Emission and Air Quality Trends Review 1999-2011

Pennsylvania

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, 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

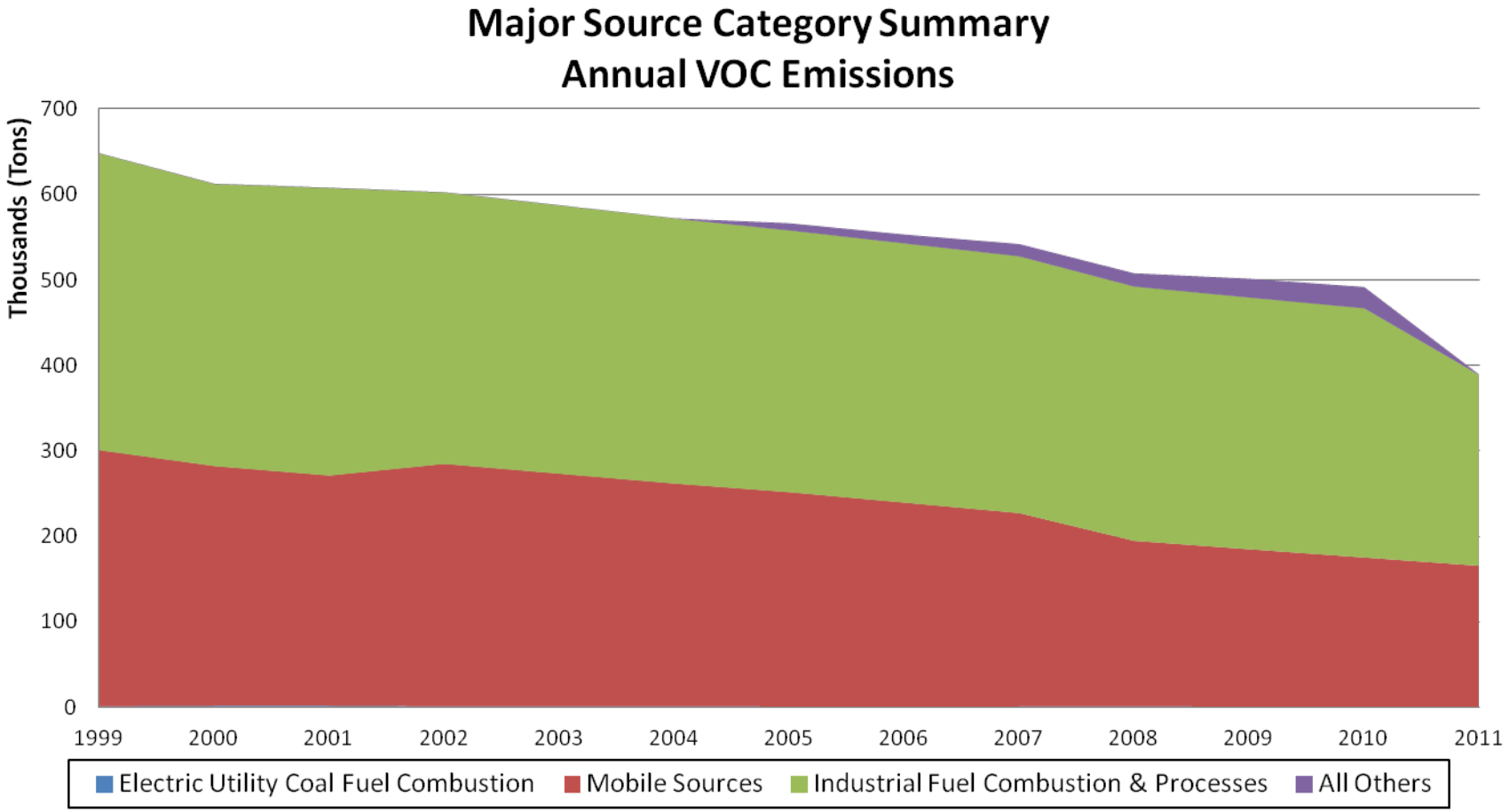
- Negative values indicate decrease in emissions, positive values indicate an increase

Pennsylvania Emission Trends (VOC)

	Annual Emissions (Tons)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	904	1,370	941	656	662	706	799	686	745	373
Mobile Sources	299,582	269,419	271,990	250,693	238,409	226,125	193,572	183,833	174,094	164,795
Industrial Fuel Combustion & Processes	347,918	337,222	314,590	307,152	304,216	301,279	298,343	295,407	292,470	224,119
All Others	273	415	329	8,395	10,405	14,442	15,579	22,029	24,929	400
Total	**648,677**	**608,428**	**587,850**	**566,896**	**553,692**	**542,552**	**508,293**	**501,955**	**492,238**	**389,687**

	Annual Emissions Change (Percent since 1999)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	0%	52%	4%	-27%	-27%	-22%	-12%	-24%	-18%	-59%
Mobile Sources	0%	-10%	-9%	-16%	-20%	-25%	-35%	-39%	-42%	-45%
Industrial Fuel Combustion & Processes	0%	-3%	-10%	-12%	-13%	-13%	-14%	-15%	-16%	-36%
All Others	0%	52%	21%	2973%	3709%	5187%	5603%	7964%	9025%	47%
Total	**0%**	**-6%**	**-9%**	**-13%**	**-15%**	**-16%**	**-22%**	**-23%**	**-24%**	**-40%**

Pennsylvania Emission Trends (VOC)

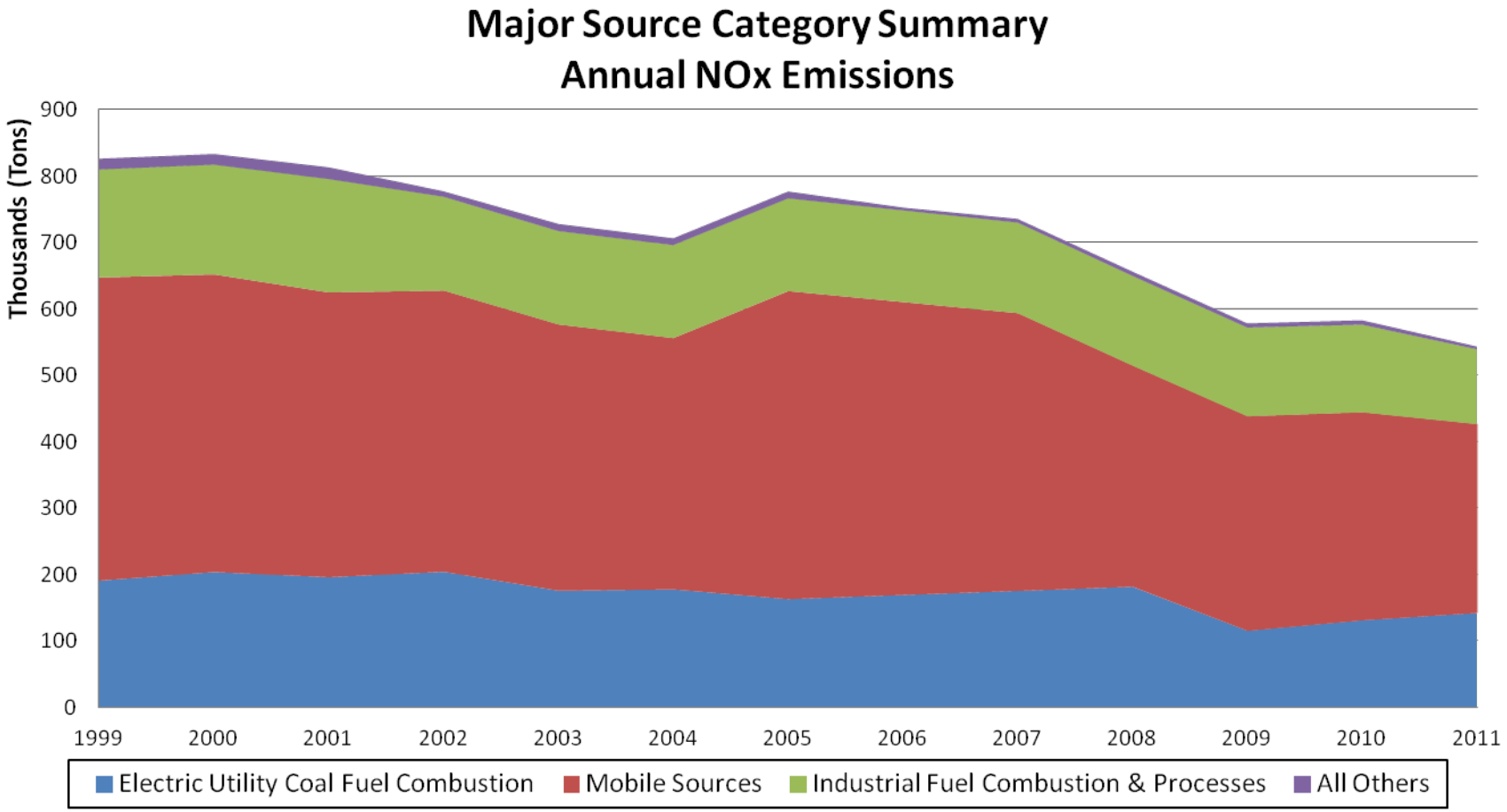


Pennsylvania Emission Trends (NOx)

	Annual Emissions (Tons)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	190,793	195,955	175,582	162,886	169,215	175,307	181,587	115,170	130,994	142,014
Mobile Sources	456,670	428,935	401,208	464,112	441,282	418,451	333,323	323,511	313,699	284,905
Industrial Fuel Combustion & Processes	162,931	171,006	140,811	139,840	138,225	136,606	135,385	133,806	132,146	112,818
All Others	16,134	17,566	10,651	10,373	4,238	5,490	6,274	6,157	6,518	4,157
Total	**826,528**	**813,463**	**728,252**	**777,211**	**752,961**	**735,855**	**656,570**	**578,644**	**583,357**	**543,894**

	Annual Emissions Change (Percent since 1999)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	0%	3%	-8%	-15%	-11%	-8%	-5%	-40%	-31%	-26%
Mobile Sources	0%	-6%	-12%	2%	-3%	-8%	-27%	-29%	-31%	-38%
Industrial Fuel Combustion & Processes	0%	5%	-14%	-14%	-15%	-16%	-17%	-18%	-19%	-31%
All Others	0%	9%	-34%	-36%	-74%	-66%	-61%	-62%	-60%	-74%
Total	**0%**	**-2%**	**-12%**	**-6%**	**-9%**	**-11%**	**-21%**	**-30%**	**-29%**	**-34%**

Pennsylvania Emission Trends (NOx)

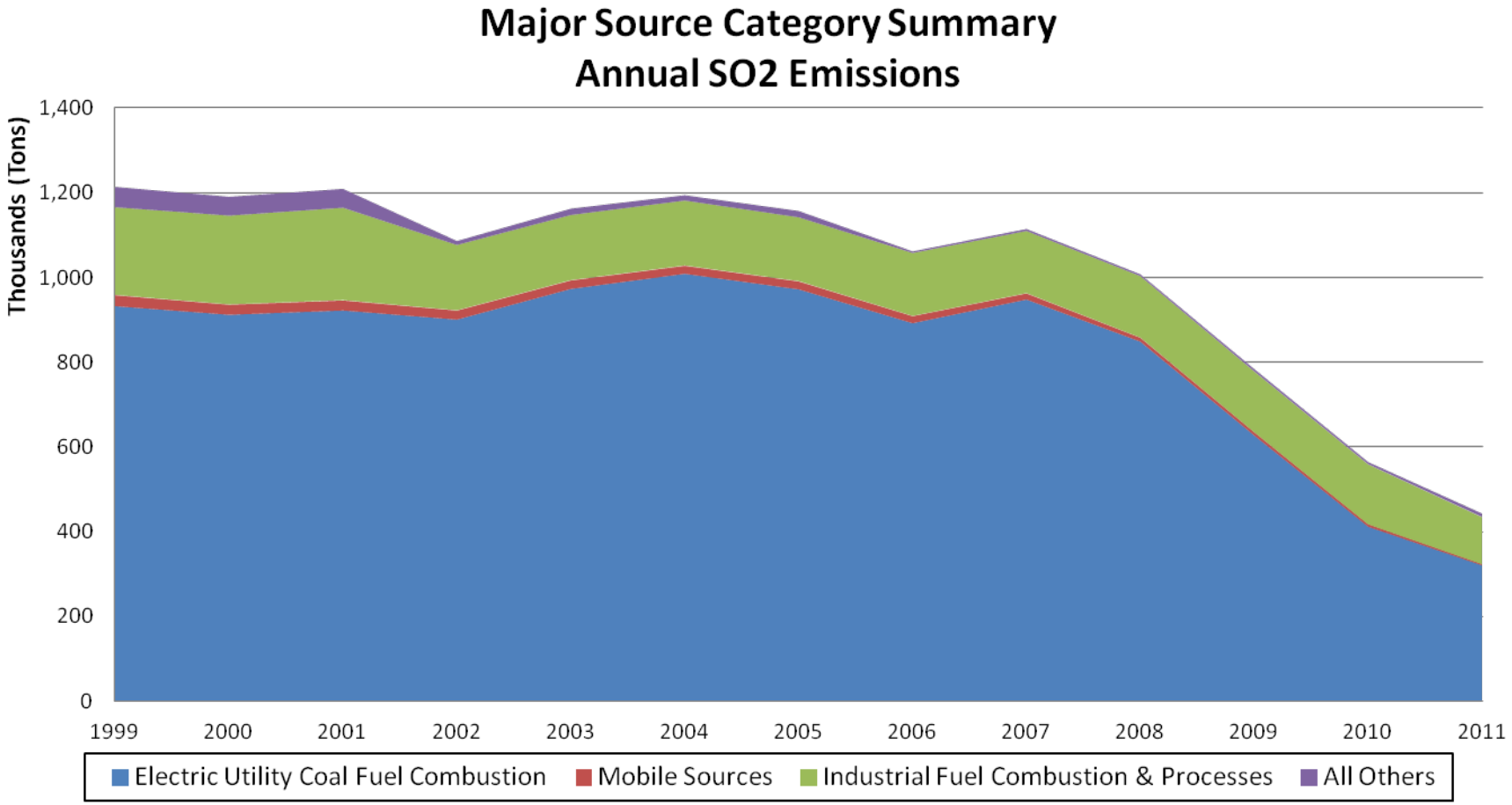


Pennsylvania Emission Trends (SO_2)

	Annual Emissions (Tons)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	933,049	922,783	973,729	972,744	892,783	948,671	849,119	627,265	411,715	320,504
Mobile Sources	25,937	23,906	20,150	18,819	16,679	14,539	9,306	7,934	6,562	3,822
Industrial Fuel Combustion & Processes	206,602	217,686	153,479	150,364	148,449	146,526	144,884	143,249	141,232	110,830
All Others	47,745	44,406	14,794	14,739	3,370	4,467	4,014	5,354	4,962	8,128
Total	**1,213,333**	**1,208,781**	**1,162,152**	**1,156,666**	**1,061,281**	**1,114,203**	**1,007,324**	**783,803**	**564,470**	**443,284**

	Annual Emissions Change (Percent since 1999)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	0%	-1%	4%	4%	-4%	2%	-9%	-33%	-56%	-66%
Mobile Sources	0%	-8%	-22%	-27%	-36%	-44%	-64%	-69%	-75%	-85%
Industrial Fuel Combustion & Processes	0%	5%	-26%	-27%	-28%	-29%	-30%	-31%	-32%	-46%
All Others	0%	-7%	-69%	-69%	-93%	-91%	-92%	-89%	-90%	-83%
Total	**0%**	**0%**	**-4%**	**-5%**	**-13%**	**-8%**	**-17%**	**-35%**	**-53%**	**-63%**

Pennsylvania Emission Trends (SO_2)

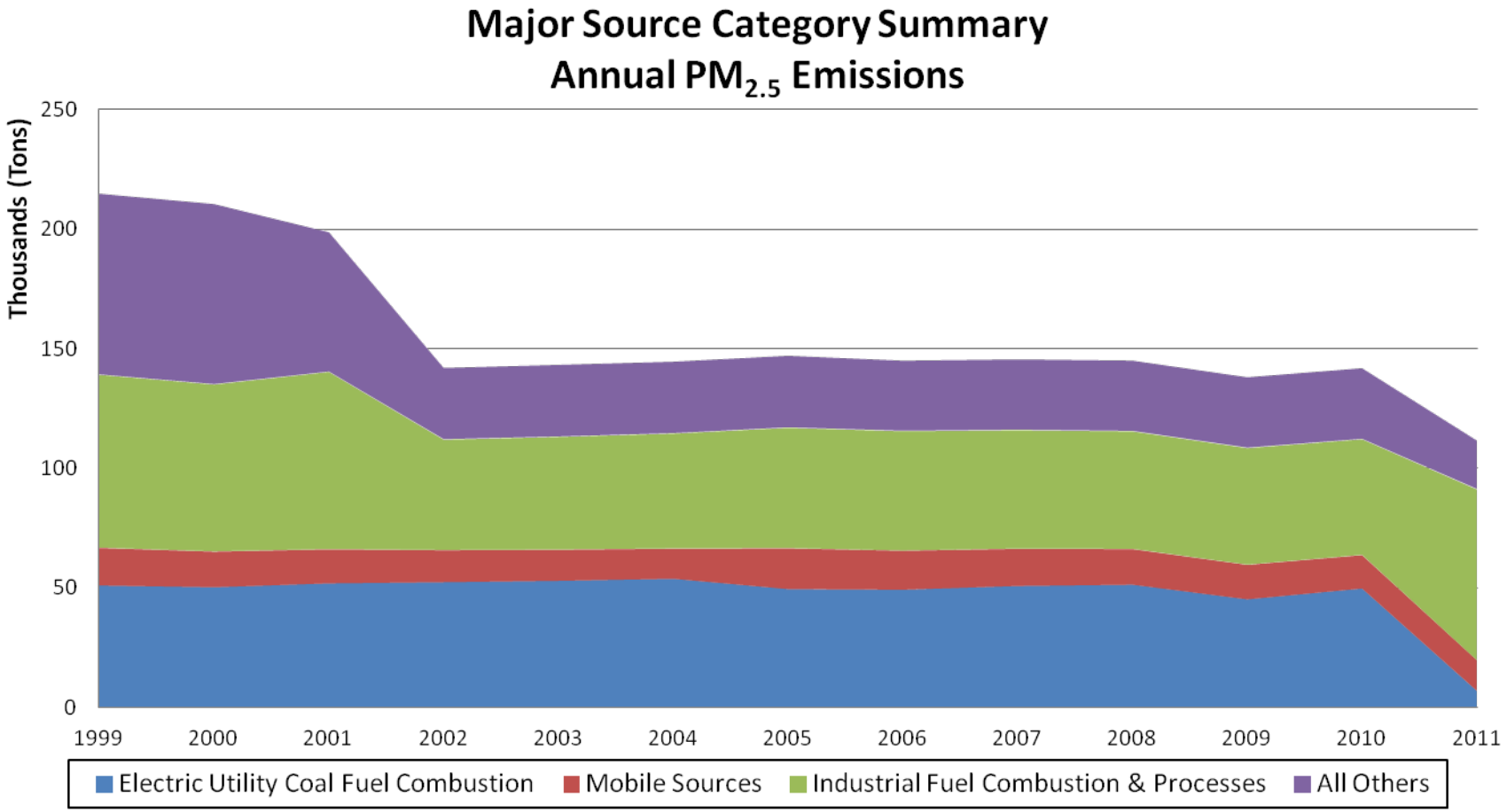


Pennsylvania Emission Trends ($PM_{2.5}$)

	Annual Emissions (Tons)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	51,111	51,976	53,078	49,585	49,320	50,906	51,447	45,275	49,825	6,753
Mobile Sources	15,810	14,359	13,071	17,184	16,408	15,631	14,993	14,535	14,076	12,998
Industrial Fuel Combustion & Processes	72,359	74,126	47,110	50,303	49,918	49,532	49,147	48,761	48,375	71,495
All Others	75,741	58,417	29,993	29,976	29,347	29,464	29,433	29,458	29,557	20,236
Total	**215,021**	**198,879**	**143,252**	**147,048**	**144,992**	**145,533**	**145,020**	**138,028**	**141,832**	**111,482**

	Annual Emissions Change (Percent since 1999)									
Source Category	**1999**	**2001**	**2003**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Electric Utility Coal Fuel Combustion	0%	2%	4%	-3%	-4%	0%	1%	-11%	-3%	-87%
Mobile Sources	0%	-9%	-17%	9%	4%	-1%	-5%	-8%	-11%	-18%
Industrial Fuel Combustion & Processes	0%	2%	-35%	-30%	-31%	-32%	-32%	-33%	-33%	-1%
All Others	0%	-23%	-60%	-60%	-61%	-61%	-61%	-61%	-61%	-73%
Total	**0%**	**-8%**	**-33%**	**-32%**	**-33%**	**-32%**	**-33%**	**-36%**	**-34%**	**-48%**

Pennsylvania Emission Trends ($PM_{2.5}$)



Emission Trends Summary

- All pollutants have decreased since 1999 in aggregate across Pennsylvania
- 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

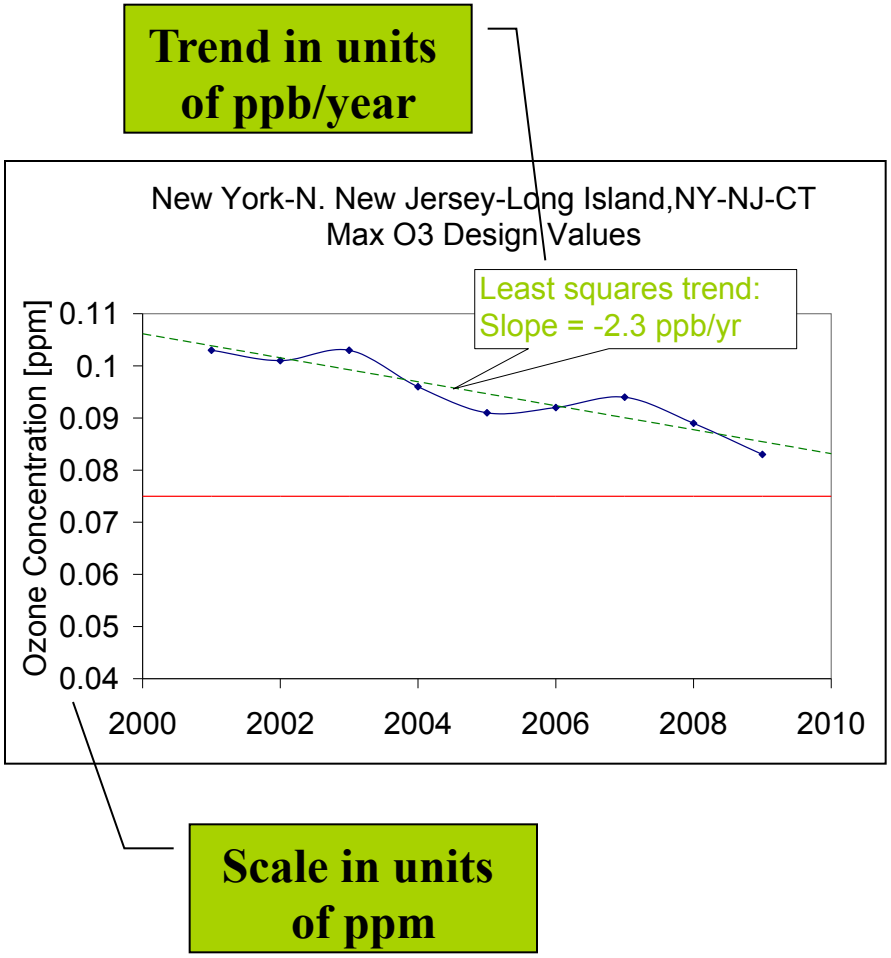
Data Handling Procedures

- 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

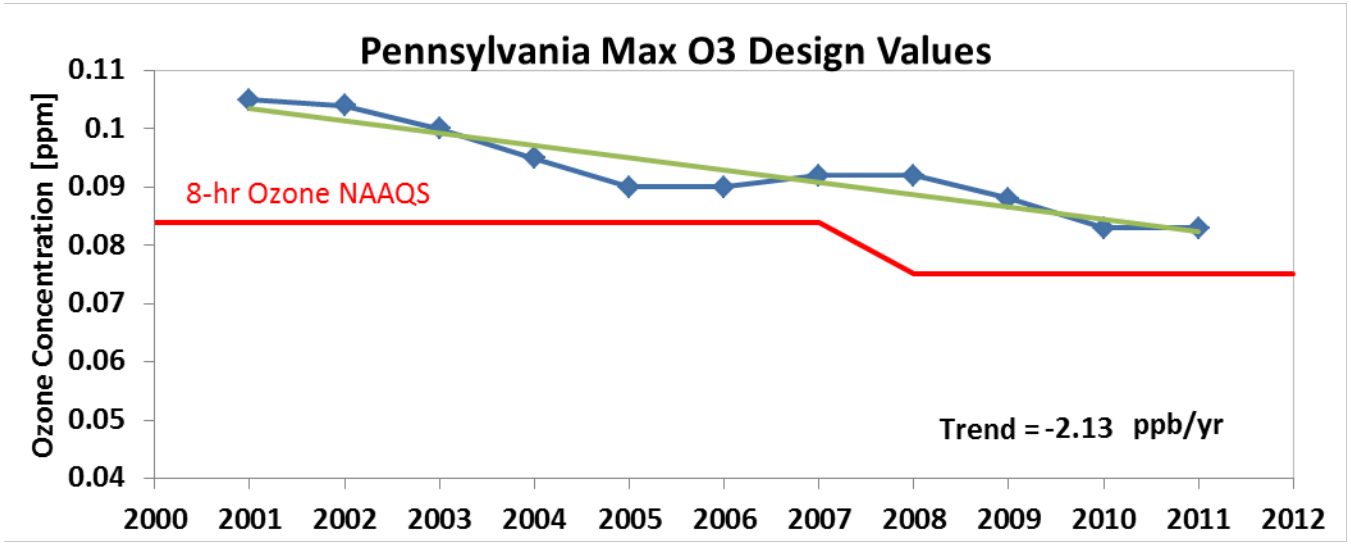
- Annual $PM_{2.5}$ DV and 24-hr $PM_{2.5}$ DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculations based on EPA data handling conventions
  - Data extracted from monitors that have a non-regulatory monitoring type are omitted
  - Selection of trend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

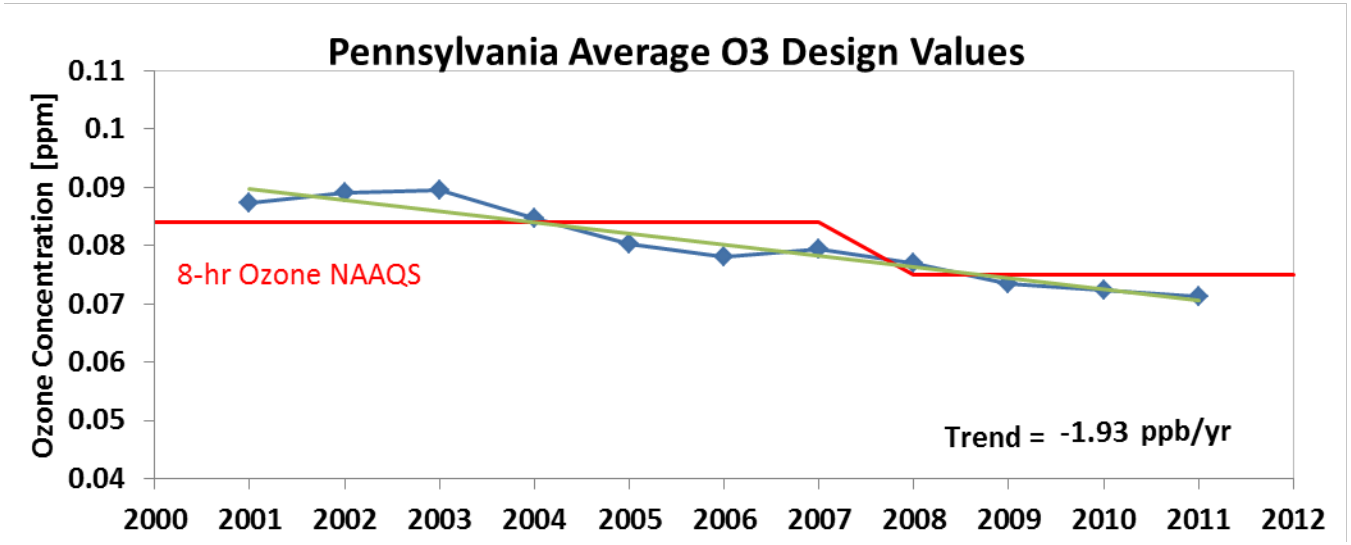
Trend Calculation



- 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 Pennsylvania

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/ yr]
420300084420101	Allegheny, PA	0.074	-1.52
420300104420101	Allegheny, PA	0.071	-2.45
420300674420101	Allegheny, PA	0.075	-1.95
420310054420101	Allegheny, PA	0.08	-1.29
420500014420101	Armstrong, PA	0.073	-2.00
420700024420101	Beaver, PA	0.069	-2.36
420700054420101	Beaver, PA	0.072	-2.23
420700144420101	Beaver, PA	0.071	-1.75
420130801442010 1	Blair, PA	0.07	-1.75
420170012442010 1	Bucks, PA	0.08	-2.19
420210011442010 1	Cambria, PA	0.069	-2.38

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in Pennsylvania

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
420270100442010 1	Centre, PA	0.07	-1.93
420290100442010 1	Chester, PA	0.074	-2.94
420334000442010 1	Clearfield, PA	0.072	-1.80
420430401442010 1	Dauphin, PA	0.069	-1.67
420431100442010 1	Dauphin, PA	0.073	-2.00
420450002442010 1	Delaware, PA	0.073	-2.27
420490003442010 1	Erie, PA	0.072	-1.90
420550001442010 1	Franklin, PA	0.065	-3.13
420590002442010 1	Greene, PA	0.069	-2.32
420690101442010 1	Lackawanna, PA	0.071	-1.69

Note: Only monitoring sites meeting data completeness criteria listed

Ozone Trends by Site in Pennsylvania

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
4206920064420101	Lackawanna, PA	0.066	-1.77
4207100074420101	Lancaster, PA	0.076	-2.02
4207300154420101	Lawrence, PA	0.067	-1.35
4207700044420101	Lehigh, PA	0.076	-2.19
4207911004420101	Luzerne, PA	0.065	-2.03
4207911014420101	Luzerne, PA	0.062	-2.26
4208501004420101	Mercer, PA	0.073	-1.95
4209100134420101	Montgomery, PA	0.077	-2.31
4209500254420101	Northampton, PA	0.075	-2.30
4209580004420101	Northampton, PA	0.069	-1.15

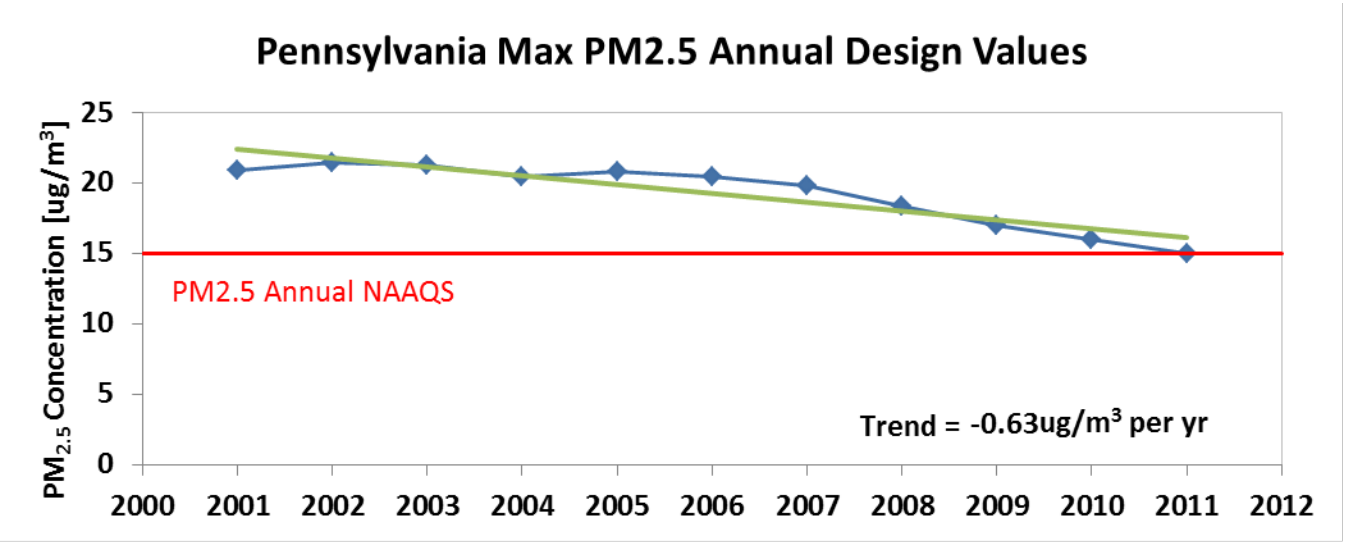
Note: Only monitoring sites meeting data completeness criteria listed

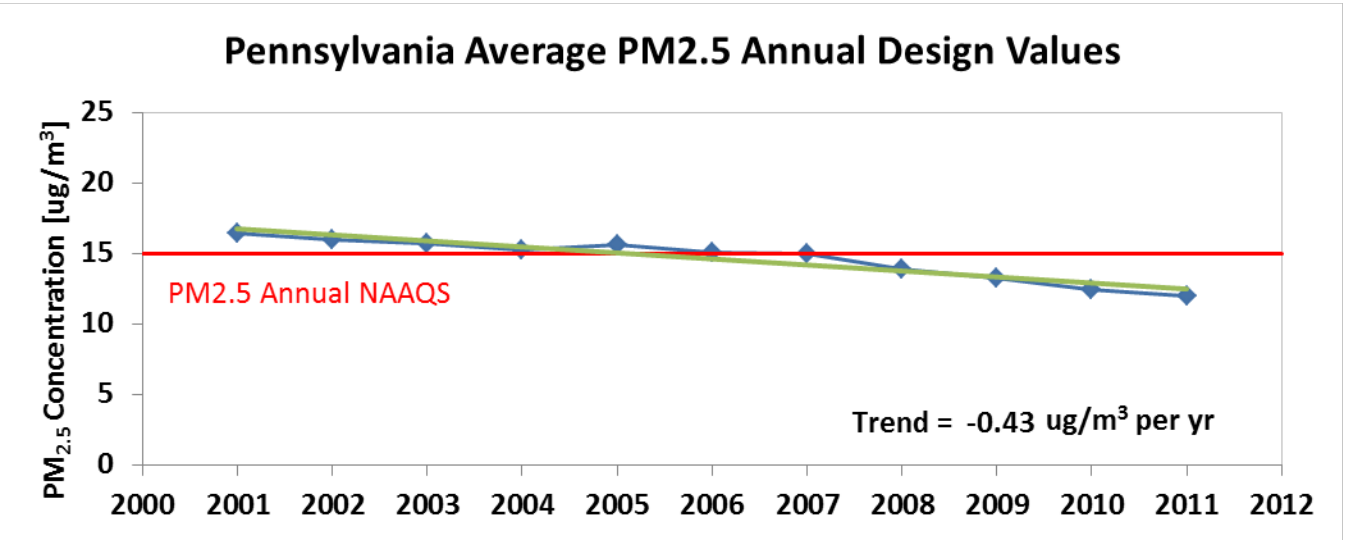
Ozone Trends by Site in Pennsylvania

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
4209903014420101	Perry, PA	0.067	-1.65
4210100044420101	Philadelphia, PA	0.068	-0.70
4210100244420101	Philadelphia, PA	0.083	-0.99
4211740004420101	Tioga, PA	0.069	-1.76
4212500054420101	Washington, PA	0.069	-2.05
4212502004420101	Washington, PA	0.068	-2.28
4212550014420101	Washington, PA	0.069	-2.00
4212900064420101	Westmoreland, PA	0.068	-1.51
4212900084420101	Westmoreland, PA	0.069	-2.04
4213300084420101	York, PA	0.071	-1.95

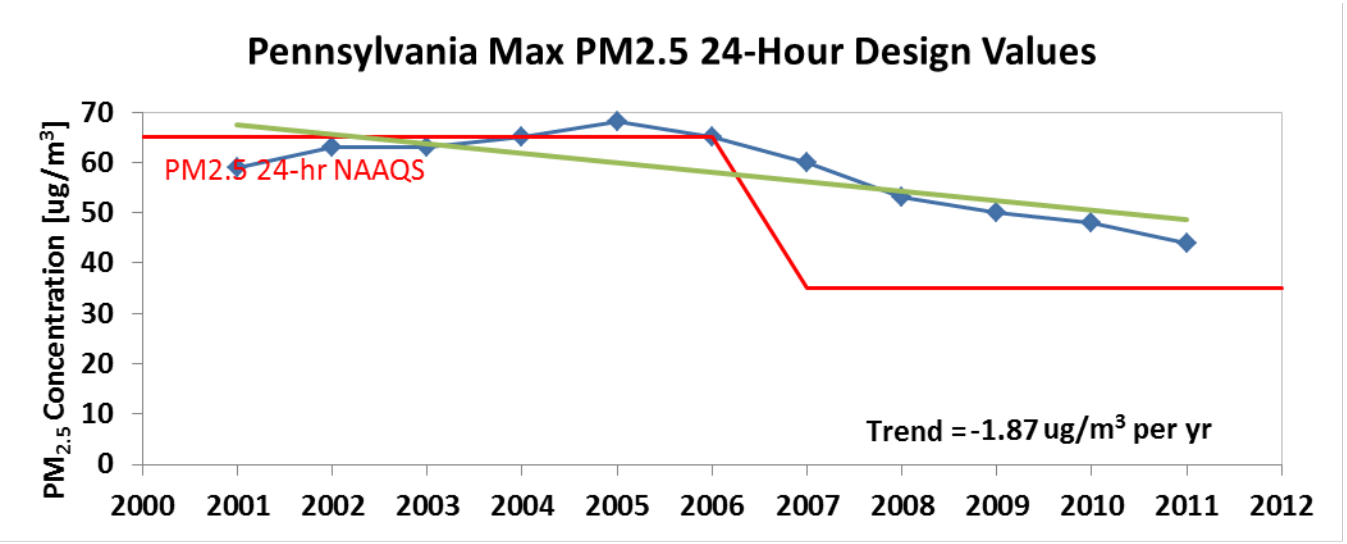
Note: Only monitoring sites meeting data completeness criteria listed

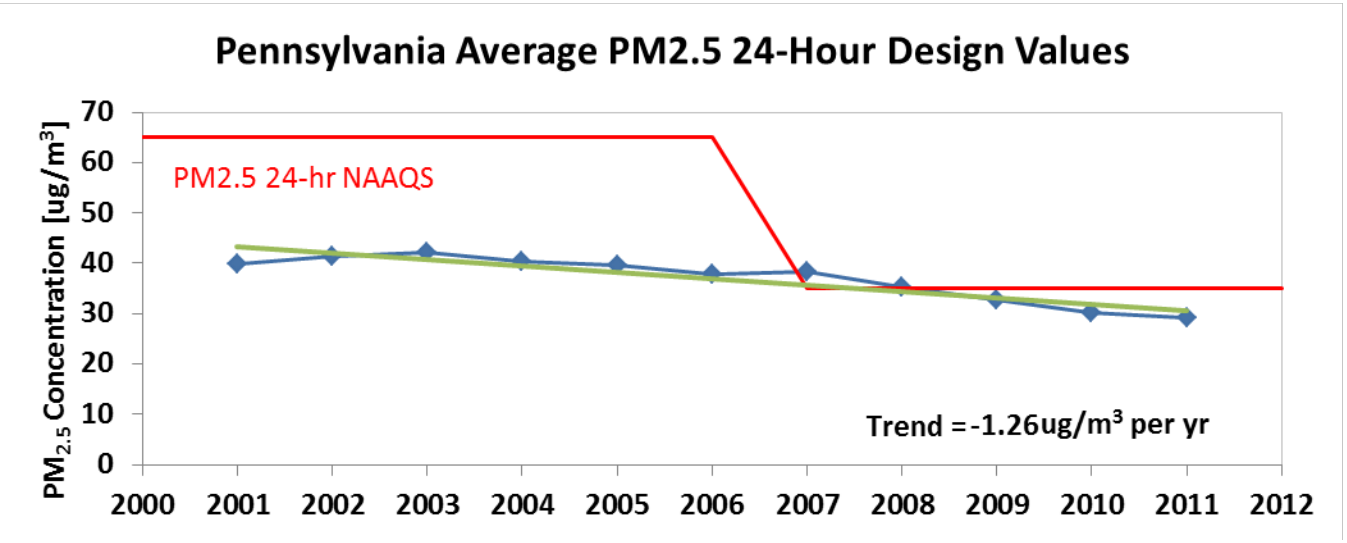
Max/Ave $PM_{2.5}$ Annual DVs and Trend





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





$PM_{2.5}$ Trends by Site in Pennsylvania

		2009-2011 DV [ug/m³]		Trend [ug/m³ per year]	
Monitoring Site	**County**	**Annual**	**24-Hr**	**Annual DV**	**24-Hr DV**
420010001	Adams	11.7	29	-0.25	-1.03
420030008	Allegheny	11.6	27	-0.47	-1.07
420030064	Allegheny	15.0	44	-0.63	-1.87
420030067	Allegheny	N/A	27	N/A	-1.88
420031008	Allegheny	12.4	N/A	-0.39	N/A
420031301	Allegheny	12.7	34	-0.43	-1.19
420070014	Beaver	12.4	29	-0.38	-1.37
420110011	Berks	10.7	27	-0.60	-1.65
420170012	Bucks	10.9	28	-0.42	-1.13
420210011	Cambria	12.4	30	-0.33	-1.34
420270100	Centre	N/A	26	N/A	-1.50
420410101	Cumberland	N/A	31	N/A	-1.47
420430401	Dauphin	12.1	32	-0.38	-1.37

Note: Only monitoring sites meeting data completeness criteria listed

$PM_{2.5}$ Trends by Site in Pennsylvania

		2009-2011 DV [ug/m³]		Trend [ug/m³ per year]	
Monitoring Site	**County**	**Annual**	**24-Hr**	**Annual DV**	**24-Hr DV**
420450002	Delaware	12.7	30	-0.32	-0.94
420692006	Lackawanna	9.4	25	-0.37	-1.61
420710007	Lancaster	12.0	31	-0.53	-1.26
420850100	Mercer	10.5	N/A	-0.47	N/A
420950025	Northampton	13.4	33	-0.22	-0.81
421010004	Philadelphia	N/A	28	N/A	-1.24
421010047	Philadelphia	N/A	27	N/A	-1.07
421250005	Washington	12.6	28	-0.29	-1.35
421250200	Washington	11.3	27	-0.40	-1.17
421255001	Washington	N/A	20	N/A	-1.18
421290008	Westmoreland	N/A	N/A	-0.23	-0.90
421330008	York	11.5	28	-0.53	-1.67

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 Pennsylvania

- O_3 and $PM_{2.5}$ design values have decreased since 1999 in all currently designated O_3 and $PM_{2.5}$ non-attainment areas in Pennsylvania in which monitoring data met the 1999–2011 trends completeness criteria. Additional O_3 or $PM_{2.5}$ nonattainment areas in Pennsylvania in which monitoring data did not meet the 1999–2011 trends completeness criteria include:
  - Reading, PA (Ozone)