

Emission and Air Quality Trends Review 1999-2011

Michigan

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

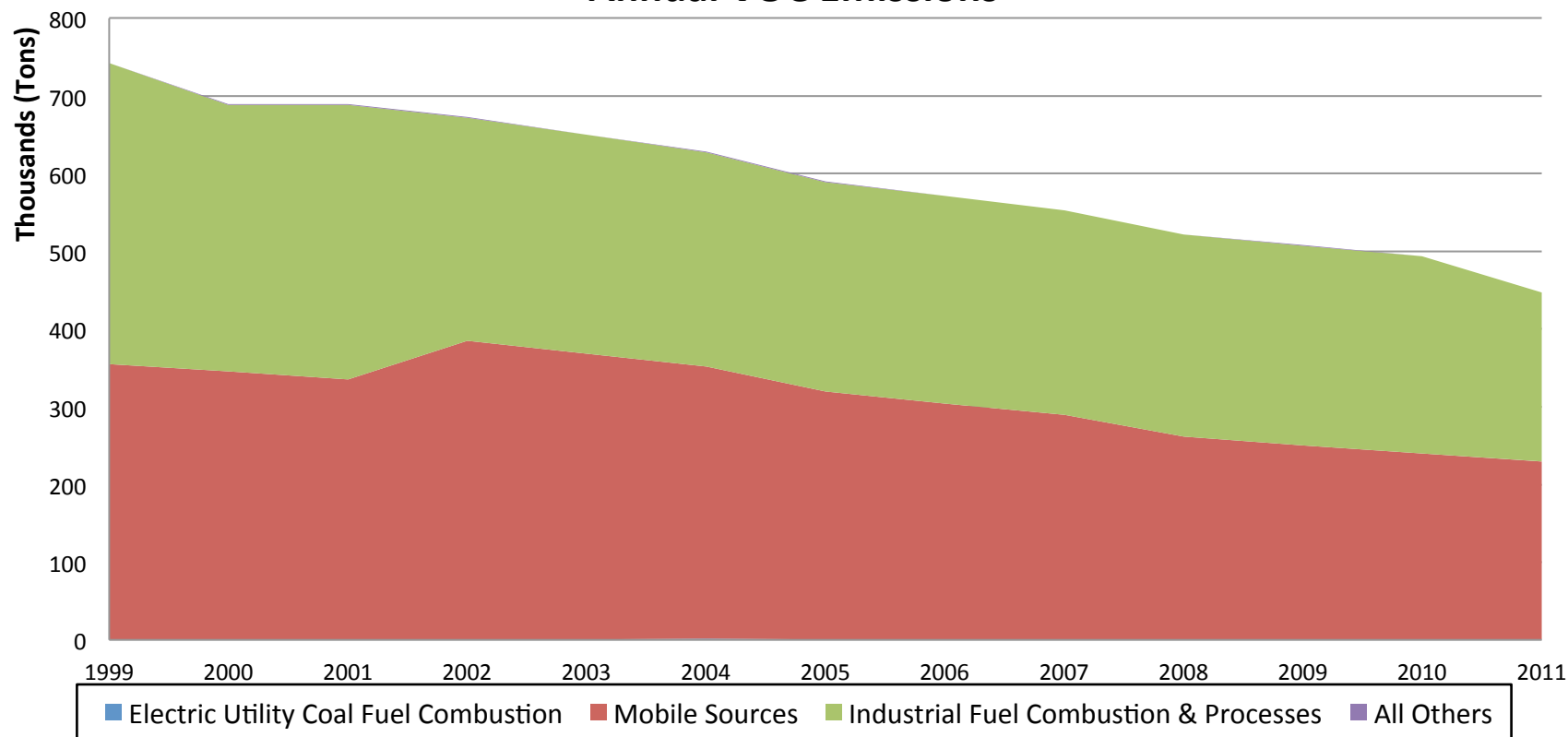
Michigan Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	389	404	1,039	648	639	656	668	622	632	972
Mobile Sources	354,627	334,721	367,045	319,015	303,977	288,939	260,786	250,036	239,287	228,711
Industrial Fuel Combustion & Processes	387,322	353,799	281,868	269,722	266,527	263,335	260,153	256,960	253,768	217,015
All Others	461	1,044	430	339	320	320	382	344	357	767
Total	742,799	689,968	650,382	589,724	571,463	553,249	521,988	507,962	494,045	447,465

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	4%	167%	67%	64%	69%	72%	60%	63%	150%
Mobile Sources	0%	-6%	4%	-10%	-14%	-19%	-26%	-29%	-33%	-36%
Industrial Fuel Combustion & Processes	0%	-9%	-27%	-30%	-31%	-32%	-33%	-34%	-34%	-44%
All Others	0%	126%	-7%	-27%	-31%	-31%	-17%	-25%	-23%	66%
Total	0%	-7%	-12%	-21%	-23%	-26%	-30%	-32%	-33%	-40%

Michigan Emission Trends (VOC)

**Major Source Category Summary
Annual VOC Emissions**



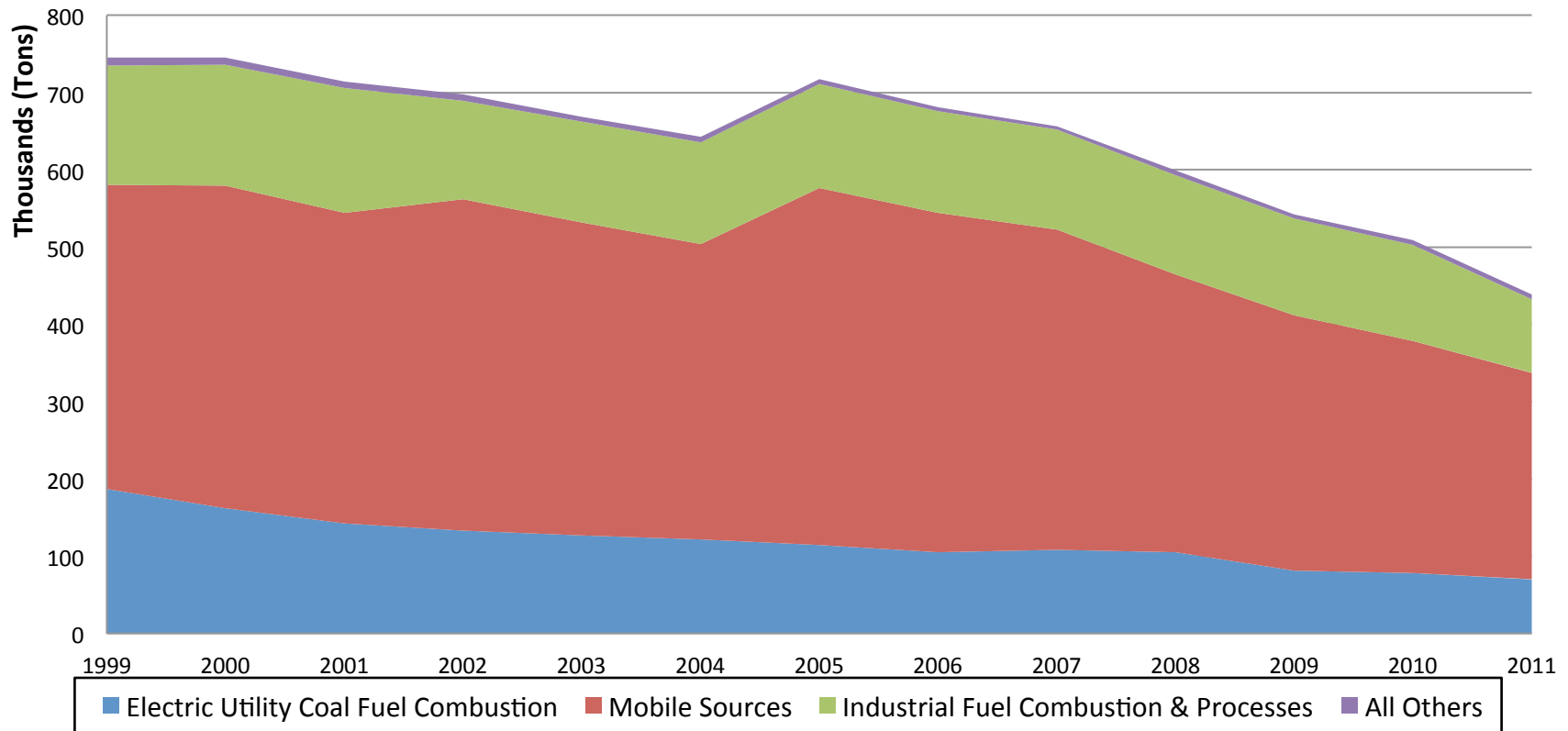
Michigan Emission Trends (NO_x)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	187,215	143,023	126,567	114,590	105,690	108,112	104,823	81,481	78,394	70,328
Mobile Sources	393,786	401,089	405,758	462,316	438,521	414,726	359,691	330,263	300,836	267,265
Industrial Fuel Combustion & Processes	153,794	161,609	129,905	134,365	131,616	129,046	128,329	125,631	123,472	95,016
All Others	10,805	8,649	6,907	6,165	5,117	5,023	6,735	5,553	6,199	6,626
Total	745,600	714,370	669,137	717,436	680,944	656,907	599,577	542,928	508,901	439,234

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-24%	-32%	-39%	-44%	-42%	-44%	-56%	-58%	-62%
Mobile Sources	0%	2%	3%	17%	11%	5%	-9%	-16%	-24%	-32%
Industrial Fuel Combustion & Processes	0%	5%	-16%	-13%	-14%	-16%	-17%	-18%	-20%	-38%
All Others	0%	-20%	-36%	-43%	-53%	-54%	-38%	-49%	-43%	-39%
Total	0%	-4%	-10%	-4%	-9%	-12%	-20%	-27%	-32%	-41%

Michigan Emission Trends (NO_x)

**Major Source Category Summary
Annual NO_x Emissions**



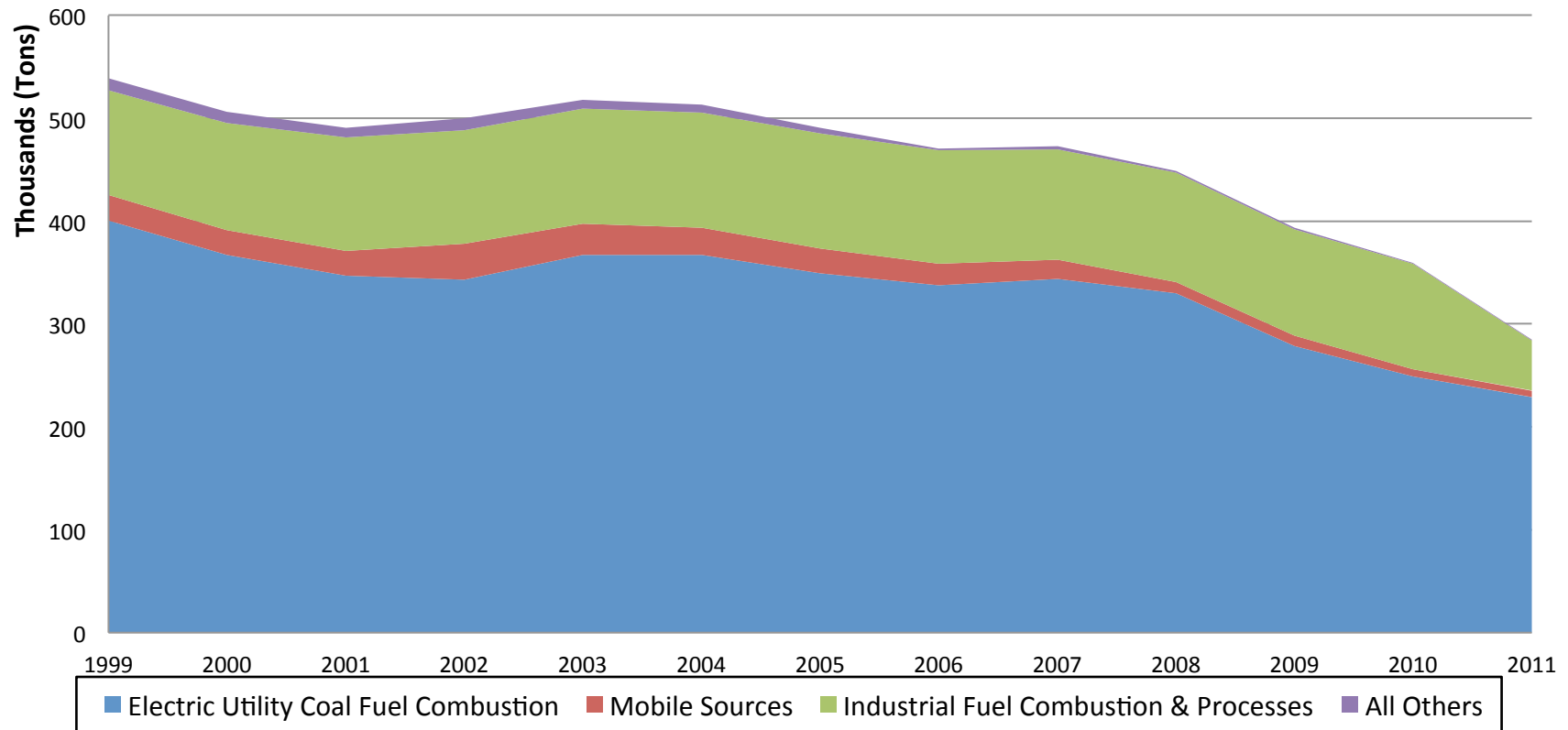
Michigan Emission Trends (SO₂)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	400,868	347,278	367,541	349,581	337,761	344,066	330,042	278,994	248,791	229,015
Mobile Sources	24,369	24,007	30,206	23,766	20,961	18,157	11,110	9,360	7,610	6,471
Industrial Fuel Combustion & Processes	101,798	110,086	111,527	112,119	109,905	107,689	106,310	104,037	101,963	48,256
All Others	11,725	9,288	8,442	5,553	1,732	2,776	1,602	1,360	1,348	1,162
Total	538,761	490,659	517,716	491,019	470,359	472,688	449,065	393,751	359,712	284,904

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-13%	-8%	-13%	-16%	-14%	-18%	-30%	-38%	-43%
Mobile Sources	0%	-1%	24%	-2%	-14%	-25%	-54%	-62%	-69%	-73%
Industrial Fuel Combustion & Processes	0%	8%	10%	10%	8%	6%	4%	2%	0%	-53%
All Others	0%	-21%	-28%	-53%	-85%	-76%	-86%	-88%	-89%	-90%
Total	0%	-9%	-4%	-9%	-13%	-12%	-17%	-27%	-33%	-47%

Michigan Emission Trends (SO₂)

**Major Source Category Summary
Annual SO₂ Emissions**



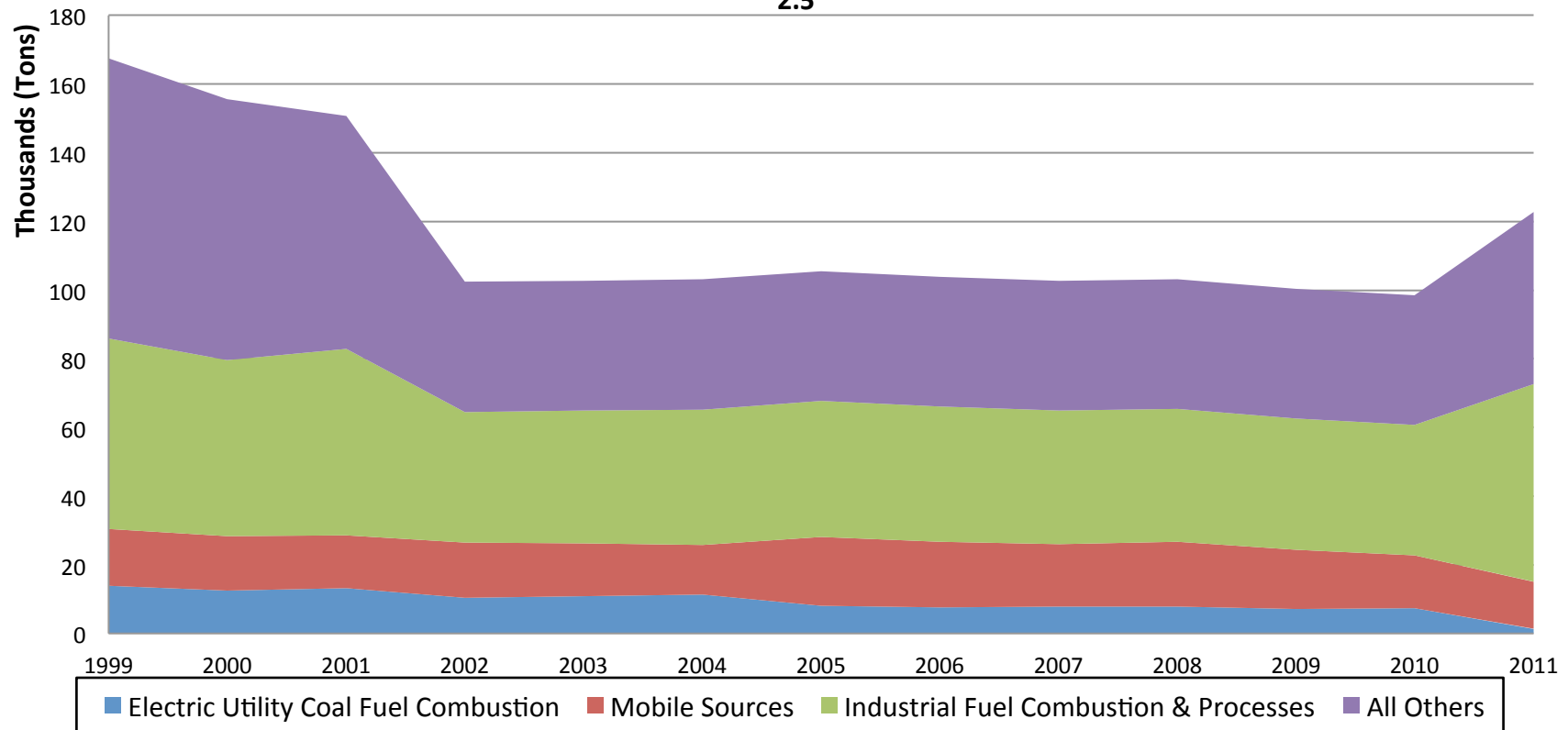
Michigan Emission Trends (PM_{2.5})

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	13,854	13,121	10,832	8,053	7,687	7,902	7,747	7,045	7,257	1,384
Mobile Sources	16,644	15,429	15,326	19,971	19,008	18,045	19,003	17,252	15,500	13,726
Industrial Fuel Combustion & Processes	55,305	54,420	38,669	39,663	39,296	38,930	38,623	38,256	37,891	57,593
All Others	81,593	67,644	37,975	37,842	37,772	37,782	37,753	37,733	37,756	49,939
Total	167,396	150,614	102,802	105,529	103,764	102,660	103,127	100,286	98,404	122,642

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-5%	-22%	-42%	-45%	-43%	-44%	-49%	-48%	-90%
Mobile Sources	0%	-7%	-8%	20%	14%	8%	14%	4%	-7%	-18%
Industrial Fuel Combustion & Processes	0%	-2%	-30%	-28%	-29%	-30%	-30%	-31%	-31%	4%
All Others	0%	-17%	-53%	-54%	-54%	-54%	-54%	-54%	-54%	-39%
Total	0%	-10%	-39%	-37%	-38%	-39%	-38%	-40%	-41%	-27%

Michigan 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 Michigan
- NOx and SO2 from Electric Utility Fuel Combustion sources show significant decrease over time as a result of Acid Rain Program, NOx Budget Trading Program and CAIR control implementation
- 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

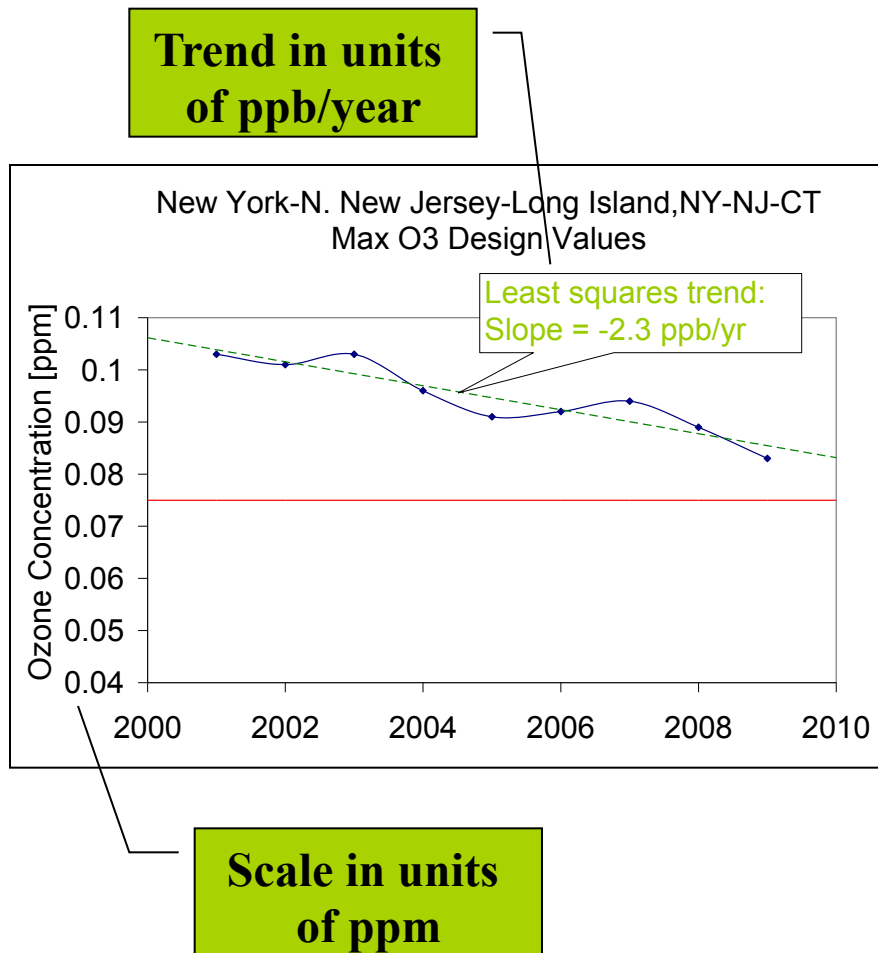
Data Handling Procedures

- 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

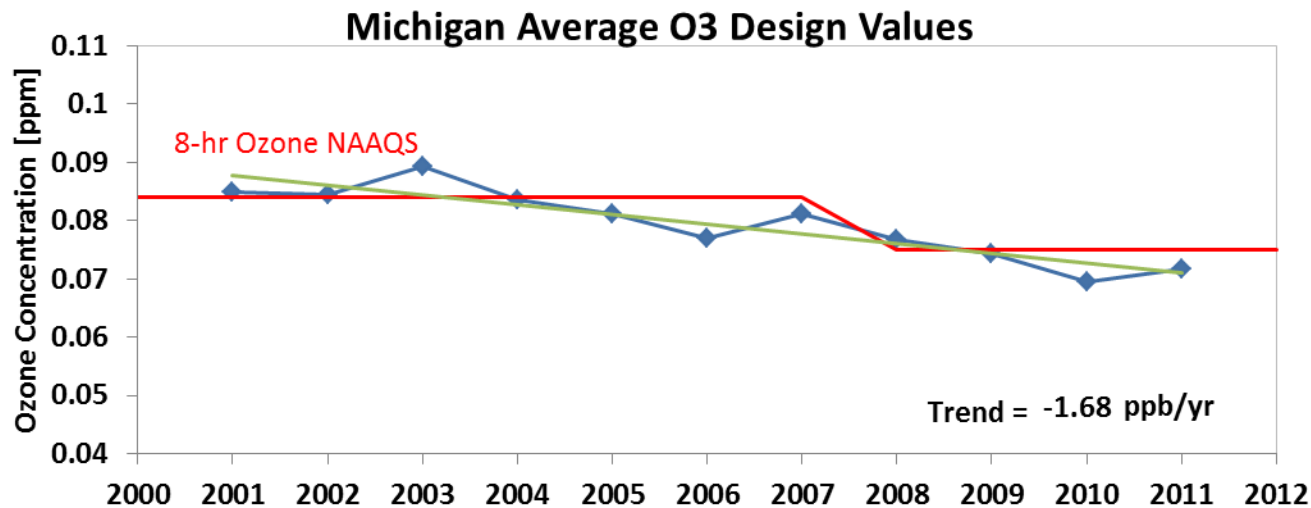
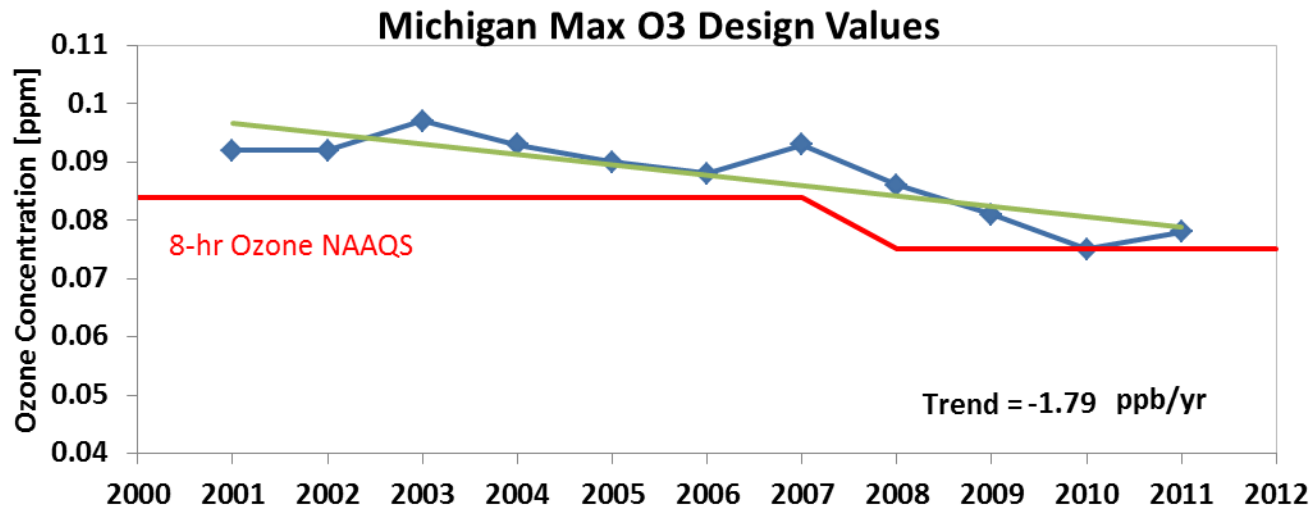
- ❑ Annual PM_{2.5} DV and 24-hr PM_{2.5} DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
 - DV calculations based on EPA data handling conventions
 - Data extracted from monitors that have a non-regulatory monitoring type are omitted
 - Selection of trend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

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
2600500034420101	Allegan, MI	0.078	-1.59
2601900034420101	Benzie, MI	0.07	-2.05
2602100144420101	Berrien, MI	0.075	-1.68
2603700014420102	Clinton, MI	0.066	-1.90
2604900214420101	Genesee, MI	0.069	-1.85
2604920014420101	Genesee, MI	0.069	-1.98
2606300074420101	Huron, MI	0.068	-1.74
2606500124420102	Ingham, MI	0.068	-1.65
2607700084420101	Kalamazoo, MI	0.071	-1.43
2608100204420101	Kent, MI	0.07	-1.16
2608100224420101	Kent, MI	0.071	-1.52
2609100074420101	Lenawee, MI	N/A	-1.55

Note: Only monitoring sites meeting data completeness criteria listed

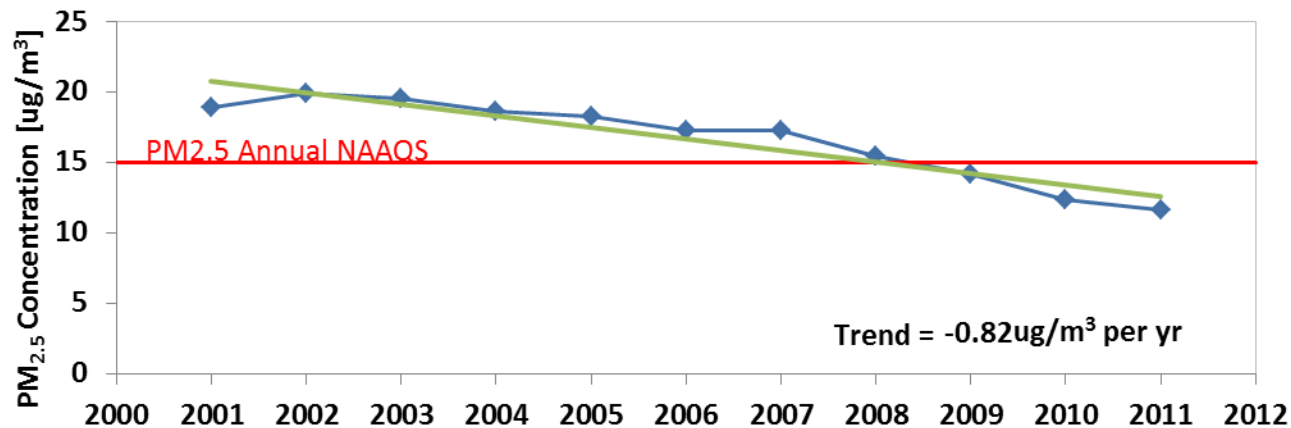
Ozone Trends by Site in Michigan

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
2609900094420101	Macomb, MI	0.075	-1.83
2609910034420101	Macomb, MI	0.076	-1.63
2610500074420101	Mason, MI	0.07	-2.21
2611300014420101	Missaukee, MI	0.065	-1.67
2612100394420101	Muskegon, MI	0.076	-1.80
2612500014420102	Oakland, MI	0.075	-1.45
2613900054420101	Ottawa, MI	0.073	-1.52
2614700054420101	St. Clair, MI	0.074	-1.65
2616100084420101	Washtenaw, MI	0.069	-2.58
2616300014420102	Wayne, MI	0.069	-1.41
2616300194420102	Wayne, MI	0.078	-1.10

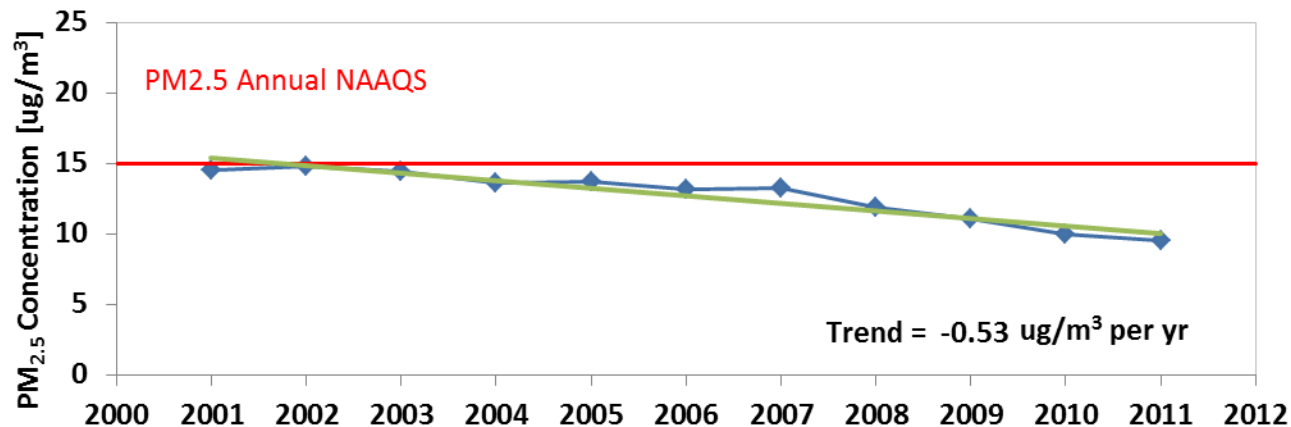
Note: Only monitoring sites meeting data completeness criteria listed

Max/Ave PM_{2.5} Annual DVs and Trend

Michigan Max PM_{2.5} Annual Design Values

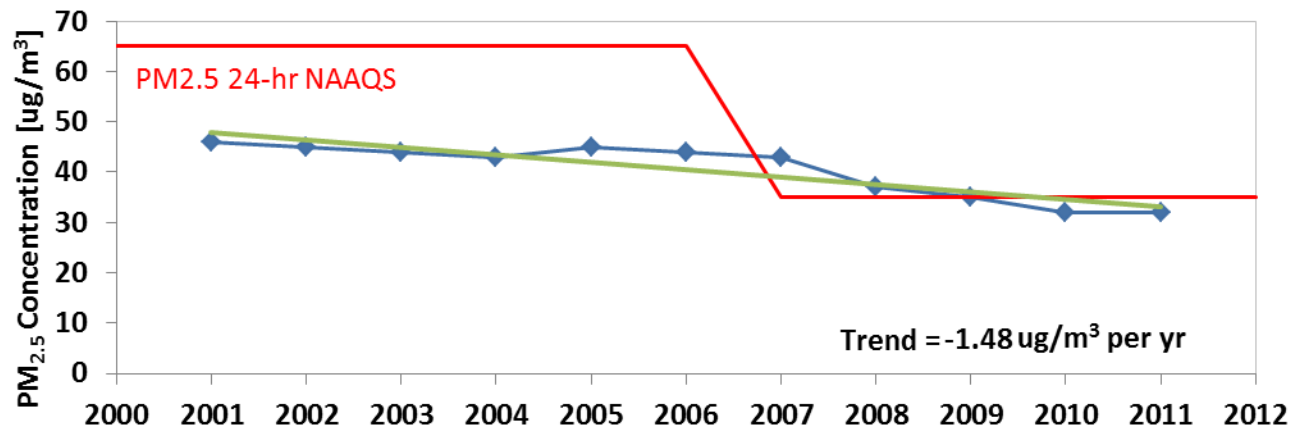


Michigan Average PM_{2.5} Annual Design Values

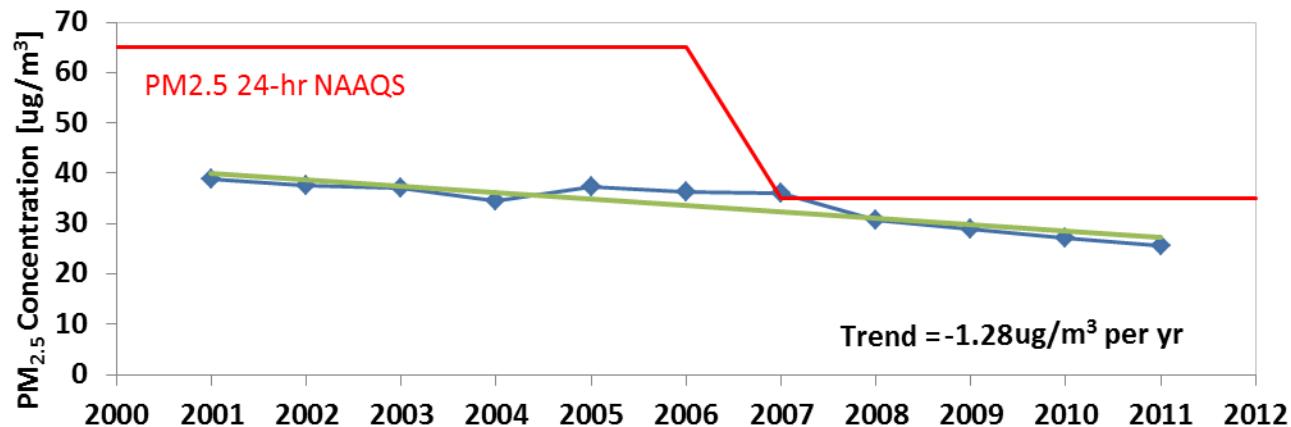


Max/Ave PM_{2.5} 24-Hour DVs and Trend

Michigan Max PM_{2.5} 24-Hour Design Values



Michigan Average PM_{2.5} 24-Hour Design Values



PM_{2.5} Trends by Site in Michigan

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
260050003	Allegan	8.5	25	-0.38	-1.14
260170014	Bay	8.0	25	-0.41	-0.92
260210014	Berrien	8.8	22	-0.38	-0.92
260490021	Genesee	8.7	24	-0.42	-1.11
260650012	Ingham	8.9	24	-0.47	-1.21
260770008	Kalamazoo	9.4	24	-0.56	-1.31
260810020	Kent	9.5	26	-0.46	-1.25
260990009	Macomb	9.0	25	-0.43	-1.12
261150005	Monroe	9.9	24	-0.63	-1.87
261210040	Muskegon	8.5	24	-0.38	-1.12
261250001	Oakland	N/A	27	N/A	-1.25

Note: Only monitoring sites meeting data completeness criteria listed

PM_{2.5} Trends by Site in Michigan

Monitoring Site	County	2009-2011 DV [ug/m ³]		Trend [ug/m ³ per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
261390005	Ottawa	9.2	24	-0.42	-1.20
261470005	St. Clair	N/A	26	N/A	-1.03
261610008	Washtenaw	9.6	25	-0.66	-1.23
261630001	Wayne	10.5	27	-0.63	-1.50
261630015	Wayne	10.9	28	-0.73	-1.37
261630016	Wayne	10.1	28	-0.64	-1.52
261630019	Wayne	9.9	27	-0.67	-1.30
261630025	Wayne	N/A	26	N/A	-1.38
261630033	Wayne	11.6	32	-0.82	-1.38
261630036	Wayne	9.6	24	-0.83	-1.94

Note: Only monitoring sites meeting data completeness criteria listed

Air Quality Trends Summary

- Average O_3 and $PM_{2.5}$ design values have decreased since 1999 in Michigan
- There are no currently designated O_3 non-attainment areas in Michigan. $PM_{2.5}$ design values have decreased since 1999 in Detroit-Ann Arbor, MI, the only $PM_{2.5}$ non-attainment area in Michigan