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Office of Air Quality
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Research Triangle Park NC 27711

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March 2000

Air

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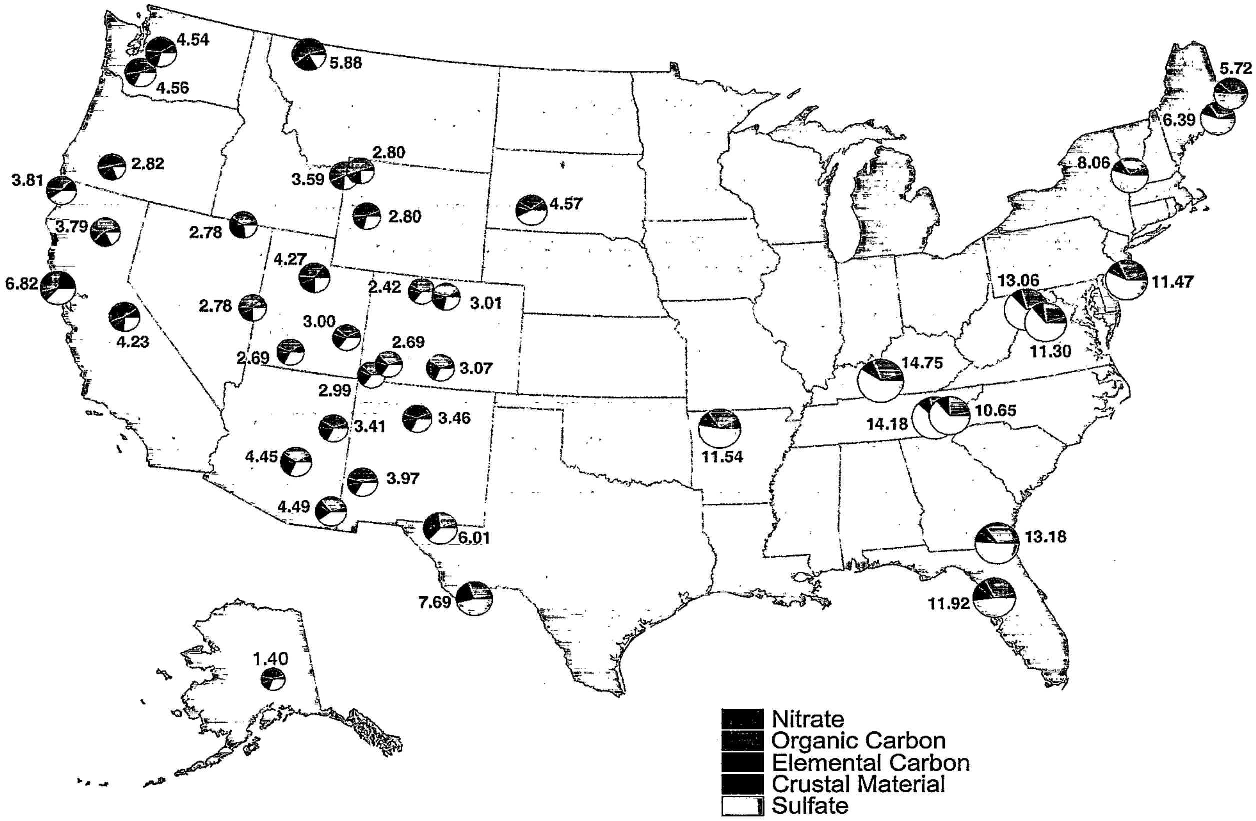
National Air Quality and Emissions Trends Report, 1998



1998 Annual Average $PM_{2.5}$ Concentrations (in µg/m^3) in Rural Areas of the United States

454/R-00-003

National Air Quality and Emissions Trends Report, 1998

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Emissions Monitoring and Analysis Division
Air Quality Trends Analysis Group
Research Triangle Park, North Carolina 27711

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About the Cover

The map on the cover displays the 1998 annual average $PM_{2.5}$ concentrations at monitoring sites in the Interagency Monitoring of PROtected Environments (IMPROVE) network. The IMPROVE network was established in 1987 to track visibility impairment in the nation's most pristine areas, like national parks and wilderness areas. (See Chapter 6 for more information on the IMPROVE network.) The size of the pie charts is proportional to the annual average concentration of measured $PM_{2.5}$. The slices of the pie charts show the percentages of the known chemical constituents of $PM_{2.5}$. The map reveals that rural $PM_{2.5}$ concentrations vary regionally, with sites in the East typically having higher annual average concentrations. Levels at most sites in the West are roughly less than half of those in the East.
Data Source: The IMPROVE network.

Disclaimer

This report has been reviewed and approved for publication by the U.S. Environmental Protection Agency's Office of Air Quality Planning and Standards. Mention of trade names or commercial products are not intended to constitute endorsement or recommendation for use.

Acknowledgments

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Preface

This is the twenty-sixth annual report on air pollution trends in the United States issued by the U.S. Environmental Protection Agency. The report is prepared by the Air Quality Trends Analysis Group (AQTAG) in Research Triangle Park, North Carolina and is directed toward both the technical air pollution audience and other interested parties and individuals.

The report can be accessed via the Internet at **http://www.epa.gov/airtrends/**. AQTAG solicits comments on this report and welcomes suggestions regarding techniques, interpretations, conclusions, or methods of presentation. Comments can be submitted via the website or mailed to:

Attn: Trends Team
AQTAG (MD-14)
U.S. EPA
Research Triangle Park, NC 27711

Readers can access data from the Aerometric Information Retrieval System (AIRS) at **http://www.epa.gov/airsdata/** and real time air pollution data at **http://www.epa.gov/airnow/**.

Contents

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Acronyms

AIRS	Aerometric Information Retrieval System
AQRV	Air-Quality Related Values
AIRMoN	Atmospheric Integrated Assessment Monitoring Network
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CARB	California Air Resources Board
CASAC	Clean Air Scientific Advisory Committee
CASTNet	Clean Air Status and Trends Network
CEMs	Continuous Emissions Monitors
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CMSA	Consolidated Metropolitan Statistical Area
DST	Daylight Savings Time
EPA	Environmental Protection Agency
FRM	Federal Reference Method
GDP	Gross Domestic Product
GLM	General Linear Model
HAPs	Hazardous Air Pollutants
IADN	Integrated Atmospheric Deposition Network
I/M	Inspection and Maintenance Programs
IMPROVE	Interagency Monitoring of PROtected Environments
MACT	Maximum Achievable Control Technology
MARAMA	Mid-Atlantic Regional Air Management Association
MDN	Mercury Deposition Network
MSA	Metropolitan Statistical Area
MDL	Minimum Detectable Level
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NAMS	National Air Monitoring Stations
NAPAP	National Acid Precipitation Assessment Program
NARSTO	North American Research Strategy for Tropospheric Ozone
NESCAUM	Northeast States for Coordinated Air Use Management
NMOC	Non-Methane Organic Compound
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NPS	National Park Service
NTI	National Toxics Inventory
O_3	Ozone
OTAG	The Ozone Transport Assessment Group
PAHs	Polyaromatic Hydrocarbons
PAMS	Photochemical Assessment Monitoring Stations
PAN	Peroxyacetyl Nitrate
Pb	Lead
PCBs	Polychlorinated Biphenyls
PM_{10}	Particulate Matter of 10 micrometers in diameter or less
$PM_{2.5}$	Particulate Matter of 2.5 micrometers in diameter or less
POM	Polycyclic Organic Matter
ppm	Parts Per Million
PSI	Pollutant Standards Index
RFG	Reformulated Gasoline
RVP	Reid Vapor Pressure
SLAMS	State and Local Air Monitoring Stations
SNMOC	Speciated Non-Methane Organic Compound
SO_2	Sulfur Dioxide
SO_x	Sulfur Oxides
TNMOC	Total Non-Methane Organic Compound
TRI	Toxic Release Inventory
TSP	Total Suspended Particulate
UATMP	Urban Air Toxics Monitoring Program
VMT	Vehicle Miles Traveled
VOCs	Volatile Organic Compounds
$\mu g/m^3$	Micrograms Per Cubic Meter

CHAPTER 1

Executive Summary

http://www.epa.gov/oar/aqtrnd98/chapter1.pdf

Criteria pollutants are those pollutants for which the United States Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS). They include carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2).

This is the twenty-sixth annual report documenting air pollution trends in the United States.[1-25] This document highlights the Environmental Protection Agency's most recent assessment of the nation's air quality, focusing on the 10-year period from 1989 to 1998. It features comprehensive information for the criteria pollutants and hazardous air pollutants, as well as relevant ambient air pollution information for visibility impairment and acid rain.

Discussions throughout this report are based on the principle that many of the programs designed to reduce ambient concentrations of the criteria pollutants also aid in reducing pollution that contributes to air toxics pollution, visibility impairment, and acid rain. Likewise, requirements under the various air toxics, visibility, and acid rain programs can also help reduce emissions that contribute to ambient concentrations of the criteria pollutants.

CHAPTER 2

CRITERIA POLLUTANTS — NATIONAL TRENDS

Percent Decrease in National Air Quality Concentrations 1989–1998

Carbon Monoxide	39
Lead	56
Nitrogen Dioxide	14
Ozone*	4
Particulate Matter (PM_{10})	25
Sulfur Dioxide	39

* based on 1-hour level.

Air quality concentrations are based on actual measurements of pollutant concentrations in the air at selected monitoring sites across the country.

Fine particulate matter, or $PM_{2.5}$, are those particles whose aerodynamic size is less than or equal to 2.5 micrometers.

EPA tracks trends associated with the criteria pollutant standards. The national and regional air quality trends, along with supporting emissions data, are presented in this chapter. National average air quality has improved from 1989 to 1998 for all the criteria pollutants.

While the national trends have improved over this 10-year period, trends in some areas, including rural locations, have worsened. Ozone concentrations, for example, have increased at 17 of the 24 National Park Service sites with trend data. Increases at nine of those sites are statistically significant. The 1998 levels were particularly high at two parks in the eastern United States, Shenandoah and the Great Smoky Mountains. Ozone levels at these sites were the highest in a decade and 30–40 percent higher than the national ozone standard.[26] Fine particle concentrations have also increased in some areas in the rural East. $PM_{2.5}$ concentrations increased at 7 of the 10 rural eastern sites with trend data from 1992 to 1998. During that same period, average $PM_{2.5}$ levels in the western United States decreased 5 percent.

On July 18, 1997, EPA revised the ozone and particulate matter standards following a thorough scientific review process. In May 1999, however, the U.S. Court of Appeals for the D.C. Circuit issued an opinion affecting these revised standards. In particular, the court remanded the ozone standard back to EPA for further consideration. The court also vacated the revised PM_{10} standard and remanded the $PM_{2.5}$ standards back to EPA for further consideration. Following the denial of a petition for a rehearing by the D.C. Circuit, the Justice Department has filed a petition for review before the Supreme Court. See

Special Report Chapter 2 features a special report on the impact of major wildfires on U.S. air quality.

Chapter 2 for trends relating to the revised ozone and PM NAAQS and refer to **http://www.epa.gov/airlinks/** for up-to-date information concerning actions surrounding the revised standards.

CHAPTER 3

CRITERIA POLLUTANTS—METROPOLITAN AREA TRENDS

Summary of MSA Trend Analyses, by Pollutant

	Trend Statistics	Total # MSAs	# MSAs Up	# MSAs Down Change	# MSAs with No Significant
CO	Second Max 8-hour	139	0	104	35
Lead	Max Quarterly Mean	90	1	61	28
NO_2	Arithmetic Mean	97	4	44	49
Ozone	Fourth Max 8-hour	198	13	25	160
Ozone	Second Daily Max 1-hour	198	11	23	164
PM_{10}	Weighted Annual Mean	211	1	152	58
PM_{10}	90th Percentile	211	0	132	79
SO_2	Arithmetic Mean	148	0	103	45
SO_2	Second Max 24-hour	148	0	91	57

Chapter 3 characterizes air quality on a more local level, using three different indicators. First, this chapter lists the 1998 peak air quality concentrations for metropolitan areas. Second, ten-year trends are assessed for each area using a statistical method to measure whether the trend is up or down. The results show that 21 areas had a statistically significant upward trend in ambient concentrations for at least one criteria pollutant, while 221 areas had a statistically significant downward trend for at least one criteria pollutant. The third way in which local air quality is evaluated is by looking at the Air Quality Index (AQI) in the nation's 94 largest metropolitan areas. The AQI analysis shows that between 1989 and 1998 the total number of "unhealthy" days decreased an average of 57 percent in southern California (which, for the purposes of this analysis, includes the Los Angeles, Riverside, Bakersfield, and San Diego), but actually rose 10 percent in the remaining major cities across the United States.

CHAPTER 4

CRITERIA POLLUTANTS—NONATTAINMENT AREAS

Nonattainment Status

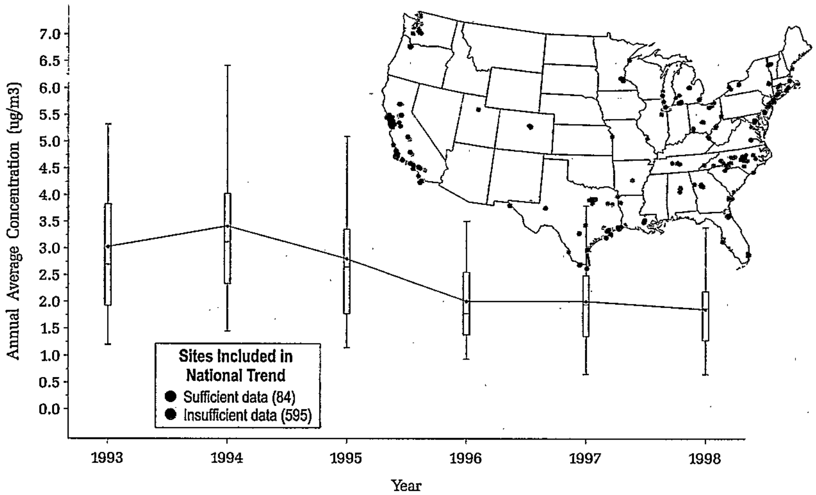
	Original # areas	1999 # areas	1999 Pop. (in 1000s)
CO	43	20	33,230
Pb	12	8	1,116
NO_2	1	0	0
O_3	101	32	92,505
PM_{10}	85	77	29,880
SO_2	51	31	4,371

Chapter 4 summarizes the current status of nonattainment areas, which are those areas not meeting the NAAQS for at least one of the six criteria pollutants. Under the Clean Air Act Amendments (CAAA) of 1990, there were 274 areas designated nonattainment for at least one ambient air quality standard. As of September 1999, 121 areas are designated nonattainment. These areas are displayed on a map in this chapter. A second map depicts the current ozone nonattainment areas, color-coded to indicate the severity of the ozone problem in each area. The condensed list of nonattainment areas as of September 1999 is presented in Table A-17. This table is also on the Internet at **http://www.epa.gov/airs/nonattn.html** and is updated as areas are redesignated.

CHAPTER 5

AIR TOXICS

National Trend in Annual Average Benzene Concentrations in Metropolitan Areas, 1993–1998



Chapter 5 presents information on another set of air pollutants regulated under the CAA. Hazardous Air Pollutants (HAPs), commonly called air toxics, are pollutants known to cause or suspected of causing cancer or other serious human health effects or ecosystem damage. The CAA lists 188 such pollutants and targets the sources emitting them for regulation. Examples of air toxics include mercury, chromium, benzene, and perchloroethylene ("perc"). Air toxics are emitted from literally thousands of sources, including familiar sources like electric utilities, automobiles, and dry cleaners.

In 1990, Congress amended Section 112 of the CAA by adding a new approach to the regulation of HAPs. This new approach is divided into two phases. The first requires the development of technology-based emissions standards for sources of the 188 HAPs. The second phase is to evaluate remaining problems or risks and develop additional regulations to address sources of those problems as needed.

The success of the Air Toxics Program depends on our ability to quantify the impacts of air toxics emissions on public health and the environment. To that end, EPA has initiated numerous National Air Toxics Assessment (NATA) activities to help identify areas of concern, characterize risks, and track progress. These activities include expanded air toxics monitoring, improving and periodically updating emissions inventories, national- and local-scale air quality and exposure modeling, and continued research on effects and assessment tools.

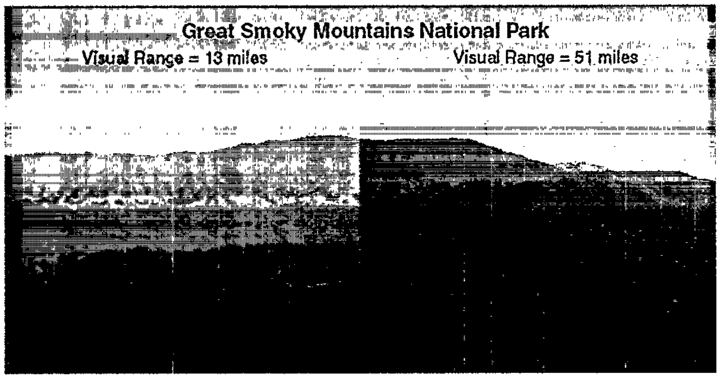
Currently, there are approximately 300 monitoring sites producing ambient data on HAPs. EPA is working together with state and local air monitoring agencies to build upon these monitoring sites to develop a monitoring network which is representative of air toxics problems on a national scale. EPA's Photochemical Assessment Monitoring Stations (PAMS) also measure HAPs among the many pollutants that are precursors of ozone. Although these existing data sources are limited in their geographic scope, they still provide useful information on the trends in ambient air toxics. The results generally reveal downward trends for most of the monitored HAPs. The most consistent improvement is apparent for benzene, which is predominantly emitted by mobile sources. Benzene decreased 37 percent from 1993 to 1998, with much of the reduction occurring between 1994 and 1996. This reduction is due, in large part, to the use of reformulated gasoline.

CHAPTER 6

VISIBILITY TRENDS

The CAA authorizes EPA to protect visibility, or visual air quality, through a number of programs. In 1987, the Interagency Monitoring of PROtected Visual Environments (IMPROVE) visibility monitoring network was established as a cooperative effort between EPA, National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish & Wildlife Service, and state governments. The objectives of the network are to establish current conditions, to track progress toward the national visibility goal by documenting long-term trends, and to provide information for determining the types of pollutants and sources primarily responsible for visibility impairment.

The trends analyses presented in this chapter are based on data from the IMPROVE network. There were 34 sites having data adequate for assessing trends between 1989 and 1998. Because of the significant regional variations in visibility conditions, the trends are grouped into eastern and western regions, rather than a national aggregate. The trends are presented in terms of the annual average values for the "clearest," "typical," and "haziest" days monitored each year.



The results show that, in general, visibility is worse in the east than in the west. In fact, the worst visibility days in the west are only slightly more impaired than the best days in the east. The 10-year trends show that visibility in the west has improved slightly for all three ranges (clearest, typical, and haziest days), while visibility in the east does not seem to be improving for any of the ranges. In fact, eastern visibility impairment on the haziest days has worsened from 1997 to 1998, and the Great Smoky Mountains National Park experienced its worst visibility in more than a decade.

In April of 1999, EPA issued the final regional haze regulation. This regulation addresses visibility impairment in national parks and wilderness areas that is caused by numerous sources located over broad regions. The program lays out a framework within which states can work together to develop implementation plans that are designed to achieve "reasonable progress" toward the national visibility goal of no human-caused impairment in the 156 mandatory Class I federal areas across the country. Implementation of the PM and Ozone NAAQS in conjunction with a future regional haze program is expected to improve visibility in urban as well as rural areas across the country.

CHAPTER 7

ATMOSPHERIC DEPOSITION OF SULFUR AND NITROGEN COMPOUNDS

Comparison of ambient sulfate concentrations in the rural eastern United States from CASTNet monitoring data, 1990–1991 vs. 1997–1998.

1990–1991 | 1997–1998 | Decrease in ambient sulfate concentrations in the rural eastern United States, 1990–1991 vs. 1997–1998.

Acidic deposition or "acid rain" occurs when emissions of sulfur dioxide (SO_2) and oxides of nitrogen (NOx) in the atmosphere react with water, oxygen, and oxidants to form acidic compounds. These compounds fall to the Earth in either dry form (gas and particles) or wet form (rain, snow, and fog). Some are carried by the wind, sometimes hundreds of miles, across state and national borders. In the United States, about 64 percent of annual SO_2 emissions and 26 percent of NO_x emissions are produced by electric utility plants that burn fossil fuels.

The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) and the Clean Air Status and Trends Network (CASTNet), two monitoring networks described in detail in the chapter, monitor wet and dry acid deposition, respectively. NADP/NTN consists of nearly 200 sites nationwide, while CASTNet contains 79 sites. These sites monitor a number of compounds, including sulfates and nitrates, which are formed from SO_2 and NO_x reacting in the atmosphere.

Wet deposition data from the NADP/NTN show that sulfate concentrations in precipitation have decreased over the past two decades. In 1995 and 1996, concentrations of sulfates in precipitation over a large area of the eastern United States exhibited a dramatic and unprecedented reduction. Sulfates have been estimated to be 10–25 percent lower than levels expected with at continuation of the 1983–1994 trend. This important reduction in acid precipitation is directly related to the large regional decreases in SO_2 emissions resulting from phase I of the Acid Rain program (see the SO_2 section in Chapter 2 for more details). Nitrate concentrations in recent years at the NADP/NTN sites are not appreciably different from historical levels.

Dry deposition data from the CASTNet sites in the eastern rural United States show that average sulfate concentrations decreased 22 percent between 1989 and 1998. However, a 10-percent increase in average sulfate concentrations occurred between 1997 and 1998. Most of the increase occurred during the second and third calendar quarters. Between these warmer months of 1997 and 1998, regional sulfur dioxide emissions increased 12 percent and average sulfate concentrations increased 21 percent. The higher summertime emissions in 1998 are attributed, in part, to the extra demand on electric utilities due to extremely warm temperatures throughout the Southeast.

The trend in nitrate concentrations is essentially flat, corresponding to the small change in NO_x emissions during this period. The highest nitrate concentrations are found in Ohio, Indiana, and Illinois, while the highest sulfate concentrations are adjacent to the Ohio Valley and in northern Alabama, which correspond to the locations of large electric utilities.

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26. Based on the level of the 8-hour ozone standard (0.08 ppm).

CHAPTER 2

Criteria Pollutants — National Trends

http://www.epa.gov/oar/aqtrnd98/chapter2.pdf

This chapter presents national and regional trends for each of the pollutants for which the United states Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS). NAAQS are in place for the following six criteria pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2). Table 2-1 lists the NAAQS for each pollutant in terms of the level and averaging time of the standard used to evaluate compliance.

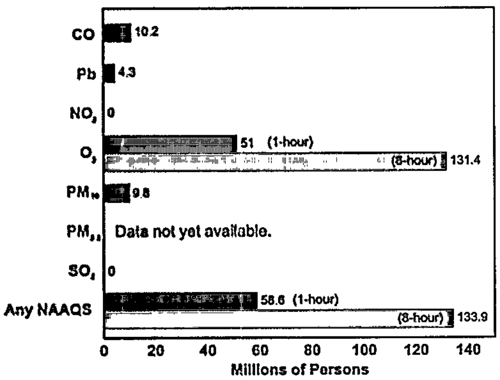
There are two types of standards: primary and secondary. Primary standards protect against adverse human health effects, whereas secondary standards protect against welfare effects such as damage to crops, ecosystems, vegetation, buildings, and decreased visibility. There are primary standards for all of the criteria pollutants, and some pollutants (PM and SO_2) have primary standards for both long-term (annual average) and short-term (24 hours or less) averaging times. Short-term standards most directly protect people from adverse health effects associated with peak short-term exposures to air pollution, while long-term standards can protect people from adverse health effects associated with short- and long-term exposures to air pollution. Second-

Table 2-1. NAAQS in effect as of December 1999.

Pollutant	Primary Standard (Health Related)		Secondary Standard (Welfare Related)	
	Type of Average	Standard Level Concentration[c]	Type of Average	Standard Level Concentration[a]
CO	8-hour[b]	9 ppm (10 mg/m³)	No Secondary Standard	
	1-hour[b]	35 ppm (40 mg/m³)	No Secondary Standard	
Pb	Maximum Quarterly Average	1.5 μg/m³	Same as Primary Standard	
NO_2	Annual Arithmetic Mean	0.053 ppm (100 μg/m³)	Same as Primary Standard	
O_3	Maximum Daily 1-hour Average[c]	0.12 ppm (235 μg/m³)	Same as Primary Standard	
	4th Maximum Daily[d] 8-hour Average	0.08 ppm (157 μg/m³)	Same as Primary Standard	
PM_{10}	Annual Arithmetic Mean	50 μg/m³	Same as Primary Standard	
	24-hour[b]	150 μg/m³	Same as Primary Standard	
$PM_{2.5}$	Annual Arithmetic Mean[e]	15 μg/m³	Same as Primary Standard	
	24-hour[f]	65 μg/m³	Same as Primary Standard	
SO_2	Annual Arithmetic Mean	0.03 ppm (80 μg/m³)	3-hour[b]	0.50 ppm (1,300 μg/m³)
	24-hour[b]	0.14 ppm (365 μg/m³)		

a Parenthetical value is an approximately equivalent concentration. (See *40 CFR* Part 50).
b Not to be exceeded more than once per year.
c The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than one, as determined according to Appendix H of the Ozone NAAQS.
d Three-year average of the annual 4th highest daily maximum 8-hour average concentration.
e Spatially averaged over designated monitors.
f The form is the 98th percentile.

ary standards have been established for each criteria pollutant except CO. Secondary standards are identical to the primary standards, with the exception of SO_2. Approximately 134 million people in the United states reside in counties that did not meet the primary standard for at least one of the criteria pollutants for the single year 1998.



Number of people living in counties with air quality concentrations above the level of NAAQS in 1998.

On July 18, 1997, EPA revised the ozone and PM NAAQS. The averaging time of the ozone standard changed from a 1-hour average to an 8-hour average to protect against longer exposure periods that are of concern for both human health and welfare. The primary PM standards were revised to change the form of the PM_{10} standards and to add two new $PM_{2.5}$ standards to protect against fine particles.

In May 1999, however, the U.S. Court of Appeals for the D.C. Circuit issued an opinion affecting these revised standards. In particular, the court remanded the ozone standard back to EPA for further consideration. The court also vacated the revised PM_{10} standard and remanded the $PM_{2.5}$ standards back to EPA for further consideration. Following the denial of a petition for a rehearing by the D.C. Circuit, the Justice Department has filed a petition for review before the Supreme Court. Refer to **http://www.epa.gov/airlinks** for up-to-date information concerning actions surrounding the revised standards.

The trends information presented in this chapter is based on two types of data: ambient concentrations and emissions estimates. Ambient concentrations are measurements of pollutant concentrations in the ambient air from monitoring sites across the country. This year's report contains trends data accumulated from 1989 to 1998 on the criteria pollutants at thousands of monitoring stations located throughout the United states. The trends presented here are derived from the composite average of these direct measurements. The averaging times and air quality statistics used in the trends calculations relate directly to the NAAQS.

The second type of data presented in this chapter are national emissions estimates. These are based largely on engineering calculations of the amounts and kinds of pollutants emitted by automobiles, factories, and other sources over a given period. In addition, some emissions estimates are based on measurements from continuous emissions monitors (CEMs) that have recently been installed at major electric utilities to measure actual emissions. This report incorporates data from CEMs collected between 1994 and 1998 for NO_x and SO_2 emissions at major electric utilities. The emissions data summarized in this chapter and in Appendix A were obtained from the *National Air Pollutant Emission Trends Report, 1900–1998*, which can be found at **http://www.epa.gov/ttn/chief/trends98/emtrnd.html.**

Changes in ambient concentrations do not always track changes in emissions estimates. There are four known reasons for this. First, because most monitors are positioned in urban, population-oriented locales, air quality trends are more likely to track changes in urban emissions rather than changes in total national emissions. Urban emissions are generally dominated by mobile sources, while total emissions in rural areas may be dominated by large stationary sources such as power plants and smelters.

Second, emissions for some pollutants are calculated or measured in a different form than the primary air pollutant. For example, concentrations of ozone are caused by VOC emissions as well as NO_x emissions.

Third, the amount of some pollutants measured at monitoring locations depends on what chemical reactions, if any, occur in the atmosphere during the time it takes the pollutant to travel from its source to the monitoring station.

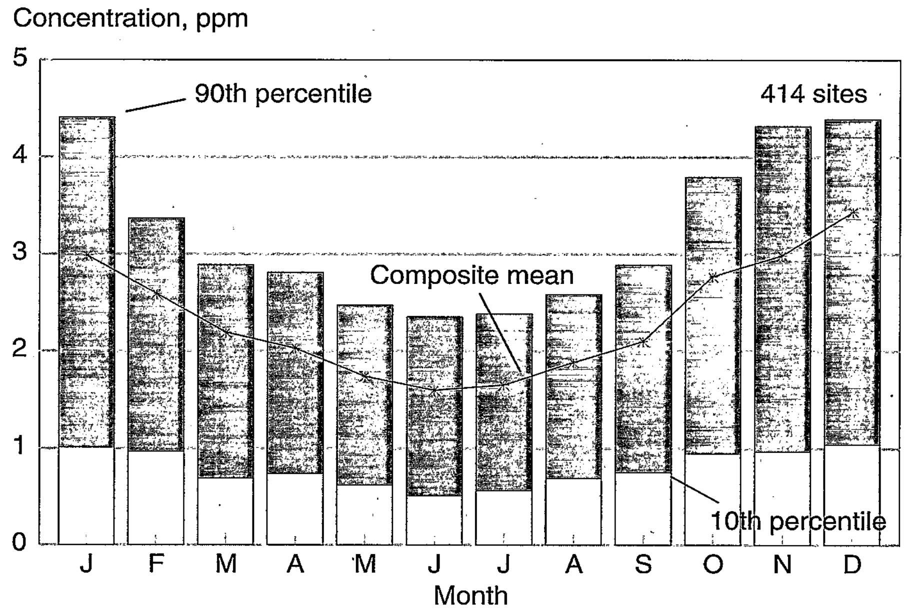
Finally, meteorological conditions often control the formation and buildup of pollutants in the ambient air. For example, peak ozone concentrations typically occur during hot, dry, stagnant summertime conditions; CO is predominately a cold weather problem; also, the amount of rainfall can affect particulate matter levels and the frequency of forest fires.

For a more detailed discussion of the methodology used to compute the trend statistics in this chapter, please refer to Appendix B.

Carbon Monoxide

Air Quality Concentrations		
1989–98	39%	decrease
1997–98	3%	decrease
Emissions		
1989–98	16%	decrease
1997–98	5%	decrease

Figure 2-1. Average daily maximum 1-hour CO concentrations by month, 1998.



Nature and Sources

CO is a colorless, odorless, (and at much higher levels) poisonous gas, formed when carbon in fuels is not burned completely. It is a product of motor vehicle exhaust, which contributes about 60 percent of all CO emissions nationwide. High concentrations of CO generally occur in areas with heavy traffic congestion. In cities, as much as 95 percent of all CO emissions may emanate from automobile exhaust. Other sources of CO emissions include industrial processes, non-transportation fuel combustion, and natural sources such as wildfires. Woodstoves, cooking, cigarette smoke, and space heating are sources of CO in indoor environments. Peak CO concentrations typically occur during the colder months of the year when CO automotive emissions are greater and nighttime inversion conditions are more frequent. Figure 2-1 shows this seasonal pattern in average daily maximum 1-hour CO concentrations at 414 sites reporting complete data in 1998.

Health Effects

Carbon monoxide enters the bloodstream through the lungs and reduces oxygen delivery to the body's organs and tissues. The health threat from lower levels of CO is most serious for those who suffer from cardiovascular disease, such as angina pectoris. At much higher levels of exposure, CO can be poisonous, and healthy individuals may also be affected. Visual impairment, reduced work capacity, reduced manual dexterity, poor learning ability, and difficulty in performing complex tasks are all associated with exposure to elevated CO levels.

Primary Standards

There are two primary NAAQS for ambient CO—a 1-hour average of 35 ppm, and an 8-hour average of 9 ppm. These concentrations are not to be exceeded more than once per year. There currently are no secondary standards for CO.

National 10-Year Trends

The 10-year trend in ambient CO concentrations is shown in Figure 2-2. Nationally, CO concentrations decreased 39 percent during the past 10 years as measured by the composite average of the annual second highest 8-hour concentration (referred to as the second maximum non-overlapping 8-hour concentration). Year-to-year reductions in peak 8-hour CO concentrations have continued since the upturn in 1994. Between 1997 and 1998, CO concentrations decreased 3 percent on average and are the lowest level recorded during the past 10 years. Exceedances of the 8-hour CO NAAQS (which are simply a count of the number of times the level of the standard is exceeded) have declined 98 percent since 1989.

Long-term reductions in ambient CO concentrations have been measured across all monitoring environments—rural, suburban, and urban sites. Figure 2-3 shows that on average, urban monitoring sites record higher CO concentrations than suburban sites, with the lowest levels found at 12 rural CO sites. During the past 10 years, the composite mean CO 8-hour concentration decreased 36 percent at 12 rural monitoring sites, 37 percent at 148 suburban sites, and 41 percent at 200 urban sites.

Emissions Trends

Figure 2-4 shows that national total CO emissions have decreased 16 percent since 1989. Emissions from all transportation sources have decreased 16 percent during the past 10 years. Despite a 23-percent increase in vehicle miles traveled (VMT), emissions from on-road vehicles decreased 24 percent during the past 10 years as a result of automotive emissions control programs. Total CO emissions decreased 5 percent since 1997, while CO emissions from on-road vehicles recorded a 2-percent decline. Figure 2-5 shows that the transportation category, composed of on-road and off-road sources, accounts for 79 percent of the nation's total CO emissions in 1998.

Table 2-2 lists some of the major milestones in the control of emissions from automobiles starting with the Clean Air Act (CAA) of 1970. At the national level, these measures, which have led to reductions in emissions of CO as well as other pollutants, include establishing national standards for tailpipe emissions, new vehicle technologies, and clean fuels programs. State and local emissions reduction measures include inspection and maintenance (I/M) programs and transportation management programs.

Figure 2-2. Trend in 2nd maximum non-overlapping 8-hour average CO concentrations, 1989–1998.

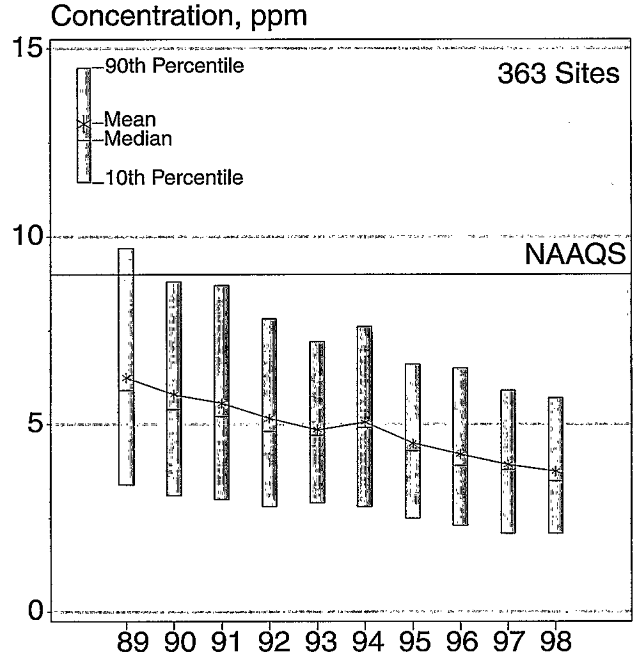


Figure 2-3. Trend in 2nd maximum non-overlapping 8-hour average CO concentrations by type of location, 1989–1998.

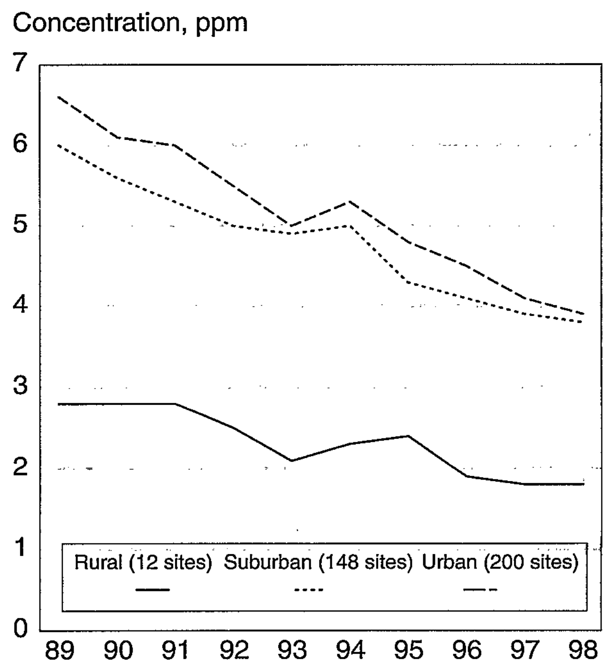


Figure 2-4. Trend in national total CO emissions, 1989–1998.

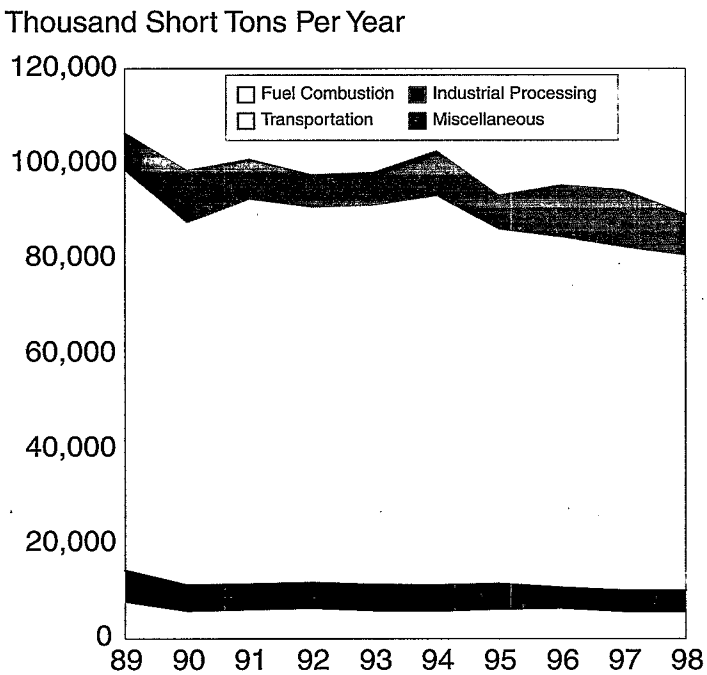


Figure 2-5. CO emissions by source category, 1998.

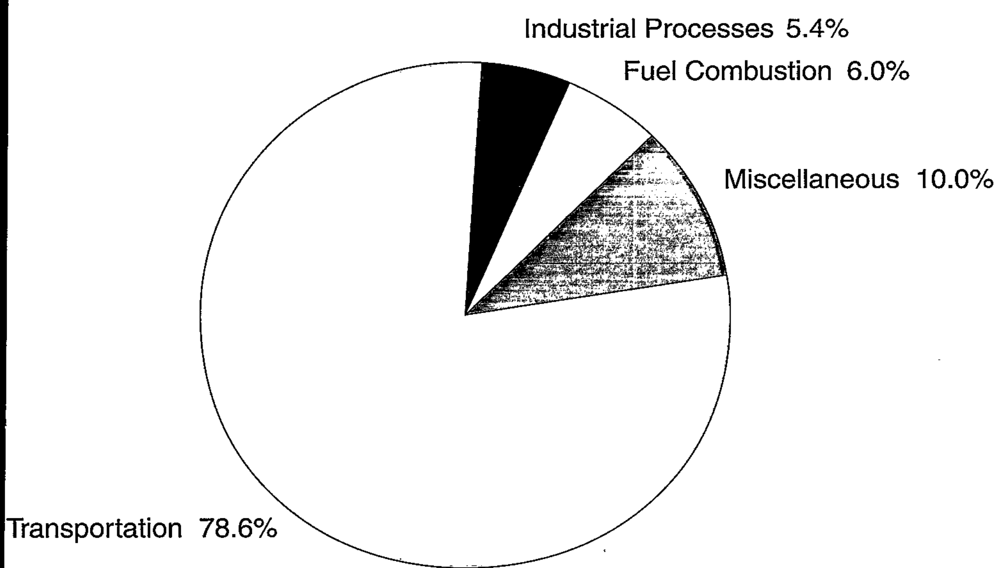


Table 2-2. Milestones in Motor Vehicle Emissions Control

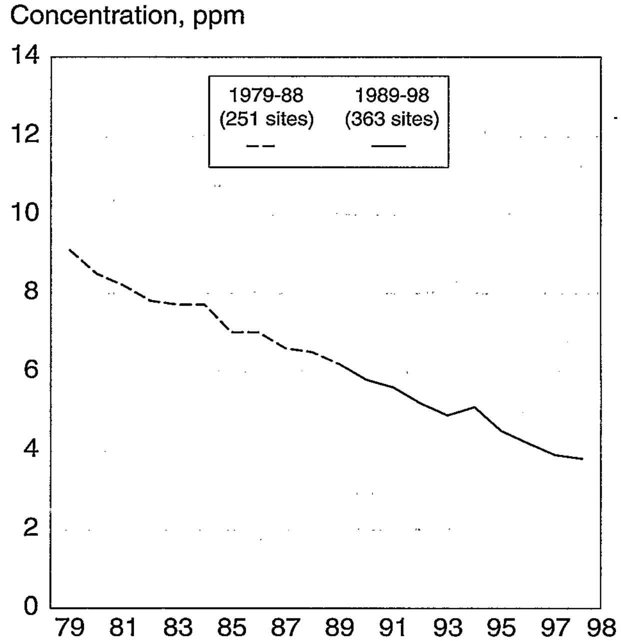
1970	New Clean Air Act sets auto emissions standards.
1971	Charcoal canisters appear to meet evaporative standards.
1972	EGR valves appear to meet NO_x standards.
1974	Fuel economy standards are set.
1975	The first catalytic converters appear for hydrocarbon, CO.
	Unleaded gas appears for use in catalyst equipped cars.
1981	3-way catalysts with on-board computers and O_2 sensors appear.
1983	I/M programs are established in 64 cities.
1989	Fuel volatility limits are set for RVP.
1990	CAAA set new tailpipe standards.
1992	Oxy-fuel introduced in cities with high CO levels.
1993	Limits set on sulfur content of diesel fuel.
1994	Phase-in begins of new vehicle standards and technologies.
1995	On-board diagnostic systems in 1996 model year cars.
1998	Sales of 1999 model year California emissions equipped vehicles begin in the Northeast.

In the area of clean fuels, the 1990 Clean Air Act Amendments (CAAA) require oxygenated gasoline programs in several regions of the country during the winter months. Under the program regulations, a minimum oxygen content (2.7 percent by weight) is required in gasoline to ensure more complete fuel combustion.[1,2] Of the 36 CO nonattainment areas that initially implemented the program in 1992, 25 areas participated in the program during January and February 1998, while 17 areas continued to use oxygenated fuels during November and December 1998. An analysis of the oxygenated fuels program in several cities with winter oxygenated gasoline programs showed reductions in ambient CO concentrations of about 10 percent.[3] Other studies estimated that the oxy-fuel effect was an average total reduction in ambient CO concentrations of 7 to 14 percent overall for the eight winter seasons from 1986 through 1994.[4,5]

Blue Ribbon Panel on Oxygenates in Gasoline

In November 1998, in response to the public concern regarding the detection of MTBE (methyl tertiary butyl ether—one of two fuel oxygenates used in reformulated gasoline to help improve air quality) in water, EPA Administrator Carol M. Browner announced the creation of a blue ribbon panel of leading experts from the public health and scientific communities, automotive fuels industry, water utilities, and local and state governments to review the important issues posed by the use of MTBE and other oxygenates in gasoline. The Panel's final report stated that "the Wintertime Oxyfuel Program continues to provide a means for some areas of the country to come into, or maintain, compliance with the carbon monoxide standard. Only a few metropolitan areas continue to use MTBE in this program. In most areas today, ethanol can, and is, meeting these wintertime needs for oxygen without raising fuel volatility concerns given the season of the year. The Panel recommends that the Wintertime Oxyfuel program be continued (a) for as long as it provides a useful compliance and/or maintenance tool for the affected states and metropolitan areas, and (b) assuming that the clarification of state and federal authority described above is enacted to enable states, where necessary, to regulate and/or eliminate the use of gasoline additives that threaten drinking water supplies."[6] The Panel's Executive Summary and final report entitled *Achieving Clean Air and Clean Water: The Report of the Blue Ribbon Panel on Oxygenates in Gasoline* can be found on the Panel's homepage at: http://www.epa.gov/oms/consumer/fuels/oxypanel/blueribb.htm.

Figure 2-6. Long-term trend in 2nd maximum non-overlapping 8-hour average CO concentrations, 1979–1998.



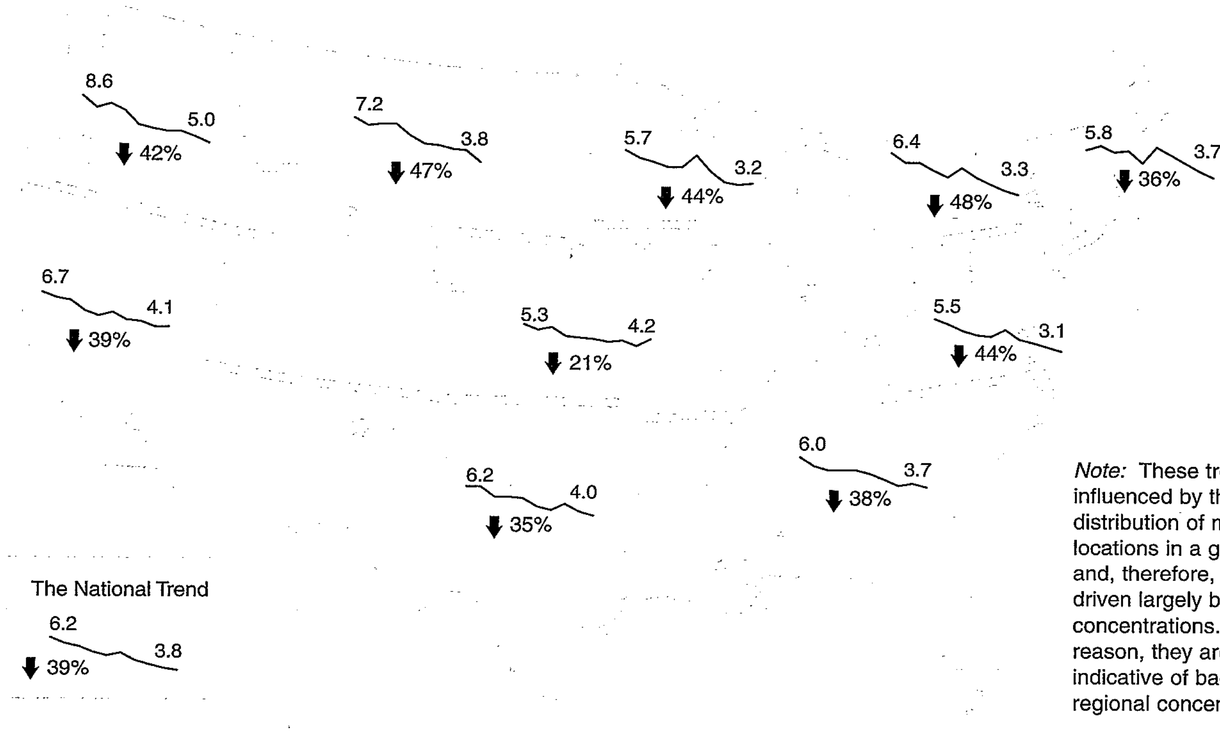
National 20-Year Trends

Because of the annual loss and replacement of ambient monitoring sites (e.g., redevelopment, new leases, etc.), too few sites are able to meet a 20-year trends data completeness criteria. Thus, long-term trends are assessed by piecing together two separate 10-year trends databases. Although there are differences in the mix of trend sites for the two periods (251 vs. 363 sites), Figure 2-6 shows a consistent decline in CO concentrations during the past 20 years. Nationally, the 1998 composite average ambient concentration is 58 percent lower than 1979, and is the lowest level recorded during the past 20 years of monitoring.

Regional Trends

The map in Figure 2-7 shows the regional trends in ambient CO concentrations during the past 10 years, 1989–1998. All 10 EPA Regions recorded 10-year declines in CO levels as measured by the regional composite mean concentrations. The largest 10-year concentration reductions are in the Northcentral, Rocky Mountain and Northwest states. Smaller reductions can be seen in the New England, West, South and Midwest regions. Two regions (Region 5 and Region 7) saw increases in the composite mean CO concentration be-

Figure 2-7. Trend in CO 2nd maximum non-overlapping 8-hour concentrations by EPA Region, 1989–1998.



Note: These trends are influenced by the distribution of monitoring locations in a given region and, therefore, can be driven largely by urban concentrations. For this reason, they are not indicative of background regional concentrations.

Alaska is in EPA Region 10; Hawaii, EPA Region 9; and Puerto Rico, EPA Region 2. Concentrations are ppm.

tween 1997 and 1998 (increases of 3 percent and 14 percent, respectively).

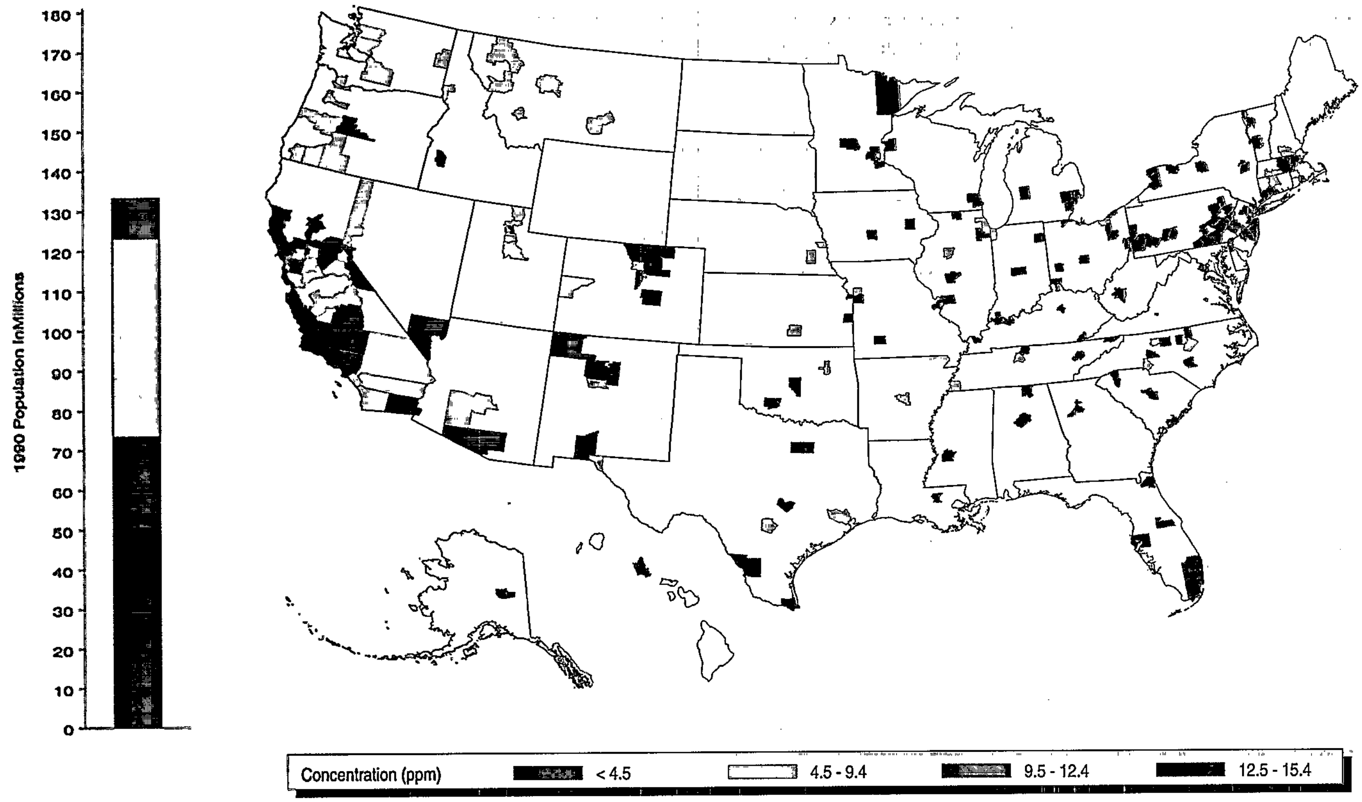
1998 Air Quality Status

The map in Figure 2-8 shows the variations in CO concentrations across the country in 1998. The air quality indicator is the largest annual second maximum 8-hour CO concentration measured at any site in each county. The bar chart to the left of the map displays the number of people living in counties within each concentration range. The colors on the map and bar chart correspond to the colors of the concentration ranges displayed in the map legend. Only seven of the 526 monitoring sites reporting ambient CO data to the Aerometric Information Retrieval System (AIRS) failed to meet the CO NAAQS in 1998. These seven sites were located in six counties—Los Angeles County, CA; Fairbanks Burough, AK; Clarke County, NV (Las Vegas, NV); Polk County, IA (Des Moines, IA); Hancock County, WV (Weirton, WV); and Imperial County, CA (Calexico, CA). The two sites in this latter area are located just north of the border crossing with Mexicali, Mexico. There are 10 million people living in these six counties, compared to the 1997 count of three counties with a total population of 9 million people.

Data Sources

The CO ambient trends plotting points and emissions totals, by source category, are listed in Tables A-1 and A-2. The plotting points for the 20-year trend charts are listed in Table A-9. The 1998 county maximum second-highest non-overlapping 8-hour CO concentrations are listed in Table A-11.

Figure 2-8. Highest 2nd maximum non-overlapping 8-hour average CO concentration by county, 1998.



Lead

Air Quality Concentrations		
1989–98	56%	decrease
1997–98		no change
Emissions		
1989–98	27%	decrease
1997–98	1%	increase

Nature and Sources

Twenty years ago, automotive sources were the major contributor of lead emissions to the atmosphere. As a result of EPA's regulatory efforts to reduce the content of lead in gasoline, the contribution from the transportation sector has declined. Today, metals processing is the major source of lead emissions to the atmosphere. The highest ambient air concentrations of lead are found in the vicinity of ferrous and nonferrous smelters, battery manufacturers, and other stationary sources of lead emissions.

Health and Environmental Effects

Exposure to lead occurs mainly through inhalation and through ingestion of lead in food, water, soil, or dust. It accumulates in the blood, bones, and soft tissues. Lead can also adversely affect the kidneys, liver, nervous system, and other organs. Excessive exposure to lead may cause neurological impairments such as seizures, mental retardation, and/or behavioral disorders. Even at low doses, lead exposure is associated with changes in fundamental enzymatic, energy transfer, and homeostatic mechanisms in the body. At low doses, fetuses and children may suffer from central nervous system damage. Recent studies show that lead may be a factor in high blood pressure and subsequent heart disease. Recent studies also indicate that neurobehavioral changes may result from lead exposure during the child's first years of life.

Airborne lead can also have adverse impacts on the environment. Wild and domestic grazing animals may ingest lead that has deposited on plant or soil surfaces or that has been absorbed by plants through leaves or roots. Animals, however, do not appear to be more susceptible or more sensitive to adverse effects from lead than humans. For this reason, the secondary standard for lead is identical to the primary standard.

At relatively low concentrations (2–10 µg/m^3), lead can inhibit plant growth and result in a shift to more tolerant plant species growing near roadsides and stationary source emissions. In spite of the fact that the majority of soil lead becomes bound so that it is insoluble, immobile, and biologically unavailable, elevated soil lead concentrations have been observed to cause shifts in the microbial community (fungi and bacteria), reduced numbers of invertebrates, reduced decomposition and nitrification rates, and altered other soil parameters. Because lead remains in the soil, soil concentrations continue to build over time, even when deposition rates are low. Thus, another concern is that acid precipitation may be increasing the mobility and bioavailability of soil lead in some places.

Lead enters water systems mainly through urban runoff and sewage and industrial effluents. Most of this lead is readily complexed and bound in the sediment. However, water lead concentrations can reach levels that are associated with increased mortality and impaired reproduction in aquatic invertebrates and blood and neurological changes in fish. Given the above effects, there continue to be implications for the long-term impact of lead on ecosystem function and stability. (See also the Toxics chapter and the *December 1990 OAQPS Staff Paper* (EPA-450/2-89-022)).

Primary and Secondary Standards

The primary and secondary NAAQS for lead is a quarterly average concentration not to exceed 1.5 µg/m^3.

National 10-Year Trends

The statistic used to track ambient lead air quality is the maximum quarterly mean concentration of each year. A total of 189 ambient lead monitors met the trends data completeness criteria for the 10-year period 1989–1998. Point-source oriented monitoring data were excluded from all ambient trends analyses presented in this section to avoid masking the underlying urban trends. Figure 2-9 indicates that between 1989 and 1998, maximum quarterly average lead concentrations decreased 56 percent at population-oriented monitors. Between 1997 and 1998, national average lead concentrations (approaching the minimum detectable level) remained unchanged. Figure 2-10 looks at urban, rural, and suburban 10-year trends separately. The figure shows that background levels of lead are similar in the three demographic regions.

Emissions Trends

Figure 2-11 shows that total lead emissions decreased 27 percent between 1989 and 1998. The large ambient and emissions reductions are a waning result of the phase-out of leaded gasoline. Table A-3, which lists lead emissions by major source category, shows that on-road vehicles accounted for 64 percent of the 10-year emissions decline. Between 1997 and 1998, lead emissions estimates did not change substantially. Figure 2-12 shows that industrial processes were the major source of lead emissions in 1998, accounting for 74 percent of the total. The transportation sector (on-road and non-road sources) now accounts for only 13 percent of total 1998 lead emissions, with most of that coming from aircraft.

National 20-Year Trends

The effect of the conversion to unleaded gasoline usage on ambient lead concentrations is most impressive when viewed over a longer period, such as illustrated in Figure 2-13. Between 1979 and 1998, ambient concentrations of lead declined 96 percent. This large decline tracks well with overall lead emissions, which declined 98 percent between 1979 and 1998.

Regional Trends

Figure 2-14 segregates the ambient trend analysis by EPA Region. Although most regions showed large concentration reductions between 1989 and 1998, there were some intermittent upturns. Many of the "bumps" in the graphs can be attributed to the inherent variability associated with data reported near the minimum detectable level.

1998 Air Quality Status

The large reductions in long-term lead emissions from transportation sources have changed the nature of the ambient lead problem in the United States. Because industrial pro-

Figure 2-9. Trend in maximum quarterly average Pb concentrations (excluding source-oriented sites), 1989–1998.

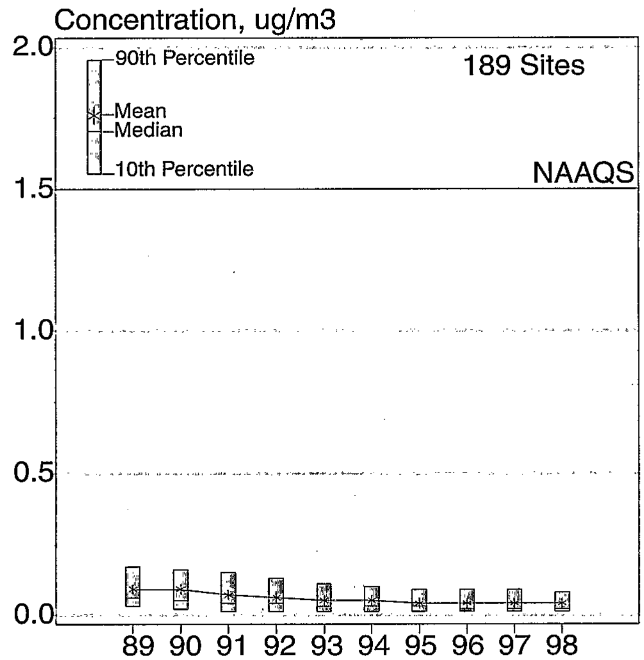


Figure 2-10. Pb maximum quarterly mean concentration trends by location (excluding point-source-oriented sites), 1989–1998.

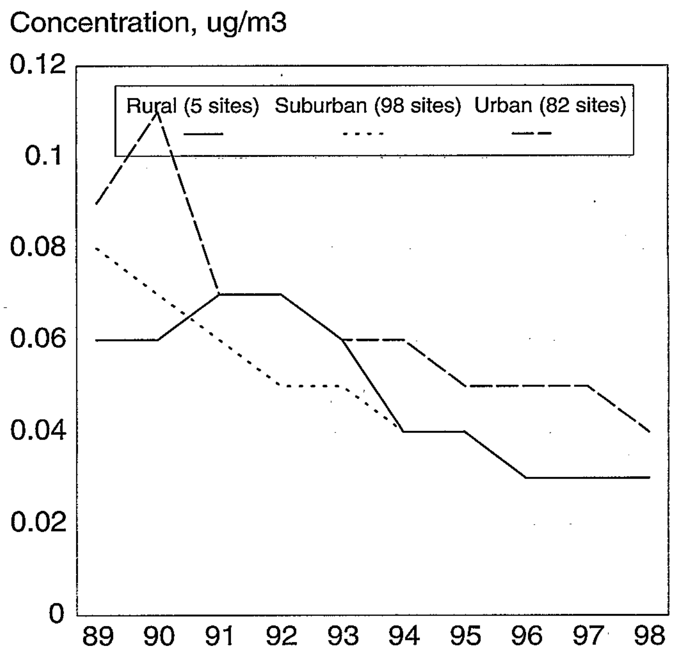


Figure 2-11. National total Pb emissions trend, 1989–1998.

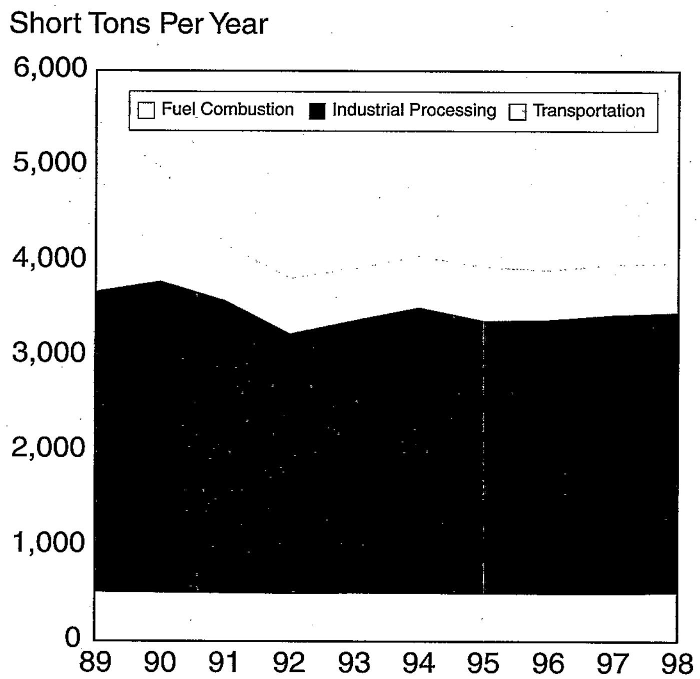
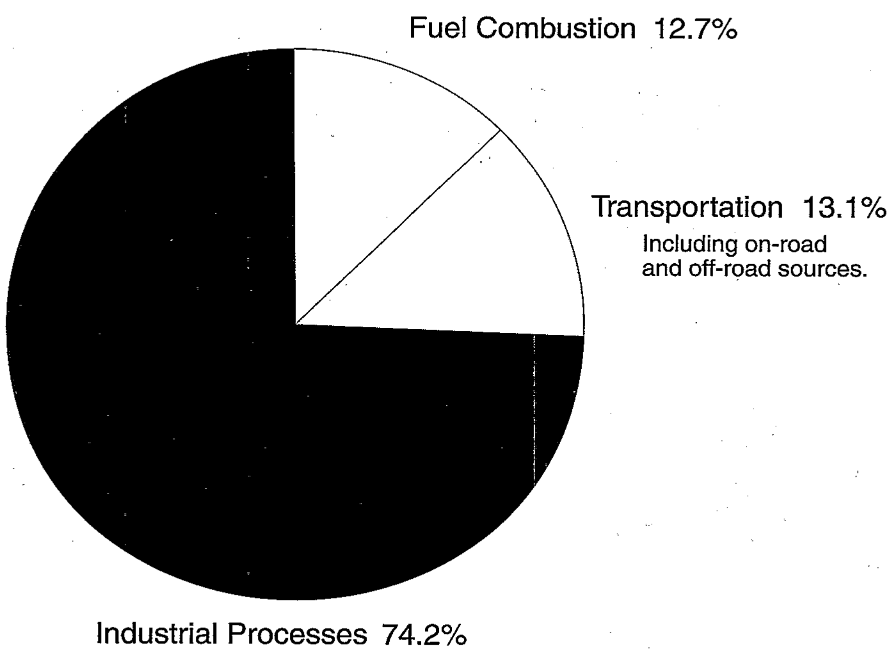


Figure 2-12. Pb emissions by source category, 1998.



cesses are now responsible for all violations of the lead standard, the lead monitoring strategy now focuses on emissions from these point sources. The map in Figure 2-15 shows the lead monitors located in the vicinity of major sources of lead emissions. In 1998, five lead point sources had one or more source-oriented monitors that violated the NAAQS. These five sources are ranked in Figure 2-15 according to the site with the greatest maximum quarterly mean. Various enforcement and regulatory actions are being actively pursued by EPA and the states for these sources.

The map in Figure 2-16 shows the highest quarterly mean lead concentration by county in 1998. Five counties, with a total population of 4.3 million and containing the point sources identified in Figure 2-15, did not meet the lead NAAQS in 1998.

Monitoring Status

Because of the shift in ambient air monitoring focus from mobile-source emissions to stationary point sources of lead air pollution, EPA revised the lead air monitoring regulations by publishing a new rule on January 20, 1999. This action was taken at the direct request of numerous state and local agencies whose on-road mobile-source oriented lead monitors have been reporting peak lead air pollution values that are many times less than the quarterly lead NAAQS of 1.5 $\mu g/m^3$ for a number of consecutive years.

The previous regulation required that each urbanized area with a population of 500,000 or more operate at least two lead National Air Monitoring Stations (NAMS). The new rule allows state and local agencies more flexibility. The rule substantially reduces the requirements for measuring lead air pollutant concentrations near major highways, thus shifting the focus to point sources and their impact on neighboring populations. The regulation allows states to reduce the number of NAMS from approximately 85 to approximately 15. This reduction will still allow EPA to confirm that lead air pollution in populated areas remains well below the NAAQS, but it refocuses available monitoring resources into areas with industrial sources.

Figure 2-13. Long-term ambient Pb trend, 1979–1998.

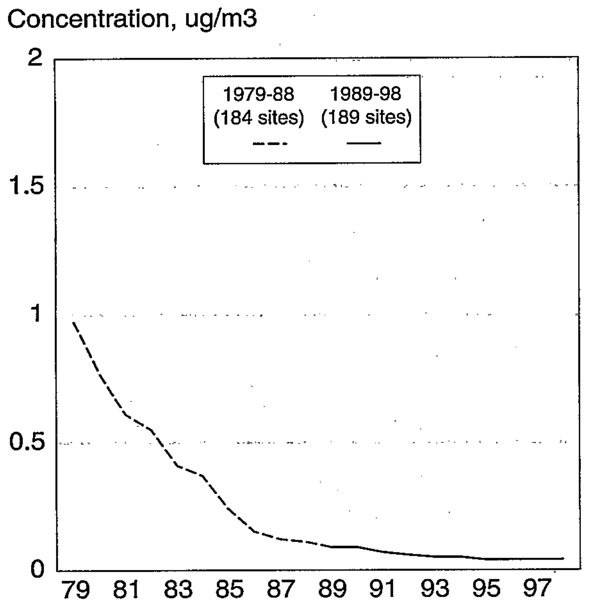
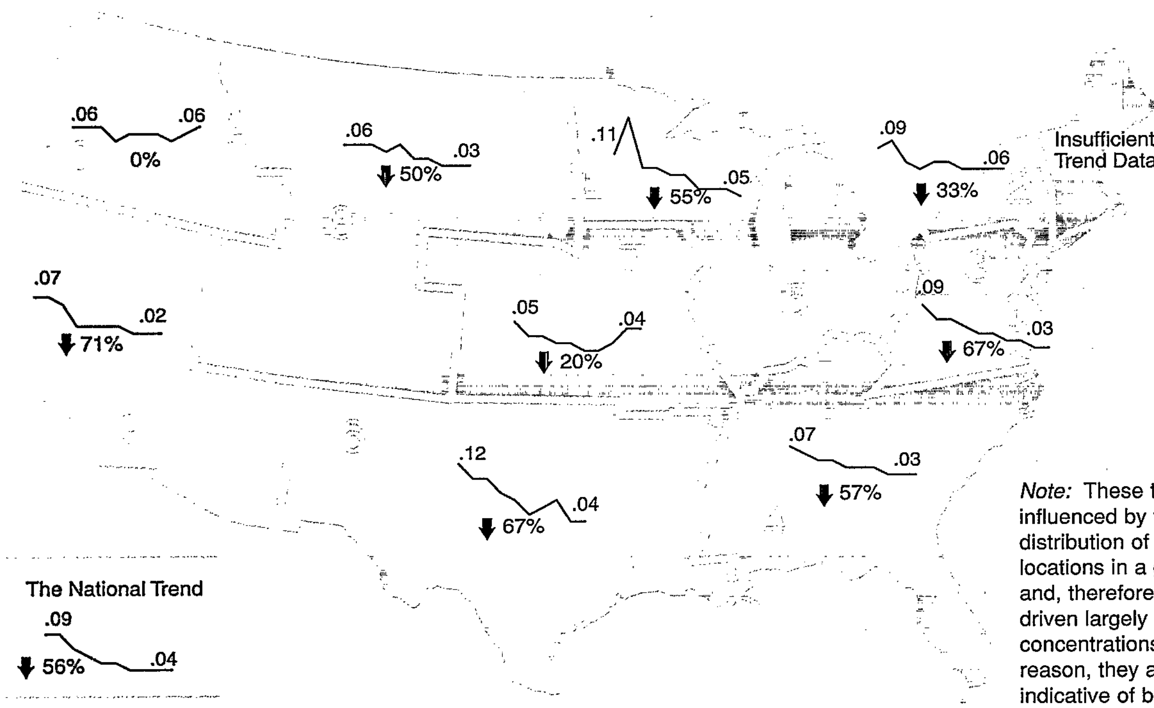


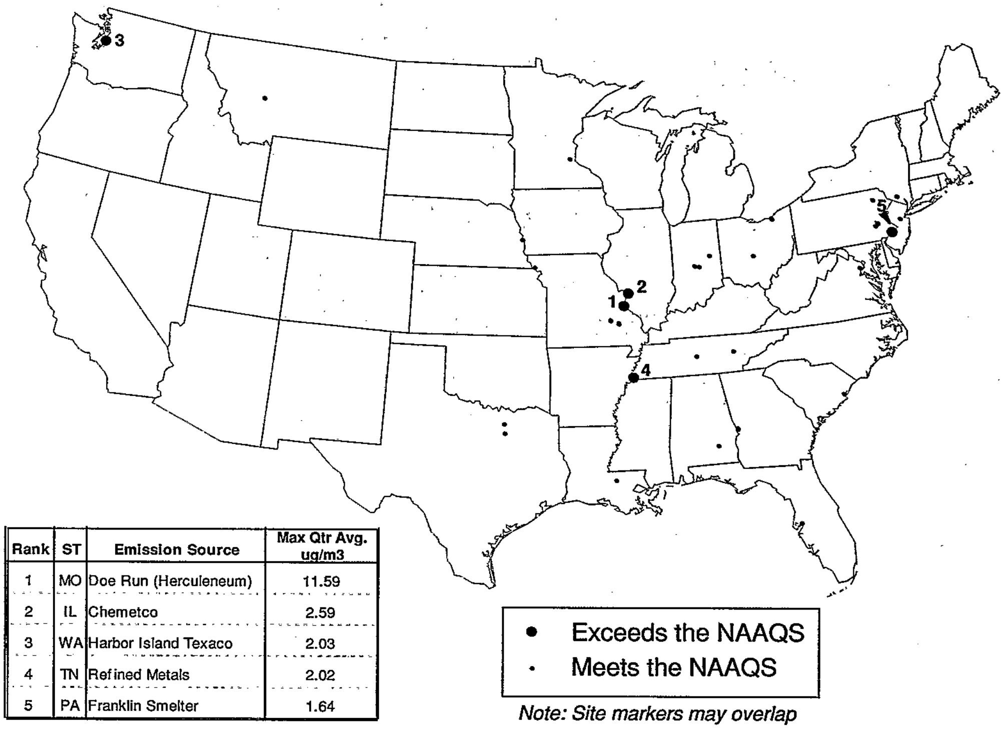
Figure 2-14. Trend in Pb maximum quarterly mean concentration by EPA Region, 1989–1998.



Note: These trends are influenced by the distribution of monitoring locations in a given region and, therefore, can be driven largely by urban concentrations. For this reason, they are not indicative of background regional concentrations.

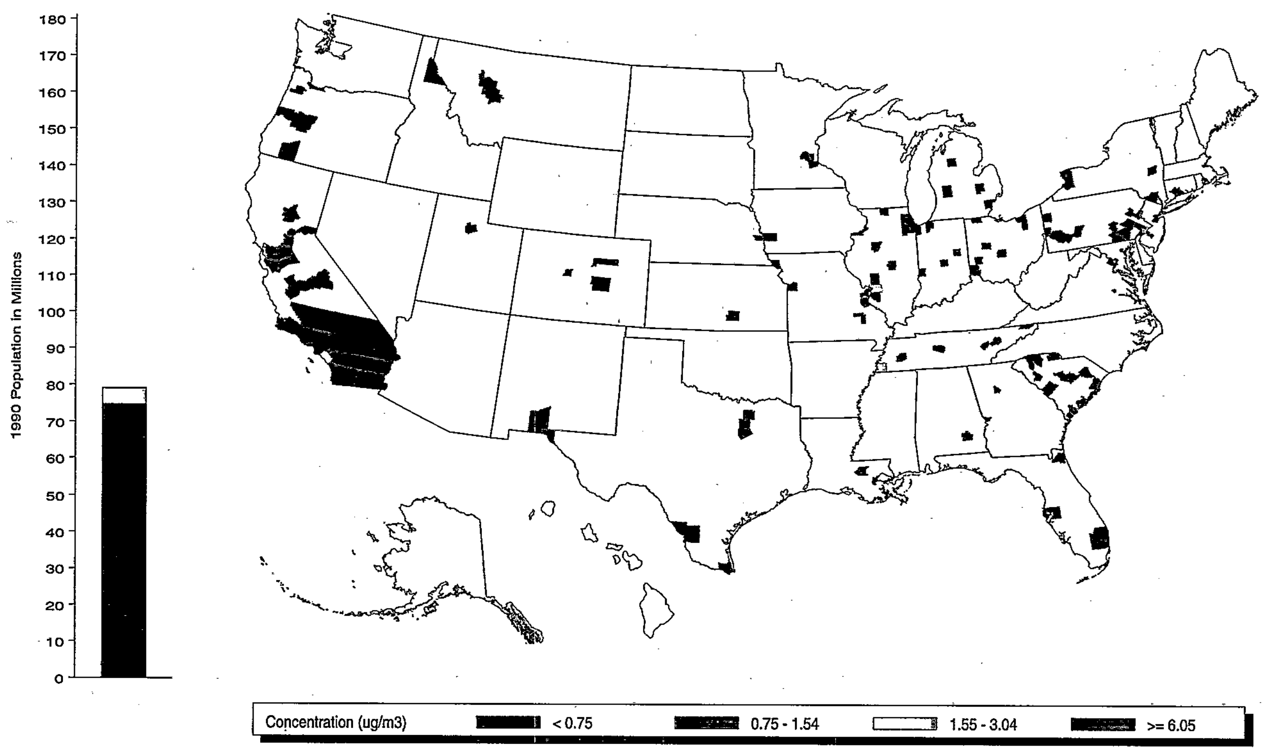
Alaska is in EPA Region 10; Hawaii, EPA Region 9; and Puerto Rico, EPA Region 2. Concentrations are µg/m³.

Figure 2-15. Pb maximum quarterly concentration in the vicinity of Pb point sources, 1998.



Rank	ST	Emission Source	Max Qtr Avg. ug/m3
1	MO	Doe Run (Herculeneum)	11.59
2	IL	Chemetco	2.59
3	WA	Harbor Island Texaco	2.03
4	TN	Refined Metals	2.02
5	PA	Franklin Smelter	1.64

Figure 2-16. Highest Pb maximum quarterly mean by county, 1998.



Nitrogen Dioxide

Air Quality Concentrations		
1989–98	14%	decrease
1997–98		no change

Emissions		
1989–98	2%	increase
1997–98	1%	decrease

Nature and Sources

Nitrogen dioxide (NO_2) is a reddish brown, highly reactive gas that is formed in the ambient air through the oxidation of nitric oxide (NO). Nitrogen oxides (NO_x), the term used to describe the sum of NO, NO_2 and other oxides of nitrogen, play a major role in the formation of ozone in the atmosphere through a complex series of reactions with volatile organic compounds (VOCs). A variety of NO_x compounds and their transformation products occur both naturally and as a result of human activities. Anthropogenic (i.e., man-made) emissions of NO_x account for a large majority of all nitrogen inputs to the environment. The major sources of anthropogenic NO_x emissions are high-temperature combustion processes, such as those occurring in automobiles and power plants. Most of NO_x from combustion sources (about 95 percent) is emitted as NO; the remainder is largely NO_2. Because NO is readily converted to NO_2 in the environment, the emissions estimates reported here assume nitrogen oxides are in the NO_2 form. Natural sources of NO_x are lightning, biological and abiological processes in soil, and stratospheric intrusion. Ammonia and other nitrogen compounds produced naturally are important in the cycling of nitrogen through the ecosystem. Home heaters and gas stoves also produce substantial amounts of NO_2 in indoor settings.

Health and Environmental Effects

Nitrogen dioxide is the most widespread and commonly found nitrogen oxide and is a matter of public health concern. The health effects of most concern associated with short-term exposures (i.e., less than three hours) to NO_2 at or near the ambient NO_2 concentrations seen in the United States, include changes in airway responsiveness and pulmonary function in individuals with preexisting respiratory illnesses, as well as increases in respiratory illnesses in children 5–12 years old.[7,8]

Evidence suggests that long-term exposures to NO_2 may lead to increased susceptibility to respiratory infection and may cause alterations in the lungs. Atmospheric transformation of NO_x can lead to the formation of ozone and nitrogen-bearing particles (e.g., nitrates and nitric acid). As discussed in the ozone and PM sections of this report, exposure to both PM and ozone is associated with adverse health effects.

Nitrogen oxides contribute to a wide range of effects on public welfare and the environment, including global warming and stratospheric ozone depletion. Deposition of nitrogen can lead to fertilization, eutrophication, or acidification of terrestrial, wetland and aquatic (e.g., fresh water bodies, estuaries, and coastal water) systems. These effects can alter competition between existing species, leading to changes in the number and type of species (composition) within a community. For example, eutrophic conditions in aquatic systems can produce explosive algae growth leading to a depletion of oxygen in the water and/or an increase in levels of toxins harmful to fish and other aquatic life. Nitrogen oxides are also important precursors or components of ozone, particulate matter and visibility impairment. (See sections on ozone, particulate mater, and sulfur dioxide, as well as chapters on visibility and atmospheric deposition).

Primary and Secondary Standards

The level for both the primary and secondary national ambient air quality standards (NAAQS) for NO_2 is 0.053 ppm annual arithmetic average, not to be exceeded.

National 10-Year Trends

The annual mean NO_2 concentration is the statistic used to track ambient NO_2 air quality trends. A total of 225 ambient NO_2 monitoring sites met the trends data completeness criteria for the 10-year period 1989–1998. Figure 2-17 shows that the national composite annual mean NO_2 concentration in 1998 is 14 percent lower than the composite mean recorded in 1989, and is unchanged from the 1997 level. Except for 1994, annual mean NO_2 concentrations have decreased, or remained unchanged, each year since 1989. Figure 2-18 shows how the trends in annual mean NO_2 concentrations vary among rural, suburban and urban monitoring locations. The highest annual mean NO_2 concentrations are typically found in urban areas, with significantly lower annual mean concentrations recorded at rural sites. The 1998 composite mean at 80 urban sites is 12 percent lower than the 1989 level, compared to an 18-percent reduction at 104 suburban sites. At 39 rural sites, the

Figure 2-17. Trend in annual NO_2 mean concentrations, 1989–1998.

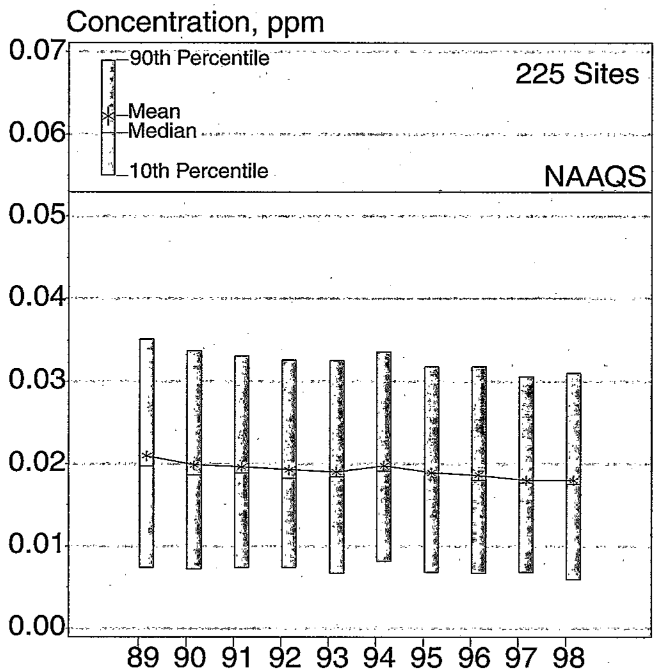
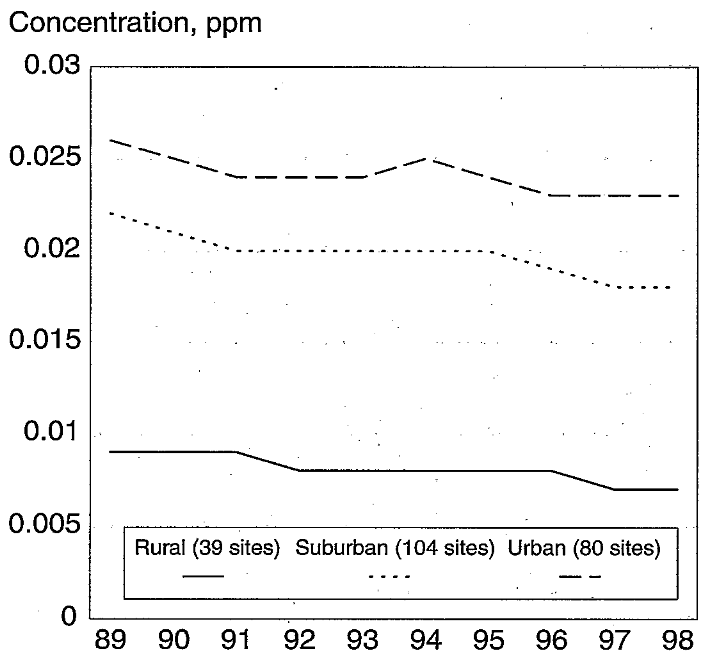


Figure 2-18. Trend in annual mean NO_2 concentrations by type of location, 1989–1998.



composite mean NO_2 concentration decreased 22 percent from the 1989 concentration level. (See Figure B-3 in Appendix B for a map of the NO_2 monitoring site locations.)

Atmospheric concentrations of NO_2 are determined by indirect photomultiplier measurement of the luminescence produced by a critical reaction of NO with ozone. The measurement of NO_2 is based first on the conversion of NO_2 to NO, and then subsequent detection of NO using this well characterized chemiluminescence technique. This conversion is not specific for NO_2, hence chemiluminescence analyzers are subject to interferences produced by response to other nitrogen containing compounds (e.g., peroxyacetyl nitrate [PAN]) that can be converted to NO. The chemiluminescence technique has been reported to overestimate NO_2 due to these interferences. This is not an issue for compliance since there are no violations of the NO_2 NAAQS. In addition, the interferences are believed to be relatively small in urban areas.[9] The national and regional air quality trends depicted are based primarily on data from monitoring sites in urban locations, and are expected to be reasonable representations of urban NO_2 trends. That is not the case in rural and remote areas, however, where air mass aging could foster greater relative levels of PAN and nitric acid and interfere significantly with the interpretation of NO_2 monitoring data.

Emissions Trends

Figure 2-19 shows the 10-year trend in NO_x emissions. National total NO_x emissions in 1998 are 2 percent higher than the 1989 total, although changes in data availability and methodology between 1989 and 1990 (in the other combustion category) introduce uncertainty in this comparison. Emissions from electric utility fuel combustion sources in 1998 are 7 percent lower than the 1989 level, while emissions from on-road sources have increased 1 percent during the past 10 years. Figure 2-20 shows that the two primary sources of NO_x emissions are fuel combustion and transportation. Together, these two sources comprise 95 percent of 1998 total NO_x emissions. Title IV (Acid Deposition Control) of the CAA required EPA to establish NO_x annual average emission limits for coal-fired electric utility units in two phases. NO_x reductions are approximately 400,000 tons per year during Phase I (1996–1999) and two million tons per year in Phase II (year 2000 and subsequent years).[10] In 1998, 265 Phase I coal-fired utility units were subject to the Title IV emission limitations. For these 265 affected utility units, total NO_x emissions in 1998 were 29 percent lower than in 1990, but 3 percent higher than in 1997.[10] While this is the second year that NO_x emissions from these sources have increased, the ascent can be attributed in part to greater electrical production compared to 1996.[10]

National 20-Year Trends

As discussed in previous sections of this report, long-term national ambient air quality trends are difficult to assess because few monitoring sites have operated continuously in the same location for 20 years. Figure 2-21 presents 20-year trends in ambient NO_2 concentrations by combining two separate 10-year trends databases, 1979–1988 (127 sites) and 1989–1998 (225 sites). Nationally, annual mean NO_2 concentrations have decreased approximately 25 percent

Figure 2-19. Trend in national total NO_x emissions, 1989–1998.

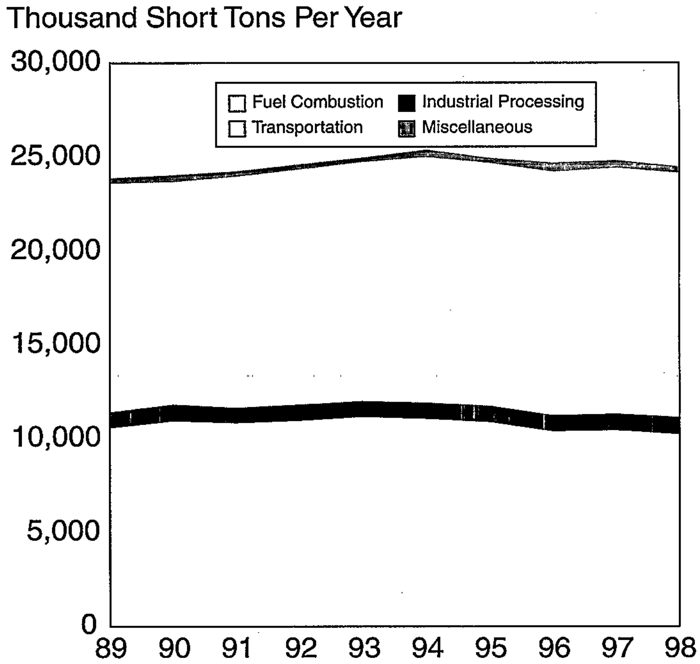


Figure 2-20. NO_x emissions by source category, 1998.

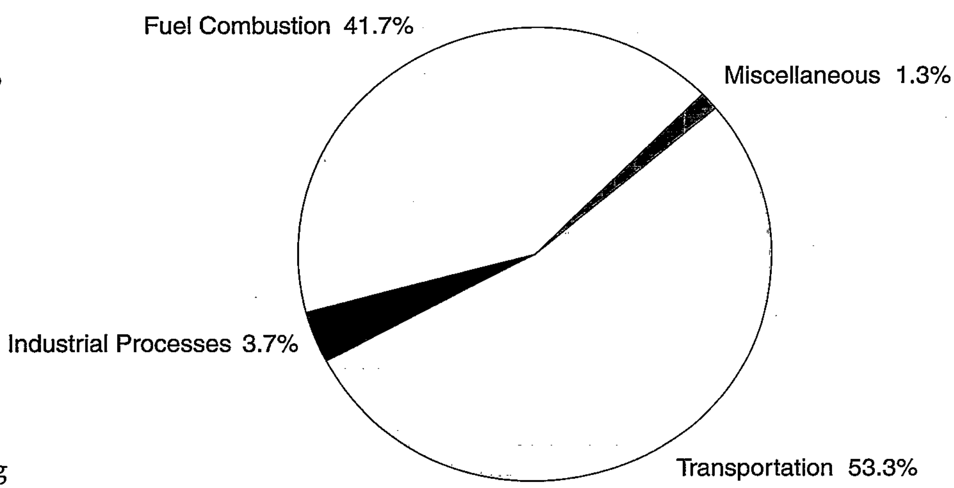
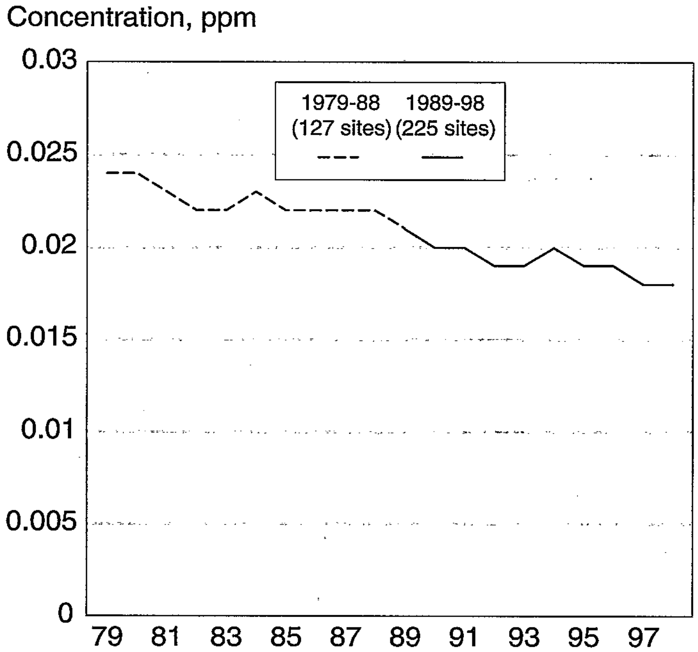


Figure 2-21. Long-term trend in annual mean NO_2 concentrations, 1979–1998.



since 1979. Annual mean NO_2 concentrations declined in the early 1980s, were relatively unchanged during the mid-to-late 1980s, and resumed their decline in the 1990s. Because most NO_2 monitoring sites are mobile-source oriented sites in urban areas, the 20-year decline in NO_2 concentrations more closely tracks the 19-percent reduction in NO_x emissions from on-road vehicles since 1980.

Regional Trends

The map in Figure 2-22 shows regional trends in NO_2 concentrations during the past 10 years, 1989–1998 (except Region 10 which does not have any NO_2 trend sites). The trends statistic is the regional composite mean of the NO_2 annual mean concentrations across all sites with at least 8 years of ambient measurements. Figure 2-22 shows that the largest reductions in composite annual mean NO_2 concentrations occurred in the South Coast of California, followed by the New England states, and the northeastern states, New York and New Jersey. Smaller reductions in mean NO_2 concentrations were recorded in mid-Atlantic, southeast, southwest and Rocky Mountain states. The 1989 and 1998 composite mean NO_2 concentrations were the same level in both the North Central and Midwest states.

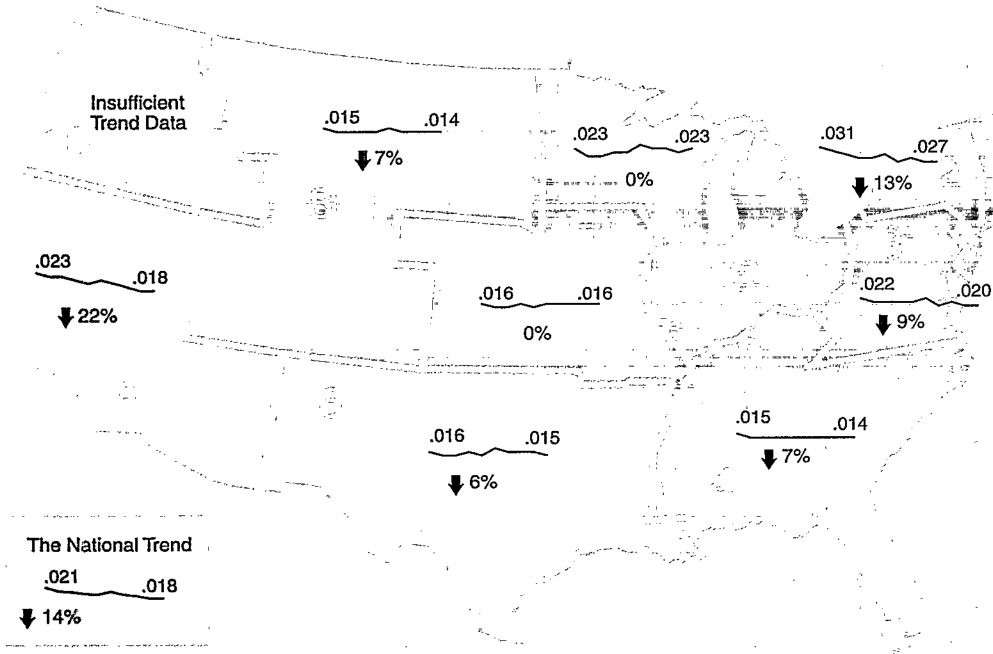
1998 Air Quality Status

All monitoring locations across the nation, including Los Angeles, met the NO_2 NAAQS in 1998. This is reflected on the map in Figure 2-23 that displays the highest annual mean NO_2 concentration measured in each county. In July 1998, EPA announced the redesignation of the South Coast Air Basin (the last remaining nonattainment area for NO_2) to attainment for the NO_2 NAAQS.[11]

Data Sources

The NO_2 ambient trends plotting points and emissions totals by source category are listed in Tables A-1 and A-4, respectively. The plotting points for the 20-year trend charts are listed in Table A-9. Table A-11 contains the highest annual mean NO_2 concentration by county in 1998.

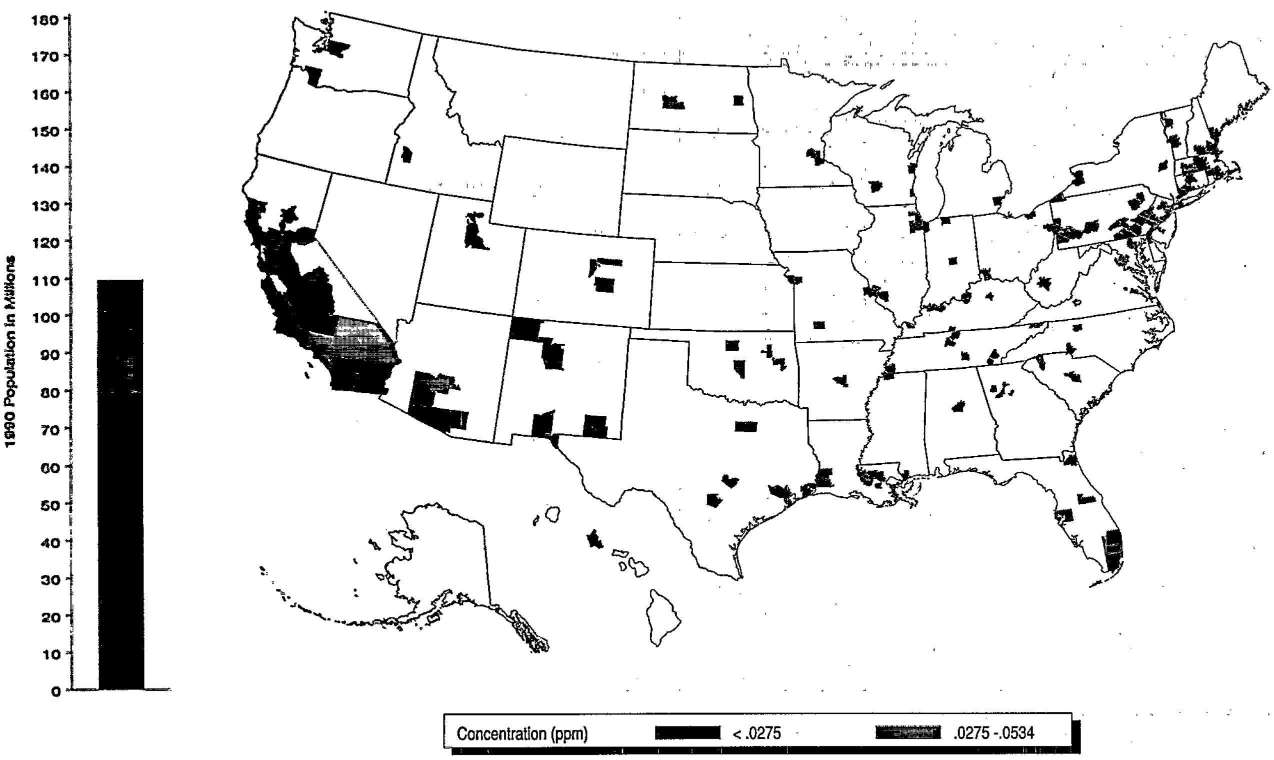
Figure 2-22. Trend in NO_2 maximum quarterly mean concentration by EPA Region, 1989–1998.



Note: These trends are influenced by the distribution of monitoring locations in a given region and, therefore, can be driven largely by urban concentrations. For this reason, they are not indicative of background regional concentrations.

Alaska is in EPA Region 10; Hawaii, EPA Region 9; and Puerto Rico, EPA Region 2. Concentrations are ppm.

Figure 2-23. Highest NO_2 annual mean concentration by county, 1998.



Ozone

Air Quality Concentrations		
1989–98	4%	decrease (1-hr)
		no change (8-hr)
1997–98	5%	increase (1-hr)
	4%	increase (8-hr)

Emissions (Anthropogenic VOCs)		
1989–98	20%	decrease
1997–98	5%	decrease

Nature and Sources

Ground level ozone remains a pervasive pollution problem in the United States. Ozone is readily formed in the atmosphere by the reaction of VOCs and NO_x in the presence of heat and sunlight, which are most abundant in the summer. VOCs are emitted from a variety of sources including: motor vehicles, chemical plants, refineries, factories, consumer and commercial products, other industries, and natural (biogenic) sources. Nitrogen oxides are emitted from motor vehicles, power plants, and other sources of combustion, and natural sources including lightning and biological processes in soil. Changing weather patterns contribute to yearly differences in ozone concentrations. Ozone and the precursor pollutants that cause ozone also can be transported into an area from pollution sources located hundreds of miles upwind.

Health and Environmental Effects

Ozone occurs naturally in the stratosphere and provides a protective layer high above the Earth. However, at ground level, it is the prime ingredient of smog. Short-term (1–3 hours) and prolonged (6–8 hours) exposures to ambient ozone concentrations have been linked to a number of health effects of concern. For example, increased hospital admissions and emergency room visits for respiratory causes have been associated with ambient ozone exposures.

Exposures to ozone may make people more susceptible to respiratory infection, result in lung inflammation, and aggravate preexisting respiratory diseases such as asthma. Other health effects attributed to short-term and prolonged exposures to ozone, generally while individuals are engaged in moderate or heavy exertion, include significant decreases in lung function and increased respiratory symptoms such as chest pain and cough. Children active outdoors during the summer when ozone levels are at their highest are most at risk of experiencing such effects. Other at-risk groups include adults who are active outdoors, such as outdoor workers, and individuals with preexisting respiratory disorders such as asthma and chronic obstructive lung disease. Within each of these groups are individuals who are unusually sensitive to ozone. In addition, repeated long-term exposure to ozone presents the possibility of irreversible changes in the lungs which could lead to premature aging of the lungs and/or chronic respiratory illnesses.

Ozone also affects sensitive vegetation and ecosystems. Specifically, ozone can lead to reductions in agricultural and commercial forest yields, reduced survivability of sensitive tree seedlings, and increased plant susceptibility to disease, pests, and other environmental stresses such as harsh weather. In long-lived species, these effects may become evident only after several years or even decades. As these species are out-competed by others, long-term effects on forest ecosystems and habitat quality for wildlife and endangered species occurs. Furthermore, ozone injury to the foliage of trees and other plants can decrease the aesthetic value of ornamental species as well as the natural beauty of our national parks and recreation areas.

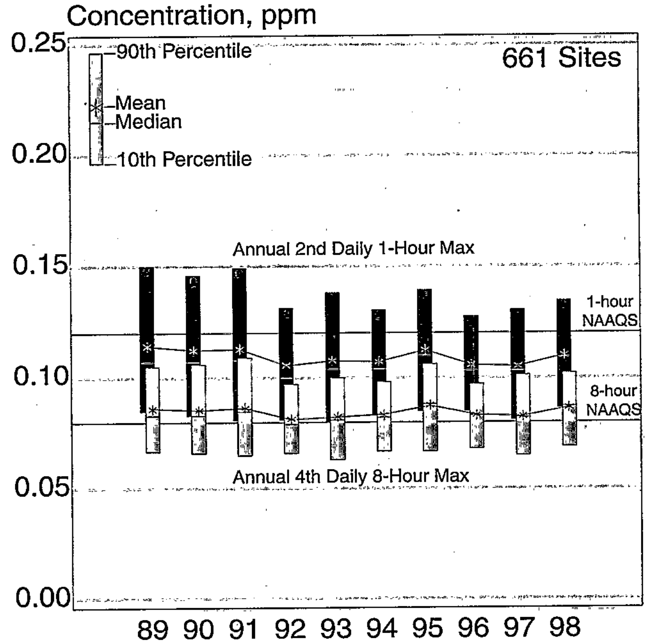
Primary and Secondary 1-hour Ozone Standards

In 1979, EPA established 1-hour primary and secondary standards for ozone. The level of the 1-hour primary and secondary ozone NAAQS is 0.12 ppm daily maximum 1-hour concentration that is not to be exceeded more than once per year on average. To encourage an orderly transition to the revised ozone standards (promulgated in 1997; see following section for more information), EPA initiated a policy in which the 1-hour standards would no longer apply once an area experienced air quality data meeting the 1-hour standards. In 1998 and early 1999, EPA revoked the 1-hour ozone NAAQS in 2,942 counties in the United States, leaving 201 counties where the 1-hour standard still applies.[12,13,14] However, due to unresolved legal challenges, the Agency is unable to enforce and effectively implement the 8-hour standard. As a result, many areas are without applicable air quality standards adequate to ensure public health and welfare. Therefore, at the time of publication of this report, EPA has proposed to reinstate the 1-hour standard nationwide to alleviate this unanticipated policy outcome and provide protection of public health and welfare.[15]

Primary and Secondary 8-hour Ozone Standards

On July 18, 1997, EPA established an 8-hour primary ozone standard to protect against longer exposure periods that are of concern for both human health and environmental welfare.[16] The level of the national 8-hour primary and secondary ambient air quality standards for ozone is 0.08 ppm, daily maximum 8-hour average over 3 years. The standards are met when the 3-year average of the annual fourth-highest daily maximum 8-hour ozone concentration is less than or equal to 0.08 ppm.[16] In May 1999, however, the U.S. Court of Appeals for the D.C. Circuit issued an opinion concerning the revised ozone standard. The court remanded the case back to EPA for further consideration. Following the denial of a petition for rehearing by the D.C. Circuit, the Justice Department has filed a petition for review before the Supreme Court.

Figure 2-24. Trend in annual 2nd-highest daily maximum 1-hour, and 4th-highest daily 8-hour O_3 concentrations, 1989–1998.



Air Quality Trends

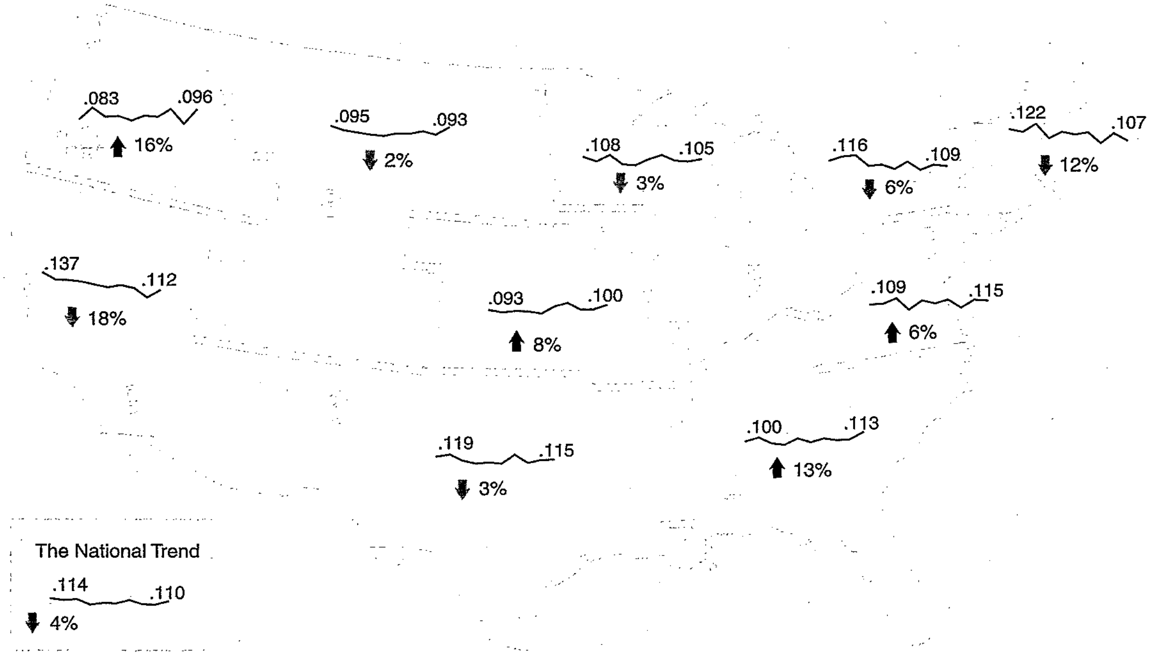
Because the 1-hour and 8-hour NAAQS have different averaging times and forms, two different statistics are used in this report to track ambient ozone air quality trends. For the 1-hour O_3 NAAQS, this report uses the composite mean of the annual second-highest daily maximum 1-hour O_3 concentration as the statistic to evaluate trends. For the 8-hour ozone NAAQS, the report relies on the annual fourth-highest 8-hour daily maximum O_3 concentration as the statistic of interest to assess trends.

National 10-Year Trends

As shown in Figure 2-24, peak 1-hour O_3 concentrations at 661 monitoring sites across the country have declined 4 percent over the past 10 years. The variability among monitoring locations across the country for this measure is represented by the 90th percentile, median, composite mean, and 10th percentile values. During the past 10 years, values at the sites with the highest concentrations of the second daily maximum ozone level values have continued to decline more substantially than those at the sites with average levels of this measure. While the concentrations at the more typical sites (composite mean) are only 4 percent lower in 1998 than in 1989, the 1-hour ozone levels at higher concentration sites (the 90th percentile) declined by 11 percent during the same period. Although not shown in a figure, the national exceedance rate (i.e., the average number of days when the daily maximum 1-hour average concentration exceeds the level of the 1-hour NAAQS) has declined 62 percent compared to the rate in 1989. As noted in previous reports, this statistic, which is simply a count of the number of times the level of the NAAQS has been exceeded, can vary significantly from year to year. Figure 2-24 also shows the national trend in 8-hour ozone concentrations across the same 661 sites. The 8-hour concentration at typical sites is the same level in 1998 as observed in 1989. However, the 8-hour ozone values at the higher concentration sites (as shown by the 90th percentile) have decreased by 3 percent since 1989. The trend in the 8-hour ozone statistic is similar to the trend in the 1-hour values, although the concentration range is smaller.

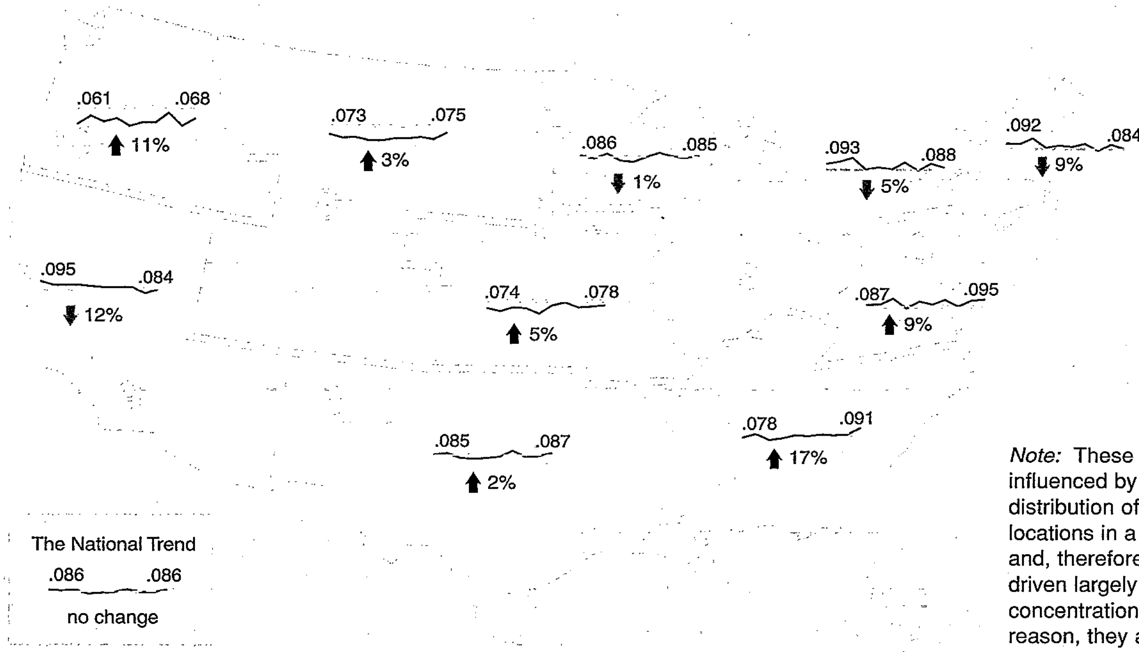
The maps in Figures 2-25 and 2-26 examine the trend in 1-hour and 8-hour ozone concentrations during the past 10 years, by geographic region of the country. For both the 1-hour and 8-hour ozone measurements, trends in the Mid-Atlantic, Southeast, Central, and Northwest increased from 1989 to 1998. In addition, the Southwest region also experienced an increase over the same 10-year period for the 8-hour ozone

Figure 2-25. Trend in 2nd highest daily 1-hour O_3 concentration by EPA Region, 1989–1998.



Alaska is in EPA Region 10; Hawaii, EPA Region 9; and Puerto Rico, EPA Region 2.
Concentrations are ppm.

Figure 2-26. Trend in 4th highest daily 8-hour O_3 concentration by EPA Region, 1989–1998.



Note: These trends are influenced by the distribution of monitoring locations in a given region and, therefore, can be driven largely by urban concentrations. For this reason, they are not indicative of background regional concentrations.

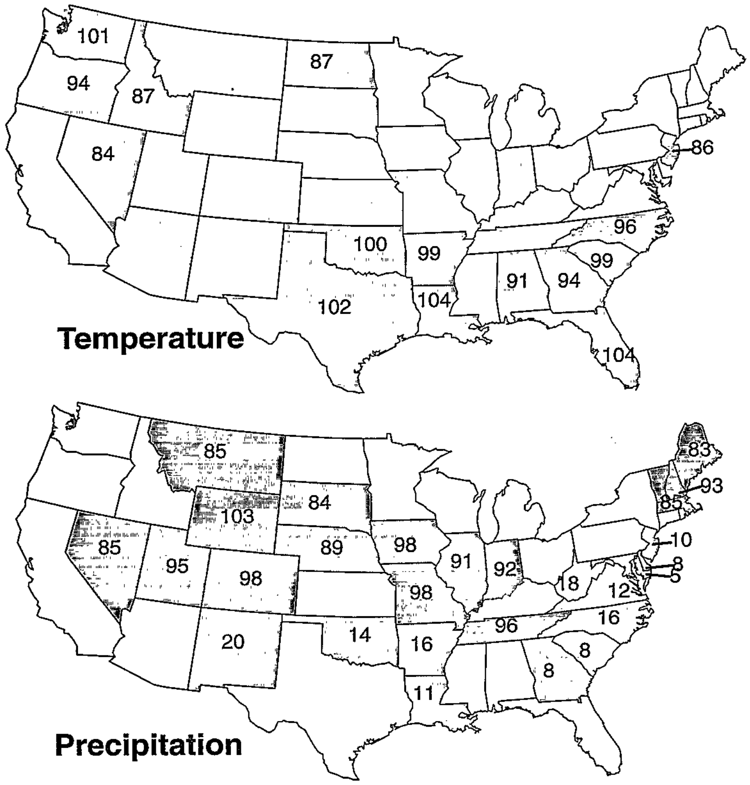
Alaska is in EPA Region 10; Hawaii, EPA Region 9; and Puerto Rico, EPA Region 2.
Concentrations are ppm.

measurement only. The ozone levels in all other areas followed declining trends similar to that of the national observations. These patterns are generally consistent with, and partially explained by, the meteorological conditions experienced during the 1998 summer in these areas. The summer of 1998 was among the 10 hottest seasons (of the last 100) for many states within the Southeast, Southwest and Northwest regions of the country, and was among the 20 driest summers in the Southeast. Statewide temperature and precipitation ranks for the summer of 1998 are shown in Figure 2-27 based on preliminary meteorological data available from National Oceanic and Atmospheric Administration (NOAA).[18]

In Figure 2-28, the national 1-hour ozone trend is deconstructed to show the 10-year change in ambient ozone concentrations among rural, suburban, and urban monitoring sites. The highest ambient ozone concentrations are typically found at suburban sites, consistent with the downwind transport of emissions from the urban center. During the past 10 years, ozone concentrations decreased by 3 percent at 304 suburban sites, and 9 percent at 117 urban sites. However, at 222 rural sites, 1-hour ozone levels for 1998 are only 1 percent lower than the 1989 level and, for the first time, are greater than the level observed for urban sites.

Figure 2-29 presents the trend in 8-hour ozone concentrations for 34 Clean Air Status and Trends Network (CASTNet) sites from 1989–1998.[18a] The 8-hour ozone concentrations at these eastern CASTNet sites, which were the highest during the hot and dry summers of 1991 and 1998, have increased 6 percent over the last 10-

Figure 2-27. Summer 1998 statewide ranks for temperature and precipitation.



Note: For each individual state, the last 104 summers were ranked warmest to coldest and wettest to driest. A rank of 104 corresponds to the warmest or wettest, while a rank of 1 corresponds to the coldest or driest. Light gray states are in the warmest or wettest 20 percent of the last 104 years and dark gray states are in the driest 20 percent. There were no states having ranks in the coldest 20 percent in 1998.

Figure 2-28. Trend in annual 2nd-highest daily maximum 1-hour O_3 concentrations by location, 1989–1998.

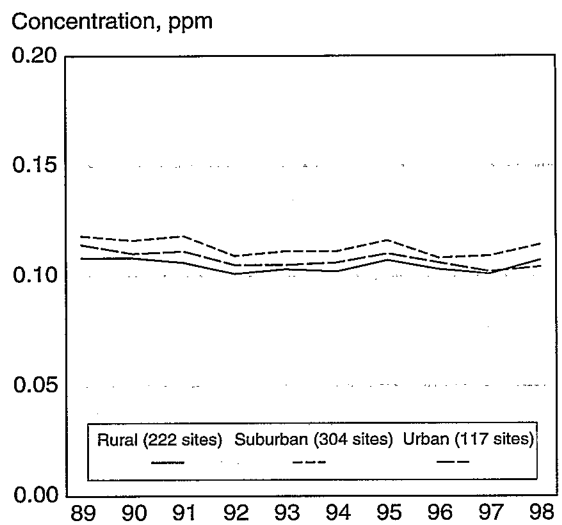
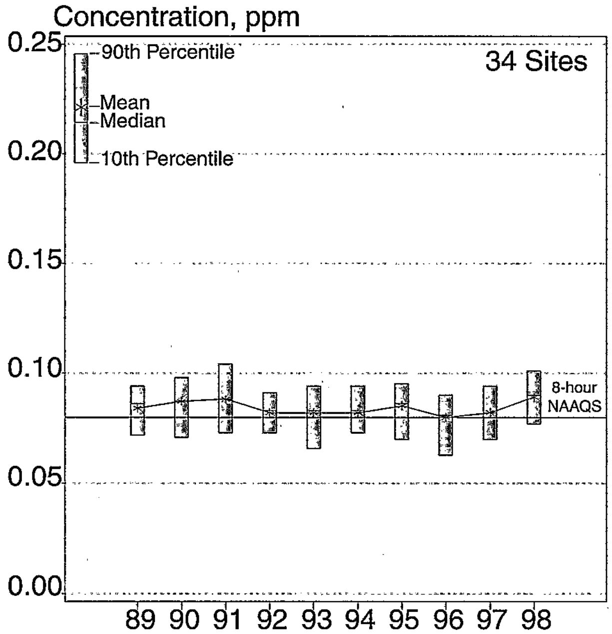


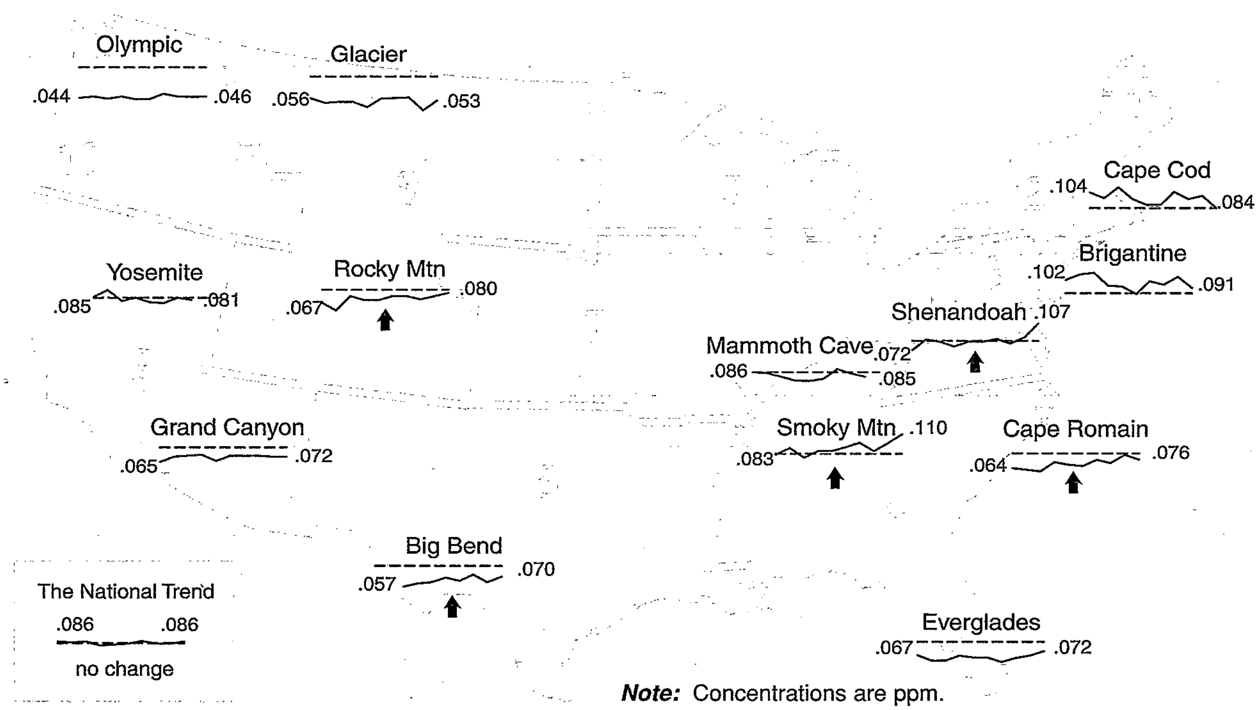
Figure 2-29. Trend in 4th-highest daily 8-hour O_3 based on 34 CASTNet sites in the rural eastern United States, 1989–1998.



year period and 8 percent from 1997–1998. The CASTNet data complement the larger ozone data sets gathered by the State and Local Monitoring (SLAMS) and National Air Monitoring (NAMS) networks with additional rural coverage.

Figure 2-30 further examines patterns in ozone levels by presenting the 10-year trend in the 8-hour ozone concentrations across 24 National Park Service (NPS) sites as well as specific trends in ambient ozone levels for each individual site.[19] These sites are located in Class I areas, a special subset of rural environments (all national parks and wilderness areas exceeding 5,000 acres) accorded a higher degree of protection under the CAA provisions for the prevention of significant dete-

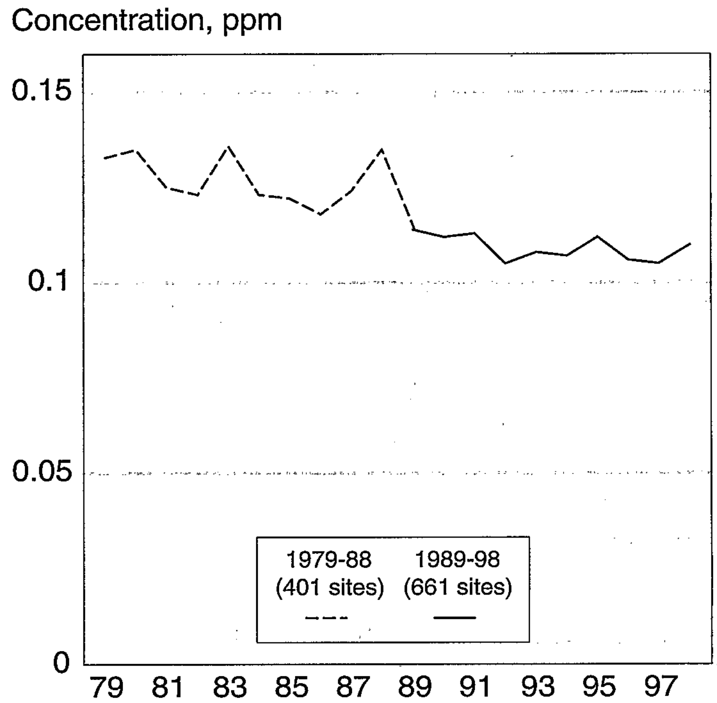
Figure 2-30. Trend in annual 4th-highest daily maximum 8-hour O_3 concentrations in National Parks, 1989–1998.



↑ Indicates a statistically significant upward trend. Otherwise the trend was not statistically significant.

rioration. There are more than 24 NPS sites nationally; however, this analysis focuses on the specific sites with sufficient data to evaluate 10-year trends. Although the composite mean ozone concentration for 1998 across all 24 sites was unchanged from the level in 1989, nine of the NPS sites experienced statistically significant upward trends in 8-hour ozone levels. Figure 2-30 highlights five such sites: two in the Great Smoky Mountains National Park, one in Big Bend National Park, one in the Rocky Mountain National Park, and one in Cape Romain National Wildlife Refuge. Although not statistically significant, the 8-hour ozone levels at eight of the remaining 15 sites increased between 1989 and 1998, while only three showed downward slopes, and four sites showed no change. The 1998 levels were particularly high at the Shenandoah National Park and the Great Smoky Mountains National Park. Ozone levels at these sites were the highest in a decade and 30–40 percent higher than the 8-hour ozone standard. Table A-18 provides data on 10-year trends in air quality at all 24 NPS sites.

Figure 2-31. Trend in annual 2nd-highest daily maximum 1-hour O_3 concentrations, 1979–1998.



National 20-Year Trends

Since 1979, 1-hour O_3 concentrations have declined 17 percent nationally. Figure 2-31 clearly shows the peak ozone years of 1980, 1983, 1988 and 1995. Because only a few sites have monitored continuously for two decades, the 20-year trends line in Figure 2-31 is composed of two segments—401 sites with complete data during the first 10 years (1979–1987) and 661 sites meeting the data completeness criteria in the most recent 10 years (1989–1998). It is important to interpret such long-term, quantitative ambient ozone trends carefully given changes in network design, siting criteria, spatial coverage and monitoring instrument calibration procedures during the past two decades.

Change Since Last Year

A comparison of the change in 1-hour ozone concentrations for the two most recent years of data reveals a 5-percent increase between 1997 and 1998. Similarly, the national 8-hour ozone concentrations increased 4 percent between 1997 and 1998 (Figure 2-24). Ambient ozone trends are influenced by year-to-year changes in meteorological conditions, population growth, changes in emissions levels from ongoing control measures as well as the relative levels of ozone precursors VOC and NO_x.

As discussed in previous *Trends Reports*, EPA uses a statistical model to adjust data on the annual rate of change in ozone from individual metropolitan areas to account for meteorological impacts, including surface temperature and wind speed.[20] Figure 2-32 presents the composite meteorologically-adjusted trend in 1-hour average daily maximum ozone concentrations for 40 metropolitan areas between 1986 and 1998. As seen in this figure, even after adjusting for meteorological conditions, 1-hour ozone levels in these selected areas increased slightly more than 1 percent between 1997 and 1998. This modest one year increase is within the range of uncertainty of this analysis and its significance should not be over interpreted. However, this increase combined with a similar rise in adjusted ozone levels

Figure 2-32. Comparison of actual and meteorologically adjusted 1-hour O_3 trends, 1989–1998.

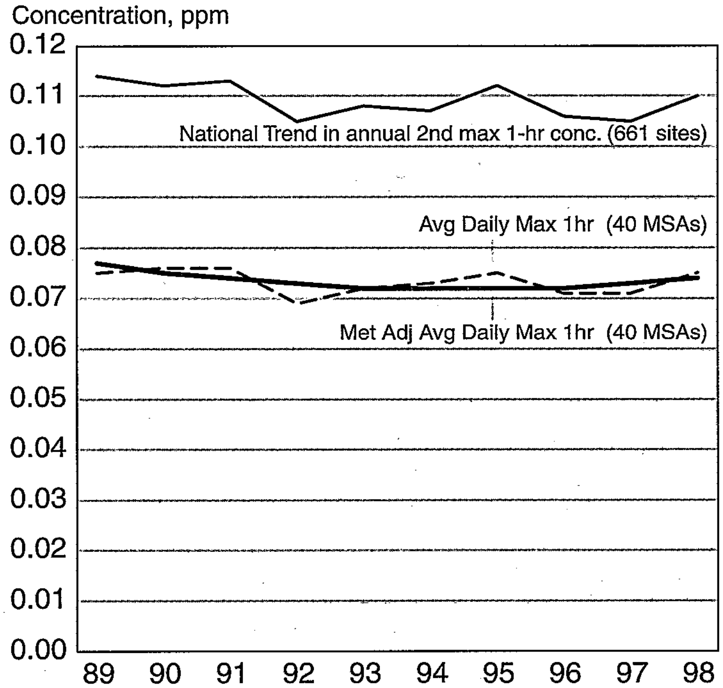
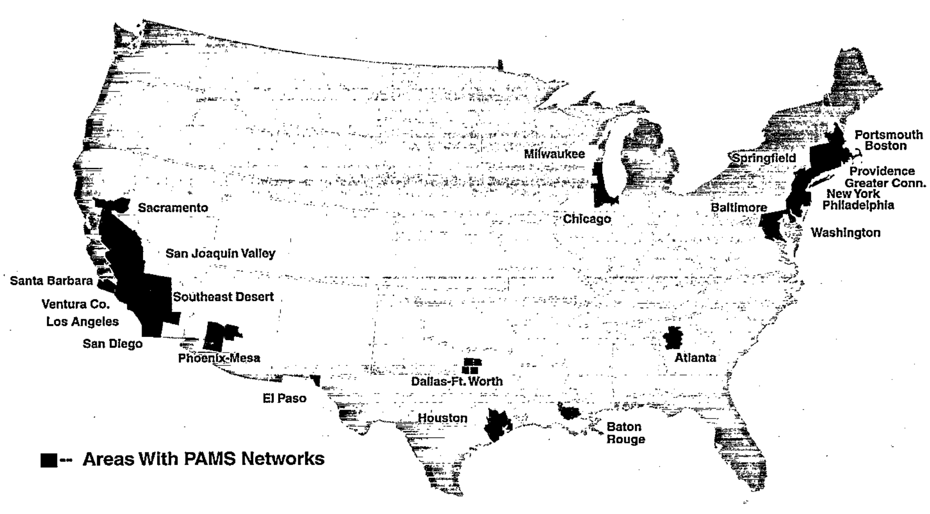


Figure 2-33. Areas with PAMS networks.

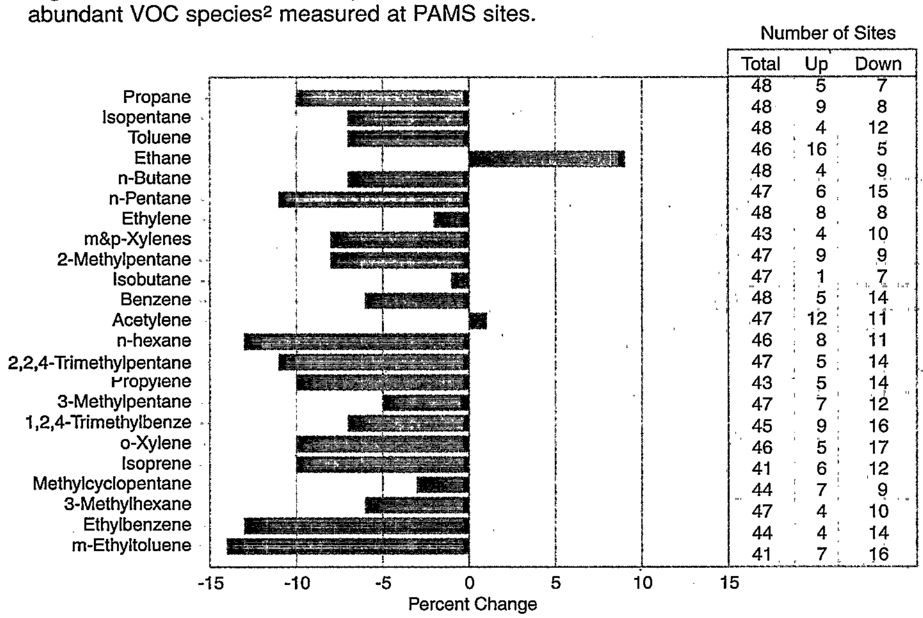


between 1996 and 1997 (slightly greater than 1 percent) for these same areas suggests the beginnings of a possible upward trend in the adjusted statistic which will continue to be monitored and evaluated in future analyses and *Trends Reports*.

The 1-hour ozone concentrations in urban areas with the most severe and persistent ozone problems (i.e., those classified as extreme, severe, and serious ozone nonattainment areas) also increased between 1997 and 1998. This 2-percent increase, based on data from sites in the areas required to operate the Photochemical Assessment Monitoring Stations (PAMS) network, is consistent with, but less pronounced than, the 5-percent increase seen nationwide (at the 661 10-year trend sites). Currently, 22 of the nation's remaining 32 nonattainment areas for the 1-hour ozone NAAQS are required to operate PAMS sites.[21] In addition, although recently reclassified to attainment for the 1-hour standard, Boston and Providence still maintain PAMS sites. Areas with PAMS networks are shown in Figure 2-33. Each PAMS network consists of as many as five monitoring stations, depending on the area's population. These stations are carefully located according to meteorology, topography, and relative proximity to emissions sources of VOC and NO_x. As of October 1999, there were 83 active designated PAMS sites.

In addition to measuring ozone levels, PAMS sites include measurements of NO_x, total non-methane organic compounds (TNMOC), a target list of VOC species including several carbonyls, plus surface and upper air meteorology during summer months when weather conditions are most conducive to ozone formation. Table 2-3 shows changes in summer 6:00–9:00 a.m. VOC and NO_x concentrations for selected PAMS sites.[22] Morning periods for NO_x and VOCs are used because those time frames are generally thought to be an appropriate indicator of anthropogenic emissions. Morning NO_x concentrations showed a median decline of 3 percent between 1997 and 1998 across 60 PAMS sites. Summer morning VOC concentrations registered a median decline of 7 percent across 45 PAMS sites. Figure 2-34 presents the median changes in summer morning concentrations of the most abundant VOC species measured at PAMS sites. These 23 VOC species are the focus of this analysis because they account for more than 75 percent (by volume) of the VOCs concentrated on in the PAMS program. Twenty-one of the 23 compounds included showed declines in median values between 1997 and 1998.[23]

Figure 2-34. The median changes in summer morning concentrations of the most abundant VOC species[2] measured at PAMS sites.



Notes: 1. The numbers shown in the "Up" and "Down" columns refer to the number of sites in which the change in summer 6–9 a.m. mean concentrations between 1997 and 1998 is statistically significant (as determined by a t-test with a significance level of .05). The total number of sites ("Total") may not equal the sum of the corresponding "Up" and "Down" categories.

2. Results for Formaldehyde and Acetaldehyde (both carbonyl compounds) were not included in this analysis. EPA is continuing to assess carbonyl sampling issues to compare these measurements.

Table 2-3. Summary of 1997–1998 Changes in Summer 6–9 a.m. Mean Concentrations of NO_x and TNMOC at PAMS Sites

	Number of Sites			Median
	Total	**Up**	**Down**	**Change**
NO_x	60	6	13	-3%
TNMOC	45	6	11	-7%

Note: The numbers shown in the "Up" and "Down" columns refer to the number of sites in which the change in summer 6–9 a.m. mean concentrations between 1997 and 1998 is statistically significant. The total number of sites ("Total") may not equal the sum of the corresponding "Up" and "Down" categories.

Emissions Trends

Figure 2-35 shows that national total VOC emissions (which contribute to ozone formation) from anthropogenic (man-made) sources decreased 20 percent between 1989 and 1998. National total NO_x emissions (the other major precursor to ozone formation) increased 2 percent over the same 10-year period, although changes in data availability and methodology between 1989 and 1990 (in the other combustion category) introduce uncertainty in this comparison. Nationally, the two major sources of VOC emissions are industrial processes (47 percent) and transportation sources (44 percent) as shown in Figure 2-36. Solvent use comprises 62 percent of the industrial process emissions category and 29 percent of total VOC emissions. The emissions totals by source category and year can be found in Table A-5. Recent control measures to reduce emissions include regulations to lower fuel volatility and to reduce NO_x and VOC emissions from tailpipes.[24] The effectiveness of these control measures is reflected in the 20-percent decrease in VOC emissions from transportation sources. VOC emissions from highway vehicles have declined 26 percent since 1989, while highway vehicle NO_x emissions have increased 1 percent over the same period.

Figure 2-35. Trend in national total anthropogenic VOC emissions, 1989–1998.

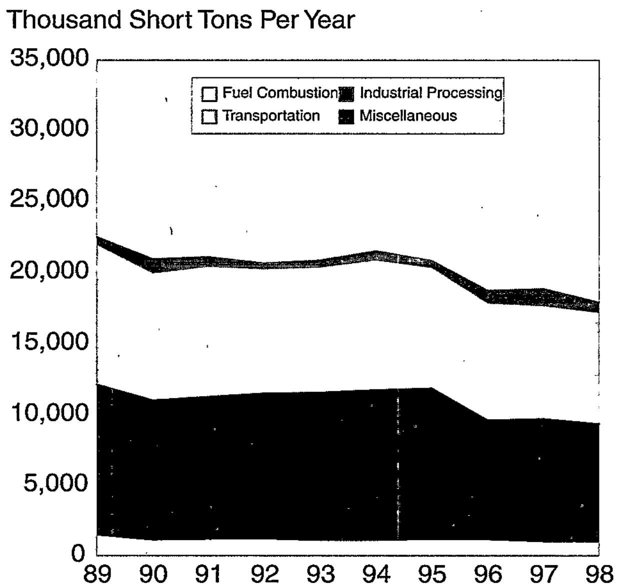


Figure 2-36. Anthropogenic VOC emissions by source category.

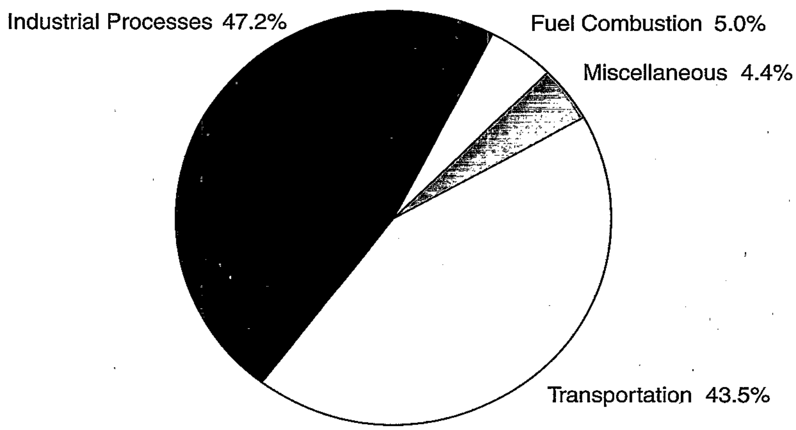


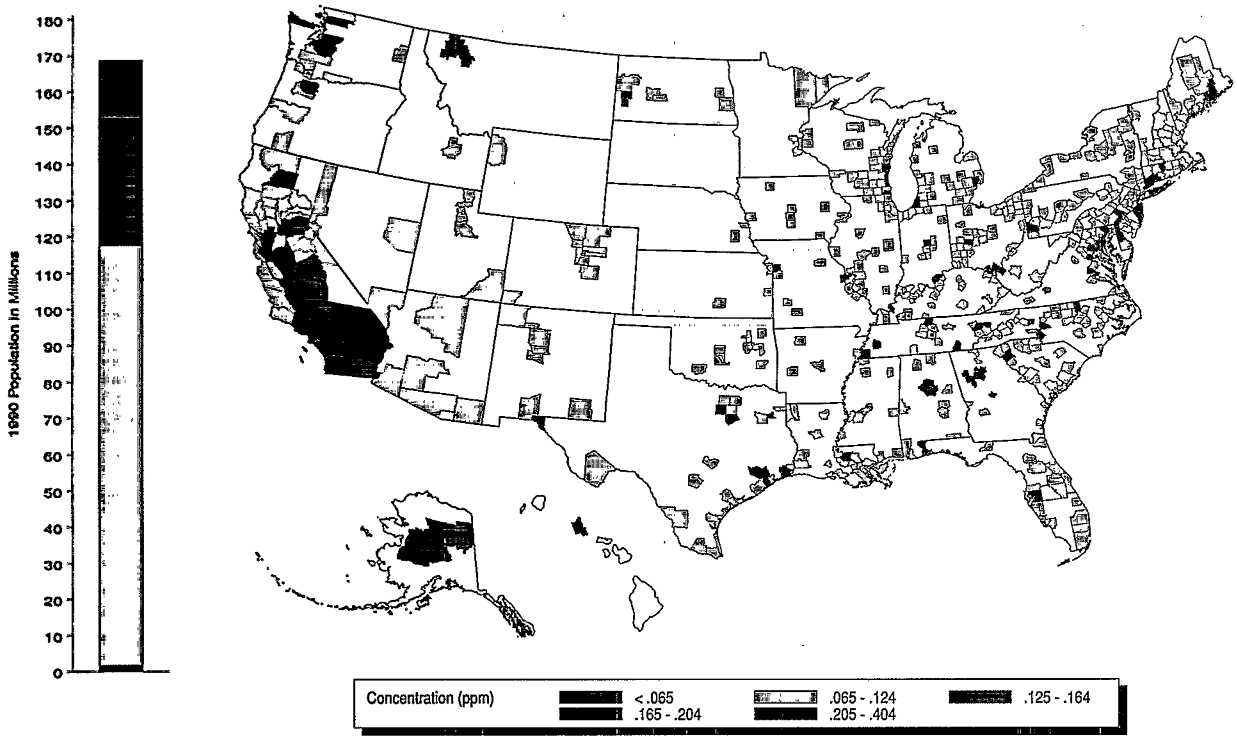
Table 2-4. Biogenic sources of VOC emissions by region.

Region	VOC	Source
Southwestern United States	Isoprene	Oak (mostly), citrus, eucalyptus
	Monoterpenes	Pine, citrus, eucalyptus
Northeastern United States	Isoprene	Oak (mostly), spruce
	Monoterpenes	Maple, hickory, pine, spruce, fir, cottonwood

As required by the CAA, the Federal Reformulated Gasoline Program (RFG) implemented in 1995 has resulted in emissions reductions that exceed those required by law.[25, 26] However, the discovery of MTBE (one of two fuel oxygenates used in reformulated gasoline to help improve air quality) in the water supplies around the country has required examination of the approach used in this program. As previously described in the carbon monoxide section of this report, in November 1998, EPA Administrator Carol M. Browner announced the creation of a blue ribbon panel of leading experts from the public health and scientific communities, automotive fuels industry, water utilities, and local and state government to review the important issues posed by the use of MTBE and other oxygenates in gasoline. The Panel concluded that RFG provides considerable air quality improvements and benefits for millions of U.S. citizens. However, due to MTBE's persistence and mobility in water, and its likelihood to contaminate ground and surface water, the Panel recommended that its use in gasoline be substantially reduced.[27]

In addition to anthropogenic sources of VOCs and NO_x, there are natural or biogenic sources of these compounds as well. Table 2-4 shows the different predominant plant species responsible for VOC emissions in different parts of the country for two major biogenic species of concern, isoprene and monoterpenes. Though it is not possible to control the level of these natural emissions, when developing ozone control strategies, their presence is an important factor to consider. Biogenic NO_x emissions are associated with lightning and biological processes in soil.

Figure 2-37. Highest second daily maximum 1-hour O_3 concentration by county, 1998.



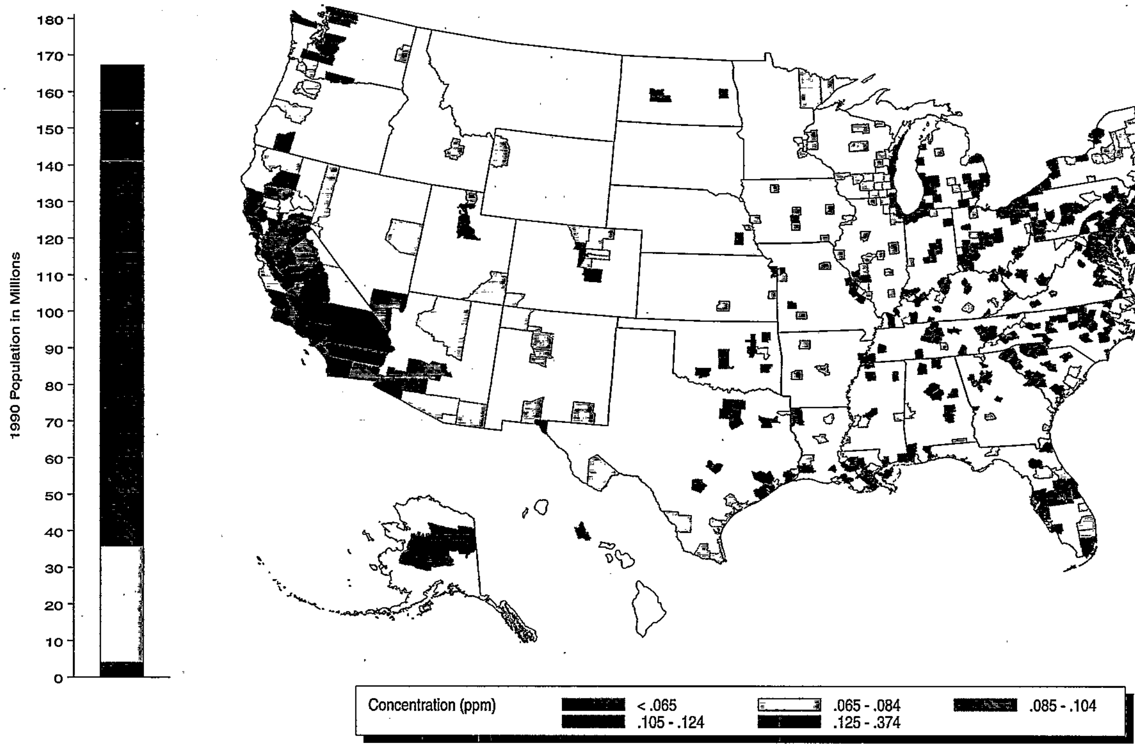
On a regional basis, biogenic VOC emissions can be greater than anthropogenic VOC emissions. Biogenic NO_x emissions, on the other hand, are less than 10 percent of total NO_x emissions.[28]

1998 Air Quality Status

The map in Figure 2-37 presents second highest daily maximum 1-hour ozone concentrations by county in 1998. The accompanying bar chart to the left of the map reveals that in 1998 approximately 51 million people lived in 92 counties where ozone concentrations were above the level of the 1-hour ozone NAAQS. These numbers represent an slight increase from the totals reported last year (49 million people living in 77 counties) with ozone concentrations above the level of the ozone NAAQS in 1997. As noted previously, meteorological conditions in some regions of the country were more conducive to peak ozone formation in 1998, than in 1997. The map in Figure 2-37 shows large spatial differences, with higher ozone concentrations typically found in Southern California, the Gulf Coast, and the Northeast and North Central states. Historically, the highest 1-hour concentrations have been found in Los Angeles and this is again the case in 1998.

Figure 2-38 presents a map of fourth highest daily maximum 8-hour ozone values by county in 1998 and an accompanying bar chart of the number of people in counties corresponding to various air quality ranges. The map reveals widespread areas with high 8-hour ozone concentrations (i.e., greater than 0.084 ppm) in much of the eastern half of the country and in California as well as isolated counties in the West. The corresponding bar chart indicates that roughly 130 million people live in counties where fourth highest daily maximum 8-hour ozone concentrations were greater than 0.084 ppm.

Figure 2-38. Highest fourth daily maximum 8-hour O_3 concentration by county, 1998.



Air Quality Impact of Major Wildfires

Biomass burning has been recognized as having the potential for significantly impacting visibility as well as contributing to elevated ambient concentrations of ozone and particulate matter.[1,2] Two severe wildfire incidents occurred during 1998 that affected ambient concentrations of ozone and particulate matter in specific areas of the United States. The first incident occurred late April to early June in Mexico and Central America, when thousands of fires of unusual intensity resulted in elevated air pollution levels. Figures 2-39 and 2-40 show NASA's images of the widespread area affected by smoke plumes that caused elevated pollution levels mainly for the central section of the United States. These images show levels of absorbing aerosol particles (airborne microscopic dust/smoke) from NASA's Total Ozone Mapping Spectrometer (TOMS) instrument. The TOMS data images have been used increasingly to understand the behavior of this material within the atmosphere. The TOMS is the first instrument to allow observation of aerosols as the particles cross the land/sea boundary. Using these data, it is possible to observe a wide range of phenomena such as desert dust storms, forest fires and biomass burning. In Figure 2-41, the smoke plumes almost two weeks later have diminished significantly from their earlier impacts on the United States. Guidance was issued by the Agency to assure that monitoring data was properly flagged and effects on air quality are adequately documented.[3]

Figure 2-39. Smoke/dust over North America for May 15, 1998.

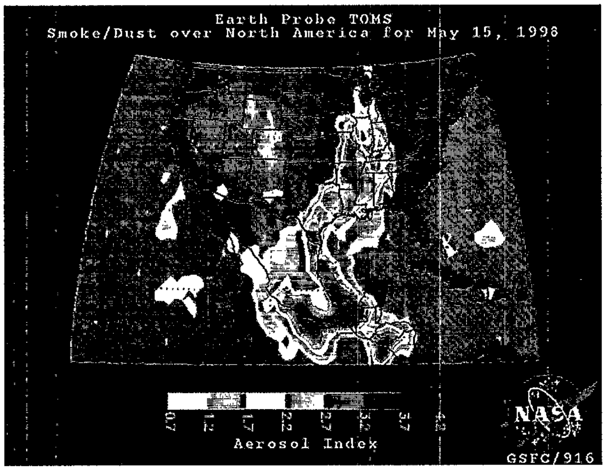


Figure 2-40. Smoke/dust over North America for May 16, 1998.

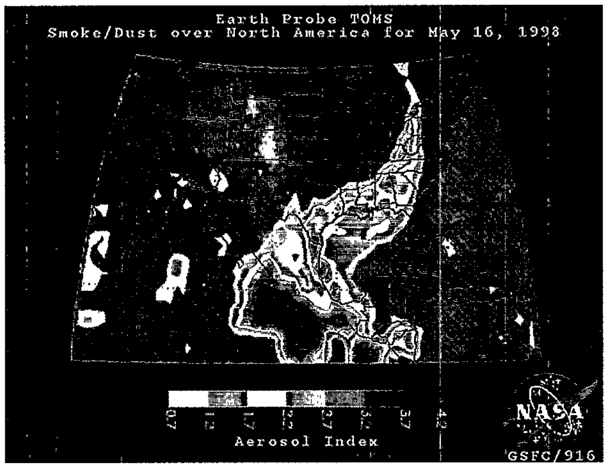


Figure 2-41. Smoke/dust over North America for May 28, 1998.

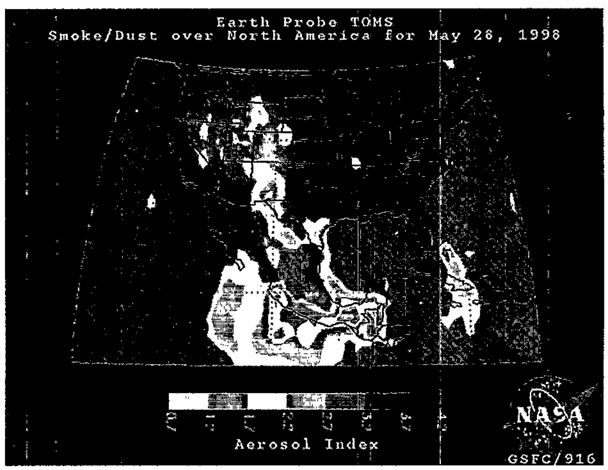


Figure 2-42. Smoke/dust over North America for June 22, 1998.

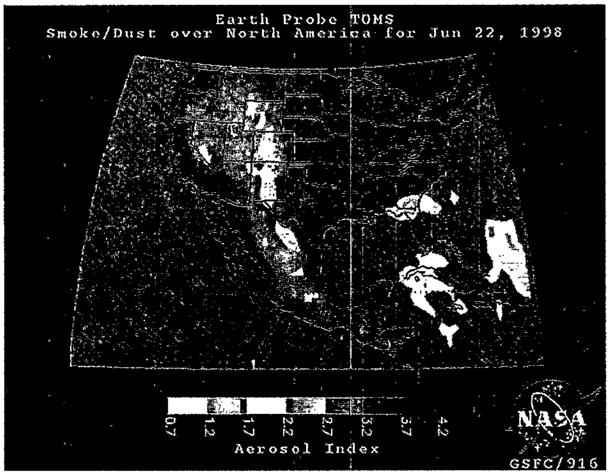
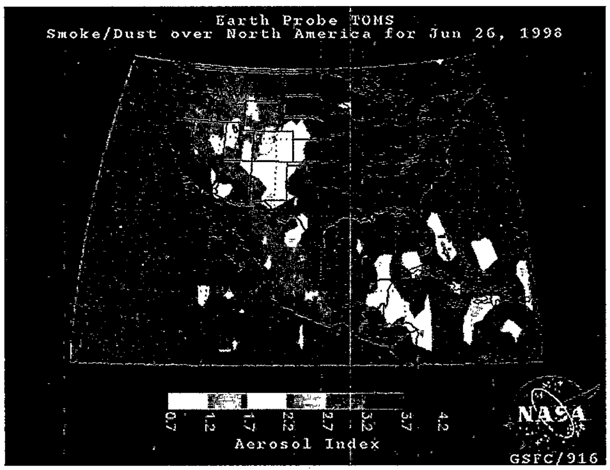


Figure 2-43. Smoke/dust over North American for June 26, 1998.



In late June, a second significant wildfire incident occurred in Central Florida and also caused elevated air pollution levels. Figure 2-42 shows the areas of Florida affected by the smoke plumes. These plumes a week later, as shown in Figure 2-43, were over the Atlantic Ocean. The State of Florida worked closely with EPA regional offices, and the public was alerted to potential health concerns. The ambient monitoring data affected by these fires were also properly flagged and effects on air quality are adequately documented.

Ambient concentration data resulting from exceptional events, such as these, are excluded from the trends analyses and tables in this report because they are not indicative of typical air quality levels.

1. Mauzerall, D.L., et al, "Photochemistry in biomass burning plumes and implications for tropospheric ozone over the tropical South Atlantic," *Journal of Geophysical Research*, Vol. 103, Number. D7, 1998.

2. Andreae, M.O., et al, "Biomass-Burning Emissions and Associated Haze Layers Over Amazonia," *Journal of Geophysical Research*, Vol. 93, Number. D2, 1988.

3. Memorandum on "Guidance on Assessing the Impacts of May 1998 Mexican Fires on Ozone Levels in the United States" from John S. Seitz to all Regional Office Directors, 1998.

Particulate Matter

Air Quality Concentrations (PM_{10})		
1989–98	25%	decrease
1997–98		no change

Emissions (PM_{10})		
1989–98	19%	decrease
1997–98		no change

Nature and Sources

Particulate matter (PM) is the general term used for a mixture of solid particles and liquid droplets found in the air. These particles, which come in a wide range of sizes and shapes, originate from many different stationary and mobile sources, as well as from natural sources. They may be emitted directly by a source (direct emissions) or formed in the atmosphere by the transformation of gaseous precursor emissions such as SO_2 and NO_x (secondary particles). Their chemical and physical compositions vary depending on location, time of year, and meteorology.

Health and Environmental Effects

Scientific studies show a link between inhalable PM (alone, or combined with other pollutants in the air) and a series of significant health effects. Inhalable PM includes both fine and coarse particles. Fine particles are those that are less than 2.5 micrometers in diameter. Those between 2.5 and 10 micrometers are known as coarse particles. Both coarse and fine particles can accumulate in the respiratory system and are associated with numerous adverse health effects. Exposure to coarse particles is primarily associated with the aggravation of respiratory conditions such as asthma. Fine particles are most closely associated with adverse health effects including decreased lung function, increased hospital admissions and emergency room visits, increased respiratory symptoms and disease, and premature death. Sensitive groups that appear to be at greatest risk to such PM effects include the elderly, individuals with cardiopulmonary disease such as asthma, and children.

Particulate matter also can also cause adverse impacts to the environment. Fine PM is the major cause of reduced visibility in parts of the United States, including many of our national parks. Other environmental impacts occur when particles deposit onto soils, plants, water, or materials. For example, particles containing nitrogen and sulfur that deposit onto land or water bodies may change the nutrient balance and acidity of those environments so that species composition and buffering capacity change. An ecosystem condition known as "nitrogen saturation," where additions of nitrogen to soil over time exceed the capacity of the plants and microorganisms to utilize and retain the nitrogen, has already occurred in some areas of the United States.

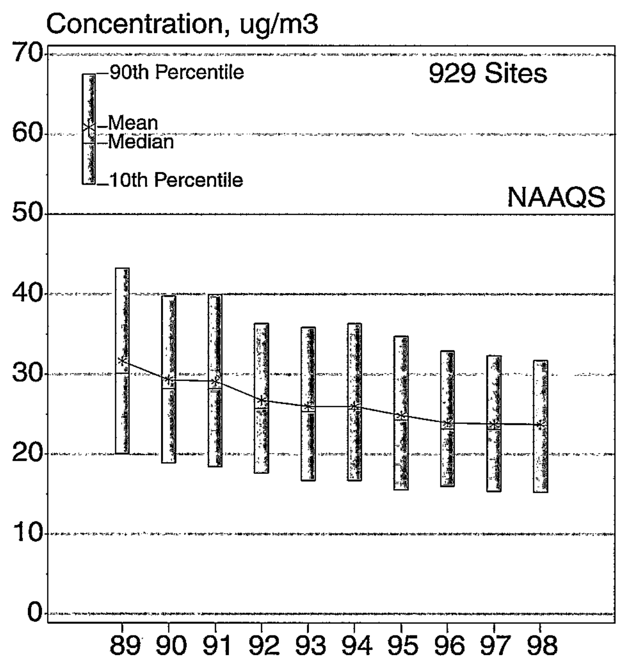
Particles that are deposited directly onto the leaves of plants can, depending on their chemical composition, corrode leaf surfaces or interfere with plant metabolism. When deposited in sufficient quantities, such as near unpaved roads, tilled fields, or quarries, particles block sunlight from reaching the leaves, stressing or killing the plant. Finally, PM causes soiling and erosion damage to materials, including culturally important objects such as carved monuments and statues.

Primary and Secondary PM Standards

The original standards for PM, established in 1971, were for total suspended particulate matter (TSP). In 1987, EPA replaced the TSP standards with PM_{10} standards to focus on smaller particles of aerodynamic diameter less than or equal to 10 micrometers. These smaller particles cause greater health concern than TSP because of their ability to penetrate into sensitive regions of the respiratory tract. The standards for PM_{10} include both short- and long-term NAAQS. The short-term (24-hour) standard of 150 $\mu g/m^3$ is not to be exceeded more than once per year on average over three years. The long-term standard specifies an expected annual arithmetic mean not to exceed 50 $\mu g/m^3$ averaged over three years. These are the primary, or health-based, PM_{10} standards. The secondary, or welfare-based, standards for PM_{10} are identical to the primary standards.

The most recent review of the PM standards concluded that still more protection from adverse health effects was needed. In July 1997, the primary (health-based) PM standards were revised to add two new $PM_{2.5}$ standards, for protection from fine particles, and to change the form of the PM_{10} standards. The new $PM_{2.5}$ standards were set at 15 $\mu g/m^3$ and 65 $\mu g/m^3$, respectively, for the annual and 24-hour standards.[29] The secondary (welfare-based) $PM_{2.5}$ standards were made identical to the primary standards, and will be implemented in conjunction with a revised visibility protection program to address regional haze in mandatory federal Class I areas (certain large national parks and wilderness areas).

Figure 2-44. Trend in annual mean PM_{10} concentrations, 1989–1998.



In May 1999, however, the U.S. Court of Appeals for the D.C. Circuit issued an opinion concerning the revised particulate matter standards. The court vacated the revised PM_{10} standard and remanded the $PM_{2.5}$ standards back to EPA for further consideration. Following the denial of a petition for rehearing by the D.C. Circuit, the Justice Department has filed a petition for review before the Supreme Court.

National 10-Year Trends

The first complete year of PM_{10} trends data for most monitors is 1988. Therefore, this is only the second time that the *Trends Report* has been able to present a full 10-year air quality trend for PM_{10}. Figure 2-44 shows a 25-percent decrease in the average of annual mean PM_{10} concentrations measured at 929 monitoring sites across the country between 1989 and 1998. The downward trend in PM_{10} annual means is apparent, with a leveling off of the trend occurring in the later years. The final year (1997–1998) shows no change. This same general trend can be seen if the sites are grouped as rural, suburban, and urban, as in Figure 2-45. The highest values are generally found at the urban sites, followed closely by the suburban sites. The PM_{10} composite annual mean is significantly lower at the rural sites, which are generally located away from local sources of PM_{10}.

Several factors have played a role in reducing PM_{10} concentrations. Where appropriate, states required emissions from industrial sources and construction activities to be reduced to meet the PM_{10} standards. Measures were also adopted to reduce street dust emissions, including the use of clean anti-skid materials like washed sand, better control of the amount of material used, and removal of the material from the street as soon as the ice and snow melt. Cleaner burning fuels like natural gas and fuel oil have replaced wood and coal as fuels for residential heating, industrial furnaces, and electric utility and industrial boilers.

Emissions Trends

Nationally, PM_{10} direct emissions decreased 19 percent between 1989 and 1998 (see Figure 2-45). Direct PM_{10} emissions are generally examined in two separate groups. First there are the more traditionally inventoried sources, shown in Figures 2-46 and 2-47. These include fuel combustion, industrial processes, and transportation. Of these, the fuel combustion category saw the largest decrease over the 10-year period (21 percent), with most of the decline attributable to a decrease in emissions from residential wood burning. Local control programs to curtail the use of residential wood heaters during times when the air was stagnant and to replace old woodstoves with new, cleaner-burning models are responsible for the decrease in residential wood burning, along with lower natural gas and fuel oil prices. Emissions from the industrial processes category decreased 20 percent, and emissions from the transportation category decreased 15 percent.

The second group of direct PM_{10} emissions is a combination of miscellaneous and natural sources including agriculture and forestry, wildfires and managed burning, fugitive dust from paved and unpaved roads, and wind erosion. As Figure 2-48 shows, these miscellaneous and natural sources actually account for a large percentage of the total direct PM_{10}

emissions nationwide, although they can be difficult to quantify compared to the traditionally inventoried sources. The trend of emissions in the miscellaneous/natural group may be more uncertain from one year to the next or over several years because these emissions tend to fluctuate a great deal from year to year.

Table A-6 lists PM_{10} emissions estimates for the traditionally inventoried sources for 1989–1998. Miscellaneous and natural source PM_{10} emissions estimates are provided in Table A-7.

Regional Trends

Figure 2-49 is a map of regional trends for the PM_{10} annual mean from 1989–1998. All 10 EPA regions show decreasing trends over the 10-year period, ranging from 18–38 percent declines. The largest decreases are generally seen in the western part of the United States. This is significant since the two westernmost regions, 9 and 10, started at the highest annual mean concentrations back in 1989. In the western states, programs such as those with residential wood heaters and agricultural practices have helped reduce emissions of PM_{10}. Soil moisture levels have also been higher (from more rainfall) in many western states in recent years. In the eastern United States, the Title IV Acid Rain Program has certainly contributed to the decrease in PM_{10} emissions. The program has reduced SO_2 and NO_x emissions, both precursors of particulate matter in the atmosphere (see Chapter 7 on Atmospheric Deposition and the SO_2 section in this chapter for more information on the Acid Rain Program).

Figure 2-45. PM_{10} annual mean concentration trends by location, 1989–1998.

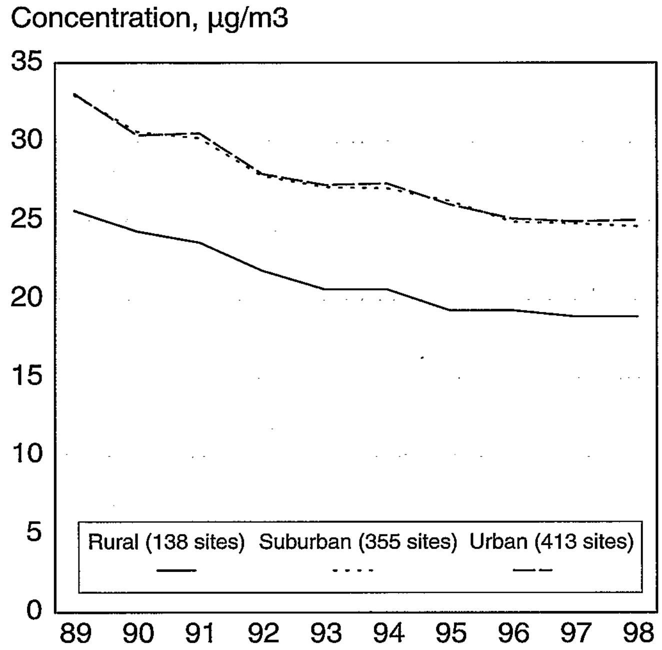


Figure 2-46. National PM_{10} emissions trend, 1989–1998 (traditionally inventoried sources only).

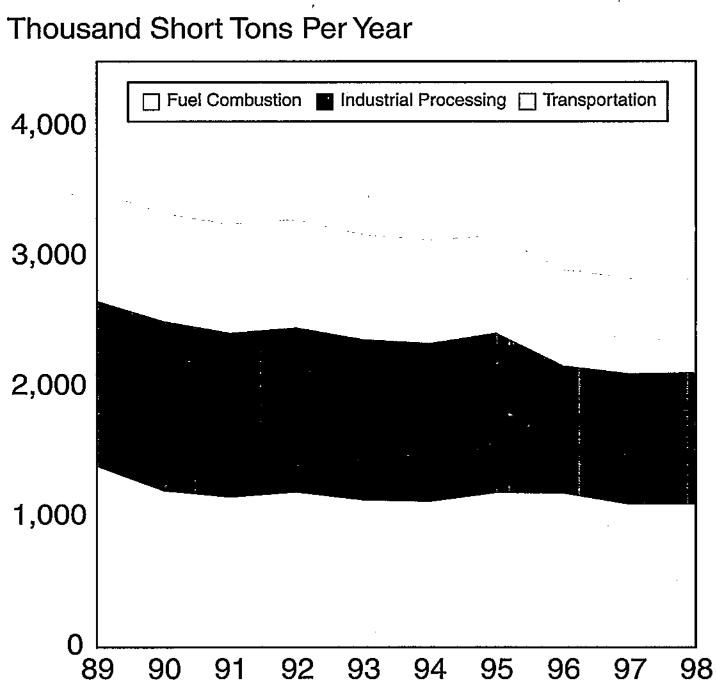


Figure 2-47. PM_{10} emissions from traditionally inventoried source categories, 1998.

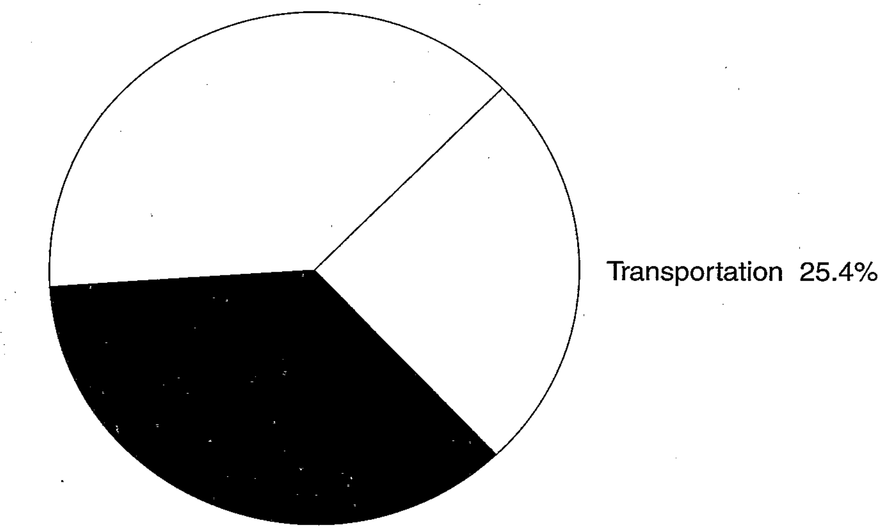
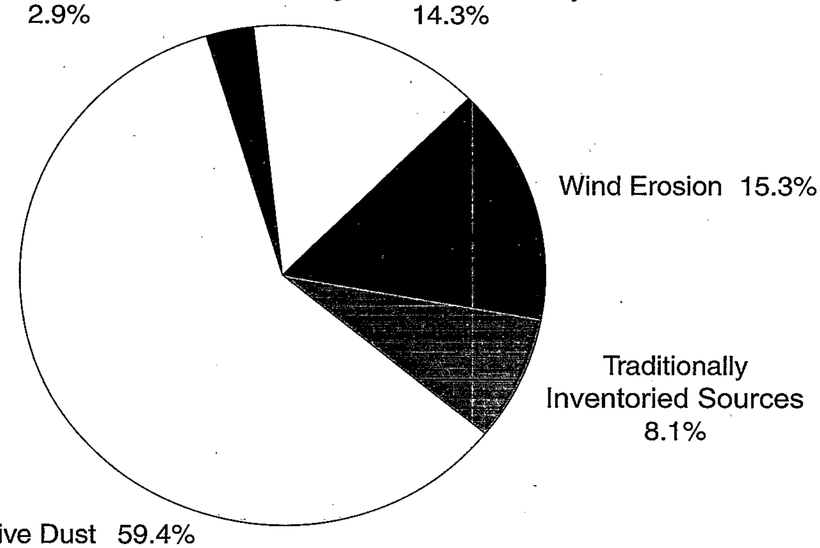


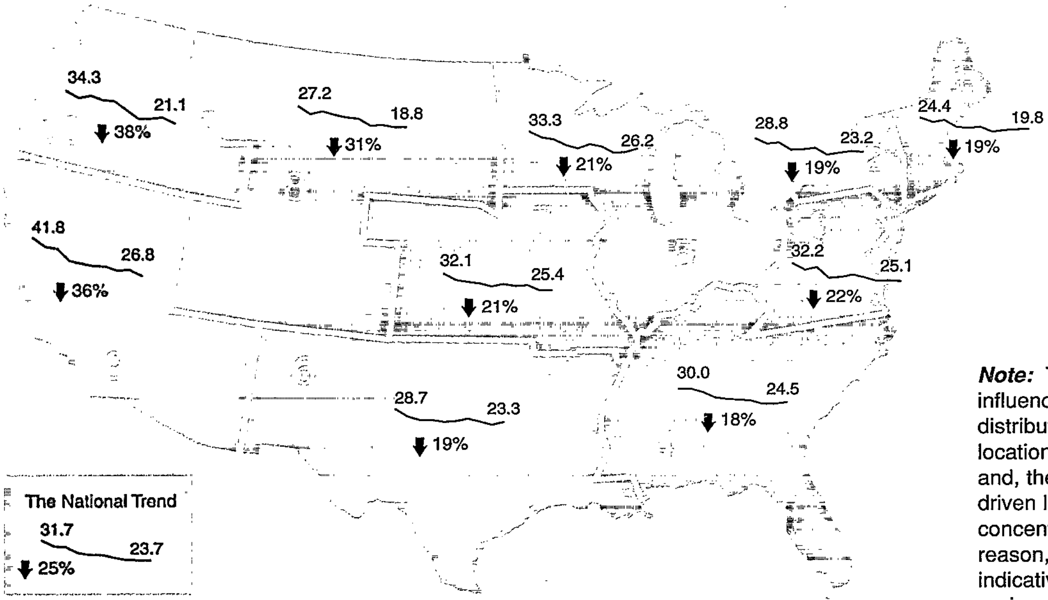
Figure 2-48. Total PM_{10} emissions by source category, 1998.



1998 Air Quality Status

The map in Figure 2-50 displays the highest second maximum 24-hour PM_{10} concentration in each county for 1998. The largest of these was recorded in Inyo County, California, caused by wind blown dust from a dry lake bed. The bar chart which accompanies the national map shows the number of people living in counties within each concentration range. The colors on the map and bar chart correspond to the colors of the concentration ranges displayed in the map legend. In 1998, approximately 4 million people lived in 9 counties where the highest second maximum 24-hour PM_{10} concentration was above the level of the 24-hour PM_{10} NAAQS. When both the annual and 24-hour PM_{10} standards are considered, there were 10 million people living in 13 counties with PM_{10} concentrations above the NAAQS in 1998.

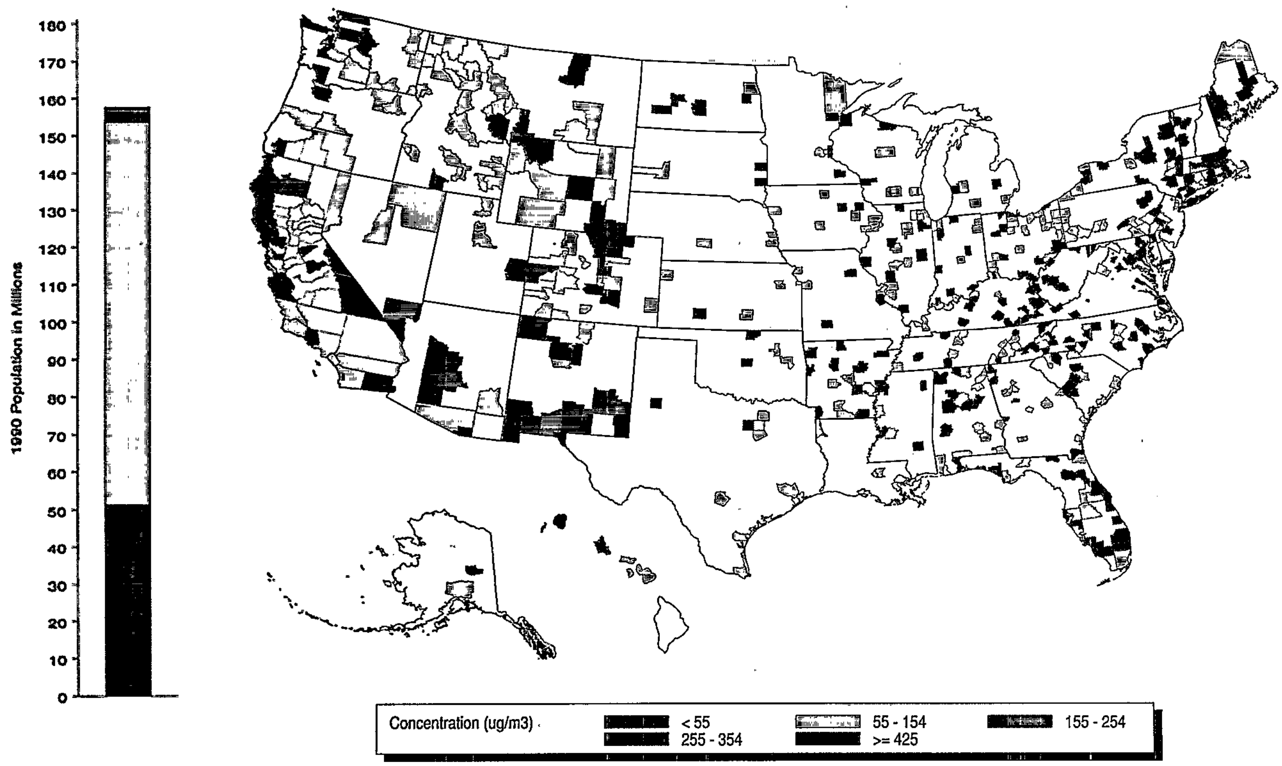
Figure 2-49. Trend in PM_{10} annual mean concentration by EPA Region, 1989–1998.



Alaska is in EPA Region 10; Hawaii, EPA Region 9; and Puerto Rico, EPA Region 2. Concentrations are µg/m3.

Note: These trends are influenced by the distribution of monitoring locations in a given region and, therefore, can be driven largely by urban concentrations. For this reason, they are not indicative of background regional concentrations.

Figure 2-50. Highest 2nd maximum 24-hour PM_{10} concentration by county, 1998.



Fine Particulate Matter ($PM_{2.5}$)

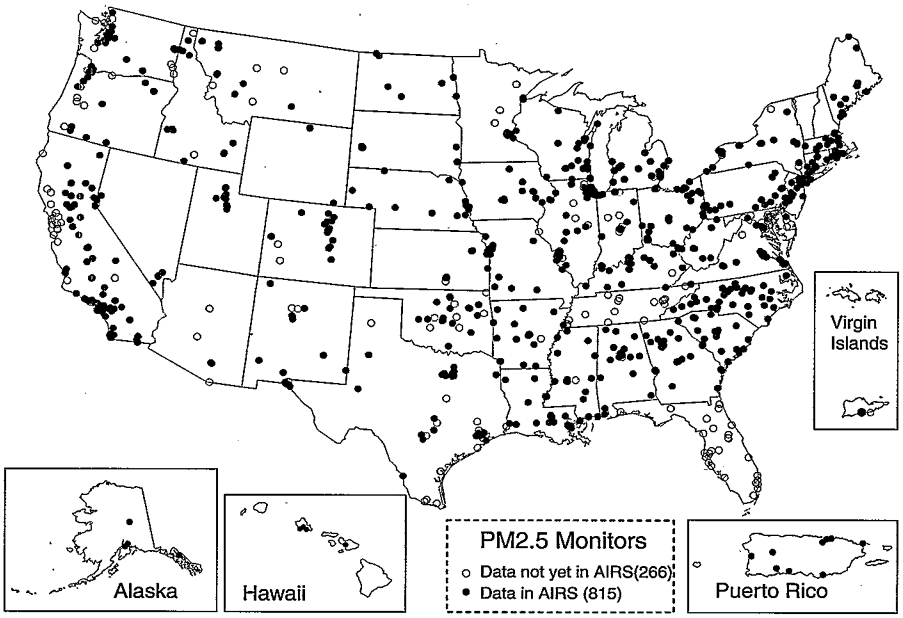
Characterizing $PM_{2.5}$ Trends

A new monitoring network designed to assess fine PM data with respect to the new $PM_{2.5}$ standards began deployment in early 1999. The status of this network is shown in Figure 2-51. As of February 2000, approximately 94 percent of the Federal Reference Method (FRM) monitoring sites were operating and 815 of them had already reported data to EPA's Aerometric Information Retrieval System (AIRS). Once deployment is completed in December 2000, the network will consist of approximately 1,700 monitors at over 1,100 sites. These monitors include the mass monitors (the FRMs), speciation sites, continuous monitoring sites, and additional Interagency Monitoring of Protected Visual Environments (IMPROVE) sites.

Since this monitoring network started in 1999, data from another network, the IMPROVE network of predominately rural sites, were used to assess ambient $PM_{2.5}$ concentrations in this report. Since the monitors in the IMPROVE network are non-FRM, the data cannot be used for compliance purposes (i.e., to tell whether or not an area meets the $PM_{2.5}$ standard). They do, however, provide a good indication of $PM_{2.5}$ concentrations and compositions over broad regions of the country.

The IMPROVE network was established in 1987 to track visibility impairment in the nation's most pristine areas, like national parks and wilderness areas. (The IMPROVE network is discussed in further detail in Chapter 6: Visibility Trends.) For this reason, the data primarily represent rural areas. There is, however, one urban site (Washington, D.C.) in the network with adequate trend data. Data from this site and other sites meeting data completeness criteria described in Appendix B, are presented in this section. Figure 2-52 shows the location of these sites by region.

Figure 2-51. Status of new $PM_{2.5}$ Monitor Deployment, based on AIRS February, 2000.



1998 Rural $PM_{2.5}$ Concentrations and Composition

Rural $PM_{2.5}$ concentrations vary regionally. Sites in the east typically have higher annual mean concentrations. Figure 2-53 shows annual mean concentrations for 1998 and reveals the natural break that forms between the eastern and western halves of the country. Some comparisons can be made between the two regions. Of the 12 eastern sites, 10 have higher annual averages of measured $PM_{2.5}$ than any sites in the west. In fact, most sites in the west are roughly less than half of those in the east. This difference is mainly due to higher sulfate concentrations in the east. Sulfate concentrations in the eastern sites are 4–5 times greater than those in the western sites. Electric utilities account for 71 percent of the SO_2 emissions in the eastern United States. The trend in ambient sulfates and sulfur dioxides both appear to generally correspond to the change in annual sulfur dioxide emissions from electric utilities in the eastern United States. In the most recent year (1997–1998), sulfate concentrations increased 10 percent in the East (as shown later in Figure 2-54). (Atmospheric deposition of sulfur and nitrogen compounds is discussed in further detail in Chapter 7).

The chemical composition of $PM_{2.5}$ also varies regionally. Sulfate and organic carbon account for most of the $PM_{2.5}$ concentrations in the east and the west. Sites in the east on average have a higher percentage of sulfate concentrations (56 percent)

Figure 2-52. Class I Areas in the IMPROVE Network meeting the data completeness criteria in Appendix B.

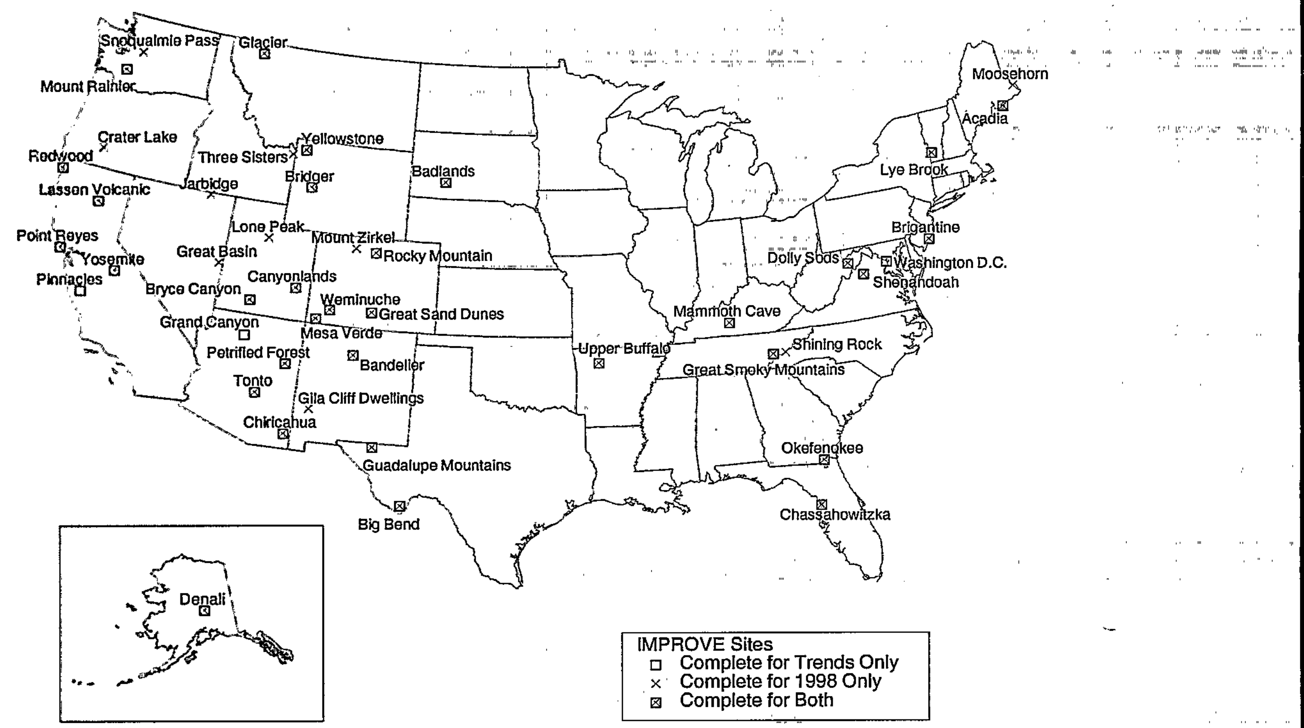


Figure 2-53. Annual average 1998 $PM_{2.5}$ concentrations (in μg/m³) at IMPROVE sites and contribution by individual constituents. Pie chart sizes are scaled by annual average $PM_{2.5}$ concentrations.

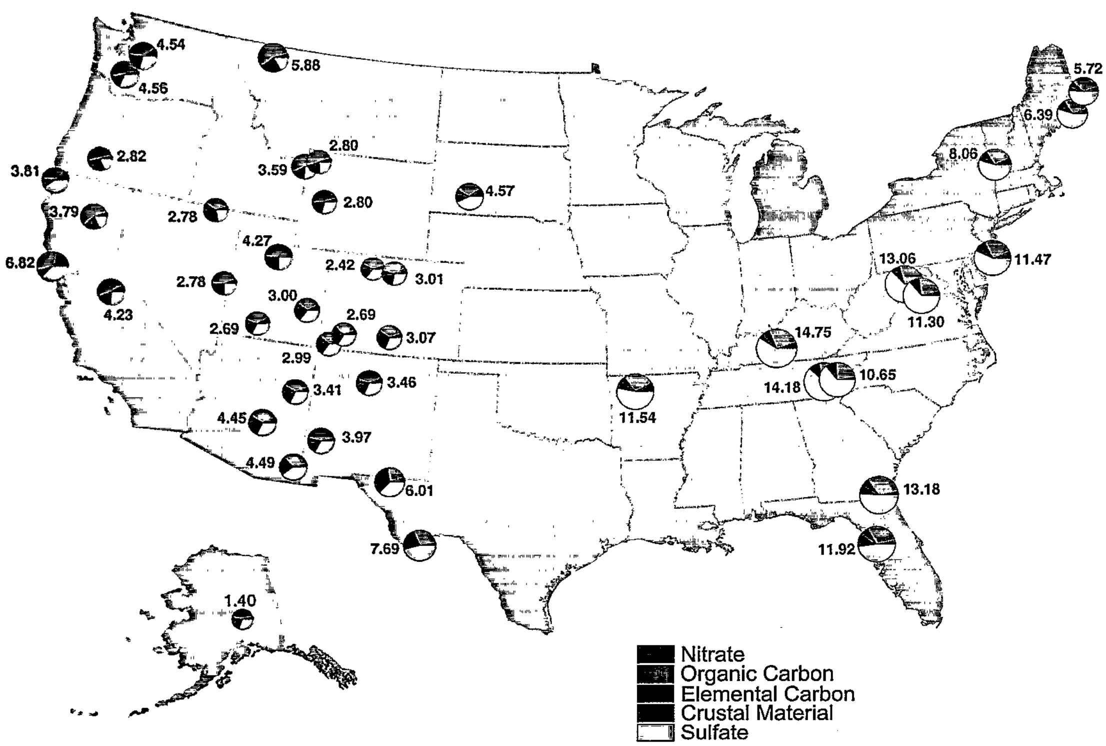


Figure 2-54. $PM_{2.5}$ Concentrations, 1989–1998 at eastern IMPROVE sites meeting trends criteria.

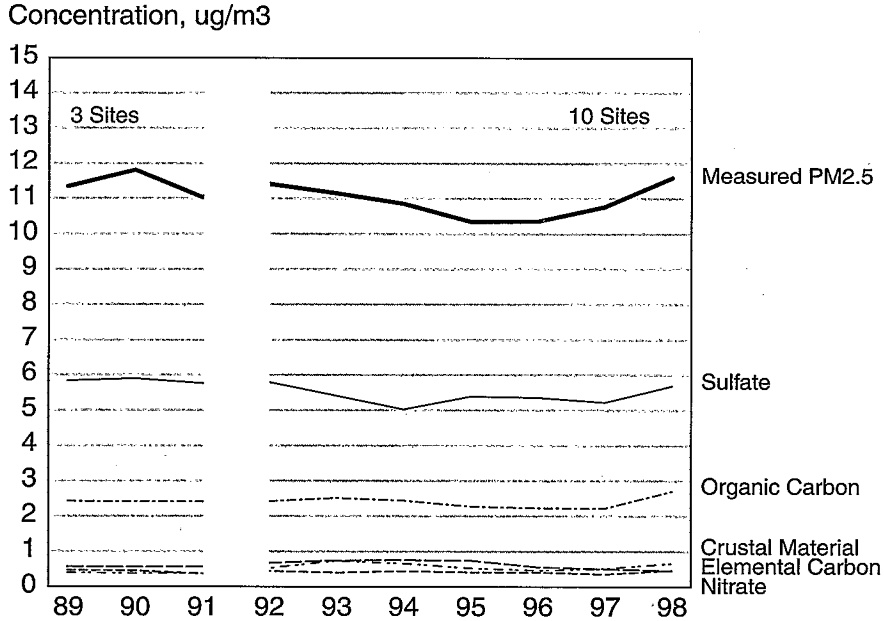
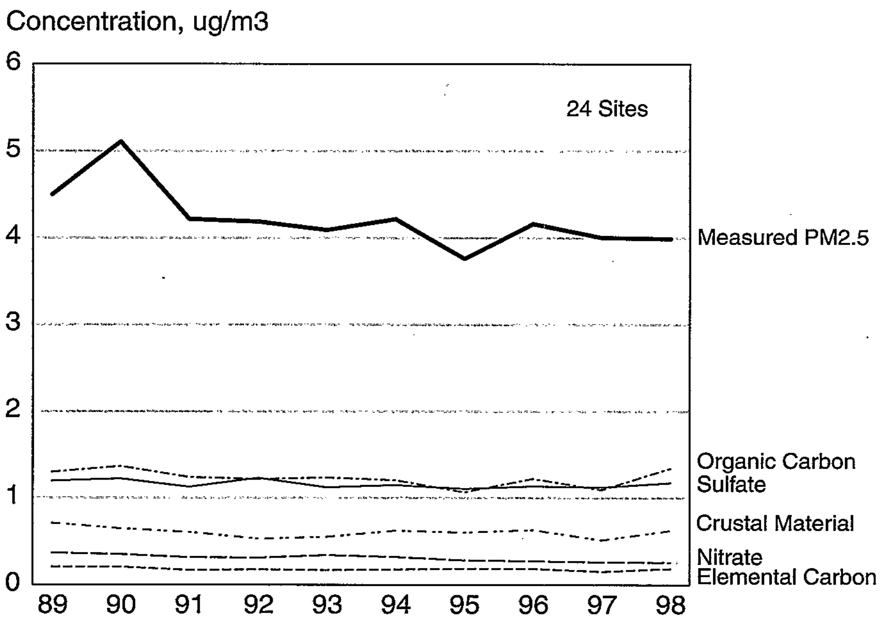


Figure 2-55. $PM_{2.5}$ Concentrations, 1989–1998 at western IMPROVE sites meeting trends criteria.



relative to those in the west (33 percent). Table 2-5 shows the difference in percent contribution of each species for the eastern versus western regions of the United States.

Table 2-5. Percent Contribution to $PM_{2.5}$ by Component, 1998

	East	West
Sulfate	56	33
Elemental Carbon	5	6
Organic Carbon	27	36
Nitrate	5	8
Crustal Material	7	17

10-Year Trends

Rural

Because of the significant regional variations in rural $PM_{2.5}$ concentrations, trends are aggregated by eastern and western regions as shown in Figures 2-54 and 2-55. Based on the 10 sites with trend data in the East, measured $PM_{2.5}$ concentrations decreased 9 percent between 1992 and 1995, then increased 12 percent from 1995 to 1998. The net change between 1992 and 1998 is a 2 percent increase. Trends in the West, though, decreased 5 percent during the 1992 to 1998 period and decreased 11 percent over the longer, 10-year period from 1989 to 1998.

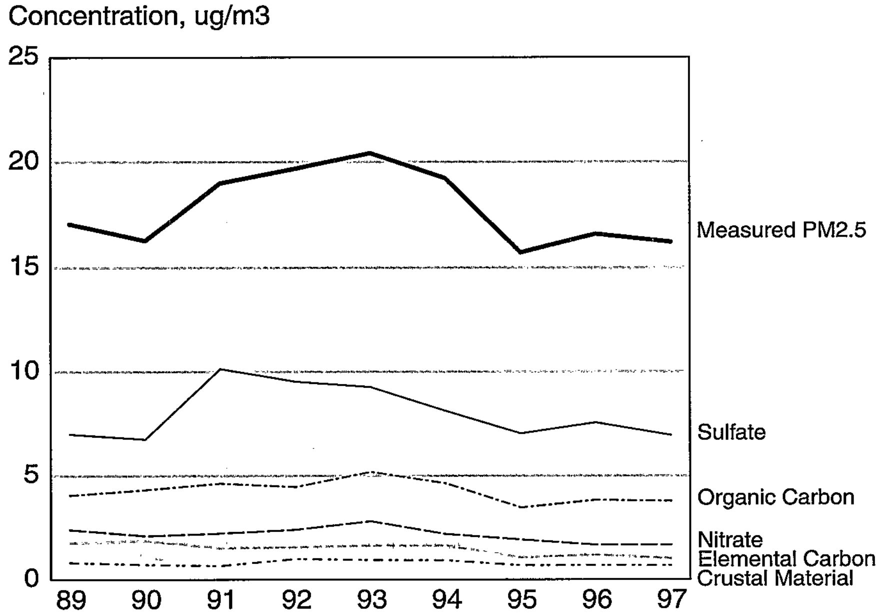
Measured mass represents the direct mass measurement from the filter. The individual concentrations do not equal this value because they do not account for all measured mass. For more information on the IMPROVE network, visit **http://alta_vista.cira.colostate.edu/**.

Urban

The Washington, D.C. site is not grouped with the other eastern sites because it has much higher concentrations. Figure 2-56 shows that

$PM_{2.5}$ concentrations decreased 5 percent between 1989 and 1997. Data for this site was incomplete for 1998. The available, incomplete data indicate that the trend might have increased slightly 1997–1998 consistent with the eastern rural sites. The elevated levels from 1991 to 1994 are primarily due to changes in sulfate concentrations.

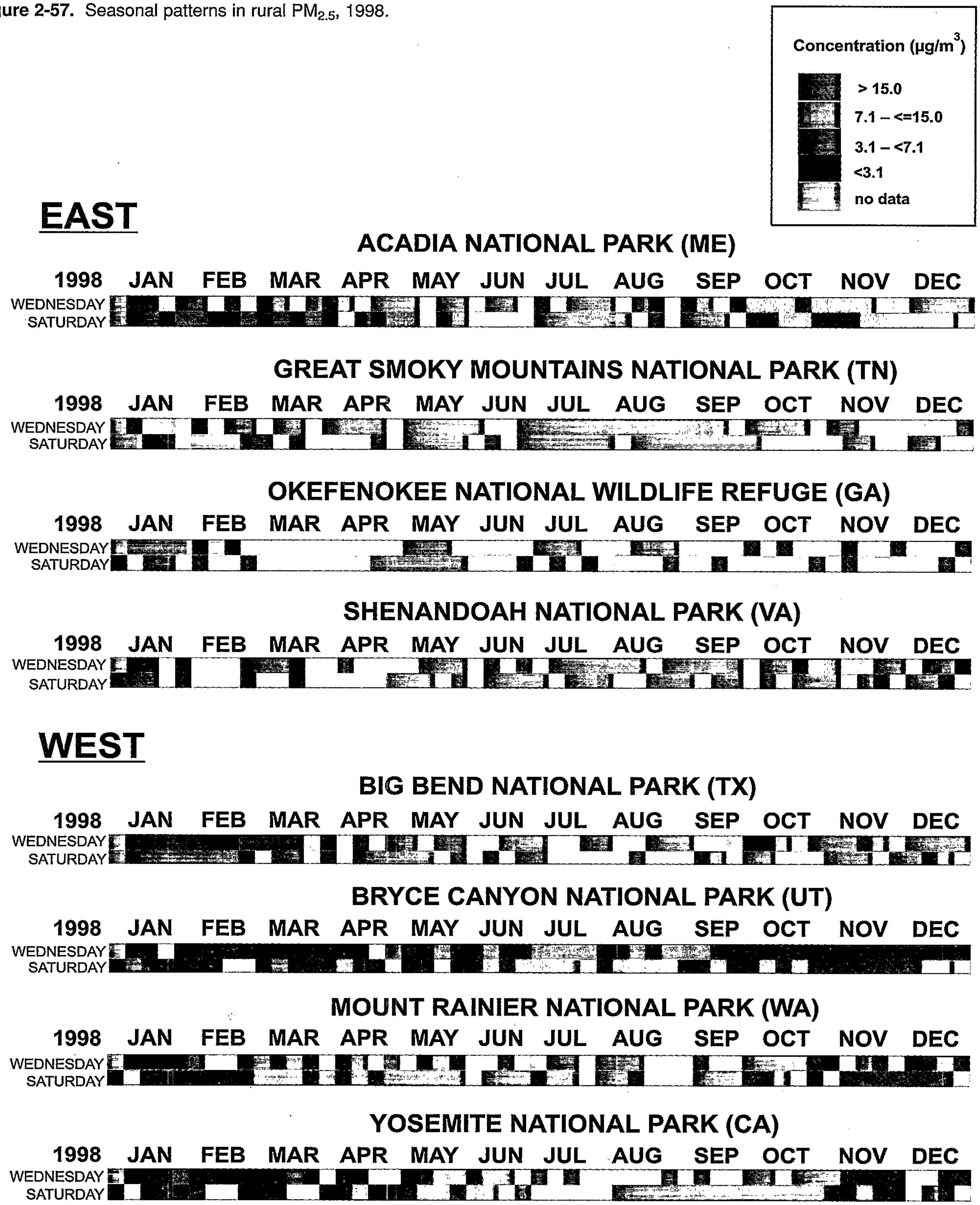
Figure 2-56. $PM_{2.5}$ Concentrations, 1989-1998, at the Washington, D.C. IMPROVE site.



Seasonal Trends

Figure 2-57 shows the 1998 seasonal patterns for $PM_{2.5}$ at eastern and western IMPROVE sites. These sites were selected to represent typical patterns across the two regions. Each square, or tile, represents one day of the year. The color of each tile corresponds to the daily $PM_{2.5}$ concentration level. Higher levels are yellow and orange. The chronological arrangement of daily concentrations over the course of the year reveals that summer months typically experience higher $PM_{2.5}$ concentrations. Daily concentrations at some sites are more variable throughout the year and do not necessarily follow this pattern as closely. Most western sites experience few, if any, days with concentrations above 15 µg/m^3, while most eastern sites regularly exceed this value in the summertime. In fact, daily levels at the highest annual mean site in the west (Big Bend) are comparable to the second lowest annual mean site in the east (Acadia). Both sites had six days with concentrations above 15 µg/m^3 in 1998.

Figure 2-57. Seasonal patterns in rural $PM_{2.5}$, 1998.



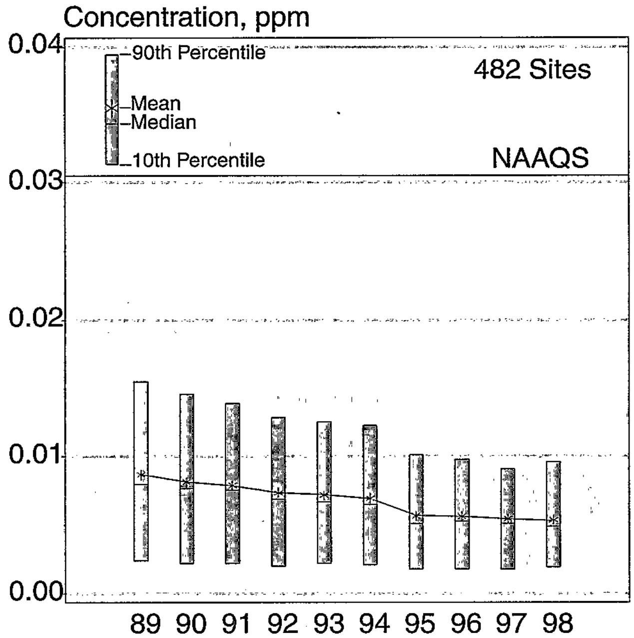
Sulfur Dioxide

Air Quality Concentrations		
1989–98	39%	decrease
1997–98	2%	decrease
Emissions		
1989–98	16%	decrease
1997–98		no change

Nature and Sources

Sulfur dioxide (SO_2) belongs to the family of sulfur oxide (SO_x) gases. These gases are formed when fuel containing sulfur (mainly coal and oil) is burned, and during metal smelting and other industrial processes. The highest monitored concentrations of SO_2 have been recorded in the vicinity of large industrial facilities.

Figure 2-58. Trend in annual mean SO_2 concentrations, 1989–1998.



Health and Environmental Effects

High concentrations of SO_2 can result in temporary breathing impairment for asthmatic children and adults who are active outdoors. Short-term exposures of asthmatic individuals to elevated SO_2 levels while at moderate exertion may result in reduced lung function that may be accompanied by symptoms such as wheezing, chest tightness, or shortness of breath. Other effects that have been associated with longer-term exposures to high concentrations of SO_2, in conjunction with high levels of PM, include respiratory illness, alterations in the lungs' defenses, and aggravation of existing cardiovascular disease. The subgroups of the population that may be affected under these conditions include individuals with cardiovascular disease or chronic lung disease, as well as children and the elderly.

Additionally, there are a variety of environmental concerns associated with high concentrations of SO_2. Because SO_2, along with NO_x, is a major precursor to acidic deposition (acid rain), it contributes to the acidification of soils, lakes and streams and the associated adverse impacts on ecosystems (see Chapter 7, Atmospheric Deposition of Sulfur and Nitrogen Compounds). Sulfur dioxide exposure to vegetation can increase foliar injury, decrease plant growth and yield, and decrease the number and variety of plant species in a given community. Sulfur dioxide also is a major precursor to $PM_{2.5}$, which is of significant concern to human health (as discussed in the particulate matter section of this chapter), as well as a main pollutant that impairs visibility (see Chapter 6, Visibility Trends). Finally, SO_2 can accelerate the corrosion of natural and man-made materials (e.g., concrete and limestone) which are used in buildings and monuments, as well as paper, iron-containing metals, zinc and other protective coatings.

Primary and Secondary Standards

There are both short- and long-term primary NAAQS for SO_2. The short-term (24-hour) standard of 0.14 ppm (365 $\mu g/m^3$) is not to be exceeded more than once per year. The long-term standard specifies an annual arithmetic mean not to exceed 0.030 ppm (80 $\mu g/m^3$). The secondary NAAQS (3-hour) of 0.50 ppm (1,300 $\mu g/m^3$) is not to be exceeded more than once per year.

National 10-Year Trends

The national composite average of SO_2 annual mean concentrations decreased 39 percent between 1989 and 1998 as shown in Figure 2-58, with the largest single-year reduction (16 percent) occurring between 1994 and 1995.[30] The trend has since leveled off, declining only 2 percent from 1997–1998. This same general trend is seen in Figure 2-59, which plots the ambient concentrations grouped by rural, suburban, and urban

Figure 2-59. Annual mean SO_2 concentration by trend location, 1989–1998.

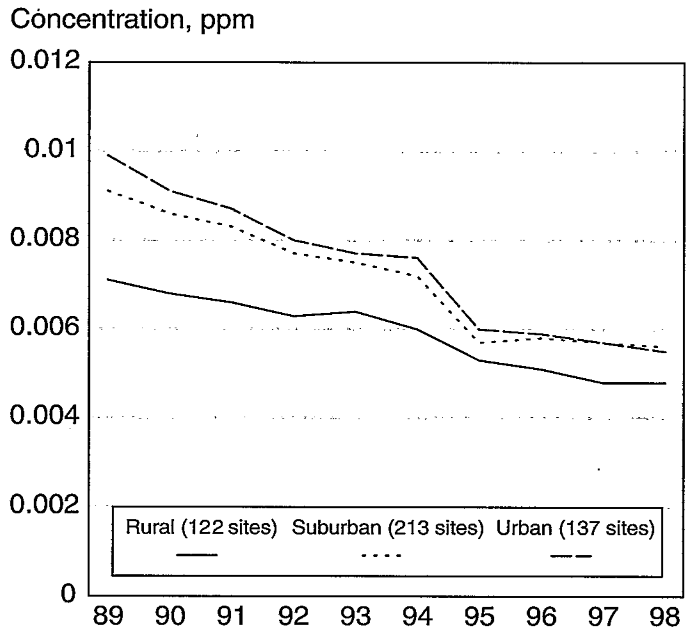
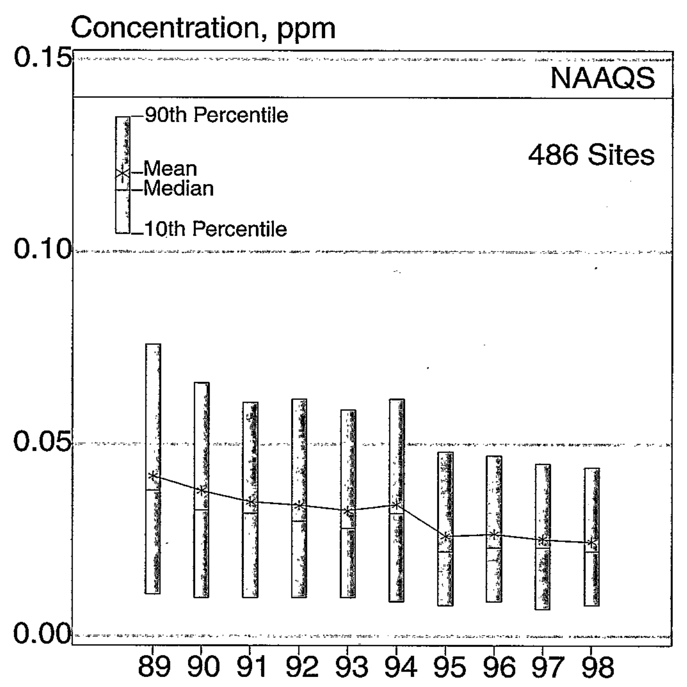


Figure 2-60. Trend in 2nd max 24-hour average SO_2 concentrations, 1989–1998.



sites. It shows that the mean concentrations at the urban and suburban sites are consistently higher than those at the rural sites. However, the 1994–1995 reduction in the concentrations at non-rural sites does narrow the gap between the trends. The greater reduction seen in the non-rural sites reflects the fact that the proportion of non-rural sites is greater in the eastern United States, which is where most of the 1994–1995 emissions reductions at electric utilities occurred.[31] The national composite second maximum 24-hour SO_2 annual mean concentrations decreased 42 percent between 1989 and 1998, as shown in Figure 2-60, with the largest single-year reduction (25 percent) occurring between 1994 and 1995. See also Chapter 7, Atmospheric Deposition of Sulfur and Nitrogen Compounds.

Emissions Trends

National SO_2 emissions decreased 16 percent between 1989 and 1998, with a sharp decline between 1994 and 1995, similar to the decline in the ambient concentrations. Unlike the air quality trend, however, the emissions trend begins to climb again from 1995–1998, as shown in Figure 2-61. This dramatic reduction and subsequent increase is driven by the yearly changes in emissions from the electric utility industry. Much of the increase was caused by units not yet affected by the acid rain program. These units will be in the program and subject to a national emissions cap beginning in 2000. The electric utility industry accounts for most of the fuel combustion category in Figure 2-62. In particular, the coal-burning power plants have consistently been the largest contributor to SO_2 emissions, as documented in Table A-8 in Appendix A. See also Chapter

7, Atmospheric Deposition of Sulfur and Nitrogen Compounds.

The Acid Rain Program

The national reductions from 1994–1995 in emissions and ambient concentrations of SO_2 are due mainly to Phase I implementation of the Acid Rain Program. Established by EPA under Title IV of the CAA, the Acid Rain Program's principal goal is to achieve significant reductions in SO_2 and NO_x emissions. Phase I compliance for SO_2 began in 1995 and significantly reduced emissions from the participating utilities.[32] Table 2-6 shows this reduction in terms of Table 1 units (units required to participate in Phase I) and Non-Table I and other units. The 1994–1995 decrease in total SO_2 emissions from electric utilities is due largely to the Phase I emissions reduction.

Since 1995, however, total SO_2 emissions from electric utilities have increased. Again, Table 2-6 explains this increase in terms of Table I units and Non-Table I units. Most Phase I plants over-complied in 1995, banking their emission allowances for use in Phase II, which begins in 2000. As a result, SO_2 emissions have increased slightly at some Phase I sources since the initial 1995 reduction. However, Table I units account for only 18 percent of the total 1995 to 1998 increase. The majority of the increase is attributed to those units not yet participating in the Acid Rain Program. Most of these units will be included in Phase II of the Program. When fully implemented, total SO_2 emissions from electric utilities will be capped at 8.95 million tons per year. For more information on the Acid Rain Program, visit **http://www.epa.gov/airmarkets**. See also

Table 2-6. Total SO_2 Emissions from Table I units and Non-Table I units, 1994–1998 (thousand short tons).

	1994	1995	1996	1997	1998	Percent Change 1994–95	Percent Change 1995–98
Phase I units[33]	7,379	4,455	4,760	4,766	4,660	-40	+5
Non-Phase I units	7,510	7,625	7,871	8,324	8,557	+2	+12
All Electric Utility units	14,889	12,080	12,631	13,090	13,217	-19	+9

Figure 2-61. National total SO_2 emissions trend, 1989–1998.

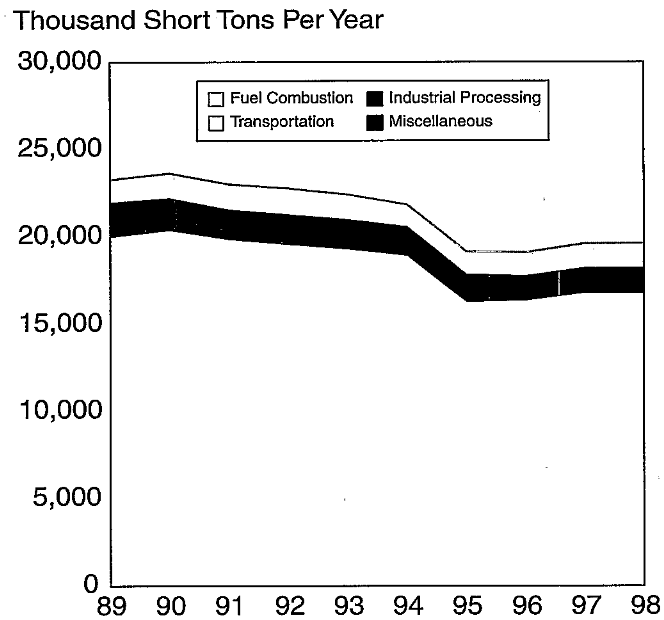


Figure 2-62. SO_2 emissions by source category, 1998.

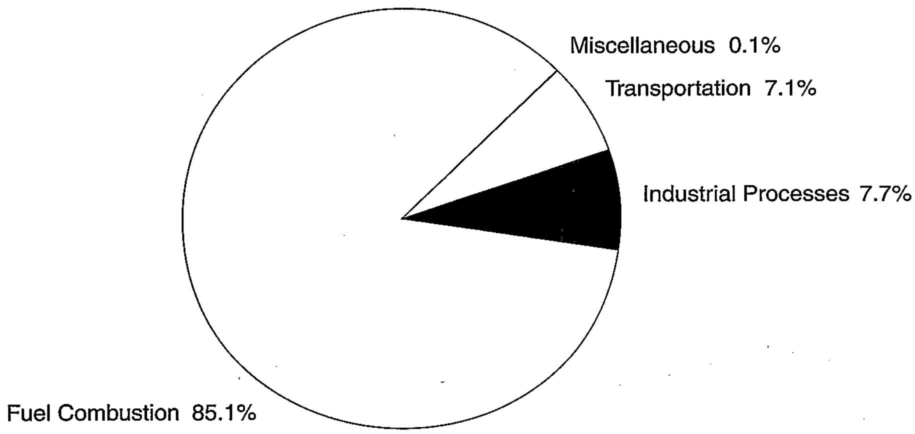
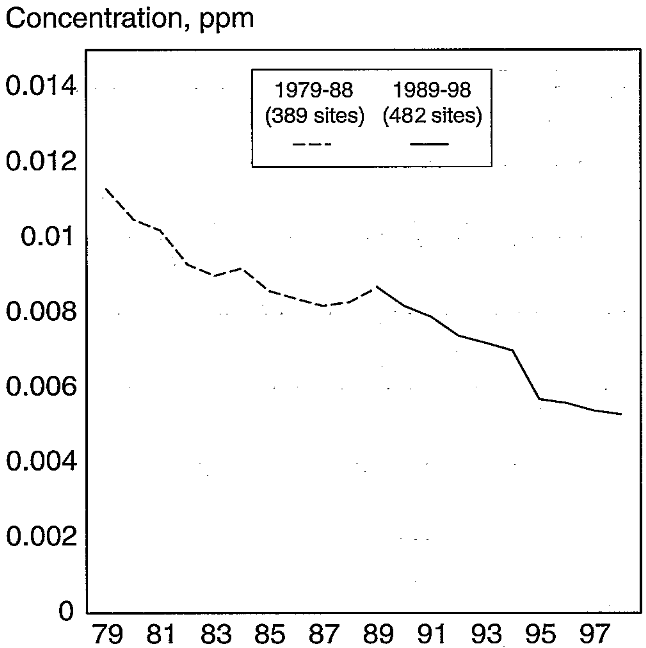


Figure 2-63. Long-term ambient SO_2 trend, 1979–1998.

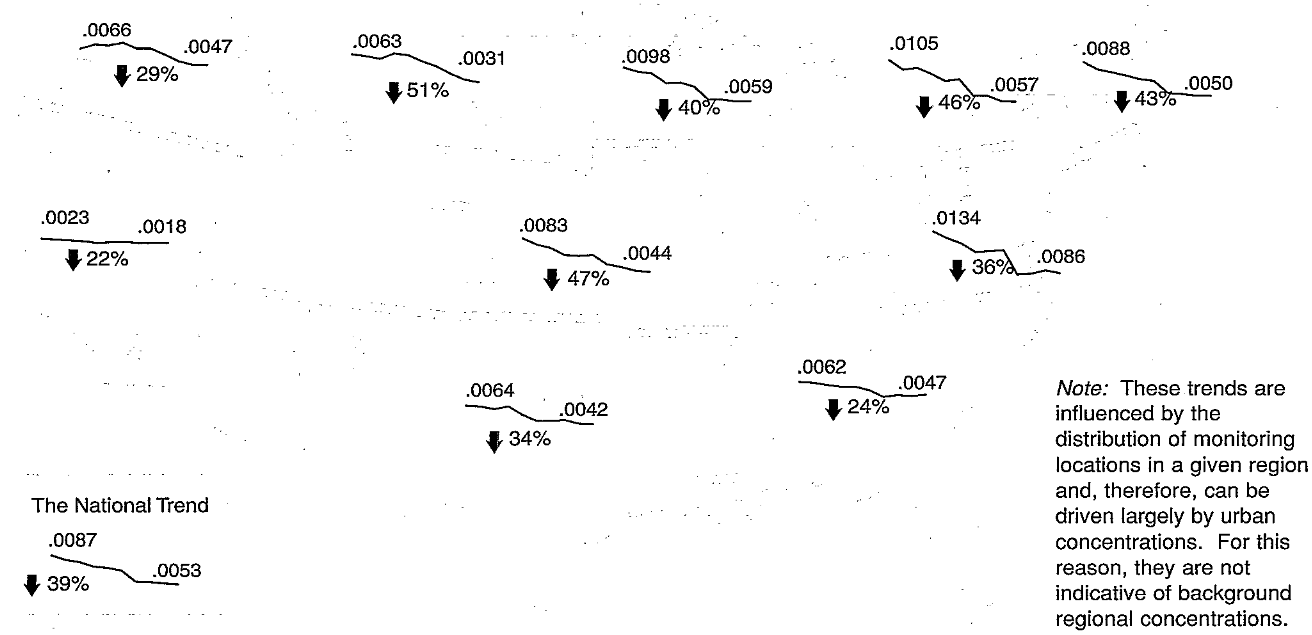


Chapter 7, Atmospheric Deposition of Sulfur and Nitrogen Compounds.

National 20-Year Trends

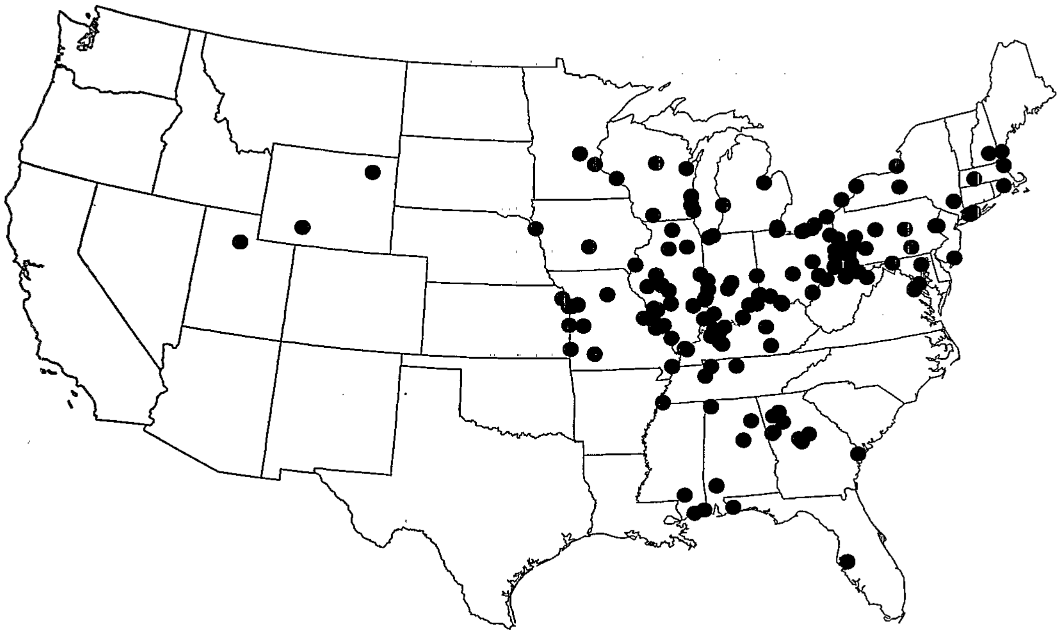
The progress in reducing ambient SO_2 concentrations during the past 20 years is shown in Figure 2-63. While there is a slight disconnect in the trend line between 1988 and 1989 due to the mix of trend sites in each 10-year period, an overall downward trend is evident. The national 1998 composite average SO_2 annual mean concentration is 53 percent lower than 1979. In addition to the previously mentioned effects of the Acid Rain Program, these steady reductions over time were accomplished by installing flue-gas control equipment at coal-fired generating plants, reducing emissions from industrial

Figure 2-64. Trend in SO_2 annual arithmetic mean concentration by EPA Region, 1989–1998.



Alaska is in EPA Region 10; Hawaii, EPA Region 9; and Puerto Rico, EPA Region 2.
Concentrations are ppm.

Figure 2-65. Plants affected by Phase I of the Acid Rain Program.



processing facilities such as smelters and sulfuric acid manufacturing plants, reducing the average sulfur content of fuels burned, and using cleaner fuels in residential and commercial burners.

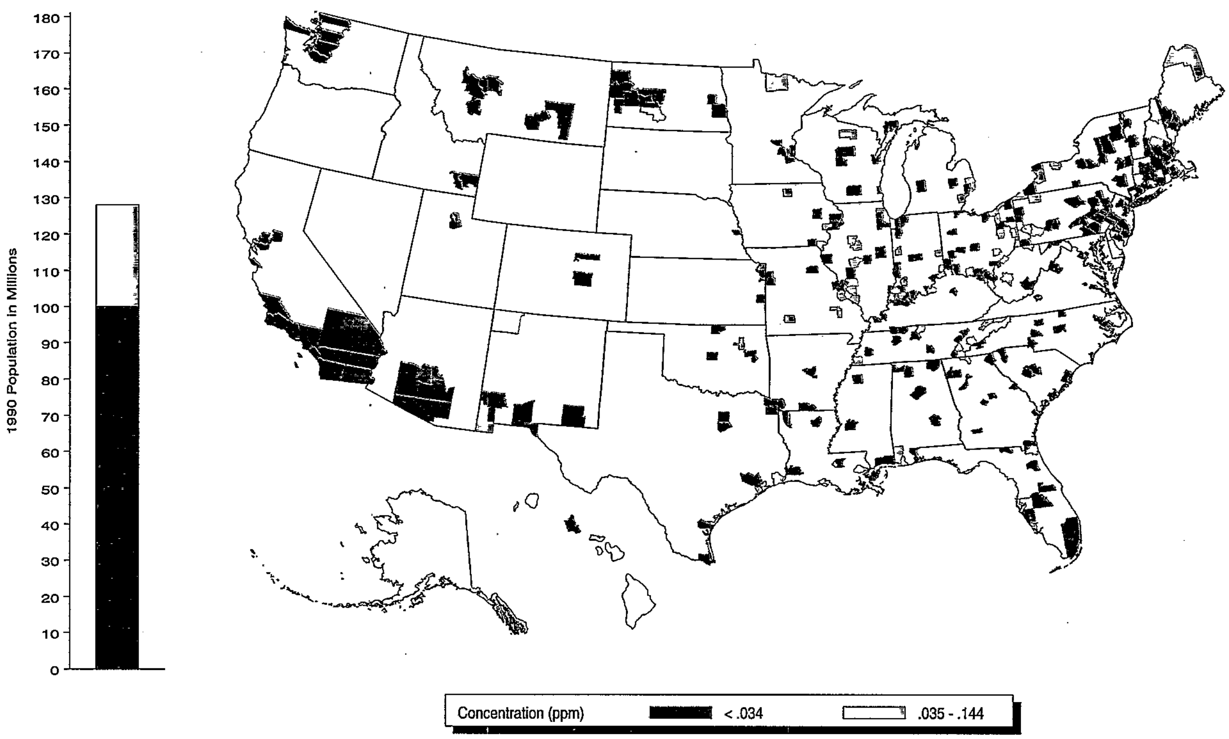
Regional Trends

The map of regional trends in Figure 2-64 shows that ambient SO_2 concentrations are generally higher in the northeastern United States. The effects of Phase I of the Acid Rain Program are seen most vividly in the northeast. In particular, concentrations fell 20–25 percent between 1994 and 1995 in EPA Regions 1, 2, 3, and 5. These broad regional trends are not surprising since most of the units affected by Phase I of the Acid Rain Program also are located in the east as shown in Figure 2-65. This figure also shows that ambient concentrations have increased slightly between 1995 and 1997 in Regions 3 and 4 where many of the electric utility units not yet affected by the Acid Rain Program are located.

1998 Air Quality Status

The most recent year of ambient data shows that all counties did meet the primary SO_2 short-term standard, according to Figure 2-66.

Figure 2-66. Highest 2nd maximum 24-hour SO_2 concentration by county, 1998.



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1. *Oxygenated Gasoline Implementation Guidelines*, EPA, Office of Mobile Sources, Washington, D.C., July 27, 1992.

2. *Guidelines for Oxygenated Gasoline Credit Programs and Guidelines on Establishment of Control Periods Under Section 211(m) of the Clean Air Act as Amended*, 57 FR 47853 (October 20, 1992).

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4. G. Whitten, J. Cohen, and A. Kuklin, *Regression Modeling of Oxyfuel Effects on Ambient CO Concentrations: Final Report*, SYSAPP-96/78, prepared for the Renewable Fuels Association and Oxygenated Fuels Association by System Applications International, Inc., San Rafael, CA, January 1997.

5. Cook, J. R., P. Enns, and M. S. Sklar, *Regression Analysis of Ambient CO Data from Oxyfuel and Nonoxyfuel Areas*, Paper No. 97-RP139.02, Air and Waste Management Association 90th Annual Meeting, Toronto, Ontario, June 1997.

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8. "Review of the National Ambient Air Quality Standards for Nitrogen Oxides: Assessment of Scientific and Technical Information," EPA-452/R-95-005, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1995.

9. J. H. Seinfeld and S. N. Pandis, *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*, John Wiley & Sons, Inc., New York, NY, 1998.

10. "1998 Compliance Report," U.S. Environmental Protection Agency, Acid Rain Program, Washington, D.C., August 1999.

11. "Approval and Promulgation of State Implementation Plans and Redesignation of the South Coast Air Basin in California to Attainment for Nitrogen Dioxide; Direct Final Rule," *Federal Register, 63 FR 39747*, Washington, D.C., July 24, 1998.

12. "Identification of Ozone Areas Attaining the 1-hour Standard and to Which the 1-hour Standard is No Longer Applicable; Final Rule," *Federal Register*, 63 FR 2804, Washington, D.C., June 5, 1998.

13. "Identification of Additional Ozone Areas Attaining the 1-hour Standard and to Which the 1-hour Standard is No Longer Applicable; Final Rule," *Federal Register*, 63 FR 39431, Washington, D.C., July 22, 1998.

14. "Identification of Additional Ozone Areas Attaining the 1-hour Standard and to Which the 1-hour Standard is No Longer Applicable; Final Rule," *Federal Register*, 64 FR 30911, Washington, D.C., June 9, 1999.

15. "Rescinding Findings that the 1-hour Ozone Standard No Longer Applies in Certain Areas," *Federal Register*, 64 FR 57424, Washington, D.C., November 5, 1999.

16. "National Ambient Air Quality Standards for Ozone; Final Rule," *Federal Register, 62 FR 38856*, Washington, D.C., July 18, 1997.

17. "Re-Issue of Early Planning Guidance for the Revised Ozone and Particulate Matter (PM) National Ambient Air Quality Standards (NAAQS)," memorandum from S. Shaver, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 17, 1998.

18. "Climate Variations Bulletin: August 1997," *Historical Climatology Series 4–7*, Volume 9, Number 8, National Climatic Data Center, NOAA, Asheville, NC, September 1997.

18a. CASTNet is considered the nation's primary source for atmospheric data to estimate dry acidic deposition and to provide data on rural ozone levels. Established in 1987, CASTNet now comprises 79 monitoring stations across the United States. The longest data records are primarily at eastern sites. The majority of the monitoring stations are operated by EPA's Office of Air and Radiation; however, 27 stations are operated by the National Park Service (NPS) in cooperation with EPA. A more detailed treatment of CASTNet's atmospheric deposition role and data are provided in Chapter 7: Atmospheric Deposition of Sulfur and Nitrogen Compounds.

19. This analysis utilizes a non-parametric procedure to assess statistical significance. A description of this nonparametric regression procedure is provided in Chapter 3: Criteria Pollutants—Metropolitan Area Trends.

20. W. M. Cox and S. H. Chu, "Meteorologically Adjusted Ozone Trends in Urban Areas: A Probabilistic Approach," *Atmospheric Environment*, Vol. 27B, No. 4, Pergamon Press, Great Britain, 1993.

21. "Ambient Air Quality Surveillance: Final Rule," *Federal Register, 58 FR 8452*, Washington, D.C., February 12, 1993.

22. "Selected PAMS sites" refers to the inclusion of only those sites with measurements of NO_x or VOC in both years were used *Median changes* (in summer site 6–9 a.m. means) are highlighted for NO_x and VOC since that indicator minimizes the greater variability seen in concentrations of those parameters in this smaller data set.

23. Although among the top 25 VOC species (by volume) of the PAMS program formaldehyde and acetaldehyde (both carbonyl compounds) were not included in this analysis due to lack of definitive analytic results. Further,

EPA has evaluating carbonyl sampling over the past several years and improved measurement protocols will be issued soon.

24. "Volatility Regulations for Gasoline and Alcohol Blends Sold in Calendar Years 1989 and Beyond," *Federal Register, 54 FR 11868*, Washington, D.C., March 22, 1989.

25. "Reformulated Gasoline: A Major Step Toward Cleaner Air," EPA-420-B-94-004, U.S. Environmental Protection Agency, Office of Air and Radiation, Washington, D.C., September 1994.

26. The Clean Air Act requires that RFG contain 2 percent oxygen by weight. "Requirements for Reformulated Gasoline," *Federal Register*, 59 FR 7716, Washington, D.C., February 16, 1994.

27. The Panel's Executive Summary and final report entitled *"Achieving Clean Air and Clean Water: The Report of the Blue Ribbon Panel on Oxygenates in Gasoline"* can be found on the Panel's homepage at: http://www.epa.gov/oms/consumer/fuels/oxypanel/blueribb.htm

28. *National Air Pollutant Emission Trends, 1900–1996*, EPA-454/R-97-011, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1997.

29. *National Ambient Air Quality Standards for Particulate Matter: Final Rule, July 18, 1997*. (62 FR 38652), http://www.epa.gov/ttn/oarpg/rules.html.

30. The annual mean is used to show trends in national SO_2 air quality because it is a more stable statistic than the 24-hour statistic.

31. *National Air Pollutant Emissions Trends Report*, EPA-454/R-97-011, US EPA, Research Triangle Park, NC 27711, December 1997.

32. *1997 Compliance Report: Acid Rain Program*, EPA-430-R-98-012, U.S. Environmental Protection Agency, Office of Air and Radiation, Washington, D.C., August 1998.

33. These data were obtained from the 1998 Emission Scorecard found at **http://www.epa.gov/acidrain/score98/es1998.htm**.

CHAPTER 3

Criteria Pollutants — Metropolitan Area Trends

http://www.epa.gov/oar/aqtrnd98/chapter3.pdf

This chapter presents status and trends in criteria pollutants for Metropolitan Statistical Areas (MSAs) in the United States. The MSA trends and status give a local picture of air pollution and can reveal regional patterns of trends. Such information can allow one to gauge the air pollution situation where they live, although not all areas in the country are in MSAs, and not all MSAs are included here. A complete list of MSAs and their boundaries can be found in the Statistical Abstract of the United States.[1] The status and trends of metropolitan areas are based on four tables found in Appendix A (A-13 through A-16). Table A-13 gives the 1998 peak statistics for all MSAs, providing the status of the most recent year. Ten-year trends are shown for the 258 MSAs having data that meet the trends requirements explained in Appendix B. Table A-14 lists these MSAs and reports criteria pollutant trends as "upward" or "downward," or "not significant." These categories are based on a statistical test, known as the Theil test, which is described later in this chapter.

Another way to assess trends in MSAs is to examine Air Quality Index (AQI) values.[2,3] The AQI is used to present daily information on one or more criteria pollutants to the public, in an easily understood format and in a timely manner. Tables A-15 and A-16 list the number of days with AQI values greater than 100 (unhealthy for sensitive groups) for the nation's 94 largest metropolitan areas (population greater than 500,000). Table A-15 lists AQI values based on all pollutants, while Table A-16 lists AQI values based on ozone alone. The tables listing Pollutant Standard Index (PSI) data from previous reports may not agree with the tables in this report because the new AQI is completely different. These changes are presented in more detail later in this chapter.

For several reasons, these tables are incomplete with respect to MSAs and data. For example, not every MSA appears in the tables and data for all pollutants does not appear for each MSA. This is because the MSA population is so small, or the air quality is so good, that AQI reporting is not required. Some data entries in Table A-13 are listed as "ND," or no data. Not all criteria pollutants are measured in all MSAs. Ambient monitoring for a particular pollutant may not be conducted if there is no problem. This is why data for some MSAs are designated as "ND" (no data) for those pollutants. In addition, there are MSAs with too little monitoring data for trends analysis purposes (see Appendix B). Finally, there are MSAs that do not meet the population threshold required for inclusion in Tables A-15 and A-16.

Status: 1998

The air quality status for MSAs can be found in Table A-13 (for related information, see Table A-12, peak concentrations for all counties with monitors that reported to the Aerometric Information Retrieval System (AIRS) database). Table A-13 lists peak statistics for all criteria pollutants measured in an MSA. Peak statistics for MSAs are found in Table A-13, which shows that 173 areas had peak concentrations exceeding standard levels for at least one criteria pollutant. The number of these areas increased 34 percent over the count from 1997 data (129 areas). The increase can be attributed to the many areas that have peak 8-hour ozone concentrations just above the level of the 8-hour ozone standard in 1998. These 173 areas represent 64 percent of the U.S. population. Similarly, there were 14 areas representing 14 percent of the population that had peak statistics that exceeded two or more standards. Only one area, (Las Vegas, NV-AZ) representing less than 1 percent of the U.S. population, had peak statistics from three pollutants that exceeded the respective standards. The high value for PM_{10} is due to area sources (dust) for this MSA.

There were no areas, however, that violated four or more standards.

Trends Analysis

Table A-14 displays air quality trends for MSAs. The data in this table are average statistics of pollutant concentrations from the subset of ambient monitoring sites that meet the trends criteria explained in Appendix B. A total of 258 MSAs have at least one monitoring site that meet these criteria. As stated previously, not all pollutants are measured in every MSA.

From 1989–1998, statistics related to the NAAQS were calculated for each site and pollutant with available data. Spatial averages were obtained for each of the 258 MSAs by averaging these statistics across all sites in an MSA. This process resulted in one value per MSA per year for each pollutant. Although there are seasonal aspects of certain pollutants and, therefore, seasonality in monitoring intensity for different MSAs, the averages for every MSA and year provide consistent values with which to assess trends.

Since air pollution levels are affected by variations in meteorology, emissions, and day-to-day activities of populations in MSAs, trends in air pollution levels are not always well defined. To assess upward or downward trends, a linear regression was applied to these data. An advantage of using the regression analysis is the ability to test whether or not the upward or downward trend is real (significant) or just a chance product of year-to-year variation (not significant). Since the underlying pollutant distributions do not meet the usual assumptions required for common least squares regression, the regression analysis was based upon a non-parametric method commonly referred to as the Theil test.[5,6,7] Because linear regression estimates the trend from changes during the entire 10-year period, it is possible to detect an upward or downward trend even when the concentration level of the first year equals the concentration level of the last year. Also, this method uses a median estimator which is not influenced by a single extreme value.

Table 3-1. Summary of MSA Trend Analyses, by Pollutant

	Trend Statistic	Total # MSAs	# MSAs Up	# MSAs Down	# MSAs with No Significant Change
CO	Second Max 8-hour	139	0	104	35
Lead	Max Quarterly Mean	90	1	61	28
NO_2	Arithmetic Mean	97	4	44	49
Ozone	Fourth Max 8-hour	198	13	25	160
Ozone	Second Daily Max 1-hour	198	11	23	164
PM_{10}	Weighted Annual Mean	211	1	152	58
PM_{10}	90th Percentile	211	0	132	79
SO_2	Arithmetic Mean	148	0	103	45
SO_2	Second Max 24-hour	148	0	91	57

Table 3-1 summarizes the trend analysis performed on the 258 MSAs by pollutant. It shows that there were no upward trends in carbon monoxide (CO) and sulfur dioxide (SO_2 maximum daily mean) at any of the MSAs over the past decade. Summarized by area, of the 258 MSAs, 221 had downward trends in at least one of the criteria pollutants, and only 21 had upward trends. A closer look at these 21 MSAs reveals that most are well below the standard levels for the respective pollutant, meaning that their upward trends are not immediately in danger of exceeding the standard levels. The areas with a significant upward trend that were near or exceeding a standard level all involved 8-hour ozone. Overall, these results demonstrate significant improvements in urban air quality over the past decade.

Geographical summaries of the trends analysis show variations from one region to another. Trends for CO show that while most of the nation is experiencing a downward trend, there are isolated areas where the trend is nonsignificant (Southern Pennsylvania, Washington, Oregon, Nebraska, Iowa, and Texas). Trends for lead (Pb) are down for almost all of the country (one upward trend in the Seattle area). Trends for NO_2 are either down or nonsignificant with a small pocket of upward trends in Texas. Based on the 1-hour ozone standard, most MSAs have a nonsignificant trend, with downward trends showing up in the West (California, Nevada, and Colorado) and upward trends showing up in the East. Trends based on the 8-hour ozone standard show more areas with 1998 data above the level of the revised standard. Trends for the annual form of the PM_{10} standards show the PM_{10}

Table 3-2. AQI Categories, Colors, and Ranges

Category	AQI	O_3 (ppm) 8-hour	O_3 (ppm) 1-hour	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)
Good	0 – 50	0.000 – 0.064	(2)	0.0 - 15.4	0 – 54	0.0 – 4.4	0.000 – 0.034	(3)
Moderate	51 – 100	0.065 – 0.084	(2)	15.5 – 40.4	55 – 154	4.5 – 9.4	0.035 – 0.144	(3)
Unhealthy for Sensitive Groups	101 – 150	0.085 – 0.104	0.125 – 0.164	40.5 – 65.4	155 – 254	9.5 – 12.4	0.145 – 0.224	(3)
Unhealthy	151 – 200	0.105 – 0.124	0.165 – 0.204	65.5 – 150.4	255 – 354	12.5 – 15.4	0.225 – 0.304	(3)
Very unhealthy	201 – 300	0.125 – 0.374	0.205 – 0.404	150.5 – 250.4	355 – 424	15.5 – 30.4	0.305 – 0.604	0.65 – 1.24
Hazardous	301 – 400	(1)	0.405 – 0.504	250.5 – 350.4	425 – 504	30.5 – 40.4	0.605 – 0.804	1.25 – 1.64
	401 – 500	(1)	0.505 – 0.604	350.5 – 500.4	505 – 604	40.5 – 50.4	0.805 – 1.004	1.65 – 2.04

1. No health effects information for these levels–use 1-hour concentrations.
2. One hour concentrations provided for areas where AQI based on one hour values might be more cautionary.
3. NO_2 has no short term standard but does have a short term "alert" level.

weighted annual mean has mostly downward trends with the exception of one area in Pennsylvania. Trends based on the daily SO_2 form of the standard are mostly down for the nation. The majority of MSAs with downward trends are in the northern half of the nation, while the majority of the MSAs with non significant trends are in the southern half of the nation.

The Air Quality Index

The Air Quality Index (AQI) provides information on pollutant concentrations for ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. The AQI is "normalized" across pollutants so that an AQI value of 100 represents the level of health protection associated with the national health-based standard for each pollutant and an AQI value of 500 represents the level at which the pollutant causes significant harm . This Index has been adopted internationally and is used around the world to provide the public with information on air pollutants.

EPA has revised its Air Quality Index to enhance the public's understanding of air pollution across the nation. Previously known as the Pollutant Standards Index (PSI), this uniform air quality index is used by state and local agencies for reporting on daily air quality to the public. The revised Index can also serve as a basis for programs that encourage the public to take action to reduce air pollution on days when levels are projected to be of concern to local communities. A new national Internet website, AIRNOW (www.epa.gov/airnow), which includes "real time" air quality data and forecasts of summertime smog levels in many states, uses the AQI categories, colors, and descriptors to communicate information about air quality.

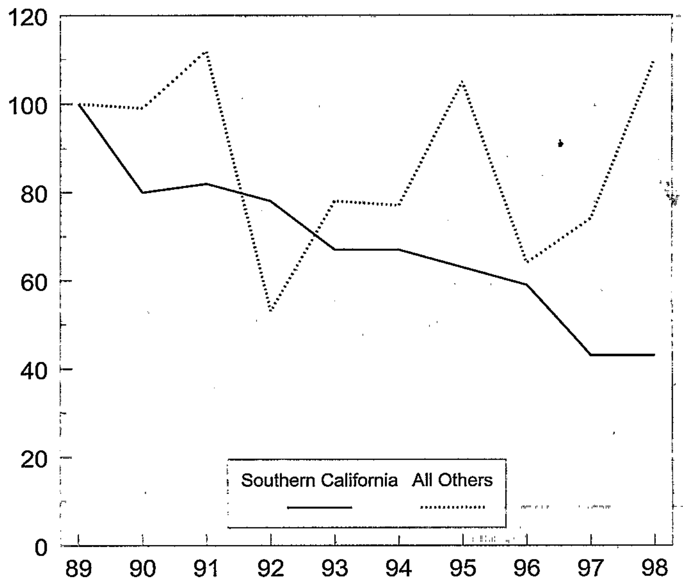
AQI values are derived from pollutant concentrations. They are reported daily in all MSAs of the United States with populations exceeding 350,000. The AQI is reported as a value between zero and 500 and a descriptive name (e.g., "unhealthy for sensitive groups") and is featured on local television or radio news programs and in newspapers.

Based on the short-term NAAQS, Federal Episode Criteria,[8] and Significant Harm Levels for each pollutant,[9] the AQI is computed for PM_{10}, SO_2, CO, O_3, and NO_2. Lead is the only criteria pollutant not included in the index because it does not have a short-term NAAQS, a Federal Episode Criteria, or a Significant Harm Level. Since the AQI is a tool used to communicate pollution concerns to a wide audience, there are also colors linked to the general descriptors of air quality. The six AQI color categories, their respective health effects descriptors, index ranges, and corresponding concentration ranges are listed in Table 3-2. EPA has also developed an AQI logo (Figure 3-1) to increase the visibility of the AQI in reports and also alert the public that the AQI is based on the uniform index throughout the country.

The AQI integrates information on criteria pollutant concentrations across an entire monitoring network into a single number that represents the worst daily air quality experienced in an urban area. For each of the criteria pollutants, concentrations are converted into an index value between zero and 500. The pollutant

Figure 3-1. Air Quality Index logo.

Figure 3-2. Number of days with AQI values > 100, as a percentage of 1989 value.



with the highest index value is reported as the AQI for that day. Therefore, the AQI does not take into account the possible adverse effects associated with combinations of pollutants (i.e., synergism).[2,3]

An AQI value greater than 100 indicates that at least one criteria pollutant (NO_2 has no short-term standard) exceeded the level of the standard, therefore, designating air quality to be in the "unhealthy for sensitive groups" range on that day. Relatively high AQI values activate public health warnings. For example, an AQI above 200 initiates a First Stage Alert at which time sensitive populations (e.g., the elderly and persons with respiratory illnesses) are advised to remain indoors and reduce physical activity. An AQI over 300 initiates a Second Stage Alert at which time the general public is advised to avoid outdoor activity.

EPA has changed the name of the Pollutant Standards Index to the Air Quality Index. The revised index adds an additional air quality category just above the level of the standard. Previously, values from 101–200 were characterized "unhealthful." The revised index establishes a category from 101–150 characterized as "unhealthy for sensitive groups," and a category of 151–200 as "unhealthy."

When air quality is "unhealthy for sensitive groups," EPA has added a corresponding requirement to report a pollutant-specific statement indicating what specific groups in the population are most at risk. For example, when the AQI is above 100 for ozone the AQI report will contain the statement "Children and people with asthma are the groups most at risk."

To the extent that state and local agencies use colors to communicate AQI values, specific colors are required. For instance, any agency that chooses to use colors to communicate such values must represent the Index values of 151–200 as "red." Examples of the use of color in Index reporting include the color bars that appear in many newspapers, and the color contours of the ozone map found on the AIRNOW website.

The revised Index includes a new sub-index for 8-hour average ozone concentrations and 24-hour concentrations of fine particulate matter. These changes to the Index are based on health effects information from the review of the ozone and particulate matter standards, as well as information and feedback provided by state and local agencies and the public.

The AQI includes changes to the sub-indices for 1-hour average ozone concentrations, particulate matter (PM_{10}), carbon monoxide and sulfur dioxide to reflect the addition of the new air quality category of "unhealthy for sensitive groups."

Summary of AQI Analyses

Since an AQI value greater than 100 indicates that the level for at least one criteria pollutant has reached levels where people in sensitive groups are likely to suffer health effects, the number of days with AQI values greater than 100 provides an indicator of air quality in urban areas. Figure 3-2 shows the trend in the number of days with AQI values greater than 100 summed across the nation's 94 largest metropolitan areas as a percentage of the 1989 value. Because of their magnitude, AQI totals for Los Angeles, Riverside, Bakersfield, and San Diego are shown separately as Southern California. Plotting these values as a percentage of 1989 values allows two trends of different magnitudes to be compared on the same graph. The long-term air quality improvement in southern California urban areas is evident in this figure. Between 1989 and 1998, the total number of days with AQI values greater than 100 decreased 57 percent in southern California but actually rose 10 percent in the remaining major cities across the United States. While five criteria pollutants can contribute to the AQI, the index is driven mostly by ozone. [*Note:* NO_2 is rarely the highest pollutant measured because it is not calculated for AQI values below 201; and NO_2 values in this range have not been recorded in the United States for at least five years.]

AQI estimates depend on the number of pollutants monitored as well as the number of monitoring sites where data are collected. The more pollutants measured and sites that are available in an area, the better the estimate of the AQI for a given day. Ozone accounts for the majority of days with AQI values above 100, but is collected at only a small number of sites in each area. Table A-16 shows the number of days with AQI values greater than 100 that are attributed to ozone alone. Comparing Tables A-15 and A-16, the number of days with an AQI above 100 are increasingly due to ozone. In fact, the percentage of days with an AQI above 100 due to ozone have increased from 92 percent in 1989, to 97 percent in 1998. This increase reveals that ozone increasingly accounts for those days above the 100 level and reflects the success in achieving lower CO and PM_{10} concentrations. However, the typical one-in-six day sampling schedule for most PM_{10} sites limits the number of days that PM_{10} can factor into the AQI determination.

References

1. *Statistical Abstracts of the United States*, 1998, U.S. Department of Commerce, U.S. Bureau of the Census.

2. *Measuring Air Quality, The Pollutant Standards Index*, EPA-451/K-94-001, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, February 1994.

3. *Code of Federal Regulations, 40 CFR Part 58, Appendix G.*

4. Note: Although the results are summarized in the report for comparison purposes, the intent of publishing Tables A-14 through A-16 is to present information on a localized basis, to be used on a localized basis (i.e., one MSA at a time). Therefore, no attempt was made to adjust the Type I error to a table-wide basis. All the tests for trends were conducted at the 5-percent significance level. No inference has been made from the tables as a whole.

5. T. Fitz-Simons and D. Mintz, "Assessing Environmental Trends with Nonparametric Regression in the SAS Data Step," American Statistical Association 1995 Winter Conference, Raleigh, NC, January, 1995.

6. Freas, W.P. and E.A. Sieurin, "A Nonparametric Calibration Procedure for Multi-Source Urban Air Pollution Dispersion Models," presented at the Fifth Conference on Probability and Statistics in Atmospheric Sciences, American Meteorological Society, Las Vegas, NV, November 1977.

7. M. Hollander and D.A. Wolfe, *Nonparametric Statistical Methods*, John Wiley and Sons, Inc., New York, NY, 1973.

8. *Code of Federal Regulations*, 40 CFR Part 51, Appendix L.

9. *Code of Federal Regulations*, 40 CFR Part 51, section 51.151.

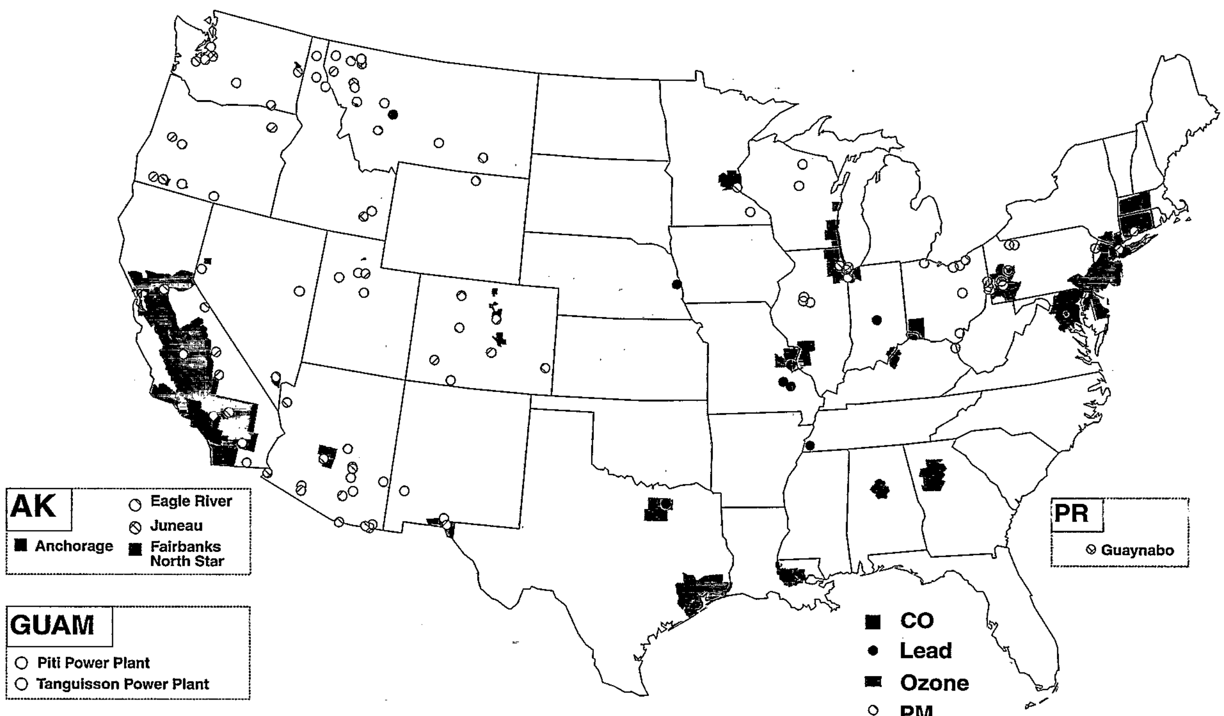
CHAPTER 4

Criteria Pollutants — Nonattainment Areas

http://www.epa.gov/oar/aqtrnd98/chapter4.pdf

This chapter provides general information on geographical regions known as nonattainment areas. When an area does not meet the air quality standard for one of the criteria pollutants the area may be subject to the formal rule-making process which designates the area as nonattainment. The 1990 Clean Air Act Amendments (CAAA) further classify ozone, carbon monoxide, and some particulate matter nonattainment areas based on the magnitude of an area's problem. Nonattainment classifications may be used to specify what air pollution reduction measures an area must adopt and when the area must reach attainment. The technical details underlying these classifications are discussed in the *Code of Federal Regulations*, Part 81 (40 CFR 81), see **http://www.epa.gov/epacfr40.**

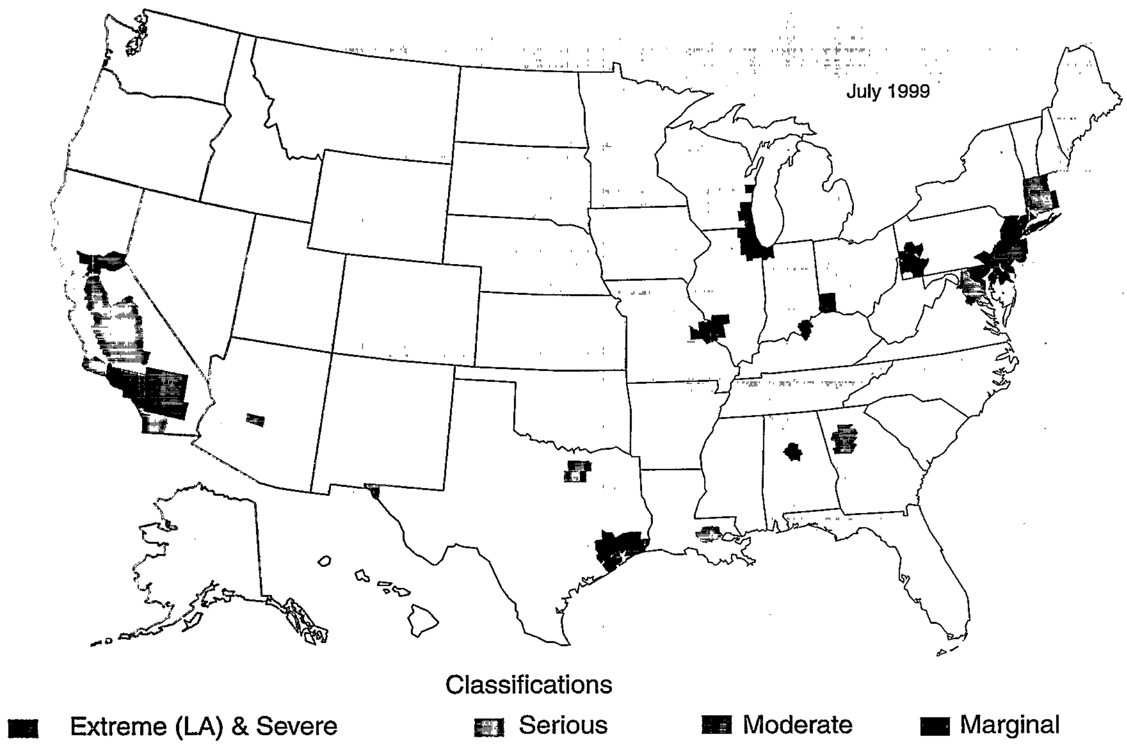
Figure 4-1. Location of nonattainment areas for criteria pollutants, September 1999.



Note: Incomplete data, not classified, and Section 185(a) areas are not shown.
*Ozone nonattainment areas on map are based on the pre-existing ozone standard.

**PM_{10} nonattainment areas on map are based on the pre-existing PM_{10} standards. Nonattainment designations based on the revised PM_{10} standards have not been made.

Figure 4-2. Classified ozone nonattainment areas where 1-hour standard still applies.



Note: San Francisco is classified Other / Sec 185A & incomplete data areas not included.

Figure 4-1 shows the location of the nonattainment areas for each criteria pollutant as of September 1999. Figure 4-2 identifies the classified ozone nonattainment areas by degree of severity. A summary of nonattainment areas can be found in Table A-17 in Appendix A. This condensed list is located on the Internet at **http://www.epa.gov/airs/nonattn.html** and is updated as areas are redesignated. An area is on the condensed list if the area is designated nonattainment for one or more of the criteria pollutants. Note that Section 185a areas (formerly known as "transitional areas") and incomplete areas are excluded from the counts in Table A-17. Another source of information for areas designated as nonattainment, including Section 185a and incomplete areas, is the Green Book. The current Green Book is located at **http://www.epa.gov/oar/oaqps/greenbk**.

As of September 1999, there were a total of 121 nonattainment areas on the condensed nonattainment list. The areas on the condensed list are displayed alphabetically by state. There were, as of September 1999, approximately 105 million people living in areas designated as nonattainment for at least one of the criteria pollutants. Areas redesignated between September 1998 and September 1999 are listed in Table 4-1, by pollutant. All redesignations were to attainment except for the Fort Hall Indian Reservation Area which was designated to nonattainment for PM_{10}. Subsequent to the 1997 O_3 National Ambient Air Quality Standards (NAAQS) revision, EPA revoked the 1-hour O_3 NAAQS in U.S. counties with three years of clean air quality.[1,2] Nonattainment areas that had the 1-hour O_3 standard or the PM_{10} standard revoked between September 1998 and September 1999 are listed in Table 4-2. Because of pending legal challenges, the EPA is not able to enforce the 8-hour standard resulting in many areas without applicable air quality standards. At the time of report publication, the Agency has proposed to reinstate the 1-hour standard.[3] The present status of nonattainment areas compared to the status after nonattainment designations resulting from the CAAA is shown in Table 4-3.

Table 4-1. Areas Redesignated Between September 1998 and September 1999

SO_2	Muhlenberg Co., Ky; Lake Co., OH and Jefferson Co., OH
PM_{10}	Fort Hall Indian Reservation, ID
CO	Connecticut portion of New York-N. New Jersey-Long Island, NY-NJ-CT
Pb	Muscogee Co., Ga and Williamson Co. (Nashville), TN
O_3	The number of O_3 areas remained the same between September 1998 and September 1999.

Table 4-2. Revocations of Nonattainment Areas Only Between September 1998 and September 1999

O_3

Boston-Lawerence-Worcester, MA-NH	Portsmouth-Dover-Rochester, NH
Muskegon, MI	Portland, ME
Providence, RI	Door Co., WI

PM_{10}

Boise, ID

Table 4-3. Nonattainment Status

Pollutant	Original # areas	1999 # areas	1999 Population (in 1000s)
CO	43	20	33,230
Pb	12	8	1,116
NO_2	1	0	0
O_3	101	32	92,505
PM_{10}	85	77	29,880
SO_2	51	31	4,371

References

1. "Identification of Ozone Areas Attaining the 1-Hour Standard and to Which the 1-Hour Standard Is No Longer Applicable; Final Rule," *Federal Register*, 63 FR 2804, Washington, D.C., June 5, 1998.

2. "Identification of Additional Ozone Areas Attaining the 1-Hour Standard and to Which the 1-Hour Standard Is No Longer Applicable; Final Rule," *Federal Register*, 63 FR 39431, Washington, D.C., July 22, 1998.

3. "Rescinding Findings that the 1-hour Ozone Standard No Longer Applies in Certain Areas," *Federal Register*, 64 FR 57424, Washington, D.C., November 5, 1999.

CHAPTER 5

Air Toxics

http://www.epa.gov/oar/aqtrnd98/chapter5.pdf

Background

Hazardous air pollutants (HAPs), commonly referred to as air toxics or toxic air pollutants are pollutants known to cause or suspected of causing cancer or other serious human health effects or ecosystem damage. Section 112 of the CAA now lists 188 pollutants or chemical groups as HAPs and targets sources emitting them for regulation.[1] Examples of air toxics include heavy metals like mercury and chromium and organic chemicals like benzene, 1,3-butadiene, perchloroethylene ("perc"), dioxins, and polycyclic organic matter (POM).

Hazardous air pollutants (HAPs) are emitted from literally thousands of sources including large stationary industrial facilities or major point sources (such as electric power plants or utilities), smaller area sources (such as neighborhood dry cleaners), and mobile sources (such as automobiles). Adverse effects to human health and the environment due to HAPs can result from exposure to air toxics from individual facilities, exposure to mixtures of pollutants found in urban settings, or exposure to pollutants emitted from distant sources that are transported through the atmosphere over regional, national or even global airsheds. Exposures of concern to HAPs can be either short-term or long-term in nature. In addition to breathing air contaminated with air toxics, exposure to some HAPs can occur by other means, such as through the ingestion of contaminated food from waters polluted from the deposition of HAPs. Some HAPs can bioaccumulate in body tissues. When a predator feeds on contaminated prey, concentrations of these bioaccumulative HAPs can build up in the predator's tissues, magnifying the toxic burden. As of December 1998, over 2,506 U.S. water bodies are under fish consumption advisories (for particular species of fish), representing approximately 15.8 percent of the nation's total lake acreage and 6.8 percent of the nation's river miles.[2]

Health and Environmental Effects

Most of the information on potential health effects of HAPs is derived from experimental animal data and studies of exposed workers. The different health effects which may be caused by HAPs include cancer, neurological, cardiovascular, and respiratory effects, effects on the liver, kidney, immune system, and reproductive system, and effects on fetal and child development. The timing of effect and the severity (e.g., minor or reversible vs. serious, irreversible, and life-threatening) may vary among HAPs and with the exposure circumstances. In some rare cases, effects can be seen immediately. Rare cases involve the catastrophic release of lethal pollutants, such as the 1984 incident in Bhopal, India, where more than 2,000 people were killed by the release of methyl isocyanate into the atmosphere. In other cases, the resulting effects (e.g., liver damage or cancer) are associated with long-term exposures and may not appear until years after exposure. More than half of the 188 HAPs have been classified by EPA as "known," "probable," or "possible" human carcinogens. Known human carcinogens are those that have been demonstrated to cause cancer in humans. Examples include benzene, which has caused leukemia in workers exposed over several years to certain amounts of it in their workplace air, and arsenic, which has been associated with elevated lung cancer rates in workers at metal smelters. Probable and possible human carcinogens include chemicals that are less certain to cause cancer in people, yet for which laboratory animal testing or limited human data indicates carcinogenic effects.

Some HAPs pose particular hazards to people of a certain age or stage in life (e.g., young children, adolescents, adults, or elderly people). Available data suggest that about a third of HAPs, may be developmental or reproductive toxicants in humans. This means that exposure during the development of a fetus or young child may prevent normal development into a healthy adult. Other such critical exposures may affect the ability to conceive or give birth to a healthy child. Ethylene oxide, for example, has been associated with increased miscarriages in exposed workers and has affected reproductive ability in both male and female laboratory animals.

Toxic air pollutants can have a variety of environmental impacts in addition to the threats they pose to human health. Animals, like humans, may experience health problems if they breathe sufficient concentrations of HAPs over time, or ingest HAPs through contaminated food (e.g., fish). Apart from the laboratory testing results on animal species that make up a large portion of the human health effects database, and aquatic toxicity criteria for some HAPs, little quantitative information currently exists to describe the nature and scope of the effects of air toxics on non-human species.

One of the more documented ecological concerns associated with toxic air pollutants is the potential for some HAPs to damage aquatic ecosystems. For example, a number of studies suggest that deposited air toxics contribute to deleterious effects such as reproductive failures, developmental disorders, disease, and premature death in fish and wildlife species native to the Great Lakes. Deposited air pollutants can be significant contributors to overall pollutant loadings entering water bodies (especially for persistent chemicals such as mercury which continue to move among air, water, and sediments). For the Great Lakes, international programs have examined the importance of deposition of air toxics, relative to other loadings such as direct discharge. While data are presently insufficient for many quantitative estimates comparing air deposition and other loading pathways, deposition of air toxics to the Great Lakes is considered significant and continues to be investigated with a binational monitoring network, the Integrated Atmospheric Deposition Network (IADN).[3]

Persistent air toxics are of particular concern in aquatic ecosystems, as toxics levels can magnify in the food web, resulting in exposures greater than those expected based solely on the levels in water or air. Such "bioaccumulation" and "biomagnification" (where the levels of a toxic substance increase at higher trophic levels of the food web) are seen in New England populations of breeding loons, birds that feed on fish in waters contaminated by airborne mercury. Studies are showing that an estimated 12–31 percent of the breeding loons have mercury levels that put them at risk of behavioral, reproductive and other effects.[4]

National Air Toxics Control Program *(The Regulatory Response)*

In 1990, Congress amended the CAA by adding a new approach to the regulation of HAPs. This new approach is divided into two phases. The first requires the development of technology-based emissions standards for stationary sources of the 188 HAPs. The second phase is to evaluate remaining problems or risks and develop additional regulations to address sources of those problems, as needed.

Phase One is composed of the technology-based standards, known as MACT (Maximum Achievable Control Technology) and GACT (Generally Achievable Control Technology) regulations, under Sections 112(d). All large, or major, sources of the 188 HAPs must be addressed by MACT or GACT regulations, as well as the smaller, area sources found to carry significant risk or identified as important under the Specific Pollutants Strategy [Section 112(c)(6)] or the urban program [Sections 112(c)(3) and 112(k)]. Some combustion sources, such as municipal waste combustors and medical waste incinerators, are regulated under equivalent requirements in Section 129. The purpose of this technology-based approach is to use available control technologies or changes in work practices to get emission reductions for as many of the listed HAPs as possible. It is intended that effective MACT standards will reduce a majority of the HAP emissions and, therefore, reduce potential risks from regulated sources.

Air toxics emission reductions also result from the particulate matter, ozone and carbon monoxide control programs which are directed at both stationary and mobile sources (see emission reductions described in Chapter 2). While the toxic reductions from EPA's mobile source emission standards have been large, prior to 1990, EPA had no specific directions from Congress for a planned program to control toxic emissions from mobile sources. However in 1990, Congress amended the CAA by adding a formal requirement to consider motor vehicle air toxics controls under Section 202(1). Section 202(1), required the Agency to complete a study of motor vehicle-related air

Table 5-1. List of 33 Urban Air Toxics Strategy HAPs

VOCs	Metals (Inorganic Compounds)	Aldehydes (Carbonyl Compounds)	SVOCs & Other HAPs
acrylonitrile	arsenic compounds	acetaldehyde	2,3,7,8-tetrachlorodibenzo-p-dioxin (& congeners & TCDF congeners)
benzene	beryllium and compounds	formaldehyde	coke oven emissions
1,3-butadiene	cadmium compounds	acrolein	hexachlorobenzene
carbon tetrachloride	chromium compounds		hydrazine
chloroform	lead compounds		polycyclic organic matter (POM)
1,2 -dibromoethane (ethylene dibromide)	manganese compounds		polychlorinated biphenyls (PCBs)
1,3-dichloropropene	mercury compounds		quinoline
1,2-dichloropropane (propylene dichloride)	nickel compounds		
ethylene dichloride, EDC (1,2-dichlorethane)			
ethylene oxide			
methylene chloride (dichloromethane)			
1,1,2,2,-tetrachloroethane			
tetrachloroethylene (perchloroethylene, PCE)			
trichloroethylene, TCE			
vinyl chloride			

toxics, and to promulgate requirements for the control of air toxics from motor vehicles. EPA completed the required study in 1993, and is presently conducting analyses to update emissions and exposure analyses done for the study as well as working on rulemaking to address the requirements of the section.

After application of the technology-based standards comes Phase Two, which consists of strategies and programs for evaluating remaining risks and ensuring that the overall program has achieved a sufficient reduction in risks to public health and the environment. This phase will be implemented through such programs as the integrated urban air toxics strategy, and the residual risk program (Section 112(f)). The integrated urban air toxics strategy identifies 33 HAPs which are judged to pose the greatest threat to public health in urban areas.[5] The strategy requires that EPA ensure a 75-percent reduction in cancer incidence from stationary sources; a "substantial" reduction in non-cancer risks from area sources; and to also ensure that disproportionate risks are addressed first by focusing efforts on sensitive populations or geographic hot spots. In addition, the strategy must assure that area sources accounting for 90 percent of the total emissions of the urban HAPs are subject to MACT or GACT regulations. The list of the 33 urban HAPs are presented in Table 5-1 and are grouped according to their chemical properties [volatile organic compounds (VOCs), metals, aldehydes, and semi-volatile organic compounds (SVOCs)]. This list includes not only those with emissions from area sources, but also includes those posing public health concerns in urban areas regardless of emission source type.

Phase Two also will use information generated through the special studies required in the CAA—the Great Waters program [Section 112(m)], and the Mercury and Utility Studies [Section 112(n)]. The Great Waters program contains an ongoing examination of atmospheric deposition of air toxics to aquatic ecosystems, and the effects of those toxics when concentrated through the food web. The Mercury Study examined the adverse effects of, and possible controls for, mercury from all sources. The Utility Study examined health hazards of, and possible controls for, the numerous toxics from electric utilities.

The CAA recognizes that not all problems are national problems or have a single solution. Authority for national emission standards are complemented by authorities to examine problems on other scales in order to address specific concerns. The CAA also provides mechanisms for increasing partnerships among EPA, states and local programs to address problems specific to these regional and local environments. As we move toward the 21st century, EPA's National Air Toxics Program is beginning to progress from the more technologically-based approach for regulating toxics to a more risk-based approach. This shift will require more and better information about all emission sources of HAPs, ambient levels of HAPs, and human and ecosystem exposure to HAPs. The development of an "information infrastructure" to inform the risk-based decisions has been a priority for the EPA over the last few years.

National Air Toxics Assessment Activities

The success of the National Air Toxics Program critically depends on our ability to quantify the impacts of air toxics emissions on public health and the environment. To that end, EPA has initiated numerous National Air Toxics Assessment (NATA) activities to help identify areas of concern, characterize risks and track progress. These activities include expanded air toxics monitoring, improving and periodically updating emissions inventories, national- and local-scale air quality and exposure modeling, and continued research on effects and assessment tools. NATA activities will lead to improved characterizations of air toxics risk and reductions in risk resulting from ongoing and future implementation of air toxics emissions control standards and initiatives. A major assessment is currently underway at EPA which will address the 188 HAPs. It includes state-by-state updates to emission inventories for the year 1996, known as the National Toxics Inventory (NTI), and nationwide estimation of air quality using the ASPEN (Assessment System for Population Exposure Nationwide) air quality dispersion model. Together with the Hazardous Air Pollutant Exposure Model (HAPEM4), the NATA national-scale screening assessment will also be used to estimate 1996 population exposures across the nation, and characterize potential public health risks due to inhalation of air toxics, including both cancer and noncancer effects. Although the NTI includes all 188 pollutants, the initial modeling activities focus on the "urban HAP list" (Table 5-1).

Ambient Monitoring

Ambient air toxics monitoring is another important component of NATA. Ambient measurements are useful to: characterize ambient concentrations and deposition in representative monitoring areas, provide data to support and evaluate dispersion and deposition models, and establish trends and evaluate the effectiveness of HAP reduction strategies. There are approximately 300 monitoring sites currently producing ambient data on hazardous air pollutants. EPA is working together with state and local air monitoring agencies to build upon these monitoring sites to develop a monitoring network which is representative of air toxics problems on a national scale and which provides a means to obtain data on a more localized basis as appropriate and necessary. The network will represent an integration of information from many monitoring programs, including PAMS, which provide information on VOCs and aldehydes, and the new urban $PM_{2.5}$ chemical speciation and rural IMPROVE networks which provide information on HAP trace metals. This new national network will be developed over the next several years. Trend data will initially be used to help characterize air quality, and to support and evaluate models and later to better describe national HAP trends.[6]

Several states have long-standing air toxics monitoring programs which already produce measurements on many HAPs including the important urban HAPs. Some of these state programs are assisted by EPA's contractor-supported Urban Air Toxics Monitoring Program (UATMP), as well as the Non-Methane Organic Compound (NMOC) and Speciated Non-Methane Organic Compound (SNMOC) monitoring programs. The UATMP is dedicated to toxics monitoring which involves measurements of 39 HAP VOCs and 13 carbonyl compounds.[7] The Agency's Photochemical Assessment Monitoring Stations (PAMS) also measure HAPs among the many pollutants that are precursors of ozone.

The PAMS program requires routine year-round measurement of VOCs which include nine HAPs: acetaldehyde, benzene, ethylbenzene, formaldehyde, n-hexane, styrene, toluene, xylenes (m/p-xylene, o-xylene) and 2,2,4-trimethlypentane. Three of these are on the list of urban HAPs (acetaldehyde, benzene and formaldehyde). For a more detailed discussion of the PAMS program, see the ozone section in Chapter 2 of this report. Although the state air toxics and PAMS data are limited in their geographic scope, they do not cover many HAPs for most states, and are not necessarily sited to represent the highest area-wide concentrations, they can still be used to provide useful information on the trends in ambient air toxics at this time.

Table 5-2. Comparison of Typical Urban and Rural Concentrations for VOCs and Aldehydes, Based on 1996 Ambient Measurements

	Urban Sites		Rural Sites		Urban to Rural
HAP	**Number of sites µg/m³**	**Annual Average Concentration, µg/m³**	**Number of sites**	**Annual Average Concentration,**	**Ratio of average concentrations**
1,2-Dibromoethane	60	0.70	1	0.04	17.5
Ethylene dichloride	88	0.40	7	0.04	9.9
Styrene	74	1.75	11	0.18	9.6
Trichloroethylene	84	0.62	8	0.08	8.0
Vinyl chloride	86	0.31	7	0.05	6.6
1,2-Dichloropropane	52	0.30	7	0.05	6.0
Tetrachloroethylene	90	1.17	8	0.21	5.6
1,3-Butadiene	60	0.84	7	0.15	5.5
1,1,2,2-Tetrachloroethane	32	0.09	2	0.02	5.2
trans-1,3-Dichloropropene	10	0.03	1	0.01	3.8
Methylene chloride	95	1.40	8	0.40	3.5
cis-1,3-Dichloropropene	10	0.03	1	0.01	2.9
Chloroform	94	0.47	8	0.21	2.2
Carbon tetrachloride	86	0.89	7	0.52	1.7
Acrolein	24	0.20	2	0.12	1.6
Toluene	101	5.68	9	3.82	1.5
Benzene	121	2.08	11	1.60	1.3
Formaldehyde	38	5.17	4	4.10	1.3
Acetaldehyde	38	2.94	4	3.37	0.9

Table 5-3. Comparison of Typical Urban and Rural Concentrations for Trace Metals, Based on 1996 Ambient Measurements

	Urban Sites		Rural Sites		Urban to Rural
HAP	**Number of sites ng/m³**	**Annual Average Concentration, ng/m³**	**Number of sites**	**Annual Average Concentration,**	**Ratio of average concentrations**
Nickel (fine)	13	1.14	65	0.22	5.2
Cadmium (pm10)	12	1.65	4	0.52	3.2
Arsenic (fine)	13	1.05	65	0.34	3.1
Lead (fine)	13	4.70	65	1.66	2.8
Manganese (fine)	13	3.34	65	1.26	2.7
Lead (coarse)	13	3.15	2	1.22	2.6
Nickel (pm10)	24	3.65	8	1.46	2.5
Nickel (tsp)	88	10.53	18	4.53	2.3
Manganese (pm10)	20	13.67	8	7.30	1.9
Chromium (coarse)	13	2.25	2	1.23	1.8
Chromium (pm10)	25	6.14	8	3.40	1.8
Beryllium (tsp)	31	0.08	7	0.05	1.6
Chromium (tsp)	90	8.03	18	5.05	1.6
Nickel (coarse)	13	1.35	2	0.87	1.6
Chromium (fine)	13	0.93	65	0.71	1.3
Lead (pm10)	40	22.40	11	19.12	1.2
Manganese (coarse)	13	12.57	2	11.35	1.1
Chromium VI	27	0.13	2	0.12	1.0
Arsenic (pm10)	25	3.09	8	3.05	1.0
Arsenic (coarse)	13	1.01	2	1.00	1.0
Beryllium (pm10)	7	0.30	4	0.30	1.0
Mercury (coarse)	13	1.02	2	1.02	1.0
Mercury (fine)	13	1.04	2	1.13	0.9
Manganese (tsp)	71	33.34	17	41.65	0.8
Mercury (pm10)	17	0.84	4	1.10	0.8
Mercury (tsp)	35	0.96	2	1.70	0.6
Arsenic (tsp)	73	7.04	9	33.86	0.2
Lead (tsp)	296	177.02	39	861.31	0.2
Cadmium (tsp)	80	1.95	17	13.33	0.1

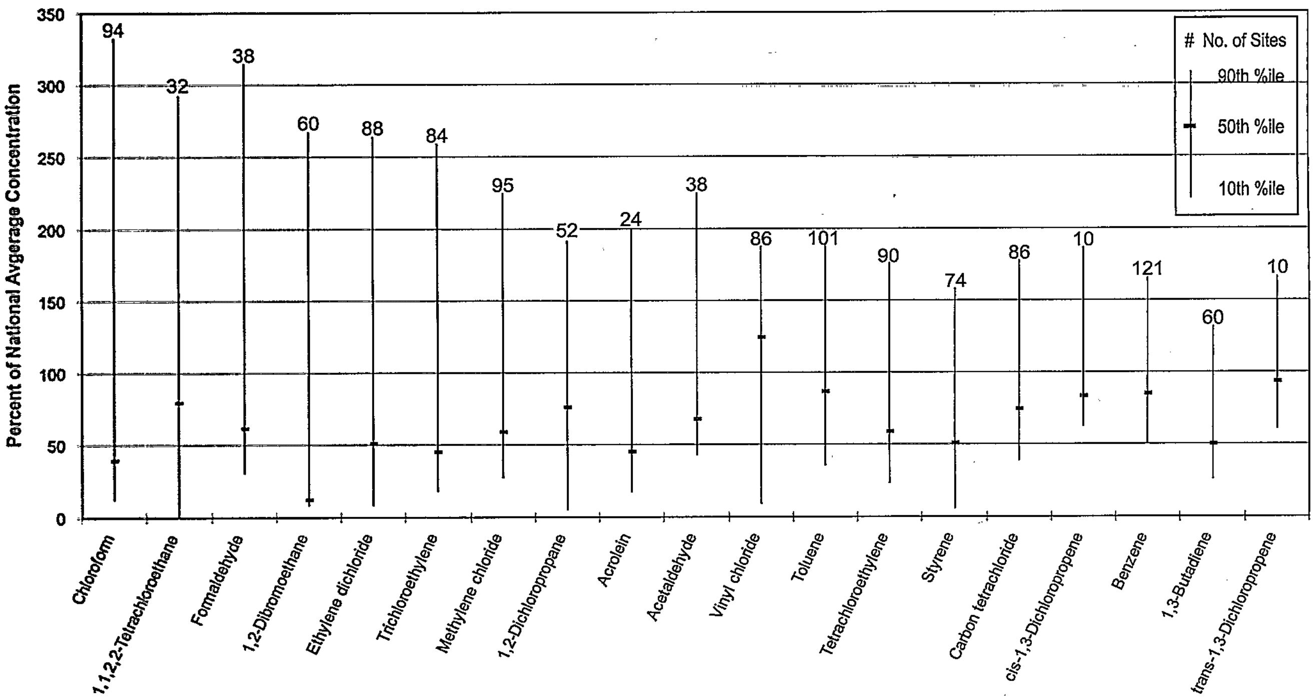
Status of Urban and Rural Ambient Concentrations

Several hundred locations monitor for air toxics year-round and have sufficient data to estimate annual average concentrations for many HAPs. This section focuses on the urban HAP list. Year-round ambient concentrations are available for 25 HAPs on the list. Extensive data for styrene and toluene are also available. Tables 5-2 and 5-3 compare typical urban and rural annual average concentrations for VOCs, aldehydes and trace metals. Some of the HAP data are represented by more than one type of measurement [e.g., chromium (PM_{10}) and chromium (TSP)]. The amount of rural data is limited for VOCs and for some of the trace metal HAPs. Nevertheless, tentative observations about urban-rural differences in ambient levels can be presented. In this chapter, urban air quality is based on monitoring sites located within metropolitan statistical areas. It is noted that this definition is not necessarily the same as the one which will be used in Section 112k rule making.

For many VOCs and aldehydes, the concentrations are relatively similar between urban and rural locations (e.g., carbon tetrachloride, formaldehyde and benzene). In particular, pollutants associated with ubiquitous mobile sources appear to be more similar between urban and rural areas. On the other hand, several HAPs show large differences among sampling locations (e.g., styrene and vinyl chloride). This contrast may be attributed to many factors including geographic distribution of emission sources, the limited number of monitoring sites and the proximity of the sites to those sources, the lifetime / transport of the pollutant in the atmosphere and uncertainty in the measurements. For some of the metals, average rural concentrations appear higher (e.g., lead and cadmium). The number of monitoring sites are limited, therefore these reported rural concentrations are not necessarily representative of typical rural areas.

To further illustrate the variability in annual average HAP concentrations, site-specific urban data are separately examined for the distribution of annual average concentrations. Figures 5-1a – 5-1c present the 10th, 50th and 90th percentiles of annual average concentrations for urban VOCs and aldehydes as well as urban and rural trace metals. The data are normalized to their respective urban or rural annual averages to show the relative variability for

Figure 5-1a. Relative variability in VOC and aldehyde annual average concentrations among urban sites, based on 1996 ambient measurements.



Note: "National Average" represents the average concentration of all included monitoring locations.

Figure 5-1b. Relative variability in trace metal concentrations among urban sites, based on 1996 ambient measurements.

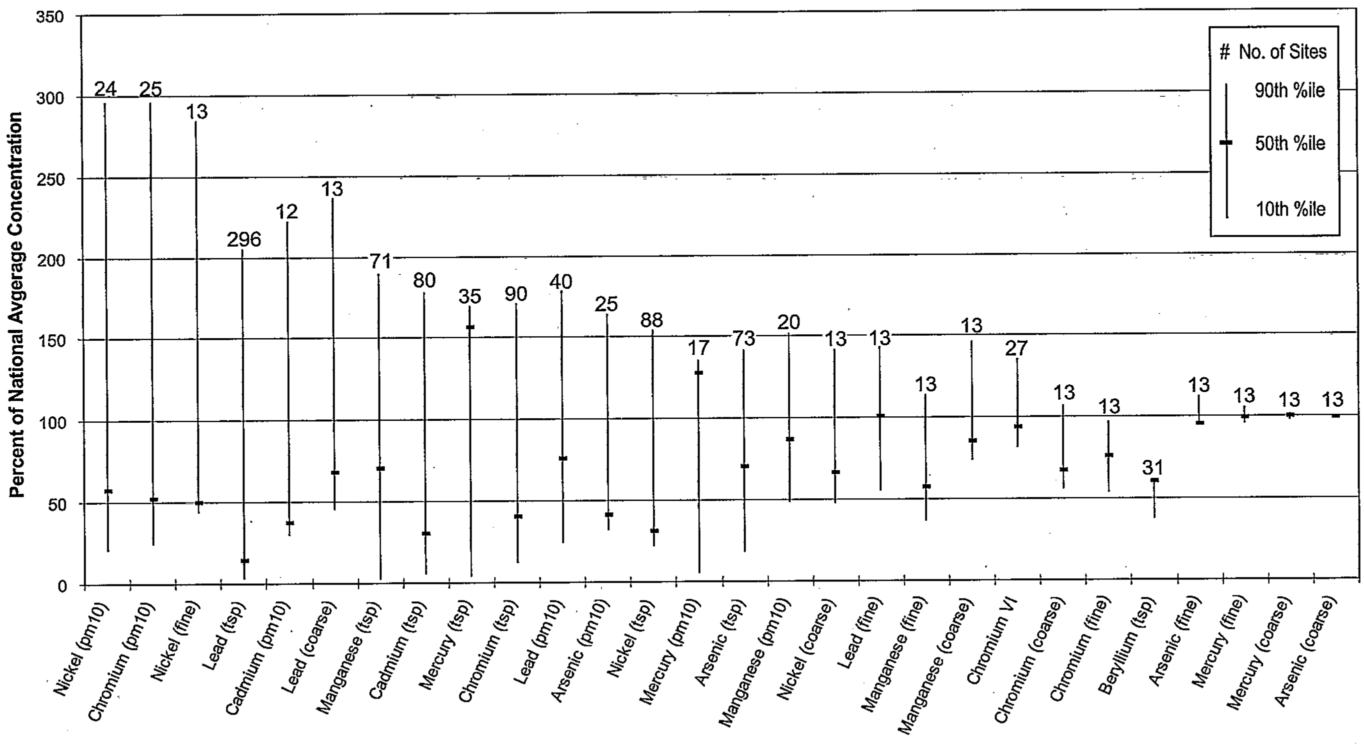
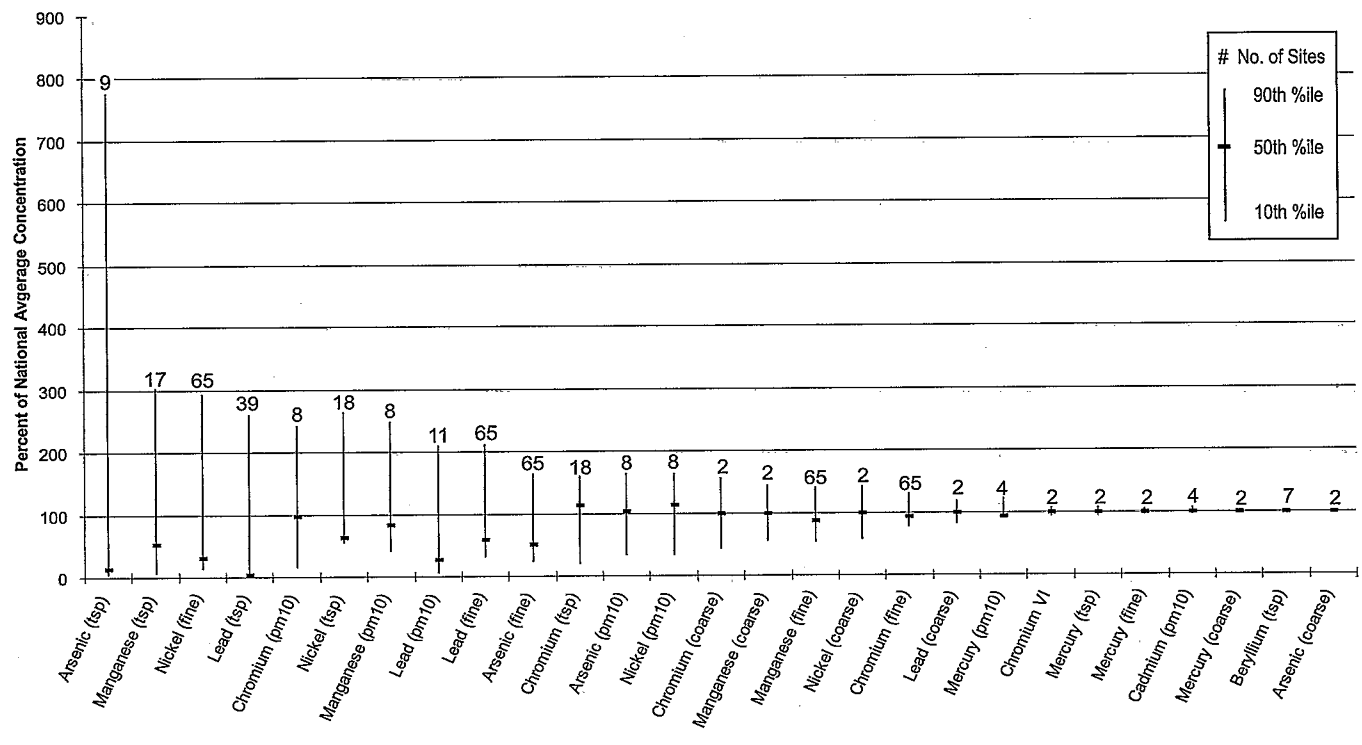


Figure 5-1c. Relative variability in trace metal concentrations among rural sites, based on 1996 ambient measurements.



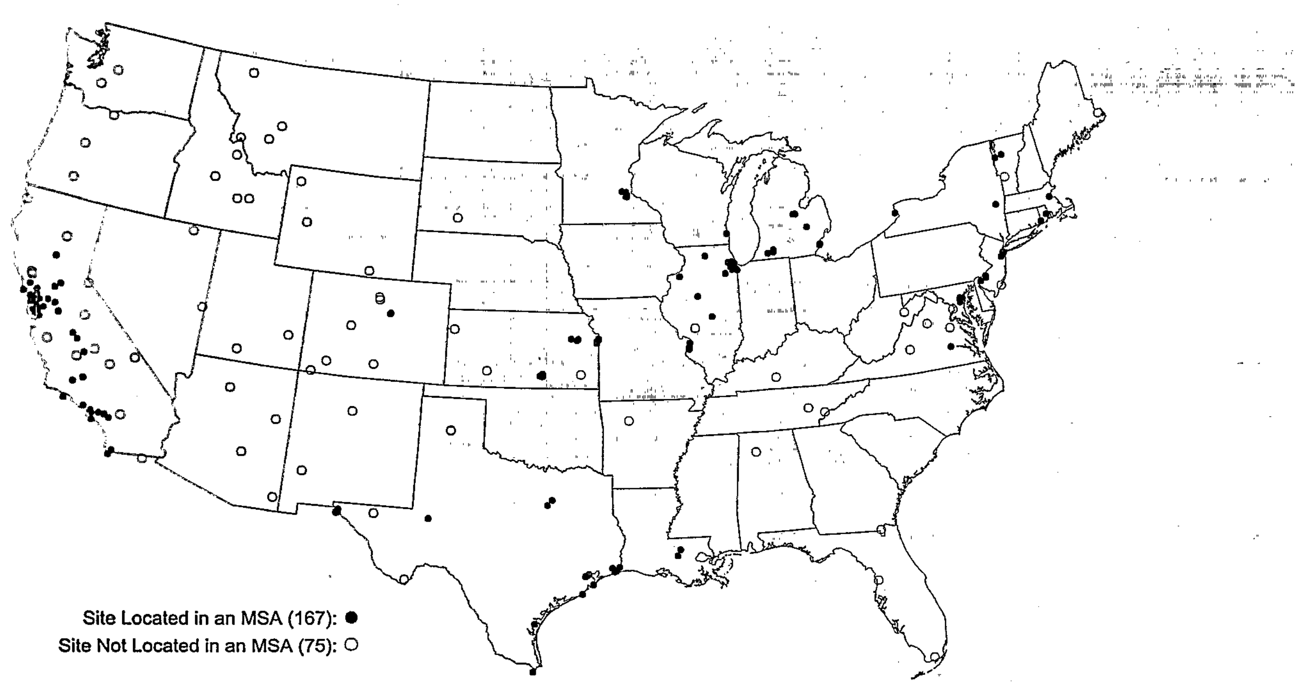
each HAP. These figures reveal large variations among reporting locations for some VOCs and aldehydes (e.g., chloroform, formaldehyde and trichloroethylene), and also show that others (e.g., benzene and 1,3-butadiene) are relatively similar among monitoring locations. Again, annual average concentrations for HAPs associated with mobile sources tend be more geographically homogeneous. For trace metals, reported urban and non-urban concentrations display large differences in annual averages for some HAPs (e.g., total suspended nickel and total suspended lead among urban locations, and arsenic among rural sites), while they are relatively similar for others. As stated above, the differences in concentration variability among HAPs may be attributed to many factors. When examining differences in annual means among individual monitoring locations, the quantity and completeness of the monitoring data may be important. Because air toxics are typically sampled 30–100 days per year, the lack of every day assessments can contribute to imprecision in annual average concentrations. This is particularly true for sites with large day-to-day variations in the concentrations of certain HAPs. These conclusions are tentative and warrant further study.

Trends In Ambient Concentrations

The most widely measured HAP is lead, which is also a criteria pollutant. It is monitored in most states, both in metropolitan and non-metropolitan areas. Other urban HAPs have been monitored in the metropolitan areas of 24 states since the mid 1990s. Several VOCs, aldehydes and metals have good data history in metropolitan areas. Most of these monitors, however, are concentrated in a few states, with 40 percent of them in California alone. Nevertheless, these data can be used to provide a preliminary picture of nationwide trends in urban air toxics. Long-term monitoring in rural areas for VOCs and aldehydes has generally been more limited. A good history of several trace metal concentrations in rural areas is derived from the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. The locations for the urban and rural monitors with long-term data are shown in Figure 5-2.

Trends derived from these data are separately presented for metropolitan

Figure 5-2. Locations for urban and rural air toxics monitors with long-term data.



Note: Sites only monitoring for lead (Pb) are not shown.

Table 5-4. National Summary of Ambient HAP Concentration Trends in Metropolitan Areas, 1993–1998

	Number of Urban Sites					
Hazardous Air Pollutant	**Total**	**Significant* UP Trend**	**Non-Significant UP Trend**	**No Trend**	**Non-Significant DOWN Trend**	**Significant* DOWN Trend**
Acrylonitrile	4		2	1	1	
Benzene	84	**3**	6		48	**27**
1,3-Butadiene	62	**6**	17	3	16	**20**
Carbon tetrachloride	65	**1**	25	3	23	**13**
Chloroform	74	**9**	28	3	23	**11**
1,2-Dibromoethane	38		5	16	15	**2**
1,2-Dichloropropane	27		5	5	9	**8**
Ethylene dichloride	55		11	17	16	**11**
Methylene chloride	73	**4**	13	2	37	**17**
1,1,2,2-Tetrachloroethane	12		6	2	4	
Tetrachloroethylene	74	**2**	13		43	**16**
Trichloroethylene	59	**5**	19	3	24	**8**
Vinyl chloride	50		10	22	13	**5**
Arsenic (coarse)	10			9	1	
Arsenic (fine)	10		1	3	6	
Arsenic (PM_{10})	14		1	1	7	**5**
Arsenic (tsp)	70	**1**	8	37	17	**7**
Beryllium (PM_{10})	7			7		
Beryllium (tsp)	28		6	20	2	
Cadmium (PM_{10})	8		3	2	1	**2**
Cadmium (tsp)	52	**1**	9	7	31	**4**
Chromium (coarse)	10				5	**5**
Chromium (fine)	10		2	1	6	**1**
Chromium (PM_{10})	14		7		6	**1**
Chromium (tsp)	63	**4**	21	2	30	**6**
Chromium VI	26		1		19	**6**
Lead (coarse)	10				4	**6**
Lead (fine)	10				7	**3**
Lead (PM_{10})	28	**1**	2	14	10	**1**
Lead (tsp)	266	**9**	47	6	147	**57**
Manganese (coarse)	10				6	**4**
Manganese (fine)	10		4		5	**1**
Manganese (PM_{10})	13		3		8	**2**
Manganese (tsp)	54	**1**	12	2	31	**8**
Mercury (coarse)	10		3	5	2	
Mercury (fine)	10		2	8		
Mercury (PM_{10})	6		4		2	
Mercury (tsp)	26		19	2	4	**1**
Nickel (coarse)	10				6	**4**
Nickel (fine)	10		2	1	4	**3**
Nickel (PM_{10})	13		3	1	6	**3**
Nickel (tsp)	63	**1**	13	2	27	**20**
Acetaldehyde	10		6		3	**1**
Formaldehyde	16	**2**	12		2	
Acrolein	7	**1**	4	1	1	
Benzo(a)pyrene (total PM_{10} & vapor)	18		1		16	**1**
Dibenz(a,h)anthracene (total PM_{10} & vapor)	18		5		13	
Indeno(1,2,3-cd)pyrene (total PM_{10} & vapor)	18				16	**2**
Benzo(b)fluoranthene (total PM_{10} & vapor)	18		1		15	**2**
Benzo(k)fluoranthene (total PM_{10} & vapor)	18				17	**1**
Styrene	60	**2**	14		35	**9**
Toluene	78	**1**	9		42	**26**

*Statistically significant at the 10-percent level (See Appendix B: Methodology, Air Toxics Methodology section).

(urban) and non-metropolitan (rural) sites. Table 5-4 present a national summary of these 6-year trends in ambient air toxics concentrations in metropolitan statistical areas. Among the 33 HAPs on the urban strategy list, 25 pollutants have sufficient historical data for this 6-year trends assessment. These air contaminants include 13 of the 15 urban VOCs, all eight urban HAP trace metals, the three aldehydes and several specific polycyclic aromatic hydrocarbons (PAHs). Also included are styrene and toluene, which are two additional pervasive air toxics whose monitoring sites have good nationwide coverage. The table presents the number of sites with increases and decreases in measured ambient concentrations from 1993–1998. For trace metals, results representing more than one particulate size fraction are included. Similarly, trends are shown separately for several individual PAHs which are constituents of POM. For each of these hazardous air pollutants with sufficient historical data, the number of sites with statistically significant changes are highlighted in **bold**. When many individual locations reveal a significant change, this is more characteristic of a national trend.

Although these ambient air toxics data are only available for a limited number of metropolitan areas, the results generally reveal downward trends for most monitored HAPs on the urban air toxics strategy list. The most consistent improvements are apparent for benzene which is predominantly emitted by mobile sources; and for total suspended lead. From 1993–1998, annual average concentrations for these two HAPs declined 37 and 41 percent respectively. The majority of ambient concentrations of lead once came from the tail pipe of cars. Since the mid-90s, however, lead has been largely removed from gasoline and almost all of these trace elements now typically emanate from major point sources. More information about particulate lead can be found in the criteria pollutant section in Chapter 2 of this report. Ambient concentrations of toluene (emitted primarily from mobile sources) also show a consistent decrease over most reporting locations. Similar to benzene, annual average toluene concentrations dropped 44 percent. The reduction in benzene and toluene is

Figure 5-3a. National trend in annual/average benzene concentrations in metropolitan areas, 1993–1998.

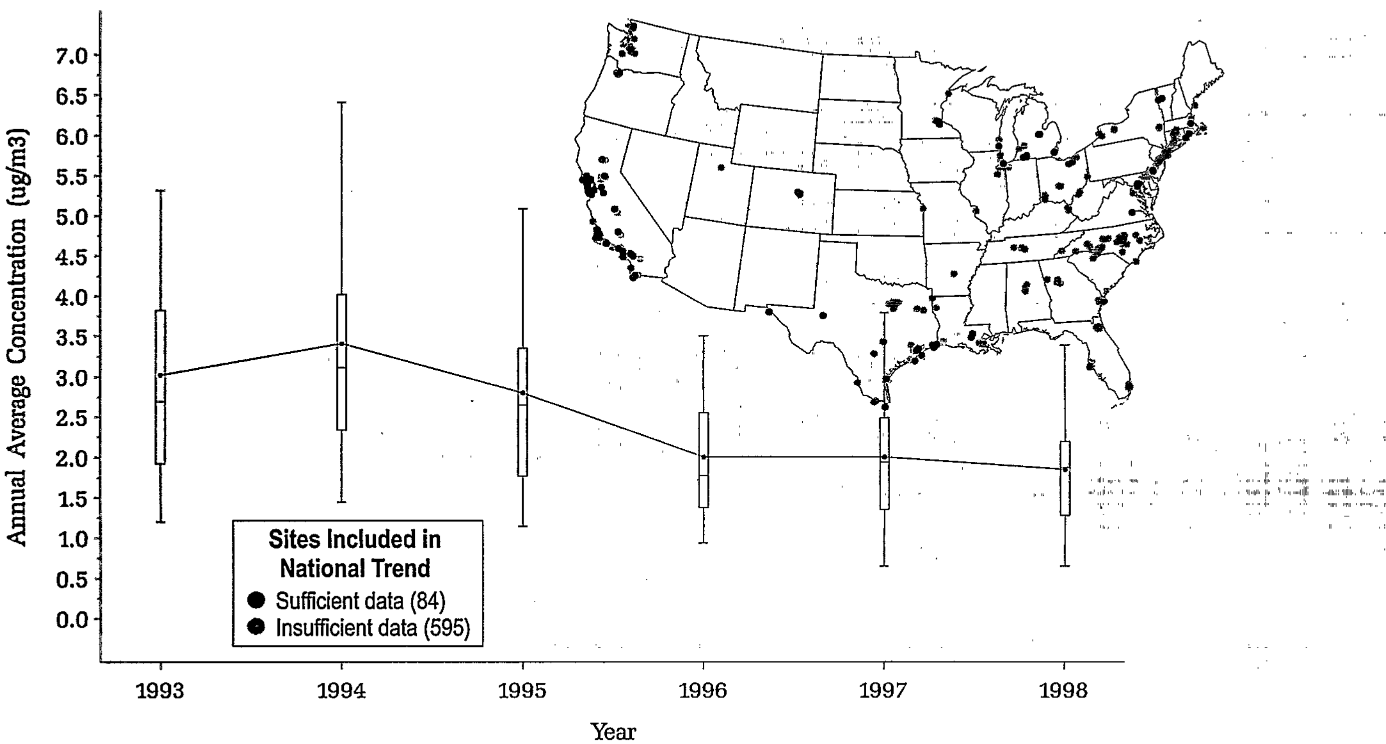


Figure 5-3b. National trend in annual/average 1,3-butadiene concentrations in metropolitan areas, 1993–1998.

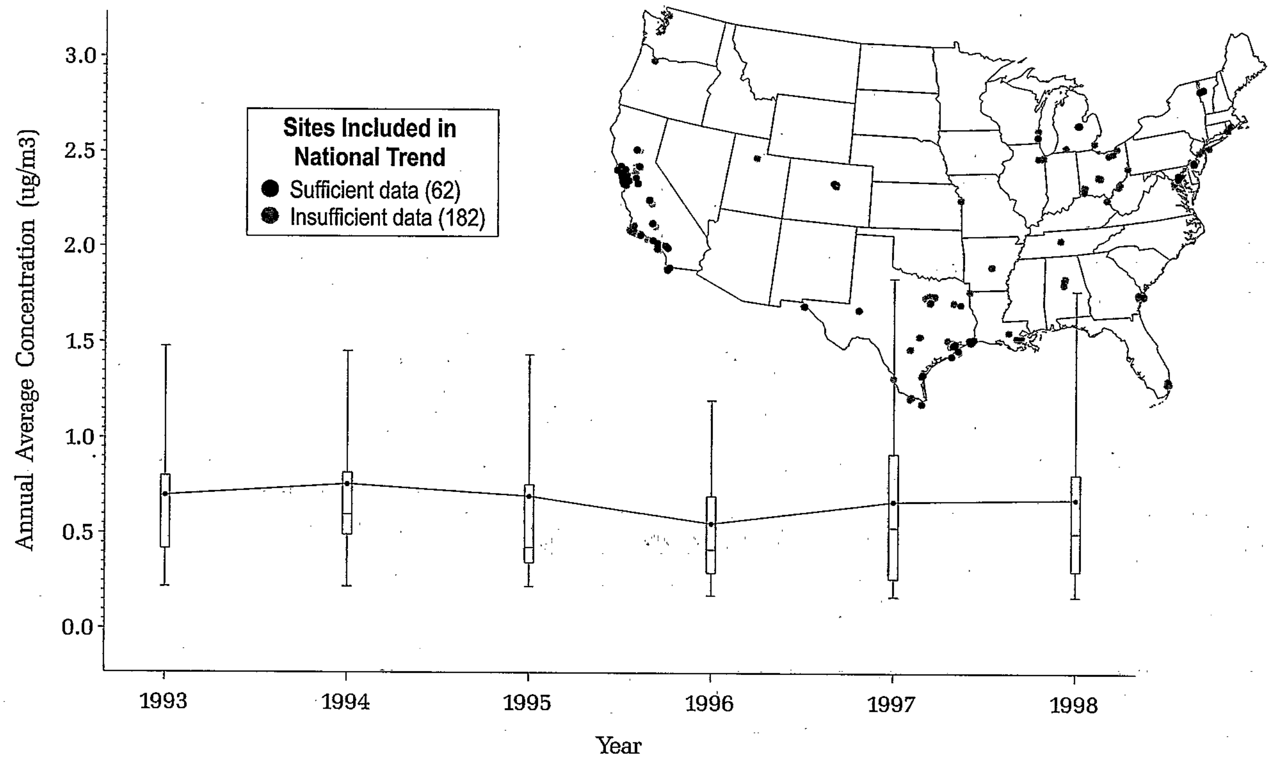


Figure 5-3c. National trend in annual/average total suspended lead concentrations in metropolitan areas, 1993–1998.

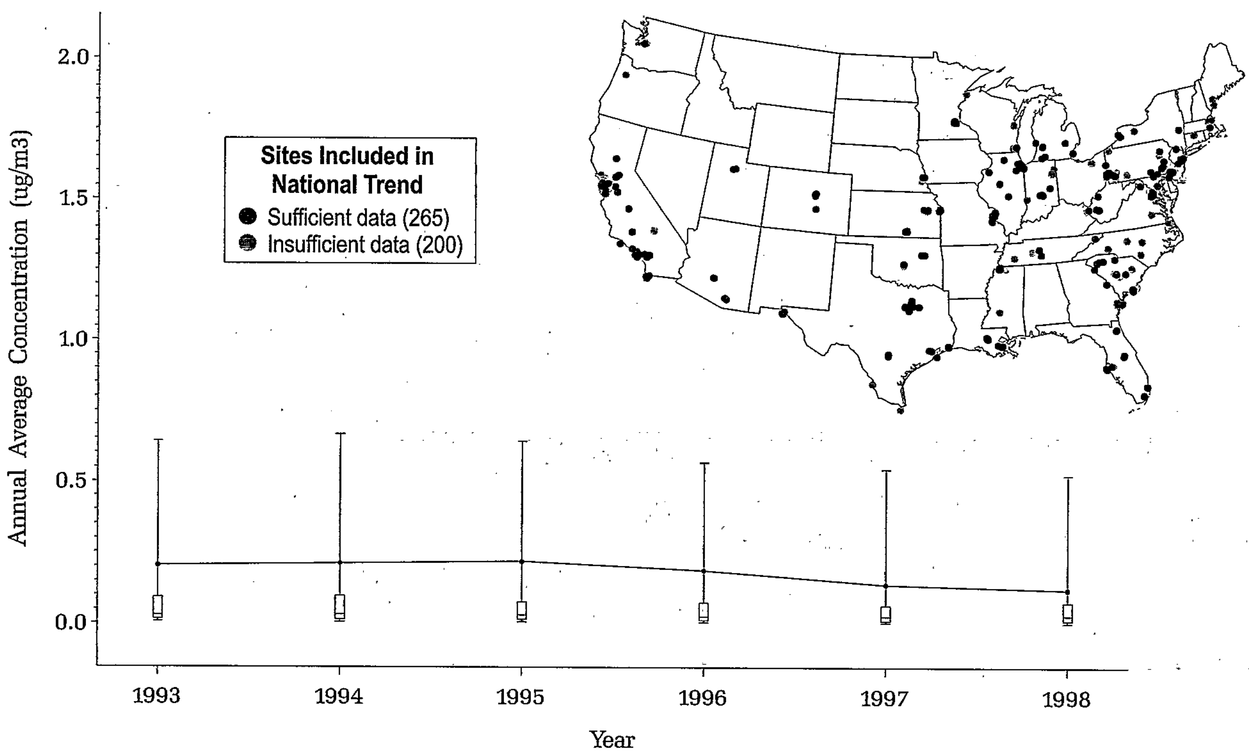


Figure 5-3d. National trend in annual/average styrene concentrations in metropolitan areas, 1993–1998.

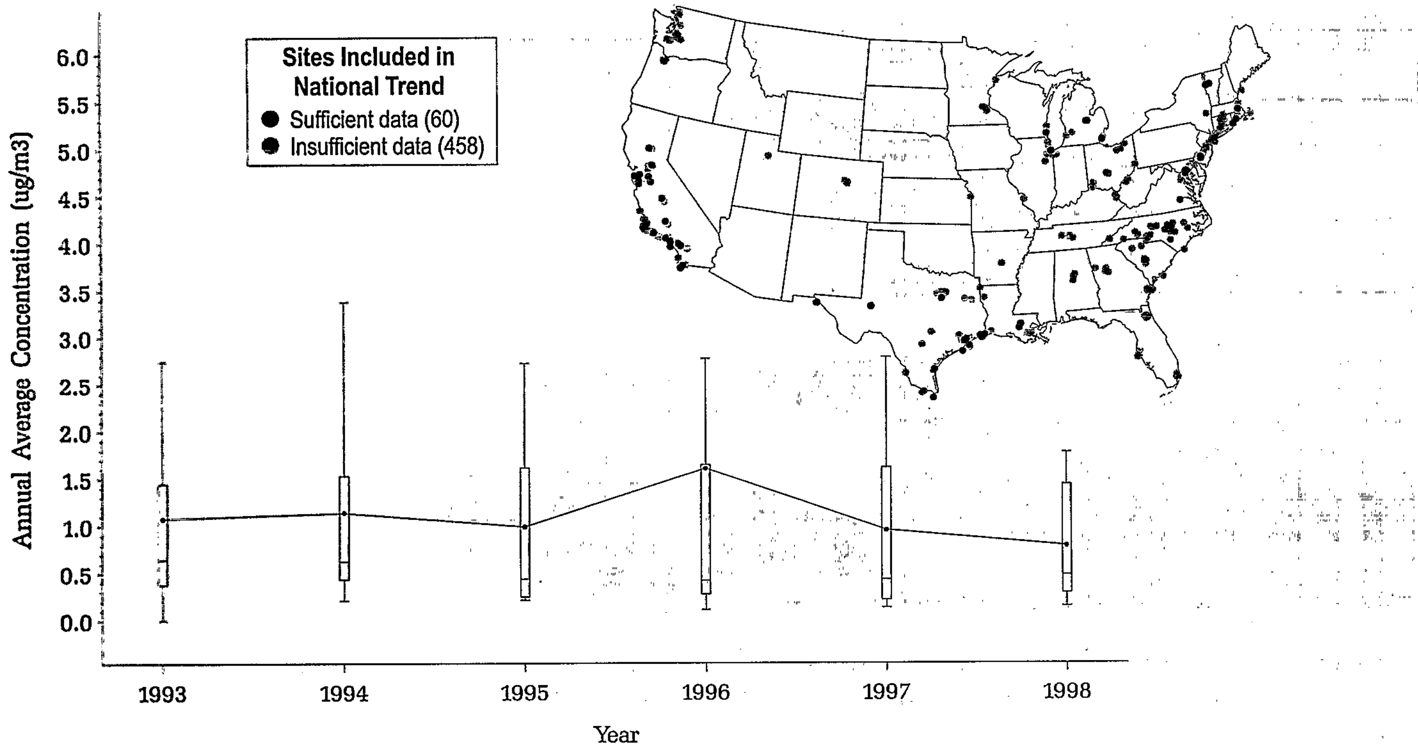


Figure 5-3e. National trend in annual/average tetrachloroethylene concentrations in metropolitan areas, 1993–1998.

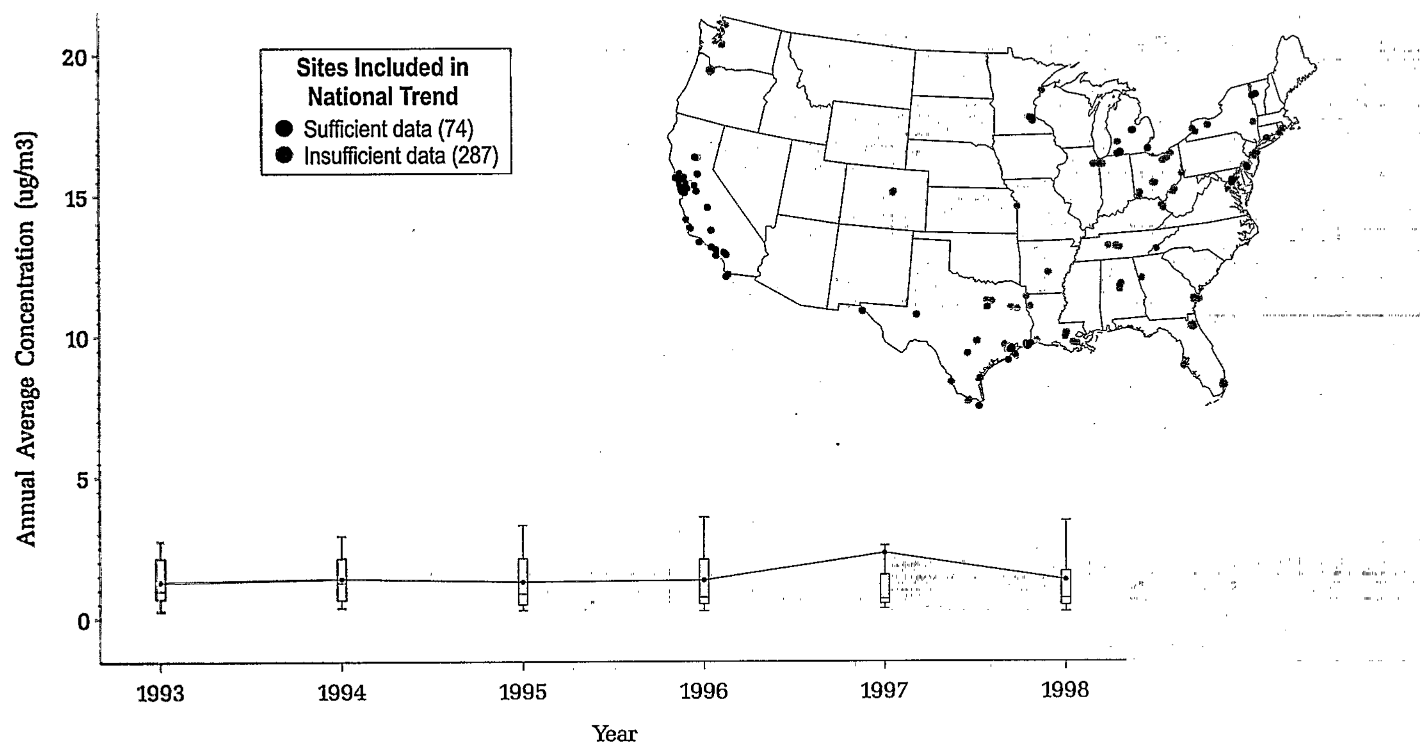
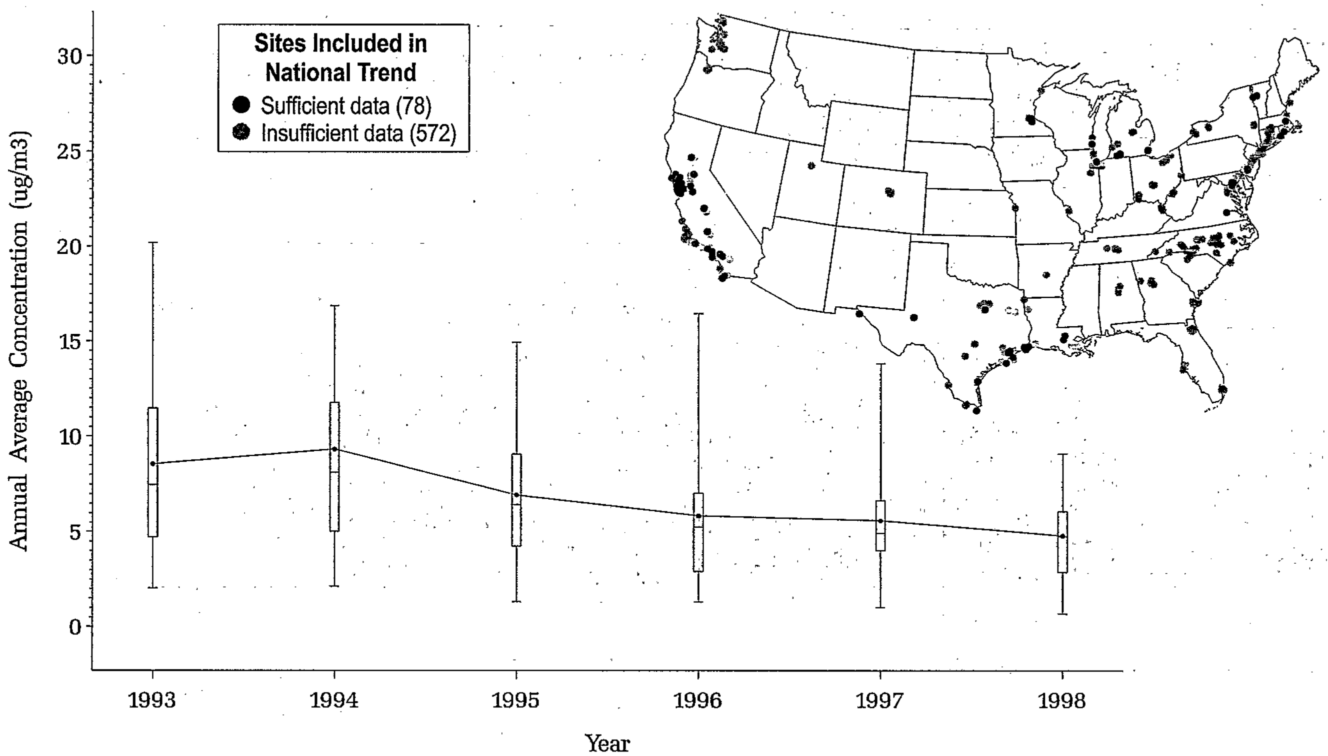


Figure 5-3f. National trend in annual/average toluene concentrations in metropolitan areas, 1993–1998.



attributed to the use of reformulated gas in many areas of the country. Other HAPs (including styrene) also reveal air quality improvement, but the downward trends are not significant across large numbers of monitoring locations. Some HAPs like 1,3-butadiene and tetrachloroethylene have trends that are more varied across the nation and result in a relatively flat national composite trend.

The composite urban trends for six HAPs are graphically presented. Boxplots of the annual average concentrations are shown for benzene, 1,3-butadiene, lead, styrene, tetrachloroethylene, and toluene in Figures 5-3a–f. The number and location of the monitoring sites are also displayed. For comparison, the maps also show the number of sites that produced any measurement data during the 6-year period. These figures depict the concentration distributions among annual averages in metropolitan areas from 1993–1998. The average trend line for benzene, lead, and toluene shows a steady 6-year air quality improvement, reflecting the consistent behavior among most monitoring locations. This represents a national pattern. Average concentrations decreased 39, 40 and 44 percent respectively.

For other HAPs, most urban locations do not reveal predominant or consistent trends among all monitoring areas. In addition, most observed trends for these 21 HAPs are not statistically significant. This is attributed in part to few states with long-term HAP monitoring, to the large year-to-year variability in computed annual average concentrations for some HAPs and the large variety of contributing emission sources for many of the air toxics. For these pollutants, a national composite trend may not be meaningful at this time. Although the general direction of change is down for most HAPs on the urban list, several states reveal significant 6-year increases at a few locations. These HAPs include 1,3-butadiene, carbon tetrachloride, chloroform, ethylene dichloride, methylene chloride, tetrachloroethylene (also known as perchloroethylene or "perc") and trichloroethylene. Except for 1,3-butadiene, all of the above mentioned HAPs are generally associated with major stationary sources or a combination of major and area sources. The majority of emissions of 1,3-butadiene come from mobile sources with the remain-

Figure 5-4a. Trend in annual average benzene concentrations for metropolitan sites in California, 1989–1998.

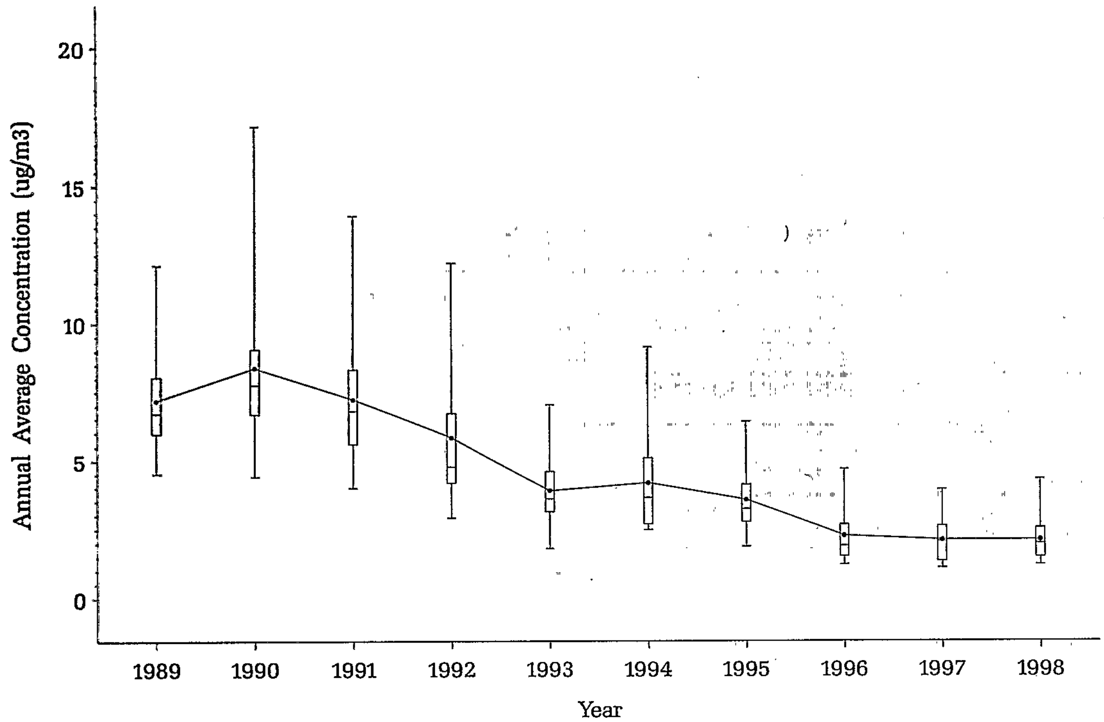


Figure 5-4b. Trend in annual average 1,3-butadiene concentrations for metropolitan sites in California, 1989–1998.

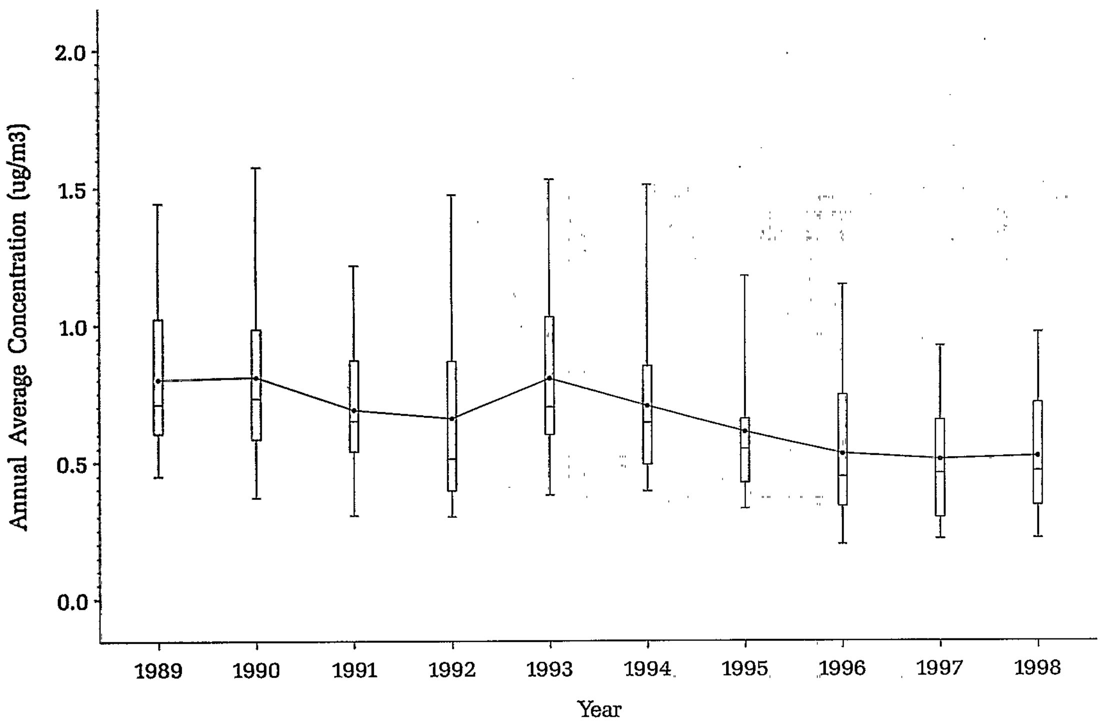


Figure 5-4c. Trend in annual average lead concentrations for metropolitan sites in California, 1989–1998.

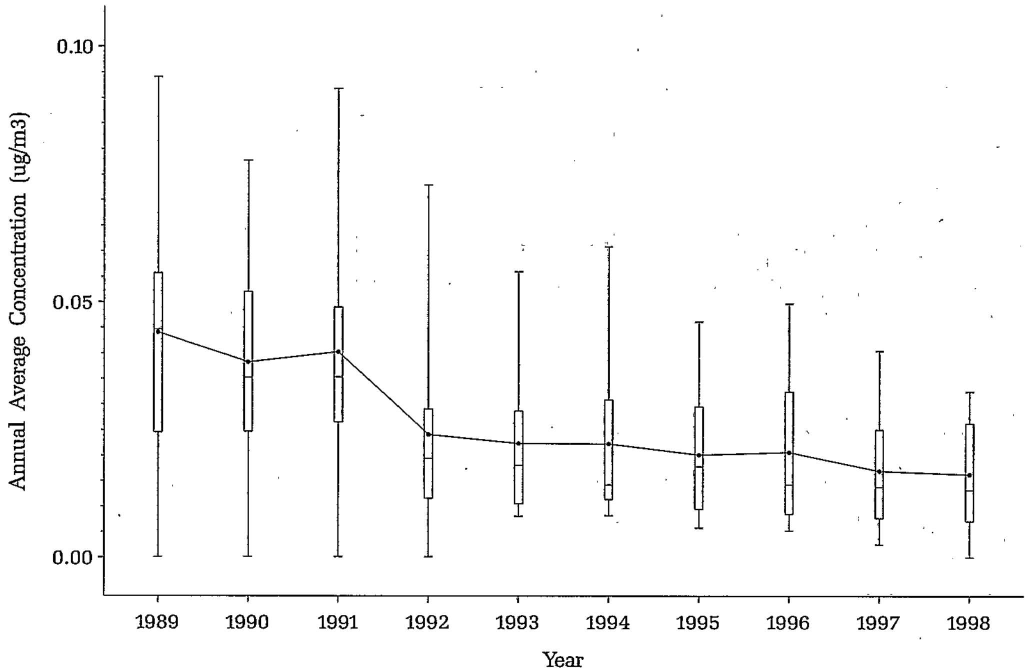


Figure 5-4d. Trend in annual average styrene concentrations for metropolitan sites in California, 1989–1998.

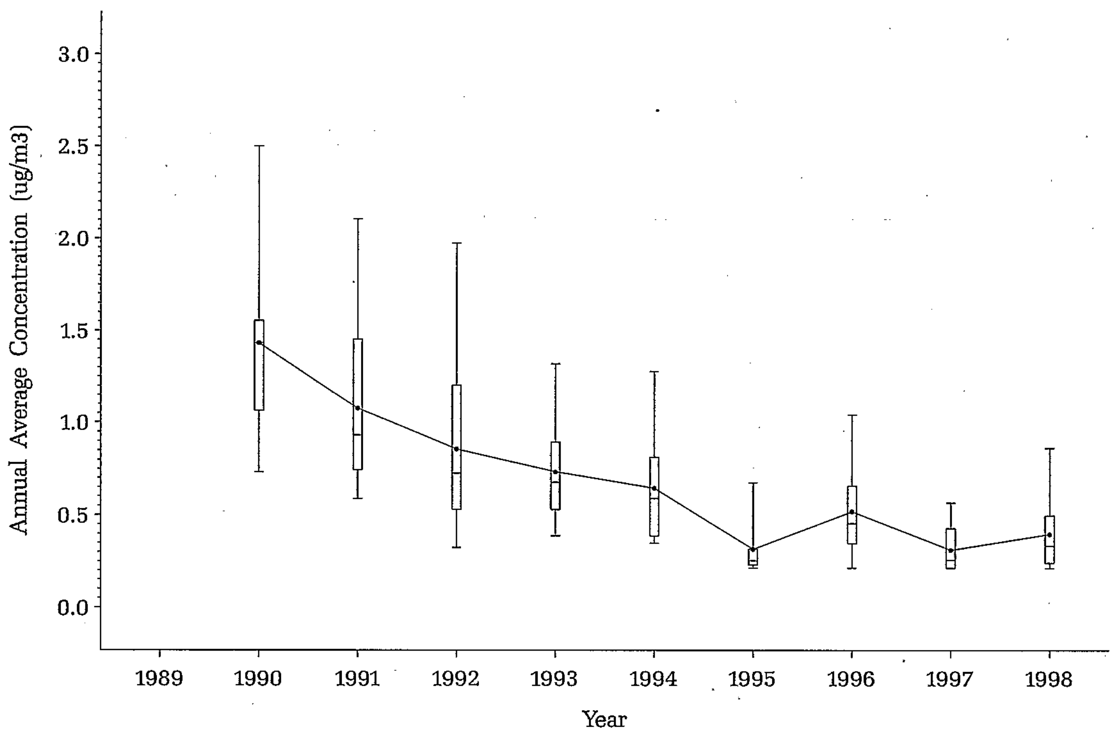


Figure 5-4e. Trend in annual average tetrachloroethylene concentrations for metropolitan sites in California, 1989–1998.

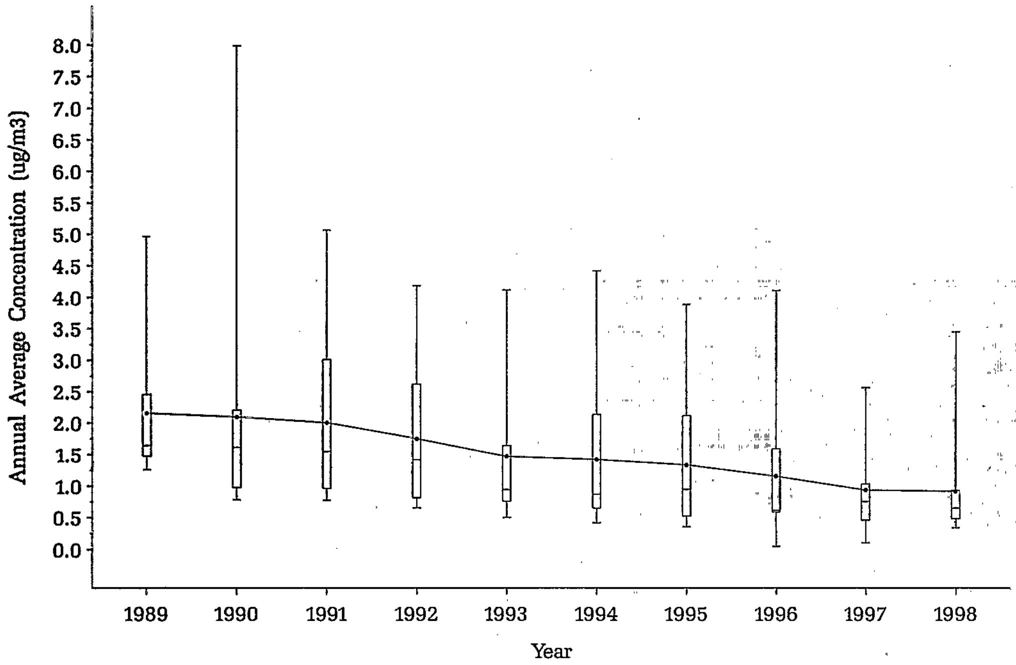
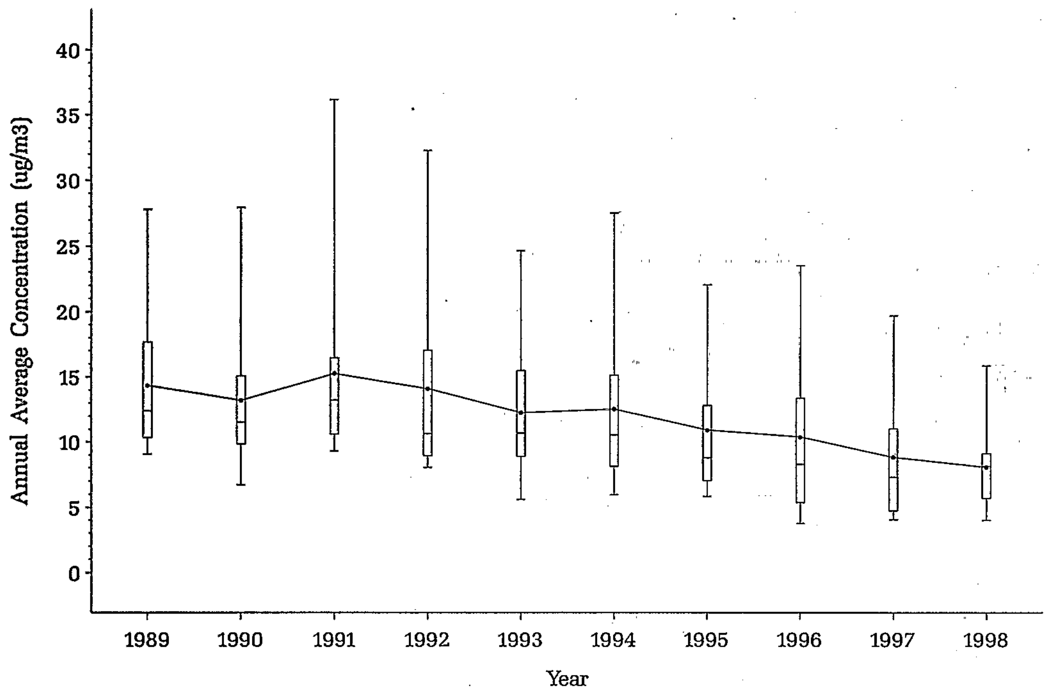


Figure 5-4f. Trend in annual average toluene concentrations for metropolitan sites in California, 1989–1998.



der mostly from area sources. To illustrate a few of the HAPs without consistent trends among reporting stations, boxplots for 1993–1998 are presented for 1,3-butadiene, styrene and tetrachloroethylene. The national trends for these HAPs appear to be flat for the six years, except for average concentration of styrene which shows a drop in 1998. To illustrate the behavior of these compounds in a particular region of the country, trends of monitoring sites in California are presented on the following page.

The State of California has the largest and longest running air toxics monitoring network. They have over 30 sites with a 10-year history for several VOCs and almost as many for several trace metals. These data allow us to take a look at a longer time trend in air toxics. Among the HAPs discussed in this section, notable improvements are seen for benzene, 1,3-butadiene, tetrachloroethylene and toluene. The impressive air quality improvement for urban benzene in California is shown in Figure 5-4a. This figure illustrates the large decrease in ambient concentrations which occurred during the early 1990s. Annual average concentrations declined 70 percent over the 10-year period. Ambient concentrations of tetrachloroethylene associated with dry cleaners is down 58 percent (Figure 5-4e). Toluene associated with mobile sources also showed consistent declines which averaged 44 percent across the state (Figure 5-4f). Another HAP which predominantly comes from mobile sources is 1,3-butadiene. Although site-specific trends for this pollutant were mixed, the composite trend in Figure 5-4d shows an overall 35-percent decline in ambient concentrations. The reductions in ambient concentrations of tetrachloroethylene are due to better controls on the use of solvents, while the improvements in benzene, 1,3-butadiene and toluene is attributed to the reformulation of gasoline. (For more information about trends in these emissions, see the ozone section in Chapter 2.) For additional detail on the derivation of Figures 5-3a to 5-4f, see Appendix B: Methodology.

Results from California's total suspended particulate lead network are consistent with the national trends. Annual average concentrations declined 63 percent and 27 percent over the 10-year and 6-year periods respectively. California has

Figure 5-5. Trends in Annual Average Fine Particle Chromium Concentrations in Rural Areas, 1993–1998.

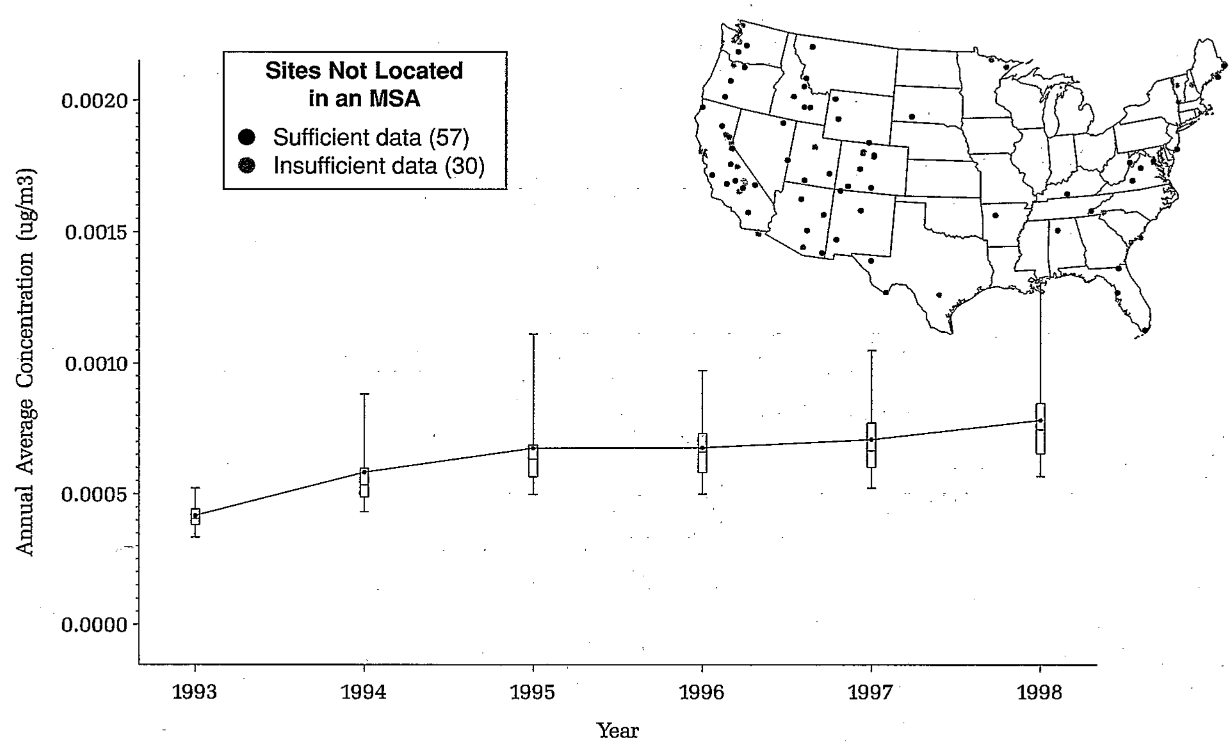


Table 5-5. National Summary of Ambient HAP Concentration Trends in Rural Areas, 1993–1998

	Number of Rural Sites					
Hazardous Air Pollutant	**Total**	**Significant* UP Trend**	**Non-Significant UP Trend**	**No Trend**	**Non-Significant DOWN Trend**	**Significant* DOWN Trend**
Benzene	5				4	**1**
1,3-Butadiene	4				1	**3**
Carbon tetrachloride	3		2		1	
Chloroform	4				3	**1**
1,2-Dichloropropane	4			1	3	
Ethylene dichloride	4				3	**1**
Methylene chloride	4				4	
Tetrachloroethylene	4				2	**2**
Trichloroethylene	4				3	**1**
Vinyl chloride	4		3		1	
Arsenic (coarse)	2		1	1		
Arsenic (fine)	61	**3**	40	1	17	
Arsenic (PM_{10})	6		1	1	3	**1**
Arsenic (tsp)	5		1	1	1	**2**
Beryllium (PM_{10})	2		1	1		
Beryllium (tsp)	3			3		
Cadmium (PM_{10})	2				2	
Cadmium (tsp)	6			3	1	**2**
Chromium (coarse)	2		1		1	
Chromium (fine)	61	**28**	29	1	3	
Chromium (PM_{10})	6	**1**	2		3	
Chromium (tsp)	7	**1**	2	1	2	**1**
Chromium VI	1					**1**
Lead (coarse)	2			1	1	
Lead (fine)	61	**1**	45		15	
Lead (PM_{10})	8	**1**	1	2	3	**1**
Lead (tsp)	31		5		15	**11**
Manganese (coarse)	2		1		1	
Manganese (fine)	61		25		35	**1**
Manganese (PM_{10})	6		3		2	**1**
Manganese (tsp)	6			1	5	
Mercury (coarse)	2		1	1		
Mercury (fine)	2			1	1	
Mercury (PM_{10})	4		2	1	1	
Mercury (tsp)	1		1			
Nickel (coarse)	2		1		1	
Nickel (fine)	61	**1**	12	1	39	**8**
Nickel (PM_{10})	6		1	1	3	**1**
Nickel (tsp)	7		1	1	4	**1**
Acetaldehyde	1				1	
Formaldehyde	1				1	
Acrolein	1				1	
Styrene	5		2		3	
Toluene	5		3		2	

*Statistically significant at the 10-percent level (See Appendix B: Methodology, Air Toxics Methodology section).

also been measuring fine particle lead (from $PM_{2.5}$) and coarse particle lead (from $PM_{10-2.5}$) in its urban areas. Although concentrations are a small fraction of the total suspended lead, these data also show 6-year declines of 26 and 54 percent, respectively. California's trace metal data also shows declines in total suspended chromium (-29 percent) and the particularly hazardous hexavalent chromium (-52 percent).

Ambient air toxics data in rural areas are much more limited, but the results in Table 5-5 and Table A-20 also indicate widespread air quality improvement for many monitored urban strategy HAPs. Significant downward trends are noted among the few rural sites for benzene and several other VOCs. Lead concentrations in rural areas are also down. In contrast, a notable steady increase in fine particle chromium concentrations is observed in the rural data set. This is illustrated in Figure 5-5. Almost all rural monitoring sites show a 6-year increase in ambient chromium concentrations and most of them are statistically significant. Average concentrations increased 88 percent. The reason for this increase in rural chromium concentrations is not known at this time. The result also needs to be viewed with caution because the reported concentrations are close to the detection limits of the monitoring method (0.57 ng/m^3).[8] Nevertheless, there is a strong trend in the concentrations above this level. Future trend reports will present more detailed trends in chromium and other HAP trace metals derived from the IMPROVE network and other rural monitoring locations.

Atmospheric Deposition

National Atmospheric Deposition Program/National Trends Network

The National Atmospheric Deposition Program (NADP) began in 1978 as a cooperative program between federal and state agencies, universities, electrical utilities, and other industries to determine geographical patterns and trends in wet deposition of sulfate, nitrate, hydrogen ion, ammonium, chloride, calcium, magnesium, and potassium. The NADP was renamed as NADP/NTN (National Trends Network) in the mid-1980s when the program had grown to almost 200 monitoring sites. The monitoring sites are located in rural areas, and data are collected on a weekly basis. The collected data provide insight into natural background levels of pollutants. The network of NADP/NTN monitoring sites allows for the development of concentration and wet deposition maps to describe the trends and spatial patterns in the constituents of acid precipitation. The Mercury Deposition Network (MDN), which is another component of the NADP, measures mercury levels in wet deposition at over 40 NADP sites located in 16 states and two Canadian provinces.

Mercury's adverse effects on ecological and public health have raised the level of awareness regarding its persistence in the environment. As a result, there has been a concerted effort by local, state, and national environmental agencies to accurately measure the annual progress of regulations and technologies aimed at reducing mercury. The MDN is a key element of these efforts by monitoring the presence of mercury and methyl mercury in precipitation. This has enabled scientists to compile a national database of weekly precipitation concentrations. As a result, state and federal air regulators can monitor progress in reducing mercury concentrations and amend policy decisions accordingly. There are plans to expand the network in the near future, pending availability of new funds. Additional information about the network is available on the Internet at **http://nadp.sws.uiuc.edu/mdn/**.

Data from 1996 and 1997 indicate that the volume-weighted mean concentration of total mercury in precipitation from 22 sites ranged from 6.0–18.9 ng/L and annual deposition of mercury ranged from 2.1–25.3 μg/m^2. In 1997, average mercury concentrations in rain ranged from 6.2–18.3 ng/L at the 21 sites that had a full year of monitoring data and the average concentration for all sites was 10.6 ng/L. In 1996, average mercury concentrations at nine sites with a full year of data ranged from 6.0–14.1 ng/L with an average for all sites of 10.2 ng/L. In 1997, the annual average wet deposition of mercury for 21 sites ranged from 4.3–25.3 μg/m^2, whereas in 1996, the annual average wet deposition of mercury for nine sites ranged from 6.3–19.7 μg/m^2. In the eastern United States, average summer mercury concentrations are more than double winter concentrations and average summer deposition values are more than three times winter values. This can be explained by higher concentrations of mercury in the rain and higher rainfall amounts during the summer.[9]

Integrated Atmospheric Deposition Network

The Integrated Atmospheric Deposition Network (IADN) is a joint United States-Canada program begun in

1990 under a formal 6-year implementation.[10] The IADN collects data that can be useful in assessing the relative importance of atmospheric deposition. IADN measures concentrations of target chemicals in rain and snow (wet deposition), airborne particles (dry deposition), and airborne organic vapors.[11] Under IADN, trends in pollutant concentrations in air and precipitation are assessed and loading estimates of atmospheric deposition and volatilization of pollutants are made every two years. The IADN network currently consists of one master station per Great Lake and 14 satellite stations. Stations are located in remote areas and do not assess urban sources of pollution.

General conclusions based on IADN data include the following:

- Levels in air and precipitation appear stable for current-use pesticides such as endosulphan, but levels for most other pesticides, PCBs, and lead are decreasing.
- Gas absorption appears to be the dominant deposition process for delivering SVOCs, including PCBs and PAHs, to lake surfaces, while wet and dry deposition dominate for the trace elements and higher molecular weight PAHs.
- For some IADN substances, like dieldrin and PCBs, the surface waters are behaving like a source since the amount that is volatilizing from the water is greater than the amount being deposited to the water.
- The lakes are sensitive to the atmospheric concentration of IADN chemicals, and this highlights the fragility of these resources given that long-range transport from other regions may be a significant source of toxic pollutants.
- Air trajectory analyses indicate that many SVOCs are potentially originating from outside the Great Lakes basin, whereas trace metals and PAHs may be associated with local sources.[12]

In 1998, the Second Implementation Plan for 1998–2004 was developed based on a review of the program from 1990–1996. No major changes are anticipated under the Second Implementation Plan. The IADN will continue surveillance and monitoring activities, related research, and to provide information for intergovernmental commitments and agreements. Additional work to be completed under the Second Implementation Plan is the development of a database for all U.S. and Canadian data. Potential modifications will be discussed in relation to the placement of satellite stations to assess urban inputs and air-water gas exchange, criteria for changes to the IADN chemical list, coordination with other research activities, quality assurance and control of IADN operations, and communication of IADN results.[12]

References

1. This list originally included 189 chemicals. The CAA allows EPA to modify this list if new scientific information becomes available that indicates a change should be made. Using this authority, the Agency modified the list to remove caprolactam in 1996, reducing the list to 188 pollutants (*Hazardous Air Pollutant List; Modification, 61 FR 30816*, June 18, 1996).

2. "Update: National Listing of Fish and Wildlife Advisories," announcing the availability of the 1998 update for the database: National Listing of Fish and Wildlife Advisories (NLFWA); U.S. EPA Fact Sheet, EPA-823-F-99-005, July 1999. Available on the Internet at: **http://www.epa.gov/ost/fish.**

3. Hillery, B.R., Hoff, R.M., and Hites, R.A. 1997. "Atmospheric contaminant deposition to the Great Lakes determined from the Integrated Atmospheric Deposition Network." Chapter 15 in *Atmospheric Deposition of Contaminants to the Great Lakes and Coastal Waters. 1997*, Joel E. Baker, Editor. SETAC Press. (Society of Environmental Toxicology and Chemistry.)

4. Evers, D. 1998. Assessing availability and risk of methylmercury to the common loon in New Hampshire and Vermont. A preliminary report. Submitted to U.S. EPA, Office of Air Quality Planning and Standards, December 3, 1998.

5. "National Air Toxics Program: The Integrated Urban Strategy," *Federal Register*, 64 FR 38705, Washington, D.C., July 19, 1999. Available on the Internet at: **http://www.epa.gov/ttnuatw1/urbanpg.html.**

6. "Air Toxics Monitoring Concept Paper," U.S Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. February 29, 2000. Peer Review Draft. Available on the Internet at: **http://www.epa.gov/ttn/amtic/airtxfil.html.**

7. "1997 Urban Air Toxics Monitoring Program (UTAMP)," EPA-454/R-99-036. January 1999. Available on the Internet at **http://www.epa.gov/ttn/amtic/airtxfil.html.**

8. Visibility Monitoring Guidance 1999, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, June 1999, EPA-454/R-99-003.

9. Sweet, C.W., E. Prestbo, B. Brunette. 1999. Atmospheric wet deposition of mercury in North America. Proceedings of the 92nd Annual Meeting of the Air and Waste Management Association. June 21-23, 1999, St. Louis, MO.

10. The IADN fulfills legislative mandates in Canada and the United States that address the monitoring of air toxics. An international Great Lakes deposition network is mandated by Annex 15 of the Great Lakes Water Quality Agreement between the United States and Canada. In the United States, the CAA requires a Great Lakes deposition network.

11. The target chemicals include PCBs, pesticides, PAHs and metals. The compounds included as "target chemicals" were selected based on the following criteria: presence on List 1 of Annex 1 of the Great Lakes Water Quality Agreement (substances believed to be toxic and present in the Great Lakes); established or perceived water quality problem; presence on the International Joint Commission's Water Quality Board's list of criteria pollutants; evidence of presence in the atmosphere and an important deposition pathway; and feasibility of measurement in a routine monitoring network.

12. U.S./Canada IADN Scientific Steering Committee. 1998. Technical summary of progress under the integrated atmospheric depositions program 1990–1996.

CHAPTER 6

Visibility Trends

http://www.epa.gov/oar/aqtrnd98/chapter6.pdf

Introduction

The Clean Air Act (CAA) authorizes the United States Environmental Protection Agency (EPA) to protect visibility, or visual air quality, through a number of programs. These programs include the National Visibility Program under sections 169a and 169b of the Act, the Prevention Of Significant Deterioration Program for the review of potential impacts from new and modified sources, the secondary National Ambient Air Quality Standards (NAAQS) for PM_{10} and $PM_{2.5}$, and section 401 under the provisions for acid deposition control. The National Visibility Program established in 1980 requires the protection of visibility in 156 mandatory federal Class I areas across the country (primarily national parks and wilderness areas). The CAA established as a national visibility goal, "the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory federal Class I areas in which impairment results from man-made air pollution." The Act also calls for state programs to make "reasonable progress" toward the national goal.

In 1987, the Interagency Monitoring of Protected Visual Environments (IMPROVE) visibility network was established as a cooperative effort between EPA, the National Oceanic and Atmospheric Administration, the National Park Service, the U.S. Forest Service, the Bureau of Land Management, the U.S. Fish & Wildlife Service, and state governments. The objectives of the network are to establish current conditions, to track progress toward the national visibility goal by documenting long-term trends, and to provide information for determining the types of pollutants and sources primarily responsible for visibility impairment. Chemical analysis of aerosol measurements provides ambient concentrations and associated light extinction for PM_{10}, $PM_{2.5}$, sulfates, nitrates, organic and elemental carbon, crustal material, and a number of other elements. The IMPROVE program has established protocols for aerosol, optical, and photographic monitoring methods, and these methods are employed at more than 70 sites, most of which are Class 1 areas. In the calendar year 2000, an additional 80 monitoring sites using the IMPROVE aerosol monitoring protocol will be established. The analyses presented in this chapter are based on data from the IMPROVE network, which can be found on the Internet at: **ftp://alta_vista.cira.colostate.edu/DATA/IMPROVE** [1]

This chapter presents aerosol and light extinction data collected between 1989 and 1998 at 34 Class I areas in the IMPROVE network. Because the CAA calls for the tracking of "reasonable progress" in preventing future impairment and remedying existing impairment, this analysis looks at trends in visibility impairment across the entire range of the visual air quality distribution. To facilitate this approach, visibility data have been sorted into quintiles, or 20 percent segments, of the overall distribution, and average values have been calculated for each quintile. Trends are presented in terms of the haziest ("worst") 20 percent, typical ("middle") 20 percent, and clearest ("best") 20 percent of the annual distribution of data. Figure 6-1 provides a photographic illustration of very clear and very hazy conditions at Glacier National Park in Montana, and Dolly Sods Wilderness Area in West Virginia.[2] Figure 6-2 is a map of the 34 Class I areas with seven or more years of IMPROVE monitoring data included in this analysis.

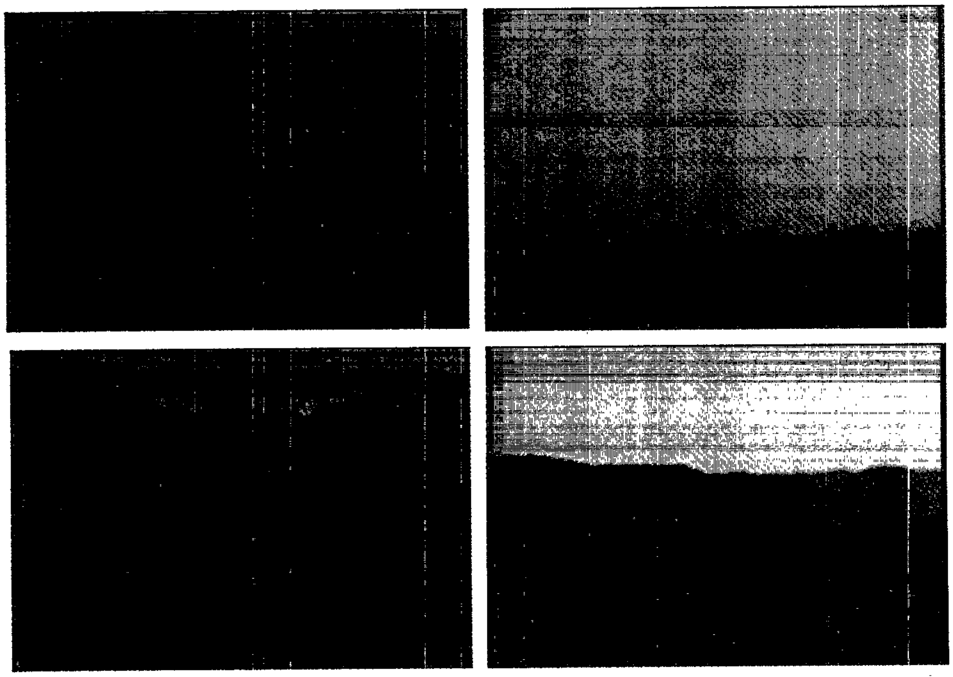
Nature and Sources of the Problem

Visibility impairment occurs as a result of the scattering and absorption of light by particles and gases in the atmosphere. It is most simply described as the haze that obscures the clarity, color, texture, and form of what we see. The same particles

Figure 6-1. Images of Glacier National Park and Dolly Sods Wilderness Area.

Condition: Bad
Visual Range: 15–25 km
Deciviews: 33–28

Condition: Good
Visual Range: 150–200 km
Deciviews: 10–7



Condition: Bad
Visual Range: <10 km
Deciviews: >37

Condition: Good
Visual Range: 80–140 km
Deciviews: 16–10

Glacier National Park | **Dolly Sods Wilderness Area**

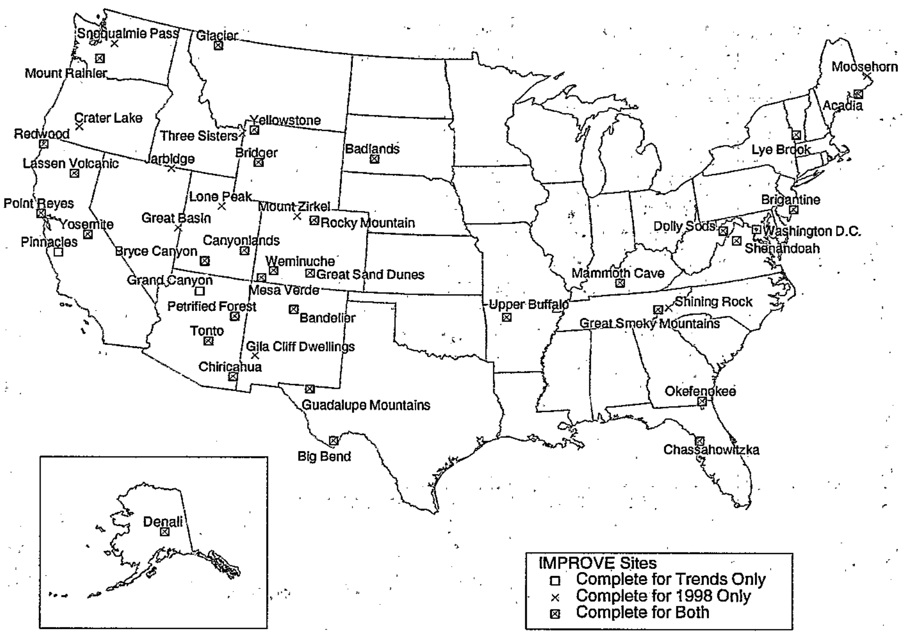
linked to serious health and environmental effects (sulfates, nitrates, organic carbon, elemental carbon [commonly called soot], and crustal material) can also significantly affect our ability to see.

Both primary emissions and secondary formation of particles contribute to visibility impairment. Primary particles, such as elemental carbon from diesel and wood combustion or dust from certain industrial activities or natural sources, are emitted directly into the atmosphere. Secondary particles that are formed in the atmosphere from primary gaseous emissions include sulfate from sulfur dioxide (SO_2) emissions, nitrates from nitrogen oxide (NO_x) emissions, and organic carbon particles formed from condensed hydrocarbon emissions. In the eastern United States, reduced visibility is mainly attributable to secondarily formed particles, particularly those less than a few micrometers in diameter. While secondarily formed particles still account for a significant amount in the West, primary emissions from sources such as woodsmoke generally contribute a larger percentage of the total particulate load than in the East. The only primary gaseous pollutant that directly reduces visibility is nitrogen dioxide (NO_2), which can sometimes be seen in a visible plume from an industrial facility, or in some urban areas with high levels of motor vehicle emissions.

Visibility conditions in Class I and other rural areas vary regionally across the United States. Rural areas in the East generally have higher levels of impairment than most remote sites in the West. Higher eastern levels are generally due to higher regional concentrations of sulfur dioxide and other anthropogenic emissions, higher estimated regional background levels of fine particles, and higher average relative humidity levels. Humidity can significantly increase the effect of pollution on visibility. Some particles, such as sulfates, accumulate water and grow in size, becoming more efficient at scattering light. Annual average relative humidity levels are 70–80 percent in the East as compared to 50–60 percent in the West. Poor summer visibility in the eastern United States is primarily the result of high sulfate particle concentrations combined with high humidity levels.

Visibility conditions are commonly expressed in terms of three mathematically related metrics: visual range, light extinction, and deciviews. Visual range is the metric best

Figure 6-2. IMPROVE sites meeting data completeness requirements.



Note: The Washington, DC site is not included in the rural visibility trends analysis.

known by the general public. It is the maximum distance at which one can identify a black object against the horizon, and is typically described in miles or kilometers. Light extinction, inversely related to visual range, is the sum of light scattering and light absorption by particles and gases in the atmosphere. It is typically expressed in terms of inverse megameters (Mm^{-1}), with larger values representing poorer visibility. Unlike visual range, the light extinction coefficient allows one to express the relative contribution of one particulate matter (PM) constituent versus another to overall visibility impairment. Using speciated mass measurements collected from the IMPROVE samplers "reconstructed light extinction" can be calculated by multiplying the aerosol mass for each constituent by its appropriate "dry extinction coefficient," and then summing these values for each constituent. Because sulfates and nitrates become more efficient at scattering light with increasing humidity, these values are also multiplied by a relative humidity adjustment factor.[3] Annual and seasonal light extinction values developed by this approach correlate well with optical measurements of light extinction (by transmissometer) and light scattering (by nephelometer).

The deciview metric was developed because changes in visual range and light extinction are not proportional to human perception of visibility impairment. For example, a 5-mile change in visual range can be either very apparent or not perceptible, depending on the base line level of ambient pollution. The deciview metric provides a linear scale for perceived visual changes over the entire range of conditions, from clear to hazy, analogous to the decibel scale for sound. Under many scenic conditions, a change of one deciview is considered to be perceptible by the average person. A deciview of zero represents pristine conditions.

It is important to understand that the same amount of pollution can have dramatically different effects on visibility depending on existing conditions. Most importantly, visibility in cleaner environments is more sensitive to increases in $PM_{2.5}$ particle concentrations than visibility in more polluted areas. This principle is illustrated in Figure 6-3, which characterizes visibility at Shenandoah National Park under a range of conditions.[5] A clear day at Shenandoah can be represented by a visual range of 80 miles, with conditions approximating naturally-occurring visibility (i.e., without pollution created by human activities). An average day at Shenandoah is represented by a visual range of 18 miles, and is the result of an additional 10 mg/m^3 of fine particles in the atmosphere. The two bottom scenes, with visual ranges of eight and six miles respectively, illustrate that the perceived change in visibility due to an additional 10 mg/m^3 of fine particles to an already degraded atmosphere is much less perceptible than adding this amount to a clean atmosphere. Thus, to achieve a given level of perceived visibility improvement, a large reduction in fine particle concentrations is needed in more polluted areas. Conversely, a small amount of pollution in a clean area can dramatically decrease visibility.

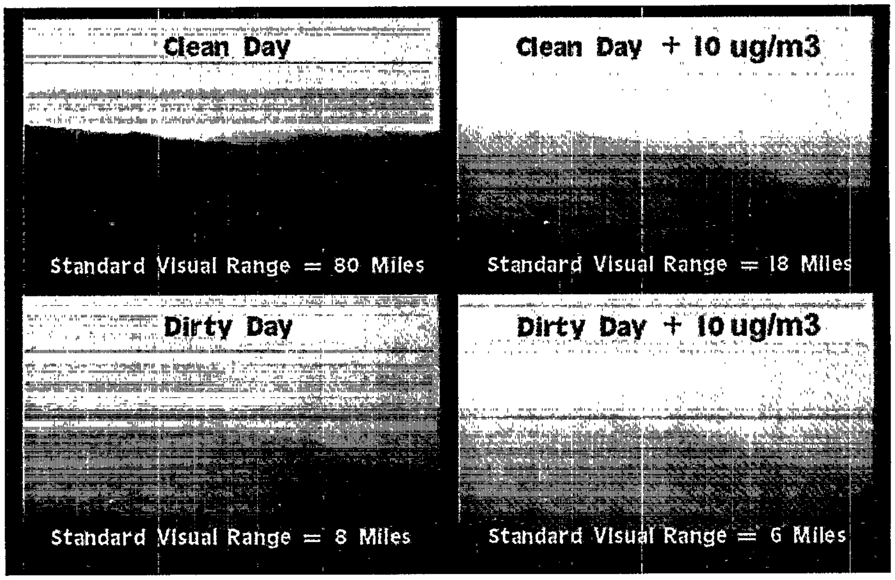
Long-Term Trends (1970–1990)

Visibility impairment is presented here using visual range data collected since 1960 at 280 monitoring stations located at airports across the country. Trends in visibility impairment can be inferred from these long-term records of visual range. Figure 6-4 describes long-term U.S. visibility impairment trends derived from such data.[4] The maps show the amount of haze during the summer months of 1970, 1980, and 1990. The dark blue color represents the best visibility, and red represents the worst visibility. Overall, these maps show that summer visibility in the eastern United States declined between 1970 and 1980, and improved slightly between 1980 and 1990. These trends follow overall trends in emissions of sulfur oxides during these periods.

Recent Trends (1989–1998)

Aerosol and light extinction data are presented for 34 sites which produced at least seven years of fine particle data from 1989–1998: 10 are located in the east, and 24 are located in the west, as shown in Figure 6-2. Because of the significant regional variations in visibility conditions, this chapter does not present aggregate national trends, but instead groups the data into eastern and western regions. As noted earlier, trends in this chapter are presented in terms of the annual average values for the clearest ("best") 20 percent, middle ("typical") 20 percent, and haziest ("worst") 20 percent of the days monitored each year. To date, two 24-hour aerosol samples have been taken each week from IMPROVE sites, resulting in a potential for 104 sampling days per year. Beginning in 2000, aerosol samples will be taken every three days, consistent with the approach used for national $PM_{2.5}$ aerosol monitoring.

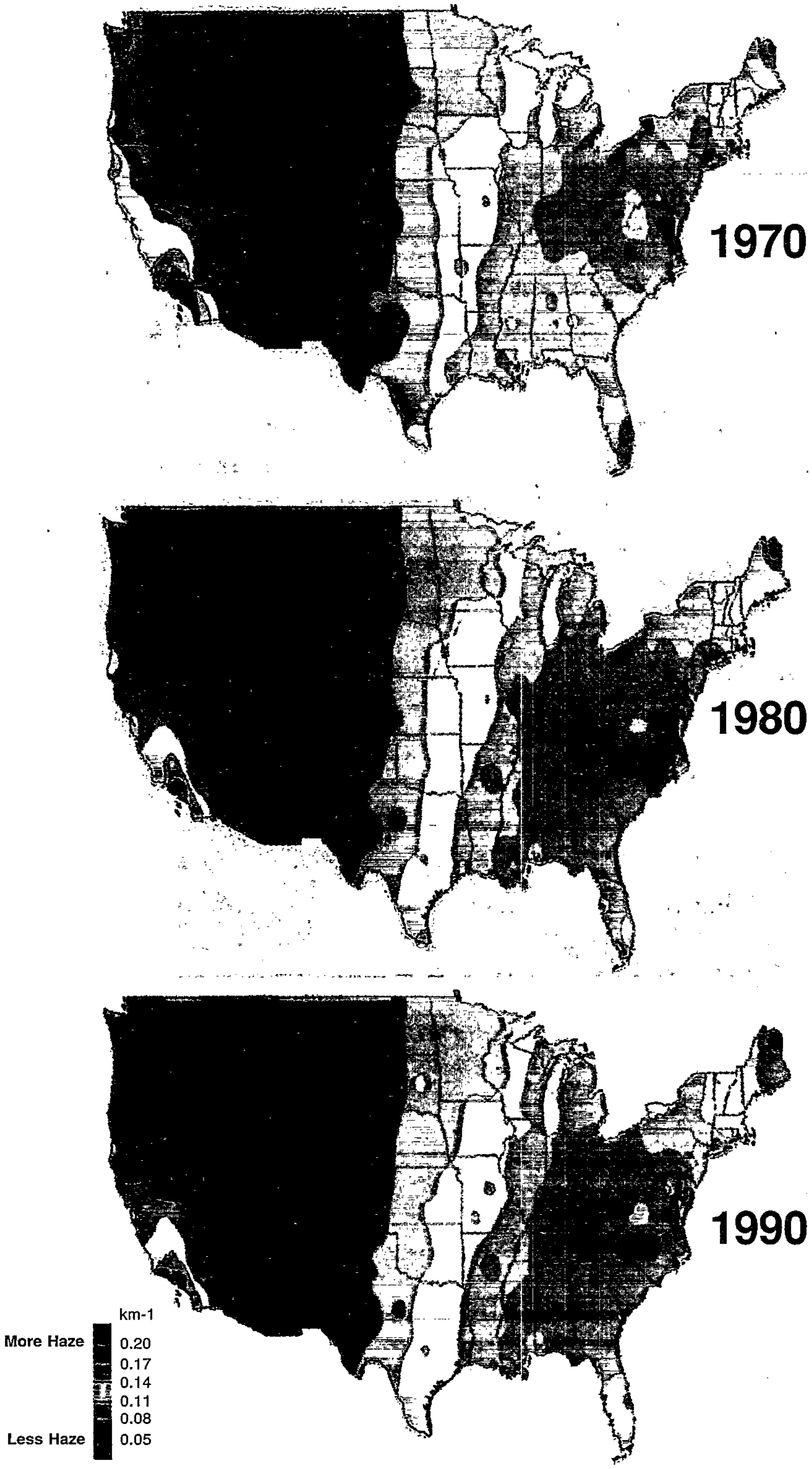
Figure 6-3. Shenandoah National Park on clear and hazy days and the effect of adding 10 μg/m³ of fine particles to each.



Regional Visibility Trends for the Eastern and Western United States

Figures 6-5a and 6-5b illustrate eastern and western trends for total light extinction. These figures, presented with equivalent scales, demonstrate the regional difference in overall levels of visibility impairment. For this graph, the light scattering associated with gaseous molecules in clear air is included (known as Rayleigh extinction). One can see that the worst visibility days in the West are only slightly more impaired than the best days in the East. It should also be noted that beginning in 1992, seven additional eastern sites are reflected in Figure 6-5a, bringing the total number of eastern sites reflected in the values plotted in Figure 6-5a for 1992–1998, to 10. By adding the seven eastern sites to the data set, the magnitude of average impairment levels has increased, although the general slope of the trends for clearest, typical, and haziest days appear similar to the trends based on three sites. Figure 6-5a shows that in the East, the haziest visibility days do not appear to be getting any better. Overall, essentially no change in visibility is noted between 1989 and 1998 (based on 3 sites), and a 4-percent degradation occurred since 1992 (based on 10 sites). It is noted that impairment on the haziest days in the East showed modest improvement in 1993. The best visibility days appear to be improving for the three sites over the 10-year period, but show no change since 1992 based on the 10 locations. The typical days (or middle 20 percent of the distribution) show more than a 10-percent visibility improvement for the three sites,

Figure 6-4. Long-term trend for 75th percentile light coefficient from airport visual data (July–September).



and a more modest 5-percent change since 1992 for the 10 sites.

In the West, there appears to be steady visibility improvement for the clearest, typical, and haziest days as presented in Figure 6-5b for the period 1989–1998. Total light extinction for the aggregation of 24 western sites declined by 10–15 percent for each of the 3 categories. This improvement in total light extinction for the worst days corresponds to a reduction of 0.9 deciviews.

The Components of PM Contributing to Trends in Visibility Impairment

The area plots in Figures 6-6a through 6-6f show the relative contribution to aerosol light extinction by the five principal particulate matter constituents measured by IMPROVE at eastern and western sites for the best, middle, and worst 20 percent days. Note that the scale differs for the eastern and western figures in order to more clearly present the relative contribution of the five components. By understanding the total magnitude of each $PM_{2.5}$ component, the change in aerosol composition over time, and the effect of these components on changing visibility, policymakers can design strategies to address health and environmental concerns.

In the East, (Figures 6-6a, b, and c), sulfate is clearly the largest contributor to visibility impairment, ranging from an average of 75–79 percent of each year's annual aerosol extinction during the haziest days to 62–69 percent on the typical days, and to 53–62 percent on the clearest days. Over the 1992–1998 period, the magnitude of aerosol extinction due to sulfates increased, most notably between 1997 and 1998. This change corresponds to the reported increase in sulfate aerosols and summer time increase in regional SO_2 emissions discussed in Chapter 7 (Atmospheric Deposition of Sulfur and Nitrogen Compounds). The organic carbon is the next largest contributor to visibility impairment in the East, accounting for 11–15 percent of annual aerosol extinction on the best days and 10–11 percent on the most impaired days. The third largest contributor in the East is nitrate, which also accounts for about 10–16 percent of annual aerosol light extinction on the best days and about 2–6 percent on the haziest days.

In the West, sulfate is also the most significant single contributor to aerosol light extinction on the clearest, typical, and haziest days. Sulfate accounts for 30–40 percent of annual aerosol light extinction on the best days, 36–44 on the typical days, and 34–41 on the haziest days. However, organic carbon (20–33 percent), crustal material (16–25 percent), and nitrates (7–12 percent) play a more significant role (as a percentage of aerosol extinction) in western sites than eastern ones. Based on this aggregation of 24 sites, the decrease in light extinction noted above can be attributed to downward trends in aerosol elemental carbon and organic carbon. However, carbon increased between 1997 and 1998, offsetting some of these improvements in western Class I areas.

Trends in Specific Class I Areas

IMPROVE data from 34 Class I area monitoring sites[7] were analyzed for upward or downward trends using a nonparametric regression methodology described in Appendix B: Methodology.

Figure 6-5a. Total light extinction trends for eastern Class I areas for clearest, middle, and haziest 20 percent of the days in the distribution, 1989–1998.

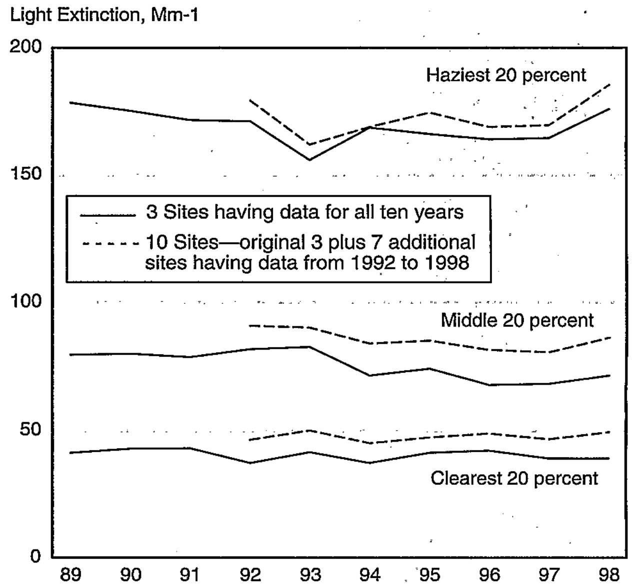
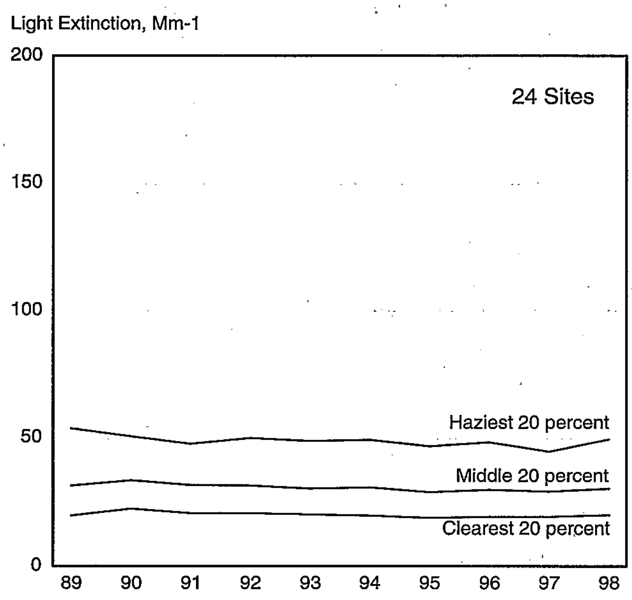


Figure 6-5b. Total light extinction trends for western Class I areas for clearest, middle, and haziest 20 percent of the days in the distribution, 1989–1998.



Note: In the eastern Class I area plots, the 1989–1991 trend is based on the three sites with available data. Beginning in 1992 and going through 1998, there are seven additional sites with trend data.

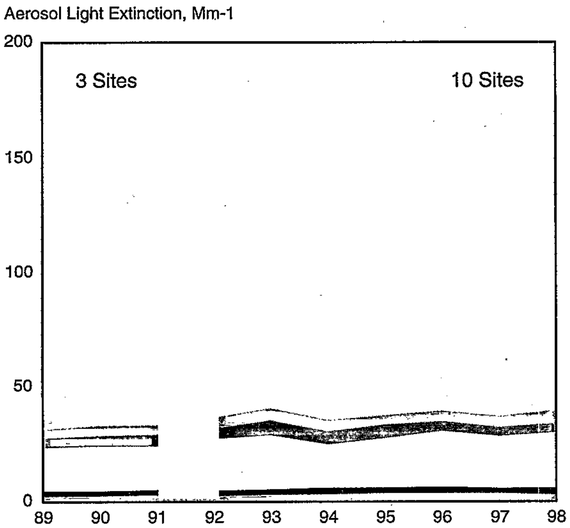


Figure 6-6a. Aerosol light extinction in eastern Class I areas for the clearest 20 percent of the days in the distribution, 1989–1998.

- Organic Carbon
- Nitrate
- Sulfate
- Elemental Carbon
- Crustal Material

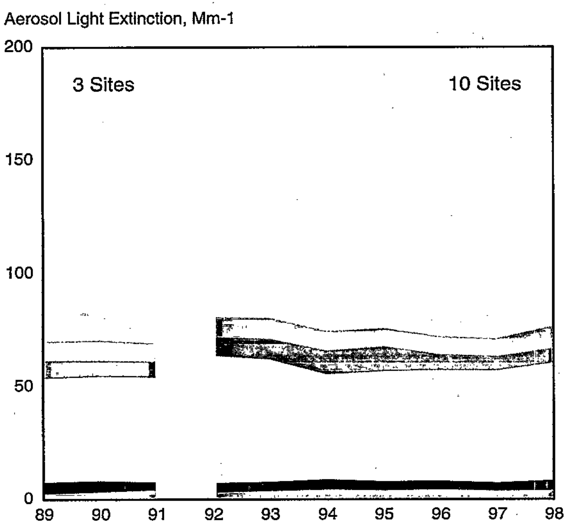


Figure 6-6b. Aerosol light extinction in eastern Class I areas for the middle 20 percent of the days in the distribution, 1989–1998.

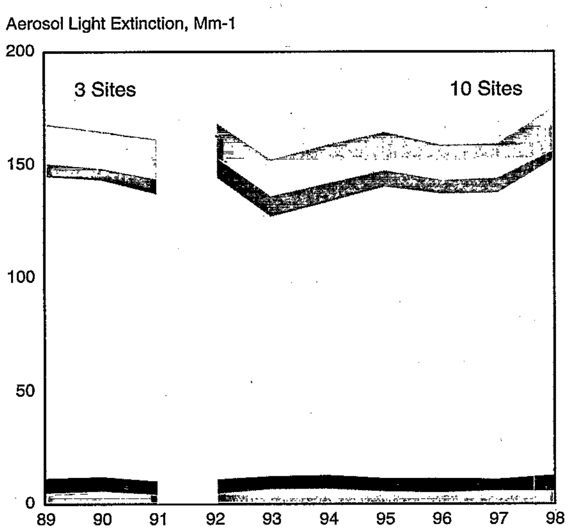


Figure 6-6c. Aerosol light extinction in eastern Class I areas for the haziest 20 percent of the days in the distribution, 1989–1998.

Table 6-1 summarizes the trends analysis performed on these 34 sites for total light extinction (expressed in deciviews) on an area-by-area basis. Four areas in the West showed a significant downward trend in deciviews on the haziest days. However, the 30 remaining Class I areas did not have significant visibility improvement on the haziest days over the 7- to 10-year period.

Current Visibility Conditions

Current annual average conditions range from about 18–40 miles in the rural East and about 35–90 miles in the rural West. On an annual average basis, natural visibility conditions have been estimated at approximately 80–90 miles in the East and up to 140 miles in the West.[4] Natural visibility varies by region, primarily because of slightly higher estimated background levels of $PM_{2.5}$ particles in the East, and the more significant effect of relative humidity on particle concentrations in the East than in the West.

Figures 6-7a, 6-7b, and 6-7c illustrate regional visibility impairment in terms of reconstructed aerosol light extinction based on measurements at IMPROVE sites between 1995 and 1997. Maps are presented for the clearest, typical, and haziest 20 percent of the distribution. The pie

Notes:

1) To better discern the trend in each component, the vertical scales for the plots of the western Class I areas are smaller than those for the plots of the eastern Class I areas.

2) In the eastern Class I area plots, the 1989-1991 trend is based on the 3 sites with available data. Beginning in 1992 and going through 1998, there are 7 additional sites with trend data.

charts show the relative contribution of different particle constituents to visibility impairment. Annual average aerosol light extinction due to these particles is indicated by the value next to each pie and by the size of each pie.[6] Figure 6-7 also shows that visibility impairment is generally greater in the rural East compared to most of the West. As noted earlier, the pies show that, for most rural eastern sites, sulfates account for more than 60 percent of annual average light extinction on the best days and for more than 75 percent of annual average light extinction on the haziest days. Sulfate plays a particularly significant role in the humid summer months due to its nature to attract and dissolve in atmospheric water vapor, most notably in the Appalachian, northeast, and mid-south regions. The figure also shows that organic carbon and nitrates each account for 10–15 percent of aerosol extinction on the clearest days while elemental carbon only contributes 5–7 percent. On the other hand, organic carbon contributes around 10 percent to aerosol light extinction on the haziest days while nitrates and elemental carbon each typically contribute 2–6 percent.

In the rural West, sulfates also play a significant role, typically accounting for about 30–40 percent of aerosol light extinction on the best days and 35–45 percent on the haziest days. In several areas of the West, however, sulfates account for over 50 percent of annual average aerosol extinction, including Mt Rainier, WA, Redwood National Park, CA, and the Cascades of Oregon. In contrast, it contributes less than 25 percent in southern California. Organic carbon typically makes up 20–30 percent of aerosol light extinction in the rural

Figure 6-6d. Aerosol light extinction in western Class I areas for the clearest 20 percent of the days in the distribution, 1989–1998.

Organic Carbon
Nitrate
Sulfate
Elemental Carbon
Crustal Material

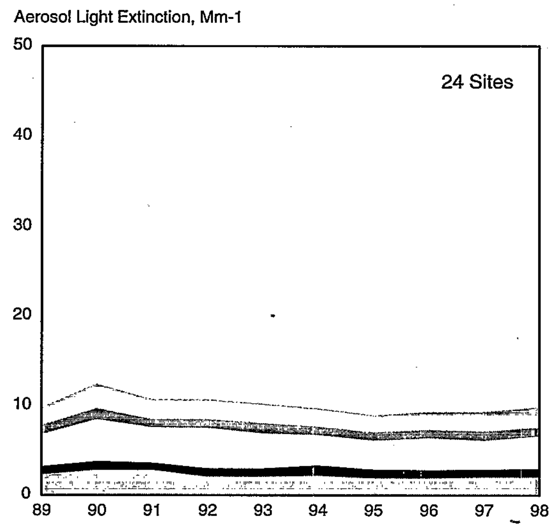


Figure 6-6e. Aerosol light extinction in western Class I areas for the middle 20 percent of the days in the distribution, 1989–1998.

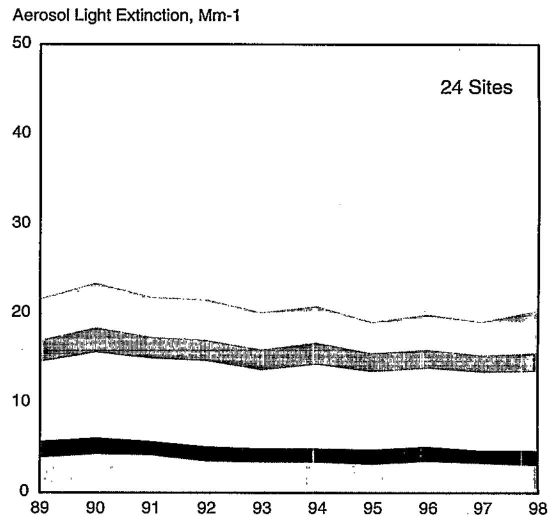


Figure 6-6f. Aerosol light extinction in western Class I areas for the haziest 20 percent of the days in the distribution, 1989–1998.

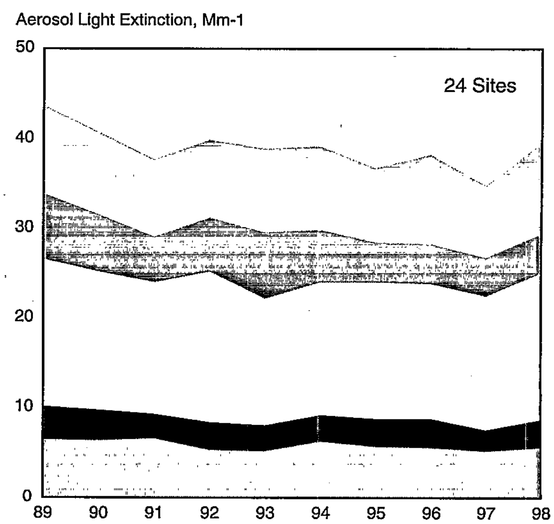


Table 6-1. Summary of Class I Area Trend* Analysis

Parameter	Number of Sites With Significant Upward (*Deteriorating*) Trends West	East	Number of Sites With Significant Downward (*Improving*) Trends West	East
Deciviews, worst 20%	1	0	4	0
Deciviews, middle 20%	0	0	3	3
Deciviews, best 20%	1	1	5	0
Light extinction due to sulfate, worst 20%	3	0	3	0
Light extinction due to sulfate, middle 20%	2	0	1	3
Light extinction due to sulfate, best 20%	1	0	9	1
Light extinction due to organic carbon, worst 20%	0	0	4	0
Light extinction due to organic carbon, middle 20%	0	0	6	0
Light extinction due to organic carbon, best 20%	3	0	4	0

* Based on a total of 34 monitored sites with at least seven years of data: 24 in the west, 10 in the east.

West, elemental carbon (absorption) accounts for about 10 percent, and crustal matter (including coarse PM) accounts for about 15–25 percent. Nitrates typically account for less than 10 percent of total light extinction in western locations, except in the southern California region, where it accounts for almost 40 percent.

Figures 6-8a, 6-8b, and 6-8c illustrate current levels of visibility impairment, in terms of deciviews, for the clearest, typical, and haziest 20 percent days based on IMPROVE data from 1995–1997.[7] Note that the deciview scale is more compressed than the scale for visual range or light extinction, with larger values representing greater visibility degradation. Most of the sites in the intermountain West and Colorado Plateau have annual average impairment of 12 deciviews or less, with the worst days ranging up to 16 deciviews. Several other western sites in the northwest and California experience levels on the order of 15–25 deciviews on the haziest 20 percent of days. Many rural locations in the East have annual average values exceeding 23 deciviews, with average visibility levels on the haziest days up to 33 deciviews.

Programs to Improve Visibility

In April of 1999, EPA issued the final regional haze regulation.[8] This regulation addresses visibility impairment in national parks and wilderness areas that is caused by numerous sources located over broad regions. The program lays out a framework within which states can work together to develop implementation plans that are designed to achieve "reasonable progress" toward the national visibility goal of no human-caused impairment in the 156 mandatory Class I federal areas across the country.

States are required to establish goals to improve visibility on the 20 percent worst days and to allow no degradation on the 20 percent best days for each Class I area in the state. In establishing any progress goal, the state must analyze the rate of progress for the next 10–15 year implementation period which, if maintained, would achieve natural visibility conditions by 2064. The state will need to show whether this rate of progress or another rate is more reasonable based on certain factors in the Clean Air Act, including costs and the remaining useful life of affected sources. Along with these goals, the state plans must also include emission reduction measures to meet these goals (in combination with other states' measures), requirements for Best Available Retrofit Technology on certain large existing sources (or an alternative emissions trading program), and visibility monitoring representative of all class I areas.

State regional haze plans are due in the 2003–2008 timeframe. Because of the common precursors and the regional nature of the PM and regional haze problems, the haze rule includes specific provisions for states that work together in regional planning groups to assess the nature and sources of these problems and to develop coordinated, regional emission reduction strategies. One provision allows nine Grand Canyon Visibility Transport Commission States (Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oregon, Utah, and Wyoming) to submit initial plans in 2003 to implement their past recommendations within the framework of the national re-

Figure 6-7a. Aerosol light extinction (in Mm^{-1}) for the clearest 20 percent days and contribution by individual particulate matter constituents, based on 1995–1997 IMPROVE data.

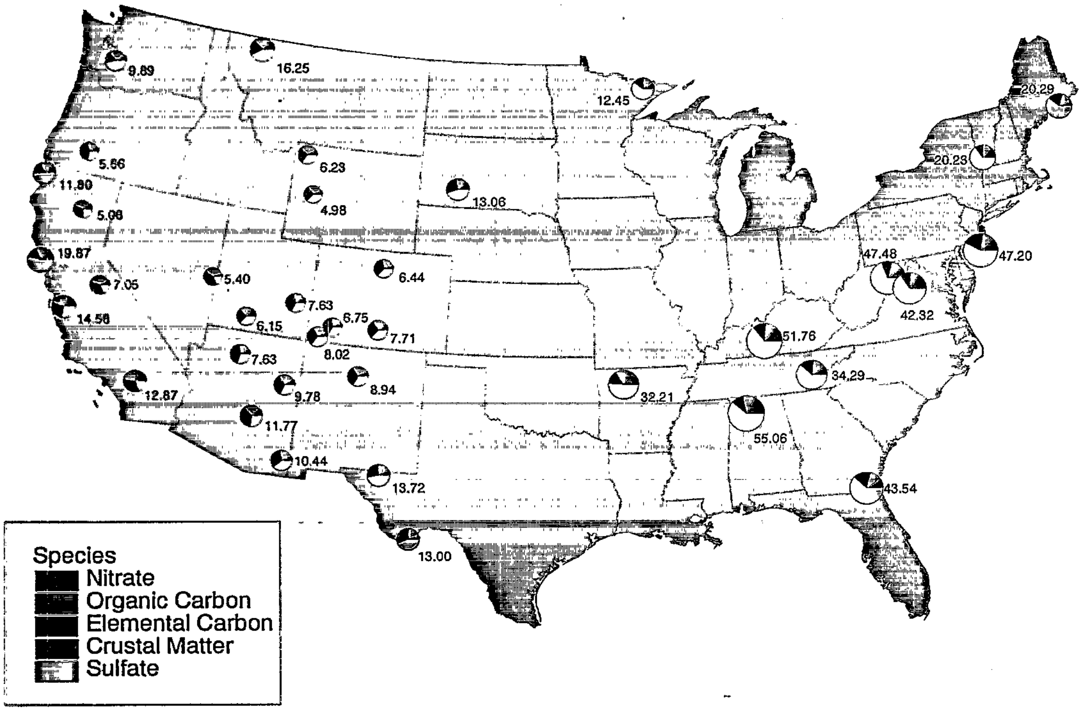


Figure 6-7b. Aerosol light extinction (in Mm^{-1}) for the middle 20 percent days and contribution by individual particulate matter constituents, based on 1995–1997 IMPROVE data.

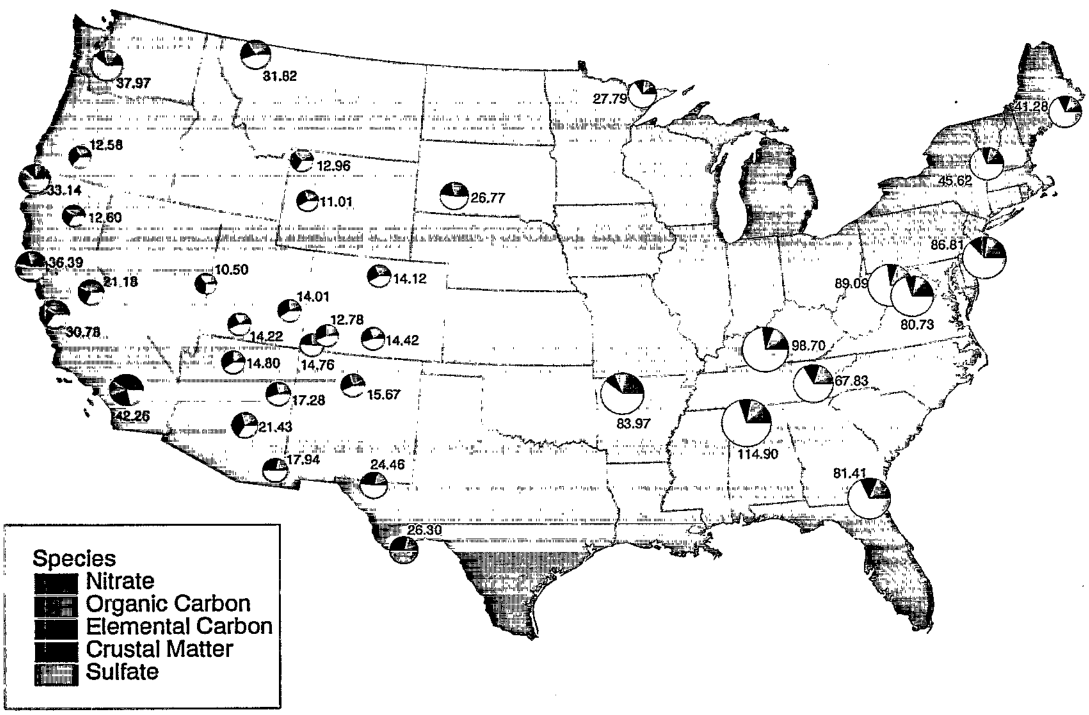


Figure 6-7c. Aerosol light extinction (in Mm^{-1}) for the haziest 20 percent days and contribution by individual particulate matter constituents, based on 1995–1997 IMPROVE data.

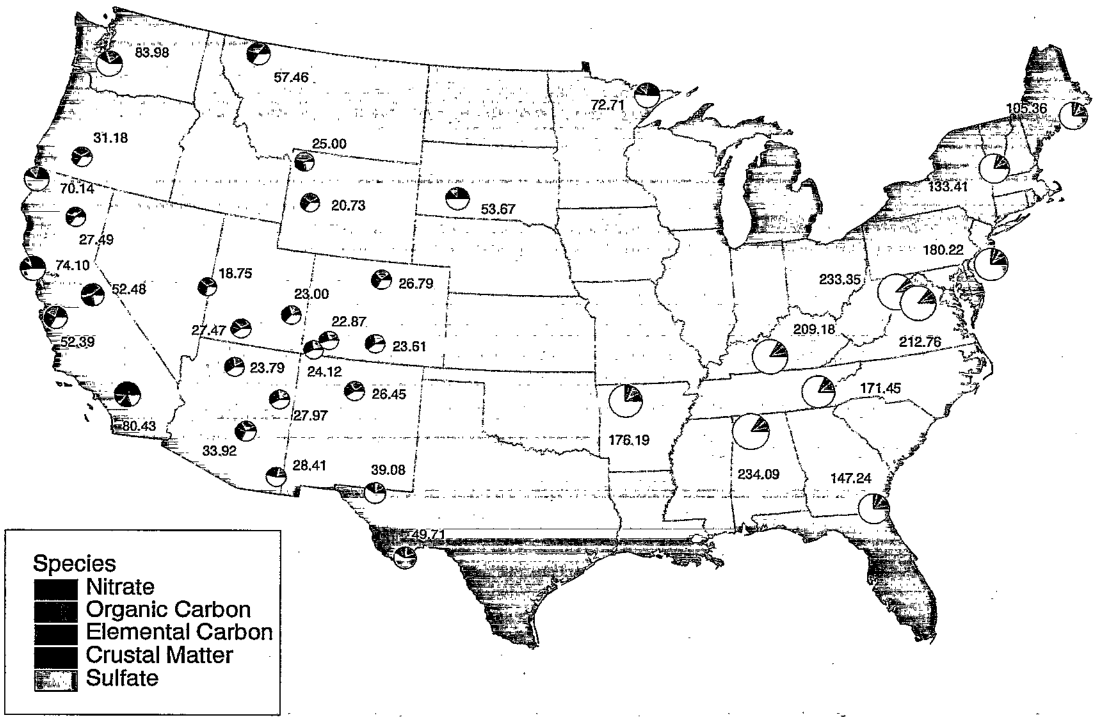


Figure 6-8a. Current visibility impairment expressed in deciviews for the clearest 20 percent days based on 1995–1997 IMPROVE data.

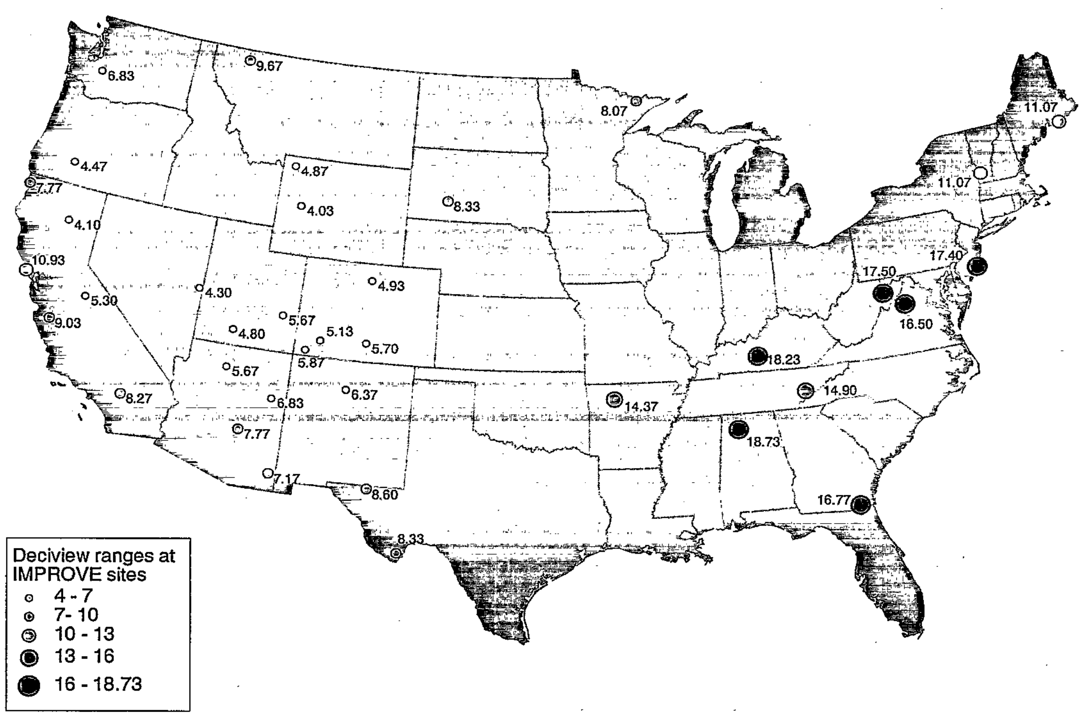


Figure 6-8b. Current visibility impairment expressed in deciviews for the middle 20 percent days based on 1995–1997 IMPROVE data.

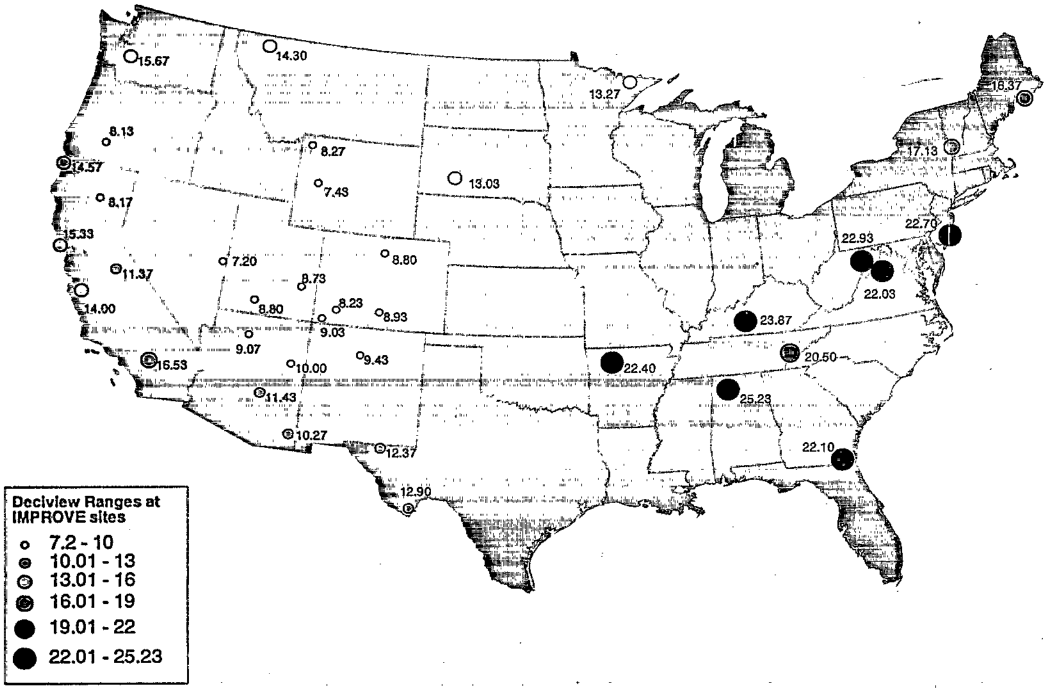
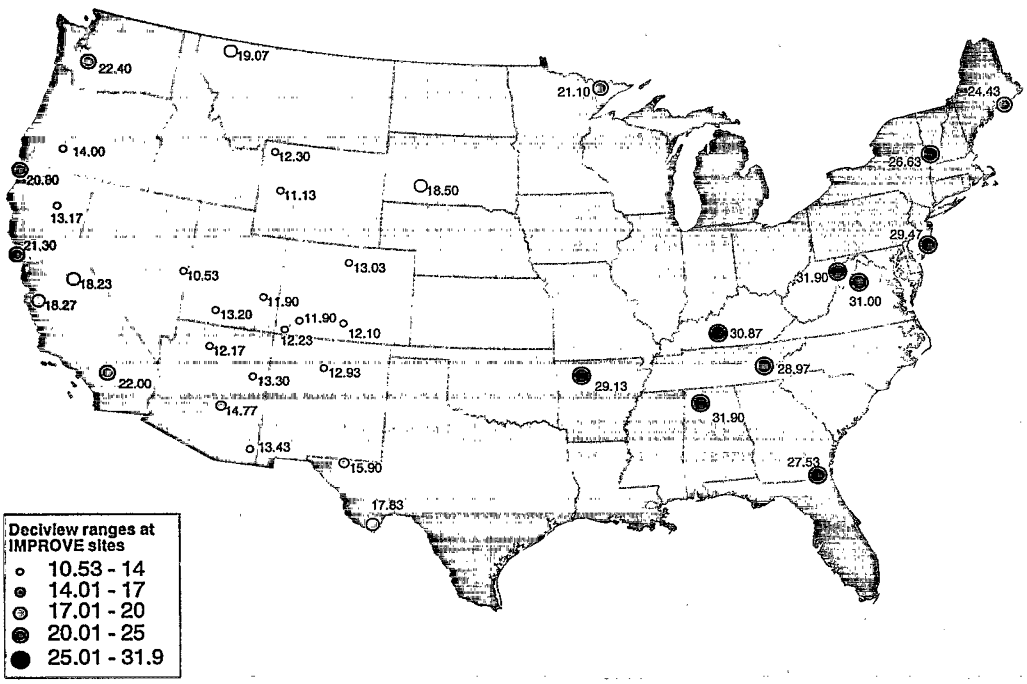


Figure 6-8c. Current visibility impairment expressed in deciviews for the haziest 20 percent days based on 1995–1997 IMPROVE data.



gional haze program. Another provision allows certain states until 2008 to develop coordinated strategies for regional haze and PM contingent upon future participation in regional planning groups.

Implementation of the PM and Ozone NAAQS in conjunction with a future regional haze program is expected to improve visibility in urban as well as rural areas across the country. Other air quality programs are expected to bring about emissions reductions that will improve visibility in certain regions of the country. The acid rain program will achieve significant regional reductions in the emissions of SO_2, which will reduce sulfate haze particularly in the eastern United States. When implemented, the NO_x State Implementation Plan (SIP) call to reduce emissions from sources of NOx to reduce formation of ozone should also improve regional visibility conditions to some degree. In addition, visibility impairment in class I areas should improve as a result of a number of other programs, including mobile source emissions and fuel standards, certain air toxics standards, and implementation of smoke management and woodstove programs to reduce fuel combustion and soot emissions.

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1. Data from IMPROVE Visibility Monitoring Network, 1998.

2. PhotoCD images provided by Kristi Savig and John Molenar, Air Resource Specialists, Inc., Fort Collins, Colorado 80525.

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7. See reference 1.

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CHAPTER 7

Atmospheric Deposition of Sulfur and Nitrogen Compounds

http://www.epa.gov/oar/aqtrnd98/chapter7.pdf

Sulfur and nitrogen oxides are emitted into the atmosphere primarily from the burning of fossil fuels. These emissions react in the atmosphere to form compounds that are transported long distances and are subsequently deposited in the form of pollutants such as particulate matter (sulfates, nitrates) and related gases (nitrogen dioxide, sulfur dioxide and nitric acid). Nitrogen oxides will also interact with volatile organic compounds to form ozone. The effects of atmospheric deposition include acidification of lakes and streams, nutrient enrichment of coastal waters and large river basins, soil nutrient depletion and decline of sensitive forests, agricultural crop damage, and impacts on ecosystem biodiversity. Toxic pollutants and metals can also be transported and deposited through atmospheric processes. (See Chapter 5: Air Toxics.)

Both local and long-range emission sources contribute to atmospheric deposition. Total atmospheric deposition is determined using both wet and dry deposition measurements. Wet deposition is the portion dissolved in cloud droplets and is deposited during rain or other forms of precipitation. Dry deposition is the portion deposited on dry surfaces during periods of no precipitation as particles or in a gaseous form. Although the term "acid rain" is widely recognized, the dry deposition portion can range from 20–60 percent of total deposition.

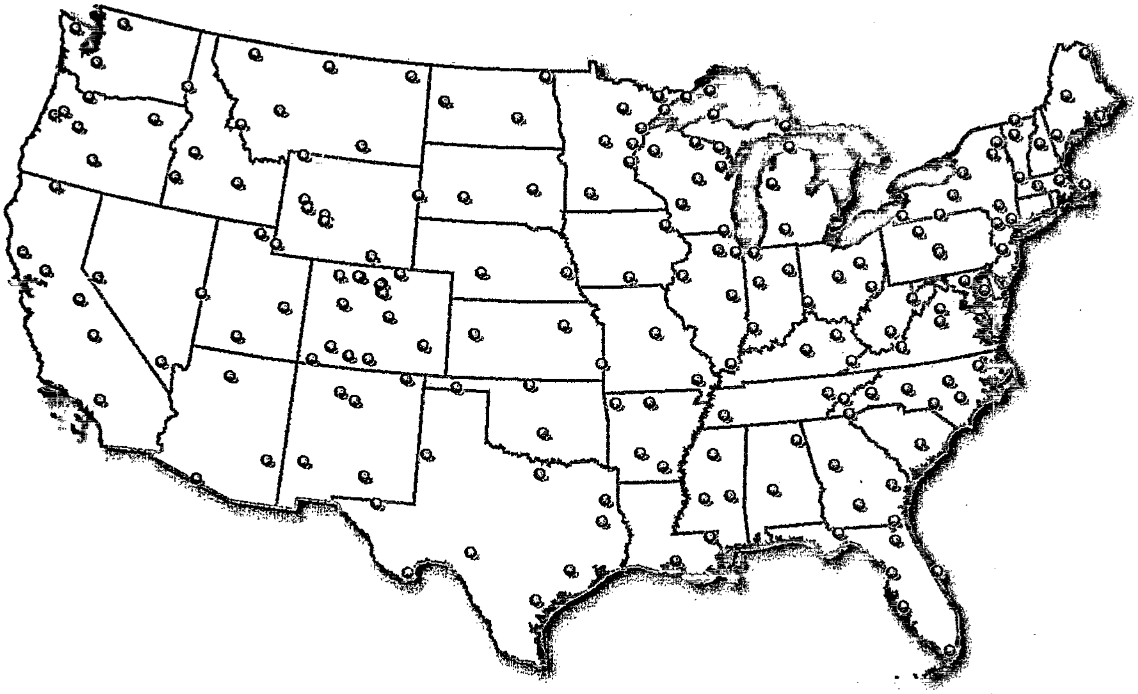
EPA is required by several Congressional and other mandates to assess the effectiveness of air pollution control efforts. These mandates include Title IX of the Clean Air Act Amendments (the National Acid Precipitation Assessment Program), the Government Performance and Results Act, and the U.S./Canada Air Quality Agreement. One measure of effectiveness of these efforts is whether sustained reductions in the amount of atmospheric deposition over broad geographic regions are occurring. However, changes in the atmosphere happen very slowly and trends are often obscured by the wide variability of measurements and climate. Numerous years of continuous and consistent data are required to overcome this variability, making long-term monitoring networks especially critical for characterizing deposition levels and identifying relationships among emissions, atmospheric loadings and effects on human health and the environment.

For wet and dry deposition, these studies typically include measurement of concentration levels of key chemical components as well as precipitation amounts. For dry deposition, analyses must also include meteorological measurements that are used to estimate rate of the actual deposition, or "flux." Data representing total deposition loadings (e.g., total sulfate or nitrate) are what many environmental scientists use for integrated ecological assessments.

Primary Atmospheric Deposition Monitoring Networks

The National Atmospheric Deposition Program (NADP) and the Clean Air Status and Trends Network (CASTNet) were developed to monitor wet and dry acid deposition, respectively. Monitoring site locations are predominantly rural by design to assess the relationship between regional pollution and changes in regional patterns in deposition. CASTNet also includes measurements of rural ozone and the

Figure 7-1. The NADP/NTN Network.



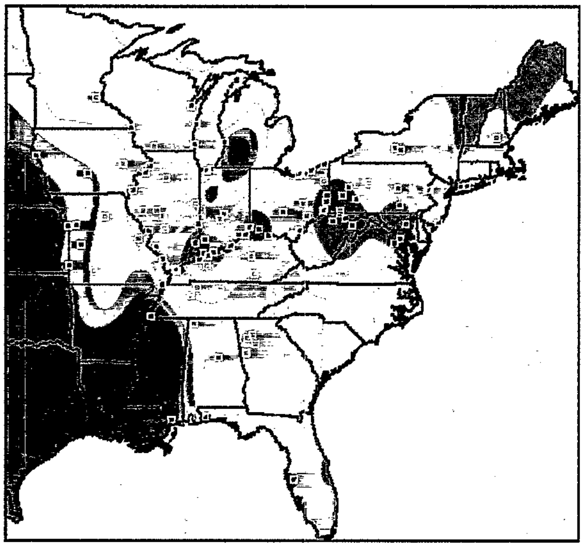
chemical constituents of $PM_{2.5}$. Rural monitoring sites of NADP and CASTNet provide data where sensitive ecosystems are located and provide insight into natural background levels of pollutants where urban influences are minimal. These data provide needed information to scientists and policy analysts to study and evaluate numerous environmental effects, particularly those caused by regional sources of emissions for which long range transport plays an important role. Measurements from these networks are also important for understanding non-ecological impacts of air pollution such as visibility impairment and damage to materials, particularly those of cultural and historical importance.

National Atmospheric Deposition Network

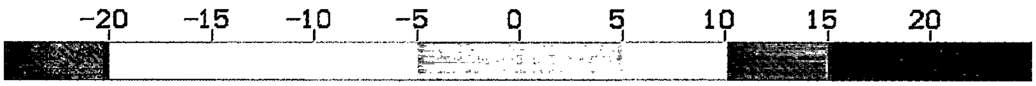
The National Atmospheric Deposition Program (NADP) was initiated in the late 1970s as a cooperative program between federal and state agencies, universities, and electric utilities and other industries to determine geographical patterns and trends in precipitation chemistry in the United States. Collection of weekly wet deposition samples began in 1978. The size of the NADP Network grew rapidly in the early 1980s when the major research effort by the National Acid Precipitation Assessment Program (NAPAP) called for characterization of acid deposition levels. At that time, the network became known as the NADP/NTN (National Trends Network). By the mid-1980s, the NADP had grown to nearly 200 sites, where it stands today as the longest running national deposition monitoring network (see Figure 7-1).

The NADP analyzes the constituents important in precipitation chemistry, including those affecting rainfall acidity and those that may have ecological effects. The Network measures sulfate, nitrate, hydrogen ion (measure of acidity), ammonia, chloride, and base cations (calcium, magnesium, potassium). To ensure comparability of results, laboratory analyses for all samples are conducted by NADP's Central Analytical Lab at the Illinois State Water Survey. A new subnetwork of the NADP, the Mercury Deposition Network (MDN) measures mercury in precipitation. For more information on the MDN, see Chapter 5: Air Toxics.

Figure 7-2. Percent differences in mean annual measured sulfate concentrations as compared to projected concentrations for 1995–1996 for the eastern United States (from NADP/NTN).



Small squares on the map show locations of electric utility plants affected under Phase I of the Acid Rain Program. Areas on the map depicting higher sulfate concentrations (e.g., south and east of Lake Michigan and the southwestern portion of map) appear to be due to below average precipitation volumes, which are associated with higher concentrations of sulfate. In addition, these results may have been affected by SO_2 emission increases at some Phase II emissions sources that are controlled by the Acid Rain Program in the year 2000.



Trends Analyses for Sulfate and Nitrate Concentrations in Wet Deposition

Sulfate concentrations in precipitation have decreased over the past two decades.[1] The reductions were relatively large in the early 1980s followed by more moderate declines until 1995. These reductions in wet sulfates are similar to changes in SO_2 emissions. In 1995 and 1996, however, concentrations of sulfates in precipitation over a large area of the eastern United States exhibited a dramatic and unprecedented reduction. Sulfates have been estimated to be 10–25 percent lower than levels expected with a continuation of 1983–1994 trends (see Figure 7-2). This important reduction in acid precipitation is directly related to the large regional decreases in SO_2 emissions resulting from phase I of the Acid Rain Program (See "Trends in SO_2" in Chapter 2 of this report). The largest reductions in sulfate concentrations occurred along the Ohio River Valley and in states immediately downwind of this region. For example, the average reduction in sulfate concentrations in Ohio was approximately 21 percent, in Maryland 27 percent, and in Pennsylvania 15 percent. The largest decrease (32 percent) occurred in the northern portion of West Virginia. Reductions in hydrogen ion concentrations in the East, the primary indicator of precipitation acidity, were very similar to those of sulfate concentrations, both in magnitude and location. Nitrate concentrations at NADP/NTN sites were not appreciably different in 1995–1996 from historical levels.[2]

The effects of decreased SO_2 emissions on sulfates can also be seen by comparing deposition maps for the eastern United States. Figures 7-3a and 7-3b compare wet sulfate deposition between 1989–1991 and 1995–1998.[3] The sulfate concentrations in

Table 7-1. Mean Annual Sulfate Wet Deposition, 1989–1998, in Three Sensitive Regions in the Eastern United States

Region	Mean Annual Sulfate Wet Deposition (kg/ha) (1989–91	1995–98)	Percent Change in Mean Annual Sulfate Wet Deposition (1989–91 to 1995–98)
Adirondacks	25.6	18.9	-26
Mid-Appalachian	27.3	21.4	-21
Southern Blue Ridge	22.9	19.6	-15

precipitation are still highest in the Great Lake states and areas extending eastward, but the magnitude of the levels are greatly reduced.

The percent improvement between 1989–1991 and 1995–1998 can also be viewed in terms of three sensitive regions in the eastern United States: Adirondacks, Mid-Appalachians, and Southern Blue Ridge. Table 7-1 shows that the improvements range from 15–26 percent. The largest improvements were in the Adirondacks and Mid-Appalachians.[3]

Clean Air Status and Trends Network

The Clean Air Status and Trends Network provides atmospheric data on the dry deposition component of total acid deposition, ground-level ozone and other forms of atmospheric pollution. CASTNet is considered the nation's primary source for atmospheric data to estimate dry acidic deposition and to provide data on rural ozone levels. Used in conjunction with other national monitoring networks, CASTNet is used to determine the effectiveness of national emission control programs. Established in 1987, CASTNet now comprises 79 monitoring stations across the United States. The longest data records are primarily at eastern sites. The majority of the monitoring stations are operated by EPA's Office of Air and Radiation; however, 27 stations are operated by the National Park Service (NPS) in cooperation with EPA. Of the total number of sites, 74 measure dry-deposition, 19 measure wet-deposition, 68 measure ozone, and eight measure aerosols for visibility assessment.

Each CASTNet dry deposition station measures:

Figure 7-3a. Trends in wet sulfate deposition (kg/ha); 1995–1997.

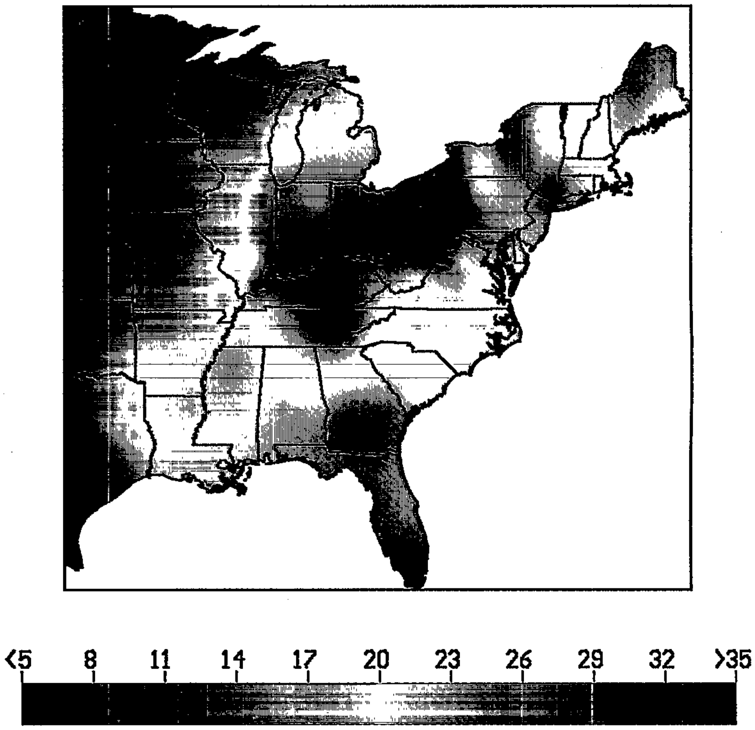


Figure 7-3b. Trends in wet sulfate deposition (kg/ha); 1989–1991.

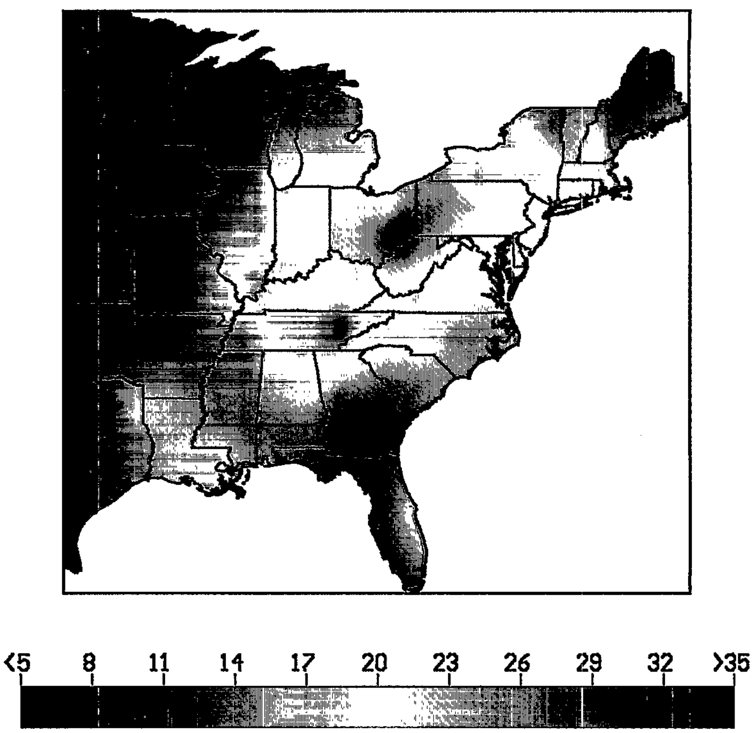
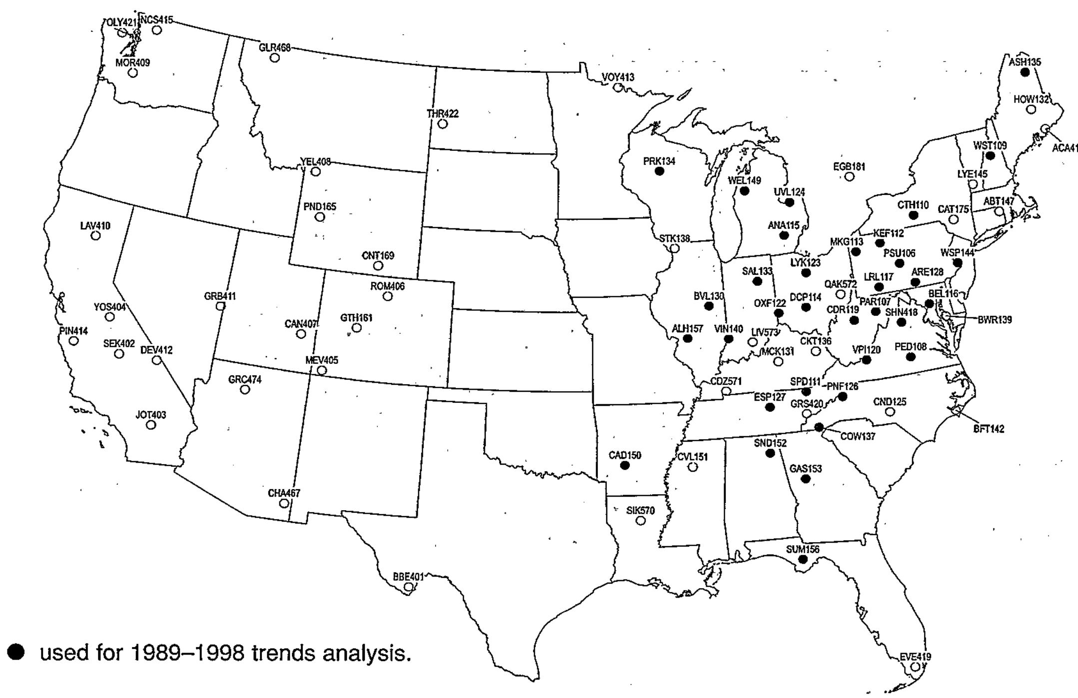


Figure 7-4. CASTNet Network and subset of 34 sites used for 1989–1998 trends analysis.



- Weekly average atmospheric concentrations of sulfate, nitrate, ammonium, sulfur dioxide, and nitric acid (sulfate, nitrate and ammonium generally exist as fine particles).
- Hourly concentrations of ambient ozone levels.
- Meteorological conditions required for calculating dry deposition rates.

Dry Deposition

Dry deposition rates are calculated using atmospheric concentrations, meteorological data and information on land use, vegetation, and surface conditions. CASTNet complements the database compiled by NADP. Because of the interdependence of wet and dry deposition, CASTNet also collected wet deposition data at the 18 sites where there are no NADP/NTN stations within a 50 km radius. Now, these sites are officially part of the NADP. Together, these two long-term databases provide the necessary data to estimate trends and spatial patterns in total atmospheric deposition. NOAA also operates a smaller dry deposition network called Atmospheric Integrated Assessment Monitoring Network (AIRMoN) focused on addressing research issues specifically related to dry deposition measurement.

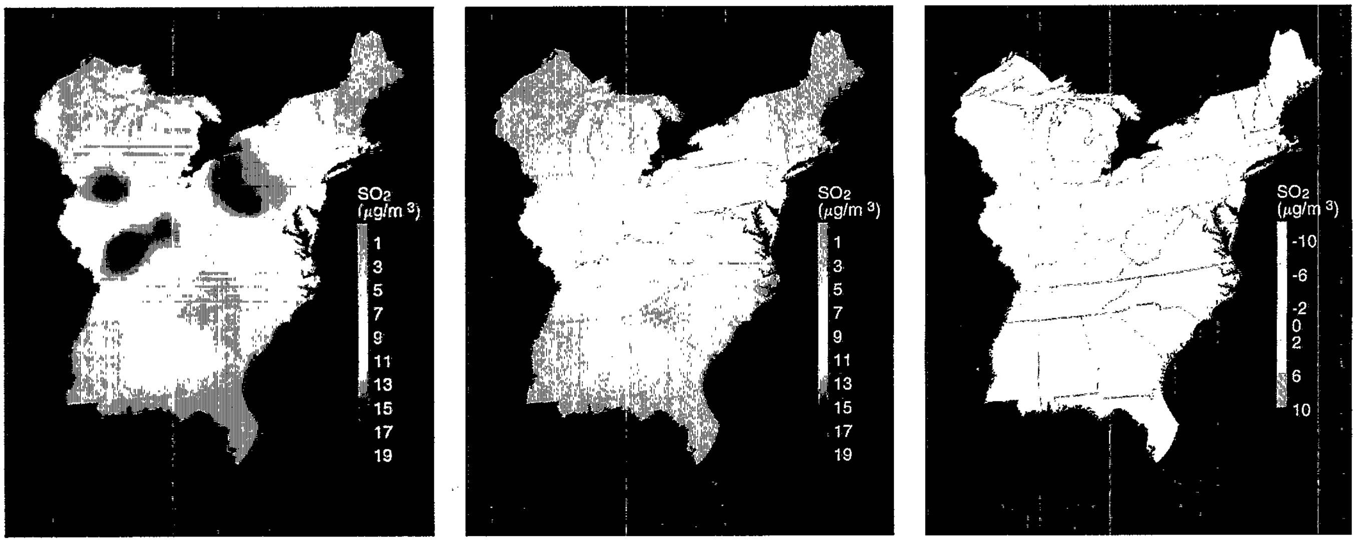
Concentration Trends Analysis at CASTNet Sites

CASTNet ambient concentration data in the eastern United States were analyzed for the period 1989 to 1998 for the change in ambient sulfur dioxide, sulfates, total nitrates and ammonium. First, maps are presented for a comparison of 2-year periods at the beginning and end of the 10-year period based on data from all 50 eastern locations in the CASTNet monitoring program. Then data from a subset of 34 Eastern CASTNet sites with the most complete historical record are examined for year to year changes from 1989 to 1998.[5]

In the early 1990s, ambient SO_2 concentrations in the rural eastern United States were highest in western Pennsylvania, along the Ohio Valley and in the vicinity of Chicago/Gary Indiana. Large improvement in SO_2 air quality can be seen by comparing 1990–1991 with 1997–1998. The largest decreases in concentrations are noted in the vicinity of Chicago and throughout the states bordering the Ohio Valley (IL, IN, OH, PA, KY, WV). The highest SO_2 concentrations in the rural parts of the eastern United States are now concentrated in southwestern PA.

In the early 1990s, sulfate concentrations greater than 5 $\mu g/m^3$* cover

Figure 7-5a. Comparison of ambient sulfur dioxide concentrations in the rural eastern United States from CASTNet monitoring data, 1990–1991 vs. 1997–1998



1990–1991

1997–1998

Decrease in ambient sulfur dioxide concentrations in the rural eastern United States, 1990–1991 vs. 1997–1998.

most of the eastern United States. Regions of concentrations greater than 6 µg/m^3 are estimated to cover the Ohio Valley States (Il, IN, OH, KY, WV), PA and the other mid-Atlantic states from New Jersey to Virginia. The highest sulfate concentrations (> 7 µg/m^3) were adjacent to the Ohio Valley and in northern Alabama. These are the locations of large electric utilities.

In the late 1990s (represented by the period 1997–1998), sulfates were dramatically lower. Although there are differences between 1997 and 1998, as discussed below, both the size of the region with and the magnitude of the highest concentrations has decreased. However, the region with concentrations higher than 5 µg/m^3 does not appear to have changed appreciably.

The location of all CASTNet sites and those used for the 10-year trend analysis are shown in Figure 7-4. During this 10-year period, atmospheric concentrations of SO_2 and sulfate both showed statistically-significant declining trends. The average reduction in the these rural sulfur dioxide and sulfate levels was 38 percent** and 22 percent respectively. The distribution of annual average concentrations is presented as box-plots in Figures 7-6 and 7-7. An average 10-percent increase in sulfates between 1997 and 1998 is also noted.

The trend in total nitrate concentrations (nitrates plus nitric acid) was essentially flat, corresponding to the small change in NO_x emissions during this period. The highest nitrate concentrations are found in the States of Ohio, Indiana and Illinois.

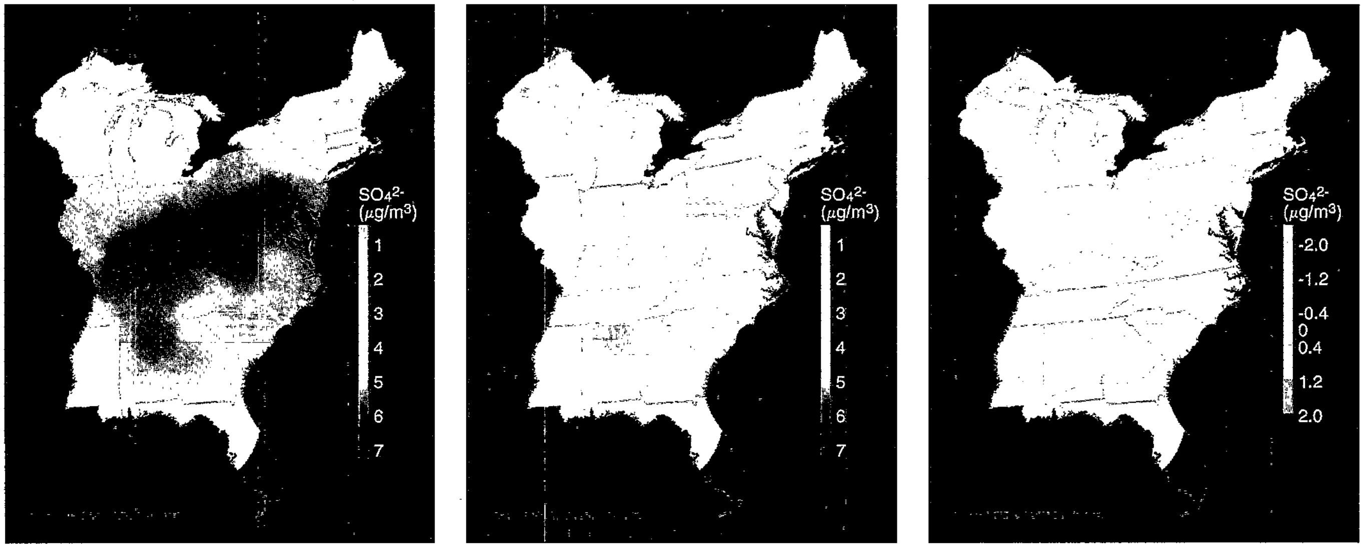
Ammonium concentrations in the ambient air are typically associated with sulfate and nitrate compounds. The ammonium maps presented in Figure 7-5d show that the highest ammonium concentrations are also highest in the midwest. However, the decrease in ambient ammonium over the 10-year period primarily occurred in the Ohio Valley and appears to be associated with the reduction in sulfate concentrations.

Electric utilities account for 71 percent of the SO_2 emissions in the eastern United States. However, they accounted for most of the nationwide reduction in SO_2 emissions.[7] The trend in ambient sulfates and sulfur

*Sulfate concentrations represent the sulfate ion, SO_4^{-2}, and do not represent the compounds (i.e., ammonium sulfate or ammonium bisulfate) typically associated with this analyte.

**The overall 38-percent decline in ambient SO_2 concentrations in rural areas matches the national air quality improvement in urban areas as measured by the state and local air monitoring stations.

Figure 7-5b. Comparison of ambient sulfate concentrations in the rural eastern United States from CASTNet monitoring data, 1990–1991 vs. 1997–1998.

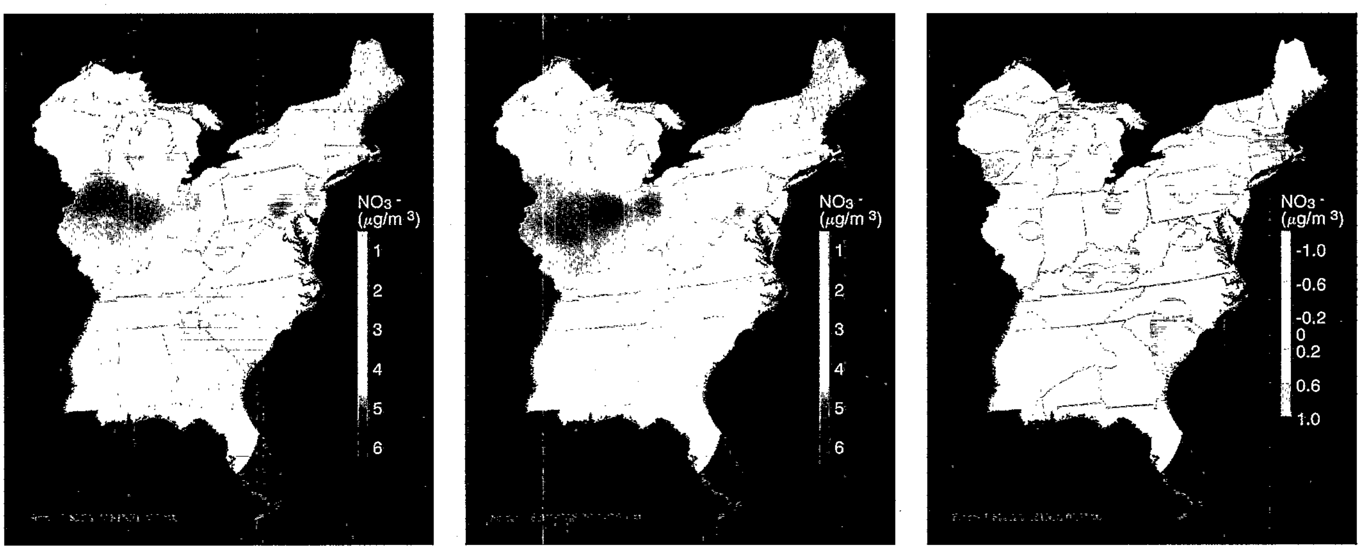


1990–1991

1997–1998

Decrease in ambient sulfate concentrations in the rural eastern United States, 1990–1991 vs. 1997–1998.

Figure 7-5c. Comparison of ambient total nitrate concentrations in the rural eastern United States from CASTNet data, 1990–1991 vs. 1997–1998.

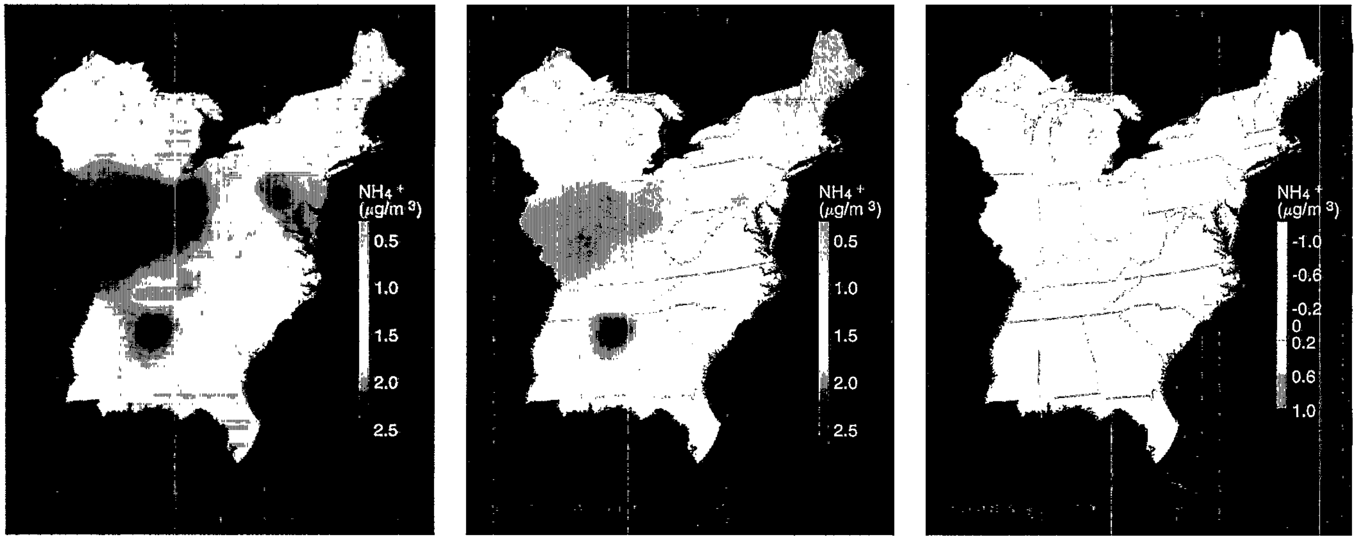


1990–1991

1997–1998

Decrease in ambient total nitrate concentrations in the rural eastern United States, 1990–1991 vs. 1997–1998.

Figure 7-5d. Comparison of ambient ammonium concentrations in the rural eastern United States from CASTNet data, 1990–1991 vs. 1997–1998.



1990–1991

1997–1998

Decrease in ambient ammonium concentrations in the rural eastern United States, 1990–1991 vs. 1997–1998.

dioxide are generally consistent with the change in annual sulfur dioxide emissions from electric utilities in the eastern United States. Figure 7-8 shows that the 22 percent 10-year decline in sulfates matches the overall 21-percent decline in SO_2 emissions. In addition, the 1997–1998 increase in ambient sulfates (10 percent) appears to follow the 5-percent increase in annual emissions.

Figure 7-9 presents the trends in ambient sulfates, ambient sulfur dioxide, and SO_2 emissions by calendar quarter. Most of the increase in emissions and ambient sulfates occurred during the high sulfate "season" (i.e., the 2nd and 3rd calendar quarters). This season with its slow moving air masses and high photochemical activity contributes 65–70 percent to the typical annual average

Figure 7-6. Trend in ambient sulfates in the rural eastern United States, based on CASTNet monitoring data, 1989–1998.

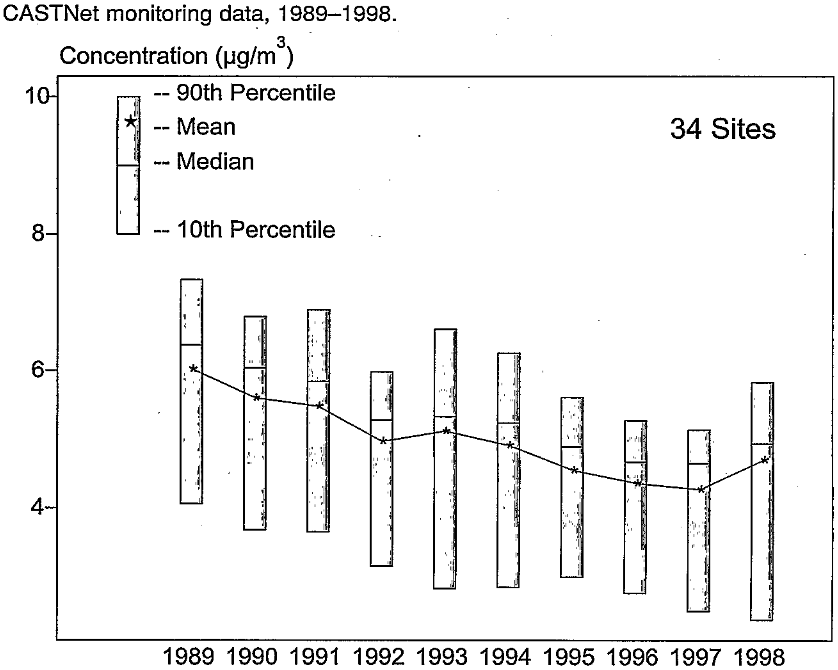


Figure 7-7. Trend in ambient sulfur dioxide in the rural United States, based on CASTNet monitoring data, 1989–1998.

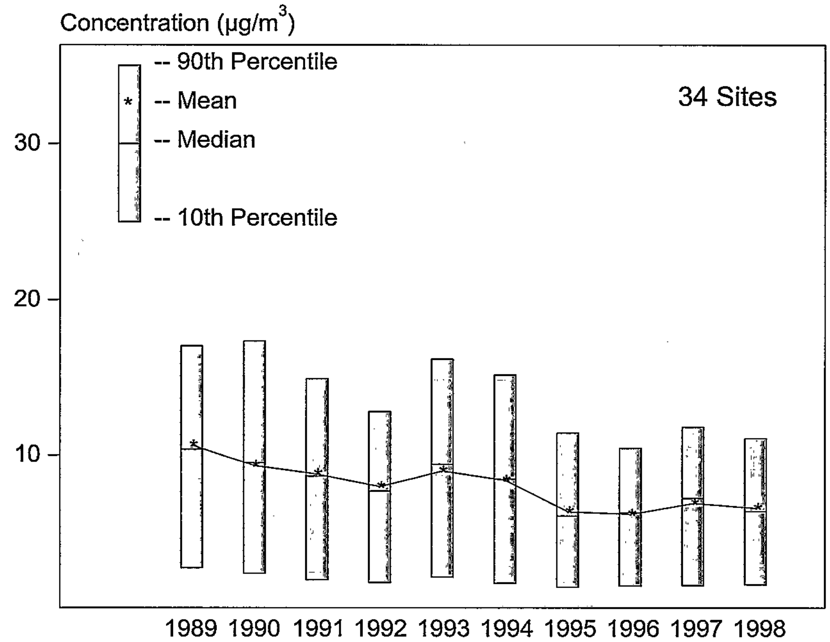
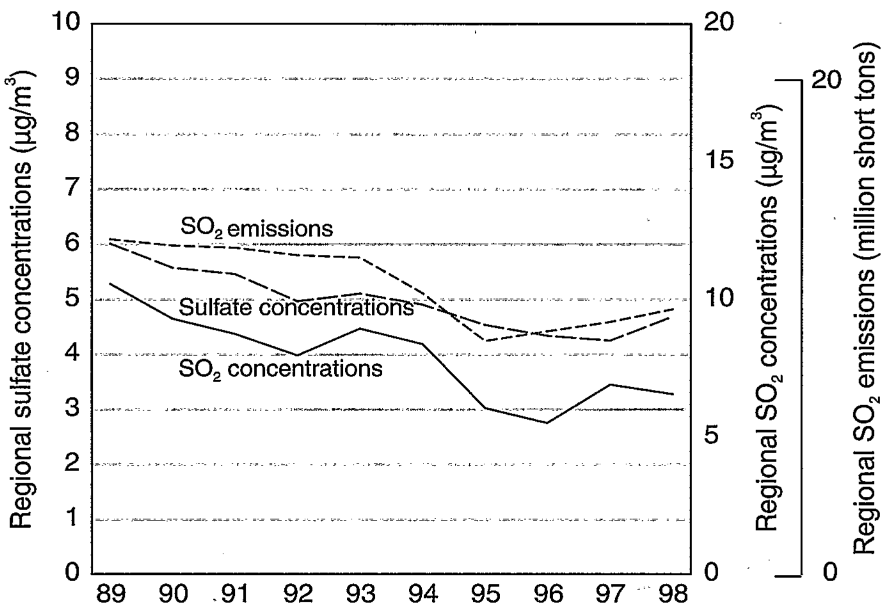


Figure 7-8. Trend in annual average ambient sulfur dioxide and sulfate concentrations, based on CASTNet monitoring data, and regional SO_2 emissions from electric utilities in rural eastern United States, 1989–1998.



concentrations of sulfates. It also has slightly more than half of the annual SO_2 emissions. Between these warmer months of 1997 and 1998, regional sulfur dioxide emissions increased 12 percent between 1997 and 1998 and average sulfates increased 21 percent. The higher summertime emissions in 1998 are attributed in part to the extra demands on electric utilities due to extremely warm temperatures throughout the Southeast (see Figure 2-27 in the ozone section of Chapter 2.)

For annual average ambient sulfur dioxide, the trend appears to better mimic the large drop in regional emissions which occurred between 1993 and 1995. The 10-year improvement in rural ambient SO_2 levels in eastern United States was also more substantial than the 10-year decrease in regional emissions. Unlike sulfates, however, ambient SO_2 is highest during the colder months (i.e., 1st and 4th calendar quarters) and most of the 10-year decrease in ambient SO_2 occurred during these quarters. From 1989–1998, the 6-cold-month average SO_2 concentrations (now accounting for 60–65 percent of the annual average) decreased 44 percent. The 10-year decline in emissions, -29 percent, was also greater during the colder months. During the last two years, annual average SO_2 decreased while annual emissions increased. However, air quality and emissions match more closely on a seasonal basis. During the cold months, average SO_2 concentrations and total emissions increased slightly in the 1st quarter but decreased during the latter part of the year. For the warmer months (the 2nd and 3rd calendar quarters), the figure reveals a large increase in SO_2 emissions, ambient sulfates and ambient sulfur dioxide between 1997 and 1998 during. (See the criteria pollutants section in Chapter 2 for more information about SO_2 emission trends and the acid rain program. Also see www.epa.gov/acidrain/).

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2. Lynch, J.A., V.C Bowersox and J.W. Grim. 1996. *Trends in Precipitation Chemistry in the United States: An Analysis of the Effects in 1995 of Phase I of the Clean Air Act Amendments of 1990, Title IV.* U.S. Geological Survey. Open-file Report 96-0346.

3. "Changes in Sulfate Deposition in the Eastern USA Following Enactment of Title IV of the Clean Air Act Amendments of 1990." Lynch, J.A., Bowersox, V.C. and Grimm, J.W., 1999. *Atmospheric Environment*. In Press.

4. Holland, D. P. Principe and J. Sickles, II. 1998. In press, *Atmospheric Environment*.

5. Clean Air Status and Trends Network (CASTNet), *1998 Annual Report*. <http://www.epa.gov/acidrain/castnet/annual98/annual98.html>

6. The overall 38-percent decline in ambient SO_2 concentrations in rural areas matches the national air quality improvement in urban areas as measured by the State and local air monitoring stations.

7. Eighty-four percent of the 10-year nationwide reduction in SO_2 emissions is attributed to fuel combustion from electric utilities.

Figure 7-9a. Trend in annual average ambient sulfur dioxide and sulfate concentrations, based on CASTNet monitoring data, and regional SO_2 emissions from electric utilities in rural eastern United States by calendar quarter, 1989–1998; quarter 1.

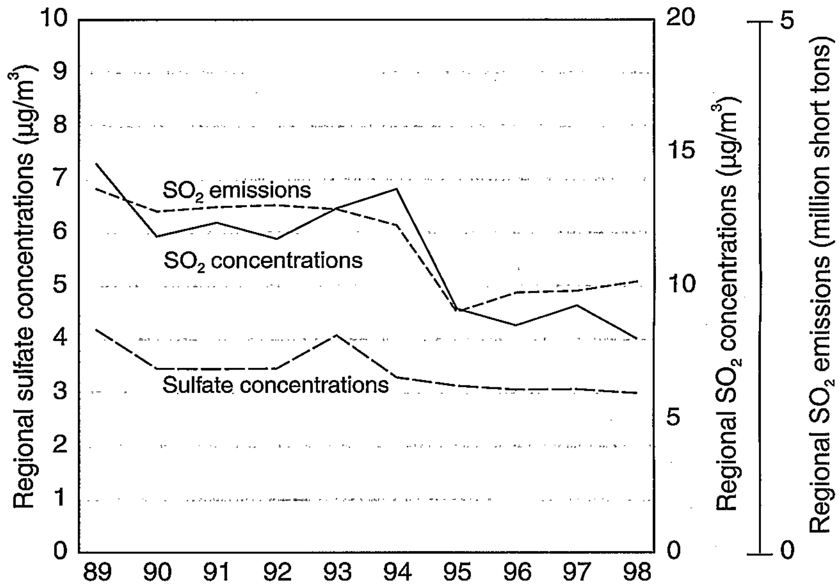


Figure 7-9b. Trend in annual average ambient sulfur dioxide and sulfate concentrations, based on CASTNet monitoring data, and regional SO_2 emissions from electric utilities in rural eastern United States by calendar quarter, 1989–1998; quarter 2.

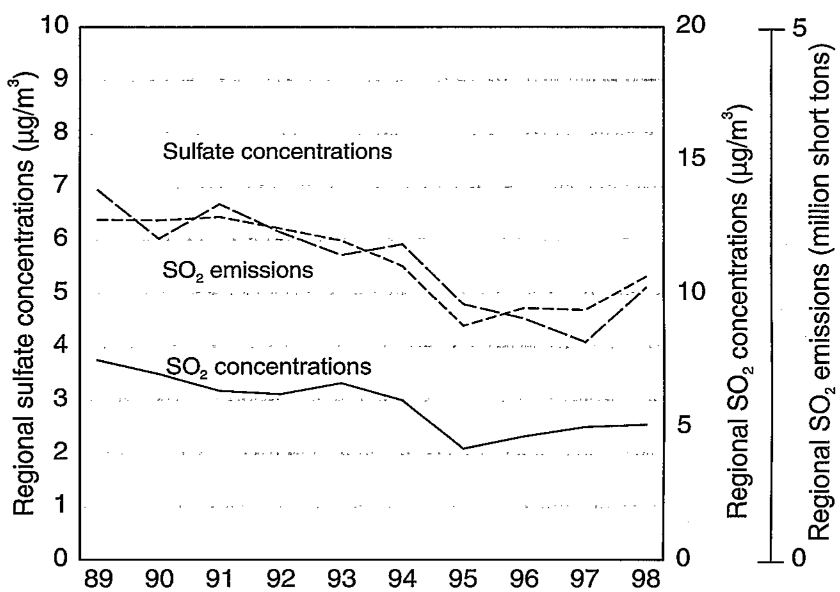


Figure 7-9c. Trend in annual average ambient sulfur dioxide and sulfate concentrations, based on CASTNet monitoring data, and regional SO_2 emissions from electric utilities in rural eastern United States by calendar quarter, 1989–1998; quarter 3.

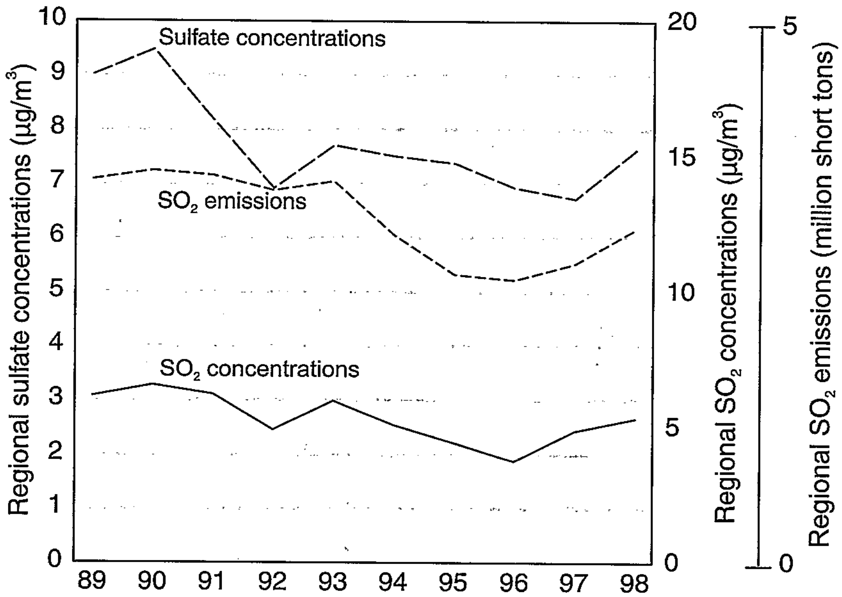
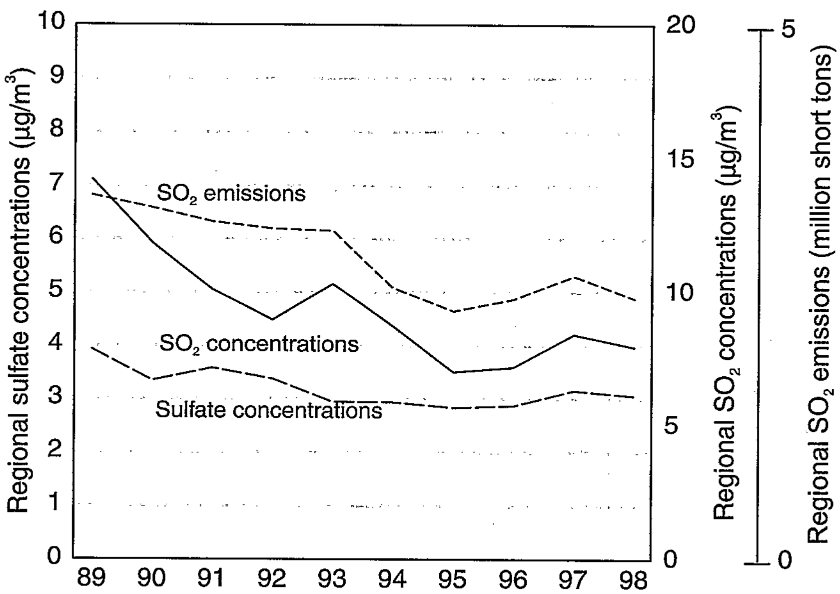


Figure 7-9d. Trend in annual average ambient sulfur dioxide and sulfate concentrations, based on CASTNet monitoring data, and regional SO_2 emissions from electric utilities in rural eastern United States by calendar quarter, 1989–1998; quarter 4.



APPENDIX A

Data Tables

http://www.epa.gov/oar/aqtrnd98/appenda.pdf

Table A-1. National Air Quality Trends Statistics for Criteria Pollutants, 1989–1998

Statistic	# of Sites	Units	Percentile	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Carbon Monoxide													
2nd Max. 8-hr.	363	ppm	95th	10.9	10.5	9.8	8.5	8.0	8.1	7.6	7.4	6.7	6.3
2nd Max. 8-hr.	363	ppm	90th	9.7	8.8	8.7	7.8	7.2	7.6	6.6	6.5	5.9	5.7
2nd Max. 8-hr.	363	ppm	75th	7.7	7.0	7.0	6.4	5.9	6.2	5.5	5.1	4.9	4.6
2nd Max. 8-hr.	363	ppm	50th	5.9	5.4	5.2	4.8	4.7	4.9	4.3	3.9	3.8	3.5
2nd Max. 8-hr.	363	ppm	25th	4.4	4.2	3.9	3.7	3.6	3.8	3.3	3.0	2.9	2.7
2nd Max. 8-hr.	363	ppm	10th	3.4	3.1	3.0	2.8	2.9	2.8	2.5	2.3	2.1	2.1
2nd Max. 8-hr.	363	ppm	5th	2.6	2.5	2.3	2.4	2.2	2.2	2.3	2.0	1.7	1.9
2nd Max. 8-hr.	363	ppm	Arith. Mean	6.2	5.8	5.6	5.2	4.9	5.1	4.5	4.2	3.9	3.8
Lead													
Max. Qtr. AM	189	ppm	95th	0.27	0.35	0.21	0.18	0.18	0.14	0.14	0.13	0.12	0.13
Max. Qtr. AM	189	ppm	90th	0.17	0.16	0.15	0.13	0.11	0.10	0.09	0.09	0.09	0.08
Max. Qtr. AM	189	ppm	75th	0.11	0.09	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.04
Max. Qtr. AM	189	ppm	50th	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02
Max. Qtr. AM	189	ppm	25th	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01
Max. Qtr. AM	189	ppm	10th	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Max. Qtr. AM	189	ppm	5th	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Max. Qtr. AM	189	ppm	Arith. Mean	0.09	0.09	0.07	0.06	0.05	0.05	0.04	0.04	0.04	0.04
Nitrogen Dioxide													
Arith. Mean	225	ppm	95th	0.043	0.040	0.043	0.038	0.037	0.040	0.039	0.037	0.034	0.035
Arith. Mean	225	ppm	90th	0.035	0.034	0.033	0.033	0.033	0.034	0.032	0.032	0.031	0.031
Arith. Mean	225	ppm	75th	0.027	0.025	0.025	0.024	0.024	0.024	0.023	0.024	0.022	0.023
Arith. Mean	225	ppm	50th	0.020	0.019	0.019	0.018	0.018	0.019	0.019	0.018	0.018	0.018
Arith. Mean	225	ppm	25th	0.013	0.013	0.012	0.013	0.013	0.013	0.012	0.012	0.012	0.012
Arith. Mean	225	ppm	10th	0.007	0.007	0.007	0.007	0.007	0.008	0.007	0.007	0.007	0.006
Arith. Mean	225	ppm	5th	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.004	0.004	0.004
Arith. Mean	225	ppm	Arith. Mean	0.021	0.020	0.020	0.019	0.019	0.020	0.019	0.019	0.018	0.018
Ozone													
2nd Max. 1-hr.	661	ppm	95th	0.171	0.170	0.170	0.160	0.150	0.150	0.150	0.144	0.142	0.154
2nd Max. 1-hr.	661	ppm	90th	0.150	0.146	0.149	0.131	0.138	0.130	0.139	0.127	0.130	0.134
2nd Max. 1-hr.	661	ppm	75th	0.124	0.120	0.124	0.111	0.120	0.117	0.123	0.114	0.116	0.119
2nd Max. 1-hr.	661	ppm	50th	0.107	0.107	0.108	0.100	0.104	0.104	0.110	0.103	0.103	0.109
2nd Max. 1-hr.	661	ppm	25th	0.095	0.095	0.095	0.090	0.091	0.092	0.098	0.093	0.091	0.096
2nd Max. 1-hr.	661	ppm	10th	0.085	0.083	0.081	0.081	0.080	0.083	0.085	0.085	0.081	0.086
2nd Max. 1-hr.	661	ppm	5th	0.080	0.075	0.075	0.074	0.075	0.077	0.078	0.079	0.075	0.076
2nd Max. 1-hr.	661	ppm	Arith. Mean	0.114	0.112	0.113	0.105	0.108	0.107	0.112	0.106	0.105	0.110
4th Max. 8-hr.	661	ppm	95th	0.117	0.116	0.116	0.107	0.110	0.106	0.112	0.103	0.105	0.110
4th Max. 8-hr.	661	ppm	90th	0.105	0.106	0.109	0.097	0.100	0.098	0.106	0.097	0.101	0.102
4th Max. 8-hr.	661	ppm	75th	0.093	0.094	0.097	0.087	0.090	0.090	0.096	0.090	0.091	0.095
4th Max. 8-hr.	661	ppm	50th	0.083	0.083	0.085	0.079	0.081	0.082	0.088	0.083	0.082	0.087
4th Max. 8-hr.	661	ppm	25th	0.075	0.075	0.073	0.073	0.073	0.074	0.077	0.075	0.074	0.077
4th Max. 8-hr.	661	ppm	10th	0.067	0.066	0.065	0.066	0.063	0.067	0.067	0.068	0.065	0.069
4th Max. 8-hr.	661	ppm	5th	0.060	0.059	0.059	0.061	0.058	0.060	0.061	0.063	0.059	0.060
4th Max. 8-hr.	661	ppm	Arith. Mean	0.086	0.085	0.086	0.081	0.082	0.083	0.087	0.083	0.083	0.086

Table A-1. National Air Quality Trends Statistics for Criteria Pollutants, 1989–1998 (continued)

Statistic	# of Sites	Units	Percentile	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
PM_{10}													
Annual Avg.	934	µg/m3	95th	51.5	46.4	46.4	42.0	41.5	39.4	38.8	37.6	37.5	35.8
Annual Avg.	934	µg/m3	90th	43.3	39.8	39.9	36.4	35.9	36.4	34.8	33.0	32.4	31.8
Annual Avg.	934	µg/m3	75th	36.3	34.5	33.7	31.0	30.2	30.4	29.1	27.7	27.3	27.7
Annual Avg.	934	µg/m3	50th	30.1	28.2	28.2	25.8	25.4	25.6	24.3	23.2	23.2	23.6
Annual Avg.	934	µg/m3	25th	25.3	23.4	23.6	22.0	21.0	21.1	19.8	19.3	19.4	19.3
Annual Avg.	934	µg/m3	10th	20.1	18.9	18.4	17.6	16.7	16.7	15.5	16.0	15.3	15.2
Annual Avg.	934	µg/m3	5th	17.1	15.7	14.5	13.6	12.7	13.1	12.2	12.2	12.1	12.3
Annual Avg.	934	µg/m3	Arith. Mean	31.7	29.4	29.1	26.8	26.0	26.0	24.9	23.9	23.8	23.7
Sulfur Dioxide													
Annual Mean	482	ppm	95th	0.0183	0.0175	0.0162	0.0154	0.0153	0.0143	0.0115	0.0113	0.0107	0.0106
Annual Mean	482	ppm	90th	0.0153	0.0146	0.0138	0.0128	0.0126	0.0122	0.0101	0.0097	0.0090	0.0095
Annual Mean	482	ppm	75th	0.0115	0.0107	0.0099	0.0095	0.0092	0.0090	0.0074	0.0074	0.0071	0.0069
Annual Mean	482	ppm	50th	0.0080	0.0077	0.0076	0.0069	0.0067	0.0065	0.0051	0.0053	0.0051	0.0049
Annual Mean	482	ppm	25th	0.0048	0.0044	0.0046	0.0043	0.0040	0.0037	0.0033	0.0032	0.0031	0.0032
Annual Mean	482	ppm	10th	0.0024	0.0022	0.0022	0.0020	0.0022	0.0021	0.0018	0.0018	0.0018	0.0019
Annual Mean	482	ppm	5th	0.0016	0.0015	0.0016	0.0014	0.0015	0.0015	0.0014	0.0014	0.0014	0.0014
Annual Mean	482	ppm	Arith. Mean	0.0087	0.0082	0.0079	0.0074	0.0072	0.0069	0.0056	0.0056	0.0054	0.0053
2nd Max. 24-hr.	486	ppm	95th	0.0960	0.0870	0.0750	0.0750	0.0720	0.0720	0.0555	0.0600	0.0520	0.0520
2nd Max. 24-hr.	486	ppm	90th	0.0740	0.0660	0.0610	0.0610	0.0580	0.0620	0.0470	0.0470	0.0450	0.0430
2nd Max. 24-hr.	486	ppm	75th	0.0520	0.0480	0.0440	0.0440	0.0420	0.0440	0.0330	0.0330	0.0330	0.0310
2nd Max. 24-hr.	486	ppm	50th	0.0380	0.0330	0.0320	0.0300	0.0280	0.0320	0.0220	0.0230	0.0230	0.0220
2nd Max. 24-hr.	486	ppm	25th	0.0230	0.0210	0.0200	0.0190	0.0180	0.0190	0.0150	0.0150	0.0140	0.0140
2nd Max. 24-hr.	486	ppm	10th	0.0110	0.0100	0.0100	0.0100	0.0100	0.0090	0.0080	0.0090	0.0070	0.0080
2nd Max. 24-hr.	486	ppm	5th	0.0070	0.0060	0.0070	0.0060	0.0055	0.0050	0.0050	0.0050	0.0050	0.0050
2nd Max. 24-hr.	486	ppm	Arith. Mean	0.0414	0.0375	0.0348	0.0339	0.0324	0.0340	0.0257	0.0262	0.0250	0.0240

Table A-2. National Carbon Monoxide Emissions Estimates, 1989–1998 (thousand short tons)

Source Category	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMBUSTION	**7,443**	**5,510**	**5,856**	**6,155**	**5,587**	**5,519**	**5,934**	**6,148**	**5,423**	**5,374**
Electric Utilities	321	363	349	350	363	370	372	391	405	417
Coal	*233*	*234*	*234*	*236*	*246*	*247*	*250*	*248*	*254*	*254*
Oil	*26*	*20*	*19*	*15*	*16*	*15*	*10*	*11*	*12*	*17*
Gas	*51*	*51*	*51*	*51*	*49*	*53*	*55*	*79*	*83*	*89*
Internal Combustion	*11*	*57*	*45*	*47*	*51*	*55*	*58*	*54*	*56*	*57*
Industrial	672	879	920	955	1,043	1,041	1,056	1,154	1,126	1,114
Coal	*87*	*105*	*101*	*102*	*101*	*100*	*98*	*109*	*108*	*105*
Oil	*46*	*74*	*60*	*64*	*66*	*66*	*71*	*60*	*58*	*56*
Gas	*271*	*226*	*284*	*300*	*322*	*337*	*345*	*335*	*334*	*330*
Other	*173*	*279*	*267*	*264*	*286*	*287*	*297*	*349*	*333*	*335*
Internal Combustion	*96*	*195*	*208*	*227*	*268*	*251*	*245*	*301*	*295*	*289*
Other	6,450	4,269	4,587	4,849	4,181	4,108	4,506	4,603	3,892	3,843
Residential Wood	*6,161*	*3,781*	*4,090*	*4,332*	*3,679*	*3,607*	*3,999*	*4,200*	*3,487*	*3,452*
Other	*153*	*262*	*281*	*292*	*274*	*268*	*273*	*260*	*257*	*247*
INDUSTRIAL PROCESSES	**7,013**	**5,852**	**5,740**	**5,683**	**5,898**	**5,838**	**5,790**	**4,692**	**4,844**	**4,860**
Chemical & Allied Processing	1,925	1,183	1,127	1,112	1,093	1,171	1,223	1,100	1,119	1,129
Metals Processing	2,132	2,640	2,571	2,496	2,536	2,475	2,380	1,429	1,510	1,495
Petroleum & Related Industries	436	333	345	371	371	338	348	356	369	368
Other Industrial Processes	716	537	548	544	594	600	624	600	623	632
Solvent Utilization	2	5	5	5	5	5	6	2	2	2
Storage & Transport	55	76	28	17	51	24	25	78	80	80
Waste Disposal & Recycling	1,747	1,079	1,116	1,138	1,248	1,225	1,185	1,127	1,141	1,154
TRANSPORTATION	**83,829**	**76,039**	**80,659**	**78,858**	**79,593**	**81,629**	**74,331**	**73,494**	**71,980**	**70,300**
On-Road Vehicles	66,050	57,848	62,074	59,859	60,202	61,833	54,106	53,262	51,666	50,386
Non-Road Sources	17,779	18,191	18,585	18,999	19,391	19,796	20,224	20,232	20,314	19,914
MISCELLANEOUS	**8,153**	**11,122**	**8,618**	**6,934**	**7,082**	**9,657**	**7,298**	**11,144**	**12,164**	**8,920**
Fires	8,153	11,090	8,589	6,904	7,048	9,628	7,270	11,121	12,141	8,896
Other	0	32	28	30	34	29	29	23	24	24
TOTAL ALL SOURCES	**106,439**	**98,523**	**100,872**	**97,630**	**98,160**	**102,643**	**93,353**	**95,479**	**94,410**	**89,454**

Note: Some columns may not sum to totals due to rounding.

Table A-3. National Lead Emissions Estimates, 1989–1998 (short tons)

Source Category	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMBUSTION	**505**	**500**	**495**	**491**	**497**	**496**	**490**	**492**	**493**	**503**
Electric Utilities	67	64	61	59	62	62	57	61	64	68
Coal	*46*	*46*	*46*	*47*	*50*	*50*	*50*	*53*	*54*	*54*
Oil	*21*	*18*	*15*	*12*	*12*	*12*	*7*	*8*	*10*	*14*
Industrial	18	18	18	18	19	19	18	16	16	19
Coal	*14*	*14*	*15*	*14*	*14*	*14*	*14*	*13*	*14*	*13*
Oil	*4*	*3*	*3*	*4*	*5*	*5*	*4*	*3*	*2*	*5*
Other	420	418	416	414	416	415	415	415	413	416
Commercial/Institutional Coal	*4*	*4*	*3*	*4*	*4*	*3*	*4*	*5*	*5*	*5*
Commercial/Institutional Oil	*4*	*4*	*4*	*4*	*4*	*4*	*3*	*3*	*2*	*4*
Misc. Fuel Comb. (Except Residential)	*400*	*400*	*400*	*400*	*400*	*400*	*400*	*400*	*400*	*400*
Residential Other	*12*	*10*	*9*	*7*	*8*	*8*	*8*	*7*	*6*	*6*
INDUSTRIAL PROCESSES	**3,161**	**3,278**	**3,081**	**2,736**	**2,872**	**3,007**	**2,875**	**2,882**	**2,937**	**2,948**
Chemical & Allied Processing	136	136	132	93	92	96	163	167	188	175
Metals Processing	2,088	2,170	1,974	1,774	1,900	2,027	2,049	2,055	2,080	2,098
Other Industrial Processes	173	169	167	56	55	54	59	51	54	54
Waste Disposal & Recycling	765	804	808	812	825	830	604	609	615	620
TRANSPORTATION	**1,802**	**1,197**	**592**	**584**	**547**	**544**	**564**	**525**	**523**	**522**
On-Road Vehicles	982	421	18	18	19	19	19	19	20	19
Non-Road Sources	820	776	574	565	529	525	544	505	503	503
TOTAL ALL SOURCES	**5,468**	**4,975**	**4,169**	**3,810**	**3,916**	**4,047**	**3,929**	**3,899**	**3,952**	**3,973**

Note: Some columns may not sum to totals due to rounding.

Table A-4. National Nitrogen Oxides Emissions Estimates, 1989–1998 (thousand short tons)

Source Category	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMBUSTION	**10,537**	**10,895**	**10,779**	**10,928**	**11,111**	**11,015**	**10,827**	**10,354**	**10,403**	**10,189**
Electric Utilities	6,593	6,663	6,519	6,504	6,651	6,565	6,384	6,057	6,191	6,103
Coal	*5,676*	*5,642*	*5,559*	*5,579*	*5,744*	*5,636*	*5,579*	*5,542*	*5,609*	*5,395*
Oil	*285*	*221*	*212*	*170*	*180*	*163*	*96*	*103*	*129*	*208*
Gas	*582*	*565*	*580*	*579*	*551*	*591*	*562*	*265*	*299*	*344*
Internal Combustion	*49*	*235*	*168*	*175*	*176*	*175*	*148*	*147*	*154*	*156*
Industrial	3,209	3,035	2,979	3,071	3,151	3,147	3,144	3,072	3,019	2,969
Coal	*615*	*585*	*570*	*574*	*589*	*602*	*597*	*642*	*636*	*622*
Oil	*294*	*265*	*237*	*244*	*245*	*241*	*247*	*231*	*223*	*216*
Gas	*1,625*	*1,182*	*1,250*	*1,301*	*1,330*	*1,333*	*1,324*	*1,184*	*1,168*	*1,154*
Other	*120*	*131*	*129*	*126*	*124*	*124*	*123*	*124*	*119*	*119*
Internal Combustion	*556*	*874*	*793*	*825*	*863*	*846*	*854*	*967*	*948*	*932*
Other	736	1,196	1,281	1,353	1,308	1,303	1,298	1,224	1,193	1,117
Commercial/Institutional Coal	*38*	*40*	*36*	*38*	*40*	*40*	*38*	*33*	*34*	*36*
Commercial/Institutional Oil	*106*	*97*	*88*	*93*	*93*	*95*	*103*	*92*	*94*	*77*
Commercial/Institutional Gas	*159*	*200*	*210*	*225*	*232*	*237*	*231*	*238*	*243*	*234*
Misc. Fuel Comb. (Except Residential)	*11*	*34*	*32*	*28*	*31*	*31*	*30*	*26*	*27*	*28*
Residential Wood	*75*	*46*	*50*	*53*	*45*	*44*	*49*	*51*	*43*	*42*
Residential Other	*347*	*780*	*865*	*916*	*867*	*857*	*847*	*783*	*752*	*700*
INDUSTRIAL PROCESSES	**852**	**892**	**816**	**857**	**861**	**878**	**873**	**854**	**884**	**893**
Chemical & Allied Processing	273	168	165	163	155	160	158	146	149	152
Metals Processing	83	97	76	81	83	91	98	83	88	88
Petroleum & Related Industries	97	153	121	148	123	117	110	134	138	138
Other Industrial Processes	311	378	352	361	370	389	399	386	404	408
Solvent Utilization	3	1	2	3	3	3	3	2	2	2
Storage & Transport	2	3	6	5	5	5	6	7	7	7
Waste Disposal & Recycling	84	91	95	96	123	114	99	95	96	97
TRANSPORTATION	**12,210**	**11,893**	**12,368**	**12,556**	**12,748**	**13,090**	**12,954**	**13,016**	**13,126**	**13,044**
On-Road Vehicles	7,682	7,089	7,469	7,622	7,806	8,075	7,826	7,848	7,875	7,765
Non-Road Sources	4,528	4,804	4,900	4,934	4,942	5,015	5,128	5,167	5,251	5,280
MISCELLANEOUS	**293**	**369**	**286**	**255**	**241**	**390**	**267**	**452**	**411**	**328**
TOTAL ALL SOURCES	**23,893**	**24,049**	**24,249**	**24,596**	**24,961**	**25,372**	**24,921**	**24,676**	**24,824**	**24,454**

Note: Some columns may not sum to totals due to rounding.

Table A-5. National Volatile Organic Compounds Emissions Estimates, 1989–1998 (thousand short tons)

Source Category	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMBUSTION	**1,372**	**1,005**	**1,075**	**1,114**	**993**	**989**	**1,073**	**1,036**	**900**	**893**
Electric Utilities	37	47	44	44	45	45	44	49	51	54
Coal	*27*	*27*	*27*	*27*	*29*	*29*	*29*	*28*	*29*	*29*
Oil	*7*	*6*	*5*	*4*	*4*	*4*	*3*	*3*	*3*	*5*
Gas	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*8*	*8*	*9*
Internal Combustion	*1*	*12*	*10*	*10*	*10*	*10*	*10*	*10*	*11*	*11*
Industrial	134	182	196	187	186	196	206	166	162	161
Coal	*7*	*7*	*6*	*7*	*6*	*8*	*6*	*7*	*6*	*6*
Oil	*16*	*12*	*11*	*12*	*12*	*12*	*12*	*8*	*8*	*8*
Gas	*61*	*58*	*60*	*52*	*51*	*63*	*73*	*49*	*49*	*49*
Other	*36*	*51*	*51*	*49*	*51*	*50*	*50*	*40*	*38*	*38*
Internal Combustion	*15*	*54*	*68*	*66*	*66*	*64*	*65*	*62*	*61*	*60*
Other	1,200	776	835	884	762	748	823	821	686	678
Residential Wood	*1,169*	*718*	*776*	*822*	*698*	*684*	*759*	*759*	*624*	*620*
Other	*31*	*58*	*59*	*62*	*64*	*63*	*64*	*62*	*61*	*58*
INDUSTRIAL PROCESSES	**10,755**	**10,000**	**10,178**	**10,380**	**10,578**	**10,738**	**10,780**	**8,591**	**8,812**	**8,452**
Chemical & Allied Processing	980	634	710	715	701	691	660	388	390	396
Metals Processing	74	122	123	124	124	126	125	72	76	75
Petroleum & Related Industries	639	612	640	632	649	647	642	488	499	496
Other Industrial Processes	403	401	391	414	442	438	450	428	444	450
Solvent Utilization	5,964	5,750	5,782	5,901	6,016	6,162	6,183	5,506	5,654	5,278
Storage & Transport	1,753	1,495	1,532	1,583	1,600	1,629	1,652	1,286	1,324	1,324
Waste Disposal & Recycling	941	986	999	1,010	1,046	1,046	1,067	423	427	433
TRANSPORTATION	**9,744**	**8,858**	**9,080**	**8,665**	**8,727**	**9,074**	**8,401**	**8,155**	**7,902**	**7,786**
On-Road Vehicles	7,192	6,313	6,499	6,072	6,103	6,401	5,701	5,490	5,330	5,325
Non-Road Sources	2,552	2,545	2,581	2,594	2,624	2,672	2,699	2,664	2,572	2,461
MISCELLANEOUS	**642**	**1,073**	**769**	**500**	**569**	**734**	**564**	**954**	**1,263**	**785**
Other Combustion	641	1,049	743	474	544	707	537	891	1,199	721
Fires	*641*	*1,046*	*740*	*471*	*541*	*704*	*533*	*887*	*1,196*	*717*
Other	*NA*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
Other	1	24	26	26	25	27	28	63	64	65
TOTAL ALL SOURCES	**22,513**	**20,936**	**21,102**	**20,659**	**20,868**	**21,535**	**20,817**	**18,736**	**18,876**	**17,917**

Note: Some columns may not sum to totals due to rounding.

Table A-6. National PM_{10} Emissions Estimates, 1989–1998 (thousand short tons)

Source Category	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMBUSTION	**1,382**	**1,196**	**1,147**	**1,183**	**1,124**	**1,113**	**1,179**	**1,174**	**1,089**	**1,091**
Electric Utilities	271	295	257	257	279	273	268	287	293	302
Coal	*255*	*265*	*232*	*234*	*253*	*246*	*244*	*264*	*268*	*273*
Oil	*12*	*9*	*10*	*7*	*9*	*8*	*5*	*5*	*6*	*9*
Gas	*1*	*1*	*1*	*0*	*1*	*1*	*1*	*1*	*1*	*1*
Internal Combustion	*3*	*20*	*15*	*16*	*17*	*17*	*18*	*18*	*18*	*19*
Industrial	243	270	233	243	257	270	302	255	249	245
Coal	*70*	*84*	*72*	*74*	*71*	*70*	*70*	*77*	*76*	*74*
Oil	*48*	*52*	*44*	*45*	*45*	*44*	*49*	*46*	*43*	*42*
Gas	*44*	*41*	*34*	*40*	*43*	*43*	*45*	*43*	*42*	*42*
Other	*78*	*87*	*72*	*74*	*86*	*74*	*73*	*77*	*73*	*74*
Internal Combustion	*3*	*6*	*10*	*11*	*12*	*38*	*64*	*16*	*16*	*15*
Other	869	631	657	683	588	570	610	632	548	544
Residential Wood	*817*	*501*	*535*	*558*	*464*	*446*	*484*	*503*	*415*	*411*
Other	*52*	*130*	*122*	*124*	*124*	*125*	*126*	*129*	*133*	*133*
INDUSTRIAL PROCESSES	**1,276**	**1,306**	**1,264**	**1,269**	**1,240**	**1,219**	**1,231**	**985**	**1,010**	**1,016**
Chemical & Allied Processing	63	77	68	71	66	76	67	63	64	65
Metals Processing	211	214	251	250	181	184	212	164	171	171
Petroleum & Related Industries	58	55	43	43	38	38	40	32	32	32
Other Industrial Processes	591	583	520	506	501	495	511	327	337	339
Solvent Utilization	2	4	5	5	6	6	6	6	6	6
Storage & Transport	101	102	101	117	114	106	109	90	93	94
Waste Disposal & Recycling	251	271	276	278	334	313	287	304	307	310
TRANSPORTATION	**844**	**825**	**838**	**833**	**804**	**800**	**749**	**739**	**730**	**718**
On-Road Vehicles	367	336	349	343	321	320	293	282	272	257
Non-Road Sources	477	489	489	490	483	480	456	457	458	461
TOTAL ALL SOURCES	**3,502**	**3,327**	**3,249**	**3,286**	**3,168**	**3,133**	**3,159**	**2,898**	**2,830**	**2,825**

Table A-7. Miscellaneous and Natural Particulate Matter Emissions Estimates, 1989–1998 (thousand short tons)

Source Category	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
MISCELLANEOUS	**37,461**	**24,542**	**24,234**	**23,959**	**24,329**	**25,620**	**22,766**	**24,836**	**26,089**	**26,609**
Agriculture & Forestry	7,320	5,292	5,234	5,017	4,575	4,845	4,902	4,905	4,971	4,970
Other Combustion	912	1,181	924	770	801	1,053	850	1,254	1,313	1,018
Fires	*853*	*1,159*	*902*	*747*	*777*	*1,029*	*826*	*1,235*	*1,292*	*997*
Other	*59*	*22*	*23*	*23*	*23*	*24*	*24*	*19*	*21*	*21*
Cooling Towers	NA	0	0	0	0	0	1	2	2	2
Fugitive Dust	29,229	18,069	18,076	18,171	18,954	19,722	17,013	18,675	19,804	20,619
Wind Erosion	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Unpaved Roads	*11,798*	*11,234*	*11,206*	*10,918*	*11,430*	*11,370*	*10,362*	*12,059*	*12,530*	*12,668*
Paved Roads	*5,769*	*2,248*	*2,399*	*2,423*	*2,462*	*2,538*	*2,409*	*2,390*	*2,538*	*2,618*
Construction	*11,269*	*4,249*	*4,092*	*4,460*	*4,651*	*5,245*	*3,654*	*3,578*	*4,022*	*4,545*
Other	*392*	*336*	*377*	*369*	*409*	*569*	*586*	*646*	*713*	*788*
NAT. SOURCES (wind erosion)	**12,101**	**2,092**	**2,077**	**2,227**	**509**	**2,160**	**1,146**	**5,307**	**5,307**	**5,307**
TOTAL ALL SOURCES	**49,562**	**26,635**	**26,311**	**26,186**	**24,838**	**27,780**	**23,912**	**30,143**	**31,396**	**31,916**

Note: Some columns may not sum to totals due to rounding.

Table A-8. National Sulfur Dioxide Emissions Estimates, 1989–1998 (thousand short tons)

Source Category	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FUEL COMBUSTION	**19,924**	**20,290**	**19,796**	**19,493**	**19,245**	**18,887**	**16,230**	**16,320**	**16,732**	**16,722**
Electric Utilities	16,215	15,909	15,784	15,416	15,189	14,889	12,080	12,631	13,090	13,217
Coal	*15,404*	*15,220*	*15,087*	*14,824*	*14,527*	*14,313*	*11,603*	*12,137*	*12,542*	*12,426*
Oil	*779*	*639*	*652*	*546*	*612*	*522*	*413*	*436*	*488*	*730*
Gas	*1*	*1*	*1*	*1*	*1*	*1*	*9*	*3*	*1*	*2*
Internal Combustion	*30*	*49*	*45*	*46*	*49*	*53*	*55*	*56*	*59*	*60*
Industrial	3,086	3,550	3,256	3,292	3,284	3,218	3,357	3,022	2,964	2,895
Coal	*1,840*	*1,914*	*1,805*	*1,783*	*1,763*	*1,740*	*1,728*	*1,536*	*1,521*	*1,485*
Oil	*812*	*927*	*779*	*801*	*809*	*777*	*912*	*844*	*801*	*773*
Gas	*346*	*543*	*516*	*552*	*555*	*542*	*548*	*556*	*563*	*558*
Other	*82*	*158*	*142*	*140*	*140*	*141*	*147*	*140*	*134*	*133*
Internal Combustion	*6*	*9*	*14*	*16*	*17*	*19*	*23*	*17*	*16*	*16*
Other	624	831	755	784	772	780	793	667	677	609
Commercial/Institutional Coal	*169*	*212*	*184*	*190*	*193*	*192*	*200*	*177*	*183*	*194*
Commercial/Institutional Oil	*274*	*425*	*376*	*396*	*381*	*391*	*397*	*338*	*345*	*275*
Commercial/Institutional Gas	*2*	*7*	*7*	*7*	*8*	*8*	*8*	*10*	*10*	*10*
Misc. Fuel Comb. (Except Residential)	*1*	*6*	*6*	*6*	*6*	*6*	*5*	*4*	*4*	*4*
Residential Wood	*11*	*7*	*7*	*8*	*6*	*6*	*7*	*7*	*6*	*6*
Residential Other	*167*	*175*	*176*	*177*	*178*	*177*	*176*	*131*	*130*	*121*
INDUSTRIAL PROCESSES	**2,010**	**1,900**	**1,721**	**1,758**	**1,723**	**1,676**	**1,637**	**1,452**	**1,503**	**1,503**
Chemical & Allied Processing	440	297	280	278	269	275	286	291	296	299
Metals Processing	695	726	612	615	603	562	530	429	450	444
Petroleum & Related Industries	429	430	378	416	383	379	369	337	346	345
Other Industrial Processes	405	399	396	396	392	398	403	350	365	370
Solvent Utilization	1	0	0	1	1	1	1	1	1	1
Storage & Transport	5	7	10	9	5	2	2	3	3	3
Waste Disposal & Recycling	36	42	44	44	71	60	47	41	42	42
TRANSPORTATION	**1,349**	**1,458**	**1,513**	**1,546**	**1,489**	**1,292**	**1,304**	**1,332**	**1,371**	**1,410**
On-Road Vehicles	570	542	570	578	517	301	304	316	322	326
Non-Road Sources	779	916	944	968	972	990	999	1,016	1,050	1,084
MISCELLANEOUS	**11**	**12**	**11**	**10**	**10**	**15**	**10**	**17**	**16**	**12**
TOTAL ALL SOURCES	**23,293**	**23,660**	**23,041**	**22,806**	**22,466**	**21,870**	**19,181**	**19,121**	**19,622**	**19,647**

Note: Some columns may not sum to totals due to rounding.

Table A-9. National Long-Term Air Quality Trends, 1979–1998

Year	CO 2nd Max. 8-hr ppm	Pb Max. Qtr. μg/m³	NO_2 Arith. Mean ppm	Ozone 2nd Max. 1-hr ppm	PM_{10} Wtd. Arith. Mean μg/m³	SO_2 Arith. Mean ppm
1979–88	*(251 sites)*	*(184 sites)*	*(127 sites)*	*(401 sites)*	—	*(389 sites)*
1979	9.1	0.97	0.024	0.133	—	0.0113
1980	8.5	0.77	0.024	0.135	—	0.0105
1981	8.2	0.61	0.023	0.125	—	0.0102
1982	7.8	0.55	0.022	0.123	—	0.0093
1983	7.7	0.41	0.022	0.136	—	0.0090
1984	7.7	0.37	0.023	0.123	—	0.0092
1985	7.0	0.24	0.022	0.122	—	0.0086
1986	7.0	0.15	0.022	0.118	—	0.0084
1987	6.6	0.12	0.022	0.124	—	0.0082
1988	6.5	0.11	0.022	0.135	—	0.0083
1989–98	*(363 sites)*	*(189 sites)*	*(225 sites)*	*(661 sites)*	*(934 sites)*	*(483 sites)*
1989	6.2	0.09	0.021	0.114	31.7	0.0087
1990	5.8	0.09	0.020	0.112	29.4	0.0082
1991	5.6	0.07	0.020	0.113	29.1	0.0079
1992	5.2	0.06	0.019	0.105	26.8	0.0074
1993	4.9	0.05	0.019	0.108	26.0	0.0072
1994	5.1	0.05	0.020	0.107	26.0	0.0070
1995	4.5	0.04	0.019	0.112	24.9	0.0057
1996	4.2	0.04	0.019	0.106	23.9	0.0056
1997	3.9	0.04	0.018	0.105	23.8	0.0054
1998	3.8	0.04	0.018	0.110	23.7	0.0053

Table A-10. National Air Quality Trends by Monitoring Location, 1989–1998

Statistic	# of Sites	Units	Location	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Carbon Monoxide													
2nd Max. 8-hr.	12	ppm	Rural	2.8	2.8	2.8	2.5	2.1	2.3	2.4	1.9	1.8	1.8
2nd Max. 8-hr.	148	ppm	Suburban	6.0	5.6	5.3	5.0	4.9	5.0	4.3	4.1	3.9	3.8
2nd Max. 8-hr.	200	ppm	Urban	6.6	6.1	6.0	5.5	5.0	5.3	4.8	4.5	4.1	3.9
Lead													
Max. Qtr.	5	μg/m³	Rural	0.06	0.06	0.07	0.07	0.06	0.04	0.04	0.03	0.03	0.03
Max. Qtr.	98	μg/m³	Suburban	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.03
Max. Qtr.	82	μg/m³	Urban	0.09	0.11	0.07	0.07	0.06	0.06	0.05	0.05	0.05	0.04
Nitrogen Dioxide													
Arith. Mean	39	ppm	Rural	0.009	0.009	0.009	0.008	0.008	0.008	0.008	0.008	0.007	0.007
Arith. Mean	104	ppm	Suburban	0.022	0.021	0.020	0.020	0.020	0.020	0.020	0.019	0.018	0.018
Arith. Mean	80	ppm	Urban	0.026	0.025	0.024	0.024	0.024	0.025	0.024	0.023	0.023	0.023
Ozone													
2nd Max. 1-hr.	222	ppm	Rural	0.108	0.108	0.106	0.101	0.103	0.102	0.107	0.103	0.101	0.107
2nd Max. 1-hr.	304	ppm	Suburban	0.118	0.116	0.118	0.109	0.111	0.111	0.116	0.108	0.109	0.114
2nd Max. 1-hr.	117	ppm	Urban	0.114	0.110	0.111	0.105	0.105	0.106	0.110	0.106	0.102	0.104
PM_{10}													
Wtd. Arith. Mean	138	μg/m³	Rural	25.6	24.3	23.6	21.8	20.6	20.6	19.3	19.3	18.9	18.9
Wtd. Arith. Mean	355	μg/m³	Suburban	32.9	30.6	30.2	27.8	27.1	27.0	26.2	24.9	24.8	24.6
Wtd. Arith. Mean	418	μg/m³	Urban	33.0	30.4	30.5	27.9	27.2	27.3	26.0	25.1	24.9	25.0
Sulfur Dioxide													
Arith. Mean	122	ppm	Rural	0.0071	0.0068	0.0066	0.0063	0.0064	0.0060	0.0053	0.0051	0.0048	0.0048
Arith. Mean	213	ppm	Suburban	0.0091	0.0086	0.0083	0.0077	0.0075	0.0072	0.0057	0.0058	0.0057	0.0056
Arith. Mean	137	ppm	Urban	0.0099	0.0091	0.0087	0.0080	0.0077	0.0076	0.0060	0.0059	0.0057	0.0055

Table A-11. National Air Quality Trends Statistics by EPA Region, 1989–1998

	Statistic	# of Sites	Units	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Region 1													
CO	2nd Max. 8-hr.	17	ppm	5.8	6.1	5.6	5.7	4.8	6.0	5.4	4.8	4.2	3.7
Pb	Max. Qtr.	—	µg/m³	—	—	—	—	—	—	—	—	—	—
NO_2	Arith. Mean	14	ppm	0.023	0.022	0.022	0.021	0.022	0.022	0.020	0.020	0.020	0.020
O_3	2nd Max. 1-hr.	38	ppm	0.122	0.119	0.130	0.110	0.119	0.115	0.118	0.103	0.117	0.107
O_3	4th Max. 8-hr.	38	ppm	0.092	0.091	0.099	0.086	0.089	0.087	0.091	0.081	0.090	0.084
PM_{10}	Wtd. Arith. Mean	72	µg/m³	24.4	22.8	23.5	20.7	20.2	20.7	18.7	19.3	19.7	19.8
SO_2	Arith. Mean	50	ppm	0.0088	0.0080	0.0077	0.0073	0.0069	0.0067	0.0053	0.0052	0.0050	0.0050
Region 2													
CO	2nd Max. 8-hr.	27	ppm	6.4	5.7	5.7	5.1	4.6	5.3	4.6	4.1	3.6	3.3
Pb	Max. Qtr.	4	µg/m³	0.09	0.10	0.07	0.06	0.07	0.07	0.06	0.06	0.06	0.06
NO_2	Arith. Mean	12	ppm	0.031	0.030	0.029	0.028	0.028	0.029	0.027	0.028	0.027	0.027
O_3	2nd Max. 1-hr.	34	ppm	0.116	0.122	0.124	0.109	0.111	0.105	0.115	0.104	0.111	0.109
O_3	4th Max. 8-hr.	34	ppm	0.093	0.096	0.101	0.085	0.088	0.085	0.095	0.083	0.093	0.088
PM_{10}	Wtd. Arith. Mean	68	µg/m³	28.8	26.6	27.0	24.2	24.3	24.8	22.1	22.9	23.5	23.2
SO_2	Arith. Mean	41	ppm	0.0105	0.0094	0.0096	0.0089	0.0081	0.0083	0.0064	0.0064	0.0058	0.0057
Region 3													
CO	2nd Max. 8-hr.	40	ppm	5.5	5.1	4.6	4.3	4.2	4.7	4.0	3.7	3.4	3.1
Pb	Max. Qtr.	25	µg/m³	0.09	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03
NO_2	Arith. Mean	35	ppm	0.022	0.021	0.021	0.021	0.021	0.022	0.020	0.021	0.020	0.020
O_3	2nd Max. 1-hr.	71	ppm	0.109	0.110	0.118	0.102	0.115	0.111	0.116	0.105	0.116	0.115
O_3	4th Max. 8-hr.	71	ppm	0.087	0.088	0.096	0.082	0.092	0.088	0.094	0.085	0.093	0.095
PM_{10}	Wtd. Arith. Mean	67	µg/m³	32.2	29.7	30.6	26.5	26.8	27.7	26.6	25.2	25.3	25.1
SO_2	Arith. Mean	71	ppm	0.0134	0.0126	0.0120	0.0110	0.0111	0.0112	0.0084	0.0085	0.0089	0.0086
Region 4													
CO	2nd Max. 8-hr.	55	ppm	6.0	5.3	5.0	5.0	5.0	4.7	4.3	3.8	4.0	3.7
Pb	Max. Qtr.	26	µg/m³	0.07	0.06	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03
NO2	Arith. Mean	25	ppm	0.015	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014
O3	2nd Max. 1-hr.	115	ppm	0.100	0.105	0.097	0.095	0.104	0.099	0.104	0.102	0.103	0.112
O3	4th Max. 8-hr.	115	ppm	0.078	0.083	0.075	0.077	0.081	0.080	0.082	0.081	0.082	0.091
PM10	Wtd. Arith. Mean	130	µg/m3	30.0	30.0	28.6	26.5	25.8	25.5	25.2	23.9	23.9	24.5
SO2	Arith. Mean	67	ppm	0.0062	0.0061	0.0058	0.0056	0.0056	0.0052	0.0044	0.0046	0.0045	0.0047
Region 5													
CO	2nd Max. 8-hr.	43	ppm	5.7	5.1	4.8	4.4	4.4	5.3	4.1	3.3	3.1	3.2
Pb	Max. Qtr.	47	µg/m³	0.11	0.16	0.09	0.09	0.08	0.08	0.06	0.06	0.06	0.05
NO_2	Arith. Mean	14	ppm	0.023	0.021	0.021	0.022	0.022	0.024	0.023	0.023	0.022	0.023
O_3	2nd Max. 1-hr.	126	ppm	0.108	0.102	0.112	0.098	0.097	0.105	0.111	0.103	0.102	0.105
O_3	4th Max. 8-hr.	126	ppm	0.086	0.082	0.089	0.079	0.077	0.084	0.090	0.085	0.083	0.085
PM_{10}	Wtd. Arith. Mean	161	µg/m³	33.4	30.9	30.2	27.8	26.4	28.1	27.3	24.7	24.8	26.2
SO_2	Arith. Mean	120	ppm	0.0098	0.0093	0.0091	0.0080	0.0081	0.0076	0.0061	0.0061	0.0059	0.0059

Table A-11. National Air Quality Trends Statistics by EPA Region, 1989–1998 (continued)

	Statistic	# of Sites	Units	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Region 6													
CO	2nd Max. 8-hr.	31	ppm	6.2	6.2	5.4	5.4	5.3	4.7	4.4	4.9	4.3	4.0
Pb	Max. Qtr.	25	µg/m³	0.12	0.10	0.10	0.08	0.07	0.05	0.06	0.07	0.04	0.04
NO_2	Arith. Mean	22	ppm	0.016	0.015	0.015	0.016	0.015	0.017	0.016	0.016	0.016	0.015
O_3	2nd Max. 1-hr.	69	ppm	0.119	0.122	0.113	0.109	0.111	0.109	0.122	0.110	0.114	0.116
O_3	4th Max. 8-hr.	69	ppm	0.085	0.087	0.080	0.079	0.080	0.082	0.091	0.082	0.083	0.087
PM_{10}	Wtd. Arith. Mean	94	µg/m³	28.7	25.7	24.3	24.4	23.6	23.8	24.7	23.7	22.3	23.3
SO_2	Arith. Mean	32	ppm	0.0064	0.0063	0.0060	0.0063	0.0053	0.0046	0.0046	0.0047	0.0043	0.0042
Region 7													
CO	2nd Max. 8-hr.	22	ppm	5.3	4.9	5.1	4.4	4.3	4.2	4.0	4.1	3.7	4.2
Pb	Max. Qtr.	19	µg/m³	0.05	0.03	0.03	0.02	0.02	0.01	0.01	0.02	0.04	0.04
NO_2	Arith. Mean	12	ppm	0.016	0.015	0.015	0.016	0.015	0.016	0.016	0.016	0.016	0.016
O_3	2nd Max. 1-hr.	29	ppm	0.093	0.090	0.092	0.091	0.088	0.098	0.103	0.094	0.094	0.100
O_3	4th Max. 8-hr.	29	ppm	0.074	0.070	0.075	0.074	0.066	0.078	0.082	0.075	0.076	0.078
PM_{10}	Wtd. Arith. Mean	49	µg/m³	32.1	29.7	28.9	28.2	27.0	27.9	27.1	27.5	25.5	25.4
SO_2	Arith. Mean	30	ppm	0.0083	0.0076	0.0072	0.0064	0.0063	0.0064	0.0053	0.0050	0.0046	0.0044
Region 8													
CO	2nd Max. 8-hr.	17	ppm	7.2	6.6	6.7	6.7	5.8	5.2	5.1	4.8	4.7	3.8
Pb	Max. Qtr.	7	µg/m³	0.06	0.06	0.06	0.05	0.06	0.04	0.04	0.03	0.03	0.03
NO_2	Arith. Mean	14	ppm	0.015	0.014	0.014	0.014	0.014	0.015	0.014	0.014	0.014	0.014
O_3	2nd Max. 1-hr.	17	ppm	0.095	0.089	0.086	0.083	0.081	0.085	0.084	0.088	0.083	0.093
O_3	4th Max. 8-hr.	17	ppm	0.073	0.068	0.069	0.065	0.064	0.067	0.067	0.069	0.066	0.075
PM_{10}	Wtd. Arith. Mean	106	µg/m³	27.2	24.1	25.2	23.8	22.7	22.2	19.3	19.6	18.8	18.8
SO_2	Arith. Mean	27	ppm	0.0063	0.0061	0.0058	0.0064	0.0062	0.0055	0.0049	0.0041	0.0034	0.0031
Region 9													
CO	2nd Max. 8-hr.	95	ppm	6.7	6.3	6.1	5.3	4.9	5.2	4.6	4.5	4.1	4.1
Pb	Max. Qtr.	31	µg/m³	0.07	0.07	0.06	0.03	0.03	0.03	0.03	0.02	0.02	0.02
NO_2	Arith. Mean	77	ppm	0.023	0.022	0.022	0.021	0.020	0.021	0.020	0.019	0.018	0.018
O_3	2nd Max. 1-hr.	149	ppm	0.137	0.127	0.126	0.125	0.120	0.117	0.119	0.115	0.102	0.112
O_3	4th Max. 8-hr.	149	ppm	0.095	0.090	0.090	0.090	0.088	0.086	0.087	0.087	0.078	0.084
PM_{10}	Wtd. Arith. Mean	119	µg/m³	41.8	38.3	37.5	32.7	31.6	30.6	30.5	28.7	29.1	26.8
SO_2	Arith. Mean	35	ppm	0.0030	0.0026	0.0025	0.0025	0.0023	0.0022	0.0025	0.0024	0.0022	0.0021
Region 10													
CO	2nd Max. 8-hr.	16	ppm	8.6	7.7	8.0	7.5	6.4	6.1	5.9	5.9	5.5	5.0
Pb	Max. Qtr.	5	µg/m³	0.06	0.06	0.06	0.04	0.05	0.05	0.05	0.04	0.05	0.06
NO_2	Arith. Mean	—	ppm	—	—	—	—	—	—	—	—	—	—
O_3	2nd Max. 1-hr.	13	ppm	0.083	0.099	0.086	0.087	0.081	0.088	0.086	0.097	0.076	0.097
O_3	4th Max. 8-hr.	13	ppm	0.061	0.072	0.064	0.069	0.058	0.063	0.063	0.076	0.058	0.068
PM_{10}	Wtd. Arith. Mean	63	µg/m³	34.3	31.5	32.5	30.7	30.3	26.7	23.2	23.2	23.5	21.1
SO_2	Arith. Mean	9	ppm	0.0066	0.0071	0.0070	0.0073	0.0066	0.0066	0.0059	0.0051	0.0047	0.0047

Table A-12. Maximum Air Quality Concentrations by County, 1998

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
AL	CLAY CO	13,252	.	.	.	0.117	0.094	.	.
AL	COLBERT CO	51,666	.	.	.	.	.	45	0.019
AL	DE KALB CO	54,651	.	.	.	.	.	58	.
AL	ELMORE CO	49,210	.	.	.	0.116	0.091	.	.
AL	ESCAMBIA CO	35,518	.	.	.	.	.	59	.
AL	ETOWAH CO	99,840	.	.	.	.	.	65	.
AL	FRANKLIN CO	27,814	.	.	.	.	.	46	.
AL	GENEVA CO	23,647	.	.	.	0.092	0.077	.	.
AL	HOUSTON CO	81,331	.	.	.	.	.	63	.
AL	JACKSON CO	47,796	.	.	.	.	.	.	0.025
AL	JEFFERSON CO	651,525	4.4	.	.	0.127	0.101	109	0.032
AL	LAWRENCE CO	31,513	.	.	.	0.102	0.085	.	0.011
AL	LIMESTONE CO	54,135	.	.	.	.	.	43	.
AL	MADISON CO	238,912	3.3	.	.	0.118	0.092	57	.
AL	MARENGO CO	23,084	.	.	.	.	.	46	.
AL	MOBILE CO	378,643	.	.	.	0.114	0.098	153	0.073
AL	MONTGOMERY CO	209,085	.	.	.	0.121	0.092	57	0.010
AL	PIKE CO	27,595	.	0.63	.	.	.	56	.
AL	RUSSELL CO	46,860	.	.	.	.	.	56	.
AL	SHELBY CO	99,358	.	.	0.0090	0.137	0.107	52	.
AL	SUMTER CO	16,174	.	.	.	0.083	0.068	.	.
AL	TALLADEGA CO	74,107	.	.	.	.	.	53	.
AL	TUSCALOOSA CO	150,522	.	.	.	.	.	54	.
AL	WALKER CO	67,670	.	.	.	.	.	50	.
AK	ANCHORAGE BOROUGH	226,338	8.4	.	.	.	.	103	.
AK	FAIRBANKS N. STAR BOR.	77,720	10.2	.	.	.	.	47	.
AK	JUNEAU BOROUGH	26,751	.	.	.	.	.	41	.
AK	MATANUSKA-SUSITNA BOR.	39,683	.	.	.	.	.	87	.
AK	YUKON-KOYUKUK CA	8,478	.	.	.	0.057	0.054	.	.
AZ	COCHISE CO	97,624	.	.	.	0.077	0.067	89	.
AZ	COCONINO CO	96,591	.	.	.	0.076	0.072	.	.
AZ	GRAHAM CO	26,554	.	.	.	.	.	68	.
AZ	MARICOPA CO	2,122,101	8.1	.	0.0350	0.113	0.090	208	0.018
AZ	PIMA CO	666,880	4.0	.	0.0165	0.094	0.077	78	0.004
AZ	PINAL CO	116,379	.	.	.	.	.	.	0.027
AZ	SANTA CRUZ CO	29,676	.	.	.	.	.	171	.
AZ	YAVAPAI CO	107,714	.	.	.	.	.	30	.
AZ	YUMA CO	106,895	.	.	.	0.101	0.089	.	.
AR	ARKANSAS CO	21,653	.	.	.	.	.	73	.
AR	ASHLEY CO	24,319	.	.	.	.	.	52	.
AR	CRAIGHEAD CO	68,956	.	.	.	.	.	54	.
AR	CRITTENDEN CO	49,939	.	.	.	0.101	0.086	.	.
AR	GARLAND CO	73,397	.	.	.	.	.	57	.
AR	JEFFERSON CO	85,487	.	.	.	.	.	47	.
AR	MARION CO	12,001	.	.	.	.	.	35	.
AR	MILLER CO	38,467	.	.	.	.	.	53	0.015
AR	MONTGOMERY CO	7,841	.	.	.	0.092	0.071	.	.
AR	NEWTON CO	7,666	.	.	.	0.084	0.078	.	.
AR	OUACHITA CO	30,574	.	.	.	.	.	55	.
AR	PHILLIPS CO	28,838	.	.	.	.	.	43	.
AR	POPE CO	45,883	.	.	.	.	.	47	.
AR	PULASKI CO	349,660	4.8	.	0.0105	0.098	0.082	98	0.006
AR	SEBASTIAN CO	99,590	.	.	.	.	.	49	.
AR	UNION CO	46,719	.	.	.	.	.	57	0.028

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
AR	WASHINGTON CO	113,409	.	.	.	.	.	44	.
AR	WHITE CO	54,676	.	.	.	.	.	51	.
CA	ALAMEDA CO	1,279,182	4.2	0.00	0.0203	0.139	0.096	54	.
CA	AMADOR CO	30,039	1.3	.	.	0.129	0.107	.	.
CA	BUTTE CO	182,120	3.8	0.00	0.0133	0.103	0.078	60	.
CA	CALAVERAS CO	31,998	0.8	.	.	0.124	0.105	35	.
CA	COLUSA CO	16,275	.	.	.	0.096	0.078	75	.
CA	CONTRA COSTA CO	803,732	3.1	0.01	0.0163	0.130	0.088	64	0.014
CA	DEL NORTE CO	23,460	.	.	.	.	.	33	.
CA	EL DORADO CO	125,995	4.2	.	0.0099	0.144	0.115	55	.
CA	FRESNO CO	667,490	6.9	0.00	0.0199	0.167	0.122	126	.
CA	GLENN CO	24,798	.	.	.	0.095	0.074	73	.
CA	HUMBOLDT CO	119,118	.	.	.	.	.	41	.
CA	IMPERIAL CO	109,303	13.3	0.02	0.0114	0.137	0.098	231	0.017
CA	INYO CO	18,281	.	.	.	0.087	0.082	814	.
CA	KERN CO	543,477	3.4	0.00	0.0238	0.158	0.124	131	.
CA	KINGS CO	101,469	.	.	0.0142	0.136	0.104	126	.
CA	LAKE CO	50,631	.	.	.	0.070	0.055	22	.
CA	LOS ANGELES CO	8,863,164	11.5	0.05	0.0434	0.200	0.140	78	0.012
CA	MADERA CO	88,090	.	.	0.0112	0.127	0.094	.	.
CA	MARIN CO	230,096	3.2	.	0.0172	0.073	0.047	46	.
CA	MARIPOSA CO	14,302	.	.	.	0.111	0.097	40	.
CA	MENDOCINO CO	80,345	3.2	.	0.0096	0.072	0.060	41	.
CA	MERCED CO	178,403	.	.	0.0114	0.140	0.112	.	.
CA	MONO CO	9,956	2.9	.	.	0.078	.	46	.
CA	MONTEREY CO	355,660	1.9	.	0.0095	0.085	0.067	50	.
CA	NAPA CO	110,765	3.5	.	0.0124	0.101	0.069	33	.
CA	NEVADA CO	78,510	.	.	.	0.112	0.095	112	.
CA	ORANGE CO	2,410,556	6.6	.	0.0339	0.158	0.093	65	0.005
CA	PLACER CO	172,796	2.2	0.00	0.0156	0.145	0.099	57	.
CA	PLUMAS CO	19,739	.	.	.	0.081	0.069	65	.
CA	RIVERSIDE CO	1,170,413	4.6	0.05	0.0221	0.193	0.135	114	0.009
CA	SACRAMENTO CO	1,041,219	6.1	0.01	0.0205	0.154	0.113	99	0.015
CA	SAN BENITO CO	36,697	.	.	.	0.113	0.088	36	.
CA	SAN BERNARDINO CO	1,418,380	4.5	0.04	0.0356	0.241	0.183	102	0.009
CA	SAN DIEGO CO	2,498,016	4.7	0.01	0.0229	0.135	0.114	88	0.016
CA	SAN FRANCISCO CO	723,959	3.5	0.01	0.0197	0.051	0.042	49	0.006
CA	SAN JOAQUIN CO	480,628	5.3	0.00	0.0230	0.115	0.089	102	.
CA	SAN LUIS OBISPO CO	217,162	2.0	.	0.0113	0.114	0.098	67	0.030
CA	SAN MATEO CO	649,623	3.9	.	0.0176	0.065	0.047	51	.
CA	SANTA BARBARA CO	369,608	3.9	0.00	0.0212	0.116	0.086	55	0.004
CA	SANTA CLARA CO	1,497,577	6.3	0.01	0.0248	0.142	0.094	60	.
CA	SANTA CRUZ CO	229,734	0.8	.	0.0044	0.092	0.068	67	0.003
CA	SHASTA CO	147,036	.	.	.	0.140	0.105	54	.
CA	SIERRA CO	3,318	.	.	.	.	.	55	.
CA	SISKIYOU CO	43,531	.	.	.	0.077	0.066	63	.
CA	SOLANO CO	340,421	4.9	.	0.0135	0.129	0.096	49	0.005
CA	SONOMA CO	388,222	3.0	.	0.0146	0.100	0.086	40	.
CA	STANISLAUS CO	370,522	5.4	0.00	0.0181	0.145	0.107	110	.
CA	SUTTER CO	64,415	3.9	.	0.0129	0.104	0.088	55	.
CA	TEHAMA CO	49,625	.	.	.	0.120	0.098	.	.
CA	TRINITY CO	13,063	.	.	.	.	.	39	.
CA	TULARE CO	311,921	3.6	.	0.0166	0.144	0.109	136	.
CA	TUOLUMNE CO	48,456	5.4	.	.	0.116	0.100	.	.

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
CA	VENTURA CO	669,016	2.9	0.00	0.0189	0.144	0.113	52	0.011
CA	YOLO CO	141,092	1.1	.	0.0107	0.111	0.087	79	.
CO	ADAMS CO	265,038	3.5	0.11	0.0229	0.104	0.083	107	0.013
CO	ALAMOSA CO	13,617	.	.	.	.	.	90	.
CO	ARAPAHOE CO	391,511	.	.	.	0.113	0.084	.	.
CO	ARCHULETA CO	5,345	.	.	.	.	.	71	.
CO	BOULDER CO	225,339	4.8	.	.	0.111	0.089	47	.
CO	DELTA CO	20,980	.	.	.	.	.	68	.
CO	DENVER CO	467,610	5.2	0.03	0.0353	0.107	0.085	81	0.023
CO	DOUGLAS CO	60,391	.	.	.	0.112	0.081	48	.
CO	EL PASO CO	397,014	3.8	0.01	0.0204	0.074	0.062	72	0.011
CO	FREMONT CO	32,273	.	.	.	.	.	41	.
CO	GARFIELD CO	29,974	.	.	.	.	.	67	.
CO	GUNNISON CO	10,273	.	.	.	.	.	149	.
CO	JEFFERSON CO	438,430	3.6	.	0.0101	0.118	0.095	50	.
CO	LAKE CO	6,007	.	0.03	.	.	.	.	.
CO	LA PLATA CO	32,284	.	.	.	.	.	77	.
CO	LARIMER CO	186,136	4.1	.	.	0.092	0.080	33	.
CO	MESA CO	93,145	5.3	.	.	.	.	51	.
CO	MONTEZUMA CO	18,672	.	.	.	0.074	0.068	.	.
CO	MONTROSE CO	24,423	.	.	.	.	.	79	.
CO	PITKIN CO	12,661	.	.	.	.	.	72	.
CO	PROWERS CO	13,347	.	.	.	.	.	100	.
CO	PUEBLO CO	123,051	.	.	.	.	.	52	.
CO	ROUTT CO	14,088	.	.	.	.	.	87	.
CO	SAN MIGUEL CO	3,653	.	.	.	.	.	72	.
CO	SUMMIT CO	12,881	.	.	.	.	.	77	.
CO	TELLER CO	12,468	.	.	.	.	.	124	.
CO	WELD CO	131,821	4.4	.	.	0.102	0.075	40	.
CT	FAIRFIELD CO	827,645	3.8	.	0.0183	0.134	0.097	50	0.025
CT	HARTFORD CO	851,783	7.1	.	0.0198	0.110	0.082	66	0.019
CT	LITCHFIELD CO	174,092	.	.	.	0.118	0.097	44	.
CT	MIDDLESEX CO	143,196	.	.	.	0.118	0.089	.	.
CT	NEW HAVEN CO	804,219	2.7	0.02	0.0269	0.130	0.097	71	0.031
CT	NEW LONDON CO	254,957	.	.	.	0.116	0.083	42	0.018
CT	TOLLAND CO	128,699	.	.	.	0.132	0.098	.	0.016
CT	WINDHAM CO	102,525	.	.	.	.	.	36	.
DE	KENT CO	110,993	.	.	.	0.131	0.102	.	.
DE	NEW CASTLE CO	441,946	3.1	.	0.0163	0.126	0.098	76	0.044
DE	SUSSEX CO	113,229	.	.	.	0.123	0.102	.	.
DC	WASHINGTON	606,900	4.6	0.02	0.0265	0.116	0.102	57	0.020
FL	ALACHUA CO	181,596	.	.	.	0.105	0.093	40	.
FL	BAY CO	126,994	.	.	.	.	.	53	.
FL	BREVARD CO	398,978	.	.	.	0.098	0.085	44	.
FL	BROWARD CO	1,255,488	3.5	0.03	0.0095	0.105	0.079	53	0.017
FL	COLLIER CO	152,099	.	.	.	.	.	42	.
FL	DADE CO	1,937,094	3.4	.	0.0151	0.112	0.087	62	0.004
FL	DUVAL CO	672,971	3.1	0.02	0.0150	0.103	0.101	65	0.037
FL	ESCAMBIA CO	262,798	.	.	.	0.128	0.102	51	0.024
FL	GULF CO	11,504	.	.	.	.	.	66	.
FL	HAMILTON CO	10,930	.	.	.	.	.	41	0.021
FL	HILLSBOROUGH CO	834,054	4.1	0.51	0.0111	0.131	0.097	105	0.036
FL	LAKE CO	152,104	.	.	.	.	.	63	.
FL	LEE CO	335,113	.	.	.	0.109	0.092	37	.

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
FL	LEON CO	192,493	.	.	.	0.090	0.079	63	.
FL	MANATEE CO	211,707	.	.	.	0.115	0.089	38	0.019
FL	MARION CO	194,833	.	.	.	0.097	0.083	.	.
FL	NASSAU CO	43,941	.	.	.	.	.	49	0.022
FL	ORANGE CO	677,491	3.5	.	0.0110	0.117	0.096	55	0.007
FL	OSCEOLA CO	107,728	.	.	.	0.123	0.091	.	.
FL	PALM BEACH CO	863,518	3.0	0.00	0.0120	0.105	0.081	52	0.004
FL	PASCO CO	281,131	.	.	.	0.103	0.091	.	.
FL	PINELLAS CO	851,659	3.0	0.01	0.0115	0.108	0.091	47	0.048
FL	POLK CO	405,382	.	.	.	0.106	0.088	91	0.027
FL	PUTNAM CO	65,070	.	.	.	.	.	41	0.012
FL	ST LUCIE CO	150,171	.	.	.	0.095	0.079	35	.
FL	SARASOTA CO	277,776	5.6	.	.	0.122	0.091	82	0.019
FL	SEMINOLE CO	287,529	.	.	.	0.101	0.089	47	.
FL	VOLUSIA CO	370,712	.	.	.	0.096	0.082	48	.
GA	BALDWIN CO	39,530	.	.	.	.	.	.	0.015
GA	BARTOW CO	55,911	.	.	.	.	.	.	0.014
GA	BIBB CO	149,967	.	.	.	0.137	0.106	59	0.019
GA	CHATHAM CO	216,935	.	.	.	0.097	0.075	79	0.027
GA	CHATTOOGA CO	22,242	.	.	.	.	.	62	.
GA	DAWSON CO	9,429	.	.	.	0.109	0.096	.	.
GA	DE KALB CO	545,837	4.1	0.01	.	0.142	0.112	58	.
GA	DOUGHERTY CO	96,311	.	.	.	.	.	66	0.006
GA	DOUGLAS CO	71,120	.	.	.	0.133	0.110	56	.
GA	FANNIN CO	15,992	.	.	.	0.100	0.081	.	0.052
GA	FAYETTE CO	62,415	.	.	.	0.141	0.111	.	.
GA	FLOYD CO	81,251	.	.	.	.	.	49	0.016
GA	FULTON CO	648,951	3.1	.	0.0241	0.157	0.126	71	0.019
GA	GLYNN CO	62,496	.	.	.	0.109	0.082	119	.
GA	GWINNETT CO	352,910	.	.	.	0.139	0.111	.	.
GA	MUSCOGEE CO	179,278	.	0.58	.	0.113	0.091	50	.
GA	PAULDING CO	41,611	.	.	0.0060	0.138	0.104	.	.
GA	RICHMOND CO	189,719	.	.	.	0.119	0.099	60	0.011
GA	ROCKDALE CO	54,091	.	.	0.0077	0.134	0.113	.	.
GA	SPALDING CO	54,457	.	.	.	.	.	54	.
GA	SUMTER CO	30,228	.	.	.	0.095	0.081	.	.
GA	WALKER CO	58,340	.	.	.	.	.	54	.
GA	WASHINGTON CO	19,112	.	.	.	.	.	83	.
HI	HONOLULU CO	836,231	2.3	.	0.0044	0.056	0.049	39	0.009
HI	KAUAI CO	51,177	.	.	.	.	.	30	.
HI	MAUI CO	100,374	.	.	.	.	.	128	.
ID	ADA CO	205,775	3.9	.	0.0202	.	.	62	.
ID	BANNOCK CO	66,026	.	.	.	.	.	105	0.034
ID	BLAINE CO	13,552	.	.	.	.	.	66	.
ID	BONNER CO	26,622	.	.	.	.	.	67	.
ID	BONNEVILLE CO	72,207	.	.	.	.	.	98	.
ID	BUTTE CO	2,918	.	.	.	0.070	0.065	.	.
ID	CANYON CO	90,076	.	.	.	.	.	69	.
ID	CARIBOU CO	6,963	.	.	.	.	.	101	0.018
ID	KOOTENAI CO	69,795	.	.	.	.	.	85	.
ID	LEMHI CO	6,899	.	.	.	.	.	102	.
ID	LEWIS CO	3,516	.	.	.	.	.	61	.
ID	MADISON CO	23,674	.	.	.	.	.	94	.
ID	MINIDOKA CO	19,361	.	.	.	.	.	78	.

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
ID	NEZ PERCE CO	33,754	4.8	.	.	.	.	76	.
ID	SHOSHONE CO	13,931	.	0.15	.	.	.	120	.
ID	TWIN FALLS CO	53,580	.	.	.	.	.	46	.
IL	ADAMS CO	66,090	.	.	.	0.095	0.073	46	0.022
IL	CHAMPAIGN CO	173,025	.	.	.	0.105	0.083	52	0.019
IL	COOK CO	5,105,067	5.0	0.10	0.0322	0.109	0.086	102	0.051
IL	DU PAGE CO	781,666	.	0.03	.	0.097	0.068	60	0.022
IL	EFFINGHAM CO	31,704	.	.	.	0.093	0.083	.	.
IL	HAMILTON CO	8,499	.	.	.	0.089	0.075	.	.
IL	JACKSON CO	61,067	.	.	.	.	.	46	.
IL	JERSEY CO	20,539	.	.	.	0.122	0.091	.	.
IL	KANE CO	317,471	.	.	.	0.092	0.074	69	.
IL	LAKE CO	516,418	.	.	.	0.107	0.088	.	.
IL	LA SALLE CO	106,913	.	.	.	.	.	134	.
IL	MC HENRY CO	183,241	.	.	.	0.092	0.078	.	.
IL	MACON CO	117,206	.	0.02	.	0.094	0.078	69	0.020
IL	MACOUPIN CO	47,679	.	0.02	.	0.109	0.079	45	0.011
IL	MADISON CO	249,238	2.9	2.59	.	0.118	0.088	116	0.087
IL	PEORIA CO	182,827	5.8	0.02	.	0.086	0.076	53	0.045
IL	RANDOLPH CO	34,583	.	.	.	0.099	0.082	.	0.048
IL	ROCK ISLAND CO	148,723	.	0.01	.	0.086	0.072	58	0.008
IL	ST CLAIR CO	262,852	.	0.10	0.0182	0.101	0.078	84	0.069
IL	SANGAMON CO	178,386	1.9	.	.	0.093	0.078	65	0.061
IL	TAZEWELL CO	123,692	.	.	.	.	.	55	0.037
IL	WABASH CO	13,111	.	.	.	.	.	.	0.033
IL	WILL CO	357,313	0.8	0.01	0.0087	0.095	0.081	49	0.024
IL	WINNEBAGO CO	252,913	3.6	0.04	.	0.085	0.073	53	.
IN	ALLEN CO	300,836	3.0	.	.	0.105	0.089	58	.
IN	CLARK CO	87,777	.	.	.	0.140	0.104	54	.
IN	DAVIESS CO	27,533	.	.	.	.	.	.	0.041
IN	DEARBORN CO	38,835	.	.	.	.	.	.	0.036
IN	DE KALB CO	35,324	.	.	.	.	.	66	.
IN	DELAWARE CO	119,659	.	0.90	.	.	.	.	.
IN	DUBOIS CO	36,616	.	.	.	.	.	51	.
IN	ELKHART CO	156,198	.	.	.	0.106	0.082	.	.
IN	FLOYD CO	64,404	.	.	.	0.131	0.100	.	0.033
IN	FOUNTAIN CO	17,808	.	.	.	.	.	.	0.043
IN	GIBSON CO	31,913	.	.	.	.	.	.	0.056
IN	HAMILTON CO	108,936	.	.	.	0.125	0.100	.	.
IN	HANCOCK CO	45,527	.	.	.	0.119	0.094	.	.
IN	HENDRICKS CO	75,717	3.8	.	.	.	.	.	0.014
IN	JASPER CO	24,960	.	.	.	.	.	44	0.015
IN	JEFFERSON CO	29,797	.	.	.	.	.	.	0.027
IN	JOHNSON CO	88,109	.	.	.	0.101	0.090	.	.
IN	LAKE CO	475,594	4.5	0.12	0.0189	0.113	0.087	136	0.055
IN	LA PORTE CO	107,066	.	0.02	.	0.121	0.093	.	0.016
IN	MADISON CO	130,669	.	.	.	0.117	0.097	39	.
IN	MARION CO	797,159	2.8	0.08	0.0189	0.115	0.095	58	0.024
IN	MORGAN CO	55,920	.	.	.	0.102	0.090	.	.
IN	PERRY CO	19,107	.	.	.	0.114	.	84	0.029
IN	PIKE CO	12,509	.	.	.	.	.	.	0.029
IN	PORTER CO	128,932	.	.	.	0.121	0.090	66	0.026
IN	POSEY CO	25,968	.	.	.	0.107	0.092	.	.
IN	ST JOSEPH CO	247,052	.	.	0.0122	0.117	0.095	46	.

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (μg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (μg/m³)	SO_2 24-hr (ppm)
IN	SPENCER CO	19,490	.	.	.	.	.	.	0.023
IN	SULLIVAN CO	18,993	.	.	.	.	.	.	0.026
IN	VANDERBURGH CO	165,058	4.0	.	.	0.117	0.094	53	0.049
IN	VIGO CO	106,107	.	0.02	.	0.099	0.084	52	0.032
IN	WARRICK CO	44,920	.	.	.	0.116	0.096	.	0.071
IN	WAYNE CO	71,951	.	.	.	.	.	.	0.037
IA	BLACK HAWK CO	123,798	.	.	.	.	.	54	.
IA	CERRO GORDO CO	46,733	.	.	.	.	.	120	0.087
IA	CLINTON CO	51,040	.	.	.	.	.	72	0.024
IA	DELAWARE CO	18,035	.	.	.	.	.	52	.
IA	HARRISON CO	14,730	.	.	.	0.093	0.079	.	.
IA	LEE CO	38,687	.	.	.	.	.	.	0.047
IA	LINN CO	168,767	2.5	.	.	0.078	0.066	76	0.020
IA	MUSCATINE CO	39,907	.	.	.	.	.	60	0.091
IA	PALO ALTO CO	10,669	.	.	.	0.081	0.068	.	.
IA	POLK CO	327,140	10.4	.	.	0.065	0.056	68	.
IA	POTTAWATTAMIE CO	82,628	.	0.01	.	.	.	.	.
IA	SCOTT CO	150,979	.	.	.	0.097	0.077	121	0.018
IA	STORY CO	74,252	.	.	.	0.083	0.070	.	.
IA	VAN BUREN CO	7,676	.	.	.	0.084	0.071	.	0.009
IA	WARREN CO	36,033	.	.	.	0.083	0.070	.	.
IA	WOODBURY CO	98,276	.	.	.	.	.	67	.
KS	FORD CO	27,463	.	.	.	.	.	52	.
KS	LINN CO	8,254	1.0	.	.	0.104	0.080	.	0.002
KS	SEDGWICK CO	403,662	5.5	0.01	.	0.100	0.083	75	.
KS	SHAWNEE CO	160,976	.	.	.	.	.	67	.
KS	SHERMAN CO	6,926	.	.	.	.	.	66	.
KS	WYANDOTTE CO	161,993	4.0	.	.	0.113	0.087	69	0.015
KY	BELL CO	31,506	3.9	.	.	0.102	0.087	51	.
KY	BOONE CO	57,589	.	.	.	0.110	0.084	.	.
KY	BOYD CO	51,150	7.2	.	.	0.090	.	94	0.038
KY	BULLITT CO	47,567	.	.	0.0123	0.108	0.096	46	.
KY	CAMPBELL CO	83,866	.	.	0.0180	0.113	0.089	.	0.040
KY	CARTER CO	24,340	.	.	.	0.118	0.096	.	.
KY	CHRISTIAN CO	68,941	.	.	.	0.111	0.086	.	.
KY	DAVIESS CO	87,189	1.0	.	0.0125	0.110	0.086	57	0.023
KY	EDMONSON CO	10,357	.	.	.	0.112	0.097	.	.
KY	FAYETTE CO	225,366	2.9	.	0.0109	0.106	0.089	64	0.023
KY	FLOYD CO	43,586	.	.	.	.	.	39	.
KY	GRAVES CO	33,550	.	.	.	0.105	0.086	.	.
KY	GREENUP CO	36,742	.	.	.	0.133	0.099	.	0.030
KY	HANCOCK CO	7,864	.	.	.	0.113	0.095	.	0.028
KY	HARDIN CO	89,240	.	.	.	0.100	0.083	42	.
KY	HARLAN CO	36,574	.	.	.	.	.	41	.
KY	HENDERSON CO	43,044	2.1	.	0.0176	0.111	0.084	67	0.031
KY	JEFFERSON CO	664,937	5.5	.	0.0233	0.121	0.097	59	0.045
KY	JESSAMINE CO	30,508	.	.	.	0.105	0.089	.	.
KY	KENTON CO	142,031	2.6	.	0.0179	0.121	0.091	54	.
KY	LAWRENCE CO	13,998	.	.	.	0.088	.	49	.
KY	LIVINGSTON CO	9,062	.	.	.	0.131	0.093	56	0.017
KY	MC CRACKEN CO	62,879	2.4	.	0.0123	0.109	0.090	55	0.019
KY	MC LEAN CO	9,628	.	.	.	0.110	0.085	.	.
KY	MADISON CO	57,508	.	.	.	.	.	51	.
KY	MARSHALL CO	27,205	.	.	.	.	.	80	.

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax ($\mu g/m^3$)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max ($\mu g/m^3$)	SO_2 24-hr (ppm)
KY	OLDHAM CO	33,263	.	.	.	0.120	0.101	.	.
KY	PERRY CO	30,283	.	.	.	0.091	0.073	50	.
KY	PIKE CO	72,583	.	.	.	0.101	0.085	47	.
KY	PULASKI CO	49,489	.	.	.	0.102	0.084	37	.
KY	SCOTT CO	23,867	.	.	.	0.106	0.088	.	.
KY	SIMPSON CO	15,145	.	.	0.0108	0.113	0.092	.	.
KY	TRIGG CO	10,361	.	.	.	0.100	0.083	.	.
KY	WARREN CO	76,673	.	.	.	.	.	44	.
KY	WHITLEY CO	33,326	.	.	.	.	.	45	.
LA	ASCENSION PAR	58,214	.	.	.	0.123	0.091	.	.
LA	BEAUREGARD PAR	30,083	.	.	0.0068	0.106	0.082	.	.
LA	BOSSIER PAR	86,088	.	.	.	0.111	0.090	.	0.010
LA	CADDO PAR	248,253	.	.	.	0.107	0.090	57	.
LA	CALCASIEU PAR	168,134	.	.	0.0052	0.123	0.090	.	0.012
LA	EAST BATON ROUGE PAR	380,105	3.9	0.04	0.0187	0.131	0.107	64	0.017
LA	GRANT PAR	17,526	.	.	.	0.102	0.084	.	.
LA	IBERVILLE PAR	31,049	.	.	0.0103	0.120	0.091	.	.
LA	JEFFERSON PAR	448,306	.	.	0.0112	0.122	0.091	.	.
LA	LAFAYETTE PAR	164,762	.	.	.	0.100	0.088	.	.
LA	LAFOURCHE PAR	85,860	.	.	.	0.110	0.090	.	.
LA	LIVINGSTON PAR	70,526	.	.	0.0055	0.117	0.089	.	.
LA	ORLEANS PAR	496,938	3.3	0.08	0.0204	0.092	0.076	61	.
LA	OUACHITA PAR	142,191	.	.	.	0.090	0.078	.	0.012
LA	POINTE COUPEE PAR	22,540	.	.	0.0073	0.103	0.075	.	.
LA	ST BERNARD PAR	66,631	.	.	.	0.108	0.086	.	0.026
LA	ST CHARLES PAR	42,437	.	.	.	0.105	0.086	56	.
LA	ST JAMES PAR	20,879	.	.	0.0106	0.101	0.081	.	.
LA	ST JOHN THE BAPTIST PAR	39,996	.	0.11	.	0.118	0.087	.	.
LA	ST MARY PAR	58,086	.	.	.	0.105	0.091	.	.
LA	WEST BATON ROUGE PAR	19,419	.	0.05	0.0152	0.128	0.083	64	0.036
ME	ANDROSCOGGIN CO	105,259	.	.	.	.	.	36	0.019
ME	AROOSTOOK CO	86,936	.	.	.	.	.	99	0.036
ME	CUMBERLAND CO	243,135	.	.	.	0.120	0.089	68	0.025
ME	FRANKLIN CO	29,008	.	.	.	.	.	31	.
ME	HANCOCK CO	46,948	.	.	.	0.125	0.094	.	.
ME	KENNEBEC CO	115,904	.	.	.	0.102	0.077	66	.
ME	KNOX CO	36,310	.	.	.	0.107	0.077	46	.
ME	OXFORD CO	52,602	.	.	.	0.072	0.060	54	0.017
ME	PENOBSCOT CO	146,601	.	.	.	0.094	0.077	43	.
ME	PISCATAQUIS CO	18,653	.	.	.	0.068	0.061	.	.
ME	SAGADAHOC CO	33,535	.	.	.	0.124	0.091	.	.
ME	YORK CO	164,587	.	.	0.0102	0.120	0.089	.	.
MD	ALLEGANY CO	74,946	.	.	.	.	.	.	0.012
MD	ANNE ARUNDEL CO	427,239	.	.	.	0.136	0.111	52	0.021
MD	BALTIMORE CO	692,134	.	.	0.0200	0.116	0.094	48	.
MD	CALVERT CO	51,372	.	.	.	0.112	0.092	.	.
MD	CARROLL CO	123,372	.	.	.	0.119	0.095	.	.
MD	CECIL CO	71,347	.	.	.	0.124	0.101	33	.
MD	CHARLES CO	101,154	.	.	.	0.123	0.105	.	.
MD	FREDERICK CO	150,208	.	.	.	0.108	0.095	.	.
MD	GARRETT CO	28,138	.	.	.	.	.	44	.
MD	HARFORD CO	182,132	.	.	.	0.132	0.099	.	.
MD	KENT CO	17,842	.	.	.	0.117	0.098	.	.
MD	MONTGOMERY CO	757,027	.	.	.	0.122	0.097	.	.

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
MD	PRINCE GEORGES CO	729,268	4.8	.	.	0.128	0.104	53	.
MD	WICOMICO CO	74,339	.	.	.	.	.	35	.
MD	BALTIMORE	736,014	5.0	0.01	0.0258	0.116	0.091	65	0.020
MA	BARNSTABLE CO	186,605	.	.	0.0040	0.103	0.084	.	.
MA	BERKSHIRE CO	139,352	.	.	.	0.078	.	.	.
MA	BRISTOL CO	506,325	.	.	0.0077	0.107	0.088	44	0.024
MA	ESSEX CO	670,080	.	.	0.0145	0.113	0.100	41	0.031
MA	HAMPDEN CO	456,310	4.6	.	0.0204	0.115	0.093	62	0.026
MA	HAMPSHIRE CO	146,568	.	.	0.0058	0.117	0.093	35	0.016
MA	MIDDLESEX CO	1,398,468	3.4	.	.	0.114	0.098	40	0.024
MA	NORFOLK CO	616,087	.	.	.	.	.	34	.
MA	SUFFOLK CO	663,906	3.2	0.03	0.0307	0.096	0.087	71	0.036
MA	WORCESTER CO	709,705	3.5	.	0.0187	0.124	0.097	50	0.017
MI	ALLEGAN CO	90,509	.	.	.	0.124	0.097	.	.
MI	BENZIE CO	12,200	.	.	.	0.107	0.090	.	.
MI	BERRIEN CO	161,378	.	.	.	0.136	0.093	.	.
MI	CALHOUN CO	135,982	.	.	.	.	.	66	.
MI	CASS CO	49,477	.	.	.	0.110	0.091	.	.
MI	CLINTON CO	57,883	.	.	.	0.097	0.078	.	.
MI	DELTA CO	37,780	.	.	.	.	.	.	0.007
MI	GENESEE CO	430,459	.	0.01	.	0.114	0.089	39	0.014
MI	HURON CO	34,951	.	.	.	0.113	0.087	.	.
MI	INGHAM CO	281,912	.	.	.	0.102	0.081	.	.
MI	KALAMAZOO CO	223,411	.	.	.	0.106	0.087	.	.
MI	KENT CO	500,631	2.9	0.01	.	0.106	0.087	55	0.008
MI	LENAWEE CO	91,476	.	.	.	0.097	0.086	.	.
MI	MACOMB CO	717,400	2.2	.	.	0.126	0.098	.	0.017
MI	MASON CO	25,537	.	.	.	0.108	0.087	.	.
MI	MISSAUKEE CO	12,147	.	0.00	.	0.097	0.079	.	.
MI	MUSKEGON CO	158,983	.	.	.	0.115	0.092	.	.
MI	OAKLAND CO	1,083,592	2.2	.	.	0.102	0.089	.	.
MI	OTTAWA CO	187,768	.	.	.	0.101	0.085	40	.
MI	ST CLAIR CO	145,607	.	.	.	0.116	0.091	.	0.073
MI	WASHTENAW CO	282,937	.	.	.	0.099	0.084	.	.
MI	WAYNE CO	2,111,687	3.5	0.08	0.0230	0.117	0.093	114	0.044
MN	ANOKA CO	243,641	2.8	.	.	0.093	0.072	.	.
MN	CARLTON CO	29,259	.	.	.	.	.	37	.
MN	DAKOTA CO	275,227	1.1	0.14	0.0129	0.087	0.071	.	0.013
MN	HENNEPIN CO	1,032,431	3.7	0.02	0.0256	.	.	73	0.024
MN	KOOCHICHING CO	16,299	.	.	.	.	.	.	0.059
MN	LAKE CO	10,415	.	.	.	0.077	0.068	.	.
MN	OLMSTED CO	106,470	.	.	.	.	.	36	.
MN	RAMSEY CO	485,765	7.0	0.02	0.0180	.	.	64	0.009
MN	ST LOUIS CO	198,213	3.7	.	.	0.075	0.067	81	.
MN	SHERBURNE CO	41,945	.	.	.	.	.	.	0.019
MN	STEARNS CO	118,791	3.6	.	.	.	.	.	.
MN	WASHINGTON CO	145,896	.	.	.	0.097	0.076	49	0.013
MS	ADAMS CO	35,356	.	.	.	0.095	0.084	.	.
MS	COAHOMA CO	31,665	.	.	.	.	.	41	.
MS	DE SOTO CO	67,910	.	.	0.0106	0.109	0.089	.	.
MS	HANCOCK CO	31,760	.	.	0.0039	0.108	0.089	.	.
MS	HARRISON CO	165,365	.	.	.	.	.	.	0.022
MS	HINDS CO	254,441	3.7	.	.	0.104	0.082	76	0.008
MS	JACKSON CO	115,243	.	.	.	0.118	0.097	.	0.015

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
MS	JONES CO	62,031	.	.	.	.	.	45	.
MS	LAUDERDALE CO	75,555	.	.	.	0.091	0.078	.	.
MS	LEE CO	65,581	.	.	.	0.107	0.088	32	.
MS	MADISON CO	53,794	.	.	.	0.106	0.086	.	.
MS	PANOLA CO	29,996	.	.	.	0.119	0.089	.	0.005
MS	WARREN CO	47,880	.	.	.	0.096	0.082	47	.
MS	WASHINGTON CO	67,935	.	.	.	.	.	56	.
MO	BUCHANAN CO	83,083	.	.	.	.	.	124	0.121
MO	CEDAR CO	12,093	.	.	.	0.096	0.087	.	.
MO	CLAY CO	153,411	4.6	.	0.0130	0.133	0.095	.	0.008
MO	GREENE CO	207,949	4.0	.	0.0122	0.094	0.071	43	0.042
MO	HOLT CO	6,034	.	0.62	.	.	.	.	.
MO	IRON CO	10,726	.	1.14	.	.	.	.	0.084
MO	JACKSON CO	633,232	3.9	0.01	.	0.099	0.073	68	0.010
MO	JEFFERSON CO	171,380	.	11.59	.	0.111	0.091	48	0.049
MO	MONROE CO	9,104	.	.	.	0.091	0.079	36	0.014
MO	PLATTE CO	57,867	.	.	0.0132	0.123	0.090	.	0.005
MO	ST CHARLES CO	212,907	.	.	0.0115	0.135	0.097	.	0.021
MO	STE GENEVIEVE CO	16,037	.	.	.	0.103	0.090	.	.
MO	ST LOUIS CO	993,529	4.0	0.04	0.0225	0.122	0.092	62	0.027
MO	ST LOUIS	396,685	6.0	.	0.0258	0.103	0.079	71	0.038
MT	BIG HORN CO	11,337	.	.	.	.	.	144	.
MT	BROADWATER CO	3,318	.	.	.	.	.	66	.
MT	CASCADE CO	77,691	4.5	.	.	.	.	.	0.010
MT	FLATHEAD CO	59,218	5.0	.	.	0.062	.	118	.
MT	GALLATIN CO	50,463	.	.	.	.	.	73	.
MT	GLACIER CO	12,121	.	.	.	.	.	78	.
MT	JEFFERSON CO	7,939	.	.	.	.	.	75	0.030
MT	LAKE CO	21,041	.	.	.	.	.	108	.
MT	LEWIS AND CLARK CO	47,495	.	0.89	.	.	.	99	0.032
MT	LINCOLN CO	17,481	.	.	.	.	.	107	.
MT	MADISON CO	5,989	.	.	.	.	.	34	.
MT	MISSOULA CO	78,687	4.7	.	.	.	.	73	.
MT	PARK CO	14,562	.	.	.	.	.	21	.
MT	PHILLIPS CO	5,163	.	.	.	.	.	53	.
MT	RAVALLI CO	25,010	.	.	.	.	.	76	.
MT	ROSEBUD CO	10,505	.	.	.	.	.	153	0.012
MT	SANDERS CO	8,669	.	.	.	.	.	68	.
MT	SILVER BOW CO	33,941	4.9	.	.	.	.	97	.
MT	YELLOWSTONE CO	113,419	5.4	.	.	.	.	.	0.032
NE	CASS CO	21,318	.	.	.	.	.	106	.
NE	DAWSON CO	19,940	.	.	.	.	.	87	.
NE	DOUGLAS CO	416,444	7.7	0.25	.	0.090	0.070	85	0.032
NE	LANCASTER CO	213,641	6.0	.	.	0.068	0.058	.	.
NV	CLARK CO	741,459	10.1	.	.	0.108	0.092	188	.
NV	DOUGLAS CO	27,637	1.8	.	.	0.075	0.069	.	.
NV	ELKO CO	33,530	.	.	.	.	.	58	.
NV	LANDER CO	6,266	.	.	.	.	.	59	.
NV	WASHOE CO	254,667	6.6	.	.	0.093	0.075	139	.
NV	WHITE PINE CO	9,264	.	.	.	0.083	0.070	.	.
NV	CARSON CITY	40,443	4.5	.	.	0.080	0.067	.	.
NH	BELKNAP CO	49,216	.	.	.	0.072	0.064	.	.
NH	CARROLL CO	35,410	.	.	.	0.078	0.068	.	.
NH	CHESHIRE CO	70,121	.	.	.	0.085	0.073	.	0.023

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (μg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (μg/m³)	SO_2 24-hr (ppm)
NH	COOS CO	34,828	.	.	.	.	.	.	0.046
NH	GRAFTON CO	74,929	.	.	.	0.086	0.076	.	.
NH	HILLSBOROUGH CO	336,073	5.3	.	0.0148	0.100	0.084	.	0.027
NH	MERRIMACK CO	120,005	.	.	.	0.088	0.074	.	0.043
NH	ROCKINGHAM CO	245,845	.	.	0.0124	0.118	0.085	.	0.016
NH	STRAFFORD CO	104,233	.	.	.	0.092	0.079	.	.
NH	SULLIVAN CO	38,592	.	.	.	0.091	0.067	.	0.018
NJ	ATLANTIC CO	224,327	.	.	.	0.118	0.091	.	0.010
NJ	BERGEN CO	825,380	3.7	.	.	0.080	.	.	0.018
NJ	BURLINGTON CO	395,066	3.6	.	.	.	.	.	0.023
NJ	CAMDEN CO	502,824	3.0	0.01	0.0219	0.118	0.097	52	0.023
NJ	CUMBERLAND CO	138,053	.	.	.	0.117	0.098	.	0.012
NJ	ESSEX CO	778,206	2.6	.	0.0328	0.112	0.087	71	0.025
NJ	GLOUCESTER CO	230,082	.	.	.	0.120	0.098	46	0.015
NJ	HUDSON CO	553,099	5.6	.	0.0269	0.118	0.089	63	0.024
NJ	HUNTERDON CO	107,776	.	.	.	0.118	0.096	.	.
NJ	MERCER CO	325,824	.	.	0.0153	0.113	0.095	.	.
NJ	MIDDLESEX CO	671,780	3.0	0.08	0.0191	0.117	0.099	.	0.018
NJ	MONMOUTH CO	553,124	2.8	.	.	0.129	0.093	.	.
NJ	MORRIS CO	421,353	3.3	.	0.0112	0.119	0.097	.	0.020
NJ	OCEAN CO	433,203	3.2	.	.	0.135	0.104	.	.
NJ	PASSAIC CO	453,060	.	.	.	0.102	0.089	59	.
NJ	UNION CO	493,819	5.1	.	0.0419	.	.	58	0.021
NM	BERNALILLO CO	480,577	5.9	.	0.0157	0.093	0.074	88	.
NM	CHAVES CO	57,849	.	.	.	.	.	48	.
NM	DONA ANA CO	135,510	4.2	0.04	0.0101	0.124	0.082	158	0.019
NM	EDDY CO	48,605	.	.	0.0058	0.084	0.075	.	0.005
NM	GRANT CO	27,676	.	.	.	.	.	37	0.022
NM	HIDALGO CO	5,958	.	.	.	.	.	24	0.044
NM	LEA CO	55,765	.	.	.	.	.	41	.
NM	LUNA CO	18,110	.	.	.	.	.	36	.
NM	OTERO CO	51,928	.	.	.	.	.	41	.
NM	SANDOVAL CO	63,319	1.0	.	0.0093	0.090	0.072	39	.
NM	SAN JUAN CO	91,605	3.8	.	0.0099	0.079	0.071	28	0.074
NM	SANTA FE CO	98,928	2.0	.	.	.	.	29	.
NM	TAOS CO	23,118	.	.	.	.	.	75	.
NM	VALENCIA CO	45,235	.	.	.	0.082	0.069	.	.
NY	ALBANY CO	292,594	1.2	0.03	0.0145	0.100	0.079	58	0.016
NY	BRONX CO	1,203,789	3.2	.	0.0359	0.095	0.078	51	0.037
NY	BROOME CO	212,160	.	.	.	.	.	51	.
NY	CHAUTAUQUA CO	141,895	.	.	.	0.111	0.095	62	0.032
NY	CHEMUNG CO	95,195	.	.	.	0.094	0.082	.	0.011
NY	COLUMBIA CO	62,982	.	.	.	.	.	46	.
NY	DUTCHESS CO	259,462	.	.	.	0.108	0.089	.	.
NY	ERIE CO	968,532	3.1	0.04	0.0208	0.110	0.094	50	0.049
NY	ESSEX CO	37,152	.	.	.	0.098	0.079	43	0.006
NY	GREENE CO	44,739	.	.	.	.	.	56	.
NY	HAMILTON CO	5,279	.	.	.	0.089	0.080	.	0.005
NY	HERKIMER CO	65,797	.	.	.	0.085	0.070	38	0.005
NY	JEFFERSON CO	110,943	.	.	.	0.103	0.088	.	.
NY	KINGS CO	2,300,664	4.1	0.14	.	.	.	54	0.029
NY	MADISON CO	69,120	.	.	.	0.094	0.082	.	0.011
NY	MONROE CO	713,968	3.1	.	.	0.088	0.076	50	0.054
NY	NASSAU CO	1,287,348	4.0	.	0.0219	.	.	46	0.022

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (μg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (μg/m³)	SO_2 24-hr (ppm)
NY	NEW YORK CO	1,487,536	5.8	0.13	0.0397	0.109	0.075	114	0.038
NY	NIAGARA CO	220,756	1.4	0.04	.	0.101	0.089	55	0.016
NY	ONEIDA CO	250,836	.	.	.	0.091	0.076	45	.
NY	ONONDAGA CO	468,973	3.0	.	.	0.092	0.082	62	0.009
NY	ORANGE CO	307,647	.	0.14	.	0.104	0.088	.	.
NY	PUTNAM CO	83,941	.	.	.	0.112	0.093	39	0.014
NY	QUEENS CO	1,951,598	2.2	.	.	0.119	0.089	.	0.033
NY	RENSSELAER CO	154,429	.	.	.	.	.	48	0.009
NY	RICHMOND CO	378,977	.	0.02	.	0.129	0.090	47	0.024
NY	ROCKLAND CO	265,475	.	.	.	.	.	45	.
NY	SARATOGA CO	181,276	.	.	.	0.099	0.076	44	.
NY	SCHENECTADY CO	149,285	4.4	.	.	0.090	0.069	48	0.013
NY	SUFFOLK CO	1,321,864	.	.	.	0.143	0.095	40	0.033
NY	ULSTER CO	165,304	.	.	.	0.093	0.081	52	0.009
NY	WAYNE CO	89,123	.	.	.	0.103	0.085	.	.
NY	WESTCHESTER CO	874,866	.	.	.	0.109	0.090	.	.
NC	ALEXANDER CO	27,544	.	.	.	0.133	0.096	.	.
NC	AVERY CO	14,867	.	.	.	0.096	0.082	.	.
NC	BEAUFORT CO	42,283	.	.	.	.	.	.	0.017
NC	BUNCOMBE CO	174,821	.	.	.	0.114	0.090	55	.
NC	CABARRUS CO	98,935	.	.	.	.	.	46	.
NC	CALDWELL CO	70,709	.	.	.	0.114	0.098	.	.
NC	CAMDEN CO	5,904	.	.	.	0.092	0.079	.	.
NC	CASWELL CO	20,693	.	.	.	0.119	0.096	.	.
NC	CATAWBA CO	118,412	.	.	.	.	.	44	.
NC	CHATHAM CO	38,759	.	.	.	0.106	0.090	.	0.009
NC	CUMBERLAND CO	274,566	4.2	.	.	0.112	0.098	47	.
NC	DAVIDSON CO	126,677	.	.	.	.	.	48	.
NC	DAVIE CO	27,859	.	.	.	0.123	0.102	.	.
NC	DUPLIN CO	39,995	.	.	.	0.104	0.091	.	.
NC	DURHAM CO	181,835	5.2	.	.	0.112	0.095	47	.
NC	EDGECOMBE CO	56,558	.	.	.	0.107	0.091	43	.
NC	FORSYTH CO	265,878	5.4	.	0.0170	0.123	0.100	63	0.023
NC	FRANKLIN CO	36,414	.	.	.	0.110	0.099	.	.
NC	GASTON CO	175,093	.	.	.	.	.	41	.
NC	GRANVILLE CO	38,345	0.9	.	.	0.130	0.098	.	.
NC	GUILFORD CO	347,420	3.6	.	.	0.115	0.097	54	.
NC	HARNETT CO	67,822	.	.	.	.	.	63	.
NC	HAYWOOD CO	46,942	.	.	.	0.109	0.102	49	.
NC	HENDERSON CO	69,285	.	.	.	.	.	43	.
NC	JOHNSTON CO	81,306	.	.	.	0.111	0.092	.	.
NC	LENOIR CO	57,274	.	.	.	0.109	0.092	.	.
NC	LINCOLN CO	50,319	.	.	.	0.117	0.090	.	.
NC	MC DOWELL CO	35,681	.	.	.	.	.	48	.
NC	MARTIN CO	25,078	.	.	.	0.094	0.084	.	0.006
NC	MECKLENBURG CO	511,433	5.0	.	0.0177	0.135	0.110	73	0.011
NC	MITCHELL CO	14,433	.	.	.	.	.	52	.
NC	NEW HANOVER CO	120,284	.	.	.	0.102	0.087	41	0.026
NC	NORTHAMPTON CO	20,798	.	.	.	0.109	0.087	.	.
NC	ONSLOW CO	149,838	.	.	.	.	.	42	.
NC	ORANGE CO	93,851	3.8	.	.	.	.	.	.
NC	PASQUOTANK CO	31,298	.	.	.	.	.	40	.
NC	PERSON CO	30,180	.	.	.	0.117	0.093	.	0.016
NC	PITT CO	107,924	.	.	.	0.109	0.091	42	.

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
NC	ROCKINGHAM CO	86,064	.	.	.	0.112	.	.	.
NC	ROWAN CO	110,605	0.8	.	.	0.126	0.101	.	0.012
NC	SWAIN CO	11,268	.	.	.	0.090	0.078	39	0.006
NC	WAKE CO	423,380	5.4	.	.	0.124	0.106	63	.
NC	WAYNE CO	104,666	.	.	.	.	.	44	.
NC	YANCEY CO	15,419	.	.	.	0.083	.	.	.
ND	BILLINGS CO	1,108	.	.	.	0.060	.	.	0.004
ND	BURLEIGH CO	60,131	.	.	.	.	.	32	.
ND	CASS CO	102,874	.	.	.	0.068	.	.	0.005
ND	DUNN CO	4,005	.	.	.	.	.	.	0.005
ND	GRAND FORKS CO	70,683	.	.	.	.	.	81	.
ND	MC KENZIE CO	6,383	.	.	.	0.065	.	.	0.013
ND	MC LEAN CO	10,457	.	.	.	.	.	.	0.008
ND	MERCER CO	9,808	.	.	0.0047	0.069	0.059	28	0.018
ND	MORTON CO	23,700	.	.	.	.	.	.	0.116
ND	OLIVER CO	2,381	.	.	0.0031	0.067	0.058	.	0.014
ND	STARK CO	22,832	.	.	.	.	.	40	.
ND	STEELE CO	2,420	.	.	0.0026	0.068	0.059	48	0.010
ND	WILLIAMS CO	21,129	.	.	.	.	.	.	0.013
OH	ADAMS CO	25,371	.	.	.	.	.	.	0.036
OH	ALLEN CO	109,755	.	.	.	0.102	0.089	46	0.017
OH	ASHTABULA CO	99,821	.	.	.	0.116	0.096	.	0.020
OH	ATHENS CO	59,549	.	.	.	.	.	39	.
OH	BELMONT CO	71,074	.	.	.	.	.	54	.
OH	BUTLER CO	291,479	.	0.02	.	0.118	0.092	74	0.022
OH	CLARK CO	147,548	.	.	.	0.125	0.100	.	0.016
OH	CLERMONT CO	150,187	.	.	.	0.117	0.099	.	0.021
OH	CLINTON CO	35,415	.	.	.	0.118	0.103	.	.
OH	COLUMBIANA CO	108,276	.	.	0.0146	.	.	88	0.049
OH	CUYAHOGA CO	1,412,140	6.4	0.65	0.0273	0.113	0.094	117	0.037
OH	DELAWARE CO	66,929	.	.	.	0.119	0.102	.	.
OH	FRANKLIN CO	961,437	3.7	0.03	.	0.113	0.096	83	0.019
OH	FULTON CO	38,498	.	0.35	.	.	.	.	.
OH	GEAUGA CO	81,129	.	.	.	0.117	0.088	.	.
OH	GREENE CO	136,731	.	.	.	0.116	0.097	43	.
OH	HAMILTON CO	866,228	4.4	0.01	0.0293	0.124	0.092	84	0.029
OH	HANCOCK CO	65,536	.	.	.	.	.	44	.
OH	JEFFERSON CO	80,298	3.6	.	.	0.089	0.077	65	0.047
OH	KNOX CO	47,473	.	.	.	0.102	0.091	.	.
OH	LAKE CO	215,499	1.6	.	.	0.123	0.100	50	0.057
OH	LAWRENCE CO	61,834	.	.	.	0.136	0.101	50	0.020
OH	LICKING CO	128,300	.	.	.	0.112	0.096	.	.
OH	LOGAN CO	42,310	.	0.24	.	0.099	0.081	.	.
OH	LORAIN CO	271,126	.	.	.	0.105	0.088	80	0.020
OH	LUCAS CO	462,361	2.1	.	.	0.106	0.090	51	0.024
OH	MADISON CO	37,068	.	.	.	0.112	0.099	.	.
OH	MAHONING CO	264,806	.	.	.	0.114	0.097	62	0.023
OH	MEDINA CO	122,354	.	.	.	0.106	0.092	.	.
OH	MEIGS CO	22,987	.	.	.	.	.	.	0.026
OH	MIAMI CO	93,182	.	.	.	0.109	0.090	.	.
OH	MONROE CO	15,497	.	.	.	.	.	54	.
OH	MONTGOMERY CO	573,809	3.4	0.01	.	0.112	0.093	61	0.022
OH	MORGAN CO	14,194	.	.	.	.	.	.	0.070
OH	OTTAWA CO	40,029	.	.	.	.	.	54	.

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
OH	PORTAGE CO	142,585	.	.	.	0.110	0.097	.	.
OH	PREBLE CO	40,113	.	.	.	0.102	0.081	.	.
OH	RICHLAND CO	126,137	.	.	.	.	.	66	.
OH	SANDUSKY CO	61,963	.	.	.	.	.	72	.
OH	SCIOTO CO	80,327	.	.	.	.	.	54	0.014
OH	SENECA CO	59,733	.	.	.	.	.	56	.
OH	STARK CO	367,585	3.5	.	.	0.115	0.098	58	0.029
OH	SUMMIT CO	514,990	3.0	0.02	.	0.114	0.097	70	0.044
OH	TRUMBULL CO	227,813	.	.	.	0.115	0.101	63	.
OH	TUSCARAWAS CO	84,090	.	.	.	.	.	.	0.049
OH	UNION CO	31,969	.	.	.	0.112	0.088	.	.
OH	WARREN CO	113,909	.	.	.	0.123	0.097	.	.
OH	WASHINGTON CO	62,254	.	.	.	0.115	0.091	68	.
OH	WOOD CO	113,269	.	.	.	0.097	0.083	.	.
OH	WYANDOT CO	22,254	.	.	.	.	.	92	.
OK	CLEVELAND CO	174,253	2.6	.	0.0124	0.111	0.093	.	.
OK	COMANCHE CO	111,486	1.8	.	.	0.093	0.085	.	.
OK	GARFIELD CO	56,735	.	.	0.0079	.	.	.	.
OK	KAY CO	48,056	.	.	.	.	.	41	0.022
OK	LATIMER CO	10,333	.	.	.	0.108	0.093	.	.
OK	MC CLAIN CO	22,795	.	.	.	0.104	0.087	.	.
OK	MAYES CO	33,366	.	.	.	0.106	0.087	.	.
OK	MUSKOGEE CO	68,078	.	.	0.0075	0.091	0.081	70	0.016
OK	OKLAHOMA CO	599,611	4.1	.	0.0099	0.109	0.090	46	0.007
OK	OKMULGEE CO	36,490	.	.	.	0.106	0.092	.	.
OK	TULSA CO	503,341	4.7	.	0.0150	0.119	0.093	56	0.059
OR	CLACKAMAS CO	278,850	.	.	.	0.136	0.081	36	.
OR	COLUMBIA CO	37,557	.	.	.	0.093	0.066	.	.
OR	DESCHUTES CO	74,958	4.4	.	.	.	.	69	.
OR	JACKSON CO	146,389	5.3	0.03	.	0.117	0.085	70	.
OR	JOSEPHINE CO	62,649	4.7	.	.	.	.	51	.
OR	KLAMATH CO	57,702	4.5	.	.	.	.	80	.
OR	LAKE CO	7,186	.	.	.	.	.	75	.
OR	LANE CO	282,912	4.6	0.02	.	0.106	0.078	78	.
OR	MARION CO	228,483	4.6	.	.	0.112	0.077	.	.
OR	MULTNOMAH CO	583,887	4.6	0.05	.	.	.	59	.
OR	UMATILLA CO	59,249	.	.	.	.	.	68	.
OR	UNION CO	23,598	.	.	.	.	.	57	.
OR	YAMHILL CO	65,551	.	0.30	.	.	.	.	.
PA	ADAMS CO	78,274	0.6	.	0.0034	.	.	.	.
PA	ALLEGHENY CO	1,336,449	3.8	0.06	0.0310	0.118	0.104	130	0.065
PA	ARMSTRONG CO	73,478	.	.	.	0.113	0.100	.	.
PA	BEAVER CO	186,093	1.5	0.05	0.0187	0.116	0.098	86	0.094
PA	BERKS CO	336,523	3.2	0.71	0.0208	0.106	0.092	58	0.025
PA	BLAIR CO	130,542	1.2	.	0.0126	0.114	0.098	58	0.032
PA	BUCKS CO	541,174	3.5	.	0.0180	0.115	0.096	59	0.024
PA	CAMBRIA CO	163,029	3.1	0.04	0.0152	0.124	0.098	64	0.027
PA	CARBON CO	56,846	.	0.12	.	.	.	.	.
PA	CENTRE CO	123,786	.	.	.	0.113	0.092	.	.
PA	CHESTER CO	376,396	.	.	.	.	.	66	.
PA	CLEARFIELD CO	78,097	.	.	.	0.116	0.101	.	.
PA	DAUPHIN CO	237,813	3.0	0.04	0.0185	0.116	0.097	65	0.021
PA	DELAWARE CO	547,651	.	0.04	0.0191	0.125	0.099	72	0.035
PA	ERIE CO	275,572	5.1	.	0.0142	0.122	0.098	64	0.068

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
PA	FRANKLIN CO	121,082	.	.	.	0.120	0.104	.	.
PA	GREENE CO	39,550	.	.	.	0.110	0.100	.	0.021
PA	LACKAWANNA CO	219,039	1.9	.	0.0160	0.108	0.089	54	0.026
PA	LANCASTER CO	422,822	1.9	0.04	0.0149	0.119	0.101	62	0.020
PA	LAWRENCE CO	96,246	2.4	.	0.0188	0.096	0.077	93	0.032
PA	LEHIGH CO	291,130	2.9	.	0.0163	0.106	0.095	51	0.030
PA	LUZERNE CO	328,149	3.1	.	0.0148	0.102	0.088	53	0.022
PA	LYCOMING CO	118,710	.	.	.	0.099	0.084	.	0.021
PA	MERCER CO	121,003	.	0.04	.	0.121	0.106	75	0.029
PA	MONROE CO	95,709	1.0	.	.	0.108	0.091	.	0.014
PA	MONTGOMERY CO	678,111	1.8	0.04	0.0193	0.126	0.103	54	0.022
PA	NORTHAMPTON CO	247,105	2.5	0.00	0.0170	0.111	0.089	37	0.033
PA	PERRY CO	41,172	.	.	0.0060	0.110	0.092	53	0.012
PA	PHILADELPHIA CO	1,585,577	4.9	1.64	0.0340	0.116	0.095	105	0.030
PA	SCHUYLKILL CO	152,585	1.4	.	.	.	.	.	0.026
PA	WARREN CO	45,050	.	.	.	.	.	.	0.098
PA	WASHINGTON CO	204,584	2.0	.	0.0172	0.127	0.108	62	0.043
PA	WESTMORELAND CO	370,321	2.3	0.04	0.0178	0.101	0.082	71	0.039
PA	YORK CO	339,574	2.4	0.05	0.0186	0.112	0.095	60	0.023
RI	KENT CO	161,135	.	.	.	0.109	0.087	32	.
RI	PROVIDENCE CO	596,270	4.7	.	0.0249	0.098	0.077	59	0.027
RI	WASHINGTON CO	110,006	.	.	.	0.101	0.080	.	.
SC	ABBEVILLE CO	23,862	.	.	.	0.114	0.091	.	.
SC	AIKEN CO	120,940	.	0.02	.	0.111	0.098	51	.
SC	ANDERSON CO	145,196	.	.	.	0.125	0.102	.	.
SC	BARNWELL CO	20,293	.	.	.	0.111	0.095	44	.
SC	BEAUFORT CO	86,425	.	0.03	.	.	.	.	.
SC	BERKELEY CO	128,776	.	.	.	0.106	0.083	.	.
SC	CHARLESTON CO	295,039	2.9	0.03	0.0095	0.096	0.081	57	0.013
SC	CHEROKEE CO	44,506	.	.	.	0.120	0.096	.	.
SC	CHESTER CO	32,170	.	.	.	0.122	0.093	.	.
SC	COLLETON CO	34,377	.	.	.	0.099	0.087	.	.
SC	DARLINGTON CO	61,851	.	.	.	0.108	0.089	.	.
SC	EDGEFIELD CO	18,375	.	.	.	0.119	0.091	.	.
SC	FAIRFIELD CO	22,295	.	.	.	.	.	53	.
SC	FLORENCE CO	114,344	.	0.01	.	.	.	.	.
SC	GEORGETOWN CO	46,302	.	0.02	.	.	.	75	0.004
SC	GREENVILLE CO	320,167	4.3	0.02	0.0166	.	.	58	0.015
SC	GREENWOOD CO	59,567	.	0.01	.	.	.	.	.
SC	LEXINGTON CO	167,611	.	.	.	.	.	188	0.022
SC	OCONEE CO	57,494	.	.	.	0.106	0.093	.	0.006
SC	PICKENS CO	93,894	.	.	.	0.109	0.096	.	.
SC	RICHLAND CO	285,720	3.7	0.01	0.0137	0.116	0.098	145	0.010
SC	SPARTANBURG CO	226,800	.	0.01	.	0.112	0.097	48	.
SC	SUMTER CO	102,637	.	0.01	.	.	.	.	.
SC	UNION CO	30,337	.	.	.	0.105	0.087	.	.
SC	WILLIAMSBURG CO	36,815	.	.	.	0.091	0.079	.	.
SC	YORK CO	131,497	.	0.02	.	0.114	0.087	57	.
SD	BROOKINGS CO	25,207	.	.	.	.	.	54	.
SD	MINNEHAHA CO	123,809	.	.	.	.	.	54	.
SD	PENNINGTON CO	81,343	.	.	.	.	.	113	.
TN	ANDERSON CO	68,250	.	.	.	0.107	0.088	.	0.024
TN	BLOUNT CO	85,969	.	.	.	0.120	0.110	64	0.038
TN	BRADLEY CO	73,712	.	.	0.0145	.	.	50	0.031

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (μg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (μg/m³)	SO_2 24-hr (ppm)
TN	COFFEE CO	40,339	.	.	0.0045	0.096	0.081	.	0.015
TN	DAVIDSON CO	510,784	5.6	.	0.0109	0.120	0.091	66	0.024
TN	HAMBLEN CO	50,480	.	.	.	.	.	.	0.036
TN	HAMILTON CO	285,536	.	.	.	0.131	0.103	57	.
TN	HAWKINS CO	44,565	.	.	.	.	.	.	0.057
TN	HAYWOOD CO	19,437	.	.	.	0.128	0.098	.	0.009
TN	HUMPHREYS CO	15,795	.	.	.	.	.	.	0.019
TN	JEFFERSON CO	33,016	.	.	.	0.126	0.107	.	.
TN	KNOX CO	335,749	3.9	0.00	.	0.138	0.114	64	.
TN	LAWRENCE CO	35,303	.	.	.	0.105	0.090	40	.
TN	MC MINN CO	42,383	.	.	0.0151	.	.	84	0.045
TN	MADISON CO	77,982	.	0.01	.	.	.	38	.
TN	MAURY CO	54,812	.	.	.	.	.	75	.
TN	MONTGOMERY CO	100,498	.	.	.	.	.	45	0.020
TN	POLK CO	13,643	.	.	.	.	.	.	0.111
TN	PUTNAM CO	51,373	.	.	.	0.106	0.090	.	.
TN	ROANE CO	47,227	.	0.33	.	.	.	67	0.022
TN	RUTHERFORD CO	118,570	.	.	.	0.104	0.087	.	.
TN	SEVIER CO	51,043	.	.	.	0.120	0.106	.	.
TN	SHELBY CO	826,330	5.4	2.02	0.0285	0.130	0.103	65	0.041
TN	STEWART CO	9,479	.	.	.	.	.	.	0.013
TN	SULLIVAN CO	143,596	3.4	0.31	0.0170	0.115	0.097	50	0.039
TN	SUMNER CO	103,281	2.1	.	0.0131	0.127	0.107	87	0.046
TN	UNION CO	13,694	.	.	.	.	.	174	.
TN	WASHINGTON CO	92,315	.	.	.	.	.	47	.
TN	WILLIAMSON CO	81,021	.	1.25	.	0.114	0.096	.	.
TN	WILSON CO	67,675	.	.	.	0.105	0.085	.	.
TX	BEXAR CO	1,185,394	4.6	.	0.0240	0.121	0.090	61	.
TX	BOWIE CO	81,665	.	.	.	.	.	.	0.009
TX	BRAZORIA CO	191,707	.	.	.	0.111	0.090	.	.
TX	BREWSTER CO	8,681	.	.	.	0.077	0.070	.	.
TX	CAMERON CO	260,120	3.2	0.01	.	0.081	0.071	62	0.005
TX	CASS CO	29,982	.	.	.	.	.	.	0.008
TX	COLLIN CO	264,036	.	0.67	.	0.118	0.097	75	.
TX	DALLAS CO	1,852,810	4.4	0.10	0.0200	0.118	0.094	68	0.006
TX	DENTON CO	273,525	.	.	.	0.122	0.101	.	.
TX	ELLIS CO	85,167	.	0.30	.	0.130	0.097	67	0.023
TX	EL PASO CO	591,610	8.3	0.14	0.0310	0.125	0.092	258	0.027
TX	GALVESTON CO	217,399	.	.	0.0030	0.168	0.113	69	0.039
TX	GREGG CO	104,948	.	.	.	0.129	0.104	.	.
TX	HARRIS CO	2,818,199	5.2	.	0.0230	0.203	0.121	129	0.024
TX	HIDALGO CO	383,545	.	.	.	0.086	0.071	.	.
TX	JEFFERSON CO	239,397	.	.	0.0079	0.143	0.096	.	0.050
TX	LUBBOCK CO	222,636	.	.	.	.	.	44	.
TX	MARION CO	9,984	.	.	.	0.094	0.076	.	.
TX	NUECES CO	291,145	.	.	.	0.102	0.082	68	0.029
TX	ORANGE CO	80,509	.	.	0.0089	0.110	0.076	.	.
TX	SMITH CO	151,309	.	.	.	0.108	0.090	.	.
TX	TARRANT CO	1,170,103	2.5	.	0.0140	0.128	0.102	50	.
TX	TRAVIS CO	576,407	1.1	.	0.0040	0.115	0.088	.	.
TX	VICTORIA CO	74,361	.	.	.	0.097	0.078	.	.
TX	WEBB CO	133,239	3.9	0.02	.	0.097	0.067	.	.
UT	CACHE CO	70,183	5.0	.	.	0.080	0.068	76	.
UT	DAVIS CO	187,941	3.1	.	0.0201	0.122	0.096	.	0.010

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
UT	GRAND CO	6,620	.	.	.	.	.	52	.
UT	SALT LAKE CO	725,956	5.7	0.09	0.0272	0.124	0.095	105	0.010
UT	SAN JUAN CO	12,621	.	.	.	0.078	0.071	.	.
UT	UTAH CO	263,590	6.0	.	0.0239	0.114	0.090	80	.
UT	WEBER CO	158,330	7.5	.	0.0243	0.111	0.090	71	.
VT	BENNINGTON CO	35,845	.	.	.	0.085	0.075	.	.
VT	CHITTENDEN CO	131,761	2.4	.	0.0175	0.082	0.073	54	0.008
VT	RUTLAND CO	62,142	2.4	.	0.0127	.	.	48	0.029
VT	WASHINGTON CO	54,928	.	.	.	.	.	49	.
VA	ARLINGTON CO	170,936	2.3	.	0.0253	0.112	0.098	.	.
VA	CAROLINE CO	19,217	.	.	.	0.121	0.095	.	.
VA	CARROLL CO	26,594	.	.	.	.	.	36	.
VA	CHARLES CITY CO	6,282	.	.	0.0117	0.116	0.092	.	0.019
VA	CHESTERFIELD CO	209,274	.	.	.	0.116	0.090	.	.
VA	CULPEPER CO	27,791	.	.	.	.	.	39	.
VA	FAIRFAX CO	818,584	3.3	0.03	0.0234	0.127	0.103	45	0.025
VA	FAUQUIER CO	48,741	.	.	.	0.111	0.093	.	.
VA	FREDERICK CO	45,723	.	.	.	0.113	0.098	.	.
VA	HANOVER CO	63,306	.	.	.	0.125	0.100	.	.
VA	HENRICO CO	217,881	.	.	.	0.121	0.096	.	.
VA	KING WILLIAM CO	10,913	.	.	.	.	.	48	.
VA	LOUDOUN CO	86,129	.	.	.	0.116	0.102	.	.
VA	MADISON CO	11,949	.	.	.	0.115	0.098	.	.
VA	NORTHUMBERLAND CO	10,524	.	.	.	.	.	44	.
VA	PRINCE WILLIAM CO	215,686	.	.	0.0146	0.124	0.098	50	.
VA	ROANOKE CO	79,332	.	.	0.0141	0.126	0.099	.	0.009
VA	ROCKINGHAM CO	57,482	.	.	.	.	.	55	0.009
VA	STAFFORD CO	61,236	.	.	.	0.126	0.092	.	.
VA	TAZEWELL CO	45,960	.	.	.	.	.	38	.
VA	WARREN CO	26,142	.	.	.	.	.	45	.
VA	WISE CO	39,573	.	.	.	.	.	40	.
VA	WYTHE CO	25,466	.	.	.	0.098	0.087	.	.
VA	ALEXANDRIA	111,183	3.5	.	0.0272	0.114	0.094	.	0.022
VA	CHARLOTTESVILLE	40,341	.	.	.	.	.	49	.
VA	CHESAPEAKE	151,976	.	.	.	.	.	48	.
VA	FREDERICKSBURG	19,027	.	.	.	.	.	41	.
VA	HAMPTON	133,793	.	.	.	0.104	0.090	47	0.018
VA	NEWPORT NEWS	170,045	2.8	.	.	.	.	.	.
VA	NORFOLK	261,229	6.2	.	0.0194	.	.	49	0.021
VA	RICHMOND	203,056	1.9	0.01	0.0212	.	.	53	0.016
VA	ROANOKE	96,397	3.9	.	.	.	.	64	.
VA	SUFFOLK	52,141	.	.	.	0.105	0.087	.	.
VA	WINCHESTER	21,947	.	.	.	.	.	48	.
WA	ASOTIN CO	17,605	.	.	.	.	.	86	.
WA	BENTON CO	112,560	.	.	.	.	.	90	.
WA	CHELAN CO	52,250	.	.	.	.	.	46	.
WA	CLALLAM CO	56,464	.	.	.	0.062	0.046	39	0.007
WA	CLARK CO	238,053	5.5	.	0.0121	0.097	0.070	26	.
WA	COWLITZ CO	82,119	.	.	0.0073	0.094	0.070	45	.
WA	KING CO	1,507,319	5.5	2.03	0.0204	0.135	0.085	67	0.016
WA	KITSAP CO	189,731	.	.	.	.	.	24	.
WA	KITTITAS CO	26,725	.	.	.	.	.	72	.
WA	KLICKITAT CO	16,616	.	.	.	0.077	0.063	.	.
WA	LEWIS CO	59,358	.	.	.	0.065	0.056	.	.

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
WA	PIERCE CO	586,203	5.8	.	.	0.126	0.085	62	0.020
WA	SKAGIT CO	79,555	.	.	.	0.052	0.042	.	0.042
WA	SNOHOMISH CO	465,642	5.1	.	.	.	.	44	0.009
WA	SPOKANE CO	361,364	6.8	.	.	0.082	0.070	89	.
WA	STEVENS CO	30,948	.	.	.	.	.	82	.
WA	THURSTON CO	161,238	4.8	.	.	0.105	0.074	47	.
WA	WALLA WALLA CO	48,439	.	.	.	.	.	136	.
WA	WHATCOM CO	127,780	.	.	.	0.070	0.056	32	0.015
WA	YAKIMA CO	188,823	5.1	.	.	.	.	81	.
WV	BROOKE CO	26,992	.	.	.	.	.	63	0.062
WV	CABELL CO	96,827	.	.	.	0.136	0.105	.	0.023
WV	FAYETTE CO	47,952	.	.	.	.	.	45	.
WV	GREENBRIER CO	34,693	.	.	.	0.113	0.102	.	0.014
WV	HANCOCK CO	35,233	13.2	.	0.0145	0.099	0.088	119	0.067
WV	KANAWHA CO	207,619	2.0	.	0.0221	0.115	0.091	42	0.037
WV	MARSHALL CO	37,356	.	.	.	.	.	53	0.061
WV	MONONGALIA CO	75,509	.	.	.	.	.	48	0.041
WV	OHIO CO	50,871	3.5	.	.	0.104	0.087	56	0.040
WV	PUTNAM CO	42,835	.	.	.	.	.	53	.
WV	WAYNE CO	41,636	.	.	.	.	.	43	0.038
WV	WOOD CO	86,915	.	.	.	0.111	0.094	54	0.089
WI	BROWN CO	194,594	.	.	.	0.098	0.077	.	0.011
WI	COLUMBIA CO	45,088	.	.	.	0.089	0.076	.	.
WI	DANE CO	367,085	.	.	.	0.089	0.076	79	0.016
WI	DODGE CO	76,559	.	.	.	0.100	0.081	.	.
WI	DOOR CO	25,690	.	.	.	0.114	0.092	.	.
WI	DOUGLAS CO	41,758	.	.	.	.	.	44	.
WI	FLORENCE CO	4,590	.	.	.	0.086	0.076	.	.
WI	FOND DU LAC CO	90,083	.	.	.	0.094	0.078	.	.
WI	JEFFERSON CO	67,783	.	.	.	0.093	0.082	.	.
WI	KENOSHA CO	128,181	.	.	.	0.127	0.093	.	.
WI	KEWAUNEE CO	18,878	.	.	.	0.107	0.091	.	.
WI	MANITOWOC CO	80,421	.	.	0.0034	0.114	0.097	.	.
WI	MARATHON CO	115,400	.	.	.	0.098	0.077	59	0.031
WI	MILWAUKEE CO	959,275	2.5	.	0.0212	0.129	0.093	64	0.022
WI	ONEIDA CO	31,679	.	.	.	0.086	0.070	.	0.044
WI	OUTAGAMIE CO	140,510	.	.	.	0.086	0.072	.	.
WI	OZAUKEE CO	72,831	.	.	.	0.134	0.095	.	.
WI	POLK CO	34,773	0.6	.	.	0.090	0.078	.	.
WI	RACINE CO	175,034	3.0	.	.	0.124	0.084	.	.
WI	ROCK CO	139,510	.	.	.	0.100	0.084	.	.
WI	ST CROIX CO	50,251	.	.	.	0.090	0.073	.	.
WI	SAUK CO	46,975	.	.	0.0042	0.089	0.080	.	.
WI	SHEBOYGAN CO	103,877	.	.	.	0.134	0.095	.	.
WI	VERNON CO	25,617	.	.	.	0.082	0.073	41	.
WI	VILAS CO	17,707	.	.	.	.	.	27	.
WI	WALWORTH CO	75,000	.	.	.	0.100	0.084	.	.
WI	WASHINGTON CO	95,328	.	.	.	0.103	0.079	.	.
WI	WAUKESHA CO	304,715	2.1	.	.	0.097	0.077	62	.
WI	WINNEBAGO CO	140,320	.	.	.	0.084	0.074	.	.
WI	WOOD CO	73,605	.	.	.	.	.	.	0.020
WY	ALBANY CO	30,797	.	.	.	.	.	44	.
WY	CAMPBELL CO	29,370	.	.	.	.	.	66	.
WY	CONVERSE CO	11,128	.	.	.	.	.	77	.

Table A-12. Maximum Air Quality Concentrations by County, 1998 (continued)

State	County	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 (1-hr) 2nd Max (ppm)	O_3 (8-hr) 4th Max (ppm)	PM_{10} 2nd Max (µg/m³)	SO_2 24-hr (ppm)
WY	FREMONT CO	33,662	.	.	.	.	.	70	.
WY	LARAMIE CO	73,142	.	.	.	.	.	31	.
WY	NATRONA CO	61,226	.	.	.	.	.	37	.
WY	PARK CO	23,178	.	.	.	.	.	51	.
WY	SHERIDAN CO	23,562	.	.	.	.	.	82	.
WY	SWEETWATER CO	38,823	.	.	.	.	.	70	.
WY	TETON CO	11,172	.	.	.	0.072	0.066	64	.

CO = Highest second maximum non-overlapping 8-hour concentration *(Applicable NAAQS is 9 ppm)*
Pb = Highest quarterly maximum concentration *(Applicable NAAQS is 1.5 µg/m3)*
NO_2 = Highest arithmetic mean concentration *(Applicable NAAQS is 0.053 ppm)*
O_3 (1-hr) = Highest second daily maximum 1-hour concentration *(Applicable NAAQS is 0.12 ppm)*
O_3 (8-hr) = Highest fourth daily maximum 8-hour concentration *(Applicable NAAQS is 0.08 ppm)*
PM_{10} = Highest second maximum 24-hour concentration *(Applicable NAAQS is 150 µg/m3)*
SO_2 = Highest second maximum 24-hour concentration *(Applicable NAAQS is 0.14 ppm)*
PPM = Units are parts per million
µg/m³ = Units are micrograms per cubic meter

Data from exceptional events not included.

Note: The reader is cautioned that this summary is not adequate in itself to numerically rank counties according to their air quality. The monitoring data represent the quality of air in the vicinity of the monitoring site but may not necessarily represent urban-wide air quality.

Table A-13. Maximum Air Quality Concentrations by Metropolitan Statistical Area, 1998

Metropolitan Statistical Area	1990 Population	CO 8-hr (ppm)	Pb QMax (μg/m³)	NO_2 AM (ppm)	O_3 1-hr (ppm)	O_3 8-hr (ppm)	PM_{10} Wtd AM (μg/m³)	PM_{10} 2nd Max (μg/m³)	SO_2 AM (ppm)	SO_2 24-hr (ppm)
ABILENE, TX	119,655	ND	ND	ND	ND	ND	ND	ND	ND	ND
AGUADILLA, PR	128,172	ND	ND	ND	ND	ND	ND	ND	ND	ND
AKRON, OH	657,575	3	0.02	ND	0.11	0.10	24	70	0.010	0.044
ALBANY, GA	112,561	ND	ND	ND	ND	ND	IN	66	0.001	0.006
ALBANY-SCHENECTADY-TROY, NY	861,424	4	0.03	0.015	0.10	0.08	21	58	0.004	0.016
ALBUQUERQUE, NM	589,131	6	ND	0.016	0.09	0.07	17*	87	ND	ND
ALEXANDRIA, LA	131,556	ND	ND	ND	ND	ND	ND	ND	ND	ND
ALLENTOWN-BETHLEHEM-EASTON, PA	595,081	3	0.12	0.017	0.11	0.10	IN	41	0.011	0.033
ALTOONA, PA	130,542	1	ND	0.013	0.11	0.10	IN	58	0.008	0.032
AMARILLO, TX	187,547	ND	ND	ND	ND	ND	ND	ND	ND	ND
ANCHORAGE, AK	226,338	8	ND	ND	ND	ND	26	98	ND	ND
ANN ARBOR, MI	490,058	ND	ND	ND	0.10	0.09	ND	ND	ND	ND
ANNISTON, AL	116,034	ND	ND	ND	ND	ND	IN	IN	ND	ND
APPLETON-OSHKOSH-NEENAH, WI	315,121	ND	ND	ND	0.09	0.07	ND	ND	ND	ND
ARECIBO, PR	155,005	ND	ND	ND	ND	ND	ND	ND	ND	ND
ASHEVILLE, NC	191,774	ND	ND	ND	0.11	0.09	20	55	ND	ND
ATHENS, GA	126,262	ND	ND	ND	ND	ND	ND	ND	ND	ND
ATLANTA, GA	2,959,950	4	0.01	0.024	0.16	0.13	31	71	0.005	0.019
ATLANTIC-CAPE MAY, NJ	319,416	ND	ND	ND	0.12	0.09	ND	ND	0.003	0.010
AUGUSTA-AIKEN, GA-SC	415,184	ND	0.02	ND	0.12	0.10	28	60	0.003	0.011
AURORA-ELGIN, IL	356,884	ND	ND	ND	ND	ND	ND	ND	ND	ND
AUSTIN-SAN MARCOS, TX	846,227	1	ND	0.004	0.12	0.09	ND	ND	ND	ND
BAKERSFIELD, CA	543,477	3	0.00	0.024	0.16	0.12	40	131	ND	ND
BALTIMORE, MD	2,382,172	5	0.01	0.026	0.14	0.11	31	65	0.007	0.020
BANGOR, ME	91,629	ND	ND	ND	0.09	0.08	18	40	ND	ND
BARNSTABLE-YARMOUTH, MA	134,954	ND	ND	ND	ND	ND	ND	ND	ND	ND
BATON ROUGE, LA	528,264	4	0.05	0.019	0.13	0.11	32*	64*	0.007	0.036
BEAUMONT-PORT ARTHUR, TX	361,226	ND	ND	0.009	0.14	0.10	ND	ND	0.008	0.050
BELLINGHAM, WA	127,780	ND	ND	ND	0.07	0.06	13	31	0.005	0.015
BENTON HARBOR, MI	161,378	ND	ND	ND	0.14	0.09	ND	ND	ND	ND
BERGEN-PASSAIC, NJ	1,278,440	4	ND	IN	0.10	0.09	38*	59*	0.004	0.018
BILLINGS, MT	113,419	5	ND	ND	ND	ND	ND	ND	0.006	0.032
BILOXI-GULFPORT-PASCAGOULA, MS	312,368	ND	ND	0.004	0.12	0.10	IN	IN	0.003	0.022
BINGHAMTON, NY	264,497	ND	ND	ND	ND	ND	IN	51	ND	ND
BIRMINGHAM, AL	840,140	4	ND	0.009	0.14	0.11	36	109	0.007	0.032
BISMARCK, ND	83,831	ND	ND	ND	ND	ND	16	32	0.006	0.116
BLOOMINGTON, IN	108,978	ND	ND	ND	ND	ND	ND	ND	ND	ND
BLOOMINGTON-NORMAL, IL	129,180	ND	ND	ND	ND	ND	ND	ND	ND	ND
BOISE CITY, ID	295,851	4	ND	0.020	ND	ND	27	67	ND	ND
BOSTON, MA-NH	3,227,707	3	0.03	0.031	0.11	0.10	32	71	0.010	0.036
BOULDER-LONGMONT, CO	225,339	5	ND	ND	0.11	0.09	IN	45	ND	ND
BRAZORIA, TX	191,707	ND	ND	ND	0.11	0.09	ND	ND	ND	ND
BREMERTON, WA	189,731	ND	ND	ND	ND	ND	13	24	ND	ND
BRIDGEPORT, CT	443,722	3	ND	0.018	0.13	0.10	21	46	0.007	0.024
BROCKTON, MA	236,409	ND	ND	0.008	0.11	0.09	ND	ND	ND	ND
BROWNSVILLE-HARLINGEN-SAN BENITO, TX	260,120	3	0.01	ND	0.08	0.07	25*	62*	0.001	0.005
BRYAN-COLLEGE STATION, TX	121,862	ND	ND	ND	ND	ND	ND	ND	ND	ND
BUFFALO-NIAGARA FALLS, NY	1,189,288	3	0.04	0.021	0.11	0.09	24	55	0.009	0.049
BURLINGTON, VT	151,506	2	ND	0.018	ND	ND	21	54	0.002	0.008
CAGUAS, PR	279,501	ND	ND	ND	ND	ND	ND	ND	ND	ND
CANTON-MASSILLON, OH	394,106	4	ND	ND	0.12	0.10	26	58	0.007	0.029
CASPER, WY	61,226	ND	ND	ND	ND	ND	17	37	ND	ND
CEDAR RAPIDS, IA	168,767	3	ND	ND	0.08	0.07	25	76	0.005	0.020
CHAMPAIGN-URBANA, IL	173,025	ND	ND	ND	0.11	0.08	24	51	0.003	0.019

Table A-13. Maximum Air Quality Concentrations by Metropolitan Statistical Area, 1998 (continued)

Metropolitan Statistical Area	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 1-hr (ppm)	O_3 8-hr (ppm)	PM_{10} Wtd AM (µg/m³)	PM_{10} 2nd Max (µg/m³)	SO_2 AM (ppm)	SO_2 24-hr (ppm)
CHARLESTON-NORTH CHARLESTON, SC	506,875	3	0.03	0.010	0.11	0.08	25	57	0.003	0.013
CHARLESTON, WV	250,454	2	ND	0.022	0.12	0.09	23	53	0.011	0.037
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	1,162,093	5	0.02	0.018	0.14	0.11	32	72	0.004	0.011
CHARLOTTESVILLE, VA	131,107	ND	ND	ND	ND	ND	23	49	ND	ND
CHATTANOOGA, TN-GA	424,347	ND	ND	ND	0.13	0.10	29	56	ND	ND
CHEYENNE, WY	73,142	ND	ND	ND	ND	ND	IN	31	ND	ND
CHICAGO, IL	7,410,858	5	0.10	0.032	0.11	0.09	43	102	0.008	0.051
CHICO-PARADISE, CA	182,120	4	0.00	0.013	0.10	0.08	22	57	ND	ND
CINCINNATI, OH-KY-IN	1,526,092	4	0.01	0.029	0.12	0.10	32	84	0.010	0.040
CLARKSVILLE-HOPKINSVILLE, TN-KY	169,439	ND	ND	ND	0.11	0.09	23	45	0.006	0.020
CLEVELAND-LORAIN-ELYRIA, OH	2,202,069	6	0.65[a]	0.027	0.12	0.10	45	117	0.011	0.057
COLORADO SPRINGS, CO	397,014	4	0.01	0.020	0.07	0.06	26	72	0.003	0.011
COLUMBIA, MO	112,379	ND	ND	ND	ND	ND	ND	ND	ND	ND
COLUMBIA, SC	453,331	4	0.01	0.014	0.12	0.10	51	188	0.004	0.022
COLUMBUS, GA-AL	260,860	ND	0.58[b]	ND	0.11	0.09	30	55	ND	ND
COLUMBUS, OH	1,345,450	4	0.03[c]	ND	0.12	0.10	34	83	0.005	0.019
CORPUS CHRISTI, TX	349,894	ND	ND	ND	0.10	0.08	35*	68*	0.004	0.029
CUMBERLAND, MD-WV	101,643	ND	ND	ND	ND	ND	IN	IN	IN	IN
DALLAS, TX	2,676,248	4	0.67[d]	0.020	0.13	0.10	33*	75*	0.003	0.023
DANBURY, CT	193,597	ND	ND	ND	0.12	0.09	20	38	0.004	0.020
DANVILLE, VA	108,711	ND	ND	ND	ND	ND	ND	ND	ND	ND
DAVENPORT-MOLINE-ROCK ISLAND, IA-IL	350,861	ND	0.01	ND	0.10	0.08	30	121	0.004	0.018
DAYTON-SPRINGFIELD, OH	951,270	3	0.01	ND	0.13	0.10	28	61	0.005	0.022
DAYTONA BEACH, FL	399,413	ND	ND	ND	0.10	0.08	22	47	ND	ND
DECATUR, AL	131,556	ND	ND	ND	0.10	0.09	IN	IN	0.003	0.011
DECATUR, IL	117,206	ND	0.02	ND	0.09	0.08	32	68	0.005	0.020
DENVER, CO	1,622,980	5	0.11	0.035	0.12	0.10	36	99	0.004	0.023
DES MOINES, IA	392,928	10	ND	ND	0.08	0.07	30	66	ND	ND
DETROIT, MI	4,266,654	4	0.08	0.023	0.13	0.10	40	114	0.012	0.073
DOTHAN, AL	130,964	ND	ND	ND	ND	ND	IN	60	ND	ND
DOVER, DE	110,993	ND	ND	ND	0.13	0.10	ND	ND	ND	ND
DUBUQUE, IA	86,403	ND	ND	ND	ND	ND	ND	ND	ND	ND
DULUTH-SUPERIOR, MN-WI	239,971	4	ND	ND	0.08	0.07	20	81	ND	ND
DUTCHESS COUNTY, NY	259,462	ND	ND	ND	0.11	0.09	ND	ND	ND	ND
EAU CLAIRE, WI	137,543	ND	ND	ND	ND	ND	ND	ND	ND	ND
EL PASO, TX	591,610	8	0.14	0.031	0.13	0.09	49	198	0.006	0.027
ELKHART-GOSHEN, IN	156,198	ND	ND	ND	0.11	0.08	ND	ND	ND	ND
ELMIRA, NY	95,195	ND	ND	ND	0.09	0.08	ND	ND	0.003	0.011
ENID, OK	56,735	ND	ND	0.008	ND	ND	ND	ND	ND	ND
ERIE, PA	275,572	5	ND	0.014	0.12	0.10	IN	61	0.010	0.068
EUGENE-SPRINGFIELD, OR	282,912	5	0.02	ND	0.11	0.08	19	78	ND	ND
EVANSVILLE-HENDERSON, IN-KY	278,990	4	ND	0.018	0.12	0.10	29	67	0.015	0.071
FARGO-MOORHEAD, ND-MN	153,296	ND	ND	IN	0.07	IN	IN	IN	IN	IN
FAYETTEVILLE, NC	274,566	4	ND	ND	0.11	0.10	27	47	ND	ND
FAYETTEVILLE-SPRINGDALE-ROGERS, AR	259,462	ND	ND	ND	ND	ND	23*	44*	ND	ND
FITCHBURG-LEOMINSTER, MA	138,165	ND	ND	ND	ND	ND	ND	ND	ND	ND
FLAGSTAFF, AZ-UT	101,760	ND	ND	ND	0.08	0.07	ND	ND	ND	ND
FLINT, MI	430,459	ND	0.01	ND	0.11	0.09	IN	39	0.002	0.014
FLORENCE, AL	131,327	ND	ND	ND	ND	ND	IN	42	0.003	0.019
FLORENCE, SC	114,344	ND	0.01	ND	ND	ND	ND	ND	ND	ND
FORT COLLINS-LOVELAND, CO	186,136	4	ND	ND	0.09	0.08	IN	32	ND	ND
FORT LAUDERDALE, FL	1,255,488	4	0.03	0.010	0.11	0.08	22	51	0.003	0.017
FORT MYERS-CAPE CORAL, FL	335,113	ND	ND	ND	0.11	0.09	IN	36	ND	ND
FORT PIERCE-PORT ST. LUCIE, FL	251,071	ND	ND	ND	0.10	0.08	19	35	ND	ND

Table A-13. Maximum Air Quality Concentrations by Metropolitan Statistical Area, 1998 (continued)

Metropolitan Statistical Area	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 1-hr (ppm)	O_3 8-hr (ppm)	PM_{10} Wtd AM (µg/m³)	PM_{10} 2nd Max (µg/m³)	SO_2 AM (ppm)	SO_2 24-hr (ppm)
FORT SMITH, AR-OK	175,911	ND	ND	ND	ND	ND	25*	49*	ND	ND
FORT WALTON BEACH, FL	143,776	ND	ND	ND	ND	ND	ND	ND	ND	ND
FORT WAYNE, IN	456,281	3	ND	ND	0.11	0.09	34	66	ND	ND
FORT WORTH-ARLINGTON, TX	1,361,034	3	ND	0.014	0.13	0.10	26*	50*	ND	ND
FRESNO, CA	755,580	7	0.00	0.020	0.17	0.12	39	117	ND	ND
GADSDEN, AL	99,840	ND	ND	ND	ND	ND	31	63	ND	ND
GAINESVILLE, FL	181,596	ND	ND	ND	0.11	0.09	22	39	ND	ND
GALVESTON-TEXAS CITY, TX	217,399	ND	ND	0.003	0.17	0.11	25*	69*	0.004	0.039
GARY, IN	604,526	5	0.12	0.019	0.12	0.09	32	136	0.009	0.055
GLENS FALLS, NY	118,539	ND	ND	ND	ND	ND	ND	ND	ND	ND
GOLDSBORO, NC	104,666	ND	ND	ND	ND	ND	22	44	ND	ND
GRAND FORKS, ND-MN	103,181	ND	ND	ND	ND	ND	IN	81	ND	ND
GRAND JUNCTION, CO	93,145	5	ND	ND	ND	ND	20	51	ND	ND
GRAND RAPIDS-MUSKEGON-HOLLAND, MI	937,891	3	0.01	ND	0.12	0.10	20	55	0.002	0.008
GREAT FALLS, MT	77,691	5	ND	ND	ND	ND	ND	ND	0.003	0.010
GREELEY, CO	131,821	4	ND	ND	0.10	0.08	IN	39	ND	ND
GREEN BAY, WI	194,594	ND	ND	ND	0.10	0.08	ND	ND	0.003	0.011
GREENSBORO—WINSTON-SALEM—HIGH POINT	1,050,304	5	ND	0.017	0.12	0.10	27	61	0.006	0.023
GREENVILLE, NC	107,924	ND	ND	ND	0.11	0.09	21	42	ND	ND
GREENVILLE-SPARTANBURG-ANDERSON, SC	830,563	4	0.02	0.017	0.13	0.1	24	58	0.003	0.015
HAGERSTOWN, MD	121,393	ND	ND	ND	ND	ND	ND	ND	ND	ND
HAMILTON-MIDDLETOWN, OH	291,479	ND	0.02	ND	0.12	0.09	36	74	0.007	0.022
HARRISBURG-LEBANON-CARLISLE, PA	587,986	3	0.04	0.019	0.12	0.1	22*	65	0.006	0.021
HARTFORD, CT	1,157,585	7	ND	0.02	0.13	0.1	21	66	0.005	0.019
HATTIESBURG, MS	98,738	ND	ND	ND	ND	ND	ND	ND	ND	ND
HICKORY-MORGANTON-LENOIR, NC	292,409	ND	ND	ND	0.13	0.1	23	43	ND	ND
HONOLULU, HI	836,231	2	ND	0.004	0.06	0.05	16	39	0.002	0.009
HOUMA, LA	182,842	ND	ND	ND	0.11	0.09	ND	ND	ND	ND
HOUSTON, TX	3,322,025	5	ND	0.023	0.2	0.12	54*	129*	0.004	0.024
HUNTINGTON-ASHLAND, WV-KY-OH	312,529	7	ND	IN	0.14	0.11	35	92	0.009	0.038
HUNTSVILLE, AL	293,047	3	ND	ND	0.12	0.09	22	56	ND	ND
INDIANAPOLIS, IN	1,380,491	3	0.08[e]	0.019	0.13	0.1	30	58	0.006	0.024
IOWA CITY, IA	96,119	ND	ND	ND	ND	ND	ND	ND	ND	ND
JACKSON, MI	149,756	ND	ND	ND	ND	ND	ND	ND	ND	ND
JACKSON, MS	395,396	4	ND	ND	0.11	0.09	28	76	0.002	0.008
JACKSON, TN	90,801	ND	0.01	ND	ND	ND	IN	38	ND	ND
JACKSONVILLE, FL	906,727	3	0.02	0.015	0.1	0.1	IN	64	0.004	0.037
JACKSONVILLE, NC	149,838	ND	ND	ND	ND	ND	22	42	ND	ND
JAMESTOWN, NY	141,895	ND	ND	ND	0.11	0.1	23	62	0.007	0.032
JANESVILLE-BELOIT, WI	139,510	ND	ND	ND	0.1	0.08	ND	ND	ND	ND
JERSEY CITY, NJ	553,099	6	ND	0.027	0.12	0.09	27*	63*	0.009	0.024
JOHNSON CITY-KINGSPORT-BRISTOL, TN-VA	436,047	3	0.31	0.017	0.12	0.1	25	50	0.011	0.057
JOHNSTOWN, PA	241,247	3	0.04	0.015	0.12	0.1	IN	64	0.008	0.027
JONESBORO, AR	68,956	ND	ND	ND	ND	ND	27*	54*	ND	ND
JOPLIN, MO	134,910	ND	ND	ND	ND	ND	ND	ND	ND	ND
KALAMAZOO-BATTLE CREEK, MI	429,453	ND	ND	ND	0.11	0.09	IN	66	ND	ND
KANKAKEE, IL	96,255	ND	ND	ND	ND	ND	ND	ND	ND	ND
KANSAS CITY, MO-KS	1,582,875	5	0.01	0.013	0.13	0.1	35	64	0.005	0.015
KENOSHA, WI	128,181	ND	ND	ND	0.13	0.09	ND	ND	ND	ND
KILLEEN-TEMPLE, TX	255,301	ND	ND	ND	ND	ND	ND	ND	ND	ND
KNOXVILLE, TN	585,960	4	0	ND	0.14	0.11	48	174	0.007	0.038
KOKOMO, IN	96,946	ND	ND	ND	ND	ND	ND	ND	ND	ND
LA CROSSE, WI-MN	116,401	ND	ND	ND	ND	ND	ND	ND	ND	ND
LAFAYETTE, LA	344,853	ND	ND	ND	0.1	0.09	ND	ND	ND	ND

Table A-13. Maximum Air Quality Concentrations by Metropolitan Statistical Area, 1998 (continued)

Metropolitan Statistical Area	1990 Population	CO 8-hr (ppm)	Pb QMax ($\mu g/m^3$)	NO_2 AM (ppm)	O_3 1-hr (ppm)	O_3 8-hr (ppm)	PM_{10} Wtd AM ($\mu g/m^3$)	PM_{10} 2nd Max ($\mu g/m^3$)	SO_2 AM (ppm)	SO_2 24-hr (ppm)
LAFAYETTE, IN	161,572	ND	ND	ND	ND	ND	ND	ND	ND	ND
LAKE CHARLES, LA	168,134	ND	ND	0.005	0.12	0.09	ND	ND	0.003	0.012
LAKELAND-WINTER HAVEN, FL	405,382	ND	ND	ND	0.11	0.09	26	91	0.006	0.027
LANCASTER, PA	422,822	2	0.04	0.015	0.12	0.1	32*	62	0.006	0.02
LANSING-EAST LANSING, MI	432,674	ND	ND	ND	0.1	0.08	ND	ND	ND	ND
LAREDO, TX	133,239	4	0.02	ND	0.1	0.07	ND	ND	ND	ND
LAS CRUCES, NM	135,510	4	0.04	0.01	0.12	0.08	32	148	0.004	0.019
LAS VEGAS, NV-AZ	852,737	10	ND	ND	0.11	0.09	45	188	ND	ND
LAWRENCE, KS	81,798	ND	ND	ND	ND	ND	ND	ND	ND	ND
LAWRENCE, MA-NH	353,232	ND	ND	ND	0.1	0.08	IN	39	0.008	0.031
LAWTON, OK	111,486	2	ND	IN	0.09	0.09	IN	IN	ND	ND
LEWISTON-AUBURN, ME	93,679	ND	ND	ND	ND	ND	18	36	0.004	0.019
LEXINGTON, KY	405,936	3	ND	0.011	0.11	0.09	24	64	0.006	0.023
LIMA, OH	154,340	ND	ND	ND	0.1	0.09	24	46	0.003	0.017
LINCOLN, NE	213,641	6	ND	ND	0.07	0.06	IN	IN	ND	ND
LITTLE ROCK-NORTH LITTLE ROCK, AR	513,117	5	ND	0.011	0.1	0.08	34*	98*	0.002	0.006
LONGVIEW-MARSHALL, TX	193,801	ND	ND	ND	0.13	0.1	ND	ND	ND	ND
LOS ANGELES-LONG BEACH, CA	8,863,164	12	0.05	0.043	0.2	0.14	41	78	0.004	0.012
LOUISVILLE, KY-IN	948,829	6	ND	0.023	0.14	0.1	27	58	0.009	0.045
LOWELL, MA-NH	280,578	3	ND	ND	ND	ND	ND	ND	ND	ND
LUBBOCK, TX	222,636	ND	ND	ND	ND	ND	21*	44*	ND	ND
LYNCHBURG, VA	193,928	ND	ND	ND	ND	ND	IN	IN	ND	ND
MACON, GA	290,909	ND	ND	ND	0.14	0.11	30	59	0.003	0.019
MADISON, WI	367,085	IN	ND	ND	0.09	0.08	27	75	0.003	0.016
MANCHESTER, NH	50,000	ND	ND	ND	ND	ND	IN	IN	ND	ND
MANSFIELD, OH	174,007	ND	ND	ND	ND	ND	24	66	ND	ND
MAYAGUEZ, PR	237,143	ND	ND	ND	ND	ND	ND	ND	ND	ND
MCALLEN-EDINBURG-MISSION, TX	383,545	ND	ND	ND	0.09	0.07	ND	ND	ND	ND
MEDFORD-ASHLAND, OR	146,389	5	0.03	ND	0.12	0.09	20	70	ND	ND
MELBOURNE-TITUSVILLE-PALM BAY, FL	398,978	ND	ND	ND	0.1	0.09	17	44	ND	ND
MEMPHIS, TN-AR-MS	1,007,306	5	2.02[f]	0.029	0.13	0.1	28	65	0.006	0.041
MERCED, CA	178,403	ND	ND	0.011	0.14	0.11	ND	ND	ND	ND
MIAMI, FL	1,937,094	3	ND	0.015	0.11	0.09	28	62	0.001	0.004
MIDDLESEX-SOMERSET-HUNTERDON, NJ	1,019,835	3	0.08[g]	0.019	0.12	0.1	ND	ND	0.005	0.018
MILWAUKEE-WAUKESHA, WI	1,432,149	3	ND	0.021	0.13	0.1	30	63	0.004	0.022
MINNEAPOLIS-ST. PAUL, MN-WI	2,538,834	7	0.14[h]	0.026	0.1	0.08	IN	73	0.005	0.019
MISSOULA, MT	78,687	ND	ND	ND	ND	ND	ND	ND	ND	ND
MOBILE, AL	476,923	ND	ND	ND	0.11	0.1	31	153	0.009	0.073
MODESTO, CA	370,522	5	0	0.018	0.15	0.11	31	105	ND	ND
MONMOUTH-OCEAN, NJ	986,327	3	ND	ND	0.14	0.1	ND	ND	ND	ND
MONROE, LA	142,191	ND	ND	ND	0.09	0.08	ND	ND	0.003	0.012
MONTGOMERY, AL	292,517	ND	ND	ND	0.12	0.09	27	57	0.002	0.01
MUNCIE, IN	119,659	ND	0.9[i]	ND	ND	ND	ND	ND	ND	ND
MYRTLE BEACH, SC	144,053	ND	ND	ND	ND	ND	ND	ND	ND	ND
NAPLES, FL	152,099	ND	ND	ND	ND	ND	IN	41	ND	ND
NASHUA, NH	168,233	5	ND	0.015	0.1	0.08	IN	IN	0.007	0.027
NASHVILLE, TN	985,026	6	1.25[j]	0.013	0.13	0.11	33	87	0.006	0.046
NASSAU-SUFFOLK, NY	2,609,212	4	ND	0.022	0.14	0.1	20	46	0.007	0.033
NEW BEDFORD, MA	175,641	ND	ND	ND	0.1	0.08	16	42	ND	ND
NEW HAVEN-MERIDEN, CT	530,180	3	ND	0.027	0.13	0.1	27	71	0.006	0.031
NEW LONDON-NORWICH, CT-RI	290,734	ND	ND	ND	0.12	0.08	18	41	0.004	0.018
NEW ORLEANS, LA	1,285,270	3	0.11	0.02	0.12	0.09	29	61*	0.004	0.026
NEW YORK, NY	8,546,846	6	0.14	0.04	0.13	0.09	56	114	0.012	0.038
NEWARK, NJ	1,915,928	5	ND	0.042	0.12	0.1	40*	71*	0.007	0.025

Table A-13. Maximum Air Quality Concentrations by Metropolitan Statistical Area, 1998 (continued)

Metropolitan Statistical Area	1990 Population	CO 8-hr (ppm)	Pb QMax (μg/m³)	NO_2 AM (ppm)	O_3 1-hr (ppm)	O_3 8-hr (ppm)	PM_{10} Wtd AM (μg/m³)	PM_{10} 2nd Max (μg/m³)	SO_2 AM (ppm)	SO_2 24-hr (ppm)
NEWBURGH, NY-PA	335,613	ND	0.14[k]	ND	0.1	0.09	ND	ND	ND	ND
NORFOLK-VIRGINIA BEACH-NEWPORT NEWS,VA	1,443,244	6	ND	0.019	0.11	0.09	24	49	0.006	0.021
OAKLAND, CA	2,082,914	4	0.01	0.02	0.14	0.1	22	59	0.003	0.014
OCALA, FL	194,833	ND	ND	ND	0.1	0.08	ND	ND	ND	ND
ODESSA-MIDLAND, TX	255,545	ND	ND	ND	ND	ND	ND	ND	ND	ND
OKLAHOMA CITY, OK	958,839	4	ND	0.012	0.11	0.09	IN	IN	0.003	0.007
OLYMPIA, WA	161,238	5	ND	ND	0.11	0.07	IN	46	ND	ND
OMAHA, NE-IA	639,580	8	0.25[l]	ND	0.09	0.07	39	106	0.002	0.032
ORANGE COUNTY, CA	2,410,556	7	ND	0.034	0.16	0.09	36	65	0.002	0.005
ORLANDO, FL	1,224,852	4	ND	0.011	0.12	0.1	28	63	0.002	0.007
OWENSBORO, KY	87,189	1	ND	0.013	0.11	0.09	25	57	0.007	0.023
PANAMA CITY, FL	126,994	ND	ND	ND	ND	ND	IN	52	ND	ND
PARKERSBURG-MARIETTA, WV-OH	149,169	ND	ND	ND	0.12	0.09	29	68	0.013	0.089
PENSACOLA, FL	344,406	ND	ND	ND	0.13	0.1	22	50	0.004	0.024
PEORIA-PEKIN, IL	339,172	6	0.02	ND	0.09	0.08	26	54	0.007	0.045
PHILADELPHIA, PA-NJ	4,922,175	5	1.64[m]	0.034	0.13	0.1	31*	105	0.01	0.035
PHOENIX-MESA, AZ	2,238,480	8	ND	0.035	0.11	0.09	81	208	0.008	0.027
PINE BLUFF, AR	85,487	ND	ND	ND	ND	ND	24*	47*	ND	ND
PITTSBURGH, PA	2,384,811	4	0.06	0.031	0.13	0.11	41	130	0.016	0.094
PITTSFIELD, MA	88,695	ND	ND	ND	0.08	IN	ND	ND	ND	ND
POCATELLO, ID	66,026	ND	ND	IN	ND	ND	27	92	0.006	0.034
PONCE, PR	3,442,660	ND	ND	ND	ND	ND	IN	IN	ND	ND
PORTLAND, ME	221,095	ND	ND	ND	0.12	0.09	IN	67	0.005	0.025
PORTLAND-VANCOUVER, OR-WA	1,515,452	6	0.3	0.012	0.14	0.08	29	59	ND	ND
PORTSMOUTH-ROCHESTER, NH-ME	223,271	ND	ND	0.012	0.12	0.09	IN	IN	0.004	0.016
PROVIDENCE-FALL RIVER-WARWICK, RI-MA	1,134,350	5	ND	0.025	0.11	0.09	18	59	0.007	0.027
PROVO-OREM, UT	263,590	6	ND	0.024	0.11	0.09	28	75	ND	ND
PUEBLO, CO	123,051	ND	ND	ND	ND	ND	IN	52	ND	ND
PUNTA GORDA, FL	110,975	ND	ND	ND	ND	ND	ND	ND	ND	ND
RACINE, WI	175,034	3	ND	ND	0.12	0.08	ND	ND	ND	ND
RALEIGH-DURHAM-CHAPEL HILL, NC	855,545	5	ND	ND	0.12	0.11	25	62	0.005	0.009
RAPID CITY, SD	81,343	ND	ND	ND	ND	ND	31	110	ND	ND
READING, PA	336,523	3	0.71[n]	0.021	0.11	0.09	IN	51	0.009	0.025
REDDING, CA	147,036	ND	ND	ND	0.14	0.11	23	54	ND	ND
RENO, NV	254,667	7	ND	ND	0.09	0.08	46	125	ND	ND
RICHLAND-KENNEWICK-PASCO, WA	150,033	ND	ND	ND	ND	ND	IN	90	ND	ND
RICHMOND-PETERSBURG, VA	865,640	2	0.01	0.021	0.13	0.1	23	53	0.006	0.019
RIVERSIDE-SAN BERNARDINO, CA	2,588,793	5	0.05	0.036	0.24	0.18	50	114	0.002	0.009
ROANOKE, VA	224,477	4	ND	0.014	0.13	0.1	33	64	0.003	0.009
ROCHESTER, MN	106,470	ND	ND	ND	ND	ND	IN	36	ND	ND
ROCHESTER, NY	1,062,470	3	ND	ND	0.1	0.09	IN	50	0.01	0.054
ROCKFORD, IL	329,676	4	0.04	ND	0.09	0.07	24	52	ND	ND
ROCKY MOUNT, NC	133,235	ND	ND	ND	0.11	0.09	22	43	ND	ND
SACRAMENTO, CA	1,340,010	6	0.01	0.021	0.15	0.12	27	99	0.003	0.015
SAGINAW-BAY CITY-MIDLAND, MI	399,320	ND	ND	ND	ND	ND	ND	ND	ND	ND
ST. CLOUD, MN	190,921	4	ND	ND	ND	ND	ND	ND	ND	ND
ST. JOSEPH, MO	83,083	ND	ND	ND	ND	ND	IN	124	0.007	0.121
ST. LOUIS, MO-IL	1,836,302	6	11.6[o]	0.026	0.14	0.1	46	116	0.009	0.069
SALEM, OR	278,024	5	ND	ND	0.11	0.08	ND	ND	ND	ND
SALINAS, CA	355,660	2	ND	0.01	0.09	0.07	27	50	ND	ND
SALT LAKE CITY-OGDEN, UT	1,072,227	8	0.09	0.027	0.12	0.1	33	99	0.004	0.01
SAN ANGELO, TX	98,458	ND	ND	ND	ND	ND	ND	ND	ND	ND
SAN ANTONIO, TX	1,324,749	5	ND	0.024	0.12	0.09	27*	61*	ND	ND
SAN DIEGO, CA	2,498,016	5	0.01	0.023	0.14	0.11	43	88	0.003	0.016

Table A-13. Maximum Air Quality Concentrations by Metropolitan Statistical Area, 1998 (continued)

Metropolitan Statistical Area	1990 Population	CO 8-hr (ppm)	Pb QMax (μg/m³)	NO_2 AM (ppm)	O_3 1-hr (ppm)	O_3 8-hr (ppm)	PM_{10} Wtd AM (μg/m³)	PM_{10} 2nd Max (μg/m³)	SO_2 AM (ppm)	SO_2 24-hr (ppm)
SAN FRANCISCO, CA	1,603,678	4	0.01	0.02	0.07	0.05	22	46	0.002	0.006
SAN JOSE, CA	1,497,577	6	0.01	0.025	0.14	0.09	25	60	ND	ND
SAN JUAN-BAYAMON, PR	1,836,302	6	ND	IN	0.04	0.04	36	99	0.005	0.019
SAN LUIS OBISPO-ATASCADERO-PASO ROBLE	217,162	2	ND	0.011	0.11	0.1	22	67	0.005	0.03
SANTA BARBARA-SANTA MARIA-LOMPOC, CA	369,608	4	0	0.021	0.12	0.09	25	55	0.002	0.002
SANTA CRUZ-WATSONVILLE, CA	229,734	1	ND	0.004	0.09	0.07	29	67	0.001	0.003
SANTA FE, NM	117,043	2	ND	ND	ND	ND	14	28	ND	ND
SANTA ROSA, CA	388,222	3	ND	0.015	0.1	0.09	18	38	ND	ND
SARASOTA-BRADENTON, FL	489,483	6	ND	ND	0.12	0.09	23	82	0.003	0.019
SAVANNAH, GA	258,060	ND	ND	ND	0.1	0.08	26	79	0.003	0.027
SCRANTON–WILKES-BARRE–HAZLETON, PA	638,466	3	ND	0.016	0.11	0.09	29*	54	0.006	0.026
SEATTLE-BELLEVUE-EVERETT, WA	2,033,156	6	2.03[p]	0.02	0.14	0.09	15	67	0.006	0.016
SHARON, PA	121,003	ND	0.04	ND	0.12	0.11	28*	75*	0.007	0.029
SHEBOYGAN, WI	103,877	ND	ND	ND	0.13	0.1	ND	ND	ND	ND
SHERMAN-DENISON, TX	95,021	ND	ND	ND	ND	ND	ND	ND	ND	ND
SHREVEPORT-BOSSIER CITY, LA	376,330	ND	ND	ND	0.11	0.09	26*	57*	0.002	0.01
SIOUX CITY, IA-NE	115,018	ND	ND	ND	ND	ND	28	56	ND	ND
SIOUX FALLS, SD	139,236	ND	ND	ND	ND	ND	IN	53	ND	ND
SOUTH BEND, IN	247,052	ND	ND	0.012	0.12	0.1	24	45	ND	ND
SPOKANE, WA	361,364	7	ND	ND	0.08	0.07	26	87	ND	ND
SPRINGFIELD, IL	189,550	2	ND	ND	0.09	0.08	25	65	0.007	0.061
SPRINGFIELD, MO	264,346	4	ND	0.012	0.09	0.07	18	43	0.004	0.042
SPRINGFIELD, MA	587,884	5	ND	0.02	0.12	0.09	28	62	0.005	0.026
STAMFORD-NORWALK, CT	329,935	4	ND	ND	0.11	0.09	28	50	0.006	0.025
STATE COLLEGE, PA	123,786	ND	ND	ND	0.11	0.09	ND	ND	ND	ND
STEUBENVILLE-WEIRTON, OH-WV	142,523	13	ND	0.015	0.1	0.09	35	119	0.016	0.067
STOCKTON-LODI, CA	480,628	5	0	0.023	0.12	0.09	29	95	ND	ND
SUMTER, SC	102,637	ND	0.01	ND	ND	ND	ND	ND	ND	ND
SYRACUSE, NY	742,177	3	ND	ND	0.09	0.08	27	62	0.002	0.011
TACOMA, WA	586,203	6	ND	ND	0.13	0.09	18	62	0.006	0.02
TALLAHASSEE, FL	233,598	ND	ND	ND	0.09	0.08	IN	63	ND	ND
TAMPA-ST. PETERSBURG-CLEARWATER, FL	2,067,959	4	0.51[q]	0.012	0.13	0.1	32	105	0.008	0.048
TERRE HAUTE, IN	147,585	ND	0.02	ND	0.1	0.08	28	52	0.01	0.032
TEXARKANA, TX-TEXARKANA, AR	120,132	ND	ND	ND	ND	ND	23*	53*	IN	IN
TOLEDO, OH	614,128	2	0.35	ND	0.11	0.09	IN	51	0.004	0.021
TOPEKA, KS	160,976	ND	ND	ND	ND	ND	IN	67	ND	ND
TRENTON, NJ	325,824	ND	ND	0.015	0.11	0.1	ND	ND	ND	ND
TUSCON, AZ	666,880	4	ND	0.017	0.09	0.08	39	78	0.002	0.004
TULSA, OK	708,954	5	ND	0.015	0.12	0.09	25*	56*	0.019	0.059
TUSCALOOSA, AL	150,522	ND	ND	ND	ND	ND	28	53	ND	ND
TYLER, TX	151,309	ND	ND	ND	0.11	0.09	ND	ND	ND	ND
UTICA-ROME, NY	316,633	ND	ND	ND	0.09	0.08	13	45	0.001	0.005
VALLEJO-FAIRFIELD-NAPA, CA	451,186	5	ND	0.014	0.13	0.1	17	46	0.002	0.005
VENTURA, CA	669,016	3	0	0.019	0.14	0.11	24	52	0.003	0.011
VICTORIA, TX	74,361	ND	ND	ND	0.1	0.08	ND	ND	ND	ND
VINELAND-MILLVILLE-BRIDGETON, NJ	138,053	ND	ND	ND	0.12	0.1	ND	ND	0.004	0.012
VISALIA-TULARE-PORTERVILLE, CA	311,921	4	ND	0.017	0.14	0.11	40	123	ND	ND
WACO, TX	189,123	ND	ND	ND	ND	ND	ND	ND	ND	ND
WASHINGTON, DC-MD-VA-WV	4,223,485	5	0.03[r]	0.027	0.13	0.11	28	57	0.01	0.025
WATERBURY, CT	221,629	ND	0.02	ND	ND	ND	21	60	0.006	0.021
WATERLOO-CEDAR FALLS, IA	123,798	ND	ND	ND	ND	ND	IN	52	ND	ND
WAUSAU, WI	115,400	ND	ND	ND	0.1	0.08	24	57	0.003	0.031
WEST PALM BEACH-BOCA RATON, FL	863,518	3	0	0.012	0.11	0.08	22	52	0.001	0.004
WHEELING, WV-OH	159,301	4	ND	ND	0.1	0.09	25	56	0.015	0.061

Table A-13. Maximum Air Quality Concentrations by Metropolitan Statistical Area, 1998 (continued)

Metropolitan Statistical Area	1990 Population	CO 8-hr (ppm)	Pb QMax (µg/m³)	NO_2 AM (ppm)	O_3 1-hr (ppm)	O_3 8-hr (ppm)	PM_{10} Wtd AM (µg/m³)	PM_{10} 2nd Max (µg/m³)	SO_2 AM (ppm)	SO_2 24-hr (ppm)
WICHITA, KS	485,270	6	0.01	ND	0.1	0.08	26	75	ND	ND
WICHITA FALLS, TX	130,351	ND	ND	ND	ND	ND	ND	ND	ND	ND
WILLIAMSPORT, PA	118,710	ND	ND	ND	0.1	0.08	24*	ND	0.005	0.021
WILMINGTON-NEWARK, DE-MD	513,293	3	ND	0.016	0.13	0.1	28*	76	0.008	0.044
WILMINGTON, NC	171,269	IN	ND	ND	0.1	0.09	IN	40	0.007	0.026
WORCESTER, MA-CT	478,384	4	ND	0.019	0.12	0.1	20	50	0.005	0.017
YAKIMA, WA	188,823	5	ND	ND	ND	ND	26	81	ND	ND
YOLO, CA	141,092	1	ND	0.011	0.11	0.09	27	73	ND	ND
YORK, PA	339,574	2	0.05	0.019	0.11	0.1	29*	60	0.008	0.023
YOUNGSTOWN-WARREN, OH	600,859	ND	ND	0.015	0.12	0.1	39	88	0.009	0.049
YUBA CITY, CA	122,643	4	ND	0.013	0.1	0.09	23	54	ND	ND
YUMA, AZ	106,895	ND	ND	ND	0.1	0.09	ND	ND	ND	ND

CO – Highest second maximum non-overlapping 8-hour concentration *(Applicable NAAQS is 9 ppm)*
Pb – Highest quarterly maximum concentration *(Applicable NAAQS is 1.5 µg/m3)*
NO_2 – Highest arithmetic mean concentration *(Applicable NAAQS is 0.053 ppm)*
O_3 (1-hr) – Highest second daily maximum 1-hour concentration *(Applicable NAAQS is 0.12 ppm)*
O_3 (8-hr) – Highest fourth daily maximum 8-hour concentration *(Applicable NAAQS is 0.08 ppm)*
PM_{10} – Highest weighted annual mean concentration *(Applicable NAAQS is 50 µg/m3)*
– Highest second maximum 24-hour concentration *(Applicable NAAQS is 150 µg/m3)*
SO_2 – Highest annual mean concentration *(Applicable NAAQS is 0.03 ppm)*
– Highest second maximum 24-hour concentration *(Applicable NAAQS is 0.14 ppm)*
ND – Indicates data not available
IN – Indicates insufficient data to calculate summary statistic
Wtd – Weighted
AM – Annual mean
µg/m³ – Units are micrograms per cubic meter
PPM – Units are parts per million

Data from exceptional events not included.

(*) – These PM_{10} statistics were converted from local temperature and pressure to standard temperature and pressure to ensure all PM_{10} data in this table reflect standard conditions.
(a) – Localized impact from an industrial source in Cleveland, OH. Highest population-oriented site in MSA is in Cleveland, OH (0.05 µg/m³).
(b) – Localized impact from an industrial source in Columbus, GA.
(c) – Localized impact from an industrial source in Columbus, OH. Highest population-oriented site in MSA is in Columbus, OH (0.01 µg/m³).
(d) – Localized impact from an industrial source in Frisco, TX. Highest population-oriented site in MSA is in Midlothian, TX (0.30 µg/m³).
(e) – Localized impact from an industrial source in Indianapolis, IN.
(f) – Localized impact from an industrial source in Memphis, TN. Highest population-oriented site in MSA is in Memphis, TN (0.03 µg/m³).
(g) – Localized impact from an industrial source in New Brunswick, NJ.
(h) – Localized impact from an industrial source in Eagan, MN. Highest population-oriented site in MSA is in Richfield, MN (0.02 µg/m³).
(i) – Localized impact from an industrial source in Muncie, IN.
(j) – Localized impact from an industrial source in Williamson Co., TN.
(k) – Localized impact from an industrial source in Middletown, NY. Highest population-oriented site in MSA is in Middletown, NY (0.03 µg/m³).
(l) – Localized impact from an industrial source in Omaha, NE.
(m) – Localized impact from an industrial source in Philadelphia, PA. Highest population-oriented site in MSA is in Philadelphia, PA (0.38 µg/m³).
(n) – Localized impact from an industrial source in Berks Co., PA.
(o) – Localized impact from an industrial source in Herculaneum, MO. Highest population-oriented site in MSA is in Wood River, IL (0.14 µg/m³).
(p) – Localized impact from an industrial source in Seattle, WA. This facility has been shut down.
(q) – Localized impact from an industrial source in Tampa, FL. Highest population-oriented site in MSA is in Tampa, FL (0.23 µg/m³).
(r) – Localized impact from an industrial source in Lorton, VA. Highest population-oriented site in MSA is in Washington, DC (0.02 µg/m³).

Note: The reader is cautioned that this summary is not adequate in itself to numerically rank MSAs according to their air quality. The monitoring data represent the quality of air in the vicinity of the monitoring site but may not necessarily represent urban-wide air quality.

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998

Metropolitan Statistical Area			Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AKRON, OH														
	CO	2ND MAX 8-HOUR	DOWN	1	5.2	5.7	3.3	4.1	3.1	5.3	3.3	3.4	3.2	2.6
	LEAD	MAX QUARTERLY MEAN	DOWN	2	0.10	0.04	0.06	0.05	0.06	0.06	0.03	0.04	0.04	0.02
	O_3	4TH MAX 8-HOUR	NS	2	0.10	0.10	0.09	0.10	0.09	0.09	0.09	0.09	0.09	0.09
		2ND DAILY MAX 1-HOUR	NS	2	0.13	0.11	0.12	0.11	0.11	0.10	0.12	0.11	0.10	0.11
	PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	34	26	28	27	25	28	26	25	24	24
		90TH PERCENTILE	DOWN	1	52	49	51	44	49	51	48	35	39	39
	SO_2	ARITHMETIC MEAN	DOWN	1	0.015	0.015	0.015	0.013	0.015	0.012	0.009	0.010	0.012	0.010
		2ND MAX 24-HOUR	NS	1	0.053	0.061	0.051	0.064	0.056	0.042	0.046	0.042	0.072	0.044
ALBANY-SCHENECTADY-TROY, NY														
	CO	2ND MAX 8-HOUR	DOWN	1	5.7	6.2	5.4	4.7	3.8	5.2	4.3	3.7	4.5	4.4
	LEAD	MAX QUARTERLY MEAN	DOWN	1	0.04	0.13	0.04	0.03	0.03	0.04	0.04	0.03	0.03	0.03
	O_3	4TH MAX 8-HOUR	NS	3	0.08	0.08	0.08	0.08	0.09	0.08	0.08	0.08	0.07	0.08
		2ND DAILY MAX 1-HOUR	NS	3	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.10	0.10
	PM_{10}	WEIGHTED ANNUAL MEAN	NS	5	21	21	21	21	20	21	18	19	20	20
		90TH PERCENTILE	NS	5	36	36	36	34	34	40	32	29	32	36
	SO_2	ARITHMETIC MEAN	DOWN	1	0.005	0.006	0.007	0.006	0.006	0.006	0.005	0.005	0.004	0.003
		2ND MAX 24-HOUR	DOWN	1	0.022	0.028	0.030	0.022	0.026	0.027	0.016	0.021	0.017	0.013
ALBUQUERQUE, NM														
	CO	2ND MAX 8-HOUR	DOWN	6	6.6	6.1	5.5	5.0	5.1	4.9	5.0	4.3	3.7	3.7
	NO_2	ARITHMETIC MEAN	NS	1	0.019	0.018	0.004	0.021	0.024	0.023	0.018	0.022	0.019	0.016
	O_3	4TH MAX 8-HOUR	NS	7	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.07
		2ND DAILY MAX 1-HOUR	NS	7	0.09	0.09	0.08	0.09	0.08	0.08	0.08	0.08	0.08	0.09
	PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	8	33	24	22	23	23	22	24	24	21	21
		90TH PERCENTILE	DOWN	8	52	39	37	34	36	36	39	38	33	32
ALEXANDRIA, LA														
	PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	23	23	22	25	21	23	21	19	23	23
		90TH PERCENTILE	DOWN	1	38	38	37	40	36	38	37	27	32	32
ALLENTOWN-BETHLEHEM-EASTON, PA														
	CO	2ND MAX 8-HOUR	DOWN	2	4.8	5.3	5.3	3.8	3.6	6.6	4.7	3.2	2.9	3.0
	LEAD	MAX QUARTERLY MEAN	DOWN	1	0.78	0.40	0.46	0.28	0.18	0.13	0.07	0.08	0.09	0.12
	NO_2	ARITHMETIC MEAN	NS	1	0.020	0.017	0.018	0.018	0.020	0.021	0.018	0.018	0.016	0.016
	O_3	4TH MAX 8-HOUR	NS	3	0.09	0.09	0.09	0.10	0.08	0.08	0.08	0.10	0.09	0.10
		2ND DAILY MAX 1-HOUR	NS	3	0.10	0.11	0.12	0.10	0.11	0.11	0.11	0.11	0.11	0.11
	SO_2	ARITHMETIC MEAN	NS	3	0.009	0.009	0.008	0.007	0.007	0.009	0.007	0.007	0.009	0.010
		2ND MAX 24-HOUR	NS	3	0.040	0.039	0.036	0.031	0.028	0.045	0.027	0.030	0.030	0.032
ALTOONA, PA														
	CO	2ND MAX 8-HOUR	NS	1	1.7	1.7	1.7	2.8	2.0	2.4	1.7	1.9	1.5	1.2
	NO_2	ARITHMETIC MEAN	DOWN	1	0.015	0.015	0.015	0.014	0.015	0.015	0.013	0.013	0.014	0.013
	O_3	4TH MAX 8-HOUR	UP	1	0.07	0.07	0.08	0.09	0.08	0.09	0.09	0.09	0.08	0.10
		2ND DAILY MAX 1-HOUR	UP	1	0.10	0.10	0.11	0.10	0.10	0.11	0.11	0.10	0.11	0.11
	SO_2	ARITHMETIC MEAN	DOWN	1	0.011	0.011	0.011	0.009	0.009	0.010	0.008	0.008	0.010	0.008
		2ND MAX 24-HOUR	DOWN	1	0.059	0.062	0.044	0.046	0.052	0.058	0.037	0.033	0.046	0.032
ANCHORAGE, AK														
	PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	26	31	30	31	28	27	26	25	25	20
		90TH PERCENTILE	NS	3	47	63	57	61	55	50	51	48	51	37
ANN ARBOR, MI														
	O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.09
		2ND DAILY MAX 1-HOUR	NS	1	0.10	0.09	0.11	0.10	0.10	0.09	0.11	0.10	0.10	0.10
ANNISTON, AL														
	PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	28	28	29	25	25	24	23	19	23	26
		90TH PERCENTILE	NS	1	46	46	46	37	38	40	40	27	42	41
ASHEVILLE, NC														
	O_3	4TH MAX 8-HOUR	NS	1	0.07	0.07	0.07	0.06	0.06	0.07	0.07	0.08	0.07	0.08
		2ND DAILY MAX 1-HOUR	UP	1	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.08	0.09	0.11
	PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	29	25	24	23	22	19	18	19	21	20
		90TH PERCENTILE	DOWN	1	47	41	41	40	43	30	28	29	38	36
ATLANTA, GA														
	CO	2ND MAX 8-HOUR	DOWN	1	6.2	5.4	6.5	5.1	4.9	5.3	4.5	3.7	4.3	4.1
	LEAD	MAX QUARTERLY MEAN	DOWN	2	0.04	0.03	0.04	0.03	0.02	0.03	0.05	0.03	0.02	0.02
	NO_2	ARITHMETIC MEAN	NS	2	0.023	0.021	0.020	0.020	0.020	0.018	0.017	0.021	0.020	0.019
	O_3	4TH MAX 8-HOUR	NS	2	0.09	0.09	0.12	0.09	0.09	0.11	0.10	0.11	0.10	0.10
		2ND DAILY MAX 1-HOUR	NS	2	0.12	0.14	0.12	0.13	0.14	0.12	0.14	0.13	0.13	0.14
	PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	33	39	32	28	29	27	28	27	28	28
		90TH PERCENTILE	NS	3	52	68	53	46	47	43	45	41	49	50
	SO_2	ARITHMETIC MEAN	DOWN	2	0.007	0.007	0.006	0.006	0.006	0.004	0.004	0.004	0.004	0.004
		2ND MAX 24-HOUR	DOWN	2	0.043	0.026	0.032	0.028	0.036	0.023	0.018	0.018	0.023	0.017
ATLANTIC-CAPE MAY, NJ														
	O_3	4TH MAX 8-HOUR	NS	1	0.10	0.10	0.11	0.11	0.09	0.09	0.08	0.10	0.10	0.11
		2ND DAILY MAX 1-HOUR	NS	1	0.12	0.16	0.14	0.12	0.12	0.10	0.12	0.11	0.13	0.12
	SO_2	ARITHMETIC MEAN	DOWN	1	0.005	0.004	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.003
		2ND MAX 24-HOUR	NS	1	0.029	0.012	0.011	0.016	0.014	0.019	0.011	0.014	0.011	0.010

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
AUGUSTA-AIKEN, GA-SC													
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.02
O_3	4TH MAX 8-HOUR	NS	3	0.08	0.08	0.09	0.07	0.07	0.08	0.08	0.08	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	3	0.10	0.10	0.10	0.09	0.10	0.09	0.10	0.10	0.11	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	21	22	23	22	22	21	19	19	21	22
	90TH PERCENTILE	NS	1	39	36	35	32	35	35	29	29	31	38
AUSTIN-SAN MARCOS, TX													
CO	2ND MAX 8-HOUR	NS	1	4.2	5.9	3.4	3.7	3.0	5.8	3.5	3.2	3.2	3.2
NO_2	ARITHMETIC MEAN	UP	1	0.017	0.017	0.016	0.017	0.017	0.018	0.021	0.018	0.018	0.018
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.07
	2ND DAILY MAX 1-HOUR	NS	2	0.11	0.11	0.10	0.09	0.09	0.10	0.11	0.10	0.09	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	25	21	24	23	19	20	22	19	19	19
	90TH PERCENTILE	DOWN	2	37	34	35	34	35	34	35	26	26	26
BAKERSFIELD, CA													
NO_2	ARITHMETIC MEAN	DOWN	4	0.017	0.017	0.017	0.016	0.015	0.015	0.013	0.013	0.013	0.013
O_3	4TH MAX 8-HOUR	NS	5	0.11	0.11	0.10	0.11	0.10	0.11	0.10	0.11	0.11	0.10
	2ND DAILY MAX 1-HOUR	NS	5	0.13	0.13	0.13	0.12	0.13	0.13	0.13	0.14	0.12	0.13
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	4	46	47	54	38	33	30	33	28	28	25
	90TH PERCENTILE	DOWN	4	83	89	91	62	60	47	62	47	45	46
SO_2	ARITHMETIC MEAN	NS	1	0.004	0.004	0.002	0.003	0.002	0.003	0.003	0.003	0.003	0.003
	2ND MAX 24-HOUR	DOWN	1	0.014	0.011	0.010	0.010	0.010	0.007	0.008	0.009	0.009	0.009
BALTIMORE, MD													
CO	2ND MAX 8-HOUR	DOWN	3	6.5	7.1	6.4	5.5	5.4	5.8	4.7	3.6	4.6	4.1
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.11	0.06	0.04	0.04	0.04	0.03	0.03	0.03	0.01	0.01
NO_2	ARITHMETIC MEAN	DOWN	1	0.035	0.034	0.033	0.031	0.033	0.032	0.026	0.027	0.026	0.026
O_3	4TH MAX 8-HOUR	NS	7	0.09	0.09	0.10	0.11	0.09	0.11	0.10	0.10	0.09	0.11
	2ND DAILY MAX 1-HOUR	NS	7	0.12	0.13	0.14	0.12	0.13	0.13	0.14	0.12	0.14	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	5	36	33	36	30	29	30	29	27	28	29
	90TH PERCENTILE	DOWN	5	60	52	58	47	51	53	48	43	46	48
SO_2	ARITHMETIC MEAN	DOWN	2	0.012	0.008	0.009	0.009	0.008	0.009	0.006	0.007	0.008	0.007
	2ND MAX 24-HOUR	DOWN	2	0.042	0.030	0.030	0.027	0.026	0.030	0.022	0.026	0.025	0.021
BANGOR, ME													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	26	21	25	22	22	22	20	19	21	18
	90TH PERCENTILE	NS	1	42	33	41	32	34	35	32	27	33	34
BATON ROUGE, LA													
LEAD	MAX QUARTERLY MEAN	NS	3	0.08	0.05	0.03	0.10	0.03	0.04	0.05	0.03	0.04	0.05
NO_2	ARITHMETIC MEAN	NS	1	0.015	0.014	0.015	0.016	0.012	0.016	0.016	0.015	0.013	0.015
O_3	4TH MAX 8-HOUR	NS	3	0.09	0.09	0.11	0.09	0.08	0.08	0.08	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	3	0.14	0.15	0.13	0.11	0.11	0.12	0.12	0.11	0.12	0.13
PM_{10}	WEIGHTED ANNUAL MEAN	NS	2	28	28	28	27	22	26	24	24	27	27
	90TH PERCENTILE	NS	2	44	43	49	37	35	41	38	35	44	44
SO_2	ARITHMETIC MEAN	NS	1	0.007	0.005	0.009	0.008	0.006	0.008	0.006	0.006	0.006	0.007
	2ND MAX 24-HOUR	NS	1	0.056	0.022	0.036	0.033	0.021	0.025	0.034	0.024	0.027	0.036
BEAUMONT-PORT ARTHUR, TX													
CO	2ND MAX 8-HOUR	NS	1	2.0	2.3	2.3	2.4	3.3	2.0	1.7	2.1	2.1	2.1
LEAD	MAX QUARTERLY MEAN	NS	1	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02
NO_2	ARITHMETIC MEAN	NS	2	0.010	0.009	0.010	0.011	0.009	0.010	0.010	0.010	0.010	0.008
O_3	4TH MAX 8-HOUR	NS	3	0.09	0.09	0.09	0.10	0.09	0.09	0.08	0.10	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	3	0.13	0.12	0.13	0.13	0.12	0.11	0.13	0.12	0.14	0.12
SO_2	ARITHMETIC MEAN	DOWN	2	0.008	0.009	0.008	0.006	0.006	0.006	0.005	0.005	0.006	0.005
	2ND MAX 24-HOUR	DOWN	2	0.088	0.042	0.059	0.044	0.047	0.039	0.025	0.041	0.037	0.033
BELLINGHAM, WA													
O_3	4TH MAX 8-HOUR	NS	1	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.06	0.05
	2ND DAILY MAX 1-HOUR	NS	1	0.08	0.08	0.07	0.07	0.08	0.08	0.08	0.08	0.07	0.07
SO_2	ARITHMETIC MEAN	DOWN	1	0.006	0.007	0.006	0.007	0.006	0.007	0.006	0.005	0.005	0.005
	2ND MAX 24-HOUR	DOWN	1	0.018	0.028	0.021	0.022	0.017	0.019	0.018	0.013	0.012	0.015
BERGEN-PASSAIC, NJ													
CO	2ND MAX 8-HOUR	DOWN	2	7.5	6.8	6.6	4.5	5.2	6.2	4.9	3.8	4.9	3.7
NO_2	ARITHMETIC MEAN	DOWN	1	0.035	0.031	0.031	0.030	0.029	0.031	0.029	0.028	0.028	0.028
O_3	4TH MAX 8-HOUR	NS	1	0.10	0.10	0.10	0.10	0.08	0.08	0.09	0.10	0.08	0.10
	2ND DAILY MAX 1-HOUR	NS	1	0.12	0.13	0.14	0.10	0.11	0.11	0.12	0.11	0.12	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	35	37	39	33	31	35	31	31	31	31
	90TH PERCENTILE	DOWN	3	61	59	62	50	51	57	49	48	49	49
SO_2	ARITHMETIC MEAN	DOWN	2	0.011	0.010	0.010	0.009	0.008	0.007	0.005	0.006	0.005	0.005
	2ND MAX 24-HOUR	DOWN	2	0.045	0.041	0.035	0.040	0.026	0.037	0.027	0.022	0.021	0.021
BILLINGS, MT													
SO_2	ARITHMETIC MEAN	DOWN	4	0.018	0.016	0.016	0.020	0.021	0.015	0.013	0.009	0.007	0.006
	2ND MAX 24-HOUR	DOWN	4	0.078	0.066	0.069	0.081	0.104	0.066	0.059	0.056	0.032	0.025
BILOXI-GULFPORT-PASCAGOULA, MS													
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.08	0.08	0.09	0.08	0.09	0.09	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.12	0.12	0.12	0.11	0.10	0.12	0.11	0.10	0.09	0.11
SO_2	ARITHMETIC MEAN	DOWN	1	0.006	0.007	0.006	0.006	0.004	0.003	0.003	0.003	0.002	0.003
	2ND MAX 24-HOUR	NS	1	0.029	0.037	0.034	0.020	0.029	0.022	0.024	0.043	0.025	0.022

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
BIRMINGHAM, AL													
CO	2ND MAX 8-HOUR	DOWN	3	7.5	6.9	7.1	6.9	6.9	6.6	6.3	5.3	5.8	4.7
LEAD	MAX QUARTERLY MEAN	NS	1	0.13	0.14	0.09	0.08	0.07	0.07	0.09	0.13	0.13	0.13
O_3	4TH MAX 8-HOUR	NS	6	0.08	0.08	0.09	0.08	0.08	0.08	0.08	0.10	0.09	0.08
	2ND DAILY MAX 1-HOUR	NS	6	0.10	0.12	0.10	0.11	0.11	0.10	0.12	0.13	0.11	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	6	31	35	32	29	27	25	26	25	26	27
	90TH PERCENTILE	DOWN	6	50	57	54	45	42	38	42	38	45	40
SO_2	ARITHMETIC MEAN	DOWN	1	0.008	0.008	0.007	0.007	0.009	0.007	0.006	0.004	0.006	0.007
	2ND MAX 24-HOUR	NS	1	0.025	0.025	0.020	0.027	0.050	0.037	0.016	0.015	0.018	0.032
BOISE CITY, ID													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	42	29	35	34	37	35	30	28	29	23
	90TH PERCENTILE	DOWN	3	85	55	74	58	64	63	50	49	46	39
BOSTON, MA-NH													
CO	2ND MAX 8-HOUR	DOWN	4	5.0	5.6	4.1	4.7	4.0	4.9	3.6	3.6	3.8	2.9
NO_2	ARITHMETIC MEAN	DOWN	3	0.031	0.029	0.031	0.029	0.030	0.030	0.027	0.028	0.026	0.027
O_3	4TH MAX 8-HOUR	DOWN	4	0.09	0.09	0.08	0.09	0.09	0.09	0.08	0.09	0.07	0.08
	2ND DAILY MAX 1-HOUR	DOWN	4	0.12	0.10	0.13	0.11	0.11	0.11	0.11	0.09	0.10	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	NS	7	26	25	24	22	22	23	21	23	21	24
	90TH PERCENTILE	NS	7	41	40	39	35	35	38	34	39	33	41
SO_2	ARITHMETIC MEAN	DOWN	11	0.010	0.009	0.009	0.009	0.009	0.008	0.006	0.006	0.006	0.006
	2ND MAX 24-HOUR	DOWN	11	0.041	0.038	0.030	0.037	0.032	0.032	0.023	0.025	0.029	0.023
BOULDER-LONGMONT, CO													
CO	2ND MAX 8-HOUR	DOWN	2	6.6	5.7	5.7	5.9	5.3	4.5	4.2	4.0	4.4	3.4
O_3	4TH MAX 8-HOUR	DOWN	1	0.08	0.08	0.07	0.08	0.07	0.07	0.07	0.07	0.07	0.07
	2ND DAILY MAX 1-HOUR	NS	1	0.11	0.10	0.10	0.09	0.10	0.09	0.10	0.09	0.09	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	29	23	23	23	24	19	16	17	17	17
	90TH PERCENTILE	DOWN	2	51	39	44	35	44	29	27	27	24	26
BRAZORIA, TX													
O_3	4TH MAX 8-HOUR	DOWN	1	0.10	0.10	0.10	0.09	0.10	0.09	0.09	0.11	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	1	0.15	0.15	0.13	0.13	0.13	0.11	0.15	0.11	0.14	0.11
BRIDGEPORT, CT													
CO	2ND MAX 8-HOUR	DOWN	1	5.2	5.0	5.5	4.7	3.7	5.8	4.9	3.0	4.0	2.8
NO_2	ARITHMETIC MEAN	DOWN	1	0.026	0.026	0.025	0.024	0.024	0.026	0.024	0.024	0.023	0.023
O_3	4TH MAX 8-HOUR	DOWN	2	0.11	0.11	0.10	0.11	0.08	0.10	0.09	0.10	0.09	0.10
	2ND DAILY MAX 1-HOUR	NS	2	0.16	0.15	0.15	0.12	0.16	0.15	0.13	0.11	0.13	0.13
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	27	25	28	22	21	26	22	21	21	21
	90TH PERCENTILE	DOWN	1	47	41	49	37	43	44	37	32	34	33
SO_2	ARITHMETIC MEAN	DOWN	1	0.014	0.013	0.012	0.011	0.010	0.010	0.007	0.006	0.007	0.007
	2ND MAX 24-HOUR	DOWN	1	0.051	0.050	0.044	0.040	0.035	0.049	0.028	0.023	0.031	0.024
BROCKTON, MA													
O_3	4TH MAX 8-HOUR	NS	1	0.09	0.09	0.09	0.10	0.09	0.09	0.10	0.10	0.08	0.08
	2ND DAILY MAX 1-HOUR	DOWN	1	0.13	0.12	0.15	0.11	0.11	0.12	0.13	0.10	0.10	0.10
BROWNSVILLE-HARLINGEN-SAN BENITO, TX													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	22	22	24	24	22	23	21	19	21	21
	90TH PERCENTILE	NS	1	36	36	36	36	45	36	35	28	36	36
BUFFALO-NIAGARA FALLS, NY													
CO	2ND MAX 8-HOUR	DOWN	3	4.4	3.4	3.1	4.6	3.4	3.2	2.6	2.9	2.2	2.2
LEAD	MAX QUARTERLY MEAN	NS	1	0.04	0.03	0.03	0.03	0.05	0.05	0.03	0.03	0.04	0.04
NO_2	ARITHMETIC MEAN	NS	2	0.022	0.020	0.018	0.018	0.017	0.019	0.019	0.019	0.018	0.017
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.09	0.09	0.08	0.08	0.08	0.09	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	2	0.10	0.11	0.11	0.11	0.09	0.09	0.10	0.10	0.09	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	12	25	19	25	21	19	19	18	19	19	20
	90TH PERCENTILE	NS	12	47	35	48	33	35	34	34	29	34	39
SO_2	ARITHMETIC MEAN	DOWN	4	0.012	0.011	0.012	0.011	0.010	0.010	0.008	0.007	0.007	0.007
	2ND MAX 24-HOUR	DOWN	4	0.051	0.054	0.062	0.058	0.042	0.039	0.040	0.034	0.040	0.029
BURLINGTON, VT													
CO	2ND MAX 8-HOUR	DOWN	1	3.7	4.6	3.8	3.9	3.9	3.9	2.5	3.3	2.0	2.4
NO_2	ARITHMETIC MEAN	NS	1	0.019	0.018	0.017	0.016	0.017	0.017	0.017	0.017	0.017	0.018
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	25	24	23	23	21	21	20	20	20	21
	90TH PERCENTILE	DOWN	2	38	38	37	39	36	35	35	29	30	30
SO_2	ARITHMETIC MEAN	DOWN	1	0.007	0.008	0.008	0.003	0.003	0.003	0.002	0.002	0.002	0.002
	2ND MAX 24-HOUR	DOWN	1	0.031	0.021	0.022	0.013	0.011	0.013	0.006	0.014	0.012	0.008
CANTON-MASSILLON, OH													
O_3	4TH MAX 8-HOUR	NS	2	0.09	0.09	0.09	0.10	0.08	0.09	0.08	0.09	0.09	0.08
	2ND DAILY MAX 1-HOUR	NS	2	0.11	0.10	0.11	0.09	0.10	0.10	0.10	0.10	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	35	30	31	28	26	28	29	25	26	25
	90TH PERCENTILE	DOWN	2	64	52	50	45	45	50	52	36	44	43
SO_2	ARITHMETIC MEAN	DOWN	1	0.012	0.011	0.010	0.010	0.010	0.009	0.006	0.006	0.007	0.007
	2ND MAX 24-HOUR	NS	1	0.041	0.036	0.037	0.040	0.046	0.052	0.033	0.032	0.025	0.029

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
CEDAR RAPIDS, IA													
CO	2ND MAX 8-HOUR	NS	1	3.5	3.5	4.1	4.9	3.2	4.2	2.6	7.8	2.4	2.5
O_3	4TH MAX 8-HOUR	NS	1	0.07	0.07	0.05	0.07	0.07	0.06	0.06	0.07	0.06	0.06
	2ND DAILY MAX 1-HOUR	NS	1	0.08	0.07	0.08	0.08	0.07	0.07	0.08	0.07	0.07	0.07
PM_{10}	WEIGHTED ANNUAL MEAN	NS	3	33	28	29	27	22	23	23	23	23	24
	90TH PERCENTILE	NS	3	55	43	45	45	35	34	39	35	38	37
SO_2	ARITHMETIC MEAN	DOWN	3	0.006	0.005	0.005	0.005	0.004	0.004	0.003	0.002	0.003	0.003
	2ND MAX 24-HOUR	DOWN	3	0.044	0.037	0.033	0.034	0.023	0.027	0.021	0.013	0.014	0.013
CHAMPAIGN-URBANA, IL													
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.08	0.07	0.07	0.07	0.08	0.08	0.09	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.09	0.09	0.08	0.09	0.07	0.09	0.10	0.09	0.09	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	32	28	30	31	22	25	22	19	23	24
	90TH PERCENTILE	DOWN	1	56	46	47	47	41	44	44	31	35	39
SO_2	ARITHMETIC MEAN	DOWN	1	0.005	0.004	0.005	0.004	0.004	0.004	0.003	0.003	0.004	0.003
	2ND MAX 24-HOUR	NS	1	0.025	0.030	0.038	0.018	0.015	0.024	0.011	0.013	0.018	0.019
CHARLESTON-NORTH CHARLESTON, SC													
CO	2ND MAX 8-HOUR	NS	1	5.9	4.7	4.9	5.2	5.8	4.0	6.4	4.7	3.9	2.9
LEAD	MAX QUARTERLY MEAN	NS	1	0.02	0.03	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.03
NO_2	ARITHMETIC MEAN	DOWN	2	0.008	0.008	0.008	0.008	0.008	0.007	0.007	0.007	0.007	0.007
O_3	4TH MAX 8-HOUR	NS	3	0.08	0.08	0.07	0.07	0.07	0.08	0.07	0.07	0.07	0.07
	2ND DAILY MAX 1-HOUR	NS	3	0.09	0.09	0.09	0.09	0.10	0.09	0.09	0.10	0.09	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	29	28	25	23	21	20	19	19	19	21
	90TH PERCENTILE	DOWN	3	45	46	40	34	35	32	28	29	29	37
SO_2	ARITHMETIC MEAN	NS	2	0.003	0.002	0.003	0.003	0.002	0.002	0.002	0.002	0.002	0.002
	2ND MAX 24-HOUR	DOWN	2	0.024	0.016	0.017	0.021	0.014	0.021	0.012	0.014	0.014	0.010
CHARLESTON, WV													
CO	2ND MAX 8-HOUR	NS	1	2.9	2.8	3.1	3.3	2.2	3.5	2.4	2.3	1.9	2.0
LEAD	MAX QUARTERLY MEAN	DOWN	3	0.02	0.04	0.02	0.03	0.02	0.03	0.02	0.02	0.01	0.01
NO_2	ARITHMETIC MEAN	NS	1	0.021	0.020	0.020	0.017	0.018	0.019	0.020	0.020	0.020	0.022
O_3	4TH MAX 8-HOUR	NS	1	0.07	0.07	0.08	0.09	0.06	0.06	0.08	0.09	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.12	0.12	0.07	0.08	0.10	0.11	0.10	0.10	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	35	36	29	28	29	28	26	24	21	21
	90TH PERCENTILE	DOWN	1	62	58	47	44	52	49	40	41	32	35
SO_2	ARITHMETIC MEAN	NS	2	0.014	0.012	0.009	0.009	0.009	0.010	0.007	0.008	0.009	0.009
	2ND MAX 24-HOUR	DOWN	2	0.062	0.056	0.036	0.031	0.034	0.037	0.023	0.031	0.031	0.031
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC													
CO	2ND MAX 8-HOUR	DOWN	5	7.0	7.1	6.3	6.0	5.6	5.8	4.7	4.4	4.8	4.2
LEAD	MAX QUARTERLY MEAN	NS	1	0.03	0.04	0.01	0.08	0.02	0.03	0.01	0.01	0.01	0.02
NO_2	ARITHMETIC MEAN	NS	1	0.017	0.017	0.016	0.016	0.017	0.016	0.016	0.016	0.018	0.018
O_3	4TH MAX 8-HOUR	UP	3	0.09	0.09	0.10	0.09	0.09	0.10	0.09	0.09	0.10	0.10
	2ND DAILY MAX 1-HOUR	NS	3	0.12	0.12	0.12	0.10	0.13	0.11	0.11	0.13	0.12	0.13
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	33	33	31	30	28	29	28	30	28	30
	90TH PERCENTILE	NS	3	50	50	50	48	41	44	42	44	43	49
CHARLOTTESVILLE, VA													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	30	27	28	22	24	22	23	21	21	23
	90TH PERCENTILE	NS	1	50	44	47	32	40	33	41	35	36	33
CHATTANOOGA, TN-GA													
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.09	0.08	0.08	0.09	0.09	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	2	0.10	0.12	0.10	0.09	0.10	0.11	0.11	0.11	0.11	0.13
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	36	38	38	34	32	33	32	32	27	28
	90TH PERCENTILE	DOWN	2	57	61	63	52	52	51	49	53	45	45
CHEYENNE, WY													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	19	19	19	17	16	18	15	15	13	14
	90TH PERCENTILE	DOWN	1	30	30	30	25	24	28	26	25	20	22
CHICAGO, IL													
CO	2ND MAX 8-HOUR	NS	7	4.5	5.0	4.2	4.5	4.6	6.4	3.5	3.2	3.3	3.4
LEAD	MAX QUARTERLY MEAN	DOWN	9	0.09	0.07	0.06	0.07	0.06	0.05	0.05	0.04	0.04	0.04
NO_2	ARITHMETIC MEAN	NS	5	0.026	0.022	0.021	0.026	0.026	0.029	0.029	0.029	0.029	0.028
O_3	4TH MAX 8-HOUR	NS	17	0.08	0.08	0.07	0.09	0.08	0.07	0.08	0.09	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	17	0.10	0.09	0.11	0.10	0.09	0.10	0.12	0.10	0.10	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	13	37	35	33	33	31	35	32	30	30	33
	90TH PERCENTILE	DOWN	13	61	60	51	54	51	56	55	45	46	50
SO_2	ARITHMETIC MEAN	DOWN	10	0.008	0.007	0.008	0.006	0.006	0.006	0.005	0.005	0.005	0.005
	2ND MAX 24-HOUR	DOWN	10	0.039	0.037	0.040	0.028	0.031	0.033	0.023	0.021	0.023	0.024
CHICO-PARADISE, CA													
CO	2ND MAX 8-HOUR	DOWN	2	6.4	6.2	7.4	5.9	4.7	4.6	4.1	4.4	4.0	4.2
NO_2	ARITHMETIC MEAN	DOWN	1	0.016	0.015	0.016	0.016	0.016	0.015	0.014	0.013	0.013	0.013
O_3	4TH MAX 8-HOUR	DOWN	1	0.08	0.08	0.08	0.07	0.08	0.08	0.08	0.08	0.07	0.07
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.12	0.09	0.09	0.09	0.10	0.09	0.10	0.07	0.10

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
CINCINNATI, OH-KY-IN													
CO	2ND MAX 8-HOUR	DOWN	3	4.9	4.2	4.2	4.5	4.7	4.3	3.4	2.9	2.7	3.2
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.07	0.04	0.04	0.04	0.05	0.04	0.06	0.04	0.03	0.03
NO_2	ARITHMETIC MEAN	NS	2	0.024	0.022	0.022	0.021	0.022	0.022	0.021	0.022	0.023	0.022
O_3	4TH MAX 8-HOUR	NS	7	0.09	0.09	0.09	0.09	0.08	0.08	0.09	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	7	0.11	0.11	0.12	0.09	0.10	0.11	0.12	0.11	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	7	41	36	32	30	31	30	31	28	29	28
	90TH PERCENTILE	DOWN	7	69	64	57	49	58	51	54	42	49	47
SO_2	ARITHMETIC MEAN	DOWN	4	0.012	0.012	0.012	0.011	0.011	0.009	0.006	0.009	0.009	0.009
	2ND MAX 24-HOUR	DOWN	4	0.046	0.054	0.044	0.045	0.044	0.044	0.025	0.035	0.037	0.038
CLARKSVILLE-HOPKINSVILLE, TN-KY													
SO_2	ARITHMETIC MEAN	NS	1	0.007	0.007	0.006	0.009	0.010	0.007	0.006	0.006	0.005	0.006
	2ND MAX 24-HOUR	DOWN	1	0.042	0.038	0.029	0.036	0.058	0.037	0.019	0.023	0.026	0.020
CLEVELAND-LORAIN-ELYRIA, OH													
CO	2ND MAX 8-HOUR	DOWN	2	5.9	4.7	4.7	5.1	4.3	5.3	5.7	3.7	3.5	3.2
LEAD	MAX QUARTERLY MEAN	DOWN	4	0.19	0.32	0.18	0.21	0.21	0.14	0.11	0.06	0.05	0.05
NO_2	ARITHMETIC MEAN	DOWN	1	0.025	0.022	0.022	0.021	0.022	0.021	0.021	0.020	0.020	0.020
O_3	4TH MAX 8-HOUR	NS	6	0.09	0.09	0.08	0.09	0.08	0.09	0.08	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	6	0.10	0.11	0.11	0.10	0.11	0.11	0.11	0.11	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	NS	11	37	33	35	30	29	35	32	30	30	31
	90TH PERCENTILE	DOWN	11	60	56	59	50	54	58	55	46	47	49
SO_2	ARITHMETIC MEAN	DOWN	9	0.012	0.010	0.010	0.009	0.008	0.008	0.006	0.006	0.006	0.006
	2ND MAX 24-HOUR	DOWN	9	0.042	0.041	0.039	0.038	0.039	0.040	0.023	0.030	0.029	0.027
COLORADO SPRINGS, CO													
CO	2ND MAX 8-HOUR	DOWN	4	6.0	5.2	4.8	4.4	4.1	3.6	4.1	3.6	3.8	3.1
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
NO_2	ARITHMETIC MEAN	NS	3	0.015	0.016	0.016	0.016	0.015	0.017	0.017	0.016	0.015	0.015
O_3	4TH MAX 8-HOUR	DOWN	1	0.07	0.07	0.06	0.07	0.06	0.06	0.06	0.06	0.06	0.05
	2ND DAILY MAX 1-HOUR	DOWN	1	0.08	0.07	0.08	0.07	0.06	0.07	0.07	0.07	0.06	0.06
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	12	27	22	25	22	22	21	19	20	19	20
	90TH PERCENTILE	DOWN	12	43	35	40	33	36	36	32	31	29	32
SO_2	ARITHMETIC MEAN	NS	3	0.004	0.003	0.003	0.004	0.003	0.004	0.004	0.003	0.003	0.003
	2ND MAX 24-HOUR	NS	3	0.013	0.011	0.011	0.013	0.011	0.018	0.015	0.010	0.007	0.009
COLUMBIA, SC													
CO	2ND MAX 8-HOUR	DOWN	1	6.5	5.8	6.0	6.3	5.6	4.7	4.0	3.4	2.9	3.7
LEAD	MAX QUARTERLY MEAN	DOWN	2	0.03	0.03	0.05	0.04	0.02	0.02	0.01	0.01	0.01	0.01
NO_2	ARITHMETIC MEAN	NS	1	0.013	0.013	0.009	0.011	0.013	0.011	0.013	0.013	0.011	0.014
O_3	4TH MAX 8-HOUR	NS	3	0.08	0.08	0.08	0.07	0.08	0.08	0.08	0.08	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	3	0.11	0.11	0.10	0.10	0.11	0.10	0.10	0.10	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	6	20	20	17	17	16	16	13	15	15	16
	90TH PERCENTILE	DOWN	6	57	56	55	51	49	47	46	45	49	55
SO_2	ARITHMETIC MEAN	NS	4	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003
	2ND MAX 24-HOUR	NS	4	0.011	0.012	0.013	0.013	0.011	0.011	0.008	0.013	0.012	0.011
COLUMBUS, GA-AL													
LEAD	MAX QUARTERLY MEAN	DOWN	1	2.04	2.04	2.04	1.46	1.01	1.43	0.78	0.47	0.45	0.29
O_3	4TH MAX 8-HOUR	UP	2	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.08	0.08
	2ND DAILY MAX 1-HOUR	UP	2	0.09	0.10	0.09	0.09	0.10	0.10	0.11	0.09	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	26	29	27	26	25	27	28	22	26	30
	90TH PERCENTILE	NS	1	38	46	40	43	37	44	44	33	39	45
COLUMBUS, OH													
CO	2ND MAX 8-HOUR	DOWN	3	5.7	4.1	4.8	4.9	3.9	4.5	3.8	2.5	2.4	3.0
LEAD	MAX QUARTERLY MEAN	DOWN	2	0.08	0.06	0.06	0.06	0.04	0.04	0.04	0.03	0.04	0.04
O_3	4TH MAX 8-HOUR	NS	3	0.09	0.09	0.09	0.10	0.08	0.08	0.09	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	3	0.11	0.11	0.11	0.09	0.10	0.10	0.11	0.11	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	NS	2	31	31	30	26	27	27	29	24	27	30
	90TH PERCENTILE	NS	2	55	58	53	44	48	47	52	36	52	51
SO_2	ARITHMETIC MEAN	DOWN	1	0.008	0.008	0.007	0.006	0.007	0.007	0.004	0.004	0.004	0.005
	2ND MAX 24-HOUR	DOWN	1	0.038	0.038	0.033	0.030	0.034	0.041	0.019	0.021	0.025	0.019
CORPUS CHRISTI, TX													
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.08	0.07	0.08	0.08	0.08	0.09	0.08	0.07
	2ND DAILY MAX 1-HOUR	NS	2	0.10	0.10	0.11	0.09	0.12	0.11	0.12	0.10	0.09	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	30	27	31	29	29	28	28	23	25	25
	90TH PERCENTILE	NS	2	45	40	43	41	52	44	44	34	41	41
SO_2	ARITHMETIC MEAN	NS	2	0.003	0.002	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.002
	2ND MAX 24-HOUR	NS	2	0.019	0.013	0.027	0.018	0.024	0.012	0.016	0.013	0.012	0.017
CUMBERLAND, MD-WV													
SO_2	ARITHMETIC MEAN	DOWN	1	0.011	0.010	0.009	0.006	0.008	0.010	0.005	0.003	0.006	0.006
	2ND MAX 24-HOUR	DOWN	1	0.049	0.031	0.028	0.024	0.027	0.037	0.015	0.019	0.020	0.020

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
DALLAS, TX													
CO	2ND MAX 8-HOUR	NS	1	4.5	4.7	3.8	5.6	5.4	5.3	5.9	5.5	3.7	2.7
LEAD	MAX QUARTERLY MEAN	DOWN	10	0.18	0.20	0.15	0.17	0.17	0.11	0.12	0.07	0.07	0.07
NO_2	ARITHMETIC MEAN	UP	1	0.012	0.012	0.013	0.015	0.014	0.016	0.019	0.019	0.018	0.016
O_3	4TH MAX 8-HOUR	NS	2	0.10	0.10	0.10	0.06	0.09	0.10	0.09	0.11	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	2	0.13	0.14	0.10	0.12	0.13	0.12	0.14	0.12	0.12	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	NS	5	29	28	26	26	27	26	30	30	26	26
	90TH PERCENTILE	NS	5	49	43	39	40	41	41	49	49	41	41
DANBURY, CT													
O_3	4TH MAX 8-HOUR	NS	1	0.10	0.10	0.11	0.10	0.08	0.10	0.09	0.09	0.08	0.11
	2ND DAILY MAX 1-HOUR	NS	1	0.13	0.15	0.14	0.12	0.14	0.13	0.13	0.11	0.14	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	25	22	26	22	19	26	22	22	21	20
	90TH PERCENTILE	DOWN	1	45	38	44	38	40	37	34	36	35	30
SO_2	ARITHMETIC MEAN	DOWN	1	0.008	0.007	0.008	0.007	0.006	0.006	0.004	0.005	0.005	0.004
	2ND MAX 24-HOUR	DOWN	1	0.036	0.033	0.032	0.027	0.024	0.037	0.020	0.020	0.024	0.020
DAVENPORT-MOLINE-ROCK ISLAND, IA-IL													
LEAD	MAX QUARTERLY MEAN	NS	1	0.02	0.03	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.01
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.07	0.08	0.08	0.07	0.07	0.08	0.08	0.07
	2ND DAILY MAX 1-HOUR	NS	2	0.10	0.08	0.09	0.10	0.08	0.09	0.09	0.09	0.08	0.09
PM_{10}	WEIGHTED ANNUAL MEAN	NS	4	32	31	30	29	27	31	31	30	30	32
	90TH PERCENTILE	NS	4	53	51	46	51	44	51	53	50	49	56
SO_2	ARITHMETIC MEAN	DOWN	3	0.005	0.005	0.004	0.004	0.004	0.004	0.004	0.003	0.003	0.003
	2ND MAX 24-HOUR	DOWN	3	0.025	0.022	0.020	0.019	0.018	0.023	0.017	0.016	0.015	0.013
DAYTON-SPRINGFIELD, OH													
CO	2ND MAX 8-HOUR	DOWN	2	4.8	3.2	3.5	3.6	3.6	3.4	3.0	2.4	3.0	2.8
LEAD	MAX QUARTERLY MEAN	DOWN	2	0.06	0.05	0.04	0.04	0.06	0.04	0.05	0.04	0.04	0.03
O_3	4TH MAX 8-HOUR	NS	3	0.09	0.09	0.09	0.09	0.08	0.09	0.09	0.09	0.10	0.09
	2ND DAILY MAX 1-HOUR	NS	3	0.12	0.11	0.11	0.10	0.11	0.11	0.12	0.11	0.11	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	31	26	28	25	25	24	26	23	24	25
	90TH PERCENTILE	DOWN	3	57	48	43	41	46	40	44	38	41	42
SO_2	ARITHMETIC MEAN	NS	2	0.006	0.006	0.005	0.005	0.006	0.006	0.004	0.005	0.005	0.005
	2ND MAX 24-HOUR	NS	2	0.031	0.023	0.022	0.020	0.031	0.032	0.016	0.027	0.027	0.019
DECATUR, AL													
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	25	25	28	25	25	22	25	21	23	25
	90TH PERCENTILE	NS	1	42	42	54	41	44	35	40	32	41	41
DECATUR, IL													
LEAD	MAX QUARTERLY MEAN	NS	1	0.07	0.03	0.03	0.03	0.03	0.05	0.03	0.02	0.03	0.02
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.08	0.09	0.08	0.07	0.08	0.08	0.09	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.09	0.09	0.10	0.09	0.08	0.10	0.10	0.10	0.09	0.09
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	40	34	36	38	28	29	30	28	27	32
	90TH PERCENTILE	DOWN	1	68	56	54	63	46	53	56	43	41	49
SO_2	ARITHMETIC MEAN	DOWN	1	0.012	0.008	0.007	0.005	0.006	0.007	0.005	0.005	0.006	0.005
	2ND MAX 24-HOUR	DOWN	1	0.108	0.060	0.039	0.023	0.025	0.030	0.024	0.022	0.021	0.020
DENVER, CO													
CO	2ND MAX 8-HOUR	DOWN	6	7.8	7.2	7.0	8.3	6.6	6.1	5.6	4.8	4.7	3.9
LEAD	MAX QUARTERLY MEAN	DOWN	3	0.05	0.06	0.05	0.06	0.06	0.04	0.05	0.03	0.02	0.02
NO_2	ARITHMETIC MEAN	DOWN	2	0.033	0.032	0.032	0.032	0.027	0.032	0.029	0.027	0.029	0.029
O_3	4TH MAX 8-HOUR	DOWN	5	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	2ND DAILY MAX 1-HOUR	NS	5	0.10	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	11	26	24	25	24	27	23	20	20	21	21
	90TH PERCENTILE	DOWN	11	48	46	49	43	55	45	37	37	42	40
SO_2	ARITHMETIC MEAN	DOWN	2	0.006	0.006	0.006	0.007	0.006	0.006	0.004	0.005	0.005	0.004
	2ND MAX 24-HOUR	NS	2	0.023	0.020	0.026	0.038	0.025	0.025	0.016	0.020	0.021	0.018
DES MOINES, IA													
CO	2ND MAX 8-HOUR	NS	3	4.4	4.6	4.6	3.9	4.5	3.9	4.0	3.2	3.0	5.7
O_3	4TH MAX 8-HOUR	NS	2	0.05	0.05	0.04	0.04	0.07	0.05	0.05	0.07	0.06	0.06
	2ND DAILY MAX 1-HOUR	NS	2	0.06	0.07	0.06	0.08	0.08	0.07	0.08	0.08	0.08	0.07
PM_{10}	WEIGHTED ANNUAL MEAN	NS	3	33	32	29	28	29	30	30	31	32	26
	90TH PERCENTILE	NS	3	60	56	48	55	49	52	54	53	59	45
DETROIT, MI													
CO	2ND MAX 8-HOUR	DOWN	6	6.0	4.5	5.1	4.2	4.5	6.6	4.5	3.9	3.3	3.1
LEAD	MAX QUARTERLY MEAN	NS	6	0.06	0.05	0.04	0.04	0.03	0.04	0.03	0.03	0.04	0.04
NO_2	ARITHMETIC MEAN	NS	2	0.021	0.021	0.020	0.020	0.021	0.022	0.020	0.021	0.020	0.021
O_3	4TH MAX 8-HOUR	NS	8	0.09	0.09	0.08	0.09	0.08	0.08	0.09	0.09	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	8	0.12	0.10	0.12	0.10	0.10	0.12	0.12	0.10	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	6	39	36	33	28	33	38	35	31	28	29
	90TH PERCENTILE	DOWN	6	65	64	59	47	55	61	59	50	45	53
SO_2	ARITHMETIC MEAN	DOWN	10	0.010	0.010	0.008	0.007	0.007	0.007	0.006	0.006	0.005	0.006
	2ND MAX 24-HOUR	NS	10	0.037	0.038	0.033	0.030	0.030	0.032	0.030	0.034	0.027	0.032
DOTHAN, AL													
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	26	31	28	25	26	28	28	22	25	27
	90TH PERCENTILE	NS	1	42	64	44	43	52	47	46	36	45	41

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
DUBUQUE, IA													
SO_2	ARITHMETIC MEAN	NS	1	0.005	0.005	0.004	0.004	0.003	0.005	0.006	0.003	0.003	0.003
	2ND MAX 24-HOUR	DOWN	1	0.030	0.037	0.028	0.029	0.014	0.037	0.027	0.022	0.022	0.022
DULUTH-SUPERIOR, MN-WI													
CO	2ND MAX 8-HOUR	NS	1	9.9	4.4	5.2	4.0	4.1	4.3	4.5	4.5	3.2	3.7
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	6	26	22	23	20	19	19	19	19	18	20
	90TH PERCENTILE	DOWN	6	39	41	37	34	32	31	32	32	31	30
DUTCHESS COUNTY, NY													
O_3	4TH MAX 8-HOUR	DOWN	1	0.10	0.10	0.10	0.10	0.09	0.10	0.09	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	DOWN	1	0.13	0.13	0.13	0.11	0.14	0.12	0.12	0.11	0.11	0.11
EL PASO, TX													
CO	2ND MAX 8-HOUR	DOWN	5	9.8	10.9	9.1	8.1	8.0	6.6	6.8	8.4	6.9	6.6
LEAD	MAX QUARTERLY MEAN	DOWN	4	0.30	0.27	0.27	0.19	0.18	0.12	0.13	0.20	0.09	0.11
NO_2	ARITHMETIC MEAN	NS	2	0.025	0.022	0.023	0.026	0.026	0.029	0.029	0.029	0.027	0.025
O_3	4TH MAX 8-HOUR	NS	3	0.08	0.08	0.08	0.07	0.07	0.07	0.08	0.08	0.08	0.07
	2ND DAILY MAX 1-HOUR	DOWN	3	0.13	0.12	0.12	0.12	0.11	0.13	0.11	0.12	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	8	37	32	28	28	24	25	28	27	23	23
	90TH PERCENTILE	DOWN	8	68	63	53	50	43	47	51	51	45	44
SO_2	ARITHMETIC MEAN	DOWN	3	0.013	0.010	0.010	0.012	0.009	0.007	0.008	0.008	0.007	0.006
	2ND MAX 24-HOUR	DOWN	3	0.055	0.055	0.047	0.053	0.049	0.029	0.038	0.036	0.030	0.028
ELMIRA, NY													
O_3	4TH MAX 8-HOUR	NS	1	0.07	0.07	0.08	0.09	0.07	0.08	0.07	0.08	0.07	0.07
	2ND DAILY MAX 1-HOUR	NS	1	0.09	0.10	0.10	0.09	0.09	0.08	0.09	0.09	0.08	0.09
SO_2	ARITHMETIC MEAN	DOWN	1	0.005	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.003	0.003
	2ND MAX 24-HOUR	DOWN	1	0.026	0.021	0.022	0.021	0.019	0.023	0.014	0.016	0.015	0.011
ERIE, PA													
NO_2	ARITHMETIC MEAN	NS	1	0.015	0.015	0.013	0.014	0.014	0.015	0.015	0.015	0.015	0.014
O_3	4TH MAX 8-HOUR	NS	1	0.09	0.09	0.08	0.09	0.08	0.08	0.09	0.09	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	1	0.12	0.10	0.11	0.10	0.11	0.10	0.11	0.10	0.10	0.12
SO_2	ARITHMETIC MEAN	DOWN	1	0.014	0.014	0.010	0.011	0.011	0.010	0.009	0.011	0.009	0.010
	2ND MAX 24-HOUR	NS	1	0.074	0.057	0.044	0.056	0.072	0.076	0.050	0.066	0.035	0.068
EUGENE-SPRINGFIELD, OR													
CO	2ND MAX 8-HOUR	NS	2	5.5	4.9	5.2	6.2	5.3	5.9	5.2	5.2	5.0	4.3
LEAD	MAX QUARTERLY MEAN	NS	1	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
O_3	4TH MAX 8-HOUR	NS	2	0.06	0.06	0.07	0.07	0.07	0.05	0.07	0.06	0.09	0.06
	2ND DAILY MAX 1-HOUR	NS	2	0.08	0.09	0.09	0.10	0.08	0.09	0.08	0.11	0.07	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	5	31	28	32	28	29	25	23	20	21	18
	90TH PERCENTILE	DOWN	5	62	56	65	56	63	46	44	37	37	34
EVANSVILLE-HENDERSON, IN-KY													
CO	2ND MAX 8-HOUR	NS	1	2.3	2.5	2.0	2.3	2.6	2.7	2.7	2.0	2.3	2.1
NO_2	ARITHMETIC MEAN	DOWN	1	0.020	0.018	0.021	0.018	0.017	0.018	0.017	0.017	0.016	0.018
O_3	4TH MAX 8-HOUR	NS	5	0.09	0.09	0.09	0.09	0.08	0.08	0.09	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	5	0.11	0.11	0.11	0.09	0.10	0.11	0.11	0.10	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	4	34	31	32	29	29	31	31	25	26	27
	90TH PERCENTILE	NS	4	54	50	47	49	49	51	52	40	44	44
SO_2	ARITHMETIC MEAN	DOWN	7	0.013	0.014	0.013	0.012	0.012	0.012	0.010	0.011	0.011	0.012
	2ND MAX 24-HOUR	DOWN	7	0.056	0.062	0.061	0.068	0.051	0.048	0.042	0.048	0.048	0.046
FAYETTEVILLE, NC													
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.09	0.08	0.08	0.09	0.08	0.08	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	2	0.10	0.10	0.10	0.09	0.11	0.10	0.10	0.10	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	29	31	27	26	27	25	23	25	25	27
	90TH PERCENTILE	NS	1	47	50	45	39	41	40	35	39	41	41
FAYETTEVILLE-SPRINGDALE-ROGERS, AR													
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	26	23	24	22	24	25	24	23	20	20
	90TH PERCENTILE	NS	1	37	38	38	30	39	40	36	36	31	31
FLINT, MI													
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.08	0.09	0.07	0.07	0.07	0.08	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.10	0.10	0.09	0.10	0.09	0.09	0.10	0.10	0.11
FLORENCE, AL													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	24	24	24	21	23	20	22	18	19	22
	90TH PERCENTILE	DOWN	1	39	39	41	34	37	34	37	29	32	35
SO_2	ARITHMETIC MEAN	DOWN	1	0.005	0.005	0.004	0.004	0.004	0.003	0.003	0.003	0.003	0.003
	2ND MAX 24-HOUR	DOWN	1	0.036	0.027	0.025	0.019	0.022	0.022	0.018	0.019	0.020	0.019
FORT COLLINS-LOVELAND, CO													
CO	2ND MAX 8-HOUR	DOWN	1	8.3	7.0	9.8	6.9	6.6	6.0	5.2	5.1	5.2	4.1
O_3	4TH MAX 8-HOUR	NS	2	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	2ND DAILY MAX 1-HOUR	NS	2	0.09	0.08	0.09	0.09	0.09	0.10	0.09	0.09	0.09	0.09
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	29	23	25	23	22	22	22	20	16	16
	90TH PERCENTILE	DOWN	1	49	39	50	35	36	34	41	33	24	26

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
FORT LAUDERDALE, FL													
CO	2ND MAX 8-HOUR	DOWN	5	4.8	4.0	4.1	4.2	3.7	3.6	3.9	3.3	3.2	2.5
LEAD	MAX QUARTERLY MEAN	NS	1	0.03	0.01	0.02	0.04	0.03	0.03	0.02	0.05	0.04	0.04
NO_2	ARITHMETIC MEAN	NS	1	0.009	0.009	0.009	0.009	0.010	0.009	0.011	0.010	0.010	0.010
O_3	4TH MAX 8-HOUR	NS	3	0.08	0.08	0.07	0.06	0.08	0.08	0.07	0.07	0.07	0.07
	2ND DAILY MAX 1-HOUR	NS	3	0.11	0.09	0.09	0.10	0.10	0.09	0.09	0.09	0.09	0.10
FORT MYERS-CAPE CORAL, FL													
O_3	4TH MAX 8-HOUR	DOWN	1	0.08	0.08	0.07	0.06	0.07	0.07	0.08	0.07	0.06	0.07
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.08	0.08	0.08	0.08	0.09	0.09	0.07	0.08	0.11
FORT SMITH, AR-OK													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	28	26	25	24	25	24	26	25	22	22
	90TH PERCENTILE	NS	1	43	38	37	36	39	38	44	36	39	39
FORT WAYNE, IN													
O_3	4TH MAX 8-HOUR	NS	1	0.09	0.09	0.08	0.09	0.09	0.08	0.10	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	1	0.12	0.09	0.10	0.09	0.10	0.11	0.11	0.11	0.10	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	29	27	27	23	23	24	24	17	20	24
	90TH PERCENTILE	DOWN	1	53	53	44	38	36	43	44	28	28	39
FORT WORTH-ARLINGTON, TX													
CO	2ND MAX 8-HOUR	DOWN	2	4.8	4.2	3.7	4.0	3.4	3.2	3.2	3.0	3.0	2.9
LEAD	MAX QUARTERLY MEAN	NS	2	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.02	0.02	0.02
NO_2	ARITHMETIC MEAN	NS	1	0.013	0.012	0.014	0.015	0.013	0.017	0.017	0.015	0.016	0.013
O_3	4TH MAX 8-HOUR	NS	2	0.10	0.10	0.10	0.11	0.08	0.09	0.10	0.10	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	2	0.13	0.14	0.15	0.12	0.11	0.13	0.14	0.13	0.12	0.13
PM_{10}	WEIGHTED ANNUAL MEAN	NS	3	24	24	23	21	21	20	24	25	22	22
	90TH PERCENTILE	NS	3	38	41	33	31	33	33	38	40	34	34
SO_2	ARITHMETIC MEAN	NS	1	0.001	0.002	0.002	0.003	0.001	0.002	0.001	0.001	0.001	0.001
	2ND MAX 24-HOUR	NS	1	0.007	0.008	0.006	0.013	0.005	0.006	0.004	0.011	0.011	0.011
FRESNO, CA													
CO	2ND MAX 8-HOUR	DOWN	4	5.7	5.7	6.1	4.6	4.2	4.9	4.2	4.2	3.5	3.5
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.07	0.07	0.04	0.04	0.03	0.02	0.02	0.01	0.01	0.01
NO_2	ARITHMETIC MEAN	DOWN	4	0.021	0.021	0.021	0.020	0.021	0.020	0.020	0.019	0.018	0.018
O_3	4TH MAX 8-HOUR	NS	5	0.10	0.10	0.10	0.11	0.11	0.11	0.10	0.10	0.11	0.10
	2ND DAILY MAX 1-HOUR	NS	5	0.14	0.14	0.15	0.14	0.14	0.13	0.13	0.14	0.13	0.15
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	5	55	55	54	45	43	40	41	35	40	34
	90TH PERCENTILE	DOWN	5	107	107	100	73	86	63	80	59	77	62
GADSDEN, AL													
PM_{10}	WEIGHTED ANNUAL MEAN	NS	2	28	33	32	31	33	30	30	23	26	31
	90TH PERCENTILE	NS	2	45	55	56	52	58	46	43	36	47	50
GALVESTON-TEXAS CITY, TX													
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.03	0.02	0.02	0.02	0.03	0.02	0.03	0.02	0.02	0.02
O_3	4TH MAX 8-HOUR	NS	1	0.10	0.10	0.09	0.09	0.07	0.11	0.09	0.14	0.08	0.10
	2ND DAILY MAX 1-HOUR	NS	1	0.14	0.15	0.15	0.10	0.18	0.13	0.20	0.11	0.18	0.15
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	28	24	22	24	24	23	25	19	20	20
	90TH PERCENTILE	DOWN	3	47	40	38	35	45	36	40	27	32	32
SO_2	ARITHMETIC MEAN	NS	1	0.008	0.007	0.007	0.005	0.005	0.006	0.006	0.014	0.006	0.004
	2ND MAX 24-HOUR	NS	1	0.045	0.063	0.050	0.039	0.056	0.052	0.089	0.067	0.053	0.039
GARY, IN													
CO	2ND MAX 8-HOUR	NS	2	4.3	4.2	4.1	4.4	4.7	5.6	3.9	3.3	3.7	3.9
LEAD	MAX QUARTERLY MEAN	NS	4	0.23	0.21	0.11	0.11	0.08	0.17	0.12	0.13	0.10	0.10
O_3	4TH MAX 8-HOUR	NS	3	0.08	0.08	0.08	0.09	0.08	0.07	0.08	0.10	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	3	0.10	0.09	0.11	0.11	0.09	0.11	0.12	0.11	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	8	33	33	29	26	24	26	25	21	22	23
	90TH PERCENTILE	DOWN	8	54	52	45	43	39	42	41	33	33	36
SO_2	ARITHMETIC MEAN	DOWN	5	0.011	0.010	0.008	0.007	0.007	0.006	0.005	0.005	0.005	0.005
	2ND MAX 24-HOUR	DOWN	5	0.047	0.048	0.028	0.028	0.032	0.032	0.022	0.023	0.024	0.027
GLENS FALLS, NY													
SO_2	ARITHMETIC MEAN	DOWN	1	0.004	0.005	0.004	0.004	0.004	0.004	0.003	0.002	0.002	0.002
	2ND MAX 24-HOUR	DOWN	1	0.023	0.040	0.020	0.017	0.018	0.027	0.011	0.013	0.013	0.013
GOLDSBORO, NC													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	27	27	27	24	24	21	20	23	23	22
	90TH PERCENTILE	DOWN	1	46	46	46	36	36	33	30	33	36	34
GRAND FORKS, ND-MN													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	24	25	20	18	17	16	18	15	15	15
	90TH PERCENTILE	DOWN	1	48	38	34	33	28	28	30	22	22	22
GRAND RAPIDS-MUSKEGON-HOLLAND, MI													
CO	2ND MAX 8-HOUR	NS	1	4.5	3.5	4.0	3.2	3.2	4.0	4.6	3.3	2.4	2.9
LEAD	MAX QUARTERLY MEAN	DOWN	3	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
O_3	4TH MAX 8-HOUR	NS	4	0.10	0.10	0.10	0.10	0.08	0.08	0.09	0.10	0.09	0.08
	2ND DAILY MAX 1-HOUR	DOWN	4	0.13	0.13	0.13	0.11	0.10	0.11	0.12	0.12	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	29	30	26	35	22	27	21	20	19	21
	90TH PERCENTILE	DOWN	2	46	55	41	54	39	46	40	35	32	38
SO_2	ARITHMETIC MEAN	DOWN	1	0.004	0.004	0.004	0.003	0.003	0.003	0.002	0.002	0.002	0.002
	2ND MAX 24-HOUR	DOWN	1	0.016	0.012	0.014	0.015	0.012	0.013	0.011	0.011	0.008	0.008

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
GREAT FALLS, MT													
CO	2ND MAX 8-HOUR	NS	1	5.6	5.6	6.6	5.8	6.9	4.8	6.2	5.4	6.4	4.5
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	20	24	21	21	21	21	18	19	20	20
	90TH PERCENTILE	NS	1	31	39	44	40	40	34	30	35	32	32
GREELEY, CO													
CO	2ND MAX 8-HOUR	DOWN	1	7.3	7.1	7.8	7.5	5.8	5.2	5.3	7.0	4.8	4.4
O_3	4TH MAX 8-HOUR	NS	1	0.07	0.07	0.08	0.08	0.06	0.06	0.07	0.07	0.07	0.07
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.11	0.10	0.08	0.09	0.09	0.09	0.10	0.10	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	30	25	26	25	23	23	20	18	18	17
	90TH PERCENTILE	DOWN	1	50	43	51	43	39	37	34	30	30	30
GREEN BAY, WI													
SO_2	ARITHMETIC MEAN	DOWN	1	0.006	0.005	0.005	0.004	0.003	0.003	0.004	0.003	0.003	0.003
	2ND MAX 24-HOUR	DOWN	1	0.024	0.020	0.042	0.021	0.018	0.015	0.017	0.011	0.017	0.011
GREENSBORO–WINSTON-SALEM–HIGH POINT, NC													
CO	2ND MAX 8-HOUR	DOWN	1	9.7	6.8	6.6	5.7	5.5	6.0	6.2	4.3	4.7	5.4
NO_2	ARITHMETIC MEAN	NS	1	0.016	0.017	0.016	0.015	0.017	0.017	0.016	0.016	0.017	0.017
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.09	0.08	0.08	0.09	0.09	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	UP	2	0.09	0.11	0.10	0.10	0.12	0.11	0.11	0.11	0.11	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	32	31	31	27	27	25	26	24	24	25
	90TH PERCENTILE	DOWN	3	51	49	48	41	45	35	39	35	37	39
SO_2	ARITHMETIC MEAN	NS	1	0.007	0.008	0.007	0.006	0.006	0.007	0.007	0.007	0.007	0.006
	2ND MAX 24-HOUR	NS	1	0.024	0.023	0.027	0.019	0.022	0.021	0.025	0.026	0.023	0.023
GREENVILLE, NC													
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.08	0.09	0.10
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.10	0.09	0.10	0.11	0.09	0.10	0.10	0.12	0.11
GREENVILLE-SPARTANBURG-ANDERSON, SC													
LEAD	MAX QUARTERLY MEAN	DOWN	3	0.04	0.04	0.04	0.02	0.02	0.02	0.02	0.01	0.01	0.02
O_3	4TH MAX 8-HOUR	UP	4	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	UP	4	0.10	0.09	0.10	0.09	0.11	0.10	0.11	0.11	0.10	0.12
SO_2	ARITHMETIC MEAN	NS	1	0.002	0.002	0.003	0.003	0.003	0.003	0.001	0.002	0.003	0.003
	2ND MAX 24-HOUR	NS	1	0.011	0.011	0.017	0.013	0.012	0.016	0.007	0.012	0.014	0.015
HAMILTON-MIDDLETOWN, OH													
O_3	4TH MAX 8-HOUR	NS	2	0.09	0.09	0.10	0.09	0.07	0.09	0.09	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	2	0.11	0.12	0.11	0.10	0.12	0.11	0.13	0.11	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	NS	4	34	34	36	30	31	30	34	29	30	30
	90TH PERCENTILE	NS	4	60	60	61	51	63	53	58	45	54	53
SO_2	ARITHMETIC MEAN	DOWN	2	0.010	0.010	0.009	0.007	0.008	0.008	0.005	0.007	0.007	0.006
	2ND MAX 24-HOUR	DOWN	2	0.040	0.037	0.040	0.033	0.035	0.038	0.019	0.025	0.034	0.021
HARRISBURG-LEBANON-CARLISLE, PA													
LEAD	MAX QUARTERLY MEAN	NS	1	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
NO_2	ARITHMETIC MEAN	NS	2	0.014	0.013	0.014	0.013	0.011	0.015	0.014	0.015	0.013	0.012
O_3	4TH MAX 8-HOUR	NS	3	0.09	0.09	0.09	0.10	0.08	0.09	0.09	0.09	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	3	0.10	0.11	0.11	0.09	0.11	0.12	0.11	0.10	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	21	19	22	18	21	22	21	19	22	22
	90TH PERCENTILE	NS	1	33	35	39	27	30	44	32	31	33	33
SO_2	ARITHMETIC MEAN	DOWN	2	0.006	0.005	0.006	0.005	0.006	0.007	0.005	0.005	0.005	0.005
	2ND MAX 24-HOUR	NS	2	0.029	0.021	0.021	0.022	0.021	0.035	0.017	0.021	0.022	0.017
HARTFORD, CT													
CO	2ND MAX 8-HOUR	DOWN	2	6.7	6.7	6.1	6.1	5.6	6.4	5.8	5.0	4.8	5.4
NO_2	ARITHMETIC MEAN	NS	1	0.020	0.019	0.020	0.017	0.018	0.020	0.017	0.016	0.018	0.020
O_3	4TH MAX 8-HOUR	DOWN	3	0.11	0.11	0.10	0.11	0.09	0.10	0.10	0.10	0.08	0.10
	2ND DAILY MAX 1-HOUR	NS	3	0.15	0.15	0.16	0.12	0.15	0.13	0.13	0.10	0.14	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	NS	6	23	20	23	20	18	20	16	17	18	18
	90TH PERCENTILE	DOWN	6	37	35	38	34	31	35	29	30	33	31
SO_2	ARITHMETIC MEAN	DOWN	4	0.007	0.007	0.007	0.006	0.005	0.006	0.004	0.004	0.004	0.004
	2ND MAX 24-HOUR	DOWN	4	0.034	0.030	0.030	0.027	0.019	0.027	0.019	0.018	0.021	0.019
HONOLULU, HI													
CO	2ND MAX 8-HOUR	DOWN	3	2.6	2.2	2.0	2.1	2.4	2.3	2.0	1.9	1.8	1.7
LEAD	MAX QUARTERLY MEAN	NS	2	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.02	0.02
O_3	4TH MAX 8-HOUR	UP	1	0.02	0.02	0.03	0.04	0.05	0.05	0.05	0.05	0.04	0.05
	2ND DAILY MAX 1-HOUR	NS	1	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.05	0.05	0.06
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	16	16	17	17	16	19	15	16	18	20
	90TH PERCENTILE	NS	1	20	23	25	22	22	26	23	24	23	27
SO_2	ARITHMETIC MEAN	DOWN	1	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.002
	2ND MAX 24-HOUR	NS	3	0.006	0.006	0.006	0.006	0.009	0.006	0.005	0.007	0.005	0.007
HOUMA, LA													
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.08	0.08	0.07	0.08	0.09	0.10	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.11	0.12	0.10	0.09	0.10	0.10	0.14	0.09	0.10	0.11

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
HOUSTON, TX													
CO	2ND MAX 8-HOUR	DOWN	4	5.8	6.8	6.0	6.8	5.6	4.9	4.0	5.3	4.3	3.8
LEAD	MAX QUARTERLY MEAN	DOWN	2	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00
NO_2	ARITHMETIC MEAN	DOWN	4	0.022	0.023	0.022	0.022	0.019	0.021	0.021	0.020	0.021	0.019
O_3	4TH MAX 8-HOUR	NS	10	0.11	0.11	0.12	0.10	0.10	0.09	0.10	0.12	0.10	0.11
	2ND DAILY MAX 1-HOUR	NS	10	0.18	0.19	0.17	0.16	0.16	0.15	0.17	0.16	0.17	0.17
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	5	32	31	31	30	30	31	30	26	29	29
	90TH PERCENTILE	DOWN	5	53	50	48	48	50	50	48	39	48	48
SO_2	ARITHMETIC MEAN	DOWN	7	0.005	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.003	0.003
	2ND MAX 24-HOUR	DOWN	7	0.026	0.025	0.025	0.022	0.020	0.018	0.026	0.022	0.017	0.018
HUNTINGTON-ASHLAND, WV-KY-OH													
CO	2ND MAX 8-HOUR	NS	1	5.5	4.7	4.4	4.1	3.8	5.2	3.8	3.7	3.8	7.2
LEAD	MAX QUARTERLY MEAN	DOWN	2	0.06	0.04	0.04	0.04	0.04	0.03	0.04	0.03	0.02	0.02
O_3	4TH MAX 8-HOUR	NS	3	0.09	0.09	0.09	0.10	0.08	0.09	0.09	0.09	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	3	0.12	0.11	0.13	0.10	0.11	0.13	0.12	0.10	0.11	0.13
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	5	34	34	32	29	28	31	30	26	28	26
	90TH PERCENTILE	DOWN	5	58	54	50	46	52	52	48	39	45	44
SO_2	ARITHMETIC MEAN	DOWN	8	0.013	0.012	0.012	0.010	0.011	0.010	0.009	0.008	0.008	0.008
	2ND MAX 24-HOUR	DOWN	8	0.075	0.070	0.050	0.043	0.052	0.049	0.034	0.028	0.031	0.033
HUNTSVILLE, AL													
CO	2ND MAX 8-HOUR	DOWN	1	5.2	4.2	4.1	4.2	4.0	3.5	3.6	3.0	3.1	3.3
O_3	4TH MAX 8-HOUR	NS	1	0.07	0.07	0.08	0.08	0.09	0.09	0.08	0.08	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	1	0.09	0.09	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	32	32	28	27	24	23	23	21	21	22
	90TH PERCENTILE	DOWN	2	49	47	50	44	41	34	33	32	39	35
INDIANAPOLIS, IN													
CO	2ND MAX 8-HOUR	DOWN	2	4.0	4.0	5.2	3.5	4.0	3.5	3.9	2.8	3.2	2.7
LEAD	MAX QUARTERLY MEAN	DOWN	6	0.66	0.76	0.51	0.45	0.45	0.69	0.21	0.06	0.04	0.05
NO_2	ARITHMETIC MEAN	NS	1	0.018	0.018	0.018	0.018	0.018	0.019	0.020	0.018	0.015	0.019
O_3	4TH MAX 8-HOUR	NS	6	0.09	0.09	0.09	0.09	0.08	0.08	0.09	0.09	0.10	0.09
	2ND DAILY MAX 1-HOUR	NS	6	0.11	0.10	0.10	0.09	0.10	0.11	0.11	0.12	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	13	35	33	31	28	28	28	28	23	23	24
	90TH PERCENTILE	DOWN	13	58	54	49	43	51	46	46	34	36	39
SO_2	ARITHMETIC MEAN	DOWN	8	0.010	0.009	0.008	0.007	0.008	0.007	0.005	0.005	0.005	0.005
	2ND MAX 24-HOUR	DOWN	8	0.038	0.033	0.029	0.029	0.036	0.039	0.021	0.024	0.023	0.021
JACKSON, MS													
O_3	4TH MAX 8-HOUR	UP	2	0.07	0.07	0.08	0.07	0.07	0.07	0.07	0.08	0.08	0.08
	2ND DAILY MAX 1-HOUR	UP	2	0.08	0.10	0.09	0.08	0.09	0.09	0.09	0.09	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	26	26	26	27	23	21	23	22	24	20
	90TH PERCENTILE	DOWN	1	44	44	44	43	38	32	34	34	36	32
JACKSON, TN													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	31	28	27	27	23	23	25	22	23	23
	90TH PERCENTILE	DOWN	2	47	44	39	41	37	32	43	34	34	34
JACKSONVILLE, FL													
CO	2ND MAX 8-HOUR	DOWN	5	5.5	4.2	3.7	4.1	4.0	3.8	3.6	3.1	2.6	2.8
LEAD	MAX QUARTERLY MEAN	DOWN	2	0.04	0.04	0.03	0.02	0.05	0.02	0.03	0.02	0.02	0.02
NO_2	ARITHMETIC MEAN	NS	1	0.015	0.015	0.014	0.014	0.015	0.014	0.016	0.015	0.014	0.015
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.08	0.07	0.08	0.08	0.07	0.07	0.07	0.08
	2ND DAILY MAX 1-HOUR	NS	2	0.11	0.11	0.09	0.10	0.11	0.10	0.11	0.09	0.10	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	36	34	32	26	27	26	27	24	24	27
	90TH PERCENTILE	DOWN	3	50	45	44	38	37	39	41	32	35	38
SO_2	ARITHMETIC MEAN	DOWN	5	0.004	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	2ND MAX 24-HOUR	DOWN	5	0.037	0.037	0.023	0.023	0.025	0.030	0.019	0.020	0.017	0.021
JACKSONVILLE, NC													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	24	24	24	23	23	20	20	22	20	22
	90TH PERCENTILE	NS	1	39	39	39	35	35	28	29	32	32	37
JAMESTOWN, NY													
O_3	4TH MAX 8-HOUR	UP	1	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.10	0.10	0.10	0.10	0.09	0.10	0.10	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	NS	2	21	21	21	18	16	16	16	17	17	19
	90TH PERCENTILE	NS	2	39	39	39	29	32	33	30	28	34	37
SO_2	ARITHMETIC MEAN	DOWN	2	0.011	0.010	0.010	0.009	0.009	0.008	0.007	0.006	0.006	0.006
	2ND MAX 24-HOUR	DOWN	2	0.051	0.047	0.039	0.039	0.041	0.053	0.039	0.033	0.029	0.026
JERSEY CITY, NJ													
CO	2ND MAX 8-HOUR	DOWN	1	7.3	7.2	7.5	6.0	5.6	5.9	6.2	4.9	4.3	4.1
NO_2	ARITHMETIC MEAN	DOWN	1	0.031	0.030	0.028	0.028	0.027	0.026	0.026	0.027	0.026	0.027
O_3	4TH MAX 8-HOUR	NS	1	0.10	0.10	0.11	0.12	0.09	0.10	0.10	0.10	0.09	0.11
	2ND DAILY MAX 1-HOUR	NS	1	0.12	0.18	0.14	0.11	0.13	0.12	0.13	0.12	0.12	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	NS	3	33	31	32	26	27	32	25	27	26	26
	90TH PERCENTILE	NS	3	51	52	53	43	44	55	40	41	41	41
SO_2	ARITHMETIC MEAN	DOWN	2	0.014	0.013	0.012	0.010	0.009	0.009	0.007	0.008	0.008	0.007
	2ND MAX 24-HOUR	DOWN	2	0.047	0.043	0.035	0.041	0.030	0.036	0.026	0.027	0.025	0.022

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
JOHNSON CITY-KINGSPORT-BRISTOL, TN-VA													
CO	2ND MAX 8-HOUR	NS	1	3.7	3.4	3.3	3.0	6.5	3.4	3.0	3.0	3.5	3.4
NO_2	ARITHMETIC MEAN	NS	1	0.019	0.019	0.019	0.018	0.017	0.017	0.018	0.018	0.018	0.017
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.10	0.08	0.08	0.09	0.08	0.09	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.11	0.12	0.12	0.10	0.13	0.10	0.11	0.10	0.11	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	31	32	32	29	29	28	27	26	25	25
	90TH PERCENTILE	DOWN	3	50	50	50	44	50	42	43	42	42	39
SO_2	ARITHMETIC MEAN	NS	3	0.010	0.009	0.009	0.009	0.008	0.009	0.008	0.009	0.009	0.009
	2ND MAX 24-HOUR	NS	3	0.053	0.044	0.044	0.039	0.042	0.045	0.039	0.044	0.050	0.043
JOHNSTOWN, PA													
CO	2ND MAX 8-HOUR	NS	1	4.1	3.7	4.8	4.4	4.2	4.1	3.5	4.8	2.7	3.1
NO_2	ARITHMETIC MEAN	DOWN	1	0.019	0.018	0.019	0.018	0.017	0.018	0.015	0.018	0.016	0.015
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.08	0.10	0.07	0.08	0.08	0.09	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.10	0.11	0.09	0.10	0.09	0.10	0.10	0.10	0.12
SO_2	ARITHMETIC MEAN	DOWN	1	0.017	0.014	0.015	0.013	0.015	0.014	0.012	0.011	0.009	0.008
	2ND MAX 24-HOUR	DOWN	1	0.089	0.046	0.043	0.052	0.049	0.080	0.042	0.034	0.030	0.027
KALAMAZOO-BATTLE CREEK, MI													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	34	28	29	27	24	26	26	22	23	27
	90TH PERCENTILE	DOWN	1	61	58	56	42	39	44	50	33	38	47
KANSAS CITY, MO-KS													
CO	2ND MAX 8-HOUR	DOWN	3	5.2	4.4	4.0	3.9	4.2	4.3	3.3	3.2	3.2	3.7
LEAD	MAX QUARTERLY MEAN	NS	5	0.06	0.03	0.03	0.02	0.02	0.02	0.02	0.03	0.10	0.10
NO_2	ARITHMETIC MEAN	NS	3	0.011	0.011	0.010	0.010	0.009	0.010	0.010	0.012	0.010	0.012
O_3	4TH MAX 8-HOUR	UP	6	0.07	0.07	0.07	0.08	0.08	0.07	0.08	0.09	0.08	0.09
	2ND DAILY MAX 1-HOUR	UP	6	0.10	0.10	0.10	0.09	0.10	0.10	0.12	0.10	0.11	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	7	34	31	32	30	30	30	24	33	26	27
	90TH PERCENTILE	DOWN	7	56	51	51	47	48	47	44	56	40	44
SO_2	ARITHMETIC MEAN	NS	5	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.003
	2ND MAX 24-HOUR	NS	5	0.016	0.022	0.017	0.016	0.020	0.025	0.018	0.024	0.013	0.010
KENOSHA, WI													
O_3	4TH MAX 8-HOUR	NS	2	0.10	0.10	0.08	0.11	0.08	0.09	0.09	0.10	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	2	0.13	0.11	0.14	0.11	0.11	0.12	0.12	0.13	0.11	0.12
KNOXVILLE, TN													
CO	2ND MAX 8-HOUR	DOWN	1	6.7	5.1	4.5	4.5	4.6	4.3	4.1	3.3	4.8	3.9
O_3	4TH MAX 8-HOUR	UP	4	0.07	0.07	0.09	0.08	0.08	0.09	0.09	0.09	0.09	0.10
	2ND DAILY MAX 1-HOUR	UP	4	0.09	0.11	0.10	0.10	0.11	0.11	0.12	0.11	0.12	0.13
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	8	32	32	34	30	30	32	31	31	26	26
	90TH PERCENTILE	DOWN	8	51	53	52	47	48	49	49	49	44	41
SO_2	ARITHMETIC MEAN	NS	3	0.006	0.006	0.006	0.006	0.006	0.006	0.007	0.006	0.006	0.005
	2ND MAX 24-HOUR	NS	3	0.030	0.030	0.034	0.034	0.037	0.034	0.034	0.037	0.033	0.028
LAKE CHARLES, LA													
O_3	4TH MAX 8-HOUR	NS	1	0.09	0.09	0.09	0.09	0.07	0.08	0.08	0.08	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	1	0.12	0.11	0.12	0.11	0.10	0.10	0.11	0.09	0.11	0.12
LAKELAND-WINTER HAVEN, FL													
SO_2	ARITHMETIC MEAN	NS	2	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.006
	2ND MAX 24-HOUR	NS	2	0.015	0.018	0.015	0.015	0.019	0.016	0.013	0.019	0.016	0.022
LANCASTER, PA													
CO	2ND MAX 8-HOUR	NS	1	4.1	3.4	2.6	2.6	3.0	3.8	2.4	2.6	3.3	1.9
LEAD	MAX QUARTERLY MEAN	NS	1	0.05	0.06	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
NO_2	ARITHMETIC MEAN	NS	1	0.018	0.017	0.018	0.015	0.015	0.019	0.016	0.017	0.016	0.015
O_3	4TH MAX 8-HOUR	NS	1	0.09	0.09	0.09	0.10	0.09	0.10	0.09	0.10	0.09	0.10
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.10	0.12	0.11	0.12	0.11	0.12	0.10	0.13	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	UP	1	31	31	30	27	31	38	33	31	34	34
	90TH PERCENTILE	NS	1	52	52	45	41	54	61	55	46	50	50
SO_2	ARITHMETIC MEAN	NS	1	0.007	0.006	0.006	0.006	0.007	0.006	0.006	0.005	0.007	0.006
	2ND MAX 24-HOUR	DOWN	1	0.037	0.028	0.023	0.023	0.026	0.030	0.018	0.021	0.023	0.020
LANSING-EAST LANSING, MI													
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	2	0.10	0.10	0.11	0.09	0.10	0.09	0.10	0.09	0.09	0.10
LAS CRUCES, NM													
CO	2ND MAX 8-HOUR	DOWN	1	6.1	6.3	6.5	4.9	8.7	5.0	4.4	4.3	4.8	4.2
LEAD	MAX QUARTERLY MEAN	DOWN	2	0.16	0.17	0.15	0.13	0.12	0.05	0.09	0.07	0.07	0.07
O_3	4TH MAX 8-HOUR	NS	2	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06
	2ND DAILY MAX 1-HOUR	NS	2	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.09
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	45	35	31	31	30	33	34	33	27	27
	90TH PERCENTILE	DOWN	3	74	60	52	57	47	55	55	50	43	42
SO_2	ARITHMETIC MEAN	DOWN	2	0.010	0.011	0.010	0.009	0.006	0.004	0.004	0.004	0.003	0.003
	2ND MAX 24-HOUR	DOWN	2	0.061	0.056	0.055	0.052	0.055	0.023	0.021	0.030	0.014	0.012

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
LAS VEGAS, NV-AZ													
CO	2ND MAX 8-HOUR	DOWN	2	10.0	10.9	9.5	7.9	8.6	8.8	7.8	8.4	7.8	8.2
O_3	4TH MAX 8-HOUR	NS	3	0.08	0.08	0.07	0.07	0.08	0.08	0.08	0.07	0.08	0.07
	2ND DAILY MAX 1-HOUR	DOWN	3	0.10	0.10	0.09	0.09	0.10	0.09	0.09	0.09	0.09	0.09
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	60	69	59	48	43	47	47	53	60	60
	90TH PERCENTILE	NS	1	107	127	88	76	75	67	77	82	90	90
LAWRENCE, MA-NH													
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.07	0.09	0.07	0.08	0.08	0.07	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.11	0.09	0.12	0.09	0.10	0.10	0.08	0.09	0.10	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	21	21	18	19	18	16	13	14	15	15
	90TH PERCENTILE	NS	1	32	32	30	32	36	32	24	22	25	28
SO_2	ARITHMETIC MEAN	DOWN	2	0.009	0.008	0.007	0.008	0.008	0.006	0.006	0.005	0.005	0.006
	2ND MAX 24-HOUR	DOWN	2	0.036	0.029	0.026	0.027	0.026	0.027	0.025	0.019	0.020	0.021
LAWTON, OK													
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	32	30	27	26	27	28	25	28	26	26
	90TH PERCENTILE	NS	1	53	51	43	41	35	43	44	44	48	48
LEWISTON-AUBURN, ME													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	25	25	29	24	24	20	20	20	21	18
	90TH PERCENTILE	DOWN	1	41	41	50	43	49	35	37	31	35	31
SO_2	ARITHMETIC MEAN	DOWN	1	0.008	0.007	0.006	0.005	0.007	0.006	0.004	0.004	0.004	0.004
	2ND MAX 24-HOUR	DOWN	1	0.035	0.027	0.023	0.020	0.025	0.025	0.020	0.018	0.017	0.019
LEXINGTON, KY													
CO	2ND MAX 8-HOUR	NS	1	5.6	3.7	4.9	3.8	6.5	4.2	3.0	3.1	5.2	5.2
NO_2	ARITHMETIC MEAN	DOWN	1	0.019	0.017	0.016	0.016	0.017	0.016	0.017	0.014	0.014	0.011
O_3	4TH MAX 8-HOUR	NS	2	0.09	0.09	0.08	0.08	0.06	0.08	0.09	0.08	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	2	0.11	0.10	0.09	0.08	0.10	0.10	0.11	0.09	0.09	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	31	29	29	25	24	28	25	24	22	23
	90TH PERCENTILE	DOWN	3	50	48	46	40	42	46	40	39	37	39
SO_2	ARITHMETIC MEAN	NS	1	0.006	0.006	0.008	0.007	0.007	0.008	0.006	0.006	0.006	0.006
	2ND MAX 24-HOUR	NS	1	0.034	0.020	0.025	0.030	0.026	0.037	0.016	0.020	0.016	0.023
LIMA, OH													
O_3	4TH MAX 8-HOUR	NS	1	0.09	0.09	0.08	0.09	0.08	0.09	0.09	0.09	0.09	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.09	0.10
SO_2	ARITHMETIC MEAN	DOWN	1	0.006	0.005	0.006	0.004	0.005	0.004	0.003	0.003	0.003	0.003
	2ND MAX 24-HOUR	NS	1	0.033	0.026	0.021	0.020	0.023	0.036	0.015	0.015	0.016	0.017
LINCOLN, NE													
CO	2ND MAX 8-HOUR	NS	2	6.1	6.2	7.4	4.5	4.3	4.0	4.9	3.4	5.0	4.3
O_3	4TH MAX 8-HOUR	NS	1	0.06	0.06	0.06	0.06	0.07	0.05	0.06	0.06	0.05	0.05
	2ND DAILY MAX 1-HOUR	NS	1	0.06	0.07	0.07	0.07	0.06	0.08	0.07	0.06	0.06	0.07
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	33	29	30	25	26	28	25	28	24	26
	90TH PERCENTILE	DOWN	2	51	49	53	42	38	46	45	44	39	40
LITTLE ROCK-NORTH LITTLE ROCK, AR													
NO_2	ARITHMETIC MEAN	NS	1	0.009	0.009	0.009	0.012	0.009	0.011	0.011	0.011	0.010	0.011
O_3	4TH MAX 8-HOUR	NS	2	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	2	0.09	0.10	0.10	0.09	0.10	0.09	0.11	0.10	0.10	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	4	29	29	25	28	27	27	29	26	25	25
	90TH PERCENTILE	NS	4	49	49	43	47	44	47	50	41	42	42
SO_2	ARITHMETIC MEAN	NS	1	0.002	0.003	0.003	0.005	0.006	0.003	0.002	0.002	0.002	0.002
	2ND MAX 24-HOUR	DOWN	1	0.010	0.014	0.012	0.012	0.017	0.009	0.008	0.009	0.006	0.006
LONGVIEW-MARSHALL, TX													
O_3	4TH MAX 8-HOUR	NS	1	0.09	0.09	0.09	0.08	0.08	0.09	0.08	0.10	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.13	0.11	0.10	0.11	0.10	0.15	0.11	0.12	0.13
LOS ANGELES-LONG BEACH, CA													
CO	2ND MAX 8-HOUR	DOWN	13	9.6	9.0	8.8	7.8	6.8	8.0	7.5	6.8	6.6	6.1
LEAD	MAX QUARTERLY MEAN	DOWN	6	0.09	0.09	0.10	0.08	0.06	0.06	0.05	0.05	0.05	0.04
NO_2	ARITHMETIC MEAN	DOWN	13	0.044	0.041	0.041	0.038	0.036	0.039	0.038	0.035	0.033	0.033
O_3	4TH MAX 8-HOUR	DOWN	14	0.14	0.14	0.12	0.13	0.13	0.12	0.11	0.11	0.10	0.09
	2ND DAILY MAX 1-HOUR	DOWN	14	0.22	0.19	0.19	0.20	0.17	0.17	0.15	0.14	0.12	0.15
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	9	57	49	53	41	40	39	39	38	39	33
	90TH PERCENTILE	DOWN	9	88	78	80	64	65	59	64	61	57	55
SO_2	ARITHMETIC MEAN	DOWN	4	0.004	0.003	0.003	0.004	0.003	0.003	0.003	0.003	0.003	0.003
	2ND MAX 24-HOUR	DOWN	4	0.015	0.012	0.013	0.015	0.011	0.008	0.008	0.008	0.007	0.009
LOUISVILLE, KY-IN													
CO	2ND MAX 8-HOUR	DOWN	4	6.0	5.9	5.9	5.2	5.4	5.9	4.4	3.9	5.0	4.4
LEAD	MAX QUARTERLY MEAN	DOWN	2	0.05	0.04	0.05	0.05	0.05	0.02	0.05	0.02	0.02	0.02
O_3	4TH MAX 8-HOUR	NS	4	0.08	0.08	0.08	0.09	0.07	0.09	0.09	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	4	0.11	0.11	0.12	0.09	0.13	0.12	0.12	0.11	0.12	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	6	35	34	33	30	29	30	29	26	29	26
	90TH PERCENTILE	DOWN	6	59	56	51	48	51	47	46	44	48	42
SO_2	ARITHMETIC MEAN	DOWN	4	0.010	0.010	0.010	0.009	0.010	0.010	0.008	0.007	0.006	0.007
	2ND MAX 24-HOUR	DOWN	4	0.055	0.041	0.037	0.034	0.035	0.040	0.028	0.031	0.031	0.033

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
LOWELL, MA-NH													
CO	2ND MAX 8-HOUR	NS	1	5.3	7.3	5.8	5.9	5.1	6.5	7.8	4.5	3.6	3.4
LUBBOCK, TX													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	34	24	25	22	20	23	21	22	17	17
	90TH PERCENTILE	DOWN	1	55	36	39	34	30	33	34	34	27	27
LYNCHBURG, VA													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	30	24	28	24	26	23	24	23	23	21
	90TH PERCENTILE	NS	1	47	43	41	39	44	33	49	36	37	33
MADISON, WI													
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	34	24	25	22	21	22	23	20	20	27
	90TH PERCENTILE	NS	1	58	36	38	32	36	33	43	30	34	43
MANCHESTER, NH													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	24	20	20	18	18	15	14	16	19	17
	90TH PERCENTILE	DOWN	2	36	34	38	31	37	34	26	28	29	28
MANSFIELD, OH													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	27	27	27	26	28	29	25	24	23	24
	90TH PERCENTILE	NS	1	42	42	40	39	44	49	42	40	39	41
MEDFORD-ASHLAND, OR													
CO	2ND MAX 8-HOUR	DOWN	1	11.0	8.2	8.1	6.4	6.9	6.2	5.3	6.4	5.7	5.2
LEAD	MAX QUARTERLY MEAN	NS	1	0.04	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	4	45	35	34	31	30	28	22	21	23	21
	90TH PERCENTILE	DOWN	4	94	67	62	52	53	47	36	35	36	33
MELBOURNE-TITUSVILLE-PALM BAY, FL													
O_3	4TH MAX 8-HOUR	DOWN	2	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	2ND DAILY MAX 1-HOUR	NS	2	0.10	0.08	0.09	0.08	0.09	0.09	0.08	0.09	0.09	0.09
MEMPHIS, TN-AR-MS													
CO	2ND MAX 8-HOUR	DOWN	5	8.2	7.5	6.1	7.7	7.6	7.3	6.0	5.3	5.0	4.9
LEAD	MAX QUARTERLY MEAN	NS	4	1.08	1.04	0.79	1.00	1.05	1.03	0.65	1.04	0.59	0.93
NO_2	ARITHMETIC MEAN	UP	1	0.026	0.023	0.024	0.026	0.026	0.027	0.027	0.024	0.028	0.029
O_3	4TH MAX 8-HOUR	NS	4	0.08	0.08	0.09	0.08	0.08	0.08	0.09	0.10	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	4	0.11	0.11	0.11	0.10	0.11	0.11	0.13	0.12	0.12	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	31	31	27	28	29	27	27	27	26	25
	90TH PERCENTILE	NS	2	42	50	45	44	49	43	45	40	44	41
SO_2	ARITHMETIC MEAN	DOWN	2	0.007	0.007	0.007	0.007	0.006	0.005	0.004	0.003	0.003	0.003
	2ND MAX 24-HOUR	DOWN	2	0.029	0.027	0.025	0.031	0.029	0.025	0.019	0.011	0.011	0.011
MERCED, CA													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	52	53	52	46	43	39	39	31	31	31
	90TH PERCENTILE	DOWN	1	102	95	106	75	86	55	77	50	50	50
MIAMI, FL													
CO	2ND MAX 8-HOUR	DOWN	2	7.3	6.0	7.2	6.2	5.3	4.4	4.9	4.5	3.8	3.1
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.08	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NO_2	ARITHMETIC MEAN	NS	2	0.013	0.011	0.011	0.011	0.012	0.010	0.011	0.011	0.012	0.011
O_3	4TH MAX 8-HOUR	NS	4	0.08	0.08	0.07	0.06	0.07	0.08	0.07	0.07	0.07	0.07
	2ND DAILY MAX 1-HOUR	NS	4	0.11	0.10	0.09	0.10	0.10	0.09	0.09	0.09	0.10	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	27	28	26	27	27	26	24	25	23	26
	90TH PERCENTILE	DOWN	3	39	37	37	39	36	35	31	37	31	36
SO_2	ARITHMETIC MEAN	NS	1	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.001
	2ND MAX 24-HOUR	NS	1	0.003	0.003	0.003	0.005	0.004	0.004	0.004	0.005	0.004	0.004
MIDDLESEX-SOMERSET-HUNTERDON, NJ													
CO	2ND MAX 8-HOUR	DOWN	1	5.4	5.4	4.2	3.9	3.7	4.3	5.3	3.3	3.8	3.0
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.38	0.30	1.15	1.22	0.33	0.12	0.07	0.06	0.08	0.08
O_3	4TH MAX 8-HOUR	NS	1	0.10	0.10	0.11	0.11	0.09	0.10	0.09	0.10	0.09	0.10
	2ND DAILY MAX 1-HOUR	DOWN	1	0.13	0.14	0.12	0.12	0.12	0.11	0.12	0.11	0.12	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	34	29	30	25	25	27	22	25	25	25
	90TH PERCENTILE	DOWN	1	59	46	45	38	43	44	35	41	41	41
SO_2	ARITHMETIC MEAN	DOWN	1	0.010	0.007	0.007	0.006	0.005	0.005	0.004	0.005	0.005	0.005
	2ND MAX 24-HOUR	DOWN	1	0.037	0.032	0.025	0.026	0.018	0.028	0.018	0.024	0.019	0.018
MILWAUKEE-WAUKESHA, WI													
CO	2ND MAX 8-HOUR	DOWN	5	3.9	4.5	3.7	3.2	4.0	4.5	3.0	1.9	2.0	2.1
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.06	0.08	0.06	0.05	0.04	0.03	0.05	0.03	0.03	0.03
NO_2	ARITHMETIC MEAN	DOWN	1	0.020	0.019	0.018	0.018	0.017	0.017	0.017	0.017	0.016	0.016
O_3	4TH MAX 8-HOUR	NS	8	0.10	0.10	0.08	0.09	0.08	0.08	0.08	0.10	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	8	0.13	0.11	0.14	0.10	0.10	0.12	0.11	0.10	0.12	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	4	35	33	29	26	26	28	27	25	24	27
	90TH PERCENTILE	DOWN	4	57	57	49	41	45	42	49	38	38	41
SO_2	ARITHMETIC MEAN	DOWN	1	0.005	0.006	0.005	0.004	0.003	0.004	0.004	0.004	0.004	0.004
	2ND MAX 24-HOUR	NS	1	0.027	0.040	0.029	0.023	0.018	0.032	0.025	0.028	0.028	0.022

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
MINNEAPOLIS-ST. PAUL, MN-WI													
CO	2ND MAX 8-HOUR	DOWN	3	9.0	6.5	7.2	5.9	5.2	6.4	6.0	5.1	4.5	4.9
LEAD	MAX QUARTERLY MEAN	DOWN	3	0.38	0.77	0.31	0.25	0.12	0.07	0.23	0.12	0.09	0.06
NO_2	ARITHMETIC MEAN	NS	1	0.017	0.017	0.016	0.016	0.018	0.019	0.017	0.019	0.017	0.018
O_3	4TH MAX 8-HOUR	NS	4	0.07	0.07	0.07	0.07	0.08	0.06	0.07	0.08	0.07	0.07
	2ND DAILY MAX 1-HOUR	NS	4	0.09	0.09	0.08	0.09	0.08	0.08	0.10	0.09	0.09	0.09
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	8	28	26	25	21	21	21	22	21	21	22
	90TH PERCENTILE	DOWN	8	46	42	40	36	33	33	38	34	32	36
SO_2	ARITHMETIC MEAN	DOWN	8	0.004	0.004	0.004	0.003	0.003	0.003	0.002	0.002	0.002	0.002
	2ND MAX 24-HOUR	DOWN	8	0.021	0.020	0.021	0.019	0.015	0.014	0.012	0.013	0.013	0.011
MOBILE, AL													
O_3	4TH MAX 8-HOUR	NS	2	0.07	0.07	0.08	0.05	0.07	0.07	0.07	0.08	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	2	0.09	0.10	0.07	0.10	0.09	0.09	0.11	0.10	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	NS	4	31	31	32	34	32	31	29	25	26	30
	90TH PERCENTILE	NS	4	42	49	49	51	51	51	43	40	45	47
SO_2	ARITHMETIC MEAN	NS	1	0.008	0.008	0.009	0.010	0.010	0.011	0.009	0.009	0.008	0.009
	2ND MAX 24-HOUR	NS	1	0.064	0.038	0.050	0.054	0.066	0.052	0.053	0.070	0.049	0.073
MODESTO, CA													
CO	2ND MAX 8-HOUR	DOWN	1	11.8	10.5	9.4	5.9	6.6	6.3	5.4	5.6	4.2	5.4
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.04	0.04	0.04	0.02	0.02	0.02	0.01	0.01	0.01	0.01
NO_2	ARITHMETIC MEAN	DOWN	1	0.027	0.026	0.024	0.022	0.024	0.023	0.022	0.022	0.021	0.020
O_3	4TH MAX 8-HOUR	NS	1	0.09	0.09	0.10	0.09	0.08	0.09	0.09	0.10	0.09	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.11	0.12	0.11	0.11	0.11	0.12	0.13	0.13	0.11	0.13
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	46	44	48	39	40	37	34	28	30	23
	90TH PERCENTILE	DOWN	2	91	85	101	69	72	54	68	41	48	38
MONMOUTH-OCEAN, NJ													
CO	2ND MAX 8-HOUR	DOWN	2	6.1	5.7	5.5	4.7	5.3	4.9	3.8	4.4	3.7	3.0
O_3	4TH MAX 8-HOUR	NS	1	0.11	0.11	0.11	0.11	0.09	0.10	0.08	0.11	0.09	0.10
	2ND DAILY MAX 1-HOUR	DOWN	1	0.14	0.14	0.15	0.14	0.13	0.11	0.15	0.12	0.13	0.13
MONTGOMERY, AL													
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.08	0.07	0.08	0.09	0.08	0.09	0.08	0.07
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.10	0.09	0.10	0.11	0.10	0.10	0.10	0.09	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	23	27	26	24	23	25	26	23	24	28
	90TH PERCENTILE	NS	1	35	41	44	39	34	36	43	37	40	39
NASHUA, NH													
CO	2ND MAX 8-HOUR	NS	2	6.2	7.1	6.9	6.8	5.2	7.5	6.8	7.7	4.7	4.5
NO_2	ARITHMETIC MEAN	NS	1	0.022	0.019	0.016	0.015	0.016	0.015	0.014	0.019	0.016	0.015
O_3	4TH MAX 8-HOUR	NS	2	0.07	0.07	0.08	0.09	0.08	0.08	0.08	0.08	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	2	0.09	0.10	0.10	0.10	0.11	0.10	0.10	0.10	0.11	0.09
PM_{10}	WEIGHTED ANNUAL MEAN	NS	3	20	18	19	17	16	14	13	16	17	18
	90TH PERCENTILE	NS	3	34	32	34	29	28	31	25	29	29	30
SO_2	ARITHMETIC MEAN	DOWN	3	0.008	0.007	0.005	0.006	0.006	0.006	0.005	0.005	0.006	0.005
	2ND MAX 24-HOUR	DOWN	3	0.040	0.036	0.024	0.025	0.022	0.028	0.023	0.021	0.025	0.019
NASHVILLE, TN													
CO	2ND MAX 8-HOUR	DOWN	3	7.4	5.9	5.0	5.5	6.4	5.4	4.8	3.9	4.7	4.4
LEAD	MAX QUARTERLY MEAN	NS	5	0.63	1.26	1.06	0.99	0.89	0.93	1.78	0.57	0.63	0.74
NO_2	ARITHMETIC MEAN	NS	1	0.012	0.012	0.010	0.014	0.012	0.020	0.014	0.012	0.012	0.011
O_3	4TH MAX 8-HOUR	UP	7	0.08	0.08	0.09	0.08	0.08	0.08	0.08	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	UP	7	0.10	0.11	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	6	37	36	35	31	31	30	31	28	28	28
	90TH PERCENTILE	DOWN	6	58	57	52	48	47	51	50	43	47	45
SO_2	ARITHMETIC MEAN	DOWN	2	0.011	0.013	0.012	0.008	0.010	0.007	0.005	0.006	0.006	0.005
	2ND MAX 24-HOUR	NS	3	0.062	0.058	0.062	0.023	0.047	0.034	0.026	0.041	0.048	0.032
NASSAU-SUFFOLK, NY													
CO	2ND MAX 8-HOUR	DOWN	1	6.5	7.2	6.6	5.6	5.6	5.4	5.0	4.9	4.7	4.0
NO_2	ARITHMETIC MEAN	DOWN	1	0.029	0.028	0.029	0.026	0.026	0.028	0.025	0.026	0.025	0.022
O_3	4TH MAX 8-HOUR	NS	1	0.11	0.11	0.11	0.11	0.09	0.10	0.09	0.11	0.09	0.11
	2ND DAILY MAX 1-HOUR	NS	1	0.15	0.14	0.18	0.13	0.13	0.13	0.15	0.12	0.14	0.14
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	27	27	27	22	23	23	19	18	20	18
	90TH PERCENTILE	DOWN	2	54	54	54	38	42	39	33	29	34	30
SO_2	ARITHMETIC MEAN	DOWN	2	0.010	0.009	0.009	0.008	0.008	0.007	0.005	0.007	0.006	0.006
	2ND MAX 24-HOUR	DOWN	2	0.045	0.045	0.039	0.039	0.033	0.037	0.030	0.028	0.029	0.028
NEW BEDFORD, MA													
O_3	4TH MAX 8-HOUR	NS	1	0.09	0.09	0.10	0.10	0.09	0.07	0.08	0.11	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	1	0.12	0.13	0.13	0.11	0.09	0.10	0.14	0.12	0.12	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	23	23	20	17	17	19	14	16	18	16
	90TH PERCENTILE	NS	1	34	34	35	29	24	37	21	27	29	25

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
NEW HAVEN-MERIDEN, CT													
NO_2	ARITHMETIC MEAN	NS	1	0.028	0.027	0.028	0.025	0.027	0.030	0.025	0.026	0.024	0.027
O_3	4TH MAX 8-HOUR	NS	2	0.10	0.10	0.10	0.12	0.08	0.09	0.09	0.10	0.08	0.10
	2ND DAILY MAX 1-HOUR	NS	2	0.15	0.13	0.16	0.12	0.14	0.14	0.14	0.11	0.14	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	6	32	30	33	27	29	29	24	22	23	23
	90TH PERCENTILE	DOWN	6	51	49	58	46	51	52	41	36	36	36
SO_2	ARITHMETIC MEAN	DOWN	2	0.012	0.010	0.010	0.009	0.008	0.008	0.006	0.006	0.005	0.005
	2ND MAX 24-HOUR	DOWN	2	0.071	0.045	0.055	0.042	0.038	0.049	0.031	0.027	0.028	0.028
NEW LONDON-NORWICH, CT-RI													
O_3	4TH MAX 8-HOUR	NS	1	0.12	0.12	0.11	0.11	0.09	0.10	0.09	0.10	0.10	0.11
	2ND DAILY MAX 1-HOUR	NS	1	0.14	0.16	0.14	0.12	0.13	0.12	0.14	0.12	0.15	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	23	21	24	20	18	22	17	19	18	17
	90TH PERCENTILE	DOWN	2	39	35	40	32	31	39	29	31	29	28
SO_2	ARITHMETIC MEAN	DOWN	1	0.008	0.008	0.007	0.006	0.006	0.005	0.005	0.005	0.004	0.004
	2ND MAX 24-HOUR	DOWN	1	0.027	0.029	0.027	0.025	0.019	0.029	0.017	0.016	0.022	0.018
NEW ORLEANS, LA													
CO	2ND MAX 8-HOUR	DOWN	2	6.1	4.9	4.2	5.4	5.1	4.6	3.6	4.0	3.3	3.2
LEAD	MAX QUARTERLY MEAN	NS	1	0.09	0.05	0.03	0.03	0.02	0.02	0.03	0.02	0.02	0.02
NO_2	ARITHMETIC MEAN	NS	2	0.017	0.016	0.015	0.017	0.016	0.015	0.016	0.015	0.014	0.016
O_3	4TH MAX 8-HOUR	NS	6	0.08	0.08	0.08	0.07	0.08	0.08	0.08	0.08	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	6	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.10	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	31	27	26	27	25	25	24	22	25	25
	90TH PERCENTILE	DOWN	1	49	44	48	39	42	40	37	31	36	36
SO_2	ARITHMETIC MEAN	NS	2	0.003	0.003	0.004	0.005	0.005	0.005	0.005	0.005	0.004	0.004
	2ND MAX 24-HOUR	NS	2	0.017	0.013	0.023	0.018	0.019	0.021	0.019	0.025	0.016	0.020
NEW YORK, NY													
CO	2ND MAX 8-HOUR	DOWN	5	7.7	7.1	6.7	6.1	5.3	5.9	6.5	4.6	3.6	3.7
LEAD	MAX QUARTERLY MEAN	NS	1	0.12	0.16	0.12	0.11	0.16	0.14	0.12	0.16	0.16	0.14
NO_2	ARITHMETIC MEAN	DOWN	2	0.044	0.043	0.043	0.037	0.040	0.042	0.039	0.039	0.038	0.038
O_3	4TH MAX 8-HOUR	NS	5	0.09	0.09	0.10	0.11	0.08	0.09	0.09	0.10	0.09	0.10
	2ND DAILY MAX 1-HOUR	NS	5	0.12	0.13	0.14	0.12	0.12	0.12	0.12	0.12	0.13	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	12	34	31	29	26	25	28	25	26	26	25
	90TH PERCENTILE	NS	12	56	52	46	41	41	47	41	40	41	41
SO_2	ARITHMETIC MEAN	DOWN	7	0.015	0.014	0.014	0.013	0.012	0.013	0.010	0.010	0.009	0.008
	2ND MAX 24-HOUR	DOWN	7	0.060	0.054	0.048	0.051	0.039	0.054	0.038	0.040	0.033	0.030
NEWARK, NJ													
CO	2ND MAX 8-HOUR	DOWN	3	7.6	7.1	8.3	5.6	4.9	7.7	6.0	5.1	4.6	3.7
NO_2	ARITHMETIC MEAN	NS	4	0.030	0.029	0.028	0.030	0.028	0.030	0.028	0.029	0.028	0.029
O_3	4TH MAX 8-HOUR	NS	2	0.09	0.09	0.10	0.10	0.09	0.09	0.09	0.10	0.09	0.10
	2ND DAILY MAX 1-HOUR	NS	2	0.12	0.13	0.12	0.10	0.12	0.11	0.12	0.11	0.11	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	NS	3	35	31	30	29	30	35	28	31	31	31
	90TH PERCENTILE	NS	3	59	55	52	44	52	57	46	49	49	49
SO_2	ARITHMETIC MEAN	DOWN	4	0.012	0.010	0.010	0.009	0.007	0.008	0.006	0.006	0.006	0.006
	2ND MAX 24-HOUR	DOWN	4	0.047	0.040	0.035	0.040	0.025	0.033	0.025	0.027	0.023	0.021
NEWBURGH, NY-PA													
LEAD	MAX QUARTERLY MEAN	DOWN	2	1.42	1.01	0.66	0.58	0.34	0.08	0.08	0.06	0.20	0.10
NORFOLK-VIRGINIA BEACH-NEWPORT NEWS,VA-N													
CO	2ND MAX 8-HOUR	NS	3	5.2	4.5	5.1	4.3	5.0	5.4	4.3	4.3	4.0	4.6
NO_2	ARITHMETIC MEAN	NS	1	0.020	0.019	0.020	0.020	0.021	0.019	0.018	0.018	0.019	0.019
O_3	4TH MAX 8-HOUR	NS	3	0.08	0.08	0.09	0.08	0.09	0.09	0.08	0.08	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	3	0.10	0.10	0.10	0.13	0.12	0.10	0.11	0.09	0.11	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	27	26	26	22	23	20	20	21	22	22
	90TH PERCENTILE	DOWN	3	43	38	42	37	40	31	34	32	34	34
SO_2	ARITHMETIC MEAN	DOWN	2	0.007	0.007	0.007	0.006	0.007	0.007	0.006	0.006	0.006	0.006
	2ND MAX 24-HOUR	DOWN	2	0.033	0.025	0.022	0.024	0.026	0.024	0.022	0.022	0.025	0.020
OAKLAND, CA													
CO	2ND MAX 8-HOUR	DOWN	6	4.9	4.8	4.8	4.0	3.4	3.6	2.7	2.9	2.9	2.9
LEAD	MAX QUARTERLY MEAN	DOWN	4	0.13	0.08	0.10	0.02	0.02	0.02	0.02	0.01	0.01	0.01
NO_2	ARITHMETIC MEAN	DOWN	2	0.022	0.021	0.022	0.020	0.020	0.020	0.019	0.018	0.017	0.018
O_3	4TH MAX 8-HOUR	NS	8	0.07	0.07	0.06	0.06	0.06	0.07	0.06	0.08	0.07	0.06
	2ND DAILY MAX 1-HOUR	NS	8	0.10	0.09	0.09	0.09	0.11	0.10	0.13	0.10	0.09	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	4	32	31	33	27	24	24	21	22	21	19
	90TH PERCENTILE	DOWN	4	56	56	63	43	41	38	36	34	33	30
SO_2	ARITHMETIC MEAN	NS	3	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	2ND MAX 24-HOUR	DOWN	3	0.013	0.011	0.010	0.009	0.010	0.007	0.007	0.007	0.008	0.009
OKLAHOMA CITY, OK													
CO	2ND MAX 8-HOUR	DOWN	2	5.2	4.5	3.9	4.3	5.2	4.3	3.8	4.0	4.0	3.4
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.04	0.04	0.04	0.03	0.02	0.01	0.02	0.01	0.00	0.00
NO_2	ARITHMETIC MEAN	NS	3	0.013	0.012	0.011	0.011	0.011	0.012	0.012	0.012	0.013	0.012
O_3	4TH MAX 8-HOUR	NS	4	0.08	0.08	0.08	0.08	0.07	0.07	0.08	0.09	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	4	0.10	0.10	0.10	0.09	0.09	0.09	0.11	0.09	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	NS	4	23	22	22	22	21	21	21	24	22	22
	90TH PERCENTILE	NS	4	38	36	35	34	34	34	38	39	39	39

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
OLYMPIA, WA													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	28	24	25	24	24	17	17	16	16	14
	90TH PERCENTILE	DOWN	1	74	44	43	42	49	30	35	30	36	22
OMAHA, NE-IA													
CO	2ND MAX 8-HOUR	NS	2	4.8	5.2	5.8	5.9	5.3	4.0	5.5	4.9	4.2	5.3
LEAD	MAX QUARTERLY MEAN	NS	6	0.94	0.84	0.75	1.33	1.29	1.68	1.03	1.00	0.35	0.05
O_3	4TH MAX 8-HOUR	DOWN	3	0.07	0.07	0.06	0.06	0.06	0.05	0.06	0.06	0.06	0.06
	2ND DAILY MAX 1-HOUR	NS	3	0.08	0.07	0.08	0.08	0.06	0.07	0.08	0.07	0.07	0.08
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	7	42	37	36	36	31	33	30	33	33	34
	90TH PERCENTILE	NS	7	64	63	59	62	48	52	52	49	52	60
ORANGE COUNTY, CA													
CO	2ND MAX 8-HOUR	DOWN	4	9.0	8.3	7.0	7.5	5.8	7.3	5.7	5.8	4.8	5.0
NO_2	ARITHMETIC MEAN	DOWN	3	0.038	0.039	0.038	0.034	0.032	0.034	0.033	0.029	0.028	0.029
O_3	4TH MAX 8-HOUR	DOWN	4	0.12	0.12	0.11	0.10	0.10	0.09	0.10	0.08	0.08	0.07
	2ND DAILY MAX 1-HOUR	DOWN	4	0.21	0.17	0.18	0.17	0.15	0.16	0.12	0.12	0.11	0.14
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	45	45	41	37	36	36	41	33	37	33
	90TH PERCENTILE	DOWN	2	72	75	68	53	57	54	68	47	50	52
SO_2	ARITHMETIC MEAN	NS	1	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.001	0.001	0.002
	2ND MAX 24-HOUR	DOWN	1	0.008	0.008	0.007	0.008	0.006	0.005	0.005	0.004	0.006	0.005
ORLANDO, FL													
CO	2ND MAX 8-HOUR	DOWN	2	4.3	4.5	3.6	3.9	3.8	3.6	3.3	3.3	3.6	3.0
LEAD	MAX QUARTERLY MEAN	NS	2	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NO_2	ARITHMETIC MEAN	NS	1	0.013	0.012	0.012	0.011	0.012	0.011	0.010	0.013	0.013	0.011
O_3	4TH MAX 8-HOUR	DOWN	3	0.09	0.09	0.08	0.07	0.08	0.08	0.08	0.08	0.07	0.08
	2ND DAILY MAX 1-HOUR	NS	3	0.11	0.11	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	NS	3	27	27	27	24	24	23	22	23	23	24
	90TH PERCENTILE	NS	3	36	37	35	36	33	31	32	33	33	35
SO_2	ARITHMETIC MEAN	NS	1	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	2ND MAX 24-HOUR	NS	1	0.006	0.011	0.007	0.007	0.011	0.012	0.006	0.008	0.006	0.007
OWENSBORO, KY													
NO_2	ARITHMETIC MEAN	NS	1	0.014	0.011	0.011	0.012	0.012	0.012	0.013	0.011	0.012	0.013
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.09	0.08	0.08	0.08	0.09	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.11	0.09	0.09	0.11	0.11	0.11	0.11	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	31	29	29	27	25	29	27	24	24	25
	90TH PERCENTILE	DOWN	3	49	45	45	45	45	45	48	41	42	43
SO_2	ARITHMETIC MEAN	DOWN	1	0.010	0.009	0.009	0.009	0.009	0.009	0.007	0.007	0.007	0.007
	2ND MAX 24-HOUR	DOWN	1	0.053	0.038	0.044	0.053	0.050	0.035	0.028	0.020	0.027	0.023
PARKERSBURG-MARIETTA, WV-OH													
LEAD	MAX QUARTERLY MEAN	NS	1	0.04	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.01
O_3	4TH MAX 8-HOUR	NS	2	0.09	0.09	0.08	0.10	0.08	0.09	0.09	0.10	0.09	0.08
	2ND DAILY MAX 1-HOUR	DOWN	2	0.12	0.11	0.12	0.16	0.11	0.11	0.12	0.11	0.11	0.11
SO_2	ARITHMETIC MEAN	NS	1	0.016	0.014	0.014	0.014	0.014	0.017	0.010	0.010	0.010	0.013
	2ND MAX 24-HOUR	NS	1	0.076	0.064	0.060	0.059	0.065	0.084	0.041	0.046	0.052	0.089
PENSACOLA, FL													
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.09	0.08	0.09	0.08	0.09	0.08	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	2	0.09	0.11	0.10	0.10	0.10	0.11	0.12	0.10	0.11	0.12
SO_2	ARITHMETIC MEAN	DOWN	1	0.007	0.008	0.006	0.007	0.005	0.004	0.003	0.003	0.004	0.004
	2ND MAX 24-HOUR	DOWN	1	0.057	0.078	0.056	0.057	0.032	0.039	0.019	0.015	0.028	0.022
PEORIA-PEKIN, IL													
CO	2ND MAX 8-HOUR	DOWN	1	7.7	7.4	6.3	7.2	7.3	5.7	5.6	4.6	4.7	5.8
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.04	0.04	0.02	0.02	0.03	0.02	0.03	0.02	0.02	0.02
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.07	0.08	0.07	0.06	0.08	0.08	0.08	0.07
	2ND DAILY MAX 1-HOUR	NS	2	0.10	0.08	0.10	0.09	0.08	0.09	0.09	0.09	0.09	0.08
PM_{10}	WEIGHTED ANNUAL MEAN	NS	2	28	27	26	28	22	23	22	22	26	26
	90TH PERCENTILE	DOWN	2	46	45	43	45	37	41	40	34	40	41
SO_2	ARITHMETIC MEAN	NS	2	0.007	0.007	0.008	0.007	0.007	0.007	0.007	0.007	0.007	0.007
	2ND MAX 24-HOUR	NS	2	0.046	0.055	0.065	0.043	0.039	0.049	0.084	0.045	0.042	0.041
PHILADELPHIA, PA-NJ													
CO	2ND MAX 8-HOUR	DOWN	9	7.1	4.9	4.6	4.7	4.7	5.2	4.1	4.2	3.3	3.1
LEAD	MAX QUARTERLY MEAN	NS	11	1.25	1.63	1.69	2.12	2.18	2.49	1.56	1.68	1.33	0.26
NO_2	ARITHMETIC MEAN	NS	7	0.027	0.025	0.025	0.025	0.025	0.026	0.025	0.026	0.025	0.025
O_3	4TH MAX 8-HOUR	NS	8	0.10	0.10	0.10	0.11	0.09	0.10	0.09	0.11	0.09	0.10
	2ND DAILY MAX 1-HOUR	NS	8	0.13	0.13	0.14	0.11	0.13	0.12	0.13	0.12	0.13	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	6	35	32	35	29	30	33	30	30	30	29
	90TH PERCENTILE	NS	6	60	57	60	45	51	57	52	47	53	48
SO_2	ARITHMETIC MEAN	DOWN	13	0.011	0.010	0.009	0.008	0.008	0.009	0.007	0.007	0.007	0.006
	2ND MAX 24-HOUR	DOWN	13	0.043	0.039	0.034	0.034	0.031	0.040	0.028	0.026	0.027	0.024

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
PHOENIX-MESA, AZ													
CO	2ND MAX 8-HOUR	DOWN	8	7.6	6.7	6.2	6.5	6.0	6.3	6.2	5.7	5.1	5.3
LEAD	MAX QUARTERLY MEAN	DOWN	2	0.09	0.09	0.11	0.06	0.05	0.05	0.06	0.04	0.02	0.02
O_3	4TH MAX 8-HOUR	UP	8	0.07	0.07	0.08	0.07	0.08	0.08	0.08	0.09	0.09	0.08
	2ND DAILY MAX 1-HOUR	NS	8	0.10	0.11	0.10	0.11	0.11	0.11	0.12	0.11	0.10	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	NS	8	49	43	43	40	41	40	41	41	46	38
	90TH PERCENTILE	NS	8	73	66	66	63	61	62	65	61	70	63
SO_2	ARITHMETIC MEAN	NS	1	0.002	0.003	0.005	0.004	0.003	0.003	0.002	0.003	0.004	0.004
	2ND MAX 24-HOUR	NS	1	0.006	0.011	0.013	0.010	0.009	0.009	0.008	0.017	0.009	0.011
PINE BLUFF, AR													
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	27	21	19	22	23	25	26	23	25	25
	90TH PERCENTILE	NS	1	44	39	30	38	39	39	56	39	41	41
PITTSBURGH, PA													
CO	2ND MAX 8-HOUR	DOWN	5	5.3	5.6	4.3	4.8	3.8	4.3	3.8	3.3	2.5	2.6
LEAD	MAX QUARTERLY MEAN	DOWN	4	0.12	0.09	0.09	0.07	0.07	0.08	0.06	0.04	0.05	0.04
NO_2	ARITHMETIC MEAN	DOWN	5	0.023	0.023	0.023	0.022	0.022	0.023	0.021	0.021	0.020	0.022
O_3	4TH MAX 8-HOUR	NS	8	0.09	0.09	0.08	0.09	0.07	0.09	0.09	0.10	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	8	0.11	0.10	0.11	0.09	0.11	0.11	0.12	0.11	0.12	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	13	35	33	34	30	29	33	29	28	29	28
	90TH PERCENTILE	DOWN	13	62	61	59	52	51	62	52	47	52	50
SO_2	ARITHMETIC MEAN	DOWN	16	0.017	0.016	0.015	0.015	0.015	0.015	0.011	0.011	0.011	0.011
	2ND MAX 24-HOUR	DOWN	16	0.072	0.071	0.058	0.072	0.061	0.073	0.044	0.043	0.046	0.042
PITTSFIELD, MA													
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.09	0.09	0.09	0.08	0.07	0.07	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.09	0.11	0.10	0.11	0.11	0.09	0.09	0.11	0.09	0.08
PONCE, PR													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	46	38	30	29	30	27	24	24	29	28
	90TH PERCENTILE	NS	1	73	60	47	49	53	38	33	35	47	51
PORTLAND, ME													
O_3	4TH MAX 8-HOUR	NS	1	0.10	0.10	0.09	0.11	0.10	0.09	0.09	0.10	0.08	0.10
	2ND DAILY MAX 1-HOUR	NS	1	0.13	0.13	0.14	0.12	0.11	0.12	0.12	0.10	0.13	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	NS	2	27	25	26	23	25	24	28	24	26	23
	90TH PERCENTILE	NS	2	44	39	44	38	44	43	50	36	43	39
SO_2	ARITHMETIC MEAN	DOWN	1	0.010	0.010	0.009	0.008	0.009	0.008	0.006	0.005	0.005	0.005
	2ND MAX 24-HOUR	DOWN	1	0.039	0.034	0.032	0.029	0.032	0.043	0.022	0.021	0.023	0.025
PORTLAND-VANCOUVER, OR-WA													
CO	2ND MAX 8-HOUR	DOWN	2	8.2	8.5	9.1	7.0	6.3	7.0	5.7	6.1	5.4	5.1
LEAD	MAX QUARTERLY MEAN	DOWN	2	0.07	0.06	0.06	0.05	0.06	0.04	0.03	0.02	0.04	0.05
O_3	4TH MAX 8-HOUR	NS	4	0.06	0.06	0.08	0.06	0.07	0.06	0.06	0.07	0.09	0.06
	2ND DAILY MAX 1-HOUR	NS	4	0.09	0.12	0.09	0.10	0.09	0.09	0.10	0.12	0.08	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	6	25	25	26	23	25	23	20	20	21	19
	90TH PERCENTILE	DOWN	6	45	42	43	39	43	37	31	33	32	31
PORTSMOUTH-ROCHESTER, NH-ME													
NO_2	ARITHMETIC MEAN	DOWN	1	0.015	0.015	0.015	0.013	0.014	0.013	0.012	0.013	0.013	0.012
O_3	4TH MAX 8-HOUR	NS	2	0.09	0.09	0.08	0.10	0.09	0.09	0.09	0.09	0.08	0.10
	2ND DAILY MAX 1-HOUR	NS	2	0.12	0.11	0.14	0.11	0.11	0.11	0.12	0.10	0.13	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	21	20	19	19	18	14	15	16	17	18
	90TH PERCENTILE	DOWN	2	34	33	36	32	30	27	26	27	29	29
SO_2	ARITHMETIC MEAN	DOWN	1	0.008	0.007	0.007	0.006	0.006	0.006	0.004	0.004	0.004	0.004
	2ND MAX 24-HOUR	DOWN	1	0.029	0.025	0.021	0.027	0.019	0.022	0.017	0.015	0.018	0.016
PROVIDENCE-FALL RIVER-WARWICK, RI-MA													
CO	2ND MAX 8-HOUR	NS	1	6.2	7.3	7.4	6.3	5.4	6.7	7.0	4.4	5.6	4.7
NO_2	ARITHMETIC MEAN	NS	1	0.024	0.024	0.025	0.023	0.022	0.022	0.022	0.025	0.025	0.025
O_3	4TH MAX 8-HOUR	NS	2	0.09	0.09	0.09	0.10	0.08	0.09	0.09	0.10	0.07	0.09
	2ND DAILY MAX 1-HOUR	DOWN	2	0.12	0.13	0.14	0.11	0.11	0.12	0.13	0.10	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	31	29	30	24	26	29	24	27	25	23
	90TH PERCENTILE	DOWN	3	48	44	48	40	43	49	38	41	38	36
SO_2	ARITHMETIC MEAN	DOWN	5	0.010	0.009	0.008	0.009	0.008	0.007	0.005	0.006	0.006	0.005
	2ND MAX 24-HOUR	DOWN	5	0.043	0.039	0.039	0.044	0.036	0.035	0.022	0.030	0.030	0.029
PROVO-OREM, UT													
NO_2	ARITHMETIC MEAN	NS	1	0.028	0.025	0.022	0.019	0.026	0.024	0.023	0.024	0.023	0.024
O_3	4TH MAX 8-HOUR	NS	1	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.07
	2ND DAILY MAX 1-HOUR	NS	1	0.11	0.09	0.08	0.09	0.08	0.08	0.08	0.10	0.08	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	49	32	42	37	38	34	29	34	30	27
	90TH PERCENTILE	DOWN	3	95	55	91	68	71	56	49	57	50	47
PUEBLO, CO													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	33	26	30	26	26	30	26	26	27	22
	90TH PERCENTILE	DOWN	1	55	43	46	46	38	45	45	42	41	33
RACINE, WI													
CO	2ND MAX 8-HOUR	DOWN	1	6.4	5.5	5.7	4.9	4.1	4.3	4.3	3.0	3.1	3.0
O_3	4TH MAX 8-HOUR	NS	1	0.11	0.11	0.09	0.10	0.08	0.08	0.09	0.10	0.08	0.10
	2ND DAILY MAX 1-HOUR	NS	1	0.14	0.11	0.14	0.10	0.10	0.11	0.11	0.13	0.12	0.12

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
RALEIGH-DURHAM-CHAPEL HILL, NC													
CO	2ND MAX 8-HOUR	DOWN	1	10.9	8.7	8.8	7.3	7.2	6.9	6.6	5.6	6.6	5.4
O_3	4TH MAX 8-HOUR	NS	1	0.09	0.09	0.09	0.09	0.08	0.10	0.08	0.08	0.08	0.10
	2ND DAILY MAX 1-HOUR	NS	1	0.11	0.12	0.11	0.10	0.11	0.11	0.10	0.09	0.11	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	29	29	26	24	25	22	23	25	25	24
	90TH PERCENTILE	NS	2	46	45	41	36	39	31	34	39	39	40
RAPID CITY, SD													
PM_{10}	WEIGHTED ANNUAL MEAN	NS	2	26	27	28	25	23	29	24	23	25	24
	90TH PERCENTILE	NS	2	46	44	47	40	38	50	41	36	41	38
READING, PA													
CO	2ND MAX 8-HOUR	DOWN	1	5.0	6.4	4.6	4.6	3.8	5.4	3.9	3.4	3.0	3.0
LEAD	MAX QUARTERLY MEAN	DOWN	10	0.74	0.66	0.72	0.62	0.52	0.54	0.37	0.35	0.41	0.43
NO_2	ARITHMETIC MEAN	NS	1	0.023	0.022	0.022	0.020	0.021	0.023	0.021	0.022	0.021	0.021
O_3	4TH MAX 8-HOUR	NS	2	0.09	0.09	0.09	0.10	0.09	0.09	0.08	0.09	0.09	0.09
	2ND DAILY MAX 1-HOUR	NS	2	0.11	0.11	0.12	0.10	0.11	0.10	0.11	0.11	0.11	0.11
SO_2	ARITHMETIC MEAN	DOWN	2	0.011	0.010	0.010	0.009	0.009	0.011	0.009	0.009	0.009	0.009
	2ND MAX 24-HOUR	DOWN	2	0.042	0.035	0.034	0.033	0.033	0.040	0.033	0.036	0.030	0.024
REDDING, CA													
O_3	4TH MAX 8-HOUR	NS	1	0.07	0.07	0.08	0.07	0.07	0.06	0.08	0.07	0.07	0.07
	2ND DAILY MAX 1-HOUR	NS	1	0.09	0.09	0.08	0.08	0.07	0.09	0.09	0.08	0.08	0.09
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	26	25	29	25	20	24	20	19	17	18
	90TH PERCENTILE	DOWN	1	44	42	56	45	37	39	34	32	30	30
RENO, NV													
CO	2ND MAX 8-HOUR	DOWN	5	7.3	7.0	7.5	5.9	5.0	6.0	4.4	5.2	5.0	4.7
O_3	4TH MAX 8-HOUR	NS	4	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.07	0.07	0.06
	2ND DAILY MAX 1-HOUR	NS	4	0.10	0.11	0.09	0.08	0.09	0.09	0.08	0.09	0.08	0.09
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	6	42	44	36	36	40	36	32	29	32	31
	90TH PERCENTILE	DOWN	6	83	92	73	64	71	65	52	52	52	54
RICHMOND-PETERSBURG, VA													
CO	2ND MAX 8-HOUR	DOWN	2	4.0	4.4	3.7	2.5	3.9	3.4	2.6	2.9	3.2	2.8
NO_2	ARITHMETIC MEAN	DOWN	1	0.025	0.023	0.024	0.023	0.024	0.024	0.022	0.022	0.021	0.021
O_3	4TH MAX 8-HOUR	NS	4	0.08	0.08	0.08	0.09	0.09	0.10	0.09	0.09	0.08	0.10
	2ND DAILY MAX 1-HOUR	NS	4	0.11	0.11	0.11	0.12	0.12	0.11	0.11	0.10	0.12	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	28	25	26	22	23	21	23	24	22	22
	90TH PERCENTILE	NS	3	43	40	45	36	43	33	38	37	37	37
SO_2	ARITHMETIC MEAN	DOWN	1	0.009	0.006	0.006	0.005	0.007	0.006	0.005	0.005	0.005	0.005
	2ND MAX 24-HOUR	NS	1	0.032	0.034	0.027	0.024	0.023	0.022	0.016	0.027	0.024	0.024
RIVERSIDE-SAN BERNARDINO, CA													
CO	2ND MAX 8-HOUR	DOWN	7	5.1	4.4	5.1	3.6	3.5	3.5	3.4	2.9	3.1	2.9
LEAD	MAX QUARTERLY MEAN	NS	4	0.06	0.05	0.06	0.03	0.04	0.04	0.04	0.04	0.04	0.04
NO_2	ARITHMETIC MEAN	DOWN	7	0.030	0.029	0.029	0.027	0.028	0.028	0.029	0.027	0.024	0.024
O_3	4TH MAX 8-HOUR	DOWN	15	0.16	0.16	0.15	0.15	0.14	0.13	0.14	0.13	0.12	0.11
	2ND DAILY MAX 1-HOUR	DOWN	15	0.22	0.21	0.21	0.20	0.18	0.19	0.18	0.17	0.15	0.17
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	11	67	60	57	47	46	44	44	43	42	40
	90TH PERCENTILE	DOWN	11	102	94	88	76	78	68	71	66	64	65
SO_2	ARITHMETIC MEAN	NS	4	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.002
	2ND MAX 24-HOUR	DOWN	4	0.013	0.006	0.008	0.009	0.006	0.004	0.005	0.004	0.004	0.007
ROANOKE, VA													
NO_2	ARITHMETIC MEAN	NS	1	0.014	0.013	0.014	0.013	0.014	0.013	0.013	0.013	0.013	0.014
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.08	0.08	0.07	0.08	0.08	0.08	0.07	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.09	0.10	0.09	0.10	0.10	0.09	0.08	0.10	0.13
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	35	36	33	32	35	36	34	33	30	29
	90TH PERCENTILE	NS	2	55	58	51	48	56	55	54	58	52	49
SO_2	ARITHMETIC MEAN	DOWN	1	0.005	0.004	0.004	0.004	0.004	0.004	0.003	0.003	0.003	0.003
	2ND MAX 24-HOUR	DOWN	1	0.022	0.018	0.019	0.016	0.018	0.011	0.010	0.014	0.013	0.009
ROCHESTER, MN													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	30	28	23	21	20	21	20	19	20	21
	90TH PERCENTILE	DOWN	1	50	48	37	37	31	33	32	34	31	31
ROCHESTER, NY													
CO	2ND MAX 8-HOUR	NS	2	3.6	3.5	3.3	3.5	3.2	4.5	3.2	3.7	1.9	2.7
O_3	4TH MAX 8-HOUR	NS	2	0.09	0.09	0.09	0.10	0.08	0.08	0.08	0.09	0.07	0.09
	2ND DAILY MAX 1-HOUR	NS	2	0.10	0.11	0.11	0.09	0.09	0.09	0.11	0.08	0.10	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	24	21	26	22	23	20	21	21	20	20
	90TH PERCENTILE	DOWN	2	42	38	49	38	40	33	37	35	33	36
SO_2	ARITHMETIC MEAN	DOWN	2	0.013	0.012	0.011	0.011	0.010	0.011	0.010	0.009	0.008	0.009
	2ND MAX 24-HOUR	NS	2	0.054	0.040	0.043	0.039	0.041	0.043	0.038	0.033	0.038	0.053
ROCKFORD, IL													
CO	2ND MAX 8-HOUR	DOWN	1	6.6	6.5	5.1	4.6	4.3	4.0	4.5	3.2	3.7	3.6
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.07	0.09	0.04	0.06	0.03	0.04	0.03	0.05	0.03	0.04
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.07	0.08	0.08	0.07	0.08	0.09	0.08	0.07
	2ND DAILY MAX 1-HOUR	NS	2	0.09	0.09	0.09	0.09	0.08	0.10	0.10	0.09	0.08	0.08
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	25	25	22	21	16	19	19	18	26	24
	90TH PERCENTILE	NS	1	44	45	35	31	26	36	39	29	42	39

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
SACRAMENTO, CA													
CO	2ND MAX 8-HOUR	DOWN	6	9.0	8.9	8.2	6.2	6.4	6.2	5.2	4.9	4.5	4.5
LEAD	MAX QUARTERLY MEAN	DOWN	2	0.07	0.10	0.04	0.02	0.05	0.02	0.02	0.01	0.01	0.01
NO_2	ARITHMETIC MEAN	DOWN	4	0.019	0.018	0.016	0.016	0.017	0.015	0.015	0.015	0.014	0.015
O_3	4TH MAX 8-HOUR	NS	6	0.08	0.08	0.09	0.10	0.10	0.09	0.09	0.10	0.09	0.08
	2ND DAILY MAX 1-HOUR	NS	6	0.12	0.13	0.13	0.13	0.12	0.11	0.13	0.12	0.11	0.13
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	42	42	42	31	29	30	29	25	23	23
	90TH PERCENTILE	DOWN	1	88	88	88	51	54	49	67	40	40	40
SO_2	ARITHMETIC MEAN	DOWN	1	0.006	0.006	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.001
	2ND MAX 24-HOUR	DOWN	1	0.020	0.010	0.010	0.010	0.003	0.004	0.004	0.003	0.003	0.004
ST. JOSEPH, MO													
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	45	40	44	39	32	34	33	32	31	26
	90TH PERCENTILE	DOWN	1	78	71	79	70	56	62	67	52	57	47
ST. LOUIS, MO-IL													
CO	2ND MAX 8-HOUR	DOWN	8	4.9	4.3	4.3	3.5	3.5	3.8	3.3	3.4	3.2	3.4
LEAD	MAX QUARTERLY MEAN	DOWN	13	0.85	0.76	0.68	0.70	0.57	0.66	0.68	0.67	0.54	0.43
NO_2	ARITHMETIC MEAN	NS	9	0.019	0.018	0.018	0.019	0.018	0.019	0.019	0.019	0.018	0.019
O_3	4TH MAX 8-HOUR	NS	16	0.08	0.08	0.08	0.09	0.08	0.07	0.09	0.09	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	16	0.11	0.11	0.11	0.10	0.11	0.12	0.12	0.11	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	15	37	33	32	32	28	31	31	27	28	30
	90TH PERCENTILE	DOWN	15	61	54	48	51	46	50	51	43	45	49
SO_2	ARITHMETIC MEAN	DOWN	16	0.012	0.011	0.010	0.009	0.009	0.009	0.008	0.008	0.007	0.006
	2ND MAX 24-HOUR	DOWN	16	0.054	0.042	0.041	0.038	0.040	0.040	0.037	0.038	0.034	0.034
SALINAS, CA													
CO	2ND MAX 8-HOUR	DOWN	1	2.3	2.5	2.1	2.3	2.1	2.0	1.7	2.4	1.7	1.9
NO_2	ARITHMETIC MEAN	DOWN	1	0.014	0.012	0.012	0.012	0.012	0.012	0.011	0.011	0.010	0.010
O_3	4TH MAX 8-HOUR	DOWN	3	0.07	0.07	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.06
	2ND DAILY MAX 1-HOUR	DOWN	3	0.09	0.08	0.08	0.08	0.08	0.08	0.07	0.08	0.07	0.07
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	25	23	23	23	22	20	21	20	21	18
	90TH PERCENTILE	NS	1	37	39	33	34	35	29	43	34	31	29
SALT LAKE CITY-OGDEN, UT													
CO	2ND MAX 8-HOUR	DOWN	1	7.7	6.8	7.5	6.5	6.4	5.9	4.5	6.2	5.4	4.9
LEAD	MAX QUARTERLY MEAN	DOWN	2	0.12	0.08	0.08	0.05	0.07	0.05	0.05	0.03	0.07	0.06
NO_2	ARITHMETIC MEAN	NS	2	0.023	0.019	0.020	0.020	0.024	0.023	0.022	0.023	0.022	0.022
O_3	4TH MAX 8-HOUR	NS	2	0.09	0.09	0.08	0.08	0.07	0.08	0.08	0.08	0.09	0.08
	2ND DAILY MAX 1-HOUR	NS	2	0.14	0.11	0.11	0.10	0.10	0.11	0.12	0.11	0.10	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	6	45	33	41	36	37	32	29	33	29	27
	90TH PERCENTILE	DOWN	6	91	56	89	74	68	53	49	61	49	46
SO_2	ARITHMETIC MEAN	DOWN	3	0.011	0.009	0.010	0.009	0.007	0.004	0.003	0.003	0.003	0.003
	2ND MAX 24-HOUR	DOWN	3	0.081	0.039	0.051	0.046	0.043	0.013	0.013	0.014	0.008	0.008
SAN ANTONIO, TX													
CO	2ND MAX 8-HOUR	NS	2	6.3	5.4	4.6	4.7	5.1	3.5	3.8	4.8	4.7	4.8
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.04	0.07	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.08	0.08	0.07	0.08	0.09	0.09	0.08	0.08
	2ND DAILY MAX 1-HOUR	NS	2	0.11	0.10	0.11	0.10	0.11	0.11	0.12	0.12	0.10	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	28	25	25	25	23	23	21	19	19	19
	90TH PERCENTILE	DOWN	3	42	40	38	41	40	38	33	27	28	28
SAN DIEGO, CA													
CO	2ND MAX 8-HOUR	DOWN	8	6.3	5.6	5.3	5.0	4.4	4.7	4.2	4.3	3.8	3.5
LEAD	MAX QUARTERLY MEAN	DOWN	3	0.08	0.09	0.04	0.03	0.03	0.02	0.03	0.02	0.02	0.01
NO_2	ARITHMETIC MEAN	DOWN	7	0.027	0.025	0.025	0.024	0.020	0.021	0.021	0.019	0.019	0.018
O_3	4TH MAX 8-HOUR	DOWN	9	0.11	0.11	0.11	0.10	0.09	0.09	0.08	0.08	0.08	0.08
	2ND DAILY MAX 1-HOUR	DOWN	9	0.16	0.15	0.15	0.14	0.13	0.11	0.12	0.10	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	3	39	34	37	32	30	31	32	28	27	23
	90TH PERCENTILE	DOWN	3	57	54	54	44	46	42	46	38	38	36
SO_2	ARITHMETIC MEAN	NS	3	0.004	0.004	0.003	0.004	0.002	0.003	0.003	0.004	0.003	0.003
	2ND MAX 24-HOUR	NS	3	0.015	0.015	0.017	0.017	0.009	0.013	0.012	0.015	0.012	0.011
SAN FRANCISCO, CA													
CO	2ND MAX 8-HOUR	DOWN	4	5.9	5.7	6.2	4.8	4.6	4.3	3.7	3.9	3.4	3.5
LEAD	MAX QUARTERLY MEAN	DOWN	1	0.08	0.04	0.04	0.02	0.03	0.02	0.03	0.01	0.02	0.01
NO_2	ARITHMETIC MEAN	DOWN	1	0.026	0.021	0.024	0.022	0.024	0.022	0.021	0.022	0.020	0.020
O_3	4TH MAX 8-HOUR	NS	3	0.06	0.06	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.05
	2ND DAILY MAX 1-HOUR	NS	3	0.08	0.06	0.06	0.06	0.08	0.07	0.09	0.08	0.07	0.06
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	33	28	32	29	27	25	21	21	24	22
	90TH PERCENTILE	DOWN	1	59	59	66	56	39	47	34	32	33	34
SO_2	ARITHMETIC MEAN	DOWN	1	0.003	0.002	0.002	0.003	0.002	0.001	0.002	0.002	0.002	0.002
	2ND MAX 24-HOUR	DOWN	1	0.015	0.010	0.013	0.012	0.010	0.005	0.005	0.007	0.006	0.006

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
WATERLOO-CEDAR FALLS, IA													
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	35	35	35	34	31	29	36	32	31	30
	90TH PERCENTILE	DOWN	1	57	57	57	63	48	45	52	48	47	47
WAUSAU, WI													
SO_2	ARITHMETIC MEAN	DOWN	1	0.004	0.004	0.004	0.004	0.004	0.004	0.003	0.003	0.002	0.003
	2ND MAX 24-HOUR	NS	1	0.030	0.030	0.030	0.024	0.039	0.024	0.022	0.015	0.013	0.031
WEST PALM BEACH-BOCA RATON, FL													
CO	2ND MAX 8-HOUR	NS	1	3.7	2.7	3.1	3.7	3.1	2.8	2.8	2.5	3.6	2.5
NO_2	ARITHMETIC MEAN	NS	1	0.013	0.014	0.012	0.011	0.013	0.012	0.012	0.012	0.012	0.012
O_3	4TH MAX 8-HOUR	NS	2	0.06	0.06	0.07	0.06	0.05	0.08	0.07	0.06	0.06	0.06
	2ND DAILY MAX 1-HOUR	NS	2	0.10	0.09	0.08	0.07	0.12	0.08	0.08	0.09	0.08	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	NS	2	19	19	18	20	19	18	18	18	20	20
	90TH PERCENTILE	NS	2	27	27	28	30	29	25	25	28	29	31
SO_2	ARITHMETIC MEAN	DOWN	1	0.003	0.002	0.002	0.003	0.004	0.003	0.002	0.002	0.002	0.001
	2ND MAX 24-HOUR	NS	1	0.009	0.007	0.012	0.010	0.028	0.016	0.019	0.014	0.013	0.004
WHEELING, WV-OH													
CO	2ND MAX 8-HOUR	DOWN	1	5.2	7.1	5.6	5.6	4.1	4.6	5.0	3.5	3.1	3.5
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.08	0.09	0.08	0.08	0.08	0.09	0.09	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.11	0.11	0.11	0.10	0.11	0.10	0.10	0.11	0.11	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	34	30	31	30	29	28	28	28	24	25
	90TH PERCENTILE	DOWN	2	59	50	53	52	51	49	46	42	41	46
SO_2	ARITHMETIC MEAN	DOWN	3	0.021	0.020	0.020	0.018	0.018	0.015	0.010	0.011	0.010	0.011
	2ND MAX 24-HOUR	DOWN	3	0.065	0.064	0.074	0.077	0.075	0.065	0.055	0.058	0.043	0.045
WICHITA, KS													
CO	2ND MAX 8-HOUR	DOWN	3	7.9	5.9	5.9	5.6	5.0	4.9	5.2	5.8	4.8	4.8
LEAD	MAX QUARTERLY MEAN	DOWN	5	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
O_3	4TH MAX 8-HOUR	NS	2	0.07	0.07	0.08	0.08	0.07	0.06	0.07	0.07	0.07	0.08
	2ND DAILY MAX 1-HOUR	NS	2	0.07	0.10	0.09	0.08	0.08	0.09	0.10	0.09	0.09	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	4	30	28	31	32	31	26	27	25	22	24
	90TH PERCENTILE	NS	4	50	49	51	53	56	50	51	43	40	41
WILLIAMSPORT, PA													
O_3	4TH MAX 8-HOUR	NS	1	0.07	0.07	0.07	0.08	0.07	0.08	0.07	0.07	0.07	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.08	0.09	0.10	0.09	0.09	0.08	0.09	0.08	0.09	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	29	26	31	24	24	28	28	25	26	26
	90TH PERCENTILE	NS	1	46	50	60	36	47	52	49	36	40	40
SO_2	ARITHMETIC MEAN	NS	1	0.007	0.006	0.007	0.007	0.006	0.006	0.006	0.006	0.008	0.005
	2ND MAX 24-HOUR	NS	1	0.042	0.025	0.025	0.029	0.025	0.042	0.027	0.028	0.028	0.021
WILMINGTON-NEWARK, DE-MD													
CO	2ND MAX 8-HOUR	NS	1	4.5	5.4	4.0	4.1	3.8	4.3	4.6	3.6	4.5	3.1
O_3	4TH MAX 8-HOUR	NS	1	0.10	0.10	0.10	0.11	0.09	0.09	0.09	0.12	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	1	0.12	0.14	0.14	0.12	0.14	0.12	0.14	0.11	0.12	0.12
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	33	30	28	24	25	29	28	25	25	24
	90TH PERCENTILE	DOWN	2	52	48	45	39	43	52	45	42	43	41
SO_2	ARITHMETIC MEAN	DOWN	2	0.016	0.013	0.012	0.013	0.013	0.012	0.010	0.009	0.008	0.007
	2ND MAX 24-HOUR	DOWN	2	0.048	0.043	0.033	0.046	0.041	0.044	0.036	0.035	0.034	0.027
WORCESTER, MA-CT													
CO	2ND MAX 8-HOUR	DOWN	1	7.9	6.0	7.2	8.0	6.1	5.9	4.2	5.3	3.4	3.5
NO_2	ARITHMETIC MEAN	DOWN	1	0.026	0.022	0.023	0.024	0.028	0.025	0.021	0.019	0.019	0.019
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	26	23	21	20	20	20	19	20	20	19
	90TH PERCENTILE	DOWN	2	37	41	38	34	37	36	32	34	32	33
SO_2	ARITHMETIC MEAN	DOWN	1	0.011	0.008	0.009	0.007	0.007	0.008	0.006	0.005	0.004	0.005
	2ND MAX 24-HOUR	DOWN	1	0.040	0.034	0.029	0.033	0.025	0.024	0.023	0.021	0.021	0.017
YAKIMA, WA													
CO	2ND MAX 8-HOUR	NS	1	8.7	7.4	9.0	8.8	7.9	8.0	7.1	7.4	7.4	7.4
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	2	33	33	40	32	35	29	24	30	32	26
	90TH PERCENTILE	DOWN	2	62	62	81	60	63	55	46	59	59	43
YOLO, CA													
O_3	4TH MAX 8-HOUR	NS	1	0.08	0.08	0.08	0.07	0.09	0.08	0.08	0.08	0.09	0.07
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.10	0.11	0.11	0.09	0.10	0.11	0.11	0.09	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	46	46	46	35	29	30	30	24	25	22
	90TH PERCENTILE	DOWN	1	81	81	81	63	62	46	61	40	37	42
YORK, PA													
CO	2ND MAX 8-HOUR	DOWN	1	4.6	4.4	3.7	3.6	3.3	3.9	2.7	2.8	3.4	2.4
LEAD	MAX QUARTERLY MEAN	NS	1	0.05	0.05	0.05	0.05	0.04	0.04	0.04	0.07	0.04	0.05
NO_2	ARITHMETIC MEAN	DOWN	1	0.022	0.022	0.021	0.020	0.022	0.024	0.021	0.021	0.019	0.019
O_3	4TH MAX 8-HOUR	NS	1	0.09	0.09	0.10	0.10	0.08	0.09	0.08	0.09	0.08	0.09
	2ND DAILY MAX 1-HOUR	NS	1	0.10	0.12	0.11	0.10	0.11	0.12	0.10	0.10	0.11	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	NS	1	31	30	32	27	31	32	30	28	31	31
	90TH PERCENTILE	NS	1	50	56	60	44	52	51	56	46	49	49
SO_2	ARITHMETIC MEAN	NS	1	0.008	0.007	0.008	0.007	0.008	0.009	0.006	0.007	0.009	0.008
	2ND MAX 24-HOUR	NS	1	0.035	0.023	0.020	0.034	0.032	0.041	0.020	0.022	0.026	0.023

Table A-14. Metropolitan Statistical Area Air Quality Trends, 1989–1998 (continued)

Metropolitan Statistical Area		Trend	#Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
YOUNGSTOWN-WARREN, OH													
O_3	4TH MAX 8-HOUR	NS	1	0.09	0.09	0.08	0.10	0.09	0.08	0.08	0.10	0.09	0.08
	2ND DAILY MAX 1-HOUR	NS	1	0.11	0.10	0.12	0.10	0.10	0.10	0.11	0.10	0.10	0.11
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	9	34	31	33	29	27	29	28	26	25	27
	90TH PERCENTILE	DOWN	9	55	53	55	49	49	49	48	39	43	47
SO_2	ARITHMETIC MEAN	DOWN	2	0.016	0.016	0.016	0.013	0.011	0.011	0.010	0.009	0.008	0.008
	2ND MAX 24-HOUR	NS	2	0.043	0.053	0.048	0.056	0.063	0.051	0.038	0.044	0.037	0.030
YUBA CITY, CA													
O_3	4TH MAX 8-HOUR	NS	2	0.08	0.08	0.08	0.08	0.09	0.08	0.08	0.09	0.09	0.07
	2ND DAILY MAX 1-HOUR	NS	2	0.09	0.10	0.10	0.11	0.11	0.10	0.11	0.11	0.09	0.10
PM_{10}	WEIGHTED ANNUAL MEAN	DOWN	1	39	39	39	34	30	34	33	29	29	23
	90TH PERCENTILE	DOWN	1	60	60	73	57	59	51	68	50	48	44

CO = Highest second maximum non-overlapping 8-hour concentration *(Applicable NAAQS is 9 ppm)*
Pb = Highest quarterly maximum concentration *(Applicable NAAQS is 1.5 µg/m3)*
NO_2 = Highest arithmetic mean concentration *(Applicable NAAQS is 0.053 ppm)*
O_3 (1-hr) = Highest second daily maximum 1-hour concentration *(Applicable NAAQS is 0.12 ppm)*
O_3 (8-hr) = Highest fourth daily maximum 8-hour concentration *(Applicable NAAQS is 0.08 ppm)*
PM_{10} = Highest second maximum 24-hour concentration *(Applicable NAAQS is 150 µg/m3)*
SO_2 = Highest second maximum 24-hour concentration *(Applicable NAAQS is 0.14 ppm)*
PPM = Units are parts per million
µg/m³ = Units are micrograms per cubic meter

Table A-15. Number of Days with AQI Values Greater Than 100 at Trend Sites, 1989–1998, and All Sites in 1998

Metropolitan Statistical Area	# of Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Total # of Sites	AQI > 100 1998
AKRON, OH	5	15	9	30	8	10	8	12	11	6	14	6	14
ALBANY-SCHENECTADY-TROY, NY	7	4	4	9	5	5	6	3	4	3	2	13	2
ALBUQUERQUE, NM	21	8	8	5	0	0	1	0	0	0	0	25	0
ALLENTOWN-BETHLEHEM-EASTON, PA	9	11	10	14	3	6	10	17	6	13	18	9	18
ATLANTA, GA	7	14	42	23	18	30	12	33	21	26	43	18	60
AUSTIN-SAN MARCOS, TX	5	4	4	3	1	2	4	12	0	0	5	5	6
BAKERSFIELD, CA	7	113	97	109	100	97	98	104	109	55	75	16	78
BALTIMORE, MD	15	28	29	50	23	48	41	36	28	30	51	22	51
BATON ROUGE, LA	6	12	28	11	5	5	7	15	7	8	14	10	21
BERGEN-PASSAIC, NJ	8	12	8	11	2	3	5	11	3	5	0	8	0
BIRMINGHAM, AL	16	5	28	5	12	10	6	32	15	8	23	16	23
BOSTON, MA-NH	25	12	7	13	9	6	10	8	2	8	7	25	9
BUFFALO-NIAGARA FALLS, NY	21	4	8	9	3	1	4	6	3	1	13	21	13
CHARLESTON-NORTH CHARLESTON, SC	9	5	1	2	0	2	2	1	3	3	3	9	3
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	10	12	31	12	11	23	9	13	18	26	48	26	51
CHICAGO, IL	46	16	4	22	4	3	8	21	6	9	7	61	10
CINCINNATI, OH-KY-IN	20	19	19	22	3	13	19	23	11	11	14	23	20
CLEVELAND-LORAIN-ELYRIA, OH	24	18	10	23	11	13	23	24	17	11	20	40	22
COLUMBUS, OH	10	7	4	17	5	7	10	15	16	8	19	12	23
DALLAS, TX	8	18	24	2	11	12	15	36	12	15	18	11	36
DAYTON-SPRINGFIELD, OH	10	10	13	12	2	11	14	11	18	9	19	13	21
DENVER, CO	20	14	9	6	8	3	1	2	0	0	5	29	9
DETROIT, MI	30	18	11	28	8	5	13	14	13	12	17	32	17
EL PASO, TX	17	25	19	7	10	7	11	5	7	3	5	22	8
FORT LAUDERDALE, FL	8	6	1	0	2	4	1	1	1	0	1	18	1
FORT WORTH-ARLINGTON, TX	8	17	16	20	7	9	31	28	14	14	17	8	17
FRESNO, CA	11	91	62	83	69	59	55	61	70	75	67	15	69
GARY, IN	18	15	2	8	5	0	6	17	11	12	9	22	10
GRAND RAPIDS-MUSKEGON-HOLLAND, MI	8	16	10	26	6	3	12	17	7	8	13	10	19
GREENSBORO–WINSTON-SALEM–HIGH PT, NC	7	6	12	5	2	20	7	6	6	13	25	16	30
GREENVILLE-SPARTANBURG-ANDERSON, SC	5	3	2	3	5	9	5	8	7	10	29	7	29
HARRISBURG-LEBANON-CARLISLE, PA	7	10	10	21	1	15	12	13	3	9	22	7	22
HARTFORD, CT	15	19	13	23	15	14	18	14	5	16	10	15	10
HONOLULU, HI	6	0	0	0	0	0	0	0	0	0	0	14	0
HOUSTON, TX	26	43	54	37	32	28	45	66	28	47	38	26	40
INDIANAPOLIS, IN	29	15	9	12	7	9	22	19	13	12	19	37	22
JACKSONVILLE, FL	15	4	3	0	2	3	2	1	1	4	10	15	10
JERSEY CITY, NJ	7	15	15	25	9	19	12	16	5	9	7	7	7
KANSAS CITY, MO-KS	21	4	2	11	1	4	10	22	10	18	15	22	15
KNOXVILLE, TN	14	2	23	10	7	20	13	20	19	36	52	18	55
LAS VEGAS, NV-AZ	6	36	21	8	4	6	8	1	5	0	0	28	11
LITTLE ROCK-NORTH LITTLE ROCK, AR	7	1	1	3	0	2	2	7	1	1	2	7	3
LOS ANGELES-LONG BEACH, CA	38	215	173	169	175	134	139	113	94	60	56	38	56
LOUISVILLE, KY-IN	18	15	10	15	2	20	27	21	10	13	24	26	29
MEMPHIS, TN-AR-MS	13	8	24	9	14	15	10	21	19	17	27	14	27
MIAMI, FL	10	5	1	1	3	6	1	2	1	3	8	12	8
MIDDLESEX-SOMERSET-HUNTERDON, NJ	4	19	24	24	8	13	9	16	8	18	21	4	22
MILWAUKEE-WAUKESHA, WI	18	17	8	24	3	4	9	14	5	4	10	22	12

Table A-15. Number of Days with AQI Values Greater Than 100 at Trend Sites, 1989–1998, and All Sites in 1998 (continued)

Metropolitan Statistical Area	# of Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Total # of Sites	AQI > 100 1998
MINNEAPOLIS-ST. PAUL, MN-WI	24	8	4	2	3	0	4	7	1	0	0	37	1
MONMOUTH-OCEAN, NJ	3	15	21	20	6	11	3	6	12	12	19	4	31
NASHVILLE, TN	17	12	31	13	6	18	21	28	23	20	30	21	32
NASSAU-SUFFOLK, NY	4	14	20	25	5	15	10	9	6	8	10	8	11
NEW HAVEN-MERIDEN, CT	10	11	17	29	10	17	14	14	8	19	10	10	10
NEW ORLEANS, LA	11	4	6	2	5	6	8	20	8	7	7	11	7
NEW YORK, NY	29	29	36	49	10	19	21	19	15	23	17	39	21
NEWARK, NJ	12	21	23	35	10	13	13	20	12	13	23	12	23
NORFOLK-VA BEACH-NEWPORT NEWS,VA-NC	12	4	8	7	8	19	6	6	4	17	15	12	15
OAKLAND, CA	20	6	4	4	3	4	3	12	11	0	11	29	12
OKLAHOMA CITY, OK	10	4	4	4	2	2	5	13	2	4	7	14	7
OMAHA, NE-IA	9	1	1	0	0	1	1	1	1	0	5	12	5
ORANGE COUNTY, CA	11	56	45	35	35	25	15	9	9	3	6	11	6
ORLANDO, FL	9	9	4	1	4	4	3	1	1	4	11	13	14
PHILADELPHIA, PA-NJ	36	44	39	49	24	51	26	30	22	32	37	44	38
PHOENIX-MESA, AZ	23	30	12	11	13	16	10	22	17	12	17	49	37
PITTSBURGH, PA	41	21	19	21	9	13	19	25	11	20	39	53	39
PONCE, PR	1	0	0	0	0	0	0	0	0	0	0	1	0
PORTLAND-VANCOUVER, OR-WA	12	2	11	8	6	0	2	2	6	0	3	17	3
PROVIDENCE-FALL RIVER-WARWICK, RI-MA	11	9	13	20	5	7	7	11	4	10	4	13	5
RALEIGH-DURHAM-CHAPEL HILL, NC	4	14	15	5	0	11	2	1	1	13	21	18	40
RICHMOND-PETERSBURG, VA	10	11	6	18	8	30	13	19	5	21	28	11	28
RIVERSIDE-SAN BERNARDINO, CA	35	187	158	154	174	168	149	124	119	106	94	51	96
ROCHESTER, NY	8	5	5	16	2	0	1	6	0	6	4	8	4
SACRAMENTO, CA	13	63	36	54	44	14	30	32	30	5	17	33	33
ST. LOUIS, MO-IL	54	25	23	32	15	9	32	34	20	15	23	63	24
SALT LAKE CITY-OGDEN, UT	12	21	5	20	9	5	13	4	8	1	12	23	19
SAN ANTONIO, TX	7	3	4	3	1	3	4	18	3	3	6	7	6
SAN DIEGO, CA	23	127	96	67	66	58	46	48	31	14	33	28	35
SAN FRANCISCO, CA	9	0	0	0	0	0	0	2	0	0	0	11	0
SAN JOSE, CA	8	18	7	11	3	4	2	10	7	0	5	11	8
SAN JUAN-BAYAMON, PR	10	0	0	0	0	0	0	0	1	2	1	27	1
SCRANTON–WILKES-BARRE–HAZLETON, PA	11	6	9	17	3	10	7	12	4	11	7	11	7
SEATTLE-BELLEVUE-EVERETT, WA	16	6	9	4	3	0	3	0	6	1	3	26	3
SPRINGFIELD, MA	13	10	13	15	12	13	12	9	5	10	7	13	7
SYRACUSE, NY	6	2	1	11	2	4	0	1	0	0	2	8	3
TACOMA, WA	7	3	5	1	2	0	2	0	1	0	4	9	4
TAMPA-ST. PETERSBURG-CLEARWATER, FL	22	4	6	1	1	1	3	2	3	4	11	32	11
TOLEDO, OH	6	8	3	6	2	7	9	9	11	4	5	6	6
TUSCON, AZ	20	2	1	0	1	1	1	3	0	1	0	25	0
TULSA, OK	11	5	16	12	1	4	12	21	14	7	9	11	9
VENTURA, CA	12	87	70	87	54	37	63	65	62	44	29	15	30
WASHINGTON, DC-MD-VA-WV	32	24	25	48	14	48	20	29	18	29	45	46	47
WEST PALM BEACH-BOCA RATON, FL	6	1	0	0	0	3	0	0	0	0	2	9	2
WILMINGTON-NEWARK, DE-MD	5	12	9	12	7	10	5	12	3	6	8	10	28
YOUNGSTOWN-WARREN, OH	9	8	3	14	5	2	0	11	5	3	15	15	22

Table A-16. (Ozone only) Number of Days with AQI Values Greater Than 100 at Trend Sites, 1989–1998, and All Sites in 1998

Metropolitan Statistical Area	# of Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Total # of Sites	AQI > 100 1998
AKRON, OH	2	15	9	30	8	10	8	12	11	6	14	2	14
ALBANY-SCHENECTADY-TROY, NY	3	4	4	9	5	5	6	3	4	3	2	3	2
ALBUQUERQUE, NM	7	0	2	0	0	0	1	0	0	0	0	9	0
ALLENTOWN-BETHLEHEM-EASTON, PA	3	11	10	14	3	6	9	17	6	13	18	3	18
ATLANTA, GA	2	14	42	23	18	30	12	33	21	26	43	7	60
AUSTIN-SAN MARCOS, TX	2	4	4	3	1	2	4	12	0	0	5	2	6
BAKERSFIELD, CA	5	111	95	107	100	97	98	104	109	55	75	8	76
BALTIMORE, MD	7	28	28	50	23	48	40	36	28	30	51	8	51
BATON ROUGE, LA	3	12	28	11	5	5	7	15	7	8	14	7	21
BERGEN-PASSAIC, NJ	1	10	8	11	2	3	5	11	3	5	0	1	0
BIRMINGHAM, AL	6	5	28	5	12	10	6	32	15	8	23	6	23
BOSTON, MA-NH	4	12	7	13	9	6	10	8	2	8	7	5	9
BUFFALO-NIAGARA FALLS, NY	2	4	7	9	3	1	4	6	3	1	13	2	13
CHARLESTON-NORTH CHARLESTON, SC	3	5	1	1	0	2	2	1	3	3	3	3	3
CHARLOTTE-GASTONIA-ROCK HILL, NC-SC	3	12	29	12	11	23	9	13	18	26	48	7	51
CHICAGO, IL	17	15	3	22	4	3	7	21	6	9	7	22	10
CINCINNATI, OH-KY-IN	7	19	19	22	3	13	19	23	11	11	14	8	20
CLEVELAND-LORAIN-ELYRIA, OH	6	17	10	23	10	12	22	21	17	11	19	9	21
COLUMBUS, OH	3	7	4	17	5	7	10	15	16	8	19	5	23
DALLAS, TX	2	18	24	2	11	12	15	36	12	15	18	6	36
DAYTON-SPRINGFIELD, OH	3	10	13	12	2	11	14	11	18	9	19	5	21
DENVER, CO	5	5	4	0	1	0	0	0	0	0	5	8	9
DETROIT, MI	8	18	11	28	7	5	11	12	12	12	17	8	17
EL PASO, TX	3	5	6	1	3	3	7	5	2	1	5	4	6
FORT LAUDERDALE, FL	3	6	1	0	2	4	1	1	1	0	1	3	1
FORT WORTH-ARLINGTON, TX	2	17	16	20	7	9	31	28	14	14	17	2	17
FRESNO, CA	5	89	56	81	69	59	55	61	70	75	67	7	69
GARY, IN	3	15	2	8	5	0	6	17	11	11	9	4	10
GRAND RAPIDS-MUSKEGON-HOLLAND, MI	4	16	10	26	6	3	12	17	7	8	13	5	19
GREENSBORO–WINSTON-SALEM–HIGH PT, NC	2	4	12	5	2	20	7	6	6	13	25	6	30
GREENVILLE-SPARTANBURG-ANDERSON, SC	4	3	2	3	5	9	5	8	7	10	29	4	29
HARRISBURG-LEBANON-CARLISLE, PA	3	10	10	21	1	15	12	13	3	9	22	3	22
HARTFORD, CT	3	18	13	21	14	14	18	13	5	16	10	3	10
HONOLULU, HI	1	0	0	0	0	0	0	0	0	0	0	1	0
HOUSTON, TX	10	43	54	37	32	28	45	66	28	47	38	12	40
INDIANAPOLIS, IN	6	15	9	11	6	9	22	19	13	12	19	9	22
JACKSONVILLE, FL	2	4	3	0	2	3	2	1	1	4	10	2	10
JERSEY CITY, NJ	1	15	15	25	9	19	12	16	5	9	7	1	7
KANSAS CITY, MO-KS	6	4	2	11	1	3	10	22	9	18	15	6	15
KNOXVILLE, TN	4	2	23	10	7	20	13	20	19	36	52	7	54
LAS VEGAS, NV-AZ	3	2	2	0	1	2	2	0	2	0	0	4	3
LITTLE ROCK-NORTH LITTLE ROCK, AR	2	1	1	3	0	2	2	7	1	1	2	2	2
LOS ANGELES-LONG BEACH, CA	14	149	130	126	140	112	117	97	74	45	46	14	46
LOUISVILLE, KY-IN	4	13	10	15	2	19	27	21	10	13	24	7	29
MEMPHIS, TN-AR-MS	4	6	22	9	13	13	10	21	18	17	27	4	27
MIAMI, FL	4	5	1	1	3	6	1	2	1	3	8	4	8
MIDDLESEX-SOMERSET-HUNTERDON, NJ	1	19	24	24	8	13	9	16	8	18	21	2	22
MILWAUKEE-WAUKESHA, WI	8	17	8	24	3	4	9	14	5	4	10	9	12

Table A-16. (Ozone only) Number of Days with AQI Values Greater Than 100 at Trend Sites, 1989–1998, and All Sites in 1998 (continued)

Metropolitan Statistical Area	# of Trend Sites	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Total # of Sites	AQI > 100 1998
MINNEAPOLIS-ST. PAUL, MN-WI	4	1	1	0	2	0	0	4	1	0	0	5	1
MONMOUTH-OCEAN, NJ	1	15	21	20	6	11	3	6	12	12	19	2	31
NASHVILLE, TN	7	10	31	13	6	18	21	28	23	20	30	7	32
NASSAU-SUFFOLK, NY	1	14	20	25	5	15	10	9	6	8	10	2	11
NEW HAVEN-MERIDEN, CT	2	11	15	28	10	13	13	14	8	19	10	2	10
NEW ORLEANS, LA	6	4	6	2	5	6	8	20	8	7	7	6	7
NEW YORK, NY	5	24	33	47	10	19	21	18	15	23	17	7	21
NEWARK, NJ	2	20	22	32	10	13	12	20	12	13	23	2	23
NORFOLK-VA BEACH-NEWPORT NEWS,VA-NC	3	4	8	7	8	19	6	6	4	17	15	3	15
OAKLAND, CA	8	6	4	3	3	4	3	12	11	0	11	9	12
OKLAHOMA CITY, OK	4	4	4	4	2	2	5	13	2	4	7	4	7
OMAHA, NE-IA	3	0	1	0	0	0	0	0	0	0	0	3	0
ORANGE COUNTY, CA	4	43	38	35	35	25	15	8	9	3	6	4	6
ORLANDO, FL	3	9	4	1	4	4	3	1	1	4	11	4	14
PHILADELPHIA, PA-NJ	8	42	39	49	24	51	25	30	22	32	37	10	37
PHOENIX-MESA, AZ	8	4	7	7	11	16	7	19	17	10	17	18	33
PITTSBURGH, PA	8	14	11	20	8	13	19	24	11	20	39	11	39
PONCE, PR	0	0	0	0	0	0	0	0	0	0	0	0	0
PORTLAND-VANCOUVER, OR-WA	4	0	8	3	6	0	1	2	6	0	3	4	3
PROVIDENCE-FALL RIVER-WARWICK, RI-MA	2	9	13	20	5	7	7	11	4	10	4	3	5
RALEIGH-DURHAM-CHAPEL HILL, NC	1	10	15	5	0	11	2	1	1	13	21	8	40
RICHMOND-PETERSBURG, VA	4	11	6	18	8	30	13	19	5	21	28	4	28
RIVERSIDE-SAN BERNARDINO, CA	15	180	153	152	172	167	148	119	116	102	94	19	96
ROCHESTER, NY	2	5	5	16	2	0	1	6	0	6	4	2	4
SACRAMENTO, CA	6	30	17	44	43	14	30	32	30	5	17	12	33
ST. LOUIS, MO-IL	16	21	23	32	15	9	31	34	20	14	23	17	24
SALT LAKE CITY-OGDEN, UT	2	14	5	3	0	2	4	4	6	1	12	7	19
SAN ANTONIO, TX	2	3	4	3	1	3	4	18	3	3	6	2	6
SAN DIEGO, CA	9	122	96	67	66	58	46	48	31	14	33	10	35
SAN FRANCISCO, CA	3	0	0	0	0	0	0	2	0	0	0	3	0
SAN JOSE, CA	4	7	4	5	3	4	2	10	7	0	5	6	8
SAN JUAN-BAYAMON, PR	0	0	0	0	0	0	0	0	0	0	0	1	0
SCRANTON–WILKES-BARRE–HAZLETON, PA	4	6	9	17	3	10	7	12	4	11	7	4	7
SEATTLE-BELLEVUE-EVERETT, WA	2	0	7	3	3	0	3	0	6	1	3	4	3
SPRINGFIELD, MA	4	10	13	15	12	13	12	9	4	10	7	4	7
SYRACUSE, NY	1	0	0	11	2	4	0	1	0	0	2	2	3
TACOMA, WA	1	0	4	0	2	0	2	0	1	0	4	2	4
TAMPA-ST. PETERSBURG-CLEARWATER, FL	6	4	6	1	1	1	3	2	3	4	11	7	11
TOLEDO, OH	3	8	3	6	2	7	9	9	11	4	5	3	6
TUSCON, AZ	6	0	1	0	1	1	1	3	0	1	0	6	0
TULSA, OK	3	5	16	12	1	4	12	21	14	7	9	3	9
VENTURA, CA	5	87	70	87	54	37	63	65	62	43	29	7	30
WASHINGTON, DC-MD-VA-WV	12	23	25	48	14	48	20	29	18	29	45	17	47
WEST PALM BEACH-BOCA RATON, FL	2	1	0	0	0	3	0	0	0	0	2	2	2
WILMINGTON-NEWARK, DE-MD	1	12	9	12	7	10	5	12	3	6	8	4	28
YOUNGSTOWN-WARREN, OH	1	8	3	14	5	2	0	11	5	3	15	3	22

Table A-17. Condensed Nonattainment Areas List(a)

			Pollutant(c)						Population(d)					
	State	Area Name(b)	O_3	CO	SO_2	PM_{10}	Pb	NO_2	O_3	CO	SO_2	PM_{10}	Pb	All
1	AK	Anchorage	.	1	.	1	.	.		222	.	170	.	222
2	AK	Fairbanks	.	1	.	.	.	.	.	30	.	.	.	30
3	AK	Juneau	.	.	.	1	.	.	.	.	.	12	.	12
4	AL	Birmingham	1	.	.	.	.	.	751	.	.	.	.	751
5	AZ	Ajo	.	.	1	1	.	.	.	.	6	6	.	6
6	AZ	Bullhead City	.	.	.	1	.	.	.	.	.	5	.	5
7	AZ	Douglas	.	.	1	1	.	.	.	.	13	13	.	13
8	AZ	Miami-Hayden	.	.	2	1	.	.	.	.	3	3	.	3
9	AZ	Morenci	.	.	1	.	.	.	.	.	8	.	.	8
10	AZ	Nogales	.	.	.	1	.	.	.	.	.	19	.	19
11	AZ	Paul Spur	.	.	.	1	.	.	.	.	.	1	.	1
12	AZ	Payson	.	.	.	1	.	.	.	.	.	8	.	8
13	AZ	Phoenix	1	1	.	1	.	.	2,092	2,006	.	2,122	.	2,122
14	AZ	Rillito	.	.	.	1	.	.	.	.	.	0	.	0
15	AZ	San Manuel	.	.	1	.	.	.	.	.	5	.	.	5
16	AZ	Yuma	.	.	.	1	.	.	.	.	.	54	.	54
17	CA	Imperial Valley	.	.	.	1	.	.	.	.	.	92	.	92
18	CA	Los Angeles-South Coast Air Basin	1	1	.	1	.	.	13,000	13,000	.	13,000	.	13,000
19	CA	Mono Basin (in Mono Co.)	.	.	.	1	.	.	.	.	.	0	.	0
20	CA	Owens Valley	.	.	.	1	.	.	.	.	.	18	.	18
21	CA	Sacramento Metro	1	.	.	1	.	.	1,639	.	.	1,041	.	1,639
22	CA	San Diego	1	.	.	.	.	.	2,498	.	.	.	.	2,498
23	CA	San Francisco-Oakland-San Jose	1	.	.	.	.	.	5,815	.	.	.	.	5,815
24	CA	San Joaquin Valley	1	.	.	1	.	.	2,742	.	.	2,742	.	2,742
25	CA	Santa Barbara-Santa Maria-Lompoc	1	.	.	.	.	.	370	.	.	.	.	370
26	CA	Searles Valley	.	.	.	1	.	.	.	.	.	30	.	30
27	CA	Southeast Desert Modified AQMA	1	.	.	2	.	.	384	.	.	349	.	384
28	CA	Ventura Co.	1	.	.	.	.	.	669	.	.	.	.	669
29	CO	Aspen	.	.	.	1	.	.	.	.	.	5	.	5
30	CO	Canon City	.	.	.	1	.	.	.	.	.	12	.	12
31	CO	Colorado Springs	.	1	.	.	.	.	.	353	.	.	.	353
32	CO	Denver-Boulder	.	1	.	1	.	.	.	1,800	.	1,836	.	1,836
33	CO	Fort Collins	.	1	.	.	.	.	.	106	.	.	.	106
34	CO	Lamar	.	.	.	1	.	.	.	.	.	8	.	8
35	CO	Longmont	.	1	.	.	.	.	.	52	.	.	.	52
36	CO	Pagosa Springs	.	.	.	1	.	.	.	.	.	1	.	1
37	CO	Steamboat Springs	.	.	.	1	.	.	.	.	.	6	.	6
38	CO	Telluride	.	.	.	1	.	.	.	.	.	1	.	1
39	CT	Greater Connecticut	1	.	.	1	.	.	2,470	.	.	126	.	2,470
40	DC-MD-VA	Washington	1	.	.	.	.	.	3,923	.	.	.	.	3,923
41	GA	Atlanta	1	.	.	.	.	.	2,653	.	.	.	.	2,653
42	GU	Piti Power Plant	.	.	1	.	.	.	.	.	0	.	.	0
43	GU	Tanguisson Power Plant	.	.	1	.	.	.	.	.	0	.	.	0
44	ID	Bonner Co.(Sandpoint)	.	.	.	1	.	.	.	.	.	26	.	26
45	ID	Fort Hall I.R.	.	.	.	1	.	.	.	.	.	1	.	1
46	ID	Portneuf Valley	.	.	.	1	.	.	.	.	.	74	.	74
47	ID	Shoshone Co.	.	.	.	2	.	.	.	.	.	13	.	13
48	IL-IN	Chicago-Gary-Lake County	1	.	1	3	.	.	7,887	.	475	625	.	7,887
49	IN	Marion Co. (Indianapolis)	.	.	.	.	1	.	.	.	.	.	16	16
50	KY	Boyd Co. (Ashland)		.	1	.	.	.	.	.	51	.	.	51
51	KY-IN	Louisville	1	.	.	.	.	.	834	.	.	.	.	834

Table A-17. Condensed Nonattainment Areas List(a) (continued)

	State	Area Name(b)	Pollutant(c)						Population(d)					
			O_3	CO	SO_2	PM_{10}	Pb	NO_2	O_3	CO	SO_2	PM_{10}	Pb	All
52	LA	Baton Rouge	1	.	.	.	.	.	559	.	.	.	.	559
53	MA	Springfield (W. Mass)	1	.	.	.	.	.	812	.	.	.	.	812
54	MD	Baltimore	1	.	.	.	.	.	2,348	.	.	.	.	2,348
55	MD	Kent and Queen Anne Cos.	1	.	.	.	.	.	52	.	.	.	.	52
56	MN	Minneapolis-St. Paul	.	1	.	1	.	.	.	2,310	.	272	.	2,310
57	MN	Olmsted Co. (Rochester)	.	.	1	.	.	.	.	.	71	.	.	71
58	MO	Dent	.	.	.	.	1	.	.	.	.	.	3	3
59	MO	Liberty-Arcadia	.	.	.	.	1	.	.	.	.	.	2	2
60	MO-IL	St. Louis	1	.	.	.	1	.	2,390	.	.		2	2,390
61	MT	Butte	.	.	.	1	.	.	.	.	.	33	.	33
62	MT	Columbia Falls	.	.	.	1	.	.	.	.	.	3	.	3
63	MT	Kalispell	.	.	.	1	.	.	.	.	.	12	.	12
64	MT	Lame Deer	.	.	.	1	.	.	.	.	.	1	.	1
65	MT	Lewis & Clark (E. Helena)	.	.	1	.	1	.	.	.	2	.	2	2
66	MT	Libby	.	.	.	1	.	.	.	.	.	3	.	3
67	MT	Missoula	.	1	.	1	.	.	.	43	.	43	.	43
68	MT	Polson	.	.	.	1	.	.	.	.	.	3	.	3
69	MT	Ronan	.	.	.	1	.	.	.	.	.	2	.	2
70	MT	Thompson Falls	.	.	.	1	.	.	.	.	.	1	.	1
71	MT	Whitefish	.	.	.	1	.	.	.	.	.	3	.	3
72	MT	Yellowstone Co. (Laurel)	.	.	1	.	.	.	.	.	5	.	.	5
73	NE	Douglas Co. (Omaha)	.	.	.	.	1	.	.	.	.	.	1	1
74	NM	Anthony	.	.	.	1	.	.	.	.	.	2	.	2
75	NM	Grant Co.	.	.	1	.	.	.	.	.	28	.	.	28
76	NM	Sunland Park	1	.	.	.	.	.	8	.	.	.	.	8
77	NV	Central Steptoe Valley	.	.	1	.	.	.	.	.	2	.	.	2
78	NV	Las Vegas	.	1	.	1	.	.	.	258	.	741	.	741
79	NV	Reno	.	1	.	1	.	.	.	134	.	254	.	254
80	NY-NJ-CT	New York-N. New Jersey-Long Island	1	1	.	1	.	.	17,943	12,338	.	1,488	.	17,943
81	OH	Cleveland-Akron-Lorain	.	.	2	1	.	.	.	.	1,683	1,412	.	1,683
82	OH	Coshocton Co.	.	.	1	.	.	.	.	.	35	.	.	35
83	OH	Gallia Co.	.	.	1	.	.	.	.	.	31	.	.	31
84	OH	Jefferson Co. (Steubenville)	.	.	.	1	.	.	.	.	.	4	.	4
85	OH	Lucas Co. (Toledo)	.	.	1	.	.	.	.	.	462	.	.	462
86	OH-KY	Cincinnati-Hamilton	1	.	.	.	.	.	1,705	.	.	.	.	1,705
87	OR	Grants Pass	.	1	.	1	.	.	.	17	.	17	.	17
88	OR	Klamath Falls	.	1	.	1	.	.	.	18	.	18	.	18
89	OR	LaGrande	.	.	.	1	.	.	.	.	.	12	.	12
90	OR	Lakeview	.	.	.	1	.	.	.	.	.	3	.	3
91	OR	Medford	.	1	.	1	.	.	.	62	.	63	.	63
92	OR	Oakridge	.	.	.	1	.	.	.	.	.	3	.	3
93	OR	Springfield-Eugene	.	.	.	1	.	.	.	.	.	157	.	157
94	PA	Lancaster	1	.	.	.	.	.	423	.	.	.	.	423
95	PA	Pittsburgh-Beaver Valley	1	.	2	1	.	.	2,468	.	446	75	.	2,468
96	PA	Warren Co	.	.	2	.	.	.	.	.	22	.	.	22
97	PA-DE-NJ-MD	Philadelphia-Wilmington-Trenton	1	.	.	.	.	.	6,010	.		.	.	6,010
98	PA-NJ	Allentown-Bethlehem	.	.	1	.	.	.	.	.	91	.	.	91
99	PR	Guaynabo Co.	.	.	.	1	.	.	.	.	.	85	.	85
100	TN	Shelby Co. (Memphis)	.	.	.	.	1	.	.	.	.	.	826	826
101	TX	Beaumont-Port Arthur	1	.	.	.	.	.	361	.	.	.	.	361
102	TX	Dallas-Fort Worth	1	.	.	.	1	.	3,561	.	.	.	264	3,561

Table A-17. Condensed Nonattainment Areas List(a)

	State	Area Name(b)	Pollutant(c) O_3	CO	SO_2	PM_{10}	Pb	NO_2	Population(d) O_3	CO	SO_2	PM_{10}	Pb	All
103	TX	El Paso	1	1	.	1	.	.	592	54	.	515	.	592
104	TX	Houston-Galveston-Brazoria	1	.	.	.	.	.	3,731	.	.	.	.	3,731
105	UT	Ogden	.	1	.	1	.	.	.	63	.	63	.	63
106	UT	Salt Lake City	.	.	1	1	.	.	.	.	725	725	.	725
107	UT	Tooele Co.	.	.	1	.	.	.	.	.	26	.	.	26
108	UT	Utah Co. (Provo)	.	1	.	1	.	.	.	85	.	263	.	263
109	WA	Olympia-Tumwater-Lacey	.	.	.	1	.	.	.	.	.	63	.	63
110	WA	Seattle-Tacoma	.	.	.	3	.	.	.	.	.	730	.	730
111	WA	Spokane	.	1	.	1	.	.	.	279	.	177	.	279
112	WA	Wallula	.	.	.	1	.	.	.	.	.	47	.	47
113	WA	Yakima	.	.	.	1	.	.	.	.	.	54	.	54
114	WI	Manitowoc Co.	1	.	.	.	.	.	80	.	.	.	.	80
115	WI	Marathon Co. (Wausau)	.	.	1	.	.	.	.	.	115	.	.	115
116	WI	Milwaukee-Racine	1	.	.	.	.	.	1,735	.	.	.	.	1,735
117	WI	Oneida Co. (Rhinelander)	.	.	1	.	.	.	.	.	31	.	.	31
118	WV	Follansbee	.	.	.	1	.	.	.	.	.	3	.	3
119	WV	New Manchester Gr. (in Hancock Co)	.	.	1	.	.	.	.	.	10	.	.	10
120	WV	Wier.-Butler-Clay (in Hancock Co)	.	.	1	1	.	.	.	.	25	22	.	25
121	WY	Sheridan	.	.	.	1	.	.	.	.	.	13	.	13
			32	20	31	77	8	0	92,505	33,230	4,371	29,804	1,116	105,106

Notes:

(a) This is a simplified listing of Classified Nonattainment areas. Unclassified and Section 185a nonattainment areas are not included. In certain cases, footnotes are used to clarify the areas involved. For example, the lead nonattainment area listed within the Dallas-Fort Worth ozone nonattainment area is in Frisco, Texas, which is not in Dallas county, but is within the designated boundaries of the ozone nonattainment area. Readers interested in more detailed information should use the official *Federal Register* citation (40 CFR 81).

(b) Names of nonattainment areas are listed alphabetically within each state. The largest city determines which state is listed first in the case of multiple-city nonattainment areas. When a larger nonattainment area, such as ozone, contains 1 or more smaller nonattainment areas, such as PM_{10} or lead, the common name for the larger nonattainment area is used. Note that several smaller nonattainment areas may be inside one larger nonattainment area, as is the case in Figure A-1. For the purpose of this table, these are considered one nonattainment area and are listed on one line. Occasionally, two nonattainment areas may only partially overlap, as in Figure A-2. These are counted as two distinct nonattainment areas and are listed on separate lines.

(c) The number of nonattainment areas for each of the criteria pollutants is listed.

(d) Population figures were obtained from 1990 census data. For nonattainment areas defined as only partial counties, population figures for just the nonattainment area were used when these were available. Otherwise, whole county population figures were used. When a larger nonattainment area encompasses a smaller one, double-counting the population in the "All" column is avoided by only counting the population of the larger nonattainment area.

(e) Lead nonattainment area is a portion of Franklin township, Marion county, Indiana.

(f) Sulfur dioxide nonattainment area is a portion of Boyd county.

(g) Lead nonattainment area is Herculaneum, Missouri in Jefferson county.

(h) Lead nonattainment area is a portion of Lewis and Clark county, Montana.

(i) Ozone nonattainment area is a portion of Dona Ana county, New Mexico.

(j) Lead nonattainment area is a portion of Shelby county, Tennessee.

(k) Lead nonattainment area is Frisco, Texas, in Collin county.

Table A-17. Condensed Nonattainment Areas List(a) (continued)

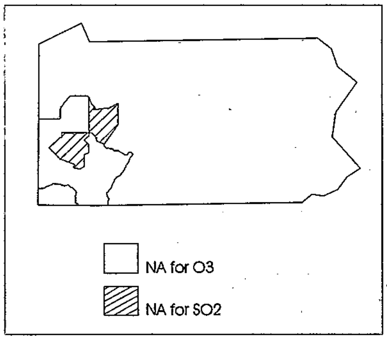


Figure A-1. (Multiple NA areas within a larger NA area) Two SO_2 areas inside the Pittsburgh–Beaver Valley ozone NA. Counted as one NA area.

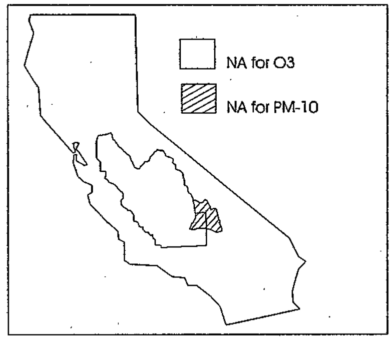


Figure A-2. (Overlapping NA areas) Searles Valley PM_{10} NA partially overlaps the San Joaquin Valley ozone NA. Counted as two NA areas.

Table A-18. Trend in 8-hr ozone concentrations at National Park and National Monument sites, 1989–98

National Park	Trend	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Acadia NP	NS	0.076	0.089	0.095	0.080	0.080	0.075	0.092	0.073	0.077	nd
		2	4	7	1	3	0	5	2	1	nd
Big Bend NP	UP	nd	nd	0.057	0.061	0.063	0.069	0.065	0.073	0.063	0.07
		nd	nd	0	0	0	0	0	0	0	0
Brigantine	NS	0.102	0.109	0.111	0.094	0.093	0.083	0.1	0.095	0.106	0.091
		13	17	34	8	13	2	10	13	18	22
Cape Cod NS	NS	0.104	0.097	0.111	0.096	0.088	0.088	0.105	0.096	0.1	0.084
		10	9	16	6	4	4	9	8	17	2
Cape Romain	UP	0.064	nd	0.06	0.072	0.069	0.067	0.075	0.071	0.082	0.076
		1	nd	0	0	0	0	1	1	3	0
Chiricahua NM	NS	0.066	0.069	0.071	0.065	0.068	0.071	0.059	0.072	0.065	0.067
		0	0	0	0	0	0	0	0	0	0
Congaree Swamp	UP	nd	nd	0.059	0.067	0.063	0.064	0.076	0.074	0.065	0.081
		nd	nd	0	0	0	0	1	0	0	0
Cowpens NB	UP	0.081	0.074	0.078	0.086	0.082	0.083	0.084	0.080	0.091	0.096
		1	0	1	4	3	2	3	2	6	15
Denali NP	UP	0.046	0.048	0.049	0.05	0.048	0.049	0.053	0.053	0.051	0.054
		0	0	0	0	0	0	0	0	0	0
Everglades NP	NS	0.067	0.060	0.060	0.061	0.064	0.064	0.058	0.063	0.066	0.072
		0	0	0	0	0	0	0	0	0	0
Glacier NP	NS	0.056	0.050	0.051	0.051	0.044	0.055	nd	0.057	0.040	0.053
		0	0	0	0	0	0	nd	0	0	0
Grand Canyon NP	NS	0.065	0.072	0.073	0.074	0.066	0.073	nd	0.073	0.072	0.072
		0	0	0	0	0	0	nd	0	0	0
Great Smoky Mtn	UP	0.083	0.092	0.079	0.088	0.088	0.093	0.099	0.088	0.098	0.11
		2	5	2	5	4	10	11	8	19	35
Great Smoky Mtn	UP	0.079	0.087	0.082	0.075	0.089	0.088	0.093	0.092	0.095	0.106
		0	4	1	0	7	6	12	12	20	34
Lassen Volcanic	NS	0.073	0.078	0.066	0.069	0.064	0.078	0.074	0.073	0.067	0.078
		0	1	0	0	0	1	0	1	0	1
Mammoth Cave NP	NS	0.084	0.083	0.078	0.073	0.072	0.075	0.088	0.082	0.078	nd
		2	2	0	0	0	1	5	2	1	nd
Olympic NP	NS	0.044	0.046	0.043	0.046	0.042	0.042	0.049	0.046	0.045	0.046
		0	0	0	0	0	0	0	0	0	0
Pinnacles NM	NS	0.080	0.083	0.084	0.084	0.060	0.078	0.083	0.094	0.076	0.088
		1	3	3	3	0	0	3	9	1	5
Rocky Mountain	UP	0.067	0.057	0.076	0.071	0.071	0.076	0.076	0.072	nd	0.080
		0	0	0	0	1	0	0	0	nd	1
Saguaro NM	NS	0.072	0.075	0.073	0.074	0.082	0.080	0.083	0.076	0.079	0.077
		0	0	0	1	1	0	2	0	0	0
Sequoia/Kings C	NS	0.093	0.096	0.097	0.102	0.106	0.106	0.095	0.105	0.097	0.094
		29	27	34	50	48	58	18	50	26	26
Shenandoah NP	UP	0.072	0.086	0.083	0.077	0.083	0.083	0.087	0.081	0.089	0.107
		0	4	3	1	2	2	7	1	6	22
Theodore Roosevelt	NS	0.065	0.062	0.060	0.057	0.055	0.057	0.058	0.059	0.071	inc
		0	0	0	0	0	0	0	0	0	0
Yosemite NP	NS	0.085	0.094	0.080	0.084	0.078	0.077	0.084	0.081	nd	nd
		4	19	1	3	0	0	2	1	nd	nd

Notes:

1. The trends statistic is the annual fourth highest daily maximum 8-hour ozone concentration (ppm). The number of exceedances of the level of the 8-hour ozone NAAQS is shown below the concentration value.
2. "nd" indicates no data available for that year.
3. "inc" indicates less than 90 days of monitoring data available for that year.
4. "NS" indicates no statistically significant trend (at the 0.05 level).
5. "UP" indicates a statistically significant upward trend in ozone concentrations.

APPENDIX B

Methodology

http://www.epa.gov/oar/aqtrnd98/appendb.pdf

AIRS Methodology

The ambient air quality data presented in Chapters 2 and 3 of this report are based on data retrieved from AIRS on July 14, 1999. These are direct measurements of pollutant concentrations at monitoring stations operated by state and local governments throughout the nation. The monitoring stations are generally located in larger urban areas. EPA and other federal agencies also operate some air quality monitoring sites on a temporary basis as a part of air pollution research studies. The national monitoring network conforms to uniform criteria for monitor siting, instrumentation, and quality assurance.[1,2]

In 1999, 4,369 monitoring sites reported air quality data for one or more of the six NAAQS pollutants to AIRS, as seen in Table B-1. The geographic locations of these monitoring sites are displayed in Figures B-1 to B-6. The sites are identified as National Air Monitoring Stations (NAMS), State and Local Air Monitoring Stations (SLAMS), or "other." NAMS were established to ensure a long-term national network for urban area-oriented ambient monitoring and to provide a systematic, consistent data base for air quality comparisons and trends analysis. SLAMS allow state or local governments to develop networks tailored for their immediate monitoring needs. "Other" monitors may be Special Purpose Monitors, industrial monitors, tribal monitors, etc.

Table B-1. Number of Ambient Monitors Reporting Data to AIRS

Pollutant	# of Sites Reporting Data to AIRS in 1998	# of Trend Sites 1989–1998
CO	511	363
Pb	306	189
NO_2	422	225
O_3	1,048	661
PM_{10}	1,436	934
SO_2	646	482
Total	4,369	2,854

Air quality monitoring sites are selected as national trends sites if they have complete data for at least eight of the 10 years between 1989 and 1998. The annual data completeness criteria are specific to each pollutant and measurement methodology. Table B-1 displays the number of sites meeting the 10-year trend completeness criteria. Because of the annual turnover of monitoring sites, the use of a moving 10-year window maximizes the number of sites available for trends and yields a data base that is consistent with the current monitoring network.

The air quality data are divided into two major groupings: daily (24-hour) measurements and continuous (1-hour) measurements. The daily measurements are obtained from monitoring instruments that produce one measurement per 24-hour period and typically operate on a systematic sampling schedule of once every six days, or 61 samples per year. Such instruments are used to measure PM_{10} and lead. More frequent sampling of PM_{10} (every other day or every day) is also common. Only PM_{10} weighted (for each quarter to account for seasonality) annual arithmetic means that meet the AIRS annual summary criteria are selected as valid means for trends purposes.[3] Beginning in 1998, some sites began reporting PM_{10} data based on local conditions, instead of standard, or "reference," conditions. For these sites, PM_{10} statistics were converted from local conditions to standard conditions to ensure all PM_{10} data in this report are consistent and reflect standard conditions.[4] Only lead sites with at least six samples per quarter in three of the four calendar quarters qualify as trends sites. Monthly composite lead data are used if at least two monthly samples are available for at least three of the four calendar quarters.

Monitoring instruments that operate continuously produce a measurement every hour for a possible total of 8,760 hourly measurements in a

Figure B-1. Carbon monoxide monitoring program, 1998.

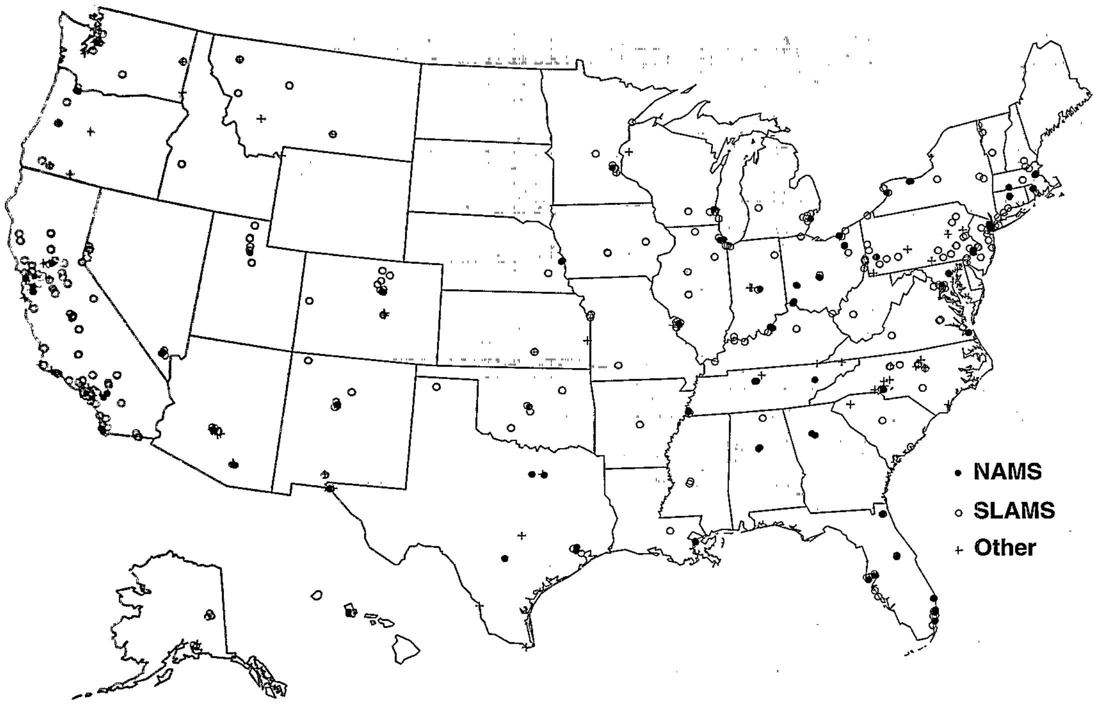


Figure B-2. Lead monitoring program, 1998.

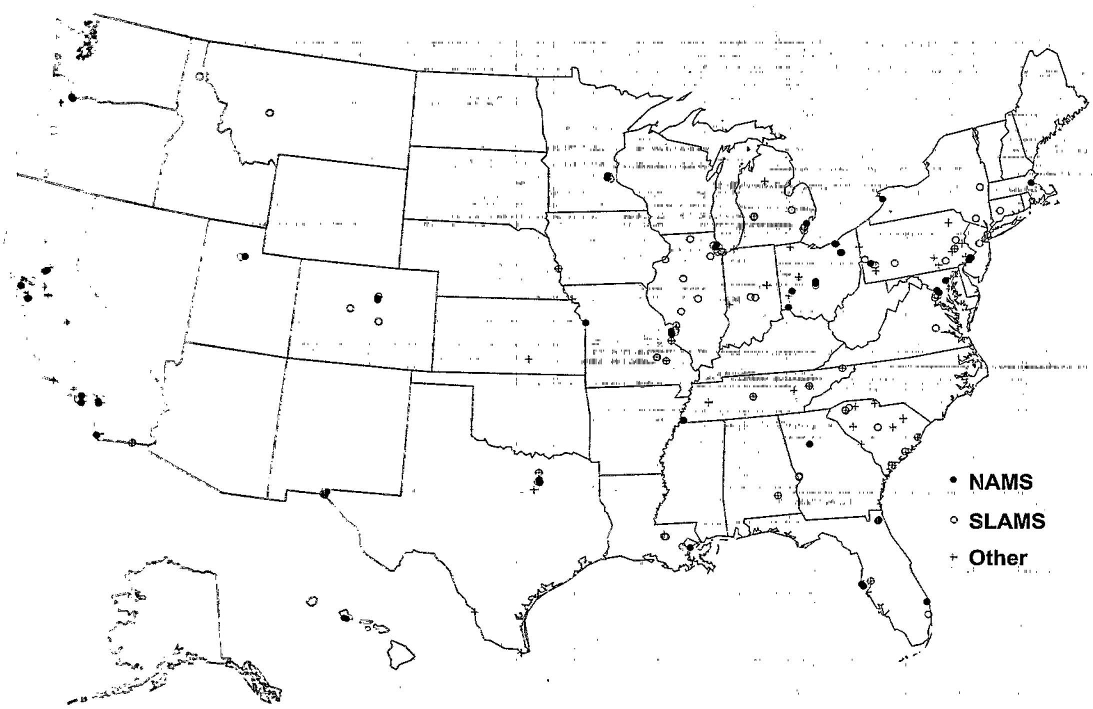


Figure B-3. Nitrogen dioxide monitoring program, 1998.

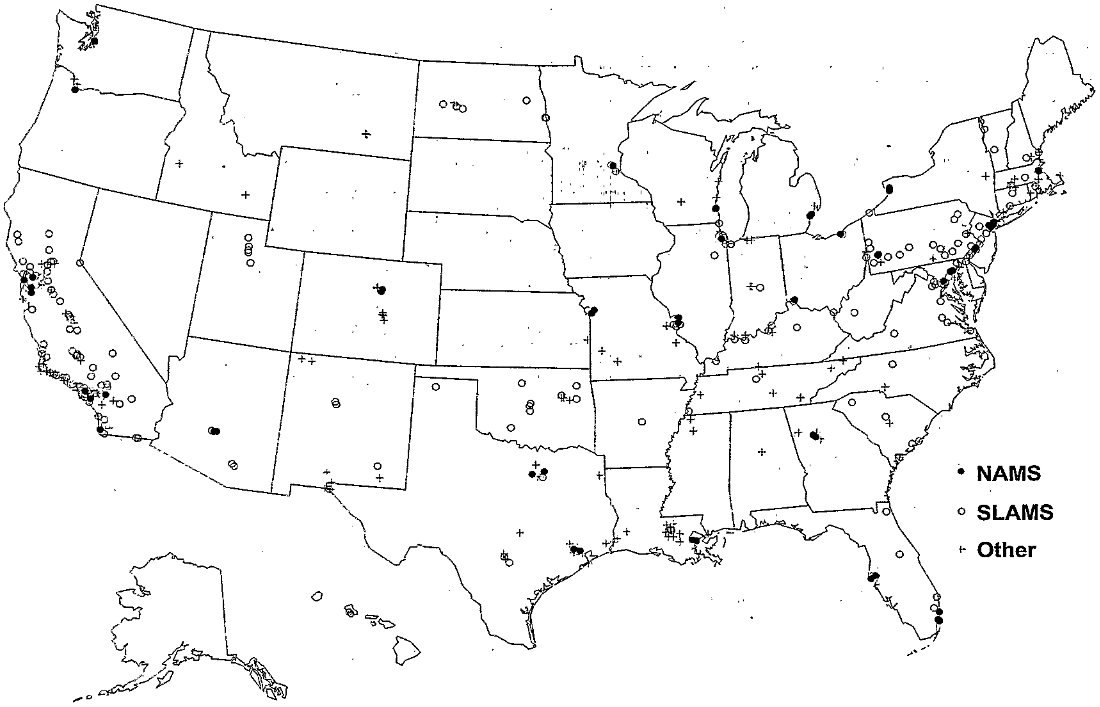


Figure B-4. Ozone program, 1998.

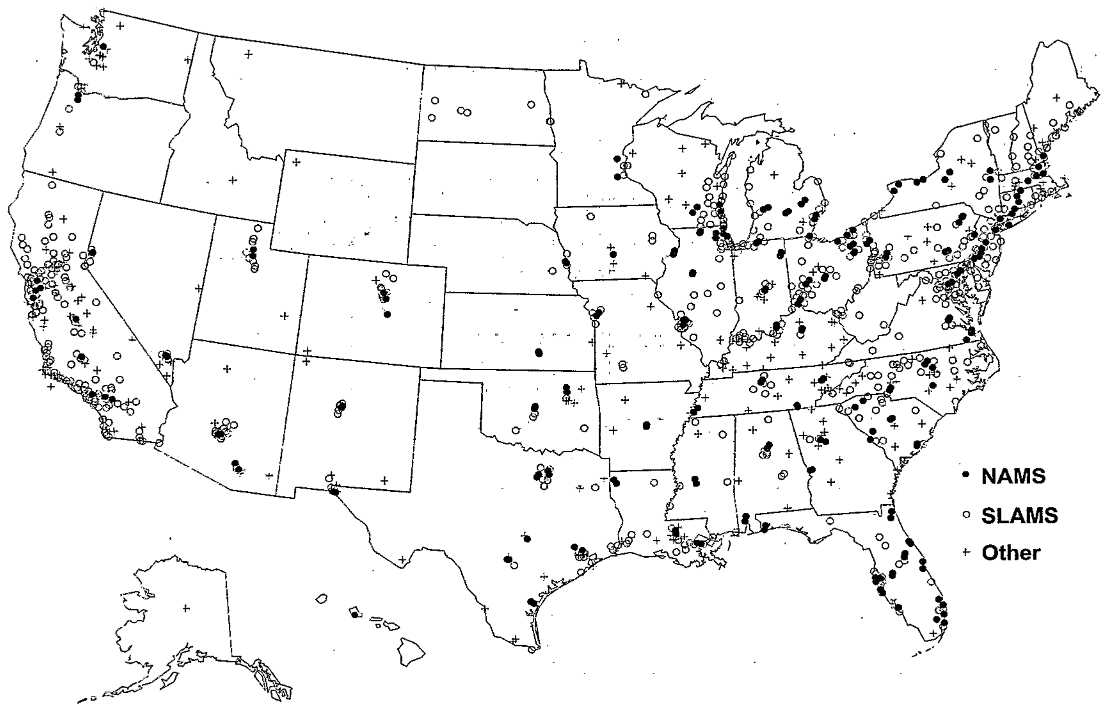


Figure B-5. PM_{10} monitoring program, 1998.

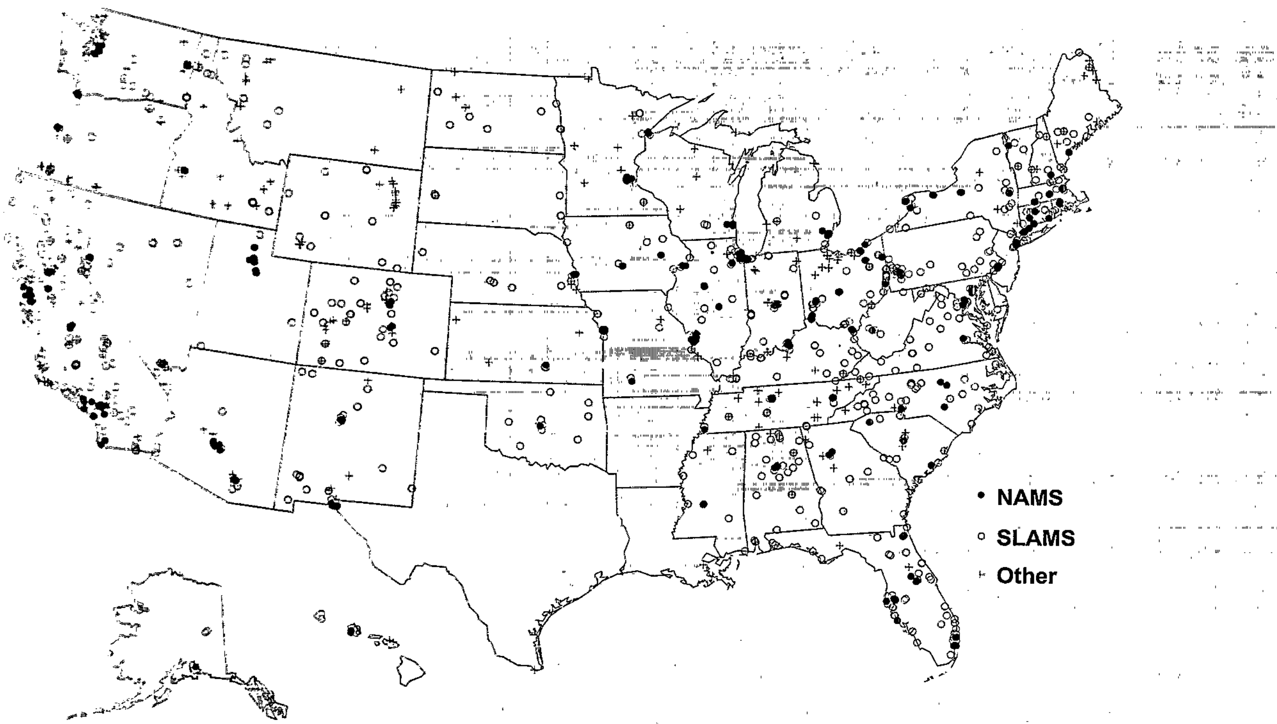


Figure B-6. Sulfur dioxide monitoring program, 1998.

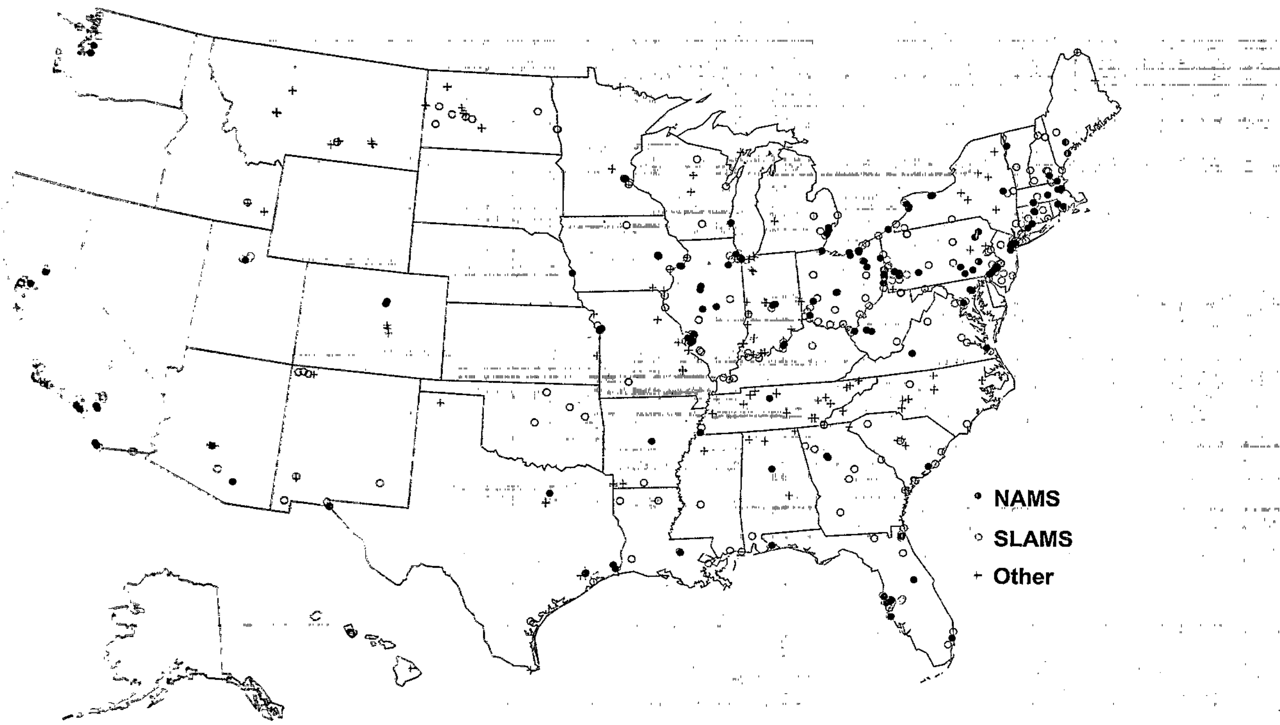
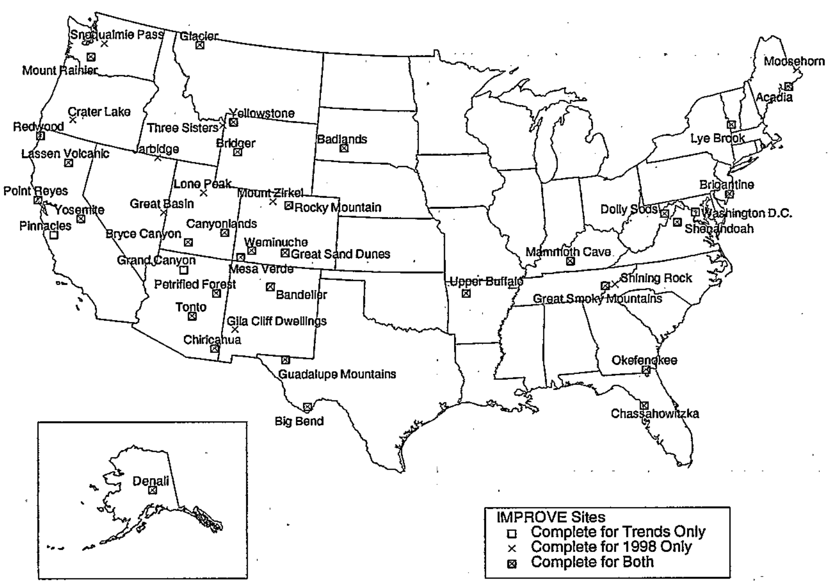


Figure B-7. Class I Areas in the IMPROVE Network meeting data completeness criteria.



year. For hourly data, only annual averages based on at least 4,380 hourly observations are considered as trends statistics. The SO_2 standard-related daily statistics require at least 183 daily values to be included in the analysis. Ozone sites meet the annual trends data completeness requirement if they have at least 50 percent of the daily data available for the ozone season, which varies by state, but typically runs from May through September.[5]

Air Quality Trend Statistics

The air quality statistics presented in this report relate to the pollutant-specific NAAQS and comply with the recommendations of the Intra-Agency Task Force on Air Quality Indicators.[6] A composite average of each trend statistic is used in the graphical presentations throughout this report. All sites were weighted equally in calculating the composite average trend statistic. Missing annual summary statistics for the second through ninth years for a site are estimated by linear interpolation from the surrounding years. Missing end points are replaced with the nearest valid year of data. The resulting data sets are statistically balanced, allowing simple statistical procedures and graphics to be easily applied. This procedure is conservative since end-point rates of change are dampened by the interpolated estimates.

IMPROVE Methodology

Data collected from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network is summarized in Chapters 2 ($PM_{2.5}$ section) and 6 of this report. The completeness criteria and averaging method used to summarize the IMPROVE data are slightly different from those used for the criteria pollutants. (Data handling guidance is currently being developed for the IMPROVE network. Future summaries will be based on this guidance.)

The source data sets are available on the public FTP site. The $PM_{2.5}$ data were obtained from Dr. James Sisler of Colorado State University. The visibility data were obtained from **ftp://alta_vista.cira.colostate.edu/DATA/IMPROVE/Trends 88-98/10-50-90/TREND98.LIS.**

The annual average statistics in these files were used to assess trends in this report. The IMPROVE data are not reported in terms of a calendar year. The IMPROVE year runs from March to February of the following year. It follows that the four seasons are: March to May (spring), June to August (summer), September to November (autumn), and December to the following February (winter). The network samplers monitor on Wednesdays and Saturdays throughout the year, yielding 104 samples per year and 26 samples per season. Sites were required to have data at least 50 percent of the scheduled samples (13 days) for every calendar quarter.

IMPROVE monitoring sites are selected as trends sites if they have complete data for at least eight of the 10 years between 1989 and 1998 or (six of seven years for those who began monitoring in 1992). A year is valid only if there are at least 13 samples (50 percent complete) per season for both measured and reconstructed $PM_{2.5}$. The same linear interpolation applied to the criteria pollutants is applied here. In all, 34 IMPROVE sites met the data completeness criteria. They are denoted in Figure B-7 with a square or a square with an X.

For consistency, the same sites are used in both the $PM_{2.5}$ section and the Visibility chapter. The exception is Washington D.C., which is not

State-supplied MOBILE model inputs for 1990, 1995, and 1996 were used, as well as state-supplied VMT data for 1990. Rule effectiveness from pre-1990 chemical and allied product emissions was removed. Lead content of unleaded and leaded gasoline for the on-road and non-road engine lead emission estimates was revised, and Alaska and Hawaii nonutility point and area source emissions from several sources were added. Also, this report incorporates data from CEMs collected between 1994 and 1998 for NO_x and SO_2 emissions at major electric utilities.

All of these changes are part of a broad effort to update and improve emissions estimates. Additional emissions estimates and a more detailed description of the estimation methodology are available in two companion reports, the *National Air Pollutant Emission Trends, 1900–1998* and the *National Air Pollutant Emission Trends Procedures Document, 1900–1998*.[10,11]

References

1. Clean Air Act Amendments of 1990, U.S. Code, volume 42, section 7403 (c)(2), 1990.

2. Ambient Air Quality Surveillance, 44 CFR 27558, May 10, 1979.

3. Aerometric Information Retrieval System (AIRS), Volume 2, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, October, 1993.

4. Falke, S. and Husar, R. (1998) Correction of Particulate Matter Concentrations to Reference Temperature and Pressure Conditions, Paper Number 98-A920, Air & Waste Management Association Annual Meeting, San Diego, CA, June 1998.

5. Ambient Air Quality Surveillance, 51 FR 9597, March 19, 1986.

6. U.S. Environmental Protection Agency Intra-Agency Task Force Report on Air Quality Indicators, EPA-450/4-81-015, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, February 1981.

7. Rosenbaum, A. S., Stiefer, M. P., and Iwamiya, R. K. November, 1999. *Air Toxics Data Archive and AIRS Combined Dataset: Contents Summary Report.* SYSAPP-99/26d. Systems Applications International, San Rafael, CA.

8. In most cases, four non-missing quarterly means are available after applying the GLM method, so that the resulting annual mean is the arithmetic mean of the four quarterly averages. In some cases, a quarter was incomplete for all the sites in the database so that no filled-in quarterly mean would be available for that quarter. Seasonal averaging was thus employed to deal with this situation in a reasonable manner.

9. Cohen, J.P. and A. K. Pollack. 1990. *General Linear Models Approach to Estimating National Air Quality Trends Assuming Different Regional Trends.* SYSAPP-90/102. Systems Applications International, San Rafael, CA.

10. National Air Pollutant Emission Trends, 1900-1998, EPA-454/R-00-002, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, February 2000.

11. National Air Pollutant Emission Trends Procedures Document, 1900-1998, EPA-454/R-00-001, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, February 2000.

TECHNICAL REPORT DATA

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16. ABSTRACT

THIS REPORT PRESENTS NATIONAL TRENDS IN AIR QUALITY FOR CARBON MONOXIDE, LEAD, NITROGEN DIOXIDE, OZONE, PARTICULATE MATTER, AND SULFUR DIOXIDE. TRENDS ARE PRESENTED FOR THE LONG TERM (WHEN AVAILABLE). FOR THE 10 YEAR PERIOD FROM 1989 TO 1998, AND FOR THE SHORT TERM (CHANGES OVER THE PAST YEAR). IN ADDITION TO AIR QUALITY TRENDS FROM DATA COLLECTED AT MONITORING STATIONS ACROSS THE COUNTRY, TRENDS IN ANNUAL NATIONWIDE EMISSIONS ARE ALSO PRESENTED.

WHILE THE POLLUTANTS NAMED ABOVE ARE EMPHASIZED IN THIS REPORT, RELATED TOPICS ARE ALSO INCLUDED. THESE INCLUDE VISIBILITY, ACID DEPOSITION, AIR TOXICS, NON-ATTAINMENT AREAS, AND TRENDS IN METROPOLITAN STATISTICAL AREAS. THE REPORT ALSO CONTAINS A SUBSTANTIAL APPENDIX OF DATA TABLES.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI FIELD/GROUP
ACID DEPOSITION, VISIBILITY, AIR TOXICS, AIR POLLUTION TRENDS, POLLUTANT STANDARDS INDEX (PSI) PARTICULATE MATTER, EMISSIONS TRENDS, AIR QUALITY STANDARDS, NON-ATTAINMENT AREAS, CARBON MONOXIDE, LEAD, OZONE, NITROGEN DIOXIDE, SULFUR DIOXIDE.		

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