



2020 Annual Report on Roadway Traffic Congestion in the Denver Region

September 2021



In response to the COVID-19 pandemic, several local governments temporarily expanded use of some streets for bicyclists and pedestrians, and installed features such as roundabouts to create a shared street environment.

Introduction

For the past 15 years, DRCOG's *Annual Report on Roadway Traffic Congestion in the Denver Region* has provided consistent analysis and monitoring of the performance of the region's roadways. The COVID-19 pandemic, which began affecting the United States in 2020, disrupted long-standing travel patterns as government policies and personal safety measures to reduce the spread of the virus changed how people traveled and the amount of vehicle traffic on the region's roadways.

The loss of life and economic disruption of the pandemic was tremendous, coupled with uncertainty and the challenging personal decisions it caused individuals and families to make. During the pandemic, businesses, restaurants, offices and schools closed or changed how they operated, significantly decreasing demand for travel. Personal safety measures resulted in people staying home and minimizing nonessential trips.

Communities and organizations across the region have demonstrated resilience in adapting and rebuilding as a result of the pandemic. DRCOG's

staff intends to use 2020 pandemic year data and observations to enhance the understanding of travel in the region, and use what it has learned to improve travel conditions.

In a deviation from the typical format of DRCOG's previous annual reports on congestion, this report addresses the extraordinary changes in regional travel that occurred in 2020. It illustrates the relationship between vehicle travel and roadway congestion through changes observed in 2020. The report also addresses how observations from 2020 may inform future transportation planning activities and explores the potential long-term effects of the pandemic, primarily in changes to work locations and time-of-day travel patterns.

The report concludes with regional travel projections for 2050 associated with the newly adopted 2050 Metro Vision Regional Transportation Plan. The 2050 plan, along with extensive local, regional and state planning efforts, created new considerations for how DRCOG will measure and monitor traffic congestion into the future.

Traffic volume variations in 2020

Pre-pandemic predictability

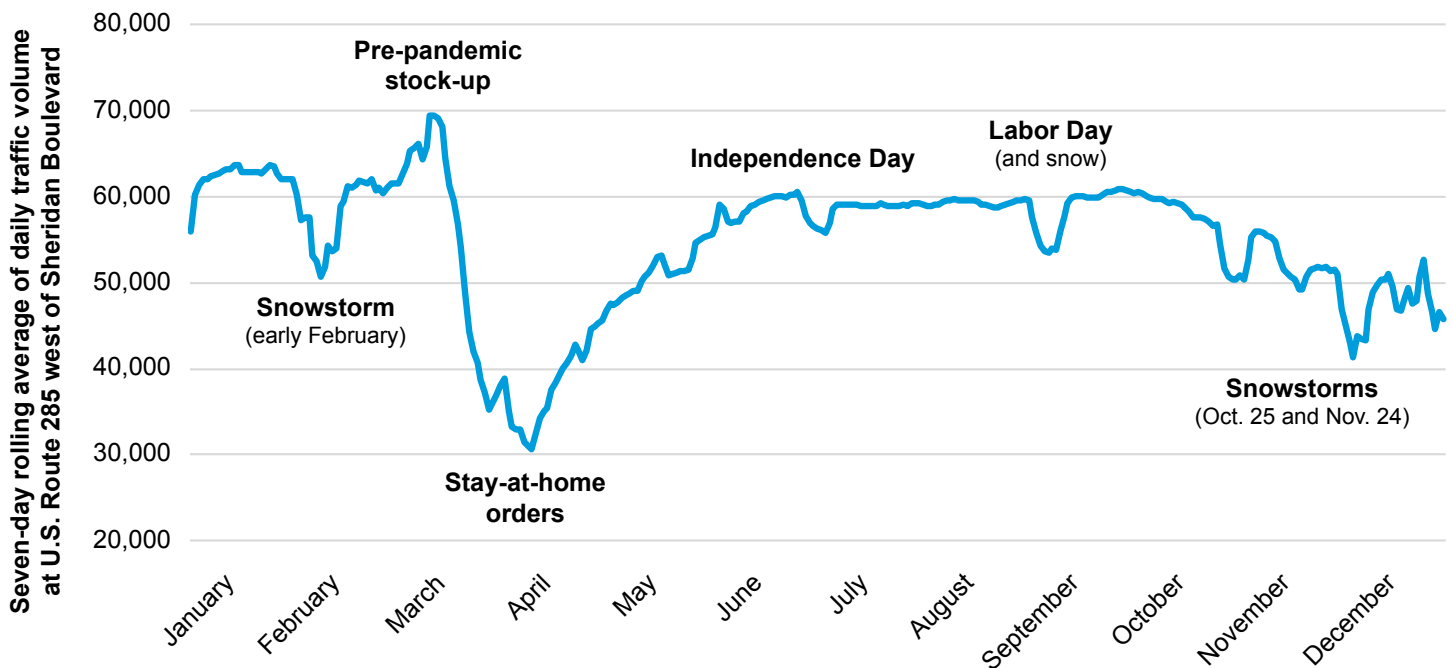
Traffic volumes and congestion in the beginning of 2020 were as expected by the region's transportation planners. January and February were comparable to the same months in 2019. But as in every year, daily variations due to snowstorms and other disruptive events caused unique daily vehicle travel results. Based on January and February alone, transportation planners expected that changes to traffic volume and congestion across the region would remain comparable to 2019 with new congestion in areas where significant growth and development had occurred during the previous year.

Pandemic disruptions

The pandemic began to influence traffic volumes and congestion in the Denver region in March 2020. Permanent traffic counters maintained by the Colorado Department of Transportation revealed an increase in volumes for a few days mid-March, likely due to individuals in the region stocking up on goods in anticipation of shortages and travel restrictions. Traffic volumes began to decline significantly in late March. The decrease in travel occurred for several reasons:

- Stay-at-home orders.
- Job loss and restricted options for leisure activities.
- An increase in teleworking.

Figure 1: 2020 traffic volume (representative sample)

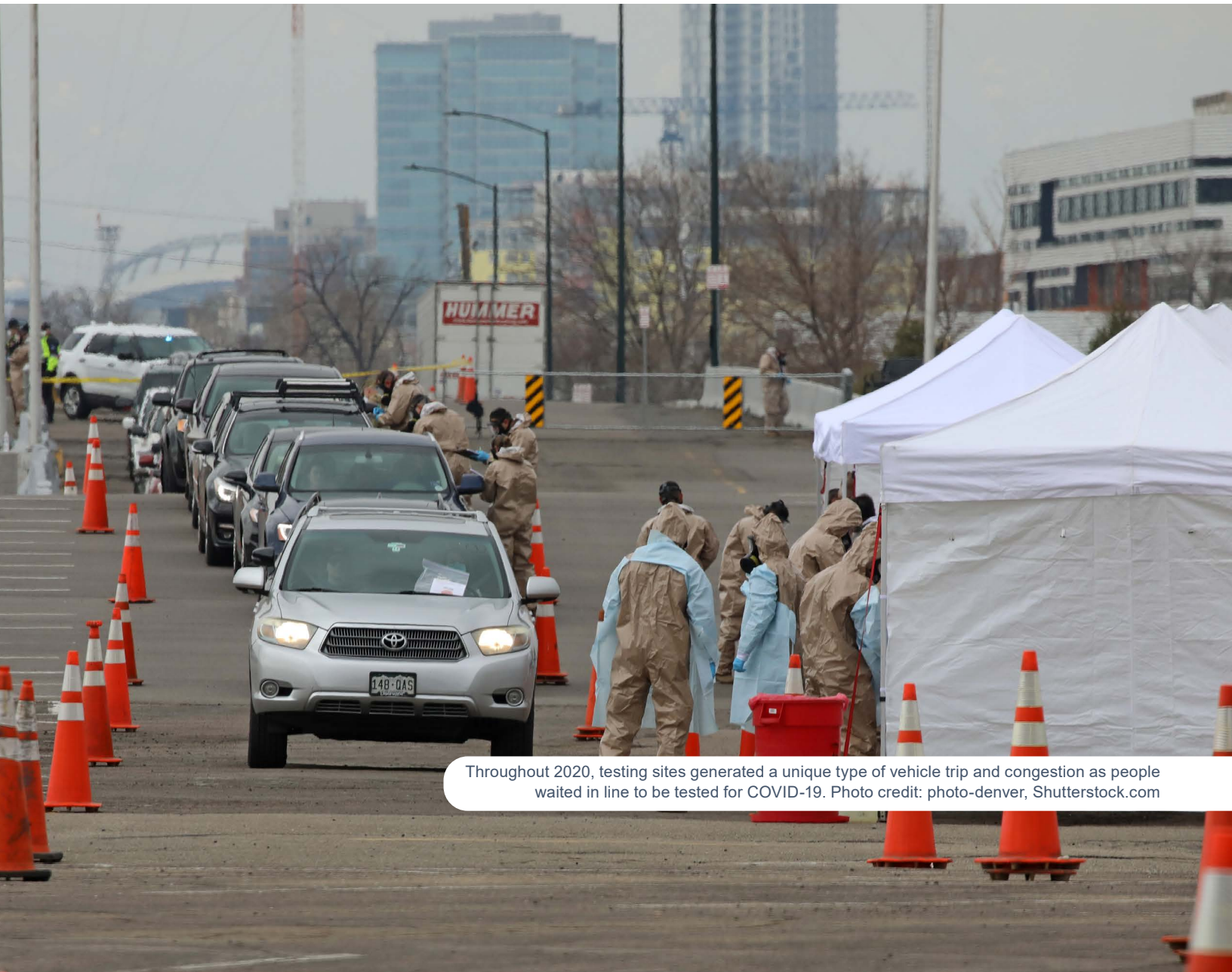


Source: Colorado Department of Transportation Automated Traffic Recorder Data

Figure 1 shows how traffic volumes changed on U.S. Route 285 west of Sheridan Boulevard, a representative roadway in the region. The volume displayed is a seven-day rolling average for all days of the week. Day-to-day averages reveal that total vehicle miles traveled on U.S. Route 285 bottomed out in April with 50-60% less vehicle miles traveled than in 2019.

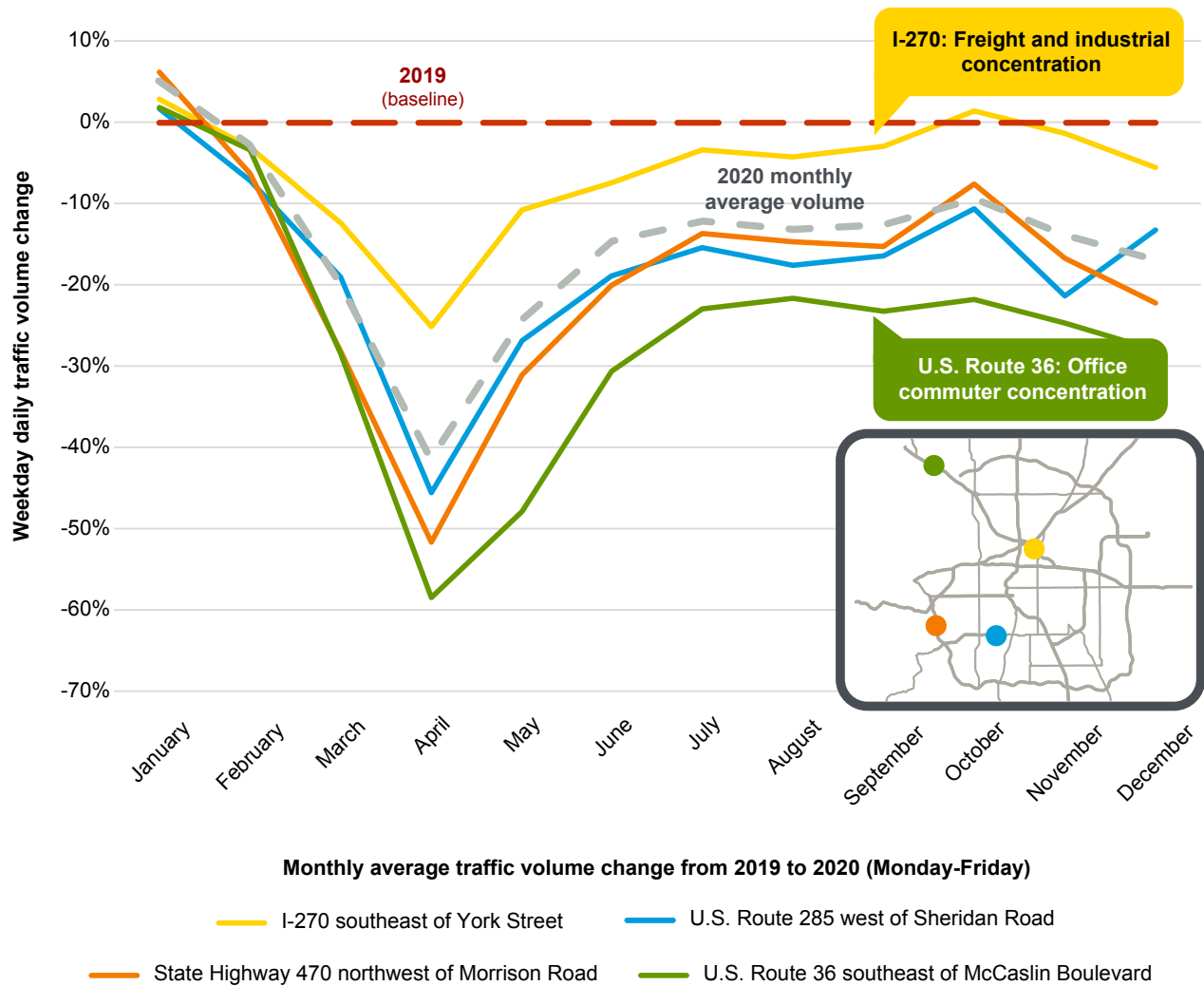
For the region as a whole, weekday traffic volumes in April 2020 were 40% less than in April 2019. Daily

traffic volumes increased through the spring. In June 2020, regional average volumes were approximately 15% less than in June 2019. By October 2020, average regional traffic volumes returned to approximately 10% less than they had been in October 2019. November and December brought more variation due to holiday travel and evolving gathering restrictions. For November and December, average weekday regional traffic volumes in 2020 were approximately 15-20% less than in 2019.



Throughout 2020, testing sites generated a unique type of vehicle trip and congestion as people waited in line to be tested for COVID-19. Photo credit: photo-denver, Shutterstock.com

Figure 2: 2019 to 2020 traffic volume changes



In 2020, regional traffic volume decreased regionwide from 2019 level, but the amount of the decrease varied widely at specific locations throughout the region. Source: Colorado Department of Transportation Automated Traffic Recorder Data

Differences by location

Despite some regionwide trends, the amount of the decrease in traffic volume varied greatly at specific locations across the region. Figure 2 shows the differences in volumes at four locations across the region, comparing Monday through Friday volumes in 2019 and 2020.

In April of 2020, monthly average traffic on U.S. Route 36 southeast of McCaslin Boulevard decreased by

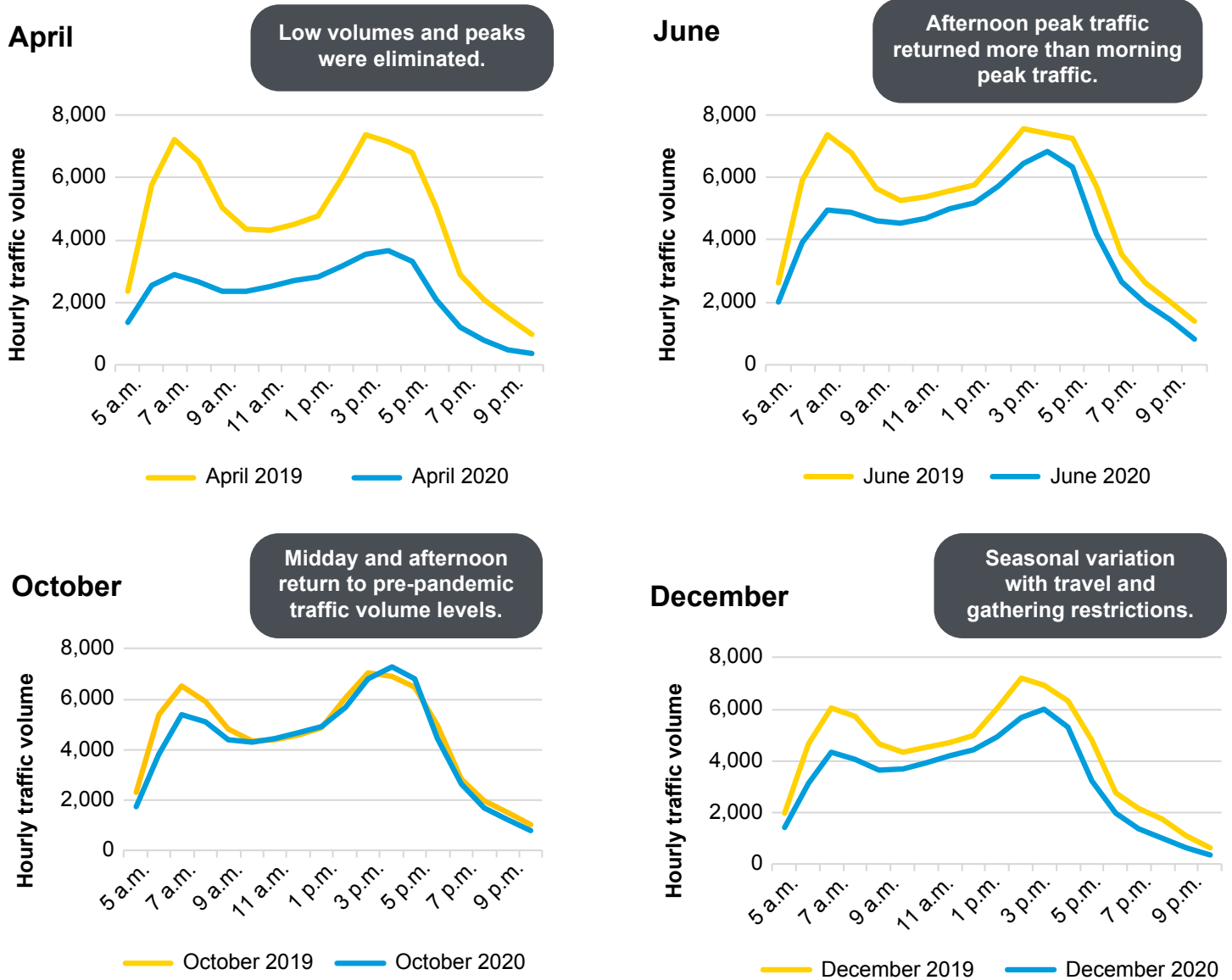
almost 60%, a considerably larger decrease than other locations where CDOT has permanent vehicle-counting equipment. The relative decrease in volumes persisted throughout the year, likely due to the high share of office commuters who use U.S. Route 36 who continued to work from home throughout 2020. At I-270 southeast of York Street, a higher share of commercial activity resulted in a decrease of only 25% in April 2020. By October 2020, this location had slightly more average weekday traffic than in 2019.

Differences by time of day

In response to the pandemic, people also changed the time of day they were traveling. Daily travel by hour and the distribution of traffic volumes throughout the day were affected by the differences in travel demand. Figure 3 shows hourly traffic volumes for State Highway 470 northwest of State Highway 8

(Morrison Road), comparing 2019 and 2020 for April, June, October and December. Generally, peak hour trips decreased more than midday trips. Afternoon peak trips returned to close to normal levels, while morning peak trips have not returned to 2019 levels.

Figure 3: Hourly traffic volumes on State Highway 470 northwest of Morrison Road by month



Source: Colorado Department of Transportation Automated Traffic Recorder Data.

Vehicle miles traveled

Every year, DRCOG staff estimates the annual change in total vehicle miles traveled on the region’s roadways during an average weekday.

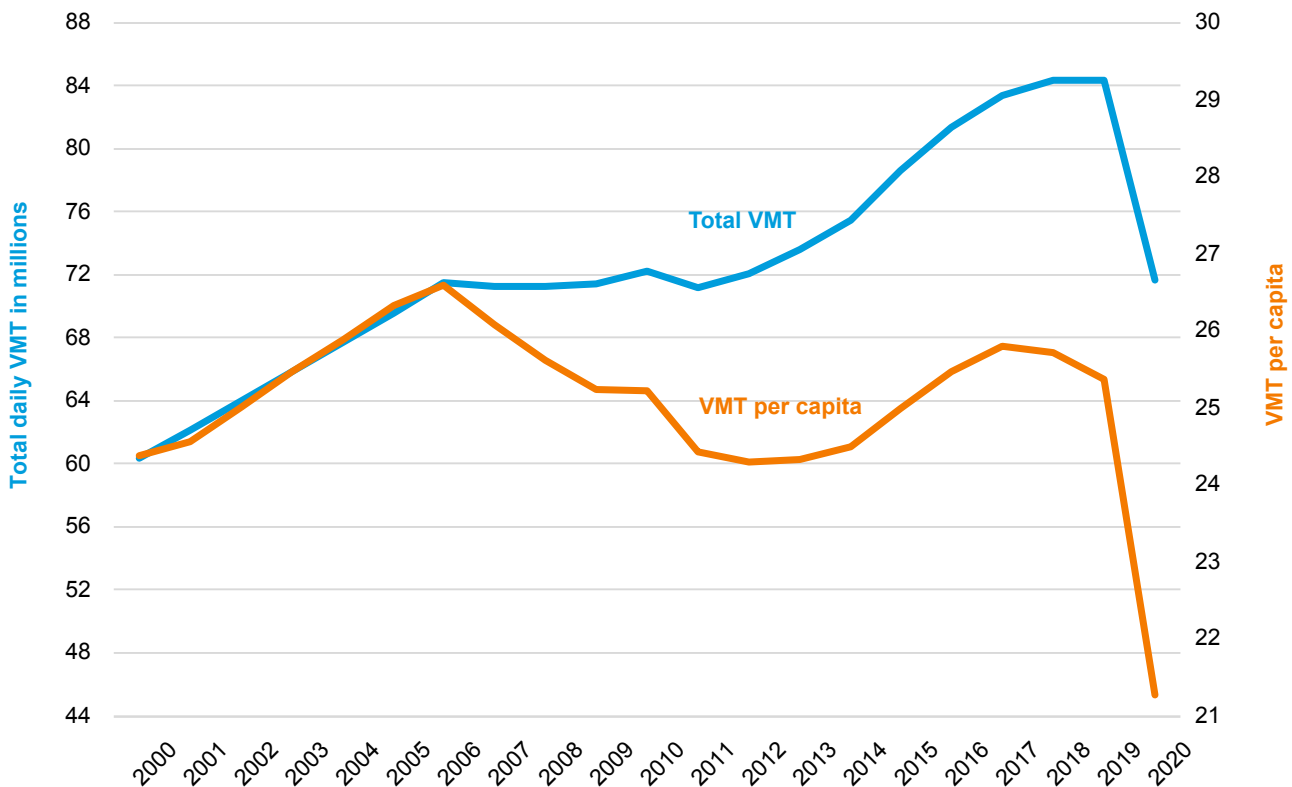
Seasonal variations and other disruptions commonly affect average daily VMT throughout the year. Even in a typical year, no two days’ results are exactly alike, however, the levels of variation throughout 2020 were unprecedented. Due to the extreme variation, estimating what would be considered the annual average VMT on all the segments across the region was particularly challenging. Ultimately, DRCOG staff estimated a 15% reduction from 2019 for traffic volumes across the region.

To understand VMT in 2020, DRCOG used its typical sources: regionwide short-term counts,

CDOT permanent traffic count locations, Federal Highway Administration VMT reports, and CDOT’s Highway Performance Monitoring System. This year, the availability of reliable year-to-year count data throughout the region was limited as many studies were put on hold, resulting in fewer available counts.

From 2000 to 2018, VMT in the region increased approximately 40% and then remained flat during the period before the pandemic affected the U.S. in 2020 (see Figure 4). However, during 2020, the average daily VMT declined by about 15% to levels not seen since between 2005 and 2011. The more significant VMT decrease in April and May reduced average weekday VMT in the region to below-2000 levels. In 2020, VMT per capita was significantly lower than in 2000, and likely lower than any time since the late 1980s.

Figure 4: Average daily vehicle miles traveled in the Denver region (2000-2020)



Source: DRCOG

Observations

Four key observations of travel and congestion during 2020 are explored further here. This section provides additional context beyond traffic volume data for each observation, and highlights the effects of the pandemic on travel behavior and roadway congestion.

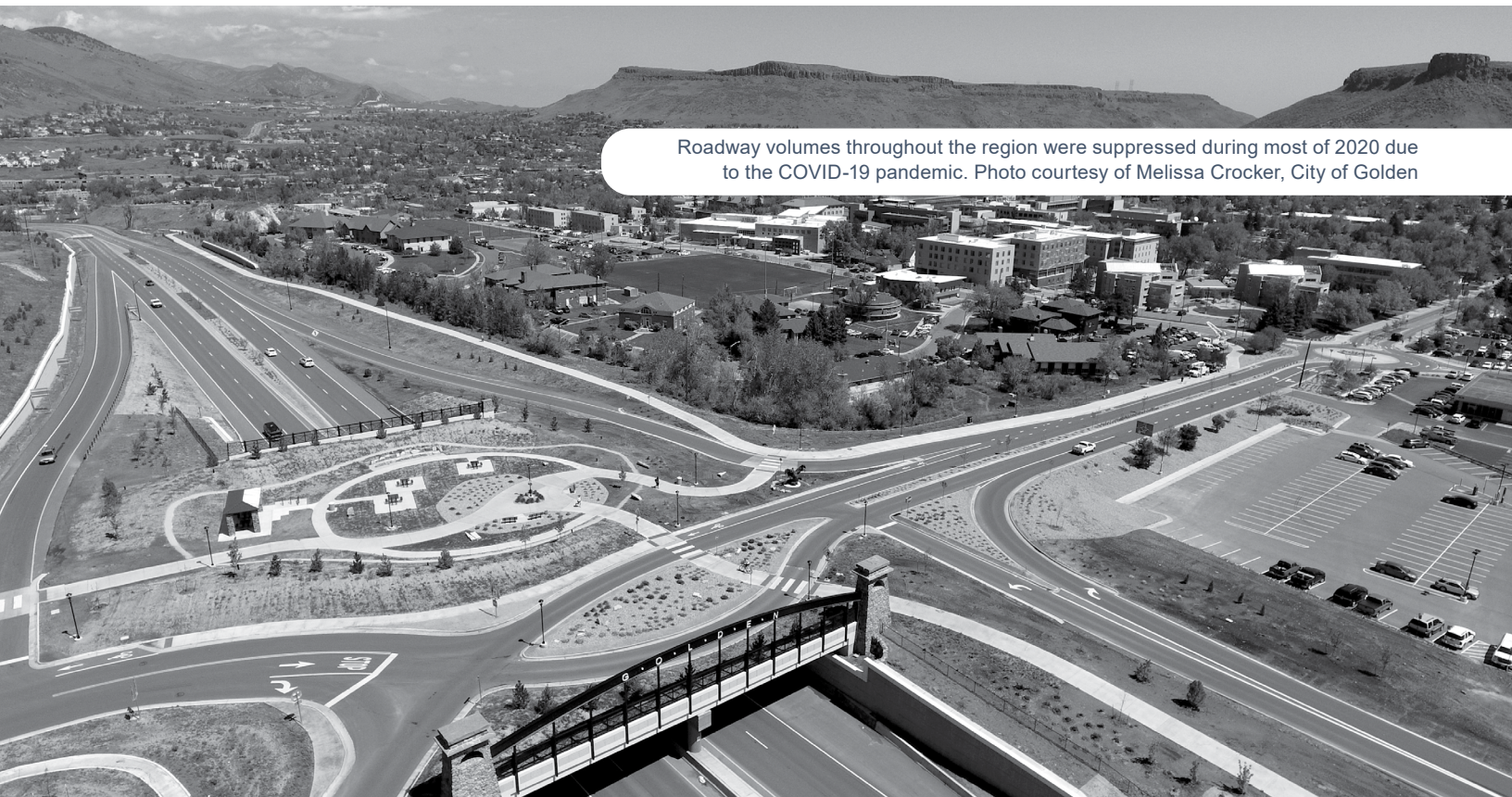
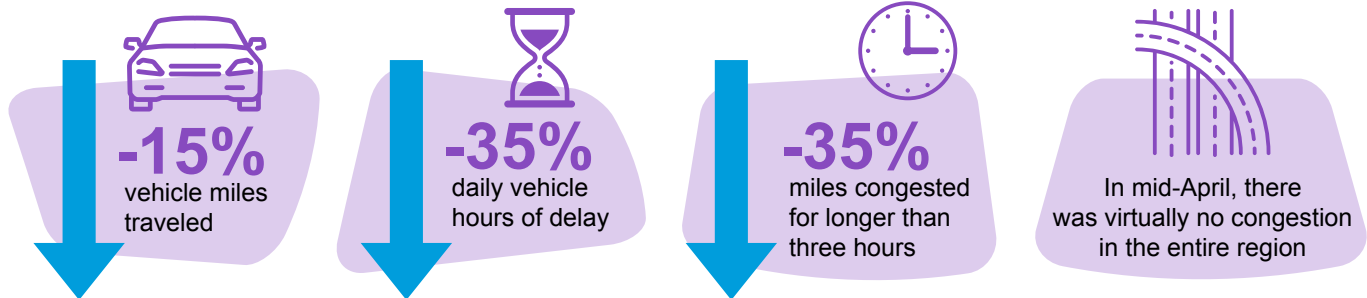
Observation 1: Congestion by the numbers

In 2020, there was significantly less traffic congestion and fewer travel delays than in years with comparable VMT because of the time-of-day of travel distribution

illustrated in Figure 3. DRCOG staff observed that as volumes at the traffic counters decreased, congestion delays and travel times decreased at an even higher rate. The relationship between traffic volumes and congestion is detailed later in the report.

Congestion is measured and tracked in the region in several ways. During 2020, DRCOG transportation staff observed significant changes in congestion due to the change in travel demand.

Congestion in 2020 compared with 2019

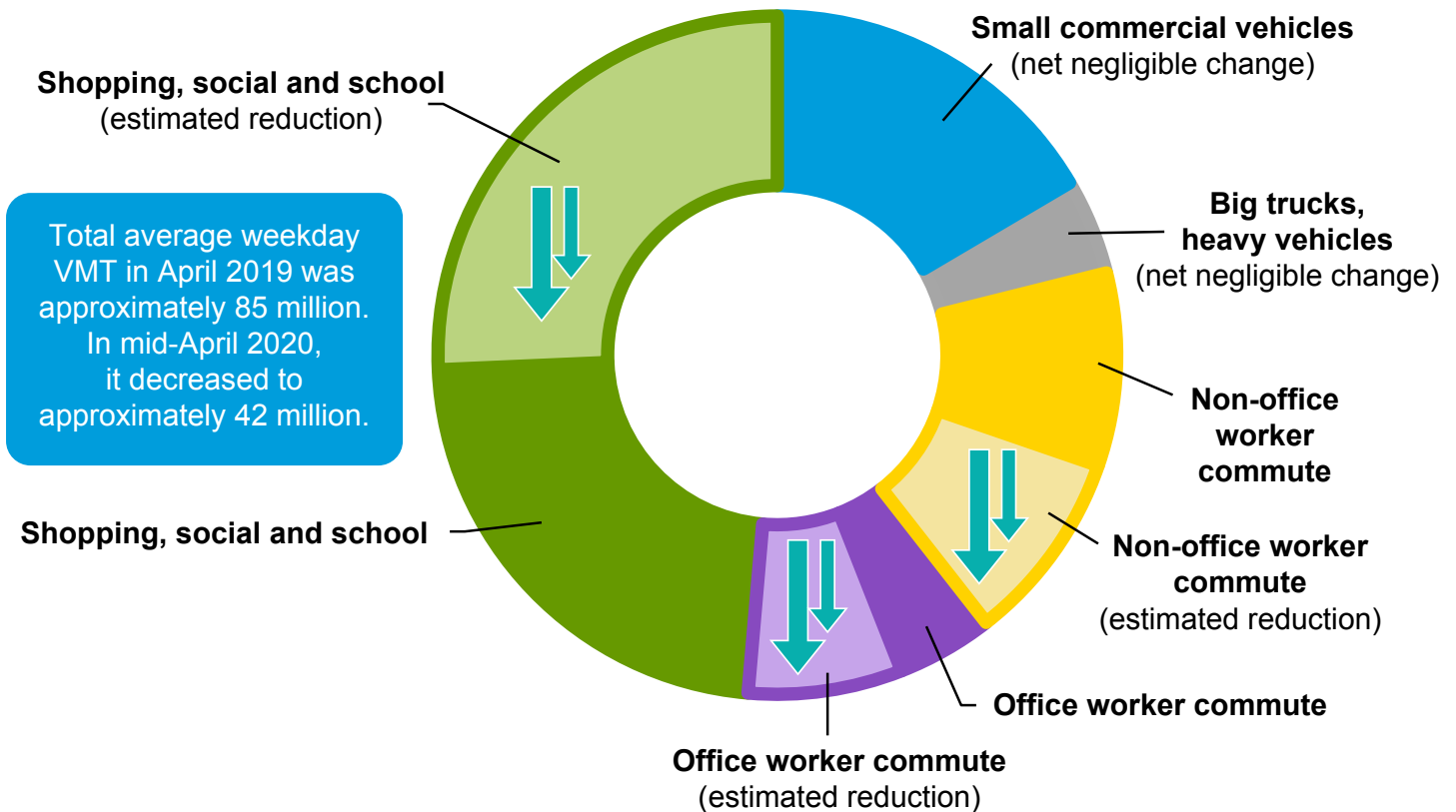


Observation 2: VMT change by trip purpose

Travel associated with certain trip purposes declined more significantly than others in 2020. Figure 5 shows the magnitude of change in VMT by the types of trips people made. April 2019 data is based on the national household travel survey and the regional travel model, while April 2020 estimates consider changes understood to have been caused by stay-at-home orders, business closures, a reduction of travelers using Denver International Airport and unemployment. Most of the reduction was due to people making fewer social, shopping and school trips. The data also reflected a major reduction of visitors to the Denver

region, with data from Denver International Airport showing a significant reduction in travel to and from the airport. Work-related VMT decreased due to people who were laid off, had work hours reduced or started teleworking more often. The ongoing increase in teleworking aligns with efforts by the staff of DRCOG’s Way to Go program and its transportation demand management partners to promote telework and flexible work schedules in the region. Figure 5 indicates net negligible change in commercial vehicle trip VMT. While there was likely a decrease in commercial vehicle trips to places like restaurants and retail outlets, there was an increase in household delivery trips.

Figure 5: Vehicle miles traveled by trip purpose: April 2019 and April 2020

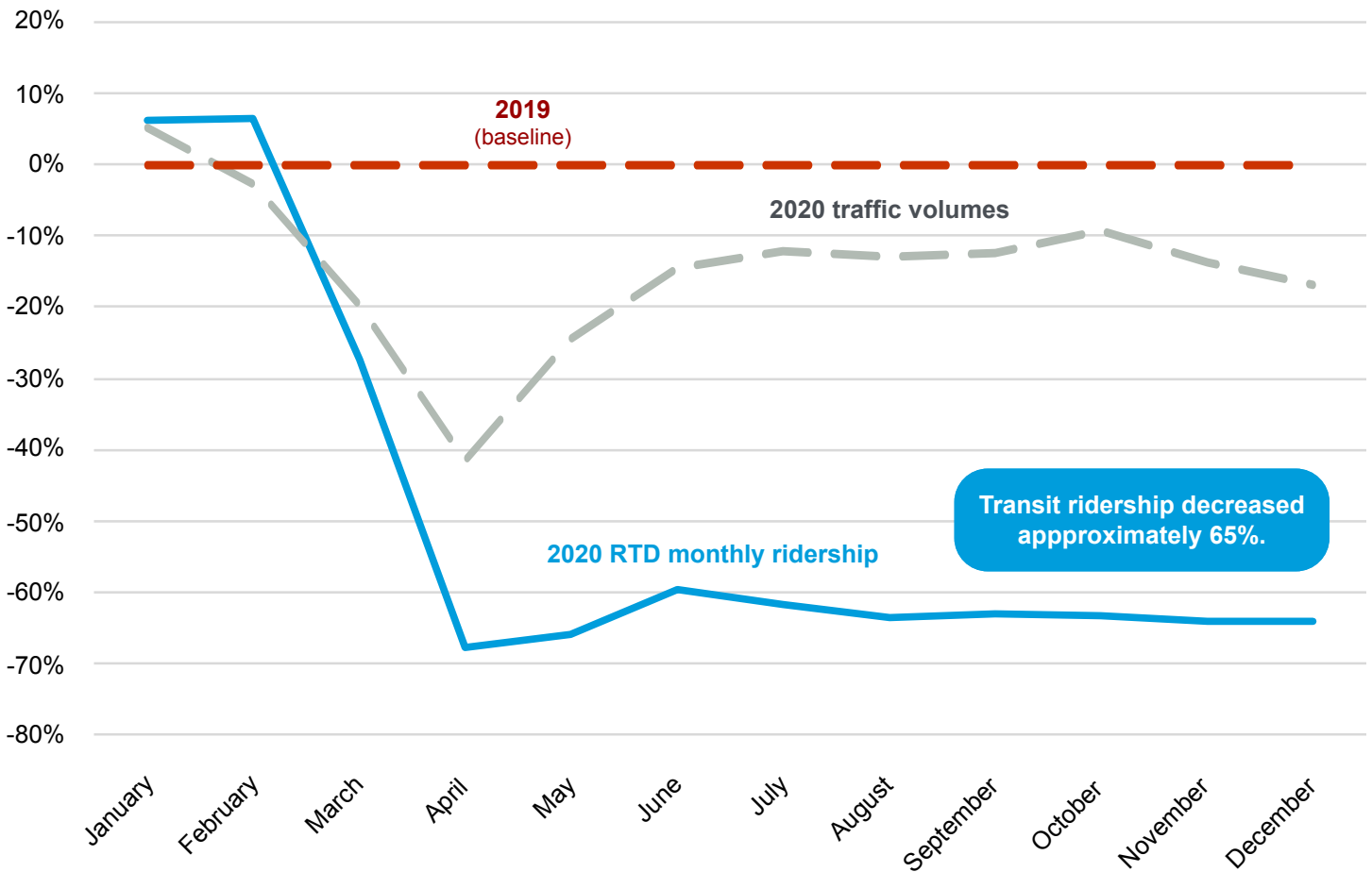


Observation 3: 2020 Regional Transportation District transit ridership

In March 2020, RTD's transit ridership decreased by nearly 70% of March 2019 ridership. While traffic volumes rebounded across the region, transit ridership did not. Figure 6 shows the sustained reduction of transit ridership throughout 2020, in contrast to the rebounding trend of vehicle volume recorded at the region's traffic count stations.

Fewer workers in office buildings, increased telework, concerns about virus transmission and reduced transit service levels have all contributed to the sustained reduction in transit ridership. Reimagine RTD, a two-year effort to identify comprehensive strategies to better connect people to the places they want and need to go, will shape efforts to regain ridership in the future as the region moves beyond the COVID-19 crisis.

Figure 6: 2019 to 2020 RTD ridership and traffic volume changes



Transit ridership decreased approximately 65%.

Source: National Transit Database

Observation 4: 2020 roadway fatality data

Despite an unprecedented year-over-year reduction in state and regional VMT, roadway fatalities in the Denver region only decreased slightly in 2020 compared with the most recent five-year average. Beyond the Denver region, fatalities in the rest of Colorado noticeably increased compared with

the most recent five-year average (see Table 1). Once nonfatal crash data for 2020 is published and processed, DRCOG will thoroughly analyze the full crash dataset. If, as the data suggests, notable reductions in traffic volume do not prevent fatalities, the challenges of increasing safety on the region's roadways — strictly through design and use considerations — have become even clearer in 2020.

Table 1: Annual roadway fatalities

	2015	2016	2017	2018	2019	2015-2019 average	2020*
Denver region	238	274	264	242	270	258	250
Outside the Denver region	309	334	384	390	326	349	372
Statewide	547	608	648	632	596	606	622

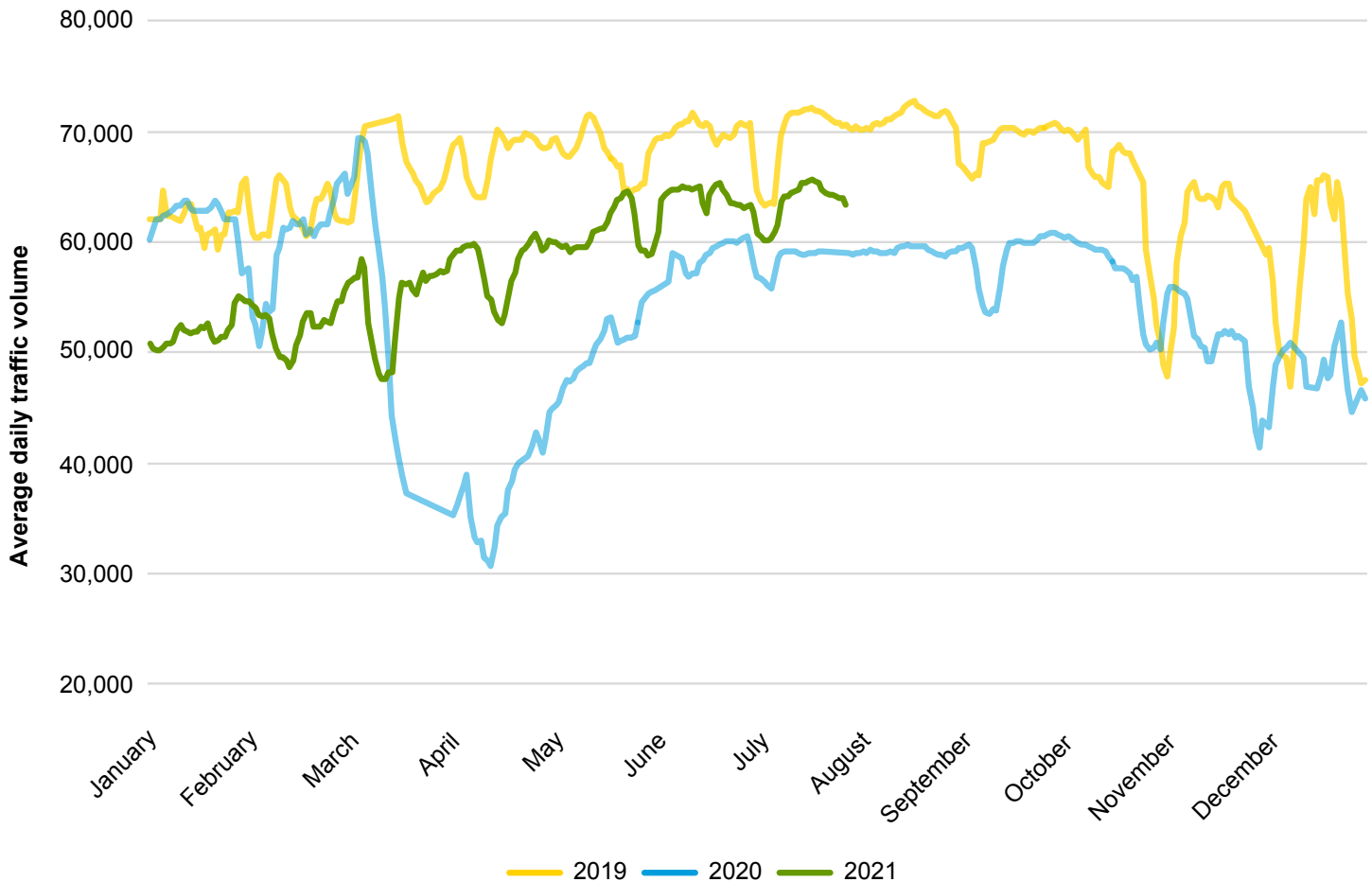
*2020 data was not official as of presstime.
Source: Colorado Department of Transportation

2021 – The pandemic story, continued

The pandemic did not end in 2020, and its effects on travel are ongoing. While DRCOG’s annual congestion reports focus on a single year of travel, DRCOG’s transportation staff believed it was important to consider preliminary data from 2021 given the evolving influence of the pandemic. Figure 7 shows the seven-day rolling average for 2019, 2020

and 2021 for U.S. Route 285, which DRCOG staff considers representative of the region as a whole. At presstime, traffic volumes were still below 2019 levels, but not nearly as dramatically as in 2020 due to changes caused by the immediate response to the pandemic in the region.

Figure 7: Traffic volumes in 2019, 2020 and 2021 (rolling average at U.S. Route 285 west of Sheridan Boulevard)



Source: Colorado Department of Transportation Automated Traffic Recorder Data

Peña Boulevard traffic volume

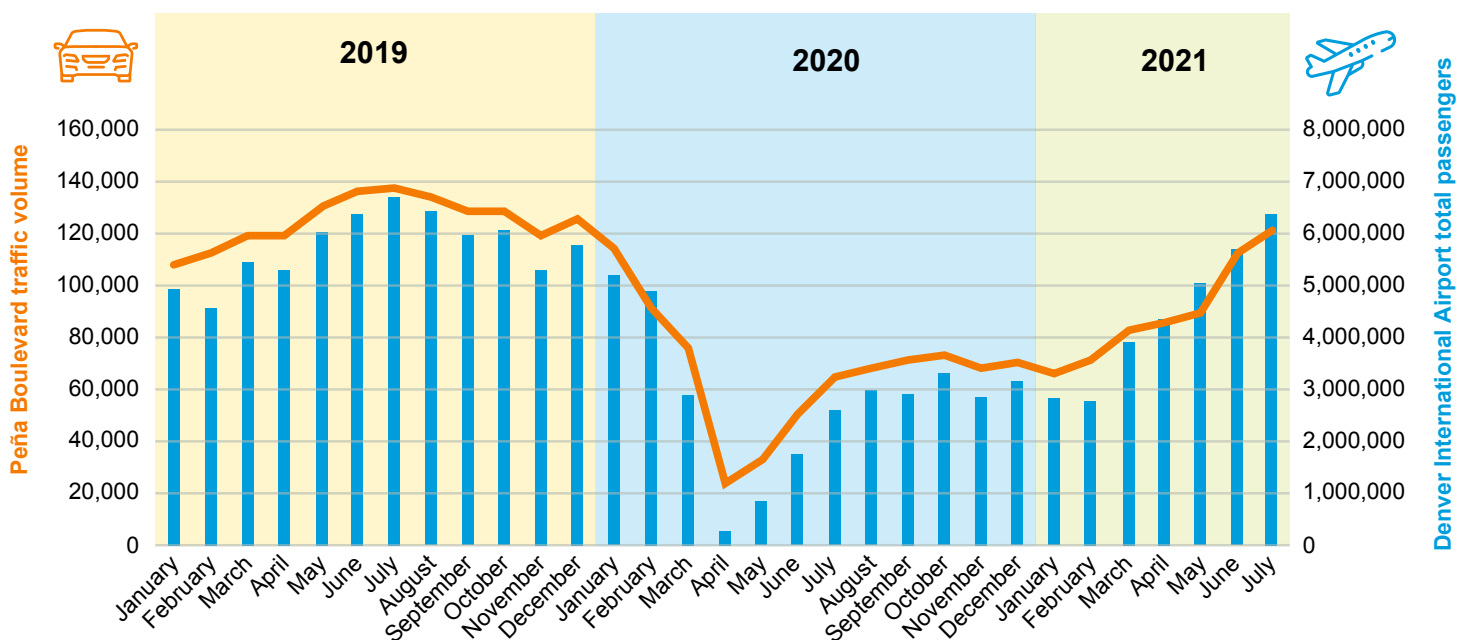
Peña Boulevard is a unique roadway within the region. While it carries freight and individual travelers, a large portion of the daily volume is related to airport travel, one of the sectors most drastically affected by the pandemic. Although many businesses across the region had reopened at full capacity by early 2021, the number of airline passengers did not return to 2019 levels, especially for business-related travel. Peña Boulevard traffic volumes decreased consistent with decreases among airline passengers.

Traffic volumes on Peña Boulevard east of E-470 were higher in January 2020 than the year before, reflecting the long-term trend of increasing airline traffic volumes at Denver International Airport. By April 2020, as a result of pandemic disruptions to

international and national travel, traffic volumes dropped to about 15% of the average volume in 2019. In December 2020, traffic volumes approached only 55% of the 2019 monthly average.

As this report was being finalized, total traffic volumes appeared to be increasing throughout the region, and airline travel had begun to recover as well. Figure 8 shows Peña Boulevard’s average daily traffic volumes month-to-month for 2019, 2020 and 2021, as well as total Denver International Airport passenger averages. Figure 8 clearly depicts the relationship between air travel and traffic on Peña Boulevard. The data reveals the evolution of travel during the pandemic, with travel gradually but steadily increasing during the spring of 2021. June 2021 reflected the largest jump in travel — to nearly pre-pandemic levels.

Figure 8: Peña Boulevard traffic and Denver International Airport total passengers by month



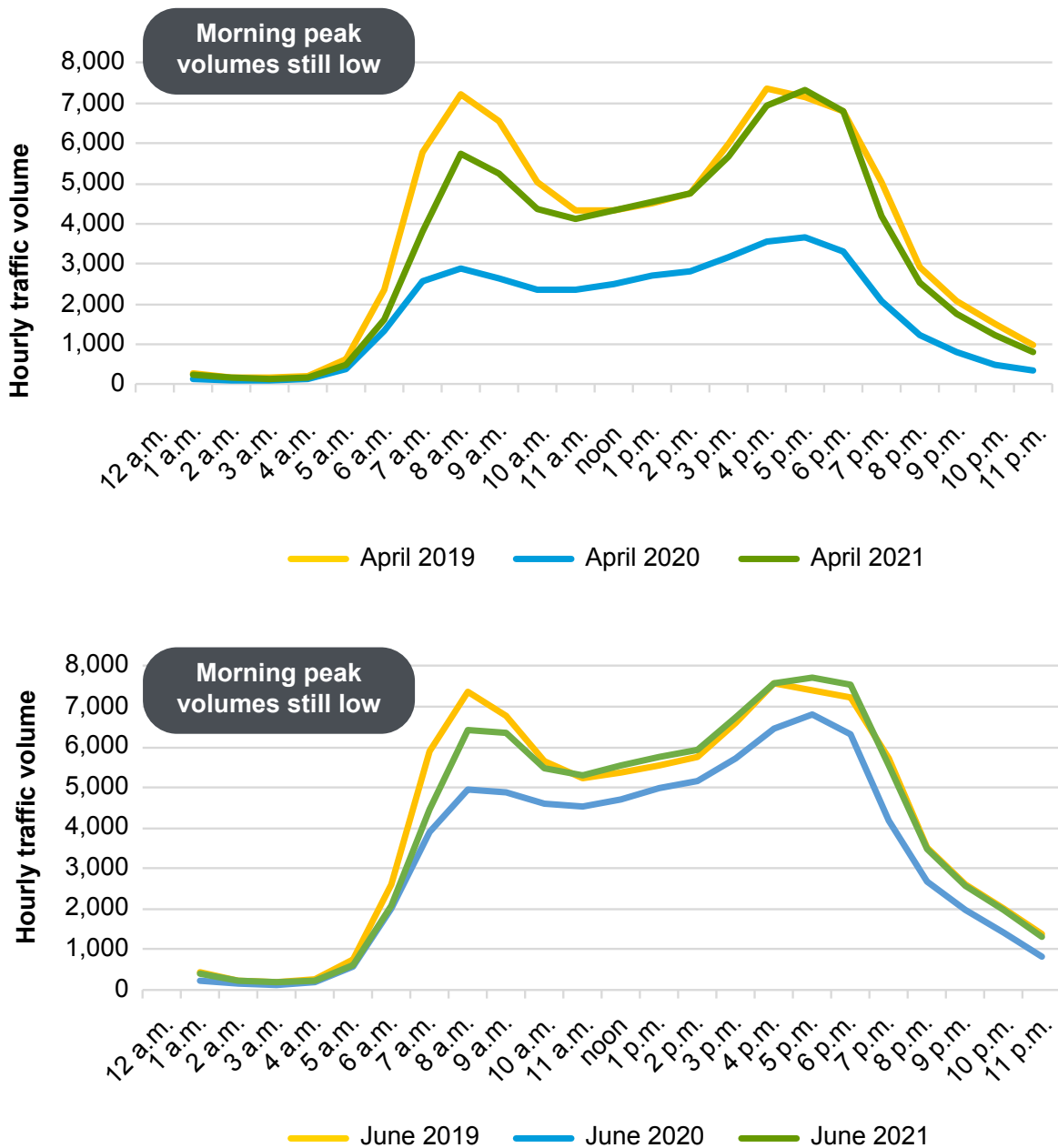
Peña Boulevard east of E-470 Traffic and Denver International Airport total passengers by month in 2019, 2020 and 2021. Source: Denver International Airport data.

Differences by time of day from 2019 to 2021

Figure 9 expands upon Figure 3 by including April 2021 and June 2021 time-of-day data. The data confirms that, as recently as June 2021, morning peak-period volumes remained below 2019 volumes.

While total traffic volumes throughout the region remain slightly lower than in 2019, the afternoon peak-period traffic has returned to 2019 levels at many locations throughout the region.

Figure 9: April and June hourly traffic volumes: State Highway 470 northwest of Morrison Road



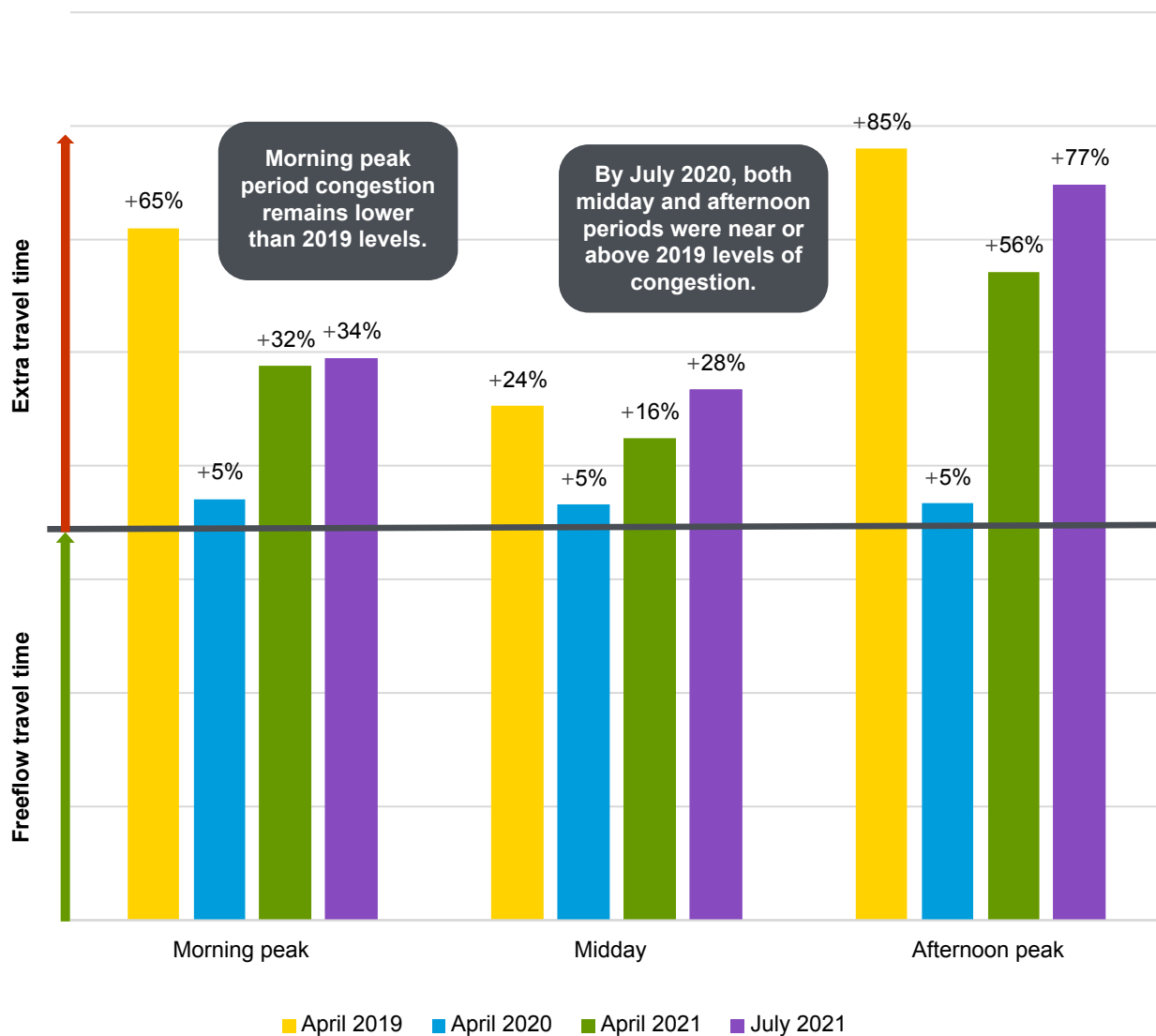
Hourly traffic volumes for April and June 2019; April and June 2020; and April and June 2021
 Source: Colorado Department of Transportation automated traffic recorder data.

Extra travel time

Due to the sustained decreases in total traffic volume, INRIX data reveals the most-congested freeways across the region, as defined in DRCOG's 2019 congestion report, experience slightly less congestion and faster travel times compared with 2019 on

average in the morning and afternoon peak periods. However midday congestion and travel times in July 2021 had returned to approximately the same levels as before the pandemic. Figure 10 compares the extra travel time caused by congestion on the region's most-congested freeways during different time-of-day periods in 2019 through 2021.

Figure 10: Average weekday travel time on the Denver region's most-congested freeways



Source: INRIX data

Why congestion decreased in 2020

Technical details

As explored earlier in this report, the region experienced significant decreases in travel in 2020. The decreased travel provided an example of how minor reductions in roadway traffic volumes can lead to even greater reductions in congestion. This section is technical, but it helps explain how congestion causes traffic delays.

With the exception of unexpected occurrences like severe weather or crashes, traffic congestion is primarily caused by:

1. The number of vehicles on a roadway (volume) compared with:
2. The operational capacity of the roadway, which incorporates:
 - a. The physical space on the roadway (lanes and shoulders).
 - b. Roadway physical factors such as on- and off-ramps, steep hills, traffic signals, and curb cuts.
 - c. The level of turbulence caused by varying vehicle movements such as weaving and braking.

Table 2: Volume-to-capacity and speed and travel time

	Example one-mile freeway Segment	Volume-to-capacity ratio	Average speed (mph)	Travel time (seconds)
●	Off-peak free flow	0.3	60	60
★	Peak hour congestion	1.25	20	180
✕	Peak hour with 15% reduction	1.06	35	103

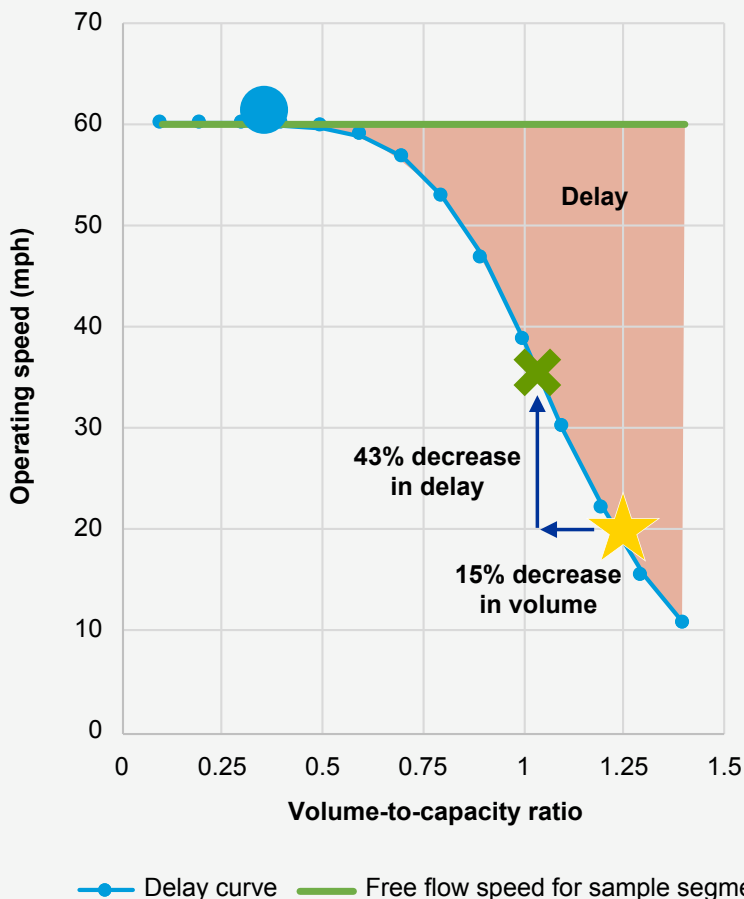
As the hourly traffic volume (V) of a roadway segment approaches the capacity (C), expressed in a ratio as V/C, there is an increase in stop-and-go delays and travel times increase. A delay formula is used to estimate the speed and travel time along a roadway given its volume-to-capacity ratio.

For example, if a congested freeway with a speed limit of 60 mph was carrying 15,000 vehicles per hour, and the roadway’s operational capacity was 12,000 vehicles per hour, the V/C would be calculated as

1.25. Using the delay curve shown in Figure 12, a 1.25 V/C ratio would signify the average speed on a 60 mph free-flow roadway would be reduced to 20 mph, or 33% of the free-flow operating speed.

In 2020, the region saw an average VMT decrease of 15%. Using the previous example, reducing 15,000 vehicles per hour by 15% to 12,750 per hour results in a V/C of 1.06 and an average speed of 35 mph. Thus, a 15% reduction in volume results in a 43% reduction in travel time, as depicted in Table 2 and Figure 11.

Figure 11: Freeway travel delay curve



Key takeaways:

- Decreases in vehicle turbulence from weaving traffic and on- and off-ramp movements have a significant effect on travel delays. How traffic flows is similar to how water moves in a river or through a pipe.
- Synchronization and maintenance of traffic signal timing on arterial streets affects overall congestion.
- Transportation demand management efforts which reduce minor amounts of total traffic can have a significant effect on congestion.

Congestion in 2050

Based on forecast data, DRCOG's staff anticipates the region will grow by more than 1 million people and add 600,000 new jobs by 2050. Between now and then, technological advancement will result in additional travel modes, mobility services and safety systems. [DRCOG's 2017 Annual Report on Roadway Traffic Congestion in the Denver Region](#) examined the future effects technology may have on regional transportation and DRCOG's endeavors to address them through efforts like the Advanced Mobility Partnership. Several categories of unknowns beyond DRCOG's staff's ability to make predictions will likely affect travel, including changes to transportation costs, and local and global economic and environmental disruptions. As DRCOG's staff plans for the transportation future of 2050, the pace of innovation and need to respond to unanticipated challenges guarantees that the region's overall transportation system will operate much differently in 30 years.

While all long-range planning efforts involve levels of uncertainty in their estimates, the COVID-19 pandemic demonstrated how quickly unpredictable disruptions to long-established norms can happen. Reflecting on the past year begs the question: Will the effects of the pandemic still have ramifications in 2050 or did they just accelerate existing trends and changes that were to come? Are some of the lifestyle changes people made in 2020 here to stay, or will the region's travelers return to status quo behaviors?

The 2050 Metro Vision Regional Transportation Plan outlines how the region will continue to improve transportation infrastructure and services as population grows. Considering the rapid adoption of teleworking during the pandemic, DRCOG has adjusted future-year modeling to reflect a sustained

increase in teleworking and working from home. Census data already indicated an increase in working from home from 2012-2019 and ongoing observations and reports from the business community indicate that an increased level of telework will likely be sustained into the future.

Understanding the limitations of long-range transportation planning estimates, this report is the first to include congestion metrics associated with DRCOG's 2050 Metro Vision Regional Transportation Plan. While the metrics represent just one future scenario, they are DRCOG staff's best attempt to represent travel in the region in 2050. The large increase in people and jobs in the region will be the primary influence on increased VMT and its associated congestion.

Because 2020 was such an anomaly, comparing 2020 with 2050 isn't meaningful, so this section uses 2019 congestion levels as the baseline for reference. The map in Figure 12 compares the most congested segments from 2019 with 2050 and demonstrates how many additional roads will experience high levels of congestion in the future based on four key metrics:

- **Severity:** How bad does congestion get on the roadway during rush hour?
- **Duration:** How many hours per day is the roadway congested?
- **Magnitude:** How many people (traffic volume) are affected by congestion on the roadway?
- **Reliability:** How often do crashes or incidents occur on the roadway?

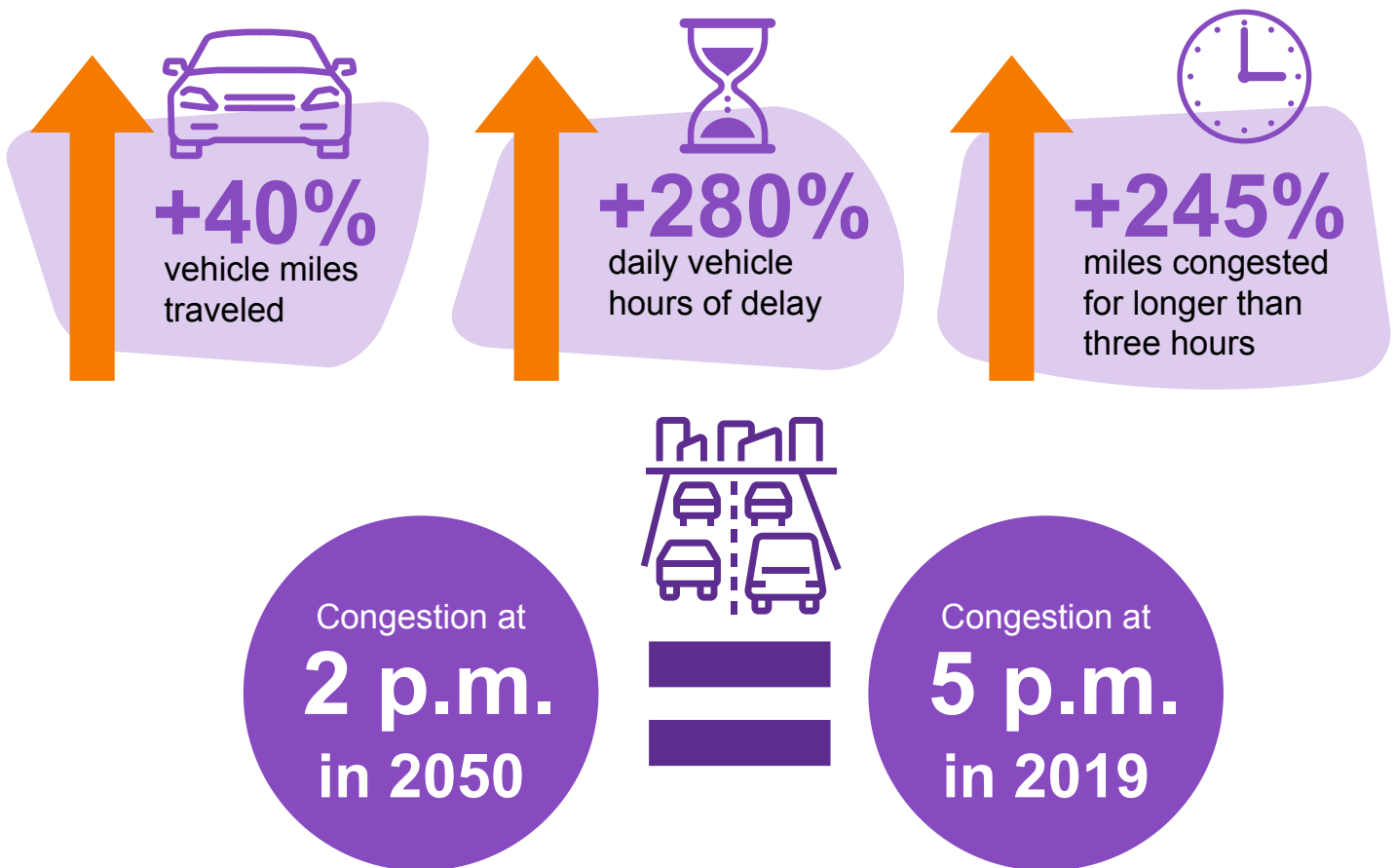
Regionwide, DRCOG staff estimates a 41% increase in daily VMT compared with 2019, primarily associated with the increase in population. The

increase in VMT will lead to a significantly larger percentage increase in congestion. As illustrated by examples in the “Why congestion decreased in 2020” section, there is not a linear relationship between increased traffic volume and congestion. A 31% increase in VMT will likely result in immensely more congestion on some roadways — resulting in longer

delays and increasing travel times.

The infographics below reflect regionwide congestion measures, comparing 2019 with 2050. Table 3 includes a summary of congestion measures across three timeframes: 2019 (pre-pandemic), 2020 (pandemic) and 2050.

Congestion in 2050 compared with 2019



Sources: DRCOG Congestion Management Program Database, RTD Ridership Statistics, 2050 Metro Vision Regional Transportation Plan

Figure 12. Key Congested Locations in 2019 and 2050
 Segments with a Congestion Mobility Score of 11 of Higher

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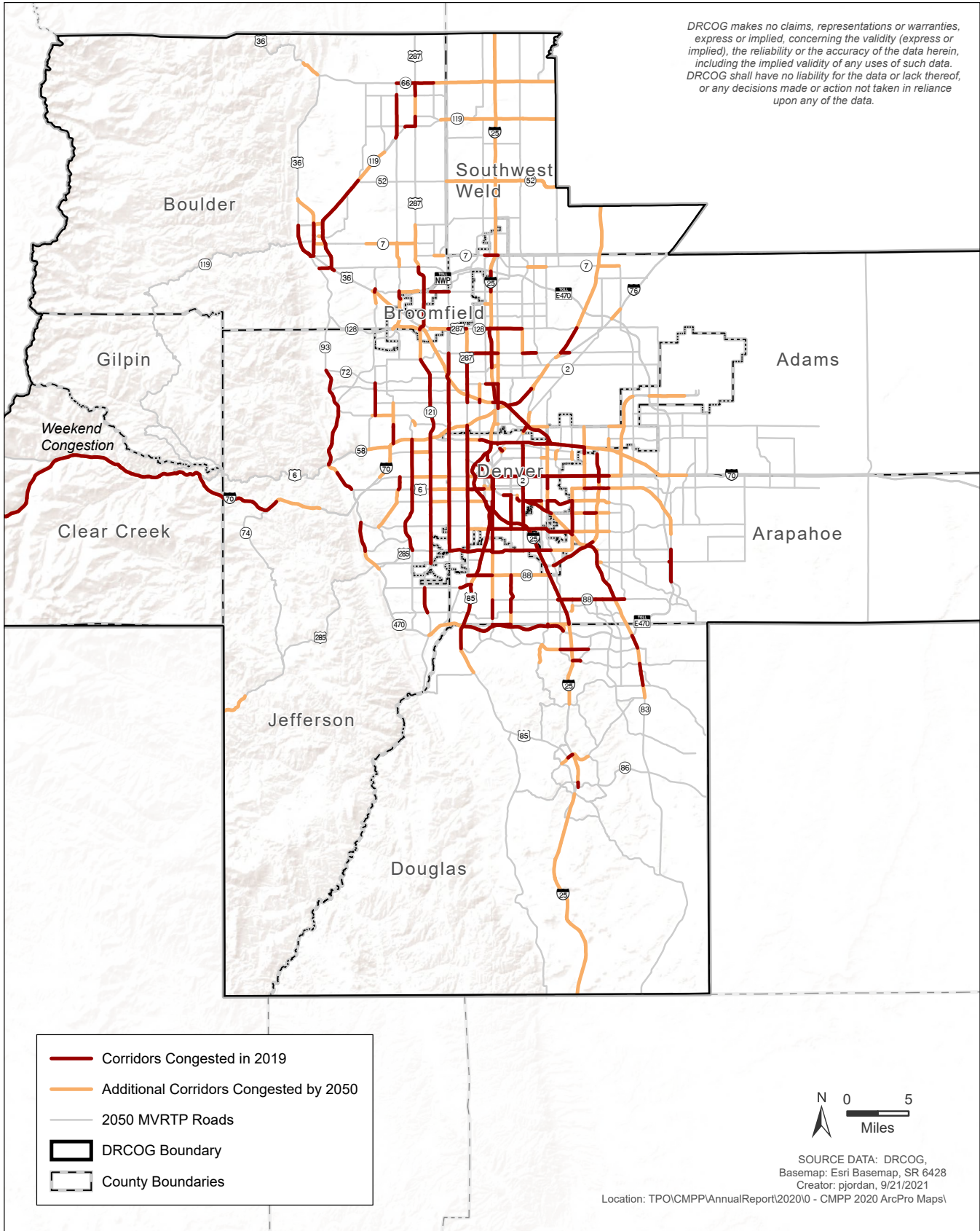


Table 3: Current and future congestion measures on Denver regional freeways and major roads on an average weekday

<i>Note: These measures are only for the designated Regional Roadway System.</i>	2019 weekday	2020 weekday	2050 weekday	Change between 2019 and 2050
Vehicle measures				
Vehicle miles traveled	66,191,000	56,355,000	93,045,000	41%
Vehicle hours traveled	1,425,000	1,177,000	2,250,000	58%
Vehicle hours of delay	183,500	119,900	523,000	185%
Travel delay per driven registered vehicle ¹ (minutes)	4.1	3.9	12.9	117%
Person measures				
Person miles traveled	90,848,000	77,404,000	128,825,000	42%
Person hours traveled	1,963,000	1,621,000	3,111,000	58%
Person hours of delay	254,300	166,000	720,700	183%
Travel delay per household (minutes/day)	11.4	7.5	23.4	105%
Travel delay per resident (minutes/day)	4.6	3.0	9.9	116%
Other congestion measures				
Percent of travel time in delayed conditions	13%	10%	23%	79%
Extra travel time (5 p.m. peak vs. free-flow)*	19%	13%	31%	69%
Extra travel time (2 p.m. peak vs. free-flow)	14%	10%	23%	66%
Lane-miles of roads congested for three or more hours	1,306	859	3,026	132%
<i>(Percent of total lane-miles)</i>	<i>18%</i>	<i>12%</i>	<i>37%</i>	<i>106%</i>
Economic travel delay costs				
Commercial vehicles ²	\$1,221,000	\$807,000	\$2,978,000	144%
Passenger vehicle individuals ²	\$3,641,000	\$2,321,000	\$5,679,000	56%
Total cost of delay	\$4,862,000	\$3,128,000	\$8,657,000	78%

Technical notes:

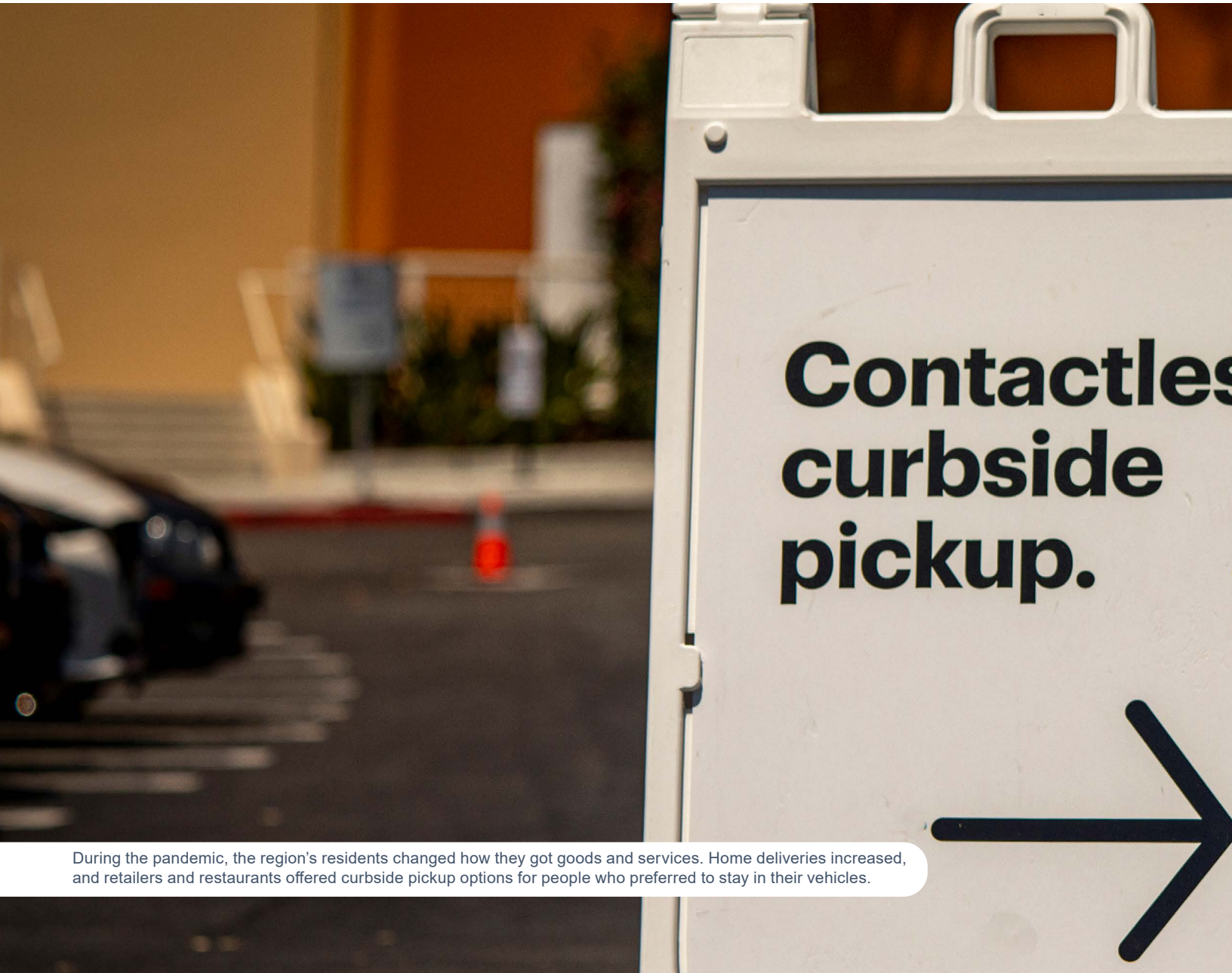
¹ Assumption of 1,850,267 driven registered vehicles in 2020 and 2,429,296 in 2050.

² Cost calculations incorporate \$12 per hour per adult in car, \$48.30 per hour per light commercial vehicle operator and \$71 per hour for heavy commercial.

Conclusion

As this report was being finalized, it included the most up-to-date data on traffic volumes and congestion in the Denver region. However, DRCOG staff knows the effects of the pandemic on travel behaviors, traffic volumes and roadway congestion continue to evolve. As the nation and the region continue to meet the challenges of, and recover from, the COVID-19 pandemic, residents will seek to reestablish many of the habits and ways of life they'd pursued before the pandemic.

The growth in population and jobs in the Denver region requires thoughtful management of transportation system resources. As people and economic participants increase travel demand, they compete for the limited supply of resources that constitute the regional transportation system. As demand for limited resources becomes more competitive, transportation demand management partners, transit agencies and innovation in mobility technologies will be essential to mitigating congestion and its negative effects on air quality, the



During the pandemic, the region's residents changed how they got goods and services. Home deliveries increased, and retailers and restaurants offered curbside pickup options for people who preferred to stay in their vehicles.

economy and residents' well-being and quality of life. Providing the region with dynamic, flexible and safe multimodal travel options will be more important than ever. DRCOG's staff takes seriously the responsibility of creating partnerships to mitigate the most severe negative effects of congestion and monitoring regional trends.

As 2050 approaches, congestion in the region is expected to worsen significantly. Some growth in

congestion is expected, but the amount which is acceptable is a matter of perception. Changing the trajectory of major increases in congestion, while supporting economic growth, a growing population, and efforts to reduce greenhouse gas emissions, will require effective planning, partnership and innovation. DRCOG is committed to partnering with state, regional and local agencies to keep people, goods and services moving efficiently across all modes.



Visit DRCOG's partner agency websites for more information:

Colorado Department of Transportation | codot.gov

Regional Transportation District | rtd-denver.com

Colorado Department of Transportation Traveler Information | cotrip.org

For ways to avoid or adapt to congestion, visit Way to Go | waytogo.org

Preparation of this report has been financed in part through grants from the U.S. Department of Transportation, Federal Highway Administration and Federal Transit Administration. This report and others are available at DRCOG's congestion mitigation webpage (drcog.org/congestion).

Contact Robert Spotts, program manager, at rspotts@drcog.org for additional information regarding DRCOG's congestion mitigation program.



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