2002 Ambient Air Quality Report

STATE OF NORTH CAROLINA
Michael F. Easley, Governor

DEPARTMENT OF
ENVIRONMENT
AND
NATURAL RESOURCES
William G. Ross, Jr., Secretary

DIVISION OF AIR QUALITY
B. Keith Overcash, P.E., Director

AMBIENT MONITORING SECTION
Hoke P. Kimball, Chief

PUBLISHED
November 2008

2002 Ambient Air Quality Report

Ambient Monitoring Section Report # 2008.02

Acknowledgements:

Primary Author: Wayne Cornelius
Additional Assistance: Lucyna Kozek

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

Published: **November 2008**

Preface

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

Particulate Matter	Nitrogen Dioxide
Carbon Monoxide	Ozone
Sulfur Dioxide	Lead

A brief discussion of the ambient air monitoring program, including a description of the monitoring network, is provided. Detailed results are presented of monitoring that was conducted in 2002 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 described also.

Acid rain data from the National Atmospheric Deposition Program/National Trends Network for North Carolina also are included for 2002. Data collected after 2002 will be discussed in later reports.

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

Charlotte area 704-333-SMOG

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

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

and on the Division of Air Quality's website http://daq.state.nc.us/monitor/reports/ .

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 2002, the North Carolina Division of Air Quality (DAQ), the three local program agencies and one tribal agency (listed in Appendix A) collected 415,909 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.

Three different types of **particulate matter** were sampled in North Carolina during 2002. 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 not sampled since 2001, but we report the most recent sampling within three years. In 2000 TSP was sampled at 2 sites, yielding 92 daily samples. No exceedances of the state TSP ambient air quality standard for 24-hour samples (150 $\mu g/m^3$) were observed in 2000.

PM_{10} was sampled at 24 sites, yielding 2,205 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 5,610 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), the most common air pollutant, largely results from fuel combustion. The most likely areas to have excessive CO concentrations are larger cities where there are more cars and congested streets.

CO was sampled at 9 sites, yielding 52,203 valid hourly averages. The National Ambient Air Quality Standards for CO are 35 ppm for the maximum one-hour average and 9 ppm for the maximum eight-hour average. There were no exceedances of the standards. The

highest one-hour concentration of 6.6 was observed at the Tryon site in Charlotte. The highest eight hour concentration of 4.5 ppm was observed at the Tryon site in Charlotte. 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 45 sites, yielding 227,496 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 2002, there were 19 exceedances of the one-hour standard, all of which occurred on four days in June, five days in July and two days in August. Six exceedances occurred in North Carolina in 2001, and eight occurred in 2000. Mecklenburg, Rowan and Wake Counties met or exceeded the criteria for nonattainment of the one-hour ozone standard with nine, ten and two exceedances respectively over a three-year period, however EPA had rescinded the one-hour standard during that time period. Mecklenburg County was redesignated as in attainment for ozone in July 1995. Hydrocarbon control strategies continue to be used there to help reduce ozone concentrations.

In 2002, the 8-hour standard was exceeded 613 times, on 51 different days, with twenty three 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, 38.

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 14 sites, yielding 111,829 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 16,616 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 2002. 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 2002 ranged from 4.57 (Rowan County) to 4.91 (Sampson County).

CONTENTS

1 Introduction....1
2 Description of Criteria Pollutants....2
2.1 Particulate Matter....2
2.1.1 Sources....2
2.1.2 Effects....3
2.2 Carbon Monoxide....3
2.2.1 Sources....3
2.2.2 Effects....3
2.3 Ozone....4
2.3.1 Sources....4
2.3.2 Effects....4
2.4 Sulfur Dioxide....4
2.4.1 Sources....4
2.4.2 Effects....5
2.5 Nitrogen Oxides....5
2.5.1 Sources....5
2.5.2 Effects....5
2.6 Lead....5
2.6.1 Sources....5
3 Standards....7
4 Ambient Air Quality Monitoring Program....9
5 Criteria Pollutant Monitoring Results....18
5.1 Total Suspended Particulates....18
5.2 Particulate Matter (Ten Microns)....20
5.3 Particulate Matter (2.5 Microns)....25
5.4 Carbon Monoxide....31
5.5 Ozone....35
5.6 Sulfur Dioxide....44
5.7 Nitrogen Dioxide....48
5.8 Lead....49
5.8.1 Special Studies....49
6 Air Quality Index....52
7 Acid Rain....61
7.1 Sources....61
7.2 Effects....61
7.3 Monitoring....61
8 Statewide Trends....65
8.1 Particulate Matter....65
8.2 Carbon Monoxide....65
8.3 Ozone....65
8.4 Sulfur Dioxide....65
8.5 Nitrogen Dioxide....65
8.6 pH....65
8.7 Ammonium Ion....66
8.8 Nitrate Ion....66
8.9 Sulfate Ion....66
Appendix A. Air Pollution Monitoring Agencies....74
Appendix B. Exceptional Events....77
Appendix C. Box-And-Whisker Plots....78
Appendix D. Nonattainment and North Carolina....79

List of Tables

Table 3.1 National and North Carolina Ambient Air Quality Standards....................................... 8
Table 4.1 Ambient Air Monitoring Sites Operated in North Carolina, 2002 11
Table 5.1 Total Suspended Particulates in Micrograms Per Cubic Meter for 2002 19
Table 5.2 PM_{10} in Micrograms Per Cubic Meter for 2002 21
Table 5.3 $PM_{2.5}$ in Micrograms Per Cubic Meter for 2002.. 26
Table 5.4 Carbon Monoxide in Parts Per Million for 2002 32
Table 5.5 One-Hour Ozone in Parts Per Million for 2002.. 36
Table 5.6 Eight-Hour Ozone in Parts Per Million for 2002... 40
Table 5.7 Sulfur Dioxide in Parts Per Million from All Sites for 2000-2002 45
Table 5.8 Nitrogen Dioxide in Parts Per Million for 2002 48
Table 5.9 Lead- $PM_{2.5}$ in Part Per Million for 2002…………………………………………….50
Table 6.1 Air Quality Index Category Days in the Major Metropolitan Statistical Areas, 2002..54
Table 7.1 pH, Conductivity in Microsiemans per Centimeter and Precipitation in Inches from the National Atmospheric Deposition Program for 2002………………………………………63
Table 7.2 Ion Concentrations in Milligrams per Liter (Precipitation-weighted Annual Means) from the National Atmospheric Deposition Program Data for 2002………………………64

List of Figures

Figure 4.1 Monitoring Sites Active in 2002 10
Figure 5.1 Location of PM10 Monitoring Sites.. 21
Figure 5.2 PM_{10}: Second Highest 24-Hour Averages, 2002... 24
Figure 5.3 PM_{10}: Maximum Annual Arithmetic Means, 2002 24
Figure 5.4 Location of $PM_{2.5}$ Monitoring Sites 25
Figure 5.5 $PM_{2.5}$: Second Highest 24-Hour Averages, 2002 29
Figure 5.6 $PM_{2.5}$: Maximum Annual Arithmetic Means, 2002 29
Figure 5.7 $PM_{2.5}$: Design Values by County, 2000-2002 30
Figure 5.8 Location of Carbon Monoxide Monitoring Sites 32
Figure 5.9 Carbon Monoxide: Second Highest 1-Hour Average, 2002 34
Figure 5.10 Carbon Monoxide: Second Highest Non-overlapping 8-Hour Average, 2002 34
Figure 5.11 Location of Ozone Monitoring Sites 36
Figure 5.12 Ozone: Second Highest Annual 1-Hour Average, 2002 43
Figure 5.13 Ozone: Mean Annual Fourth Highest 8-Hourr Average, 2000-2002...................... 43
Figure 5.14 Locations of Sulfur Dioxide Monitoring Sites in 2000,2001 and 2002 45
Figure 5.15 Sulfur Dioxide: Second Highest 3-Hour Averages in the Most recent Year of Data from 2000, 2001 and 2002 47
Figure 5.16 Sulfur Dioxide: Second Highest 24-Hour Averages in the Most Recent Year of Data from 2000, 2001 or 2002 47
Figure 5.17 Location of Nitrogen Dioxide Monitoring Sites 48
Figure 5.18 Location of Lead - $PM_{2.5}$ Monitoring Sites……………………………………50
Figure 5.19 Lead - $PM_{2.5}$: Second Highest 24-Hour Averages, 2002…………………………...51
Figure 6.1 Daily Air Quality Index Values for Asheville,………………………………………55
Figure 6.2 Daily Air Quality Index Summary for Asheville, ... 55
Figure 6.3 Daily Air Quality Index Values for Charlotte-Gastonia,....................................... 56
Figure 6.4 Daily Air Quality Index Summary for Charlotte-Gastonia, ... 56
Figure 6.5 Daily Air Quality Index Values for Fayetteville 57
Figure 6.6 Daily Air Quality Index Summary for Fayetteville... 57
Figure 6.7 Daily Air Quality Index Values Greensboro-Winston-Salem-High Point 58
Figure 6.8 Daily Air Quality Index Summary Greensboro-Winston-Salem-High Point............. 58
Figure 6.9 Daily Air Quality Index Values for Raleigh-Durham- Chapel Hill 59
Figure 6.10 Daily Air Quality Index Summary for Raleigh-Durham-Chapel Hill...................... 59
Figure 6.11 Daily Air Quality Index Values for Wilmington... 60
Figure 6.12 Daily Air Quality Index Summary for Wilmington 60
Figure 7.1 Annual Mean pH Values at North Carolina NADP Sites, 2002……………………...62
Figure 8.1 Distribution of Statewide Second-Maximum 24-Hour PM_{10} Concentrations, 1989-2002, and Smoothed Regression Trend Line……………………………………………67
Figure 8.2 Distribution of Statewide Second-Maximum 8-Hour Carbon Monoxide Concentrations, 1991-2002, and Smoothed Regression Trend Line……………..….……67

Figure 8.3 Distribution of Statewide Fourth-Maximum 8-Hour Ozone Concentrations, 1985-2002, and Smoothed Regression Trend Line……………………………………………68
Figure 8.4 Number of days with exceedances of 8-Hour Ozone Averages of 0.085 ppm or Greater, 1985-2002 ……………………………………………………………..……..68
Figure 8.5 Distribution of Statewide Second-Maximum 3-Hour Sulfur Dioxide Concentrations, 1989- 2002, and Smoothed Regression Trend Line……………………………………69
Figure 8.6 Distribution of Statewide Second- Maximum 24-Hour Sulfur Dioxide Concentrations, 1989- 2002, and Smoothed Regression Trend Line…………………………………..…69
Figure 8.7 Distributions of Forsyth and Mecklenburg County Annual Mean Nitrogen Dioxide Concentrations, 1989- 2002, and Smoothed Regression Trend Line……………………...70
Figure 8.8 Distribution of Statewide Annual Mean pH, 1989- 2002, and Smoothed Regression Trend Line ……………………………………………………………………………70
Figure 8.9 Distribution of Statewide Annual Mean Ammonium Ion Concentrations, 1989- 2002, and Smoothed Regression Trend Line ………………………………………………….71
Figure 8.10 Distribution of Statewide Annual Mean Nitrate Ion Concentrations, 1989- 2002, and Smoothed Regression Trend Line ………………………………………………….71
Figure 8.11 Distribution of Statewide Annual Mean Sulfate Ion Concentrations, 1989- 2002, and Smoothed Regression Trend Line….…………………………………………………72

1 Introduction

This annual report summarizes the ambient air monitoring performed in calendar year 2002 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 416,001[1] 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 provides a statewide summary of trends for the criteria pollutants from 1989 (1991 for CO and 1985 O_3) through 2002.

[1] The number includes TSP samples collected in 2000.

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 1991). The new $PM_{2.5}$ standard was adopted by North Carolina on April 1, 1999. On May 14, 1999 the U.S. Court of Appeals ruled the setting or the standard by EPA was an unconstitutional use of authority and could be vacated. 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.

2.2.2 Effects

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

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

Ambient CO apparently does not adversely affect vegetation or materials.

2.3 Ozone

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

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

2.3.1 Sources

Ozone (O_3) is the major component of a complex mixture of compounds known as photochemical oxidants. Ozone is not usually emitted directly into the atmosphere, but is formed by a series of complex reactions involving hydrocarbons, nitrogen oxides and sunlight. Ozone concentrations are higher during the daytime in late spring, summer and early autumn when the temperature is above 601F 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 and newspaper inks

2.6.2 Effects

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

3 Standards

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

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

A pollutant measurement that is greater than the ambient air quality standard for a specific averaging time is called an *exceedance*. The national primary, secondary and North Carolina ambient air quality standards that were in effect during 2002 are summarized in Table 3.1.

Table 3.1 National and North Carolina Ambient Air Quality Standards

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

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

1. In 1987, National standards for PM-10 replaced those for TSP.
2. Arithmetic mean over the 3 most current years.
3. In July 1997, 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 2002. 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 2002 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.

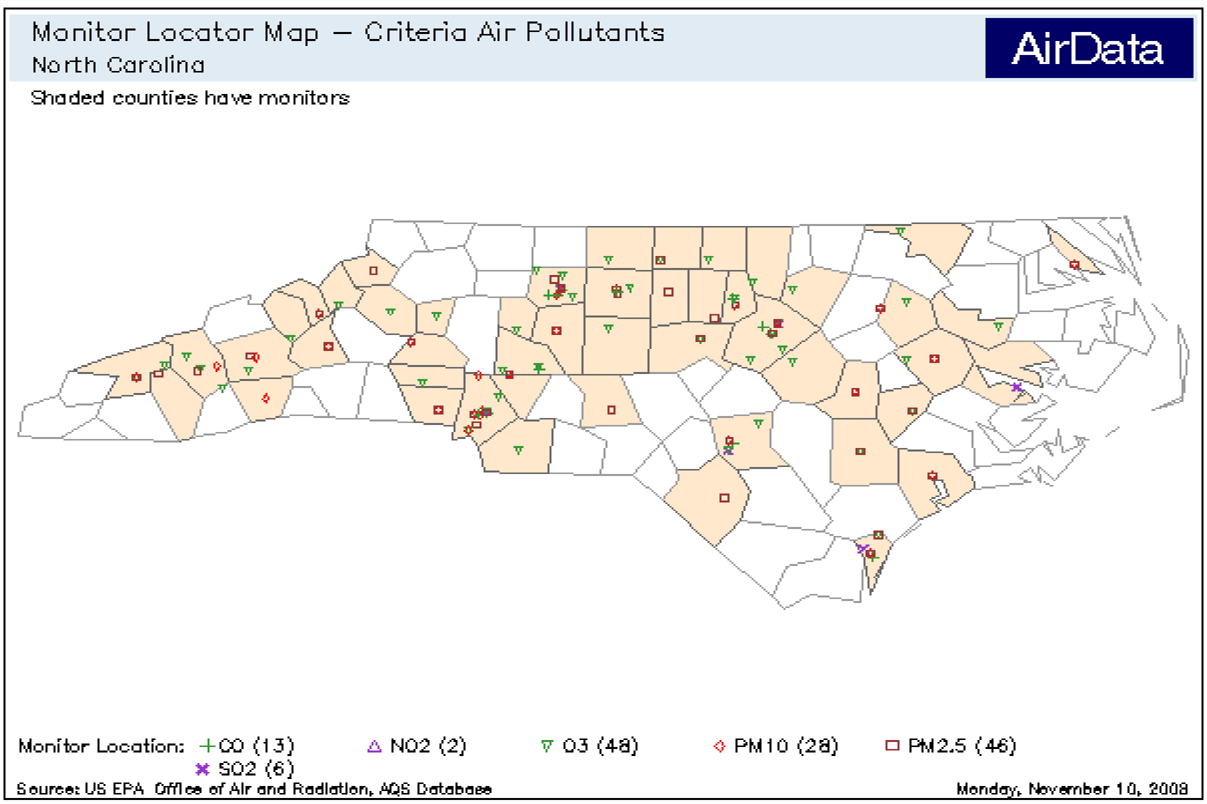


Figure 4.1 Monitoring Sites Active in 2002

Table 4.1 Ambient Air Monitoring Sites Operated in North Carolina, 2002

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	
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	O3	
37-013-0006 BEAUFORT	NC 306 @ PCS ENTRANCE AURORA	SO2	
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BLDG WOODFIN ST ASHEVILLE	PM10	
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	PM10	PM2.5
37-027-0003 CALDWELL	HWY 321 NORTH LENOIR	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	ROUTE 4 BOX 62 PITTSBORO	O3	PM2.5
37-051-0007 CUMBERLAND	CUMBERLAND CO ABC BOARD, 1705 OWEN DR FAYETTEVILLE	CO	

SITE / COUNTY	ADDRESS	POLLUTANTS
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 SO2
37-057-0002 DAVIDSON	SOUTH SALISBURY STREET LEXINGTON	PM10 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	CO O3
37-065-0003 EDGECOME	TALBERT PARK AT SPRUCE & CAROLINA ROCKY MOUNT	PM10 PM2.5
37-065-0099 EDGECOME	7589 NC HIGHWAY 33 NW TARBORO	O3
37-067-0022 FORSYTH	1300 BLK HATTIE AVENUE WINSTON-SALEM	CO O3 SO2 NO2 PM2.5 PM10
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY WINSTON-SALEM	CO PM10
37-067-0024 FORSYTH	NORTH FORSYTH HIGH SCHOOL WINSTON-SALEM	PM2.5
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE WINSTON-SALEM	O3

SITE / COUNTY	ADDRESS	POLLUTANTS
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 GASOTNIA	PM10 PM2.5
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSP BUTNER	O3
37-081-0009 GUILFORD	EDGEWORTH & BELLEMEADE ST'S GREENSBORO	PM2.5
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
37-087-0011 HAYWOOD	PROSPECT AND NORTHSIDE STREETS CANTON	PM10
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PARKWAY MILE MARKER 410	O3
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAINS NATIONAL PARK	O3

SITE COUNTY	ADDRESS	POLLUTANTS				
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 LENIOR	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	PM10	PM2.5			
37-117-0001 MARTIN	1210 HAYES STREET JAMESVILLE	O3				
37-119-0001 MECKLENBURG	600 EAST TRADE STREET CHARLOTTE	PM10				
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			
37-119-0038 MECKLENBURG	301 NORTH TRYON STREET CHARLOTTE	CO				
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	CO	PM2.5	SO2	O3	NO2
37-119-0042 MECKLENBURG	1935 EMERYWOOD DRIVE CHARLOTTE	PM2.5				

SITE / COUNTY	ADDRESS	POLLUTANTS	
37-119-1001 MECKLENBURG	FILTER PLANT DAVIDSON	PM10	
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	PM10	PM2.5
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	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	
37-129-0009 NEW HANOVER	2710 MARKET STREET WILMINGTON	PM10	PM2.5
37-131-0002 NORTHAMPTON	ROUTE 46 GASTON	O3	
37-133-0005 ONSLOW	617 HENDERSON 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	PM10	PM2.5
37-145-0003 PERSON	STATE ROAD 1102 & NC 49 ROXBORO	O3	

SITE COUNTY	ADDRESS	POLLUTANTS
37-147-0005 PITT	851 HOWELL STREET GREENVILLE	PM10 PM2.5
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	CO 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	CO PM2.5 O3
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

SITE COUNTY	ADDRESS	POLLUTANTS
37-189-0003 WATAUGA	361 JEFFERSON ROAD BOONE	PM2.5
37-191-0005 WAYNE	DILLARD MIDDLE SHOOL, DEVEREAU STREET GOLDSBORO	PM10 PM2.5
37-199-0003 YANCEY	STATE HIGHWAY 128 BURNSVILLE	O3
Sites operated in 2002	87	

5 Criteria 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 2002 ambient air quality report were collected at 151 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. Eight of the 151 monitors used for this report operated most recently in 2000 or 2001.

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 will resume a limited sampling program again in 2003. In 2000, two sites in Mecklenburg County were used to monitor TSP and 92 samples were collected. A detailed summary of the data from each site is given in Table 5.1.

No sample exceeded the N.C. TSP ambient air quality standards in 2000. The highest 24-hour average was 116, which was 77 percent of the standard. This value occurred at the Fire Station # 10 site in Charlotte. Attainment status is based on the second highest 24-hour concentration and on the geometric mean of all the 24-hour concentrations at a given site.

The largest geometric mean TSP average was 45 $\mu g/m^3$, which is 59 percent of the level of the air quality standard. This value occurred at the East Trade Street site in Charlotte.

During early November 2000, especially November 2, 3, 4, and 8 there were several sites on which particulate matter samplers were affected by smoke from forest fires in North Carolina and neighboring states. A reading of 152 $\mu g/m^3$, which is above the standard of 150 $\mu g/m^3$, was recorded at the East Trade Street site in Charlotte. The geometric mean increased to 49 $\mu g/m^3$ as well.

Table 5.1 Total Suspended Particulates in Micrograms Per Cubic Meter for 2000

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAX 1st	2nd	3rd	4th	ARITH MEAN	GEOM MEAN	GEOM SD
37-119-0001 MECKLENBURG	600 EAST TRADE STREET CHARLOTTE	40	90	82	75	70	47	45	1.4
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD CHARLOTTE	52	116	75	73	71	44	41	1.5
Total Samples Total Sites Sampled		92 2							

5.2 Particulate Matter – Ten Microns (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 2002, 2,205 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 2002. The highest 24-hour maximum concentration was 60 $\mu g/m^3$, or about 40 percent of the standard (150 $\mu g/m^3$). The highest annual arithmetic mean was 27.0 $\mu g/m^3$, which is about 50 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.)

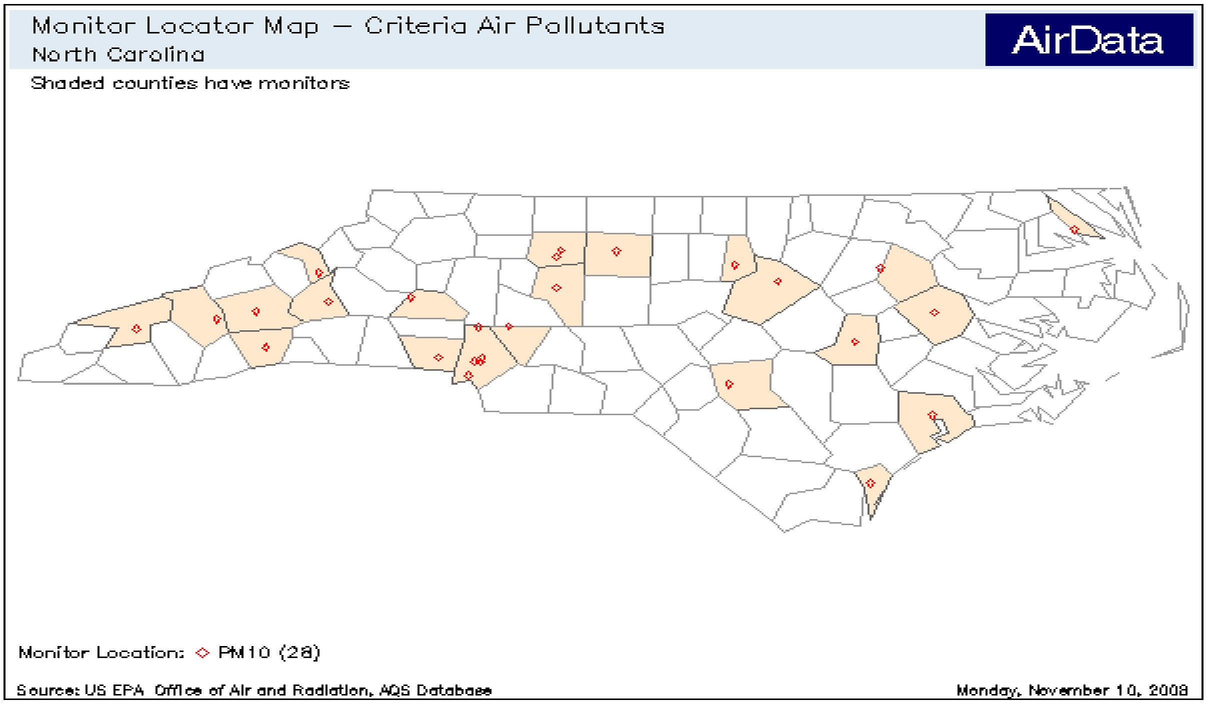


Figure 5.1 Location of PM10 Monitoring Sites

Table 5.2 PM_{10} in Micrograms Per Cubic Meter for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-021-0003 BUNCOMBE	HEALTH & SOCIAL SERVICES BLDG WOODFIN ST ASHEVILLE	51	42	37	31	31	7.6
37-025-0004 CABARRUS	933 FLOYD STREET KANNAPOLIS	61	44	39	35	35	20.7
37-035-0004 CATAWBA	1650 1ST. ST. HICKORY	60	54	43	40	39	22.0
37-051-0009 CUMBERLAND	4533 RAEFORD ROAD FAYETTEVILLE	57	45	44	37	35	20.3
37-057-0002 DAVIDSON	S. SALISBURY ST. LEXINGTON, NC	53	38	36	34	34	19.1
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST DURHAM	59	40	37	35	34	20.4

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
			1st	2nd	3rd	4th	
37-065-0003 EDGECOMBE	TALBERT PARK at SPRUCE ST ROCKY MOUNT	61	39	38	38	37	20.0
37-067-0022 FORSYTH	1300 BLK. HATTIE AVE WINSTON-SALEM	361	53	49	47	45	19.7
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY WINSTON-SALEM	357	60	57	52	50	22.5
37-071-0016 GASTON	1622 E. GARRISON BLVD GASTONIA	59	37	36	34	34	20.8
37-081-0009 GUILFORD	EDGEWORTH & BELLEMEADE STS GREENSBORO	2	19	10	N/A	N/A	14.5
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	61	42	40	32	32	17.9
37-087-0011 HAYWOOD	PROSPECT AND NORTHSIDE STREETS	60	47	39	37	36	21.8
37-089-1006 HENDERSON	CORNER OF ALLEN & WASHINGTON STS HENDERSON-VILLE	60	55	39	38	38	22.0
37-111-0004 MC DOWELL	BALWIN AVENUE (EAST MARION JR. HIGH SCHOOL) MARION	59	50	38	37	36	20.9
37-119-0001 MECKLENBURG	600 EAST TRADE STREET CHARLOTTE	25	49	40	36	33	23.0
37-119-0003 MECKLENBURG	FIRE STA #11 620 MORETZ STREET CHARLOTTE	45	44	44	43	43	24.3
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT RD CHARLOTTE	60	44	43	43	40	23.3
37-119-1001 MECKLENBURG	FILTER PLANT DAVIDSON	47	45	39	33	33	21.8
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	56	52	49	49	48	27.0

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
			1st	2nd	3rd	4th	
37-121-0001 MITCHELL	CITY HALL SUMMIT ST SPRUCE PINE	54	47	44	42	38	22.5
37-129-0009 NEW HANOVER	2710 MARKET STREET WILMINGTON	61	39	32	31	30	15.6
37-133-0005 ONSLOW	617 HENDERSON DRIVE JACKSONVILLE	55	36	34	33	30	15.7
37-139-0002 PASQUOTANK	600 WESTOVER STREET ELIZABETH CITY	59	40	35	33	31	15.5
37-147-0005 PITT	851 HOWELL STREET GREENVILLE	58	35	35	35	33	16.8
37-173-0002 SWAIN	CENTER ST/PARKS 7 REC FACILITY	61	51	36	36	35	19.6
37-183-0014 WAKE	3801 SPRING FOREST RD. RALEIGH	365	62	59	58	54	20.4
37-183-0014 WAKE	3801 SPRING FOREST RD. RALEIGH	61	50	43	37	35	20.1
37-191-0005 WAYNE	DILLARD MIDDLE SCHOOL DEVEREAU ST GOLDSBORO	59	39	38	37	33	19.6
Total Samples		2,205					
Total Sites Sampled		24					

Figure 5.2 PM_{10}: Second Highest 24-Hour Averages, 2002

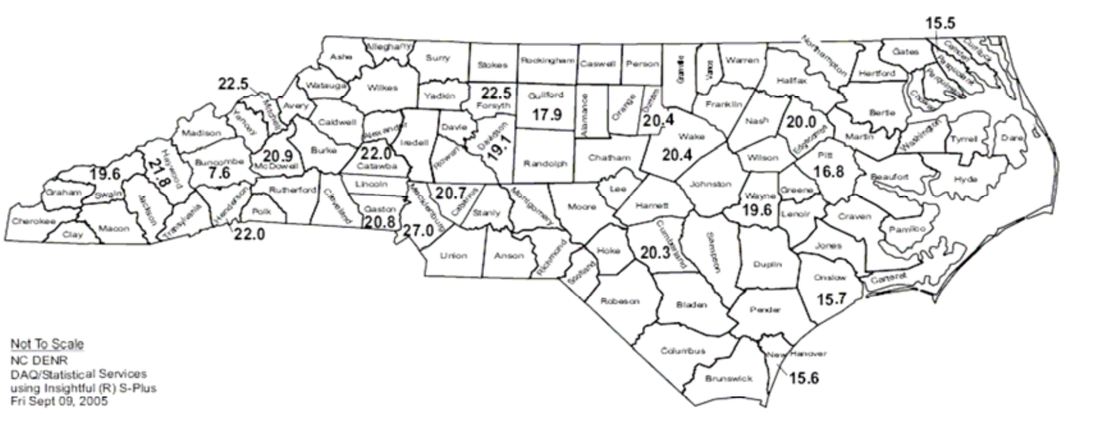


Figure 5.3 PM_{10}: Maximum Annual Arithmetic Means, 2002

5.3 Particulate Matter two and one-half microns ($PM_{2.5}$)

In 2002, 38 sites were used to monitor $PM_{2.5}$ and 5,610 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 2002.

The highest 24-hour maximum concentration was 62.7 µg/m^3, or about 96 percent of the standard (65 µg/m^3) (See Table 5.3).
The highest annual arithmetic mean was 15.74 µg/m^3, which is about 5 percent over the level of the standard (15 µg/m^3) at the Lexington in Davidson County.
The other monitors exceeded the annual arithmetic mean standard in 2002:
Hickory in Catawba County
(See Table 5.3).

NAAQS attainment is based on the level of the 98th percentile concentration (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 2000 through 2002, 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 2002 through 2004, which may or may not resemble the values illustrated here.

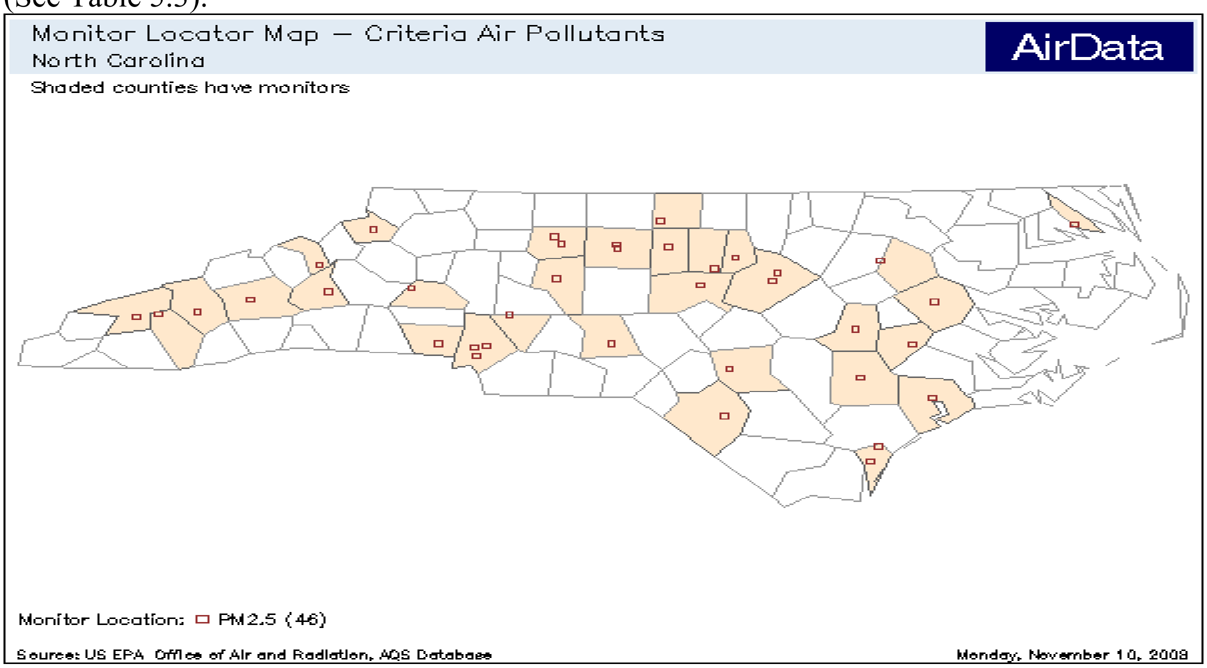


Figure 5.4 Location of $PM_{2.5}$ Monitoring Sites

Table 5.3 $PM_{2.5}$ in Micrograms Per Cubic Meter for 2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	PERCENTILE 98TH	ARITH MEAN
37-001-0002 ALAMANCE	827 S.GRAHAM & HOPEDALE RD BURLINGTON	116	34.5	31.9	28.8	27.2	28.8	13.49
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	114	41.7	32.9	30.5	30.4	30.5	13.77
37-025-0004 CABARRUS	933 FLOYD STREET KANNAPOLIS	122	34.9	34.3	32.5	30.3	32.5	14.40
37-033-0001 CASWELL	7074 CHERRY GROVE RECREATION	116	34.3	32.2	30.9	30.7	30.9	13.33
37-035-0004 CATAWBA	1650 1ST. ST. HICKORY	118	40.7	33.5	33.5	30.0	33.5	15.35
37-037-0004 CHATHAM	325 RUSSETT PITTSBORO	118	28.4	27.3	27.2	26.1	27.2	12.22
37-051-0009 CUMBERLAND	4533 RAEFORD ROAD FAYETTEVILLE	121	43.2	38.3	36.1	30.9	36.1	14.08
37-057-0002 DAVIDSON	SOUTH SALISBURY STREET LEXINGTON	111	43.7	36.9	33.1	31.1	33.1	15.74
37-061-0002 DUPLIN	HWY 50 KENANANSVILLE	118	41.4	31.9	30.8	28.5	30.8	12.35
37-063-0001 DURHAM	HEALTH DEPT 300 E MAIN ST DURHAM	315	47.5	38.1	34.4	34.0	32.9	13.63
38-065-0003 EDGECOMBE	TALBERT PARK at SPRUCE ST ROCKY MOUNT	118	40.2	38.3	29.1	29.0	29.1	13.41
37-067-0022 FORSYTH	1300 BLOCK, HATTIE AVENUE WINSTON-SALEM	344	41.6	40.0	36.5	35.7	33.8	14.27
37-067-0024 FORSYTH	NORTH FORSYTH HIGH SCHOOL WINSTON-SALEM	112	33.2	32.7	32.6	32.3	32.6	14.30

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	PERCENTILE 98TH	ARITH MEAN
37-071-0016 GASTON	1622 EAST GARRISON BLVD GASTONIA	120	42.0	30.5	28.8	27.5	28.8	14.07
37-081-0009 GUILFORD	EDGEWORTH & BELLEMEADE GREENSBORO	78	24.8	22.1	21.3	20.2	22.1	12.08
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	345	49.2	41.8	41.8	37.7	33.4	13.71
37-081-1005 GUILFORD	E GREEN & S CENTENNIAL ST HIGH POINT	50	24.6	23.7	23.6	22.5	24.6	14.1
37-087-0010 HAYWOOD	9 MAIN STREET WAYNESVILLE	120	35.5	31.4	28.5	27.0	28.5	13.43
37-099-0006 JACKSON	US RT 19 NORTH CHEROKEE RES	95	34.7	30.3	27.8	25.0	30.3	12.97
37-107-0004 LENOIR	CORNER HWY 70 EAST KINSTON	119	30.0	29.0	27.6	26.0	27.6	11.50
37-111-0004 MC DOWELL	BALDWIN AVE MARION	117	38.4	30.7	28.5	28.4	28.5	14.64
37-119-0010 MECKLENBURG	FIRE STA #10 2136 REMOUNT ROAD CHARLOTTE	340	50.9	39.6	36.4	35.3	31.7	14.67
37-119-1041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	347	45.2	44.8	35.5	34.5	30.3	13.89
37-119-1042 MECKLENBURG	1935 EMERYWOOD DRIVE CHARLOTTE	121	34.5	34.3	31.0	30.6	31.0	14.14
37-121-0001 MITCHELL	CITY HALL SUMMIT ST SPRUCE PINE	119	35.4	30.5	30.0	28.9	30.0	13.79
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	121	31.3	29.3	28.3	27.2	28.3	12.25
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD	55	24.8	24.5	21.5	18.9	24.5	9.91

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	PERCENTILE 98TH	ARITH MEAN
37-129-0009 NEW HANOVER	2710 MARKET STREET WILMINGTON	114	28.1	25.5	23.0	22.9	23.0	10.49
37-133-0005 ONSLOW	617 HENDERSON DRIVE JACKSONVILLE	117	29.0	28.1	27.0	23.8	27.0	11.02
37-135-0007 ORANGE	MASON FARM ROAD CHAPEL HILL	118	34.4	26.9	26.4	26.4	26.4	12.80
37-139-0002 PASQUOTANK	600 WESTOVER STREET ELIZABETH CITY	116	42.7	34.0	32.8	29.3	32.8	11.33
37-147-0005 PITT	851 HOWELL STREET GREENVILLE	115	35.8	32.5	30.6	30.0	30.6	12.42
37-155-0005 ROBESON	1170 LINKHAM ROAD LUMBERTON	120	37.0	27.6	27.5	26.0	27.5	12.50
37-173-0002 SWAIN	CENTER ST/PARKS 7 REC FACILITY	108	26.6	26.5	24.7	24.7	24.7	12.36
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	351	62.7	43.8	37.0	35.7	32.3	13.60
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	122	46.1	36.4	35.7	27.7	35.7	13.57
37-189-0003 WATAUGA	361JEFFERSON HWY BOONE	118	35.1	34.6	32.3	29.8	32.3	11.74
37-191-0005 WAYNE	DILLARD MIDDLE SCHOOL GOLDSBORO	121	45.8	31.0	29.8	28.8	29.8	13.32
Total Samples		5,610						
Total Sites Sampled		38						

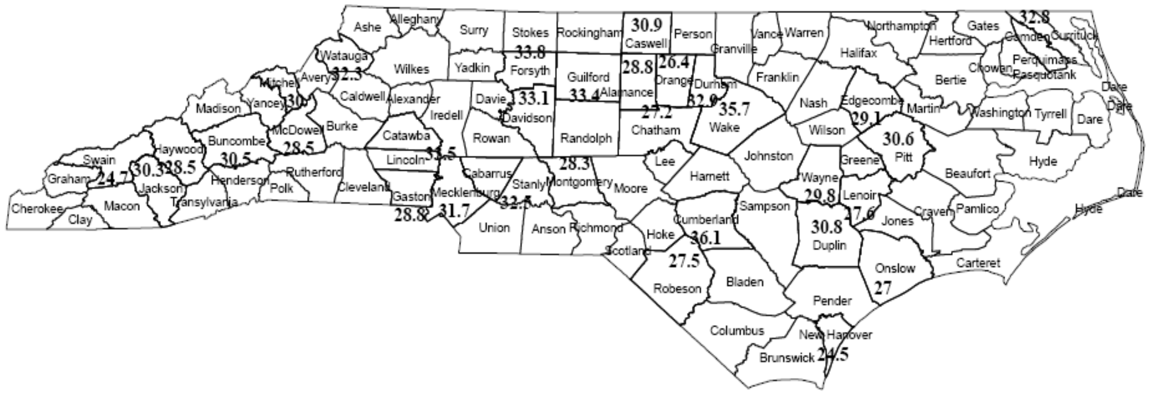


Figure 5.5 $PM_{2.5}$: 98[th] percentile, 2002

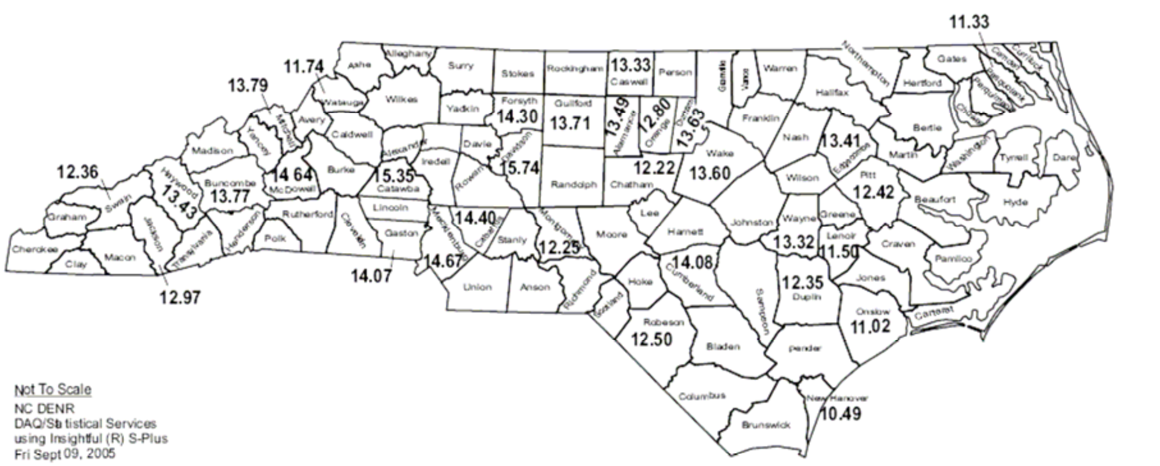


Figure 5.6 $PM_{2.5}$: Annual Arithmetic Means, 2002

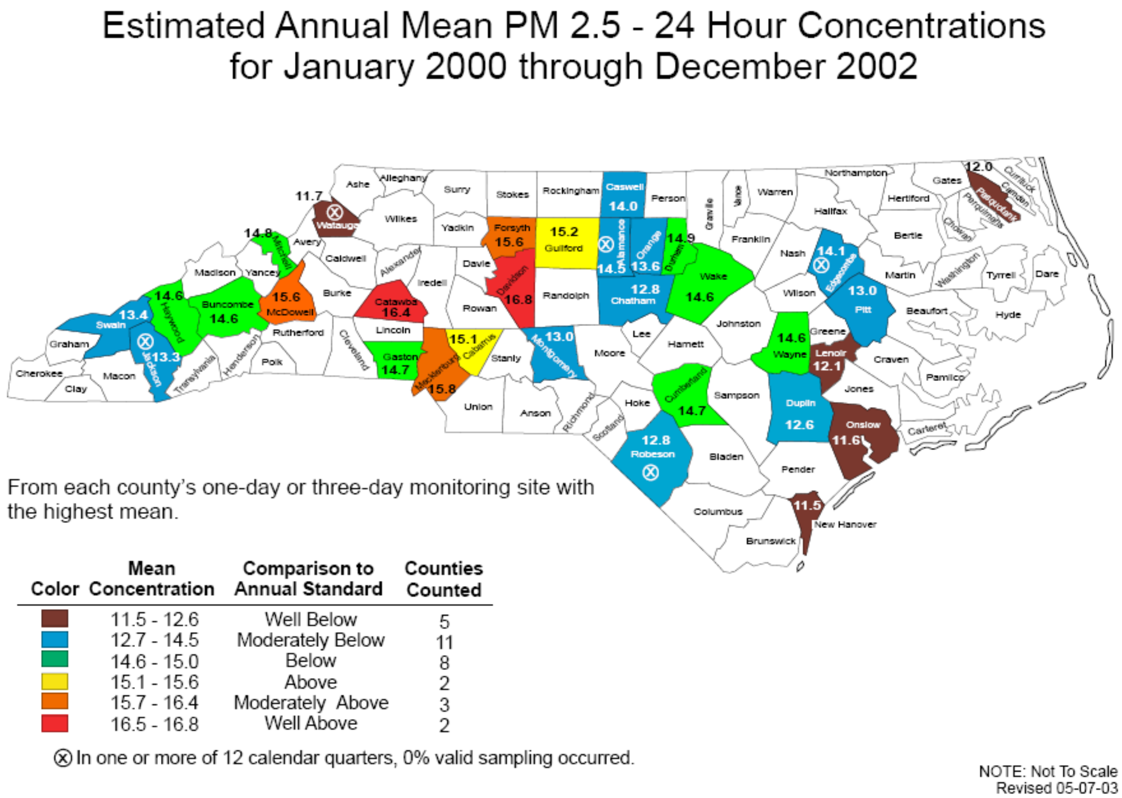


Figure 5.7 $PM_{2.5}$ Design Values by County, 2000-2002

5.4 Carbon Monoxide

Carbon monoxide (CO) data were collected for two purposes in 2002: 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, 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 2002, 9 sites were used to monitor CO and 52,203 valid hourly averages were collected. To keep operating costs minimal, some sites are operated only in the colder months. A map of the CO sampling sites is shown in Figure 5.8, 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 2002. The highest 1-hour average was 6.6 parts per million (ppm), or about 18 percent of the standard (35 ppm). This value occurred at the Tryon Street site in Charlotte. 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.

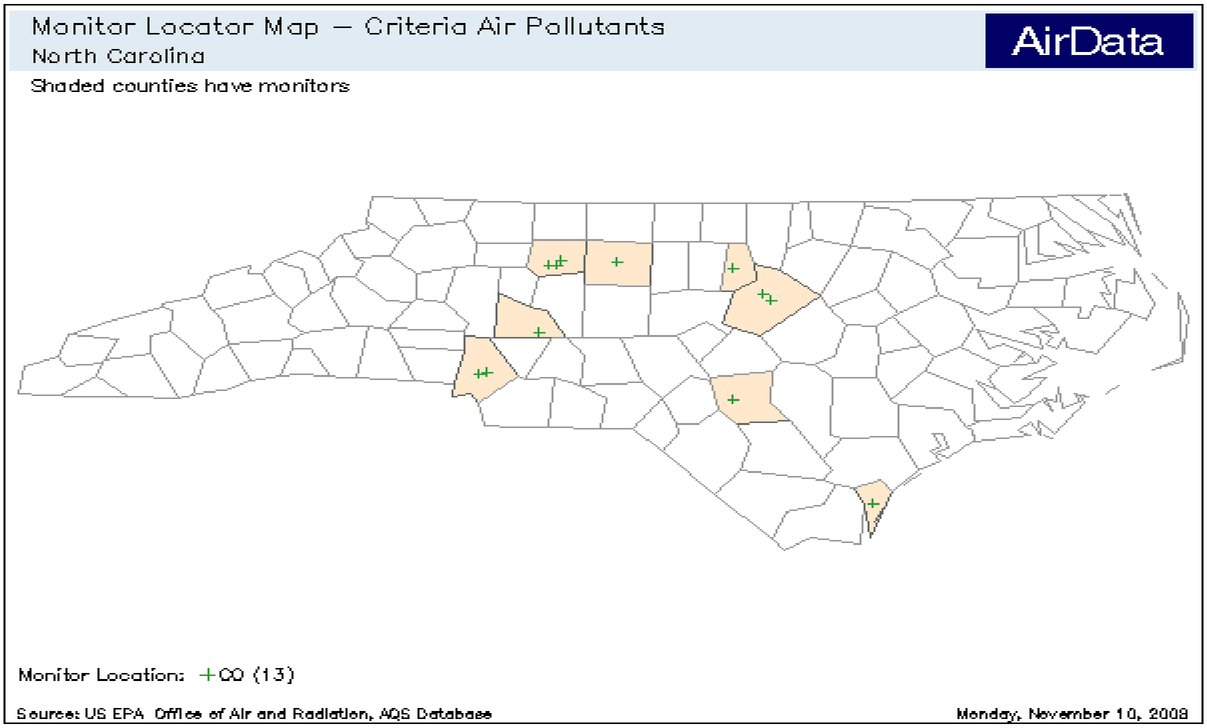


Figure 5.8 Location of Carbon Monoxide Monitoring Sites

Table 5.4 Carbon Monoxide in Parts Per Million for 2002

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	4,342	4.6	4.3	3.6	3.2
37-063-0013 DURHAM	2700 NORTH DUKE STREET DURHAM	2,951	2.0	1.4	1.2	1.0
37-067-0023 FORSYTH	1401 CORPORATION PKY WINSTON-SALEM	8,706	4.2	4.1	3.4	3.4
37-067-0029 FORSYTH	1985 GRIFFITH ROAD WINSTON-SALEM	8,720	5.9	5.7	4.2	4.1
37-081-1011	401 WEST WENDOVER	4,335	3.6	3.6	3.2	2.9

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		EIGHT-HOUR MAXIMA	
			1st	2nd	1st	2nd
GUILFORD	GREENSBORO					
37-119-0038	301 N TRYON ST	6,245	6.6	5.7	4.5	3.2
MECKLENBURG	CHARLOTTE					
37-119-0041	1130 EASTWAY DRIVE	8,393	4.3	3.8	3.2	3.0
MECKLENBURG	CHARLOTTE					
37-129-0008	OLEANDER & COLLEGE	4,330	5.2	4.0	2.7	2.7
NEW HANOVER	WILMINGTON					
37-183-0018	US HWY 70 WEST AND NC HWY 50 NORTH	4,181	4.7	4.6	3.2	3.1
WAKE	RALEIGH					
Total Samples		52,203				
Total Sites Sampled		9				

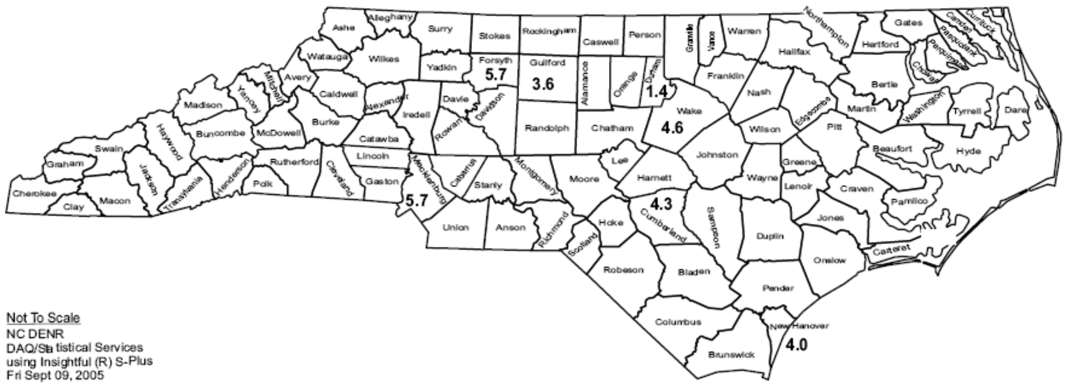


Figure 5.9 Carbon Monoxide: Second Highest 1-Hour Concentration, 2002

Figure 5.10 Carbon Monoxide: Second Highest Non-overlapping 8-Hour Concentration, 2002

5.5 Ozone

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

The state and local program agencies operated 45 monitoring sites in 2002 during the ozone season, April through October. A map of the O_3 sampling sites is presented in Figure 5.11, and a detailed summary of the one-hour data from each site is given in Table 5.5, and the 8-hour data in Table 5.6. These 45 monitoring sites provided 9,479 site-days of valid data (a success rate of 96 percent for the days that sampling is required).

There were 19 exceedances of the 1-hour ozone standard in North Carolina in 2002, one each in Winston-Salem, Clayton, Charlotte and Raleigh, two at Keely Park (Guilford County), Mecklenburg Cab (Mecklenburg County), Bethany School (Rockingham County), Gold Hill (Rowan County) and Charles (Union County) and five at Enochville (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 613 times at the 45 sites that monitored for O_3. Forty-four monitors had at least one exceedance. The largest number at one monitor was 28 in Enochville (Rowan County). These exceedances were distributed over 51 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 2002. 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 2002 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.

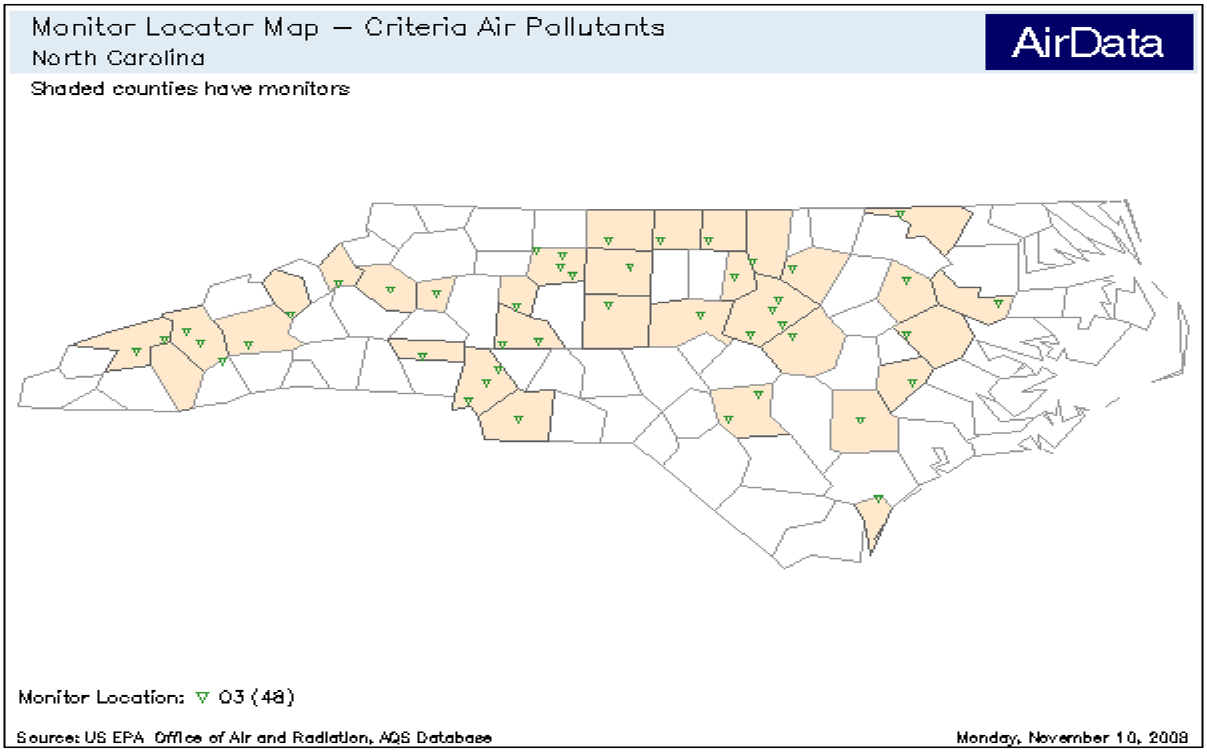


Figure 5.11 Location of Ozone Monitoring Sites

Table 5.5 One-Hour Ozone in Parts Per Million for 2002

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	5136	.116	.111	.110	.104	0	0.00
37-011-0002 AVERY	7510 BLUE RIDGE LINVILLE	4920	.102	.094	.094	.093	0	0.00
37-021-0030 BUNCOMBE	ROUTE 191 SOUTH BREVARD RD ASHEVILLE	4992	.107	.106	.105	.103	0	0.00
37-027-0003 CALDWELL	HWY 321 NORTH LENOIR	5136	.108	.106	.098	.097	0	0.00
37-033-0001 CASWELL	7074 CHERRY GROVE REIDSVILLE	5064	.123	.119	.112	.105	0	0.00

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA 1st	2nd	3rd	4th	NO. VALUES > 0.125 MEAS	EST
37-037-0004 CHATHAM	325 RUSSETT RUN ROAD PITTSBORO	5088	.111	.110	.109	.107	0	0.00
37-051-0008 CUMBERLAND	1/4MI SR1857/US301/1857 WADE	4992	.118	.113	.107	.105	0	0.00
37-051-1003 CUMBERLAND	3625 GOLFVIEW ROAD HOPE MILLS	5112	.116	.113	.106	.105	0	0.00
37-059-0002 DAVIE	246 MAIN STREET COOLEEMEE	5112	.118	.116	.116	.110	0	0.00
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	5112	.107	.105	.093	.093	0	0.00
37-063-0013 DURHAM	2700 NORTH DUKE STREET DURHAM	5136	.121	.117	.117	.114	0	0.00
37-065-0099 EDGECOMBE	7589 NC HWY 33-NW LEGGETT	5136	.118	.109	.109	.103	0	0.00
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	5112	.120	.119	.118	.116	0	0.00
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE WINSTON-SALEM	5112	.118	.115	.113	.103	0	0.00
37-067-0028 FORSYTH	6496 BAUX MOUNTAIN RD WINSTON-SALEM	5112	.118	.117	.117	.113	0	0.00
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	5136	.127	.113	.112	.107	1	1.00
37-069-0001 FRANKLIN	431 S. HILLBOROUGH ST FRANKLINTON	5088	.122	.116	.114	.111	0	0.00
37-077-0001 GRANVILLE	WATER TREATMENT PLANT, JOHN UMSTEAD HOSPITAL BUTNER	5040	.118	.117	.108	.106	0	0.00
37-081-0011 GUILFORD	KEELY PARK, KEELY RD, GREENSBORO	5136	.134	.129	.121	.116	2	2.00
37-087-0004 HAYWOOD	2177 SCHEVILLS ROAD WAYNESVILLE	4872	.095	.093	.091	.091	0	0.00

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA 1st	2nd	3rd	4th	NO. VALUES > 0.125 MEAS	EST
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PARKWAY MILE MARKER 410	5112	.107	.104	.101	.098	0	0.00
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAIN NATIONAL PARK	5088	.108	.105	.104	.104	0	0.00
37-099-0005 JACKSON	BARNET KNOB FIRE TOWER CHEROKEE	3624	.108	.096	.096	.095	0	0.00
37-101-0002 JOHNSTON	1338 JACK ROAD CLAYTON	5064	.127	.117	.113	.112	1	1.00
37-107-0004 LENOIR	CORNER HWY EAST KINSTON	4992	.104	.102	.098	.097	0	0.00
37-109-0004 LINCOLN	1487 RIVERVIEW ROAD LINCOLNTON	5136	.110	.108	.105	.105	0	0.00
37-117-0001 MARTIN	1210 HAYES STREET JAMESVILLE	5064	.100	.100	.099	.099	0	0.00
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	5136	.119	.117	.116	.116	0	0.00
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	5016	.127	.120	.116	.108	1	1.00
37-119-1009 MECKLENBURG	29 N@ MECKLENBURG CAB CO CHARLOTTE	5136	.136	.130	.121	.115	2	2.00
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD CASTLE HAYNE	5064	.094	.091	.089	.088	0	0.00
37-131-0002 NORTHAMPTON	ROUTE 46 GASTON	5088	.109	.107	.106	.105	0	0.00
37-145-0003 PERSON	STATE ROAD 1102 & NC 49 ROXBORO	5136	.120	.118	.117	.113	0	0.00
37-147-0099 PITT	US 264 NEAR WATTER TOWER FARMVILLE	5136	.111	.106	.103	.103	0	0.00
37-151-0004 RANDOLPH	4507 BRANSON DAVIS ROAD SOPHIA	5136	.106	.104	.103	.103	0	0.00

SITE NUMBER COUNTY	ADDRESS	NUM OBS	DAILY 1-HR MAXIMA 1st	2nd	3rd	4th	NO. VALUES > 0.125 MEAS	EST
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL BETHANY	5136	.128	.125	.116	.106	2	2.00
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVENUE ROCKWELL	5136	.135	.125	.117	.114	2	2.00
37-159-0022 ROWAN	925 N ENOCHVILLE AVE ENOCHVILLE	5112	.129	.128	.127	.127	5	5.00
37-173-0002 SWAIN	CENTER ST/PARKS & RECREATION FACILITY BRYSON CITY	5112	.102	.088	.086	.086	0	0.00
37-179-0003 UNION	701 CHARLES STREET MONROE	5136	.126	.125	.122	.110	2	2.00
37-183-0014 WAKE	3801 SPRING FOREST ROAD RALEIGH	5136	.133	.115	.111	.110	1	1.00
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	5136	.124	.123	.120	.118	0	0.00
37-183-0016 WAKE	201 NORTH BROAD STREET FUQUAY-VARINA	5112	.110	.108	.108	.107	0	0.00
37-183-0017 WAKE	5033 TV TOWER ROAD GARNER	5088	.121	.119	.117	.110	0	0.00
37-199-0003 YANCY	STATE HIGHWAY 128 BURNSVILLE	4920	.108	.101	.099	.097	0	0.00
Total Samples		227,496					19	19.00
Total Sites Sampled		45						

Table 5.6 Eight-Hour Ozone in Parts Per Million for 2002

SITE NUMBER COUNTY	ADDRESS	VALID DAYS	VALID DAILY 8-HR MAXIMUM 1st	2nd	3rd	4th	N0. VALUES .>.085 MEAS
37-003-0003 ALEXANDER	324 MINNIGAN LANE TAYLORSVILLE	210	.103	.100	.098	.095	17
37-011-0002 AVERY	7510 BLUE RIDGE LINVILLE	193	.091	.089	.087	.087	4
37-021-0030 BUNCOMBE	ROUT 191 SOUTH BREVARD RD ASHEVILLE	205	.097	.094	.091	.090	7
37-027-0003 CALDWELL	HWY 321 NORTH LENOIR	211	.099	.093	.092	.092	10
37-033-0001 CASWELL	7074 CHERRY GROVE RD REIDSVILLE	209	.113	.102	.095	.095	15
37-037-0004 CHATHAM	325 RUSSETT RUN PITTSBORO	208	.104	.097	.096	.094	13
37-051-0008 CUMBERLAND	1/4MI SR1857/US301/1857 WADE	203	.099	.098	.095	.094	17
37-051-1003 CUMBERLAND	3625 GOLFVIEW ROAD HOPE MILLS	212	.108	.103	.099	.095	14
37-059-0002 DAVIE	246 MAIN STREET COOLEEMEE	213	.112	.100	.099	.098	22
37-061-0002 DUPLIN	HWY 50 KENANSVILLE	198	.095	.095	.087	.085	4
37-063-0013 DURHAM	2700 NORTH DUKE STREET DURHAM	212	.103	.102	.100	.100	17
37-065-0099 EDGECOMBE	7589 NC HWY 33-NW LEGGETT	208	.109	.102	.097	.095	17
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	213	.113	.111	.099	.099	15
37-067-0027 FORSYTH	7635 HOLLYBERRY LANE WINSTON-SALEM	213	.106	.092	.090	.088	6
37-067-0028 FORSYTH	6496 BAUX MOUNTAIN RD WINSTON-SALEM	213	.106	.100	.095	.094	8
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	214	.108	.106	.095	.093	15
37-069-0001 FRANKLIN	431 S. HILLBOROUGH ST FRANKLINTON	208	.112	.105	.101	.100	19
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSPITAL BUTNER	207	.107	.102	.101	.098	16
37-081-0011 GUILFORD	KEELY PARK, KEELY RD, GREENSBORO	213	.115	.111	.105	.104	20

SITE NUMBER / COUNTY	ADDRESS	VALID DAYS	VALID DAILY 8-HR MAXIMUM 1st	2nd	3rd	4th	N0. VALUES .>.085 MEAS
37-087-0004 HAYWOOD	2177 SHEVILLE ROAD WAYNESVILLE	198	.087	.085	.084	.084	2
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PARKWAY MILE MARKER 410	211	.099	.094	.091	.090	13
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAIN NATIONAL PARK	206	.098	.095	.094	.094	18
37-099-0005 JACKSON	BARNET KNOB FIRE TOWER CHEROKEE	150	.093	.093	.091	.091	4
37-101-0002 JOHNSTON	1338 JACK ROAD CLAYTON	211	.112	.099	.099	.097	19
37-107-0004 LENOIR	CORNER HWY 70 EAST KINSTON	202	.095	.088	.087	.085	5
37-109-0004 LINCOLN	1487 RIVERVIEW ROAD LINCOLNTON	209	.097	.097	.095	.095	21
37-117-0001 MARTIN	1210 HAYES STREET JAMESVILLE	204	.094	.091	.089	.087	8
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	214	.108	.104	.103	.103	21
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	209	.104	.102	.097	.094	12
37-119-1009 MECKLENBURG	29 N@ MECKLENBURG CAB CO CHARLOTTE	214	.119	.117	.112	.107	22
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD CASTLE HAYNE	197	.088	.082	.080	.080	1
37-131-0002 NORTHAMPTON	ROUTE 46 GASTON	208	.101	.097	.097	.095	14
37-145-0003 PERSON	SR NC 49 ROXBORO	213	.114	.106	.105	.102	16
37-147-0099 PITT	US 264 NEAR WATER TOWER FARMVILLE	209	.096	.094	.091	.091	13
37-151-0004 RANDOLPH	4507 BRANSON DAVIS RD SOPHIA	214	.097	.095	.094	.092	10
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL BETHANY	214	.115	.108	.107	.096	15
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	207	.118	.106	.106	.106	22
37-159-0022 ROWAN	925 N ENOCHVILLE AVE ENOCHVILLE	202	.111	.110	.109	.108	28
37-173-0002 SWAIN	CENTER ST/PARKS & RECREATION FACILITY BRYSON CITY	206	.084	.083	.081	.079	0
37-179-0003 UNION	701 CHARLES STREET MONROE	206	.116	.109	.100	.100	17

SITE NUMBER COUNTY	ADDRESS	VALID DAYS	VALID DAILY 8-HR MAXIMUM				N0. VALUES .>.085 MEAS
			1st	2nd	3rd	4th	
37-183-0014 WAKE	E. MILLBROOK JR HI 3801 SPRING FOREST ROAD RALEIGH	210	.110	.103	.102	.100	17
37-183-0015 WAKE	808 NORTH STATE STREET RALEIGH	210	.109	.107	.107	.107	19
37-183-0016 WAKE	201 NORTH BROAD STREET FUQUAY-VARINA	211	.103	.101	.097	.095	20
37-183-0017 WAKE	5033 TV TOWER ROAD GARNER	214	.107	.100	.099	.096	12
37-199-0003 YANCY	STATE HIGHWAY 128 BURNSVILLE	200	.095	.095	.088	.087	8
Total Samples Total Sites Sampled		9,312 45					613

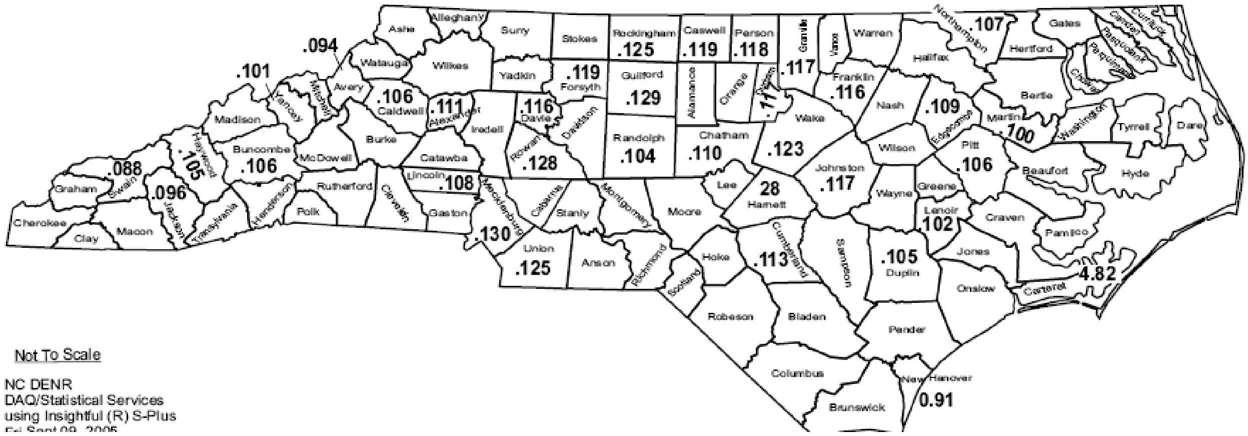


Figure 5.12 Ozone: Second Highest Annual 1-Hour Average, 2002

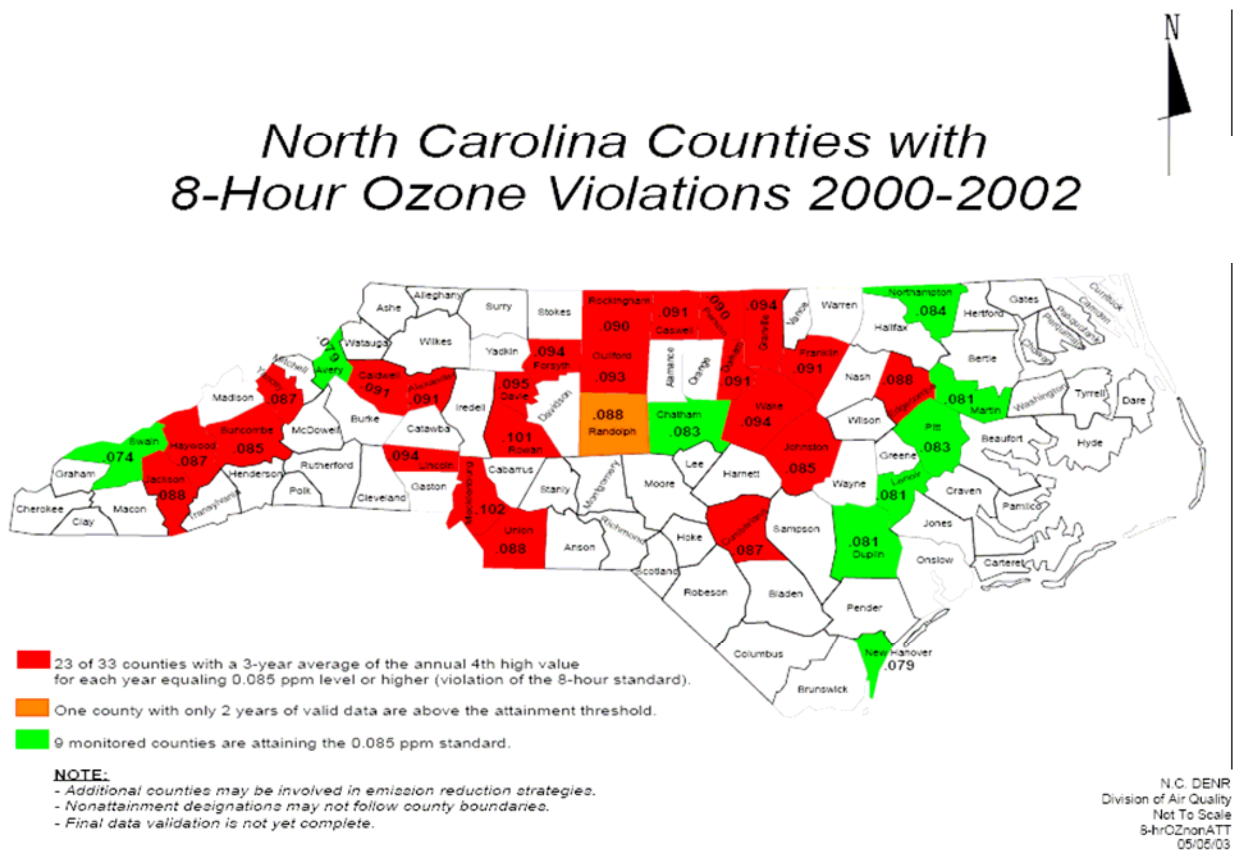


Figure 5.13 Ozone: Mean Annual Fourth Highest 8-Hour Average, 2000-2002

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 2002. Some SO_2 sites are operated only every third year. We supplemented this report with 4 monitors that operated last in 2001, (and will next be operated in 2004), and 4 monitors that operated last in 2000 (and will next be operated in 2003).

From the 14 sites with SO_2 data obtained between 2000 and 2002, 111,829 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 2002. The highest annual arithmetic mean was 0.007 ppm, or about 20 percent of the standard (0.03 ppm). The highest maximum 24-hour average was 0.044 ppm, about 30 percent of the standard (0.14 ppm), and the highest maximum 3-hour average was 0.16 ppm, about 32 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.

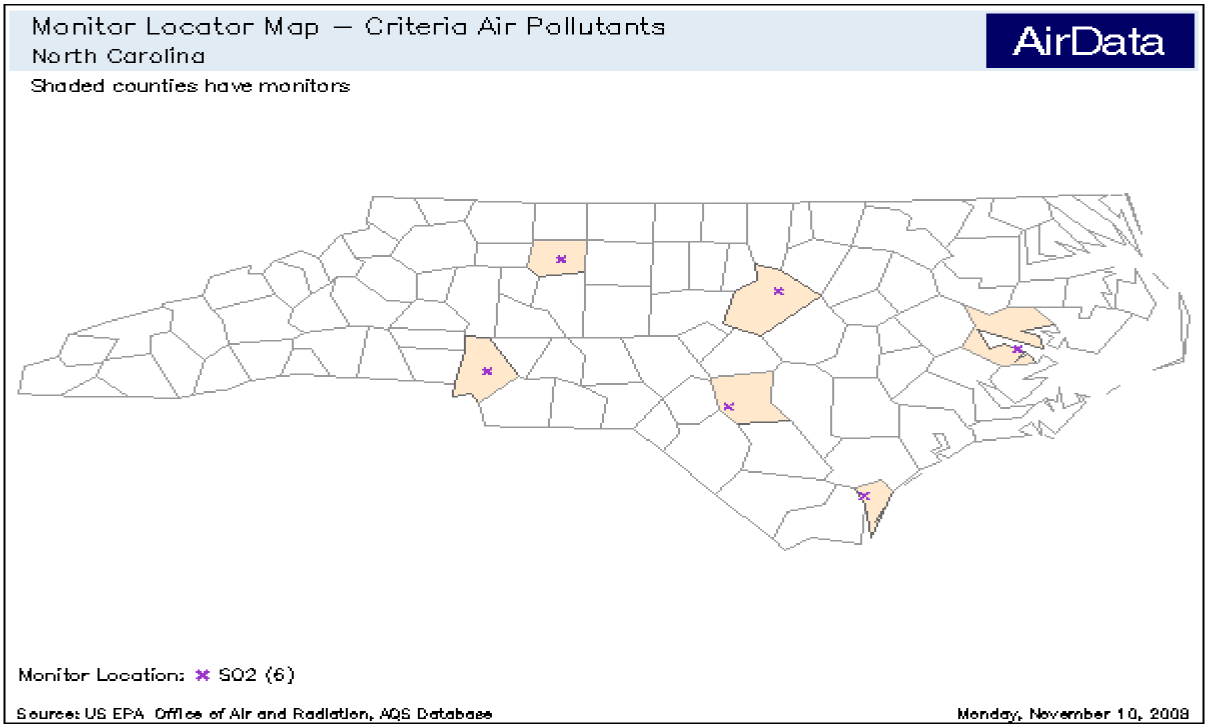


Figure 5.14 Locations of Sulfur Dioxide Monitoring Sites in 2002.

Table 5.7 Sulfur Dioxide in Parts Per Million from All Sites for 2000-2002

SITE NUMBER / COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA 1st	ONE-HOUR MAXIMA 2nd	THREE-HOUR MAXIMA 1st	THREE-HOUR MAXIMA 2nd	24-HOUR MAXIMA 1st	24-HOUR MAXIMA 2nd	ARITH MEAN
2002 DATA									
37-013-0006 BEAUFORT	NC 306 @ PCS ENTRANCE AURORA	8,200	.118	.113	.071	.067	.042	.033	.003
37-051-1003 CUMBERLAND	3625 GOLFVIEW ROAD HOPE MILLS	7,114	.016	.014	.011	.010	.007	.007	.002
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	8,632	.169	.114	.091	.088	.025	.024	.005
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	8,388	.069	.053	.037	.034	.012	.011	.003
37-129-0006 NEW HANOVER	HWY 421 NORTH	8,277	.436	.147	.162	.103	.044	.040	.007
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	7,698	.033	.028	.021	.021	.010	.010	.003
Total Samples		48,309							
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	
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	STATE ROAD 1102 & NC 49 ROXBORO	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							
2000 data									
37-059-0002 DAVIE	246 MAIN STREET COOLEEMEE	8,249	0.071	0.054	0.055	0.049	0.019	0.018	0.004
37-109-0004 LINCOLN	1487 RIVERVIEW ROAD LINCOLNTON	8,159	0.076	0.066	0.046	0.043	0.022	0.018	0.004
37-131-0002 NORTHAMPTON	RT 46 GASTON	8,361	0.037	0.033	0.025	0.022	0.012	0.012	0.004
37-147-0099 PITT	US 264 NEAR WATER TOWER FARMVILLE	8,153	0.023	0.023	0.017	0.016	0.009	0.007	0.003
Total Samples		32,922							
Total Sites Sampled		4							

Figure 5.15 Sulfur Dioxide: Second Highest 3-Hour Averages in the Most Recent Year of Data from 2000, 2001 or 2002

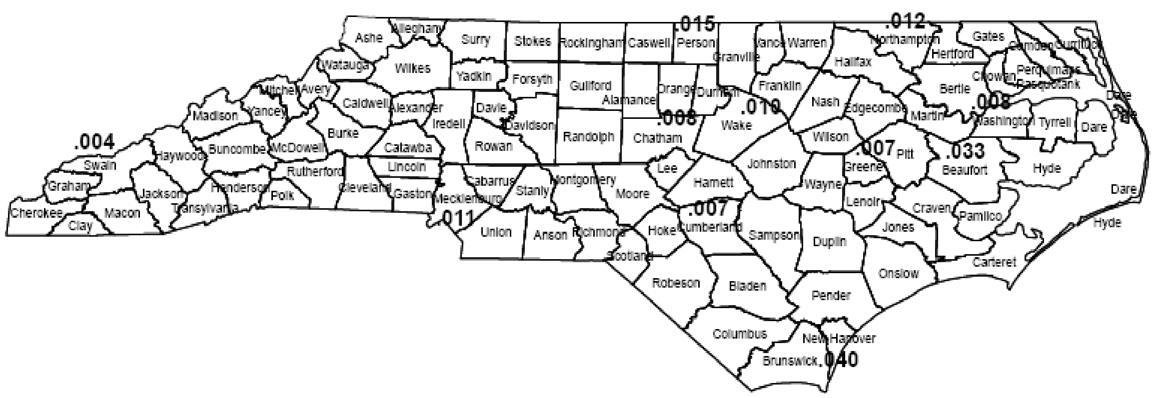


Figure 5.16 Sulfur Dioxide: Second Highest 24-Hour Averages in the Most Recent Year of Data from 2000, 2001or 2002

5.7 *Nitrogen Dioxide*

Nitrogen dioxide (NO_2) concentrations were measured using EPA reference or equivalent continuous monitors in 2002 at one local program site in Forsyth County and one local program site in Mecklenburg County.

From these two sites, 16,616 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 2002 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.

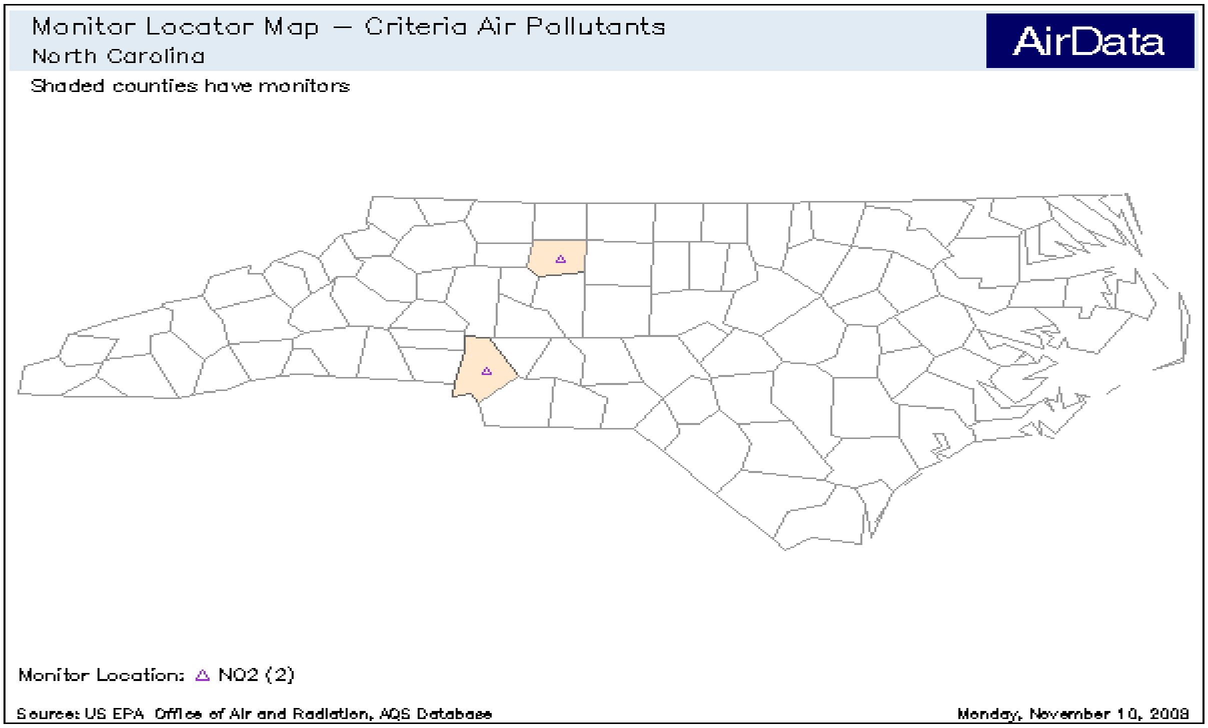


Figure 5.17 Location of Nitrogen Dioxide Monitoring Sites

Table 5.8 Nitrogen Dioxide in Parts Per Million for 2002

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA 1ST	ONE-HOUR MAXIMA 2ND	ARITH MEAN
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	8,363	0.060	0.060	0.014
37-067-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	8,253	0.070	0.065	0.015
Total Samples Total Sites Sampled		16,616 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 2002.

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 $\mu g/m^3$.

In 2002, concentrations of Lead (Pb) in $PM_{2.5}$ particles were measured in samples collected using low volume $PM_{2.5}$ samplers at seven sites in NC. Filters are analyzed by the instrument method Met One SASS Teflon (Met One Instruments Speciation Air Sampling System using a $PM_{2.5}$ filter made of Teflon), and the analytical technique for lead is energy dispersive XRF (X-ray fluorescence).

Out of 423 valid samples analyzed only 9 exceeded 0.01 $\mu g/m^3$ and only 1 exceeded 0.04 $\mu g/m^3$, with value of 0.04370 $\mu g/m^3$.

The lead standard remained 1.5 $\mu g/m^3$ for a quarterly average until 2008, when EPA approved a standard of 0.15 $\mu g/m^3$-quarterly along with revisions in the methodology for sampling and computing the average. (More information about the new standard will be published in a future report after North Carolina begins collecting lead data using the appropriate samplers and techniques.)

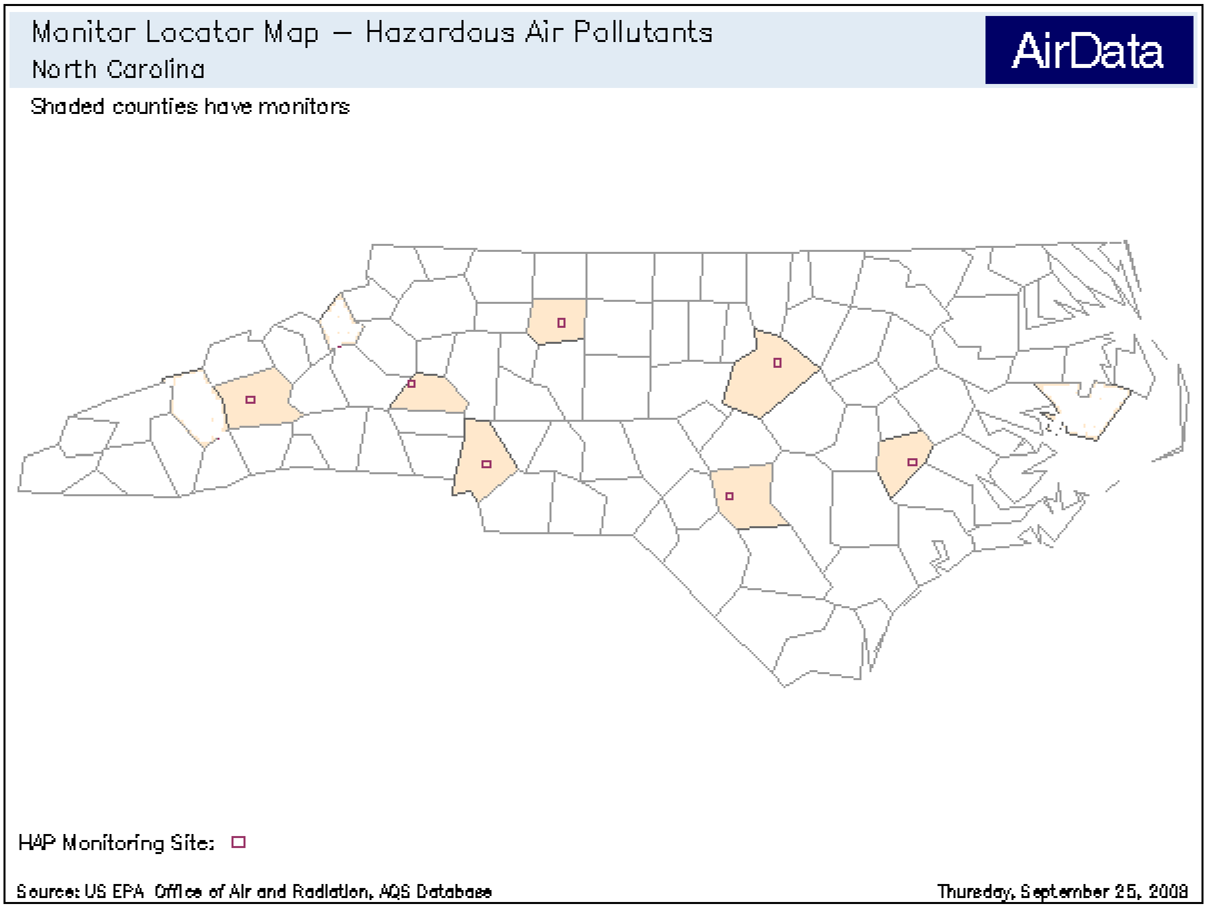


Figure 5.18 Location of Lead - $PM_{2.5}$ Monitoring Sites

Table 5.9 Lead - $PM_{2.5}$ in Micrograms/Cubic Meter 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	.007	.007	.006	.006	.0032
37-035-0004 CATAWBA	1650 1ST. ST HICKORY	50	.010	.009	.009	.008	.0036
37-051-0009 CUMBERLAND	4533 RAEFORD ROAD FAYETTEVILLE	57	.012	.010	.008	.007	.0034
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	59	.014	.013	.011	.010	.0041

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-107-0004 LENOIR	HIGHWAY 70 EAST AND HIGHWAY 58 SOUTH KINSTON	55	.044	.012	.008	.006	.0040
37-119-0041 MEKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	95	.022	.011	.009	.009	.0037
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	58	.008	.007	.007	.007	.0033
Total Samples		423					
Total Sites Sampled		7					

Figure 5.19 Lead -$PM_{2.5}$: Second Highest 24-Hour Averages, 2002

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 2002, 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.)

Asheville did not have AQI monitors operating every day of the year. During January through March PM10 and PM2.5 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, PM10 and PM2.5 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 ocured in June, five occurred in August, and one during September.

Figure 6.1 shows the 2002 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 2002 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 19 out of 365 days monitored. All 19 of these days occurred between May and September. Figure 6.5 shows the 2002 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 32 out of 365 days monitored. All 32 of these days occurred between May and September. Figure 6.7 shows the 2002 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 30 out of 365 days monitored. All 30 of these days occurred between May and September. 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 "*unhealthy for sensitive groups*" or "*unhealthy*" only 2 days out of 365 days monitored. One occurred in May and one during July. Figure 6.11 shows the 2002 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, 2002

MSA	STATISTICAL TREATMENT	GOOD	MODERATE	UNHEALTHY FOR SENSITIVE GROUPS	UNHEALTHY
Asheville	actual	195.0	60.0	7.0	0.0
Asheville	*adjusted*	*289.3*	*68.6*	*7.1*	*0.0*
Charlotte	actual	194.0	132.0	28.0	10.0
Fayetteville	actual	219.0	127.0	18.0	1.0
Greensboro	actual	199.0	134.0	28.0	4.0
Raleigh	actual	204.0	131.0	23.0	7.0
Wilmington	actual	302.0	61.0	2.0	0.0

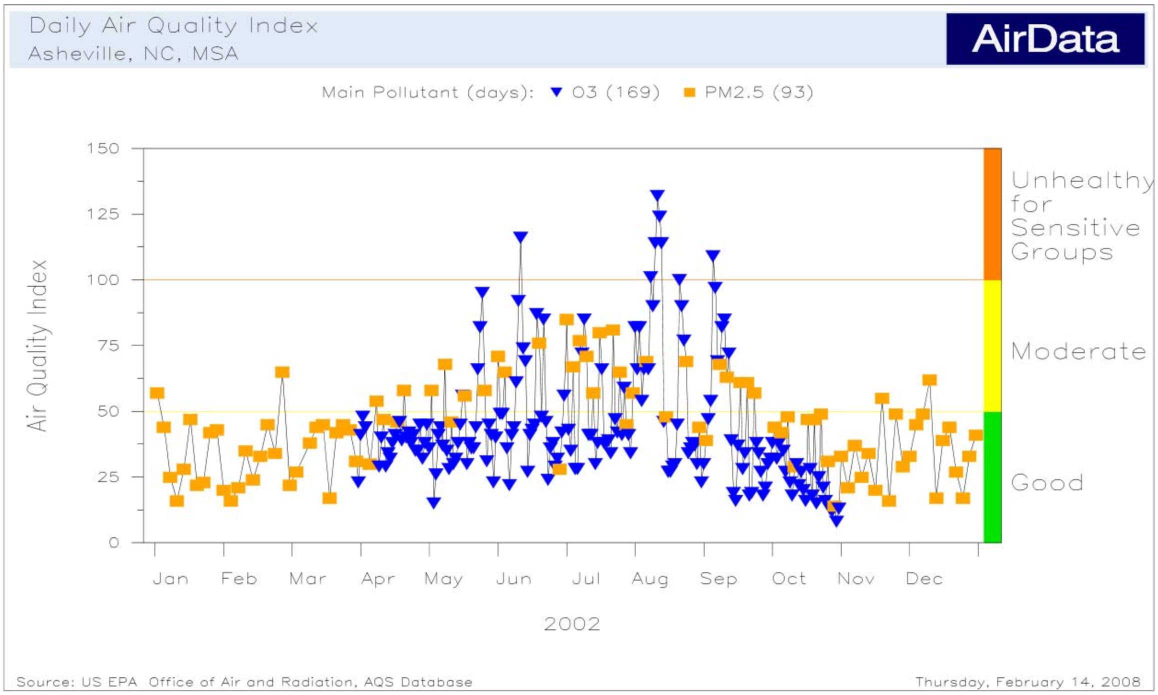


Figure 6.1 Daily Air Quality Index Values for Asheville

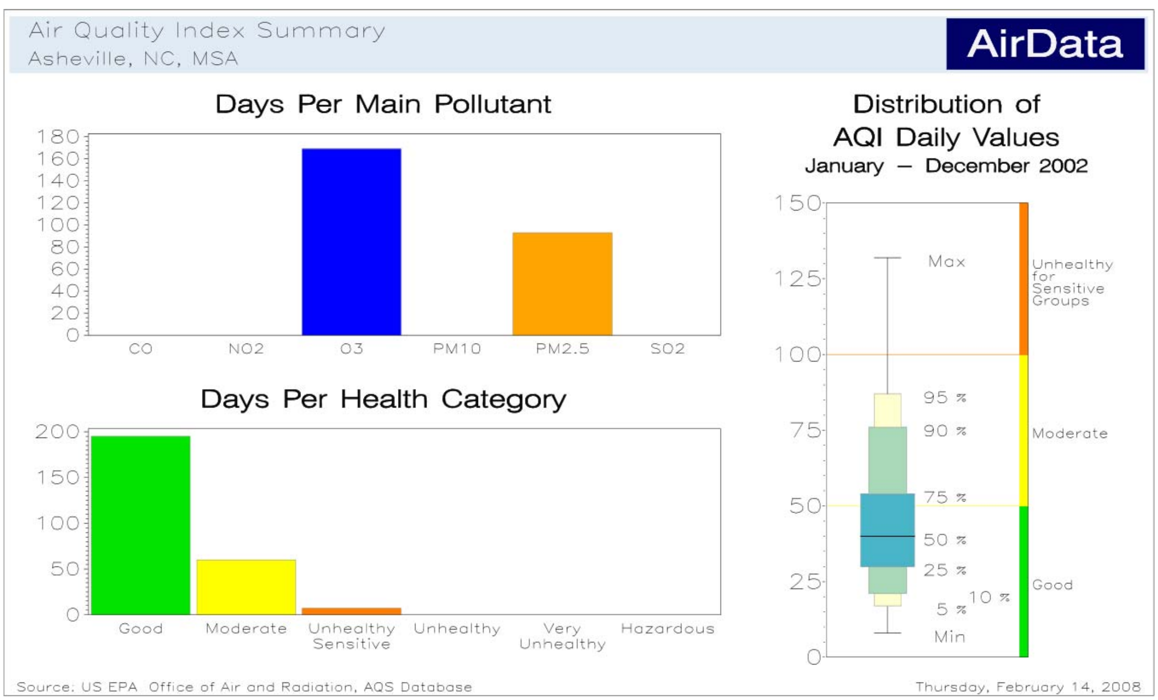


Figure 6.2 Daily Air Quality Index Summary for Asheville

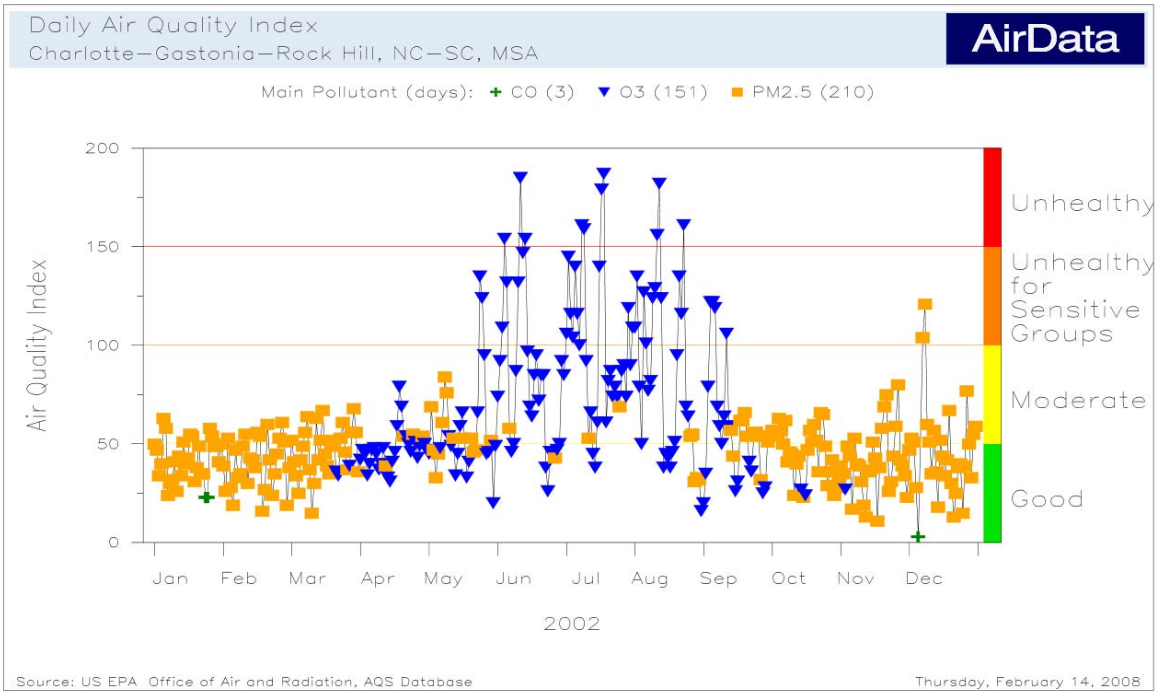


Figure 6.3 Daily Air Quality Index Values for Charlotte-Gastonia

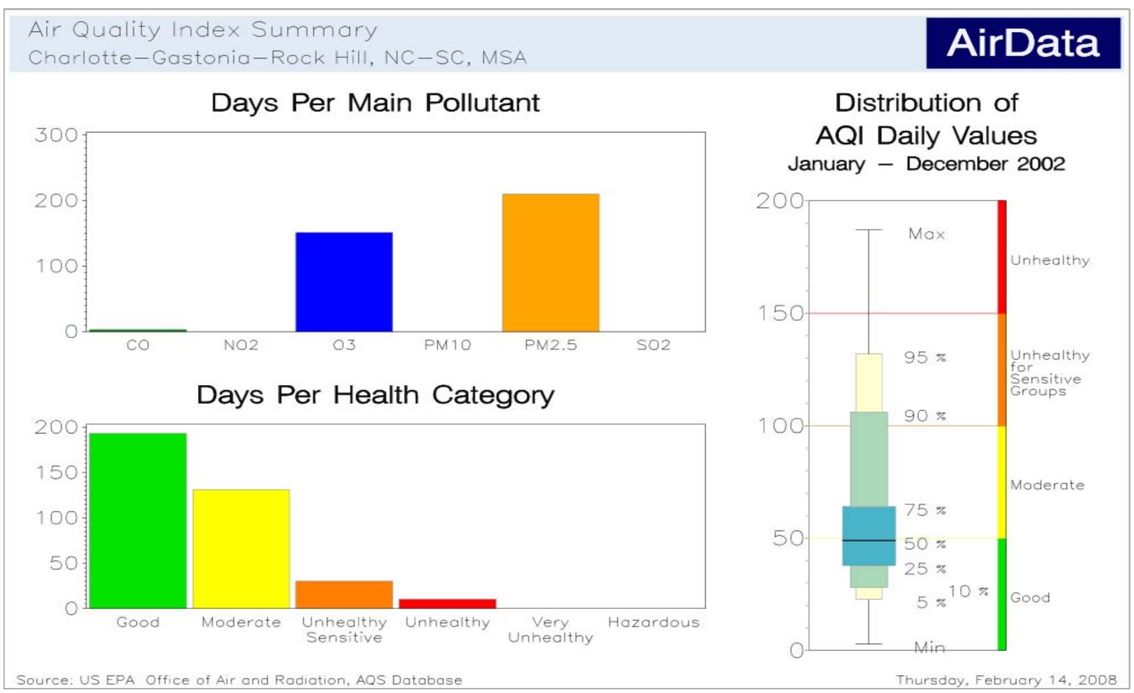


Figure 6.4 Daily Air Quality Index Summary for Charlotte-Gastonia

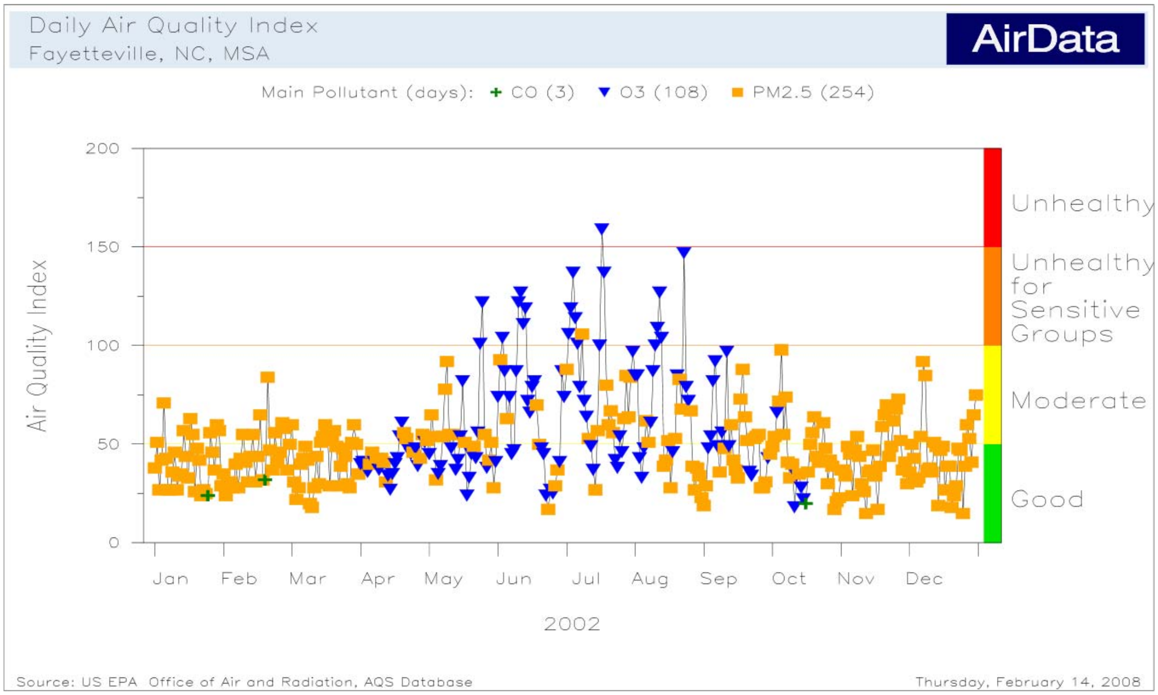


Figure 6.5 Daily Air Quality Index Values for Fayetteville

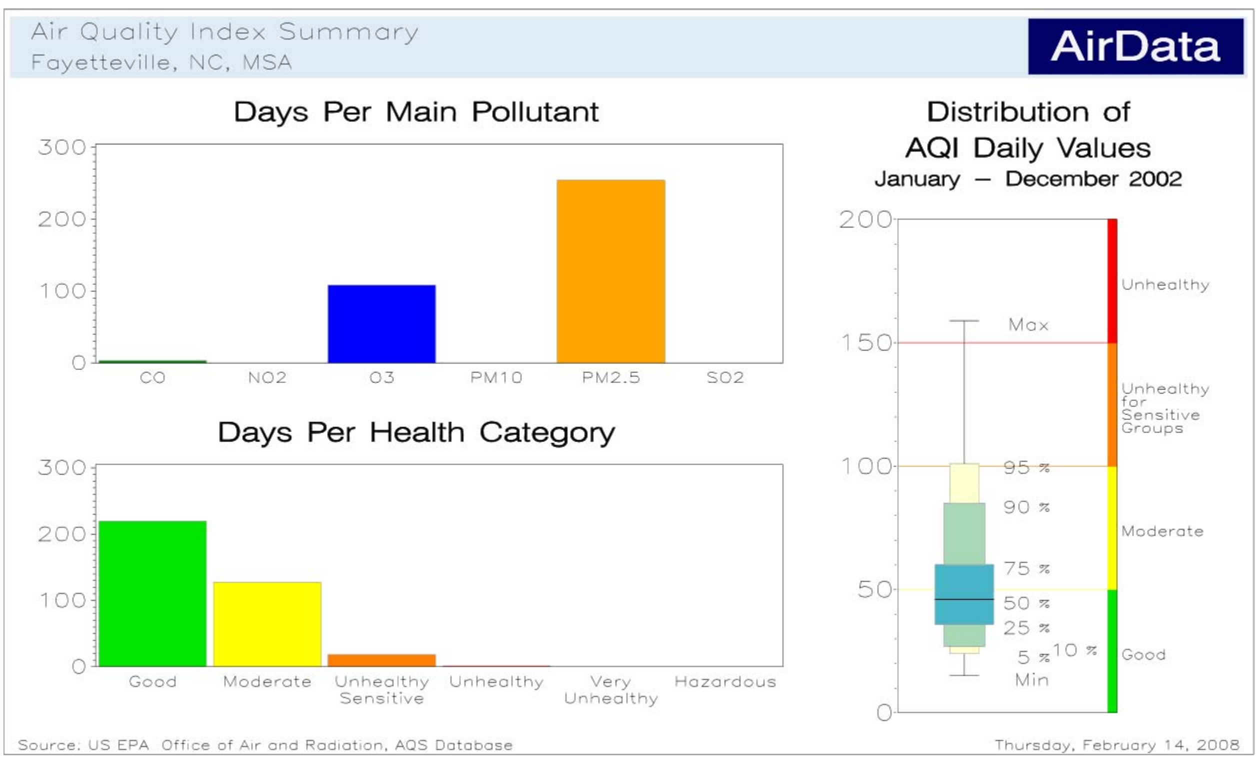


Figure 6.6 Daily Air Quality Index Summary for Fayetteville

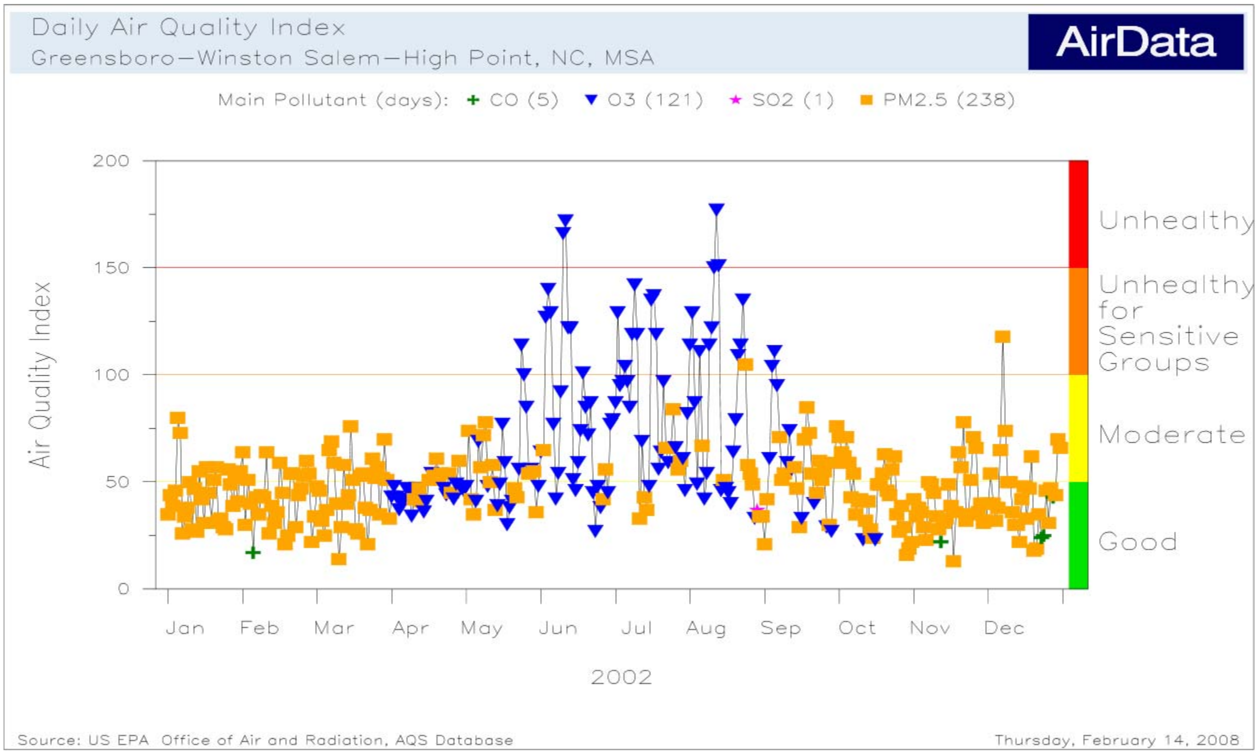


Figure 6.7 Daily Air Quality Index Values for Greensboro-Winston-Salem-High Point

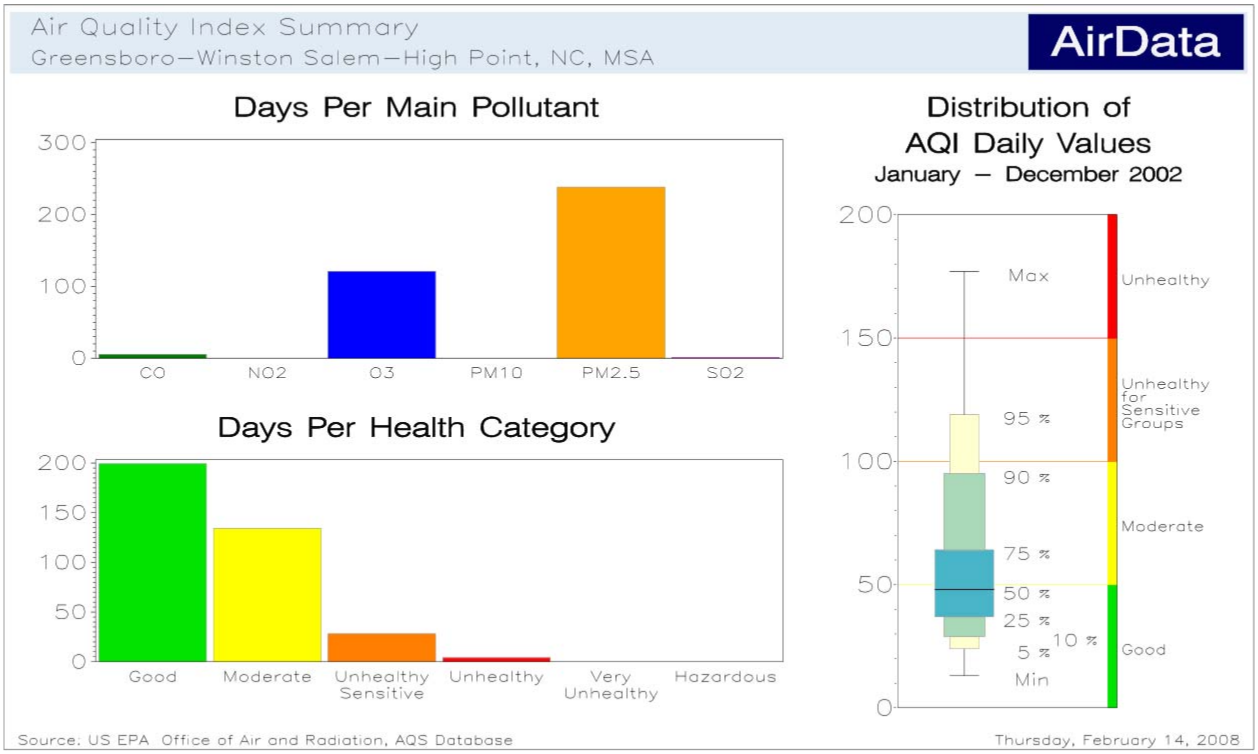


Figure 6.8 Daily Air Quality Index Summary for Greensboro-Winston-Salem-High Point

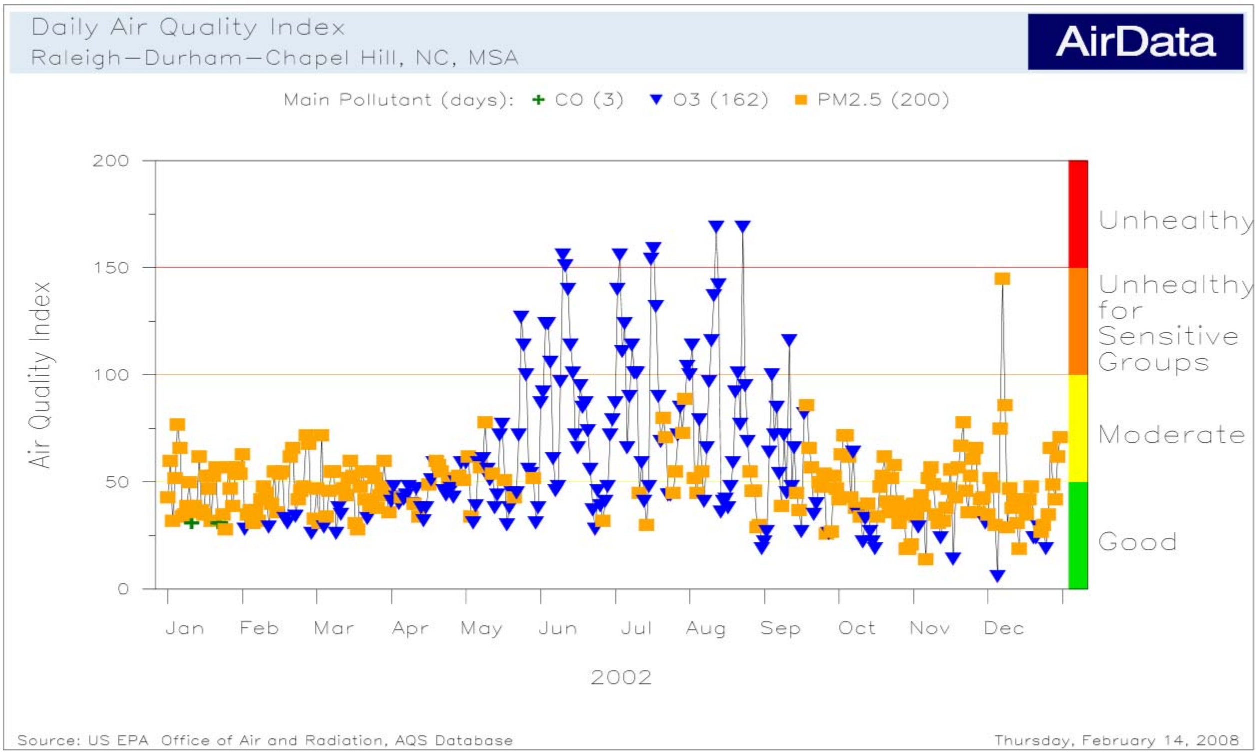


Figure 6.9 Daily Air Quality Index Values for Raleigh-Durham-Chapel Hill,

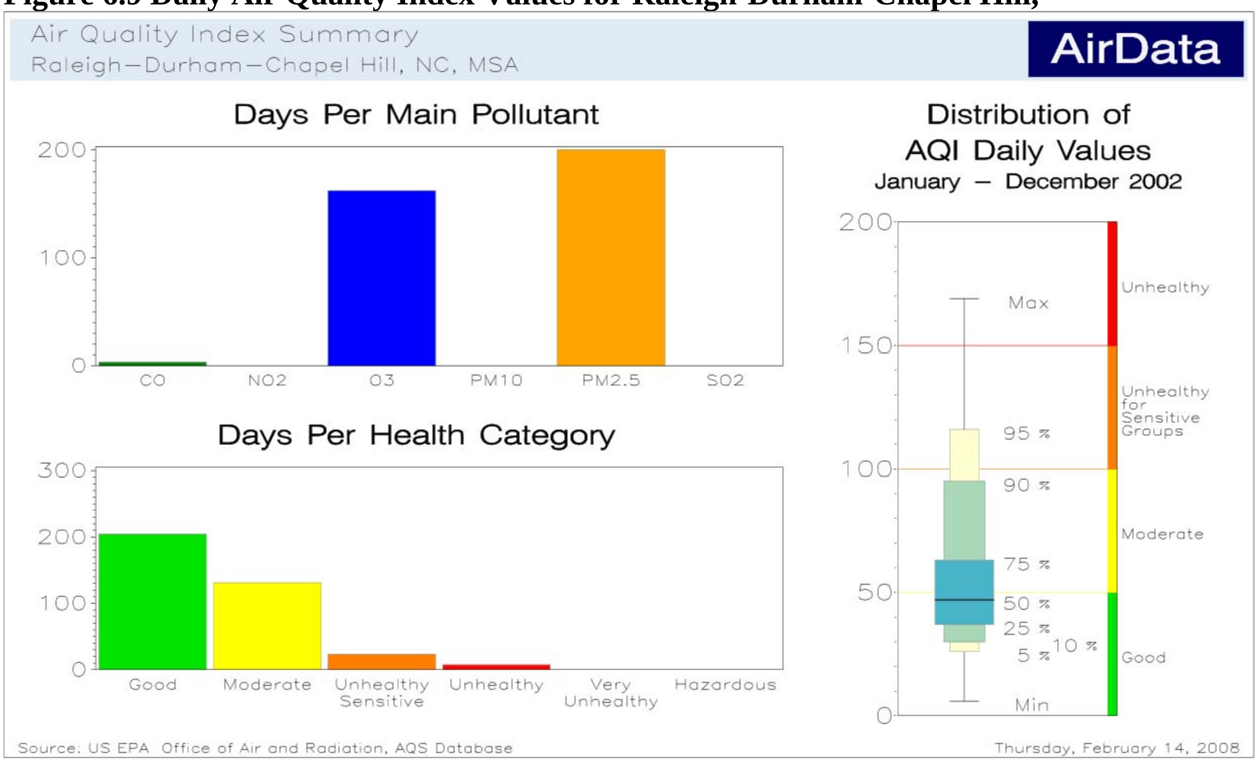


Figure 6.10 Daily Air Quality Index Summary for Raleigh-Durham-Chapel Hill

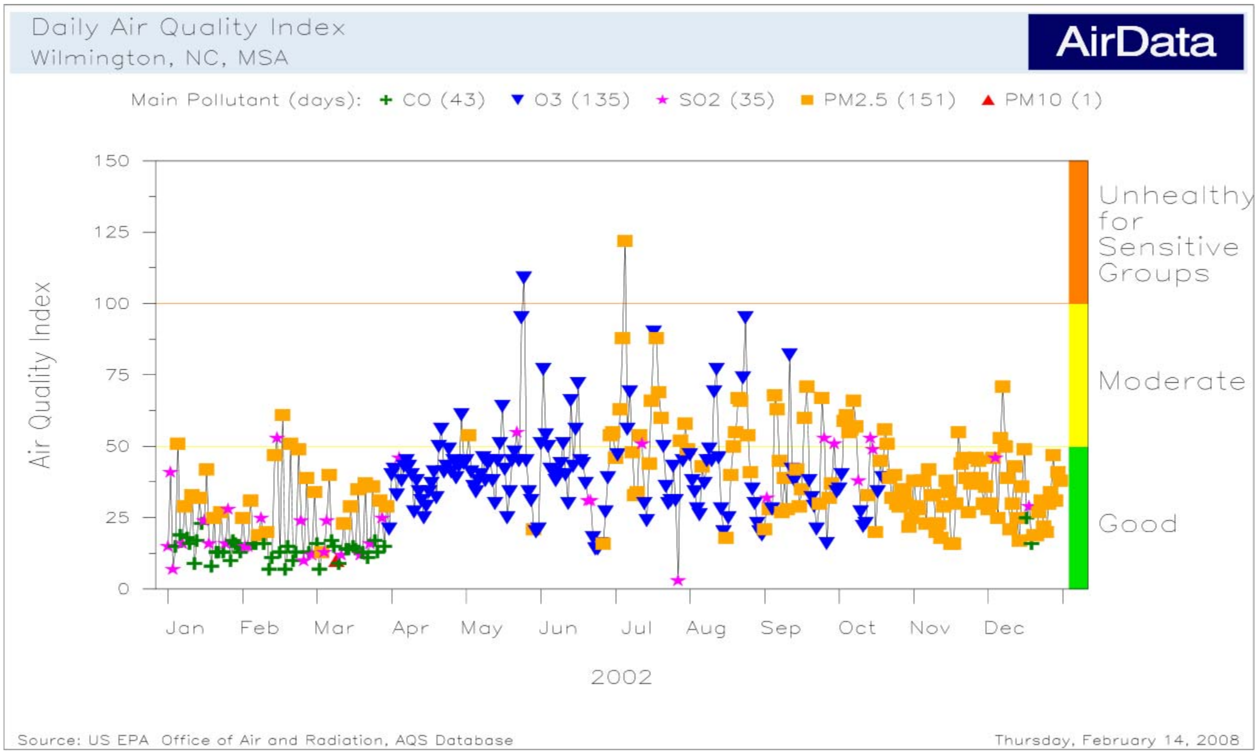


Figure 6.11 Daily Air Quality Index Values for Wilmington

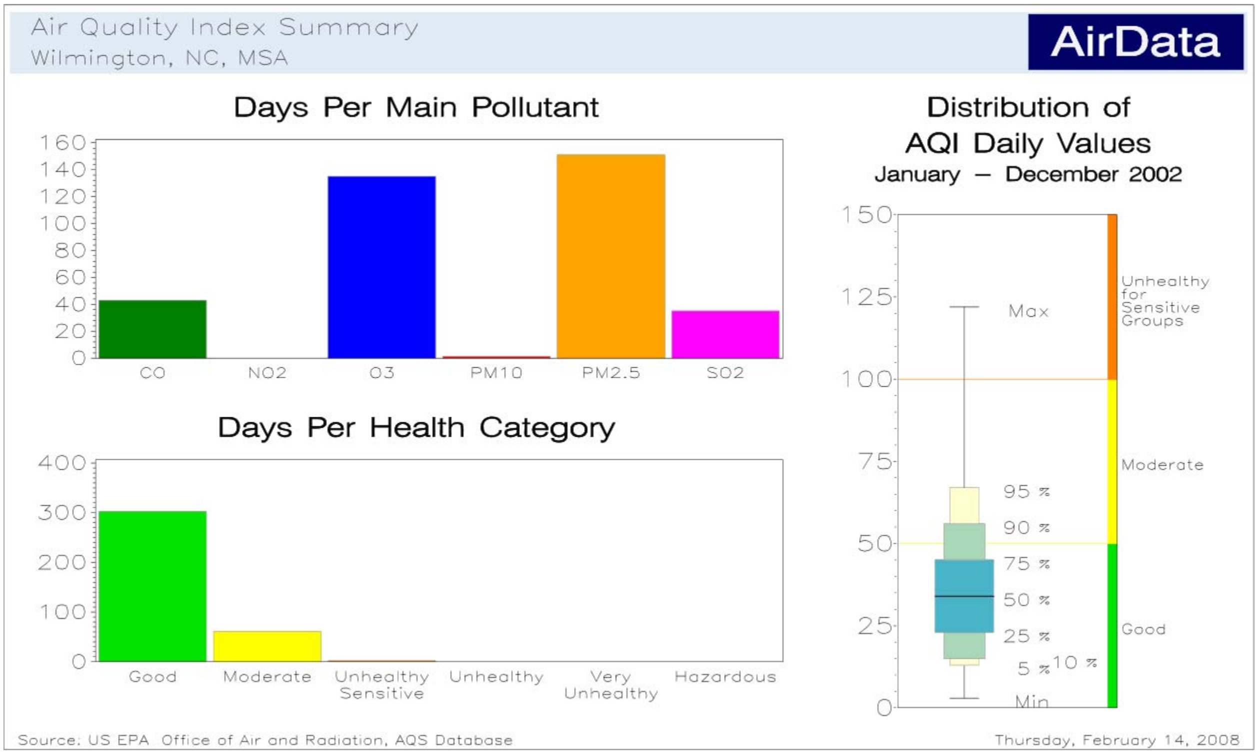


Figure 6.12 Daily Air Quality Index Summary for Wilmington

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 2002, 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 2002 ranged from 4.57 to 4.91 with a mean of 4.72. The 2002 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 highest at the Sampson County site.

Figure 7.1 Annual Mean pH Values at North Carolina NADP Sites, 2002

Table 7.1 pH, Conductivity in Microsiemans per Centimeter and Precipitation in Inches from the National Atmospheric Deposition Program for 2002.

County Site ID Address	pH	Conductivity	Precipitation
Bertie NC03 Lewiston	4.62	16.02	44.48
Carteret NC06 Beaufort	4.82	13.61	62.78
Macon NC25 Coweeta	4.80	10.02	66.94
Rowan NC34 Piedmont Research Station	4.57	17.04	37.36
Sampson NC35 Clinton Crops Research Station	4.91	11.81	46.30
Scotland NC36 Jordan Creek	4.64	15.04	44.74
Wake NC41 Finley Farm	4.72	13.38	44.81
Yancey NC45 Mt. Mitchell	4.82	9.12	70.12
Sevier (TN) TN11 Great Smoky Mountains National Park-Elkmont	4.62	15.28	64.98

Table 7.2 Ion Concentrations in Milligrams per Liter (Precipitation-weighted Annual Means) from the National Atmospheric Deposition Program Data for 2002.

County Site ID	% Complete-ness	Ca	Mg	K	Na	NH4	NO3	Cl	SO4
Bertie NC03	82	0.061	0.027	0.018	0.205	0.243	0.999	0.373	1.327
Beaufort NC06	96	0.052	0.069	0.029	0.629	0.105	0.573	1.143	0.833
Macon NC25	88	0.039	0.011	0.023	0.077	0.128	0.564	0.142	0.822
Rowan NC34	92	0.059	0.017	0.062	0.087	0.204	0.879	0.203	1.533
Sampson NC35	92	0.042	0.022	0.027	0.176	0.397	0.797	0.327	1.129
Scotland NC36	90	0.048	0.020	0.017	0.163	0.208	0.884	0.299	1.231
Wake NC41	92	0.040	0.015	0.013	0.124	0.263	0.879	0.234	1.153
Yancey NC45	83	0.031	0.007	0.009	0.044	0.105	0.452	0.085	0.765
Sevier (TN) TN11	85	0.078	0.017	0.060	0.066	0.207	0.875	0.129	1.354

8 Statewide Trends

The N.C. DENR has published an analysis of long term trends in North Carolina, statewide and within the individual Air Quality Control Regions, covering air pollutant concentrations from 1972 through 2002 (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.

8.1 *Particulate Matter*

The statewide distribution of second-highest 24-hour PM_{10} concentrations for each monitor from 1989 to 2002 is shown in Figure 8.1. Concentrations have decreased from 58 to about 40 $\mu g/m^3$ (a 32 percent decline).

8.2 Carbon Monoxide

The statewide distribution of second-highest eight-hour CO concentrations from 1991 to 2002 is shown in Figure 8.2. The average value of this concentration decreased from 5.93 ppm in 1991 to 3.2 ppm in 2002 (a decline of 46 percent). There have been no CO exceedances since 1991.

8.3 Ozone

The statewide distribution of fourth-highest eight-hour ozone concentrations is shown in Figure 8.3. In 2002, the end point of the 18 year period, the monitoring network average was 0.095, which is 118 percent of the standard. Figure 8.4 shows the number of days with exceedances every year from 1985 to 2002. Exceedance days decreased steadily from 76 in 1998 to 34 in 2001, but there were 51 days in 2002. However, 1988 with 76 days of exceedances, has been the worst year for ozone on record on a national basis.

8.4 Sulfur Dioxide

The statewide distribution of second-largest three-hour sulfur dioxide (SO_2) concentrations from 1989 to 2002 is shown in Figure 8.5. The average decreased from 0.088 ppm in 1989 to 0.05 ppm in 2002 (11 percent of the standard), for a 39 percent decrease. The statewide distribution of second-largest 24-hour SO_2 concentrations from 1989 to 2002 is shown in Figure 8.6. The average decreased from 0.027 ppm in 1989 to 0.02 ppm in 2002 (15 percent of the standard), for a 23 percent decrease.

8.5 Nitrogen Dioxide

The Forsyth and Mecklenburg County distribution of annual average nitrogen dioxide (NO_2) concentrations from 1989 to 2002 is shown in Figure 8.7. The average concentration was approximately constant around 0.016 ppm (30 percent of the standard).

8.6 pH

The statewide distribution of annual average pH values of rainfall from 1989 to 2002 for the NADP sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 8.8. The mean pH has increased 4 percent over the 18 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).

8.7 Ammonium Ion

The statewide distribution of annual average ammonium ion (NH_4^+) concentrations from 1989 to 2002 for the NADP sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 8.9. From 1989 to 2002 there appears to be a decrease of 7 percent. Ammonium ion concentration in rain increased significantly in Sampson County in 2000 where there is concentrated animal production. (Cornelius, 1997) but it decreased slightly in 2002. The NADP study suggested that the 1994 protocol change had no net effect on measured NH_4^+ concentrations (NADP 1995).

8.8 Nitrate Ion

The statewide distribution of annual average nitrate ion (NO_3^-) concentrations from 1989 to 2002 for the NADP/NTN sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 8.10. The mean has decreased by 15 percent over the study period. The NADP study suggested that NO_3^- concentrations will decrease by a median amount of 0.01 (s.e. = 0.002) due to the protocol change in 1994 (NADP 1995).

8.9 Sulfate Ion

The statewide distribution of annual average sulfate ion (SO_4^{2-}) concentrations from 1989 to 2002 for the NADP sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 8.11. The average has decreased from 1.5 mg/L in 1989 to 1.1 mg/L in 2002, for a 29 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).

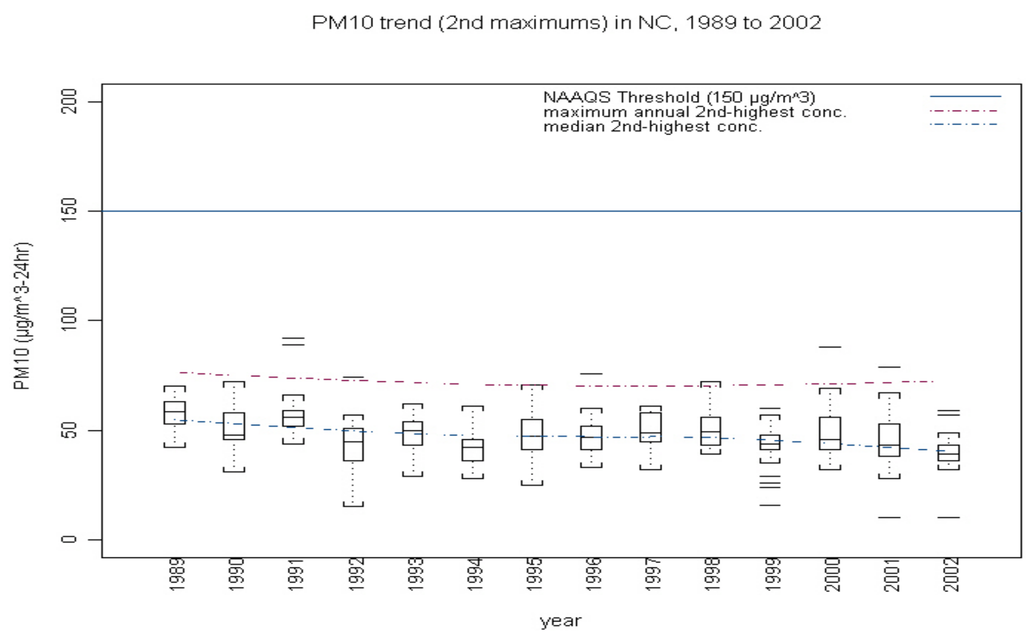


Figure 8.1 Distribution of Statewide Second-Maximum 24-Hour PM_{10} Concentrations, 1989- 2002, and Smoothed Regression Trend Line.

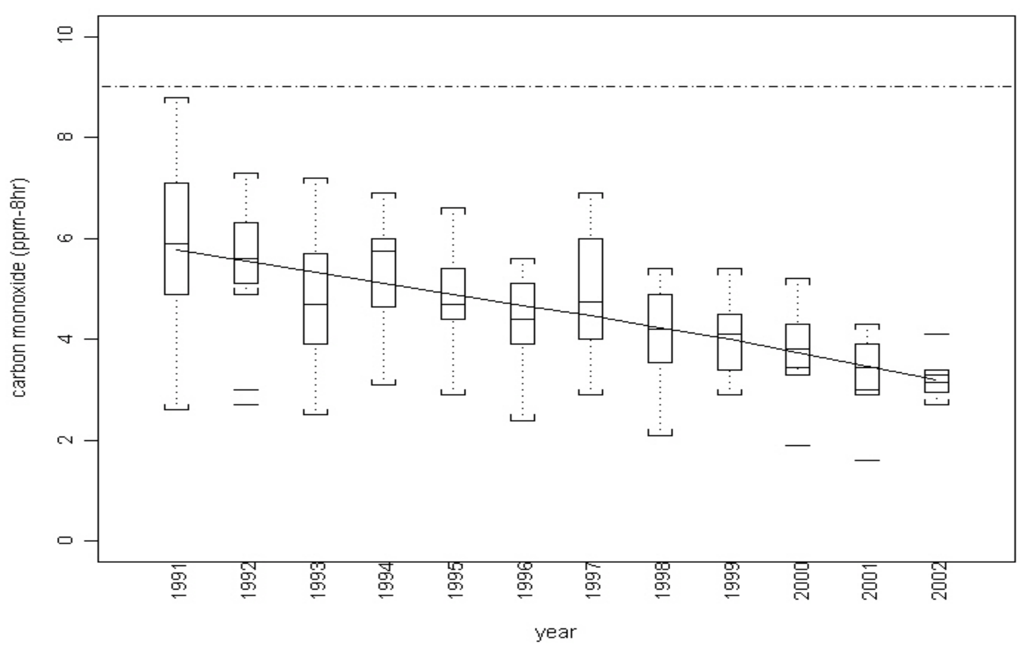


Figure 8.2 Distribution of Statewide Second-Maximum 8-Hour Carbon Monoxide Concentrations, 1991- 2002, and Smoothed Regression Trend Line.

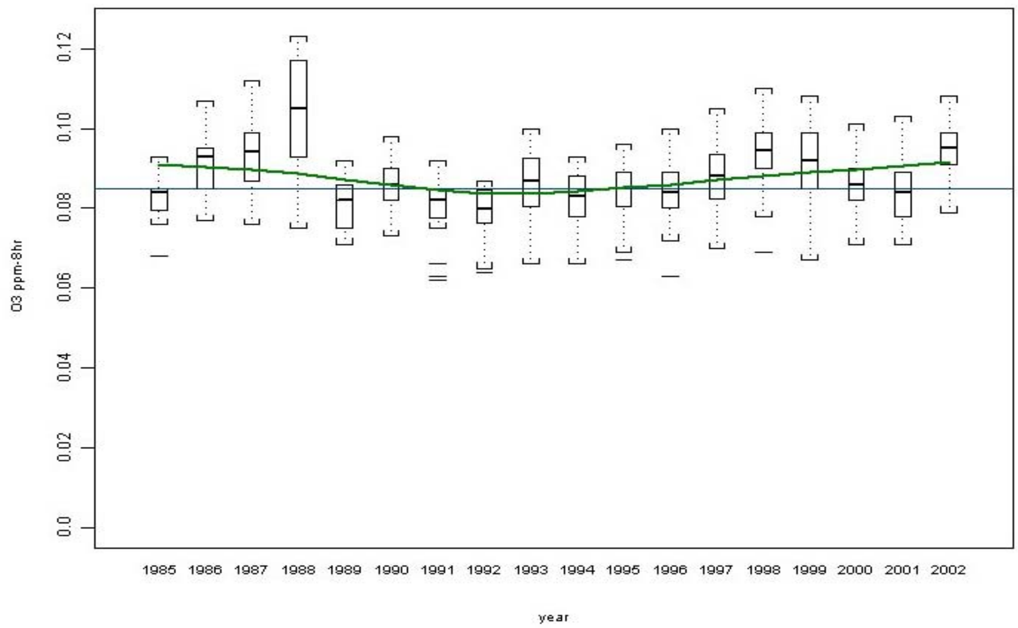


Figure 8.3 Distribution of Statewide Fourth-Maximum 8-Hour Ozone Concentrations, 1985- 2002, and Smoothed Regression Trend Line.

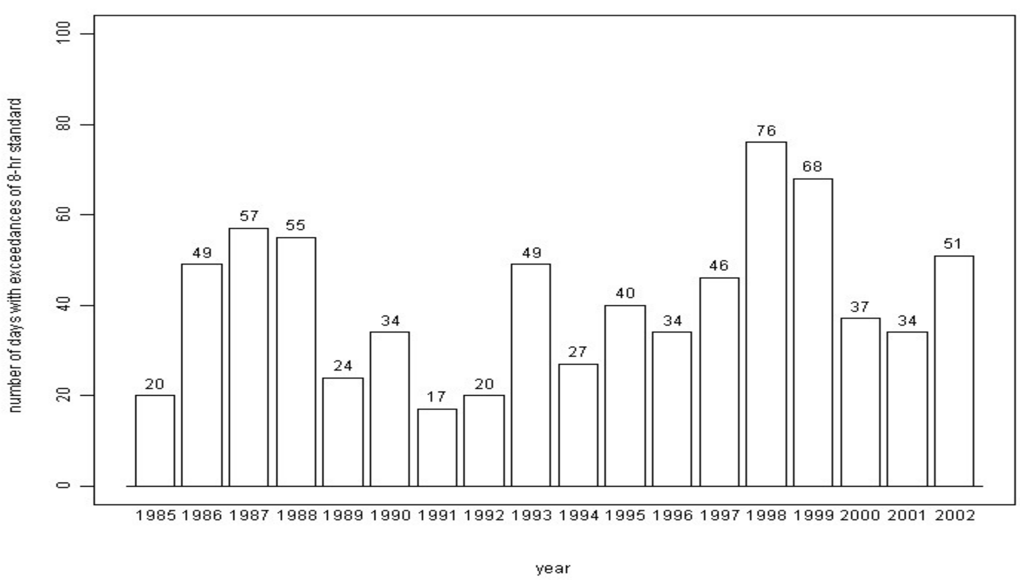


Figure 8.4 Number of days with exceedances of 8-Hour Ozone Averages of 0.085 ppm or Greater, 1985 – 2002.

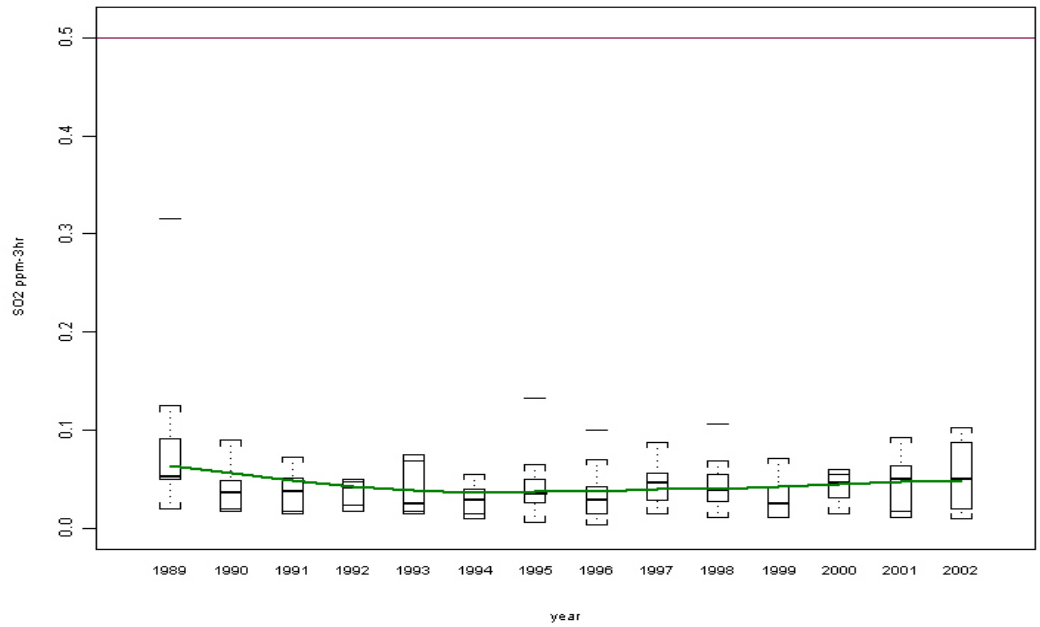


Figure 8.5 Distribution of Statewide Second-Maximum 3-Hour Sulfur Dioxide Concentrations, 1989- 2002, and Smoothed Regression Trend Line.

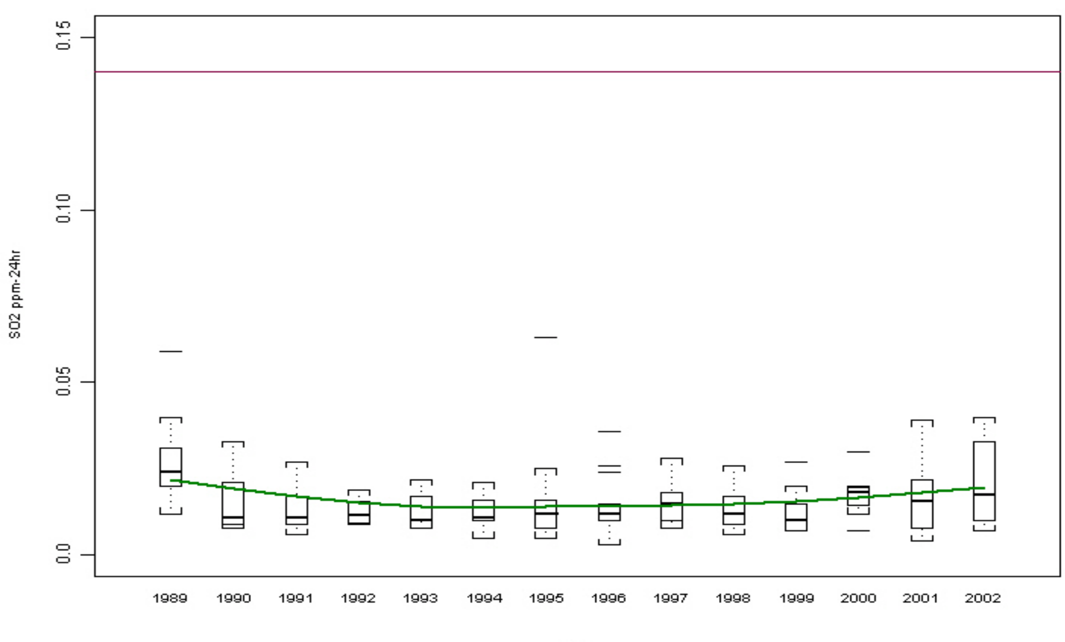


Figure 8.6 Distribution of Statewide Second- Maximum 24-Hour Sulfur Dioxide Concentrations, 1989- 2002, and Smoothed Regression Trend Line.

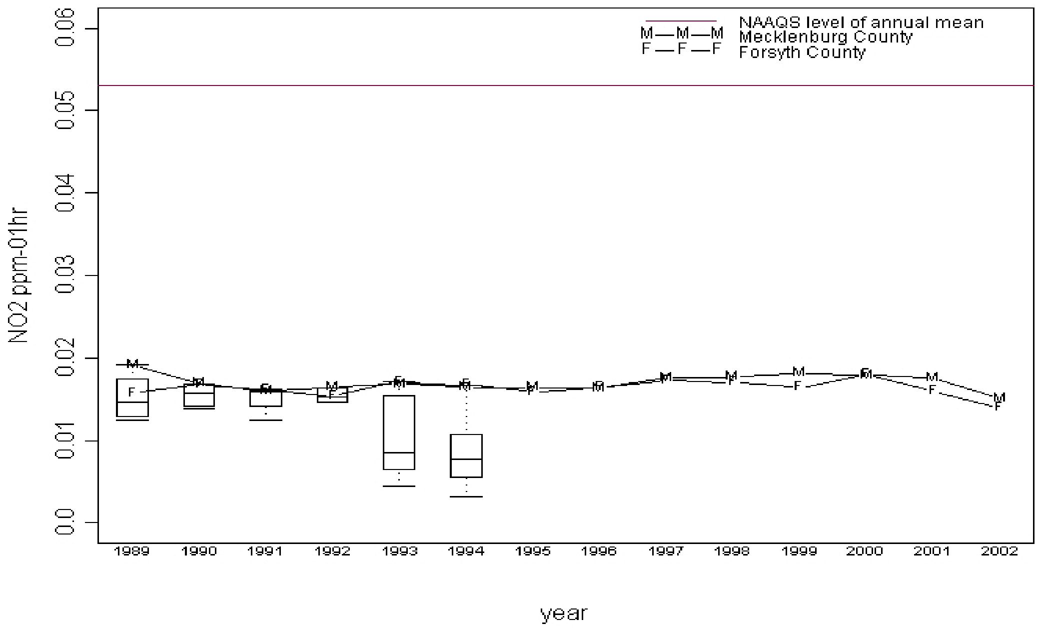


Figure 8.7 Distributions of Forsyth and Mecklenburg County Annual Mean Nitrogen Dioxide Concentrations, 1989 - 2002, and Smoothed Regression Trend Line.

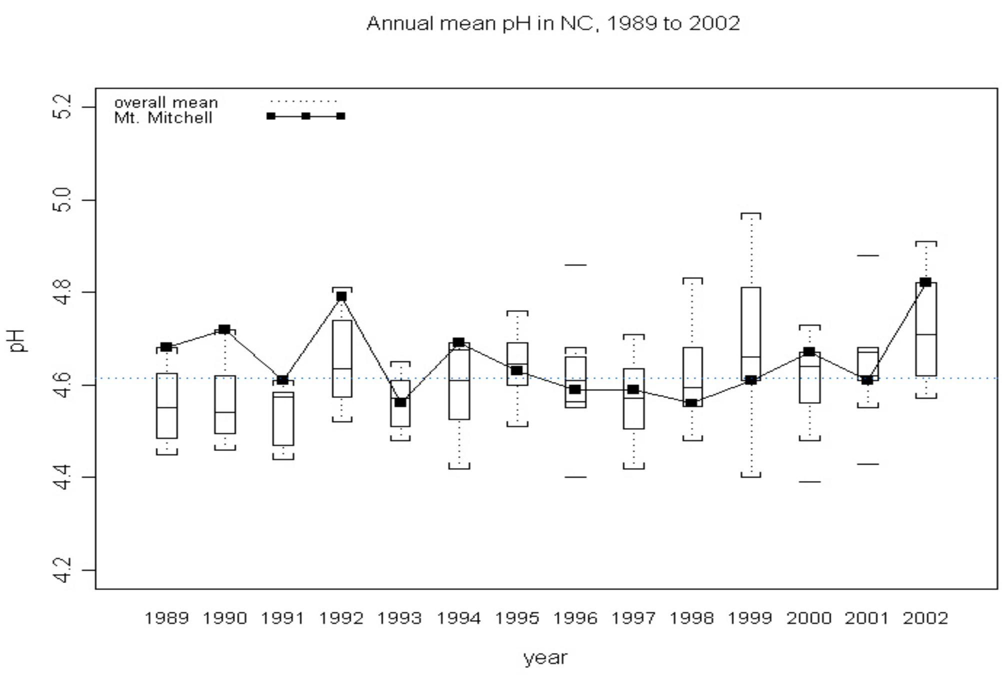


Figure 8.8 Distribution of Statewide Annual Mean pH, 1989 – 2002.

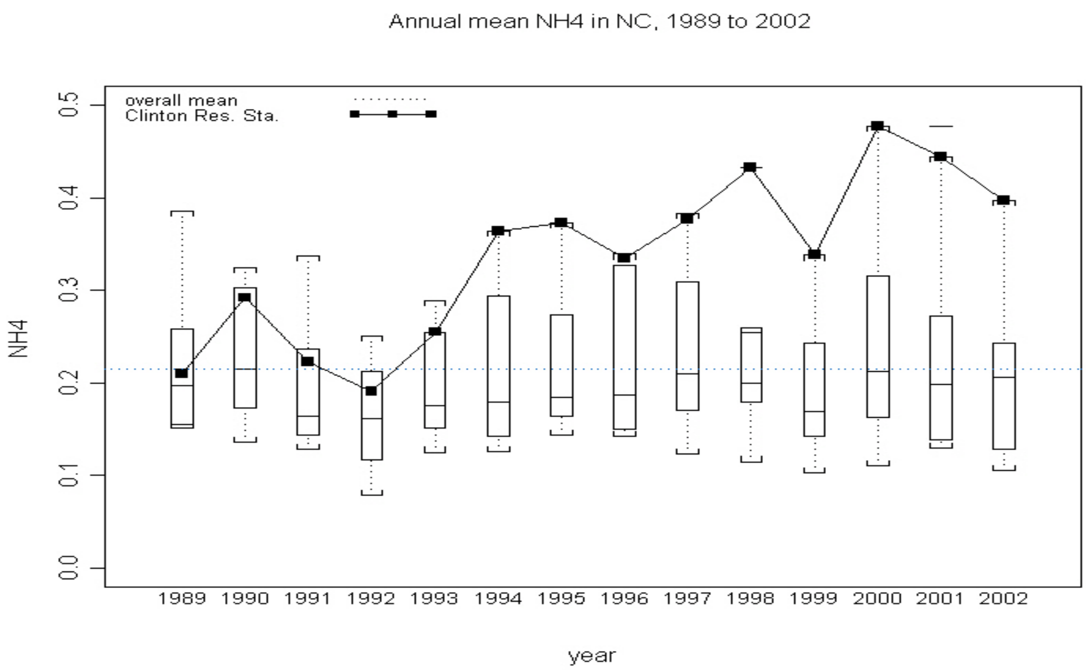


Figure 8.9 Distribution of Statewide Annual Mean Ammonium Ion Concentrations, 1989-2002.

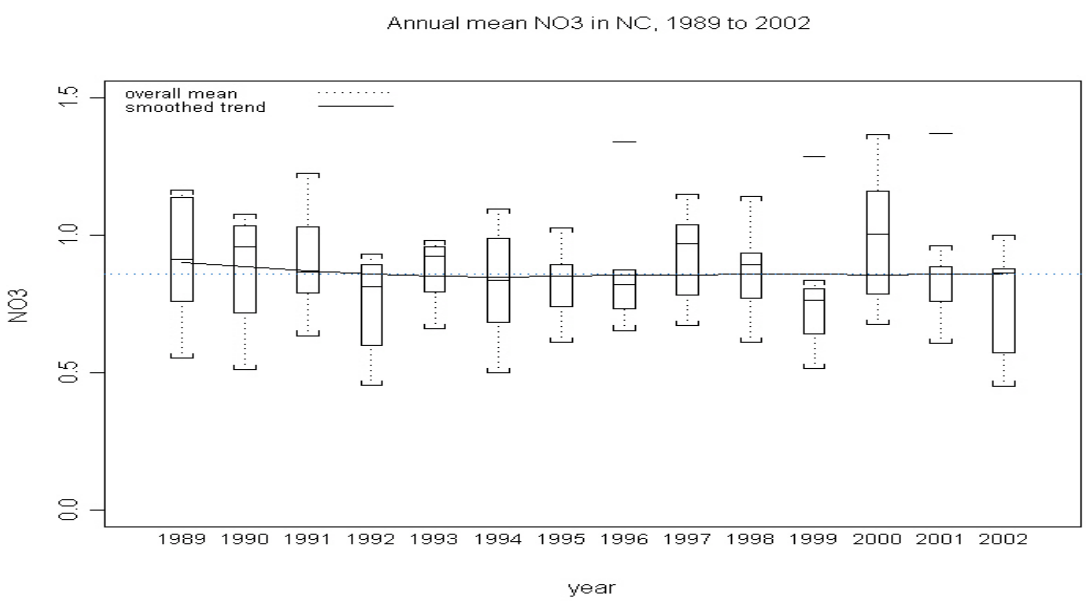


Figure 8.10 Distribution of Statewide Annual Mean Nitrate Ion Concentrations, 1989-2002, and Smoothed Regression Trend Line.

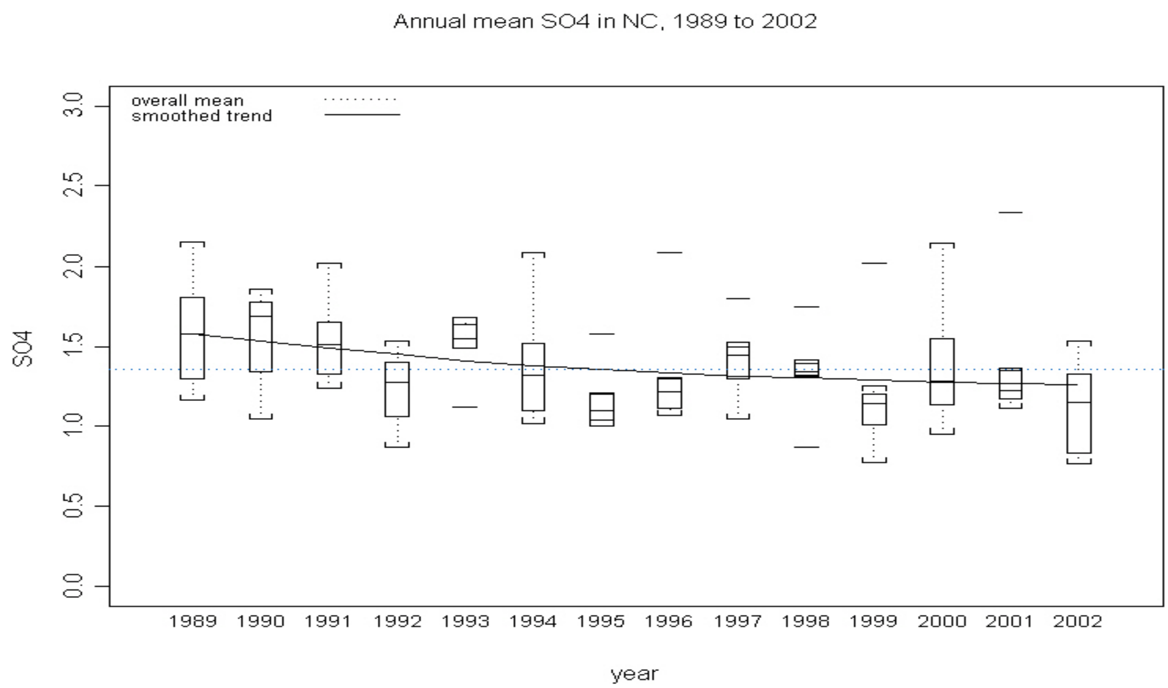


Figure 8.11 Distribution of Statewide Annual Mean Sulfate Ion Concentrations, 1989-2002, and Smoothed Regression Trend Line.

References

Cornelius, Wayne L. (1996). Effects of North Carolina′s Oxygenated Fuel Program on Ambient Carbon Monoxide Concentrations. *Air Quality Section, Division of Environmental Management, N.C. Dept. Of Env., Health, and Nat. Res.*

Cornelius, Wayne L. (1997). Comparison of Nitrogenous Ion Deposition and Human and Animal Census Trends in Eastern North Carolina. *Air Quality Section, Division of Environmental Management, N.C. Dept. Of Env., Health, and Nat. Res.*

Maynard, Andrew D. and Paul a. Jensen (2001). Aerosol Measurement in the Workplace. Chapter 25 in *Aerosol Measurement: Principles, Techniques, and Applications, Second Edition*, Paul A. Baron and Klause Willeke, eds., p. 779-799.

NADP (National Atmospheric Deposition Program) (1995). Notification of Important Change in NADP/NTN Procedures on 11 January 1994.

North Carolina Department of Environment, Health, and Natural Resources (1991a). 1989 Ambient Air Quality Report. *Air Quality Section, Division of Environmental Management, N.C. Dept. Of Env., Health, and Nat. Res.*

North Carolina Department of Environment, Health, and Natural Resources (1991b). Ambient Air Quality Trends in North Carolina 1972-1989. *Air Quality Section, Division of Environmental Management, N.C. Dept. Of Env., Health, and Nat. Res.*

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

Watson, John G. and Judith C. Chow (2001). Ambient Air Sampling. Chapter 27 in *Aerosol Measurement: Principles, Techniques, and Applications, Second Edition*, Paul A. Baron and Klause Willeke, eds., p. 821-844

Appendix A. Air Pollution Monitoring Agencies

North Carolina State Headquarters

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, NC 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, NC 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

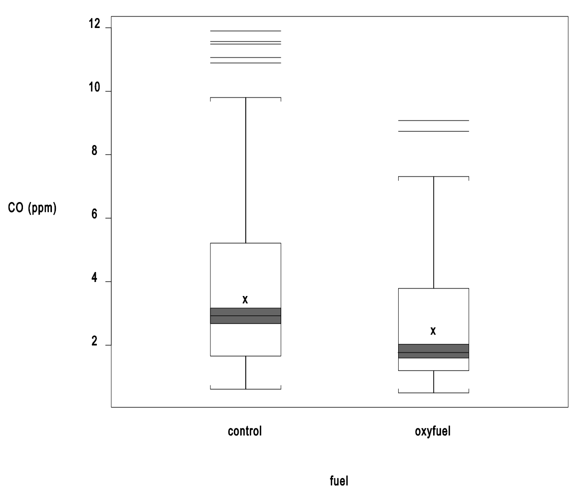
Appendix B. Exceptional Events

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 tailpipe 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.