RESEARCH REPORT

Fine Particulate Matter ($PM_{2.5}$) and Ozone (O_3) Air Quality in Western Pennsylvania in the 2000s

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SECTION 1: INTRODUCTION

PURPOSE OF ASSESSMENT

For the last decade, the American Lung Association (ALA) has produced its "State of the Air" report, documenting current air quality and air quality trends in the United States.[1] The report focuses on two of the six national criteria pollutants: ozone (O_3) and fine particulate matter ($PM_{2.5}$), rating counties and urban areas across the country. Based on the ALA analysis, the Pittsburgh region has consistently been identified with having some of the worst air quality in the United States.

The analyses presented here offer an independent assessment of the air quality in western Pennsylvania as determined by ambient measurements of ozone and fine particulate matter. Local air quality metrics are tracked over the last decade and compared to measurements made from across the United States over the same period. For trends in ranking across the decade, only those monitors that have existed for the entire period of record are used. In this way, each monitor stands on its own, such that relative changes in ranking are not influenced by the introduction or removal of monitor sites. Reports and studies published by the Allegheny County Health Department (ACHD) and United States Environmental Protection Agency (EPA) are reviewed, along with emissions information, to help understand the trends evident in the ambient air quality measurements.

The overarching philosophy used in this report assumes that the EPA approaches to air quality data evaluation represent the gold standard. This judgment is based on the rationale that air quality changes in a region are driven by air quality standards; failure to meet a standard will necessarily lead to emissions reductions that improve air quality. Simply put, Pittsburgh fails to meet both the current ozone and fine particle standards, which implies that the air quality fails to sufficiently protect the health of the people living in the region. Ranking the region's air quality relative to the rest of the United States, although perhaps of interest, should not take away from the fundamental reality: The current air quality is unacceptably poor.

KEY FINDINGS

- Pittsburgh currently has some of the worst levels of $PM_{2.5}$ and O_3 in the country. Despite significant improvement, air quality has remained poor throughout the last decade in Pittsburgh and the surrounding region. Poor air quality is not isolated to one location, although some areas are worse than others. In many instances, the pace of air quality improvement has been slower than that seen nationwide.
- People in the region may be dying prematurely from exposure to harmful levels of air pollution. The Pittsburgh region fails to meet current air quality standards for $PM_{2.5}$ and O_3. Given recent health evidence of harm at lower pollutant concentrations, the EPA will likely continue to make the air quality standard more stringent, keeping the region from attaining clean air status into the future.
- Currently, data from more than half the $PM_{2.5}$ monitors in the region rank in the worst 10 percent of monitors across the country for annual averages; the cleanest monitored areas in the Pittsburgh region have slid further behind, with daily 98th percentile $PM_{2.5}$ levels worse than three-fourths of the rest of the United States. Concentrations of O_3 immediately downwind of Pittsburgh have not improved over the decade and now rank in the worst 10 percent of measured levels in the country.

- The reduction in emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx) from power plants in Pennsylvania between 2000 and 2009 lags the average reduction rate across the other 35 states in the eastern United States.
- Pennsylvania sources may account for one-half to two-thirds of the $PM_{2.5}$ monitored in the Pittsburgh region on average. Recent analyses by the EPA predict 30 percent of sulfate and 35 percent of nitrate $PM_{2.5}$ at Allegheny County monitors originates from Pennsylvania emissions. Pittsburgh-area industrial and mobile sources (car and trucks) contribute substantially to air pollution the in region, ranging from 20 to 40 percent of the total $PM_{2.5}$ based on source apportionment modeling.
- The existing pollution monitoring network may not adequately reflect the full range of pollution impacts in the region due to complex local terrain combined with local industrial and transportation sources.

BACKGROUND ON AIR QUALITY IN SOUTHWESTERN PENNSYLVANIA

Air quality regulation in the United States has roots in western Pennsylvania. In the middle of the last century, a severe air pollution episode in Donora led to the deaths of 20 local residents.[2] This incident raised public awareness of the ill-effects of air pollution and contributed to the passage of the Clean Air Act by Congress.

Local industry responsible for the pollution of the past has reduced emissions substantially over recent decades.[3] As a result, the air quality problem today in western Pennsylvania seems to have disappeared. While historically smoke-filled skies may no longer provide the immediate visual indications of harmful pollution, no one should breathe easily. Harmful concentrations of pollutants measured in the region persist.

In fact, western Pennsylvania has many areas that fail to meet the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ and O_3. The Clean Air Act (CAA) requires the EPA to establish these standards for six "criteria" pollutants, including $PM_{2.5}$ and O_3, that are deemed harmful to public health and the environment. The primary standard serves to protect public health, especially the health of vulnerable populations such as asthmatics, children and the elderly. A secondary standard limits harm to animals, crops, vegetation and buildings. The CAA stipulates that these standards be reviewed periodically to evaluate new, relevant scientific information. The responsibility to implement programs that assure air quality standards are met, or attained, falls to individual states.

For particulate matter, two areas within Allegheny County have been designated nonattainment for $PM_{2.5}$ (both the annual standard set in 1997 and the revised daily standard established in 2006). The worst air quality can be found in one isolated area where problems can be traced in large part to local industry. The much larger Pittsburgh metropolitan area, covering Allegheny and surrounding counties fails to meet the same annual and daily $PM_{2.5}$ standards. Additionally, the metro-region exceeds the 1997 standard for eight-hour ozone. Forthcoming revised standards for sulfur and nitrogen dioxides may place the region into nonattainment of those standards as well.[4] Furthermore, the Pittsburgh area also experiences elevated levels of air toxics that have adverse health consequences; no NAAQS exist for these contaminants, although Pennsylvania does have ambient standards for some air toxics like hydrogen sulfide (H2S), hydrogen fluoride (HF) and beryllium (Be).[5]

SECTION 2: PARTICULATE MATTER

The United States Environmental Protection Agency (EPA) initially regulated particulate matter as total suspended particulates in 1971, later moving to a particle standard of 10 microns or less (PM_{10}). In 1997, it reduced the regulated particle size once again, promulgating an air quality standard for fine particulate matter ($PM_{2.5}$). These standard revisions occurred as improved scientific information showed the adverse health consequences of smaller particles able to reach deep into the lungs. The health-based primary $PM_{2.5}$ standard had two components, annual and daily, for which levels were set to an annual maximum concentration of 15 $\mu g/m^3$, based on the three-year average of the annual arithmetic mean $PM_{2.5}$ concentrations average and a 24-hour concentration of 65 $\mu g/m^3$, based on the three-year average of the 98th percentile of 24-hour $PM_{2.5}$ concentrations. In 2006, the EPA revised the level of the daily standard to 35 $\mu g/m^3$. Based on the current review of the standard, the agency will likely further revise the standard to more stringent levels.[6]

MONITORING NETWORK

The Clean Air Act requires every state to establish a network of air monitoring stations for criteria pollutants, using guidelines set by the EPA's Office of Air Quality Planning and Standards (OAQPS) for their location and operation. The Allegheny County Health Department (ACHD) runs the monitoring network within Allegheny County (by delegated authority), while the Pennsylvania Department of Environmental Protection (PA DEP) controls monitors in the counties surrounding Pittsburgh. Ambient measurements from the monitoring network provide data for evaluation against the NAAQS and to track trends in air quality. In the early years (1999–2001) of monitoring for $PM_{2.5}$, 16 to 17 locations collected air quality data in the seven-county Pittsburgh metropolitan area. In 2009, there were a total of 14 sites that monitored for $PM_{2.5}$. The monitoring network provides information on both the temporal and spatial variation in air quality for the region.

This study relies heavily on air quality data collected as part of these statewide networks. The EPA maintains a pollution database from which it calculates the metrics, called "design values,"[7] to evaluate a region's compliance with air quality standards. The design values for $PM_{2.5}$ are determined by averaging over a three-year period.[8] The EPA provides summary spreadsheets of these design values on its website. Over the period 1999–2009, 593 sites across the country consistently measured $PM_{2.5}$. Design values from these sites were analyzed and ranked by year. Sites that measured the same levels of pollution were ranked equally, at the midpoint of the rank for that pollution level (i.e. three sites measuring the same pollution that had 99 sites with higher levels would each be given the rank 101, as they occupy the 100th, 101st and 102nd ranks). The design values were available for each three-year period ranging from 1999–2001 to 2007–2009.

$PM_{2.5}$ AIR QUALITY TRENDS

$PM_{2.5}$ concentrations in western Pennsylvania have trended downward over the past decade. Most of the movement occurred in the early and late part of the period, with some leveling off in the middle years, as seen especially in the annual averages plotted in Figure 2-1. The lowest monitored levels in the region have occurred in the last three years, most probably due to a combination of emission reductions due to air quality control efforts, as demonstrated in the emissions section of this report and reductions due to the poor economy.[9] Similar behavior is observed at the extreme 24-hour averages, as determined by the daily design values (Figure 2-2). The graphic reveals that extreme values tend to vary more widely from year to year than the annual averages.

Each figure plots the appropriate $PM_{2.5}$ standard, annual (15 $\mu g/m^3$) and daily (65, revised to 35 $\mu g/m^3$) as a horizontal red-dashed line. Only recently have levels across the region begun to meet the existing NAAQS, except for the monitor in Liberty Borough, south of Pittsburgh. Although this development represents good news for western Pennsylvania, the EPA has undertaken a periodic review of the standard that will most likely lead to a downward revision of the health-protective levels. The EPA's review concludes that the 2006 $PM_{2.5}$ standard levels fail to protect public health, a finding supported by the Clean Air Scientific Advisory Committee (CASAC).[10] The range being considered for a revised standard is 11-13 $\mu g/m^3$ annual and 30 $\mu g/m^3$ daily,[11] which current regional air quality around Pittsburgh would exceed. The figures highlight as red rectangles the current and historical levels determined by CASAC as protective of health, based on the available science at the time. These ranges represent both the real uncertainty in the science as well as the differences in interpretations of the studies by the committee members. In addition to these uncertainties, the wide range for the short-term standard reflects the dearth of available information until recent years.

The entire country has experienced improved air quality in recent years. Table 2-1 places western Pennsylvania's progress in the context of the rest of the United States. Design value rankings based on measurements from the 593 $PM_{2.5}$ monitors are tabulated for both annual and daily standards for three time-periods: 1999–2001, 2003–2005 and 2007–2009, representing the initial years of measurement for $PM_{2.5}$, mid-decade and recent air quality. Bold values in the table indicate periods that failed to meet the 2006 air quality standard. In the early years, only the background areas met the standards. The relative air quality in the region worsened, as compared to the rest of the country during the middle of the decade, as the rankings increased (a lower ranking represents relatively worse air quality, with a ranking of one being the worst air quality in the United States).

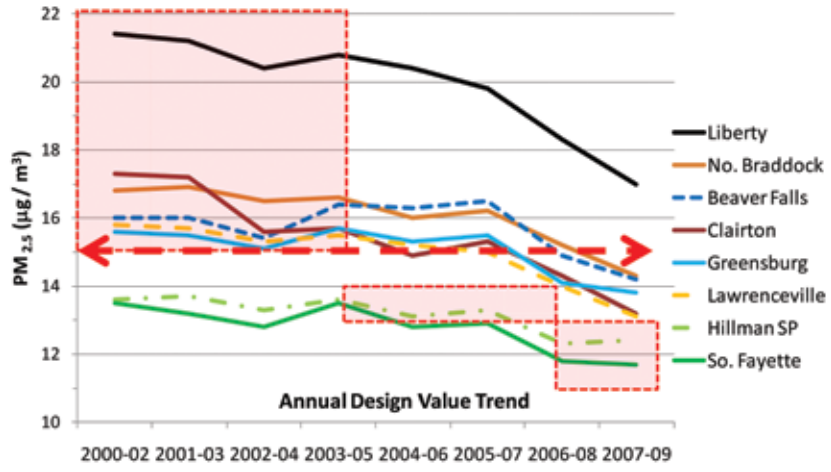

Figure 2-1 Decadal trend in annual $PM_{2.5}$ Design Value. Red-shaded areas reflect CASAC recommendations as described in the text.

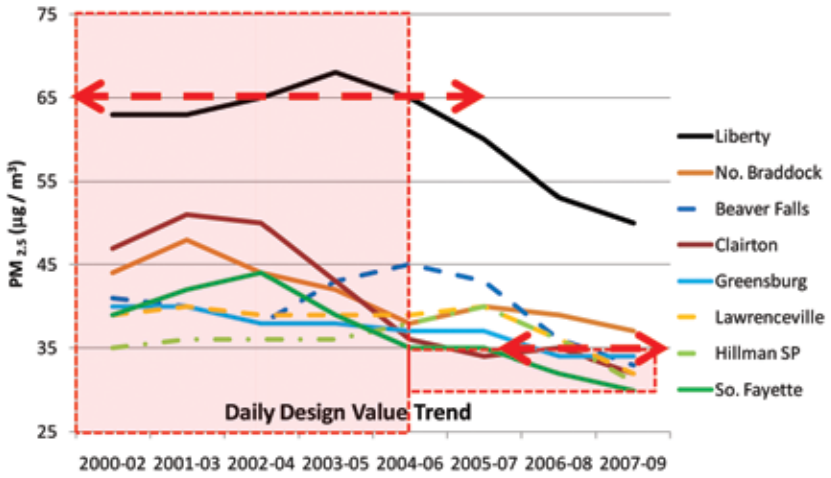

Figure 2-2 Decadal trend in daily $PM_{2.5}$ Design Value. Red-shaded areas reflect CASAC recommendations as described in the text.

This trend toward relatively poorer air quality continued to the end of the decade, with the exception of the monitor in the City of Clairton in southern Allegheny County (Figure 2-3). The figure shows that data from more than half the monitors in the region rank in the worst 10 percent of monitors across the United States. This worsening trend was absent in Columbus, OH, a growing metropolitan area to the west of Pittsburgh. The most recent annual measurements in Columbus (plotted as Franklin County) have improved relative to the rest of the country, markedly so at one of the three monitors. Perhaps more important, the cleanest monitored areas in the Pittsburgh region have slid further behind, with annual levels worse than three-fourths of the rest of the United States at Hillman State Park and worse still for the daily extreme levels, where both South Fayette Township and Hillman State Park have some of the worst air quality—worst fourth and fifth, respectively (Figure 2-4). Some of the worst air quality in the country can be found at the Liberty monitor, which remains in the top ~2 percent of monitored air quality.

	Annual Design Value Ranking				24-hour Design Value Ranking			
Monitor	1999-2001	2003-2005	2007-2009	%ile	1999-2001	2003-2005	2007-2009	%ile
Liberty	**10**	**2**	**8**	1.3%	**18**	**1**	**14**	2.3%
No. Braddock	**72**	**28**	24	4.0%	**53**	**37**	**35**	5.9%
Beaver Falls	**115**	**34**	26	4.4%	**64**	**32**	71	12.0%
Lawrenceville	**131**	**69**	84	14.2%	**230**	**77**	91	15.3%
So. Fayette	250	230	229	38.5%	270	**77**	154	25.9%
Hillman SP	321	223	154	26.0%	270	**146**	121	20.4%
Columbus OH	**36**	**47**	88	14.8%	**108**	**60**	248	41.7%
Steubenville	**34**	**19**	49	8.3%	**88**	**20**	121	20.4%

Table 2-1 Ranking of select $PM_{2.5}$ sites among 593 monitored areas in the United States 1999-2009

In the earliest period, 202 of the 593 long-term monitors violated the annual standard, and 249 monitors surpassed the daily standard established in 2006. By 2003–2005, those numbers fell to 96 and 163 monitors. The most recent period had only 12 monitors exceeding the annual standard with another 41 out of attainment with the daily level of 35 $\mu g/m^3$. The median annual change in air quality at these 593 monitors was 2.7 $\mu g/m^3$, representing a nearly 20 percent improvement. Five of the 11 monitors around Pittsburgh had greater absolute reduction in $PM_{2.5}$. On a percentage basis, only the Clairton monitor realized a concentration decline of greater than 20 percent. The 202 monitors that violated the annual standard experienced, on average, a 23 percent decline in PM pollution. The median change in $PM_{2.5}$ for the daily design value over the decade was 7 $\mu g/m^3$, which was slightly more than a 20 percent reduction. While several sites in western Pennsylvania had reductions greater than this, only three improved more on a percentage basis. Air quality improvements at those sites (Clairton, Harrison

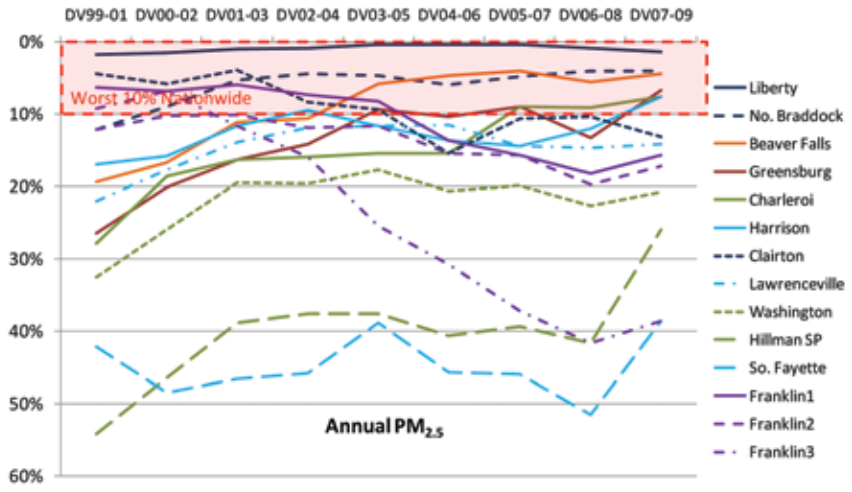

Figure 2-3. Annual $PM_{2.5}$ percentile ranking for western Pennsylvania PM monitors and Franklin County, OH.[12]

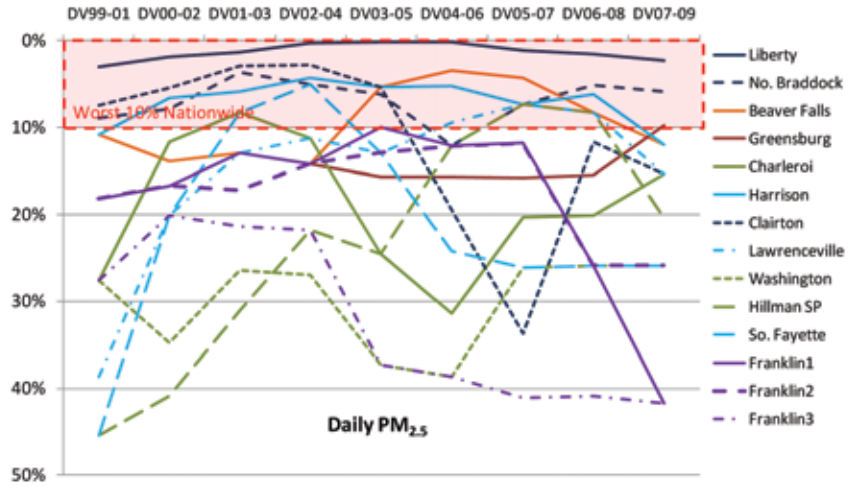

Figure 2-4. Same as Figure 2-3 except for Daily $PM_{2.5}$ percentile rankings

Township, the City of Beaver Falls) kept pace with the average improvement observed at the 249 monitors where levels were greater than 35 in 1999–2001. The other six monitors in Pittsburgh with the worst daily levels failed to sustain the average improvement. Overall, the air quality improvements, although substantial, were not as large on average as those experienced across the United States.

KEY RESULTS FROM $PM_{2.5}$ MONITORED VALUES AND TRENDS

- Despite significant improvement, air quality has remained poor throughout the last decade in Pittsburgh and the surrounding region. Poor air quality is not isolated to one location, although some areas are worse than others. In many instances, the pace of air quality improvement has been slower than that seen nationwide.
- The Pittsburgh region fails to meet current air quality standards for $PM_{2.5}$, which means the people living in the region continue to breathe harmful levels of air pollution. Given recent health evidence of harm at lower pollutant concentrations, the EPA will likely continue to tighten the air quality standard, keeping the region from attaining clean air status into the future.
- Currently, data from more than half the $PM_{2.5}$ monitors in the region rank in the worst 10 percent of monitors across the country for annual averages; the cleanest monitored areas in the Pittsburgh region have slid further behind, with daily 98th percentile $PM_{2.5}$ levels worse than three-fourths of the rest of the United States.

SECTION 3 OZONE

In 1971, the EPA promulgated its first one-hour average ozone standard, at a level of 0.08 parts per million (PPM) maximum. Eight years later the level was relaxed to be 0.12 PPM. The standard was revised again in 1997 to an eight-hour averaged standard of 0.08 PPM. The design value is calculated as the average of the fourth highest value from three consecutive years. After strengthening the eight-hour standard to 0.075 PPM in 2008, the courts remanded the decision for the EPA administrator's reconsideration.

Western Pennsylvania was classified nonattainment for the one-hour ozone standard in 1991. Ten years later Allegheny County was re-designated attainment, with the rest of western Pennsylvania seeing the one-hour standard revoked in 2005. After the eight-hour standard was promulgated, the region depicted in Figure 3-1 was designated nonattainment, a designation it retains currently.

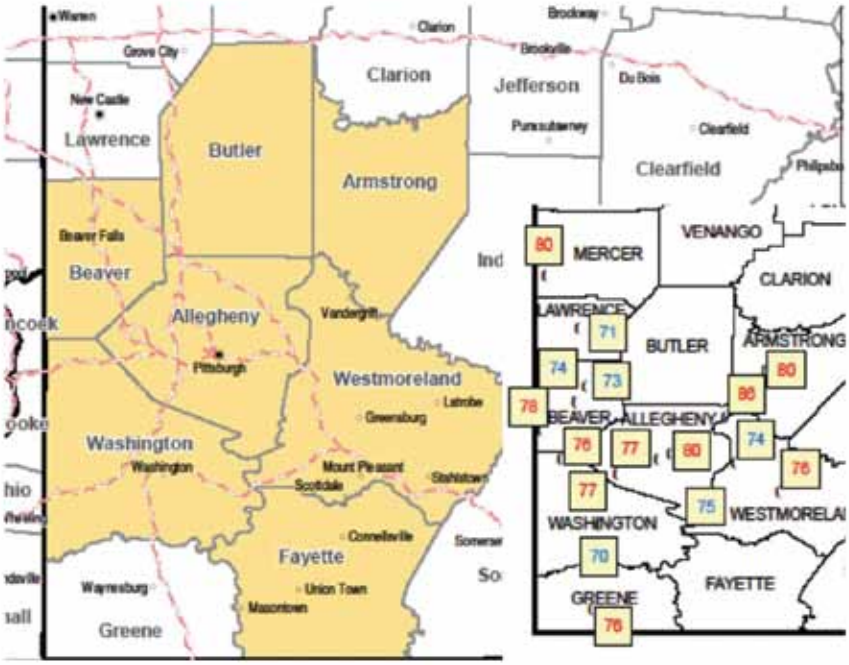

Figure 3-1 Current eight-hour nonattainment area with monitor locations and DVs from 2006-2008.[13]

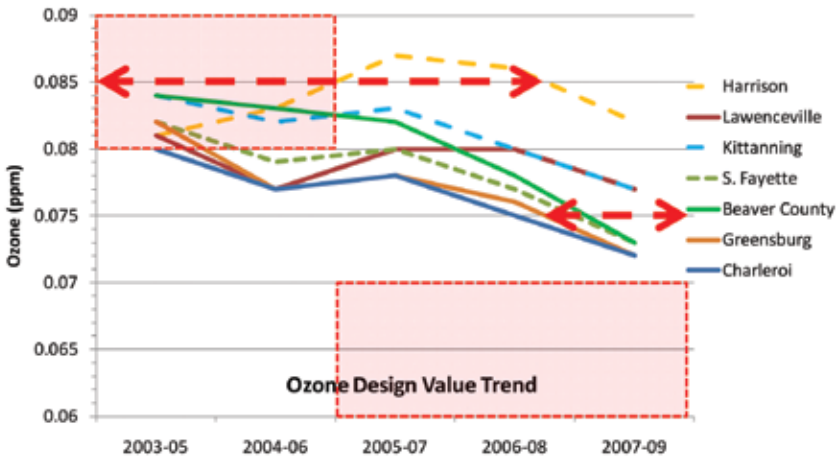

Figure 3-2 Trends in eight-hour maximum ozone for sites in western Pennsylvania. Red-shaded areas reflect CASAC recommendations as described in the text.

MONITORING NETWORK

In 2009 there were 13 ozone monitors in the region. The locations and recent design values from 2006–2008 are shown on Figure 3-1. Each of these monitors has been measuring ozone since at least 2003. Like $PM_{2.5}$, the design values for O_3 are determined by averaging over a three-year period. The period of record provided by the EPA on its website for ozone is shorter than its $PM_{2.5}$ reporting, covering 2003 through 2009. Eight hundred and eighty-five sites across the country consistently measured air quality for this period. Design values, available from 2003–2005 through 2007–2009, were analyzed and ranked by year, following the same method used for the $PM_{2.5}$ data.

AIR QUALITY TRENDS

Ozone levels, like PM, have generally declined across the United States in the last decade. Western Pennsylvania, by and large, has experienced this air quality improvement since 2003, as seen in Figure 3-2. The area was considered for re-designation earlier this decade, until ozone levels measured at Harrison climbed to violate the standard in the later part of the decade. The 2007–2009 design values across the region are once again below the level established in 1997.

The dashed red lines in the trend figure shows the level of the 1997 and 2008 standards. Rectangular boxes reflect the CASAC ranges recommended to protect human health, with the large downward shift due to recent scientific findings. After being remanded, the EPA has considered an even tighter standard consistent with CASAC recommendations. The region will likely remain in nonattainment in the foreseeable future, given the prospect for a lower standard level in 2011 and current ozone levels.

In the population of nearly 900 monitors that measured ozone over the period 2003–2009, more than 60 percent of monitor design values in 2003–2005 exceeded 0.075 PPM. This percentage fell to 51 percent in 2006–2008 and to 31 percent in 2007–2009. As compared to the rest of the country, the improvement in ozone air quality in western Pennsylvania has been equally notable. Table 3.1 highlights some of this improvement over much of the last decade.

Based on 2003–2005 levels, the cleanest site in the region ranked in the worst third of the country (larger numbers in the table mean relatively cleaner air). Toward the end of the decade the relative air quality had improved such that several monitors had air quality in the less-polluted half of U.S. monitors, as shown in the percentile column. The most notable exception to this behavior occurs at the Harrison monitor, which is downwind of the city center of Pittsburgh. The air quality at that site as shown in Figure 3-2 got worse and then recovered to its prior levels in 2007–2009. Relatively speaking, ozone measured at that site has continued to get worse, with concentrations worse than 90 percent of those measured in the rest of the country. The relative trends for ozone measured at the 13 sites in western Pennsylvania are plotted in Figure 3-3.

The difference in behavior at the Harrison site as compared to others in the region likely stems from differences in the precursor levels of NOx and volatile organic carbon (VOCs). The NOx State Implementation Plan call likely reduced NOx levels throughout the region. The impact of this decrease may have been much less immediately downwind of the city, given the typically large NOx emissions from mobile sources in urban areas.

	Design Value Ranking			
Monitor	2003-2005	2006-2008	2007-2009	%ile
Harrison	**293**	**104**	**90**	10%
Kittanning	**184**	**246**	**209**	24%
Greene (Beaver Co.)	**184**	**332**	425	48%
Charleroi	**329**	472	485	55%
Greensburg	**248**	**424**	485	55%
Marietta OH (SW)	**293**	**204**	**209**	24%
Trumbull OH (NW)	**141**	**204**	**250**	28%
Steubenville OH (W)	**464**	**378**	485	55%

Table 3-1 Ranking of sites among 885 ozone monitors in the United States from 2003-2009

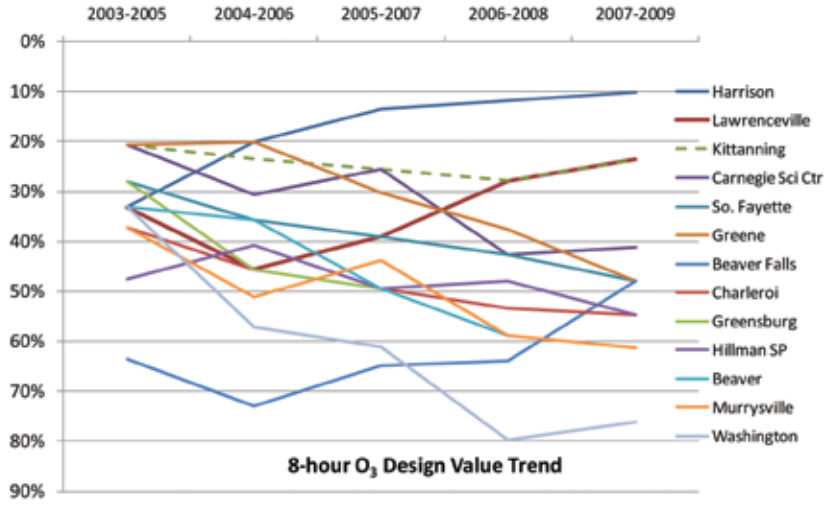

Figure 3-3. Percentile ranking trends for 13 monitors in western Pennsylvania out of 885 U.S. monitors

KEY RESULTS FROM O_3 MONITORED VALUES AND TRENDS

- The region has experienced widespread improvement in ozone levels, with only three of 13 monitors showing worsening trends relative to the rest of the United States. The only site where actual ozone concentrations are worse in 2007–2009 than they were in 2003–2005 is downwind of Pittsburgh in Harrison.
- Several sites in the Pittsburgh region fail to meet the current air quality standards for O_3, which means the people living in the region continue to breathe harmful levels of air pollution. Given recent health evidence of harm at lower pollutant concentrations, the EPA will likely continue to tighten the air quality standard, keeping the region from attaining clean air status into the future.

SECTION 4: EMISSIONS

One route to understanding changes in measured air pollution goes through an evaluation of emissions. A wide array of source types and pollutants contribute to the observed levels of fine particulate and ozone. For particulates, the following section will review the major species that contribute, including sulfates, nitrates, ammonium, organic carbon, elemental carbon and trace elements. The previous section referred briefly to the precursors of ozone, VOCs and NOx. This section reviews emission trends of sulfur dioxide (SO_2) and NOx from the power sector as a means to help explain the observed pollutant trends in the previous sections. This sector represents one of the primary source types that have been regulated to improve air quality in the eastern United States.

SULFUR DIOXIDE

Sulfur dioxide is the precursor to sulfates found in $PM_{2.5}$. Based on measurement results, sulfates represent the largest species type found in western Pennsylvania. Much of that measured sulfate is likely derived from electricity generation, which according to the EPA's 2005 National Emission Inventory (NEI) is responsible for 73 percent of the SO_2 emissions in the country. As seen in Figure 4-1, the largest SO_2 emitters in western Pennsylvania are from this sector.

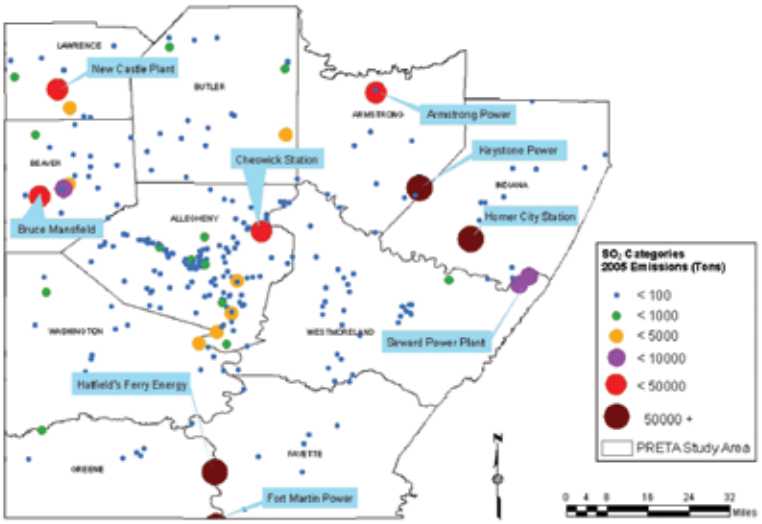

Figure 4-1 Sulfur dioxide point-source emissions in western Pennsylvania[14]

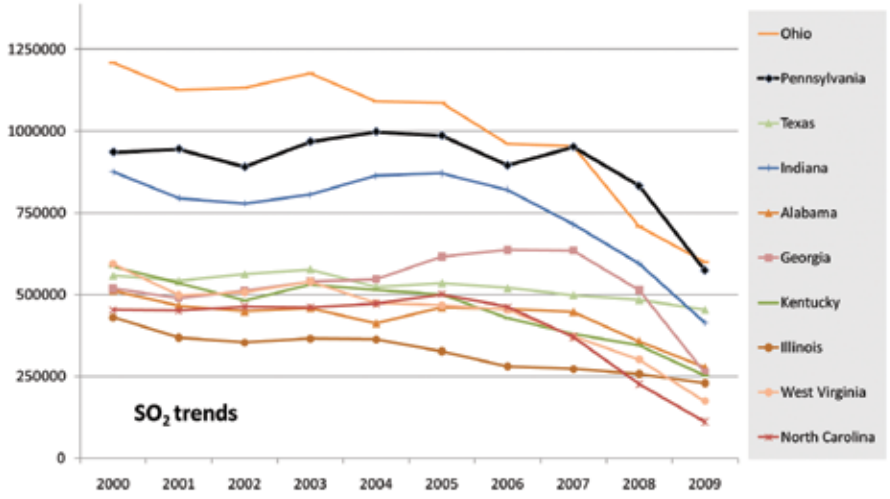

Figure 4-2 Trends in SO_2 emissions from the Acid Rain Database (top 10 state emitters)

Between 2000 and 2009, SO_2 emissions from electric generating units (EGUs) in the Acid Rain Database, covering 36 states east of the Rocky Mountains, decreased nearly 50 percent. Data from the top 10 emitting states are plotted in Figure 4-2. The graph shows fairly modest changes on a statewide basis until the last half of the decade, with the exception of Ohio, where the trend is more consistently downward. Pennsylvania emissions remained steadily above all of the other states except Ohio and did not start to trend down until 2008.

The database contains emissions for each power plant, which allows a closer inspection of regional variations in emission trends. Since the design value trend graphs for pollution rely on three-year averages, a comparison of emissions averaged over three years would be useful. To assess if emission changes in southwestern Pennsylvania were different from the bordering states of Ohio and West Virginia, emissions were summed by county for 2000–2002 and 2007–2009. The eight counties for the Pittsburgh area included Allegheny, Armstrong, Beaver, Fayette, Greene, Indiana, Lawrence and Washington (see Figure 4-1 for facility locations). Emissions from all facilities in Pennsylvania, Ohio and West Virginia were reduced by 30 percent from 2000–2002 to 2007–2009. In southwestern Pennsylvania, however, the emission reduction was only 18 percent. Emissions in the Ohio and West Virginia, counties closest to southwest Pennsylvania were reduced about 40 percent, with 34 percent reductions in the counties along the Ohio River between Ohio and West Virginia. Although the emission reductions were substantial in the Pittsburgh region, their relative change lagged the changes in the broader region and across the country, which may partially explain the relatively slower progress toward lower $PM_{2.5}$ levels around Pittsburgh. Figure 4-3 plots state-specific changes in SO_2 emissions referenced to the emissions in 2000. Emissions from these states were determined by EPA modeling to have the greatest impact on $PM_{2.5}$ near Pittsburgh.

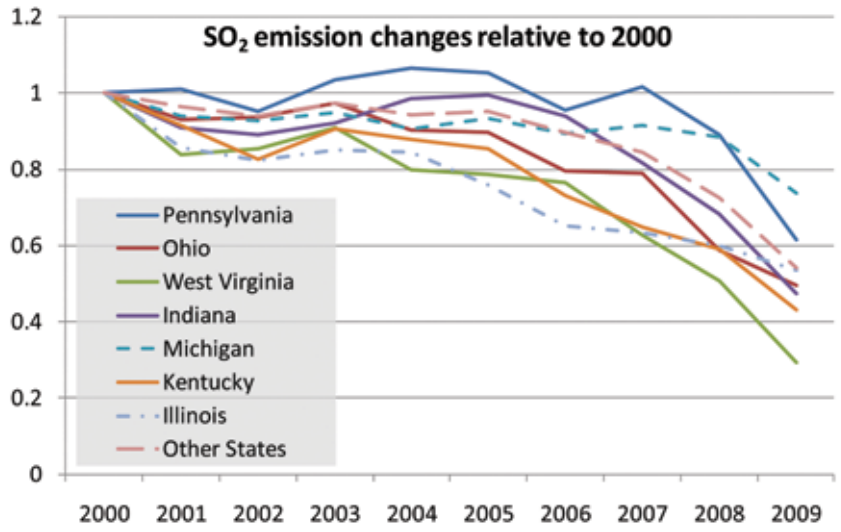

Figure 4-3. Power plant SO_2 emission trends normalized to 2000 emissions.

OXIDES OF NITROGEN

Based on the EPA's 2005 NEI nationally, EGUs account for 21 percent of NOx emissions, with the bulk of emissions coming from on-road (36 percent) and off-road sources (23 percent). Between 2000 and 2009, NOx emissions from EGUs in the Acid Rain Database decreased by more than 60 percent. Major point sources of NOx emissions are shown in Figure 4-4 including the location of EGUs. The source percentage contributions are similar for Pennsylvania, based on the 2002 NEI: EGUs (26 percent), on-road (44 percent), off-road (10 percent) and non-EGU point (6.4 percent).

Similar to changes seen for SO_2, substantial reductions in NOx emissions from the power sector have occurred. Figure 4-5 displays emission trends for the top 10 emitting states for 2000–2009. While at the beginning of the decade emissions from Pennsylvania ranked seventh, their ranking climbed to third by the end of the decade, despite substantial emission reductions. Focusing on the same counties in southwestern Pennsylvania for the two periods 2003–2005 and 2007–2009 that corresponds to the ozone trends (Figure 3-2), the power plant NOx reductions were 10.5 percent. Statewide reductions across Pennsylvania, Ohio and West Virginia were 32 percent for the same period. For emissions in counties nearby southwestern Pennsylvania and along the Ohio River between Ohio and West Virginia the reductions were greater still (more than 40 percent). Using the 2000–2002 period as a baseline yields similar results, with emission reductions in southwest Pennsylvania (28 percent) lagging behind other nearby areas (more than 50 percent reductions). Again, the relatively slower pace of local emission reductions may help to explain why air quality improvements in the region have not been as substantial as those observed elsewhere. Akin to Figure 4-3, Figure 4-6 shows state-specific changes in NOx emissions referenced to the emissions in 2000. The Pennsylvania reduction rate stands out as the lowest of the states whose NOx emissions impact air quality around Pittsburgh. Although the observation is significant, mobile sources remain the main NOx source in the western part of the state.

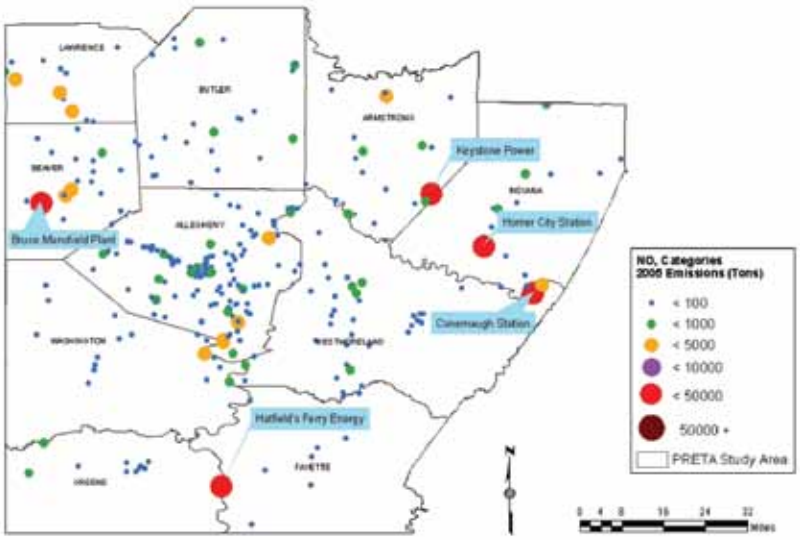

Figure 4-4 NOx point-source emissions in western Pennsylvania[14]

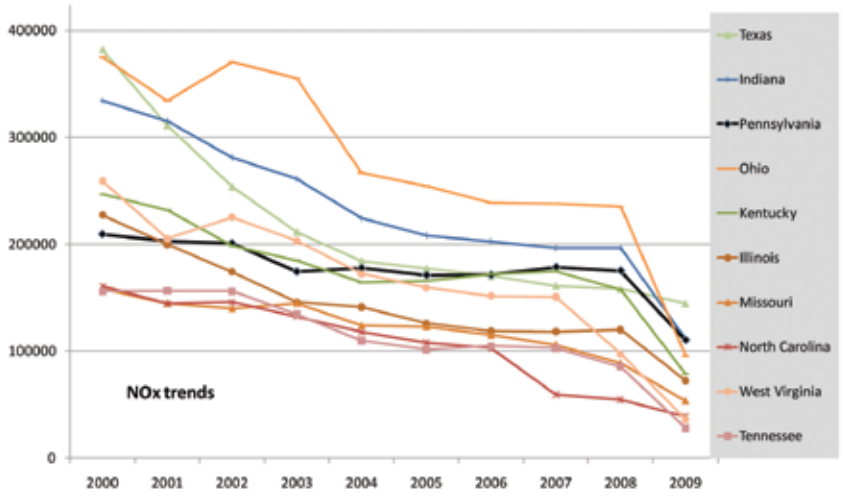

Figure 4-5 Trends in NOx emissions from the Acid Rain Database (top 10 state emitters)

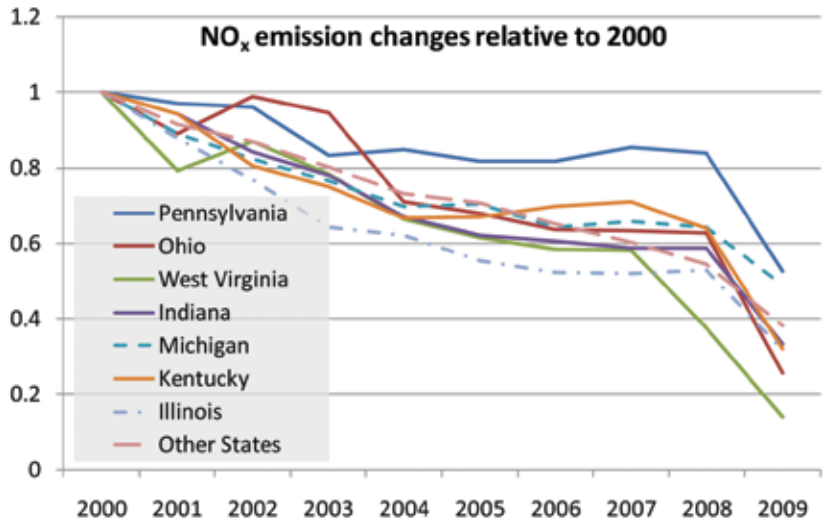

Figure 4-6. Power plant NO_x emission trends self-normalized to 2000 emissions

KEY RESULTS FROM THE EMISSIONS DATABASE

- Eight states surpassed Pennsylvania in absolute reductions of SO_2 emissions across the last decade. Pennsylvania SO_2 emissions did not start to trend down until 2008. For NOx, emissions from Pennsylvania ranked seventh at the beginning of the decade, but climbed to third by the end of the decade. Pennsylvania ranked 15th in absolute reductions of NOx emissions.
- In southwestern Pennsylvania, the SO_2 emission reduction was 18 percent. Emissions in the nearby counties in Ohio and West Virginia were reduced at twice that rate. Similarly, the rate of NOx emission reductions in the Pittsburgh region were two to three times lower, depending upon the base-year period of 2003–2005 (coinciding with the ozone data) or 2000–2002.

SECTION 5: LOCAL AND REGIONAL AIR POLLUTION SOURCE IMPACTS

This section focuses on existing $PM_{2.5}$ air quality monitoring and modeling data to help understand the nature of the air pollution in western Pennsylvania. The data sources include measurements from the PM Federal Reference Method (FRM) network and Speciation Trends Network (STN). Comparison of these data from different monitoring sites can provide general information on local source impacts. The speciation data can be further analyzed by source apportionment modeling to help determine the source types that affect each measurement site. Air quality modeling conducted by the EPA supplement the ambient measurements. Dispersion modeling helps reveal the spatial variations in single-source impacts on air quality while regional chemical transport modeling tracks state-specific pollutant impacts at receptor sites in the modeling domain. Taken together, analysis and review of these different information sources implies that local sources of pollution contribute significantly to the air quality problem in the Pittsburgh region.

EVALUATION OF URBAN EXCESS

Measurements from different monitoring sites can be used to help understand the relative importance of local and regional pollution sources.[15] By comparing data on a day-by-day basis through scatter plots and time series, one can estimate the pollution levels similarity among sites. Differences between sites in a region may reflect differences in local sources affecting individual sites. The analysis does not exactly determine the relative contributions of local and transported sources, but should reasonably characterize the *minimum* amount of local contributions to the site with poorer air quality (e.g., the difference represents the contribution of local sources at the more polluted site minus the local source contribution at the cleaner site). This difference may be expressed as an urban excess of pollution.

Four Federal Reference Monitoring (FRM) sites were chosen to evaluate the contribution of local sources to $PM_{2.5}$ in the Pittsburgh region. Two sites, one located at Hillman State Park and the other in South Fayette, are classified as rural and suburban background sites, upwind of Pittsburgh. These two sites reasonably capture pollution transported into the region from the west with relatively low, very local pollution impacts. The other two sites, Pittsburgh's Lawrenceville neighborhood and Liberty Borough, reflect air quality in the core urban area of Pittsburgh and an area just south of Pittsburgh impacted by local industrial sources, respectively. Three of the four sites operate daily, while the South Fayette site samples once every three days.

Time series plots, as shown in Figure 5-1, help to demonstrate the regional aspect of pollution episodes. Daily average mass values from the four sites are plotted for the first six months of 2008. Generally speaking, the peaks and valleys occur simultaneously, although the Liberty measurements clearly reflect the direct impact of local sources given the frequent divergence of behavior from the other sites.

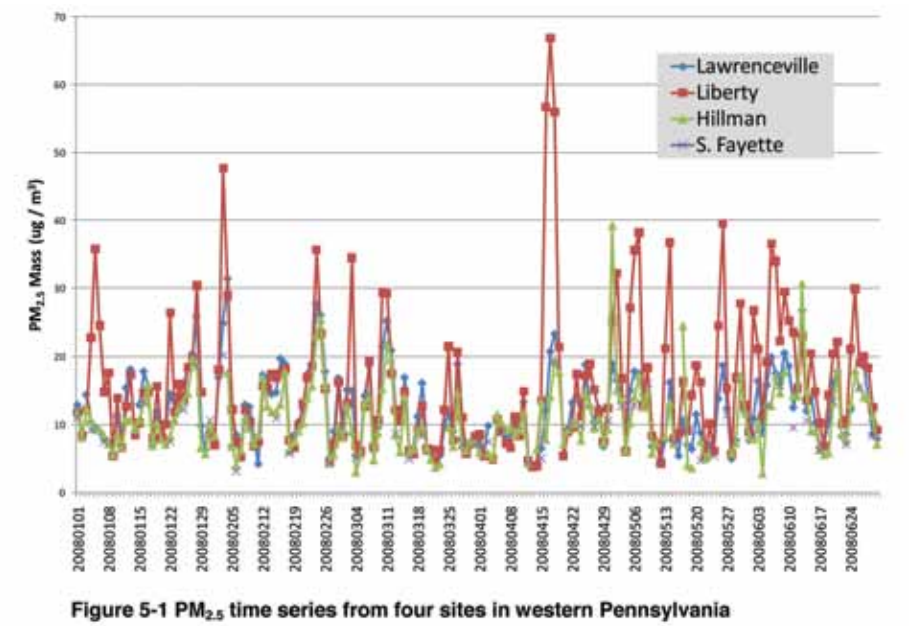

Figure 5-1 $PM_{2.5}$ time series from four sites in western Pennsylvania

The scatter plot shown in Figure 5-2 again compares these four sites using 10 years of data covering 1999–2008. The x-axis shows data from the regional transport monitor at Hillman State Park. Corresponding measurements from the other three sites are plotted: red triangles for the Liberty monitor, blue squares for the Pittsburgh monitor, and green diamonds for the South Fayette monitor. Linear regression equations are given based on nearly 3,000 data pairs for the two daily sites and 1,000 for South Fayette. R-squared values demonstrate that the Pittsburgh and South Fayette monitors track along with the Hillman site quite well. With a slope slightly less than one and a small positive intercept, one could argue that Hillman and South Fayette are influenced by very similar air masses. Similarly, the Pittsburgh site has a slope near one. Its positive intercept likely reflects the impact of urban Pittsburgh sources. The intercept is about 2.3 $\mu g/m^3$. A review of the annual averages from these sites indicates both the background sites are similar, and the Pittsburgh annual average is just over 2 $\mu g/m^3$ greater (Figure 2-1) – as would be expected given that both figures use identical data. The scatter plot confirms the substantial regional component based on the high correlation coefficients with an additional local contribution in the urban core. The intercept represents the urban excess at Pittsburgh. Note that this urban excess does not represent the full effect of sources immediately local to the Pittsburgh monitor. The excess simply implies how much greater the immediately local component at Pittsburgh is relative to the local component at the background site. The relative contribution of $PM_{2.5}$ at the transport sites cannot be readily decomposed into nearby versus long-range transport sources by this simple comparison of total particulate mass.

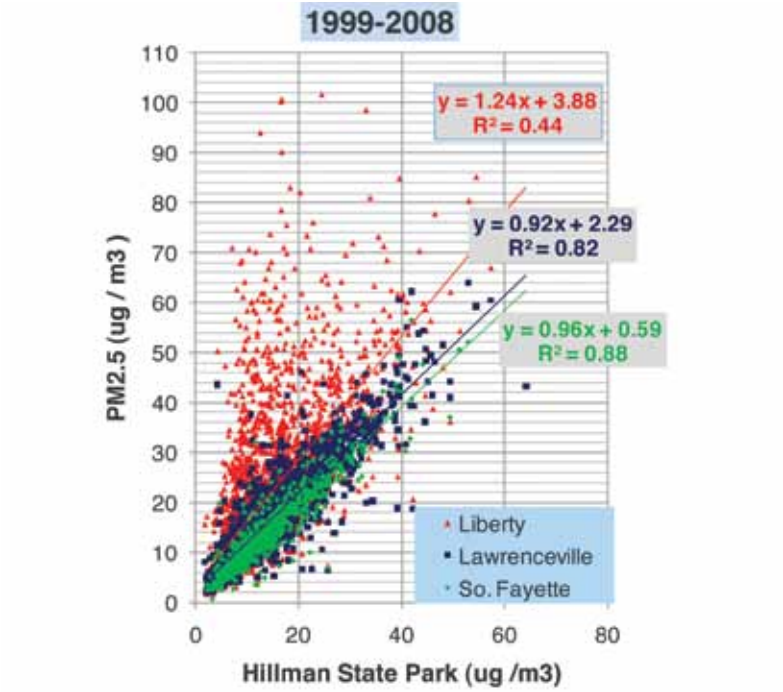

Figure 5-2 Ten years of daily $PM_{2.5}$ data with best-fit linear regression

Agreement between the measurements of the Liberty site and the Hillman site is lower, with an r-squared of 0.44. Substantial scatter above the best-fit line is observed across a wide range of background PM levels. These indicate local source impacts at the Liberty monitor. The slope and offset from the scatter give an idea of the average influence of the local sources. Assuming annual background levels in western Pennsylvania of 12 $\mu g/m^3$ and using the regression, annual pollution levels at Liberty would be nearly 19 $\mu g/m^3$. Given the scatter, the local source impact clearly dominates the pollution level on many days, and may be nearly absent on others. On average, it seems to be at least one-fourth of the PM measured at the Liberty monitor. Based on the daily design values, the local sources contribute more than half of the PM on many of the worst air quality days, since for much of the decade the ratio of the design values for Liberty and Hillman State Park are about 2:1.

$PM_{2.5}$ SPECIATION ANALYSIS

Speciation Data

Analyses by the ACHD provide additional insights into the nature of the local source contribution to $PM_{2.5}$ in western Pennsylvania. They conducted two useful analyses of $PM_{2.5}$ collected from speciation monitors.[16] Unlike the mass data from FRM monitors, speciation monitors apportion the mass to the major PM species: sulfate (SO_4), nitrate (NO_4), ammonium (NH_4), organic carbon (OC) and elemental carbon (EC). Samples are also analyzed for trace metals, which are useful for source apportionment work. The speciation report compares major species among the four sites in western Pennsylvania using data from 2003–2004. The Liberty and Lawrenceville sites are the collocated with the FRM monitors discussed previously, with the background site at Hillman State Park (Florence).

The data permit an evaluation of urban excess on a species-by-species basis (Figure 5-3). Sulfate levels are most similar of the five major species, showing a roughly 10 percent excess (0.4 μg/m^3) of sulfate at the Lawrence and Liberty sites as compared to Florence. Nitrate differences are more substantial, with nearly double the amount of nitrate mass measured in Pittsburgh as compared to the upwind site (nearly 0.8 μg/m^3 higher downtown). Both EC and OC have markedly higher levels at Liberty as compared to either of the other sites. Compared with Florence, the OC mass at Liberty is more than 3 μg/m^3 greater (more than double) and EC is more than 2 μg/m^3 greater, nearly five times as great as the levels observed at the background site. Based on the speciation monitors, the excess PM at Lawrenceville is about 3.4 μg/m^3 while at Liberty the excess is 7.2 μg/m^3, which is consistent with the FRM scatter plot results.

Results comparing New York City monitors to each other and with an upwind background site were similar these Pittsburgh results.[17] Sulfate levels varied by only 10–15 percent among all sites. Nitrates in the city were at least twice as high as the background site, with 25 percent variation across the city. EC and OC were as much as five and two times greater, respectively, in the urban area relative to the upwind site, with a factor of two variation for both across the city.

The speciation measurements improve the understanding of the nature of sources that impact the region. Sulfate levels in the urban areas are not too much greater than at the background site, which implies longer-range transport as the major source of sulfate. This contrasts with results for the other three major components: nitrate, OC and EC, for which levels are augmented in Allegheny County. Presumably much of the excess nitrate comes from mobile sources. Some of the excess OC and EC, particularly at Lawrenceville, is likely from mobile sources, too. The substantial excess of OC and EC at Liberty are derived from the industrial facilities immediately upwind of the monitor, consistent with dispersion modeling and knowledge of emissions from the coke works.

Trends in the sulfate, nitrate and ammonium are apparent for the Lawrenceville and Florence sites based on STN data covering 2002 through 2008. A comparison of data average over 2002–2004 to data

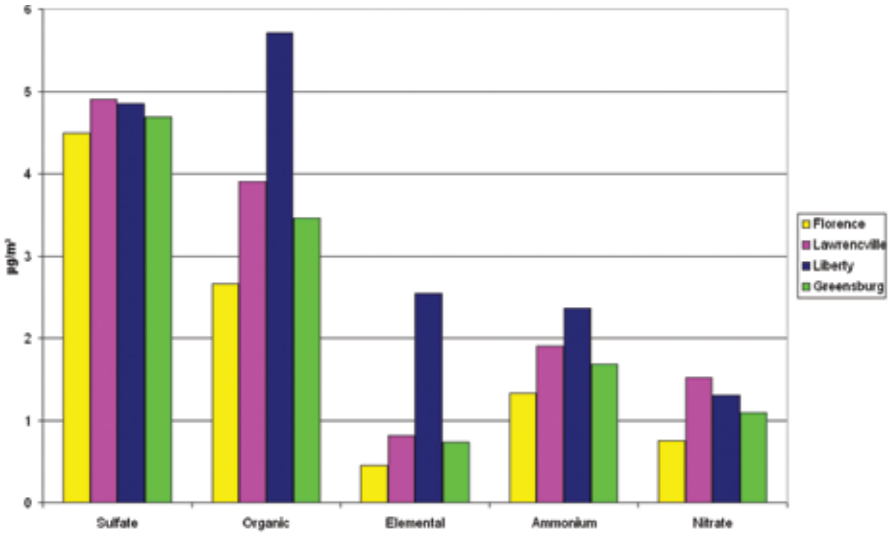

Figure 5-3 Southwest Pennsylvania sites major $PM_{2.5}$ species averages (2003-2004)[16]

from 2005–2008 revealed more than 90 percent of the reduction in $PM_{2.5}$ was due to reductions in these inorganic $PM_{2.5}$ components at Lawrenceville. A similar magnitude reduction in these components was observed at Florence, although that site showed small increases in the other component that partially offset the improvements. Data for Liberty were not available for the same period, but after 2005 there seems to be a strong reduction in the carbon-based $PM_{2.5}$. It appears regional controls have helped to reduce the inorganics across western Pennsylvania, but only Liberty shows a strong decline in carbonaceous $PM_{2.5}$.

Source Apportionment Modeling

Source apportionment modeling also can yield insights into source types that impact an area. The ACHD used Positive Matrix Factorization (PMF) to investigate the nature of sources that contribute to $PM_{2.5}$ at Lawrenceville and Liberty. This form of modeling possesses some drawbacks in that the factors produced consist of species groupings that correlate together. This sometimes means a factor may be combinations of different collocated source types that have similar temporal behavior. The interpretation of those source factors and the associated species masses can be challenging. Nonetheless, expert judgment and experience can establish reasonable understanding of the underlying sources.

Graphical results from the ACHD work are reproduced in Figure 5-4. The two pie charts apportion the PM into a number of source categories for each of the two sites. The Lawrenceville site showed five dominant factors, including a secondary sulfate, secondary nitrate, mobile/industrial, crustal/road dust and miscellaneous burning sources. These sources can be interpreted along with the speciation data itself to allocate PM to the geographic location of sources. A reasonable assumption would place the mobile/industrial and miscellaneous burning/cooking sources into sources within the Pittsburgh Metropolitan Statistical Area. The crustal source is also likely dominated by local sources. The secondary inorganic sources may be more regional in nature, although the previous analysis showed half of the nitrate being locally generated. Since the mobile source component had no nitrate apportioned to it, some of the nitrate mass in the secondary source may be incorrectly assigned. The sulfate source most likely comes from the power sector, primarily. Many of those facilities are located upwind in the Ohio River Valley, although substantial emissions from Pennsylvania-based power plants should also be included in that source category.

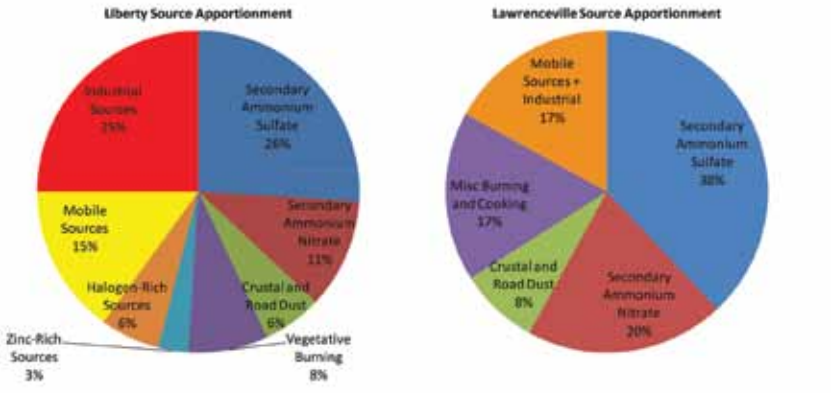

Figure 5-4 Positive matrix factorization $PM_{2.5}$ source apportionment results for Liberty and Lawrenceville[16] in Allegheny County

The Liberty source apportionment results had many similarities to the ones from Lawrenceville, including the two secondary inorganic sources, mobile sources, crustal/dust and the burning source. There were three sources unique to Liberty: industrial, zinc-rich and halogen-rich. Those three sources may all be related to local industrial contributions to PM at Liberty.

The factor analysis yields the richest information to divide the PM into local and long-range transported components. When combined with knowledge of actual local sources and factor profiles, one may tease out local sources that may be somewhat different within western part of the state from the impacts from regional sources outside of Pennsylvania. Industrial and mobile sources are primarily of local origin. Ammonium sulfate and nitrate are 30–35 percent Pennsylvania origin based on EPA air quality modeling discussed in the next section. Local sources may account for half of the other source types. Based on these assumptions, Pennsylvania sources may contribute nearly two-thirds of $PM_{2.5}$ at Liberty and one-half at Lawrenceville.

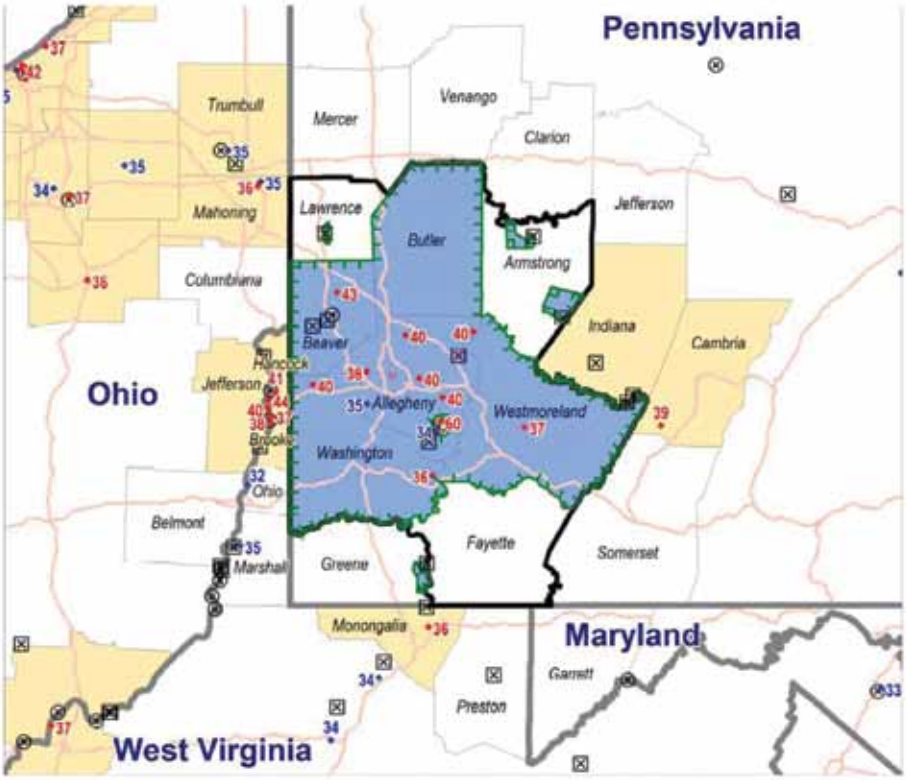

Figure 5-5 Pittsburgh-Beaver Valley $PM_{2.5}$ nonattainment area 2005-2007 design values (EPA)[18]

EPA AIR QUALITY MODELING ANALYSES

In its technical support document for designating areas for nonattainment of the 2006 PM NAAQS, the EPA produced a regional map that displays the daily PM design values from 2005–2007 in the region (Figure 5-5). The map shows the locations of monitors and their consistent measurements of daily extremes, with the exception of the Liberty monitor. The EPA addresses the specific local point-source impacts at Liberty in the appendix of its regulatory impact analysis for select urban areas. For its Clean Air Transport Rule (CATR), the EPA tracked emissions of sulfur and nitrogen to allocate source-receptor impacts for areas expected to exceed the PM NAAQS.

AERMOD Dispersion Analysis

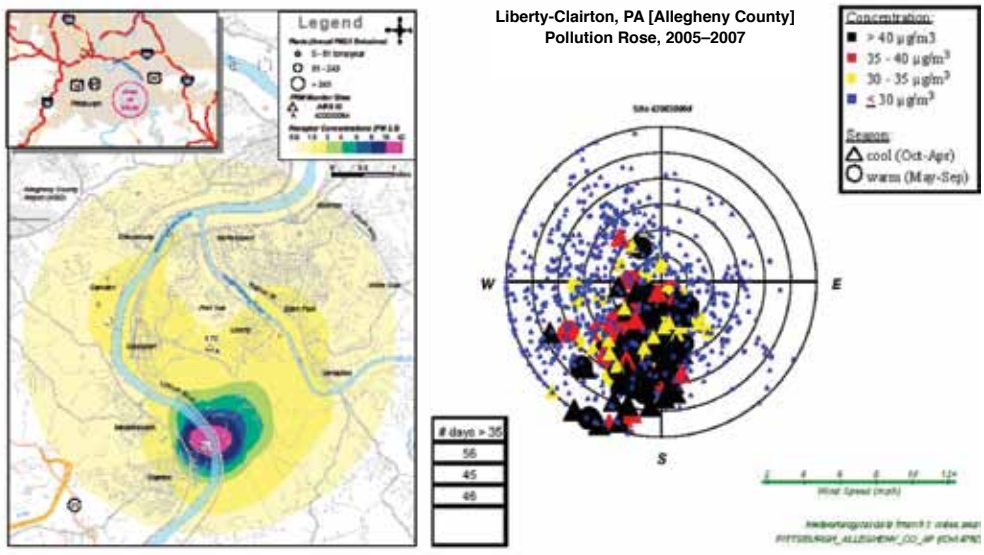

Figure 5-6 $PM_{2.5}$ pollution gradients from AERMOD (left).[19] Pollution rose at Liberty monitor (right).

The EPA's regulatory impact analysis presents point-source dispersion modeling results from AERMOD that shows strong PM gradients in the Mon Valley, driven primarily by emissions from the Clairton Coke Works (Figure 5-6). The analysis includes pollution increases that demonstrate winds come from the south and southwest when the Liberty monitor experiences the worst pollution, corresponding with emissions from the Clairton area. The Liberty monitor is represented by a triangle just under two miles north of the largest modeled point source, shown as a circle in the middle of the pink-colored maximum impact region. The source's direct impact quickly diminishes after traveling a mile away, roughly demonstrated by the pink, blue and green region around the source. The dispersion pattern suggests the pollution will flow north along the river bed, or to the east-northeast. No monitors directly capture the zone of greatest impacts. Notably, the modeled annual impact at Liberty is 1.75 $\mu g/m^3$, substantially lower than predictions based on ambient measurements. State Implementation

Regional Transport Modeling Source Apportionment

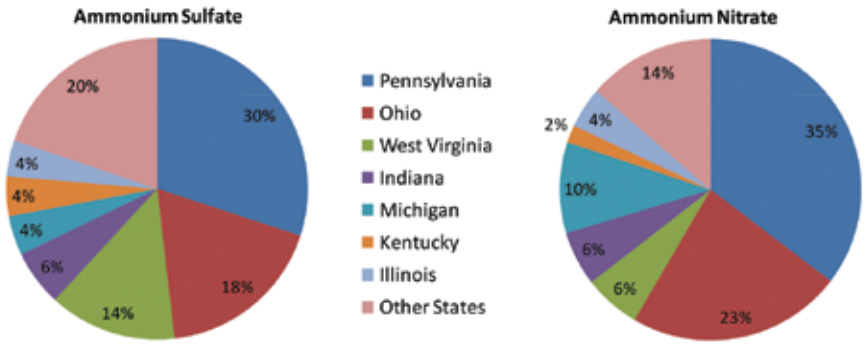

Figure 5-7 Annual average percent contribution to ammonium sulfate and nitrate at monitored locations in Allegheny County, Pennsylvania, from EPA source attribution modeling for the Clean Air Transport Rule

Plan modeling by the ACHD provides more reasonable estimates of annual impacts at the monitor from the Clairton facility.[20] Modeling only primary $PM_{2.5}$ emissions may partially account for this discrepancy.

In July 2010, the EPA proposed its CATR to help states address pollution transported into their borders from other states.[21] As part of this rule, they conducted air quality modeling that quantifies state-specific contributions to O_3 and $PM_{2.5}$ pollution at receptors in the modeling domain to help assign the responsibility for air quality reductions required from upwind states under section 110(a)(2)(D)(i)(I) of the Clean Air Act. This provision of the CAA requires states to prohibit emissions that contribute significantly to nonattainment in, or interfere with maintenance by, any other state with respect to any primary or secondary NAAQS. This is in addition to the states' primary responsibility under the act to attain and maintain air quality that satisfies the NAAQS. The transport rule augments air quality reductions already required by a state's implementation plan, which addresses its own contributions to local air quality problems.

The EPA relied on a regional chemical transport model, Comprehensive Air Quality Model with Extension (CAMx)[22], to apportion states' O_3 and $PM_{2.5}$ contribution to pollution at receptors in other states. They tracked emissions of SO_2 and NOx estimated for 2012 and quantified their impact on secondary pollutants sulfate, nitrate and ozone. The primary impact of emissions generally occurred within a state's own borders before being transported to other regions. This agrees with earlier modeling that recognized the greatest impact from a source occurs near to the source, for both secondary pollutants and especially primary pollutants.[23]

$PM_{2.5}$ results for monitors in Allegheny County are summarized in Figure 5-7. Contributions from Pennsylvania sources account for 30 percent and 35 percent of the modeled ammonium sulfate and nitrate at Allegheny County monitors. Six other states (Ohio, West Virginia, Indiana, Michigan, Kentucky and Illinois) are responsible for half of the rest of the sulfate and nitrate impacts in the county. Although not presented here, Pennsylvania NOx sources on average contributed to half of the modeled ozone at monitors in the Pittsburgh MSA.

LIMITATIONS OF THE EXISTING MONITORING NETWORK

Monitoring networks are costly to operate and are designed to characterize pollution levels across a region in order to assess compliance with NAAQS. They reasonably achieve that goal, especially in light of the difficulty in finding a location that is both accessible and with electricity. In a region like Pittsburgh, however, the complex topography combined with settlements, roadways and industry located along river valleys, potentially leads to strong gradients or pockets of pollution.

The EPA's dispersion modeling demonstrates the influence of complex terrain on dispersion from local pollution sources. Modeled missions from the Clairton Coke Works spread along two directions: up the river valley or toward the east, while the monitor sited to capture the pollution in the region is sited in between these two dominant paths of pollution transport. More important, the model predicts very strong gradients near the source, which implies the Liberty monitor may not be capturing the worst air quality that occurs near the source. With all of the hills and valleys, along with varied sources, there exists a high likelihood that other pockets of high pollution escape the direct capture of the current monitoring network.

With a mass-based ambient standard, measurements need only capture total $PM_{2.5}$ mass on a 24-hour averaged basis. Speciated mass measurements and hourly measurements would provide substantial additional information to improve the understanding of source impacts in the region. These types of measurements can be expensive and, as a result, are limited in number. The work by ACHD illustrates the added value these types of monitors provide, directly and through source-apportionment methods. As the air quality standards continue to tighten, these additional measurement types may help to pinpoint local air quality sources that contribute to pollution in the region.

KEY RESULTS FROM DATA AND MODELING ANALYSES

- FRM $PM_{2.5}$ monitors provide information on spatial gradients of pollution, correlations between monitoring sites and limited insights into relative local source impacts.
- Speciated $PM_{2.5}$ data suggest sulfates as the main regional pollution, with substantial local sources of other major components (nitrate, organic and elemental carbon).
- Regional reductions in sulfates and nitrates were observed from 2002–2008, while carbonaceous $PM_{2.5}$ decreased strongly at Liberty and increased a small amount at Florence.
- Based on source apportionment modeling and ambient data, nearly two-thirds of $PM_{2.5}$ at Liberty and one-half at Lawrenceville may be from sources within the Pittsburgh MSA.
- Chemical transport modeling predicts 30 percent of sulfate and 35 percent of nitrate at monitoring sites in Allegheny Count originates from Pennsylvania sources.
- Monitoring networks are primarily designed to demonstrate attainment of air quality standards and the region's topography may frustrate the ability to accurately determine air quality for all locations. Expanded monitoring is required to reflect the full range of $PM_{2.5}$ impacts in the region.

SECTION 6: CONCLUSIONS

Analysis of $PM_{2.5}$ and ozone air quality measurements and precursor emissions presented in this report show that the Pittsburgh region of southwestern Pennsylvania has made significant strides in improving air quality but still fails to meet the current air quality standards. Despite these observed positive trends that may continue, regional air pollution will likely continue to exceed ambient air quality standards for both pollutants into at least the next decade. This would happen if, in light of continued evidence of adverse health effects at increasingly lower exposure levels, further reductions in the NAAQS occur. The nature of air quality management in the United States renders impossible an accurate guess of when Pittsburgh will finally achieve clean air that protects its citizens from harm. If recent history holds into the future, a reasonable estimate would be at least a decade away, and more likely beyond.

The trends show that not only have improvements in air quality not occurred quickly enough to meet the ambient standards, but in some instances they do not keep up with improvements made in other regions of the country (Table 6.1). This observation applies broadly to both the annual and daily $PM_{2.5}$ levels, and to a limited extent for changes in ambient O_3 concentrations. The table shows that at Liberty, where the most substantial air quality improvements have occurred for both daily and annual $PM_{2.5}$, the ranking relative to other areas remains poor. In other words, improvements are not happening faster there than they are in other areas. The recent reductions due to temporary shutdowns may increase the chance for data from the monitor to worsen relative to others in the rest of the U.S. At the Lawrenceville monitor in Pittsburgh, the relative ranking has worsened, as reductions there have not kept pace with reductions in the rest of the country. Some indications based on emissions from the power sector in the region point toward a slower pace of local emission reductions of SO_2 and NOx as a contributing factor. The percentage reduction in western Pennsylvania has trailed reductions across the eastern United States by 10 percent and 20 percent for SO_2 and NOx, respectively.

Substantial spatial variation exists in the monitored levels of pollution. The primary cause of these differences relates to a non-uniform distribution of emission sources, in location and emission intensity. Topographic differences also play a key role. Despite substantial inflows of pollution from other states (primarily Ohio and West Virginia), some sites like Liberty clearly bear the brunt of emissions from local industrial facilities. Dispersion modeling and ambient measurements suggest emission reductions in Clairton would provide the greatest benefit within several miles of the facility. Changes in carbonaceous $PM_{2.5}$ imply reductions at Liberty do not substantially influence reductions as far away as the Lawrenceville monitor. This observation of immediately local impact also would be true of other substantial sources of primary pollutants, like other industrial facilities or the exit of pollution from roadway tunnels.

For ozone, concentrations measured downwind of Pittsburgh in Harrison remain unchanged despite large pollution reductions throughout the region (Table 6.1). That behavior points squarely to the influence of local emission sources and the specific chemical regime downwind of the city.

Location	Pollutant[24]	Early years of decade		End of decade	
		Level	Rank (%)	Level	Rank (%)
Liberty	$PM_{2.5}$ (A)	**20.9 µg/m³**	10 (1.7%)	**17.0 µg/m³**	8 (1.3%)
	$PM_{2.5}$ (D)	**59 µg/m³**	18 (3.0%)	**50 µg/m³**	12 (2.0%)
Lawrenceville	$PM_{2.5}$ (A)	**16.1 µg/m³**	127 (21.4%)	13.1 µg/m³	81 (13.7%)
	$PM_{2.5}$ (D)	**36 µg/m³**	210 (35.4%)	32 µg/m³	78 (13.2%)
Harrison	O_3	**81 ppb**	293 (33%)	**82 ppb**	90 (10%)
		Early Years		End of Decade	Decrease
Western PA	SO_2	607		499	17.7%
	NOx	347		310	10.5%
Eastern US	SO_2	28,997		20,684	28.7%
	NOx	9,398		6,579	30.0%

Table 6-1 Summary of ambient air concentrations and pollutant emissions (thousand tons per year).

As a result, air quality measured at that monitor has fallen into the worst 10 percent in the country. Apparently, ozone may not be as sensitive to changes in NOx levels downwind of Pittsburgh as more remote areas seem to be. Comparisons of mass and speciation at different PM monitoring sites in the region also reveal differences from site to site. Source apportionment modeling suggests that one-half of the $PM_{2.5}$ measured in Pittsburgh was derived from a combination of Pennsylvania sources, while almost two-thirds of the mass at Liberty points toward local and in-state source contributions.

The EPA concludes in its documentation that examines the nature of the fine particle air quality problem through the nine-factor analysis that the Pittsburgh-Beaver Valley area is affected by long-range transport. They also recognize the importance of the Pennsylvania power sector SO_2 and NOx emissions and motor vehicle activity as contributors to the nonattainment of the PM NAAQS. This understanding comports with the Clean Air Act, which generally treats air pollution as a local problem with each state primarily responsible for maintaining healthful air quality within its borders. States must submit implementation plans that outline reductions they can make within their borders to meet and maintain the NAAQS. The EPA's CATR provides additional measures to prevent nonattainment of standards from out of state pollution.

A large state like Pennsylvania will both be affected by emissions from upwind and contribute its own emissions to its downwind neighbors. The air quality and modeling data in this report demonstrate how effective local emission reductions can be at reducing air pollution, as seen at Liberty. They also suggest that the regional pollution reductions have occurred through reductions in regional pollution sources. Based on the acid rain dataset, those reductions have been more substantial in states other than Pennsylvania. Reductions from power plants in western Pennsylvania will be required to help attain standards not only in the state, but also downwind in other states adversely affected by their emissions.

The evidence based on analyses of ambient air quality data and modeling demonstrates the substantial contribution of emissions sources within Pennsylvania to elevated pollution concentrations across the region. This is true especially at sites directly affected by major sources like the coke works in Clairton. The criticism leveled at ALA for characterizing the region's air quality in large part from measurements made at Liberty would have people believe that air quality in Pittsburgh itself is acceptable, but for this isolated area. Suggestions that this specific offending monitor be discounted or removed from the analysis do a disservice to those people whose air quality really is represented by that specific monitor. The claim fails to acknowledge that many of the other areas whose air quality ranked poorly by ALA have monitors in their air sheds like Liberty, where pollution can be directly linked to major local pollution sources. These arguments simply distract people from the unfortunate, indisputable reality for Pittsburgh: Air quality throughout much of the region fails to meet the levels set by the EPA that protect the health of the public with a reasonable margin of safety.

Based on this study, a number of recommendations have emerged to help focus the region on attainment of its air quality goals. These include:

- Encourage public officials and industry leaders to ensure local power plants meet the same emission-reduction levels as those in other states.
- Review the region's monitoring system to determine whether improvements can be made to get the most accurate measurements possible of population exposures to air pollution.
- Improve emissions estimates to help identify important sources of pollution and aid in tracking emission reductions. The power sector SO_2 and NOx emission database exemplifies the utility of high-quality data for emissions accounting and accountability.
- Support the use of regulatory tools such as the State Implementation Plans to better identify local and regional sources of pollution and require follow-through that links ambient air quality improvements to specific programmatic elements within the SIP.
- Encourage the EPA to enact in a timely fashion National Ambient Air Quality Standards that adequately protect health.

DATA SOURCES

Air quality data used in this report were obtained from the following EPA websites:

www.epa.gov/airtrends/values.html

This website provides excel spreadsheets with design value calculations and monitor specific air quality metrics (e.g. annual averages, 98th percentile values, quarterly averages).

www.epa.gov/air/data/index.html

This website was used to obtain monitor summary information, including monitor location and other identifying characteristics.

www.epa.gov/airexplorer

This website provides access to the Air Quality System (AQS) database and can be queried to obtain air quality data collected by state and local agencies. Hourly and daily data were collected from this website for specific monitors in Pennsylvania.

www.camddataandmaps.epa.gov/gdm/index.cfm?fuseaction=emissions.wizard

Emissions data for major sulfur dioxide and nitrogen oxides emitters were obtained from the Clean Air Markets Division website. Specifically, the Acid Rain Database was used as a source of emissions data and trends over the last decade.

ENDNOTES

1 www.lungusa.org/assets/documents/publications/state-of-the-air/sota2010_report-history.pdf

2 Helfand, W.H., Lazarus, J. and P. Theerman. Donora, Pennsylvania: An Environmental Disaster of the 20th Century. Am J Public Health. 2001, 91(4): 553.

3 www.achd.net/air/pubs/pdf/08report_final.pdf

4 www.epa.gov/ttn/ecas/regdata/RIAs/fso2ria100602ch3a.pdf; www.epa.gov/ttn/ecas/regdata/RIAs/FinalNO2RIACh2Appendix2a1-20-10.pdf

5 Air Toxics in Allegheny County: Sources, Airborne Concentrations, and Human Exposure Technical Report, Carnegie Mellon University, 2009. www.pacode.com/secure/data/025/chapter131/s131.3.html

6 EPA Second Draft Policy Assessment for Review of the PM NAAQS www.epa.gov/ttn/naaqs/standards/pm/data/20100630seconddraftpmpa.pdf

7 A design value is the monitored air pollution concentration used by EPA to determine an area's air quality status relative to the appropriate air quality standard.

8 Averaging over three years minimizes the effect of variations due to year to year weather changes and creates a more stable value for comparison to the air quality standard.

9 www.achd.net/air/pubs/pdf/08report_final.pdf

10 CASAC Review of Policy Assessment for the Review of the PM NAAQS—Second External Review Draft (June 2010).

11 An important note—epidemiological results to date do not support a threshold of $PM_{2.5}$ concentration and response where there is no excess risk. The levels established by CASAC reflect the increased certainty of adverse health effects at lower and lower concentrations.

12 Three-year annual averages were ranked for the 593 monitors that operated from 1999–2009. The shaded red area shows the worst 10 percent in the U.S., or the 59 sites that measured the highest pollution over three years.

13 www.epa.gov/air/ozonepollution/designations/2008standards/rec/letters/03_PA_rec.pdf

14 Volz, CD, Michanowiz, D., Christen, C., Malone, S. and Ferrer, K., 2011, Unpublished Results of the Pittsburgh Environmental Threat Analysis (PRETA): www.chec.pitt.edu/Projects.html

15 Sources impacting a site can be thought of as falling into three spatial categories: local (within ~5 miles), regional (within ~50 miles) and long-range transport. Differences between sites in the Pittsburgh Metropolitan Statistical Area (MSA) help to quantify the differences in the locals sources that impact a site. Impact variation from sources within the MSA exists as well, while variation from long-range transport between sites should be very small relative to differences from more local sources.

16 www.achd.net/airqual/pubs/pdf/pmf0106.pdf Source Apportion Results; www.achd.net/airqual/pubs/pdf/speciation_report.pdf Speciation Report

17 NYSERDA Report 08-01 Assessment of Carbonaceous $PM_{2.5}$ for New York and the Region.

18 www.epa.gov/pmdesignations/2006standards/final/TSD/tsd_4.0_4.3_4.3.3_r03_PA.pdf

19 www.epa.gov/ttn/ecas/ria.html: RIA Appendix B- AERMOD Analysis for 2006 PM NAAQS

20 www.achd.net/airqual/SIP_Appendices_Feb_2011.zip (Appendix J)

21 www.epa.gov/airquality/transport/tech.html

22 Environ International Corporation. Novato, CA. March 2009.

23 Levy, J.I.; Spengler, J.D.; Hlinka, D.; Sullivan, D.; Moon, D. Using CALPUFF to Evaluate the Impacts of Power Plant Emissions in Illinois: Model Sensitivity and Implications; Atmos. Environ., 36 (2002) 1063–1075.

24 Early years for PM are 1999–2001; for O_3 and NOx 2003–2005; for SO_2 2000-2002.

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