# Emission and Air Quality Trends Review 1999-2011

## Maryland

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

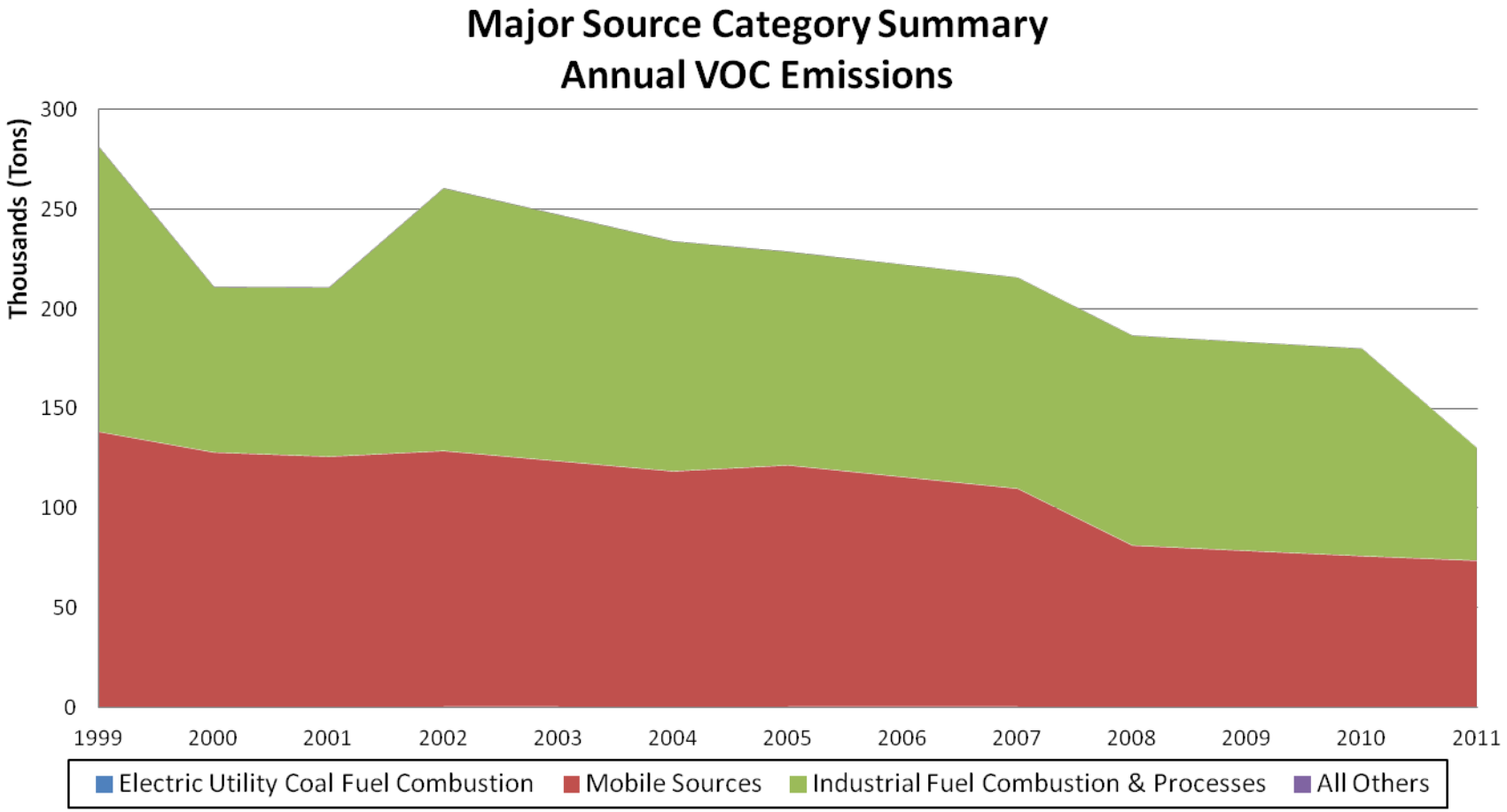
- Negative values indicate decrease in emissions, positive values indicate an increase

# Maryland Emission Trends (VOC)

| | Annual Emissions (Tons) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source Category** | **1999** | **2001** | **2003** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| Electric Utility Coal Fuel Combustion | 393 | 337 | 371 | 365 | 364 | 368 | 354 | 312 | 330 | 218 |
| Mobile Sources | 137,875 | 125,505 | 123,210 | 121,139 | 115,259 | 109,379 | 80,824 | 78,174 | 75,525 | 73,326 |
| Industrial Fuel Combustion & Processes | 142,984 | 84,836 | 123,778 | 107,262 | 106,642 | 106,022 | 105,401 | 104,781 | 104,161 | 56,590 |
| All Others | 190 | 240 | 129 | 130 | 65 | 72 | 53 | 40 | 52 | 17 |
| **Total** | **281,442** | **210,918** | **247,488** | **228,896** | **222,329** | **215,840** | **186,634** | **183,307** | **180,068** | **130,150** |

| | Annual Emissions Change (Percent since 1999) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source Category** | **1999** | **2001** | **2003** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| Electric Utility Coal Fuel Combustion | 0% | -14% | -6% | -7% | -7% | -6% | -10% | -21% | -16% | -45% |
| Mobile Sources | 0% | -9% | -11% | -12% | -16% | -21% | -41% | -43% | -45% | -47% |
| Industrial Fuel Combustion & Processes | 0% | -41% | -13% | -25% | -25% | -26% | -26% | -27% | -27% | -60% |
| All Others | 0% | 26% | -32% | -32% | -66% | -62% | -72% | -79% | -73% | -91% |
| **Total** | **0%** | **-25%** | **-12%** | **-19%** | **-21%** | **-23%** | **-34%** | **-35%** | **-36%** | **-54%** |

# Maryland Emission Trends (VOC)

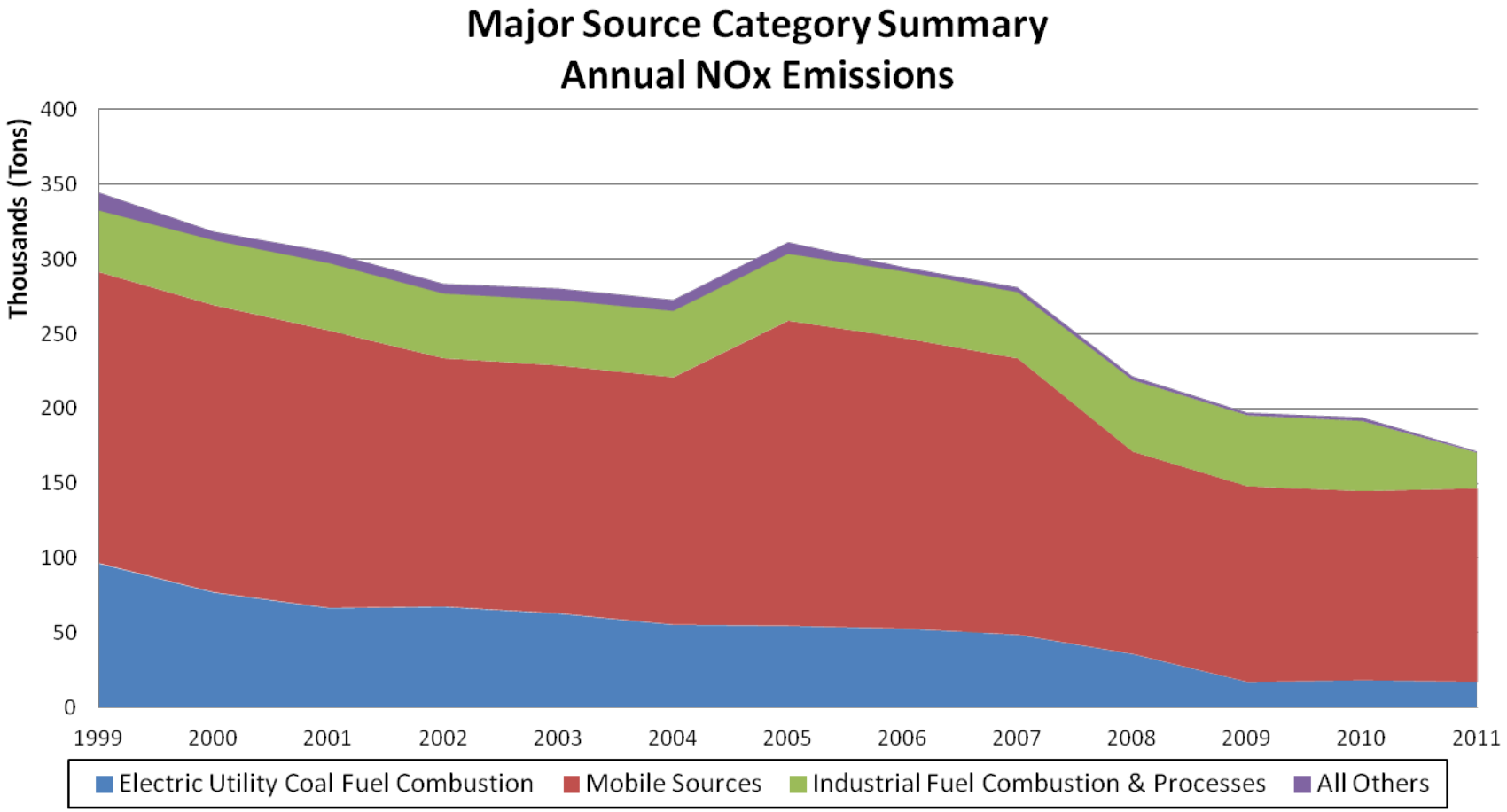


# Maryland Emission Trends (NOx)

| | Annual Emissions (Tons) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source Category** | **1999** | **2001** | **2003** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| Electric Utility Coal Fuel Combustion | 96,271 | 66,300 | 62,698 | 54,465 | 52,577 | 48,423 | 35,518 | 16,732 | 17,882 | 16,823 |
| Mobile Sources | 194,822 | 185,752 | 165,901 | 204,106 | 194,514 | 184,921 | 135,524 | 131,077 | 126,631 | 129,558 |
| Industrial Fuel Combustion & Processes | 41,704 | 45,491 | 44,156 | 45,224 | 44,961 | 44,697 | 48,060 | 47,549 | 47,074 | 23,977 |
| All Others | 12,015 | 7,545 | 7,747 | 7,769 | 2,869 | 3,197 | 2,412 | 1,706 | 2,294 | 834 |
| **Total** | **344,813** | **305,088** | **280,502** | **311,563** | **294,920** | **281,238** | **221,514** | **197,064** | **193,881** | **171,192** |

| | Annual Emissions Change (Percent since 1999) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source Category** | **1999** | **2001** | **2003** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| Electric Utility Coal Fuel Combustion | 0% | -31% | -35% | -43% | -45% | -50% | -63% | -83% | -81% | -83% |
| Mobile Sources | 0% | -5% | -15% | 5% | 0% | -5% | -30% | -33% | -35% | -33% |
| Industrial Fuel Combustion & Processes | 0% | 9% | 6% | 8% | 8% | 7% | 15% | 14% | 13% | -43% |
| All Others | 0% | -37% | -36% | -35% | -76% | -73% | -80% | -86% | -81% | -93% |
| **Total** | **0%** | **-12%** | **-19%** | **-10%** | **-14%** | **-18%** | **-36%** | **-43%** | **-44%** | **-50%** |

# Maryland Emission Trends (NOx)

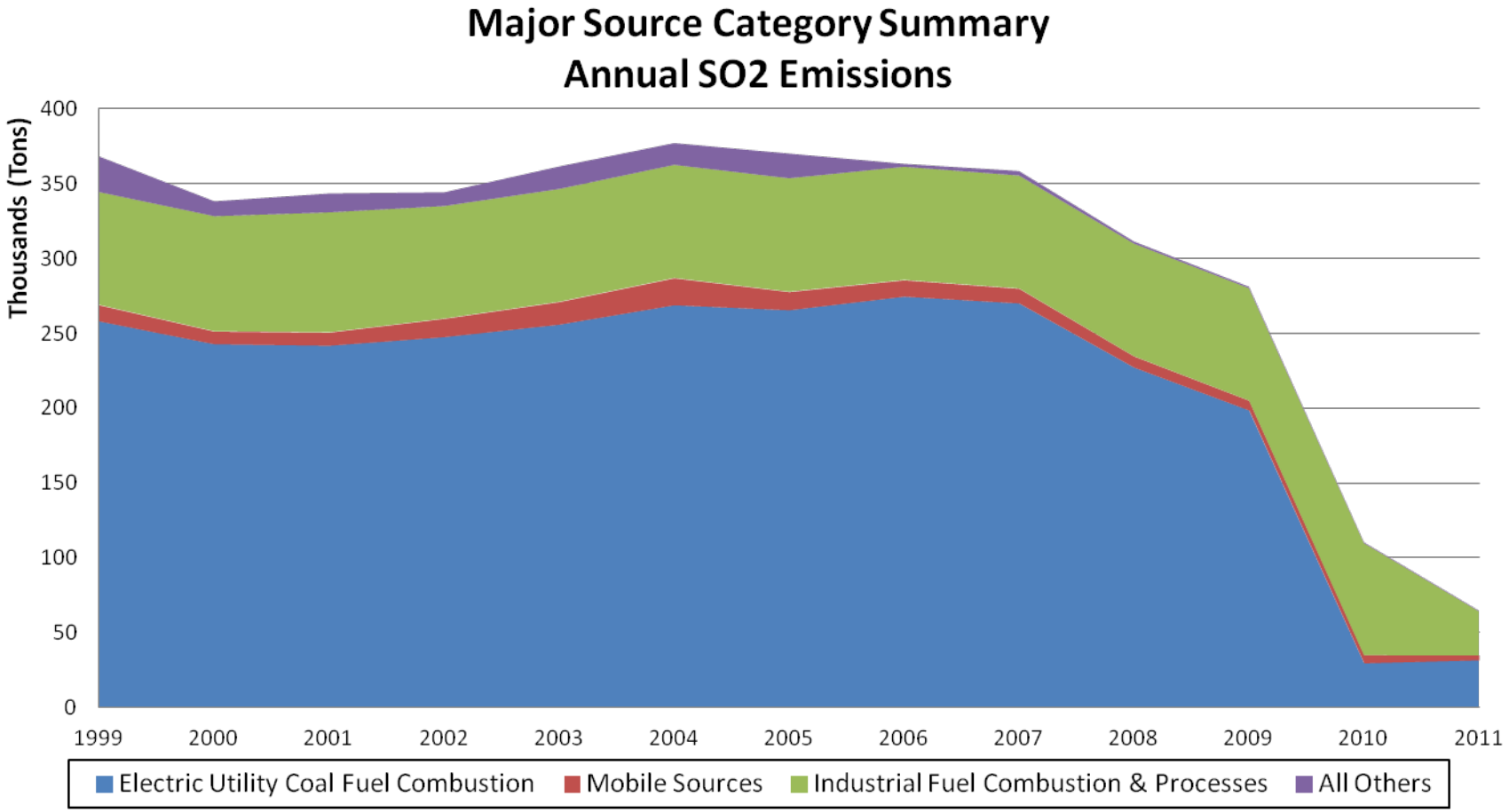


# Maryland Emission Trends ($SO_2$)

| | Annual Emissions (Tons) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source Category** | **1999** | **2001** | **2003** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| Electric Utility Coal Fuel Combustion | 258,173 | 241,869 | 255,958 | 265,595 | 274,669 | 270,161 | 227,225 | 198,537 | 29,498 | 31,465 |
| Mobile Sources | 10,754 | 8,763 | 15,130 | 12,182 | 10,983 | 9,784 | 7,462 | 6,555 | 5,648 | 3,425 |
| Industrial Fuel Combustion & Processes | 75,384 | 80,152 | 75,326 | 75,743 | 75,579 | 75,414 | 75,250 | 75,086 | 74,922 | 29,660 |
| All Others | 23,693 | 12,546 | 14,978 | 16,466 | 1,866 | 2,940 | 1,360 | 925 | 541 | 439 |
| **Total** | **368,003** | **343,330** | **361,392** | **369,986** | **363,097** | **358,299** | **311,297** | **281,102** | **110,608** | **64,988** |

| | Annual Emissions Change (Percent since 1999) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source Category** | **1999** | **2001** | **2003** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| Electric Utility Coal Fuel Combustion | 0% | -6% | -1% | 3% | 6% | 5% | -12% | -23% | -89% | -88% |
| Mobile Sources | 0% | -19% | 41% | 13% | 2% | -9% | -31% | -39% | -47% | -68% |
| Industrial Fuel Combustion & Processes | 0% | 6% | 0% | 0% | 0% | 0% | 0% | 0% | -1% | -61% |
| All Others | 0% | -47% | -37% | -31% | -92% | -88% | -94% | -96% | -98% | -98% |
| **Total** | **0%** | **-7%** | **-2%** | **1%** | **-1%** | **-3%** | **-15%** | **-24%** | **-70%** | **-82%** |

# Maryland Emission Trends ($SO_2$)

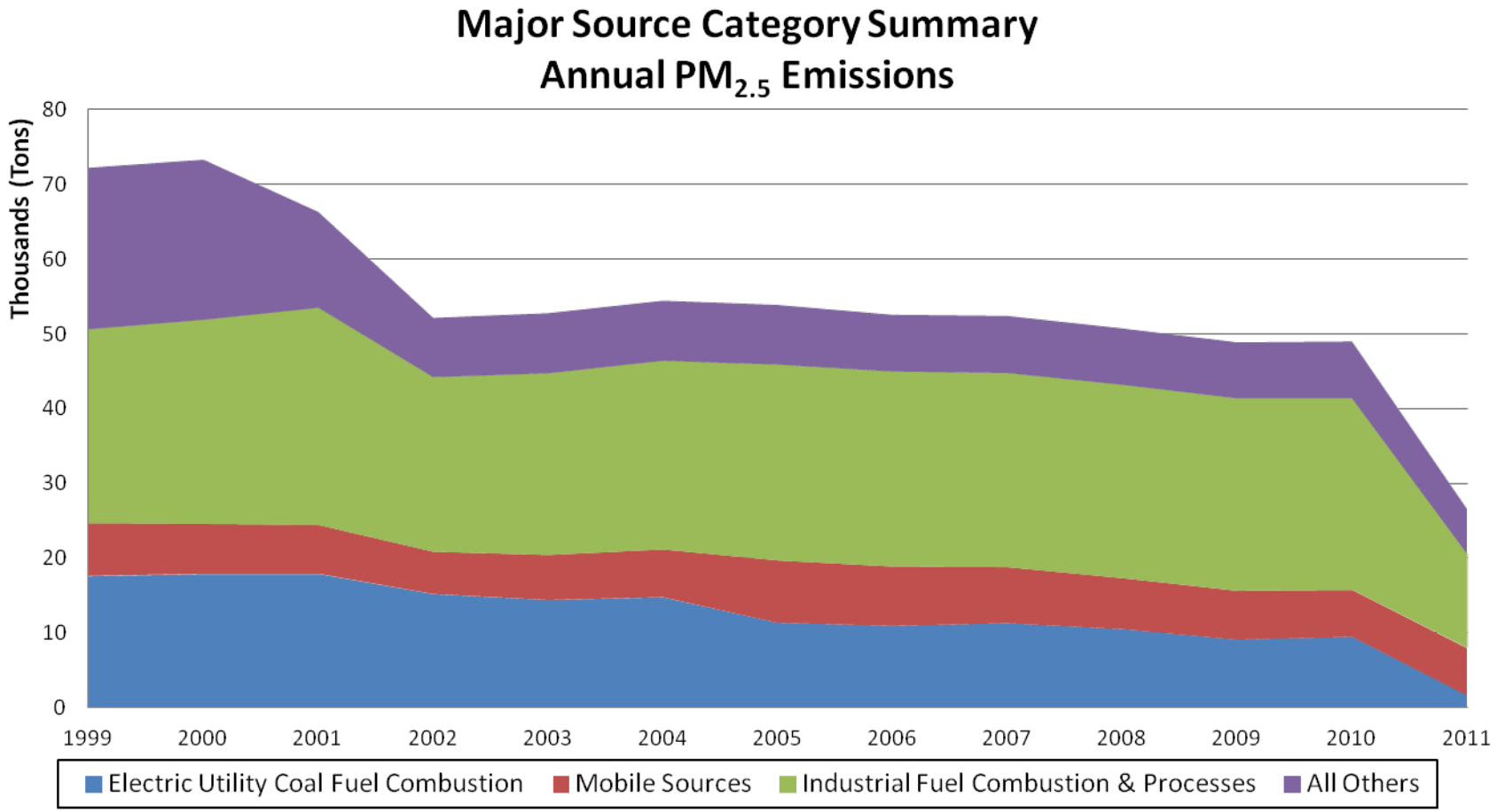


# Maryland Emission Trends ($PM_{2.5}$)

| | Annual Emissions (Tons) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source Category** | **1999** | **2001** | **2003** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| Electric Utility Coal Fuel Combustion | 17,561 | 17,868 | 14,367 | 11,312 | 10,925 | 11,266 | 10,472 | 9,055 | 9,457 | 1,624 |
| Mobile Sources | 7,077 | 6,505 | 6,010 | 8,330 | 7,903 | 7,476 | 6,808 | 6,532 | 6,256 | 6,316 |
| Industrial Fuel Combustion & Processes | 26,035 | 29,168 | 24,378 | 26,282 | 26,165 | 26,048 | 25,930 | 25,813 | 25,696 | 12,646 |
| All Others | 21,629 | 12,834 | 8,052 | 7,989 | 7,595 | 7,651 | 7,551 | 7,503 | 7,611 | 5,998 |
| **Total** | **72,301** | **66,375** | **52,808** | **53,913** | **52,587** | **52,441** | **50,762** | **48,903** | **49,019** | **26,585** |

| | 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% | -18% | -36% | -38% | -36% | -40% | -48% | -46% | -91% |
| Mobile Sources | 0% | -8% | -15% | 18% | 12% | 6% | -4% | -8% | -12% | -11% |
| Industrial Fuel Combustion & Processes | 0% | 12% | -6% | 1% | 1% | 0% | 0% | -1% | -1% | -51% |
| All Others | 0% | -41% | -63% | -63% | -65% | -65% | -65% | -65% | -65% | -72% |
| **Total** | **0%** | **-8%** | **-27%** | **-25%** | **-27%** | **-27%** | **-30%** | **-32%** | **-32%** | **-63%** |

# Maryland Emission Trends ($PM_{2.5}$)



# Emission Trends Summary

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

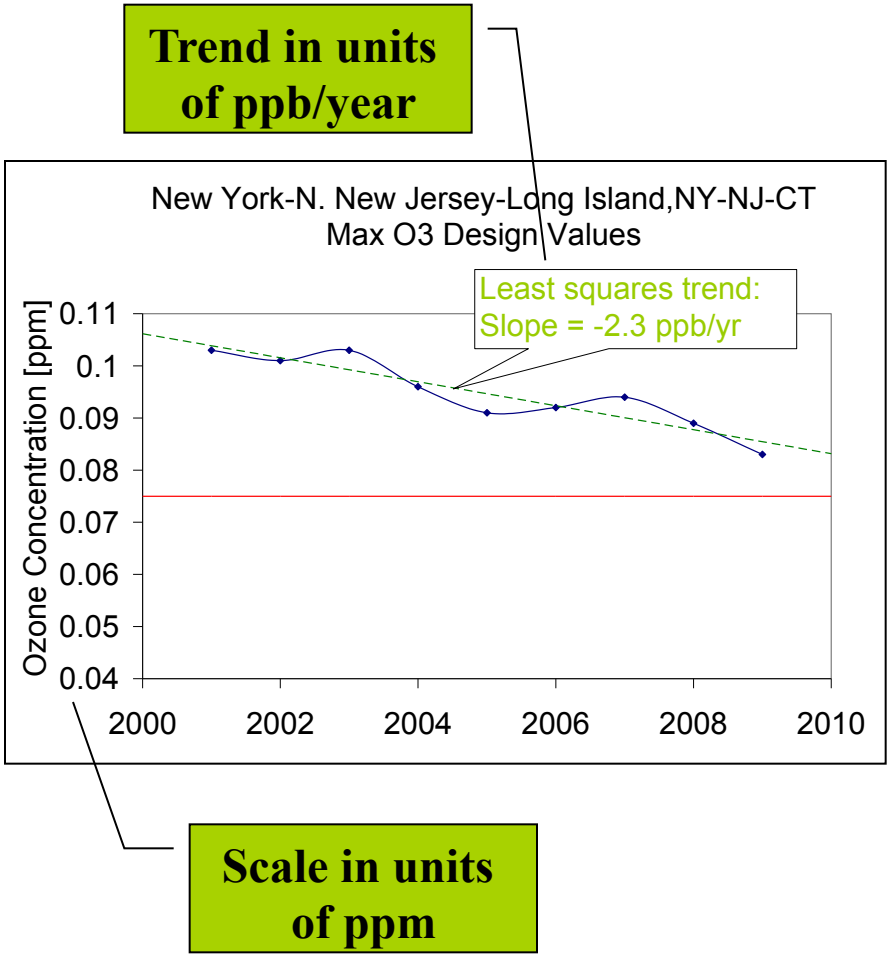
# Data Handling Procedures

- $O_3$ design value (DV) for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculated using annual 4$^{th}$ 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

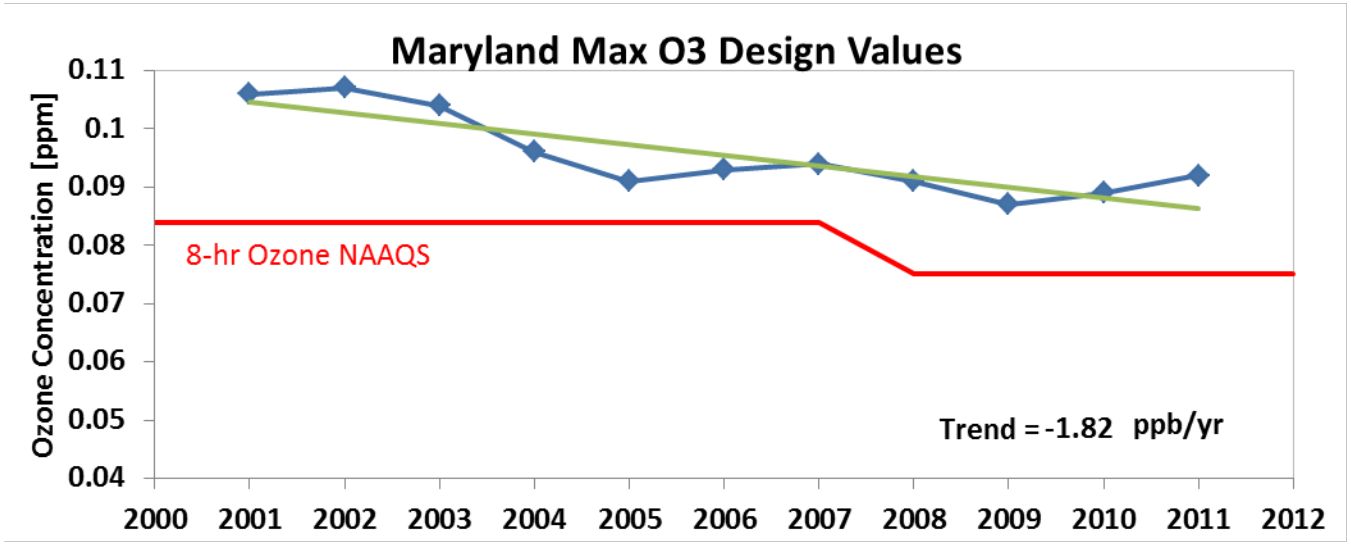
- Annual $PM_{2.5}$ DV and 24-hr $PM_{2.5}$ DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculations based on EPA data handling conventions
  - Data extracted from monitors that have a non-regulatory monitoring type are omitted
  - Selection of trend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

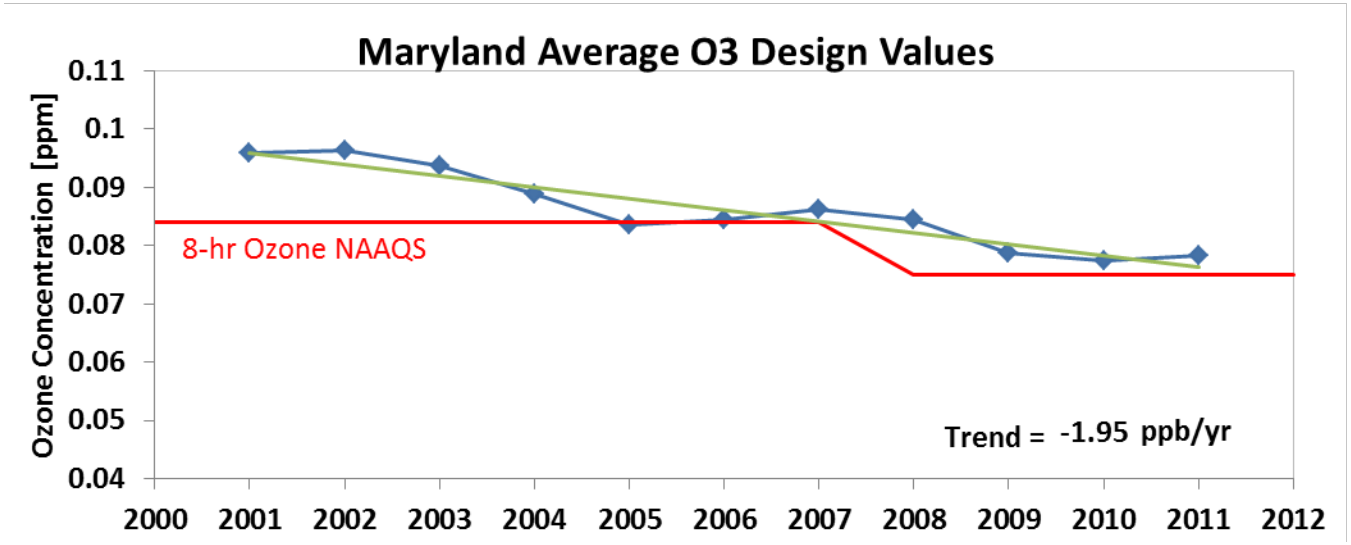
# Trend Calculation




- 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



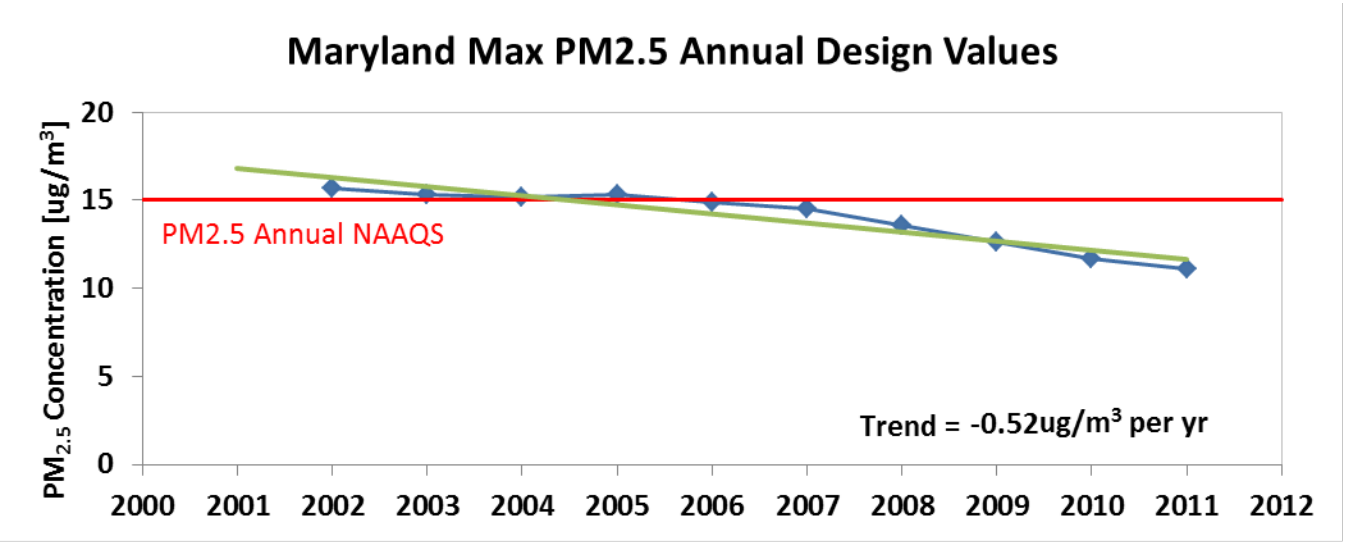



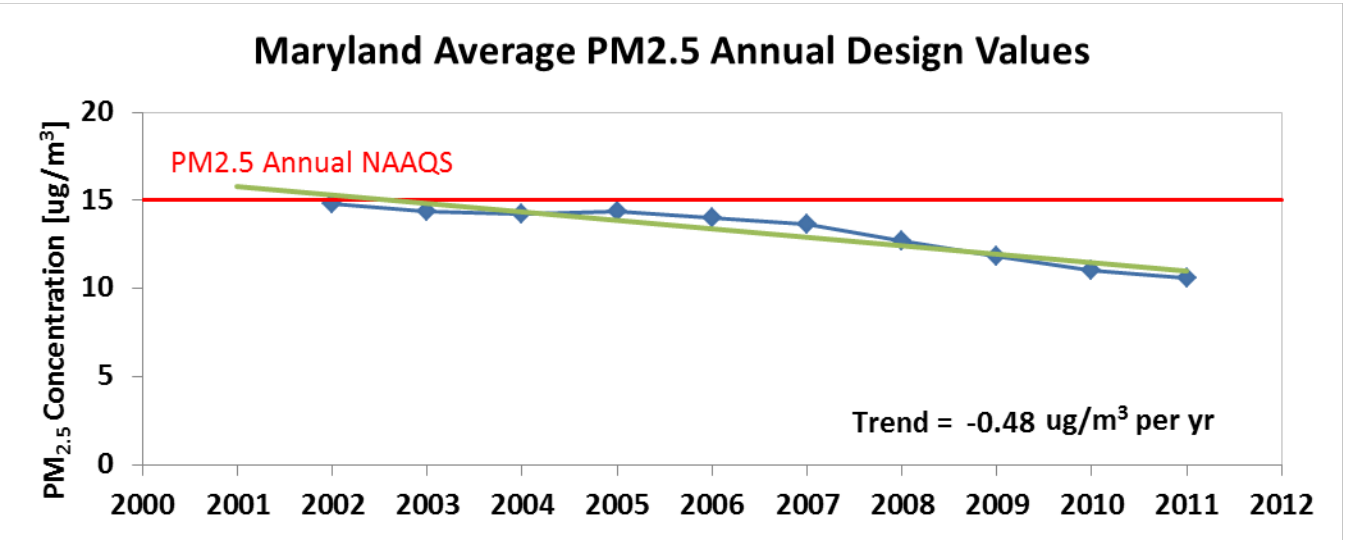
# Ozone Trends by Site in Maryland

| Monitoring Sites | County | 2009-2011 DV [ppm] | Trend [ppm/ yr] |
|---|---|---|---|
| 2400300144420101 | Anne Arundel, MD | 0.081 | -2.46 |
| 2400510074420101 | Baltimore, MD | 0.077 | -1.75 |
| 2400530014420101 | Baltimore, MD | 0.08 | -1.56 |
| 2401300014420101 | Carroll, MD | 0.076 | -1.65 |
| 2401500034420101 | Cecil, MD | 0.081 | -2.62 |
| 2401700104420101 | Charles, MD | 0.077 | -2.26 |
| 2402100374420101 | Frederick, MD | 0.076 | -1.56 |
| 2402510014420101 | Harford, MD | 0.092 | -1.69 |
| 2402590014420101 | Harford, MD | 0.078 | -2.25 |
| 2402900024420101 | Kent, MD | 0.074 | -2.73 |
| 2403130014420101 | Montgomery, MD | 0.076 | -1.34 |
| 2404300094420101 | Washington, MD | 0.072 | -1.57 |

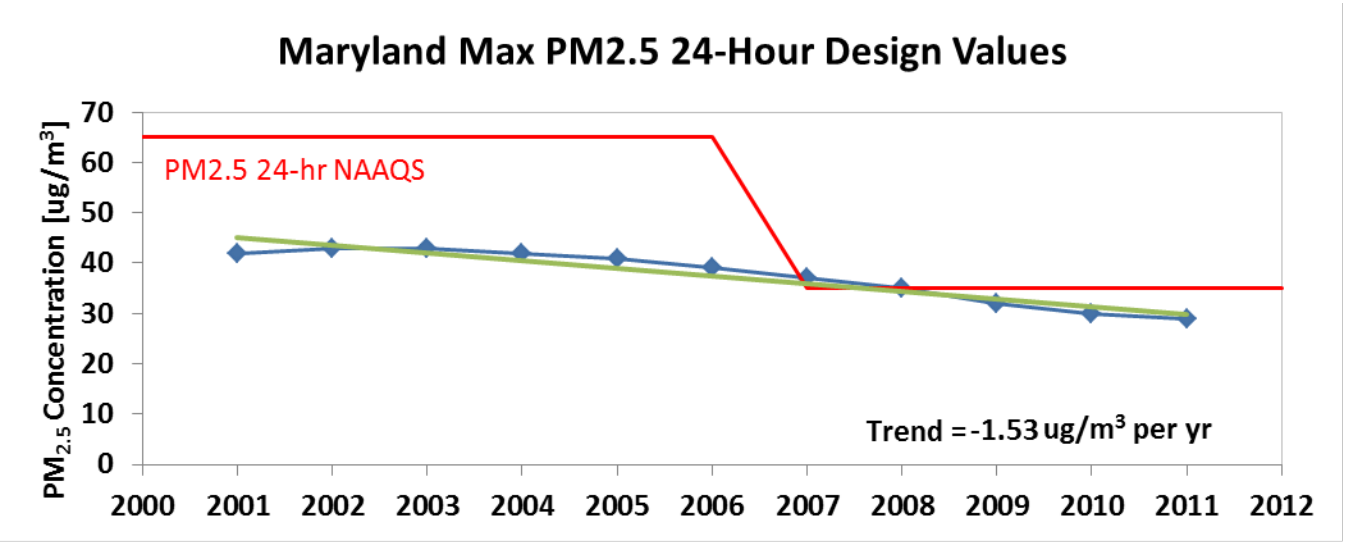
Note: Only monitoring sites meeting data completeness criteria listed

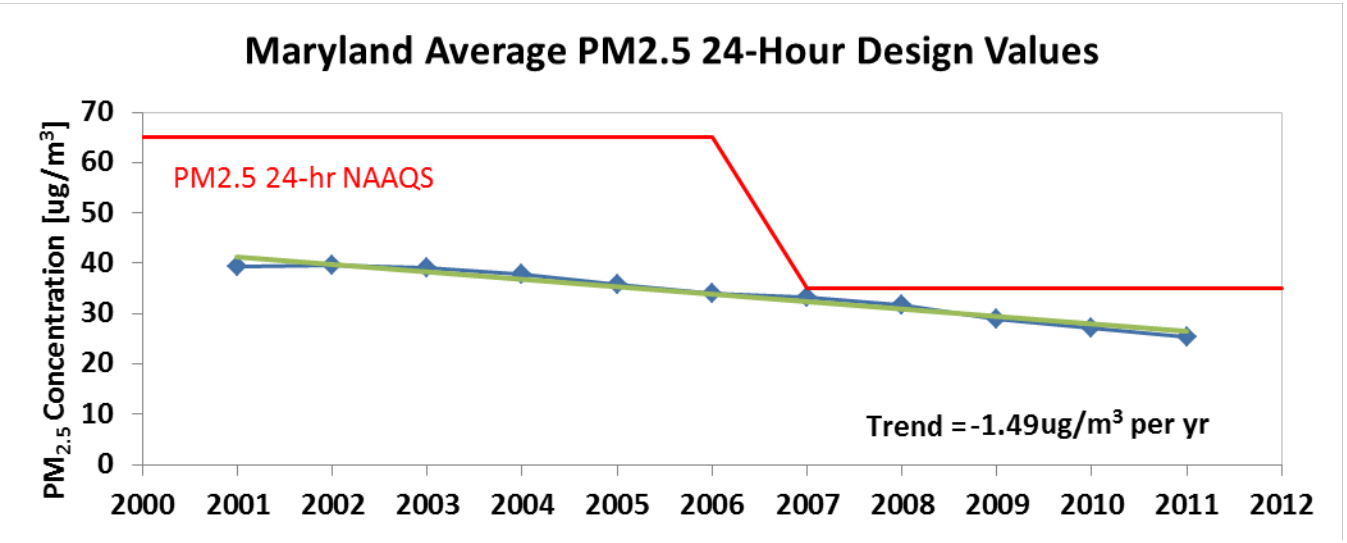
# Max/Ave $PM_{2.5}$ Annual DVs and Trend



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



# $PM_{2.5}$ Trends by Site in Maryland

| | | 2009-2011 DV [ug/m³] | | Trend [ug/m³ per year] | |
|---|---|---|---|---|---|
| **Monitoring Site** | **County** | **Annual** | **24-Hr** | **Annual DV** | **24-Hr DV** |
| 240031003 | Anne Arundel | 10.9 | 26 | -0.55 | -1.58 |
| 240051007 | Baltimore | 10.1 | 22 | -0.52 | -1.86 |
| 240053001 | Baltimore | 11.1 | 29 | -0.54 | -1.27 |
| 240150003 | Cecil | N/A | 28 | N/A | -0.98 |
| 240251001 | Harford | N/A | 22 | N/A | -2.03 |
| 240313001 | Montgomery | 10.2 | 25 | -0.35 | -1.33 |
| 240430009 | Washington | 10.9 | 27 | -0.45 | -1.76 |
| 245100006 | Baltimore city | N/A | 22 | N/A | -1.68 |
| 245100007 | Baltimore city | 10.2 | 23 | -0.58 | -1.65 |
| 245100008 | Baltimore city | N/A | 27 | N/A | -1.10 |
| 245100040 | Baltimore city | N/A | 29 | N/A | -1.57 |

Note: Only monitoring sites meeting data completeness criteria listed

# Air Quality Trends Summary

- Average $O_3$ and 24-hr $PM_{2.5}$ design values have decreased since 1999 in Maryland; average annual $PM_{2.5}$ design values have decreased since 2000 (incomplete data in 1999)

- $O_3$ and $PM_{2.5}$ design values have decreased since 1999 in all currently designated $O_3$ and $PM_{2.5}$ non-attainment areas