



Air quality conformity determination documents

Air Quality Conformity Determination Documents

for the Denver Regional Council of Governments Fiscally Constrained Element of the 2050 Metro Vision Regional Transportation Plan and the DRCOG 2022-2025 Transportation Improvement Program and the Southern Subarea Portion of the Upper Front Range 2045 Regional Transportation Plan and the 2022-2025 State Transportation Improvement Program for the Upper Front Range Transportation Planning Region

April 2021 Action Draft

Denver Regional Council of Governments
1001 17th St, Suite 700
Denver, CO 80202

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January 7, 2021

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Executive summary

The Denver Regional Council of Governments completed this transportation conformity determination as part of the transportation and air quality planning process. DRCOG's update to the long-range transportation plan triggered the need to perform the conformity analysis. The ozone nonattainment area continues to meet air quality conformity standards associated with the DRCOG and Upper Front Range Transportation Planning Region respective long-range transportation plans and short-range transportation improvement programs.

Emissions test results

Table 1 shows the budgets for volatile organic compounds and nitrogen oxides, the pollutants that directly contribute to ozone. The modeled emissions must be below budget to pass conformity tests. All staging-year results for the Denver Southern Subarea are reported in Table 1. All tests are passed based on model results for emissions being below the budgets. This means the plans associated with this determination meet conformity requirements for the 2020 Ozone State Implementation Plan budgets (2008 and 2015 ozone standards). The emissions estimates were generated by Air Pollution Control Division using the transportation inputs from DRCOG's travel demand models and the Motor Vehicle Emission Simulator model.

Other pollutants

This document details ozone conformity. Currently, the DRCOG region is designated as a maintenance area for carbon monoxide and particulate matter equal to or less than 10 microns in aerodynamic diameter particulate matter. The carbon monoxide and particulate matter conformity determination, last adopted in May 2019 by the DRCOG Board of Directors, is being updated concurrently with this document.

Table 1. 8-Hour ozone conformity for Denver southern subarea results (emission tons per day)

	2017 State Implementation Plan budgets (2008 Ozone Standard)	Modeling results				
		2023 emissions	2030 emissions	2040 emissions	2050 emissions	Pass/fail
Volatile organic compounds	47	35	28	21	21	pass all tests
Nitrogen oxides	61	35	24	16	16	pass all tests

Chapter 1. What is transportation conformity?

Each metropolitan planning organization associated with an air quality nonattainment area is required to show conformity of its long-range fiscally constrained regional transportation plan and transportation improvement program with the state implementation plan for air quality before transportation plans and programs may be adopted. Section 176(c) of the Clean Air Act, as amended in 1990, requires that new conformity determinations must be made when there are additions or deletions of funded regionally significant projects not depicted as such in a current conformity determination or if a new Transportation Improvement Program (with different programming years) is proposed for adoption. Project additions or deletions usually occur in relation to the Regional Transportation Plan. Since Transportation Improvement Program projects are contingent upon already being identified in the Regional Transportation Plan, Transportation Improvement Program changes alone rarely trigger the need for a new conformity determination. This new determination was triggered by DRCOG's update to the Regional Transportation Plan consistent with a shift in Metro Vision Regional Transportation Plan horizon years from 2040 to 2050.

The Clean Air Act defines conformity as alignment with an air quality implementation plan's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards and achieving expeditious attainment of such standards. In addition, activities may not cause or contribute to new violations of air quality standards, exacerbate existing violations or interfere with the timely attainment of required emissions reductions toward attainment. For pollutants for which a region currently meets standards but was formerly in nonattainment, the applicable State Implementation Plan may also be referred to as a maintenance plan, which demonstrates continued attainment of the standards. According to 40 Code of Federal Regulations 93.109 of the Transportation Conformity Rule, criteria and procedures for determining conformity of transportation plans, programs, and projects must satisfy different criteria depending on whether the state has submitted a State Implementation Plan revision, and whether the U.S. Environmental Protection Agency has approved the revision.¹

¹ Transportation Conformity Guidance for 2015 Ozone National Ambient Air Quality Standards Nonattainment Areas (Environmental Protection Agency-420-B-18-023) June 2018: §93.109(c) (1) In such 8-hour ozone nonattainment and maintenance areas the budget test must be satisfied as required by §93.118 for conformity determinations made on or after:

(i) the effective date of Environmental Protection Agency's finding that a motor vehicle emissions budget in a submitted control strategy implementation plan revision or maintenance plan for the 8-hour ozone National Ambient Air Quality Standards is adequate for transportation conformity purposes.

On Jan. 9, 2008, the Environmental Protection Agency administrator signed an amendment to the conformity rule (the “Final Rule”), to implement the provisions of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. The Environmental Protection Agency final transportation conformity rule is located at 40 Code of Federal Regulations Part 93, Subpart A. The Final Rule was promulgated Feb. 25, 2008. The most recent Environmental Protection Agency revision to the conformity rule occurred on March 14, 2012 (77 FR 14979, effective April 13, 2012). To address revised standards and changes in conformity requirements, the Environmental Protection Agency has promulgated several amendments to the final rule in recent years. The Air Quality Control Commission Regulation No. 10 or “Criteria for Analysis of Transportation Conformity,” was adopted by the commission in 1998. It formally defines the process for determining conformity. The Environmental Protection Agency approved Regulation No. 10 on Sept. 21, 2001 (66 FR 48561), making it federally enforceable. Regulation No. 10 was updated and approved by the Air Quality Control Commission on Dec. 15, 2011.

Chapter 2. Ozone nonattainment area

Area boundaries and history

The Environmental Protection Agency's process to determine the nonattainment area dates to 1997. Within the DRCOG region, there are several key planning organizations. Table 2 depicts the three organizations, their roles in the region and their geographic boundaries. Figure 1 depicts the boundary of all three metropolitan planning organizations/transportation planning regions involved in this report's 8-hour ozone conformity determination.

For long-term and short-term planning, DRCOG's 2050 Metro Vision Regional Transportation Plan includes the entire DRCOG transportation planning region. The DRCOG Transportation Improvement Program covers the transportation management area, while the Colorado Department of Transportation and the State Transportation Improvement Program covers the remaining portions of the region.

Table 2. Area planning organizations

Organization	Role	Boundaries
Denver Regional Council of Governments	Metropolitan planning organization and transportation planning region for the Denver Transportation Management Area	The transportation management area includes four urbanized areas and the portions of Adams and Arapahoe counties west of Kiowa Creek; all of Boulder County except Rocky Mountain National Park; all of Broomfield, Denver, Douglas and Jefferson counties; and parts of southwestern Weld County. The transportation planning region area includes the transportation management area plus the portions of Adams and Arapahoe counties east of Kiowa Creek, Clear Creek and Gilpin counties, and the Rocky Mountain National Park area of Boulder County.
North Front Range Metropolitan Planning Organization	Metropolitan Planning Organization for the North Front Range Transportation Management Area	Includes 15 local governments in portions of Larimer and Weld counties.
Upper Front Range	Transportation planning region for North-Central Colorado	Comprises Larimer, Morgan and Weld counties, and excludes the urbanized areas in Larimer and Weld counties.

The DRCOG transportation management area boundary expansion into southwestern Weld County was approved by the governor on Feb. 21, 2008. The ozone non-attainment area includes a more expansive area of Weld County.

Figure 1. Planning organizations involved in Denver Metro/ North Front Range 8-hour ozone nonattainment area

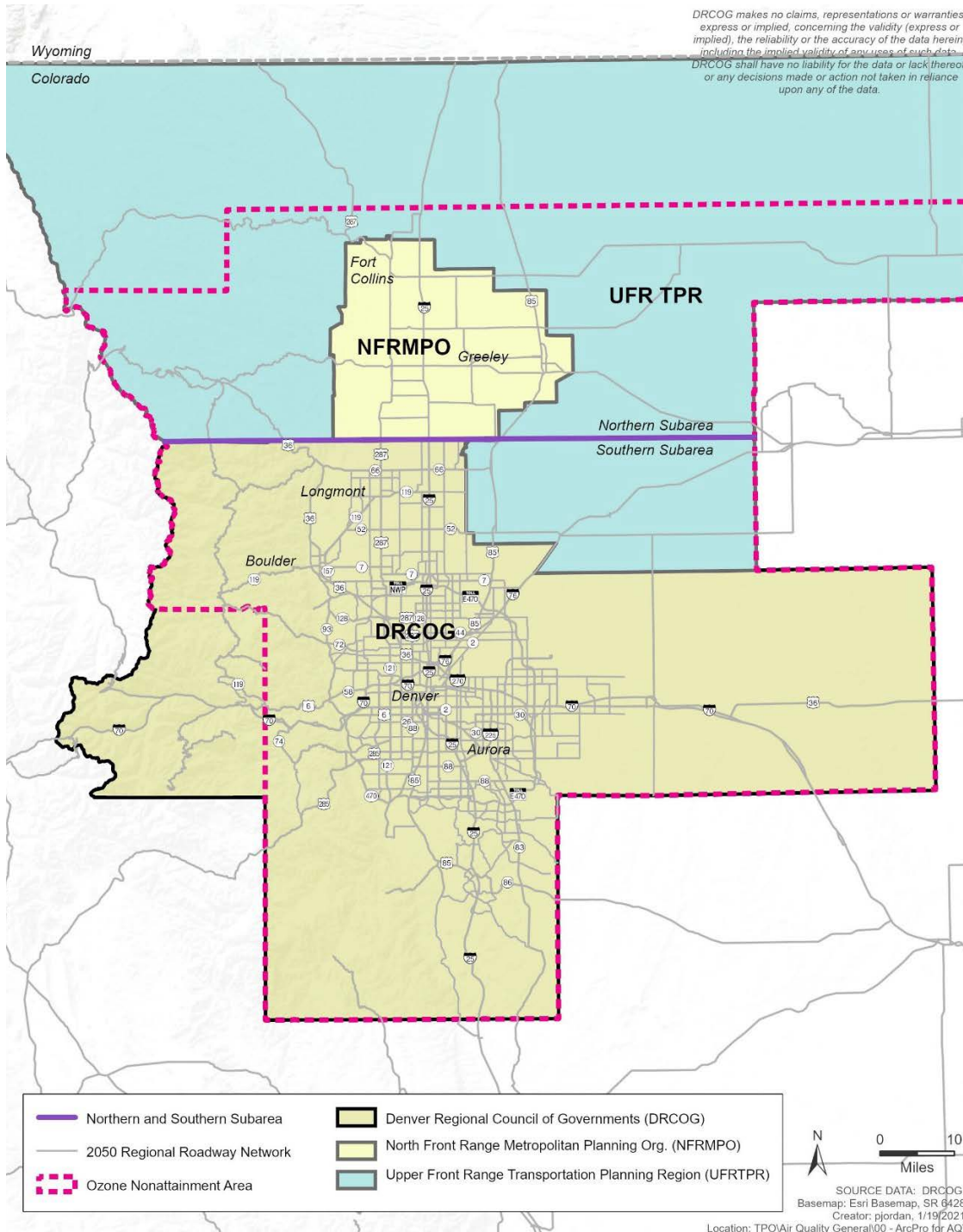


Table 3 is a historical summary of the 1997, 2008 and 2015 8-hour ozone National Ambient Air Quality Standards for the Denver Metro/North Front Range region. The 8 hour ozone nonattainment area is comprised of two subareas (Northern and Southern), shown in Figure 2. The boundary between the two subareas is the Boulder/Larimer county line extended through southern Weld County to the Morgan County line. Per 2004 designation, the area includes nine counties in the Denver Metro/North Front Range region (Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson and the southern portions of Larimer and Weld counties).

Table 3. Historical summary for the 8-hour ozone national ambient air quality standards in the Denver Metro/North Front Range nonattainment area

Date	Milestone	Comments
1997	U.S. Environmental Protection Agency established the 8-hour ozone National Ambient Air Quality Standard of 80 parts per billion.	Due to litigation at the federal level, it took the Environmental Protection Agency until 2004 to designate nonattainment area.
April 30, 2004	The Environmental Protection Agency promulgated Phase I ozone implementation rule and designated nine Denver Metro/North Front Range counties as marginal nonattainment for the 1997 8-hour ozone National Ambient Air Quality Standards	Nine counties in the Denver Metro/North Front Range region: Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, and the southern portions of Larimer and Weld effective date: June 15, 2004 (69 FR 23951)
March 27, 2008	The Environmental Protection Agency lowered the National Ambient Air Quality Standards for ground-level ozone to 0.075 parts per million; same nine counties marginal nonattainment	New 2008 standard is 75 parts per billion; secondary standards are identical to the revised primary standard effective date: May 27, 2008 (73 FR 16436)
May 21, 2012	The Environmental Protection Agency designated the Denver Metro/North Front Range region as marginal nonattainment under the new standard.	
Conclusion of the 2014 ozone season	The Denver Metro/North Front Range region failed to attain air quality standards based on the three-year average of ozone data from 2012 to 2014.	

Date	Milestone	Comments
Oct. 26, 2015	The Environmental Protection Agency published the final rule revising 8-hour ozone National Ambient Air Quality Standards (2015 8-hour ozone National Ambient Air Quality Standards).	New 2015 standard is 0.070 parts per million; secondary standards are identical to the revised primary standard effective date: Dec. 28, 2015 (80 FR 65291)
May 4, 2016	The Environmental Protection Agency reclassified the region from a marginal to a moderate nonattainment area for the 2008 ozone National Ambient Air Quality Standards, extending the attainment year to 2017.	A Moderate State Implementation Plan was developed to demonstrate how the Denver Metro/North Front Range region will comply with the federal Clean Air Act.
May 2017	New motor vehicle emissions budgets were submitted to the Environmental Protection Agency as part of the State Implementation Plan package for the 2008 ozone National Ambient Air Quality Standards	
June 4, 2018	The Environmental Protection Agency published a final rule designating the Denver Metro/North Front Range region as marginal for the 2015 ozone National Ambient Air Quality Standards	The same nine-county Denver Metro/North Front Range geography was used as with the 2008 ozone National Ambient Air Quality Standards. Until new motor vehicle emissions budgets are approved and become effective, the Denver Metro/North Front Range nonattainment area demonstrates conformity to the 2015 ozone National Ambient Air Quality Standards by meeting the approved moderate State Implementation Plan motor vehicle emissions budget tests for the 2008 National Ambient Air Quality Standards (40 Code of Federal Regulations 93.109(c)(2)(i)) ² . effective date: Aug. 3, 2018.

2 Transportation Conformity Guidance for 2015 Ozone National Ambient Air Quality Standards Nonattainment Areas (Environmental Protection Agency-420-B-18-023), June 2018

Memorandum of agreement

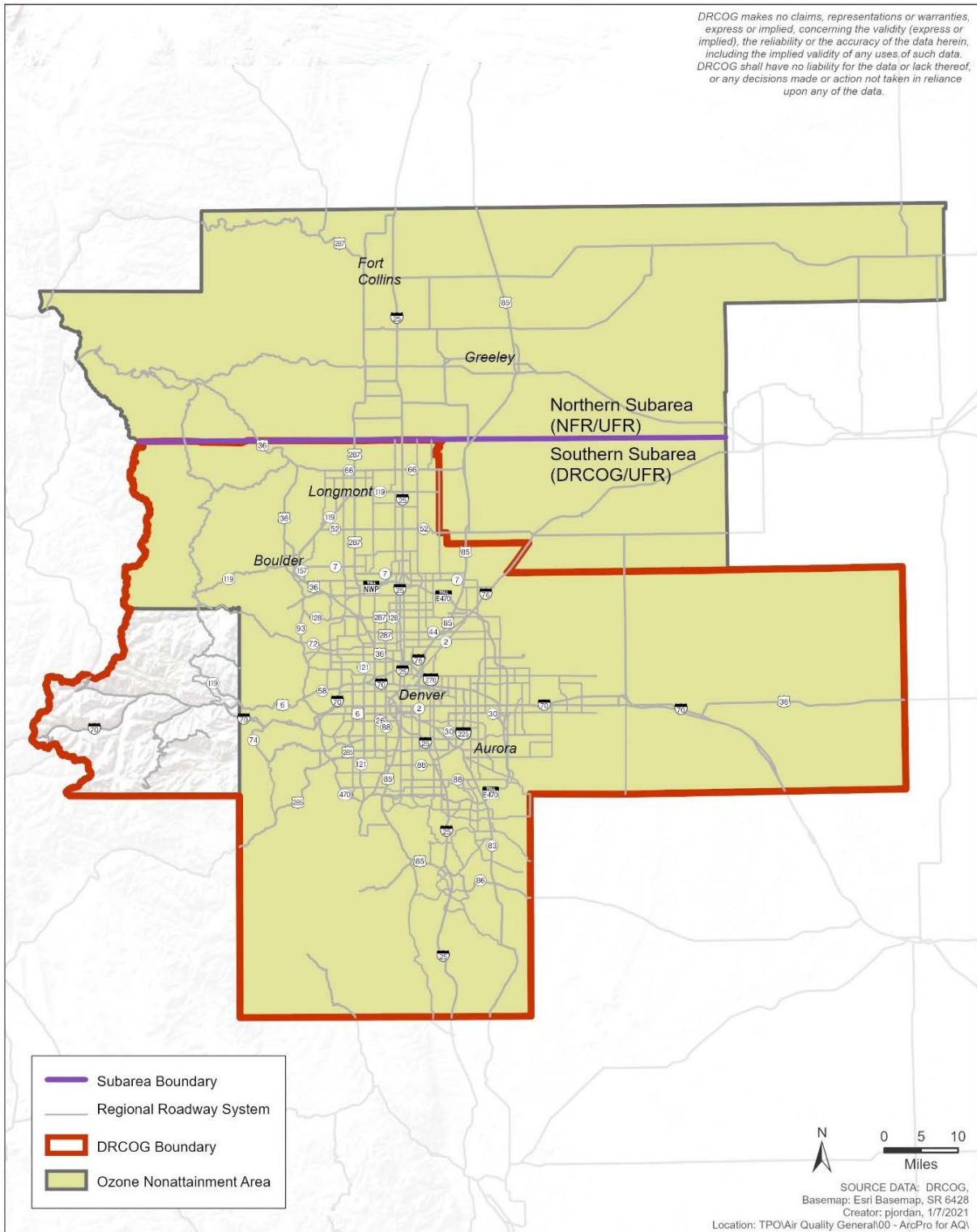
Federal Transportation Regulations at 23 Code of Federal Regulations 450.314(b) states:

“where a metropolitan planning area (MPA) does not include an entire nonattainment area, there shall be written agreement among the State Department of Transportation, state air quality agency, affected local agencies, and the MPO describing the process for cooperative planning and analysis of all projects outside the MPA within the nonattainment area.”

A memorandum of agreement was signed in March 2008 by the Colorado Department of Public Health and Environment, Colorado Department of Transportation, Regional Air Quality Council, Upper Front Range Transportation Planning Region, North Front Range Metropolitan Planning Organization, and DRCOG. A new memorandum of agreement reflecting the updated Regulation No. 10 was signed by North Front Range Metropolitan Planning Organization, Colorado Department of Public Health and Environment, Regional Air Quality Council, and DRCOG in 2015. Both are still in effect. It updated the specific roles and responsibilities in conformity evaluations and findings for each agency. The memorandum of agreement also includes courses of action to be pursued if a subarea exceeds an emission budget. This superseded the November 1998 memorandums of agreement the Colorado Department of Public Health and Environment signed with DRCOG and the North Front Range Metropolitan Planning Organization. A copy of the 2008 and 2015 memorandums of agreement are in Appendix D.

The memorandum of agreement stipulates that DRCOG will make conformity determinations for the Southern Subarea of the 8-hour ozone nonattainment area, while the North Front Range Metropolitan Planning Organization will make the conformity determination for the Northern Subarea of the 8-hour ozone nonattainment area, with boundaries as shown in Figure 2. Both the North Front Range Metropolitan Planning Organization and DRCOG worked cooperatively with an interagency consultation group (Federal Highway Administration, Federal Transit Administration, Regional Air Quality Council, North Front Range Metropolitan Planning Organization, Upper Front Range Transportation Planning Region, Environmental Protection Agency, Colorado Department of Transportation and the Air Pollution Control Division) to review the conformity documentation and planning assumptions. Per the memorandum of agreement, the travel demand model outputs from each metropolitan planning organization are sent to the Air Pollution Control Division of the Colorado Department of Public Health and Environment for generation of emissions estimates.

Figure 2. Denver Metro/North Front Range ozone nonattainment area and subareas



Motor vehicle emission budgets

Motor vehicle emission budgets are established as part of a State Implementation Plan. The Regional Air Quality Council is the air quality planning agency for the Denver metropolitan area (Southern Subarea) as well as the North Front Range metropolitan area and Upper Front Range transportation planning region (Northern Subarea) and is charged with preparing the State Implementation Plan.

The 2008 memorandum of agreement calls for the establishment of overall area motor vehicle emissions budgets based on the entire 8-hour ozone nonattainment area and allows for the option of establishing subarea emissions budgets based on subareas. The memorandum of agreement describes that after the initial motor vehicle emissions budget-based conformity determination, DRCOG and the North Front Range Metropolitan Planning Organization may switch from using the total nonattainment area motor vehicle emissions budgets for joint determinations to using the subarea budgets for individual conformity determinations. If using subarea budgets, as is the current practice, both subareas must demonstrate conformity for their plans. If one subarea fails, the other subarea cannot adopt a new conformity determination until the failure is resolved. To switch methods DRCOG and the North Front Range Metropolitan Planning Organization must use the process as described in the Denver Metro/North Front Range Ozone State Implementation Plan.

The motor vehicle emissions budgets for nitrogen oxides and volatile organic compounds went through the process of:

- Submittal to the Environmental Protection Agency in 2009 as part of the State Implementation Plan for the 1997 Ozone National Ambient Air Quality Standards
- Environmental Protection Agency finding budgets adequate for transportation conformity purposes on March 4, 2010 (75 FR 9893), effective March 19, 2010
- Environmental Protection Agency subsequently approving budgets in a final rule on Aug. 5, 2011 (76 FR 47443), effective Sept. 6, 2011

DRCOG and the North Front Range Metropolitan Planning Organization used these budgets for subsequent transportation conformity determinations until 2017. Due to the reclassification to a moderate nonattainment area in 2016, additional planning requirements were triggered including the requirement to submit updated motor vehicle emissions budgets for the 2017 attainment year. Following the same approach as under the 1997 ozone National Ambient Air Quality Standards, the Moderate Area Ozone State Implementation Plan set new motor vehicle emissions budgets for the northern and southern subareas found in Table 4. These lower budgets were submitted to the Environmental Protection Agency in May 2017 as part of the State Implementation Plan package for the 2008 ozone National Ambient Air Quality Standards. The Environmental Protection Agency found the budgets adequate on March 16, 2018 (83 FR 11751) with an effective date of April 2, 2018. The Regional Air Quality Council is undergoing the process of updating the State Implementation Plan, and reclassifying the nonattainment to serious, which will change the motor vehicle emissions budgets. Until new budgets are approved and become effective, the Denver Metro/ North Front Range nonattainment area demonstrates conformity to the 2015 ozone National Ambient Air Quality Standards by meeting the approved Moderate State Implementation Plan motor vehicle emissions budget tests for the 2008 National Ambient Air Quality Standards (40 Code of Federal Regulations 93.109(c)(2)(i)). 3

Table 4. 8-Hour ozone conformity by subarea budgets (emission tons per day)

Motor vehicle emissions budgets	Volatile organic compounds tons per day	Nitrogen oxide tons per day
Northern subarea budget (North Front Range Metropolitan Planning Organization and Upper Front Range Transportation Planning Region subarea)	8	12
Southern subarea budget (DRCOG and Upper Front Range Transportation Planning Region subarea)	47	61
Total nonattainment area budget (entire nonattainment area)	55	73

3 Transportation Conformity Guidance for 2015 Ozone National Ambient Air Quality Standards Nonattainment Areas (Environmental Protection Agency-420-B-18-023)-June 2018.

Relevant planning efforts

DRCOG Metro Vision Regional Transportation Plan

DRCOG's Metro Vision plan is the long-range growth and development strategy for the Denver region. It integrates plans for growth and development, transportation and environmental quality into a single comprehensive foundation for regional planning. Metro Vision calls for a balanced multimodal surface transportation system including rapid transit, a regional bus network, bicycle and pedestrian facilities, and improvements to the existing roadway system. Among Metro Vision's regional objectives is to "Improve air quality and reduce greenhouse gas emissions," which reflects the region's commitment to improve air quality through local and regional initiatives that reduce ground-level ozone, greenhouse gas emissions and other air pollutants. Supporting objectives include:

- Increase collaboration with local and regional partners on air quality initiatives.
- Increase public awareness of air quality issues.
- Improve the fuel economy of the region's vehicle fleet.

The Metro Vision Regional Transportation Plan implements the transportation element of Metro Vision. The Metro Vision Regional Transportation Plan contains an unconstrained vision plan, outlining the region's total transportation needs, as well as the Fiscally Constrained Regional Transportation Plan, which includes those projects that can be implemented given reasonably anticipated revenues through 2050. When the 2050 Metro Vision Regional Transportation Plan is referenced in this document it denotes the fiscally constrained element of the plan.

The 2022-2025 Transportation Improvement Program identifies transit, multimodal and roadway projects to be funded from fiscal year 2022 through fiscal year 2025. Regionally significant projects funded in the Transportation Improvement Program must first be identified in the 2050 Metro Vision Regional Transportation Plan. Regionally significant projects are listed in Appendix A. The Transportation Improvement Program will implement selected projects and strategies identified in the first staging periods of the 2050 Metro Vision Regional Transportation Plan.

DRCOG staff fostered public participation throughout development of the 2050 Metro Vision Regional Transportation plan and 2022-2025 Transportation Improvement Program, and continue to facilitate youth and civic engagement on a regular basis. DRCOG has provided numerous public participation opportunities, including workshops, county forums, stakeholder meetings, surveys, interactive online forums, a Youth Advisory Panel and a Civic Advisory Group.

Upper Front Range Regional Transportation Plan

The Upper Front Range Transportation Planning Region provided its 2045 Regional Transportation Plan for public comment in May of 2020 and was approved by the Upper Front Range Regional Planning Commission in September 2020. The Upper Front Range Transportation Planning Region 2045 Regional Transportation Plan contains both a vision plan as well as a fiscally constrained plan. Short-range transportation projects in the plan are contained in the Statewide Transportation Improvement Program. There have been no regionally significant amendments to either of these documents since the last determination.

Consistent with the process used for the memorandum of understanding, information about and summaries of DRCOG's public hearings were circulated within the Upper Front Range Transportation Planning Region, available through DRCOG's website and in the office. Additionally, the public was encouraged to provide input to their local elected officials and government staff who work closely with DRCOG.

Chapter 3. Transportation control measures

For this conformity determination, there are no transportation control measures identified for timely completion or implementation as part of the applicable implementation plan. The 8-hour ozone State Implementation Plan that was adopted by the Air Quality Control Commission in November 2016 did not include any transportation control measures.

Chapter 4. Emission test process and assumptions

Background and staging years

The transportation plan and program must pass a series of 8-hour ozone emissions tests to demonstrate conformity. These emissions tests relate to the two ozone precursors, nitrogen oxides and volatile organic compounds. The plan and program must meet the motor vehicle emissions budget in the applicable State Implementation Plan or plan submittal. Satisfying these tests involves demonstrating that relevant emissions in future years are less than or equal to the emissions budget established in the State Implementation Plan.

In accordance with Environmental Protection Agency regulations 40 Code of Federal Regulations 93.118, the Interagency Consultation Group agreed upon the following base and reporting years for this 8-hour ozone conformity determination.

- 2020 – regional transportation plan base year (no emissions analysis)
- 2023 – an intermediate modeling year
- 2030 – an intermediate modeling year
- 2040 – an intermediate modeling year
- 2050 – the last year (horizon) of regional transportation plan

Under the terms of the memorandum of agreement (as described above), DRCOG is responsible for the 8-hour ozone nonattainment area's Southern Subarea, while the North Front Range Metropolitan Planning Organization is responsible for the conformity determination for the 8-hour ozone nonattainment area's Northern Subarea, as shown in Figure 1.

Technical models

The technical process used to estimate future pollutant emission levels is based on the latest planning assumptions in effect at the time of this conformity determination. Assumptions behind the analysis were derived from estimates of current and future population, employment, travel and congestion most recently developed by DRCOG. Information concerning vehicle miles traveled and operating speeds was updated as part of this conformity finding process.

The memorandum of agreement stipulates that the emissions estimates are to be performed by the Air Pollution Control Division. The Air Pollution Control Division of the Colorado Department of Public Health and Environment estimates air pollution emissions using the Environmental Protection Agency Motor Vehicle Emission Simulator model. The conformity analysis for this 8-hour ozone conformity determination began in December 2020 when DRCOG transferred initial travel model output files to Air Pollution Control Division to be used with Environmental Protection Agency's most current mobile source emission model (Motor Vehicle Emission Simulator 2014b) to estimate emissions. An update to the Environmental Protection Agency model was underway during the analysis for this update and will be applied in the future.

The DRCOG travel demand model covers the whole Southern Subarea. Appendix B describes the modeling structure and recent enhancements for the DRCOG travel demand model in more detail. Appendix C of this conformity determination includes more information on the transportation and demographic assumptions used in this emissions analysis.

Demographic assumptions

Growth in population and employment is the principal factor for the increased demand for travel on the region's transportation facilities and services. The population forecast for the Southern Subarea of the Denver Metro/North Front Range 8-hour Ozone Nonattainment Area in 2050 is 4,404,997. This is an increase of 31 percent over the 2020 estimated population of 3,358,999. The employment forecast for

2050 is 2,970,635 compared to the 2020 estimate of 2,160,276, an increase of 38 percent. Table 5 shows the latest forecasts of population and employment for 2020, 2023, 2030, 2040 and 2050 for the Southern Subarea of the Denver Metro/North Front Range Nonattainment Area. Table 6 lists 2020 and 2050 population and employment estimates by each of the counties in the DRCOG ozone modeling Southern Subarea.

Table 5. Population and employment forecasts – southern subarea

	2020	2023	2030	2040	2050
Population	3,358,999	3,520,911	3,806,424	4,180,711	4,404,997
Employment	2,160,276	2,241,691	2,443,012	2,706,188	2,970,635

Source: State Demography Office, Colorado Department of Local Affairs 2019 Data Pull. Weld County portioning applied by DRCOG staff. Counties included in totals: Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson and southern Weld.

Table 6. 2020 And 2050 population and employment estimates by county – southern subarea

County	Population		Employment	
	2020	2050	2020	2050
Adams county	523,778	842,689	267,686	365,949
Arapahoe county	659,564	837,991	426,173	584,069
Boulder county	331,025	420,105	248,111	339,920
Broomfield county	72,773	98,239	48,254	66,192
Denver county	736,531	883,165	646,251	885,225
Douglas county	354,508	464,189	174,176	238,725
Jefferson county	586,965	661,332	313,198	429,177
Southern weld county	93,855	197,287	36,427	61,378
Total DRCOG ozone modeling southern subarea	3,358,999	4,404,997	2,160,276	2,970,635

Source: State Demography Office, Colorado Department of Local Affairs 2019 Data Pull. Weld County portioning applied by DRCOG staff.

Transportation network assumptions

DRCOG

Emission tests were based on the 2020, 2023, 2030, 2040 and 2050 transportation networks and associated planning assumptions as defined in DRCOG's 2050 Metro Vision Regional Transportation Plan. The networks included financially constrained roadway and transit system improvements and resulting networks to be completed by the year 2050. The networks include both federally and locally funded projects. The Metro Vision Regional Transportation Plan and Transportation Improvement Program also include many other projects that will help to reduce emissions associated with ozone such as:

- transit operating funds and bus purchases
- bicycle and pedestrian facilities
- transportation demand management programs
- intelligent transportation systems infrastructure
- traffic signal systems and coordination
- master plans for areas around transit stations and urban centers

All roadway and rapid transit projects and staging years through 2050 are shown in the figures found in Appendix A. The full project list is also detailed in Appendix A.

Upper Front Range transportation planning region

There were no regionally significant transportation improvement projects in the Upper Front Range Transportation Planning Region portion of the Southern Subarea, and no amendments are proposed for this cycle.

Other mobile source reduction strategies

Two categories of strategies to reduce regional emissions are funded and assumed to continue through 2050, but are not specifically analyzed in the future year transportation and air quality modeling:

- Transportation demand management programs such as DRCOG's regional Way to Go program, transit pass subsidies and other transportation demand management actions will help to reduce the amount of single-occupant-vehicle driving by the growing population of the region. Such efforts will also take advantage of the increased provision of pedestrian and bicycling facilities across the region.
- The DRCOG Regional Transportation Operations and Technology Program will implement projects that allow the transportation systems to operate much more efficiently. The projects cover four key areas:
 - traffic signal system equipment
 - traffic signal coordination and timing
 - transportation incident management and communications
 - intelligent transportation systems technological improvements covering a range of communications (vehicle and infrastructure), monitoring, public information and other projects

Chapter 5. Conclusion

Emission test results

The results of the Denver Southern Subarea emissions tests by year are reported in Table 1, included in the executive summary and repeated here. The emissions estimates were generated by Air Pollution Control Division using the transportation inputs from DRCOG's travel demand models and the MOVES model. The 8-hour ozone conformity analysis was performed and is reported for the years 2023, 2030, 2040 and 2050, which meet the requirements for the staging years specified in 40 Code of Federal Regulations 93.118.

Summary statement

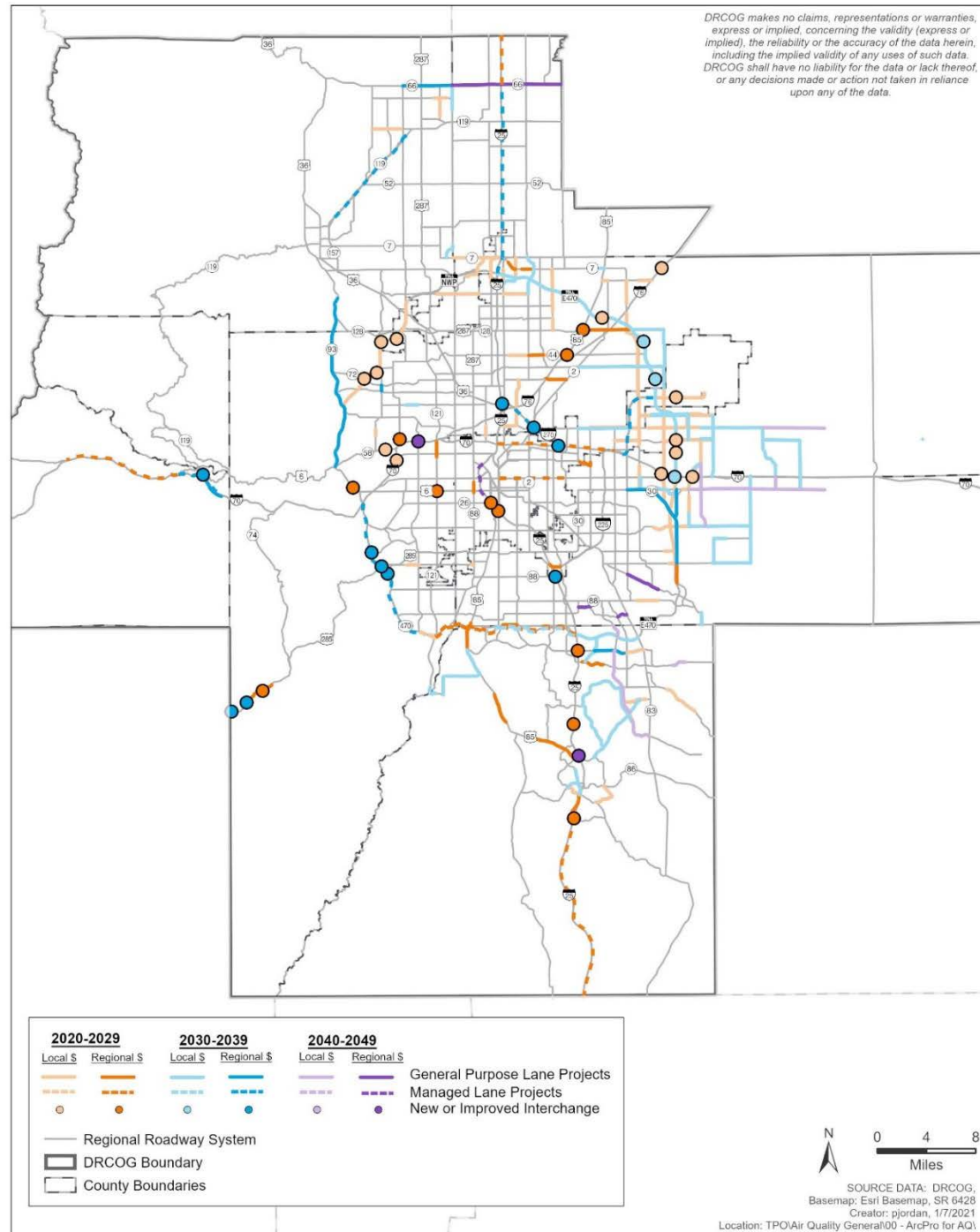
DRCOG has assessed its compliance with the applicable ozone conformity criteria requirements and affirms conformity. The test results do not indicate any failures in the reporting years of the program or plan that would lead to a finding of nonconformity for the 2020 State Implementation Plan budgets (2008 Ozone Standard and 2015 Ozone Standard). Based on the quantitative conformity analysis, the DRCOG staff has determined conformity is demonstrated for the amended DRCOG 2050 Metro Vision Regional Transportation Plan, Upper Front Range 2045 Regional Transportation Plan, and the regionally significant projects funded in the DRCOG 2022-2025 Transportation Improvement Program and 2022-2025 Statewide Transportation Improvement Program within the Denver Southern Subarea associated with the 2008 and 2015 8-hour ozone standards.

Table 1. 8-Hour ozone conformity for Denver southern subarea results (emission tons per day)

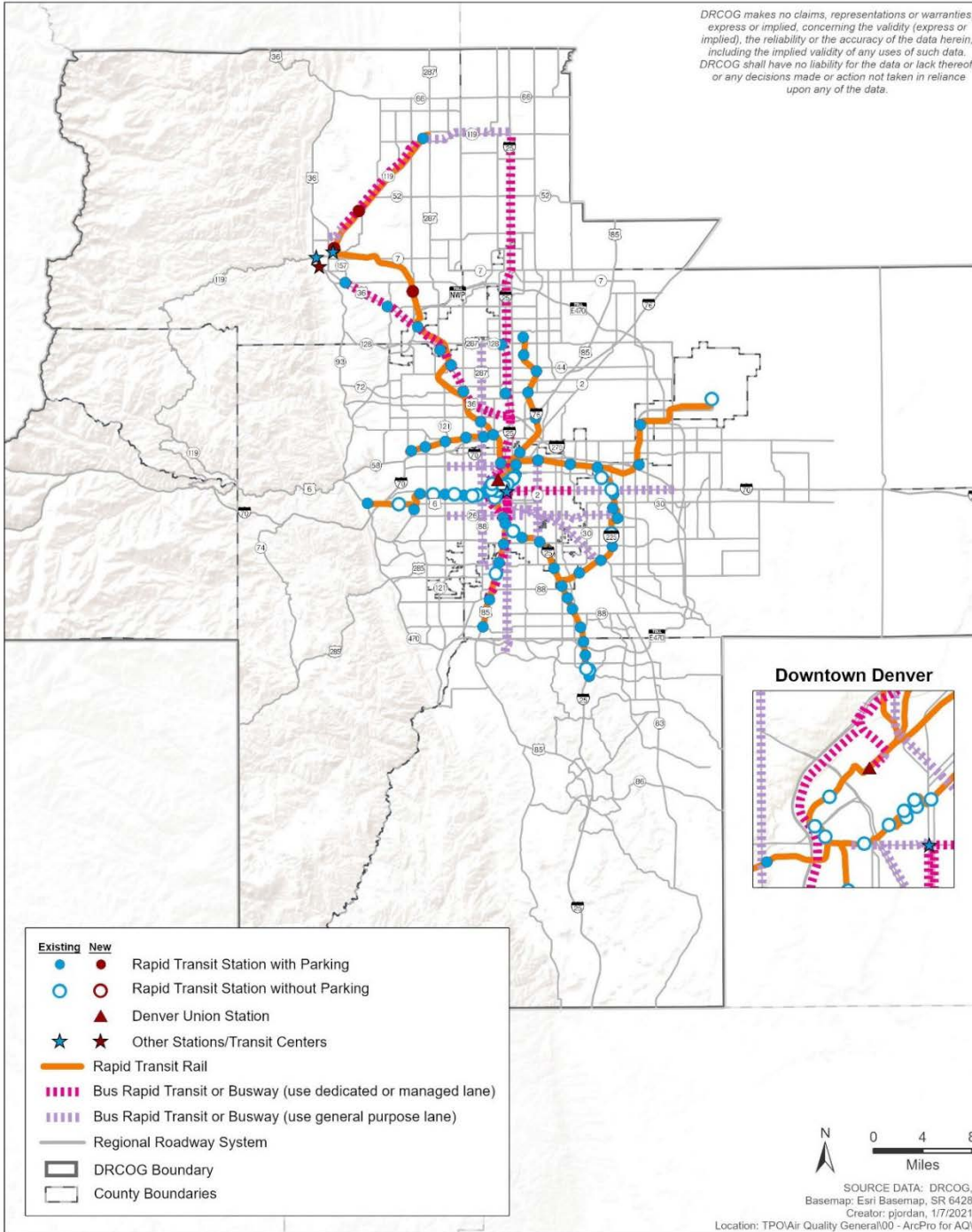
	2017 State Implementation Plan budgets (2008 ozone standard)	Modeling results			
		2023 emissions	2030 emissions	2040 emissions	2050 emissions
Volatile organic compounds	47	35	28	21	21
Nitrogen oxides	61	35	24	16	16

Appendix A. DRCOG transportation network and project assumptions

2050 Staging of fiscally constrained roadway capacity projects



2050 fiscally constrained rapid transit system guideway facilities and stations



DRCOG transportation network and project assumptions

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
2050 RTP: Regionally-funded projects and programs							
Colorado Department of Transportation administered multimodal capital projects							
US-85	104th Ave.	New Interchange	Adams	\$100,000,000	2023-2029		CDOT
US-85	120th Ave.	New Interchange	Adams	\$100,000,000	2023-2029	✓	CDOT
I-25 North	84th Ave. to 104th Ave.	Operational Improvements, Center-Loading Transit Station at 88th Ave., and GP Lane	Adams	\$230,000,000	2045-2050		CDOT
Vasquez Boulevard	60th Ave.	Intersection Improvements	Adams	\$80,000,000	2040-2044		CDOT
I-270	I-25/US-36 to I-70	New Managed Lanes	Adams	\$500,000,000	2030-2039	✓	CDOT
I-270	I-25/US-36 and I-70	New Freeway "direct connects" at each end of I-270	Adams	\$300,000,000	2030-2039		CDOT
I-25	Bellevue	Interchange Reconstruction and Pedestrian Connections	Arapahoe	\$112,000,000	2030-2039		CDOT
SH-83 (Parker Rd.)	SH-86 to East Mississippi Ave.	Corridor Planning/Investment for Multimodal Mobility, Operations, and Safety	Arapahoe/Douglas	\$150,000,000	2030-2039		CDOT/DR COG
SH-66	Lyons to Main St. (US-287)	Widen from 2 to 4 Lanes (Hover to St. Main St.) and Operational/Safety Improvements from Lyons to Longmont	Boulder	\$10,000,000	2030-2039	✓	CDOT
I-25 North	E-470 to SH-7	Managed Lanes, SH-7 interchange reconstruction, & SH-7 Mobility Hub	Broomfield	\$200,000,000	2030-2039	✓	CDOT
I-25 North (Segment 4)	SH-7 to SH-66	Managed Lanes, SH-119 Mobility Hub, ITS, Bicycle and Pedestrian Trail Connections	Broomfield/Weld	\$150,000,000	2030-2039		CDOT
I-70	Twin Tunnels to Empire Junction (US-40)	Add 1 WB Peak Period Managed Lane	Clear Creek	\$0	2020-2022		CDOT
I-70 Floyd Hill Eastbound Improvements	Floyd Hill to Veterans Memorial Tunnel	TBD	Clear Creek	\$250,000,000	2030-2039		CDOT
I-70 Floyd Hill Westbound Improvements	Floyd Hill to Veterans Memorial Tunnel	TBD	Clear Creek	\$450,000,000	2030-2039		CDOT

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
Eisenhower Johnson Memorial Tunnels Maintenance	Eisenhower Johnson Memorial Tunnels	Major rehabilitation of the Eisenhower-Johnson Memorial Tunnels	Clear Creek	\$142,000,000	2020-2050		CDOT
I-25	Santa Fe Dr. (US-85) to Alameda Ave.	Interchange Capacity	Denver	\$30,000,000	2023-2029		CDOT
Central I-25 Buildout	Colfax Ave. to 20th St.	Ultimate Buildout of Corridor Improvements	Denver	\$420,000,000	2040-2044	✓	CDOT
I-25 Valley Highway/Burnham Yard	Santa Fe Blvd. to Colfax Ave.	Managed Lanes, Includes ROW, Burnham Yard, Central Main Line Relocation	Denver	\$900,000	2045-2050	✓	CDOT
Federal Boulevard	6th Ave. to Howard Pl.	Widen from 5 to 6 Lanes	Denver	\$0	2020-2022		CDOT
I-70	I-25 to Chambers Rd.	Add 2 New Managed Lanes	Denver/Adams	\$0	2020-2022	✓	CDOT/DRCOG
I-25	El Paso County Line to North of Crystal Valley Parkway	Add 1 Toll/Managed Lane each Direction	Douglas	\$0	2020-2022	✓	CDOT
US-85	Louviers to MP 191.75	Widen from 2 to 4 Lanes	Douglas	\$0	2020-2022	✓	CDOT
US-85	Sedalia to Daniels Park	Widen from 2 to 4 Lanes	Douglas	\$35,000,000	2023-2029	✓	CDOT
US-85	Daniels Park to Meadows	Widen from 2 to 4 Lanes	Douglas	\$32,000,000	2023-2029	✓	CDOT
US-6	Wadsworth Blvd.	Interchange Capacity	Jefferson	\$80,000,000	2023-2029	✓	CDOT
US-285	Pine Valley Rd. (CR 126)/Mt Evans Blvd.	New Interchange	Jefferson	\$40,000,000	2030-2039		CDOT
US-285	Kings Valley Dr.	New Interchange	Jefferson	\$15,000,000	2023-2029		CDOT
US-285	Kings Valley Dr. to Richmond Hill Rd.	Widen from 3 to 4 Lanes (Add 1 SB Lane)	Jefferson	\$25,000,000	2023-2029		CDOT
US-285	Shaffers Crossing to Kings Valley Dr.	Widen from 3 to 4 Lanes (Add 1 SB Lane)	Jefferson	\$60,000,000	2023-2029		CDOT
US-285	Parker Ave.	New Interchange	Jefferson	\$25,000,000	2030-2039		CDOT
I-70 Kipling Interchange Reconstruction	Kipling	Interchange Reconstruction and Pedestrian Connections	Jefferson	\$80,000,000	2045-2050		CDOT
C-470	US-285/Morrison/Quincy	Interchange Complex Reconstruction	Jefferson	\$150,000,000	2030-2039		CDOT

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
C-470	Wadsworth to I-70	New Managed Lanes	Jefferson	\$410,000,000	2030-2039		CDOT
I-25 North (Segment 5)	SH-66 to WCR 38 (DRCOG Boundary)	Add 1 Toll/Managed Lane each Direction	Weld	\$175,000,000	2023-2029		CDOT
CDOT Projects Total				\$4,351,900,000			
Denver Regional Council of Governments (DRCOG) Administered Multimodal Capital Projects							
TIP Set-Asides	Varies	Investment in Transportation Demand Management, Air Quality, Operations and Technology, and Human Services Transportation	DRCOG Region	\$372,862,551	2020-2050	✓	DRCOG
88th Ave.	I-76 NB Ramps to SH-2	Widen from 2 to 4 Lanes	Adams	\$21,500,000	2020-2022	✓	DRCOG
104th Ave.	Colorado Blvd. to McKay Rd.	Widen from 2 to 4 Lanes	Adams	\$8,100,000	2020-2022	✓	DRCOG
SH-7	164th Ave. to Dahlia St.	Widen from 2 to 4 Lanes	Adams	\$24,000,000	2020-2022	✓	DRCOG
120th Avenue	US-85 to E-470	Widen to 4 Lanes	Adams	\$24,000,000	2023-2029		DRCOG
I-25 North Improvements	104th Ave. to 120th Avenue	Shoulders; General Purpose Lanes; Bridge	Adams	\$70,000,000	2045-2050		DRCOG
I-225/Yosemite	DTC Blvd. to I-25 on ramp	Interchange and Ramp Reconstruction	Arapahoe	\$60,000,000	2023-2029		DRCOG
Smoky Hill Road	Buckley Road to Picadilly St	Widen from 4 to 6 Lanes	Arapahoe	\$10,000,000	2040-2044		DRCOG
Gun Club Rd.	State Highway 30 to 6th Ave	Widen from 2 to 4/6 Lanes, Includes Stream Crossing Upgrade at Coal Creek	Arapahoe	\$32,000,000	2030-2039		DRCOG
Gun Club Rd.	Quincy to Aurora Pkwy.	Widen from 2 to 6 Lanes	Arapahoe	\$15,000,000	2023-2029		DRCOG
Broncos Parkway/Easter/Dry Creek Corridor Improvements	Parker Road to Havana	Widening to 6 Lanes, Bridge Widening, and Intersection Improvements	Arapahoe	\$35,000,000	2040-2044		DRCOG
SH-30	Airport Blvd. to Quincy Ave.	Widen from 2 to 6 Lanes	Arapahoe	\$175,000,000	2030-2039		DRCOG, CDOT, Local
US-85 (Santa Fe) Improvements	C-470 to Bowles	Corridor Planning/Investment for Multimodal Mobility, Operations, and Safety	Arapahoe	\$150,000,000	2040-2044	✓	DRCOG, CDOT
SH 66	US-287/Main Street to East County Line Road	Capacity, Operations, and Bicycle/Pedestrian	Boulder	\$15,000,000	2030-2039		DRCOG

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
US 287/120th Ave.	Midway Blvd. to Lowell Blvd.	Improve circulation, safety, active transportation access, business access, congestion and transit operations	Broomfield	\$15,000,000	2023-2029	✓	DRCOG
I-25	Broadway	Interchange Capacity	Denver	\$50,000,000	2020-2022	✓	DRCOG
Martin Luther King Jr. Blvd.	Havana St./Iola St. to Peoria St.	Widen 2 to 4 Lanes; New 4 Lane Road	Denver	\$0	2020-2022	✓	DRCOG
Pena Boulevard	I-70 to 64th Avenue	Add one managed lane in each direction	Denver	\$139,000,000	2030-2039		DRCOG, Local
Pena Boulevard	64th Avenue to E-470	Add one managed lane in each direction	Denver	\$124,000,000	2030-2039		DRCOG, Local
County Line Rd.	Phillips St. to University Blvd.	Widen from 2 to 4 Lanes	Douglas	\$9,500,000	2020-2022	✓	DRCOG
I-25	Lincoln Ave.	Interchange Capacity	Douglas	\$49,400,000	2020-2022	✓	DRCOG
Ridgegate Pkwy.	Havana St. to Lone Tree E. City Limit	Widen from 2 to 4 Lanes	Douglas	\$0	2020-2022	✓	DRCOG
US-85	Highlands Ranch Pkwy. to n/o County Line Rd.	Widen from 4 to 6 Lanes	Douglas	\$0	2020-2022	✓	DRCOG
I-25	Crystal Valley Pkwy.	New Interchange & South Frontage Road	Douglas	\$80,000,000	2023-2029	✓	DRCOG, Local
I-25	Happy Canyon Rd.	Interchange Reconstruction	Douglas	\$30,000,000	2023-2029		DRCOG, Local
Lincoln Ave.	Oswego to Keystone	Widen 4 to 6 lanes	Douglas	\$24,000,000	2030-2039		DRCOG, Local
I-25	Meadows/Fountains	Interchange Reconstruction	Douglas	\$50,000,000	2045-2050		DRCOG, Local
Wadsworth Blvd.	35th Ave. to 48th Ave.	Widen from 4 to 6 Lanes	Jefferson	\$31,000,000	2020-2022	✓	DRCOG
SH-93	SH-58 to SH-170	Widen to 4 Lanes and Safety/Transit Improvements	Jefferson	\$200,000,000	2030-2039		DRCOG
US-6	Heritage Rd.	New Interchange	Jefferson	\$30,000,000	2023-2029	✓	DRCOG
Indiana (SH-72)	W. 80th Ave. to W. 86th Pkwy.	Widen to 4 Lanes	Jefferson	\$39,000,000	2030-2039		DRCOG
Kipling St.	Kentucky Ave. to I-70	Multimodal Corridor Improvements	Jefferson	\$250,000,000	2040-2044		DRCOG
Wadsworth Blvd.	17th Ave. to 35th Ave.	Multimodal Corridor Improvements	Jefferson	\$60,000,000	2040-2044		DRCOG
SH-66	WCR 1 - WCR 19	Widen 2 to 4 Lanes, Pedestrian Improvements	Weld	\$35,000,000	2045-2050		DRCOG

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
SH-52	WCR 1 - WCR 13	PEL Outcomes - Safety, Operational, and Multimodal Improvements	Weld	\$20,000,000	2045-2050		DRCOG
DRCOG Projects Total				\$2,248,362,551			
Regional Transportation District (RTD) Administered Multimodal Capital Projects							
Northwest Rail	Westminster Station to Downtown Longmont	Implement Peak Period Service Plan	Adams/Boulder/Broomfield/Jefferson	\$700,000,000	2045-2050		RTD
RTD Projects Total				\$700,000,000			
Regional Bus Rapid Transit (BRT) Projects							
Colfax Ave. BRT	Lincoln St. to I-225	BRT Service and Supporting Safety/Multimodal Improvements	Adams/Arapahoe/Denver	\$250,000,000	2023-2029		CDOT, DRCOG, 53019-CIG, Local
Colfax Ave. Extension BRT	I-225 to E-470	BRT Service and Supporting Safety/Multimodal Improvements	Adams/Arapahoe	\$100,000,000	2040-2044		DRCOG, CDOT, Local
SH-119 BRT	Downtown Boulder to I-25/SH-119 Mobility Hub	BRT Service and Supporting Safety/Multimodal Improvements	Boulder/Weld	\$350,000,000	2030-2039		CDOT, DRCOG, RTD, Local
Colorado Blvd. BRT	University of Colorado A Line to I-25	BRT Service and Supporting Safety/Multimodal Improvements	Denver	\$35,000,000	2023-2029		DRCOG, CDOT, 5309-CIG, Local
Alameda BRT	Wadsworth to R-Line	BRT Service and Supporting Safety/Multimodal Improvements	Arapahoe/Denver/Jefferson	\$61,000,000	2030-2039		DRCOG, CDOT, 5309-CIG, Local
Broadway/Lincoln BRT	Colfax to Highlands Ranch Pkwy	BRT Service and Supporting Safety/Multimodal Improvements	Arapahoe/Denver/Douglas	\$61,000,000	2040-2044		DRCOG, 5309-CIG, Local
38th/Park BRT	Wadsworth to Colfax	BRT Service and Supporting Safety/Multimodal Improvements	Denver/Jefferson	\$40,000,000	2045-2050		DRCOG
Speer/Leetsdale/Parker BRT	Colfax to I-225	BRT Service and Supporting Safety/Multimodal Improvements	Arapahoe/Denver	\$95,000,000	2030-2039		DRCOG, CDOT
Federal Blvd. BRT	120th to Santa Fe/Dartmouth	BRT Service and Supporting Safety/Multimodal Improvements	Adams/Denver	\$94,000,000	2030-2039		DRCOG, CDOT, 5309-CIG, Local

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
North I-25 BRT	Union Station to SH-119	BRT Service and Supporting Safety/Multimodal Improvements	Adams/Broomfield /Denver/Weld	\$97,000,000	2045-2050		DRCOG, CDOT, 5309-CIG, Local
New Bus Maintenance Facility	TBD-northern area of RTD District	Construction of a new bus maintenance facility in the RTD's northern area	TBD	\$50,000,000	2023-2029		DRCOG
Regional BRT Total				\$1,233,000,000			
Corridor Transit Planning Projects and Programs							
Regional Mobility Hubs	Varies	Construction of Multimodal Mobility Hubs	DRCOG Region	\$200,137,636	2020-2050		CDOT, DRCOG, RTD
South Boulder Rd.	Lafayette to Boulder	Multimodal Corridor Improvements	Boulder	\$75,000,000	2040-2044		DRCOG
SH-7	Boulder to Brighton	Multimodal Corridor Improvements	Adams/Boulder/Broomfield	\$100,000,000	2030-2039	✓	CDOT
US-287	US-36 to Larimer County Line	Safety, Operational, and Multimodal Improvements	Boulder/Broomfield	\$200,000,000	2030-2039		CDOT, DRCOG
West Colfax	Sheridan to Broadway/Lincoln	Transit Corridor and Supporting Safety/Multimodal Improvements	Denver	\$26,573,077	2045-2050		DRCOG
RidgeGate Parkway Transit Mobility Corridor	Mainstreet in Parker to Lone Tree City Center RTD station	Transit Corridor	Douglas	\$100,000,000	2045-2050		DRCOG
Castle Pines Transit Mobility Corridor	Castle Pines to RidgeGate RTD station	Transit Corridor	Douglas	\$20,000,000	2030-2039		DRCOG
Golden/Mines Autonomous Circulator	Downtown Golden, School of Mines, RTD W Line	Autonomous Circulator	Jefferson	\$3,500,000	2023-2029		DRCOG
Transit Corridor Planning Total				\$725,210,713			
Arterial Safety/Regional Vision Zero Projects and Programs							
Arterial Safety/Regional Vision Zero Set-Aside	High Injury Network and Critical Corridors identified in the Taking Action on Regional Vision Zero	Vision Zero and Safety Improvements	DRCOG Region	\$151,672,902	2020-2050	✓	DRCOG

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
Federal Boulevard Multimodal Improvements	52nd Avenue to 120th Avenue	Bicycle/Pedestrian/Transit Improvements; Turn Lanes; Bus/Business Access Lanes	Adams	\$50,000,000	2023-2029		DRCOG
US-285 Congestion Mitigation Improvements	Knox Ctt/Lowell Blvd. (west) to Havana (east)	Speed and Reliability Corridor & Vision Zero Improvements	Arapahoe/Denver	\$88,200,000	2023-2029	✓	DRCOG
US-36	Boulder to Lyons	Corridor Safety Improvements	Boulder	\$20,000,000	2020-2022		DRCOG
US-36/28th St. & SH-93/Broadway	US-36/28th St. & SH-93/Broadway	Corridor Safety Improvements	Boulder	\$15,200,000	2030-2039		CDOT
SH-42	Louisville and Lafayette	Safety and Operational Improvements	Boulder	\$50,000,000	2030-2039	✓	CDOT, DRCOG
West Mississippi Avenue	South Federal Blvd. to S. Broadway	Vision Zero and Pedestrian Improvements	Denver	\$18,600,000	2020-2022	✓	DRCOG
Brighton Boulevard	Race to York	Reconstruction, Vision Zero, Safety, and Freight Improvements	Denver	\$19,762,500	2045-2050		DRCOG
Chambers Rd	E 56th Ave to E 40th Ave	Vision Zero Corridor Improvements	Denver	\$16,712,500	2023-2029		DRCOG
Sheridan Safety Improvements	52nd to Hampden	Vision Zero Corridor Improvements	Denver/Jefferson	\$17,100,000	2023-2029		DRCOG
Colfax Safety Improvements	Wadsworth to Sheridan	Multimodal Arterial Safety	Jefferson	\$12,000,000	2020-2022	✓	DRCOG
US-85 Operational & Safety Improvements	Weld CR 2 to Weld CR 10	Safety and Operational Improvements	Weld	\$6,100,000	2023-2029		CDOT
			Arterial Safety/Regional Vision Zero Total	\$465,347,902			
Active Transportation Projects and Programs							
Active Transportation Set-Aside	Short-Trip Opportunity Zones identified in the Active Transportation Plan	Bicycle and Pedestrian Improvements	DRCOG Region	\$31,598,521	2020-2050		DRCOG
Smith Road Bicycle/Pedestrian Facilities	Peoria Street to Powhatan Road	New Multi-Use Path	Adams	\$4,000,000	2020-2022		DRCOG
RTD Rail Trail	Boulder to Erie	Regional Trail	Boulder	\$6,000,000	2020-2022		DRCOG
St. Vrain Greenway	Longmont to Lyons	Regional Trail	Boulder	\$4,000,000	2020-2022	✓	DRCOG
McCaslin Regional Trail	Rock Creeky Pkwy. to SH-128	Regional Trail	Boulder	\$3,000,000	2020-2022	✓	DRCOG

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
Clear Creek Greenway	Jefferson County Line to Loveland Ski Area	Clear Creek Greenway portion of Peaks to Plains trail system	Clear Creek	\$50,000,000	2045-2050		DRCOG
S. Platte River Trail	(not specified)	Complete Missing Links and Upgrade Trail Section	Denver	\$50,000,000	2030-2039		DRCOG
Bear Creek Trail	(not specified)	Upgrade Trail for Safe Crossings and Consistent Cross Section. Integrate ITS/AI Equipment.	Denver	\$31,200,000	2045-2050		DRCOG
Active Transportation Total				\$179,798,521			
Freight Projects and Programs							
Freight Set-Aside	Varies	Freight improvements including but not limited to bridge reconstructions, overpasses/underpasses, new bridges	DRCOG Region	\$75,836,451	2020-2050		DRCOG
Peoria Street Bridge	Sand Creek	Bridge Reconstruction	Adams	\$19,000,000	2020-2022		DRCOG
Alameda Pkwy. Bridge over I-225	Between Potomac Street and Abilene Street	Bridge reconstruction	Arapahoe	\$20,000,000	2020-2022		DRCOG
47th Avenue/48th Avenue	I-25 to Pecos	Bridge Reconstruction, New Multimodal Underpass, and New Bicycle/Pedestrian Bridge.	Denver	\$45,225,000	2040-2044		DRCOG
Ward Rd./BNSF	I-70 FR North and Ridge Rd.	Multimodal Grade Separation	Jefferson	\$60,000,000	2023-2029	✓	DRCOG
Freight Total				\$220,061,451			
Grand Total				\$10,123,681,138			
<i>Note: Projects with \$0 cost have funds fully obligated prior to fiscal year 2020.</i>							

Appendix B. Summary of transportation model calibration and validation for the 2050 RTP, Jan. 7, 2021

Introduction

In support of the conformity determination for the 2050 Metro Vision Regional Transportation Plan, the Denver Regional Council of Governments' maintains the Regional UrbanSim Socio-economic Model and the Focus regional travel modeling system.

The Focus travel demand model simulates the millions of trips made throughout the region on a typical weekday. The Focus model sums all travel to forecast how many vehicles will be driven on major roads; travel speed and delay; and how many people will walk, ride a bicycle or use transit to get to where they want to go. To realistically simulate each person's daily household travel, Focus models the many choices each person makes, through the activity based model (ABM) components including:

- 1) where to work
- 2) where to go to school
- 3) how many automobiles are owned by the person's household
- 4) how many trips each person makes in a day, and for what purposes
- 5) which trips are chained together into home-to-home tours
- 6) the location where each individual trip begins and ends
- 7) the travel mode used for each trip
- 8) which roadways or bus routes were chosen to reach each destination

In addition to the ABM components for household travel, Focus also incorporates three add-on gravity models for:

- Commercial Vehicle trips – by light, medium, and heavy duty vehicles
- External Station trips – starting or ending outside the DRCOG modeling area
- Denver International Airport (DIA) trips – for trips not captured by the ABM components

An UrbanSim model is used to forecast household and employment levels by small-area transportation analysis zones over time. The Focus model takes into account many characteristics of people, such as their age, gender, employment status, and income; and how the region will change demographically over time. It also takes into account characteristics of the built environment such as transit stops and stations, household and employment density, bicycling facilities and walkability.

The Focus travel model creates an origin and destination for each trip. Specific groupings of "O&Ds" were initially estimated based on detailed data from a 1998 survey called the Travel Behavior Inventory.

Small area development estimates

In 2016, Focus was recalibrated using more recent data sources including roadway counts, transit boardings, American Community Survey Census data, and results from the following surveys:

- Regional Transportation District's 2008 Regional On-Board Transit Survey – a questionnaire handed out to light rail and bus travelers to understand how transit travel patterns have changed since the opening of the Southeast Corridor Light Rail in November 2006. The survey contains information on almost 24,000 transit trips.
- The 2010 Front Range Travel Counts Household Survey – A survey of over 12,000 households along the Colorado Front Range, including 7,000 in the DRCOG region, using a format similar to the 1997 Travel Behavior Inventory described above.

In 2020, further refinements were made to the Focus model based on additional results of the 2010 Front Range Travel Counts Survey, the 2016 Commercial Vehicle Survey and Regional Transportation District's updated 2018 Regional On-Board Survey.

The final trip assignment outputs of Focus were validated against traffic counts, operating travel speed observations, and Regional Transportation District ridership data to make sure the overall regional travel patterns being forecasted were reasonable.

Regional socioeconomic forecasts

DRCOG uses county-level forecasts of population, households and employment produced by the Colorado State Demography Office as the basis for future growth in the Focus model.

To provide household and employment data at a level of detail necessary for the travel model, the regional urban activity forecasts are disaggregated into 2,800 transportation analysis zones, as shown in Figure 1. The allocation to Transportation Analysis Zones is carried out within the UrbanSim model based on the dynamics of urban land markets and the simulated decisions of land developers, and residential and commercial land customers. The UrbanSim model considers questions such as:

- What parcels of land are profitable for development, and for what uses?
- Where should a firm locate to conduct its business in accordance with zoning regulations, and with suitable access to workers, supplies, and finished product markets?
- Does a family's current residence continue to meet its needs and be convenient to jobs, schools, and other activities, or should the family move to a "better" location?
- What size and types of residence does a family need based on the number and ages of its members and its household income?
- Where are designated open spaces, parks, and other undevelopable lands located?

The UrbanSim model outputs are used in a population synthesizer that creates a descriptive database record for each household in the region (about 1.3 million records for 2020) and each person (about 3.3 million records in 2020). Figure 2 shows a flowchart for the process of socioeconomic forecasting in the Denver region.

Figure 1. DRCOG transportation analysis zones

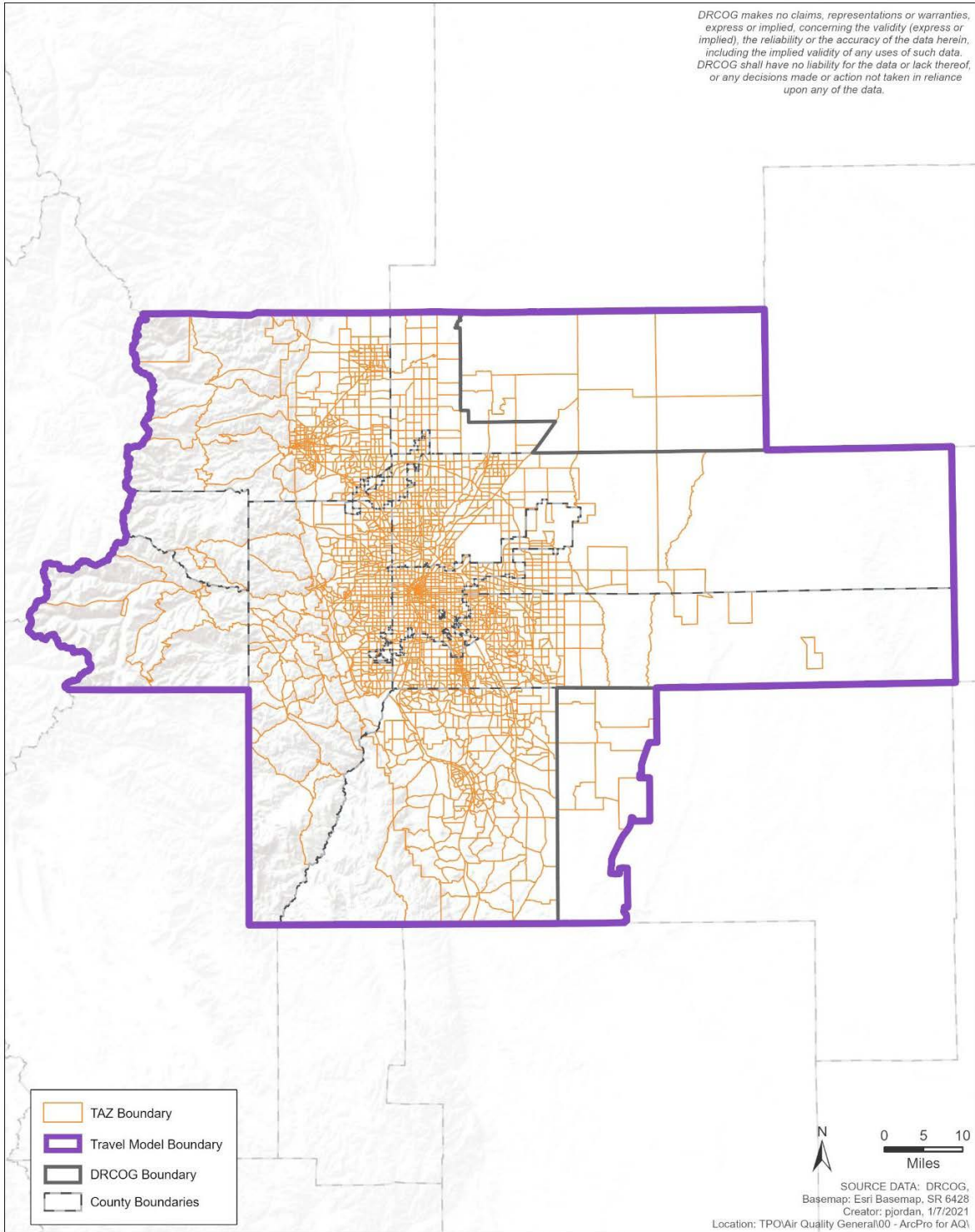
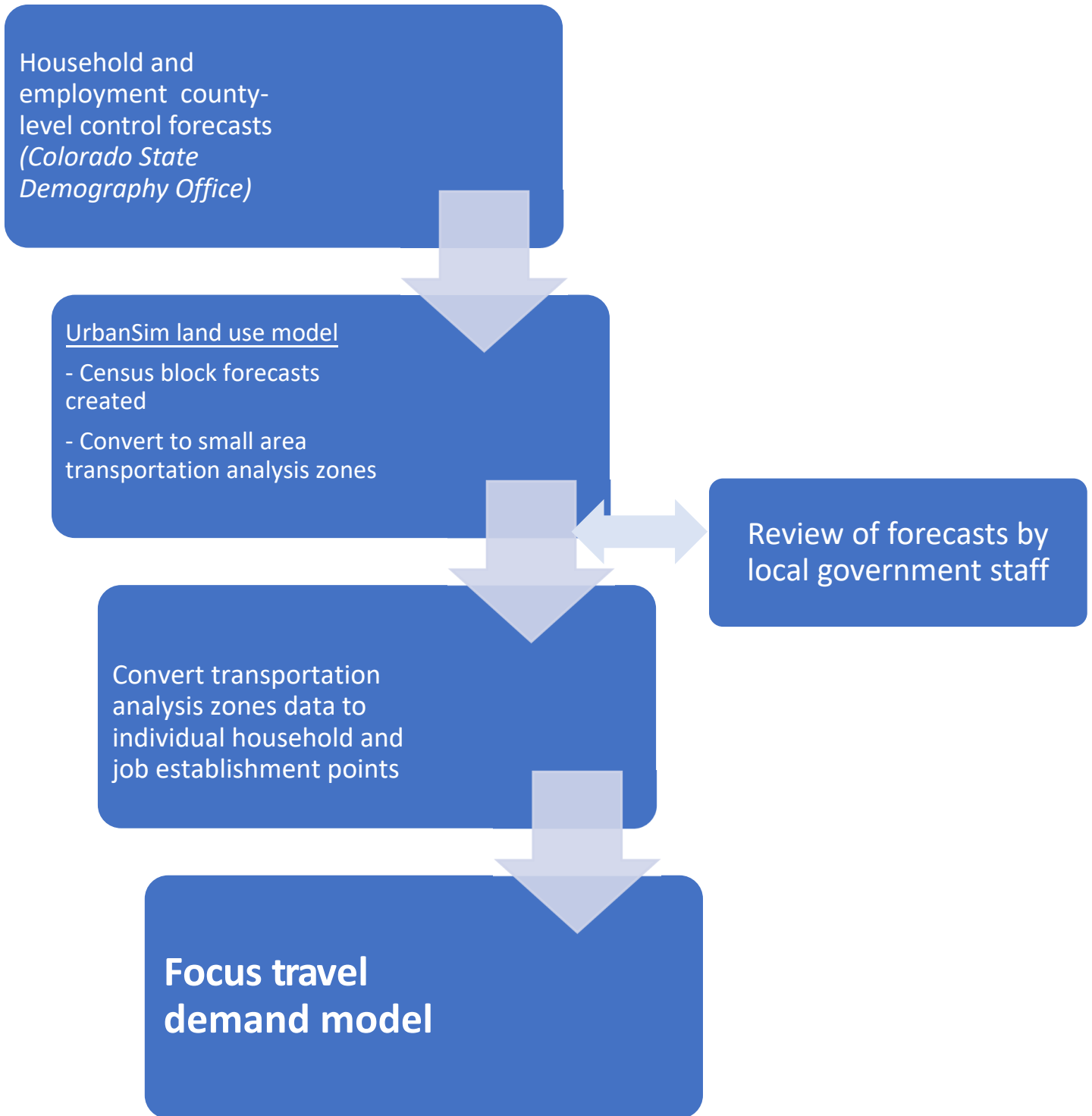


Figure 2. Socioeconomic model elements and flow



Focus model process overview

Figure 3 shows a simplified diagram of how the Focus model components flow after the socioeconomic forecast has been completed.

First, travel time and cost information between zones are calculated by travel mode and time of day. Tours are the first travel elements to be created. Figure 4 shows a diagram depicting an example set of tours for a person in one day, including intermediate stops.

The model runs through a set of steps for each tour, including activity generation, location choice, mode choice, and time of day choice model components. Then the model runs through a parallel set of model components for each trip within a tour.

Figure 3. Focus activity based model elements

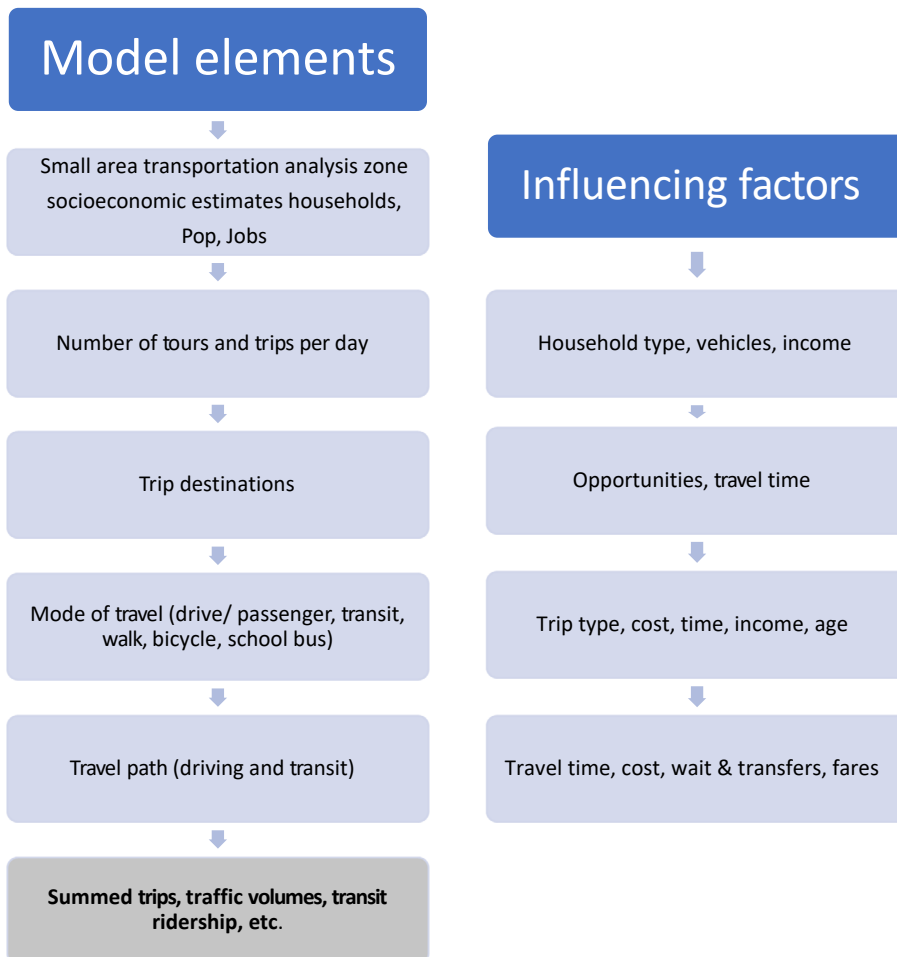
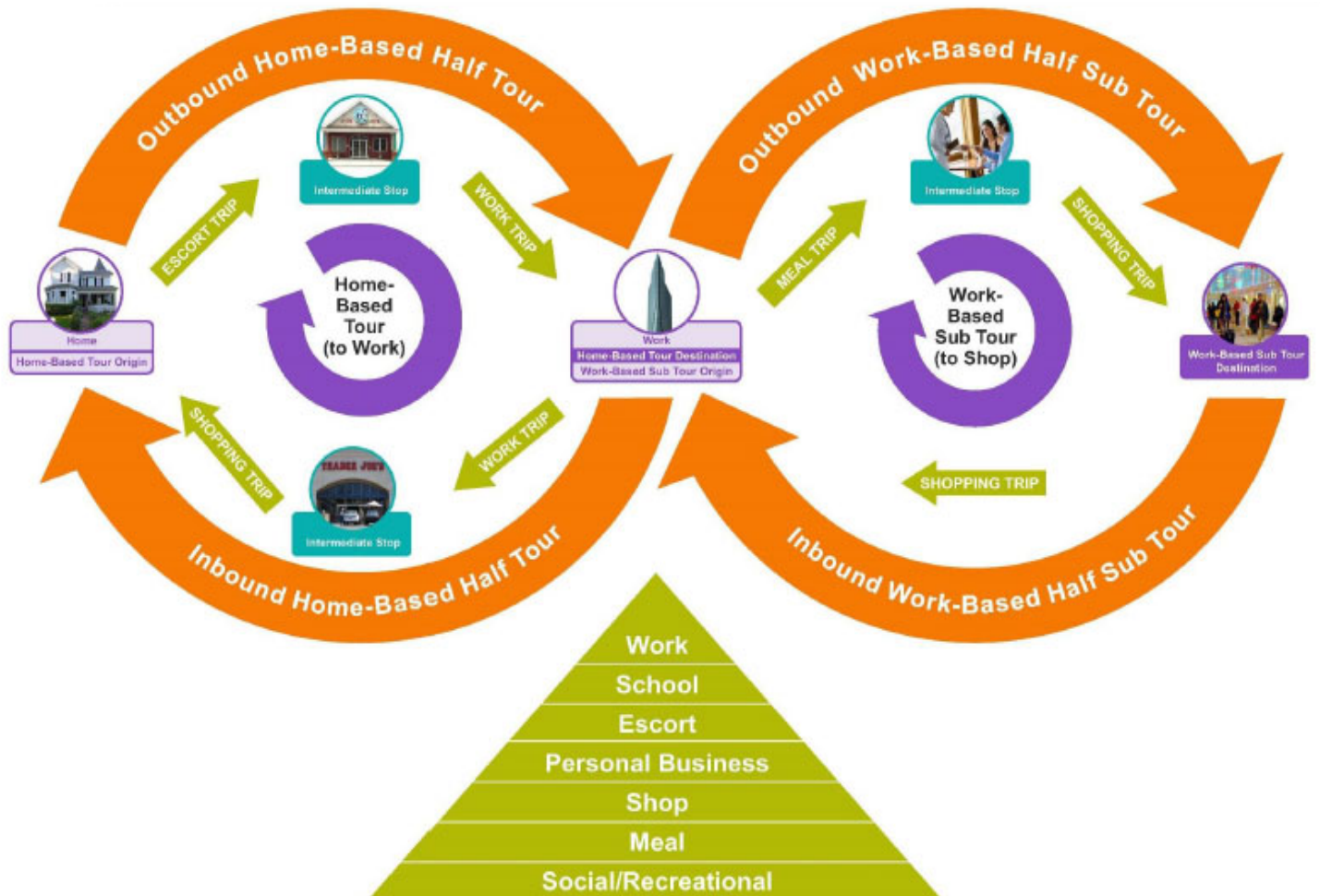


Figure 4. Sample tour diagram



Roadway and transit system

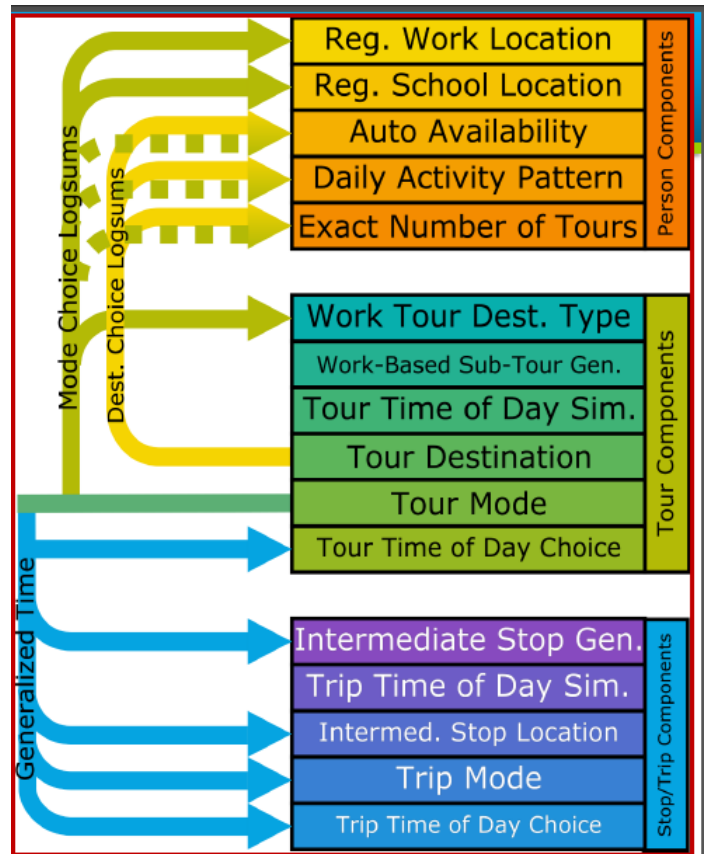
One of the most critical components is the transportation network representation. The roadway network is represented by over 25,000 directional road segments, described by location, length, number of lanes, functional classification, and area type. High-occupancy vehicle and managed lanes also are represented as special links. Tollway links are assessed an additional cost impedance to reflect toll charges. The model also includes a fully detailed representation of transit facilities, including all bus and rapid transit lines, Park-n-Ride lots, bus stops, stations, and walk access/egress routes. Bus routes follow the same roadway network as auto trips, and bus travel speeds are based on auto speeds. Overall transit travel time also includes access, wait, and transfer time. Rail speeds are developed based on transit schedule information. Capture areas for Park-n-Ride lots are quite broad, permitting trip-makers in the model to select the lot that produces the most convenient overall transit path to their destination. As part of the process of estimating roadway and transit use, minimum impedance paths are calculated using time, distance and toll cost over the roadway and high-occupancy vehicles system, and time and cost over the transit system.

Model components

The most important model components are briefly described in the sections below, and Table 1 lists all model components. Most model components are multinomial logit or nested logit models, which are statistical models that have two or more discrete choice outcomes.

Table 1. Key focus model components (activity based model components in red)

1. TransCAD Initialization
2. Size Sum Variable Calculator
3. TransCAD Trip Generation
4. TransCAD Skimming (Path Selection)
5. TransCAD Airport, Commercial Vehicle, and External Travel Distribution and Mode Choice
6. Regular Workplace Location
7. Regular School Location
8. Auto Availability
9. Aggregate Destination Choice Logsum Generation
10. Daily Activity Pattern
11. Exact Number of Tours
12. Work Tour Destination Type
13. Work-Based Subtour Generation
14. Tour Time of Day Simulation
15. Tour Primary Destination Choice
16. Tour Priority Assignment
17. Tour Main Mode Choice
18. Tour Time of Day Choice
19. Intermediate Stop Generation Choice
20. Trip Time of Day Simulation
21. Intermediate Stop Location Choice
22. Trip Mode Choice
23. Trip Time of Day
24. Write Trips To TransCAD
25. TransCAD Highway and Transit Assignment



Roadway and transit skims (path selection)

Representative roadway and transit paths are initially used for all origin-destination zone pairs (2,800 x 2,800) and each of the ten time-of-day periods. The paths consider travel time, travel cost, and other factors. The time and cost transportation analysis zone-to-transportation analysis zone matrices are used extensively in later model components such as location choice, mode choice, and time of day choice.

Denver International Airport/commercial vehicle/internal-external/external-external trips

After optimal paths are identified via the skims, all Compass model components must be run to generate and assign airport trips, internal-external trips, commercial vehicle trips, and external-external trips.

Regular workplace and school location

The work location choice model takes all regional workers and assigns them a regular work location transportation analysis zone and point. Characteristics of the worker and their home transportation analysis zone are used in combination with transportation analysis zone characteristics to determine the desirability of any transportation analysis zone.

The regular school location choice model assigns each student a regular school location transportation analysis zone and school. The model uses information about the student, such as income and age, and information on school enrollment and distance from home to determine which schools will be attractive for students. There are four school location choice models by student grade level: pre-school, kindergarden-8th grade, 9th-12th grade, and university. Four separate models are used to reflect that the decision-making of school location for different grade ranges has significantly different characteristics. The models are all multinomial logit with the choice being the location of the school zone.

Auto availability choice

The auto availability choice model is a multinomial logit model that selects number of automobiles available for each household in the region. The choices range from no cars to 4+ cars. The model uses information about households such as income and their accessibility to work and school to determine how many autos are available to households.

Tour models

After *Focus* has projected the long-term decisions about work and school location and auto availability, it forecasts daily activities on a tour-level.

The **day activity pattern** model determines which combinations of up to seven purposes (work, school, escort a family member, personal business, shopping, dining, and social or recreational) a person will make tours or stops along a tour.

The **exact number of tours** model determines how many tours of each type each person will make in his or her day. The tour types predicted for each person include: work, school, escort, personal business, shop, meal, and social recreation.

The **work tour destination type** model determines whether a person making a work tour will travel to his or her usual work location, or somewhere else, perhaps to meet with clients or customers, or for off-site training. If the regular workplace is selected, this information is entered into the tours table in the database.

Work-based subtour generation determines whether someone will leave their regular workplace and return during the middle of the day. Such a person may be eating out, running errands, or attending meetings, for example. After this point, the Focus model treats work-based subtours similarly to home-based ones.

In reality, a person might consider the interactions of destination, mode, and departure time choices together in creating an itinerary for the day's travel and activities. Despite its complexity, the Focus model needs to have some simplifying assumptions to make its mathematical relationships and software workable.

Tour time of day simulation is one such simplification, allowing destination and mode choices to be modeled as if the time of travel is known (so the right time and cost matrices can be used) as an initial guess. The simulated times of days are based on observed survey distributions. The later **tour time of day choice** confirms whether the initially simulated time of day was reasonable, or whether a shift earlier or later might be justified.

The ***tour primary destination choice*** model selects the destination of tour based the development (e.g., jobs and households) located within the zone. It then assigns a point within each zone as the final destination.

After the tour destination is known, the ***tour main mode choice*** model predicts the main travel mode used on the tour. The mode chosen is based on the impedances associated with each mode from the tour origin to the tour destination, zonal characteristics such as density, travel mode facilities, and demographic person characteristics. The tour main mode is used for most of the distance of the tour, but not necessarily for all trips. For example, if a parent is driving a child to school, the return trip would necessarily be driving alone. In other cases, stops along a tour might be close enough that walking or bicycling would be more attractive than a motorized tour mode. The tour and trip modes are related by rules of precedence used to simplify the Focus model.

Given the known tour origin, destination and mode from previous models, the ***tour arrival and departure time*** model predicts the time arriving at the primary destination of the tour and the time leaving the primary destination, both to within one hour periods.

Trip models

After the tour-level models are run, a series of trip-level models are run. The first trip level model is the **intermediate stop generation** model, which determines the number of intermediate stops on each tour (if any).

As with the tour models, there is a **trip time of day simulation** component to simplify the location and mode choices that are modeled next.

The **intermediate stop location choice** model selects the zone for each intermediate stop. The locations of all intermediate stops on tours are modeled one at a time, first for stops from home to the primary activity and then for stops from the primary activity to home.

The **trip mode choice** model determines the mode of travel for all trips. The tour mode is used in combination with skim data, zonal data, and person data to determine the modes for each trip on these tours.

Given the origin, destination and mode of each trip, the trip time of day choice model predicts the time each intermediate stop will occur. The **trip time of day choice** model has 24 alternatives corresponding to each hour period.

After the trip models have been run, the following information is known for every trip internal to the region:

- Origin and Destination Zone and Point Location
- Trip Purpose (work, school, escort, personal business, shop, social recreation)
- Trip Mode (drive alone, shared ride 2, shared ride 3+, walk to transit, drive to transit, walk, bicycle, school bus)
- Trip Time of Day (one of 24 hours)
- Which tour the trip is part of
- What person made the trip
- What household the person who made the trip belongs

The **write trips to TransCAD** component assembles the individual records for auto and transit trips into origin-destination trip tables (matrices) that TransCAD can use for assignment. These trip tables are then combined with those developed for DIA, commercial vehicle, internal-external, external-internal, and external-external trips developed earlier.

Network assignment

Household vehicle, airport trips, internal-external trips, commercial vehicle trips, and external-external trips are assigned to the roadway network via a “user equilibrium” algorithm. The user equilibrium process assigns the trips between each origin and each destination transportation analysis zone in such a way that, by the end of the process, no trip can reduce its travel time by changing its path. The process takes into account the congestion produced by all other trips in the region, each trip is following its minimum path. High-occupancy vehicles are loaded simultaneously with single-occupant vehicles. During this process, TransCAD keeps track of which vehicles are eligible to use high-occupancy vehicles facilities, and which might need to pay a toll to use high-occupancy/toll lanes, such as the reversible I-25 Express Lanes north of downtown Denver. The model also takes into account the effect of toll costs in roadway route choice by converting toll costs into equivalent time cost using an estimated value of time for automobile trip-makers.

Transit assignment is performed separately, using an all-or-nothing algorithm that does not take into account the possibility that high demand or crowding on some transit routes may motivate some riders to shift to other routes. Regional Transportation District has special modeling tools that allow them to use Focus model forecasts for more detailed operational planning.

Finally, the model is run through several iterations, feeding back the output speeds from roadway assignment to the input stages that require them as input (among them, the trip distribution stage) until the output speeds and the input speeds match closely enough.

Model calibration and validation

Each Focus model component was originally calibrated to 2010 inputs, comparing the model “forecast” for 2010 to external data sources such as:

- 2010 American Community Survey means of travel to work
- 2010 Front Range travel counts
- 2010 Highway performance monitoring system estimated regional vehicle miles traveled
- 2019 Regional Transportation District transit boardings

Once comparisons were made of model results against the observed datasets, each model component was calibrated. The calibration involved changing the coefficients describing the mathematical models and travel and adding variables. Then the model was re-run, results compared again, and modifications made again. This process was repeated until satisfactory results were achieved.

The major regional level model results of the validation review for 2020 are shown in Table 2 and Table 3. Note the 2020 values actually represent the time and travel patterns prior to the COVID-19 pandemic. These tables demonstrate that the aggregate model results reflect the observed representative counts and transit boardings sufficiently well. When summed over the region, the links with observed traffic counts were observed to carry about 28.0 million vehicles per weekday. The sum of Focus Model estimates was within one percent difference.

Air quality modeling

Formal air pollutant emissions modeling is conducted by the Air Pollution Control Division. However, DRCOG, the Air Pollution Control Division, and other agencies work closely together in this effort, both in developing the modeling techniques, assumptions, and parameters, and in executing the model runs. Travel model link speed and vehicle miles traveled results are one of the principal inputs to the air pollutant emissions model. The model produces estimates of the amount of emissions of carbon monoxide, volatile organic compounds, nitrogen oxides, and particulate matter generated by motor vehicles. The results are then combined with numerous assumptions concerning meteorology and atmospheric chemical reactions to produce air pollutant concentration estimates.

Table 2. Sum of 2020 observed estimates and modeled weekday counts

	2019/20 observed (est.) counts average daily travel sum vehicle miles traveled	2020 model results average daily travel sum vehicle miles traveled	Model variation
Colorado Department of Transportation roadways w/counts	15,937,900	16,100,100	1.0%
Highway performance monitoring system roadways w/counts	20,619,200	20,018,600	-3.0%
Highway performance monitoring system urbanized area network est.	67,381,400	73,270,000	8.0%
All model links w/counts	26,552,800	25,824,200	-2.8%

Table 3. Observed estimates and modeled 2020 transit weekday boardings

	2019/20 observed (est.) counts average daily travel sum vehicle miles traveled	2020 model results average daily travel sum vehicle miles traveled	Model variation
Colorado Department of Transportation roadways w/counts	15,937,900	16,100,100	1.0%
Highway performance monitoring system roadways w/counts	20,619,200	20,018,600	-3.0%
Highway performance monitoring system urbanized area network est.	67,381,400	73,270,000	8.0%
All model links w/counts	26,552,800	25,824,200	-2.8%

Appendix C. Modeling summary table

Table 1 – Denver Regional Council of Governments assumptions for the entire modeling area and data for base and future years

	2020	2050
Total population	3,408,152	4,478,343
Employment	2,180,587	3,000,647
Dwelling units (households)	1,361,781	1,882,031
Persons/dwelling unit (household)	2.50	2.38
Vehicle miles traveled by roadway type		
-Freeway	34,777,226	48,560,516
-Expressway	5,306,800	7,173,836
-Principal	25,367,941	36,412,893
-Minor	8,533,124	12,053,757
-Other (collectors, centroid connectors, ramps)	17,388,152	26,333,878
Total	91,373,242	130,534,879
Speed by roadway type (miles per hour)		
-Freeway	58.3	53.2
-Expressway	42.7	39.1
-Principal	32.5	30.7
-Minor	29.2	27.7
-Other (collectors, centroid connectors, ramps)	27.3	27.1
Total (Average Speed)	37.6	35.4
Lane Miles by roadway type		
-Freeway	2,190	2,478
-Expressway	542	561
-Principal	4,280	5,130
-Minor	2,895	3,126
-Other (collectors, ramps)	6,507	6,555
Total	16,414	17,851

Appendix D. Memoranda of agreement – transportation conformity evaluation conducted under the 8-hour ozone standard

MEMORANDUM OF AGREEMENT

FOR

TRANSPORTATION CONFORMITY EVALUATIONS
CONDUCTED UNDER THE 8-HOUR OZONE STANDARD

BY AND BETWEEN

THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT,
THE DENVER REGIONAL AIR QUALITY COUNCIL,
THE COLORADO DEPARTMENT OF TRANSPORTATION,
THE UPPER FRONT RANGE TRANSPORTATION PLANNING REGION,
THE NORTH FRONT RANGE TRANSPORTATION AND AIR QUALITY
PLANNING COUNCIL (a.k.a. the North Front Range MPO),
AND THE DENVER REGIONAL COUNCIL OF GOVERNMENTS

March 14, 2008

Abbreviations Guide

APCD – Air Pollution Control Division
AQCC – Air Quality Control Commission, (“the Commission”)
CDPHE – Colorado Department of Public Health and Environment
CDOT - Colorado Department of Transportation
DRCOG – Denver Regional Council of Governments
MOA – Memorandum of Agreement
MPA – Metropolitan Planning Area
MPO – Metropolitan Planning Organization
NFR – North Front Range
NFRT& AQPC – North Front Range Transportation & Air Quality Planning Council (the NFR MPO)
NOx – Nitrogen Oxides
RAQC – (Denver) Regional Air Quality Council
SIP – State Implementation Plan
UFR – Upper Front Range
TIP – Transportation Improvement Program
TPR – Transportation Planning Region
USDOT – United States Department of Transportation
USEPA – United States Environmental Protection Agency
VOC – Volatile Organic Compounds

Terminology

Consulting parties – Those agency parties involved in data and document review for the purposes making or commenting on a Conformity Determination. Includes the Air Quality Control Commission, USDOT and USEPA, who are not signatory parties to this MOA.

Signatories/Signatory parties – The parties signatory to this document. This group of six agencies does not include USDOT or USEPA.

On-road motor vehicle – Refers to cars, trucks, buses, motorcycles, vans and other motorized vehicles that use public highways, streets and roadways; to be distinguished from motor vehicles that may be designed for off-road use, e.g., all-terrain vehicles, and from agricultural and construction equipment.

A. Background and Purpose

The U.S. Environmental Protection Agency (USEPA) has designated an area ([See map, Attachment A](#)) inclusive of the Denver Metro Area and portions of both the North Front Range Metropolitan Planning area and the Upper Front Range Transportation Planning Region as nonattainment under the 8-hour ozone standard. The nonattainment designation became effective November 20, 2007. The Upper Front Range TPR is not represented by a Metropolitan Planning Organization as it comprises a largely rural area. Furthermore, the TPR lacks the expertise and wherewithal to provide or purchase transportation and modeling forecasts as part of the Conformity Determination process for the 8-hour ozone area.

Federal Transportation Regulations at 23CFR 450.314 (b) state that where a metropolitan planning area does not include an entire nonattainment area or maintenance area, “there shall be written agreement among the State Department of Transportation, State air quality agency, affected local agencies, and the MPO describing the process for cooperative planning and analysis of all projects outside the MPA within the nonattainment or maintenance area. The agreement must also indicate how the total transportation-related emissions for the nonattainment or maintenance area, including areas outside the MPA, will be treated for the purposes of determining conformity in accordance with EPA’s transportation conformity rule (40 CFR Part 93). The agreement shall address policy mechanisms for resolving conflicts concerning transportation-related emissions...**(and)** (c): In nonattainment or maintenance areas, if the MPO is not the designated agency for air quality planning...there shall be a written agreement between the MPO and the designated air quality planning agency describing their respective roles and responsibilities for air quality related transportation planning. (d) If more than one MPO has been designated to serve an urbanized area, there shall be written agreement among the MPOs, the State(s), and the public transportation operator(s) describing how the metropolitan transportation planning processes will be coordinated to assure the development of consistent metropolitan transportation plans and TIPs across the MPA boundaries....”

Similarly, EPA regulations at 40 CFR 93.105(e) and 51.390 require states to create consultation procedures in the SIP whereby MPO representatives, state and local air quality planning agencies, state and local transportation agencies and other organizations must consult with each other and with U.S. Environmental Protection Agency (USEPA) and U.S. Department of Transportation (USDOT) regarding development of State Implementation Plans (SIPs), transportation plans, transportation improvement programs (TIPs), and Conformity Determinations.

This Memorandum of Agreement (MOA) is designed to allow for and to guide cooperative transportation planning in conformance with State air quality plans, and related review and analysis in the pursuit of transportation Conformity Determinations associated with the 8-hour ozone State Implementation Plan (SIP).

B. Conformity Determinations Prior to/In Lieu of the Establishment of On-Road Motor Vehicle Emission Budgets

The first Conformity Determination for the area of concern is due November 20, 2008, as required by the federal Conformity Rule at 40 CFR 93.102(d). Since adequate or

approved motor vehicle emission budgets will not be available until late 2009, one or more Conformity Determinations for the nonattainment or maintenance area of concern must follow the procedures at 40 CFR 93.109(e)(2)(iii).

The Denver Regional Council of Governments and the North Front Range MPO shall perform transportation emissions forecasting for the respective areas described in Section C.1 and C.2 for Conformity Determinations, regardless of whether emission budgets have been established, and regardless of whether overall nonattainment-or maintenance area emission budgets or sub-area emission budgets are used.

C. Motor Vehicle Emission Budgets for the 8-Hour Ozone Nonattainment (or Maintenance) Area and Sub-Areas

In the SIP development process, the Air Pollution Control Division (APCD), the North Front Range Metropolitan Planning Organization (NFRMPO), and the Regional Air Quality Council (RAQC) shall work together to propose overall area motor vehicle emission budgets for volatile organic compounds (VOC) and nitrogen oxides (NO_x) for the 8-hour ozone nonattainment or maintenance area. Said budgets must be adopted by the Commission and affirmed via USEPA adequacy determinations in order to become viable for use in Conformity Determinations.

Sub-area emission budgets for ozone precursors under the 8-hour ozone standard may also be proposed to the AQCC for the following two sub-areas:

1. The combined areas of the Denver Metro Region and the southern portion of the Upper Front Range Transportation Planning Region (TPR) as designated nonattainment by USEPA, i.e., the area south of the north line of Township 3 north of the 6th Principal Meridian; said line is the southern boundary of the North Front Range MPO extended to the east line of Weld County. For this sub-area, the budgets for NO_x and VOC shall be proposed during SIP development for the federal 8-hour ozone standard by the RAQC with input from the APCD, CDOT, DRCOG, and UFR to be considered for adoption by the Commission.
2. The combined areas of the North Front Range MPO area and the northern portion of the Upper Front Range TPR, as designated nonattainment by USEPA, i.e., the area north of the north line of Township 3 north of the 6th Principal Meridian; said line is the southern boundary of the North Front Range MPO extended to the east line of Weld County. For this sub-area, the budgets for NO_x and VOC shall be proposed determined during SIP development for under the federal 8-hour ozone standard by the NFR MPO in consultation with the APCD and the RAQC, with input from CDOT and UFR, to be considered for adoption by the Commission.

Sub-area budgets, agreed to by the signatories and approved by the Commission, may be used to measure the conformity of plans and programs for the respective areas, once determined adequate by the USEPA.

Sub-areas as described above and Conformity procedures described in this document shall remain the same when and if the 8-Hour Nonattainment Area is re-designated an “Attainment/Maintenance Area.

D. Granting of Authority, Responsibilities

The Upper Front Range TPR lacks the expertise and wherewithal to provide or purchase transportation and modeling forecasts as part of the Conformity Determination process for the 8-hour ozone area. By this agreement:

1. The DRCOG agrees to provide transportation forecasts and make Conformity Determinations for the area described in Section C.1 above. The area includes the DRCOG MPO area and other 8-hour ozone nonattainment areas within the DRCOG TPR, as well as a portion of the nonattainment area of the Upper Front Range TPR.
2. The North Front Range MPO agrees to provide transportation forecasts and make Conformity Determinations for an area described in Section C.2 above. The area includes North Front Range MPO 8-hour ozone nonattainment areas as well as portions of the Upper Front Range TPR nonattainment area.
3. The Upper Front Range TPR authorizes the DRCOG and the NFR MPO to prepare transportation forecasts and make Conformity Determinations for the relevant nonattainment areas of the Upper Front Range as described in Section C of this document.
4. The agreed-upon transportation forecasting authorities shall continue for the 8-Hour Ozone Area after it is re-designated “Attainment/Maintenance” status by USEPA.

E. Compensation to MPOs for Additional Responsibilities

It is anticipated that over the next one-to-four years, funding will be needed for enhanced transportation forecasting and to perform Conformity Determinations for the Upper Front Range areas of concern. The CDOT has the responsibility to fund required Conformity Determinations and associated transportation modeling efforts for areas outside of the MPOs.

As forecasting and modeling work for the UFR will extend beyond the MPO boundaries, the CDOT will provide necessary funding to DRCOG and NFR based upon a mutually agreeable course of action delineating tasks, schedule, and costs among the signatory agencies. The signatory agencies will look to the USEPA and USDOT to assure consistency with federal requirements regarding tasks. The CDOT will execute separate intergovernmental agreements with the NFRMPO and DRCOG detailing the specific work that will be done for the agreed-to compensation.

F. Conformity Review – Procedural

The agencies shall follow the interagency consultation process and procedures identified in Colorado Air Quality Control Commission Regulation No. 10 for sharing information and conducting review of transportation data, projections, and determining Transportation Conformity to the State Implementation Plan under the 8-hour ozone standard, and generally the process outlined in memoranda of agreement for Transportation Conformity evaluations by and between the CDPHE and the Denver Regional Council of Governments (1998) and with the North Front Range Transportation and Air Quality Planning Council (2003).

The DRCOG and NFR MPO shall provide forecasts for their respective areas as described in Section C. 1 and C.2. In cases where one Conformity finding is to be made for the overall 8-Hour Ozone Nonattainment (or Attainment/Maintenance) Area, and no sub-area emission budgets are to be used, the MPOs, in consultation with the other signatory parties and with USEPA and USDOT, shall sum the ozone precursor emissions from their respective areas for overall-Area totals of VOC and NO_x, to determine whether forecasted emissions meet the appropriate Conformity test(s). In such cases, the MPOs jointly shall produce one Conformity Determination document for the overall 8-Hour Ozone Nonattainment (or Attainment/Maintenance) Area.

The APCD will perform independent emission budget tests and other applicable analyses for the overall Nonattainment (or Attainment/Maintenance) region and, as well as for the sub-areas described in C.1 and C.2 if sub-area budgets are to be used, within 30 days of receiving the final submittal of transportation data, although such data will be submitted to the APCD as early in the process as possible. The APCD may also assist with enhanced emissions forecasting for the Upper Front Range area, or provide other in-kind assistance to emissions forecasting efforts.

Assuming the APCD agrees with a Conformity Determination, it will recommend that the Air Commission comment formally via letter to the relevant MPO and to CDOT regarding its concurrence.

In the event that future sub-area emissions exceed a Conformity test or emission budget, the sub-area MPO shall immediately and diligently pursue actions, e.g., transportation plan and/or TIP amendment, that would bring projected emissions under budget (or in line with the Conformity test being used) and thus to conform to the SIP (and/or not threaten to increase the severity of the 8-Hour Area's nonattainment status). Such endeavor would be pursued as part of standard interagency process. If the sub-area were to fail to meet a Conformity test/make a positive Conformity Determination, all parties to this MOA shall confer on an emergency basis to review emission budgets and to consider the merits of the following actions, which may be needed to achieve or to re-establish Conformity:

- Potential revisions to transportation plans and/or transportation programs
- Potential modeling (by both MPO's) of the entire nonattainment (or Attainment/Maintenance) Area for a Conformity Determination, if allowed by the SIP
- Potential appeal (via the SIP process) for emission budget revisions
- Potential additional SIP revisions.

A course of action employing one or more of the above-listed actions shall be determined by the parties to this agreement. Parties may appeal to the USDOT and USEPA for guidance in establishing Conformity.

G. Dispute Resolution

Any protracted disagreements between consulting parties reviewing a Conformity Determination shall be elevated to the Commission, per the provisions in AQCC Regulation No. 10. Any continuing dispute that devolves or threatens to devolve into a situation of official non-conformance of transportation plans with the State Implementation Plan may be elevated to the Governor, just as a disputed Conformity Determination may be elevated to the Governor, as provided in AQCC Regulation No. 10 and at 40 CFR Section 93.105(d).

H. Termination of Agreement

This agreement shall be binding upon the signatory parties-until the 8-hour ozone area has achieved attainment status and maintains said status for a period of at least 20 years, unless the undersigned agencies revise or replace this MOA via unanimous, written agreement.

The undersigned hereby agree to the delegations, responsibilities and procedures described above.



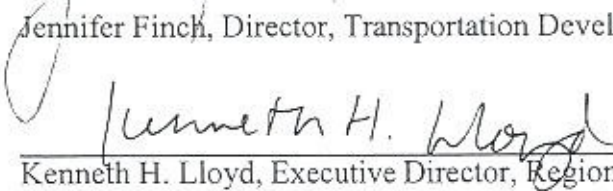
3/14/08

Paul Tourangeau, Director, Air Pollution Control Division, CDPHE Date



3/14/08

Jennifer Finch, Director, Transportation Development Division, CDOT Date



3/14/08

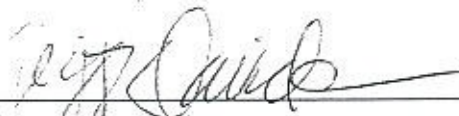
Kenneth H. Lloyd, Executive Director, Regional Air Quality Council Date



3/24/08

Robert D. Masden, Weld County Commissioner,
Chairman, Upper Front Range TPR

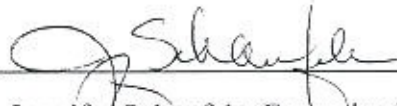
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3/20/08

Cliff Davidson, Executive Director, North Front Range MPO

Date

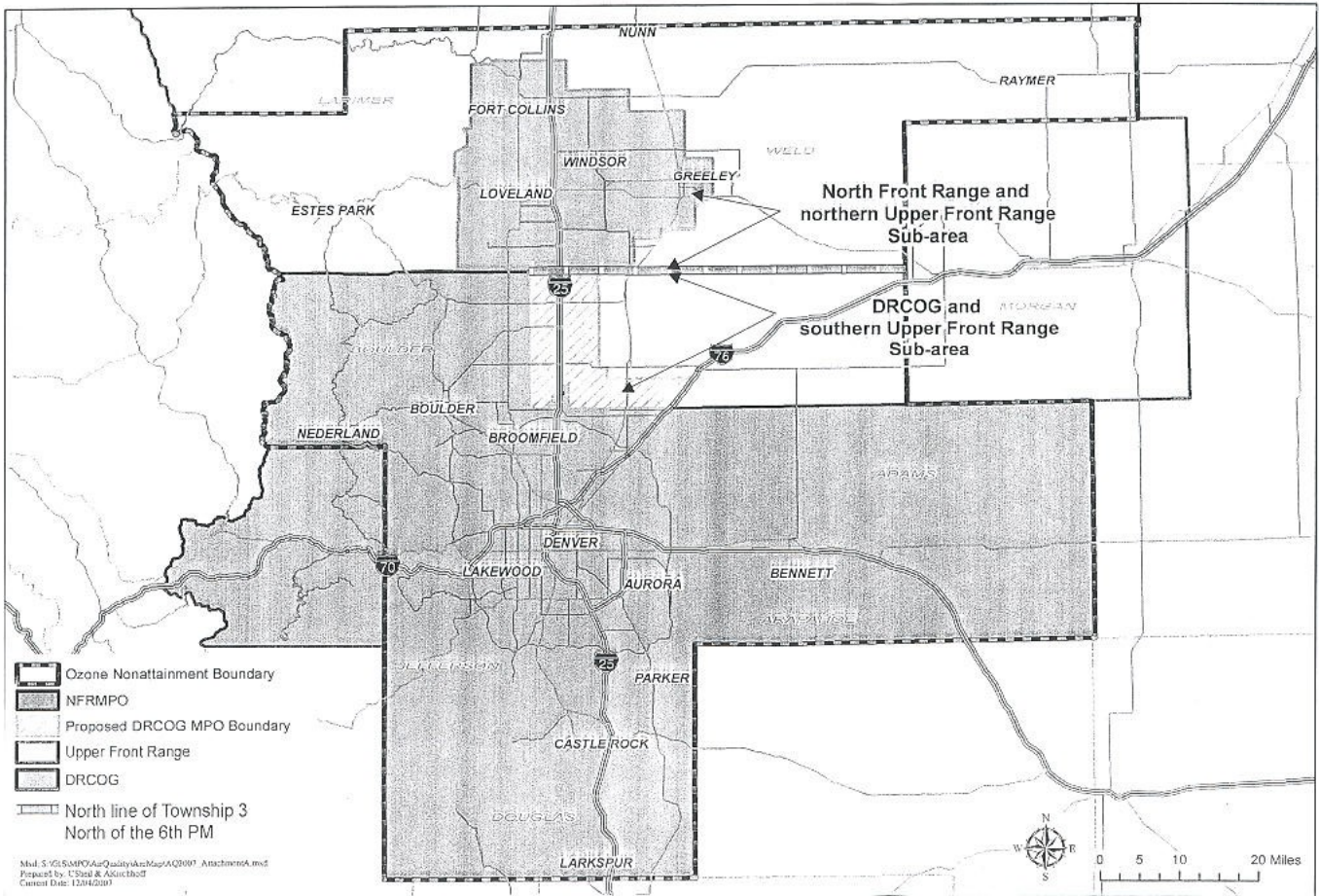


3/14/08

Jennifer Schaufele, Executive Director,
Denver Regional Council of Governments

Date

**Attachment A:
8-Hour Ozone Nonattainment Area
and Sub-areas**



Map S:\015\MPO\AirQuality\Map\AQ0001_AttachmentA.mxd
Prepared by: C. Boyd & Associates
Current Date: 12/14/2009

2015
MEMORANDUM OF AGREEMENT
FOR
TRANSPORTATION CONFORMITY EVALUATIONS

BY AND BETWEEN
THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
AND
THE REGIONAL AIR QUALITY COUNCIL
AND
THE DENVER REGIONAL COUNCIL OF GOVERNMENTS
AND
THE NORTH FRONT RANGE TRANSPORTATION AND
AIR QUALITY PLANNING COUNCIL

PURPOSE

This Memorandum of Agreement (MOA) is established for the purpose of defining the specific roles and responsibilities of the Air Pollution Control Division (APCD) of the Colorado Department of Health and Environment (CDPHE), the Regional Air Quality Council (RAQC), the Denver Regional Council of Governments (DRCOG), and the North Front Range Transportation and Air Quality Planning Council (NFRMPO) for transportation conformity evaluations and modeling for the Denver and North Front Range regions. Hereafter, the above are referenced as “parties,” and DRCOG and NFRMPO are referenced to as the “MPO(s)” (Metropolitan Planning Organization(s)).

Section 176(c) of the Clean Air Act Amendments of 1990 calls for conformity evaluations to be made for transportation plans, programs, and projects, and for these conformity determinations to be developed through an interagency consultation process. Title 23, Part 450 of the Code of Federal Regulations calls for a continuing, cooperative and comprehensive transportation planning process, including provision of complete information, opportunity for early and continuing public involvement, and access to technical and policy information used in developing transportation documents. These federal mandates are best carried out with the explicit understanding of how the state air quality agency and the MPOs will coordinate efforts, especially with regard to transmitting and analyzing data, and identifying key assumptions used in planning documents.

This MOA augments interagency consultation requirements set forth in federal law and Colorado Air Quality Control Commission (AQCC) Regulation Number 10, Section III. The MOA is to be used in conjunction with these federal and state requirements for transportation conformity determinations required under the Clean Air Act. Specifically, this MOA identifies the roles and responsibilities of RAQC, DRCOG, NFRMPO and APCD in conducting conformity evaluations and sets forth a procedural framework to ensure appropriate consultation and coordination between RAQC, DRCOG, NFRMPO and APCD in carrying out these responsibilities. It also clarifies what key assumptions and data are expected in draft documents and materials used in the interagency consultation process.

This MOA supersedes the prior agreements between the parties dated November 19, 1998 (DRCOG and APCD) and November 24, 1998 (NFRMPO and APCD).

CONFORMITY EVALUATIONS RESPONSIBILITIES

Conformity evaluations are conducted in association with new conformity determinations. The evaluations require the modeling and calculation of pollutant emissions.

MPO RESPONSIBILITIES

As defined in Regulation 10, Section III, MPOs are responsible for the development, maintenance, accuracy, and operation of the regional travel demand models which provide input data to the official emissions model. MPOs will notify APCD and RAQC staff once a need for a new conformity determination is identified and a schedule for conformity modeling has been established. The estimated time period over which APCD modeling work would be required will be defined. Any changes in the schedule will be discussed with APCD staff as soon as such changes are known by the MPO. When requesting APCD to model emissions, MPO staff will forward all necessary travel model data, for each staging year that will be modeled. The NFRMPO is responsible for travel modeling in the Ozone Northern Subarea and DRCOG is responsible in the Ozone Southern Subarea, as defined in the March 14, 2008 Memorandum of Agreement.

APCD RESPONSIBILITIES

The APCD is responsible for the development, maintenance, accuracy, and operation of the official emissions model. After receiving travel model inputs to the emissions model, the APCD will inform the parties regarding an estimated schedule for completion of the emissions results. After the APCD performs emissions modeling, it will provide the parties with the emission model output results as soon as possible.

RAQC RESPONSIBILITIES

The RAQC shall review travel and emissions modeling inputs and outputs and provide comments to the parties. The RAQC will provide technical support and advice regarding model modifications.

MODEL MODIFICATIONS AND CORRECTIONS

Once travel and emission models have been established, modifications and updates to those models by the APCD or MPO may occur for some of the following reasons: updated models, updated input information, such as fleet mix or travel demand model changes, or other issues that are discovered.

If a modification or correction is required in the travel or emissions model, the following steps should be led by the agency making the identification:

- Identify all affected parties and potential work items
- Notify the affected parties and provide an initial explanation
- If needed, call a meeting to review and explain the issue to all parties
- Establish timeline and assigned duties for implementing the modification or correction
- Obtain concurrence and approval for the process for implementation from all parties
- Ensure that the APCD or MPO updates the model with the new information for use with the next applicable conformity cycle
- Share and/or discuss model results with all parties

Changes to the models will be documented and provided to the affected parties and, if needed, may be incorporated into the applicable conformity determination report.

INTERAGENCY CONSULTATION PROCESS (OR GROUP)

An Interagency Consultation Group (ICG) has been established for consultation purposes as identified in Regulation 10. The APCD, DRCOG, and NFRMPO staff will submit technical data for review and recommendation by the ICG that is comprised of representatives from Federal Highway Administration (FHWA), Colorado Department of Transportation (CDOT), Environmental Protection Agency (EPA), Regional Air Quality Council (RAQC), Air Pollution Control Division (APCD), Upper Front Range Transportation Planning Region (UFR), Denver Regional Council of Governments (DRCOG), and North Front Range MPO (NFRMPO).

The ICG will meet as needed to review data pertaining to conformity determinations and advise in a timely fashion. In this way, the assumptions and procedures used in transportation and air quality modeling can be reviewed by staff before the final modeling is performed. Data to be submitted to the ICG for review as part of the regular transportation planning process should be sufficient for making decisions and may include transportation network and land use assumptions, descriptions of any calibrations or updates to the travel model, and updates or changes to the air quality model. If changes which could affect air emissions modeling or evaluations are made after the above data have been reviewed by the ICG, these differences will be disclosed to the ICG and to the other parties to this MOA prior to initiating the final air quality modeling.

Per Regulation 10 section III.H.2, the APCD, shall decide if the conformity determination needs to be reviewed by the AQCC (non-routine) or solely by APCD (routine).

AQCC CONFORMITY REVIEW

The MPO will follow the procedures identified in the AQCC Procedural Rules calling for a public meeting by the AQCC for purposes of commenting on the MPO's non-routine conformity determinations. The parties acknowledge the initial conformity determination document must be available to the Commission office at least 15 days prior to requesting that the AQCC schedule a public meeting, and the final conformity determination document must be available to the Commission office at least 30 days prior to the AQCC's public meeting at which the conformity determination is scheduled to be discussed. The initial document should contain all modeling results and the appropriate supporting materials, and the final documents should contain any updates, revisions or corrections. The Commission can entertain deviations from this schedule on a case-by-case basis.

The Division will provide the MPO with a copy of its written comments, if any, on the conformity determination at the same time it provides them to the AQCC. All AQCC comments on determinations of conformity shall be forwarded to the MPO by APCD. Any AQCC appeal of such conformity determination will follow the procedure outlined in Regulation 10. After review, the APCD will send the MPO a letter of concurrence of a positive conformity determination. If the AQCC does not concur on the conformity determination made by the MPO, this disagreement is forwarded to the Governor's Office unless the parties revise the conformity determination.

LIMITATIONS

1. Nothing in this MOA impairs or otherwise affects the authority of the heads of the signatory party over their organizations.
2. This MOA is intended to outline an agreement among the parties and does not create or confer any right or benefit on any person or party, private or public. Nothing in this MOA is intended to

restrict the authority of any signatory to act as provided by law or regulation, or to restrict any agency from enforcing any laws within its authority and jurisdiction.

3. This MOA in no way restricts signatory parties from participating in similar activities with other public or private agencies, organizations, and individuals.
4. Nothing in this MOA shall obligate any signatory party to obligate or transfer any funds, nor does it supplement existing statutory authorities of the signatory party agencies.
5. This MOA, consisting of five (5) pages, represents the entire and integrated agreement between the parties and supersedes all prior negotiations, representations, and agreements concerning this MOA, whether written or oral.

EXECUTION, MODIFICATION AND TERMINATION OF AGREEMENT

It is mutually agreed and understood by all signatory parties that:

1. Any party to this agreement may suspend it by a 60-day written notice to the other parties. If this occurs, the parties agree to consult further to determine whether the issues can be resolved and the agreement re-implemented in an amended form.
2. Changes to the scope of this MOA shall be made by the issuance of a multilaterally executed modification. These changes are to be mutually agreed upon between the parties to this MOA, shall be incorporated by written instrument, executed and signed by all parties to this MOA and are effective as of the date of the last signature obtained.
3. This MOA may be executed in counterparts. A copy with the original signature pages affixed will constitute the original MOA. The effective date shall be the date of the final signatory party agency's signature, and the MOA shall remain in effect until modified or dissolved.
4. This MOA may not serve as the basis for any challenges or appeals.
5. Colorado Open Records Act (CORA). Any information furnished by any parties under this Memorandum is subject to the Colorado Open Records Act (24-72-201 to 24-72-309, C.R.S.).
6. **RESPONSIBILITIES OF PARTIES.** The subject parties intend to handle their own activities and utilize their own resources, including the expenditure of their own funds, in pursuing these objectives. Each party intends to carry out its separate activities in a coordinated and mutually beneficial manner.
7. **NON-FUND OBLIGATING DOCUMENT.** Nothing in this MOA shall obligate the subject parties to obligate or transfer any funds. Specific work projects or activities that involve the transfer of funds, services, or property among the various agencies and offices of the parties will require execution of separate agreements and be contingent upon the availability of appropriated funds. This MOA does not provide such authority. Negotiation, execution, and administration of each such agreement must comply with all applicable statutes and regulations.
8. **ESTABLISHMENT OF RESPONSIBILITY.** This MOA is not intended to, and does not create, any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity, by a party against any of the signatory parties, including but not limited to, their agencies, their officers, or any other person.
9. **AUTHORIZED REPRESENTATIVES.** By signature below, the signatory party certifies that the individuals listed in this document as representatives of the signatory party are authorized to act in their respective areas for matters related to this agreement.
10. **GOVERNMENTAL IMMUNITY:** The parties do not waive their governmental immunity by entering into this MOA and retain all immunities and defenses provided by law with respect to any action based on or occurring as a result of this MOA.

11. The parties agree that exclusive venue for any action related to performance of this agreement shall be in the City and County of Denver, Colorado.

The undersigned parties hereby agree to the responsibilities and procedures described above.

Lisa M. Wolk

Larry Wolk, Executive Director &
Chief Medical Officer
Colorado Department of Public Health and Environment

5-28-15

Date

Ken Lloyd

Ken Lloyd, Executive Director
Regional Air Quality Council

March 31, 2015

Date

Jennifer Schaufele

Jennifer Schaufele, Executive Director
Denver Regional Council of Governments

March 25, 2015

Date

Terri Blackmore

Terri Blackmore, Executive Director
North Front Range MPO

May 7, 2015

Date

Carbon Monoxide and Particular Matter Air Quality Conformity Determination Documents

for the DRCOG Fiscally Constrained Element of the 2050 Metro Vision Regional Transportation Plan and the DRCOG 2022-2025 Transportation Improvement Program and the Southern Subarea Portion of the Upper Front Range 2045 Regional Transportation Plan and the 2022-2025 State Transportation Improvement Program for the Upper Front Range Transportation Planning Region

April 2021 Action Draft

Denver Regional Council of Governments
1001 17th St, Suite 700
Denver, CO 80202

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Appendix A. DRCOG Transportation Network and Project Assumptions

Appendix B. Summary of Transportation Model Calibration and Validation and Validation for the
2050 RTP, January 7, 2021

Appendix C. Modeling Summary Table

Appendix D. Particular Matter Street Emissions Reduction Commitments

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Executive summary

The Denver Regional Council of Governments (DRCOG) has completed this transportation conformity determination as part of the transportation and air quality planning process. DRCOG's update to the long-range transportation plan triggered the need to perform the conformity analysis. This document demonstrates the area meets federally prescribed air pollution emissions budget tests for carbon monoxide, particular matter, and nitrogen oxides associated with particular matter. The attainment maintenance areas continue to meet air quality conformity standards associated with DRCOG's long-range transportation plans and short-range transportation improvement programs.

Emission test results

The modeled emissions estimates were generated by the Air Pollution Control Division outputs from DRCOG's transportation model, Focus, as in input to the Motor Vehicle Emission Simulator model. The modeled emissions must be below the budgets to pass conformity tests. All staging year results for the Denver region are reported in Table 1. Model results for emissions are below the budgets, thus all tests are passed and conformity requirements are met.

Table 1. Conformity emissions test results

Pollutant	Test	Result < budget (tons per day)	Pass/fail
Carbon monoxide	2021 Staging ≤ budget	405 < 1,600	Pass
	2030 Staging ≤ budget	263 < 1,600	Pass
	2040 Staging ≤ budget	198 < 1,600	Pass
	2050 RTP ≤ budget	187 < 1,600	Pass
Particular matter	2022 Staging ≤ budget	28 < 55	Pass
	2030 Staging ≤ budget	31 < 55	Pass
	2040 Staging ≤ budget	34 < 55	Pass
	2050 RTP ≤ budget	37 < 55	Pass
Nitrogen oxides associated with particular matter	2022 Staging ≤ budget	34 < 56	Pass
	2030 Staging ≤ budget	22 < 56	Pass
	2040 Staging ≤ budget	16 < 56	Pass
	2050 RTP ≤ budget	15 < 56	Pass

Chapter 1. What is transportation conformity?

Background and federal requirements

The Denver Regional Council of Governments is the Metropolitan Planning Organization for the Denver Transportation Management Area shown in Figure 1. The region has been redesignated as an attainment maintenance area for CO and Particulate matter, from the previous designation of nonattainment. The pollutants and their violation status for the Denver region are shown in Table 2. DRCOG is required to show conformity of its fiscally constrained transportation plan and Transportation Improvement Program with the State Implementation Plan for air quality before these transportation plans and programs are adopted. This action is required under Section 176(c) of the Clean Air Act, as amended in 1990.

The Clean Air Act defines conformity as compliance to the implementation plan's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards and achieving expeditious attainment of such standards. In addition, activities may not cause or contribute to new violations of air quality standards, exacerbate existing violations, or interfere with the timely attainment of required emissions reductions towards attainment. The U.S. Environmental Protection Agency criteria and procedures vary according to the status of the State Air Quality Implementation Plans for individual pollutants. Transportation plans and programs must satisfy different criteria depending on whether the state has submitted a State Implementation Plan revision, and whether the Environmental Protection Agency has approved the revision. For pollutants for which a region currently meets standards but was formerly in nonattainment, the applicable State Implementation Plan may also be referred to as a maintenance plan, which demonstrates continued attainment of the standards. The Environmental Protection Agency final transportation conformity rule is located at 40 Code of Federal Regulations Part 93. To address revised standards and changes in conformity requirements, the Environmental Protection Agency promulgated several amendments to the final rule as detailed in Table 3.

Table 2. Pollutant status in the Denver region

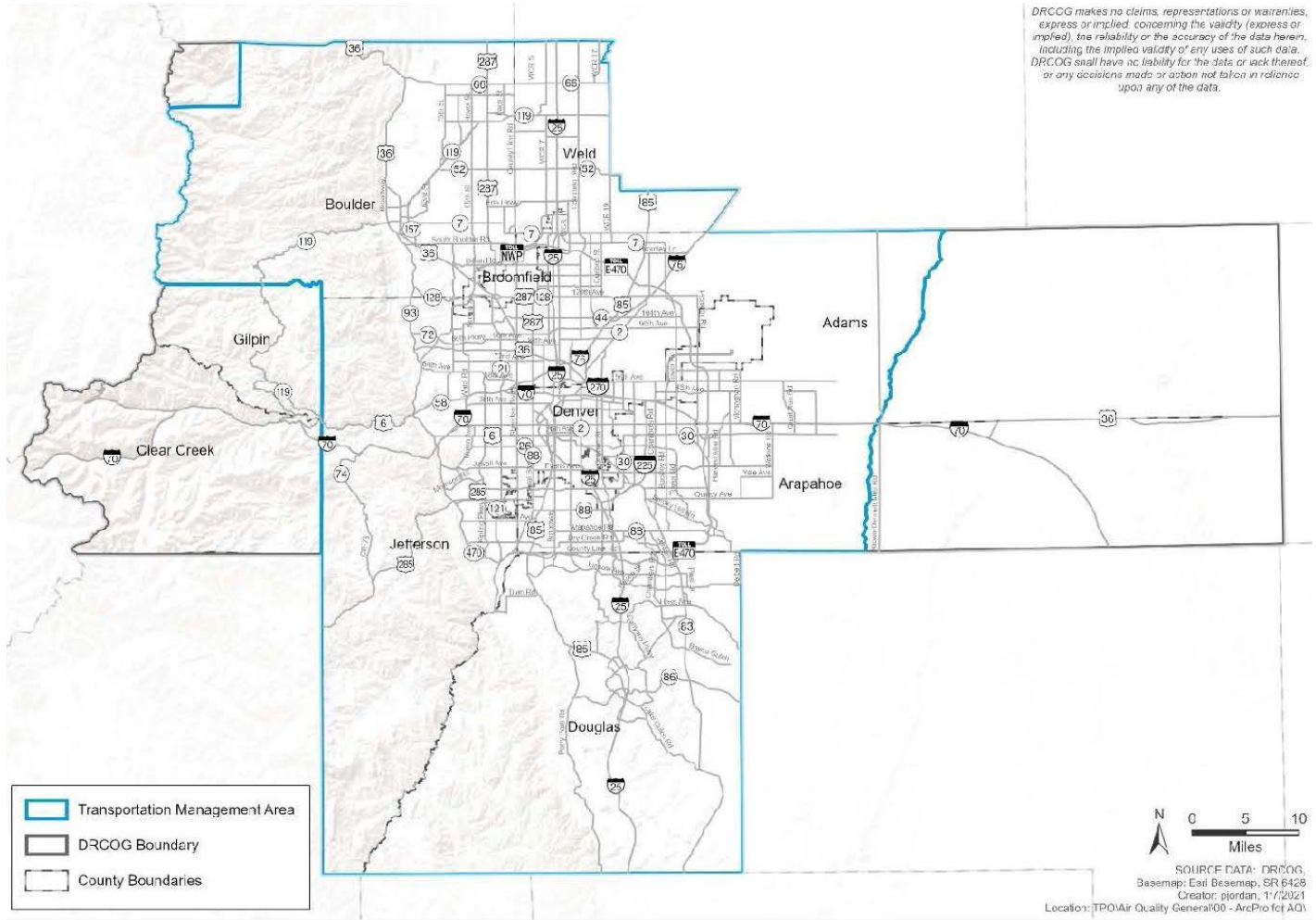
Pollutant	Standard	Status
Carbon monoxide	A violation of the carbon monoxide standard occurs when a monitoring station shows more than one exceedance per year of the 8-hour (9 parts per million) or 1 hour (35 parts per million) standard.	The carbon monoxide standard was last violated in 1995. There has been no violation for CO in the Denver region since.
Particular matter	An exceedance of the particular matter 2.5 standard occurs when a monitoring station exceeds the annual average of 12 µg/m ³ or the 24-hour average of 35 µg/m ³ . A violation of the 24-hour standard occurs only if the 3-year average of the 98th percentile of all 24 hour readings at a monitor exceeds 35 µg/m ³ or the 3-year average of the annual averages exceeds 12 µg/m ³ .	The Denver metropolitan area has never violated either of the two particular matter 2.5 standards.
Particular matter	An exceedance of the particular matter standard occurs when a monitoring station exceeds a 24 hour average of 150 µg/m ³ . If the 24-hour standard is exceeded more than three times over a three-year period, it is a violation.	The particular matter standard was last violated on three days in 1993. There has been no violation for particular matter in the Denver region since.

Table 3. Historical summary for National Ambient Air Quality Standards in the Denver region

Date	Milestone	Comments
July 1, 2004	Environmental Protection Agency issued amendments to the final transportation conformity rule.	These addressed conformity regulations for the 8-hour ozone and fine particulate matter 2.5 National Ambient Air Quality Standards, the incorporation of existing federal guidance that is consistent with a U.S. Court of Appeals decision, and streamlining and improving of the rule. ¹
March 10, 2006	Environmental Protection Agency issued revisions addressing particular matter 2.5 and particular matter Hot-Spot Analyses in Project-Level Transportation Conformity Determinations.	These project-level conformity analyses are the responsibility of project sponsors. This conformity finding covers plan and program level conformity only.
January 24, 2008	The U.S. Department of Transportation and Environmental Protection Agency issued the transportation conformity rule.	Titled: “Transportation Conformity Rule Amendments To Implement Provisions Contained in the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
March 8, 2012	Environmental Protection Agency issued amendments which restructure several sections of the existing transportation conformity rule.	Included restructuring two sections of the conformity rule, 40 Code of Federal Regulations 93.109 and 93.119, so that the existing rule requirements clearly apply to areas designated for future new or revised National Ambient Air Quality Standards, thus reducing the need to amend the transportation conformity rule merely to reference specific new National Ambient Air Quality Standards. Conformity rules applies to any future new National Ambient Air Quality Standards.
October 17, 2020	Environmental Protection Agency submitted a letter that the conformity requirements no longer apply to the Longmont carbon monoxide maintenance area due to the expiration of the 20-year maintenance plan.	The Longmont carbon monoxide maintenance area showed continuous maintenance of the Carbon Monoxide National Ambient Air Quality Standards from November 23, 1999 through October 16, 2020, meeting its obligation to demonstrate maintenance of the CO National Ambient Air Quality Standards for 20 years. Therefore, as of October 17, 2020, DRCOG is no longer required to address transportation conformity determination for the Longmont carbon monoxide maintenance area.

¹40 Code of Federal Regulations Part 93

Figure 1. Transportation Management Area



Relevant agencies and ongoing planning efforts

DRCOG Metro Vision Regional Transportation Plan

DRCOG's Metro Vision plan is the long-range growth and development strategy for the Denver region. It integrates plans for growth and development, transportation and environmental quality into a single comprehensive foundation for regional planning. Metro Vision calls for a balanced multimodal surface transportation system including rapid transit, a regional bus network, bicycle and pedestrian facilities, and improvements to the existing roadway system. Among Metro Vision's regional objectives is to "Improve air quality and reduce greenhouse gas emissions," which reflects the region's commitment to improve air quality through local and regional initiatives that reduce ground-level ozone, greenhouse gas emissions and other air pollutants. Supporting objectives include:

- Increase collaboration with local and regional partners on air quality initiatives.
- Increase public awareness of air quality issues.
- Improve the fuel economy of the region's vehicle fleet.

The Metro Vision Regional Transportation Plan implements the transportation element of Metro Vision. The Metro Vision Regional Transportation Plan contains an unconstrained vision plan, outlining the region's total transportation needs, as well as the Fiscally Constrained Regional Transportation Plan, which includes those projects that can be implemented given reasonably anticipated revenues through 2050. When the 2050 Metro Vision Regional Transportation Plan is referenced in this document it denotes the fiscally constrained element of the plan.

The 2022-2025 Transportation Improvement Program identifies transit, multimodal and roadway projects to be funded from fiscal year 2022 through fiscal year 2025. Regionally significant projects funded in the Transportation Improvement Program must first be identified in the 2050 Metro Vision Regional Transportation Plan. Regionally significant projects are listed in Appendix A. The Transportation Improvement Program will implement selected projects and strategies identified in the first staging periods of the 2050 Metro Vision Regional Transportation Plan.

DRCOG staff fostered public participation throughout development of the 2050 Metro Vision Regional Transportation plan and 2022-2025 Transportation Improvement Program, and continue to facilitate youth and civic engagement on a regular basis. DRCOG has provided numerous public participation opportunities, including workshops, county forums, stakeholder meetings, surveys, interactive online forums, a Youth Advisory Panel and a Civic Advisory Group.

Air quality planning

The status of air quality planning is important as it determines the emissions tests that must be met to show conformity. The most recent revised Denver Carbon Monoxide Maintenance Plan, approved by the Colorado Air Quality Control Commission on December 15, 2005, established the emission budget at 1,625 tons per day through 2020, and 1,600 tons per day for 2021 and beyond. On May 3, 2007, Environmental Protection Agency found the revised carbon monoxide budget of 1,600 tons per day adequate for use in conformity determinations for 2021 and beyond. Environmental Protection Agency's approval of the revised Denver Carbon Monoxide Maintenance Plans became effective on October 16, 2007.

The State of Colorado submitted the latest Denver particulate matter equal to and less than 10 microns in aerodynamic diameter Particulate Matter Maintenance Plan to the Environmental Protection Agency in December 2005. Environmental Protection Agency approved this latest Particulate Matter State Implementation Plan Revision on January 7, 2008. This latest Particulate Matter Maintenance Plan revision contains the particulate matter budgets of 54 tons per day for the years 2015 through 2021, and 55 tons per day for 2022 and beyond, respectively, as well as the wintertime nitrogen oxides budgets of 70 tons per day and 56 tons per day for the years 2015 through 2021, and 2022 and beyond, respectively.

On December 14, 2012, Environmental Protection Agency strengthened the annual particulate matter 2.5 standard from 15 to 12 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and retained the 24-hour particulate matter 2.5 standard of 35 $\mu\text{g}/\text{m}^3$. The agency also retained the existing standard for particulate matter. Based on the existing particulate matter 2.5 monitor data, the Denver region does not violate either the new annual particulate matter 2.5 standard, or the existing 24-hour particulate matter 2.5 standard.

Agency roles

The Conformity State Implementation Plan was developed by the Air Quality Control Commission and adopted in 1998. It formally defines the process for finding conformity. The Environmental Protection Agency approved the Conformity State Implementation Plan on September 21, 2001 (66 FR 48561), making it federally enforceable.

DRCOG, as the Metropolitan Planning Organization, and the Federal Transit Administration and Federal Highway Administration, as representatives of the U.S. Department of Transportation, are charged with determining conformity for the Denver Transportation Management Area. The development of this conformity determination has been a cooperative process between DRCOG and the Regional Air Quality Commission, the Air Pollution Control Division of the Colorado Department of Public Health and Environment, the U.S. Environmental Protection Agency, the and the Federal Transit Administration and Federal Highway Administration, the Colorado Department of Transportation, and the Regional Transportation District. In 2015, a memorandum of agreement was signed by DRCOG, the North Front Range Metropolitan Planning Organization, the Colorado Department of Public Health and Environment, and the Regional Air Quality Commission for the purpose of defining the specific roles and responsibilities in conformity evaluations and findings.

Chapter 2. Transportation control measures

For this conformity determination, there are no transportation control measures identified for timely completion or implementation as part of the applicable implementation plan. All transportation control measures associated with the carbon monoxide or Particulate Matter State Implementation Plans were completed by 2006.

Chapter 3. Emissions test process and assumptions

Background and budgets

The transportation plan and program must pass a series of emissions tests to demonstrate conformity. These emissions tests relate to the pollutants and their precursors for which the Denver region is designated as attainment-maintenance of the National Ambient Air Quality Standards.

These pollutants and precursors include:

- Carbon monoxide
- Particular matter
- Nitrogen oxides as a precursor for particular matter (wintertime estimate)

Each pollutant and precursor in specific geographic areas must pass a number of tests. The plan and program must respect the motor vehicle emissions budget in the applicable State Implementation Plan or State Implementation Plan submittal. Satisfying these tests involves demonstrating that relevant emissions in future years are less than or equal to the emissions budget established in the applicable maintenance plan. As required by 40 Code of Federal Regulations 93.118, consistency with the motor vehicle emissions budget(s) must be demonstrated for each year for which the applicable implementation plan specifically establishes motor vehicle emissions budget(s), for the attainment year (if it is within the timeframe of the transportation plan), for the last year of the transportation plan's forecast period, and for any intermediate years as necessary so that the years for which consistency is demonstrated by analysis are no more than ten years apart.

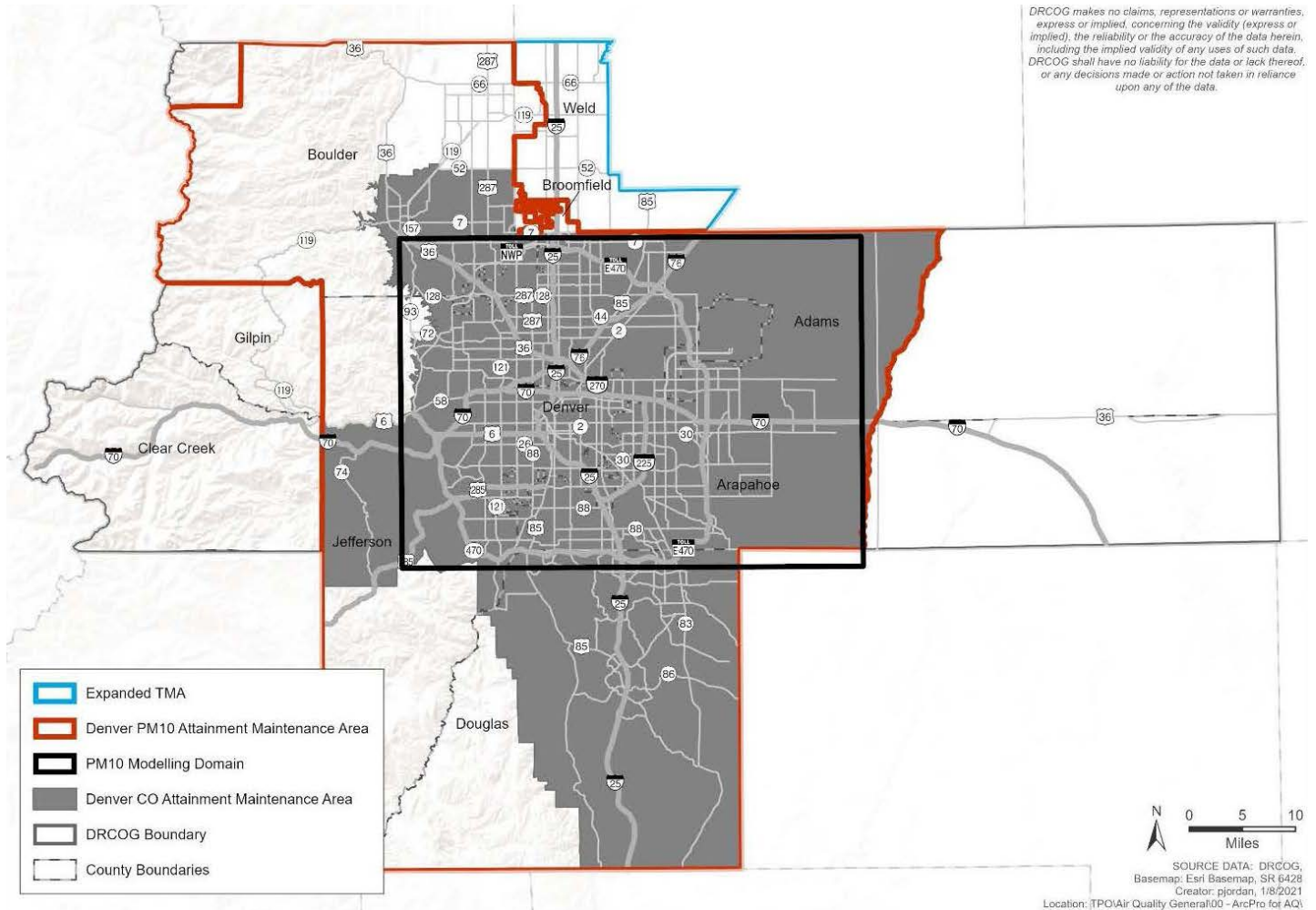
In addition, when a maintenance plan has been submitted, emissions must be less than or equal to the motor vehicle emissions budget(s) established for the last year of the maintenance plan and any year for which the maintenance plan establishes budgets. Applying these tests for the prescribed time periods for each of the pollutants results in 16 emissions tests as listed in Table 4.¹ The analysis areas are shown in Figure 2.

Table 4. Conformity emissions tests

Pollutant	Tests
Carbon monoxide	2021 staging ≤ budget of 1,600 tons per day 2030 staging ≤ budget of 1,600 tons per day 2040 staging ≤ budget of 1,600 tons per day 2050 RTP ≤ budget of 1,600 tons per day
Particular matter	2022 staging ≤ budget of 55 tons per day 2030 staging ≤ budget of 55 tons per day 2040 staging ≤ budget of 55 tons per day 2050 RTP ≤ budget of 55 tons per day
Nitrogen oxides associated with particular matter	2022 staging ≤ budget of 56 tons per day 2030 staging ≤ budget of 56 tons per day 2040 staging ≤ budget of 56 tons per day 2050 RTP ≤ budget of 56 tons per day

¹Transportation model runs represent the beginning of a calendar year. Test dates listed in Table 4 refer to model run dates.

Figure 2. Attainment maintenance areas



Technical process

The technical process used to estimate future pollutant emission levels is based on the latest planning assumptions in effect at the time of this conformity determination. Assumptions behind the analysis were derived from estimates of current and future population, employment, travel, and congestion most recently developed by DRCOG. Information concerning vehicle miles traveled and operating speeds were updated as part of this conformity finding process. Appendix B describes the modeling structure and recent enhancements for the DRCOG travel demand model in more detail. The assumptions are also used in the Motor Vehicle Emission Simulator model to estimate emissions.

Demographic assumptions

The population forecast for the full DRCOG region in 2050 is 4,382,172. This is a 31 percent increase over the 2020 estimated population of 3,337,670. Employment is forecast to be 2,948,530 in 2050 compared to the 2020 estimate of 2,147,815, an increase of 37 percent. Growth in population and employment will be the principal factor for the increased demand for travel on the region's transportation facilities and services. Table 5 shows the latest forecasts of population and employment for 2020, 2023, 2030, 2040, and 2050 for the DRCOG region. Table 6 lists 2020 and 2050 population and employment estimates by each of the nine counties, as well as the southwest portion of Weld County within the DRCOG region.

DRCOG transportation assumptions

In order to complete the emissions tests, the 2020, 2023, 2030, 2040, and 2050 transportation networks must first be defined. DRCOG's 2050 Metro Vision Regional Transportation Plan specifies financially constrained highway and transit system improvements and resulting networks to be completed by the year 2050. The 2022-2025 Transportation Improvement Program identifies funding to complete regionally significant projects on the designated regional roadway and rapid transit system that are also contained in the 2050 Metro Vision Regional Transportation Plan. All roadway and rapid transit network and staging assumptions through 2050 are shown in the figures found in Appendix A.

Air quality modeling assumptions

The Air Pollution Control Division of the Colorado Department of Public Health and Environment calculates air pollutant emissions using Motor Vehicle Emission Simulator. The conformity analysis began in December 2016. The models and assumptions used by Air Pollution Control Division in the conformity analysis were consistent with those used in the development of the carbon monoxide and particular matter State Implementation Plans. The Motor Vehicle Emission Simulator model accounts for estimates of vehicle types by miles traveled, effects on emissions caused by vehicle regulations, street sweeping commitments, and more.

Table 5. Population and employment forecasts

	2020	2023	2030	2040	2050
Population	3,337,670	3,498,995	3,785,201	4,159,665	4,382,172
Employment	2,147,815	2,228,303	2,427,498	2,687,506	2,948,530

Source: State Demography Office, Colorado Department of Local Affairs 2019 Data Pull. Weld County portioning applied by DRCOG staff. Counties included in totals: Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson and southwestern Weld.

Table 6. 2020 And 2050 population and employment estimates by county – southern subarea

County	Population		Employment	
	2020	2050	2020	2050
Adams county	523,778	842,689	267,686	365,949
Arapahoe county	659,564	837,991	426,173	584,069
Boulder county	331,025	420,105	248,111	339,920
Broomfield county	72,773	98,239	48,254	66,192
Denver county	736,531	883,165	646,251	885,225
Douglas county	354,508	464,189	174,176	238,725
Jefferson county	586,965	661,332	313,198	429,177
Southwestern weld county	72,526	174,462	23,966	39,273
Total carbon monoxide and particular matter nonattainment area	3,337,670	4,382,172	2,147,815	2,948,530

Source: State Demography Office, Colorado Department of Local Affairs 2019 Data Pull. Weld County portioning applied by DRCOG staff. Counties included in totals: Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson and southwestern Weld.

Particular Matter Street Maintenance Actions

There are several actions or projects described or assumed in the State Implementation Plans that are federally enforceable control measures. Particular matter street maintenance actions are one of the control measures.

DRCOG must demonstrate that future year estimates of particular matter emissions will be less than or equal to the maintenance particular matter emissions budgets to show conformity with the particular matter State Implementation Plan. The mobile source particular matter budgets are 54 tons per day through 2021, and 55 tons per day for 2022 and beyond.

Air Quality Control Commission Regulation 16 is essential to the control of mobile source emissions. Adopted on August 15, 1991, the regulation has undergone several revisions, with the latest occurring on April 19, 2001. Re-entrained road dust in the Denver metropolitan area from winter street sanding causes between 40 and 60 percent of particular matter emissions. It is the single largest contributor to particular matter emissions.¹ Regulation 16 targets street sanding and sweeping practices.

Since October 1, 1991, street sanding material providers have been required to meet set standards for the sanding materials they provide to state, city, and county governments. The regulation applies to both new and recycled sanding materials. All materials must meet requirements regulating their angularity, percent fines, and degree of durability. The burden of material testing to meet these standards falls on the private companies supplying the materials. An independent laboratory must conduct all testing.

Reductions in the applied amount of sanding material are also set for all the local governments and street maintaining agencies (Colorado Department of Transportation, Regional Transportation District, E-470 Authority, Northwest Parkway Authority) within the nonattainment area. A reduction of 30 percent from their established baseline amount is mandated. Baseline amounts are typically based on 1989 practices. In the defined “foothills” area, a 20 percent reduction from the established baseline is mandated.

¹In June 1998, the Colorado Department of Transportation, with technical assistance of Midwest Research Institute, concluded a study of the role of sand in particular matter emissions. Findings from this study demonstrated that the percentage of the total particular matter emissions from road traffic that consist of road dust increases from about 50 percent to as much as 80 or 90 percent during the high impact 24-hour period following road sanding. Previously, the particular matter emissions analysis had been using a sand share of 33.8 percent or about half of the recent study findings. Increasing the role of sand in producing particular matter emission increases the benefits of reduced street sanding. Over the past few years, local governments, Colorado Department of Transportation, Regional Transportation District and the E-470 Public Highway Authority have made major strides to reduce particular matter emissions from street sand by reducing the amount of sand spread on the streets during snow storms by about 40 percent from 1989 street sanding levels and increasing the sweeping of sanded streets within four days of each snow storm from none to 40 percent.

In addition to the above requirements, there are specific requirements to the City and County of Denver and Colorado Department of Transportation:

- The City and County of Denver shall achieve a 72% reduction within the Denver central business district. The central business district is defined as the area bounded by and inclusive of Colfax Avenue, Speer Boulevard, Wynkoop Street, 20th Street, and Broadway.
- Colorado Department of Transportation shall achieve a 54% reduction from Interstate 25 and its entrance/exit ramps between 6th Avenue and University Boulevard.
- The City and County of Denver and Colorado Department of Transportation shall achieve a 50% reduction on roadways within the area bounded by, and including, Federal Boulevard, Downing Street, 38th Avenue, and Louisiana Avenue.

Records and reports of the reductions and practices used must be submitted yearly to the Air Pollution Control Division and the Regional Air Quality Council.

Finally, Regulation 16 sets rules for street sweeping to achieve reductions in particular matter emissions. These rules include time requirements for sweeping after deployments of street sanding materials, definition of the sweeping techniques to be used, and targeted areas for increased sweeping. Record keeping and reporting of dates, equipment use, and areas swept are required under these rules.

Preliminary estimates of emissions for the original 2035 Regional Transportation Plan in 2012 indicated that particular matter emissions would be higher than the 55 tons per day emissions budget after accounting for the impacts of Regulation 16. Because of this anticipated exceedance of the particular matter emissions budget, local governments and road agencies were asked to provide commitments to further reduce emissions as part of the Regional Transportation Plan update. These commitments are for additional reductions in sand application and an increase in street sweeping activities, above and beyond Regulation 16, to further reduce mobile source particular matter emissions. In 2020, 44 agencies submitted their commitments to DRCOG. The local governments and agencies have decided on the combination of the above actions to meet their commitments. The street sanding and sweeping commitments made by local governments and road agencies in 2020 are detailed in Appendix C.

Actions that can be employed to achieve particular matter reductions:

- Reducing the total amount of sanding materials used.
- Using anti-icers, deicers, and other sand substitutes in place of sanding materials.
- Street sweeping within four days of each snow event.

The particular matter maintenance plan also identifies a test whereby the region must demonstrate that transportation construction emissions do not exceed those assumed in the emissions budgets. The budgets were established on the assumption that all of the facilities in the 2020 Fiscally Constrained Regional Transportation Plan. To pass the test, the rate of lane-mile construction proposed in the 2050 Metro Vision Regional Transportation Plan must be less than or equal to the rate of construction in the 2020 Fiscally Constrained Regional Transportation Plan. The construction emissions of the 2050 Metro Vision Regional Transportation Plan are less than the construction emissions assumed in the budgets and the test is passed.

Other mobile source reduction measures

Two categories of strategies to reduce regional emissions are funded and assumed to continue through 2050, but are not specifically analyzed in the future year transportation and air quality modeling:

- Travel demand management (TDM) programs such as DRCOG's Regional Way to Go Program, transit pass subsidies, and other TDM actions will help to reduce the amount of single-occupant-vehicle driving by the growing population of the region. TDM efforts will also take advantage of the increased provision of pedestrian and bicycling facilities across the region.
- The DRCOG Regional Transportation Operations and Technology Program will implement projects that allow the transportation systems to operate much more efficiently. The projects cover four key areas:
 - Traffic signal system equipment
 - Traffic signal coordination and timing
 - Transportation incident management and communications
 - Intelligent transportation systems (ITS) technological improvements covering a range of communications (vehicle and infrastructure), monitoring, public information, and other projects

Emission test results

The results of emissions tests are reported in Table 1, repeated here. All tests are passed as the emissions test results for the Denver region are less than all of the budgets. The emissions estimates were generated by Air Pollution Control Division using transportation inputs and emissions models. The test results do not indicate any failures in the horizon years of the program or plan that would lead to a finding of non-conformity.

Table 1. Conformity emissions test results

Pollutant	Test	Result<budget (tons per day)	Pass/fail
Carbon Monoxide	2021 Staging ≤ budget ¹	405 < 1,600	Pass
	2030 Staging ≤ budget	263 < 1,600	Pass
	2040 Staging ≤ budget	198 < 1,600	Pass
	2050 RTP ≤ budget	187 < 1,600	Pass
Particular matter	2022 Staging ≤ budget ²	28 < 55	Pass
	2030 Staging ≤ budget	31 < 55	Pass
	2040 Staging ≤ budget	34 < 55	Pass
	2050 RTP ≤ budget	37 < 55	Pass
Nitrogen oxides associated with particular matter	2022 Staging ≤ budget ³	34 < 56	Pass
	2030 Staging ≤ budget	22 < 56	Pass
	2040 Staging ≤ budget	16 < 56	Pass
	2050 RTP ≤ budget	15 < 56	Pass

¹ 2021 derived from interpolation of 2020 and 2023 emission estimates.

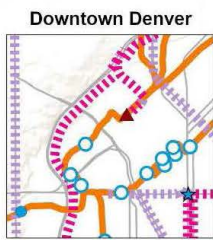
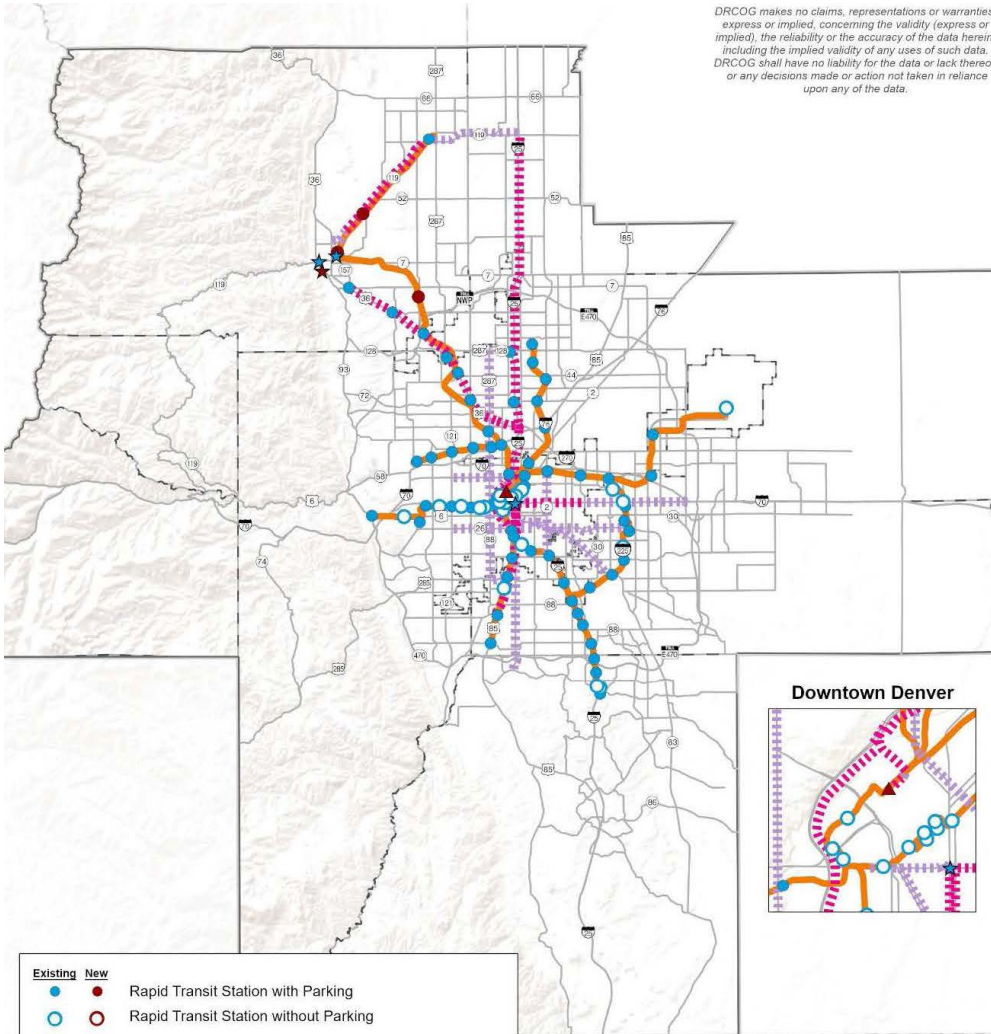
² 2022 derived from interpolation of 2020 and 2023 emission estimates.

³ 2022 derived from interpolation of 2020 and 2023 emission estimates.

Appendix A. DRCOG transportation network and project assumptions

2050 Fiscally constrained rapid transit system guideway facilities and stations

DRCOG makes no claims, representations or warranties, express or implied, concerning the validity (express or implied), the reliability or the accuracy of the data herein, including the implied validity of any uses of such data. DRCOG shall have no liability for the data or lack thereof, or any decisions made or action not taken in reliance upon any of the data.

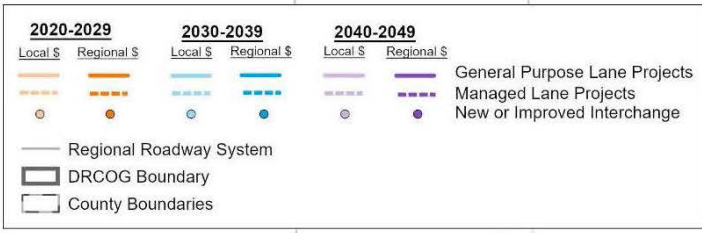
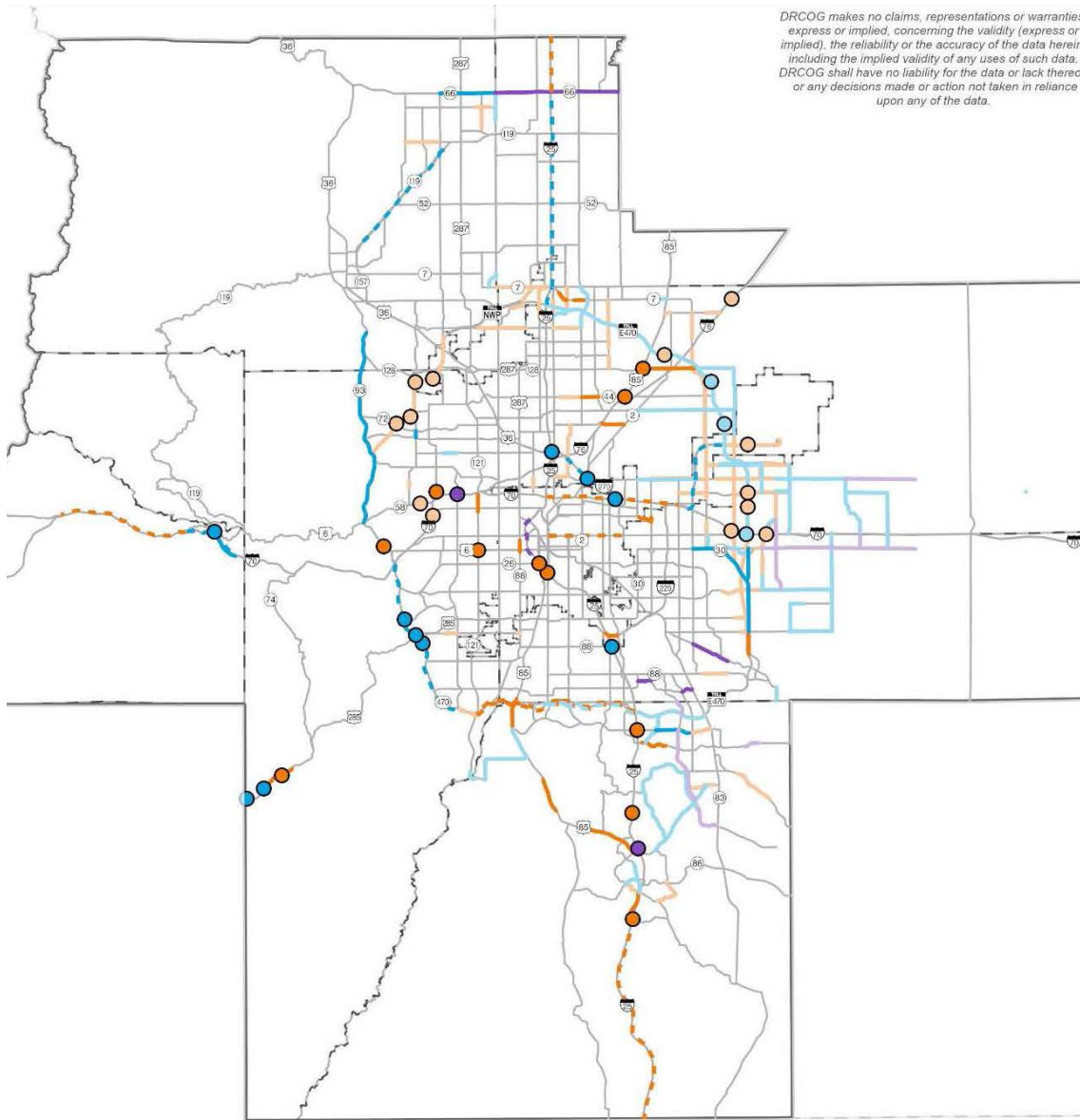


- | Existing | New | |
|----------|-----|---|
| ● | ● | Rapid Transit Station with Parking |
| ○ | ○ | Rapid Transit Station without Parking |
| | ▲ | Denver Union Station |
| ★ | ★ | Other Stations/Transit Centers |
| — | — | Rapid Transit Rail |
| — | — | Bus Rapid Transit or Busway (use dedicated or managed lane) |
| — | — | Bus Rapid Transit or Busway (use general purpose lane) |
| — | — | Regional Roadway System |
| — | — | DRCOG Boundary |
| — | — | County Boundaries |



SOURCE DATA: DRCOG, Basemap: Esri Basemap, SR 6428
 Creator: plordan, 1/7/2021
 Location: TPO/Air Quality General/00 - ArcPro for AQI

2050 Staging of fiscally constrained roadway capacity projects



SOURCE DATA: DRCOG,
 Basemap: Esri Basemap, SR 6428
 Creator: pjordan, 1/7/2021
 Location: TPO\Air Quality General\00 - ArcPro for AQ\

DRCOG transportation network and project assumptions

Project name/corridor	Location/limits	Project description	County	Project cost (2020)	Staging period	2022-2025 TIP	Funding source
2050 RTP: Regionally-funded projects and programs							
Colorado Department of Transportation administered multimodal capital projects							
US-85	104th Ave.	New Interchange	Adams	\$100,000,000	2023-2029		CDOT
US-85	120th Ave.	New Interchange	Adams	\$100,000,000	2023-2029	✓	CDOT
I-25 North	84th Ave. to 104th Ave.	Operational Improvements, Center-Loading Transit Station at 88th Ave., and GP Lane	Adams	\$230,000,000	2045-2050		CDOT
Vasquez Boulevard	60th Ave.	Intersection Improvements	Adams	\$80,000,000	2040-2044		CDOT
I-270	I-25/US-36 to I-70	New Managed Lanes	Adams	\$500,000,000	2030-2039	✓	CDOT
I-270	I-25/US-36 and I-70	New Freeway "direct connects" at each end of I-270	Adams	\$300,000,000	2030-2039		CDOT
I-25	Bellevue	Interchange Reconstruction and Pedestrian Connections	Arapahoe	\$112,000,000	2030-2039		CDOT
SH-83 (Parker Rd.)	SH-86 to East Mississippi Ave.	Corridor Planning/Investment for Multimodal Mobility, Operations, and Safety	Arapahoe/Douglas	\$150,000,000	2030-2039		CDOT DRCOG
SH-66	Lyons to Main St. (US-287)	Widen from 2 to 4 Lanes (Hover to St. Main St.) and Operational/Safety Improvements from Lyons to Longmont	Boulder	\$10,000,000	2030-2039	✓	CDOT
I-25 North	E-470 to SH-7	Managed Lanes, SH-7 interchange reconstruction, & SH-7 Mobility Hub	Broomfield	\$200,000,000	2030-2039	✓	CDOT
I-25 North (Segment 4)	SH-7 to SH-66	Managed Lanes, SH-119 Mobility Hub, ITS, Bicycle and Pedestrian Trail Connections	Broomfield/Weld	\$150,000,000	2030-2039		CDOT
I-70	Twin Tunnels to Empire Junction (US-40)	Add 1 WB Peak Period Managed Lane	Clear Creek	\$0	2020-2022		CDOT
I-70 Floyd Hill Eastbound Improvements	Floyd Hill to Veterans Memorial Tunnel	TBD	Clear Creek	\$250,000,000	2030-2039		CDOT
I-70 Floyd Hill Westbound Improvements	Floyd Hill to Veterans Memorial Tunnel	TBD	Clear Creek	\$450,000,000	2030-2039		CDOT
Eisenhower Johnson Memorial Tunnels Maintenance	Eisenhower Johnson Memorial Tunnels	Major rehabilitation of the Eisenhower-Johnson Memorial Tunnels	Clear Creek	\$142,000,000	2020-2050		CDOT
I-25	Santa Fe Dr. (US-85) to Alameda Ave.	Interchange Capacity	Denver	\$30,000,000	2023-2029		CDOT

Project name/corridor	Location/limits	Project description	County	Project cost (2020)	Staging period	In 2022-2025 TIP	Funding source
Central I-25 Buildout	Colfax Ave. to 20th St.	Ultimate Buildout of Corridor Improvements	Denver	\$420,000,000	2040-2044	✓	CDOT
I-25 Valley Highway/Burnham Yard	Santa Fe Blvd. to Colfax Ave.	Managed Lanes, Includes ROW, Burnham Yard, Central Main Line Relocation	Denver	\$900,000	2045-2050	✓	CDOT
Federal Boulevard	6th Ave. to Howard Pl.	Widen from 5 to 6 Lanes	Denver	\$0	2020-2022		CDOT
I-70	I-25 to Chambers Rd.	Add 2 New Managed Lanes	Denver/Adams	\$0	2020-2022	✓	CDOT / DRCOG
I-25	El Paso County Line to North of Crystal Valley Parkway	Add 1 Toll/Managed Lane each Direction	Douglas	\$0	2020-2022	✓	CDOT
US-85	Louviers to MP 191.75	Widen from 2 to 4 Lanes	Douglas	\$0	2020-2022	✓	CDOT
US-85	Sedalia to Daniels Park	Widen from 2 to 4 Lanes	Douglas	\$35,000,000	2023-2029	✓	CDOT
US-85	Daniels Park to Meadows	Widen from 2 to 4 Lanes	Douglas	\$32,000,000	2023-2029	✓	CDOT
US-6	Wadsworth Blvd.	Interchange Capacity	Jefferson	\$80,000,000	2023-2029	✓	CDOT
US-285	Pine Valley Rd. (CR 126)/Mt Evans Blvd.	New Interchange	Jefferson	\$40,000,000	2030-2039		CDOT
US-285	Kings Valley Dr.	New Interchange	Jefferson	\$15,000,000	2023-2029		CDOT
US-285	Kings Valley Dr. to Richmond Hill Rd.	Widen from 3 to 4 Lanes (Add 1 SB Lane)	Jefferson	\$25,000,000	2023-2029		CDOT
US-285	Shaffers Crossing to Kings Valley Dr.	Widen from 3 to 4 Lanes (Add 1 SB Lane)	Jefferson	\$60,000,000	2023-2029		CDOT
US-285	Parker Ave.	New Interchange	Jefferson	\$25,000,000	2030-2039		CDOT
I-70 Kipling Interchange Reconstruction	Kipling	Interchange Reconstruction and Pedestrian Connections	Jefferson	\$80,000,000	2045-2050		CDOT
C-470	US-285/Morrison/Quincy	Interchange Complex Reconstruction	Jefferson	\$150,000,000	2030-2039		CDOT
C-470	Wadsworth to I-70	New Managed Lanes	Jefferson	\$410,000,000	2030-2039		CDOT
I-25 North (Segment 5)	SH-66 to WCR 38 (DRCOG Boundary)	Add 1 Toll/Managed Lane each Direction	Weld	\$175,000,000	2023-2029		CDOT
CDOT Projects Total				\$4,351,900,000			
Denver Regional Council of Governments (DRCOG) Administered Multimodal Capital Projects							
TIP Set-Asides	Varies	Investment in Transportation Demand Management, Air Quality, Operations and Technology, and Human Services Transportation	DRCOG Region	\$372,862,551	2020-2050	✓	DRCOG

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
88th Ave.	I-76 NB Ramps to SH-2	Widen from 2 to 4 Lanes	Adams	\$21,500,000	2020-2022	✓	DRCOG
104th Ave.	Colorado Blvd. to McKay Rd.	Widen from 2 to 4 Lanes	Adams	\$8,100,000	2020-2022	✓	DRCOG
SH-7	164th Ave. to Dahlia St.	Widen from 2 to 4 Lanes	Adams	\$24,000,000	2020-2022	✓	DRCOG
120th Avenue	US-85 to E-470	Widen to 4 Lanes	Adams	\$24,000,000	2023-2029		DRCOG
I-25 North Improvements	104th Ave. to 120th Avenue	Shoulders; General Purpose Lanes; Bridge	Adams	\$70,000,000	2045-2050		DRCOG
I-225/Yosemite	DTC Blvd. to I-25 on ramp	Interchange and Ramp Reconstruction	Arapahoe	\$60,000,000	2023-2029		DRCOG
Smoky Hill Road	Buckley Road to Picadilly St	Widen from 4 to 6 Lanes	Arapahoe	\$10,000,000	2040-2044		DRCOG
Gun Club Rd.	State Highway 30 to 6th Ave	Widen from 2 to 4/6 Lanes, Includes Stream Crossing Upgrade at Coal Creek	Arapahoe	\$32,000,000	2030-2039		DRCOG
Gun Club Rd.	Quincy to Aurora Pkwy.	Widen from 2 to 6 Lanes	Arapahoe	\$15,000,000	2023-2029		DRCOG
Broncos Parkway/Easter/Dry Creek Corridor Improvements	Parker Road to Havana	Widening to 6 Lanes, Bridge Widening, and Intersection Improvements	Arapahoe	\$35,000,000	2040-2044		DRCOG
SH-30	Airport Blvd. to Quincy Ave.	Widen from 2 to 6 Lanes	Arapahoe	\$175,000,000	2030-2039		DRCOG, CDOT, Local
US-85 (Santa Fe) Improvements	C-470 to Bowles	Corridor Planning/Investment for Multimodal Mobility, Operations, and Safety	Arapahoe	\$150,000,000	2040-2044	✓	DRCOG, CDOT
SH 66	US-287/Main Street to East County Line Road	Capacity, Operations, and Bicycle/Pedestrian	Boulder	\$15,000,000	2030-2039		DRCOG
US 287/120th Ave.	Midway Blvd. to Lowell Blvd.	Improve circulation, safety, active transportation access, business access, congestion and transit operations	Broomfield	\$15,000,000	2023-2029	✓	DRCOG
I-25	Broadway	Interchange Capacity	Denver	\$50,000,000	2020-2022	✓	DRCOG
Martin Luther King Jr. Blvd.	Havana St./Iola St. to Peoria St.	Widen 2 to 4 Lanes; New 4 Lane Road	Denver	\$0	2020-2022	✓	DRCOG
Pena Boulevard	I-70 to 64th Avenue	Add one managed lane in each direction	Denver	\$139,000,000	2030-2039		DRCOG, Local
Pena Boulevard	64th Avenue to E-470	Add one managed lane in each direction	Denver	\$124,000,000	2030-2039		DRCOG, Local
County Line Rd.	Phillips St. to University Blvd.	Widen from 2 to 4 Lanes	Douglas	\$9,500,000	2020-2022	✓	DRCOG
I-25	Lincoln Ave.	Interchange Capacity	Douglas	\$49,400,000	2020-2022	✓	DRCOG

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
Ridgegate Pkwy.	Havana St. to Lone Tree E. City Limit	Widen from 2 to 4 Lanes	Douglas	\$0	2020-2022	✓	DRCOG
US-85	Highlands Ranch Pkwy. to n/o County Line Rd.	Widen from 4 to 6 Lanes	Douglas	\$0	2020-2022	✓	DRCOG
I-25	Crystal Valley Pkwy.	New Interchange & South Frontage Road	Douglas	\$80,000,000	2023-2029	✓	DRCOG, Local
I-25	Happy Canyon Rd.	Interchange Reconstruction	Douglas	\$30,000,000	2023-2029		DRCOG, Local
Lincoln Ave.	Oswego to Keystone	Widen 4 to 6 lanes	Douglas	\$24,000,000	2030-2039		DRCOG, Local
I-25	Meadows/Founders	Interchange Reconstruction	Douglas	\$50,000,000	2045-2050		DRCOG, Local
Wadsworth Blvd.	35th Ave. to 48th Ave.	Widen from 4 to 6 Lanes	Jefferson	\$31,000,000	2020-2022	✓	DRCOG
SH-93	SH-58 to SH-170	Widen to 4 Lanes and Safety/Transit Improvements	Jefferson	\$200,000,000	2030-2039		DRCOG
US-6	Heritage Rd.	New Interchange	Jefferson	\$30,000,000	2023-2029	✓	DRCOG
Indiana (SH-72)	W. 80th Ave. to W. 86th Pkwy.	Widen to 4 Lanes	Jefferson	\$39,000,000	2030-2039		DRCOG
Kipling St.	Kentucky Ave. to I-70	Multimodal Corridor Improvements	Jefferson	\$250,000,000	2040-2044		DRCOG
Wadsworth Blvd.	17th Ave. to 35th Ave.	Multimodal Corridor Improvements	Jefferson	\$60,000,000	2040-2044		DRCOG
SH-66	WCR 1 - WCR 19	Widen 2 to 4 Lanes, Pedestrian Improvements	Weld	\$35,000,000	2045-2050		DRCOG
SH-52	WCR 1 - WCR 13	Widen 2 to 4 Lanes, Safety, Operational, and Multimodal Improvements	Weld	\$20,000,000	2045-2050		DRCOG
DRCOG Projects Total				\$2,248,362,551			
Regional Transportation District (RTD) Administered Multimodal Capital Projects							
Northwest Rail	Westminster Station to Downtown Longmont	Implement Peak Period Service Plan	Adams/Boulder/Broomfield/Jefferson	\$700,000,000	2045-2050		RTD
RTD Projects Total				\$700,000,000			
Regional Bus Rapid Transit (BRT) Projects							
Colfax Ave. BRT	Lincoln St. to I-225	BRT Service and Supporting Safety/Multimodal Improvements	Adams/Arapahoe/Denver	\$250,000,000	2023-2029		CDOT, DRCOG, 53019-CIG, Local
Colfax Ave. Extension BRT	I-225 to E-470	BRT Service and Supporting Safety/Multimodal Improvements	Adams/Arapahoe	\$100,000,000	2040-2044		DRCOG, CDOT, Local
SH-119 BRT	Downtown Boulder to I-25/SH-119 Mobility Hub	BRT Service and Supporting Safety/Multimodal Improvements	Boulder/Weld	\$350,000,000	2030-2039		CDOT, DRCOG, RTD, Local
Colorado Blvd. BRT	University of Colorado A Line to I-25	BRT Service and Supporting Safety/Multimodal Improvements	Denver	\$35,000,000	2023-2029		DRCOG, CDOT, 5309-CIG, Local

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
Alameda BRT	Wadsworth to R-Line	BRT Service and Supporting Safety/Multimodal Improvements	Arapahoe/Denver/Jefferson	\$61,000,000	2030-2039		DRCOG, CDOT, 5309-CIG, Local
Broadway/Lincoln BRT	Colfax to Highlands Ranch Pkwy	BRT Service and Supporting Safety/Multimodal Improvements	Arapahoe/Denver/Douglas	\$61,000,000	2040-2044		DRCOG, 5309-CIG, Local
38th/Park BRT	Wadsworth to Colfax	BRT Service and Supporting Safety/Multimodal Improvements	Denver/Jefferson	\$40,000,000	2045-2050		DRCOG
Speer/Leetsdale/Parker BRT	Colfax to I-225	BRT Service and Supporting Safety/Multimodal Improvements	Arapahoe/Denver	\$95,000,000	2030-2039		DRCOG, CDOT
Federal Blvd. BRT	120th to Santa Fe/Dartmouth	BRT Service and Supporting Safety/Multimodal Improvements	Adams/Denver	\$94,000,000	2030-2039		DRCOG, CDOT, 5309-CIG, Local
North I-25 BRT	Union Station to SH-119	BRT Service and Supporting Safety/Multimodal Improvements	Adams/Broomfield/Denver/Weld	\$97,000,000	2045-2050		DRCOG, CDOT, 5309-CIG, Local
New Bus Maintenance Facility	TBD-northern area of RTD District	Construction of a new bus maintenance facility in the RTD's northern area	TBD	\$50,000,000	2023-2029		DRCOG
Regional BRT Total				\$1,233,000,000			
Corridor Transit Planning Projects and Programs							
Regional Mobility Hubs	Varies	Construction of Multimodal Mobility Hubs	DRCOG Region	\$200,137,636	2020-2050		CDOT, DRCOG, RTD
South Boulder Rd.	Lafayette to Boulder	Multimodal Corridor Improvements	Boulder	\$75,000,000	2040-2044		DRCOG
SH-7	Boulder to Brighton	Multimodal Corridor Improvements	Adams/Boulder/Broomfield	\$100,000,000	2030-2039	✓	CDOT
US-287	US-36 to Larimer County Line	Safety, Operational, and Multimodal Improvements	Boulder/Broomfield	\$200,000,000	2030-2039		CDOT, DRCOG
West Colfax	Sheridan to Broadway/Lincoln	Transit Corridor and Supporting Safety/Multimodal Improvements	Denver	\$26,573,077	2045-2050		DRCOG
RidgeGate Parkway Transit Mobility Corridor	Mainstreet in Parker to Lone Tree City Center RTD station	Transit Corridor	Douglas	\$100,000,000	2045-2050		DRCOG
Castle Pines Transit Mobility Corridor	Castle Pines to RidgeGate RTD station	Transit Corridor	Douglas	\$20,000,000	2030-2039		DRCOG
Golden/Mines Autonomous Circulator	Downtown Golden, School of Mines, RTD W Line	Autonomous Circulator	Jefferson	\$3,500,000	2023-2029		DRCOG
Transit Corridor Planning Total				\$725,210,713			

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
Arterial Safety/Regional Vision Zero Projects and Programs							
Arterial Safety/Regional Vision Zero Set-Aside	High Injury Network and Critical Corridors identified in the Taking Action on Regional Vision Zero	Vision Zero and Safety Improvements	DRCOG Region	\$151,672,902	2020-2050	✓	DRCOG
Federal Boulevard Multimodal Improvements	52nd Avenue to 120th Avenue	Bicycle/Pedestrian/Transit Improvements; Turn Lanes; Bus/Business Access Lanes	Adams	\$50,000,000	2023-2029		DRCOG
US-285 Congestion Mitigation Improvements	Knox Ctt/Lowell Blvd. (west) to Havana (east)	Speed and Reliability Corridor & Vision Zero Improvements	Arapahoe/Denver	\$88,200,000	2023-2029	✓	DRCOG
US-36	Boulder to Lyons	Corridor Safety Improvements	Boulder	\$20,000,000	2020-2022		DRCOG
US-36/28th St. & SH-93/Broadway	US-36/28th St. & SH-93/Broadway	Corridor Safety Improvements	Boulder	\$15,200,000	2030-2039		CDOT
SH-42	Louisville and Lafayette	Safety and Operational Improvements	Boulder	\$50,000,000	2030-2039	✓	CDOT, DRCOG
West Mississippi Avenue	South Federal Blvd. to S. Broadway	Vision Zero and Pedestrian Improvements	Denver	\$18,600,000	2020-2022	✓	DRCOG
Brighton Boulevard	Race to York	Reconstruction, Vision Zero, Safety, and Freight Improvements	Denver	\$19,762,500	2045-2050		DRCOG
Chambers Rd	E 56th Ave to E 40th Ave	Vision Zero Corridor Improvements	Denver	\$16,712,500	2023-2029		DRCOG
Sheridan Safety Improvements	52nd to Hampden	Vision Zero Corridor Improvements	Denver/Jefferson	\$17,100,000	2023-2029		DRCOG
Colfax Safety Improvements	Wadsworth to Sheridan	Multimodal Arterial Safety	Jefferson	\$12,000,000	2020-2022	✓	DRCOG
US-85 Operational & Safety Improvements	Weld CR 2 to Weld CR 10	Safety and Operational Improvements	Weld	\$6,100,000	2023-2029		CDOT
			Arterial Safety/Regional Vision Zero Total	\$465,347,902			
Active Transportation Projects and Programs							
Active Transportation Set-Aside	Short-Trip Opportunity Zones identified in the Active Transportation Plan	Bicycle and Pedestrian Improvements	DRCOG Region	\$31,598,521	2020-2050		DRCOG
Smith Road Bicycle/Pedestrian Facilities	Peoria Street to Powhatan Road	New Multi-Use Path	Adams	\$4,000,000	2020-2022		DRCOG
RTD Rail Trail	Boulder to Erie	Regional Trail	Boulder	\$6,000,000	2020-2022		DRCOG
St. Vrain Greenway	Longmont to Lyons	Regional Trail	Boulder	\$4,000,000	2020-2022	✓	DRCOG
McCaslin Regional Trail	Rock Creeky Pkwy. to SH-128	Regional Trail	Boulder	\$3,000,000	2020-2022	✓	DRCOG

Project Name/Corridor	Location/Limits	Project Description	County	Project Cost (2020)	Staging Period	In 2022-2025 TIP	Funding Source
Clear Creek Greenway	Jefferson County Line to Loveland Ski Area	Clear Creek Greenway portion of Peaks to Plains trail system	Clear Creek	\$50,000,000	2045-2050		DRCOG
S. Platte River Trail	(not specified)	Complete Missing Links and Upgrade Trail Section	Denver	\$50,000,000	2030-2039		DRCOG
Bear Creek Trail	(not specified)	Upgrade Trail for Safe Crossings and Consistent Cross Section. Integrate ITS/AI Equipment.	Denver	\$31,200,000	2045-2050		DRCOG
Active Transportation Total				\$179,798,521			
Freight Projects and Programs							
Freight Set-Aside	Varies	Freight improvements including but not limited to bridge reconstructions, overpasses/underpasses, new bridges	DRCOG Region	\$75,836,451	2020-2050		DRCOG
Peoria Street Bridge	Sand Creek	Bridge Reconstruction	Adams	\$19,000,000	2020-2022		DRCOG
Alameda Pkwy. Bridge over I-225	Between Potomac Street and Abilene Street	Bridge reconstruction	Arapahoe	\$20,000,000	2020-2022		DRCOG
47th Avenue/48th Avenue	I-25 to Pecos	Bridge Reconstruction, New Multimodal Underpass, and New Bicycle/Pedestrian Bridge.	Denver	\$45,225,000	2040-2044		DRCOG
Ward Rd./BNSF	I-70 FR North and Ridge Rd.	Multimodal Grade Separation	Jefferson	\$60,000,000	2023-2029	✓	DRCOG
Freight Total				\$220,061,451			
Grand Total				\$10,123,681,138			
<i>Note: Projects with \$0 cost have funds fully obligated prior to fiscal year 2020.</i>							

Appendix B. Summary of transportation model calibration and validation for the 2050 RTP, Jan. 7, 2021

Introduction

In support of the conformity determination for the 2050 Metro Vision Regional Transportation Plan, the Denver Regional Council of Governments' maintains the Regional UrbanSim Socio-economic Model and the Focus regional travel modeling system.

The Focus travel demand model simulates the millions of trips made throughout the region on a typical weekday. The Focus model sums all travel to forecast how many vehicles will be driven on major roads; travel speed and delay; and how many people will walk, ride a bicycle or use transit to get to where they want to go. To realistically simulate each person's daily household travel, Focus models the many choices each person makes, thought the activity based model components including:

- 1) where to work
- 2) where to go to school
- 3) how many automobiles are owned by the person's household
- 4) how many trips each person makes in a day, and for what purposes
- 5) which trips are chained together into home-to-home tours
- 6) the location where each individual trip begins and ends
- 7) the travel mode used for each trip
- 8) which roadways or bus routes were chosen to reach each destination

In addition to the ABM components for household travel, Focus also incorporates three add-on gravity models for:

- Commercial vehicle trips – by light, medium, and heavy duty vehicles
- External station trips – starting or ending outside the DRCOG modeling area
- Denver International Airport trips – for trips not captured by the ABM components

An UrbanSim model is used to forecast household and employment levels by small-area transportation analysis zones over time. The Focus model takes into account many characteristics of people, such as their age, gender, employment status, and income; and how the region will change demographically over time. It also takes into account characteristics of the built environment such as transit stops and stations, household and employment density, bicycling facilities and walkability.

The Focus travel model creates an origin and destination for each trip. Specific groupings of "O&Ds" were initially estimated based on detailed data from a 1998 survey called the Travel Behavior Inventory.

Small area development estimates

In 2016, *Focus* was recalibrated using more recent data sources including roadway counts, transit boardings, American Community Survey Census data, and results from the following surveys:

- Regional Transportation District's 2008 Regional On-Board Transit Survey – a questionnaire handed out to light rail and bus travelers to understand how transit travel patterns have changed since the opening of the Southeast Corridor Light Rail in November 2006. The survey contains information on almost 24,000 transit trips.
- The 2010 Front Range Travel Counts Household Survey – A survey of over 12,000 households along the Colorado Front Range, including 7,000 in the DRCOG region, using a format similar to the 1997 Travel Behavior Inventory described above.

In 2020, further refinements were made to the *Focus* model based on additional results of the 2010 Front Range Travel Counts Survey, the 2016 Commercial Vehicle Survey and Regional Transportation District's updated 2018 Regional On-Board Survey.

The final trip assignment outputs of *Focus* were validated against traffic counts, operating travel speed observations, and Regional Transportation District ridership data to make sure the overall regional travel patterns being forecasted were reasonable.

Regional socioeconomic forecasts

DRCOG uses county-level forecasts of population, households and employment produced by the Colorado State Demography Office as the basis for future growth in the *Focus* model.

To provide household and employment data at a level of detail necessary for the travel model, the regional urban activity forecasts are disaggregated into 2,800 transportation analysis zones, as shown in Figure 1. The allocation to transportation analysis zones is carried out within the UrbanSim model based on the dynamics of urban land markets and the simulated decisions of land developers, and residential and commercial land customers. The UrbanSim model considers questions such as:

- What parcels of land are profitable for development, and for what uses?
- Where should a firm locate to conduct its business in accordance with zoning regulations, and with suitable access to workers, supplies, and finished product markets?
- Does a family's current residence continue to meet its needs and be convenient to jobs, schools, and other activities, or should the family move to a "better" location?
- What size and types of residence does a family need based on the number and ages of its members and its household income?
- Where are designated open spaces, parks, and other undevelopable lands located?

The UrbanSim model outputs are used in a population synthesizer that creates a descriptive database record for each household in the region (about 1.3 million records for 2020) and each person (about 3.3 million records in 2020). Figure 2 shows a flowchart for the process of socioeconomic forecasting in the Denver region.

Figure 1. DRCOG transportation analysis zones

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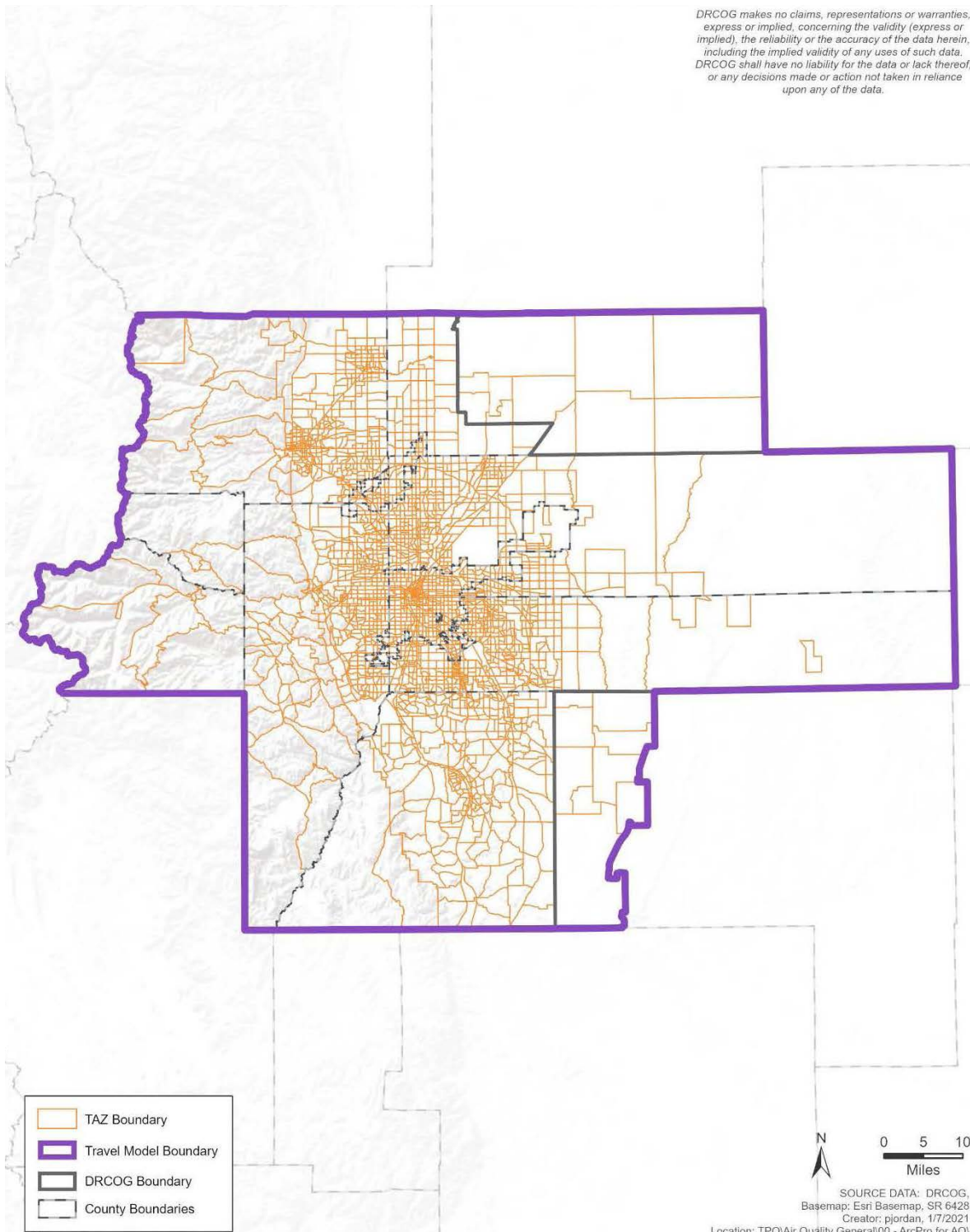
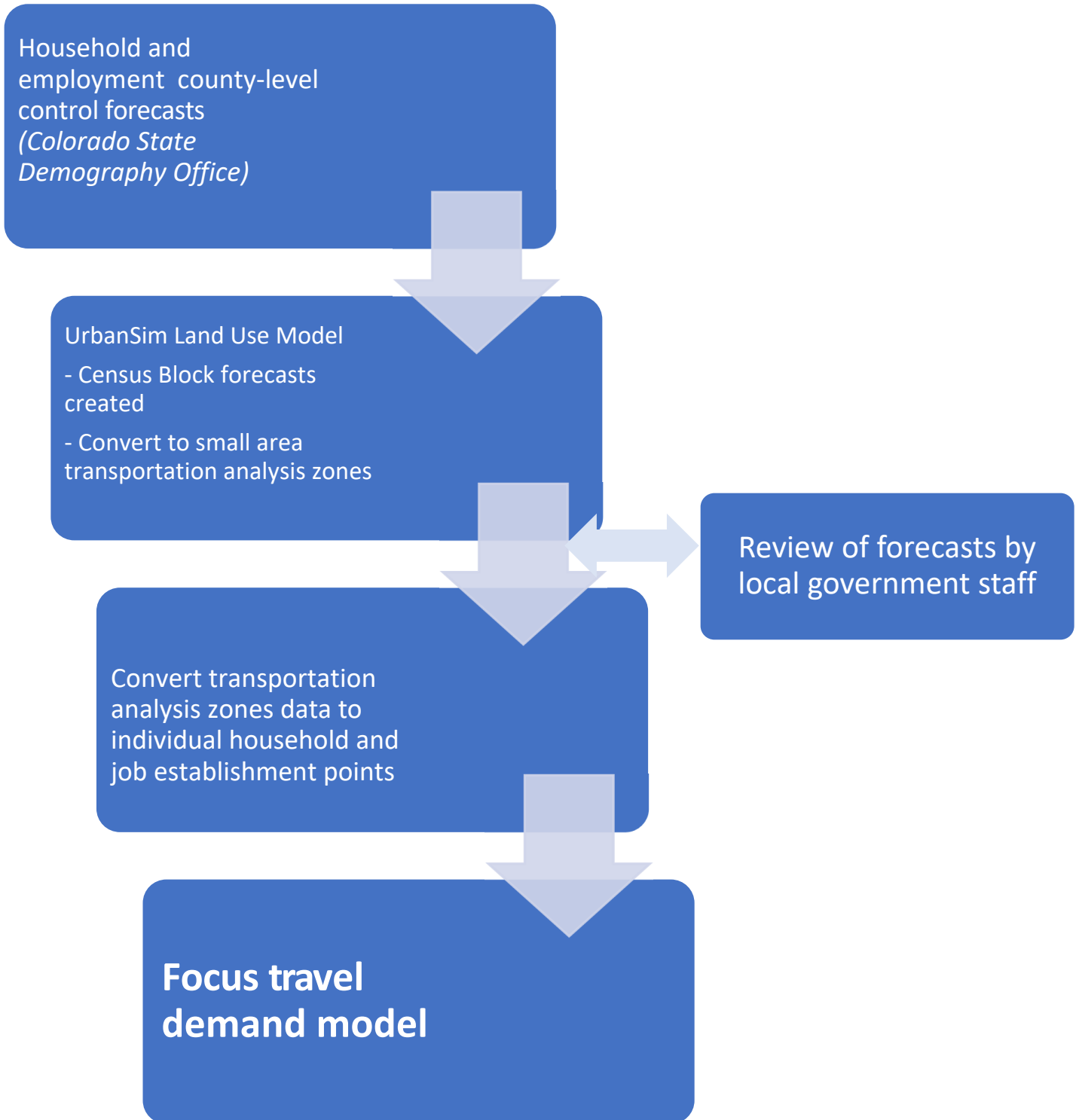


Figure 2. Socioeconomic model elements and flow



Focus model process overview

Figure 3 shows a simplified diagram of how the Focus model components flow after the socioeconomic forecast has been completed.

First, travel time and cost information between zones are calculated by travel mode and time of day. Tours are the first travel elements to be created. Figure 4 shows a diagram depicting an example set of tours for a person in one day, including intermediate stops.

The model runs through a set of steps for each tour, including activity generation, location choice, mode choice, and time of day choice model components. Then the model runs through a parallel set of model components for each trip within a tour.

Figure 3. Focus activity based model elements

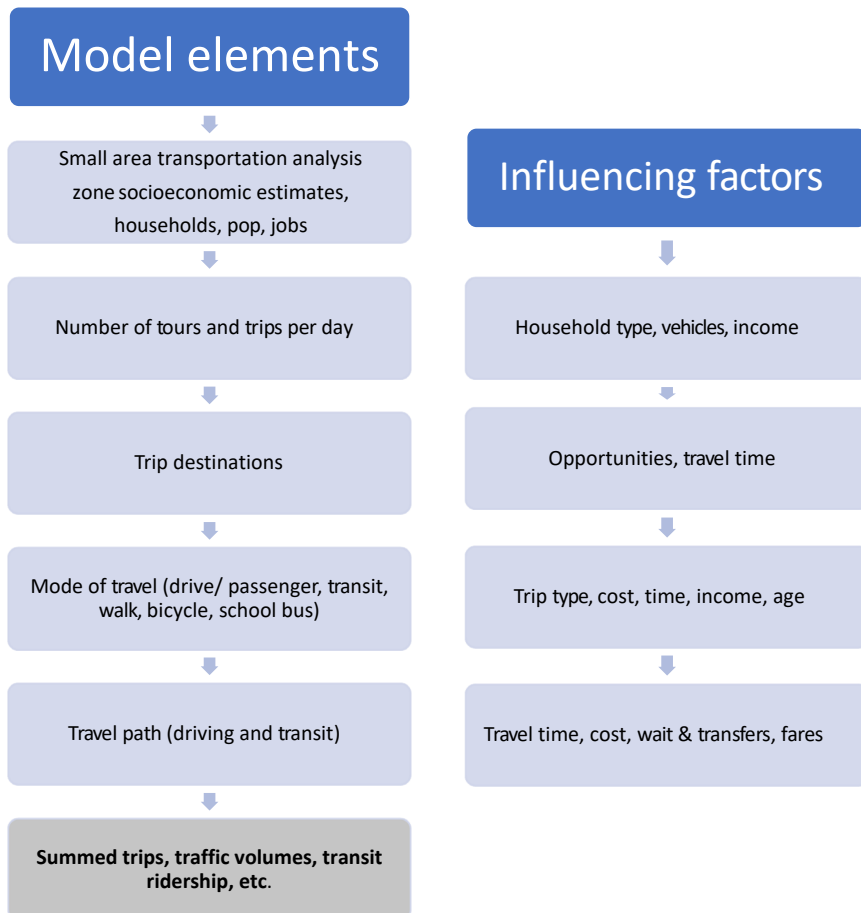
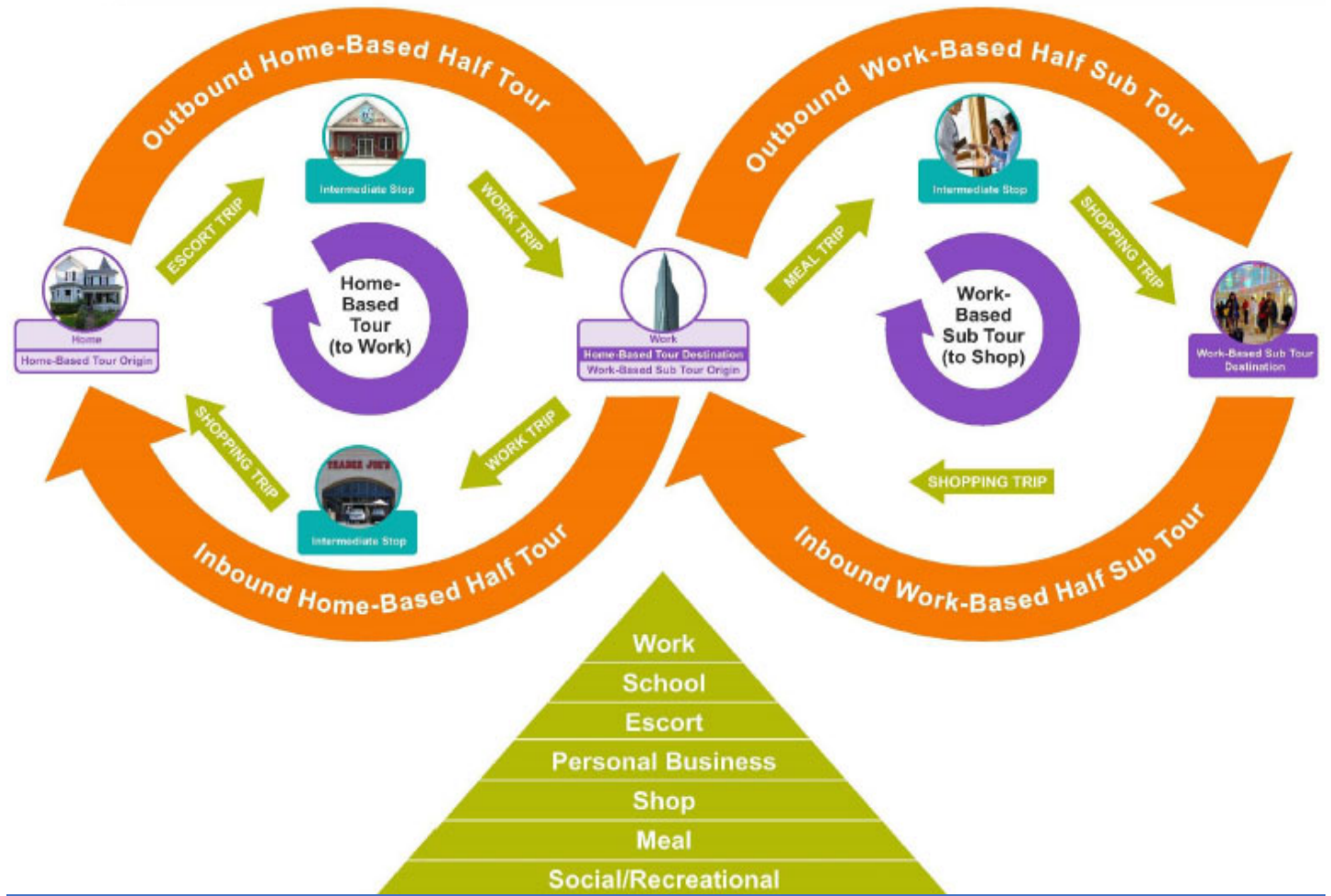


Figure 4. Sample tour diagram



Roadway and transit system

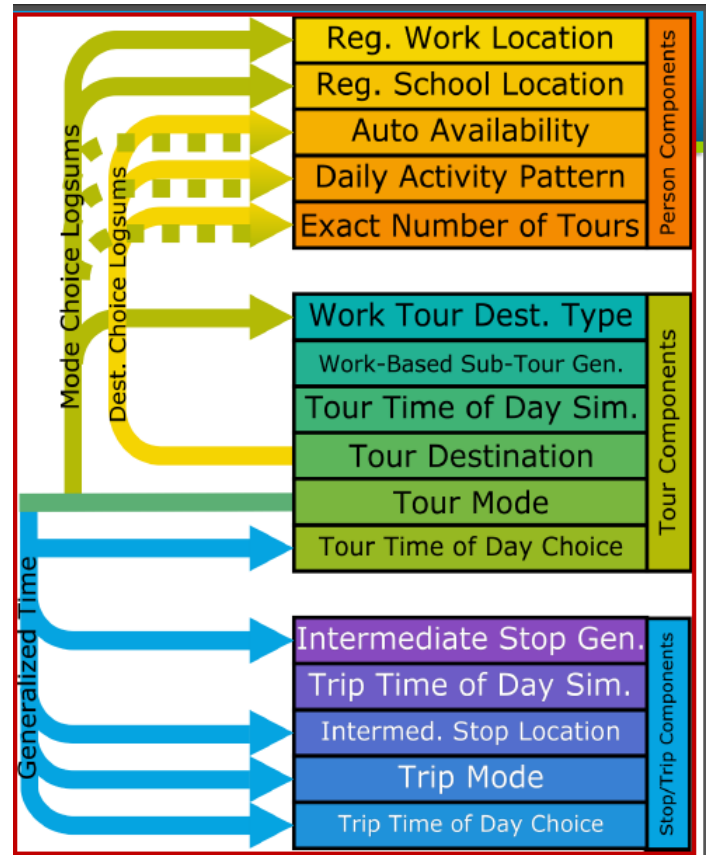
ne of the most critical components is the transportation network representation. The roadway network is represented by over 25,000 directional road segments, described by location, length, number of lanes, functional classification, and area type. High-occupancy vehicle and managed lanes also are represented as special links. Tollway links are assessed an additional cost impedance to reflect toll charges. The model also includes a fully detailed representation of transit facilities, including all bus and rapid transit lines, Park-n-Ride lots, bus stops, stations, and walk access/egress routes. Bus routes follow the same roadway network as auto trips, and bus travel speeds are based on auto speeds. Overall transit travel time also includes access, wait, and transfer time. Rail speeds are developed based on transit schedule information. Capture areas for Park-n-Ride lots are quite broad, permitting trip-makers in the model to select the lot that produces the most convenient overall transit path to their destination. As part of the process of estimating roadway and transit use, minimum impedance paths are calculated using time, distance and toll cost over the roadway and high-occupancy vehicles system, and time and cost over the transit system.

Model components

The most important model components are briefly described in the sections below, and Table 1 lists all model components. Most model components are multinomial logit or nested logit models, which are statistical models that have two or more discrete choice outcomes.

**Table 1. Key focus model components
(activity based model components in red)**

1. TransCAD Initialization
2. Size Sum Variable Calculator
3. TransCAD Trip Generation
4. TransCAD Skimming (Path Selection)
5. TransCAD Airport, Commercial Vehicle, and External Travel Distribution and Mode Choice
6. Regular Workplace Location
7. Regular School Location
8. Auto Availability
9. Aggregate Destination Choice Logsum Generation
10. Daily Activity Pattern
11. Exact Number of Tours
12. Work Tour Destination Type
13. Work-Based Subtour Generation
14. Tour Time of Day Simulation
15. Tour Primary Destination Choice
16. Tour Priority Assignment
17. Tour Main Mode Choice
18. Tour Time of Day Choice
19. Intermediate Stop Generation Choice
20. Trip Time of Day Simulation
21. Intermediate Stop Location Choice
22. Trip Mode Choice
23. Trip Time of Day
24. Write Trips To TransCAD
25. TransCAD Highway and Transit Assignment



Roadway and transit skims (path selection)

Representative roadway and transit paths are initially used for all origin-destination zone pairs (2,800 x 2,800) and each of the ten time-of-day periods. The paths consider travel time, travel cost, and other factors. The time and cost transportation analysis zone-to-transportation analysis zone matrices are used extensively in later model components such as location choice, mode choice, and time of day choice.

Denver International Airport/commercial vehicle/internal-external/external-external trips

After optimal paths are identified via the skims, all Compass model components must be run to generate and assign airport trips, internal-external trips, commercial vehicle trips, and external-external trips.

Regular workplace and school location

The work location choice model takes all regional workers and assigns them a regular work location transportation analysis zone and point. Characteristics of the worker and their home transportation analysis zone are used in combination with transportation analysis zone characteristics to determine the desirability of any transportation analysis zone.

The regular school location choice model assigns each student a regular school location transportation analysis zone and school. The model uses information about the student, such as income and age, and information on school enrollment and distance from home to determine which schools will be attractive for students. There are four school location choice models by student grade level: pre-school, kindergarden-8th grade, 9th-12th grade, and university. Four separate models are used to reflect that the decision-making of school location for different grade ranges has significantly different characteristics. The models are all multinomial logit with the choice being the location of the school zone.

Auto availability choice

The auto availability choice model is a multinomial logit model that selects number of automobiles available for each household in the region. The choices range from no cars to 4+ cars. The model uses information about households such as income and their accessibility to work and school to determine how many autos are available to households.

Tour models

After *Focus* has projected the long-term decisions about work and school location and auto availability, it forecasts daily activities on a tour-level.

The **day activity pattern** model determines which combinations of up to seven purposes (work, school, escort a family member, personal business, shopping, dining, and social or recreational) a person will make tours or stops along a tour.

The **exact number of tours** model determines how many tours of each type each person will make in his or her day. The tour types predicted for each person include: work, school, escort, personal business, shop, meal, and social recreation.

The **work tour destination type** model determines whether a person making a work tour will travel to his or her usual work location, or somewhere else, perhaps to meet with clients or customers, or for off-site training. If the regular workplace is selected, this information is entered into the tours table in the database.

Work-based subtour generation determines whether someone will leave their regular workplace and return during the middle of the day. Such a person may be eating out, running errands, or attending meetings, for example. After this point, the *Focus* model treats work-based subtours similarly to home-based ones.

In reality, a person might consider the interactions of destination, mode, and departure time choices together in creating an itinerary for the day's travel and activities. Despite its complexity, the *Focus* model needs to have some simplifying assumptions to make its mathematical relationships and software workable.

Tour time of day simulation is one such simplification, allowing destination and mode choices to be modeled as if the time of travel is known (so the right time and cost matrices can be used) as an initial guess. The simulated times of days are based on observed survey distributions. The later **tour time of day choice** confirms whether the initially simulated time of day was reasonable, or whether a shift earlier or later might be justified.

The **tour primary destination choice** model selects the destination of tour based the development (e.g., jobs and households) located within the zone. It then assigns a point within each zone as the final destination.

After the tour destination is known, the **tour main mode choice** model predicts the main travel mode used on the tour. The mode chosen is based on the impedances associated with each mode from the tour origin to the tour destination, zonal characteristics such as density, travel mode facilities, and demographic person characteristics. The tour main mode is used for most of the distance of the tour, but not necessarily for all trips. For example, if a parent is driving a child to school, the return trip would necessarily be driving alone. In other cases, stops along a tour might be close enough that walking or bicycling would be more attractive than a motorized tour mode. The tour and trip modes are related by rules of precedence used to simplify the *Focus* model.

Given the known tour origin, destination and mode from previous models, the **tour arrival and departure time** model predicts the time arriving at the primary destination of the tour and the time leaving the primary destination, both to within one hour periods.

Trip models

After the tour-level models are run, a series of trip-level models are run. The first trip level model is the **intermediate stop generation** model, which determines the number of intermediate stops on each tour (if any).

As with the tour models, there is a **trip time of day simulation** component to simplify the location and mode choices that are modeled next.

The **intermediate stop location choice** model selects the zone for each intermediate stop. The locations of all intermediate stops on tours are modeled one at a time, first for stops from home to the primary activity and then for stops from the primary activity to home.

The **trip mode choice** model determines the mode of travel for all trips. The tour mode is used in combination with skim data, zonal data, and person data to determine the modes for each trip on these tours.

Given the origin, destination and mode of each trip, the **trip time of day choice** model predicts the time each intermediate stop will occur. The trip time of day choice model has 24 alternatives corresponding to each hour period.

After the trip models have been run, the following information is known for every trip internal to the region:

- Origin and Destination Zone and Point Location
- Trip Purpose (work, school, escort, personal business, shop, social recreation)
- Trip Mode (drive alone, shared ride 2, shared ride 3+, walk to transit, drive to transit, walk, bicycle, school bus)
- Trip Time of Day (one of 24 hours)
- Which tour the trip is part of
- What person made the trip
- What household the person who made the trip belongs

The **write trips to TransCAD** component assembles the individual records for auto and transit trips into origin-destination trip tables (matrices) that TransCAD can use for assignment. These trip tables are then combined with those developed for DIA, commercial vehicle, internal-external, external-internal, and external-external trips developed earlier.

Network assignment

Household vehicle, airport trips, internal-external trips, commercial vehicle trips, and external-external trips are assigned to the roadway network via a “user equilibrium” algorithm. The user equilibrium process assigns the trips between each origin and each destination transportation analysis zone in such a way that, by the end of the process, no trip can reduce its travel time by changing its path. The process takes into account the congestion produced by all other trips in the region, each trip is following its minimum path. High-occupancy vehicles are loaded simultaneously with single-occupant vehicles. During this process, TransCAD keeps track of which vehicles are eligible to use high-occupancy vehicles facilities, and which might need to pay a toll to use high-occupancy/toll lanes, such as the reversible I-25 Express Lanes north of downtown Denver. The model also takes into account the effect of toll costs in roadway route choice by converting toll costs into equivalent time cost using an estimated value of time for automobile trip-makers.

Transit assignment is performed separately, using an all-or-nothing algorithm that does not take into account the possibility that high demand or crowding on some transit routes may motivate some riders to shift to other routes. Regional Transportation District has special modeling tools that allow them to use Focus model forecasts for more detailed operational planning.

Finally, the model is run through several iterations, feeding back the output speeds from roadway assignment to the input stages that require them as input (among them, the trip distribution stage) until the output speeds and the input speeds match closely enough.

Model calibration and validation

Each Focus model component was originally calibrated to 2010 inputs, comparing the model “forecast” for 2010 to external data sources such as:

- 2010 American Community Survey means of travel to work
- 2010 Front Range Travel Counts
- 2010 Highway performance monitoring system estimated regional vehicle miles traveled
- 2019 Regional Transportation District transit boardings

Once comparisons were made of model results against the observed datasets, each model component was calibrated. The calibration involved changing the coefficients describing the mathematical models and travel and adding variables. Then the model was re-run, results compared again, and modifications made again. This process was repeated until satisfactory results were achieved.

The major regional level model results of the validation review for 2020 are shown in Table 2 and Table 3. Note the 2020 values actually represent the time and travel patterns prior to the COVID-19 pandemic. These tables demonstrate that the aggregate model results reflect the observed representative counts and transit boardings sufficiently well. When summed over the region, the links with observed traffic counts were observed to carry about 28.0 million vehicles per weekday. The sum of Focus Model estimates was within one percent difference.

Air quality modeling

Formal air pollutant emissions modeling is conducted by the Air Pollution Control Division. However, DRCOG, the Air Pollution Control Division, and other agencies work closely together in this effort, both in developing the modeling techniques, assumptions, and parameters, and in executing the model runs. Travel model link speed and vehicle miles traveled results are one of the principal inputs to the air pollutant emissions model. The

model produces estimates of the amount of emissions of carbon monoxide, volatile organic compounds, nitrogen oxides, and particulate matter generated by motor vehicles. The results are then combined with numerous assumptions concerning meteorology and atmospheric chemical reactions to produce air pollutant concentration estimates.

Table 2. Sum of 2020 observed estimates and modeled weekday counts

	2019/20 observed (est.) counts average daily travel sum vehicle miles traveled	2020 model results average daily travel sum vehicle miles traveled	Model variation
Colorado Department of Transportation roadways w/counts	15,937,900	16,100,100	1.0%
Highway performance monitoring system roadways w/counts	20,619,200	20,018,600	-3.0%
Highway performance monitoring system urbanized area network est.	67,381,400	73,270,000	8.0%
All model links w/counts	26,552,800	25,824,200	-2.8%

Table 3. Observed estimates and modeled 2020 transit weekday boardings

	2019 observed (est.)	2020 modeled	Model variation
Regional Transportation District boardings	340,800	340,200	-0.2%
Regional Transportation District trips	237,900	222,900	-6.8%

Appendix C. Modeling summary table

Table 1 – Denver Regional Council of Governments assumptions for the entire modeling area and data for base and future years

	2020	2050
Total population	3,408,152	4,478,343
Employment	2,180,587	3,000,647
Dwelling units (households)	1,361,781	1,882,031
Persons/dwelling unit (household)	2.50	2.38
Vehicle miles traveled by roadway type		
-Freeway	34,777,226	48,560,516
-Expressway	5,306,800	7,173,836
-Principal	25,367,941	36,412,893
-Minor	8,533,124	12,053,757
-Other (collectors, centroid connectors, ramps)	17,388,152	26,333,878
Total	91,373,242	130,534,879
Speed by roadway type (miles per hour)		
-Freeway	58.3	53.2
-Expressway	42.7	39.1
-Principal	32.5	30.7
-Minor	29.2	27.7
-Other (collectors, centroid connectors, ramps)	27.3	27.1
Total (average speed)	37.6	35.4
Lane miles by roadway type		
-Freeway	2,190	2,478
-Expressway	542	561
-Principal	4,280	5,130
-Minor	2,895	3,126
-Other (collectors, ramps)	6,507	6,555
Total	16,414	17,851

Appendix D. Particular matter street emissions reduction commitments

See companion document for commitments.

Appendix E. U.S. Department of Transportation conformity finding
