Emission and Air Quality Trends Review

Michigan

May 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 generation 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, NOx, SO_2, 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

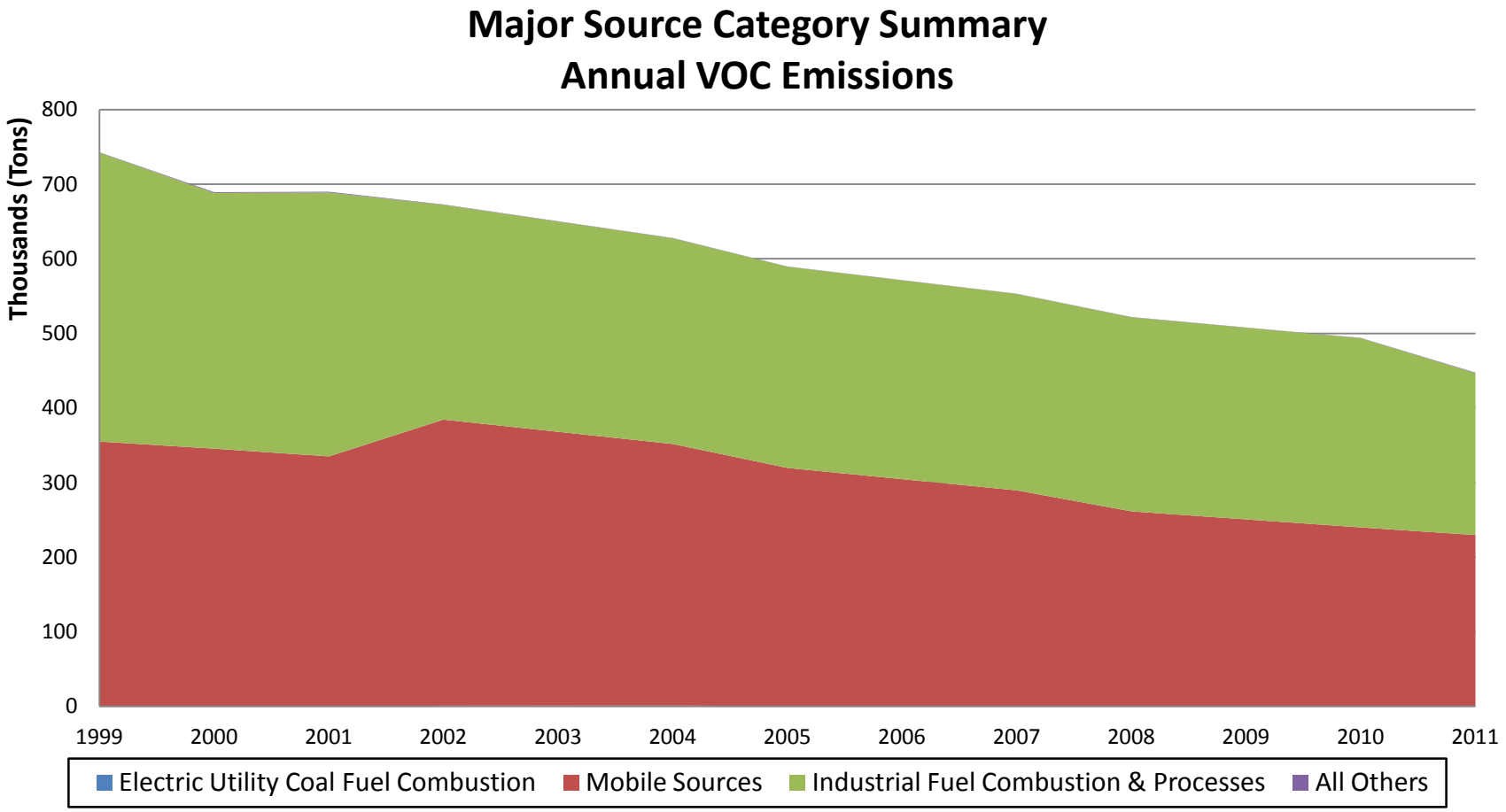
- Negative values indicate decrease in emissions, positive values indicate an increase

Michigan Emission Trends (VOC)

	Annual Emissions (Tons)									
Source Category	**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**

	Annual Emissions Change (Percent since 1999)									
Source Category	**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)

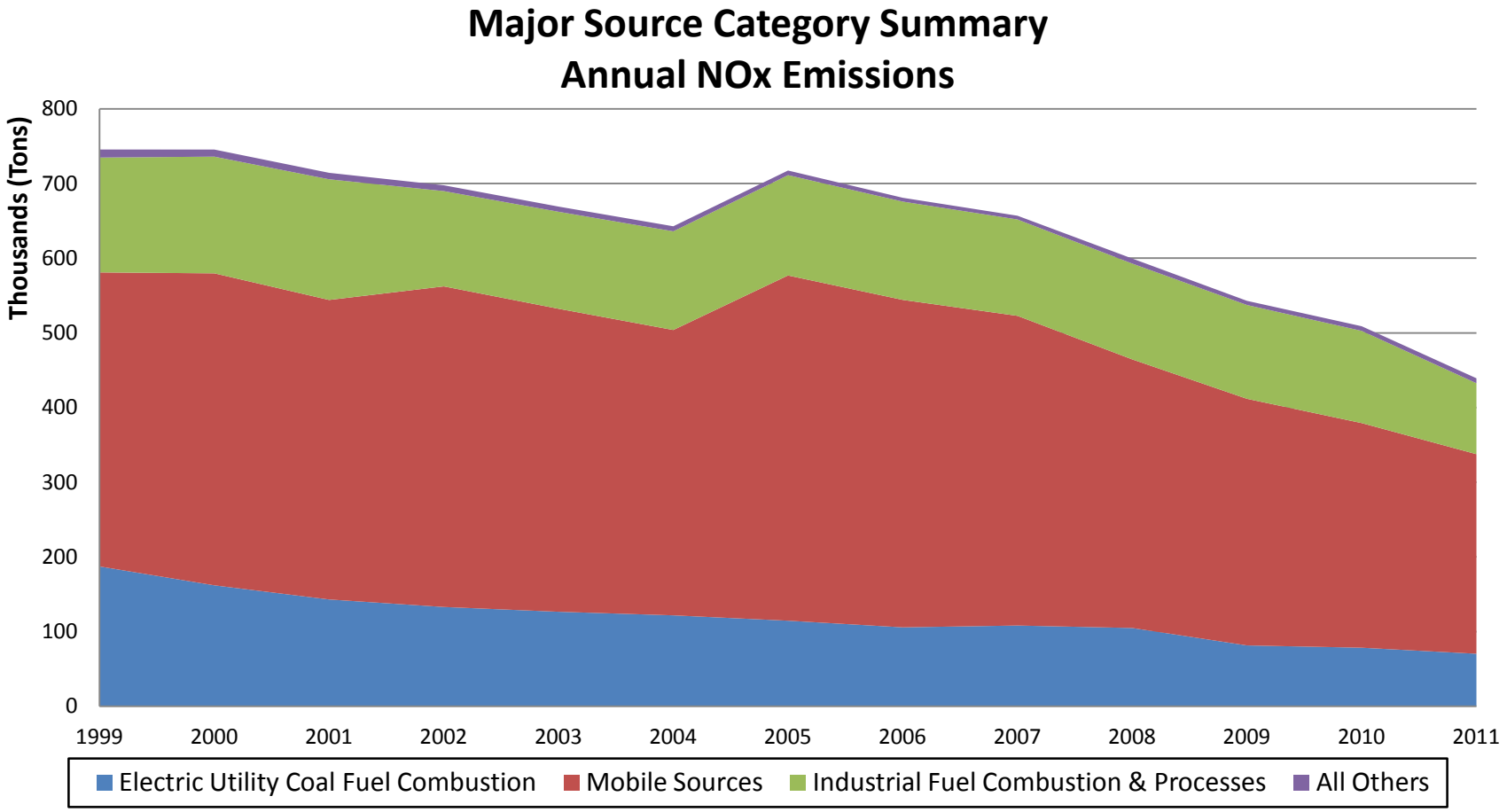


Michigan Emission Trends (NOx)

	Annual Emissions (Tons)									
Source Category	**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**

	Annual Emissions Change (Percent since 1999)									
Source Category	**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 (NOx)

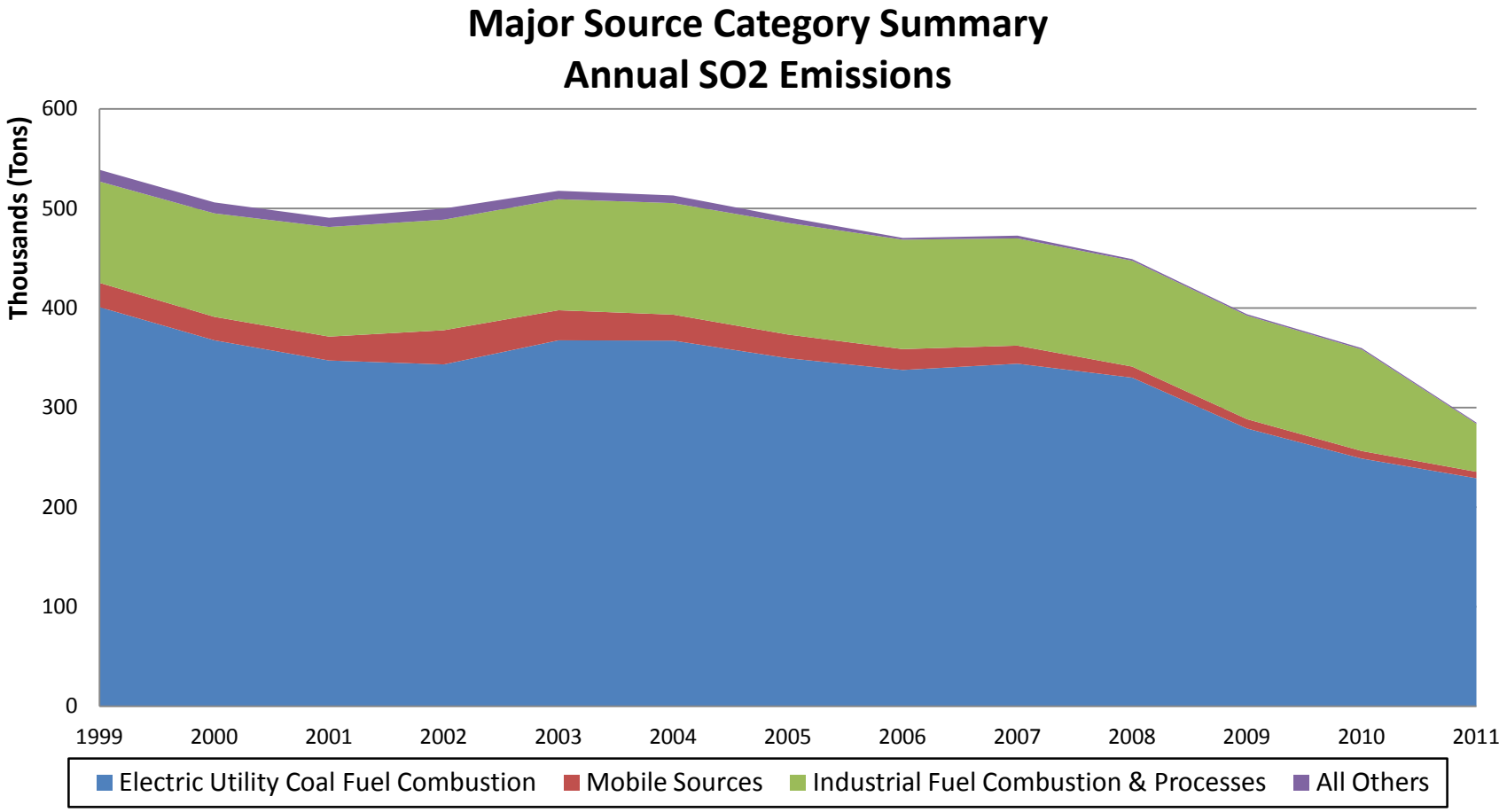


Michigan Emission Trends (SO_2)

	Annual Emissions (Tons)									
Source Category	**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**

	Annual Emissions Change (Percent since 1999)									
Source Category	**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 (SO_2)

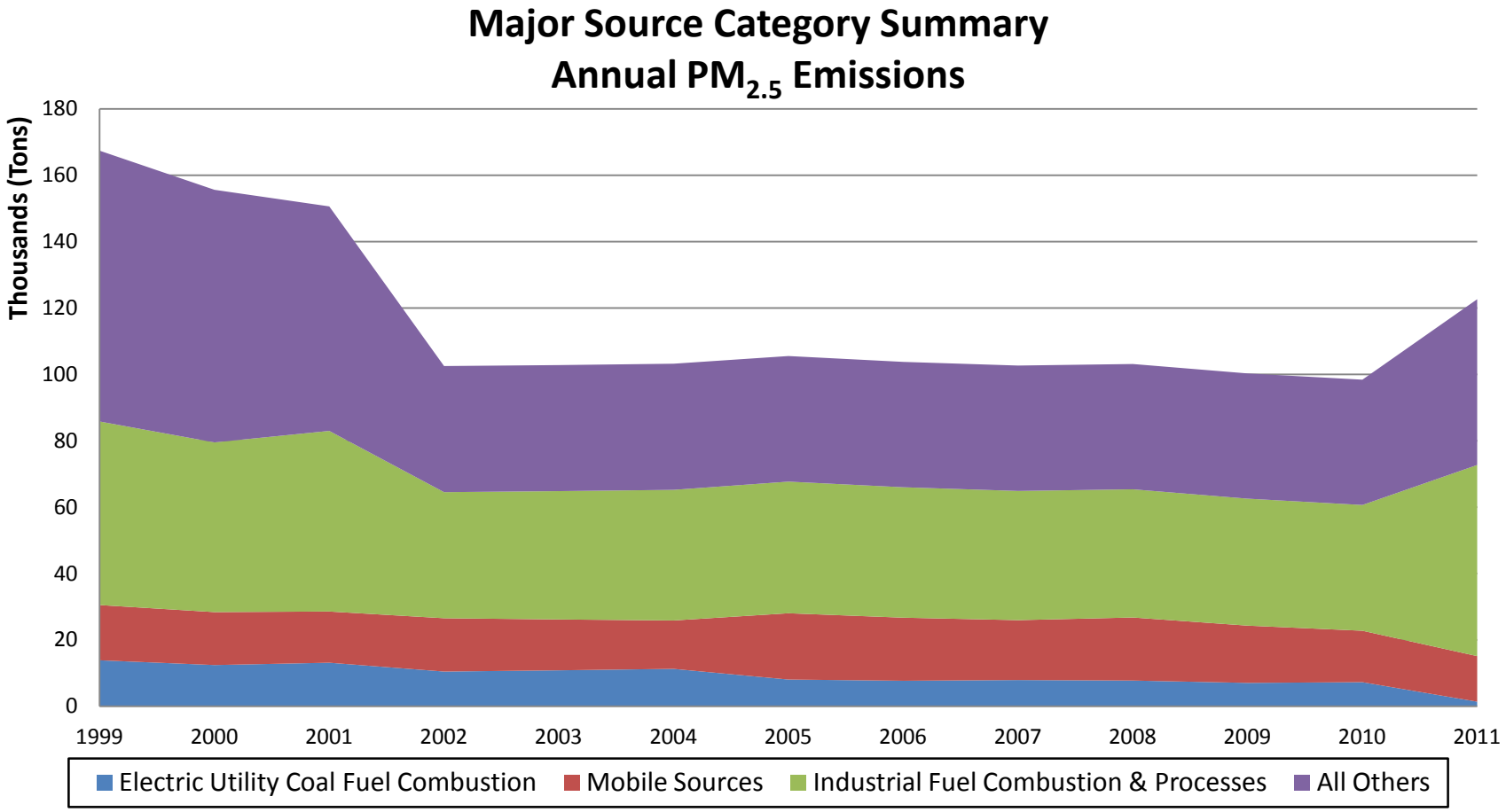


Michigan Emission Trends ($PM_{2.5}$)

	Annual Emissions (Tons)									
Source Category	**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**

	Annual Emissions Change (Percent since 1999)									
Source Category	**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 ($PM_{2.5}$)



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/m^3
- $PM_{2.5}$ 24-Hour
  - Annual 98th percentile of daily averages averaged over three consecutive years
  - Current standard = 35 ug/m^3

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

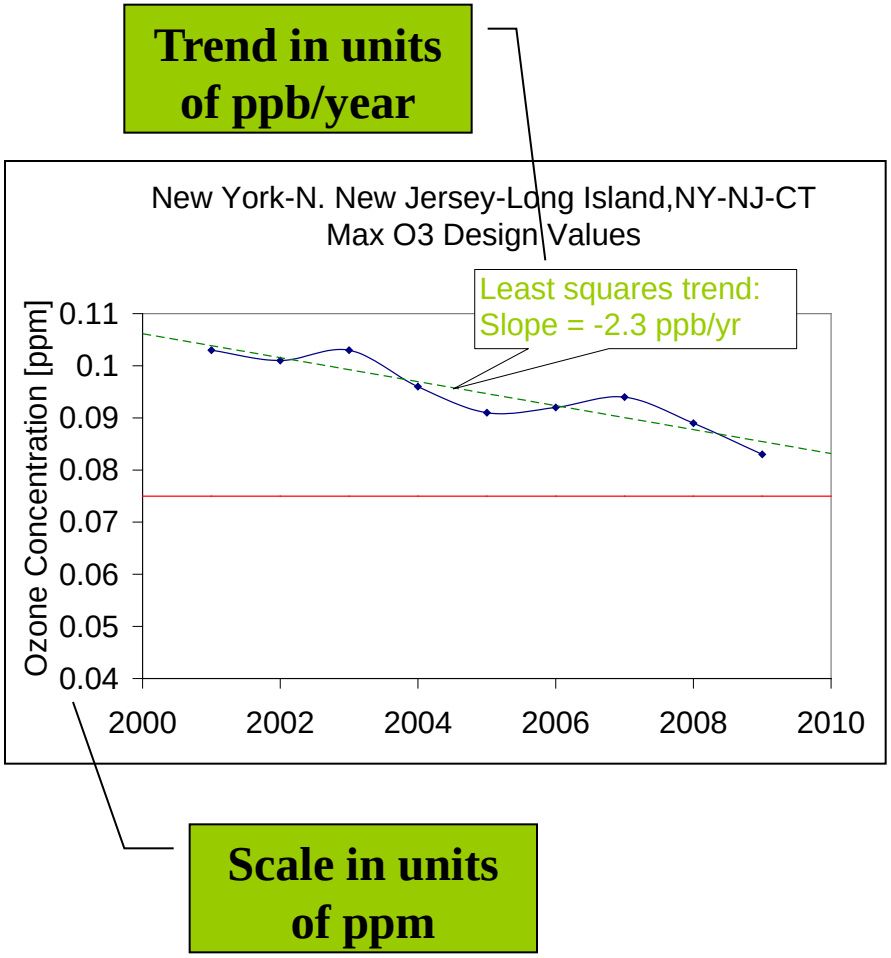
Data Handling Procedures

- O_3 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

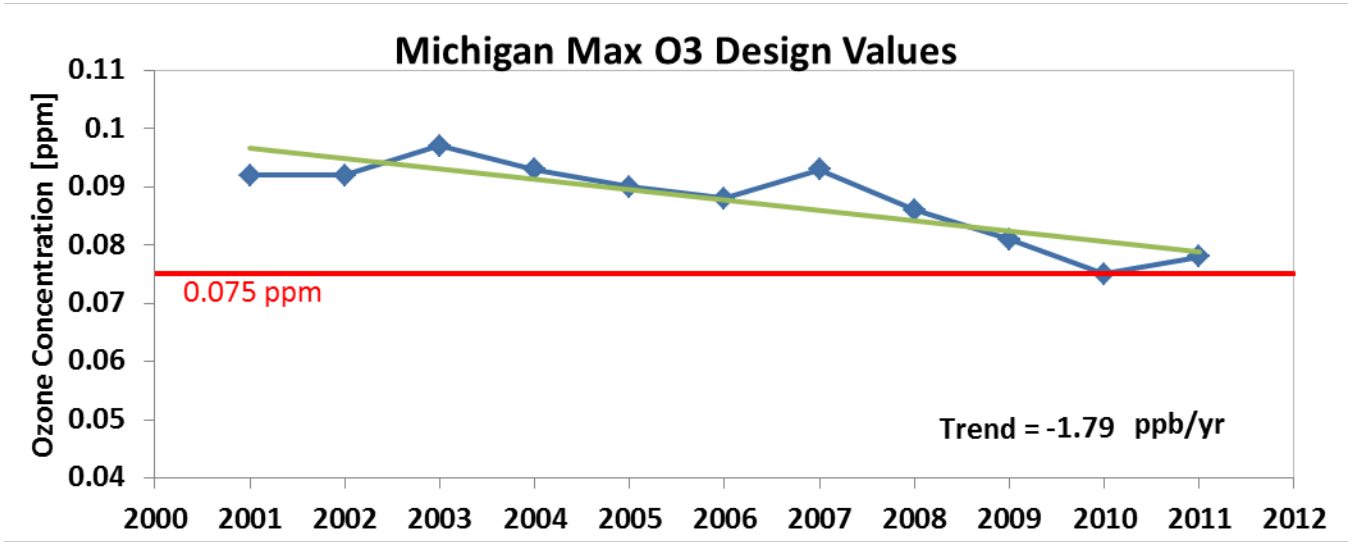
- Annual $PM_{2.5}$ DV and 24-hr $PM_{2.5}$ DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculations based on EPA data handling conventions
  - Data extracted from monitors that have a non-regulatory monitoring type are omitted
  - Selection of trend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

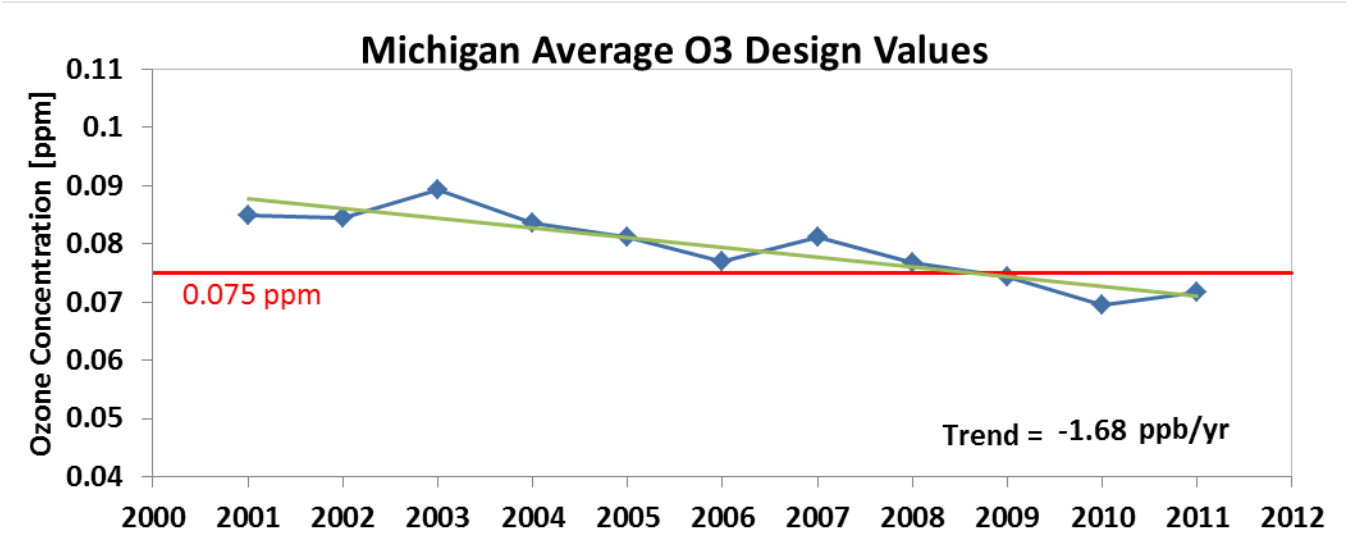
Trend Calculation



- 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 O_3 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

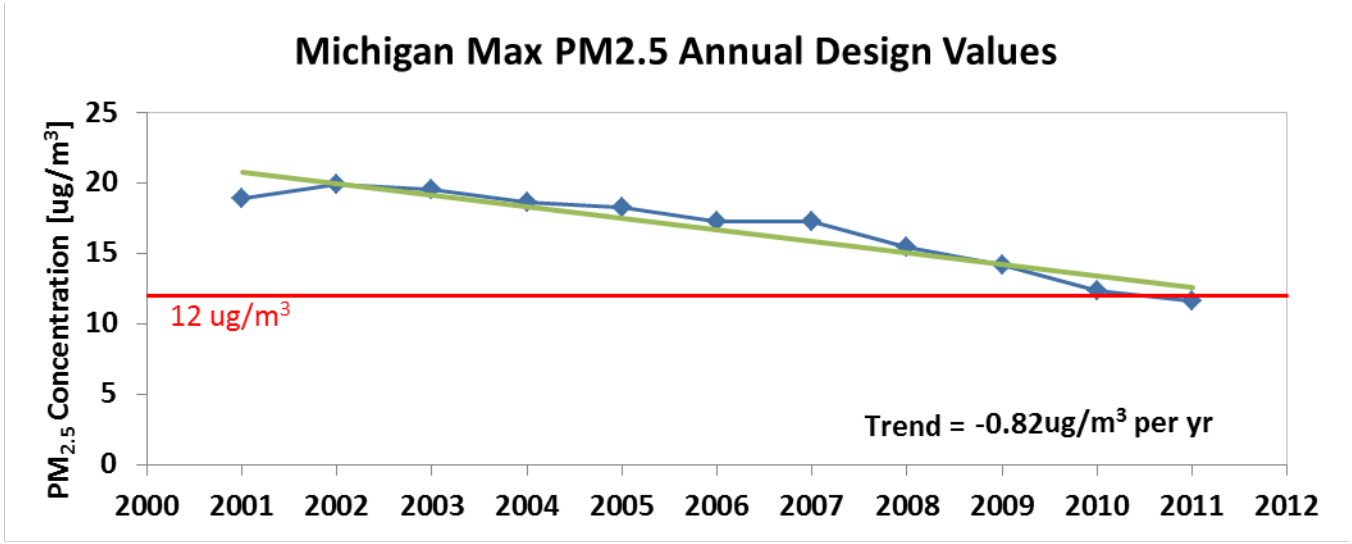
Note: Only monitoring sites meeting data completeness criteria listed

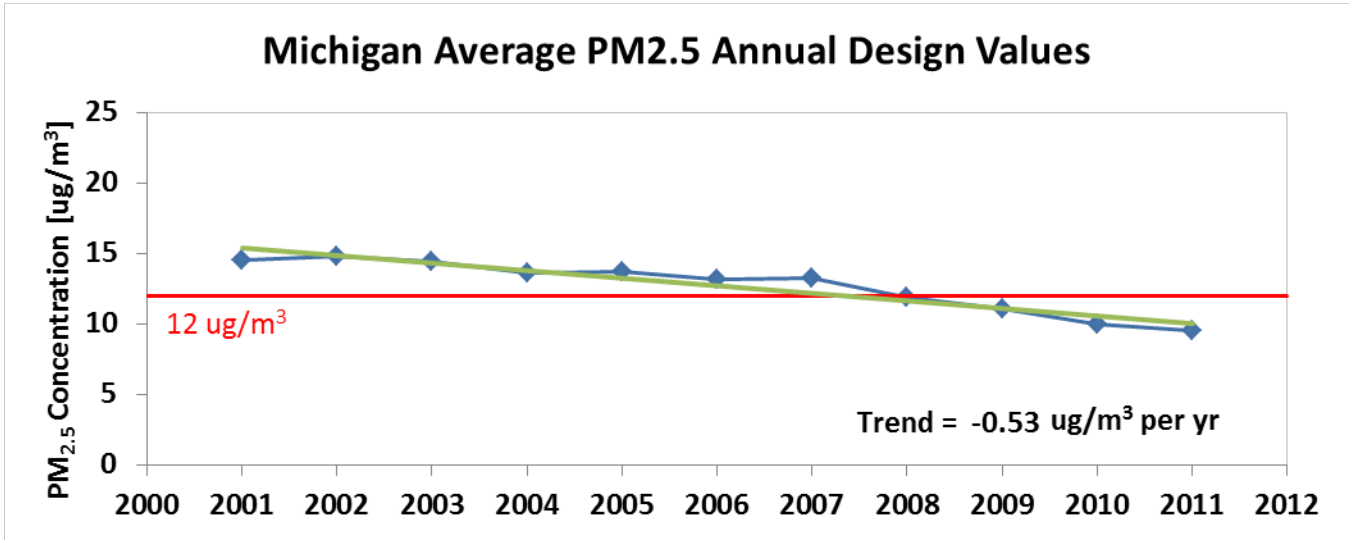
Ozone Trends by Site in Michigan

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

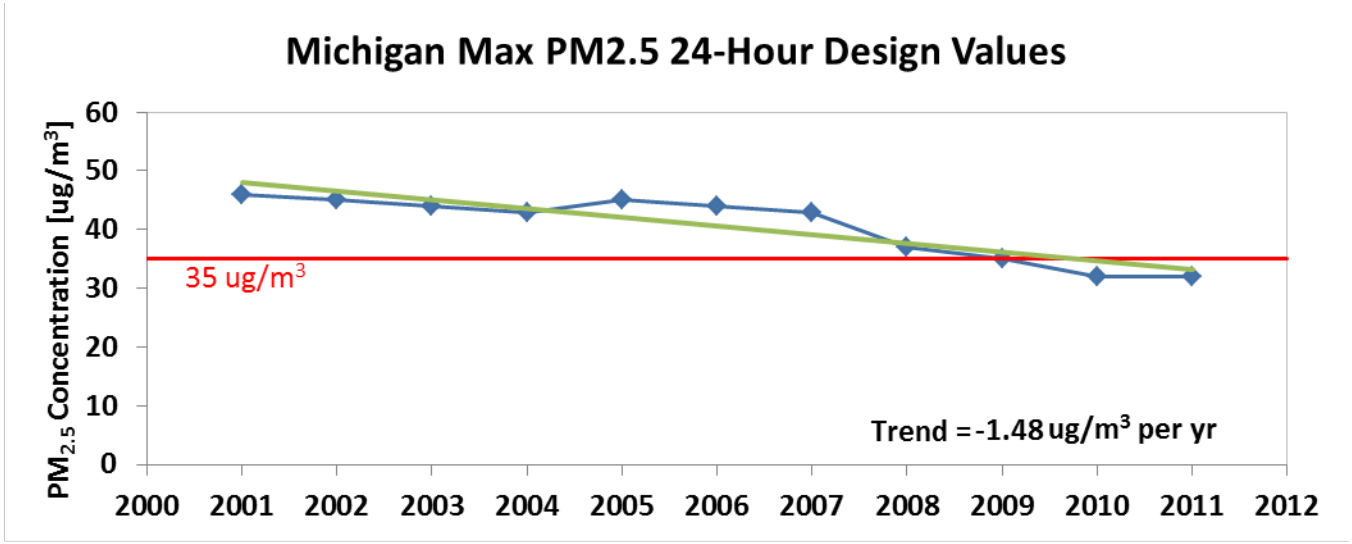
Note: Only monitoring sites meeting data completeness criteria listed

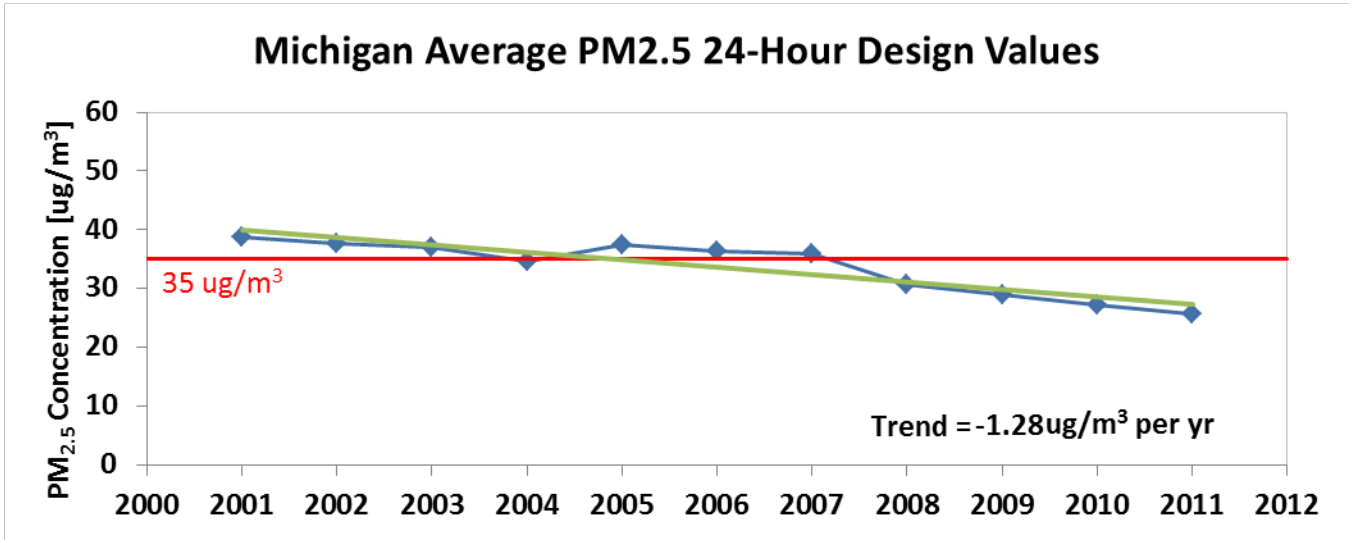
Max/Ave $PM_{2.5}$ Annual DVs and Trend





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





$PM_{2.5}$ Trends by Site in Michigan

		2009-2011 DV [ug/m³]		Trend [ug/m³ per year]	
Monitoring Site	County	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

		2009-2011 DV [ug/m³]		Trend [ug/m³ per year]	
Monitoring Site	County	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