2011 Ambient Air Quality Report

STATE OF NORTH CAROLINA
Pat McCrory, Governor

DEPARTMENT OF
ENVIRONMENT
AND
NATURAL RESOURCES
John E. Skvarla, III, Secretary

DIVISION OF AIR QUALITY
Sheila C. Holman, Director

AMBIENT MONITORING SECTION
Donald D. Redmond, Jr., Chief

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Acknowledgements:

Primary Author: Wayne Cornelius
Additional Assistance: Lucyna Kozek
Vitaly Karpusenko
John Holland

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National Atmospheric Deposition Program (NRSP-3). 2010. NADP Program Office, Illinois State Water Survey, 2204 Griffith Dr., Champaign, IL 61820 http://nadp.sws.uiuc.edu/

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Preface

This report is issued by the Division of Air Quality of the Department of Environment and Natural Resources to inform the public about 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
Carbon Monoxide
Sulfur Dioxide
Nitrogen Dioxide
Ozone
Lead

The report begins with a brief discussion of the ambient air monitoring program, including a description of the monitoring network. It presents detailed results of monitoring that was conducted in 2011 to measure the outdoor concentrations of air pollutants. The data are presented graphically and as statistical summaries, including comparisons to the ambient air quality standards. The report discusses the recorded data, and the seasonal variability of some pollutants. Data and areas exceeding the ambient air quality standards are identified. Factors that have contributed to those exceedances are also described.

Acid rain data summaries from the National Atmospheric Deposition Program/National Trends Network for North Carolina also are included for 2011.

Current air pollution information is available to the public 24 hours a day on the Division of Air Quality's website http://www.ncair.org/monitor/aqi/.

In 2002, the air monitoring program deployed a network of fine particle speciation monitors. This report provides data summaries from these monitors for 2011.

Also in 2002, the Division of Air Quality established a small network of Urban Air Toxics monitors. It supplements a new national toxics database, and some key toxics pollutants are summarized for 2011 in this report.

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

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

Division of Air Quality
1641 Mail Service Center
Raleigh, North Carolina 27699-1641

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

Sheila C. Holman, Director
Division of Air Quality

Executive Summary

In 2011, the North Carolina Division of Air Quality (DAQ), the three local program agencies and one tribal agency (listed in Appendix A) collected 109,175 ambient 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 (NADP) at seven North Carolina sites and one Tennessee site very close to the North Carolina border. It discusses acid rain and presents summary tables, maps, charts and explanations of the data.

This report provides data summaries from a network of fine particle speciation monitors for 2011. The DAQ and two federal agencies deployed these monitors in 2002 to characterize more fully fine particulate matter by composition. This report presents a map and summary tables of the major speciation categories for 2011.

Also in 2002, the Division of Air Quality established a small network of Urban Air Toxics monitors. It supplements a new national toxics database, and some key toxics pollutants are summarized for 2011 in this report. This report presents a map and summary tables of five important volatile organic compounds for 2011.

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

Two different types of **particulate matter** are routinely sampled in North Carolina. 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 and NC since 1999.

PM_{10} was sampled at 12 sites, yielding 1,275 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 35 sites yielding 4,574 daily samples. There were no exceedances of the ambient air quality standards for PM2.5 (35 $\mu g/m^3$ for 24-hour samples). None of the 35 sites exceeded the annual arithmetic mean standard of 15 $\mu g/m^3$.

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

CO was sampled at four sites, yielding 27,460 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 2.6 ppm was observed at 1401 Corporation Pky in Winston-Salem. The highest eight-hour concentration of 2.3 ppm was observed at 1401 Corporation Pky in Winston-Salem. The mean one-hour average has been decreasing by about 4 percent per year and the mean eight-hour average has been decreasing by about 18 percent per year. The combined effects of newer cars in the vehicle fleet, traffic control strategies, and the Inspection and Maintenance program in 48 counties have helped reduce the measured ambient concentrations of CO from previous years.

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

O_3 was sampled at 45 sites, yielding 9,275 valid hourly averages. The National Ambient Air Quality Standard for O_3 in 2011 was 0.075 ppm for the maximum 8-hour average.

In 2011, the 8-hour standard was exceeded 100 times, on 26 different days, with two counties having 9 exceedances at individual sites.

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 eight sites, yielding 49,752 valid hourly averages. There were no exceedances of the 1971 National Ambient Air Quality Standards (140 ppb for a 24-hour average, 500 ppb for a three-hour average, 30 ppb for the annual arithmetic mean) at any network monitoring sites. However, there was one exceedance of the 2011 National Ambient Air Quality Standards (75 ppb for an 1-hour daily maximum concentration) at one network monitoring site: Highway 421 North, Wilmington in New Hanover County.

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.

The criteria pollutant NO_2 was sampled at two sites, yielding 16,464 valid hourly averages. There were no exceedances of the National Ambient Air Quality Standard (0.053 ppm for the annual arithmetic mean).

There were no exceedances of the 2010 National Ambient Air Quality Standards (100 ppb for the 1 hour average). The mean 1-hour average concentration has been stable for the past two years.

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 2011 using a Federal Reference Method. There have been no recent exceedances of the ambient air quality standard for lead (0.15 µg/m^3 for a rolling three month arithmetic mean). From 1979 through 1999, mean lead concentrations have decreased by 92 percent. 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.

The annual mean pH in 2011 ranged from 4.95 (Scotland County) to 5.35 (Sampson County).

Speciated particulate samples were collected at four sites by the DAQ, two sites by the National Park Service and one site by the U.S. Forest Service. Categorizing these as nitrates, sulfates, ammonium, organic carbon, elemental carbon and crustal material, there were 3,680 quantifiable concentrations in 2011.

By category, the highest concentrations of speciated particulate samples in 2011 were: organic carbon 23.60 µg/m^3; sulfate 9.11 µg/m^3; nitrate 5.68 µg/m^3; ammonium 3.36 µg/m^3 ; crustal component 2.43 µg/m^3 and elemental carbon 1.39 µg/m^3.

Although there was no sampling for lead using a criteria pollutant method, the speciated particulate monitoring network provided 832 samples of $PM_{2.5}$ lead in 2011; 829 of these sample concentrations (99.6 percent) were less than the detection limit of the method. The largest sample exceeded 0.014 µg/m^3.

Urban Air Toxics sampling in 2011 occurred at six sites, five urban and one rural. This effort contributes to the U.S. EPA’s Air Toxics Monitoring Strategy by providing data to help assess health risks.

The median benzene concentrations were 0.13 to 0.28 ppb at the urban sites and 0.33 ppb at the rural site. Median toluene concentrations were 0.18 to 0.46 ppb at the urban sites and 0.09 ppb at the rural site. Median ethylbenzene concentrations were 0.05 to .09 ppb at the urban sites and less than 0.03 ppb at the rural site. Median m/p-xylene concentrations were 0.12 to 0.16 ppb at the urban sites and less than 0.04 ppb at the rural site. Median o-xylene concentrations were 0.05 to 0.011 ppb at the urban sites and less than 0.02 at the rural site. Median 1, 3-butadiene concentrations were 0.00 to 0.05 ppb at the urban sites and less than 0.001 at the rural site. Ambient monitoring data for hazardous and/or toxic air pollutants are available on the web at http://daq.state.nc.us/toxics/uat/uat_data.shtml.

Ambient Trends: Annual average statewide concentrations of criteria pollutants changed in 2011 as follows:

- PM_{10} decreased by 48 percent since 1991.
- $PM_{2.5}$ decreased by 40 percent since 1999.
- CO (as 8-hour overlapping averages) decreased by 62 percent since 1998.
- Ozone (as daily maximum 8-hour concentrations) decreased by 11 percent since 1991.
- Nitrogen dioxide concentrations (monitored only in Forsyth and Mecklenburg counties) have remained nearly constant since 1991.

Acid Rain Trends: From 1991 to 2011:

- The annual average pH in rain increased about 11 percent.
- Annual average ammonium concentrations increased about 52 percent; but this was dominated by very significant increases in Sampson County associated with concentrated livestock animal production.
- Annual average nitrate concentrations in rain decreased about 32 percent.
- Annual average sulfate concentrations in rain decreased about 51 percent.

CONTENTS

List of Tables

List of Figures

1. Introduction

This annual report summarizes the ambient air monitoring performed in calendar year 2011 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.

These agencies collected 109,175 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 for 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. It also includes a map of the calendar year mean pH level and site statistics for the calendar year in two tables.

Chapter 8 describes a small network of fine particulate speciation compounds. The chapter contains annual summaries of seven main components of fine particles. We also report summary of lead here (instead of chapter 5).

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

Chapter 10 provides a statewide summary of trends for the criteria pollutants from 1989 and 1991 (1997 for CO and 1990 for O_3) through 2011.

2 Descriptions 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 2011, two sizes of particulate matter were monitored, PM_{10} and $PM_{2.5}$. PM_{10} is particulate matter with an aerodynamic diameter less than or equal to 10 μm. PM_{10} has been sampled in North Carolina since 1985. Monitoring $PM_{2.5}$ (aerodynamic diameter less than or equal to 2.5 μm) became a separate requirement in 1999, and sampling has been performed in N.C. since that year.

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 from 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 has little or no impact on vegetation or materials.

2.3 Ozone

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

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

2.3.1 Sources

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

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

2.3.2 Effects

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

Ozone damages vegetation by injuring leaves. Ozone also accelerates material aging by 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 average concentration of lead in leaded gasoline has decreased, and the availability of leaded automotive fuel has declined, virtually eliminating automotive gasoline as a source of atmospheric lead. Significant remaining sources include coal combustion (lead exists in very small quantities as an impurity in coal) and sandblasting of highway structures and water tanks. Lead also is used in some batteries, paints, insecticides, newspaper inks and piston engine aircraft gasoline.

2.6.2 Effects

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

3 Standards

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

Ambient air quality standards are classified as primary and secondary. Primary standards are those established to protect public health. Secondary standards are those established to protect the public welfare from adverse pollution effects on soils, water, crops, vegetation, man-made 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 2011 are summarized in Table 3.1.

Table 3.1 National and North Carolina Ambient Air Quality Standards in 2011

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**
PM-2.5 24 hour average (40CFR50, App. N)	1 year	average[1] quarterly-weighted arithmetic mean	12 µg/m^{3}(2)	12 µg/m^{3}(2)	12 µg/m^{3}(2)
	1 year	average[1] quarterly-weighted arithmetic mean	15 µg/m^{3}(3)	15 µg/m^{3}(3)	15 µg/m^{3}(3)
	1 day	average[1] 98th percentile	35 µg/m^{3}(4)	35 µg/m^{3}(4)	35 µg/m^{3}(4)
PM-10 24 hour average (40CFR50, App. N)	1 day	average[1] 2nd maximum[5]	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)	8 hours	Average[6] arithmetic mean 4th maximum	0.075 ppm (7) (157 µg/m^3)	0.075 ppm (7) (157 µg/m^3)	0.075 ppm (7) (157 µg/m^3)
SO$_2$ 1 hour average	3 hours (non-overlapping)	2nd maximum		500 ppb (1,300 µg/m^3)	0.50 ppm (1,300 µg/m^3)
	1 year	99th percentile of Daily Maximum	75 ppb(8)		75 ppb(8)
NO$_2$ 1 hour average	1 year	arithmetic mean	0.053 ppm	0.053 ppm	0.053 ppm
	1 year	98th percentile of Daily Maximum	(100 µg/m^3)	(100 µg/m^3)	(100 µg/m^3)
Pb 24-hour average	3 months	arithmetic mean	0.15 µg/m^{3}(9)	0.15 µg/m^{3}(9)	0.15 g/m^{3}(9)

1. Arithmetic mean over the 3 most current years.
2. Effective December 14, 2012.
3. 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.
4. To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3 (effective December 17, 2006).
5. In July 1997, a percentile-based statistic replaced the 2nd maximum, but in May 1999 the 2nd maximum standard was reinstated.
6. Arithmetic mean value over the most recent 3 consecutive, complete calendar years.
7. Effective May 27, 2008
8. To attain this standard, the 3-year average of the 99th percentile of 1-hour daily maximum concentrations must not exceed 75 ppb (effective June 2, 2010).
9. Effective October 15, 2008.

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 2011. 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 2011 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.

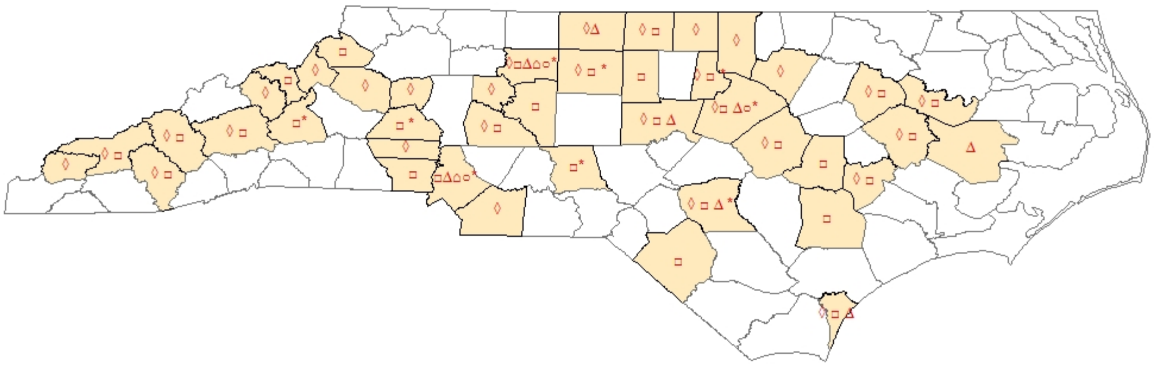
All monitors have known precision, accuracy, interferences and operational parameters. The monitors – as well as all measurement devices – are carefully calibrated at predetermined frequencies, varying from daily to quarterly. Measurements are traceable to National Institute of Standards and Technology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

Shaded counties have monitors.



Monitor Location: ◊ O3 □ PM2.5 ○ CO Δ SO2 ⌂ NO2 * PM10

Figure 4.1 Monitoring Sites Active in 2011

Table 4.1 Ambient Air Monitoring Sites Operated in North Carolina, 2011

SITE COUNTY	ADDRESS	POLLUTANTS		
37-001-0002 ALAMANCE	827 S GRAHAM & HOPEDALE RD BURLINGTON	PM2.5		
37-003-0004 ALEXANDER	106 WAGGIN TRAIL RD TAYLORSVILLE	O3		
37-011-0002 AVERY	7510 BLUE RIDGE PARKWAY SPUR LINVILLE	O3		
37-011-9991 AVERY	PISGAH NATIONAL FOREST NEWLAND	O3		
37-013-0007 BEAUFORT	1945 SANDY FORKS RD AURORA	SO2		
37-013-0151 BEAUFORT	229 NC HWY 306 N BATH	SO2		
37-021-0030 BUNCOMBE	ROUTE 191 SOUTH BREVARD RD ASHEVILLE	O3		
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	PM2.5		
37-027-0003 CALDWELL	HWY 321 NORTH LENOIR	O3		
37-031-9991 CARTERET	OPEH GROUNDS FARM BEAUFORT	O3		
37-033-0001 CASWELL	7074 CHERRY GROVE RD REIDSVILLE	O3	PM2.5	
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	PM10	PM2.5	
37-037-0004 CHATHAM	325 RUSSETT RUN ROAD PITTSBORO	O3	PM2.5	SO2
37-051-0008 CUMBERLAND	7112 COVINGTON LANE WADE	O3		
37-051-0009 CUMBERLAND	4533 RAEFORD RD FAYETTEVILLE	PM10	PM2.5	

SITE COUNTY	ADDRESS	POLLUTANTS
37-051-1003 CUMBERLAND	3625 GOLFVIEW RD HOPE MILLS	O3 SO2
37-057-0002 DAVIDSON	SOUTH SALISBURY STREET LEXINGTON	PM2.5
37-059-0003 DAVIE	220 CHERRY STREET MOCKSVILLE	O3
37-061-0002 DUPLIN	HIGHWAY 50 KENANSVILLE	PM2.5
37-063-0015 DURHAM	801 STADIUM DRIVE DURHAM	O3 PM2.5 PM10
37-065-0004 EDGECOMBE	900 SPRINGFIELD RD ROCKY MOUNT	PM2.5
37-065-0099 EDGECOMBE	7589 NC HIGHWAY 33 NW TARBORO	O3
37-067-0022 FORSYTH	1300 BLK HATTIE AVENUE WINSTON-SALEM	PM10 O3 SO2 NO2 PM2.5
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY WINSTON-SALEM	CO PM10
37-067-0028 FORSYTH	6496 BAUX MOUNTAIN ROAD WINSTON-SALEM	O3
37-067-0030 FORSYTH	FRATERNITY CHURCH WINSTON-SALEM	O3 PM2.5
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	O3
37-069-0001 FRANKLIN	431 S. HILLSBOROUGH STREET FRANKLINTON	O3
37-071-0016 GASTON	1622 EAST GARRISON BLVD GASTONIA	PM2.5
37-075-0001 GRAHAM	FOREST ROAD 423 SPUR KILMER	O3

SITE COUNTY	ADDRESS	POLLUTANTS
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSP BUTNER	O3
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	PM2.5 PM10 O3
37-081-0014 GUILFORD	2127 SANDY RIDGE ROAD COLFAX	PM2.5
37-087-0008 HAYWOOD	2236 ASHEVILLE ROAD WAYNESVILLE	O3
37-087-0012 HAYWOOD	550 VANCE STREET WAYNESVILLE	PM2.5
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PARKWAY MILE MARKER 410	O3
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAINS NATIONAL PARK	O3
37-099-0005 JACKSON	BARTNET KNOB FIRETOWER ROAD CHEROKEE	O3
37-099-0006 JACKSON	US ROUTE 19 NORTH CHEROKEE RESERVATION	PM2.5
37-101-0002 JOHNSTON	1338 JACK ROAD CLAYTON	O3 PM2.5
37-107-0004 LENOIR	CORNER HIGHWAY 70 EAST KINSTON	O3 PM2.5
37-109-0004 LINCOLN	1487 RIVERVIEW ROAD LINCOLNTON	O3
37-111-0004 MCDOWELL	676 STATE STREET MARION	PM2.5 PM10
37-113-9991 MONTGOMERY	USDA SOUTHERN RESEARCH STATION COWEETA	O3
37-117-0001 MARTIN	1210 HAYES STREET JAMESVILLE	O3 PM2.5

SITE COUNTY	ADDRESS	POLLUTANTS
37-119-0003 MECKLENBURG	FIRE STATION # 11, 620 WEST 28TH STREET CHARLOTTE	PM10
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	CO SO2 PM2.5 NO2 O3 PM10
37-119-0042 MECKLENBURG	1935 EMERYWOOD DRIVE CHARLOTTE	PM2.5 PM10
37-119-0043 MECKLENBURG	513 RADIO ROAD CHARLOTTE	PM2.5
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	O3
37-119-1009 MECKLENBURG	HWY 29 NORTH AT HUDSPETH RD CHARLOTTE	O3
37-121-0001 MITCHELL	CITY HALL, SUMMIT STREET SPRUCE PINE	PM2.5
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	PM2.5 PM10
37-123-9991 MONTGOMERY	136 PERRY DR CANDOR	O3
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER ROAD CASTLE HAYNE	O3 PM2.5
37-129-0006 NEW HANOVER	HIGHWAY 421 NORTH WILMINGTON	SO2
37-145-0003 PERSON	STATE HIGHWAY 49 SOUTH ROXBORO	O3
37-147-0006 PITT	403 GOVERNMENT CIRCLE GREENVILLE	O3 PM2.5
37-155-0005 ROBESON	1170 LINKHAW ROAD LUMBERTON	PM2.5
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL BETHANY	O3 SO2
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVENUE ROCKWELL	O3 PM2.5

SITE COUNTY	ADDRESS	POLLUTANTS				
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			
37-179-0003 UNION	701 CHARLES STREET MONROE	O3				
37-183-0014 WAKE	3801 SPRING FOREST ROAD RALEIGH	O3	PM2.5	PM10	SO2	CO
37-183-0016 WAKE	201 NORTH BROAD STREET FUQUAY-VARINA	O3				
37-183-0018 WAKE	US HIGHWAY 70 WEST AND NC HIGHWAY 50 NORTH RALEIGH	CO				
37-183-0020 WAKE	E. MILLBROOK MIDDLE SCHOOL 3720 LAKE WHEELER RD RALEIGH	PM2.5				
37-189-0003 WATAUGA	361 JEFFERSON ROAD BOONE	PM2.5				
37-191-0005 WAYNE	DILLARD MIDDLE SHOOL, DEVEREAU STREET GOLDSBORO	PM2.5				
37-199-0004 YANCEY	4666 STATE HIGHWAY 128 BURNSVILLE	O3				
Sites operated in 2011	71					

5 Pollutant Monitoring Results

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

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

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

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

Air quality also may be influenced by “exceptional events” in the short term. Exceptional events may be either natural (e.g., forest fire) or manmade (e.g., construction or demolition). Unusual data that can be attributed to an exceptional event are considered biased and may be omitted from data summaries when they are not representative of normal conditions. In the tabular listings in this report, data affected by exceptional events that have been reviewed and approved by EPA 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 2011 ambient air quality report were collected at 108 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. Two of the 108 monitors used for this report operated most recently in 2010 or 2009.

5.1 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 2011, 1,275 ordinary 24-hour samples of PM_{10} were collected from monitors located at 12 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 5.1.

There were no exceedances of the PM_{10} ambient air quality standards in 2011. The highest 24-hour maximum concentration was 43 $\mu g/m^3$, or about 29 percent of the standard (150 $\mu g/m^3$). The highest annual arithmetic mean was 19.4 $\mu g/m^3$.

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.)

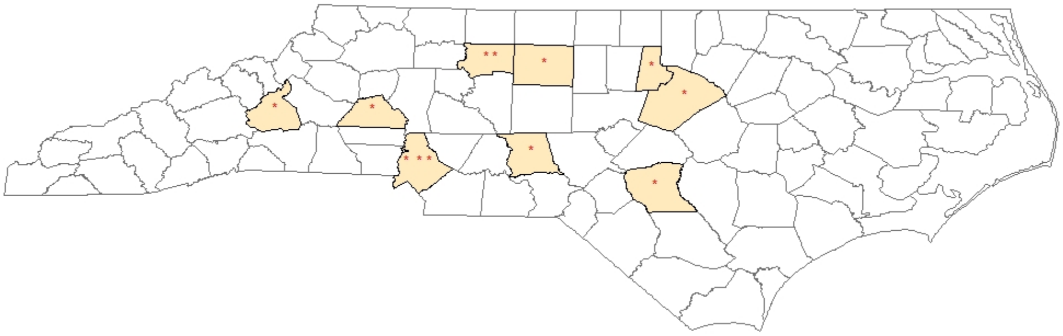


Figure 5.1 Location of PM10 Monitoring Sites

Table 5.1 PM_{10} in Micrograms Per Cubic Meter for 2011

SITE NUMBER **COUNTY**	ADDRESS	NUM OBS	**24-HOUR MAXIMA**				**ARITH MEAN**
			1st	**2nd**	**3rd**	**4th**	
37-035-0004 CATAWBA	1650 1ST. ST. HICKORY	59	26	25	25	25	13.6
37-051-0009 CUMBERLAND	4533 RAEFORD ROAD FAYETTEVILLE	61	37	30	27	25	13.3
37-063-015 DURHAM	801 STADIUM DRIVE DURHAM	110	33	32	27	26	14.4
37-067-0022 FORSYTH	1300 BLK. HATTIE AVE WINSTON-SALEM	288	33	30	30	30	14.8
37-067-0023 FORSYTH	1401 CORPORATION PARKWAY WINSTON-SALEM	186	34	33	31	31	15.6
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	57	25	20	19	18	10.1
37-111-0004 MCDOWELL	676 STATE STREET MARION	49	26	25	23	23	12.8
37-119-0003 MECKLENBURG	FIRE STA #11 620 MORETZ STREET CHARLOTTE	58	43	43	43	32	19.4
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	118	37	35	34	33	15.9
37-119-0042 MECKLENBURG	1935 EMERYWOOD DRIVE CHARLOTTE	119	43	34	33	33	16.7
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	52	27	25	25	17	11.5
37-183-0014 WAKE	3801 SPRING FOREST RD. RALEIGH	118	32	26	25	24	13.9
Total Samples		1,275					
Total Sites Sampled		12					

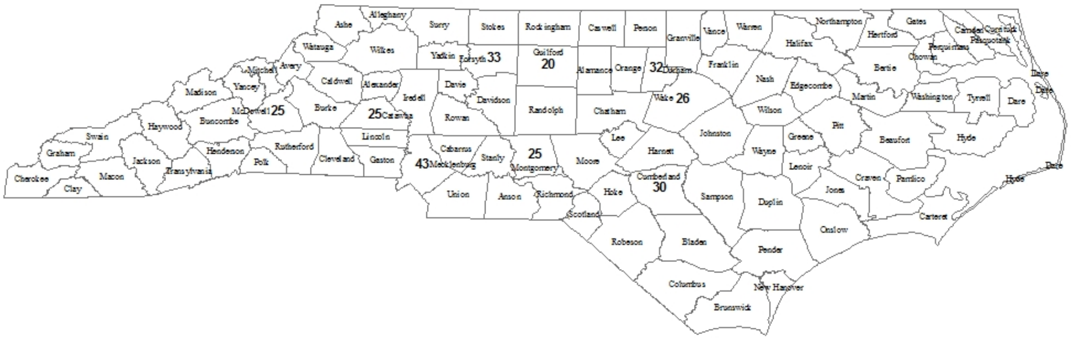


Figure 5.2 PM$_{10}$: Second Highest 24-Hour Averages, 2011

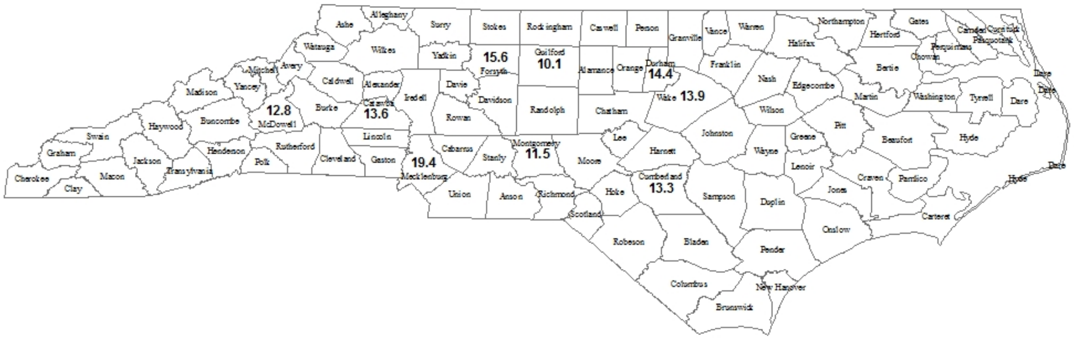


Figure 5.3 PM$_{10}$: Maximum Annual Arithmetic Means, 2011

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

In 2011, 35 sites were used to monitor $PM_{2.5}$ and 4,574 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 5.2.

There were no exceedances of the $PM_{2.5}$ 24-hour ambient air quality standards in 2011. The highest annual arithmetic mean was 11.00 µg/m^3, which is about 17 percent below the level of the standard (15 µg/m^3), at Charlotte in Mecklenburg County. (See Table 5.2).

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

Figure 5.7 is a map of "design values" for $PM_{2.5,}$ computed from the highest 3-year average arithmetic mean in each county for 2009 through 2011, using the federal reference method monitors. Thirty counties have enough reported data to compute this metric correctly, all of them appear to be attaining the ambient standard. Attainment decisions for $PM_{2.5}$ will be based on the design values observed during 2009 through 2011.

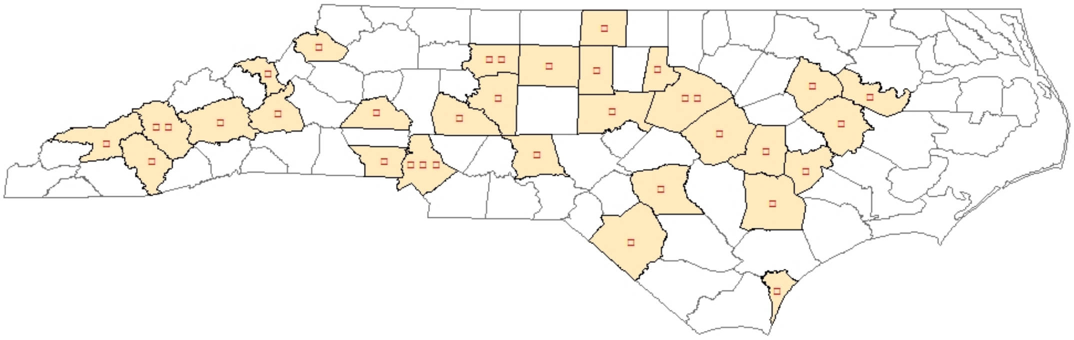


Figure 5.4 Location of $PM_{2.5}$ Monitoring Sites

Table 5.2 PM$_{2.5}$ in Micrograms Per Cubic Meter for 2011

SITE NUMBER	ADDRESS	NUM OBS	24-HOUR MAXIMA				PERCENTILE	ARITH MEAN
COUNTY			1st	2nd	3rd	4th	98TH	
37-001-0002 ALAMANCE	827 S. GRAHAM & HOPEDALE RD BURLINGTON	90	35.5	20.7	20.5	17.8	20.7	9.52
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	119	20.0	18.8	18.5	18.2	18.5	9.18
37-033-0001 CASWELL	7074 CHERRY GROVE RECREATION	61	18.6	18.3	17.9	16.3	18.3	8.33
37-035-0004 CATAWBA	1650 1ST. ST. HICKORY	231	32.2	27.7	24.2	22.7	22.3	10.42
37-037-0004 CHATHAM	325 RUSSETT PITTSBORO	117	25.4	24.1	19.5	18.6	19.5	8.37
37-051-0009 CUMBERLAND	4533 RAEFORD ROAD FAYETTEVILLE	91	24.0	22.1	20.7	20.6	22.1	9.74
37-057-0002 DAVIDSON	SOUTH SALISBURY STREET LEXINGTON	119	21.5	20.4	20.2	20.1	20.2	10.72
37-061-0002 DUPLIN	328LIMESTONE RD KENANSVILLE	119	40.0	21.3	21.0	20.5	21.0	9.13
37-063-0015 DURHAM	801 STADIUM DRIVE DURHAM	115	21.3	20.0	18.6	18.0	18.6	9.19
37-065-0004 EDGECOMBE	900 SPRINGFIELD ROCKY MOUNT	114	29.0	28.2	21.8	21.6	21.8	8.98
37-067-0022 FORSYTH	1300 BLOCK, HATTIE AVENUE WINSTON-SALEM	344	26.5	24.1	22.2	20.9	19.9	9.61
37-067-0030 FORSYTH	FRATERNITY CHURCH ROAD WINSTON-SALEM	109	22.9	20.2	19.3	17.8	19.3	9.27
37-071-0016 GASTON	1622 EAST GARRISON BLVD GASTONIA	85	28.7	26.4	23.3	22.3	26.4	10.54
37-081-0013 GUILFORD	205 WILOUGHBY BLVD GREENSBORO	87	26.0	21.1	19.3	17.3	21.1	8.87
37-081-0014 HAYWOOD	2127 SANDY RIDGE ROAD WAYNESVILLE	116	23.5	20.0	20.0	17.8	20.0	9.18

SITE NUMBER	ADDRESS	NUM OBS	24-HOUR MAXIMA				PERCENTILE	ARITH MEAN
COUNTY			1st	2nd	3rd	4th	98TH	
37-087-0012 HAYWOOD	550 VANCE STREET WAYNESVILLE	117	27.3	27.0	22.8	21.7	22.8	9.98
37-099-0006 JACKSON	US RT 19 NORTH CHEROKEE	99	22.1	21.8	20.3	18.7	21.8	9.61
37-101-0002 JOHNSTON	1338 JACK ROAD CLAYTON	106	35.8	28.0	20.2	19.8	20.2	9.18
37-107-0004 LENOIR	CORNER HWY 70 EAST KINSTON	119	71.7	41.5	27.5	26.3	27.5	9.96
37-111-0004 MCDOWELL	676 STATE STREET MARION	116	24.1	22.7	21.0	18.9	21.0	9.85
37-117-0001 MARTIN	1210 HAYES ST JAMESVILLE	115	31.3	31.0	29.4	23.7	29.4	8.98
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	349	28.7	28.0	26.1	25.6	23.1	10.70
37-119-0042 MECKLENBURG	1935 EMERYWOOD DRIVE CHARLOTTE	116	31.2	26.2	26.2	24.7	26.2	11.00
37-119-0043 MECKLENBURG	513 RADIO ROAD CHARLOTTE	353	28.3	27.0	26.0	22.9	21.4	10.15
37-121-0001 MITCHELL	CITY HALL SUMMIT ST SPRUCE PINE	116	23.5	20.1	19.2	18.1	19.2	9.05
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	118	30.3	22.6	20.8	20.2	20.8	9.17
37-129-002 NEW HANOVER	6028 HOLLY SHELTER RD CASTLE HAYNE	119	35.9	34.2	33.1	25.0	33.1	8.58
37-147-0006 PITT	403 GOVERNMENT CIRCLE	121	28.7	27.7	24.0	22.4	24.0	8.14
37-155-0005 ROBESON	1170 LINKHAM ROAD LUMBERTON	119	35.2	22.7	20.6	19.3	20.6	10.10
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	117	22.4	18.7	18.5	17.7	18.5	10.15
37-173-0002 SWAIN	CENTER ST/PARKS 7 REC FACILITY	48	21.3	17.1	16.2	15.6	21.3	9.01
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	119	27.5	24.0	20.2	19.0	20.2	9.46

SITE NUMBER	ADDRESS	NUM OBS	24-HOUR MAXIMA				PERCENTILE	ARITH MEAN
COUNTY			1st	2nd	3rd	4th	98TH	
37-183-0020 WAKE	3720 LAKE WHEELER RD	115	27.7	25.0	22.8	20.4	22.8	9.56
37-189-0003 WATAUGA	361JEFFERSON HWY BOONE	116	21.6	21.1	20.0	19.8	20.0	8.08
37-191-0005 WAYNE	DILLARD MIDDLE SCHOOL GOLDSBORO	59	28.6	22.3	21.7	16.3	22.3	9.39
Total Samples		4,574						
Total Sites Sampled		35						

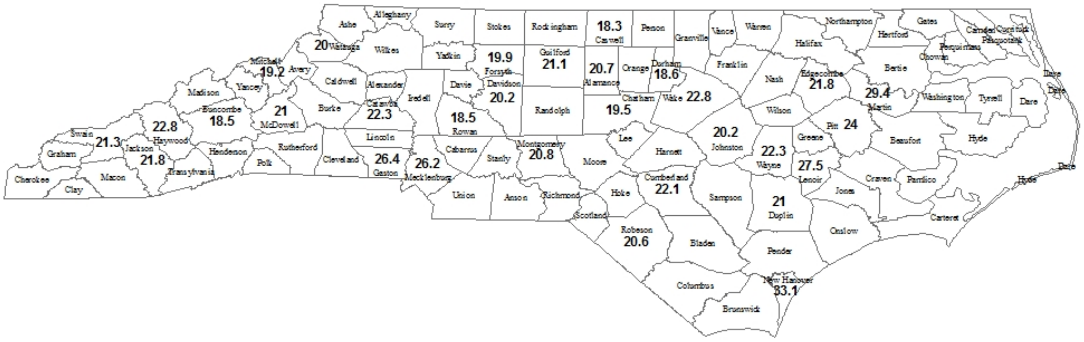


Figure 5.5 $PM_{2.5}$: 98th Percentile, 2011

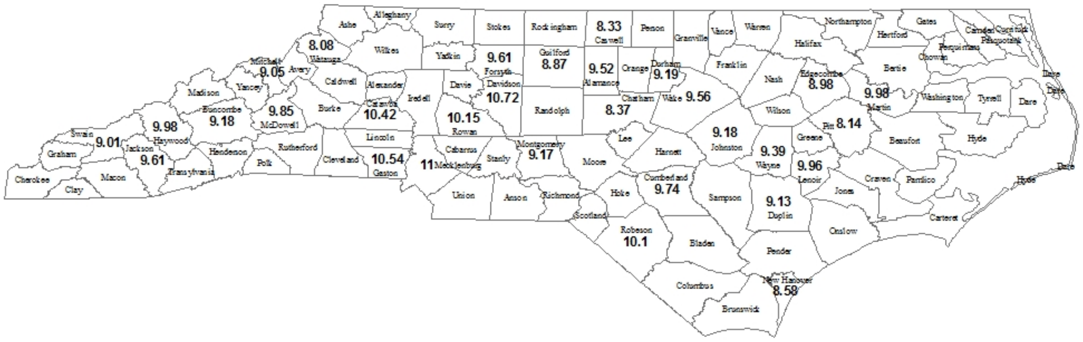


Figure 5.6 PM$_{2.5}$: Annual Arithmetic Means, 2011

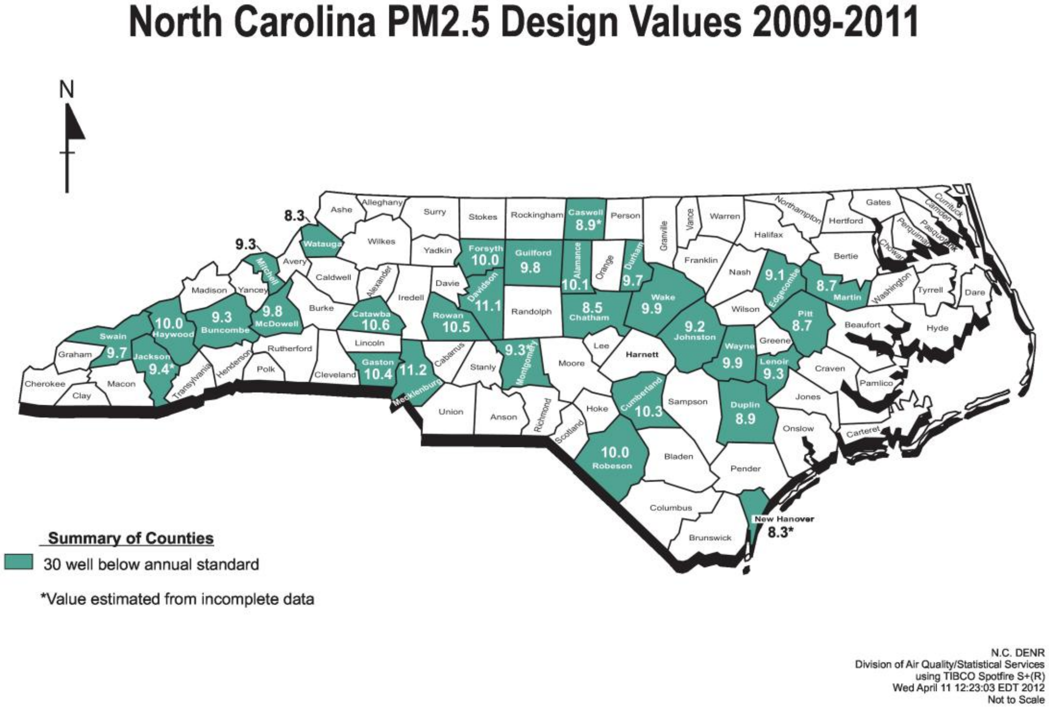


Figure 5.7 PM$_{2.5}$ Design Values by County, 2009-2011

5.3 Carbon Monoxide

Carbon monoxide (CO) data were collected for two purposes in 2011: 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 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 2011, four sites were used to monitor CO and 27,460 valid hourly averages were collected. Data were collected from monitors in Charlotte, Winston-Salem and Raleigh (at 2 locations, one of which is operated only in winter 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 5.3.

There were no exceedances of the CO ambient air quality standards in 2011. The highest 1-hour average was 2.6 parts per million (ppm), or about 7 percent of the standard (35 ppm). This value occurred at the 1401 Corporation Parkway site in Winston-Salem (Forsyth County). The highest 8-hour average was 2.3 ppm, at the 1401 Corporation Parkway site, which is about 26 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 48 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.

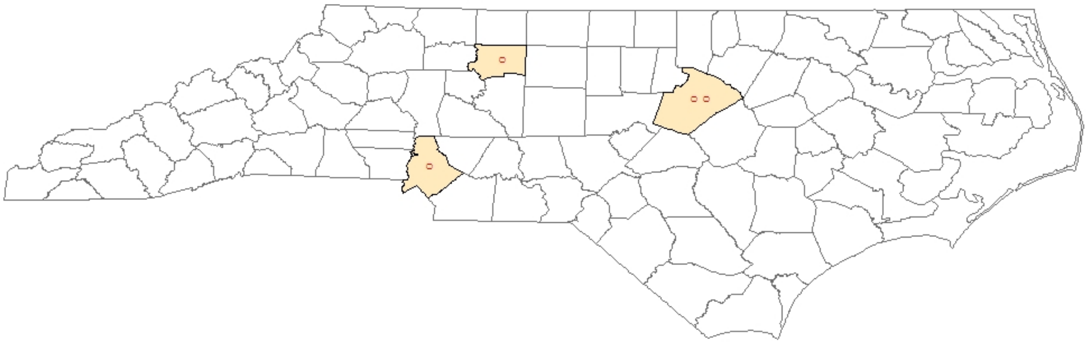


Figure 5.8 Location of Carbon Monoxide Monitoring Sites

Table 5.3 Carbon Monoxide in Parts Per Million for 2011

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA 1st	ONE-HOUR MAXIMA 2nd	EIGHT-HOUR MAXIMA 1st	EIGHT-HOUR MAXIMA 2nd
37-067-0023 FORSYTH	1401 CORPORATION PKY WINSTON-SALEM	8,536	2.6	2.6	2.3	2.1
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	8,624	2.3	2.0	1.8	1.5
37-183-0014 WAKE	3801 SPRING FOREST RD. RALEIGH	8,255	1.8	1.8	1.4	1.4
37-183-0018 WAKE	US HWY 70 WEST AND NC HWY 50 NORTH RALEIGH	2,045	1.9	1.8	1.5	1.4
Total Samples		27,460				
Total Sites Sampled		4				

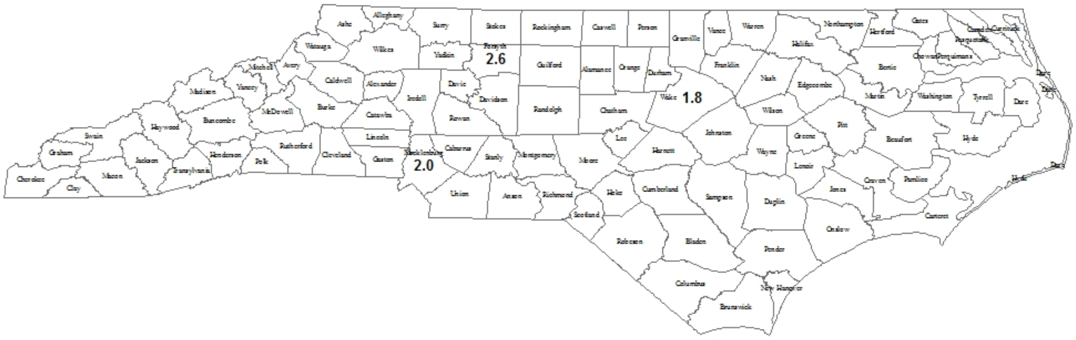


Figure 5.9 Carbon Monoxide: Second Highest 1-Hour Concentration, 2011

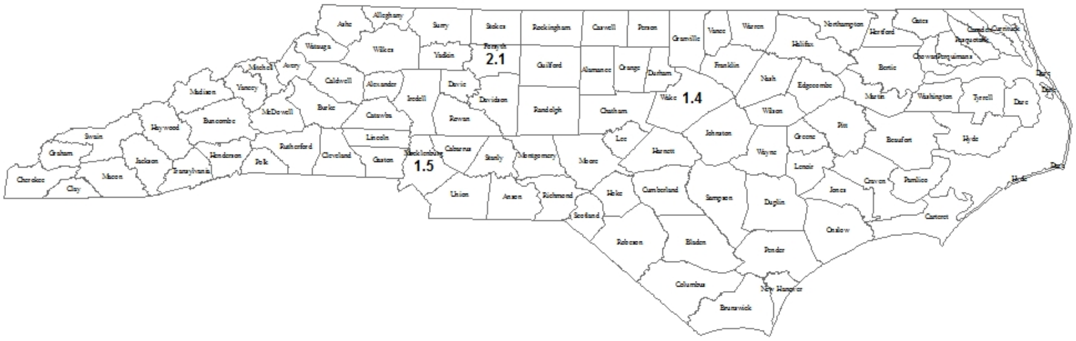


Figure 5.10 Carbon Monoxide: Second Highest Non-overlapping 8-Hour Concentration, 2011

5.4 Ozone

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

Federal, state, local and tribal program agencies operated 45 monitoring sites in 2011 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 8-hour data is given in Table 5.4. These 45 monitoring sites provided 9,275 site-days of valid data (a success rate of 96 percent for the days that sampling is required).

The 8-hour standard is exceeded at the monitoring site when any of the highest daily 8-hour averages in the same calendar year are greater than 0.075 ppm. The 8-hour standard was exceeded total of 100 times at the 45 sites that monitored for O_3. Twenty-six monitors had at least one exceedance. The largest number at one monitor was 9 in Enochville (Rowan County) and in Charlotte in (Mecklenburg County). These exceedances were distributed over 26 days during the ozone season when at least one site within the state recorded values greater than 0.075 ppm. More information about dates and places of these ozone exceedances can be found online in http://www.ncair.org/monitor/data/files/o3data_2011.pdf or http://www.ncair.org/monitor/data/files/o3data_2011.pdf .

Historical average fourth-highest 8-hour concentrations of O_3 in counties where monitors were operated in 2011 are shown in Figure 5.12. Monitors whose fourth-highest 8-hour ozone concentration (averaged over *three* years) exceeds 0.075 ppm are deemed in violation of the EPA 8-hour standard.

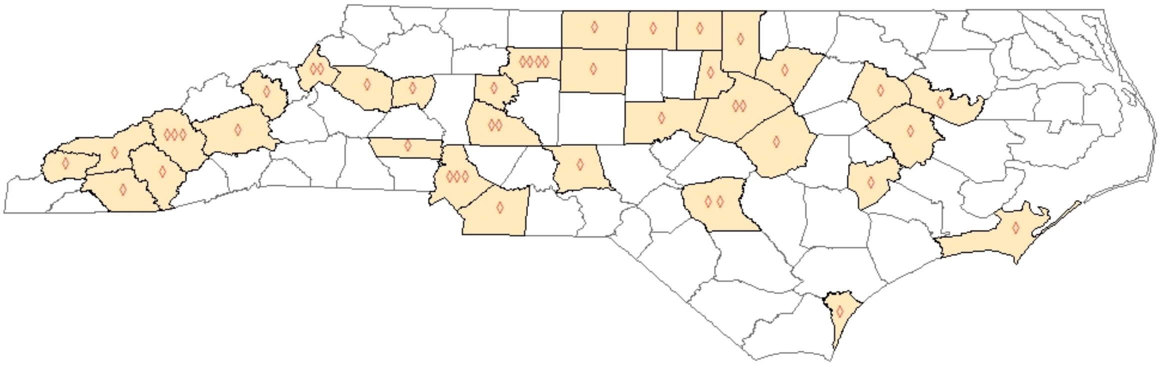


Figure 5.11 Location of Ozone Monitoring Sites

Table 5.4 Eight-Hour Ozone in Parts Per Million for 2011

SITE NUMBER	ADDRESS	VALID	VALID DAILY 8-HR MAXIMUM				N0. VALUES .>.075
COUNTY		DAYS	1st	2nd	3rd	4th	MEAS
37-003-0004 ALEXANDER	106 WAGGIN' TRAIL TAYLORSVILLE	206	.072	.071	.071	.067	0
37-011-0002 AVERY	7510 BLUE RIDGE LINVILLE	210	.065	.063	.063	.062	0
37-011-9991 AVERY	PISGAH NATIONAL FOREST NEWLAND	196	.065	.065	.064	.062	0
37-021-0030 BUNCOMBE	ROUTE 191 SOUTH BREVARD RD BENT CREEK	208	.070	.067	.067	.067	0
37-027-0003 CALDWELL	HWY 321 NORTH LENOIR	214	.070	.067	.067	.066	0
37-031-9991 CARTERET	OPEN GROUNDS FARM BEAUFORT	161	.066	.065	.065	.063	0
37-033-0001 CASWELL	7074 CHERRY GROVE RD REIDSVILLE	209	.079	.075	.074	.070	1
37-037-0004 CHATHAM	325 RUSSETT RUN PITTSBORO	214	.070	.069	.067	.067	0
37-051-0008 CUMBERLAND	7112 COVINGTON LANE WADE	213	.075	.074	.074	.073	0
37-051-1003 CUMBERLAND	3625 GOLFVIEW ROAD HOPE MILLS	213	.083	.081	.080	.076	4
37-059-0003 DAVIE	220 CHERRY STREET MOCKSVILLE	214	.076	.074	.072	.072	1
37-063-0015 DURHAM	801 STADIUM DRIVE DURHAM	208	.077	.074	.072	.070	1
37-065-0099 EDGECOMBE	7589 NC HWY 33-NW LEGGETT	201	.077	.075	.074	.072	1
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	214	.084	.081	.079	.076	5
37-067-0028 FORSYTH	6496 BAUX MOUNTAIN RD WINSTON-SALEM	214	.071	.070	.069	.068	0
37-067-0030 FORSYTH	FRATERNITY CHURCH ROAD WINSTON-SALEM	187	.077	.076	.074	.073	2
37-067-1008 FORSYTH	3656 PIEDMONT MEMORIAL DRIVE WINSTON-SALEM	208	.081	.076	.074	.074	2
37-069-0001 FRANKLIN	431 S. HILLBOROUGH ST FRANKLINTON	212	.081	.075	.074	.072	1
37-075-0001	FOREST ROAD 423 SPUR	201	.077	.075	.075	.074	1

SITE NUMBER COUNTY	ADDRESS	VALID DAYS	VALID DAILY 8-HR MAXIMUM 1st	2nd	3rd	4th	N0. VALUES .>.075 MEAS
GRAHAM	KILMER						
37-077-0001 GRANVILLE	WATER TREATMENT PLANT JOHN UMSTEAD HOSPITAL BUTNER	211	.088	.075	.073	.072	1
37-081-0013 GUILFORD	205 WILOUGHBY GREENSBORO	214	.082	.080	.080	.076	4
37-087-0008 HAYWOOD	2236 ASHEVILLE ROAD WAYNESVILLE	207	.069	.067	.066	.065	0
37-087-0035 HAYWOOD	TOWER BLUE RIDGE PARKWAY MILE MARKER 410	170	.076	.071	.070	.070	1
37-087-0036 HAYWOOD	GREAT SMOKY MOUNTAIN NATIONAL PARK	209	.077	.072	.067	.066	1
37-099-0005 JACKSON	BARNET KNOB FIRETOWER RD CHEROKEE	208	.078	.073	.071	.071	1
37-101-0002 JOHNSTON	1338 JACK ROAD CLAYTON	214	.081	.075	.075	.074	1
37-107-0004 LENOIR	CORNER HWY 70 EAST KINSTON	207	.072	.072	.071	.069	0
37-109-0004 LINCOLN	1487 RIVERVIEW ROAD LINCOLNTON	211	.079	.078	.078	.077	6
37-113-9991 MACON	USDA SOUTHERN RESEARCH STATION COWEETA	184	.069	.067	.066	.066	0
37-117-0001 MARTIN	1210 HAYES STREET JAMESVILLE	206	.074	.070	.067	.066	0
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	209	093	.091	.088	.088	14
37-119-1005 MECKLENBURG	400 WESTINGHOUSE BLVD. CHARLOTTE	211	.090	.087	.086	.082	6
37-119-1009 MECKLENBURG	29 N @ MECKLENBURG CAB CO CHARLOTTE	212	.088	.087	.084	.083	13
37-123-9991 MONTGOMERY	136 PERRY DR CANDOR	206	.074	.069	.069	.069	0
37-129-0002 NEW HANOVER	6028 HOLLY SHELTER RD CASTLE HAYNE	208	.065	.064	.064	.064	0
37-145-0003 PERSON	STATE HIGHWAY 49 SOUTH ROXBORO	213	.083	.073	.073	.072	1
37-147-0006 PITT	403 GOVERNMENT CIRCLE GREENVILLE	207	.081	.077	.077	.074	3
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY SCHOOL BETHANY	212	.079	.077	.074	.071	2
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	211	.085	.079	.078	.077	8

SITE NUMBER COUNTY	ADDRESS	VALID DAYS	VALID DAILY 8-HR MAXIMUM				N0. VALUES .>.075 MEAS
			1st	2nd	3rd	4th	
37-159-0022 ROWAN	925 N ENOCHVILLE AVE ENOCHVILLE	211	.089	.080	.078	.078	6
37-173-0002 SWAIN	CENTER STREET PARKS 7 REC FACILITY	207	.062	.061	.060	.060	0
37-179-0003 UNION	701 CHARLES STREET MONROE	207	.078	.078	.075	.073	2
37-183-0014 WAKE	3801 SPRING FOREST ROAD RALEIGH	214	.079	.078	.078	.074	3
37-183-0016 WAKE	201 NORTH BROAD STREET FUQUAY-VARINA	214	.088	.084	.079	.078	6
37-199-0004 YANCEY	4666 STATE HIGHWAY 128 BURNSVILLE	189	.078	.076	.074	.071	2
Total Samples Total Sites Sampled		9,275 45					100

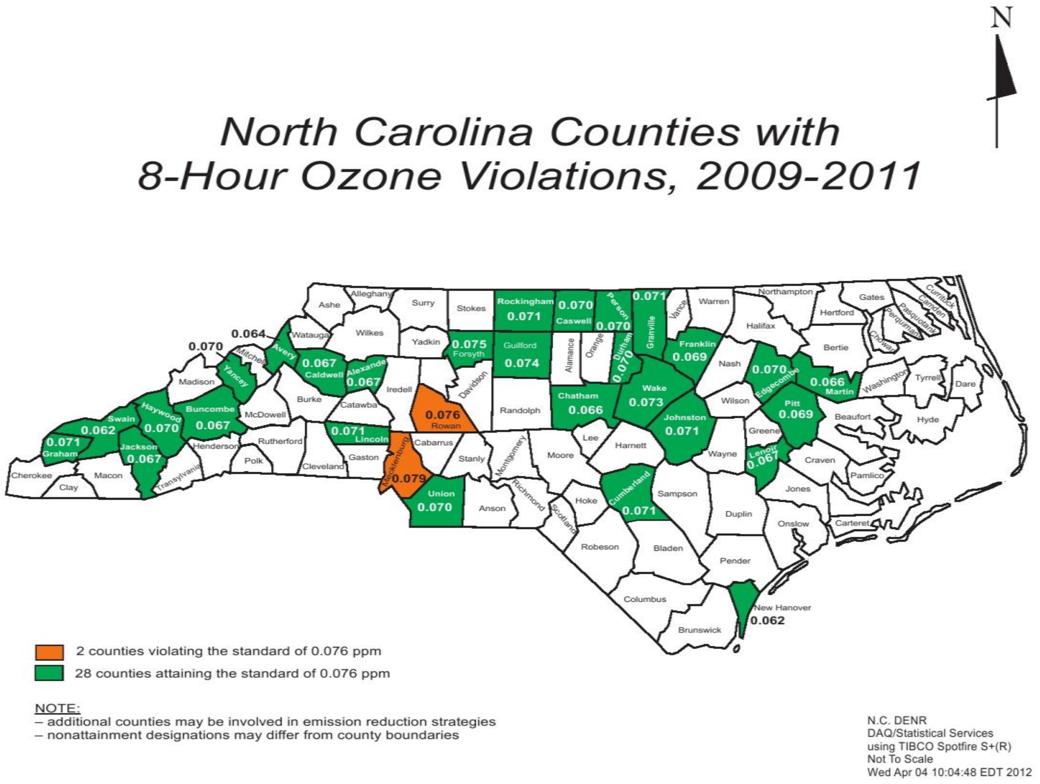


Figure 5.12 Ozone: Mean Annual Fourth Highest 8-Hour Average, 2009-2011

5.5 Sulfur Dioxide

Sulfur dioxide (SO_2) concentrations were measured by the state and two local program agencies using EPA reference or equivalent methods. Eight SO_2 monitors were active in North Carolina in 2011. Some SO_2 sites are operated only every third year. We supplemented this report with one monitor that operated last in 2010 and one monitor that operated last in 2009.

From the 10 sites with SO_2 data obtained between 2009 and 2011, 66,242 valid hourly averages were collected. A map of the active SO_2 sampling sites is presented in Figure 5.13, and a detailed summary of the data from each site is given in Table 5.5.

The highest annual arithmetic mean was 1.50 ppb. The highest maximum 24-hour average was 9.3 ppb.

There was 1 day (7/ 2/ 2011) on which the maximum daily concentration exceeded the level of the 99th percentile standard. The concentration was 79 ppb at monitoring site at Highway 421 North, Wilmington.

The size of an urban area appears to have no significant effect on 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 one-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.

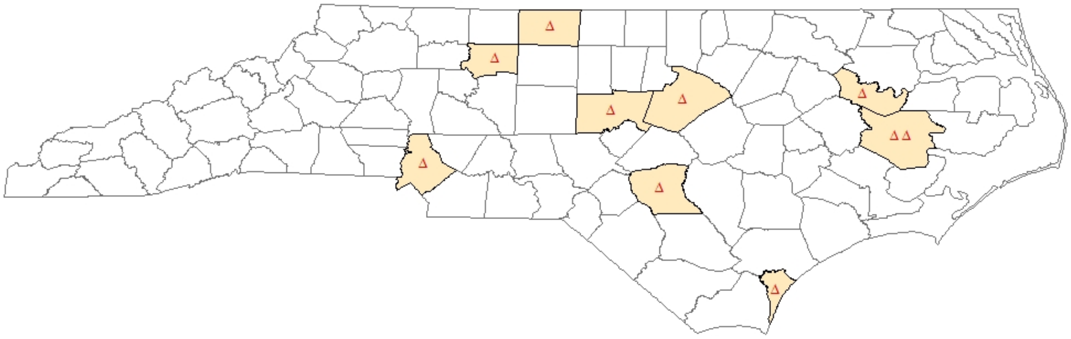


Figure 5.13 Locations of Sulfur Dioxide Monitoring Sites in 2009, 2010 and 2011

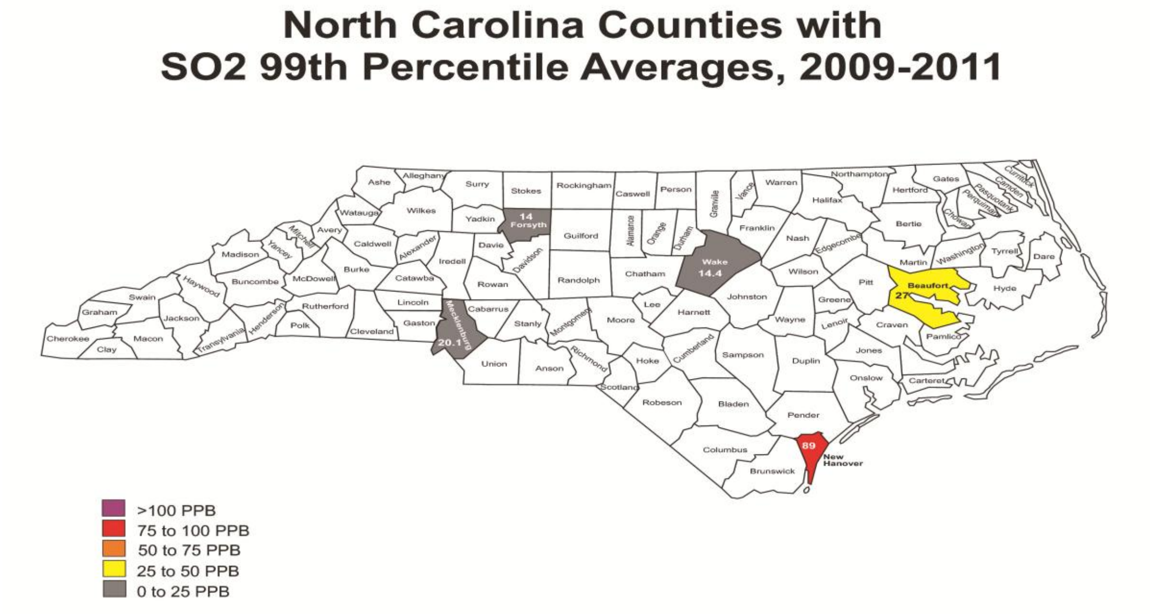


Figure 5.14 Sulfur Dioxide Design Values by County, 2009-2011

Table 5.5 Sulfur Dioxide in Parts Per Billion from All Sites for 2009-2011

SITE NUMBER	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		24-HOUR MAXIMA		99th PERCENTILE	ARITH MEAN
COUNTY			1st	2nd	1st	2nd		
2011								
37-013-0007 BEAUFORT	1645 SANDY LANDING AURORA	581	21.0	9.0	3.5	2.3	21.0	1.13
37-013-0151 BEAUFORT	229 NC HWY 306 N BATH	7,475	32.0	31.0	6.2	4.7	26.0	.63
37-037-0004 CHATHAM	325 RUSSETT RUN ROAD PITTSBORO	8,274	20.0	18.0	5.9	4.3	13.0	.79
37-067-0022 FORSYTH	1300 BLK. HATTIE AVE WINSTON-SALEM	8,704	13.8	10.7	3.8	3.5	9.0	.50
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	8,406	21.6	21.2	4.9	3.3	14.5	.60
37-129-0006 NEW HANOVER	HIGHWAY 421 NORTH WILMINGTON	8,054	76.0	69.0	9.3	7.8	54.0	1.50

SITE NUMBER	ADDRESS	NUM OBS	ONE-HOUR MAXIMA		24-HOUR MAXIMA		99th PER-CENTILE	ARITH MEAN
COUNTY			1st	2nd	1st	2nd		
37-157-0099 ROCKINGHAM	6371 NC 65 @ BETHANY REIDSVILLE	8,110	23.0	18.0	4.5	4.4	18.0	1.28
37-183-0014 WAKE	3801SPRING FOREST RD. RALEIGH	8,258	18.0	16.3	3.8	3.7	12.7	.68
Total Samples		49,752						
Total Sites Sampled		8						
2010								
37-117-0001 MARTIN	1210HAYES STREET JAMESVILLE	8,176	10.0	8.0	3.3	3.1	6.0	.45
Total Samples		8,176						
Total Sites Sampled		1						
2009								
37-051-1003 CUMBERLAND	3625 GOLFVIEW RD HOPE MILLS	8,314	11.0	10.0	4.3	4.2	10.0	1.11
Total Samples		8,314						
Total Sites Sampled		1						

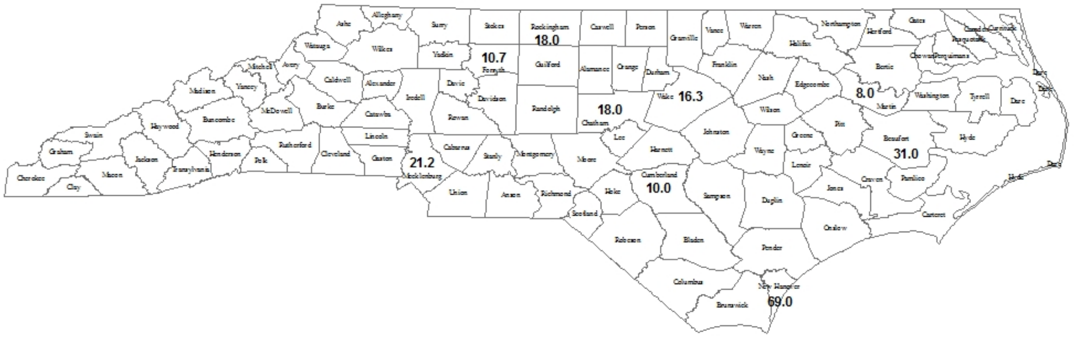


Figure 5.15 Sulfur Dioxide: Second Highest 1-Hour Averages in the Most Recent Year of Data from 2009, 2010 or 2011

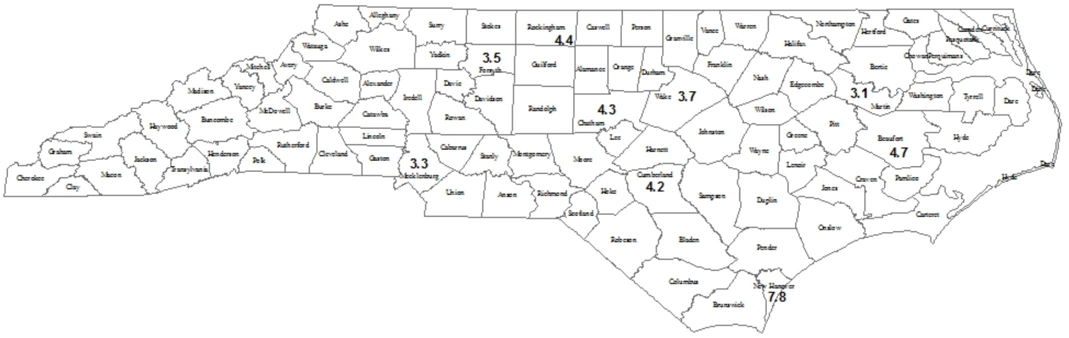


Figure 5.16 Sulfur Dioxide: Second Highest 24-Hour Averages in the Most Recent Year of Data from 2009, 2010 or 2011

5.7 Nitrogen Dioxide

Nitrogen dioxide (NO_2) concentrations were measured using EPA reference or equivalent continuous monitors in 2011 at local program sites in Forsyth and Mecklenburg counties.

From these two sites, 16,464 hourly NO_2 measurements were reported. The 98th percentile concentrations and the annual arithmetic means of the 2011 NO_2 data are given in Table 5.6. A map of the NO_2 sampling sites is presented in Figure 5.17.

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 5.6) are about 19 percent of the annual standard, and the 98th percentile values are about 43 percent of the daily standard.

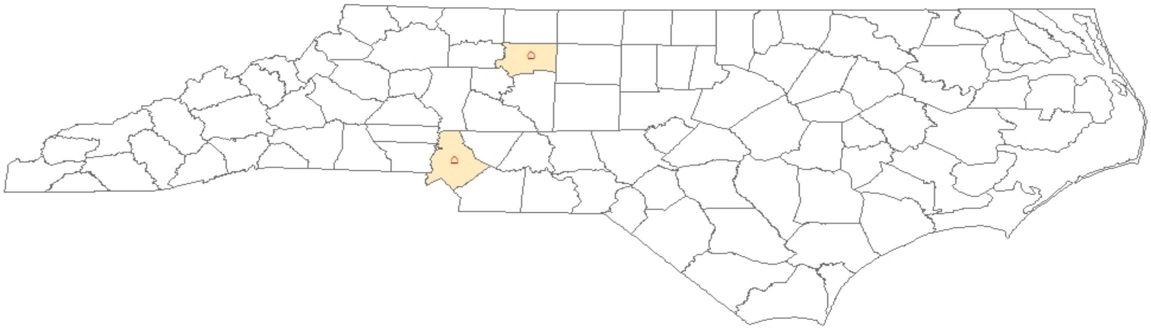


Figure 5.17 Location of Nitrogen Dioxide Monitoring Sites

Table 5.6 Nitrogen Dioxide in Parts Per Billion for 2011

SITE NUMBER COUNTY	ADDRESS	NUM OBS	ONE-HOUR MAXIMA 1ST	ONE-HOUR MAXIMA 2ND	98th PERCENTILE	ARITH MEAN
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	7,978	49.0	46.0	43.0	7.72
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	8,486	44.0	43.0	42.0	10.09
Total Samples Total Sites Sampled		16,464 2				

5.8 Lead

The state and local program agencies have not performed routine analysis of ambient lead (Pb) in North Carolina since 1982. Pb monitoring was discontinued as a result of the low measurements and a continuing decrease in the Pb concentrations being reported. The decrease in ambient Pb concentrations is due to the reduction and elimination of leaded gasoline, resulting in greatly reduced Pb 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. The purpose of these sites was to gather background information about Pb and other metals. No Pb sites operated in 2011.

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. Pb, 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 Pb 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 $\mu g/m^3$.

5.8.2 Future Lead Monitoring

As a result of revised federal standards and monitoring requirements, Pb sampling will resume in 2012. Pb will be monitored at 3801 Spring Forest Rd., Raleigh in Wake County and 1130 Eastway Drive, Charlotte in Mecklenburg County.

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, in which 100 corresponds to the EPA primary standard for a 24-hour average (8-hour CO average, 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 summer months in North Carolina the highest air quality index value tends to be attributed to ozone, but during winter months $PM_{2.5}$ predominates.

In 2011, 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.ncair.org/monitor).

In this printed report, we have summarized AQI statistics for ten metropolitan areas in North Carolina. (Note: finalized AQI statistics may differ from the forecasts that were reported daily during the year.) Table 6.1 shows the number of days in each health category at each area. AQI statistics for areas other than those reported below are available from the Ambient Monitoring Section on request. (In Table 6.1, the Greenville and Rocky Mount areas have two entries, "actual" and "adjusted", because AQI monitoring intentionally occurred only every third day during the months before and after ozone monitoring season (i.e., before April and after October). The adjusted entry gives our estimate of the number of days that *would have occurred* in each category, had all 151 days of these months been monitored. We do not similarly adjust for missing days in April through October, because these days are not numerous and not intentionally planned.) AQI statistics for areas other than those reported below are available from the Ambient Monitoring Section on request.

In the Asheville metropolitan area consisting of Buncombe and Madison counties, the AQI was not "*unhealthy for sensitive groups*" or "*unhealthy*" for any of the 364 days monitored.

Figure 6.1 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, and Figure 6.2 shows the number of days the AQI was in each respective health category, for Asheville in 2011.

In the Charlotte-Gastonia-Rock Hill metropolitan area consisting of Cabarrus, Gaston, Lincoln, Mecklenburg, Rowan and Union counties, the AQI was "*unhealthy for sensitive groups*" or "*unhealthy*" on 24 out of 365 days monitored. All 24 of these days occurred between June and September.

Figure 6.3 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, and Figure 6.4 shows the number of days the AQI was in each respective health category for Charlotte-Gastonia-Rock Hill in 2011.

In the Fayetteville metropolitan area consisting of Cumberland County, the AQI was "*unhealthy for sensitive groups*" or "*unhealthy*" on four out of 365 days monitored. All four of these days occurred in June.

Figure 6.5 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, and Figure 6.6 shows the number of days the AQI was in each respective health category for Fayetteville in 2011.

In the Goldsboro metropolitan area consisting of Wayne County, the AQI was "*unhealthy for sensitive groups*" or "*unhealthy*" on two out of 346 days monitored. All two of these days occurred between June and July.

Figure 6.7 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, and Figure 6.8 shows the number of days the AQI was in each respective health category for Goldsboro.

In the Greensboro–Winston-Salem–High Point metropolitan area consisting of Alamance, Davidson, Davie, Forsyth, Guilford, Randolph, Stokes and Yadkin counties, the AQI was "*unhealthy for sensitive groups*" or "*unhealthy*" on eight out of 365 days monitored. All eight of these days occurred between June and July.

Figure 6.9 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, and Figure 6.10 shows the number of days the AQI was in each respective health category for Greensboro–Winston-Salem–High Point in 2011.

In the Greenville metropolitan area consisting of Pitt County, during January through March $PM_{2.5}$ monitors operated on 30 of the 90 days; during April through October, $PM_{2.5}$ and ozone monitors operated on 209 of the 214 days; and in November and December, $PM_{2.5}$ monitors operated on 61 of the 61 days. The AQI was "*unhealthy for sensitive groups*" or "*unhealthy*" for three out of the 290 days monitored. All two of these days occurred between June and July.

Figure 6.11 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, and Figure 6.12 shows the number of days the AQI was in each respective health category for Greenville in 2011 (based on adjusting the January-March, November and December counts to total 151 days instead of 91 days).

In the Hickory-Morganton-Lenoir metropolitan area consisting of Alexander, Burke, Caldwell and Catawba counties, the AQI was not "*unhealthy for sensitive groups*" or "*unhealthy*" for any of the 365 days monitored.

Figure 6.13 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, and Figure 6.14 shows the number of days the AQI was in each respective health category for Hickory-Morganton-Lenoir in 2011.

In the Raleigh-Durham-Chapel Hill metropolitan area consisting of Chatham, Durham, Franklin, Johnston, Orange and Wake counties, the AQI was "*unhealthy for sensitive groups*" or "*unhealthy*" for six out of the 365 days monitored. All six of these days occurred between June and July.

Figure 6.15 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, and Figure 6.16 shows the number of days the AQI was in each respective health category for Raleigh-Durham-Chapel Hill in 2011.

In the Rocky Mount metropolitan area consisting of Edgecombe and Nash counties, during January through March $PM_{2.5}$ monitors operated on 29 of the 90 days; during April through October, $PM_{2.5}$ and ozone monitors operated on 213 of the 209 days; and in November and December, $PM_{2.5}$ monitors operated on 61 of the 61 days. The AQI was "*unhealthy for sensitive groups*" or "*unhealthy*" for two out of the 336 days monitored. All two of these days occurred between June and July.

Figure 6.17 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, and Figure 6.18 shows the number of days the AQI was in each respective health category for Rocky Mount in 2011 (based on adjusting the January-March, November and December counts to total 151 days instead of 90 days).

In the Wilmington metropolitan area consisting of Brunswick and New Hanover counties, the AQI was "*unhealthy for sensitive groups*" or "*unhealthy*" on two out of the 362 days monitored. These days occurred in July.

Figure 6.19 shows summaries of the numbers of days each respective pollutant was responsible for the AQI, and Figure 6.20 shows the number of days the AQI was in each respective health category for Wilmington in 2011.

Table 6.1 Air Quality Index Category Days in the Major Metropolitan Areas, 2011

AREA	STATISTICAL TREATMENT	GOOD	MODERATE	UNHEALTHY FOR SENSITIVE GROUPS	UNHEALTHY
Asheville	actual	310	54	0	0
Charlotte	actual	223	118	24	0
Fayetteville	actual	284	77	4	0
Goldsboro	actual	302	42	2	0
Greensboro	actual	244	113	8	0
Greenville	actual	214	43	3	0
Greenville	*adjusted*	242	45	3	0
Hickory	actual	284	81	0	0
Raleigh	actual	257	102	6	0
Rocky Mount	actual	249	48	2	0
Rocky Mount	*adjusted*	283	51	2	0
Wilmington	actual	311	49	2	0

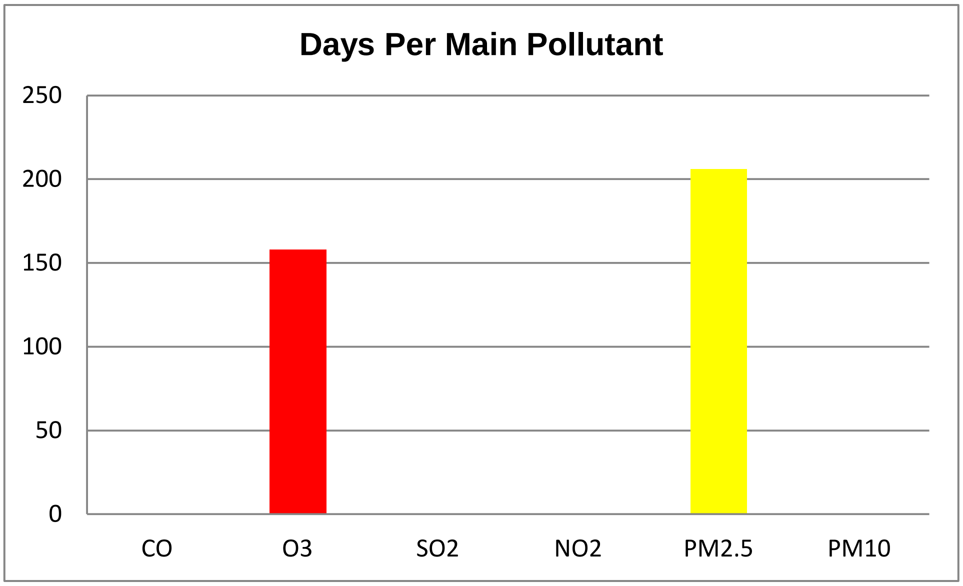


Figure 6.1 Daily Air Quality Index Values for Asheville, 2011

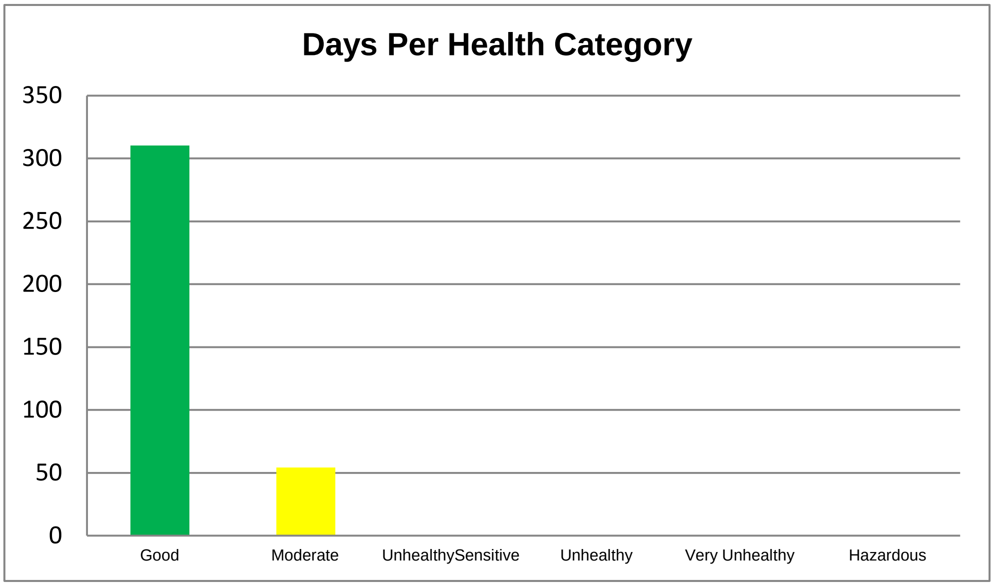


Figure 6.2 Daily Air Quality Index Summary for Asheville, 2011

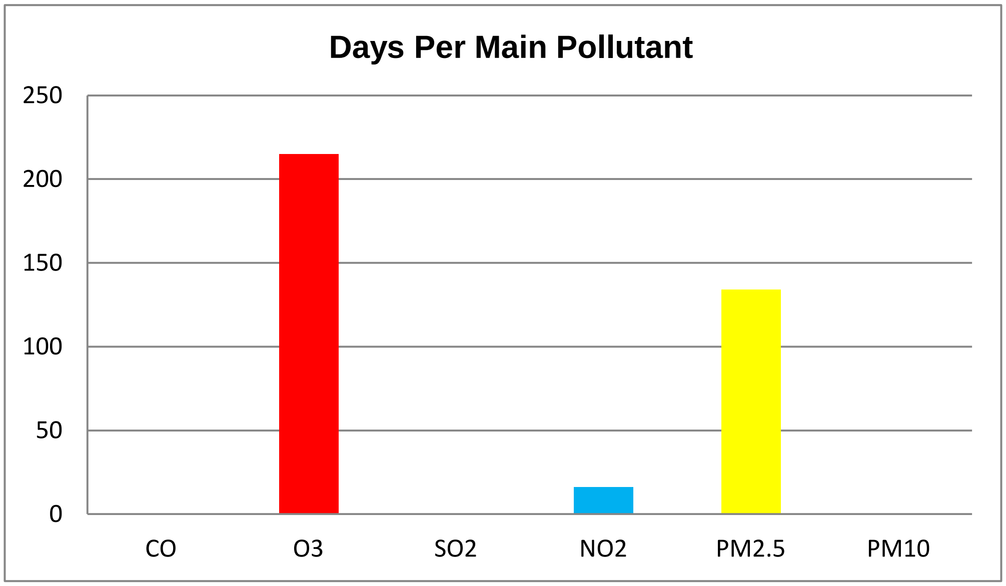


Figure 6.3 Daily Air Quality Index Values for Charlotte-Gastonia, 2011

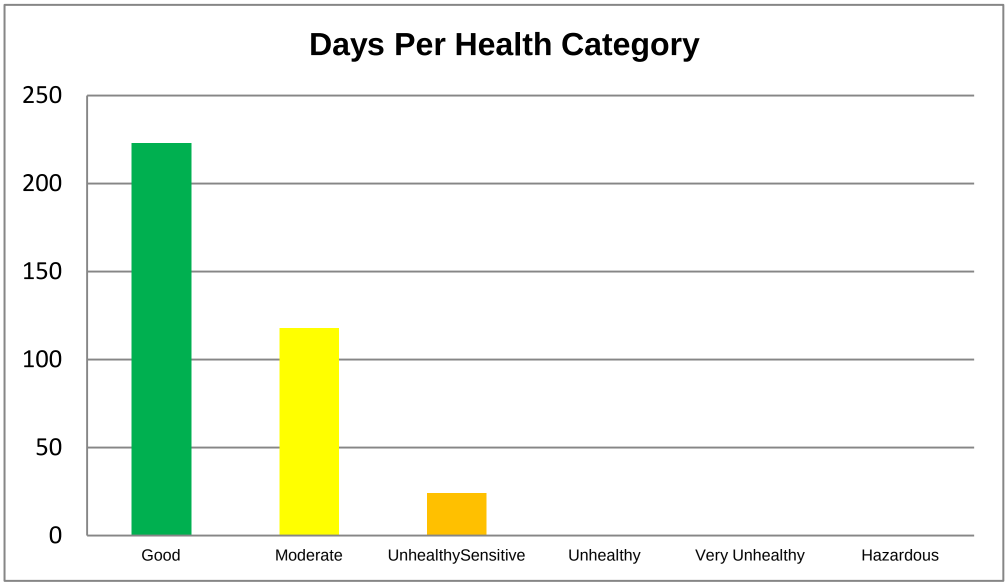


Figure 6.4 Daily Air Quality Index Summary for Charlotte-Gastonia, 2011

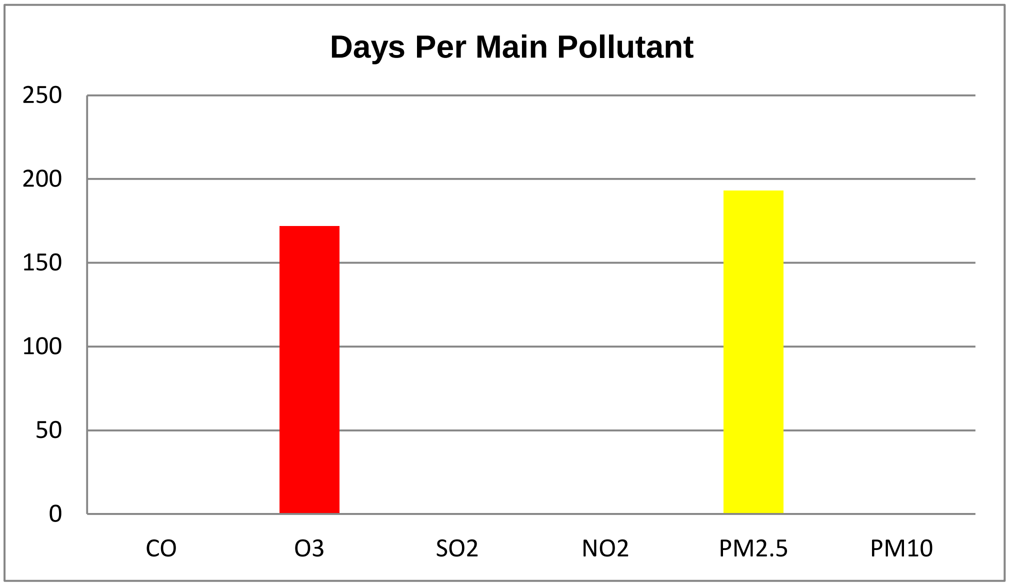


Figure 6.5 Daily Air Quality Index Values for Fayetteville, 2011

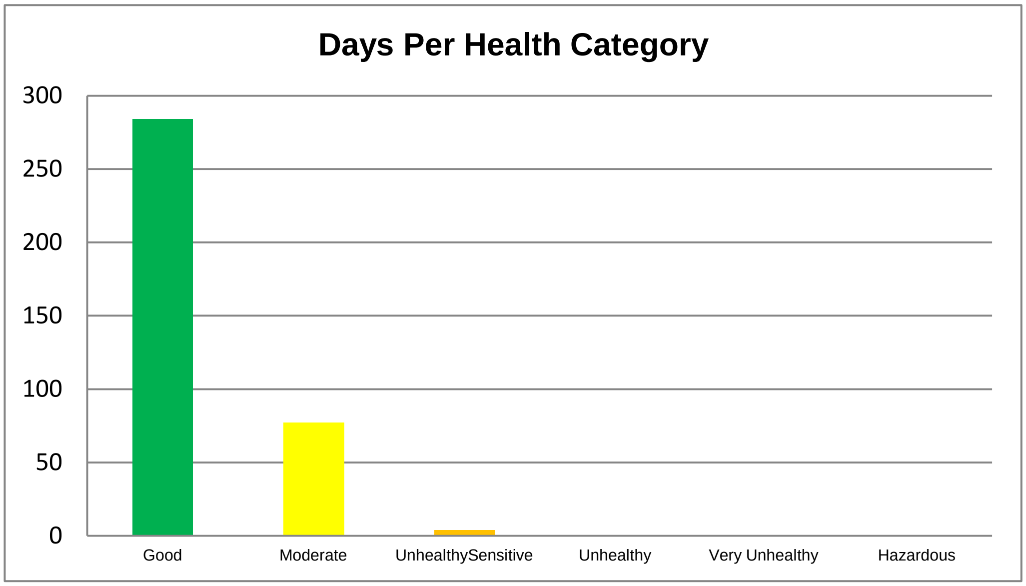


Figure 6.6 Daily Air Quality Index Summary for Fayetteville, 2011

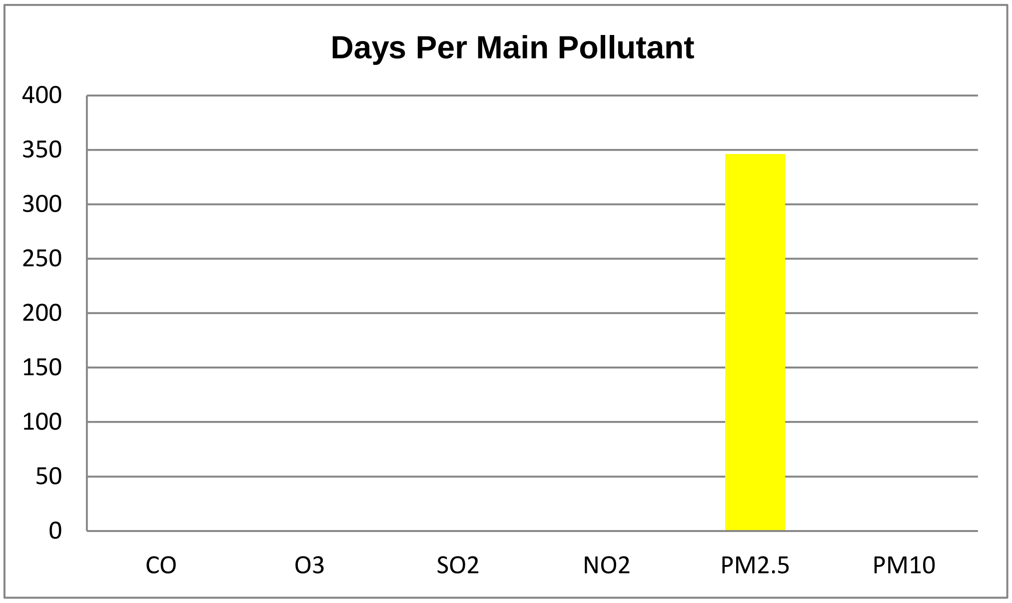


Figure 6.7 Daily Air Quality Index Values for Goldsboro, 2011

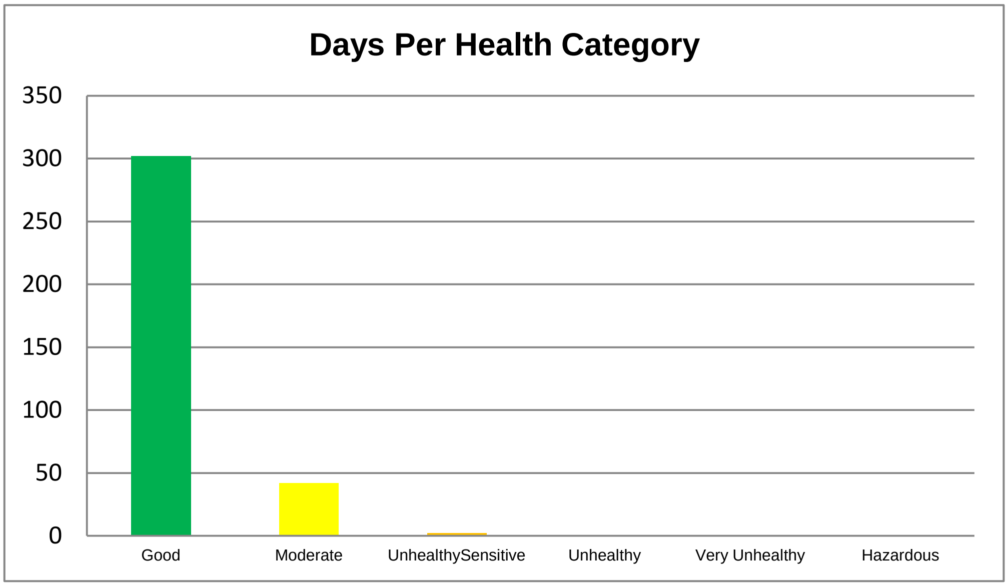


Figure 6.8 Daily Air Quality Index Summary for Goldsboro, 2011

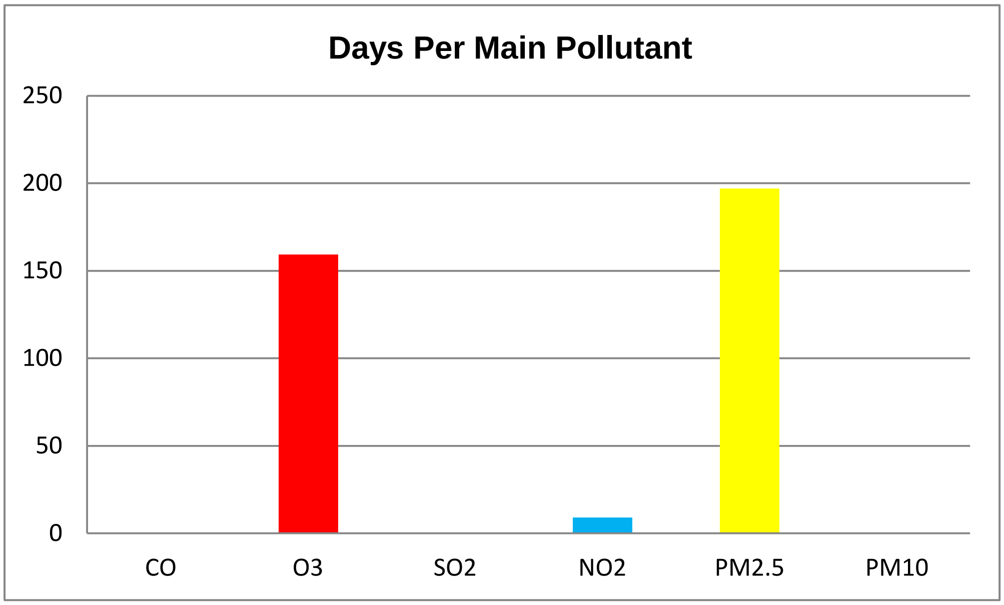


Figure 6.9 Daily Air Quality Index Values for Greensboro-Winston-Salem-High Point, 2011

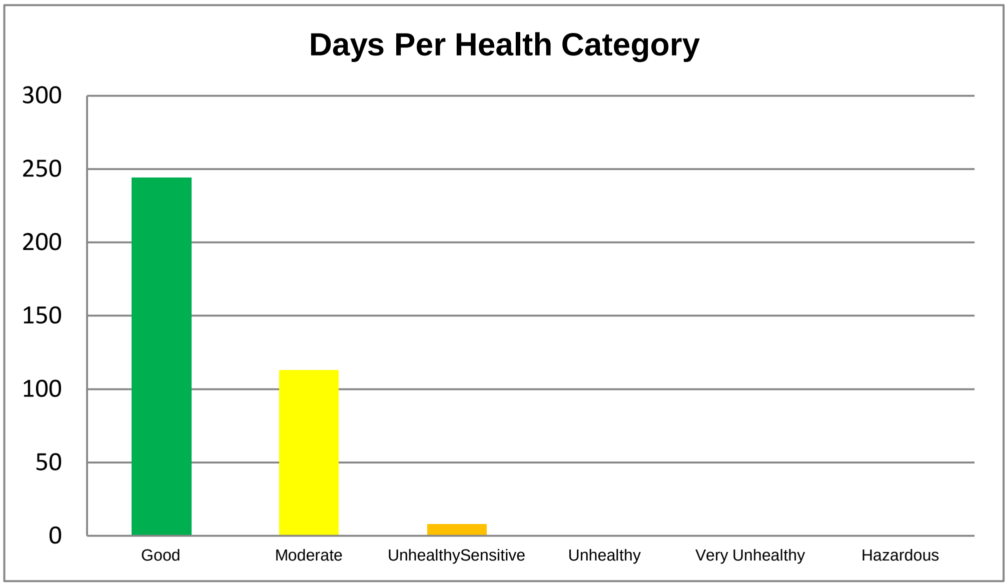


Figure 6.10 Daily Air Quality Index Summary for Greensboro-Winston-Salem-High Point, 2011

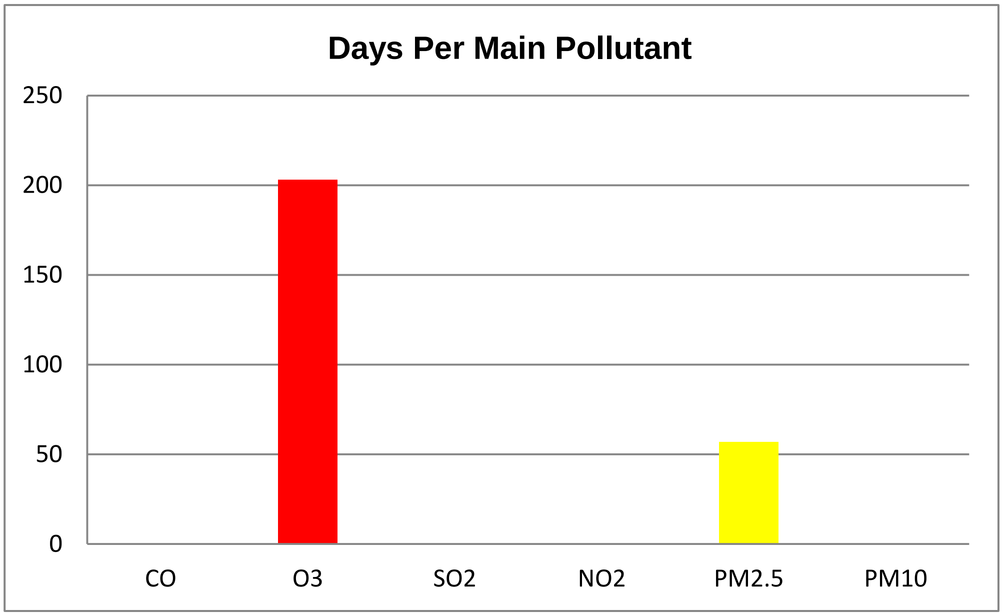


Figure 6.11 Daily Air Quality Index Values for Greenville, 2011

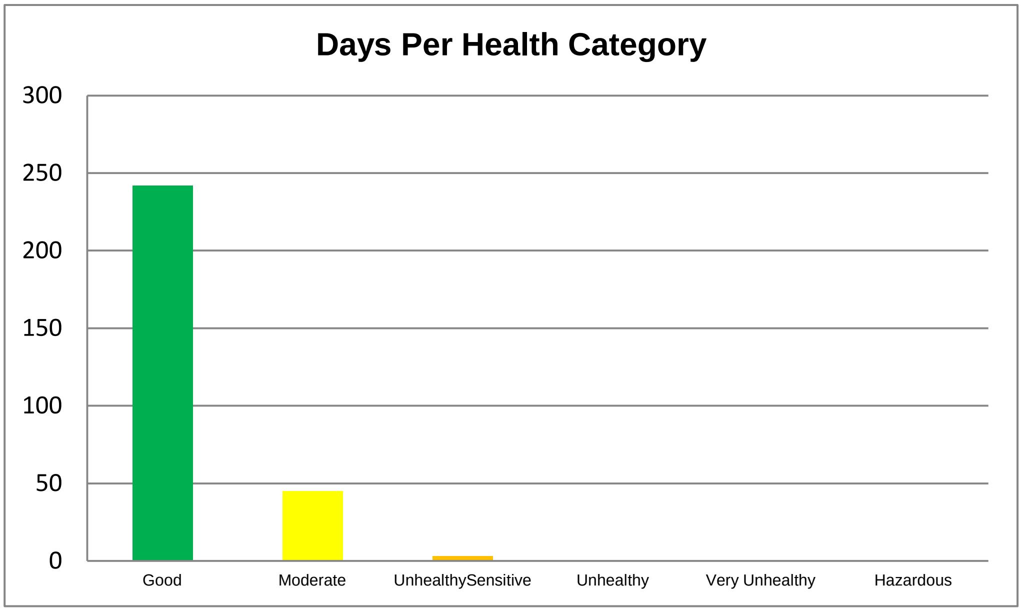


Figure 6.12 Daily Air Quality Index Summary for Greenville, 2011

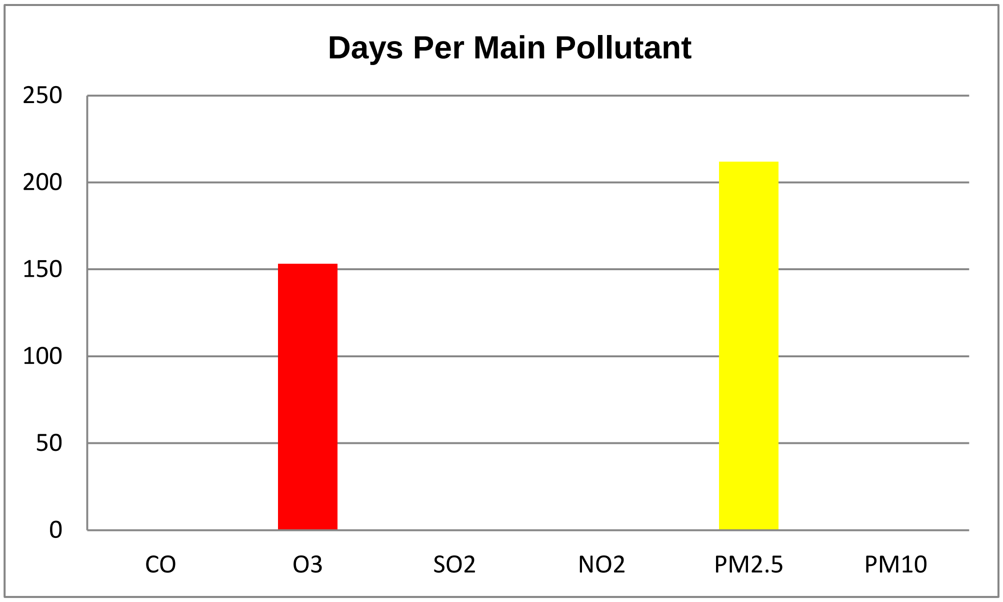


Figure 6.13 Daily Air Quality Index Values for Hickory-Morganton-Lenoir, 2011

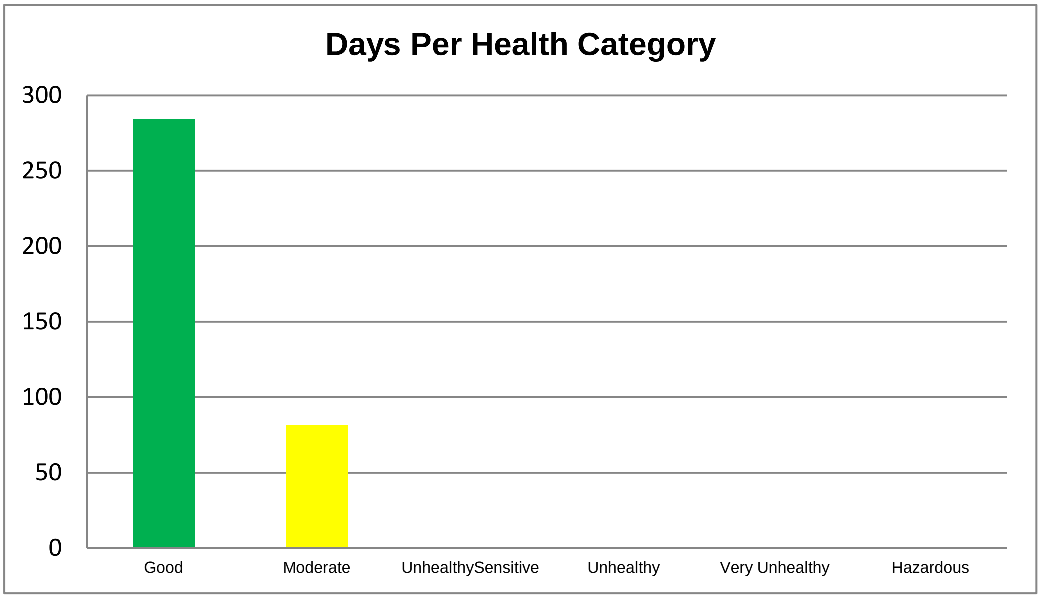


Figure 6.14 Daily Air Quality Index Summary for Hickory-Morganton-Lenoir, 2011

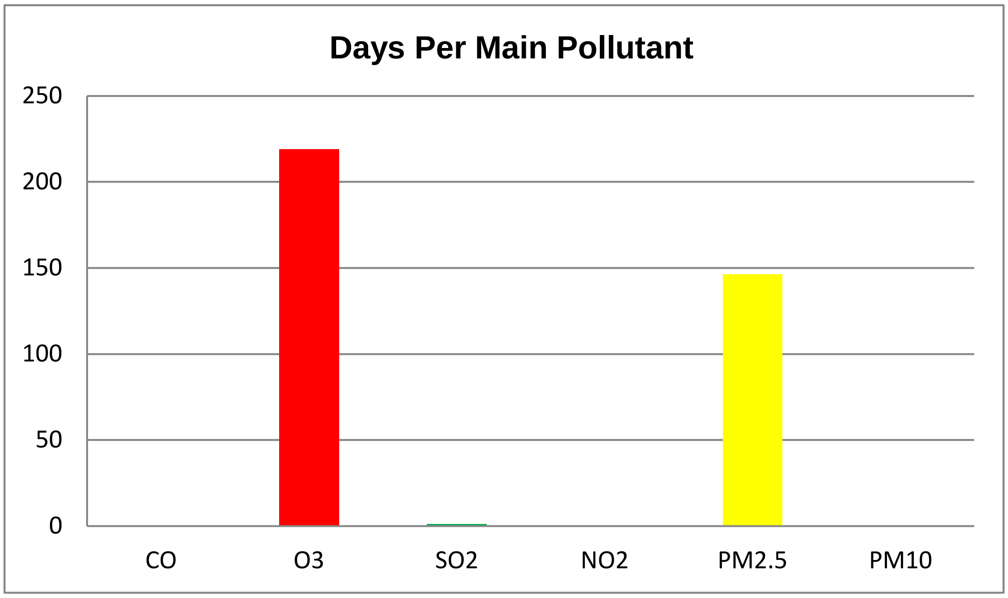


Figure 6.15 Daily Air Quality Index Values for Raleigh-Durham-Chapel Hill, 2011

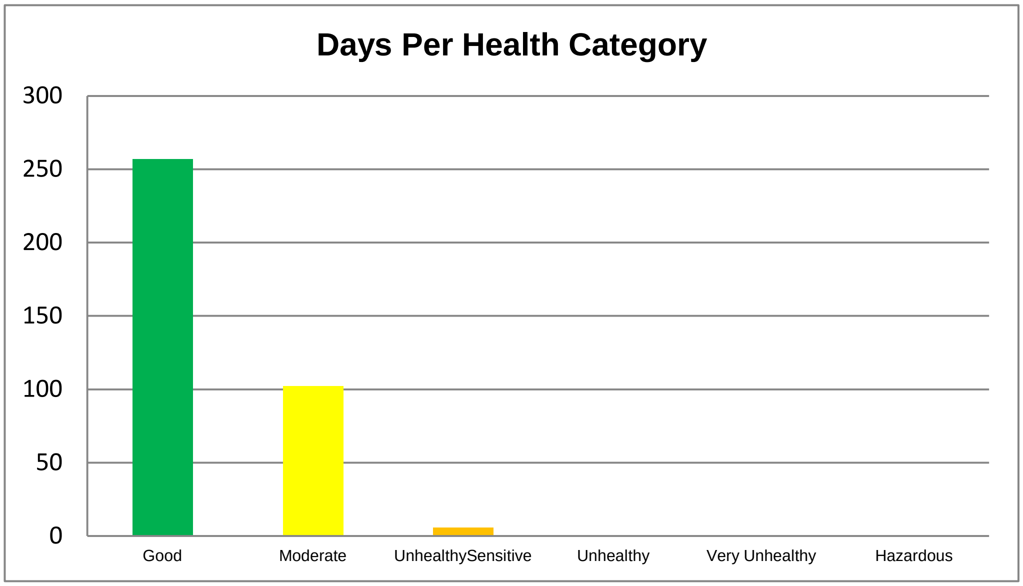


Figure 6.16 Daily Air Quality Index Summary for Raleigh-Durham-Chapel Hill, 2011

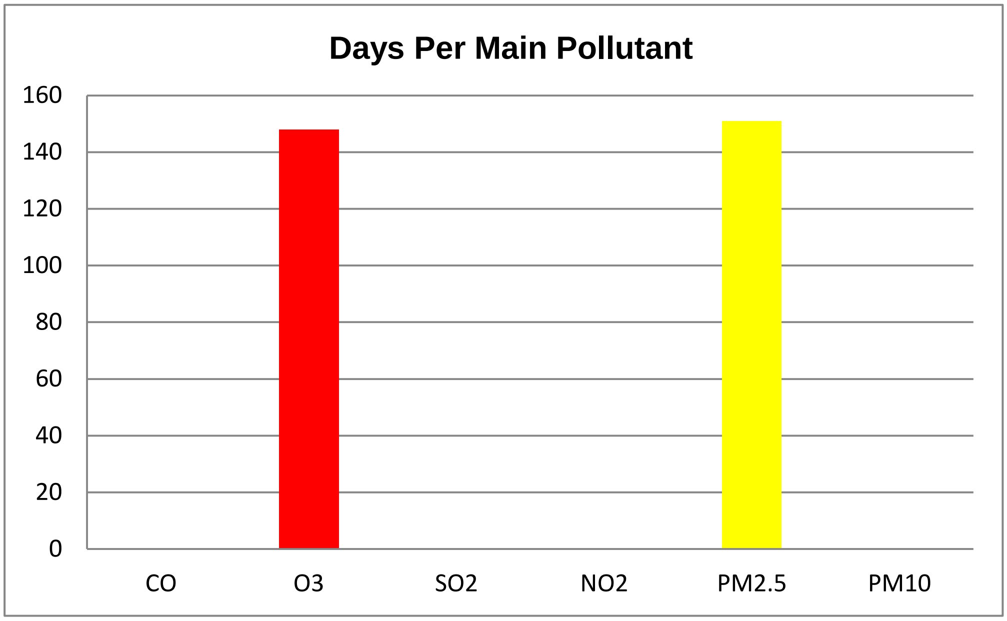


Figure 6.17 Daily Air Quality Index Values for Rocky Mount, 2011

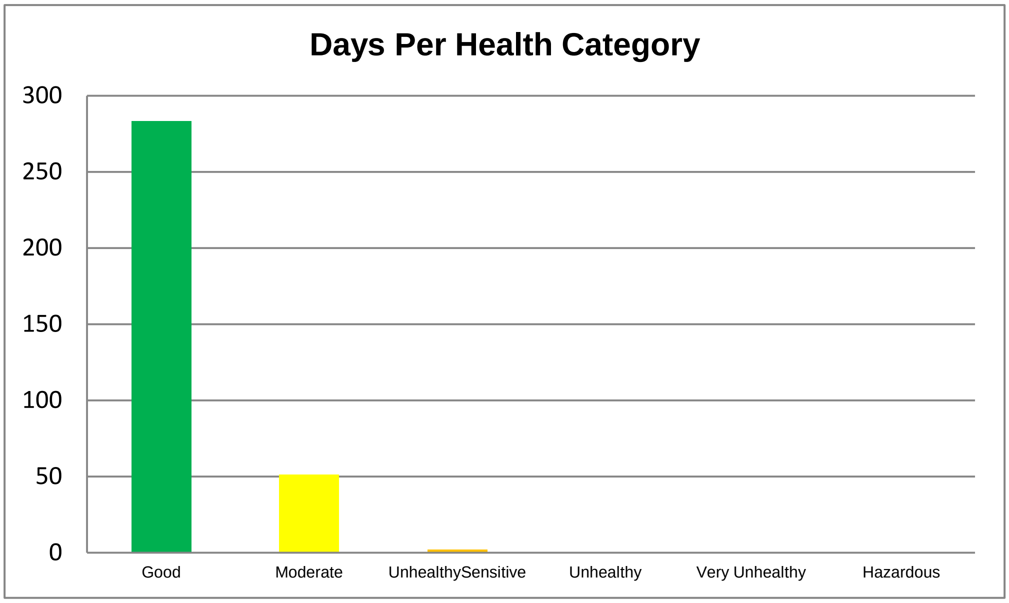


Figure 6.18 Daily Air Quality Index Summary for Rocky Mount, 2011

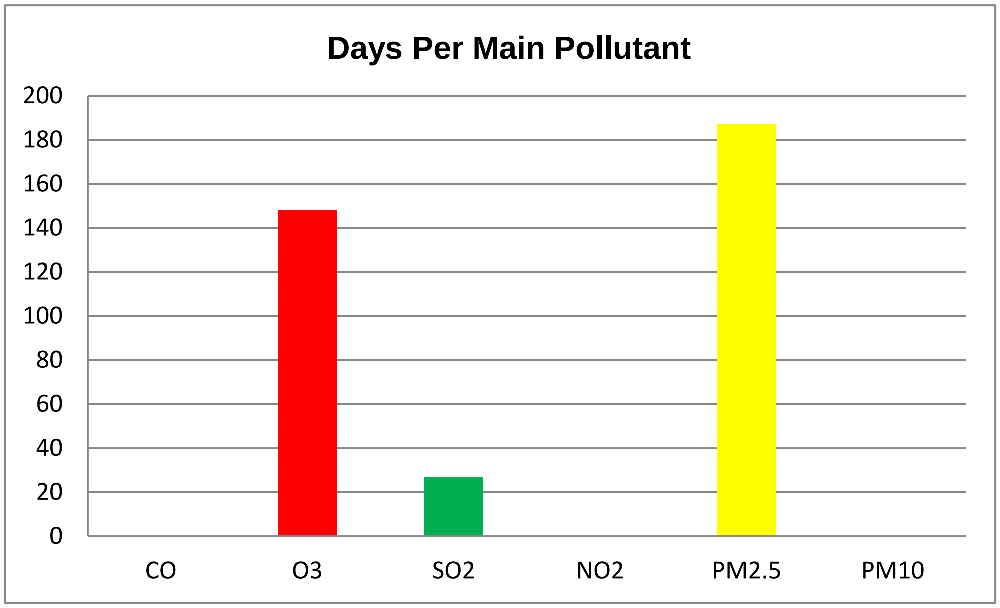


Figure 6.19 Daily Air Quality Index Values for Wilmington, 2011

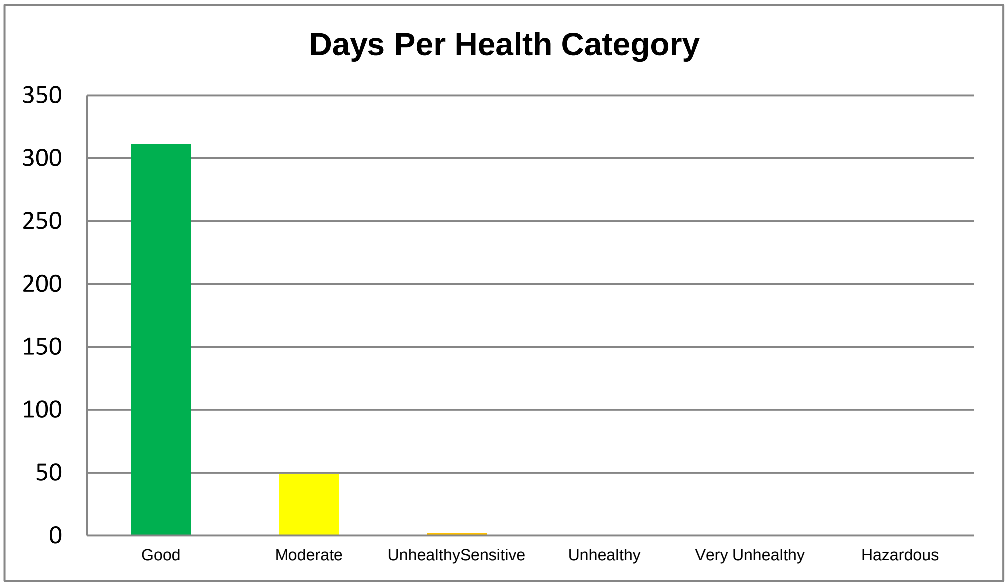


Figure 6.20 Daily Air Quality Index Summary for Wilmington, 2011

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 react 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 2011, 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 10 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 2011 ranged from 4.97 to 5.35 with a mean of 5.06. The 2011 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 acidic) 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.

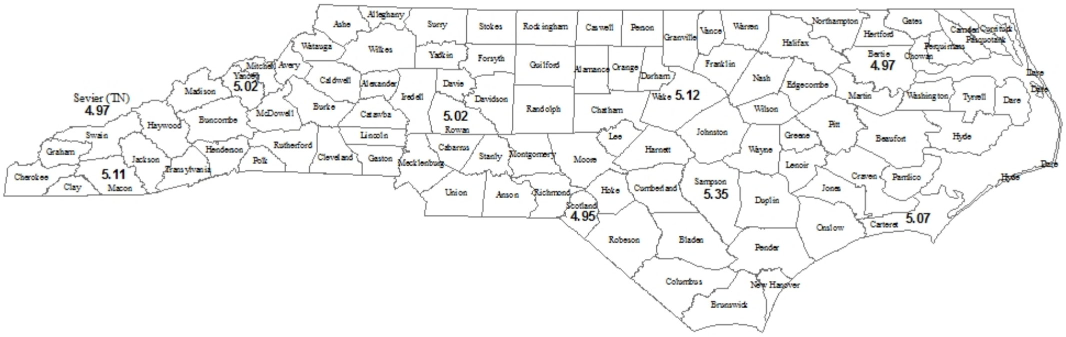


Figure 7.1 Annual Mean pH Values at North Carolina NADP Sites, 2011

Table 7.1 pH, Conductivity in Microsiemans per Centimeter and Precipitation in Inches from the National Atmospheric Deposition Program for 2011

County Site ID Address	pH	Conductivity	Precipitation
Bertie NC03 Lewiston	4.97	9.95	43.33
Carteret NC06 Beaufort	5.07	12.90	40.13
Macon NC25 Coweeta	5.11	6.21	71.98
Rowan NC34 Piedmont Research Station	5.02	9.25	44.83
Sampson NC35 Clinton Crops Research Station	5.35	8.54	36.83
Scotland NC36 Jordan Creek	4.95	9.34	38.97
Wake NC41 Finley Farm	5.12	8.71	37.75
Yancey NC45 Mt. Mitchell	5.02	6.20	71.22
Sevier (TN) TN11 Great Smoky Mountains National Park-Elkmont	4.97	7.46	65.81

Table 7.2 Ion Concentrations in Milligrams per Liter (Precipitation-weighted Annual Means) from the National Atmospheric Deposition Program Data for 2011

County Site ID	% Complete-ness	Ca	Mg	K	Na	NH4	NO3	Cl	SO4
Bertie NC03	87	0.096	0.032	0.039	0.190	0.360	0.799	0.334	0.908
Beaufort NC06	74	0.105	0.113	0.046	0.911	0.225	0.565	1.608	0.814
Macon NC25	92	0.073	0.018	0.021	0.103	0.158	0.437	0.176	0.542
Rowan NC34	83	0.082	0.021	0.080	0.107	0.444	0.730	0.186	.908
Sampson NC35	93	0.081	0.037	0.027	0.263	0.517	0.696	0.466	0.828
Scotland NC36	89	0.094	0.031	0.024	0.209	0.278	0.718	0.364	0.795
Wake NC41	96	0.076	0.031	0.054	0.203	0.399	0.685	0.357	0.825
Yancey NC45	77	0.055	0.010	0.014	0.043	0.155	0.388	0.073	0.553
Sevier (TN) TN11	87	0.089	0.014	0.024	0.040	0.170	0.589	0.072	0.666

8. Fine Particle Speciation

8.1 Description of pollutants

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

8.1.1 Nitrate

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

8.1.2 Sulfate

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

8.1.3 Ammonium

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

8.1.4 Organic Carbon

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

8.1.5 Elemental Carbon

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

8.1.6 Crustal Component (Fine Dust)

Suspended dust consists mainly of oxides of aluminum, silicon, calcium, titanium, iron, lead and other metal oxides (Chow and Watson, 1998). The precise combination of these minerals depends on the geology of the area and industrial processes such as steel-making, smelting, mining and cement production. Geological material is mostly in the coarse particle fraction, and typically constitutes about 50 percent of PM_{10} while only contributing 5 to 15 percent of $PM_{2.5}$ (Chow and Watson, 1998).

Lead is a toxic metal that was used for many years in products found in and around homes. Lead also is emitted into the air from motor vehicles and industrial sources. Lead may cause a range of health effects, from behavioral problems and learning disabilities, to seizures and death. The DAQ monitored lead as a federal criteria pollutant in the past (see chapter 5) until it became undetectable by the prescribed sampling method.* For these reasons we include concentration of the lead in PM2.5 in this report.

8.1.7 "Other" Speciated components.

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

8.2 Sources

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

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

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

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* EPA promulgated a new lead standard in 2008, and DAQ anticipates establishing a reporting network for it in 2012.

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

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

8.3 Effects

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

8.4 Monitoring

The state and local programs in NC used two kinds of samplers to acquire $PM_{2.5}$ mass and its chemical composition: MetOne SASS monitors and URG 3000N monitors. A program operated by federal government agencies, the Interagency Monitoring of Protected Visual Environments, used their own sampling system, called the IMPROVE monitor.

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

The organic carbon and soot-like carbon are collected using the URG 3000N sampler, which is the same method as used for IMPROVE using quartz filters and thermal optical reflective (TOR) analysis.

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

State and local program data are validated on a monthly basis when reports are received from the contract laboratory RTI International. NCDAQ and the local programs collected data at seven sites using MetOne SASS and the URG 3000N methods, the National Park Service collected at three sites during 2011 using the IMPROVE method. Figure 8.1 shows a map of all these sites. Table 8.1 identifies the sites.

Nitrate samples in 2011 are summarized in Table 8.2 and 8.3. The highest concentration observed was 5.68 $\mu g/m^3$ at Charlotte.

Sulfate samples in 2011 are summarized in Table 8.4 and 8.5. The highest concentration observed was 9.11 $\mu g/m^3$ at Charlotte.

Ammonium samples in 2011 are summarized in Table 8.6 and 8.7. The highest concentration observed was 3.36 $\mu g/m^3$ at Charlotte.

Organic Carbon samples in 2011 are summarized in Table 8.8 and 8.9. The highest concentration observed was 23.60 $\mu g/m^3$ at Durham.

Elemental Carbon samples in 2011 are summarized in Table 8.10 and 8.11. The highest concentration observed was 1.39 $\mu g/m^3$ at Hickory.

Crustal Component samples in 2011 are summarized in Table 8.12 and 8.13. The highest concentration observed was 2.43 $\mu g/m^3$ at Raleigh.

Elemental lead samples for 2011 are summarized in Table 8.14 and 8.15. Out of 832 samples statewide, three samples exceeded 0.01 $\mu g/m^3$; 829 of these sample concentrations (100 percent) were less than 0.01 $\mu g/m^3$. One sample was greater than 0.014 $\mu g/m^3$. The highest concentration observed was 0.021 $\mu g/m^3$ at Winston-Salem.

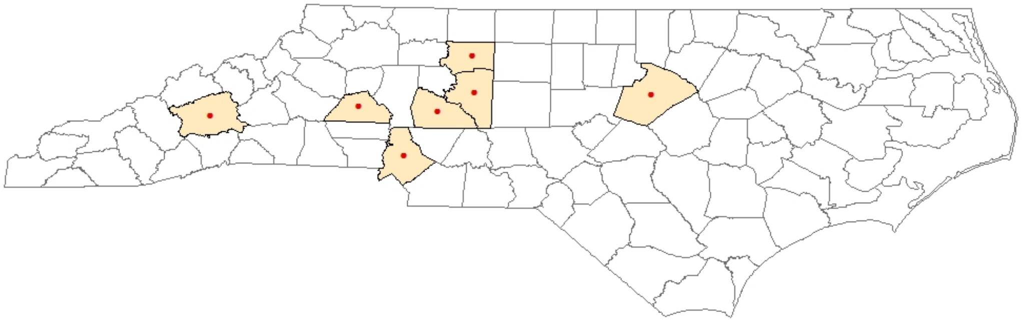

Figure 8.1 Location of Nitrate, Sulfate, Ammonium, Organic Carbon, Elemental Carbon, Crustal component, Monitoring Sites 2011.

Table 8.1 Fine Particle Speciation Sites Operated in North Carolina in 2011

SITE NUMBER COUNTY	ADDRESS
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE
37-035-0004 CATAWBA	1650 1ST STREET HICKORY
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH
SITES OPERATED IN 2011	7

Table 8.2 Mean and Maximum Nitrate PM2.5 Concentration for 2011

SITE NUMBER	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
COUNTY			1st	2nd	3rd	4th	
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	1.40	1.39	1.16	1.07	.39
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	4.55	2.22	1.97	1.90	0.65
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	61	3.38	1.79	1.64	1.55	.58
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	50	4.25	1.58	1.43	1.30	.57
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	118	5.68	4.87	3.86	2.94	.66
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	59	2.99	2.33	1.62	1.50	.53
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	113	3.00	2.78	2.53	2.45	.55
Total Samples		520					
Total Sites Sampled		7					

Table 8.3 Nitrate PM2.5 - Quartile statistics - Micrograms/Cubic Meter (LC) for 2011

SITE NUMBER	ADDRESS	NUM OBS	QUARTILES Mg/m^2			MAXIMUM
COUNTY			1st	2nd	3rd	
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	.21	.30	.44	1.40
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	.27	.38	.73	4.55
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	61	.26	.40	.72	3.38
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	50	.26	.36	.62	4.25
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	118	.23	.34	.70	5.68

SITE NUMBER	ADDRESS	NUM OBS	QUARTILES Mg/m^2			MAXIMUM
COUNTY			1st	2nd	3rd	
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	59	.23	.34	.64	2.99
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	113	.24	.35	.64	3.00
Effective Sample Count*		520				
Total Sites Sampled		7				

Table 8.4 Mean and Maximum Sulfate PM2.5 Concentration for 2011

SITE NUMBER	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
COUNTY			1st	2nd	3rd	4th	
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	8.16	6.77	5.84	5.61	2.51
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	7.90	4.92	4.82	4.45	2.27
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	61	5.80	4.95	4.88	4.66	2.26
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	50	7.06	5.14	4.68	4.48	2.40
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	118	9.11	5.84	5.82	5.50	2.35
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	59	6.09	5.42	5.04	4.61	2.23
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	113	8.22	6.13	5.91	4.93	2.32
Total Samples		520					
Total Sites Sampled		7					

*** Not including collocated samples.**

Table 8.5 Sulfate PM2.5 - Quartile statistics - Micrograms/Cubic Meter (LC) for 2011

SITE NUMBER COUNTY	ADDRESS	NUM OBS	QUARTILES 1st	2nd	3rd	MAXIMUM
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	1.23	2.33	3.38	8.16
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	1.16	2.21	2.92	7.90
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	61	1.25	2.15	3.06	5.80
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	50	1.37	2.24	3.19	7.06
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	118	1.20	2.01	3.04	9.11
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	59	1.18	1.99	2.92	6.09
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	113	1.42	2.02	2.97	8.22
Effective Sample Count*		520				
Total Sites Sampled		7				

Table 8.6 Mean and Maximum Ammonium Ion PM2.5 Concentration for 2011

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	1.84	1.58	1.48	1.36	.68
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	2.18	2.15	2.11	1.86	.72
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	61	2.14	2.05	1.95	1.74	.75
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	50	2.17	2.03	1.95	1.76	.75

*** Not including collocated samples.**

SITE NUMBER	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
COUNTY			1st	2nd	3rd	4th	
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	118	3.36	2.40	2.25	1.96	.74
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	59	2.06	1.96	1.72	1.68	.68
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	113	2.22	2.04	1.76	1.68	.73
Total Samples		520					
Total Sites Sampled		7					

Table 8.7 Ammonium Ion PM2.5 - Quartile statistics - Micrograms/Cubic Meter (LC) for 2011

SITE NUMBER	ADDRESS	NUM OBS	QUARTILES			MAXIMUM
COUNTY			1st	2nd	3rd	
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	.32	.65	.88	1.84
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	.35	65	.94	2.18
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	61	.37	.70	.97	2.14
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM KINSTON	50	.38	.66	.98	2.17
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	118	.30	.65	.97	3.36
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	59	.30	.59	.89	2.06
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	113	.39	.66	.99	2.22
Effective Sample Count*		520				
Total Sites Sampled		7				

*** Not including collocated samples.**

Table 8.8 Mean and Maximum Organic Carbon CSN PM2.5 Concentration for 2011

SITE NUMBER	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
COUNTY			1st	2nd	3rd	4th	
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	5.70	5.21	5.11	4.89	2.37
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	7.43	6.42	6.18	5.52	2.99
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	58	5.49	5.38	5.11	5.09	2.79
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	36	5.31	5.12	4.70	3.76	2.35
37-063-0099 DURHAM	109 TW ALEXANDER DRIVE DURHAM	57	23.60	9.23	6.84	6.49	3.89
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	97	7.40	6.53	6.33	5.76	2.95
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	58	6.31	6.24	5.62	5.47	2.68
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	114	8.77	6.74	6.25	6.14	2.88
Total Samples		539					
Total Sites Sampled		8					

Table 8.9 Organic Carbon CSN PM2.5 - Quartile statistics - Micrograms/Cubic Meter (LC) for 2011

SITE NUMBER	ADDRESS	NUM OBS	QUARTILES			MAXIMUM
COUNTY			1st	2nd	3rd	
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	1.53	2.31	3.07	5.70
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	2.03	2.71	3.87	7.43
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	58	1.95	2.63	3.26	5.49
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	36	1.55	2.16	2.78	5.31

37-063-0099 DURHAM	109 TW ALEXANDER DRIVE DURHAM	57	2.42	3.40	4.55	23.60
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	97	1.86	2.78	3.78	7.40
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	58	1.69	2.64	3.07	6.31
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	114	1.90	2.64	3.52	8.77
Effective Sample Count*		539				
Total Sites Sampled		8				

Table 8.10 Mean and Maximum Elemental Carbon CSN PM2.5 Concentration for **2011**

SITE NUMBER COUNTY	ADDRESS	NUM OBS	24-HOUR MAXIMA 1st	2nd	3rd	4th	ARITH MEAN
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	.69	.66	.59	.51	.23
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	1.39	1.28	.99	.94	.39
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	58	1.24	.89	.56	.54	.31
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	36	.58	.57	.52	.42	.24
37-063-0099 DURHAM	109 TW ALEXANDER DRIVE DURHAM	57	.49	.45	.42	.42	.22
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	97	.97	.74	.74	.67	.30
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	58	.83	.64	.58	.51	.23
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	114	1.29	.83	.82	.68	.26
Total Samples		539					
Total Sites Sampled		8					

*** Not including collocated samples.**

^ These IMPROVE monitors do not report this speciation component

Table 8.11 Elemental Carbon CSN PM2.5 - Quartile statistics - Micrograms/Cubic Meter (LC) for 2011

SITE NUMBER COUNTY	ADDRESS	NUM OBS	QUARTILES 1st	2nd	3rd	MAXIMUM
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	.13	.17	.30	.69
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	.21	.30	.47	1.39
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	58	.20	.25	.35	1.24
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	36	.15	.21	.27	.58
37-063-0099 DURHAM	109 TW ALEXANDER DRIVE DURHAM	57	.15	.20	.25	.49
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	97	.17	.24	.38	.97
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	58	.13	.19	.26	.83
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	114	.16	.22	.28	1.29
Effective Sample Count*		539				
Total Sites Sampled		8				

*** Not including collocated samples.**

^ These IMPROVE monitors do not report this speciation component

Table 8.12 Mean and Maximum Crustal Component PM2.5 Concentration for 2011

SITE NUMBER	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
COUNTY			1st	2nd	3rd	4th	
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	1.12	1.07	.84	.71	.32
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	1.00	.87	.81	.67	.31
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	61	.98	.79	.79	.77	.36
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	51	.77	.71	.57	.54	.25
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	118	1.81	1.19	1.00	.99	.38
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	59	1.20	.94	.91	.67	.30
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	113	2.43	1.79	1.13	.96	.36
Total Samples		521					
Total Sites Sampled		7					

Table 8.13 Crustal Component CSN PM2.5 - Quartile statistics - Micrograms/Cubic Meter (LC) for 2011

SITE NUMBER	ADDRESS	NUM OBS	QUARTILES			MAXIMUM
COUNTY			1st	2nd	3rd	
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	.16	.27	.39	1.12
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	.16	.26	.38	1.00
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	61	.19	.35	.49	.98
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	51	.13	.20	.31	.77
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	118	.19	.31	.48	1.81

SITE NUMBER	ADDRESS	NUM OBS	QUARTILES			MAXIMUM
COUNTY			1st	2nd	3rd	
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	59	.14	.24	.40	1.20
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	113	.20	.29	.43	2.43
Effective Sample Count*		521				
Total Sites Sampled		7				

Table 8.14 Mean and Maximum Lead $PM_{2.5}$ Concentration for 2011

SITE NUMBER	ADDRESS	NUM OBS	24-HOUR MAXIMA				ARITH MEAN
COUNTY			1st	2nd	3rd	4th	
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	.006	.004	.003	.003	.0008
37-035-0004 CATAWBA	1650 1ST. ST HICKORY	61	.009	.006	.006	.006	.0015
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	61	.011	.006	.005	.005	.0013
37-067-0022 FORSYTH	1300 BLK. HATTIE AVENUE WINSTON-SALEM	51	.021	.013	.008	.006	.0021
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	118	.007	.006	.006	.006	.0014
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	59	.008	.005	.005	.004	.0012
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	113	.006	.005	.005	.005	.0002
Total Samples		521					
Total Sites Sampled		7					

*** Not including collocated samples.**

Table 8.15 Lead $PM_{2.5}$ - Quartile statistics - Micrograms/Cubic Meter (LC) for 2011

SITE NUMBER COUNTY	ADDRESS	NUM OBS	QUARTILES 1st	2nd	3rd	MAXIMUM
37-021-0034 BUNCOMBE	175 BINGHAM ROAD ASHEVILLE	58	.000	.000	.001	.006
37-035-0004 CATAWBA	1650 1ST STREET HICKORY	61	.000	.000	.002	.009
37-057-0002 DAVIDSON	S.SALISBURY ST LEXINGTON	61	.000	.000	.002	.011
37-067-0022 FORSYTH	1300 BLK HATTIE AVE WINSTON-SALEM	51	.000	.001	.003	.021
37-119-0041 MECKLENBURG	1130 EASTWAY DRIVE CHARLOTTE	118	.000	.000	.003	.007
37-159-0021 ROWAN	301 WEST ST & GOLD HILL AVE ROCKWELL	59	.000	.000	.002	.008
37-183-0014 WAKE	3801 SPRING FOREST RD RALEIGH	113	.000	.000	.001	.006
Effective Sample Count*		521				
Total Sites Sampled		7				

*** Not including collocated samples.**

9. Urban Air Toxics

The DAQ operates an urban air toxics monitoring network in conjunction with a national program originally proposed and designed by the EPA in 1999.

In 2001, the EPA initiated a national network for monitoring air toxics compounds present in ambient air. Although no national network sites are located in NC, DAQ recognizes the importance of toxics monitoring and supports the continuation of the program. The objective of this monitoring is to generate ambient air data and to compile these data in an extensive air toxics database. The use of actual field measurements to compare and reconcile with estimates from source dispersion models will refine the model and ultimately allow a better overall estimate of population exposure. The ultimate goal of the EPA's Air Toxics Monitoring Strategy is to assess health risks.

In the time period covered by this report, DAQ continued the North Carolina air toxics monitoring program for Volatile Organic Compounds (VOC) at five urban sites and one rural site.

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

9.1 Sources

Thousands of products emit VOCs. Examples include: paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials, such as glues and adhesives, permanent markers, and photographic solutions.

9.2 Effects

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

9.3 Benzene

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

9.3.1 Sources

Benzene is a natural component of crude oil, and gasoline contains 1 to 5 percent by volume. Benzene is produced in large quantities from petroleum sources and is used for the chemical synthesis of ethyl benzene, phenol, cyclohexane and other substituted aromatic hydrocarbons.

Besides these industrial sources, emissions also occur from different combustion sources, such as motor engines, wood combustion and stationary fossil fuel combustion. Motor vehicles account for approximately 50-80 percent of the total benzene emissions, with the remainder attributed to nonroad mobile sources (25 percent) and stationary sources (15 percent). The major source is exhaust emissions and evaporation losses from motor vehicles, and evaporation losses during the handling, distribution and storage of motor vehicle fuels.

9.3.2 Effects

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

The major effects of benzene are chronic (long-term) exposure through the blood. Benzene damages the bone marrow and can cause a decrease in red blood cells, leading to anemia. It can also cause excessive bleeding and depress the immune system, increasing the chance of infection. Benzene targets liver, kidney, lung, heart and the brain and can cause chromosomal damage.

The US Department of Health and Human Services (DHHS) classifies benzene as a human carcinogen. Long-term exposure to excessive levels of benzene in the air causes leukemia, a potentially fatal cancer of the blood-forming organs, in susceptible individuals.

9.4 Toluene

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

9.4.1 Sources

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

9.4.2 Effects

The primary routes of potential human exposure to toluene are inhalation and dermal contact. In humans and animals, the primary effect associated with inhalation exposure to toluene is central nervous system depression with effects such as fatigue, confusion, lack of coordination, and impairments in reaction time, perception, and motor control and function.

9.5 Ethylbenzene

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

9.5.1 Sources

Sources of ethylbenzene to the atmosphere include petroleum and coal refining, vehicle emissions, and evaporation from solvents and thinners.

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

9.5.2 Effects

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

9.6 Xylene

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

9.6.1 Sources

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

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

9.6.2 Effects

Short-term exposure of people to high levels of xylene can cause irritation of the skin, eyes, nose, and throat; difficulty in breathing; impaired function of the lungs; delayed response to a visual stimulus; impaired memory; stomach discomfort; and possible changes in the liver and kidneys. Both short- and long-term exposure to high concentrations of xylene can also cause a number of effects on the nervous system, such as headaches, lack of muscle coordination, dizziness or confusion (ATSDR).

9.7 1,3-Butadiene

1,3-Butadiene is a colorless, flammable gas at room temperature with a mild gasoline-like odor. It is insoluble in water, and its two conjugated double bonds make it highly reactive.

9.7.1 Sources

1,3-Butadiene is a chemical made from the processing of petroleum. Large amounts of 1,3-butadiene are produced each year from petroleum gases. 1,3-Butadiene is formed in vehicle exhaust by the incomplete combustion of the fuel and is assumed not to be present in emissions. Small amounts of 1,3-butadiene are found in gasoline, cigarette smoke, and wood-fire smoke.

1,3-Butadiene is transformed rapidly in the atmosphere. Three chemical reactions of 1,3-butadiene are important in the ambient atmosphere: reaction with hydroxyl radical (OH·), reaction with ozone (O_3), and reaction with nitrogen trioxide radical (NO_3·). All three of these reactions are relatively rapid, and all produce formaldehyde and acrolein, species which are themselves toxic and/or irritants. The oxidation of 1,3-butadiene by NO_3· produces organic nitrates as well.

9.7.2 Effects

Most of the information on the health effects of 1,3-butadiene comes from studies where the exposure was from breathing contaminated air. Breathing very high levels of 1,3-butadiene for a short time can cause central nervous system damage, blurred vision, nausea, fatigue, headache, decreased blood pressure and pulse rate, and unconsciousness. Breathing lower levels may cause irritation of the eyes, nose, and throat (ATSDR).

9.8 Monitoring in 2011

There were multiple systems failures in the toxics analytic lab that required several months during 2011 to repair, replace or upgrade. Because of this, only 56 percent of the required sampling was successful during 2011, and the successful samples were unevenly distributed among the seasons or quarters of the year. Thus the toxics data do not properly represent 2011 as a whole and should not be casually used for trends or other analyses

Toxic air pollutant monitoring data were developed using EPA Compendium Method TO-15, “Determination of Volatile Organic Compounds in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography / Mass Spectrometry.” Using this method, samples were obtained over a 24-hour period, generally from midnight to midnight and represent a 24-hour aggregated average. Samples of volatile organic compounds were obtained once every six days.

During 2011, toxics monitoring data were collected at five urban monitoring sites in Asheville, Charlotte, Raleigh, Wilmington and Winston-Salem and at one rural site, near Candor, in Montgomery County (Figure 9.1). The map in Figure 9.1 shows the locations of the six sites.

This report shows summary statistics for 2011 in Table 9.1 through Table 9.6 and discusses averages of concentrations for each pollutant and site below. Some pollutants were not detectable in many of the samples. This introduces uncertainty and bias in the arithmetic mean, so this report describes average concentrations in terms of the median, or second quartile, concentrations and to show all three of the data quartiles and the maximum in the tables. The "first (second, third) quartile" is a number selected so that ¼ (½, ¾) of the data values are less than or equal to the numeric value of these statistics.

For VOC samples at concentrations below an established detection limit, it is a standard (although controversial) practice to substitute one-half of the minimum reporting limit or detection limit for the observed or reported concentration. In the summary statistics discussions following, report comparisons between North Carolina and other states are based on medians, rather than problematic arithmetic means. When there are concentrations "less than or equal to" the lowest quantitation limit, concentrations are represented by the actual value or zero if no concentration could be measured.

Benzene samples in 2011 are summarized in Table 9.1. Median (2nd quartile) concentrations ranged from 0.13 to 0.28 ppb at urban sites, while at the rural site the median concentration was 0.33 ppb. Nationwide median benzene concentrations ranged from ≤0.07 ppb to 0.35 ppb with the overall median of 0.19 ppb. North Carolina was the 11th highest state among 36 reporting states with a median of 0.22 ppb.

Toluene samples in 2011 are summarized in Table 9.2. Median (2nd quartile) concentrations ranged from 0.18 to 0.46 ppb at the urban sites, while at the rural site the median concentration was 0.09 ppb. Nationwide median toluene concentrations ranged from ≤0.10 ppb to .90 ppb with the overall median of 0.26 ppb. North Carolina was the 19th highest state among 34 reporting states with a median of 0.24 ppb.

Ethylbenzene samples in 2011 are summarized in Table 9.3. Median (2nd quartile) concentrations ranged from 0.05 to 0.09 ppb at the urban sites, while at the rural site the median concentration was 0.03. Data indicate that 72 percent of the sample concentrations at Candor, the rural site, were below the smallest value that could be reliably detected using TO-15. Nationwide median ethylbenzene concentrations ranged from ≤0.00 ppb to 0.20 ppb with the overall median of 0.04 ppb. North Carolina was the 10th highest state among 34 reporting states with a median of 0.06 ppb.

The results for m/p-Xylene in 2011 are summarized in Table 9.4. Sample medians ranged from 0.12 to 0.16 ppb at the urban sites, while at the rural site the median concentration was 0.04. Data indicate that in 2011, 69 percent of the sample concentrations at Candor, the rural site, were below the smallest value that could be reliably detected using TO-15. Nationwide median m/p-Xylene concentrations ranged from ≤0.00 ppb to 0.40 ppb with the overall median of 0.10 ppb. North Carolina was the 13th highest state among 34 reporting states with a median of 0.12 ppb.

o-Xylene samples in 2011 are summarized in Table 9.5. Median (2nd quartile) concentrations ranged from

0.05 to 0.11 ppb at the urban sites while at the rural site the median was 0.02 ppb. Data indicate that 72 percent of the sample concentrations at Candor, the rural site, were below the smallest value that could be reliably detected using TO-15. Nationwide median o-Xylene concentrations ranged from ≤0.00 ppb to 0.20 ppb with the overall median of 0.04 ppb. North Carolina was the 13th highest state among 34 reporting states with a median of 0.08 ppb.

1,3-Butadiene samples in 2011 are summarized in Table 9.6. Median (2nd quartile) concentrations ranged from 0.00 to 0.05 ppb at the urban sites while at the rural site the median was 0.00 ppb. Nationwide median1,3-Butadiene concentrations ranged from 0.00 ppb to 0.20 ppb with the overall median of ≤0.01 ppb. Ranking the states using the median 1,3-Butadiene concentration is ambiguous, because the median is less than or equal to 0.05 ppb for North Carolina and almost every other reporting state. However, based on the fourth maximum sample concentrations, North Carolina was the 19th highest state among 33 reporting states and based on the 90 th percentile North Carolina was the 9th highest state.

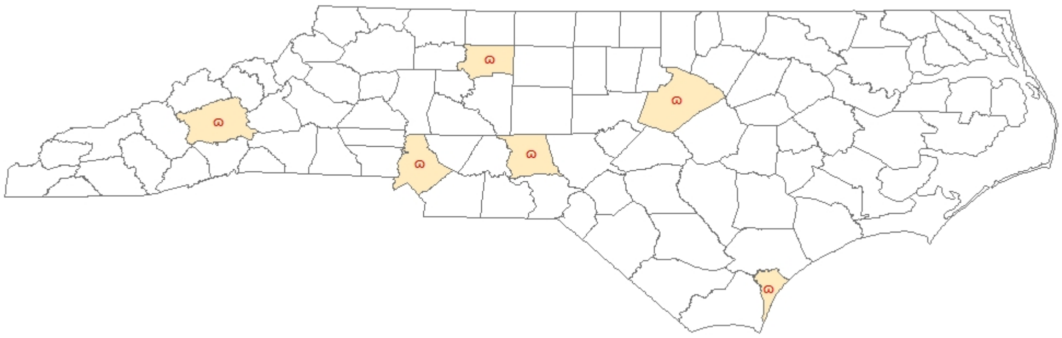

Figure 9.1 Locations of NC Urban Air Toxics Monitoring Sites

Table 9.1 Benzene - Parts per billion for 2011

SITE NUMBER	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES			MAXI MUM	ARITH MEAN
COUNTY				1st	2nd	3rd		
37-021-0035 BUNCOMBE	AB TECHNICAL COLLEGE ASHEVILLE	37	0%	.17	.22	.25	.63	.23
37-067-0022 FORSYTH	HATTIE AVENUE WINSTON-SALEM	36	0%	.16	.24	1.03	1.45	.55
37-119-0041 MECKLENBURG	GARINGER HIGH SCHOOL	31	0%	.17	.28	.43	.88	.32

SITE NUMBER	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES			MAXI MUM	ARITH MEAN
COUNTY				1st	2nd	3rd		
	1130 EASTWAY DRIVE CHARLOTTE							
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	32	3%	.16	.33	.51	1.00	.38
37-129-0010 NEW HANOVER	BATTLESHIP MUSEUM WILMINGTON	36	3%	.11	.13	.18	1.05	.17
37-183-0014 WAKE	E. MILLBROOK SCH. 3801 SPRING FOREST RD, RALEIGH	37	3%	.12	.18	.33	.73	.24
Effective Sample Count* Total Sites Sampled		209 6						

Table 9.2 Toluene - Parts per billion for 2011

SITE NUMBER	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES			MAXI MUM	ARITH MEAN
COUNTY				1st	2nd	3rd		
37-021-0035 BUNCOMBE	AB TECHNICAL COLLEGE ASHEVILLE	33	0%	.24	.31	.50	.86	.37
37-067-0022 FORSYTH	HATTIE AVENUE WINSTON-SALEM	32	0%	.17	.36	.74	1.51	.45
37-119-0041 MECKLENBURG	GARINGER HIGH SCHOOL 1130 EASTWAY DRIVE CHARLOTTE	31	0%	.23	.46	.79	1.37	.53
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	30	0%	.09	.09	.16	.34	.13
37-129-0010 NEW HANOVER	BATTLESHIP MUSEUM	34	6%	.09	.18	.25	.97	.22
37-183-0014 WAKE	E. MILLBROOK SCH. 3801 SPRING FOREST RD, RALEIGH	32	0%	.14	.24	.53	1.97	.38
Effective Sample Count* Total Sites Sampled		192 6						

*** Not including collocated samples.**

Table 9.3 Ethylbenzene - Parts per billion for 2011

SITE NUMBER COUNTY	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES 1st	2nd	3rd	MAXI MUM	ARITH MEAN
37-021-0035 BUNCOMBE	AB TECHNICAL COLLEGE ASHEVILLE	36	33%	.05	.08	.15	.19	.10
37-067-0022 FORSYTH	HATTIE AVENUE WINSTON-SALEM	36	39%	.04	.09	.15	.31	.10
37-119-0041 MECKLENBURG	GARINGER HIGH SCHOOL 1130 EASTWAY DRIVE CHARLOTTE	31	26%	.06	.09	.15	.31	.11
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	32	72%	.01	.03	.09	.11	.04
37-129-0010 NEW HANOVER	BATTLESHIP MUSEUM	36	53%	.02	.05	.11	.65	.10
37-183-0014 WAKE	E. MILLBROOK SCH. 3801 SPRING FOREST RD RALEIGH	37	41%	.04	.09	.14	.44	.10
Effective Sample Count*		208						
Total Sites Sampled		6						

Table 9.4 m/p-Xylene - Parts per billion for 2011

SITE NUMBER COUNTY	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES 1st	2nd	3rd	MAXI MUM	ARITH MEAN
37-021-0035 BUNCOMBE	AB TECHNICAL COLLEGE ASHEVILLE	33	0%	.011	.14	.19	.28	.15
37-067-0022 FORSYTH	HATTIE AVENUE WINSTON-SALEM	34	15%	.07	.15	.21	.46	.16
37-119-0041 MECKLENBURG	GARINGER HIGH SCHOOL 1130 EASTWAY DRIVE CHARLOTTE	31	10%	.09	.16	.26	.49	.19

*** Not including collocated samples.**

SITE NUMBER	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES			MAXI MUM	ARITH MEAN
COUNTY				1st	2nd	3rd		
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	32	69%	.03	.04	.09	.11	.05
37-129-0010 NEW HANOVER	BATTLESHIP MUSEUM	34	18%	.09	.13	.25	1.16	.23
37-183-0014 WAKE	E. MILLBROOK SCH. 3801 SPRING FOREST RD RALEIGH	34	18%	.09	.12	.20	.70	.16
Effective Sample Count*		198						
Total Sites Sampled		6						

Table 9.5 o-Xylene - Parts per billion for 2011

SITE NUMBER	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES			MAXI MUM	ARITH MEAN
COUNTY				1st	2nd	3rd		
37-021-0035 BUNCOMBE	AB TECHNICAL COLLEGE ASHEVILLE	35	34%	.04	.08	.16	.20	.10
37-067-0022 FORSYTH	HATTIE AVENUE WINSTON-SALEM	36	44%	.04	.09	.18	.39	.11
37-119-0041 MECKLENBURG	GARINGER HIGH SCHOOL 1130 EASTWAY DRIVE CHARLOTTE	31	32%	.05	.11	.19	.38	.13
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	32	72%	.01	.02	.08	.11	.04
37-129-0010 NEW HANOVER	BATTLESHIP MUSEUM	35	54%	.02	.05	.11	.54	.10
37-183-0014 WAKE	E. MILLBROOK SCH. 3801 SPRING FOREST RD RALEIGH	36	44%	.03	.08	.17	.55	.10
Effective Sample Count*		205						
Total Sites Sampled		6						

*** Not including collocated samples.**

Table 9.6 1,3-Butadiene - Parts per billion for 2011

SITE NUMBER COUNTY	ADDRESS	NUM OBS	PCT OF DATA ≤ .05	QUARTILES 1st	2nd	3rd	MAXI MUM	ARITH MEAN
37-021-0035 BUNCOMBE	AB TECHNICAL COLLEGE ASHEVILLE	32	72%	.00	.05	.08	.13	.04
37-067-0022 FORSYTH	HATTIE AVENUE WINSTON-SALEM	31	87%	.00	.00	.05	.15	.03
37-119-0041 MECKLENBURG	GARINGER HIGH SCHOOL 1130 EASTWAY DRIVE CHARLOTTE	31	61%	.00	.05	.09	.23	.06
37-123-0001 MONTGOMERY	112 PERRY DRIVE CANDOR	29	100%	.00	.00	.00	.05	.00
37-129-0010 NEW HANOVER	BATTLESHIP MUSEUM	32	94%	.00	.00	.00	.08	.01
37-183-0014 WAKE	E. MILLBROOK SCH. 3801 SPRING FOREST RD RALEIGH	32	75%	.00	.00	.06	.18	.03
Effective Sample Count*		187						
Total Sites Sampled		6						

*** Not including collocated samples.**

10 Statewide Trends

Summarizing statewide annual changes in the criteria pollutants and acid deposition ions helps evaluate the success of programs intended to reduce pollution and prioritize future efforts. The emphasis in this annual report is on general, moderately long- term trends. In 1991, DENR published a more detailed analysis of trends within the regions of the state and at individual monitoring stations covering air pollutant concentrations from 1972 through 1989 (North Carolina Department of Environment, Health, and Natural Resources 1991b).

10.1 Particulate Matter

The statewide distribution of second-highest 24-hour PM_{10} concentrations for each monitor from 1991 to 2011 is shown in Figure 10.1. Concentrations have decreased from 59 to about 31 $\mu g/m^3$ (a 48 percent decline).
The statewide distribution of weighted annual mean 24-hour $PM_{2.5}$ concentrations for each monitor from 1999 to 2011 is shown in Figure 10.2. Average values across NC have decreased from 15 to about 9 $\mu g/m^3$ (a 40 percent decline).
The statewide distribution of 98th percentile 24-hour $PM_{2.5}$ concentrations for each monitor from 1999 to 2011 is shown in Figure 10.3. Average values across NC have decreased from 33 to 21 $\mu g/m^3$ (a 36 percent decline).

10.2 Carbon Monoxide

The statewide distribution of second-highest eight-hour CO concentrations from 1998 to 2011 is shown in Figure 10.4. The average value of this concentration decreased from 4.08 ppm in 1998 to 1.54 ppm in 2011 (a decline of 62 percent). There have been no CO exceedances since 1991.

10.3 Ozone

The statewide distribution of fourth-highest eight-hour ozone concentrations is shown in Figure 10.5. Ozone concentrations oscillate in a long cycle and showed no specific trend from the early 1990s to mid 2000s, but there has been a decreasing trend since the early 2000s, and in 2011 the monitoring network average was 0.071, which is 95 percent of the standard. Figure 10.6 shows the number of days with exceedances every year from 1991 to 2011. Exceedance days decreased steadily from 112 in 1999 to 27 in 2004 followed by an increase to 65 in 2007 and a decrease to 26 in 2011. However, 1998 was the worst year for ozone on record on a national basis.

10.4 Sulfur Dioxide

The statewide distribution of 99th percentile highest daily one-hour sulfur dioxide (SO_2) concentrations from 1991 to 2011 is shown in Figure 10.7. The average of 99th percentiles remained generally steady between 40 and 60 ppb from 1991 through 2005, and then it decreased rapidly to about 21 ppb (28 percent of the standard).

10.5 Nitrogen Dioxide

The Forsyth and Mecklenburg county distributions of annual average nitrogen dioxide (NO_2) concentrations from 1991 to 2011 are shown in Figure 10.8. The average concentration decreased from 63 ppb in 1991 to 43 ppb in 2011 (a decline of 32 percent).

10.6 pH

The statewide distribution of annual average pH values of rainfall from 1991 to 2011 for the NADP sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 10.9. The mean pH has increased 11 percent over the 21 year time period. This is good news because it means that the rain is becoming less acidic.

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

10.7 Ammonium Ion

The statewide distribution of annual average ammonium ion (NH_4^+) concentrations from 1991 to 2010 for the NADP sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 10.10. From 1991 to 2011 there appears to be an increase of 52 percent. Ammonium ion concentration in rain increased significantly in Sampson County in 2000 where there is concentrated livestock animal production. (Cornelius, 1997) but it decreased slightly in 2002 and increased again in 2007. The NADP study suggested that the 1994 protocol change had no net effect on measured NH_4^+ concentrations (NADP 1995).

10.8 Nitrate Ion

The statewide distribution of annual average nitrate ion (NO_3^-) concentrations from 1991 to 2011 for the NADP/NTN sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 10.11. The mean has decreased by 32 percent over the study period. The NADP study suggested that NO_3^- concentrations will decrease by a median amount of 0.01 (s.e. = 0.002) due to the protocol change in 1994 (NADP 1995).

10.9 Sulfate Ion

The statewide distribution of annual average sulfate ion (SO_4^{2-}) concentrations from 1991 to 2010 for the NADP sites (including two collocated sites and the Great Smoky Mountain, Tennessee site) is shown in Figure 10.12. The average has decreased from 1.530 mg/L in 1991 to 0.751 mg/L in 2011, for a 51 percent decrease. The NADP study suggested that SO_4^{2-} concentrations will decrease by a median

amount of 0.02 (s.e. = 0.002) due to the
protocol change in 1994 (NADP 1995).

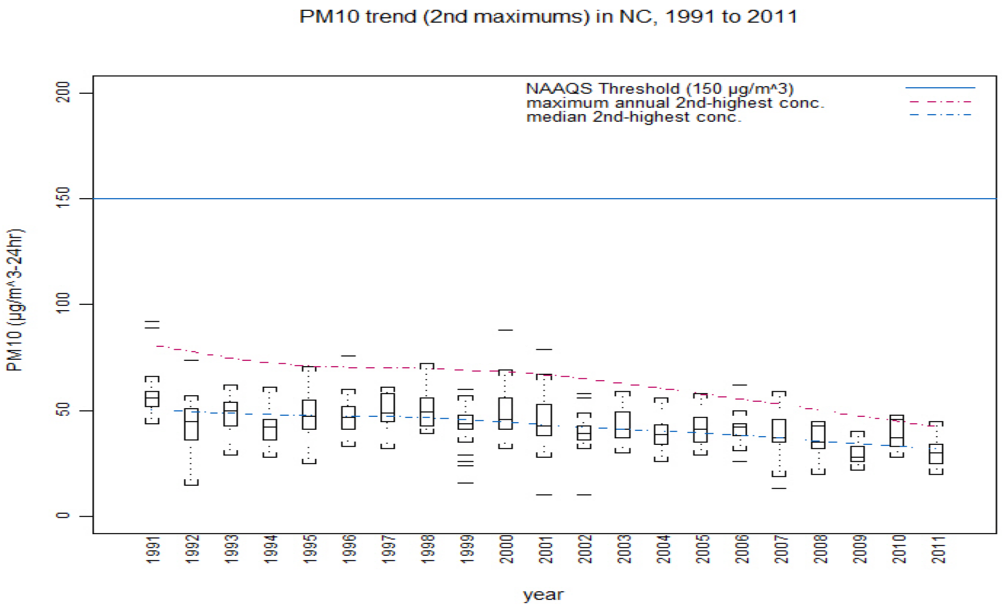

Figure 10.1 Distribution of Statewide Second-Maximum 24-Hour PM$_{10}$ Concentrations, 1991- 2011, and Smoothed Regression Trend Lines.

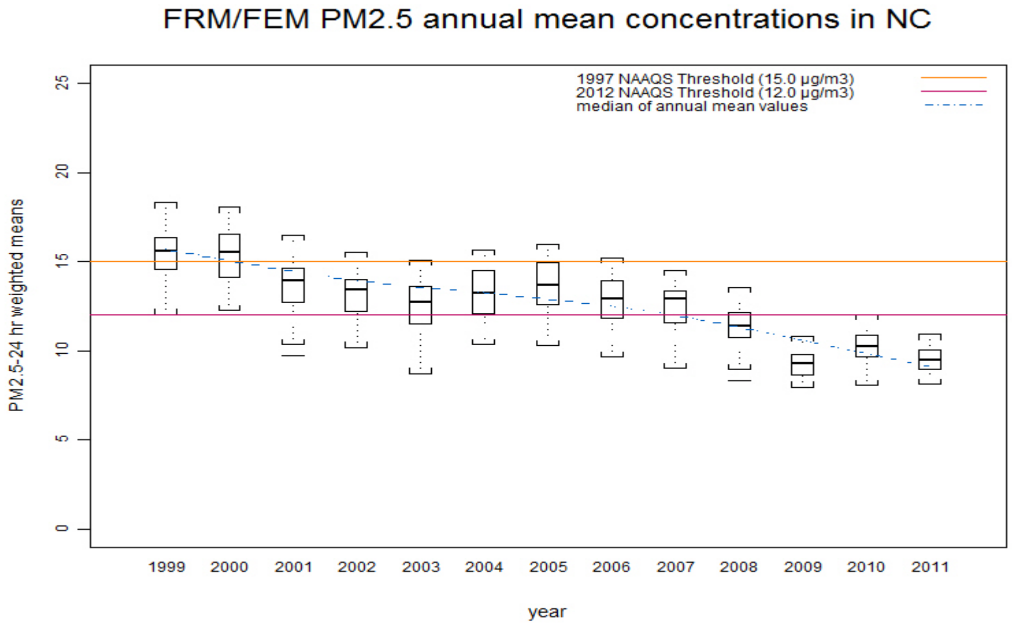

Figure 10.2 Distribution of Statewide Weighted Annual Mean PM$_{2.5}$ Concentrations, 1999- 2011, and Smoothed Regression Trend Line.

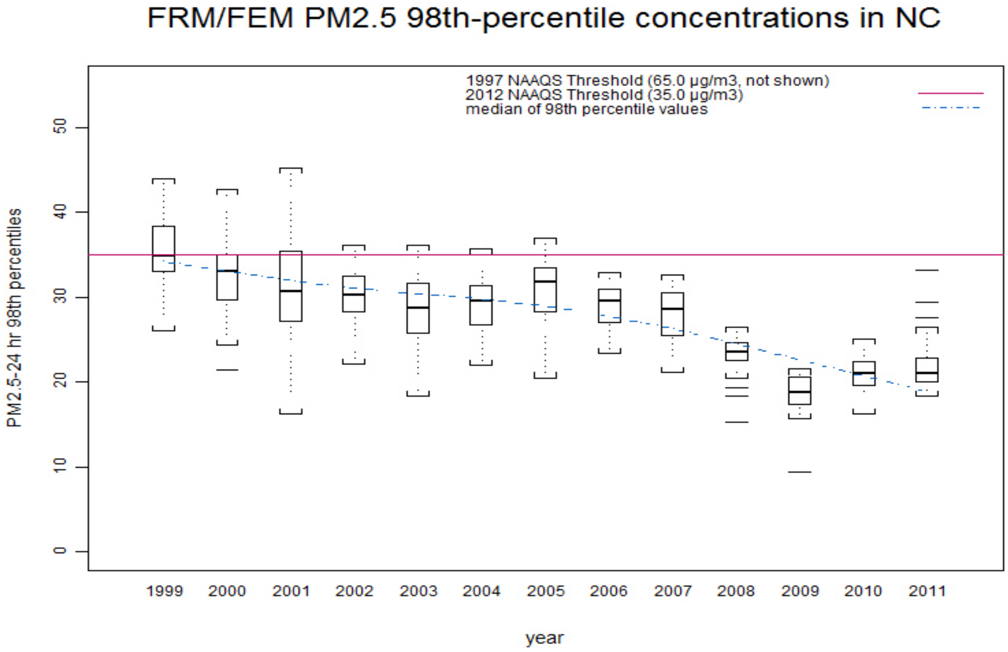

Figure 10.3 Distribution of Statewide 98th Percentile PM2.5 Concentrations, 1999-2011, and Smoothed Regression Trend Line.

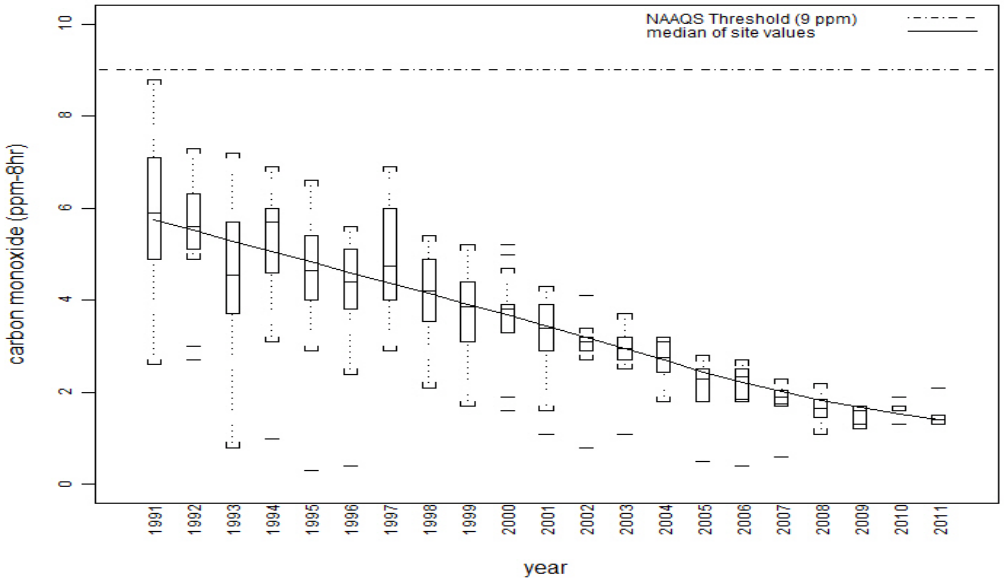

Figure 10.4 Distribution of Statewide Second-Maximum 8-Hour Carbon Monoxide Concentrations, 1991- 2011, and Smoothed Regression Trend Line.

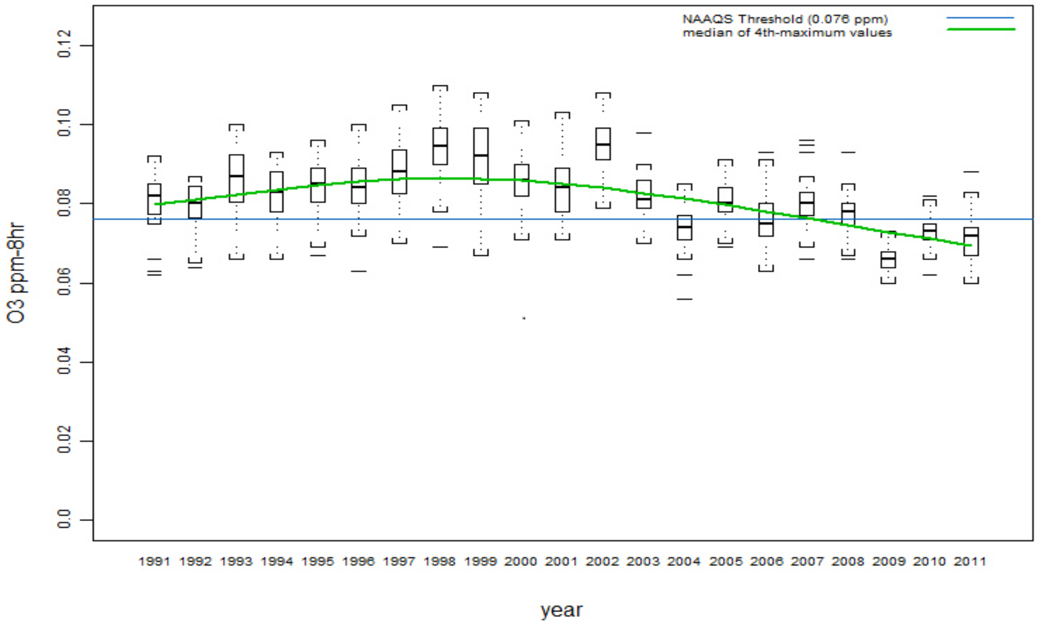

Figure 10.5 Distribution of Statewide Fourth-Maximum 8-Hour Ozone Concentrations, 1991- 2011, and Smoothed Regression Trend Line.

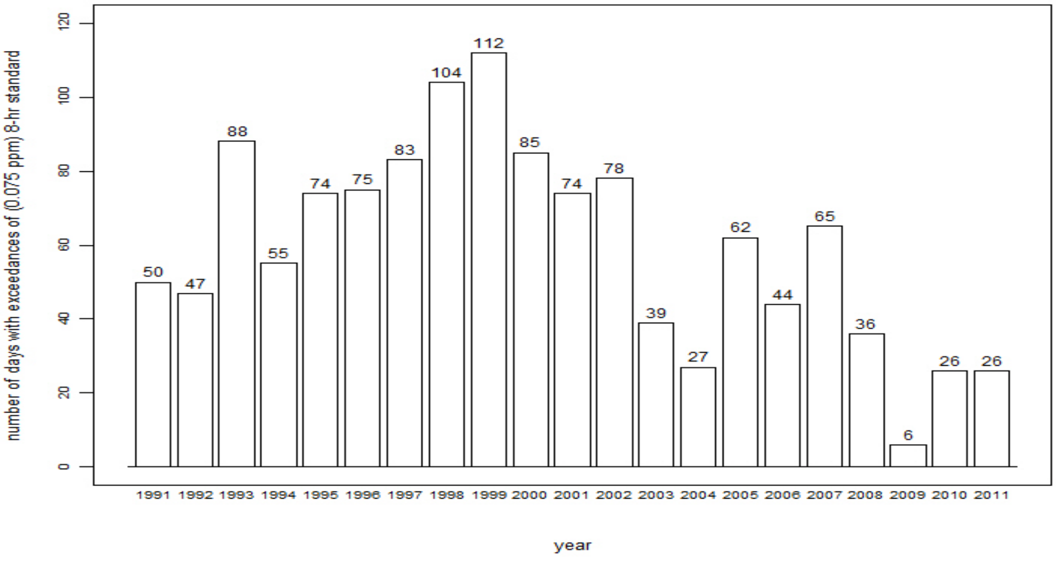

Figure 10.6 Number of days with Exceedances of 8-Hour Ozone Averages of 0.075 ppm or Greater, 1991 – 2011.

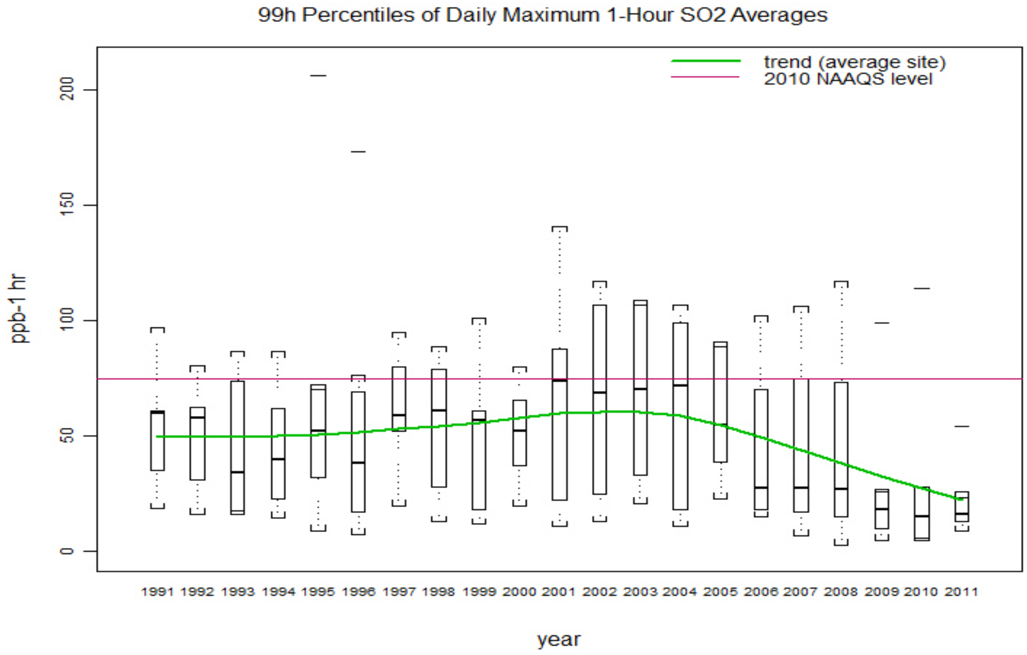

Figure 10.7 Distribution of Statewide 99th Percentile of Daily Maximum 1-HR Sulfur Dioxide Concentrations, 1991- 2011, and Smoothed Regression Trend Line.

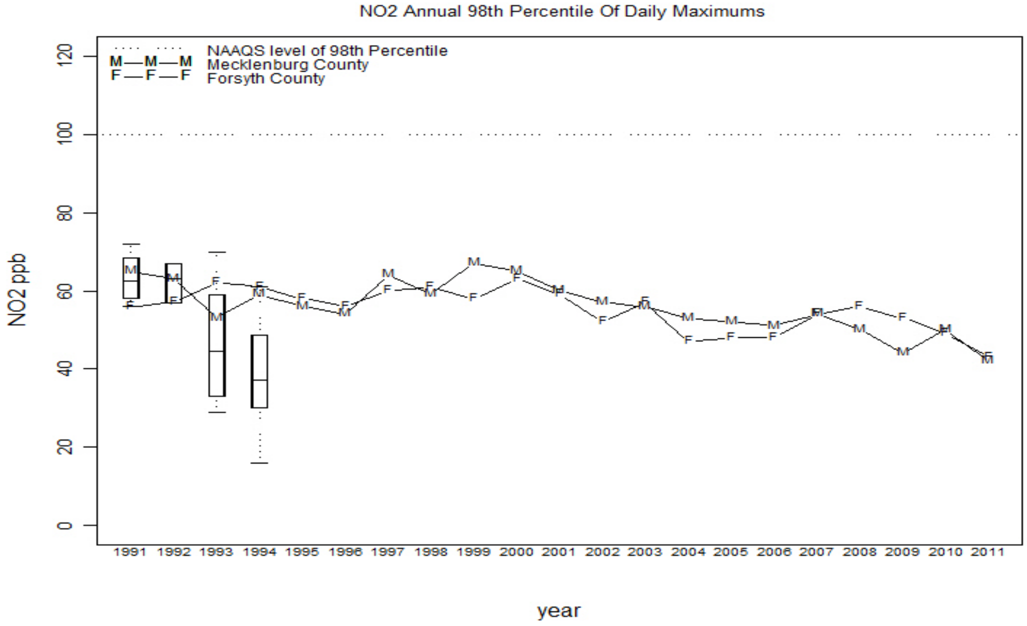

Figure 10.8 Distributions of Forsyth and Mecklenburg County Annual Mean Nitrogen Dioxide Concentrations, 1991- 2011.

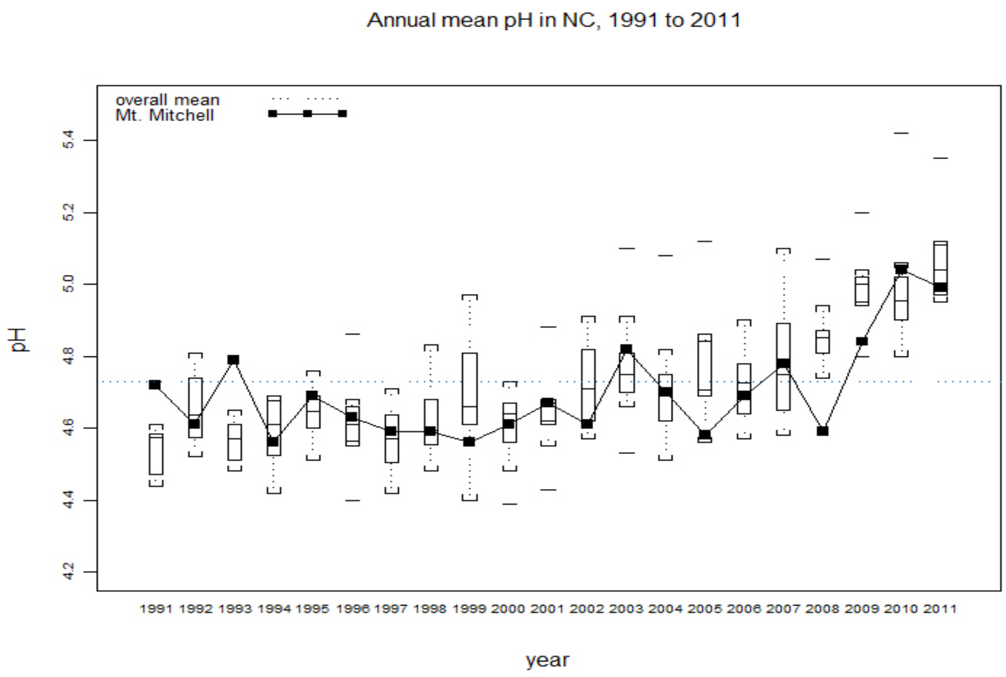

Figure 10.9 Distribution of Statewide Annual Mean pH, 1991- 2011.

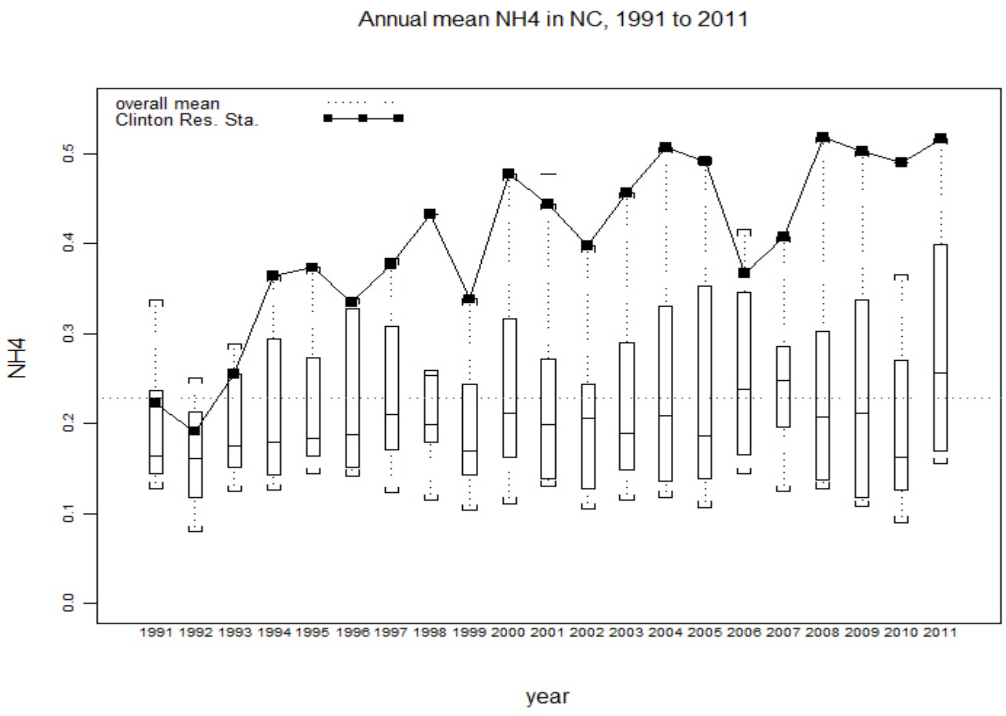

Figure 10.10 Distribution of Statewide Annual Mean Ammonium Ion Concentrations, 1991- 2011.

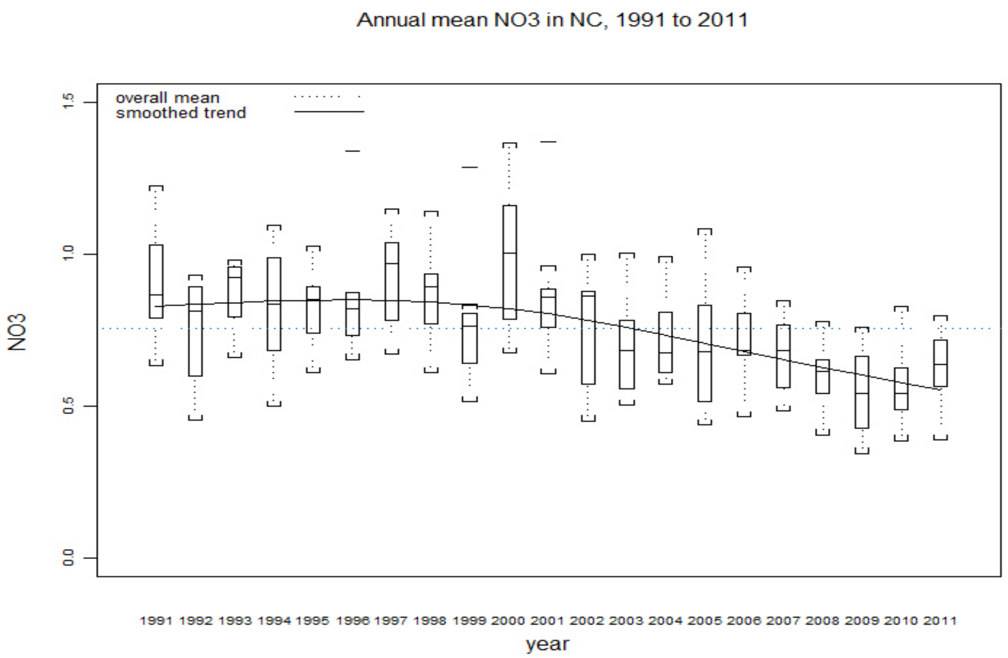

Figure 10.11 Distribution of Statewide Annual Mean Nitrate Ion Concentrations, 1991- 2011, and Smoothed Regression Trend Line.

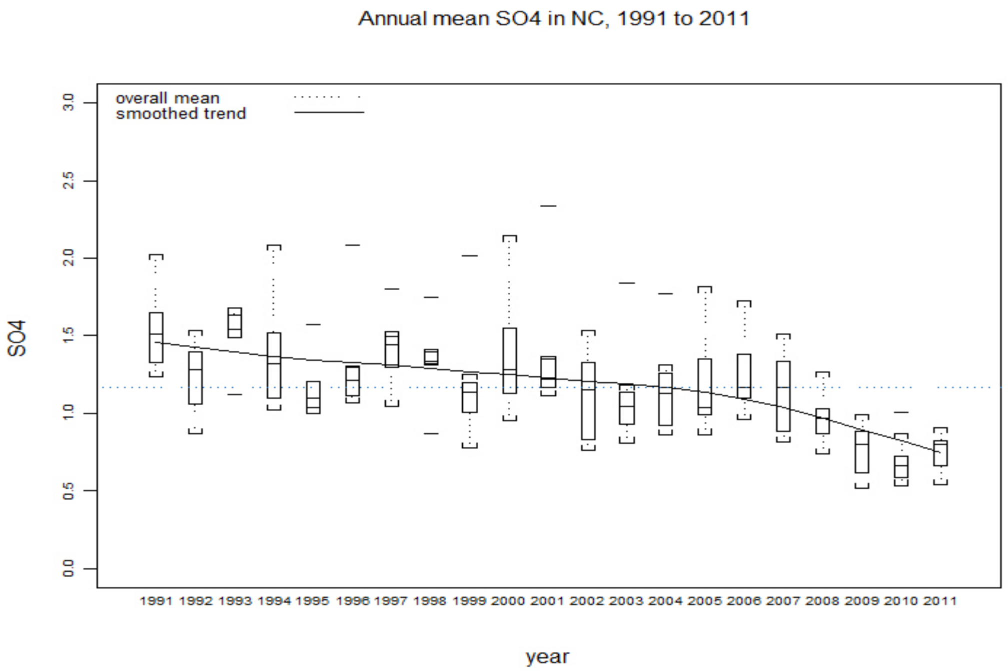

Figure 10.12 Distribution of Statewide Annual Mean Sulfate Ion Concentrations, 1991- 2011, and Smoothed Regression Trend Line.

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Appendix A. Air Pollution Monitoring Agencies

North Carolina Central Office

Division of Air Quality

Raleigh Central Office
217 West Jones Street
Raleigh, North Carolina 27603
1641 Mail Service Center
Raleigh, North Carolina 27699-1641
(919) 707-8400

North Carolina Regional Offices

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Local Agencies in North Carolina

Forsyth County Office of Environmental Assistance and Protection
201 North Chestnut Street, 5th Floor
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

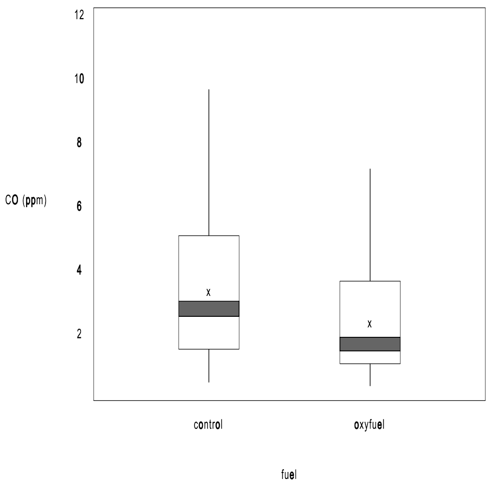
Appendix B. Exceptional Events

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 outliers–small dots for those just beyond the inner fences and larger dots or circles for *extreme outliers* at a distance of more than 3.0 times the interquartile range beyond the fourths. This boundary between outliers and extreme outliers is termed the *outer fence* and usually not explicitly shown in the plot.



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

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

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

Appendix D. Nonattainment and North Carolina

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

The United States Environmental Protection Agency (EPA) sets National Ambient Air Quality Standards. North Carolina monitors concentrations of air pollutants in the ambient air. Some of these monitors have measured concentrations of ozone and, fine particles ($PM_{2.5}$) 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 $PM_{2.5}$ and ozone precursors. Other sources of $PM_{2.5}$ include industrial processes, grass mowing agricultural tilling and open burning. In the urban areas, 60 percent of the nitrogen oxides and 25 percent of the man-made hydrocarbons or volatile organic compound emissions come from motor vehicles; the rest comes from off-road vehicles, utility and industrial boilers, petroleum marketing, factories, businesses, and households. Nitrogen oxides react with volatile organic compounds and sunlight in warm weather to produce ozone.

Why is my county nonattainment?

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

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

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

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

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

How will it affect citizens?

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

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

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

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

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

What does inspection/maintenance cost?

As of December, 2001, the inspection/maintenance (I/M), or motor vehicle emissions testing process, costs the motorist $30.00 maximum per vehicle. 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 increased to 48 in 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.