Ohio's Interstate Pollution Transport Analysis

2012 Annual PM2.5 Standard

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Division of Air Pollution Control

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1. Executive Summary

The Clean Air Act (CAA) section 110(a)(2)(D)(i)(I) "Good Neighbor provision" requires each state in its state implementation plan (SIP) to prohibit emissions that will significantly contribute to nonattainment, or interfere with maintenance, of a National Ambient Air Quality Standard (NAAQS), in any other state. The purpose of this study is to evaluate Ohio's contribution to nonattainment, and interference of maintenance, of the 2012 annual PM2.5 NAAQS in other states.

There are a total of nine nonattainment areas of the 2012 annual PM2.5 standard: one area in Ohio, one area in Idaho, three areas in Pennsylvania and four areas in California. Cuyahoga and Lorain Counties comprise the Cleveland nonattainment area in Ohio and Allegheny, Lebanon and Delaware Counties comprise the nonattainment areas in Pennsylvania. Ohio is not focusing this analysis on nonattainment areas in Idaho or California as historically Ohio emissions have never contributed to nonattainment or interfered with maintenance of these western states. The majority of these nonattainment areas are moving towards better air quality year after year. The annual PM2.5 design values for some of these areas- including Cleveland, Ohio- improved by more than 35% over the last ten years.

The study identifies potential problems in meeting, and maintaining, the 2012 annual PM2.5 NAAQS at monitors Ohio has historically been determined to contribute to nonattainment, or interfere with maintenance. The analysis conducted by U.S. EPA as a part of the Cross-State Air Pollution Rule (CSAPR) was used to assist with this analysis[1]. This assessment is conservative as Ohio's contribution to monitors under CSAPR is based upon older monitoring values, predicted concentrations, emissions levels, and controls strategies. As this study will demonstrate, Ohio has made greater strides in reducing emissions than predicted under CSAPR.

Based on Ohio EPA's analysis conducted below, Ohio EPA believes no additional emissions reductions beyond existing and planned controls are necessary to mitigate Ohio's contribution to the downwind 2012 annual PM2.5 NAAQS air quality problems.

[1] http://www3.epa.gov/airtransport/CSAPR/techinfo.html

2. Nonattainment Areas of the 2012 Annual $PM_{2.5}$ Standard

In 2012 U.S. EPA changed the annual fine particulate (PM2.5) standard from 15.0 µg/m^3 to 12.0 µg/m^3. US EPA issued final area designations for the 2012 annual PM2.5 standard on January 15, 2015 (80 FR 2206) with an effective date of March 31, 2015. Figure 1 shows the areas with nonattainment designation based on the air quality monitoring data from 2011-2013. There are a total of nine nonattainment areas. Cleveland (Cuyahoga and Lorain Counties) is the only nonattainment area in Ohio and the ID for the monitor used for the nonattainment designation is 390350038. The three nonattainment areas in Pennsylvania are Allegheny County, Lebanon County, and Delaware County and the monitors used for the nonattainment designation are 420030064, 420750100, and 420450002, respectively. West Silver Valley is the nonattainment area in Idaho and the ID for the monitor used for the designation is 160790017. The four nonattainment areas in California are Imperial County, Los Angeles South Coast, Plumas County, and San Joaquin Valley and the IDs for the monitors used for the designation are 060250005, 060658005, 060631010, and 060392010, respectively. Table 1 and Figure 2 also show the historical design values and post-designation design values for the nonattainment areas[1]. Based on a review of historical monitoring and post-designations monitoring, there has been a clear improvement in air quality trends in the majority of the areas. For example, the Cleveland, Ohio nonattainment area has seen a 31.5% improvement in annual PM2.5 concentrations in the last ten years (18.1 µg/m^3 (2003-2005 design value) to 12.4 µg/m^3 (2012-2014 design value).

This study will focus on Ohio's contribution to nonattainment and interference of maintenance of the 2012 annual PM2.5 standard in the eastern states because historically Ohio's emissions have not contributed to nonattainment or interference with maintenance of western states and by addressing any impacts in the eastern states, any minimal impacts to western states are also mitigated. As shown in Table 1, the 2012-2014 design value for the nonattainment areas in the eastern states (Ohio and Pennsylvania) are within 1.0 µg/m^3 from complying with the 2012 annual PM2.5 standard. These eastern states nonattainment areas are expected to come into attainment in accordance with the attainment deadline as a result of planned reduction in NOx and SO2, including the reductions by CSAPR, as will be explained in more details later in this study.

[1] http://www3.epa.gov/airtrends/values.html

Figure 1. 2012 Annual PM2.5 Standard's Nonattainment Areas
Source: http://www3.epa.gov/airquality/particlepollution/designations/2012standards/final/20150331map.jpg

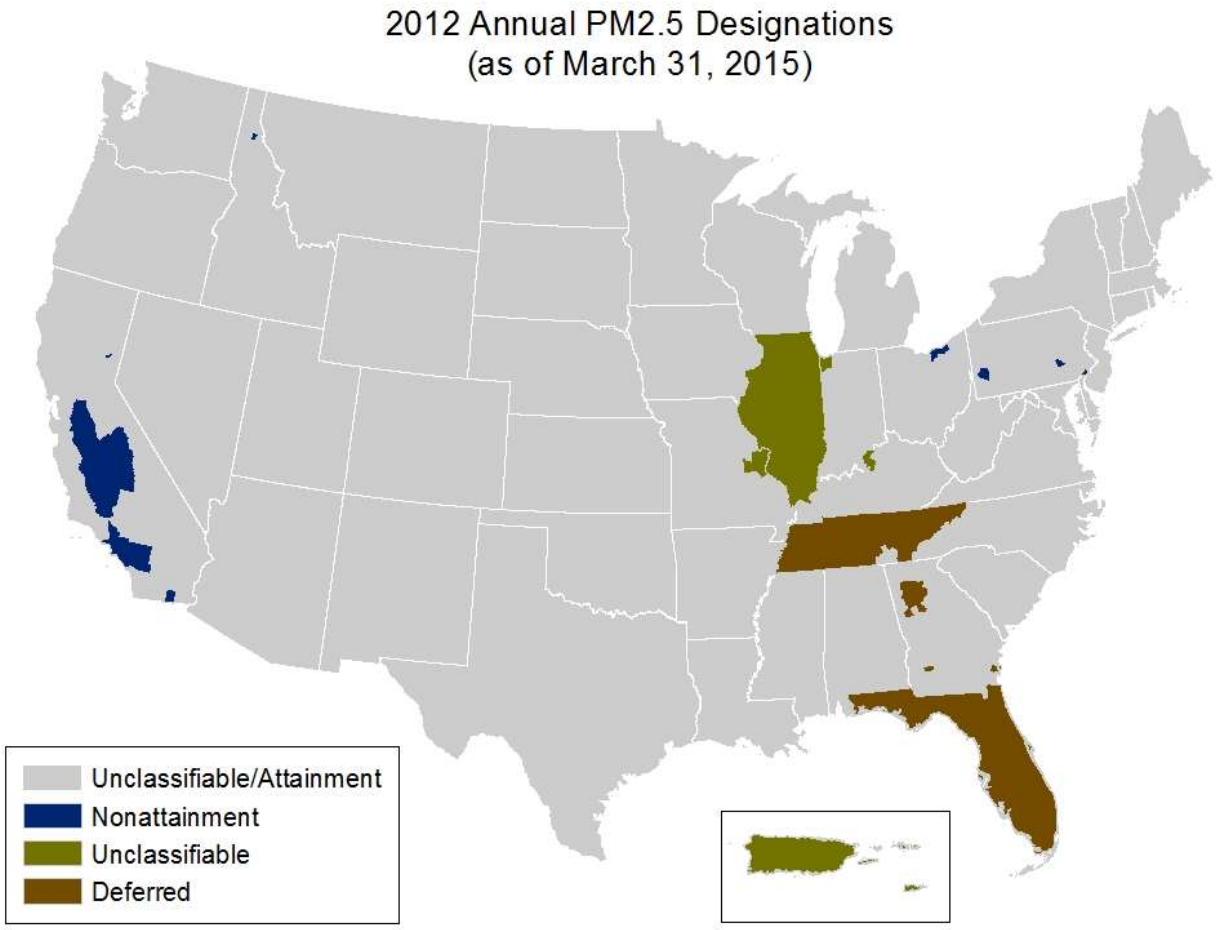


Figure 2. Historical and Post-Designation Design Values for the 2012 Annual PM2.5 Standard's Nonattainment Areas

Source: http://www3.epa.gov/airtrends/values.html

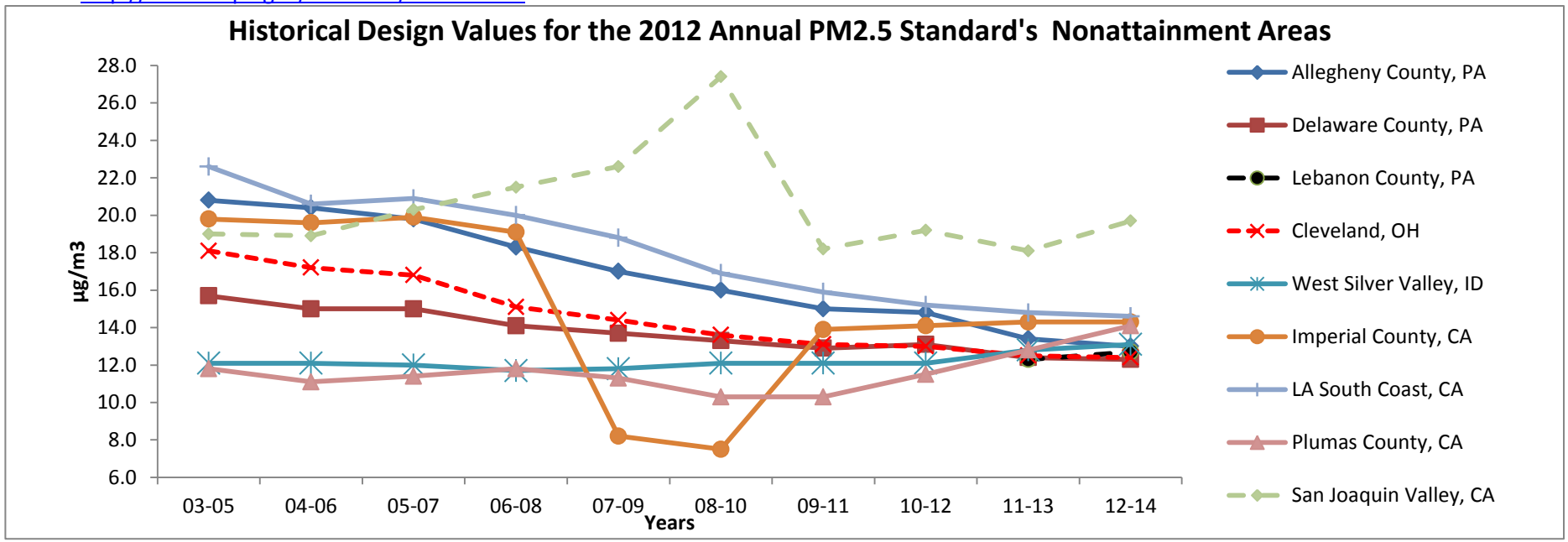


Table 1. Historical and Post-Designation Design Values for the 2012 Annual PM2.5 Standard's Nonattainment Areas

Source: http://www3.epa.gov/airtrends/values.html

State	Designated Area	Monitor ID	2003-2005 Design Value ($\mu g/m^3$)	2004-2006 Design Value ($\mu g/m^3$)	2005-2007 Design Value ($\mu g/m^3$)	2006-2008 Design Value ($\mu g/m^3$)	2007-2009 Design Value ($\mu g/m^3$)	2008-2010 Design Value ($\mu g/m^3$)	2009-2011 Design Value ($\mu g/m^3$)	2010-2012 Design Value ($\mu g/m^3$)	2011-2013 Design Value ($\mu g/m^3$)	2012-2014 Design Value ($\mu g/m^3$)	03-05 to 12-14 Change (%)
PA	Allegheny County, PA	420030064	20.8	20.4	19.8	18.3	17.0	16.0	15.0	14.8	13.4	13.0	-37.5%
PA	Delaware County, PA	420450002	15.7	15.0	15.0	14.1	13.7	13.3	12.9	13.1	12.4	12.3	-21.7%
PA	Lebanon County, PA	420750100									12.3	12.7	
OH	Cleveland, OH	390350038	18.1	17.2	16.8	15.1	14.4	13.6	13.1	13.0	12.5	12.4	-31.5%
ID	West Silver Valley, ID	160790017	12.1	12.1	12.0	11.7	11.8	12.1	12.1	12.1	12.8	13.1	8.3%
CA	Imperial County, CA	060250005	19.8	19.6	19.9	19.1	8.2	7.5	13.9	14.1	14.3	14.3	-27.8%
CA	LA South Coast, CA	060658005	22.6	20.6	20.9	20.0	18.8	16.9	15.9	15.2	14.8	14.6	-35.4%
CA	Plumas County, CA	060631010	11.8	11.1	11.4	11.8	11.3	10.3	10.3	11.5	12.8	14.1	19.5%
CA	San Joaquin Valley, CA	060392010	19.0	18.9	20.3	21.5	22.6	27.4	18.2	19.2	18.1	19.7	3.7%

3. Nonattainment and maintenance monitors in the US

This study starts with identifying potential problems in meeting or maintaining the 2012 annual PM2.5 NAAQS. The CSAPR analysis was used to identify the areas that require attention in regards to the 2012 annual PM2.5 standard. In the CSAPR analysis, a 5-year weighted average for monitor values was used to project concentrations in 2012 and 2014.[1] The 2014 base case and 2014 remedy case were intended to quantify the benefits of implementing CSAPR.

Using the projections identified by U.S. EPA in the CSAPR analysis, Ohio EPA selected nonattainment monitors as those with a 5-year weighted average (2010-2012, 2011-2013, and 2012-2014) design value above or equal to 12.0 µg/m^3. Maintenance monitors are the ones with the maximum design value among 2010-2012, 2011-2013, and 2012-2014 higher than or equal to 12.0 µg/m^3 as long as they are not nonattainment monitors. Figure 3 shows the monitors with 2011-2013 design value larger than12.0 µg/m^3. Table 2 shows the nonattainment monitors while Table 3 shows the maintenance monitors. The monitors used for nonattainment area designations under the 2012 PM2.5 NAAQS are highlighted in yellow.

Table 4 summarizes the number of nonattainment and maintenance monitors by state. There are a total of 75 nonattainment monitors in 18 states and their 5-year weighted average is 14.0 µg/m^3, these include 27 monitors in California with a 5-year weighted average of 15.4 µg/m^3, 9 monitors in Ohio with a 5-year weighted average of 13.2 µg/m^3, 8 monitors in Illinois with a 5-year weighted average of 12.6 µg/m^3, 6 monitors in Indiana with a 5-year weighted average of 12.8 µg/m^3, 6 monitors in Kentucky with a 5-year weighted average of 12.3 µg/m^3, and 5 monitors in in Pennsylvania with a 5-year weighted average of 13.4 µg/m^3. There are a total of 44 maintenance monitors in 17 states, including 8 monitors in Ohio, 7 monitors in Pennsylvania and 6 monitors in Georgia and 6 monitors in Indiana. The maintenance monitor with the highest design value (13.9 µg/m^3) was in Fairbanks North Star County, Alaska. Obviously, the actual nonattainment and maintenance conditions for the 2012 PM2.5 NAAQS is significantly smaller than those shown in Table 4 based on the CSAPR analysis.

Ohio is expected to have contribution mainly to the nonattainment and/or maintenance monitors in Pennsylvania, Kentucky, West Virginia and Indiana, as supported by the CSAPR analysis that will be discussed later. Pennsylvania's nonattainment monitors are located in Allegheny, Cambria, Delaware, Lancaster, and Lebanon Counties, with 5-year weighted average ranging from 12.1 to15.9 µg/m^3. Pennsylvania's maintenance monitors are located in Allegheny, Beaver, Chester, Lancaster, Northampton and Westmoreland Counties. Kentucky nonattainment monitors are located in Jefferson, Kenton, and Ohio Counties, with 5-year weighted average ranging from 12.0 to12.8 µg/m3. Kentucky also has a maintenance monitor in Bullitt County. Indiana's nonattainment monitors are located in Clark, Madison, Marion, Vanderburgh, and Vigo Counties, with 5-year weighted average ranging from 12.1 to13.9 µg/m^3. Indian's maintenance monitors are located in Dubois, Lake, Mario, Spencer, and Vanderburgh Counties. West Virginia has no nonattainment monitors but its maintenance monitors are located in Broke and Marshall Counties. Except for few nonattainment monitors, the 5-year weighted average in the states of interest is within 1.0 µg/m^3 from the 12.0 µg/m^3 annual PM2.5 standard. Several of the nonattainment and maintenance monitors are moving towards a better air quality and many of them already have 2012-2014 annual PM2.5 design values below 12.0 µg/m^3. Moreover, these states belong to Group I of the CSAPR control program that took effect in 2015 and they are required to make emissions reductions in two Phases.

[1] http://www3.epa.gov/airtransport/CSAPR/pdfs/AQModeling.pdf

More attention was given to 2012-2014 annual PM2.5 design values as the most current design value and for a better prediction of future trends. Table 5 shows the monitors with 2012-2014 design values greater than or equal to 12.0 µg/m^3, the monitors used for nonattainment area designations are highlighted. Table 6 summarizes the number of monitors by state. There are 46 monitors in 11 states with 2012-2014 design values greater than or equal to 12.0 µg/m^3, these include: 26 monitors in California with a design value ranging from 12.1 µg/m^3 to 40.3 µg/m^3 and with an average of 15.4 µg/m^3; 4 monitors in Pennsylvania with a design value ranging from 12.3 µg/m^3 to 15.9 µg/m^3 and with an average of 13.5 µg/m^3; 4 monitors in Ohio with a design value ranging from 12.0 µg/m^3 to 12.9 µg/m^3 and with an average of 12.4 µg/m^3; 2 monitors in Alaska with a design value average of 20.3 µg/m^3; 2 monitors in Illinois with a design value average of 12.7 µg/m^3; 2 monitors in Idaho with a design value average of 12.6 µg/m^3; 2 monitors in Kentucky with a design value average of 12.3 µg/m^3; a monitor in Indiana with a design value of 12.8 µg/m^3; a monitor in Nevada with a design value of 12.3 µg/m^3; a monitor in Hawaii with a design value of 12.3 µg/m^3; and a monitor in Maryland with a design value of 12.0 µg/m^3. The highest 2012-2014 design value (40.3 µg/m^3) was for a monitor in Fresno County, California.

Several of the nonattainment and maintenance monitors were not included in Table 5 since they already have a 2012-2014 annual PM2.5 design values below 2.0 µg/m^3. This is another indication that the air quality is improving in many states. The major recipient states of Ohio contribution (Pennsylvania, Kentucky, West Virginia, and Indiana) also improved. The remaining Counties with a monitor or more with 2012-2014 annual PM2.5 design values greater than or equal to 12.0 µg/m^3 are Allegheny, Delaware, Lancaster, and Lebanon Counties in Pennsylvania, Jefferson County in Kentucky, and Marion County in Indiana. None of West Virginia Counties has a monitor or more with 2012-2014 annual PM2.5 design values greater than or equal to 12.0 µg/m^3.

Figure 3. 2012 Annual PM2.5 Nonattainment monitors in the US with 2011-2013 design values higher than 12 µg/m^3 (red dots)
Source: http://geoplatform2.epa.gov/pm_map/index.html

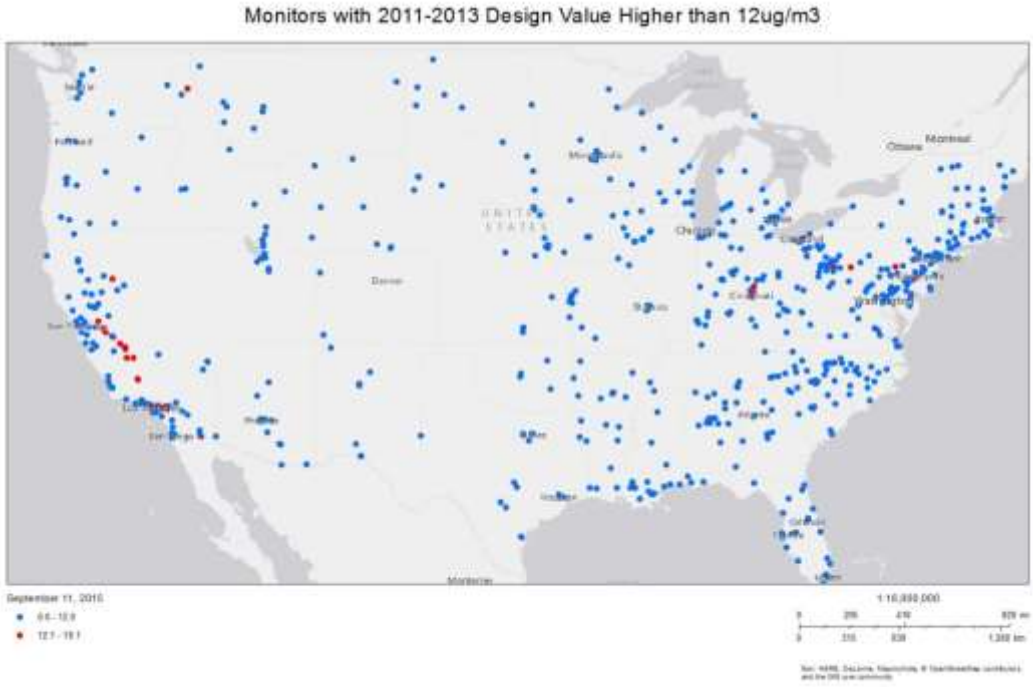


Table. 2. 2012 Annual PM2.5 nonattainment monitors in the US with an average 2010-2012, 2011-2013 and 2012-2014 design value higher than or equal to 12.0 µg/m3 (monitors used for nonattainment areas designation are highlighted)

Source: http://www3.epa.gov/airtrends/values.html

Site ID	State	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2010-2012 Annual PM2.5 DV (µg/m3)	2011-2013 Annual PM2.5 DV (µg/m3)	2012-2014 Annual PM2.5 DV (µg/m3)	Average of 10-12, 11-13, 12-14 DV
10730023	Alabama	Jefferson		13.0	11.9	11.3	12.1
20900035	Alaska	Fairbanks North Star		16.8	23.0	26.6	22.1
51310008	Arkansas	Sebastian		11.9	12.3		12.1
60190008	California	Fresno	San Joaquin Valley	22.9	27.9	40.3	30.4
60190011	California	Fresno	San Joaquin Valley	14.2	15.4	15.4	15.0
60195001	California	Fresno	San Joaquin Valley	16.0	16.4	15.3	15.9
60195025	California	Fresno	San Joaquin Valley	13.8	14.7	14.1	14.2
60250005	California	Imperial	Imperial County	14.1	14.3	14.3	14.2
60290010	California	Kern	San Joaquin Valley	44.2		18.1	31.2
60290014	California	Kern	San Joaquin Valley	14.5	16.4	17.2	16.0
60290016	California	Kern	San Joaquin Valley	15.6	17.3	19.7	17.5
60310004	California	Kings	San Joaquin Valley	15.8	15.0	15.8	15.5
60311004	California	Kings	San Joaquin Valley	15.8	17.0	16.8	16.5
60371002	California	Los Angeles	LA South Coast	12.6	12.5	12.1	12.4
60371103	California	Los Angeles	LA South Coast	12.5	12.5	12.3	12.4
60371302	California	Los Angeles	LA South Coast	12.4	12.2	12.1	12.2
60371602	California	Los Angeles	LA South Coast	12.3	12.0	11.9	12.1
60392010	California	Madera	San Joaquin Valley	19.2	18.1	15.9	17.7
60470003	California	Merced	San Joaquin Valley	14.3	13.3	11.7	13.1
60550003	California	Napa		13.7	12.7	12.5	13.0
60631009	California	Plumas	Plumas County	11.5	12.2	12.4	12.0
60631010	California	Plumas	Plumas County		15.3	14.1	14.7
60658001	California	Riverside	LA South Coast	13.4	13.2	12.8	13.1
60658005	California	Riverside	LA South Coast	15.2	14.8	14.6	14.9
60710025	California	San Bernardino	LA South Coast	12.9	12.6	12.5	12.7
60712002	California	San Bernardino	LA South Coast	12.4	12.6	12.8	12.6
60771002	California	San Joaquin	San Joaquin Valley	11.4	13.8	14.0	13.1
60990005	California	Stanislaus	San Joaquin Valley	12.9	13.6	12.5	13.0
60990006	California	Stanislaus	San Joaquin Valley	14.9	15.7	14.0	14.9
61072002	California	Tulare	San Joaquin Valley	14.8	16.6	17.2	16.2
150011012	Hawaii	Hawaii		13.9	11.6	11.0	12.2
150012020	Hawaii	Hawaii		13.0	11.5	12.1	12.2
160410001	Idaho	Franklin		16.8			16.8
160790017	Idaho	Shoshone	West Silver Valley	12.1	12.8	13.1	12.7
170190004	Illinois	Champaign		12.7			12.7
170310022	Illinois	Cook		14.0		11.6	12.8
170310050	Illinois	Cook		12.5			12.5

Site ID	State	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2010-2012 Annual PM2.5 DV (µg/m3)	2011-2013 Annual PM2.5 DV (µg/m3)	2012-2014 Annual PM2.5 DV (µg/m3)	Average of 10-12, 11-13, 12-14 DV
170310052	Illinois	Cook		12.6		11.9	12.3
170313103	Illinois	Cook		12.6		11.7	12.2
171191007	Illinois	Madison		14.3		12.9	13.6
171193007	Illinois	Madison		12.0		12.5	12.3
171634001	Illinois	Saint Clair		12.8			12.8
180190006	Indiana	Clark		13.2	12.1	11.8	12.4
180950009	Indiana	Madison		13.9			13.9
180970081	Indiana	Marion		12.7	11.9	11.8	12.1
180970087	Indiana	Marion				12.8	12.8
181630020	Indiana	Vanderburgh		13.6	13.8		13.7
181670023	Indiana	Vigo		12.1			12.1
211110043	Kentucky	Jefferson		12.3	12.0	11.7	12.0
211110051	Kentucky	Jefferson		13.3	12.6	12.5	12.8
211110067	Kentucky	Jefferson		12.7	12.0	11.3	12.0
211110075	Kentucky	Jefferson				12.0	12.0
211170007	Kentucky	Kenton		12.1			12.1
211830032	Kentucky	Ohio		12.6			12.6
240270006	Maryland	Howard				12.0	12.0
320050007	Nevada	Douglas			16.5	12.3	14.4
390350038	Ohio	Cuyahoga	Cleveland	13.0	12.4	12.3	12.6
390350060	Ohio	Cuyahoga	Cleveland	13.0	12.5	12.4	12.6
390350065	Ohio	Cuyahoga	Cleveland	12.7	12.1	12.0	12.3
390610014	Ohio	Hamilton		13.4	12.3	11.7	12.5
390610042	Ohio	Hamilton		13.2	12.2	11.5	12.3
390610048	Ohio	Hamilton				12.9	12.9
390617001	Ohio	Hamilton		14.1			14.1
390618001	Ohio	Hamilton		17.6			17.6
391510017	Ohio	Stark		13.0	12.1	11.7	12.3
400019009	Oklahoma	Adair		14.0			14.0
410250002	Oregon	Harney		14.0			14.0
420030064	Pennsylvania	Allegheny	Allegheny County	14.8	13.4	13.0	13.7
420210011	Pennsylvania	Cambria		12.3	12.3	11.6	12.1
420450002	Pennsylvania	Delaware	Delaware County	13.1	12.4	12.3	12.6
420710012	Pennsylvania	Lancaster				15.9	15.9
420750100	Pennsylvania	Lebanon	Lebanon County	12.8	12.3	12.7	12.6
481410053	Texas	El Paso		13.2			13.2
490495008	Utah	Utah		14.8	21.6		18.2
550350100	Wisconsin	Eau Claire		11.9	12.8		12.4

Table 3. 2012 Annual PM2.5 maintenance monitors in the US with a maximum design value among 2010-2012, 2011-2013 and 2012-2014 higher than or equal to 12.0 µg/m^3

Source: http://www3.epa.gov/airtrends/values.html

Site ID	State	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2010-2012 Annual PM2.5 DV (µg/m3)	2011-2013 Annual PM2.5 DV (µg/m3)	2012-2014 Annual PM2.5 DV (µg/m3)	Maximum among 10-12, 11-13, 12-14 DV
10732003	Alabama	Jefferson		12.0	11.1	10.8	12.0
11130001	Alabama	Russell		12.2	11.2	10.7	12.2
20900033	Alaska	Fairbanks North Star		8.3	10.7	13.9	13.9
51191008	Arkansas	Pulaski		12.2	11.7	11.1	12.2
60730003	California	San Diego		10.6	10.6	12.1	12.1
60772010	California	San Joaquin	San Joaquin Valley	12.1	10.2	9.8	12.1
130210007	Georgia	Bibb		13.1	11.8	10.9	13.1
130630091	Georgia	Clayton		12.3	11.1	10.3	12.3
131150003	Georgia	Floyd		12.1	10.8	10.3	12.1
131210039	Georgia	Fulton		13.0	11.6	11.0	13.0
132150001	Georgia	Muscogee		12.5	10.8	10.2	12.5
133190001	Georgia	Wilkinson		12.5	11.2	10.6	12.5
160590004	Idaho	Lemhi		11.2	12.0	12.1	12.1
170310057	Illinois	Cook		12.0		10.7	12.0
170310076	Illinois	Cook		12.3		9.7	12.3
170313301	Illinois	Cook		12.2		10.6	12.2
171150013	Illinois	Macon		12.2		10.4	12.2
171192009	Illinois	Madison		13.3		10.4	13.3
171630010	Illinois	Saint Clair		13.0		10.9	13.0
180372001	Indiana	Dubois		12.4	11.4	10.9	12.4
180890031	Indiana	Lake		12.2	11.6	11.5	12.2
180970083	Indiana	Marion		12.6	11.6	11.3	12.6
180970084	Indiana	Marion		12.5	11.6	11.3	12.5
181470009	Indiana	Spencer		12.0	11.1	10.5	12.0
181630016	Indiana	Vanderburgh		12.2	11.3	10.9	12.2
191390015	Iowa	Muscatine		12.2	11.3	10.8	12.2
210290006	Kentucky	Bullitt		12.4	11.3		12.4
325100020	Nevada	Carson City			12.1	8.8	12.1
360050110	New York	Bronx		12.1	11.4	10.3	12.1
390170003	Ohio	Butler		12.5	11.7	11.2	12.5
390170016	Ohio	Butler		12.2	11.3	10.7	12.2
390170019	Ohio	Butler		12.1	11.7	11.2	12.1
390350045	Ohio	Cuyahoga	Cleveland	12.2	11.5	11.3	12.2
390610040	Ohio	Hamilton		12.0	11.1	10.5	12.0
390810017	Ohio	Jefferson		12.2	11.6	10.9	12.2
391130032	Ohio	Montgomery		12.3	11.0	10.7	12.3
391530017	Ohio	Summit		12.0	11.0	10.7	12.0
420030002	Pennsylvania	Allegheny	Allegheny	13.4	11.4	10.6	13.4

Site ID	State	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2010-2012 Annual PM2.5 DV (µg/m3)	2011-2013 Annual PM2.5 DV (µg/m3)	2012-2014 Annual PM2.5 DV (µg/m3)	Maximum among 10-12, 11-13, 12-14 DV
420031301	Pennsylvania	Allegheny	Allegheny	12.5	11.7	11.4	12.5
420070014	Pennsylvania	Beaver		12.0	11.6	11.3	12.0
420290100	Pennsylvania	Chester		12.3	11.1	9.9	12.3
420710007	Pennsylvania	Lancaster		12.1	12.0	11.6	12.1
420950025	Pennsylvania	Northampton		13.2	12.2	10.5	13.2
421290008	Pennsylvania	Westmoreland		12.5	11.7	10.1	12.5
482011035	Texas	Harris		12.1	11.8	11.6	12.1
530110023	Washington	Clark			12.3	10.1	12.3
530670013	Washington	Thurston			12.6	10.0	12.6
540090005	West Virginia	Brooke		12.7	11.6	11.1	12.7
540511002	West Virginia	Marshall		12.8	11.6	11.1	12.8

Table 4. Summary of the number of the 2012 annual PM2.5 nonattainment and maintenance monitors by state

State	Nonattainment		Maintenance	
	number of state monitors	Average design value of the state's nonattainment monitors	number of state Monitors	Highest design value of the state's maintenance monitors
Alabama	1	12.1	2	12.2
Alaska	1	22.1	1	13.9
Arkansas	1	12.1	1	12.2
California	27	15.4	2	12.1
Georgia	0		6	13.1
Hawaii	2	12.2	0	
Idaho	2	14.7	1	12.1
Illinois	8	12.6	1	13.3
Indiana	6	12.8	6	12.6
Iowa	0		1	12.2
Kentucky	6	12.3	1	12.4
Maryland	1	12.0	0	
Nevada	1	16.5	1	12.1
New York	0		1	12.1
Ohio	9	13.2	8	12.5
Oklahoma	1	14.0	0	
Oregon	1	14.6	0	
Pennsylvania	5	13.4	7	13.4
Texas	1	13.2	1	12.1
Utah	1	18.2	0	
Washington	0		2	12.6
West Virginia	0		2	12.8
Wisconsin	1	12.4	0	
All States	**75**	**14.0**	**44**	**13.9**

Table 5. Monitors with 2012-2014 annual PM2.5 design values greater than or equal to 12.0 µg/m^3 (monitors used for nonattainment areas designation are highlighted)
Source: http://www3.epa.gov/airtrends/values.html

Site ID	State	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2012-2014 Annual PM2.5 DV (µg/m3)
20900033	Alaska	Fairbanks North Star		13.9
20900035	Alaska	Fairbanks North Star		26.6
60190008	California	Fresno	San Joaquin Valley	40.3
60190011	California	Fresno	San Joaquin Valley	15.4
60195001	California	Fresno	San Joaquin Valley	15.3
60195025	California	Fresno	San Joaquin Valley	14.1
60250005	California	Imperial	Imperial County	14.3
60290010	California	Kern	San Joaquin Valley	18.1
60290014	California	Kern	San Joaquin Valley	17.2
60290016	California	Kern	San Joaquin Valley	19.7
60310004	California	Kings	San Joaquin Valley	15.8
60311004	California	Kings	San Joaquin Valley	16.8
60371002	California	Los Angeles	LA South Coast	12.1
60371103	California	Los Angeles	LA South Coast	12.3
60371302	California	Los Angeles	LA South Coast	12.1
60392010	California	Madera	San Joaquin Valley	15.9
60550003	California	Napa		12.5
60631009	California	Plumas	Plumas County	12.4
60631010	California	Plumas	Plumas County	14.1
60658001	California	Riverside	LA South Coast	12.8
60658005	California	Riverside	LA South Coast	14.6
60710025	California	San Bernardino	LA South Coast	12.5
60712002	California	San Bernardino	LA South Coast	12.8
60730003	California	San Diego		12.1
60771002	California	San Joaquin	San Joaquin Valley	14.0
60990005	California	Stanislaus	San Joaquin Valley	12.5
60990006	California	Stanislaus	San Joaquin Valley	14.0
61072002	California	Tulare	San Joaquin Valley	17.2
150012020	Hawaii	Hawaii		12.1
160590004	Idaho	Lemhi		12.1
160790017	Idaho	Shoshone	West Silver Valley	13.1
171191007	Illinois	Madison		12.9
171193007	Illinois	Madison		12.5
180970087	Indiana	Marion		12.8
211110051	Kentucky	Jefferson		12.5
211110075	Kentucky	Jefferson		12.0
240270006	Maryland	Howard		12.0
320050007	Nevada	Douglas		12.3
390350038	Ohio	Cuyahoga	Cleveland	12.3
390350060	Ohio	Cuyahoga	Cleveland	12.4
390350065	Ohio	Cuyahoga	Cleveland	12.0

Site ID	State	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2012-2014 Annual PM2.5 DV (µg/m3)
390610048	Ohio	Hamilton		12.9
420030064	Pennsylvania	Allegheny	Allegheny County	13.0
420450002	Pennsylvania	Delaware	Delaware County	12.3
420710012	Pennsylvania	Lancaster		15.9
420750100	Pennsylvania	Lebanon	Lebanon County	12.7
All States Average (monitors above or equal to 12.0 µg/m^3 only)				**14.5**
All States Maximum				**40.3**

Table 6. The number of monitors with 2012-2014 design value higher than or equal to 12.0 µg/m3 by state

State	Number of Monitors	Monitors Average DV (µg/m3)
California	26	15.4
Pennsylvania	4	13.5
Ohio	4	12.4
Alaska	2	20.3
Illinois	2	12.7
Idaho	2	12.6
Kentucky	2	12.3
Indiana	1	12.8
Nevada	1	12.3
Hawaii	1	12.1
Maryland	1	12.0
All monitors	**46**	**14.5**

4. Ohio Contribution to the nonattainment and maintenance monitors in CSAPR states

The second phase of the study was to evaluate Ohio's contribution to the nonattainment of 2012 annual PM2.5 at states in the eastern US, where Ohio has historically shown contribution to nonattainment or interference with maintenance. The emissions and modeling for the CSAPR (also referred to as the Transport Rule) consists of four emissions cases: 2005 base case, 2012 base case, 2014 base case, and 2014 remedy (control) case[1]. The 2005 was selected for the CSAPR base year because it was the most recent year with complete National Emission Inventory (NEI) at that time. The 2012 base case modeling was used to identify future nonattainment and maintenance locations and to quantify the contributions of emissions in upwind states to annual and 24-hour PM2.5 and 8-hour ozone at downwind receptors. The 2014 base case and 2014 remedy case were used to quantify the benefits of the emissions reductions by the CSAPR. The Air Quality Model with extensions (CAMx) version 5.3 was used to simulate ozone and PM2.5 concentrations for the 2005 base year, 2012 future year and 2014 future year air quality modeling for the CSAPR[1]. SMOKE version 2.6 was used to create the emissions files for the 2005 base case. CAMx required the raw emissions data to be processed into hourly emissions of the pollutants in the grid cells contained in the modeled region[1]. Emissions data for the stationary sources was mainly obtained from the 2005 NEI version 2. The CAMx modeling focused on states in the Eastern U.S. using a horizontal grid resolution of 12 x 12 km[1]. Thirty seven states and the District of Columbia are wholly contained with the modeling domain. Figure 4 shows the CSAPR domain.

The 2012 base case was used for quantifying the contributions of emissions in upwind states to receptors in downwind states. The PM2.5 ambient data were processed consistent with the formats associated with the NAAQs for PM2.5. The 3-year average annual mean concentration was computed at each site by averaging the daily Federal Reference Method (FRM) samples by quarter, averaging the quarterly averages to obtain an annual average, and finally averaging the three annual averages to get the annual design value[1]. The annual PM2.5 average values in 2012 were estimated by applying the 2005 to 2012 relative change in the concentration of the model predicted PM2.5 species compared to the measured (2003-2007) concentrations. PM2.5 species include sulfate, nitrate, ammonia, particle bound water, elemental carbon, salt, primary PM2.5, and organic aerosol mass[1]. The same procedure was used to estimate the annual PM2.5 average values for 2014.

CAMx PSAT (Particulate Source Apportionment Technique) was used for the CSAPR to calculate contributions of one state to another downstream state[1]. The CAMx PSAT is capable of tracking (tagging) source category emissions for certain PM species and precursor emissions. CAMx PSAT was used to track NOx, and SO2 from the relevant sources within the individual states[1]. Each state was a separate tag and the tagged emissions followed the state boundaries. Nitrate concentrations were used to track NOx emissions, sulfate concentrations were used to track SO2 emissions. The net contribution to PM2.5 was calculated by combining contributions of nitrate and sulfate. Primary PM2.5 emissions form an upwind state was excluded from calculating net contribution to PM2.5 in downstream states. The PM2.5 contributions from the thirty seven states and the District of Columbia to all monitoring sites in the 12 km Eastern modeling domain were provided in the CSAPR docket.

Ohio's contribution to the 2012 base case annual PM2.5 average values to all the monitors in the 12 km Eastern modeling domain was used for this study. Table 7 shows Ohio's contribution in $\mu g/m^3$ and percent to the 2012 base case annual PM2.5 average value at the monitors in the

[1] http://www3.epa.gov/airtransport/CSAPR/pdfs/AQModeling.pdf

CSAPR domain that were identified as nonattainment monitors in section 3 of this study. Based on the modeling results, Ohio contributed more than 1.0 µg/m^3 to the 2012 base case annual PM2.5 average value at 3 monitors in Pennsylvania, 2 monitors in Kentucky, and 2 monitors in Indiana. Ohio contributed 1.3 µg/m^3 to the 17.9 µg/m^3 2012 base case annual PM2.5 average value at the monitor used to designate Allegheny County, Pennsylvania as a 2012 PM2.5 nonattainment area. Ohio contributed 0.5 µg/m^3 to the 12.8 µg/m^3 2012 base case annual PM2.5 average value at the monitor used to designate Delaware County, Pennsylvania as a 2012 PM2.5 nonattainment area. The monitor used to designate Lebanon County, Pennsylvania as a 2012 PM2.5 nonattainment area did not exist at the time of the modeling study. The three monitors are highlighted in table 7.

Table 8 shows Ohio's contribution in µg/m^3 and percent to the 2012 base case annual PM2.5 average value at the monitors in the CSAPR domain that were identified as maintenance monitors in section 3 of this study. Based on the modeling results, Ohio contributed more than 1.0 µg/m^3 to the 2012 base case annual PM2.5 average value at 3 monitors in Pennsylvania, 2 monitors in West Virginia, and one monitors in Kentucky. One of the monitors was located in Allegheny County, Pennsylvania 2012 annual PM2.5 nonattainment area and Ohio contribution to the monitor's 11.4 µg/m^3 2012 base case annual PM2.5 average value was 1.4 µg/m^3.

Table 9 compares the 2012 predicted to actual 2012 measured annual PM2.5 average values for the nonattainment and maintenance monitors in CSAPR states. The CSAPR predicted values were overestimated for most of the monitors. The predicted values were about 8% higher than the measured values in average for all the nonattainment and maintenance monitors. For example, the estimated 2012 annual PM2.5 average value for the monitor that was used for the designation of Allegheny County was 17.9 µg/m^3 compared to the measured value of 15.3 µg/m^3 (about 15% overestimation). Based on this information, it is believed that Ohio's contribution to the receptors in other states is lower than what was expected in the CSAPR analysis. Ohio contributions from the CSAPR analysis are mainly used in this study to identify the states that are most likely be affected by Ohio's emissions. The CSAPR analysis shows that Ohio's emissions may affect Pennsylvania, Kentucky, West Virginia and Indiana. U.S. EPA expects states will need to address its contributions of as low as 1% of the standard in other states. In this analysis, by addressing Ohio's larger contributions predicted in the CSPAR modeling, smaller predicted contributions will be addressed. In addition, focusing Ohio's analysis on addressing contribution to areas predicted as nonattainment will ensure contributions to maintenance are addressed.

The monitor in Madison County, Indiana (Table 7) is the monitor Ohio emissions have the largest nonattainment contribution to, according to the CSAPR modeling. CSAPR modeling predicted a 7.4% contribution and a 2012 average value of 12.9 µg/m^3. However, this county is actually in attainment for the 2012 PM2.5 NAAQS and has a 2012-2014 design value of 9.8 µg/m^3, well below the 2012 PM2.5 NAAQS. Therefore, Ohio is focusing its analysis on the highest monitor for an area actually designated nonattainment for the 2012 PM2.5 NAAQS with a similar contribution to the Indiana monitor. This is the Alleghany County monitor in Pennsylvania. CSAPR modeling predicted a 6.5% contribution and a 2012 average value of 17.94 µg/m^3. Actual 2012 average value (table 9) is 15.3 µg/m^3, an over prediction of 14.90%. The 2012-2014 design value for this monitor is 13.0 µg/m^3.

Figure 4. Transport Rule air quality modeling domains
Source: http://www3.epa.gov/crossstaterule/pdfs/AQModeling.pdf

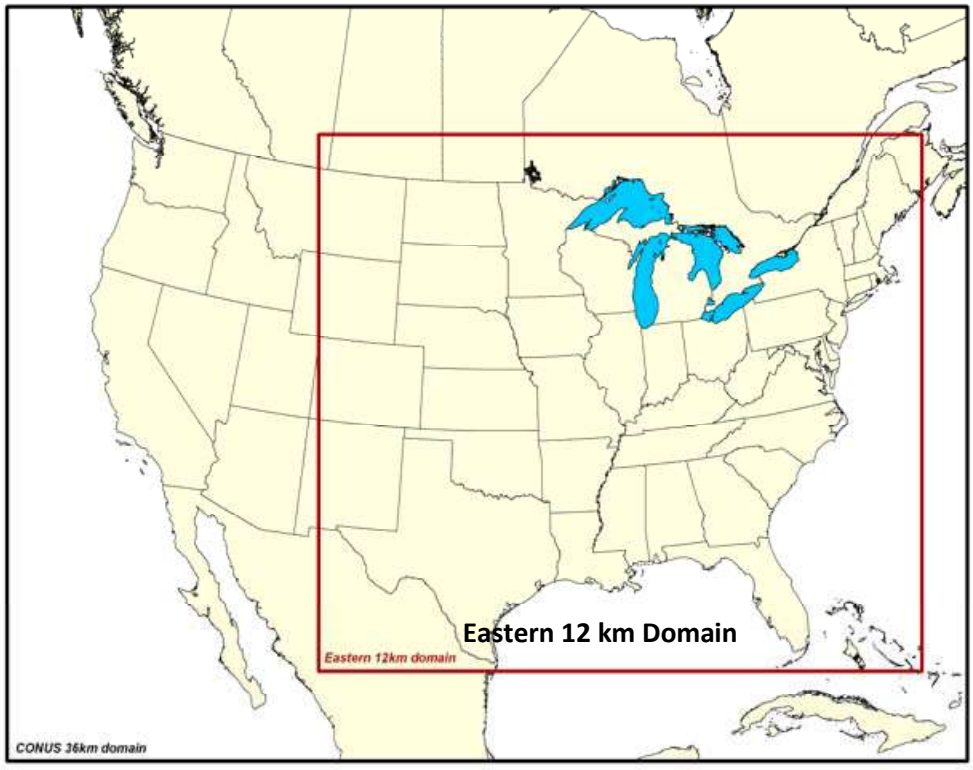


Table 7. Ohio Contribution to nonattainment monitors of the 2012 annual PM2.5 standard in CSAPR States (monitors used for nonattainment areas designation are in yellow rows)
Source: http://www3.epa.gov/airtransport/CSAPR/techinfo.html

Site ID	State	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2012-2014 Annual PM2.5 DV (µg/m3)	2012 Base Case Annual PM2.5 Average Values (µg/m3)	OH Contrib. to 2012 Base Case (µg/m3)	OH Contrib. to 2012 Base Case (%)
10730023	Alabama	Jefferson		11.3	16.15	0.246	1.3%
51310008	Arkansas	Sebastian					
170190004	Illinois	Champaign			11.41	0.539	4.2%
170310022	Illinois	Cook		11.6	13.73	0.352	2.3%
170310050	Illinois	Cook			13.29	0.406	2.7%
170310052	Illinois	Cook		11.9	14.09	0.377	2.4%
170313103	Illinois	Cook		11.7			
171191007	Illinois	Madison		12.9	15.46	0.423	2.5%
171193007	Illinois	Madison		12.5	13.45	0.373	2.6%
171634001	Illinois	Saint Clair			13.23	0.450	3.1%
180190006	Indiana	Clark		11.8	14.83	1.029	6.2%
180950009	Indiana	Madison		9.8	12.90	1.061	7.4%
180970081	Indiana	Marion		11.8	14.86	0.947	5.8%
180970087	Indiana	Marion		12.8			
181630020	Indiana	Vanderburgh					
181670023	Indiana	Vigo			12.16	0.722	5.3%
211110043	Kentucky	Jefferson		11.7	14.04	0.978	6.2%
211110051	Kentucky	Jefferson		12.5	13.30	1.028	6.7%
211110067	Kentucky	Jefferson		11.3			
211110075	Kentucky	Jefferson		12.0			
211830032	Kentucky	Ohio					
240270006	Maryland	Howard		12.0			
400019009	Oklahoma	Adair					
420030064	Pennsylvania	Allegheny	Allegheny Co	13.0	17.94	1.343	6.5%
420210011	Pennsylvania	Cambria		11.6	13.61	1.038	6.7%
420450002	Pennsylvania	Delaware	Delaware Co	12.3	12.85	0.496	3.2%
420710012	Pennsylvania	Lancaster		15.9			
420750100	Pennsylvania	Lebanon	Lebanon Co	12.7			
481410053	Texas	El Paso					
550350100	Wisconsin	Eau Claire					

Table 8. Ohio Contribution to maintenance monitors of the 2012 annual PM2.5 standard in CSAPR States *(Source: http://www3.epa.gov/airtransport/CSAPR/techinfo.html)*

Site ID	State	County	Nonattain. Area of the 2012 Annual PM2.5 Standard	2012-2014 Annual PM2.5 DV (µg/m3)	2012 Base Case Annual PM2.5 Average Values (µg/m3)	OH Contrib. to 2012 Base Case (µg/m3)	OH Contrib. to 2012 Base Case (%)
10732003	Alabama	Jefferson		10.8	15.16	0.264	1.5%
11130001	Alabama	Russell		10.7	13.91	0.312	2.0%
51191008	Arkansas	Pulaski		11.1			
130210007	Georgia	Bibb		10.9	14.58	0.316	1.9%
130630091	Georgia	Clayton		10.3	14.30	0.325	1.9%
131150003	Georgia	Floyd		10.3	14.21	0.411	2.5%
131210039	Georgia	Fulton		11.0	15.07	0.326	1.9%
132150001	Georgia	Muscogee		10.2	13.16	0.312	2.1%
133190001	Georgia	Wilkinson		10.6	13.59	0.313	2.0%
170310057	Illinois	Cook		10.7	13.38	0.371	2.4%
170310076	Illinois	Cook		9.7	13.30	0.366	2.4%
170313301	Illinois	Cook		10.6	13.62	0.358	2.3%
171150013	Illinois	Macon		10.4	12.21	0.502	3.7%
171192009	Illinois	Madison		10.4	13.16	0.379	2.6%
171630010	Illinois	Saint Clair		10.9	14.40	0.427	2.7%
180372001	Indiana	Dubois		10.9	13.90	0.886	5.7%
180890031	Indiana	Lake		11.5			
180970083	Indiana	Marion		11.3	14.71	0.948	5.8%
180970084	Indiana	Marion		11.3			
181470009	Indiana	Spencer		10.5	13.06	0.863	5.9%
181630016	Indiana	Vanderburgh		10.9	13.81	0.604	4.0%
191390015	Iowa	Muscatine		10.8	11.85	0.225	1.7%
210290006	Kentucky	Bullitt			13.57	1.030	6.7%
360050110	New York	Bronx		10.3	11.51	0.267	1.9%
420030002	Pennsylvania	Allegheny	Allegheny County	10.6			
420031301	Pennsylvania	Allegheny	Allegheny County	11.4	14.32	1.352	8.2%
420070014	Pennsylvania	Beaver		11.3	14.44	1.442	8.8%
420290100	Pennsylvania	Chester		9.9	12.88	0.639	4.2%
420710007	Pennsylvania	Lancaster		11.6	14.06	0.678	3.9%
420950025	Pennsylvania	Northampton		10.5	11.72	0.493	3.5%
421290008	Pennsylvania	Westmoreland		10.1	13.65	1.248	8.0%
482011035	Texas	Harris		11.6	13.93	0.081	0.5%
540090005	West Virginia	Brooke		11.1	14.33	2.002	11.9%
540511002	West Virginia	Marshall		11.1	13.25	1.637	10.7%

Table 9. 2012 predicted compared to 2012 measured annual PM2.5 average values for the nonattainment and maintenance monitors in CSAPR states

(Source: http://www3.epa.gov/airtransport/CSAPR/techinfo.html)

Site ID	State	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2012 Measured Annual PM2.5 Average Values	2012 Base Case Annual PM2.5 Average Values (µg/m3)	2012 Base to 2012 Measured
10730023	Alabama	Jefferson		13.2	16.15	-18.27%
10732003	Alabama	Jefferson		12.2	15.16	-19.31%
11130001	Alabama	Russell		12.3	13.91	-11.81%
51191008	Arkansas	Pulaski		12.1		
51310008	Arkansas	Sebastian		11.5		
130210007	Georgia	Bibb		13.1	14.58	-10.15%
130630091	Georgia	Clayton		12.6	14.30	-11.89%
131150003	Georgia	Floyd		12.2	14.21	-14.14%
131210039	Georgia	Fulton		12.5	15.07	-16.83%
132150001	Georgia	Muscogee		12.8	13.16	-2.74%
133190001	Georgia	Wilkinson		12.9	13.59	-5.32%
170190004	Illinois	Champaign		11.8	11.41	3.71%
170310022	Illinois	Cook		13.2	13.73	-4.10%
170310050	Illinois	Cook		12.0	13.29	-9.71%
170310052	Illinois	Cook		12.6	14.09	-10.81%
170310057	Illinois	Cook		11.8	13.38	-11.56%
170310076	Illinois	Cook		11.9	13.30	-10.28%
170313103	Illinois	Cook		12.8		
170313301	Illinois	Cook		12.0	13.62	-11.65%
171150013	Illinois	Macon		11.8	12.21	-3.08%
171191007	Illinois	Madison		13.6	15.46	-11.82%
171192009	Illinois	Madison		12.3	13.16	-6.28%
171193007	Illinois	Madison		11.7	13.45	-12.76%
171630010	Illinois	Saint Clair		12.6	14.40	-12.50%
171634001	Illinois	Saint Clair		12.5	13.23	-5.77%
180190006	Indiana	Clark		13.6	14.83	-8.29%
180372001	Indiana	Dubois		12.8	13.90	-8.15%
180890031	Indiana	Lake		12.3		
180950009	Indiana	Madison		12.9	12.90	0.26%
180970081	Indiana	Marion		13.1	14.86	-11.62%
180970083	Indiana	Marion		12.9	14.71	-12.08%
180970084	Indiana	Marion		12.7		
180970087	Indiana	Marion				
181470009	Indiana	Spencer		12.2	13.06	-6.33%
181630016	Indiana	Vanderburgh		12.6	13.81	-9.00%
181630020	Indiana	Vanderburgh		13.2		
181670023	Indiana	Vigo		11.9	12.16	-2.41%
191390015	Iowa	Muscatine		12.7	11.85	6.89%
210290006	Kentucky	Bullitt		12.4	13.57	-8.38%
211110043	Kentucky	Jefferson		12.8	14.04	-9.19%

Site ID	State	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2012 Measured Annual PM2.5 Average Values	2012 Base Case Annual PM2.5 Average Values (µg/m3)	2012 Base to 2012 Measured
211110051	Kentucky	Jefferson		13.1	13.30	-1.88%
211110067	Kentucky	Jefferson		12.9		
211110075	Kentucky	Jefferson				
211170007	Kentucky	Kenton		11.8	13.12	-10.06%
211830032	Kentucky	Ohio		12.1		
240270006	Maryland	Howard				
360050110	New York	Bronx		11.2	11.51	-2.98%
390170003	Ohio	Butler		13.0		
390170016	Ohio	Butler		12.9	14.34	-10.27%
390170019	Ohio	Butler		12.4		
390350038	Ohio	Cuyahoga	Cleveland	13.2	15.99	-17.24%
390350045	Ohio	Cuyahoga	Cleveland	12.5	15.14	-17.66%
390350060	Ohio	Cuyahoga	Cleveland	13.1	15.67	-16.61%
390350065	Ohio	Cuyahoga	Cleveland	12.9	14.67	-11.84%
390610014	Ohio	Hamilton		13.9	15.76	-12.01%
390610040	Ohio	Hamilton		12.5	14.12	-11.24%
390610042	Ohio	Hamilton		13.7	15.40	-10.82%
390610048	Ohio	Hamilton				
390617001	Ohio	Hamilton		13.7	14.74	-6.83%
390618001	Ohio	Hamilton		16.1	16.01	0.35%
390810017	Ohio	Jefferson		12.6	13.37	-6.01%
391130032	Ohio	Montgomery		12.8	14.10	-9.22%
391510017	Ohio	Stark		13.4	14.47	-7.39%
391530017	Ohio	Summit		12.6	13.70	-7.79%
400019009	Oklahoma	Adair		12.7		
420030002	Pennsylvania	Allegheny	Allegheny Co	14.8		
420030064	Pennsylvania	Allegheny	Allegheny Co	15.3	17.94	-14.90%
420031301	Pennsylvania	Allegheny	Allegheny Co	12.8	14.32	-10.38%
420070014	Pennsylvania	Beaver		12.5	14.44	-13.43%
420210011	Pennsylvania	Cambria		12.4	13.61	-8.65%
420290100	Pennsylvania	Chester		13.3	12.88	3.00%
420450002	Pennsylvania	Delaware	Delaware Co	13.1	12.85	1.95%
420710007	Pennsylvania	Lancaster		12.2	14.06	-12.99%
420710012	Pennsylvania	Lancaster				
420750100	Pennsylvania	Lebanon	Lebanon Co	12.1		
420950025	Pennsylvania	Northampton		13.1	11.72	11.49%
421290008	Pennsylvania	Westmoreland		13.2	13.65	-3.30%
481410053	Texas	El Paso		14.1		
482011035	Texas	Harris		12.4	13.93	-10.74%
540090005	West Virginia	Brooke		13.1	14.33	-8.35%
540511002	West Virginia	Marshall		13.0	13.25	-2.14%
550350100	Wisconsin	Eau Claire		10.6		
Nonattainment and Maintenance Monitors Average				**12.7**	**14.0**	**-8.28%**

5. Pennsylvania nonattainment areas

The third phase of the study was to conduct review and analysis of the emissions in the nonattainment areas downwind from Ohio giving more attention to the actual 2012 PM2.5 nonattainment areas downwind to Ohio that are more likely to be impacted by Ohio's emissions. The 2012 annual PM2.5 nonattainment areas in a state that is neighbor to Ohio are Allegheny County, Lebanon County, and Delaware County and the three areas are in Pennsylvania. Figure 5 shows the nonattainment areas in Ohio and Pennsylvania and the IDs for the monitors used for the designation (one area in Ohio and three areas in Pennsylvania). Figure 5 also shows the point sources within 25 miles buffer zone around the monitors used to designate the nonattainment areas. Figures 6 to 8 show that none of Ohio point sources are located within 275-, 220-, and 40-miles from the monitor used to designate Delaware County, Lebanon County and Allegheny County as a 2012 annual PM2.5 nonattainment area, respectively.

Figures 9 to 11 shows the individual nonattainment areas in Pennsylvania at a larger scale. The monitors with a 2011-2013 annual PM2.5 design value higher than or equal to 12.0 $\mu g/m^3$ are in red dots, while the monitors with 2011-2013 annual PM2.5 design value lower than 12.0 $\mu g/m^3$ are in blue dots. Each of Figures 9 to 11 shows the point sources within 25 miles buffer zone around the monitors used to designate the nonattainment areas. The point sources are shown as black flags. Tables 10 to 12 shows the 2011 emissions inventory[1] of PM2.5, NOx, SO2, VOC, and NH3 as provided by NEI for the point sources within 25 mile buffer around the nonattainment designation monitors. The tables provide the total 2011 point source emissions of PM2.5, NOx, SO2, VOC, and NH3 in the 25-mile buffer zone for each of the three nonattainment areas.

The major emissions sources in the 25-miles buffer around the monitor used to designate Allegheny County, Pennsylvania as a 2012 annual PM2.5 nonattainment area are Allegheny Energy Supply Company, Allegheny Ludlum LLC, Genon Energy Inc., Shenango Inc., and USS Corp. with a total 2011 emission of 2,190 tons of PM2.5, 11,695 tons of NOx and 14,604 tons of SO2.

The major emissions sources in the 25-miles buffer around the monitor used to designate Lebanon County, Pennsylvania as a 2012 annual PM2.5 nonattainment area are Genon Rema LLC, Lehigh Cement Co., PPG Industries Inc., and PPL Brunner Island LLC, with a total 2011 emission of 1,440 tons of PM2.5, 24,632 tons of NOx and 23,166 tons of SO2.

The major emissions sources in the 25-miles buffer around the monitor used to designate Delaware County, Pennsylvania as a 2012 annual PM2.5 nonattainment area are Camden County Municipal Utilities Authority, Carneys Point Generating Plant, Covanta Delaware Valley LP, Delaware City Refinery, Kimberly Clark PA LLC, Philadelphia International, Marcus Hook Refinery, and Philadelphia Refinery, with a total 2011 emission of 3,650 tons of PM2.5, 14,817 tons of NOx and 8,413 tons of SO2.

[1] http://www3.epa.gov/airquality/particlepollution/designations/2012standards/techinfo.htm http://www.epa.state.oh.us/dapc/aqmp/eiu/eis.aspx#126013925-download-eis-data-and-reportshttp://geoplatform2.epa.gov/pm_map/index.html

Figure 12 and Table 13 compare the total 2011 emissions of PM2.5, NOx, and SO2 for Pennsylvania nonattainment areas. The Lebanon County monitor has the highest 2011 NOx and SO2 emissions within 25 miles compared to the other two.

It was determined that the three closest nonattainment areas to Ohio have significant emissions within their boundaries. It is unlikely that Ohio is contributing significantly to the nonattainment at these areas, especially Lebanon and Delaware Counties. Ohio believes efforts by Pennsylvania to bring these areas in compliance with the 2012 annual PM2.5 standard by addressing the local emissions at these nonattainment areas will be much more effective than addressing the emissions from upwind states.

Because of its location relative to Ohio and based on the results of the CSAPR analysis discussed in section 4 of this study, it is expected that Ohio's impact is likely larger on Allegheny County compared to the remaining 2012 annual PM2.5 nonattainment areas. Moreover, Ohio believes that addressing its impact on Allegheny County will benefit other nonattainment and maintenance areas at a larger distance downwind.

Figure 5. 2012 Annual PM2.5 Standard's Nonattainment Areas in Ohio and Pennsylvania

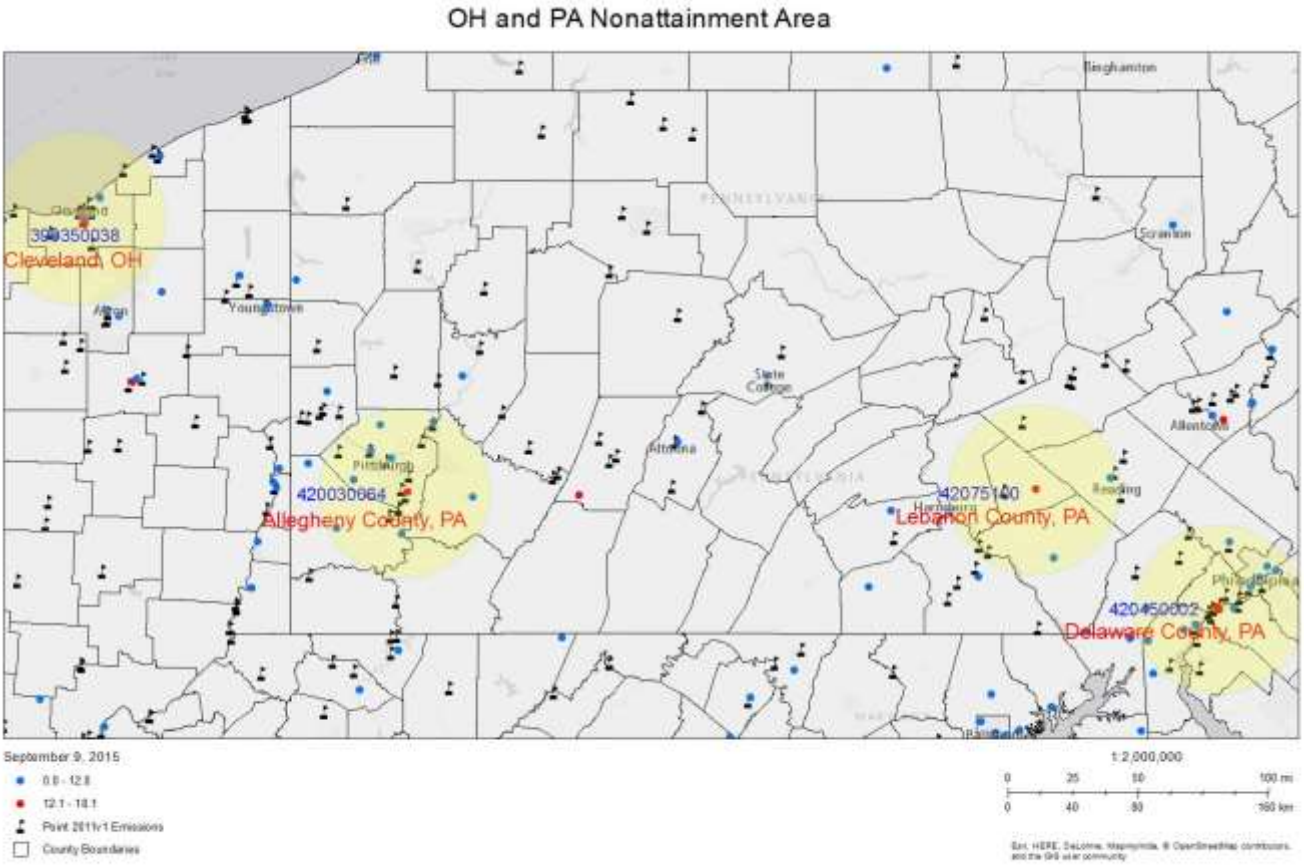


Figure 6. A 275-miles buffer around the monitor used for the designation of Delaware County, PA as a 2012 Annual PM2.5 nonattainment area

Figure 7. A 220-miles buffer around the monitor used for the designation of Lebanon County, PA as a 2012 Annual PM2.5 nonattainment area

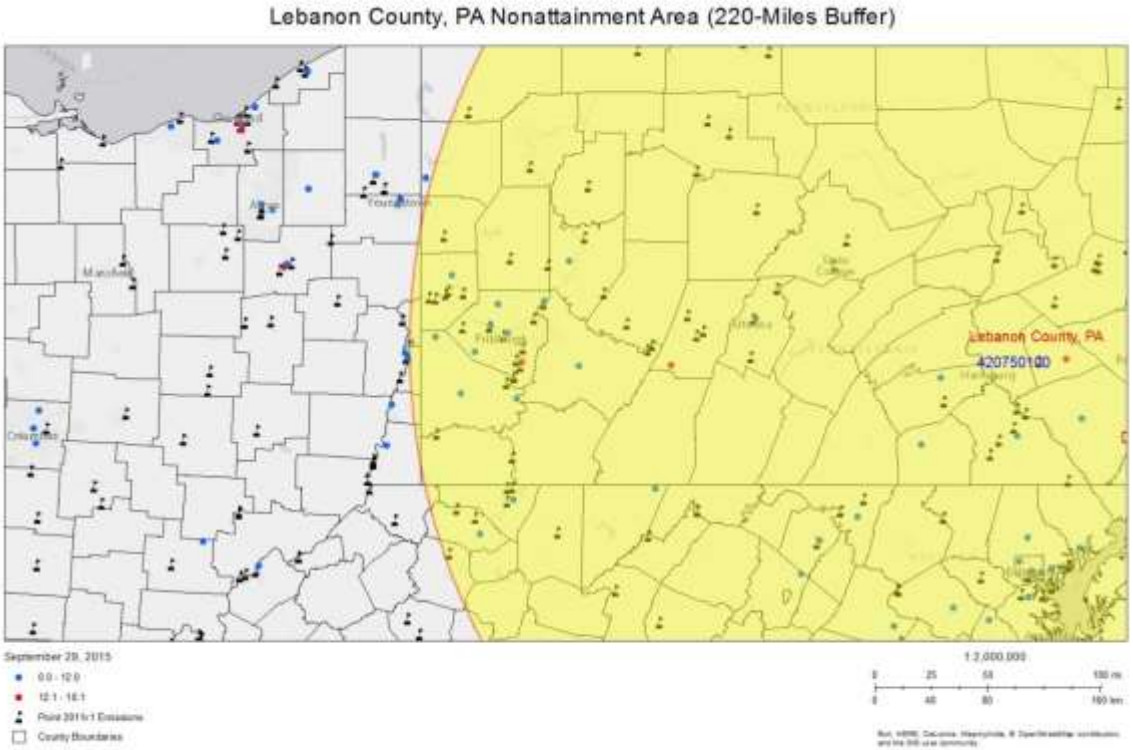


Figure 8. A 40-miles buffer around the monitor used for the designation of Allegheny County, PA as a 2012 Annual PM2.5 nonattainment area

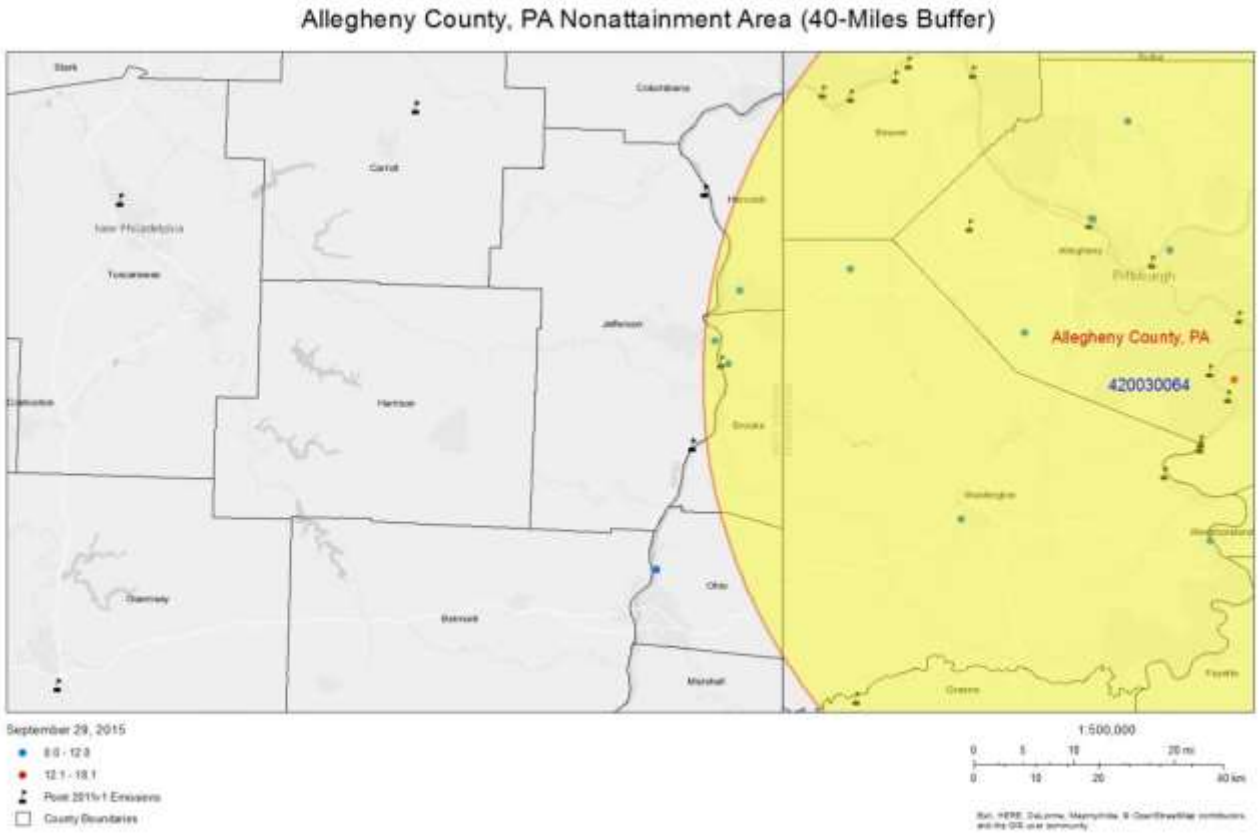


Figure 9. A 25-miles buffer zone around the monitor used for the designation of Allegheny County, PA as a 2012 Annual PM2.5 nonattainment area

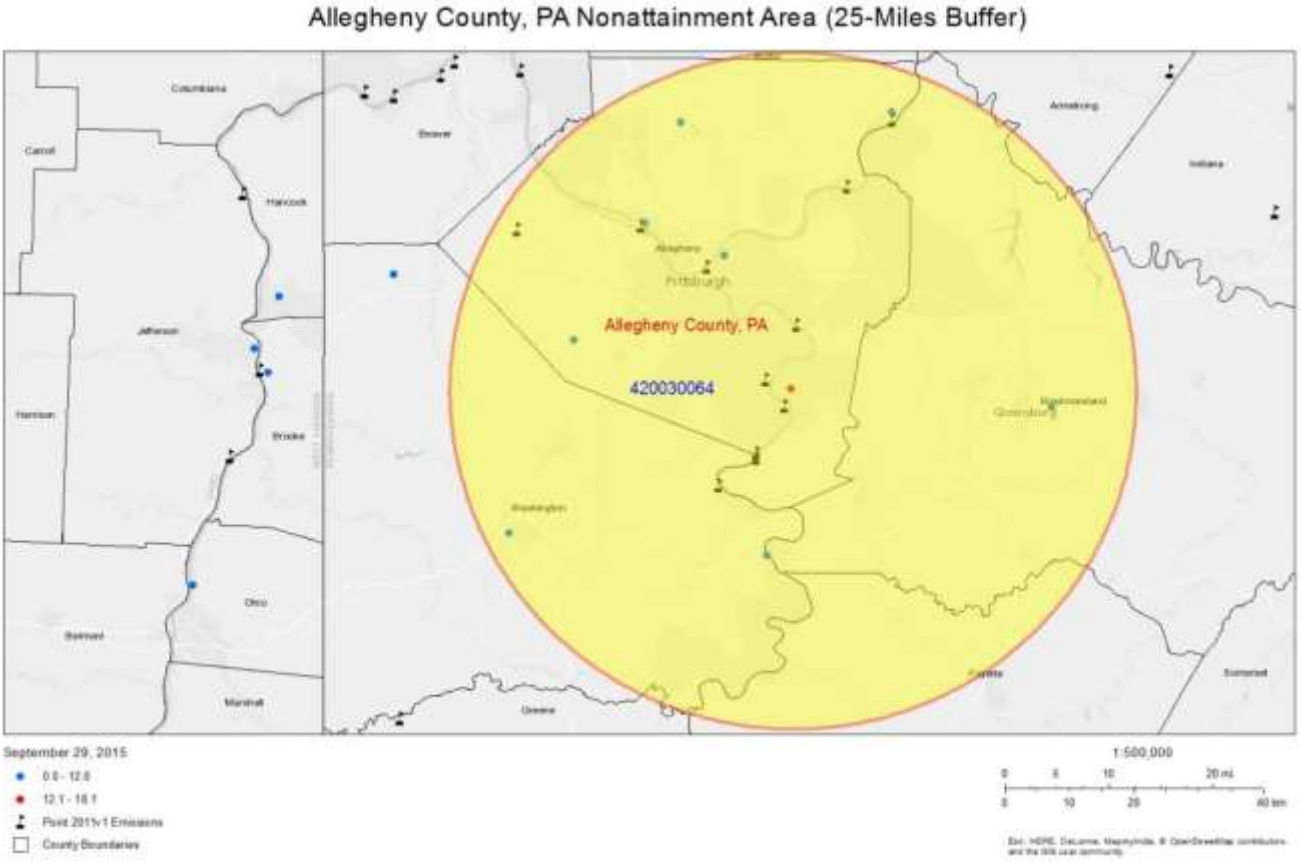


Table 10. Point sources within 25 miles from the monitor used for the designation of Allegheny County, PA as a 2012 Annual PM2.5 nonattainment area

Source: http://www3.epa.gov/airquality/particlepollution/designations/2012standards/techinfo.htm

State	County	Facility	2011 PM2.5 (ton)	2011 NOx (ton)	2011 SO2 (ton)	2011 VOC (ton)
PA	Allegheny	Allegheny Energy Supply Co./ Mitchell Power Station	85	1,305	863	11
PA	Allegheny	Allegheny Ludlum LLC/ Brackenridge	223	255	33	62
PA	Allegheny	Bay Valley Foods LLC/ PGH	20	212	313	1
PA	Allegheny	Genon Energy Inc./ Cheswick Station	498	3,294	9,290	10
PA	Washington	Genon Power Midwest LP/ Elrama Plant	24	561	428	4
PA	Allegheny	Guardian Industries Corp./ Jefferson Hills	22	978	73	19
PA	Allegheny	Pittsburgh International	17	550	68	94
PA	Allegheny	Shenango Inc./ Shenango Coke Plant	97	427	372	100
PA	Allegheny	USS Corp./Clairton Works	500	3,075	1,468	336
PA	Allegheny	USS Corp./Edgar Thomson Works	633	275	1,279	41
PA	Allegheny	US Steel Corp./ Irvin Plant	72	762	419	61
Total			**2,191**	**11,695**	**14,604**	**739**

Figure 10. A 25-miles buffer zone around the monitor used for the designation of Lebanon County, PA as a 2012 Annual PM2.5 nonattainment area

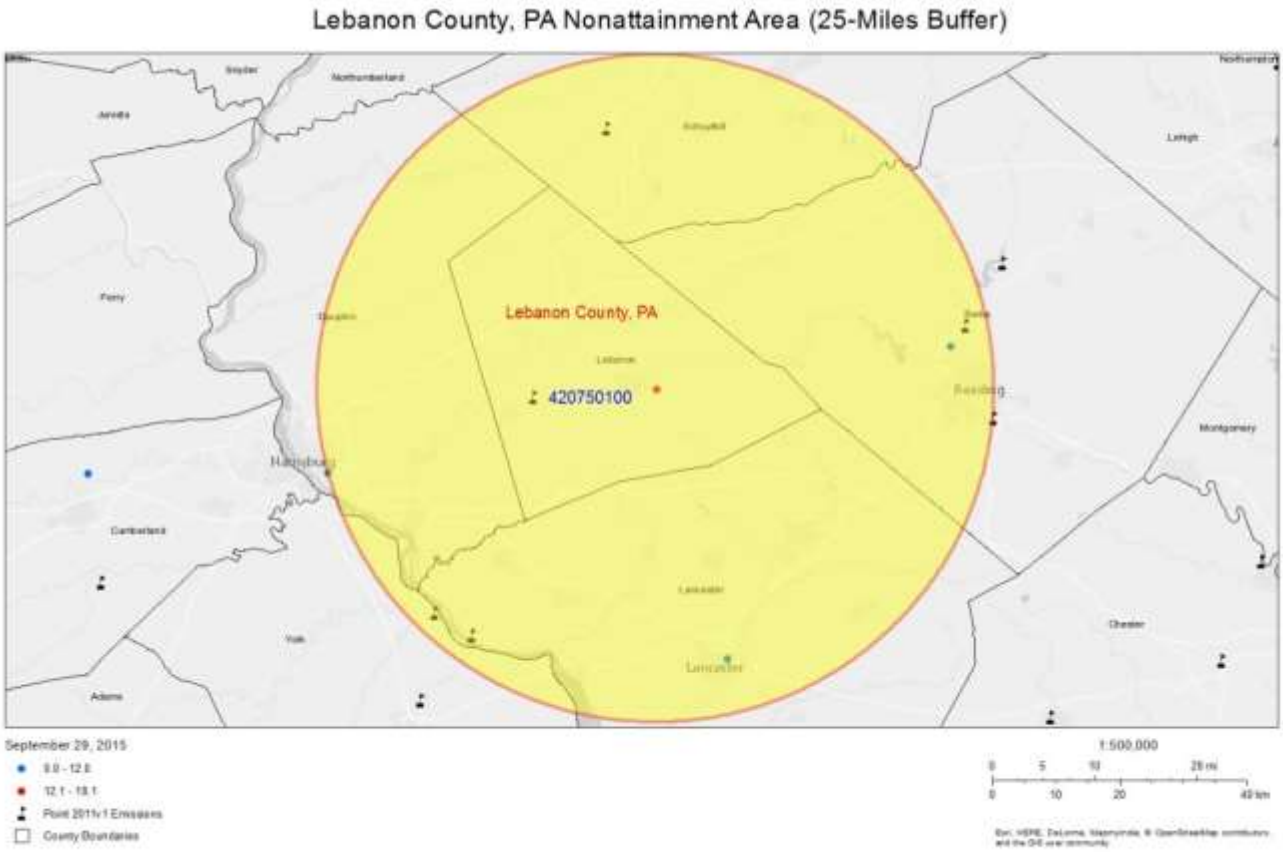


Table 11. Point sources within 25 miles from the monitor used for the designation of Lebanon County, PA as a 2012 Annual PM2.5 nonattainment area

Source: http://www3.epa.gov/airquality/particlepollution/designations/2012standards/techinfo.htm

State	County	Facility	2011 PM2.5 (ton)	2011 NOx (ton)	2011 SO2 (ton)	2011 VOC (ton)	2011 NH3 (ton)
PA	Lebanon	Carmeuse Lime Inc./ Millard Lime Plant	14	444	262	4	0
PA	Berks	Cryovac Inc./ Cryovac Rigid Packaging	0	0	0	556	0
PA	Berks	Genon Rema LLC/ Titus Generation Station	43	683	4,087	5	0
PA	Lancaster	Lancaster County Refinery	4	577	12	4	0
PA	Berks	Lehigh Cement Co LLC/ Evansville Cement Plant and Quarry	134	1,225	200	12	41
PA	Cumberland	PPG Industries INC/Works No 6	488	4,593	681	24	0
PA	York	PPL Brunner Island LLC/ Brunner Island	753	16,891	17,657	2	2
PA	Schuylkill	WPS Westwood Generation LLC	5	220	268	13	0
Total			**1,441**	**24,632**	**23,166**	**619**	**43**

Figure 11. A 25-miles buffer zone around the monitor used for the designation of Delaware County, PA as a 2012 Annual PM2.5 nonattainment area

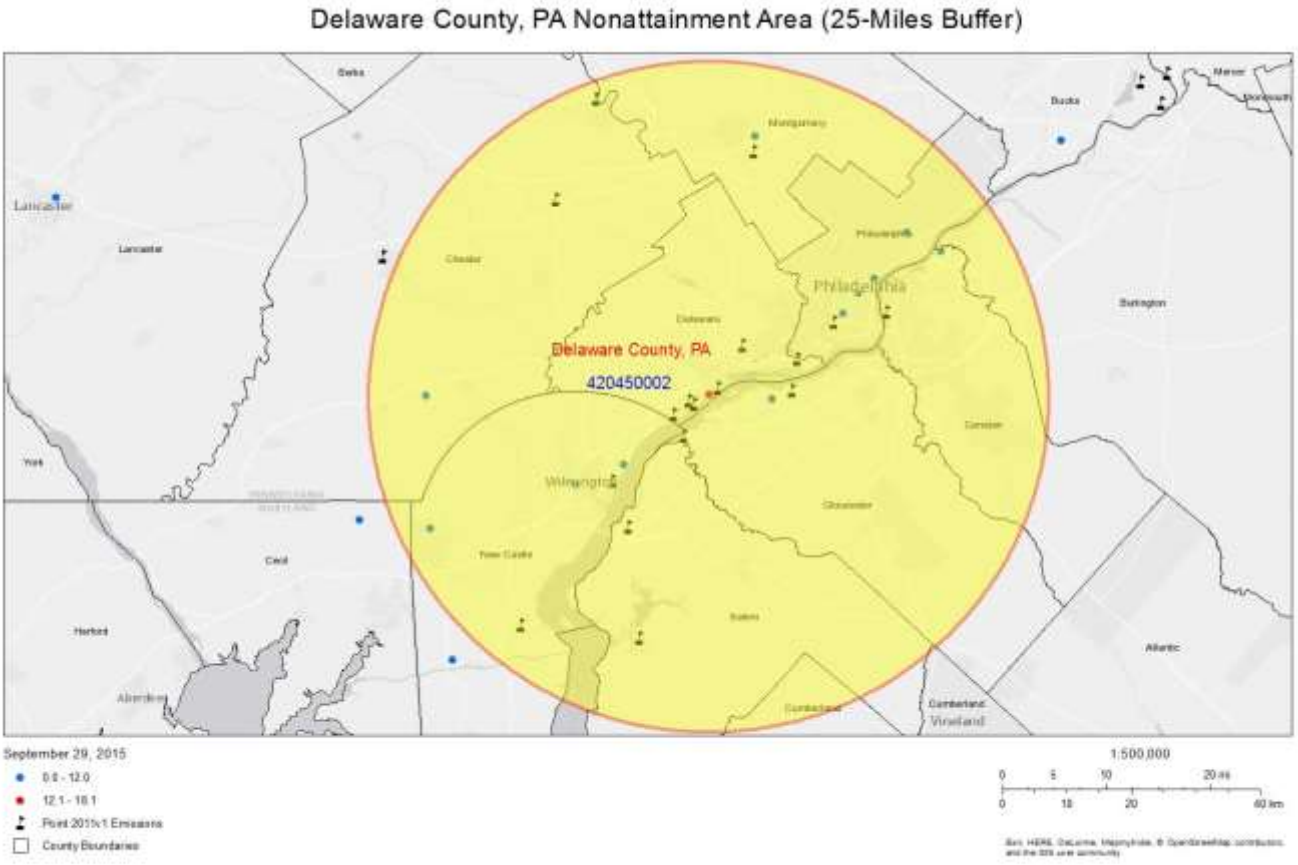


Table 12. Point sources within 25 miles from the monitor used for the designation of Delaware County, PA as a 2012 Annual PM2.5 nonattainment area

Source: http://www3.epa.gov/airquality/particlepollution/designations/2012standards/techinfo.htm

State	County	Facility	2011 PM2.5 (ton)	2011 NOx (ton)	2011 SO2 (ton)	2011 VOC (ton)	2011 NH3 (ton)
PA	Chester	Arcelormittal Plate LLC/ Coatesville	72	255	111	133	4
NJ	Salem	Aucher Glass Container Corp.	67	509	90	9	1
NJ	Camden	Camden County Municipal Utilities Authority	521	14	0	26	2
NJ	Salem	Carneys Point Generating Plant	39	752	1,157	3	2
PA	Delaware	Covanta Delaware Valley LP	182	1,260	242	6	0
PA	Montgomery	Covanta Plymouth Renewable Energy/ Plymouth	8	735	25	2	1
DE	New Castle	Delaware City Refinery	281	1,072	333	139	7
PA	Delaware	Exeleon Generation Co./ Eddystone	77	830	940	11	6
PA	Chester	Exelon Generation Co./ Cromby Generation Station	38	493	826	2	2
DE	New Castle	HAY Road Energy Center	106	602	11	33	53
PA	Delaware	Kimberly Clark PA LLC/ Chester	17	240	1,265	26	2
NJ	Gloucester	Logan Generating Plant, LP	17	656	600	6	2
PA	Delaware	Monroe Energy LLC/ Trainer	228	656	142	241	6
NJ	Gloucester	Paulsboro Refining Company LLC	238	655	77	308	5
PA	Delaware	Philadelphia International	53	2,246	254	318	0
PA	Delaware	Sonoco Inc./ Marcus Hook Refinery	674	1,490	2,044	331	6
PA	Philadelphia	Sunoco Inc./ Philadelphia Refinery	722	1,315	297	749	4
PA	York	Transcontinental Gas Pipe Line Co/ Station 195	37	444	0	78	0
PA	Chester	Transcontinental Gas/ Frazer Station 200	248	595	1	49	0
Total			**3,625**	**14,817**	**8,413**	**2,471**	**102**

Figure 12. Total emissions from sources (in tons) within 25 miles from the monitors used for the designation of the 2012 Annual PM2.5 nonattainment areas in PA based on NEI 2011

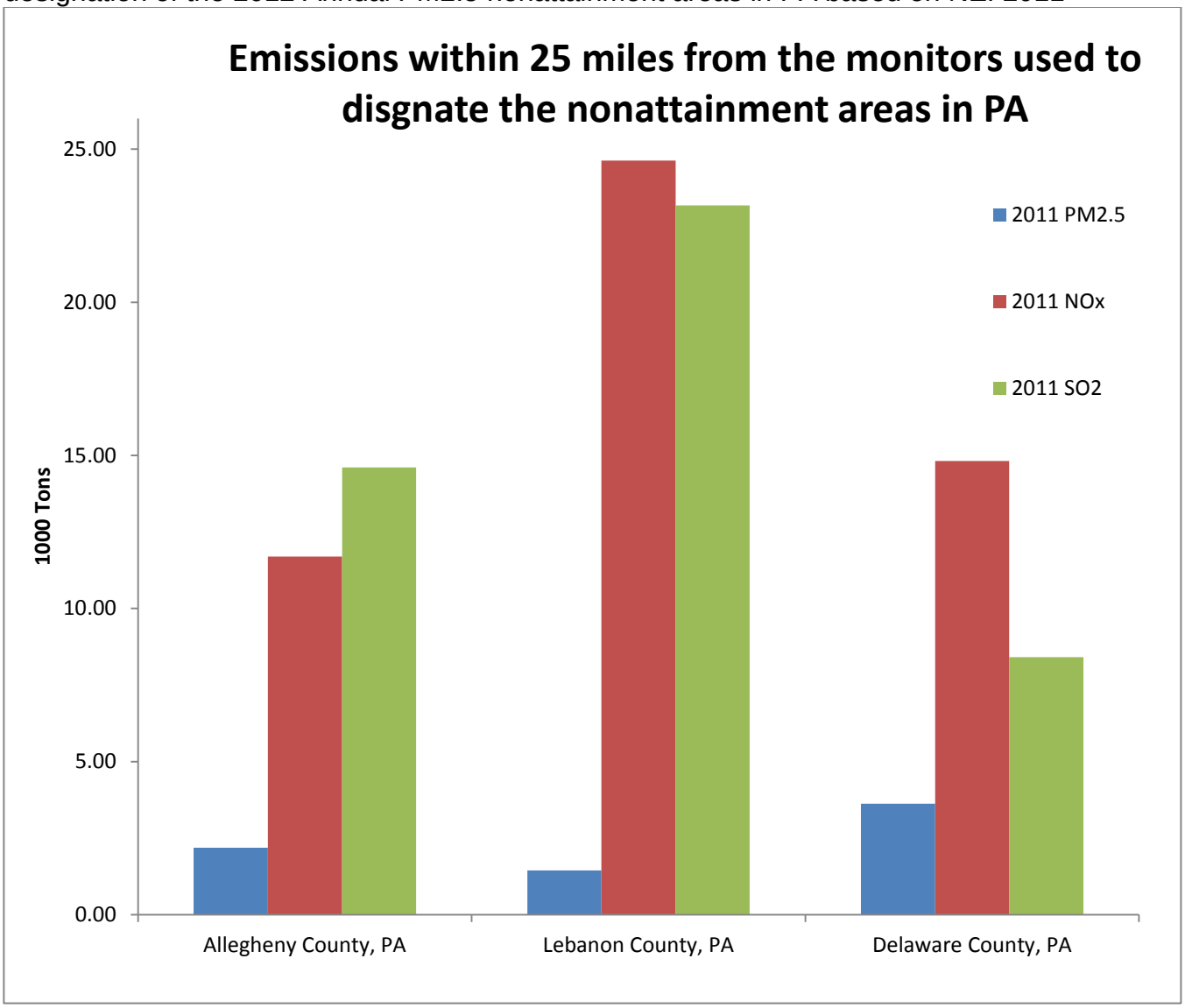


Table 13. Total emissions from sources (in tons) within 25 miles from the monitors used for the designation of the 2012 Annual PM2.5 nonattainment areas in PA based on NEI 2011

Nonattainment area	2011 PM2.5	2011 NOx	2011 SO2	2011 VOC	2011 NH3
Allegheny County, PA	2,191	11,695	14,604	739	161
Lebanon County, PA	1,441	24,632	23,166	619	43
Delaware County, PA	3,625	14,817	8,413	2,471	102

6. Emissions analysis in proximity to Allegheny County, PA nonattainment area

In the section of the study, detailed analysis was conducted of the emissions in proximity to the Allegheny County nonattainment area, with special attention to Ohio's emissions. Allegheny County is the closest nonattainment in a downwind state. Moreover, based on the results of the CSAPR modeling study, Ohio's PM2.5 contribution to Allegheny County is greater than its contribution to PM2.5 at the remaining nonattainment areas. As it was shown by the CSAPR analysis, Ohio PM2.5 contribution decreased with distance to the receptors at downwind states. Decreasing Ohio's contribution at the closest and most affected receptors, proportionally decreases its impact at other longer distance receptors downwind.

Figure 13 shows a 25, 50, 75, 100, and 125 miles buffer around the monitor used for the designation of Allegheny County as a 2012 annual PM2.5 nonattainment area. Table 14 shows the 2011 point source emissions by state of PM2.5, NOx, SO2, VOC, and NH3 in tons in each of these buffer zones. Table 14 also shows the percentage of Ohio's total point source emissions in each of these buffers. It also compares Ohio's point source emissions to the total emissions in each zone. There are no Ohio emissions within 40 miles from the Allegheny County's designation monitor. Figures 14 to 16 show Ohio's point source emissions, and the total point source emissions of PM2.5, NOx, and SO2, respectively. Only 7.9% of the SO2 and 11.1% of the NO2 emissions in the 100 miles buffer are from Ohio. Ohio's NOx and SO2 emissions become greater at a distance more than 125 miles away from Allegheny county designation monitor. Figures 17 to 19 compare the 2011 point source emissions by state of PM2.5, NOx, and SO2 within 25, 50, 75, 100 and 125 miles, respectively. There are emission sources from Pennsylvania, Ohio, West Virginia, and Maryland within 75 to 125 miles from the designation monitor. Ohio NOx and SO2 point source emissions are less than 11% of the total emissions from all the point sources at different states located within 75 miles away from the designation monitor. Moreover, NOx and SO2 point source emissions from West Virginia are higher than Ohio's point source emissions within 75 miles from the Allegheny designation monitor. Figures 20 to 22 show the 2011 point source emissions of PM2.5, NOx, and SO2 within 50, 75, 100, and 125 miles from Allegheny county designation monitor compared to Ohio's total point source emissions. Figures 20 to 22 show that the majority of Ohio's point source emissions occur at a distance more than 125 miles from Allegheny designation monitor. As shown in table 4, less than 7% of Ohio's 2011 SO2 point source emissions and less than 10% of Ohio's NOx point source emissions occur within 100 miles from Allegheny County designation monitor.

It has been determined that most of Ohio's emissions occur at a great distance from the 2012 PM2.5 nonattainment areas in other states. It is believed that Ohio's emissions are not contributing significantly to the nonattainment or maintenance problems in these states and addressing localized emissions will ensure attainment and maintenance.

Figure 13. A 25, 50, 75, 100, and 125-miles buffer around the monitor used for the designation of Allegheny, PA as a 2012 Annual PM2.5 nonattainment area

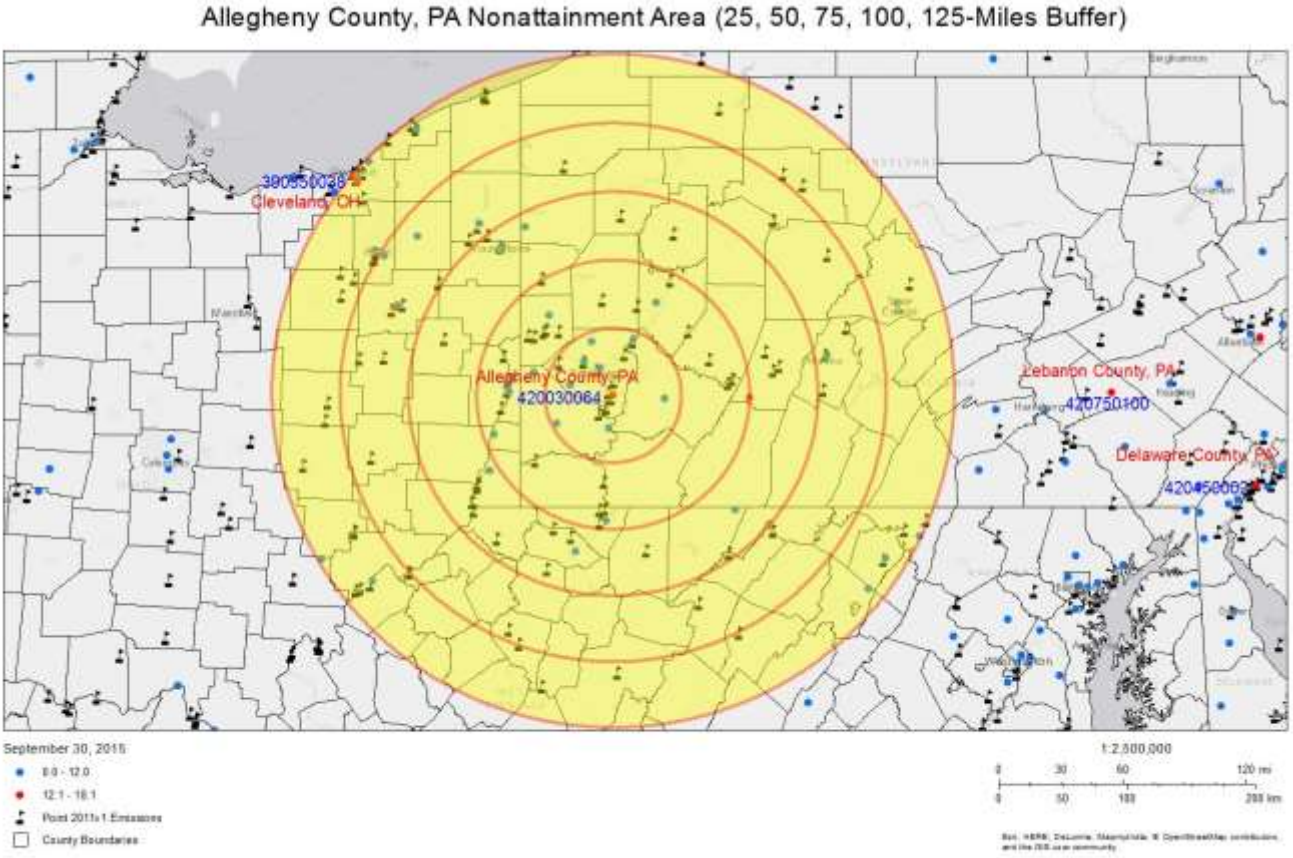


Table 14. NEI 2011 total point source emissions by state within 25, 50, 75, 100, and 125-miles from the monitor used for the designation of Allegheny, PA as a 2012 Annual PM2.5 nonattainment area in tons

Source: http://www3.epa.gov/airquality/particlepollution/designations/2012standards/techinfo.htm

Buffer	State	PM2.5	NOx	SO2	VOC	NH3
	PA	2,191	11,695	14,604	739	161
	OH	0	0	0	0	0
	WV	0	0	0	0	0
	MD	0	0	0	0	0
	Total	2,191	11,695	14,604	739	161
25 miles	**Ohio %**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
	PA	7,827	108,182	221,373	1,384	361
	OH	7,533	9,795	29,275	244	4
	WV	1,040	13,268	6,048	335	56
	MD	0	0	0	0	0
	Total	16,400	131,245	256,696	1,963	422
50 miles	**Ohio %**	**45.9%**	**7.5%**	**11.4%**	**12.4%**	**1.0%**
	PA	8,115	110,879	231,473	1,410	367
	OH	8,292	12,088	37,669	321	4
	WV	4,724	37,050	56,869	1,558	99
	MD	459	3,607	22,660	217	0
	Total	21,589	163,624	348,671	3,506	471
75 miles	**Ohio %**	**38.4%**	**7.4%**	**10.8%**	**9.1%**	**0.9%**
	PA	8,816	117,529	260,938	1,607	406
	OH	9,151	14,033	43,253	2,706	29
	WV	5,616	41,857	60,293	1,882	100
	MD	676	4,282	24,002	220	10
	Total	24,258	177,702	388,486	6,414	544
100 miles	**Ohio %**	**37.7%**	**7.9%**	**11.1%**	**42.2%**	**5.3%**
	PA	9,162	120,071	264,126	2,168	489
	OH	19,194	50,977	245,626	6,043	58
	WV	6,780	52,356	78,285	3,006	124
	MD	775	36,480	60,313	2,272	389
	Total	35,910	259,884	648,351	13,488	1,059
125 miles	Ohio %	53.4%	19.6%	37.9%	44.8%	5.4%
All Ohio's point source emissions		42,310	145,409	667,048	14,303	1,990
% of Ohio's emissions in 50 miles buffer		17.8%	6.7%	4.4%	1.7%	0.2%
% of Ohio's emissions in 75 miles buffer		19.6%	8.3%	5.6%	2.2%	0.2%
% of Ohio's emissions in 100 miles buffer		21.6%	9.7%	6.5%	18.9%	1.5%
% of Ohio's emissions in 125 miles buffer		45.4%	35.1%	36.8%	42.2%	2.9%

Figure 14. 2011 PM2.5 total point source emissions within 25, 50, 75, 100, and 125 miles from the monitor used for the designation of Allegheny, PA as a 2012 Annual PM2.5 nonattainment area in tons

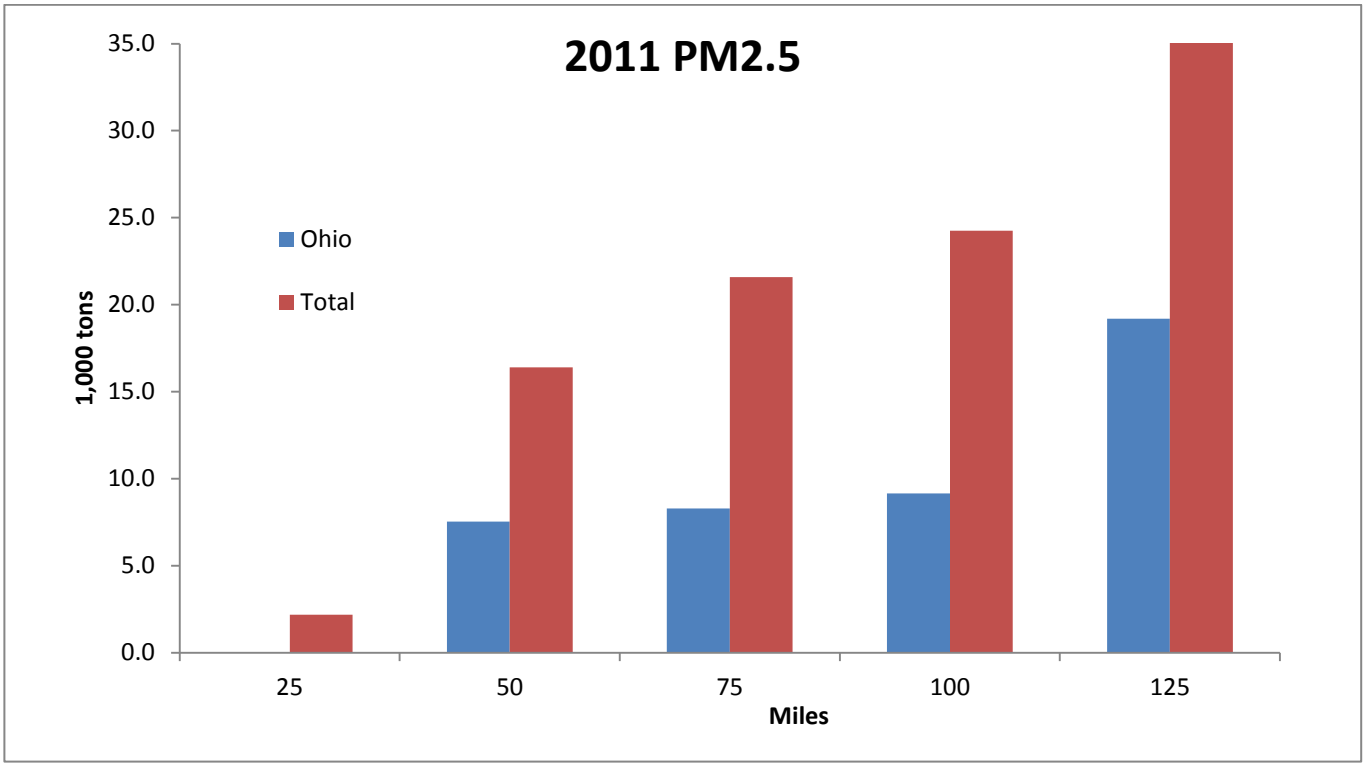


Figure 15. 2011 NOx total point source emissions within 25, 50, 75, 100 and 125 miles from the monitor used for the designation of Allegheny, PA as a 2012 Annual PM2.5 nonattainment area in tons

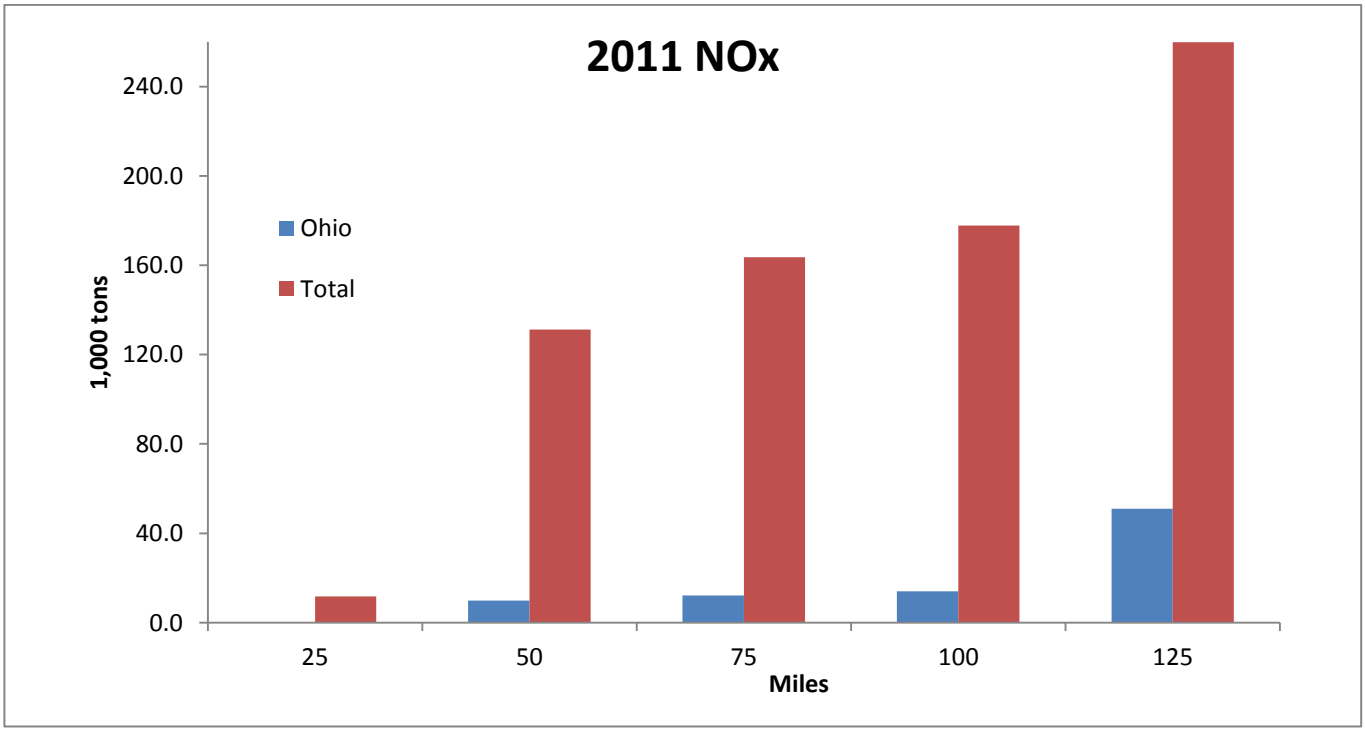


Figure 16. 2011 SO2 total point source emissions within 25, 50, 75, 100 and 125 miles from the monitor used for the designation of Allegheny, PA as a 2012 Annual PM2.5 nonattainment area in tons

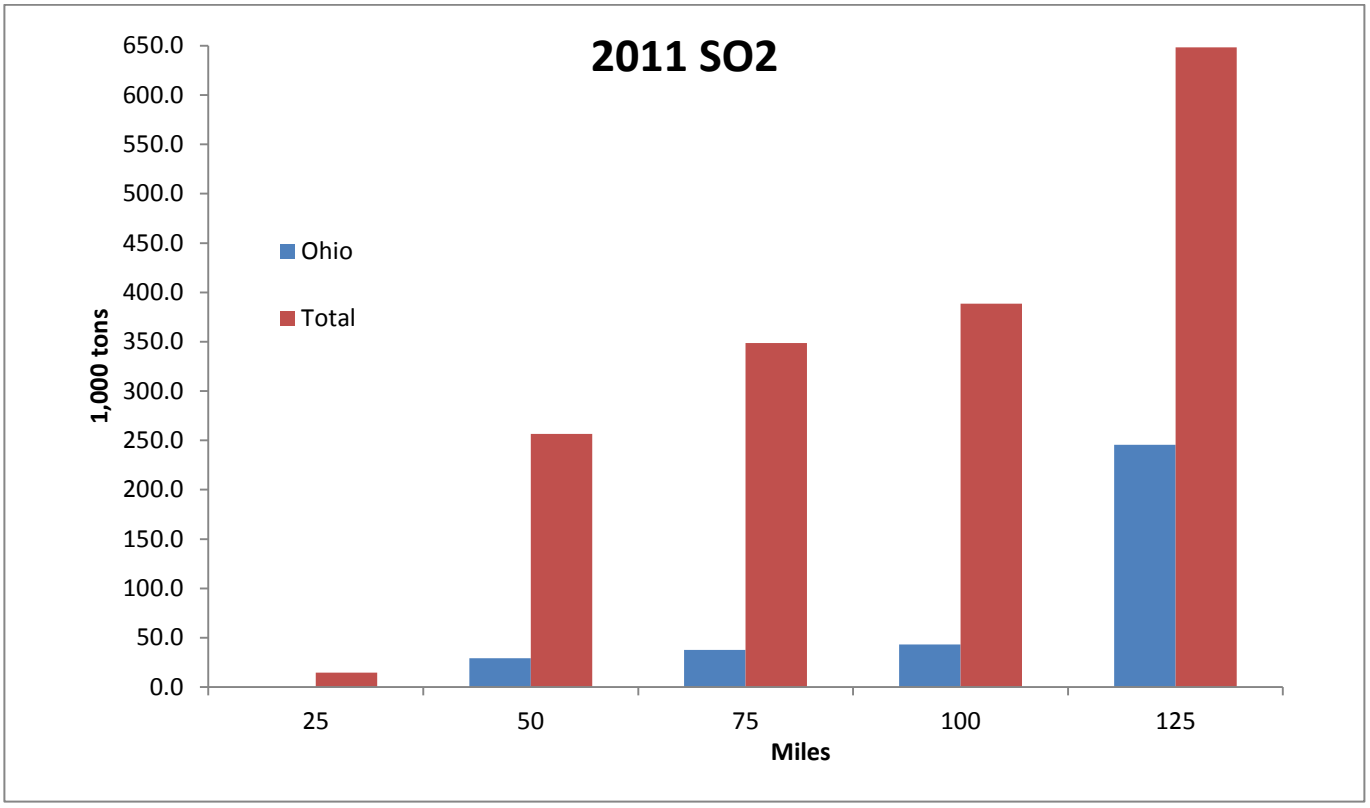


Figure 17. 2011 PM2.5 point source emissions by state within 25, 50, 75, 100 and 125 miles from the monitor used for the designation of Allegheny, PA as a 2012 Annual PM2.5 nonattainment area in tons

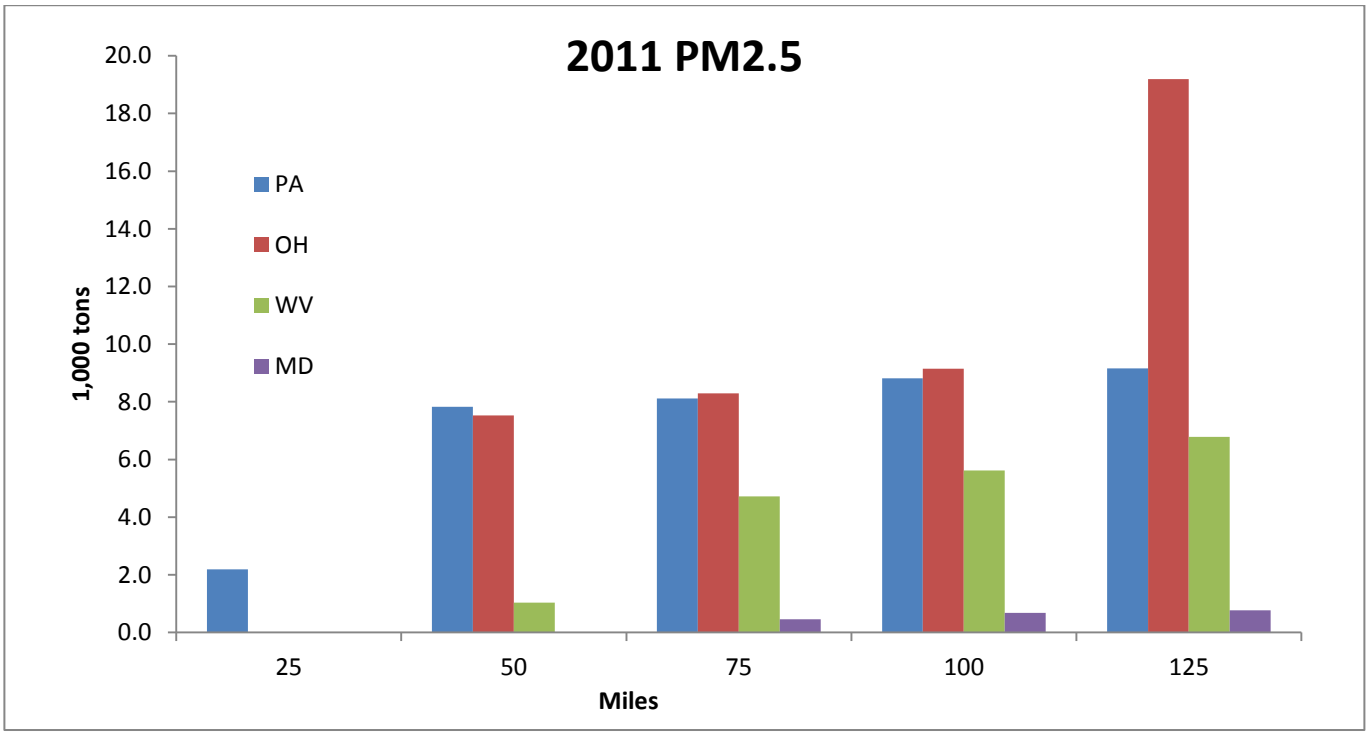


Figure 18. 2011 NOx point source emissions by state within 25, 50, 75, 100 and 125 miles from the monitor used for the designation of Allegheny, PA as a 2012 Annual PM2.5 nonattainment area in tons

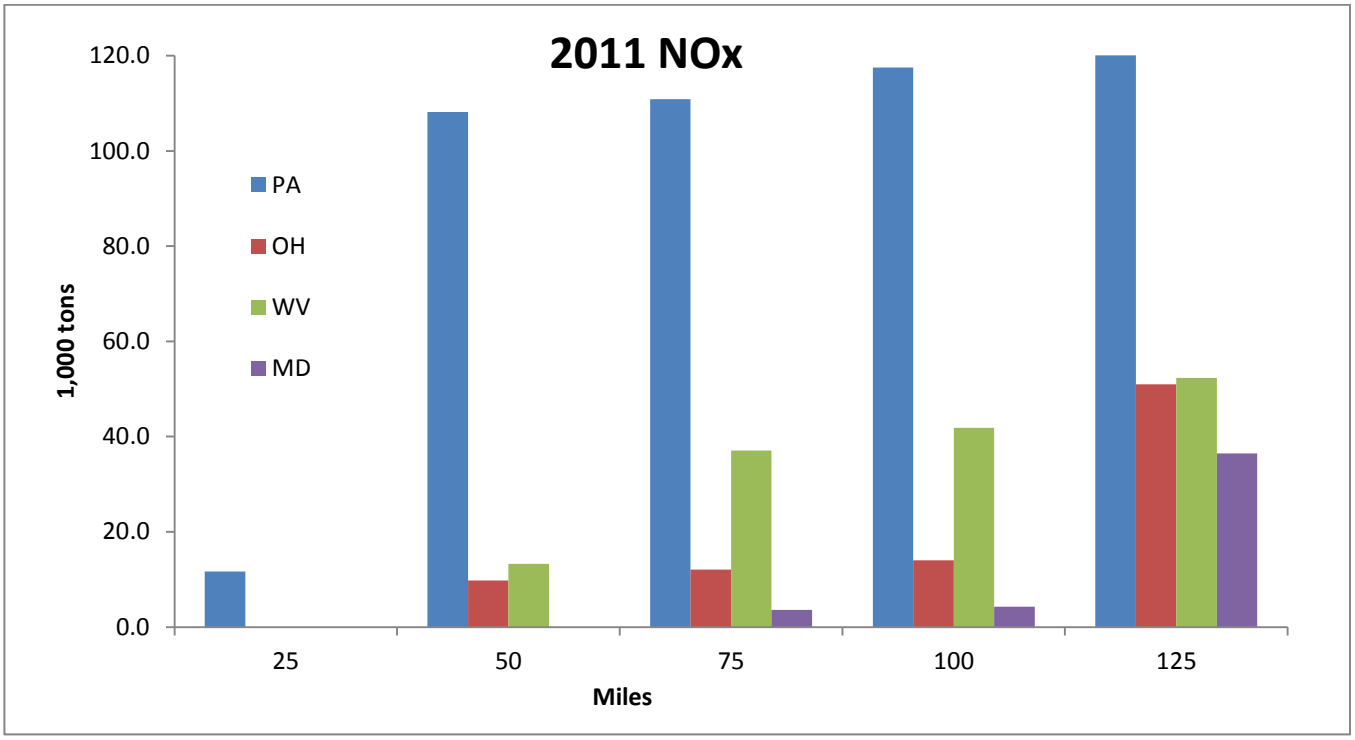


Figure 19. 2011 SO2 point source emissions by state within 25, 50, 75, 100 and 125 miles from the monitor used for the designation of Allegheny, PA as a 2012 Annual PM2.5 nonattainment area in tons

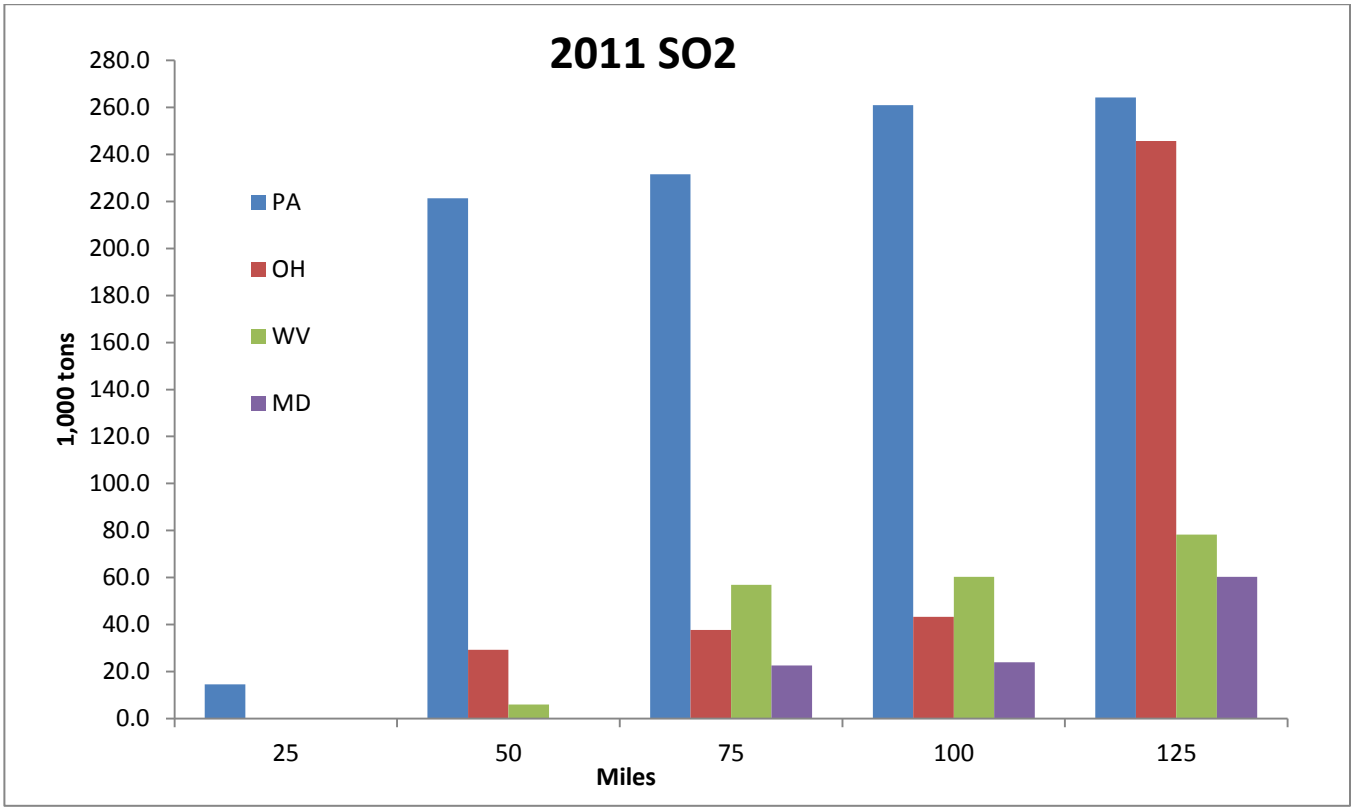


Figure 20. Ohio's 2011 PM2.5 point source emissions in a range of 50, 75, 100, and 125 miles from the monitor used for the designation of Allegheny, PA as a 2012 Annual PM2.5 nonattainment area compared to Ohio's total point source emissions

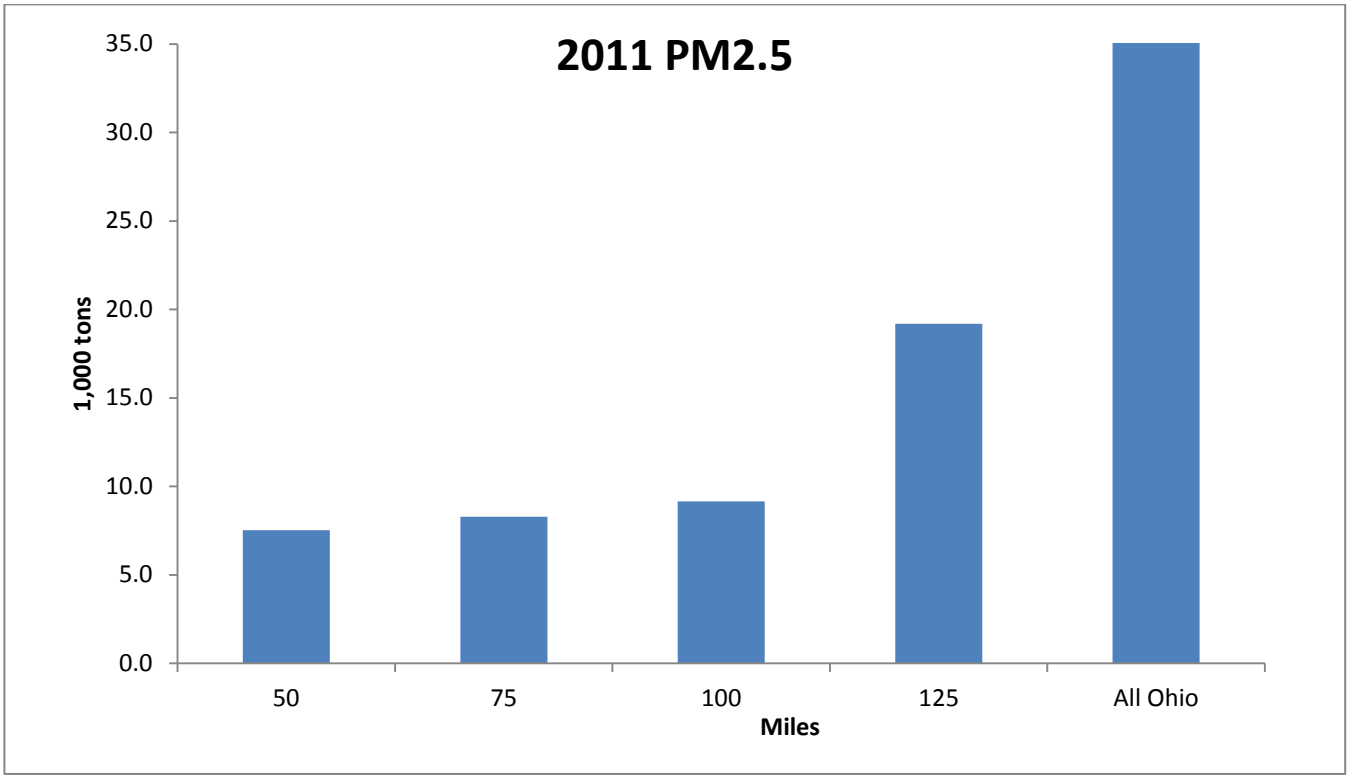


Figure 21. Ohio's 2011 NOx point source emissions in a range of 50, 75, 100, and 125 miles from the monitor used for the designation of Allegheny, PA as a 2012 Annual PM2.5 nonattainment area compared to Ohio's total point source emissions

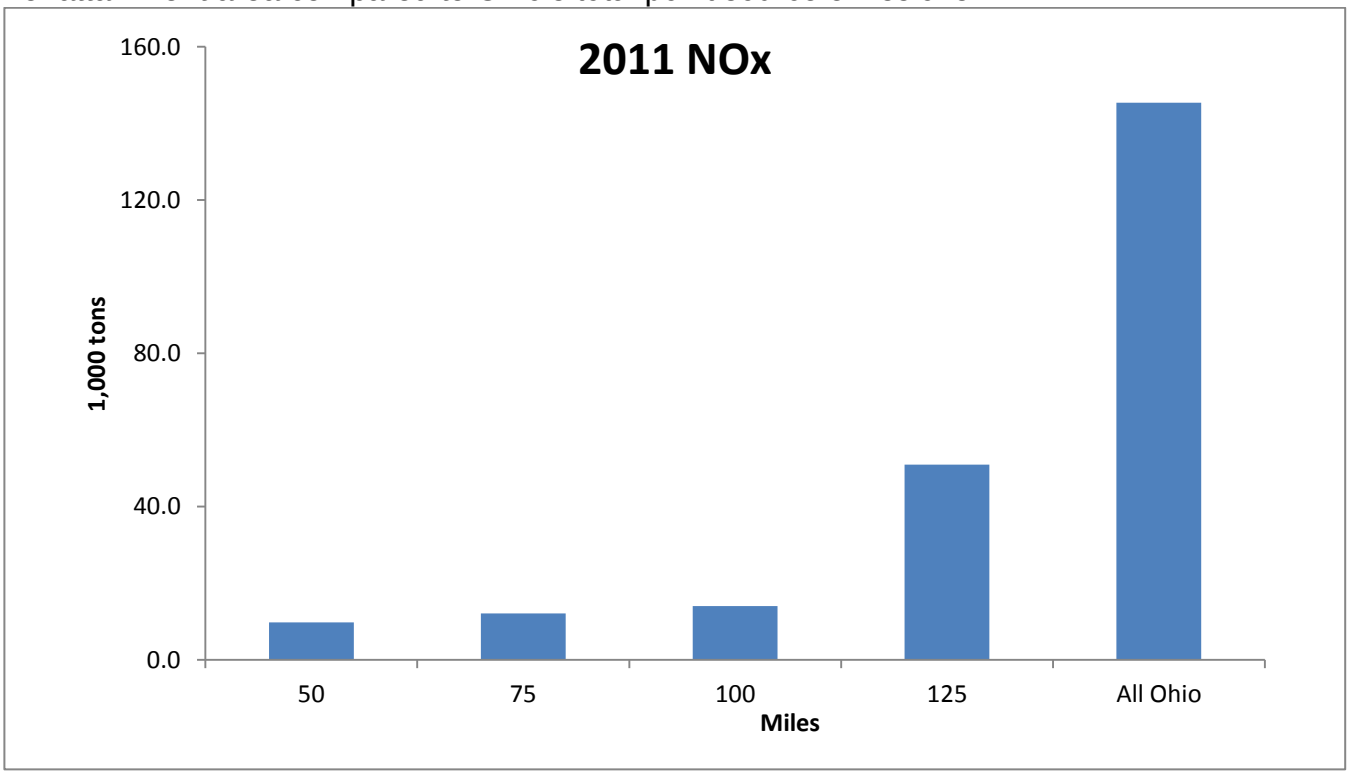
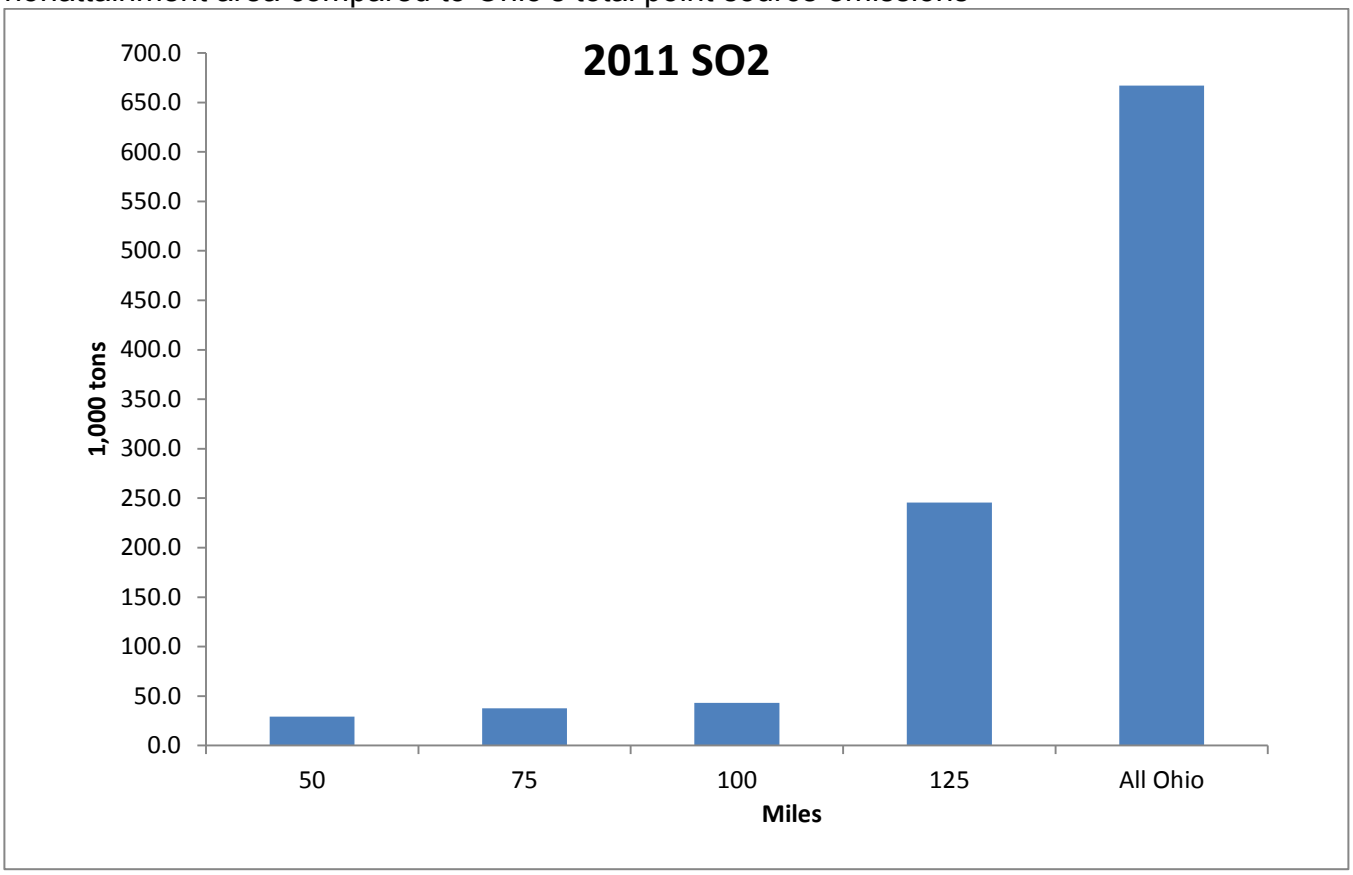


Figure 22. Ohio's 2011 SO2 point source emissions in a range of 50, 75, 100, and 125 miles from the monitor used for the designation of Allegheny, PA as a 2012 Annual PM2.5 nonattainment area compared to Ohio's total point source emissions



7. CSAPR Impact on Air Quality

The final phase of the study was to determine if Ohio needs to implement additional emissions reductions to prevent contributing significantly to downwind PM2.5 noncompliance or maintenance problems. As explained in section 4 of this study, the CSAPR modeling study consists of four emissions cases: 2005 base case, 2012 base case, 2014 base case, and 2014 remedy control case. The 2012 base case modeling was used to identify future nonattainment and maintenance locations and to quantify the contributions of emissions in upwind states to annual and 24-hour PM2.5 and 8-hour ozone at downwind receptors. The 2014 base case and 2014 remedy case used to quantify the benefits of the emissions reductions by the Transport Rule.

CSAPR requires states to significantly improve air quality by reducing power plant emissions that cross state lines and contribute to ozone and fine particle emissions in other states. CSAPR requires a total of 28 states to reduce annual SO2 emissions, annual NOx emissions and/or ozone season NOx emissions. Twenty states (including Ohio and Pennsylvania) are required to control SO2 emissions, annual NOx emissions and ozone season NOx emissions. Three states are required to control SO2 emissions and annual NOx emissions. Five states are required to control ozone season NOx emissions only. The states covered by CSAPR are shown in Figure 23. CSAPR divides the states required to reduce SO2 into two groups, Group 1 and Group 2. Phase I implementation of CSAPR was originally scheduled for 2012 now it is scheduled for 2015. Phase 2 was originally scheduled in 2014 now it is scheduled beginning of 2017. Both groups must reduce their SO2 emissions in Phase 1. Group 1 states (that includes Ohio, Pennsylvania, Kentucky, West Virginia and Indiana) must make additional reductions in SO2 emissions for Phase II in order to eliminate their significant contribution to air quality problems in downwind areas. Table 15 shows the change in annual SO2 budget allocations for the CSAPR states between 2015 and 2017. There is a reduction in the annual SO2 budget of about 173,000 tons (55% reduction) for Ohio's electric generating units (EGUs) and 166,000 tons (60% reduction) for Pennsylvania's EGUs between 2015 and 2017.Table 16 compares the maximum historic emissions of SO2, NOx and ozone season NOx as well as the 2010 and 2014 annual emissions to the annual 2015 and 2017 budget allocation for these pollutants for Ohio's EGUs. Figure 24 compares Ohio's EGUs historic maximum emission, 2010 and 2014 emissions of SO2, NOx, and ozone season NOx to the 2015 and 2017 budget allocation. There is a reduction of about 89% for SO2, 75% for NOx, and 71% for ozone season NOx between the maximum historic baseline for all Ohio's EGUs and the 2017 CSAPR budget allocation. As can be seen, Ohio's 2017 EGU SO2 annual allocation is about 50% of the actual 2014 annual emissions (a reduction of about 148,000 tons of SO2). As a precursor for PM2.5, this reduction in SO2 emissions will help Ohio in complying with the 2012 annual PM2.5 standard as well as significantly reducing its minimal PM2.5 contributions to other states.

CSAPR modeling projected a 67% reduction of annual SO2 emissions for EGUs in Group 1 states as a whole with the CSAPR control scenario compared to those in 2014 base case[1]. Figure 25 shows the difference in annual total county-level SO2 emissions between 2014 base and remedy case for the CSAPR states. Some of Ohio and Pennsylvania counties, including Jefferson (nearest to Pennsylvania) and Allegheny, were predicted to see a reduction of more than 15,000 tons of SO2 per year when the CASPR control is fully implemented. The CSAPR modeling study also predicted an 11% reduction in annual emissions of NOx from EGUs in the remedy scenario compared to the 2014 base case for the states that were modeled as part of the CSAPR. Figure 26 shows the difference in winter NOx emissions between 2014 remedy

[1] http://www3.epa.gov/crossstaterule/pdfs/AQModeling.pdf

case and 2014 base case for the counties in CSAPR states. Alleghany County was predicted to see a reduction between 500 and 1,000 tons of NOx per season when the CSAPR control is fully implemented. Figure 27 shows the reduction on annual PM2.5 design values resulting from the emissions reductions in the 2014 remedy scenario compared to the 2014 base case scenario. The annual PM2.5 design value was predicted to be lowered by more than 2 $\mu g/m^3$ in areas in the eastern US, including Ohio and Pennsylvania, when the CSAPR control is fully implemented. The monitoring in Jefferson County, Ohio shows a reduction of more than 18%.

There were 50 PM2.5 monitors in Ohio during 2014. Figure 28 shows the distribution of Ohio's PM2.5 monitors. The projected annual PM2.5 average values for the 2014 base case and 2014 remedy scenario at individual monitoring sites in Ohio are shown in table 17. There was an average reduction of 17.3% in annual PM2.5 for all of Ohio's monitors included in the CSAPR modeling study between the 2014 base case and remedy scenario. The monitor used to designate Cleveland as a 2012 annual PM2.5 nonattainment area was predicted to improve by 16.4%.

The improvement in air quality as a result of CSAPR will help the CSAPR states, including Ohio, in complying with the 2012 annual PM2.5 standard and it will help in reducing the contribution of one state to the nonattainment or maintenance problems at another state. Ohio believes that no additional emission reductions is necessary beyond the CSAPR control and other planned controls to reduce its impact on complying with the 2012 annual PM2.5 standard.

Figure 23. Cross-State Air Pollution Rule (CSAPR) or Transport Rule States
Source: http://www3.epa.gov/crossstaterule/statesmap.html

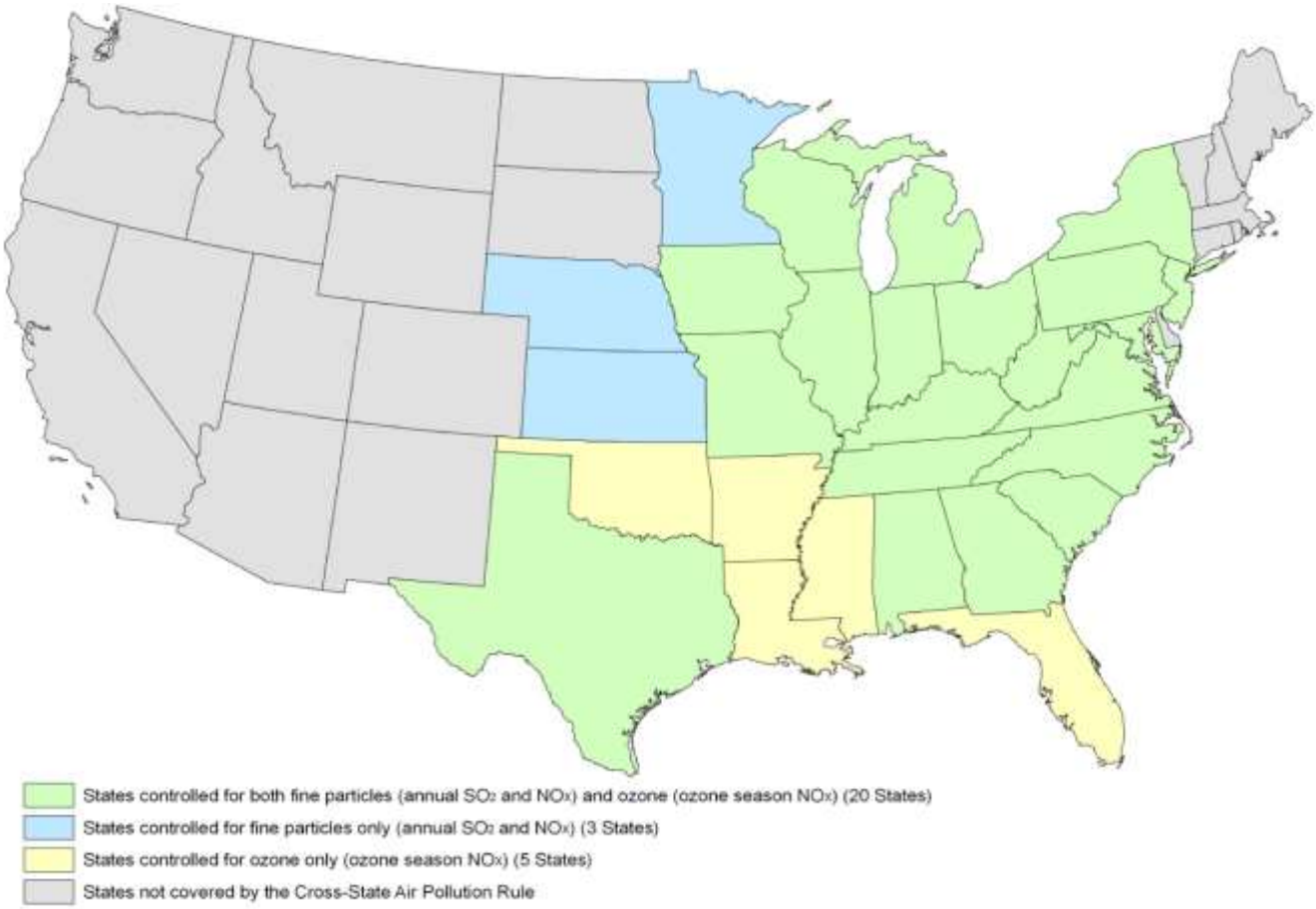


Table 15. CSAPR Annual SO2 Budgets by state
Source: http://www3.epa.gov/crossstaterule/actions.html

State	SO2 Group	2015	2017	Change (tons)	Change (%)
Alabama	2	216,033	213,258	**-2,775**	-1.3%
Georgia	2	158,527	135,565	**-22,962**	-14.5%
Illinois	1	234,889	124,123	**-110,766**	-47.2%
Indiana	1	290,762	166,449	**-124,313**	-42.8%
Iowa	1	107,085	75,184	**-31,901**	-29.8%
Kansas	2	41,980	41,980	**0**	0.0%
Kentucky	1	232,662	106,284	**-126,378**	-54.3%
Maryland	1	30,120	28,203	**-1,917**	-6.4%
Michigan	1	229,303	143,995	**-85,308**	-37.2%
Minnesota	2	41,981	41,981	**0**	0.0%
Missouri	1	207,466	165,941	**-41,525**	-20.0%
Nebraska	2	68,162	68,162	**0**	0.0%
New Jersey	1	7,670	5,574	**-2,096**	-27.3%
New York	1	36,296	27,556	**-8,740**	-24.1%
North Carolina	1	136,881	57,620	**-79,261**	-57.9%
Ohio	1	315,393	142,240	**-173,153**	-54.9%
Pennsylvania	1	278,651	112,021	**-166,630**	-59.8%
South Carolina	2	96,633	96,633	**0**	0.0%
Tennessee	1	148,150	58,833	**-89,317**	-60.3%
Texas	2	294,471	294,471	**0**	0.0%
Virginia	1	70,820	35,057	**-35,763**	-50.5%
West Virginia	1	146,174	75,668	**-70,506**	-48.2%
Wisconsin	1	79,480	47,883	**-31,597**	-39.8%
Total		**3,469,589**	**2,264,681**	**-1,204,908**	**-34.7%**
Group 1 Total		**2,551,802**	**1,372,631**	**-1,179,171**	**-46.2%**
Group 2 Total		**917,787**	**892,050**	**-25,737**	**-2.8%**

Table 16. Ohio's EGUs annual emissions and budget allocation of SO2, NOx and ozone season NOx *Sources: http://www3.epa.gov/crossstaterule/actions.html) and* http://ampd.epa.gov/ampd/

Pollutant	Maximum Historic Baseline (tons)	2010 Annual Emissions (tons)	2014 Annual Emissions (Tons)	2015 Allocation (tons)	2017 Allocation (tons)	2017 allocation compared to baseline
SO2	1,329,629	572,140	290,452	315,393	142,240	-89.3%
NOx	364,206	104,882	86,318	95,468	90,258	-75.2%
OS NOx	133,763	47,582		41,284	39,013	-70.8%

Figure 24. Ohio State emissions and budget allocation of SO2, NOx and ozone season NOx

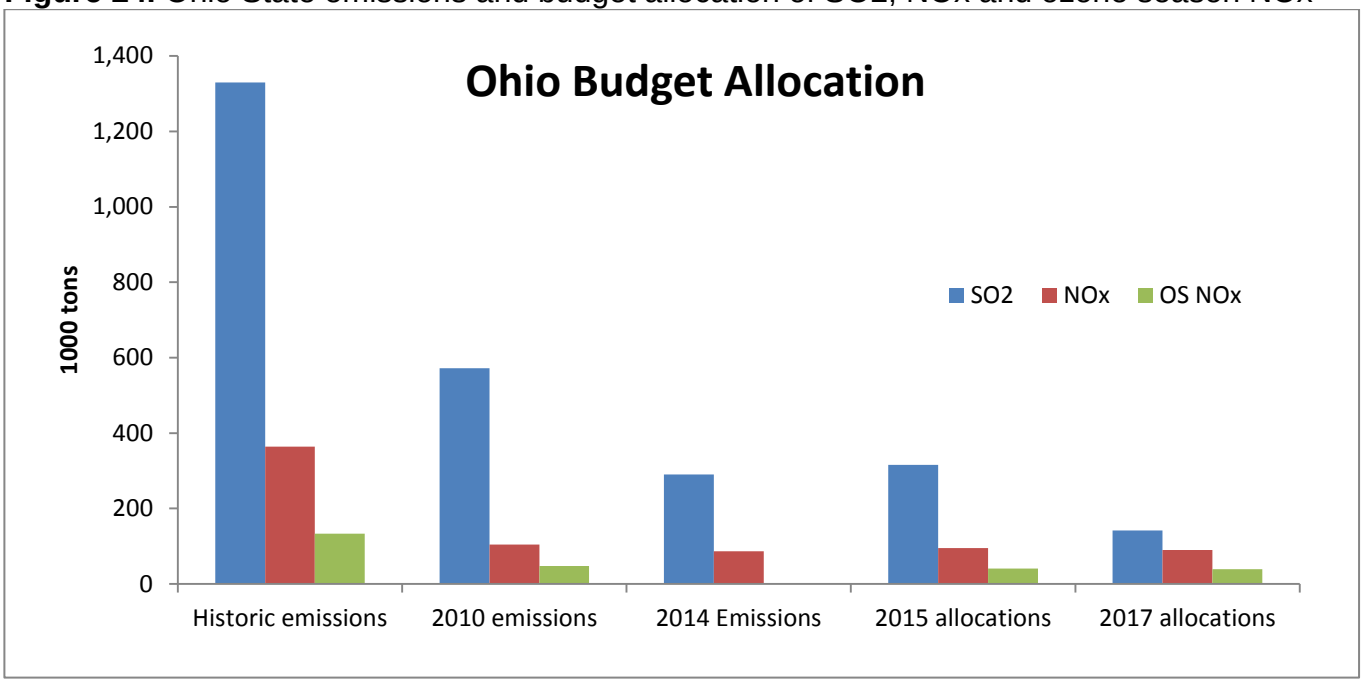


Figure 25. Change in county total annual EGU SO2 emissions between the 2014 base and control scenarios

Source: http://www3.epa.gov/crossstaterule/pdfs/AQModeling.pdf

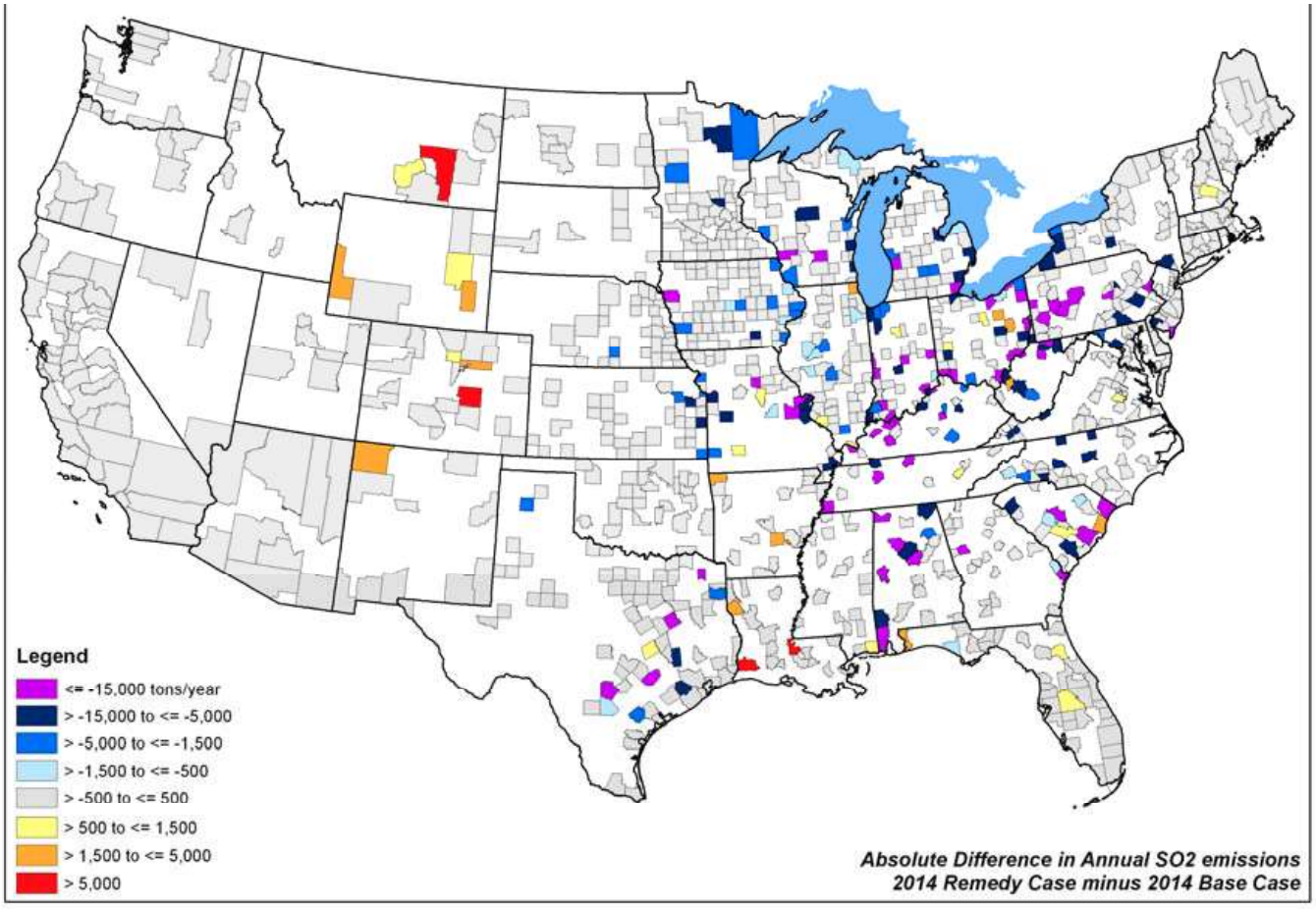


Figure 26. Change in winter season county total EGU NOx emissions between the 2014 base and control scenarios at individual facilities.
Source: http://www3.epa.gov/crossstaterule/pdfs/AQModeling.pdf

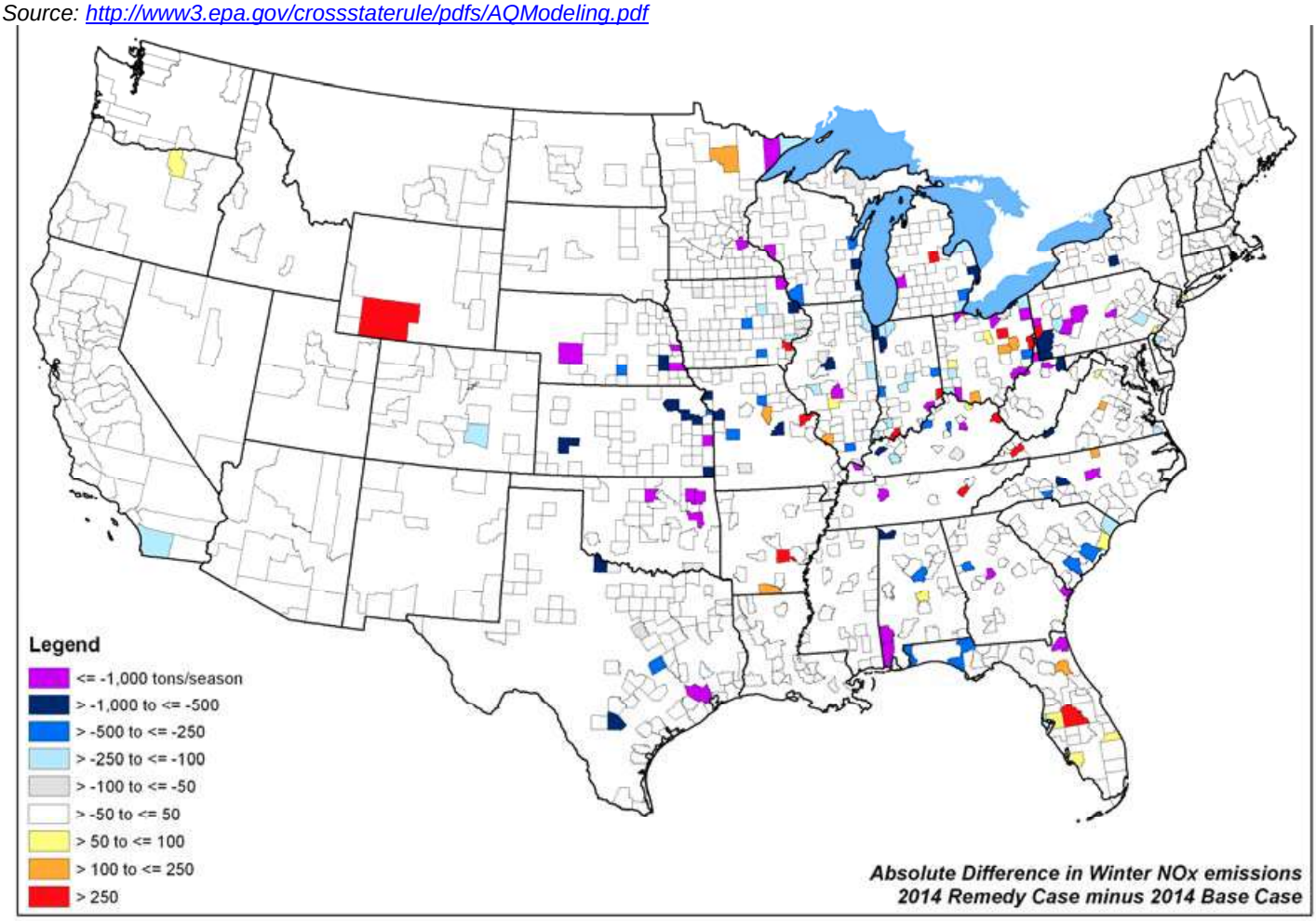


Figure 27. Impacts on annual average PM2.5 concentrations (µg/m3) resulting from the emissions reductions in the 2014 remedy scenario compared to the 2014 base case scenario.
Source: http://www3.epa.gov/crossstaterule/pdfs/AQModeling.pdf

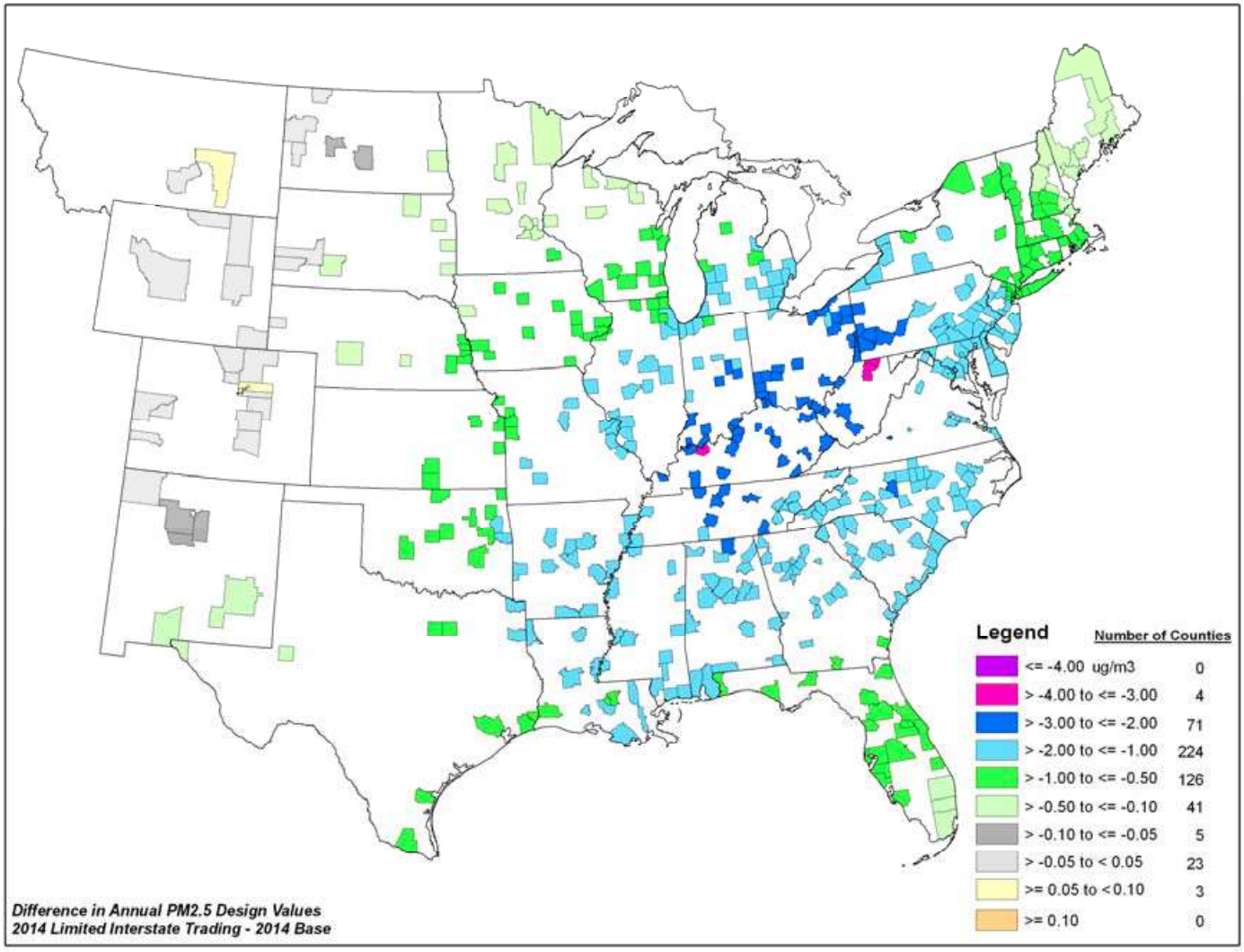


Figure 28. Ohio PM2.5 Monitors

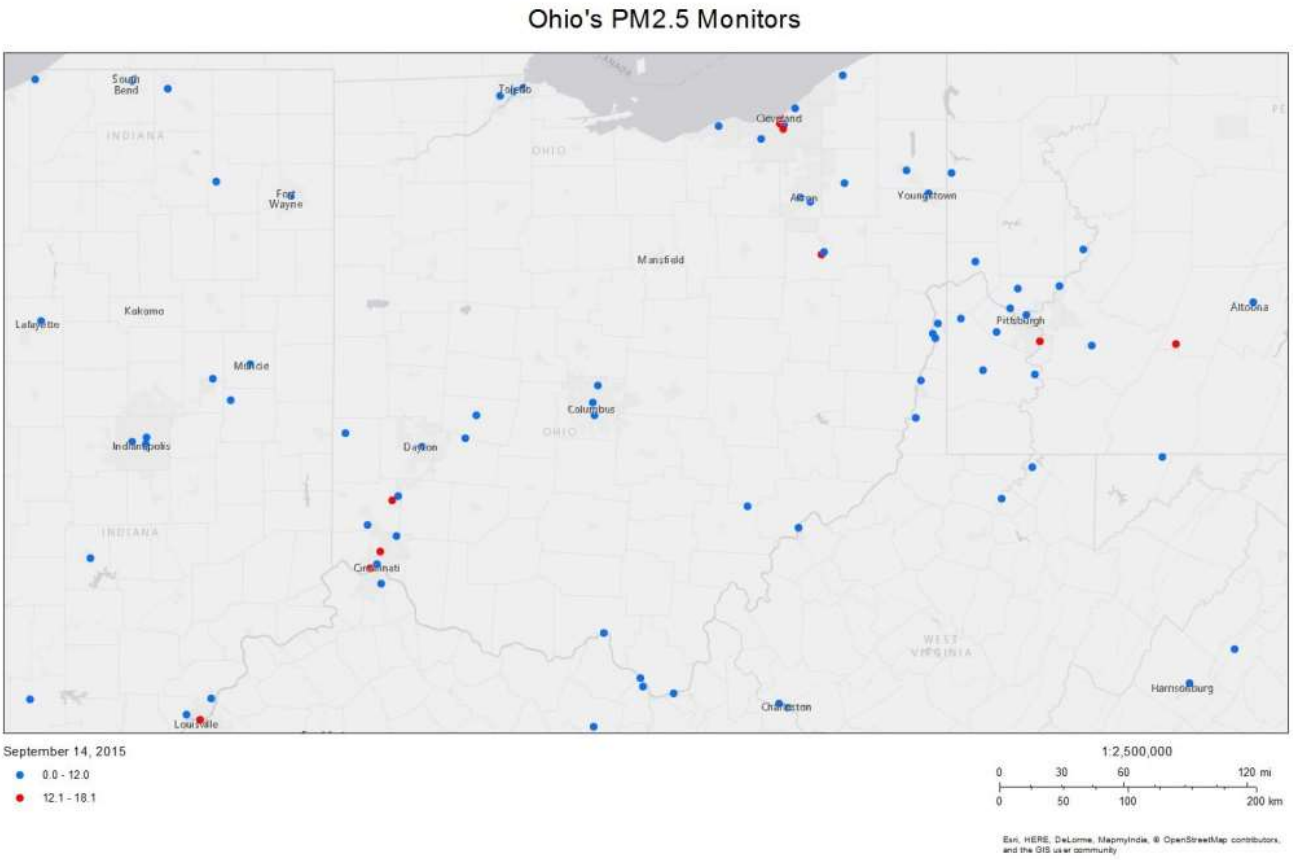


Table 17. The difference between the CSAPR predicted 2014 base case annual PM2.5 average values and 2014 remedy case annual PM2.5 average values at Ohio monitors (the monitor used for designating Cleveland, Ohio as a nonattainment area is highlighted)

Source: http://www3.epa.gov/airtransport/CSAPR/techinfo.html

Site ID	State	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2014 Base Case Annual PM2.5 Average Values (µg/m3)	2014 Remedy Annual PM2.5 Average Values (µg/m3)	2014 Base to 12-14 Remedy Change
390030009	Ohio	Allen				
390090003	Ohio	Athens		10.39	8.14	-21.7%
390170003	Ohio	Butler				
390170016	Ohio	Butler		13.78	11.28	-18.1%
390170017	Ohio	Butler		13.63	11.38	-16.5%
390170019	Ohio	Butler				
390170020	Ohio	Butler				
390171004	Ohio	Butler		13.19	10.85	-17.7%
390230005	Ohio	Clark		12.90	10.74	-16.7%
390250022	Ohio	Clermont		12.43	9.82	-21.0%
390350013	Ohio	Cuyahoga	Cleveland			
390350027	Ohio	Cuyahoga	Cleveland	13.80	11.28	-18.3%
390350034	Ohio	Cuyahoga	Cleveland	12.37	9.98	-19.3%
390350038	Ohio	Cuyahoga	Cleveland	15.54	12.99	-16.4%
390350045	Ohio	Cuyahoga	Cleveland	14.70	12.15	-17.3%
390350060	Ohio	Cuyahoga	Cleveland	15.21	12.70	-16.5%
390350065	Ohio	Cuyahoga	Cleveland	14.25	11.69	-18.0%
390350066	Ohio	Cuyahoga	Cleveland			
390351002	Ohio	Cuyahoga	Cleveland	12.58	10.38	-17.5%
390490024	Ohio	Franklin		13.12	11.12	-15.2%
390490025	Ohio	Franklin		12.95	10.95	-15.4%
390490039	Ohio	Franklin				
390490081	Ohio	Franklin		12.33	10.35	-16.1%
390570005	Ohio	Greene		11.61	9.43	-18.8%
390610006	Ohio	Hamilton		12.97	10.47	-19.3%
390610010	Ohio	Hamilton				
390610014	Ohio	Hamilton		15.16	12.47	-17.7%
390610040	Ohio	Hamilton		13.55	10.86	-19.9%
390610041	Ohio	Hamilton				
390610042	Ohio	Hamilton		14.81	12.16	-17.9%
390610043	Ohio	Hamilton		13.61	11.13	-18.2%
390610048	Ohio	Hamilton				
390617001	Ohio	Hamilton		14.17	11.48	-19.0%
390618001	Ohio	Hamilton		15.41	12.73	-17.4%
390810016	Ohio	Jefferson				
390810017	Ohio	Jefferson		12.91	10.57	-18.1%
390810021	Ohio	Jefferson				
390811001	Ohio	Jefferson		13.82	11.28	-18.4%
390850007	Ohio	Lake				

Site ID	State	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2014 Base Case Annual PM2.5 Average Values (µg/m3)	2014 Remedy Annual PM2.5 Average Values (µg/m3)	2014 Base to 12-14 Remedy Change
390851001	Ohio	Lake		11.81	9.53	-19.3%
390853002	Ohio	Lake				
390870010	Ohio	Lawrence		13.07	10.71	-18.1%
390870012	Ohio	Lawrence				
390930016	Ohio	Lorain	Cleveland	12.43	10.15	-18.3%
390932003	Ohio	Lorain	Cleveland			
390933002	Ohio	Lorain	Cleveland	11.57	9.72	-16.0%
390950024	Ohio	Lucas		12.62	10.98	-13.0%
390950025	Ohio	Lucas		12.24	10.57	-13.6%
390950026	Ohio	Lucas		12.38	10.75	-13.2%
390950028	Ohio	Lucas				
390990005	Ohio	Mahoning		12.74	10.60	-16.8%
390990014	Ohio	Mahoning		13.22	11.07	-16.3%
391030003	Ohio	Medina				
391030004	Ohio	Medina				
391130014	Ohio	Montgomery				
391130031	Ohio	Montgomery		12.76	10.58	-17.1%
391130032	Ohio	Montgomery		13.62	11.38	-16.4%
391130038	Ohio	Montgomery				
391330002	Ohio	Portage		11.69	9.66	-17.4%
391351001	Ohio	Preble		12.25	9.92	-19.0%
391450013	Ohio	Scioto		12.55	10.12	-19.4%
391510017	Ohio	Stark		14.02	11.70	-16.5%
391510020	Ohio	Stark		13.21	11.31	-14.4%
391530017	Ohio	Summit		13.31	11.33	-14.9%
391530023	Ohio	Summit		12.52	10.59	-15.4%
391550005	Ohio	Trumbull				
391550007	Ohio	Trumbull		12.78	10.66	-16.6%
391650007	Ohio	Warren				
Average						**-17.3%**

8. Comparing Ohio's annual PM2.5 measured values to CSAPR predicted values

This section of the study compares the CSAPR predicted PM2.5 average values to the actual measured values. Table 18 compares CSAPR predicted 2014 annual PM2.5 average values (2014 base case) to the measured 2014 annual PM2.5 average values at Ohio's monitors. The 2014 measured annual PM2.5 values are lower than the CSAPR predicted values by 15.4% for all Ohio's monitors in average. The air quality in Ohio is much better than it was predicted in the CSAPR modeling study. At one of the monitors in Jefferson County, the difference between the predicted and measured annual PM2.5 average values was 21.1%. Most of Ohio's monitors were predicted to have an annual PM2.5 design values greater than 12.0 $\mu g/m^3$; however, only 8 of the 50 monitors in 2014 exceeded 12.0 $\mu g/m^3$.

As explained in section 7, the implementation of Phase I of CSAPR was changed from 2012 to 2015 and Phase II implementation was changed from 2014 to 2017. Table 19 compares CSAPR predicted 2014 remedy case to the measured 2014 annual PM2.5 average values at Ohio's monitors. The 2014 measured annual PM2.5 values are just about 2.3% above the CSAPR remedy case although the CSAPR implementation was not in place in 2014. Phase I of CSPAR took effect in 2015 and Phase II will start in 2017. As it was shown in section 7, the CSAPR analysis predicted a 17.3% reduction in annual PM2.5 for all Ohio's monitors in average when both phases of CSAPR are implemented. Moreover, Ohio's 2017 EGU SO2 annual allocation is about 148,000 tons less than the actual 2014 emissions for these EGUs. To accomplish these reductions by 2017, Ohio's EGUs will be required to reduce emissions significantly. These additional SO2 reductions will improve the air quality in Ohio and since SO2 is a PM2.5 precursor, the emission reductions will positively impact Ohio's PM2.5 contributions at other states.

Table 18. The difference between the CSAPR predicted 2014 base case annual PM2.5 average values and the measured 2014 annual PM2.5 average values at Ohio monitors (the monitor used for designating Cleveland, Ohio as a nonattainment area is highlighted)

Source: http://www3.epa.gov/airtransport/CSAPR/techinfo.html

Site ID	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2010-2012 Annual PM2.5 DV (µg/m3)	2011-2013 Annual PM2.5 DV (µg/m3)	2012-2014 Annual PM2.5 DV (µg/m3)	2014 Measured Annual PM2.5 Average Values (µg/m3)	2014 Base Case Annual PM2.5 Average Values (µg/m3)	2014 Base to 2014 Measured
390030009	Allen		10.6	10.3	9.8	10.2		
390090003	Athens		8.9	8.5	8.2	8.5	10.4	-17.9%
390170003	Butler		12.5	11.7	11.2	11.8		
390170016	Butler		12.2	11.3	10.7	11.4	13.8	-17.3%
390170017	Butler						13.6	
390170019	Butler		12.1	11.7	11.2	11.7		
390170020	Butler							
390171004	Butler						13.2	
390230005	Clark		11.9	10.9	10.2	11.0	12.9	-14.7%
390250022	Clermont		11.5	11.0		11.3	12.4	-9.5%
390350013	Cuyahoga	Cleveland						
390350027	Cuyahoga	Cleveland					13.8	
390350034	Cuyahoga	Cleveland	10.1	9.6	9.5	9.7	12.4	-21.3%
390350038	Cuyahoga	Cleveland	13.0	12.4	12.3	12.6	15.5	-19.1%
390350045	Cuyahoga	Cleveland	12.2	11.5	11.3	11.7	14.7	-20.6%
390350060	Cuyahoga	Cleveland	13.0	12.5	12.4	12.6	15.2	-16.9%
390350065	Cuyahoga	Cleveland	12.7	12.1	12.0	12.3	14.3	-13.9%
390350066	Cuyahoga	Cleveland						
390351002	Cuyahoga	Cleveland	10.5	9.7	9.5	9.9	12.6	-21.3%
390490024	Franklin		11.9	10.9	10.3	11.0	13.1	-15.9%
390490025	Franklin		11.6	10.8	10.8	11.1	13.0	-14.5%
390490039	Franklin				9.0	9.0		
390490081	Franklin		11.0	10.3	10.1	10.5	12.3	-15.1%
390570005	Greene		11.4	10.2	9.7	10.4	11.6	-10.1%
390610006	Hamilton		11.6	10.7	10.2	10.8	13.0	-16.5%
390610010	Hamilton		11.2	11.0	10.5	10.9		
390610014	Hamilton		13.4	12.3	11.7	12.5	15.2	-17.8%
390610040	Hamilton		12.0	11.1	10.5	11.2	13.6	-17.3%
390610041	Hamilton							
390610042	Hamilton		13.2	12.2	11.5	12.3	14.8	-16.9%
390610043	Hamilton						13.6	
390610048	Hamilton				12.9	12.9		
390617001	Hamilton		14.1			14.1	14.2	-0.5%
390618001	Hamilton		17.6			17.6	15.4	14.2%
390810016	Jefferson							
390810017	Jefferson		12.2	11.6	10.9	11.6	12.9	-10.4%
390810021	Jefferson			7.6	9.1	8.4		

Site ID	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2010-2012 Annual PM2.5 DV (µg/m3)	2011-2013 Annual PM2.5 DV (µg/m3)	2012-2014 Annual PM2.5 DV (µg/m3)	2014 Measured Annual PM2.5 Average Values (µg/m3)	2014 Base Case Annual PM2.5 Average Values (µg/m3)	2014 Base to 2014 Measured
390811001	Jefferson		11.4	10.8	10.5	10.9	13.8	-21.1%
390850007	Lake		9.6	9.0	8.7	9.1		
390851001	Lake						11.8	
390853002	Lake							
390870010	Lawrence						13.1	
390870012	Lawrence		11.3	10.3	9.2	10.3		
390930016	Lorain	Cleveland					12.4	
390932003	Lorain	Cleveland						
390933002	Lorain	Cleveland	9.8	9.2	9.1	9.4	11.6	-19.0%
390950024	Lucas		10.6	10.1	10.0	10.2	12.6	-18.9%
390950025	Lucas						12.2	
390950026	Lucas		10.7	10.1	10.0	10.3	12.4	-17.1%
390950028	Lucas		11.0	10.3	10.1	10.5		
390990005	Mahoning		11.2	10.7	10.5	10.8	12.7	-15.2%
390990014	Mahoning		11.3	10.4	9.9	10.5	13.2	-20.3%
391030003	Medina		10.8			10.8		
391030004	Medina		10.0	9.7	9.0	9.6		
391130014	Montgomery							
391130031	Montgomery						12.8	
391130032	Montgomery		12.3	11.0	10.7	11.3	13.6	-16.8%
391130038	Montgomery				8.7	8.7		
391330002	Portage		10.3	9.5	9.1	9.6	11.7	-17.6%
391351001	Preble		10.7	10.0	9.4	10.0	12.3	-18.1%
391450013	Scioto		10.6	9.6	9.0	9.7	12.6	-22.4%
391510017	Stark		13.0	12.1	11.7	12.3	14.0	-12.5%
391510020	Stark		11.8	10.8	10.6	11.1	13.2	-16.2%
391530017	Summit		12.0	11.0	10.7	11.2	13.3	-15.6%
391530023	Summit		11.2	10.4	10.0	10.5	12.5	-15.9%
391550005	Trumbull		10.6	9.9	9.8	10.1		
391550007	Trumbull						12.8	
391650007	Warren		11.5	11.0		11.3		
Ohio Average						**10.9**	**13.2**	**-15.4%**

Table 19. The difference between the CSAPR predicted 2014 remedy case annual PM2.5 average values and the measured 2014 annual PM2.5 average values at Ohio monitors (the monitor used for designating Cleveland, Ohio as a nonattainment area is highlighted)

Source: http://www3.epa.gov/airtransport/CSAPR/techinfo.html

Site ID	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2010-2012 Annual PM2.5 DV (µg/m3)	2011-2013 Annual PM2.5 DV (µg/m3)	2012-2014 Annual PM2.5 DV (µg/m3)	2014 Measured Annual PM2.5 Average Values (µg/m3)	2014 Remedy Annual PM2.5 Average Values (µg/m3)	2014 Remedy to 2014 Measured
390030009	Allen		10.6	10.3	9.8	10.2		
390090003	Athens		8.9	8.5	8.2	8.5	8.1	4.8%
390170003	Butler		12.5	11.7	11.2	11.8		
390170016	Butler		12.2	11.3	10.7	11.4	11.3	1.1%
390170017	Butler						11.4	
390170019	Butler		12.1	11.7	11.2	11.7		
390170020	Butler							
390171004	Butler						10.9	
390230005	Clark		11.9	10.9	10.2	11.0	10.7	2.4%
390250022	Clermont		11.5	11.0		11.3	9.8	14.6%
390350013	Cuyahoga	Cleveland						
390350027	Cuyahoga	Cleveland					11.3	
390350034	Cuyahoga	Cleveland	10.1	9.6	9.5	9.7	10.0	-2.5%
390350038	Cuyahoga	Cleveland	13.0	12.4	12.3	12.6	13.0	-3.3%
390350045	Cuyahoga	Cleveland	12.2	11.5	11.3	11.7	12.2	-4.0%
390350060	Cuyahoga	Cleveland	13.0	12.5	12.4	12.6	12.7	-0.5%
390350065	Cuyahoga	Cleveland	12.7	12.1	12.0	12.3	11.7	4.9%
390350066	Cuyahoga	Cleveland						
390351002	Cuyahoga	Cleveland	10.5	9.7	9.5	9.9	10.4	-4.6%
390490024	Franklin		11.9	10.9	10.3	11.0	11.1	-0.8%
390490025	Franklin		11.6	10.8	10.8	11.1	11.0	1.1%
390490039	Franklin				9.0	9.0		
390490081	Franklin		11.0	10.3	10.1	10.5	10.4	1.1%
390570005	Greene		11.4	10.2	9.7	10.4	9.4	10.6%
390610006	Hamilton		11.6	10.7	10.2	10.8	10.5	3.5%
390610010	Hamilton		11.2	11.0	10.5	10.9		
390610014	Hamilton		13.4	12.3	11.7	12.5	12.5	0.0%
390610040	Hamilton		12.0	11.1	10.5	11.2	10.9	3.1%
390610041	Hamilton							
390610042	Hamilton		13.2	12.2	11.5	12.3	12.2	1.2%
390610043	Hamilton						11.1	
390610048	Hamilton				12.9	12.9		
390617001	Hamilton		14.1			14.1	11.5	22.8%
390618001	Hamilton		17.6			17.6	12.7	38.3%
390810016	Jefferson							
390810017	Jefferson		12.2	11.6	10.9	11.6	10.6	9.4%
390810021	Jefferson			7.6	9.1	8.4		

Site ID	County	Nonattainment Area of the 2012 Annual PM2.5 Standard	2010-2012 Annual PM2.5 DV (µg/m3)	2011-2013 Annual PM2.5 DV (µg/m3)	2012-2014 Annual PM2.5 DV (µg/m3)	2014 Measured Annual PM2.5 Average Values (µg/m3)	2014 Remedy Annual PM2.5 Average Values (µg/m3)	2014 Remedy to 2014 Measured
390811001	Jefferson		11.4	10.8	10.5	10.9	11.3	-3.4%
390850007	Lake		9.6	9.0	8.7	9.1		
390851001	Lake						9.5	
390853002	Lake							
390870010	Lawrence						10.7	
390870012	Lawrence		11.3	10.3	9.2	10.3		
390930016	Lorain	Cleveland					10.2	
390932003	Lorain	Cleveland						
390933002	Lorain	Cleveland	9.8	9.2	9.1	9.4	9.7	-3.6%
390950024	Lucas		10.6	10.1	10.0	10.2	11.0	-6.8%
390950025	Lucas						10.6	
390950026	Lucas		10.7	10.1	10.0	10.3	10.8	-4.5%
390950028	Lucas		11.0	10.3	10.1	10.5		
390990005	Mahoning		11.2	10.7	10.5	10.8	10.6	1.9%
390990014	Mahoning		11.3	10.4	9.9	10.5	11.1	-4.8%
391030003	Medina		10.8			10.8		
391030004	Medina		10.0	9.7	9.0	9.6		
391130014	Montgomery							
391130031	Montgomery						10.6	
391130032	Montgomery		12.3	11.0	10.7	11.3	11.4	-0.4%
391130038	Montgomery				8.7	8.7		
391330002	Portage		10.3	9.5	9.1	9.6	9.7	-0.3%
391351001	Preble		10.7	10.0	9.4	10.0	9.9	1.1%
391450013	Scioto		10.6	9.6	9.0	9.7	10.1	-3.8%
391510017	Stark		13.0	12.1	11.7	12.3	11.7	4.8%
391510020	Stark		11.8	10.8	10.6	11.1	11.3	-2.2%
391530017	Summit		12.0	11.0	10.7	11.2	11.3	-0.9%
391530023	Summit		11.2	10.4	10.0	10.5	10.6	-0.5%
391550005	Trumbull		10.6	9.9	9.8	10.1		
391550007	Trumbull						10.7	
391650007	Warren		11.5	11.0		11.3		
Ohio Average						**10.9**	**10.9**	**2.3%**

9. Analysis of air quality trends in Ohio and Allegheny County, PA

Figure 29 shows county level 2012-2014 annual PM2.5 design values in $\mu g/m^3$ in Ohio counties where data was collected. Only Cuyahoga County has a 2012-2014 annual PM2.5 design value higher than 12.0 $\mu g/m^3$.Table 20 shows the historical annual PM2.5 design values at Ohio's monitors. It shows that the average annual PM2.5 design value for all Ohio monitors has been reduced for about 32% within the last 10 years (2002-2005 to 2012-2014). At the monitor used to designate Cleveland as a nonattainment area, the annual PM2.5 design value decreased from 18.1 $\mu g/m^3$ in 2003-2005 to 12.3 $\mu g/m^3$ in 2012-2014, a 32% reduction as well. The number of Ohio monitors with design value larger than or equal to 12.0 $\mu g/m^3$ changes from 16 in 2010-2012 to 4 in 2012-2014. Among these, two of the 2010-2012 monitors do not exist anymore but one of the 2012-2014 monitors is new.

Table 21 and Figure 30 show the historical annual PM2.5 design values at Allegheny County monitors. They show that the average annual PM2.5 design value for all Allegheny County monitors has been reduced for about 35.7% within the last 10 years (2002-2005 to 2012-2014). At the monitor used to designate Allegheny County as a nonattainment area, the annual PM2.5 design value decreased from 20.8 $\mu g/m^3$ in 2003-2005 to 13.0 $\mu g/m^3$ in 2012-2014, a 37.5% reduction. The number of Allegheny County monitors with design value larger than or equal to 12.0 $\mu g/m^3$ changes from two in 2010-2012 to only one in 2012-2014.

Meteorological conditions affect the fate and transport of air pollutants from the emissions sources. Wind roses are graphic illustrations of the frequency of wind direction and wind speed. Figure 31 shows the wind roses in and around Allegheny County. Wind direction can be used to help in identifying contributing emissions. The dominant wind directions in the monitor area are south and west, with a larger southerly component. The following sources are located to the south of the monitor: Clairton Coke Works (1.3 miles), Guardian Industrial Corp. (5.3 miles), Genon Power Midwest/ Elrama Power Plant (5.7 miles), and Allegheny Energy Supply Co./Mitchell Power Station (8.9 miles). US Steel Corp./ Irvin Plant is located 2.0 miles to the west of the monitor. Table 10 shows the 2011 emissions of these sources. The total 2011 emissions from the sources within 9 miles south or west of the monitor were 702 tons of PM.5, 6,681 tons of NOx, and 3,250 tons of SO2. Figure 32 shows the location of Clairton Coke Works, the closest from the south side, to the monitor. It is located about a mile and a half south of the monitor and its 2011 emissions were 500 tons of PM2.5, 3,075 tons of NOx, and 1, 468 tons of SO2. The geography/topography also has an impact. The Clairton Coke Works sits on the west bank of the Monongahela River at the base of the Mon Valley. On the east bank of the river, the terrain raises sharply reaching elevations more than 300 feet above the Clairton Coke Works within a short distance from the plant, where the monitor is located[1]. Finally, vehicle miles traveled (VMT) is another factor that contribute to PM2.5 concentrations. Allegheny County has a total of 8,276,513,524 VMT[2]. Figure 33 shows the high VML at Allegheny County relative to the surrounding counties.

The results presented in this section show that Ohio and Allegheny County (the closest 2012 annual PM2.5 nonattainment areas to Ohio) are moving towards a lower annual PM2.5 design values year after year. This is also consistent with the study findings that most of the 2012 annual PM2.5 nonattainment and maintenance problems in the eastern US will be resolved in the upcoming years.

[1] http://www3.epa.gov/airquality/particlepollution/designations/2012standards/eparesp/03_PA_120tsd.pdf
[2] http://www3.epa.gov/airquality/particlepollution/designations/2012standards/techinfo.htm#A

Figure 29. County level 2012-2014 annual PM2.5 design values in µg/m^3 in Ohio counties where data was collected

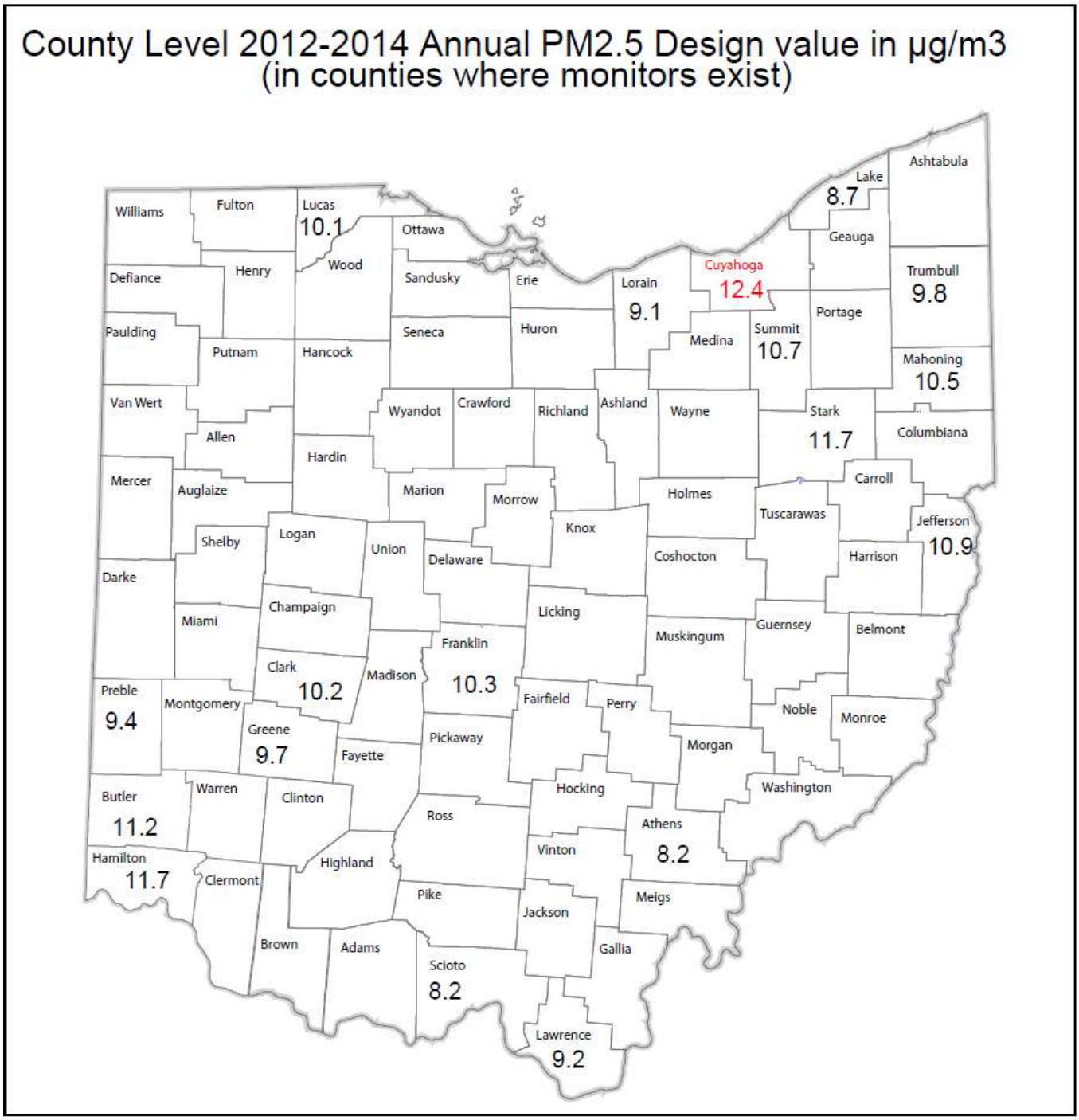


Table 20. Ohio monitors historical annual PM2.5 design values in µg/m^3
(the monitor used for designating Cleveland, Ohio as a nonattainment area is highlighted)

Site ID	State	County	Nonattainment Area	2003-2005	2004-2006	2005-2007	2006-2008	2007-2009	2008-2010	2009-2011	2010-2012	2011-2013	2012-2014	03-05 to 12-14 Change (%)
390030009	Ohio	Allen							10.9	10.9	10.6	10.3	9.8	
390090003	Ohio	Athens		12.3	12.2	12.7	11.8	10.9	9.7	9.0	8.9	8.5	8.2	-33.3%
390170003	Ohio	Butler		16.2	15.7	16.2	14.4	14.0	13.4	13.0	12.5	11.7	11.2	-30.9%
390170016	Ohio	Butler		16.1	15.5	15.6	14.2	13.9	13.4	13.0	12.2	11.3	10.7	-33.5%
390170017	Ohio	Butler		15.4	15.7	17.2								
390170019	Ohio	Butler								12.7	12.1	11.7	11.2	
390170020	Ohio	Butler												
390171004	Ohio	Butler		15.1	14.6	15.0	14.0	14.6						
390230005	Ohio	Clark		14.7	14.4	14.8	13.5	13.3	12.8	12.6	11.9	10.9	10.2	-30.6%
390250022	Ohio	Clermont		15.7	14.2	14.2	12.8	12.3	11.6	11.3	11.5	11.0		
390350013	Ohio	Cuyahoga	Cleveland	16.7										
390350027	Ohio	Cuyahoga	Cleveland	16.1	15.3	14.9	13.6	12.8	11.9	10.6				
390350034	Ohio	Cuyahoga	Cleveland	14.1	13.4	13.8	12.0	11.6	10.7	10.4	10.1	9.6	9.5	-32.6%
390350038	Ohio	Cuyahoga	Cleveland	18.1	17.2	16.8	15.1	14.4	13.6	13.1	13.0	12.4	12.3	-32.0%
390350045	Ohio	Cuyahoga	Cleveland	17.0	16.2	16.2	14.3	13.6	12.9	12.3	12.2	11.5	11.3	-33.5%
390350060	Ohio	Cuyahoga	Cleveland	17.7	16.9	16.8	15.0	14.1	13.4	12.8	13.0	12.5	12.4	-29.9%
390350065	Ohio	Cuyahoga	Cleveland	16.4	15.6	15.8	14.5	14.3	13.4	12.7	12.7	12.1	12.0	-26.8%
390350066	Ohio	Cuyahoga	Cleveland	12.8	11.7									
390351002	Ohio	Cuyahoga	Cleveland	14.6	13.9	13.9	12.3	12.1	11.4	10.9	10.5	9.7	9.5	-34.9%
390490024	Ohio	Franklin		16.0	15.0	14.9	13.7	13.0	12.5	12.2	11.9	10.9	10.3	-35.6%
390490025	Ohio	Franklin		15.5	14.9	14.9	13.6	12.9	12.2	11.9	11.6	10.8	10.8	-30.3%
390490039	Ohio	Franklin											9.0	
390490081	Ohio	Franklin		14.3	13.7	13.5	12.3	11.7	11.3	11.2	11.0	10.3	10.1	-29.4%
390570005	Ohio	Greene		12.4	13.2	13.6	12.3	12.1	12.1	12.0	11.4	10.2	9.7	-21.8%
390610006	Ohio	Hamilton		16.6	14.9	14.8	13.5	13.1	12.4	12.2	11.6	10.7	10.2	-38.6%
390610010	Ohio	Hamilton								11.8	11.2	11.0	10.5	
390610014	Ohio	Hamilton		17.5	17.1	17.3	15.7	15.0	14.4	13.8	13.4	12.3	11.7	-33.1%
390610040	Ohio	Hamilton		15.9	15.2	15.4	13.8	13.5	12.9	12.7	12.0	11.1	10.5	-34.0%

Site ID	State	County	Nonattainment Area	2003-2005	2004-2006	2005-2007	2006-2008	2007-2009	2008-2010	2009-2011	2010-2012	2011-2013	2012-2014	03-05 to 12-14 Change (%)
390610041	Ohio	Hamilton		15.2	15.2	15.8								
390610042	Ohio	Hamilton		17.3	16.7	16.6	15.1	14.7	14.2	13.8	13.2	12.2	11.5	-33.5%
390610043	Ohio	Hamilton		15.8	15.4	15.4	14.2	14.1	13.3					
390610048	Ohio	Hamilton											12.9	
390617001	Ohio	Hamilton		16.6	16.0	15.9	14.4	13.9	13.6	13.5	14.1			
390618001	Ohio	Hamilton		17.9	17.4	17.3	15.5	14.6	15.1	15.5	17.6			
390810016	Ohio	Jefferson		17.7										
390810017	Ohio	Jefferson		15.8	15.4	15.5	14.8	14.2	13.0	12.5	12.2	11.6	10.9	-31.0%
390810021	Ohio	Jefferson										7.6	9.1	
390811001	Ohio	Jefferson		17.2	16.3	16.1	14.8	13.6	12.7	11.8	11.4	10.8	10.5	-39.0%
390850007	Ohio	Lake						10.4	10.4	10.1	9.6	9.0	8.7	
390851001	Ohio	Lake		13.0	12.6	13.1	11.3							
390853002	Ohio	Lake			11.5	12.7	12.3	12.7	11.5					
390870010	Ohio	Lawrence		15.0	15.0	15.4	13.4	12.9	10.8					
390870012	Ohio	Lawrence					13.1	12.2	12.2	11.4	11.3	10.3	9.2	
390930016	Ohio	Lorain	Cleveland	14.1	13.6	12.7	10.8	10.1						
390932003	Ohio	Lorain	Cleveland											
390933002	Ohio	Lorain	Cleveland	12.8	12.6	13.0	11.9	11.4	10.6	9.9	9.8	9.2	9.1	-28.9%
390950024	Ohio	Lucas		14.7	14.1	14.4	13.1	12.7	11.5	11.1	10.6	10.1	10.0	-32.0%
390950025	Ohio	Lucas		14.4	13.6	13.9	12.6	12.9	11.6					
390950026	Ohio	Lucas		14.3	13.8	14.2	13.1	12.5	11.5	11.0	10.7	10.1	10.0	-30.1%
390950028	Ohio	Lucas					12.0	11.7	11.6	11.4	11.0	10.3	10.1	
390990005	Ohio	Mahoning		15.0	14.5	14.5	13.5	12.9	12.3	11.4	11.2	10.7	10.5	-30.0%
390990014	Ohio	Mahoning		15.5	15.0	14.8	13.6	13.0	12.4	11.8	11.3	10.4	9.9	-36.1%
391030003	Ohio	Medina		15.2	13.6	13.3	12.1	11.8	11.1	10.8	10.8			
391030004	Ohio	Medina								10.8	10.0	9.7	9.0	
391130014	Ohio	Montgomery												
391130031	Ohio	Montgomery		15.0	14.6	14.9	13.1							
391130032	Ohio	Montgomery		15.9	15.2	15.5	14.2	13.8	13.2	12.9	12.3	11.0	10.7	-32.7%
391130038	Ohio	Montgomery											8.7	

Site ID	State	County	Nonattainment Area	2003-2005	2004-2006	2005-2007	2006-2008	2007-2009	2008-2010	2009-2011	2010-2012	2011-2013	2012-2014	03-05 to 12-14 Change (%)
391330002	Ohio	Portage		13.4	13.2	13.6	12.6	12.3	11.5	10.9	10.3	9.5	9.1	-32.1%
391351001	Ohio	Preble		13.9	13.5	13.9	12.7	12.2	11.7	11.3	10.7	10.0	9.4	-32.4%
391450013	Ohio	Scioto		14.6	14.5	14.8	13.5	12.3	11.6	10.9	10.6	9.6	9.0	-38.4%
391510017	Ohio	Stark		16.7	16.0	16.1	14.8	14.3	13.8	13.4	13.0	12.1	11.7	-29.9%
391510020	Ohio	Stark		15.2	14.2	14.3	12.9	12.9	12.7	12.3	11.8	10.8	10.6	-30.3%
391530017	Ohio	Summit		15.6	15.0	14.9	14.0	13.7	13.3	12.6	12.0	11.0	10.7	-31.4%
391530023	Ohio	Summit		14.6	14.1	14.1	13.1	12.7	12.3	11.7	11.2	10.4	10.0	-31.5%
391550005	Ohio	Trumbull							11.9	11.3	10.6	9.9	9.8	
391550007	Ohio	Trumbull		14.7	14.4	14.5	13.3	13.5	12.8					
391650007	Ohio	Warren				14.0	13.0	12.5	11.8	11.5	11.5	11.0		
													Average	**-32.1%**

Table 21. Historical annual PM2.5 design values in µg/m3 for monitors in Allegheny County, Pennsylvania (the monitor used for designating Allegheny County, Pennsylvania as a nonattainment area is in yellow row)

Source: http://www3.epa.gov/airtrends/values.html

Site ID	2003-2005	2004-2006	2005-2007	2006-2008	2007-2009	2008-2010	2009-2011	2010-2012	2011-2013	2012-2014	03-05 to 12-14 Change (%)
420030008	15.5	15.2	15.0	14.0	13.1	12.2	11.6	11.1	10.3	10.0	-35.5%
420030064	20.8	20.4	19.8	18.3	17.0	16.0	15.0	14.8	13.4	13.0	-37.5%
420030067	13.5	12.8	12.9	11.8	11.7	11.1	11.0	10.5	9.6	9.0	-33.3%
420030093	13.6	12.7	13.0	12.3	11.3	10.1	9.7	9.4	8.8	8.5	-37.5%
420031008	15.5	15.0	15.0	14.2	13.7	13.0	12.4	11.7	10.6	10.0	-35.5%
420031301	16.6	16.0	16.2	15.2	14.3	13.3	12.7	12.5	11.7	11.4	-31.3%
420033007	15.7	14.9	15.3	14.3	13.2	12.4	11.5	10.9	9.8	9.5	-39.5%
										Average	**-35.7%**

Figure 30. Historical annual PM2.5 design values in µg/m3 for monitors in Allegheny County, Pennsylvania

Source: http://www3.epa.gov/airtrends/values.html

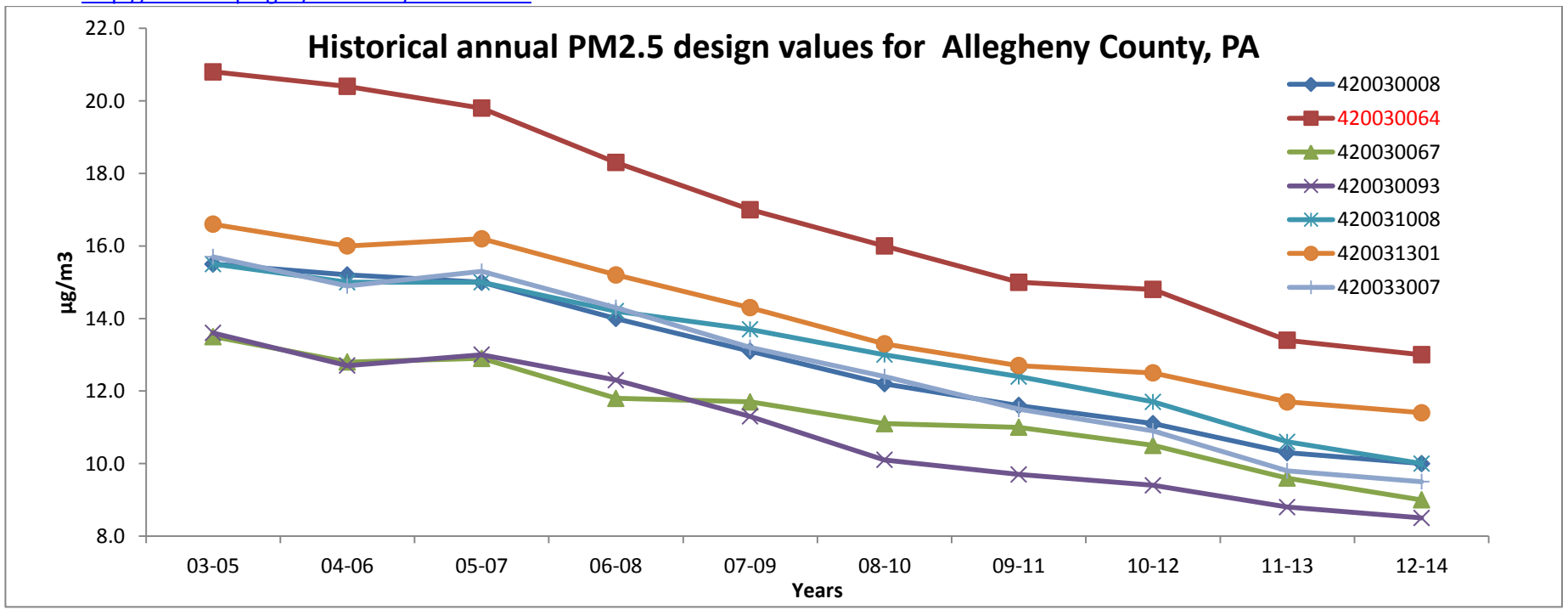


Figure 31. Wind Roses in Allegheny County, Pennsylvania

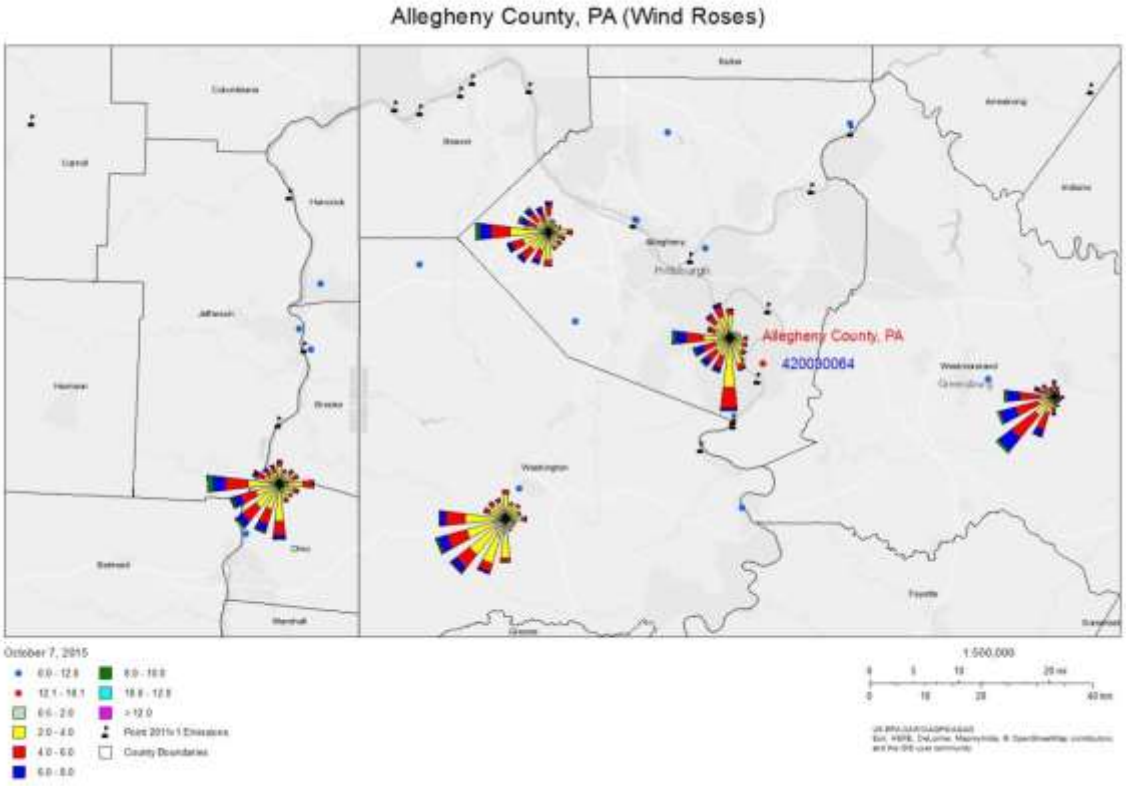


Figure 32. The distance and direction of Clairton Coke Works relative to Allegheny County nonattainment designation monitor

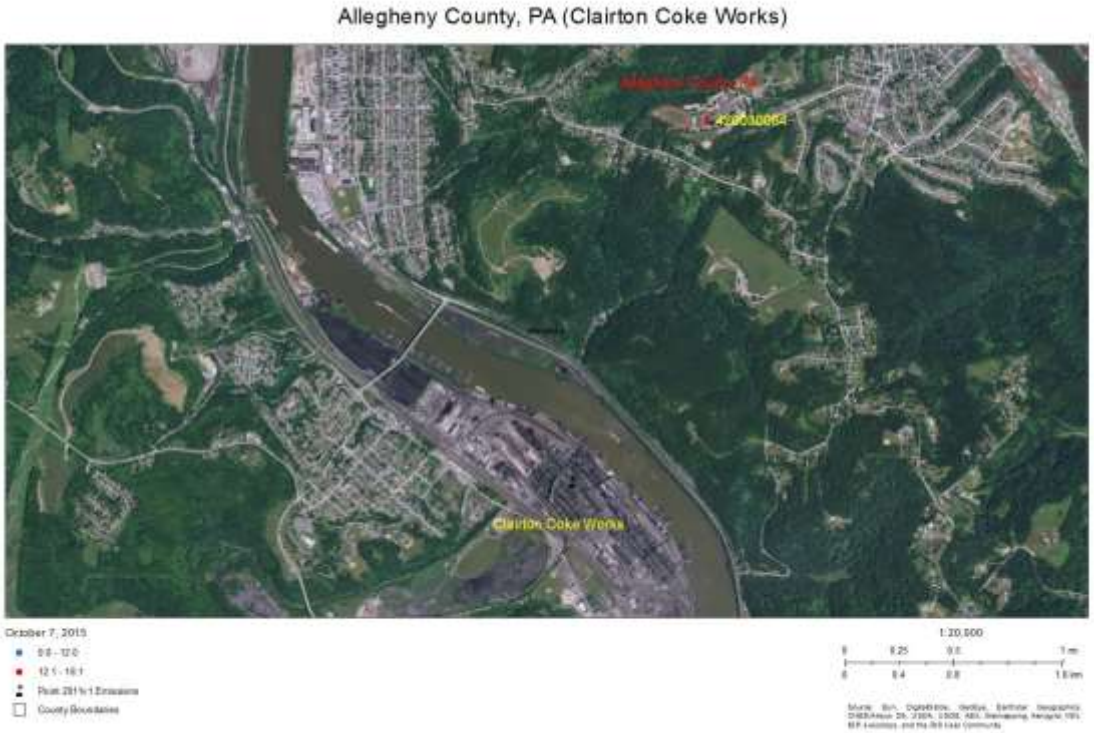
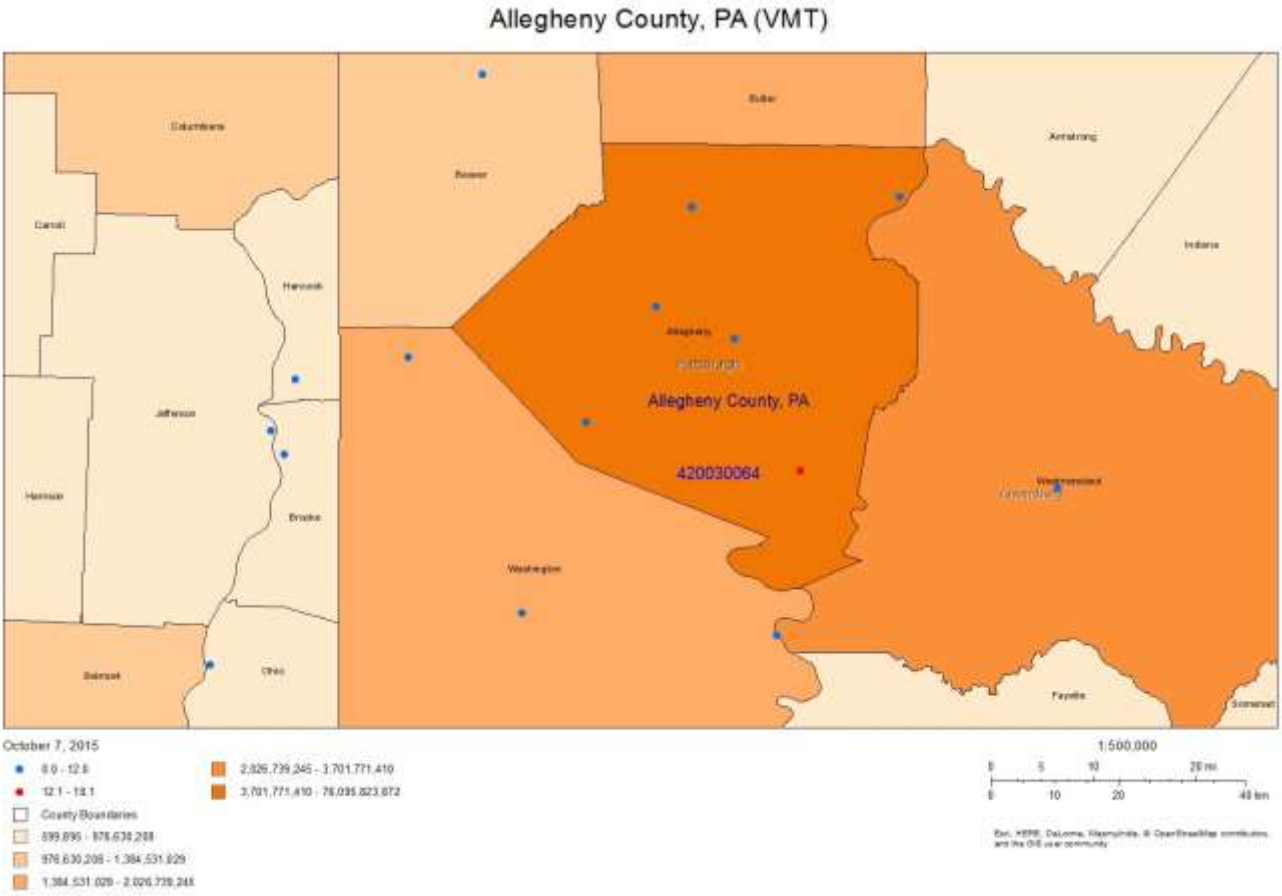


Figure 33. The VMT at Allegheny County, PA compared to the surrounding counties.



10. Conclusions

There is a clear improvement in reducing annual PM2.5 in the majority of the 2012 annual PM2.5 nonattainment areas. The 2012-2014 design value for the nonattainment areas in the eastern states (Ohio and Pennsylvania) are within 1.0 $\mu g/m^3$ from complying with the 2012 annual PM2.5 standard.

The study identified the monitors with high annual PM2.5 design values and classified them into nonattainment and maintenance monitors. Ohio's contribution to these monitors based on the CSAPR analysis was used for ranking purposes. Ohio greatest PM2.5 contributions are mainly to the nonattainment and/or maintenance monitors in Pennsylvania, Kentucky, West Virginia and Indiana. The measured 2012 annual PM2.5 was lower than the CSAPR predicted 2012 annual PM2.5 values, indicating that Ohio's contribution is smaller than what was predicted by the CSAPR analysis.

Several of the monitors identified as nonattainment or maintenance monitors recorded a 2012-2014 annual PM2.5 lower than 12.0 $\mu g/m^3$, confirming that many states are moving towards better air quality in regards to PM2.5 and are actually demonstrating attainment and maintenance currently although U.S. EPA's CSAPR analysis indicated otherwise.

Ohio's analysis focused on Pennsylvania assuming that the smaller contributions at a larger distance downwind will be addressed by addressing the larger contributions to this current nonattainment area.

There were significant emissions of PM2.5, NOx, and SO2 in the three nonattainment areas in Pennsylvania, this suggest that Ohio is unlikely contributing significantly to their nonattainment problem. However, Ohio is still required to address its contributions over 1.0% to other states.

Only a small portion of Ohio's emissions are released close to the Pennsylvania monitors. Less than 7% of Ohio's 2011 SO2 point source emissions and less than 10% of Ohio's NOx point source emissions occur within 100 miles from the Allegheny County nonattainment designation monitor (the closest nonattainment area to Ohio). It is believed that Ohio's emissions are not contributing significantly to the nonattainment or maintenance problems at other states and Ohio's emissions are mainly affecting Ohio. The 2014 measured annual PM2.5 values are lower than the CSAPR predicted values by 15.4% for all Ohio's monitors in average. Also, the 2014 measured annual PM2.5 values are just about 2.3% above the CSAPR remedy case although implementation of CSAPR was not in place in 2014 (originally was scheduled in 2015 now scheduled in 2017).

The CSAPR analysis predicted an average reduction of 17.3% in annual PM2.5 for all of Ohio's monitors when the CSAPR control is fully implemented (i.e. by 2017). The 2017 SO2 annual allocation for Ohio's EGUs is about 50% of their 2014 annual emissions (a reduction of about 148,000 tons of SO2). As a precursor for PM2.5, this additional reduction in SO2 emissions will help Ohio in complying with the 2012 annual PM2.5 standard as well as reduce its PM2.5 contributions to other states to insignificant levels.

The improvement in air quality as a result of CSAPR will help the CSAPR states in complying with the 2012 annual PM2.5 standard and it will help in reducing the contribution of one state to the nonattainment or maintenance problems at another state. Ohio believes that no additional emission reductions is necessary beyond the CSAPR control and other planned controls to reduce its impact on complying with the 2012 annual PM2.5 standard.