Denver Metropolitan Area and North Front Range 8-Hour Ozone State Implementation Plan

Emissions Inventory

DRAFT FINAL
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1 Introduction to the Emission Inventory

This portion of the Technical Support Document (TSD) provides greater detail and technical information to supplement the description of the Emission Inventory presented in other Denver Metro Area and North Front Range 8-hour ozone state implementation plan (SIP) documents.

For additional detail on the emission inventory, see:

- Morris R., E. Tai, Tanarit Sakulyanontvittaya, D. McNally and C. Loomis. 2008a. "*2010 Ozone Attainment Demonstration Modeling for the Denver 8-Hour Ozone State Implementation Plan Control Strategy.*" ENVIRON International Corporation, Novato, California. Prepared for Denver Regional Air Quality Council (RAQC), Denver, Colorado. September 22, 2008. <http://www.colorado.gov/airquality/documents/deno308/Denver_2010ControlStrat_Draft_Sep22_2008.pdf>
- Morris R., E. Tai, Tanarit Sakulyanontvittaya, D. McNally and C. Loomis. 2008b. "*Model Performance Evaluation for the June-July 2006 Ozone Episode for the Denver 8-Hour Ozone State Implementation Plan*." ENVIRON International Corporation, Novato, California. Prepared for Denver Regional Air Quality Council (RAQC), Denver, Colorado. August 29, 2008. <http://www.colorado.gov/airquality/documents/deno308/Denver_2006MPE_DraftFinal_Aug29_2008.pdf

2 Summary of Emission Inventory for 2006 and 2010 Base Case

This section presents emissions inventories for the SIP nonattainment area, 2006 base case, and the 2010 base case used in the modeling scenarios. Inventories for the 8-hour ozone control area 2010 control case modeling are presented later in this document and include the additional control measures that are included in the attainment demonstration for the 8-hour ozone National Ambient Air Quality Standard (NAAQS). All of the base and control case inventories are for the 8-hour ozone nonattainment area (NAA), which includes the counties of Denver, Jefferson Douglas, Broomfield, Boulder, Adams, Arapahoe, and portions of Weld[1] and Larimer[2] counties. These inventories in tons per summer day (tpsd) represent emissions estimates for an average episode day during the peak summer ozone season (May through September).

The emission estimates were developed based on the most recent vehicle miles traveled (VMT) estimates contained in: 1) Denver Regional Council of Government's (DRCOG) conformity analysis for the updated fiscally constrained element of the 2035 Regional Transportation Plan; 2) North Front Range Transportation and Air Quality Planning Council's (NFRTAQPC) 2035 Regional Transportation Plan; 3) the Air Pollution Control Division (APCD) estimates of VMT derived from data provided by the Colorado Department of Transportation (CDOT); and 4) Population estimates from the State Demographer. Demographic data are presented in Table 1.

[1] That portion of Weld County that lies south of a line described as follows: Beginning at a point on Weld County's eastern boundary and Logan County's western boundary intersected by 40 degrees, 42 minutes, 47.1 seconds north latitude, proceed west on 40 degrees, 42 minutes, 47.1 seconds north latitude until this line intersects Weld County's western boundary and Larimer County's eastern boundary.

[2] That portion of Larimer County (including part of Rocky Mountain National Park) that lies south of a line described as follows: Beginning at a point on Larimer County's eastern boundary and Weld County's western boundary intersected by 40 degrees, 42 minutes, and 47.1 seconds north latitude, proceed west to a point defined by the intersection of 40 degrees, 42 minutes, 47.1 seconds north latitude and 105 degrees, 29 minutes, and 40.0 seconds west longitude, thence proceed south on 105 degrees, 29 minutes, 40.0 seconds west longitude to the intersection with 40 degrees, 33 minutes and 17.4 seconds north latitude, thence proceed west on 40 degrees, 33 minutes, 17.4 seconds north latitude until this line intersects Larimer County's western boundary and Grand County's eastern boundary.

Table 1. Demographic Data

	2006	2010
DRCOG VMT	69,548,803	76,551,505
NFRTAQPC VMT	10,537,341	11,753,832
NON-DRCOG/NFR VMT	1,715,579	1,835,149
TOTAL NAA VMT	81,801,723	90,140,486
NAA Population	3,118,439	3,357,009

The 2006 and 2010 base case inventories incorporate the control measures in place at that time. Control measures in place in 2006 and assumed for 2010 include:

1. Federal tailpipe standards and regulations, including those for small engines and non-road mobile sources. Credit is taken for these federal requirements but they are not part of the Colorado SIP. The credits change from 2006 to 2010 as the United States Environmental Protection Agency (EPA) Tier II and low sulfur gasoline standards become effective.

2. Air Quality Control Commission Regulation No. 11--covering the Automobile Inspection and Readjustment (A.I.R.) program in place during the 2006 ozone season, which includes an enhanced Inspection/Maintenance (I/M). For 2006, a maximum of 10% fleet coverage is assumed, and for 2010, a maximum of 50% fleet coverage is assumed for the remote sensing clean screen program in the Denver metro area (DMA) based on Regulation No. 11.

3. Air Quality Control Commission Regulations No. 3, No. 6, No. 7, and Common Provisions--covering gasoline station and industrial source control programs. The Common Provisions, Parts A and B of Regulation No. 3, and the volatile organic compounds (VOC) control requirements of Regulation No. 7 are already included in the approved SIP. Regulation No. 6 and Part C of Regulation No. 3 implement the federal standards of performance for new stationary sources and the federal operating permit program. This reference to Regulation No. 6 and Part C of Regulation No. 3 shall not be construed to mean that these regulations are included in the SIP.

4. Since 2004, gasoline sold in the Denver metro area during the summer Reid Vapor Pressure (RVP) ozone season (June 1 to September 15) has been subject to a national RVP limit of 7.8 pounds per square inch (psi) to reduce fuel volatility. For ethanol-blended fuels, the RVP limit is 8.8 psi due to the federal 1.0 psi RVP waiver for ethanol.

   Since 1991, gasoline sold in the Larimer and Weld area during the summer ozone season (June 1 to September 15) has been subject to a national RVP limit of 9.0 psi to reduce fuel volatility. For ethanol-blended fuels, the RVP limit is 10.0 psi due to the federal 1.0 psi RVP waiver for ethanol.

   For 2006, the RVP of gasoline for the Denver metropolitan portion of nonattainment area was determined by survey to be at 8.2 psi, with an ethanol market share of 60%, and for the Larimer and Weld portion of the nonattainment area the RVP was determined to be 8.4 psi with the same ethanol share of 60%. For purposes of the base case 2010 mobile source inventory, the RVP of the base gasoline is assumed to be 7.8 psi for the Denver metropolitan portion of nonattainment area, with an ethanol market share of 85%, and for the Larimer and Weld portion of the nonattainment area the RVP was assumed to be 9.0 psi with an ethanol share of 25%.

5. The EPA approved the EAC Ozone Action Plan (OAP) on August 19, 2005. The OAP included an amendment to Regulation No. 7 requiring the reduction of flash emissions of volatile organic compounds from condensate collection, storage, processing and handling operations by May 1, 2005. This initial rule required the installation of air pollution control technology to achieve a system-wide 47.5% reduction from uncontrolled emissions of volatile organic compounds from new and existing oil and gas exploration and production operations located within the 8-hour ozone nonattainment area designated by EPA for operators with total emissions greater than 30 tons per year. The 2006 base case estimate was

developed from actual reported emissions based on the system-wide 47.5% reduction requirement.

6. In February 13, 2008, the EPA approved revisions to Regulation No. 7 to require the system-wide reduction of condensate tank flash VOC emissions of 75% for the 2007 ozone season by May 1, 2007 and 78% reduction for the 2012 ozone season, with technology that achieves a 95% reduction in VOC emissions. The 2010 base case emissions estimate assumes the 75% system-wide reduction requirement.

7. The effect of EPA final locomotive Tier 3 standards were considered and included, where appropriate, in the 2010 area source estimates. Tier 4 locomotive standards do not go into effect until 2015 and therefore were not included in the 2010 inventories.

All of the inventories in this 8-hour Ozone Attainment SIP were developed using EPA approved emissions modeling methods, including EPA's MOBILE6 model and local VMT data for on-road mobile source emissions, EPA's non-road model and local demographic information for area and off-road sources, and reported actual emissions for point sources. Estimates for future emissions are based on the above-mentioned tools and the EPA's Economic Growth and Analysis System (EGAS) model for estimating future point sources activity, VMT growth for on-road mobile sources, and 2010 and 2012 demographic data for off-road and area sources. The technical support document contains detailed information on model assumptions and parameters for each source category.

Highway mobile source emissions are from the ENVIRON Consolidated Community Emissions Processing Tool (CONCEPT) model inventory, which is based on DRCOG VMT data and MOBILE6 input data provided by APCD and expanded to the entire NAA based on VMT from the North Front Range Transportation and Air Quality Planning Council and CDOT.

Non-road source emissions are from the EPA Non-Road Model. This model includes the impact of future controls on non-road engines, which is used in equipment such as lawn and garden equipment and construction equipment. Oil and gas source emissions are from the revised Independent Petroleum Association of Mountain States (IPAMS) inventory, and were projected to 2010 using the methodology in the IPAMS projection methodology document. The IPAMS inventory was sponsored by the IPAMS and is Phase III of a regional oil and gas emission inventory for the Inter-Mountain West jointly with the Western Regional Air Partnership (WRAP).

Non-oil and gas area source emissions (including heating, consumer solvent use, aircraft and railroads, etc.) are from the 2002 EPA National Emissions Inventory (NEI), grown to 2006 and 2010 by population growth from data from the State Demographer. Consumer solvent emission reductions based on 75% of the per-person reductions listed in the EPA May 30, 2007 Emission Reduction Credit Memo were applied to the projected 2010 non-oil and gas area source inventory. A check on the non-oil and gas area sources estimates comparing the recently available 2005 NEI emissions data is shown later in this document. An inventory completed in 2005 for Denver International Airport (DIA) was used for aircraft and airport non-road source emissions from DIA for both 2006 and 2010.

Non-oil and gas point source emissions were grown to 2010 by the EPA EGAS economic model, and by adding sources for which permits have been issued.

Emissions of VOC and nitrogen oxides (NOx) from biogenic sources have been generated by the Model of Emissions of Gases and Aerosols from Nature (MEGAN) Biogenic Emissions Model using land cover data base of biomass type and density and hourly meteorology data. The National Center of Atmospheric Research (NCAR) has produced a global data base of land use data, the MEGAN Driving Variable Database Version 1.2, for use with MEGAN. Surface temperatures are provided by the Mesoscale Meteorological Model (MM5) modeling.

Summaries of the VOC and NOx base case inventories for the nonattainment area for 2006 and 2010 are presented in Table 2. Emissions of NOx and VOCs are in tons per average episode day. Additional detail on the categories of emissions can be found in the TSD.

Wildfire emissions, though not included in tables, have been considered for the background ozone concentrations in the modeling effort. Wildfire emissions can vary significantly on a day-to-day basis depending on conditions.

Table 2. Base Case Inventories for 8-Hour Ozone DMA/NFR NAA

(tons per average episode day)

	2006		2010	
Source Category	**NOx**	**VOC**	**NOx**	**VOC**
Point Sources				
Electric Generation Units (EGU)	55.6	0.7	58.5	1.6
External Combustion Boilers	9.5	0.4	10.0	0.5
Industrial Processes	12.5	10.2	14.0	11.0
Petroleum and Solvent Evaporation	0.3	19.0	0.3	22.0
Other	3.1	1.8	3.6	2.0
Point Sources Subtotal	**81.0**	**32.1**	**86.4**	**37.0**
Oil & Gas Point & Area Sources				
Condensate Tanks		126.5		129.6
Other O&G Point Sources	22.6	6.8	23.6	8.6
Pneumatic Devices (Area Source)		24.8		31.1
Unpermitted Fugitives (Area Source)		16.2		20.4
Other Area Sources	17.1	10.8	22.5	13.7
O&G Point & Area Sources Subtotal	**39.7**	**185.2**	**46.2**	**203.3**
Area Sources				
Personal Care Products		7.1		7.0
Household Products		21.4		17.9
Automotive Aftermarket Products		11.9		13.0
Architectural Coatings		20.1		16.8
Aircraft	7.4	1.3	8.2	1.5
Railroad	12.8	0.5	13.8	0.6
Other Coatings/Pesticides/Cooking/ Miscellaneous.		3.9		4.1
Area Source Subtotal	**20.2**	**66.3**	**22.1**	**61.0**
Non-Road Mobile Sources				
Agricultural Equipment	7.0	0.9	6.3	0.7
Airport Equipment	0.7	0.1	0.6	0.1
Commercial Equipment	5.3	6.2	5.1	7.0
Construction and Mining Equipment	35.7	5.5	31.2	4.5
Industrial Equipment	10.5	2.4	6.9	1.4
Lawn and Garden Equipment (Commercial)	9.4	35.9	8.9	28.1
Lawn and Garden Equipment (Residential)	1.2	7.5	1.2	11.8
Boats/Recreational Equipment/Miscellaneous	0.7	6.9	0.8	7.8
Non-Road Mobile Source Subtotal	**70.5**	**65.3**	**61.0**	**61.3**
On-Road Mobile Sources				
On-Road Mobile (including vehicle refueling)	165.5	129.7	122.9	109.2
On-Road Mobile Subtotal	**165.5**	**129.7**	**122.9**	**109.2**
Anthropogenic Total	**376.8**	**478.6**	**338.5**	**471.8**
Biogenic Total	**53.0**	**694.0**	**53.0**	**694.0**
Anthropogenic & Biogenic Total	**429.8**	**1172.6**	**391.5**	**1165.8**

3 Summary of Emission Inventory for 2010 Control Case

Reductions from the control measures described in the "Denver Metro Area & North Front Range 8-Hour Ozone Attainment Plan" have been applied to the 2010 base case emissions inventories to provide an additional safety margin as follows:

- Reid Vapor Pressure of base gasoline to be 7.8 pounds per square inch (psi) (maintains 1.0 psi waiver for ethanol-blended gasoline at 85% market share) in North Front Range--estimated 3 tons per day (tpd) VOC reduction to direct onroad mobile source emissions and in refueling (gas station) emissions.
- Controls on new condensate tanks ≥ 2 tons per year (tpy) and existing tanks ≥10 tpy--estimated 24 tpd reduction in VOC based on an assumed Rule Effectiveness adjustment of 0.83 applied to the calculated actual emissions reduction.
- New and existing pneumatic control devices required to be low-bleed devices--approximately 19 tpd VOC reduction based on an assumed Rule Effectiveness adjustment of 0.83.
- Tighten Regulation No. 11 I/M cut-points--1 tpd VOC, 3 tpd NOx and 13 tpd CO.
- Additional Regulation No. 3 and No. 7 changes--no additional credit assumed.

Rule Effectiveness (RE) reflects the actual ability of a regulatory program for controlled point sources or source categories to achieve the emissions reductions required by regulation. During the Air Quality Control Commission (AQCC) 2006 rule making on Regulation No. 7 revisions related to controls on condensate tank emissions, new EPA guidance on RE was reviewed. In consultation with EPA Region 8 staff, an RE of 0.83 was established for the oil and gas industry facilities. This essentially discounts the calculated reduction estimates by 17%. The previously agreed upon RE of 0.83 was assumed for condensate tank controls and pneumatic devices for the purposes of facilitating the 2010 base case and control case modeling.

The APCD has recently analyzed both the weekly compliance rate through reporting and compliance rate of random inspections on condensate controls for the 2007 peak ozone

season for each of the companies with total system wide VOC emissions of 30 tpy. The analysis indicates an 83% compliance rate based on weekly reporting and a 91% compliance rate based on random inspections. Based on this analysis and the proposed revisions to strengthen Regulation No. 7, the State believes a rule effectiveness factor of at least 0.83 is still valid. Analysis supporting the final RE used in modeling is found in a separate TSD.

The total emission reduction, compared to the 2006, for these control strategies (together with the federal and existing state controls assumed for the 2010 base case) is approximately 47 tpd VOC and 3 tpd NOx in the 8-hour nonattainment area (However, the total VOC reduction could be as great as 70 tpd without the rule effectiveness reduction.). The resulting 2010 control inventory based on the total control package noted above is presented in Table 3 (VOC) and Table 4 (NOx) for the 8-hour nonattainment area. All inventories presented as tons per summer day (tpsd) in this section represent a typical average episode day. In the photochemical modeling, all anthropogenic source categories are varied by day of the week, time of day, temperature, location, speciation and other factors. Biogenic sources are varied by differing meteorological conditions and diurnally varied by temperature.

Table 3. VOC Base Case and Control Case Emission Inventory

(tons per average episode day)

	2006 Base	2010 Base	2010 Control
Source Category	**VOC**	**VOC**	**VOC**
Point Sources			
Electric Generation Units (EGU)	0.7	1.6	1.6
External Combustion Boilers	0.4	0.5	0.5
Industrial Processes	10.2	11.0	11.0
Petroleum and Solvent Evaporation	19.0	22.0	22.0
Other	1.8	2.0	2.0
Point Sources Subtotal	**32.1**	**37.0**	**37.0**
Oil & Gas Point & Area Sources			
Condensate Tanks	126.5	129.6	105.6
Other O&G Point Sources	6.8	8.6	8.6
Pneumatic Devices (Area Source)	24.8	31.1	12.0
Unpermitted Fugitives (Area Source)	16.2	20.4	20.4
Other Area Sources	10.8	13.7	13.7
O&G Point & Area Sources Subtotal	**185.2**	**203.3**	**160.1**
Area Sources			
Personal Care Products	7.1	7.0	7.0
Household Products	21.4	17.9	17.9
Automotive Aftermarket Products	11.9	13.0	13.0
Architectural Coatings	20.1	16.8	16.8
Aircraft	1.3	1.5	1.5
Railroad	0.5	0.6	0.6
Other Coatings/Pesticides/Cooking/Miscellaneous	3.9	4.1	4.1
Area Source Subtotal	**66.3**	**61.0**	**61.0**
Non-Road Mobile Sources			
Agricultural Equipment	0.9	0.7	0.7
Airport Equipment	0.1	0.1	0.1
Commercial Equipment	6.2	7.0	7.0
Construction and Mining Equipment	5.5	4.5	4.5
Industrial Equipment	2.4	1.4	1.4
Lawn and Garden Equipment (Commercial)	35.9	28.1	28.1
Lawn and Garden Equipment (Residential)	7.5	11.8	11.8
Boats/Recreational Equipment/Miscellaneous	6.9	7.8	7.8
Non-Road Mobile Source Subtotal	**65.3**	**61.3**	**61.3**
On-Road Mobile Sources			
On-Road Mobile (including vehicle refueling)	129.7	109.2	106.0
On-Road Mobile Subtotal	**129.7**	**109.2**	**106.0**
Anthropogenic Total	**478.6**	**471.8**	**425.4**
Biogenic Total	**694.0**	**694.0**	**694.0**
Anthropogenic & Biogenic Total	**1172.6**	**1165.8**	**1119.4**

Table 4. NOx Base Case and Control Case Emission Inventory

(tons per average episode day)

	2006 Base	2010 Base	2010 Control
Source Category	**NOx**	**NOx**	**NOx**
Point Sources			
Electric Generation Units (EGU)	55.6	58.5	58.5
External Combustion Boilers	9.5	10.0	10.0
Industrial Processes	12.5	14.0	14.0
Petroleum and Solvent Evaporation	0.3	0.3	0.3
Other	3.1	3.6	3.6
Point Sources Subtotal	**81.0**	**86.4**	**86.4**
Oil & Gas Point & Area Sources			
Condensate Tanks			
Other O&G Point Sources	22.6	23.6	23.6
Pneumatic Devices (Area Source)			
Unpermitted Fugitives (Area Source)			
Other Area Sources	17.1	22.5	22.5
O&G Point & Area Sources Subtotal	**39.7**	**46.2**	**46.2**
Area Sources			
Personal Care Products			
Household Products			
Automotive Aftermarket Products			
Architectural Coatings			
Aircraft	7.4	8.2	8.2
Railroad	12.8	13.8	13.8
Other Coatings/Pesticides/Cooking/Miscellaneous			
Area Source Subtotal	**20.2**	**22.1**	**22.1**
Non-Road Mobile Sources			
Agricultural Equipment	7.0	6.3	6.3
Airport Equipment	0.7	0.6	0.6
Commercial Equipment	5.3	5.1	5.1
Construction and Mining Equipment	35.7	31.2	31.2
Industrial Equipment	10.5	6.9	6.9
Lawn and Garden Equipment (Commercial)	9.4	8.9	8.9
Lawn and Garden Equipment (Residential)	1.2	1.2	1.2
Boats/Recreational Equipment/Miscellaneous	0.7	0.8	0.8
Non-Road Mobile Source Subtotal	**70.5**	**61.0**	**61.0**
On-Road Mobile Sources			
On-Road Mobile (including vehicle refueling)	165.5	122.9	118.9
On-Road Mobile Subtotal	**165.5**	**122.9**	**118.9**
Anthropogenic Total	**376.8**	**338.5**	**334.6**
Biogenic Total	**53.0**	**53.0**	**53.0**
Anthropogenic & Biogenic Total	**429.8**	**391.5**	**387.6**

4 VOC and NOx Motor Vehicle Emission Budgets

According to EPA regulations and guidance, the SIP may establish a budget or budgets that apply to the entire nonattainment area, and/or subarea budgets for each metropolitan planning organization or subarea within the nonattainment area.

For purposes of this SIP, motor vehicle emissions budgets for VOC and NOx are established for the 2010 attainment year. Budgets are specifically established for two sub-regional areas and for the entire nonattainment area for purposes of transportation conformity. The two subareas are defined as follows and shown in Figure 1:

- **Southern Subarea** - Area denoted by the ozone nonattainment area south of the Boulder County northern boundary and extended through southern Weld County to the Morgan County line. This area includes the nonattainment portion of DRCOG's' regional planning area and the southern Weld County portion of the Upper Front Range Transportation Planning Region (TPR).
- **Northern Subarea** - Area denoted by the ozone nonattainment area north of the Boulder County northern boundary and extended through southern Weld County to the Morgan County line. This area includes the North Front Range Transportation and Air Quality Planning Council transportation planning area as well as the northern ozone nonattainment area portion the Upper Front Range TPR in Larimer and Weld counties.

When subarea budgets are created in the SIP, the sum of the subarea budgets must equal the total allowable emissions the area can have from the transportation sector and still lead to attainment of the standard. If each subarea meets its motor vehicle emission budgets or if the total emissions for the entire nonattainment area (the sum of the subareas) are less than or equal to the budget for the entire nonattainment area, then the entire area will meet the total SIP's purpose of attaining the relevant standard.

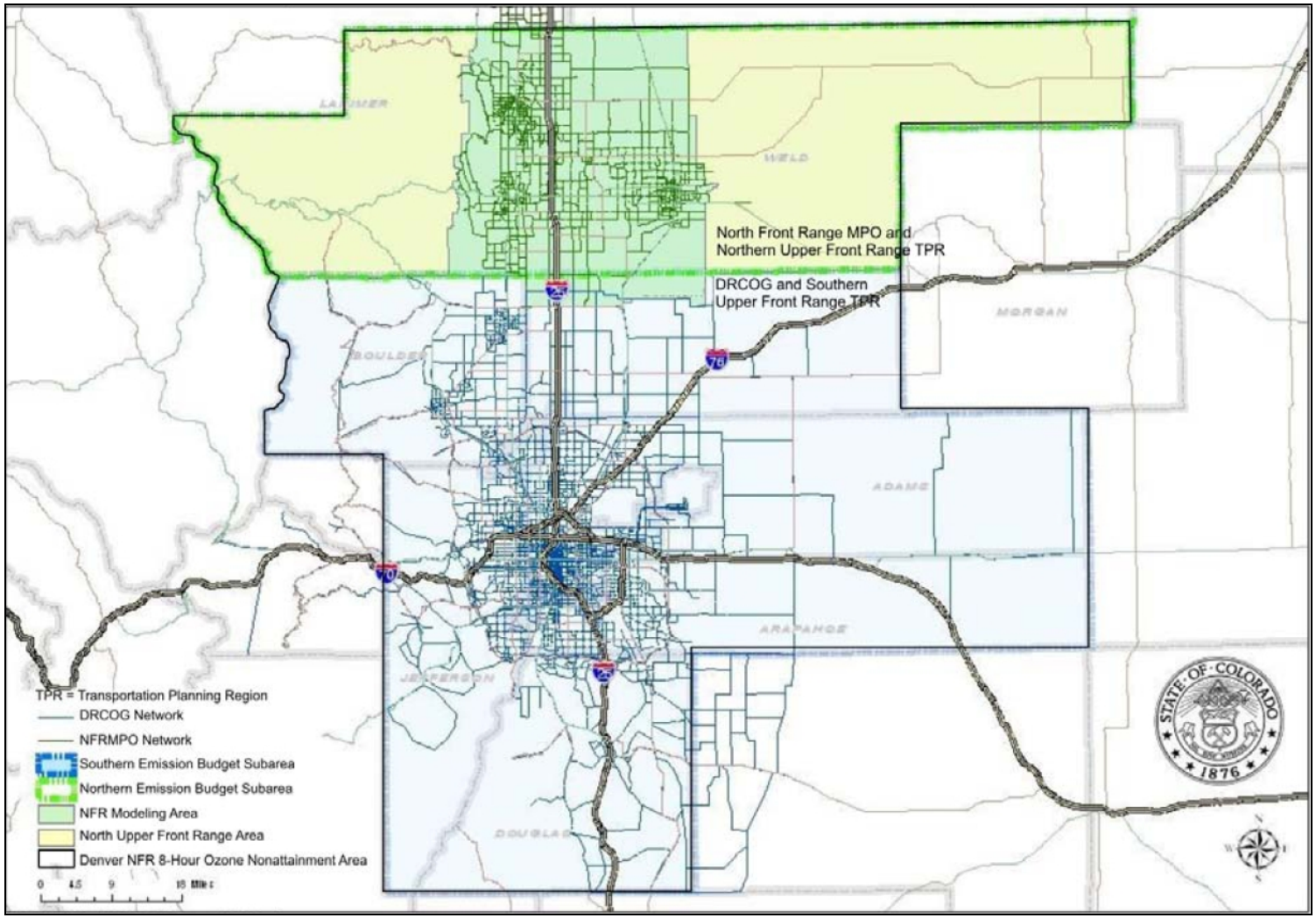

Figure 1. Denver Metro Area and North Front Range 8-Hour Ozone Emission Budget Subareas

4.1 Proposed 2010 Emissions Budgets for the Denver Metro and North Front Range 8-Hour Ozone Subareas

Table 5 shows both the regional motor vehicle emissions budgets and the separate motor vehicle emissions budgets for the ozone precursors VOC and NOx for the two subareas discussed above.

Table 5. Subarea and Nonattainment Area-Wide 2010 Motor Vehicle Emission Budgets

Motor Vehicle Emissions Budget Subareas	2010	
	VOC (tpd)	NOx (tpd)
Southern Subarea Budget (*DRCOG & UFR TPR Subarea*)	89.7	102.4
Northern Subarea Budget (*NFRTAQPC & UFR TPR Subarea*)	19.5	20.5
Total Nonattainment Area Budget (*Entire Nonattainment Area*)	109.2	122.9

The 2010 VMT estimates were used with 2010 emission factors obtained from the EPA MOBILE6.2 Emission Factor Model to calculate emissions. The two subarea budgets presented in the table add to the sum of the total 2010 motor vehicle emissions for the entire nonattainment area in the 2010 base case inventory (See Table 2), which demonstrates attainment of the standard.

For the underlying transportation modeling, the roadway and transit links in DRCOG's 2005 and 2015 Cycle 2 (2007) networks were truncated to include only the portion of the network within the 8-hour ozone nonattainment area. VMT estimates from these networks were interpolated to obtain 2006 and 2010 baseline VMT estimates for purposes of developing the SIP emissions inventories. Likewise, the 2005 and 2015 (2007) networks from the North Front Range MPO were truncated to include only the

portion of the network within the 8-hour ozone nonattainment area. The VMT estimates were interpolated to obtain 2006 and 2010 baseline VMT estimates. Where there was overlap between the North Front Range (NFR) and DRCOG networks in Weld County, the DRCOG network was used. In areas where there was no MPO network, the Federal Highway Authority (FHWA) Highway Performance Management System (HPMS) and Colorado Department of Transportation (CDOT) networks, plus a growth factor, were used to calculate VMT.

Table 6 summarizes the VMT estimates for each of the budget subareas. The total VMT is identical to the 2010 base case VMT estimates in Table 2.

Table 6. Distribution of VMT between the Budget Subareas (2010)

Southern Subarea	
DRCOG Network VMT	76,551,505
Upper Front Range VMT	777,910
Total Southern Area VMT	77,329,415
Northern Subarea	
NFR MPO Network VMT	11,753,832
Upper Front Range VMT	1,057,239
Total Northern Area VMT	12,811,071
Total Nonattainment Area VMT	90,140,486

The 2006 and 2010 VMT estimates were used with emission factors obtained from the EPA Mobile 6.2 Emission Factor Model to calculate emissions. Emissions were calculated on a link-by-link basis. Speeds were obtained from the MPO transportation networks and the roadway speed limit was used for CDOT links. The ambient temperatures for the regional emissions analysis were derived from the meteorological modeling performed for the attainment demonstration for a typical ozone episode period. The motor vehicle mix was obtained from the CDOT automated traffic counters.

5 Highway Vehicle Sources

Emissions modeling was conducted using two systems, the Sparse Matrix Operating Kernel Emissions (SMOKE) model (Coats, 1996) and the Consolidated Community Emissions Processing Tool (CONCEPT) (Loomis et al., 2005). The CONCEPT link-based mobile emissions modeling system was used to generate the on-road mobile source emissions the Denver Regional Council of Governments (DRCOG) portion of the 8-hour ozone nonattainment area (NAA). The SMOKE emissions modeling system does not generate link-based mobile source emissions and was used for the less critical areas of the NAA. SMOKE used countywide vehicle miles traveled (VMT) data from Larimer and Weld Counties not covered by the DRCOG transportation network. It used VMT from the North Front Range Transportation and Air Quality Planning Council (NFR) and Colorado Department of Transportation (CDOT), together with spatial surrogates. SMOKE assumes a constant speed across all VMT of the same roadway type.

The CONCEPT MV emissions model estimates and grids link-level emissions using the output from DRCOG Transportation Demand Model (TDM). The TDM provides VMT or volume for multi-hour periods, and CONCEPT uses temporal allocation factors and VMT mix fractions to estimate hourly emissions for each vehicle class for each roadway Type and speed.

EPA's EPA Mobile 6.2 Emission Factor Model (MOBILE6) is executed within CONCEPT to generate the gram/mile (for running emissions) and gram/trip (for trip start and trip ends) emission factors. The emission factors depend on meteorological data (temperature and humidity), which are obtained from MM5 meteorological modeling runs for every grid cell in the modeling domain, and the speeds associated with each link. CONCEPT then estimates emissions for each emissions mode by multiplying the activity data (VMT or trips by vehicle class) by the appropriate MOBILE6 emission factors. For each hour of each episode day, for each link in each grid cell, CONCEPT uses the grid

cell ID, county, temperature increase bin, road type, and speed to determine the correct emission factor for each vehicle class, pollutant and (non-start) emission mode. Emissions for each vehicle class, emission type, and pollutant are estimated as the product of the emission factor and the VMT on that link associated with the vehicle class and speed.

Both CONCEPT and SMOKE use temporal adjustments to adjust VMT for the day of week. Both models also speciate the emissions as required for input to an air quality model. The result of both CONCEPT and SMOKE was an hourly, gridded, speciated inventory for a two-month period ready for input to the Comprehensive Air-quality Model with extensions (CAMx) air quality model (ENVIRON, 2008).

For the SIP summary inventory tables (Table 2, Table 3, and Table 4) and for the Motor Vehicle Emissions Budgets in Table 5, a single number for highway vehicle emissions is needed. The basic technique used in the CONCEPT model was used to calculate emissions for the SIP and the Emission Budgets. The principal difference was that emissions were calculated on a daily basis instead of an hourly basis.

The 2006 and 2010 VMT estimates were used with emission factors obtained from the EPA Mobile 6.2 Emission Factor Model to calculate emissions. Emissions were calculated on a link-by-link basis. Speeds were obtained from the MPO transportation networks and the roadway speed limit was used for CDOT links. The ambient temperatures for the regional emissions analysis were derived from the meteorological modeling performed for the attainment demonstration for a typical ozone episode period. The motor vehicle mix was obtained from the CDOT automated traffic counters.

For the CONCEPT area modeling (Adams. Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson and a portion of Weld counties), the ambient temperature used for modeling is: MIN/MAX TEMPERATURE: 42.6 101.2.

For the SMOKE area modeling (Larimer, and most of Weld counties), the ambient temperature used for modeling is: MIN/MAX TEMPERATURE: 59.0 89.0.

Table 7 presents a summary of the CONCEPT and SMOKE highway vehicle modeling used in the CAMx ozone modeling for the July 11-17 period for the base case in 2006 and 2010.

Table 7. Emissions summary for July 11 -17 Period from CAMx Ozone Modeling

July11-17 Emissions Summary for July 11 –17 Ozone Modeling (tons/day)								weekday
CONCEPT 2006	Fri	Sat	Sun	Mon	Tue	Wed	Thu	average
NOX	139.4	102.8	85.2	119.6	120.9	130.9	137.7	129.7
TOG	115.2	88.6	78.5	90.9	87.4	97.1	108.1	99.7
CO	934.2	750.7	663.5	801.8	806.8	862.7	890.1	859.1
CONCEPT 2010								
NOX	104.0	77.1	64.1	89.3	90.3	97.7	102.7	96.8
TOG	94.4	74.8	66.8	74.7	71.8	79.3	88.6	81.8
CO	751.9	604.6	532.7	642.5	653.3	697.9	716.4	692.4
SMOKE 2010								
NOx	26.2	22.4	20.4	24.0	23.5	23.8	25.7	24.7
TOG	16.1	15.2	14.5	15.3	14.4	14.7	15.6	15.2
CO	192.5	169.9	155.1	174.9	182.4	180.4	190.2	184.1
TOTAL 2010								
NOx	130.2	99.5	84.4	113.3	113.8	121.6	128.4	121.4
TOG	110.5	90.0	81.2	90.0	86.2	94.0	104.3	97.0
CO	944.4	774.5	687.9	817.4	835.7	878.3	906.6	876.5

Table 8 and Table 9 compare the CONCEPT and SMOKE output summary on a weekday average basis with the single number used in summary Table 2, Table 3, and Table 4 and in the Motor Vehicle Emissions Budgets in Table 5. As can be seen, the single numbers calculated for the SIP and Emission Budgets are a reasonable representation of the emissions used in the ozone modeling.

Table 8. 2006 Emissions Modeling Comparison

	July11-17 CONCEPT MODEL	SIP Method	
	week day average	DRCOG tons	% diff
NOX	129.7	135.4	4.4%
TOG/VOC	99.7	100.4	0.6%
CO	859.1	930.3	8.3%
	Smoke*	non-DRCOG tons	% diff
NOX	39.611	28.5	-28.0%
TOG/VOC	21.177	20.4	-3.5%
CO	276.492	196.8	-28.8%
	NAA TOTAL 2006	SIP NAA TOTAL	% diff
NOX	169.3	163.9	**-3.2%**
TOG/VOC	120.9	120.8	**-0.1%**
CO	1135.6	1127.1	**-0.8%**
* 2006 Smoke is from Tuesday July 18, 2006			

Table 9. 2010 Emissions Modeling Comparison

	July11-17 CONCEPT MODEL	SIP Method	
	week day average	DRCOG 2010 tons	% diff
NOX	96.8	100.4	3.7%
TOG/VOC	81.8	86.9	6.3%
CO	692.4	775.5	12.0%
	Smoke	non-DRCOG tons	% diff
NOX	24.650	22.5	-8.7%
TOG/VOC	15.236	19.5	27.8%
CO	184.083	189.2	2.8%
	NAA TOTAL 2010	SIP NAA TOTAL	% diff
NOX	121.4	122.9	**1.2%**
TOG/VOC	97.0	106.4	**9.7%**
CO	876.5	964.7	**10.1%**

5.1 Ethanol Marketshare Assumptions

The 2006 60% ethanol marketshare for Denver is based on actual sampling. The increase in 2010 accounts for marketshare trends, most notably actual sampling in 2005 and 2007 showing an 85% ethanol marketshare. Actual sampling was also used to calculate the 60% NFR marketshare for 2006. However, because over the years prior to 2008 the NFR sampling has been done on a smaller scale, and sample locations have not been as rigorously selected, the Division did not feel as comfortable projecting out a marketshare to 2010, and accordingly, conservatively estimated that the 2010 marketshare in the NFR would be 25% consistent with the marketshare utilized in the EAC modeling. In retrospect, the Division agrees that for consistency sake, the same projecting out methodology used in Denver should have been used for the NFR, notwithstanding the smaller sample set. Nevertheless, based on the ethanol sensitivity tests for 2010, 0% vs 100% ethanol market penetration for the entire NAA area does not change the outcome of the ozone modeling attainment demonstration at the key monitors (e.g., Rocky Flats North and Fort Collins West). Therefore, it can be concluded that changing the ethanol market penetration for the NFR from 25% to a higher percentage based on projecting out from a limited sample set would have a negligible effect on ozone.

5.2 2006 Base Year Input to the Mobile Model for Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas and Jefferson Counties

```
REBUILD EFFECTS    : 0.10
EXPAND EVAPORATIVE :
EXPAND EXHAUST     :

I/M PROGRAM        : 1 1982 2050 2 T/O 2500/IDLE
I/M MODEL YEARS    : 1 1982 2050
I/M VEHICLES       : 1 11111 22222222 2
I/M STRINGENCY     : 1 10.0 (Set to min. allowed, pre 81 stringency not
applicable)
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 .00 .57 (Pre 81 rate n/a, post 80 rates from
insp. year 2001)
I/M GRACE PERIOD   : 1 5

I/M PROGRAM        : 2 1982 2050 2 T/O IM240
I/M MODEL YEARS    : 2 1982 2050
I/M CUTPOINTS      : 2 06CUTPC.D
I/M VEHICLES       : 2 21111 11111111 1
I/M STRINGENCY     : 2 10.0 (Set to min. allowed, pre 81 stringency not
applicable)
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 .00 .64 (Pre 81 rate n/a, post 80 rates from
insp. year 2001)
I/M GRACE PERIOD   : 2 5

I/M PROGRAM        : 3 1982 2050 2 T/O IM240
I/M MODEL YEARS    : 3 1982 2050
I/M CUTPOINTS      : 3 06CUTPT.D
I/M VEHICLES       : 3 12222 11111111 1
I/M STRINGENCY     : 3 10.0 (Set to min. allowed, pre 81 stringency not
applicable)
I/M COMPLIANCE     : 3 95.0
I/M WAIVER RATES   : 3 .00 .91 (Pre 81 rate n/a, post 80 rates from
insp. year 2001)
I/M GRACE PERIOD   : 3 5

I/M PROGRAM        : 4 1998 2050 2 T/O GC
I/M MODEL YEARS    : 4 1982 2050
I/M VEHICLES       : 4 22222 11111111 1
I/M COMPLIANCE     : 4 94.8 (Compliance data from insp. year 2001)
I/M WAIVER RATES   : 4 .00 .91 (Pre 81 rate n/a, post 80 rates from
insp. year 2001)
I/M GRACE PERIOD   : 4 5

ANTI-TAMP PROG     :
82 75 02 22222 22222222 2 12 095. 22111112

FUEL PROGRAM       : 4
  88.0  116.0  122.0  124.0   74.0   57.0   57.7   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
1000.0 1000.0 1000.0 1000.0  303.0  303.0   248.0   87.0
```

```
  80.0   80.0   80.0   80.0   80.0   80.0   80.0   80.0

OXYGENATED FUELS    : 0.000 0.600 0.000 0.035 2
FUEL RVP            : 7.7
REG DIST            : REG_MET.D
  </run>
  <scenario>
ALTITUDE            : 2
```

5.3 2006 Base Year Input to the Mobile Model for Larimer and Weld Counties

```
REBUILD EFFECTS     : 0.10
EXPAND EVAPORATIVE  :
EXPAND EXHAUST      :
FUEL PROGRAM        : 4
  88.0  116.0  122.0  124.0   74.0   57.0   57.7   30.0
  30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
1000.0 1000.0 1000.0 1000.0  303.0  303.0   248.0   87.0
  80.0   80.0   80.0   80.0   80.0   80.0   80.0   80.0

OXYGENATED FUELS    : 0.000 0.600 0.000 0.035 2
FUEL RVP            : 7.4
REG DIST            : REG_LAR.D
 </run>
  <scenario>
ALTITUDE            : 2
```

5.4 2010 Base Year Input to the Mobile Model for Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas and Jefferson Counties

```
REBUILD EFFECTS     : 0.35

I/M PROGRAM         : 1 1982 2050 2 T/O 2500/IDLE
I/M MODEL YEARS     : 1 1982 2050
I/M VEHICLES        : 1 11111 22222222 2
I/M STRINGENCY      : 1 10.0 (Set to min. allowed, pre 81 stringency not
applicable)
I/M COMPLIANCE      : 1 95.0
I/M WAIVER RATES    : 1 .00 .57 (Pre 81 rate n/a, post 80 rates from
insp. year 2001)
I/M GRACE PERIOD    : 1 5

I/M PROGRAM         : 2 1982 2050 2 T/O IM240
I/M MODEL YEARS     : 2 1982 2050
I/M CUTPOINTS       : 2 10CUTPC.D
I/M VEHICLES        : 2 21111 11111111 1
I/M STRINGENCY      : 2 10.0 (Set to min. allowed, pre 81 stringency not
applicable)
I/M COMPLIANCE      : 2 95.0
I/M WAIVER RATES    : 2 .00 .64 (Pre 81 rate n/a, post 80 rates from
insp. year 2001)
I/M GRACE PERIOD    : 2 5
```

```
I/M PROGRAM         : 3 1982 2050 2 T/O IM240
I/M MODEL YEARS     : 3 1982 2050
I/M CUTPOINTS       : 3 10CUTPT.D
I/M VEHICLES        : 3 12222 11111111 1
I/M STRINGENCY      : 3 10.0 (Set to min. allowed, pre 81 stringency not
applicable)
I/M COMPLIANCE      : 3 95.0
I/M WAIVER RATES    : 3 .00 .91 (Pre 81 rate n/a, post 80 rates from
insp. year 2001)
I/M GRACE PERIOD    : 3 5

I/M PROGRAM         : 4 1998 2050 2 T/O GC
I/M MODEL YEARS     : 4 1982 2050
I/M VEHICLES        : 4 22222 11111111 1
I/M COMPLIANCE      : 4 94.8 (Compliance data from insp. year 2001)
I/M WAIVER RATES    : 4 .00 .91 (Pre 81 rate n/a, post 80 rates from
insp. year 2001)
I/M GRACE PERIOD    : 4 5

ANTI-TAMP PROG      :
82 75 02 22222 22222222 2 12 095. 22111112

FUEL PROGRAM        : 3

OXYGENATED FUELS    : 0.000 0.850 0.000 0.035 2
FUEL RVP            : 7.8
REG DIST            : REG_MET.D
```

5.5 2010 Base Year Input to the Mobile Model for Larimer and Weld Counties

```
REBUILD EFFECTS     : 0.35
EXPAND EVAPORATIVE  :
EXPAND EXHAUST      :
FUEL PROGRAM        : 3

OXYGENATED FUELS    : 0.000 0.250 0.000 0.035 2
FUEL RVP            : 9.0
REG DIST            : REG_LAR.D
 </run>
  <scenario>
ALTITUDE            : 2
```

The REBUILD EFFECTS command allows the user to change the Rebuild program effectiveness rate used to reduce heavy-duty diesel vehicle NOx off-cycle emissions. The command was used by the contractors in the SIP modeling, and was set to be consistent with the values used in other SIPs (those done by NESCAUM and LADCO). The command reduces the credit assigned to this program from the default effectiveness rate of 90%.

5.6 2010 Control Case Input to the Mobile Model for Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, and Jefferson Counties

```
REBUILD EFFECTS    : 0.35
EXPRESS HC AS VOC  :


I/M PROGRAM        : 1 1982 2050 2 T/O 2500/IDLE
I/M MODEL YEARS    : 1 1982 2050
I/M VEHICLES       : 1 11111 22222222 2
I/M STRINGENCY     : 1 10.0 (Set to min. allowed, pre 81 stringency not
applicable)
I/M COMPLIANCE     : 1 95.0
I/M WAIVER RATES   : 1 .00 .57 (Pre 81 rate n/a, post 80 rates from
insp. year 2001)
I/M GRACE PERIOD   : 1 5

I/M PROGRAM        : 2 1982 2050 2 T/O IM240
I/M MODEL YEARS    : 2 1982 2050
I/M CUTPOINTS      : 2 10CPCb.D
I/M VEHICLES       : 2 21111 11111111 1
I/M STRINGENCY     : 2 10.0 (Set to min. allowed, pre 81 stringency not
applicable)
I/M COMPLIANCE     : 2 95.0
I/M WAIVER RATES   : 2 .00 .26 (Pre 81 rate n/a, post 80 rates from
insp. year 2007)
I/M GRACE PERIOD   : 2 5

I/M PROGRAM        : 3 1982 2050 2 T/O IM240
I/M MODEL YEARS    : 3 1982 2050
I/M CUTPOINTS      : 3 10CPTb.D
I/M VEHICLES       : 3 12222 11111111 1
I/M STRINGENCY     : 3 10.0 (Set to min. allowed, pre 81 stringency not
applicable)
I/M COMPLIANCE     : 3 95.0
I/M WAIVER RATES   : 3 .00 .16 (Pre 81 rate n/a, post 80 rates from
insp. year 2007)
I/M GRACE PERIOD   : 3 5

I/M PROGRAM        : 4 1998 2050 2 T/O GC
I/M MODEL YEARS    : 4 1982 2050
I/M VEHICLES       : 4 22222 11111111 1
I/M COMPLIANCE     : 4 94.8 (Compliance data from insp. year 2001)
I/M WAIVER RATES   : 4 .00 .26 (Pre 81 rate n/a, post 80 rates from
insp. year 2007)
I/M GRACE PERIOD   : 4 5

ANTI-TAMP PROG     :
82 75 02 22222 22222222 2 12 095. 22111112

REG DIST           : ..\..\regdist\Reg_Met.D
FUEL PROGRAM       : 3
FUEL RVP           :  7.8
OXYGENATED FUELS   : .000 .850 .000 .035 2
```

```
MIN/MAX TEMPERATURE: 42.6 101.2
```

5.7 2010 Control Case Input to the Mobile Model for Larimer and Weld Counties

```
REBUILD EFFECTS    : 0.35
REG DIST           : ..\..\regdist\REG_LAR.D
FUEL PROGRAM       : 3
OXYGENATED FUELS   : 0.000 0.850 0.000 0.035 2
FUEL RVP           : 7.8
MIN/MAX TEMPERATURE: 42.6 101.2
```

The control case uses more stringent I/M cutpoints in the Denver area, along with updated I/M program effectiveness parameters, and 7.8 RVP gasoline in Larimer and Weld Counties.

6 Non-Road Mobile Sources

Non-road source emissions are from the EPA NONROAD Model. This model includes the impact of future controls on non-road engines, which is used in equipment such as lawn and garden equipment and construction equipment.

Inputs to the NONROAD Model are shown in Table 10 and Table 11.

Table 10. 2006 Base Year NONROAD Model Input

Fuel RVP (psi) : 8.20
Fuel Oxygen weight %: 2.04
Gasoline Sulfur % : 0.0339
Diesel Sulfur % : 0.0500
Marine Diesel Sulfur: 0.0500
LPG/CNG Sulfur % : 0.0030
Minimum Temperature : 58.00
Maximum Temperature : 91.00
Average Ambient Temp: 77.30

Table 11. 2010 Base Year and Control Case NONROAD Model Input

Fuel RVP for gas : 8.8
Oxygen Weight % : 2.97
Gas sulfur % : 0.0011
Diesel sulfur % : .0050
Marine Dsl sulfur %: .0050
CNG/LPG sulfur % : 0.003
Minimum temper. (F): 58.0
Maximum temper. (F): 91.0
Average temper. (F): 77.3

6.1 Locomotive Emissions

Locomotive emissions from the 2002 NEI were grown by population growth and the effect of EPA final locomotive Tier 3 standards were considered and included, where appropriate, in the 2010 area source estimates. The effect of the standards were calculated based on "*Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder*" (EPA, March 2008).

6.2 Aircraft and Airport Emissions – Denver International Airport

An inventory completed in 2005 for Denver International Airport (DIA) was used for aircraft and airport non-road source emissions from DIA for both 2006 and 2010 (Ricondo & Associates, June 2005).

7 Stationary Sources

7.1 Area Sources (Non-Oil and Gas)

Non-oil and gas area source emissions (including heating, consumer solvent use, pesticides, etc) are from the 2002 EPA National Emissions Inventory (NEI), grown to 2006 and 2010 by population growth from data from the State Demographer. While EPA now has a 2005 NEI available, it is only a placeholder Inventory because there are major revisions to the NEI methodology that are to be implemented with the 2008 NEI. For area sources, the 2002 and 2005 NEIs are identical, as seen in Table 12.

Table 12. Non-Oil and Gas Area Sources - Comparison of 2002 and 2005 NEI

9 County Metro Area **2005** NEI tons/year			9 County Metro Area **2002** NEI tons/year		
TIER1NAME	TIER3NAME	VOC	SCC6_DESC	SCC8_DESC	VOC
SOLVENT UTILIZATION	architectural	5,354.36	Architectural Coatings	Total: All Solvent Types	5354.36
			All Household Products	Total: All Solvent Types	1740.26
			All Products/Processes	Total: All Solvent Types	79.29
			Automotive Aftermarket Products	Total: All Solvent Types	2505.13
			Household Products	Total: All Solvent Types	2731.89
			Personal Care Products	Total: All Solvent Types	1522.11
SOLVENT UTILIZATION	consumer solvents	8,578.68	Consumer Solvents	SUM	8578.68
			Pesticide Application: Agricultural	All Processes	379.76
			Pesticide Application	Total: All Solvent Types	379.76
SOLVENT UTILIZATION	pesticide application	759.52	Pesticide	SUM	759.52
SOLVENT UTILIZATION	traffic markings	374.10	Traffic Markings	Total: All Solvent Types	374.1

Consumer solvent emission reductions based on 75% of the per-person reductions listed in the EPA May 30, 2007 Emission Reduction Credit Memo were applied to the projected 2010 non-oil and gas area source inventory. Non-oil and gas point source emissions were grown to 2010 by the EPA EGAS economic model, and by adding sources for which permits have been issued.

7.2 Point Source Emissions

Point source emissions were taken from Air Pollution Control Division's (APCD) Air Pollutant Emission Notice (APEN) database. All sources in Colorado emitting criteria and/or hazardous air pollutants (HAPs), including those emitting such ozone formation contributors (OFCs) as volatile organic compounds (VOCs) and criteria pollutants such as nitrogen oxides (NOx) specifically, are required to submit an APEN. The de minimis level for reporting criteria pollutants is 1 ton/year (tpy) in nonattainment areas and 2 tons/year in attainment areas (actual uncontrolled emissions). In addition, source inspections, the active contacting of sources identified from mailing lists, and stricter permitting requirements contribute to the APCD's knowledge of potential emissions sources of OFCs. For HAPs the de minimis levels for reporting vary based on a combination of the specific HAP's toxicity and scenarios for its release, but can be as low as 50 pounds/year. Estimates for future emissions are based on the EPA's Economic Growth and Analysis System (EGAS) model for estimating future point sources activity.

7.2.1 Electrical Generation Utilities (EGUs)

Continuous Emissions Monitoring (CEM) data for electrical generation utilities (EGUs) in the vicinity of Denver were used for the 2006 Actual Base Case emissions inventory. The data were analyzed to also develop point source emissions for the 2006 Typical Base Case emissions inventory. The CEM data analysis resulted in emissions that were lower than the reported APEN emissions. Because of this, EGU emissions for 2010 were not grown using EGAS. Instead, the 2006 reported APEN emissions were used.

For the photochemical modeling, actual hourly CEM emission data were modeled for the 2006 model performance evaluation runs. Then, using the CEM data, "typical" temporal emissions profiles were developed. These temporal profiles were designed to reflect the expected emissions patterns for the local area and meteorological conditions being modeled. That is, the temporal profiles derived from the CEM data were used to

disaggregate the annual emissions to the daily and hourly estimates required for input to the photochemical model

To account for growth in EGU emissions from recently permitted emission units that are not included in the 2006 APEN inventory but expected to be in operation by 2010, case-by-case review was conducted to determine the actual emissions for 2010. Specifically:

- Comanche Power Plant. The new Unit 3 was permitted subject to netting under Regulation No. 3. As part of the SIP inventory development process, it was determined that the actual emissions from all three Comanche units in 2006 would be a reliable estimate of actual emissions in 2010 for NOx and SO_2. However, since the increase in CO and VOC emissions from Unit 3 were not accounted for in the 2006 emissions estimates from Unit 1 and Unit 2, the increase in CO and VOC emissions from the new Unit 3 were added to the 2010 inventory.
- Fort Saint Vrain Power Plant. Permitted emission limits for two new turbines were included in the 2010 inventory.
- Plains End Generating Station. Permitted emission limits for fourteen new natural-gas fired ICE units were included in the 2010 inventory.
- Platte River Power Authority – Rawhide Power Plant. Permitted emission limits for a new turbine was included in the 2010 inventory.
- Spindle Hill Energy. Permitted emission limits for new turbines were included in the 2010 inventory.
- Tri-State Generation Craig Plant. A permit modification at this facility was subject to netting under Regulation No. 3. It was determined that the actual emissions for this facility in 2006 are a reliable estimate of actual emissions in 2010.

7.3 Oil and Gas Emissions

Oil and gas source emissions are based on estimates from the WRAP Phase III oil and gas emissions inventory development study, which was sponsored by the Independent Petroleum Association of Mountain States (IPAMS):
http://www.wrapair.org/forums/ssjf/documents/eictts/OilGas/2008-04_%2706_Baseline_Emissions_DJ_Basin_Technical_Memo_(04-30).pdf
or
http://www.colorado.gov/airquality/documents/deno308/2008-04_2706_Baseline_Emissions_DJ_Basin_Technical_Memo_(04-30).pdf

WRAP Phase III oil and gas emissions were projected to 2010 using the methodology in the WRAP Phase III projection methodology document:
http://www.wrapair.org/forums/ssjf/documents/eictts/OilGas/2008-04_%2710_Projection_Emissions_DJ_Basin_Technical_Memo(04-30).pdf
or
http://www.colorado.gov/airquality/documents/deno308/2008-04_2710_Projection_Emissions_DJ_Basin_Technical_Memo(04-30).pdf

7.3.1 Calculation of Emission Reductions From the Oil and Gas Industry

7.3.1.1 Condensate Tank Emissions Controls

Uncontrolled emissions from condensate tanks are from the IPAMS inventory. The modifications to Regulation 7 would control emissions from all tanks greater than 10 tons per year by 95% and new and modified small tanks greater than 2 tons per year by 95%. The basic equation for calculating controlled emissions is as follows.

Equation 1:
Controlled emissions = Uncontrolled emissions X (1 – CE x RE x RP)

Where CE is the control efficiency (95%), RE is the rule effectiveness (a discount to account for less than perfect compliance, calculated elsewhere in the TSD as 83% or 0.83) and RP is rule penetration, calculated below.

7.3.1.1.1 Small Tanks (Less than 5 tons per year):

The 2007 Air Pollution Emission Notice (APEN) data (the latest complete year) was used as the basis to calculate the average effectiveness of emissions controls for tanks. Since only data for units with emissions of more than 5 tons per year were required to be submitted, the data are essentially nonexistent for small tanks and unreliable. The APEN data are limited to tanks greater than 5 tons per year within the 8-Hour Ozone Nonattainment Area (NAA).

Given this, two approaches could be used to estimate the number of small tanks for each range of emissions (greater than zero to 1 ton per year, greater than 1 to 2 tons per year, greater than 2 to 3 tons per year, greater than 3 to 4 tons per year, and greater than 4 to 5 tons per year). One approach would be to assume a statistical distribution and try to use data from large tanks to infer information about small tanks.. Another approach is to develop a mathematical model to predict the number of small units.

The Division investigated both approaches and provided some preliminary results to stakeholders based on the first approach. However, upon further review, the Division

decided that the second approach would provide a more technically defensible result because there is insufficient data to determine the type of statistical distribution to apply to small tanks.

A regression modeling approach was chosen. It uses the large tank APEN data to construct a regression analysis for the relationship between the number of units in each range of 1-ton interval of emissions and the emission rate. This regression is presented below in Figure 2 below.

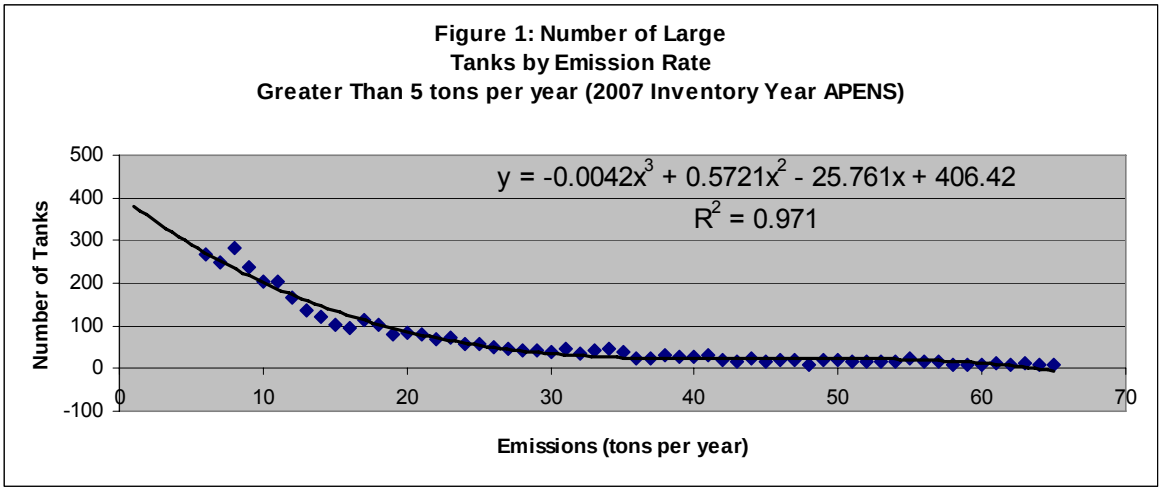

Figure 2. Number of Large Tanks by Emission Rate

The regression equation has an R^2 value of 0.97. That is, the regression equation fits the data well. A fundamental assumption in this approach is that the same equation will be a good predictor for the number of small tanks beyond the range of available APEN data. Based on the regression equation in the Figure 1, ($y = -0.0042x^3 + 0.5721x^2 - 25.761x + 406.42$) where y is the number of units at each emission interval and x is the emission rate in each 1 ton per year interval, the number of units in each interval of small tank emissions was determined.

Evaluating the equation for the interval from 3 to 4 (3), we find:

$$\mathbf{Y = -0.0042x(3)^3 + 0.5721x(3)^2 - 25.761x(3) + 406.42}$$

Y = -0.1134 + 5.1489 + -77.283 + 406.42
Y = 334.1525

The results of the reconstructed count and corresponding emissions in tons per year are given in Table 13 below.

Table 13. Reconstructed Count of Small Tanks with VOC Emissions Less than 5 Tons per Year

ton/year interval	Count	Total Emissions
0	reconstructed count	(t/y - 0.5) x Count
1	381	191
2	357	536
3	334	835
4	312	1,093
5	291	1,311

The last column of Table 13 is calculated by multiplying the count by the assumed average emission rate for each interval (assumed to be the midpoint of the interval – that is 1.5 for the 1 to 2 interval). This column represents the total emissions of all sources in each interval. So for the interval 3 we have:

emissions = 2.5 x 334 = 835 tons per year

The emissions from 2 to 5 tons per year sum to 3,240 tons (835 + 1093 + 1311). The emissions from 0 to 5 tons per year sum to 3,966 tons. Dividing 3,240 by 3,966 gives the fraction of emissions affected by controlling units with emissions greater than 2 tons per year. This fraction, 0.82, is also called “Rule Penetration” (RP).

Table 14 summarizes the results of **Equation 1** and the IPAMS inventory for small condensate tanks.

Table 14. Small Condensate Tanks

County	2006 Uncontrolled Emissions T/Y	Growth Factor	2010 Uncontrolled Emissions T/Y	New Emissions Uncontrolled	OLD Emissions 2010 Uncontrolled	CE	RP	RE	New Emissions 2010 Controlled	OLD Emissions 2010 Controlled	OLD Controlled + NEW Controlled
ADAMS	173.7	0.730	126.86		126.86	0	0.82	0.83	0	126.9	126.86
ARAPAHOE	23.9	0.730	17.47		17.47	0	0.82	0.83	0	17.5	17.47
BOULDER	56.6	0.730	41.32		41.32	0	0.82	0.83	0	41.3	41.32
BROOMFLD	13.6	0.730	9.92		9.92	0	0.82	0.83	0	9.9	9.92
DENVER	6.3	0.730	4.58		4.58	0	0.82	0.83	0	4.6	4.58
LARIMER	36.5	0.730	26.63		26.63	0	0.82	0.83	0	26.6	26.63
WELD	5,208.8	1.302	6,784.40	393.90	6,390.51	0.95	0.82	0.83	140	6390.5	6,530.70
TOTAL	5,519.4		7,011.17	372.94	6,617.27				140	6,617.27	6,757.46
Total Tons/Day	15.1		19.2	1.0	18.1				0.4	18.1	**18.5**

7.3.1.1.2 Large Tanks (Greater than 5 tons per year)

Table 15 summarizes the results of **Equation 1** and the IPAMS inventory for large condensate tanks. The rule penetration for large tanks was calculated from the APEN data, and is the fraction of large tanks that have emissions greater than 10 tons per year.

Table 15. Large Condensate Tanks

County	2006 Uncontrolled Emissions T/Y	Growth Factor	2010 Uncontrolled Emissions T/Y			Control Factor	RP	RE	New Emissions 2010 Controlled	OLD Emissions 2010 Controlled	Controlled 2010 T/Y
ADAMS	2,644.7	0.730	1,930.99		1,930.99	0.95	0.884	0.830	0	584.7	584.74
ARAPAHOE	364.2	0.730	265.89		265.89	0.95	0.884	0.830	0	80.5	80.52
BOULDER	861.5	0.730	629.02		629.02	0.95	0.884	0.830	0	190.5	190.48
BROOMFLD	206.7	0.730	150.93		150.93	0.95	0.884	0.830	0	45.7	45.70
DENVER	95.4	0.730	69.65		69.65	0.95	0.884	0.830	0	21.1	21.09
LARIMER	555.1	0.730	405.33		405.33	0.95	0.884	0.830	0	122.7	122.74
WELD	79,287.7	1.302	103,271.06	5,995.83	97,275.23	0.95	0.884	0.830	1,268	29456.6	30,724.73
TOTAL	84,015.4	1.27028	106,722.87	5,676.88	100,727.03				1,268.12	30,501.88	31,770
Total T0ns/Day	230.2		292.4	15.6	276.0				3.5	83.6	87.0

In applying Equation **1** in Table 15, rule penetration is as shown in the table for existing tanks, but is 1.00 for new and modified tanks, since all new and modified tanks are controlled.

7.3.1.2 Pneumatic Device Emissions Controls

Uncontrolled emissions from Pneumatic Devices are from the IPAMS inventory. The modifications to Colorado Air Quality Control Commission Regulation 7 would require the use of low-bleed devices, which have been determined elsewhere in the TSD to control emissions from Pneumatic Devices by 74.8% (using enhanced maintenance). The basic equation for calculating controlled emissions is **Equation 1**. The result of applying **Equation 1** to the IPAMS inventory is shown in Table 16, below. The rule penetration is 1.00 because all devices in the NAA are to be controlled. The calculation of rule effectiveness is discussed elsewhere in the TSD.

Table 16. Nonattainment Area Pneumatic Devices Emissions

Nonattainment Area Pneumatic Devices Emissions (tons/year)					
County	**2010 Uncontrolled Emissions T/Y**	**Control Factor**	**Rule Penetration**	**Rule Effectiveness**	**Pneumatic Devices Controlled 2010 T/Y**
ADAMS	595	0.748	1	0.83	226
ARAPAHOE	68	0.748	1	0.83	26
BOULDER	167	0.748	1	0.83	63
BROOMFLD	42	0.748	1	0.83	16
DENVER	23	0.748	1	0.83	9
LARIMER	65	0.748	1	0.83	25
WELD	10,395	0.748	1	0.83	3,940
Grand Total	11,355				4,304
Tons Per Day	**31.1**				**11.8**

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