2050 small-area forecast & scenario planning analysis

Purpose

To understand how demands on transportation system will change between now and 2050, DRCOG must forecast how growth and development will affect the distribution of users of the system, households and jobs throughout the region. The State Demography Office in the Colorado Department of Local Affairs forecasts future population, household and job levels in the state's 64 counties. DRCOG must allocate this county-level growth across 2,804 small areas within the Denver region, each of which is known as Transportation Analysis Zone. With forecasts available for each Transportation Analysis Zone, DRCOG and its partners can model future travel demand between zones to anticipate the effects on the transportation network and vehicle emissions, as well as mobility and accessibility for people and freight.

Regionwide forecast

Total forecast for the Denver region

The Denver region covers the 10-county area: Adams, Arapahoe, Boulder, Broomfield, Clear Creek, Denver, Douglas, Gilpin, Jefferson and a portion of Weld County that extends north along I-25 and east to I-76.

According to the State Demography Office, by 2050, the Denver region could be home to 4.42 million people, 1.86 million households and 2.96 million jobs (see Table 1).

Table 1. Denver region forecast, 2020-2050

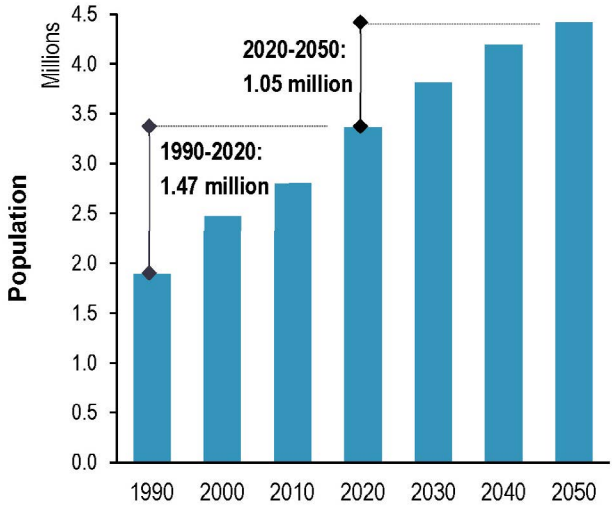
	2020	2030	2040	2050	Change, 2020-2050	
					Absolute	Percentage
Population	3,364,500	3,813,800	4,190,500	4,415,900	1,051,400	31%
Households	1,346,000	1,570,300	1,741,500	1,858,700	512,700	38%
Jobs	2,160,400	2,440,800	2,702,000	2,964,600	804,200	37%

Source: "Population by Single Year of Age," "Jobs Forecast," "Household Forecast," State Demography Office, Colorado Department of Local Affairs Job forecast extended from 2040 to 2050 by DRCOG staff. Weld County portioning applied by DRCOG staff.

Growth deceleration

Population growth is slowing. Expect less regional growth over the next 30 years than during the past 30 years (see Figure 1). Table 2 shows the larger 1990 to 2020 growth in population, households and jobs for comparison with Table 1.

Figure 1. Denver region population, 1990-2050



Source: "Population by Single Year of Age," State Demography Office, Colorado Department of Local Affairs. Weld County portioning applied by DRCOG staff.

Table 2. Denver region trend, 1990-2020

	1990	2000	2010	2020	Change, 1990-2020	
					Absolute	Percentage
Population	1,892,000	2,472,800	2,800,200	3,364,500	1,472,500	78%
Households	751,800	967,800	1,126,600	1,346,000	594,200	79%
Jobs	1,137,800	1,616,100	1,677,900	2,160,400	1,022,600	90%

Source: "County Data Lookup," "Population by Single Year of Age," "Jobs Forecast," "Household Forecast," State Demography Office, Colorado Department of Local Affairs. Weld County portioning applied by DRCOG staff.

Although state and regional growth rates continue to outpace the nation's, the same demographic realities slowing national growth will also affect the Denver region. Contributors, as identified in the State Demography Office's Colorado's Population and Economic Trends report, include lower birth rates and an aging population.

The region, along with the state, has experienced lower birth rates since 2007 — the peak birth year in U.S. history. This recent trend compounds over the course of the forecast period as smaller cohorts born after 2007 reach child-bearing age. An older population also means lower fertility overall, as well as a higher propensity to move away, decreasing net migration.

Due to aging, the region is facing an increasing number of retirements and will need to accommodate more household growth from 2020 to 2030 than it experienced from 2010 to 2020 simply to maintain the needed labor force.

Small-area forecasting process

County control totals

DRCOG allocates household and job growth forecast by the State Demography Office at a county level across 2,804 Transportation Analysis Zones. This includes the 10-county Denver region as described above, as well as additional Transportation Analysis Zones in Weld County (east to the Morgan County border) and Elbert County (along its western border with Douglas County). This means that the totals reflected in Table 3 and Table 4 may not match totals reported elsewhere for the territory within the council of governments boundary and the smaller Den-ver transportation management area designated for metropolitan planning organization purposes.

During the allocation process, growth remains within each county's control. Transportation Analysis Zones within each county can only be allocated growth for the county it is within. The total across all Transportation Analysis Zones in a county remains within these state-forecast county-control totals.

Table 3. Household forecast by county in DRCOG modeling area

County	2010	2020	2030	2040	2050
Adams	153,800	186,000	232,500	277,900	323,000
Arapahoe	224,300	261,200	298,400	329,200	350,100
Boulder	119,300	134,000	151,300	163,400	174,100
Broomfield	21,400	28,500	37,000	39,500	41,800
Clear Creek	4,200	4,400	4,500	4,800	5,200
Denver	262,400	327,900	379,300	416,600	423,400
Douglas	102,100	134,400	164,400	182,000	192,900
Elbert*	6,600	8,200	10,800	12,800	14,700
Gilpin	2,500	2,700	2,700	2,600	2,600
Jefferson	218,500	241,300	262,600	274,000	280,200
Weld*	25,200	33,200	45,400	59,100	74,000

* Only a portion of Elbert and Weld are within the 2,804-Transportation Analysis Zone modeling area.

Source: “Household Forecast,” State Demography Office, Colorado Department of Local Affairs. Weld County portioning factor applied by DRCOG staff based on the 2010 census, U.S. Census Bureau.

Table 4. Job forecast by county in DRCOG modeling area

County	2010	2020	2030	2040	2050
Adams	192,200	268,500	303,100	335,000	367,500
Arapahoe	336,600	427,300	482,800	534,300	586,400
Boulder	203,400	248,100	280,200	309,900	339,900
Broomfield	35,700	48,300	54,500	60,400	66,200
Clear Creek	4,300	4,400	4,400	4,800	5,200
Denver	493,000	646,300	729,900	807,500	885,200
Douglas	123,300	174,200	196,800	217,700	238,700
Elbert*	5,600	7,800	11,000	12,500	13,900
Gilpin	6,100	6,100	6,500	6,700	7,000
Jefferson	267,300	313,200	353,700	391,400	429,200
Weld*	25,100	36,400	44,600	53,000	61,400

*Only a portion of Elbert and Weld are within the 2,804-Transportation Analysis Zone modeling area.

Source: “Jobs Forecast,” State Demography Office, Colorado Department of Local Affairs. Weld County portioning factor applied by DRCOG staff based on 2010 observations of “Worker Area Characteristics” from the Longitudinal Employer-Household Dynamics, U.S. Census Bureau.

Predictive model

DRCOG relies on a predictive model, the UrbanSim block model, which simulates household and employment location choices with real estate market dynamics and within natural and regulatory constraints.

Base data

All base data for DRCOG's customized instance of UrbanSim is in 2010 vintage census blocks and was prepared in collaboration with UrbanSim unless otherwise noted.

- Block-level household data is from the 2010 census.
- Block-level job data is from the "Worker Area Characteristics" table from Longitudinal Employer-Household Dynamics data, also from the U.S. Census Bureau, with the number of jobs in a sector by block inflated by DRCOG staff proportionally to match the State Demography Office jobs estimates by county.
- Disaggregate household data was synthesized using the U.S. Census Bureau's Public Use Microdata Sample and 2009-2013 American Community Survey five-year estimates.
- Disaggregate residential unit, rent and price data was created from 2009-2013 American Community Survey five-year estimates (B25032, B25036, B25058 and B25077) fit to 2010 census residential unit block counts.

Because the base data for UrbanSim is 2010, this allows for the validation and calibration of the loca-tion choice models using other observations over subsequent years. DRCOG staff uses other infor-mation to incorporate observed change since 2010 during each simulation (see the "Scheduled development" section below).

Natural and regulatory constraints

DRCOG staff assigns every block a capacity for residential units and employment. This value constrains the number of additional households and jobs that can be allocated to an area through UrbanSim simulations out to 2050. DRCOG staff bases this value on an analysis that considers:

- The size of the block.
- The portion of the block covered by water or flood plains.
- The portion of the block that is under ownership that could prevent development, such as protected open space, parks and schools.
- The amount and extent of various local zoning districts that cover the block.
- Local government feedback (see section below).

DRCOG annually requests geospatial data from local governments, including local zoning data. DRCOG staff estimate local zoning district capacity for over 1,400 unique districts. DRCOG staff uses point-level housing and employment data it licenses, collects and compiles to identify current housing and em-ployment levels both within individual census blocks and apportioned to the specific local zoning dis-trict. DRCOG staff estimate residential unit and employment capacity for a given zoning district based on existing density across all blocks. County-level estimates for aggregated zoning types, local zoning codes, local comprehensive plans and jurisdiction feedback are used to supplement DRCOG block-level estimates.

Scheduled development

The UrbanSim block model allows for DRCOG staff to add in scheduled development for individual census blocks. This allows for residential units and jobs to be placed during simulation without relying on the predictive location choice models, but without exceeding the county control totals. Use cases for this model input include:

- Large master planned communities, planned or in-progress.
- Recent approvals, permitting or building activity.
- Other local knowledge about investments and commitments.
- Observable housing and employment development since the base year using point-level housing and employment data DRCOG licenses, collects and compiles, as well as more recent block-level employment data from U.S. Census Bureau's Longitudinal Employer-Household Dynamics.
- Development activity information available and maintained on jurisdiction websites.
- Other specific local government feedback (see section below).

Local government feedback

DRCOG relies on extensive feedback from local government partners on preliminary model results to improve model inputs. DRCOG staff received 889 comments from 31 local jurisdictions over two comment periods:

- In September 2019, DRCOG invited feedback on a preliminary UrbanSim block model run that used newly estimated housing unit and employment capacities estimated with local zoning data as described in the "Natural and regulatory constraints" section above. DRCOG staff used this feedback to make zoning districtwide capacity adjustments.
- In May 2020, DRCOG invited feedback on a Transportation Analysis Zone-level UrbanSim block model run after completing a series of model and data improvements: updated county control totals (see section above), new scheduled development information and improved housing unit and employment capacities from the earlier review.

The types of model input improvements DRCOG used this feedback to address include:

- Block-level adjustments to reduce or add housing or employment capacity.
- Zoning districtwide capacity adjustments.
- Improving scheduled development information based on feedback from jurisdictions.
- Adding missing projects through scheduled development based on feedback from jurisdictions.

Small-area forecast results

The following series of maps shows the current (2020) and future (2050) distribution of households and employment in the Denver region based on the small-area forecast.

Figure 2 and Figure 3 depict the estimated distribution of households in 2020 and the forecast distribution in 2050. Darker shades of blue represent areas with a higher density or intensity of households, while lighter shades of blue represent areas with a lower density of households. Comparing the two maps shows that by 2050, much of the distribution pattern of households in 2020 persists. Some well-settled areas are gaining household intensity while a few less populated areas are also emerging as new concentrations.

The Figure 4 and Figure 5 maps depict the estimated distribution of jobs in 2020 and the forecast distribution in 2050. Darker shades of purple represent higher intensity employment centers, while lighter shades of purple represent areas with lower intensity employment. Comparing the two maps shows that by 2050, the major concentrations of jobs identified in 2020 remain. Areas of greater intensity remain in or adjacent to the 2020 concentrations with very limited exceptions.

The Figure 6 map depicts the change in households between 2020 and 2050 without showing any of the pre-2020 households, highlighting the highest concentrations of household growth, including in and around central Denver, new growth areas in Aurora and Arapahoe County, several new growth areas in northern Adams County, northern Broomfield County, southwest Weld County and northern areas of Douglas County.

The Figure 7 map depicts the change in jobs between 2020 and 2050 without showing any of the pre-2020 employment, highlighting the highest concentration of job growth, including throughout Denver, Aurora, communities in southern Arapahoe County and northern Douglas County, Jefferson County along Colfax Avenue, northern Broomfield County, Boulder, and communities in southeastern and north-eastern Boulder County. The highest concentrations of job growth between 2020 and 2050 are anticipated in existing concentrations of employment.

Figure 2. Current (2020) and future (2050) distribution of households and employment in the Denver region based on the small-area forecast

Estimated distribution of households in 2020

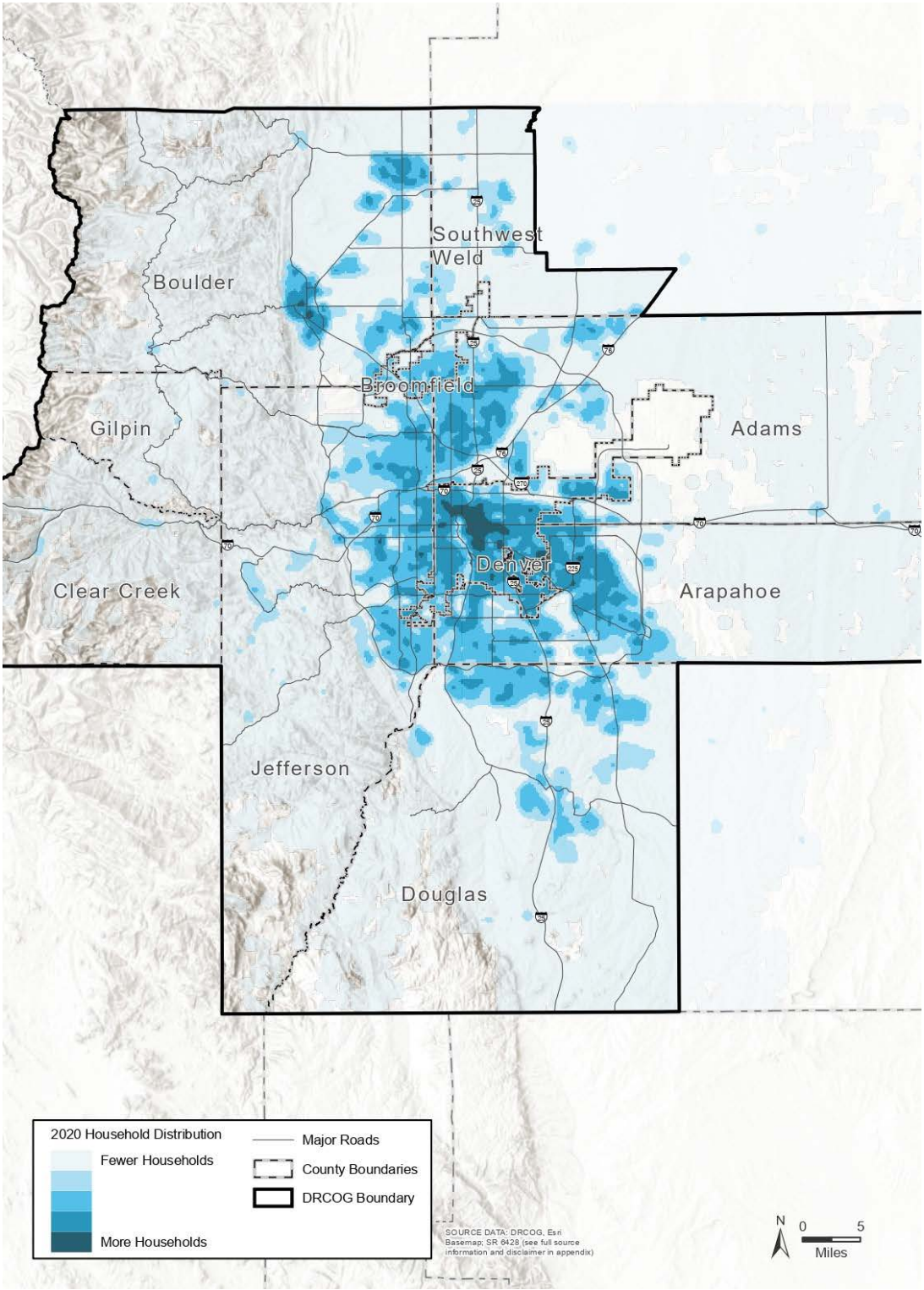


Figure 3. Current (2020) and future (2050) distribution of households and employment in the Denver region based on the small-area forecast

Forecasted distribution of households in 2050

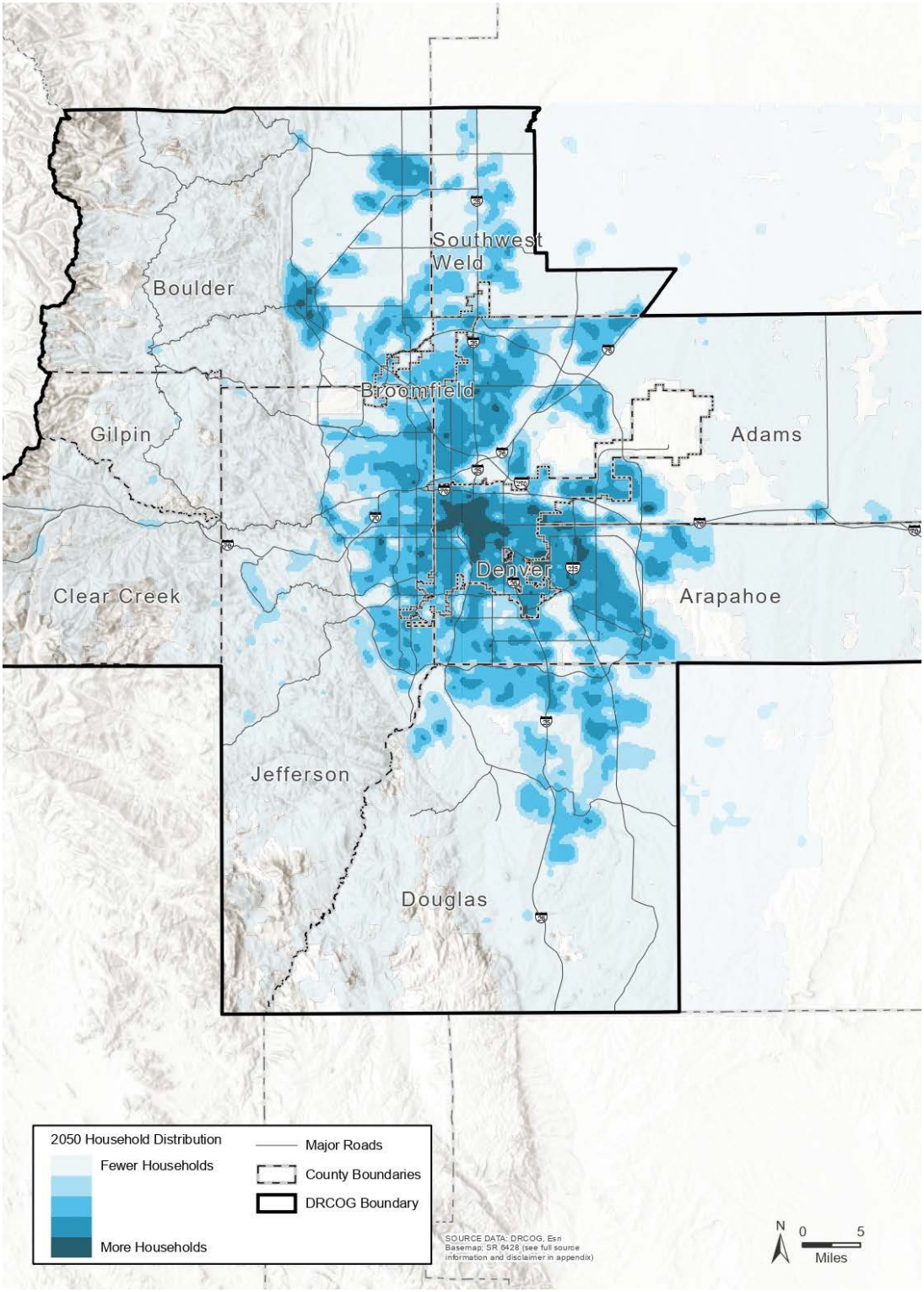


Figure 4. Current (2020) and future (2050) distribution of households and employment in the Denver region based on the small-area forecast

Estimated distribution of jobs in 2020

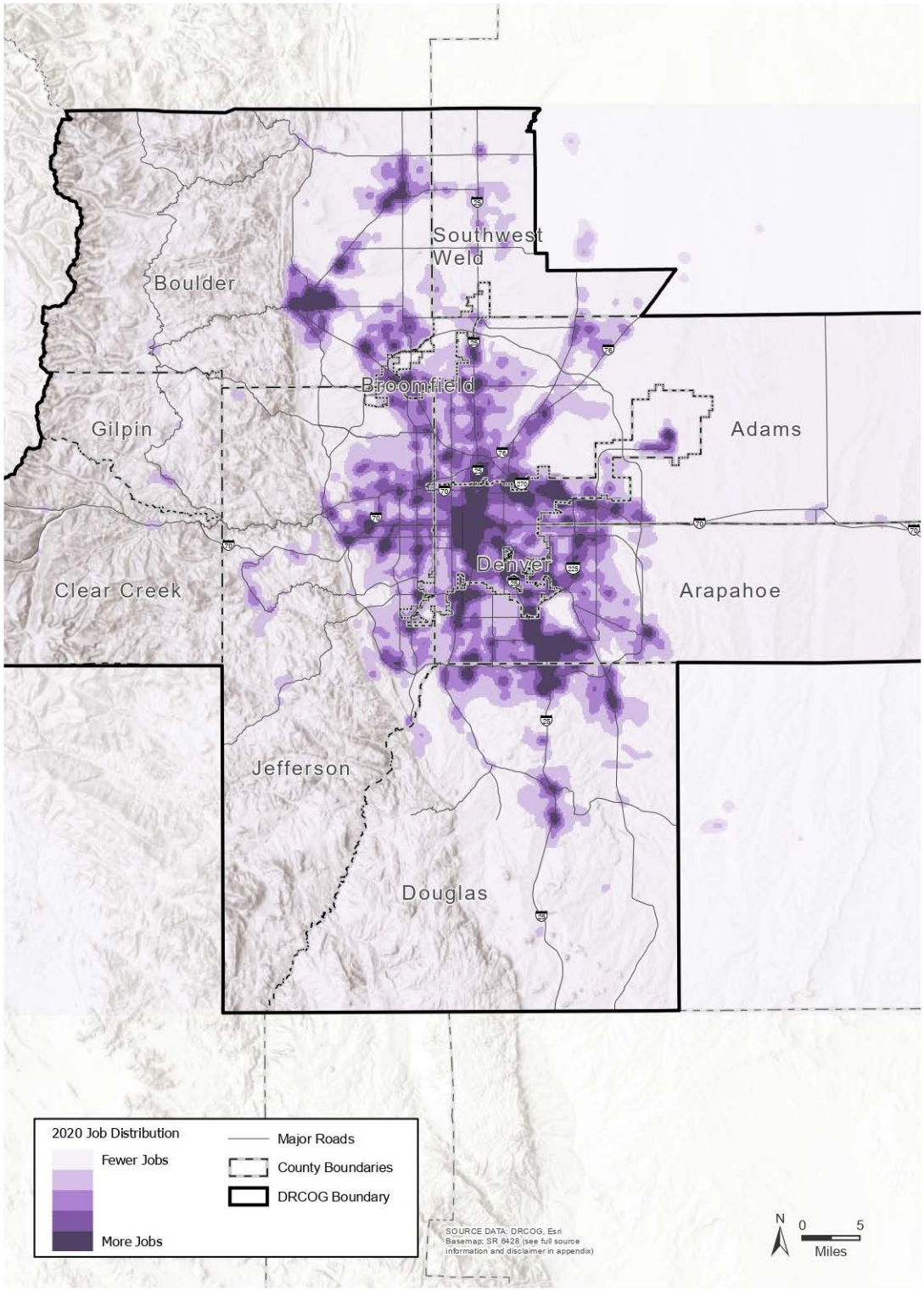


Figure 5. Current (2020) and future (2050) distribution of households and employment in the Denver region based on the small-area forecast

Forecasted distribution of jobs in 2050

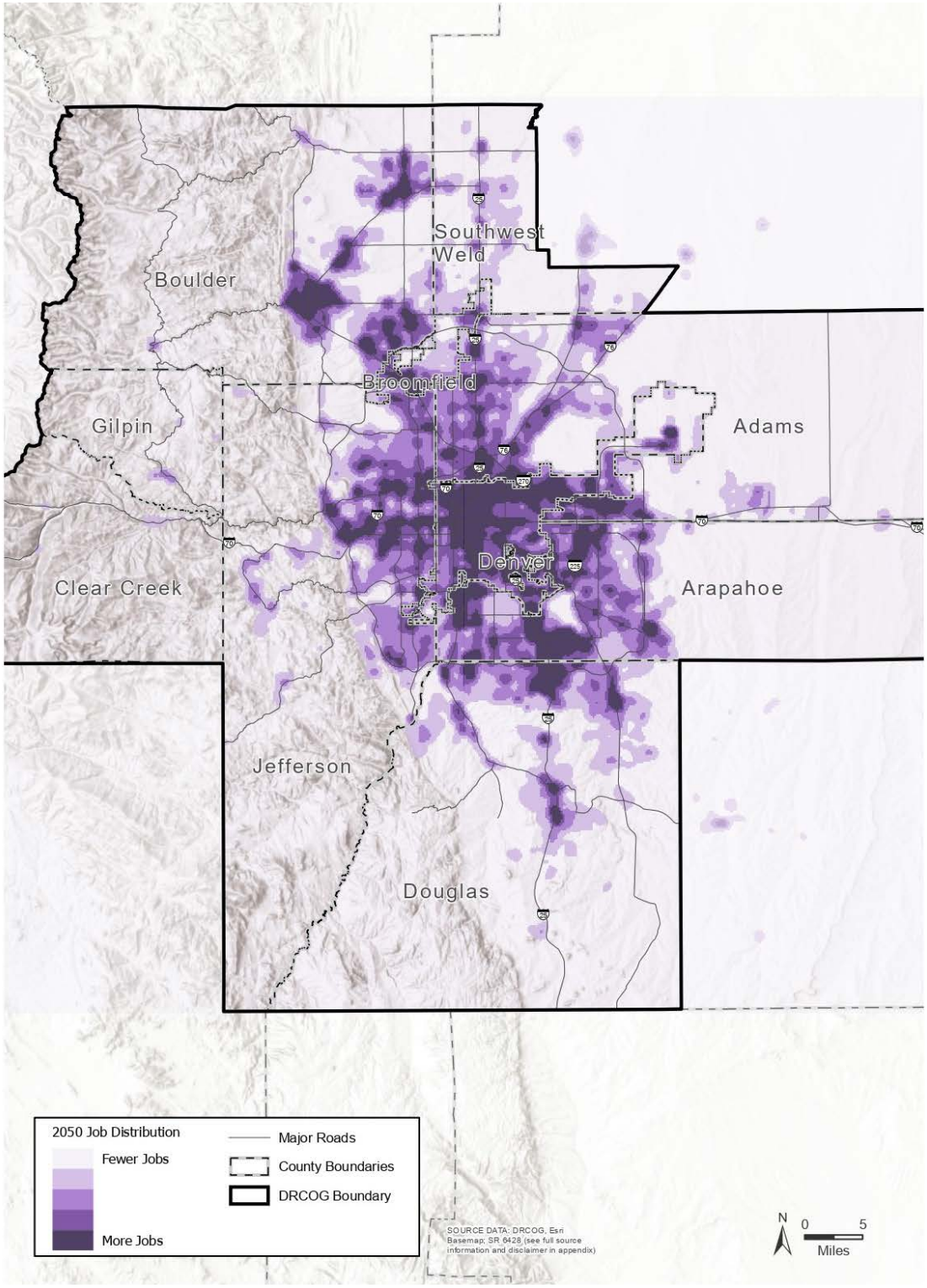


Figure 6. Current (2020) and future (2050) distribution of households and employment in the Denver region based on the small-area forecast

Change in households between 2020 and 2050, without showing any pre-2020 households

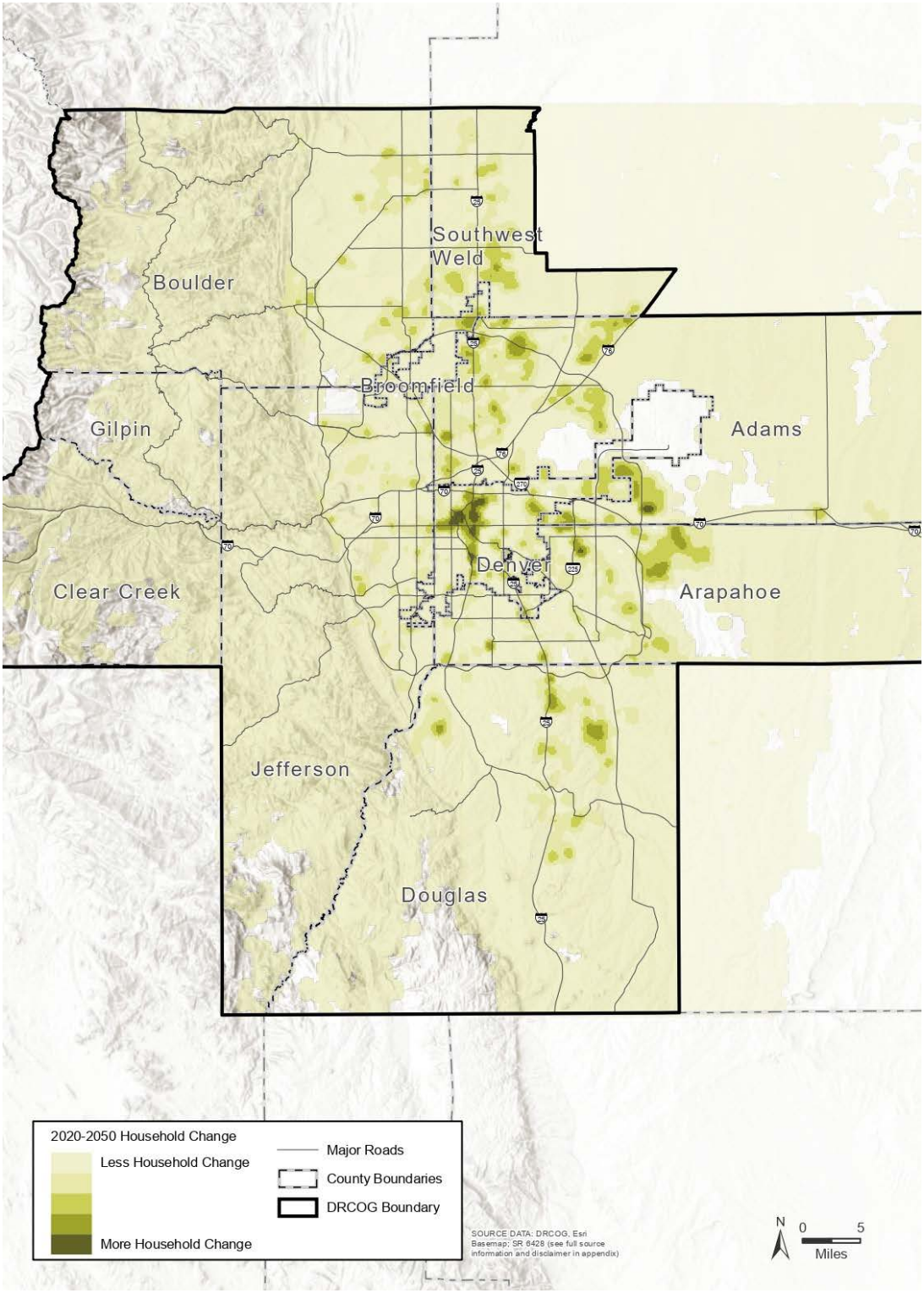
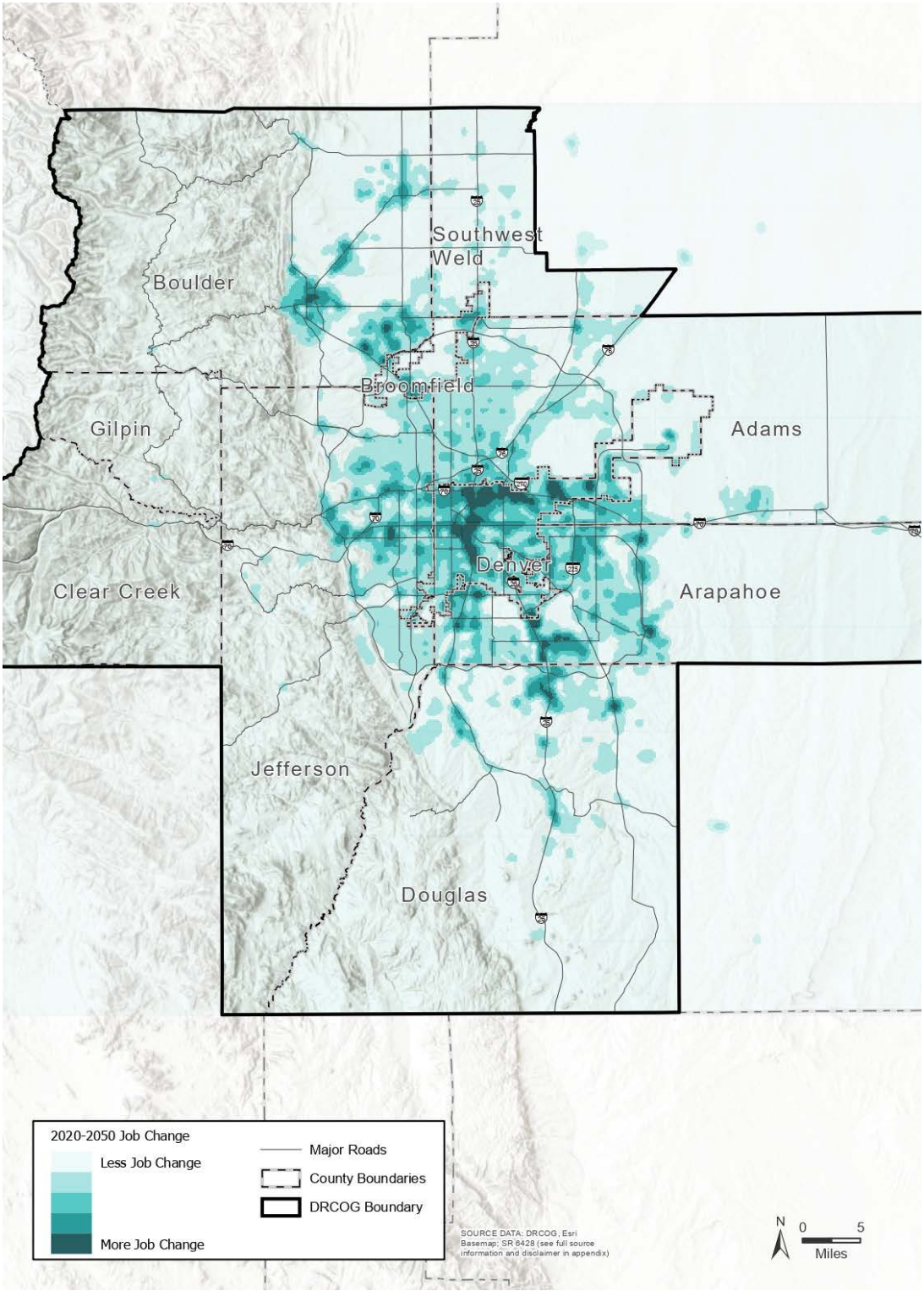


Figure 7. Current (2020) and future (2050) distribution of households and employment in the Denver region based on the small-area forecast

Change in jobs between 2020 and 2050, without showing any pre-2020 employment



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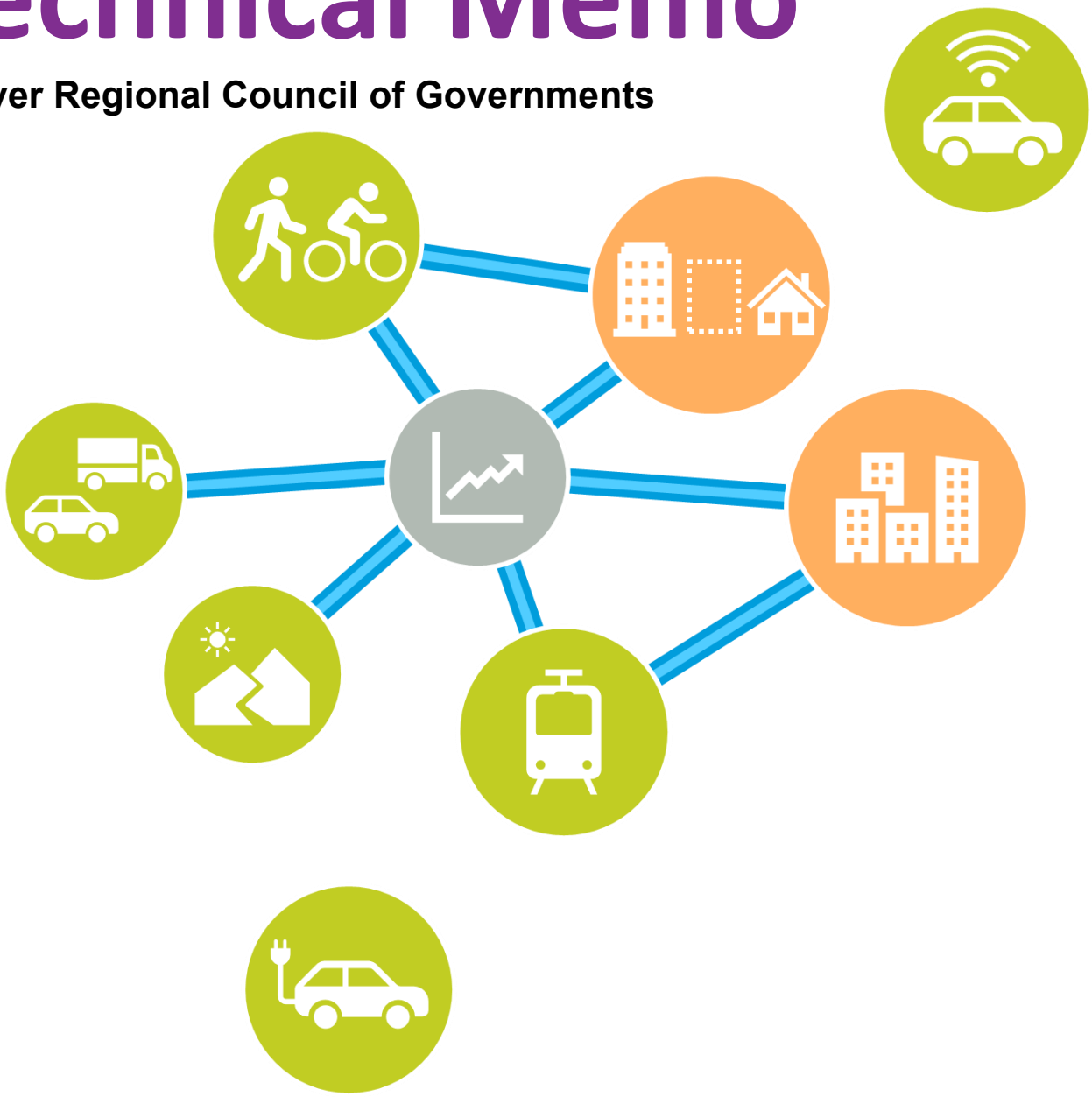
2050 Metro Vision Regional Transportation Plan

Scenario Planning Technical Memo

Denver Regional Council of Governments



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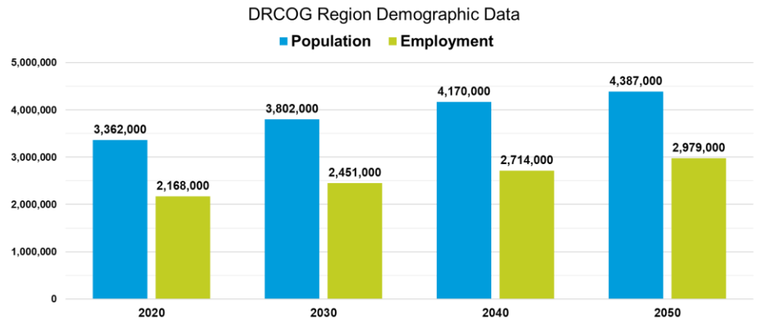
DENVER REGIONAL COUNCIL OF GOVERNMENTS

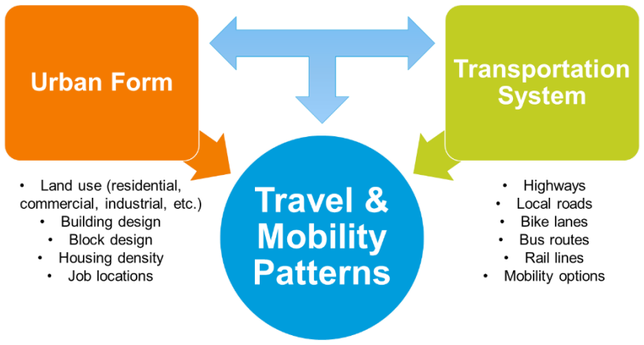
Scenario Planning in the DRCOG Region

The Denver region's quality of life depends greatly on mobility and the efficient movement of people and goods to, from and within the region. Over the last 30 years, the region has grown by over 1.4 million people. The region has responded with significant investments in the transportation system to improve mobility. Despite these investments, the region's residents and visitors still experience mobility and accessibility challenges.

Over the next 30 years, the state's demographers forecast that the region's population will increase from about 3.3 million in 2020 to 4.4 million by 2050, an increase of 33%. The number of jobs is forecast to increase from 2.2 million in 2020 to almost 3 million by 2050, an increase of 35%. How might the region respond? What choices will be available to those moving to, from and within the region regarding where to live, work, learn, recreate, shop or access other important services? What travel choices will be available to accommodate these travel patterns?



A major component of the developing the 2050 Metro Vision Regional Transportation Plan was the use of scenario analysis to better understand the relationships between the built environment, multimodal transportation strategies and mobility outcomes. Analysis of alternative scenarios can help the region's decision-makers explore the outcomes of different courses of action, informing the 2050 MVRTP as well as local plans for growth and development. The results can be also used to consider how changes in transportation, growth and development, and other factors could affect connectivity, mobility and resiliency for communities across the region. The scenarios incorporate ambitious, exploratory infrastructure and growth alternatives to aid decision-makers in identifying which strategies may help meet the region's vision, goals and objectives. Scenario planning considers:



DRCOG has long been a leader in using scenario analyses to inform regional planning and decision-making. DRCOG's first scenario planning effort was in the mid-1990s. It guided the development of the original Metro Vision 2020 plan and laid out a long-range vision for the sustainable growth and development of the Denver region. As part of the development of the 2050 MVRTP, DRCOG once again performed a scenario analysis to identify how various strategies may help meet the region's vision, goals and objectives.

When discussing scenario analysis in the development of the 2050 MVRTP, each scenario allows an exploration of alternative futures. These alternative futures offer relative comparisons to each other and a baseline, while not choosing or judging a scenario. The intent from this scenario analysis was not to "choose" a scenario, but instead to evaluate the choices and tradeoffs that could occur associated with various transportation investment and development intensity strategies. Finally, the results from the scenario analysis provide guidance to the public, staff, committees, and Board members in the development of the 2050 MVRTP.

Modeling Tools

The primary tools used to create and analyze scenarios are DRCOG's UrbanSim and Focus models. These two state-of-the-art models have been used for several years and continuously improved since initial development.

UrbanSim Model

DRCOG provides household and employment forecasts for neighborhoods and communities throughout the Denver region. UrbanSim helps predict the pattern of growth and development by simulating the dynamic interaction of households, jobs, real estate markets and the regional transportation system within the constraints of local growth policies.

UrbanSim simulates a behavioral representation of the region's real estate market through several location choice models. These statistical models are estimated and calibrated using local data to predict future location choices. However, these choices are only available within the model as allowed by local growth policies, such as zoning, and other observable natural constraints.

For more information visit: https://drcog.org/services-and-resources/data-maps-and-modeling/economics-and-land-use

Focus Model

The Focus travel model is an activity-based mathematical model that simulates individual households, people and their travel throughout a typical weekday. It is based on personal and travel-related characteristics obtained from travel surveys and census data.

The model's forecasts are based on a wide variety of data about the region's people, transportation systems and development pattern, including:

- where roads will be located and the travel conditions (congestion and delays) at different times of the day
- the location of transit lines and amount of service
- transportation costs
- the demographic characteristics of the region's population over time, such as an increasing number of retirees
- the locations where people work, shop, recreate, and obtain health and education services

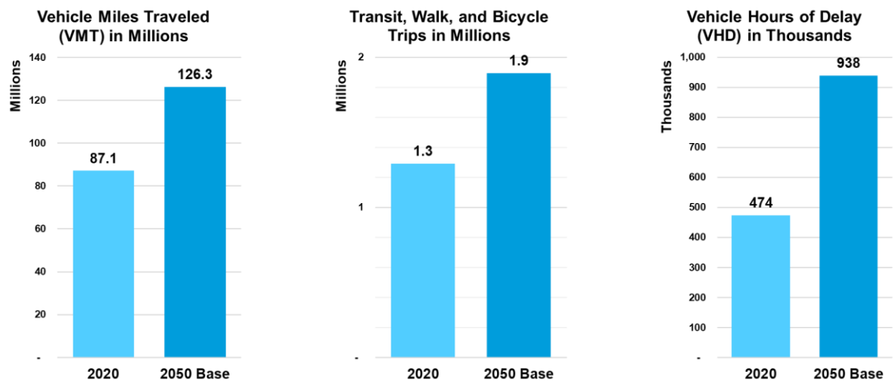
For more information visit: https://drcog.org/services-and-resources/data-maps-and-modeling/travel-modeling/focus-travel-model

The 2050 Base and Scenarios

The distinct transportation scenarios are compared against a baseline scenario that assumes completion of transportation projects from DRCOG's 2040 Fiscally-Constrained Regional Transportation Plan alongside the unmodified output from the 2050 UrbanSim model.

The 2040 MVRTP defines transportation elements and services to be provided by 2040, based on reasonably expected revenues. For more information on the 2040 Fiscally-Constrained Network visit: https://drcog.org/planning-great-region/transportation-planning/regional-transportation-plan

By 2050, people living in, working in and visiting the region will make over 21 million total person-trips per day. Of these, DRCOG's baseline forecast suggests about 14.3 million vehicle trips will be made by cars, trucks and buses traveling more than 126 million miles per weekday. While the forecast estimates a 45% increase in the amount of transit, walking and bicycle trips, the additional traffic volume on roadways would result in an average 33% increase of travel delay for people in vehicles compared with 2020.



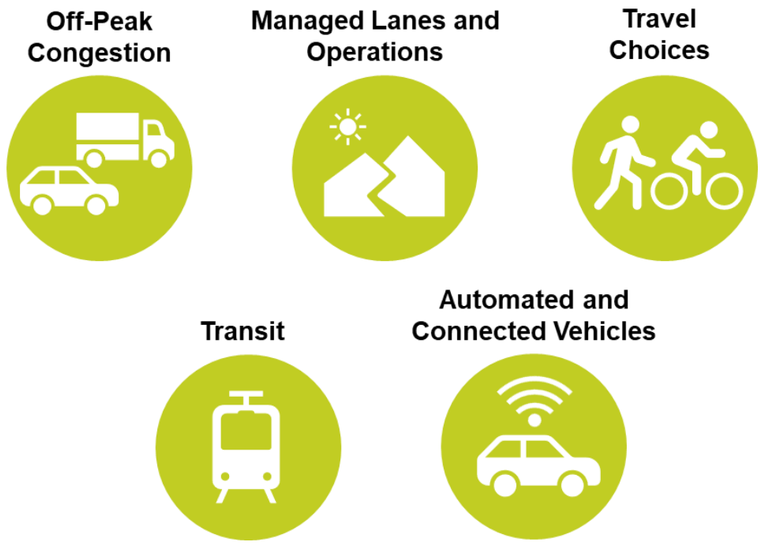
Five transportation scenarios and two land use scenarios were developed to be tested and compared against each other and the 2050 Base. In the Fall of 2019, DRCOG staff gathered input from the public through the Youth Advisory Panel (YAP) and Civic Advisory Group (CAG), as well as DRCOG's standing committees, the Transportation Advisory Committee (TAC) and the Regional Transportation Committee (RTC). Additionally, input was collected from several County Subregional Transportation Forums to help shape each scenario. The DRCOG Board ultimately endorsed these scenarios in December 2019.

Mobility Choices – Future Transportation Scenarios

As the Metro Vision Regional Transportation Plan outlines the vision of the region's multimodal transportation system, five distinct transportation scenarios have been developed to evaluate their individual impacts on regional mobility. Each of these scenarios was developed around distinct modes that make up the regional transportation system. So while ultimately a combination of strategies could be used in each scenario, the goal of each was to determine each mode's impact on regional mobility.

- The **Off-Peak Congestion** Scenario focuses on the region's hotpots and bottlenecks on the highways and interstates. It widens the highway/interstate system to address traffic/congestion that occurs outside of normal morning/afternoon commute times. As traffic and congestion will likely continue to occur as people travel to/from home and work, this scenario looked at what it would take for there to be no congestion on the region's highways outside of commute hours.
- The **Managed Lanes and Operations** Scenario focuses on improving the operations and efficiency of traffic flow on the region's highways and interstates. Instead of adding general purpose lanes, this scenario builds out a regional toll-way network to determine if there is a positive impact on regional mobility of toll-lanes. Additionally, this scenario improves incident management like State Farm Safety Truck to better respond to crashes and breakdowns on the region's highways and interstates.
- The **Travel Choices** Scenario is focused on increasing the region's bicycle, walking, and rolling trips, and making people safer when they walk, bike, or roll on the region's arterials. This scenario builds out sidewalks across the region, increases the number of bike lanes, and slows down traffic on major roads in the region. Additionally, as more people have opted to work from home over the last few years, this scenario continues that trend and assumes in the future more people would telework.
- The **Transit Scenario** focuses on improving and increasing transit service in the region. In addition to finishing FasTracks, this scenario looks at building out a regional system of high-frequency busses to improve mobility and increase transit trips. Transit is also made free in this scenario to test if there is an increase in transit trips with the expected mobility and equity improvements for residents.
- The **Automated and Connected Vehicles** scenario explores the vast range of positive and negative impacts of increased autonomy of vehicles on the region's roadways, ss there is not currently a consensus on the role automated vehicles and connected vehicles (AVs/CVs) will have on mobility. This scenario looked at increasing and decreasing the operational capacity of the region's roadways to reflect the potential positive and negative impacts on mobility.

DRCOG staff evaluated each scenario using the three previously mentioned metrics compared to the 2050 Base **– Vehicle Miles Traveled (VMT); Transit, Walk, and Bicycle Trips; and Vehicle Hours of Delay (VHD)**. For more information on the individual components that went into each of the transportation scenarios, see **Appendix B** for greater detail.



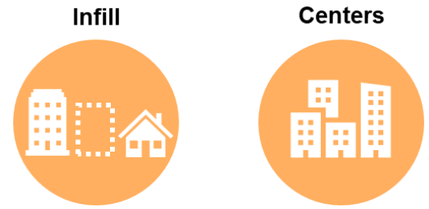
Growing Differently – Future Land Use Development Scenarios

The baseline forecast for the distribution of households and jobs throughout the region represents a growth trajectory based on current assumptions about the location choices available to homebuilders, other developers and employers.

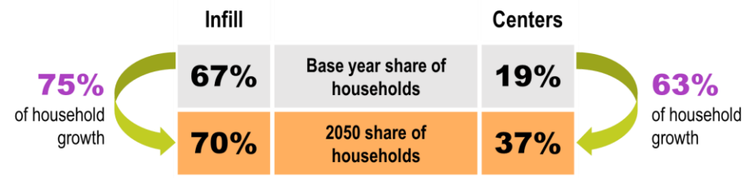
However, the region also adopted a set of 14 interrelated, aspirational outcomes in Metro Vision that outline a desired future in which the distribution of households and jobs could look quite different. Five themes organize these outcomes, which describe the shared future that DRCOG, local governments and partners will work toward together:

- an efficient and predictable development pattern
- a connected multimodal region
- a safe and resilient natural and built environment
- healthy, inclusive and livable communities
- a vibrant regional economy

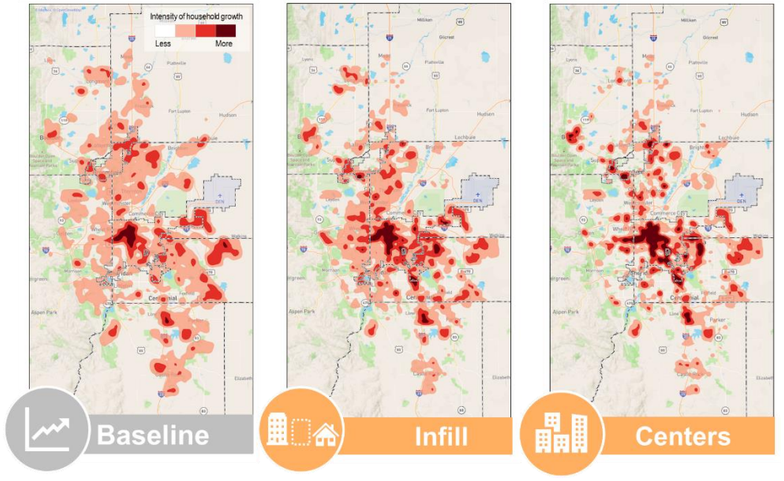
Metro Vision does not prescribe specific actions for local governments regarding land use decisions. Its outcomes can be achieved as individual jurisdictions and other partners pursue initiatives that address current issues, while contributing to the region's outcomes and objectives through various pathways and at different speeds. Thus, the land use scenarios remain high-level, focused on testing two alternative distributions of households and jobs that could be achieved through a variety of means at a local level:



- The **Infill Scenario** is inspired by Metro Vision. It imagines a region where "new urban development occurs in an orderly and compact pattern." This scenario aims to "promote investment/reinvestment in existing communities," and "protect a variety of open spaces"
- The **Centers Scenario** is also inspired by Metro Vision. It imagines a region where "connected urban centers and multimodal corridors throughout the region accommodate a growing share of the region's housing and employment." This scenario aims to "increase opportunities for diverse housing accessible by multimodal transportation" and "improve access to and from the region's employment centers."



As a result of the Infill Scenario, 75% of future household growth would be located in areas that consist of 11% of the region's land area. Through the Centers Scenario, 63% of future household growth would be located in areas that make up 3% of the region's land area. The result of these scenarios are graphically represented below by varying intensity of household growth throughout the region, with the Infill Scenario showing greater concentrations of intensity of household growth than the more-dispersed growth pattern of the Baseline Scenario. The Centers Scenario shows even greater concentrations of intensity of household growth than the Infill Scenario.



Several Metro Vision performance metrics can be measured across the three scenarios, including **regional population-weighted density**, the **share of households in urban centers** and the **share of jobs in urban centers**.

Regional population-weighted density measures the population density of census tracts in the region; a measure that increases as people settle in and near neighborhoods that are already well-settled. All three scenario exceed the 2040 Metro Vision target for regional population-weighted density of 6,063 people per square mile.

Both the Infill and Centers Scenarios fall short of Metro Vision's 2040 target of 25% of total households located in urban centers; however, the Centers Scenario nearly doubles the share of households in urban centers in the Baseline Scenario. Similarly, both the Infill and Centers Scenarios fall short of Metro Vision's 2040 target of 50% of total jobs located in urban centers; however, the Centers scenario increases the share of jobs in urban centers by 10 percentage points when compared to the Baseline Scenario.

Outcome Metric		Baseline	Infill	Centers	Metro Vision Target
Density	Regional population-weighted density	6,152 people per square mile	7,620 people per square mile	9,816 people per square mile	6,063 people per square mile
Urban Centers	Share of total households in urban centers	11%	15%	20%	25%
	Share of total jobs in urban centers	31%	35%	41%	50%

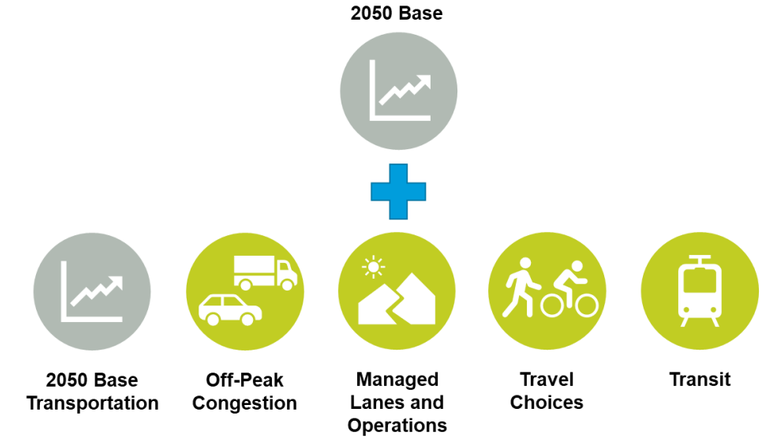
Other outcome metrics include the **median distance of household growth to a top 10 regional employment center**, **share of single-family areas remaining in a similar state of development**, and the **share of households in the highest range of development intensity**. While the Baseline Scenario estimates the median distance of new household growth to be 5.8 miles from a top 10 employment center, both the Infill and Centers Scenarios result in a significant improvement with this measure.

Outcome Metric		Baseline	Infill	Centers
Jobs/ Housing	Median distance of household growth to a top 10 employment center	5.8 miles	2.6 miles	1.8 miles
Area Stability	Share of single-family areas remaining in that range of development intensity	81%	82%	88%
Intensity of Change	Share of households in highest range of development intensity	15%	18%	24%

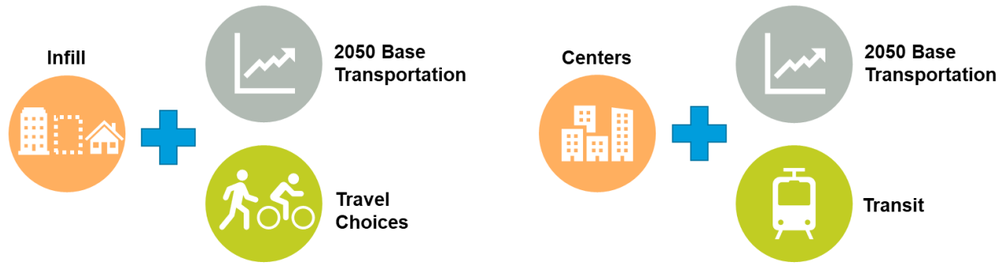
Scenario Results Summary

Scenario Combinations

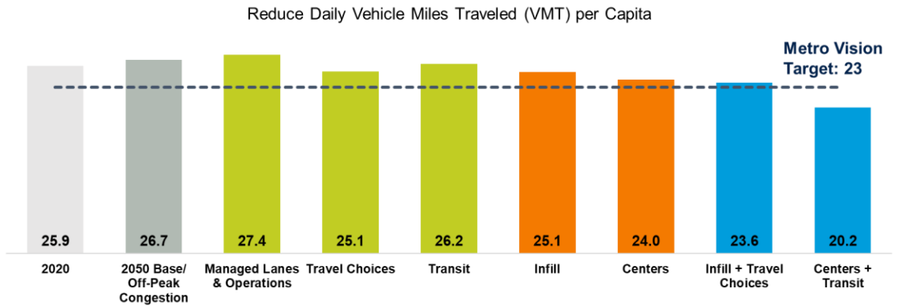
The four distinct transportation Scenarios of **Off-Peak Congestion, Managed Lanes and Operations, Travel Choices,** and **Transit** were combined with the 2050 Base Land Use Scenario to compare outcomes against the 2050 Base Transportation Scenario.



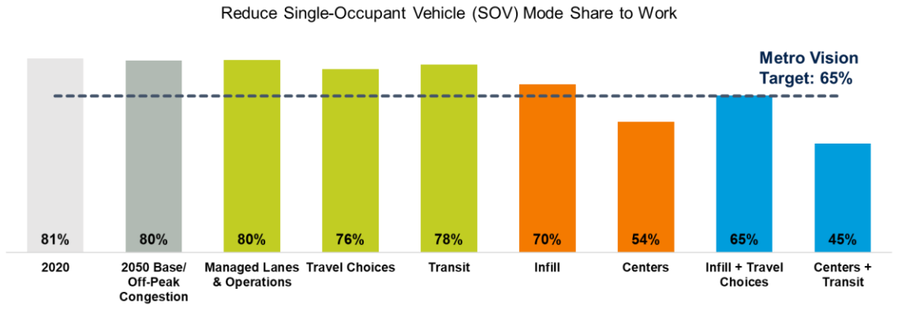
Additionally, select transportation scenarios, such as the **Travel Choices** and **Transit** Scenarios, were combined with a potentially complementary land use scenario to examine whether regional outcomes were more greatly improved compared to the 2050 Base.



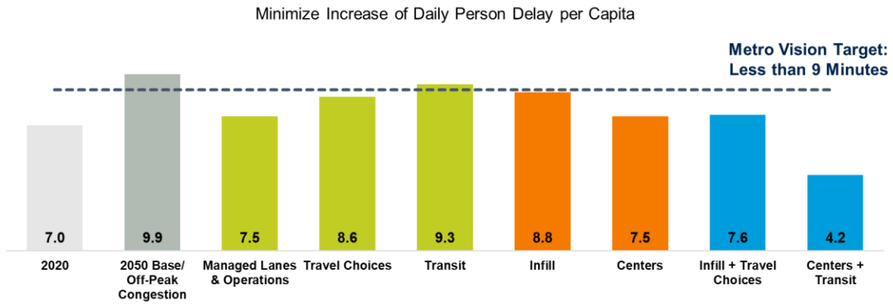
A summary of results of each of the scenario runs are provided on the next page as they relate to the achievement of select targets from the region's adopted Metro Vision plan.



Across each of the scenarios including the 2050 Base, only one scenario achieves the stated Metro Vision target of 23 daily VMT per capita, the combination **Centers + Transit** Scenario.



Like the daily VMT Metro Vision target, few of the scenarios achieve the 65% single-occupant vehicle mode share to work target from Metro Vision. However, the **Centers** Land Use Scenario and both combination scenarios, the **Infill + Travel Choices** and **Centers + Transit** Scenarios contribute to the region achieving its target.



When evaluating the scenarios on Daily Person Delay Per Capita, the majority of scenarios achieve the stated target of less than 9 minutes. The highest performing scenarios are the two combination scenarios of **Infill + Travel Choices** and **Centers + Transit**, as well as the standalone **Managed Lanes and Operations** Transportation Scenario and **Centers** Land Use Scenario.

The results of each scenario compared to the 2050 Base using the three previously mentioned metrics; **VMT**; **transit, walk and bicycle trips**; and **VHD**, are outlined in greater detail in the next section.

In an effort to provide a snapshot of the major outcomes of each of the scenario runs, a graphic summary appears at the conclusion of each scenario section. The graphic uses colors and symbols to convey whether there are positive or negative trends and whether certain targets are being achieved.

Also, the transit, walk and bicycle trips outcome has been split into transit trips and walk/bicycle trips to provide a more complete picture of the effects of each scenario on the travel outcomes in the region.

Off-Peak Congestion

Description: Expand key freeway segments that experience congestion throughout the day.

Cost: $4 billion

Widen I-270 and I-25 (between E-470/NW Pkwy. and C-470/E-470)

Major **interchange reconstructions** at four bottleneck locations:

- I-225 / I-70
- I-225 / I-25
- US-6 / I-25
- US-285 / C-470

Land Use:

The baseline forecast for the distribution of households and jobs throughout the region represents a growth trajectory based on current assumptions about the location choices available to homebuilders, other developers and employers.

Transportation Network Changes:

This scenario includes the widening of I-270 and I-25 between E-470/Northwest Parkway and C-470/E-470. Additionally, interchange reconstructions are completed at four regional bottlenecks. The purpose of this scenario is to alleviate off-peak congestion in the region, as peak congestion is assumed to persist through the planning period.

Compared to the 2050 Base:

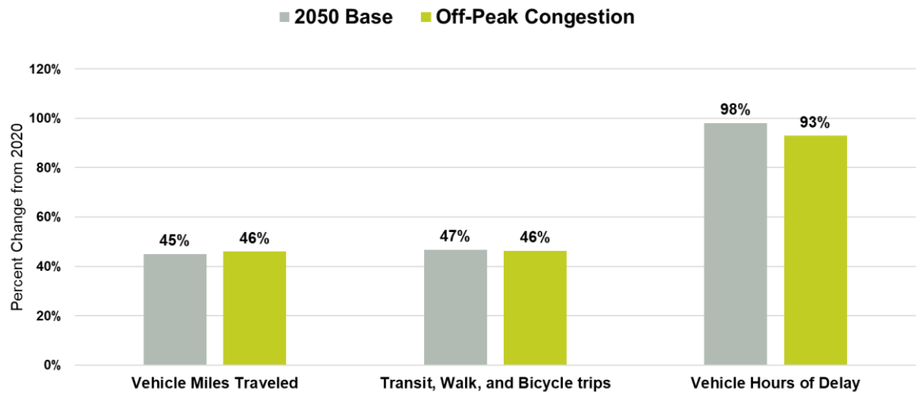
Despite the significant investment in widening I-170 and I-25 and reconstructing four interchanges, both vehicle miles traveled and non-single-occupant trips are projected to change less than 1% compared to the 2050 Base Scenario. However, total regional delay decreases by 3% and some traffic is diverted from arterial streets to the widened freeways.

Less than 1% change in vehicle miles traveled and transit trips

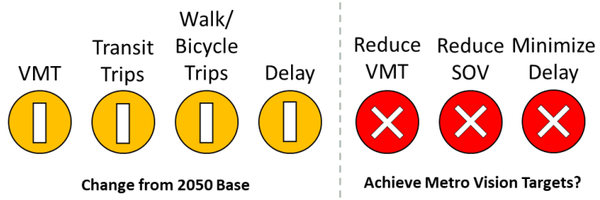
(Regional person delay decreases by 3%)

	Morning Peak I-25 from C-470 (Lone Tree) to SH-7 (Broomfield)	Daily Volume I-25 @ Speer
2020 Base	70 minutes	260,000
2050 Base	88 minutes	330,000
Off-Peak Congestion Scenario	79 minutes	380,000

What changes from 2020 would occur in this scenario, compared with the 2050 Base Scenario?



Conclusions:



As illustrated on the previous pages, the Off-Peak Congestion Scenario results in essentially no changes across the outcomes under evaluation compared to the 2050 Base.

Additionally, none of the three Metro Vision targets are met, despite a $4 billion investment in the region's transportation system.

Managed Lanes and Operations

Description: Improve operations and traffic flow on the region's highways/freeways.

Cost: $6.5 billion

Build **325 additional lane miles** of freeway managed lanes
(High-Performance Transportation Enterprise Express Lanes Master Plan)

Improve operations and incident management strategies
(CDOT State Farm Safety Patrol)

Land Use:

The baseline forecast for the distribution of households and jobs throughout the region represents a growth trajectory based on current assumptions about the location choices available to homebuilders, other developers and employers.

Transportation Network Changes:

A significant investment to the region's transportation network, this scenario reflects construction of 325 additional lanes miles of freeway-managed lanes. The network is based off the Colorado Department of Transportation's High-Performance Transportation Enterprise (HPTE) Express Lanes Master Plan.

Additionally, operations and incident management strategies, like CDOT's State Farm Safety Patrol and dynamic message signs, would play an important role in helping people in vehicles move efficiently in the region.

Compared to the 2050 Base:

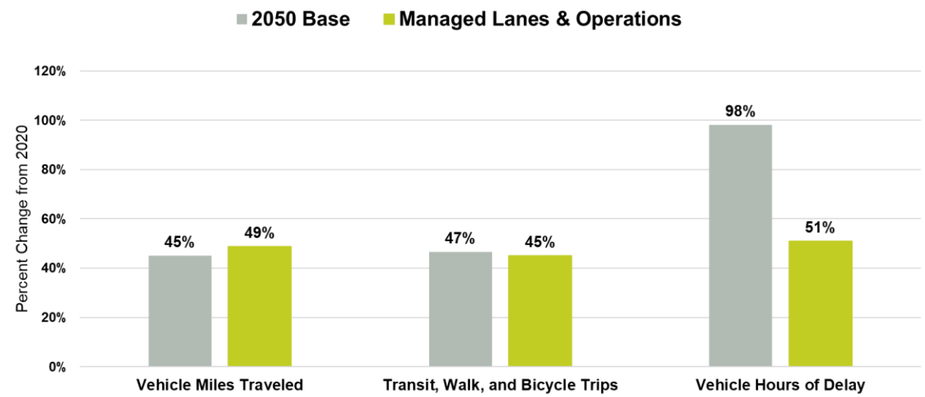
People in vehicles experience **25% less delay** on average

3% increase in vehicle miles traveled
(~800,000 more daily VMT compared to the 2050 Base)

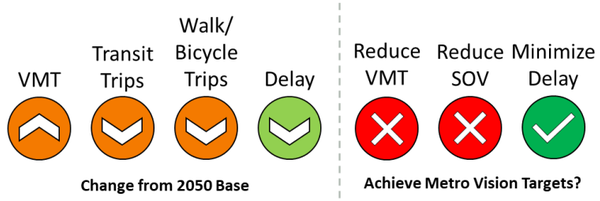
While there would be a slight increase in vehicle miles traveled when compared to the 2050 Base Scenario, regional delay experienced by people in all vehicles would drop 25%, a significant reduction considering the region is expected to increase by 1 million people and 800,000 jobs by 2050.

This drop in delay would improve travel reliability across the region, and with improved operations and incident management there would be significant safety outcomes for all users. There would also be a slight decrease in transit, walk and bicycle trips as some people would start driving because of more reliable travel times.

What changes from 2020 would occur in this scenario, compared with the 2050 Base Scenario?



Conclusions:



While the Managed Lanes and Operations Scenario results in a slightly less delay compared to the 2050 Base, this is offset by the slight increase in vehicle miles traveled and less transit, walk and bicycle trips.

Additionally, only one of the three Metro Vision targets are met, despite a significant $6.5 billion investment in the region's transportation system.

Travel Choices

Description: Increase travel and mobility choices along region's major arterials.

Cost: $3 billion

Active transportation is encouraged through **better infrastructure and lower speeds** on high activity urban arterials

Telecommuting and other transportation demand management (TDM) strategies

Land Use:

The baseline forecast for the distribution of households and jobs throughout the region represents a growth trajectory based on current assumptions about the location choices available to homebuilders, other developers and employers.

Transportation Network Changes:

The Travel Choices scenario is focused on leveraging investment to promote mobility choices in the region and improve safety outcomes for all users. In this scenario, pedestrian and bicycle infrastructure is improved along arterial corridors.

In addition to the Complete Streets focus of this scenario, the importance of safety for all users is emphasized by the reduction of speed limits on high-activity corridors, making walking and rolling more attractive options for residents. A key component of this scenario is also the increased use of telecommuting to shift or eliminate many trips.

Compared to the 2050 Base:

More than **twice** as many teleworkers

400,000 fewer drive alone work trips every day

50% increase in bicycle/pedestrian trips

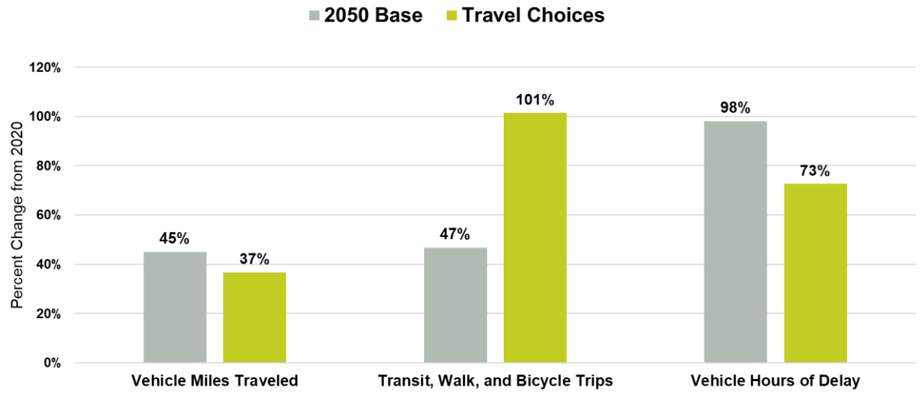
(Slight decrease in transit trips)

This scenario results in a decrease in vehicle miles traveled as compared to the 2050 Base. Additionally, with over twice as many teleworkers, there are 400,000 fewer drive-alone work trips every day and a significant increase in bicycle and pedestrian trips.

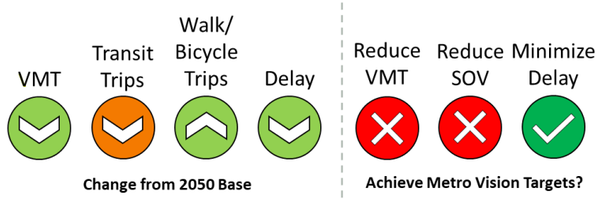
While bicycle and pedestrian trips increased by 50% compared to the 2050 Base in this scenario, there is a slight decrease in transit trips as residents find walking and rolling easier and safer for trips of shorter distances. Reduced speed limits also improve the region's safety outcomes, with fewer crashes, injuries and fatalities.

Despite the slower speed limits on high-activity arterials, there is also less delay across the region as workers take fewer commute trips and more traffic is shifted to bicycle and walking.

What changes from 2020 would occur in this scenario, compared with the 2050 Base Scenario?



Conclusions:



The Travel Choices scenario records positive trends in vehicle miles traveled, walk/bicycle trip, and delay. However, the increase in walk and bicycle trips comes at the expense of the transit trips, as this scenario records less compared to the 2050 Base.

Again, only one of the three Metro Vision targets are met, despite a $3 billion investment in the region's transportation system. Perhaps surprisingly, however, the Metro Vision target met is related to delay. Despite slower speeds on high-activity corridors, the fewer drive-alone work trips result in less people on the roads.

Transit

Description: Improve and expand the region's transit network and service.

Cost: $6 billion (plus an additional $1 billion annually for operating expenses)

Completion of **FasTracks and additional miles of rail**

Extensive **bus rapid transit (BRT)** network and expanded transit service on all routes
(Eight times as many service hours)

Free fares and improved station/stop access

Land Use:

The baseline forecast for the distribution of households and jobs throughout the region represents a growth trajectory based on current assumptions about the location choices available to homebuilders, other developers and employers.

Transportation Network Changes:

This scenario envisions the completion of the FasTracks system as currently proposed, as well as additional rail extensions to Watkins in the east and to Golden in the west. The bus rapid transit network was defined from a selection of networks examined in RTD's 2019 Regional Bus Rapid Transit Feasibility Study.

Additionally, transit would be free, which includes the additional benefit of speeding up the boarding process. Bicycle and pedestrian infrastructure, such as more direct paths and additional bridges, make access from these modes faster and safer.

Compared to the 2050 Base:

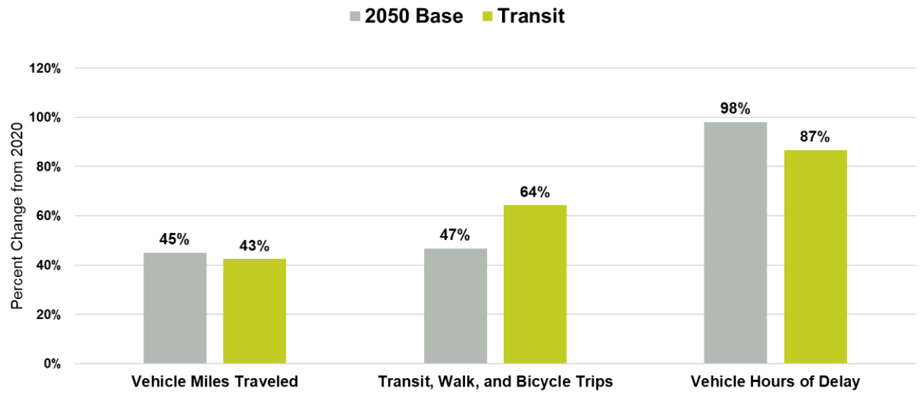
Transit would become a more appealing option for many people, as a larger percent of households would have better access to jobs and other destinations. Free transit provides personal, mobility and equity benefits to the region's residents. While the total number of transit trips would increase by 76% compared with the 2050 Base Scenario, this only results in a 2% decrease in vehicle miles traveled, as a majority of trips would still be taken in personal vehicles.

79% of households have good transit access to jobs
(Compared to 58% in the 2050 Base)

76% more transit trips
(Small decrease in walk and bike trips)

100,000 more households use transit
(14% of all households)

What changes from 2020 would occur in this scenario, compared with the 2050 Base Scenario?



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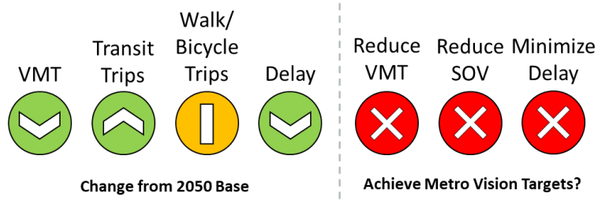


The Transit Scenario records positive trends on vehicle miles traveled, non-single-occupant vehicle travel and delay. Despite the significant investment, transit trips only increased slightly compared to the 2050 Base.

Additionally, none of the three Metro Vision targets are met, despite a significant $6 billion investment in the region's transportation system and $1 billion in annual operating expenses.

Infill

Description: Local governments allow for more urban and suburban redevelopment and infill.

Cost: Not Applicable

Allow for more housing and jobs in **existing urban and inner suburban areas**

Land Use:

Under this land use scenario, future growth and development is focused in redevelopment and infill in existing urban and suburban areas. “New urban development occurs in an orderly and compact pattern.”

This scenario aims to “promote investment/reinvestment in existing communities,” and “protect a variety of open spaces.” 75% of future household growth is focused in areas that account for only 11% of the region’s total land area.

Transportation Network Changes:

This baseline transportation scenario completes transportation projects from DRCOG’s 2040 Fiscally Constrained Regional Transportation Plan alongside the unmodified output from the 2050 UrbanSim model. The 2040 MVRTP defines transportation elements and services to be provided by 2040, based on reasonably expected revenues.

Compared to the 2050 Base:

6% decrease in vehicle miles traveled

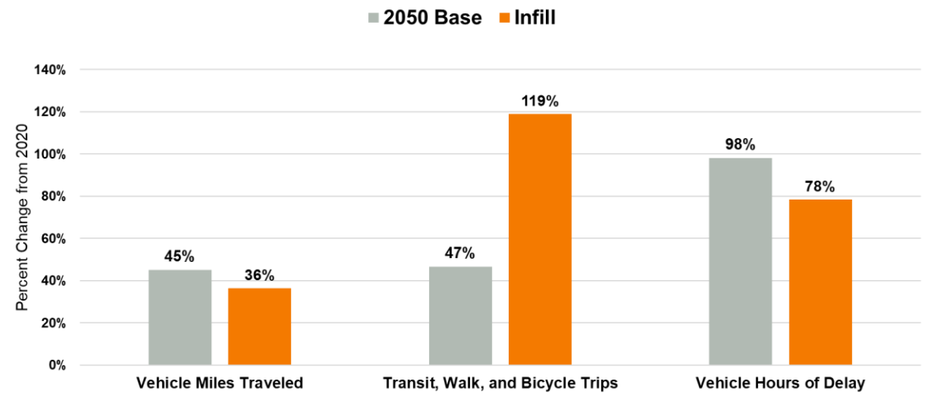
People in vehicles experience **11% less delay** on average

Almost **twice** as many transit trips

(and a 50% increase in walk and bike trips)

While there are no significant transportation investments beyond the adopted 2040 MVRTP, the Infill Scenario shows a significant decline in vehicle miles traveled and vehicle hours of delay as compared to the 2050 Base. Additionally, in this scenario, there are almost twice as many transit trips taken, as the system is more reliable in reaching amenities and needs in the region. This also results in a 50% increase in walk and bicycle trips since goods and services are co-located closer to existing developed areas. With focused redevelopment and infill across the region, 82% of single-family areas remain single-family in 2050, maintaining neighborhood character.

What changes from 2020 would occur in this scenario, compared with the 2050 Base Scenario?



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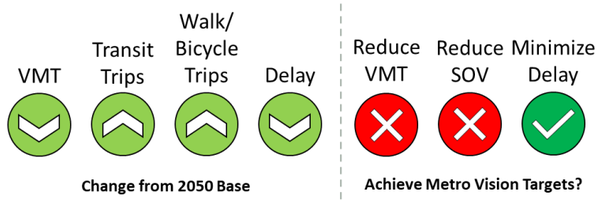


Despite not including any additional significant transportation investment, the Infill Scenario records positive trends across each metric, with both vehicle miles traveled and delay decreasing and non-single-occupant vehicle travel increasing.

However, only one of the three Metro Vision targets are met.

Infill + Travel Choices

Description: Local governments allow for more urban and suburban redevelopment and infill. Increase travel and mobility choices along region's major arterials.

Cost: $3 billion

Allow for more housing and jobs in **existing urban and inner suburban areas**

+

Active transportation is encouraged through **better infrastructure and lower speeds** on high activity urban arterials

Telecommuting and other transportation demand management (TDM) strategies

Land Use:

Under this land use scenario, future growth and development is focused in redevelopment and infill in existing urban and suburban areas. "New urban development occurs in an orderly and compact pattern."

This scenario aims to "promote investment/reinvestment in existing communities," and "protect a variety of open spaces." 75% of future household growth is focused in areas that account for only 11% of the region's total land area.

Transportation Network Changes:

The Travel Choices scenario is focused on leveraging investment to promote mobility choices in the region and improve safety outcomes for all users. In this scenario, pedestrian and bicycle infrastructure is improved along arterial corridors.

In addition to the Complete Streets focus of this scenario, the importance of safety for all users is emphasized by the reduction of speed limits on high-activity corridors, making walking and rolling a more attractive option for residents. A key component of this scenario is also the increased use of telecommuting to shift or eliminate many trips.

Compared to the 2050 Base:

When the Infill and Travel Choices scenarios are combined, the outcomes show they are highly complementary. The amount of vehicle miles traveled is significantly smaller compared to the 2050 Base, and the growth in vehicle hours of delay has been halved. These two outcomes show a more reliable and balanced regional transportation system. In this scenario, walking and bicycle trips make up 16% of all trips in the region, twice as many compared to the 2050 Base Scenario.

Perhaps surprisingly, there are also now more transit trips taken in this scenario than in the stand-alone Transit Scenario. With region-wide redevelopment targeted across the region, a range of housing options are available benefitting residents and improving the economic vitality of the region.

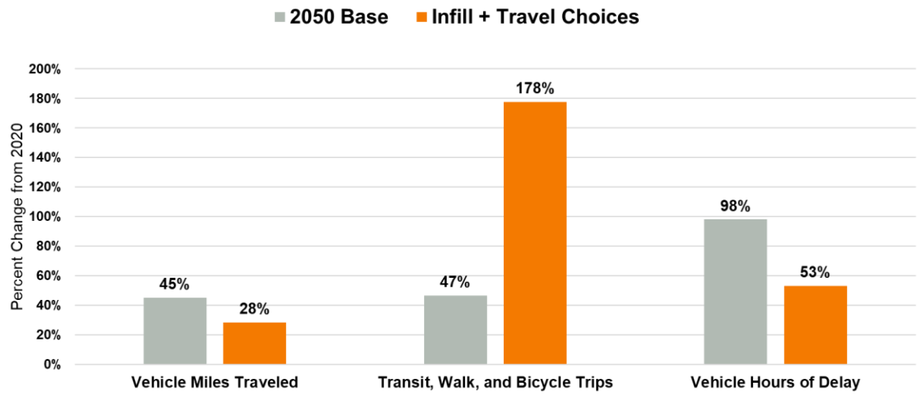
Vehicle miles traveled decreases by **14.5 million** each day

(Approximately 11% less VMT compared to the 2050 Base)

Twice as many walking and biking trips

(Approximately 16% of all trips taken in the region)

What changes from 2020 would occur in this scenario, compared with the 2050 Base Scenario?



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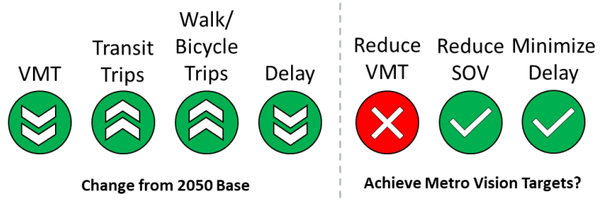


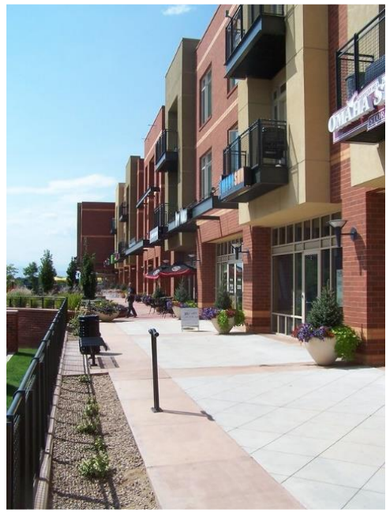
When the Infill and Travel Choices Scenarios are combined, significant positive trends are seen across each of the metrics. This complementary effect of land use and transportation results in significant increases in non-single-occupant vehicle trips compared to the 2050 Base. There are also significant decreases in vehicle miles traveled and delay. Additionally, in this combination of scenarios, two of the three Metro Vision targets are met.

Centers

Description: Local governments focus opportunity for development around key centers and corridors.

Cost: Not Applicable

Focus housing and jobs around **key centers and corridors**



Land Use:

Under this land use scenario, future growth and development is focused in key areas across the region, including urban centers, employment centers, rapid transit stations and key corridors. “Connected urban centers and multimodal corridors throughout the region accommodate a growing share of the region’s housing and employment.”

This scenario aims to “increase opportunities for diverse housing accessible by multimodal transportation” and “improve access to and from the region’s … employment centers.” While these centers only make up 3% of the total land area, they capture almost two-thirds of future household growth.

Transportation Network Changes:

This baseline transportation scenario completes transportation projects from DRCOG’s 2040 Fiscally Constrained Regional Transportation Plan alongside the unmodified output from the 2050 UrbanSim model. The 2040 MVRTP defines transportation elements and services to be provided by 2040, based on reasonably expected revenues.

Compared to the 2050 Base:

The Centers Scenario results in over three times as many transit trips, roughly 1.2 million trips daily. This significant increase in transit trips is also reflected in over twice as many walk and bicycle trips compared to the 2050 Base. With growth and development focused on key corridors and centers, the regional transportation system is more reliable and efficient in connecting people to their daily needs using modes other than a personal vehicle.

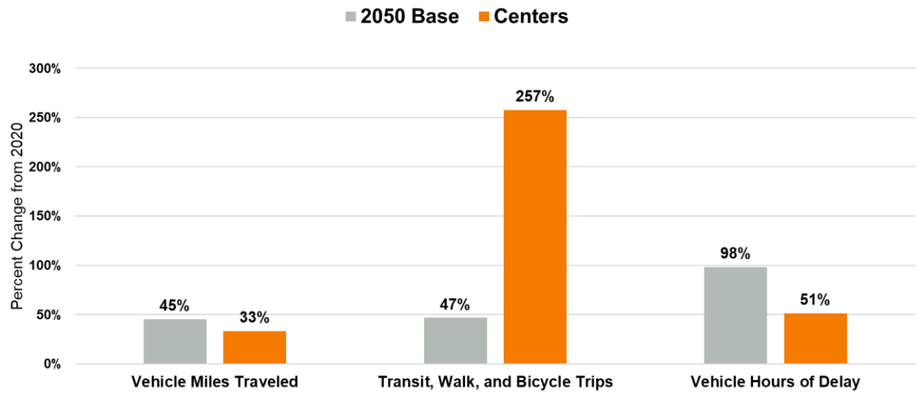
Additionally, because the Centers Scenario results in significant change in a small geographic area, 88% of single-family areas remain single-family out to 2050. This smaller geography and more efficient co-located development also result in a transportation system where the average delay experienced by people each trip decreases by 27%.

8% decrease in vehicle miles traveled

Over **three times** as many transit trips

Over **twice** as many walk and bicycle trips

What changes from 2020 would occur in this scenario, compared with the 2050 Base Scenario?



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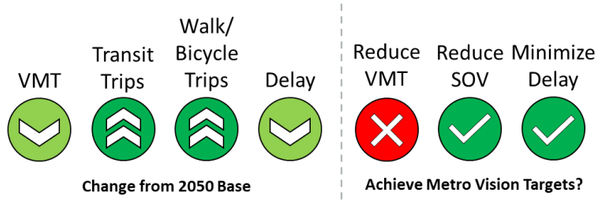


While there are no additional significant transportation investments associated with the Centers Scenario, each of the outcomes shows positive trends. Non-single-occupant vehicle travel has increased significantly and there are decreases in vehicles miles traveled and delay compared to the 2050 Base.

Additionally, despite only being a land use scenario two of the three Metro Vision targets are met, reduced single-occupant vehicle travel and minimized delay.

Centers + Transit

Description: Local governments focus opportunity for development around key centers and corridors. Improve and expand the region's transit network and service.

Cost: $6 billion (plus an additional $1 billion annually for operating expenses)

Focus housing and jobs around **key centers and corridors**

Cost of driving and parking increases significantly

Completion of **FasTracks and additional miles of rail**

Extensive **bus rapid transit network** and expanded service

Free fares & improved station/stop access

Land Use:

Under this land use scenario, future growth and development is focused in key areas across the region, including urban centers, employment centers, rapid transit stations and key corridors. “Connected urban centers and multimodal corridors throughout the region accommodate a growing share of the region’s housing and employment.”

This scenario aims to “increase opportunities for diverse housing accessible by multimodal transportation” and “improve access to and from the region’s … employment centers.” While these centers only make up 3% of the total land area, they capture almost two-thirds of future household growth.

Transportation Network Changes:

This scenario envisions the completion of the FasTracks system as currently proposed, as well as additional rail extensions to Watkins in the east and to Golden in the west. The bus rapid transit network was defined from a selection of networks examined in RTD’s Regional Bus Rapid Transit Study. Transit would be free, which includes the additional benefit of speeding up the boarding process. Bicycle and pedestrian infrastructure, such as more direct paths and additional bridges, make access from these modes faster and safer.

Compared to the 2050 Base:

When combined, the Centers and Transit Scenarios illustrate highly complementary outcomes as well. Again, while there are 1 million more people and 800,000 jobs in the region under this scenario, vehicle miles traveled decrease significantly compared to the 2050 Base. The scenario results in three times as many walk and bicycle trips, and six times as many transit trips compared to the 2050 Base, equating to roughly 2.4 million transit trips daily. The results also indicate that there are overall more person-trips as people have more free time to make shorter trips.

Vehicle miles traveled **decrease 24%**

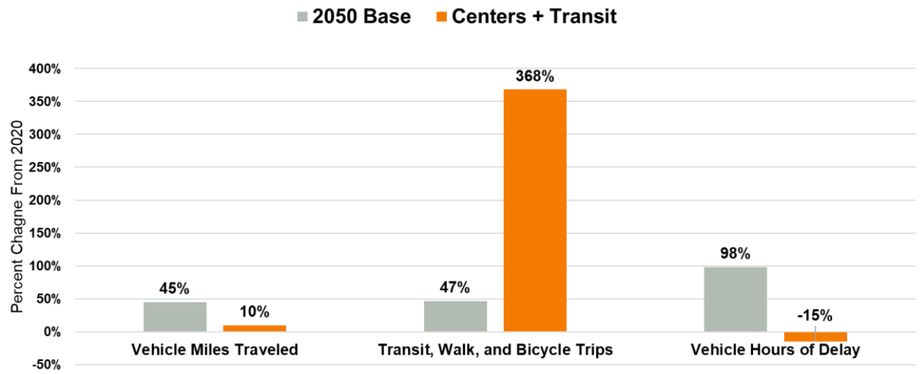
3 times as many walk and bicycle trips

6 times as many transit trips

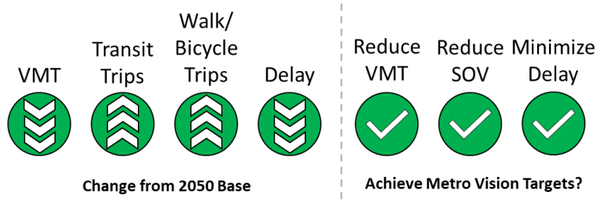
(2.4 million transit trips daily)

With redevelopment focused on such a small geographic area and more efficiently co-located, the result is also a transportation system where the average delay experienced by people each trip decreases by 50%, an actual decrease compared to the 2020 Base.

What changes from 2020 would occur in this scenario, compared with the 2050 Base Scenario:



Conclusions:



The combination of the Centers Scenario and the Transit Scenario results in significant positive trends among the outcomes evaluated. Transit, walk and bicycle trips have increased significantly compared to the 2050 Base and vehicle miles traveled and delay have decreased significantly as well. In fact, the reduction in delay is not just a reduction compared to the 2050 Base, but also 2020 levels.

Finally, this is the only scenario or combination of scenarios that result in all three of the Metro Vision targets being met.

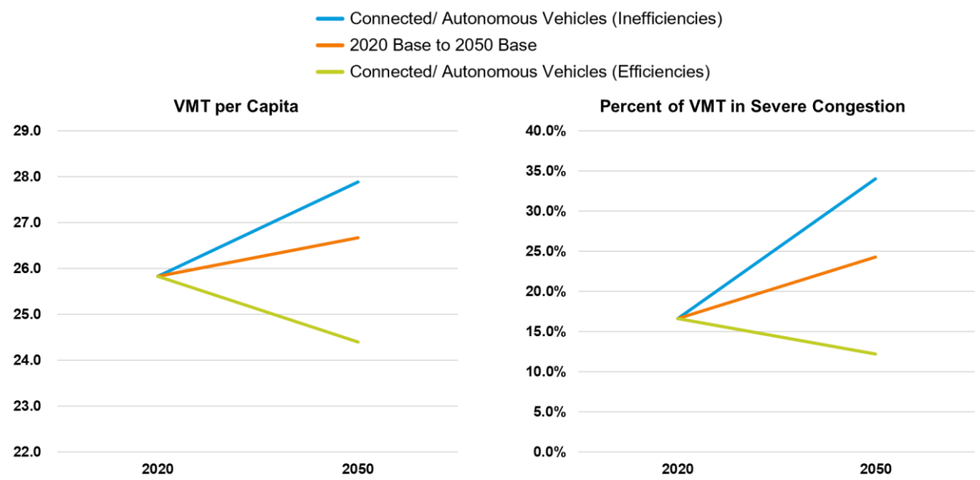
Automated and Connected Vehicles

Description: Mobility technology and autonomous vehicles benefit or affect regional mobility.

Cost: $1 billion annually for operating expenses

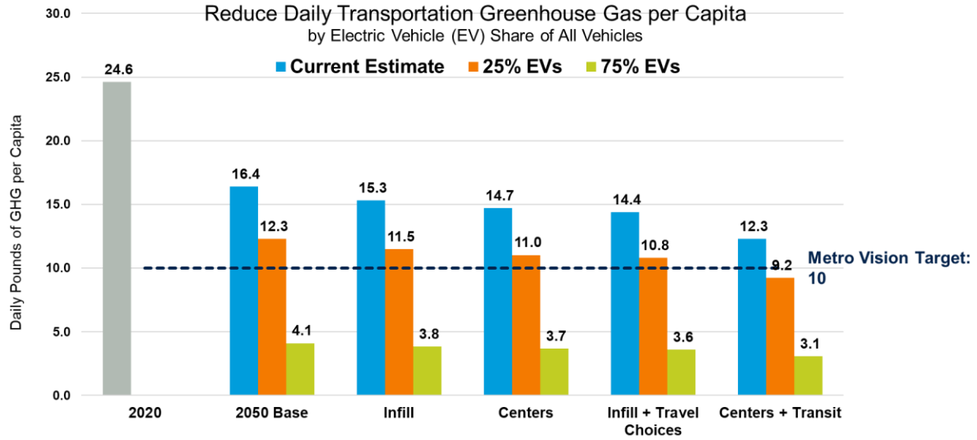
The overall effects of connected and automated vehicles on regional travel measures are extremely difficult to estimate, especially from a modeling perspective. While regional and transportation planners can derive examples of individual trip-making decisions due to new automated services, trends are harder to capture. However, there are many unknowns as to how and where automated vehicles (personal and commercial) might operate and how that translates into overall travel demand. Researchers have identified a wide array of potential positive and negative effects on general traffic operations and trip-making habits. Thus, progress towards Metro Vision targets is difficult to gauge with any level of reliability. Traffic congestion or VMT could decline significantly or increase greatly with highly advanced automation of vehicles.

To transportation and regional planners, the potential safety benefits of connected vehicle technology is worthy of consideration. New cars come standard with many driver-assist features and alert systems. Such systems will be enhanced further as vehicles (and occupants) are able to communicate more extensively with other vehicles, the roadway infrastructure and transportation control centers to warn of pending or immediate incidents. For drivers, it will remain critical that they do not reduce their level of alertness or become overly dependent on such technology.



Electric Vehicles and Greenhouse Gas Emissions

The chart below demonstrates that none of the scenarios achieved Metro Vision's target of reducing greenhouse gas emissions per capita by 60% compared to 2010, or 10 pounds per person per day. These estimates come from the federal Mobile Vehicle Emission Simulator model and are based on current federal vehicle regulations. The estimates do not assume a widespread electrification of vehicles on the roadway. If by 2050 a significant portion of the vehicles in the region were electric, achieving the Metro Vision target and well beyond could be accomplished, conceivably even to zero emissions from the entire fleet of vehicles on the roadway. The region will need to rely, in part, on vehicle electrification to meet this target.



Conclusions:

Specific conclusions are challenging to define. Each of the scenarios enhances mobility in unique ways which affect specific corridors, parts of the region or travel modes. The scenarios examine very different futures for the region and certain aspects of each scenario may appeal differently to the diverse set of individuals that make up the region's population. However, in examining the most influential factors on making progress toward Metro Vision's transportation mobility and air quality targets, the following elements appeared to affect the greatest change in outcomes:

1. **Development Patterns:** The scenarios that tested increased development as infill or concentrated near regional centers significantly affected progress toward Metro Vision targets, even without additional transportation infrastructure.
2. **Increased teleworking (working at home):** In the Travel Choices Scenario, doubling the amount of people that teleworked reduced total trips, vehicle miles traveled and congestion, particularly during peak periods that are prone to the most delay.
3. **Increased costs to drivers of cars/trucks:** The Transit + Centers Scenario also included increases in the cost of operating and parking vehicles, while also providing attractive alternative modes for travel. This played a significant role in reducing vehicle miles traveled in the scenario.
4. **Electric Vehicle expansion:** While none of the scenarios achieved the Metro Vision target for greenhouse gas reduction with current vehicle fleet assumptions, widespread electrification of vehicles in the region could result in achieving reductions well beyond that target in any of the scenarios.

Other outcomes include:

- The effects of commercial vehicle traffic and package deliveries in relation to development patterns
- The benefits of increased transit and lower fares on VMT or Person Hours of Delay – **especially when** combined with significant land use development changes.

Many more conclusions could be drawn from the overwhelming amount of data produced in this exercise. While the preceding pages highlight some of the key changes in each scenario, the appendix includes more detailed data from the results.

2050 Metro Vision Regional Transportation Plan

Scenario Planning

Appendices

Appendix A: Scenario Outputs Summary Results

Scenario Modeling Measures (Weekday - DRCOG Region)	2020 Base	2050 Base	2050 SCENARIOS										Metro Vision Target
			Off-Peak Congestion	Regional Managed Lanes and Operations	Travel Choices	Transit	Infill Land Use	Travel Choices + Infill Land Use	Centers Land Use	Transit + Centers Land Use	Connected and Autonomous Vehicles (Efficiencies)	Connected and Autonomous Vehicles (Inefficiencies)	
Total Travel													
Person Miles Traveled (PMT) Grand Total	120,158,000	177,463,000	178,724,000	181,782,000	168,120,000	178,017,000	170,577,000	161,559,000	171,124,000	160,083,000	169,584,000	185,504,000	
PMT in Autos & Trucks	118,648,000	171,757,000	173,063,000	176,265,000	161,922,000	168,865,000	161,493,000	151,903,000	154,557,000	129,908,000	165,507,000	179,604,000	
PMT on Transit, Walk, Bike	2,499,000	3,746,000	3,712,000	3,584,000	4,178,000	6,135,000	6,615,000	7,031,000	13,056,000	26,980,000	2,368,000	3,926,000	
PMT on Transit	1,828,000	2,765,000	2,733,000	2,615,000	2,752,000	5,209,000	5,343,000	5,270,000	11,269,000	24,790,000	1,578,000	2,935,000	
PMT on Transit, Walk, Bike / Total PMT	2.1%	2.1%	2.1%	2.0%	2.5%	3.4%	3.9%	4.4%	7.6%	16.9%	1.4%	2.1%	
Total Person Trips	15,143,000	21,040,000	21,047,000	21,058,000	20,725,000	20,727,000	21,375,000	21,062,000	22,136,000	22,189,000	21,104,000	21,038,000	
Vehicle Trips	10,269,000	14,301,000	14,308,000	14,321,000	13,477,000	14,098,000	13,774,000	12,909,000	12,913,000	11,611,000	15,588,000	17,342,000	
Trips by Transit, Walk, and Bike	1,292,000	1,894,000	1,889,000	1,873,000	2,603,000	2,124,000	2,827,000	3,585,000	4,616,000	6,044,000	1,513,000	1,918,000	
Percent of Households Making Transit Trips	9%	9%	9%	9%	9%	14%	15%	15%	26%	38%	6%	9%	
Share of Work Trips Non-SOV	19%	20%	20%	20%	24%	22%	30%	35%	46%	55%	17%	21%	> 35%
Vehicle Miles Traveled (VMT)	87,080,000	126,285,000	127,074,000	129,606,000	119,060,000	124,165,000	118,740,000	111,693,000	116,187,000	95,521,000	115,538,000	132,062,000	
VMT/PMT	72%	71%	71%	71%	71%	70%	70%	69%	68%	60%	68%	71%	
VMT per Capita	25.8	26.7	26.8	27.4	25.1	26.2	25.1	23.6	24.5	20.2	24.4	27.9	< 23.0
Vehicle Hours Traveled (VHT)	2,496,000	3,851,000	3,835,000	3,651,000	3,753,000	3,748,000	3,577,000	3,472,000	3,306,000	2,591,000	3,264,000	4,585,000	
Delay													
Vehicle Hours of Delay	474,000	939,000	914,000	716,000	819,000	885,000	845,000	726,000	716,000	403,000	520,000	1,473,000	
Person Hours of Delay In-Vehicle	645,000	1,277,000	1,243,000	973,000	1,113,000	1,204,000	1,150,000	987,000	974,000	548,000	707,000	2,004,000	
Average Person Delay Per Trip (minutes)	3.0	4.1	4.0	3.1	3.7	3.9	3.8	3.4	3.4	2.1	2.0	5.5	
Percent of Total VMT in Severe Congestion	16.4%	24.3%	23.1%	17.3%	22.4%	23.5%	23.3%	21.2%	22.2%	11.3%	7.8%	34.0%	
Severly Congested Lane Miles	1,275	2,600	2,511	1,745	1,860	2,429	2,366	1,684	1,915	898	981	4,417	
Demographics													
Teleworkers on Typical Day	232,000	318,000	318,000	318,000	697,000	317,000	315,000	692,000	309,000	277,000	318,000	319,000	
Households in Urban Centers	241,000	340,000	340,000	340,000	340,000	340,000	415,000	415,000	514,000	514,000	340,000	340,000	
Jobs in Urban Centers	871,000	1,081,000	1,081,000	1,081,000	1,081,000	1,081,000	1,190,000	1,190,000	1,348,000	1,348,000	1,081,000	1,081,000	
Roadway Transportation Greenhouse Gasses	41,000.00	39,000.00	39,000.00	40,000.00	36,000.00	38,000.00	36,000.00	34,000.00	35,000.00	29,000.00	37,000.00	40,000.00	
Greenhouse Gasses Per Capita	24.6	17.6	17.7	18.1	16.6	17.3	16.5	15.6	15.8	13.3	17.0	18.4	< 10.0

Appendix B: Scenario Inputs Summary Components

Scenario	Scenario Component Inputs
Off-Peak Congestion	**Expand key freeway segments that experience congestion throughout the day.** 1. Add unique bottleneck improvements to code in model - Add additional lanes to six severely congested interchanges 2. Add 1 general purpose lane to I-25 from C-470 to E-470
Managed Lanes and Operations	**Improve operations & traffic flow on region's highways/freeways.** 1. HPTE Express Lanes Master Plan corridors - Add managed lanes to all freeways stuided in HPTE Express Lanes Master Plan as well as US-285, US-6, and I-70 West. - Pricing structure 2. Increase operating capacity (reduced crashes, incident management) - 20% increase in capacity on freeways - 10% increase in capacity on arterials
Travel Choices	**Increase travel & mobility choices along region's major arterials.** 1. Increase walk/pedestrian and bicycle mode choice attractiveness - Increase bike/ped attractiveness with higher sidewalk/bike path density - Increase speed on transit walk links - Increase walk speed and bicycle operating speed - Modify other attractiveness utility functions 2. Work location modifications - Double telecommuting share for "office" workers 3. Reduce speeds on multimodal arterials - Manually reduce free flow speeds by facility type and area type throughout the region

Scenario	Scenario Component Inputs
Transit ***Transit + Base Land Use (Inputs 1-4)*** ***Transit + Centers (Inputs 1-6)***	**Improve/expand the region's transit network and service.** 1. Regional bus rapid transit (BRT) system: - Add BRT system to the region based on the "Tier 3" corridors evaluated in RTD's Regional BRT Feasibility Study - Additional BRT/Bus Corridors (Bustang or Front Range Rail proxy): - Castle Rock to Downtown - North I-25 border to SH-119 - Idaho Springs to Downtown 2. Rail corridors - Complete FasTracks: North Metro; Northwest Rail; Southwest Rail Extension; Central Extension - Additional rail corridors: - From 40th/Pena to Watkins - Extend G Line to Golden 3. Free fares - Free transit fares - Reduce dwell time by 50% 4. Increased transit frequency - Cut all transit headways in half with a max of 10 minutes - If no mid-day or reverse peak service, add to all routes - Max "transit wait time" to 10 minutes 5. Improve transit access - Remove transit transfer penalty - Reduce walk-access times - Increase speed on transit walk links 6. Related driving factors - Triple existing cost of parking - Add Denver Tech Center and Fitzsimons as a new areas with paid parking - Double auto operating cost

Scenario	Scenario Component Inputs
Automated and Connected Vehicles	**Mobility technology & autonomous vehicles benefit or impact regional mobility.** 1. Increase roadway operating capacity (closer vehicle spacing, connected vehicle infrastructure, reduced crashes, etc.) - Increase base roadway capacity - Freeway: 50% increase - Arterial (or Non-Freeway): 20% increase - Increase vehicle availabilty - Decrease terminal time by 50% - Reduce parking costs by 50% - Change 25% of drive alone trips to shared ride before assignment - Decreased impact (value) of time in vehicle? 2. Decrease roadway operating capacity (longer vehicle spacing, more cautious gap entry - Reduce capacity on mixed-vehicle facilities - Decreased impact (value) of time in vehicle? - Increased VMT due to zero occupancy vehicles (ride-hailing services repositioning, personal deadheading)?

For more information on the 2050 MVRTP, please visit drcog.org to see previous meeting materials, handouts and presentations.

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