1995

Ambient Air Quality Report

North Carolina
Department of
Environment and Natural Resources

Division Air Quality

Ambient Monitoring Section

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1995 Ambient Air Quality Report

STATE OF NORTH CAROLINA
James B. Hunt, Jr., Governor

DEPARTMENT OF
ENVIRONMENT
AND
NATURAL RESOURCES
Wayne McDevitt, Secretary

DIVISION OF AIR QUALITY
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AMBIENT MONITORING SECTION
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Foreword

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 1995 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 also described.

Acid rain data from the National Atmospheric Deposition Program/National Trends Network for North Carolina also is included for 1995. The report concludes with an account of pollutant concentration trends through 1995. Data collected after 1995 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
P O Box 29580
Raleigh, North Carolina 27626-0580

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 1995, 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 504,204 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, and nitrogen dioxide. 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 1972 (or the earliest year available) through 1995. The following summary discusses trends only for those pollutants having either increasing or decreasing tendencies.

Two different types of **particulate matter** were sampled in North Carolina during 1995. 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.

TSP was sampled at 16 sites, yielding 838 24-hour samples. One exceedance of the state TSP ambient air quality standard for 24-hour samples (150 $\mu g/m^3$) was observed in 1995, at Morehead City, Carteret County. The exceedance was attributed to an unusually high pollen count, which is identified as an "exceptional event" and is not counted as a violation of the standard.

PM_{10} was sampled at 48 sites, yielding 3,495 24-hour 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.

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 17 sites, yielding 127,002 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 one eight-

hour concentration of 8.7 ppm (97 percent of the standard) was observed at the Person Street, Raleigh site in Wake County. 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 emphasis in control of ozone has been to limit hydrocarbon emissions.

O_3 was sampled at 51 sites, yielding 236,866 valid hourly averages. The National Ambient Air Quality Standard for O_3 is 0.12 ppm for the maximum one-hour average. No exceedances occurred in North Carolina in 1994, and 11 occurred in 1993.

In 1995, there were five exceedances of the standard: two in Charlotte and one in Winston-Salem on July 14; one in Rockwell, Rowan County on August 14; and one in Yancey County, on Mt. Gibbs (near Mt. Mitchell), on August 17. Mecklenburg County was redesignated as in attainment for ozone in July. However, hydrocarbon control strategies continue to be used there to help reduce ozone concentrations.

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 19 sites, yielding 120,134 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).

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. NO_x was 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 15,869 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.

Although no lead samples were taken in 1995, 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 been decreasing by 17 to 40 percent annually in recent years. 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 and industrial sources reach the upper atmosphere, react with moisture in the air, and are deposited as acid precipitation. Monitoring of pH and 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 1995 ranged from 4.51 (Rowan County) to 4.76 (Sampson County).

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1. Introduction

This annual report summarizes the ambient air monitoring performed in calendar year 1995 by the North Carolina Division of Environmental Management (DEM) and three local air pollution agencies, which are more fully described in Appendix A on pp. 90-92. (The DEM was superseded in 1996 by the Division of Air Quality [DAQ].)

There were 504,204 air quality samples of the U.S. Environmental Protection Agency's (EPA) criteria pollutants – particulate matter, carbon monoxide, ozone, sulfur dioxide, and nitrogen dioxide – which are discussed in this report. No samples of another criteria pollutant, lead, were taken in 1995.

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 DEM and four 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 the early 1970s (1985 for PM_{10}) and pH values from 1978 through 1995.

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 (25°C) and pressure (760 mm mercury) and has an aerodynamic diameter of less than 100 micrometers. Currently, two sizes of particulate matter are monitored, total suspended particulate (TSP) and PM_{10}. 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).

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 coarse (2.5 - 60 micrometers), but particles formed in the atmosphere will usually be fine. Generally, coarse 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 transformation.

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 60°F and the sunlight is more intense.

Two natural sources of upper atmosphere ozone are solar radiation and electrical discharge during thunderstorms. These are not significant sources of tropospheric 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 emphysma. 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

Pollutant	Type of Average	Standard Level Concentration		
		Primary (Health Related)	Secondary (Welfare Related)	North Carolina
TSP	Annual Geom. Mean	NA[a]	NA[a]	75 $\mu g/m^3$
	24-hour	NA[a]	NA[a]	150 $\mu g/m^3$([b])
PM-10	Expected Annual Arith. Mean	50 $\mu g/m^3$	50 $\mu g/m^3$	50 $\mu g/m^3$
	24-hour[c]	150 $\mu g/m^3$	150 $\mu g/m^3$	150 $\mu g/m^3$
CO	8-hour[b]	9 ppm (10 mg/m^3)[d]	NA	9 ppm (10 mg/m^3)
	1-hour[b]	35 ppm (40 mg/m^3)	NA	35 ppm (40 mg/m^3)
O_3	Maximum Daily 1-hour Average[e]	0.12 ppm (235 $\mu g/m^3$)	0.12 ppm (235 $\mu g/m^3$)	0.12 ppm (235 $\mu g/m^3$)
SO_2	Annual Arith. Mean	80 $\mu g/m^3$ (0.03 ppm)	NA	80 $\mu g/m^3$ (0.03 ppm)
	24-hour[b]	365 $\mu g/m^3$ (0.14 ppm)	NA	365 $\mu g/m^3$ (0.14 ppm)
	3-hour[b]	NA	1,300 $\mu g/m^3$ (0.50 ppm)	1,300 $\mu g/m^3$ (0.50 ppm)
NO_2	Annual Arith. 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	Maximum Quarterly Arith. Mean	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$

a. National TSP standards were discontinued in 1987 and superseded by standards for PM_{10}.

b. Not to be exceeded more than once per year.

c. The standard is attained when the expected number of days per calendar year (following 40 CFR 50 App. K [US EPA 1993, p. 773-777]) above the standard concentration is less than or equal to 1.0.

d. Concentrations in parentheses are approximately equivalent to the adjacent specified standard.

e. The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations (following 40 CFR 50 App. H [US EPA 1993, p. 767-769]) above the standard concentration is equal to or less than 1.0.

4. Ambient Air Quality Monitoring Program

Ambient monitoring and analyses of samples were conducted by the North Carolina Air Quality Section and three local air pollution control programs (Appendix A, pp. 90-92). (The Air Quality Section became the Division of Air Quality [DAQ] in 1996.) 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. A list of all monitoring sites active in 1995 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, 5.12, 5.16, and 5.19.

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.

Table 4.1 Ambient Air Monitoring Sites Operated in North Carolina, 1995.

SITE COUNTY	STREET	POLLUTANTS	
37-001-0002 ALAMANCE	827 S GRAHAM & HOPEDALE RD	PM10	
37-003-0003 ALEXANDER	STATE ROAD 1177	SO2	PM10
37-011-8001 AVERY	ROARING CREEK RD., PISGAH N.F.	O3	
37-013-0003 BEAUFORT	NC HIGHWAY 306	SO2	
37-013-0004 BEAUFORT	SOUTH FERRY LANDING PAMLICO RIVER	SO2	
37-013-0005 BEAUFORT	SLATESTONE ROAD (NEAR WATER TOWER)	PM10	
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BLDG WOODFIN ST	TSP	PM10
37-021-0030 BUNCOMBE	ROUT 191 SOUTH BREVARD RD	O3	
37-021-0032 BUNCOMBE	LONDON RD ASHVILLE	PM10	
37-021-0033 BUNCOMBE	US70 WEST SWANNANOA	PM10	
37-025-0004 CABARRUS	FLOYD ST. KANNAPOLIS	PM10	
37-027-0003 CALDWELL	HWY 321 N LENOIR	O3	

SITE COUNTY	STREET	POLLUTANTS			
37-029-0099 CAMDEN	COUNTY ROAD 1136 & 1134	O3			
37-031-0003 CARTERET	ARENDELL & 4TH MOREHEAD CITY	TSP			
37-031-8001 CARTERET	MERRIMON ROAD BEAUFORT	O3			
37-033-0001 CASWELL	CHERRY GROVE RECREATION	O3	HSCO[a]		
37-035-0004 CATAWBA	1650 1ST. ST.	TSP	PM10		
37-037-0004 CHATHAM	RT4 BOX62 PITTSBORO	O3	HSCO	SO2	PM10
37-047-0001 COLUMBUS	ACME-DELCO SAMPLING SITE HWY 87	TSP	SO2		
37-051-0004 CUMBERLAND	F.S. # 5 3296 VILLAGE DR.	TSP	PM10		
37-051-0007 CUMBERLAND	CUMBERLAND CO ABC BOARD, 1705 OWEN DRIVE	CO			
37-051-0008 CUMBERLAND	1/4MI SR1857/US301/1857	O3			
37-051-1002 CUMBERLAND	HOPE MILLS POLICE DPT, ROCKFISH RD.	O3			

[a]HSCO is CO monitored only during the ozone season, using a "high sensitivity" instrument, in support of special purpose monitoring for ozone precursors, rather than criteria pollutant monitoring.

SITE COUNTY	STREET	POLLUTANTS	
37-057-0002 DAVIDSON	S.SALISBURY ST.LEXINGTON	PM10	
37-057-1002 DAVIDSON	400 SALEM STREET	TSP	PM10
37-059-0099 DAVIE	FORK RECREATION CENTER	PM10	
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	O3	
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST	PM10	
37-063-0011 DURHAM	201 NORTH ROXBORO ST	CO	
37-063-0012 DURHAM	4001 CHAPEL HILL BLVD	CO	
37-063-0013 DURHAM	2700 NORTH DUKE STREET	O3	HSCO
37-065-0002 EDGECOMBE	LEGETT RD.,WASTE TREATMENT PLANT	PM10	
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	PM10	
37-067-0007 FORSYTH	5337 OLD RURAL HALL ROAD	O3	
37-067-0009 FORSYTH	INDIANA AV & AKRON DR HANES HOSIERY PK	PM10	

SITE COUNTY	STREET	POLLUTANTS			
37-067-0013 FORSYTH	720 RIDGE AVENUE	PM10			
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE	O3	HSCO	SO2	NO2
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY	PM10	HSCO		
37-067-0025 FORSYTH	100 SW STRATFORD RD	CO			
37-067-0026 FORSYTH	1590 BOLTON STREET	CO			
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE	O3			
37-067-1001 FORSYTH	BODENHEIMER ST	PM10			
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE	CO			
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE	O3			
37-069-0001 FRANKLIN	431 S HILLSBOROUGH ST FRANKLINTON	O3	HSCO		
37-071-0014 GASTON	RANKIN LAKE RD,GASTONIA	TSP			
37-071-0015 GASTON	1555 EAST GARRISON BLVD	CO			

SITE COUNTY	STREET	POLLUTANTS	
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSP	O3	HSCO
37-077-0002 GRANVILLE	3200 WEBB SCHOOL RD OXFORD	PM10	
37-081-0009 GUILFORD	EDGEWORTH & BELLEMEADE STS	PM10	
37-081-0011 GUILFORD	KEELY PARK, KEELY RD.	O3	
37-081-1005 GUILFORD	E GREEN & S CENTENNIAL ST	PM10	
37-081-1011 GUILFORD	401 WEST WENDOVER	CO	
37-083-0002 HALIFAX	NE CORNER OF 5TH & CAROLINA ST.	PM10	
37-085-0001 HARNETT	MUNICIPAL BUILDING	TSP	PM10
37-087-0002 HAYWOOD	ROOF, CANTON FIRE DEPT.	PM10	
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PKWY MILE MARKER 410	O3	
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAIN NATIONAL PARK	O3	
37-089-1006 HENDERSON	CORNER OF ALLEN & WASHINGTON STS	PM10	

SITE COUNTY	STREET	POLLUTANTS			
37-101-0002 JOHNSTON	3411 JACK ROAD CLAYTON NC	O3			
37-109-0003 LINCOLN	EAST CONGRESS ST	PM10			
37-109-0004 LINCOLN	RIVERVIEW ROAD	O3	HSCO	SO2	PM10
37-111-0002 MC DOWELL	COURTHOUSE	PM10			
37-113-8001 MACON	COWEETA HYDROLOGIC LABRATORY	O3			
37-117-0001 MARTIN	HAYES STREET (#2WELL SITE)	O3			
37-117-0001 MARTIN	HAYES STREET (#2WELL SITE)	SO2			
37-119-0001 MECKLENBURG	600 EAST TRADE STREET	TSP			
37-119-0001 MECKLENBURG	600 EAST TRADE STREET	PM10			
37-119-0003 MECKLENBURG	FIRE STA #11 620 MORETZ STREET	PM10			
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD	TSP	PM10		
37-119-0032 MECKLENBURG	5137 CENTRAL AVE.	CO			

SITE COUNTY	STREET	POLLUTANTS			
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL	O3	HSCO	SO2	NO2
37-119-0035 MECKLENBURG	1330 SPRING ST GRNVILLE NEIGHBORHOOD CNT	CO			
37-119-0037 MECKLENBURG	415 EAST WOODLAWN RD	CO			
37-119-0038 MECKLENBURG	301 N TRYON ST	CO			
37-119-1001 MECKLENBURG	FILTER PLANT	PM10			
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD.	O3	PM10		
37-119-1009 MECKLENBURG	29 N@ MECKLENBURG CAB CO	O3	HSCO		
37-121-0001 MITCHELL	CITY HALL SUMMIT ST	TSP	PM10		
37-123-8001 MONTGOMERY	112 PERRY DRIVE	O3			
37-129-0006 NEW HANOVER	HWY 421 NORTH	SO2			
37-129-0007 NEW HANOVER	WAREHSE & RECEIVING ST UNCW WILM	TSP	PM10		
37-131-0002 NORTHAMPTON	RT 46 GASTON NORTH CAROLINA	O3	SO2		

SITE COUNTY	STREET	POLLUTANTS		
37-133-0004 ONSLOW	2553 ONSLOW DRIVE, JACKSONVILLE	PM10		
37-135-0005 ORANGE	109 1/2 EAST FRANKLIN STREET	CO		
37-139-0001 PASQUOTANK	WATER PLANT N WILSON ST	TSP	PM10	
37-145-0099 PERSON	SR 1102 & NC 49	O3	SO2	
37-147-0003 PITT	1500 BEATTY ST GREENVILLE	PM10		
37-147-0099 PITT	US 264 NEAR FARMVILLE WATER TOWER	O3		
37-155-0003 ROBESON	SO. WATER ST.	PM10		
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL	O3		
37-159-0021 ROWAN	WEST ST & GOLD HILL AVENUE	O3	HSCO	
37-159-0022 ROWAN	925 N ENOCHVILLE AVE	O3	HSCO	
37-159-1006 ROWAN	CORNER OF CHURCH & KERR STS	PM10		
37-173-0002 SWAIN	CENTER ST/PARKS 7 REC FACILITY	O3	SO2	PM10
37-175-0002 TRANSYLVANIA	HWY 64	TSP		

SITE COUNTY	STREET		POLLUTANTS
37-183-0003 WAKE	FIRE STATION #9 SIX FORKS RD NORTH HILLS	TSP	PM10
37-183-0011 WAKE	420 S PERSON ST	CO	
37-183-0013 WAKE	EF HUTTON, HWY 70 WEST	CO	
37-183-0014 WAKE	E MILLBROOK JR HI 3801 SPRING FOREST RD	O3	
37-183-0015 WAKE	808 NORTH STATE STREET	O3	HSCO
37-183-0016 WAKE	201 NORTH BROAD STREET	O3	HSCO
37-183-0017 WAKE	5033 TV TOWER RD GARNER	O3	
37-183-0018 WAKE	HWY 70WEST AND HWY 50 NORTH	CO	
37-187-0002 WASHINGTON	OLD ACRE RD.	TSP	
37-189-0003 WATAUGA	HARDIN PRK ELEMENTARY SCHL HWY194 BOONE	PM10	
37-191-0004 WAYNE	HWY 70 WEST PATROL STA.GOLDSBORO	PM10	
37-195-0002 WILSON	N.W. CORNER OF KENAN ST.& TARBORO ST.	PM10	

SITE COUNTY	STREET	POLLUTANTS
37-199-0003 YANCEY	BLUE RIDGE PARKWAY	O3

Sites Operated in 1995	109

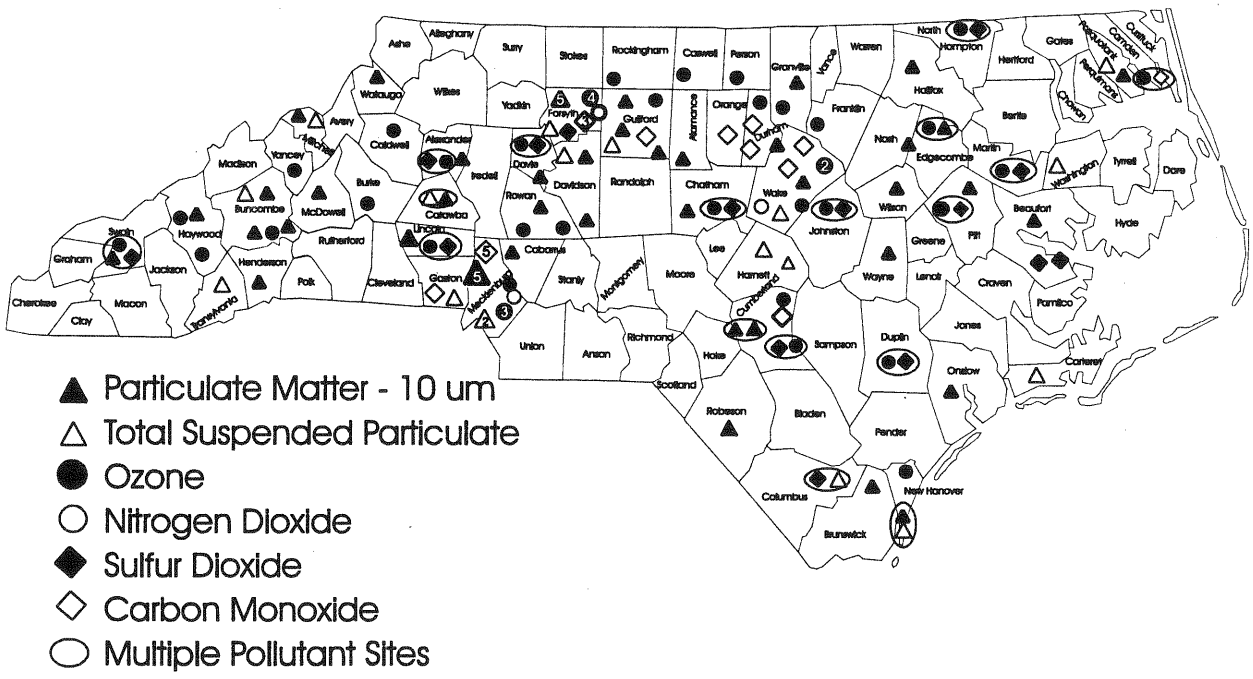

Figure 4.1 Monitoring Sites Active in 1995.

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 1995 ambient air quality report were collected at 158 air pollutant monitors operated by state and local agencies in North Carolina (listed in Appendix A, pp. 90-92). To save operating costs, some ozone monitors and sulfur dioxide monitors are operated only every third year. Nineteen of the 158 monitors used for this report operated most recently in 1993 or 1994. Lead concentration data are collected annually by the state and local agencies, but they are analyzed by EPA. Thus, the availability of lead data may be more delayed than that for other pollutants. The most recent lead data available are from 1990 and involve 5 of the 158 monitors.

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 1995, 16 sites were used to monitor TSP and 838 samples were collected. A map of the TSP sampling sites is shown in Figure 5.1, and a detailed summary of the data from each site is given in Table 5.1.

Only one sample exceeded the N.C. TSP ambient air quality standards in 1995, compared to two exceedances in both 1994 and 1993. All of these exceedances have been attributed to exceptional events, rather than typical ambient air. The 1995 exceedance occurred in Morehead City, Carteret County, on 22 March. This was attributed to an unusually high pollen count, contributing to a measured concentration of 215 $\mu g/m^3$ of TSP, which is 145 percent of the standard for a 24 hour sample. 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 55 $\mu g/m^3$, which is 75 percent of the level of the air quality standard. The second highest 24-hour concentrations are charted by county in Figure 5.2 and the annual geometric means are similarly charted in Figure 5.3. (In counties with more than one TSP monitoring site, the concentration reported in Figure 5.2 is the county-wide second largest concentration, and the geometric mean reported in Figure 5.3 is the maximum geometric mean for the county.)

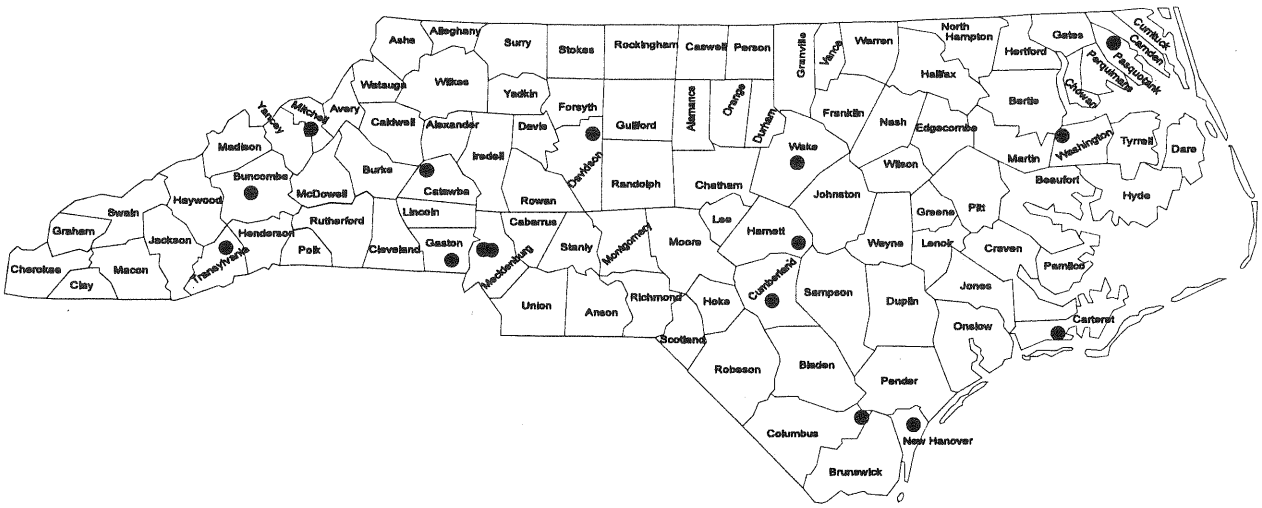

Figure 5.1 Location of TSP Monitoring Sites.

Table 5.1 Total Suspended Particulates in Micrograms per Cubic Meter for 1995.

SITE NUMBER COUNTY	STREET	NUM OBS	24-HOUR MAXIMA 1ST	2ND	3RD	4TH	ARITH. MEAN	GEOM. MEAN	GEOM. SD
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BLDG WOODFIN ST	52	58	57	56	51	32.8	30.4	1.51
37-031-0003 CARTERET	ARENDELL & 4TH MOREHEAD CITY	60	**215**[a]	105	85	79	43.9	37.0	1.80
37-035-0004 CATAWBA	1650 1ST. ST.	54	125	108	100	97	59.9	55.3	1.53
37-047-0001 COLUMBUS	ACME-DELCO SAMPLING SITE HWY 87	61	83	67	53	52	28.3	25.0	1.67
37-051-0004 CUMBERLAND	F.S. # 5 3296 VILLAGE DR.	58	113	85	72	71	44.6	41.5	1.48
37-057-1002 DAVIDSON	400 SALEM STREET	53	92	87	81	73	47.2	43.7	1.53
37-071-0014 GASTON	RANKIN LAKE RD, GASTONIA	58	91	80	69	66	39.2	35.4	1.64
37-085-0001 HARNETT	MUNICIPAL BUILDING	60	84	74	69	68	45.0	41.8	1.51
37-119-0001 MECKLENBURG	600 EAST TRADE STREET	61	91	87	87	84	50.8	47.4	1.50
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD	59	82	78	62	61	39.7	37.5	1.42
37-121-0001 MITCHELL	CITY HALL SUMMIT ST	8	95	74	69	62	54.6	48.0	1.80
37-129-0007 NEW HANOVER	WAREHSE & RECEIVING ST UNCW WILM	61	111	88	67	60	30.7	26.9	1.66

[a]Exceeds secondary standard of 150 $\mu g/m^3$. The exceedance sample occurred on 22 March 1995 and was attributed to a high pollen count (40 percent of the particulate matter on the filter was pollen). The fourth maximum excluding the exceedance was 78 $\mu g/m^3$.

SITE NUMBER COUNTY	STREET	NUM OBS	24-HOUR MAXIMA 1ST	2ND	3RD	4TH	ARITH. MEAN	GEOM. MEAN	GEOM. SD
37-139-0001 PASQUOTANK	WATER PLANT N WILSON ST	56	103	58	57	56	33.5	31.0	1.48
37-175-0002 TRANSYLVANIA	HWY 64	17	87	80	51	47	39.1	34.4	1.72
37-183-0003 WAKE	FIRE STATION #9 SIX FORKS RD NORTH HILLS	61	84	75	75	72	40.9	37.8	1.51
37-187-0002 WASHINGTON	OLD ACRE RD.	59	144	116	78	62	40.2	36.8	1.49

Total Samples	**838**
Total Sites Sampled	**16**

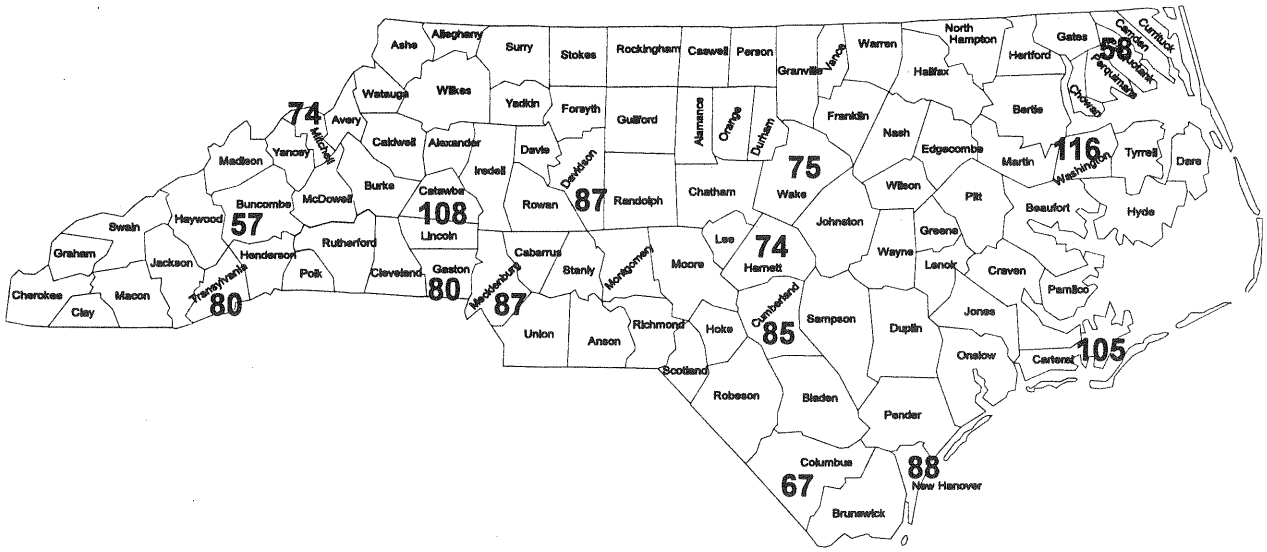

Figure 5.2 Total Suspended Particulates: Second Highest 24-Hour Averages, 1995

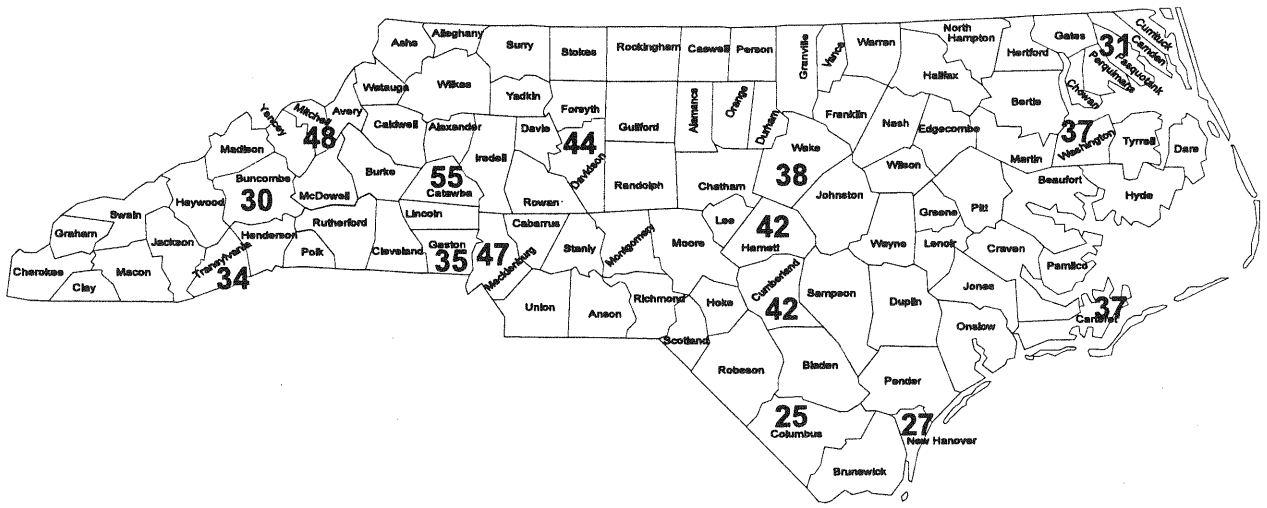

Figure 5.3 Total Suspended Particulates: Maximum Annual Geometric Means, 1995

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 1995 48 sites were used to monitor PM_{10} and 3,495 samples were collected. A map of the PM_{10} 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_{10} ambient air quality standards in 1995. The greatest 24-hour maximum concentration was 78 $\mu g/m^3$, or about 50 percent of the standard (150 $\mu g/m^3$). The greatest annual arithmetic mean was 33 $\mu g/m^3$, which is 65 percent of the standard (50 $\mu g/m^3$).

The second highest 24-hour concentrations are charted by county in Figure 5.5 and the annual arithmetic means are shown in Figure 5.6. (In counties with more than one TSP monitoring site, the concentration reported in Figure 5.5 is the county-wide second maximum 24-hour concentration, and the mean reported in Figure 5.6 is the maximum arithmetic mean for the county.)

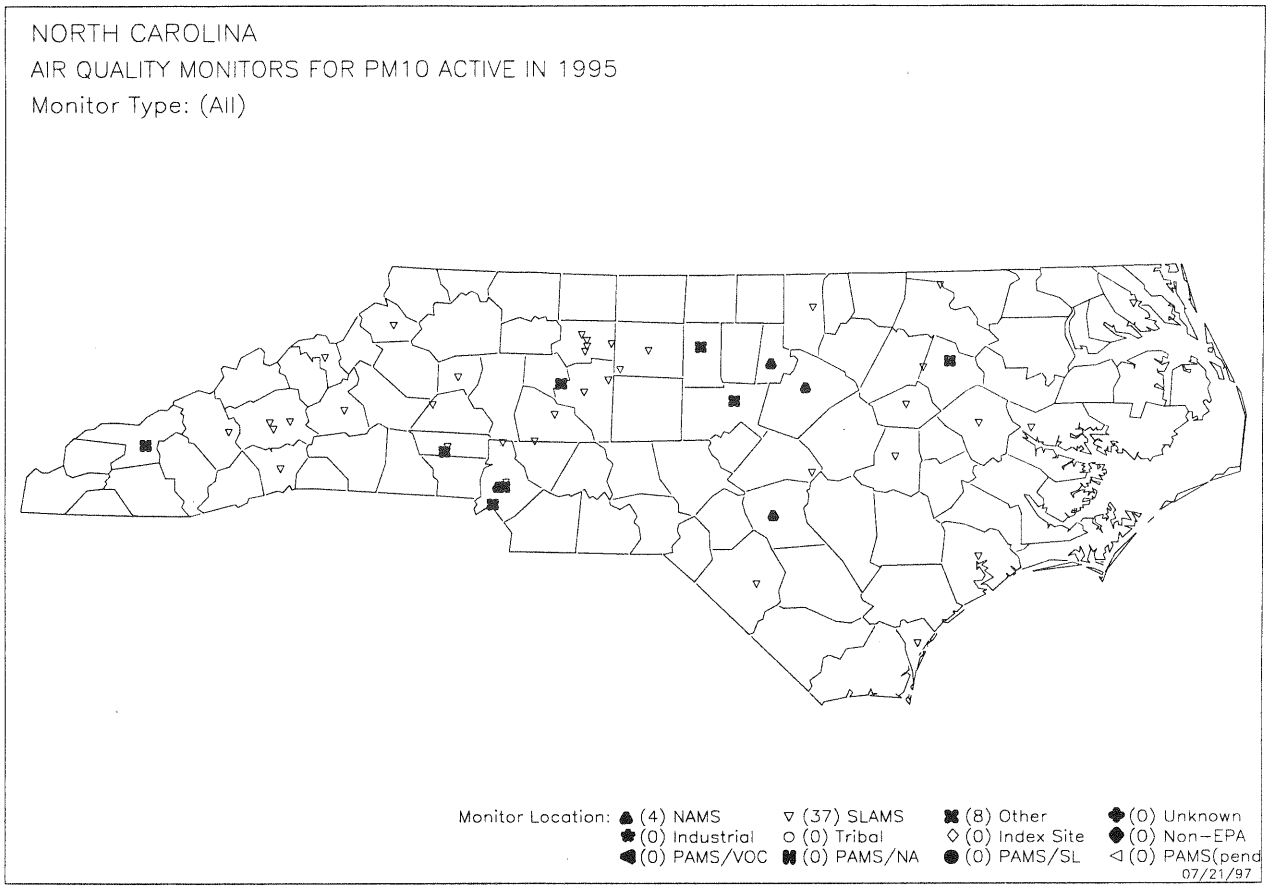

Figure 5.4 Location of PM_{10} Monitoring Sites.

Table 5.2 PM_{10} in Micrograms per Cubic Meter for 1995.

SITE COUNTY	STREET	NUM. OBS	24-HOUR MAXIMA 1ST	2ND	3RD	4TH	ARITH. MEAN
37-001-0002 ALAMANCE	827 S GRAHAM & HOPEDALE RD	55	59	59	43	41	23
37-003-0003 ALEXANDER	STATE ROAD 1177	60	52	48	41	41	21
37-013-0005 BEAUFORT	SLATESTONE ROAD (NEAR WATER TOWER)	56	45	31	30	30	17
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BLDG WOODFIN ST	53	41	38	29	29	18
37-021-0032 BUNCOMBE	LONDON RD ASHVILLE	365	77	71	61	57	25
37-021-0033 BUNCOMBE	US70 WEST SWANNANOA	297	74	61	56	51	22
37-025-0004 CABARRUS	FLOYD ST. KANNAPOLIS	61[a]	50	42	37	36	22
37-035-0004 CATAWBA	1650 1ST. ST.	58	55	51	41	39	23
37-037-0004 CHATHAM	RT4 BOX62 PITTSBORO	58	46	43	43	30	19
37-051-0004 CUMBERLAND	F.S. # 5 3296 VILLAGE DR.	58	44	38	38	37	23
37-057-0002 DAVIDSON	S.SALISBURY ST. LEXINGTON	60	59	56	46	44	26
37-057-1002 DAVIDSON	400 SALEM STREET	58	61	55	48	46	26

[a]This count includes one sample affected by a documented "exceptional event" on 26 July 1995, when the interior of a nearby water tank was sandblasted. The PM_{10} concentration was 25 $\mu g/m^3$.

SITE COUNTY	STREET	NUM. OBS	24-HOUR MAXIMA 1ST	2ND	3RD	4TH	ARITH. MEAN
37-059-0099 DAVIE	FORK RECREATION CENTER	15	27	25	23	21	22
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST	59	53	51	50	41	24
37-065-0002 EDGECOMBE	LEGETT RD.,WASTE TREATMENT PLANT	56	78	48	44	43	23
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	58	46	42	41	34	18
37-067-0009 FORSYTH	INDIANA AV & AKRON DR HANES HOSIERY PK	61	65	57	54	46	26
37-067-0013 FORSYTH	720 RIDGE AVENUE	58	64	55	44	44	26
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY	58	63	58	56	48	28
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY	364	69	66	63	63	25
37-067-1001 FORSYTH	BODENHEIMER ST	59	61	58	48	43	25
37-077-0002 GRANVILLE	3200 WEBB SCHOOL RD OXFORD	61	54	48	41	38	20
37-081-0009 GUILFORD	EDGEWORTH & BELLEMEADE STS	59	64	57	49	43	26
37-081-1005 GUILFORD	E GREEN & S CENTENNIAL ST	46	45	43	39	38	27
37-083-0002 HALIFAX	NE CORNER OF 5TH & CAROLINA ST.	52	52	51	46	39	23
37-085-0001 HARNETT	MUNICIPAL BUILDING	59	54	53	46	42	24
37-087-0002 HAYWOOD	ROOF, CANTON FIRE DEPT.	54	43	41	37	37	24

SITE COUNTY	STREET	NUM. OBS	24-HOUR MAXIMA 1ST	2ND	3RD	4TH	ARITH. MEAN
37-089-1006 HENDERSON	CORNER OF ALLEN & WASHINGTON STS	58	50	46	45	39	24
37-109-0003 LINCOLN	EAST CONGRESS ST	58	52	41	38	37	22
37-109-0004 LINCOLN	RIVERVIEW ROAD	8	27	25	23	23	17
37-111-0002 MC DOWELL	COURTHOUSE	61	55	52	50	48	28
37-119-0001 MECKLENBURG	600 EAST TRADE STREET	60	52	47	44	42	27
37-119-0003 MECKLENBURG	FIRE STA #11 620 MORETZ STREET	60	55	53	48	48	29
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD	61	54	50	45	44	28
37-119-1001 MECKLENBURG	FILTER PLANT	60	51	51	45	42	22
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD.	59	59	58	54	51	31
37-121-0001 MITCHELL	CITY HALL SUMMIT ST	58	74	71	54	53	33
37-129-0007 NEW HANOVER	WAREHSE & RECEIVING ST UNCW WILM	61	40	38	34	31	18
37-133-0004 ONSLOW	2553 ONSLOW DRIVE, JACKSONVILLE	56	43	38	38	36	20
37-139-0001 PASQUOTANK	WATER PLANT N WILSON ST	59	34	31	30	30	18
37-147-0003 PITT	1500 BEATTY ST GREENVILLE	60	47	35	35	33	19
37-155-0003 ROBESON	SO. WATER ST.	58	52	44	37	34	22

SITE COUNTY	STREET	NUM. OBS	24-HOUR MAXIMA 1ST	2ND	3RD	4TH	ARITH. MEAN
37-159-1006 ROWAN	CORNER OF CHURCH & KERR STS	58	51	42	40	33	22
37-173-0002 SWAIN	CENTER ST/PARKS 7 REC FACILITY	27	45	43	42	40	24
37-183-0003 WAKE	FIRE STATION #9 SIX FORKS RD NORTH HILLS	61	49	45	42	35	23
37-189-0003 WATAUGA	HARDIN PRK ELEMENTARY SCHL HWY194 BOONE	33	34	34	32	32	21
37-191-0004 WAYNE	HWY 70 WEST PATROL STA. GOLDSBORO	61	41	34	33	32	20
37-195-0002 WILSON	N.W. CORNER OF KENAN ST.& TARBORO ST.	60	47	45	43	38	21
Total Samples		**3,495**					
Total Sites Sampled		**48**					

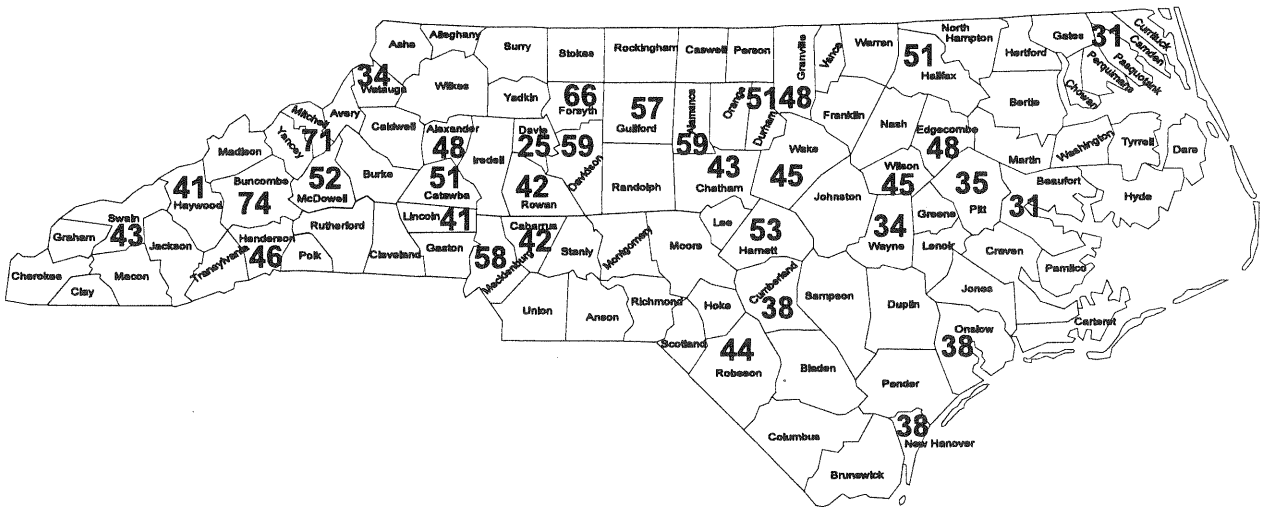

Figure 5.5 PM_{10}: Second Highest 24-Hour Averages, 1995

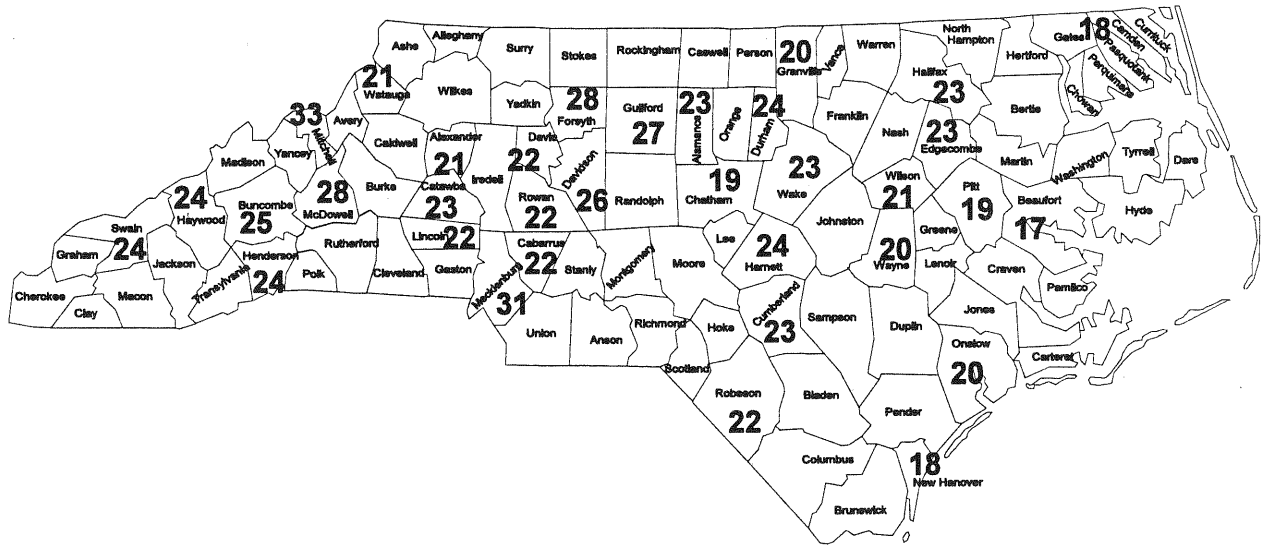

Figure 5.6 PM_{10}: Maximum Annual Arithmetic Means, 1995.

5.3. Carbon Monoxide

Carbon monoxide (CO) data were collected for two purposes in 1995: 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 the Urban Airshed 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 Foreword for a mailing address).

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

In 1995, 17 sites were used to monitor CO and 127,002 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 1995. The greatest 1-hour average was 12.4 parts per million (ppm), or about 35 percent of the standard (35 ppm). The greatest 8-hour average was 8.7 ppm, which is 97 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. (These second highest averages must be lower than the standard.)

Monthly distributions of 8-hour CO averages are graphed in Figure 5.10 as box-and-whisker plots. (See Appendix C on p. 94 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.

Figure 5.11 identifies areas designated nonattainment under the 1990 Clean Air Act and adjoining areas in which EPA later mandated the wintertime sale of oxygenated gasoline as a control strategy because of the history of exceedances in Forsyth, Durham and Wake Counties. Currently, all monitored areas are attaining the ambient air quality standards for CO and are forecast to continue doing so in the future. Because of this, Forsyth County was redesignated attainment in 1994, and mandatory sale of oxygenated fuel in the Piedmont-Triad counties ended in February 1994. Wake and Durham Counties were redesignated attainment in 1995. Oxygenated fuel sales

were required in Wake, Franklin, Durham, and Orange Counties in January and February, 1995, but were not required in November and December.

Oxygenated fuel typically reduces tailpipe emissions of CO by about 25 percent. We observed about 10 percent lower ambient CO concentrations in Wake and Durham Counties that seem attributable to oxygenated fuel use. However, there was no corresponding reduction of ambient concentrations detectable in Guilford or Forsyth Counties (Cornelius 1996).

However, other factors also have reduced CO concentrations, including increased news media interest and public awareness, and the reporting of the Air Quality Index (see Chapter 6 of this report). As a consequence of increased awareness, more people are keeping their cars in better running condition, thus operating more cleanly; older vehicles are gradually being replaced with newer, more efficient vehicles; and traffic flow is improving as new roads are built and better coordinated traffic signals are installed. The motor vehicle Inspection and Maintenance program in effect in Cabarrus, Gaston, Mecklenburg, Union, Forsyth, Guilford, Durham, Orange, and Wake Counties is an intentional control strategy that helps assure cleaner-running cars.

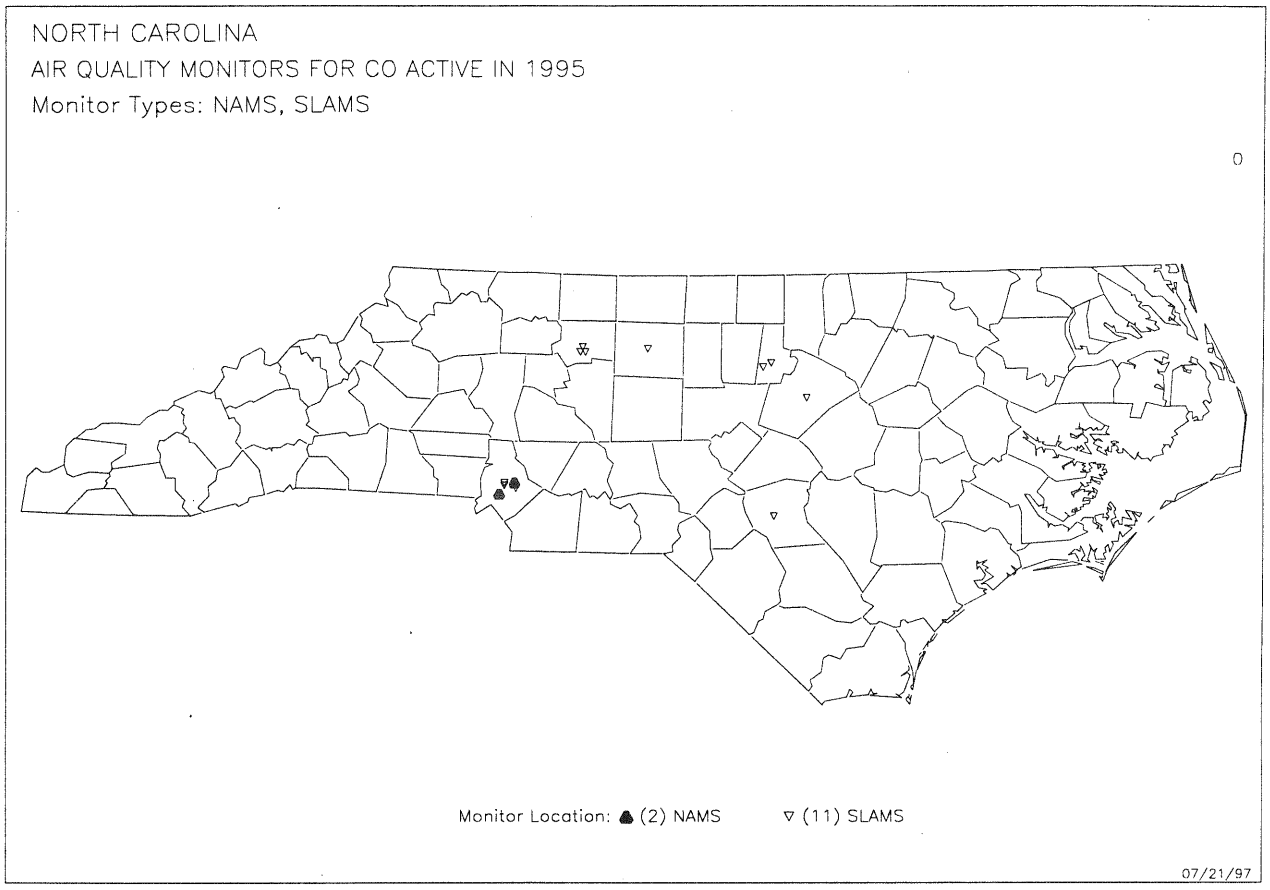

Figure 5.7 Location of Carbon Monoxide Monitoring Sites. This map excludes Special Purpose Monitors used for ambient air quality monitoring in Gaston Co., Orange Co. and Wake Co. (two monitors).

Table 5.3 Carbon Monoxide in Parts per Million from All Sites for 1995.

SITE NUMBER COUNTY	STREET	NUM OBS	ONE-HOUR MAXIMA		EIGHT-HOUR MAXIMA	
			1ST	2ND	1ST	2ND
37-051-0007 CUMBERLAND	CUMBERLAND CO ABC BOARD, 1705	8,565	7.5	7.2	5.4	5.4
37-063-0011 DURHAM	201 NORTH ROXBORO ST	8,675	11.6	9.3	5.5	5.4
37-063-0012 DURHAM	4001 CHAPEL HILL BLVD	8,662	7.1	6.8	5.6	4.5
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY	8,614	10.8	9.6	7.7	6.2
37-067-0025 FORSYTH	100 SW STRATFORD RD	8,666	7.2	6.4	3.6	2.9
37-067-0026 FORSYTH	1590 BOLTON STREET	8,688	4.5	4.5	3.5	3.3
37-071-0015 GASTON	1555 EAST GARRISON BLVD	4,095	7.2	7.1	4.8	4.0
37-081-1011 GUILFORD	401 WEST WENDOVER	8,553	6.7	6.6	6.6	5.8
37-119-0032 MECKLENBURG	5137 CENTRAL AVE.	8,565	11.2	9.2	5.9	5.4
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL	8,589	8.7	8.2	4.9	4.8
37-119-0035 MECKLENBURG	1330 SPRING ST GRNVILLE NEIGHB	8,675	6.3	6.2	5.3	4.5

SITE NUMBER COUNTY	STREET	NUM OBS	ONE-HOUR MAXIMA		EIGHT-HOUR MAXIMA	
			1ST	2ND	1ST	2ND
37-119-0037 MECKLENBURG	415 EAST WOODLAWN RD	8,656	8.0	8.0	4.3	4.0
37-119-0038 MECKLENBURG	301 N TRYON ST	8,640	10.4	8.4	5.4	4.7
37-135-0005 ORANGE	109 1/2 EAST FRANKLIN STREET	4,243	10.4	9.0	7.2	5.8
37-183-0011 WAKE	420 S PERSON ST	8,628	12.4	11.9	8.7	6.6
37-183-0013 WAKE	EF HUTTON, HWY 70 WEST	4,375	9.0	7.3	6.0	4.6
37-183-0018 WAKE	HWY 70 WEST AND HWY 50 NORTH	2,113	6.7	6.4	5.4	4.4
Total Samples		**127,002**				
Total Sites Sampled		**17**				

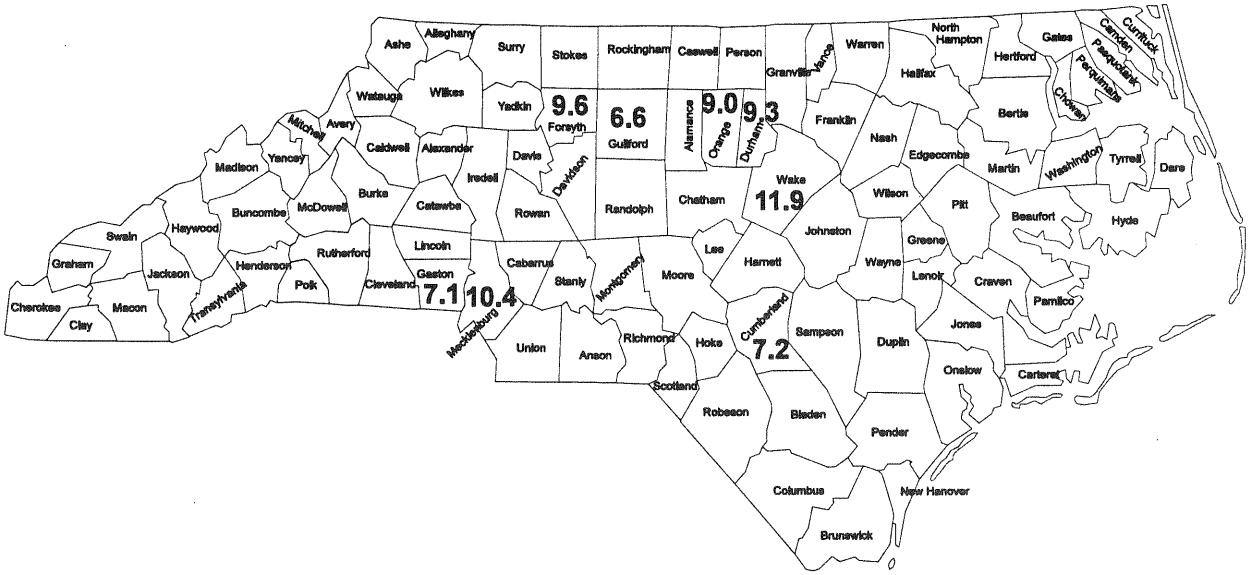

Figure 5.8 Carbon Monoxide: Second Highest One-Hour Average, 1995

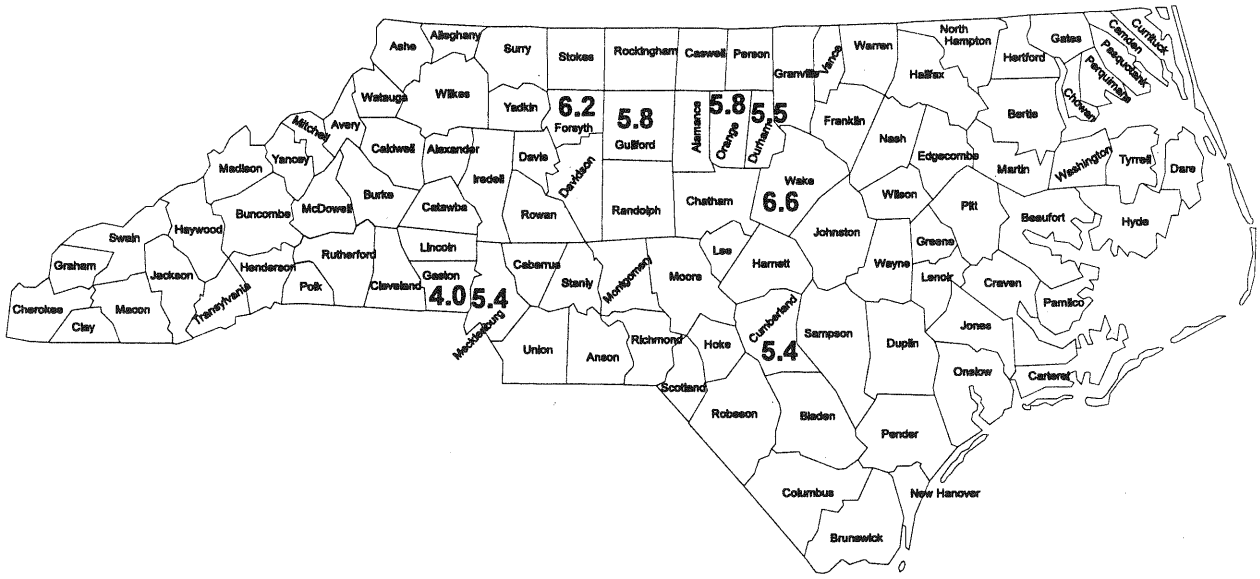

Figure 5.9 Carbon Monoxide: Second Highest Non-overlapping Eight-Hour Average, 1995

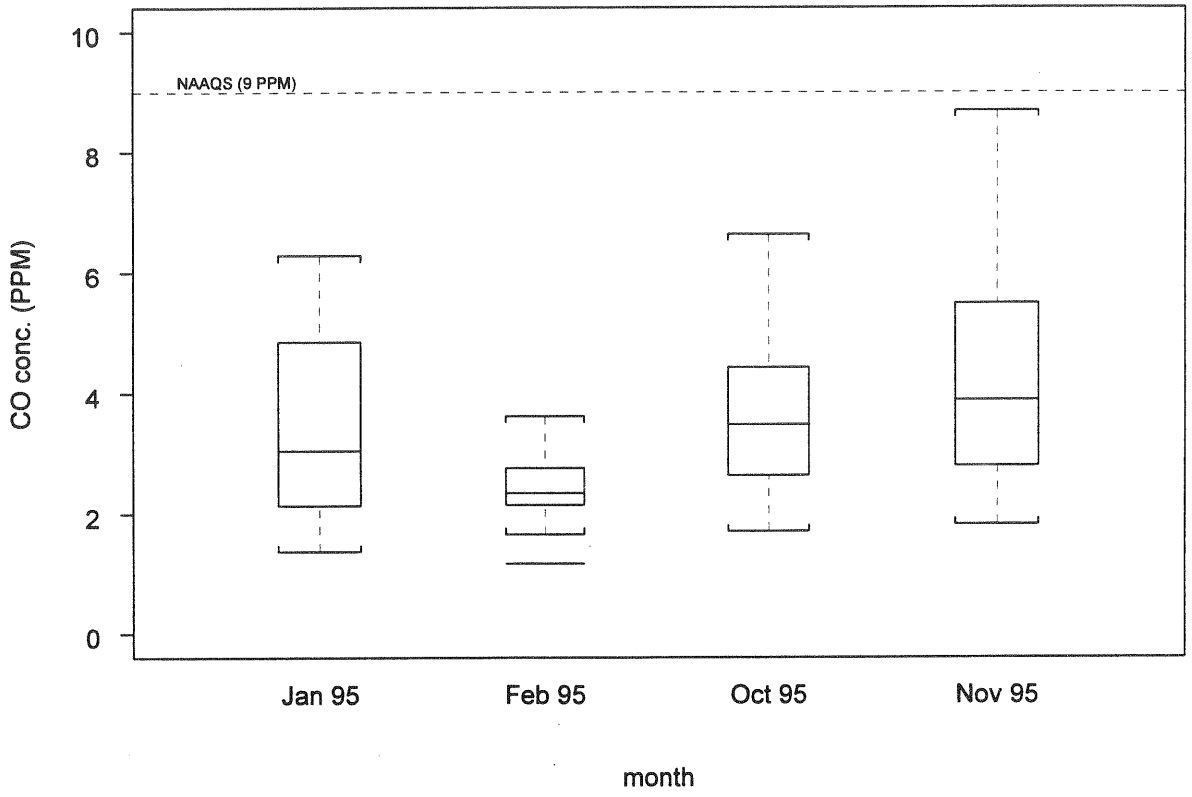

Figure 5.10 Carbon Monoxide: Monthly Distribution of Highest Daily Eight-Hour Averages, 1995

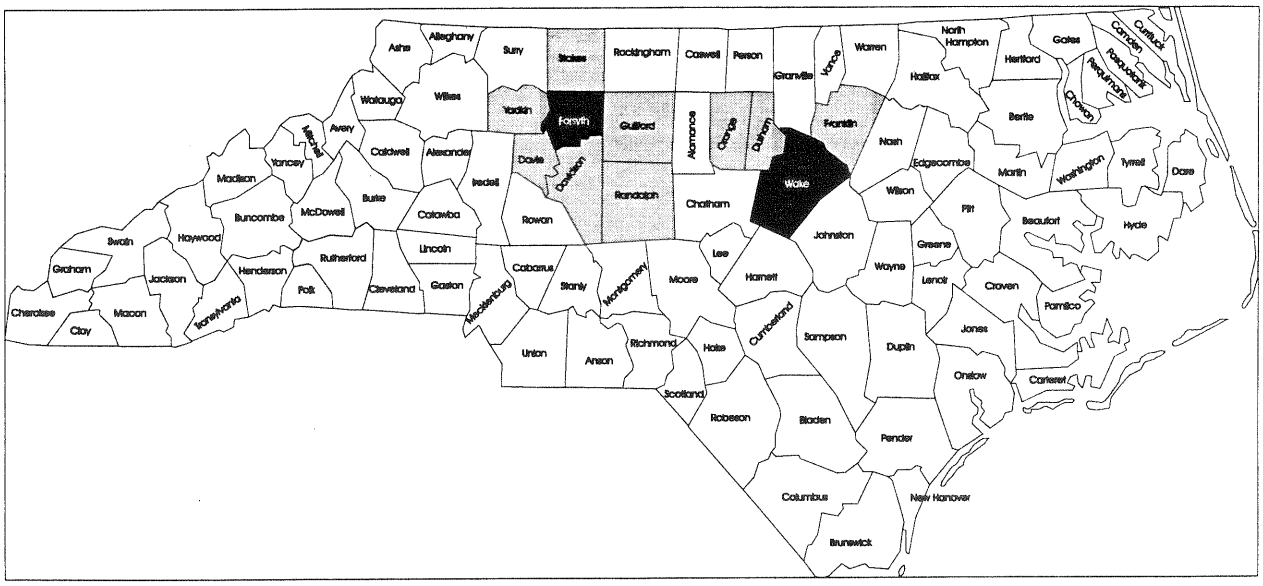

Figure 5.11 Areas With Excessive Carbon Monoxide Subject to Mandatory Oxygenated Fuel Sales by the 1990 Clean Air Act Amendments. The oxygenated fuel requirement for Forsyth County and its neighboring counties was suspended in November 1994. The requirement for Wake County and its neighboring counties was suspended in November 1995.

5.4. 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 38 monitoring sites in 1995 during the ozone season, April through October. A map of the O_3 sampling sites is presented in Figure 5.12, and a detailed summary of the data from each site is given in Table 5.4. In North Carolina some O_3 sites are operated only every third year, so the monitors considered "active" in 1995 included seven sites that were last operated in 1994 and five sites that were last operated in 1993. These 50 active monitoring sites provided 232,051 hourly samples.

There were five exceedances of the ozone standard in North Carolina in 1995 (Table 5.5). Three of these occurred on July 14, two in Charlotte and one in Winston-Salem. One exceedance occurred on August 14 in Rowan County, 30-40 miles downwind from Charlotte. The last exceedance occurred on August 17 on Mount Mitchell.

The 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.)

As a consequence of past ozone exceedances, Mecklenburg County was designated a moderate ozone nonattainment area in January, 1992, and strict hydrocarbon control strategies were implemented, affecting all of the counties in the Charlotte-Gastonia-Rock Hill metropolitan statistical area (Cabarrus, Gaston, Lincoln, Mecklenburg, Rowan and Union Counties, and also York County, South Carolina). The Mecklenburg County area was redesignated as in attainment on 5 July 1995. However, hydrocarbon control strategies continue to be used to help maintain reduced ozone concentrations. A discussion of ozone nonattainment is provided in Appendix D (see pp. 95-96).

The second highest 1-hour concentrations in each county are charted in Figure 5.13 for areas with one or more monitors active in 1993, 1994 or 1995 (using only the latest available year of data).

Figure 5.14 shows the number of "high" ozone values on a monthly basis in 1995. Monthly distributions of all the 1-hour O_3 data for 1995 are graphed in Figure 5.15 as box-and-whisker plots.

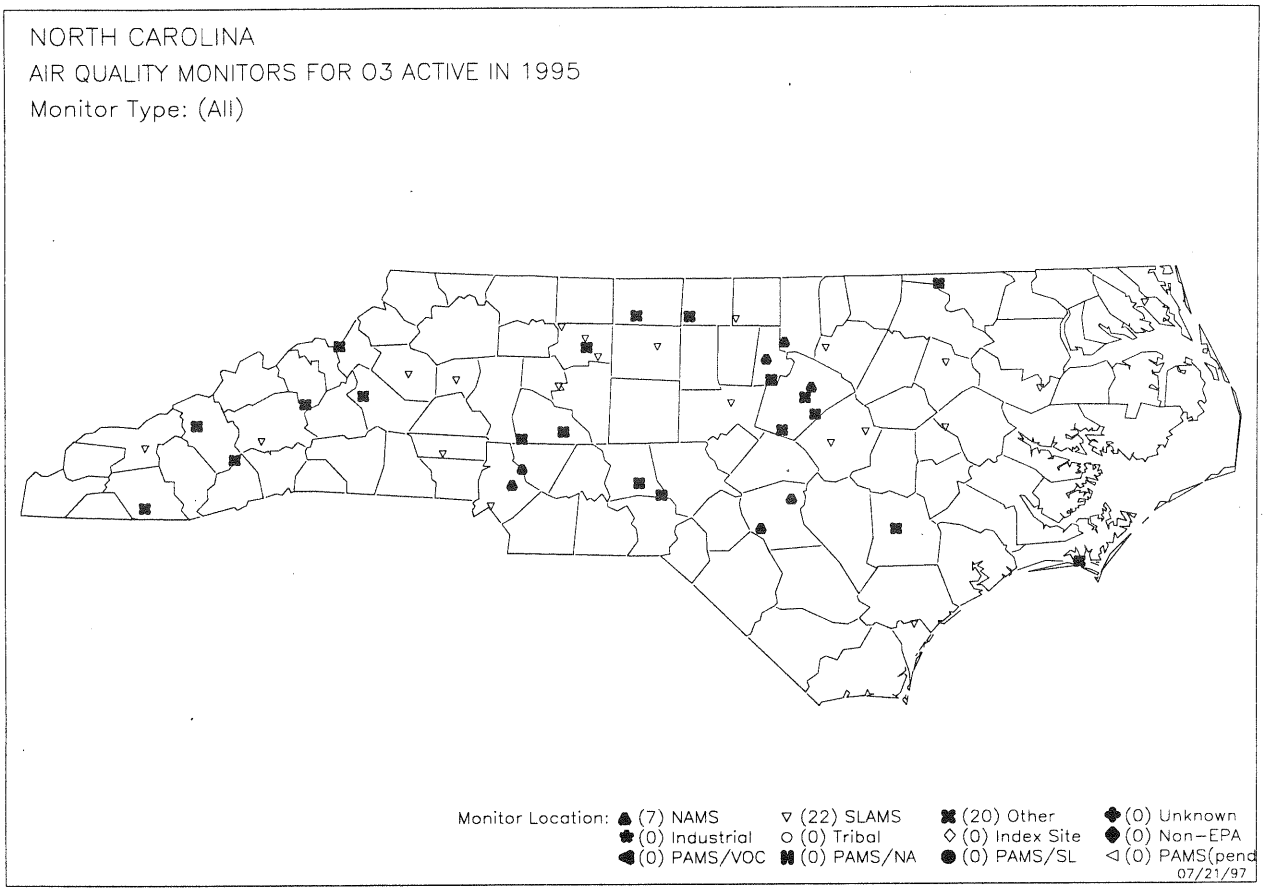

Figure 5.12 Location of Ozone Monitoring Sites.

Table 5.4 Ozone in Parts per Million for 1995.

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA				NO. VALUES ≥ 0.125	
			1ST	2ND	3RD	4TH	MEAS	EST
1995 Data								
37-021-0030 BUNCOMBE	ROUTE 191 S BREVARD RD ASHEVILLE	5,081	0.089	0.085	0.085	0.085	0	0.0
37-027-0003 CALDWELL	HWY 321 N LENOIR	4,868	0.100	0.095	0.092	0.091	0	0.0
37-029-0099 CAMDEN	COUNTY ROAD 1136 & 1134 CAMDEN	4,689	0.100	0.093	0.093	0.091	0	0.0
37-031-8001 CARTERET	MERRIMON ROAD BEAUFORT	4,408	0.097	0.084	0.078	0.078	0	0.0
37-033-0001 CASWELL	CHERRY GROVE RECREATION	4,784	0.115	0.108	0.102	0.098	0	0.0
37-037-0004 CHATHAM	RT4 BOX62 PITTSBORO	4,863	0.103	0.102	0.101	0.100	0	0.0
37-051-0008 CUMBERLAND	1/4MI SR1857/US301	4,878	0.105	0.100	0.095	0.095	0	0.0
37-051-1002 CUMBERLAND	HOPE MILLS POLICE DPT ROCKFISH RD. FAYETTEVILLE	4,674	0.110	0.104	0.098	0.098	0	0.0
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	4,738	0.078	0.077	0.075	0.074	0	0.0
37-063-0013 DURHAM	2700 NORTH DUKE STREET	4,678	0.103	0.101	0.100	0.096	0	0.0
37-067-0007 FORSYTH	5337 OLD RURAL HALL ROAD WINSTON-SALEM	4,957	0.117	0.111	0.109	0.099	0	0.0
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE	4,850	0.130	0.117	0.108	0.106	1	1.0
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE	5,095	0.118	0.093	0.090	0.089	0	0.0

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA				NO. VALUES ≥ 0.125	
			1ST	2ND	3RD	4TH	MEAS	EST
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	5,079	0.114	0.109	0.103	0.102	0	0.0
37-069-0001 FRANKLIN	431 S HILLBOROUGH ST	4,862	0.091	0.091	0.090	0.087	0	0.0
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSP BUTNER	4,852	0.111	0.109	0.108	0.105	0	0.0
37-081-0011 GUILFORD	KEELY PARK KEELY RD MCCLEANSVILLE	4,850	0.117	0.111	0.109	0.099	0	0.0
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PKWY MILE MARKER 410	4,703	0.101	0.095	0.094	0.092	0	0.0
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAIN NATIONAL PARK	3,122	0.107	0.107	0.101	0.094	0	0.0
37-101-0002 JOHNSTON	3411 JACK ROAD CLAYTON	4,423	0.113	0.104	0.095	0.095	0	0.0
37-109-0004 LINCOLN	RIVERVIEW ROAD	4,868	0.117	0.106	0.105	0.105	0	0.0
37-117-0001 MARTIN	HAYES STREET (#2WELL SITE)	4,830	0.089	0.089	0.083	0.082	0	0.0
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL CHARLOTTE	5,061	0.129	0.111	0.109	0.108	1	1.0
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	5,044	0.122	0.118	0.118	0.116	0	0.0
37-119-1009 MECKLENBURG	29 N@ MECKLENBURG CAB CO CHARLOTTE	5,068	0.128	0.109	0.108	0.107	1	1.0
37-123-8001 MONTGOMERY	112 PERRY DRIVE	4,147	0.118	0.091	0.088	0.088	0	0.0

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA				NO. VALUES ≥ 0.125	
			1ST	2ND	3RD	4TH	MEAS	EST
37-131-0002 NORTHAMPTON	RT 46 GASTON	4,781	0.106	0.101	0.100	0.096	0	0.0
37-145-0099 PERSON	SR 1102 & NC 49 GORDONTON	4,768	0.096	0.094	0.093	0.093	0	0.0
37-147-0099 PITT	US 264 NEAR WATER TOWER FARMVILLE	4,798	0.101	0.098	0.097	0.097	0	0.0
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL	4,756	0.093	0.088	0.088	0.083	0	0.0
37-159-0021 ROWAN	WEST ST & GOLD HILL AVENUE ROCKWELL	4,522	0.131	0.110	0.110	0.109	1	1.1
37-159-0022 ROWAN	925 N ENOCHVILLE AVE	3,017	0.119	0.111	0.102	0.102	0	0.0
37-173-0002 SWAIN	CENTER ST/ PARKS 7 REC FACILITY	4,650	0.081	0.077	0.076	0.075	0	0.0
37-183-0014 WAKE	E MILLBROOK JR HI 3801 SPRING FOREST RD RALEIGH	4,877	0.102	0.096	0.093	0.091	0	0.0
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	4,815	0.111	0.108	0.102	0.100	0	0.0
37-183-0016 WAKE	201 NORTH BROAD STREET FUQUAY-VARINA	4,818	0.102	0.101	0.096	0.095	0	0.0
37-183-0017 WAKE	5033 TV TOWER RD GARNER	2,953	0.114	0.114	0.107	0.102	0	0.0
37-199-0003 YANCEY	BLUE RIDGE PARKWAY	3,913	0.127	0.111	0.108	0.103	1	1.2

Total Samples	**176,140**
Total Sites Sampled	**38**

1994 Data

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA				NO. VALUES ≥ 0.125	
			1ST	2ND	3RD	4TH	MEAS	EST
37-003-0003 ALEXANDER	STATE ROAD 1177 TAYLORSVILLE	4,746	0.094	0.092	0.089	0.086	0	0.0
37-011-8001 AVERY	ROARING CREEK RD., PISGAH N.F.	5,079	0.106	0.095	0.087	0.084	0	0.0
37-023-0004 BURKE	126 AND 1254	4,922	0.103	0.101	0.098	0.096	0	0.0
37-059-0099 DAVIE	FORK RECREATION CENTER	4,832	0.086	0.085	0.082	0.079	0	0.0
37-101-0099 JOHNSTON	HIGHWAY 301 & SR 2141	4,823	0.107	0.103	0.097	0.097	0	0.0
37-113-8001 MACON	COWEETA HYDROLOGIC LAB	5,092	0.089	0.088	0.084	0.083	0	0.0
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD CASTLE HAYNE	4,836	0.106	0.104	0.096	0.095	0	0.0
Total Samples		**34,330**						
Total Sites Sampled		**7**						
1993 Data								
37-027-0003 CALDWELL	HWY 321 N LENOIR	4,769	0.095	0.088	0.087	0.087	0	0.0
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	4,792	0.113	0.110	0.110	0.107	0	0.0
37-067-0006 FORSYTH	GOODWILL CHURCH RD AT VOL FIRE DEPT. WINSTON-SALEM	4,979	0.107	0.103	0.093	0.093	0	0.0
37-087-0034 HAYWOOD	MILE POST 408 BLUE RIDGE ROAD	2,125	0.092	0.087	0.082	0.076	0	0.0
37-109-0099 LINCOLN	SR 1315 & SR 1313 IRON STATION	4,877	0.119	0.119	0.115	0.104	0	0.0

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA				NO. VALUES ≥ 0.125	
			1ST	2ND	3RD	4TH	MEAS	EST
37-183-2001 WAKE	HWY 98 WATER TREATMENT PLANT WAKE FOREST	4,854	0.103	0.101	0.101	0.100	0	0.0
Total Samples		**26,396**						
Total Sites Sampled		**6**						

Table 5.5 Ozone Exceedances in 1995.

SITE NUMBER COUNTY	ADDRESS	DATE	EXCEEDANCE
1995 Data			
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE	14 July	0.130
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL CHARLOTTE	14 July	0.129
37-119-1009 MECKLENBURG	29 N@ MECKLENBURG CAB CO CHARLOTTE	14 July	0.128
37-159-0021 ROWAN	WEST ST & GOLD HILL AVENUE ROCKWELL	14 August	0.131
37-199-0003 YANCEY	BLUE RIDGE PARKWAY	17 August	0.127

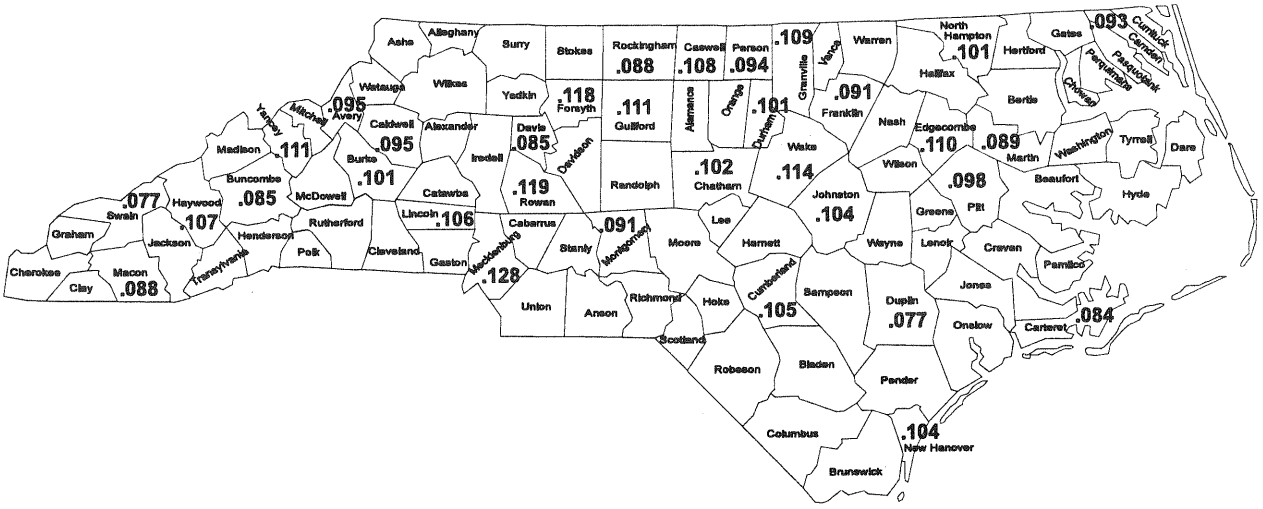

Figure 5.13 Ozone: Second Highest Annual One-Hour Average in the Most Recent Year of Data, from 1993, 1994 or 1995.

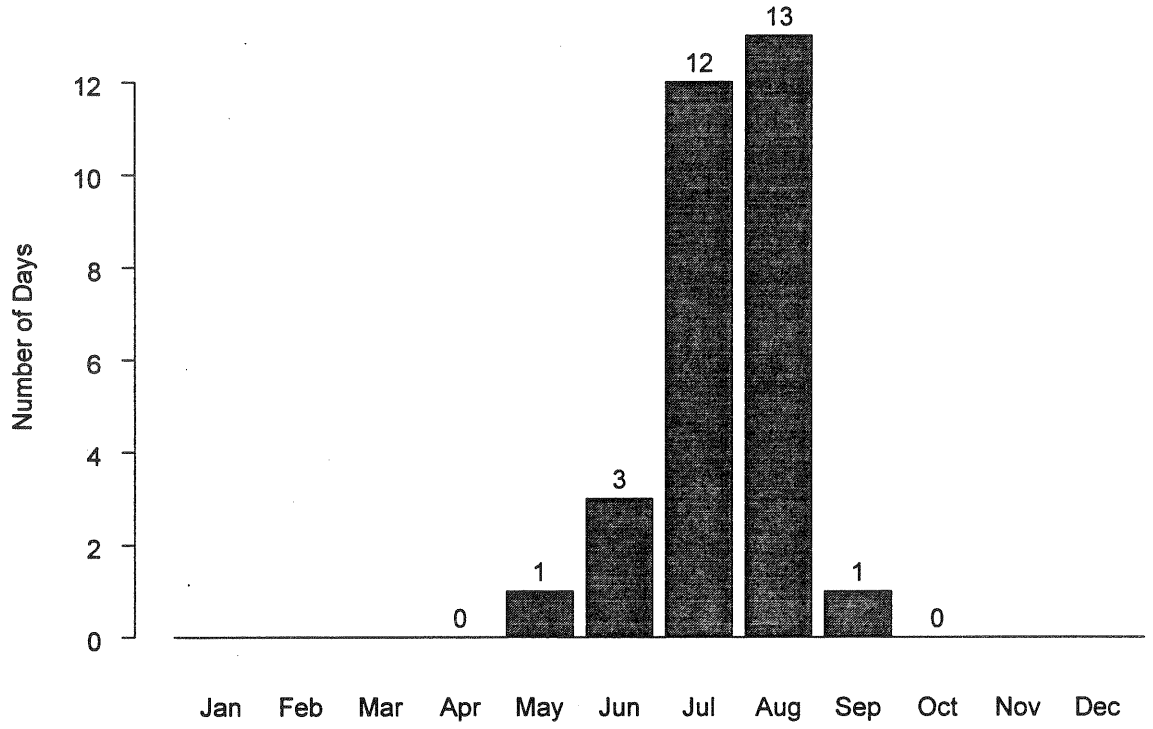

Figure 5.14 Number of Days with 1-Hour Ozone Averages in Excess of 0.10 ppm, 1995.

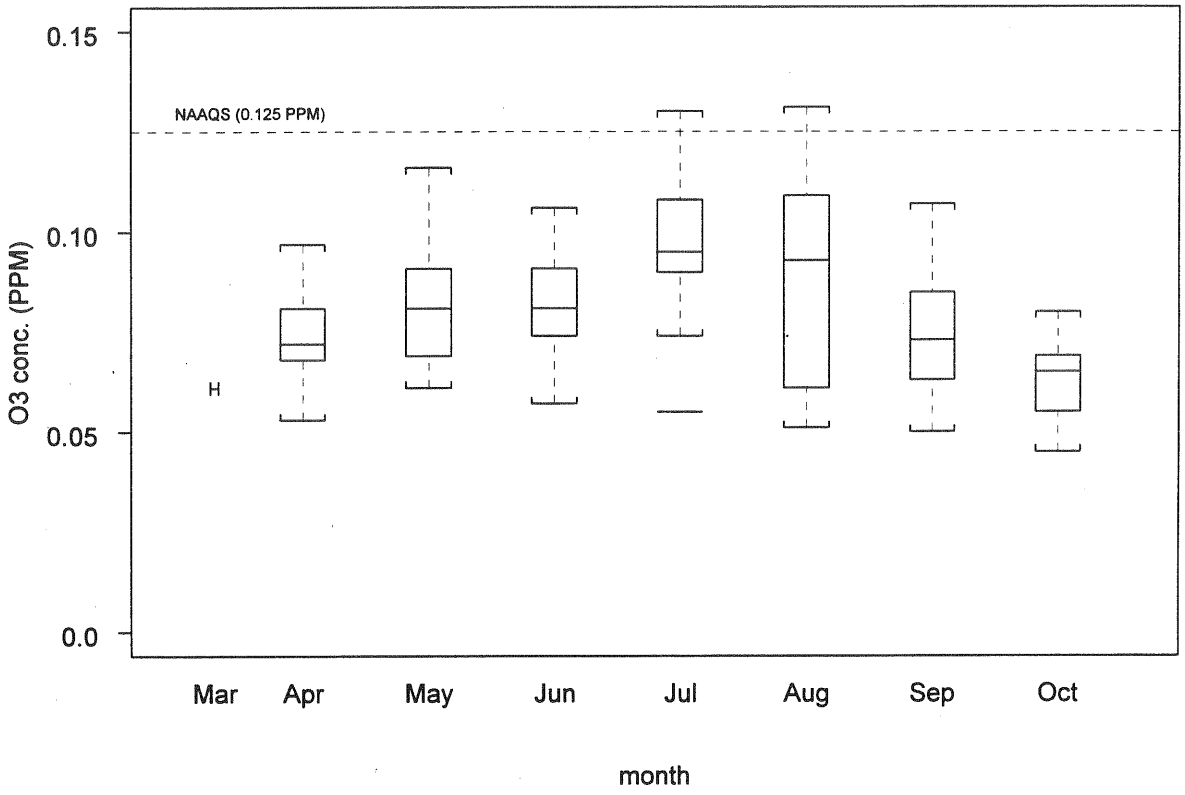

Figure 5.15 Monthly Distributions of Ozone Measurements, 1995

5.5. Sulfur Dioxide

Sulfur dioxide (SO_2) concentrations were measured by the state and two local program agencies using EPA reference or equivalent methods. Fifteen SO_2 monitors were active in North Carolina in 1995. However, some SO_2 sites are operated only every third year. So, 13 sites provided data in 1995, four sites provided data in 1994 (and will next be operated in 1997), and two sites provided data in 1993 (and will next be operated in 1996).

From the 19 sites with SO_2 data obtained between 1993 and 1995, 120,134 valid hourly averages were collected. A map of the"active" SO_2 sampling sites is presented in Figure 5.16, and a detailed summary of the data from each site is given in Table 5.6.

There were no exceedances of the SO_2 ambient air quality standards in 1995. The greatest annual arithmetic mean was 19 $\mu g/m^3$, or about 25 percent of the standard (80 $\mu g/m^3$), the greatest maximum 24-hour average was 92 $\mu g/m^3$, about 25 percent of the standard (365 $\mu g/m^3$), and the greatest maximum 3-hour average was 389 $\mu g/m^3$, about 30 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 5.17. The second highest 24-hour concentrations in each county are charted in Figure 5.18.

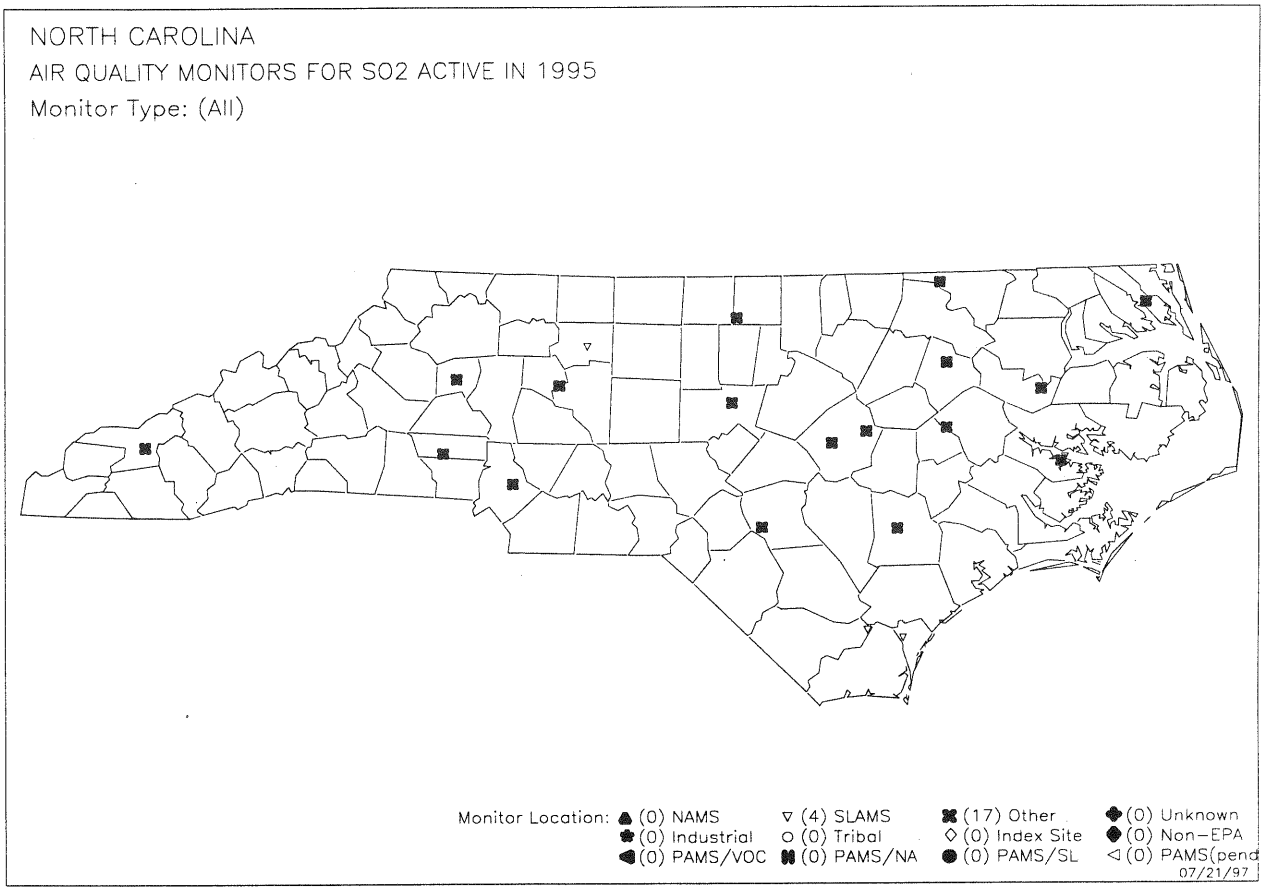

Figure 5.16 Location of Sulfur Dioxide Monitoring Sites.

Table 5.6 Sulfur Dioxide in Parts per Million from All Sites for 1993-95.

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		THREE-HOUR MAXIMA		24-HOUR MAXIMA		ARITH. MEAN
			1ST	2ND	1ST	2ND	1ST	2ND	
1995 Data									
37-003-0003 ALEXANDER	STATE ROAD 1177 TAYLORSVILLE	294	0.009	0.009	0.009	0.008	0.005	0.005	0.004
37-013-0003 BEAUFORT	NC HIGHWAY 306	8,045	0.078	0.071	0.049	0.044	0.018	0.017	0.003
37-013-0004 BEAUFORT	SOUTH FERRY LANDING PAMLICO RIVER	7,848	0.109	0.092	0.065	0.050	0.015	0.014	0.003
37-037-0004 CHATHAM	RT4 BOX62 PITTSBORO	8,107	0.046	0.044	0.041	0.027	0.012	0.008	0.003
37-047-0001 COLUMBUS	ACME-DELCO SAMPLING SITE HWY 8	8,057	0.069	0.059	0.036	0.035	0.014	0.013	0.004
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE	8,034	0.129	0.092	0.094	0.051	0.025	0.025	0.007
37-109-0004 LINCOLN	RIVERVIEW ROAD	2,885	0.060	0.054	0.044	0.040	0.025	0.016	0.005
37-117-0001 MARTIN	HAYES STREET (#2WELL SITE)	8,237	0.019	0.018	0.015	0.014	0.009	0.007	0.003
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL CHARLOTTE	8,498	0.055	0.055	0.032	0.029	0.011	0.010	0.004
37-129-0006 NEW HANOVER	HWY 421 NORTH	7,984	0.301	0.244	0.175	0.132	0.065	0.062	0.009
37-131-0002 NORTHAMPTON	RT 46 GASTON	6,658	0.056	0.047	0.042	0.029	0.010	0.010	0.003
37-145-0099 PERSON	SR 1102 & NC 49 GORDONTON	8,138	0.085	0.073	0.065	0.065	0.017	0.012	0.004
37-173-0002 SWAIN	CENTER ST/ PARKS 7 REC FACILITY	6,018	0.013	0.013	0.012	0.012	0.006	0.006	0.003

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		THREE-HOUR MAXIMA		24-HOUR MAXIMA		ARITH. MEAN
			1ST	2ND	1ST	2ND	1ST	2ND	
Total Samples		**88,803**							
Total Sites Sampled		**13**							
1994 Data									
37-029-0099 CAMDEN	COUNTY ROAD 1136 & 1134 CAMDEN	2,014	0.031	0.030	0.027	0.025	0.014	0.010	0.004
37-051-1002 CUMBERLAND	HOPE MILLS POLICE DPT, ROCKFIS	2,686	0.027	0.026	0.025	0.022	0.013	0.011	0.004
37-059-0099 DAVIE	FORK RECREATION CENTER	8,087	0.060	0.056	0.042	0.040	0.018	0.016	0.004
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	2,698	0.018	0.016	0.014	0.014	0.009	0.008	0.004
Total Samples		**15,485**							
Total Sites Sampled		**4**							
1993 Data									
37-065-0099 EDGECOMBE	RT 2, BOX 195 TARBORO	7,701	0.208	0.204	0.070	0.069	0.010	0.010	0.003
37-101-0099 JOHNSTON	HIGHWAY 301 & SR 2141	8,145	0.222	0.020	0.075	0.016	0.011	0.010	0.003
Total Samples		**15,846**							
Total Sites Sampled		**2**							

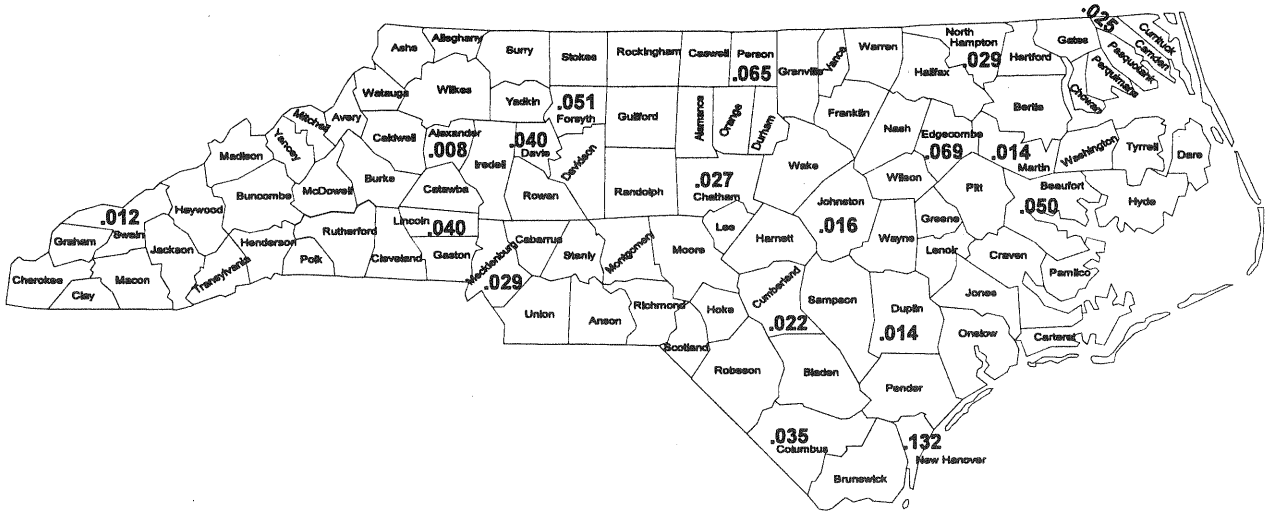

Figure 5.17 So_2: Second Highest Three-hour Averages in the Most Recent Year of Data from 1993, 1994, or 1995.

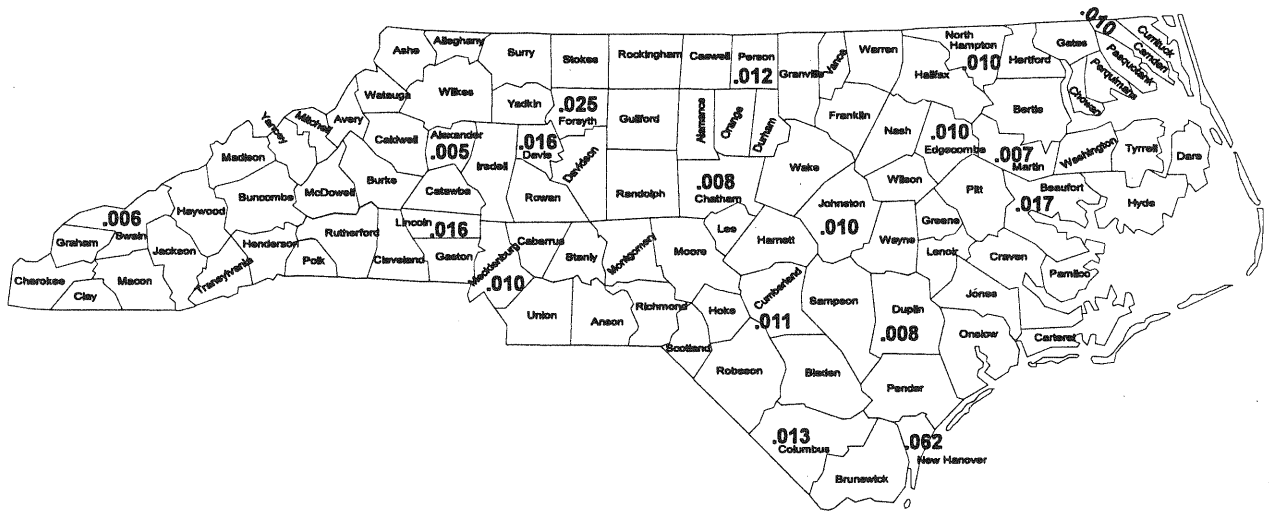

Figure 5.18 So_2: Second Highest 24-hour Averages in the Most Recent Year of Data from 1993, 1994, or 1995.

5.6. Nitrogen Dioxide

Nitrogen dioxide (NO_2) concentrations were measured using EPA reference or equivalent continuous monitors in 1995 at one local program site in Forsyth County and one local program site in Mecklenburg County.

From these two sites, 15,869 hourly NO_2 measurements were reported. A map of the NO_2 sampling sites is presented in Figure 5.19, and a summary of the 1995 NO_2 data is given in Table 5.7.

Figure 5.20 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. Although ambient NO_2 generally does not vary by season, these two sites clearly have lower average concentrations and higher maximum concentrations in the warmer months. This pattern could be attributable to reactions associated with ozone formation. However, that explanation does not seem to account for the high values observed in March at both sites.

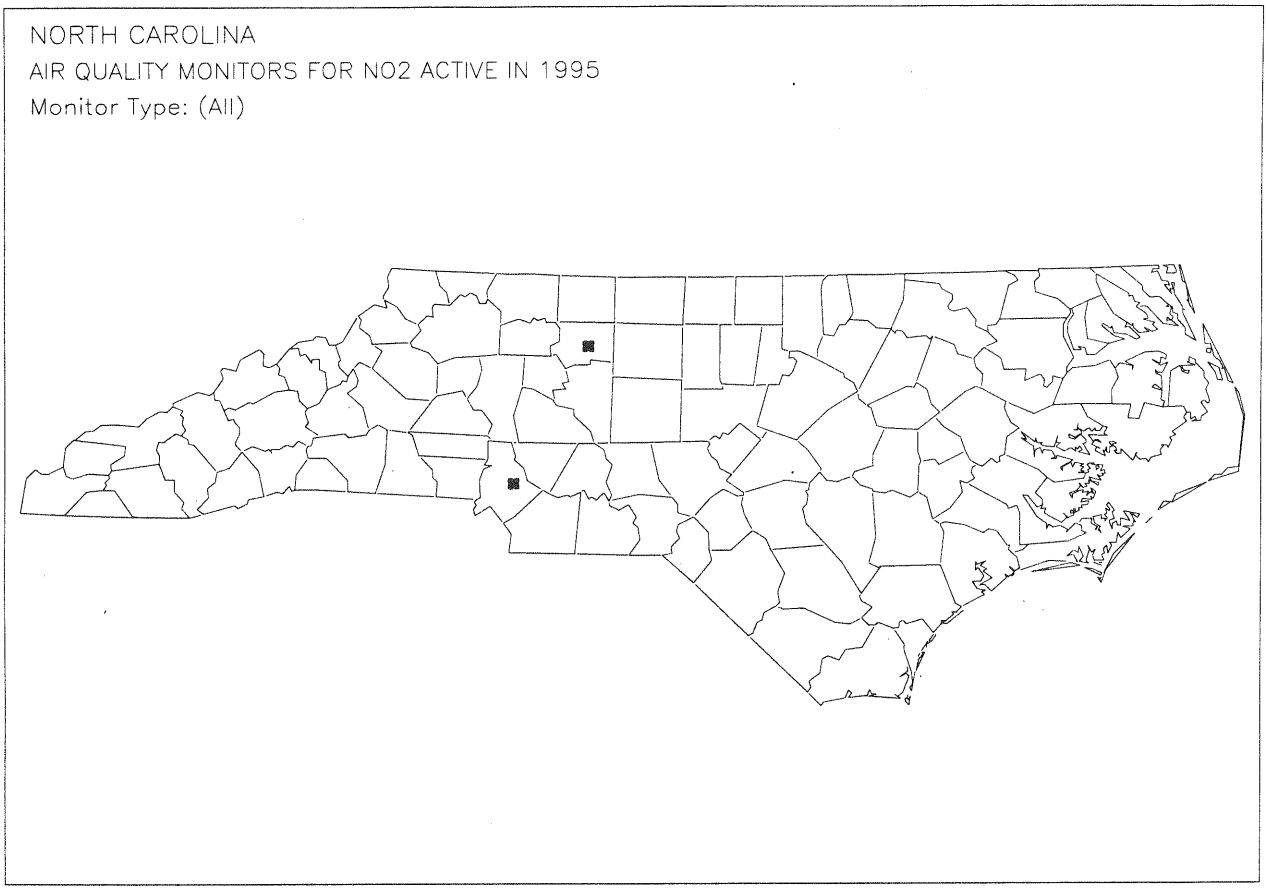

Figure 5.19 Location of Nitrogen Dioxide Monitoring Sites.

Table 5.7. Nitrogen Dioxide in Parts per Million (ppm) for 1995

SITE NUMBER COUNTY	STREET	NUM OBS	ONE-HOUR MAXIMA 1ST	2ND	ARITH. MEAN
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE	7,748	0.078	0.078	0.016
37-119-0034 MECKLENBURG	PLAZA ROAD AND LAKEDELL	8,121	0.067	0.064	0.016
Total Samples		**15,869**			
Total Sites Sampled		**2**			

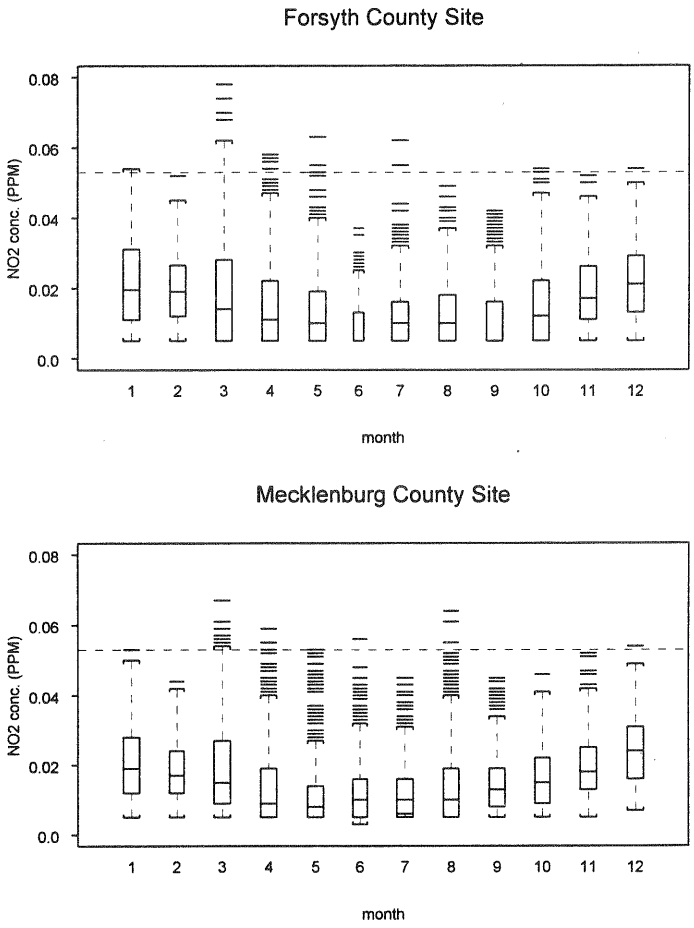

Figure 5.20 Distributions of Nitrogen Dioxide Concentrations, 1995. Dashed line marks the NAAQS concentration, which is not to be exceeded by the annual mean.

5.7. 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. Ambient Pb concentrations in 1982 were approximately one-half the concentrations observed in 1979. 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 state and local agencies provide particulate filter samples from five sites to EPA. EPA performs lead analysis on these filters as part of the National Particulate Analysis program (formerly the National Filter Analysis Network, NFAN). The most recent year of data available is 1990; no data have been provided for later years. Lead concentrations in 1990 averaged less than half the concentrations measured in 1987 and less than 1/10 of the concentrations measured in 1982. The greatest quarterly lead concentration in 1990 in North Carolina was 0.08 $\mu g/m^3$, which is about 5 percent of the standard.

Summaries of the lead data from 1990 are given in Table 5.8.

Table 5.8 Lead in Micrograms per Cubic Meter ($\mu g/m^3$) for 1990.

COUNTY SITE NUMBER ADDRESS CITY	NUM OBS	QUARTERLY ARITHMETIC MEANS				MEANS >1.5
		1ST	2ND	3RD	4TH	
DURHAM 37-063-0001 300 EAST MAIN ST DURHAM	4	0.02	0.01	0.00	0.02	0
FORSYTH 37-067-0001 SIXTH AND BROAD ST WINSTON-SALEM	4	0.01	0.01	0.00	0.01	0
GUILFORD 37-081-0009 EDGEWORTH AND BELLEMEADE ST GREENSBORO	3	0.02	0.01	0.01		0
MECKLENBURG 37-119-0001 600 EAST TRADE ST CHARLOTTE	4	0.03	0.08	0.05	0.03	0
WAKE 37-183-0003 FIRE STATION #9 NORTH HILLS PLAZA RALEIGH	2		0.00	0.01		0
Total Samples	**17**					
Total Sites Sampled	**5**					

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_{10}, CO, O_3, SO_2 and NO_2. AQI measurements are made and reported in all U.S. metropolitan areas with a population over 200,000. Ambient concentrations for each of these five pollutants are converted to a segmented linear 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-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", "unhealthful, "very unhealthful", or "hazardous" is included with the report, with the descriptions corresponding to AQI values of 0-50, 51-100, 101-200, 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 (unhealthful) 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 mimimize physical exertion.

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

In 1995, four areas provided an AQI report to the public by telephone using computer-generated recorded voice announcements 24 hours daily. These areas were Raleigh, Durham, Fayetteville, and Charlotte. 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:

Asheville	888-AIR-WISE (888-247-9473)
Charlotte	704-333-SMOG (704-333-7664)
Durham	888-AIR-WISE (888-247-9473)
Fayetteville	888-AIR-WISE (888-247-9473)
Greensboro	888-AIR-WISE (888-247-9473)
Greenville	888-AIR-WISE (888-247-9473)
Raleigh	888-AIR-WISE (888-247-9473)
Wilmington	888-AIR-WISE (888-247-9473)
Winston-Salem	888-AIR-WISE (888-247-9473)

Air Quality Index values for 1995 at five metropolitan areas in North Carolina are given in Figures 6.1, 6.2, 6.3, 6.4 and 6.5.

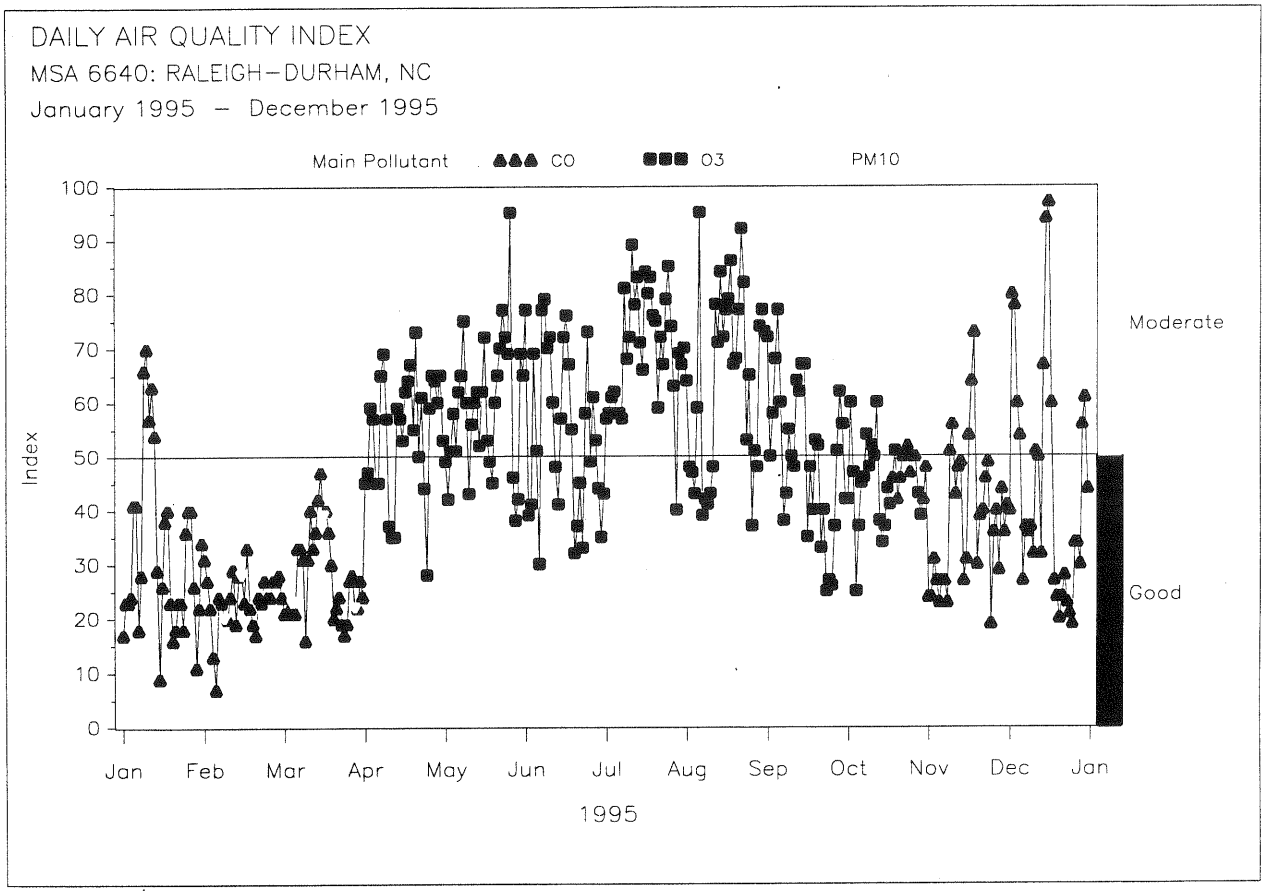

Figure 6.1 Daily Air Quality Index Values for Raleigh-Durham, NC, Metropolitan Statistical Area, 1995.

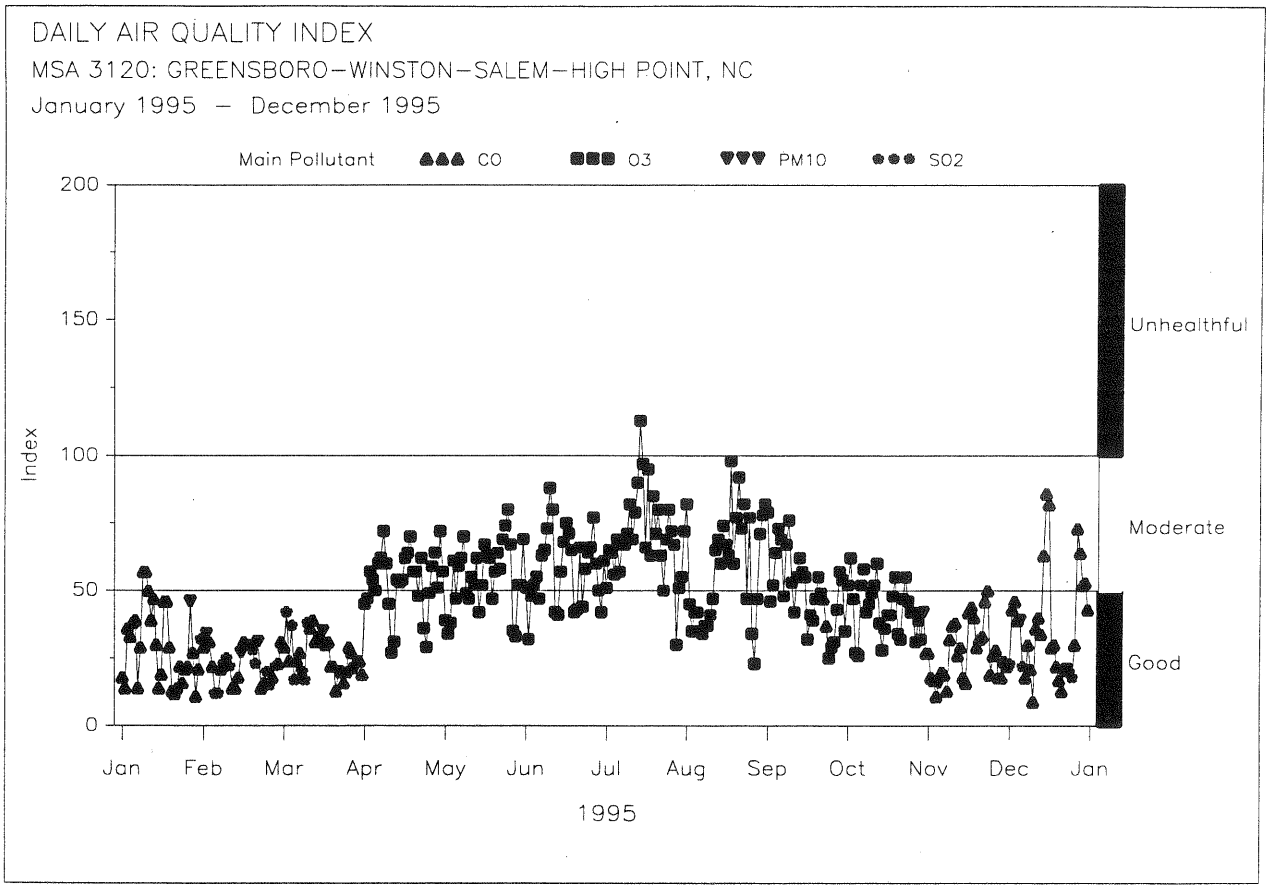

Figure 6.2 Daily Air Quality Index Values for Greensboro-Winston-Salem-High Point, NC, Metropolitan Statistical Area, 1995.

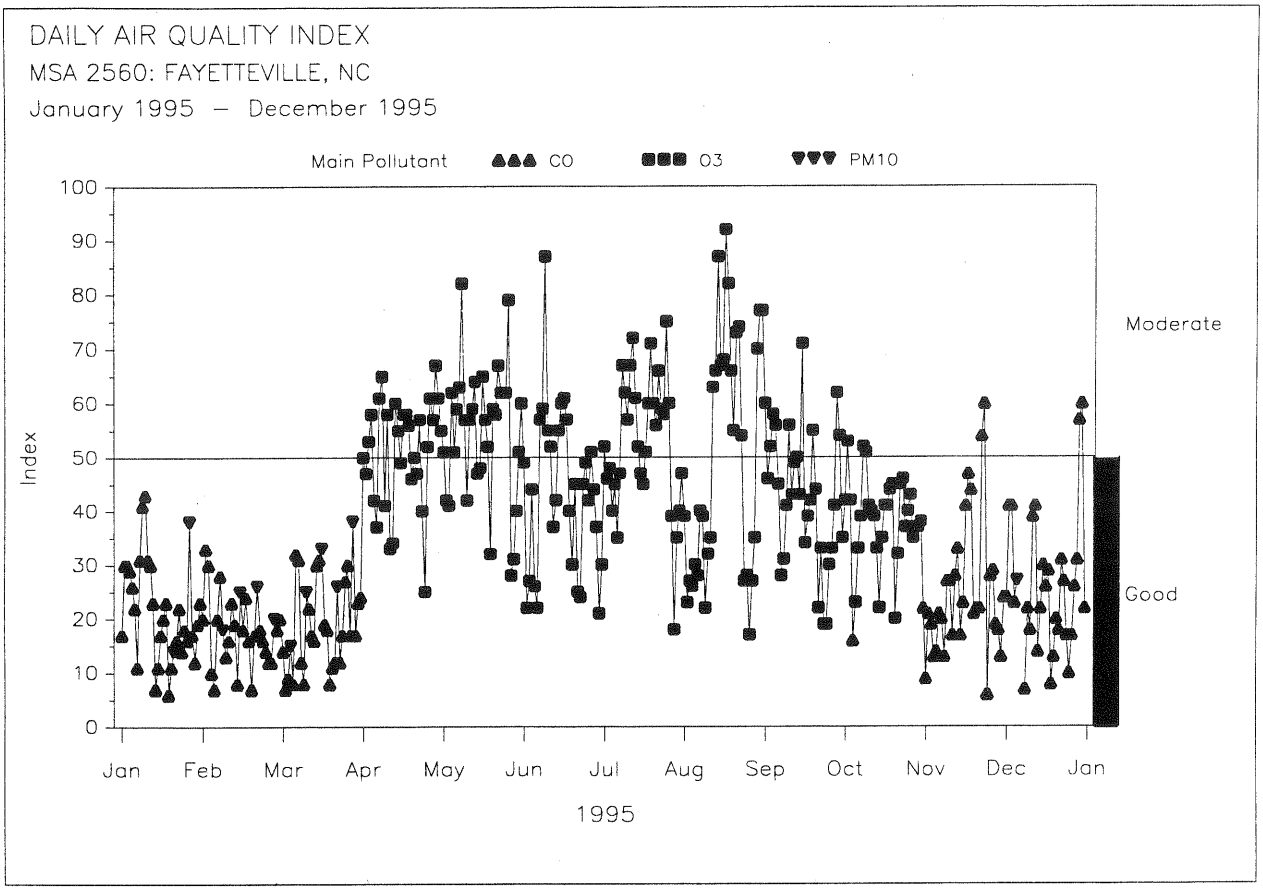

Figure 6.3 Daily Air Quality Index Values for Fayetteville, NC, Metropolitan Statistical Area, 1995.

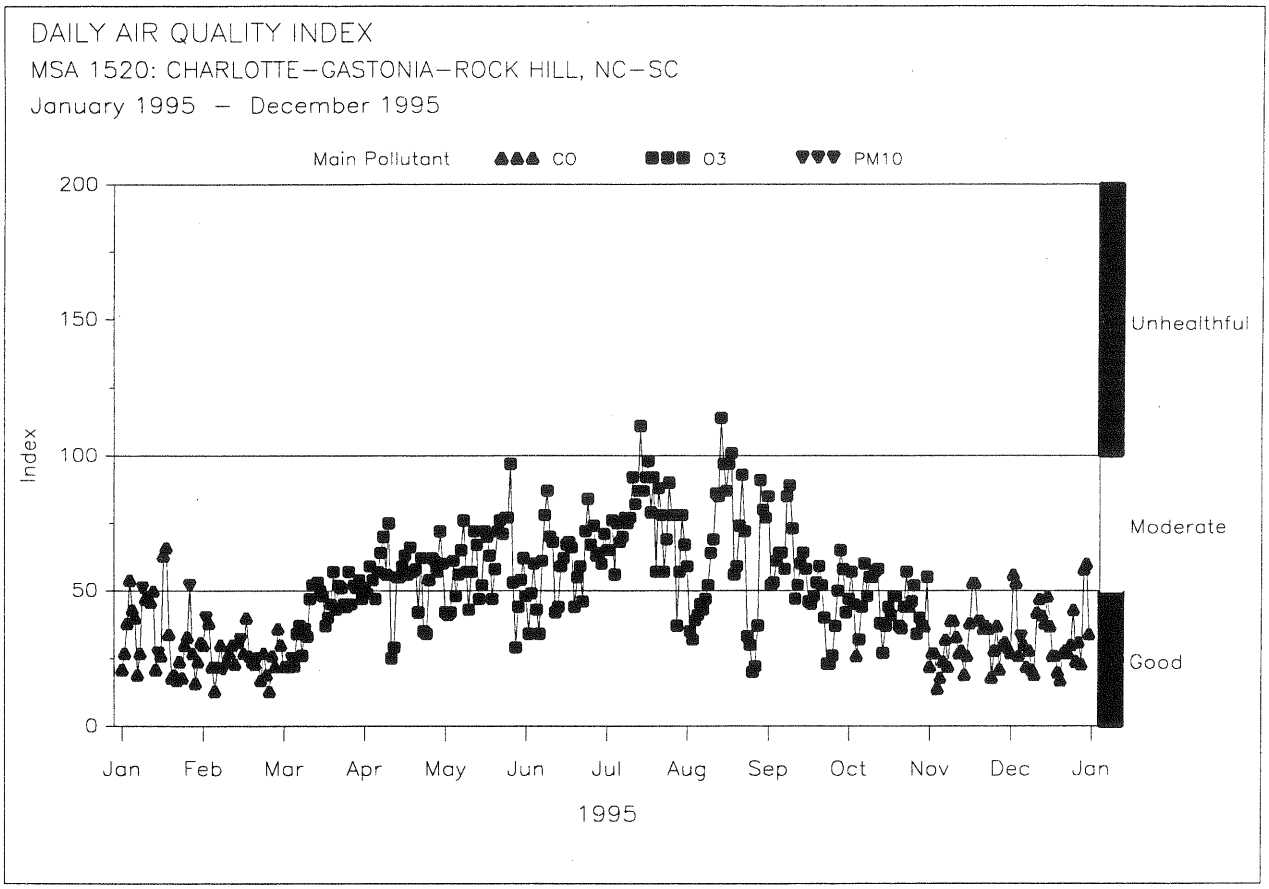

Figure 6.4 Daily Air Quality Index Values for Charlotte-Gastonia, NC,-Rock Hill, SC, Metropolitan Statistical Area, 1995

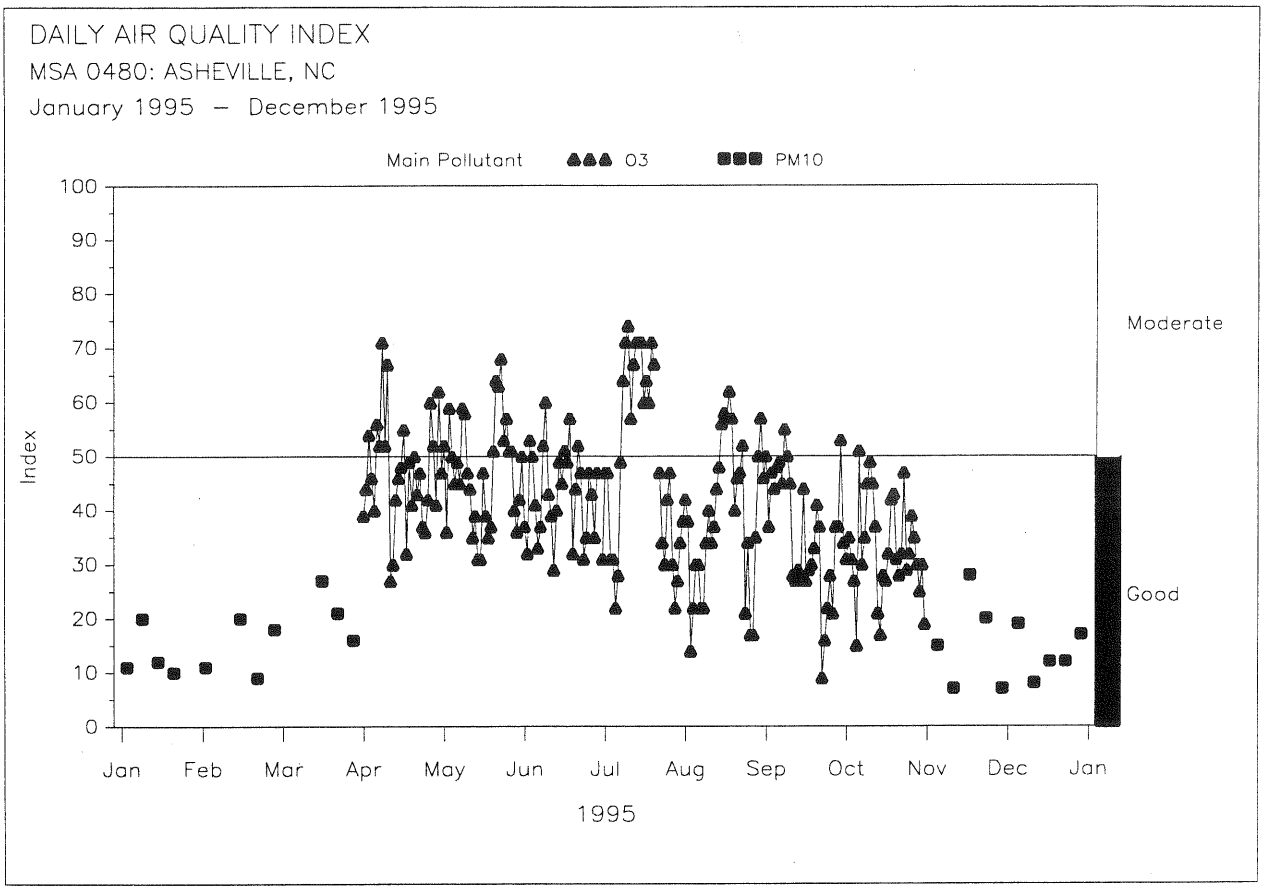

Figure 6.5 Daily Air Quality Index Values for Asheville, NC, Metropolitan Statistical Area, 1995

7. Acid Rain

7.1. Sources

Acid rain is produced when nitrate and sulfate ions from automobile and industrial sources are released into the upper 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 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 1995, 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 1995 ranged from 4.51 to 4.76 with a mean of 4.64. The 1995 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.

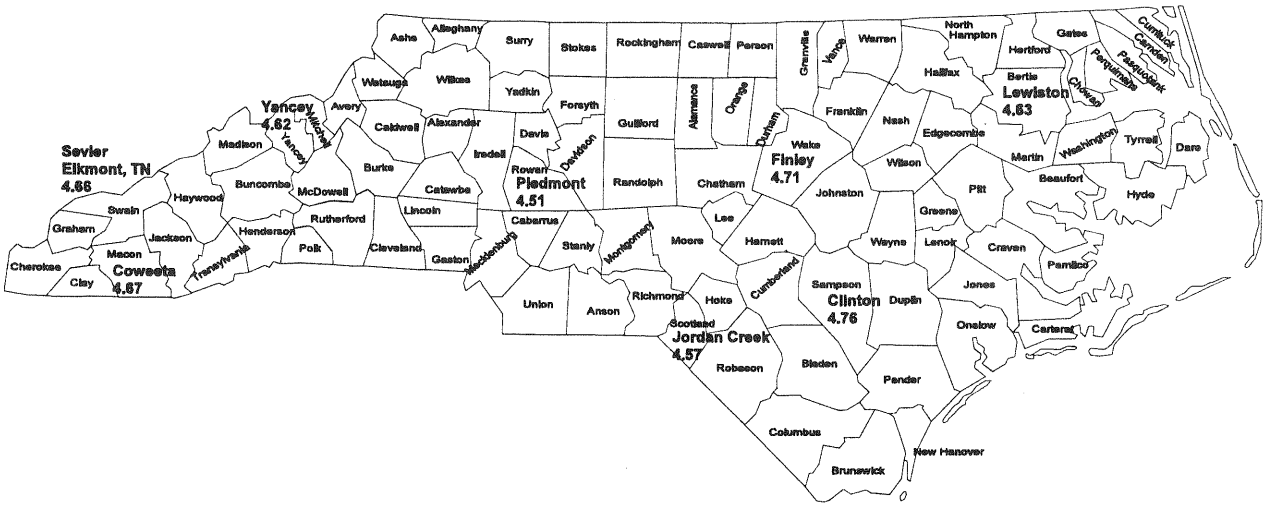

Figure 7.1 Annual Mean pH Values at North Carolina NADP/NTN/NDDN Sites, 1995

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 1995.

COUNTY SITE ADDRESS	pH	Conductivity	Precipitation
Bertie 340320 Lewiston	4.63	14.8	123.11
Macon 342500 Coweeta	4.67	12.1	192.54
Rowan 343460 Piedmont Research Station	4.51	17.9	132.74
Sampson 343560 Clinton Crops Res. Station	4.76	13.6	110.78
Scotland 343600 Jordan Creek	4.57	15.7	127.02
Wake 344160 Finley Farm	4.71	13.1	132.78
Yancey 344500 Mt. Mitchell	4.62	12.9	191.57
Sevier (TN) 441190 Great Smoky Mts Nat'l Park Elkmont TN	4.66	12.6	144.60

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 1995.

COUNTY SITE ADDRESS	% complete	Ca	Mg	K	Na	NH4	NO3	Cl	SO4
Bertie 340320 Lewiston	96.2	0.05	0.040	0.024	0.351	0.18	0.86	0.55	1.13
Macon 342500 Coweeta	90.6	0.04	0.011	0.023	0.076	0.15	0.67	0.12	1.01
Rowan 343460 Piedmont Research Station	94.2	0.06	0.020	0.034	0.125	0.28	1.03	0.22	1.58
Sampson 343560 Clinton Crops Res. Station	96.2	0.06	0.043	0.024	0.361	0.37	0.89	0.63	1.21
Scotland 343600 Jordan Creek	84.6	0.05	0.026	0.016	0.199	0.18	0.89	0.33	1.20
Wake 344160 Finley Farm	96.2	0.05	0.032	0.018	0.281	0.26	0.85	0.45	1.07
Yancey 344500 Mt. Mitchell	77.6	0.04	0.010	0.011	0.065	0.14	0.62	0.10	1.07
Sevier (TN) 441190 Great Smoky Mts Nat'l Park Elkmont TN	86.5	0.07	0.011	0.021	0.062	0.18	0.81	0.10	1.00

8. Statewide Trends

The N.C. DENR recently 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 year-to-year 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 1998. This chapter provides some interim analyses at the statewide level.

8.1. Particulate Matter

The statewide distribution of second-largest 24-hour PM_{10} concentrations for each monitor from 1985 to 1995 is shown in Figure 8.1. Concentrations have decreased from about 65 to about 45 $\mu g/m^3$, a 30 percent decline.

8.2. Carbon Monoxide

The statewide distribution of second-largest one-hour carbon monoxide (CO) concentrations from 1973 to 1995 is shown in Figure 8.2. The average value of this concentration has decreased from 25.9 ppm in 1973 to 18.8 ppm in 1980 (a decline of 3.9 percent per year) and from 16.3 ppm in 1981 to 7.8 ppm in 1995 (a decline of 3.5 percent per year).

North Carolina did not experience an exceedance of the one-hour standard for CO from 1973 through 1995.

The statewide distribution of second-largest eight-hour CO concentrations from 1973 to 1995 is shown in Figure 8.3. The average value of this concentration decreased from 15.6 ppm in 1973 to 9.9 ppm in 1980 (a decline of 5.5 percent per year) and from 8.9 ppm in 1981 to 4.8 ppm in 1995 (a decline of 3 percent per year).

There were more than 700 exceedances of the 8-hour standard for CO from 1973 through 1990, and the number of exceedances per year is shown in Figure 8.4. The average number of exceedances decreased steadily from about 60 per year in 1973-75 to 50 per year in 1978. That number stayed approximately constant through 1983, and finally decreased again, to 5

exceedances in 1989. There have been no CO exceedances since 1989.

8.3. Ozone

The statewide distribution of second-largest one-hour ozone concentrations is shown in Figure 8.5. The average ozone (O_3) concentration was nearly steady from 1972 to 1995, averaging 0.104 ppm (87 percent of the standard). Figure 8.5 suggests a possible downward trend beginning in the mid-1980s.

There were about 200 exceedances of the ozone NAAQS from 1972 through 1995, 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 20 annually. An exception was 1988, when 69 exceedances occurred. The solid trend line in Figure 8.6 suggests an average of 6.4 exceedances per year from 1973 through 1984, followed by a rapid increase from 1985 through 1987 and gradual decrease from 1987 through 1995. The average number of exceedances from 1985 through 1995 was 17.7 per year. The rapid increase in this trend in 1985 can be attributed almost entirely to the 69 exceedances of 1988. If the trend is examined with that year excluded (dashed line in Figure 8.6), the number of exceedances remained approximately constant through the entire interval from 1975 through 1995, averaging about 9 per year.

8.4. Sulfur Dioxide

The statewide distribution of second-largest three-hour sulfur dioxide (SO_2) concentrations from 1972 to 1995 is shown in Figure 8.7. The average decreased from 0.090 ppm in 1972 to 0.039 ppm in 1983 (8 percent of the standard) and remained generally between 0.04 and 0.06 ppm in the subsequent years.

The statewide distribution of second-largest 24-hour SO_2 concentrations from 1972 to 1995 is shown in Figure 8.8. The average was approximately constant around 0.015 ppm (10 percent of the standard) from 1973 through 1995.

8.5. Nitrogen Oxides

The statewide distribution of annual average nitrogen dioxide (NO_2) concentrations from 1972 to 1995 is shown in Figure 8.9. The mean concentration decreased from 0.0204 ppm in 1978 to 0.0151 ppm in 1995 (28 percent of the standard), or about 1.5 percent per year.

8.6. Lead

The statewide distribution of quarterly lead (Pb) concentrations is shown in Figure 8.10, using all available data from 1972 through 1990. The average lead concentration decreased from 0.125 in 1985 to 0.028 in 1988 and 0.019 in 1990, an average annual decrease of 40 percent from 1985 to 1988 and 17 percent from 1988 to 1990.

8.7. pH

The statewide distribution of annual average pH values from 1978 to 1995 for the

NADP/NTN sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 8.11. The mean pH was approximately constant through the mid 1980s, and now seems to be increasing slightly year by year.

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 amonium ion (NH_4^+) concentrations from 1978 to 1995 for the NADP/NTN sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 8.12. The average has stayed about 0.2 mg/L in the 1990s. 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 1978 to 1995 for the NADP/NTN sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 8.13. The mean has been slowly decreasing in the 1990s, about 1.75 percent per year. 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 1978 to 1995 for the NADP/NTN sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 8.14. The average has been decreasing about 2.75 percent per year, to about 1.2 mg/L in 1995. 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).

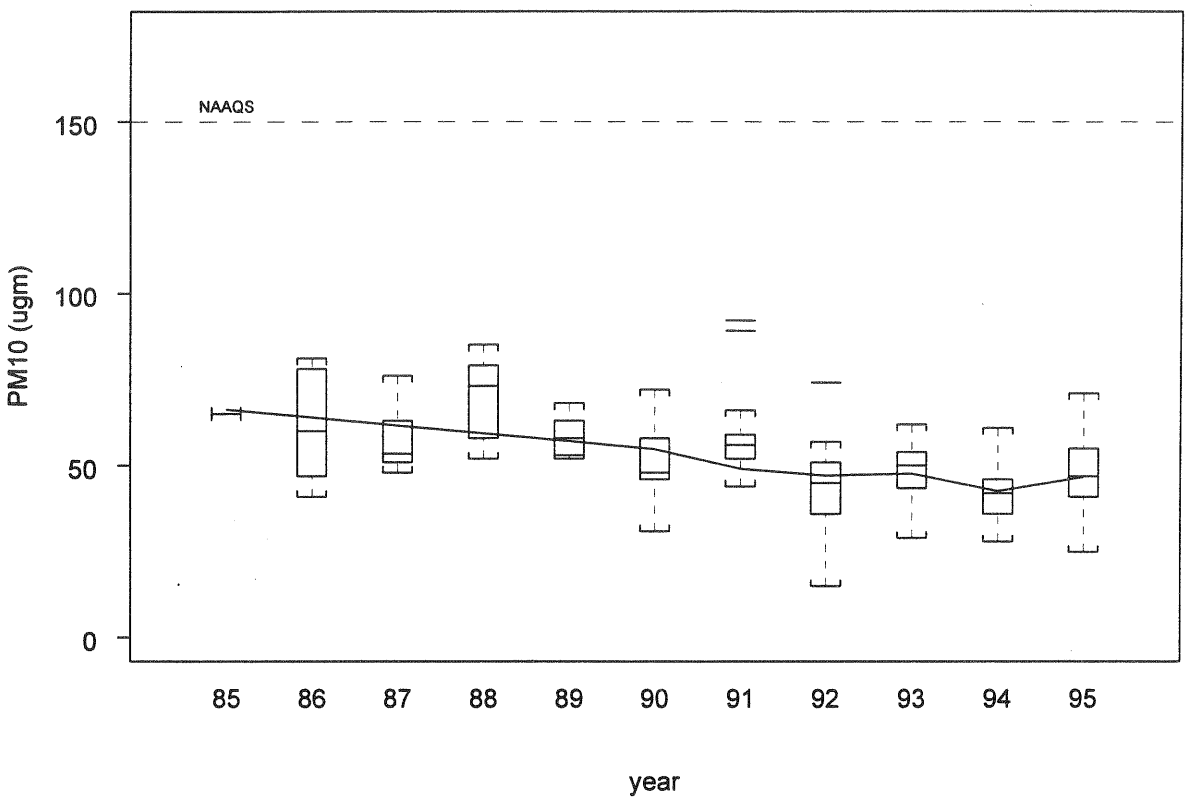

Figure 8.1 Distribution of Statewide 24-hour Particulate (PM_{10}) Concentrations, 1985-95, and Smoothed Regression Trend Line.

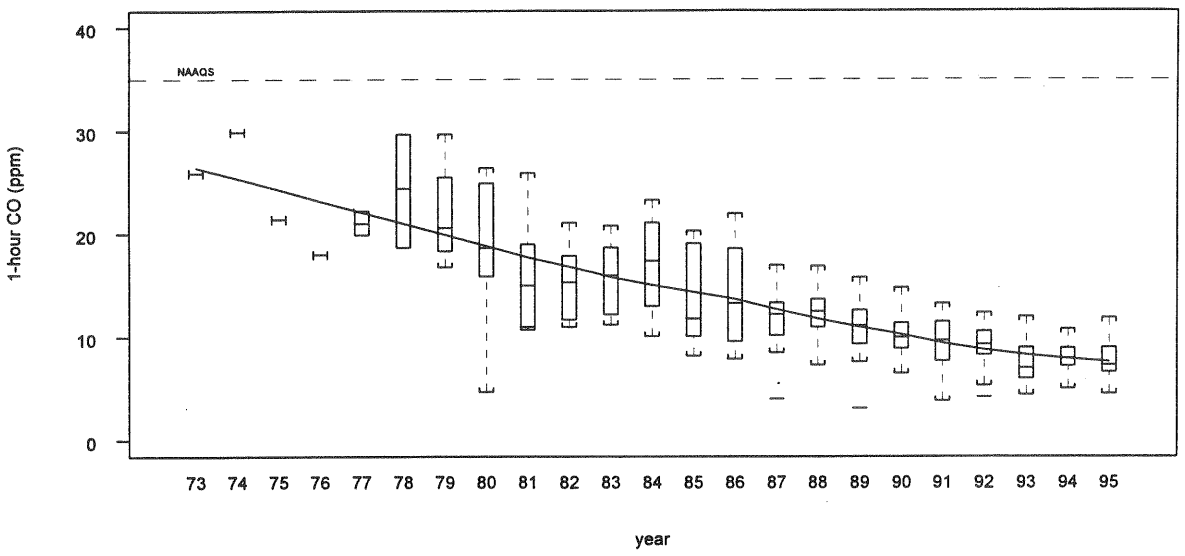

Figure 8.2 Distribution of Statewide 1-hour Carbon Monoxide (CO) Concentrations, 1973-95, and Smoothed Regression Trend Line.

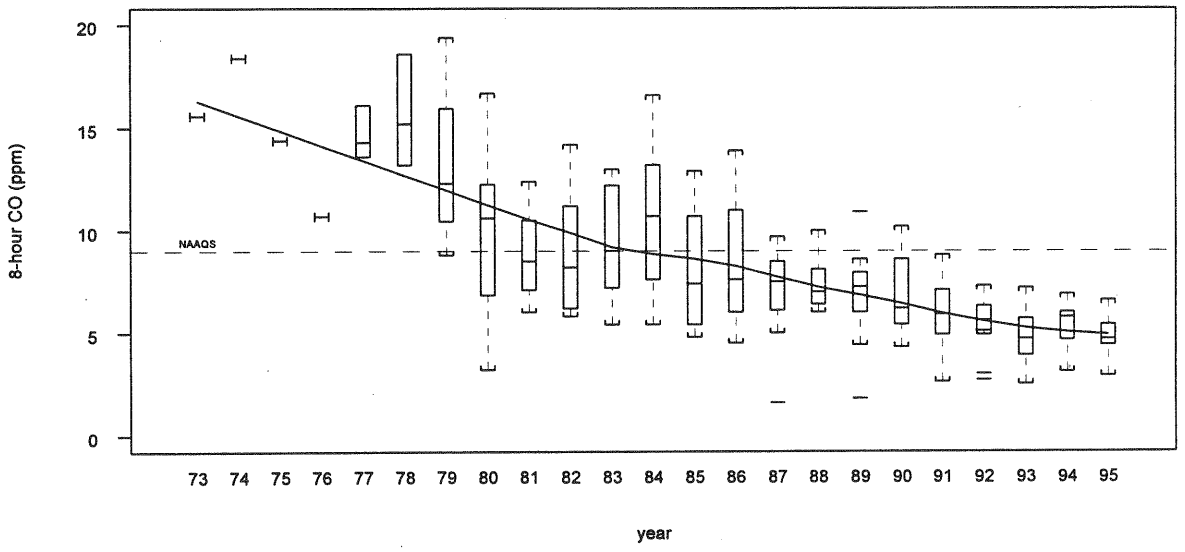

Figure 8.3 Distribution of Statewide 8-hour Carbon Monoxide (CO) Concentrations, 1973-95, and Smoothed Regression Trend Line.

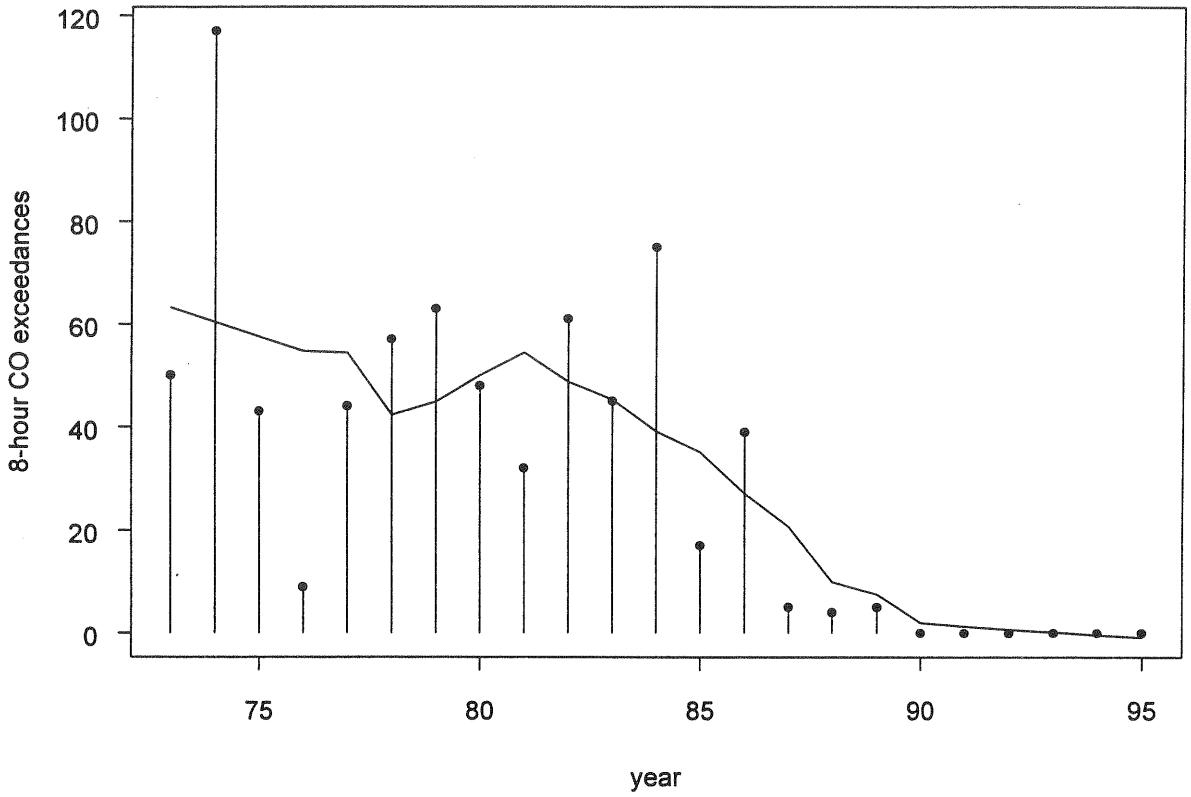

Figure 8.4 Number of Exceedances of 8-hour Carbon Monoxide (CO) NAAQS, 1973-95, and Smoothed Regression Trend Line.

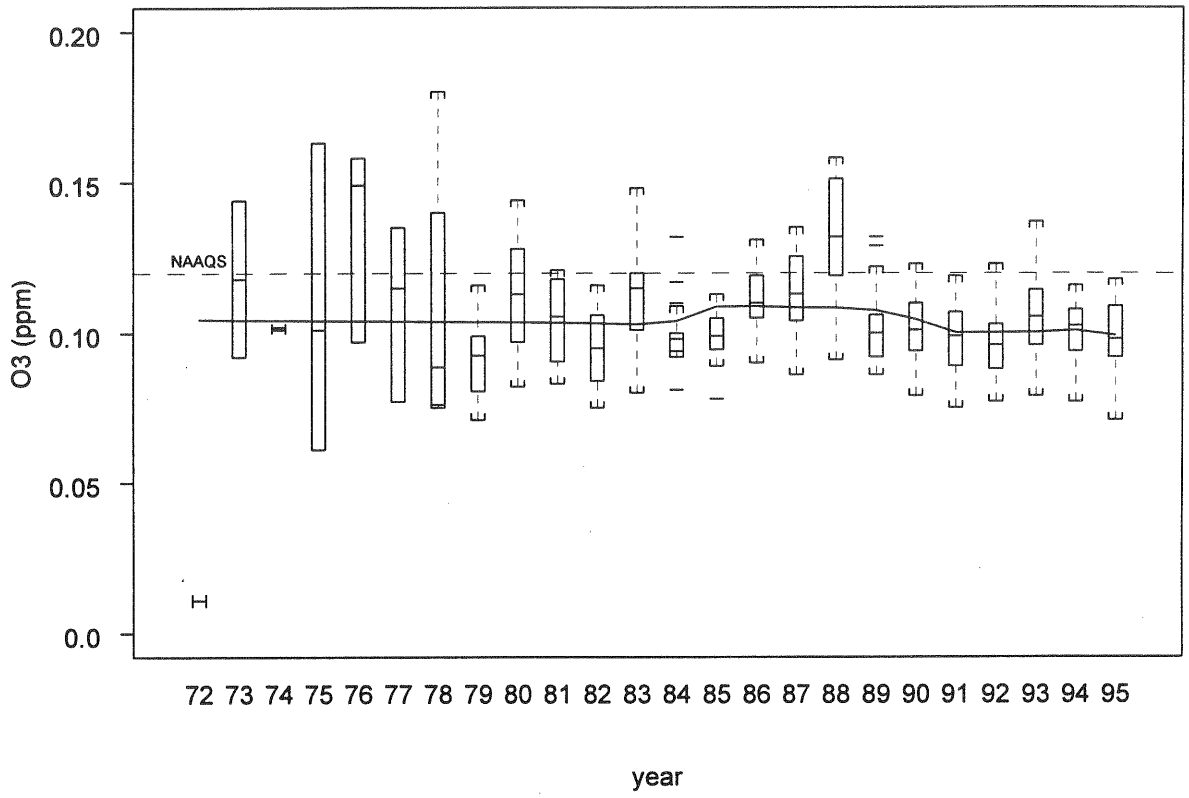

Figure 8.5 Distribution of Statewide 1-hour Ozone (O_3) Concentrations, 1972-95, and Smoothed Regression Trend Line.

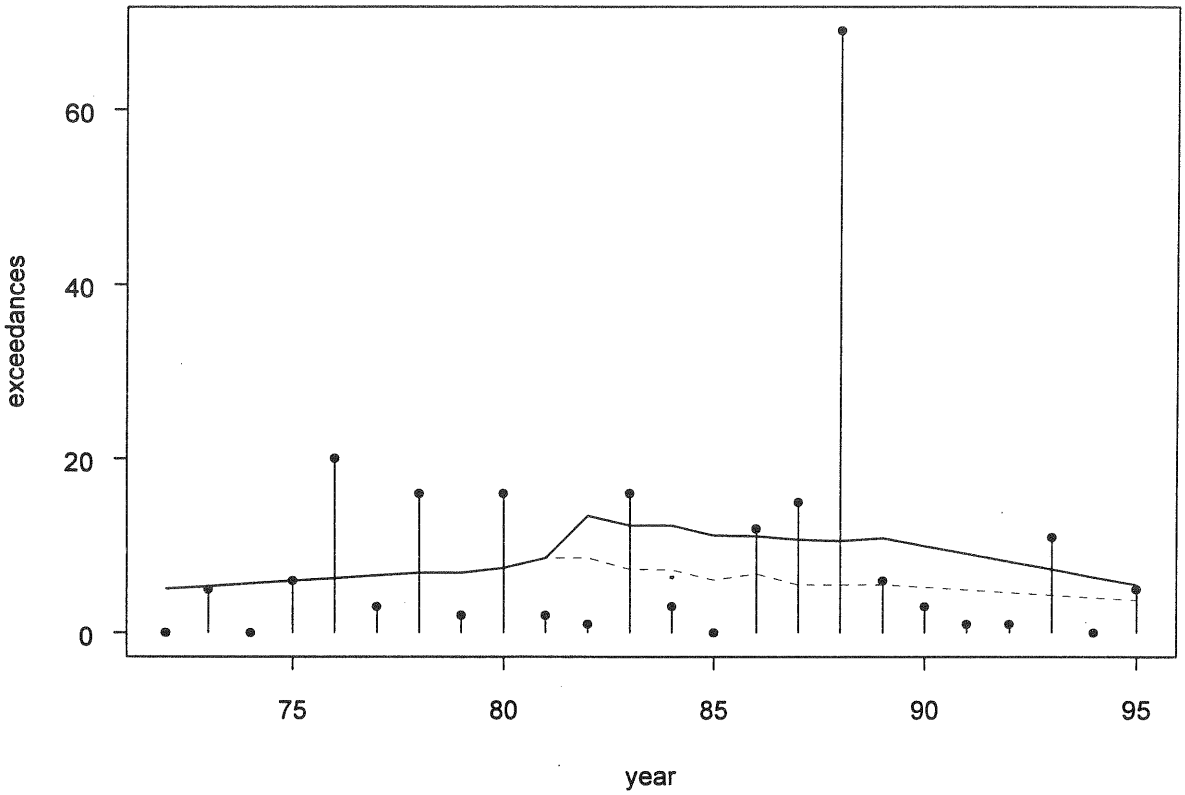

Figure 8.6 Number of Exceedances of Ozone (O_3) NAAQS, 1972-95, and Smoothed Regression Trend Lines. Solid trend line uses all of the available data; dotted trend line treats the 1988 data value as an outlier.

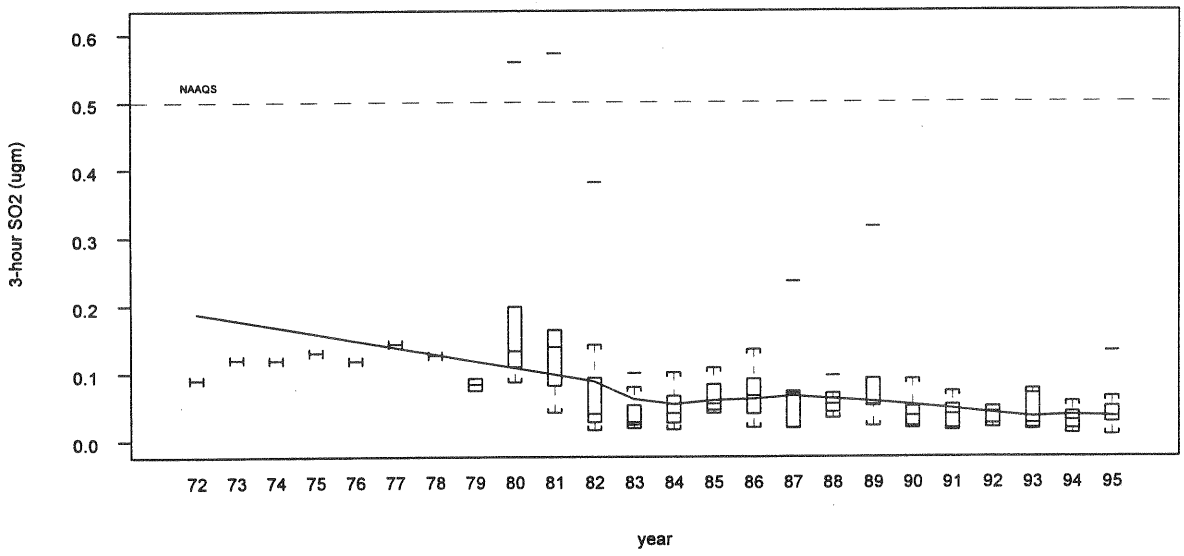

Figure 8.7 Distribution of Statewide 3-hour Sulfur Dioxide (SO_2) Concentrations, 1973-95, and Smoothed Regression Trend Line.

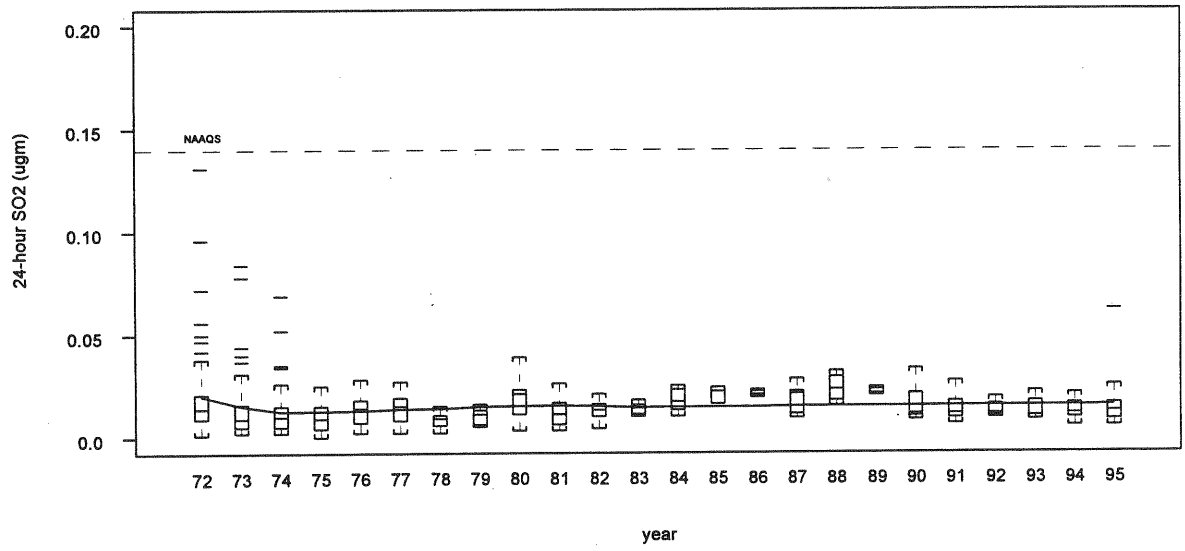

Figure 8.8 Distribution of Statewide 24-hour Sulfur Dioxide (SO_2) Concentrations, 1973-95, and Smoothed Regression Trend Line.

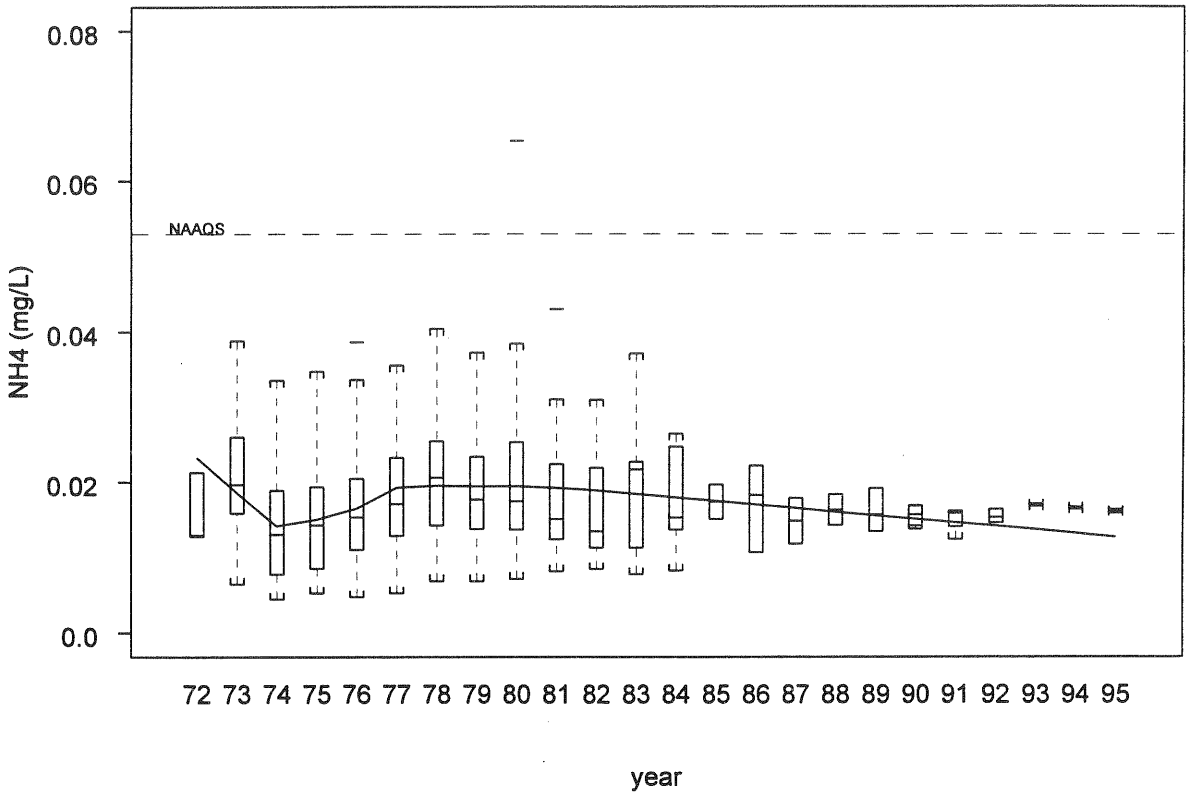

Figure 8.9 Distribution of Statewide Annual Mean Nitrogen Dioxide (NO_2) Concentrations, 1972-91, and Smoothed Regression Trend Line.

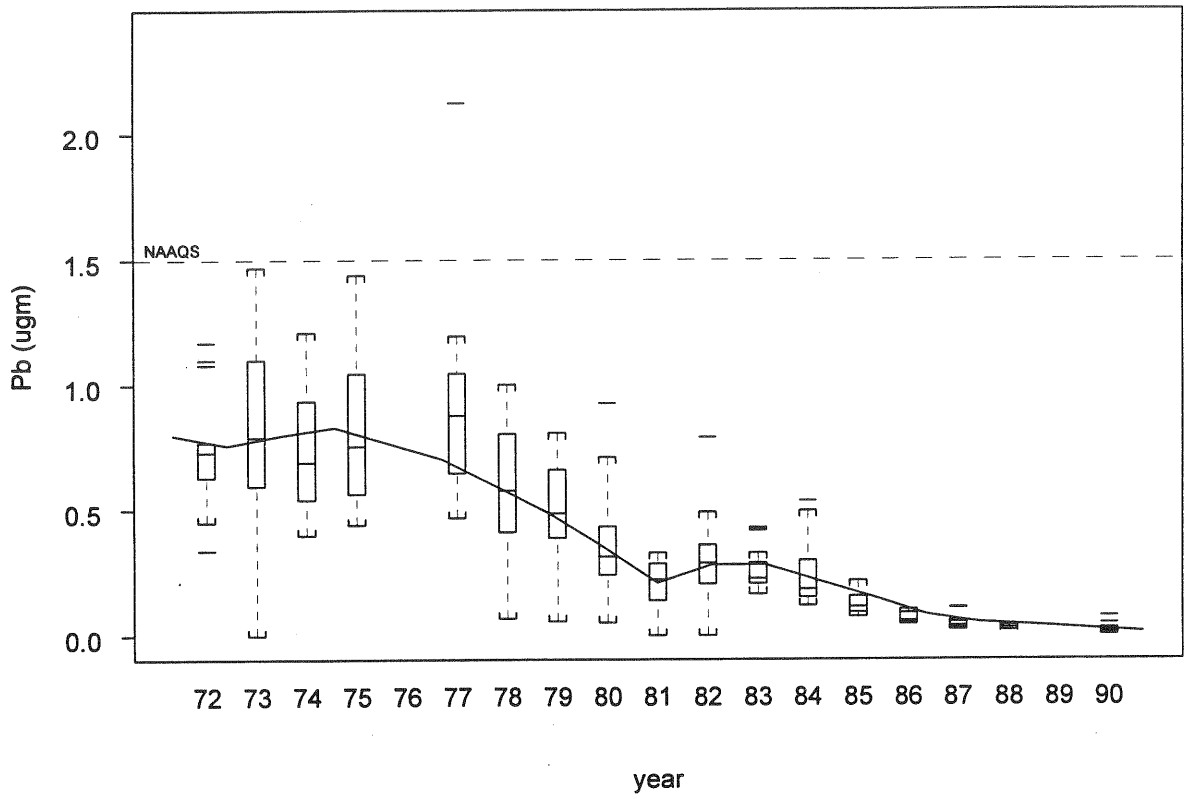

Figure 8.10 Distribution of Statewide Quarterly Lead (Pb) Concentrations, 1972-90, and Smoothed Regression Trend Line.

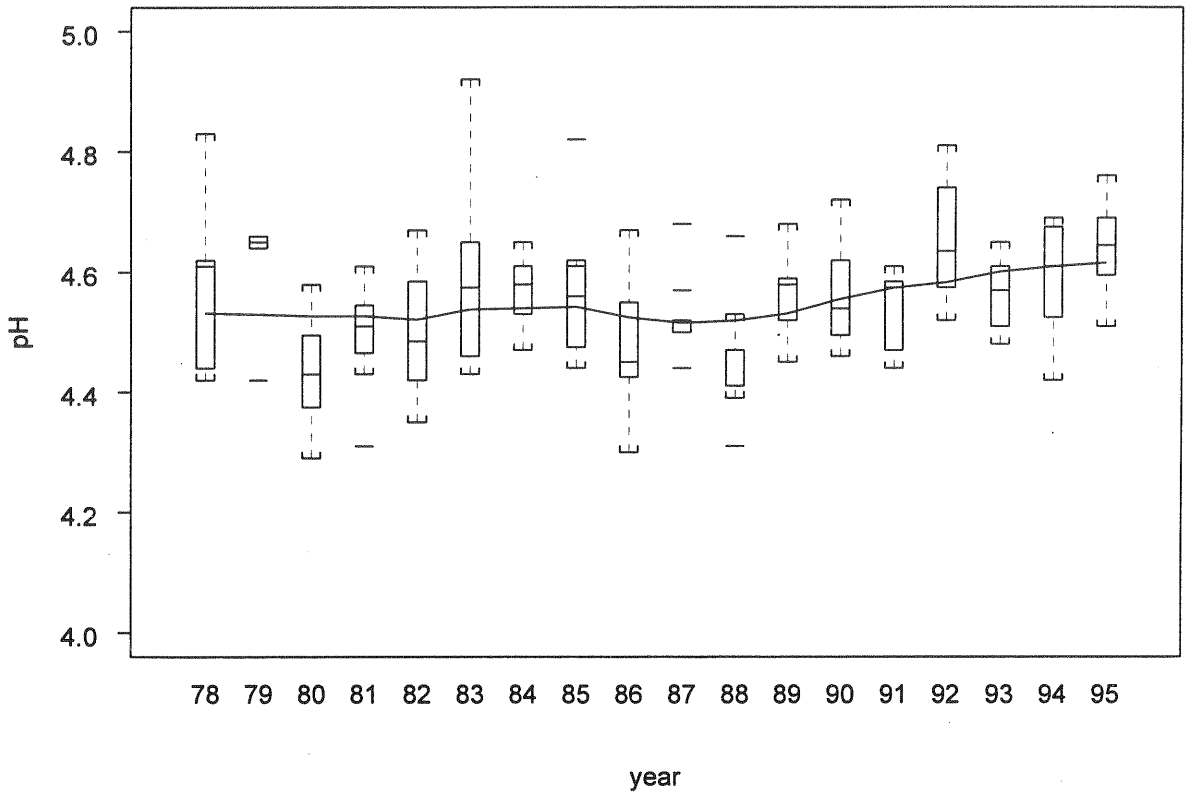

Figure 8.11 Distribution of Statewide Annual Mean pH, 1978-95, and Smoothed Regression Trend Line. Note: due to a sampling protocol change established on 11 January 1994, summaries for 1994 and 1995 are not directly comparable to earlier summaries (NADP 1995).

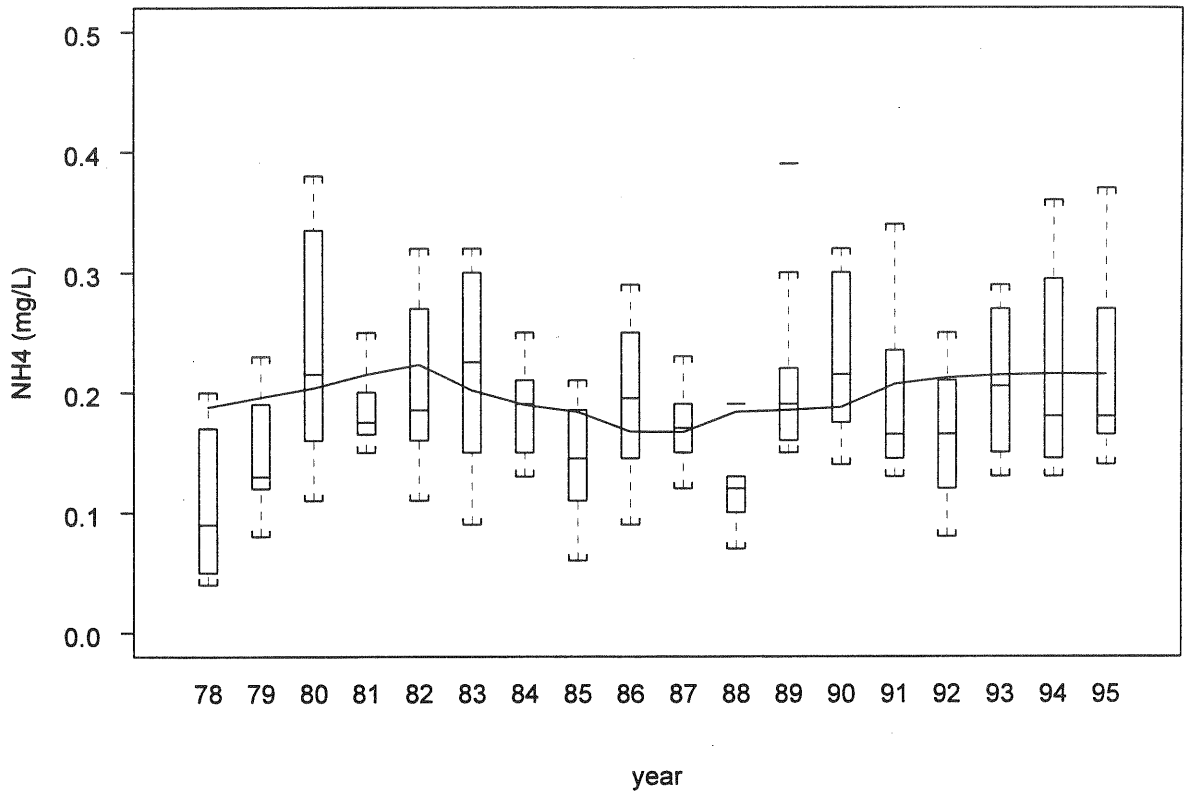

Figure 8.12 Distribution of Statewide Annual Mean Ammonium Ion (NH_4^+) 1978-95, and Smoothed Regression Trend Line. Note: due to a sampling protocol change established on 11 January 1994, summaries for 1994 and 1995 are not directly comparable to earlier summaries (NADP 1995).

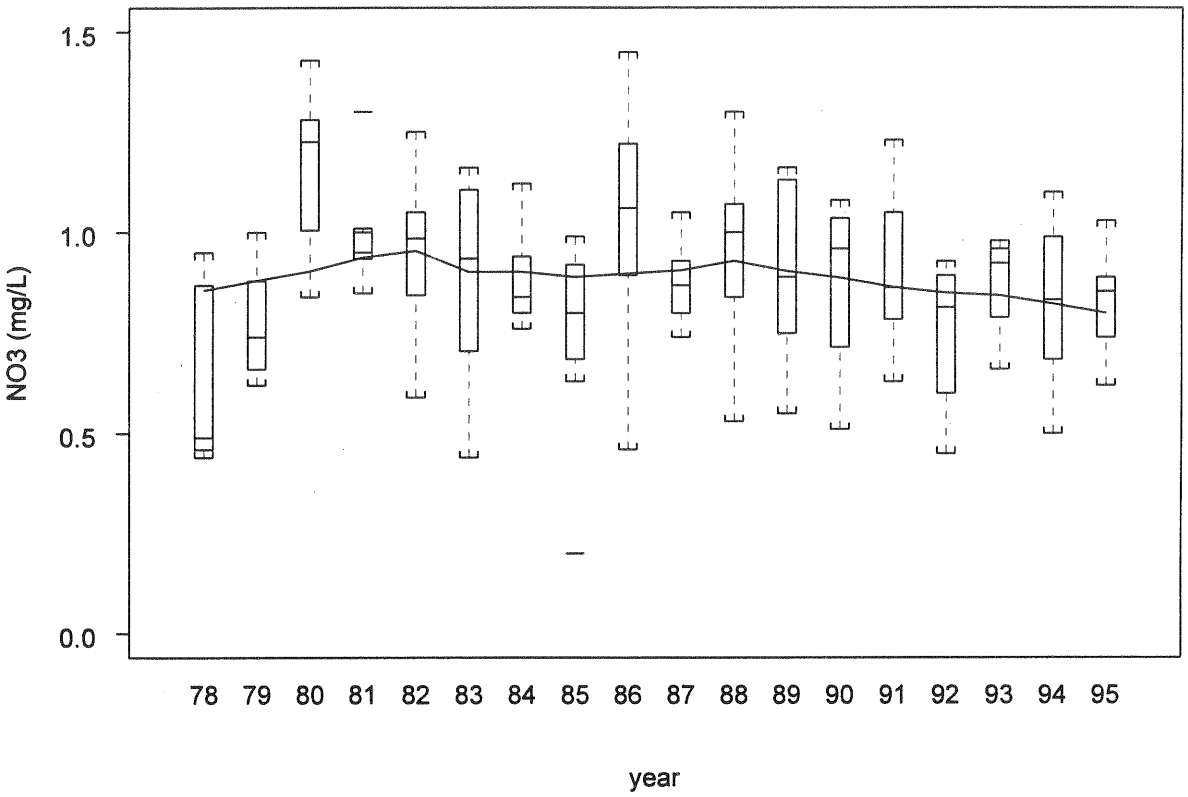

Figure 8.13 Distribution of Statewide Annual Mean Nitrate Ion (NO_3^-) 1978-95, and Smoothed Regression Trend Line. Note: due to a sampling protocol change established on 11 January 1994, summaries for 1994 and 1995 are not directly comparable to earlier summaries (NADP 1995).

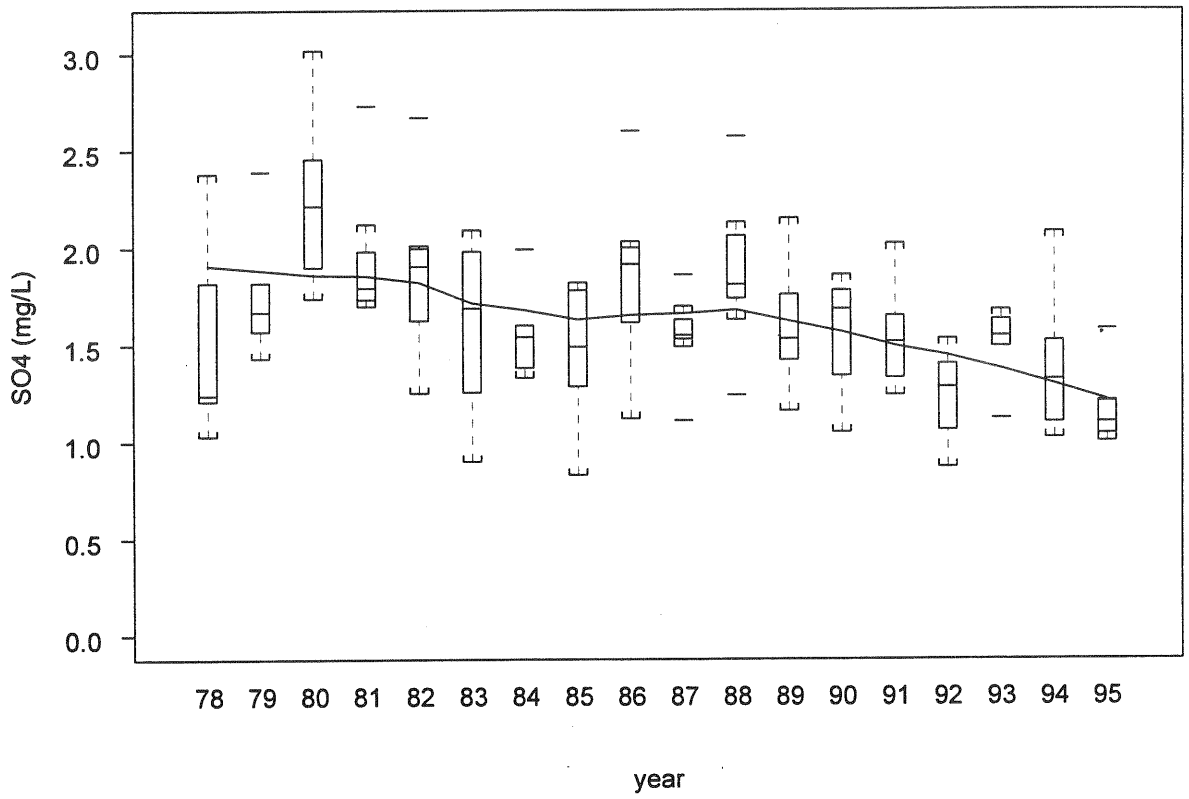

Figure 8.14 Distribution of Statewide Annual Mean Sulfate Ion (SO_4^{2-}) 1978-95, and Smoothed Regression Trend Line. Note: due to a sampling protocol change established on 11 January 1994, summaries for 1994 and 1995 are not directly comparable to earlier summaries (NADP 1995).

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Appendix A. Air Pollution Monitoring Agencies

North Carolina State Headquarters

[Through 1995]
Division of Environmental Management
Archdale Building
512 North Salisbury Street
P O Box 29535
Raleigh, North Carolina 27626-0535
(919) 733-3340

[Effective 1996]
Division of Air Quality
Parker Lincoln Building
2728 Capital Boulevard
P O Box 29580
Raleigh, North Carolina 27626-0580
(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, Buncombe, 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, Mecklenburg, 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.

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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, Forsyth, Guilford, Rockingham, Randolph, Stokes, Surry, Yadkin, Watauge, and Wilkes.

Local Agencies

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 Control Agency (Buncombe County and Haywood County)
Buncombe County Courthouse Annex
Asheville, North Carolina 28801-3569
(704) 255-5655

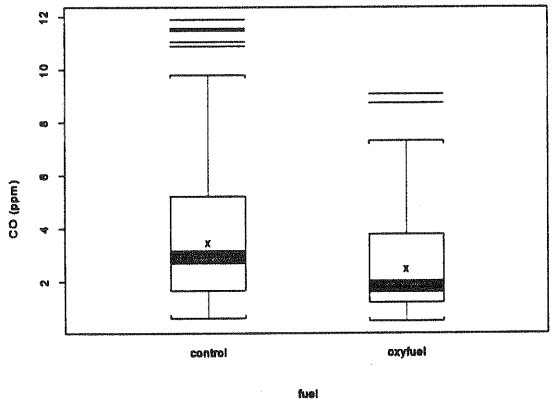
Appendix B. Exceptional Events

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
High pollen count	PM
Unintentional Manmade 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 Manmade 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. Thirty percent to 50 percent of the man-made hydrocarbons or volatile organic compound emissions come from motor vehicles; the rest comes from petroleum marketing, factories, businesses, and households. Volatile organic compounds react with nitrogen oxides and sunlight in warm weather to produce ozone.

Why is my county nonattainment?

Unless the state can demonstrate a better alternative, EPA has indicated that they will designate nonattainment areas based on Metropolitan Statistical Areas (MSAs). These MSAs were established by the Office of Management and Budget. Monitors showing violations of standards may not be in every county. Previous emission control programs instituted in single counties across the nation often have failed to produce compliance with standards. Pollution from one county blows into neighboring counties, especially with ozone. EPA concluded that the control plans must cover metropolitan areas, not single counties.

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. It is likely that 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. EPA's approval process 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 or carbon monoxide or both. 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 processis. This might include requirements that gas stations trap escaping vapors when vehicles are refueled or that gasoline contain pollution-reducing additives.

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 ban the construction 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?

The inspection/maintenance (I/M), or motor vehicle tailpipe testing process, costs the motorist $15.40 as of October 1, 1990. If a vehicle fails the test, it must be repaired. A waiver is available if a vehicle still fails after $50.00 worth of repairs have been done. The $50.00 limit does not apply to tampered or misfueled vehicles. The inspection/maintenance program includes tests for hydrocarbon (HC) and carbon monoxide (CO) emissions. Mecklenburg and Wake Counties began testing for HC in April 1991; Guilford and Forsyth Counties started I/M programs in July 1991; Durham and Gaston Counties began in July 1992; Cabarrus County in January 1993; and Orange and Union Counties in July 1993. 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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