# *Commonwealth of Massachusetts 1999 Air Quality Report*

**Picture Omitted to make file smaller**

**Executive Office of Environmental Affairs**
**Department of Environmental Protection**
**Bureau of Waste Prevention**
**Division of Planning and Evaluation**

**Air Assessment Branch**
**Wall Experiment Station**
**37 Shattuck Street**
**Lawrence, Massachusetts 01843**

ACKNOWLEDGEMENTS

The data in this report represents the work of the Massachusetts Department of Environmental Protection (MADEP) Air Assessment Branch (AAB) to collect representative, complete, and accurate air quality data throughout the Commonwealth.

The following MADEP AAB staff are acknowledged for their efforts to operate and maintain air monitoring equipment and stations: Damon Chaplin, Diana Conti, Mark Ducomb, Kevin Dufour, Charlene Flynn, Dennis Flynn, Jose Kemperman, Mark Lally, Jack McPartlen, Iva Nesin, Jenmina Ojuka, John Paino, Tony Pikul, Robert Quevillon, Peter Russell, Lisa Shore, Yan Song, Sharri Tyas, Kathy Vertefeuille, and Bradley Webber.

The following MADEP and Executive Office of Environmental Affairs (EOEA) staff contributed to the publication of this report: Leslie Collyer, Steve Dennis, Richard Driscoll, Jen D'Urso, Ross Edward, Richard Fields, Sonia Hamel, John Lane, Thomas McGrath, Ken Santlal, Nancy Seidman, Jerry Sheehan, Ann Sorensen, Margaret Valis, Sharon Weber, and Leah Weiss.

The photograph on the cover is the air monitoring site for Particulate Matter 2.5 Microns ($PM_{2.5}$) located in Boston's North End.

This document is available in Adobe Acrobat PDF format from the MADEP web site. The address is http://www.state.ma.us/dep/bwp/daqc

Inquiries may be directed to:
John Lane
Air Assessment Branch
Wall Experiment Station
Lawrence, MA 01843-1343
(978) 975-1138
email: John.Lane@state.ma.us

# Table of Contents



*Continued on next page*

# **Table of Contents,** continued

# List of Figures

**Executive Summary**



**Section II – Attainment and Exceedances of Air Quality Standards**



**Section III – Massachusetts Air Quality Data Summaries**



*Continued on next page*

# List of Figures, continued

**Section III – Massachusetts Air Quality Data Summaries (continued)**



**Section IV – PAMS/Air Toxics Monitoring**



**Section V – PAMS/Air Toxics Monitoring**

# List of Abbreviations

AAB...............Air Assessment Branch
AIRS..............Aerometric Information Retrieval System
BP..................Barometric Pressure
CAA...............Clean Air Act
CFR...............Code of Federal Regulations
CO.................Carbon Monoxide
$CO_2$................Carbon Dioxide
DVMT...........Daily Vehicle Miles Traveled
EOEA............Executive Office of Environmental Affairs
MADEP.........Massachusetts Department of Environmental Protection
$mg/m^3$............milligrams per cubic meter
NAAQS..........National Ambient Air Quality Standard
NADP............National Atmospheric Deposition Program
NAMS............National Air Monitoring Stations
NESCAUM....Northeast States for Coordinated Air Use Management
NOAA............National Oceanic and Atmospheric Administration
NO.................Nitrogen Oxide
$NO_x$................Nitrogen Oxides
$NO_y$................Total Reactive Oxidized Nitrogen
$NO_2$................Nitrogen Dioxide
$NO_3$................Nitrate
$O_3$...................Ozone
PAMS............Photochemical Assessment Monitoring Stations
Pb...................Lead
PEI.................Periodic Emissions Inventory
pH..................Concentration of hydrogen cations ($H^+$) in solution. An indicator of acidity.
ppb.................parts per billion by volume
ppm................parts per million by volume
$PM_{2.5}$..............Particulate matter 2.5 microns
$PM_{10}$...............Particulate matter 10 microns
PSI.................Pollutant Standards Index
QA/QC...........Quality Assurance and Quality Control
RH.................Relative Humidity
SIP.................State Implementation Plan
SLAMS..........State and Local Air Monitoring Stations
$SO_2$.................Sulfur Dioxide
$SO_4$.................Sulfate
TSP................Total Suspended Particulates
$ug/m^3$..............micrograms per cubic meter
USEPA...........United States Environmental Protection Agency
VOC...............Volatile Organic Compounds
WS/WD..........Wind Speed/Wind Direction

# Executive Summary

**Introduction**

The Massachusetts Department of Environmental Protection (MADEP) monitors the outdoor air quality and implements emissions controls, as necessary, for pollutants that adversely affect the public health and welfare. This report provides summary information and statistics of air monitoring activities for 1999, including long-term trends of air quality and emissions data.

**Criteria pollutant monitoring**

During 1999, MADEP analyzed the ambient air for ozone ($O_3$), sulfur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), carbon monoxide (CO), particulate matter less than 10 microns ($PM_{10}$), particulate matter less than 2.5 microns ($PM_{2.5}$) and lead (Pb). These are criteria pollutants, which the U.S. Environmental Protection Agency (USEPA) requires states to monitor.

**Enhanced ozone monitoring**

Enhanced ozone monitoring continued during 1999 and included the measurement of volatile organic compounds (VOCs). VOCs are contributors to the formation of ozone and include pollutants known or suspected to cause cancer or other serious health effects, such as birth defects. This is also called the Photochemical Assessment Monitoring Station program (PAMS).

**A new monitoring network established**

During 1999, monitoring for $PM_{2.5}$ started at eighteen sites located in fifteen cities throughout Massachusetts. $PM_{2.5}$ comprises very fine particulates (smaller than 2.5 microns). Several thousand $PM_{2.5}$ particles could fit on the period at the end of this sentence. USEPA added $PM_{2.5}$ as a particulate standard, in addition to the $PM_{10}$ standard, following studies that indicate smaller particles are largely responsible for the health effects of greatest concern.

**How is the data used?**

The outdoor monitoring data is used to:

- determine whether Massachusetts is meeting public health standards for air;
- report the state of air quality in the Commonwealth; and
- assess whether the air pollution control strategies in place are reducing the public health and environmental impacts of air pollutants.

**Factors affecting air quality trends**

Air quality is influenced by many factors. To reduce the human contribution to air pollution, over the past 25 years Massachusetts and neighboring states have initiated many control measures to reduce the level of pollutant emissions going into the air. These have resulted in significant air quality improvements.

Peak $O_3$ levels in Massachusetts, for example, have dropped significantly since the 1980s, with peak values today measuring some 30% lower than those in the 1980s. Despite this improvement, elevated $O_3$ levels averaged over 8 hours continue to be a problem. Also, there remain striking year-to-year differences in the frequency of elevated $O_3$ and, thus, the population's exposure to $O_3$.

*Continued on next page*

**Factors affecting air quality trends** Continued

While the state of the economy, as reflected by industrial and commercial activity and the resultant levels of emissions, contributes to these fluctuations, the role of meteorology is significant. On a given day, meteorology governs how much ozone-related pollution enters the state from other areas, and whether sunshine is present to drive the chemical reactions that produce $O_3$. Over a season, the frequency of ozone-favorable weather, and thus the severity of the $O_3$ season, is related to the mean position and strength of the upper air jet stream. Therefore, as jet stream behavior changes year-to-year, so does $O_3$ season severity.

**Ozone exceedance trends**

Ozone ($O_3$) has two air quality standards: one for values averaged over a 1-hour period and a newer, more stringent standard averaged over an 8-hour period. The 8-hour standard was instituted in 1997 in response to studies that indicate that longer-term exposures to lower $O_3$ levels cause adverse health effects.

On 22 days during 1999, unhealthy (exceedance) 8-hour $O_3$ levels were found somewhere in the state, easily surpassing 1998's total of 12 exceedance days. There were a total of 85 exceedances of the 8-hour standard in 1999 (61 in 1998). During 1999, for the1-hour standard, there were 4 exceedance days and a total of 5 exceedances.

The long-term $O_3$ exceedance trends displayed in Figures 1 and 2 show that, under the more stringent 8-hour standard, there are more exceedances compared to the 1-hour standard.

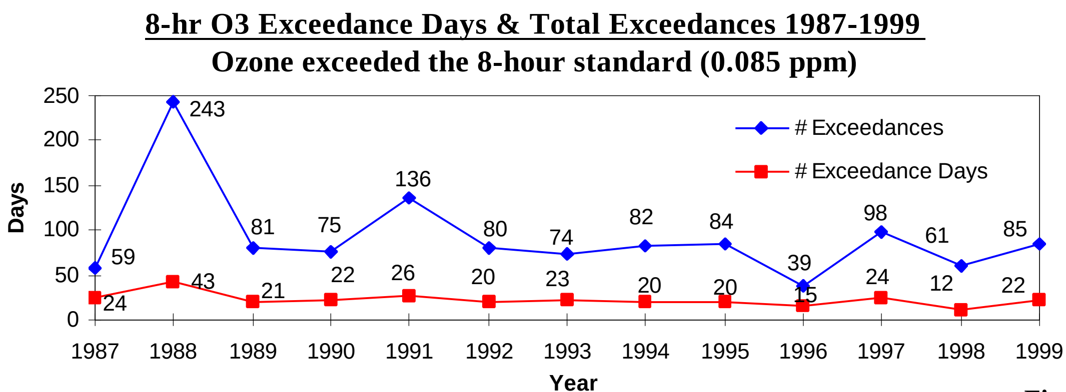



**Figure 1**

*Continued on next page*

**Ozone exceedance trends** Continued

The long-term $O_3$ exceedance trends show that, under the more stringent 8-hour standard, there are more exceedances compared to the 1-hour standard.

**1-hr O3 Exceedance Days & Total Exceedances 1987-1999**
**Ozone exceeded the 1-hour standard(0.125 ppm)**

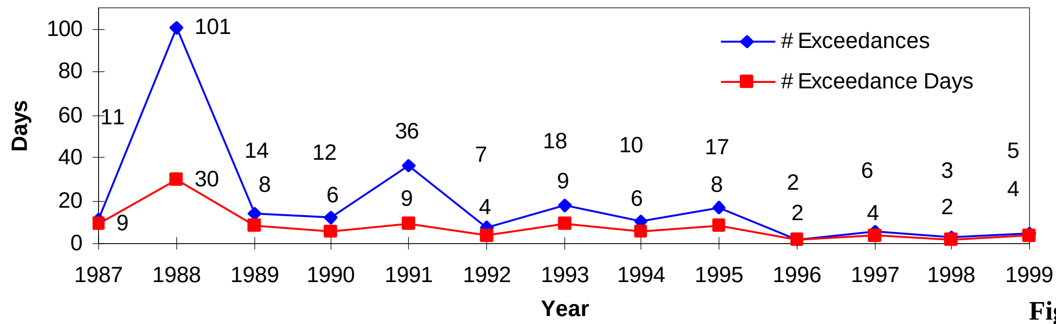



**Figure 2**

**Carbon monoxide trend**

The carbon monoxide (CO) long-term trend of 8-hour values is downward for the period. CO, as indicated by the 8-hour 2nd-maximum concentration, has decreased by 54% over the period. Massachusetts is below the standard.

**CO Concentrations 1985-1999**
**8-hr 2nd Maximum Value**
**Standard = 9ppm**

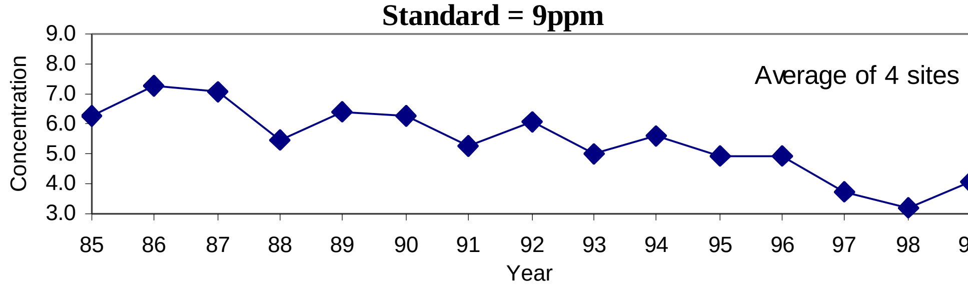



**Figure 3**

*Continued on next page*

**Nitrogen dioxide trend**

The nitrogen dioxide ($NO_2$) long-term trend has been stable the last few years, but over the period the annual arithmetic mean concentration has decreased by 30%. Massachusetts is below the standard.

**NO2 Concentrations 1985-1999**
**Annual Arithmetic Mean**
**NO2 standard = 0.53 ppm**

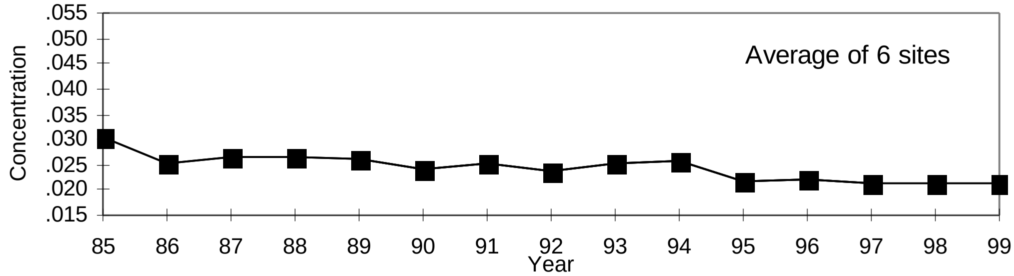



**Figure 4**

**Sulfur dioxide trend**

The sulfur dioxide ($SO_2$) long-term trend has been stable the last few years, but over the period the annual arithmetic mean concentration has decreased by 55%. Massachusetts is below the standard.

**SO2 Concentrations 1986 - 1999**
**Annual Arithmetic Mean**
**Standard = 0.03 ppm**

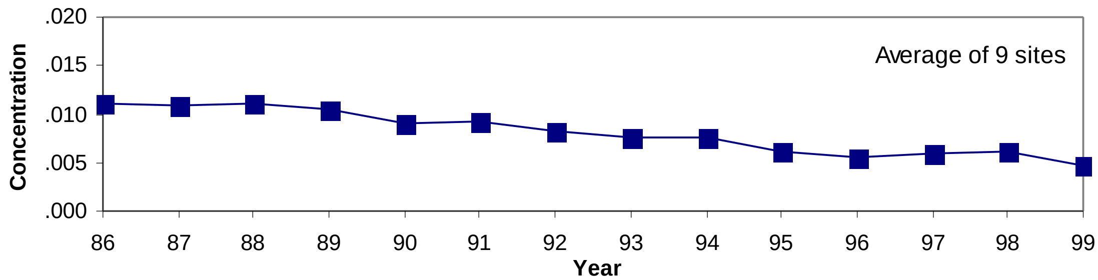



**Figure 5**

*Continued on next page*

**Particulate matter ($PM_{10}$) trend**

The particulate matter less than 10 microns ($PM_{10}$) long-term trend has been stable the last few years, but over the period the annual arithmetic mean concentration has decreased by 14%. Massachusetts is below the standard.

Monitoring for particulate matter less than 2.5 microns ($PM_{2.5}$) began in 1999. Designation for the $PM_{2.5}$ standard requires 3 years of data.

**PM10 Concentrations 1989-1999**
**Annual Arithmetic Mean**
**Standard = 50 ug/m3**

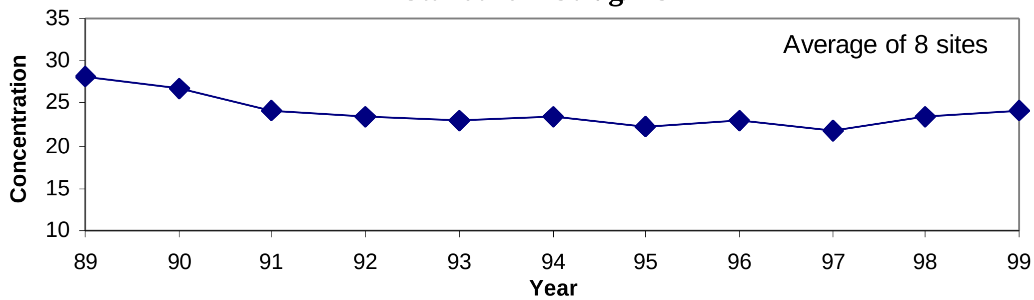



**Figure 6**

**Lead trend**

As required by USEPA, lead (Pb) monitoring was reinstituted at one site in 1998 after being discontinued in June 1995. As Figure 7 indicates, the concentration of Pb in the air decreased substantially since the 1980s. This result is attributed to the use of unleaded gasoline in motor vehicles, which are the primary source of airborne lead emissions. Massachusetts is well below the standard.

**Pb Concentrations 1985-1999**
**Annual Arithmetic Mean**
**Standard = 1.5ug/m3**

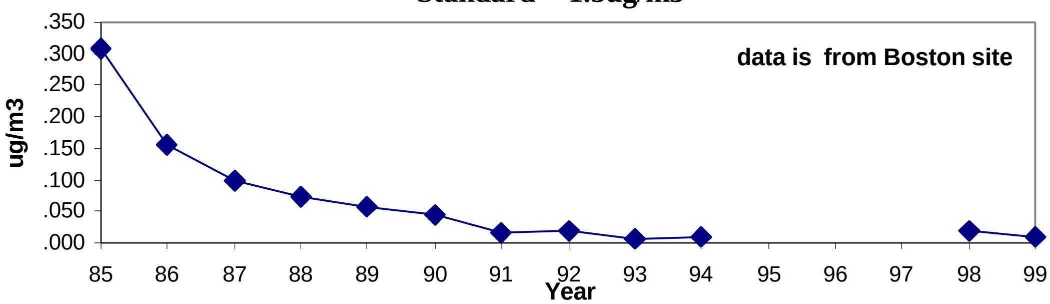



**Figure 7**

*Continued on next page*

**PAMS monitoring**

PAMS monitoring for VOCs has been conducted for five years. Analyses of the outdoor concentration levels indicate a decline in certain toxic VOCs. There have been substantial decreases in benzene, ethlybenzene, toluene, and xylene. The decreases are probably the result of the use of reformulated gas beginning in 1995, which has significantly reduced the emissions of these toxic pollutants. The trend for benzene for the Lynn and Chicopee sites is shown in Figure 8.

**Benzene Concentrations 1994-1999**
**Annual Arithmetic Mean of 24-hour Values**
***Allowable Ambient Limit (AAL) = 0.04 ppb**

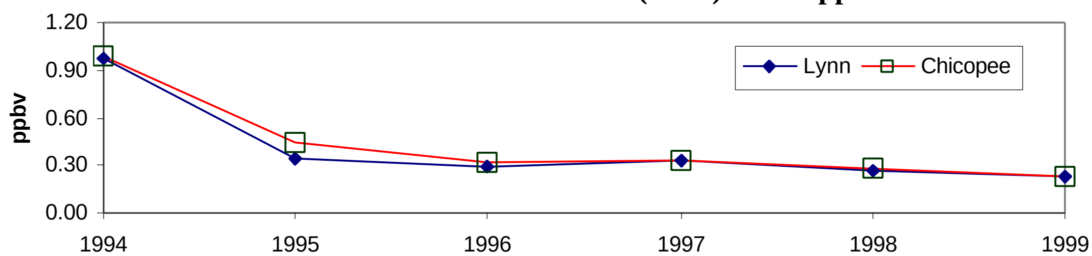



**Figure 8**

*Allowable Ambient Limits (AALs) are health-based air toxics guidelines developed by MADEP based on potential known or suspected carcinogenic and toxic health properties of individual compounds. Safety factors are incorporated into the AALs to account for exposures from pathways other than air. AALs are reviewed and updated periodically to reflect current toxicity information.

**Point source emission trends**

Point sources are large manufacturing facilities and power plants. Emissions inventories are required to be reported to the USEPA through the State Implementation Plan (SIP) because Massachusetts is non-attainment for the O3 and CO national air quality standards. The $O_3$ SIP describes the estimated emissions and control measures for VOCs and oxides of nitrogen ($NO_x$), since these "$O_3$ precursors" in reaction with sunlight under the right conditions produce $O_3$. The 1990 SIP included a base year emissions inventory for VOCs, $NO_x$, and CO, from which air pollution programs were developed.

Figure 9 shows there have been substantial decreases in VOCs during the period 1990-1996. CO emissions have remained relatively constant throughout this period.

**VOC and CO Point Source Emissions 1990-1996**

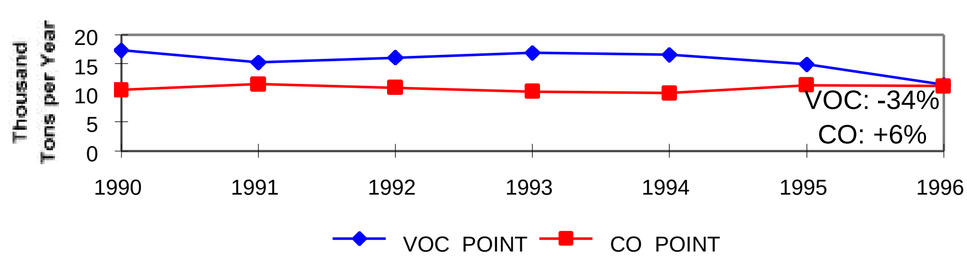



**Figure 9**

*Continued on next page*

**Point source emission trends** Continued

$SO_2$ emissions are tracked annually by MADEP because of the requirements of the 1985 State Acid Rain (STAR) program. The STAR program was implemented to control emissions that cause acid deposition, which is harmful to the environment.

Figure 10 shows there have been substantial decreases in $SO_2$ and $NO_x$ emissions from point sources during the period 1990-1996.

**SO2 and NOx Point Source Emissions 1990 - 1996**

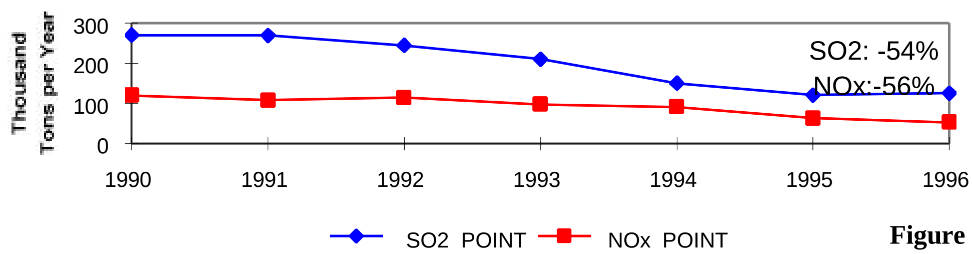



**Figure 10**

**The emission trends presented in Figures 9, 10, and 11 are based on the 1996 Periodic Emissions Inventory (PEI). The PEI is done every 3 years. The draft 1999 PEI will be available during summer 2001.**

**On-road mobile source emission trends**

On-road mobile sources include vehicles such as autos, trucks, motorcycles, and buses. Figure 11 shows the 1990-1996 trends for on-road mobile VOC and $NO_x$ emissions, together with daily vehicle miles traveled (DVMT).

The VOC emissions decreased by 28% despite an increase of 11% in DVMT. This is a reflection of the effective on-road mobile source control programs that were instituted during the period, such as: controls on car tailpipe emissions, federal reformulated gasoline, and fuel controls such as Stage II vapor recovery systems at gasoline stations.

$NO_x$ emissions increased by 22% during the 1990-1996 period. $NO_x$ controls for mobile sources have been put in place more recently, and their effect will be reflected as the vehicle fleet turns over.

**On-Road Mobile Emissions and DVMT**

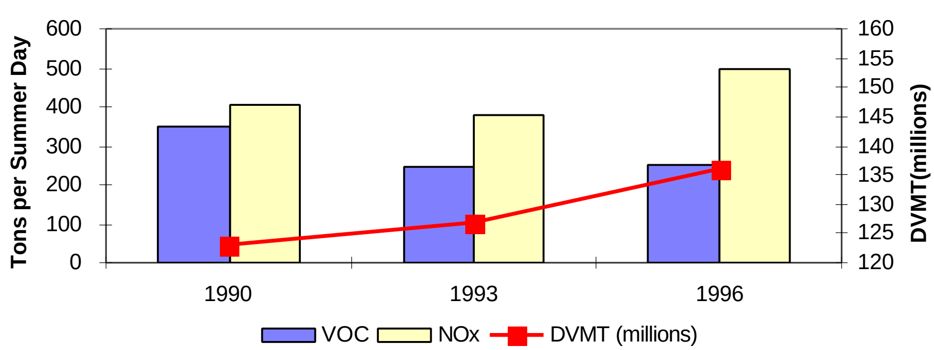



**Figure 11**

**DVMT = daily vehicle miles traveled**

*Continued on next page*

**The continuing need for emission controls**

While current data trends are downward for many pollutants, MADEP's position is that existing emission control programs must be maintained and improved to sustain the improvements to date and offset expected growth in emissions.

**Challenges ahead**

In November 2000 the US Supreme Court will hear oral arguments in USEPA's appeal of the Washington D.C. Circuit Court of Appeals ruling that affected the setting and enforcement of the National Ambient Air Quality Standards (NAAQS) for PM2.5 and ozone (O3). The main questions are whether setting a NAAQS under the Clean Air Act (CAA) is an unconstitutional delegation of power by Congress, and whether one section of the CAA, which sets out the requirements for areas in non-attainment of the 1-hour $O_3$ standard, has the effect of prohibiting USEPA from enforcing the 8-hour $O_3$ standard.

The US Supreme Court is expected to rule on these issues in the summer 2001. The ruling may affect the designations for non-attainment areas of the 8-hour O3 and the PM2.5 standards. As noted above, Massachusetts would be designated non-attainment for the 8-hour standard if the current form of the standard remains. With that designation, revisions in the Massachusetts' State Implementation Plan (SIP) would be necessary, including the possible addition of control measures. The SIP is the mechanism for documenting the strategies to attain the NAAQS in non-attainment areas. In addition, DEP will continue to monitor for PM2.5 and once the final form of that standard and designation are known, then revisions to the SIP as needed will proceed.

# Section I

## Ambient Air Monitoring Program

## Program Overview

**Introduction**

Regulations set forth in the Code of Federal Regulations (Title 40, Part 58) require each state to establish an air monitoring network. A network of National Air Monitoring Stations (NAMS) located in urban areas and based on population provides a consistent nationwide database. The network of State and Local Air Monitoring Stations (SLAMS) supplements the NAMS sites, allowing a more comprehensive assessment of air quality.

The Air Assessment Branch (AAB) of the Department of Environmental Protection (MADEP) collects ambient air quality data from sites throughout Massachusetts. During 1999, AAB operated a public monitoring network of 41 stations located in 25 cities and towns. AAB also oversaw an industrial network of six stations located in two cities and one town.

MADEP submits the ambient air quality data into the Aerometric Information Retrieval System (AIRS), a computer-based repository of national air quality information administered by the U.S. Environmental Protection Agency (USEPA).

**Why is air quality data collected?**

The ambient air quality data is used for the following purposes:

- to verify compliance with national ambient air quality standards;
- to support development of regulations designed to reduce ambient air pollution;
- to assess the effectiveness of existing air pollution control strategies;
- to provide aerometric data for long-term trend analysis and special research; and
- to fulfill USEPA reporting requirements for ambient air quality data.

**What is monitored?**

The parameters monitored by the Air Assessment Branch fall into the following categories:

- **Criteria pollutants -** have National Ambient Air Quality Standards (NAAQS). The seven criteria pollutants are:
  - sulfur dioxide ($SO_2$)
  - ozone ($O_3$)
  - carbon monoxide (CO)
  - nitrogen dioxide ($NO_2$)
  - lead (Pb)
  - particulate matter 10 microns ($PM_{10}$)
  - particulate matter 2.5 microns ($PM_{2.5}$)

*Continued on next page*

**What is monitored?,** Continued

- **Non-criteria pollutants -** do not have national standards established. These pollutants are:
  - nitrogen oxide (NO) • total nitrogen oxides ($NO_x$)
  - total reactive oxidized nitrogen ($NO_y$) • total suspended particulates (TSP)
  - volatile organic compounds (VOC) – these are ozone precursors and reaction product chemicals measured as part of the Photochemical Assessment Monitoring Stations (PAMS) program • black carbon

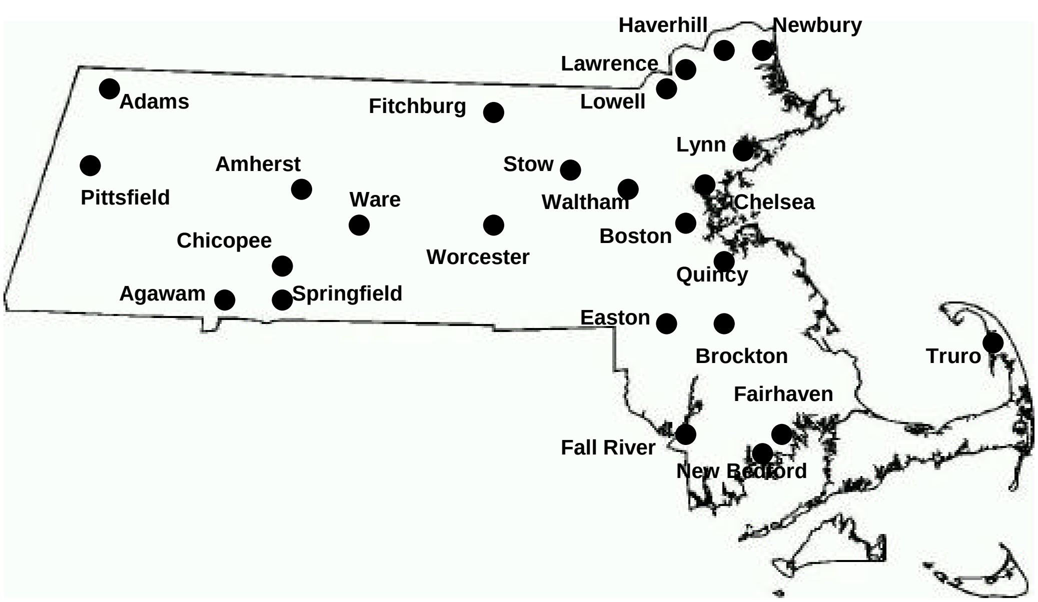
- **Meteorological parameters** monitored are:
  - wind speed/wind direction (WS/WD) • relative humidity (RH)
  - temperature (TEMP) • barometric pressure (BP) • solar radiation

**Monitoring station locations**

The monitoring locations for the different pollutants are sited to provide data for various purposes. Some sites are located in “hot spots” where maximum concentrations are expected. Other sites provide data which is representative of larger land areas. The topography and the location of pollutant sources are factors that determine the scale of representation for a particular monitor location.

Each pollutant has a network of monitors located throughout the state. The monitoring networks are designed to accurately reflect pollutant concentrations throughout the state. In Section III, which contains the data summaries for each pollutant, there are maps that show the monitor locations for each network. Also, the site directory in this section lists the different monitors located at each site.

The map below shows the cities and towns in Massachusetts that had monitors during 1999.




*Continued on next page*

**For further information**

For further information pertaining to this report, contact the Air Assessment Branch. For information about other air quality matters, please contact MADEP's Division of Planning and Evaluation in Boston, or a MADEP regional office. The addresses are listed below. Maps showing the cities and towns covered by each regional office are on the following pages.

| | |
|---|---|
| **DEP – WERO (WESTERN)**<br>436 Dwight Street<br>Springfield, MA 01103<br>(413) 784-1100<br><br>Michael Gorski: Regional Director | **DEP - CERO (CENTRAL)**<br>627 Main Street<br>Worcester, MA 01608<br>(508) 792-7650<br><br>Robert W. Golledge Jr.: Regional Director |
| **DEP - NERO (NORTHEAST/MET-BOSTON)**<br>205A Lowell Street<br>Wilmington, MA 01887<br>(978) 661-7600<br><br>William Gaughan: Regional Director | **DEP - SERO (SOUTHEAST)**<br>20 Riverside Drive<br>Lakeville, MA 02347<br>(508) 946-2700<br><br>Paul Taurasi: Regional Director |
| **BUREAU OF WASTE PREVENTION**<br>One Winter Street<br>Boston, MA 02108<br>(617) 292-5593<br><br>James C. Colman: Assistant Commissioner | **AIR ASSESSMENT BRANCH**<br>William X. Wall Experiment Station<br>Lawrence, MA 01843<br>(978) 975-1138<br><br>Jerry Sheehan: Branch Chief |

Information about MADEP's various programs are available on the internet from MADEP's web site (www.state.ma.us/dep/). The USEPA maintains a web site (www.epa.gov/airsdata/) which has air quality information from all the states.

## DEP’s Western Region Map

Maps are in separate file.

# DEP’s Central Region Map

Maps are in separate file.

# DEP's Northeast Region Map

Maps are in separate file.

# DEP’s Southeast Region Map

Maps are in separate file.

# National Ambient Air Quality Standards

---

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards -** designed to protect against damage to crops, vegetation, and buildings from air pollution.

| POLLUTANT | AVERAGING TIME* | PRIMARY | SECONDARY |
|---|---|---|---|
| **$SO_2$** | Annual Arithmetic Mean | 0.03 ppm (80 ug/m$^3$) | None |
| | 24-Hour | 0.14 ppm (365 ug/m$^3$) | None |
| | 3-Hour | None | 0.50 ppm (1300 ug/m$^3$) |
| **CO** | 8-Hour | 9 ppm (10 mg/m$^3$) | Same as Primary Standard |
| | 1-Hour | 35 ppm (40 mg/m$^3$) | Same as Primary Standard |
| **$O_3$** | 1-Hour | 0.12 ppm (235 ug/m$^3$) | Same as Primary Standard |
| | 8-Hour | 0.08 ppm (157 ug/m$^3$) | Same as Primary Standard |
| • The 1-hour standard:<br>• applies only to areas with continued violations of the 1-hour standard. In Massachusetts, it applies to the western region of the state, in Berkshire, Hampshire, Hampden and Franklin counties.<br>• is met when the expected exceedance days (the daily maximum 1-hour concentration exceeds 0.12 ppm) do not exceed one per year (3-year average).<br>• The 8-hour standard is met when the 3-year average of the 4th-highest daily maximum 8-hour average does not exceed 0.08 ppm. | | | |
| **Pb** | Calendar Quarter Arithmetic Mean | 1.5 ug/m$^3$ | Same as Primary Standard |
| **$NO_2$** | Annual Arithmetic Mean | 0.053 ppm 100 ug/m$^3$ | Same as Primary Standard |
| **$PM_{2.5}$**<br>Particulates up to 2.5 microns in size | Annual Arithmetic Mean | 15.0 ug/m$^3$ | Same as Primary Standard |
| | 24-Hour | 65 ug/m$^3$ | Same as Primary Standard |
| • The annual standard is met when the annual average of the quarterly mean $PM_{2.5}$ concentrations is less than or equal to 15 ug/m$^3$ (3-year average). If spatial averaging is used, the annual average from all monitors within the area may be averaged in the calculation of the 3-year mean.<br>• The 24-hour standard is met when 98th percentile value is less than or equal to 65 ug/m$^3$ (3-year average). | | | |
| **$PM_{10}$**<br>Particulates up to 10 microns in size | Annual Arithmetic Mean | 50 ug/m$^3$ | Same as Primary Standard |
| | 24-Hour | 150 ug/m$^3$ | Same as Primary Standard |
| • The $PM_{10}$ standard is based upon estimated exceedance calculations described in 40CFR Part 50, Appendix K.<br>• The annual standard is met if the estimated annual arithmetic mean does not exceed 50 ug/m$^3$.<br>• The 24-hour standard is attained if the estimated number of days per calendar year above 150 ug/m$^3$ does not exceed one per year. | | | |

**mg/m$^3$ =** micrograms per cubic meter **ppm =** parts per million **mg/m$^3$ =** milligrams per cubic meter

***** Standards based upon averaging times other than the annual arithmetic mean must not be exceeded more than once a year.

---

## Pollutant Health Effects and Sources

**Ozone ($O_3$)**

- Ground-level and stratospheric $O_3$ are often confused. Whereas stratospheric $O_3$ is beneficial because it filters out the sun's harmful ultraviolet radiation, ground-level $O_3$ is a health and environmental problem.
- $O_3$ irritates mucous membranes. This causes reduced lung function, nasal congestion, eye and throat irritation, and reduced resistance to infection.
- $O_3$ is toxic to vegetation, inhibiting growth and causing leaf damage.
- $O_3$ weakens materials such as rubber and fabrics.
- $O_3$ is unique in that it is formed by reactions between other pollutants in presence of high-energy sunlight, of the intensity found during the summer months. The complexity and subsequent time needed to complete these reactions results in the build up of ground-level ozone concentrations far downwind from the original source of the precursors.
- Sources of ground-level $O_3$ precursors, nitrogen oxides and hydrocarbons, include motor vehicles and power plants.

**Carbon Monoxide (CO)**

- CO reacts in the bloodstream with hemoglobin, reducing oxygen carried to organs and tissues.
- The health threat is most severe for those with cardiovascular disease.
- Symptoms of high CO exposure include:
  •shortness of breath •chest pain •headaches •confusion •loss of coordination.
- High levels of CO are possible near parking lots and city streets with slow-moving cars.
- Motor vehicles are the largest source of CO, which is produced from incomplete combustion of carbon in fuels.

**Sulfur Dioxide ($SO_2$)**

- $SO_2$ combines with water vapor to form acidic aerosols harmful to the respiratory tract, aggravating symptoms associated with lung diseases such as asthma and bronchitis.
- $SO_2$ is a primary contributor to acid deposition. Impacts of acid deposition include:
  • acidification of lakes and streams • damage to vegetation
  • damage to materials • degradation of visibility
- $SO_2$ is a product of fuel combustion (e.g., burning coal and oil). Sources include heat and power generation facilities, and petroleum refineries.

**Nitrogen Dioxide ($NO_2$)**

- $NO_2$ lowers resistance to respiratory infections and aggravates symptoms associated with asthma and bronchitis.
- $NO_2$ contributes to acid deposition. [See $SO_2$ listing above for the effects.]
- $NO_2$ and NO contribute to the formation of ozone.
- $NO_2$ is formed from the oxidation of nitric oxide (NO). Major sources of NO are fuel combustion, heating and power plants, and motor vehicles.

*Continued on next page*

## Pollutant Health Effects and Sources, Continued

| | |
|---|---|
| **Particulate Matter ($PM_{10}$ and $PM_{2.5}$)** | • Particulate matter is tiny airborne particles or aerosols, which include dust, dirt, smoke, and liquid droplets.<br>• The numbers, 2.5 and 10, refer to the particle size, measured in microns, which are collected by the monitors. Several thousand $PM_{2.5}$ particles could fit on the period at the end of this sentence.<br>• The small size of the particles allows entry into the respiratory system. Long-term exposure allows the particles to accumulate in the lungs and affects breathing and respiratory symptoms.<br>• Particulate matter causes soiling and corrosion to materials.<br>• Particulate matter contributes to atmospheric haze that degrades visibility.<br>• Sources include industrial process emissions, motor vehicles, incinerators, heat and power plants, and motor vehicles. |
| **Lead (Pb)** | • Exposure to lead may occur by inhalation or ingestion of food, water, soil or dust particles.<br>• Children and fetuses are more susceptible to the effects of lead exposure.<br>• Lead causes mental retardation, brain damage, and liver disease. It may be a factor in high blood pressure and damages the nervous system.<br>• The primary source for airborne lead used to be motor vehicles, but the use of unleaded gasoline has greatly reduced those emissions. Other sources are lead smelters and battery plants. |

# Public and Industrial Network Descriptions

**1999 Public Monitoring Network**

The Air Assessment Branch operates a public ambient air monitoring network.

**Network size**

- 41 - monitoring stations
- 25 - cities & towns with monitoring stations

**Number of continuous monitors**

Continuous monitors measure the air quality 24 hours a day. The data is averaged to provide 1-hour averages.

- Criteria pollutant monitors – these pollutants have National Ambient Air Quality Standards (NAAQS).
  - 9 – CO (carbon monoxide)
  - 13 – $NO_2$ (nitrogen dioxide). NO (nitrogen oxide) and $NO_x$ (total nitrogen oxides) are also measured by these monitors.
  - 17 – $O_3$ (ozone)
  - 10 – $SO_2$ (sulfur dioxide)

- Meteorological monitors
  - 9 – BP (barometric pressure)
  - 8 – RH (relative humidity)
  - 8 - SOLAR RAD (solar radiation)
  - 11 – TEMP (temperature)
  - 13 – WS/WD (wind speed/wind direction)
  - 1 – Upper Meteorology – this monitor measures WS/WD and TEMP at various altitudes. This aids in the analysis of pollutant transport.

- Other Monitors
  - 2 – $NO_y$ (Total Reactive Oxidized Nitrogen)
  - 4 - PAMS (Photochemical Assessment Monitoring Station). These monitors measure VOCs (volatile organic compounds).
  - 1 – $PM_{2.5}$ (particulate matter – 2.5 microns)
  - 1- Black Carbon

**Number of intermittent monitors**

Intermittent monitors take discrete samples for a specific time period. The samples are taken every day, every third day, or every sixth day. The data is averaged in 3-hour or 24-hour intervals.

- Criteria pollutant monitors – these pollutants have National Ambient Air Quality Standards (NAAQS).
  - 1 – Pb (Lead)
  - 8 - $PM_{10}$ – (particulate matter – 10 microns)
  - 18 – $PM_{2.5}$ – (particulate matter – 2.5 microns)

*Continued on next page*

### 1999 Public Monitoring Network, continued

**Number of intermittent monitors,** Continued

- Other Monitors
  - 1 - Acid Deposition. Precipitation is collected and analyzed for acidic compounds that are harmful to the environment. This monitor, located in Waltham, is part of the National Atmospheric Deposition Program (NADP). Two other monitors in Massachusetts not operated by MADEP, in Truro and Ware, are also part of the NADP.
  - 8 - PAMS (photochemical assessment monitoring station). These monitors measure VOCs (volatile organic compounds).
  - 1 – TSP (total suspended particulates)
  - 2 - Toxics. These monitors measure health-relevant VOCs.

### 1999 Industrial Monitoring Network

Industries monitor air quality and submit data under agreement with MADEP. The data must be collected using quality assurance requirements established by MADEP and USEPA.

**Network size**

- 6 - monitoring stations
- 3 - cities and towns with monitoring stations

**Number of continuous monitors**

Continuous monitors measure the air quality 24 hours a day. The data is averaged to provide 1-hour averages.

- Criteria pollutant monitors – these pollutants have National Ambient Air Quality Standards (NAAQS).
  - 1 – $NO_2$ (nitrogen dioxide). NO (nitrogen oxide) and $NO_x$ (total nitrogen oxides) are also measured by this monitor.
  - 6 – $SO_2$ (sulfur dioxide)

- Meteorological monitors
  - 6 – WS/WD (wind speed/wind direction)

**Number of intermittent monitors**

Intermittent monitors take discrete samples for a specific time period. These monitors sample every sixth day, and the data is averaged for a 24-hour interval.

- Other Monitors
  - 4 – TSP (total suspended particulates)
  - 4 – $SO_4$ (sulfate)

# Public Site Directory

| CITY<br>SITE LOCATION | DATE SAMPLING BEGAN | AIRS CODE | PARAMETERS MONITORED |
|---|---|---|---|
| ADAMS<br>Mt. Greylock Summit | 05/01/89 | 25-003-4002 | $O_3$ |
| AGAWAM<br>152 Westfield St. | 01/01/82 | 25-013-0003 | PAMS; $O_3$;$NO_2$;NO; $NO_x$; TEMP; WS/WD; SOLAR RAD; RH; BP |
| AMHERST<br>N. Pleasant St. | 04/01/88 | 25-015-0103 | $O_3$ |
| BOSTON<br>Kenmore Square<br>590 Commonwealth Ave. | 01/01/65 | 25-025-0002 | $SO_2$; $NO_2$; NO; $NO_x$; CO; $PM_{10}$;TSP, Pb; $PM_{2.5}$ |
| BOSTON<br>Fire Headquarters<br>Southampton St. | 07/01/70 | 25-025-0012 | $PM_{10}$ |
| BOSTON<br>Sumner Tunnel<br>Visconti St.<br>East Boston | 01/01/74 | 25-025-0016 | CO (site closed 7/1/99) |
| BOSTON<br>340 Bremen St.<br>East Boston | 01/01/79 | 25-025-0021 | $SO_2$; $NO_2$; NO; $NO_x$; CO; |
| BOSTON<br>Fire Station<br>200 Columbus Ave. | 01/01/81 | 25-025-0024 | $PM_{10}$ |
| BOSTON<br>1 City Square<br>Charlestown | 01/01/85 | 25-025-0027 | $PM_{10}$; $PM_{2.5}$ |
| BOSTON<br>Post Office Square | 12/29/89 | 25-025-0038 | CO |
| BOSTON<br>Long Island | 12/01/98 | 25-025-0041 | $O_3$; NO; $NO_2$; $NO_x$; WS/WD; TEMP; SOLAR RAD; RH; BP; Toxics |
| BOSTON<br>Harrison Ave.<br>Roxbury | 12/15/98 | 25-025-0042 | $O_3$; WS/WD; TEMP; SOLAR RAD; RH; BP; Black Carbon; $PM_{2.5}$; Toxics |
| BROCKTON<br>120 Commercial St | 12/01/98 | 25-023-0004 | $PM_{2.5}$ |
| CHELSEA<br>Soldier's Home<br>Powder Horn Hill | 01/01/84 | 25-025-1003 | $O_3$; $SO_2$; $NO_2$; NO; $NO_x$<br>(site closed 12/31/99) |
| CHICOPEE<br>Westover Air Force Base | 01/01/83 | 25-013-0008 | PAMS; $O_3$; $NO_2$; NO; $NO_x$; TEMP; WS/WD; SOLAR RAD; RH;BP; $PM_{2.5}$ |
| EASTON<br>Borderland State Park | 07/01/95 | 25-005-1005 | PAMS; $O_3$; $NO_2$; NO; $NO_x$; WS/WD; TEMP; SOLAR RAD;RH; BP |
| FAIRHAVEN<br>Wood School<br>Scontuit Rd. | 01/01/82 | 25-005-1002 | $O_3$; WS/WD |

*Continued on next page*

## Public Site Directory, Continued

| CITY<br>SITE LOCATION | DATE SAMPLING BEGAN | AIRS CODE | PARAMETERS MONITORED |
|---|---|---|---|
| FALL RIVER<br>Fire Headquarters<br>165 Bedford St. | 01/01/58 | 25-003-3001 | $PM_{2.5}$ |
| FALL RIVER<br>Fire Station<br>Globe St. | 02/01/75 | 25-005-1004 | $SO_2$ |
| FITCHBURG<br>Fitchburg State College<br>67 Rindge St. | 12/01/98 | 25-027-2004 | $PM_{2.5}$ |
| HAVERHILL<br>Consentino School<br>Washington St. | 07/19/94 | 25-009-5005 | $PM_{2.5}$ |
| LAWRENCE<br>Wall Experiment Station<br>37 Shattuck Street | 04/03/99 | 25-009-6001 | $PM_{2.5}$ |
| LAWRENCE<br>Storrow Park<br>High St. | 01/01/80 | 25-009-0005 | $O_3$; $SO_2$; WS/WD |
| LOWELL<br>Old City Hall<br>Merrimack St. | 07/17/81 | 25-017-0007 | CO |
| LYNN<br>Lynn Water Treatment Plant<br>390 Parkland St. | 01/01/92 | 25-009-2006 | PAMS; $O_3$; $NO_2$; NO; $NO_x$,, WS/WD; TEMP; SOLAR RAD; RH; BP; $PM_{2.5}$ |
| NEW BEDFORD<br>YMCA<br>25 Water St. | 01/01/84 | 25-005-2004 | $PM_{2.5}$ |
| NEWBURY<br>US Department of the Interior<br>Sunset Boulevard | 08/01/84 | 25-009-4004 | PAMS; $O_3$; $NO_2$; NO; $NO_x$; WS/WD; TEMP; SOLAR RAD; BP |
| PITTSFIELD<br>Silvio Conte Federal Building<br>78 Center St. | 12/01/98 | 25-003-5001 | $PM_{2.5}$ |
| QUINCY<br>Fire Station<br>Hancock St. | 01/01/76 | 25-021-0007 | $PM_{2.5}$ |
| SPRINGFIELD<br>Howard School<br>59 Howard Street | 01/01/78 | 25-013-0011 | $PM_{10}$ |
| SPRINGFIELD<br>Liberty St. | 04/01/88 | 25-013-0016 | $SO_2$; $NO_2$; NO; $NO_x$; CO; WS/WD; $PM_{2.5}$ |
| SPRINGFIELD<br>Longhill St. | 01/01/78 | 25-013-1009 | $SO_2$ (site closed 12/31/99) |

*Continued on next page*

## Public Site Directory, Continued

| CITY SITE LOCATION | DATE SAMPLING BEGAN | AIRS CODE | PARAMETERS MONITORED |
|---|---|---|---|
| SPRINGFIELD<br>1586 Columbus Ave. | 11/01/81 | 25-013-2007 | CO; $PM_{10}$; $PM_{2.5}$ |
| STOW<br>U.S. Military Reservation | 04/01/98 | 25-017-1102 | $O_3$; Upper Meteorology; $PM_{2.5}$ |
| TRURO<br>Cape Cod National Park<br>Fox Bottom Area | 04/01/87 | 25-001-0002 | PAMS; $O_3$; $NO_2$; NO; $NO_x$; NOy; WS/WD; TEMP; BP; RH; SOLAR RAD |
| WALTHAM<br>U. Mass Field Station<br>Beaver St. | 01/01/71 | 25-017-4003 | $O_3$; $SO_2$; WS/WD; TEMP; Acid Deposition (site closed 7/1/99 except for Acid Deposition) |
| WARE<br>Quabbin Summit | 06/01/85 | 25-015-4002 | PAMS; $O_3$; $SO_2$; $NO_2$; NO; $NO_x$; NOy; $PM_{10}$; WS/WD; TEMP; BP; RH; SOLAR RAD; $PM_{2.5}$ |
| WORCESTER<br>Worcester Airport | 05/07/79 | 25-027-0015 | $O_3$; WS/WD; TEMP |
| WORCESTER<br>YWCA<br>2 Washington St. | 01/01/78 | 25-027-0016 | $PM_{10}$ |
| WORCESTER<br>Fire Station<br>Central St. | 01/01/82 | 25-027-0020 | $SO_2$; $NO_2$; NO; $NO_x$; CO; $PM_{2.5}$ |
| WORCESTER<br>Grafton and Franklin Sts. | 07/28/92 | 25-027-0022 | CO |

# Industrial Site Directory

| REPORTING ORGANIZATION<br>CITY<br>SITE LOCATION | DATE SAMPLING BEGAN | AIRS CODE | PARAMETERS MONITORED |
|---|---|---|---|
| ATLANTIC GELATIN<br>Stoneham (Hill St.)<br>Hill Street | 01/01/78 | 25-017-1701 | $SO_2$; WS/WD |
| SITHE NEW ENGLAND<br>Boston<br>Long Island | 01/01/78 | 25-025-0019 | $SO_2$; WS/WD; TSP; $SO_4$ |
| SITHE NEW ENGLAND<br>Dorchester<br>Dewar Street | 01/01/78 | 25-025-0020 | $SO_2$; WS/WD; TSP; $SO_4$ |
| SITHE NEW ENGLAND<br>East Boston<br>Bremen Street | 01/01/79 | 25-025-0021 | $SO_2$; WS/WD; TSP; $SO_4$ |
| SITHE NEW ENGLAND<br>South Boston<br>East First Street | 01/01/93 | 25-025-0040 | $SO_2$; $NO_2$; NO; $NO_x$; WS/WD; TSP; $SO_4$ |
| HAVERHILL PAPERBOARD<br>Haverhill<br>Nettle School | 09/10/85 | 25-009-5004 | $SO_2$; WS/WD |

# Air Quality Related Web Sites

**Web sites of interest**

The table below has a listing of internet web sites that have air quality data or related information.

| Web Address | Organization | Description |
|---|---|---|
| http://www.state.ma.us/dep/ | MADEP | **Massachusetts DEP Home Page**. Links to MADEP programs, regions and publications. Links to the Daily Ozone Forecast during ozone season (May1 through September 30). |
| http://www.state.ma.us/dep/bwp/daqc/ | MADEP | **MADEP Air Program Planning Unit Home Page**. |
| http://www.state.ma.us/dep/bwp/dhm/tura | MADEP | **Toxic Use Production Program** –establishes toxics use reduction as the preferred means for achieving compliance with any federal or state law or regulation pertaining to toxics production and use. |
| http://www.airbeat.org | MADEP | **Current AIR Quality in Roxbury** – web page of MADEP's Roxbury monitor that shows current levels of ozone and particulates in the air. |
| http://www.turi.org | TURI | **Toxics Use Reduction Institute** –a multi-disciplinary research, education, and technical support center located at the University of Massachusetts/Lowell. Promotes reduction in the use of toxic chemicals and the generation of toxic by-products in industry and commerce in Massachusetts. The web site includes a link to **TURAData**, which makes information available to the public about toxics use in their communities. |
| http://www.epa.gov/airnow/ozone.html | USEPA | **Ozone Mapping Project** – color-coded animated maps using near real-time data that show how ozone is formed and transported downwind. |
| http://www.epa.gov/region01/eco/dailyozone/ozone.html | USEPA | **Ozone maps of the Northeast U.S.** using near real-time data. |
| http://www.epa.gov/region01/eco/ozone/smogalrt | USEPA | **EPA Smog Alert System** – sign up and receive e-mail alerts whenever Massachusetts predicts unhealthy ozone levels. |
| http://www.epa.gov/airsdata/ | USEPA | **AIRSData -** Access to air pollution data for the entire U.S. |
| http://www.epa.gov/ceis/ | USEPA | **Center for Environmental Information and Statistics** – a single convenient source for information on environmental quality. |
| http://www.epa.gov/oar/oaqps | USEPA | **EPA's Office of Air and Radiation/Office of Air Quality Planning and Standards** |
| http://www.epa.gov/region01 | USEPA | **EPA Region 1 Home Page** |
| http://www.epa.gov/ttn/ | USEPA | **EPA Technology Transfer Network -** a collection of technical Web sites containing information about many areas of air pollution science, technology, regulation, measurement, and prevention. |

*Continued on next page*

**Web sites of interest,** continued

The table below has a listing of internet web sites that have air quality data or related information.

| Web Address | Organization | Description |
|---|---|---|
| http://www.epa.gov/enviro/index_java.html | USEPA | **EPA Envirofacts** – data extracted from (4) major EPA databases: • PCS (Permit Compliance System) • RCRIS (Resource Conservation and Recovery Information System) • CERCLIS (Comprehensive Environmental Response, Compensation and Liability Information System) • TRIS (Toxic Release Inventory System) |
| http://es.epa.gov/index.html | USEPA | **Enviro$en$e Network -** a free, public environmental information system. Provides users with pollution prevention/cleaner production solutions, compliance and enforcement assistance information, and innovative technology options. |
| http://www.epa.gov/docs/ozone/index.html | USEPA | **EPA Ozone Depletion Home Page** – learn about the importance of the "good" ozone in the stratospheric ozone layer. |
| http://www.epa.gov/acidrain/ | USEPA | **The Acid Rain Program** – overall goal is to achieve significant environmental and public health benefits through reductions in emissions of sulfur dioxide (SO2) and nitrogen oxides (NOX), the primary causes of acid rain. Emissions data from the nation's largest power generating facilities is available here. |
| Maine<br>http://janus.state.me.us/dep/air/ozone.htm<br><br>New Hampshire<br>http://www.des.state.nh.us/ard/ozone.htm<br><br>New York<br>http://www.dec.state.ny.us/website/dar/bts/ozone/oz4cast.html<br><br>New Jersey<br>http://www.state.nj.us/dep/airmon/<br><br>Rhode Island<br>http://www.state.ri.us/dem/ozone/ozoneday.htm | | **Ozone predictions and some real-time ozone data** from neighboring states (some states report other pollutants, as well). |

*Continued on next page*

# Air Quality Related Web Sites, Continued

**Web sites of interest,** continued

The table below has a listing of internet web sites that have air quality data or related information.

| Web Address | Organization | Description |
|---|---|---|
| http://www.epa.gov/ttn/uatw/ | USEPA | **Unified Air Toxics Website -** This site is a central clearinghouse and repository for air toxics implementation information |
| http://www.epa.gov/airtrends | USEPA | **AIRTrends -** information on USEPA's evaluation of status and trends in the nation's outdoor air quality. |
| http://www.4cleanair.org/links.html | STAPPA/ALAPCO | **State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials** – site has links to air quality related agencies and organizations. |
| http://www.nescaum.org/ | NESCAUM | **Northeast States for Coordinated Air Use Management** – an interstate association of air quality control divisions from the six New England states, New York and New Jersey. |
| http://www.wunderground.com/ | University of Michigan | **The Weather Underground** -. another good source of weather information in the US and world. |
| http://cirrus.sprl.umich.edu/wxnet | University of Michigan | **The WeatherNet –** a good source of weather information. Also has a great list of weather links. |
| http://www.nws.noaa.gov/er/box | NWS | **The National Weather Service's Boston office** provides local forecasts and climate information. |
| http://www.wcvb.com/weather/pollencount/ | WCVB | **WCVB TV Pollen Count –** provides the daily pollen and mold count. |
| http://www.hazecam.net/ | NESCAUM (CAMNET) | **Real-time Air Pollution Visibility Camera Network -** live pictures and air quality conditions for urban and rural vistas across the Northeast U.S. |
| http://www.arb.ca.gov/homepage.htm | CARB | **California Air Resources Board Home Page** |
| http://www.awma.org/ | AWMA | **The Air & Waste Management Association -** a nonprofit, nonpartisan professional organization that provides training, information, and networking opportunities to 12,000 environmental professionals in 65 countries. |
| http://nadp.sws.uiuc.edu/ | NADP | **National Atmospheric Deposition Program** – maps and data from the nationwide precipitation monitoring network. Site also has data from the Mercury Deposition Network. |
| http://www.lungusa.org/index | American Lung Association | **American Lung Association** – public health advocacy organization involved in public policy, research, and education mission is to prevent lung disease |

# Section II

# Attainment and Exceedances of Air Quality Standards

## Attainment Status Summary

**What determines attainment status?**

The National Ambient Air Quality Standards (NAAQS) determined by USEPA set the concentration limits that determine the attainment status for each criteria pollutant. The NAAQS are listed on page 16. Massachusetts does not attain the public health standard for two pollutants – ozone ($O_3$) for the entire state and carbon monoxide (CO) in a few cities. The attainment status for $O_3$ and CO is described in this section.

**Revision of the ozone ($O_3$) standard**

In July 1997, USEPA finalized a revision of the $O_3$ standard to an 8-hour average. This provides increased health protection against longer-term exposures to $O_3$ at lower concentrations.

When USEPA finalized the 8-hour $O_3$ standard, it determined that the existing 1-hour $O_3$ standard would remain in place until an area monitored no violations. Therefore, when an area no longer violated the 1-hour $O_3$ standard, USEPA would revoke that standard, and only the 8-hour $O_3$ standard would apply. This procedure was intended to provide a smooth transition to the 8-hour $O_3$ standard.

**One-hour $O_3$ attainment status**

Massachusetts' 1-hour $O_3$ standard attainment status has changed several times since July 1997, when the 8-hour standard was instituted. At that time, the designation for all of Massachusetts was non-attainment for the 1-hour $O_3$ standard.

- May 14, 1999: In response to challenges filed by industry and others, the Washington D.C. Circuit Court of Appeals rules that, although the 8-hour $O_3$ standard is retained, USEPA can not enforce it.
- June 9, 1999: The 1-hour $O_3$ standard is revoked for Eastern Massachusetts (including Worcester county and east) in a ruling published by the USEPA. These areas had no violations of the 1-hour $O_3$ standard during the period 1996–1998.
- October 25, 1999: Reacting to the May 1999 court ruling, USEPA proposes to reinstate the 1-hour $O_3$ standard in all areas where it has been revoked, including Eastern Massachusetts.
- July 20, 2000: USEPA issues a final rule reinstating the 1-hour $O_3$ standard and the prior classification (i.e., serious non-attainment) for Eastern Massachusetts. The rule becomes effective in January 2001.
- November 7, 2000: The US Supreme Court will hear oral arguments in USEPA's appeal of the Washington D.C. Circuit Court of Appeals May 1999 decision. The main questions are whether setting a NAAQS under the Clean Air Act (CAA) is an unconstitutional delegation of power by Congress, and whether one section of the CAA, which sets out the requirements for areas in non-attainment of the 1-hour $O_3$ standard, has the effect of prohibiting USEPA from enforcing the 8-hour $O_3$ standard. Also up for review is whether USEPA is required to take costs into account in setting the NAAQS.

*Continued on next page*

## Attainment Status Summary, Continued

**Eight-hour $O_3$ attainment status,** Continued

USEPA expects to make available proposed designations for non-attainment areas of the 8-hour $O_3$ standard in late 2000. $O_3$ data collected during the 3-year period of 1997-1999 will be used to determine what areas do not meet the standard. Following a period for comment to the proposal, final designations will be made after June 2001.

Massachusetts Governor Celluci, as part of the designation process, submitted a letter to USEPA on July 21, 2000. The letter recommended that Eastern and Western Massachusetts be designated "non-attainment", based on the 1997-1999 data that showed sites throughout the state violate the 8-hour $O_3$ standard.

**CO attainment status**

Massachusetts has made significant progress in attaining the CO standard by implementing air pollution control programs. The last violation of the CO NAAQS occurred in Boston in 1986. The Boston metropolitan area was redesignated to attainment of the CO federal air quality standard by the USEPA in 1996.

Lowell, Springfield, Waltham, and Worcester remain in non-attainment of the CO standard. MADEP is currently preparing a request to the USEPA to redesignate these areas to attainment for CO because monitoring data has been below the standard for many years. The redesignation request, which includes technical support and a maintenance plan, will be subject to public review and comment prior to being submitted to the USEPA.

# Ozone Exceedances

**What determines an exceedance?**

An $O_3$ exceedance occurs when a daily $O_3$ value exceeds the concentration of the National Ambient Air Quality Standards (NAAQS). There are two $O_3$ standards based on different averaging times, 1-hour and 8-hours. An exceedance of the 1-hour standard is an hourly value during a day that is equal to or greater than 0.125 ppm. An exceedance of the 8-hour standard is an 8-hour averaged value during a day that is equal to or greater than 0.085 ppm.

**The difference between an exceedance and a violation**

Recording an exceedance of the $O_3$ standards does not necessarily mean that a violation of the standard has occurred. Violations of the 1-hour and 8-hour standards are based upon 3-year averages of $O_3$ data as explained below.

Violations of the 1-hour standard are determined using the number of expected exceedance days – days with a 1-hour value that exceeds the standard of 0.12 ppm. (Expected exceedance days are used to account for missing data). A violation of the 1-hour standard requires a 3-year average that is greater than one expected exceedance day. In other words, if there are 4 or more days during a 3-year period with $O_3$ 1-hour values that are equal to or greater than 0.125 ppm, a violation of the 1-hour standard has occurred.

Violations of the 8-hour standard are determined using the annual 4th-highest daily maximum 8-hour $O_3$ value. A violation requires a 3-year average of the annual 4th-highest daily maximum 8-hour value that is equal to or greater than 0.085 ppm. In other words, the highest 8-hour value for each day during a year is ranked from highest to lowest. Then, the 4th-highest value for 3 consecutive years is averaged. If the 3-year average is 0.085 ppm or greater, a violation of the 8-hour standard has occurred.

**$O_3$ exceedances and violations during 1999**

During 1999, there were 4 exceedance days and a total of 5 exceedances of the 1-hour standard. There were 22 exceedance days and 85 exceedances of the 8-hour standard. An exceedance day is a day during which an exceedance occurred. A monitoring site records only one exceedance per day – the exceedance with the highest value.

Using data from 1997–1999, only one out of fifteen sites violated the 1-hour standard. The more stringent 8-hour standard was violated at ten of the fifteen sites for the 1997-1999 period.

*Continued on next page*

**1999 $O_3$ Exceedances (ppm)**

| DATE | SITE | 8-HOUR EXC. | 1-HOUR EXC. |
|---|---|---|---|
| May 30, 1999 | Truro | .089 | |
| May 31, 1999 | Adams | .086 | |
| | Chicopee | .088 | |
| | Fairhaven | .087 | |
| | Long Island | .087 | |
| | Lynn | .088 | |
| | Newbury | .089 | |
| | Truro | .093 | |
| | Ware | .088 | |
| | Worcester | .086 | |
| June 1, 1999 | Agawam | .088 | |
| | Amherst | .089 | |
| | Chicopee | .095 | |
| | Lawrence | .088 | |
| | Long Island | .089 | |
| | Lynn | .085 | |
| | Stow | .093 | |
| | Waltham | .091 | |
| | Ware | .102 | |
| | Worcester | .093 | |
| June 2, 1999 | Ware | .092 | |
| June 7, 1999 | Fairhaven | .109 | |
| | Truro | .116 | |
| June 7, 1999 | Truro | | .127 |
| June 8, 1999 | Truro | .090 | |
| June 23, 1999 | Fairhaven | .101 | |
| | Truro | .095 | |
| June 24, 1999 | Chelsea | .089 | |
| | Easton | .091 | |
| | Long Island | .100 | |
| | Lynn | .101 | |
| | Newbury | .108 | |
| | Stow | .091 | |
| | Truro | .101 | |
| | Waltham | .098 | |
| | Ware | .089 | |
| | Worcester | .101 | |
| June 26, 1999 | Fairhaven | .094 | |
| | Truro | .091 | |
| June 27, 1999 | Amherst | .085 | |
| | Chicopee | .088 | |
| | Ware | .090 | |
| July 6, 1999 | Fairhaven | .098 | |
| | Truro | .090 | |
| July 6, 1999 | Fairhaven | | .139 |
| July 16, 1999 | Chelsea | .102 | |
| | Chicopee | .089 | |
| | Easton | .089 | |
| | Fairhaven | .112 | |
| | Long Island | .102 | |
| | Lynn | .109 | |
| | Newbury | .112 | |
| | Stow | .096 | |
| | Truro | .115 | |
| | Waltham | .104 | |
| | Worcester | .096 | |
| July 16, 1999 | Fairhaven | | .125 |
| | Truro | | .138 |
| July 17, 1999 | Chelsea | .093 | |
| | Easton | .086 | |
| | Fairhaven | .096 | |
| | Lynn | .096 | |
| | Newbury | .086 | |
| | Stow | .086 | |
| | Truro | .104 | |
| | Waltham | .091 | |
| | Worcester | .088 | |
| July 18, 1999 | Fairhaven | .098 | |
| | Truro | .099 | |
| July 23, 1999 | Newbury | .087 | |
| July 24, 1999 | Ware | .094 | |
| July 28, 1999 | Truro | .087 | |
| July 30, 1999 | Chicopee | .093 | |
| | Stow | .094 | |
| | Ware | .093 | |
| | Worcester | .085 | |
| July 31, 1999 | Amherst | .098 | |
| | Chicopee | .087 | |
| | Stow | .091 | |
| | Waltham | .086 | |
| | Ware | .094 | |
| | Worcester | .086 | |
| August 17, 1999 | Chicopee | .087 | |
| | Lynn | .085 | |
| | Stow | .095 | |
| | Ware | .106 | |
| | Worcester | .098 | |
| August 17, 1999 | Ware | | .125 |
| August 25, 1999 | Newbury | .087 | |
| Sept. 2, 1999 | Stow | .092 | |

**Exceedance days and total exceedance trends**

The following figures show the recent trends of exceedance days and the total number of exceedances of the 1-hour and 8-hour $O_3$ standards. An exceedance day is a day on which an exceedance of the standard has occurred.

The trend for the 1-hour data in Figure 12 shows a decline in the number of exceedances and exceedance days over the period. The trend in Figure 13 shows that, under the new more stringent 8-hour standard, there are a greater number of exceedances and exceedance days compared to the 1-hour standard.

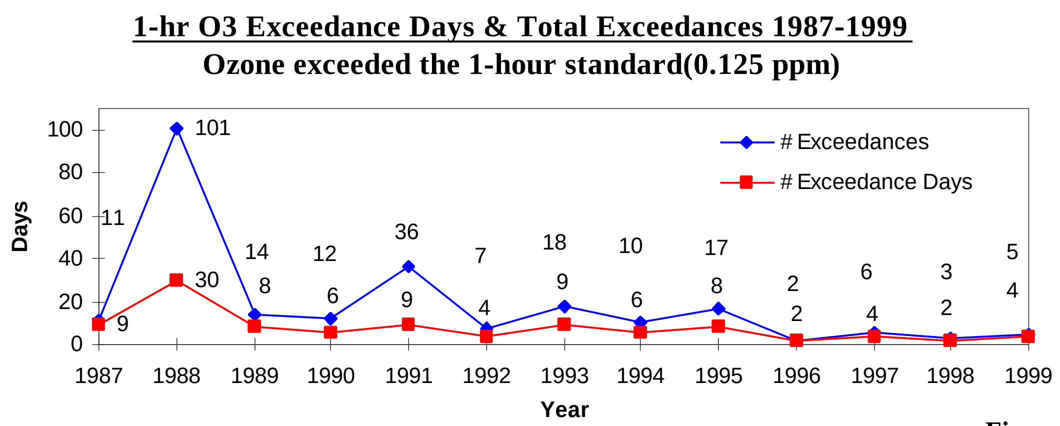



**Figure 12**

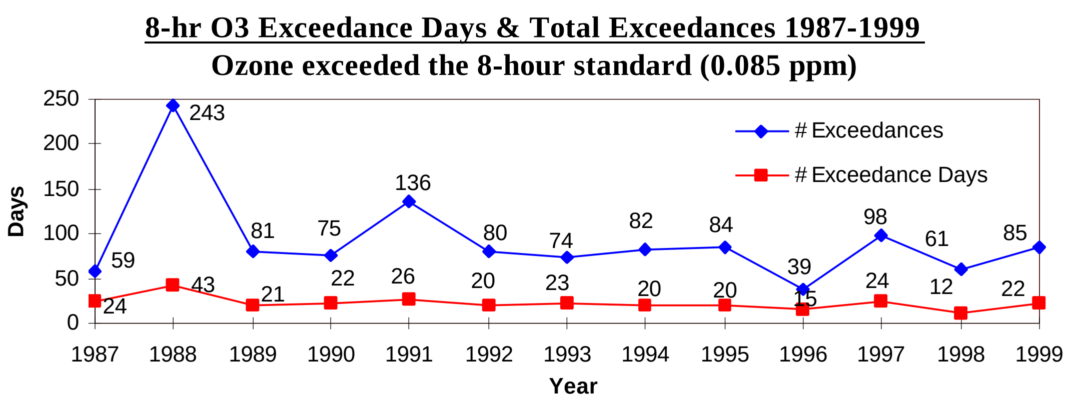



**Figure 13**

*Continued on next page*

**1-hour $O_3$ violations**

A violation of the 1-hour standard requires a 3-year average greater than one for the number of expected exceedance days (the daily maximum $O_3$ value exceeds 0.12 ppm). In June 1999, the USEPA revoked the 1-hour standard in parts of Massachusetts. Massachusetts remains in non-attainment of the $O_3$ standard in the western region of the state, including Berkshire, Franklin, Hampden, and Hampshire counties.

Figure 14 shows the 3-year average of expected 1-hour exceedances at the Massachusetts' sites for the period 1997–1999. Only the site located in Ware was in violation of the 1-hour standard during this period. Figure 15 shows the decrease in the number of 1-hour violation sites in Massachusetts during the last 13 years.

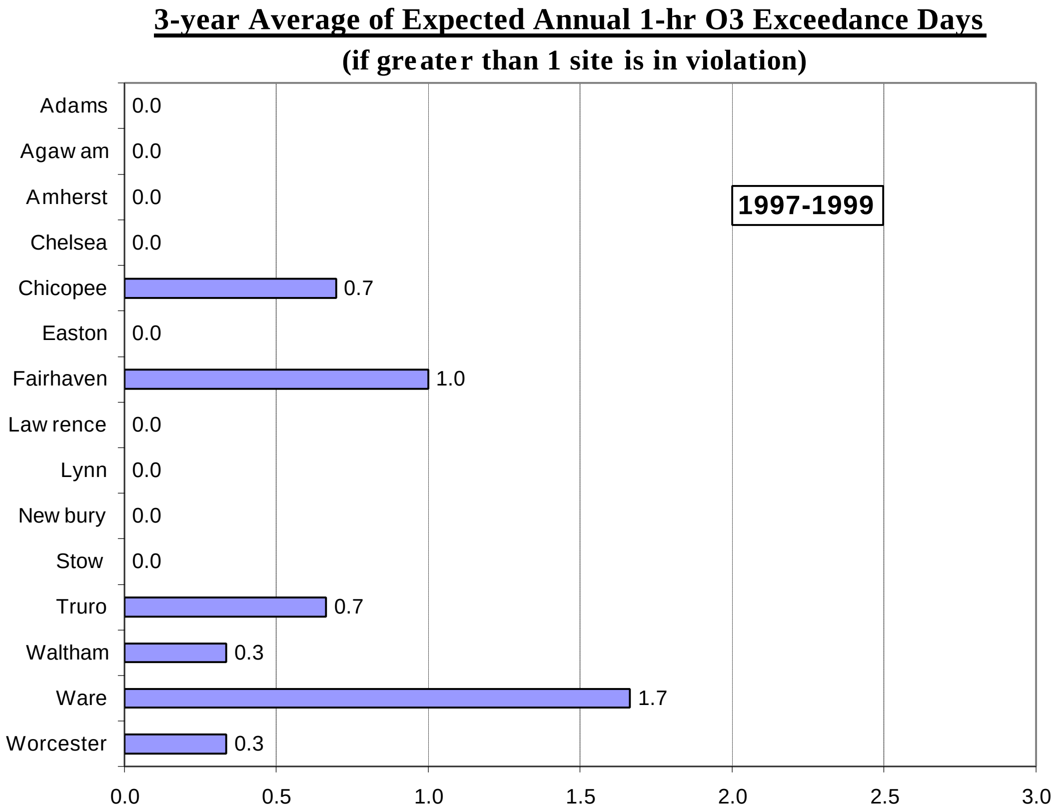



**Figure 14**

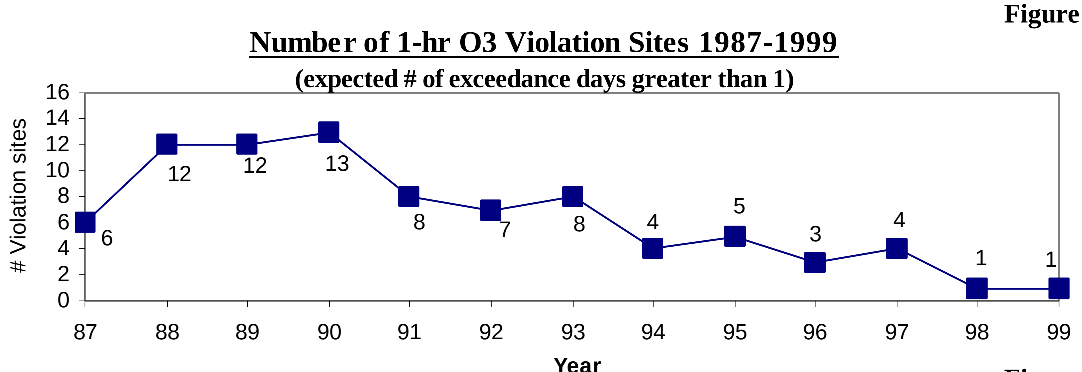



**Figure 15**

***Continued on next page***

**8-hour $O_3$ violations**

A violation of the 8-hour standard requires a 3-year average of the annual 4th-highest daily maximum 8-hour value that is equal to or greater than 0.085 ppm. The standard became effective in 1997, so 1997-1999 is the first period to be used to designate attainment status.

Based upon the period 1997–1999, ten of the fifteen sites with 3 years of data were in violation of the 8-hour standard. Figure 16 shows the 8-hour violation status for the 1996–1998 period. Figure 17 shows the trend for the number of violation sites from 1987-1999. The number of violation sites has decreased, but has been stable at ten sites throughout the state the last six years.

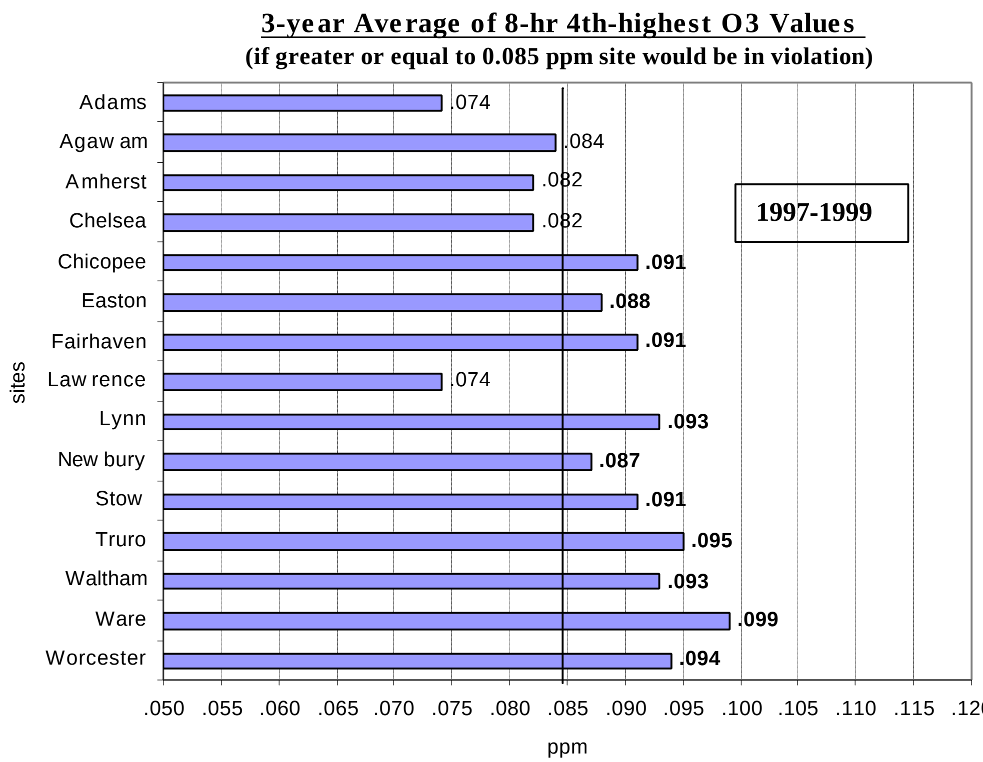



**Figure 16**

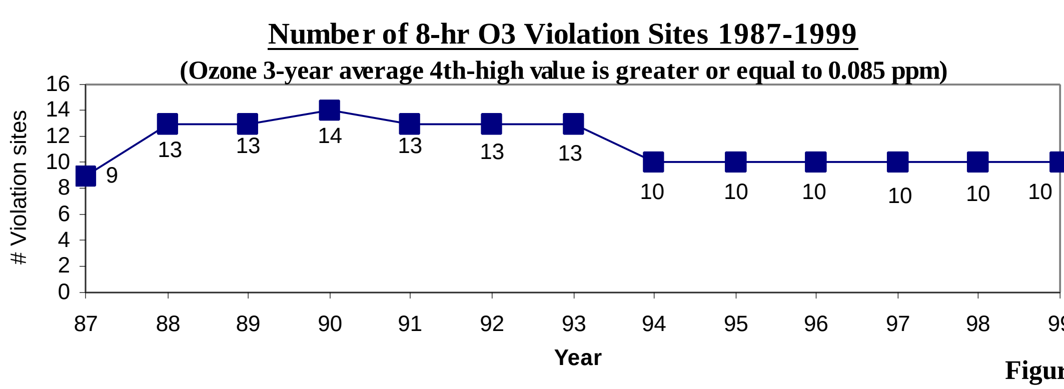



**Figure 17**

# A Look at the 1999 Ozone ($O_3$) Season

**Ozone and weather during 1999**

Massachusetts weather observing stations recorded temperatures that averaged above a 105 year norm each month from May through September. This was mainly due to a large upper atmospheric high pressure system positioned for much of the summer over the central U.S. This high pressure forced stronger winds northward into Canada, preventing the passage of weather fronts across much of the eastern U.S. The result: little rain and several lengthy hot spells across the east.

Generally, when heat, sunshine, and southwesterly winds combined in 1999, ozone rose to levels that exceeded the federal 8-hour standard over part or most of Massachusetts. On 22 days this season, unhealthy ozone levels were found somewhere in the state, easily surpassing 1998's total of 12 unhealthy air days.

**How the 1999 ozone season progressed**

In late May, the season's first ozone-conducive weather pattern took shape when a high pressure system moved from the Midwest to the east coast on the 29th, then lingered offshore for several days. Ozone values in Massachusetts reached either high moderate or unhealthy levels each day from May 29 to June 3. After a brief respite, conditions favoring elevated ozone returned as high pressure built off the east coast again June 6, remaining there into the 8th.

A slight shift in the weather pattern led to lower ozone during middle June before hot weather returned late in June. With the heat came unhealthy ozone levels on June 23, 24, 26, and 27, as high pressure sat off the New England coast for days. The high produced a combination of recirculating air and southwesterly transport.

July began with rain on the 1st, heralding a clean start for the month. Except for a south coast and Cape-only episode on July 6, the state recorded no unhealthy air days until the 16th, when one of the worst ozone days of the season occurred.

The continued warm pattern resulted in three unhealthy air days in August, and one, the season's last, in September.

**What were the primary ozone-causing weather patterns?**

During the summer, three distinct weather patterns played roles in causing high ozone in Massachusetts. One episode type, such as occurred on June 7, exposed communities along the Massachusetts south coast and Cape Cod to unhealthy air, while leaving the rest of the state's air fairly clean. This type of event features westerly winds except along the south coast, where the flow turns southwesterly. This draws some of the polluted air exiting the New York City - New Jersey area over those coastal communities.

Another type of event, such as occurred on July 31, brought high ozone to most of the state, but not to the south coast and Cape Cod. In this case, a Bermuda high-induced south-southwesterly flow brought elevated ozone to western and interior sections. But a much cleaner marine flow kept ozone levels down along the south coast and Cape Cod.

*Continued on next page*

**What were the primary ozone-causing weather patterns?** Continued

A third episode type - one we don't often see here, but which occurred on at least two occasions during the summer - produced ozone hot spots over interior areas only. On September 2, a weak, flat pressure field produced a feeble southeasterly breeze – a wind direction not normally associated with high ozone here. But on this day the onshore flow, enhanced by coastal seabreezes, pushed pollutants, including those Massachusetts emitted, inland where ozone accumulated to unhealthy levels. Elsewhere in the state, ozone levels stayed low. Cleaner marine air protected areas closer to the coast, and near-calm conditions over western Massachusetts insulated that area from the pollutant buildup farther east.

**How Massachusetts contributes to ozone downwind**

Each summer, we see evidence that pollutants entering Massachusetts' airspace, either from in-state sources or from transport from upwind states, travel downwind and raise pollutant levels in New Hampshire and Maine. Air trajectories calculated from wind data reveal that, on many of Maine and New Hampshire's high ozone days, the air arriving along these northern coasts had resided over eastern Massachusetts earlier in the day.

**Were ozone levels bad throughout the east?**

As the chart below shows, Massachusetts was not alone in suffering frequent bouts of ozone in 1999. It also illustrates the role latitude and, hence, climate plays; more southern areas receive more sunlight, have longer summers, and generate more ozone.

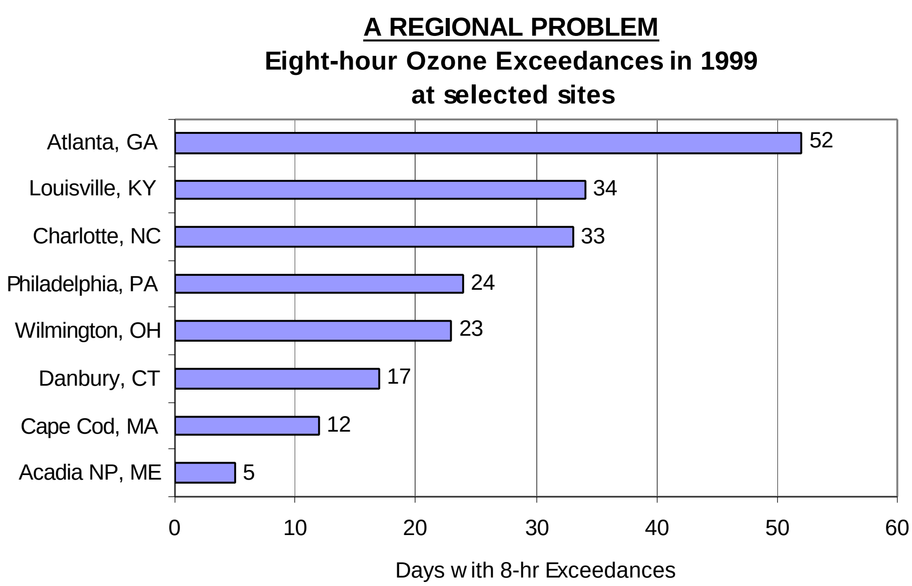



**Figure 18**

# Daily Ozone ($O_3$) Forecast

**Introduction**

MADEP forecasts air quality daily from May through September during the $O_3$ season. Each day during that period, MADEP predicts the air quality as good, moderate, or unhealthy.

**Determining the air quality level rating**

The air quality rating is determined through analysis of National Weather Service observations and weather modeling predictions. Also, meteorological, $O_3$, and nitrogen oxides data are used from the statewide and regional monitoring networks.

**The air quality ratings**

The table below gives information about the ratings used in the daily air quality forecasts.

| Air Quality Rating | Adverse Health Effects | Ways to Protect Your Health |
|---|---|---|
| Good | None expected. | No precautions necessary. |
| Moderate | $O_3$ levels in the upper part of this range may cause respiratory problems in some children and adults engaged in outdoor activities. These effects are of particular concern for those with existing lung problems. | People with respiratory diseases such as asthma and other sensitive individuals should consider limiting outdoor exercise and strenuous activities during the afternoon and early evening hours, when $O_3$ levels are highest. |
| Unhealthy | As $O_3$ levels increase, both the severity of the health effects and the number of people affected increase. Health effects include eye, nose, and throat irritation; chest pain; decreased lung function; shortness of breath; increased susceptibility to respiratory infection, and aggravation of asthma.<br><br>It is important to be aware that individuals react differently when exposed to various $O_3$ levels in the unhealthy range; some people experience problems at lower unhealthy levels, while others may not be affected until higher levels are reached. | In general, everyone should limit strenuous outdoor activity during the afternoon and early evening hours, when $O_3$ levels are usually the highest.<br><br>If you are particularly sensitive to $O_3$, or if you have asthma or other respiratory problems, stay in an area where it is cool and, if possible, where it is air-conditioned.<br><br>If you want to take action to minimize exposure to unhealthy $O_3$ levels, you should consider scheduling outdoor exercise and children's outdoor activities in the morning hours, when $O_3$ levels are generally lower. |

**Forecast availability**

The daily air quality forecast is available May through September from MADEP's website (www.state.ma.us/dep/) or by calling the Air Quality Hotline (1-800-882-1497).

*Continued on next page*

**Ozone maps**

The USEPA maintains a couple of internet web sites containing current and archived $O_3$ maps and "real-time" $O_3$ movies using $O_3$ data that is provided by participating states. These sites are (www.epa.gov/region01/eco/dailyozone/ozone.html) and (www.epa.gov/airnow/ozone.html).

# State Implementation Plan (SIP)

**Overview**

The federal Clean Air Act requires states that are in non-attainment of a standard to develop and implement strategies to attain that standard. The State Implementation Plan (SIP) is the mechanism for documenting this process, and all revisions to the SIP must be approved by the USEPA.

**Reasonable Further Progress SIPs**

The following list contains the measures that have been submitted to the USEPA since 1993 as part of Massachusetts' "Reasonable Further Progress" toward attaining the ozone standard. Note that this is not a comprehensive list of air regulations, as there are many MADEP air regulations that are not specifically credited in the "Reasonable Further Progress" SIPs.

**Air Pollution Programs in the Reasonable Further Progress Toward $O_3$ Attainment SIPs**

Stationary Point Source Controls:

- Reasonably Available Control Technology (RACT) for 50 Ton VOC Sources (310 CMR 7.18)
- RACT for 50 Ton $NO_x$ Sources (310 CMR 7.19)

Stationary Area Source Controls:

- Reformulated Architectural and Industrial Maintenance Coatings (310 CMR 7.25)
- Reformulated Traffic Markings (310 CMR 7.25)
- Reformulated Consumer and Commercial Products (310 CMR 7.25)
- Automotive Refinishing Controls (310 CMR 7.18)

On-Road Mobile Source Controls:

- Stage II Vapor Recovery Systems at Gasoline Stations (310 CMR 7.24)
- Federal Reformulated Gasoline
- Enhanced Automobile Inspection and Maintenance (I/M) up to 10,000 Gross Vehicle Weight Rating (310 CMR 60.02)
- Low Emission Vehicle (LEV) Program (310 CMR 7.40)
- Federal Motor Vehicle Program (FMVCP) - Pre-Clean Act New Engine Performance Standards
- Federal Tier I New Engine Performance Standards
- Traffic Flow Improvements

Off-Road Mobile Source Controls:

- Federal Reformulated Gasoline for Off-Highway Equipment
- Federal New Engine Performance Standards for Off-Highway Equipment

*Continued on next page*

**Attainment Demonstration SIP**

In July 1998, MADEP submitted an Attainment Demonstration SIP to USEPA. In it, MADEP demonstrated that some additional VOC and $NO_x$ reductions in Massachusetts, coupled with large-scale regional $NO_x$ reductions, would likely allow Massachusetts to attain the one-hour $O_3$ standard.

The VOC and $NO_x$ reduction in Massachusetts will come from:

- Additional federal measures (e.g., off-road and locomotive engine standards)
- Final implementation of Massachusetts' previous SIP commitments (e.g., Enhanced Vehicle I/M, which began operation in Fall 1999)
- Enhancement of Massachusetts Stage II enforcement program
- Municipal Waste Combustor $NO_x$ Reductions (310 CMR 7.08 (2))
- $NO_x$ Allowance Trading Program (310 CMR 7.27 and 310 CMR 7.28)

MADEP also expects that the regional $NO_x$ reductions will be achieved through compliance with the program known as EPA's "$NO_x$ SIP Call" (63 FR 57356). It requires more than 20 Eastern states to reduce their $NO_x$ emissions by May 2003.

# Section III

# Massachusetts Air Quality Data Summaries

## Ozone ($O_3$) Summary

**Introduction**

There were sixteen $O_3$ sites during 1999 in the state-operated monitoring network. Two new sites were established in Boston - on Long Island and in Roxbury (Harrison Ave.). The Chelsea site closed at the end of the year.

**$O_3$ health effects and sources**

- Ground-level and stratospheric $O_3$ are often confused. Whereas stratospheric $O_3$ is beneficial because it filters out the sun's harmful ultraviolet radiation, ground-level $O_3$ is a health and environmental problem.
- $O_3$ irritates mucous membranes. This causes reduced lung function, nasal congestion, eye and throat irritation, and reduced resistance to infection.
- $O_3$ is toxic to vegetation, inhibiting growth and causing leaf damage.
- $O_3$ weakens materials such as rubber and fabrics.
- O3 is unique in that it is formed by reactions between other pollutants in presence of high-energy sunlight, of the intensity found during the summer months. The complexity and subsequent time needed to complete these reactions results in the build up of ground level ozone concentrations far downwind from the original source of the precursors.
- Sources of ground-level $O_3$ precursors, nitrogen oxides and hydrocarbons, include motor vehicles and power plants.

**The $O_3$ standard**

The National Ambient Air Quality Standard is listed below.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards** - designed to protect against damage to crops, vegetation, and buildings from air pollution.

| POLLUTANT | AVERAGING TIME | PRIMARY | SECONDARY |
|---|---|---|---|
| **$O_3$** | 1-Hour | 0.12 ppm (235 ug/m$^3$) | Same as Primary Standard |
| | 8-Hour | 0.08 ppm (157 ug/m$^3$) | Same as Primary Standard |

- The 1-hour standard:
  - applies only to areas with continued violations of the 1-hour standard. In Massachusetts, it applies to the western region of the state, in Berkshire, Hampshire, Hampden and Franklin counties.
  - is met when the expected exceedance days (the daily maximum 1-hour concentration exceeds 0.12 ppm) do not exceed one per year (3-year average).
- The 8-hour standard is met when the 3-year average of the 4th-highest daily maximum 8-hour average does not exceed 0.08 ppm.

.

**μg/m$^3$ =** micrograms per cubic meter **ppm =** parts per million **mg/m$^3$ =** milligrams per cubic meter

*Continued on next page*

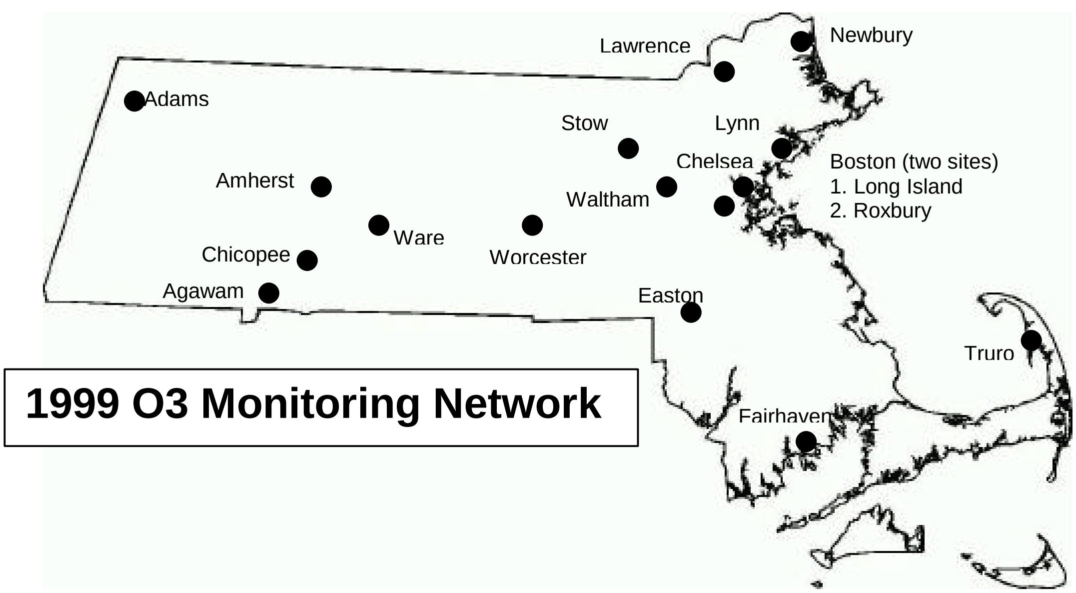
# Ozone (O3) Summary, Continued

**1999 $O_3$ data summary**

A summary of the 1999 data during $O_3$ season (April 1 – Sept. 30) is listed below. All of the sites achieved the requirement of 75% or greater data capture for the year.

| | P | | | | UNITS: PPM | | | | VALS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | O | M | | | | % | -1 HR | MAX- | | -8-HR | MAX | IMA- | VALS |
| SITE ID | C | T | CITY | COUNTY | ADDRESS | OBS | 1ST | 2ND | >.125 | 1ST | 2ND | 4TH | >.085 |
| 25-003-4002 | 1 | 2 | ADAMS | BERKSHIRE | MT. GREYLOCK | 81 | .093 | .092 | 0 | .086 | .083 | .075 | 1 |
| 25-013-0003 | 1 | 8 | AGAWAM | HAMPDEN | 152 S. WESTFIELD | 97 | .104 | .099 | 0 | .088 | .084 | .081 | 1 |
| 25-015-0103 | 1 | 2 | AMHERST | HAMPSHIRE | NORTH PLEASANT | 93 | .111 | .110 | 0 | .098 | .089 | .084 | 3 |
| 25-025-0041 | 1 | 2 | BOSTON | SUFFOLK | LONG IS. HOSPITAL | 98 | .123 | .114 | 0 | .102 | .100 | .087 | 4 |
| 25-025-0042 | 1 | 2 | BOSTON | SUFFOLK | HARRISON AVE | 85 | .097 | .077 | 0 | .066 | .064 | .058 | 0 |
| 25-025-1003 | 1 | 1 | CHELSEA | SUFFOLK | POWDER HORN HILL | 96 | .109 | .105 | 0 | .102 | .093 | .084 | 3 |
| 25-013-0008 | 1 | 7 | CHICOPEE | HAMPDEN | ANDERSON ROAD | 98 | .113 | .111 | 0 | .095 | .093 | .088 | 7 |
| 25-005-1005 | 1 | 7 | EASTON | BRISTOL | BORDERLAND PARK | 95 | .101 | .099 | 0 | .091 | .089 | .083 | 3 |
| 25-005-1002 | 1 | 2 | FAIRHAVEN | BRISTOL | L. WOOD SCHOOL | 98 | .139 | .125 | 2 | .112 | .109 | .098 | 8 |
| 25-009-0005 | 1 | 1 | LAWRENCE | ESSEX | HIGH STREET | 97 | .092 | .090 | 0 | .088 | .083 | .068 | 1 |
| 25-009-2006 | 1 | 8 | LYNN | ESSEX | 390 PARKLAND AVE | 98 | .122 | .115 | 0 | .109 | .101 | .088 | 6 |
| 25-009-4004 | 1 | 7 | NEWBURY | ESSEX | SUNSET BOULEVARD | 95 | .124 | .120 | 0 | .112 | .108 | .087 | 6 |
| 25-017-1102 | 1 | 2 | STOW | MIDDLESEX | US MILITARY RESERV. | 98 | .111 | .108 | 0 | .096 | .095 | .093 | 8 |
| 25-001-0002 | 1 | 2 | TRURO | BARNSTABLE | FOX BOTTOM AREA | 98 | .138 | .127 | 2 | .116 | .115 | .101 | 12 |
| 25-017-4003 | 1 | 2 | WALTHAM | MIDDLESEX | BEAVER STREET | 97 | .112 | .106 | 0 | .104 | .098 | .091 | 5 |
| 25-015-4002 | 1 | 7 | WARE | HAMPSHIRE | QUABBIN SUMMIT | 93 | .125 | .113 | 1 | .106 | .102 | .094 | 9 |
| 25-027-0015 | 1 | 1 | WORCESTER | WORCESTER | WORCESTER AIRPORT | 96 | .114 | .113 | 0 | .101 | .098 | .093 | 8 |

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **.MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER; 7 = PAMS/NAMS; 8 = PAMS/SLAMS) **% OBS** = PERCENTAGE OF VALID DAYS MONITORED DURING O3 SEASON **1ST, 2ND 1-HR MAX** = MAXIMUM 1-HR VALUE FOR THE 1ST & 2ND HIGHEST DAY **VALS > 0.125** = NUMBER OF MEASURED DAILY 1-HR MAXIMUM VALUES GREATER THAN OR EQUAL TO 0.125 PPM (1-HR STANDARD) **1ST, 2ND, 4TH 8-HR MAXIMA** = MAXIMUM 8-HR VALUE FOR THE 1ST, 2ND & 4TH HIGHEST DAY **VALS > 0.O85** = NUMBER OF MEASURED DAILY 8-HR MAXIMUM VALUES GREATER THAN OR EQUAL TO 0.085 PPM (8-HR STANDARD)




**1999 O3 Monitoring Network**

# Ozone ($O_3$) Summary, Continued

**Maximum 1-hour $O_3$ Values**

The figures below display the 1st and 2nd daily maximum 1–hour values at each site during 1999. The 1st and 2nd maximum values are for different days.

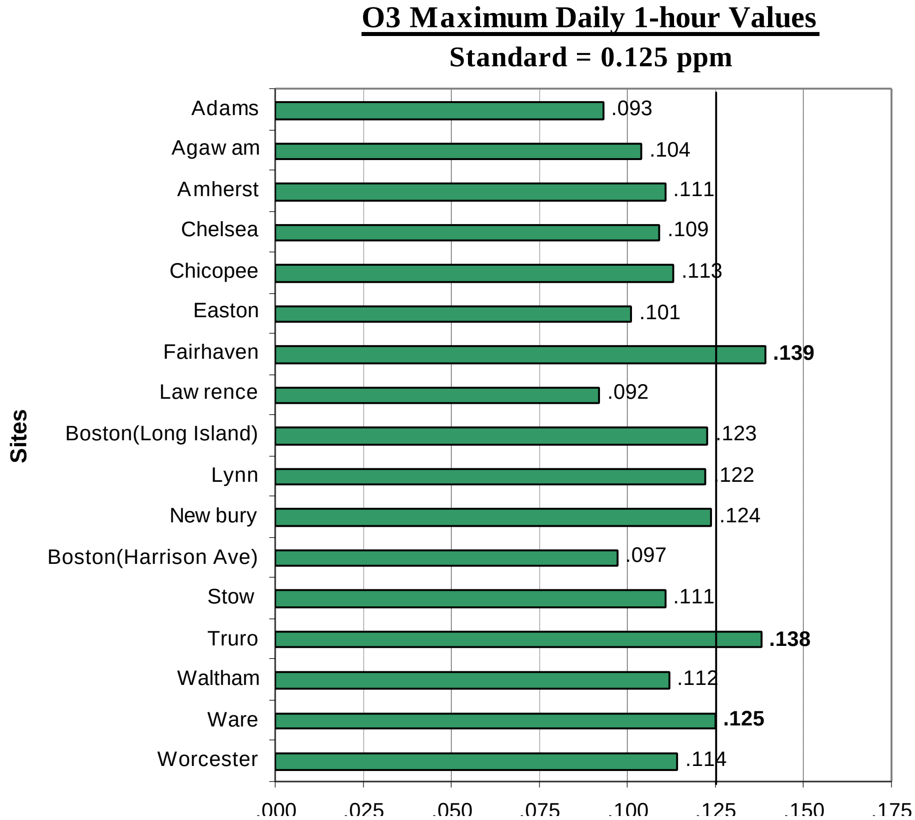



Figure 19

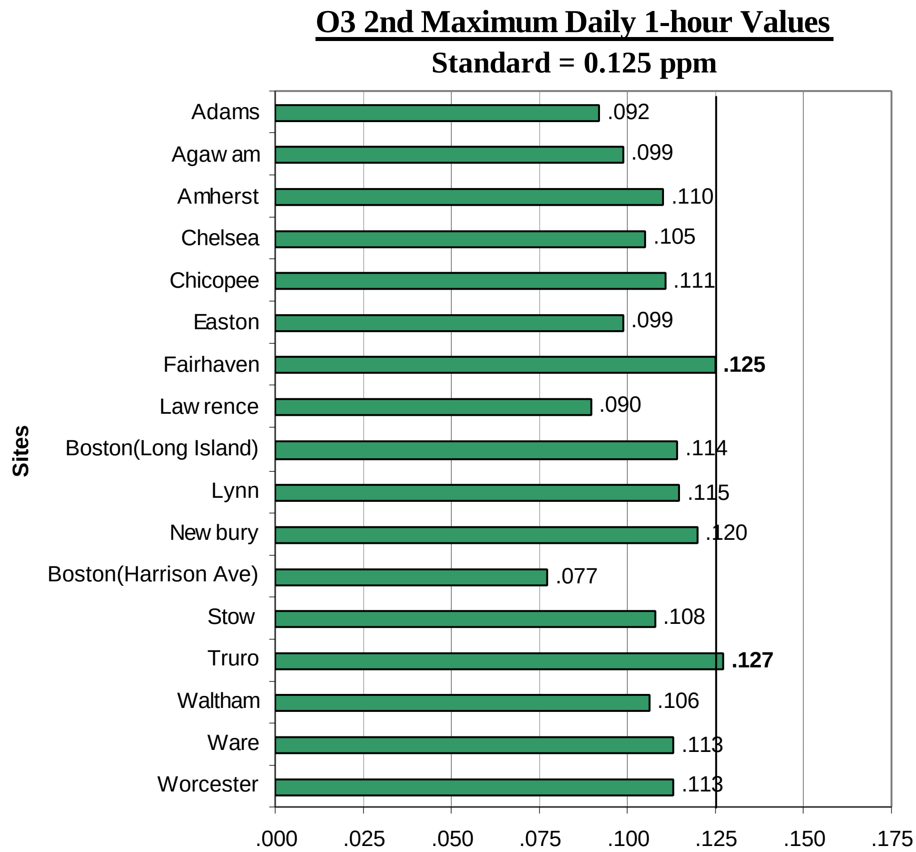



Figure 20

# Ozone ($O_3$) Summary, Continued

**Maximum 8-hour $O_3$ values**

The 1st and 4th maximum daily 8-hour $O_3$ values are shown below. A 3-year average of the 4th maximum value is used to determine attainment status.

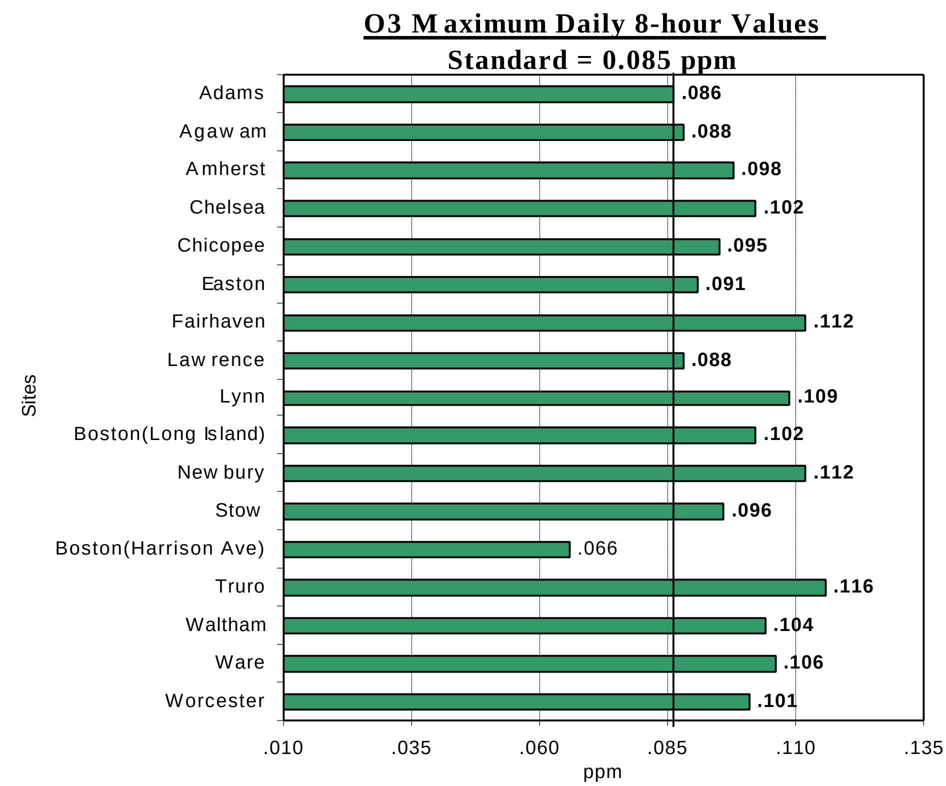



Figure 21

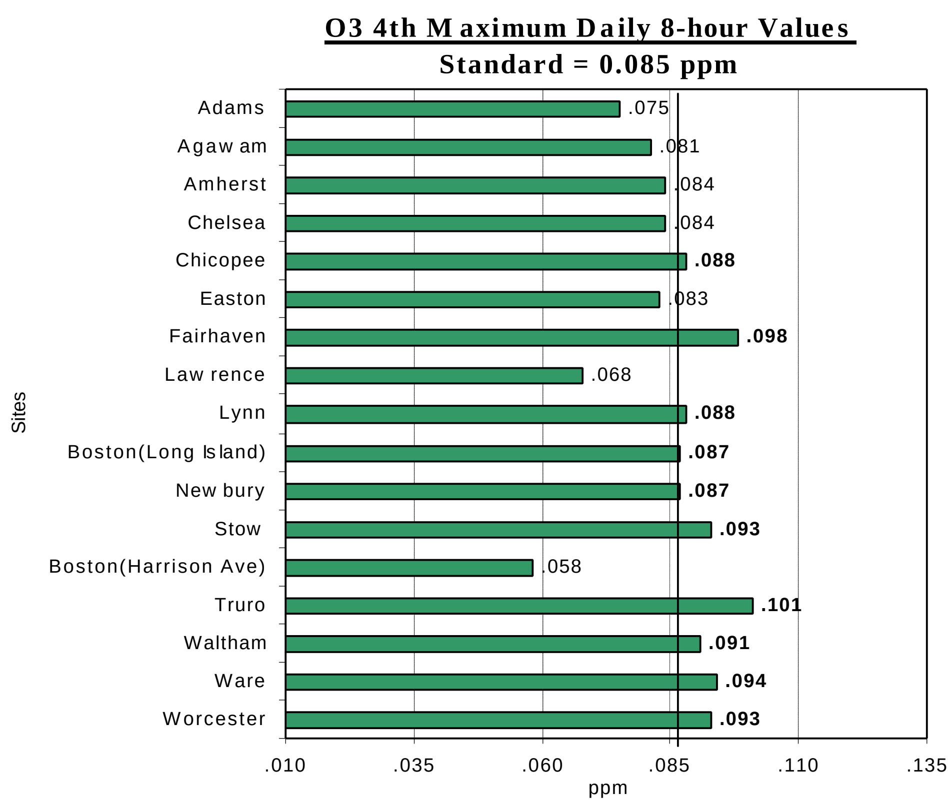



Figure 22

# Ozone ($O_3$) Summary, Continued

**1-hour $O_3$ exceedance day trends**

The long-term trends of 1-hour $O_3$ exceedance days for each site are shown below.

**O3 1-hour Exceedance Day Trends**
**number of days O3 exceeded the standard (0.125 )ppm)**

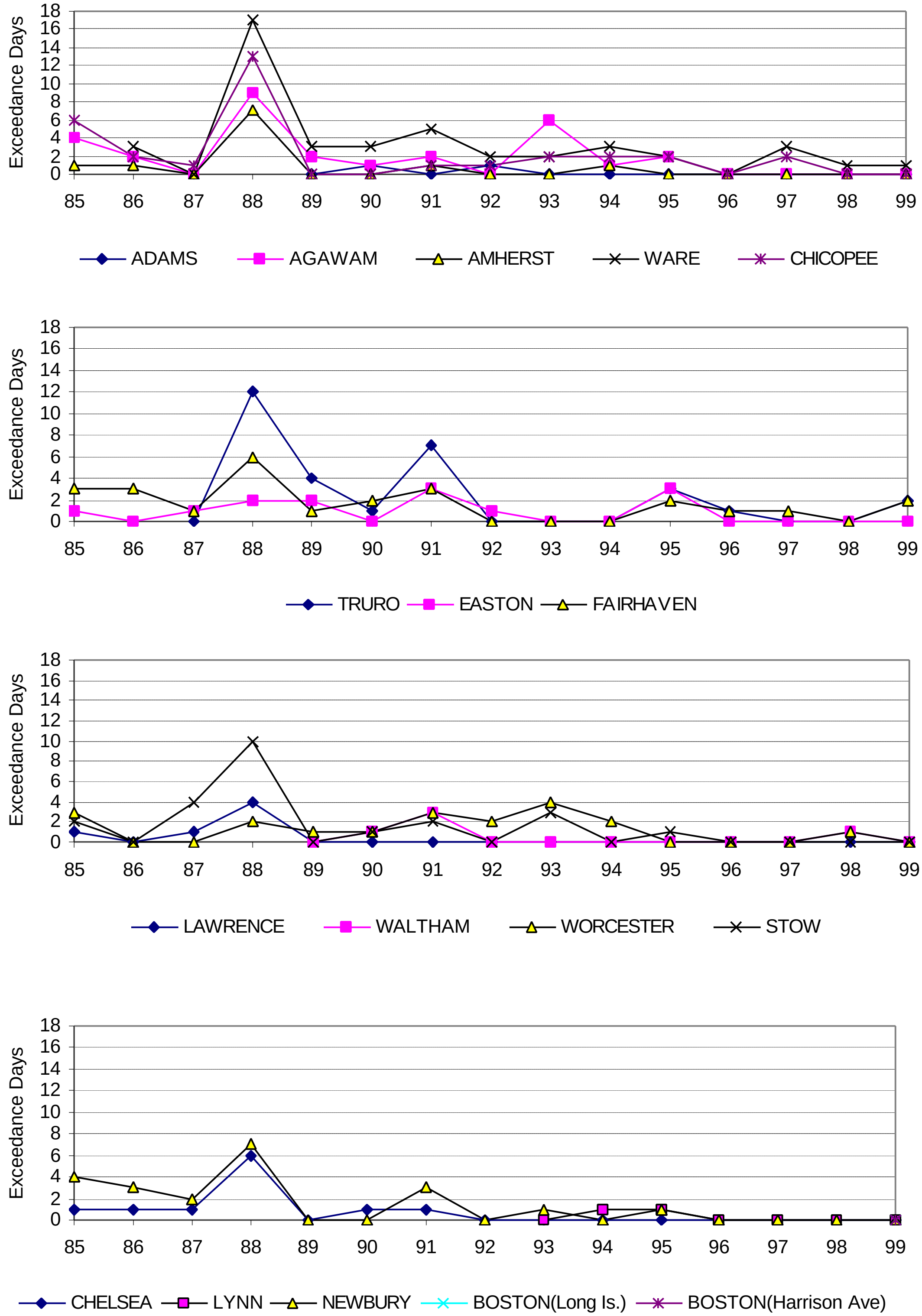



Figure 23

# Ozone ($O_3$) Summary, Continued

**8-hour $O_3$ exceedance day trends**

The long-term trends of 8-hour $O_3$ exceedance days for each site are shown below.

**O3 8-hour Exceedance Day Trends**
**Number of days O3 exceeded the standard (0.085)**

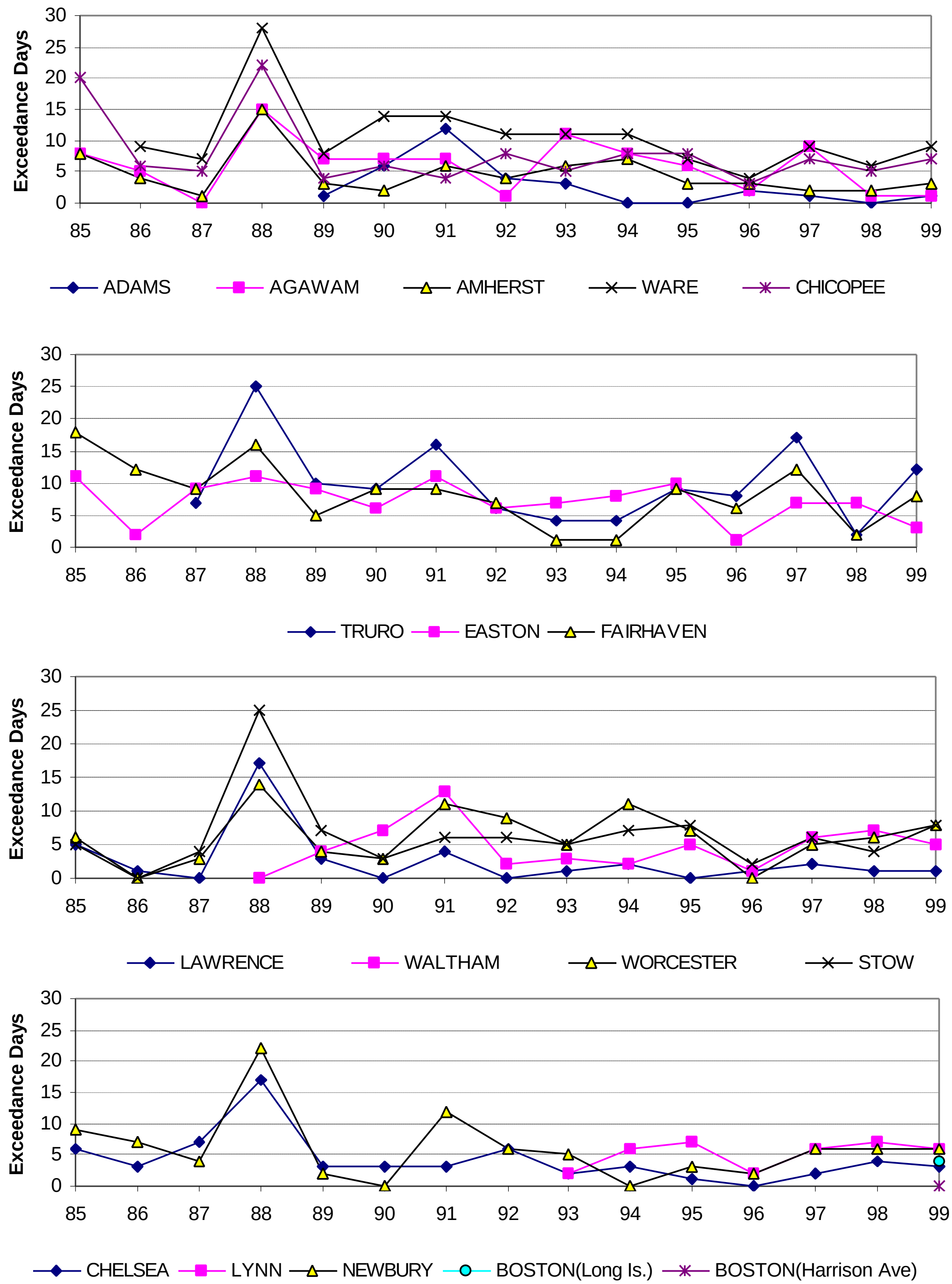



Figure 24

# Sulfur Dioxide ($SO_2$) Summary

**Introduction**

There were ten $SO_2$ sites during 1999 in the state-operated monitoring network. Three sites were closed during the year. The Waltham site was closed on June 30, and the Springfield (Longhill Street) and Chelsea sites both closed at the end of the year.

**$SO_2$ health effects and sources**

- $SO_2$ combines with water vapor to form acidic aerosols harmful to the respiratory tract, aggravating symptoms associated with lung diseases such as asthma and bronchitis.
- $SO_2$ is a primary contributor to acid deposition. Impacts of acid deposition include:
  - acidification of lakes and streams
  - damage to vegetation
  - damage to materials
  - degradation of visibility
- $SO_2$ is a product of fuel combustion (e.g., burning coal and oil). Sources include heat and power generation facilities, and petroleum refineries.

**The $SO_2$ standard**

The National Ambient Air Quality Standard is listed below.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards -** designed to protect against damage to crops, vegetation, and buildings from air pollution.

| POLLUTANT | AVERAGING TIME* | PRIMARY | SECONDARY |
|---|---|---|---|
| **$SO_2$** | Annual Arithmetic Mean | 0.03 ppm (80 ug/m³) | None |
| | 24-Hour | 0.14 ppm (365 ug/m³) | None |
| | 3-Hour | None | 0.50 ppm (1300 ug/m³) |

m**g/m³ =** micrograms per cubic meter **ppm =** parts per million **mg/m³ =** milligrams per cubic meter

***** Standards based upon averaging times other than the annual arithmetic mean must not be exceeded more than once a year.

*Continued on next page*

# Sulfur Dioxide (SO2) Summary, Continued

**1999 $SO_2$ data summary**

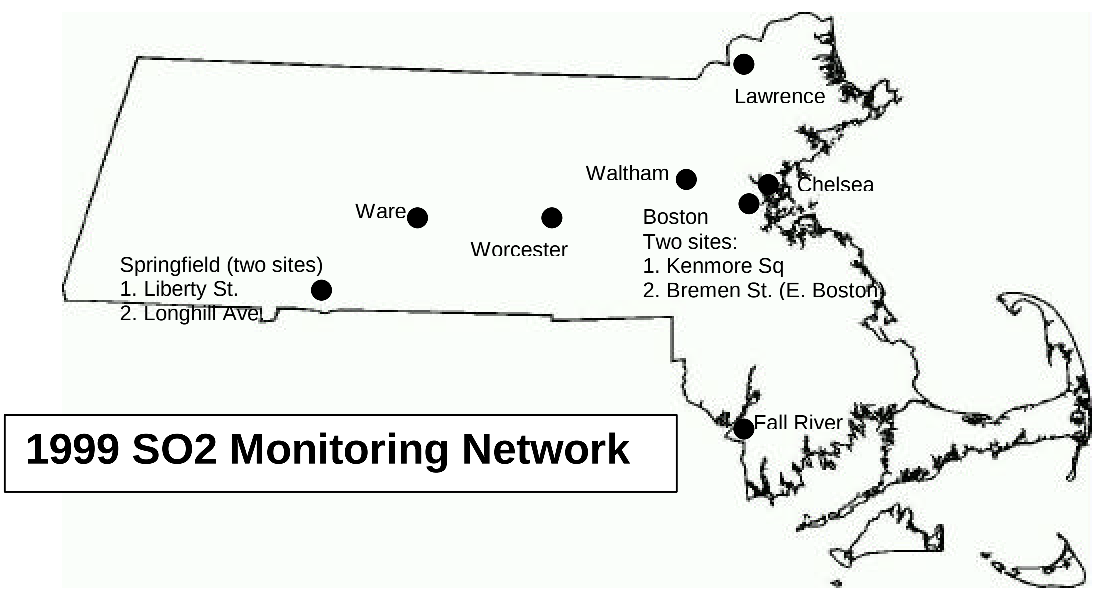
A summary of the 1999 data is listed below. All of the sites achieved the requirement of 75% or greater data capture for the year except Waltham, which closed on June 30.

| SITE ID | P O C | M T | CITY | COUNTY | UNITS:PPM ADDRESS | % OBS | MAX 24-HR 1ST | MAX 24-HR 2ND | MAX 3-HR 1ST | MAX 3-HR 2ND | MAX 1-HR 1ST | MAX 1-HR 2ND | ANN ARITH MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-025-0002 | 1 | 1 | BOSTON | SUFFOLK | KENMORE SQUARE | 97 | .027 | .026 | .057 | .045 | .064 | .062 | .007 |
| 25-025-0021 | 1 | 1 | BOSTON | SUFFOLK | 340 BREMEN ST. | 90 | .022 | .022 | .047 | .046 | .067 | .062 | .006 |
| 25-025-1003 | 1 | 1 | CHELSEA | SUFFOLK | POWDERHORN HILL | 97 | .024 | .024 | .057 | .056 | .071 | .069 | .007 |
| 25-005-1004 | 1 | 1 | FALL RIVER | BRISTOL | GLOBE STREET | 96 | .033 | .021 | .081 | .074 | .114 | .104 | .004 |
| 25-009-0005 | 1 | 1 | LAWRENCE | ESSEX | HIGH STREET | 97 | .024 | .021 | .059 | .055 | .088 | .065 | .005 |
| 25-013-0016 | 1 | 1 | SPRINGFIELD | HAMPDEN | LIBERTY STREET | 96 | .019 | .019 | .030 | .030 | .046 | .038 | .004 |
| 25-013-1009 | 1 | 1 | SPRINGFIELD | HAMPDEN | LONGHILL STREET | 96 | .026 | .024 | .036 | .036 | .044 | .042 | .005 |
| 25-017-4003 | 1 | 1 | WALTHAM | MIDDLESEX | BEAVER STREET | 94 | .024 | .020 | .067 | .059 | .102 | .099 | .005? |
| 25-015-4002 | 1 | 2 | WARE | HAMPSHIRE | QUABBIN SUMMIT | 98 | .019 | .017 | .030 | .027 | .040 | .032 | .005 |
| 25-027-0020 | 1 | 1 | WORCESTER | WORCESTER | CENTRAL STREET | 87 | .018 | .013 | .025 | .024 | .045 | .033 | .004 |

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER LESS THAN 75%)
TO CONVERT UNITS FROM PPM TO uG/M³ MULTIPLY PPM x 2620

Standards: Annual Mean = 0.03 ppm 24-hour = 0.14 ppm 3-hour = 0.50 ppm

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER) **REP ORG** = REPORTING ORGANIZATION **% OBS** = DATA CAPTURE PERCENTAGE **MAX 24-HR, MAX 3-HR, MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **OBS > .14** = NUMBER OF 24-HR AVG. GREATER THAN 0.14 PPM (24-HR STANDARD) **OBS > .50** = NUMBER OF 3-HR AVG. GREATER THAN 0.50 PPM (3-HR STANDARD) **ANN ARITH MEAN** = ANNUAL ARITHMETIC MEAN (STANDARD = 0.03 PPM)



# Sulfur Dioxide ($SO_2$) Summary, Continued

**Summary of $SO_2$ Values**

The figures below present the 1999 data relative to the air quality standards. The 2nd-maximum value is displayed because it is the value that the 3-hour and 24-hour standards apply to. The highest 24-hour and 3- hour values occurred in Fall River, and the highest annual mean occurred at the Boston and Chelsea sites. All of the values were well within the air quality standards.

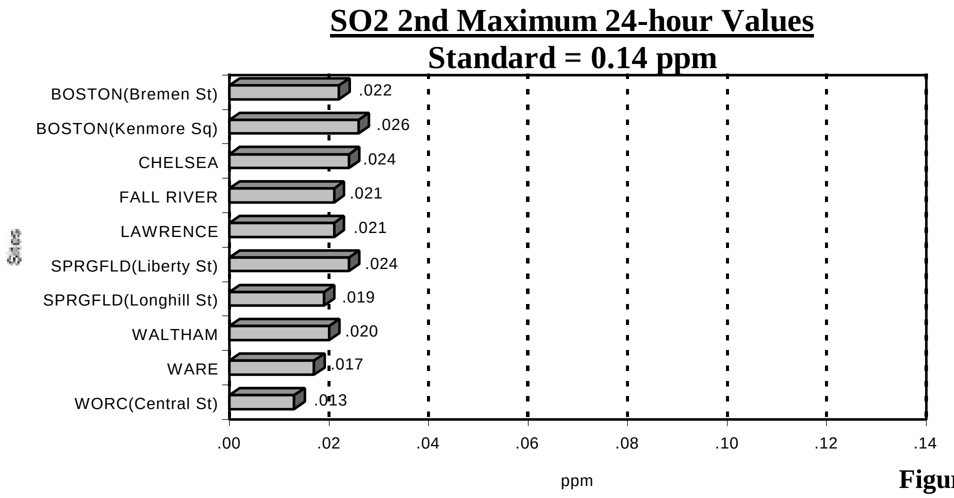



**Figure 25**

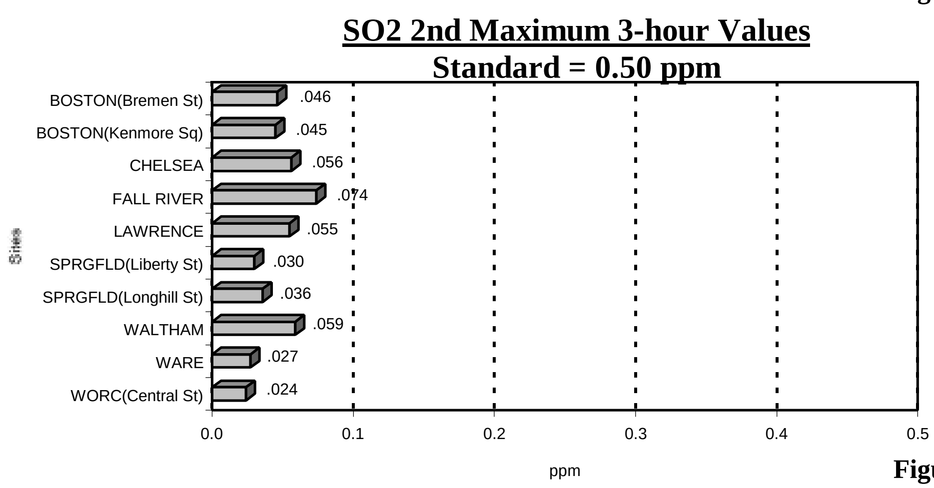



**Figure 26**

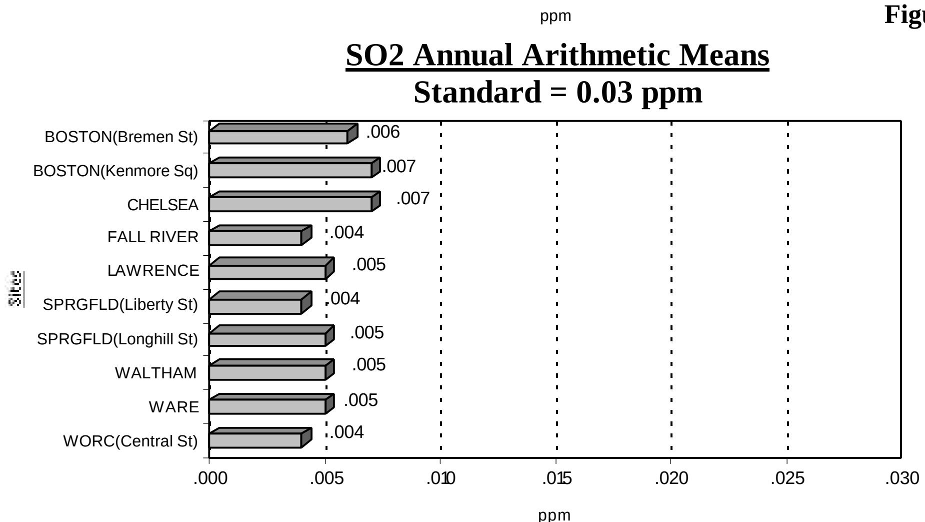


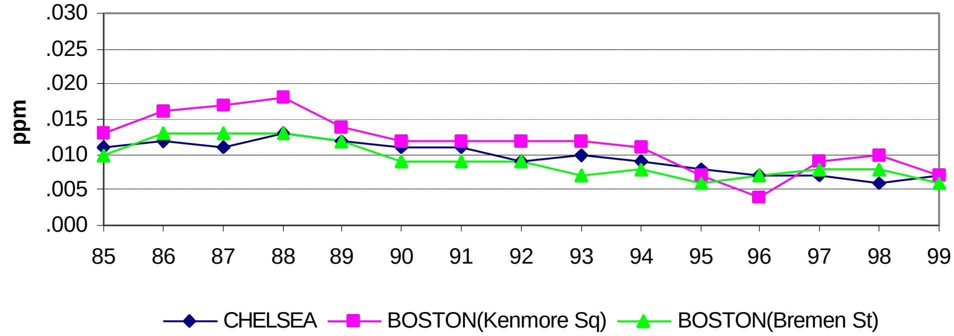

**Figure 27**

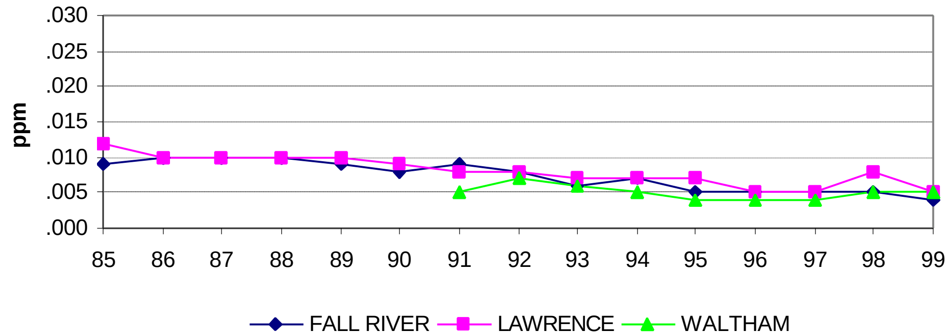
---

**$SO_2$ trends**

The long-term trends of the annual arithmetic mean for each $SO_2$ site are shown below. The trend has been stable the last few years and downward for the entire period. Massachusetts is well below the standard.

**<u>SO2 Trends 1985-1999</u>**
**Annual Arithmetic Means**
**Standard = 0.03 ppm**



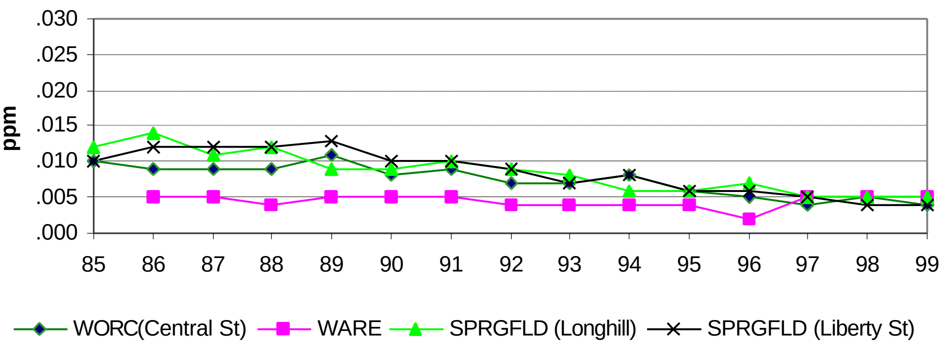




**Figure 28**

# Nitrogen Dioxide ($NO_2$) Summary

**Introduction**

There were thirteen $NO_2$ sites during 1999 in the state-operated monitoring network. A new site was established in Boston (Long Island) and at the end of the year the Chelsea site was shut down.

**$NO_2$ health effects and sources**

- $NO_2$ lowers resistance to respiratory infections and aggravates symptoms associated with asthma and bronchitis.
- $NO_2$ contributes to acid deposition. Impacts of acid deposition include:
  - acidification of lakes and streams
  - damage to vegetation
  - damage to materials
  - degradation of visibility
- $NO_2$ and NO contribute to the formation of ozone.
- $NO_2$ is formed from the oxidation of nitric oxide (NO). Major sources of NO are fuel combustion, heating and power plants, and motor vehicles.

**The $NO_2$ standard**

The National Ambient Air Quality Standard is listed below.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards -** designed to protect against damage to crops, vegetation, and buildings from air pollution.

| POLLUTANT | AVERAGING TIME* | PRIMARY | SECONDARY |
|---|---|---|---|
| **$NO_2$** | Annual Arithmetic Mean | 0.053 ppm 100 ug/m³ | Same as Primary Standard |

m**g/m³ =** micrograms per cubic meter **ppm =** parts per million **mg/m³ =** milligrams per cubic meter

*Continued on next page*

# Nitrogen Dioxide (NO2) Summary, Continued

**1999 $NO_2$ data summary**

Several sites did not meet the 75% data capture requirement. These monitors, located at PAMS (Photochemical Assessment Monitoring Stations), were closed September 1 when the PAMS season ended and were to be restarted with the start of $O_3$ season in 2000. They were closed so staff resources could be directed towards other projects.

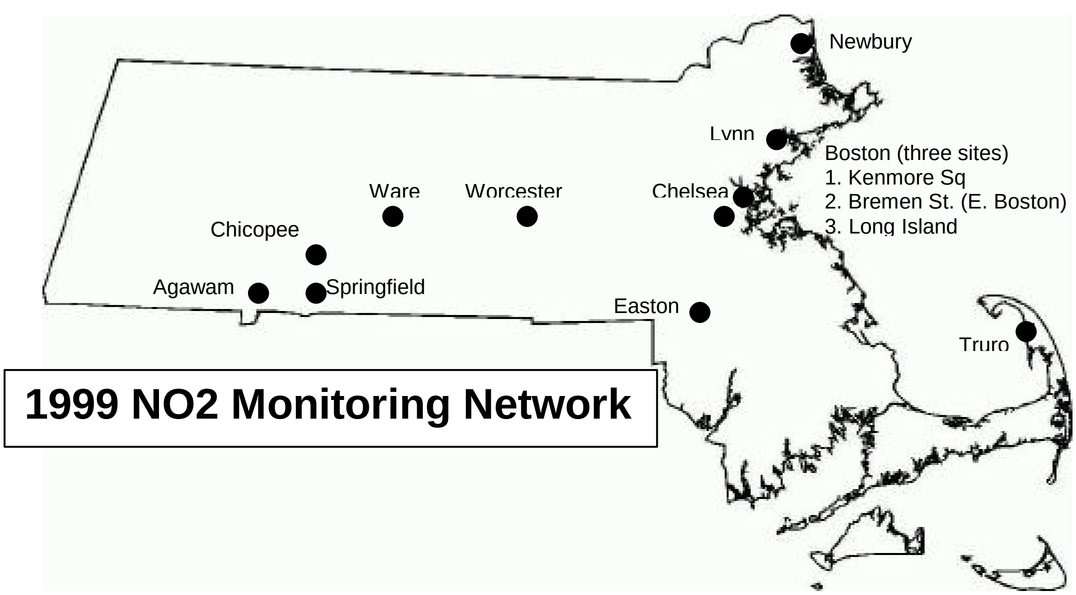
A summary of the 1999 data is listed below.

| SITE ID | P O C | M T | CITY | COUNTY | UNITS: PPM ADDRESS | % OBS | MAX 1ST | 1-HR 2ND | ARITH MEAN |
|---|---|---|---|---|---|---|---|---|---|
| 25-013-0003 | 1 | 8 | AGAWAM | HAMPDEN | 152 SOUTH WESTFIELD STREET | 55 | .060 | .056 | .008 |
| 25-025-0002 | 1 | 3 | BOSTON | SUFFOLK | KENMORE SQUARE | 93 | .093 | .093 | .030 |
| 25-025-0021 | 1 | 1 | BOSTON | SUFFOLK | 340 BREMEN STREET, EAST BOSTON | 85 | .117 | .103 | .027 |
| 25-025-0041 | 1 | 8 | BOSTON | SUFFOLK | LONG ISLAND HOSPITAL ROAD | 47 | .072 | .071 | .013? |
| 25-025-1003 | 1 | 1 | CHELSEA | SUFFOLK | POWDER HORN HILL | 86 | .082 | .074 | .021 |
| 25-013-0008 | 1 | 8 | CHICOPEE | HAMPDEN | ANDERSON ROAD AIR FORCE BASE | 63 | .101 | .063 | .012 |
| 25-005-1005 | 1 | 8 | EASTON | BRISTOL | 1 BORDERLAND ST. | 56 | .041 | .041 | .007? |
| 25-009-2006 | 1 | 8 | LYNN | ESSEX | 390 PARKLAND AVE. | 63 | .074 | .071 | .013? |
| 25-009-4004 | 1 | 8 | NEWBURY | ESSEX | SUNSET BOULEVARD | 56 | .047 | .045 | .006? |
| 25-013-0016 | 1 | 2 | SPRINGFIELD | HAMPDEN | LIBERTY STREET PARKING LOT | 92 | .141 | .106 | .022 |
| 25-001-0002 | 1 | 8 | TRURO | BARNSTABLE | FOX BOTTOM AREA-CAPE COD | 64 | .047 | .046 | .004? |
| 25-015-4002 | 1 | 8 | WARE | HAMPSHIRE | QUABBIN SUMMIT | 95 | .057 | .057 | .007 |
| 25-027-0020 | 1 | 2 | WORCESTER | WORCESTER | CENTRAL STREET FIRE STATION | 83 | .084 | .083 | .020 |

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER LESS THAN 75%)
TO CONVERT UNITS FROM PPM TO uG/M³ MULTIPLY PPM x 1880

Standard: Annual Arithmetic Mean = 0.053

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER; 7 = PAMS/NAMS; 8 = PAMS/SLAMS) **REP ORG** = REPORTING ORGANIZATION **% OBS** = DATA CAPTURE PERCENTAGE **MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **ARITH MEAN** = ANNUAL ARITHMETIC MEAN



# Nitrogen Dioxide ($NO_2$) Summary, Continued

**$NO_2$ data summary**

The figures below present the 1999 data relative to the air quality standard. There is no 1-hour $NO_2$ ambient air quality standard, but there is one for the annual arithmetic mean. The highest mean occurred in Boston and was well below the standard.

**NO2 Maximum 1-hour Values**
**(there is no federal standard)**

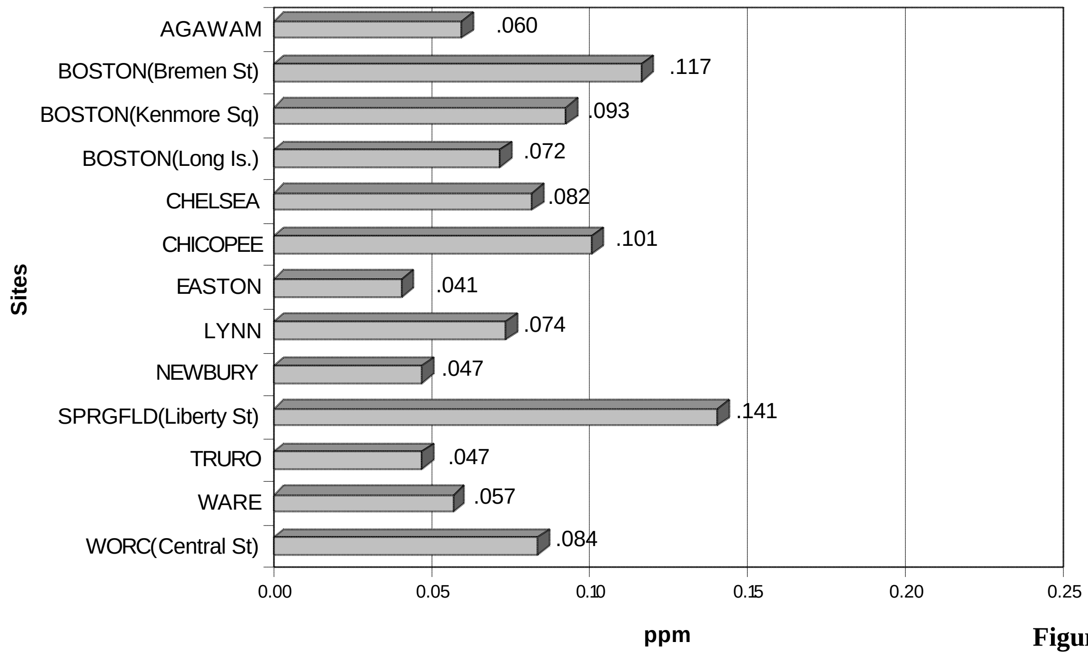



**Figure 29**

**NO2 Annual Arithmetic Means**
**Standard = 0.05 ppm**

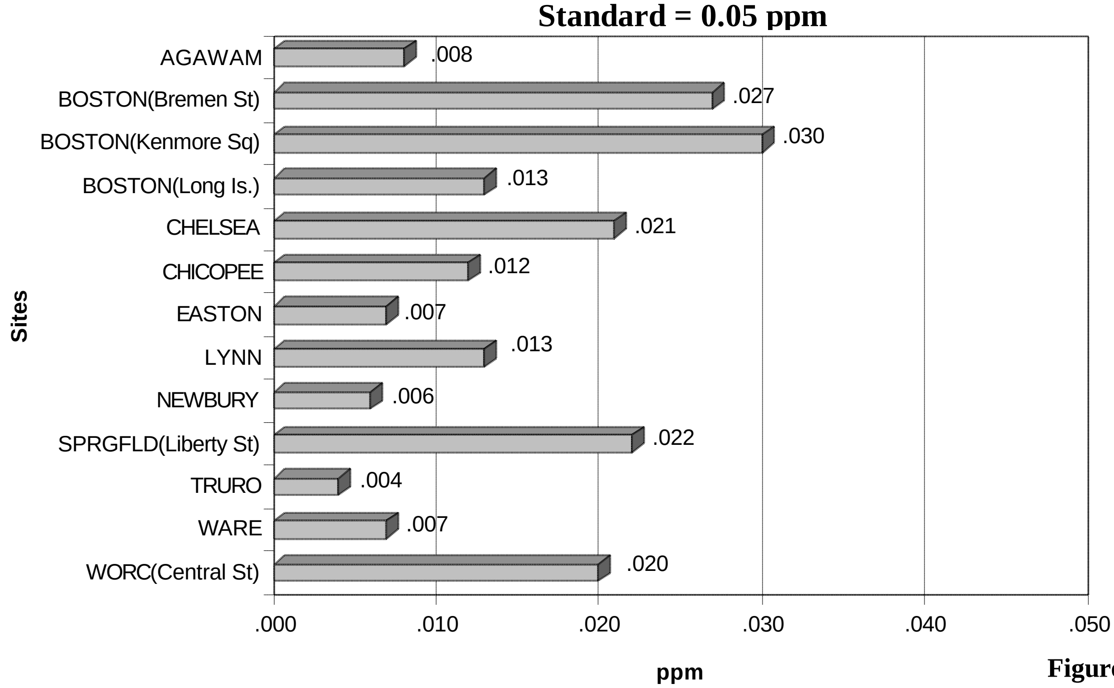



**Figure 30**

## **Nitrogen Dioxide ($NO_2$) Summary,** Continued

---

**$NO_2$ trends** The long-term trends of the annual arithmetic means for each $NO_2$ site are shown below. The trend has been stable the last few years and downward for the entire period. Massachusetts is below the standard.

**<u>NO2 Trends 1985-1999</u>**
**Annual Arithmetic Means**
**Standard = 0.05 ppm**

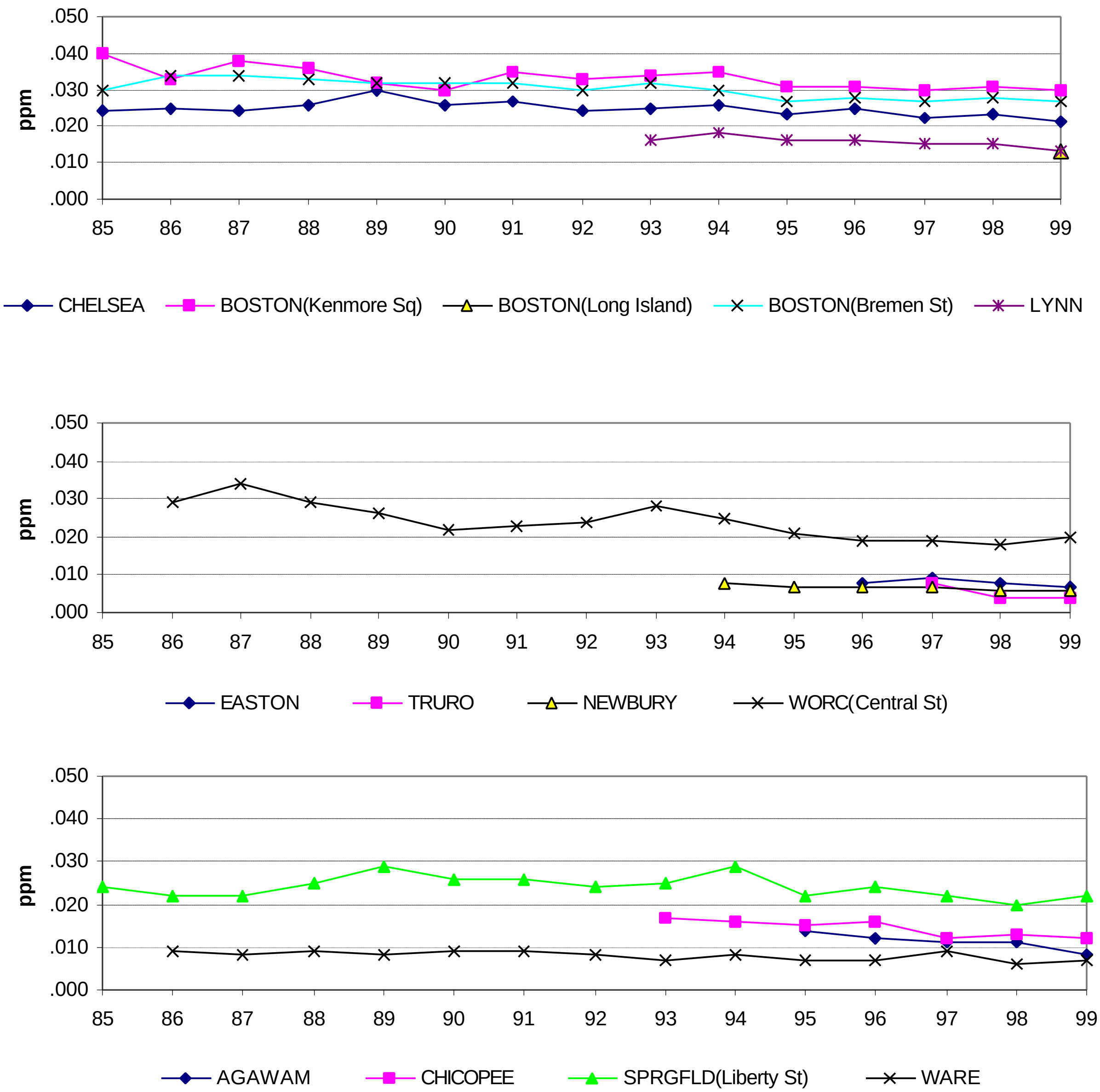



**Figure 31**

# Carbon Monoxide (CO) Summary

**Introduction**

There were nine CO sites during 1999 in the state-operated monitoring network. The Boston Sumner Tunnel site was closed on June 30.

**CO health effects and sources**

- CO reacts in the bloodstream with hemoglobin reducing oxygen carried to organs and tissues.
- The health threat is most severe for those with cardiovascular disease.
- Symptoms of high CO exposure include:
  •shortness of breath •chest pain •headaches •confusion •loss of coordination.
- High levels of CO are possible near parking lots and city streets with slow-moving cars.
- Motor vehicles are the largest source of CO, which is produced from incomplete combustion of carbon in fuels.

**The CO standard**

The National Ambient Air Quality Standard is listed below.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards -** designed to protect against damage to crops, vegetation, and buildings from air pollution.

| POLLUTANT | AVERAGING TIME* | PRIMARY | SECONDARY |
|---|---|---|---|
| **CO** | 8-Hour | 9 ppm (10 mg/$m^3$) | Same as Primary Standard |
| | 1-Hour | 35 ppm (40 mg/$m^3$) | Same as Primary Standard |

m**g/$m^3$ =** micrograms per cubic meter **ppm =** parts per million **mg/$m^3$ =** milligrams per cubic meter

***** Standards based upon averaging times other than the annual arithmetic mean must not be exceeded more than once a year.

*Continued on next page*

# Carbon Monoxide (CO) Summary, Continued

**1999 CO data summary**

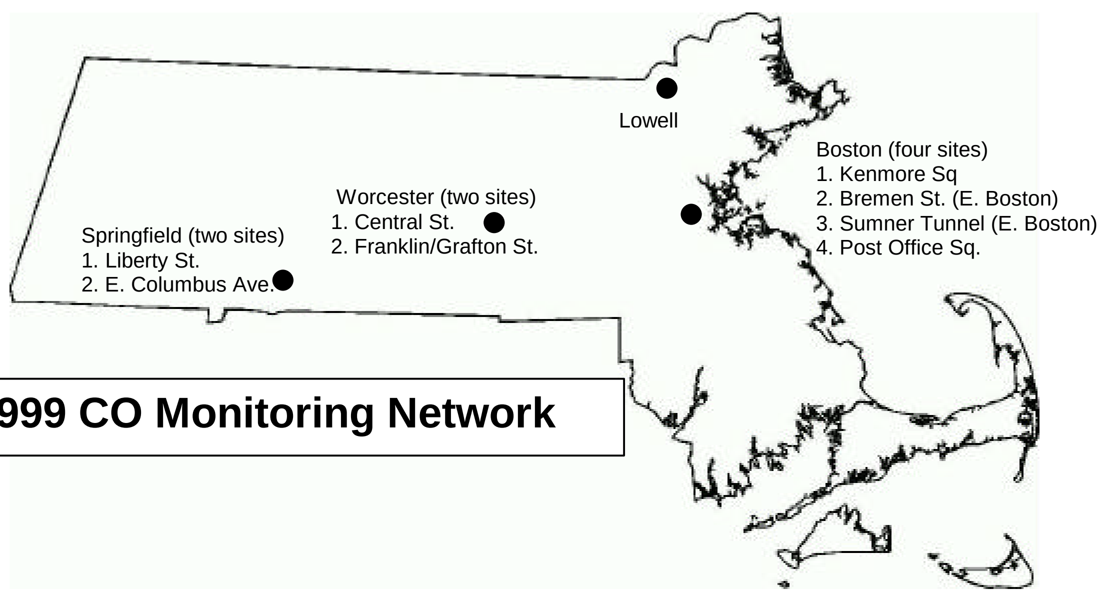
All of the sites achieved the requirement of 75% or greater data capture for the year except for the Boston Sumner Tunnel site, which closed on June 30.

A summary of the 1999 data is listed below.

| SITE ID | POC | MT | CITY | COUNTY | ADDRESS (UNITS: PPM) | % OBS | MAX 1-HR 1ST | MAX 1-HR 2ND | OBS > 35 | MAX 8-HR 1ST | MAX 8-HR 2ND | OBS > 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-025-0002 | 1 | 2 | BOSTON | SUFFOLK | KENMORE SQ., 590 COMM. AVE | 93 | 4.8 | 4.6 | 0 | 4.2 | 3.6 | 0 |
| 25-025-0016 | 1 | 2 | BOSTON | SUFFOLK | SUMNER TUNNEL, EAST BOSTON | 93 | 5.9 | 5.9 | 0 | 5.0 | 3.8 | 0 |
| 25-025-0021 | 1 | 1 | BOSTON | SUFFOLK | 340 BREMEN ST., E. BOSTON | 82 | 9.1 | 7.0 | 0 | 5.3 | 4.2 | 0 |
| 25-025-0038 | 1 | 1 | BOSTON | SUFFOLK | FEDERAL POST OFFICE BLDG | 93 | 4.6 | 4.4 | 0 | 3.5 | 3.3 | 0 |
| 25-017-0007 | 1 | 2 | LOWELL | MIDDLESEX | OLD CITY HALL, MERRIMACK ST | 91 | 8.6 | 8.4 | 0 | 4.2 | 4.2 | 0 |
| 25-013-0016 | 1 | 1 | SPRINGFIELD | HAMPDEN | LIBERTY STREET PARKING LOT | 93 | 5.1 | 5.0 | 0 | 4.1 | 4.0 | 0 |
| 25-013-2007 | 1 | 1 | SPRINGFIELD | HAMPDEN | EAST COLUMBUS AVENUE | 88 | 11.2 | 7.9 | 0 | 5.6 | 5.6 | 0 |
| 25-027-0020 | 1 | 2 | WORCESTER | WORCESTER | CENTRAL STREET FIRE STATION | 83 | 6.1 | 4.9 | 0 | 4.6 | 3.3 | 0 |
| 25-027-0022 | 1 | 2 | WORCESTER | WORCESTER | FRANKLIN/GRAFTON STREETS | 77 | 6.8 | 6.8 | 0 | 3.7 | 3.1 | 0 |

Standards: 1-hour = 35 ppm 8-hour = 9 ppm

**ABBREVIATIONS AND SYMBOLS USED IN TABLE 15**
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER) **% OBS** = DATA CAPTURE PERCENTAGE **MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **OBS > 35** = NUMBER OF 1-HR AVG. GREATER THAN 35 PPM (1-HR STANDARD) **OBS > 9** = NUMBER OF 8-HR AVG. GREATER THAN 9 PPM (8-HR STD)




## 1999 CO Monitoring Network

**CO data summary**

The figures below present the 1999 data relative to the air quality standards. The 2nd-maximum value is displayed because it is the value that the standards apply to. The highest 1-hour value occurred in Lowell and the highest 8-hour value occurred in Springfield. Both were well within the standard.

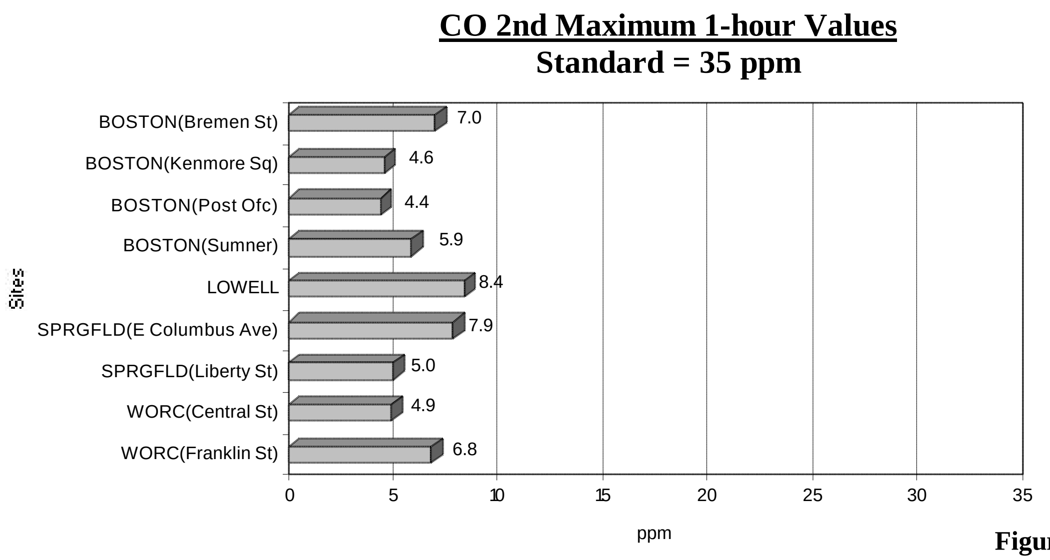



**Figure 32**

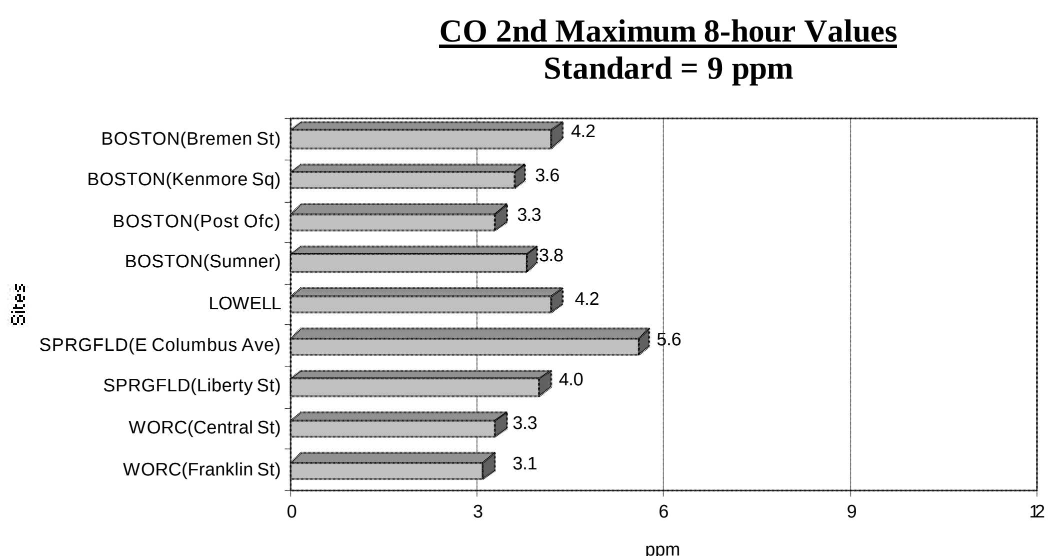
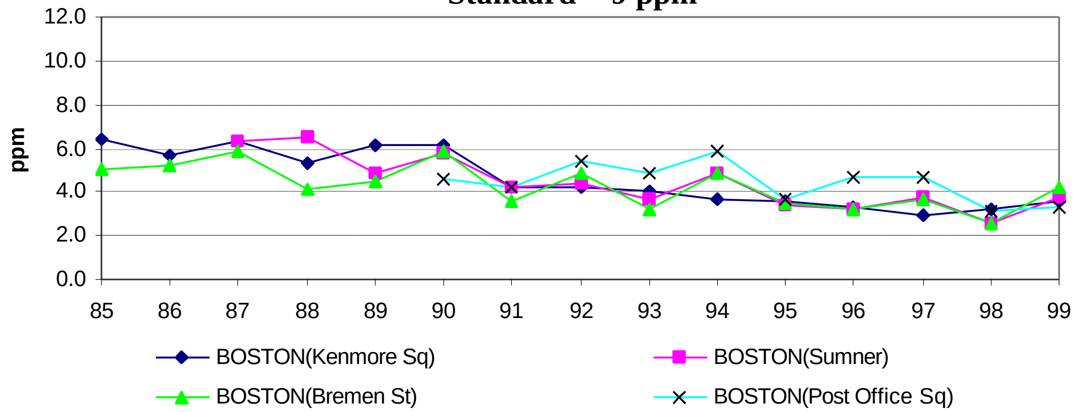


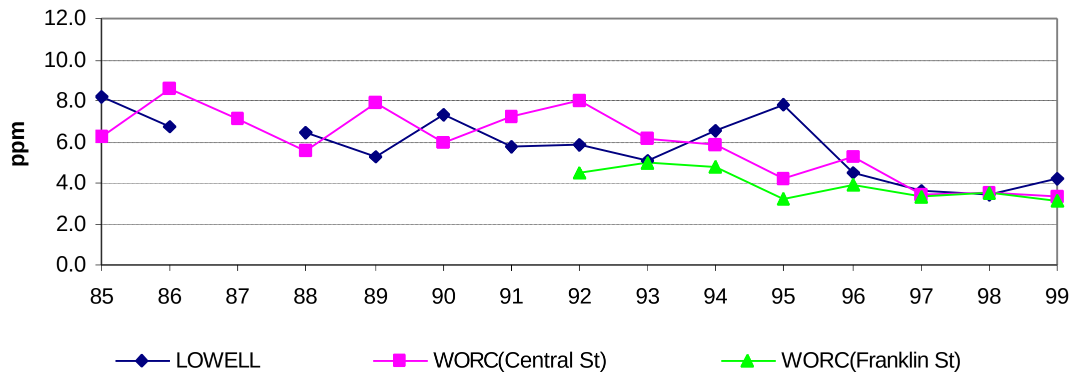

**Figure 33**

**CO trends**

The long-term trends of the 2nd-maximum 8-hour value for each CO site are shown below. The data shows a yearly variability at most sites, with the overall trend being downward. Massachusetts is below the standard.

**CO Trends 1985-1999**
**2nd Maximum 8-hour Values**
**Standard = 9 ppm**



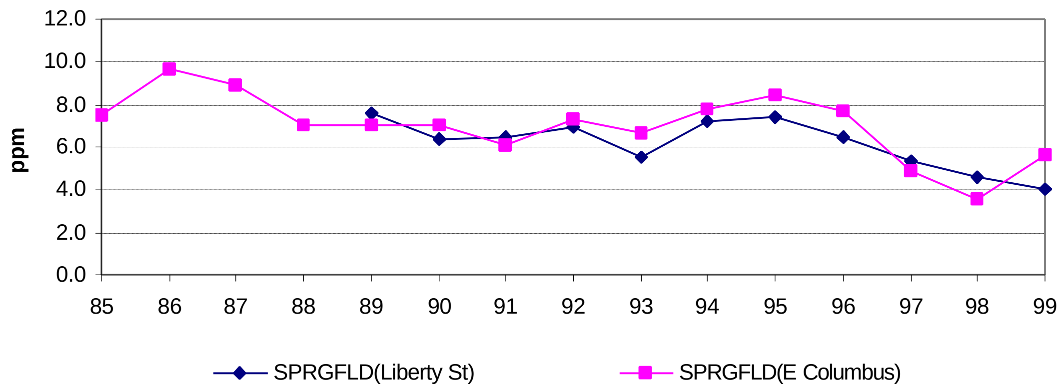




**Figure 34**

# Particulate Matter 10-Microns ($PM_{10}$) Summary

**Introduction**

There were eight $PM_{10}$ sites (three sites had collocated monitors) during 1999 in the state-operated monitoring network. The network was trimmed from the sixteen sites operated during 1998. Those areas that had sites closed are now represented in the $PM_{2.5}$ network.

**Particulate matter health effects**

- Particulate matter is tiny airborne particles or aerosols, which include dust, dirt, smoke, and liquid droplets.
- The numbers, 2.5 and 10, refer to the particle size, measured in microns, which are collected by the monitors. Several thousand $PM_{2.5}$ particles could fit on the period at the end of this sentence.
- The small size of the particles allows entry into the respiratory system. Long-term exposure allows the particles to accumulate in the lungs and affects breathing and respiratory symptoms.
- Particulate matter causes soiling and corrosion to materials.
- Particulate matter contributes to atmospheric haze that degrades visibility.
- Sources include industrial process emissions, motor vehicles, incinerators, heat and power plants, and motor vehicles.

**The $PM_{10}$ standard**

The National Ambient Air Quality Standard is listed below.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards -** designed to protect against damage to crops, vegetation, and buildings from air pollution.

| POLLUTANT | AVERAGING TIME* | PRIMARY | SECONDARY |
|---|---|---|---|
| **$PM_{10}$** Particulates up to 10 microns in size | Annual Arithmetic Mean | 50 ug/m$^3$ | Same as Primary Standard |
| | 24-Hour | 150 ug/m$^3$ | Same as Primary Standard |

- The $PM_{10}$ standard is based upon estimated exceedance calculations described in 40CFR Part 50, Appendix K.
- The annual standard is met if the estimated annual arithmetic mean does not exceed 50 ug/m$^3$.
- The 24-hour standard is attained if the estimated number of days per calendar year above 150 ug/m$^3$ does not exceed one per year.

**mg/m³ =** micrograms per cubic meter **ppm =** parts per million **mg/m³ =** milligrams per cubic meter

***** Standards based upon averaging times other than the annual arithmetic mean must not be exceeded more than once a year.

*Continued on next page*

# Particulate Matter 10-Microns (PM10) Summary, Continued

**1999 $PM_{10}$ data summary**

Six out of the eight sites achieved the requirement of 75% or greater data capture for each calendar quarter. Sampler failures caused one quarter not to achieve the data capture requirement at the Boston (Columbus Ave.) and Worcester sites.

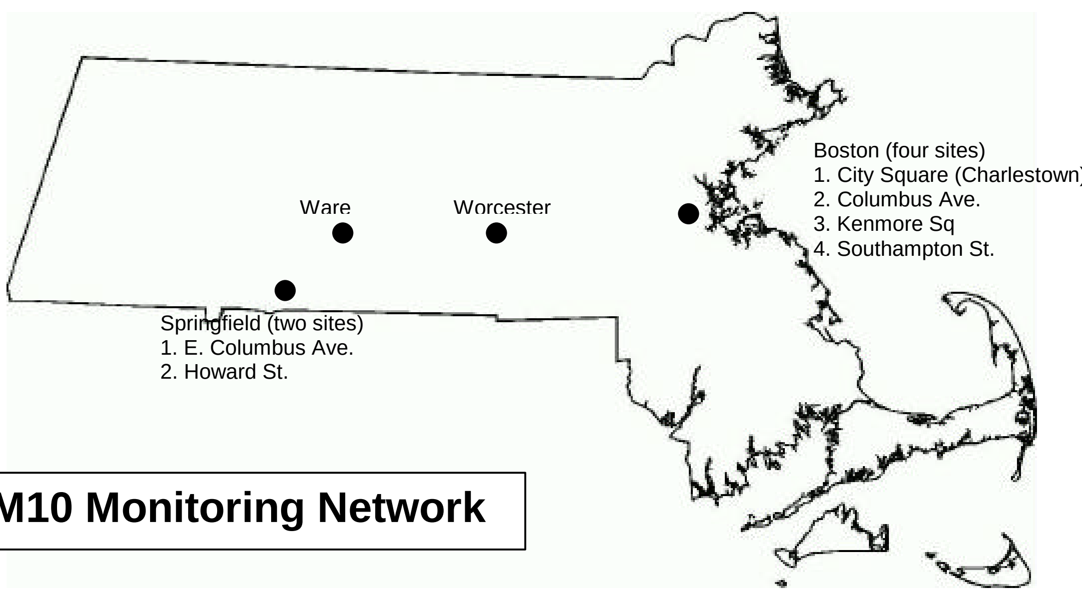
A summary of the 1999 data is listed below.

| SITE ID | POC | MT | CITY | COUNTY | ADDRESS (UNITS: UG/CU METER) | % OBS | MAX 24 HR VALUE 1ST | 2ND | 3RD | 4TH | VALS MEAS | > 150 EST | WTD ARITH MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-025-0002 | 1 | 1 | BOSTON | SUFFOLK | KENMORE SQUARE | 95 | 70 | 58 | 51 | 50 | 0 | 0.00 | 30 |
| 25-025-0012 | 1 | 1 | BOSTON | SUFFOLK | 115 SOUTHAMPTON ST. | 93 | 68 | 65 | 49 | 49 | 0 | 0.00 | 24 |
| 25-025-0012 | 2 | 3 | BOSTON | SUFFOLK | 115 SOUTHAMPTON ST. | 88 | 68 | 47 | 46 | 42 | 0 | 0.00 | 24 |
| 25-025-0024 | 1 | 1 | BOSTON | SUFFOLK | 200 COLUMBUS AVE. | 87 | 61 | 50 | 39 | 39 | 0 | 0.00 | 24? |
| 25-025-0027 | 1 | 1 | BOSTON | SUFFOLK | ONE CITY SQUARE | 92 | 70 | 64 | 51 | 49 | 0 | 0.00 | 30 |
| 25-025-0027 | 3 | 3 | BOSTON | SUFFOLK | ONE CITY SQUARE | 75 | 71 | 60 | 56 | 51 | 0 | 0.00 | 32? |
| 25-013-0011 | 2 | 2 | SPRINGFIELD | HAMPDEN | 59 HOWARD STREET | 92 | 64 | 59 | 46 | 45 | 0 | 0.00 | 21 |
| 25-013-2007 | 1 | 1 | SPRINGFIELD | HAMPDEN | EAST COLUMBUS AVE. | 95 | 69 | 61 | 57 | 55 | 0 | 0.00 | 29 |
| 25-013-2007 | 3 | 3 | SPRINGFIELD | HAMPDEN | EAST COLUMBUS AVE. | 85 | 67 | 66 | 52 | 51 | 0 | 0.00 | 30 |
| 25-015-4002 | 1 | 2 | WARE | HAMPSHIRE | QUABBIN SUMMIT | 93 | 55 | 42 | 36 | 31 | 0 | 0.00 | 14 |
| 25-027-0016 | 1 | 1 | WORCESTER | WORCESTER | 2 WASHINGTON ST. | 88 | 66 | 65 | 58 | 47 | 0 | 0.00 | 21? |

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER LESS THAN 75%)

Standards: 24-hour = 150 µg/m³  Annual Arithmetic Mean = 50 µg/m³

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER) **% OBS** = DATA CAPTURE PERCENTAGE **MAXIMUM VALUE 1ST, 2ND, 3RD, 4TH** = 1ST, 2ND, 3RD, AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR **VALS > 150 MEAS** = NUMBER OF VALUES GREATER THAN 150 µg/m³ (PM-10 STANDARD) **VALS > 150 EST** = NUMBER OF EXPECTED VIOLATIONS **WTD ARITH MEAN** = WEIGHTED ANNUAL ARITHMETIC MEAN (STANDARD = 50 µg/m³) **?** = INDICATES THAT NUMBER OF OBSERVATIONS WERE INSUFFICIENT TO CALCULATE MEAN. THE DATA CAPTURE AT A SITE MUST EXCEED 75% FOR EACH QUARTER.




**1999 PM10 Monitoring Network**

# Particulate Matter 10-Microns ($PM_{10}$) Summary, Continued

**$PM_{10}$ data summary**

The figures below present the 1999 data relative to the air quality standards. The highest 24-hour and annual arithmetic mean values each occurred in Boston. Both were well within the standards.

**PM10 2nd Maximum 24-hour Values**
**Standard – 150 ug/m3**

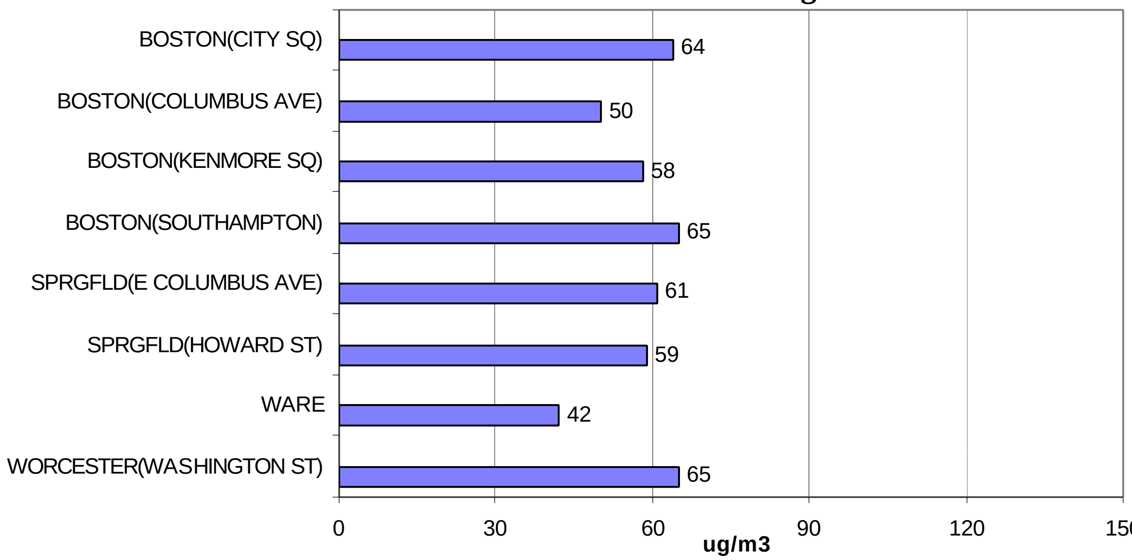



**Figure 35**

**PM10 Annual Arithmetic Mean**
**Standard – 50 ug/m3**

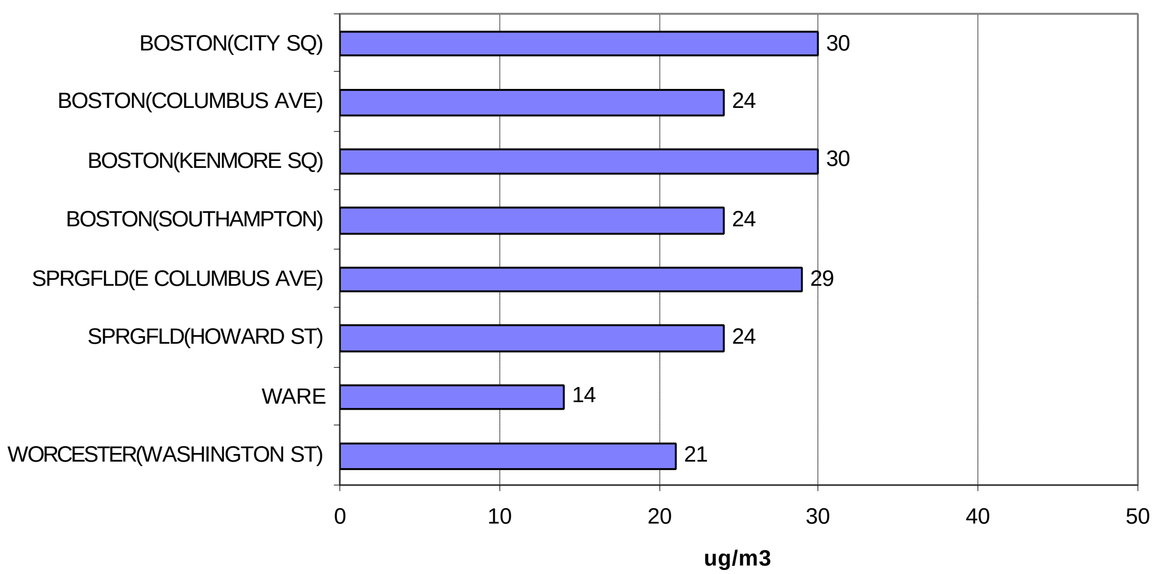



**Figure 36**

# Particulate Matter 10-Microns ($PM_{10}$) Summary, Continued

**$PM_{10}$ trends** $PM_{10}$ long-term trends are shown of the annual arithmetic mean for each $PM_{10}$ site. The data shows a yearly variability at most sites, with the overall trend downward.

**PM10 Trends 1989-1999**
**Annual Arithmetic Mean**
**Standard = 50 ug/m3**

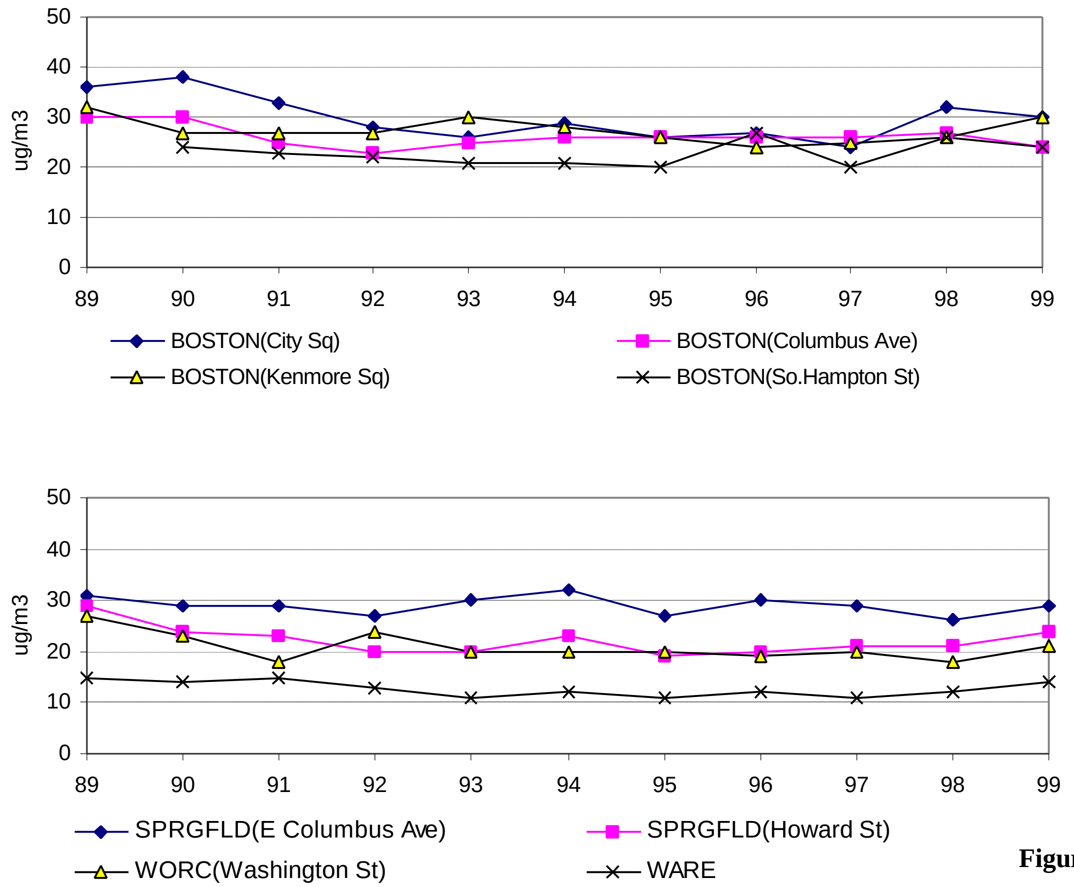



**Figure 37**

# Particulate Matter 2.5-Microns ($PM_{2.5}$) Summary

**Introduction**

The $PM_{2.5}$ monitoring network was set up during late 1998 and monitoring began in January 1999. There were eighteen $PM_{2.5}$ sites (four sites had collocated monitors) during 1999 in the state-operated monitoring network.

**The evolution of the particulate standard**

On a periodic basis USEPA conducts a review of the national ambient air quality standards (NAAQS). The process includes a compilation and scientific assessment of all the health and environmental effects information available. The information that is gathered undergoes detailed reviews by the scientific community, industry, public interest groups, the general public, and the Clean Air Scientific Advisory Committee (CASAC) – a Congressionally mandated group of independent scientific and technical experts. Based on the scientific assessments and taking into account the recommendations of CASAC, the EPA administrator decides whether or not it is appropriate to revise the standards.

The particulate matter standard has evolved over the years as new studies have been published on the health effects of particulate matter. The trend has been to control particulates of smaller sizes and to more stringent concentrations, as studies have linked exposure to fine particles with adverse health effects.

- 1970 – The standard is based on Total Suspended Particulates (TSP). The standards were set at 260 $ug/m^3$ (24-hours) and 75 $ug/m^3$ (annual geometric mean).
- 1987 – The TSP standard is replaced by the $PM_{10}$ standard (particulate matter less than 10 microns in size). The $PM_{10}$ standards are set at 150 $ug/m^3$ (24-hours) and 50 $ug/m^3$ (annual arithmetic mean).
- 1997 – The $PM_{2.5}$ standard (particulate matter less than 2.5 microns) is promulgated in addition to the $PM_{10}$ standard. The $PM_{2.5}$ standards are set at 65 $ug/m^3$ (24-hours) and 15 $ug/m^3$ (annual arithmetic mean).
- 2000: - The US Supreme Court will hear oral arguments in USEPA's appeal of the Washington D.C. Circuit Court of Appeals May 1999 decision. The main question is whether setting a NAAQS under the Clean Air Act (CAA) is an unconstitutional delegation of power by Congress. Also up for review is whether USEPA is required to take costs into account in setting the NAAQS.

**A concern in using the 1999 $PM_{2.5}$ data**

The collection of $PM_{2.5}$ data during 1999 was a challenging task. The methodology for collecting the data was new and to a certain degree untested. Trouble-shooting and fine-tuning were necessary as different problems were encountered. One such problem revealed that the measured concentrations of $PM_{2.5}$ may be biased higher (by up to 2 $\mu g/m^3$) because of possible contamination of the sample filter from the filter cassette holder. The magnitude and frequency of the problem diminished as the year progressed. The data was submitted to USEPA along with a flag to identify the suspected concern with the data.

Designation of Massachusetts for the $PM_{2.5}$ standard will be based on three years of data. The use of the 1999 $PM_{2.5}$ data for designation purposes will take into consideration the concerns about the data's quality.

*Continued on next page*

**Particulate matter health effects**

- Particulate matter is tiny airborne particles or aerosols, which include dust, dirt, smoke, and liquid droplets.
- The numbers, 2.5 and 10, refer to the particle size, measured in microns, which are collected by the monitors. Several thousand $PM_{2.5}$ particles could fit on the period at the end of this sentence.
- The small size of the particles allows entry into the respiratory system. Long-term exposure allows the particles to accumulate in the lungs and affects breathing and respiratory symptoms.
- Particulate matter causes soiling and corrosion to materials.
- Particulate matter contributes to atmospheric haze that degrades visibility.
- Sources include industrial process emissions, motor vehicles, incinerators, heat and power plants, and motor vehicles.

**The $PM_{2.5}$ standard**

The National Ambient Air Quality Standard is listed below. Designation for the $PM_{2.5}$ standard requires 3 years of data. 1999 was the first year of monitoring.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards -** designed to protect against damage to crops, vegetation, and buildings from air pollution.

| POLLUTANT | AVERAGING TIME | PRIMARY | SECONDARY |
|---|---|---|---|
| **$PM_{2.5}$** Particulates up to 2.5 microns in size | Annual Arithmetic Mean | 15.0 ug/m³ | Same as Primary Standard |
| | 24-Hour | 65 ug/m³ | Same as Primary Standard |

- The annual standard is met when the annual average of the quarterly mean $PM_{2.5}$ concentrations is less than or equal to 15 ug/m³ (3-year average). If spatial averaging is used, the annual average from all monitors within the area may be averaged in the calculation of the 3-year mean.
- The 24-hour standard is met when 98th percentile value is less than or equal to 65 ug/m³ (3-year average).

m**g/m³ =** micrograms per cubic meter **ppm =** parts per million **mg/m³ =** milligrams per cubic meter

*Continued on next page*

# Particulate Matter 2.5-Microns (PM2.5) Summary, Continued

**1999 $PM_{2.5}$ data summary**

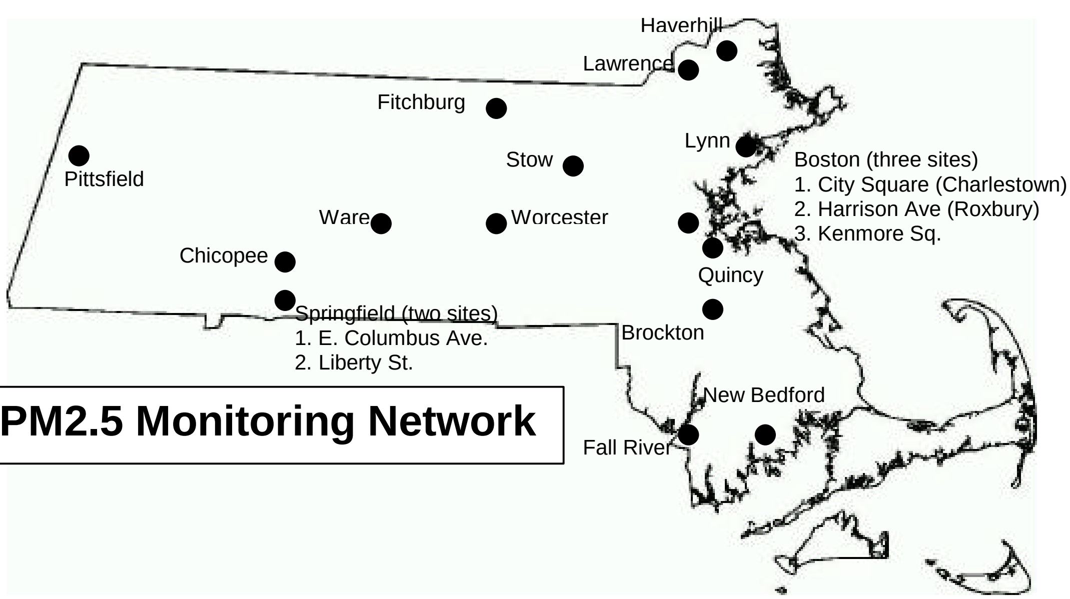
A summary of the 1999 data is listed below. Designation for the $PM_{2.5}$ standard requires 3 years of data. 1999 was the first year of monitoring. All of the 1999 data was flagged and the concentrations may be biased high. See page 63 for more details.

| SITE ID | POC | MT | CITY | COUNTY | ADDRESS (UNITS: UG/CU METER) | % OBS | -MAX 24 HR –VALUE- 1ST | 2ND | 3RD | 4TH | ARITH MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-025-0002 | 1 | 2 | BOSTON | SUFFOLK | KENMORE SQUARE | 90 | 50.1 | 47.6 | 37.0 | 36.8 | 14.88 |
| 25-025-0027 | 1 | 2 | BOSTON | SUFFOLK | ONE CITY SQUARE | 92 | 49.1 | 40.5 | 34.5 | 34.3 | 15.39 |
| 25-025-0027 | 2 | 3 | BOSTON | SUFFOLK | ONE CITY SQUARE | 52 | 49.6 | 34.3 | 31.5 | 30.9 | 15.42? |
| 25-025-0042 | 1 | 2 | BOSTON | SUFFOLK | HARRISON AVENUE | 54 | 50.8 | 37.9 | 30.2 | 29.7 | 11.51? |
| 25-023-0004 | 1 | 2 | BROCKTON | PLYMOUTH | 120 COMMERCIAL ST. | 84 | 42.4 | 36.3 | 26.0 | 25.8 | 11.27 |
| 25-023-0004 | 2 | 3 | BROCKTON | PLYMOUTH | 120 COMMERCIAL ST. | 69 | 43.7 | 39.9 | 29.7 | 27.0 | 12.15 |
| 25-013-0008 | 1 | 2 | CHICOPEE | HAMPDEN | ANDERSON ROAD | 50 | 39.2 | 27.6 | 27.3 | 27.2 | 9.90? |
| 25-005-3001 | 1 | 2 | FALL RIVER | BRISTOL | CENTRAL FIRE STATION | 93 | 38.1 | 37.9 | 36.0 | 32.5 | 11.79 |
| 25-027-2004 | 1 | 2 | FITCHBURG | WORCESTER | 67 RINDGE ROAD | 82 | 45.2 | 34.5 | 24.2 | 23.8 | 9.45 |
| 25-009-5005 | 1 | 2 | HAVERHILL | ESSEX | WASHINGTON STREET | 86 | 70.1 | 46.9 | 42.3 | 40.7 | 12.09 |
| 25-009-6001 | 1 | 2 | LAWRENCE | ESSEX | 37 SHATTUCK ST | 79 | 51.0 | 31.3 | 29.3 | 23.8 | 10.98? |
| 25-009-2006 | 1 | 2 | LYNN | ESSEX | 390 PARKLAND AVE. | 82 | 46.4 | 33.0 | 33.0 | 27.7 | 11.26 |
| 25-005-2004 | 1 | 2 | NEW BEDFORD | BRISTOL | YMCA,25 WATER ST. | 93 | 36.0 | 35.2 | 30.0 | 29.6 | 12.11 |
| 25-003-5001 | 1 | 2 | PITTSFIELD | BERKSHIRE | 78 CENTER STREET | 85 | 64.8 | 48.7 | 47.7 | 37.0 | 12.92 |
| 25-021-0007 | 1 | 2 | QUINCY | QUINCY | HANCOCK STREET | 95 | 46.6 | 29.9 | 29.1 | 28.2 | 12.20 |
| 25-021-0007 | 2 | 3 | QUINCY | QUINCY | HANCOCK STREET | 32 | 23.1 | 22.9 | 20.9 | 19.9 | 9.73? |
| 25-013-0016 | 1 | 2 | SPRINGFIELD | HAMPDEN | LIBERTY STREET | 98 | 47.7 | 47.6 | 41.1 | 39.3 | 14.67 |
| 25-013-0016 | 2 | 3 | SPRINGFIELD | HAMPDEN | LIBERTY STREET | 83 | 47.7 | 42.4 | 41.4 | 35.6 | 13.52 |
| 25-013-2007 | 1 | 2 | SPRINGFIELD | HAMPDEN | EAST COLUMBUS AVE. | 91 | 47.4 | 47.0 | 46.8 | 43.8 | 14.55 |
| 25-017-1102 | 1 | 2 | STOW | MIDDLESEX | US MILITARY RESERVAT. | 79 | 29.5 | 29.2 | 26.8 | 25.8 | 9.60 |
| 25-015-4002 | 1 | 2 | WARE | HAMPSHIRE | QUABBIN SUMMIT | 93 | 45.6 | 41.7 | 31.1 | 25.1 | 9.02 |
| 25-027-0020 | 1 | 2 | WORCESTER | WORCESTER | CENTRAL STREET | 95 | 49.1 | 35.5 | 35.5 | 35.5 | 13.38 |
| 25-027-0020 | 2 | 3 | WORCESTER | WORCESTER | CENTRAL STREET | 86 | 47.3 | 40.0 | 37.0 | 36.1 | 13.37 |

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER LESS THAN 75%)

Standards (based on 3-year averages): 24-hours = 65 $\mu g/m^3$ Annual Arithmetic Mean = 15.0 $\mu g/m^3$

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (1 = NAMS, 2 = SLAMS, 3 = OTHER) **% OBS** = DATA CAPTURE PERCENTAGE **MAXIMUM VALUE 1ST, 2ND, 3RD, 4TH** = 1ST, 2ND, 3RD, AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR **WTD ARITH MEAN** = WEIGHTED ANNUAL ARITHMETIC MEAN (STANDARD = 15.0 $\mu g/m^3$) **?** = INDICATES THAT NUMBER OF OBSERVATIONS WERE INSUFFICIENT TO CALCULATE MEAN. THE DATA CAPTURE AT A SITE MUST EXCEED 75% FOR EACH QUARTER.




**1999 PM2.5 Monitoring Network**

# Lead (Pb) Summary

**Introduction**

As required by the USEPA, lead monitoring was reinstituted in 1998 after being discontinued in July 1995. The concentrations monitored are very low. The use of unleaded gasoline has greatly diminished lead emissions, since the primary source for airborne lead is motor vehicles.

**Lead health effects**

- Exposure to lead may occur by inhalation or ingestion of food, water, soil or dust particles.
- Children and fetuses are more susceptible to the effects of lead exposure.
- Lead causes mental retardation, brain damage, and liver disease. It may be a factor in high blood pressure and damages the nervous system.
- The primary source for airborne lead used to be motor vehicles, but the use of unleaded gasoline has greatly reduced those emissions. Other sources are lead smelters and battery plants.

**The Lead standard**

The National Ambient Air Quality Standard is listed below.

- **Primary Standards** – designed to protect public health against adverse health effects with a margin of safety.
- **Secondary Standards -** designed to protect against damage to crops, vegetation, and buildings from air pollution.

| POLLUTANT | AVERAGING TIME | PRIMARY | SECONDARY |
|---|---|---|---|
| **Pb** | Calendar Quarter Arithmetic Mean | 1.5 ug/m³ | Same as Primary Standard |

m**g/m³ =** micrograms per cubic meter **ppm =** parts per million **mg/m³ =** milligrams per cubic meter

*Continued on next page*

# Lead (Pb) Summary, Continued

**1999 Pb data summary**

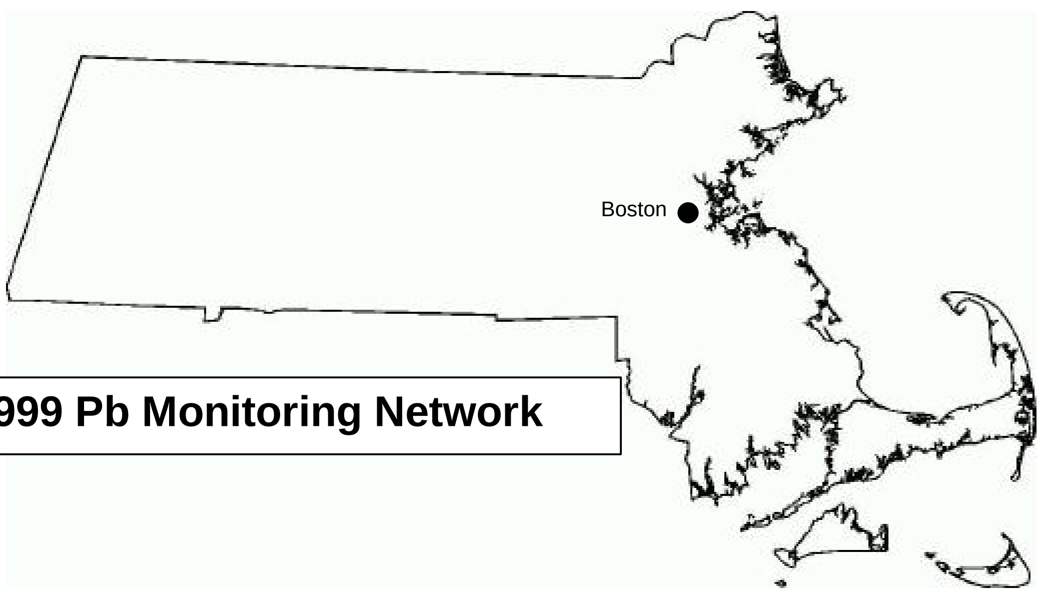
A summary of the 1999 data is listed below.

| SITE ID | POC | MT | CITY | COUNTY | ADDRESS (UNITS: UG/CU METER) | % OBS | QUARTERLY ARITH MEANS 1ST | 2ND | 3RD | 4TH | MEANS >1.5 | MAX VALUES 1ST | 2ND |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-025-0002 | 1 | 1 | BOSTON | SUFFOLK | KENMORE SQ. | 98 | .01 | .01 | .02 | .03 | 0 | .09 | .09 |

? INDICATES THAT THE MEAN DOES NOT SATISFY SUMMARY CRITERIA (NUMBER OF OBSERVATIONS FOR AT LEAST 1 QUARTER < 75%)

Standard: 1.5 $\mu g/m^3$ (Calendar Quarter Arithmetic Mean)

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (2 = SLAMS, 3 = OTHER) **% OBS** = DATA CAPTURE PERCENTAGE **QUARTERLY ARITH MEANS 1ST,2ND,3RD,4TH** = THE MEANS FOR THE 1ST,2ND,3RD AND 4TH CALENDAR QUARTERS **MEANS > 1.5** = THE NUMBER OF CALENDAR QUARTER MEANS GREATER THAN THE STANDARD (1.5 UG/M3) **MAX VALUES 1ST, 2ND** = THE 1ST & 2ND MAXIMUM 24 HOUR VALUES




**1999 Pb Monitoring Network**

# Acid Deposition

**What is acid deposition?**

Acid deposition occurs when acidic substances fall to the earth's surface from the atmosphere. The emissions of sulfur dioxide ($SO_2$) and the oxides of nitrogen ($NO_x$) react in the atmosphere with water and oxygen to form acidic compounds such as sulfuric acid and nitric acid. These compounds are returned to the earth in precipitation (such as rain, snow or fog), or in dry form as gas and particles.

**Effects of acid deposition**

Acid deposition causes acidification of surface waters, which jeopardizes the aquatic ecosystem, diminishing and in some cases eradicating fish species. It contributes to forest degradation and also affects soils, which affects the yields of some crops. The formation of the acidic particles in the atmosphere leads to haze and visibility reduction. Acid deposition also is responsible for the corrosion and deterioration of materials and buildings through its effect on stone, metals and paints.

**Monitoring in Massachusetts**

The MADEP site located in Waltham is part of the National Atmospheric Deposition Program (NADP). The NADP also operates sites in Truro and Ware. The NADP is a cooperative effort that consists of a nationwide network of over 200 precipitation monitoring sites. The NADP has a web site at http://nadp.sws.uiuc.edu/.

Precipitation is collected on a weekly basis and sent to a central lab where it is analyzed for compounds including sulfate ($SO_4$), nitrate ($NO_3$), and hydrogen (acidity as pH).

**Acid deposition trends**

Figure 38 shows the trend for the pH of precipitation, which is an indicator of acidity. The long-term trend shows the pH is increasing, and therefore less acidic, which means the precipitation is less harmful to the environment.

Distilled water that has equilibrated with carbon dioxide (CO2) in the laboratory has a pH of 5.6. Monitoring conducted by the National Oceanic and Atmospheric Administration (NOAA) at remote sites around the world shows a pH in the 5.0 range. Since pH is on a logarithmic scale, Massachusetts precipitation is 5 to 10 times more acidic than unpolluted precipitation.

**Precipitation pH Trend 1985 - 1999**
**(data represents the average of the Truro, Waltham and Ware sites)**

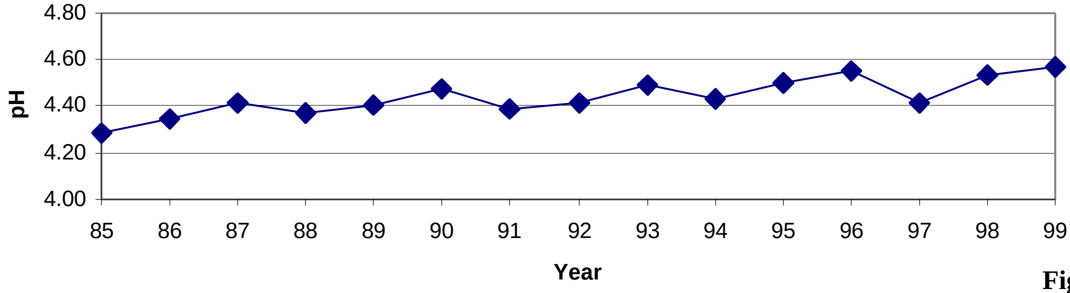



**Figure 38**

*Continued on next page*

**Acid deposition trends,** Continued

Figure 39 shows the long-term trends for nitrate ($NO_3$) and sulfate ($SO_4$), which result from the emissions of sulfur dioxide ($SO_2$) and oxides of nitrogen ($NO_x$) into the atmosphere. These compounds are harmful to the quality of surface waters. $SO_4$ increases acidity, and $NO_3$ increases acidity and can cause algae blooms.

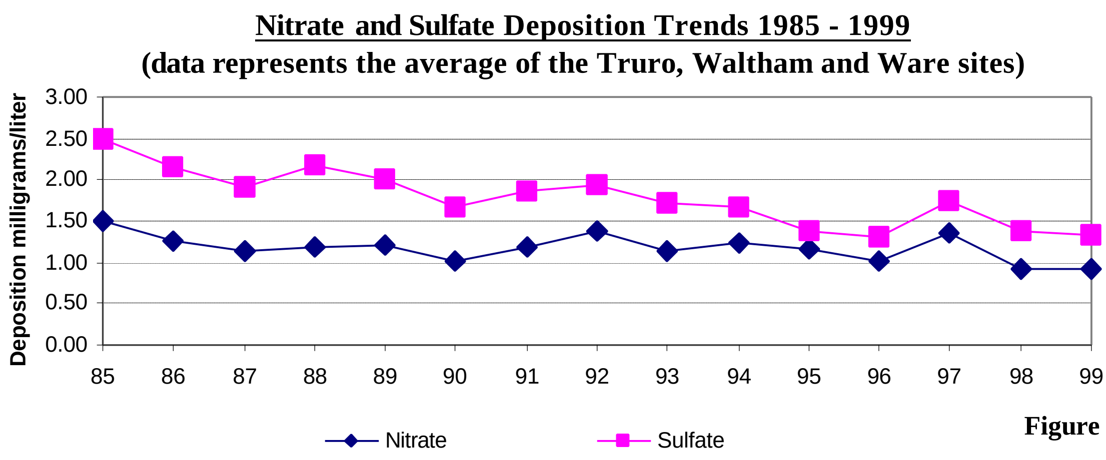



**Figure 39**

# Industrial Network Summary

**Introduction**

The industrial ambient air quality network is comprised of monitoring stations operated by industries with facilities that may potentially emit large amounts of pollutants. An example would be a coal-burning power plant, which emits $SO_2$.

The monitoring stations in the industrial network are sited to measure the maximum values from the specific point source. When the pollutant ($SO_2$) value reaches certain trigger values, the power plant switches to lower sulfur-content fuel.

The data from the industrial network is submitted to the Air Assessment Branch. It is submitted into the USEPA AIRS database after the quality assurance process has been completed.

**The Continuous Emission Monitoring System (CEMS)**

The ambient monitoring network is different from, and in addition to, the in-stack Continuous Emission Monitoring System (CEMS) equipment required at certain facilities by a DEP-issued permit or other state and federal regulations. For example, the federal Acid Rain Program requires CEMS enabling calculation of $SO_2$, $NO_x$ and $CO_2$ emissions from the nation's largest power generating facilities. The information on emissions collected by those monitors can be found on USEPA's web site (www.epa.gov/acidrain).

**Sulfur Dioxide ($SO_2$) Summary**

There were six $SO_2$ sites during 1999 in the industrial network. All of the sites achieved the requirement of 80% or greater data capture for the year. There were no violations of the $SO_2$ air quality standards during the year.

The highest values were measured at Atlantic Gelatin's site in Stoneham. The high 24-hour value was 0.042 ppm, which is 30% of the standard; the high 3-hour value was 0.076 ppm, which is 15% of the standard; and, the annual arithmetic mean was 0.007 ppm (also measured at the Sithe New England East First St. site in Boston), which is 23% of the standard.

A summary of the 1999 data is listed below.

| SITE ID | POC | MT | CITY | COUNTY | ADDRESS (UNITS: PPM) | REP ORG | % OBS | 24-HR MAX 1ST | 24-HR 2ND | 3-HR MAX 1ST | 3-HR 2ND | 1-HR MAX 1ST | 1-HR 2ND | ARIT MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-025-0019 | 1 | 4 | BOSTON | SUFFOLK | LONG ISLAND | 5 | 95 | .019 | .019 | .054 | .035 | .071 | .060 | .004 |
| 25-025-0020 | 1 | 4 | BOSTON | SUFFOLK | DEWAR STREET | 5 | 95 | .028 | .023 | .058 | .057 | .081 | .070 | .006 |
| 25-025-0021 | 2 | 4 | BOSTON | SUFFOLK | 340 BREMEN ST. | 5 | 95 | .023 | .019 | .057 | .041 | .091 | .075 | .006 |
| 25-025-0040 | 1 | 4 | BOSTON | SUFFOLK | 531A E. FIRST ST | 5 | 95 | .026 | .025 | .055 | .055 | .085 | .066 | .007 |
| 25-009-5004 | 1 | 4 | HAVERHILL | ESSEX | NETTLE SCHOOL | 2 | 98 | .020 | .020 | .026 | .023 | .030 | .027 | .006 |
| 25-017-1701 | 1 | 4 | STONEHAM | MIDDLESEX | HILL STREET | 25 | 97 | .042 | .040 | .086 | .079 | .109 | .099 | .008 |

TO CONVERT UNITS FROM PPM TO mG/M³ MULTIPLY PPM x 2620

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (4 = INDUSTRIAL) **REP ORG** = REPORTING ORGANIZATION **%OBS** = DATA CAPTURE PERCENTAGE **MAX 24-HR, MAX 3-HR, MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **OBS > .14** = NUMBER OF 24-HR AVG. GREATER THAN 0.14 PPM (24-HR STANDARD) **OBS > .50** = NUMBER OF 3-HR AVG. GREATER THAN 0.50 PPM (3-HR STANDARD) **ARIT MEAN** = ARITHMETIC MEAN (STANDARD = 0.030 PPM)

*Continued on next page*

**Nitrogen Dioxide ($NO_2$) Summary**

There was one $NO_2$ site during 1999 in the industrial network, operated by Sithe New England in Boston (East First St.). It met the requirement of 80% or greater data capture. There were no violations of the $NO_2$ air quality standard during the year. The annual arithmetic mean was 0.021 ppm, which is 40% of the standard.

A summary of the 1999 data is listed below.

| SITE ID | POC | MT | CITY | COUNTY | ADDRESS | % OBS | MAX 1-HR 1ST | MAX 1-HR 2ND | ARIT MEAN |
|---|---|---|---|---|---|---|---|---|---|
| 25-025-0040 | 1 | 4 | BOSTON | SUFFOLK | 531A EAST FIRST ST | 88 | .078 | .075 | .021 |

UNITS: PPM

TO CONVERT UNITS FROM PPM TO uG/M³ MULTIPLY PPM x 1886.8

PRIMARY STANDARD: ANNUAL ARITHMETIC MEAN = 0.053 PPM

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (4 = INDUSTRIAL) **%OBS** = DATA CAPTURE PERCENTAGE **MAX 1-HR 1ST 2ND** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED **ARIT MEAN** = ARITHMETIC MEAN (STANDARD = 0.053 PPM)

**Total Suspended Particulates (TSP) Summary**

There were four TSP sites during 1999 in the industrial network, all operated by Sithe New England in the city of Boston. All met the requirement of 80% or greater data capture.

TSP is not a criteria pollutant ($PM_{10}$ replaced it as the particulate standard in 1987), so there is no longer a standard for it. The highest 24-hour value was 253 ug/m3 at the East First St. site, which is 97% of the old standard (260 ug/m3). The highest annual geometric mean was 50 ug/m3 at the East First St. site, which is 63% of the old standard (75 ug/m3).

A summary of the 1999 data is listed below.

UNITS: UG/CU METER (25C)

| SITE ID | POC | MT | CITY | COUNTY | ADDRESS | % OBS | MAXIMUM 24-HR VALUES 1ST | 2ND | 3RD | 4TH | ARITH MEAN | GEO MEAN | GEO STD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-025-0019 | 1 | 4 | BOSTON | SUFFOLK | LONG ISLAND | 100 | 110 | 80 | 79 | 67 | 32 | 28 | 1.6 |
| 25-025-0020 | 1 | 4 | BOSTON | SUFFOLK | DEWAR STREET | 100 | 182 | 153 | 126 | 112 | 54 | 47 | 1.6 |
| 25-025-0021 | 2 | 4 | BOSTON | SUFFOLK | 340 BREMEN ST | 97 | 152 | 148 | 100 | 99 | 64 | 58 | 1.5 |
| 25-025-0040 | 1 | 4 | BOSTON | SUFFOLK | 531A EAST FIRST STREET | 98 | 223 | 154 | 94 | 90 | 53 | 47 | 1.6 |
| 25-025-0040 | 2 | 4 | BOSTON | SUFFOLK | 531A EAST FIRST STREET | 97 | 253 | 165 | 129 | 97 | 57 | 50 | 1.7 |

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **POC =** PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (4 = INDUSTRIAL) **% OBS** = DATA CAPTURE PERCENTAGE **MAXIMUM VALUES 1ST,2ND,3RD,4TH** = 1ST,2ND,3RD AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR **ARITH MEAN** = ARITHMETIC MEAN **GEO MEAN** = GEOMETRIC MEAN **GEO STD** = GEOMETRIC STANDARD DEVIATION

*Continued on next page*

# Industrial Network Summary, Continued

**Sulfate ($SO_4$) Summary**

There were four $SO_4$ sites during 1999 in the industrial network, all operated by Sithe New England in the city of Boston. All met the requirement of 80% or greater data capture.

There are no standards for $SO_4$, since it is not a criteria pollutant. The highest 24-hour value, 31 $\mu g/m^3$, was measured at East First St. The highest annual arithmetic mean was 8.17 $\mu g/m^3$ at Bremen St.

A summary of the 1999 data is listed below.

| SITE ID | POC | MT | CITY | COUNTY | ADDRESS (UNITS: UG/CU METER (25C) | % OBS | 1ST | 2ND | 3RD | 4TH | ARITH MEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | -MAXIMUM VALUES- | | | | |
| 25-025-0019 | 1 | 4 | BOSTON | SUFFOLK | LONG ISLAND | 100 | 25.0 | 14.0 | 13.0 | 12.0 | 5.93 |
| 25-025-0020 | 1 | 4 | BOSTON | SUFFOLK | DEWAR STREET | 100 | 27.0 | 15.0 | 15.0 | 13.0 | 6.73 |
| 25-025-0021 | 2 | 4 | BOSTON | SUFFOLK | 340 BREMEN STREET | 97 | 28.0 | 20.0 | 18.0 | 13.0 | 7.86 |
| 25-025-0040 | 1 | 4 | BOSTON | SUFFOLK | 531A EAST FIRST STREET | 98 | 30.0 | 17.0 | 17.0 | 14.0 | 7.44 |
| 25-025-0040 | 2 | 4 | BOSTON | SUFFOLK | 531A EAST FIRST STREET | 97 | 31.0 | 17.0 | 15.0 | 14.0 | 7.71 |

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**
**SITE ID** = AIRS SITE IDENTIFICATION NUMBER **POC** = PARAMETER OCCURRENCE CODE (DIFFERENTIATES BETWEEN MONITORS AT A SITE) **MT** = MONITOR TYPE (4 = INDUSTRIAL) **% OBS** = DATA CAPTURE PERCENTAGE **MAXIMUM VALUES 1ST,2ND,3RD,4TH** = 1ST,2ND,3RD AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR **ARITH MEAN** = ARITHMETIC MEAN

# Quality Control and Quality Assurance

**Introduction**

To ensure that the ambient air quality data is of high quality, MADEP has developed standard operating procedures (SOPs). These procedures include quality control and quality assurance techniques that assess the quality and document the activities performed in collecting the data.

**Quality control**

Quality control (QC) is comprised of those activities performed by personnel who are directly involved in the generation of the data. Examples of personnel who perform QC functions are site operators and laboratory support personnel. QC activities include calibrations, data validation procedures, and performance checks of the ambient air monitors to assess the precision of the data.

**Quality assurance**

Quality assurance (QA) is comprised of those activities performed by personnel who are not directly involved in the generation of the data and who may therefore make an unbiased assessment of the data quality. QA activities include performance audit checks of the ambient air monitors to assess the accuracy of the data.

**Precision and accuracy**

Precision is defined as a measure of the repeatability of a measurement system. Accuracy is defined as a measure of the closeness of an observed measurement value to the defined standard.

The QC and QA performance checks allow the precision and accuracy of ambient air monitors to be quantified. Testing the monitor's response to known inputs in order to assess the measurement error does this. The QC performance checks assess the precision, while the QA performance checks assess the accuracy.

The requirements and techniques for performing precision and accuracy performance checks are established in the Code of Federal Regulations (CFR), Title 40, Part 58, Appendix A.

**How precision and accuracy is described**

Precision and accuracy are given in the context of upper and lower 95-percentile probability limits for each pollutant parameter. The meaning of the 95-percentile limits is that 95% of the data for a parameter is estimated to be precise or accurate to within the percentage range defined by the upper and lower limits. As an example, if the upper and lower 95-percentile-limits for a parameter based upon precision checks are calculated to be +4.3% and –7.4%, then 95% of the data is precise within the range of +4.3 through –7.4%.

*Continued on next page*

# Quality Control and Quality Assurance, Continued

**1999 Precision and accuracy summary**

As a goal, the 95-percentile probability limits for precision (all parameters) and $PM_{10}$ and TSP accuracy should be less than ±15%. The 95 percentile probability limits for accuracy for all other parameters should be less than ±20%. A summary of the data is listed below.

| | | | | | | | PRECISION DATA | | | | ACCURACY DATA | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PRECISION AND ACCURACY DATA KEY | | | | | | | # OF | PRECIS | PROB | LIM | # AUDITS | PROB | LIM | PROB | LIM | PROB | LIM |
| RG | ST | RO | TYP | CLASS | POLL | YEAR-Q | ANLYZRS | CHECK | LO | UP | L1-3 | LO-L1 | -UP | LO-L2 | -UP | LO-L3 | -UP |
| 01 | 25 | 001 | C | A | CO | 1999 | 9 | 204 | -08 | +07 | 14 | -04 | +05 | -07 | +07 | -09 | +06 |
| CARBON MONOXIDE | | | | | | 1999-1 | 9 | 53 | -08 | +07 | 3 | -07 | +06 | -07 | +05 | -12 | +04 |
| | | | | | | 1999-2 | 9 | 60 | -06 | +06 | 5 | -13 | +13 | -08 | +08 | -10 | +08 |
| | | | | | | 1999-3 | 8 | 47 | -09 | +04 | 3 | -07 | +14 | -07 | +12 | -08 | +09 |
| | | | | | | 1999-4 | 8 | 44 | -05 | +06 | 3 | -04 | +04 | -06 | +03 | -09 | +05 |
| 01 | 25 | 001 | C | A | SO2 | 1999 | 10 | 229 | -11 | +04 | 16 | -10 | +02 | -10 | +02 | -11 | +01 |
| SULFUR DIOXIDE | | | | | | 1999-1 | 10 | 57 | -10 | +02 | 5 | -09 | +10 | -09 | +10 | -09 | +08 |
| | | | | | | 1999-2 | 10 | 62 | -08 | +02 | 4 | -11 | +01 | -11 | +02 | -09 | +02 |
| | | | | | | 1999-3 | 9 | 57 | -13 | +03 | 3 | -12 | -03 | -14 | -02 | -17 | -01 |
| | | | | | | 1999-4 | 9 | 53 | -09 | +04 | 4 | -11 | +01 | -12 | +01 | -14 | +00 |
| 01 | 25 | 001 | C | A | NO2 | 1999 | 13 | 235 | -11 | +09 | 20 | -21 | +09 | -18 | +09 | -16 | +11 |
| NITROGEN DIOXIDE | | | | | | 1999-1 | 12 | 69 | -09 | +09 | 4 | -21 | +09 | -16 | +04 | -15 | +04 |
| | | | | | | 1999-2 | 13 | 77 | -10 | +07 | 6 | -20 | +00 | -23 | +07 | -21 | +10 |
| | | | | | | 1999-3 | 13 | 58 | -09 | +08 | 7 | -19 | +12 | -16 | +11 | -16 | +14 |
| | | | | | | 1999-4 | 6 | 31 | -10 | +08 | 3 | -24 | +09 | -20 | +08 | -17 | +08 |
| 01 | 25 | 001 | C | A | O3 | 1999 | 17 | 284 | -07 | +06 | 32 | -07 | +07 | -07 | +06 | -07 | +06 |
| OZONE | | | | | | 1999-1 | 10 | 62 | -05 | +06 | 7 | -05 | +07 | -05 | +06 | -05 | +05 |
| | | | | | | 1999-2 | 17 | 100 | -05 | +05 | 12 | -08 | +07 | -08 | +07 | -07 | +06 |
| | | | | | | 1999-3 | 17 | 110 | -07 | +04 | 11 | -08 | +10 | -07 | +08 | -07 | +07 |
| | | | | | | 1999-4 | 2 | 12 | -04 | +02 | 2 | -04 | +03 | -02 | +02 | +00 | +00 |

| | | | | | | | PRECISION DATA | | | | ACCURACY DATA | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PRECISION AND ACCURACY DATA KEY | | | | | | | # OF | COLLC | PROB | LIM | VAL COLL | # | PROB | LIM | PROB | LIM |
| RG | ST | RO | TYP | CLASS | POLL | YEAR-Q | SMPLS | SITES | LO | UP | DATA PRS | AUD | LO-L1 | -UP | LO-L2 | -UP |
| 01 | 25 | 001 | I | F | PM2.5 | 1999 | 383 | 5 | -32 | +29 | 381 | 80 | | | -02 | +02 |
| PM2.5 LOCAL CONDITIONS | | | | | | 1999-1 | 76 | 5 | -37 | +36 | 76 | 17 | | | -03 | +02 |
| | | | | | | 1999-2 | 94 | 4 | -34 | +41 | 94 | 20 | | | -05 | +03 |
| | | | | | | 1999-3 | 118 | 5 | -35 | +22 | 117 | 22 | | | -04 | +04 |
| | | | | | | 1999-4 | 95 | 5 | -15 | +15 | 94 | 21 | | | -03 | +02 |
| 01 | 25 | 001 | I | F | PM10 | 1999 | 131 | 3 | -10 | +13 | 87 | 23 | | | -03 | +07 |
| PM10 TOTAL 0-10UM | | | | | | 1999-1 | 32 | 3 | -07 | +14 | 16 | 7 | | | -02 | +10 |
| | | | | | | 1999-2 | 36 | 3 | -13 | +14 | 23 | 5 | | | -09 | +08 |
| | | | | | | 1999-3 | 25 | 2 | -15 | +19 | 19 | 8 | | | -02 | +06 |
| | | | | | | 1999-4 | 38 | 3 | -03 | +04 | 29 | 3 | | | -03 | +06 |
| 01 | 25 | 001 | I | F | LEAD | 1999 | 0 | 0 | | | 0 | 4 | | | -12 | +02 |
| LEAD (TSP) | | | | | | 1999-1 | 0 | 0 | | | 0 | 1 | | | -01 | -01 |
| | | | | | | 1999-2 | 0 | 0 | | | 0 | 0 | | | | |
| | | | | | | 1999-3 | 0 | 0 | | | 0 | 2 | | | -12 | -02 |
| | | | | | | 1999-4 | 0 | 0 | | | 0 | 5 | | | -05 | -05 |

**ABBREVIATIONS AND SYMBOLS USED IN TABLE**
**RG** = EPA REGION **ST** = STATE **RO** = REPORTING ORGANIZATION **TYP** = ANALYZER TYPE (CONTINUOUS OR INTERMITTENT) **CLASS** = ANALYTICAL (A); FLOW (F) **YR** = YEAR **# OF ANLYZRS** = NUMBER OF ANALYZERS **PRECIS** CHECKS = NUMBER OF PRECISION CHECKS **PROB LIM LO/UP** = LOWER AND UPPER 95% PROBABILITY LIMITS **# AUDITS L1-3** = NUMBER OF AUDITS **PROB LIM LO-L1-UP** = LOWER AND UPPER 95% PROBABILITY LIMITS AT LOW RANGE **PROB LIM LO-L2-UP** = LOWER AND UPPER 95% PROBABILITY LIMITS AT MIDDLE RANGE **PROB LIM LO-L3-UP** = LOWER AND UPPER 95% PROBABILITY LIMITS AT HIGH RANGE **# OF SMPLS** =NUMBER OF SAMPLERS **COLLC SITES** = NUMBER OF COLLOCATED SITES **VAL COLL DATA PRS** = NUMBER OF VALID COLLOCATED SAMPLES (ABOVE THE LIMIT USED FOR PRECISION CALCULATION) **# AUD** = NUMBER OF AUDITS

**Precision data summary**

The figure below presents the precision summary for all parameters for 1999. The precision was good for all parameters except $PM_{2.5}$. The high error range for $PM_{2.5}$ is attributed to the new sampling methodology used in 1999. The results improved as the year progressed.

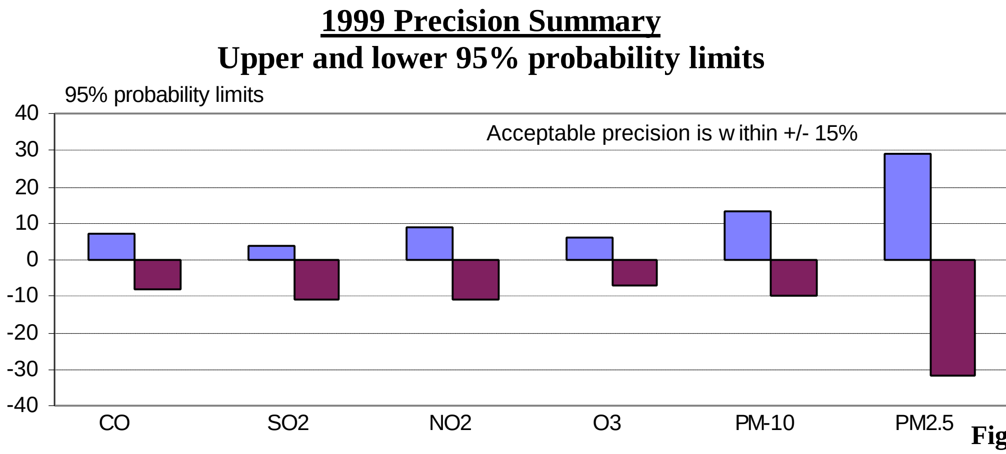



**Figure 40**

| | CO | $SO_2$ | $NO_2$ | $O_3$ | $PM_{10}$ | $PM_{2.5}$ |
|---|---|---|---|---|---|---|
| Upper | +7% | +4% | +9% | +6% | +13% | +29% |
| Lower | -8% | -11% | -11% | -7% | -10% | -32% |

**CO accuracy summary**

The figure below presents the CO accuracy summary for 1999. The results were within acceptable limits.

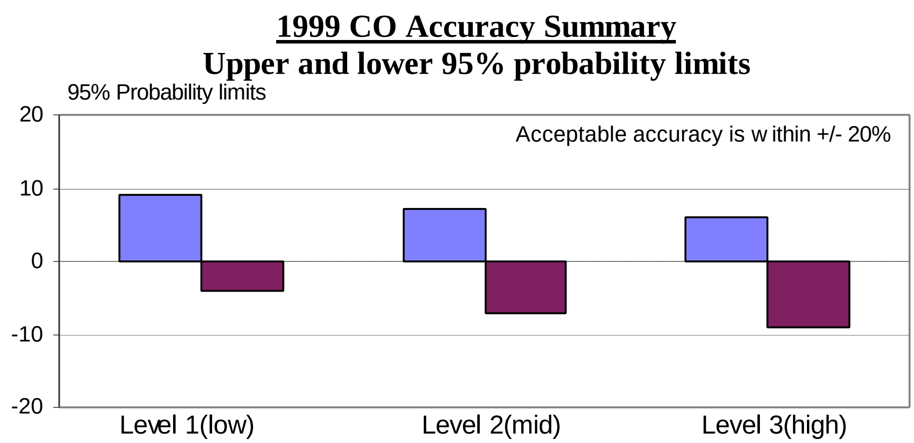



**Figure 41**

| | Level 1 (low) | Level 2 (mid) | Level 3 (high |
|---|---|---|---|
| Upper | +5% | +7% | +6% |
| Lower | -4% | -7% | -9% |

*Continued on next page*

**$NO_2$ accuracy summary**

The figure below presents the $NO_2$ accuracy summary for 1999. The results were within acceptable limits.

**1999 NO2 Accuracy Summary**
**Upper and lower 95% probability limits**

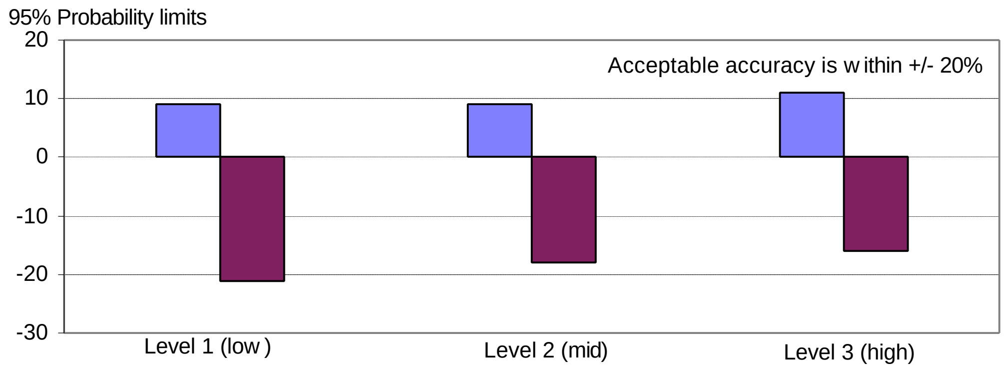



**Figure 42**

| | Level 1 (low) | Level 2 (mid) | Level 3 (high) |
|---|---|---|---|
| Upper | +9% | +9% | +11% |
| Lower | -21% | -18% | -16% |

**$O_3$ accuracy summary**

The figure below presents the $O_3$ accuracy summary for 1999. The results were within acceptable limits.

**1999 O3 Accuracy Summary**
**Upper and lower 95% probability limits**

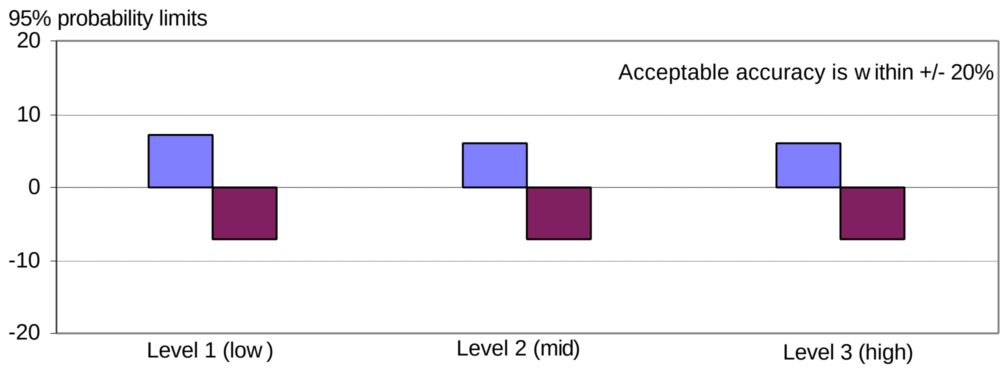



**Figure 43**

| | Level 1 (low) | Level 2 (mid) | Level 3 (high) |
|---|---|---|---|
| Upper | +7% | +6% | +6% |
| Lower | -7% | -7% | -7% |

*Continued on next page*

**$SO_2$ accuracy summary**

The figure below presents the $SO_2$ accuracy summary for 1999. The results were within acceptable limits.

**1999 SO2 Accuracy Summary**
**Upper and lower 95% probability limits**

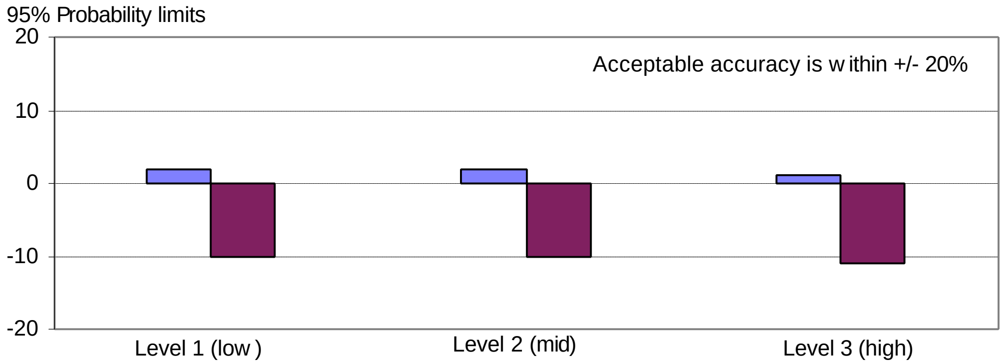



**Figure 44**

| | Level 1 (low) | Level 2 (mid) | Level 3 (high) |
|---|---|---|---|
| Upper | +2% | +2% | +1% |
| Lower | -10% | -10% | -11% |

**$PM_{10}$, $PM_{2.5}$ & Lead accuracy summary**

The figure below presents the $PM_{10}$, $PM_{2.5}$ and Lead accuracy summaries for 1999. The results were within acceptable limits.

**1999 PM10, PM2.5 & Lead Accuracy Summary**
**Upper and lower 95% probability limits**

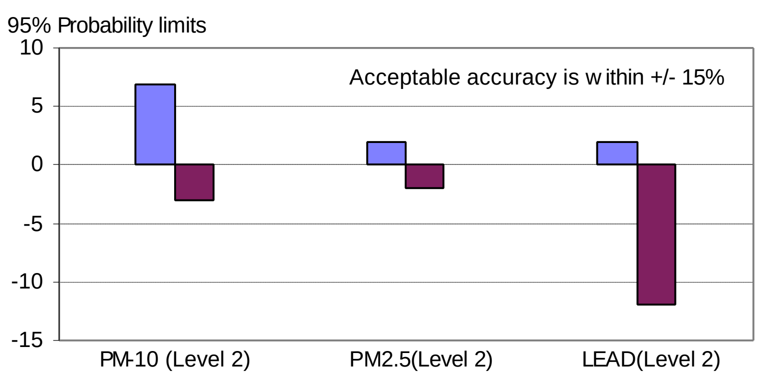



**Figure 45**

| | $PM_{10}$ (Level 2) | $PM_{2.5}$ (Level 2) | LEAD (Level 2) |
|---|---|---|---|
| Upper | +7% | +2% | +2% |
| Lower | -3% | -2% | -12% |

# Air Quality Levels By Region

**Introduction**

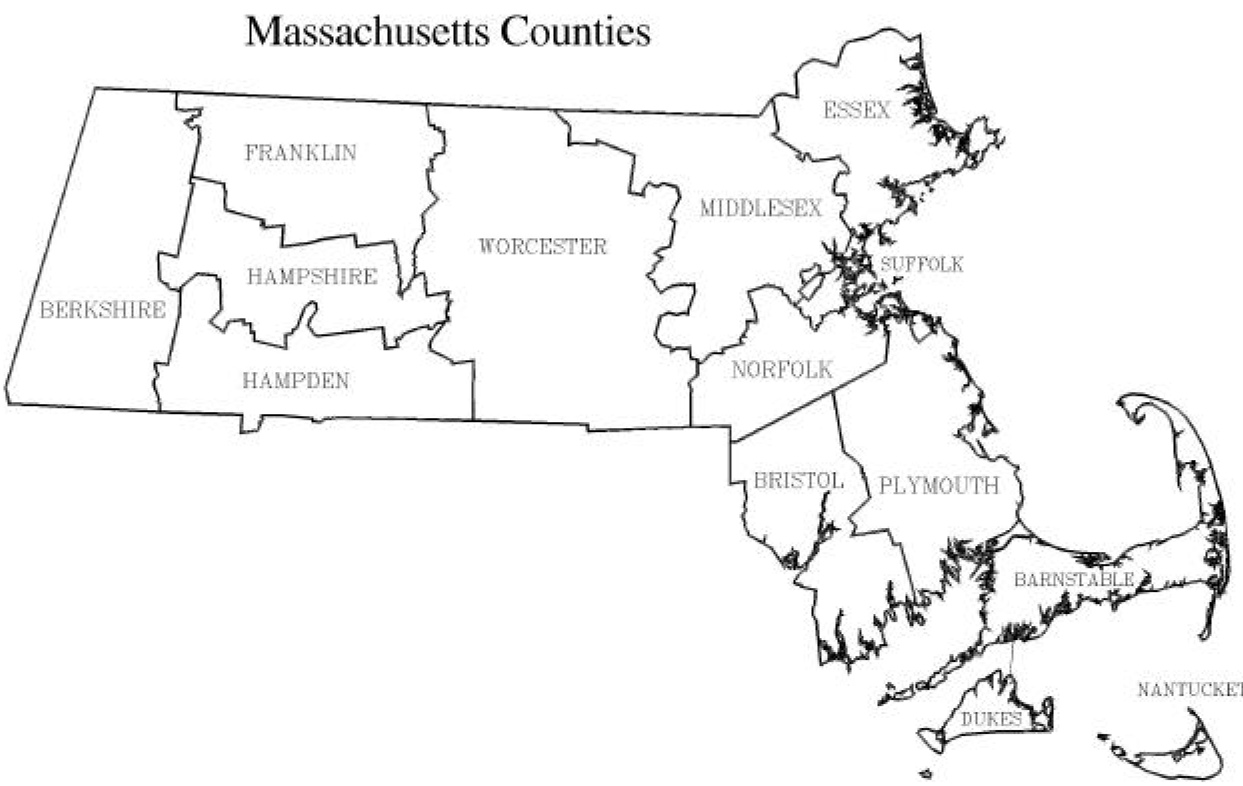
The Pollutant Standards Index (PSI) was developed by USEPA and provides a uniform way of presenting air pollution levels and rating the impact on public health for five major pollutants regulated under the Clean Air Act. The pollutants are ozone ($O_3$), carbon monoxide (CO), sulfur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), and particulate matter – $PM_{10}$ (particulates less than 10 microns) and $PM_{2.5}$ (particulates less than 2.5 microns).

The PSI value for each parameter represents the annual mean of each day's PSI. Since $NO_2$ does not have a short-term daily federal standard, a PSI value was calculated using the $NO_2$ annual mean and comparing that to the federal standard.

**Massachusetts regions**

The PSI values are presented in this section by regions. The state has been divided by county into four regions.

- Northeast region – Essex, Middlesex, and Suffolk counties
- Southeast region – Norfolk, Bristol, Plymouth, and Barnstable counties
- Central region – Worcester county
- West region – Franklin, Hampshire, Hampden, and Berkshire counties




*Continued on next page*

**Understanding PSI levels**

The PSI level converts the measured concentration of a pollutant to a number on a scale of 0 to 500. A PSI rating of 100 corresponds to the National Ambient Air Quality Standard (NAAQS) for that pollutant. $O_3$ levels are related to the one-hour NAAQS.

The categories of the PSI air quality levels are:

- Good: from 0 to 50
- Moderate: from 50 to 100
- Unhealthful: from 100 to 200
- Very unhealthful: from 200 to 300
- Hazardous: above 300.

**PSI levels by region**

The figures below present the 1999 PSI levels for the pollutants monitored in each region. The PSI levels are the average for the year of all sites in the region. All of the PSI levels are below 50, in the Good category.

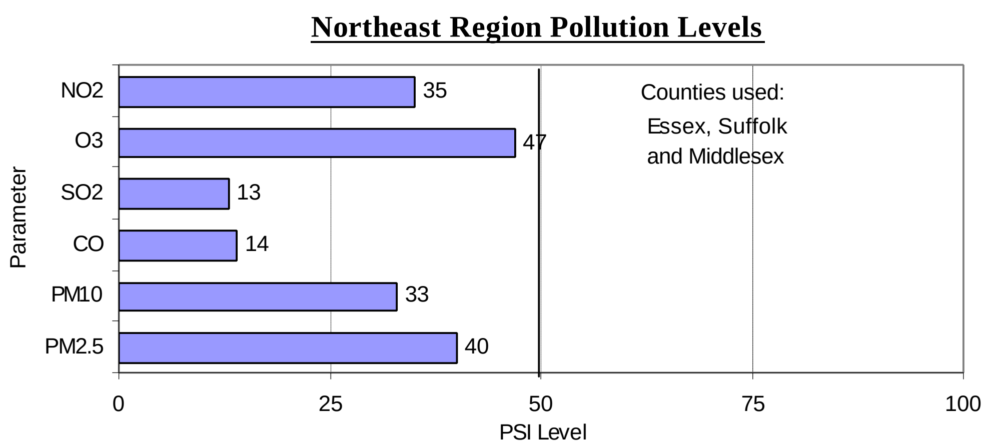



**Figure 46**

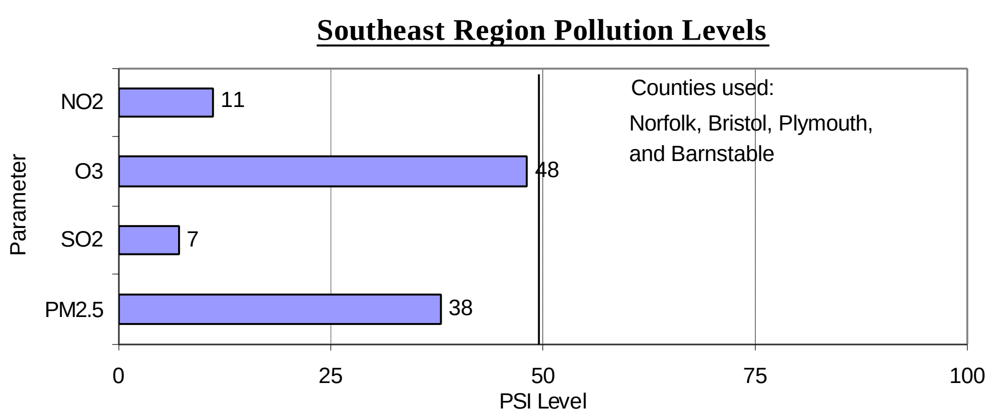



**Figure 47**

*Continued on next page*

# Air Quality Levels By Region, Continued

**PSI levels by region,** Continued

The figures below present the 1999 PSI levels for the pollutants monitored in each region. The PSI levels are the average for the year of all sites in the region. All of the PSI levels are below 50, in the Good category.

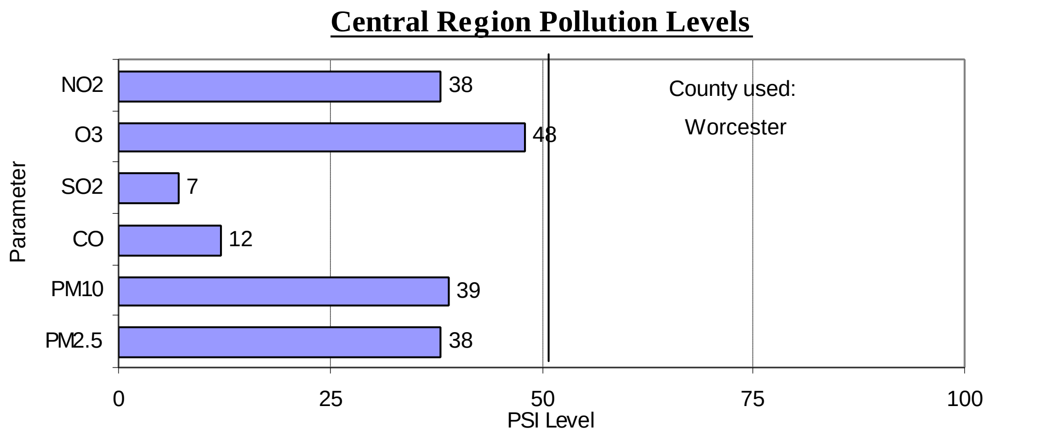



**Figure 48**

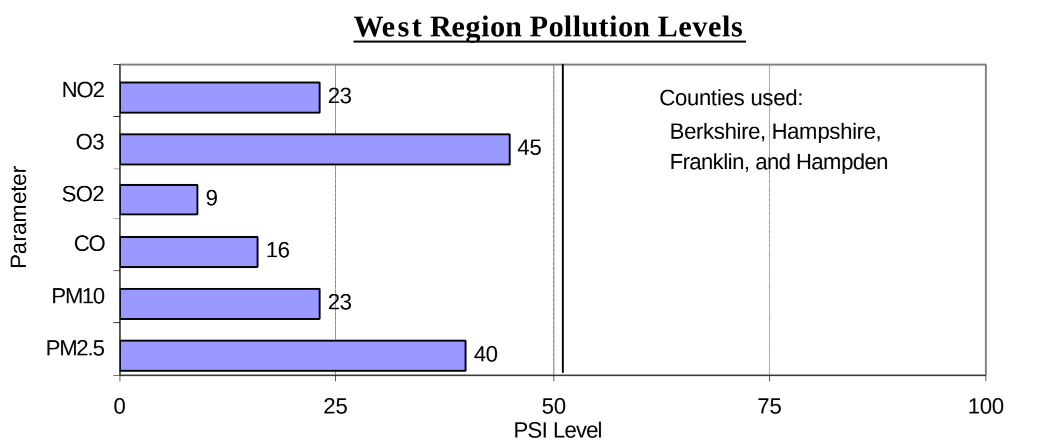



**Figure 49**

# Section IV

# PAMS/Air Toxics Monitoring

## PAMS Monitoring

**Introduction**

Non-criteria air pollutants are those pollutants that are monitored in the ambient air for which National Ambient Air Quality Standards (NAAQS) do not exist. This category covers toxic air pollutants (toxic volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), toxic elements, and other gases and particles), and ozone precursors and products (PAMS components).

Since 1993, most efforts to monitor non-criteria pollutants have been associated with the PAMS (Photochemical Assessment Monitoring Stations) project. This project, which was mandated by the 1990 Federal Clean Air Act Amendments, requires that state agencies measure a comprehensive list of pollutants and meteorological parameters related to the formation of ozone ($O_3$) and other harmful photochemical oxidants during the summer months.

**Understanding ozone ($O_3$) generation**

Ozone is unique in that it is formed by reactions between other pollutants in presence of high-energy sunlight, of the intensity found during the summer months. The complexity and subsequent time needed to complete these reactions results in the build up of ground level ozone concentrations far downwind from the original source of the precursors.

Although this complex reaction system had somewhat stymied efforts to reduce summer ozone concentrations to healthy levels, it was well known that oxides of nitrogen and light sensitive (photo-reactive) volatile organic compounds were the major ozone precursors. The PAMS program has been the first consistent effort to measure the ozone precursors, in addition to ozone itself, to gain a better understanding of the chemical reactions that produce ozone.

**What is monitored in the PAMS program**

Nitrogen oxides and ozone are two criteria pollutant categories also measured as part of the PAMS program. Additionally, two categories of volatile organic compounds (VOCs) must be measured in association with this program. These categories are Hydrocarbons (56 distinct compounds plus unidentified unknowns) and Carbonyls (acetone, acetaldehyde, and formaldehyde). Total reactive oxides of nitrogen ($NO_y$) is also measured. $NO_y$ has received recent scrutiny as a factor in $O_3$ generation.

**How are VOCs measured?**

The measurement of individual VOC pollutants in ambient air has required the introduction of sophisticated laboratory instruments and techniques, such as gas and liquid chromatography, into a large scale and routine setting. The high sensitivity of these techniques allows the measurement of very low concentrations of VOCs.

*Continued on next page*

**How are VOCs measured?,** Continued

Laboratory grade gas chromatographs (GCs) take and analyze hourly air samples at four of the seven current operating PAMS sites in Massachusetts during the summer PAMS season months (June, July, and August).

**The PAMS monitoring network**

The PAMS designated monitoring stations are sited in an upwind and downwind direction around the two cities where PAMS monitoring is required (Boston and Springfield). These sites coincide with southwesterly and northeasterly wind directions that are prevalent during high ground level ozone events.

USEPA regulations, which were issued subsequent to the passage of the Clean Air Act Amendments, require metropolitan areas to establish a certain number of PAMS sites based upon population. As a result, Springfield is required to have three PAMS sites and Boston is required to have five PAMS sites. The regional scale of the ground-level ozone issue has led to one "Boston Area" site being placed in Maine (Acadia National Park); one "Providence Area" site being placed in Massachusetts (Truro - Cape Cod National Seashore); and one site being shared by both Boston and Providence (Easton - Borderland State Park).

Below is a table of PAMS stations which are either located in Massachusetts or are associated with one of our city networks.

| Boston | Springfield | Providence |
|---|---|---|
| Easton (Borderland State Park) | Agawam | Easton (Borderland State Park) |
| Lynn | Chicopee | Truro (Cape Cod NS) |
| Newbury (Plum Island) | Ware | |
| Boston (Long Island) | | |
| Maine (Acadia NP) | | |

PAMS data is very costly to collect, and the data gathered is complex to analyze and use. Studies are underway to make the PAMS system and database more efficient, less costly, and user-friendly.

**The different types of PAMS monitoring schedules**

USEPA Clean Air Act Regulations dictate the intensity of hydrocarbon and carbonyl monitoring depending on the site's proximity to the central city. Lynn (Boston) and Chicopee (Springfield) are designated to have the most intensive PAMS related sampling. The types of samples include the following:

- Gas chromatographs take 1-hour hydrocarbon samples at the Lynn and Newbury sites in eastern Massachusetts, and at Chicopee and Ware in the western part of the state, every day throughout the summer.
- Eight, 3-hour time weighted hydrocarbon canister samples are taken every third day throughout the summer at the Agawam, Easton, and Truro locations.

*Continued on next page*

**The different types of PAMS monitoring schedules,** Continued

- Eight, 3-hour time weighted carbonyl samples are taken at the Lynn and Chicopee sites every third day throughout the summer.

Both hydrocarbon canister and carbonyl samples are brought back to the Air Assessment Branch (AAB) headquarters in Lawrence for analysis. All PAMS sites collect ozone, nitrogen oxides, and meteorological data on the same continuous hourly schedule throughout the summer.

A number of PAMS target pollutants, including benzene and formaldehyde, are of concern because of their toxic properties. In addition to the monitoring schedule described above:

- Every sixth day, 24-hour time weighted hydrocarbon canister and carbonyl samples are taken at the Lynn and Chicopee sites throughout the year to generated annual averages for some of these health relevant target compounds.
- 24-hour hydrocarbon canister samples at the other fully operating PAMS sites are taken every sixth day during the PAMS season (June, July, and August).

Currently, due to current resource restrictions, only 24-hour (year-round) hydrocarbon canister samples are being taken at the newest Boston area PAMS station, at Long Island in Boston Harbor.

**Characteristics of PAMS data**

During PAMS season, thousands of data points for a large number of parameters are generated. Air quality scientists are most interested in data collected during short periods of high ozone episodes when meteorology, precursor activities, and ozone production can be studied.

Typically, ground-level ozone concentrations rise during the morning and afternoon, depending on the solar intensity and the transport of ozone produced upwind, and fall as the sun sets and cuts off the reaction energy source. Moreover, concentrations of ozone precursors, such as nitrogen oxides and hydrocarbons emitted from vehicles, rise at the morning rush hour but decline throughout the day as they are consumed in ozone-related chemical reactions.

**Analyzing the patterns of PAMS data**

Air quality scientists can review concentration patterns in data from upwind and down wind locations, estimate how much of the ozone participating compounds are locally produced or transported from upwind, and how those proportions affect locally measured ambient ozone concentrations.

Isoprene is a particularly interesting hydrocarbon, because it is primarily emitted by trees during hot weather and participates in ozone reactions. Isoprene concentrations peak during the part of the day when the sun is hottest, but that peak precedes the peak in ozone because some isoprene is consumed in reactions to form more ozone. Peak isoprene concentrations are higher at heavier forested sampling locations and are very low or nonexistent on cool and cloudy days.

*Continued on next page*

**A look at PAMS data on a high ozone day**

The spatial and time relationships between PAMS compounds are studied to better understand their connection with ground level ozone production. The following are graphs of four ozone-related pollutants, which were measured on a high ozone day in July 1998 at the three PAMS sites in the Springfield area. Agawam is the upwind site, Chicopee is the central city location (immediately downwind of Springfield), and Ware is the downwind location (where ozone values may be expected to be highest).

Ozone, toluene, nitrogen dioxide, and isoprene are plotted on each graph.

- Toluene is plotted as an example of a petroleum hydrocarbon.
- Nitrogen dioxide is plotted as the primary reactive oxide of nitrogen.
- Isoprene is plotted in contrast to toluene, as a biogenically (i.e. trees) emitted hydrocarbon.

The Chicopee data is shown below. Toluene and nitrogen dioxide, as pollutants associated with vehicles, are expected to be highest at the city-oriented site in Chicopee. Toluene values peak during rush hours when traffic is highest. Also notice that the ozone peaks a few hours past the hydrocarbon peaks, after the chemicals have had time to react.

**Chicopee VOC, O3 and NO2 on a High Ozone Day**
**July 16, 1998**

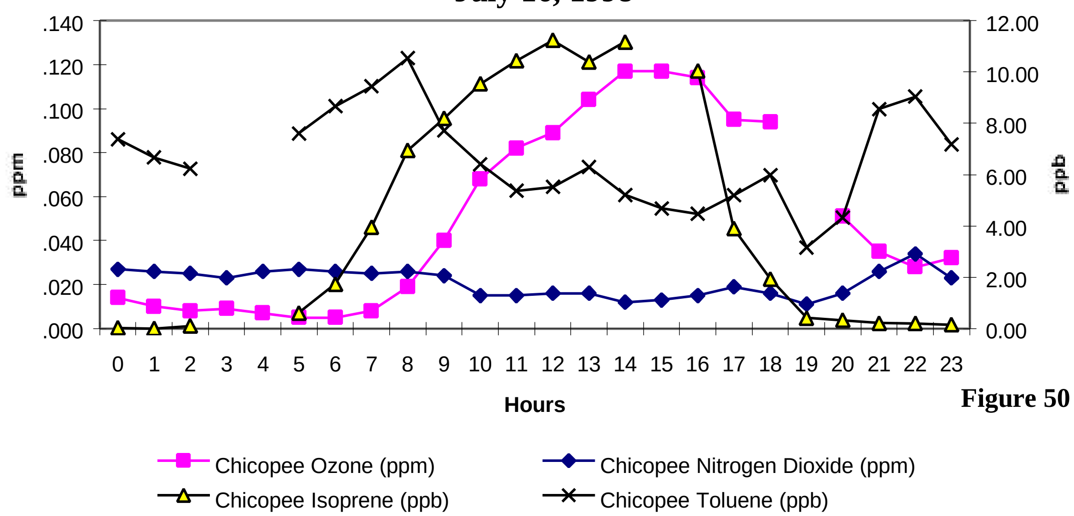



**Figure 50**

*Continued on next page*

**A look at PAMS data on a high ozone day,** Continued

The next two figures show the data from Ware and Agawam.

The structure of the ozone peak becomes more complex at the downwind site (Ware) when compared to the upwind location (Agawam) because locally produced ozone mixes with ozone transported into the region and forms two offsetting components to the peak.

The Ware station consistently records high isoprene levels because of its location at the Quabbin Reservation, which is heavily forested. Ware is a good example of the biogenics (isoprene) curve following the diurnal temperature pattern.

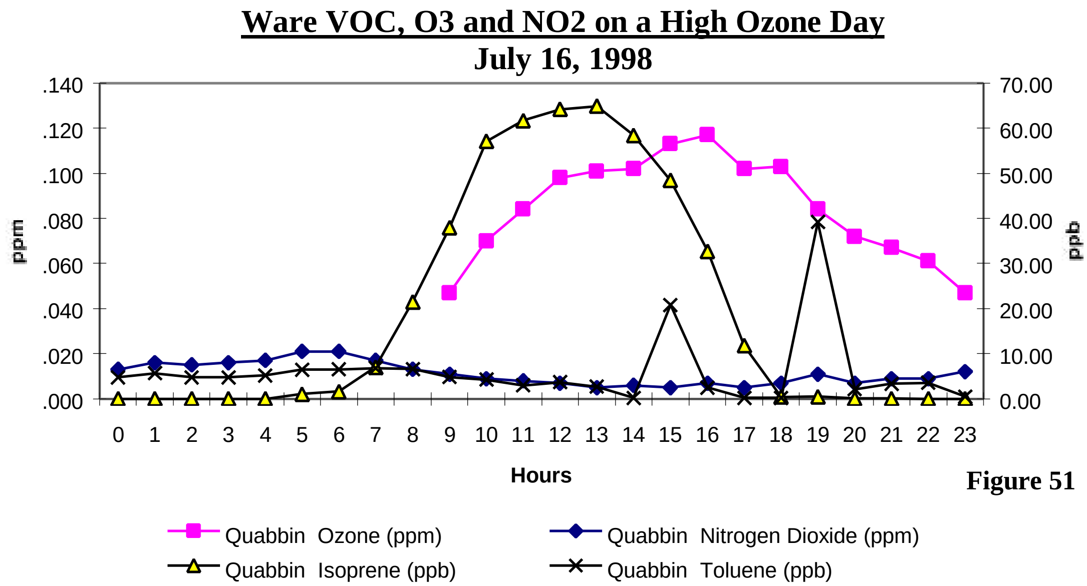



**Figure 51**

*Continued on next page*

**A look at PAMS data on a high ozone day,** Continued

Figure 52 shows that the ozone peaks at Agawam follow the same pattern as at Ware. The ozone peaks occur a few hours after the peaks in the hydrocarbons, allowing for the reaction time of the nitrogen oxides and hydrocarbons.

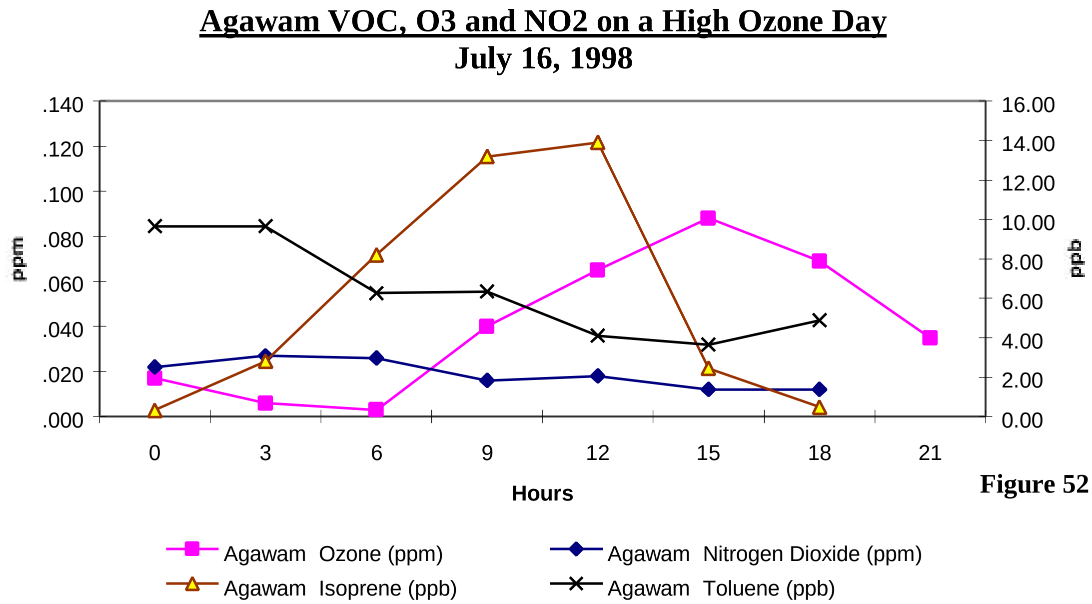



**Figure 52**

# Air Toxics Monitoring

**Introduction**

Toxic air pollutants usually refer to chemicals that are capable of causing long-term health effects and include volatile and semi-volatile organic compounds, toxic elements, and toxic minerals (e.g., asbestos and silica). Over the last fifteen years, the Air Assessment Branch has been involved with short-term, site-specific monitoring studies for toxic air pollutants, and has reviewed and commented on plans and results from such studies that have been conducted by private contractors for MADEP.

**A new air toxics monitoring program**

Recently, nationwide discussions have been held to revive efforts to monitor toxic air pollutants at representative ambient locations on a routine schedule. Starting October 1999, a program to take every sixth day canister samples began at the new Long Island (Boston Harbor) and Roxbury sites. These weekly samples will be shipped to the Rhode Island State Department of Health Laboratory for gas chromatograph-mass spectrometer (GC-MS) analysis according to USEPA Method TO-15. This analysis determines concentrations of a number of target toxic volatile organic compounds in ambient air samples.

**Air toxics results from PAMS monitoring**

As described in the above PAMS Section, MADEP collects every sixth day 24-hour hydrocarbon and carbonyl samples year round at the Chicopee and Lynn sites. From the hydrocarbon analyses, values for several health relevant compounds (benzene, toluene, and xylene) can be extracted from the PAMS results. Benzene is included on EPA's urban air toxics list. Also on the list are formaldehyde and acetaldehyde which are target PAMS carbonyl compounds.

Below is a chart summarizing concentrations of 24-hour health relevant PAMS target compounds for samples taken at the Lynn PAMS site from 1994 through 1999. The benzene concentration decreased, likely the result of the use of reformulated gas beginning in 1995.

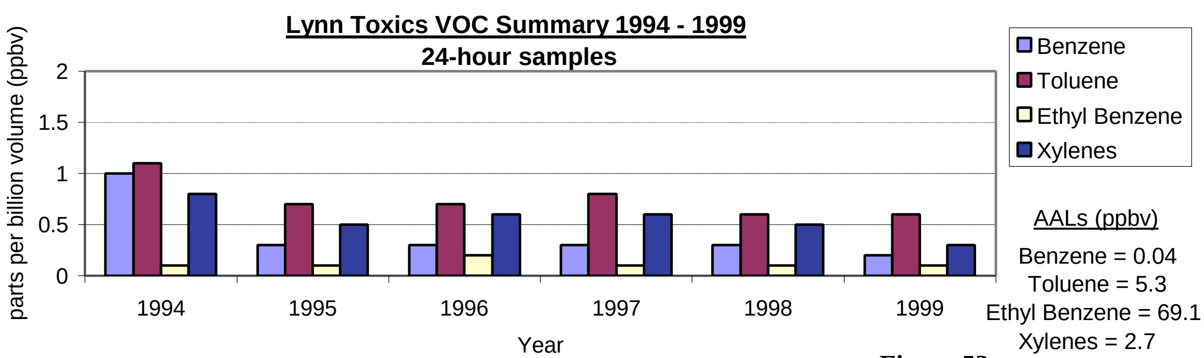



**Figure 53**

Allowable Ambient Limits (AALs) are health-based air toxics guidelines developed by MADEP based on potential known or suspected carcinogenic and toxic health properties of individual compounds. Safety factors are incorporated into the AALs to account for exposures from pathways other than air. AALs are reviewed and updated periodically to reflect current toxicity information.

*Continued on next page*

**Mercury sampling**

During 1998, a yearlong pilot ambient mercury sampling program was concluded at the Ware site. This site was one of several participating locations in New England where 24-hour mercury vapor and particulate samples were taken every sixth day for one year. These samples were sent to the University of Michigan for analysis.

The program also included a two year wet deposition component (completed in 1999) to determine mercury concentrations in rainwater in the New England Region.

A final report from these studies is expected to be published by the end of 2000.

# Section V

# Emissions Inventory

## Emissions Inventories: 1990–1996

**Introduction**

The emission trends are presented for four major pollutants of concern: volatile organic compounds (VOCs), nitrogen oxides ($NO_x$), sulfur dioxide ($SO_2$), and carbon monoxide (CO). Emissions data are not available for particulates and lead. The emissions trends cover the period 1990 to 1996.

**Reporting emission inventories**

The emissions inventories are required to be reported to the USEPA through the State Implementation Plan (SIP) because Massachusetts is non-attainment for the ozone ($O_3$) and CO national air quality standards. The $O_3$ SIP describes the estimated emissions and control measures for VOCs and $NO_x$, since these "$O_3$ precursors" in reaction with sunlight under the right conditions produce $O_3$. The 1990 SIP included a base year emissions inventory for VOCs, $NO_x$, and CO, from which air pollution control programs were developed.

Emissions inventories are required by USEPA every three years. The basic emission methodology involves multiplying an activity factor by an emission factor. MADEP uses a wide range of activity factors such as fuel types, employment, vehicle miles traveled, and population. Emissions factors and methodology are provided by USEPA. MADEP spatially adjusts the emissions to counties and seasonally adjusts them for the summer.

The emissions estimates for the years 1990, 1993, and projected 1996 emissions were submitted to USEPA as part of the SIP process. The 1996 VOC, $NO_x$, and CO emissions estimates presented here were derived from the 1996 Periodic Emissions Inventories (PEI). The PEI is done every 3 years. The 1999 draft PEI will be available for public comment in summer 2001.

**The State Acid Rain (STAR) program**

$SO_2$ emissions are tracked annually by MADEP because of the requirements of the 1985 State Acid Rain (STAR) program. The STAR program was implemented to control emissions that cause acid deposition, which is harmful to the environment. The STAR program is more stringent and establishes a lower $SO_2$ emissions cap than the federal Acid Rain Program. The 412,000 ton state cap is based upon the average annual $SO_2$ emissions during the four-year base period of 1979–1982. MADEP is required to implement additional control measures if the $SO_2$ cap is exceeded, which has not occurred since the inception of the STAR program.

*Continued on next page*

**Point source emissions trends**

The point source category of the emissions inventory comprises the large industrial facilities. This is the only category in which actual data is available for all seven years because of USEPA annual reporting requirements. Figures 54 and 55 show that VOC, $SO_2$, and $NO_x$ point source emissions during the 1990-1996 period have decreased substantially, while CO has increased slightly.

The electric utility emissions are presented in Figure 56 and decreased substantially for the period. Electric utilities comprise the major proportion of $NO_x$ and $SO_2$ point source emissions.

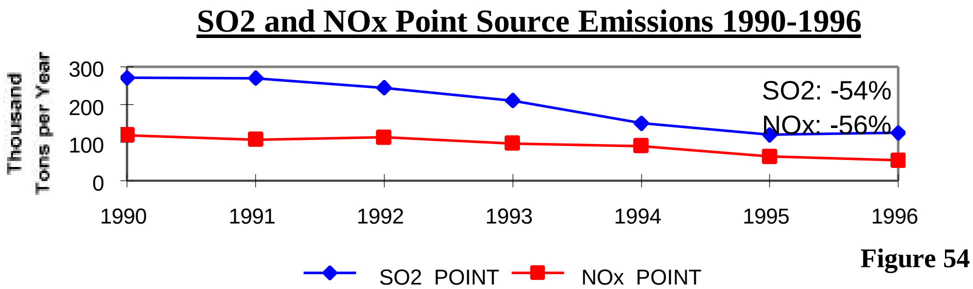



**Figure 54**

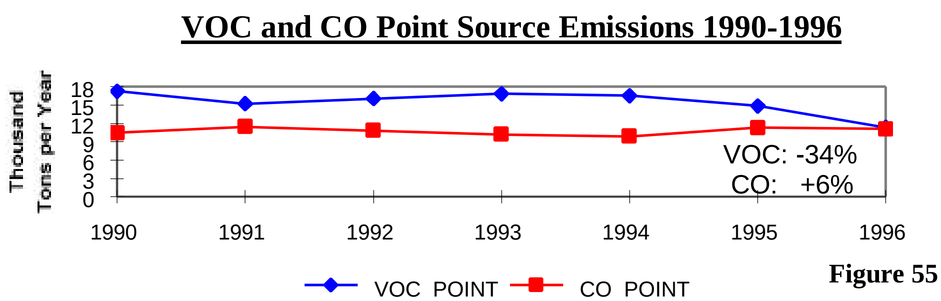



**Figure 55**

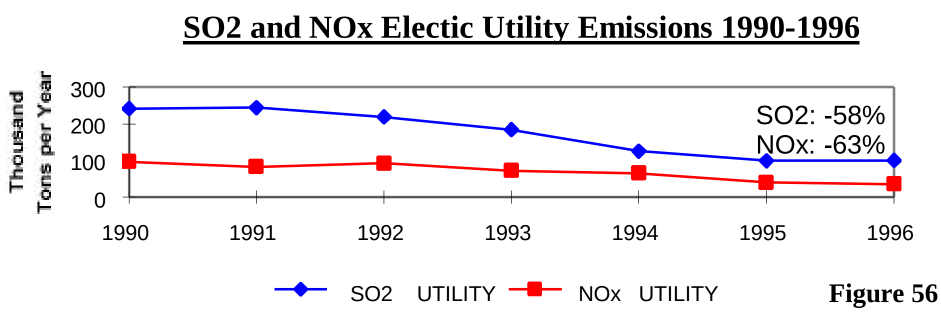



**Figure 56**

The emission trends presented in the figures above are based on the 1996 Periodic Emissions Inventory (PEI). The PEI is done every 3 years. The draft 1999 PEI will be available during summer 2001.

*Continued on next page*

**VOC, $NO_x$, CO, and $SO_2$ emissions sources**

VOC, $NO_x$, CO, and $SO_2$ emissions are produced from the source categories described below:

- Point: a stationary source of air pollution, primarily from smokestacks in manufacturing facilities and power plants.
- Area: small point sources too numerous to measure individually, such as gas stations, dry cleaners, and consumer products. Taken in the aggregate they may release a substantial amount of emissions.
- On-Road Mobile: a category of mobile sources that includes common on-road vehicles such as autos, trucks, motorcycles, and buses.
- Off-Road Mobile: a category of mobile sources that comprises engines that are not usually operated on a road, such as construction equipment, boats, snowmobiles, and lawnmowers.

**VOC emissions trends**

Total VOC emissions were reduced by 10% during the period 1990-1996. Figure 57 shows the composite VOC emissions trends for the period.

On-road mobile VOC emissions were reduced by 28% even though the vehicle miles traveled (VMT) increased 11% during the period. The on-road mobile reduction is attributed to the Federal Motor Vehicle Control Program, the California Low Emission Vehicle Program (adopted by Massachusetts in 1995), the Basic Inspection and Maintenance (I/M) Program, Stage II vapor recovery for gas stations, and reformulated (lower volatility) gasoline.

The off-road mobile emissions increased by 30%. This is likely due to a revision of the Non-Road Emission Estimation Model used to calculate emissions for 1996. The USEPA did not require emissions for 1990 and 1993 to be recalculated.

**Composite VOC Emissions 1990-1996**

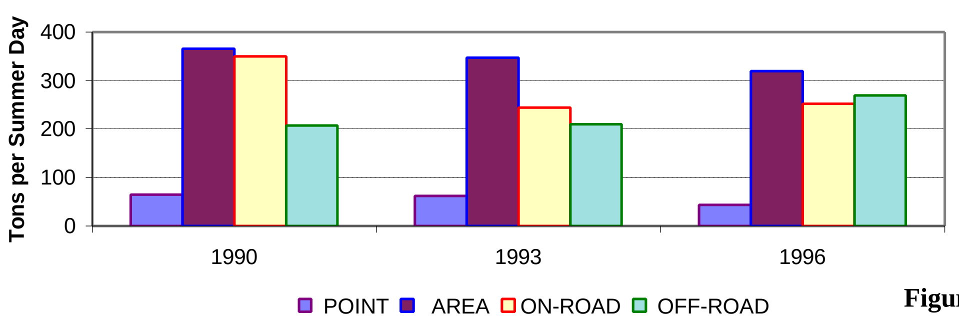



**Figure 57**

The emission trends presented in Figures 57 to 60 are based on the 1996 Periodic Emissions Inventory (PEI). The PEI is done every 3 years. The draft 1999 PEI will be available during summer 2001.

*Continued on next page*

**$NO_x$ emissions trends**

Total $NO_x$ emissions increased by 4% during the period 1990-1996. Figure 58 shows the composite $NO_x$ emissions trends for the period.

Point source emissions, primarily electric utilities, were reduced by 51% for this period. On-road and off-road mobile emissions increased by 22% and 61% respectively. The on-road increase is attributable to the 11% increase in VMT. Also, the 1990 to 1996 on-road mobile source controls targeted VOC emissions, and therefore had little effect on $NO_x$ emissions. $NO_x$ controls for mobile sources have been put in place more recently, and their effect will be reflected as the vehicle fleet turns over. The off-road increase resulted from the revised Non-Road Emission Estimation Model used to calculate emissions for 1996.

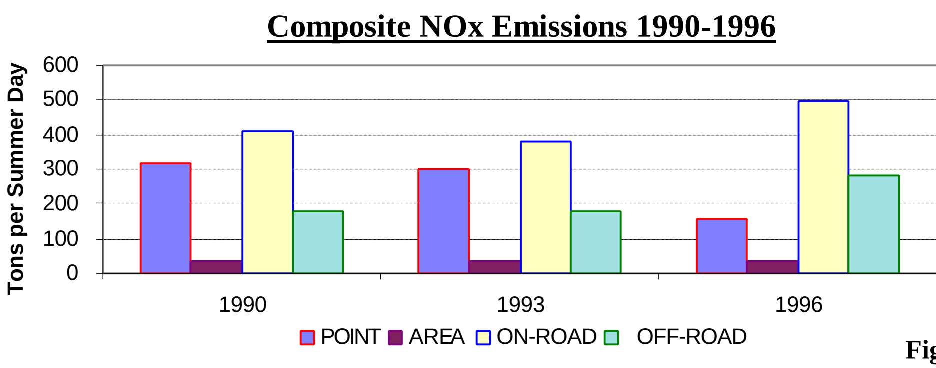



**Figure 58**

**CO emissions trends**

Total CO emissions were reduced by 5% during the period 1990-1996. Figure 59 shows the composite CO emissions trends for the period.

On-road mobile emissions decreased by 32% for this period. Because on-road vehicles contribute the lion's share of CO emissions, the decrease in emissions offsets the 47% increase in off-road emissions. Again, this off-road increase in emissions is due to the revised Non-Road Emission Estimation Model used to calculate emissions for 1996.

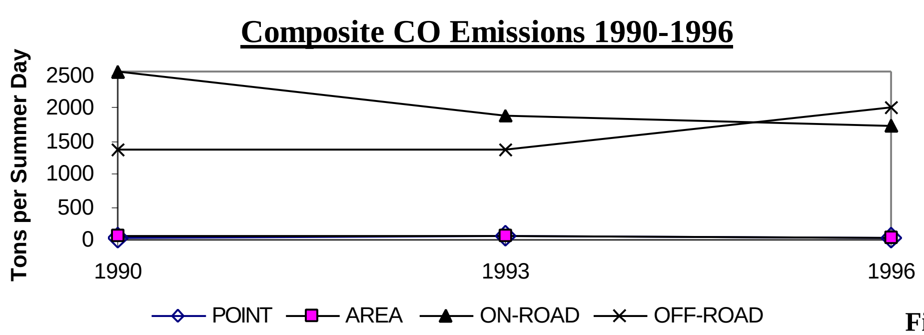



**Figure 59**

*Continued on next page*

**On-road mobile source emissions trends**

Figure 60 shows the 1990-1996 trends for on-road mobile VOC and $NO_x$ emissions, together with daily vehicle miles traveled (DVMT).

The VOC emissions decreased by 28% despite an increase of 11% in DVMT. This is a reflection of the effective on-road mobile source control programs that were instituted during the period.

$NO_x$ emissions increased by 22%, because the on-road mobile source controls had been targeted toward VOC reduction. $NO_x$ controls for mobile sources have been put in place more recently, and their effect will be reflected as the vehicle fleet turns over.

**On-Road Mobile Emissions and DVMT**

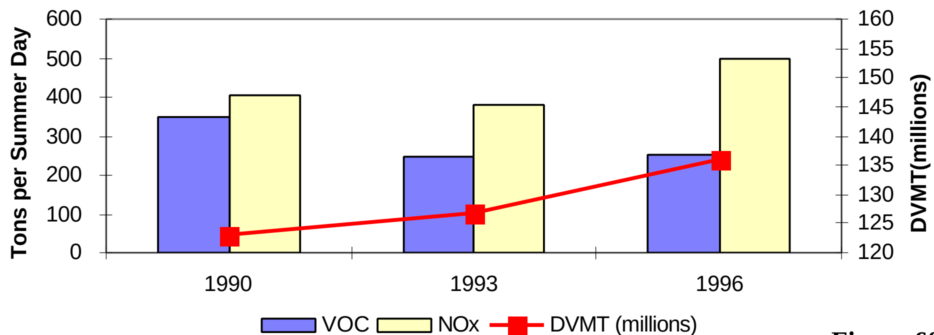



**Figure 60**

**DVMT = daily vehicle miles traveled**

# Appendix A: Public Site Location Coordinates

| CITY<br>SITE LOCATION | AIRS CODE | UTM ZONE | LOCATION COORDINATES<br>UTM (East) & (North)<br>LATITUDE & LONGITUDE |
|---|---|---|---|
| ADAMS<br>Mt. Greylock Summit | 25-003-4002 | 18 | UTM(East)650160 (North)4721890<br>LAT +42:38:12 LONG -73:10:07 |
| AGAWAM<br>152 Westfield St. | 25-013-0003 | 18 | UTM(East)692120 (North)4659040<br>LAT +42:03:42 LONG -72:40:41 |
| AMHERST<br>N. Pleasant St. | 25-015-0103 | 18 | UTM(East)703800 (North)4696975<br>LAT +42:24:01 LONG -72:31:25 |
| BOSTON<br>Kenmore Square<br>590 Commonwealth Ave. | 25-025-0002 | 19 | UTM(East)327095 (North)4690373<br>LAT +42:20:54 LONG -71:05:57 |
| BOSTON<br>Fire Headquarters<br>Southampton St. | 25-025-0012 | 19 | UTM(East)329584 (North)4688213<br>LAT +42:19:46 LONG -71:04:06 |
| BOSTON<br>Sumner Tunnel<br>East Boston | 25-025-0016 | 19 | UTM(East)332000 (North)4692500<br>LAT +42:22:07 LONG -71:02:25 |
| BOSTON<br>340 Bremen St.<br>East Boston | 25-025-0021 | 19 | UTM(East)333008 (North)4693531<br>LAT +42:22:41 LONG -71:01:42 |
| BOSTON<br>Fire Station<br>200 Columbus Ave. | 25-025-0024 | 19 | UTM(East)329406 (North)4690316<br>LAT +42:20:55 LONG -71:04:16 |
| BOSTON<br>1 City Square<br>Charlestown | 25-025-0027 | 19 | UTM(East)330090 (North)4693015<br>LAT +42:22:22 LONG -71:03:49 |
| BOSTON<br>Post Office Square | 25-025-0038 | 19 | UTM(East)330840 (North)4691500<br>LAT +42:21:34 LONG -71:03:15 |
| BOSTON<br>Long Island Hospital Road | 25-025-0041 | 19 | UTM(East)337656 (North)4686725<br>LAT +42:19:03 LONG -70:58:12 |
| BOSTON<br>Harrison Ave.<br>Roxbury | 25-025-0042 | 19 | UTM(East)328394 (North)4688242<br>LAT +42:19:46 LONG -71:04:58 |
| BROCKTON<br>120 Commercial St | 25-023-0004 | 19 | UTM(East)333300 (North)4660379<br>LAT +42:04:47 LONG -71:00:55 |
| CHELSEA<br>Soldier’s Home<br>Powder Horn Hill | 25-025-1003 | 19 | UTM(East)332910 (North)4696126<br>LAT +42:24:06 LONG -71:01:52 |
| CHICOPEE<br>Westover Air Force Base | 25-013-0008 | 18 | UTM(East)701792 (North)4674012<br>LAT +42:11:39 LONG -72:33:22 |
| EASTON<br>Borderland State Park | 25-005-1005 | 19 | UTM(East)322200 (North)4658820<br>LAT +42:03:47 LONG -71:08:56 |
| FAIRHAVEN<br>Wood School<br>Scontuit Rd. | 25-005-1002 | 19 | UTM(East)343300 (North)4610800<br>LAT +41:38:07 LONG -70:52:53 |

*Continued on next page*

| CITY<br>SITE LOCATION | AIRS CODE | UTM ZONE | LOCATION COORDINATES<br>UTM (East) & (North)<br>LATITUDE & LONGITUDE |
|---|---|---|---|
| FALL RIVER<br>Fire Headquarters<br>165 Bedford St. | 25-003-3001 | 19 | UTM(East)320961 (North)4618523<br>LAT +41:42:01 LONG -71:09:06 |
| FALL RIVER<br>Fire Station<br>Globe St. | 25-005-1004 | 19 | UTM(East)319694 (North)4616888<br>LAT +41:41:07 LONG -71:09:59 |
| FITCHBURG<br>Fitchburg State College<br>67 Rindge St. | 25-027-2004 | 19 | UTM(East)271158 (North)4719399<br>LAT +42:35:42 LONG -71:47:21 |
| HAVERHILL<br>Consentino School<br>Washington St. | 25-009-5005 | 19 | UTM(East)327700 (North)4736400<br>LAT +42:45:46 LONG -71:06:21 |
| LAWRENCE<br>Wall Experiment Station<br>37 Shattuck St. | 25-009-6001 | 19 | UTM(East)322599 (North)4729400<br>LAT +42:41:55 LONG -71:09:57 |
| LAWRENCE<br>Storrow Park<br>High St. | 25-009-0005 | 19 | UTM(East)324221 (North)4730569<br>LAT +42:42:34 LONG -71:08:47 |
| LOWELL<br>Old City Hall<br>Merrimack St. | 25-017-0007 | 19 | UTM(East)310489 (North)4723770<br>LAT +42:38:42 LONG -71:18:42 |
| LYNN<br>Lynn Water Treatment Plant<br>390 Parkland St. | 25-009-2006 | 19 | UTM(East)337855 (North)4704157<br>LAT +42:28:28 LONG -70:58:21 |
| NEW BEDFORD<br>YMCA<br>25 Water St. | 25-005-2004 | 19 | UTM(East)339500 (North)4610110<br>LAT +41:37:43 LONG -70:55:36 |
| NEWBURY<br>US Department of the Interior<br>Sunset Boulevard | 25-009-4004 | 19 | UTM(East)352040 (North)4738800<br>LAT +42:47:22 LONG -70:48:33 |
| PITTSFIELD<br>Silvio Conte Federal Building<br>78 Center St. | 25-003-5001 | 18 | UTM(East)643496 (North)4701187<br>LAT +42:27:06 LONG –73:15:18 |
| QUINCY<br>Fire Station<br>Hancock St. | 25-021-0007 | 19 | UTM(East)332391 (North)4682065<br>LAT +42:16:29 LONG -71:01:57 |
| SPRINGFIELD<br>Howard School<br>59 Howard Street | 25-013-0011 | 18 | UTM(East)699454 (North)4663358<br>LAT +42:05:56 LONG -72:35:17 |
| SPRINGFIELD<br>Liberty St. | 25-013-0016 | 18 | UTM(East)699140 (North)4664480<br>LAT +42:06:32 LONG -72:35:29 |
| SPRINGFIELD<br>Longhill St. | 25-013-1009 | 18 | UTM(East)700185 (North)4661896<br>LAT +42:05:08 LONG -72:34:47 |

*Continued on next page*

# Appendix A: Public Site Location Coordinates, Continued

| CITY<br>SITE LOCATION | AIRS CODE | UTM ZONE | LOCATION COORDINATES<br>UTM (East) & (North)<br>LATITUDE & LONGITUDE |
|---|---|---|---|
| SPRINGFIELD<br>1586 Columbus Ave. | 25-013-2007 | 18 | UTM(East)699150 (North)4663534<br>LAT +42:06:02 LONG -72:35:30 |
| STOW<br>U.S. Military Reservation | 25-017-1102 | 19 | UTM(East)295450 (North)4698475<br>LAT +42:24:49 LONG –71:29:09 |
| TRURO<br>Cape Cod National Park<br>Fox Bottom Area | 25-001-0002 | 19 | UTM(East)415100 (North)4647381<br>LAT +41:58:33 LONG -70:01:29 |
| WALTHAM<br>U. Mass Field Station<br>Beaver St. | 25-017-4003 | 19 | UTM(East)317750 (North)4694520<br>LAT +42:23:01 LONG -71:12:50 |
| WARE<br>Quabbin Summit | 25-015-4002 | 18 | UTM(East)719712 (North)4686127<br>LAT +42:17:54 LONG -72:20:05 |
| WORCESTER<br>Worcester Airport | 25-027-0015 | 19 | UTM(East)262797 (North)4684016<br>LAT +42:11:27 LONG -71:52:34 |
| WORCESTER<br>YWCA<br>2 Washington St. | 25-027-0016 | 19 | UTM(East)269108 (North)4682163<br>LAT +42:15:33 LONG -71:47:57 |
| WORCESTER<br>Fire Station<br>Central St. | 25-027-0020 | 19 | UTM(East)269152 (North)4683021<br>LAT +42:16:02 LONG -71:47:56 |
| WORCESTER<br>Grafton and Franklin Sts. | 25-027-0022 | 19 | UTM(East)269599 (North)4682294<br>LAT +42:15:39 LONG -71:47:36 |

# Appendix B: Industrial Site Location Coordinates

| REPORTING ORGANIZATION<br>CITY<br>SITE LOCATION | AIRS CODE | UTM ZONE | LOCATION COORDINATES<br>UTM (East) & (North)<br>LATITUDE & LONGITUDE |
|---|---|---|---|
| ATLANTIC GELATIN<br>Stoneham (Hill St.)<br>Hill Street | 25-017-1701 | 19 | UTM(East)326462 (North)4704385<br>LAT +42:28:28 LONG -71:06:40 |
| SITHE NEW ENGLAND<br>Boston<br>Long Island | 25-025-0019 | 19 | UTM(East)337595 (North)4686595<br>LAT +42:19:00 LONG -70:58:15 |
| SITHE NEW ENGLAND<br>Dorchester<br>Dewar Street | 25-025-0020 | 19 | UTM(East)330548 (North)4685952<br>LAT +42:18:34 LONG -71:03:22 |
| SITHE NEW ENGLAND<br>East Boston<br>Bremen Street | 25-025-0021 | 19 | UTM(East)333008 (North)4693531<br>LAT +42:22:41 LONG -71:01:42 |
| SITHE NEW ENGLAND<br>South Boston<br>East First Street | 25-025-0040 | 19 | UTM(East)331871 (North)4690009<br>LAT +42:20:46 LONG -71:02:28 |
| HAVERHILL PAPERBOARD<br>Haverhill<br>Nettle School | 25-009-5004 | 19 | UTM(East)331385 (North)4737365<br>LAT +42:46:20 LONG -71:03:40 |