1999

AMBIENT AIR QUALITY REPORT

North Carolina Department of Environment and Natural Resources
Division of Air Quality

Ambient Monitoring Section
Published March 2001

1999 Ambient Air Quality Report

STATE OF NORTH CAROLINA
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DEPARTMENT OF
ENVIRONMENT
AND
NATURAL RESOURCES
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Public Sources of Data:

North Carolina Division of Air Quality	http://daq.state.nc.us/
Forsyth County Environmental Affairs Department	http://www.co.forsyth.nc.us/EnvAffairs/weathereport.htm
EPA/AIRS Air Quality Subsystem	http://www.epa.gov/airsweb
National Atmospheric Deposition Program	http://nadp.sws.uiuc.edu

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Preface

This report is issued by the Division of Air Quality of the Department of Environment and Natural Resources to inform the public of air pollution levels throughout the state of North Carolina. It describes the sources and effects of the following pollutants for which the U.S. Environmental Protection Agency and the State of North Carolina have established ambient air quality standards:

Particulate Matter	Nitrogen Dioxide
Carbon Monoxide	Ozone
Sulfur Dioxide	Lead

A brief discussion of the ambient air monitoring program, including a description of the monitoring network, is provided. Detailed results are presented of monitoring that was conducted in 1999 to measure the outdoor concentrations. The data are presented graphically and as statistical summaries, including comparisons to the ambient air quality standards. The report discusses the recorded data, seasonal variability of some pollutants. Data and areas exceeding the ambient air quality standards are identified. Factors that have contributed to those exceedances are described also.

Acid rain data from the National Atmospheric Deposition Program/National Trends Network for North Carolina also are included for 1999. The report concludes with an account of pollutant concentration trends through 1999. Data collected after 1999 will be discussed in later reports.

Current air pollution information is available to the public 24 hours a day through the use of the air quality index telephone numbers listed below:

Statewide toll-free (for Asheville, Durham, Fayetteville, Greensboro, Greenville, Raleigh, Wilmington, and Winston-Salem areas)	888-AIR-WISE
Charlotte area	704-333-SMOG

Additional copies of this report and previous annual reports are available from:

Division of Air Quality
Department of Environment and Natural Resources
1641 Mail Service Center
Raleigh, North Carolina 27699-1641

Comments regarding this report or suggestions for improving future reports are welcomed. Comments may be sent to Dr. Wayne L. Cornelius, at the above address.

Alan W. Klimek, P.E., Director
Division of Air Quality

Executive Summary

In 1999, the North Carolina Division of Environmental Management (DEM), later the Division of Air Quality (DAQ), and the three local program agencies (listed in Appendix A) collected 455,907 air quality samples. These samples included measurements of the U.S. Environmental Protection Agency's (EPA) criteria air pollutants: particulate matter, carbon monoxide, ozone, sulfur dioxide, nitrogen dioxide and lead. This report discusses each pollutant and presents summary tables, maps, charts and explanations of the data.

The report also includes data from weekly acid rain samples collected by the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) at seven North Carolina sites and one Tennessee site very close to the North Carolina border. It discusses acid rain and presents summary tables, maps, charts and explanations of the data.

In addition, this report provides information on pollutant trends from 1980 (or the earliest year available) through 1999. The following summary discusses trends only for those pollutants having either increasing or decreasing tendencies.

Three different types of **particulate matter** were sampled in North Carolina during 1999. Total Suspended Particulate (TSP), generally considered to be particles having an aerodynamic diameter of 45 micrometers or less, is regulated by North Carolina standards. Particulate matter (PM_{10}) with an aerodynamic diameter less than or equal to a nominal 10 micrometers (0.00004 inches) is regulated by both EPA and N.C. standards. Fine particulate matter ($PM_{2.5}$) with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers (0.00001 inches) was regulated by EPA until the U.S. Appeals Court ruled the standard vacated on May 14, 1999.

TSP was sampled at 2 sites, yielding 52 daily samples. No exceedances of the state TSP ambient air quality standard for 24-hour samples (150 $\mu g/m^3$) were observed in 1999.

PM_{10} was sampled at 37 sites, yielding 2072 daily samples. There were no exceedances of the National Ambient Air Quality Standards for PM_{10} (150 $\mu g/m^3$ for 24-hour samples and 50 $\mu g/m^3$ for the annual arithmetic mean). Mean 24-hour concentrations have decreased about 30 percent since 1985.

$PM_{2.5}$ was sampled at 35 sites yielding 4695 daily samples. There were no exceedances of the ambient air quality standards for $PM_{2.5}$ (65 $\mu g/m^3$ for 24-hour samples). Twenty six of the 35 sites exceeded the annual arithmetic mean standard of 15 $\mu g/m^3$.

Carbon monoxide (CO), the most common air pollutant, largely results from fuel combustion. The most likely areas to have excessive CO concentrations are larger cities where there are more cars and congested streets.

CO was sampled at 12 sites, yielding 69,252 valid hourly averages. The National Ambient Air Quality Standards for CO are 35 ppm for the maximum one-hour average and 9 ppm for the maximum eight-hour average. There were no exceedances of the standards, although the highest one-hour concentration of 21.5 and eight hour concentration of 6.5 ppm (61, and 72 percent of the standards respectively) was observed at the East Franklin Street site in Chapel Hill. Both the mean one-hour average and the mean eight-hour average have been decreasing by about 4 percent per year. The combined effects of newer cars in the vehicle fleet, traffic control strategies, and the Inspection and Maintenance program in Durham, Orange, Wake, Forsyth, Guilford, Cabarrus, Gaston, Mecklenburg, and Union Counties have helped reduce the number and intensity of CO exceedances from previous years.

Ozone (O_3) forms in the lower atmosphere when hydrocarbons (or volatile organic compounds) and nitrogen oxides chemically react in the presence of sunlight and high temperatures. The main emphases in control of ozone has been to limit hydrocarbon and nitrogen oxide emissions.

O_3 was sampled at 45 sites, yielding 222;912 valid hourly averages. The National Ambient Air Quality Standard for O_3 is 0.08 ppm for the maximum eight-hour average and 0.12 ppm for the maximum one-hour average.

In 1999, there were 20 exceedances of the one-hour standard. Twenty four exceedances occurred in North Carolina in 1998, and four occurred in 1997. Mecklenburg, Rowan and Wake Counties met or exceeded the criteria for nonattainment of the one-hour ozone standard with six, six and five 5 exceedances respectively over a three-year period, however EPA had rescinded the one-hour standard during that time period. Mecklenburg County was redesignated as in attainment for ozone in July 1996. However, hydrocarbon control strategies continue to be used there to help reduce ozone concentrations.

In 1999, the 8-hour standard was exceeded 540 times with 14 counties having 10 or more exceedances at individual sites. The site at West Street and Gold Hill Avenue in Rockwell, Rowan County led all the sites with 34.

Sulfur dioxide (SO_2) is mainly produced by combustion of fossil fuels containing sulfur compounds and the manufacture of sulfuric acid.

SO_2 was sampled at 20 sites, yielding 143,048 valid hourly averages. There were no exceedances of the National Ambient Air Quality Standards (365 $\mu g/m^3$ or 0.14 ppm for a 24-hour average, 1300 $\mu g/m^3$ or 0.50 ppm for a three-hour average, 80 $\mu g/m^3$ or 0.03 ppm for the annual arithmetic mean) at network monitoring sites.

Nitrogen oxides (NO_x) are produced primarily from the burning of fossil fuels such as coal, oil and gasoline, due to the oxidation of atmospheric nitrogen and nitrogen compounds in the fuel. The primary combustion product is NO, which reacts with hydrocarbons, ozone and other

atmospheric compounds to form NO_2. NO_x compounds play an important role in the formation of ozone. Reactive nitrogen species (NO_y) were monitored in Charlotte, Raleigh, and Winston-Salem to gather data for the development of control strategies for ozone non-attainment areas.

The criteria pollutant NO_2 was sampled at two sites, yielding 13,350 valid hourly averages. There were no exceedances of the National Ambient Air Quality Standard (0.053 ppm for the annual arithmetic mean). The mean one-hour average concentration has been decreasing by about 1.5 percent per year.

Lead (Pb) emissions result from coal combustion and the sandblasting of highway bridges, overpasses, and water tanks. In the past, the combustion of gasoline containing tetraethyl lead as an additive was a major source.

Lead was sampled at 10 sites yielding 526 daily samples. This sampling was part of a toxic metals study focusing on arsenic. There have been no recent exceedances of the ambient air quality standard for lead (1.5 $\mu g/m^3$ for a quarterly arithmetic mean). Mean lead concentrations have decreased by 92 percent since 1979. The steady decline in the use of leaded gasoline is primarily responsible for this trend.

Acid Rain is produced when nitrate and sulfate ions from motor vehicles, combustion and industrial sources reach the upper atmosphere, react with moisture in the air, and are deposited as acid precipitation. Monitoring of pH and other ion concentrations in precipitation will help to identify trends and demonstrate the results of efforts to reduce emissions from mobile and industrial sources.

The annual mean pH in 1999 ranged from 4.40 (Rowan County) to 4.97 (Sampson County).

CONTENTS

List of Tables

List of Figures

1 Introduction

This annual report summarizes the ambient air monitoring performed in calendar year 1999 by the North Carolina Division of Air Quality (DAQ) and three local air pollution agencies, which are more fully described in Appendix A on pp. 74-76.

There were 455,907 air quality samples of the U.S. Environmental Protection Agency's (EPA) criteria pollutants – particulate matter, carbon monoxide, ozone, sulfur dioxide, nitrogen dioxide and lead - which are discussed in this report.

Chapter 2 describes the criteria pollutants and discusses their sources and effects on human health, plants and animals. Chapter 3 outlines the standards applied to criteria pollutant concentrations established by the EPA and the state of North Carolina to protect human health (primary standards) and plants, animals, and property (secondary standards). Chapter 4 describes the ambient monitoring program conducted by DAQ and three local program agencies. Chapter 5 gives detailed monitoring results for each pollutant, with a map of the monitor sites, a table of the monitor summary statistics relevant to the standards, one or more maps summarizing the important statistics for each county with monitors, and additional summaries as appropriate to each pollutant. Chapter 6 describes the EPA Air Quality Index for the criteria pollutants and charts index measurements for five Metropolitan Statistical Areas of North Carolina. Chapter 7 presents sources, effects and monitoring of acid rain data conducted in North Carolina by the National Atmospheric Deposition Program and National Trends Network (NADP/NTN). It also includes a map of the calendar year mean pH level and site statistics for the calendar year in two tables. Chapter 8 provides a statewide summary of trends for the criteria pollutants from 1980 (1985 for PM_{10}), pH values and ions from 1980 through 1999.

2 Description of Criteria Pollutants

2.1 Particulate Matter

Atmospheric particulate matter is defined as any airborne material, except uncombined water (liquid, mist, steam, etc.) that exists in a finely divided form as a liquid or solid at standard temperature (25ºC) and pressure (760 mm mercury) and has an aerodynamic diameter of less than 100 micrometers. In the period covered by this report, three sizes of particulate matter were monitored, total suspended particulate (TSP), PM_{10} and $PM_{2.5}$. TSP is any particulate matter measured by the method described in EPA regulations 40 CFR 50 App. B (United States Environmental Protection Agency [US EPA] 1993, p. 715-728) and is generally considered to be particles having an aerodynamic diameter of 45 micrometers or less. PM_{10} is particulate matter with an aerodynamic diameter less than or equal to 10 micrometers as measured according to EPA regulations 40 CFR 50 App. J (United States Environmental Protection Agency [US EPA] 1993, p. 769-773). TSP measurements have been made in North Carolina since the early 1960s and PM_{10} has been sampled locally in Charlotte since 1985 and statewide since 1986 (North Carolina Department of Environment, Health, and Natural Resources 1991). The new $PM_{2.5}$ standard was adopted by North Carolina on April 1, 1999. On May 14, 1999 the U.S. Court of Appeals ruled the setting or the standard by EPA was an unconstitutional use of authority and could be vacated. EPA continues to require monitoring for $PM_{2.5}$.

2.1.1 Sources

Particulates are emitted by many human activities, such as fuel combustion, motor vehicle operation, industrial processes, grass mowing, agricultural tilling and open burning. Natural sources include windblown dust, forest fires, volcanic eruptions, and plant pollen.

Particles emitted directly from a source may be either fine (less than 2.5 micrometers) or larger (2.5 - 60 micrometers), but particles formed in the atmosphere will usually be fine. Generally, larger particles have very slow settling velocities and are characterized as suspended particulate matter. Typically, fine particles originate by condensation of materials produced during combustion or atmospheric reactions.

2.1.2 Effects

Particulate matter can cause health problems affecting the breathing system, including aggravation of existing lung and heart disease, limitation of lung clearance, changes in form and structure of organs, and development of cancer. Individuals most sensitive to the effects of particulate matter include those with chronic obstructive lung or heart disease, those suffering from the flu, asthmatics, the elderly, children, and mouth breathers.

Health effects from inhaled particles are influenced by the depth of penetration of the particles into the respiratory system, the amount of particles deposited in the respiratory system, and by the biological reaction to the deposited particles. The risks of adverse health effects are greater when particles enter the tracheobronchial and alveolar portions of the respiratory system. Small particles can penetrate into these deeper regions of the respiratory system. Healthy respiratory systems can trap particles larger than 10 micrometers more efficiently before they move deeply into the system and can more effectively remove the particles that are not trapped before deep movement.

Particulate matter also can interfere with plant photosynthesis, by forming a film on leaves reducing exposure to sunlight. Particles also can cause soiling and degradation of property, which can be costly to clean and maintain.

Suspended particles can absorb and scatter light, causing reduction of visibility. This is a national concern, especially in areas such as national parks, historic sites and scenic attractions visited by sightseers.

2.2 Carbon Monoxide

Carbon monoxide (CO) is the most commonly occurring air pollutant. CO is a colorless and poisonous gas produced by incomplete burning of carbon-containing fuel.

2.2.1 Sources

Most atmospheric CO is produced by incomplete combustion of fuels used for vehicles, space heating, industrial processes and solid waste incineration. Transportation accounts for the majority of CO emissions. Boilers and other fuel burning heating systems are also significant sources.

2.2.2 Effects

Breathing carbon monoxide affects the oxygen-carrying capacity of the blood. Hemoglobin in the blood binds with CO more readily than with oxygen, starving the body of vital oxygen.

Individuals with anemia, lung and heart diseases are particularly sensitive to CO effects. Low concentrations affect mental function, vision and alertness. High concentrations can cause fatigue, reduced work capacity and may adversely affect fetal development. Chronic exposure to CO at concentrations as low as 70 ppm (80 mg/m^3) can cause cardiac damage. Other health

effects associated with exposure to CO include central nervous system effects and pulmonary function difficulties.

Ambient CO apparently does not adversely affect vegetation or materials.

2.3 Ozone

Ozone is a clear gas that forms in the troposphere (lower atmosphere) by chemical reactions involving hydrocarbons (or volatile organic compounds) and nitrogen oxides in the presence of sunlight and high temperatures. Even low concentrations of tropospheric ozone are harmful to people, animals, vegetation and materials. Ozone is the most widespread and serious criteria air pollutant in North Carolina.

Ozone in the upper atmosphere (stratosphere) shields the earth from harmful effects of ultraviolet solar radiation. Stratospheric ozone can be damaged by the emission of chlorofluoro-hydrocarbons (CFCs) such as Freon.

2.3.1 Sources

Ozone (O_3) is the major component of a complex mixture of compounds known as photochemical oxidants. Ozone is not usually emitted directly into the atmosphere, but is formed by a series of complex reactions involving hydrocarbons, nitrogen oxides and sunlight. Ozone concentrations are higher during the daytime in late spring, summer and early autumn when the temperature is above 60ºF and the sunlight is more intense.

Two natural sources of upper atmosphere ozone are solar radiation and lightning during thunderstorms. These are not significant sources of tropospheric (ground level) ozone.

2.3.2 Effects

Ozone is a pulmonary irritant, affecting the respiratory mucous membranes, as well as other lung tissues and respiratory functions. Ozone has been shown to impair normal function of the lung causing shallow, rapid breathing and a decrease in pulmonary function. Other symptoms of exposure include chest tightness, coughing and wheezing. People with asthma, bronchitis or emphysema probably will experience breathing difficulty when exposed to short-term concentrations between 0.15 and 0.25 ppm. Continued or repeated long-term exposure may result in permanent lung structure damage.

Ozone damages vegetation by injuring leaves. Ozone also accelerates material aging, cracking rubber, fading dyes and eroding paint.

2.4 Sulfur Dioxide

Sulfur dioxide (SO_2) is a colorless, corrosive, harmful gas with a pungent odor. Smaller concentrations of sulfur trioxide and other sulfate compounds are also found in SO_2 emissions. Sulfur oxides contribute to the formation of acid rain and the formation of particles that reduce visibility.

2.4.1 Sources

The main sources of SO_2 are combustion of fossil fuels containing sulfur compounds and the manufacture of sulfuric acid. Other sources include refining of petroleum and smelting of ores that contain sulfur.

2.4.2 Effects

The most obvious health effect of sulfur dioxide is irritation and inflammation of body tissues brought in contact with the gas. Sulfur dioxide can increase the severity of existing respiratory diseases such as asthma, bronchitis, and emphysema. Sulfuric acid and fine particulate sulfates, which are formed from sulfur dioxide, also may cause significant health problems. Sulfur dioxide causes injury to many plants. A bleached appearance between the veins and margins on leaves indicates damage from SO_2 exposure. Commercially important plants sensitive to SO_2 include cotton, sweet potatoes, cucumber, alfalfa, tulips, apple trees, and several species of pine trees.

2.5 Nitrogen Oxides

Several gaseous oxides of nitrogen are normally found in the atmosphere, including nitrous oxide (N_2O), nitric oxide (NO) and nitrogen dioxide (NO_2). Nitrous oxide is a stable gas with anesthetic characteristics and typical ambient concentrations well below the threshold concentration for a biological effect. Nitric oxide is a colorless gas with ambient concentrations generally low enough to have no significant biological effect. Nitrogen dioxide is reddish-brown but is not usually visible at typical ambient concentrations.

2.5.1 Sources

The most significant nitrogen oxide emissions result from the burning of fossil fuels such as coal, oil and gasoline, due to the oxidation of atmospheric nitrogen and nitrogen compounds in the fuel. The primary combustion product is NO, which reacts to form NO_2.

2.5.2 Effects

At typical concentrations, nitrogen dioxide has significant health effects as a pulmonary irritant, especially upon asthmatics and children. In North Carolina a much greater health concern is the formation of ozone, which is promoted by the presence of NO_2 and other nitrogen oxides.

Some types of vegetation are very sensitive to NO_2, including oats, alfalfa, tobacco, peas and carrots. Chronic exposure causes chlorosis (yellowing) and acute exposure

usually causes irregularly shaped lesions on the leaves.

Nitric oxide and nitrogen dioxide do not directly damage materials. However, NO_2 can react with moisture in the air to produce nitric acid, which corrodes metal surfaces and contributes to acid rain.

High concentrations of NO_2 may reduce visibility. Much of the brownish coloration sometimes observed in polluted air in winter months may be due to NO_2.

2.6 Lead

Lead is a toxic heavy metal element occurring in the atmosphere as small particles.

2.6.1 Sources

The major source of atmospheric lead used to be the combustion of gasoline containing the additive tetraethyl lead as an antiknock agent. However, the availability of leaded fuel has declined, and the concentration of lead in such fuel has decreased, minimizing gasoline as a source. Significant remaining sources include coal combustion (lead exists in very small quantities as an impurity in coal) and sandblasting of highway structures and water tanks. Lead also is used in some batteries, paints, insecticides and newspaper inks.

2.6.2 Effects

Lead (Pb) persists and accumulates in the environment and the human body. It may be inhaled, ingested, and eventually absorbed into the bloodstream and distributed to all body tissues. Exposure to low concentrations interferes with blood production and specific enzyme systems. It is believed to cause kidney and nerve cell damage, and severe lead poisoning is known to cause brain damage in children.

3 Standards

Ambient air quality status is determined by measuring pollutant concentrations in outdoor air and comparing the measured concentrations to corresponding standards. The US EPA (Environmental Protection Agency) defines the ambient air as "that portion of the atmosphere, external to buildings, to which the general public has access."

Ambient air quality standards are classified as primary and secondary. Primary standards are those established to protect public health. Secondary standards are those established to protect the public welfare from adverse pollution effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, climate, property, transportation, economy, and personal comfort and well-being. The scientific criteria upon which the standards are based are reviewed periodically by the EPA, which may reestablish or change the standards according to its findings.

A pollutant measurement that is greater than the ambient air quality standard for a specific averaging time is called an "exceedance." The national primary, secondary and North Carolina ambient air quality standards are summarized in Table 3.1.

Table 3.1 National and North Carolina Ambient Air Quality Standards. For new or anticipated new standards, References in the Code of Federal Regulations are given. For standards expressed in parts per million, an equivalent mass per unit volume is also shown.

Pollutant/ Ambient Measurement/ (Reference)	Averaging Period	Type of Summary	Primary National (Health Related) Standard	Secondary National (Welfare Related) Standard	North Carolina Standard
TSP 24 hour average	1 year	geometric mean	(1)	(1)	75 $\mu g/m^3$
	1 day	2nd maximum	(1)	(1)	150 $\mu g/m^3$
PM-2.5 24 hour average (40CFR50, App. N)	1 year	average[2] arithmetic mean	15 $\mu g/m^3$ (6)	15 $\mu g/m^3$ (6)	15 $\mu g/m^3$ (6)
	1 day	average[2] 98th percentile	65 $\mu g/m^3$	65 $\mu g/m^3$	65 $\mu g/m^3$ (6)
PM-10 24 hour average (40CFR50, App. N)	1 year	average[2] arithmetic mean	50 $\mu g/m^3$	50 $\mu g/m^3$	50 $\mu g/m^3$
	1 day	average[2] 99th percentile[3]	150 $\mu g/m^3$	150 $\mu g/m^3$	150 $\mu g/m^3$
CO 1 hour average	8 hours	2nd maximum	9 ppm (10 mg/m^3)		9 ppm (10 mg/m^3)
	1 hour	2nd maximum	35 ppm (40 mg/m^3)		35 ppm (40 mg/m^3)
O_3 1 hour average (40CFR50, App. I)	1 hour	expected[4] 2nd maximum	0.12 ppm (6) (235 $\mu g/m^3$)	0.12 ppm (6) (235 $\mu g/m^3$)	0.12 ppm (235 $\mu g/m^3$) (6,7)
	8 hours	average[5] arithmetic mean 4th maximum	0.08 ppm (6) (157 $\mu g/m^3$)	0.08 ppm (6) (157 $\mu g/m^3$)	0.08 ppm (6) (157 $\mu g/m^3$)
SO_2 1 hour average	1 year	arithmetic mean	0.03 ppm (80 $\mu g/m^3$)		0.03 ppm (80 $\mu g/m^3$)
	1 day	2nd maximum	0.14 ppm (365 $\mu g/m^3$)		0.14 ppm (365 $\mu g/m^3$)
	3 hours (non-overlapping)	2nd maximum		0.50 ppm (1,300 $\mu g/m^3$)	0.50 ppm (1,300 $\mu g/m^3$)
NO_2 1 hour average	1 year	arithmetic mean	0.053 ppm (100 $\mu g/m^3$)	0.053 ppm (100 $\mu g/m^3$)	0.053 ppm (100 $\mu g/m^3$)
Pb 24-hour average	1 quarter	arithmetic mean	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$

1. In 1987, National standards for PM-10 replaced those for TSP.
2. Arithmetic mean over the 3 most current years.
3. In July 1997, this percentile-based statistic replaced the 2nd maximum.
4. Determined by adjusting for incomplete days and averaging over the most recent 3 consecutive, complete calendar years.
5. Arithmetic mean value over the most recent 3 consecutive, complete calendar years.
6. On April 1, 1999 North Carolina adopted the EPA PM2.5 and Ozone standards. On May 14, 1999 the US Court of Appeals ruled the new EPA PM2.5 standard vacated and the new 8-hour ozone standard as unenforceable. The US Supreme Court has agreed to consider an appeal of that decision.
7. On May 27, 1999, the one-hour ozone standard was rescinded by the Environmental Management Commission based on EPA guidance. The one-hour standard is being reinstated by EPA.

4 Ambient Air Quality Monitoring Program

Ambient monitoring and analyses of samples were conducted by the North Carolina Division of Air Quality and three local air pollution control programs (Appendix A, pp.74-76). The air monitoring data are used to determine whether air quality standards are being met, to assist in enforcement actions, to determine the improvement or decline of air quality, and to determine the extent of allowable industrial expansion, and to provide air pollution information to the public. A list of all monitoring sites active in 1999 is presented in Table 4.1 and shown as a map in Figure 4.1. The locations of sites for individual pollutants are shown in Figures 5.1, 5.4, 5.7, 5.11, 5.17, and 5.20.

Siting of monitors involves several considerations, including size of the area represented, distance from roadways and nearby sources, unrestricted air flow, safety, availability of electricity and security. Each site has a defined monitoring objective, and annual evaluations are conducted to ensure that the objectives are met. The four basic monitoring objectives are to determine:

- the highest concentration expected in an area;
- representative concentrations in areas of high population density;
- the impact of significant sources or source categories on ambient air quality;
- general background concentration levels.

All monitors have known precision, accuracy, interferences and operational parameters. The monitors – as well as all measurement devices – are carefully calibrated at predetermined frequencies, varying from daily to quarterly. Measurements are traceable to National Institute of Standards and Technology (NIST), when standards are available.

Monitoring and analyses are performed according to a set of standard operating procedures. Field personnel visit manual sampling sites once every six days to replace sample media and check the operation and calibration of monitors. Personnel check

continuous monitors at least twice weekly for correct instrument operation.

Quality assurance activities are carried out to determine the quality of the collected ambient data, improve the quality of the data and evaluate how well the monitoring system operates. The goal of quality assurance activities is to produce high quality air pollution data with defined completeness, precision, accuracy, representativeness and comparability.

Microprocessors are used at most sites to collect the data. A computerized telemetry system aids in assembly of the data for submission to the US EPA. This enhances data validity, minimizes travel costs, and allows real-time data to be available by computer polling when needed. Numerous checks are performed to ensure that only valid data are reported.

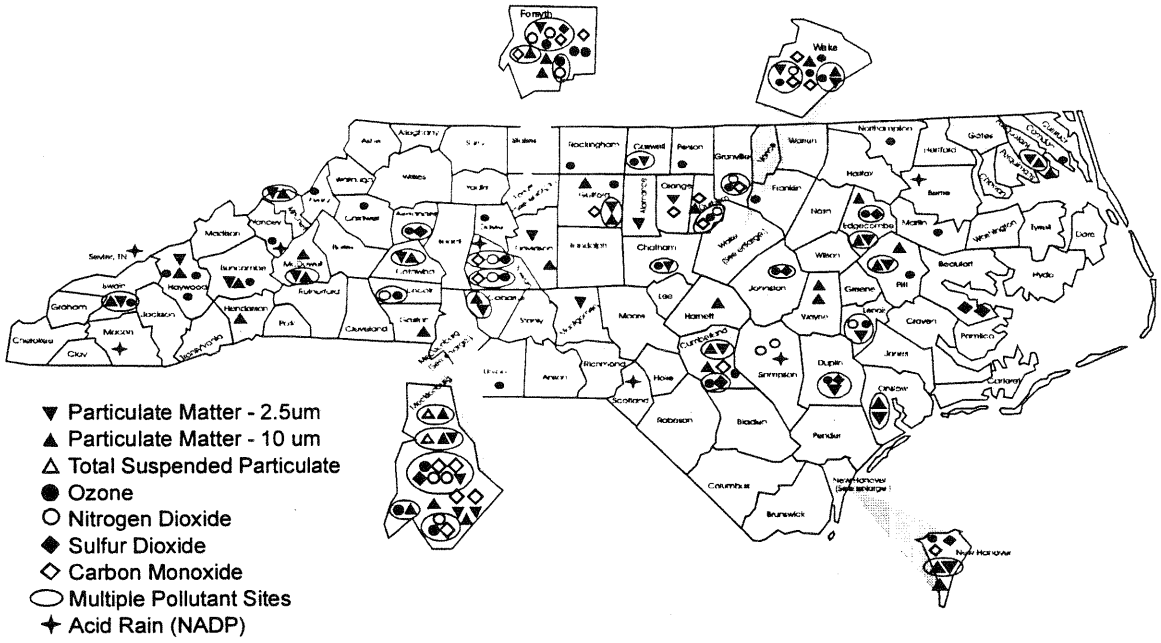


Figure 4.1 Monitoring Sites Active in 1999

Table 4.1 Ambient Air Monitoring Sites Operated in North Carolina, 1999

SITE COUNTY	ADDRESS	POLLUTANTS		
37-001-0002 ALAMANCE	827 S GRAHAM & HOPE BURLINGTON	PM2.5		
37-003-0003 ALEXANDER	STATE ROAD 1177 TAYLORSVILLE	O3	SO2	
37-011-0001 AVERY	7510 BLUE RIDGE PARKWAY	O3		
37-013-0003 BEAUFORT	NC HIGHWAY 306	SO2		
37-013-0004 BEAUFORT	SOUTH FERRY LANDING PAMLICO RIVER	SO2		
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BLDG WOODFIN ST ASHEVILLE	PM1O	Pb	
37-021-0030 BUNCOMBE	ROUT 191 SOUTH BREVARD ROAD ASHEVILLE	O3		
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	PM2.5		
37-025-0004 CABARRUS	FLOYD STREET KANNAPOLS	PM10	PM2.5	
37-027-0003 CALDWELL	HIGHWAY 321 NORTH LENOIR	O3		
37-029-0099 CAMDEN	COUNTY ROAD 1136 & 1134	O3		
37-033-0001 CASWELL	CHERRY GROVE RECREATION	O3	PM2.5	
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	PM10	PM2.5	Pb
37-037-0004 CHATHAM	ROUT 4 BOX 62 PITTSBORO	O3	PM2.5	
37-051-0004 CUMBERLAND	F.S. # 5 3296 VILLAGE DRIVE FAYETTEVILLE	PM10	Pb	

SITE COUNTY	ADDRESS	POLLUTANTS				
37-051-0007 CUMBERLAND	CUMBERLAND CO ABC BOARD 1705 OWEN DRIVE FAYETTEVILLE	CO				
37-051-0008 CUMBERLAND	1/4 MILE SR1857/US301/1857	O3				
37-051-0009 CUMBERLAND	4533 RAEFORD ROAD FAYETTEVILLE	PM10	PM2.5			
37-051-1003 CUMBERLAND	3625 GOLFVIEW ROAD HOPE MILLS	O3	SO2			
37-057-0002 DAVIDSON	SOUTH SALLSBURY STREET LEXINGTON	PM2.5				
37-057-1002 DAVIDSON	400 SALEM STREET THOMASVILLE	PM10				
37-059-0002 DAVIE	246 MAIN STREET COOLEEMEE	O3				
37-061-0002 DUPLIN	HIGHWAY 50 KENANSVILLE	O3	SO2	PM2.5		
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST DURHAM	PM10				
37-063-0011 DURHAM	210 NORTH ROXBORO STREET DURHAM	CO				
37-063-0013 DURHAM	2700 NORTH DUKE STREET DURHAM	O3	HSCO	NOy		
37-065-0002 EDGECOMBE	LEGETT RD., WASTE TREATMENT PLANT ROCKY MOUNT	PM10				
37-065-0003 EDGECOMBE	TALBERT PARK at SPRUCE STREET ROCKY MOUNT	PM10	PM2.5			
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	O3	SO2			
37-067-0009 FORSYTH	INDIANA AVE & AKRON DR HANES HOSIERY PARK WINSTON-SALEM	PM10				
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	O3	HSCO	SO2	NO2,y	PM2.5

SITE COUNTY	ADDRESS	POLLUTANTS		
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY WINSTON-SALEM	CO	PM10	
37-067-0024 FORSYTH	NORTH FORSYTH HIGH SCHOOL WINSTON-SALEM	PM10	Pb	
37-067-0025 FORSRTH	100 SW STRATFORD ROAD WINSTON-SALEM	CO		
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE WINSTON-SALEM	O3		
37-067-0028 FORSYTH	6496 BAUX MOUNTAIN ROAD WINSTON-SALEM	O3		
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	O3	NOy	
37-069-0001 FRANKLIN	431 S. HILLSBOROUGH STREET FRANKLINTON	O3		
37-071-0016 GASTON	1622 EAST GARRISON BLVD GASTONIA	PM10		
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSPITAL BUTNER	O3	HSCO	NOy
37-081-0009 GUILFORD	EDGEWORTH & BELLEMEADE ST'S GREENSBORO	PM10	Pb	
37-081-0011 GUILFORD	KEELY PARK, KEELY ROAD MC CLEANSVILLE	O3		
37-081-1005 GUILFORD	E. GREEN & S. CENTENNIAL ST HIGH POINT	PM10	PM2.5	
37-081-1011 GULFORD	401 WEST WENDOVER GREENSBORO	CO		
37-085-0001 HARNETT	MUNICIPAL BUILDING DUNN	PM10		
37-087-0002 HAYWOOD	CANTON FIRE DEPARTMENT CANTON	PM10		
37-087-0004 HAYWOOD	2177 SHEVILLE ROAD WAINSVILLE	O3		

SITE COUNTY	ADDRESS	POLLUTANTS					
37-087-0010 HAYWOOD	9 MAIN STREET WAINSVILLE	PM2.5					
37-087-0035 HAYWOOD	TOWER BLUE RODGE PARKWAY MILE MARKER 410	O3					
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAIN NATIONAL PARK	O3					
37-089-1006 HENDERSON	CORNER OF ALLEN & WASHINGTON ST'S HENDERSONVILLE	PM10					
37-099-0005 JACKSON	BARNET KNOB FIRE STATION	O3					
37-101-0002 JOHNSTON	3411 JACK ROAD CLAYTON	O3	SO2				
37-107-0004 LENIOR	CORNER HWY 70 EAST KINSTON	O3	PM2.5	NOy	Pb		
37-109-0004 LINCOLN	RIVERVIEW ROAD LINCOLNTON	O3	NOy				
37-111-0002 MC DOWELL	COURTHOUSE MARION	PM10					
37-111-0004 MC DOWELL	BALDWIN AVE MARION	PM10	PM2.5				
37-117-0001 MARTIN	HAYES STREET #2 WELL SITE	O3					
37-119-0001 MECKLENBURG	600 EAST TRADE STREET CHARLOTTE	TSP	PM10				
37-119-0003 MECKLENBURG	FIRE STATION # 11, 620 MORETZ ST CHARLOTTE	PM10					
37-119-0010 MECKLENBURG	FIRE STATION # 10, 2136 FREMOUNT RD CHARLOTTE	TSP	PM10	PM2.5	Pb		
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL CHARLOTTE	O3	HSCO	CO	SO2	NO2,y	PM2.5
37-119-0035 MECKLENBURG	1330 SPRING STREET GRANVILLE NEIGHBORHOOD CENTER CHARLOTTE	CO					

SITE COUNTY	ADDRESS	POLLUTANTS		
37-119-0038 MECKLENBURG	301 TRYON STREET CHARLOTTE	CO		
37-119-0040 MECKLENBURG	6623 PARK SOUTH DRIVE CHARLOTTE	PM2.5		
37-119-0041 MECKLENBURG	2210 EASTWAY DRIVE CHARLOTTE	PM2.5		
37-119-1001 MECKLENBURG	FILTER PLANT DAVIDSON	PM10		
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	O3	PM10	
37-119-1009 MECKLENBURG	29N @ MECKLENBURG CAB CO. CHARLOTTE	O3	HSCO	NOy
37-121-0001 MITCHELL	CITY HALL, SUMMIT STREET SPRUCE PINE	PM10	PM2.5	
37-123-0001 MONTGOMERY	112 PERRY DRIVE	PM2.5		
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER ROAD	O3		
37-129-0006 NEW HANOVER	HIGHWAY 421 NORTH WILMINGTON	SO2		
37-129-0007 NEW HANOVER	WAREHSE & RECEIVING ST.,UNCW WILMINGTON	PM10	Pb	
37-129-0008 NEW HANOVER	CORNER of OLEANDER & COLLEGE WILMINGTON	CO		
37-129-0009 NEW HANOVER	2710 MARKET STREET WILMINGTON	PM10	PM2.5	
37-131-0002 NORTHAMPTON	ROUTE 46 GASTON	O3		
37-133-0005 ONSLOW	617 HENDERSON DRIVE JACKSONVILLE	PM10	PM2.5	
37-135-0006 ORANGE	147 EAST FRANKLIN STREET CHAPEL HILL	CO		

SITE COUNTY	ADDRESS	POLLUTANTS		
37-135-0007 ORANGE	MASON FARM ROAD CHAPEL HILL	PM2.5		
37-139-0001 PASQUOTANK	WATER PLANT, NORTH WILSON STREET ELIZABETH CITY	PM10		
37-139-0002 PASQUOTANK	600 WESTOVER STREET ELIZABETH CITY	PM10	PM2.5	Pb
37-145-0003 PERSON	STATE ROAD 1102 & NC 49	O3		
37-147-0003 PITT	1500 BEATTY STREET GREENVILLE	PM10		
37-147-0005 PITT	851 HOWELL STREET GREENVILLE	PM10	PM2.5	
37-147-0099 PITT	US 264 NEAR WATER TOWER FARMVILLE	O3		
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL BETHANY	O3		
37-159-0021 ROWAN	WEST STREET & GOLD HILL AVENUE ROCKWELL	O3	HSCO	NOy
37-159-0022 ROWAN	925 NORTH ENOCHVILLE AVENUE	O3	HSCO	NOy
37-163-0003 SAMPSON	BREWER ROAD FAISON	NOy		
37-163-0004 SAMPSON	BREWER ROAD FAISON	NOy		
37-173-0002 SWAIN	CENTER STREET, PARKS 7 RECREATION FACILITY	O3	PM10	PM2.5
37-179-0002 UNION	701 CHARLES STREET MONROE	O3		
37-183-0003 WAKE	FIRE STATION #9 SIX FORKS ROAD RALEIGH	PM10		
37-183-0011 WAKE	420 PERSON STREET RALEIGH	CO		

SITE COUNTY	ADDRESS	POLLUTANTS			
37-183-0014 WAKE	EAST MILLBROOK JR HI 3801 SPRING FOREST ROAD RALEIGH	O3	PM10	PM2.5	Pb
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	O3	HSCO	PM2.5	NOy
37-183-0016 WAKE	201 NORTH BROAD STREET FUQUAY-VARINA	O3			
37-183-0017 WAKE	5033 TV TOWER ROAD GARNER	O3			
37-183-0018 WAKE	HWY 70 WEST & HWY 50 NORTH RALEIGH	CO			
37-191-0004 WAYNE	HWY 70 WEST PATROL STATION GOLDSBORO	PM10			
37-191-0005 WAYNE	DILLARD MIDDLE SCHOOL GOLDSBORO	PM10			
37-199-0003 YANCEY	BLUE RIDGE PARKWAY	O3			

Sites Operated in 1999	103

5 Pollutant Monitoring Results

Air quality in a given area is affected by many factors, including meteorological conditions, the location of pollutant sources, and the amount of pollutants emitted from them.

The speed and direction of air movement determine whether pollutant emissions cause exceedances of the ambient air quality standards and where those exceedances will occur. Atmospheric stability, precipitation, solar radiation and temperature also affect pollutant concentrations.

Geographic factors that affect concentrations include variables such as whether an area is urban or rural, and whether the area has mountains, valleys or plains.

Important economic factors affecting air quality include concentration of industries, conditions of the economy, and the day of the week.

Air quality also may be influenced by "exceptional events" in the short term. Exceptional events may be either natural (e.g., forest fire) or manmade (e.g., construction or demolition). Unusual data that can be attributed to an exceptional event are considered biased and may be omitted from data summaries when they are not representative of normal conditions. In the tabular listings in this report, data affected by exceptional events are included but flagged, but they are omitted from summaries in charts. A list of typical exceptional events is given in Appendix B.

Data for the 1999 ambient air quality report were collected at 163 air pollutant monitors operated by state and local agencies in North Carolina (listed in Appendix A, pp. 74-76). To save operating costs, some sulfur dioxide monitors are operated only every third year. Ten of the 163 monitors used for this report operated most recently in 1997 or 1998.

5.1 Total Suspended Particulates

Total Suspended Particulate matter (TSP) is collected on filters using a "high volume" sampler (an EPA Reference Method). The sampler motor is set and calibrated to an air flow rate of 40 ±4 $feet^3$/min. Gravimetric analysis is performed by comparing the exposed filter weight to the unexposed filter weight. Weights are measured to the nearest 0.1 milligram. The difference between the exposed and unexposed weights is the amount of particulate collected from a known volume of air.

In 1999, two sites in Mecklenburg County were used to monitor TSP and 52 samples were collected. A detailed summary of the data from each site is given in Table 5.1.

No sample exceeded the N.C. TSP ambient air quality standards in 1998 and 1997. The highest 24-hour average was 102, which was 68 percent of the standard. This value occurred at Charlotte. Attainment status is based on the second highest 24-hour concentration and on the geometric mean of all the 24-hour concentrations at a given site.

The largest geometric mean TSP average was 44 $\mu g/m^3$, which is 59 percent of the level of the air quality standard. This value occurred at the same site in Charlotte.

Table 5.1 Total Suspended Particulates in Micrograms Per Cubic Meter for 1999

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR 1ST	2ND	MAX 3RD	4TH	ARITH MEAN	GEOM MEAN	GEOM SD
37-119-0001 MECKLENBURG	600 EAST TRADE STREET CHARLOTTE	50	102	98	76	73	48	44	1.6
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD CHARLOTTE	2	41	40			41	41	1.0
Total Samples		52							
Total Sites Sampled		2							

5.2 PM_{10}

State and local program agencies in North Carolina use high volume samplers and size selective inlets to collect PM_{10} samples. A gravimetric analysis procedure (EPA Reference Method) is used to analyze the samples.

In 1999, 37 sites were used to monitor PM_{10} and 2,072 samples were collected. A map of the PM_{10} sampling sites is shown in Figure 5.1, and a detailed summary of the data from each site is given in Table 5.2.

There were no exceedances of the PM_{10} ambient air quality standards in 1999. The greatest 24-hour maximum concentration was 74 $\mu g/m^3$, or about 49 percent of the standard (150 $\mu g/m^3$). This value occurred at Dunn in Harnett County. The highest annual arithmetic mean was 31 $\mu g/m^3$, which is 62 percent of the standard (50 $\mu g/m^3$). This annual average occurred at the Westinghouse Blvd site in Charlotte.

The second highest 24-hour concentrations are charted by county in Figure 5.2 and the annual arithmetic means are shown in Figure 5.3. (In counties with more than one PM_{10} monitoring site, the concentration reported in Figure 5.2 is the county-wide second maximum 24-hour concentration, and the mean reported in Figure 5.3 is the maximum arithmetic mean for the county.)

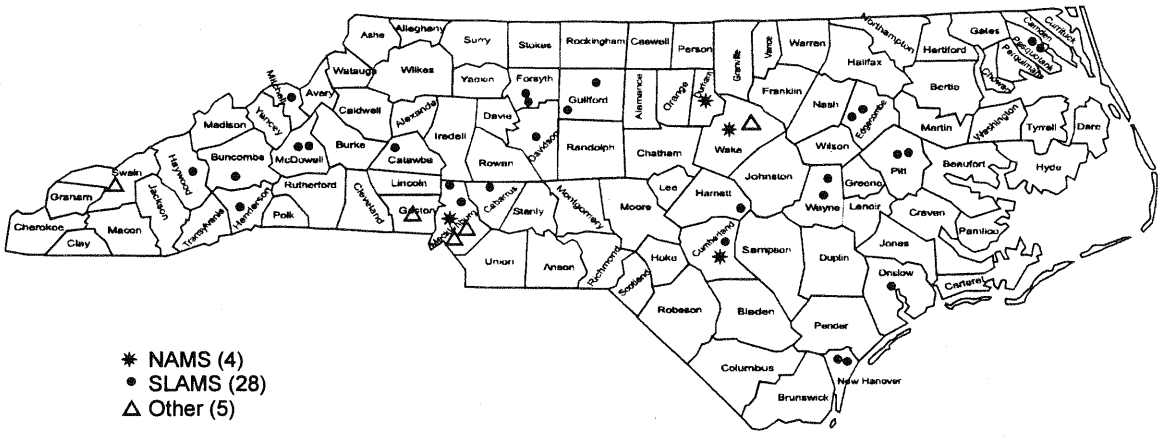


Figure 5.1 Location of PM10 Monitoring Sites

Table 5.2 PM10 in Micrograms Per Cubic Meter for 1999

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1ST	2ND	3RD	4TH	ARITH MEAN
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BLDG WOODFIN ST ASHEVILLE	53	44	41	40	40	21
37-025-0004 CABARRUS	FLOYD STREET KANNAPOLIS	50	54	45	43	42	23
37-035-0004 CATAWBA	1650 1ST. ST. HICKORY	60	51	49	46	44	25
37-051-0004 CUMBERLAND	F.S. # 5 3296 VILLAGE DR. FAYETTEVILLE	56	52	42	40	39	24
37-051-0009 CUMBERLAND	4533 RAEFORD ROAD FAYETTEVILLE	49	51	40	37	36	22
37-057-1002 DAVIDSON	400 SALEM STREET THOMASVILLE	57	45	44	43	43	25
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST DURHAM	55	46	46	45	44	24
38-065-0002 EDGECOMBE	LEGETT RD.,WASTE TREATMENT PLANT ROCKY MOUNT	8	30	39	17	16	18
38-065-0002 EDGECOMBE	TALBERT PARK at SPRUCE ST ROCKY MOUNT	37	55	44	37	35	22
37-067-0009 FORSYTH	INDIANA AV & AKRON DR HANES HOSIERY PK WINSTON-SALEM	44	45	43	43	40	23
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY WINSTON-SALEM	270	57	57	47	47	24
37-071-0016 GASTON	1622 E. GARRISON BLVD GASTONIA	57	47	43	42	41	23
37-081-0009 GUILFORD	EDGEWORTH & BELLEMEADE GREENSBORO	54	47	47	44	44	25
37-081-1005 GUILFORD	E GREEN & S CENTENNIAL ST HIGH POINT	50	50	48	48	46	27
37-085-0001 HARNETT	MUNICIPAL BUILDING DUNN	56	74	46	45	42	26
37-087-0002 HAYWOOD	ROOF, CANTON FIRE DEPT. CANTON	55	40	39	39	39	24
37-089-1006 HENDERSON	CORNER OF ALLEN & WASHINGTON STS HENDERSONVILLE	55	50	43	43	43	24
37-111-0002 MC DOWELL	COURTHOUSE MARION	5	39	35	29	16	26
37-111-0004 MC DOWELL	BALDWIN AVE & EAST M STREET MARION	49	41	40	40	39	24

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1ST	 2ND	 3RD	 4TH	ARITH MEAN
37-119-0001 MECKLENBURG	600 EAST TRADE STREET CHARLOTTE	47	56	46	46	45	28
37-119-0003 MECKLENBURG	FIRE STA #11 620 MORETZ STREET CHARLOTTE	50	60	52	47	47	30
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD CHARLOTTE	50	54	45	45	43	28
37-119-1001 MECKLENBURG	FILTER PLANT DAVIDSON	49	55	45	43	41	25
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	48	59	56	55	52	31
37-121-0001 MITCHELL	CITY HALL SUMMIT ST SPRUCE PINE	53	60	49	49	47	29
37-129-0007 NEW HANOVER	WAREHSE & RECEIVING ST UNCW WILMINGTON	8	16	16	15	15	14
37-129-0009 NEW HANOVER	2710 MARKET STREET WILMINGTON	63	53	45	34	29	17
37-133-0005 ONSLOW	617 HENDERSON DRIVE JACKSONVILLE	63	54	45	44	37	17
37-139-0001 PASQUOTANK	WATER PLANT N WILSON ST ELIZABETH CITY	17	35	26	24	17	13
37-139-0002 PASQUOTANK	600 WESTOVER STREET ELIZABETH CITY	46	45	43	41	39	20
37-147-0003 PITT	1500 BEATTY STREET GREENVILLE	8	31	24	20	18	18
37-147-0003 PITT	851 HOWELL STREET GREENVILLE	56	43	43	40	37	20
37-173-0002 SWAIN	CENTER ST/PARKS 7 REC FACILITY	53	44	41	36	36	22
37-183-0003 WAKE	FIRE STATION #9 SIX FORKS RD NORTH HILLS RALEIGH	56	51	48	44	40	22
37-183-0003 WAKE	E MILLBROOK JR HI RALEIGH	227	51	49	48	48	23
37-191-0004 WAYNE	HWY 70 WEST PATROL STATION GOLDSBORO	1	24				24
37-191-0004 WAYNE	DILLARD MIDDLE SCHOOL	67	51	48	47	39	20

Total Samples	2072
Total Sites Sampled	37

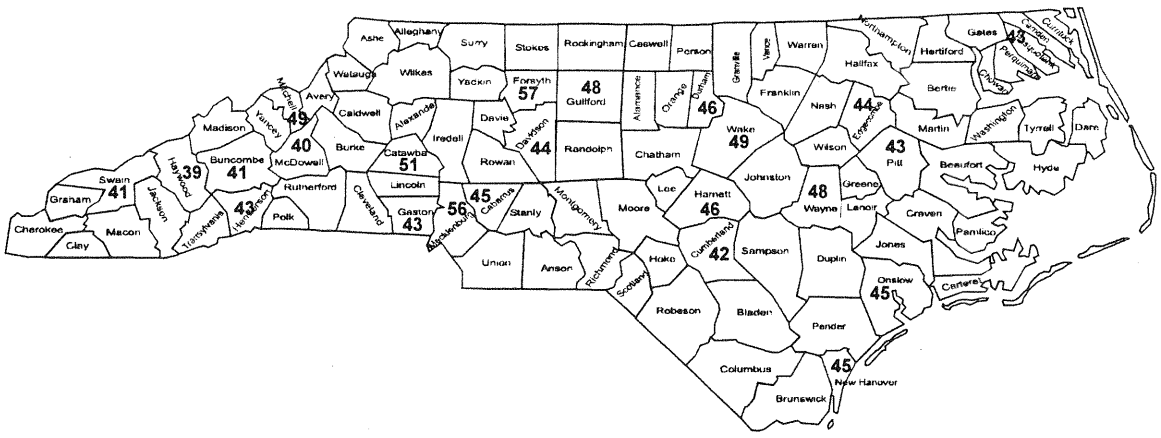


Figure 5.2 PM10: Second Highest 24-Hour Averages, 1999

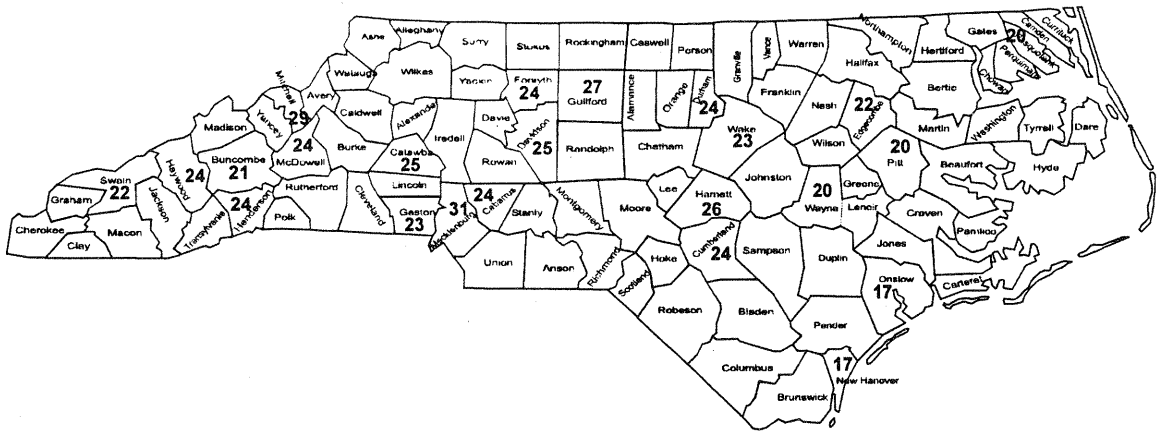


Figure 5.3 PM10: Maximum Annual Arithmetic Means, 1999

5.3 $PM_{2.5}$

In 1999, 35 sites were used to monitor $PM_{2.5}$ and 4,695 samples were collected. A map of the $PM_{2.5}$ sampling sites is shown in Figure 5.4 and a detailed summary of the data from each site is given in Table 5.3.

There were no exceedances of the $PM_{2.5}$ 24-hour ambient air quality standards in 1999. The greatest 24-hour maximum concentration was 47.2 $\mu g/m^3$, or about 73 percent of the standard (65 $\mu g/m^3$). This value occurred at the Edgeworth and Bellemeade site in Greensboro. The highest annual arithmetic mean was 17.8 $\mu g/m^3$, which is 119 percent of the standard (15 $\mu g/m^3$). This annual average occurred at the South Salsbury Street site in Lexington, Davidson County. However 26 of the 35 monitors also exceeded the annual arithmetic mean standard.

The second highest 24-hour concentrations are charted by county in Figure 5.6 and the annual arithmetic means are shown in Figure 5.7. (In counties with more than one $PM_{2.5}$ monitoring site, the concentration reported in Figure 5.6 is the county-wide second maximum 24-hour concentration, and the mean reported in Figure 5.7 is the maximum arithmetic mean for the county.

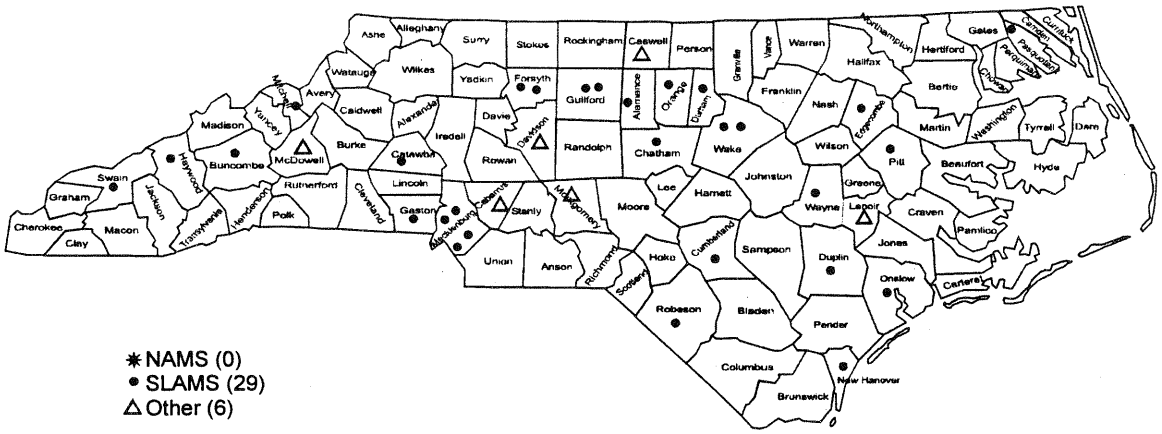


Figure 5.4 Location of PM2.5 Monitoring Sites

Table 5.3 PM2.5 in Micrograms Per Cubic Meter for 1999

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1ST	2ND	3RD	4TH	ARITH MEAN
37-021-0003 ALAMANCE	827 SOUTH GRAHAM & HOPE BURLINGTON	99	43.3	40.2	37.0	36.8	16.8
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	110	34.1	32.5	31.6	31.4	15.8
37-025-0004 CABARRUS	FLOYD STREET KANNAPOLIS	110	40.3	34.0	33.5	33.0	15.8
37-033-0001 CASWELL	CHERRY GROVE RECREATION	91	41.5	37.7	34.2	33.2	15.2
37-035-0004 CATAWBA	1650 1ST. ST. HICKORY	113	41.0	36.1	34.0	32.5	17.4
37-037-0004 CHATHAM	RT4 BOX62 PITTSBORO	102	39.4	37.1	34.0	33.0	14.3
37-051-0009 CUMBERLAND	4533 RAEFORD ROAD FAYETTEVILLE	103	45.5	37.5	33.5	33.2	16.4
37-057-0002 DAVIDSON	SOUTH SALSBURY STREET LEXINGTON	100	44.8	40.5	38.9	36.6	17.8
37-061-0001 DUPLIN	HWY 50 KEANANSVILLE	110	39.5	35.1	33.0	29.2	12.5
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST DURHAM	328	40.3	37.3	36.1	35.0	15.6
38-065-0003 EDGECOMBE	TALBERT PARK at SPRUCE ST ROCKY MOUNT	66	45.0	41.7	31.9	31.9	15.0
37-067-0022 FORSYTH	1300 BLOCK, HATTIE AVENUE WINSTON-SALEM	322	45.6	43.4	38.0	37.0	16.3
37-067-0024 FORSYTH	NORTH FORSYTH HIGH SCHOOL WINSTON-SALEM	108	42.9	34.8	34.3	32.1	15.3
37-071-0016 GASTON	1622 EAST GARRISON BLVD GASTONIA	114	38.8	35.0	32.0	31.1	16.0
37-081-0009 GUILFORD	EDGEWORTH & BELLEMEADE GREENSBORO	276	47.2	44.1	39.8	36.4	17.2
37-081-1005 GUILFORD	E GREEN & S CENTENNIAL ST HIGH POINT	73	44.7	38.7	33.9	33.0	17.4
37-087-0010 HAYWOOD	9 MAIN STREET WAYNESVILLE	108	31.5	29.1	28.6	28.5	15.9
37-107-0004 LENOIR	CORNER HWY 70 EAST KINSTON	90	32.3	26.0	25.4	35.3	11.9

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1ST	 2ND	 3RD	 4TH	ARITH MEAN
37-111-0004 MC DOWELL	BALDWIN AVE MARION	112	33.8	32.8	31.8	31.1	16.4
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD CHARLOTTE	355	44.0	41.5	41.1	40.1	17.6
37-119-0034 MECKLENBURG	PLAZA ROAD & LAKEDELL CHARLOTTE	205	41.2	41.2	39.5	36.3	16.9
37-119-1040 MECKLENBURG	6623 PARK SOUTH DRIVE CHARLOTTE	114	40.8	38.5	38.4	33.7	16.4
37-119-1041 MECKLENBURG	1120 EASTWAY DRIVE CHARLOTTE	153	40.2	38.3	36.6	35.2	16.5
37-121-0001 MITCHELL	CITY HALL SUMMIT ST SPRUCE PINE	110	38.0	32.6	31.0	30.0	15.7
37-123-0001 MONTGOMERY	112 PERRY DRIVE	46	44.0	42.7	36.6	31.2	16.2
37-129-0009 NEW HANOVER	2710 MARKET STREET WILMINGTON	111	40.4	39.0	37.4	30.0	12.8
37-133-0005 ONSLOW	617 HEHDERSON DRIVE JACKSONVILLE	111	41.2	38.8	35.7	34.2	12.7
37-135-0007 ORANGE	MASON FARM ROAD CHAPEL HILL	105	38.8	37.3	32.1	32.0	14.9
37-139-0002 PASQUOTANK	600 WESTOVER STREET ELIZABETH CITY	62	41.4	38.8	33.0	33.0	13.3
37-147-0005 PITT	851 HOWELL STREET GREENVILLE	72	40.1	39.4	39.0	23.9	15.1
37-155-0004 ROBESON	1110 MIMOSA STREET LUMBERTON	91	40.9	33.8	33.8	31.4	15.6
37-173-0002 SWAIN	CENTER ST/PARKS 7 REC FACILITY	113	36.1	31.7	30.8	30.6	14.6
37-183-0014 WAKE	EAST MILLBROOK JR HI RALEIGH	317	41.1	40.1	38.2	37.9	15.7
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	100	38.0	36.8	36.4	35.6	15.4
37-191-0005 WAYNE	DILLARD MIDDLE SCHOOL GOLDSBORO	95	41.9	40.6	37.7	36.6	15.4

Total Samples	4695
Total Sites Sampled	35

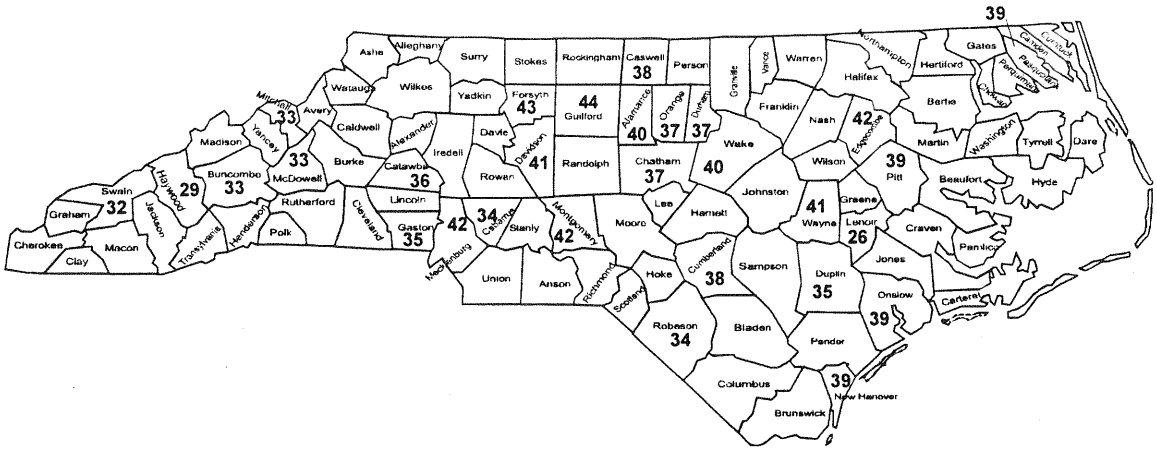


Figure 5.5 PM2.5: Second Highest 24-Hour Averages, 1999

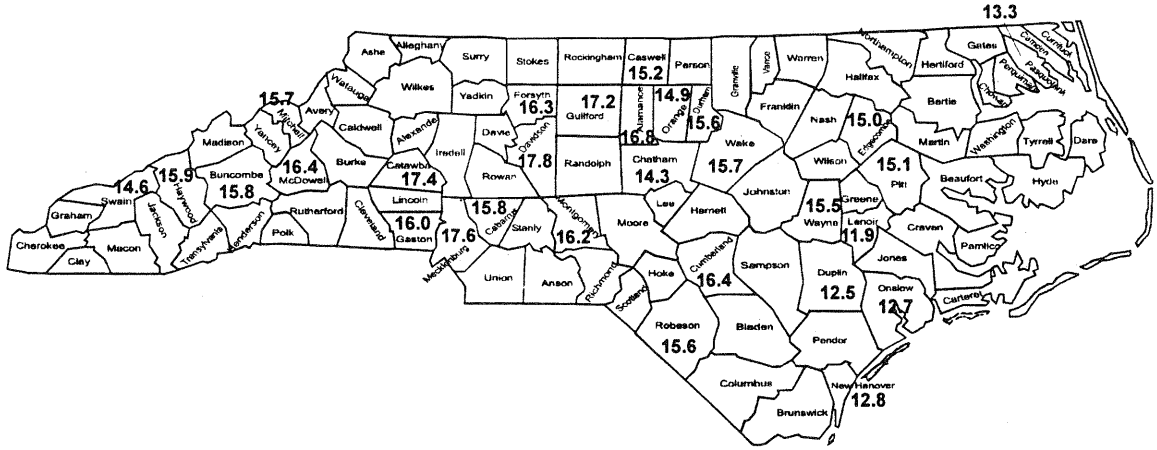


Figure 5.6 PM2.5: Maximum Annual Arithmetic Means, 1999

5.4 Carbon Monoxide

Carbon monoxide (CO) data were collected for two purposes in 1999: to determine attainment status of the ambient air quality standard and to gather data on CO as an ozone precursor. The carbon monoxide associated with ozone formation consists of very low concentrations (not greater than 2 ppm) collected at special sites considered optimal for input to a large photochemical grid model. This report will not further discuss the role of CO as an ozone precursor, but these data and more information are available on request from the Division of Air Quality (see the **Preface** for a mailing address).

To assess CO attainment status, the Division of Air Quality collected data from seven monitors in Fayetteville, Chapel Hill, Wilmington, Durham, Greensboro and Raleigh,(2) and local program agencies collected data from two monitors in Winston-Salem and three monitors in Charlotte using EPA Reference or equivalent methods to measure the concentrations.

In 1999, 12 sites were used to monitor CO and 69,252 valid hourly averages were collected. To keep operating costs minimal, some sites are operated only in the colder months. A map of the CO sampling sites is shown in Figure 5.7, and a detailed summary of the data from each site is presented in Table 5.4.

There were no exceedances of the CO ambient air quality standards in 1998. The greatest 1-hour average was 21.5 parts per million (ppm), or about 61 percent of the standard (35 ppm). This value occurred at the East Franklin Street site in Chapel Hill. The greatest 8-hour average was 6.5 ppm, at the same site, which is 72 percent of the standard.

The second highest 1-hour concentrations in each county are charted in Figure 5.8 and the second highest 8-hour concentrations are shown in Figure 5.9.

Monthly distributions of the highest daily 8-hour CO averages are graphed in Figure 5.10 as box-and-whisker plots. (See Appendix C on p. 78-79 for an explanation of this type of chart.) Historical data have demonstrated that high concentrations of CO occur more frequently in Autumn and Winter than during the warmer months of the year. There are three main reasons for this seasonal variation: (1) North Carolina experiences more atmospheric inversions in colder months, trapping air pollutants at low heights; (2) motor vehicles emit more CO due to inefficient combustion during cold starts and warm up; and (3) during colder temperatures, more fuel is burned for comfort heating.

All areas monitored are attaining the ambient air quality standards for carbon monoxide. Several factors have reduced CO concentrations, with the most significant being that older vehicles are gradually being replaced with newer, more efficient vehicles. The motor vehicle Inspection and Maintenance program (in effect in Mecklenburg, Wake, Durham, Forsyth, Guilford, Gaston, Cabarrus, Orange and Union counties) is an intentional control strategy that helps assure cleaner-running cars. Other factors include increased news media interest and public awareness, and the reporting of the Air Quality Index (see Chapter 6 of this report). As a result of greater public awareness, more cars are kept in better running condition, thus operating more cleanly. Traffic flow improvements such as new roads and better coordinated traffic signals also help reduce CO.

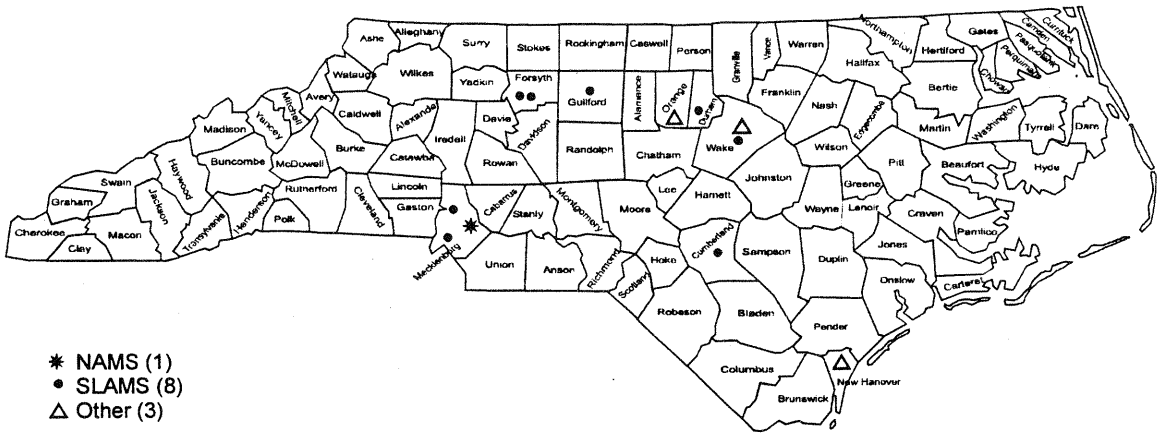


Figure 5.7 Location of Carbon Monoxide Monitoring Sites

Table 5.4 Carbon Monoxide in Parts Per Million for 1999

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA 1ST	ONE-HOUR MAXIMA 2ND	EIGHT-HOUR MAXIMA 1ST	EIGHT-HOUR MAXIMA 2ND
37-051-0007 CUMBERLAND	ABC BOARD, 1705 OWEN DR FAYETTEVILLE	3,605	5.9	5.9	4.9	4.5
37-063-0011 DURHAM	201 NORTH ROXBORO ST DURHAM	7,885	7.6	7.4	5.8	4.4
37-067-0023 FORSYTH	1401 CORPORATION PKY WINSTON-SALEM	7,938	5.6	4.7	3.6	3.4
37-067-0025 FORSYTH	100 SW STRATFORD RD WINSTON-SALEM	7,092	4.6	4.3	3.1	2.8
37-081-1001 GILFORD	401 WEST WENDOVER GREENSBORO	3,601	4.3	4.0	3.0	2.9
37-119-0034 MECKLENBURG	PLAZA ROAD & LAKEDELL CHARLOTTE	7,223	6.2	5.3	3.7	3.5
37-119-0035 MECKLENBURG	1330 SPRING ST GRANVILLE NEIGHBORHOOD CHARLOTTE	7,153	5.4	4.6	3.5	3.2
37-119-0038 MECKLENBURG	301 N TRYON ST CHARLOTTE	7,222	7.6	7.1	3.6	3.4
37-129-0008 NEW HANOVER	OLEANDER & COLLEGE WILMINGTON	4,342	8.5	8.2	4.5	4.4
37-135-0006 ORANGE	147 EAST FRANKLIN STREET CHAPEL HILL	3,398	21.5	14.2	6.5	5.4
37-183-0011 WAKE	420 S PEARSON ST RALEIGH	7,741	6.6	6.5	5.1	4.9
37-183-0018 WAKE	HWY 70 WEST AND HWY 50 NORTH RALEIGH	2,052	5.7	5.1	3.1	3.1
Total Samples		69,252				
Total Sites Sampled		12				

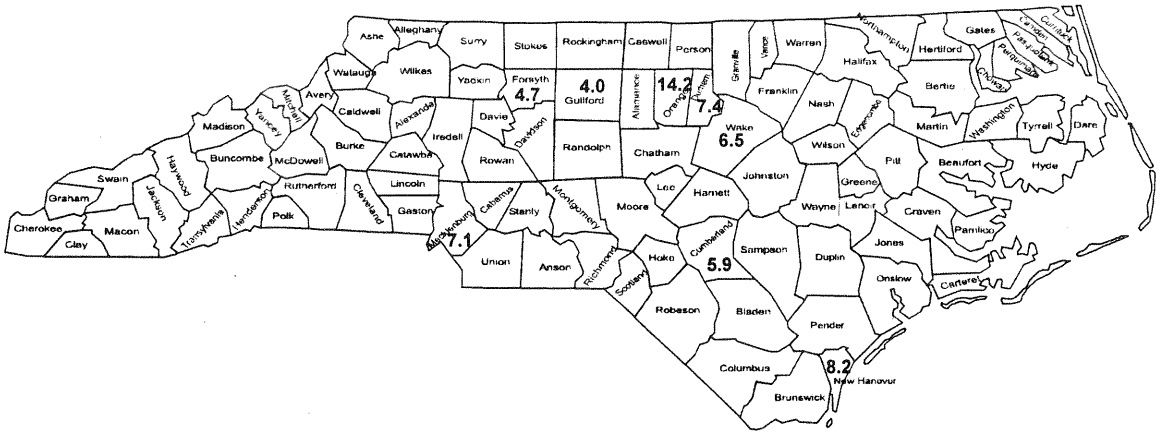


Figure 5.8 Carbon Monoxide: Second Highest 1-Hour Average, 1999

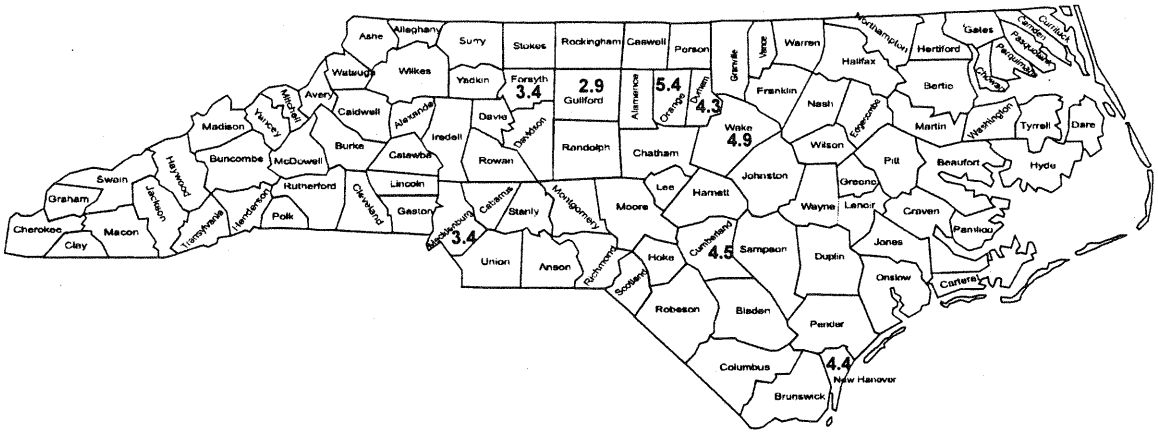


Figure 5.9 Carbon Monoxide: Second Highest Non-overlapping 8-Hour Average, 1999

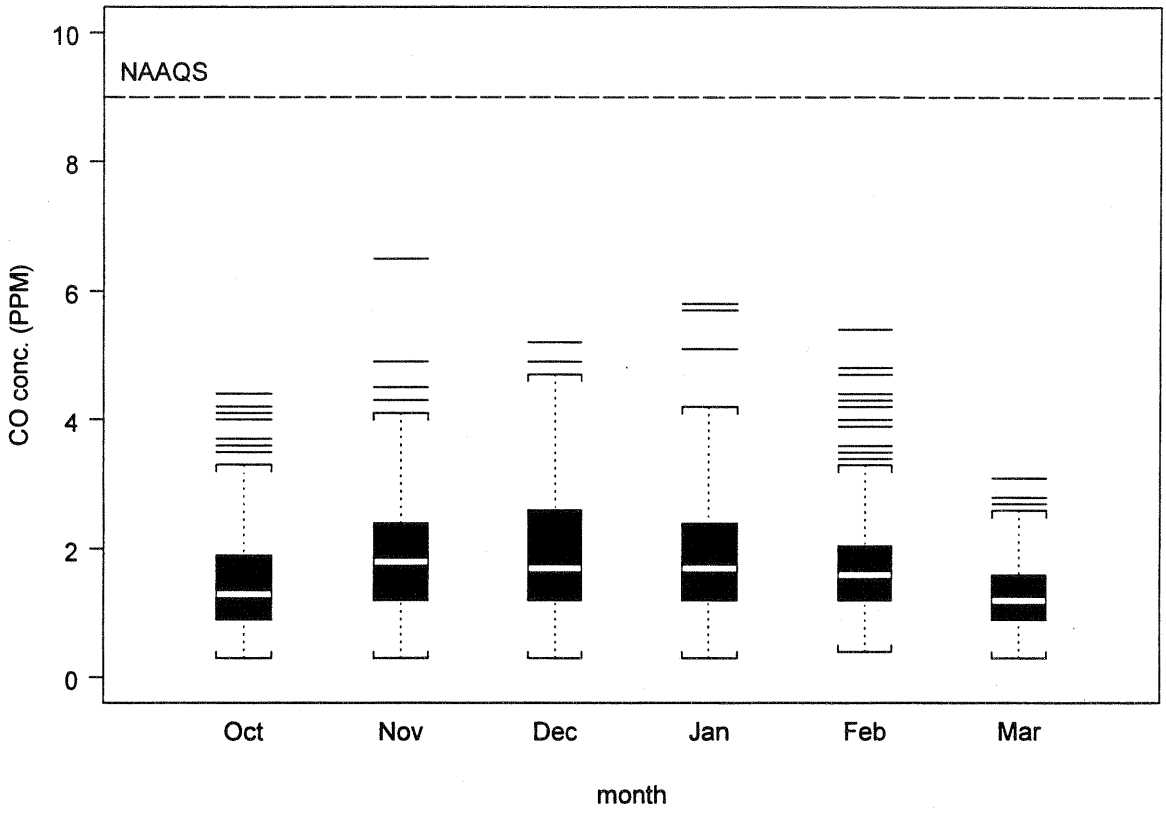


Figure 5.10 Carbon Monoxide: Monthly Distribution of Highest Daily 8-Hour Averages, for Cold Months in 1999

5.5 Ozone

Ozone (O_3) concentrations are measured using EPA reference or equivalent continuous monitors. Ozone is a seasonal pollutant formed in the atmosphere as a result of many chemical reactions that occur in sunlight, mainly during the warmer months. Thus, most ozone monitors only operate from April through October.

The state and local program agencies operated 45 monitoring sites in 1999 during the ozone season, April through October. A map of the O_3 sampling sites is presented in Figure 5.11, and a detailed summary of the one-hour data from each site is given in Table 5.5, and the 8-hour data in Table 5.6. These 45 monitoring sites provided 222,912 hourly samples.

There were 20 exceedances of the 1-hour ozone standard in North Carolina in 1999. Davie and Rowan Counties had two exceedances and Wake and Mecklenburg Counties had three exceedances.

The one-hour standard is exceeded when one valid one-hour average exceeds 0.124 ppm at a site and the expected number of exceedances is greater than 1. (To exceed the standard, the largest average must be larger than 0.12 ppm when *rounded* to two significant digits. The "expected number" of exceedances is determined from a 3-year average of exceedance day counts for an area. Moreover, when any ozone sampling day does not have a valid maximum ozone measurement for any reason, the missing day can be counted as an *estimated* exceedance day under certain circumstances [40 CFR 50 App. J, US EPA 1993, p. 767-768]. Table 5.4 gives both the actually measured and the estimated number of exceedance days at each site.)

Mecklenburg County and the Triad Counties were redesignated as attainment/maintainance areas on July 5, 1995, and November 8, 1993, respectively. Generally an area is in violation if it exceedes the standard at a monitor four or more times in any three year period. Three sites, one each in Mecklenburg, Rowan and Wake Counties had six, six and five exceedances in the three-year period 1997-99. However, since the one-hour standard was rescinded by EPA, and by the EMC on May 27, 1999 the exceedances did not cause the counties to be designated nonattainment. Since the one-hour standard is likely to be reinstated, the exceedances in 1999 may contribute to future nonattainment designations. The reader is referred to the discussion of attainment status in Appendix D of this report.

The 8-hour standard was exceeded a total of 540 times at the 45 sites that monitored for O3. Of the 32 counties that monitor for ozone, only three failed to register at least one exceedance. Fourteen counties had 10 or more exceedances with Rowan County leading the way with 34. These 540 exceedances were distributed over 72 days during the ozone season where at least one site within the state recorded values greater than 0.085 ppm.

The second highest 1-hour concentrations in each county are charted in Figure 5.12 for areas with one or more monitors active in 1999. Figure 5.13 shows the second-highest 8-hour concentrations of O3 for sites operating in 1999.

Monthly distributions of all the 1-hour O_3 data for 1999 are graphed in Figure 5.14 as box-and-whisker plots. Figure 5.15 shows the number of exceedances of the 8-hour standard on a monthly basis while Figure 5.16 portrays the monthly distribution of the 8-hour values.

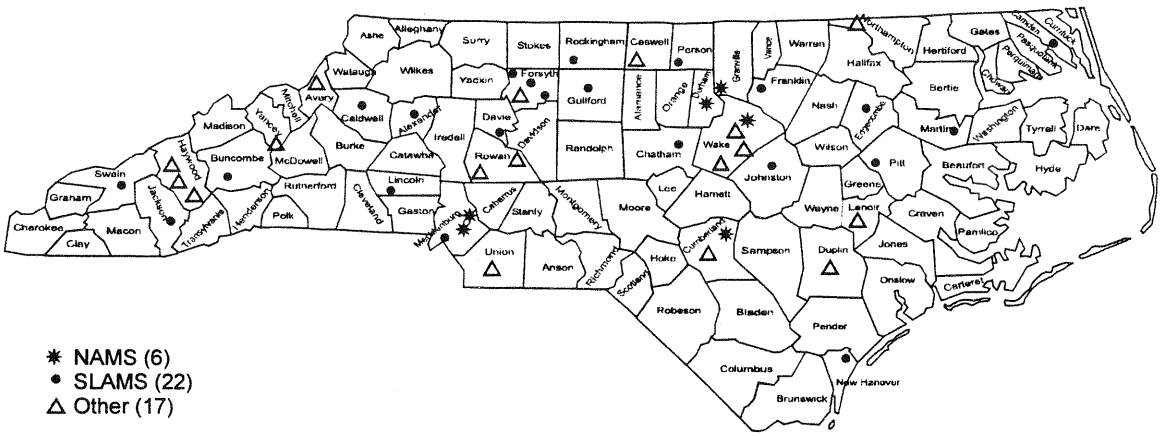


Figure 5.11 Location of Ozone Monitoring Sites

Table 5.5 One-Hour Ozone in Parts Per Million for 1999

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA 1ST	 2nd	 3rd	 4th	NO. VALUES > 0.125 MEAS	 EST
37-003-0003 ALEXANDER	STATE ROAD 1177 TAYLORSVILLE	5,136	0.109	0.106	0.098	0.093	0	0.0
37-011-0003 AVERY	7510 BLUE RIDGE	4,992	0.110	0.093	0.093	0.091	0	0.0
37-021-0030 BUNCOMBE	ROUT 191 SOUTH BREVARD RD ASHEVILLE	5,064	0.115	0.099	0.097	0.091	0	0.0
37-027-0003 CALDWELL	HWY 321 NORTH LENOIR	5,136	0.117	0.115	0.110	0.107	0	0.0
37-029-0099 CAMDEN	COUNTY ROAD 1136 & 1134	5,136	0.114	0.109	0.100	0.096	0	0.0
37-033-0001 CASWELL	CHERRY GROVE RECREATION	4,848	0.100	0.109	0.107	0.106	0	0.0
37-037-0004 CHATHAM	RT 4 BOX 64 PITTSBORO NC 27312	5,064	0.100	0.100	0.107	0.098	0	0.0
37-051-0008 CUMBERLAND	1/4MI SR1857/US301/1857	5,064	0.120	0.120	0.117	0.111	0	0.0
37-051-1003 CUMBERLAND	3625 GOLFVIEW ROAD HOPE MILLS	5,088	0.113	0.109	0.109	0.101	0	0.0
37-059-0002 DAVIE	246 MAIN STREET COOLEEMEE	5,040	0.164	0.126	0.120	0.119	2	2.0
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	5,040	0.107	0.107	0.100	0.099	0	0.0
37-063-0013 DURHAM	2700 NORTH DUKE STREET DURHAM	5,040	0.118	0.113	0.112	0.108	0	0.0
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	4,896	0.114	0.104	0.102	0.102	0	0.0
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	4,368	0.129	0.113	0.112	0.112	1	1.2
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE WINSTON-SALEM	5,064	0.120	0.113	0.107	0.105	0	0.0
37-067-0028 FORSYTH	6496 BAUX MOUNTAIN RD WINSTON-SALEM	5,112	0.127	0.123	0.100	0.099	1	1.0
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	5,136	0.118	0.113	0.112	0.110	0	0.0
37-069-0001 FRANKLIN	431 S. HILLBOROUGH ST FRANKLINTON	5,088	0.113	0.112	0.104	0.102	0	0.0
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSPITAL BUTNER	4,944	0.098	0.093	0.093	0.093	0	0.0

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA 1ST	2nd	3rd	4th	NO. VALUES > 0.125 MEAS	EST
37-081-0011 GUILFORD	KEELY PARK, KEELY RD, MCCLEANSVILLE	5,088	0.112	0.111	0.108	0.108	0	0.0
37-087-0004 HAYWOOD	2177 SCHEVILLS ROAD WAYNESVILLE	5,136	0.095	0.094	0.094	0.090	0	0.0
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PARKWAY MILE MARKER 410	5,064	0.110	0.107	0.104	0.104	0	0.0
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAIN NATIONAL PARK	5,136	0.105	0.103	0.102	0.099	0	0.0
37-099-0005 JACKSON	BARNET KNOB FIRE STATION	4,080	0.096	0.092	0.092	0.092	0	0.0
37-101-0002 JOHNSTON	3411 JACK ROAD CLAYTON	4,800	0.124	0.121	0.115	0.115	0	0.0
37-107-0004 LENIOR	CORNER HWY EAST KINSTON	4,920	0.113	0.111	0.106	0.104	0	0.0
37-109-0004 LINCOLN	RIVERVIEW ROAD LINCOLNTON	5,112	0.113	0.106	0.103	0.102	0	0.0
37-117-0001 MARTIN	HAYES STREET (#2WELL SITE)	5,040	0.103	0.102	0.089	0.088	0	0.0
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL CHARLOTTE	5,136	0.130	0.125	0.123	0.116	2	2.0
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	5,136	0.132	0.130	0.128	0.121	3	3.0
37-119-1009 MECKLENBURG	29 N@ MECKLENBURG CAB CO CHARLOTTE	5,088	0.122	0.121	0.117	0.116	0	0.0
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD	4,968	0.081	0.081	0.079	0.077	0	0.0
37-131-0002 NORTHAMPTON	ROUTE 46 GASTON	4,992	0.111	0.108	0.108	0.103	0	0.0
37-145-0099 PEARSON	SR 1102 & NC 49	5,088	0.137	0.117	0.109	0.109	1	1.0
37-147-0099 PITT	US 264 NEAR WATTER TOWER FARMVILLE	5,016	0.114	0.109	0.108	0.099	0	0.0
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL	5,040	0.112	0.105	0.094	0.093	0	0.0
37-159-0022 ROWAN	WEST ST & GOLD HILL AVENUE ROCKWELL	5,040	0.124	0.123	0.121	0.119	0	0.0
37-159-0023 ROWAN	925 N ENOCHVILLE AVE	5,088	0.160	0.128	0.123	0.123	2	2.0
37-173-0002 SWAIN	CENTER STREET PARKS 7 REC FACILITY	4,992	0.100	0.091	0.086	0.084	0	0.0

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA 1ST	 2nd	 3rd	 4th	NO. VALUES > 0.125 MEAS	 EST
37-179-0003 UNION	701 CHARLES STREET MONROE	4,488	0.115	0.115	0.114	0.113	0	0.0
37-183-0014 WAKE	E. MILLBROOK JR HI 3801 SPRING FOREST ROAD RALEIGH	4,872	0.155	0.134	0.127	0.117	3	3.1
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	4,968	0.134	0.132	0.127	0.123	3	3.1
37-183-0016 WAKE	201 NORTH BROAD STREET FUQUAY-VARINA	5,016	0.110	0.103	0.102	0.100	0	0.0
37-183-0017 WAKE	5033 TV TOWER ROAD GARNER	4,944	0.127	0.126	0.124	0.123	2	2.1
37-199-0003 YANCY	BLUE RIDGE PARKWAY	4,272	0.109	0.104	0.101	0.097	0	0.0
Total Samples		222,912					20	20.5
Total Sites Sampled		45						

Table 5.6 Eight-Hour Ozone in Parts Per Million for 1999

SITE NUMBER COUNTY	ADDRESS	NUM OBS	VALID DAILY 8-HOUR MAXIMUM 1ST	2nd	3rd	4th	5TH	6TH	NO. VALUES .>.085 MEAS
37-003-0003 ALEXANDER	STATE ROAD 1177 TAYLORSVILLE	211	0.100	0.092	0.082	0.082	0.078	0.077	2
37-001-0001 AVERY	7500 BLUE RIDGE	207	0.087	0.083	0.082	0.082	0.080	0.080	1
37-021-0030 BUNCOMBE	ROUT 191 SOUTH BREVARD RD ASHEVILLE	210	0.089	0.085	0.084	0.084	0.082	0.082	2
37-027-0003 CALDWELL	HWY 321 NORTH LENOIR	214	0.103	0.097	0.096	0.094	0.093	0.090	18
37-029-0099 CAMDEN	COUNTY ROAD 1136 & 1134	202	0.104	0.101	0.091	0.091	0.086	0.083	5
37-033-0001 CASWELL	CHERRY GROVE RECREATION	196	0.096	0.096	0.094	0.091	0.087	0.087	7
37-037-0004 CHATHAM	RT 4 BOX 64 PITTSBORO NC 27312	205	0.095	0.094	0.091	0.088	0.085	0.084	5
37-051-0008 CUMBERLAND	1/4MI SR1857/US301/1857	209	0.104	0.102	0.101	0.100	0.099	0.086	17
37-051-1003 CUMBERLAND	3625 GOLFVIEW ROAD HOPE MILLS	208	0.098	0.094	0.094	0.093	0.092	0.089	14
37-059-0002 DAVIE	246 MAIN STREET COOLEEMEE	207	0.138	0.110	0.110	0.100	0.097	0.095	24
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	198	0.092	0.091	0.090	0.089	0.088	0.087	8
37-063-0013 DURHAM	2700 NORTH DUKE STREET DURHAM	199	0.102	0.098	0.089	0.089	0.089	0.088	8
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	194	0.103	0.095	0.094	0.092	0.090	0.090	7
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	180	0.108	0.103	0.099	0.099	0.095	0.092	16
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE WINSTON-SALEM	211	0.108	0.101	0.090	0.082	0.082	0.082	3
37-067-0028 FORSYTH	6496 BAUX MOUNTAIN RD WINSTON-SALEM	213	0.110	0.100	0.091	0.086	0.085	0.085	6
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	214	0.103	0.099	0.097	0.096	0.095	0.094	11
37-069-0001 FRANKLIN	431 S. HILLBOROUGH ST FRANKLINTON	198	0.088	0.088	0.085	0.085	0.085	0.083	5
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSPITAL BUTNER	198	0.084	0.082	0.082	0.080	0.079	0.078	0

SITE NUMBER COUNTY	ADDRESS	NUM OBS	VALID DAILY 8-HOUR MAXIMUM 1ST	2nd	3rd	4th	5TH	6TH	NO. VALUES >.085 MEAS
37-081-0011 GUILFORD	KEELY PARK, KEELY RD, MCCLEANSVILLE	209	0.099	0.097	0.096	0.096	0.093	0.092	18
37-087-0004 HAYWOOD	2177 SHEVILLE ROAD WAYNESVILLE	214	0.086	0.083	0.082	0.082	0.081	0.081	1
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PARKWAY MILE MARKER 410	211	0.098	0.098	0.097	0.096	0.095	0.094	24
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAIN NATIONAL PARK	214	0.100	0.097	0.096	0.093	0.091	0.091	19
37-099-0005 JACKSON	BARNET KNOB FIRE STATION	170	0.089	0.088	0.087	0.087	0.083	0.083	4
37-101-0002 JOHNSTON	3411 JACK ROAD CLAYTON	195	0.108	0.106	0.102	0.101	0.097	0.099	18
37-107-0004 LENOIR	CORNER HWY 70 EAST KINSTON	202	0.102	0.093	0.091	0.090	0.089	0.089	6
37-109-0004 LINCOLN	RIVERVIEW ROAD LINCOLNTON	208	0.094	0.091	0.089	0.087	0.085	0.085	6
37-117-0001 MARTIN	HAYES STREET (#2WELL SITE)	202	0.095	0.088	0.084	0.081	0.079	0.078	2
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL CHARLOTTE	213	0.111	0.104	0.100	0.099	0.099	0.098	19
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	212	0.107	0.105	0.105	0.104	0.101	0.099	19
37-119-1009 MECKLENBURG	29 N@ MECKLENBURG CAB CO CHARLOTTE	212	0.115	0.109	0.105	0.103	0.102	0.101	33
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD	119	0.073	0.072	0.067	0.067	0.066	0.066	0
37-131-0002 NORTHAMPTON	ROUTE 46 GASTON	203	0.096	0.092	0.091	0.089	0.089	0.089	9
37-145-0099 PEARSON	SR 1102 & NC 49	210	0.102	0.099	0.098	0.098	0.095	0.092	19
37-147-0099 PITT	US 264 NEAR WATTER TOWER FARMVILLE	201	0.096	0.094	0.094	0.093	0.092	0.091	11
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL BETHANY	206	0.100	0.091	0.084	0.081	0.079	0.077	2
37-159-0022 ROWAN	WEST ST & GOLD HILL AVENUE ROCKWELL	206	0.112	0.111	0.108	0.107	0.106	0.104	34
37-159-0023 ROWAN	925 N ENOCHVILLE AVE ENOCHVILLE	209	0.131	0.113	0.106	0.102	0.101	0.101	30
37-173-0002 SWAIN	CENTER STREET PARKS 7 REC FACILITY	206	0.082	0.077	0.077	0.076	0.073	0.072	0

SITE NUMBER COUNTY	ADDRESS	NUM OBS	VALID DAILY 8-HOUR MAXIMUM 1ST	 2nd	 3rd	 4th	 5TH	 6TH	NO. VALUES >.085 MEAS
37-179-0003 UNION	701 CHARLES STREET MONROE	182	0.100	0.100	0.097	0.096	0.094	0.094	14
37-183-0014 WAKE	E. MILLBROOK JR HI 3801 SPRING FOREST ROAD RALEIGH	194	0.124	0.109	0.108	0.108	0.108	0.105	26
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	204	0.115	0.114	0.108	0.102	0.101	0.100	25
37-183-0016 WAKE	201 NORTH BROAD STREET FUQUAY-VARINA	201	0.098	0.096	0.092	0.092	0.091	0.087	8
37-183-0017 WAKE	5033 TV TOWER ROAD GARNER	196	0.111	0.107	0.106	0.105	0.102	0.102	22
37-199-0003 YANCY	BLUE RIDGE PARKWAY	172	0.099	0.096	0.092	0.092	0.091	0.087	14
Total Samples Total Sites Sampled		9,125 45							540

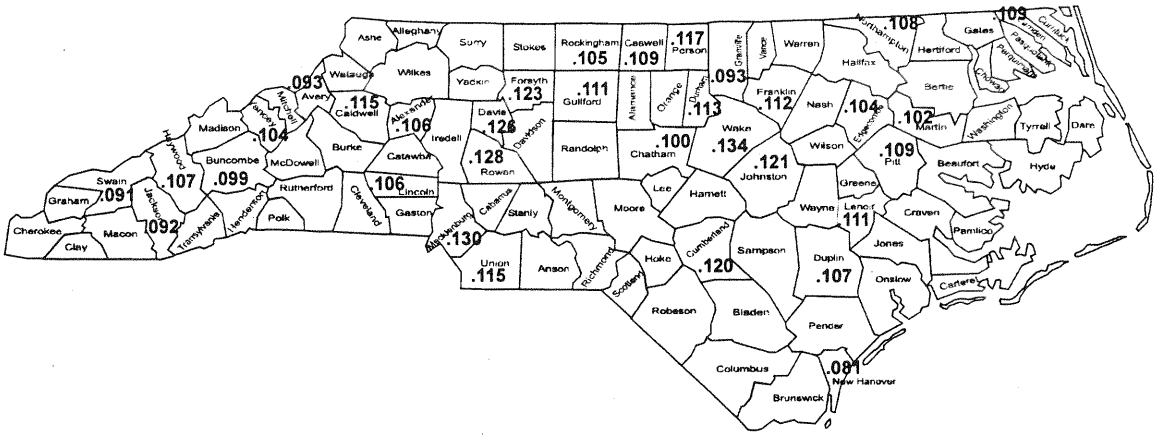


Figure 5.12 Ozone: Second Highest Annual 1-Hour Average, 1999

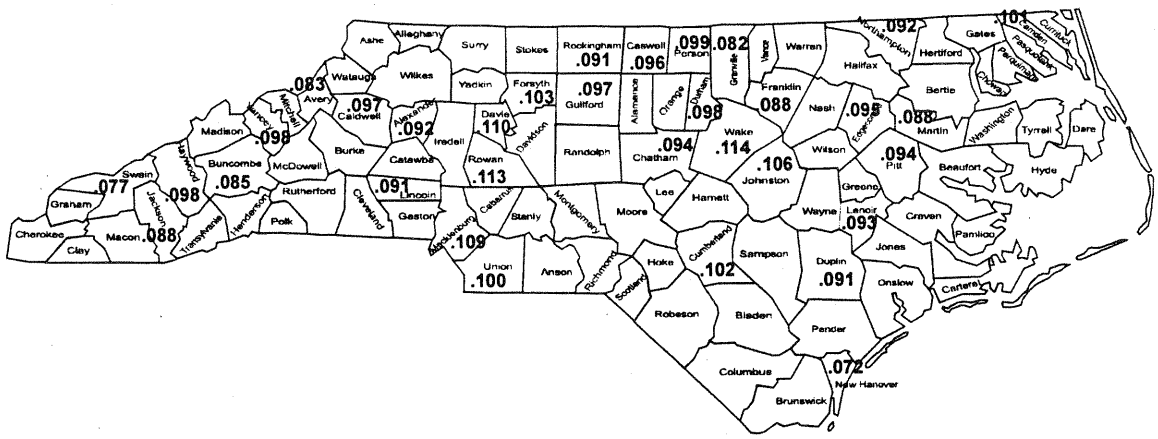


Figure 5.13 Ozone: Second Highest Annual 8-Hour Average, 1999

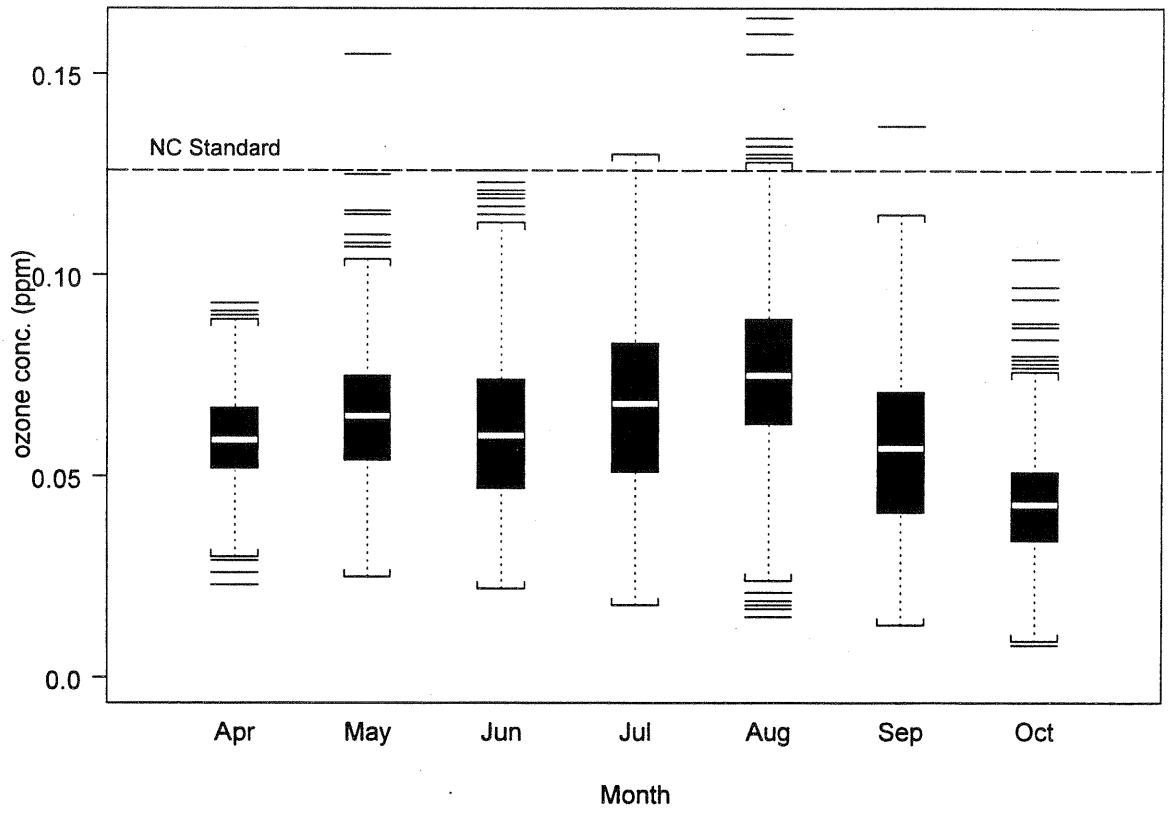


Figure 5.14 Monthly Distribution of Daily Maximum 1-Hour Ozone Averages, 1999

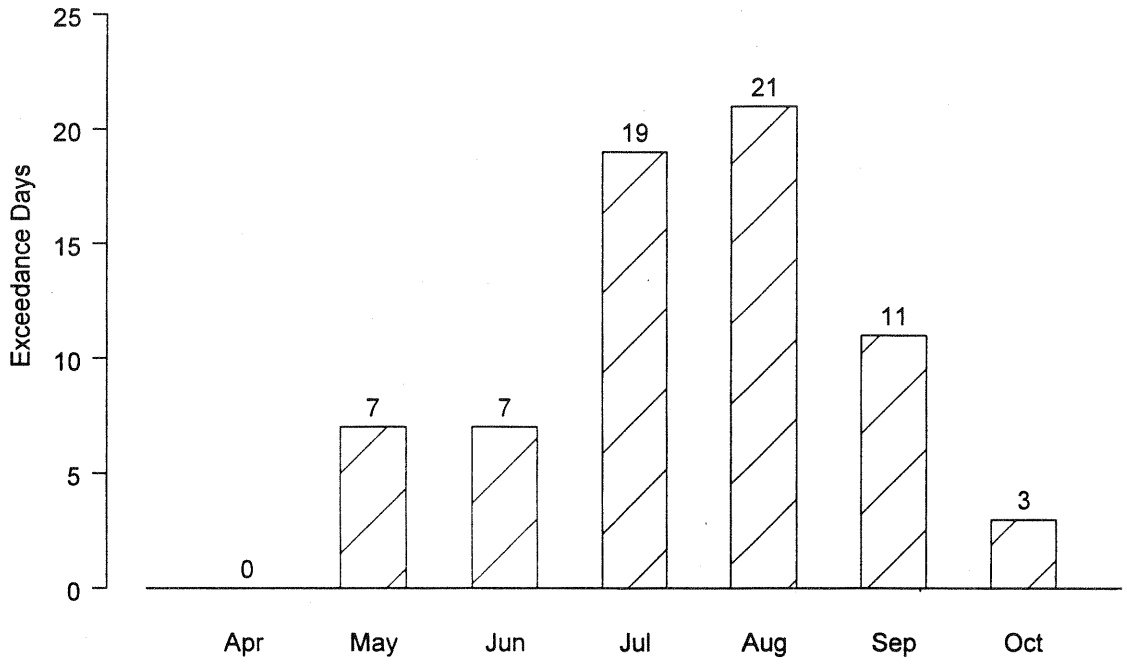


Figure 5.15 Number of Days with 8-Hour Averages in Excess of the Standard (0.085), 1999

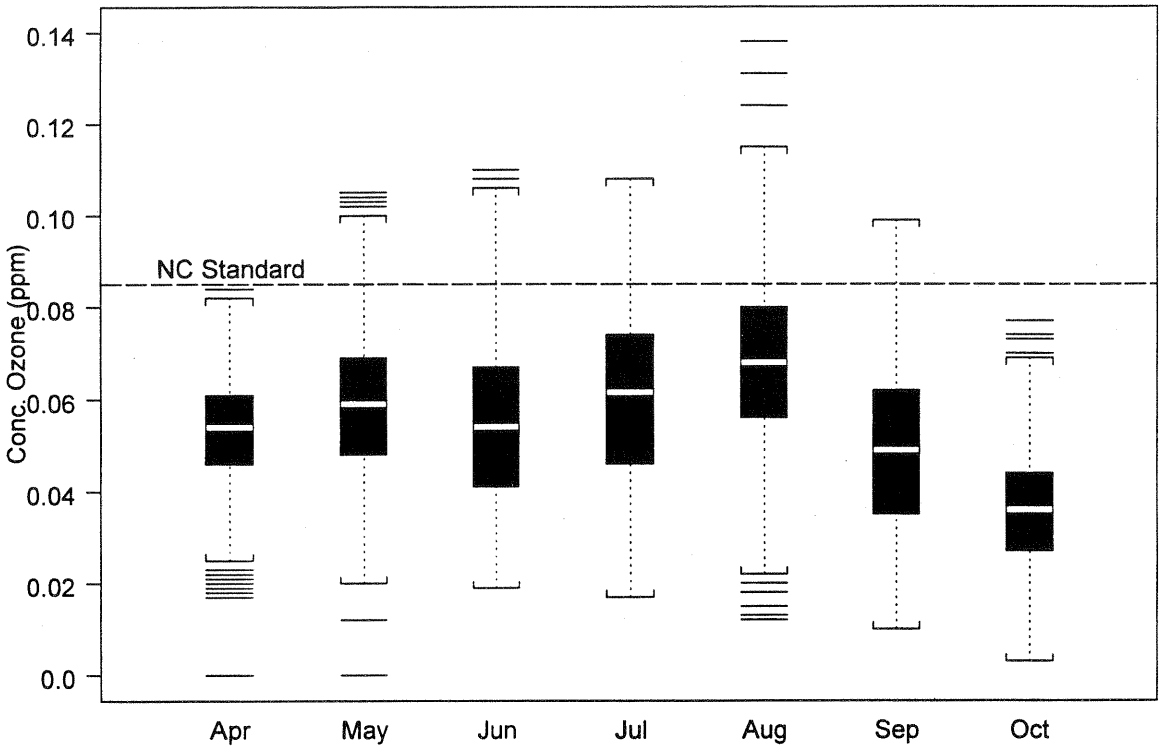


Figure 5.16 Monthly Distribution of Daily Maximum 8-Hour Ozone Averages, 1999

5.6 Sulfur Dioxide

Sulfur dioxide (SO_2) concentrations were measured by the State and two local program agencies using EPA reference or equivalent methods. Ten SO_2 monitors were active in North Carolina in 1999. Some SO_2 sites are operated only every third year. Six sites provided data in 1998, (and will next be operated in 2001), four sites provided data in 1997 (and will next be operated in 2000).

From the 20 sites with SO_2 data obtained between 1997 and 1999, 143,048 valid hourly averages were collected. A map of the active SO_2 sampling sites is presented in Figure 5.17 and a detailed summary of the data from each site is given in Table 5.7.

There were no exceedances of the SO_2 ambient air quality standards in 1999. The highest annual arithmetic mean was 27 $\mu g/m^3$, or about 33 percent of the standard (80 $\mu g/m^3$). The highest maximum 24-hour average was 81 $\mu g/m^3$, about 22 percent of the standard (365 $\mu g/m^3$), and the highest maximum 3-hour average was 325 $\mu g/m^3$, about 25 percent of the welfare-related (secondary) standard.

Apparently, the size of an urban area has little effect on the ambient concentrations of SO_2 in North Carolina. Seasonal variations, such as those with CO and O_3, do not appear to exist for SO_2. Major source characteristics such as type, size, distribution, control devices, operating conditions and dispersion situations significantly affect the amount of SO_2 in ambient air.

The second highest three-hour concentrations in each county are charted in Figure 5.18. The second highest 24-hour concentrations in each county are charted in Figure 5.19.

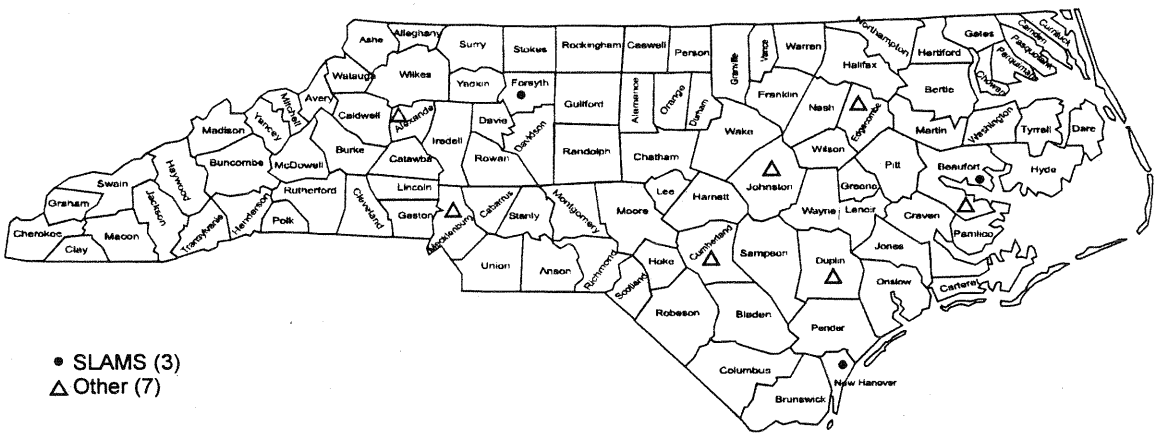


Figure 5.17 Location of Sulfur Dioxide Monitoring Sites

Table 5.7 Sulfur Dioxide in Parts Per Million from All Sites for 1997-99

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA 1ST	ONE-HOUR MAXIMA 2ND	THREE-HOUR MAXIMA 1ST	THREE-HOUR MAXIMA 2ND	24-HOUR MAXIMA 1ST	24-HOUR MAXIMA 2ND	ARITH MEAN
1999 Data									
37-003--0003 ALEXANDER	STATE ROAD 1177	7,396	0.046	0.026	0.019	0.012	0.008	0.007	0.005
37-013-0003 BEAUFORT	NC HIGHWAY 306	7,145	0.071	0.062	0.047	0.040	0.019	0.015	0.006
37-013-0004 BEAUFORT	SOUTH FERRY LANDING PAMLICO RIVER	5,181	0.063	0.060	0.043	0.037	0.017	0.015	0.005
37-051-1003 CUMBERLAND	3625 GOLFVIEW ROAD HOPE MILLS	8,271	0.018	0.018	0.012	0.012	0.007	0.007	0.005
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	8,258	0.017	0.016	0.014	0.013	0.007	0.007	0.005
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	7,416	0.063	0.060	0.012	0.011	0.008	0.008	0.005
37-067-0022 FORSYTH	1300 BLK. HATTIE AVE WINSTON-SALEM	6,383	0.088	0.067	0.074	0.043	0.020	0.019	0.005
37-101-0002 JOHNSTON	3411 JACK ROAD CLAYTON	7,567	0.042	0.037	0.033	0.019	0.013	0.009	0.005
37-119-0034 MECKLENBURG	PLAZA RD. & LAKEDELL CHARLOTTE	7,221	0.083	0.082	0.066	0.047	0.014	0.013	0.004
37-129-0006 NEW HANOVER	HWY 421 NORTH WILMINGTON	8,280	0.347	0.160	0.125	0.072	0.031	0.027	0.009
Total Samples		73,118							
Total Sites Sampled		10							
1998 Data									
37-037-0004 CHATHAM	RT4 BOX62 PITTSBORO	8,283	0.050	0.036	0.030	0.028	0.013	0.009	0.005
37-117-0001 MARTIN	HAYES STREET (#2WELL SITE)	8,184	0.014	0.013	0.012	0.012	0.007	0.006	0.005
37-145-0099 PERSON	SR 1102 & NC49	8,265	0.077	0.073	0.067	0.056	0.021	0.016	0.006
37-159-0021 ROWAN	WEST STREET & GOLD HILL AVENUE ROCKWELL	2,891	0.065	0.061	0.036	0.031	0.012	0.010	0.006
37-159-OO22 ROWAN	925 N ENOCHVILLE AVE	2,712	0.087	0.074	0.067	0.036	0.016	0.012	0.006
37-173-0002 SWAIN	CENTER ST PARKS 7 REC FACILITY	7,869	0.075	0.019	0.028	0.018	0.008	0.008	0.005
Total Samples		38,204							
Total Sites Sampled		6							

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		THREE-HOUR MAXIMA		24-HOUR MAXIMA		ARITH MEAN
			1ST	2ND	1ST	2ND	1ST	2ND	
1997 Data									
37-059-0002 DAVIE	246 MAIN STREET COOLEEMEE	8,089	0.075	0.064	0.065	0.057	0.027	0.018	0.006
37-109-0004 LINCOLN	RIVERVIEW ROAD LINCOLNTON	8,077	0.092	0.080	0.060	0.050	0.020	0.016	0.010
37-131-0002 NORTHAMPTIN	RT 46 GASTON	7,808	0.110	0.099	0.027	0.027	0.016	0.014	0.006
37-147-0099 PITT	US 264 NEAR WATER TWR FARMVILLE	7,932	0.025	0.021	0.020	0.016	0.009	0.008	0.005
Total Samples		31,906							
Total Sites Sampled		4							

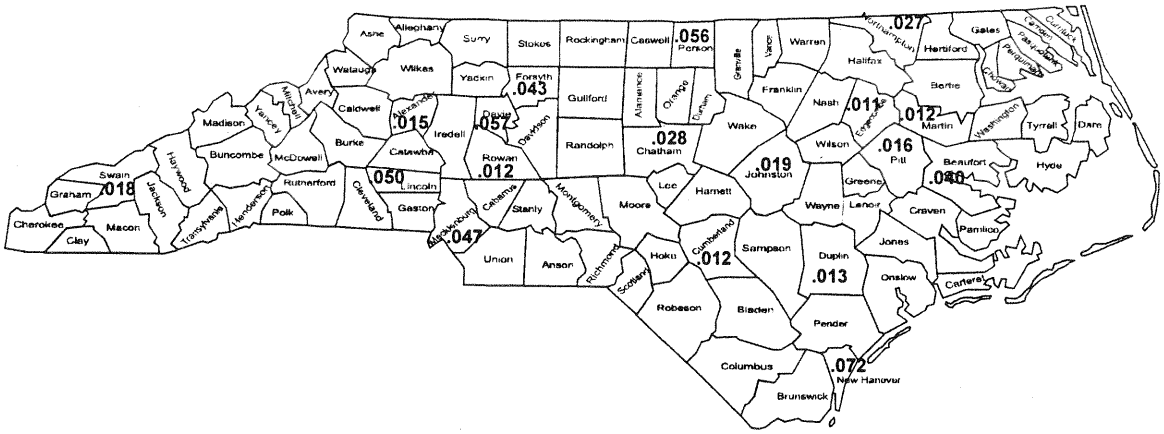


Figure 5.18 Sulfur Dioxide: Second Highest 3-Hour Averages in the Most Recent Year of Data from 1997, 1998 or 1999

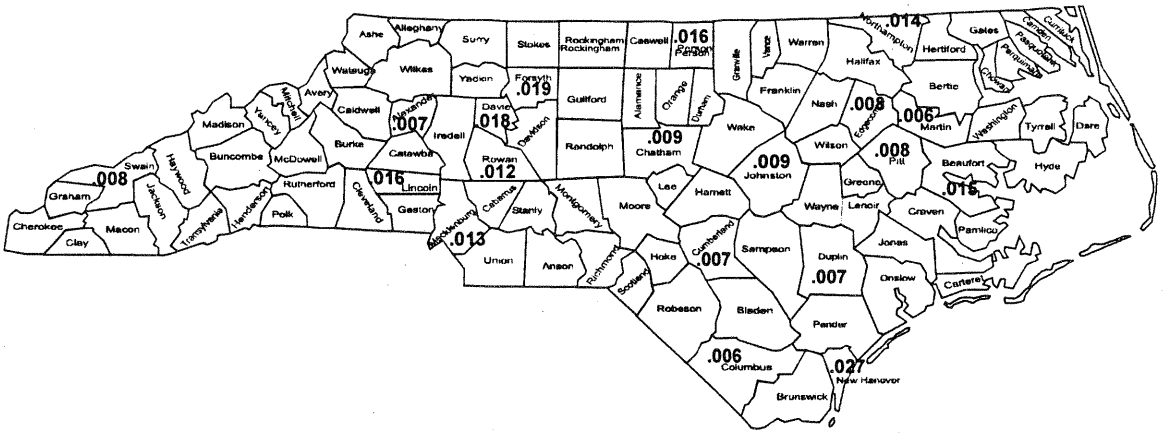


Figure 5.19 Sulfur Dioxide: Second Highest 24-Hour Averages in the Most Recent Year of Data from 1997, 1998 of 1999

5.7 Nitrogen Dioxide

Nitrogen dioxide (NO_2) concentrations were measured using EPA reference or equivalent continuous monitors in 1999 at one local program site in Forsyth County and one local program site in Mecklenburg County.

From these two sites, 13,350 hourly NO_2 measurements were reported. A map of the NO_2 sampling sites is presented in Figure 5.20, and a summary of the 1999 NO_2 data is given in Table 5.8

Figure 5.21 contains two box-and-whisker plots showing the monthly distributions of hourly average concentrations at each site, compared to the annual arithmetic mean standard of 0.053 ppm. Each urban area site has only a few outlying high hourly sample values that are above the standard defined for the annual arithmetic mean. The arithmetic means (Table 5.8) are about 34 percent of the standard. The site at Plaza Road was relocated in November, 1999.

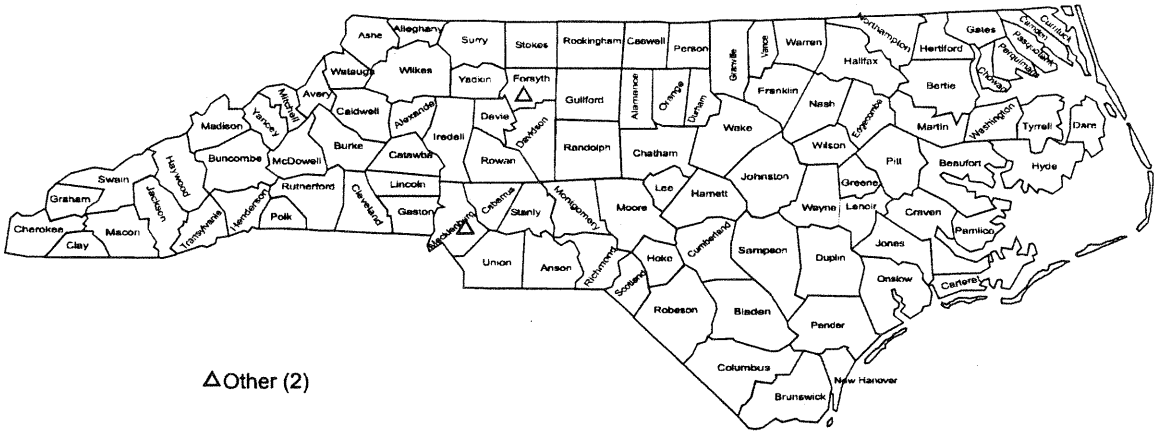


Figure 5.20 Location of Nitrogen Dioxide Monitoring Sites

Table 5.8 Nitrogen Dioxide in Parts Per Million for 1999

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA 1ST	2ND	ARITH MEAN
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	6,361	0.075	0.074	0.016
37-067-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL CHARLOTTE	6,989	0.072	0.072	0.018
Total Samples Total Sites Sampled		13,350 2			

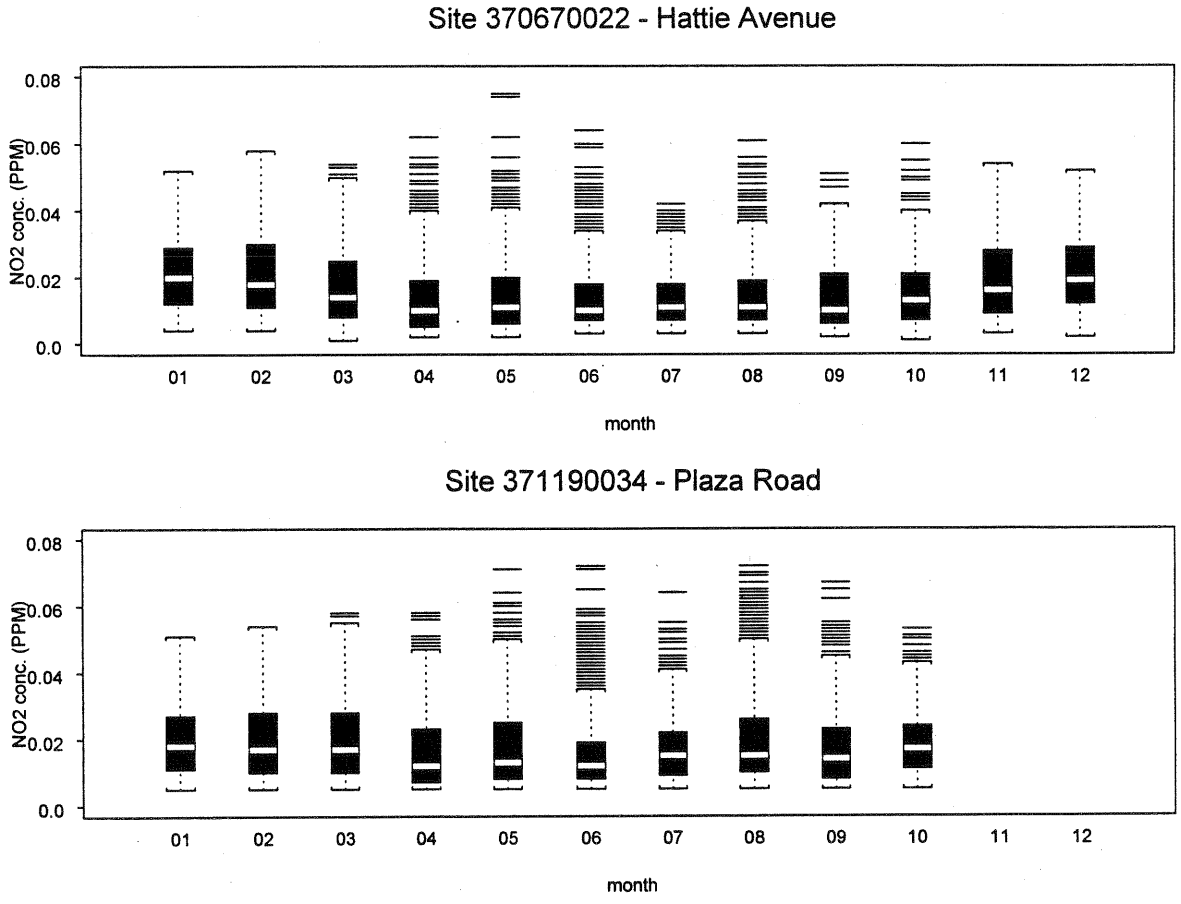


Figure 5.21 Monthly Distributions of 1-Hour Nitrogen Dioxide Averages by Site, 1999

5.8 Lead

The state and local program agencies have not performed routine analysis of ambient lead (Pb) in North Carolina since 1982. Lead monitoring was discontinued as a result of the low measurements and a continuing decrease in the lead concentrations being reported. The decrease in ambient Pb concentrations is due to the reduction and elimination of leaded gasoline, resulting in greatly reduced lead emissions from automobiles.

The most recent year of data available prior to 1996-97 was in 1990. Because the previous data was so old, the state began metals analysis at three locations on 1996. These metal sites will be relocated to other locations in future years. The purpose of these sites is to gather background information about lead and other metals. Five sites operated in 1997. No lead sites operated in 1998.

The change in analytical laboratories from the EPA's National Particulate Analysis Program to the state program also changed the minimum detectable levels of the method from 0.01 to 0.04 ug/m3 respectively. Concentrations of most metals are below detectable limits regardless of the method used.

During 1999, a special study focusing on arsenic levels was undertaken. Lead, as well as 9 other toxic metals were analyzed on TSP samplers with PM_{10} filters at 10 ambient air monitoring sites, by a contract laboratory using inductively coupled plasma/mass spectrometry (ICP/MS). This method has a sensitivity of three orders of magnitude greater than the past methods. Of the 526 samples analyzed only 39 exceeded the minimum detectable level of 0.01 ug/m3 and only 2 exceeded the minimum detectable level of 0.04 ug/m3, with values of 0.04154 ug/m3 and 0.04174 ug/m3. The lead standard remains 1.5 ug/m3 for a quarterly average.

6 Air Quality Index

The Air Quality Index (AQI) was developed by the EPA to provide the public with a simple, accessible, and uniform assessment of air quality at a specific location, based on the criteria pollutants $PM_{2.5}$, PM_{10}, CO, O_3 (both 1 and 8 hour values), SO_2 and NO_2. AQI measurements are made and reported in all U.S. metropolitan statistical areas (MSA) with a population over 350,000. Ambient concentrations for each of these seven pollutants are converted to a numerical scale ranging from 0 to 500, where 100 corresponds to the EPA primary standard for a 24-hour average (8-hour CO average, 1 and 8-hour O_3 average) and 500 corresponds to a concentration associated with "significant harm." The AQI is determined by the pollutant with the highest scaled concentration, and a subjective description of "good", "moderate", "unhealthy for seneitive groups", "unhealthy", "very unhealthfy", or "hazardous" is included with the report, with the descriptions corresponding to AQI values of 0-50, 51-100, 101-150, 151-200, 201-300, and 301-500, respectively. For AQI values between 101 and 500, an appropriate cautionary statement is included advising people susceptible to deleterious health effects to restrict activities and exposure to the ambient air.

An AQI of 101-200 (unhealthy for sensitive groups and unhealthy) can produce mild aggravation of symptoms in susceptible persons and possible irritation in healthy persons. People with existing heart or lung ailments should reduce physical exertion and outdoor activity. The general population should reduce vigorous outdoor activity.

An AQI of 201 to 300 (very unhealthful) can produce significant aggravation of symptoms and decreased exercise tolerance in persons with heart or lung disease, and a variety of symptoms in healthy persons. Elderly people and those with existing heart or lung disease should stay indoors and reduce physical activity. The general population should avoid vigorous outdoor activity.

The health effects of an AQI of over 300 (hazardous) include early onset of certain

diseases in addition to significant aggravation of symptoms and decreased exercise tolerance in healthy persons. The elderly and persons with existing diseases should stay indoors and avoid physical exertion.

At AQI values over 400, premature death of ill and elderly persons may result, and healthy people will experience adverse symptoms that affect normal activity. Outdoor activity should be avoided. All people should remain indoors, keeping windows and doors closed, and should minimize physical exertion.

During winter months in North Carolina, carbon monoxide usually has the highest air quality index value, and in summer months the highest index value is usually due to ozone.

In 1999, nine areas provided an AQI report to the public by telephone using computer-generated recorded voice announcements 24 hours daily. These areas are identified in the box below. The AQI report also may be published by local newspapers or broadcast on radio and television stations.

The Air Quality Index report is now available by telephone for nine areas, as follows:

Statewide toll-free 888-AIR-WISE
(for Asheville, Durham, Fayetteville, Greensboro, Greenville, Raleigh, Wilmington, and Winston-Salem areas)

Charlotte area 704-333-SMOG

Air Quality Index values for 1999 at six metropolitan areas in North Carolina are given in Figures 6.1, 6.2, 6.3, 6.4, 6.5 and 6.6.

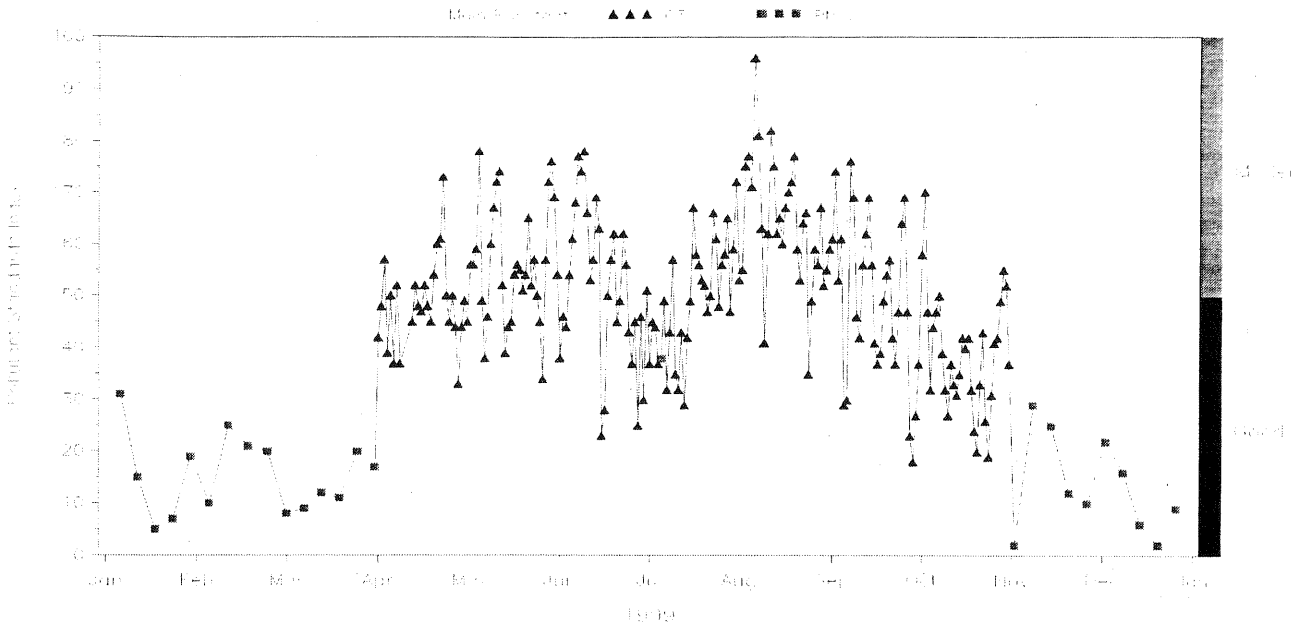
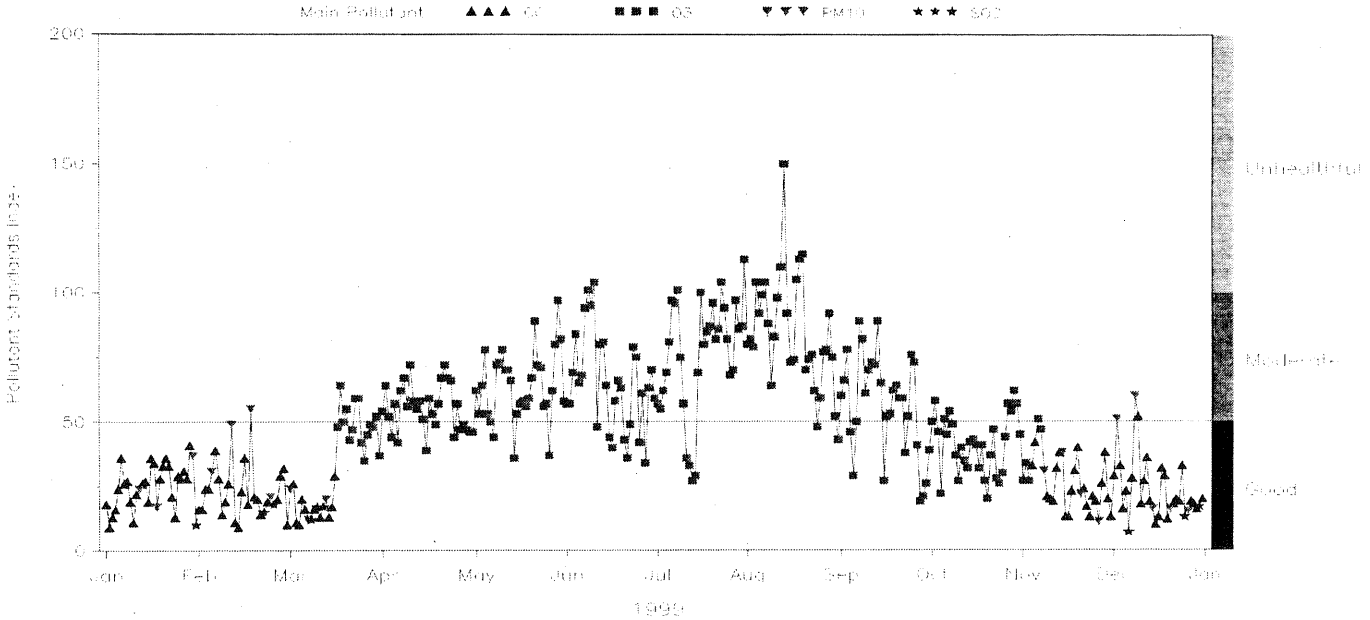


Figure 6.1 Daily Air Quality Index Values for Asheville, NC, Metropolitan Statistical Area, 1999

Figure 6.2 Daily Air Quality Values for Charlotte-Gastonia, NC,-Rock Hill, SC,



Metropolitan Statistical Area, 1999

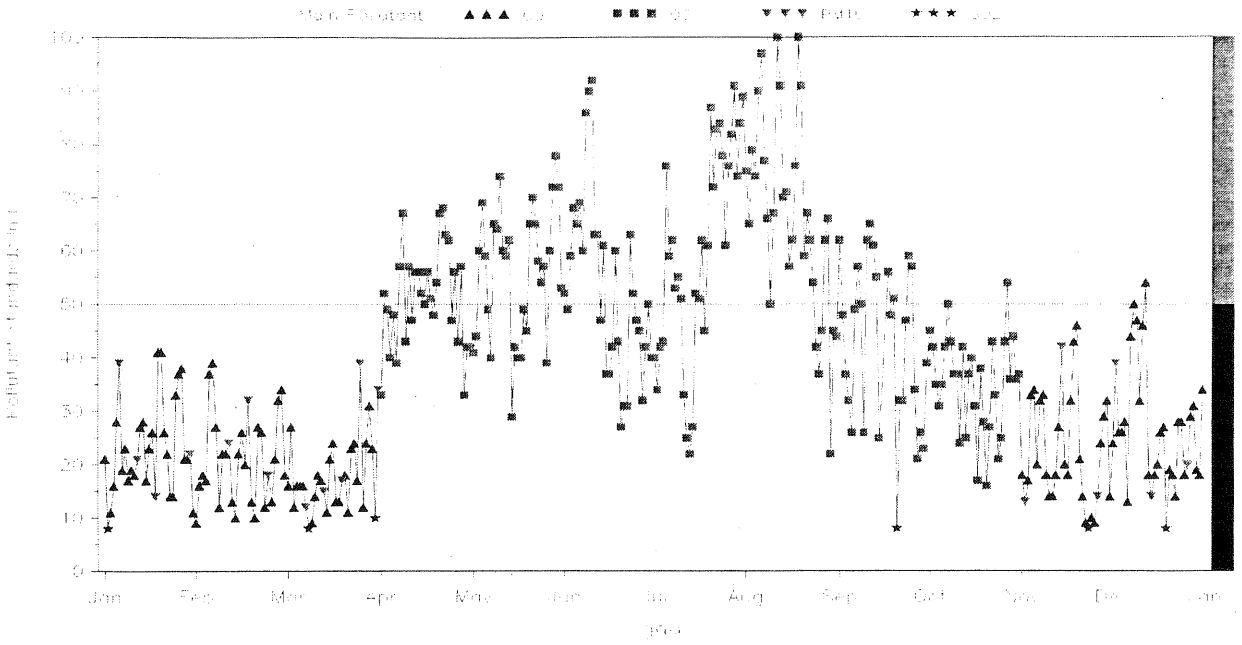


Figure 6.3 Daily Air Quality Index Values for Fayetteville, NC, Metropolitan Statistical Area, 1999

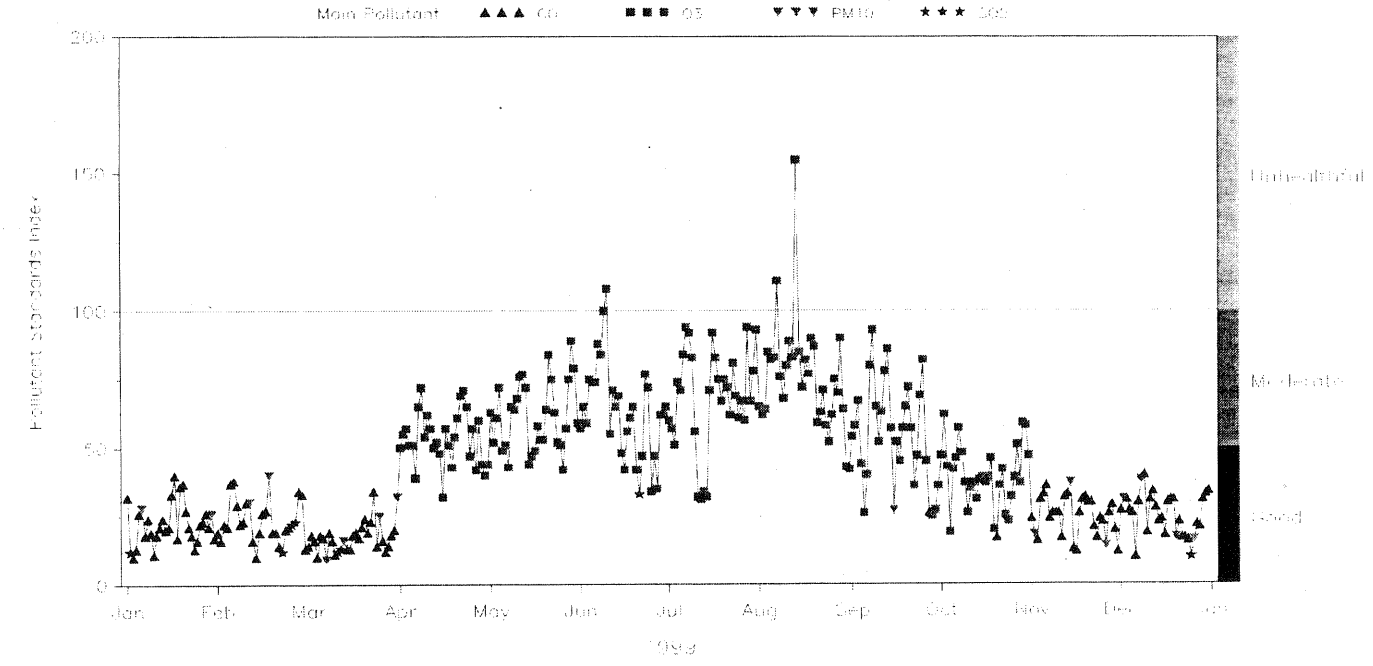


Figure 6.4 Daily Air Quality Index Values Greensboro-Winston-Salem-High Point, NC, Metropolitan Statistical Area, 1999

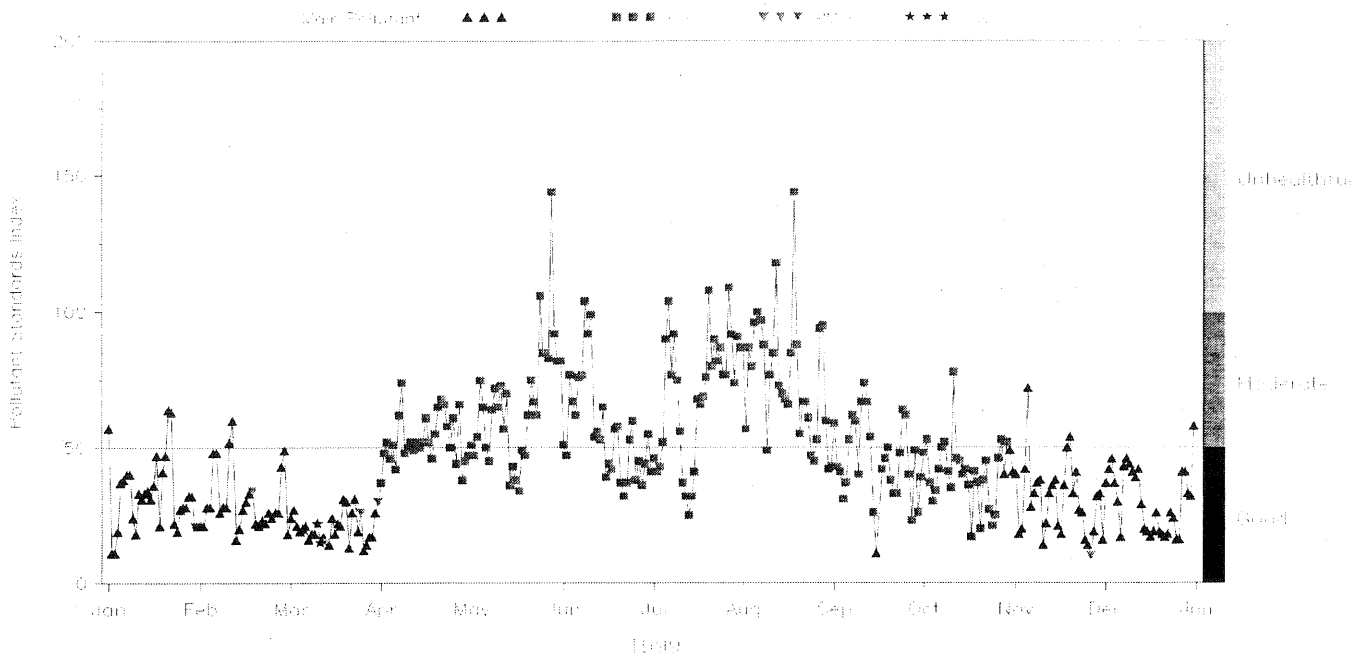


Figure 6.5 Daily Air Quality Index Values for Raleigh-Durham, NC, Metropolitan Statistical Area, 1999

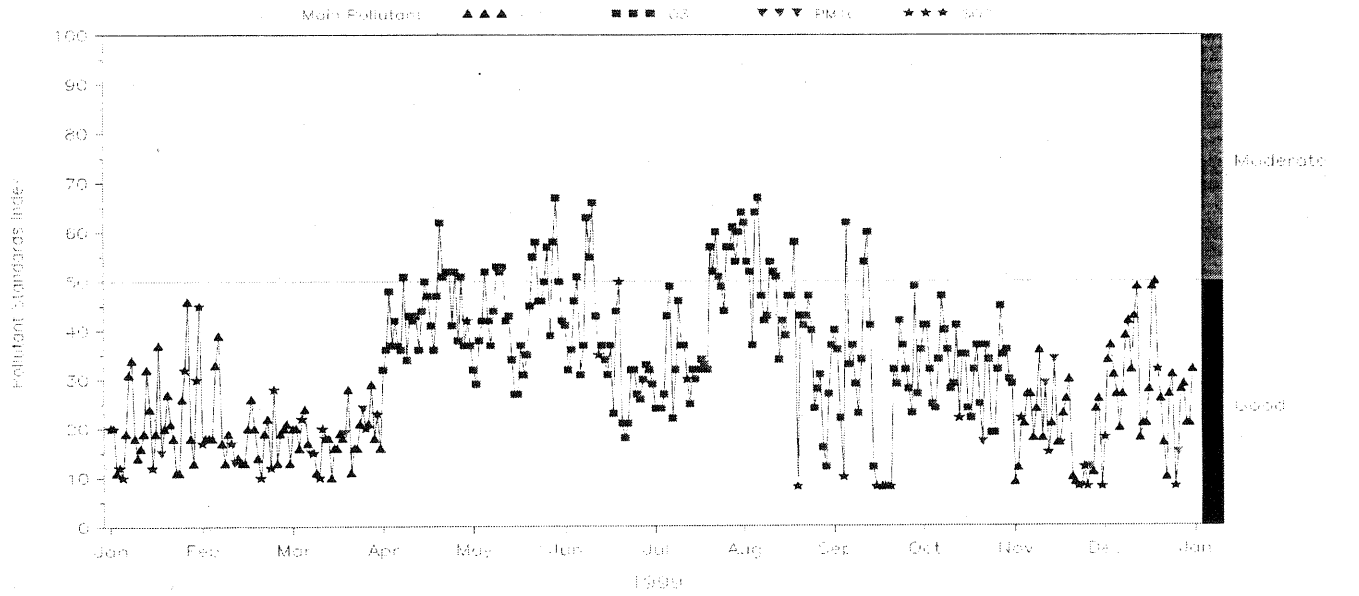


Figure 6.6 Daily Air Quality Index Values for Wilmington, NC, Metropolitan Statistical Area, 1999

7 Acid Rain

7.1 Sources

Acid rain is produced when nitrate and sulfate ions from automobile and industrial sources are released into the atmosphere, undergo a reaction with moisture in the air, and are deposited as acid precipitation. Acid ions are produced when sulfur dioxide and nitrogen oxides reach equilibrium with water to form sulfuric acid and nitric acid.

7.2 Effects

Many agricultural crops in North Carolina are sensitive to acid rain. Forests are subject to mineral loss from acid rain exposure and may also suffer root damage. Acid fogs and mists, typical in the mountains of North Carolina, can expose trees and plants to even higher acid concentrations and cause direct damage to foliage. Lakes, rivers and streams that are too acidic can impede fish and plant growth.

7.3 Monitoring

Acid rain monitoring has been conducted nationally, including in North Carolina, since 1978 by the National Atmospheric Deposition Program (NADP) and the National Trends Network (NTN) which merged with NADP in 1982. In 1999, acid rain samples were collected at seven sites in North Carolina and one Tennessee site in the Great Smoky Mountains less than 10 miles from the western border of North Carolina.

NADP/NTN conducts acid deposition monitoring using a wet/dry bucket type sampler. When rainfall is detected, a sensor is activated and a metal lid automatically covers and protects the "dry" sample, exposing the "wet" bucket to collect precipitation.

Acidity is measured using a "pH" scale. The pH scale is numbered from 0 to 14, with 0 being extremely acidic and 14 being extremely basic. A substance with a pH of five is ten times as acidic as one with a pH of six, 100 times as acidic as a substance with a pH of seven, etc. Neutral water with an equal concentration of acid and base ions has a pH of seven. The pH of vinegar is approximately 2.8, and lemon juice has a pH

of about 2.3. The pH of ammonia is approximately 12.

Pure water in equilibrium with the air is slightly acidic and has a pH of approximately 5.6. The measurements of pH at the North Carolina monitoring sites in 1999 ranged from 4.40 to 4.97 with a mean of 4.67 The 1999 pH annual means for North Carolina from the NADP/NTN database are presented in Figure 7.1 and Table 7.1. Table 7.1 also exhibits conductivity averages and precipitation totals for rainfall. Measured concentrations of several other chemical constituents of precipitation are given in Table 7.2.

The highest pH (and the least acid) precipitation occurred at the Sampson County site. This general area in southeastern North Carolina has the greatest numbers of animal producing farms. This area has the highest emissions of ammonia, a basic gas emitted from animal wastes. Table 7.2 shows that the ammonium concentration in precipitation is highest at the Sampson County site.

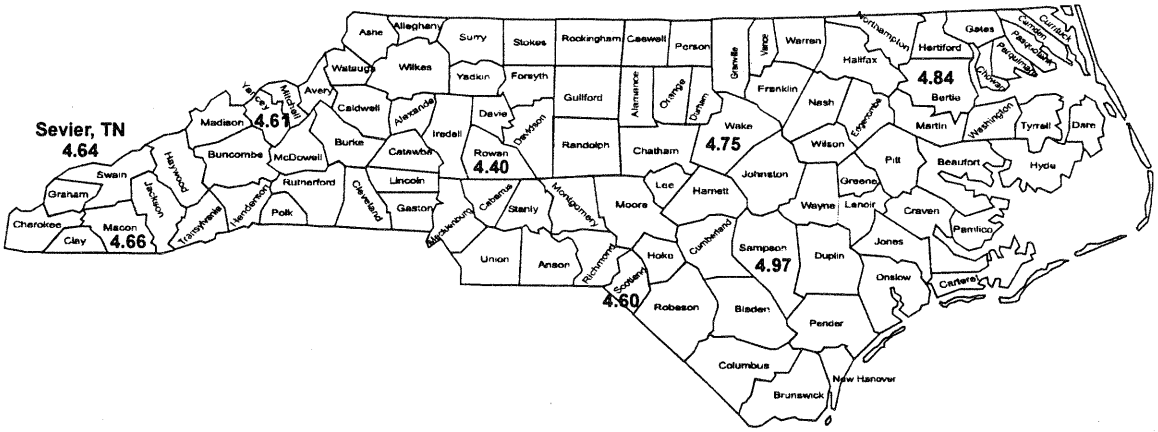


Figure 7.1 Annual Mean pH Values at North Carolina NADP/NTN/NDDN Sites, 1999

Table 7.1 pH, Conductivity in Microsiemans per Centimeter and Precipitation in Inches from the National Atmospheric Deposition Program/National Trends Network and National Dry Deposition Network Data for 1999.

COUNTY SITE ADDRESS	pH	CONDUCTIVITY	PRECIPITATION
BERTIE 340320 LEWISTON	4.84	10.4	71.1
MACON 342500 COWEETA	4.66	13.2	59.4
ROWAN 343460 PIEDMONT RESEARCH STATION	4.40	23.3	39.0
SAMPSON 343560 CLINTON CORPS RES. STATION	4.97	10.5	58.7
SCOTLAND 343600 JORDAN CREEK	4.60	15.1	49.0
WAKE 344160 FINLEY FARM	4.75	13.1	47.6
YANCEY 344500 Mt. MITCHEL	4.61	14.1	76.9
SEVIER (TN) 441190 GREAT SMOKY MTS NATIONAL PARK ELKMONT TN	4.64	13.5	57.1

Table 7.2 Ion Concentrations in Milligrams per Liter (Precipitation-weighted Annual Means) from the National Atmospheric Deposition Program/National Trends Network and National Dry Deposition Network Data for 1999.

COUNTY SITE ADDRESS	% COM- PLETENESS	Ca	Mg	K	Na	NH4	NO3	CL	SO4
BERTIE 340320 LEWISTON	86.5	0.06	0.035	0.027	0.276	0.11	0.51	0.49	0.78
MACON 342500 COWEETA	86.5	0.08	0.016	0.022	0.091	0.18	0.78	0.17	1.14
ROWAN 343460 PIEDMONT RESEARCH STATION	90.4	0.09	0.021	0.024	0.111	0.28	1.29	0.25	2.02
SAMPSON 343560 CLINTON CORPS RES. STATION	90.4	0.06	0.034	0.034	0.267	0.34	0.64	0.47	0.93
SCOTLAND 343600 JORDAN CREEK	82.7	0.06	0.018	0.105	0.122	0.17	0.84	0.30	1.20
WAKE 344160 FINLEY FARM	65.4	0.05	0.026	0.184	0.199	0.24	0.77	0.51	1.06
YANCEY 344500 Mt. MITCHEL	67.3	0.06	0.010	0.010	0.048	0.15	0.65	0.09	1.25
SEVIER (TN) 441190 GREAT SMOKY MTS NATIONAL PARK ELKMONT TN	78.8	0.08	0.012	0.029	0.037	0.14	0.80	0.08	1.15

8 Statewide Trends

The N.C. DENR has published an analysis of long term trends in North Carolina, statewide and within the individual Air Quality Control Regions, covering air pollutant concentrations from 1972 through 1989 (North Carolina Department of Environment, Health, and Natural Resources 1991b). Such a review of annual changes helps evaluate the success of programs intended to reduce pollution and prioritize future efforts. The next detailed update of the trends report is scheduled for publication in 2001. Starting with the 1998 annual air quality report and in all subsequent annual reports, the statewide trends section will be based on a 20-year moving window. This chapter provides some interim analyses at the statewide level.

8.1 Particulate Matter

The statewide distribution of second-highest 24-hour PM_{10} concentrations for each monitor from 1985 to 1999 is shown in Figure 8.1. Concentrations have decreased from 70 to about 44 $\mu g/m^3$ (a 38 percent decline). The levels have remained relatively constant at about 30 percent of the standard since 1993.

Since $PM_{2.5}$ measurements began in 1999, several years of data will be needed before meaningful statewide trends analysis will be performed for $PM_{2.5}$. For 1999, 26 sites out of 35 sites exceeded the $PM_{2.5}$ annual standard. The highest annual average (17.8 $\mu g/m^3$) occurred at Lexington.

8.2 Carbon Monoxide

The statewide distribution of second-highest one-hour carbon monoxide (CO) concentrations from 1980 to 1999 is shown in Figure 8.2. The average value of this concentration has decreased from 18 ppm in 1979 to 5.5 ppm in 1998 (a decline of 69 percent).

North Carolina did not experience an exceedance of the one-hour standard for CO from 1980 through 1999.

The statewide distribution of second-highest eight-hour CO concentrations from 1980 to 1999 is shown in Figure 8.3. The average value of this concentration decreased from 10 ppm in 1980 to 3.6 ppm in 1999 (a decline of 64 percent).

There were more than 400 exceedances of the 8-hour standard for CO from 1980 through 1990. The number of exceedances per year is shown in Figure 8.4. The average number of exceedances decreased from about 50 per year in 1980 to none in 1991. There have been no CO exceedances since 1991.

8.3 Ozone

The statewide distribution of second-highest one-hour ozone concentrations is shown in Figure 8.5. The average ozone (O_3) concentration increased by 11 percent from 1980 to 1999, ending at 0.11 ppm (92 percent of the standard).

There were 214 exceedances of the ozone one hour NAAQS from 1980 through 1999,

and the number of exceedances per year is shown in Figure 8.6. The number of exceedances generally fluctuates considerably from year to year, between zero and 23 annually. An exception was 1988, when 69 exceedances occurred. If the trend is examined with that year excluded as an outlier, in the last 6 years since 1994 (the last year when there were no exceedances), the average number of exceedances appears to be on an increase.

Because of the transition from the 1-hour ozone standard to the 8-hour ozone standard, a historical comparison of past levels is provided. The second-maximum 1-hour and the fourth-maximum 8-hour ozone averages are the most directly comparable to the one and eight hour standards. Figures 8.5 and 8.7 compare the statewide annual distributions of these values during the 1980-99 time period. Although the 8-hour distribution showed a smaller, 7 percent increase, there is a far greater percentage of the values above the standard for the 8-hour distribution than the 1-hour distribution, demonstrating that the 8-hour standard is much more restrictive than the 1-hour standard. In 1999, the end point of the 20 year period was 0.088, which is 110 percent of the standard.

Looking at the number of computed 8-hour exceedances in Figure 8.8, the increasing trend over the last few years, particularly since 1994 is apparent. The 570 and 540 exceedances in 1998 and 1999 respectively dwarf the computed 366 exceedances in 1988, which on a national basis, has been the worst year for ozone on record.

8.4 Sulfur Dioxide

The statewide distribution of second-highest three-hour sulfur dioxide (SO_2) concentrations from 1980 to 1999 is shown in Figure 8.9. The average decreased from 0.175 ppm in 1979 to 0.036 ppm in 1999 (7 percent of the standard), for a 79 percent decrease. The decrease occurred from 1980 to 1992 and the SO_2 levels have been relatively constant at .04 ppm every year since.

The statewide distribution of second-highest 24-hour SO_2 concentrations from 1980 to 1999 is shown in Figure 8.10. The average was approximately constant around 0.013 ppm (9 percent of the standard) from 1980 through 1999.

8.5 Nitrogen Oxides

The statewide distribution of annual average nitrogen dioxide (NO_2) concentrations from 1980 to 1999 is shown in Figure 8.11. The average concentration decreased from 0.0215 ppm in 1979 to 0.0154 ppm in 1999 (29 percent of the standard), or a decline of 28 percent.

8.6 Lead

The statewide distribution of quarterly lead (Pb) concentrations is shown in Figure 8.12. The average lead concentration decreased 92 percent, from 0.50 in 1980 to essentially the minimum detectable limit (MDL) of the methodology used by 1988. In 1997 the MDL was 0.04. There were lead samples taken at 10 special study sites in 1999. All of the lead samples were at or below the MDL.

8.7 pH

The statewide distribution of annual average pH values from 1980 to 1999 for the NADP/NTN sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 8.13. The mean pH has increased 3.9 percent over the 20 year time period. This is good news because it means that the rain is becoming less acidic.

The NADP/NTN instituted a change in sampling protocol during the first complete sample collected in 1994. As a consequence, acid rain data analyzed in the Central Analytical Laboratory before 1994 are not directly comparable to data analyzed in and after 1994 (NADP 1995). However, no attempt has been made here to adjust earlier or later data to be more properly comparable. The NADP study suggested that pH values less than 4.6 will decrease by a median amount of 0.03 (s.e. = 0.005) due to the protocol change (NADP 1995).

8.8 Ammonium Ion

The statewide distribution of annual average ammonium ion (NH_4^+) concentrations from 1980 to 1999 for the NADP/NTN sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 8.14. From 1980 to 1999 there appears to be a decrease of 32 percent. This trend is broken into three distinct time periods. The first 7 years show a decreasing trend, the second 11 years show an increasing trend while in the last 4 years the decreasing trend has returned. The ammonium ion concentration in rain increased significantly in Sampson County durring this time period, where there is concentrated animal production. (Cornelius, 1997) The NADP study suggested that the 1994 protocol change had no net effect on measured NH_4^+ concentrations (NADP 1995).

8.9 Nitrate Ion

The statewide distribution of annual average nitrate ion (NO_3^-) concentrations from 1980 to 1999 for the NADP/NTN sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 8.15. The mean has decreased by 27 percent over the study period. The NADP study suggested that NO_3^- concentrations will decrease by a median amount of 0.01 (s.e. = 0.002) due to the protocol change in 1994 (NADP 1995).

8.10 Sulfate Ion

The statewide distribution of annual average sulfate ion (SO_4^{2-}) concentrations from 1980 to 1999 for the NADP/NTN sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 8.16. The average has decreased from 2.3 mg/L in 1980 to 1.2 mg/L in 1999, for a 45 percent decrease. Since sulfates are the major cause of visibility reduction in the Eastern United States, this reduction should have a beneficial effect on visibility. The NADP study suggested that SO_4^{2-} concentrations will decrease by a median amount of 0.02 (s.e. = 0.002) due to the protocol change in 1994 (NADP 1995).

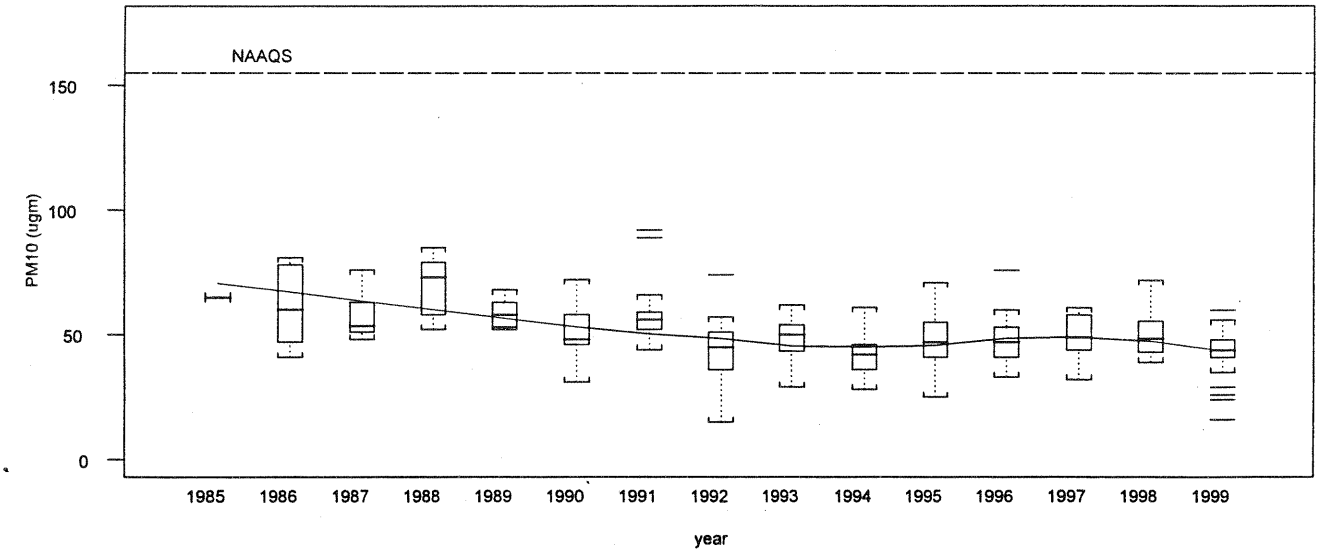


Figure 8.1. Distribution of Statewide Second-Maximum 24-Hour PM_{10} Concentrations, 1985-99, and Smoothed Regression Trend Line

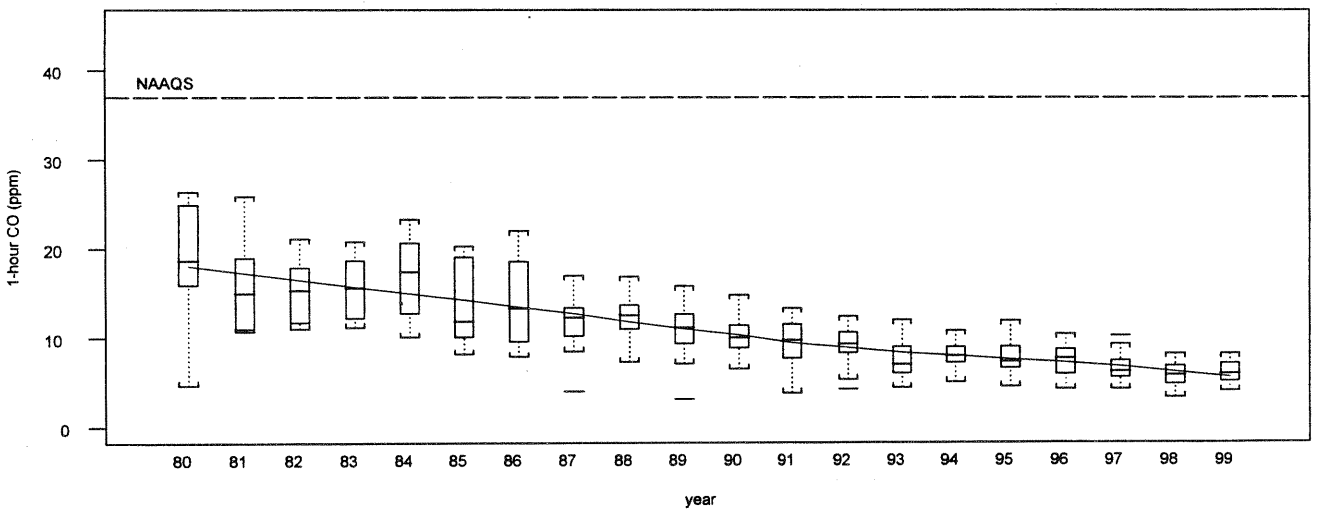


Figure 8.2. Distribution of Statewide Second-Maximum 1-Hour Carbon Monoxide Concentrations, 1980-99, and Smoothed Regression Trend Line

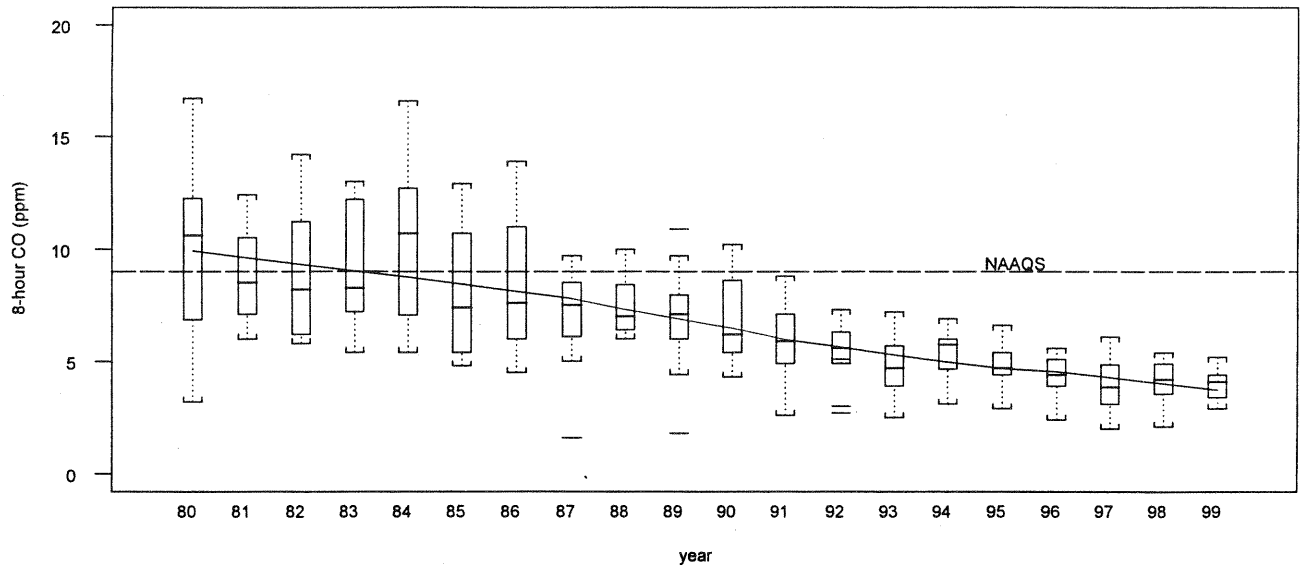


Figure 8.3. Distribution of Statewide Second-Maximum 8-Hour Carbon Monoxide Concentrations, 1980-99, and Smoothed Regression Trend Line

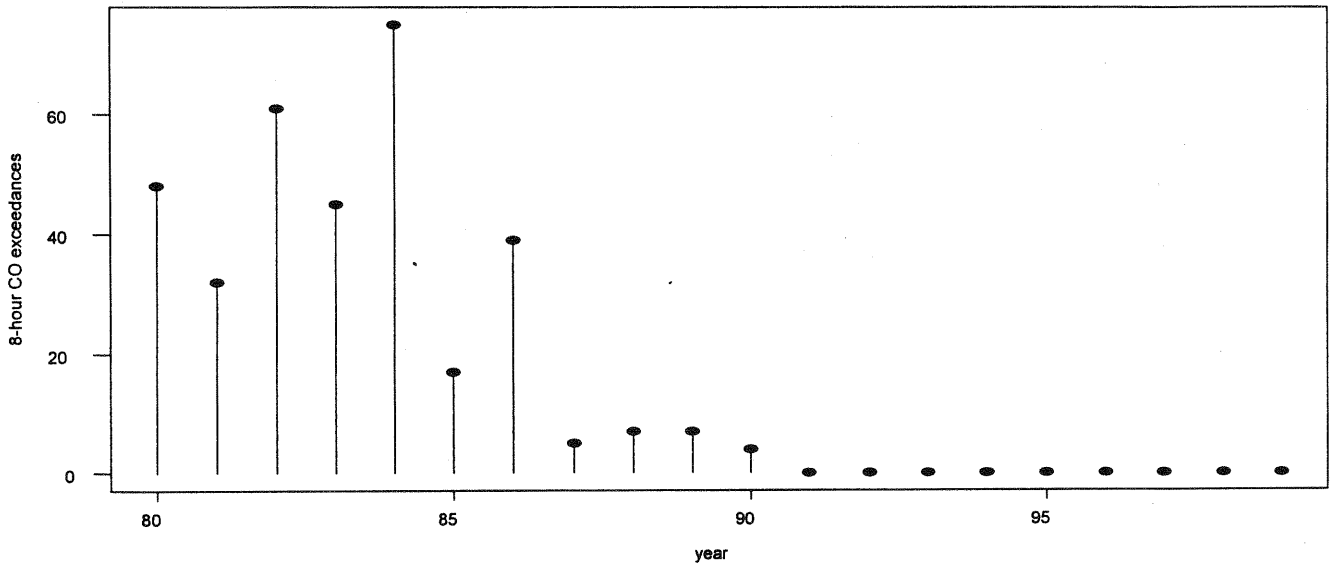


Figure 8.4. Number of Exceedances of 8-Hour Carbon Monoxide NAAQS, 1980-99

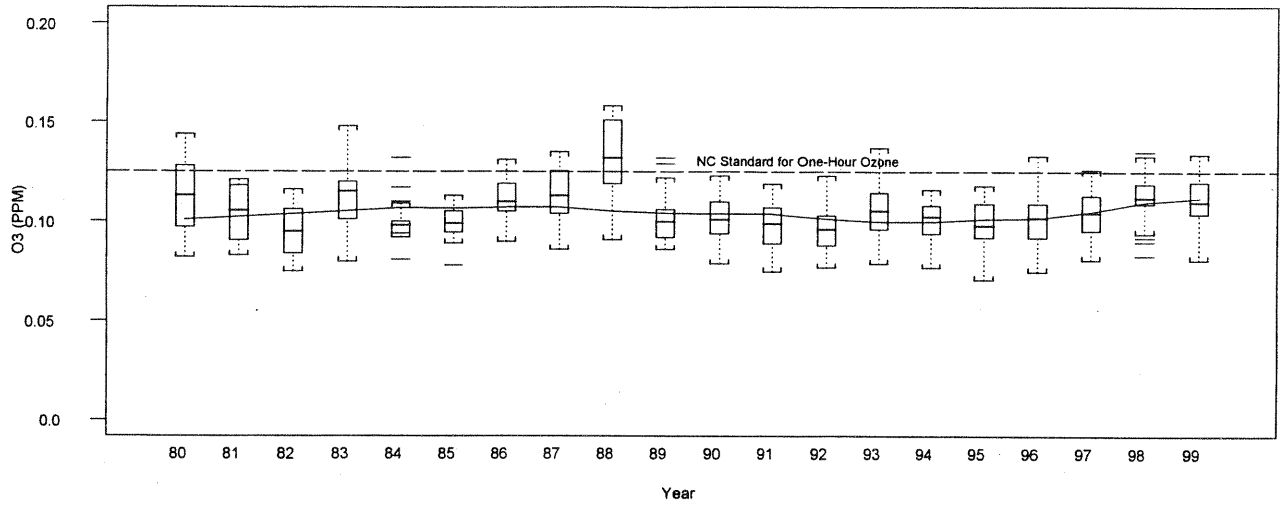


Figure 8.5. Distribution of Statewide Second-Maximum 1-Hour Ozone Concentrations, 1980-99, and Smoothed Regression Trend Line

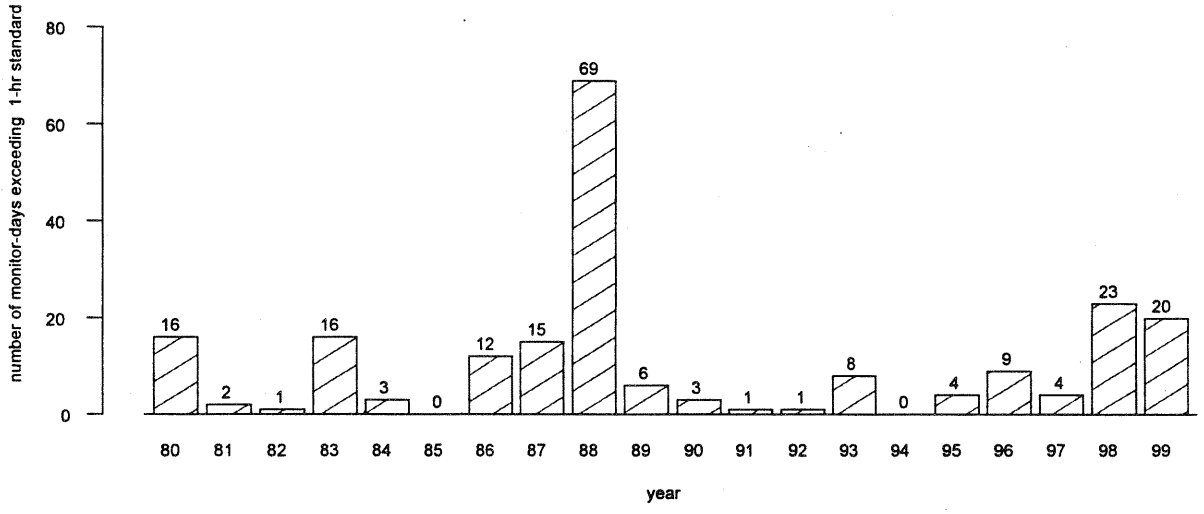


Figure 8.6. Number of Exceedances of the 1-Hour Ozone NAAQS, 1980-99

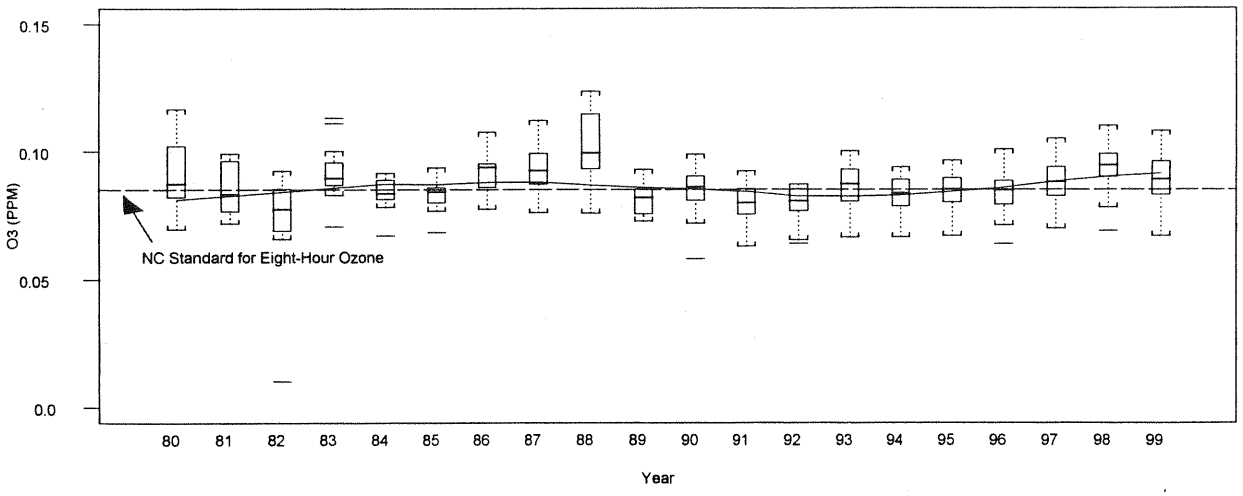


Figure 8.7 Distribution of Statewide Fourth-Maximum 8-Hour Ozone Concentrations 1980-99, and Smoothed Regression Trend Line

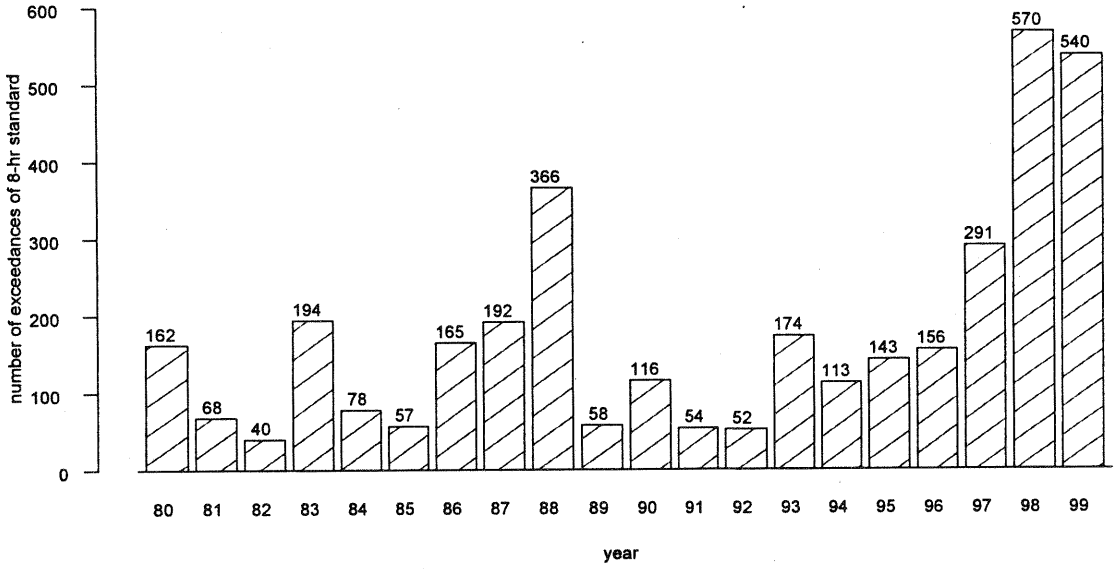


Figure 8.8 Number of Exceedances of the Daily Maximum 8-Hour Ozone Averages of 0.085 ppm or Greater, 1980-99

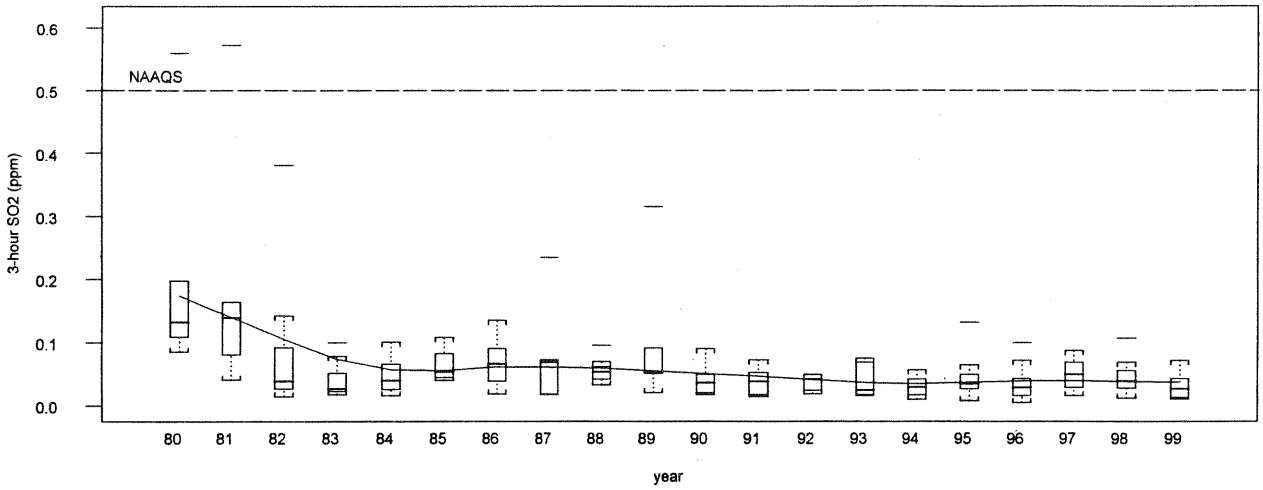


Figure 8.9 Distribution of Statewide Second-Maximum 3-Hour Sulfur Dioxide Concentrations, 1980-99, and Smoothed Regression Trend Line

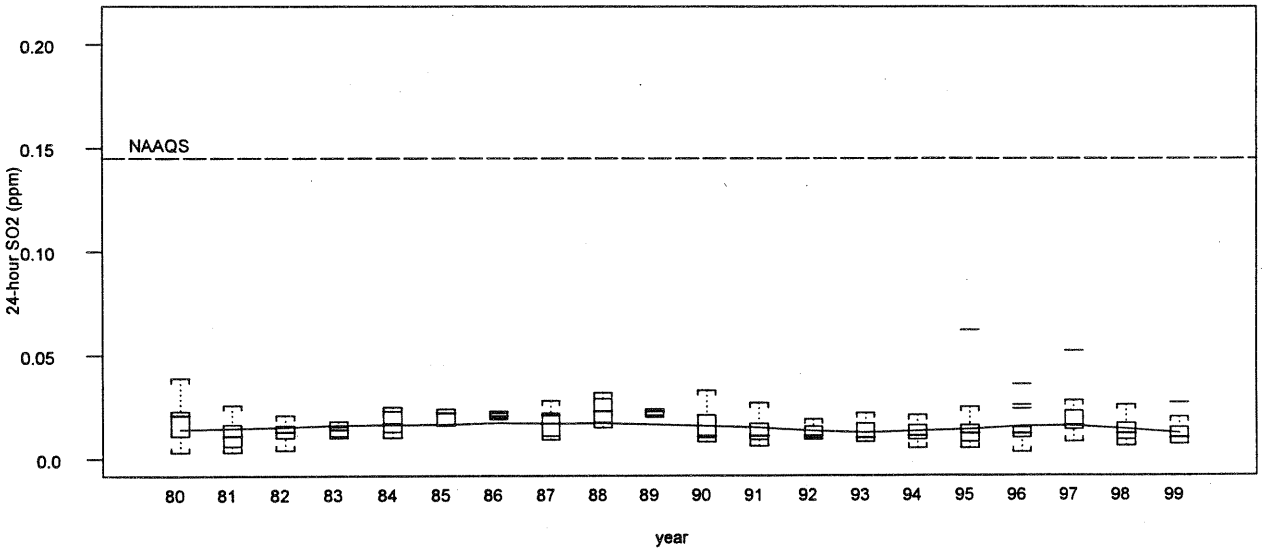


Figure 8.10 Distribution of Statewide Second-Maximum 24-Hour Sulfur Dioxide Concentrations, 1980-99, and Smoothed Regression Trend Line

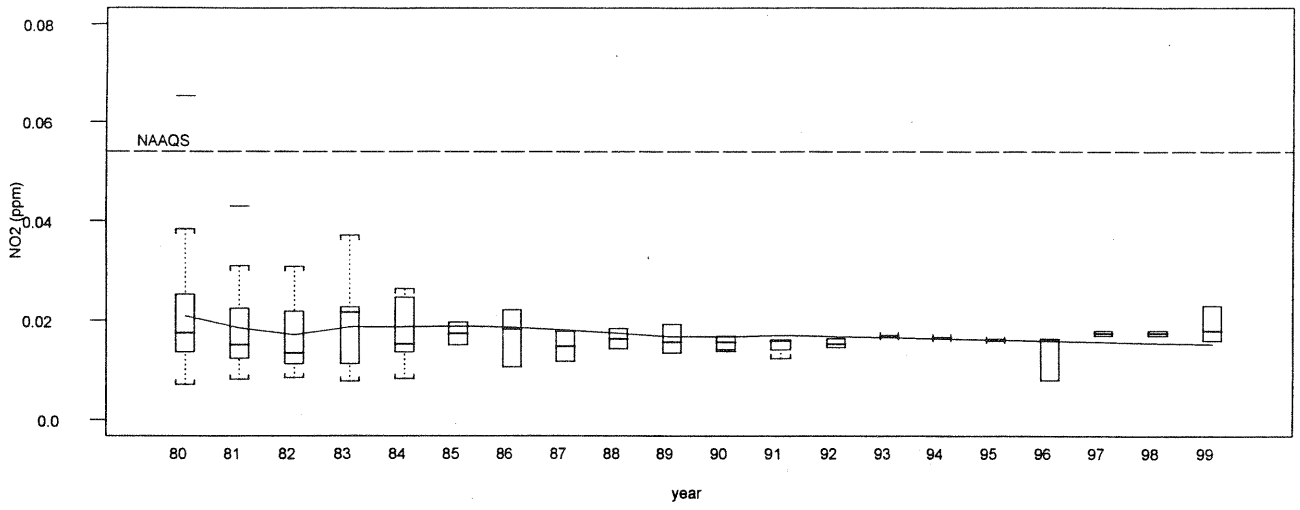


Figure 8.11 Distribution of Statewide Annual Mean Nitrogen Dioxide Concentrations, 1980-99, and Smoothed Regression Trend Line

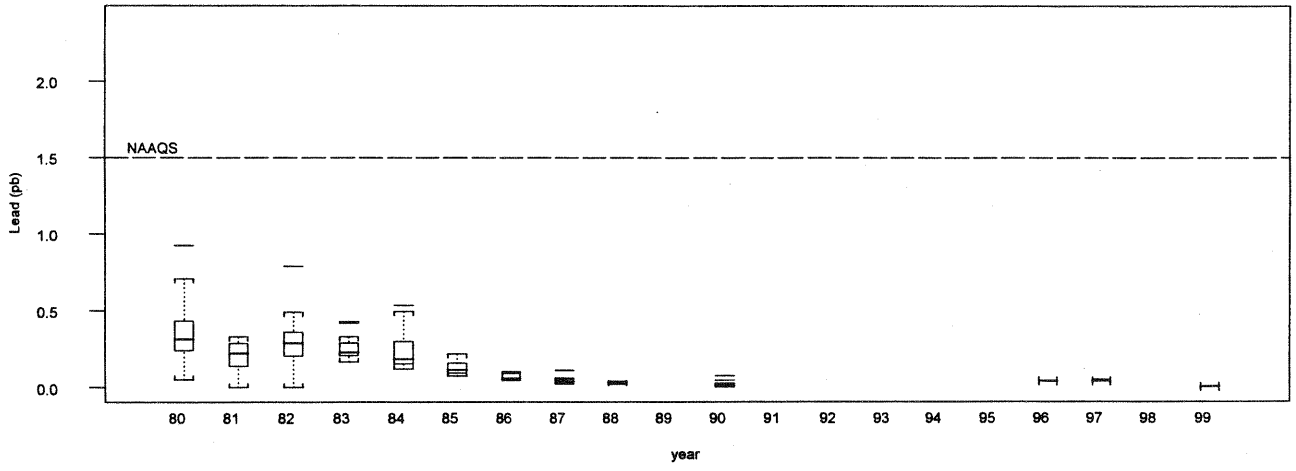


Figure 8.12 Distribution of Statewide Quarterly Lead Concentrations, 1980-99

There were no lead samples analyzed in 89, 91, 92, 93, 94, 95 and 98

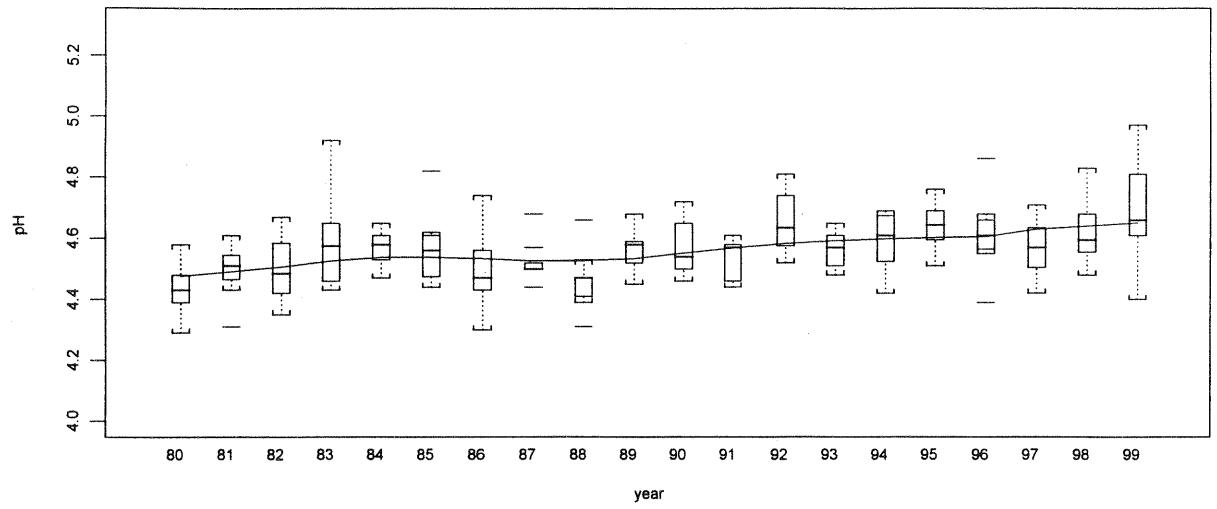


Figure 8.13 Distribution of Statewide Annual Mean pH, 1980-99, and Smoothed Regression Trend Line

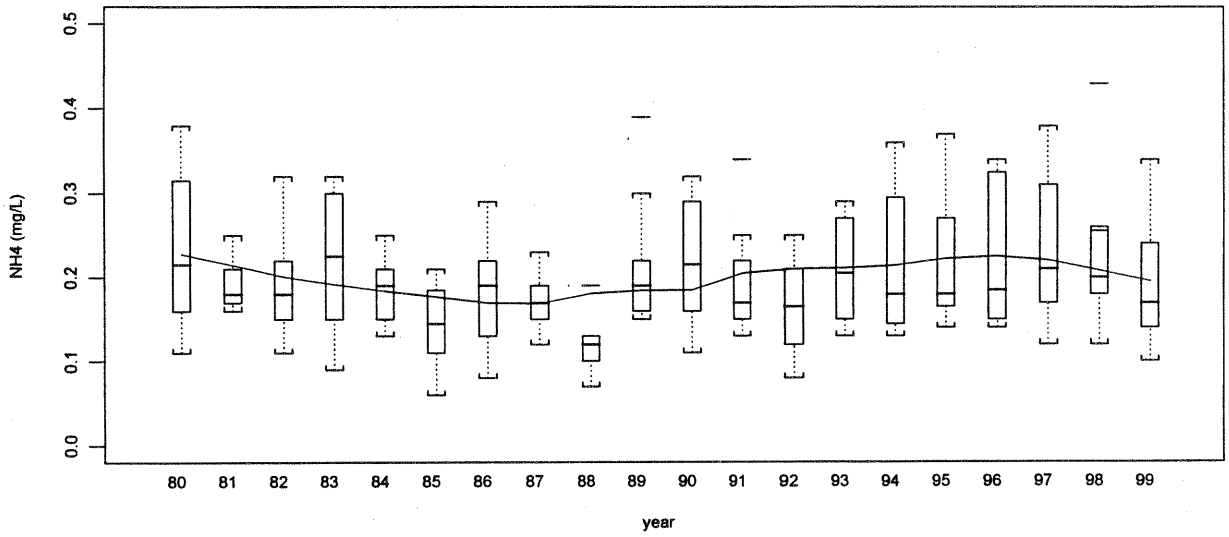


Figure 8.14 Distribution of Statewide Annual Mean Ammonium Ion Concentrations, 1980-99, and Smoothed Regression Trend Line

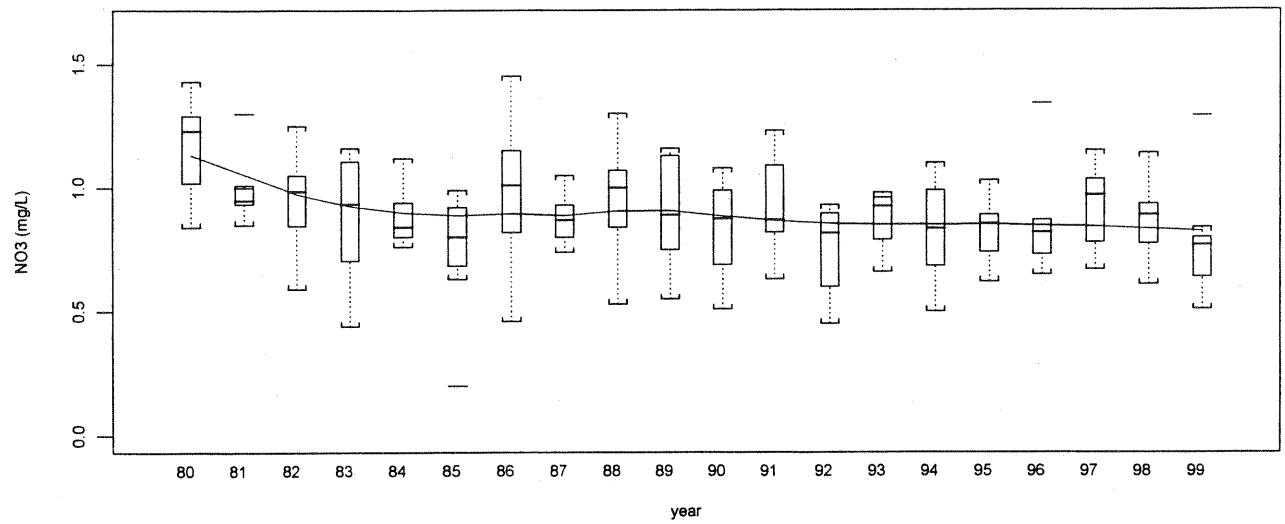


Figure 8.15 Distribution of Statewide Annual Mean Nitrate Ion Concentrations, 1980-99, and Smoothed Regression Trend Line

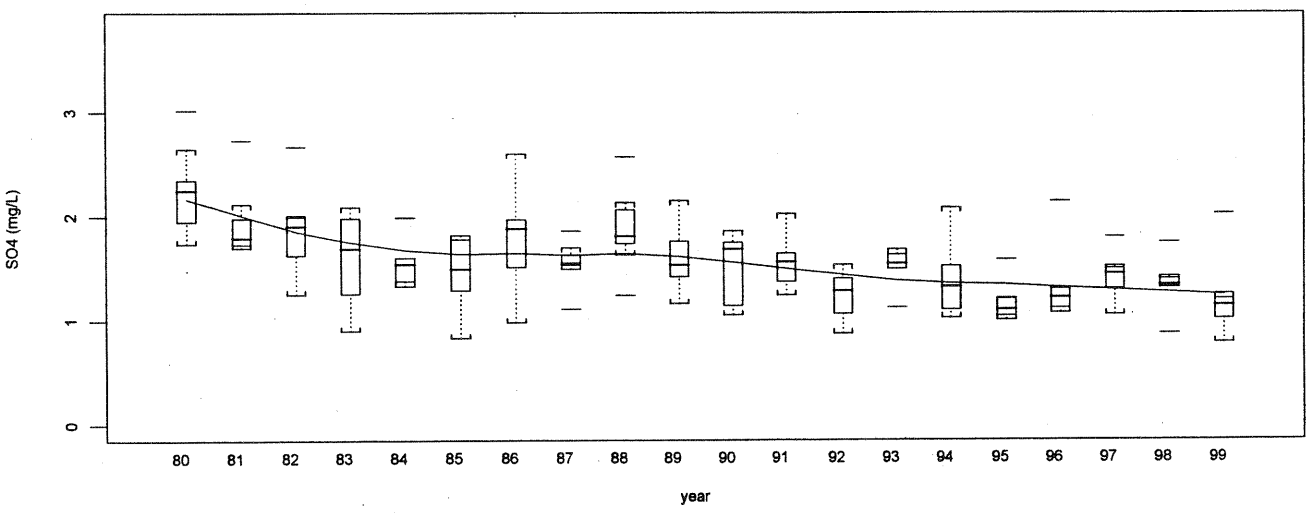


Figure 8.16 Distribution of Statewide Annual Mean Sulfate Ion Concentrations, 1980-99, and Smoothed Regression Trend Line

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United States Environmental Protection Agency [US EPA] (1993), "Code of Federal Regulations, Title 40, Parts 1 to 51, Protection of Environment," (July 1 ed.). *Office of the Federal Register (National Archives and Records Administration)*, Washington, DC.

Appendix A. Air Pollution Monitoring Agencies

North Carolina State Headquarters

Division of Air Quality
Parker Lincoln Building
2728 Capital Boulevard
1641 Mail Service Center
Raleigh, North Carolina 27699-1641
(919) 715-0665

North Carolina Regional Offices

Asheville Regional Office
Interchange Building
59 Woodfin Place
Asheville, North Carolina 28801
(704) 251-6208

Counties of Avery, Burke, Caldwell, Cherokee, Clay, Graham, Haywood, Henderson, Jackson, Macon, Madison, McDowell, Mitchell, Polk, Rutherford, Swain, Transylvania, and Yancey.

Fayetteville Regional Office
Suite 714
225 Green Street
Fayetteville, North Carolina 28301
(919) 486-1541

Counties of Anson, Bladen, Cumberland, Harnett, Hoke, Montgomery, Moore, Robeson, Richmond, Sampson, and Scotland.

Mooresville Regional Office
919 North Main Street
Mooresville, North Carolina 28115
(704) 663-1699

Counties of Alexander, Cabarrus, Catawba, Cleveland, Gaston, Iredell, Lincoln, Rowan, Stanly and Union.

Raleigh Regional Office
3800 Barrett Drive
Raleigh, North Carolina 27611
(919) 571-4700

Counties of Chatham, Durham, Edgecombe, Franklin, Granville, Halifax, Johnston, Lee, Nash, Northampton, Orange, Person, Vance, Wake, Warren, and Wilson.

Washington Regional Office
943 Washington Square Mall
Washington, North Carolina 27889
(919) 946-6481

Counties of Beaufort, Bertie, Camden, Chowan, Craven, Currituck, Dare, Gates, Greene, Hertford, Hyde, Jones, Lenoir, Martin, Pamlico, Pasquotank, Perquimans, Pitt, Tyrrell, Washington, and Wayne.

Wilmington Regional Office
127 Cardinal Drive Extension
Wilmington, North Carolina 28405-3845
(910) 395-3900

Counties of Brunswick, Carteret, Columbus, Duplin, New Hanover, Onslow and Pender.

Winston-Salem Regional Office
585 Waughtown Street
Winston-Salem, North Carolina 27107
(336) 771-4600

Counties of Alamance, Alleghany, Ashe, Caswell, Davidson, Davie, Guilford, Rockingham, Randolph, Stokes, Surry, Yadkin, Watauga, and Wilkes.

Local Agencies in North Carolina

Forsyth County Environmental Affairs Department
537 North Spruce Street
Winston-Salem, North Carolina 27101
(336) 727-8064

Mecklenburg County Department of Environmental Protection
1200 Blythe Boulevard
Charlotte, North Carolina 28203
(704) 376-4603

Western North Carolina Regional Air Pollution Quality Agency (Buncombe County and Asheville)
Buncombe County Courthouse Annex
Asheville, North Carolina 28801-3569
(704) 255-5655

Other Agencies in North Carolina

Eastern Band of Cherokee Indians
Tribal Environmental Office
P. O. Box 455
Cherokee, North Carolina 28719
(828) 497-3814

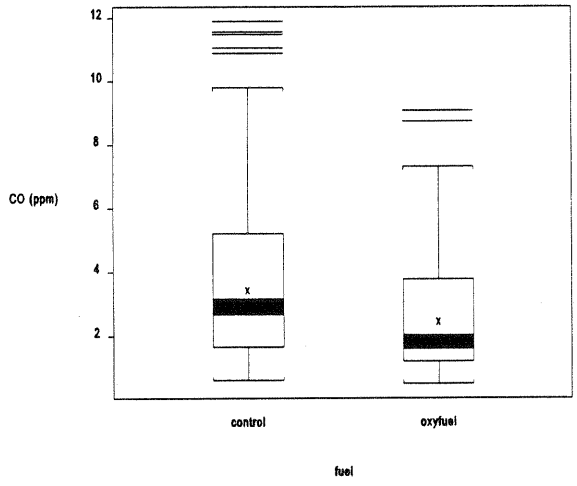
Appendix B. Exceptional Events

Type of Event	Pollutants Affected
Natural Events	
Sustained high wind speeds	particulate matter (PM)
Stagnations, inversions	all pollutants
Unusual lack of precipitation	PM
Stratospheric ozone intrusion	O_3
Volcanic eruption	CO, SO_2, PM
Forest fires	CO, PM, O_3
High pollen count	PM
Unintentional Man-made Events	
Large structural fires	CO, PM
Major traffic congestion due to accident or nonrecurring obstruction	CO
Chemical spills	SO_2, NO_2, PM, CO
Industrial accidents	SO_2, NO_2, PM, CO
Intentional Man-made Events	
Short-term construction/demolition	PM
Sandblasting	PM
High-sulfur oil refining	SO_2
Roofing operations	PM, SO_2
Salting or sanding of streets	PM
Infrequent large gatherings	PM, CO
Soot blowing from ships	PM
Agricultural tilling	PM
Prescribed burning	CO, PM
Noncompliance of local sources	CO, SO_2

Appendix C. Box-And-Whisker Plots

A *box-and-whisker plot* (also called *boxplot* or *schematic plot*) is a schematic diagram useful for depicting the location, spread and skewness of a continuous data variable. Box plots are constructed from *order statistics* (data values sorted from smallest to largest). The "box" of the box plot is oriented parallel to a continuous scale and is defined by 3 points, (1) a line or point in the interior of the box at the median of the data (a point that divides the order statistics into two equal parts), and (2) upper and (3) lower *fourths* or *quartiles.* (Fourths divide the upper and lower halves of the data values into two equal parts; quartiles divide the entire range of the data into 4 equal parts. Fourths and quartiles are not necessarily the *same*, because there may be more than one number that appropriately divides a given set of data in the prescribed way, and different computational techniques [or computer programs] may make different choices.)

The distance between the upper and lower fourth in the box plot is called the *interquartile range*. In most box plots, the length of each of the *whiskers* is 1.5 times the interquartile range or to the extreme (maximum or minimum) of the data, whichever is *shorter*. The endpoint of each whisker is called an *inner fence*. (In the box plots pictured below, the end of each whisker is marked by a "staple" for clarity.) There may be data points, called *outliers*, beyond the inner fences; if so, they are usually indicated individually on the box plot by a dot, small circle, or (as below) a short line segment perpendicular to the axis of the box. Box plots of variables with very long-tailed distributions may display two kinds of outliers—small dots for those just beyond the inner fences and larger dots or circles for *extreme outliers* at a distance of more than 3.0 times the interquartile range beyond the fourths. This boundary between outliers and extreme outliers is termed the *outer fence* and usually not explicitly shown in the plot.



The maximum and minimum values are always visible in a box-and-whisker plot as either the outermost outliers or, if there is no outlier, the position of the inner fence.

Box plots may have additional, optional features, such as a point marker at the *arithmetic mean* or a distinctive display of a *confidence interval for the median*, which is calculated from the fourths. In the figure, the arithmetic mean is marked with an "X", and the confidence interval for the median is displayed as a shaded or colored range; it is also common to display the confidence interval by cutting notches in the sides of the box at its endpoints.

Box plots are very useful for comparing two or more variables by placing two comparable variables side-by-side on the same scale (as in the figure). The statistics displayed can be directly compared, and statistical significance of difference between the medians can be assessed by examining overlap or lack of overlap of confidence intervals.

Appendix D. Nonattainment and North Carolina

What is nonattainment and what are the sources of the pollutants?

The United States Environmental Protection Agency (EPA) sets National Ambient Air Quality Standards. North Carolina monitors concentrations of air pollutants in the ambient air. Some of these monitors have measured concentrations of ozone and carbon monoxide exceeding the standards. Areas that have not met the National Ambient Air Quality Standards can be classified by EPA as "nonattainment."

Mobile sources such as cars and trucks are the primary cause of carbon monoxide and ozone precursors. About 90 percent of the carbon monoxide emissions come from motor vehicles. In the urban areas, 60 percent of the nitrogen oxides and 25 percent of the man-made hydrocarbons or volatile organic compound emissions come from motor vehicles; the rest comes from off-road vehicles, utility and industrial boilers, petroleum marketing, factories, businesses, and households. Nitrogen oxides react with volatile organic compounds and sunlight in warm weather to produce ozone.

Why is my county nonattainment?

EPA guidance recommends that an entire Metropolitan Statistical Area (MSA) be designated nonattainment when a monitor is found to be violating the National Ambient Air Quality Standards (NAAQS). This policy is due to the regional nature of certain pollutants, like ozone. Ozone is formed in the atmosphere under complex chemical reactions. Sometimes the ozone levels are higher just downwind of urban areas because of the time it takes the pollutants to react to form ozone. Therefore, larger areas are designated nonattainment to represent the likely area contributing to the air quality problems.

Once we are nonattainment, what is the process for becoming attainment?

North Carolina is required by the federal Clean Air Act and EPA to produce and implement emission reduction plans and show that these plans are strong enough to produce compliance with the standards. The plans could involve resource-intensive monitoring, emissions inventory, modeling, public participation, and strategy formulation efforts. There are deadlines for producing the plans and for achieving compliance with the standards. EPA must approve the plans.

How does the public get involved in the formulation of the emission reduction plans, known as State Implementation Plan (SIP) revisions?

Local agencies and officials, as well as state agencies, will be involved in drawing up the SIP revisions. There will be public meetings or special citizen panels. When draft SIP revisions are done, there will be public hearings on them. The SIP revisions must be approved by the N.C. Environmental Management Commission and possibly by local bodies as well. The N. C. General Assembly also reviews the SIP. EPA's approval process also includes an opportunity for public comment.

How will it affect citizens?

Emission reduction strategies fall into several categories. Motor vehicle inspection/maintenance may be required for hydrocarbons, carbon monoxide, and nitrogen oxides. Traffic patterns may be altered by changing roads or traffic signals. Both new and existing factories and business may have to reduce emissions by installing control equipment or changing processes. Cleaner burning gasoline may be required. More controls will be required on utility and industrial boilers. All of these measures may mean higher costs to the public.

What happens if North Carolina refuses to address these air pollution problems?

Under the Clean Air Act, EPA has the authority to apply sanctions. EPA can require more stringent offsets for new facilities of major pollutant sources, and may withhold federal highway construction funds in the nonattainment areas.

What is the likelihood of receiving sanctions if we are showing progress in reducing pollution?

North Carolina can avoid sanctions if it produces and carries out SIP revisions that EPA approves by the deadlines. If pollution concentrations do not recede and attain the standards as projected, the EPA could impose construction bans. However, EPA has some discretion about imposing sanctions. Sanctions are a last step to persuade states to take required positive action.

What does inspection/maintenance cost?

Currently, the inspection/maintenance (I/M), or motor vehicle tailpipe testing process, costs the motorist $19.40. If a vehicle fails the test, it must be repaired. A waiver is available if a vehicle still fails after $250.00 worth of repairs have been done. The $250.00 limit does not apply to tampered or misfueled vehicles. The inspection/maintenance program includes tests for hydrocarbon (HC) and carbon monoxide (CO) emissions for the following counties, Mecklenburg, Wake, Guilford, Forsyth, Durham, Gaston, Cabarrus, Orange, and Union. The number of counties will increase to 48 by 2006 under the Clean Air bill passed in 1999. The cost for this new test will be set by the General Assembly during the 2001 legislative session.

Currently, only gasoline powered motor vehicles built after 1974, excluding the current model year and motorcycles, are inspected in these counties. Inspection/maintenance pass/fail levels vary with vehicle age and pollutant.

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