2003 Ambient Air Quality Report

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

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

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Preface

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

Particulate Matter	Sulfur Dioxide	Ozone
Carbon Monoxide	Nitrogen Dioxide	Lead

The report begins with a brief discussion of the ambient air monitoring program, including a description of the monitoring network. It presents detailed results of monitoring that was conducted in 2003 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, and the 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 summaries from the National Atmospheric Deposition Program/National Trends Network for North Carolina also are included for 2003.

Current air pollution information is available for the Charlotte area 24 hours a day by telephoning 1-704-333-SMOG.

In 2002 the air monitoring program deployed a network of fine particle speciation monitors. This report provides data summaries from these monitors for both 2002 and 2003.

Also in 2002, the Division of Air Quality established a small network of Urban Air Toxics monitors. It supplements a new national toxics database, and some key toxics pollutants are summarized for both 2002 and 2003 in this report.

The report also contains graphical summaries of long term annual trends for the criteria pollutants and acid rain data, highlighting successful efforts at pollution control and suggesting where future priorities should be placed.

Additional copies of this report and previous annual reports are available on the Division of Air Quality's website http://daq.state.nc.us/monitor/reports/ or by writing to:

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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.

B. Keith Overcash, P.E., Director
Division of Air Quality

Executive Summary

In 2003, the North Carolina Division of Air Quality (DAQ), the three local program agencies and one tribal agency (listed in Appendix A) collected 331,150 air quality samples. These samples included measurements of the U.S. Environmental Protection Agency's (EPA) criteria air pollutants: particulate matter, carbon monoxide, ozone, sulfur dioxide, nitrogen dioxide and lead. This report discusses each pollutant and presents summary tables, maps, charts and explanations of the data.

The report also includes data from weekly acid rain samples collected by the National Atmospheric Deposition Program/National Trends Network (NADP) 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.

This report provides data summaries from a network of fine particle speciation monitors for both 2002 and 2003. The DAQ and two federal agencies deployed these monitors in 2002 to more fully characterize fine particulate matter by composition. This report presents a map and summary tables of the major speciation categories for both years.

Also in 2002, the Division of Air Quality established a small network of Urban Air Toxics monitors. It supplements a new national toxics database, and some key toxics pollutants are summarized for both 2002 and 2003 in this report. This report presents a map and summary tables of formaldehyde and four important volatile organic compounds for both years.

The report also contains graphical summaries of long term annual trends for the criteria pollutants and acid rain data, highlighting successful efforts at pollution control and suggesting where future priorities should be placed.

Three different types of **particulate matter** were sampled in North Carolina during 2003. Total Suspended Particulate (TSP), considered to be particles having an aerodynamic diameter of 100 micrometers or less, is regulated by North Carolina standards. Particulate matter (PM_{10}) with a mean aerodynamic diameter less than or equal to a nominal 10 micrometers (0.00004 inches) is regulated by both EPA and N.C. standards. Fine particulate matter ($PM_{2.5}$) with a mean aerodynamic diameter less than or equal to a nominal 2.5 micrometers (0.00001 inches) has been regulated by EPA since 1997.

TSP was sampled at 7 sites, yielding 401 daily samples. There was one exceedance of the state TSP ambient air quality standard for 24-hour samples (150 $\mu g/m^3$) observed in 2003.

PM_{10} was sampled at 16 sites, yielding 1,679 daily samples. There were no exceedances of the National Ambient Air Quality Standards for PM_{10} (150 $\mu g/m^3$ for 24-hour samples and 50 $\mu g/m^3$ for the annual arithmetic mean).

$PM_{2.5}$ was sampled at 37 sites yielding 5,419 daily samples. There were no exceedances of the ambient air quality standards for $PM_{2.5}$ (65 $\mu g/m^3$ for 24-hour samples). Two of the 37 sites exceeded the annual arithmetic mean standard of 15 $\mu g/m^3$.

Carbon monoxide (CO), 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 11 sites, yielding 50,971valid 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. The highest one-hour concentration of 6.1 was observed at the Griffith site in Winston-Salem. The highest eight hour concentration of 4.5 ppm was observed at the Griffith site in Winston-Salem. Both the mean one-hour average and the mean eight-hour average have been decreasing by about 3 percent per year. The combined effects of newer cars in the vehicle fleet, traffic control strategies, and the Inspection and Maintenance program in Durham, Orange, Wake, Forsyth, Guilford, Cabarrus, Gaston, Mecklenburg, and Union Counties have helped reduce the number and intensity of CO exceedances from previous years.

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

O_3 was sampled at 47 sites, yielding 234,600 valid hourly averages. The National Ambient Air Quality Standard for O_3 is 0.08 ppm for the maximum eight-hour average and 0.12 ppm for the maximum one-hour average.

In 2003, there were 4 exceedances of the one-hour standard, all of which occurred on two days in June and one day in August. Nineteen exceedances occurred in North Carolina in 2002, and six occurred in 2001. Mecklenburg, Rowan and Wake Counties met or exceeded the criteria for nonattainment of the one-hour ozone standard with five, twelve and one exceedances respectively over a three-year period. Mecklenburg County was redesignated as in attainment for ozone in July 1995. Hydrocarbon control strategies continue to be used there to help reduce ozone concentrations.

In 2003, the 8-hour standard was exceeded 114 times, on 14 different days, with four counties having 10 or more exceedances at individual sites. The site at 301 West Street and Gold Hill Avenue, Rockwell in Rowan County had the highest number, 32.

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 11 sites, yielding 86,021 valid hourly averages. There were no exceedances of the National Ambient Air Quality Standards (365 $\mu g/m^3$ or 0.14 ppm for a 24-hour average, 1300 $\mu g/m^3$ or 0.50 ppm for a three-hour average, 80 $\mu g/m^3$ or 0.03 ppm for the annual arithmetic mean) at network monitoring sites.

Nitrogen oxides (NO_x) are produced primarily from the burning of fossil fuels such as coal, oil and gasoline, due to the oxidation of atmospheric nitrogen and nitrogen compounds in the fuel. The primary combustion product is NO, which reacts with hydrocarbons, ozone and other atmospheric compounds to form NO_2. NO_x compounds play an important role in the formation of ozone. Reactive nitrogen species (NO_y) were monitored in Charlotte 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 17,115 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 10 percent per year.

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

Lead was not sampled in 2003 using a Federal Reference Method. There have been no recent exceedances of the ambient air quality standard for lead (1.5 $\mu g/m^3$ for a quarterly arithmetic mean). Mean lead concentrations have decreased by 92 percent since 1979. The steady decline in the use of leaded gasoline is primarily responsible for this trend.

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

The annual mean pH in 2003 ranged from 4.53 (Rowan County) to 5.10 (Sampson County).

Speciated particulate samples were collected at nine sites by the DAQ, two sites by the National Park Service and one site by the U.S. Forest Service. Categorizing these as nitrates, sulfates, ammonium, organic carbon, elemental carbon, crustal material, and "other" constitutents (liquid water, trace elements, etc.), there were 4,061 quantifiable concentrations in 2002 and 5,391 quantifiable concentrations in 2003.

By category, the highest concentrations of speciated particulate samples in 2003 were: nitrate 7.30 $\mu g/m^3$; sulfate 21.6 $\mu g/m^3$; ammonium 4.85 $\mu g/m^3$; organic carbon 14.5 $\mu g/m^3$; elemental carbon 2.36 $\mu g/m^3$; crustal component 5.00 $\mu g/m^3$; other 14.31 $\mu g/m^3$.

Although there was no sampling for lead using a criteria pollutant method, the speciated particulate monitoring network provided 479 samples of $PM_{2.5}$-lead in 2003; 473 of these sample concentrations (98.7 percent) were less than 0.01 $\mu g/m^3$. No sample exceeded 0.014 $\mu g/m^3$.

Urban Air Toxics sampling in 2002 and 2003 occurred at four sites, three urban and one rural. This effort contributes to the U.S. EPA's Air Toxics Monitoring Strategy by providing data to help assess health risks.

The median concentration of formaldehyde ranged from 0.26 to 0.50 ppb at the urban sites, and all concentrations were less than 0.15 ppb at the rural site.

Median benzene concentrations ranged from 0.19 to 0.37 ppb at the urban sites and 0.10 to 0.12 ppb at the rural site. Median toluene concentrations ranged from 0.38 to 0.79 ppb at the urban sites and 0.10 to 0.13 ppb at the rural site. Median ethylbenzene concentrations ranged from 0.08 to 0.13 ppb at the urban sites and were less than 0.05 ppb at the rural site. Median m/p-Xylene concentrations ranged from 0.26 to 0.51 ppb at the urban sites and were less than 0.05 ppb at the rural site. Median o-Xylene concentrations ranged from 0.10 to 0.18 ppb at the urban sites and were less than 0.05 ppb at the rural site.

Ambient Trends: Annual average statewide concentrations of PM_{10} have decreased by 27 percent from 1989 to 2003. Annual average statewide concentrations of CO (as 8-hour averages) decreased by 48 percent from 1992 to 2003. Ozone concentrations oscillate in a long cycle and show no specific trend to 2003. Annual average highest 3-hour sulfur dioxide concentrations have decreased by 11 percent from 1989 to 2003, and annual average of annual means decreased by 26 percent in the same time period. Annual average nitrogen dioxide concentrations have remained constant from 1989 to 2003 in Forsyth County and Mecklenburg County, the only locations where this pollutant is monitored at present.

Acid Rain Trends: Annual average pH in rain has increased about 5 percent from 1989 to 2003. Annual average ammonium concentrations have increased about 1 percent from 1989 to 2003, but this is dominated by very significant increases in Sampson County, associated with concentrated livestock animal production. Annual average nitrate concentrations in rain have increased about 25 percent from 1989 to 2003. Annual average sulfate concentrations in rain have increased about 31 percent from 1989 to 2003.

CONTENTS

List of Tables

List of Figures

1 Introduction

This annual report summarizes the ambient air monitoring performed in calendar year 2003 by the North Carolina Division of Air Quality (DAQ), three local air pollution agencies and one tribal agency, which are more fully described in Appendix A.

There were 331,150 air quality samples of the U.S. Environmental Protection Agency's (EPA) criteria pollutants (particulate matter, carbon monoxide, ozone, sulfur dioxide, nitrogen dioxide and lead), which are discussed in this report.

Chapter 2 describes the criteria pollutants and discusses their sources and effects on human health, plants and animals.

Chapter 3 outlines the standards applied to criteria pollutant concentrations established by the EPA and the state of North Carolina to protect human health (primary standards) and plants, animals, and property (secondary standards).

Chapter 4 describes the ambient monitoring program conducted by DAQ and three local program agencies.

Chapter 5 gives detailed monitoring results for each pollutant, with a map of the monitor sites, a table of the monitor summary statistics relevant to the standards, one or more maps summarizing the important statistics for each county with monitors, and additional summaries as appropriate to each pollutant.

Chapter 6 describes the EPA Air Quality Index for the criteria pollutants and charts index measurements for five Metropolitan Statistical Areas of North Carolina.

Chapter 7 presents sources, effects and monitoring of acid rain data conducted in North Carolina by the National Atmospheric Deposition Program and National Trends Network (NADP). It also includes a map of the calendar year mean pH level and site statistics for the calendar year in two tables.

Chapter 8 describes a small network of fine particulate speciation compounds that DAQ initiated in 2002. The chapter contains annual summaries of seven main components of fine particles for both 2002 and 2003. We also report 2003 summary of lead here (instead of chapter 5).

Chapter 9 describes the Urban Air Toxics monitoring program in North Carolina. The DAQ and local air pollution agencies sampled volatile organic compounds at four sites in 2002 and 2003. This chapter contains annual summaries for five important toxics pollutants.

Chapter 10 provides a statewide summary of trends for the criteria pollutants from 1989 (1991 for CO and 1985 for O_3) through 2003.

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 (μm). In the period covered by this report, three sizes of particulate matter were monitored, total suspended particulate (TSP), PM_{10} and $PM_{2.5}$. TSP is any particulate matter measured by the method described in EPA regulations 40 CFR 50 App. B (United States Environmental Protection Agency [US EPA] 1993, p. 715-728) and is generally considered to be particles having an aerodynamic diameter of 40 μm or less (Watson and Chow 2001), although particles up to about 100 μm are sometimes captured by samplers. (The probability of inhalation for 100 μm particles is about 50 percent and increases with decreasing particle size [Maynard and Jensen 2001].) PM_{10} is particulate matter with an aerodynamic diameter less than or equal to 10 μm 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 1991a). The new $PM_{2.5}$ standard was adopted by North Carolina on April 1, 1999. On May 14, 1999, the U.S. Court of Appeals ruled the setting of the standard by EPA was an unconstitutional use of authority and could be vacated. The Supreme Court later upheld the new standard. EPA continues to require monitoring for $PM_{2.5.}$

2.1.1 Sources

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

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

2.1.2 Effects

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

or heart disease, those suffering from the flu, asthmatics, the elderly, children, and mouth breathers.

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

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

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

2.2 Carbon Monoxide

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

2.2.1 Sources

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

2.1.2 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 60º F and the sunlight is more intense.

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

2.3.2 Effects

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

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

2.4 Sulfur Dioxide

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

2.4.1 Sources

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

2.4.2 Effects

The most obvious health effect of sulfur dioxide is irritation and inflammation of body tissues brought in contact with the gas. Sulfur dioxide can increase the severity of existing respiratory diseases such as asthma, bronchitis, and emphysema. Sulfuric acid and fine particulate sulfates, which are formed from sulfur dioxide, also may cause significant health problems. Sulfur dioxide causes injury to many plants. A bleached

appearance between the veins and margins on leaves indicates damage from SO_2 exposure. Commercially important plants sensitive to SO_2 include cotton, sweet potatoes, cucumber, alfalfa, tulips, apple trees, and several species of pine trees.

2.5 Nitrogen Oxides

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

2.5.1 Sources

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

2.5.2 Effects

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

Some types of vegetation are very sensitive to NO_2, including oats, alfalfa, tobacco, peas and carrots. Chronic exposure causes chlorosis (yellowing) and acute exposure usually causes irregularly shaped lesions on the leaves.

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

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

2.6 Lead

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

2.6.1 Sources

The major source of atmospheric lead used to be the combustion of gasoline containing the additive tetraethyl lead as an anti-knock 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, newspaper inks and piston engine aircraft gasoline.

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 that were in effect during 2003 are summarized in Table 3.1.

Table 3.1 National and North Carolina Ambient Air Quality Standards

For new or anticipated new standards, References in the Code of Federal Regulations are given. For standards expressed in parts per million, an equivalent mass per unit volume is also shown.

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

1. In 1987, National standards for PM-10 replaced those for TSP.
2. Arithmetic mean over the 3 most current years.
3. In July 1997, a percentile-based statistic replaced the 2nd maximum, but in May 1999 the 2nd maximum standard was reinstated.
4. Determined by adjusting for incomplete days and averaging over the most recent 3 consecutive, complete calendar years.
5. Arithmetic mean value over the most recent 3 consecutive, complete calendar years.
6. On April 1, 2000 North Carolina adopted the EPA PM2.5 and Ozone standards. On May 14, 2000 the US Court of Appeals ruled the new EPA PM2.5 standard vacated and the new 8-hour ozone standard as unenforceable. On appeal to the US Supreme Court the new standard was upheld.
7. On May 27, 2000, the one-hour ozone standard was rescinded by the Environmental Management Commission based on EPA guidance. The one-hour standard is being reinstated by EPA.

4 Ambient Air Quality Monitoring Program

The North Carolina Division of Air Quality, three local air pollution control programs, and one tribal program (Appendix A) performed ambient monitoring and analyses of samples in 2003. Ambient 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; to determine the extent of allowable industrial expansion; and to provide air pollution information to the public. A list of all monitoring sites active in 2003 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, 5.8, 5.11, 5.14, and 5.17.

In general, ambient monitors are operated year-round, but in some cases seasonal variations in pollutant levels make it feasible to suspend sampling at certain times. Ambient carbon monoxide associated with transportation and heating tends to produce significant concentrations only in cold weather conditions, so (with the US EPA's permission) we generally operate these monitors only from October through March. Ozone concentrations, by contrast, are correlated positively with ambient temperature. US EPA regulations accordingly require monitoring in NC from April through October. Along with ozone at some locations we also monitor ozone precursor pollutants. Indeed, one of the ozone precursors is carbon monoxide. See §5.4 for more information about seasonal carbon monoxide monitoring and §5.5 for more information about seasonal ozone monitoring.

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 monthly for correct instrument operation.

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

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

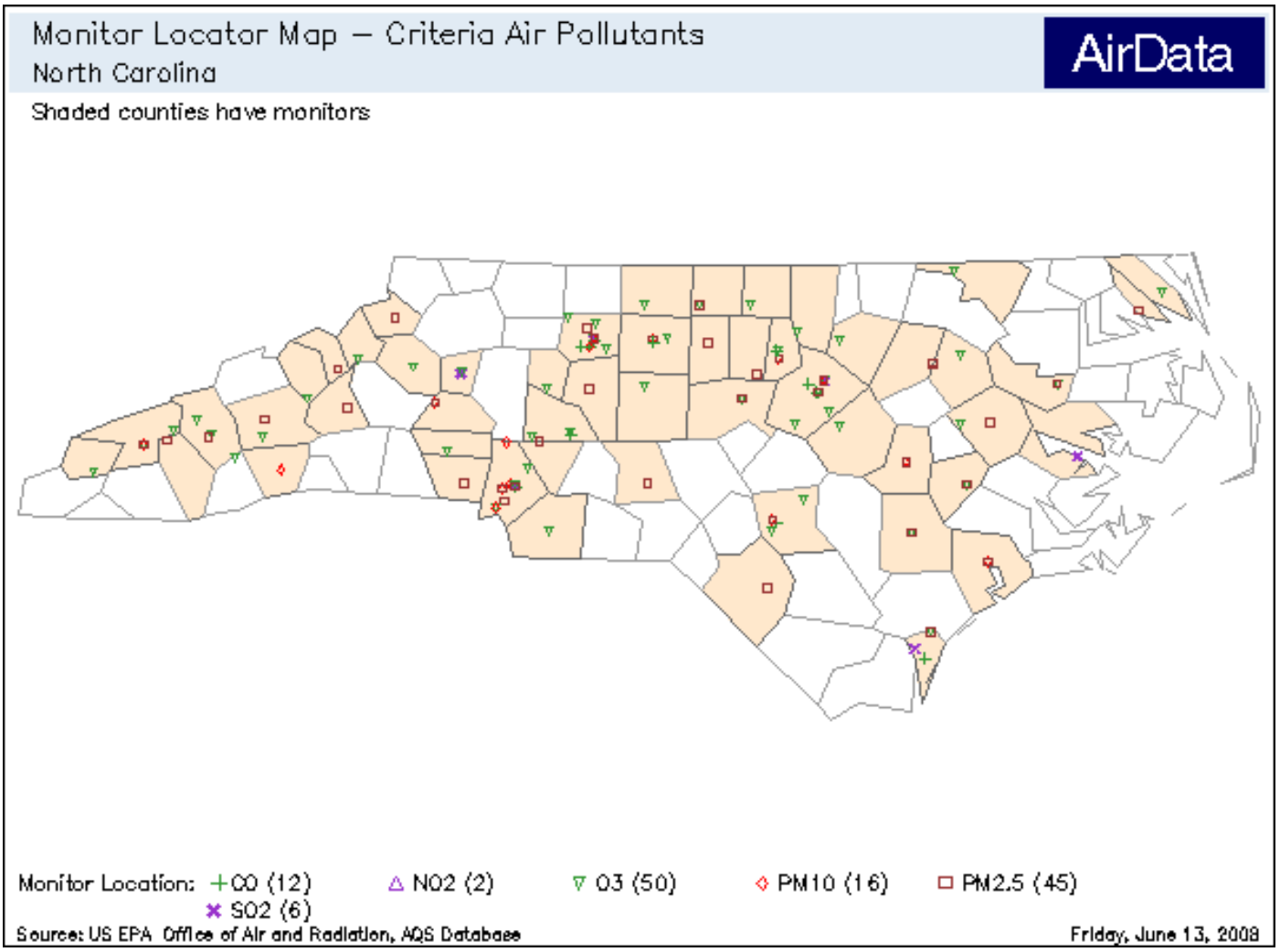

Figure 4.1 Monitoring Sites Active in 2003

Table 4.1 Ambient Air Monitoring Sites Operated in North Carolina, 2003

SITE COUNTY	ADDRESS	POLLUTANTS	
37-001-0002 ALAMANCE	827 S GRAHAM & HOPEDALE RD BURLINGTON	PM2.5	
37-003-0003 ALEXANDER	324 MINNIGAN LANE TAYLORSVILLE	O3	SO2
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	O3	
37-013-0006 BEAUFORT	NC 306 @ PCS ENTRANCE AURORA	SO2	
37-021-0030 BUNCOMBE	ROUT 191 SOUTH BREVARD RD ASHEVILLE	O3	
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	PM2.5	
37-025-0004 CABARRUS	933 FLOYD STREET KANNAPOLIS	PM2.5	
37-027-0003 CALDWELL	HWY 321 NORTH LENOIR	O3	
37-029-0099 CAMDEN	101 MCKINNEY ROAD CAMDEN	O3	
37-033-0001 CASWELL	7074 CHERRY GROVE RD REIDSVILLE	O3	PM2.5
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	PM10	PM2.5
37-037-0004 CHATHAM	325 RUSSETT RUN ROAD PITTSBORO	O3	PM2.5

SITE COUNTY	ADDRESS	POLLUTANTS
37-051-0007 CUMBERLAND	CUMBERLAND CO ABC BOARD, 1705 OWEN DR FAYETTEVILLE	CO
37-051-0008 CUMBERLAND	1/4 MILE SR1857/US301/1857 WADE	O3
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	PM10 PM2.5
37-051-1003 CUMBERLAND	3625 GOLFVIEW RD HOPE MILLS	O3
37-057-0002 DAVIDSON	SOUTH SALISBURY STREET LEXINGTON	PM2.5
37-059-0002 DAVIE	246 MAIN STREET COOLEEMEE	O3
37-061-0002 DUPLIN	HIGHWAY 50 KENANSVILLE	O3 PM2.5
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN STREET DURHAM	PM10 PM2.5
37-063-0013 DURHAM	2700 NORTH DUKE STREET DURHAM	O3
37-065-0003 EDGECOMBE	TALBERT PARK AT SPRUCE & CAROLINA ROCKY MOUNT	PM2.5
37-065-0099 EDGECOMBE	7589 NC HIGHWAY 33 NW TARBORO	O3
37-067-0022 FORSYTH	1300 BLK HATTIE AVENUE WINSTON-SALEM	PM10 O3 SO2 NO2 PM2.5
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY WINSTON-SALEM	CO PM10
37-067-0024 FORSYTH	NORTH FORSYTH HIGH SCHOOL WINSTON-SALEM	PM2.5

SITE COUNTY	ADDRESS	POLLUTANTS
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE WINSTON-SALEM	O3
37-067-0028 FORSYTH	6496 BAUX MOUNTAIN ROAD WINSTON-SALEM	O3
37-067-0029 FORSYTH	1985 GRIFFITH ROAD WINSTON-SALEM	CO
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	O3
37-069-0001 FRANKLIN	431 S. HILLSBOROUGH STREET FRANKLINTON	O3
37-071-0016 GASTON	1622 EAST GARRISON BLVD GASTONIA	PM2.5
37-075-0001 GRAHAM	FOREST ROAD 423 SPUR KILMER	O3
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSP BUTNER	O3
37-081-0011 GUILFORD	KELLY PARK , KELLY RD MC CLEANSVILLE	O3
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	PM2.5 PM10
37-081-1011 GUILFORD	401 WEST WENDOVER GREENSBORO	CO
37-087-0004 HAYWOOD	2177 ASHEVILLE ROAD WAYNESVILLE	O3
37-087-0010 HAYWOOD	9 MAIN STREET WAYNESVILLE	PM2.5
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PARKWAY MILE MARKER 410	O3

SITE COUNTY	ADDRESS	POLLUTANTS
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAINS NATIONAL PARK	O3
37-089-1006 HANDERSON	CORNER OF ALLEN & WASHINGTON ST'S HENDERSONVILLE	PM10
37-099-0005 JACKSON	BARNET KNOB FIRE TOWER RD CHEROKEE	O3
37-099-0006 JACKSON	US ROUTE 19 NORTH CHEROKEE RESERVATION	PM2.5
37-101-0002 JOHNSTON	1338 JACK ROAD CLAYTON	O3
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	O3 PM2.5
37-109-0004 LINCOLN	1487 RIVERVIEW ROAD LINCOLNTON	O3
37-111-0004 MC DOWELL	BALWIN AVENUE (EAST MARION JR. HIGH SCHOOL) MARION	PM2.5
37-117-0001 MARTIN	1210 HAYES STREET JAMESVILLE	O3 PM2.5
37-119-0003 MECKLENBURG	FIRE STATION # 11, 620 WEST 28TH STREET CHARLOTTE	PM10
37-119-0010 MECKLENBURG	FIRE STATION # 10, 2136 FREMOUNT ROAD CHARLOTTE	PM10 PM2.5
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	CO SO2 PM2.5 O3 NO2
37-119-0042 MECKLENBURG	1935 EMERYWOOD DRIVE CHARLOTTE	PM2.5
37-119-1001 MECKLENBURG	FILTER PLANT DAVIDSON	PM10

SITE COUNTY	ADDRESS	POLLUTANTS	
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	O3	PM10
37-119-1009 MECKLENBURG	29 N @ MECKLENBURG CAB CO. CHARLOTTE	O3	
37-121-0001 MITCHELL	CITY HALL, SUMMIT STREET SPRUCE PINE	PM2.5	
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	PM2.5	
37-127-0002 NASH	CENTURA BLVD @ AIRPORT RD ROCKY MOUNT	PM2.5	
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER ROAD CASTLE HAYNE	O3	PM2.5
37-129-0006 NEW HANOVER	HIGHWAY 421 NORTH WILMINGTON	SO2	
37-129-0008 NEW HANOVER	CORNER OF OLEANDER & COLLEGE RD WILMINGTON	CO	
37-131-0002 NORTHAMPTON	ROUTE 46 GASTON	O3	
37-133-0005 ONSLOW	617 HENDERSON DR JACKSONVILLE	PM10	PM2.5
37-135-0007 ORANGE	MASON FARM ROAD CHAPEL HILL	PM2.5	
37-139-0002 PASQUOTANK	600 WESTOVER STREET ELIZABETH CITY	PM2.5	
37-145-0003 PERSON	STATE ROAD 1102 & NC 49 ROXBORO	O3	
37-147-0005 PITT	851 HOWELL STREET GREENVILLE	PM2.5	

SITE COUNTY	ADDRESS	POLLUTANTS
37-147-0099 PITT	US 264 NEAR WATER TOWER FARMVILLE	O3
37-151-0004 RANDOLPH	4507 BRANSON DAVIS ROAD SOPHIA	O3
37-155-0005 ROBESON	1170 LINKHAW ROAD LUMBERTON	PM2.5
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL BETHANY	O3
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVENUE ROCKWELL	O3
37-159-0022 ROWAN	925 NORTH ENOCHVILLE AVENUE CHINA GROVE	O3
37-173-0002 SWAIN	CENTER ST/PARKS & RECREATION FACILITY BRYSON CITY	O3 PM2.5 PM10
37-179-0003 UNION	701 CHARLES STREET MONROE	O3
37-183-0014 WAKE	3801 SPRING FOREST ROAD RALEIGH	O3 PM2.5 PM10 SO2
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	O3 PM2.5
37-183-0016 WAKE	201 NORTH BROAD STREET FUQUAY-VARINA	O3
37-183-0017 WAKE	5033 TV TOWER ROAD GARNER	O3
37-183-0018 WAKE	US HIGHWAY 70 WEST & NC HIGHWAY 50 NOR RALEIGH	CO
37-189-0003 WATAUGA	361 JEFFERSON ROAD BOONE	PM2.5

SITE COUNTY	ADDRESS	POLLUTANTS	
37-191-0005 WAYNE	DILLARD MIDDLE SCHOOL, DEVEREAU STREET GOLDSBORO	PM10	PM2.5
37-199-0003 YANCEY	STATE HIGHWAY 128 BURNSVILLE	O3	
Sites operated in 2003	84		

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 excluded, and are omitted from summaries in charts. However they are addressed in the text of the report. A list of typical exceptional events is given in Appendix B.

Data for the 2003 ambient air quality report were collected at 136 air pollutant monitors operated by state and local agencies in North Carolina (listed in Appendix A). To minimize operating expenses, some sulfur dioxide monitors are operated only every third year. Five of the 127 monitors used for this report operated most recently in 2001 or 2002.

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 cubic feet per minute. 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.

The state and local program agencies discontinued routine ambient TSP sampling at the end of 2000, but resumed a limited sampling program again in 2003. In 2003, seven sites were

used to monitor TSP and 401 samples were collected. A detailed summary of the data from each site is given in Table 5.1.

One sample exceeded the N.C. TSP ambient air quality standards in 2003. The highest 24-hour average was 275, which was 183 percent of the standard. This value occurred at the 3801 Spring Forest Rd in Raleigh on April 3 and was associated with an exceptionally high pollen count. 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 34.3 $\mu g/m^3$, which is 46 percent of the level of the air quality standard. This value occurred at the 1650 1st Street site in Hickory.

Table 5.1 Total Suspended Particulates in Micrograms Per Cubic Meter for 2003

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAX 1st	2nd	3rd	4th	ARITH MEAN	GEOM MEAN	GEOM SD
37-035-0004 CATAWBA	1650 1st STREET HICKORY	48	103	66	65	56	38	34.3	1.6
37-065-0099 EDGECOMBE	7589 NC HWY 33-NW LEGGETT	89	141	135	87	56	25	19.3	2.1
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	51	116	87	81	56	29	24.5	1.8
37-087-0011 HAYWOOD	PROSPECT AND NORTHSIDE STR CANTON	53	65	63	58	52	30	27.6	1.5
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD CASTLE HAYNE	55	86	51	50	49	22	17.3	2.0
37-155-0005 ROBESON	1170 LINKHAW ROAD LUMBERTON	52	112	63	62	48	29	26.1	1.6
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	53	275	72	65	64	37	30.5	1.7
Total Samples Total Sites Sampled		401 7							

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 2003, 1679 ordinary 24-hour samples of PM_{10} were collected from monitors located at 24 sites. A map of the PM_{10} sampling sites is shown in Figure 5.1, and a detailed summary of the data from each site is given in Table 5.2.
There were no exceedances of the PM_{10} ambient air quality standards in 2003. The highest 24-hour maximum concentration was 64 $\mu g/m^3$, or about 43 percent of the standard (150 $\mu g/m^3$). The highest annual arithmetic mean was 26.7 $\mu g/m^3$, which is about 53 percent of the standard (50 $\mu g/m^3$).

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

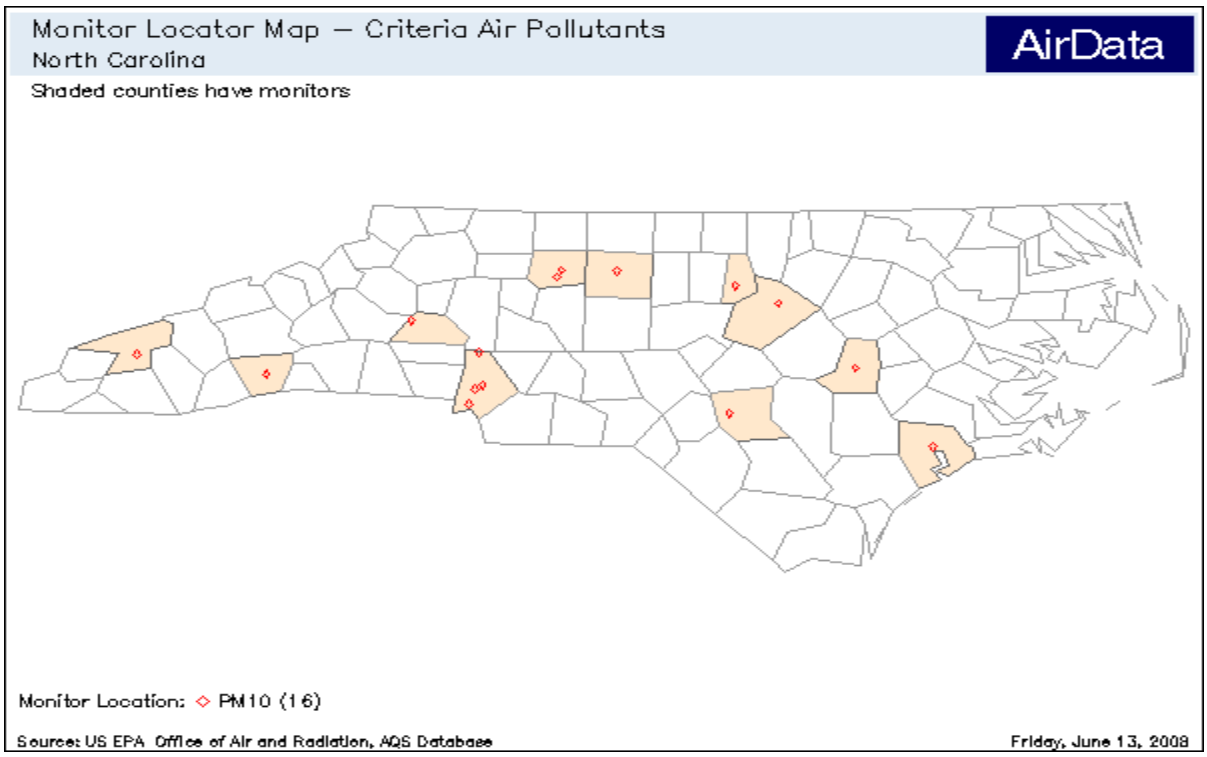

Figure 5.1 Location of PM10 Monitoring Sites

Table 5.2 PM_{10} in Micrograms Per Cubic Meter for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-035-0004 CATAWBA	1650 1ST. ST. HICKORY	58	51	45	41	34	26.7
37-051-0009 CUMBERLAND	4533 RAEFORD ROAD FAYETTEVILLE	58	44	35	34	32	19.2
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST DURHAM	53	53	36	36	35	20.3
37-067-0022 FORSYTH	1300 BLK. HATTIE AVE WINSTON-SALEM	364	58	53	48	46	18.9
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY WINSTON-SALEM	294	61	59	55	52	22.6
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	58	46	42	39	37	17.8
37-089-1006 HENDERSON	CORNER OF ALLEN & WASHINGTON STS HENDERSONVILLE	57	52	41	37	33	18.7

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	 2nd	 3rd	 4th	ARITH MEAN
37-119-0003 MECKLENBURG	FIRE STA #11 620 MORETZ STREET CHARLOTTE	49	55	52	39	38	23.4
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT RD CHARLOTTE	54	54	39	37	35	21.5
37-119-1001 MECKLENBURG	FILTER PLANT DAVIDSON	57	52	38	36	32	19.6
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	56	56	48	43	39	24.4
37-133-0005 ONSLOW	617 HENDERSON DRIVE JACKSONVILLE	60	38	30	27	25	14.3
37-173-0002 SWAIN	CENTER ST/PARKS 7 REC FACILITY	59	49	41	39	37	18.8
37-183-0014 WAKE	3801 SPRING FOREST RD. RALEIGH	285	64	51	49	48	20.6
37-183-0014 WAKE	3801 SPRING FOREST RD. RALEIGH	59	54	38	37	37	20.6
37-191-0005 WAYNE	DILLARD MIDDLE SCHOOL DEVEREAU ST GOLDSBORO	58	47	36	32	28	17.7
Total Samples		1,679					
Total Sites Sampled		16					

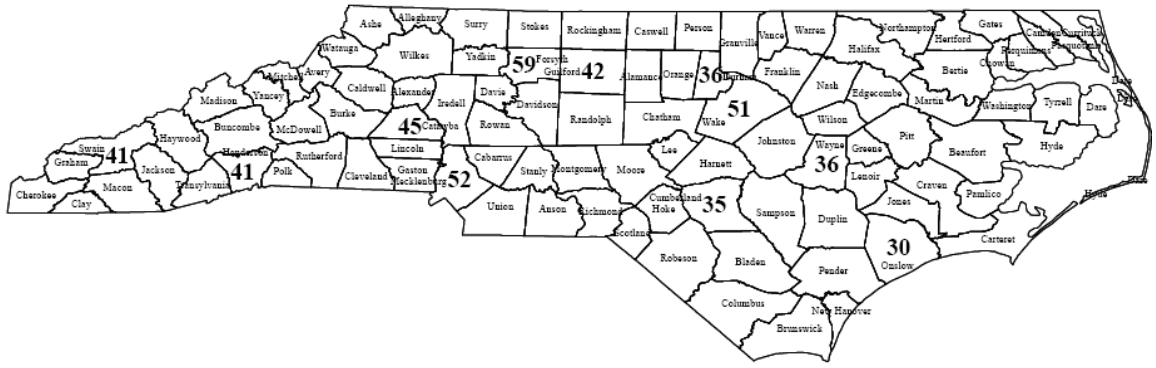

Figure 5.2 PM_{10}: Second Highest 24-Hour Averages, 2003

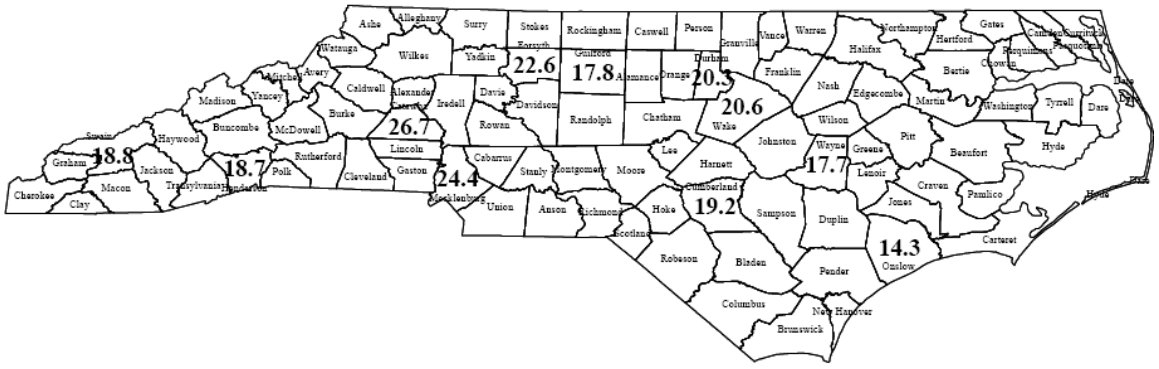

Figure 5.3 PM_{10}: Maximum Annual Arithmetic Means, 2003

5.3 Fine Particulate Matter, ($PM_{2.5}$)

In 2003, 37 sites were used to monitor $PM_{2.5}$ and 5,419 samples were collected. A map of the $PM_{2.5}$ sampling sites is shown in Figure 5.4 and a detailed summary of the data from each site is given in Table 5.3.

There were no exceedances of the $PM_{2.5}$ 24-hour ambient air quality standards in 2003.

The highest 24-hour maximum concentration was 50 $\mu g/m^3$, or about 77 percent of the standard (65 $\mu g/m^3$) (See Table 5.3).
The highest annual arithmetic mean was 15.16 $\mu g/m^3$, which is about 1 percent over the level of the standard (15 $\mu g/m^3$) at Lexington in Davidson County. The other monitor that exceeded the annual arithmetic mean standard in 2003 was Hickory in Catawba County (See Table 5.3).

NAAQS attainment is based on both the level of the 98th percentile concentration of 24 hour averages and weighted annual means (Table 3.1). The 98th percentile concentrations are shown by county in Figure 5.5, and the annual arithmetic means are shown in Figure 5.6. (In counties with more than one monitoring site, the concentration reported in Figure 5.5 is the maximum 98th percentile and the mean reported in Figure 5.6 is the maximum arithmetic mean for the county.)

Figure 5.7 is a map of "design values" for $PM_{2.5,}$ computed from the highest 3-year average arithmetic mean in each county for 2001 through 2003, using the federal reference method monitors. Thirty-one counties have enough reported data to compute this metric correctly, and seven of them appear to be violating the ambient standard that is due to be implemented. Attainment decisions for $PM_{2.5}$ will be based on the design values observed during 2003 through 2005, which may or may not resemble the values illustrated here.

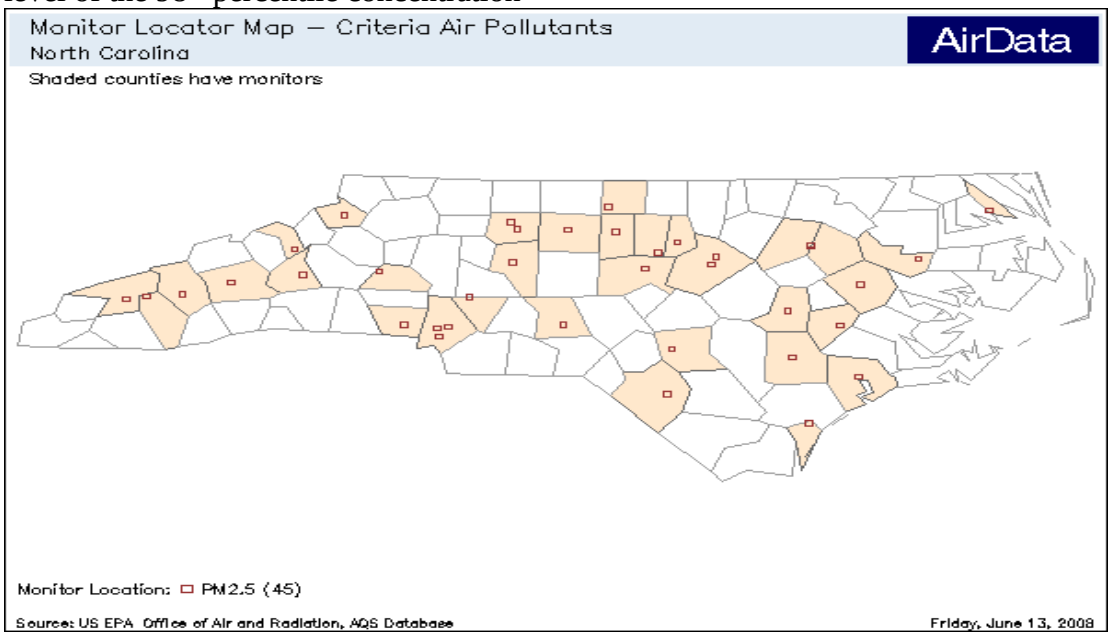

Figure 5.4 Location of $PM_{2.5}$ Monitoring Sites

Table 5.3 $PM_{2.5}$ in Micrograms Per Cubic Meter for 2003

SITE NUMBER	ADDRESS	NUM OBS	24-HOUR MAXIMA				PERCENTILE	ARITH MEAN
COUNTY			1st	2nd	3rd	4th	98TH	
37-001-0002 ALAMANCE	827 S. GRAHAM & HOPEDALE RD BURLINGTON	114	42.3	39.4	31.1	29.3	31.1	13.74
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	115	50.0	35.0	30.7	27.0	30.7	12.58
37-025-0004 CABARRUS	933 FLOYD STREET KANNAPOLIS	121	41.7	33.5	33.4	30.4	33.4	14.58
37-033-0001 CASWELL	7074 CHERRY GROVE RECREATION	119	46.5	38.8	30.5	30.3	30.5	12.86
37-035-0004 CATAWBA	1650 1ST. ST. HICKORY	114	39.8	36.4	35.6	31.6	35.6	15.04
37-037-0004 CHATHAM	325 RUSSETT PITTSBORO	115	36.3	28.0	25.5	24.1	25.5	11.52
37-051-0009 CUMBERLAND	4533 RAEFORD ROAD FAYETTEVILLE	114	35.0	28.8	28.0	26.0	28.0	13.42
37-057-0002 DAVIDSON	SOUTH SALISBURY STREET LEXINGTON	118	45.5	44.0	35.6	33.5	35.6	15.16
37-061-0002 DUPLIN	HWY 50 KENANANSVILLE	115	24.5	22.2	20.6	19.2	20.6	10.87
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST DURHAM	320	41.3	40.6	36.1	33.9	33.0	13.60
38-065-0003 EDGECOMBE	TALBERT PARK at SPRUCE ST ROCKY MOUNT	118	42.9	36.1	28.7	26.7	36.1	12.88
37-067-0022 FORSYTH	1300 BLOCK, HATTIE AVENUE WINSTON-SALEM	354	45.9	36.9	36.4	34.6	31.6	13.88
37-067-0024 FORSYTH	NORTH FORSYTH HIGH SCHOOL WINSTON-SALEM	108	42.8	42.4	33.5	30.5	33.5	13.43
37-071-0016 GASTON	1622 EAST GARRISON BLVD GASTONIA	114	41.3	30.3	29.2	28.5	29.2	13.95
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	350	46.8	42.3	41.3	39.8	32.0	13.41
37-087-0010 HAYWOOD	9 MAIN STREET WAYNESVILLE	114	41.9	30.2	27.2	26.5	27.2	12.64
37-099-0006 JACKSON	US RT 19 NORTH CHEROKEE RES	118	37.8	31.1	28.0	26.6	28.0	11.70
37-107-0004 LENOIR	CORNER HWY 70 EAST KINSTON	118	39.6	26.1	25.0	21.6	25.0	10.92
37-111-0004 MC DOWELL	BALDWIN AVE MARION	105	39.7	36.3	28.7	25.8	28.7	12.96

SITE NUMBER	ADDRESS	NUM OBS	24-HOUR MAXIMA				PERCENTILE	ARITH MEAN
COUNTY			1st	2nd	3rd	4th	98TH	
37-117-0001 MARTIN	1210 HAYES ST JAMESVILLE	30	18.3	16.9	16.5	15.0	18.3	8.74
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD CHARLOTTE	356	40.7	40.7	40.2	38.7	29.1	14.63
37-119-1041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	351	40.4	39.1	36.5	36.3	27.1	13.75
37-119-1042 MECKLENBURG	1935 EMERYWOOD DRIVE CHARLOTTE	119	39.7	27.7	27.5	27.1	27.5	13.97
37-121-0001 MITCHELL	CITY HALL SUMMIT ST SPRUCE PINE	115	36.7	30.4	24.2	24.0	24.2	12.06
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	116	34.2	23.3	22.7	22.1	22.7	11.40
37-127-0002 NASH	CENTURA BLVD & AIRPORT RD ROCKY MOUNTAIN	26	22.7	21.5	21.2	16.7	22.7	9.78
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD	120	29.7	19.7	18.4	17.9	18.4	9.23
37-133-0005 ONSLOW	617 HENDERSON DRIVE JACKSONVILLE	118	35.0	21.5	20.9	20.5	20.9	10.75
37-135-0007 ORANGE	MASON FARM ROAD CHAPEL HILL	114	39.7	33.1	29.1	27.8	29.1	12.85
37-139-0002 PASQUOTANK	600 WESTOVER STREET ELIZABETH CITY	58	44.5	27.2	25.9	18.7	27.2	10.68
37-147-0005 PITT	851 HOWELL STREET GREENVILLE	111	40.4	27.2	27.0	25.5	27.0	12.19
37-155-0005 ROBESON	1170 LINKHAM ROAD LUMBERTON	115	33.0	26.7	25.7	25.1	25.7	12.57
37-173-0002 SWAIN	CENTER ST/PARKS 7 REC FACILITY	117	40.7	30.9	30.0	28.9	30.0	12.52
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	344	45.3	42.3	36.5	36.2	33.2	13.67
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	118	40.1	33.5	32.6	26.7	32.6	12.76
37-189-0003 WATAUGA	361JEFFERSON HWY BOONE	114	42.1	30.9	29.2	24.7	29.2	11.22
37-191-0005 WAYNE	DILLARD MIDDLE SCHOOL GOLDSBORO	113	38.9	26.9	26.2	25.5	26.2	12.97
Total Samples		5,419						
Total Sites Sampled		37						

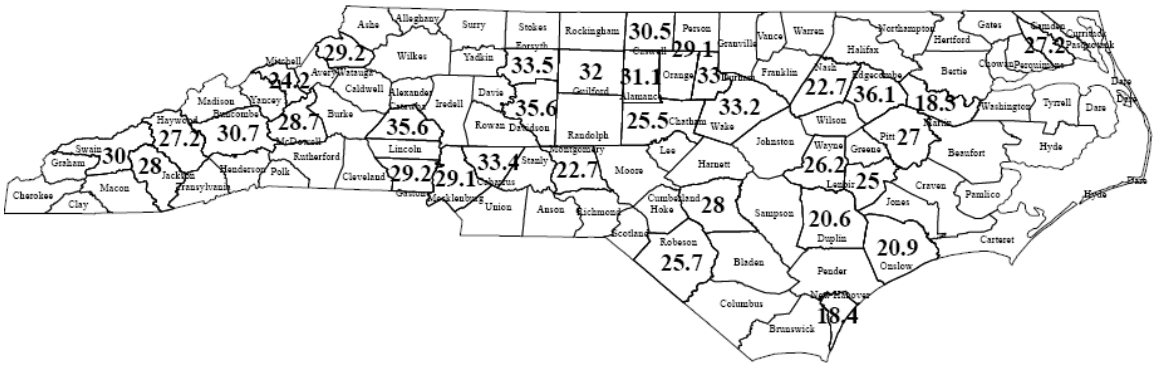

Figure 5.5 $PM_{2.5}$: 98th percentile 24 hour averages, 2003

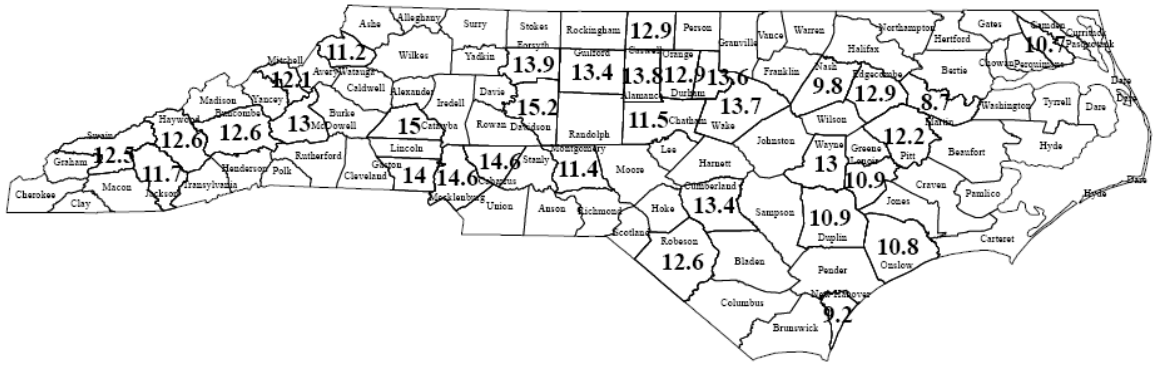

Figure 5.6 $PM_{2.5}$: Annual Arithmetic Means, 2003

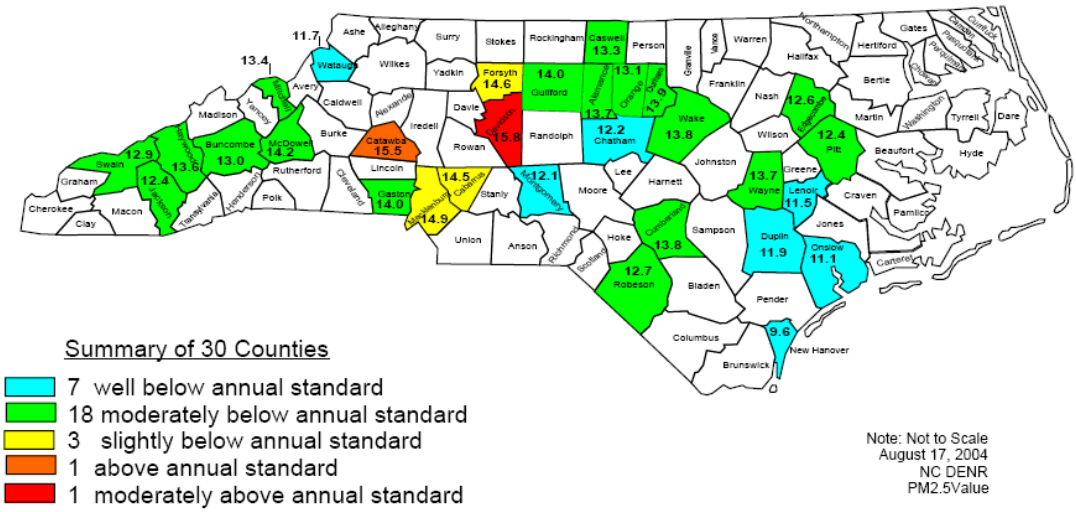

Figure 5.7 $PM_{2.5}$ Design Values by County, 2001-2003

5.4 Carbon Monoxide

Carbon monoxide (CO) data were collected for two purposes in 2003: to determine attainment status of the ambient air quality standard and to gather data on CO as an ozone precursor. The carbon monoxide associated with ozone formation consists of very low concentrations (not greater than 2 ppm) collected at special sites considered optimal for input to a large photochemical grid model. This report will not further discuss the role of CO as an ozone precursor, but these data and more information are available on request from the Division of Air Quality (see the Preface for a mailing address).

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

In 2003, 7 sites were used to monitor CO and 41,033 valid hourly averages were collected. To keep operating costs minimal, sites are operated only in the colder months. A map of the CO sampling sites is shown in Figure 5.8, 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 2003. The highest 1-hour average was 6.1 parts per million (ppm), or about 17 percent of the standard (35 ppm). This value occurred at the Griffith Road site in Winston-Salem. The highest 8-hour average was 4.5 ppm, at the same site, which is about 50 percent of the standard.

The second highest 1-hour concentrations in each county are shown in Figure 5.9 and the second highest 8-hour concentrations are shown in Figure 5.10.

Historical data have demonstrated that high concentrations of CO occur more frequently in autumn and winter than during the warmer months of the year. There are three main reasons for this seasonal variation: (1) North Carolina experiences more atmospheric inversions in colder months, trapping air pollutants at low heights; (2) motor vehicles emit more CO due to inefficient combustion during cold starts and warm up; and (3) during colder temperatures, more fuel is burned for comfort heating.

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

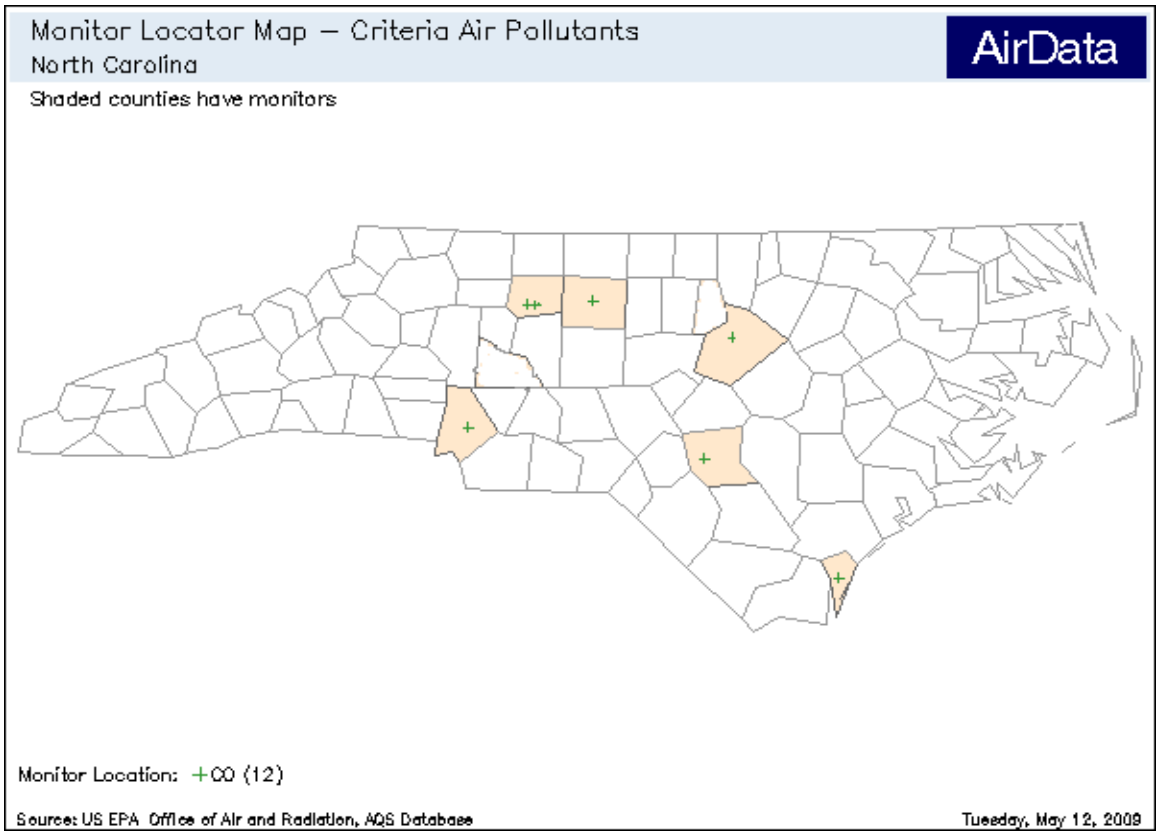

Figure 5.8 Location of Carbon Monoxide Monitoring Sites

Table 5.4 Carbon Monoxide in Parts Per Million for 2003

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		EIGHT-HOUR MAXIMA	
			1st	2nd	1st	2nd
37-051-0007 CUMBERLAND	ABC BOARD, 1705 OWEN DR FAYETTEVILLE	4,225	5.0	4.5	4.1	3.3
37-067-0023 FORSYTH	1401 CORPORATION PKY WINSTON-SALEM	7,165	4.3	4.3	3.5	3.1
37-067-0029 FORSYTH	1985 GRIFFITH ROAD WINSTON-SALEM	8,717	6.1	5.5	4.5	3.7

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		EIGHT-HOUR MAXIMA	
			1st	2nd	1st	2nd
37-081-1011 GUILFORD	401 WEST WENDOVER GREENSBORO	4,176	3.1	2.9	2.6	2.5
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	8,547	4.6	4.6	3.0	3.0
37-129-0008 NEW HANOVER	OLEANDER & COLLEGE WILMINGTON	3,956	4.8	4.6	3.7	2.9
37-183-0018 WAKE	US HWY 70 WEST AND NC HWY 50 NORTH RALEIGH	4,247	4.4	4.3	3.3	2.9
Total Samples Total Sites Sampled		41,033 7				

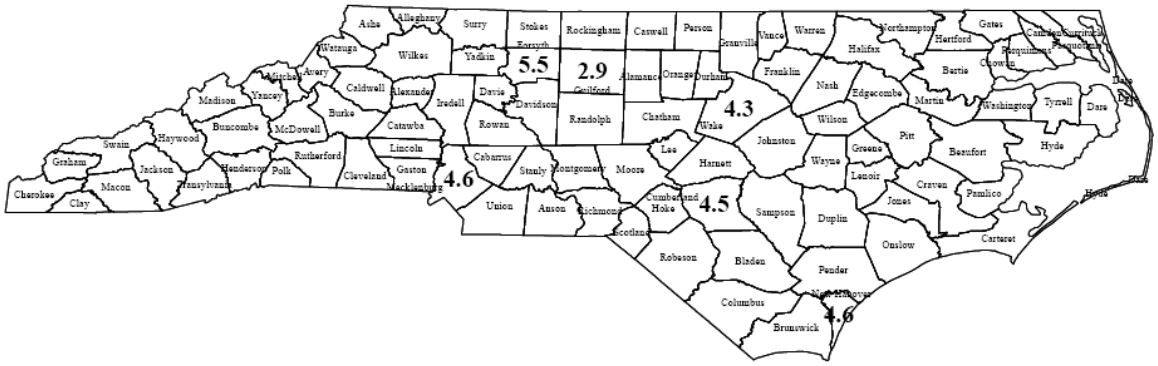

Figure 5.9 Carbon Monoxide: Second Highest 1-Hour Concentration, 2003

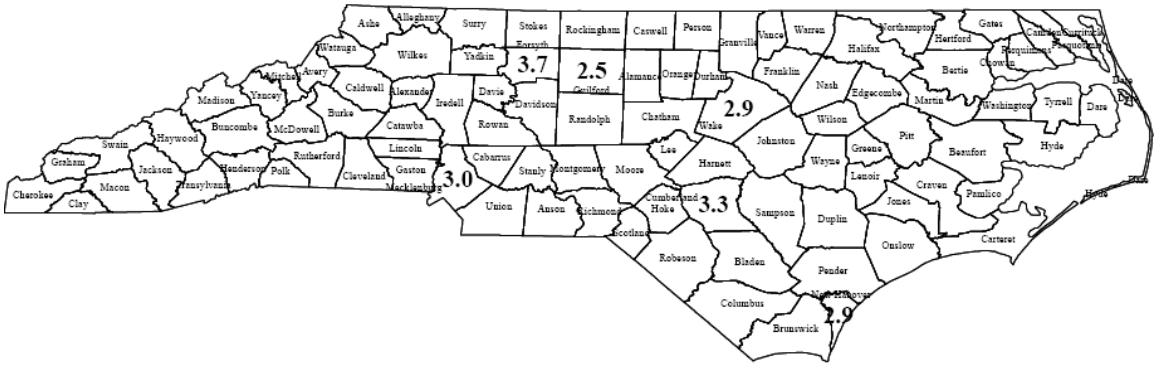

Figure 5.10 Carbon Monoxide: Second Highest Non-overlapping 8-Hour Concentration, 2003

5.5 Ozone

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

The state and local program agencies operated 47 monitoring sites in 2003 during the ozone season, April through October. A map of the O_3 sampling sites is presented in Figure 5.11, and a detailed summary of the one-hour data from each site is given in Table 5.5, and the 8-hour data in Table 5.6. These 47 monitoring sites provided 9,578 site-days of valid data (a success rate of 96 percent for the days that sampling is required).

There were 4 exceedances of the 1-hour ozone standard in North Carolina in 2003, one each in Charlotte and China Grove, and two at Rockwell (Rowan County).

The one-hour standard is exceeded when one valid one-hour average exceeds 0.124 ppm at a site and the expected number of exceedances is greater than 1. (To exceed the standard, the largest average must be larger than 0.12 ppm when *rounded* to two significant digits. The "expected number" of exceedances is determined from a 3-year average of exceedance day counts for an area. Moreover, when any ozone sampling day does not have a valid maximum ozone measurement for any reason, the missing day can be counted as an *estimated* exceedance day under certain circumstances [40 CFR 50 App. J, US EPA 1993, p. 767-768]. Table 5.5 gives both the actually measured and the estimated number of exceedance days at each site.)

The 8-hour standard was exceeded a total of 114 times at the 37 sites that monitored for O_3. Thirty-one monitors had at least one exceedance. The largest number at one monitor was 7 in Enochville (Rowan County). These exceedances were distributed over 14 days during the ozone season where at least one site within the state recorded values greater than 0.085 ppm.

The second highest 1-hour concentrations in each county are shown in Figure 5.12 for areas with one or more monitors active in 2003. Monitors whose second highest 1-hour concentration exceeds 0.124 ppm potentially violate the EPA one-hour standard (although it is no longer in effect in North Carolina).

Historical average fourth-highest 8-hour concentrations of O_3 in counties where monitors were operated in 2003 are shown in Figure 5.13. Monitors whose fourth-highest 8-hour ozone concentration (averaged over *three* years) exceeds 0.084 ppm are deemed in violation of the EPA 8-hour standard.

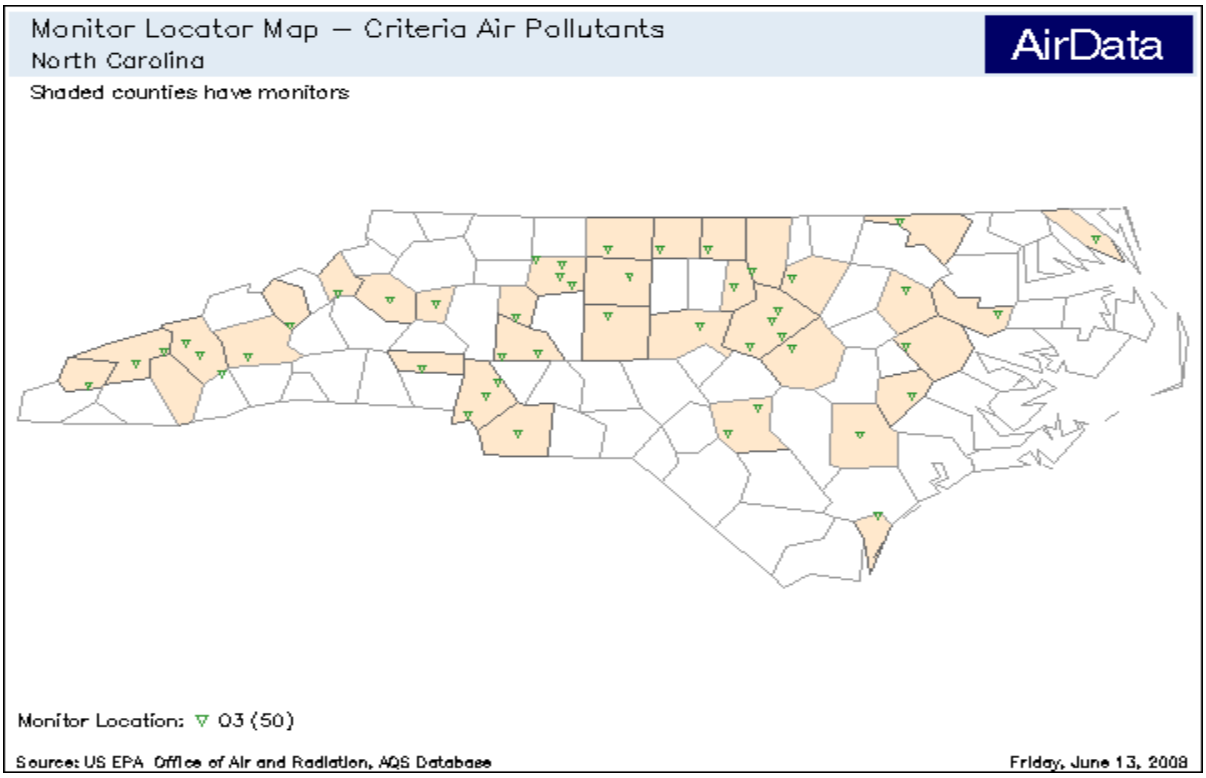

Figure 5.11 Location of Ozone Monitoring Sites

Table 5.5 One-Hour Ozone in Parts Per Million for 2003

SITE NUMBER	ADDRESS	NUM	DAILY 1-HR MAXIMA				NO. VALUES > 0.125	
COUNTY		OBS	1st	2nd	3rd	4th	MEAS	EST
37-003-0003 ALEXANDER	324 MINNIGAN LANE TAYLORSVILLE	5088	.098	.098	.096	.091	0	0.00
37-011-0002 AVERY	7510 BLUE RIDGE	5112	.095	.088	.083	.082	0	0.00
37-021-0030 BUNCOMBE	ROUTE 191 SOUTH BREVARD RD ASHEVILLE	5088	.103	.091	.090	.088	0	0.00
37-027-0003 CALDWELL	HWY 321 NORTH LENOIR	5112	.107	.094	.093	.093	0	0.00
37-029-0099 CAMDEN	101 MCKINNEY ROAD CAMDEN	4248	.096	.094	.089	.087	0	0.00

SITE NUMBER	ADDRESS	NUM	DAILY 1-HR MAXIMA				NO. VALUES > 0.125	
COUNTY		OBS	1st	2nd	3rd	4th	MEAS	EST
37-033-0001 CASWELL	7074 CHERRY GROVE REIDSVILLE	5136	.121	.105	.095	.094	0	0.00
37-037-0004 CHATHAM	325 RUSSETT RUN ROAD PITTSBORO	5040	.096	.095	.088	.087	0	0.00
37-051-0008 CUMBERLAND	1/4MI SR1857/US301/1857 WADE	5016	.102	.096	.093	.091	0	0.00
37-051-1003 CUMBERLAND	3625 GOLFVIEW ROAD HOPE MILLS	4968	.102	.097	.095	.091	0	0.00
37-059-0002 DAVIE	246 MAIN STREET COOLEEMEE	5136	.120	.116	.106	.101	0	0.00
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	5040	.083	.082	.080	.080	0	0.00
37-063-0013 DURHAM	2700 NORTH DUKE STREET DURHAM	4920	.109	.101	.095	.092	0	0.00
37-065-0099 EDGECOMBE	7589 NC HWY 33-NW LEGGETT	4920	.106	.098	.096	.095	0	0.00
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	5136	.114	.106	.104	.102	0	0.00
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE WINSTON-SALEM	5112	.094	.094	.090	.086	0	0.00
37-067-0028 FORSYTH	6496 BAUX MOUNTAIN RD WINSTON-SALEM	5136	.092	.090	.088	.097	0	0.00
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	5136	.103	.102	.096	.096	0	0.00
37-069-0001 FRANKLIN	431 S. HILLBOROUGH ST FRANKLINTON	4992	.113	.106	.102	.100	0	0.00
37-075-0001 GRAHAM	FOREST ROAD 423 SPUR KILMER	4992	.097	.091	.089	.086	0	0.00
37-077-0001	WATER TREATMENT PLANT, JOHN UMSTEAD HOSPITAL	4896	.118	.115	.108	.106	0	0.00

SITE NUMBER	ADDRESS	NUM	DAILY 1-HR MAXIMA				NO. VALUES > 0.125	
COUNTY		OBS	1st	2nd	3rd	4th	MEAS	EST
GRANVILLE	BUTNER							
37-081-0011 GUILFORD	KEELY PARK, KEELY RD, GREENSBORO	5040	.121	.109	.101	.097	0	0.00
37-087-0004 HAYWOOD	2177 SCHEVILLS ROAD WAYNESVILLE	5088	.087	.086	.084	.083	0	0.00
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PARKWAY MILE MARKER 410	4968	.093	.091	.090	.089	0	0.00
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAIN NATIONAL PARK	5040	.091	.091	.088	.086	0	0.00
37-099-0005 JACKSON	BARNET KNOB FIRE TOWER	5064	.109	.104	.101	.094	0	0.00
37-101-0002 JOHNSTON	1338 JACK ROAD CLAYTON	4968	.101	.095	.094	.093	0	0.00
37-107-0004 LENOIR	CORNER HWY EAST KINSTON	4944	.104	.094	.094	.091	0	0.00
37-109-0004 LINCOLN	1487 RIVERVIEW ROAD LINCOLNTON	5064	.109	.108	.104	.104	0	0.00
37-117-0001 MARTIN	1210 HAYES STREET JAMESVILLE	4848	.104	.097	.095	.085	0	0.00
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	5136	.109	.108	.098	.097	0	0.00
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	5112	.113	.092	.090	.089	0	0.00
37-119-1009 MECKLENBURG	29 N@ MECKLENBURG CAB CO CHARLOTTE	5112	.128	.123	.106	.106	1	1.00
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD CASTLE HAYNE	4896	.089	.086	.084	.082	0	0.00
37-131-0002 NORTHAMPTON	ROUTE 46 GASTON	4872	.090	.090	.089	.089	0	0.00

SITE NUMBER	ADDRESS	NUM	DAILY 1-HR MAXIMA				NO. VALUES > 0.125	
COUNTY		OBS	1st	2nd	3rd	4th	MEAS	EST
37-145-0003 PERSON	STATE ROAD 1102 & NC49 ROXBORO	5088	.111	.111	.107	.097	0	0.00
37-147-0099 PITT	US 264 NEAR WATTER TOWER FARMVILLE	4848	.116	.101	.097	.088	0	0.00
37-151-0004 RANDOLPH	4507 BRANSON DAVIS ROAD SOPHIA	5088	.106	.104	.087	.087	0	0.00
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL BETHANY	5136	.103	.099	.092	.092	0	0.00
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVENUE ROCKWELL	5088	.135	.129	.122	.119	2	2.00
37-159-0022 ROWAN	925 N ENOCHVILLE AVE CHINA GROVE	5112	.131	.113	.109	.106	1	1.00
37-173-0002 SWAIN	CENTER STREET BRYSON CITY	4968	.086	.082	.079	.079	0	0.00
37-179-0003 UNION	701 CHARLES STREET MONROE	4944	.113	.093	.088	.088	0	0.00
37-183-0014 WAKE	3801 SPRING FOREST ROAD RALEIGH	4968	.122	.116	.116	.104	0	0.00
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	4536	.105	.098	.093	.091	0	0.00
37-183-0016 WAKE	201 NORTH BROAD STREET FUQUAY-VARINA	5088	.108	.104	.100	.100	0	0.00
37-183-0017 WAKE	5033 TV TOWER ROAD GARNER	4392	.102	.102	.100	.097	0	0.00
37-199-0003 YANCY	STATE HIGHWAY 128	4968	.097	.092	.088	.097	0	0.00
Total Samples		234,600					4	4.00
Total Sites Sampled		47						

Table 5.6 Eight-Hour Ozone in Parts Per Million for 2003

SITE NUMBER COUNTY	ADDRESS	VALID DAYS	VALID DAILY 8-HR MAXIMUM				N0. VALUES .>.085
			1st	2nd	3rd	4th	MEAS
37-003-0003 ALEXANDER	324 MINNIGAN LANE TAYLORSVILLE	203	.086	.084	.082	.080	1
37-001-0002 AVERY	7510 BLUE RIDGE	209	.084	.083	.074	.073	0
37-021-0030 BUNCOMBE	ROUT 191 SOUTH BREVARD RD ASHEVILLE	210	.077	.076	.072	.070	0
37-027-0003 CALDWELL	HWY 321 NORTH LENOIR	213	.087	.087	.086	.079	3
37-029-0099 CAMDEN	101 MCKINNEY ROAD CAMDEN	175	.091	.088	.084	.082	2
37-033-0001 CASWELL	7074 CHERRY GROVE RD REIDSVILLE	214	.104	.087	.086	.083	3
37-037-0004 CHATHAM	325 RUSSETT RUN PITTSBORO	210	.090	.084	.078	.075	1
37-051-0008 CUMBERLAND	1/4MI SR1857/US301/1857 WADE	205	.091	.089	.088	.086	4
37-051-1003 CUMBERLAND	3625 GOLFVIEW ROAD HOPE MILLS	204	.091	.089	.088	.082	3
37-059-0002 DAVIE	246 MAIN STREET COOLEEMEE	214	.106	.100	.089	.089	4
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	195	.077	.075	.075	.075	0
37-063-0013 DURHAM	2700 NORTH DUKE STREET DURHAM	201	.098	.085	085	.083	3
37-065-0099 EDGECOMBE	7589 NC HWY 33-NW LEGGETT	199	.097	.094	.093	.088	4
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	213	.103	.095	.090	.087	5
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE WINSTON-SALEM	213	.082	.080	.078	.078	0
37-067-0028 FORSYTH	6496 BAUX MOUNTAIN RD WINSTON-SALEM	214	.083	.083	.078	.074	0
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	214	.099	.089	.087	.081	3
37-069-0001 FRANKLIN	431 S. HILLBOROUGH ST FRANKLINTON	201	.094	.093	.093	.087	4
37-075-0001 GRAHAM	FOREST ROAD 423 SPUR KLIMER	206	.086	.086	.081	.080	2

SITE NUMBER COUNTY	ADDRESS	VALID DAYS	VALID DAILY 8-HR MAXIMUM 1st	 2nd	 3rd	 4th	N0. VALUES .>.085 MEAS
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSPITAL BUTNER	198	.105	.099	.092	.090	5
37-081-0011 GUILFORD	KEELY PARK, KEELY RD, GREENSBORO	206	.111	.096	.083	.079	2
37-087-0004 HAYWOOD	2177 SHEVILLE ROAD WAYNESVILLE	212	.081	.079	.079	.079	0
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PARKWAY MILE MARKER 410	203	.084	.083	.083	.080	0
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAIN NATIONAL PARK	205	.084	.083	.082	.081	0
37-099-0005 JACKSON	BARNET KNOB FIRE TOWER	210	.092	.084	.079	.079	1
37-101-0002 JOHNSTON	1338 JACK ROAD CLAYTON	197	.091	.088	.080	.080	2
37-107-0004 LENOIR	CORNER HWY 70 EAST KINSTON	200	.092	.089	.087	.082	3
37-109-0004 LINCOLN	1487 RIVERVIEW ROAD LINCOLNTON	200	.095	.094	.090	.089	5
37-117-0001 MARTIN	1210 HAYES STREET JAMESVILLE	193	.096	.092	.083	.079	2
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	214	.101	.089	.087	.086	4
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	213	.099	.081	.081	.073	1
37-119-1009 MECKLENBURG	29 N@ MECKLENBURG CAB CO CHARLOTTE	211	.114	.100	.096	.088	4
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD	191	.079	.077	.077	.076	0
37-131-0002 NORTHAMPTON	ROUTE 46 GASTON	198	.087	.085	.084	.081	2
37-145-0003 PERSON	SR NC 49	211	.096	.095	.091	.083	3
37-147-0099 PITT	US 264 NEAR WATER TOWER FARMVILLE	197	.095	.093	.091	.080	3
37-151-0004 RANDOLPH	4507 BRANSON DAVIS RD SOPHIA	211	.101	.087	.079	.078	2
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL BETHANY	213	.087	.086	.085	.083	3
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	209	.116	.109	.098	.098	6

SITE NUMBER / COUNTY	ADDRESS	VALID DAYS	VALID DAILY 8-HR MAXIMUM 1st	2nd	3rd	4th	N0. VALUES .>.085 MEAS
37-159-0022 ROWAN	925 N ENOCHVILLE AVE ENOCHVILLE	208	.106	.104	.099	.087	7
37-173-0002 SWAIN	CENTER STREET PARKS 7 REC FACILITY	200	.078	.076	.075	.072	0
37-179-0003 UNION	701 CHARLES STREET MONROE	195	.106	.083	.083	.083	1
37-183-0014 WAKE	E. MILLBROOK JR HI 3801 SPRING FOREST ROAD RALEIGH	197	.115	.095	.094	.089	5
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	182	.099	.091	.085	.079	3
37-183-0016 WAKE	201 NORTH BROAD STREET FUQUAY-VARINA	208	.100	.098	.091	.089	4
37-183-0017 WAKE	5033 TV TOWER ROAD GARNER	179	.093	.089	.086	.084	3
37-199-0003 YANCY	BLUE RIDGE PARKWAY	204	.087	.082	.080	.080	1
Total Samples Total Sites Sampled		9,578 47					114

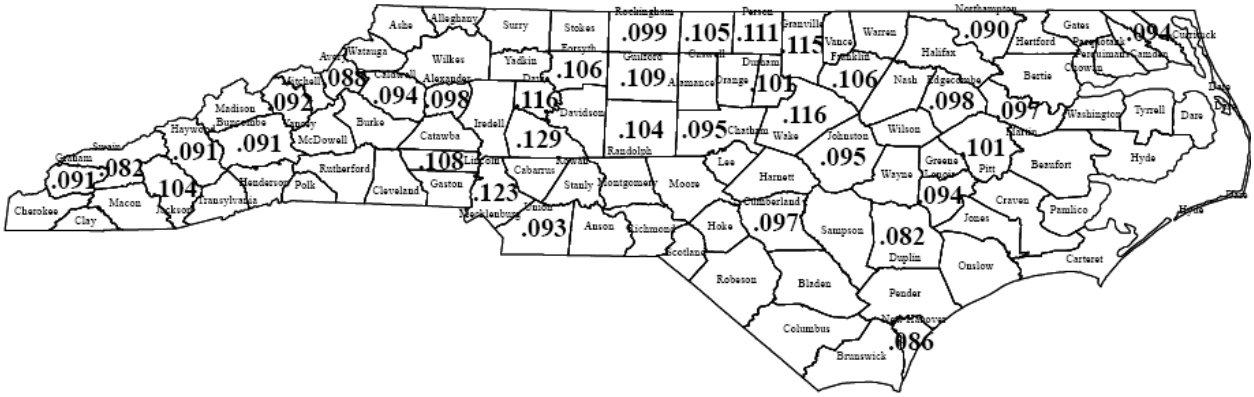

Figure 5.12 Ozone: Second Highest Annual 1-Hour Average, 2003

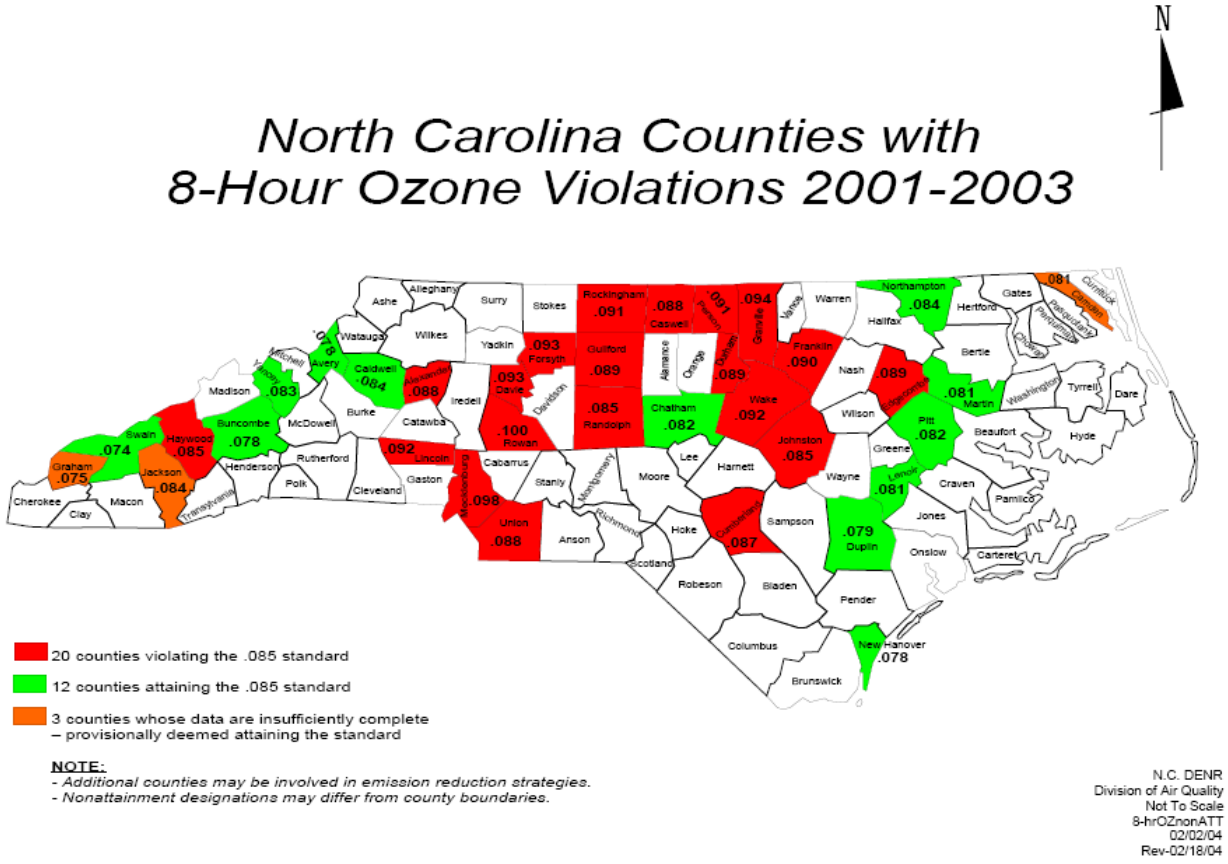

Figure 5.13 Ozone: Mean Annual Fourth Highest 8-Hour Average, 2001-2003

5.6 Sulfur Dioxide

Sulfur dioxide (SO_2) concentrations were measured by the State and two local program agencies using EPA reference or equivalent methods. Six SO_2 monitors were active in North Carolina in 2003. Some SO_2 sites are operated only every third year. We supplemented this report with one monitor that operated last in 2002, (and will next be operated in 2005), and four monitors that operated last in 2001 (and will next be operated in 2004).

From the 11 sites with SO_2 data obtained between 2001 and 2003, 86,021 valid hourly averages were collected. A map of the active SO_2 sampling sites is presented in Figure 5.14 and a detailed summary of the data from each site is given in Table 5.7.

There were no exceedances of the SO_2 ambient air quality standards in 2003. The highest annual arithmetic mean was 0.006 ppm, or about 20 percent of the standard (0.03 ppm). The highest maximum 24-hour average was 0.061 ppm, about 44 percent of the standard (0.14 ppm), and the highest maximum 3-hour average was 0.093 ppm, about 17 percent of the welfare-related (secondary) standard (0.50 ppm).

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 shown in Figure 5.15. The second highest 24-hour concentrations in each county are shown in Figure 5.16.

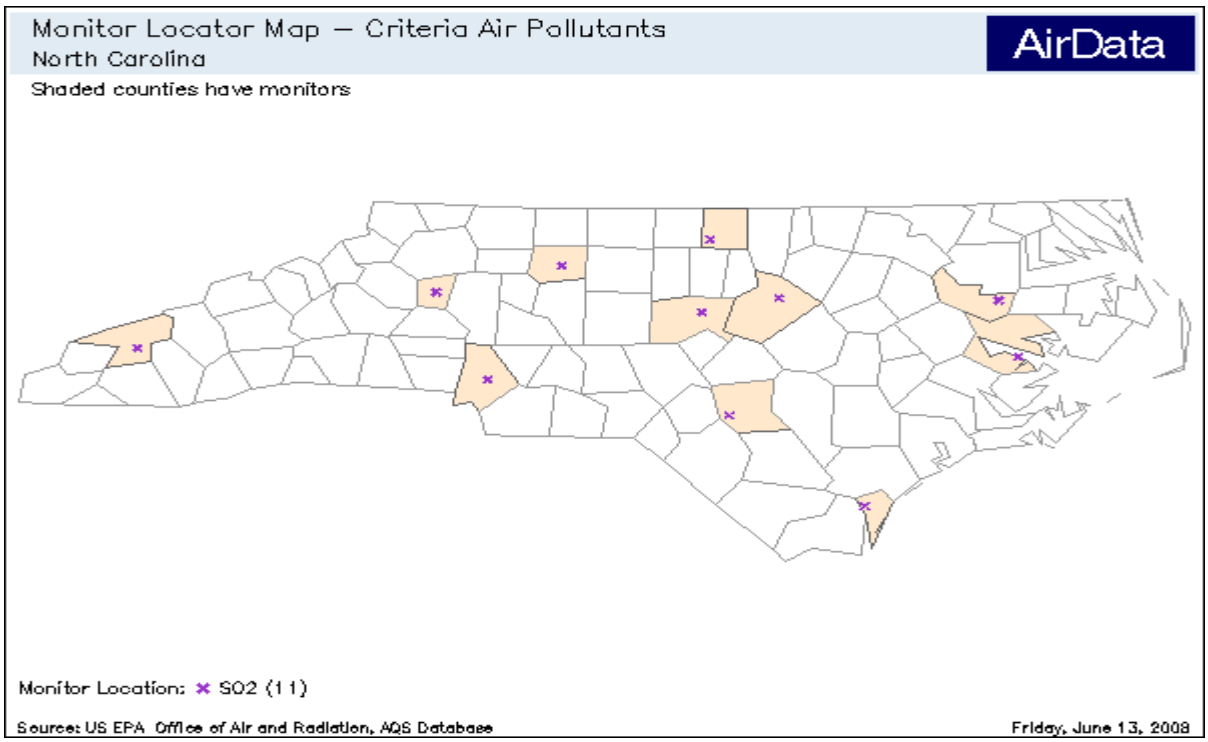

Figure 5.14 Locations of Sulfur Dioxide Monitoring Sites in 2001, 2002 and 2003.

Table 5.7 Sulfur Dioxide in Parts Per Million from All Sites for 2001-2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		THREE-HOUR MAXIMA		24-HOUR MAXIMA		ARITH MEAN
			1st	2nd	1st	2nd	1st	2nd	
2003 DATA									
37-003-0003 ALEXANDER	324 MINNIGAN LANE TAYLORSVILLE	8,274	.059	.045	.028	.028	.013	.012	.004
37-013-0006 BEAUFORT	NC 306@ PCS ENTRANCE AURORA	7,451	.136	.128	.093	.082	.026	.023	.003
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	8,609	.078	.077	.068	.066	.024	.017	.006
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	8,675	0.101	.085	.047	.044	.015	.013	.003
37-129-0006 NEW HANOVER	HIGHWAY 421 NORTH WILMINGTON	8,241	.129	.124	.089	.079	.061	.046	.005
37-183-0014 WAKE	3801 SPRING FOREST ROAD RALEIGH	6,768	.036	.025	.020	.020	.011	.010	.003
Total Samples		48,018							
Total Sites Sampled		6							

SITE NUMBER	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		THREE-HOUR MAXIMA		24-HOUR MAXIMA		ARITH MEAN
COUNTY			1st	2nd	1st	2nd	1st	2nd	
2002 DATA									
37-051-1003 CUMBERLAND	3625 GOLFVIEW ROAD HOPE MILLS	7,114	.016	.014	.011	.010	.007	.007	.002
Total Samples		7,114							
Total Sites Sampled		1							
2001 DATA									
37-037-0004 CHATHAM	RT4 BOX62 PITTSBORO	8,287	0.062	0.043	0.037	0.020	0.008	0.008	0.002
37-117-0001 MARTIN	1210 HAYES STREET	8,200	0.035	0.023	0.021	0.016	0.012	0.008	0.002
37-145-0003 PERSON	SR49	7,054	0.088	0.085	0.069	0.057	0.016	0.015	0.003
37-173-0002 SWAIN	CENTER ST/PARKS 7 REC FACILITY BRYSON CITY	7,057	0.015	0.015	0.013	0.012	0.008	0.004	0.002
Total Samples		30,598							
Total Sites Sampled		4							

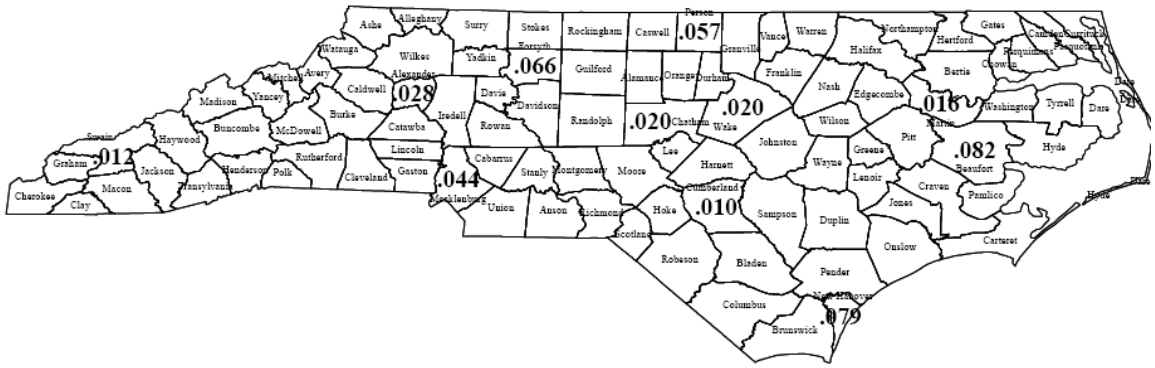

Figure 5.15 Sulfur Dioxide: Second Highest 3-Hour Averages in the Most Recent Year of Data from 2001, 2002 or 2003

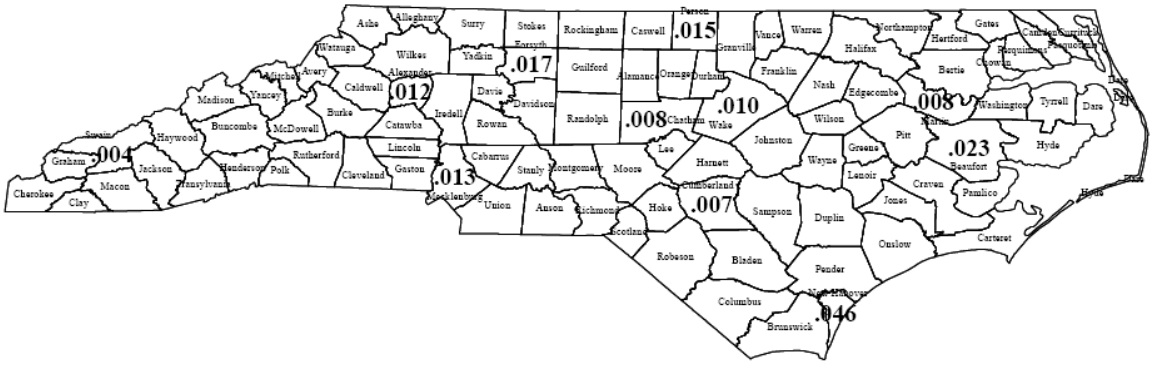

Figure 5.16 Sulfur Dioxide: Second Highest 24-Hour Averages in the Most Recent Year of Data from 2001, 2002 or 2003

5.7 Nitrogen Dioxide

Nitrogen dioxide (NO_2) concentrations were measured using EPA reference or equivalent continuous monitors in 2003 at one local program site in Forsyth County and one local program site in Mecklenburg County.

From these two sites, 17,115 hourly NO_2 measurements were reported. A map of the NO_2 sampling sites is presented in Figure 5.17, and a summary of the 2003 NO_2 data is given in Table 5.8.

Each urban area site has only a few outlying high hourly sample values that are above the standard defined for the annual arithmetic mean. The arithmetic means (Table 5.8) are about 28 percent of the standard.

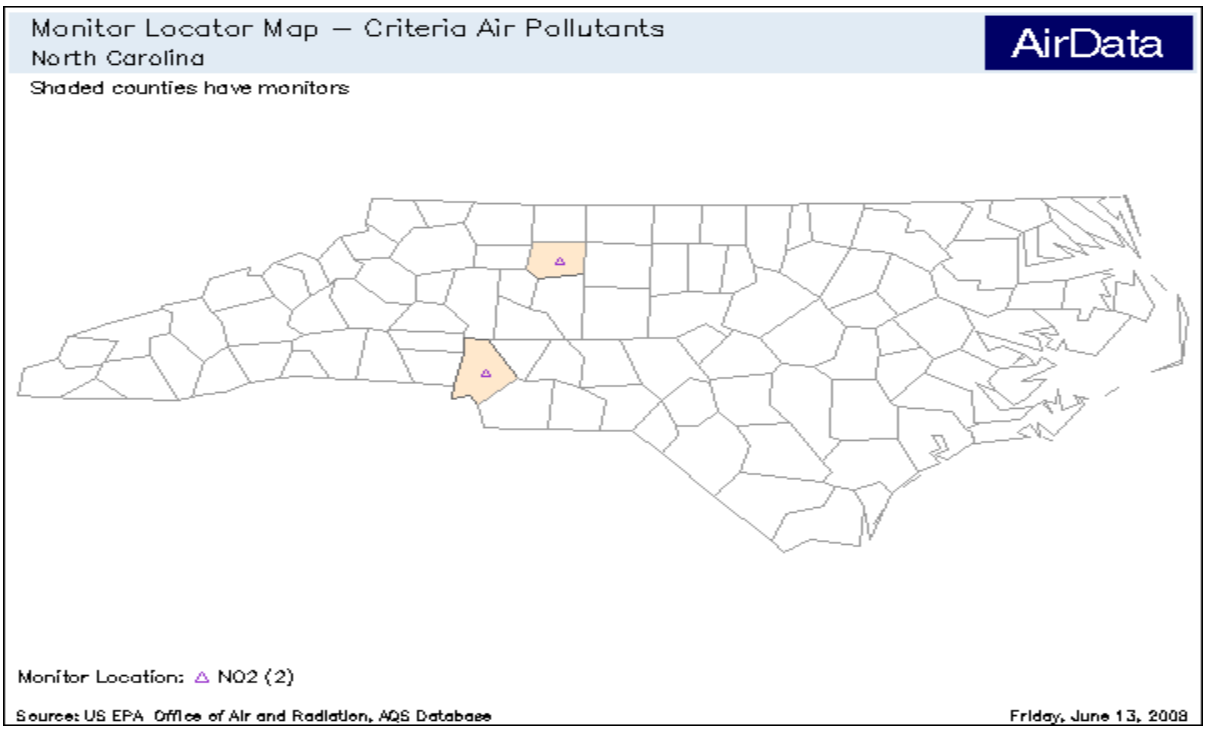

Figure 5.17 Location of Nitrogen Dioxide Monitoring Sites

Table 5.8 Nitrogen Dioxide in Parts Per Million for 2003

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		ARITH MEAN
			1ST	2ND	
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	8,478	0.068	0.063	0.015
37-067-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	8,637	0.060	0.059	0.015
Total Samples Total Sites Sampled		17,115 2			

5.8 Lead

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

5.8.1 Special Studies

The most recent year of data available prior to 1996-97 was in 1990. Because the previous data were so old, the state began metals analysis at three locations in 1996. These metal sites will be relocated to other locations in future years. The purpose of these sites is to gather background information about lead and other metals. No lead sites operated in 2003.

The change in analytical laboratories from the EPA's National Particulate Analysis Program to the state program also changed the minimum detectable levels of the method from 0.01 to 0.04 $\mu g/m^3$, respectively. Concentrations of most metals are below detectable limits regardless of the method used.

During 1999 and 2000, a special study focusing on arsenic levels was undertaken. Lead, and other toxic metals were sampled on filters using the TSP Reference Method at selected ambient air monitoring sites, by a contract laboratory using inductively coupled plasma/mass spectrometry (ICP/MS). This method can detect sample concentrations of lead as small as 0.01 nanograms (0.00001 μg) per cubic meter. Of the 526 valid samples analyzed in 1999 only 18 exceeded the Reference Method's detection limits. Only one sample exceeded 0.04 $\mu g/m^3$, and 17 others exceeded 0.01 $\mu g/m^3$.

6 Air Quality Index

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

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

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

The health effects of an AQI of over 300 (hazardous) include early onset of certain diseases in addition to significant aggravation of symptoms and decreased exercise tolerance in healthy persons. The elderly and persons with existing diseases should stay indoors and avoid physical exertion.

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

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

In 2003, Charlotte area provided an AQI report to the public by telephone using computer- generated recorded voice announcements 24 hours daily. The AQI report also may be published by local

newspapers or broadcast on radio and television stations.

The Air Quality Index report is available by telephone for Charlotte area at 704-333-SMOG. We also provide an AQI Report on the North Carolina DAQ web site, (http://www.daq.state.nc.us/monitor).

In this printed report, we have summarized AQI statistics for six metropolitan areas in North Carolina. Table 6.1 shows the number of days in each health category at each area. (The Asheville area has two entries, "actual" and "adjusted", in Table 6.1, because it was not monitored every day of the year; the "adjusted" entry gives our estimate of the number of days that *would have occurred* in each category had all 365 days been monitored.)

During January through March PM_{10} and $PM_{2.5}$ monitors operated on 30 of the 90 days; April through October, PM and ozone monitors operated on 211 of the 214 days; and in November and December, PM_{10} and $PM_{2.5}$ monitors operated on 21 of the 61 days. There were only 7 days on which an AQI value was "*unhealthy for sensitive groups*" or "*unhealthy*"; one occurred in June, five occurred in August, and one during September.

Figure 6.1 shows the 2003 AQI time series for Asheville. Figure 6.2 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, the number of days the AQI was in each respective health category, and the percentile distribution for each health category for Asheville.

In the Charlotte-Gastonia-Rock Hill MSA, the AQI was "*unhealthy for sensitive groups*" or "*unhealthy*" on 38 out of 364 days monitored. All 38 of these days occurred between May and September.

Figure 6.3 shows the 2003 AQI time series for Charlotte-Gastonia-Rock Hill. Figure 6.4 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, the number of days the AQI was in each respective health category, and the percentile distribution for each health category for Charlotte-Gastonia-Rock Hill.

In the Fayetteville MSA, the AQI was "*unhealthy for sensitive groups*" or "*unhealthy*" on 4 out of 365 days monitored. All 4 of these days occurred in June. Figure 6.5 shows the 2003 AQI time series for Fayetteville. Figure 6.6 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, the number of days the AQI was in each respective health category, and the percentile distribution for each health category for Fayetteville.

In the Greensboro-Winston-Salem-High Point MSA, the AQI was "*unhealthy for sensitive groups*" or "*unhealthy*" on 7 out of 365 days monitored. All 7 of these days occurred between April and August. Figure 6.7 shows the 2003 AQI time series for Greensboro- Winston-Salem-High Point. Figure 6.8 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, the number of days the AQI was in each respective health category, and the percentile distribution for each health category for Greensboro-Winston-Salem-High Point.

In the Raleigh-Durham-Chapel Hill MSA, the AQI was "*unhealthy for sensitive groups*" or "*unhealthy*" on 8 out of 364 days monitored. All 8 of these days occurred between June and August. Figure

6.9 shows the 2002 AQI time series for Raleigh-Durham-Chapel Hill. Figure 6.10 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, the number of days the AQI was in each respective health category, and the percentile distribution for each health category for Raleigh-Durham-Chapel Hill.

In the Wilmington MSA, the AQI was not "*unhealthy for sensitive groups*" or "*unhealthy*" for any days out of 364 days monitored. Figure 6.11 shows the 2003 AQI time series for Wilmington. Figure 6.12 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, the number of days the AQI was in each respective health category, and the percentile distribution for each health category for Wilmington.

Table 6.1 Air Quality Index Category Days in the Major Metropolitan Statistical Areas, 2003

MSA	STATISTICAL TREATMENT	GOOD	MODERATE	UNHEALTHY FOR SENSITIVE GROUPS	UNHEALTHY
Asheville	actual	221	81	2	0
Asheville	*adjusted*	*271.9*	*91.1*	*2.0*	*0*
Charlotte	actual	198	158	7	2
Fayetteville	actual	234	127	4	0
Greensboro	actual	189	169	6	1
Raleigh	actual	201	155	7	1
Wilmington	actual	307	57	0	0

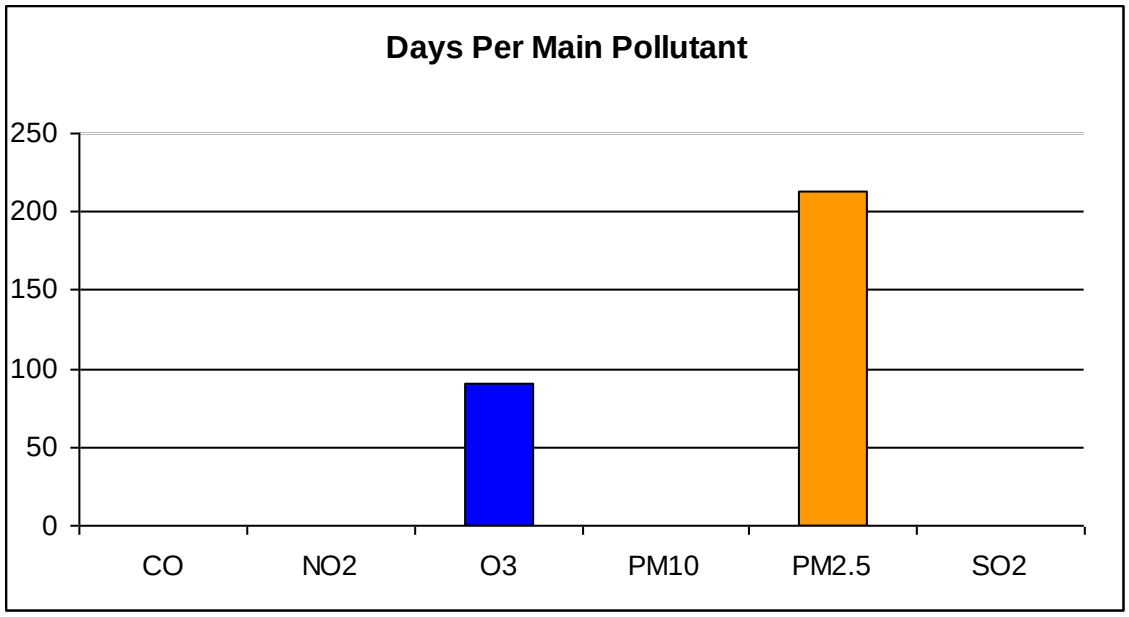

Figure 6.1 Daily Air Quality Index Values for Asheville

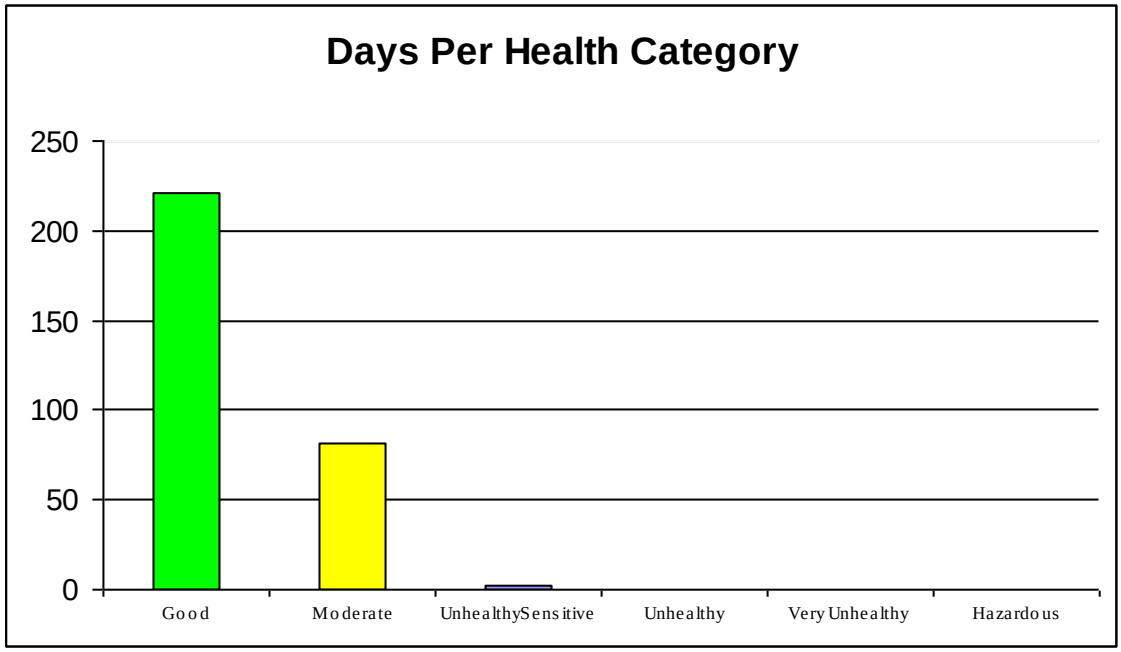

Figure 6.2 Daily Air Quality Index Summary for Asheville

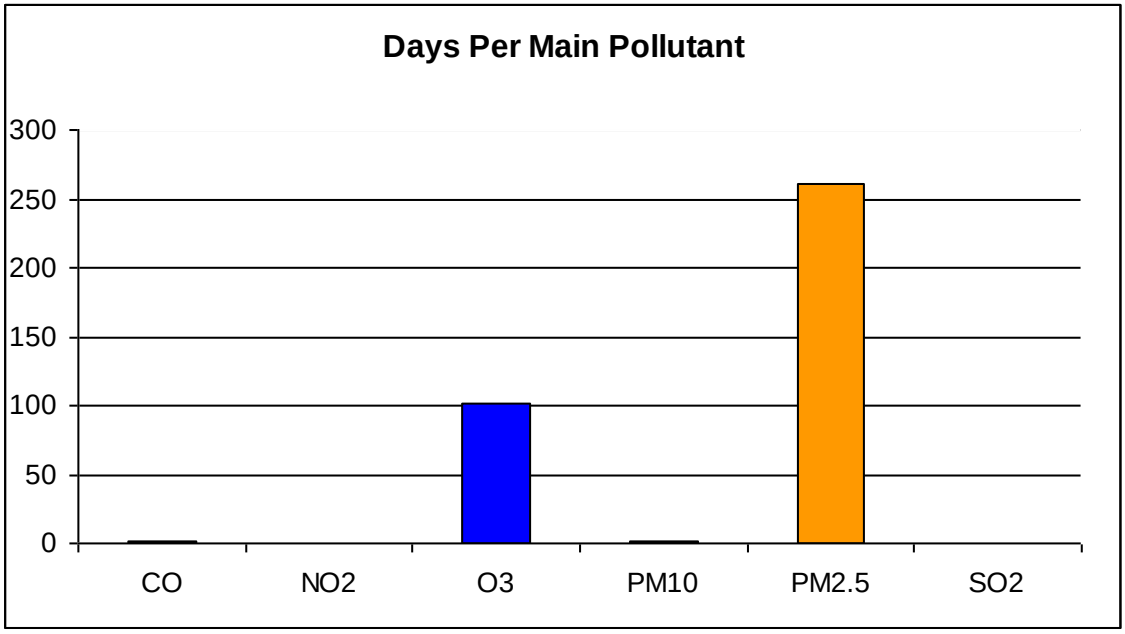

Figure 6.3 Daily Air Quality Index Values for Charlotte-Gastonia

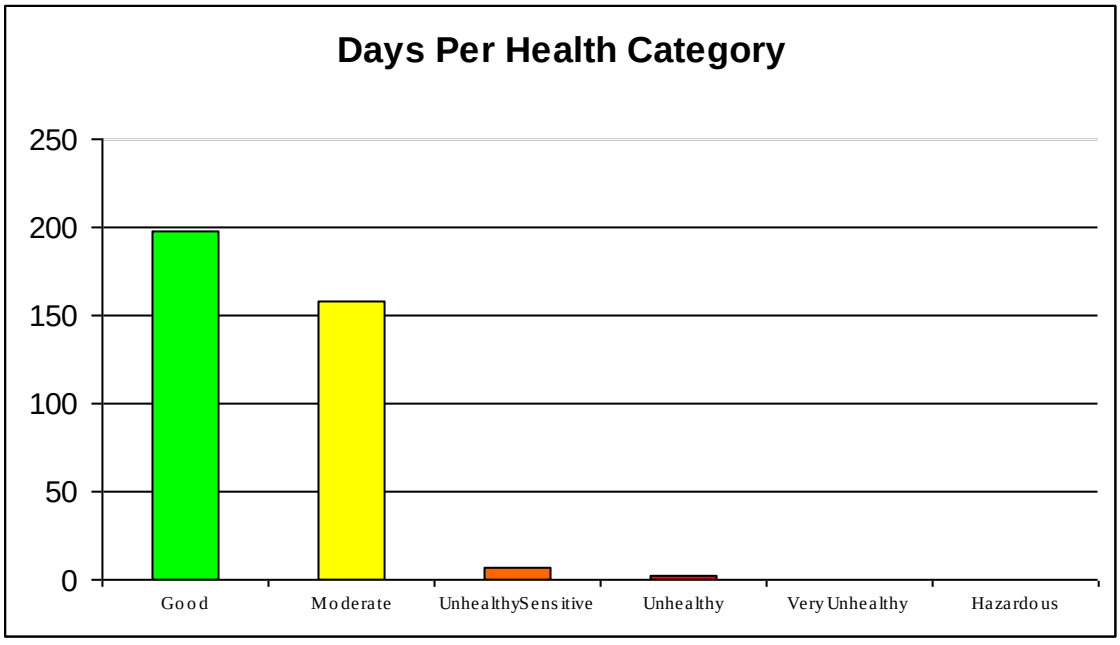

Figure 6.4 Daily Air Quality Index Summary for Charlotte-Gastonia

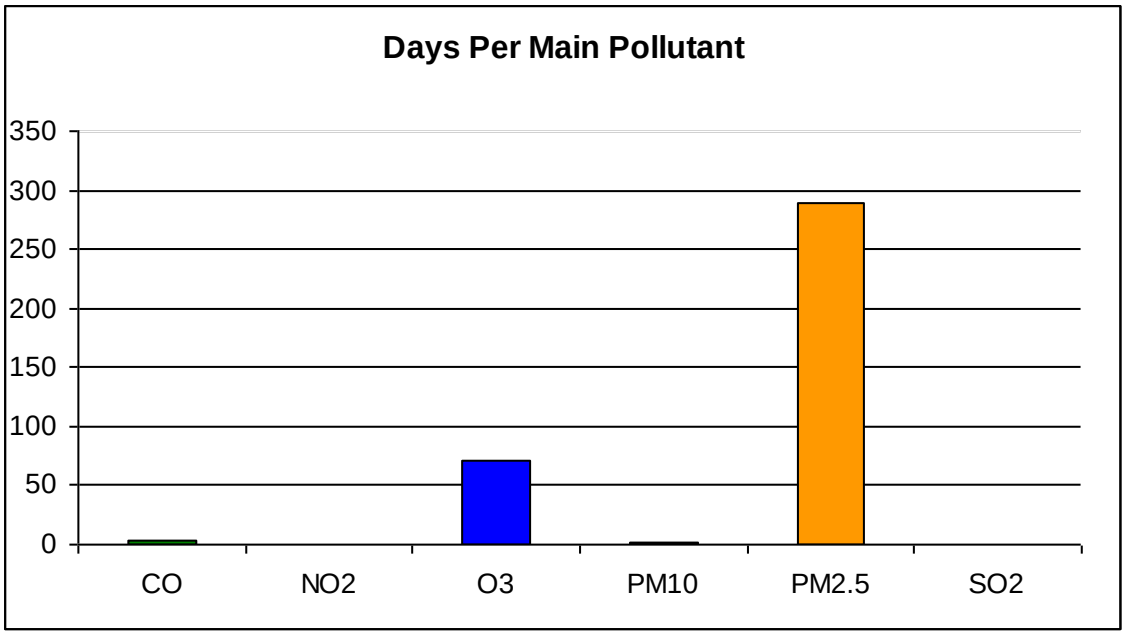

Figure 6.5 Daily Air Quality Index Values for Fayetteville

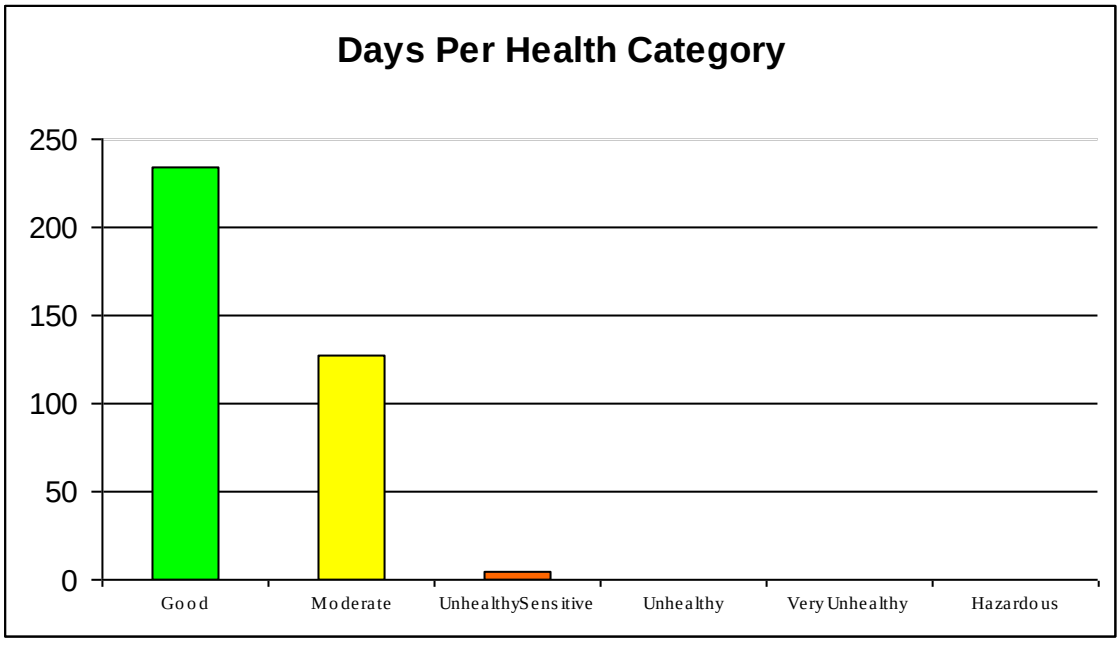

Figure 6.6 Daily Air Quality Index Summary for Fayetteville

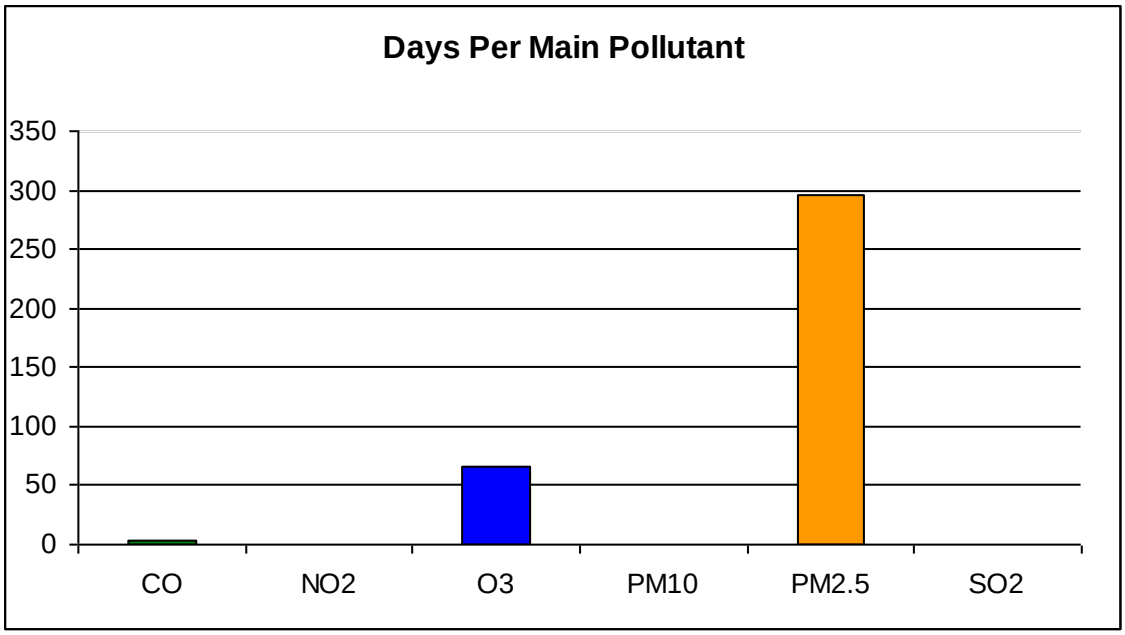

Figure 6.7 Daily Air Quality Index Values for Greensboro-Winston-Salem-High Point

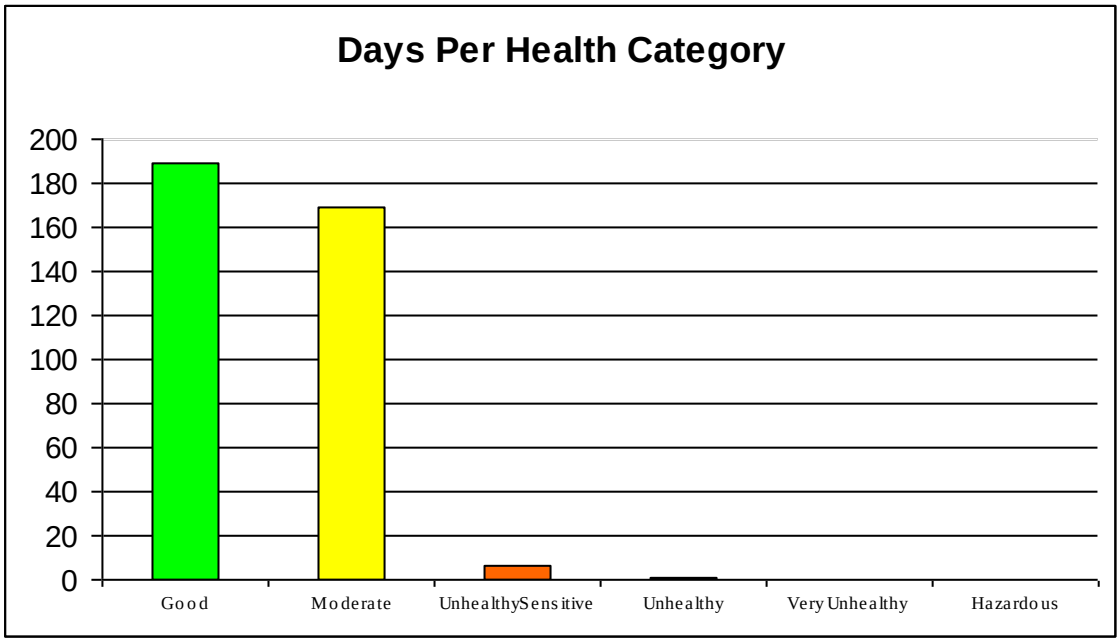

Figure 6.8 Daily Air Quality Index Summary for Greensboro-Winston-Salem-High Point

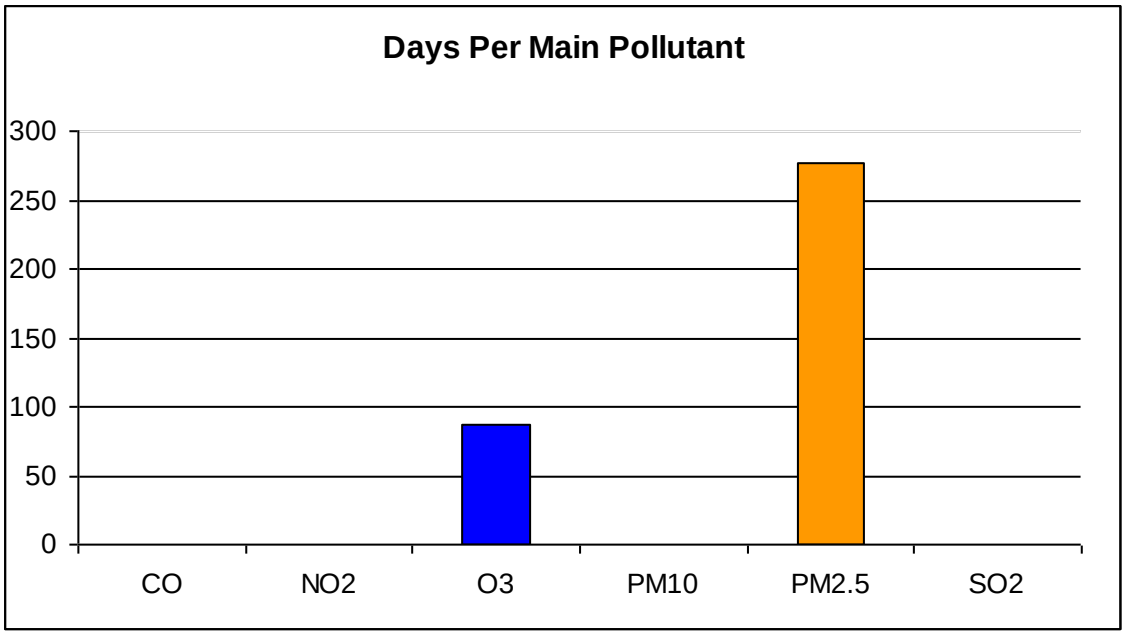

Figure 6.9 Daily Air Quality Index Values for Raleigh-Durham-Chapel Hill

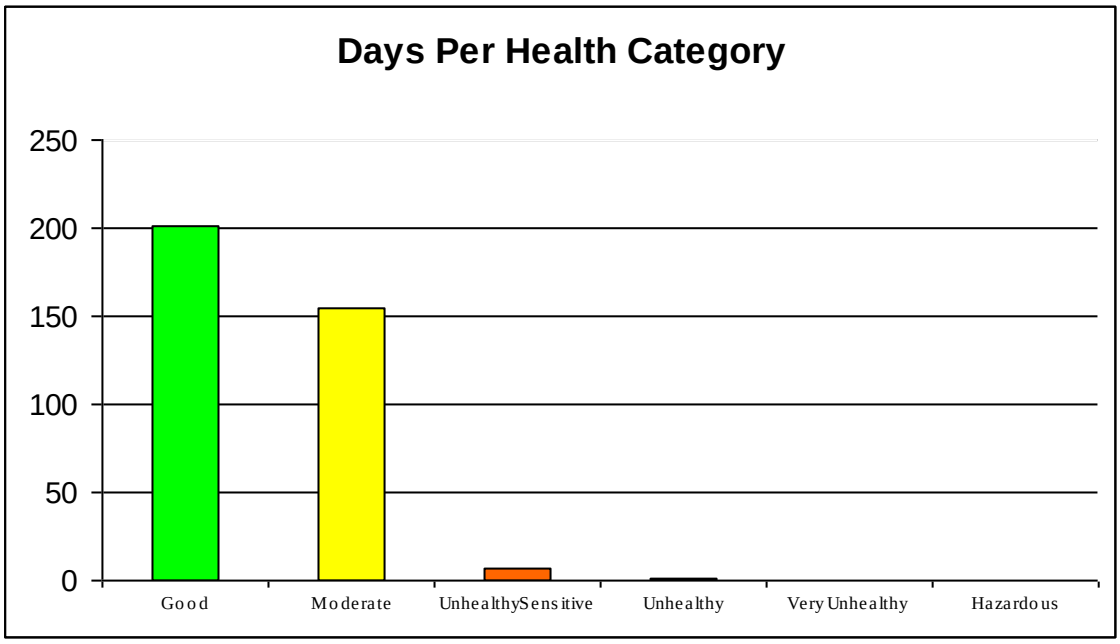

Figure 6.10 Daily Air Quality Index Summary for Raleigh-Durham-Chapel Hill

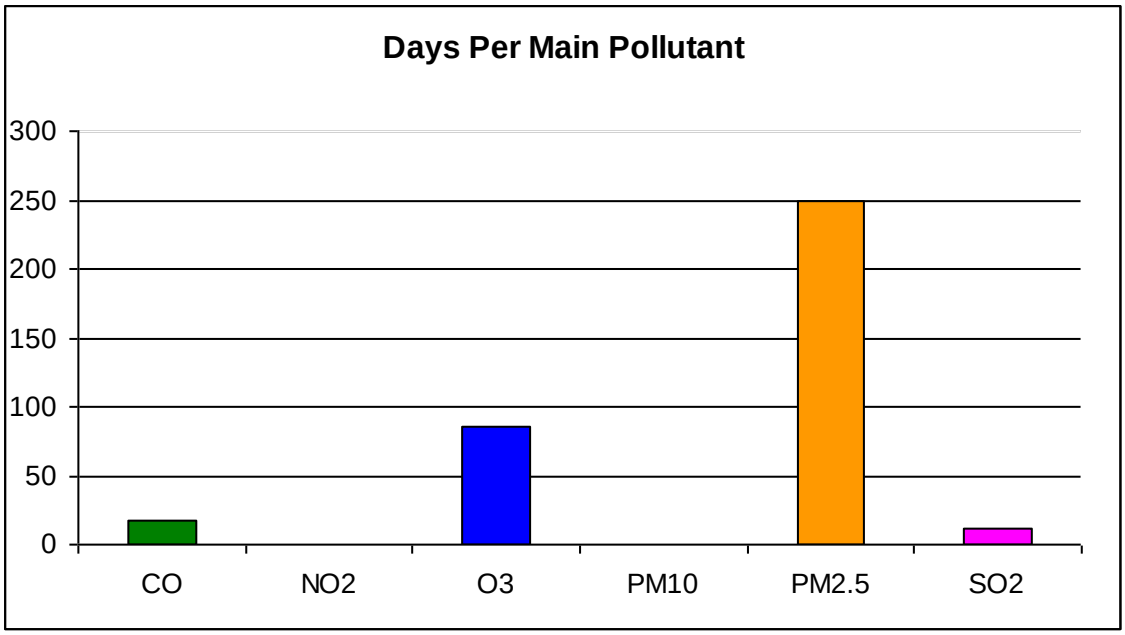

Figure 6.11 Daily Air Quality Index Values for Wilmington

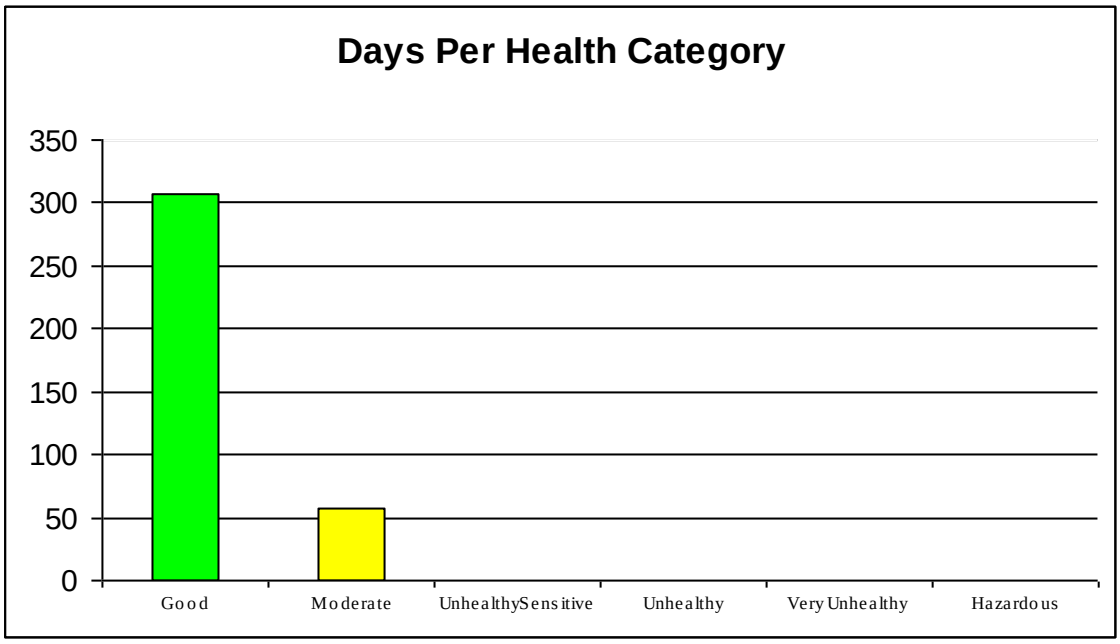

Figure 6.12 Daily Air Quality Index Summary for Wilmington

7 Acid Rain

7.1 Sources

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

7.2 Effects

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

7.3 Monitoring

Acid rain monitoring has been conducted nationally, including in North Carolina, since 1978 by the National Atmospheric Deposition Program (NADP) and the National Trends Network (NTN) which merged with NADP in 1982. In 2003, acid rain samples were collected at eight 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 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 2003 ranged from 4.53 to 5.10 with a mean of 4.72. The 2003 pH annual means for North Carolina from the NADP database are presented in Figure 7.1 and Table 7.1. Table 7.1 also exhibits conductivity averages and precipitation totals for rainfall. Measured concentrations of several other chemical constituents of precipitation are given in Table 7.2.

The highest pH (and the least acid) precipitation occurred at the Sampson County site. This general area in southeastern North Carolina has the greatest numbers of animal producing farms. This area has the highest

emissions of ammonia, a basic gas emitted from animal wastes. Table 7.2 shows that the ammonium concentration in precipitation is the second highest at the Sampson County site.

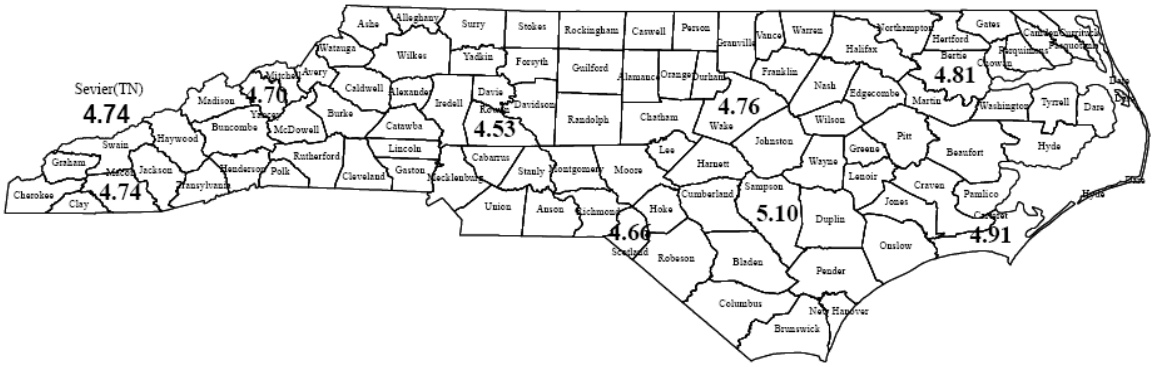

Figure 7.1 Annual Mean pH Values at North Carolina NADP Sites, 2003

Table 7.1 pH, Conductivity in Microsiemans per Centimeter and Precipitation in Inches from the National Atmospheric Deposition Program for 2003.

County Site ID Address	pH	Conductivity	Precipitation
Bertie NC03 Lewiston	4.81	11.44	60.06
Carteret NC06 Beaufort	4.91	12.10	80.77
Macon NC25 Coweeta	4.74	10.97	81.12
Rowan NC34 Piedmont Research Station	4.53	18.35	56.60
Sampson NC35 Clinton Crops Research Station	5.10	9.81	51.95
Scotland NC36 Jordan Creek	4.66	13.61	60.93
Wake NC41 Finley Farm	4.76	12.19	51.65
Yancey NC45 Mt. Mitchell	4.70	11.37	88.23
Sevier (TN) TN11 Great Smoky Mountains National Park-Elkmont	4.74	11.73	69.59

Table 7.2 Ion Concentrations in Milligrams per Liter (Precipitation-weighted Annual Means) from the National Atmospheric Deposition Program Data for 2003.

County Site ID	% Complete-ness	Ca	Mg	K	Na	NH4	NO3	Cl	SO4
Bertie NC03	96	0.070	0.030	0.052	0.185	0.226	0.705	0.338	0.986
Beaufort NC06	64	0.073	0.067	0.029	0.583	0.151	0.516	1.062	0.812
Macon NC25	88	0.050	0.011	0.013	0.071	0.148	0.607	0.140	0.93
Rowan NC34	84	0.091	0.017	0.060	0.064	0.310	1.003	0.162	1.843
Sampson NC35	90	0.064	0.028	0.031	0.231	0.456	0.660	0.426	1.056
Scotland NC36	96	0.059	0.017	0.016	0.116	0.220	0.786	0.224	1.186
Wake NC41	98	0.056	0.015	0.015	0.112	0.290	0.762	0.220	1.141
Yancey NC45	58	0.036	0.006	0.011	0.025	0.158	0.503	0.060	1.032
Sevier (TN) TN11	77	0.078	0.011	0.047	0.035	0.143	0.783	0.081	1.065

8. Fine Particle Speciation

8.1 Description of pollutants

The main species or constituents of fine particles are classified as nitrates, sulfates, ammonium, organic carbon, elemental carbon, and crustal components (dust). These account for 75 to 85 percent of the composition of fine particles.

8.1.1 Nitrate

Ammonium nitrate (NH_4NO_3) is the most abundant nitrate compound, resulting from a reversible gas/particle equilibrium between ammonia gas (NH_3), nitric acid gas (HNO_3), and particulate ammonium nitrate. Sodium nitrate ($NaNO_3$) is found in $PM_{2.5}$ and PM_{10} near sea coasts and salt playas (e.g., Watson et al., 1995a) where nitric acid vapor irreversibly reacts with sea salt (NaCl).

8.1.2 Sulfate

Ammonium sulfate ($(NH_4)_2SO_4$), ammonium bisulfate (NH_4HSO_4), and sulfuric acid (H_2SO_4) are the most common forms of sulfate found in atmospheric particles, resulting from conversion of gases to particles as described below. These compound are water-soluble and reside almost exclusively in the $PM_{2.5}$ size fraction. Sodium sulfate (Na_2SO_4) may be found in coastal areas where sulfuric acid has been neutralized by sodium chloride (NaCl) in sea salt. Though gypsum (Ca_2SO_4) and some other geological compounds contain sulfate, these are not easily dissolved in water for chemical analysis, are more abundant in PM_{10} than in $PM_{2.5}$, and they are usually classified in the geological fraction.

8.1.3 Ammonium

Ammonium sulfate ($(NH_4)_2SO_4$), ammonium bisulfate (NH_4HSO_4), and ammonium nitrate (NH_4NO_3) are the most common compounds containing ammonium.

8.1.4 Organic Carbon

Particulate organic carbon consists of hundreds, possibly thousands, of separate compounds with more than 20 carbon atoms. Because of this lack of molecular specificity and the semi-volatile nature of many carbon compounds with 20 to 40 Carbon atoms, particulate “organic carbon” is operationally defined by the sampling and analysis method.

8.1.5 Elemental Carbon

Elemental carbon is black, often called “soot.” Elemental carbon contains pure, graphitic carbon, but it also contains high molecular weight, dark-colored, non-volatile organic materials such as tar, biogenic, and coke.

8.1.6 Crustal Component (Fine Dust)

Suspended dust consists mainly of oxides of aluminum, silicon, calcium, titanium, iron, and other metal oxides (Chow and Watson, 1998). The precise

combination of these minerals depends on the geology of the area and industrial processes such as steel-making, smelting, mining, and cement production. Geological material is mostly in the coarse particle fraction, and typically constitutes ~50 percent of PM_{10} while only contributing 5 to 15 percent of $PM_{2.5}$ (Chow and Watson, 1998).

8.1.7 "Other" Speciated components.

We categorize the 15 to 25 percent of $PM_{2.5}$ not accounted for by nitrate, sulfate, ammonium, carbon and crustal components as "other" speciated data. For the purpose of this report "other" is not defined in any certain kind of particulate matter, but is simply the result of subtracting all the other components from the total $PM_{2.5}$ reported by the sampler. Among the constituents of "other" are liquid water and many trace chemical elements.

8.2 Sources

Sources of fine particles include all types of combustion activities (motor vehicles, power plants, wood burning, etc.) and certain industrial processes. Other particles may be formed in the air from the chemical change of gases. They are indirectly formed when gases from burning fuels react with sunlight and water vapor. These can result from fuel combustion in motor vehicles, at power plants, and in other industrial processes.

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

Fine particles also form from the reaction of gases or droplets in the atmosphere from sources such as power plants. These chemical reactions can occur miles from the original source of the emissions. Because fine particles can be carried long distances from their source, events such as wildfires or volcanic eruptions can raise fine particle concentrations hundreds of miles from the event.

$PM_{2.5}$ is also produced by common indoor activities. Some indoor sources of fine particles are tobacco smoke, cooking (e.g., frying, sautéing, and broiling), burning candles or oil lamps, and operating fireplaces and fuel-burning space heaters (e.g., kerosene heaters).

Particles and ozone are similar in many respects. Both can cause respiratory symptoms and other serious health problems. Fossil fuel combustion is a leading source of both pollutants. One significant difference is that particles can be a problem at any time of year, unlike ozone, which forms in warm, sunny weather and therefore tends to be seasonal in nature.

8.3 Effects

The size of the particles is what's most important from a public health viewpoint. Particles larger than 10 μm

generally get caught in the nose and throat, never entering the lungs. Particles smaller than 10 μm can get into the large upper branches just below your throat where they are caught and removed (by coughing and spitting or by swallowing). Particles smaller than 5 μm can get into your bronchial tubes, at the top of the lungs; particles smaller than 2.5 μm in diameter can get down into the deepest (alveolar) portions of your lungs where gas exchange occurs between the air and your blood stream, oxygen moving in and carbon dioxide moving out. These are the really dangerous particles because the deepest (alveolar) portions of the lung have no efficient mechanisms for removing them. If these particles are soluble in water, they pass directly into the blood stream within minutes. If they are not soluble in water, they are retained in the deep lung for long periods (months or years). About 60 percent of PM_{10} particles (by weight) have a diameter of 2.5 μm or less. These are the particles that can enter the human lung directly.

8.4 Monitoring

The MetOne SASS monitor measures $PM_{2.5}$ mass and the chemical composition of $PM_{2.5}$ (sulfates, nitrates, organic carbon, soot-like carbon and metals). This is known as $PM_{2.5}$ chemical speciation. The MetOne SASS utilizes five independent channels (the Met One Super SASS utilizes eight independent channels) with spiral impactors attached directly to the filter cartridges that are arrayed in a raised carousel. Each canister has its own $PM_{2.5}$ inlet and Federal Reference Method/Monitor filter holders. The $PM_{2.5}$ separation is produced by a sharp cut cyclone that removes both solid and liquid coarse particles with equal efficiency without the use of impaction grease or oil.

The Interagency Monitoring of Protected Visual Environments (IMPROVE) is a cooperation between federal land managers, state and local agencies and EPA to collect aerosol particulate data. IMPROVE sites use a different monitoring method. The standard IMPROVE sampler has four modules: (1) $PM_{2.5}$ mass, (2) sulfate, nitrate and chloride, (3) $PM_{2.5}$ quartz and (4) PM_{10} mass.

Data are validated on a monthly basis when reports are received from the contract laboratory RTI International. NCDAQ collected data at nine sites using MetOne SASS method, the National Park Service collected at two sites and the US Forest Service collected data at one site during 2002 and 2003 using the IMPROVE method. Figure 8.1 shows a map of all these sites. Table 8.1 identifies the sites and the specific sampling methods employed at each one.

Nitrate samples in 2002 are summarized in Table 8.2. The highest concentration observed was 5.89 $\mu g/m^3$ at Hickory. Nitrate samples in 2003 are summarized in Table 8.3. The highest concentration observed was 7.30 $\mu g/m^3$ at Charlotte.

Sulfate samples in 2002 are summarized in Table 8.4. The highest concentration observed was 19.1 $\mu g/m^3$ at Charlotte. Sulfate samples in 2003 are summarized in Table 8.5. The highest concentration observed was 21.6 $\mu g/m^3$ at Shining Rock (Frying Pan Mountain), (37-087-0035).

Ammonium samples in 2002 are summarized in Table 8.6. The highest concentration observed was 5.50 $\mu g/m^3$ at Kinston. Ammonium samples in 2003

are summarized in Table 8.7. The highest concentration observed was 4.85 $\mu g/m^3$ at Hickory.

Organic Carbon samples in 2002 are summarized in Table 8.8. The highest concentration observed was 16.8 $\mu g/m^3$ at Fayetteville. Organic Carbon samples in 2003 are summarized in Table 8.9. The highest concentration observed was 14.5 $\mu g/m^3$ at Raleigh.

Elemental Carbon samples in 2002 are summarized in Table 8.10. The highest concentration observed was 2.32 $\mu g/m^3$ at Hickory. Elemental Carbon samples in 2003 are summarized in Table 8.11. The highest concentration observed was 2.36 $\mu g/m^3$ at Kinston.

Crustal Component samples in 2002 are summarized in Table 8.12. The highest concentration observed was 3.03 $\mu g/m^3$ at Kinston. Crustal Component samples in 2003 are summarized in Table 8.13. The highest concentration observed was 5.00 $\mu g/m^3$ at Shining Rock.

"Other" samples in 2002 are summarized in Table 8.14. The highest concentration observed was 14.03 $\mu g/m^3$ at Winston-Salem. "Other" samples in 2003 are summarized in Table 8.15. The highest concentration observed was 14.31 $\mu g/m^3$ at Asheville.

Elemental lead samples for 2003 are summarized in Table 8.16 (We reported a summary for 2002 in the 2002 Annual Report). Out of 479 samples statewide 6 samples exceeded 0.01 $\mu g/m^3$; 473 of these sample concentrations (98.7 percent) were less than 0.01 $\mu g/m^3$. None were greater than 0.014 $\mu g/m^3$.

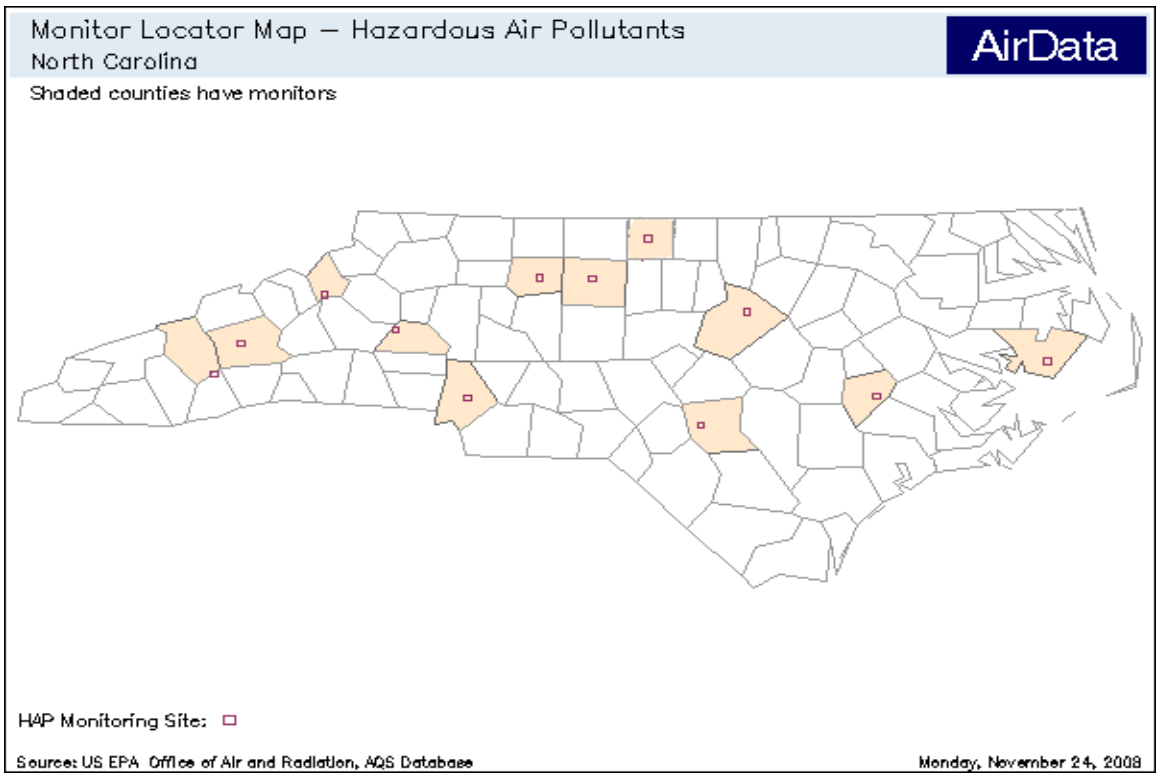

Figure 8.1 Location of Nitrate, Sulfate, Ammonium, Organic Carbon, Elemental Carbon, Crustal component, "Other" component, Monitoring Sites 2002-2003

Table 8.1 Fine Particle Speciation Sites Operated in North Carolina in 2003

SITE NUMBER COUNTY	ADDRESS	METHOD
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	IMPROVE
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	SASS
37-033-0001 CASWELL	7074 CHERRY GROVE RD REIDSVILLE	SASS
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	SASS
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	SASS
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	SASS
37-081-0013	205 WILOUGHBY BLVD	SASS

SITE NUMBER COUNTY	ADDRESS	METHOD
GUILFORD	GREENSBORO	
37-087-0035 HAYWOOD	SHINING ROCK WILDERNESS	IMPROVE
37-095-9000 HYDE	SWANQUARTER WILDLIFE REFUGE	IMPROVE
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	SASS
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	SASS
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	SASS
SITES OPERATED IN 2003	12	

Table 8.2 Nitrate PM2.5 - Micrograms/Cubic Meter (LC) for 2002

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
			1st	2nd	3rd	4th	
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	110	2.02	1.14	.97	.96	.271
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	49	4.78	2.56	1.8	1.47	.727
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	51	5.89	4.71	3.90	2.14	1.143
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	58	3.39	3.29	2.88	2.87	1.105
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	2.91	2.75	2.40	2.20	1.001
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	4	2.01	1.36	1.18	.22	1.193
37-087-0035 HAYWOOD	SHINING ROCK WILDERNESS	99	1.18	1.07	.96	.90	.261
37-095-9000 HYDE	SWANQUARTER	115	3.84	1.75	1.36	1.35	.432
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH	55	4.59	3.17	3.09	2.87	1.167

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
	KINSTON						
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	3.51	3.15	2.83	2.61	.976
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	59	2.97	2.44	2.32	1.98	.902
Total Samples		751					
Total Sites Sampled		10					

Table 8.3 Nitrate PM2.5 - Micrograms/Cubic Meter (LC) for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	118	2.313	2.099	1.688	1.299	.2697
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	2.23	2.17	2.07	1.48	.691
37-033-0001 CASWELL	7074 CHERRY GROVE RD REIDSVILLE	2	1.97	1.18	N/A	N/A	1.575
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	59	5.77	5.50	3.15	2.74	1.134
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	59	4.45	4.11	4.00	2.27	1.042
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	3.76	3.25	2.76	2.44	.976
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	4	2.01	1.36	1.18	.22	1.193
37-087-0035 HAYWOOD	SHINING ROCK WILDERNESS	104	1.392	.942	.869	.680	.2200
37-095-9000 HYDE	SWANQUARTER	104	2.059	1.835	1.720	1.362	.3649
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	57	3.93	3.80	2.67	2.55	1.081
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	7.30	4.49	3.81	3.18	.888

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	83	3.42	3.37	3.36	3.03	.892
Total Samples		803					
Total Sites Sampled		12					

Table 8.4 Sulfate PM2.5 - Micrograms/Cubic Meter (LC) for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	110	15.063	14.478	11.035	10.774	3.992
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	49	15.90	9.66	9.43	9.27	5.005
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	51	13.80	12.50	12.30	11.70	4.852
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	58	12.90	11.40	10.60	9.66	4.241
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	13.70	13.40	12.50	11.30	5.268
37-087-0035 HAYWOOD	SHINING ROCK WILDERNESS	99	11.682	10.858	10.004	9.759	3.135
37-095-9000 HYDE	SWANQUARTER	115	14.355	12.071	10.042	9.925	3.339
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	55	14.30	11.20	7.45	7.38	4.061
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	19.10	11.50	10.70	10.60	5.033
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	59	11.00	10.60	10.50	9.24	4.351
Total Samples		751					
Total Sites Sampled		10					

Table 8.5 Sulfate PM2.5 - Micrograms/Cubic Meter (LC) for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
			1st	2nd	3rd	4th	
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	118	13.812	11.590	11.343	10.666	3.5039
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	18.20	12.60	12.10	11.60	3.992
37-033-0001 CASWELL	7074 CHERRY GROVE RD REIDSVILLE	2	2.41	1.91	N/A	N/A	2.160
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	59	18.00	11.90	10.80	10.40	4.773
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	59	10.50	9.11	8.86	8.51	4.031
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	19.30	13.90	11.30	9.00	4.852
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	4	2.74	2.68	2.22	1.40	2.260
37-087-0035 HAYWOOD	SHINING ROCK WILDERNESS	104	21.589	14.316	11.671	11.454	3.2075
37-095-9000 HYDE	SWANQUARTER	104	10.377	10.361	7.406	7.243	3.0267
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	57	9.74	8.85	8.61	6.65	3.638
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	11.80	11.00	10.40	10.30	4.464
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	83	13.80	13.50	12.20	9.59	4.172
Total Samples		803					
Total Sites Sampled		12					

Table 8.6 Ammonium Ion PM2.5 - Micrograms/Cubic Meter (LC) for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
			1st	2nd	3rd	4th	
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	37	3.00	2.00	2.00	2.00	.8378
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	49	3.84	2.94	2.77	2.73	1.487
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	51	3.79	3.55	3.51	3.49	1.632
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	58	3.90	3.11	3.10	2.89	1.417
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	4.45	4.03	4.00	3.33	1.765
37-087-0035 HAYWOOD	SHINING ROCK WILDERNESS	36	3.00	2.00	2.00	2.00	.5556
37-095-9000 HYDE	SWANQUARTER	38	3.00	2.00	2.00	2.00	.8421
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	55	5.50	4.08	3.13	2.94	1.527
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	4.78	3.46	3.23	3.18	1.669
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	59	3.44	3.41	3.16	3.15	1.466
Total Samples		538					
Total Sites Sampled		10					

Table 8.7 Ammonium Ion PM2.5 - Micrograms/Cubic Meter (LC) for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
			1st	2nd	3rd	4th	
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	118	3.00	3.00	2.29	2.15	.9424
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	4.14	3.23	2.95	2.78	1.192
37-033-0001 CASWELL	7074 CHERRY GROVE RD REIDSVILLE	2	1.33	.93	N/A	N/A	1.130

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	59	4.85	3.75	3.36	3.02	1.607
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	59	3.32	3.29	3.12	3.02	1.438
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	4.44	4.32	3.57	3.92	1.640
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	4	1.30	1.16	1.02	.44	.981
37-087-0035 HAYWOOD	SHINING ROCK WILDERNESS	104	3.00	3.00	3.00	2.00	.7698
37-095-9000 HYDE	SWANQUARTER	104	4.00	3.00	2.55	2.00	.8761
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	57	4.41	3.66	3.43	3.09	1.376
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	4.42	3.68	3.36	3.33	1.468
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	83	4.64	4.52	4.36	3.20	1.458
Total Samples		803					
Total Sites Sampled		12					

Table 8.8 Organic Carbon CSN PM2.5 - Micrograms/Cubic Meter (LC) for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	49	9.72	8.84	8.03	8.02	4.626
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	51	10.10	9.90	9.63	9.51	5.245
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	58	16.80	14.00	11.70	9.99	5.515
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	9.78	8.51	8.29	8.11	5.042
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	55	12.30	9.01	8.13	8.08	4.463

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	11.50	10.30	10.20	9.62	5.369
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	59	12.00	11.90	11.30	10.10	5.349
Total Samples		427					
Total Sites Sampled		7					

Table 8.9 Organic Carbon CSN PM2.5 - Micrograms/Cubic Meter (LC) for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	10.70	7.13	6.54	6.49	4.001
37-033-0001 CASWELL	7074 CHERRY GROVE RD REIDSVILLE	3	5.39	4.86	3.15	N/A	4.467
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	59	11.00	10.20	9.44	9.13	5.094
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	59	14.10	11.80	9.59	8.55	4.959
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	10.60	9.92	9.34	8.74	4.706
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	4	6.98	6.05	4.20	1.49	4.680
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	58	14.00	7.35	7.11	6.89	3.874
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	94	13.40	10.70	10.60	9.44	4.924
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	83	14.50	13.10	12.70	9.56	4.982
Total Samples		477					
Total Sites Sampled		9					

Table 8.10 Elemental Carbon CSN PM2.5 - Micrograms/Cubic Meter (LC) for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
			1st	2nd	3rd	4th	
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	110	.740	.699	.665	.606	.3480
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	49	1.26	.99	.98	.88	.509
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	51	2.32	1.77	1.60	1.32	.717
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	58	2.11	2.06	1.42	1.33	.523
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	1.58	1.16	1.11	1.11	.536
37-087-0035 HAYWOOD	SHINING ROCK WILDERNESS	88	.580	.454	.386	.353	.1764
37-095-9000 HYDE	SWANQUARTER	115	.773	.718	.700	.698	.2661
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	55	1.60	.73	.61	.57	.354
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	1.70	1.68	1.55	1.41	.590
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	59	1.75	1.54	1.44	1.38	.547
Total Samples		740					
Total Sites Sampled		10					

Table 8.11 Elemental Carbon CSN PM2.5 - Micrograms/Cubic Meter (LC) for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
			1st	2nd	3rd	4th	
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	116	1.081	.743	.732	.703	.3420
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	49	1.26	.99	.98	.88	.509
37-033-0001 CASWELL	7074 CHERRY GROVE RD REIDSVILLE	3	.54	.51	.35	N/A	.467

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	59	1.76	1.65	1.57	1.51	.754
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	59	1.56	1.28	1.27	1.07	.493
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	1.30	1.27	1.16	1.12	.564
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	4	.99	.89	.56	.12	.640
37-087-0035 HAYWOOD	SHINING ROCK WILDERNESS	100	.727	.701	.624	.599	.2298
37-095-9000 HYDE	SWANQUARTER	104	.759	.696	.667	.594	.2228
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	58	2.36	.76	.72	.67	.339
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	94	1.93	1.49	1.27	1.16	.595
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	83	1.53	1.31	1.30	1.26	.572
Total Samples		788					
Total Sites Sampled		12					

Table 8.12 Crustal Component PM2.5 - Micrograms/Cubic Meter (LC) for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	49	2.34	1.31	1.18	1.16	.485
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	51	1.16	1.14	1.03	0.92	.432
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	58	2.37	2.22	1.64	.99	.486
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	.88	.82	.80	.79	.366
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	55	3.03	1.62	.68	.63	.362

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	1.89	1.70	1.44	1.01	.470
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	59	1.80	1.61	1.30	1.24	.491
Total Samples		427					
Total Sites Sampled		7					

Table 8.13 Crustal Component PM2.5 - Micrograms/Cubic Meter (LC) for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	117	3.65	1.44	1.42	1.09	.389
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	59	3.77	1.48	1.46	1.12	.474
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	59	4.38	1.50	.89	.87	.463
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	59	2.45	2.34	1.60	1.00	.444
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	3.75	2.15	1.13	.92	.427
37-087-0035 HAYWOOD	SHINING ROCK WILDERNESS	104	5.00	2.69	1.89	1.81	.525
37-095-9000 HYDE	SWANQUARTER	73	1.52	1.05	1.04	1.01	.321
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	57	4.23	2.31	1.26	1.03	.381
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	3.10	1.97	1.34	1.27	.445
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	83	3.93	2.78	2.33	2.13	.540
Total Samples		766					
Total Sites Sampled		10					

Table 8.14 "Other" Component PM2.5 - Micrograms/Cubic Meter (LC) for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
			1st	2nd	3rd	4th	
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	49	9.18	9.14	7.76	6.08	2.87
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	51	10.91	8.06	6.74	6.34	2.22
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	58	9.86	9.18	8.45	7.69	4.46
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	14.03	6.84	6.77	6.71	2.45
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	55	11.18	10.73	5.01	4.67	1.93
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	10.08	6.95	6.70	6.56	1.96
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	59	10.82	7.51	6.60	6.09	2.66
Total Samples		427					
Total Sites Sampled		7					

Table 8.15 "Other" Component PM2.5 - Micrograms/Cubic Meter (LC) for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
			1st	2nd	3rd	4th	
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	59	14.31	11.29	8.90	7.92	2.54
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	59	11.78	10.33	9.65	7.09	2.52
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	59	12.93	7.31	5.73	5.51	1.99
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	59	12.88	9.18	7.97	5.44	2.11
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	57	14.24	10.35	4.84	4.56	1.97
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	12.49	8.71	7.63	7.44	2.28

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	83	10.20	9.45	9.31	8.86	2.39
Total Samples		472					
Total Sites Sampled		7					

Table 8.16 Lead $PM_{2.5}$ - Micrograms/Cubic Meter for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	59	.007	.006	.006	.004	.0033
37-035-0004 CATAWBA	1650 1ST. ST HICKORY	59	.014	.006	.006	.006	.0035
37-051-0009 CUMBERLAND	4533 RAEFORD ROAD FAYETTEVILLE	59	.01	.008	.007	.007	.0034
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	59	.009	.009	.008	.005	.0035
37-081-0013 GUILFORD	205 WILOUGHBY BLD GREENSBORO	4	.01	.004	.004	.001	.005
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	57	.013	.012	.009	.009	.0041
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	96	.012	.009	.008	.007	.0035
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	83	.008	.008	.006	.005	.0029
Total Samples		479					
Total Sites Sampled		8					

9. Urban Air Toxics

The NC Division of Air Quality (DAQ) operates an urban air toxics monitoring network in conjunction with a national program originally proposed and designed by the United States Environmental Protection Agency (EPA) in 1999.

In 2001, the EPA initiated a national network for monitoring air toxics compounds present in ambient air. The objective of this monitoring is to generate ambient air data and to compile these data in an extensive air toxics database. The use of actual field measurements to compare and reconcile with estimates from source dispersion models will refine the model and ultimately allow a better overall estimate of population exposure. The ultimate goal of the EPA's Air Toxics Monitoring Strategy is to assess health risks. The DAQ recognizes the importance of this network and supports the continuation of the program.

In the time period covered by this report, DAQ expanded the North Carolina air monitoring program to include Volatile Organic Compound (VOC) sampling and carbonyl sampling at three "urban" sites and one "rural" site.

Volatile Organic Compounds (VOCs) are a large group of carbon-based chemicals that easily evaporate at room temperature. While most people can smell high levels of some VOCs, other VOCs have no odor. Odor does not indicate the level of risk from inhalation of this group of chemicals. There are thousands of different VOCs produced and used in our daily lives. Some common examples include: benzene, ethylbenzene, toluene, and xylene.

Carbonyl sampling measures common organic chemicals such as formaldehyde, acetaldehyde and acetone. (Only formaldehyde is reported here.)

9.1 Sources

Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. VOCs are emitted by thousands of products. Examples include: paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions.

9.2 Effects

The ability of organic chemicals to cause health effects varies greatly from those that are highly toxic, to those with no known health effect. As with other pollutants, the extent and nature of the health effect will depend on many factors including level of exposure and length of time exposed.

Eye and respiratory tract irritation, headaches, dizziness, visual disorders, and memory impairment are among the immediate symptoms that some people have experienced soon after exposure to some organics. At present, not much is known about what health effects occur from the levels of organics usually found in homes. Key signs or symptoms associated with exposure to VOCs include irritation of the eyelids membrane, nose and throat discomfort, headache, allergic skin reaction, shortness of breath, declines in serum cholinesterase levels, nausea, vomiting, nose bleeding, fatigue, dizziness.

9.3 Formaldehyde

Formaldehyde is a colorless gas at normal temperatures and is the simplest member of the family of aldehydes. Formaldehyde gas is soluble in water, alcohols, and other polar solvents. Formaldehyde is highly water-soluble and participates in a complex set of chemical reactions within clouds. The product of the aqueous-phase oxidation of formaldehyde is formic acid.

9.3.1 Sources

Occupational exposure to formaldehyde by inhalation is mainly from three types of sources: thermal or chemical decomposition of formaldehyde-based resins, formaldehyde emission from aqueous solutions (for example, embalming fluids), and the production of formaldehyde resulting from the combustion of a variety of organic compounds (for example, exhaust gases).

Formaldehyde is the most prevalent aldehyde in motor vehicle exhaust and is formed from incomplete combustion of the fuel. Formaldehyde is emitted in the exhaust of both gasoline and diesel-fueled vehicles. The motor vehicle contribution to ambient formaldehyde levels contains both primary (i.e., direct emissions) and secondary formaldehyde (i.e., formed from photo-oxidation of volatile organic compounds, or VOCs). It appears that roughly 33 percent of formaldehyde in the ambient air may be attributable to motor vehicles.

9.3.2 Effects

Formaldehyde (formula H_2CO) is rarely encountered in living organisms. Formaldehyde is converted to formic acid in the body, leading to a rise in blood acidity (acidosis).

Formaldehyde can be toxic, allergenic, and carcinogenic. Because formaldehyde resins are used in many construction materials it is one of the more common indoor air pollutants. At concentrations above 0.1 ppm (100 ppb) in air formaldehyde can irritate the eyes and mucous membranes, resulting in watery eyes. Formaldehyde inhaled at this concentration may cause headaches, a burning sensation in the throat, and difficulty breathing, as well as triggering or aggravating asthma symptoms.

The EPA allows no more than 0.016 ppm (160 ppb) formaldehyde in the air in new buildings constructed for that agency.

9.4 Benzene

Benzene, or benzol, is a colorless or light yellow liquid at room temperature (melting point 5.5^0C). It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable with a sweet smell and a relatively high melting point.

9.4.1 Sources

Benzene is a natural component of crude oil, and gasoline contains 1 to 5 percent by volume. Benzene is produced in large quantities from petroleum sources and is used for the chemical synthesis of ethyl benzene, phenol, cyclohexane and other substituted aromatic hydrocarbons. Benzene is emitted during its production and from coke ovens. Besides these industrial sources, emission also occurs from different combustion sources, such as motor engines, wood combustion and stationary fossil fuel combustion. Motor vehicles account for approximately 60 percent of the total benzene emissions, with the remainder attributed to nonroad mobile sources (25%) and stationary sources (15%). The major source is exhaust emissions and evaporation losses from motor vehicles, and evaporation losses during the handling, distribution and storage of petrol.

9.4.2 Effects

The short term breathing of high levels of benzene can result in death, while low levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, and death.

The major effects of benzene are chronic (long-term) exposure through the blood. Benzene damages the bone marrow and can cause a decrease in red blood cells, leading to anemia. It can also cause excessive bleeding and depress the immune system, increasing the chance of infection. Benzene causes leukemia and is associated with other blood cancers and pre-cancers of the blood.

Benzene targets liver, kidney, lung, heart and the brain and can cause DNA strand break and chromosomal damage The US Department of Health and Human Services (DHHS) classifies benzene as a human carcinogen. Long-term exposure to excessive levels of benzene in the air causes leukemia, a potentially fatal cancer of the blood-forming organs, in susceptible individuals.

The US Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit of 0.5 in the workplace during an 8-hour workday, 40-hour workweek. The short-term exposure limit for airborne benzene is 5 ppm (5000 ppb) for 15 minutes.

9.5 Toluene

Toluene, also known as methylbenzene or phenylmethane, is a clear, colorless, water-insoluble liquid with the typical smell of paint thinners, redolent of the sweet smell of the related compound benzene. It is an aromatic hydrocarbon widely used as an industrial feedstock and as a solvent.

9.5.1 Sources

Toluene occurs naturally as a component of crude oil and is produced in petroleum refining and coke oven operations. Toluene commonly used as an industrial solvent for the manufacturing of paints, chemicals, pharmaceuticals, and rubber. Toluene is a major aromatic constituent of gasoline (CEPA, OEHHA, 1999). It is used in household aerosols, nail polish, paints and paint thinners, lacquers, glues, rust inhibitor, adhesives and solvent based cleaning agents. Toluene is also utilized in printing operations, leather tanning and chemical processes. Benzene and other polycyclic aromatic hydrocarbons are common contaminants of toluene. Toluene is considered a sentinel chemical for benzene in air and water sample monitoring.

9.5.2 Effects

Toluene is reasonably anticipated to be a human carcinogen. The primary routes of potential human exposure to toluene are inhalation and dermal contact. In humans and animals, the primary effect associated with inhalation exposure to toluene is central nervous system (CNS) depression. Short-term exposure of humans to between 100 and 1500 ppm has elicited CNS effects such as fatigue, confusion, incoordination, and impairments in reaction time, perception, and motor control and function.

9.6 Ethylbenzene

Ethylbenzene is a colorless, flammable liquid that smells like gasoline. Ethylbenzene is used primarily to make another chemical, styrene. Other uses include as a solvent, in fuels, and to make other chemicals.

9.6.1 Sources

Ethylbenzene is used as a precursor in the manufacture of styrene. It is also used in the production of synthetic rubber, and is present in automobile and aviation fuels. Sources of ethylbenzene to the atmosphere include petroleum and coal refining, vehicle emissions, and evaporation from solvents and thinners.

Ethylbenzene may be released to the air through the use of consumer products such as solvents, enamel brush paints and spray paints, stains and varnishes. It may be released to soil and water from leaking underground gasoline storage tanks, landfill sites, spills during transportation, pesticide use, and discharges of industrial and municipal waste. Ethylbenzene is also found in tobacco and wood smoke.

Ethylbenzene has been detected in urban air at an average concentration of 0.66 ppb. The average level in

suburban air is about 0.62 ppb, while the average level measured in air in rural locations is about 0.01 ppb.

9.6.2 Effects

Respiratory effects, such as throat irritation and chest constriction, irritation of the eyes, and neurological effects such as dizziness, have been noted from acute (short-term) inhalation exposure to ethylbenzene in humans.

Chronic (long-term) exposure to ethylbenzene by inhalation in humans may result in effects on the blood. In a 20-year study of humans occupationally exposed to ethylbenzene, no liver toxicity was noted.

EPA has categorized ethylbenzene as a Group D, not classifiable as to human carcinogenicity. (USEPA, TTA, 2007)

9.7 Xylene

There are three forms of xylene in which the methyl groups vary on the benzene ring: meta-xylene, ortho-xylene, and para-xylene (m-, o-, and p-xylene). These different forms are referred to as isomers. The term total xylenes refers to all three isomers of xylene. Mixed xylene is a mixture of the three isomers and usually also contains 6 to 15 percent ethylbenzene. Xylene is also known as xylol or dimethylbenzene. Xylene is a colorless, flammable liquid with a sweet odor.

9.7.1 Sources

Emissions of mixed xylenes have been detected from petroleum refining, motor vehicles, residential wood-burning stoves and fireplaces. Mixed xylenes are used as chemical intermediates, as solvents, in aviation fuel, and in household products such as aerosol paints and lacquers.

The primary stationary sources that have reported emissions of m-, o-, and p-xylene are manufacturers of motor vehicles and equipment, manufacturers of metal cans and shipping containers, and petroleum refining.

9.7.2 Effects

Short-term exposure of people to high levels of xylene can cause irritation of the skin, eyes, nose, and throat; difficulty in breathing; impaired function of the lungs; delayed response to a visual stimulus; impaired memory; stomach discomfort; and possible changes in the liver and kidneys. Both short- and long-term exposure to high concentrations of xylene can also cause a number of effects on the nervous system, such as headaches, lack of muscle coordination, dizziness, confusion, and changes in one's sense of balance. People exposed to very high levels of xylene for a short period of time have died. Most of the information on long-term exposure to xylene is from studies of workers employed in industries that make or use xylene.

9.8 Monitoring 2002-2003

Air quality toxics data are developed using two methods: 1) EPA Compendium Method TO-15, "Determination of Volatile Organic Compounds in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography / Mass Spectrometry," and 2) EPA Compendium Method TO-11a, "Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography." These two methods provide a 24-hour time weighted average from midnight to midnight. VOC samples are obtained once every six days, while formaldehyde and other carbonyl compounds are sampled every 12 days.

During 2002 and 2003, toxics monitoring data were collected at three urban monitoring sites in Asheville, Charlotte, and Winston-Salem and one rural site at Candor, Montgomery County (Figure 9.1)

We show summary statistics for 2002 and 2003 in Table 9.1 through Table 9.12 and discuss averages of concentrations for each pollutant and site below. In some cases, a large number of samples had concentrations too low to be reliably detected. This introduces uncertainty and bias in the arithmetic mean, so we prefer to describe average concentrations in terms of the median, or second quartile, concentrations and to show all three of the data quartiles and the maximum in the tables. The "first (second, third) quartile" is a number selected so that ¼ (½, ¾) of the data values are less than or equal to the statistic value.

Formaldehyde samples (24-hour concentrations) in 2002 and 2003 are summarized in Table 9.1 and Table 9.2, respectively. Median (2nd Quartile) concentrations ranged from 0.26 to 0.50 ppb at the urban sites, while at the rural site the *largest* concentration was only 0.15 ppb.

Benzene samples (24-hour concentrations) in 2002 and 2003 are summarized in Table 9.3 and Table 9.4, respectively. Median (2nd Quartile) concentrations ranged from 0.19 to 0.37 ppb at the urban site and 0.10 to 0.12 ppb at the rural site.

Toluene samples (24-hour concentrations) in 2002 and 2003 are summarized in Table 9.5 and Table 9.6, respectively. Median (2nd Quartile) concentrations ranged from 0.38 to 0.79 ppb at the urban sites, and 0.10 to 0.13 ppb at the rural site. (It appears as if in 2002 32 percent of the sample concentrations at Candor were less than the smallest value that could be reliably detected using TO-15.)

Ethylbenzene samples (24-hour concentrations) in 2002 and 2003 are summarized in Table 9.7 and Table 9.8, respectively. Median (2nd Quartile) concentrations ranged from 0.08 to 0.13 ppb at the urban sites, and was less than 0.05 ppb at the rural site. (It appears as if more than 90 percent of the sample concentrations at Candor were less than the smallest value that could be reliably detected using TO-15.)

m/p-Xylene samples (24-hour concentrations) in 2002 and 2003 are summarized in Table 9.9 and Table 9.10, respectively. Median (2nd were less than the smallest value that could be reliably detected using TO-15.)

o-Xylene samples (24-hour concentrations) in 2002 and 2003 are summarized in Table 9.11 and Table 9.12, respectively. Median (2nd Quartile) concentrations ranged from Quartile) concentrations ranged from 0.26 to 0.51 ppb at the urban sites, and was less than 0.05 ppb at the rural site. (It appears as if in 2002 63 percent of the sample concentrations at Candor 0.10 to 0.18 ppb at the urban sites, and was less than 0.05 ppb at the rural site. (It appears as if about 90 percent of the sample concentrations at Candor were less than the smallest value that could be reliably detected using TO-15.)

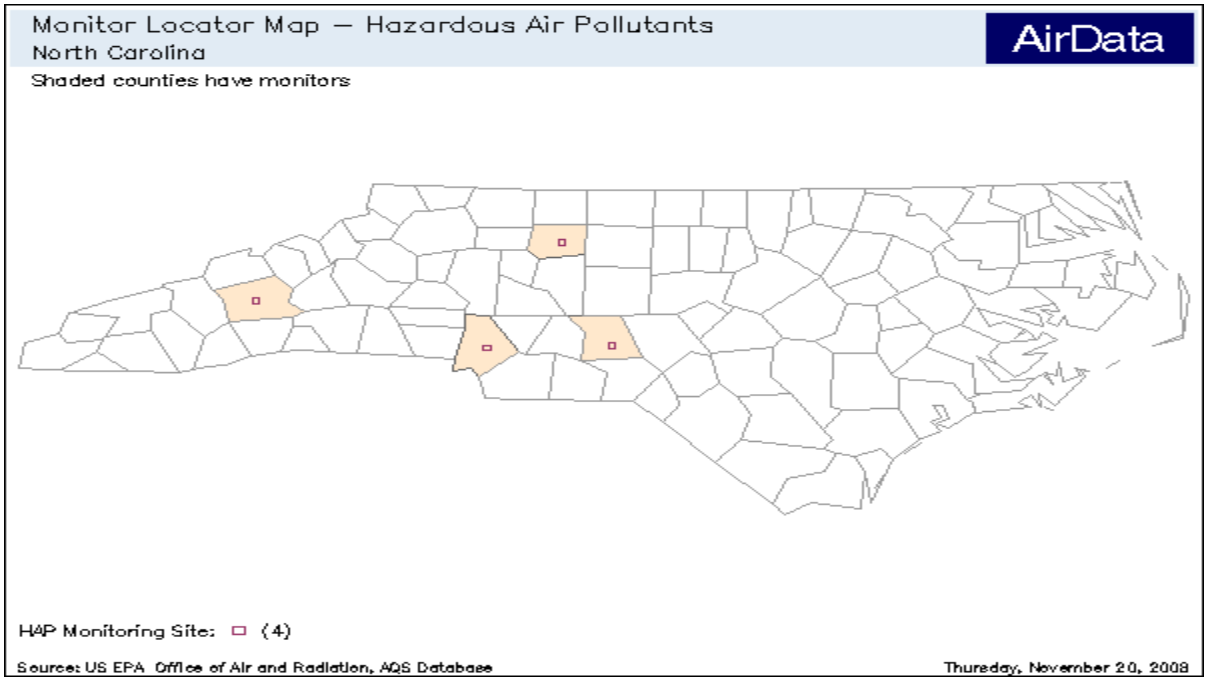

Figure 9.1 Location Urban Air Toxics Monitoring Sites 2002-2003

Table 9.1 Formaldehyde - Parts per billion for 2002

SITE NUMBER	ADDRESS	NUM OBS	QUARTILES			MAXI NUM	ARITH MEAN
COUNTY			1st	2nd	3rd		
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICE BLDG WOODFIN ST ASHEVILLE	28	.204	.366	.565	.905	.410
37-067-0022 FORSYTH	1300 BLK HATTIE AVE ST. BENEDICT THE MOOR CHURCH WINSTON-SALEM	27	.197	.277	.412	.588	.310
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE GARINGER HIGH SCHOOL CHARLOTTE	13	.170	.505	.644	.903	.437
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	19	.050	.050	.100	.150	.074
Total Samples		87					
Total Sites Sampled		4					

Table 9.2 Formaldehyde - Parts per billion for 2003

SITE NUMBER	ADDRESS	NUM OBS	QUARTILES			MAXI NUM	ARITH MEAN
COUNTY			1st	2nd	3rd		
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICE BLDG WOODFIN ST ASHEVILLE	20	.207	.264	.471	1.43	.408
37-067-0022 FORSYTH	1300 BLK HATTIE AVE ST. BENEDICT THE MOOR CHURCH WINSTON-SALEM	34	.231	.346	.499	1.20	.413
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE GARINGER HIGH SCHOOL CHARLOTTE	33	.261	.395	.722	1.43	.533
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	19	.062	.075	.085	.128	.076
Total Samples		106					
Total Sites Sampled		4					

Table 9.3 Benzene - Parts per billion for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	PC T OF DATA ≤ .05	QUARTILES 1st	QUARTILES 2nd	QUARTILES 3rd	MAXI NUM	ARITH MEAN
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICE BLDG WOODFIN ST ASHEVILLE	27	11%	.135	.255	.375	.615	.270
37-067-0022 FORSYTH	1300 BLK HATTIE AVE ST. BENEDICT THE MOOR CHURCH WINSTON-SALEM	27	4%	.112	.198	.270	.404	.197
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE GARINGER HIGH SCHOOL CHARLOTTE	12	0%	.121	.190	.360	.491	.239
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	17	29%	.050	.098	.129	.288	.107
Total Samples		83						
Total Sites Sampled		4						

Table 9.4 Benzene - Parts per billion for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	QUARTILES 1st	QUARTILES 2nd	QUARTILES 3rd	MAXI NUM	ARITH MEAN
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICE BLDG WOODFIN ST ASHEVILLE	24	.284	.318	.467	.913	.395
37-067-0022 FORSYTH	1300 BLK HATTIE AVE ST. BENEDICT THE MOOR CHURCH WINSTON-SALEM	34	.262	.309	.482	.802	.366
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE GARINGER HIGH SCHOOL CHARLOTTE	33	.288	.369	.602	1.06	.428
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	19	.096	.116	.161	.845	.186
Total Samples		110					
Total Sites Sampled		4					

Table 9.5 Toluene - Parts per billion for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES 1st	QUARTILES 2nd	QUARTILES 3rd	MAXI NUM	ARITH MEAN
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICE BLDG WOODFIN ST ASHEVILLE	28	4%	.204	.366	.565	.905	.410
37-067-0022 FORSYTH	1300 BLK HATTIE AVE ST. BENEDICT THE MOOR CHURCH WINSTON-SALEM	27	0%	.339	.598	.768	1.14	.585
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE GARINGER HIGH SCHOOL CHARLOTTE	13	0%	.374	.787	1.30	1.72	.807
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	19	32%	.050	.097	.146	.245	.109
Total Samples		87						
Total Sites Sampled		4						

Table 9.6 Toluene - Parts per billion for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	QUARTILES 1st	QUARTILES 2nd	QUARTILES 3rd	MAXI NUM	ARITH MEAN
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICE BLDG WOODFIN ST ASHEVILLE	24	.283	.382	.907	1.88	.647
37-067-0022 FORSYTH	1300 BLK HATTIE AVE ST. BENEDICT THE MOOR CHURCH WINSTON-SALEM	34	.390	.553	.889	2.45	.691
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE GARINGER HIGH SCHOOL CHARLOTTE	34	.400	.672	1.32	2.06	.838
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	19	.116	.131	.146	.204	.134
Total Samples		111					
Total Sites Sampled		4					

Table 9.7 Ethylbenzene - Parts per billion for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES 1st	QUARTILES 2nd	QUARTILES 3rd	MAXI NUM	ARITH MEAN
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICE BLDG WOODFIN ST ASHEVILLE	28	21%	.060	.115	.174	.251	.122
37-067-0022 FORSYTH	1300 BLK HATTIE AVE ST. BENEDICT THE MOOR CHURCH WINSTON-SALEM	27	4%	.081	.100	.140	.292	.110
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE GARINGER HIGH SCHOOL CHARLOTTE	13	23%	.053	.134	.211	.263	.143
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	19	89%	.050	.050	.050	.060	.051
Total Samples		87						
Total Sites Sampled		4						

Table 9.8 Ethylbenzene - Parts per billion for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES 1st	QUARTILES 2nd	QUARTILES 3rd	MAXI NUM	ARITH MEAN
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICE BLDG WOODFIN ST ASHEVILLE	24	8%	.061	.079	.159	.349	.119
37-067-0022 FORSYTH	1300 BLK HATTIE AVE ST. BENEDICT THE MOOR CHURCH WINSTON-SALEM	34	9%	.081	.110	.194	.611	.150
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE GARINGER HIGH SCHOOL CHARLOTTE	34	3%	.079	.122	.229	.388	.154
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	19	95%	.050	.050	.050	.050	.050
Total Samples		111						
Total Sites Sampled		4						

Table 9.9 m/p-Xylene - Parts per billion for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES 1st	QUARTILES 2nd	QUARTILES 3rd	MAXI NUM	ARITH MEAN
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICE BLDG WOODFIN ST ASHEVILLE	28	4%	.204	.366	.565	.905	.410
37-067-0022 FORSYTH	1300 BLK HATTIE AVE ST. BENEDICT THE MOOR CHURCH WINSTON-SALEM	27	0%	.197	.277	.412	.588	.310
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE GARINGER HIGH SCHOOL CHARLOTTE	13	0%	.170	.505	.644	.903	.437
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	19	63%	.050	.050	.100	.150	.074
Total Samples		87						
Total Sites Sampled		4						

Table 9.10 m/p-Xylene - Parts per billion for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES 1st	QUARTILES 2nd	QUARTILES 3rd	MAXI NUM	ARITH MEAN
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICE BLDG WOODFIN ST ASHEVILLE	20	0%	.207	.264	.471	1.43	.408
37-067-0022 FORSYTH	1300 BLK HATTIE AVE ST. BENEDICT THE MOOR CHURCH WINSTON-SALEM	34	0%	.231	.346	.499	1.20	.413
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE GARINGER HIGH SCHOOL CHARLOTTE	33	0%	.261	.395	.722	1.43	.533
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	19	5%	.062	.075	.085	.128	.078
Total Samples		106						
Total Sites Sampled		4						

Table 9.11 o-Xylene - Parts per billion for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES 1st	QUARTILES 2nd	QUARTILES 3rd	MAXI NUM	ARITH MEAN
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICE BLDG WOODFIN ST ASHEVILLE	28	7%	.085	.154	.222	.353	.050
37-067-0022 FORSYTH	1300 BLK HATTIE AVE ST. BENEDICT THE MOOR CHURCH WINSTON-SALEM	27	7%	.094	.111	.157	.249	.125
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE GARINGER HIGH SCHOOL CHARLOTTE	13	15%	.072	.177	.251	.343	.172
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	19	84%	.050	.050	.050	.088	.053
Total Samples		87						
Total Sites Sampled		4						

Table 9.12 o-Xylene - Parts per billion for 2003

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES 1st	QUARTILES 2nd	QUARTILES 3rd	MAXI NUM	ARITH MEAN
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICE BLDG WOODFIN ST ASHEVILLE	22	0%	.078	.104	.198	.478	.154
37-067-0022 FORSYTH	1300 BLK HATTIE AVE ST. BENEDICT THE MOOR CHURCH WINSTON-SALEM	34	6%	.100	.136	.190	.447	.162
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE GARINGER HIGH SCHOOL CHARLOTTE	33	0%	.102	.154	.283	.582	.209
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	19	95%	.050	.050	.050	.058	.050
Total Samples		108						
Total Sites Sampled		4						

10 Statewide Trends

DENR has published an analysis of long term trends in North Carolina, statewide and within the individual Air Quality Control Regions, covering air pollutant concentrations from 1972 through 1989 (North Carolina Department of Environment, Health, and Natural Resources 1991b). Such a review of annual changes helps evaluate the success of programs intended to reduce pollution and prioritize future efforts.

10.1 Particulate Matter

The statewide distribution of second-highest 24-hour PM_{10} concentrations for each monitor from 1989 to 2003 is shown in Figure 10.1. Concentrations have decreased from 58 to about 43 $\mu g/m^3$ (a 27 percent decline).

10.2 Carbon Monoxide

The statewide distribution of second-highest eight-hour CO concentrations from 1992 to 2003 is shown in Figure 10.2. The average value of this concentration decreased from 5.45 ppm in 1992 to 3.1 ppm in 2003 (a decline of 43 percent). There have been no CO exceedances since 1991.

10.3 Ozone

The statewide distribution of fourth-highest eight-hour ozone concentrations is shown in Figure 10.3. Ozone concentrations oscillate in a long cycle and shows no specific trend to 2003. In 2003, the end point of the 19 year period, the monitoring network average was 0.081, which is 102 percent of the standard.

Figure 10.4 shows the number of days with exceedances every year from 1985 to 2003. Exceedance days decreased steadily from 76 in 1998 to 14 in 2003. Then in 2002, an increase to 51 days of exceedances occurred, followed by a big decrease to 14 in 2003.

However, 1998 was the worst year for ozone on record on a national basis.

10.4 Sulfur Dioxide

The statewide distribution of second-largest three-hour sulfur dioxide (SO_2) concentrations from 1989 to 2003 is shown in Figure 10.5. The average decreased from 0.088 ppm in 1989 to 0.053 ppm in 2003 (11 percent of the standard), for a 40 percent decrease.

The statewide distribution of second-largest 24-hour SO_2 concentrations from 1989 to 2003 is shown in Figure 10.6. The average decreased from 0.027 ppm in 1989 to 0.02 ppm in 2003 (14 percent of the standard), for a 26 percent decrease.

10.5 Nitrogen Dioxide

The Forsyth and Mecklenburg County distribution of annual average nitrogen dioxide (NO_2) concentrations from 1989 to 2003 is shown in Figure 10.7. The average concentration was approximately constant around 0.016 ppm (30 percent of the standard).

10.6 pH

The statewide distribution of annual average pH values of rainfall from 1989 to 2003 for the NADP sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 10.8. The mean pH has

increased 5 percent over the 15 year time period. This is good news because it means that the rain is becoming less acidic.

The NADP network 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).

10.7 Ammonium Ion

The statewide distribution of annual average ammonium ion (NH_4^+) concentrations from 1989 to 2003 for the NADP sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 10.9. From 1989 to 2003 there appears to be an increase of 1 percent. Ammonium ion concentration in rain increased significantly in Sampson County in 2000 where there is concentrated livestock animal production. (Cornelius, 1997) but it decreased slightly in 2002 and increased again in 2003. The NADP study suggested that the 1994 protocol change had no net effect on measured NH_4^+ concentrations (NADP 1995).

10.8 Nitrate Ion

The statewide distribution of annual average nitrate ion (NO_3^-) concentrations from 1989 to 2003 for the NADP/NTN sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 10.10. The mean has decreased by 25 percent over the study period. The NADP study suggested that NO_3^- concentrations will decrease by a median amount of 0.01 (s.e. = 0.002) due to the protocol change in 1994 (NADP 1995).

10.9 Sulfate Ion

The statewide distribution of annual average sulfate ion (SO_4^{2-}) concentrations from 1989 to 2003 for the NADP sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 10.11. The average has decreased from 1.6 mg/L in 1989 to 1.1 mg/L in 2003, for a 31 percent decrease. 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).

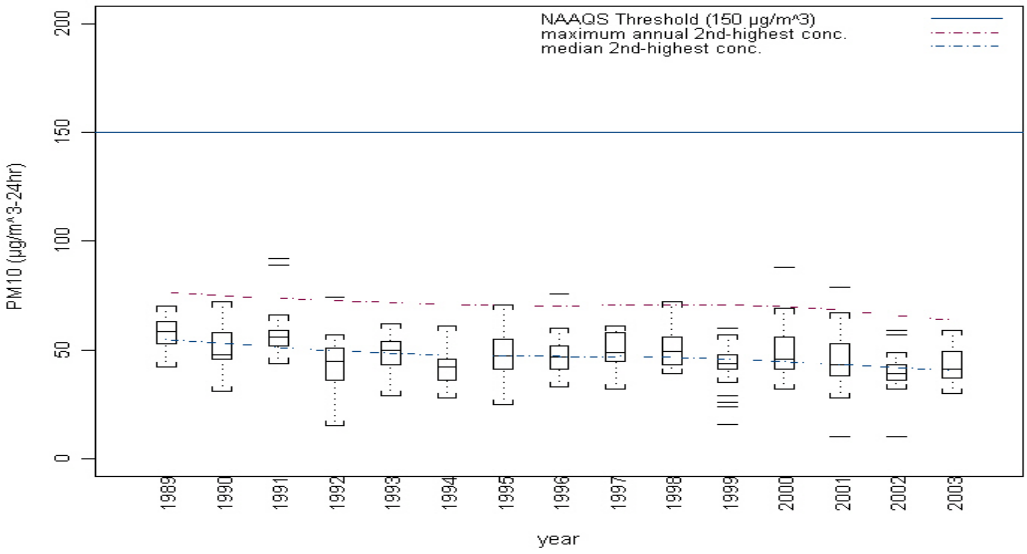

Figure 10.1 Distribution of Statewide Second-Maximum 24-Hour PM_{10} Concentrations, 1989- 2003, and Smoothed Regression Trend Line.

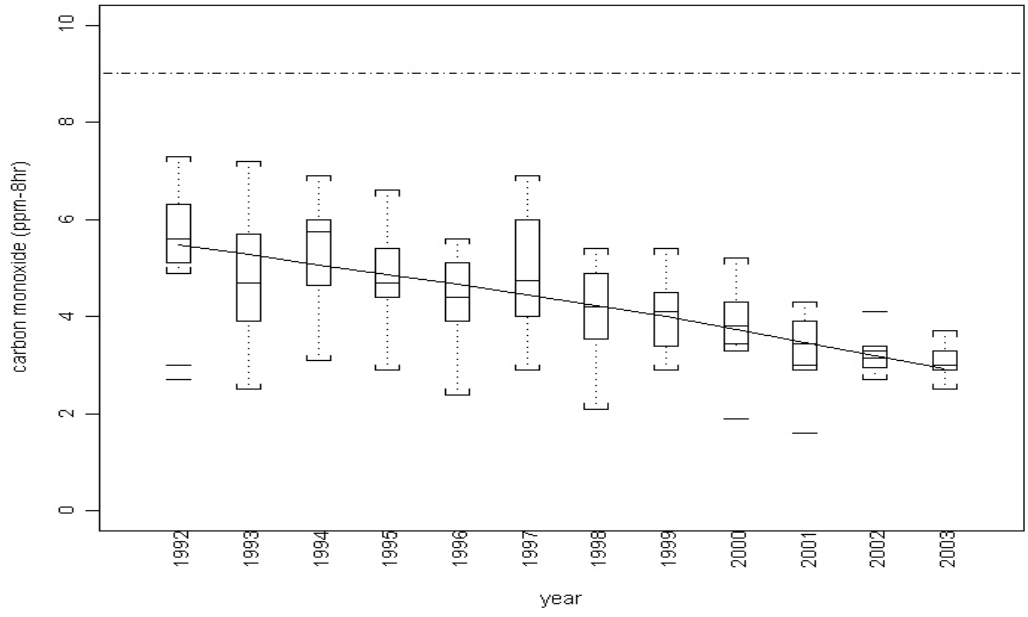

Figure 10.2 Distribution of Statewide Second-Maximum 24-Hour Carbon Monoxide Concentrations, 1992- 2003, and Smoothed Regression Trend Line.

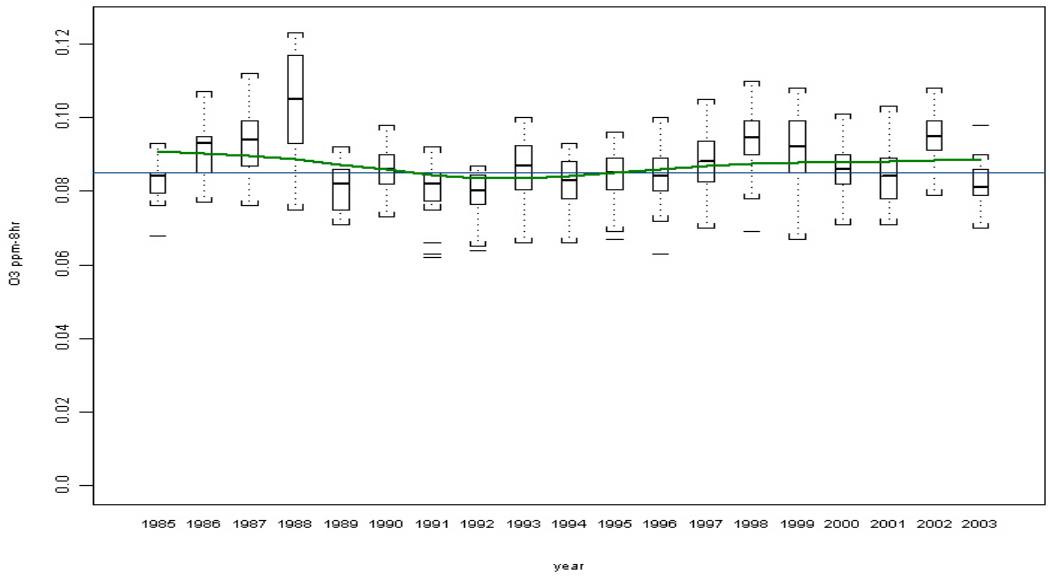

Figure 10.3 Distribution of Statewide Fourth-Maximum 8-Hour Ozone Concentrations, 1985- 2003, and Smoothed Regression Trend Line.

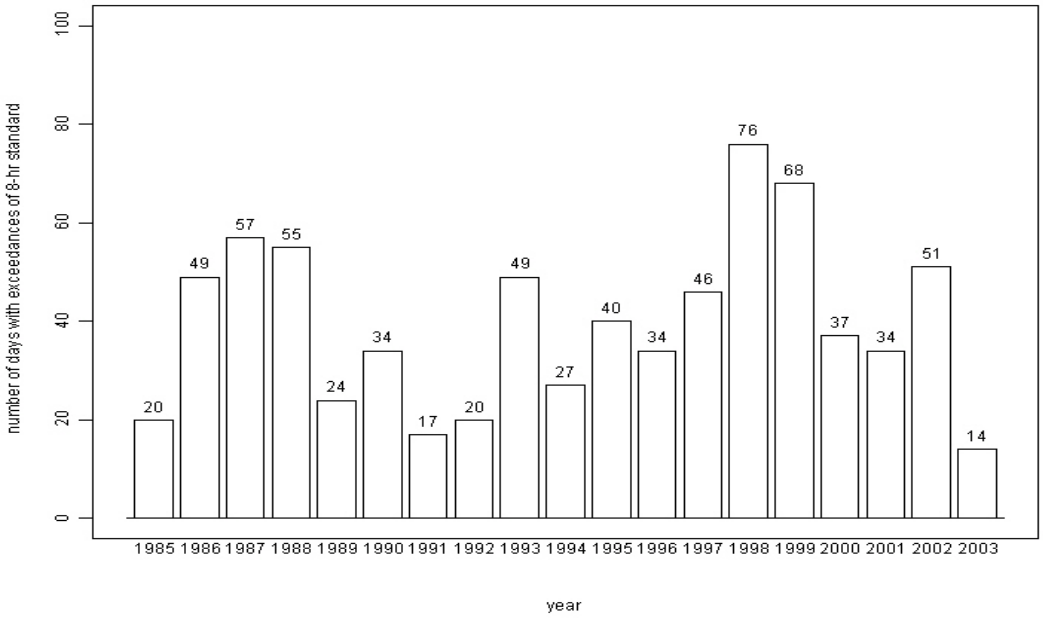

Figure 10.4 Number of days with exceedances of 8-Hour Ozone Averages of 0.085 ppm or Greater, 1985 – 2003.

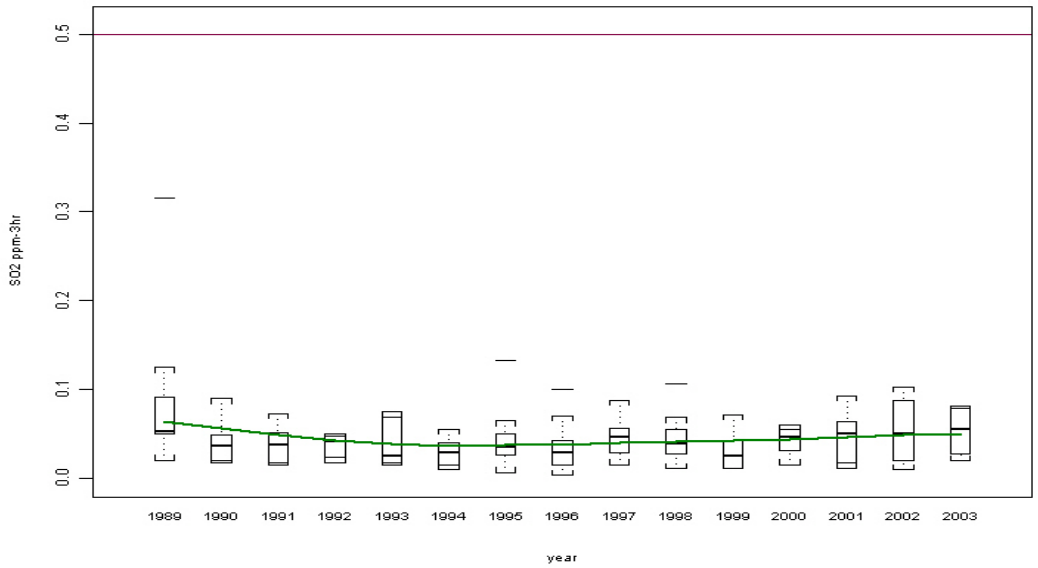

Figure 10.5 Distribution of Statewide Second-Maximum 3-Hour Sulfur Dioxide Concentrations, 1989- 2003, and Smoothed Regression Trend Line.

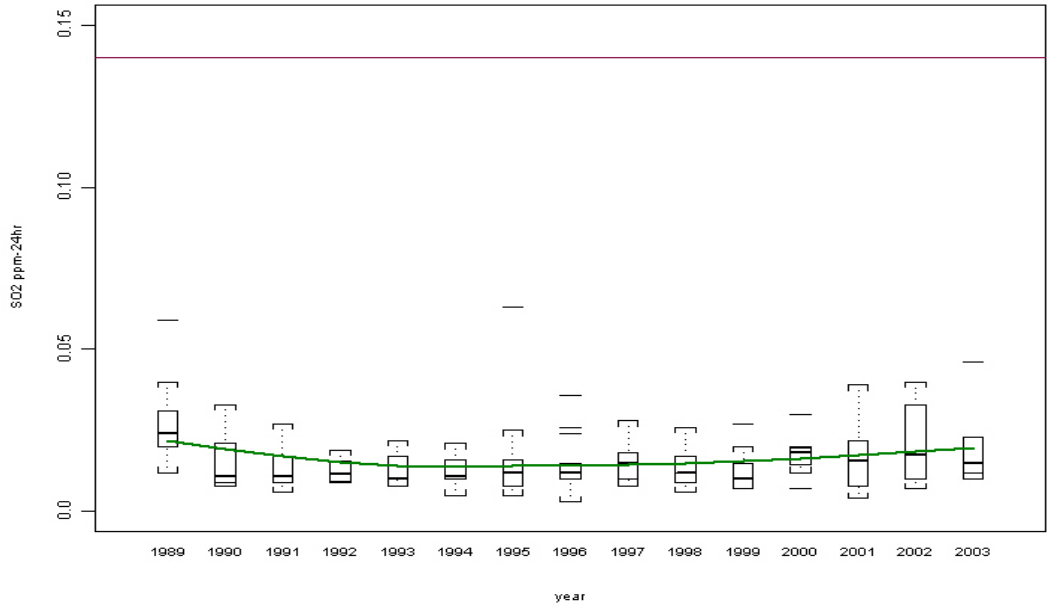

Figure 10.6 Distribution of Statewide Second- Maximum 24-Hour Sulfur Dioxide Concentrations, 1989- 2003, and Smoothed Regression Trend Line.

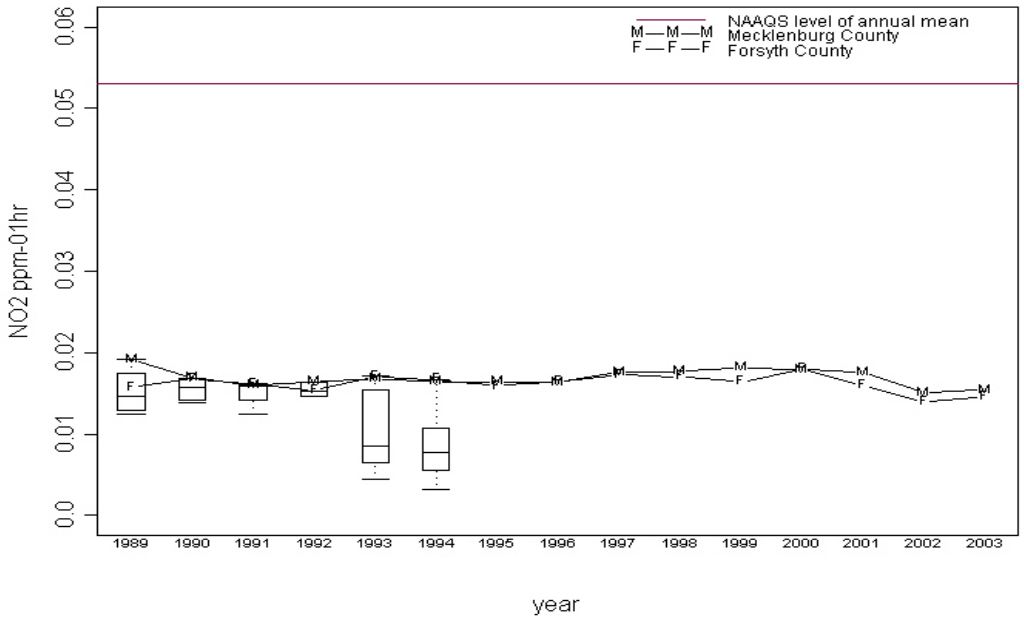

Figure 10.7 Distributions of Forsyth and Mecklenburg County Annual Mean Nitrogen Dioxide Concentrations, 1989- 2003, and Smoothed Regression Trend Line.

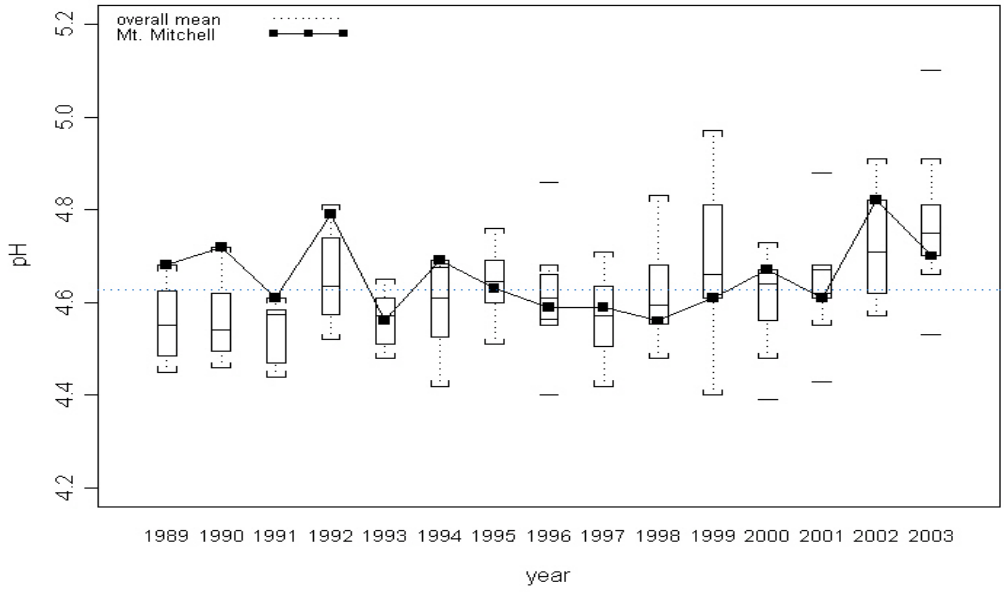

Figure 10.8 Distribution of Statewide Annual Mean pH, 1989- 2003.

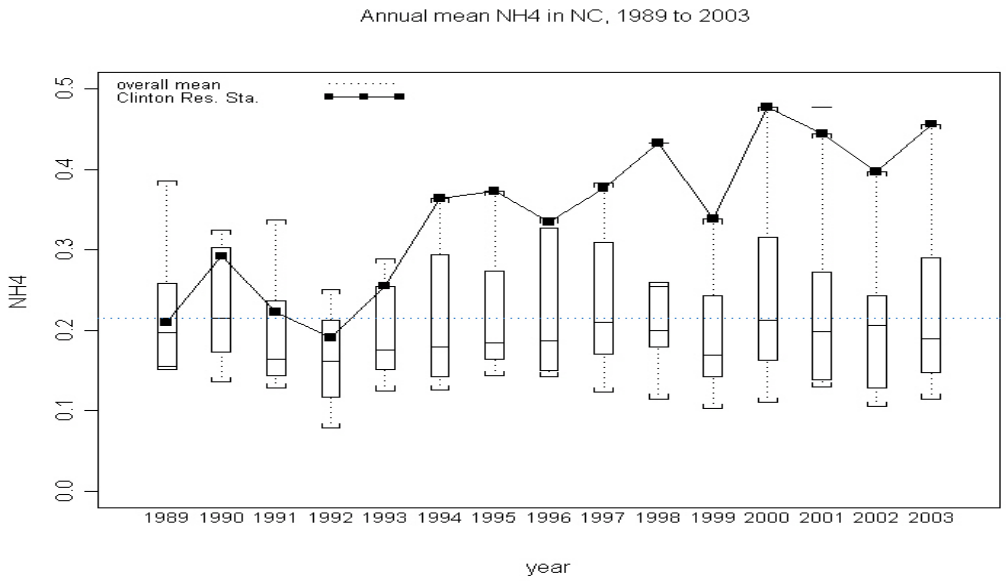

Figure 10.9 Distribution of Statewide Annual Mean Ammonium Ion Concentrations, 1989- 2003.

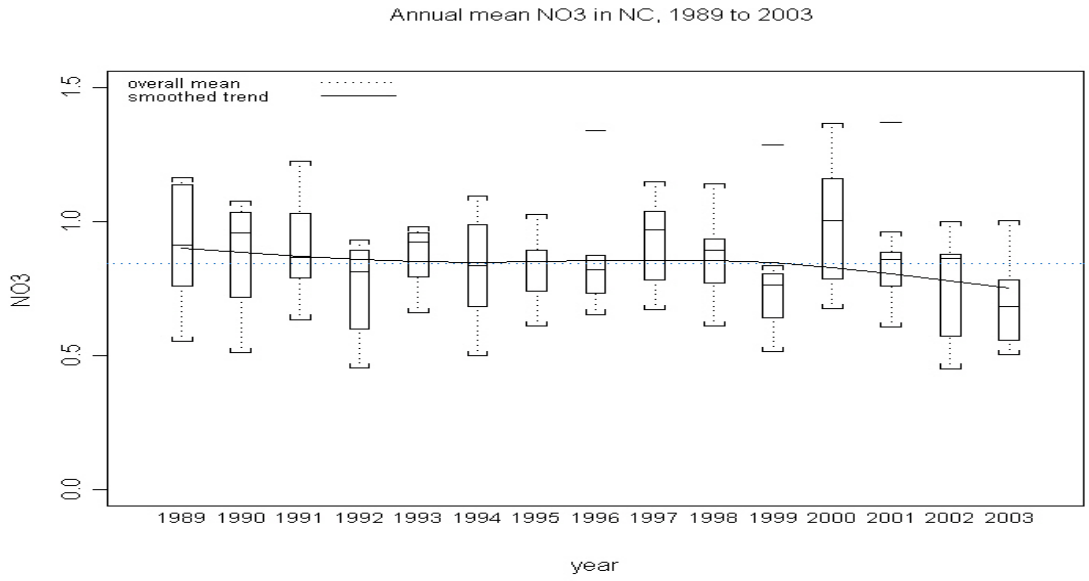

Figure 10.10 Distribution of Statewide Annual Mean Nitrate Ion Concentrations, 1989- 2003, and Smoothed Regression Trend Line.

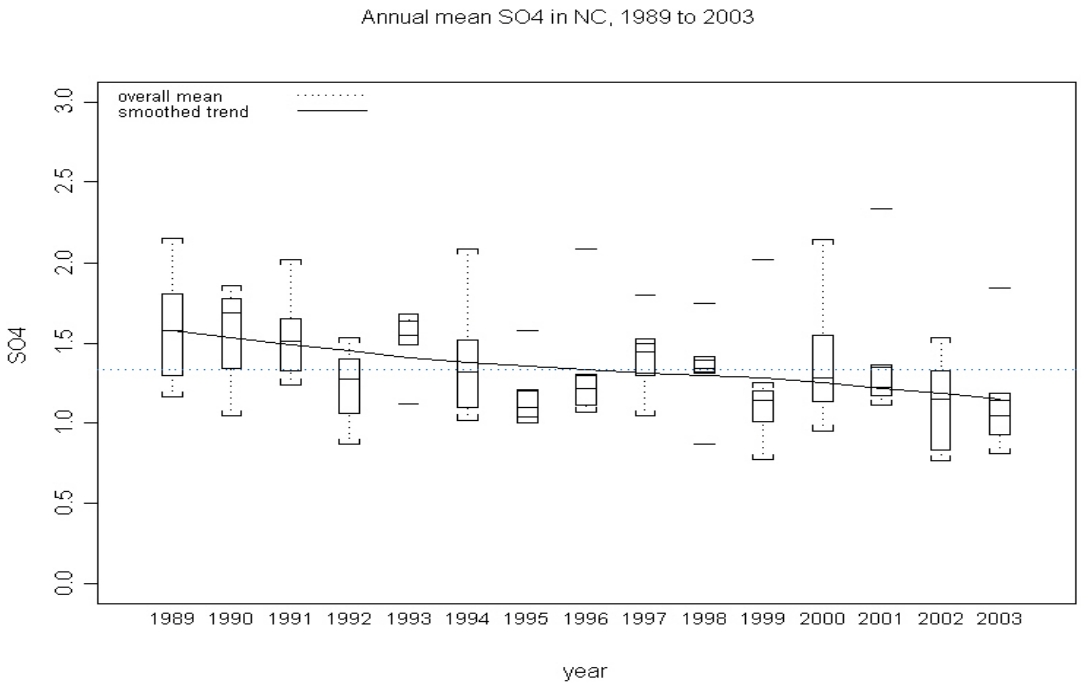

Figure 10.11 Distribution of Statewide Annual Mean Sulfate Ion Concentrations, 1989- 2003, and Smoothed Regression Trend Line.

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Appendix A. Air Pollution Monitoring Agencies

North Carolina Central Office

Division of Air Quality

Raleigh Central Office
2728 Capital Boulevard
1641 Mail Service Center
Raleigh, North Carolina 27699-1641
(919) 733-3340

North Carolina Regional Offices

Asheville Regional Office
2090 U.S. Highway 70
Swannanoa, North Carolina 28778
Phone: (828) 296-4500

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

Fayetteville Regional Office
225 Green Street, Suite 714
Fayetteville, North Carolina 28301
(910) 433-3300

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

Mooresville Regional Office
610 East Center Avenue, Suite 301
Mooresville, North Carolina 28115
Phone: (704) 663-1699

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

Raleigh Regional Office
3800 Barrett Drive
Raleigh, North Carolina 27609
(919) 791-4200

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

Washington Regional Office
943 Washington Square Mall
Washington, North Carolina 27889
(252) 946-6481

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

Wilmington Regional Office
127 Cardinal Drive Extension
Wilmington, North Carolina 28405-3845
(910) 796-7215

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

Winston-Salem Regional Office

585 Waughtown Street
Winston-Salem, North Carolina 27107
(336) 771-5000

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

Local Agencies in North Carolina

Forsyth County Environmental Affairs Department

537 North Spruce Street
Winston-Salem, North Carolina 27101
(336) 703-2440

Mecklenburg County Air Quality
700 N. Tryon Street, Suite 205
Charlotte, North Carolina 28202-2236
(704) 336-5500

Western North Carolina Regional Air Quality Agency (Buncombe County and Asheville city)
49 Mount Carmel Road
Asheville, NC 28806
(828) 250-6777

Tribal Agency in North Carolina

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

Territory overlaps with portions of Swain and Jackson Counties

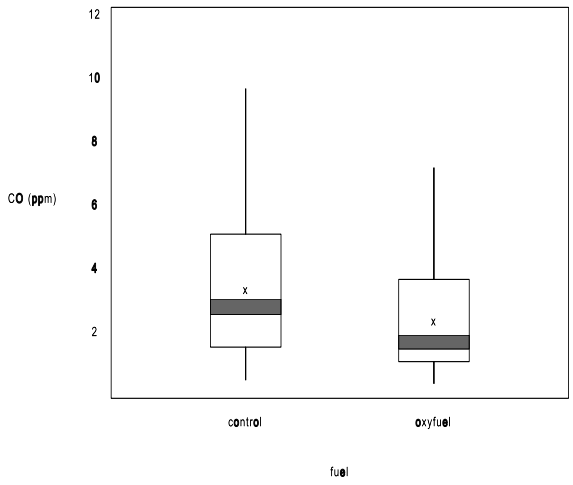
Appendix B. Exceptional Events

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

Appendix C. Box-And-Whisker Plots

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

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



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

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

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

Appendix D. Nonattainment and North Carolina

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

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

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

Why is my county nonattainment?

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

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

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

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

Local agencies and officials, as well as state agencies, will be involved in drawing up the SIP

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

How will it affect citizens?

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

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

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

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

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

What does inspection/maintenance cost?

As of December, 2001, the inspection/maintenance (I/M), or motor vehicle emissions testing process, costs the motorist $30.00. If a vehicle fails the test, it must be repaired. A waiver is available if a vehicle still fails after $200.00 worth of repairs have been done. The $200.00 limit does not apply to tampered or misfueled vehicles. The inspection/maintenance program includes tests for hydrocarbon (HC) and carbon monoxide (CO) emissions for the following counties, Mecklenburg, Wake, Guilford, Forsyth, Durham, Gaston, Cabarrus, Orange, and Union. The number of counties will increase to 48 by 2006 under the Clean Air bill passed in 2000. The cost for this new test was set by the General Assembly during the 2001 legislative session. Currently, only gasoline powered motor vehicles built after 1974, excluding the current model year and motorcycles, are inspected in these counties. Inspection/maintenance pass/fail levels vary with vehicle age and pollutant.