State of Colorado Implementation Plan to Meet the Requirements of Clean Air Act Section 110 (a)(2)(D)(i)(I) Interstate Transport Regarding the 1997 8-Hour Ozone Standard



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Colorado Department of Public Health and Environment Air Pollution Control Division 4300 Cherry Creek Drive South Denver, Colorado 80246

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Colorado Department of Public Health and Environment / Air Pollution Control Division

1. Ozone-Specific Provisions to Meet the Requirements of CAA 110(a)(2)(D)(i)(I) – Interstate Transport

1.1. Introduction

The purpose of this document is to provide a plan for the State of Colorado to meet the requirements of the Clean Air Act Section 110 (a)(2)(D)(i)(I) Interstate Transport requirements regarding the 0.08 parts per million (ppm) 8-Hour Ozone National Ambient Air Quality Standard (NAAQS). This addresses the applicable components of 110(a)(2)(D)(i)(I) demonstrating adequate provisions to prevent emissions from Colorado from interfering with attainment or maintenance of the federal ozone NAAQS in any other state. This analysis does not address ozone transport for the revised 0.075 ppm 8-Hour Ozone NAAQS.

This document replaces the section titled "Ozone-Specific Provisions" in the document "State of Colorado Implementation Plan to Meet the Requirements of Clean Air Act Section 110 (a)(2)(D)(i)(I) - Interstate Transport Regarding 8-Hour Ozone and PM_{2.5} NAAQS."

Currently, the Denver area is the only area in U.S. Environmental Protection Agency (EPA) Region VIII that is designated as nonattainment for the 8-hour ozone NAAQS of 0.08 ppm.

In this report, relevant information from the Denver Metropolitan Area and North Front Range (DMA/NFR) 8-hour Ozone State Implementation Plan (SIP) process, the Denver Early Action Compact (EAC) process, ambient ozone data for Colorado, ambient ozone data for nearby states from the EPA Air Quality System (AQS) database, and other information is used to demonstrate that Colorado does not contribute significantly to nonattainment in, or interfere with maintenance by, any other state with respect to the 0.08 ppm ozone NAAQS.

1.2. **Colorado Ozone Monitoring Network**

The 2007/2008 ozone ambient air monitoring network in the Denver area and along the northern Front Range consists of 13 stations operated by the Colorado Air Pollution Control Division (APCD) and one station operated by the National Park Service (NPS) in Rocky Mountain National Park. There have been other stations that have operated in the past. The geographical distribution of the Front Range monitors is presented in Figure 1.

As shown in Figure 1, the ozone monitors are primarily located in urbanized areas along the Front Range corridor. The monitors are located in areas where the highest ozone concentrations have been monitored historically and where elevated ozone is expected to occur. High ozone concentrations along the Front Range occur near the areas with high emissions density and dense population. In addition, elevated ozone is observed along elevated terrain to the west of the DMA/NFR Nonattainment Area. All of these monitors are designated by the U.S. Environmental Protection Agency as "equivalent" analyzers and follow all quality assurance requirements as specified in 40 CFR Part 58, Appendix A.



Figure 1. Location of Front Range Ozone Monitors

Figure 2 shows other ozone monitoring sites that exist in Colorado for 2008. These are operated by either Colorado, the Southern Ute Tribe, or various Federal agencies. All of these sites use monitors that are designated as "equivalent" analyzers by the U.S. Environmental Protection Agency. As shown, most of the sites are in the southwest corner of Colorado, either within or near the San Juan oil and gas development area.



Figure 2. Location of Statewide Ozone Monitors

Table 1, Table 2, and Table 3 present the monitoring data for the DMA/NFR NAA monitoring sites (including the NPS Rocky Mountain National Park monitoring site) as well as for other sites in Colorado. In Table 3, the fourth maximum 8-hour ozone concentrations along with the 3-year average of the fourth maximum concentrations at each site are presented. As shown in both Table 1 and Table 3, the Denver area is currently meeting the 8-hour and former 1-hour ozone NAAQS for all sites, except for the 8-Hour NAAQS at Rocky Flats North with a design value of 0.86 ppm.

		1st Max	Date	2nd Max	Date	3rd Max	Date	4th Max	Date
AQS	Site Name	1-Hour	1st Max	1-Hour	2nd Max	1-Hour	3rd Max	1-Hour	4th Max
Inumber		(ppm)	1-Hour	(ppm)	1-Hour	(ppm)	1-Hour	(ppm)	1-Hour
08-001-3001	Welby	0.100	08/29	0.095	08/05	0.092	07/10	0.089	06/20
08-005-0002	* Highland	0.065	04/04	0.064	04/08	0.064	04/18	0.062	04/19
08-013-0011	S. Boulder Creek	0.089	07/10	0.089	07/25	0.086	07/16	0.085	05/31
08-031-0014	Carriage	0.094	08/05	0.090	08/29	0.089	07/10	0.085	06/20
08-031-0025	** Denver - Animal Shelter	0.100	07/10	0.098	08/05	0.087	06/20	0.087	08/24
08-035-0004	Chatfield State Park	0.101	07/10	0.098	06/20	0.095	08/29	0.092	08/24
08-041-0013	Colo. Spgs Academy	0.085	05/24	0.083	07/10	0.082	08/06	0.080	07/18
08-041-0016	Manitou Springs	0.087	05/24	0.085	08/06	0.083	07/10	0.083	07/11
08-045-0012	** Rifle - Health	0.081	07/09	0.080	07/10	0.075	08/19	0.074	07/11
08-059-0002	Arvada	0.093	08/05	0.093	08/29	0.092	07/10	0.088	07/25
08-059-0005	Welch	0.102	07/10	0.090	06/20	0.088	08/05	0.088	08/29
08-059-0006	Rocky Flats - N	0.088	07/10	0.088	07/18	0.088	08/29	0.087	07/02
08-059-0011	NREL	0.097	08/29	0.093	07/10	0.092	08/05	0.092	08/24
08-067-7001	*** So. Ute - Ignacio	0.076	06/04	0.075	05/31	0.073	05/03	0.072	05/3
08-067-7003	*** So. Ute - Bondad	0.080	06/04	0.078	05/31	0.077	05/27	0.071	04/21
08-067-????	USFS - Shamrock	0.081	06/04	0.079	06/10	0.077	02/29	0.077	05/30
08-069-0007	Rocky Mountain Nat'l Park	0.092	07/09	0.090	07/31	0.090	08/28	0.085	05/22
08-069-0011	Ft. Collins - West	0.093	08/19	0.092	07/09	0.092	07/18	0.088	07/24
08-069-1004	Ft. Collins - CSU	0.082	08/19	0.080	07/09	0.079	08/30	0.078	07/24
08-077-0020	** Palisade - Water	0.081	07/09	0.079	07/10	0.075	07/08	0.074	07/05
08-083-0006	** Cortez	0.078	07/23	0.074	07/13	0.072	08/05	0.071	07/25
08-083-0101	Mesa Verde Nat'l Park	0.075	05/01	0.075	06/04	0.074	05/31	0.072	04/30
08-123-0009	Greeley - Weld Tower	0.094	08/20	0.092	07/24	0.089	08/01	0.087	08/04

Table 1: 2008 1-Hour Ozone Monitored Concentration (updated through Sept. 30, 2008)

NOTES:

* Highland site shut down on 4/21/08 for approx. 6-months.

** Denver - Animal Shelter site commenced on 4/22/08, Rifle - Health commenced on 6/20/08, Palisade - Water commenced on 5/30/08 and Cortez commenced on 6/17/08.

*** Southern Ute sites data only thru 6/30/08.

		1st Max	Date	2nd Max	Date	3rd Max	Date	4th Max	Date
AQS Number	Site Name	8-Hour	1st Max	8-Hour	2nd Max	8-Hour	3rd Max	8-Hour	4th Max
Inumber		(ppm)	8-Hour	(ppm)	8-Hour	(ppm)	8-Hour	(ppm)	8-Hour
08-001-3001	Welby	0.085	07/10	0.083	08/29	0.077	07/18	0.076	06/20
08-005-0002	* Highland	0.062	04/04	0.060	04/08	0.060	04/18	0.059	04/05
08-013-0011	S. Boulder Creek	0.080	07/10	0.076	05/31	0.076	07/09	0.076	07/18
08-031-0014	Carriage	0.081	07/10	0.075	08/29	0.073	06/20	0.072	07/26
08-031-0025	** Denver - Animal Shelter	0.086	07/10	0.072	08/29	0.071	07/13	0.070	07/26
08-035-0004	Chatfield State Park	0.090	07/10	0.082	06/30	0.080	06/20	0.080	06/27
08-041-0013	Colo. Spgs Academy	0.078	05/24	0.077	07/10	0.073	08/06	0.070	07/18
08-041-0016	Manitou Springs	0.080	05/24	0.076	07/10	0.074	07/11	0.072	07/31
08-045-0012	** Rifle - Health	0.076	07/09	0.076	07/10	0.069	08/19	0.066	07/13
08-059-0002	Arvada	0.081	08/29	0.080	07/10	0.077	06/20	0.074	08/05
08-059-0005	Welch	0.095	07/10	0.079	06/20	0.077	07/18	0.073	08/19
08-059-0006	Rocky Flats - N	0.083	07/10	0.080	07/18	0.079	05/31	0.079	08/29
08-059-0011	NREL	0.085	07/10	0.085	08/29	0.077	06/20	0.076	06/02
08-067-7001	*** So. Ute - Ignacio	0.069	06/04	0.067	06/10	0.066	05/10	0.066	06/13
08-067-7003	*** So. Ute - Bondad	0.073	06/04	0.067	05/27	0.067	05/31	0.067	06/05
08-067-????	USFS - Shamrock	0.074	06/04	0.073	06/10	0.071	06/13	0.069	05/30
08-069-0007	Rocky Mountain Nat'l Park	0.081	07/09	0.077	05/25	0.077	07/31	0.076	05/31
08-069-0011	Ft. Collins - West	0.081	07/18	0.079	07/09	0.078	05/25	0.076	07/24
08-069-1004	Ft. Collins - CSU	0.070	05/25	0.070	07/09	0.068	07/18	0.066	05/31
08-077-0020	** Palisade - Water	0.077	07/09	0.075	07/10	0.070	05/31	0.070	07/29
08-083-0006	** Cortez	0.067	08/02	0.066	07/23	0.065	08/07	0.064	08/05
08-083-0101	Mesa Verde Nat'l Park	0.071	06/04	0.070	04/30	0.069	04/21	0.069	06/10
08-123-0009	Greeley - Weld Tower	0.077	07/24	0.076	08/20	0.075	07/26	0.073	08/01

Table 2: 2008 8-Hour Ozone Monitored Concentration (updated through Sept. 30, 2008)

NOTES:

* Highland site shut down on 4/21/08 for approx. 6-months.

** Denver - Animal Shelter site commenced on 4/22/08, Rifle - Health commenced on 6/20/08, Palisade - Water commenced on 5/30/08 and Cortez commenced on 6/17/08.

*** Southern Ute sites data only thru 6/30/08.

Table 3: 8-Hour Design Value Using the 3-Year (2006-2008) Average of the Fourth Maximum Ozone Concentration

		$\frac{2006}{4^{\text{th}}}$	$\frac{2007}{4^{\text{th}}}$	$\frac{2008}{4^{\text{th}}}$	Design Value (2006 – 2008)
		- Maximum	- Maximum	- Maximum	(2000 – 2000) 3-Year
		8-Hour	8-Hour	8-Hour	Average
Site Name	AQS #	Average	Average	Average	4 th Maximum
		Value (ppm)	Value (ppm)	Value (ppm)	Value (ppm)
Welby	08-001-3001	0.069	0.070	0.076	0.071
* Highland	08-005-0002	0.081	0.075	0.059	0.071
S. Boulder Creek	08-013-0011	0.082	0.085	0.076	0.081
Carriage	08-031-0014	0.072	0.076	0.072	0.073
** Denver - Animal Shelter	08-031-0025			0.070	
Chatfield State Park	08-035-0004	0.086	0.082	0.080	0.082
USAF Academy	08-041-0013	0.072	0.072	0.070	0.071
Manitou Springs	08-041-0016	0.076	0.072	0.072	0.073
** Rifle - Health	08-045-0012			0.066	
Arvada	08-059-0002	0.082	0.079	0.074	0.078
Welch	08-059-0005	0.081	0.080	0.073	0.078
Rocky Flats - North	08-059-0006	0.090	0.090	0.079	0.086
NREL	08-059-0011	0.083	0.085	0.076	0.081
*** So. Ute - Ignacio	08-067-7001			0.066	
*** So. Ute - Bondad	08-067-7003	0.063	0.071	0.067	0.067
USFS - Shamrock	08-067-????	0.074	0.069	0.069	0.070
Rocky Mountain Nat'l Park	08-069-0007	0.076	0.078	0.076	0.076
Fort Collins - West	08-069-0011	0.087	0.085	0.076	0.082
Fort Collins - CSU	08-069-1004	0.078	0.069	0.066	0.071
** Palisade - Water	08-077-0020			0.070	
** Cortez	08-083-0006			0.064	
Mesa Verde Nat'l Park	08-083-0101	0.074	0.070	0.069	0.071
Greeley - Weld Tower	08-123-0009	0.082	0.074	0.073	0.076

NOTES:

* Highland site shut down on 4/21/08 for approx. 6-months.

** Denver - Animal Shelter site commenced on 4/22/08, Rifle - Health commenced on 6/20/08, Palisade - Water commenced on 5/30/08 and Cortez commenced on 6/17/08.

*** Southern Ute sites data only thru 6/30/08. Ignacio data invalid for 01/2005 to 08/2007.

1.3. Ozone Monitoring Network in Nearby States

Table 4 present 8-hour ozone monitoring data from the surrounding states of Nebraska, Kansas, New Mexico, Wyoming, and Utah. Table 4 and show that none of the monitors in surrounding states exceed the 8-hour ozone standard except for Davis County Utah. Therefore, to the extent that the network is representative of all areas, it can be concluded that the DMA/NFR sources do not significantly contribute to the 8-hour ozone standard violations at these down wind locations or even further downwind. In addition, Colorado does not significantly contribute to violations upwind including Davis County Utah. Utah's 8-hour proposed 8-hour maintenance plan for the 1997 8-hour ozone standard does not suggest that Colorado interferes with the maintenance of the standard in Davis County Utah.

Table 4: 2005-2007 3-Year Fourth Highest Average Monitoring Concentrations from Kansas, Nebraska, New Mexico, Utah and Wyoming

				2005	2006		
				8-hr	8-hr	2007	3-yr
				Ozone	Ozone	8-hr Ozone	Avg. of
			EPA	4th Max	4th Max	4th Max	4th Max
Site ID	State	County	Region	(ppm)	(ppm)	(ppm)	(ppm)
20-045-0004	KS	Douglas	7	0.073	0.081	End 2007	N/A
20-091-0010	KS	Johnson	7	0.081	0.076	0.071	0.076
20-103-0003	KS	Leavenworth	7	0.077	0.074	0.080	0.077
20-107-0002	KS	Linn	7	0.075	0.079	0.070	0.074
20-173-0001	KS	Sedgwick	7	0.065	0.065	0.059	0.063
20-173-0010	KS	Sedgwick	7	0.074	0.073	0.060	0.069
20-191-0002	KS	Sumner	7	0.078	0.080	0.070	0.076
20-195-0001	KS	Trego	7	0.071	0.076	0.068	0.071
20-209-0021	KS	Wyandotte	7	0.079	0.081	0.073	0.077
31-055-0028	NE	Douglas	7	0.069	0.072	0.066	0.069
31-055-0032	NE	Douglas	7	0.067	0.066	0.056	0.063
31-055-0035	NE	Douglas	7	0.070	0.067	0.061	0.066
31-109-0016	NE	Lancaster	7	0.056	0.056	0.054	0.055
35-001-0019	NM	Bernalillo	6	0.073	0.073	0.070	0.072
35-001-0023	NM	Bernalillo	6	0.072	0.073	0.069	0.071
35-001-0024	NM	Bernalillo	6	0.074	0.074	0.068	0.072
35-001-0027	NM	Bernalillo	6	0.073	0.072	0.071	0.072
35-001-0029	NM	Bernalillo	6	0.071	0.070	0.067	0.069
35-001-1012	NM	Bernalillo	6	0.077	0.047	0.074	0.066
35-001-1013	NM	Bernalillo	6	0.077	0.071	0.071	0.073
35-001-1014	NM	Bernalillo	6	0.072	0.072	0.064	0.069
35-013-0008	NM	Dona Ana	6	0.070	0.072	0.068	0.070
35-013-0017	NM	Dona Ana	6	0.070	0.073	0.070	0.071
35-013-0020	NM	Dona Ana	6	0.072	0.072	0.068	0.070
35-013-0021	NM	Dona Ana	6	0.076	0.080	0.076	0.077
35-013-0022	NM	Dona Ana	6	0.070	0.073	0.073	0.072
35-013-0023	NM	Dona Ana	6	0.066	0.070	0.062	0.066

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Table 4 (continued) 2005-2007 3-Year Fourth Highest Average Monitoring Concentrations from Kansa	s,
Nebraska, New Mexico, Utah and Wyoming	

				2005	2006		
				8-hr	8-hr	2007	3-yr
				Ozone	Ozone	8-hr Ozone	Avg. of
			EPA	4th Max	4th Max	4th Max	4th Max
Site ID	State	County	Region	(ppm)	(ppm)	(ppm)	(ppm)
35-015-1005	NM	Eddy	6	0.067	0.076	0.066	0.069
35-017-1003	NM	Grant	6	0.071	0.067	0.062	0.066
35-025-0008	NM	Lea	6	0.074	0.075	0.064	0.071
35-029-0003	NM	Luna	6	Start 2006	0.053	0.062	N/A
35-043-1001	NM	Sandoval	6	0.069	0.064	0.063	0.065
35-043-1003	NM	Sandoval	6	0.075	0.074	0.071	0.073
35-043-9004	NM	Sandoval	6	0.076	0.072	0.067	0.071
35-045-0009	NM	San Juan	6	0.075	0.063	0.069	0.069
35-045-0018	NM	San Juan	6	Start 2006	0.079	0.079	N/A
35-045-1005	NM	San Juan	6	0.072	0.071	0.073	0.072
49-003-0003	UT	Box Elder	8	0.079	0.078	0.077	0.078
49-003-7001	UT	Box Elder	8	0.075	0.076	0.078	0.076
49-005-0004	UT	Cache	8	0.069	0.073	0.074	0.072
49-011-0004	UT	Davis	8	0.092	0.082	0.082	0.085
49-035-0003	UT	Salt Lake	8	0.083	0.084	0.082	0.083
49-035-2004	UT	Salt Lake	8	0.086	0.082	0.082	0.083
49-035-3006	UT	Salt Lake	8	0.082	0.082	0.079	0.081
49-035-3007	UT	Salt Lake	8	0.085	0.080	0.080	0.081
49-035-3008	UT	Salt Lake	8	0.080	0.082	0.079	0.080
49-037-0101	UT	San Juan	8	0.069	0.070	0.072	0.070
49-045-0003	UT	Tooele	8	0.080	0.079	0.076	0.078
49-049-0002	UT	Utah	8	0.078	0.074	0.075	0.075
49-049-5008	UT	Utah	8	0.080	0.077	0.078	0.078
49-049-5010	UT	Utah	8	0.080	0.079	0.077	0.078
49-053-0130	UT	Washington	8	0.091	0.072	0.071	0.078
49-057-0007	UT	Weber	8	0.081	0.083	0.080	0.081
49-057-1003	UT	Weber	8	0.084	0.083	0.082	0.083
56-005-0123	WY	Campbell	8	0.063	0.072	0.072	0.069
56-005-0456	WY	Campbell	8	0.063	0.065	0.072	0.066
56-035-0098	WY	Sublette	8	0.075	0.069	0.068	0.070
56-035-0099	WY	Sublette	8	0.079	0.072	0.067	0.072
56-035-0100	WY	Sublette	8	0.066	0.074	0.066	0.068
56-037-0200	WY	Sweetwater	8	Start 2006	0.067	0.064	N/A
56-039-1011	WY	Teton	8	0.060	0.069	0.065	0.064

Figure 3 presents a map of all the U.S. nonattainment areas for the 1997 8-hour ozone standard.. Since the surrounding states of Kansas, Nebraska, Wyoming, Utah, and New Mexico do not have violations the 8-hour NAAQS for ozone, it can be reasonably concluded that Colorado sources do not significantly affect the ozone nonattainment areas

even further downwind such as Dallas-Forth Worth and St. Louis nonattainment areas. In addition, it is unlikely that Colorado would significantly affect nonattainment areas that are typically "upwind" such as Las Vegas and Phoenix. However, it is recognized that, under the types of synoptic scale meteorological regimes that occur during some regional ozone episodes, simple terms like "upwind" and "downwind" may not be applicable. Thus, photochemical modeling is needed to study the distribution of ozone under a variety of meteorological regimes.



Figure 3: 8-Hour Ozone Nonattainment Areas

1.4. Ozone Transport Conclusions from the DMA/NFR Photochemical Modeling

The DMA/NFR photochemical model domain was defined on a nested 36-kilometer (km), 12 km, and a 4 km nested-grid structure. This structure was utilized in conjunction with the Comprehensive Air-quality Model with extensions (CAMx) air quality model (ENVIRON, 2008). CAMx, SMOKE (Coats, 1996), and CONCEPT MS (Loomis et al., 2005) air quality and emissions modeling was performed for the June-July 2006 period. Nested 36/12/4 km modeling domains were used in the Denver 8-hour ozone modeling study. The CAMx model was first applied to the 36 km continental U.S. domain using boundary conditions (BCs) from a global climate air quality model. The CAMx 2006 and 2010 base case modeling results from the 36 km continental U.S. domain simulation were then processed to generate BCs for the CAMx 12/4 km domain (Figure 4) for the 2006 12/4 km base case and 2010 12/4 km base case and sensitivity simulations. The CAMx simulations for the 12/4 km domains were run using two-way interactive grid nesting (i.e., pollutants can flow back and forth between the 12 km and 4 km domains to account for recirculation). The larger 36km domain was selected to address the impact of boundary condition uncertainties for the Front Range area of Colorado, as APCD was concerned there may be transport from Southern California and Texas. The 12 km grid resolution domain essentially covers the central Rocky Mountain States or portions thereof (i.e., Arizona, Colorado, New Mexico, Utah and Wyoming.) The 4 km nested-grid covers most of the state of Colorado.



Figure 4. Nested 12/4 km modeling domains for the Denver CAMx air quality and SMOKE emissions modeling.

1.4.1. Emission Inventories and 2006 and 2010 Base Case

The photochemical modeling for the "2010 base case" emissions scenario performed for the DMA/NFR Ozone SIP process demonstrates compliance in the Front Range Region with the 8-hour 0.08 ppm ozone NAAQS. 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 nonoil 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 5. 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.

	2006 2010			
Source Category	NOx	voc	NOx	voc
Point Sources				
Electric Generation Units (EGU)	55.6	07	58.5	1 (
External Combustion Boilers	9.5	0.4	10.0	0.5
Industrial Processes	12.5	10.2	14.0	111
Petroleum and Solvent Evaporation	03	19.0	03	221
Other	3.1	1.8	36	22.
Beint Sources Subtetel	0.1	22.4	0.0	2.
	01.0	32.1	00.4	37.
Oil & Gas Point & Area Sources				
Condensate Tanks	1	126.5	i	1291
Other O&G Point Sources	22.6	6.8	23.6	120.
Proumatic Devices (Area Source)	22.0	24.8	20.0	31
Lippormitted Eugitives (Area Source)		24.0		20
Other Area Courses	474	10.2		20.4
Other Area Sources	17.1	10.8	22.5	13.
O&G Point & Area Sources Subtotal	39.7	185.2	46.2	203.
Area Sources				
Personal Care Products		71		7 (
Heuseheld Breduete		21.4		170
Automative Afformativet Dreducts		21.4		12.0
Automotive Alternarket Froducts		11.9		10.0
Aircnitectural Coatings	7 4	20.1		10.0
Aircraft	1.4	1.3	8.2	1.:
Railroad	12.8	0.5	13.8	0.0
Other Coatings/Pesticides/Cooking/ Miscellaneous.		3.9	!	4.1
Area Source Subtotal	20.2	66.3	22.1	61.0
Non-Road Mobile Sources				-
	70	٨٩	63	0.
	0.7	0.0	0.0	0.
Commorsial Equipment	53	6.7	5.0	0. 7 (
Construction and Mining Equipment	25.7	0.2	24.0	1.0
	30.7	0.0	01.2	4.3
			n 9 9 1	·
Industrial Equipment	10.0	2.4	0.0	00
Industrial Equipment Lawn and Garden Equipment (Commercial)	9.4	2.4 35.9	8.9	28.1
Industrial Equipment Lawn and Garden Equipment (Commercial) Lawn and Garden Equipment (Residential)	9.4 1.2	35.9 7.5	8.9 1.2	28.1 11.8
Industrial Equipment Lawn and Garden Equipment (Commercial) Lawn and Garden Equipment (Residential) Boats/Recreational Equipment/Miscellaneous	9.4 1.2 0.7	2.4 35.9 7.5 6.9	8.9 1.2 0.8	28.1 11.8 7.8
Industrial Equipment Lawn and Garden Equipment (Commercial) Lawn and Garden Equipment (Residential) Boats/Recreational Equipment/Miscellaneous Non-Road Mobile Source Subtotal	9.4 1.2 0.7 70.5	2.4 35.9 7.5 6.9 65.3	8.9 1.2 0.8 61.0	28.1 11.8 7.8 61.3
Industrial Equipment Lawn and Garden Equipment (Commercial) Lawn and Garden Equipment (Residential) Boats/Recreational Equipment/Miscellaneous Non-Road Mobile Source Subtotal	9.4 1.2 0.7 70.5	35.9 7.5 6.9 65.3	8.9 1.2 0.8 61.0	28.1 11.8 7.8 61. 3
Industrial Equipment Lawn and Garden Equipment (Commercial) Lawn and Garden Equipment (Residential) Boats/Recreational Equipment/Miscellaneous Non-Road Mobile Source Subtotal	9.4 1.2 0.7 70.5	2.4 35.9 7.5 6.9 65.3	8.9 1.2 0.8 61.0	28. ⁻ 11.8 7.8 61. -
Industrial Equipment Lawn and Garden Equipment (Commercial) Lawn and Garden Equipment (Residential) Boats/Recreational Equipment/Miscellaneous Non-Road Mobile Source Subtotal On-Road Mobile Sources On-Road Mobile (including vehicle refueling)	9.4 9.4 1.2 0.7 70.5	2.4 35.9 7.5 6.9 65.3 129.7	8.9 1.2 0.8 61.0 122.9	28. 11.8 7.8 61. 109.2
Industrial Equipment Lawn and Garden Equipment (Commercial) Lawn and Garden Equipment (Residential) Boats/Recreational Equipment/Miscellaneous Non-Road Mobile Source Subtotal On-Road Mobile Sources On-Road Mobile Subtotal	9.4 1.2 0.7 70.5 165.5 165.5	2.4 35.9 7.5 6.9 65.3 129.7 129.7	8.9 1.2 0.8 61.0 122.9 122.9	28. ⁻ 11.8 7.8 61.: 109.2 109.2
Industrial Equipment Lawn and Garden Equipment (Commercial) Lawn and Garden Equipment (Residential) Boats/Recreational Equipment/Miscellaneous Non-Road Mobile Source Subtotal On-Road Mobile Sources On-Road Mobile (including vehicle refueling) On-Road Mobile Subtotal Anthropogenic Total	9.4 1.2 0.7 70.5 165.5 165.5 376.8	2.4 35.9 7.5 6.9 65.3 129.7 129.7 129.7 129.7	8.9 1.2 0.8 61.0 122.9 122.9 122.9 338.5	28.2 11.8 61.3 109.2 109.2
Industrial Equipment Lawn and Garden Equipment (Commercial) Lawn and Garden Equipment (Residential) Boats/Recreational Equipment/Miscellaneous Non-Road Mobile Source Subtotal On-Road Mobile Subtotal On-Road Mobile Subtotal Anthropogenic Total Biogenic Total	10.3 9.4 1.2 0.7 70.5 165.5 165.5 376.8 53.0	2.4 35.9 7.5 6.9 65.3 129.7 129.7 478.6 694.0	8.9 1.2 0.8 61.0 122.9 122.9 338.5 53.0	28. 11. 61. 109.2 109.2 471.4

Table 5. Base Case Inventories for 8-Hour Ozone DMA/NFR NAA Photochemical Modeling

1.4.2. Discussion of 2010 Base Case CAMx Modeling Results

Currently, Colorado's highest emissions density is along the Front Range. As shown in Figure 5 Photochemical Modeling done for the DMA/NFR SIP process shows that the highest 2010 ozone design values along the foothills west of Denver and Fort Collins. Ozone concentrations decrease rapidly to the east of Denver. The maximum projected 2010 base case 8-hour ozone Design Value of 84 ppb occurs at both the Rocky Flats North and Fort Collins West monitoring sites. As this value is 84 ppb or lower, the 2010 base case modeling results pass the EPA modeled attainment demonstration test. Although the EPA 8-hour ozone projection procedure is to truncate the final projected DVF for comparisons with the NAAQS, the projected 2010 base case future years design value is 84.9 ppb (Morris, et al, 2008a). White (unshaded) areas in Figure 5 have future design value of less than 63.8 ppb.



Figure 5. Projected 2010 8-hour ozone Design Values (DVF)

Figure 6 presents the ozone source apportionment results, including the boundary conditions. The boundary conditions (BCs) show the contribution from sources outside the

15 State of Colorado Implementation Plan to Meet the Requirements of Clean Air Act Section 110 (a)(2)(D)(i)(I) - Interstate Transport Regarding 8-Hour Ozone 12 km domain (see Figure 4) for a given high ozone day (results vary by day). On this day, of the 76.1 ppb of ozone estimated at the monitor, approximately 48 ppb was transported into the 12 km domain and approximately 8 ppb was attributed to sources in the seven-county Denver Metro area (Morris, et al, 2008a) while the rest was from other counties in Colorado or from other states. This suggests that, on this day, ozone was generated primarily by global/continental scale "background" and local sources of emissions in the Denver Metro area. Transport from nearby states was relatively small.



Figure 6. Rocky Flats North source apportionment for 29 July including boundary conditions.

Conclusions from ozone source apportionment results (Morris, et al, 2008a) vary by day and by location. However, several overall trends emerged, namely:

- Regional ozone transport into the 12 km domain is the largest contributor, often accounting for more than two-thirds of the total ozone;
- At the Denver Metropolitan monitors the largest contributors are Denver Metropolitan metro area motor vehicle and non-road sources;
- At the Fort Collins and Greeley monitors, the largest contributors tend to be Larimer and Weld County motor vehicles, non-road sources and oil and gas sources, and Denver Metropolitan sources;
- The majority of the ozone formed is attributable to anthropogenic NOx emissions.

State of Colorado Implementation Plan to Meet the Requirements of Clean Air Act Section 110 (a)(2)(D)(i)(I) - Interstate Transport Regarding 8-Hour Ozone

In interpreting these results, it is important to keep in mind that the source apportionment results are based on the Denver SIP 2006 modeling episode and are meteorologically dependent For instance, the source apportionment modeling in support of the Denver Early Action Compact using a 2002 ozone episode (Morris, et al. 2004a) showed more impact from sources in northern Colorado in the Denver Metropolitan area.

Other ozone transport studies also confirm that Denver is impacted by ozone from areas well outside of Colorado. A report sponsored by the Western States Air Resources Council (WESTAR) indicates that, when ozone is greater than 85 ppb in Denver, natural background accounts for 37.5% of the total concentration, transported anthropogenic generated ozone is 37.5%, and the local anthropogenic ozone contribution is about 25% (MacDonald, et. al, 2006).

A common theme at all ozone monitors is that a majority of the peak 8-hour ozone is due to ozone transport from sources outside of Colorado and outside the 12km domain boundary. Source apportionment modeling indicates that transport into the region accounts for approximately 60-75% of the ozone formation in the DMA/NFR. This indicates that the DMA/NFR is more of a receptor of ozone and ozone precursors rather than a producer of ozone and precursors that transports ozone to areas outside of the Front Range. While the modeling suggests that the transport of ozone and/or ozone precursors is a significant issue in the west, the magnitude of ozone transport from Colorado to other states is too low to significantly contribute to nonattainment in, or interfere with maintenance by, any other state with respect to the 0.08 ppm ozone NAAQS.

Denver Metro Area/North Front Range Ozone Nonattainment 1.5. Area Contribution to Downwind Locations

As part of the Denver EAC, source apportionment modeling was conducted to evaluate the spatial extent of the 8-hour ozone impacts due to emissions from various source regions in Colorado. A similar analysis was not done as part of the DMA/NFR ozone SIP analysis, however, a similar conclusion would be expected. The conclusion is that ozone formed specifically from sources in the DMA/NFR nonattainment area decreases rapidly in concentration over the eastern plains of Colorado. Therefore, the photochemical modeling that was done for both the DMA/NFR ozone SIP and the Denver EAC suggest that ozone and/or ozone precursors from the Front Range do not contribute significantly to downwind monitors in other states.

Figure 7 displays the spatial extent of the 8-hour ozone concentrations that occurred between 10am and 6pm local time (the time when the daily maximum 8-hour ozone typically occur) on June 27, 2002 through July 1, 2002 due to all emissions (anthropogenic and biogenic) from the DMA. As shown in Figure 7, which represents a high ozone episode in Denver, the DMA can contribute approximately 10 ppb of ozone at the eastern border of Colorado. However, the concentration gradient falls off quickly and emissions from the DMA are not expected to be a significant contributor to any ozone nonattainment area downwind of the Front Range. Weld, Elbert, Morgan, Larimer, El Paso and other counties contribute even less ozone to the Colorado border states with a maximum contribution of 5-10 ppb.



Figure 7: Spatial extent of the 8-hour ozone concentrations that occurred between 10am and 6pm local time on June 27, 2002 through July 1, 2002

1.6. Section 110(a)(2)(D)(i)(I) – Ozone Transport Conclusions

With respect to the 0.08 ppm ozone NAAQS, emission control programs in the Colorado SIP are expected to adequately protect downwind neighboring states from interstate transport of ozone, per Clean Air Act (CAA) Section 110(a)(2)(D)(i)(I).

Ambient monitoring data in and around Colorado support the assertion that Colorado does not contribute significantly to nonattainment in, or interfere with maintenance by, any other state with respect to the 1997 8-hour ozone NAAQS of 0.08 ppm. Colorado is unlikely to interfere with maintenance of the 8-hour ozone standard in downwind or potentially downwind states is supported by monitoring data collected in neighboring states (see Table 4) and the results of photochemical modeling analysis as discussed in Section 1.4.2 and 1.5. Specifically:

1. Ozone concentrations measured at Kansas, Nebraska, and Wyoming monitors closest to Colorado are significantly below the nonattainment threshold. In addition, the results of the photochemical analysis discussed in the sections noted above show that the ozone values in the easternmost Colorado counties are sufficiently low to make it unlikely for ozone transport from Colorado to interfere with maintenance of the 1997 NAAQS in downwind state.

2. A review of recent ozone observations from the EPA AQS database shows that, with the exception of a single monitor in Jefferson County, Colorado (i.e., Rocky Flats North), all monitoring sites in Colorado and adjacent states that are likely to be impacted by Colorado demonstrated attainment of the 0.08 ppm 8-hour ozone NAAQS for the three year period of 2005-2007. Since ozone monitors in adjacent states comply with the 0.08 ppm NAAQS, it logically follows that Colorado does not cause or contribute to monitored violations or interfere with maintenance of the 0.08 ppm ozone NAAQS in any other state.

3. For Rocky Flats North, which is the only monitor in Colorado that has levels above the 0.08 ppm ozone NAAQS, the preliminary three-year average (2006-2008) fourth high value is 0.086 parts per million (ppm), which is only slightly above the 0.08 ppm ozone NAAQS.

4. Observations from current networks show that the highest ozone levels in Colorado occur along the Colorado Front Range and not in other areas of Colorado.

5.Ozone monitoring data from the surrounding states that are most likely to be impacted by Colorado (i.e., Nebraska, Kansas, New Mexico, Wyoming, and Utah) show that none of the monitors exceed the 0.08 ppm 8-hour ozone standard. Since the areas represented by these monitors are in monitored attainment, it is highly unlikely that existing 0.08 ppm ozone nonattainment areas beyond these areas are significantly affected by emissions from Colorado. The nearest 0.08 ppm ozone nonattainment areas to DMA/NFR Nonattainment Area are:

a. Phoenix, Arizona (Basic Area for 8-Hour ozone) at a distance of 586 miles;

- b. Las Vegas, Nevada (Basic Area for 8-hour ozone) at a distance of 628 miles:
- c. Dallas, Texas (Moderate 8-hour ozone nonattainment area) at a distance of 663 miles; and
- d. St. Louis, Missouri (Moderate 8-hour ozone nonattainment area) at a distance of 796 miles.

Photochemical modeling and other technical analyses performed for the Denver Early Action Compact (EAC) and the Denver Metro Area and North Front Range (DMA/NFR) 8-hour Ozone SIP support the assertion that Colorado does not contribute significantly to nonattainment in, or interfere with maintenance by, any other state with respect to the 0.08 ppm ozone NAAQS. Specifically:

- 1. The Denver 8-hour Ozone SIP photochemical modeling for 2010 and the associated weight of evidence analyses suggest that the DMA/NFR nonattainment area and downwind areas already comply or will comply with the 0.08 ppm ozone NAAQS by 2010.
- 2. Photochemical modeling shows that elevated ozone concentration levels generated from local emissions decrease rapidly with distance.
- 3. A review of photochemical modeling performed for both the DMA/NFR Ozone SIP and the Denver EAC, including boundary condition analyses, suggests that the magnitude of ozone transport from Colorado to other states is too low to significantly contribute to nonattainment in, or interfere with maintenance by, any other state with respect to the 0.08 ppm ozone NAAQS.

In summary, a review of monitoring data, photochemical modeling, and weight of evidence analyses generated for the DMA/NFR SIP process suggests that the transport of ozone and ozone precursors from Colorado does not cause or significantly contribute to nonattainment in, or interfere with maintenance by, any other state with respect to the 0.08 ppm 8-hour ozone NAAQS. This analysis does not address ozone transport for the revised 0.075 ppm 8-Hour Ozone NAAQS.

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