

Emission and Air Quality Trends Review 1999-2011

Colorado

July 2013

Project Objective

- ❑ To develop and present publicly available information on trends in emissions and ambient air quality in the U.S. since 1999 in easy to understand visual and tabular formats

Emission Trends

- ❑ Study Team collected and processed U.S. EPA emission inventories for years within the study period of interest (1999-2011)

- ❑ By pollutant and source category
 - electric utility coal fuel combustion
 - mobile sources
 - industrial fuel combustion & industrial processes
 - all other

Emissions Data Summary

- Data Obtained from EPA National Emission Inventory (NEI) and Trends Websites
 - EPA's Trends reports and emission comparisons include interpolations of all categories between key years (1999, 2002, 2005, 2008, 2011) at county-pollutant level
 - Represented Pollutants: VOC, NO_x, SO₂, and PM_{2.5}
- Project Improvement
 - The Study Team augmented above data with year specific CEM emissions (2002 through 2011)

Emission Changes

- ❑ The following slides also include the tonnage-based emissions change from 1999 to 2011 for each pollutant
- ❑ Negative values indicate decrease in emissions, positive values indicate an increase

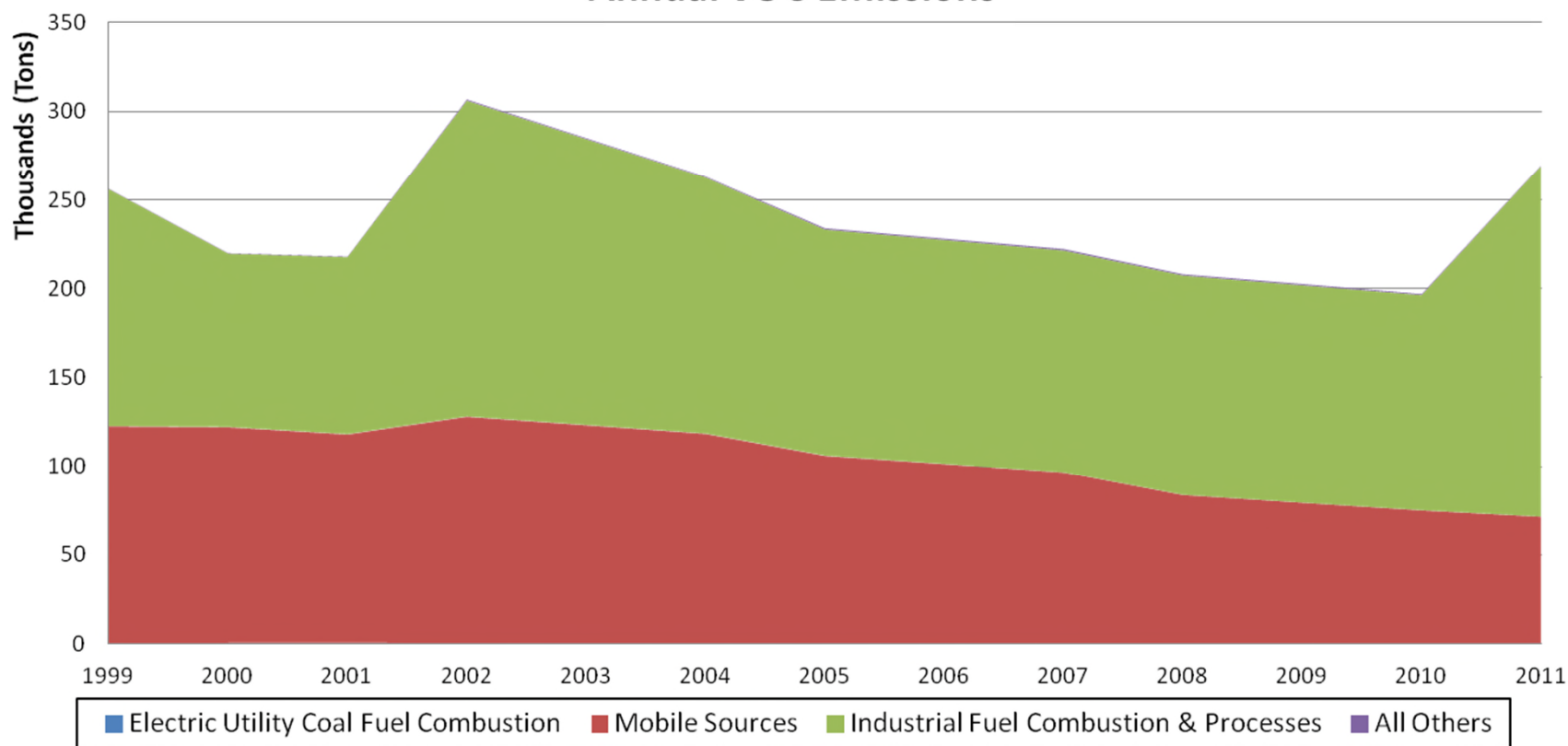
Colorado Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	476	634	524	478	490	474	461	416	415	476
Mobile Sources	122,381	117,696	122,964	105,764	101,030	96,296	83,416	79,078	74,741	71,109
Industrial Fuel Combustion & Processes	132,904	99,251	160,724	126,802	125,672	124,542	123,412	122,281	121,151	197,370
All Others	217	238	465	668	652	716	605	641	523	275
Total	255,977	217,819	284,676	233,712	227,844	222,027	207,894	202,417	196,830	269,230

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	33%	10%	0%	3%	0%	-3%	-13%	-13%	0%
Mobile Sources	0%	-4%	0%	-14%	-17%	-21%	-32%	-35%	-39%	-42%
Industrial Fuel Combustion & Processes	0%	-25%	21%	-5%	-5%	-6%	-7%	-8%	-9%	49%
All Others	0%	10%	115%	208%	201%	230%	179%	196%	141%	27%
Total	0%	-15%	11%	-9%	-11%	-13%	-19%	-21%	-23%	5%

Colorado Emission Trends (VOC)

**Major Source Category Summary
Annual VOC Emissions**



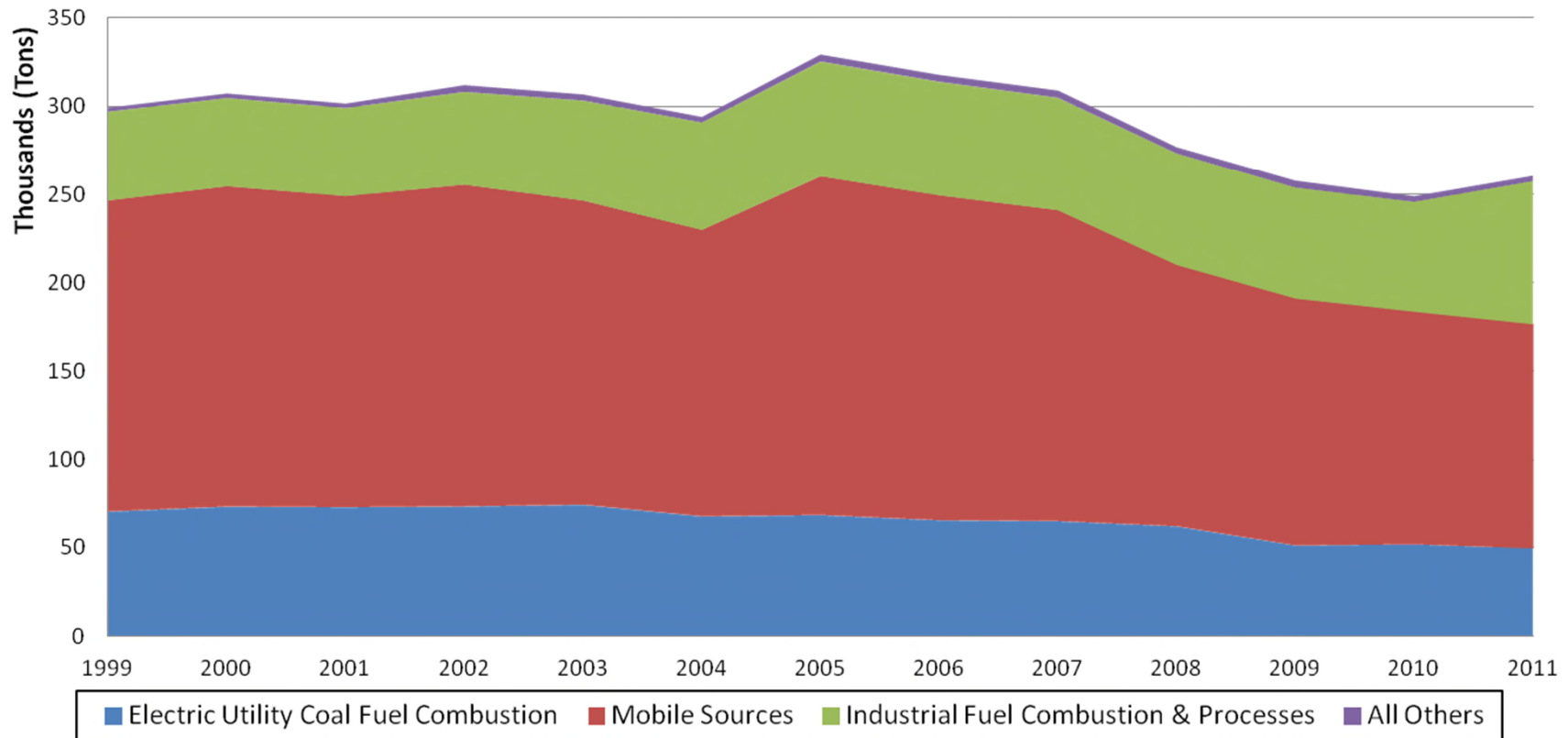
Colorado Emission Trends (NO_x)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	70,338	72,784	74,141	68,306	65,389	64,873	61,966	51,120	51,755	49,478
Mobile Sources	176,106	176,181	172,236	191,831	183,959	176,086	148,188	140,150	132,112	127,331
Industrial Fuel Combustion & Processes	50,573	50,072	56,883	65,085	64,470	63,855	63,240	62,625	62,010	80,725
All Others	2,167	2,426	3,377	3,848	3,804	3,994	3,488	3,918	3,188	3,065
Total	299,184	301,464	306,636	329,069	317,622	308,808	276,882	257,813	249,064	260,599

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	3%	5%	-3%	-7%	-8%	-12%	-27%	-26%	-30%
Mobile Sources	0%	0%	-2%	9%	4%	0%	-16%	-20%	-25%	-28%
Industrial Fuel Combustion & Processes	0%	-1%	12%	29%	27%	26%	25%	24%	23%	60%
All Others	0%	12%	56%	78%	76%	84%	61%	81%	47%	41%
Total	0%	1%	2%	10%	6%	3%	-7%	-14%	-17%	-13%

Colorado Emission Trends (NO_x)

**Major Source Category Summary
Annual NO_x Emissions**



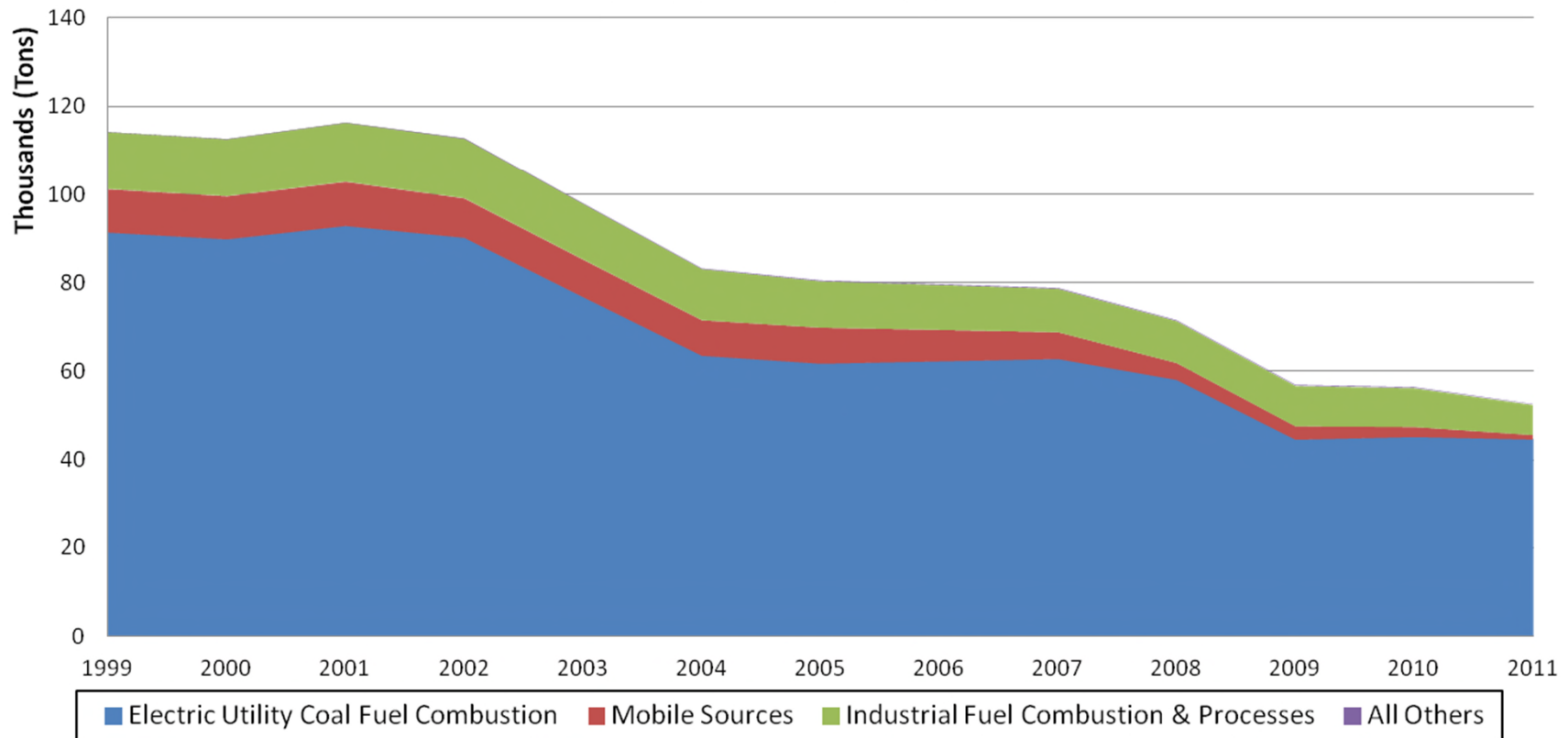
Colorado Emission Trends (SO₂)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	91,327	92,806	76,749	61,743	62,278	62,800	58,097	44,598	45,201	44,646
Mobile Sources	9,803	9,984	8,481	8,149	7,113	6,078	3,832	3,074	2,317	1,062
Industrial Fuel Combustion & Processes	12,995	13,469	12,554	10,442	10,101	9,760	9,419	9,078	8,737	6,757
All Others	95	109	162	181	179	180	169	165	155	101
Total	114,220	116,367	97,945	80,515	79,672	78,818	71,517	56,915	56,409	52,566

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	2%	-16%	-32%	-32%	-31%	-36%	-51%	-51%	-51%
Mobile Sources	0%	2%	-13%	-17%	-27%	-38%	-61%	-69%	-76%	-89%
Industrial Fuel Combustion & Processes	0%	4%	-3%	-20%	-22%	-25%	-28%	-30%	-33%	-48%
All Others	0%	15%	70%	90%	88%	89%	78%	74%	63%	6%
Total	0%	2%	-14%	-30%	-30%	-31%	-37%	-50%	-51%	-54%

Colorado Emission Trends (SO₂)

**Major Source Category Summary
Annual SO₂ Emissions**



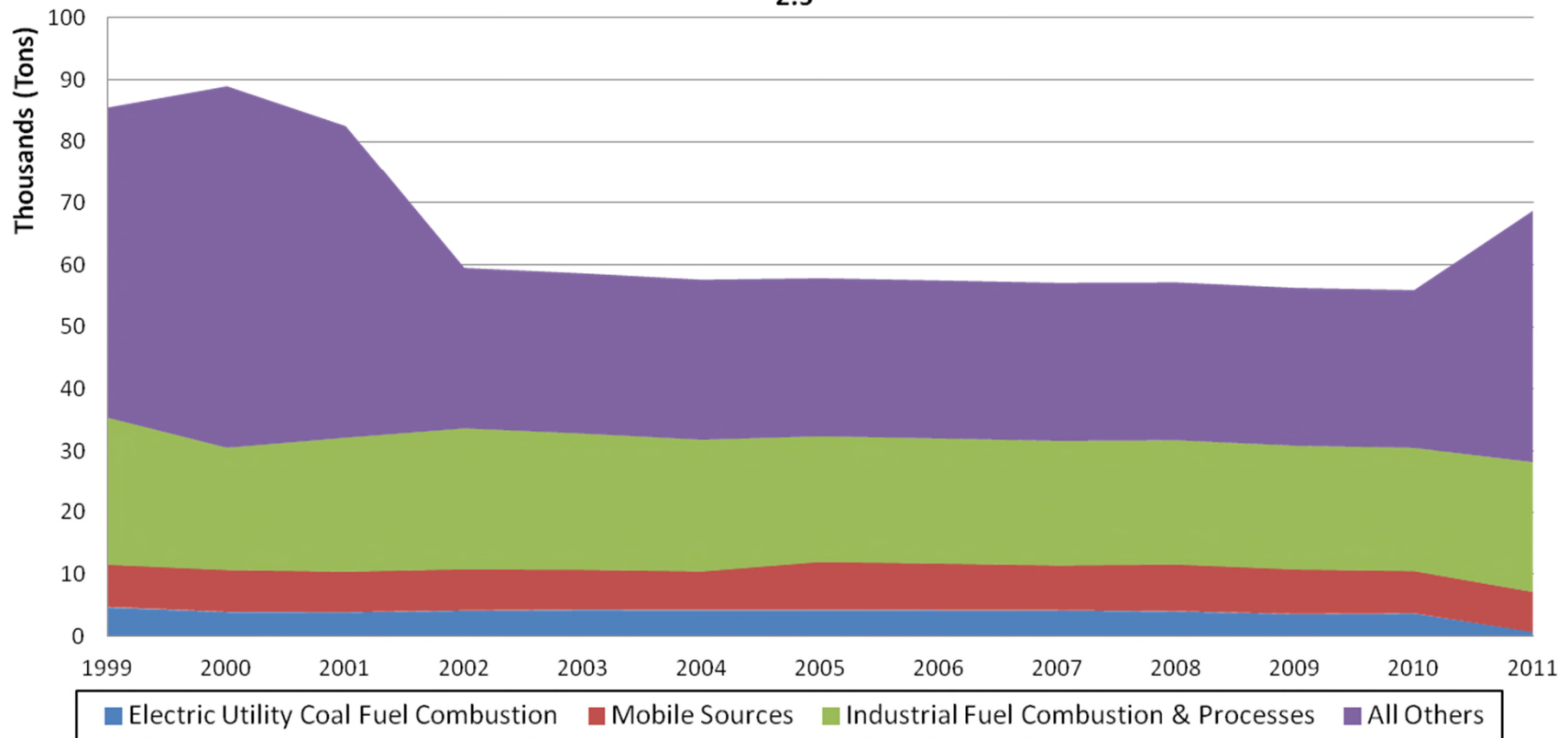
Colorado Emission Trends (PM_{2.5})

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	4,717	3,902	4,294	4,238	4,235	4,195	4,041	3,605	3,702	705
Mobile Sources	6,823	6,510	6,426	7,761	7,489	7,217	7,534	7,171	6,807	6,463
Industrial Fuel Combustion & Processes	23,798	21,729	22,079	20,361	20,288	20,215	20,142	20,070	19,997	21,013
All Others	50,153	50,335	25,798	25,461	25,449	25,439	25,423	25,412	25,396	40,499
Total	85,491	82,476	58,597	57,821	57,461	57,065	57,141	56,257	55,901	68,681

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-17%	-9%	-10%	-10%	-11%	-14%	-24%	-22%	-85%
Mobile Sources	0%	-5%	-6%	14%	10%	6%	10%	5%	0%	-5%
Industrial Fuel Combustion & Processes	0%	-9%	-7%	-14%	-15%	-15%	-15%	-16%	-16%	-12%
All Others	0%	0%	-49%	-49%	-49%	-49%	-49%	-49%	-49%	-19%
Total	0%	-4%	-31%	-32%	-33%	-33%	-33%	-34%	-35%	-20%

Colorado Emission Trends (PM_{2.5})

Major Source Category Summary
Annual PM_{2.5} Emissions



Emission Trends Summary

- All pollutants have decreased since 1999 in aggregate across Colorado
- NOx and SO2 from Electric Utility Fuel Combustion sources show decrease over time as a result of participation in the Acid Rain Program
- Onroad emission step increase seen between 2004 and 2005 is the result of EPA's method change and MOVES model integration for estimating onroad mobile source emissions

Air Quality Design Values

□ Ozone

- Annual 4th highest daily maximum 8-hour average averaged over three consecutive years
- Current standard = 0.075 ppm

□ PM_{2.5} Annual

- Annual arithmetic mean of quarterly means averaged over three consecutive years
- Current standard = 12 ug/m³

□ PM_{2.5} 24-Hour

- Annual 98th percentile of daily averages averaged over three consecutive years
- Current standard = 35 ug/m³

State-Wide Design Value (DV) Trends

- ❑ Trends in state-wide maximum DV and average DV
 - Max DV: Maximum DVs over all valid trend monitoring sites in the state in each overlapping three year period
 - Average DV: Average of DVs over all valid trend monitoring sites in the state in each overlapping three year period
- ❑ Compute linear trend via least-squares regression

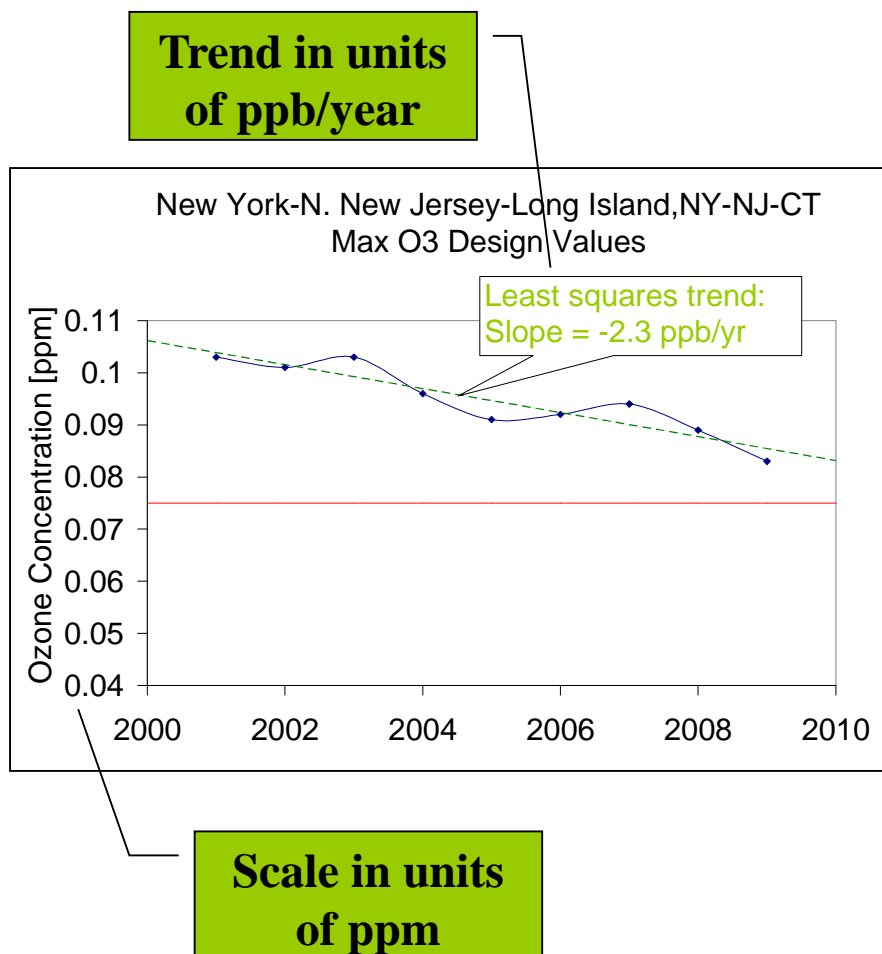
Data Handling Procedures

- O₃ design value (DV) for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculated using annual 4th highest daily max 8-hr averages and percent of valid observations, based on EPA data handling conventions
 - Data associated with exceptional events that have received EPA concurrence are omitted
 - Selection of trend sites require valid DV in 9 out of 11 three-year periods between 1999 and 2011
 - Identification of nonattainment areas is with respect to the 2008 8-hour standard only

Data Handling Procedures

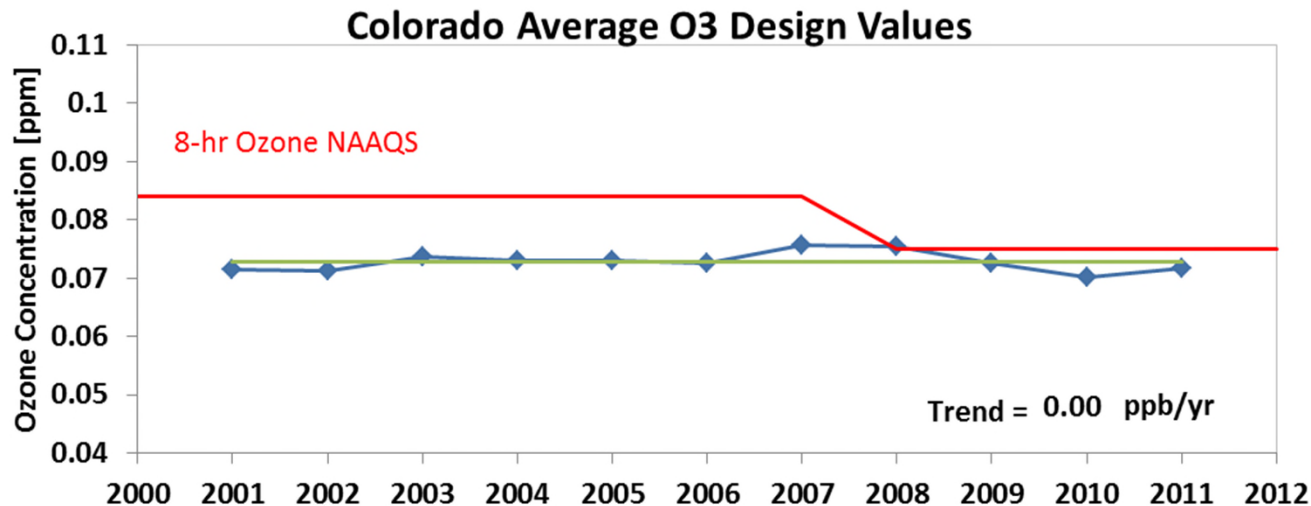
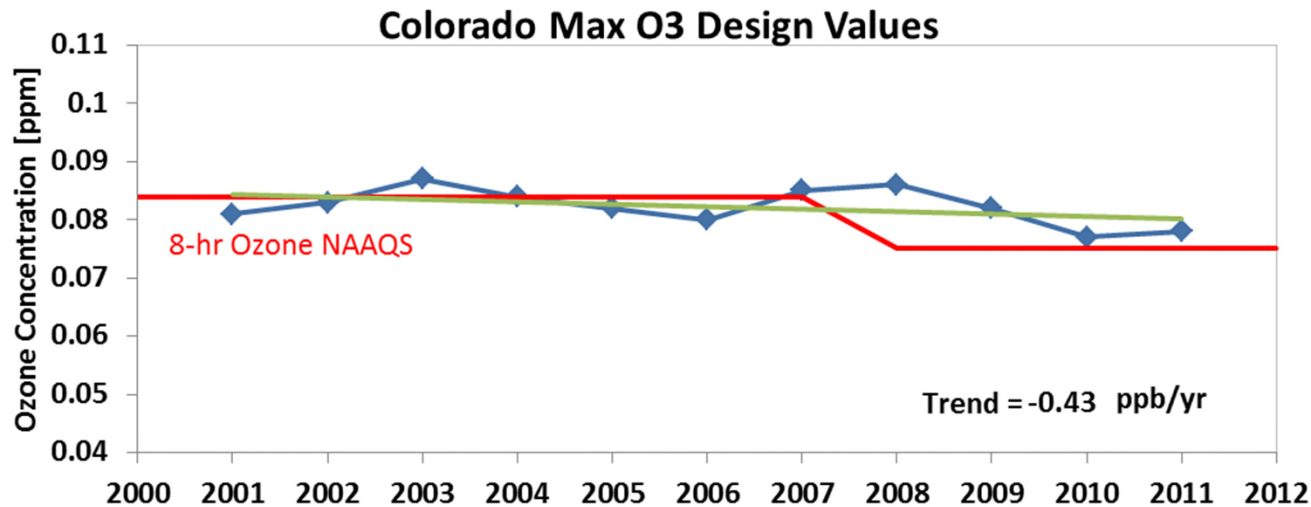
- Annual PM_{2.5} DV and 24-hr PM_{2.5} DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculations based on EPA data handling conventions
 - Data extracted from monitors that have a non-regulatory monitoring type are omitted
 - Selection of trend sites require valid DV in 9 out of 11 three-year periods between 1999 and 2011

Trend Calculation



- ▣ Trends based on linear least squares fit to rolling three year design values (DVs)
- ▣ Negative trend indicates improving air quality
- ▣ DVs based on each 3-year period: 1999-2001, 2000-2002, ... 2009-2011
- ▣ Notes
 - On plots, DVs are for three year period ending in year shown (i.e., 2009-2011 DV plotted as 2011 value)
 - Ozone trend values expressed as ppb/year (1,000 ppb = 1 ppm); DVs are plotted as ppm

Max/Ave O₃ DVs and Trend



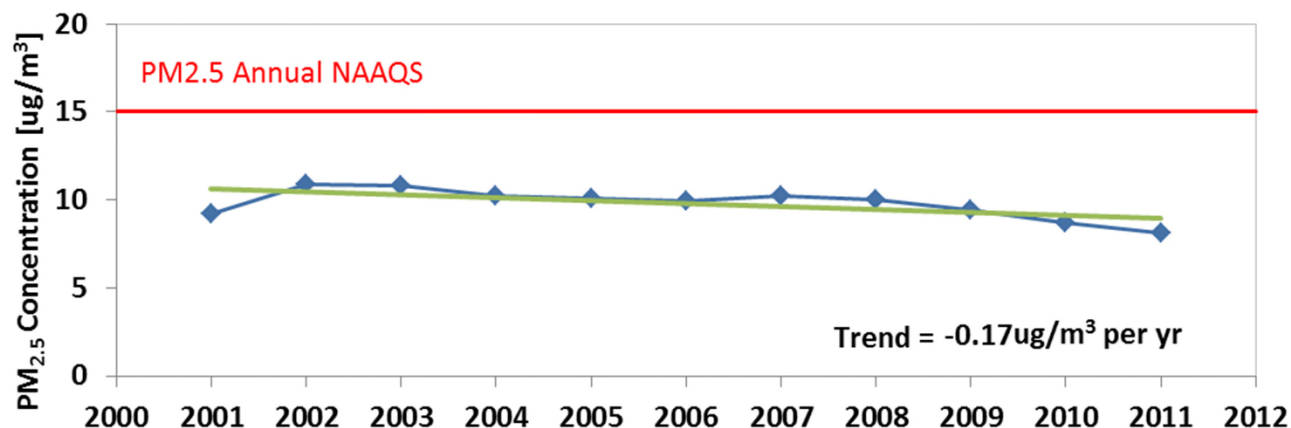
Ozone Trends by Site in Colorado

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
0800130014420102	Adams, CO	N/A	1.00
0801300114420101	Boulder, CO	0.073	0.22
0803100144420102	Denver, CO	0.069	-0.38
0804100134420101	El Paso, CO	0.067	-0.40
0805900024420101	Jefferson, CO	0.074	0.04
0805900054420101	Jefferson, CO	0.073	0.81
0805900064420101	Jefferson, CO	0.078	-0.41
0805900114420101	Jefferson, CO	0.075	-0.88
0806770034420101	La Plata, CO	N/A	1.75
0806900074420101	Larimer, CO	0.074	-0.50
0806910044420101	Larimer, CO	0.065	-0.28
0808301014420101	Montezuma, CO	0.068	0.05

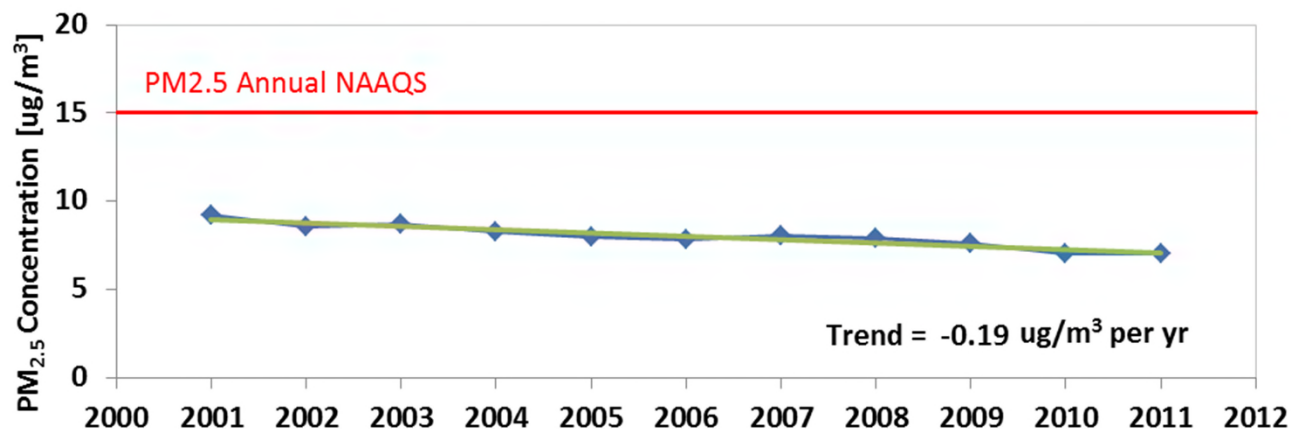
Note: Only monitoring sites meeting data completeness criteria listed

Max/Ave PM_{2.5} Annual DVs and Trend

Colorado Max PM2.5 Annual Design Values

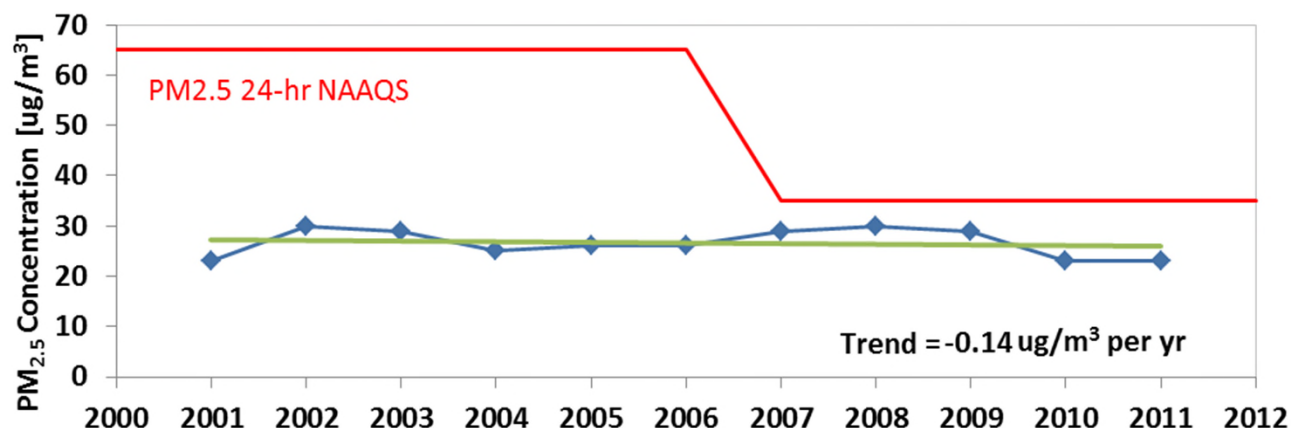


Colorado Average PM2.5 Annual Design Values

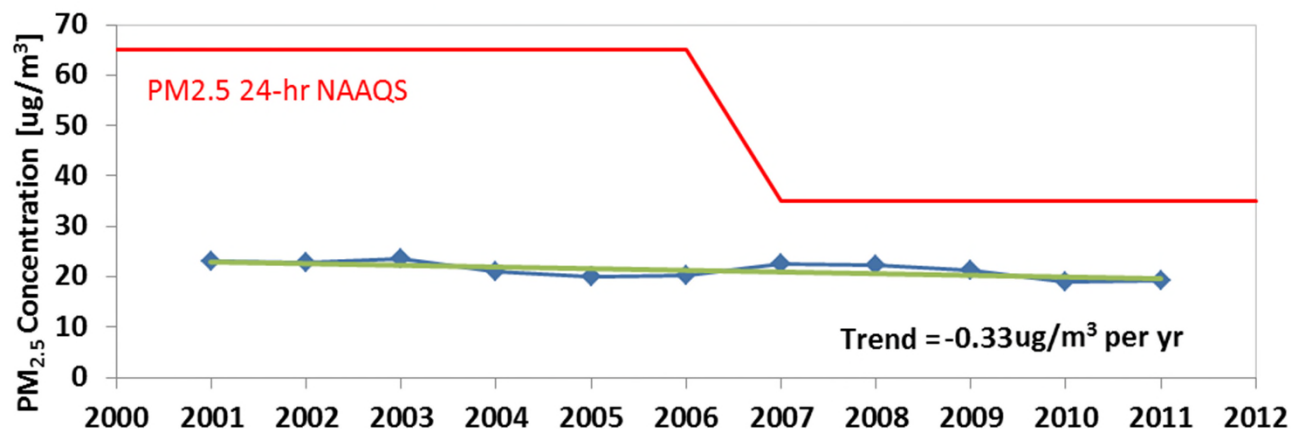


Max/Ave PM_{2.5} 24-Hour DVs and Trend

Colorado Max PM_{2.5} 24-Hour Design Values



Colorado Average PM_{2.5} 24-Hour Design Values



PM_{2.5} Trends by Site in Colorado

		2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
Monitoring Site	County	Annual	24-Hr	Annual DV	24-Hr DV
080010006	Adams	8.1	21	-0.25	-0.15
080050005	Arapahoe	6.3	15	-0.28	-0.98
080130003	Boulder	6.9	20	-0.23	-0.25
080130012	Boulder	6.3	17	-0.19	-0.39
080310002	Denver	7.6	19	-0.37	-1.09
080390001	Elbert	N/A	N/A	0.00	-0.02
080690009	Larimer	6.3	18	-0.17	-0.17
081230006	Weld	7.3	23	-0.15	-0.10
081230008	Weld	7.5	20	-0.18	-0.31

Note: Only monitoring sites meeting data completeness criteria listed

Air Quality Trends Summary

- Average O₃ design values have remained steady since 1999 in Colorado; average annual and 24-hour PM_{2.5} design values have decreased slightly since 1999 in Colorado
- O₃ design values have remained steady since 1999 at Denver-Boulder-Greeley-Ft. Collins-Love, CO, the only currently designated O₃ non-attainment area in Colorado; there are no currently designated PM_{2.5} non-attainment areas in Colorado