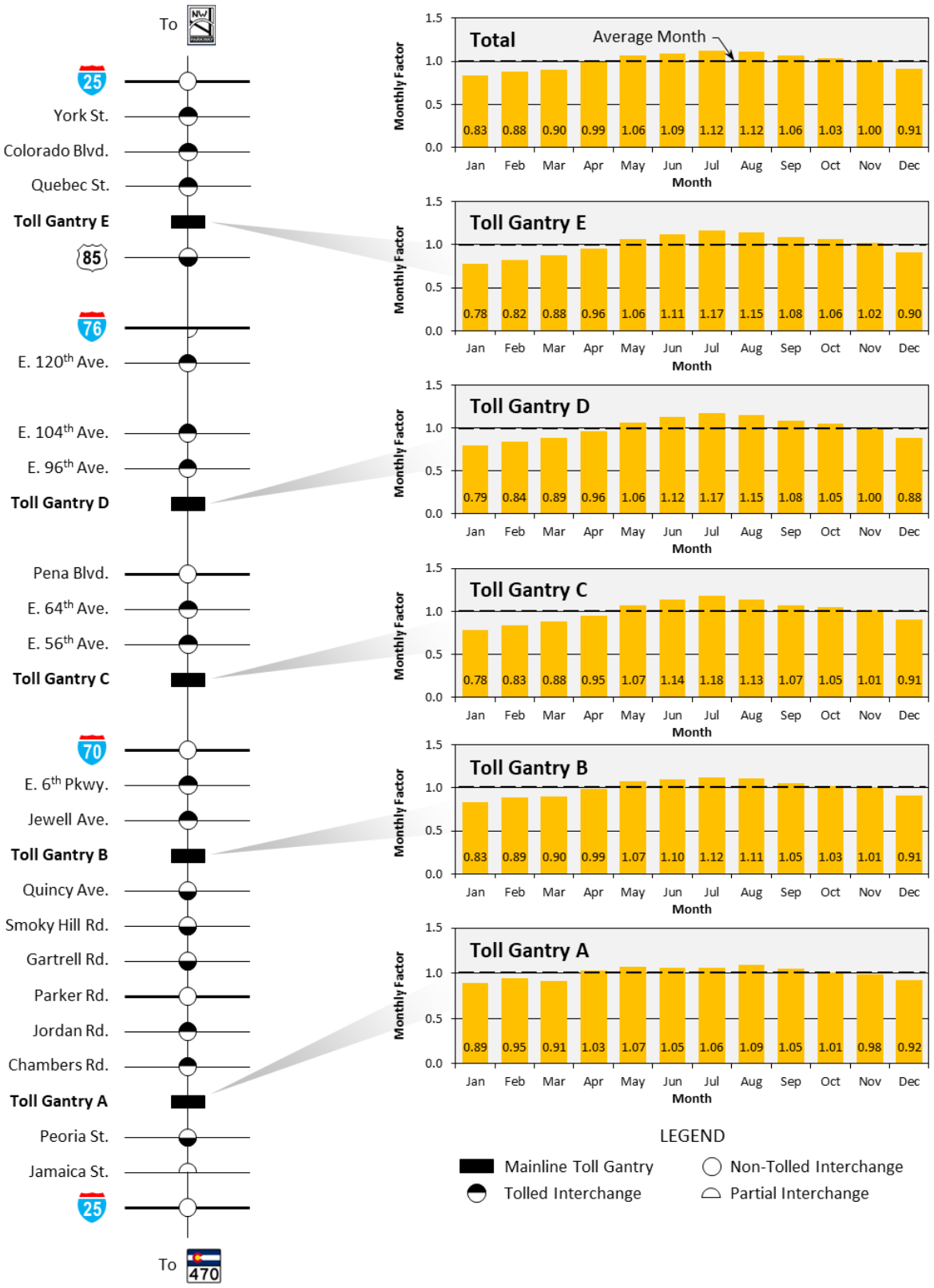


Figure 2-5
2019 Average Monthly Traffic Variations by Mainline Toll Location

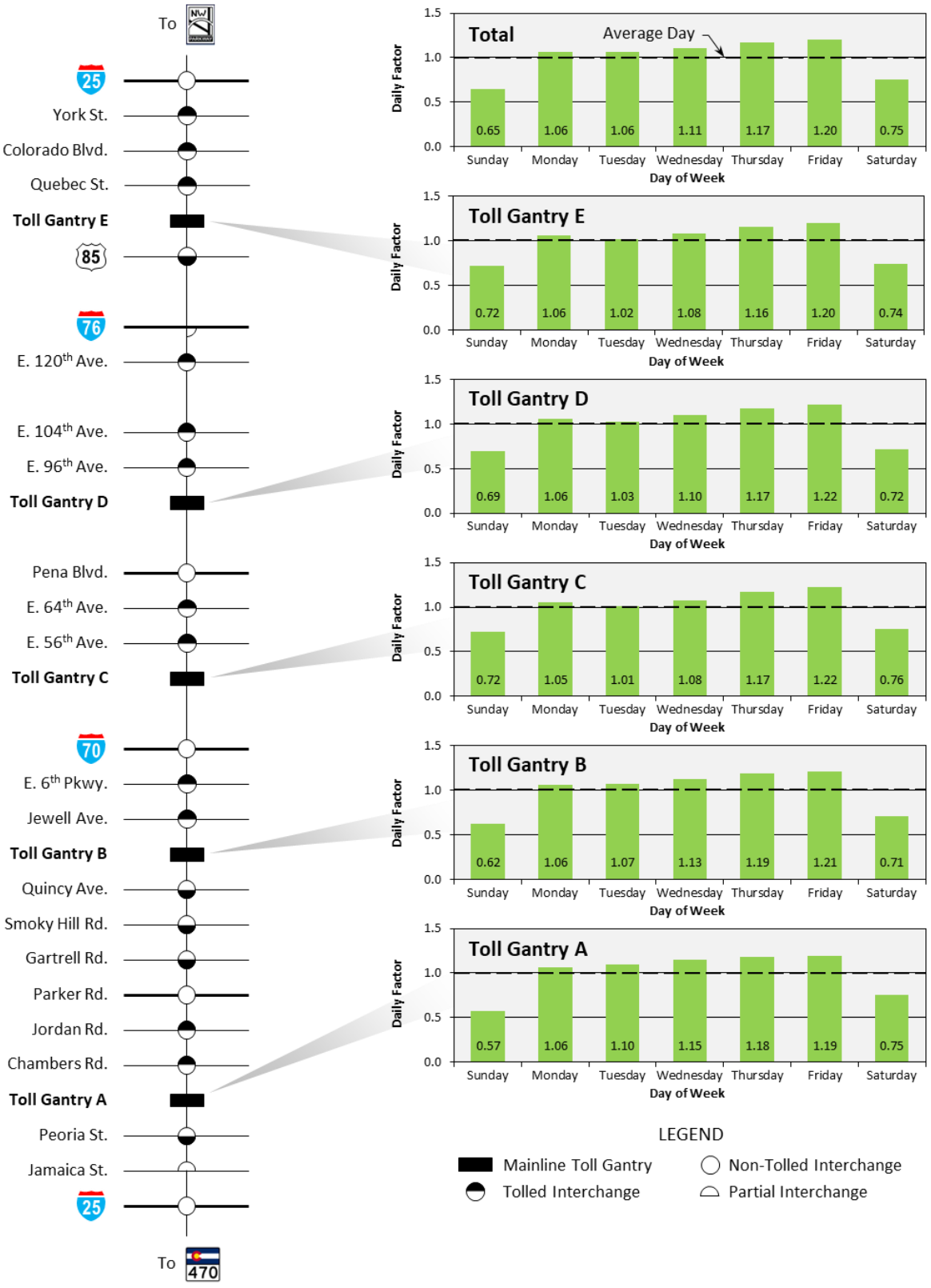


Figure 2-6
2019 Average Daily Traffic Variations by Mainline Toll Location

Table 2-5
2019 Average Weekday Hourly Traffic Volumes by Mainline Toll Gantry

Hour Beginning	Hourly Traffic Volumes [1]														
	Toll Gantry A			Toll Gantry B			Toll Gantry C			Toll Gantry D			Toll Gantry E		
	Northbound	Southbound	Two-Way	Northbound	Southbound	Two-Way	Northbound	Southbound	Two-Way	Northbound	Southbound	Two-Way	Northbound	Southbound	Two-Way
Midnight	65	103	168	49	201	250	50	190	240	282	80	362	268	51	319
1:00	33	52	85	30	93	123	30	86	116	133	46	179	123	28	152
2:00	31	29	61	42	46	88	41	41	83	64	58	121	53	42	94
3:00	78	37	116	168	41	208	160	42	202	71	212	284	45	199	244
4:00	139	125	264	359	106	464	339	117	456	176	463	638	111	368	478
5:00	385	558	942	890	287	1,177	648	272	920	384	949	1,333	239	730	969
6:00	941	2,137	3,079	1,890	1,010	2,900	1,242	813	2,055	906	2,179	3,086	652	1,502	2,154
7:00	1,370	**4,005**	**5,375**	**2,533**	1,814	4,346	1,511	1,254	2,765	1,389	**2,749**	4,138	1,119	**1,848**	2,967
8:00	1,278	3,554	4,832	2,023	1,611	3,634	1,449	1,127	2,576	1,433	2,277	3,711	1,148	1,551	2,698
9:00	1,074	1,989	3,063	1,296	1,042	2,338	1,034	791	1,825	1,178	1,443	2,620	917	1,018	1,935
10:00	1,021	1,503	2,525	976	882	1,858	778	695	1,473	1,100	1,096	2,196	826	811	1,637
11:00	1,176	1,422	2,599	959	896	1,855	780	664	1,444	1,059	1,092	2,151	810	832	1,643
Noon	1,257	1,315	2,572	950	913	1,863	759	681	1,440	1,083	1,081	2,164	801	814	1,615
13:00	1,378	1,272	2,649	1,015	1,031	2,047	834	784	1,618	1,203	1,189	2,392	891	906	1,796
14:00	1,745	1,318	3,063	1,177	1,283	2,460	990	925	1,915	1,469	1,395	2,864	1,003	1,066	2,069
15:00	2,530	1,621	4,151	1,625	2,034	3,659	1,359	1,367	2,726	2,212	1,755	3,967	1,464	1,350	2,815
16:00	**3,455**	1,837	5,292	2,075	2,801	4,876	**1,686**	1,674	**3,360**	**2,796**	2,009	**4,805**	1,894	**1,552**	**3,446**
17:00	3,433	1,853	5,286	2,018	**2,909**	**4,927**	1,553	**1,701**	3,255	2,610	1,901	4,511	**1,953**	1,405	3,358
18:00	1,851	1,292	3,143	1,152	1,657	2,809	892	1,146	2,037	1,553	1,219	2,772	1,242	895	2,137
19:00	919	749	1,668	577	875	1,451	477	676	1,153	887	689	1,575	725	509	1,233
20:00	668	509	1,177	403	664	1,067	340	548	888	724	499	1,223	622	381	1,003
21:00	504	353	857	292	518	810	260	459	719	633	388	1,021	528	294	822
22:00	288	268	556	190	450	640	178	403	580	559	282	842	508	209	716
23:00	166	165	332	109	311	420	112	289	401	423	179	602	366	124	490
Total Day	25,785	28,068	53,853	22,797	23,475	46,272	17,502	16,745	34,247	24,328	25,229	49,557	18,307	18,483	36,790

- Indicates the AM peak hour.

- Indicates the PM peak hour.

000 - Indicates the peak hour for the total day.

[1] Based on actual hourly data January through October 2019 and estimated hourly data for November and December 2019 (based on actual 2018 data and historical growth trends).

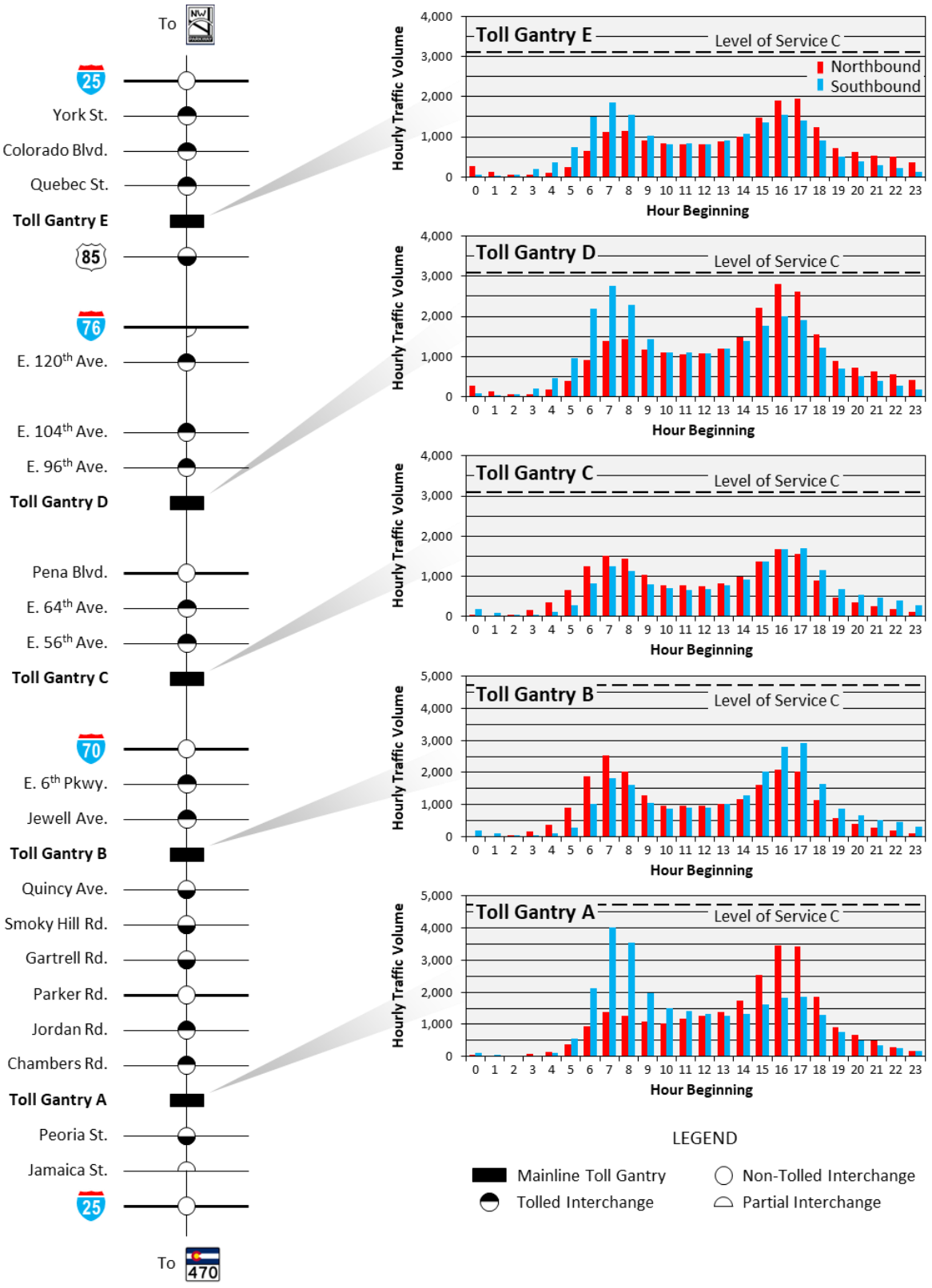


Figure 2-7
2019 Average Hourly Traffic Variations by Mainline Toll Location

There was also a relatively similar directional traffic distribution in both the AM and PM Peak hours, generally in the range of 60/40 at Toll Gantries B, D and E. Toll Gantry A exhibited a more pronounced directional distribution of traffic during both the morning and evening peak hours. During the AM Peak Hour, 75 percent of the traffic traveled in the southbound direction (25 percent traveled northbound), while during the PM Peak Hour, 65 percent traveled in the northbound direction (35 percent traveled southbound). Toll Gantry C was more atypical, having had a relatively even directional distributions of traffic in the range of 50/45 to 55/45 during the PM and AM Peak hours, respectively. This was to some extent likely related to travel demand patterns associated with DIA.

The potential for continued free-flow travel on E-470, at least in the near-term, based on current traffic volumes and mainline Level of Service C capacity is also shown. At each of the mainline toll locations, Level of Service C capacity per direction is indicated by the dashed horizontal line. Level of Service C indicates stable operation and relatively satisfactory operating speeds. As illustrated by the figure, 2019 volumes remain below LOS C capacity, although traffic growth between 2016 and 2019 has been substantial, and has all but eroded the considerable excess capacity previously available at Toll Gantries A and D. This means that in the vicinity of these gantries E-470 will have less ability to absorb future increases in peak hour traffic volumes if LOS C travel conditions are to be retained.

Trends in Method of Toll Payment

Table 2-6 provides a concise summary of ExpressToll market share percentages by toll location over the last five years. As shown, ExpressToll traffic accounted for between 67.4 and 73.5 percent of all transactions on E-470 between 2014 and 2019. It is interesting to note that the heaviest ExpressToll percentages are found at Toll Gantries A and B, which also have the heaviest concentration of commuter traffic based on a review of hourly traffic variations and responses

Table 2-6
ExpressToll Market Share Percentages
2014 - 2019

Toll Gantry	2014	Change	2015	Change	2016	Change	2017	Change	2018	Change	2019
A	64.7	(0.5)	64.2	1.5	65.7	8.4	74.1	1.8	75.9	(0.2)	75.7
B	62.1	(0.7)	61.4	2.8	64.2	8.0	72.2	1.9	74.1	(0.5)	73.6
C	65.0	(0.1)	64.9	2.8	67.7	0.4	68.1	2.1	70.2	(0.3)	69.9
D	66.7	(0.5)	66.2	1.8	68.0	(1.1)	66.9	2.4	69.3	(0.3)	69.0
E	72.0	0.2	72.2	0.8	73.0	(2.6)	70.4	2.2	72.6	(0.5)	72.1
All Mainline Gantries	66.7	(0.5)	66.2	1.8	68.0	2.6	70.6	2.0	72.6	(0.4)	72.2
Ramp Gantries	70.3	(0.4)	69.9	1.5	71.4	3.7	75.1	1.7	76.8	(1.2)	75.6
All Gantries	68.0	(0.6)	67.4	1.8	69.2	2.3	71.5	2.0	73.5	(0.6)	72.9

Source: E-470 Public Highway Authority.

from the 2017 travel pattern and trip characteristics survey of E-470 customers. The lowest market shares have historically been experienced at Toll Gantries C, D and, to a lesser extent, E, although market shares which had been close to 65 percent in 2014 and 2015, have increased to nearly 70 percent or higher in the last two years.

While pre-2014 market share percentages are not provided in **Table 2-6**, ExpressToll percentages declined from 70 to 72 percent between 2010 and 2013 to 68 percent and 67 percent in 2014 and 2015, respectively. This was primarily because LPT transactions were growing at a faster rate than ExpressToll transactions. These declines occurred despite an increase in the toll differential between ExpressToll and LPT and several overall toll increases. The faster growth in LPT transactions was speculated to be the result of new system users coming from the developing areas in Aurora and Adams County who had yet to register for ExpressToll, in addition to the return of some of the less frequent non-resident, recreational or discretionary customers lost during the recession. However, the ExpressToll market share increased by 1.8 percent in 2016 to 69.2 percent and by 2.3 percent in 2017 to 71.5 percent. It believed that the expansion of the managed lane concept in the Denver region was a contributing factor for the increase. The share of ExpressToll transactions increased by 2.0 percent in 2018 to 73.5 percent. It is believed that the toll rate changes adopted in 2018 which increased the LPT surcharge, along with the continued expansion of the managed lane concept in the Denver region, contributed to the continued rise in the ExpressToll market share. During 2019, the ExpressToll market share decreased by 0.6 percent to 72.9 percent. Declines were relatively consistent at the mainline toll gantries averaging 0.4 percent, and ranging from 0.2 percent at Toll Gantry A to 0.5 percent at Toll Gantries B and E. The greatest percent declines of 1.2 percent occurred at the ramp toll gantries, accounting for slightly more than 20 percent of E-470 transactions in 2019.

Commercial Vehicle Traffic Distribution

Table 2-7 presents the percentage of transactions by method of toll payment and vehicle class at the mainline toll gantries in 2019. Overall, two-axle vehicles, which include passenger cars, motorcycles, vans and SUVs, accounted for 96.3 percent of all transactions. Vehicles with three-or-more axles accounted for 3.7 percent of total transactions, consistent with historically observed percentages and were used in the forecasts of transactions and revenue presented in Chapter 4.

In 2019, 72.9 percent of all transactions were ExpressToll. Disaggregating the ExpressToll market participation rates by vehicle type, shows that a higher proportion of passenger vehicles transactions, 73.1 percent, were ExpressToll compared with 67.4 percent for vehicles with three-or-more-axles. Use of ExpressToll also varied within the three-or-more-axle vehicle category. ExpressToll was lowest among five-or-more-axle vehicles, which are generally 18-wheel tractor trailer trucks and other heavy commercial vehicles. ExpressToll participation by five-or-more-axle vehicles was 61.7 percent. Three-axle vehicles, which include delivery trucks, motor homes and other light commercial vehicles, had an ExpressToll participation rate of 78.0 percent.

Table 2-7
2019 Vehicle Class and Method of Payment Distributions

Vehicle Class	Method of Payment			Total Transactions
	ExpressToll	LPT	Total	
Two Axles	**73.1%**	**26.9%**	**100.0%**	**96.3%**
Three Axles	78.0%	22.0%	100.0%	0.9%
Four Axles	67.6%	32.4%	100.0%	0.9%
Five-Or-More Axles	61.7%	38.3%	100.0%	1.9%
Three-Or-More Axles	**67.4%**	**32.6%**	**100.0%**	**3.7%**
Total	**72.9%**	**27.1%**	**100.0%**	**100.0%**

E-470 Customer Trip Characteristics

CDM Smith also obtained and reviewed detailed E-470 transaction records. The purpose of this effort was to provide a better understanding of the E-470 customer base, their usage patterns, trip distributions, frequency of usage, geographical distribution, origins and destinations patterns, and demographic characteristics such as income, household size, or rates of car ownership. Towards those ends, a full year of 2018 transaction data (which was the most recent full year available at the time this analysis was conducted) by anonymous account numbers and actual ZIP codes including the toll gantry was obtained. As described in this section, the transaction data was analyzed and summarized at the individual toll gantry level to develop gantry-specific trip patterns and frequency of E-470 usage. Additionally, this information was combined with other readily available data sources such as Census, American Community Survey and Longitudinal Employer Household Dynamics (LEHD).

Data Summarization Methodology

In order to process the large volume of individual transaction records involved, CDM Smith set up an Extract-Transform-Load (ETL) pipeline to bring the 2018 E-470 transaction data for the full year into a database hosted on an Amazon Web Services (AWS) SQL cloud-based server.

The database was queried using anonymized masked transponder numbers to develop trip frequency and trip distribution information for the facility. If a transponder recorded multiple transactions at consecutive toll locations within a designated time window, those transactions were considered to be a single trip, or trip chain. Vehicle fleets were excluded from the analysis due to their sharing transponders among many hundreds of vehicles. Further rules were set up to distinguish between chain trips, data based on time of travel such as peak, off-peak and other such categories.

The trip chain data was then used to generate trip frequency by payment type statistics, as well as analysis of gantry-to-gantry movements. Setting up portioning in SQL scripts allowed a quick analysis to extract movement profiles and frequency information for transactions and trips at mainline and ramp toll gantries from the 2018 dataset.

Additionally, since each masked transponder number was associated with a customer's home ZIP code, CDM Smith created a profile of a representative E-470 customer based on US Census demographic data weighted by transaction frequency. ZIP codes with a higher share of overall transactions were weighted proportionally higher. Once generated, the weighted customer profile was also compared to demographics from the eight E-470 model area counties: Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson and Weld Counties.

Trip Frequency

CDM Smith used trip chain information to analyze average trips per week for all weeks of the year in 2018 and averaged the results to develop an estimate of transaction frequency on E-470 for the "Typical Week". The results of this analysis are presented in **Figure 2-8**. Customers making one trip per week represented 40.2 percent of total customers, while those making two trips per week represented 27.6 percent. Thus, roughly two-thirds of E-470 customers make 2 trips or less per week. Customers making 5 or more trips per week represented 16.0 percent of total customers. On average, E-470 customers made 2.77 trips per week in 2018.

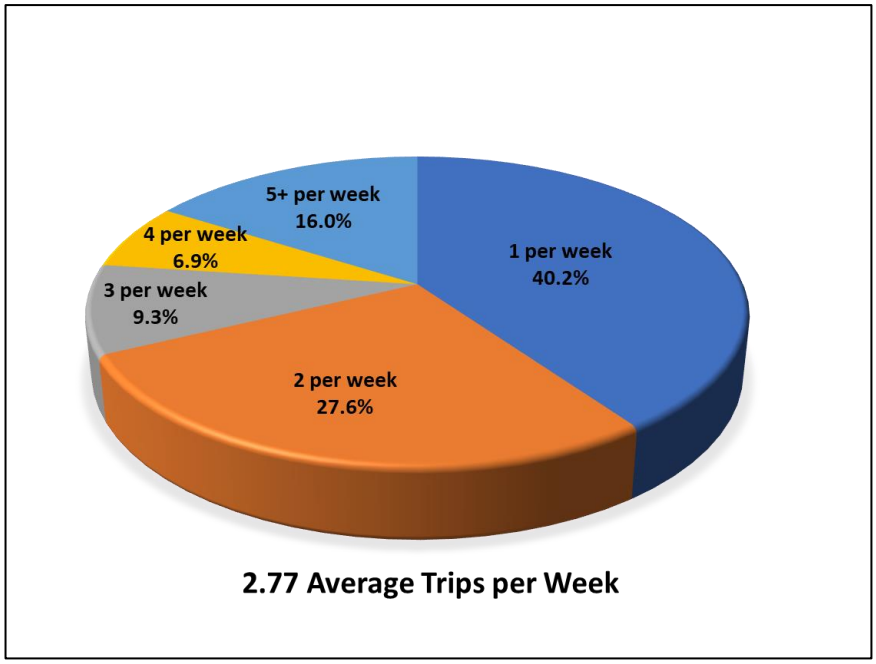


Figure 2-8
Trip Frequency Distribution for a Typical Week

Trip Movement Characteristics

The detailed transaction data and the trip identification process also allowed for the analysis of E-470 trips based on their movements across the system. Average transactions per trip were developed by mainline toll gantry, as provided in **Table 2-8**. In general, E-470 customers make shorter trips on the system, averaging 1.8 transactions per trip. This relationship between transactions and trips has historically been relatively consistent, as previously noted. ExpressToll customers made slightly less transactions per trip than LPT customers, which may be due in part to the differences in trip patterns between the two methods of payment. Additionally, trips through Gantries C and D made the most transactions per trip. This suggests that trips on the northern segments of E-470 are more "through" in nature than "local". By contrast, trips through Gantries A and B had the lowest average transactions per trip in 2018.

Table 2-8
Average 2018 Transactions per Trip
By Mainline Toll Gantry and Payment Type

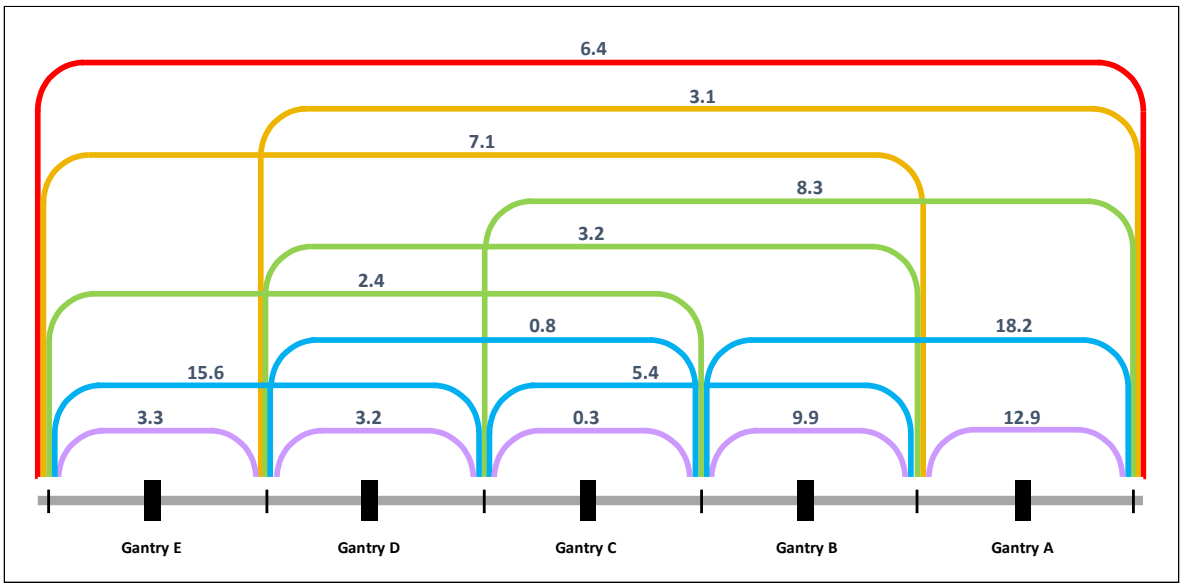
Plaza	Average Transactions per Trip
Gantry A	1.60
Gantry B	1.53
Gantry C	2.05
Gantry D	1.75
Gantry E	1.92
ExpressToll	1.77
License Plate Toll	1.82
Total System	**1.78**

The relationship between transactions and trips is primarily dependent on trip length. The longer the trip, the more toll transactions included in each trip. **Figure 2-9** illustrates the percent of E-470 trips traveling through the various E-470 "tolling segments," which are based on the location of the major free interchanges on the E-470 system. For each tolling segment, a customer will pass through only one tolling point, whether it is a mainline or ramp toll gantry. The E-470 tolling segments are:

- Tolling Segment A: I-25 (South End) to Parker Road
- Tolling Segment B: Parker Road to I-70
- Tolling Segment C: I-70 to Pena Boulevard
- Tolling Segment D: Pena Boulevard to I-76
- Tolling Segment E: I-76 to I-25 (North End)

As indicated in **Figure 2-9**, 6.4 percent of E-470 trips pass through all five tolling segments. 18.2 percent of E-470 trips make a movement through (only) Segments A and B. A significant share of E-470 trips occur on the southern portion of the facility. In total, almost three quarters (74.6 percent) of E-470 trips pass through either Segment A or Segment B. Another significant movement passes through (only) Segments D and E. This movement represents trips between Broomfield, I-25, Brighton and the Denver International Airport. As previously noted, 29.7 percent of E-470 trips are to or from the Pena Boulevard Interchange, and 21.8 percent of all E-470 trips are to or from the Denver International Airport. Trips through only segment C represent the smallest share of E-470 trips (0.3 percent), likely due to the number of parallel toll-

Figure 2-9
Distribution of 2018 Average Weekday Trips by Trip Tolling Segments
Percent of Total E-470 Trips



free facilities in this area. **Table 2-9** provides the same information by time of day and by method of payment.CDM Smith also reviewed travel patterns based on the mainline toll gantries included in each trip. This is shown in **Table 2-10**. The average daily estimates in the table represent only trips traveling through any of the mainline toll gantries, and exclude trips traveling only through ramp toll gantries. Trips traveling through a combination of mainline and ramp toll gantries are included but are only shown in terms of the mainlines through which they travelled. The data presented are a more detailed version of that presented in **Table 2-9**, indicating that the major movements on E-470 include movements through Gantry A and/or Gantry B, as well as movements through both Gantries D and E.

Customer Characteristics

Total Trips on the E-470 System by ZIP Code

The detailed transaction data, the trip identification process and ZIP code information associated with anonymized transponders was used to calculate trips by registered ZIP code. ZIP codes having at least one percent of total 2018 transactions are shown highlighted in **Figure 2-10**, with the lighter colors representing lower trips and the dark blue color representing higher number of trips. ZIP codes 80016, 80134 and 80015 in the southeast corner of the map in the city of Aurora, Douglas County and Arapahoe County, respectively, are the top three trip-generating ZIP codes based on E-470 customer data. These three ZIP codes account for 23.6 percent of all E-470 trips with the top ZIP code (80016) accounting for 10.6 percent of all the trips.

Table 2-9
Distribution of 2018 Average Weekday Trips by Trip Tolling Segments
Percent of Total E-470 Trips by Time of Day and Method of Payment

	Percent of Total Trips by Time Period				Percent of Total Daily Trips by Method of Payment		
Tolling Segments Included in Trip	AM Peak 6:30 - 9:00 AM	Midday 9:00 - 3:00 PM	PM Peak 3:00 - 7:00 PM	Nighttime 7:00 - 6:30 AM	ExpressToll	LPT	**Total Trips**
A	14.1	14.7	12.0	9.9	12.8	13.1	12.9
AB	20.7	18.3	18.9	13.7	18.8	16.5	18.2
ABC	7.1	8.0	7.0	12.5	8.3	8.3	8.3
ABCD	3.5	2.9	3.5	2.1	3.0	3.3	3.1
ABCDE	7.4	5.0	9.2	2.2	6.6	5.8	6.4
B	9.5	10.4	10.1	9.1	9.6	10.7	9.9
BC	3.8	5.1	4.1	10.1	5.6	4.9	5.4
BCD	3.1	3.1	3.5	2.9	3.0	3.7	3.2
BCDE	6.8	7.1	8.3	5.3	7.3	6.6	7.1
C	0.3	0.4	0.3	0.6	0.2	0.7	0.3
CD	0.8	0.9	0.8	0.8	0.7	1.2	0.8
CDE	2.2	2.6	2.4	2.3	2.3	2.9	2.4
D	3.7	2.8	3.0	3.6	2.8	4.1	3.2
DE	13.5	15.2	13.7	22.2	15.9	14.5	15.6
E	3.5	3.7	3.1	2.8	3.1	3.8	3.3
Grand Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Average Age by ZIP Code

The detailed transaction data was used to also calculate the average age of E-470 users. ZIP codes having at least one percent of total 2018 transactions are highlighted in **Figure 2-11**, with the lighter colors representing lower age and the darker colors representing higher age. While the weighted average age for the 8-county region is 37 years, the average age for major ZIP codes contributing most of the trips is higher at 46 years. This suggests that E-470 users are older compared to travelers on other facilities in the Denver region. ZIP code 80016, which accounts for 10.6 percent of all E-470 trips, has an average age of 42 years. The average age for the top three trip-generating zip codes is slightly higher at 43 years.

Education Level by ZIP Code

ZIP codes having at least one percent of total 2018 transactions are highlighted in **Figure 2-12** in terms of the percent with some college education or more. The lighter colors represent a lower percentage of college education and the darker colors represent a higher level of college education. While the weighted average share of population with some college or higher for the 8-county was 71 percent, the average share for major ZIP codes contributing most of the trips was higher at 78 percent. It implies that E-470 users have a higher education level, as compared to all the roadway users in the Denver metropolitan area.

Table 2-10
Distribution of 2018 Average Weekday Trips by Trip Tolling Segments
Percent of Trips by Mainline Gantry, by Direction and by Time of Day

			Percent Distribution by Gantry by Direction				
Gantry	Dir.	Gantries Passed	AM Peak (6:30-9AM)	Midday (9-3PM)	PM Peak (3-7PM)	Night (7-6:30AM)	Total Day
Gantry A	NB	A-NB	40.1	64.6	65.1	59.1	**61.1**
		AB	14.1	6.3	8.3	6.9	**8.2**
		ABC	28.5	15.3	6.9	26.1	**14.8**
		ABCD	7.1	6.8	7.5	5.1	**6.9**
		ABCDE	10.2	7.0	12.3	2.8	**9.1**
	SB	A-SB	73.3	70.8	47.7	58.0	**64.3**
		BA	8.8	7.5	15.7	5.9	**9.6**
		CBA	3.3	9.5	16.5	26.1	**11.6**
		DCBA	6.4	6.3	7.6	6.4	**6.7**
		EDCBA	8.2	5.9	12.6	3.6	**7.9**
Gantry B	NB	AB	8.0	7.5	13.6	6.4	**9.3**
		ABC	16.1	18.3	11.3	24.1	**16.7**
		ABCD	4.0	8.2	12.2	4.7	**7.8**
		ABCDE	5.8	8.4	20.1	2.6	**10.2**
		B-NB	32.4	20.3	14.5	21.7	**21.7**
		BC	10.5	10.5	4.9	22.2	**10.9**
		BCD	7.2	10.3	9.4	8.6	**9.0**
		BCDE	16.0	16.5	14.0	9.8	**14.5**
	SB	B-SB	16.6	22.4	31.5	17.2	**24.2**
		BA	19.4	10.9	11.0	5.8	**11.4**
		CB	3.5	9.5	7.9	21.7	**10.0**
		CBA	7.2	13.9	11.5	25.5	**13.9**
		DCB	9.6	10.7	8.0	9.3	**9.2**
		DCBA	14.0	9.2	5.3	6.3	**7.9**
		EDCB	11.9	14.8	16.0	10.6	**14.0**
		EDCBA	17.9	8.6	8.9	3.6	**9.4**
Gantry C	NB	ABC	24.2	22.0	13.8	29.2	**21.2**
		ABCD	6.0	9.8	14.9	5.7	**9.9**
		ABCDE	8.6	10.1	24.5	3.2	**13.0**
		BC	15.7	12.6	6.0	27.0	**13.8**
		BCD	10.7	12.3	11.5	10.4	**11.4**
		BCDE	24.0	19.8	17.1	11.9	**18.4**
		C-NB	0.8	1.0	0.6	2.0	**1.0**
		CD	2.9	4.4	4.4	4.3	**4.1**
		CDE	7.0	7.9	7.2	6.4	**7.2**
	SB	C-SB	0.5	0.9	0.5	2.1	**1.0**
		CB	4.8	12.3	12.2	24.5	**13.6**
		CBA	9.9	18.0	18.0	28.9	**18.9**
		DC	4.6	4.6	3.2	4.6	**4.1**
		DCB	13.2	14.0	12.4	10.6	**12.6**
		DCBA	19.2	12.0	8.3	7.1	**10.9**
		EDC	6.8	7.8	6.8	6.1	**6.9**
		EDCB	16.3	19.2	24.8	12.0	**19.2**
		EDCBA	24.7	11.2	13.8	4.0	**12.8**
Gantry D	NB	ABCDE	9.5	7.4	14.8	2.2	**9.4**
		ABCD	6.6	7.2	9.0	3.9	**7.2**
		BCD	11.8	9.1	6.9	7.1	**8.3**
		BCDE	26.5	14.6	10.3	8.2	**13.3**
		CD	3.2	3.3	2.6	2.9	**3.0**
		CDE	7.7	5.8	4.4	4.4	**5.2**
		D-NB	12.1	15.7	15.7	14.1	**14.9**
		DE	22.5	36.9	36.2	57.2	**38.7**
	SB	D-SB	21.0	15.0	11.7	17.3	**16.0**
		DC	2.1	2.9	2.8	3.3	**2.7**
		DCB	6.0	8.8	10.7	7.6	**8.4**
		DCBA	8.8	7.5	7.1	5.1	**7.3**
		ED	40.0	41.9	28.5	50.6	**39.5**
		EDC	3.1	4.9	5.9	4.4	**4.6**
		EDCB	7.5	12.1	21.4	8.7	**12.8**
		EDCBA	11.3	7.0	11.9	2.9	**8.6**
Gantry E	NB	ABCDE	11.9	9.9	20.5	2.6	**12.4**
		BCDE	33.2	19.6	14.3	9.9	**17.6**
		CDE	9.7	7.8	6.1	5.3	**6.9**
		DE	28.2	49.4	50.3	69.4	**51.0**
		E-NB	17.1	13.3	8.8	12.7	**12.1**
	SB	E-SB	9.3	12.5	11.2	11.6	**11.2**
		ED	58.5	55.7	37.4	67.2	**53.5**
		EDC	4.6	6.5	7.7	5.8	**6.3**
		EDCB	11.0	16.0	28.1	11.5	**17.4**
		EDCBA	16.6	9.3	15.6	3.9	**11.6**

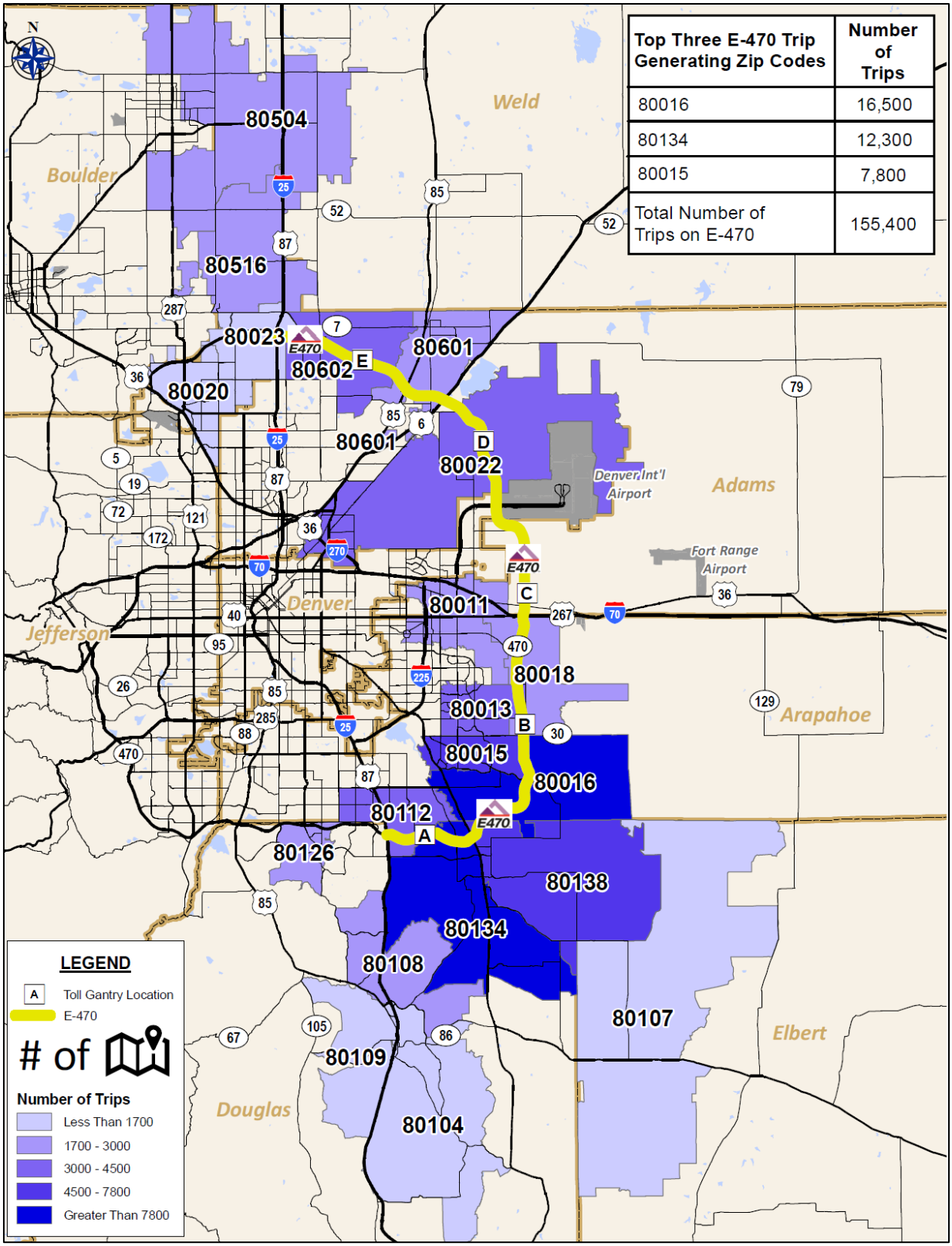


Figure 2-10
Distribution of 2018 Total Trips by ZIP Code

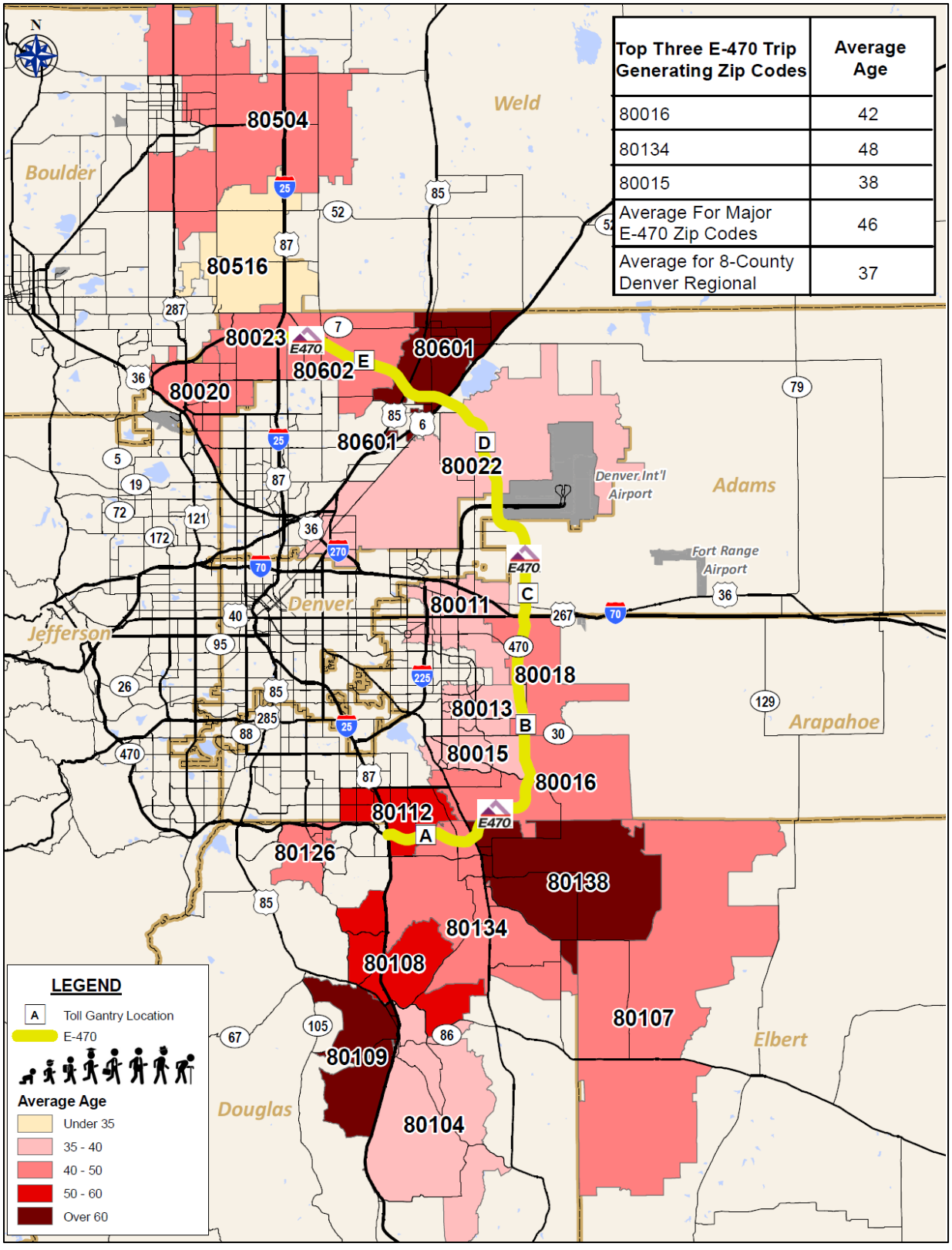


Figure 2-11
Distribution of 2018 Average Age by ZIP Code

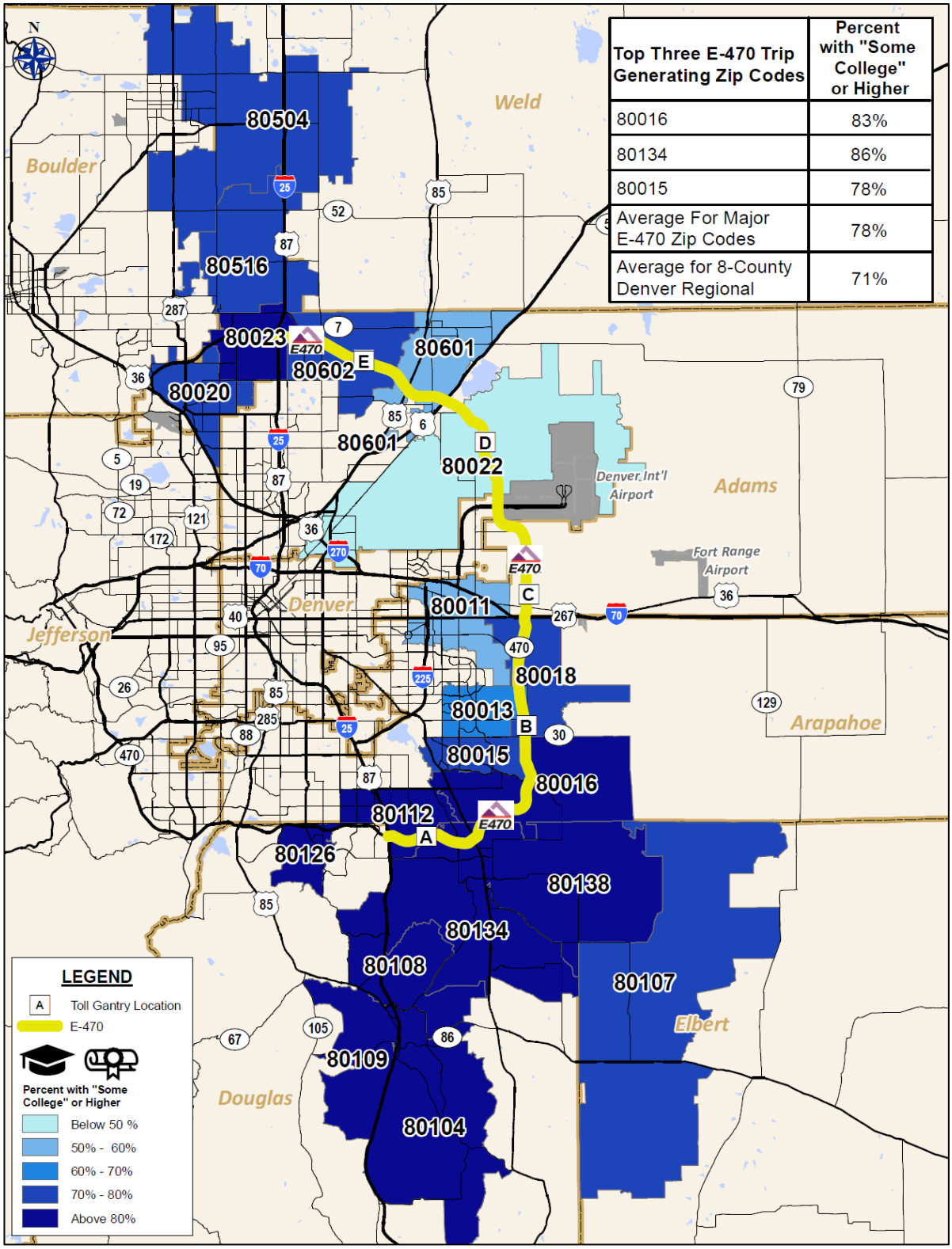


Figure 2-12
Distribution of 2018 Average Share of Population with Educational Attainment of Some College or Higher by ZIP Code

Median Household Income by ZIP Code

ZIP codes having at least one percent of total 2018 transactions are highlighted in **Figure 2-13**, with the lighter colors representing lower median household incomes and the darker color representing higher median household incomes. While the weighted average 2018 median household income for 8-county region was $72,130, the average share for major ZIP codes contributing most of the E-470 trips is 43 percent higher at $110,713 per year in 2018. ZIP code 80016, which accounts for 10.6 percent of all the trips, has median household income of $116,940 while the top three trip-generating zip codes have average median household income of $110,713. The data suggest that E-470 users on average have a higher median household income, as compared to general roadway users in the Denver metropolitan area. One reason this may be the case is that higher income households are better able to afford the cost of tolls and may even view their commute or other travel time as more valuable. This relationship between income and the willingness to pay tolls is generally reflected in the Value of Time assumption, discussed further in **Chapter 4**.

Average People per Household by ZIP Code

Figure 2-14 shows a geographical distribution of the average people per household along the E-470 corridor. While the weighted average household size for 8-county region was 2.5 people in 2018, the average household size for major ZIP codes contributing most of the trips was 2.8 people. The top trip-generating ZIP code for E-470 (80016) has household size of 3.0 people, as compared to the top three trip-generating zip codes that have an average household size of 2.9 people. The data suggest that E-470 users have slightly larger household sizes, as compared to the general roadway users in Denver metropolitan area. This may be the result of the types of housing available along the E-470 corridor, which is generally single-family housing. As a result of these local development patterns, those living close to E-470 would more likely be families, as opposed to single individuals or couples without children.

Average Vehicles per Household by ZIP Code

The geographical distribution of vehicles per household of E-470 users in 2018 is highlighted in **Figure 2-15**, with the lighter colors representing lower average vehicles per household and the darker colors representing a greater average number of vehicles per household. The average vehicles per household of E-470 users seem comparable to the average vehicles per household for all the roadway users in the Denver metropolitan area.

Average Vehicle Occupancy by ZIP Code

The average vehicle occupancy distribution for 2018 is shown in **Figure 2-16**, based on means of travel to work data obtained from the U.S. Census. The lighter colors representing a lower average vehicle occupancy (i.e., a higher percentage of Single Occupant Vehicles) and the darker colors representing a higher vehicle occupancy. While the weighted average vehicle occupancy during commutes for the 8-county region was 1.12, the average vehicle occupancy for major ZIP codes contributing most of the trips was 1.05. Vehicle occupancy for top three E-470 trip-generating zip codes was 1.04. This suggests that E-470 customers are slightly less likely to carpool than general roadway users in the Denver metropolitan area.

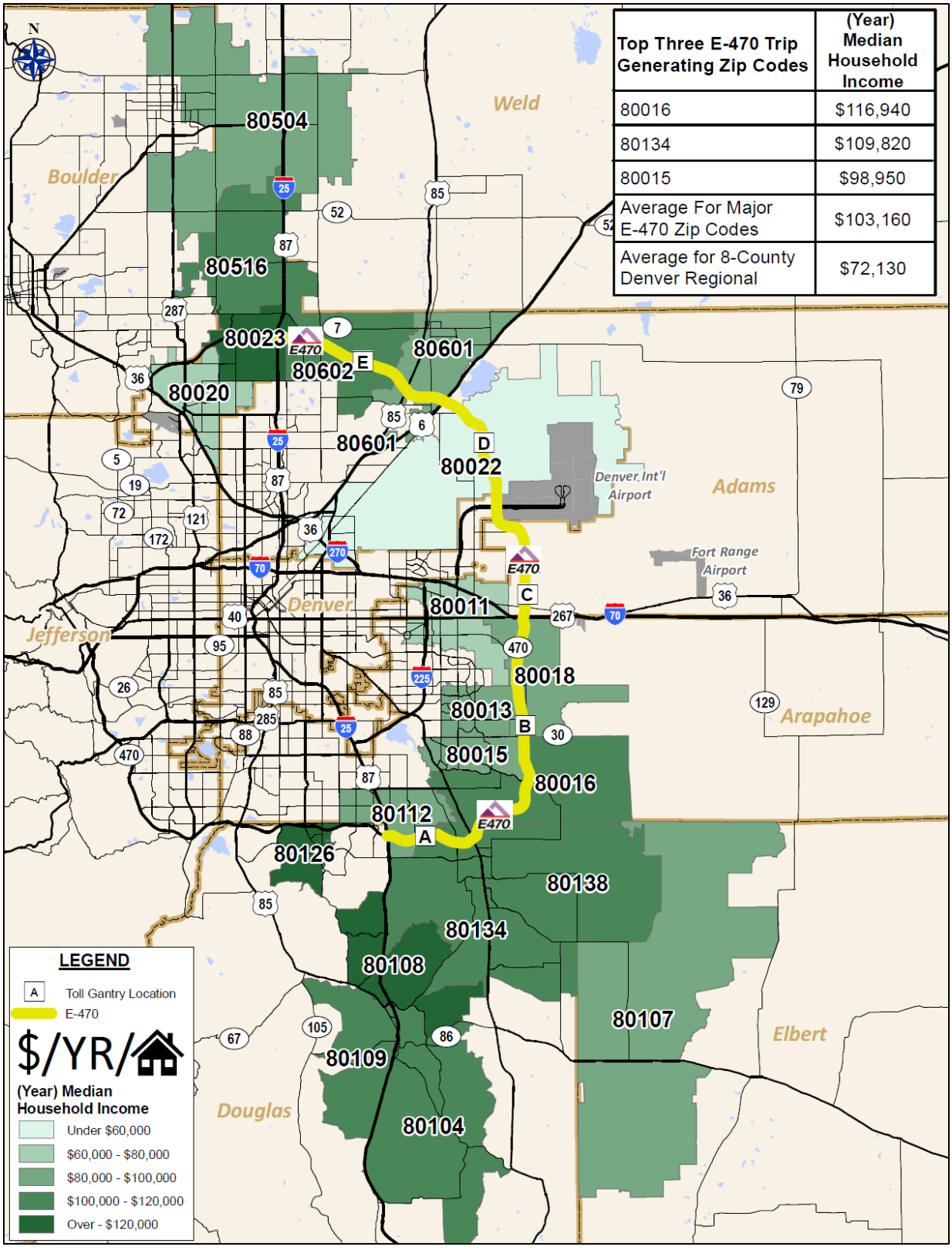


Figure 2-13
Distribution of 2018 Median Household Income by ZIP Code

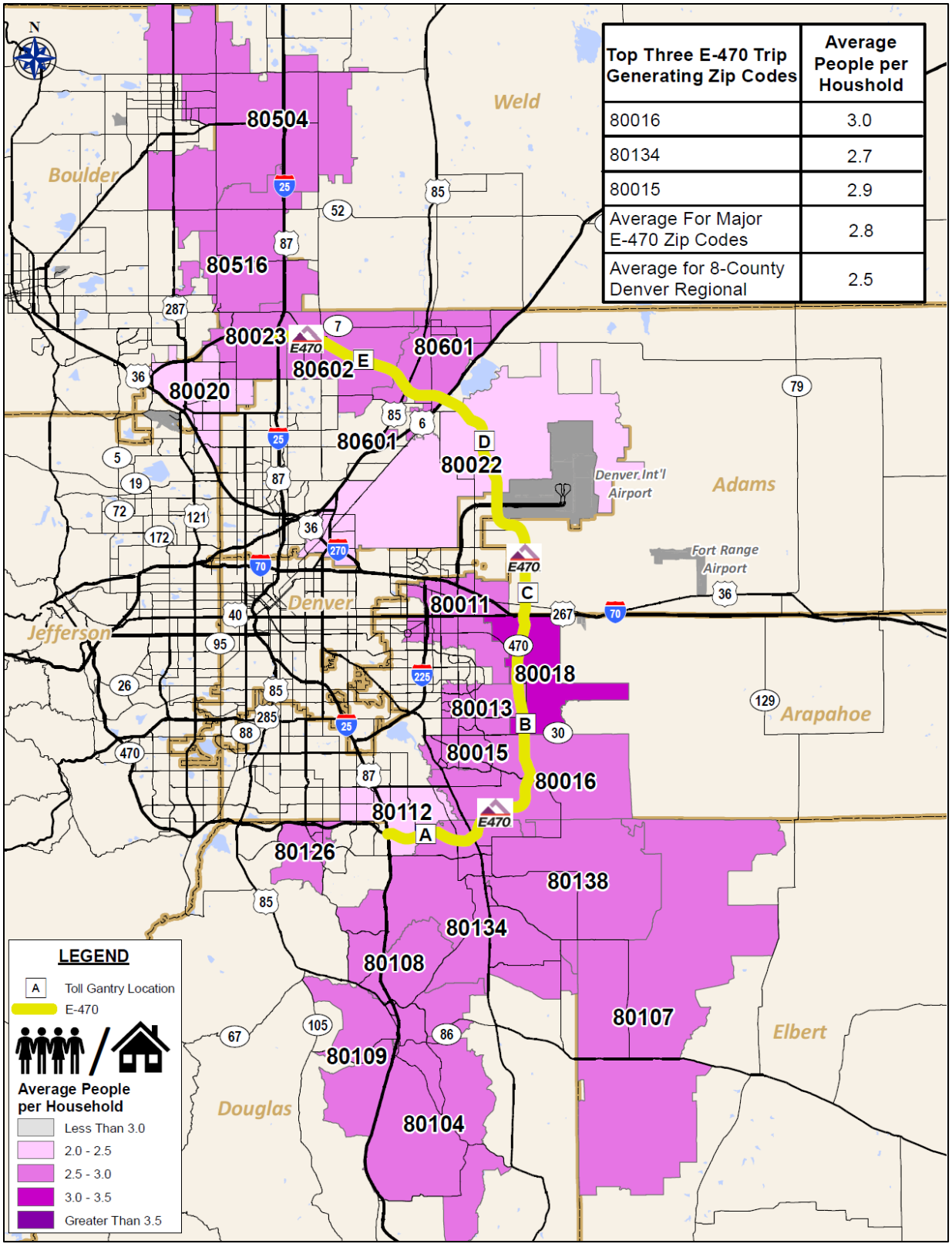


Figure 2-14
Distribution of 2018 Average People per Household by ZIP Code

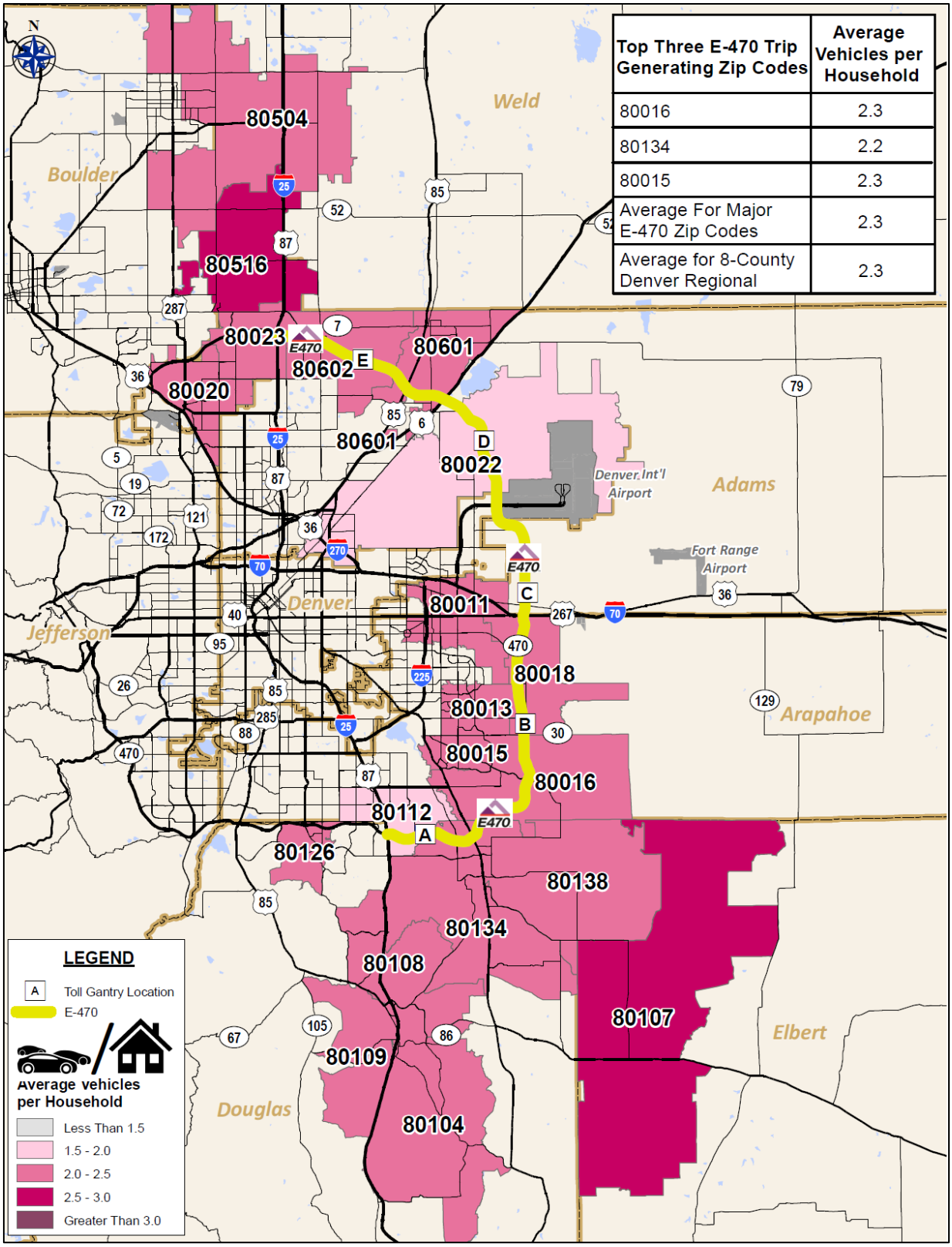


Figure 2-15
Distribution of 2018 Average Vehicles per Household by ZIP Code

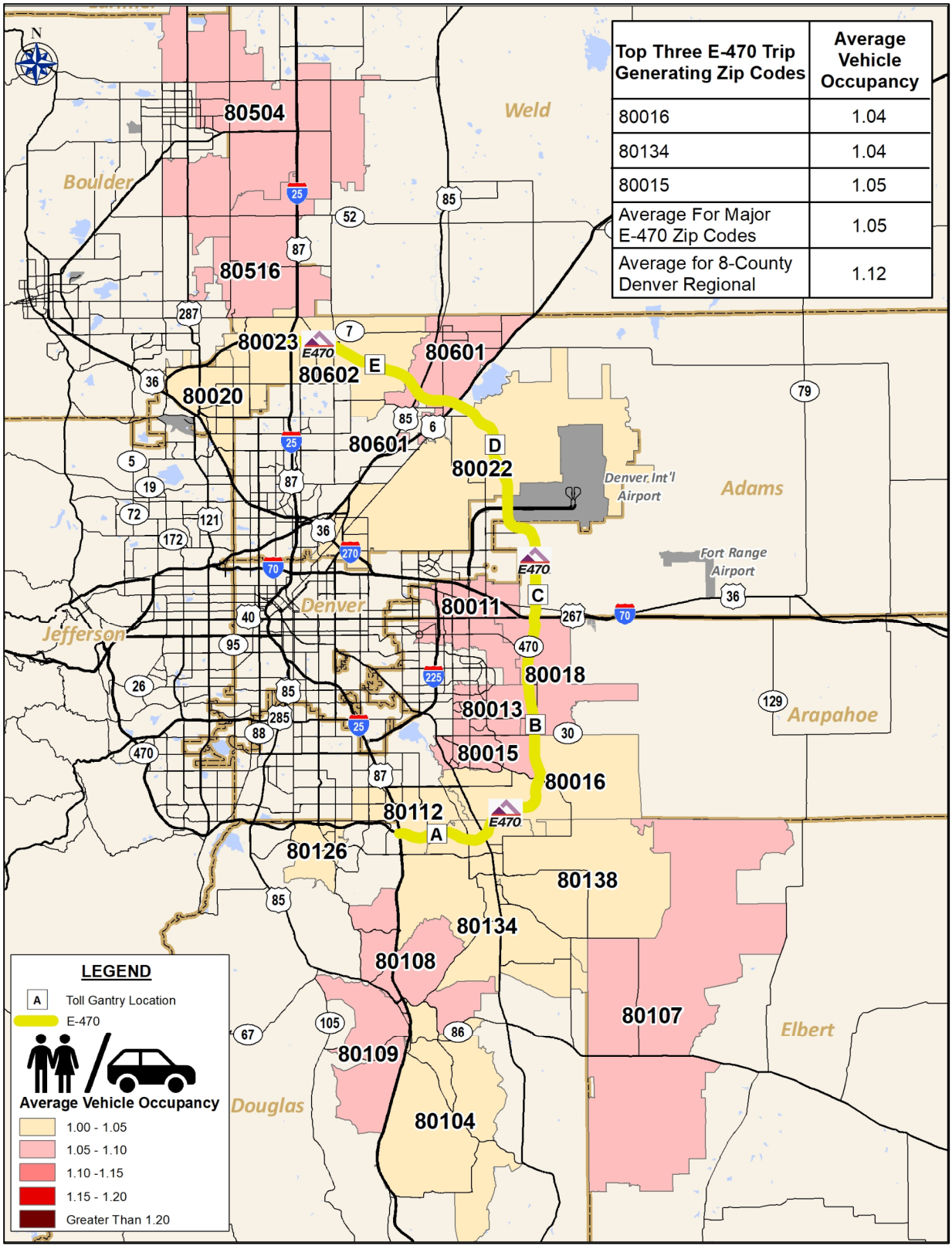


Figure 2-16
Distribution of 2018 Average Vehicle Occupancy by ZIP Code

Recent Trends Related to COVID-19

In March 2020, traffic impacts related to the Coronavirus (COVID-19) began as many states and localities began implanting stay-at-home orders, public space closures, social distancing orders and other restrictions in an effort to reduce the spread of the virus based on guidelines from the Center for Disease Control (CDC) and the Federal Government. On March 11, 2020, Governor Polis issued an emergency declaration due to COVID-19. This was followed by an order on March 18, 2020 to suspend in-person instruction at Colorado schools and a March 25, 2020 stay-at-home order. Following several prior extensions by the Governor, the current statewide stay-at-home order is set to expire on April 24, 2020. Denver Mayor Hancock issued a similar stay-at-home order on March 23, 2020, which has recently been extended to May 8, 2020. As of April 24, 2020, there have been over 10,400 confirmed cases of COVID-19 in Colorado, with almost 500 deaths. Within the 8-County Denver Metro area, there have been over 8,000 confirmed cases and almost 400 deaths, or roughly 80 percent of the total statewide impact.

These restrictions have significantly impacted regional traffic patterns. Moreover, since congestion on alternative roadways, such as I-25, I-70 and even local arterials, has been almost eliminated, E-470 no longer offers the same travel time savings to motorists as it did prior to the COVID-19 outbreak. As a result, E-470 has been particularly hard hit. Additionally, since more than 20 percent of E-470 traffic originates from or is destined for DIA, reductions in air travel and tourism related to the COVID-19 outbreak would also have impacted E-470 to a greater extent than other facilities in the region.

Figure 2-17 illustrates total daily transactions on E-470 between March 1 and April 16, 2020 (the latest available data at the time of this report). During the first week of March, prior to the major traffic impacts of COVID-19, average weekday transactions on the E-470 system were roughly 250,000 per day. These were reduced slightly during the second week of March as the national and international travel was reduced in anticipation of major COVID-19 infections and deaths. The major impacts to E-470 began on March 17th and 18th with the suspension of in-person

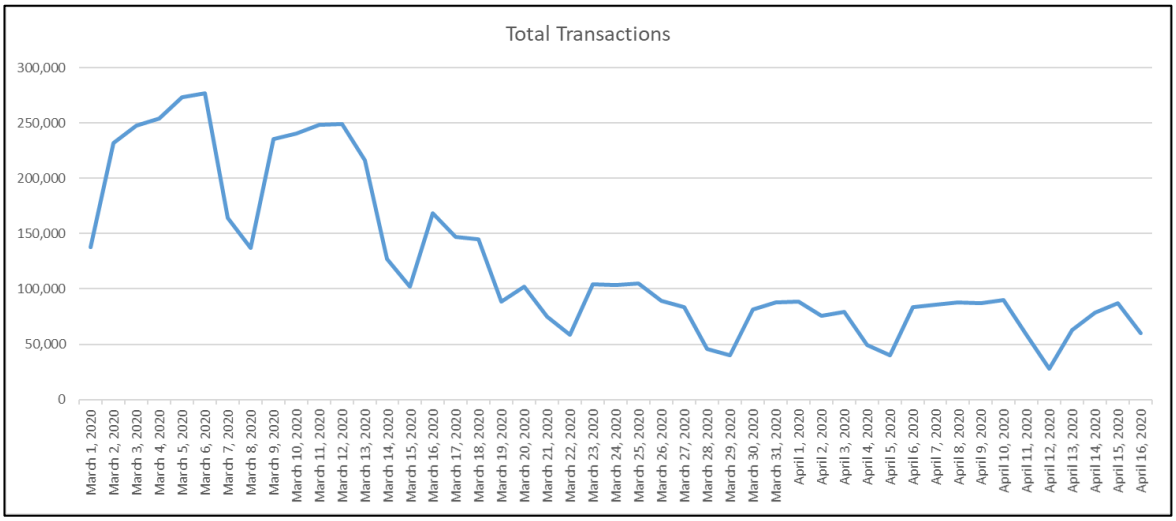


Figure 2-17
Total E-470 Transactions by Day
March 1, 2020 to April 16, 2020

instructions in Colorado schools. Transaction levels continued to fall until the March 25th and 26th, when the Governor's stay-at-home order was implemented. Systemwide E-470 transactions have averaged less than 100,000 on an average weekday since late March, a reduction of over 60 percent compared to normal levels.

Figure 2-18 illustrates the reduction in total weekly E-470 transactions, as compared with the first week of March prior to the major COVID-19 impacts. As previously indicated, some impacts were observed during the second week of March, with transactions falling roughly 10 percent week-over-week. However, the major impacts began during the third week and deepened to a reduction of more than 65 percent during the last week of March. There has been a slight increase in transactions during the first week of April, but it is unclear if this represents the beginning of a return to normal trends or simply fluctuations related to the Easter and Passover holidays. Likely, continued traffic impacts will be related to the length of government stay-at-home orders, public space and school closures, and other travel restrictions. Estimates of the continued traffic impacts related to COVID-19 are discussed further in **Chapter 4**.

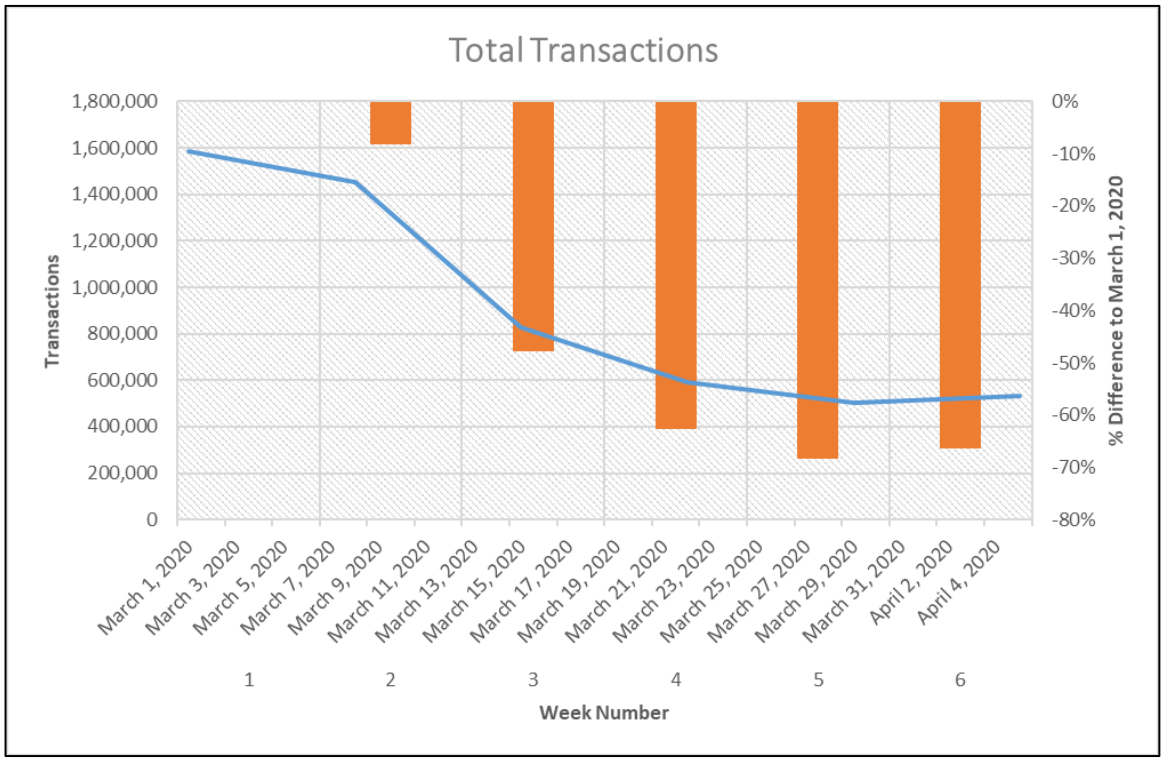


Figure 2-18
Week-over-Week Impacts of COVID-19 on E-470 Transactions
March 2020 to April 2020

One significant factor of the recent COVID-19 related traffic trends is the disparate impacts to E-470 transactions by vehicle class. Given the nature of the stay-at-home orders, daily commutes have largely stopped, while food and goods deliveries have continued. As a result, passenger car traffic has been affected much more than commercial vehicle traffic to date. **Figure 2-19** compares E-470 transactions week-over-week by vehicle class. While E-470 passenger car

transactions are down by almost 70 percent compared to the first week of March, commercial vehicle transactions are down by just over 20 percent. This matches trends observed nationally on other toll facilities. It's clear that this reduction is contingent upon continued supply chain stability and by the ability of consumers to afford food and other basic supplies. Long-term unemployment or other supply chain disruptions could produce further decreases in commercial vehicle transactions. This is discussed further as part of the traffic and revenue forecasts in **Chapter 4**.

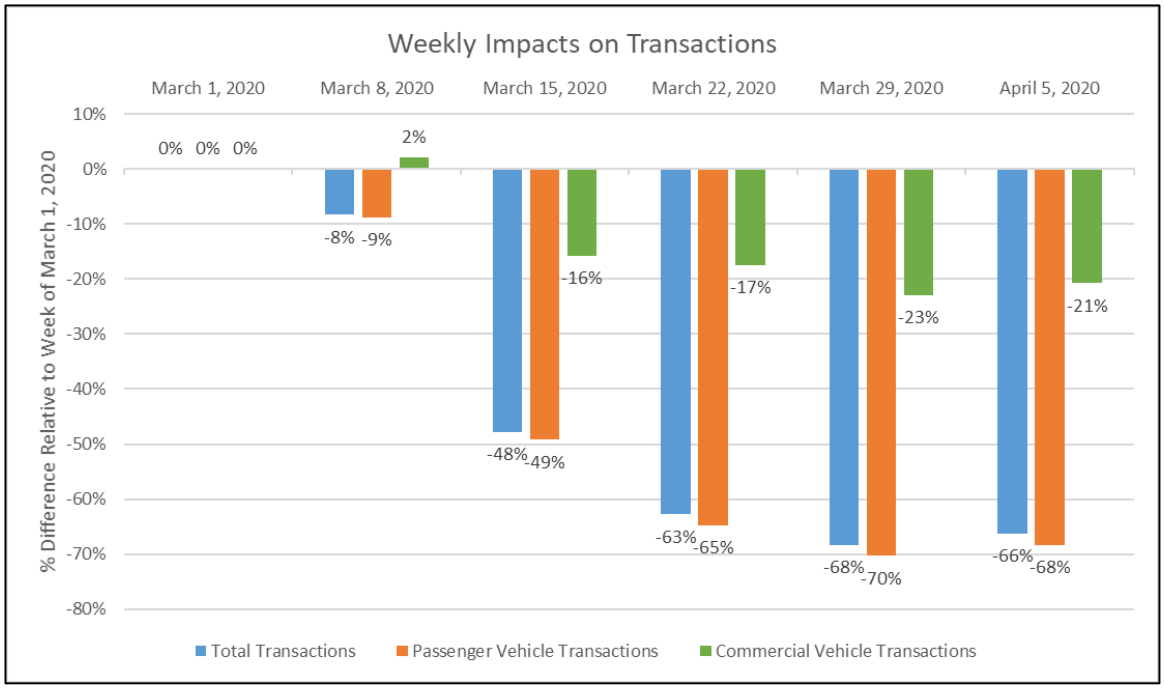


Figure 2-19
Week-over-Week Impacts of COVID-19 on E-470 Transactions by Vehicle Class
March 2020 to April 2020

Figures 2-20 and 2-21 provide the same information for weekdays and weekends specifically. Comparing the two figures, weekend transactions on E-470 have been slightly more impacted than the weekdays. This may be due to the closure of public spaces and recreational facilities, as well as a reduction in air travel and tourism within the region.

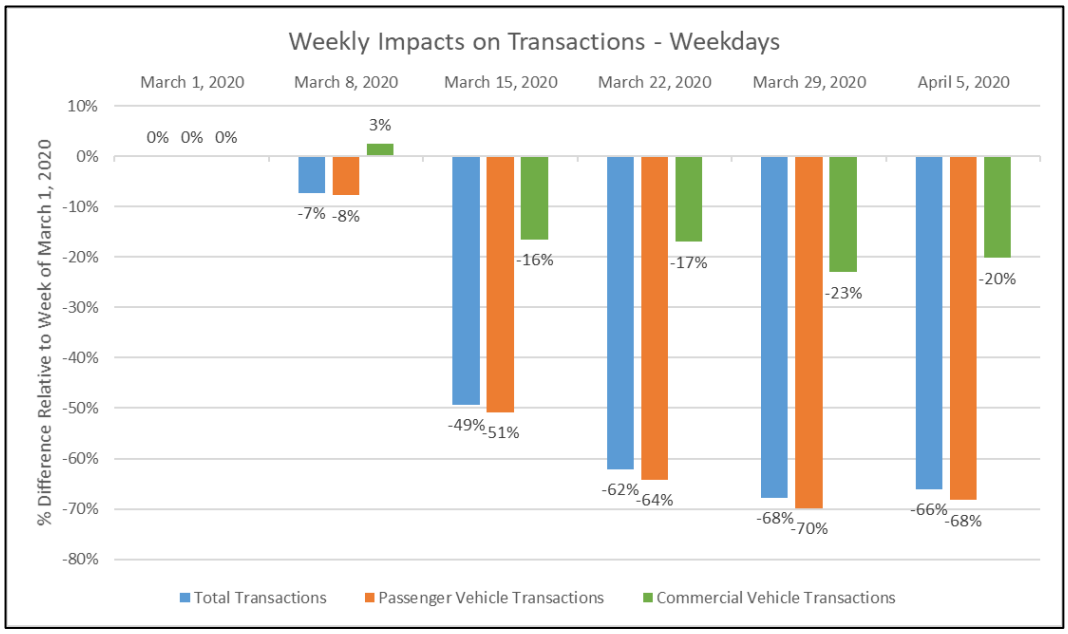


Figure 2-20
Week-over-Week Impacts of COVID-19 on E-470 Weekday Transactions by Vehicle Class
March 2020 to April 2020

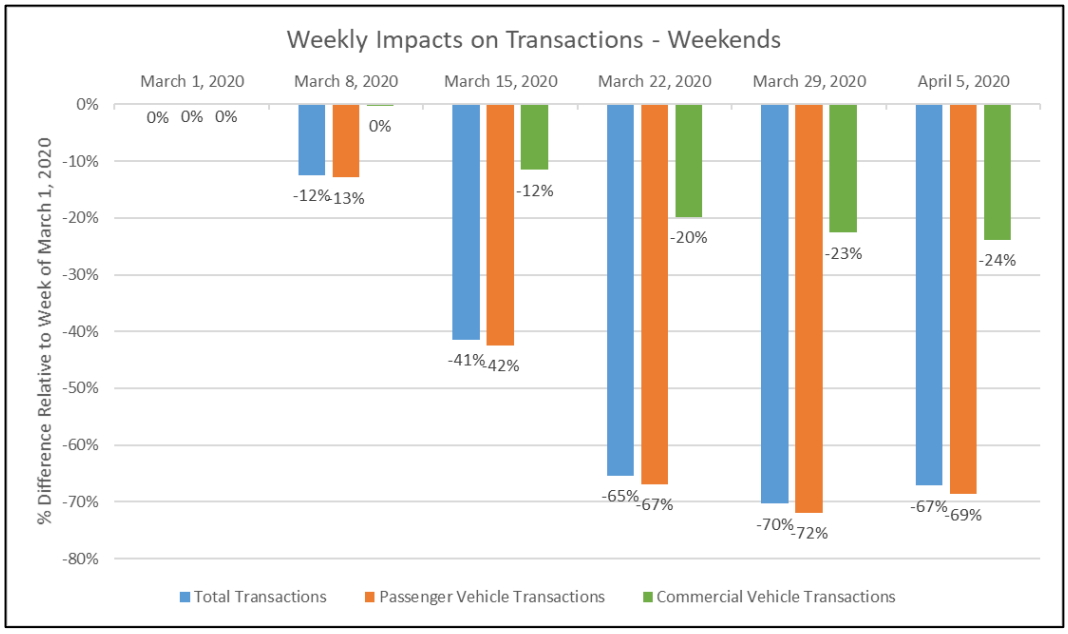


Figure 2-21
Week-over-Week Impacts of COVID-19 on E-470 Weekend Transactions by Vehicle Class
March 2020 to April 2020

Chapter 3
Corridor Growth Analysis

Presented below is an overview of the work performed to make geospatial adjustments to the 2015 to 2040 employment, population, and household projections of the Denver Regional Council of Governments (DRCOG). The findings from this work were used as a basic input to the travel demand model which, in turn, aided in the forecasting of the traffic and revenue potential for E-470.

This work, performed by Economic & Planning Systems (EPS), provided independent economic growth projections throughout the Denver Metro Area. Growth forecasts are typically prepared by the metropolitan planning organization, DRCOG, but economic conditions and major development plans, which could influence traffic demand, have been meticulously reviewed and accounted for in this assessment. Motivation for this independent review was to account for economic and demographic conditions in a dynamic regional market that continues to change and expand.

Overview

While it was beyond the scope of this analysis to recreate a sophisticated geospatial modeling methodology, it is believed that a review and recalibration of DRCOG's data and projections are justified if: a) its base year does not align with observed data at a regional, county, or municipal level; b) its growth projections are calculated off an incorrect base and appear to result in what could be characterized as overly optimistic rates of growth; and, c) it is determined that TAZ level data within the E-470 influence area contains too much, too little, or is missing socioeconomic data related to future land uses and major development plans researched in the influence area.

Purpose

This analysis documents the independent assessment of corridor growth forecasts produced by DRCOG. The primary output of this effort is an adjusted socioeconomic dataset at the TAZ level for the DRCOG Planning Area [1]. The analysis that follows aligns with DRCOG's 11-county planning area boundary, as illustrated in **Figure 3-1**. It also contains an analysis of the Denver Metropolitan Statistical Area (MSA), a 7-county subset consisting of Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, and Jefferson counties, which excludes Clear Creek, Elbert, Gilpin, and Weld counties.

Influence Area

The E-470 corridor influence area, as illustrated in **Figure 3-2**, is the primary focus, in which 199 major developments were evaluated, as well as the regional review of base year (2015) socioeconomic conditions and macro-level growth rate calibrations were performed.

[1] For the purposes of this study only, the terms "Denver region" and "DRCOG Planning Area", are synonymous. They include 11 counties: Adams, Arapahoe, Boulder, Broomfield, Clear Creek, Denver, Douglas, Elbert, Gilpin, Jefferson, and Weld.

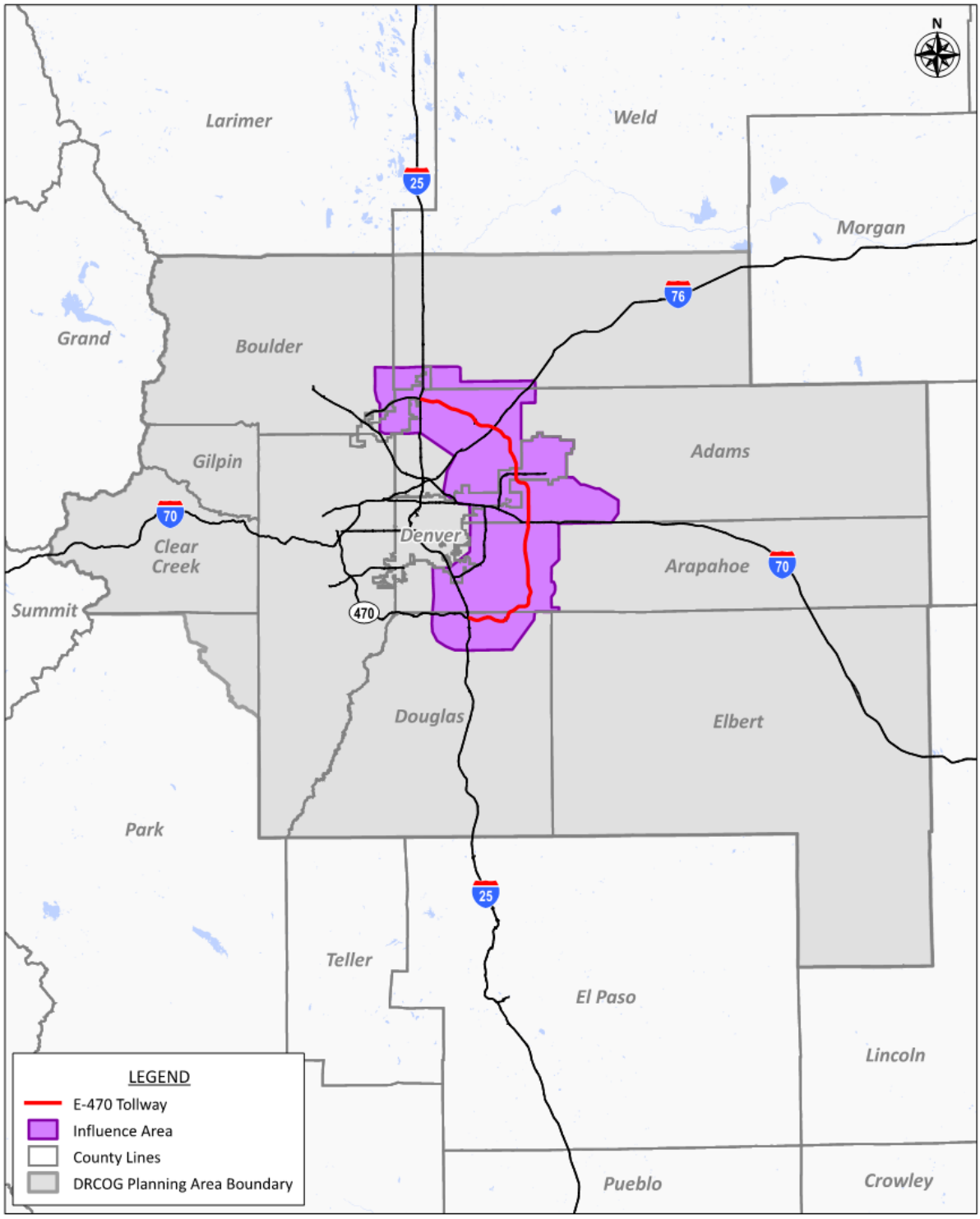


Figure 3-1
DRCOG Planning Area Boundary

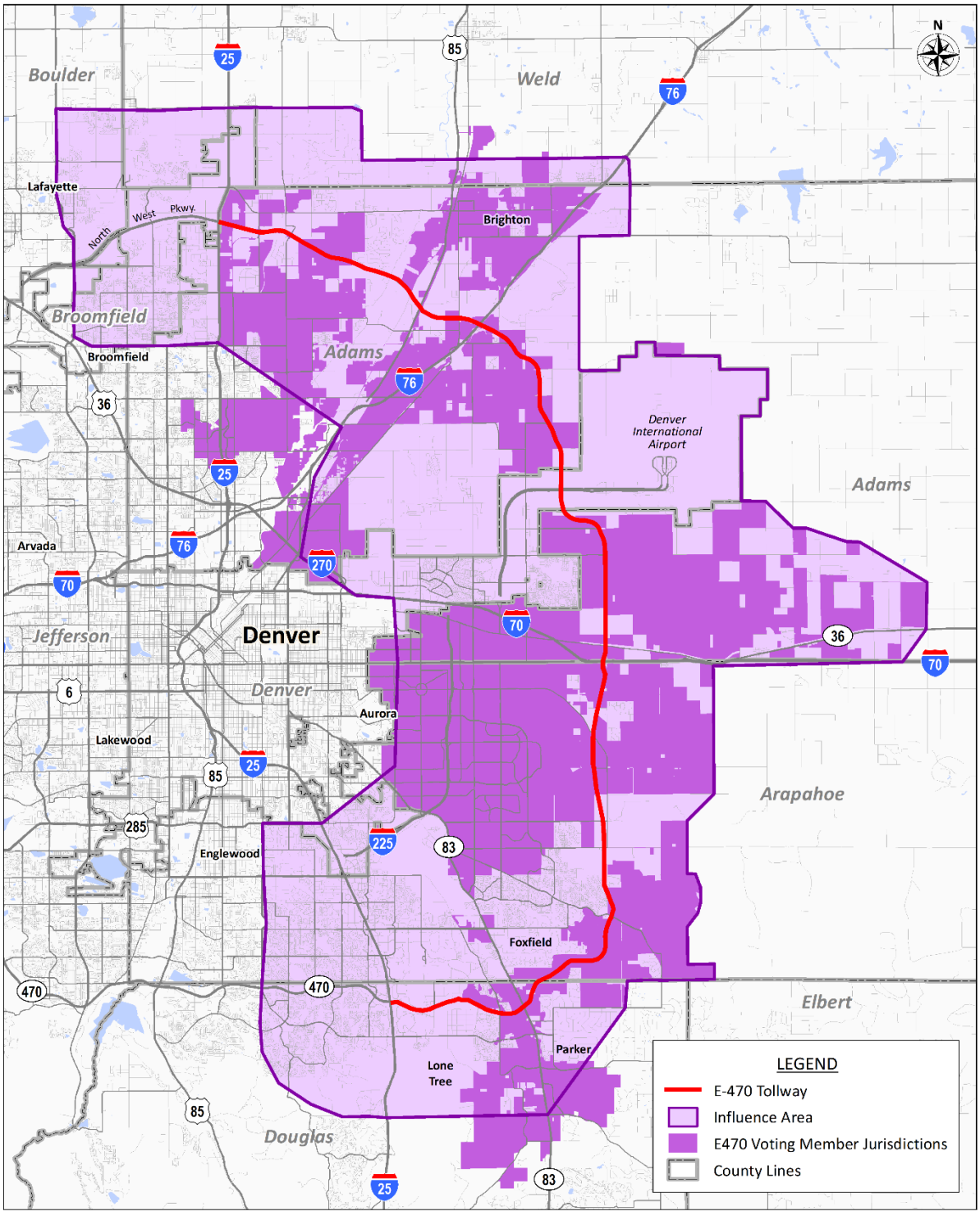


Figure 3-2
Voting Member Jurisdictions

E-470's member jurisdictions include Adams, Arapahoe, and Douglas counties, as well as the municipalities of Aurora, Brighton, Commerce City, Thornton, and Parker. There are also affiliate, non-voting members, including Arvada, Greeley, Lone Tree, Broomfield, and Weld County. As such, the influence area boundaries are drawn to reflect Board membership as well as the generally-accepted travel shed from which travel demand on E-470 is generated.

Methodology

The methodology for this growth assessment incorporates three components within the context of two principal approaches. The two approaches are a review and analysis of data at the 1) macroscopic and 2) microscopic perspectives. The three components within, as described in greater detail below, include: 1) a review of the base year 2015 population, household, and employment numbers; 2) a review and independent analysis of regional and sub-regional projections; and, 3) a review of the TAZ level data in light of research of major development plans throughout the E-470 corridor influence area. Overall, this approach provides an independent reassessment of growth patterns and expectations based on observed data, analysis and forecasting, and anticipated development patterns grounded in an understanding of real estate development potentials.[2] The following approach to adjust DRCOG's forecasts at a geospatial level was used.

- Understanding DRCOG forecasts: Meetings were held with DRCOG's regional modeling manager and chief economist who oversee the land use and travel demand forecasting processes. The purpose was to become acquainted with and to identify any changes or issues of relevance with the process, inputs, assumptions, and outputs of the new UrbanSim land use model, and to make more informed adjustments of the TAZ level data.

- Macroscopic geographic analysis: The analysis of top-down economic and demographic trends includes all 11 counties in DRCOG's planning area. Growth patterns at the national, state, county, and municipal levels using records of secondary data, such as the U.S. Census, Colorado Department of Local Affairs, U.S. Bureau of Labor Statistics (BLS), and the U.S. Bureau of Economic Analysis were reviewed.

- Independent regional forecast: An employment-based population projection for the 11-county region, assuming likely trajectories for relevant intermediary socioeconomic relationships, such as in- and out-commuting, unemployment, proprietorships, underemployment, group quarters populations, and populations under 16 and over 65 was structured. Control totals from this forecast were used as a reference and to ultimately recalibrate (in proper proportion to account for the exclusion of a majority of Weld County employment and population from DRCOG's Planning Area) DRCOG's forecasts.

- Microscopic geographic analysis: The bottom-up economic and demographic growth potentials analysis focused on research and evaluation of major development plans at the

[2] It should be noted that while DRCOG's Planning Area touches 11 counties, it does not contain the entirety of Weld County. For the purposes of this study, the region will be referred to as the 11-county region, but much of the analysis, unless otherwise specified, will reference data relevant to the 11-county portion of the total 11 counties. (The DRCOG Planning Area generally has accounted for approximately 94 percent of the 11-county population, household, and employment totals.)

TAZ (i.e., site-specific) level. In this analysis, the E-470 influence area, illustrated in Figure 3-1, was the focus.

- Market research: The research and analysis of major development plans involved documentation of the location, scale, types of projects, status, and timing of projects. These growth potentials were also evaluated against historical trends in regional and sub-regional capture of new office, industrial, retail, and residential development.

- Adjustments: Each of these analytical steps was incorporated into a recalibration of all TAZ data within the DRCOG planning area. In terms of the general approach to adjusting of DRCOG's TAZ data, because it is generally understood that analysis of small areas (i.e. TAZs) produce results with varying degrees of accuracy, the approach was taken that makes TAZ adjustments only when market information and research provides a clear basis to do so and/or when underlying TAZ forecasts deviate significantly from findings of the research and analysis performed.

Step 1) Base Year 2015 Review

DRCOG's regional projections were reviewed multiple times by EPS for a variety of studies. EPS has also spoken with DRCOG's modeling staff and chief economist on a variety of different occasions to understand and gain a more robust appreciation for their methodologies and assumptions. It has been EPS' understanding that the casualty of a modeling and vetting process that frequently takes one to two years is that data used to calibrate the model's "base" year population, households, and employment are never "observed" at the time of calibration, rather they are estimates. Furthermore, observed data on population, households, and employment are frequently available around the time or soon after projections are released. As a result, the first task in this process is to ensure that the model's base year is adjusted to observed population, household, and employment data.

Step 2) Independent Regional Forecast

This component of the analysis includes a review and analysis of historical population and employment trends at the regional and sub-regional levels, as well as a comparison of third-party forecasts. The purpose is to structure an independent employment-based population and household forecast, using a series of standard forecasting assumptions, such as wage and salary employment, in- and out-commuting patterns, unemployment rates, proprietorships, group quarters population, population by age, average household size, and vacancy rates.

The process begins with a regional shift-share analysis, benchmarking the first 10 years with data from the BLS 10-year national forecast of employment by industry, to produce a 2040 employment control total. Each of the subordinate economic and demographic variables are accounted for and aligned with, for example, the State Demographer's forecasts of population by age by county. [3]

[3] While it is known that DRCOG has recently begun aligning its base year estimates more closely, albeit not exactly, with the Department of Local Affairs State Demographer's Office, DRCOG's control totals of population are independent of the SDO's work.

Forecast Methodology

The following is an overview of the methodology employed not only for reviewing DRCOG's regional forecasts, but also producing independent control total forecasts of population, households, and employment for the geo-spatial apportionment modeling. The methodology provides a clear path commonly used by demographers to trace the relationship between wage and salary employment, un- and under-employment, group quarters, population by age, households, and housing inventory. It also provides points at which population and household counts may be vetted against observed data points. Each component and their sources for the 11-county region are as follows:

- Wage & salary employment: the employment totals identified here have been sourced from the BLS Quarterly Census of Employment and Wages (QCEW) data series. [4]
- Commuting patterns: the in- and out-commuting patterns were sourced from the U.S. Census Longitudinal Employer-Household Dynamics data series. [5] The removal of in-commuters and addition of out-commuters estimated for 2000 and 2015 results in the number of job-holding residents of the geography.
- Unemployment: unemployment statistics have been sourced from the BLS Local Area Unemployment Statistics U-3 "total unemployed" series. [6] This calculation nets the potential wage and salary labor force, i.e. those employed or "actively seeking employment".
- Proprietors: data on sole proprietors has been sourced from the U.S. Census Nonemployer Statistics data series. [7] This adds persons self-employed in the geography and yields a fuller labor force number.
- Group quarters and "underemployed persons", age 16 to 65: this adds the portion of institutionalized persons aged 16 to 65, as well as the portion of population aged 16 to 65 that would be considered in the U-4, U-5, and U-6 measures of labor utilization published by the BLS [8], netting the total population of non-institutionalized persons aged 16 to 65.
- Persons aged under 16 and over 65: this adds the total population under 16 and over 65, including group quarters, resulting in total population.

With the preceding factors traced from wage and salary employment to total population, the following few steps trace population to households and housing inventory:

- Group quarters: this removes the total population in group quarters, resulting in population in households.

[4] https://www.bls.gov/cew/datatoc.htm
[5] https://onthemap.ces.census.gov/
[6] https://www.bls.gov/lau/
[7] https://www.census.gov/econ/nonemployer/
[8] https://www.bls.gov/lau/stalt.htm

- Average household size: using the weighted average household size from U.S. Census data for the geography, total households are derived.
- Vacancy rate: using occupancy and vacancy status data from the U.S. Census, total inventory of housing is determined.

Step 3) TAZ-Level E-470 Corridor Land Use Review

The final component of the review and analysis process is a microscopic analysis of TAZ-level socioeconomic land-use data. The analysis leverages area-, site-, and development-specific research, along with future land use plans and land availability. Information and data are collected through interviews with local planners and developers regarding all major development plans. A "major development plan" is defined as a residential, non-residential, or mixed-use development that is in the process of being built, in the final plan approval process, early stage of platting, or even in the conceptual planning phase. Although not rigidly followed in all cases, a residential development is generally considered a major development plan if larger than approximately 50 units, and a non-residential development is generally considered a major development plan if it is generally larger than a single-tenant space.

The primary objective in completing this level of market research is to document uses, magnitudes, timing, status, risk, and likelihood of these major development plans. The synthesis of these approaches yields adjustments of TAZ-level socioeconomic data for the base year (though infrequently) and forecast years (2025 through 2040). It also incorporates a review of office, industrial, retail, and residential market conditions and potentials, focusing particularly in the E-470 influence area. [9]

And while described in greater detail below, the purpose of such an analysis of the construction trends and occupancy characteristics of non-residential space is instructive for the interpretation and assessment of whether and to what extent the rates of growth contained in DRCOG's most recent set of growth projections reflect any short-term anchoring bias (as compared to previous versions of DRCOG's forecasts). These conditions are also particularly instructive for understanding the market risks associated with near-term major development plans that incorporate non-residential uses.

Major Development Plans

It is generally understood that an analysis of projections at a subarea or TAZ level produces results with a generally high degree of specificity and uncertainty. Moreover, DRCOG has often cautioned users against placing great reliance on TAZ level totals, as forecasting growth in such small geographic areas is difficult. As such, the approach to making adjustments at the TAZ level is to do so only when market information and research provides a clear basis for such adjustments. In general, however, the TAZ-level data was adjusted when the difference between what was likely to materialize in terms of land use developments and what was reported at the TAZ level was significantly different from each other (e.g., more than a 10 percent difference in

[9] The E-470 Influence Area is illustrated at a high level in Figure 3-1 and with more detail in Figure 3-2.

magnitude). The following factors concerning market information and research were used to make these decisions with a clear basis.

- Development Plans
- Entitlement Process and Municipal Growth Policies
- Physical Area Attributes
- Existing Market Studies
- Development Pressure
- Proximity to Transportation Facilities
- Proximity to Employment Clusters
- Capital Improvements
- Ownership Patterns

As a result, when upward adjustments to TAZ-level data are made - which is generally the case for population and household data - population and household counts in TAZs in the respective municipality are reduced proportionally to ensure that control totals remain fixed. On the other hand, when downward adjustments to TAZ-level data are made, which is frequently the case for employment data in the influence area, employment counts in TAZs in the respective municipality are reduced proportionally to ensure that control totals remain fixed. **Figure 3-3** illustrates the location of the 199 major developments evaluated in this process. As mentioned previously, the primary objective here is to document the uses, magnitudes, timing, status, risk, and likelihood of these plans materializing over the next 20 years. [10]

Historical Demand Trends

Population

As illustrated in **Figure 3-4**, the 7-county Denver MSA has added an average of 42,200 persons per year since 1969. This graphic, using U.S. Census data, also illustrates when the MSA has experienced either above- or below-average population growth. For example, since 2010 (inclusive), the region has added approximately 54,200 people per year, well above the historical average since 1969.

Also relevant is that the region has captured large shares of the state's population growth. Since 1970, for example, the 7-county area has captured an average of 36 percent of the state's population growth, as illustrated in **Figure 3-5**. During the 2000s, it captured an average of 59 percent, and since 2010, it has captured an average of 67 percent. While such a perspective seems to indicate that state population growth is increasingly likely to occur within the MSA, recent trends have pointed toward moderation of this trend. As this relates to the adjusted population forecasts, EPS chose not to model this acceleration of state population growth capture and chose instead to model a more conservative population growth scenario for the sake of not over-estimating future travel demand in the influence area.

[10] Descriptions of each major development project evaluated and the conclusions drawn from our research and interviews regarding the scale, timing, and probability of development during the 2020 to 2040 timeframe are provided in detail in EPS' full technical report, as are specific adjustments to each major development plan in Appendix Table A1 through Table A4.

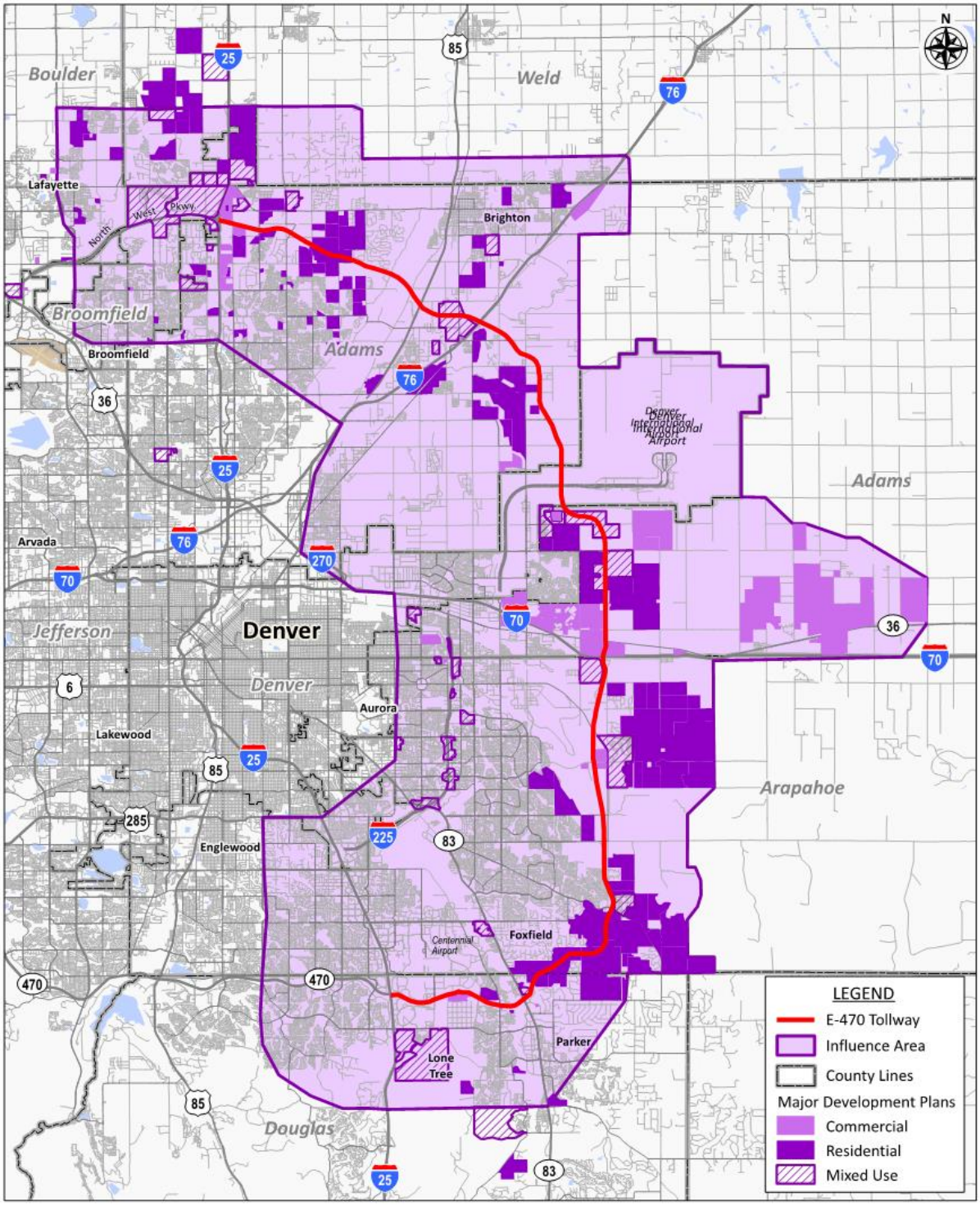


Figure 3-3
E-470 Influence Area and Major Development Plans

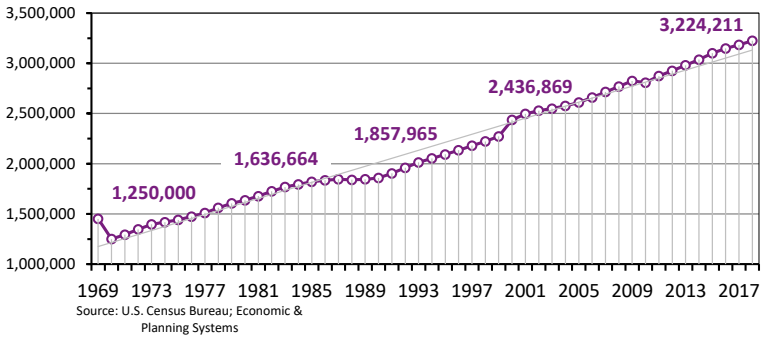


FIGURE 3-4
POPULATION GROWTH IN THE 7-COUNTY DENVER MSA 1969-2018

As indicated in **Figure 3-4**, the Metro Area lost population only twice in the past 50 years, approximately 4,700 in 1988 and approximately 17,000 in 2010. But, as shown in **Table 3-1**, the 7-county area experienced varying levels of population growth: between 1969 and 1975, population increased by approximately 36,200; between 1976 and 1987, population grew by an annual average of approximately 33,300; an annual average of approximately 43,200 between 1988 and 2003; an annual average of 36,700 between 2004 and 2010, and between 2011 and 2018 grew by an annual average of approximately 51,700 per year. [11]

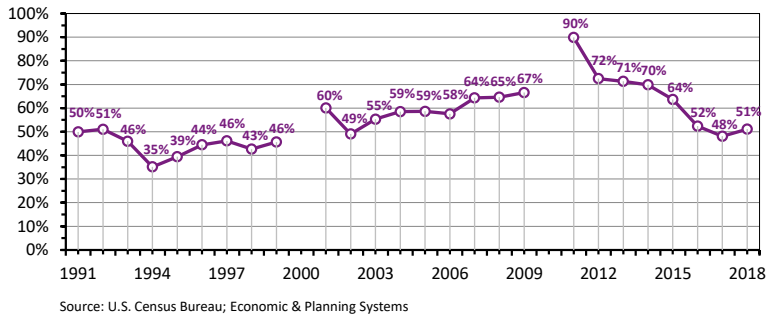


FIGURE 3-5
7-COUNTY POPULATION GROWTH AS PERCENT OF STATE GROWTH 1991-2018

Table 3-1
Population Growth Rate Shifts By County

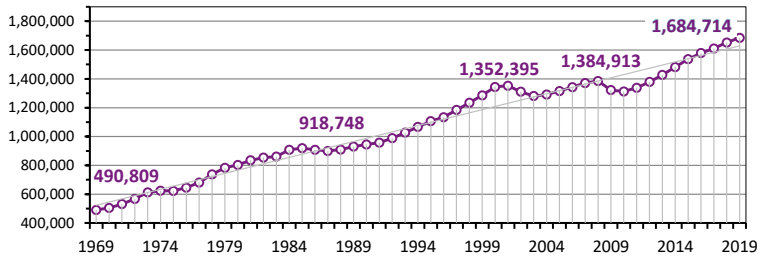
	Average Annual Growth During Cycles					
County	1969-1975	1976-1987	1988-2003	2004-2010	2011-2018	Overall
Adams	6,027	4,139	6,894	8,974	8,783	6,719
Arapahoe	10,485	13,509	8,271	8,228	9,902	10,085
Boulder	6,182	4,280	4,006	1,777	3,939	4,010
Broomfield	-	-	2,819	1,542	1,672	1,414
Denver	(1,775)	(713)	4,144	5,972	14,542	4,189
Douglas	1,143	2,675	10,944	9,070	7,164	6,834
Jefferson	14,121	9,450	6,110	1,160	5,711	7,137
Total	**36,184**	**33,340**	**43,187**	**36,723**	**51,713**	**40,386**

Source: U.S. Census; Economic & Planning Systems

[11] One purpose of this historical evaluation is to provide a juxtaposition of DRCOG's population forecasts against levels of historic activity for the sake of assessing whether the Denver region is likely to achieve such growth again in the future.

Employment

Since 1969, the 7-county area has grown by an average of 23,900 jobs per year, as illustrated in **Figure 3-6**. This graphic, using Bureau of Economic Analysis and BLS data, also illustrates when the area has experienced either above- or below-average population growth. An observation that characterizes a general concern regarding increasing economic instability is that during the previous two periods of job losses, which coincide with NBER's designations of contractions in economic activity, the percent of job losses as a percent of total jobs has been increasing, relative to previous economic contractions in employment in the region.



Source: U.S. Bureau of Economic Analysis; BLS; Economic & Planning Systems

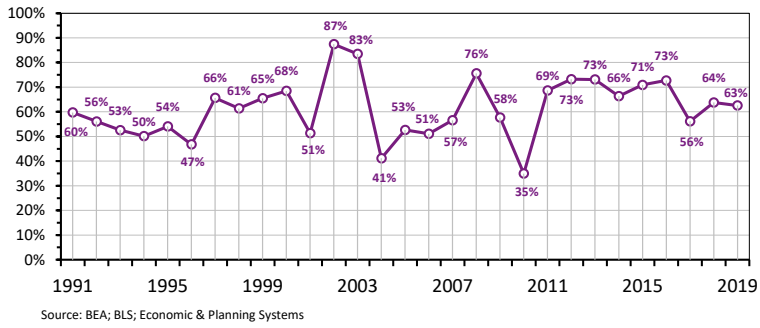
FIGURE 3-6

EMPLOYMENT GROWTH IN THE 7-COUNTY DENVER MSA 1969-2019

- 1975: 700 jobs (0.1 percent of total jobs) were lost
- 1986 to 1987: an average of 9,600 jobs (1.0 percent of total jobs) were lost per year
- 2002 to 2003: an average of 35,500 jobs (2.6 percent of total jobs) were lost per year
- 2009 to 2010: an average of 36,200 jobs (2.6 percent of total jobs) were lost per year

As a portion of the state's growth, the MSA captured an average of 60 percent of wage and salary jobs between 1991 and 2019, as illustrated in **Figure 3-7**.

During the 1990s, it captured 57 percent, whereas during the 2000s, it captured 63 percent. And during the past nine years (since 2010), it has captured an average of 68 percent of the state's total wage and salary job growth. Again, for the purposes of this study, it appears increasingly likely that state employment growth materializes in the Denver Region. As this relates to the current adjusted employment forecasts, this type of heightened rate of growth was not modeled. Instead a more conservative employment growth scenario was modeled to avoid over-estimating future travel demand.



Source: BEA; BLS; Economic & Planning Systems

FIGURE 3-7

7-COUNTY EMPLOYMENT GROWTH AS PERCENT OF STATE GROWTH 1991-2019

As shown in **Table 3-2**, the 7-county area has experienced varying levels of employment growth: between 1969 and 1975, employment increased by approximately 22,000; between 1976 and

1987, it grew by an annual average of approximately 23,000; an annual average of approximately 23,800 between 1988 and 2003; an annual average of 4,700 between 2004 and 2010 and is currently growing by an annual average of approximately 41,300 per year. [12]

Table 3-2
Employment Growth Rate Shifts By County

	Average Annual Growth in Economic Cycles					
County	1969-1975	1976-1987	1988-2003	2004-2010	2011-2019	Overall
Adams	3,599	2,144	3,556	1,143	8,440	3,764
Arapahoe	5,719	6,909	7,204	(17)	7,038	5,914
Boulder	3,139	3,785	2,844	220	3,926	2,933
Broomfield	-	-	372	581	1,182	811
Denver	3,437	3,812	2,050	(741)	11,772	3,998
Douglas	251	573	3,449	3,547	4,478	2,574
Jefferson	5,896	5,816	3,106	(85)	4,438	3,884
Total	**22,041**	**23,040**	**23,825**	**4,646**	**41,274**	**23,878**

Source: U.S. Census; Economic & Planning Systems

Historical Supply Trends

This section details supply conditions, specifically, the market's response to meeting growing population demand through residential unit construction, and the market's response to meeting growing employment demand through the construction of new non-residential inventory such as office, industrial, and retail space. Identifying these trends has two purposes:

- Illustrate where in the respective cycles these types of residential and non-residential land uses are. For example, high net absorption rates in non-residential land uses indicate market growth, and low vacancy rates signal pressure for new space development. And an under-supply of residential units would also signal pressure for new or continued residential development.
- Provide an illustration, and lens through which to interpret, regional economic trends and conditions. For example, in a market that cycles up and down from high to low vacancies and in a market with periods of high and low levels of non-residential construction activity, high vacancy rates would suggest that overall demand for, i.e., employment growth, is tracking below the regional long-term average. Alternatively, in the same type of market, low vacancy rates would suggest that recent employment growth trends are above average.

This is particularly instructive for the interpretation and assessment of whether and to what extent the rates of growth contained in DRCOG's most recent set of projections reflect any short-

[12] Again, one purpose of this historical evaluation is to provide a juxtaposition of DRCOG's population forecasts against levels of historic activity for the sake of assessing whether the Denver region is likely to achieve such growth again in the future.

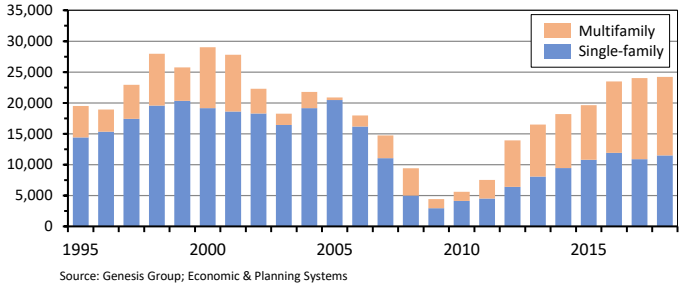
term anchoring bias (as compared to previous versions of DRCOG's forecasts). These conditions are particularly instructive for understanding the market risks associated with near-term major development plans that incorporate non-residential uses.

Residential

Meeting the demand for a growing population requires an adequate supply of housing. While a variety of quantitative and qualitative measures can be used to characterize an "adequate" supply, such as total inventory, availability of inventory for rent or purchase (i.e., not for "seasonal use"), and more subjective quality of inventory, "supply" for the purposes of this report is defined in quantitative terms as trends in new single-family and multifamily housing construction activity. It should also be noted that land and/or zoning also need to be sufficient to facilitate construction activity, such as land for greenfield developments or existing capacity for infill development or redevelopment. A land supply analysis, however, is beyond the scope of this project.

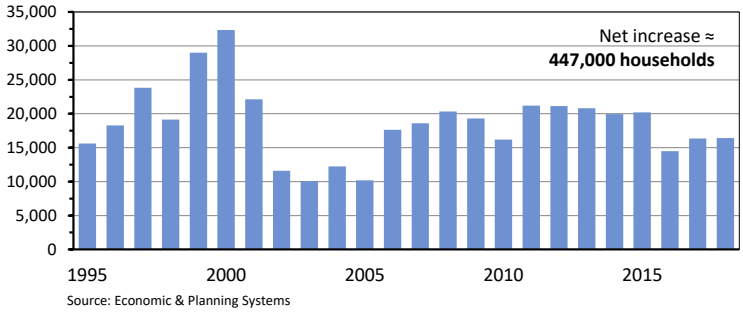
In a "balanced" market, the supply would grow in direct proportion (with no excess or insufficiency) to the magnitude of population growth. In neither the regional nor the national markets, however, has there recently been such a continually balanced market. On the contrary, construction activity has either resulted in periods of over- or under-supply. As will be demonstrated later in this section, the housing market in the region is currently under-supplied.

Figure 3-8 illustrates the magnitude of single-family and multifamily residential units that have been constructed in the 7-county MSA since 1995. Overall, nearly 455,000 units have been built in the area since 1995, which averages to approximately 19,000 units per year. On an annual basis, an average of 70 percent of units constructed were single-family and 30 percent were multifamily units.



Source: Genesis Group; Economic & Planning Systems

FIGURE 3-8
SINGLE-FAMILY AND MULTI-FAMILY CONSTRUCTION IN THE 7-COUNTY MSA 1995-2018



Source: Economic & Planning Systems

FIGURE 3-9
HOUSEHOLD GROWTH IN THE 7-COUNTY MSA 1995-2018

During the same period, **Figure 3-9** illustrates that the number of households increased by 447,000, averaging approximately 19,000 households per year. Household growth has fluctuated above and below this average over time but has been more consistent the last decade and a half.

In summary, when compared to annual growth in households during the same period of time, as shown previously, housing production capacity in the Denver region has caught up with a period of under-supply as of 2018, as depicted in **Figure 3-10**.

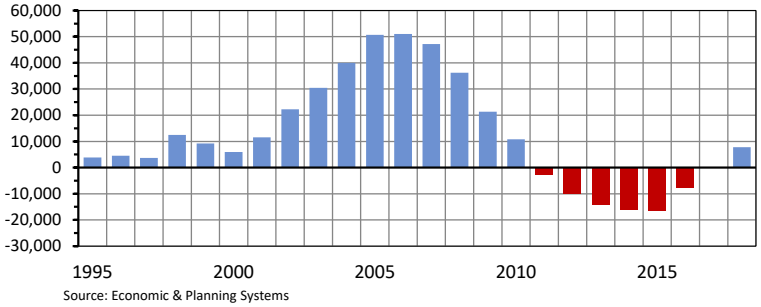


FIGURE 3-10
CUMULATIVE OVER OR UNDER-SUPPLY OF HOUSING 1995-2018

Non-Residential

Meeting the demand for a growing employment base means that an adequate and expanding supply of appropriate quality non-residential space must exist to accommodate that growth. While numerous additional considerations (e.g., lease rates, Class of space, locations) can be made for such an assessment, the metrics chosen to provide a relevant high-level overview of such conditions were net absorption and vacancy rates for industrial, office, and retail space. Indicators are identified at the regional level and for the E-470 influence area, and the data also come from Costar. It should be noted that in the commercial real estate industry, the term "absorption" is the most common way to characterize demand; "net" absorption is then defined as total new square footage leased minus the total square footage no longer occupied. These are the data reported by Costar.

Reference Forecasts

Long-Term Forecasts

Bureau of Labor Statistics

The BLS publishes projections every two years of the U.S. labor force, industry employment, and occupational employment. The most recently published projections, available from their website and in the journal *Monthly Labor Review*, cover the 10-year period 2018 through 2028.

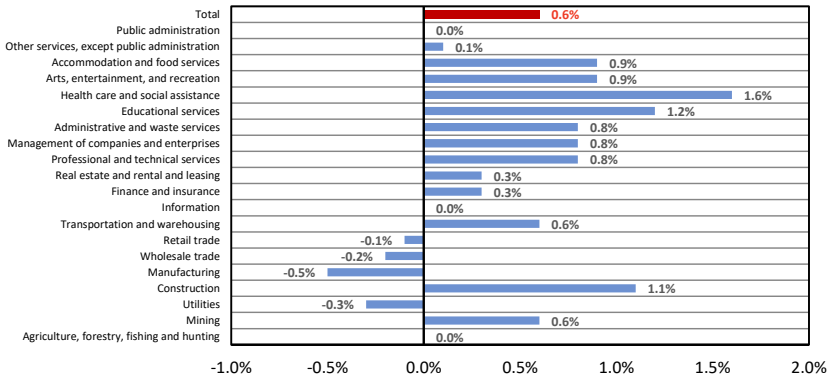
These projections are made with a few key assumptions about the characteristics of the economy, such as:

- Labor market equilibrium where labor supply meets labor demand
- Projections focus on long-term structural change as opposed to market cycles, e.g., recessions

The percentages shown in **Figure 3-11** are the BLS's projection of industry growth rates for 2018 through 2028. Overall, the BLS forecasts U.S. employment to grow an average of 0.6 percent annually over the next ten years. Industries projected to expand at above-average rates include: Accommodations and Food Service; Arts, Entertainment, and Recreation; Health Care and Social Assistance; Educational Services; Administrative Services; Management; Professional and Technical Services; and Construction. Some industries are projected to lose jobs, including: Retail Trade; Wholesale Trade; Manufacturing; and Utilities. Other industries are projected to neither expand nor contract, including: Public Administration; Information; and Agriculture.

Colorado Department of Local Affairs

The projections of population, households, and employment shown in **Table 3-3** are updated annually, as noted on the website of the Colorado Department of Local Affairs (DOLA).[13] The two differences include that of geography (DOLA's forecasts represent both the 7- and 11-county region) and sole proprietorships (DOLA's estimates include a number that is closer to the U.S. Census Nonemployer Statistics). To make direct comparisons, these projections were normalized with DRCOG's by replacing DOLA's 2015 numbers with DRCOG's. For subsequent forecast years, DOLA's rates of growth were applied. DOLA's original projections, without adjustment indicate population and household growth in the 11-county area show an increase of approximately 1.5 million, a 44 percent increase over its 2015 base; an increase of approximately 709,700 households, or 52 percent over the 2015 base, and an increase of approximately 863,700 jobs, or 42 percent over the 2015 base. With the normalization, DOLA's projections imply an increase of



Source: BLS; Economic & Planning Systems

FIGURE 3-11

BUREAU OF LABOR STATISTICS 10-YEAR EMPLOYMENT PROJECTION

Table 3-3
Summary of Regional DOLA Projections

Forecast	2015	2020	2030	2040	2015-2040 Growth Total	2015-2040 Growth Percent	2015-2040 Annual Average	2015-2040 Annual Percent	Annual Percentage 2015-2020	Annual Percentage 2020-2030	Annual Percentage 2030-2040
DOLA											
7-county											
Population	3,075,701	3,344,182	3,812,128	4,213,553	1,137,852	37%	45,514	1.27%	1.69%	1.32%	1.01%
Households	1,234,478	1,362,339	1,607,708	1,805,345	570,867	46%	22,835	1.53%	1.99%	1.67%	1.17%
Employment	1,913,109	2,248,430	2,538,281	2,675,537	762,427	40%	30,497	1.35%	3.28%	1.22%	0.53%
Normalized [1]											
Population	3,077,340	3,345,964	3,814,159	4,215,798	1,138,458	37%	45,538	1.27%	1.69%	1.32%	1.01%
Households	1,176,097	1,297,912	1,531,677	1,719,967	543,870	46%	21,755	1.53%	1.99%	1.67%	1.17%
Employment	1,682,429	1,977,317	2,232,218	2,352,924	670,495	40%	26,820	1.35%	3.28%	1.22%	0.53%
11-county											
Population	3,400,418	3,729,955	4,340,538	4,893,004	1,492,586	44%	59,703	1.47%	1.87%	1.53%	1.21%
Households	1,354,728	1,506,756	1,807,689	2,064,412	709,684	52%	28,387	1.70%	2.15%	1.84%	1.34%
Employment	2,070,916	2,437,813	2,770,027	2,934,644	863,728	42%	34,549	1.40%	3.32%	1.29%	0.58%
Normalized [1]											
Population	3,203,818	3,514,302	4,089,584	4,610,108	1,406,290	44%	56,252	1.47%	1.87%	1.53%	1.21%
Households	1,224,482	1,361,894	1,633,894	1,865,935	641,453	52%	25,658	1.70%	2.15%	1.84%	1.34%
Employment	1,715,168	2,019,039	2,294,183	2,430,522	715,354	42%	28,614	1.40%	3.32%	1.29%	0.58%

[1] EPS calibrated 2015 to DRCOG's totals for 2015 and applied DOLA's annual rates of growth to the remaining years.
Source: DOLA; Economic & Planning Systems

[13] https://demography.dola.colorado.gov/

more than 56,300 people per year, approximately 25,700 households and 28,600 wage and salary jobs per year.

Short-Term Economic Outlook

This section provides a summary of the short-term (one- to two-year) economic outlooks for the Denver Metro Area. These short-term outlooks were identified to inform the adjustment of projections for the near-term (between 2020 and 2022).

Colorado Legislative Council

The Colorado Legislative Council (CLC) staff serves as the nonpartisan research arm of the Colorado General Assembly. The CLC's role is to provide support to legislative committees, respond to requests for research and constituent services, prepare fiscal notes, provide revenue projections, and perform other centralized legislative support services. In its March 2020 release of *Focus Colorado: Economic and Revenue Forecast*, the CLC projects that the state's economy will continue to expand in 2021 and 2022, with caveats regarding the potential downside and long-term risks associated with the COVID-19 pandemic. Specifically, the document notes: "This forecast anticipates that current actions to maintain social distancing will continue over the next several months and that they will be successful in slowing the spread of the coronavirus. They will also allow the economy to reboot later this year and recover to trend levels of economic activity in 2021."

A few notable statistics from its outlook are a projection of average state population growth of 76,400 persons per year over the next two years and average state non-farm employment growth of 39,500 jobs per year. Using recent regional growth patterns as an indicator, the 7-county region might experience population growth between 45,800 and 51,900 persons per year and employment growth between 23,700 and 26,900 jobs per year.

Governor's Office of State Planning and Budgeting

The primary role of the Office of State Planning and Budgeting (OSPB) is to provide the Governor with information and recommendations to make sound public policy and budget decisions. Among the OSPB's core functions are developing reliable revenue estimates, a defensible budget, proposals for new legislation, monitoring budget implementation, anticipating issues, and developing solutions. It also publishes quarterly economic outlooks, the most recent of which was published in March 2020.

Like the CLC, OSPB's economic analysis and forecast also included a proviso: "This forecast is subject to a substantially heightened risks associated with the unfolding developments of COVID-19. The forecast reflects the latest projections of the impacts that COVID-19 may have on state revenues and expenditures, yet the epidemiological course of COVID-19 and the duration and depth of an economic slowdown are highly uncertain. Although economic conditions could be more positive than described in this forecast, the risks to the budget outlook are balanced to the downside, and the risks of a recession have increased substantially."

Comparable statistics from its outlook consist of average state population growth of 77,000 persons per year over the next two years and average state non-farm employment growth of 32,500 jobs per year – considerably lower than CLC's. Using recent regional growth patterns as an

indicator, OSPB's forecast might equate to the 7-county area experiencing population growth between 46,200 and 52,400 persons per year and employment growth between 19,500 and 22,100 jobs per year.

DRCOG Original Forecasts

Background to DRCOG Forecasts

It is noteworthy, that conditions of the past decade represented almost every outlying state of the market except steady growth, i.e., periods of exceptionally high growth, uncertainty, stagnation, and recovery. As such, the forecaster is placed in the position of creating and justifying forecasts that account for not only long-term demographic and economic relationships, but also account for the uncertainty around current conditions that do not reflect what is conventionally called "the norm". A further complication in DRCOG's role as a quasi-governmental body, overseen by its representative jurisdictions, is that these projections (at least at the jurisdictional level) are "approved" by each municipality and, thus, often influenced by non-economic or political factors.

For example, in 2006, at the height of a business cycle [14] and just before the residential construction and financial market crisis, DRCOG released its first vintage 2005-2035 forecasts with long-term annual employment growth of approximately 28,000 jobs per year. In early 2007, when observed residential construction activity data became available for 2006 and indicated that the level of construction activity had dropped by more than 30 percent in the fourth quarter, DRCOG responded to pressures to rerelease their 2005-2035 forecasts with some recognition of near-term outlook. Although DRCOG adjusted the 2010 household, population, and employment estimates, the control totals for 2035 were held constant.

In 2010, with the effects of the Great Recession still weighing heavily on the economy, DRCOG released another version of the 2005-2035 forecasts. This time, DRCOG revised its 2035 control totals and aligned some of the socioeconomic variables for 2010 more closely with recently released State Demographer's Office information. And while this adjustment placed 2010 numbers more in-line with observed data than they were previously, these newer forecasts implied an unprecedented long-term employment growth of 34,000 jobs per year between 2010 and 2035 in the 11-county MSA.

By 2014, the nation and region continued to recover from the recession, regaining employment levels not seen in more than five years. Notably, Colorado was one of a few states in the country that had already regained and surpassed pre-recession employment levels. Given the duration of the economic recovery and the delayed release of its 2040 forecasts, DRCOG produced an updated set of 2035 forecasts (2012 Cycle 2 forecasts) in 2012, in which it ran slightly modified assumptions through its model. One of the major changes to the model was a correction of the model's employment control totals for 2035, which reduced its annual employment growth to a much more justifiable long-term rate of 22,000 jobs per year between 2010 and 2035.

While a comprehensive review of the variations in DRCOG's different vintage forecasts is beyond the scope of this study, this brief overview is intended to give the reader an appreciation of not

[14] Refer to the explanation of a "cycle" in the Defining Periods of Economic Activity section, page 21 of EPS's full report located in Appendix A.

only the short-term anchoring bias commonly at play in their forecasts, but also to highlight the socioeconomic team's challenges arising from jurisdictional-level influence on the projections.

DRCOG Methodology

DRCOG's socioeconomic team is responsible for land use modeling, which has recently undergone significant changes with the introduction several years ago of UrbanSim, a parcel-based model that attempts to simulate the dynamic interaction of households, business, real estate markets, and the regional transportation system. While the geospatial modeling procedure has changed, it is important to note that the overarching employment and demographic forecasts of DRCOG's projections have not. DRCOG has historically used a third party to create a single control total for employment and population, from which it utilizes its geospatial techniques to apportion that growth by county, municipality, and TAZ. That remains the case today.

For the purposes of this study, it was important to gain an understanding of how the UrbanSim model functions and what inputs and assumptions are used; and, thus, to gain an understanding of the credibility of its outputs. In general, any model's outputs are as good as its inputs, such as regional control totals for employment and population. An analysis of DRCOG's most recent 2017 forecasts (with the horizon year 2040) and a fuller description of EPS' understanding of DRCOG's methodology are described in more detail in the DRCOG Methodology section beginning on page 36 of EPS's Final Report, Regional Economic Growth Analysis, located in Appendix A.

Summary of Forecasts

Regional composite growth projections within DRCOG's planning area are shown in **Table 3-4** at the 11-county and 7-county areas, and the E-470 influence area. The population forecast for the 11-county area shows an increase of nearly 1.2 million people between 2015 and 2040, an

Table 3-4
Summary of DRCOG Regional Growth Projections

					2015-2040						
					Growth		Annual		Annual Percentage		
Forecast	2015	2020	2030	2040	Total	Percent	Average	Percent	2015-2020	2020-2030	2030-2040
Original DRCOG Trends											
11-County region											
Population	3,181,316	3,459,096	3,948,980	4,360,742	1,179,426	37%	47,177	1.27%	1.69%	1.33%	1.00%
Households	1,285,361	1,421,009	1,650,743	1,837,423	552,062	43%	22,082	1.44%	2.03%	1.51%	1.08%
Employment	1,712,408	1,828,463	2,085,058	2,395,190	682,782	40%	27,311	1.35%	1.32%	1.32%	1.40%
7-County region											
Population	3,061,520	3,322,716	3,771,545	4,143,968	1,082,448	35%	43,298	1.22%	1.40%	1.11%	0.95%
Households	1,239,219	1,368,339	1,582,447	1,753,844	514,625	42%	20,585	1.40%	1.64%	1.25%	1.03%
Employment	1,682,905	1,796,227	2,046,643	2,349,363	666,458	40%	26,658	1.34%	1.31%	1.35%	1.39%
Influence Area											
Population	1,028,999	1,142,753	1,347,254	1,538,555	509,556	50%	20,382	1.62%	1.81%	1.50%	1.34%
Households	385,477	441,151	533,587	618,698	233,221	61%	9,329	1.91%	2.19%	1.71%	1.49%
Employment	539,656	595,659	713,462	880,057	340,401	63%	13,616	1.98%	1.88%	1.97%	2.12%

Source: DRCOG; Economic & Planning Systems

increase of 37 percent over its 2015 base, averaging to approximately 47,200 people per year. For the 7-county area, the 2040 population is projected to increase 35 percent over the 2015 base. It is important to note that DRCOG's base year population is approximately 15,800 people

lower (0.5 percent lower) than observed data from the Census.[15] In terms of households, the 11-county area shows an increase of approximately 552,100 households, 43 percent higher than the 2015 base, which is an average of approximately 22,100 households per year.

For the 7-county area, the number of households in 2040 is projected to increase by 42 percent or by 514,600 over the 2015 base. Unlike DRCOG's base year population, which was 0.5 percent lower than observed data, the base year number of households is approximately 63,200 higher (5.1 percent) than observed Census data.

In terms of wage and salary employment, DRCOG's projections show an increase of 682,800 wage and salary jobs in the 11-county area and 666,500 jobs in the 7-county area between 2015 and 2040, an increase of 40 percent over both the 11- and 7-county areas 2015 bases, which average approximately 27,300 jobs and 26,700 jobs per year, respectively.

Within the E-470 influence area, the population is projected to grow 50 percent over the 2015 base, the number of households are projected to grow 61 percent over the 2015 base, and the number of wage and salary jobs is projected to grow 63 percent over the 2015 base.

Adjustments to DRCOG Forecasts

Population

Table 3-5 illustrates the original and adjusted population forecasts, as well as differences between the two and magnitude of adjustment made for each step of the process. At the 11-county level, DRCOG projects a population of 4.36 million by 2040, an increase of 37 percent over the 2015 base, which averages to approximately 47,200 persons per year. For the same geography, EPS projects a population of 4.31 million by 2040, a 34 percent increase over an adjusted 2015 base, which averages to approximately 44,100 persons per year. Overall, EPS' population forecast for 2040 at the 11-county level is 1.3 percent lower than DRCOG's. The base year carry-through adjustments account for a 0.7 percent, 0.7 percent, 0.6 percent, and 0.5 percent upward adjustment for years 2015, 2020, 2030 and 2040, respectively. The city and county growth rate adjustments account for 0.9 percent, 1.4 percent, and 2.7 percent downward adjustments in 2020, 2030 and 2040, respectively. The TAZ-level adjustments account for a 0.5 percent reduction, a 0.1 percent increase, and a 1.0 percent increase for 2020, 2030, and 2040, respectively.

[15] A direct comparison between DRCOG's 11-county area and observed data from the U.S. Census is not possible because DRCOG does not include the entirety of Weld County in its planning area.

Table 3-5
Population Adjustments

Forecast	2015	2020	2030	2040	2015-2040 Growth Total	2015-2040 Growth Percent	2015-2040 Annual Average	2015-2040 Annual Percent	Annual Percentage 2015-2020	Annual Percentage 2020-2030	Annual Percentage 2030-2040
Original DRCOG											
E-470 Corridor	1,028,999	1,142,753	1,347,254	1,538,555	509,556	50%	20,382	1.62%	2.12%	1.66%	1.34%
Remainder	2,152,317	2,316,343	2,601,726	2,822,187	669,870	31%	26,795	1.09%	1.48%	1.17%	0.82%
11-County	**3,181,316**	**3,459,096**	**3,948,980**	**4,360,742**	**1,179,426**	**37%**	**47,177**	**1.27%**	**1.69%**	**1.33%**	**1.00%**
Adjustments											
1) Base year carry-through	22,502	22,502	22,502	22,502	---	---	---	---	---	---	---
2) County & City Level	-	(31,294)	(56,949)	(118,851)	---	---	---	---	---	---	---
3) TAZ Specific	-	(18,541)	4,919	41,671	---	---	---	---	---	---	---
Total	**22,502**	**(27,333)**	**(29,528)**	**(54,678)**	---	---	---	---	---	---	---
as % of Original											
1) Base year carry-through	0.7%	0.7%	0.6%	0.5%	---	---	---	---	---	---	---
2) County & City Level	0.0%	-0.9%	-1.4%	-2.7%	---	---	---	---	---	---	---
3) TAZ Specific	0.0%	-0.5%	0.1%	1.0%	---	---	---	---	---	---	---
Total	**0.7%**	**-0.8%**	**-0.7%**	**-1.3%**	---	---	---	---	---	---	---
EPS Adjusted Forecasts											
E-470 Corridor	1,014,235	1,096,202	1,309,231	1,497,697	483,462	48%	19,338	1.57%	1.57%	1.79%	1.35%
Remainder	2,189,583	2,335,561	2,610,221	2,808,367	618,784	28%	24,751	1.00%	1.30%	1.12%	0.73%
11-County Metro Area	**3,203,818**	**3,431,763**	**3,919,452**	**4,306,064**	**1,102,246**	**34%**	**44,090**	**1.19%**	**1.38%**	**1.34%**	**0.95%**
Difference											
E-470 Corridor	(14,764)	(46,551)	(38,023)	(40,858)	(26,094)	---	(1,044)	-0.05%	-0.55%	0.13%	0.02%
Remainder	37,266	19,218	8,495	(13,820)	(51,086)	---	(2,043)	-0.09%	-0.18%	-0.05%	-0.08%
11-County Metro Area	**22,502**	**(27,333)**	**(29,528)**	**(54,678)**	**(77,180)**	---	**(3,087)**	**-0.08%**	**-0.30%**	**0.00%**	**-0.05%**
as % of DRCOG											
E-470 Corridor	-1.4%	-4.1%	-2.8%	-2.7%	---	---	---	---	---	---	---
Remainder	1.7%	0.8%	0.3%	-0.5%	---	---	---	---	---	---	---
11-County Metro Area	**0.7%**	**-0.8%**	**-0.7%**	**-1.3%**	---	---	---	---	---	---	---

Source: DRCOG; Economic & Planning Systems

Households

Table 3-6 illustrates the original and adjusted household forecasts, as well as differences between the two and magnitude of adjustment made for each step of the process. At the 11-county level, DRCOG projects 1.84 million households by 2040, a 43 percent increase over the 2015 base, which averages to approximately 22,100 households per year. For the same geography, EPS projects 1.77 million households by 2040, a 44 percent increase over an adjusted 2015 base, which averages to approximately 21,800 households per year. Overall, EPS' household forecast for 2040 at the 11-county level is 3.7 percent lower than DRCOG's. The base year carry-through adjustments account for 4.7 percent, 4.3 percent, 3.7 percent, and 3.3 percent geography, EPS projects 1.77 million households by 2040, a 44 percent increase over an adjusted 2015 base, which averages to approximately 21,800 households per year. Overall, EPS' household forecast for 2040 at the 11-county level is 3.7 percent lower than DRCOG's. The base year carry-through adjustments account for 4.7 percent, 4.3 percent, 3.7 percent, and 3.3 percent downward adjustments in years 2015, 2020, 2030 and 2040, respectively. The city and county growth rate adjustments account for a 0.9 percent decrease, a 0.1 percent increase, and a 0.7 percent decrease in years 2020, 2030 and 2040, respectively. The TAZ-level adjustments account for a 0.8 percent reduction, a 0.4 percent reduction, and a 0.3 percent increase in years 2020, 2030 and 2040, respectively.

Table 3-6
Household Adjustments

Forecast	2015	2020	2030	2040	2015-2040 Growth Total	2015-2040 Growth Percent	2015-2040 Annual Average	2015-2040 Annual Percent	Annual Percentage 2015-2020	Annual Percentage 2020-2030	Annual Percentage 2030-2040
Original DRCOG											
E-470 Corridor	385,477	441,151	533,587	618,698	233,221	61%	9,329	1.91%	2.73%	1.92%	1.49%
Remainder	899,884	979,858	1,117,156	1,218,725	318,841	35%	12,754	1.22%	1.72%	1.32%	0.87%
11-County Metro Area	**1,285,361**	**1,421,009**	**1,650,743**	**1,837,423**	**552,062**	**43%**	**22,082**	**1.44%**	**2.03%**	**1.51%**	**1.08%**
Adjustments											
1) Base year carry-through	(60,920)	(60,879)	(60,880)	(60,879)	---	---	---	---	---	---	---
2) County & City Level	41	(12,405)	2,004	(12,546)	---	---	---	---	---	---	---
3) TAZ Specific	-	(12,040)	(6,989)	4,805	---	---	---	---	---	---	---
Total	**(60,879)**	**(85,324)**	**(65,865)**	**(68,620)**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
as % of Original											
1) Base year carry-through	-4.7%	-4.3%	-3.7%	-3.3%	---	---	---	---	---	---	---
2) County & City Level	0.0%	-0.9%	0.1%	-0.7%	---	---	---	---	---	---	---
3) TAZ Specific	0.0%	-0.8%	-0.4%	0.3%	---	---	---	---	---	---	---
Total	**-4.7%**	**-6.0%**	**-4.0%**	**-3.7%**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
EPS Adjusted Forecasts											
E-470 Corridor	357,640	396,235	495,714	581,230	223,590	63%	8,944	1.96%	2.07%	2.27%	1.60%
Remainder	866,842	939,450	1,089,164	1,187,573	320,731	37%	12,829	1.27%	1.62%	1.49%	0.87%
11-County Metro Area	**1,224,482**	**1,335,685**	**1,584,878**	**1,768,803**	**544,321**	**44%**	**21,773**	**1.48%**	**1.75%**	**1.73%**	**1.10%**
Difference											
E-470 Corridor	(27,837)	(44,916)	(37,873)	(37,468)	(9,631)	---	(385)	0.05%	-0.66%	0.34%	0.11%
Remainder	(33,042)	(40,408)	(27,992)	(31,152)	1,890	---	76	0.05%	-0.10%	0.17%	-0.01%
11-County Metro Area	**(60,879)**	**(85,324)**	**(65,865)**	**(68,620)**	**(7,741)**	**---**	**(310)**	**0.04%**	**-0.27%**	**0.22%**	**0.03%**
as % of DRCOG											
E-470 Corridor	-7.2%	-10.2%	-7.1%	-6.1%	---	---	---	---	---	---	---
Remainder	-3.7%	-4.1%	-2.5%	-2.6%	---	---	---	---	---	---	---
11-County Metro Area	**-4.7%**	**-6.0%**	**-4.0%**	**-3.7%**	**---**	**---**	**---**	**---**	**---**	**---**	**---**

Source: DRCOG; Economic & Planning Systems

Employment

Table 3-7 illustrates the original and adjusted employment forecasts, as well as differences between the two and magnitude of adjustment made for each step of the process. At the 11-county level, DRCOG projects wage and salary employment to reach 2.40 million by 2040, a 40 percent increase over the 2015 base, which averages to approximately 27,300 jobs per year. For the same geography, EPS projects 2.34 million wage and salary jobs by 2040, a 36 percent increase over an adjusted 2015 base, which averages to approximately 24,900 jobs per year.

Overall, EPS' wage and salary employment forecast for 2040 is 2.3 percent lower than DRCOG's. The base year carry-through adjustments are approximately 0.1 percent, 0.2 percent, 0.1 percent, and 0.1 percent higher in years 2015, 2020, 2030 and 2040, respectively. The city and county level adjustments are 3.6 percent higher, 0.8 percent higher, and 2.7 percent lower in years 2020, 2030, and 2040, respectively. The TAZ-level adjustments account for a 0.3 percent reduction, a 0.7 percent increase, and a 0.2 percent increase in years 2020, 2030, and 2040, respectively.

Table 3-7
Employment Adjustments

Forecast	2015	2020	2030	2040	2015-2040 Growth Total	2015-2040 Growth Percent	2015-2040 Annual Average	2015-2040 Annual Percent	Annual Percentage 2015-2020	Annual Percentage 2020-2030	Annual Percentage 2030-2040
Original DRCOG											
E-470 Corridor	539,656	595,659	713,462	880,057	340,401	63%	13,616	1.98%	1.99%	1.82%	2.12%
Remainder	1,172,752	1,232,804	1,371,596	1,515,133	342,381	29%	13,695	1.03%	1.00%	1.07%	1.00%
11-County Metro Area	**1,712,408**	**1,828,463**	**2,085,058**	**2,395,190**	**682,782**	**40%**	**27,311**	**1.35%**	**1.32%**	**1.32%**	**1.40%**
Adjustments											
1) Base year carry-through	1,965	2,760	2,760	2,760	---	---	---	---	---	---	---
2) County & City Level	795	65,203	17,625	(64,003)	---	---	---	---	---	---	---
3) TAZ Specific	-	(5,819)	14,944	5,040	---	---	---	---	---	---	---
Total	**2,760**	**62,144**	**35,329**	**(56,203)**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
as % of Original											
1) Base year carry-through	0.1%	0.2%	0.1%	0.1%	---	---	---	---	---	---	---
2) County & City Level	0.0%	3.6%	0.8%	-2.7%	---	---	---	---	---	---	---
3) TAZ Specific	0.0%	-0.3%	0.7%	0.2%	---	---	---	---	---	---	---
Total	**0.2%**	**3.4%**	**1.7%**	**-2.3%**	**---**	**---**	**---**	**---**	**---**	**---**	**---**
EPS Adjusted Forecasts											
E-470 Corridor	541,408	616,351	733,138	858,489	317,081	59%	12,683	1.86%	2.63%	1.75%	1.59%
Remainder	1,173,760	1,274,256	1,387,249	1,480,498	306,738	26%	12,270	0.93%	1.66%	0.85%	0.65%
11-County Metro Area	**1,715,168**	**1,890,607**	**2,120,387**	**2,338,987**	**623,819**	**36%**	**24,953**	**1.25%**	**1.97%**	**1.15%**	**0.99%**
Difference											
E-470 Corridor	1,752	20,692	19,676	(21,568)	(23,320)	---	(933)	-0.11%	0.63%	-0.07%	-0.53%
Remainder	1,008	41,452	15,653	(34,635)	(35,643)	---	(1,426)	-0.10%	0.65%	-0.22%	-0.35%
11-County Metro Area	**2,760**	**62,144**	**35,329**	**(56,203)**	**(58,963)**	**---**	**(2,359)**	**-0.10%**	**0.65%**	**-0.17%**	**-0.41%**
as % of DRCOG											
E-470 Corridor	0.3%	3.5%	2.8%	-2.5%	---	---	---	---	---	---	---
Remainder	0.1%	3.4%	1.1%	-2.3%	---	---	---	---	---	---	---
11-County Metro Area	**0.2%**	**3.4%**	**1.7%**	**-2.3%**	**---**	**---**	**---**	**---**	**---**	**---**	**---**

Source: DRCOG; Economic & Planning Systems

Comparison of Forecasts

Using an independent forecasting method, based on a variety of factors as described in more detail in the full report in Appendix A, and utilizing those control totals as a basis for calibrating TAZ-level data for the DRCOG Planning Area (which excludes a majority of Weld County), EPS' derived forecasts are slightly lower than DRCOG's and DOLA's projections, as shown in **Table 3-8**. And while not the basis and rationale for EPS' forecasting methodology, EPS' average employment and population increases reflect longer-term average growth trends (see Table 3-1 and Table 3-2).

In terms of population in year 2015, there is a very modest 0.5 percent difference between the DOLA and EPS forecasts versus DRCOG's original forecast. As identified in Table 3-1, the overall average growth of the past 50 years has been approximately 40,400 people per year. While EPS has not calibrated its average annual growth to this long-term average precisely, it is EPS' opinion that land use and water rights constraints, along with trends concerning aging in place and a constrained housing supply will affect the growth potentials of the region.

Table 3-8
Comparison of Forecasts for the 7-County Region

Forecast	2015	2020	2030	2040	2015-2040 Total Growth	2015-2040 Annual Average	2015-2040 Annual Percent	Annual Percentage 2015-2020	Annual Percentage 2020-2030	Annual Percentage 2030-2040
Population Forecasts										
Original DRCOG	3,061,520	3,322,716	3,771,545	4,143,968	1,082,448	43,298	1.22%	1.65%	1.28%	0.95%
DOLA	3,077,340	3,345,964	3,814,159	4,215,798	1,138,458	45,538	1.27%	1.69%	1.32%	1.01%
EPS Adjusted	3,077,340	3,281,358	3,724,073	4,064,588	987,248	39,490	1.12%	1.29%	1.27%	0.88%
Household Forecasts										
Original DRCOG	1,239,219	1,368,339	1,582,447	1,753,844	514,625	20,585	1.40%	2.00%	1.46%	1.03%
DOLA	1,176,097	1,297,912	1,531,677	1,719,967	543,870	21,755	1.53%	1.99%	1.67%	1.17%
EPS Adjusted	1,176,097	1,278,126	1,510,527	1,676,705	500,608	20,024	1.43%	1.68%	1.68%	1.05%
Employment Forecasts										
Original DRCOG	1,682,905	1,796,227	2,046,643	2,349,363	666,458	26,658	1.34%	1.31%	1.31%	1.39%
DOLA [(1)]	1,682,429	1,977,317	2,232,218	2,352,924	670,495	26,820	1.35%	3.28%	1.22%	0.53%
EPS Adjusted	1,682,429	1,854,917	2,077,469	2,289,347	606,918	24,277	1.24%	1.97%	1.14%	0.98%

[(1)] Because of the different magnitudes of sole proprietorships quantified by DOLA and Woods & Poole, EPS has calibrated each of their 2015 employment levels to EPS's adjusted totals for 2015 and applied their own respective annual rates of growth to the
Source: Economic & Planning Systems

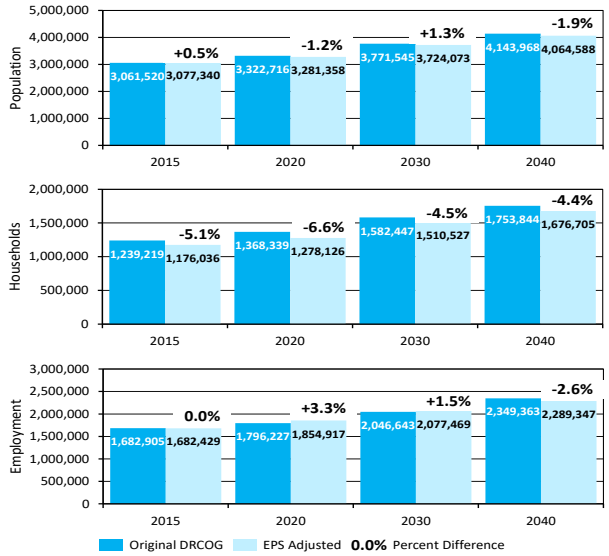
\\NHVSVR2\tft\TFT Group\Projects\CO 240041 E-470 2019 IG and Toll Rate Study\Report\DRAFT Report\Tables\[Table 3-1 through 3-8.xlsx]Table 3-8

EPS's employment forecast has been calibrated to align more with the structural implications of the long-term (see Table 3-2) than either DRCOG or DOLA forecasts. It is EPS' opinion that the lower employment growth rate was justifiable given their independent economic forecast, as well as labor market and housing constraint considerations, which will affect near-term structural growth cited by both the Colorado Legislative Council and the State Office of Planning and Budgeting.

Overview

Metro Area

The original DRCOG forecasts and the EPS adjusted forecasts for the 7-county Metro Area are illustrated in **Figure 3-12**. The adjustments reflect extensive data and market analysis, research, and understanding of the original DRCOG model and forecasts. While the EPS forecasts in years 2015, 2020, 2030 and 2040 are generally lower than the original DRCOG forecasts for population and households and lower in 2040 for employment, it does not mean that growth is not occurring. In fact, just the opposite is true. In the DRCOG region, population between 2015-2020, 2020-2030 and 2030-2040 is forecasted by



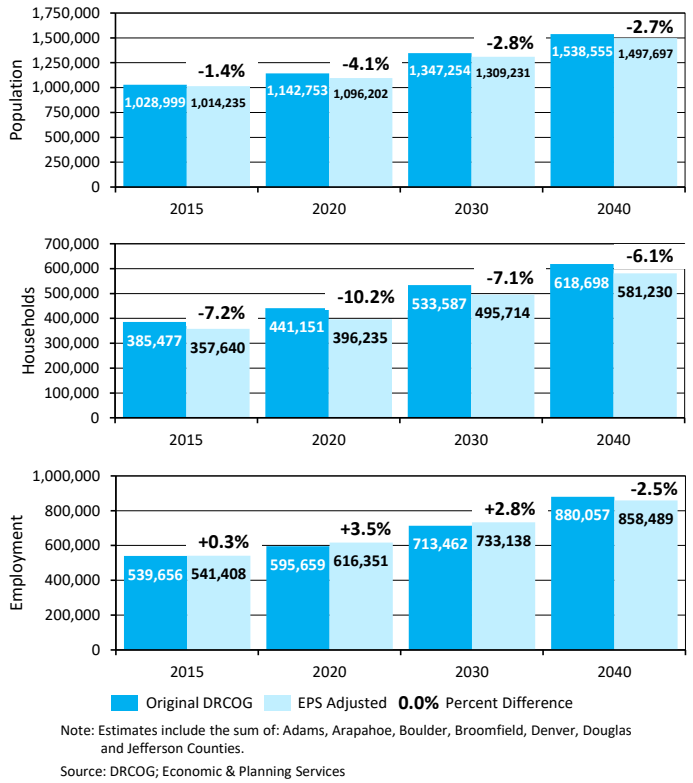
Note: Estimates include the sum of: Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas and Jefferson Counties.
Source: DRCOG; Economic & Planning Services

FIGURE 3-12
DRCOG AND EPS ADJUSTED 7-COUNTY METRO AREA FORECAST COMPARISONS

EPS to grow by 1.3 percent, 1.3 percent and 0.9 percent per annum, respectively. EPS has also forecasted households to grow by 1.7 percent, 1.7 percent and 1.1 percent per annum between 2015-2020, 2020-2030 and 2030-2040, respectively. Finally, regional employment between 2015-2020, 2020-2030 and 2030-2040 is also forecasted by EPS to grow by 2.0 percent, 1.1 percent and 1.0 percent per annum, respectively. It should also be noted that EPS' forecasted growth rates presented in this chapter reflect long-term rates, and that actual year-over-year growth rates may be higher or lower than these projections, as growth does not typically occur linearly.

Influence Area

Differences between the original DRCOG forecasts and the EPS adjusted forecasts within the E-470 influence area are illustrated in **Figure 3-13**. They are provided to contrast the extent of the differences. Between 2015-2020, 2020-2030 and 2030-2040, population is forecasted to grow by 1.6 percent, 1.8 percent and 1.4 percent per annum, respectively. This translates into population growth between 2015-2040, within the E-470 influence area that is approximately 0.5 percent per annum higher than the forecasted growth in the Denver Metro area as a whole (1.6 percent per annum versus 1.1 percent per annum).



Note: Estimates include the sum of: Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas and Jefferson Counties.

Source: DRCOG; Economic & Planning Services

FIGURE 3-13

DRCOG AND EPS ADJUSTED E-470 INFLUENCE AREA FORECAST COMPARISONS

EPS has also forecast households to grow by 2.1 percent, 2.3 percent and 1.6 percent per annum between 2015-2020, 2020-2030 and 2030-2040, respectively. This means that within the E-470 influence area, households are forecasted to grow by approximately 0.6 percent per annum more than the forecasted Metro area growth between 2015 and 2040. Finally, study area employment between 2015-2020, 2020-2030 and 2030-2040 is forecasted by EPS to grow by 2.6 percent, 1.8 percent and 1.6 percent per annum, respectively. This translates into employment growth within the E-470 corridor that is 0.7 percent per annum greater than in the Metro area as a whole.

In general, while approximately one-third of the region's population, households and employment reside within the E-470 influence area, EPS forecasts that between approximately 40-60 percent of the growth in the demographics will occur there. These adjustments, as described briefly in earlier sections of this chapter, and in more detail in the full EPS report located in Appendix A, are based on extensive data and market

analysis, research, as well as understanding of the original DRCOG forecasts, methodology and assumptions.

Disclaimer

This corridor growth analysis was prepared as the nation and world seek to address the coronavirus/COVID-19 pandemic, an unprecedented public health crisis. During this period, protecting public health is a top priority. The economic fallout, however, has so far been both significant and abrupt, yet its length and severity are unknown.

As such, the impact on the findings of the corridor growth analysis will depend on how the situation unfolds over the next three to six months. The consensus at the time of this analysis was that the economic (or fiscal, financial, market) impacts were likely to dissipate over the long-term, although the exact pace and timeframe for recovery remained unclear.

Specifically, although EPS's adjusted TAZ-level socioeconomic data have already been incorporated into the travel demand modeling and sensitivities conducted by CDM Smith, the events as they have rapidly unfolded during March 2020 have, in the opinion of EPS, the potential to significantly impact the following elements of their findings:

- Estimates of current year (2020) and near-term employment and population;
- Long-term projections of employment and population (2040); and,
- Timing of major development plans within the Influence Area.

Chapter 4
Traffic and Revenue Analysis

Chapter 4 provides a summary of the traffic and revenue forecasts based on the "Current" toll rate structure, which was introduced on January 1, 2020. This chapter also details the refinement and calibration process of the travel demand model used in developing the forecasts, as well as the assumptions underlying these forecasts, such as toll rates, values of time, vehicle operating costs and toll revenue leakage. The forecasts also recognize travel patterns along E-470 through the incorporation of anonymous trip data gleaned from E-470's 87.3 million transactions observed in 2018. Using the transaction data, the individual transactions were linked, creating trip patterns and trip lengths along E-470 which proved invaluable in travel demand model calibration and in the forecasting of future usage of E-470. The traffic forecasts also incorporated the results of an independent review of socioeconomic forecasts discussed in **Chapter 3**, **Corridor Growth Analysis**, the latest traffic data and counts, a detailed analysis of traffic profiles on E-470, and the most recent highway improvement assumptions.

The following text presents the analytical methodology, study assumptions, steps taken to reflect the socioeconomic update, and results of an analysis of the sensitivity of usage and revenue to toll rates. The final products of the analysis are the estimates of annual traffic and toll revenue under the current toll rate assumptions, a comparison of these forecasts with the last CDM Smith forecasts from December 2018, and select sensitivity tests dealing with the potential traffic and revenue impacts associated with the COVID-19 pandemic, reduced regional growth forecasts and reduced value of time assumptions.

Analytical Methodology

As part of this comprehensive traffic and revenue study, a regional travel demand model was employed to assist with the estimation of the future year transactions and toll revenue estimates. The travel demand modeling undertaken for this study utilized, as the basic modeling platform, the Denver Regional Council of Governments' (DRCOG) Focus 2.2 travel demand model. The model area covers eleven counties within the Denver metropolitan area and is divided into approximately 2,800 traffic analysis zones (TAZ). TAZs generally contain only a few blocks of residential and/or commercial properties. This allows the model to receive detailed socioeconomic data inputs, such as population, households, employment, trip characteristics, and travel behaviors and to estimate trip movements with the same level of geographic detail. The DRCOG Focus 2.2 travel demand model used in this study included a 2015 base year model and three future year models: 2020, 2030 and 2040.

The DRCOG Focus 2.2 model is an activity-based model. This modeling process differs from the traditional four-step modeling process in that it seeks to estimate trips and travel patterns based on the likely decisions and travel behaviors of individuals over the course of a typical weekday, as opposed to using trip generation assumptions based on aggregate socioeconomic and demographic estimates. This process is an improvement over the traditional four-step modeling process in that it links trips together into trip chains and can adjust sets of trips based on changes

in socioeconomic assumptions and time of day preferences. Based on the trips generated through the synthesized population process, the model then develops a traditional origin and destination trip table matrix linked to the TAZs. These trip table matrices, which are provided by time period, serve as inputs to the final traffic assignment step used to develop estimates of traffic volumes by roadway link across the model highway network.

Additionally, in order to reflect current planning throughout the corridor, the road network, transit network, and land use assumptions were reviewed and updated, as described below. These updated assumptions were then incorporated into the regional travel demand model and used to generate the ultimate traffic and revenue estimates.

Land Use and Demographic Assumptions

A summary of the results of the updated socioeconomic forecasts for years 2015, 2020, 2030, and 2040 were provided in **Chapter 3**. The independent economist provided input socioeconomic data for each of the model years utilizing the standard DRCOG household and employment categories. The development of the final socioeconomic files was completed by DRCOG staff using their UrbanSim model. This tool created the needed model input tables based on the total household and total employment numbers provided by the independent economist.

Roadway and Transit Network Review

A thorough review was completed of the roadway and transit networks included in the base DRCOG travel demand models for the base and three forecasts years by subconsultant Felsburg Holt & Ullevig (FHU). Beginning with the 2015 model, a detailed assessment of the road network, functional classifications, and number of lanes was completed to ensure consistency with the existing network. The forecast year networks included in the base DRCOG models were then reviewed and compared to the fiscally constrained roadway and rapid transit capital improvements described in the DRCOG 2040 Metro Vision Regional Transportation Plan (RTP) (Cycle Year 2019). The planning document identifies new roadways, additional lanes, and additions to the transit network consistent with the current FasTracks regional rapid transit expansion plans. Special attention was given to regional projects adjacent to the project corridor as well as those projects likely to affect the traffic forecasts on E-470. This review process, the specific projects considered, and their assumed years of construction are described in greater detail later in this chapter. A listing of the regional Metro Vision projects within the study area is included as **Table 4-1** and shown graphically in **Figure 4-1**.

The toll forecasting process was designed to provide traffic revenue forecasts for 2019, 2020, 2021, 2025, 2030, 2035 and 2040. This was achieved by using the RTP to build future year models between the available years of 2015, 2020, 2030 and 2040. In order to develop E-470 forecasts that were more representative of existing travel demands throughout the system, the RTP was reviewed to determine if any projects had already been completed since the models were established in 2015. Several key projects were identified, and the improvements were added into the base 2015 travel demand model. This incorporation was designed to provide an easier comparison between 2019 count data and an updated 2019 base/calibration year model. Specific key projects identified by FHU are listed below.

Table 4-1 (Continued)
Programmed Regional Highway Improvements

Network Year of Improvement	Facility Name	From	To	Improvement	Length	Counties
2030	56th Ave.	Dunkirk St.	Himalaya St.	Widen from 4 to 6 Lanes	0.5	Denver
2030	56th Ave.	E-470	Powhaton Rd.	Widen from 2 to 6 Lanes	2.0	Adams
2030	56th Ave.	Havana St.	Pena Blvd.	Widen from 2 to 6 Lanes	4.3	Denver
2030	56th Ave.	Himalaya St.	Picadilly Rd.	Widen from 2 to 6 Lanes	1.0	Denver
2030	56th Ave.	Pena Blvd.	Tower Rd.	Widen from 4 to 6 Lanes	0.7	Denver
2030	56th Ave.	Picadilly Rd.	E-470	Widen from 2 to 6 Lanes	1.0	Adams
2030	64th Ave.	Denver/Aurora City Limit	Himalaya St.	Widen from 2 to 6 Lanes	0.5	Adams
2030	64th Ave.	Harvest Rd.	Powhaton Rd.	New 2 Lanes	1.0	Adams
2030	64th Ave.	Himalaya Rd.	Harvest Rd.	Widen from 2 to 4 Lanes	3.0	Adams
2030	64th Ave.	Powhaton Rd.	Monaghan Rd.	New 4 Lanes	1.0	Adams
2030	64th Ave.	Tower Rd.	Denver/Aurora City Limits	Widen from 2 to 4 Lanes	0.5	Denver
2030	6th Ave.	Airport Blvd.	Tower Rd.	Widen from 2 to 6 Lanes	1.0	Arapahoe
2030	6th Ave./SH 30	Tower Rd.	6th Pkwy.	Widen from 2 to 6 Lanes	1.6	Arapahoe
2030	6th Pkwy. / Steve D. Hogan	E-470	Gun Club Rd.	Widen from 2 to 6 Lanes	0.3	Arapahoe
2030	Arapahoe Rd.	Waco St.	Himalaya St.	Widen from 4 to 6 Lanes	1.3	Arapahoe
2030	Arapahoe Rd.	Himalaya Way	Liverpool St.	Widen from 4 to 6 lanes	0.5	Arapahoe
2030	Broncos Pkwy.	Jordan Rd.	Parker Rd.	Widen from 4 to 6 Lanes	0.8	Arapahoe
2030	Broncos Pkwy. (Easter Ave.)	Havana St.	Peoria St.	Widen from 4 to 6 Lanes	1.0	Arapahoe
2030	Buckley Rd.	118th Ave.	Cameron Dr.	Widen from 2 to 6 Lanes	1.3	Adams
2030	Buckley Rd.	136th Ave.	Bromley Ln.	Widen from 2 to 4 lanes	2.0	Adams
2030	C-470	Broadway	I-25	EB: Add 1 Toll/Managed Lane	6.6	Douglas
2030	C-470	Colorado Blvd.	Lucent Blvd.	WB: Add 1 Toll/Managed Lane	3.7	Douglas
2030	C-470	S. Kipling Pkwy.	Wadsworth Blvd.	EB: Add 1 Toll/Managed Lane	3.0	Jefferson
2030	C-470	Wadsworth Blvd.	S. Kipling Pkwy.	WB: Add 1 Toll/Managed Lane	1.4	Jefferson
2030	Chambers Rd.	Main Street	Lincoln Ave.	Widen from 2 to 4 Lanes	1.4	Douglas
2030	E. Bromley Ln.	Tower Rd.	I-76	Widen from 4 to 6 Lanes	1.1	Adams
2030	E. Bromley Ln.	Hwy 85	Sable Blvd.	Widen from 4 to 6 Lanes	0.5	Adams
2030	E-470	88th Ave.		Add New Interchange		Adams
2030	E-470	I-25 South	Parker Rd.	Widen from 6 to 8 Lanes	5.5	Arapahoe
2030	E-470	Pena Blvd.	I-76	Widen from 4 to 6 anes	7.6	Adams/Denver
2030	E-470	I-70		Interchange Rebuild Completion /		Adams
2030	Green Valley Ranch Blvd.	Chambers Rd.	Pena Blvd.	Widen from 2 to 4 Lanes	1.0	Denver
2030	Green Valley Ranch Blvd.	Telluride St.	Tower Rd.	Widen from 4 to 6 Lanes	0.5	Denver
2030	Gun Club Rd.	1.5 Miles s/of Quincy Ave.	Quincy Ave.	Widen from 2 to 6 Lanes	1.6	Arapahoe
2030	Hampden Ave.	Picadilly Rd.	Gun Club Rd.	Widen from 2 to 4 Lanes	1.1	Arapahoe
2030	Harvest Mile Rd.	56th Ave.	64th Ave.	New 3 Lanes	1.0	Adams
2030	Harvest Mile Rd.	I-70	26th Ave.	New 2/4 Lanes	1.5	Adams
2030	Harvest Mile Rd.	48th Ave	56th Ave	New 6 Lanes	1.2	Adams

Table 4-1 (Continued)
Programmed Regional Highway Improvements

Network Year of Improvement	Facility Name	From	To	Improvement	Length	Counties
2030	Harvest Rd.	6th Ave.	I-70	New 6 Lanes	1.1	Adams
2030	Harvest Rd.	Alameda Ave.	6th Ave.	Widen from 3 to 6 Lanes	1.0	Arapahoe
2030	Huron St.	150th Ave.	160th Ave.	Widen from 2 to 4 lanes	1.3	Broomfield
2030	Huron St.	160th Ave.	SH-7	Widen from 2 to 4 lanes	1.2	Broomfield
2030	I-25	120th Ave.	SH-7	Add 1 Toll/Managed Lane each direction	6.0	Adams/Broomfield
2030	I-25	84th Ave.	Thornton Pkwy.	Add 1 New Lane Each Direction	2.8	Adams
2030	I-70	Harvest Rd.		Add New Interchange		Adams/Arapahoe
2030	I-70	I-25	Chambers Rd.	Add 2 New Managed Lanes	3.8	Denver/Adams
2030	I-70	Picadilly Rd.		Add New Interchange		Adams
2030	I-76	Bridge St		New Interchange		Adams
2030	Jewell Ave.	E-470	Gun Club Rd.	Widen from 2 to 6 Lanes	0.5	Arapahoe
2030	Jewell Ave.	Gun Club Rd.	Harvest Rd.	Widen from 2 to 6 Lanes	1.0	Arapahoe
2030	Jewell Ave.	Himalaya Rd.	E-470	Widen from 3 to 6 Lanes	1.4	Arapahoe
2030	Lincoln Ave.	Keystone Blvd.	Parker Rd.	Widen from 4 to 6 Lanes	1.6	Douglas
2030	Lincoln Ave.	Peoria St.	1st Ave.	Widen from 4 to 6 Lanes	0.7	Douglas
2030	Lincoln Ave.	1st St.	Keystone Blvd.	Widen from 4 to 6 Lanes	1.8	Douglas
2030	Pena Blvd.	Jackson Gap St. West Ramps	DIA Terminal	Widen from 6 to 8 Lanes	1.7	Denver
2030	Pena Blvd.	I-70	E-470	Widen from 4 to 8 Lanes	6.4	Denver
2030	Pena Blvd.	E-470	Jackson Gap St.	Widen from 6 to 8 Lanes	2.9	Denver
2030	Peoria St.	E-470	.75 miles s/o Lincoln Ave.	Widen from 2 to 4 Lanes	1.9	Douglas
2030	Picadilly Rd.	48th Ave.	56th Ave.	Widen from 2 to 6 lanes	1.2	Adams
2030	Picadilly Rd.	56th Ave.	70th Ave./Aurora City Limits	New 6 Lanes	1.7	Adams
2030	Picadilly Rd.	6th Ave.	Colfax Ave.	Widen from 2 to 6 Lanes	1.6	Arapahoe
2030	Picadilly Rd.	70th Ave.	82nd Ave.	New 6 Lanes	1.5	Denver
2030	Picadilly Rd.	Colfax Ave.	I-70	New 6 Lanes	0.3	Adams
2030	Picadilly Rd.	I-70	Smith Rd.	Widen from 2 to 6 Lanes	0.5	Adams
2030	Picadilly Rd.	Smith Rd.	48th Ave.	Widen from 2 to 6 Lanes	2.2	Adams
2030	Powhaton Rd.	26th Ave.	48th Ave	New 6 Lanes	2.0	Adams
2030	Quebec St.	120th Ave.	128th Ave.	Widen from 2 to 4 Lanes	1.0	Adams
2030	Quebec St.	132nd Ave.	160th Ave.	Widen from 2 to 4 Lanes	3.S	Adams
2030	Quincy Ave.	Plains Pkwy./Copperleaf Blvd.	Gun Club Rd.	Widen from 2 to 6 Lanes	0.6	Arapahoe
2030	Ridgegate Pkwy. (Mainstreet)	Havana St.	Lone Tree E. City Limit	Widen from 2 to 4 Lanes	1.8	Douglas
2030	SH-30	Steve D. Hogan Pkwy	Mississippi Ave.	Widen from 2 to 4 Lanes	2.2	Arapahoe
2030	SH-7	Sheridan Pkwy.	I-25	Widen from 2 to 6 Lanes	1.5	Broomfield
2030	SH-7	164th Ave.	Dahlia St.	Widen from 2 to 4 Lanes	2.2	Adams
2030	SH-7	York St	Big Dry Creek	Widen from 2 to 4 Lanes	0.7	Adams
2030	Tower Rd.	48th Ave.	56th Ave.	Widen from 4 to 6 Lanes	1.0	Denver
2030	Tower Rd.	56th Ave.	Pena Blvd.	Widen from 4 to 6 Lanes	2.4	Denver

Table 4-1 (Continued)
Programmed Regional Highway Improvements

Network Year of Improvement	Facility Name	From	To	Improvement	Length	Counties
2030	Tower Rd.	6th Ave.	Colfax Ave.	New 2 Lanes	1.0	Arapahoe
2030	Tower Rd.	Colfax Ave.	Smith Rd.	Widen from 2 to 6 Lanes	1.0	Adams
2030	Tower Rd.	Pena Blvd.	104th Ave.	Widen from 4 to 6 Lanes	3.8	Adams
2030	Tower/Buckley Rd.	105th Ave.	118th Ave.	New 4 Lanes	2.0	Adams
2030	US-85	104th Ave		New Interchange		Adams
2030	US-85	120th Ave		New Interchange		Adams
2030	Washington St.	152nd Ave.	160 Ave.	Widen from 2 to 4 Lanes	1.4	Adams
2030	York St.	160th Ave. (SH-7)	168th Ave.	Widen from 2 to 4 Lanes	1.0	Adams
2030	York St.	E-470	SH-7	Widen from 2 to 4 Lanes	0.7	Adams
2035	48th Ave.	Imboden Rd.	Quail Run Rd.	Widen from 2 to 6 Lanes	1.0	Adams
2035	6th Pkwy.	SH-30	E-470	Widen from 2 to 6 Lanes	1.3	Arapahoe
2035	E-470	112th Ave.		Add New Interchange		Adams
2035	E-470	I-25 North	I-76	Widen from 4 to 6 Lanes	11.0	Adams
2035	E-470	Parker Rd.	Smoky Hill Rd.	Widen from 6 to 8 lanes	5.4	Arapahoe/Douglas
2035	E-470	Smoky Hill Rd.	I-70	Widen from 6 to 8 lanes	9.7	Arapahoe
2035	E-470	I-76		Ramp - NB E-470 to WB I-76		Adams
2035	E-470	I-76	US 85	Widen from 3 to 6 lanes	2.8	Adams
2035	Hampden Ave./Havana St. (SH-	Florence St.	s/o Yale Ave.	Widen from 5 to 6 Lanes	1.4	Denver
2035	I-70	E-470		Interchange Capacity		Adams/Arapahoe
2035	Main Street	Lone Tree E. City Limit	Chambers Rd.	Widen from 2 to 4 lanes	0.9	Douglas
2040	120th Ave.	E-470	Picadilly Rd.	Widen from 2 to 6 Lanes	2.6	Adams
2040	120th Ave.	Sable Blvd.	E-470	Widen from 2 to 6 Lanes	2.0	Adams
2040	152nd Ave.	Washington St.	York St.	Widen from 2 to 4 Lanes	1.2	Adams
2040	48th Ave.	Powhaton Rd.	Monaghan Rd.	Widen from 2 to 4 Lanes	1.0	Adams
2040	56th Ave.	Powhaton Rd.	Imboden Rd.	Widen from 2 to 4 Lanes	5.0	Adams
2040	64th Ave.	Harvest Rd.	Powhaton Rd.	Widen from 2 to 4 Lanes	1.0	Adams
2040	64th Ave.	Himalaya Rd.	Harvest Rd.	Widen from 4 to 6 lanes	3.0	Adams
2040	96th Ave.	SH-2	Tower Road	Widen from 2 to 4 Lanes	5.0	Adams
2040	96th Ave.	Tower Rd.	Picadilly Rd.	Widen from 2 to 6 Lanes	2.0	Adams
2040	Colorado Blvd.	144th Ave.	168th Ave.	Widen from 0/2 to 4 Lanes	3.7	Adams
2040	E-470	Potomac		Add New Interchange		Adams
2040	E-470	I-76		Ramp - WB I-76 to NB E-470		Adams
2040	E-470	US 85	I-25 N	Widen from 3 to 6 lanes	8.2	Adams
2040	E-470	Pena Blvd.	I-76	Widen from 6 to 8 Lanes	7.6	Adams/Denver
2040	Gun Club Rd.	Yale Ave.	Mississippi Ave.	Widen from 2/4 to 6 Lanes	2.1	Arapahoe
2040	Harvest Mile Rd.	56th Ave.	64th Ave.	Widen from 3 to 6 Lanes	1.0	Adams
2040	Harvest Mile Rd.	I-70	26th Ave.	Widen from 4 to 6 lanes	1.5	Adams
2040	Harvest Mile Rd.	56th Ave.	64th Ave.	Widen from 3 to 6 lanes	1.0	Adams

Table 4-1 (Continued)
Programmed Regional Highway Improvements

Network Year of Improvement	Facility Name	From	To	Improvement	Length	Counties
2040	Harvest Rd.	Jewell Ave.	Mississippi Ave.	Widen from 2 to 6 lanes	1.0	Arapahoe
2040	I-225	I-25	Yosemite St.	Interchange Capacity		Denver
2040	I-270	I-25	I-70	Widen from 4 to 6 lanes		Adams
2040	Imboden Rd.	48th Ave.	56th Ave.	Widen from 2 to 4 Lanes	1.0	Adams
2040	Monaghan Rd.	Quincy Ave.	Yale Ave.	New 6 Lanes	2.0	Arapahoe
2040	Monaghan Rd.	26th Ave.	56th Ave.	Widen from 2 to 4 Lanes	5.0	Arapahoe
2040	Monaghan Rd.	56th Ave.	64th Ave.	New 4 Lanes	5.0	Arapahoe
2040	Parker Rd. (SH-83)	Quincy Ave.	Hampden Ave.	Widen from 6 to 8 Lanes	1.0	Arapahoe
2040	Peoria St.	.75 miles s/o Lincoln Ave.	Main Street	Widen from 2 to 4 Lanes	0.5	Douglas
2040	Picadilly Rd.	82nd Ave.	96th Ave.	New 6 Lanes	1.8	Adams
2040	Picadilly Rd.	96th Ave.	120th Ave.	New 6 Lanes	3.0	Adams
2040	Powhaton Rd.	Smoky Hill Rd.	County Line Rd.	Widen from 2 to 6 Lanes	1.0	Arapahoe
2040	Quail Run Rd.	I-70	48th Ave.	New 4 Lanes	3.0	Adams
2040	Quincy Ave.	Hayesmount Rd.	Watkins Rd.	Widen from 2 to 6 Lanes	2.0	Arapahoe
2040	Quincy Ave.	Monaghan Rd.	Hayesmount Rd.	Widen from 2 to 6 Lanes	1.1	Arapahoe
2040	SH-7	Riverdale Rd.	US-85	Widen from 2 to 4 Lanes	1.1	Adams
2040	Smoky Hill Rd.	Pheasant Run Pkwy.	Versailles Pkwy.	Widen from 4 to 6 Lanes	4.4	Arapahoe
2040	Tower Rd.	6th Ave.	Colfax Ave.	Widen from 2 to 6 Lanes	1.0	Arapahoe
2040	Watkins Rd.	Quincy Ave.	I-70	Widen from 2 to 6 Lanes	7.1	Arapahoe
2040	Yale Ave.	Monaghan Rd.	Hayesmount Rd.	Widen from 2 to 6 Lanes	1.1	Arapahoe
2040	York St.	152nd Ave.	E-470	Widen from 2 to 4 Lanes	0.2	Adams

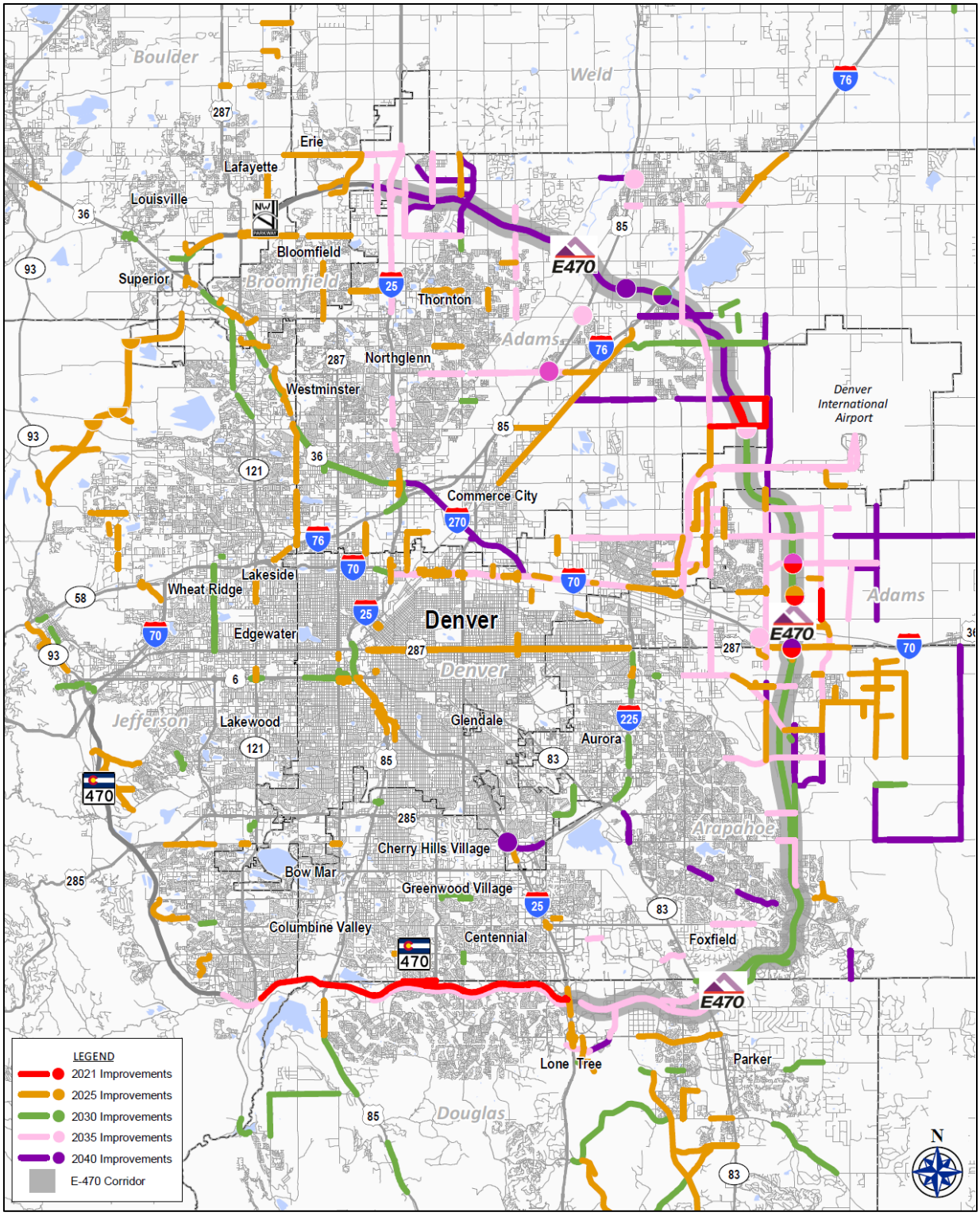


Figure 4-1
Programmed Regional Highway Improvements

- **I-25 Widening** – Widening between Ridge Gate Parkway and County Line Road was completed in 2016. This project increased the number of through lanes from six to eight.
- **E-470 Widening** – Widening between Parker Road and Quincy Avenue was completed in 2018. This project increased the number of through lanes from four to six.
- **I-25 Managed Lanes** – A single new managed lane in each direction was added between US 36 and 120th Avenue, with the improvement opening in 2016.
- **US 36 Managed Lanes** – A single new managed lane in each direction was added between I-25 and Table Mesa Drive, with the improvement opening in 2015.

Five specific future-year corridor improvements were explored based on their relation to the RTP listing. These improvements represent significant regional improvements throughout the region and were incorporated into the future year highway networks.

- **Jefferson Parkway** – The DRCOG RTP listing included the Jefferson Corridor and Interlocken Loop improvements associated with the extension of the Northwest Parkway and addition of Jefferson Parkway.
- **I-70 East Widening** – The CDOT has begun construction of a major widening project between I-25 and Chambers Road. Improvements to I-70 between I-25 and Chambers Road have been scheduled for completion by 2024 and include the addition of a new managed lane in each direction.
- **I-270 Widening** – The DRCOG RTP listing includes widening from four to six lanes between I-25 and I-70 sometime between 2030 and 2040.
- **C-470 Toll Express Lanes** – Construction is well underway for widening of C-470. While construction is behind schedule, it is expected to be completed Spring 2020. The project includes managed lanes between Wadsworth Boulevard and I-25 in each direction, with two westbound managed lanes between I-25 and Colorado Boulevard, one westbound lane continuing to Wadsworth Boulevard, and one eastbound managed lane for the entire length. A second stage of development provides a second westbound managed lane for the eastern portion of the corridor and extends the facility as a single managed lane to Kipling Street. This second stage is expected to be complete by 2029.
- **I-25 Managed Lanes Extension** – The DRCOG RTP listing includes the extensions of the single managed lanes in each direction along I-25 between 120th Avenue and SH 7, and 84th Avenue to Thornton Parkway.

In addition to the RTP project listing, one additional known improvement was included in the travel demand modeling based on the project's high likelihood of occurrence and proximity to the study corridor. This project is the construction of Aurora Parkway between Quemoy Way and Parker Road. This project is development driven and developer built and will provide a six-lane parallel facility to E-470 running between the Parker Road and Gartrell Road interchanges.

As in prior RTP documents, the current RTP does not provide the estimated project completion date for future year highway improvements. Instead, the plan indicates whether anticipated future year highway improvements should be included in the 2030 or 2040 model networks. Where project opening dates were known, as in the case of planned E-470 improvements, the impacts of improvement were applied in that year. For the RTP planned improvements, these impacts were applied in 2030 or 2040, as indicated in the planning documents.

Although listed among the highway improvements included in **Table 4-1** and **Figure 4-1** (previously shown), the programmed E-470 widenings and interchange improvements are worth specifically reviewing due to their direct impact to transactions on the system. Assumed E-470 widening and interchange improvements, based on information provided by E-470 staff, include:

Assumed E-470 Widenings

- 2021 - Quincy Avenue to I-70 - 2 to 3 lanes per direction
- 2024 - I-70 to Peña Boulevard - 2 to 3 lanes per direction
- 2027 - Peña Boulevard to I-76 - 2 to 3 lanes per direction
- 2029 - I-25 (South End) to Parker Road - 3 to 4 lanes per direction
- 2031 - Parker Road to Smoky Hill Road - 3 to 4 lanes per direction
- 2033 - Smoky Hill to I-70 - 3 to 4 lanes per direction
- 2035 - I-76 to US 85 - 2 to 3 lanes per direction
- 2038 - US 85 to I-25 (North End) - 2 to 3 lanes per direction
- 2040 - Peña Boulevard to I-76 - 3 to 4 lanes per direction

Assumed E-470 Interchange Improvements

- 2023 - Construct EB I-70 to SB E-470 Ramp
- 2024 - Construct Diamond Interchange at 38th Avenue
- 2026 - Construct Diamond Interchange at 88th Avenue
- 2030 - Completion of I-70 Interchange (Direct Connect Ramps)
- 2031 - Construct Diamond Interchange at 112th Avenue
- 2035 - Construct NB E-470 to WB I-76 Ramp
- 2036 - Construct Diamond Interchange at Potomac Avenue
- 2040 - Construct WB I-76 to NB E-470 Ramp

These improvements were paid special attention to during the travel demand modeling process due to their impact on transactions and toll revenues. It is worth noting that these projects assume the addition of four new tolled interchanges, new direct ramps to two major interstates, and the effective addition of at least one travel lane to the full E-470. These changes represent a major upgrade to the E-470 system, expanding capacity and providing new movements, which have been reflected in the ultimate transactions and toll revenue forecasts.

Toll Structure

Based on the Current E-470 toll rate assumptions for toll locations, toll rates and method of toll payment participation rates were developed. These assumptions are presented in this section.

Payment Types

Since July 4, 2009, E-470 has employed an entirely cashless toll collection system, providing two methods of toll payment: ExpressToll, and License Plate Toll (LPT). For ExpressToll transactions,

the customer is issued a transponder tag that is read by overhead equipment at the toll gantries. The appropriate toll is then automatically debited from their ExpressToll account, which is replenished as needed automatically for credit card accounts and via mailed invoice for check-paying customers. With LPT, a picture of the customer's license plate is taken and using this license plate number, the Authority attempts to recover the vehicle owner's information from the Department of Motor Vehicles. As an incentive to encourage customers to sign-up for ExpressToll, a roughly 37 percent toll discount (exact discount percentages vary by gantry) is provided compared with the LPT rates, based on the Current toll structure. This percent ExpressToll discount is assumed to be retained through the forecast period.

Toll Collection Percentages by Payment Type

Table 4-2 provides the traffic model assumptions for the percentage of ExpressToll and LPT customers used as part of the 2019 traffic model calibration based on the Current toll rate structure. These were based on historic trends and anticipated future increases in ExpressToll participation. These assumptions were used as input to the traffic modeling process for each model year and represent the total ExpressToll market participation for the model area. As shown in Table 4-2, estimated ExpressToll participation rates are assumed to remain relatively constant over the model forecast period based on recent trends, along with proposed changes to toll rate structure, which are discussed below.

Table 4-2
ExpressToll Market Participation Rates

	Percent of Total Transactions	
Year	Average Day	Average Weekday / Model Input
2019 [(1)]	72.9	73.4
2021	73.4	74.3
2025	74.3	74.6
2030	74.3	74.6
2035	74.5	74.8
2040	74.7	75.0

[(1)] Actual.

Toll Rates

E-470 currently has 22 toll locations; five mainline toll gantries and 17 toll gantries strategically located at E-470 ramps/interchanges. As presented in **Table 4-3**, the toll rate at the mainline toll locations in both 2019 and 2020 was $2.70 at Toll Gantries A and C, and $2.95 at Toll Gantries B, D, and E for ExpressToll passenger cars, representing a cost of $0.30 per mile for a 47-mile full-length trip on E-470. Toll rates for LPT passenger car customers are $4.30 at Toll Gantries A and C, and $4.65 at Toll Gantries B, D, and E, meaning that ExpressToll customers are provided a

roughly 37 percent discount over LPT toll rates. Commercial vehicles are charged by the axle based on a modified "N-1" system. Beyond 2-axles, each additional axle is charged at roughly 90 percent of the 2-axle vehicle toll. For modeling purposes, the average toll rate for commercial vehicles was used based on the average number of axles observed at mainline toll locations. This average commercial vehicle full toll rate was roughly 3.2 times the passenger car rate. As part of a two-year pilot program, a 20 percent discount is also provided to 3-or-more axle ExpressToll vehicles between 9:00 AM and 12:00 PM. These discounted commercial vehicle toll rates were not included in the traffic assignment process due to the low volume of trucks. Instead, the discounted toll rate was incorporated into the revenue forecasts as a post-processing adjustment after the modeling assignment process. At ramp toll locations, the toll rate in 2019 and 2020 was $1.25 for ExpressToll and $2.05 for LPT customers. Passenger cars and commercial vehicles pay the same toll rate at all the ramp toll locations.

Table 4-3
Passenger Car Toll Rate Assumptions

Year	Method of Payment	Toll Location					
		Gantry A	Gantry B	Gantry C	Gantry D	Gantry E	Toll Ramps
2019	ExpressToll	$ 2.70	$ 2.95	$ 2.70	$ 2.95	$ 2.95	$ 1.25
	LicensePlateToll	$ 4.30	$ 4.65	$ 4.30	$ 4.65	$ 4.65	$ 2.05
2020 [(1)]	ExpressToll	$ 2.70	$ 2.95	$ 2.70	$ 2.95	$ 2.95	$ 1.25
	LicensePlateToll	$ 4.30	$ 4.65	$ 4.30	$ 4.65	$ 4.65	$ 2.05
2021	ExpressToll	$ 2.70	$ 2.95	$ 2.70	$ 2.95	$ 2.95	$ 1.25
	LicensePlateToll	$ 4.30	$ 4.65	$ 4.30	$ 4.65	$ 4.65	$ 2.05
2025 [(2)]	ExpressToll	$ 2.75	$ 3.00	$ 2.75	$ 3.00	$ 3.00	$ 1.30
	LicensePlateToll	$ 4.40	$ 4.80	$ 4.40	$ 4.80	$ 4.80	$ 2.05
2030 [(2)]	ExpressToll	$ 2.80	$ 3.05	$ 2.80	$ 3.05	$ 3.05	$ 1.35
	LicensePlateToll	$ 4.45	$ 4.85	$ 4.45	$ 4.85	$ 4.85	$ 2.15
2035 [(2)]	ExpressToll	$ 2.85	$ 3.10	$ 2.85	$ 3.10	$ 3.10	$ 1.40
	LicensePlateToll	$ 4.55	$ 4.95	$ 4.55	$ 4.95	$ 4.95	$ 2.25
2040 [(2)]	ExpressToll	$ 2.90	$ 3.15	$ 2.90	$ 3.15	$ 3.15	$ 1.45
	LicensePlateToll	$ 4.60	$ 5.00	$ 4.60	$ 5.00	$ 5.00	$ 2.30

[(1)] Toll rates effective January 1, 2020.

[(2)] Toll rate adjustments based on a 2 percent increase and assumed to be effective on January 1.

Based on discussions with E-470 Staff, the future year toll rates were set to assume a 2 percent increase every five years. Additionally, current toll rate differentials between ExpressToll and LPT and between passenger cars and commercial vehicles are assumed to be maintained through the forecast period. As presented in Table 4-3, the toll rate at the mainline toll locations under these assumptions will be $2.90 at Toll Gantries A and C, and $3.15 at Toll Gantries B, D, and E by

2040 for ExpressToll passenger cars. These 2040 toll rates represent a cost of $0.32 per mile for a 47-mile full-length trip on E-470. Toll rates in 2040 for LPT passenger car customers based on these assumptions will be $4.60 at Toll Gantries A and C, and $5.00 at Toll Gantries B, D, and E. At ramp toll locations, the toll rate in 2040 will be $1.45 for ExpressToll and $2.30 for LPT customers based on these toll rate assumptions. It was also assumed that passenger cars and commercial vehicles will continue to pay the same toll rate at the ramp toll locations through the forecast period.

Vehicle Operating Costs and Values of Time

In addition to tolls, two major costs are considered when calculating the total cost of a trip in CDM Smith's toll diversion models. Vehicle operating costs consider drivers' perception of the wear and tear on a vehicle as expressed in maintenance costs, tires, and other variable costs such as fuel. Value of time (VOT) is the cost per minute of a specific trip as perceived by the traveler.

Vehicle Operating Costs

For the estimation of the vehicle operating costs, past studies by CDM Smith have shown that drivers perceive primarily the fuel cost in decisions regarding trip path, but also give some consideration to other usage-related costs, such as maintenance, oil, and tires at a discounted level. Factors such as depreciation and insurance were not included in the vehicle operating cost estimate. A vehicle operating cost of $0.205 per mile for passenger cars in 2019 was assumed. The 2019 vehicle operating cost was then inflated at a rate of 2.0 percent per year through 2040. These inflation rates were based on an analysis of gas price forecasts from the Energy Information Administration (EIA) as well as fuel efficiency improvements based on current national CAFÉ standards. Operating costs of truck traffic were assumed at 3 times the operating cost of passenger cars. The estimated vehicle operating costs used in this study are shown in **Table 4-4**.

Table 4-4
Estimated Vehicle Operating Costs

	Estimated Vehicle Operating Costs	
Model Year	Passenger Car	Truck
2019	$ 0.205	$ 0.615
2020	0.209	0.627
2021	0.213	0.640
2025	0.231	0.693
2030	0.255	0.765
2035	0.281	0.844
2040	0.311	0.932

Values of Time

Motorists' perception of their Value of Time (VOT) is another key component of the decision to use a toll facility or an alternative route. Refinement of VOT was done based on counts for the model area and benchmarked to the 2019 calibration year. For this study, a VOT Matrix representing the estimated VOT for each zone-to-zone movement was developed. This was achieved by combining the VOTs developed from Stated Preference (SP) surveys conducted as part of the 2017 Investment-Grade Traffic and Revenue Study, county-level VOTs generated based on data obtained from the U.S. Census Bureau American Community Survey, information from initial model validation runs to estimate the current share of eligible trips using the toll road, and estimated shares by trip purpose from the regional travel demand model. Through this process, the relationships between income and VOT, as well as between peak and non-peak period trips obtained from the prior SP surveys were applied to the county-level VOTs developed using the U.S. Census Bureau data. This was done to normalize the VOTs to average incomes in the Denver region. This process produced an estimated value of time of $0.320 per minute, or $19.22 per hour at 2019 levels.

An additional VOT adjustment for trips using the Denver International Airport was incorporated into the zonal VOT assumptions. Based on the 2017 SP surveys, airport trips possessed a higher VOT than other trip purposes. This is because the need to reach the destination on time is greater for airport trips than for other trips. In recognition of this finding, as well as the relative importance of trips to and from Denver International Airport using E-470, a minimum VOT of $0.446 per minute was applied to all airport trips regardless of zone origin or destination. This value was estimated based on the trip-purpose level VOT estimates obtained from the SP survey.

As with VOC, the 2019 average values of time were inflated by 2.0 percent per year through 2040 based on a review of average annual increases in Consumer Price Index (CPI) rates for the Denver Metro Area. We believe this is a conservative assumption in the traffic and revenue forecasts since it does not assume any real increases in VOT due to real income growth within the region. The value of time for commercial vehicle trips was assumed to be 3.0 times the value for passenger cars. The resulting estimates of VOT are provided in **Table 4-5**.

Table 4-5
Estimated Average Values of Time

Model Year	Value of Time	
	Per Minute	Per Hour
2019	$ 0.320	$ 19.22
2020	0.327	19.61
2021	0.333	20.00
2025	0.361	21.65
2030	0.398	23.90
2035	0.440	26.39
2040	0.486	29.14

Model Development

The most recent version of the DRCOG Focus 2.2 travel demand model was run using the modified land use as described in **Chapter 3** and the updated network assumptions described above to develop trip tables for 2015 and three forecast years: 2020, 2030, and 2040. The resulting trip tables were then exported from the model and used by CDM Smith in its Cube Voyager travel demand model platform for the model calibration and traffic forecasting process described in the following sections.

Adaptation of Trip Tables

For the purposes of the travel demand model, the original trip matrices developed by FHU and DRCOG based on the updated socioeconomic inputs were disaggregated into two payment type categories: the electronic toll collection (ETC) payment type consisted of ExpressToll customers, while the non-ETC payment type consisted of LPT customers. This was done in order to perform traffic assignments based on method of toll payment using CDM Smith's proprietary toll diversion algorithms. Based on prior study experience, this adjustment improves the modeling, calibration and traffic and revenue forecasts and produces results that more accurately reflect actual traffic conditions.

The DRCOG Focus 2.2 model also employs a time-of-day model, meaning that the model is run separately for various time periods. Specifically, the model was developed with ten time periods. Since hourly traffic volumes were not necessary at this level of analysis, these time periods were aggregated into four:

- AM peak period (6:30 AM – 9:00 AM);
- Midday period (9:00 AM – 3:00 PM);
- PM peak period (3:00 PM - 7:00 PM); and
- Nighttime period (7:00 PM – 6:30 AM).

This adjustment allowed for a simplification of the modelling process while maintaining a distinction in hourly variations in congestion typical of urban toll facilities.

Model Calibration

Following the development of trip tables based on the revised socioeconomic and highway improvement inputs, as well as the adjustments previously described, traffic assignments were run at 2019 levels. These assignments served as the starting point for the model calibration process, which included a comparison of network speeds, non-toll road volumes and volumes on E-470 against the most recently available actual traffic counts. The goal of the calibration and validation process was to have the model assign 2019 traffic volumes that reasonably replicated the actual 2019 average weekday traffic (AWDT) volumes on E-470 and other major roadways. Model outputs were reviewed to ensure that volumes approximated, as closely as possible, the 2019 balanced traffic profile, specifically at the five mainline toll gantry locations. Moreover, model assignment outputs were reviewed to ensure that the E-470 market share across several screenlines, approximated the actual market share observed in the count data collected.

As calibration progressed, additional minor adjustments and corrections to the model inputs were made in an attempt to obtain a better fit between the actual 2019 AWDT volumes and the assigned volumes. These adjustments included the correction of highway network errors, minor capacity or input speed changes, and adjustments to specific movements within the trip tables. These adjustments were based upon the posted and observed speed data, as well as professional judgment based on experience with traffic modeling in the Denver region.

Several assessments of the reasonableness of the traffic assignments in light of the actual 2019 AWDT volumes and observed travel speeds were conducted. Among these assessments was a comparison of the 2019 model output volumes against actual 2019 AWDT volumes along five project screenlines, which have been previously depicted in **Figure 2-3** of **Chapter 2, Traffic and Revenue Trends and Conditions**. The results of the comparison are provided in **Table 4-6**.

In general, the results of the traffic assignments indicated that, across the various screenlines and at the E-470 mainline toll locations, the updated travel demand model performed reasonably well. Specifically, total screenline model volumes ranged between -2.1 and 14.7 percent of actual screenline counts, with the largest differences in volume occurring at Screenline B. At the E-470 mainline toll gantries, the adjusted model produced volumes ranging between -4.7 percent (Toll Gantry C) and 7.3 percent (Toll Gantry A) of actual 2019 AWDT volumes. These represent differences of -1,610 and 3,930 vehicles per weekday, respectively. Based on these results, it was determined that the updated travel demand model was able to reasonably estimate the relative impacts of various tolling scenarios and highway improvements. Within the limitations of travel demand, the results of the calibration indicated that the updated travel demand model was a good tool for developing the transaction and toll revenue forecasts in combination with professional judgment and historical performance of the E-470.

Traffic Diversion Analysis

Following calibration of the model, future trip tables at 2021, 2025, 2030, 2035 and 2040 levels were developed based on the updated socioeconomic assumptions provided by the independent economist and described further in Chapter 3. These trip tables also incorporated the calibration adjustments made to the 2019 trip tables.

Traffic assignments were generated using CDM Smith's proprietary diversion assignment technique. This process involves comparing travel times and distances for each zone-to-zone movement using E-470 (if appropriate) with the best available toll-free alternate route. The estimated traffic that would be expected to use E-470 is a function of travel time and distance savings, the assumed monetary value of these savings, and the toll rate being tested in any given assignment. In general, as the total cost to use E-470 increases, the traffic on it decreases. A series of traffic assignments were run for future years 2021, 2025, 2030, 2035 and 2040 based on the ExpressToll participation rates, assumed tolls, estimated future year VOT and VOC values. The relative impacts of input assumptions between model years were applied to the actual balanced 2019 AWDT profile and form the basis for the estimated traffic and revenue forecasts provided in this analysis.

Table 4-6
Comparison of 2019 Average Weekday Screenline Counts and 2019 Traffic Model Volumes at Selected Locations

Screenline	Street Name	Location	2019 Actual Average Weekday Volumes	2019 Model Average Weekday Volumes	Difference	
					Number	Percent
A	I-25	North of SH 30 / E Hampden Ave.	258,250	287,980	29,730	11.5
	SH 30	South of E Dartmouth Ave.	45,990	45,630	(360)	-0.8
	I-225	Southwest of SH 83 / Parker Rd.	155,330	228,510	73,180	47.1
	Dam Rd.	Southwest of SH 83 / Parker Rd.	10,960	1,720	(9,240)	-84.3
	SH 88 / E Arapahoe Rd.	East of S Peroia St.	73,920	62,590	(11,330)	-15.3
	E Broncos Pkwy.	West of S Potomac St.	24,800	21,380	(3,420)	-13.8
	E County Line Rd.	East of Concord Center Dr.	10,270	6,270	(4,000)	-38.9
	Compark Blvd.	East of Concord Center Dr.	6,580	1,770	(4,810)	-73.1
	E-470	**Toll Gantry A [1]**	**53,850**	**57,780**	**3,930**	**7.3**
	E Lincoln Ave.	East of S Peoria St.	42,240	44,530	2,290	5.4
	Ridgegate Pkwy.	East of S Peoria St.	19,090	20,660	1,570	8.2
	Hess Rd.	East of S Havana St.	9,730	9,030	(700)	-7.2
	Total Screenline A		**711,010**	**787,850**	**76,840**	**10.8**
B	I-25	South of SH 6 / 6th Ave.	244,730	287,040	42,310	17.3
	SH 2 / S Colorado Blvd.	South of E 1st Ave.	55,860	50,930	(4,930)	-8.8
	SH 30 / S Havana St.	North of SH 83 / S Parker Rd.	33,500	39,090	5,590	16.7
	S Peoria St.	South of E Iliff Ave.	24,570	31,340	6,770	27.6
	I-225	North of SH 83 / S Parker Rd.	145,370	186,840	41,470	28.5
	S Chambers Blvd.	South of E Iliff Ave.	34,970	43,770	8,800	25.2
	S Buckley Rd.	South of E Iliff Ave.	30,850	31,290	440	1.4
	S Tower Rd.	South of E Iliff Ave.	28,290	31,710	3,420	12.1
	S Dunkirk St.	South of E Iliff Ave.	5,210	6,300	1,090	20.9
	E-470	**Toll Gantry B**	**46,270**	**48,020**	**1,750**	**3.8**
	SH 30 / S Gun Club Rd.	South of E Jewell Ave.	22,090	14,320	(7,770)	-35.2
	Total Screenline B		**671,710**	**770,650**	**98,940**	**14.7**
C	I-25	North of I-70	234,860	227,550	(7,310)	-3.1
	SH 265 / Brighton Blvd.	South of York St.	7,130	5,100	(2,030)	-28.5
	SH 6 / Vasquez Blvd.	North of I-70	23,510	26,360	2,850	12.1
	SH 2 / Colorado Blvd.	North of I-70	35,420	29,220	(6,200)	-17.5
	I-270	North of I-70	89,870	113,650	23,780	26.5
	Central Park Blvd.	North of I-70	31,990	21,670	(10,320)	-32.3
	Havana St.	North of I-70	31,420	28,030	(3,390)	-10.8
	Peoria St.	North of I-70	42,550	42,810	260	0.6
	Chambers Rd.	North of E 40th Ave.	39,120	36,760	(2,360)	-6.0
	Pena Blvd.	North of E 40th Ave.	126,620	150,370	23,750	18.8
	Tower Rd.	South of Green Valley Ranch Blvd.	25,660	9,950	(15,710)	-61.2
	Picadilly Rd.	South of Green Valley Ranch Blvd.	4,840	1,700	(3,140)	-64.9
	E-470	**Toll Gantry C**	**34,250**	**32,640**	**(1,610)**	**-4.7**
	Mohegan Rd.	South of E 56th Ave	930	4,310	3,380	363.4
	Total Screenline C		**728,170**	**730,120**	**1,950**	**0.3**
D	I-25	South of E 88th Ave.	175,320	173,960	(1,360)	-0.8
	I-76	South of E 88th Ave.	91,850	120,660	28,810	31.4
	Brighton Rd.	South of E 88th Ave.	4,800	5,710	910	19.0
	Rosemary St.	South of E 88th Ave.	12,910	6,650	(6,260)	-48.5
	SH 2	South of E 88th Ave.	1,500	18,390	16,890	1,126
	Tower Rd.	South of E 88th Ave.	36,530	40,710	4,180	11.4
	E-470	**Toll Gantry D**	**49,560**	**51,520**	**1,960**	**4.0**
	Total Screenline D		**372,470**	**417,600**	**45,130**	**12.1**
E	I-25	South of E 88th Ave.	175,320	173,960	(1,360)	-0.8
	E 88th Ave.	at South Platte River	23,720	28,050	4,330	18.3
	McKay Rd.	at South Platte River	18,550	15,690	(2,860)	-15.4
	SH 44 / E 104th Ave.	at South Platte River	16,300	18,220	1,920	11.8
	E 120th Ave.	at South Platte River	20,300	21,520	1,220	6.0
	Henderson Rd.	at South Platte River	7,690	2,770	(4,920)	-64.0
	E-470	**Toll Gantry E**	**36,790**	**35,760**	**(1,030)**	**-2.8**
	SH 7 / E 160th Ave.	at South Platte River	17,530	13,340	(4,190)	-23.9
	E 168th Ave.	at South Platte River	5,470	5,500	30	0.5
	Total Screenline E		**321,670**	**314,810**	**(6,860)**	**-2.1**
All	**Total Screenlines**	**All Locations**	**2,805,030**	**3,021,030**	**216,000**	**7.7**
	E-470	**Toll Gantries A, B, C, D and E**	**220,720**	**225,720**	**5,000**	**2.3**

[1] Actual average weekday traffic volumes include the negative traffic impacts resulting from C-470 Express Lane construction, which are estimated to be 6.25 percent. In order to better model future growth and impacts, modeled traffic volumes do not include this impact.

Basic Study Assumptions

Traffic and toll revenue estimates for E-470 are predicated upon the following assumptions, which are considered reasonable for purposes of the forecasts:

1. The toll collection concept and toll schedules as shown in this report will be adopted. Both ExpressToll and LPT will be employed.

2. The percentage of ExpressToll and LPT customers will be assumed as detailed earlier in this chapter.

3. Improvements to the present highway and local road system in the travel corridor will be limited to those described in this report. No other competing facilities, or capacity expansions, will occur in the forecast period.

4. Regional and corridor growth will be generally as forecast by DRCOG as reviewed and refined by Economic & Planning Systems for use in this study, as documented in **Appendix A**.

5. No major recession or significant economic restructuring will occur which would substantially reduce traffic in the region, other than the potential economic impacts described in this report related to the COVID-19 outbreak.

6. Over the long-term, motor fuel will remain in adequate supply, and future increases in fuel price will not significantly exceed the overall rate of inflation.

7. Inflation will average 2.0 percent per year through 2040.

8. Revenue leakage due to unreadable plates or uncollectable ExpressToll or LPT transactions or any transactions that cannot be processed and payment collected will occur. Leakage estimates have been estimated by CDM Smith in this analysis using actual historical data provided by the Authority.

9. The E-470 toll road will be well-maintained and effectively signed.

10. No natural disasters will occur that could significantly alter travel patterns through the area.

11. No local, regional, or national emergency will arise that would abnormally restrict the use of motor vehicles, other than those described in this report related to the COVID-19 outbreak.

Any significant departure from these basic assumptions could materially affect estimated traffic and toll revenue for the E-470.

Toll Rate Sensitivity

An analysis of hypothetical toll rate sensitivity was conducted at 2021 and 2040 levels in order to provide an indication of where the currently approved scheduled toll rates lie with respect to revenue maximization. Toll rate sensitivity estimates the impacts to transactions and revenue

due to increases or decreases in toll rates. The resulting transaction and toll revenue estimates can then be plotted on a graph as a toll sensitivity curve, illustrating the diversion trends. In this case, the toll sensitivity analysis is hypothetical, since assumed rates have already been adopted by the Authority.

Toll sensitivity traffic assignments were run at 2021 and 2040 levels assuming mainline toll rates above or below the currently approved toll rates in increments of $0.25. Toll sensitivity was considered on a gantry-by-gantry basis in order to understand the relative toll sensitivity of each segment of the E-470 system. The impacts of increasing or decreasing these toll rates were then reviewed and applied to the transaction and revenue forecast under the assumed future year toll rates presented previously in Table 4-3. The resulting toll sensitivity curves are presented by mainline toll gantry in **Figures 4-2 and 4-3**. Curves are also shown for the total E-470 system. The points on each curve show the assumed passenger car ExpressToll rates in each of the future years used in the traffic and revenue analysis, as well as the current toll rates. It should be noted that the toll sensitivity transactions, revenues and curves were developed without COVID-19 impacts so as to understand the toll sensitivity estimated by the raw model. This sensitivity was deemed to be acceptable for use in the forecasting process, since any toll rate increases would not occur under the Base Case until 2025, which is well after the anticipated recovery from the short-term COVID-19 impacts.

The multi-year toll sensitivity analysis shows the approved tolls ($0.30 per mile for through trips in 2021 and $0.32 per mile for through trips in 2040) are relatively high, but still lie below the top of the toll revenue curve. In 2021, it is estimated that toll rates for all mainline toll gantries are roughly $0.50 below the top of the toll revenue curve. As compared to estimates of toll sensitivity included in prior studies, this has generally been achieved through strong regional growth and toll reductions at Gantry C. Due to the toll differential between methods of payment, assumed 2021 ExpressToll rates fall roughly $0.75 below the top of the curve while LPT toll rates fall on the "downside" of the curve.

By 2040, the top of the toll revenue curve has shifted slightly to the right, indicating that the theoretical optimum toll rate has increased. This increase is due primarily to assumed inflationary increases in the VOT as well as increased congestion levels on parallel toll-free facilities. As a result of this shift, and the fact that the toll rate increases assumed in the traffic and revenue forecasts are less than the assumed annual rate of inflation, both the current (red) and assumed 2040 (purple) toll rates fall further down on the toll revenue curve. At 2040 levels, assumed toll rates fall roughly $0.75 to $1.00 below the theoretical optimum toll rate. LPT toll rates are estimated to fall just below the top of the curve in 2040, meaning additional toll increases would lead to some increases in revenue. This suggests some potential for increasing the ExpressToll / LPT toll differential in future years.

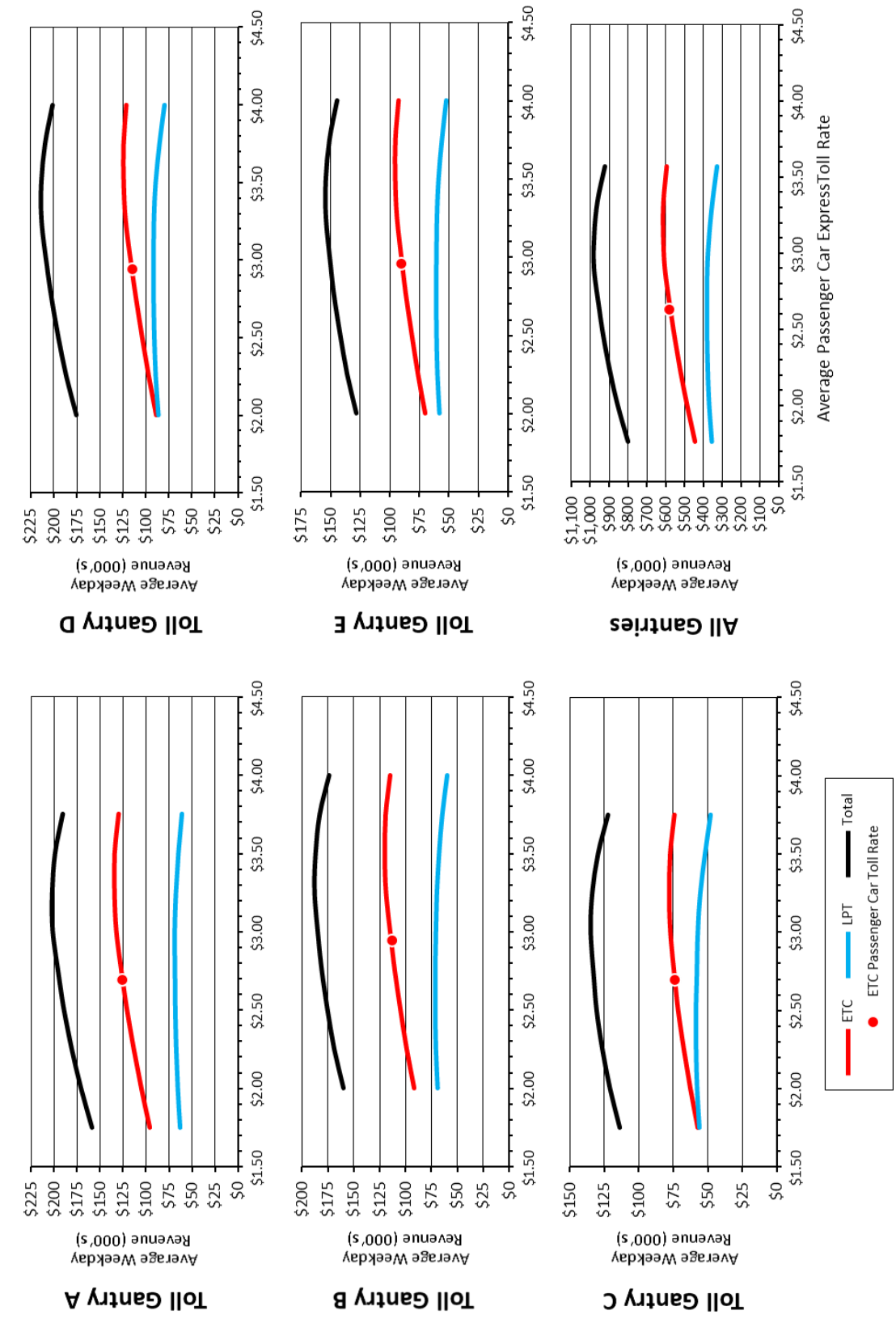


Figure 4-2
2021 Gross Toll Revenue Toll Sensitivity Curves

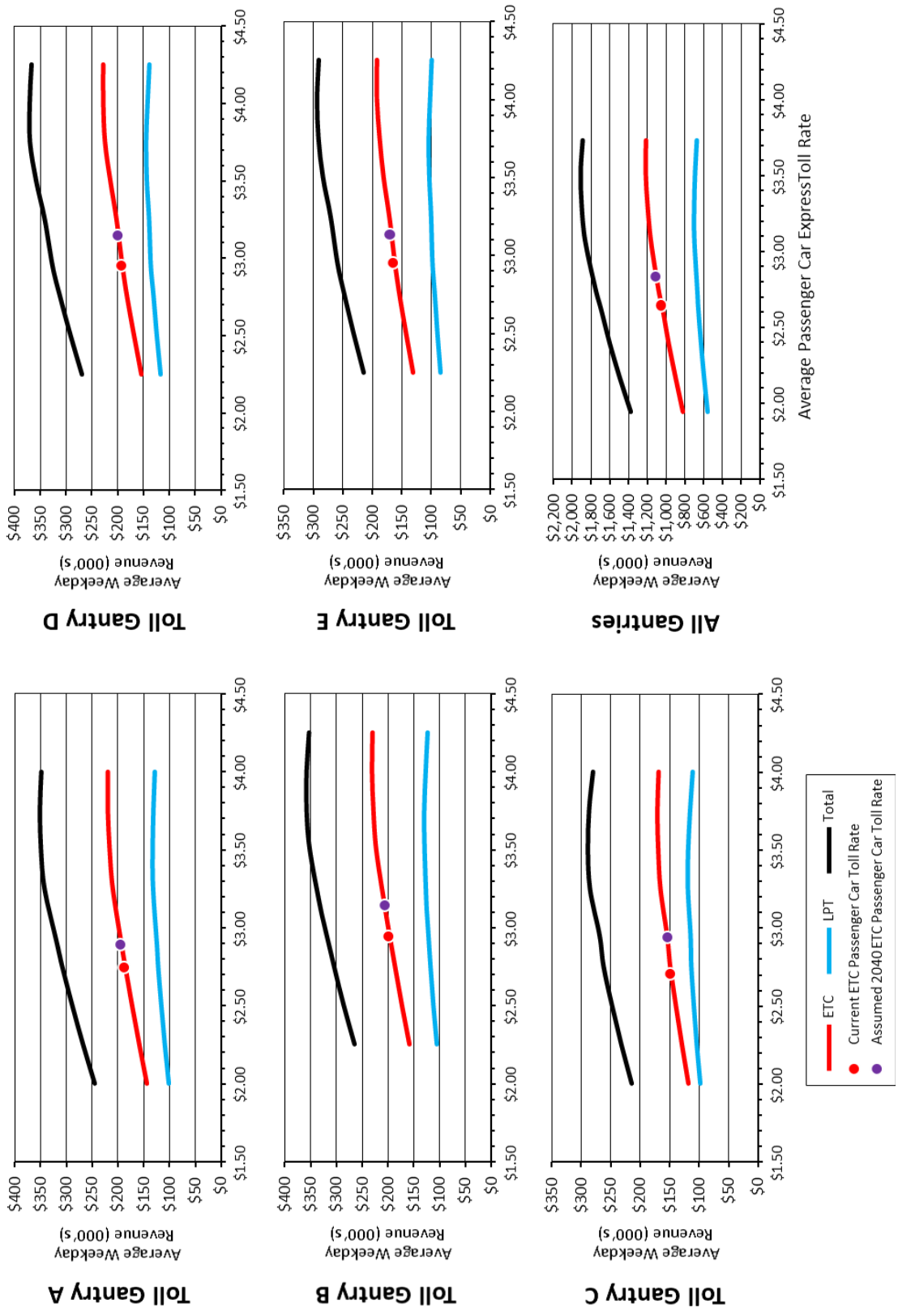


Figure 4-3
2040 Gross Toll Revenue Toll Sensitivity Curves

Estimated Base Case Traffic and Revenue

Following the year 2019 calibration process, future-year average weekday traffic assignments were run for years 2021, 2025, 2030, 2035, and 2040. The toll rates previously presented in Table 4-3 were assumed, with current toll rates increasing by 2.0 percent every five years after 2025. Values of time and vehicle operating costs were assumed to increase annually based on a 2.0 percent per year rate of inflation, based on historical increases in CPI and available forecasts of inflation.

As has been mentioned previously in **Chapter 2**, significant increases in traffic were observed on E-470 in recent years, coinciding with employment and population growth in Aurora, Broomfield, and northeast Denver and to the overall economic recovery and development activity experienced in the Denver Metro area. In developing the estimated traffic and revenue forecasts, these high short-term growth rates were taken into account when estimating initial "normal" traffic and revenue growth on E-470 through 2021. Some slight adjustments were made to short-term growth rates forecasted by the updated DRCOG model in order to incorporate the assumed construction and improvement impacts associated with the completion of the C-470 Express Lanes project. Based on these adjusted growth rates through 2021, an overall year-over-year "normal" growth rate of 3.6 percent was estimated, which is consistent with recent normal historical rates of growth. Beyond 2021, the growth rates forecasted by the travel demand model were reviewed and used as the basis for the traffic and revenue forecast through 2050.

Forecast Impacts Related to COVID-19

In addition to the "normal" growth rates developed based on historical trends and the updated DRCOG model, CDM Smith applied impacts related to the Coronavirus (COVID-19) outbreak. In March 2020, traffic impacts related to COVID-19 began as many states and localities began implementing stay-at-home orders, public space closures, social distancing orders and other restrictions in an effort to reduce the spread of the virus based on guidelines from the Center for Disease Control (CDC) and the Federal Government. On March 11, 2020, Colorado Governor Polis issued an emergency declaration due to COVID-19. This was followed by an order on March 18, 2020 to suspend in-person instruction at Colorado schools and a March 25, 2020 stay-at-home order. Following several prior extensions by the Governor, the statewide stay-at-home order expired on April 24, 2020, and was replaced by a safer-at-home order that allows slightly more travel for Colorado citizens. Denver Mayor Hancock issued a similar stay-at-home order on March 23, 2020, which expired on May 8, 2020 and was also replaced by a safer-at-home order. As of May 11, 2020, there have been almost 18,400 confirmed cases of COVID-19 in Colorado, with almost 950 deaths. Within the 8-County Denver Metro area, there have been over 13,500 confirmed cases and over 700 deaths, or roughly 75 percent of the total statewide impact.

These restrictions have significantly impacted regional traffic patterns. Moreover, since congestion on alternative roadways, such as I-25, I-70 and even local arterials, has been almost eliminated, E-470 no longer offers the same travel time savings to motorists as it did prior to the COVID-19 outbreak. As a result, E-470 has been particularly hard hit. Additionally, since more than 20 percent of E-470 traffic originates from or is destined for DIA, reductions in air travel and tourism related to the COVID-19 outbreak also have impacted E-470 to a greater extent than other facilities in the region.

As previously reviewed in **Chapter 2**, observed E-470 transactions between March 1 and April 16, 2020 (the latest available data at the time of this report) indicated that the full impact of COVID-19 on E-470 has been a reduction in systemwide transactions of over 60 percent compared to normal levels. Additionally, while E-470 passenger car transactions are down by almost 70 percent compared to the first week of March, commercial vehicle transactions are down by just over 30 percent. These reduced traffic levels were assumed as the "bottom" of the COVID-19 impacts, which would generally continue through the end of the COVID-19 outbreak, stay-at-home orders, public space closures, social distancing orders and other restrictions.

COVID-19 has impacted travel behavior in many ways. Some of these will be short-term in effect, while others will have more long-term consequences:

- **Remote working:** Many employees, particularly professional services have quickly transitioned work activities from an office to a home environment. Advances in technology, internet bandwidth, personal computing, secure networks, access to cloud-based data-files, telephone and video conference capabilities have enabled companies and employees to maintain productivity. For both employers and employees, this experience will provide more options moving forward in establishing new work protocols. Employers can view this as an opportunity to reduce office footprints, while employees may consider more flexible working reducing the frequency of work trips into the office. However, it is essential to note that the share of telecommuters is still relatively low at around 5 percent of the total employees. It is likely that this may grow in the future and will negatively impact travel demand but will be constrained by the number of occupations that this practice works effectively. Prior studies on telecommuting suggest employees prefer office environments for reasons of social engagement, creative thinking and career advancement opportunities.

- **Remote learning at all levels:** With the schools and universities switching to online education due to the current travel restrictions, the related travel has substantially decreased. Even though there might be an increased transition and reliance on online education in the short-term, we believe it is unlikely to see this change as a long-term trend affecting travel.

- **Reduced usage of shared modes of transportation:** Due to the perceived fears of close contact with other travelers, there will be a negative impact on transit, shared mobility rides services such as Uber and Lyft, and a potential reduction in the formation of High Occupancy Vehicle (HOV) pools. It is likely in the near-term that we may see a distributional shift towards Single Occupant Vehicles (SOV), potentially changing the demand characteristics of managed/express lanes and general-purpose lanes.

- **Retail Impacts:** There has been a long-term trend towards online shopping, which has been accelerated during the pandemic. Many traditional brick and mortar stores/shopping malls previously struggling against online shopping, will likely go out of business. We anticipate continued growth in warehousing distribution centers around major interstates and thoroughfares such as E-470 with increased light truck and heavy trucking movements supporting just in time delivery to customers at home.

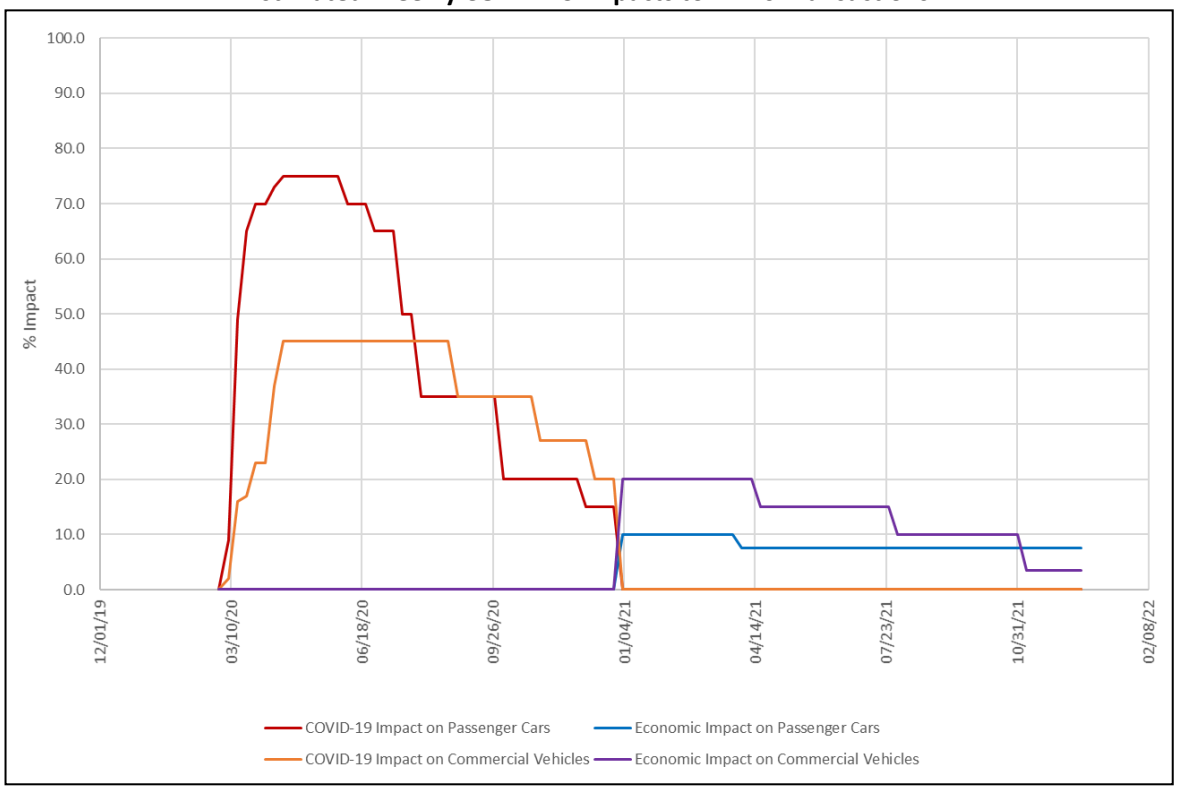
- **Change in housing and employment locations:** The changes as mentioned above in shopping behavior could mean corresponding shifts in employment locations. The urge to decrease close contact and decrease the usage of mass transit, shared mobility options could also result in a decrease in urban density. This may reduce market demand for in-fill housing and increase demand for suburban and exurban housing. These changes could, in turn, result in shift in regional travel patterns.

- **Reduced discretionary travel:** Due to the current travel restrictions, there is overwhelming evidence that there is lowered frequency of travel, increased trip chaining and lower discretionary travel. More moderate discretionary and leisure travel is leading to lower usage of roads in general. This reduced congestion along toll-free options is resulting in even lower traffic along tolled roads and managed lanes in off-peak periods, weekends and holidays. Much of this decrease in discretionary travel is related to the "stay-at-home" orders, cancellation of large gatherings or sporting events, and closure or restricted opening of shopping centers/malls. However, when the restrictive orders are lifted, the intra-city and inter-city travel might see a surge in the short-term. We expect that the discretionary travel's recovery will lag the recovery in the work-related travel, as it is tied to several other external factors that won't return to pre-COVID levels until these large gatherings/events take place and attract pre-COVID level attendance.

Based on this assessment, a review of regional and national trends, and a review of forecasts and estimates available from rating agencies and other financial institutions, annual impacts were applied to the forecast. These impacts, which are illustrated in **Figure 4-4**, were intended to account for both the short-term impacts of the COVID-19 stay-at-home orders and other closures, as well as the long-term structural economic impacts that would occur as a result of the crisis. Varied impacts are assumed for passenger cars and commercial vehicles, based on actual observations through mid-April. In the short-term, a 36.1 percent reduction in 2020 transactions was assumed, based on the forecasts of the COVID-19 crisis duration, as discussed above. This impact would result in a 33.6 percent year-over-year transaction decrease compared to 2019. Moving forward, a slow recovery was assumed in 2020. However, an annual transaction impact of 8.1 percent was applied from 2022 through the remainder of the forecast period, as compared to the forecast without COVID-19 impacts. This was done to account for the longer-term effects of the crisis, including potential recessionary impacts through 2020, increases in telecommuting, and reductions in tourism and other recreational trips.

The estimated transaction and revenue forecasts presented in the remainder of this report therefore recognize not only the forecast assumptions previously detailed in this chapter, but also the short- and long-term estimated impacts of COVID-19 crisis. We would note there is significant uncertainty to both short-term and long- term travel impacts related to the COVID-19 Pandemic. CDM Smith has attempted to use the best available information at the time of developing these forecasts. These assumptions may be subject to change depending on the escalation or recovery from COVID-19, which may materially affect the resulting traffic and revenue estimates.

Figure 4-4
Estimated Weekly COVID-19 Impacts to E-470 Transactions

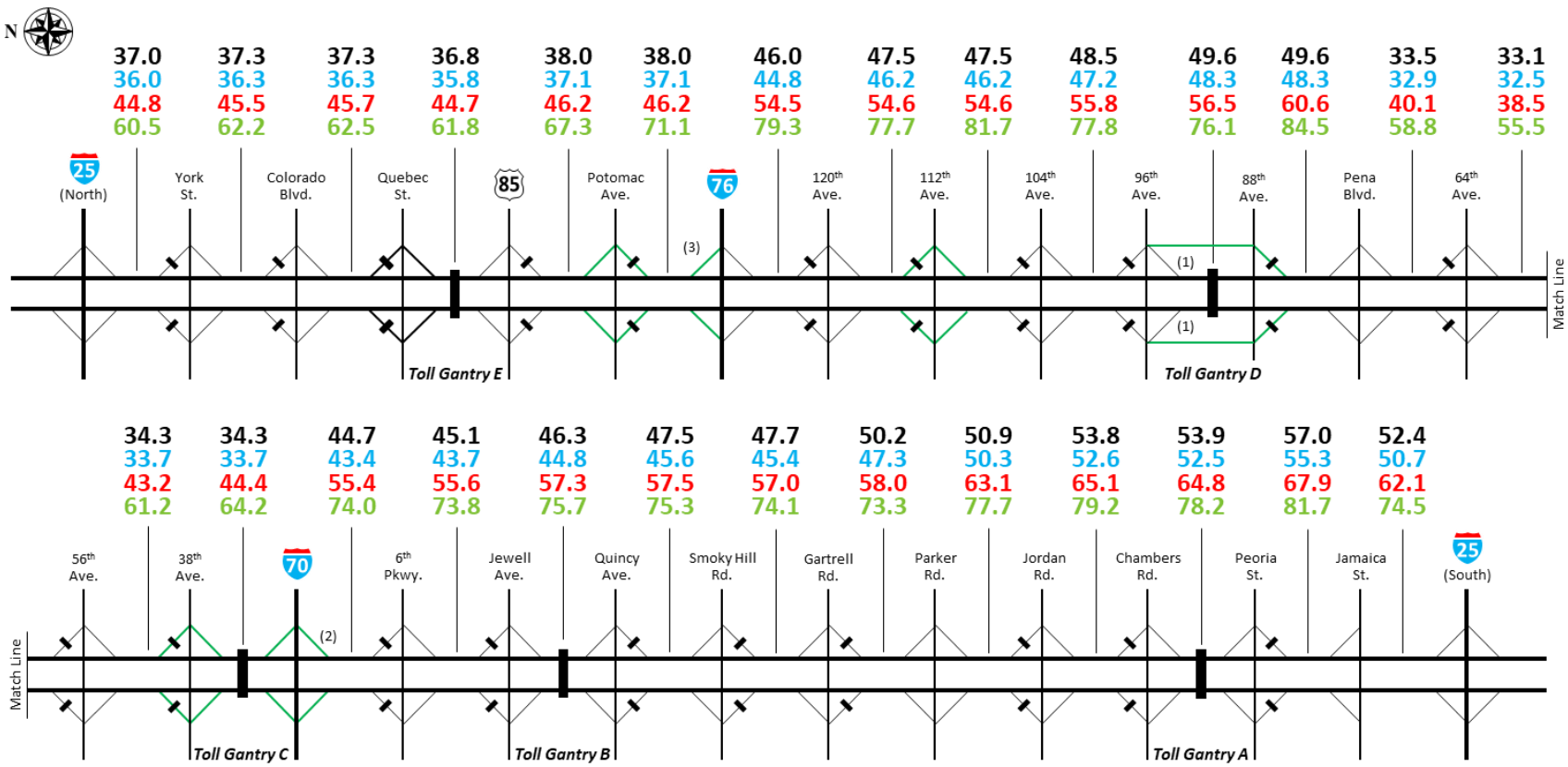


Estimated Average Weekday Traffic Volumes

Estimated AWDT volumes for each E-470 mainline segments are provided by model year in **Figure 4-5**. AWDT estimates are shown for 2019 (actual), 2021, 2030 and 2040 levels. All volumes are shown in thousands.

In general, the heaviest traffic volumes throughout the forecast period are located in the southern sections of E-470, generally between I-70 and I-25 and between Peña Boulevard and I-76. Of the five mainline toll gantries, it is estimated that Toll Gantry A will continue to experience the highest traffic volumes over the forecast period. However, by 2040, traffic volumes at Toll Gantries B and D will come close to those at Gantry A, with some mainline volumes in those areas surpassing those near Gantry A. The peak load point on the system will continue to be between Peoria Street and Jamaica Street until 2040, when it is surpassed by the mainline segment between Peña Boulevard and 88th Avenue. AWDT volumes at Gantry A are estimated to decrease from 53,900 in 2019 to 52,500 in 2021 as a result of the longer-term COVID-19 impacts. From this point, traffic volumes are estimated to increase to 64,800 and 78,200 average weekday vehicles in 2030 and 2040, respectively. Between 2021 and 2040, annual growth at Gantry A is estimated to average 2.1 percent. This is the lowest growth rate for a mainline gantry forecasted for the E-470 System, primarily due to the fact that development activity is anticipated to be greater in other areas of the facility.

At Toll Gantry B, AWDT volumes are estimated to decrease from 46,300 in 2019 to 44,800 in 2021 due to the impacts of COVID-19. These volumes also incorporate the impacts of the recent



LEGEND

000 2019 Volume
000 2021 Volume
000 2030 Volume
000 2040 Volume

Note: Volumes are in thousands.

Mainline Toll Location
Ramp Toll Location
Future Highway Improvement

(1) Ramps to be Removed In 2026

(2) EB I-70 to SB E-470 Ramp to open in 2023, and Full I-70 Interchange Reconfiguration to be completed in 2030.

(3) NB E-470 to WB I-76 Ramp to open in 2035, and WB I-76 to NB E-470 Ramp to open in 2040.

Figure 4-5
Average Weekday Mainline Traffic Volumes
2019, 2021, 2030 and 2040

widening from 4 to 6 lanes between Parker Road and Quincy Avenue. By 2040, AWDT volumes at Toll Gantry B are estimated to be 75,700, representing an average annual growth rate of 2.8 percent over 2021.

Traffic volumes between I-70 and Peña Boulevard in the vicinity of Toll Gantry C, currently among the lowest on E-470, are estimated to increase the fastest over the forecast period. This growth is estimated to occur primarily after the assumed resumption of normal growth trends in 2021. In 2019, actual AWDT at Toll Gantry C was 34,300. In 2021, estimated AWDT volumes for Toll Gantries C will decrease to 33,700 vehicles due to the COVID-19 impacts. Then, driven by highway improvements at I-70, a new interchange at E. 38th Avenue and increased development activity due to the Aurora Highlands and other developments, estimated AWDT volumes at Toll Gantry C will increase by to 44,400 in 2030 and 64,200 in 2040. This represents an average annual growth rate of 3.4 percent over 2021.

At Toll Gantry D, AWDT volumes are estimated to increase from 48,300 in 2021 to 56,500 in 2030 and to 76,100 in 2040, representing an average annual growth rate of 2.4 percent. These growth rates are driven primarily by the combination of local population and employment growth and growth in trips between Broomfield and DIA. It is notable that traffic volumes at Toll Gantry D, historically among the lowest on E-470, will be roughly the same as the highest volume gantries and mainlines by 2040 as a result of this growth.

At Toll Gantry E, AWDT volumes are estimated to decrease from 36,800 in 2019 to 35,800 in 2021, comparable to Toll Gantry C, due to the impacts of COVID-19. By 2040, AWDT volumes at Toll Gantry E are estimated to be 61,800, representing an average annual growth rate of 2.9 percent over 2021. Besides local developments, part of this growth will be due to improvements to the I-76 interchange.

Toll ramp volumes, not shown in the figure, are also assumed to increase as well, distributing the additional volume on E-470 based on the additional economic development and the changes to the highway network. Several additional interchanges are assumed to open on E-470 during the forecast period. These include interchanges at 38th Avenue (2024), 88th Avenue (2026), 112th Avenue (2031), and Potomac Street (2036). As previously shown in Figure 4-5, the ramps at 96th Avenue to and from the south are planned to be replaced with toll ramps at 88th Avenue just south of Toll Gantry D. Some existing interchanges are also planned to be improved during the forecast period, as previously reviewed under the highway improvement assumptions. The I-76 interchange is assumed to be reconfigured with additional ramps in 2035 and in 2040, with movements to and from the north on E-470 being made possible. In addition, the I-70 interchange is assumed to be reconfigured with fly-over ramps connecting Eastbound I-70 and Southbound E-470 in 2023, and a full reconstruction in 2030. The impacts for all these improvements and schedule widenings have been assumed within the future year forecasts.

Estimated Annual Transactions and Revenue

The average weekday transaction estimates were then annualized by method of payment. This was done to recognize the differences in trip frequency between ExpressToll and LPT customers. Based on actual 2018 data provided by the Authority, annualization factors of 324.2 and 330.1 were calculated for ExpressToll and LPT transactions, respectively. This reflects the relationship

between an average weekday and the annual totals. Weekday traffic is slightly higher than the 7-day average traffic hence the annualization factor of less than 365 is used. Annualization factors were also similarly calculated for toll revenue, recognizing the different mix of vehicle types between weekday and weekend traffic.

Based on the annualized transaction and revenue estimates, an annual transaction and revenue stream was developed. Beyond 2040, the average annual normal growth rate between 2030 and 2040 was assumed by toll location. Estimated impacts of toll increases were applied in 2045 and 2050 based on the modeling impacts developed for 2035 and 2040. Based on assignments performed with and without various highway improvements, the annualized impacts of programmed widenings, interchange improvements and new toll ramps were added in the assumed year of opening. Additionally, a roughly 2 to 3 percent construction impact was assumed in the area of a programmed widening during the two years prior to the scheduled completion. This level of construction impact was based on observed historical impacts of the prior widenings. Lastly, the impacts of leap years were applied.

The resulting annual transaction and revenue estimates through 2050 are provided for the total E-470 system in **Table 4-7**. These reflect the Base Case conditions, with the toll increases assumed as shown previously in Table 4-3, as well as adjustments for the short-term and long-term impacts of the COVID-19 crisis, as previously noted. Historical growth within the E-470 corridor has averaged 6.3 percent over the last five years, fueled by local development, lower gas prices and various widenings and interchange improvements. Following this trend, annual transactions are expected to decrease from an actual of 90.3 million in 2019 to 59.9 million in 2020 as a result of the COVID-19 impacts. A recovery is anticipated in 2021, with systemwide transactions increasing back to 88.0 million. Annual transactions are not estimated to return to 2019 levels until 2023, representing a four-year lag in growth as a result of the longer-term COVID-19 impacts outlined above. Including the impacts of widenings, highway improvements and toll increases, transactions on E-470 are estimated to increase to 112.1 million in 2030 and 156.0 million in 2040. This represents an average systemwide growth rate of 3.1 percent between 2021 and 2040. The estimated share of ExpressToll transactions are estimated to increase slightly from 73.1 percent in 2019 to 75.2 percent by 2040.

Annual toll revenue estimates are also provided in Table 4-7. Gross toll revenues, excluding revenue adjustments to account for non-revenue vehicles, unbillable license plate toll images and unpaid license plate toll transactions, were calculated by multiplying the estimated transactions by the nominal toll rates, as previously mentioned. Gross toll revenues are estimated to decrease from an actual of $290.4 million in 2019 to $193.5 million in 2020 as a result of the COVID-19 impacts. Reflecting the forecasted recovery in transactions, systemwide gross toll revenues are estimated to increase to $282.6 million in 2021. Annual gross toll revenues and transactions are not estimated to return to 2019 levels until 2023 as a result of the longer-term COVID-19 impacts. Gross toll revenues on E-470 are estimated to increase to $367.0 million in 2030 and $519.5 million in 2040. This represents an average systemwide growth rate of 3.5 percent between 2021 and 2040, which incorporates the impacts of widenings, highway

Table 4-7
Estimated Base Case Annual Transactions and Revenue (In Thousands)

Year		Annual Transactions (000s)			Annual Toll Revenue ($000s)		
		ExpressToll	LPT	Total	Gross [1]	Uncollectible and Unpaid [2]	Net [3]
2019	(4)	**65,910**	**24,370**	**90,280**	**$ 290,393**	**$ (41,380)**	**$ 249,013**
2020	(4)(5)(6)	44,153	15,752	59,905	193,459	(30,732)	162,727
2021	(6)(7)	**65,398**	**22,605**	**88,003**	**282,645**	**(44,291)**	**238,354**
2022		66,851	23,106	89,957	288,620	(44,889)	243,731
2023		68,521	23,627	92,148	295,331	(45,499)	249,832
2024	(5)(7)	71,545	24,510	96,055	306,862	(46,875)	259,987
2025	(8)	**72,859**	**24,616**	**97,475**	**317,254**	**(47,948)**	**269,306**
2026		74,752	25,117	99,869	321,899	(48,440)	273,459
2027	(7)	77,395	26,234	103,629	334,457	(50,350)	284,107
2028	(5)	79,497	27,072	106,569	343,834	(51,665)	292,169
2029	(7)	81,992	27,929	109,921	354,295	(53,116)	301,179
2030	(8)	**83,786**	**28,347**	**112,133**	**367,004**	**(54,461)**	**312,543**
2031	(7)	87,384	29,434	116,818	381,759	(56,560)	325,199
2032	(5)	90,618	30,543	121,161	395,173	(58,559)	336,614
2033	(7)	94,635	31,853	126,488	411,752	(60,961)	350,791
2034		98,168	33,021	131,189	425,963	(63,038)	362,925
2035	(7)(8)	**103,380**	**34,431**	**137,811**	**456,286**	**(67,215)**	**389,071**
2036	(5)	107,829	35,703	143,532	470,786	(69,206)	401,580
2037		110,038	36,495	146,533	480,398	(70,660)	409,738
2038	(7)	113,287	37,553	150,840	494,447	(72,679)	421,768
2039		115,828	38,614	154,442	506,257	(74,620)	431,637
2040	(5)(7)(8)	**117,244**	**38,776**	**156,020**	**519,513**	**(76,012)**	**443,501**
2041		119,729	39,612	159,341	529,886	(77,529)	452,357
2042		122,620	40,584	163,204	541,994	(79,300)	462,694
2043		125,604	41,585	167,189	554,428	(81,116)	473,312
2044	(5)	129,035	42,734	171,769	568,755	(83,209)	485,546
2045	(8)	**130,674**	**42,787**	**173,461**	**582,613**	**(84,391)**	**498,222**
2046		133,107	43,589	176,696	592,759	(85,855)	506,904
2047		135,600	44,412	180,012	603,116	(87,348)	515,768
2048	(5)	138,533	45,379	183,912	615,373	(89,116)	526,257
2049		140,774	46,117	186,891	624,489	(90,426)	534,063
2050	(8)	**142,143**	**46,029**	**188,172**	**638,079**	**(91,465)**	**546,614**

(1) Gross Revenue does not include adjustments for unbillable or uncollectable toll revenue.
(2) Uncollectible toll revenue represents non-revenue vehicles, bad or duplicate license plate images, or any other transactions for which revenue cannot be collected.
(3) Net Revenue includes adjustments for unbillable or uncollectable toll revenue.
(4) Includes actual data through March 2020.
(5) Leap Year.
(6) COVID-19 traffic impacts have been included in 2020 due to stay-at-home orders, public space closures and other travel restrictions. Some recovery is assumed in 2021, though longer-term traffic impacts of 8.1 percent have been included through the remainder of the forecast period.
(7) Assumed widening of various segments of the E-470 mainline.
(8) Assumed 2.0 percent Systemwide Toll Increase.

improvements and toll increases. Thus, despite the impacts of COVID-19 in 2020 and 2021, gross toll revenues are still estimated to more than double over the course of the forecast period.

Adjustments for uncollectible and unpaid revenue were developed in order to estimate net toll revenues, which include revenue adjustments to account for non-revenue vehicles, unbillable license plate toll images and unpaid license plate toll transactions. In consultation with E-470 staff and based on historical reductions in leakage rates, CDM Smith assumed the actual 2018 and 2019 leakage rates would be reduced slightly over the forecast period as toll collection technology and enforcement improve. In 2019, total actual leakage was 14.2 percent, which is a strong performance compared with that experienced by other AET facilities nationwide. This is in part due to the fact that collections were significantly improved in 2017 with the ability of the Authority to use automated processes to identify and bill customers with temporary license plates. Moving forward, slightly more conservative leakage rates, more in line with historically observed levels, were assumed (15.9 percent in 2020) and then reduced over the forecast period based on additional improvements in technology and collections. As shown previously in Table 4-7, leakage rates were estimated to be 14.8 percent by 2030 and 14.6 percent by 2035. As a result, net toll revenues are estimated to be $312.5 million in 2030 and $443.5 million in 2040.

Comparison to Prior 2018 Forecast

Table 4-8 presents the estimated annual transactions and revenue through 2048 for both the current study Base Case and the prior 2018 Traffic and Revenue Update Study. In addition to updated socioeconomic, highway improvement, ExpressToll participation rate, VOT, VOC, and toll revenue leakage assumptions, the major differences of the current study over the prior 2018 Update Study include revised toll rate assumptions and the inclusion of estimated COVID-19 impacts. Under the 2018 Update Study, assumed toll rates were planned to increase every three years by 2.1 percent starting in 2021 and did not include the midday toll discount for commercial vehicles. Compared to the current forecast, which increases toll rates by 2.0 percent every five years starting in 2025, the difference in the rate and frequency of toll increases between the studies creates a difference in assumed toll rates of 6 percent by 2040.

Annual system-wide transactions in 2021 under the current study Base Case are estimated to be 12.9 million less than the 2018 Update Study, as a result of benchmarking the forecast to 2019 transaction and ExpressToll participation levels and the incorporation of COVID-19 impacts. Estimated gross toll revenues in 2021 are estimated to be $36.8 million less under the current study Base Case, representing a difference of 13.4 percent.

By 2040, the estimated reduction in transactions and net toll revenue between the current study Base Case and the prior 2018 Study increases to 37.9 million and $125.5 million, respectively. This represents a difference of 19.5 percent in annual toll transactions and 22.1 percent in annual gross toll revenue. Although the longer-term economic lag resulting from the COVID-19 impacts represents the majority of this impact, the negative difference in transactions and toll revenue between the current study and 2018 Update Study forecasts is estimated to increase due to the slight estimated reduction in normal growth rates and assumed slower increase in toll rates under the current study forecasts.

Table 4-8
Comparison of 2018 Update Study and Current Study Forecasts
2019 to 2050

		Annual Transactions (000s)				Annual Net Revenue ($000s) (1)			
Year		2018 Update Study	Current Study Base Case	Difference	Percent Difference	2018 Update Study	Current Study Base Case	Difference	Percent Difference
2019	(2)	**92,311**	**90,280**	**(2,031)**	**(2.2)**	**$ 248,626**	**$ 249,013**	**$ 387**	**0.2**
2020	(2)(3)(4)	95,227	59,905	(35,322)	(37.1)	257,954	162,727	(95,227)	(36.9)
2021	(4)(5)(6)(7)	**100,897**	**88,003**	**(12,894)**	**(12.8)**	**275,131**	**238,354**	**(36,777)**	**(13.4)**
2022		104,136	89,957	(14,179)	(13.6)	285,363	243,731	(41,632)	(14.6)
2023		107,557	92,148	(15,409)	(14.3)	295,623	249,832	(45,791)	(15.5)
2024	(3)(5)(6)(7)	111,729	96,055	(15,674)	(14.0)	314,583	259,987	(54,596)	(17.4)
2025	(8)	**114,797**	**97,475**	**(17,322)**	**(15.1)**	**324,081**	**269,306**	**(54,775)**	**(16.9)**
2026		117,921	99,869	(18,052)	(15.3)	332,275	273,459	(58,816)	(17.7)
2027	(5)(6)(7)	122,292	103,629	(18,663)	(15.3)	350,734	284,107	(66,627)	(19.0)
2028	(3)	126,718	106,569	(20,149)	(15.9)	362,397	292,169	(70,228)	(19.4)
2029	(5)(6)	132,582	109,921	(22,661)	(17.1)	377,947	301,179	(76,768)	(20.3)
2030	(7)(8)	**136,638**	**112,133**	**(24,505)**	**(17.9)**	**395,843**	**312,543**	**(83,300)**	**(21.0)**
2031	(5)(6)	142,053	116,818	(25,235)	(17.8)	408,018	325,199	(82,819)	(20.3)
2032	(3)	147,556	121,161	(26,395)	(17.9)	421,578	336,614	(84,964)	(20.2)
2033	(5)(6)(7)	153,454	126,488	(26,966)	(17.6)	445,125	350,791	(94,334)	(21.2)
2034		159,475	131,189	(28,286)	(17.7)	459,609	362,925	(96,684)	(21.0)
2035	(5)(6)(8)	**162,796**	**137,811**	**(24,985)**	**(15.3)**	**468,176**	**389,071**	**(79,105)**	**(16.9)**
2036	(3)(7)	168,198	143,532	(24,666)	(14.7)	488,854	401,580	(87,274)	(17.9)
2037		172,789	146,533	(26,256)	(15.2)	500,997	409,738	(91,259)	(18.2)
2038	(5)(6)	179,057	150,840	(28,217)	(15.8)	518,464	421,768	(96,696)	(18.7)
2039	(7)	183,304	154,442	(28,862)	(15.7)	539,726	431,637	(108,089)	(20.0)
2040	(3)(5)(6)(8)	**193,928**	**156,020**	**(37,908)**	**(19.5)**	**569,042**	**443,501**	**(125,541)**	**(22.1)**
2041		199,347	159,341	(40,006)	(20.1)	583,712	452,357	(131,355)	(22.5)
2042	(7)	204,475	163,204	(41,271)	(20.2)	607,955	462,694	(145,261)	(23.9)
2043		210,701	167,189	(43,512)	(20.7)	625,199	473,312	(151,887)	(24.3)
2044	(3)	217,663	171,769	(45,894)	(21.1)	644,578	485,546	(159,032)	(24.7)
2045	(7)(8)	**222,583**	**173,461**	**(49,122)**	**(22.1)**	**669,797**	**498,222**	**(171,575)**	**(25.6)**
2046		229,244	176,696	(52,548)	(22.9)	688,526	506,904	(181,622)	(26.4)
2047		236,368	180,012	(56,356)	(23.8)	708,164	515,768	(192,396)	(27.2)
2048	(3)(7)	243,276	183,912	(59,364)	(24.4)	740,630	526,257	(214,373)	(28.9)
2049			186,891				534,063		
2050	(8)		**188,172**				**546,614**		

(1) Net Revenue includes adjustments for unbillable or uncollectable toll revenue.
(2) 2018 Update Study includes actual data through October 2018. Current Base Case Forecast includes actual data through March 2020.
(3) Leap Year.
(4) COVID-19 traffic impacts have been included in 2020 due to stay-at-home orders, public space closures and other travel restrictions.
Some recovery is assumed in 2021, though longer-term traffic impacts of 8.1 percent have been included through the remainder of the forecast period.
(5) Under the 2018 Update Study Forecast, assumed widening of various segments of the E-470 mainline.
(6) Under the Current Base Case Forecast, assumed widening of various segments of the E-470 mainline.
(7) Under the 2018 Update Study Forecast, assumed 2.1 Percent Systemwide Toll Increase.
(8) Under the Current Base Case Forecast, assumed 2.0 Percent Systemwide Toll Increase.

Estimated Sensitivity Test Traffic and Revenue

The Base Case traffic and revenue forecasts included in the report are based on certain assumptions and forecast of future economic growth and other events which are ultimately subject to some level of uncertainty. As such, it is typical in traffic and revenue studies of this nature to conduct sensitivity tests aimed at identifying the sensitivity of revenue forecasts to potential changes in certain basic assumptions or future forecasts of underlying variables. Sensitivity tests typically include hypothetical changes in future socioeconomic growth forecasts, value of time assumptions and so forth. For purposes of this study, traffic forecasts for the following three different sensitivity tests were developed:

1. Second Wave of COVID-19 Impacts in 2021
2. Long-Term Reduced Economic Growth (50 Percent Lower Trip Table Growth)
3. Reduced Value of Time (25 Percent VOT Growth Reduction after 2024)

For each of the various sensitivity tests, the alternative transaction and revenue estimate is shown for each respective year of tests and the percent impact as compared with the Base Case estimates. After 2025, interim year forecasts were not developed. The sensitivity tests were produced using all of the same socioeconomic inputs, highway improvements, values of time, vehicle operating costs, toll rates, and toll revenue leakage assumptions as the Base Case forecasts, except those being assessed in the particular sensitivity test.

It is important to recognize that all of the sensitivity tests assessed herein are hypothetical conditions and represent departures from economic forecasts or assumptions used in the Base Case traffic and revenue estimates. These tests are intended to show potential impacts on traffic and revenue of these hypothetical changes from basic assumptions.

Second Wave of COVID-19 Impacts

One possibility being discussed by health officials is the potential for a second wave of COVID-19 cases to occur in 2021. For this sensitivity test, CDM Smith developed estimates of COVID-19 second wave cases. These estimates assumed an increase in COVID-19 cases beginning in late December 2020, reaching a peak in late January 2021. The peak of this second wave is roughly half of the actual cases recorded during 2020. Based on this, a sensitivity test was developed assuming that a second wave of transactions and revenue impacts will occur in 2021 at 50 percent of the level observed in 2020. These impacts would be a result of self-quarantining, new stay-at-home orders, increased telecommuting and social distancing resulting from a return of COVID-19.

The assumed impacts to transactions and net toll revenue for a second wave of COVID-19 are illustrated in **Figure 4-6**. These impacts account for both the short-term impacts of the COVID-19 stay-at-home orders and other closures, as well as the long-term structural economic impacts that would occur as a result of the crisis. Based on this assessment, an additional 19.4 percent negative impact to transactions was assumed in 2021 over the Base Case forecast. Forecasted 2021 transactions and net toll revenues under the Second Wave of COVID-19 scenario are 70.7 million and $192.2 million, respectively, as presented in **Table 4-9**. After 2021, it was assumed normal growth rates would resume, consistent with those forecasted under the Base Case. However, the additional impact in 2021, representing a delay in the full year-over-year recovery from the COVID-19 impacts, would result in a 4.7 percent reduction in transactions through the remainder of the forecast period. This results in a roughly 5- to 6-year lag in growth as E-470 transactions and revenues recover. By 2040, the estimated reduction in transactions and net toll revenue between the current study Base Case and the prior 2018 Study increases to 37.9 million and $125.5 million, respectively. Estimated 2040 transactions and revenues under the Second Wave of COVID-19 scenario are 149.2 million and $422.6 million, respectively.

Figure 4-6
Estimated Weekly COVID-19 Impacts to E-470 Transactions with 2021 Second Wave of COVID-19

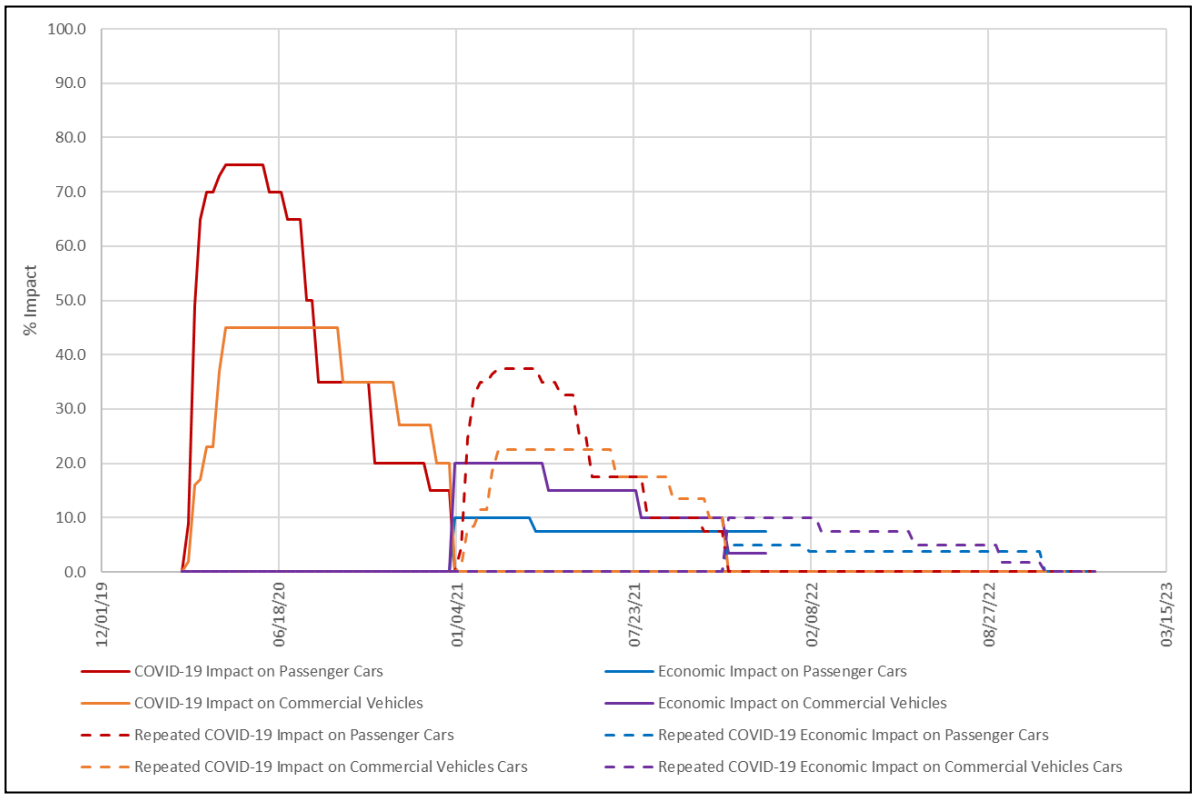


Table 4-9
Comparison of Base Case and Second COVID-19 Wave Sensitivity Test Transaction and Revenue Forecasts 2019 to 2050

		Annual Transactions (000s)				Annual Net Revenue ($000s) (1)			
Year		Current Study Base Case	Second Wave of COVID-19 Sensitivity Test	Difference	Percent Difference	Current Study Base Case	Second Wave of COVID-19 Sensitivity Test	Difference	Percent Difference
2019	(2)	**90,280**	**90,280**	-	-	**$ 249,013**	**$ 249,013**	**$ -**	-
2020	(2)(3)	59,905	59,905	-	-	162,727	162,727	-	-
2021	(3)	**88,003**	**70,740**	**(17,263)**	**(19.6)**	**238,354**	**192,221**	**(46,133)**	**(19.4)**
2022	(3)	89,957	86,003	(3,954)	(4.4)	243,731	232,221	(11,510)	(4.7)
2023		92,148	88,097	(4,050)	(4.4)	249,832	238,034	(11,798)	(4.7)
2024		96,055	91,833	(4,222)	(4.4)	259,987	247,710	(12,278)	(4.7)
2025	(4)	**97,475**	**93,191**	**(4,285)**	**(4.4)**	**269,306**	**256,588**	**(12,718)**	**(4.7)**
2030	(4)	**112,133**	**107,204**	**(4,929)**	**(4.4)**	**312,543**	**297,784**	**(14,760)**	**(4.7)**
2035	(4)	**137,811**	**131,753**	**(6,058)**	**(4.4)**	**389,071**	**370,698**	**(18,374)**	**(4.7)**
2040	(4)	**156,020**	**149,162**	**(6,858)**	**(4.4)**	**443,501**	**422,557**	**(20,944)**	**(4.7)**
2045	(4)	**173,461**	**165,836**	**(7,625)**	**(4.4)**	**498,222**	**474,693**	**(23,528)**	**(4.7)**
2050	(4)	**188,172**	**179,901**	**(8,271)**	**(4.4)**	**546,614**	**520,800**	**(25,813)**	**(4.7)**

(1) Net Revenue includes adjustments for unbillable or uncollectable toll revenue.
(2) Forecasts include actual data through March 2020.
(3) COVID-19 traffic impacts have been included in 2020 due to stay-at-home orders, public space closures and other travel restrictions.
Under the Base Case, some recovery is assumed in 2021, though longer-term traffic impacts of 8.1 percent have been included through the remainder of the forecast period.
Under the Sensitivity Test, a second wave of impacts is assumed in 2021, with a longer-term traffic impacts of 12.1 percent included through the remainder of the forecast period.
(4) Assumed 2.0 percent Systemwide Toll Increase.

Reduced Regional Growth

A key underlying parameter of any traffic and revenue forecast is estimated future economic growth in the project corridor. This particular sensitivity test was intended to evaluate the impact of a hypothetical long-term reduced level of overall economic growth throughout the entire corridor. It was simulated by reducing the net growth in trips in the trip tables by 50 percent from the rate of growth assumed in the Base Case forecasts. The 50 percent reduction in growth resulted in an average annual growth rate reduction ranging from 0.60 to 0.77 percent. This translated into overall trip table reductions of 2.9 percent in 2025, 6.3 percent in 2030, 8.6 percent in 2035 and 10.8 percent in 2040. Traffic assignments were rerun at 2025, 2030, 2035 and 2040 levels under the reduced growth assumptions and estimates of transactions and collected toll revenue were developed for those years. **Table 4-10** compares the resulting sensitivity test estimates of annual transactions and collected toll revenue against the Base Case forecasts.

Total transactions in 2025 are 93.7 million under the reduced growth assumptions of this sensitivity test. This represents a reduction in transactions of 3.9 percent over the Base Case scenarios. The level of impacts increases in 2035 to 10.8 percent, likely due to the reduction of assumed develop impacts in that year. A larger negative transaction impact of 12.8 percent is forecasted for 2040, with total transactions for the Reduced Growth scenario estimated at 136.0 million in that year. The transaction impacts beyond 2040 are estimated to continue to increase as estimated normal growth rates cause transactions to continue to diverge from the Base Case.

Table 4-10
Comparison of Base Case and Reduced Growth Sensitivity Test Transaction and Revenue Forecasts
2019 to 2050

		Annual Transactions (000s)				Annual Net Revenue ($000s) (1)			
Year		Current Study Base Case	Reduced Growth Sensitivity Test	Difference	Percent Difference	Current Study Base Case	Reduced Growth Sensitivity Test	Difference	Percent Difference
2019	(2)	**90,280**	**90,280**	-	-	**$ 249,013**	**$ 249,013**	**$ -**	-
2020	(2)(3)	59,905	59,905	-	-	162,727	162,727	-	-
2021	(3)	**88,003**	**88,003**	-	-	**238,354**	**238,354**	-	-
2022		89,957	88,848	(1,109)	(1.2)	243,731	240,812	(2,919)	(1.2)
2023		92,148	89,883	(2,265)	(2.5)	249,832	243,871	(5,961)	(2.4)
2024		96,055	92,562	(3,493)	(3.6)	259,987	250,770	(9,217)	(3.5)
2025	(4)	**97,475**	**93,689**	**(3,786)**	**(3.9)**	**269,306**	**258,878**	**(10,428)**	**(3.9)**
2030	(4)	**112,133**	**107,920**	**(4,213)**	**(3.8)**	**312,543**	**302,217**	**(10,326)**	**(3.3)**
2035	(4)	**137,811**	**122,934**	**(14,877)**	**(10.8)**	**389,071**	**347,248**	**(41,824)**	**(10.7)**
2040	(4)	**156,020**	**136,008**	**(20,012)**	**(12.8)**	**443,501**	**387,644**	**(55,857)**	**(12.6)**
2045	(4)	**173,461**	**143,950**	**(29,511)**	**(17.0)**	**498,222**	**409,006**	**(89,216)**	**(17.9)**
2050	(4)	**188,172**	**150,628**	**(37,544)**	**(20.0)**	**546,614**	**426,858**	**(119,755)**	**(21.9)**

(1) Net Revenue includes adjustments for unbillable or uncollectable toll revenue.
(2) Forecasts include actual data through March 2020.
(3) COVID-19 traffic impacts have been included in 2020 due to stay-at-home orders, public space closures and other travel restrictions.
Some recovery is assumed in 2021, though longer-term traffic impacts of 8.1 percent have been included through the remainder of the forecast period.
(4) Assumed 2.0 percent Systemwide Toll Increase.

Impacts to net toll revenues in 2025 and 2040 are comparable to the impacts estimated for transactions. Variations between the percent impact to transactions and net toll revenue are mostly due to slight changes in assumed ExpressToll participation rates between the two scenarios. Total collected toll revenues under the reduced growth assumptions are $258.9

million in 2025 and $387.6 million in 2040, representing respective impacts of 3.9 and 12.6 percent below the Base Case.

Reduced Value of Time

Value of time (VOT) is an important input parameter in estimating motorists' willingness to pay tolls. With a reduction in the assumed VOT, motorists would be less willing to pay a toll to take advantage of the potential time savings provided by E-470. A sensitivity test was developed to evaluate the impact of a hypothetical 25 percent decrease in growth of the VOT. Thus, instead of increasing VOT by 2.0 percent annually, consistent with historical and projected increases in CPI, VOT was increased by only 1.5 percent annually under this sensitivity test. Under the Base Case scenarios, the value of time averaged $0.361 per minute in 2025 and $0.486 per minute in 2040. These values were reduced under this sensitivity test to an average of $0.354 per minute in 2025 and $0.442 per minute by 2040, as shown in **Table 4-11**. Traffic assignments were then rerun at 2022 and 2040 levels under the reduced value of time assumptions and estimates of transactions and collected toll revenue were developed for those years. **Table 4-12** compares the resulting sensitivity test estimates of annual transactions and collected toll revenue against the Base Case forecasts.

Table 4-11
Estimated Average Values of Time for Sensitivity Test

Model Year	Value of Time	
	Per Minute	Per Hour
2019	$ 0.320	$ 19.22
2020	0.327	19.61
2021	0.333	20.00
2025	0.354	21.23
2030	0.381	22.87
2035	0.411	24.63
2040	0.442	26.54

As shown in the **Table 4-12**, the difference in total E-470 transactions between the Reduced VOT Scenario and the Base Case grows through 2025, as the difference in the annual VOT growth rate compounds over time. Total E-470 transactions in 2025 are estimated to be 92.8 million, or about 4.6 million below the Base Case forecast. This represents a reduction in transactions of 4.7 percent. Over the course of the forecast period, the relative impact of the reduced VOT as compared to the Base Case is held relatively steady by the impacts of various highway improvements. These improvements to other facilities, which serve to decrease the relative time savings of E-470 under both scenarios, will not impact transactions as severely under the reduced VOT scenario and will thereby mitigate some of the compounding annual impacts. This is evident in the 2030 transactions estimates, where the congestion relief provided to I-25 and I-70 as a result of the scheduled opening of managed lanes on those facilities does not create as negative an impact to E-470 under the Reduced VOT scenario as it does under the Base Case. Thus,

estimated transactions in 2030 under the Reduced VOT scenario are only estimated to differ from the Base Case by 5.6 million or 5.0 percent. Other similar widenings and improvements in 2035 and 2040 also help to mitigate some of the reduced VOT impact over the forecast period. By 2040, estimated transactions under the Reduced VOT scenario are estimated to be 145.8 million, or 6.5 percent less than those under the Base Case. Lacking highway improvements beyond 2040, this percent impact is assumed to increase over the remainder of the forecast period.

Table 4-12
Comparison of Base Case and Reduced VOT Growth Sensitivity Test Transaction and Revenue Forecasts
2019 to 2050

		Annual Transactions (000s)				Annual Net Revenue ($000s) (1)			
Year		Current Study Base Case	Reduced Value of Time Sensitivity Test	Difference	Percent Difference	Current Study Base Case	Reduced Value of Time Sensitivity Test	Difference	Percent Difference
2019	(2)	**90,280**	**90,280**	-	-	**$ 249,013**	**$ 249,013**	**$ -**	-
2020	(2)(3)	59,905	59,905	-	-	162,727	162,727	-	-
2021	(3)	**88,003**	**88,003**	-	-	**238,354**	**238,354**	-	-
2022		89,957	88,737	(1,220)	(1.4)	243,731	240,519	(3,212)	(1.3)
2023		92,148	89,658	(2,489)	(2.7)	249,832	243,280	(6,552)	(2.6)
2024		96,055	92,219	(3,836)	(4.0)	259,987	249,862	(10,125)	(3.9)
2025	(4)	**97,475**	**92,847**	**(4,628)**	**(4.7)**	**269,306**	**256,058**	**(13,247)**	**(4.9)**
2030	(4)	**112,133**	**106,481**	**(5,652)**	**(5.0)**	**312,543**	**297,302**	**(15,241)**	**(4.9)**
2035	(4)	**137,811**	**129,875**	**(7,936)**	**(5.8)**	**389,071**	**365,565**	**(23,506)**	**(6.0)**
2040	(4)	**156,020**	**145,846**	**(10,174)**	**(6.5)**	**443,501**	**413,953**	**(29,548)**	**(6.7)**
2045	(4)	**173,461**	**155,224**	**(18,237)**	**(10.5)**	**498,222**	**444,054**	**(54,167)**	**(10.9)**
2050	(4)	**188,172**	**162,052**	**(26,121)**	**(13.9)**	**546,614**	**465,087**	**(81,527)**	**(14.9)**

(1) Net Revenue includes adjustments for unbillable or uncollectable toll revenue.
(2) Forecasts include actual data through March 2020.
(3) COVID-19 traffic impacts have been included in 2020 due to stay-at-home orders, public space closures and other travel restrictions.
Some recovery is assumed in 2021, though longer-term traffic impacts of 8.1 percent have been included through the remainder of the forecast period.
(4) Assumed 2.0 percent Systemwide Toll Increase.

Impacts to collected toll revenues differ slightly from the impacts estimated for transactions over the course of the forecast period. This is due to the fact that a reduction in the assumed value of time will affect LPT and ExpressToll customers differently, affecting the estimated method of payment split on E-470 and the resulting average toll rates. Total collected toll revenues in 2025 are estimated to be $256.1 million under the Reduced VOT scenario, representing an impact of $13.2 million or 4.9 percent. By 2040, total collected toll revenues under this sensitivity test are estimated to be $414.0 million, or 6.7 percent less than the Base Case.

Disclaimer

CDM Smith used currently accepted professional practices and procedures in the development of these traffic and revenue estimates. However, as with any forecast, 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 E-470 Public Highway Authority. CDM Smith also relied upon the reasonable assurances of other 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; 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 the E-470 Public Highway Authority. 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, global pandemics and 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.

CDM Smith is not, and has not been, a municipal advisor as defined in Federal law (the Dodd Frank Bill) to the E-470 Public Highway Authority and does not owe a fiduciary duty pursuant to Section 15B of the Exchange Act to the E-470 Public Highway Authority with respect to the information and material contained in this report. CDM Smith is not recommending and has not recommended any action to the E-470 Public Highway Authority. The E-470 Public Highway Authority 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.