

# Emission and Air Quality Trends Review

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## Washington

May 2013

# Project Objective

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- 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

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- 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

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- 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<sub>x</sub>, SO<sub>2</sub>, and PM<sub>2.5</sub>
- Project Improvement
  - The Study Team augmented above data with year specific CEM emissions (2002 through 2011)

# Emission Changes

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- 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

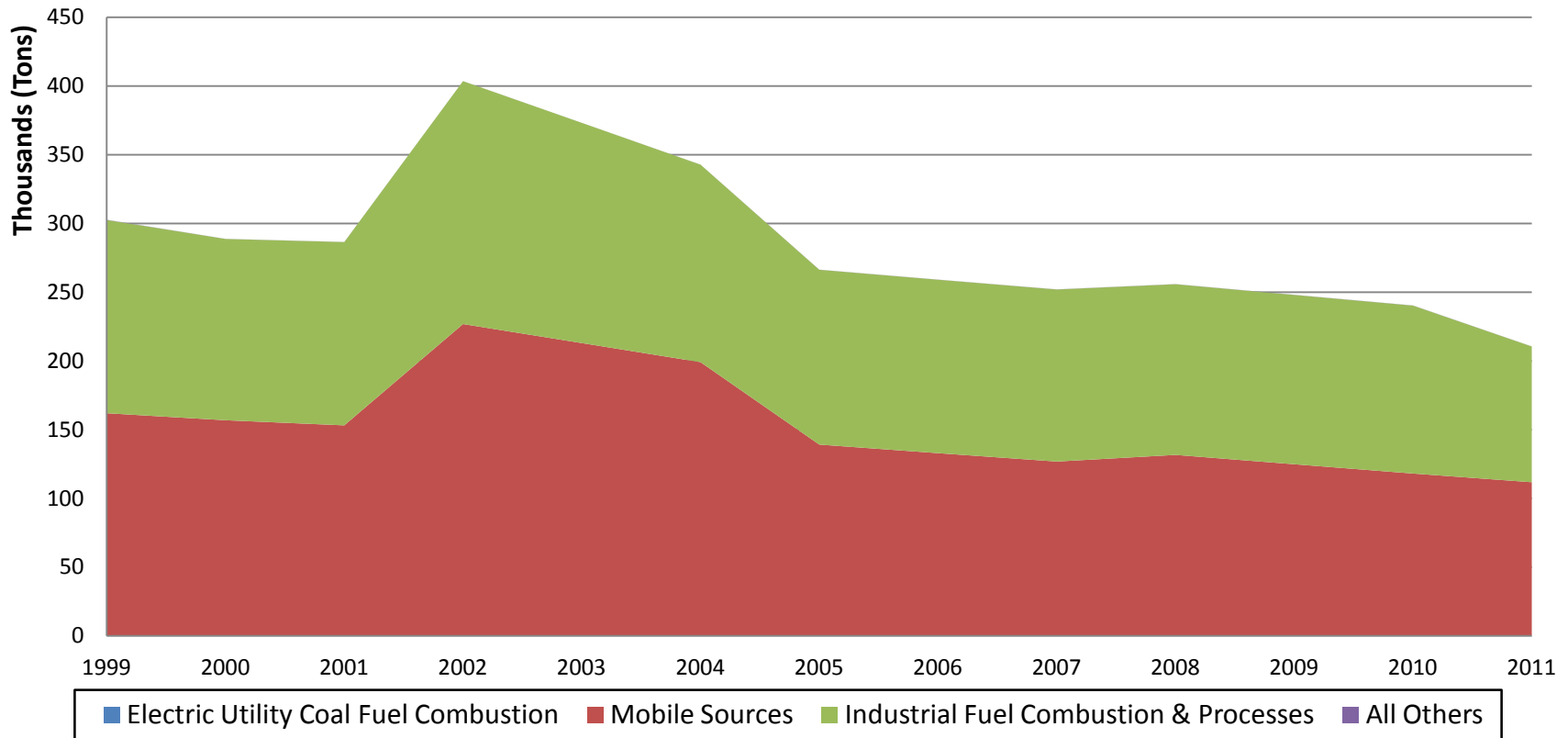
# Washington Emission Trends (VOC)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	170	180	232	221	135	181	185	166	188	3
Mobile Sources	161,783	152,955	212,773	138,926	132,777	126,628	131,453	124,676	117,899	111,768
Industrial Fuel Combustion & Processes	140,582	133,333	160,189	127,172	126,169	125,167	124,165	123,162	122,160	98,750
All Others	149	65	33	81	81	85	95	102	100	43
<b>Total</b>	<b>302,684</b>	<b>286,532</b>	<b>373,226</b>	<b>266,400</b>	<b>259,162</b>	<b>252,061</b>	<b>255,898</b>	<b>248,106</b>	<b>240,347</b>	<b>210,564</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	6%	36%	30%	-21%	7%	9%	-3%	11%	-98%
Mobile Sources	0%	-5%	32%	-14%	-18%	-22%	-19%	-23%	-27%	-31%
Industrial Fuel Combustion & Processes	0%	-5%	14%	-10%	-10%	-11%	-12%	-12%	-13%	-30%
All Others	0%	-57%	-78%	-46%	-46%	-43%	-36%	-32%	-33%	-71%
<b>Total</b>	<b>0%</b>	<b>-5%</b>	<b>23%</b>	<b>-12%</b>	<b>-14%</b>	<b>-17%</b>	<b>-15%</b>	<b>-18%</b>	<b>-21%</b>	<b>-30%</b>

# Washington Emission Trends (VOC)

**Major Source Category Summary  
Annual VOC Emissions**



# Washington Emission Trends (NO<sub>x</sub>)

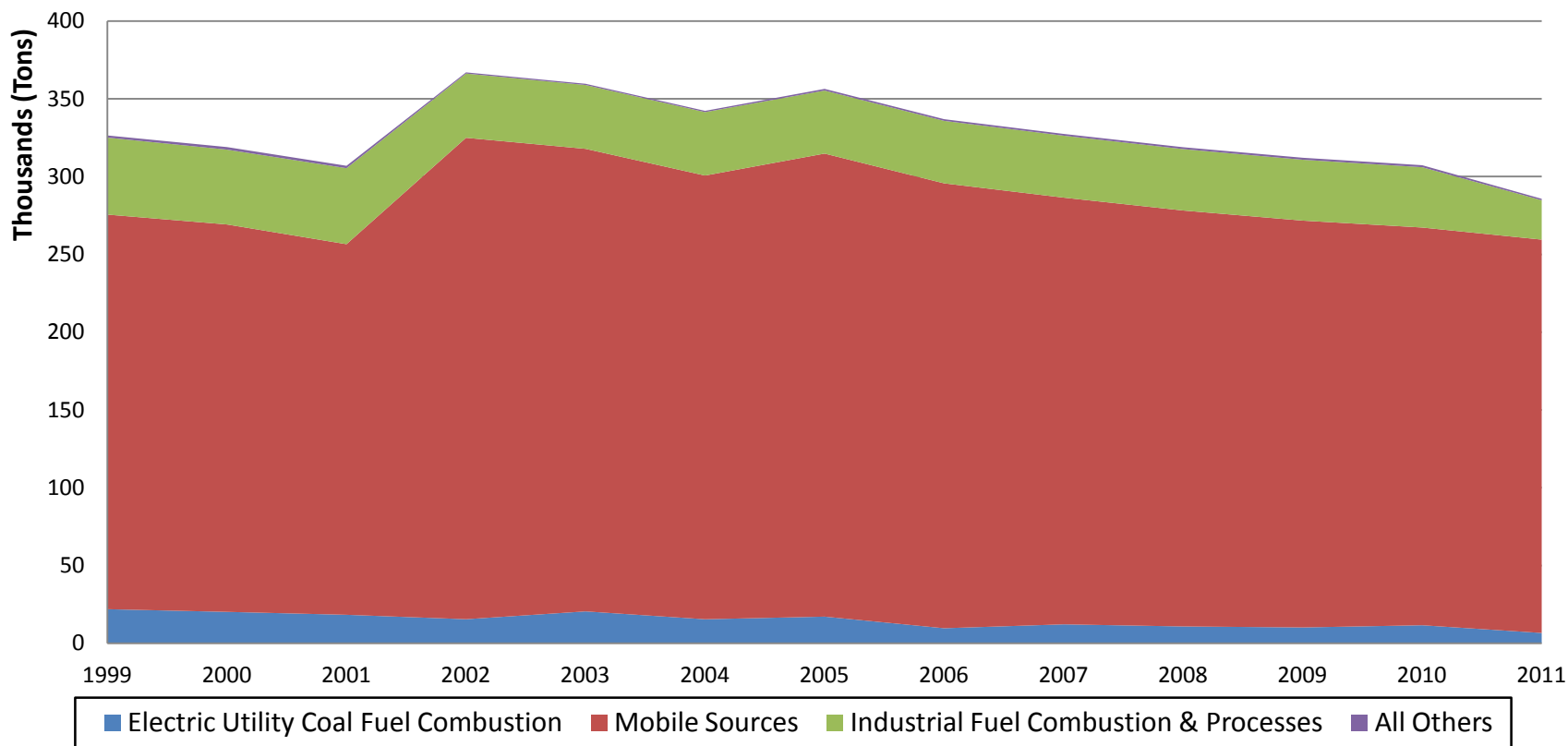
Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	21,895	18,305	20,486	17,124	9,666	12,158	10,813	10,170	11,577	6,627
Mobile Sources	253,693	238,261	297,375	297,683	286,013	274,342	267,404	261,549	255,695	252,867
Industrial Fuel Combustion & Processes	49,490	48,856	41,048	40,529	40,180	39,830	39,481	39,131	38,782	25,314
All Others	1,373	1,536	778	1,071	1,075	1,125	1,198	1,280	1,278	928
<b>Total</b>	<b>326,451</b>	<b>306,958</b>	<b>359,686</b>	<b>356,407</b>	<b>336,933</b>	<b>327,456</b>	<b>318,896</b>	<b>312,131</b>	<b>307,332</b>	<b>285,736</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-16%	-6%	-22%	-56%	-44%	-51%	-54%	-47%	-70%
Mobile Sources	0%	-6%	17%	17%	13%	8%	5%	3%	1%	0%
Industrial Fuel Combustion & Processes	0%	-1%	-17%	-18%	-19%	-20%	-20%	-21%	-22%	-49%
All Others	0%	12%	-43%	-22%	-22%	-18%	-13%	-7%	-7%	-32%
<b>Total</b>	<b>0%</b>	<b>-6%</b>	<b>10%</b>	<b>9%</b>	<b>3%</b>	<b>0%</b>	<b>-2%</b>	<b>-4%</b>	<b>-6%</b>	<b>-12%</b>



# Washington Emission Trends (NO<sub>x</sub>)

**Major Source Category Summary  
Annual NO<sub>x</sub> Emissions**



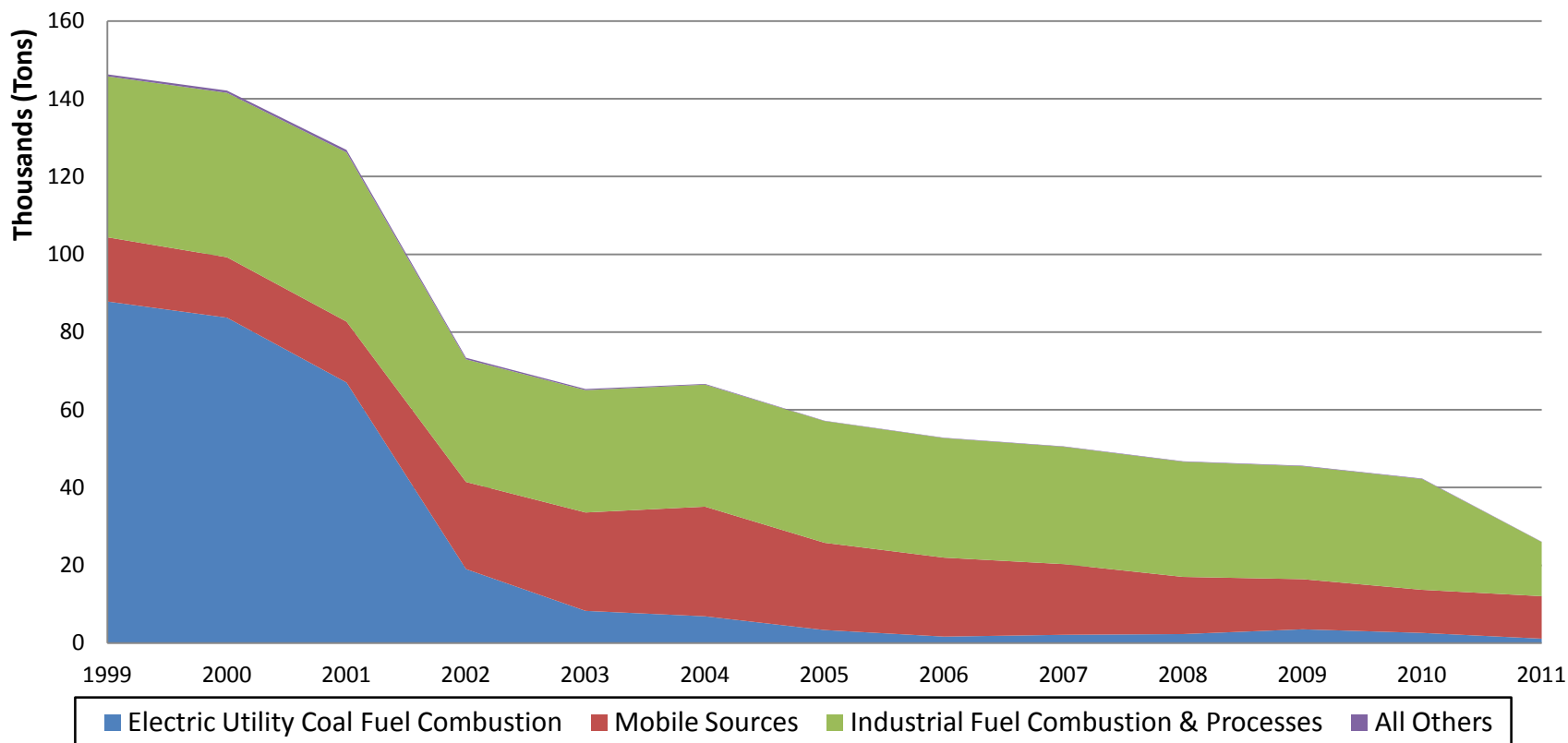
# Washington Emission Trends (SO<sub>2</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	87,862	67,030	8,283	3,353	1,664	2,127	2,315	3,538	2,612	1,136
Mobile Sources	16,514	15,658	25,305	22,442	20,311	18,180	14,707	12,898	11,088	10,922
Industrial Fuel Combustion & Processes	41,406	43,526	31,465	31,311	30,748	30,185	29,622	29,059	28,496	13,944
All Others	508	641	293	85	95	107	118	131	124	66
<b>Total</b>	<b>146,289</b>	<b>126,855</b>	<b>65,346</b>	<b>57,191</b>	<b>52,817</b>	<b>50,599</b>	<b>46,761</b>	<b>45,625</b>	<b>42,320</b>	<b>26,068</b>

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%	-91%	-96%	-98%	-98%	-97%	-96%	-97%	-99%
Mobile Sources	0%	-5%	53%	36%	23%	10%	-11%	-22%	-33%	-34%
Industrial Fuel Combustion & Processes	0%	5%	-24%	-24%	-26%	-27%	-28%	-30%	-31%	-66%
All Others	0%	26%	-42%	-83%	-81%	-79%	-77%	-74%	-76%	-87%
<b>Total</b>	<b>0%</b>	<b>-13%</b>	<b>-55%</b>	<b>-61%</b>	<b>-64%</b>	<b>-65%</b>	<b>-68%</b>	<b>-69%</b>	<b>-71%</b>	<b>-82%</b>

# Washington Emission Trends (SO<sub>2</sub>)

**Major Source Category Summary  
Annual SO<sub>2</sub> Emissions**



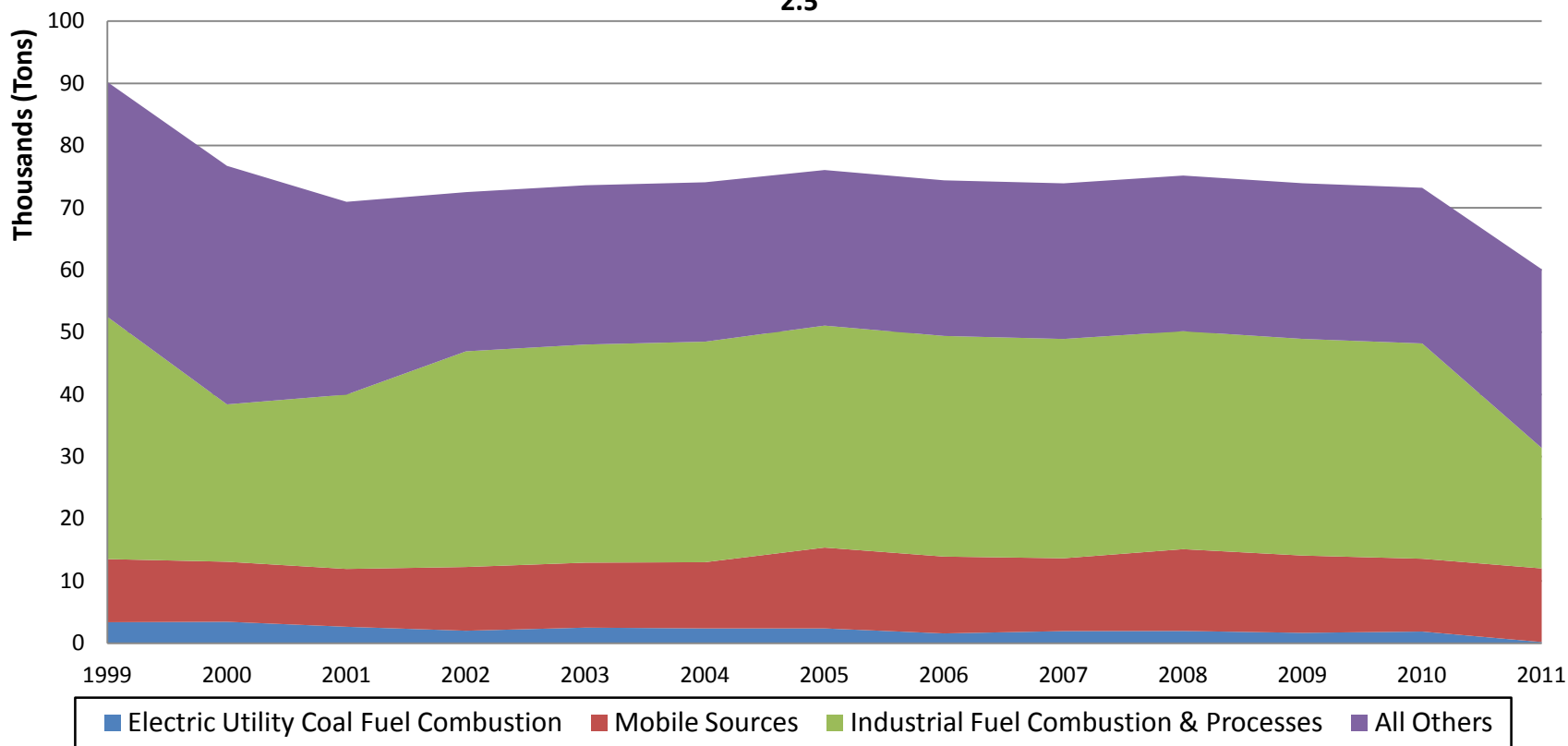
# Washington Emission Trends (PM<sub>2.5</sub>)

Source Category	Annual Emissions (Tons)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	3,380	2,649	2,514	2,386	1,582	1,954	1,977	1,675	1,882	198
Mobile Sources	10,147	9,299	10,442	12,993	12,350	11,708	13,147	12,424	11,701	11,832
Industrial Fuel Combustion & Processes	38,927	28,018	35,054	35,672	35,459	35,245	35,032	34,818	34,605	19,355
All Others	37,740	30,985	25,601	25,009	25,011	25,013	25,015	25,017	25,019	28,728
<b>Total</b>	<b>90,194</b>	<b>70,950</b>	<b>73,610</b>	<b>76,061</b>	<b>74,402</b>	<b>73,920</b>	<b>75,171</b>	<b>73,935</b>	<b>73,208</b>	<b>60,114</b>

Source Category	Annual Emissions Change (Percent since 1999)									
	1999	2001	2003	2005	2006	2007	2008	2009	2010	2011
Electric Utility Coal Fuel Combustion	0%	-22%	-26%	-29%	-53%	-42%	-42%	-50%	-44%	-94%
Mobile Sources	0%	-8%	3%	28%	22%	15%	30%	22%	15%	17%
Industrial Fuel Combustion & Processes	0%	-28%	-10%	-8%	-9%	-9%	-10%	-11%	-11%	-50%
All Others	0%	-18%	-32%	-34%	-34%	-34%	-34%	-34%	-34%	-24%
<b>Total</b>	<b>0%</b>	<b>-21%</b>	<b>-18%</b>	<b>-16%</b>	<b>-18%</b>	<b>-18%</b>	<b>-17%</b>	<b>-18%</b>	<b>-19%</b>	<b>-33%</b>

# Washington Emission Trends (PM<sub>2.5</sub>)

**Major Source Category Summary  
Annual PM<sub>2.5</sub> Emissions**



# Emission Trends Summary

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- ❑ All pollutants have decreased since 1999 in aggregate across Washington
- ❑ 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

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- Ozone
  - Annual 4<sup>th</sup> highest daily maximum 8-hour average averaged over three consecutive years
  - Current standard = 0.075 ppm
- PM<sub>2.5</sub> Annual
  - Annual arithmetic mean of quarterly means averaged over three consecutive years
  - Current standard = 12 ug/m<sup>3</sup>
- PM<sub>2.5</sub> 24-Hour
  - Annual 98<sup>th</sup> percentile of daily averages averaged over three consecutive years
  - Current standard = 35 ug/m<sup>3</sup>

# State-Wide Design Value (DV) Trends

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- 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

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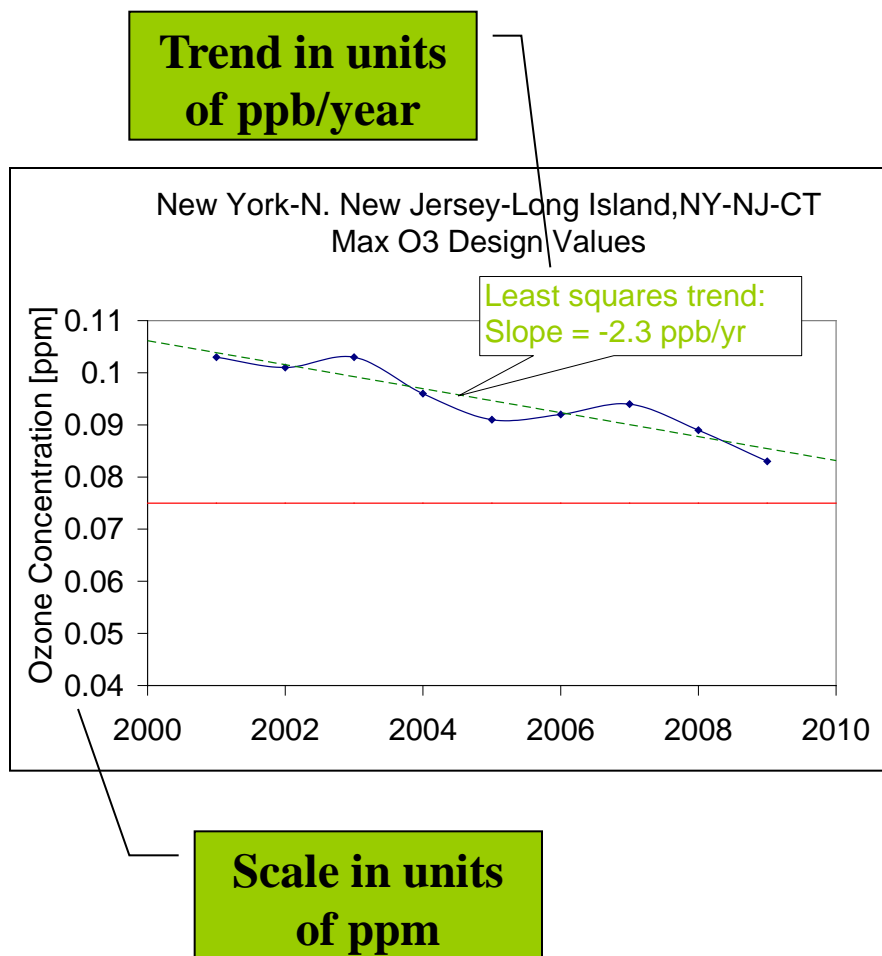
- O<sub>3</sub> design value (DV) for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculated using annual 4<sup>th</sup> highest daily max 8-hr averages and percent of valid observations, based on EPA data handling conventions
  - Data associated with exceptional 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

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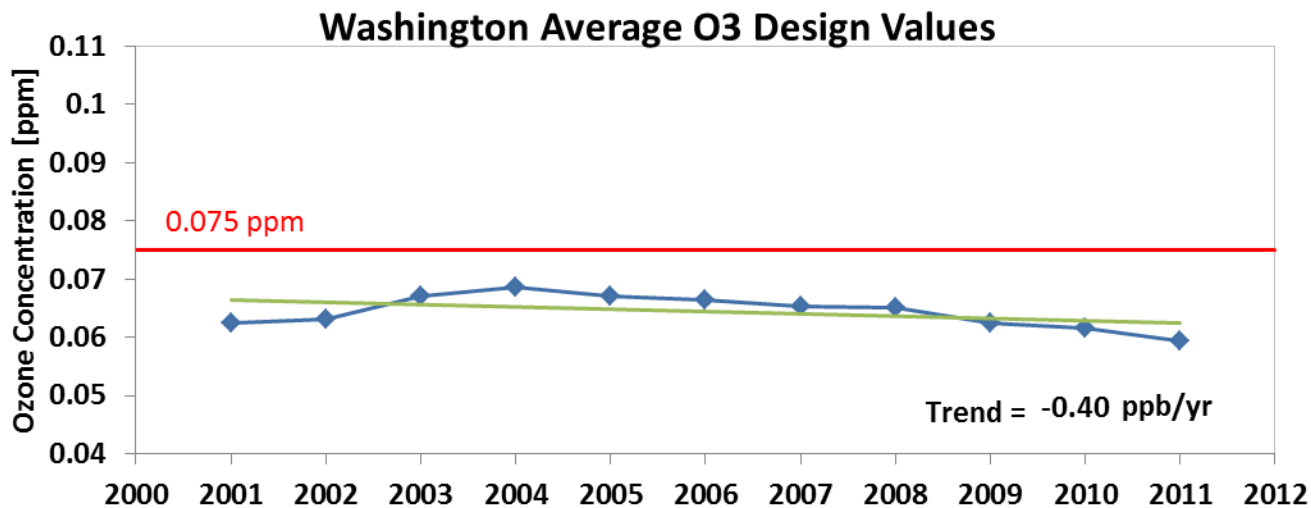
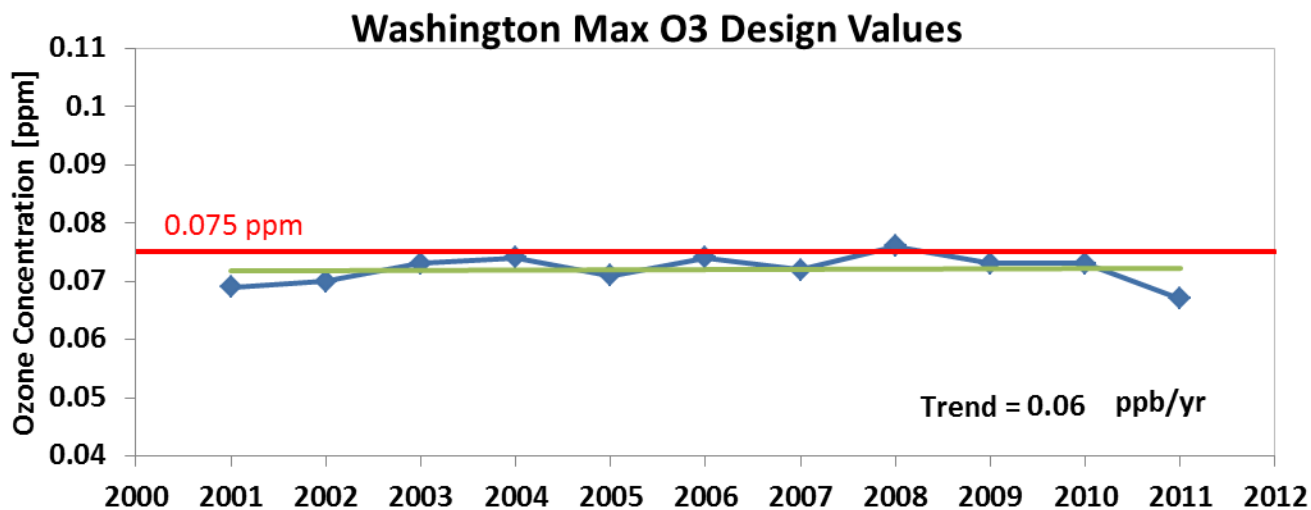
- Annual  $PM_{2.5}$  DV and 24-hr  $PM_{2.5}$  DV for each overlapping three-year period starting with 1999-2001 and ending with 2009-2011
  - DV calculations based on EPA data handling conventions
  - Data extracted from monitors that have a non-regulatory monitoring type are omitted
  - Selection 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<sub>3</sub> DVs and Trend



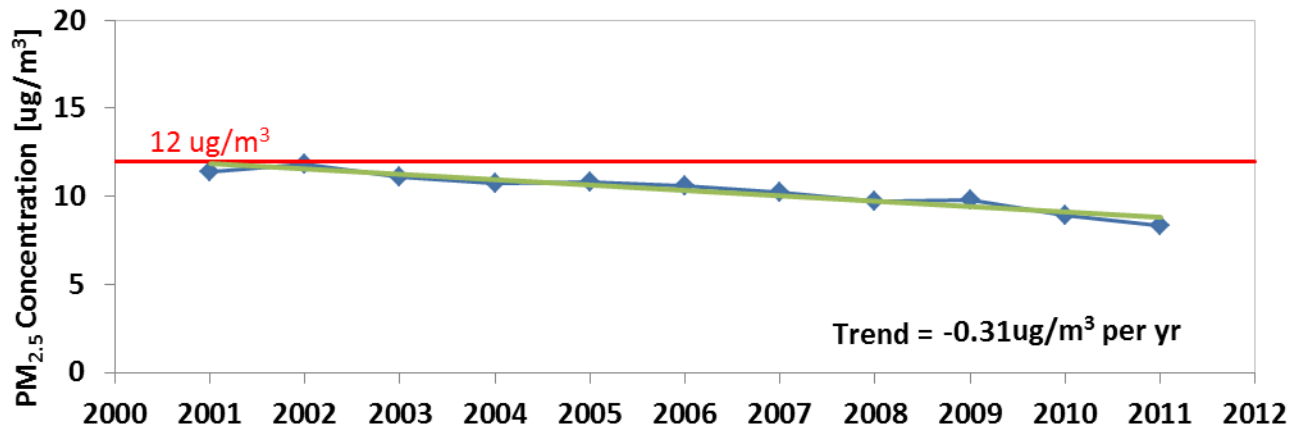
# Ozone Trends by Site in Washington

Monitoring Sites	County	2009-2011 DV [ppm]	Trend [ppm/yr]
5301100114420101	Clark, WA	0.057	-0.19
5303300104420101	King, WA	0.057	0.38
5303300174420101	King, WA	0.059	-0.97
5303300234420101	King, WA	0.067	0.21
5305310084420101	Pierce, WA	N/A	0.10
5306300464420101	Spokane, WA	0.057	-1.58

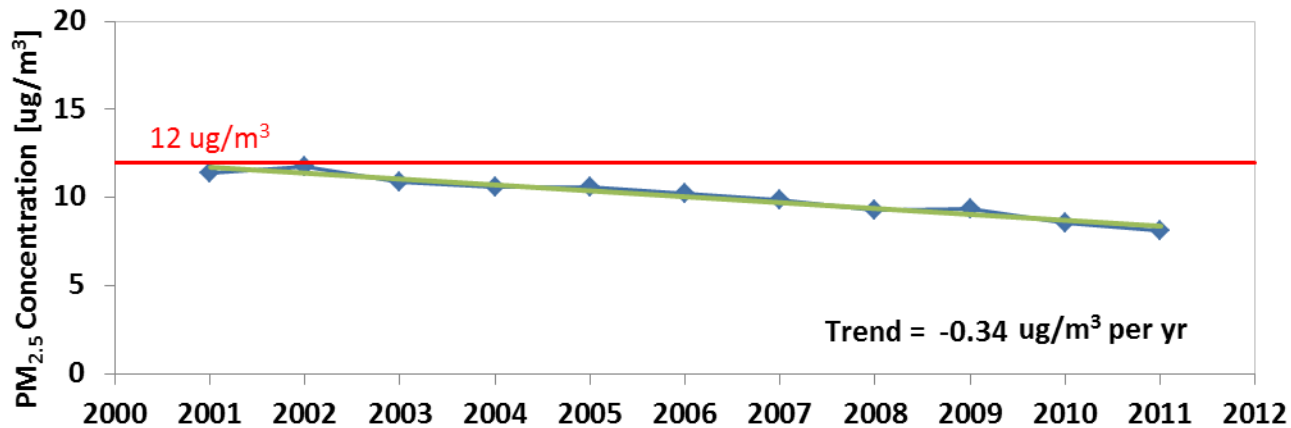
Note: Only monitoring sites meeting data completeness criteria listed

# Max/Ave PM<sub>2.5</sub> Annual DVs and Trend

Washington Max PM<sub>2.5</sub> Annual Design Values

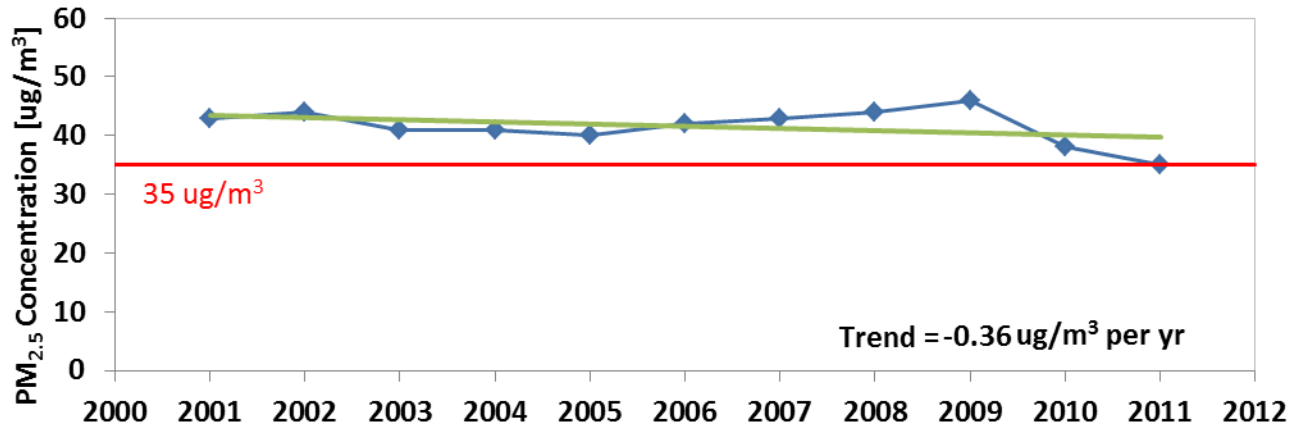


Washington Average PM<sub>2.5</sub> Annual Design Values

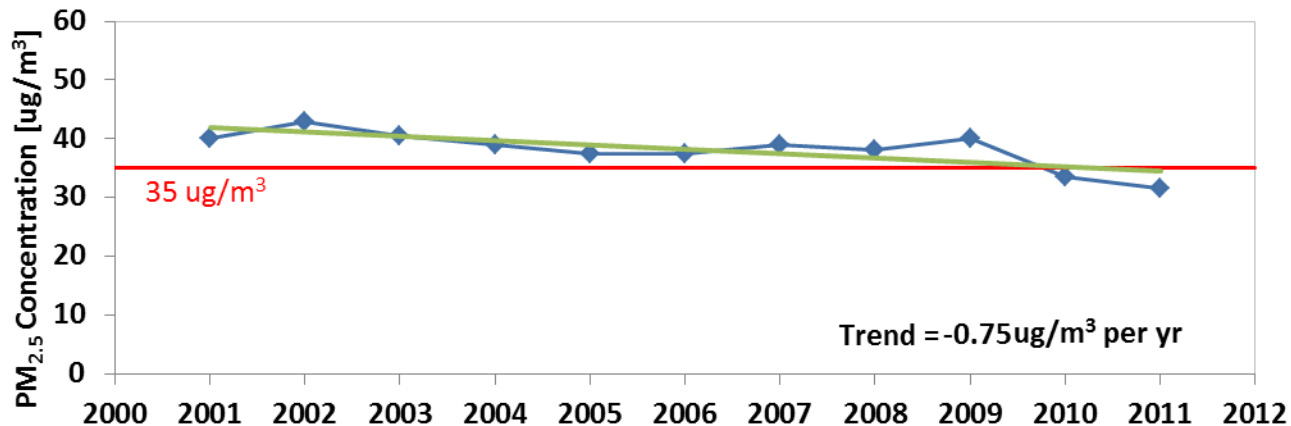


# Max/Ave PM<sub>2.5</sub> 24-Hour DVs and Trend

Washington Max PM<sub>2.5</sub> 24-Hour Design Values



Washington Average PM<sub>2.5</sub> 24-Hour Design Values



# PM<sub>2.5</sub> Trends by Site in Washington

Monitoring Site	County	2009-2011 DV [ug/m <sup>3</sup> ]		Trend [ug/m <sup>3</sup> per year]	
		Annual	24-Hr	Annual DV	24-Hr DV
530530029	Pierce	8.3	35	-0.30	-0.34
530611007	Snohomish	7.9	28	-0.39	-1.16

Note: Only monitoring sites meeting data completeness criteria listed



# Air Quality Trends Summary

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- Average O<sub>3</sub> design values have remained steady since 1999 in Washington. Average annual and 24-hr PM<sub>2.5</sub> design values have decreased since 1999 in Washington based on complete data from two monitor stations.
- There are no currently designated O<sub>3</sub> non-attainment areas in Washington; 24-hr PM<sub>2.5</sub> design values have remained steady since 1999 at Seattle-Tacoma, WA, the only currently designated PM<sub>2.5</sub> non-attainment area in Washington