Massachusetts 2014 Air Quality Report

Department of Environmental Protection
Bureau of Air and Waste
Division of Air and Climate Programs

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This 2014 Air Quality Report was prepared by the Massachusetts Department of Environmental Protection (MassDEP), Air Assessment Branch (AAB), which collects representative samples of ambient air for a number of pollutants at monitoring stations located across the Commonwealth. All samples are collected in a precise and scientifically sound manner in order to properly characterize the quality of the air in the Commonwealth and to accurately assess the exposure of its citizens to airborne pollutants.

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The photo on the cover is a view of the Greenfield site in Veteran's Field.

This report is available on MassDEP's web site at
www.mass.gov/eea/agencies/massdep/air/quality/air-monitoring-reports-and-studies.html

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List of Abbreviations

AAB ..... Air Assessment Branch
AQS ..... Air Quality System
AQI..... Air Quality Index
BAM ..... Beta Attenuation Monitor
BC ..... Black Carbon
BP..... Barometric Pressure
CAA ..... Clean Air Act
CFR..... Code of Federal Regulations
CO ..... Carbon Monoxide
CO_2..... Carbon Dioxide
FEM ..... Federal Equivalent Method
FRM ..... Federal Reference Method
EPA..... United States Environmental Protection Agency
IMPROVE ..... Interagency Monitoring of Protected Visual Environments
MassDEP ..... Massachusetts Department of Environmental Protection
NAAQS..... National Ambient Air Quality Standards (for criteria pollutants)
NATTS..... National Air Toxics Trends Station
NCore..... National Core Monitoring Network
NO..... Nitric Oxide
NO_x ..... Nitrogen Oxides
NO_y ..... Total Reactive Oxidized Nitrogen
NO_2 ..... Nitrogen Dioxide
NO_3 ..... Nitrate
O_3 ..... Ozone
PAH ..... Polycyclic Aromatic Hydrocarbon
PAMS..... Photochemical Assessment Monitoring Stations
Pb ..... Lead
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 aerodynamic diameter
PM_{10} ..... Particulate matter ≤ 10 microns aerodynamic diameter
QA/QC ..... Quality Assurance and Quality Control
RASS ..... Radio Acoustic Sounding System
RH..... Relative Humidity
SIP..... State Implementation Plan
SO_2 ..... Sulfur Dioxide
SO_4 ..... Sulfate
Solar Rad..... Solar Radiation
SVOC..... Semi-Volatile Organic Compounds
TSA..... Technical Systems Audit
TSP..... Total Suspended Particulates
$\mu g/m^3$..... micrograms per cubic meter
VOCs ..... Volatile Organic Compounds
WS/WD..... Wind Speed/Wind Direction

Section I
Ambient Air Monitoring Program

Program Overview

Introduction

The Massachusetts Department of Environmental Protection (MassDEP) is the state agency responsible for monitoring outdoor air quality in Massachusetts and developing plans and regulatory programs to reduce emissions of pollutants that adversely affect public health, welfare, and the environment.

MassDEP's Air Assessment Branch (AAB) operates an extensive network of air monitoring stations throughout the Commonwealth. During 2014, MassDEP operated a network of 30 monitoring stations located in 20 cities and towns, and oversaw the operation of one source-oriented privately-funded site in the Boston area (which closed in June). MassDEP also received data from the Wampanoag Tribe of Gay Head (Aquinnah), which operates an air monitoring station on Martha's Vineyard.

MassDEP submits all ambient air quality data to the national Air Quality System (AQS) database that is administered by the U.S. Environmental Protection Agency (EPA). In addition, MassDEP's MassAir Online website allows users to point and click on a map of the state to find current, near real-time air quality data for any location in the MassDEP air monitoring network that has a continuous air monitor. MassAir Online is found at www.mass.gov/eea/agencies/massdep/air/quality/

Why is Air Quality Data Collected?

Ambient air quality data is used for a number of purposes, including to:

- Provide information about air quality to the public;
- Provide short-term and long-term information regarding air pollution and public health;
- Verify compliance with National Ambient Air Quality Standards;
- Assess the effectiveness of current air pollution control regulations and initiatives;
- Support development of policies and regulations aimed at reducing air pollution;
- Support long-term trend analysis and special research; and
- Fulfill requirements to report ambient air quality data to EPA.

What is Monitored?

MassDEP monitors parameters in the following categories:

Criteria pollutants for which EPA has established National Ambient Air Quality Standards (NAAQS). The criteria pollutants monitored are:

- sulfur dioxide (SO_2)
- ozone (O_3)
- carbon monoxide (CO)
- nitrogen dioxide (NO_2)
- lead (Pb)
- particulate matter $\leq$10 microns (PM_{10})
- particulate matter $\leq$ 2.5 microns ($PM_{2.5}$)

Non-criteria pollutants do not have National Ambient Air Quality Standards, but can contribute to the formation of ozone and particulate matter and/or be toxic. The non-criteria pollutants monitored include:

- nitric oxide (NO)
- total nitrogen oxides (NO_x)
- total reactive oxidized nitrogen (NO_y)
- total suspended particulates (TSP)
- volatile organic compounds (VOCs) – ozone precursors and reaction product chemicals
- black carbon (i.e., soot)
- toxics – health-relevant VOCs, semi-volatile organic compounds (SVOCs), carbonyls and metals

Meteorological parameters monitored include:

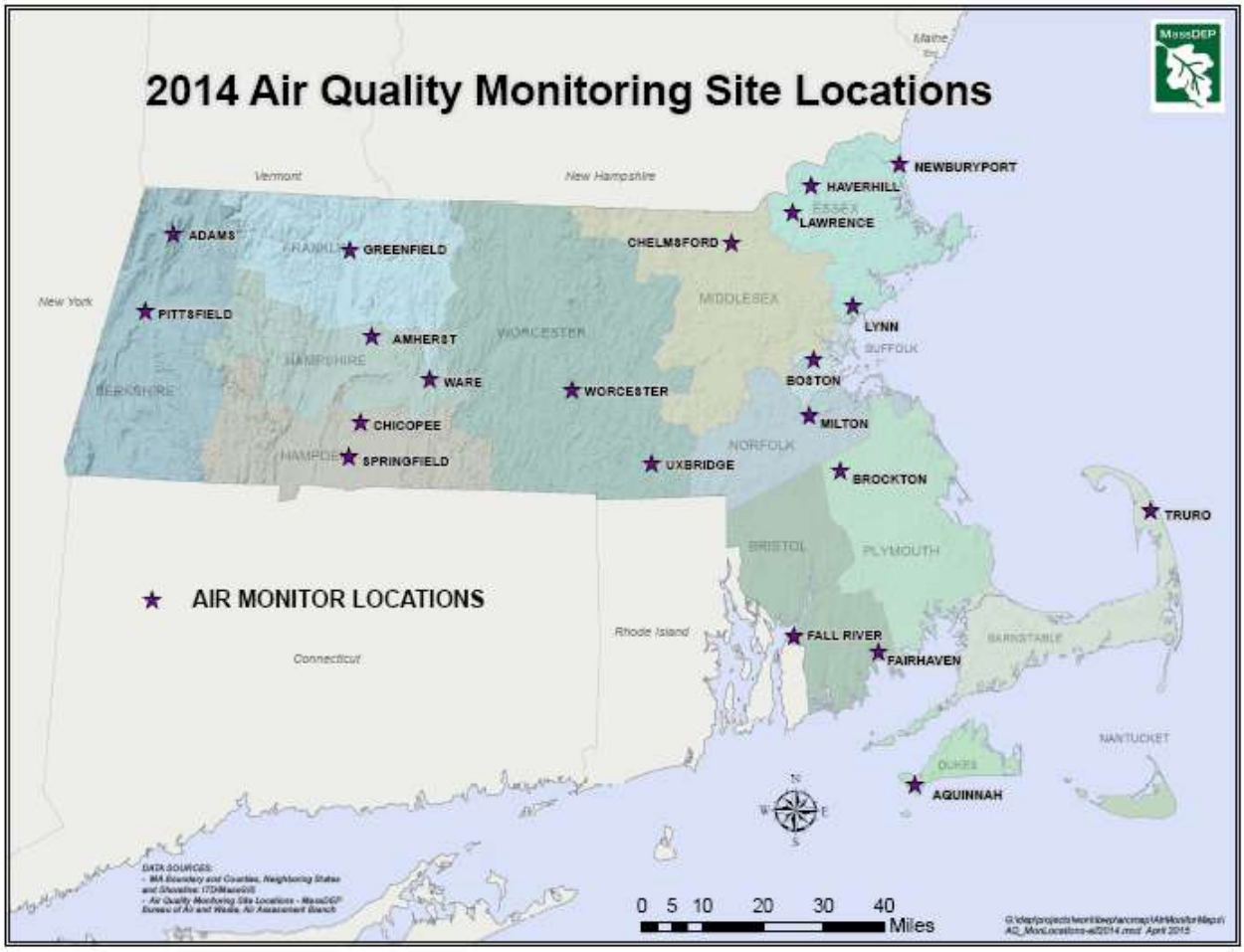
- wind speed/wind direction (WS/WD)
- relative humidity (RH)
- temperature (TEMP)
- barometric pressure (BP)
- solar radiation (Solar Rad)
- precipitation (PRECIP)

Monitoring Station Locations

Monitoring stations are sited to provide data for various purposes. Some are located where maximum pollutant concentrations are expected, while others are located in areas that will provide data that is representative of larger geographical areas. Local topography and the location of pollutant sources are factors that determine how well a particular monitor's location will represent an area.

Networks of monitors are located throughout the state. These networks are designed to reflect pollutant concentrations for all of Massachusetts. Section III of this report contains data summaries for each pollutant measured and maps showing the monitor locations for each network. Appendix A contains a list of monitor locations.

The map on page 3 shows Massachusetts cities and towns where air monitors were located during 2014.


2014 Air Quality Monitoring Site Locations
MassDEP
Maine
Vermont
New Hampshire
New York
Connecticut
Rhode Island
NEWBURYPORT
HAVERHILL
LAWRENCE
ESSEX
ADAMS
FRANKLIN
GREENFIELD
CHELMSFORD
MIDDLESEX
PITTSFIELD
AMHERST
WORCESTER
HAMPSHIRE
BERKSHIRE
WARE
WORCESTER
LYNN
SUFFOLK
BOSTON
MILTON
CHICOPEE
SPRINGFIELD
HAMPDEN
NORFOLK
UXBRIDGE
BROCKTON
TRURO
BRISTOL
PLYMOUTH
AIR MONITOR LOCATIONS
FALL RIVER
FAIRHAVEN
BARNSTABLE
NANTUCKET
DUKES
AQUINNAH
N
W
E
S
0 5 10 20 30 40
Miles

National Ambient Air Quality Standards

Below are the current National Ambient Air Quality Standards for criteria pollutants set by EPA. **Primary Standards** are designed to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. **Secondary Standards** are designed to protect public welfare, including protection against decreased visibility, damage to crops, vegetation, and buildings.

National Ambient Air Quality Standards					
Pollutant		**Primary/ Secondary**	**Averaging Time**	**Level**	**Form**
Carbon Monoxide		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead		primary and secondary	Rolling 3 month average	0.15 µg/m^3	Not to be exceeded
Nitrogen Dioxide		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		primary and secondary	Annual	0.053 ppm	Annual Mean
Ozone		primary and secondary	8-hour	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution	$PM_{2.5}$	primary	Annual	12 µg/m^3	annual mean, averaged over 3 years
		secondary	Annual	15 µg/m^3	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide		primary	1-hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

µg/m^3 = micrograms per cubic meter; ppm = parts per million; ppb = parts per billion

Pollutant Health Effects and Sources

Ozone (O_3)

- Ground-level, or Tropospheric O_3 and Stratospheric O3 in the upper atmosphere are the same chemical compound, just found at different places in the atmosphere. Stratospheric O_3 found at greater than 30,000 feet above the surface of the earth is beneficial to all life because it filters out the sun's harmful UV radiation before it reaches the earth's surface. Ground-Level O3 on the other hand is a health and environmental problem. This report pertains exclusively to ground-level O3.
- O3 is a respiratory irritant and can reduce lung function and cause asthma attacks, nasal congestion, and throat irritation, and reduce resistance to infection. It can inflame and damage (possibly permanently) cells that line the lungs, and aggravate chronic lung diseases. In addition, a number of studies have found a strong link between increases in ground-level O_3 and increased risk of premature death.
- O_3 is toxic to vegetation, inhibiting growth and causing leaf damage.
- O_3 deteriorates materials such as rubber and fabrics.
- Ground-level O_3 is unique in that it is formed by the reactions that occur between certain pollutants in the presence of intense, high-energy sunlight during the hot summer months. The complexity of the reactions and the amount of time needed to complete these reactions can result in the buildup of ground-level ozone concentrations far downwind from the original source of the precursors.
- Sources of ground-level O_3 precursors, i.e., nitrogen oxides and hydrocarbons, include motor vehicles, lawn and garden equipment, power plants and other industrial sources.

Carbon Monoxide (CO)

- CO binds with hemoglobin in the blood, reducing the amount of oxygen carried to organs and tissues.
- Symptoms of high CO exposure include shortness of breath, chest pain, headaches, confusion, and loss of coordination. The health threat is most severe for those with cardiovascular disease.
- Motor vehicle emissions are the largest source of CO, which is produced from incomplete combustion of carbon in fuels.
- Industrial processes and non-transportation fuel combustion (e.g., boilers, lawn and garden equipment) also are sources of CO.

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, and diminution of visibility.
- SO_2 is a product of fuel combustion (e.g., the burning of coal and oil that contains sulfur). Sources include power plants and business and residential sources burning heating oil.

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. Impacts of acid deposition include: acidification of lakes and streams, damage to vegetation, damage to materials, and diminution 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, space heating, power plants and motor vehicles.

Particulate Matter (PM_{10} and $PM_{2.5}$)

- Particulate matter is tiny airborne particles or aerosols, which include dust, dirt, soot, smoke, and liquid droplets. Fine particulate matter (mostly below 2.5 microns in size) are not only the result of direct emissions, but can be formed in the atmosphere by chemical reactions involving gaseous pollutants.
- The numbers 2.5 and 10 refer to the particle size (actually the particles equal or less than that 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 these particles allows easy entry into the human respiratory system. Long-term exposure causes the particles to accumulate in the lungs and affects breathing and produces respiratory symptoms. The small particles can migrate through the lungs and into the circulatory system and potentially produce cardio-vascular symptoms, as well as impacts from toxic components contained in the particulate matter.
- Particulate matter causes soiling and corrosion of materials.
- Particulate matter contributes to atmospheric haze that degrades visibility.
- Sources of particulates include industrial process emissions, motor vehicles, incinerators, power plants, and other fuel combustion sources.

Lead (Pb)

- Lead is an elemental metal that is found in nature.
- Exposure to lead can occur by inhalation or ingestion with food, water, soil or dust particles.
- Children, infants, and fetuses are the most susceptible to the effects of lead exposure.
- Lead causes intellectual disability, brain damage, and liver disease. It may be a factor in high blood pressure and damages the nervous system.
- Lead enters the atmosphere from the incineration of lead containing materials and from the manufacture and processing of lead containing products or materials like storage batteries, smelting and removal of paint that contained lead.

Monitoring Network Description

The following describes the ambient air monitoring network MassDEP operated in 2014.

Network Size

- 30 monitoring stations
- 20 cities and towns with monitoring stations
- 1 Tribal monitoring site operated by the Wampanoag Tribe in Aquinnah

Number of Continuous Monitors

Continuous monitors measure air quality 24 hours per day. The data are reported as hourly means.

- Criteria pollutant monitors measure pollutants for which National Ambient Air Quality Standards (NAAQS) have been set.
  - 7 – CO (carbon monoxide), which includes 3 trace-level CO monitors
  - 11 – NO_2 (nitrogen dioxide). NO (nitric oxide) and NO_x (total nitrogen oxides) also are measured by these monitors.
  - 19 – O_3 (ozone)
  - 6 – SO_2 (sulfur dioxide), which includes 3 trace-level SO_2 monitors
  - 13 – $PM_{2.5}$ (particulate matter – 2.5 microns) Beta Attenuation Monitors (BAMs)

- Meteorological monitors track weather conditions.
  - 14 – BP (barometric pressure)
  - 14 – RH (relative humidity)
  - 14 – Solar Rad (solar radiation)
  - 14 – TEMP (temperature)
  - 14 – WS/WD (wind speed/wind direction)
  - 2 – Precipitation

- Other Monitors
  - 3– NO_y (Total Reactive Oxidized Nitrogen)
  - 4 – PAMS (photochemical assessment monitoring station). These monitors measure VOCs (volatile organic compounds) using automated gas chromatographs (GCs) on an hourly basis during the summer.
  - 5 – 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 measure pollutants that have National Ambient Air Quality Standards (NAAQS).
  - 3 – Pb (Lead)
  - 7 – PM_{10} (particulate matter – 10 microns)
  - 18– $PM_{2.5}$ FRM (particulate matter – 2.5 microns Federal Reference Method)

- Non-criteria pollutant monitors measure pollutants that do not have NAAQS.
  - 4 – PAMS (photochemical assessment monitoring station). These monitors measure VOCs (volatile organic compounds) on a less intensive schedule than during the summer months.
  - 2 – Toxics. These monitors measure health-relevant VOCs.
  - 2 – Speciation. These monitors measure for $PM_{2.5}$, nitrates, and organics
  - 1 – PM_{10} (particulate matter – 10 microns) for metals analysis

In addition to MassDEP's monitoring network, MassDEP oversaw one private monitoring station located in Boston that submits data to MassDEP. The station monitors SO_2, SO_4, TSP, and NO_2 (as well as NO_x and NO) and wind speed/wind direction and closed in June 2014.

Section II
Attainment of Air Quality Standards

Attainment Status Summary

The Clean Air Act (CAA) contains timeframes and milestones for states to meet and maintain National Ambient Air Quality Standards (NAAQS) for criteria pollutants, which include carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide. EPA sets NAAQS at levels to protect public health and the environment. EPA must review each NAAQS every five years and may update the standards based on new scientific information as well as establish new monitoring requirements. Each state is required to monitor the ambient air to determine whether it meets each standard.[1] If monitoring shows that the air quality does not meet a standard, the state must develop and implement pollution control strategies to attain that standard. Once air quality meets a standard, a state must develop a plan to maintain that standard while accounting for future economic and emissions growth. Taken together, these plans and control strategies constitute the State Implementation Plan (SIP).

Carbon Monoxide

Prior to the mid-1980s, Massachusetts was in nonattainment of the CO standards. However, with the adoption of numerous control programs, CO emissions significantly decreased and monitored levels of CO met the standards in 1987. All of Massachusetts is designated as attainment of the CO standards.

Lead

In October 2008, EPA lowered the lead standard from 1.5 µg/m³ to 0.15 µg/m³ averaged over a rolling 3-month period. In November 2011, EPA designated all of Massachusetts as unclassifiable/attainment for the 2008 standard.

Nitrogen Dioxide

In January 2010, EPA established a new 1-hour NO_2 standard of 100 parts per billion (ppb) and new near-road monitoring requirements beginning in January 2014. In January 2012, EPA designated all of Massachusetts as unclassifiable/attainment.

Sulfur Dioxide

In June 2010, EPA established a new 1-hour SO_2 standard of 75 ppb. All six SO_2 monitors in Massachusetts show levels below the standard. EPA has proposed rules for determining designations for areas where existing monitors meet the SO_2 standard that focus on characterizing SO_2 levels around the largest sources of across the country.

[1] MassDEP develops an annual Ambient Air Monitoring Network Plan that describes recent and planned changes to the statewide monitoring network, available at www.mass.gov/eea/agencies/massdep/air/reports/annual-ambient-air-quality-monitoring-network-plan.html .

Particulate Matter

There are currently two NAAQS particulate matter standards: PM_{10} and $PM_{2.5.}$ Massachusetts has been in attainment of the PM_{10} standard for decades. Massachusetts is designated as unclassifiable/attainment of the 1997 and 2006 $PM_{2.5}$ standards statewide. On December 14, 2012, EPA lowered the primary annual $PM_{2.5}$ standard to 12 $\mu g/m^3$ (from 15 $\mu g/m^3$). In December 2013, Massachusetts requested that EPA designate all of the Commonwealth as attainment of the 2012 annual standard based on $PM_{2.5}$ monitoring data that shows levels below the standard statewide. In December 2014, EPA designated all of Massachusetts as unclassifiable/attainment.

Ozone

For decades, the NAAQS for ozone was based on the maximum 1-hour ozone concentration that occurred each day during the ozone monitoring season. 1-hour ozone concentrations are still tracked as an indicator but are no longer used for determining attainment.

In 1997, EPA promulgated a new 8-hour ozone standards that was designed to be more representative of exposure over time, rather than just the maximum concentration. Massachusetts was designated as nonattainment of this standard. However, ozone monitors currently show that Massachusetts meets the 1997 ozone standard statewide.

In 2008, EPA lowered the 8-hour ozone standard to 0.075 ppm. In April 2012, EPA designated Dukes County as nonattainment (marginal classification) of the 2008 ozone standard and designated the remainder of the Commonwealth as unclassifiable/attainment. Based on the most recent monitoring data, Dukes County now meets the 2008 ozone standard. However, EPA is expected to finalize a new lower ozone standard by October 1, 2015, which could result in new nonattainment areas in Massachusetts.

2014 Ozone Season

In 2014 there were no days when the ozone standard of 0.075 ppm was exceeded at any monitor in Massachusetts, which is the first time an ozone season has had no exceedances since MassDEP began monitoring ozone. Based on the most recent 3-years of data from 2012–2014, there also were no violations of the 0.075 ppm standard in Massachusetts.

In general, the chemical reactions that produce elevated ozone concentrations occur when there are high levels of ozone "precursor" pollutants – VOCs and NOx – on hot sunny days. Typically, Massachusetts ozone exceedances occur when a high pressure area well south of New England creates a broad southwesterly airflow that travels along the coastal urban corridor before reaching New England, where it arrives with elevated levels of VOCs, NOx, and ozone. This typical pattern also moves slowly, promoting heat wave conditions that can last several days, allowing pollutants to build up.

In the summer of 2014, the high pressure area mainly resided well out over the ocean, and this resulted in air trajectories that originated and tracked mostly over the ocean before reaching Massachusetts. The result was a summer in Massachusetts without a single heat wave, which is unusual. These meteorological conditions, combined with an overall downward trend in pollutant emissions due to state and federal air pollution control programs, such as smokestack controls, cleaner fuels, and cleaner cars and trucks – was sufficient to suppress ozone formation.

Difference Between Ozone Exceedances and Violations

An **ozone exceedance** occurs when monitored ozone concentrations exceed the ozone National Ambient Air Quality Standards (NAAQS). Ozone monitoring data is collected as an hourly average of continuous data which is then used to determine the highest 8-hour average value for the day. An exceedance of the 8-hour standard is an 8-hour averaged value that is greater than 0.075 ppm. An ozone exceedance occurs when a monitor records ambient levels of ozone above the standard. Monitoring an ozone exceedance does not mean that a violation of the ozone standard has occurred, because a violation of an ozone standard (as opposed to an exceedance) is based on 3-year averages of data at each monitor.

An **ozone violation** of the 8-hour standard is determined using the annual 4th-highest daily maximum 8-hour ozone value at each monitor. A violation requires a 3-year average of the annual 4th-highest daily maximum 8-hour value that is greater than 0.075 ppm. In other words, the 8-hour values for each day during a year for a specific monitor are ranked from highest to lowest. Then, the 4th-highest value for 3 consecutive years is averaged. If the 3-year average is greater than 0.075 ppm, a violation of the 8-hour standard has occurred at that monitoring site.

Exceedance Days and Total Exceedance Trends

Figures 1 and 2 show the trend in the number of 1-hour and 8-hour exceedance days and the total number of exceedances for each year.

Figure 1 shows a decline in the number of days in which ozone concentrations exceeded the former 1-hour standard of 0.12 ppm. Figure 2 shows that, under the 0.075 ppm 8-hour standard, there were a greater number of exceedances and exceedance days when compared to the former 1-hour standard. The 8-hour standard is designed to be more protective of public health by being more representative of exposure over time rather than a maximum concentration.

Figure 1
1-hr Ozone Exceedance Days and Total Exceedances 1987-2014
1-hour standard = 0.12 ppm (revoked June 15, 2005)

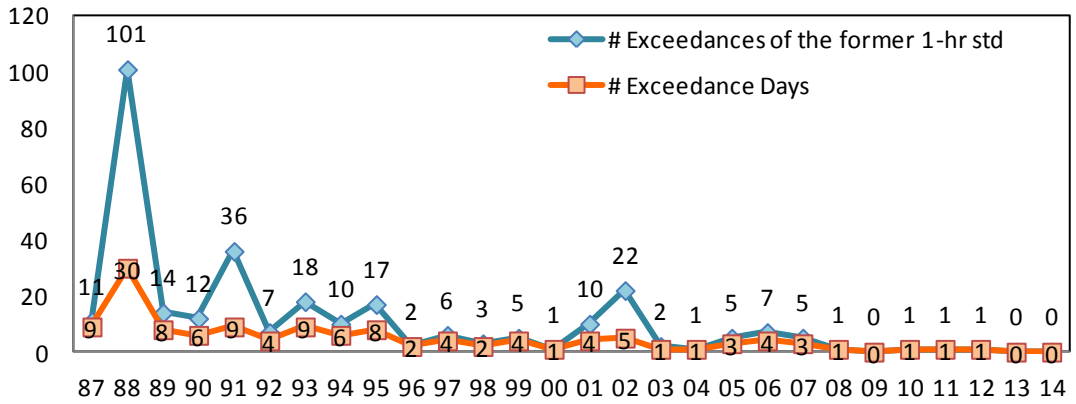
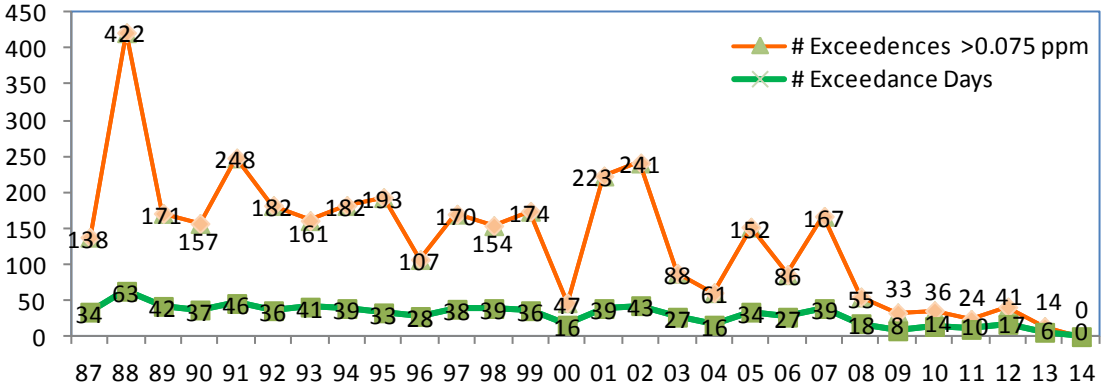


Figure 2
8-hr Ozone Exceedance Days and Total Exceedances 1987-2014
8-hour standard = 0.075 ppm
Years 1987-2007 show what exceedances
would have been with a 0.075 ppm 8-hour standard



Daily Ozone and PM Forecasts

MassDEP provides the public with daily air quality forecasts for ozone from April through September and for fine particles all year round using weather maps and meteorological factors to predict whether or not conditions will result in elevated pollution levels. The daily air quality forecasts are available from www.mass.gov/eea/agencies/massdep/air/quality/ or by calling the Air Quality Hotline (1-800-882-1497). EPA web sites that contain regional and national pollution forecasts using data that is provided by participating states are located at www.epa.gov/region01/airquality/forecast.html and http://airnow.gov/. The table below describes the ratings used in the daily air quality forecasts.

Air Quality Index (AQI): Ozone

Index Values	Levels of Health Concern	Cautionary Statements
0-50	Good	None
51-100*	Moderate	Unusually sensitive people should consider reducing prolonged or heavy exertion outdoors.
101-150	Unhealthy for Sensitive Groups	Active children and adults, and people with lung disease, such as asthma, should reduce prolonged or heavy exertion outdoors.
151-200	Unhealthy	Active children and adults, and people with lung disease, such as asthma, should avoid prolonged or heavy exertion outdoors. Everyone else, especially children, should reduce prolonged or heavy exertion outdoors.
201-300	Very Unhealthy	Active children and adults, and people with lung disease, such as asthma, should avoid all outdoor exertion. Everyone else, especially children, should avoid prolonged or heavy exertion outdoors.

* An AQI of 100 for ozone corresponds to an ozone level of 0.075 parts per million (averaged over 8 hours).

Air Quality Index (AQI): Particle Pollution

Index Values	Levels of Health Concern	Cautionary Statements
0-50	Good	None
51-100*	Moderate	Unusually sensitive people should consider reducing prolonged or heavy exertion.
101-150	Unhealthy for Sensitive Groups	People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.
151-200	Unhealthy	People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion.
201-300	Very Unhealthy	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.

*An AQI of 100 for particles up to 2.5 micrometers in diameter corresponds to a level of 35 micrograms per cubic meter (averaged over 24 hours). An AQI of 100 for particles up to 10 micrometers in diameter corresponds to a level of 150 micrograms per cubic meter (averaged over 24 hours).

Section III
Massachusetts Air Quality Data Summaries

Ozone Summary

2014 Ozone Data Summary

A summary of the data collected during the 2014 ozone season (April 1 – Sept. 30) is shown below (in parts per million). MassDEP operated 18 ozone sites during 2014. The Wampanoag Tribe operated one site in Aquinnah on Martha's Vineyard. All sites achieved the requirement of 75% or greater data capture for the year, except the Amherst site which was closed in June.

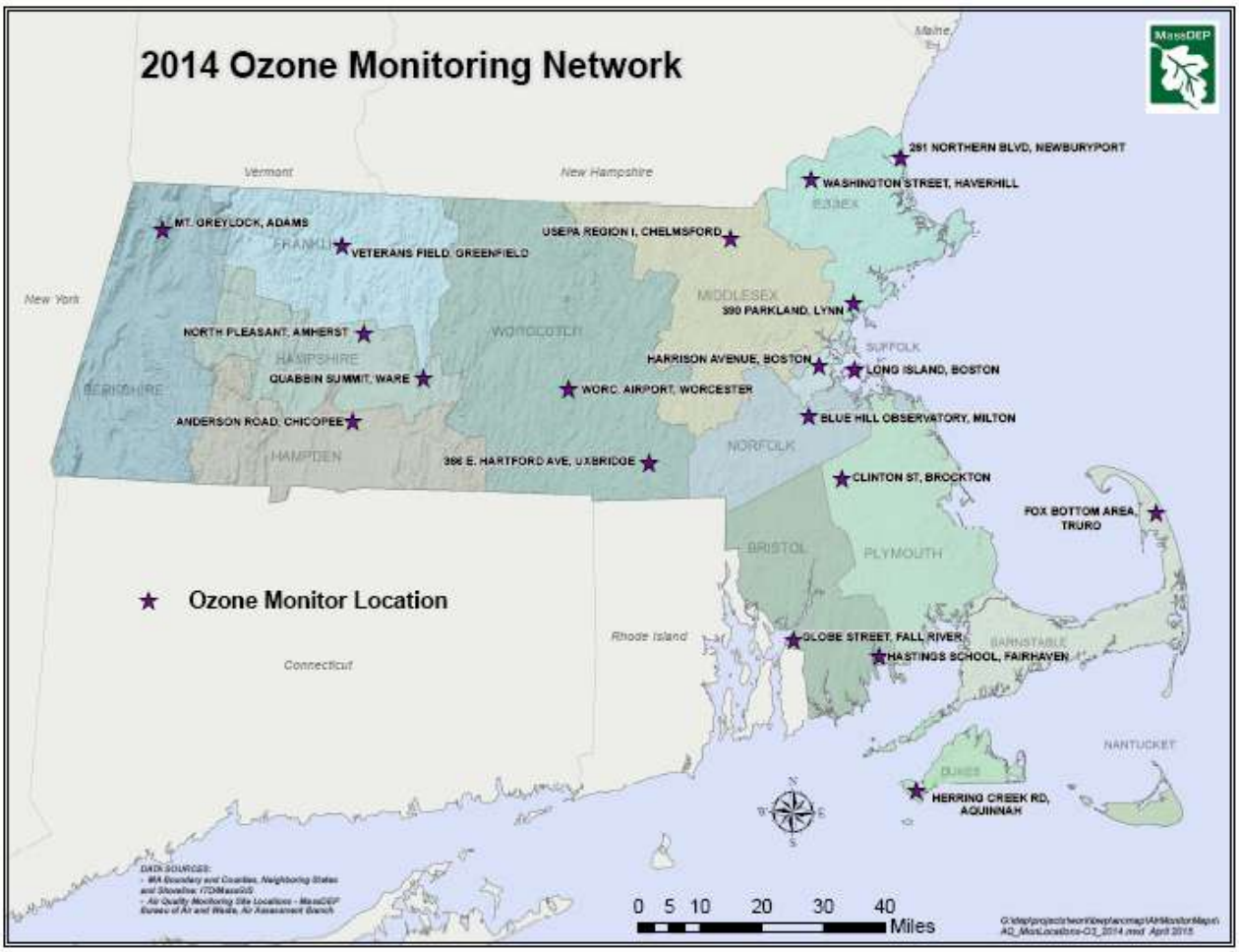
SITE ID	CITY	COUNTY	ADDRESS	% OBS	1ST MAX 1-HR	2ND MAX 1-HR	1-HR MAX>.125 STD	1ST MAX 8-HR	2ND MAX 8-HR	3RD MAX 8-HR	4TH MAX 8-HR	8-HR MAX>.075 STD
25-003-4002	Adams	Berkshire	ROUTE 8 ADAMS	98	.074	.072	0	.066	.066	.065	.063	0
25-007-0001	Aquinnah	Dukes	1 HERRING CREEK RD	95	.075	.067	0	.066	.062	.059	.059	0
25-025-0041	Boston	Suffolk	LONG ISLAND	97	.081	.071	0	.065	.062	.061	.060	0
25-025-0042	Boston	Suffolk	HARRISON AVE	98	.073	.065	0	.056	.054	.054	.054	0
25-023-0005	Brockton	Plymouth	1 CLINTON ST	99	.076	.073	0	.066	.065	.064	.060	0
25-017-0009	Chelmsford	Middlesex	11 TECHNOLOGY	97	.080	.075	0	.069	.064	.064	.064	0
25-013-0008	Chicopee	Hampden	ANDERSON RD AFB	92	.096	.087	0	.070	.066	.066	.065	0
25-005-1006	Fairhaven	Bristol	30 SCHOOL ST	96	.075	.072	0	.062	.061	.058	.058	0
25-005-1004	Fall River	Bristol	659 GLOBE ST	98	.076	.075	0	.065	.064	.061	.060	0
25-011-2005	Greenfield	Franklin	VETERANS FIELD	98	.076	.073	0	.067	.062	.061	.058	0
25-009-5005	Haverhill	Essex	685 WASHINGTON	98	.076	.073	0	.065	.065	.064	.064	0
25-009-2006	Lynn	Essex	390 PARKLAND	99	.083	.076	0	.073	.066	.064	.063	0
25-021-3003	Milton	Norfolk	BLUE HILL OBSERV	98	.086	.083	0	.072	.071	.068	.067	0
25-009-4005	Newburyport	Essex	HARBOR STREET	96	.079	.072	0	.067	.067	.066	.064	0
25-015-0103	North Amherst	Hampshire	N PLEASANT ST	52	.075	.073	0	.065	.064	.063	.061*	0
25-001-0002	Truro	Barnstable	FOX BOTTOM AREA	98	.077	.069	0	.065	.062	.060	.059	0
25-027-0024	Uxbridge	Worcester	366 E HARTFORD DR	98	.084	.080	0	.069	.066	.065	.064	0
25-015-4002	Ware	Hampshire	QUABBIN SUMMIT	99	.093	.085	0	.070	.069	.069	.068	0
25-027-0015	Worcester	Worcester	375 AIRPORT	98	.085	.082	0	.075	.070	.066	.065	0

STANDARDS: 8-hour = 0.075 ppm

Note: * indicates that the mean does not satisfy the summary criteria.

ABBREVIATIONS AND SYMBOLS USED IN TABLE

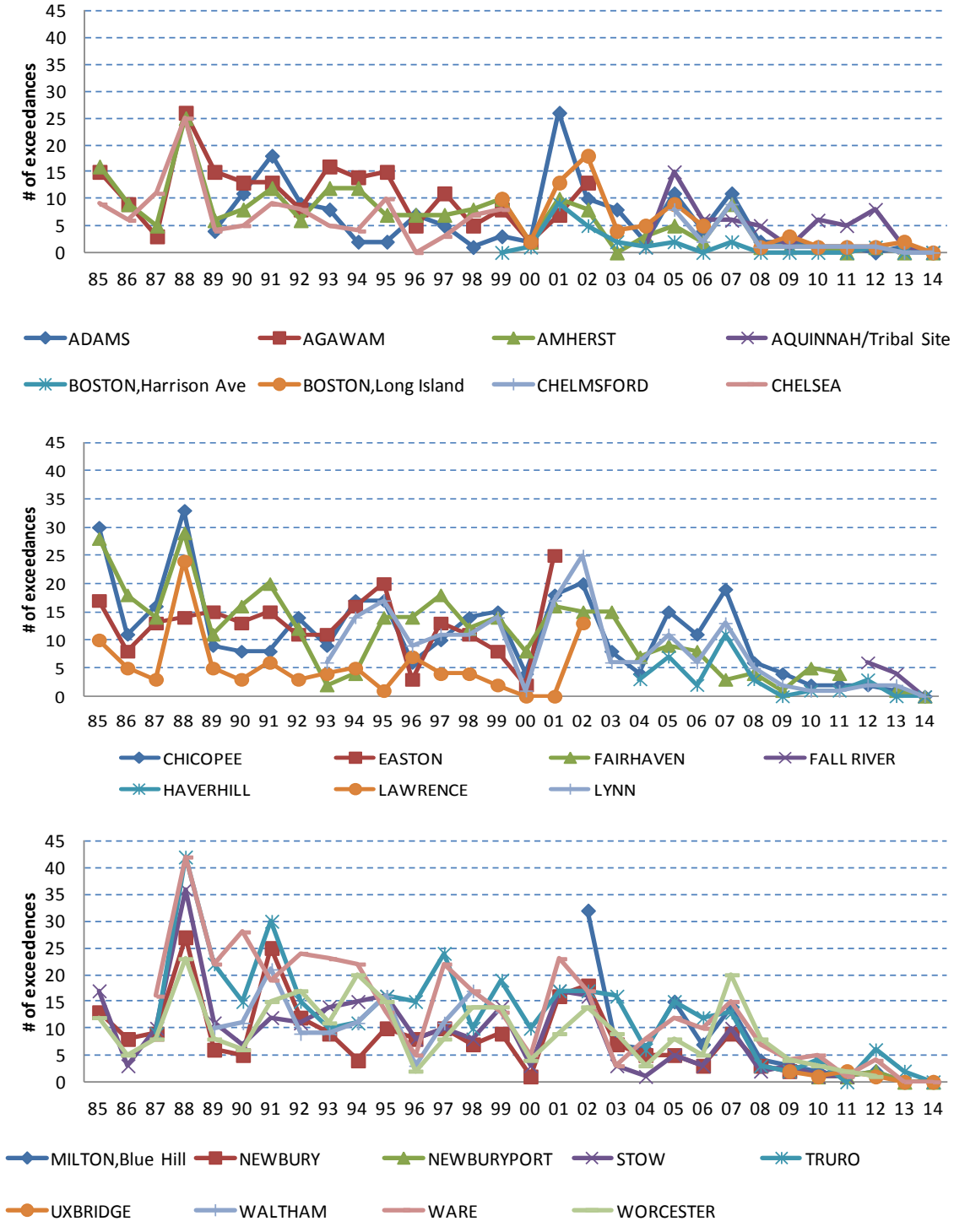
SITE ID = AIRS SITE IDENTIFICATION NUMBER; **% OBS** = PERCENTAGE OF VALID DAYS MONITORED DURING O3 SEASON; **1ST, 2ND MAX 1-HR** = MAXIMUM 1-HR VALUE FOR THE 1ST & 2ND HIGHEST DAY; **1-HR MAX > .125 STD** = NUMBER OF MEASURED DAILY 1-HOUR MAXIMUM VALUES GREATER THAN 0.12 PPM (FORMER 1-HR STANDARD); **1ST, 2ND, 3RD & 4TH MAX 8-HR** = MAXIMUM 8-HR VALUE FOR THE 1ST, 2ND, 3RD & 4TH HIGHEST DAY; **8-HR MAX > .075 STD** = NUMBER OF MEASURED DAILY 8-HOUR MAXIMUM VALUES GREATER THAN 0.075 PPM 8-HR STANDARD


2014 Ozone Monitoring Network
MassDEP
Maine
Vermont
New Hampshire
New York
Connecticut
Rhode Island
251 NORTHERN BLVD, NEWBURYPORT
WASHINGTON STREET, HAVERHILL
ESSEX
MT. GREYLOCK, ADAMS
FRANKLIN
VETERANS FIELD, GREENFIELD
USEPA REGION I, CHELMSFORD
MIDDLESEX
390 PARKLAND, LYNN
NORTH PLEASANT, AMHERST
WORCESTER
HAMPSHIRE
SUFFOLK
HARRISON AVENUE, BOSTON
LONG ISLAND, BOSTON
QUABBIN SUMMIT, WARE
BERKSHIRE
WORC. AIRPORT, WORCESTER
BLUE HILL OBSERVATORY, MILTON
ANDERSON ROAD, CHICOPEE
NORFOLK
HAMPDEN
396 E. HARTFORD AVE, UXBRIDGE
CLINTON ST, BROCKTON
FOX BOTTOM AREA, TRURO
BRISTOL
PLYMOUTH
Ozone Monitor Location
GLOBE STREET, FALL RIVER
BARNSTABLE
HASTINGS SCHOOL, FAIRHAVEN
NANTUCKET
DUKES
HERRING CREEK RD, AQUINNAH
N
W
E
S
DATA SOURCES:
0 5 10 20 30 40
Miles

8-hour Ozone Exceedance Trends

Shown below are the long-term trends of 8-hour ozone exceedances for each site based on the 2008 standard of 0.075 ppm.

Figure 3
8-hour Ozone Exceedance Trends 1985 – 2014
Standard = 0.075 ppm



Sulfur Dioxide (SO_2) Summary

2014 SO_2 Data Summary

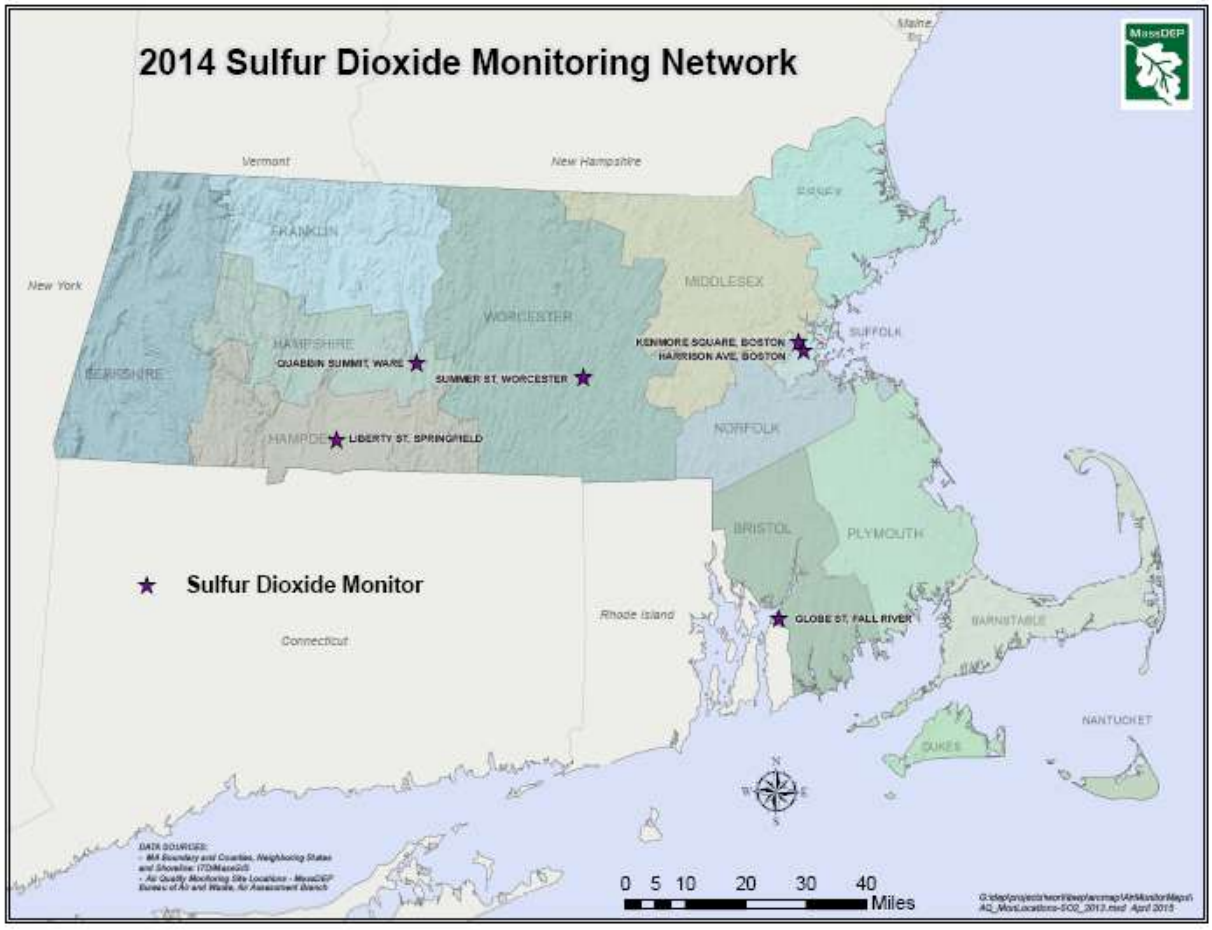
A summary of the 2014 SO_2 data is shown below (in parts per billion). MassDEP operated six SO_2 sites during 2014. All of the sites achieved the requirement of 75% or greater data capture for the year. SO_2 monitors in Boston (Kenmore Square and Harrison Avenue) and Ware are trace-level instruments that measure a lower concentration range than standard instruments to obtain more precise concentration resolution to better track SO_2 trends.

SITE ID	CITY	COUNTY	ADDRESS	COMPLETED QTRS	% OBS	1ST MAX 1-HR	2ND MAX 1-HR	99TH PCTL 1-HR	1-HR MAX >75 ppb STD	ARITH MEAN
25-025-0002	Boston	Suffolk	KENMORE SQ	4	94	15.5	12.0	9.7	0	.94
25-025-0042	Boston	Suffolk	HARRISON AVE	4	95	28.4	24.2	12.3	0	1.06
25-005-1004	Fall River	Bristol	659 GLOBE ST	4	97	16.2	14.9	13.4	0	1.50
25-013-0016	Springfield	Hampden	LIBERTY ST	4	95	10.4	9.4	6.7	0	1.37
25-015-4002	Ware	Hampshire	QUABBIN SUMMIT	4	96	7.1	5.4	5.2	0	.75
25-027-0023	Worcester	Worcester	SUMMER ST	4	95	9.1	9.0	8.5	0	1.45

STANDARDS: 1-hour = 75 ppb 3-hour = 0.5 ppm

ABBREVIATIONS AND SYMBOLS USED IN TABLE

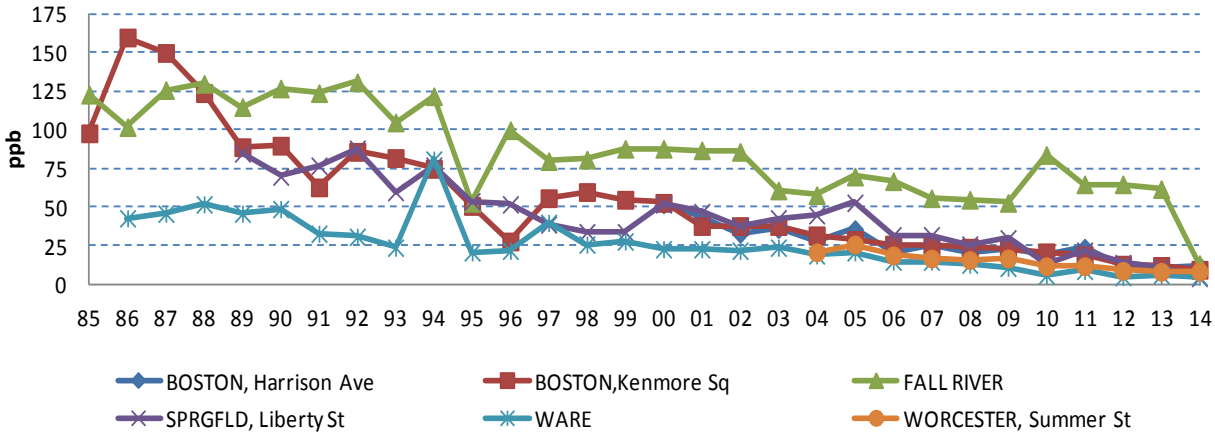
SITE ID = AIRS SITE IDENTIFICATION NUMBER; **% OBS** = PERCENT OBSERVATIONS; **COMPLETED QTRS** = COMPLETE QUARTERS; **1ST, 2ND MAX 1-HR** = FIRST AND SECOND HIGHEST 1-HOUR VALUE; **99TH PCTL 1-HR** = 99th PERCENTILE OF THE 1-HOUR MAX; **1-HR MAX >75 PPB STD** = # OF HOURLY EXCEEDENCES OF STANDARD; **ARITH MEAN** = ANNUAL ARITHMETIC MEAN



SO_2 Trends

The long-term trends of the 1-hour 99th percentile for each SO_2 site are shown below. The trend has been downward and Massachusetts is below the 1-hour standard.

Figure 4
SO_2 Trends 1985 – 2014
1-hour 99th Percentile Annual Average
Standard = 75 ppb



Nitrogen Dioxide (NO_2) Summary

2014 NO_2 Data Summary

A summary of the 2014 NO_2 data is shown below (in parts per billion). MassDEP operated 11 NO_2 sites during 2014. All of the sites met the requirement of 75% data capture for the year, except Boston-Long Island, which was closed in October.

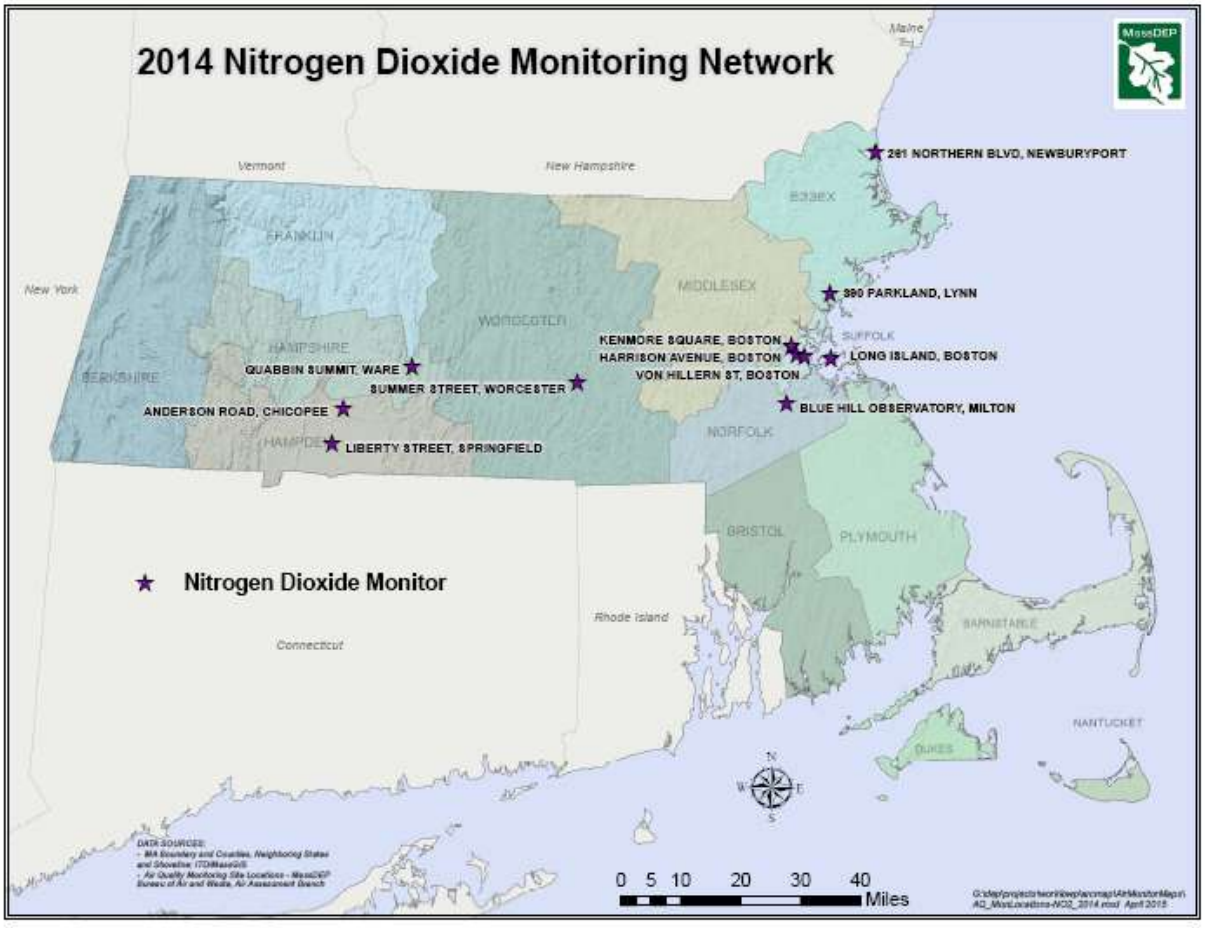
SITE ID	CITY	COUNTY	ADDRESS	COMPLETED QTRS	% OBS	1ST MAX 1-HR	2ND MAX 1-HR	98TH PERCENTILE VALUE	ARITH MEAN
25-025-0002	Boston	Suffolk	KENMORE SQ	4	92	52.0	52.0	49.0	17.17
25-025-0041	Boston	Suffolk	LONG ISLAND	3	73	54.0	45.0	38.0	6.52*
25-025-0042	Boston	Suffolk	HARRISON AVE	4	94	62.0	60.0	51.0	15.76
25-025-0044	Boston	Suffolk	19 VON HILLERN	4	95	64.0	62.0	53.0	17.49
25-013-0008	Chicopee	Hampden	ANDERSON RD AFB	4	93	46.0	45.0	41.0	7.11
25-009-2006	Lynn	Essex	390 PARKLAND	4	95	48.0	46.0	42.0	7.11
25-021-3003	Milton	Norfolk	695 HILLSIDE ST	4	93	42.0	41.0	28.0	4.64
25-009-4005	Newburyport	Essex	HARBOR STREET	4	94	40.0	39.0	25.0	3.85
25-013-0016	Springfield	Hampden	LIBERTY STREET	4	95	50.0	44.0	42.0	13.35
25-015-4002	Ware	Hampshire	QUABBIN SUMMIT	4	91	26.0	20.0	17.0	2.78
25-027-0023	Worcester	Worcester	SUMMER ST	4	95	60.0	53.0	49.0	13.01

STANDARDS: Annual Arithmetic Mean = 53 ppb 1-hour = 100 ppb

Note: * indicates that the mean does not satisfy summary criteria.

ABBREVIATIONS AND SYMBOLS USED IN TABLE

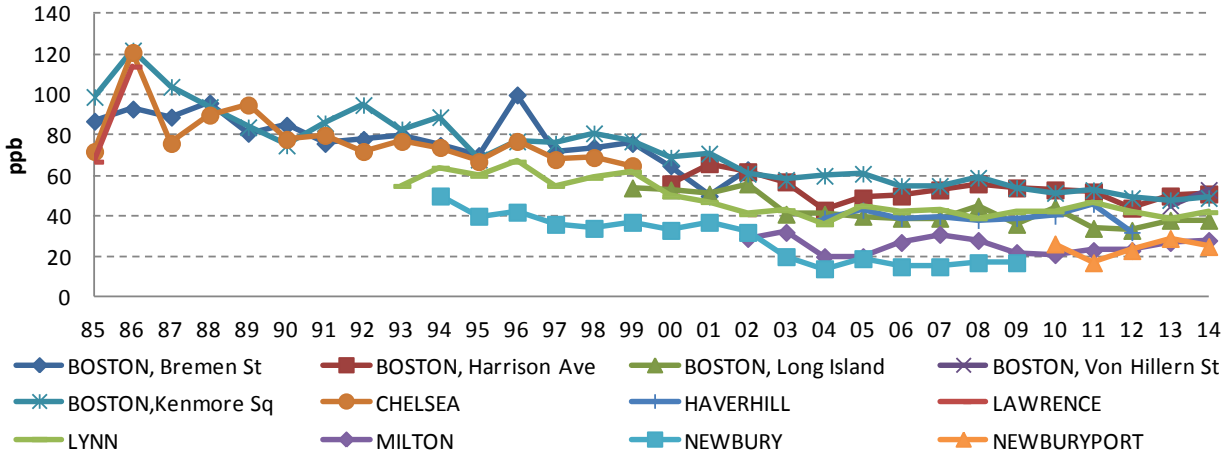
SITE ID = AIRS SITE IDENTIFICATION NUMBER; **% OBS** = PERCENTAGE OF COMPLETED OBSERVATIONS; **COMPLETED QTRS** = COMPLETE QUARTERS; **1ST, 2ND MAX 1-HR** = FIRST AND SECOND HIGHEST 1-HOUR VALUE; **98TH PERCENTILE VALUE** = 98TH PERCENTILE VALUE; **ARITH MEAN** = ANNUAL ARITHMETIC MEAN

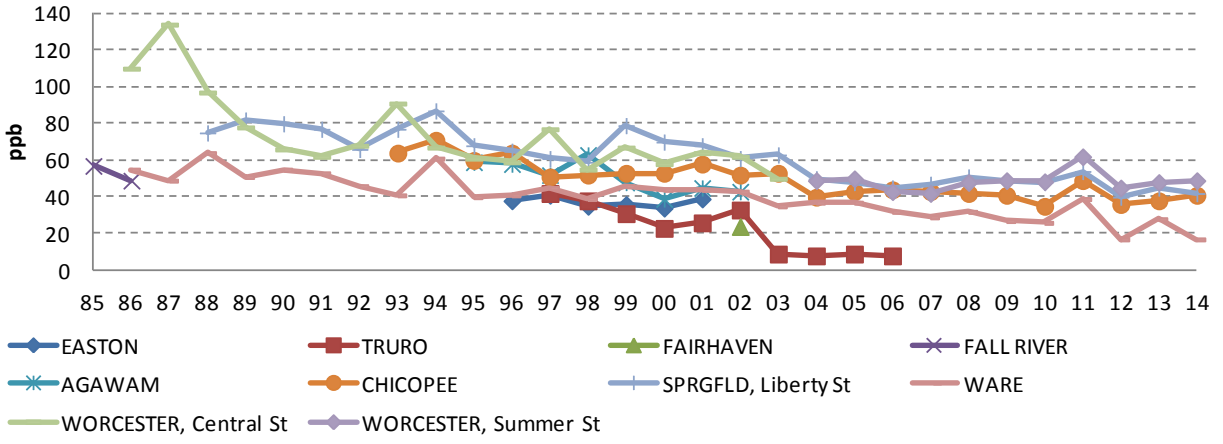


NO_2 Trends

The long-term trends of the 1-hour 98th percentile annual average 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 annual standard.

Figure 5
NO_2 Trends 1985 – 2014
1-hour 98th Percentile Annual Average
Standard = 100 ppb





Carbon Monoxide (CO) Summary

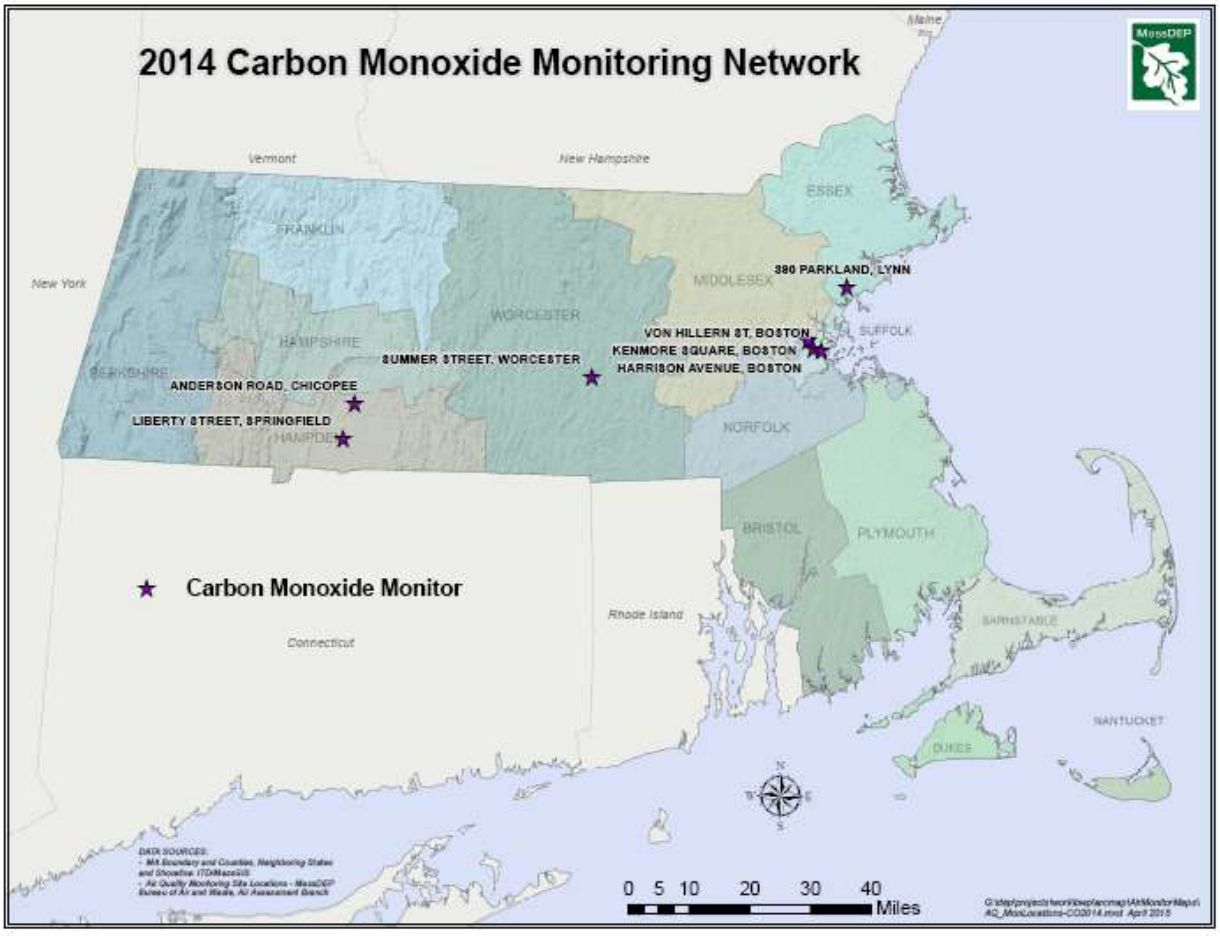
2014 CO Data Summary

A summary of the 2014 CO data is shown below (in parts per million). MassDEP operated seven CO sites during 2014. All of the sites achieved the requirement of 75% or greater data capture for the year. CO monitors in Boston (Harrison Avenue and Von Hillern), Lynn, and Chicopee are trace-level instruments that measure a lower concentration range than standard instruments to obtain more precise concentration resolution to better track CO trends.

SITE ID	CITY	COUNTY	ADDRESS	% OBS	1ST MAX 1-HR	2ND MAX 1-HR	OBS >1HR STD	1ST MAX 8-HR	2ND MAX 8-HR	OBS >8HR STD
25-025-0002	Boston	Suffolk	KENMORE SQ	90	1.5	1.3	0	1.1	.9	0
25-025-0042	Boston	Suffolk	HARRISON AVE	91	1.950	1.713	0	1.4	1.1	0
25-025-0044	Boston	Suffolk	19 VON HILLERN	78	1.890	1.620	0	.9	.9	0
25-013-0008	Chicopee	Hampden	ANDERSON RD AFB	92	1.030	.945	0	.8	.7	0
25-009-2006	Lynn	Essex	390 PARKLAND	87	1.096	.885	0	.8	.7	0
25-013-0016	Springfield	Hampden	LIBERTY STREET	93	1.5	1.4	0	.9	.9	0
25-027-0023	Worcester	Worcester	SUMMER ST	92	2.6	2.6	0	1.5	1.1	0

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

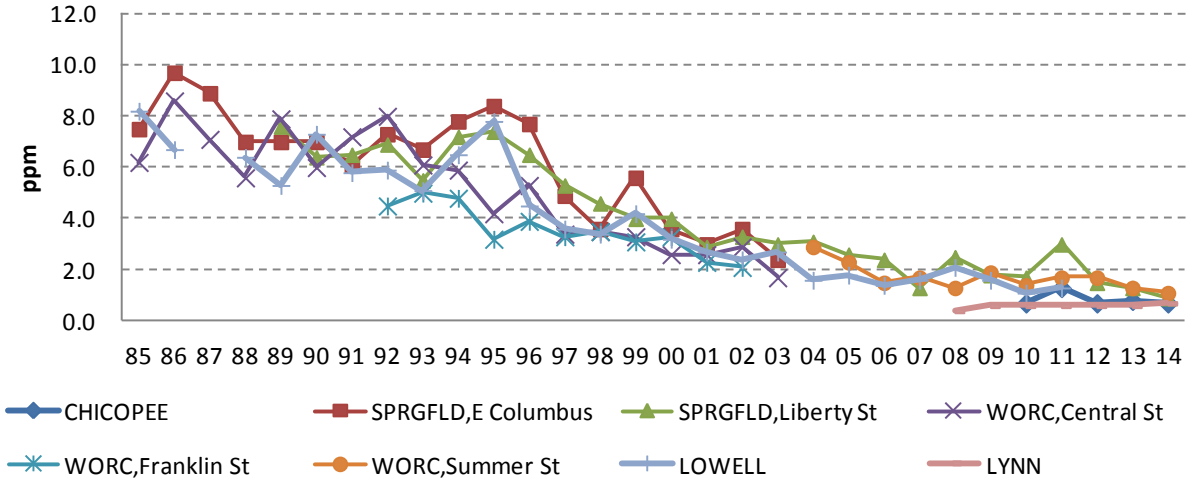
ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER; **% OBS** = PERCENT OBSERVATIONS; **1ST, 2ND MAX 1-HR** = FIRST AND SECOND HIGHEST 1-HOUR VALUE; **OBS>1 HR STD** = NUMBER OF 1-HR AVERAGES GREATER THAN THE 35 PPM 1-HR STANDARD; **1ST, 2ND MAX 8-HR** = FIRST AND SECOND HIGHEST 8-HOUR VALUE; **OBS>8HR STD** = NUMBER OF 8-HR AVERAGES GREATER THAN 9 PPM THE 8-HR STANDARD

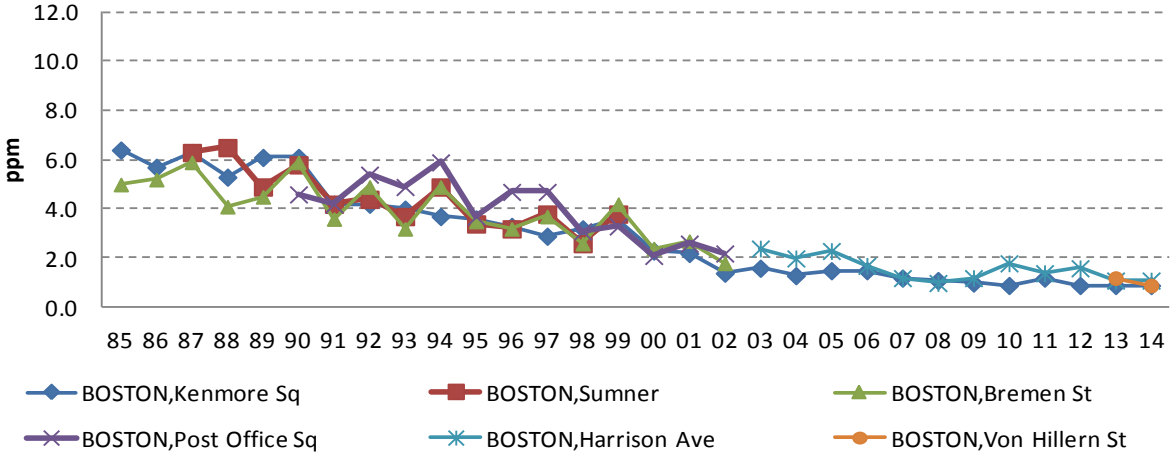


CO Trends

The long-term trends for each CO site are shown below. Massachusetts is well below the 1-hour and 8-hour standards.

Figure 6
CO Trends 1985-2014
2nd Maximum 8-hour Values
Standard = 9 ppm





Particulate Matter 10 Microns (PM_{10}) Summary

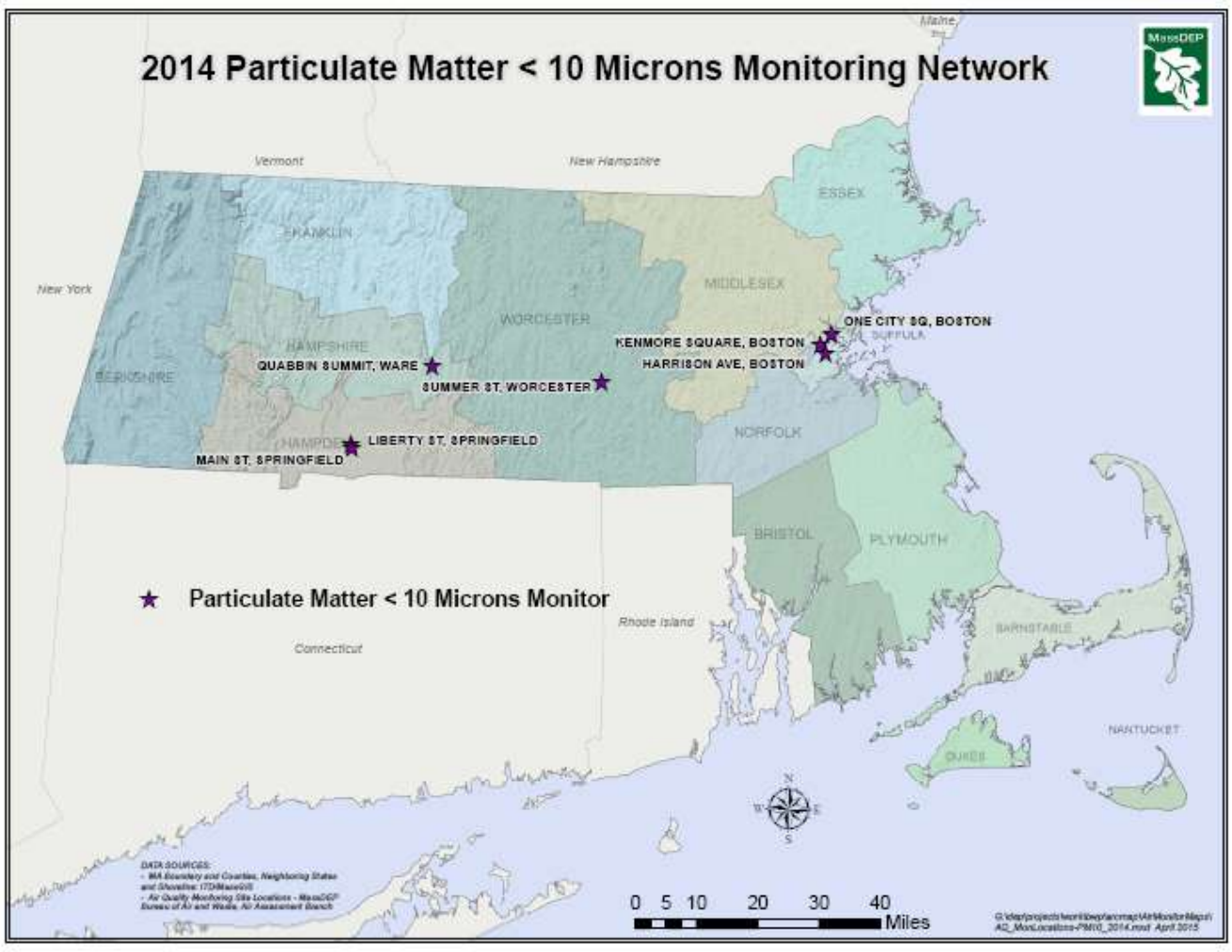
2014 PM_{10} Data Summary

A summary of the 2014 PM_{10} data is shown below (in $\mu g/m^3$). MassDEP operated seven PM_{10} sites in 2014. The Springfield site on Main Street was closed and monitoring was moved to the Liberty Street site. All but those two sites achieved the 75% data capture requirements for the year.

SITE ID		CITY	COUNTY	ADDRESS	%OBS	1ST MAX 24-HR	2ND MAX 24-HR	3RD MAX 24-HR	4TH MAX 24-HR	DAYS MAX >STD	ARITH MEAN
25-013-0016		Springfield	Hampden	LIBERTY	86	21	18	16	13	0	9.4
25-013-2009		Springfield	Hampden	1860 MAIN	83	27	21	20	19	0	12.9
25-015-4002		Ware	Hampshire	QUABBIN SUMMIT	95	13	13	10	10	0	6.0
25-025-0002		Boston	Suffolk	KENMORE SQ	95	78	53	45	37	0	14.9
25-025-0027		Boston	Suffolk	ONE CITY SQ	97	69	66	37	29	0	15.5
25-025-0042		Boston	Suffolk	HARRISON AVE	98	69	61	41	37	0	13.9
25-025-0042	colloc	Boston	Suffolk	HARRISON AVE	96	70	61	41	37	0	13.8
25-027-0023		Worcester	Worcester	SUMMER ST	93	74	67	60	53	0	15.3

STANDARDS: 24-hour = 150 $\mu g/m^3$

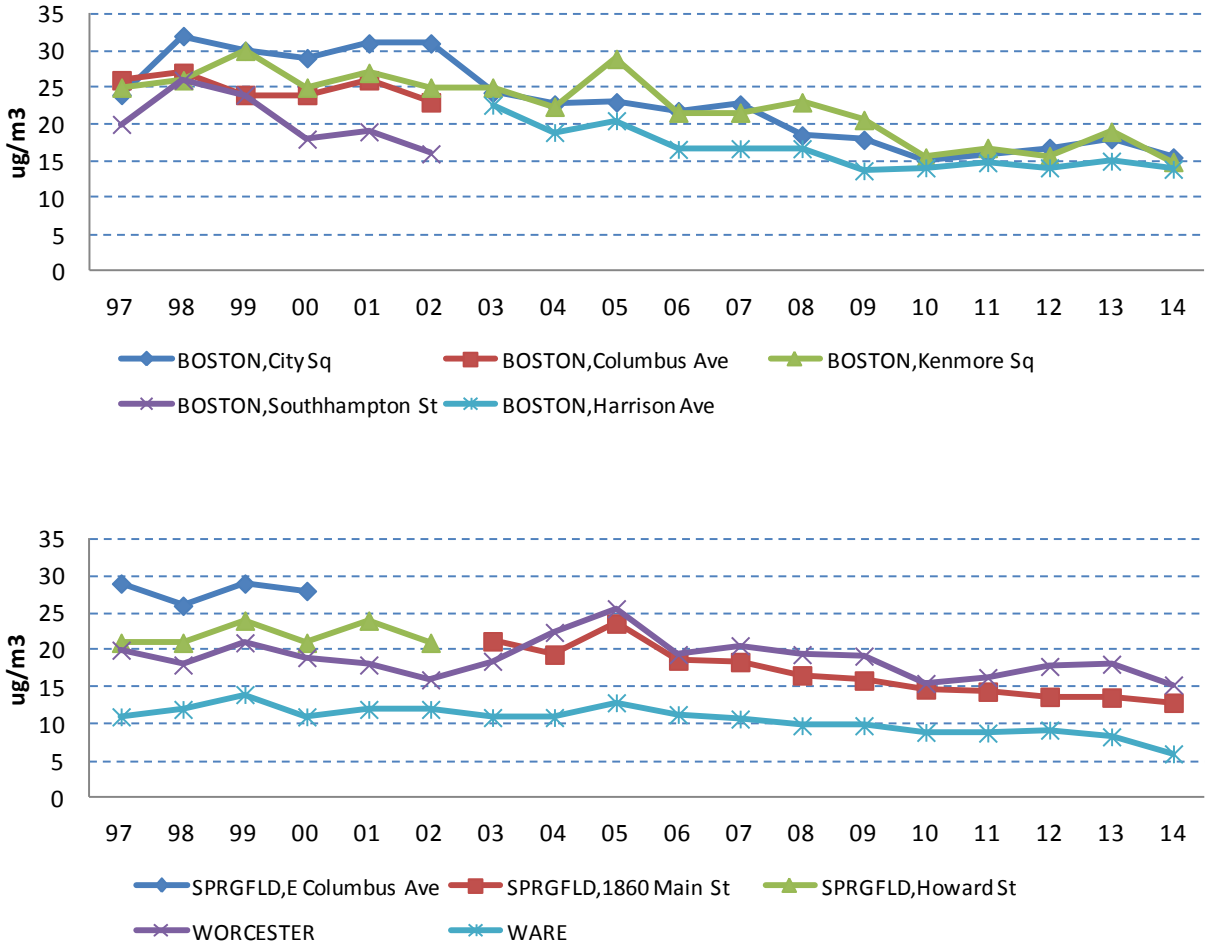
ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER; **%OBS** = PERCENT OF OBSERVATIONS; **1^{ST}, 2^{ND}, 3^{RD}, 4^{TH} MAX** = 1^{ST}, 2^{ND}, 3^{RD}, AND 4^{TH} HIGHEST 24-HOUR VALUES FOR THE YEAR; **ARITH MEAN** = ANNUAL ARITHMETIC MEAN



PM_{10} Trends

Long-term trends for each PM_{10} site are shown below. The data shows an overall downward trend and Massachusetts is well below the standard.

Figure 7
PM_{10} Trends 1997-2014
Annual Arithmetic Mean
Standard = 150 µg/m^3



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

MassDEP operated 18 Federal Reference Method (FRM) filter-based $PM_{2.5}$ sites during 2014, and operated 13 Beta Attenuation Monitor (BAM) Federal Equivalent Method (FEM) $PM_{2.5}$ sites that provide near real-time data on MassDEP's MassAir Online website (www.mass.gov/eea/agencies/massdep/air/quality/) and on EPA's AirNOW website (www.epa.gov/airnow/).

2014 $PM_{2.5}$ FRM Data Summary

A summary of the 2014 $PM_{2.5}$ FRM data is shown below (in $\mu g/m^3$).

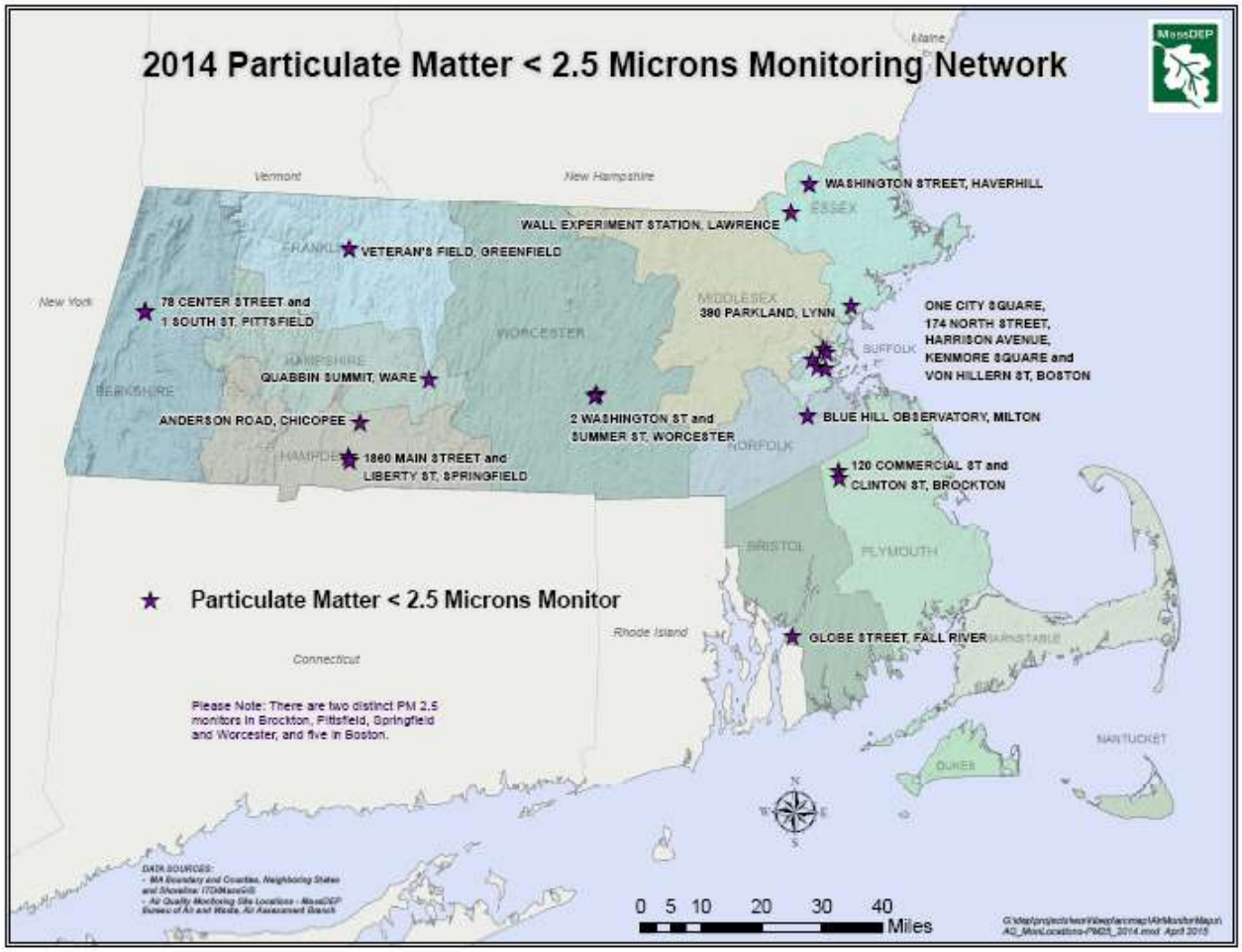
SITE ID		CITY	COUNTY	ADDRESS	NUMBER CREDITABLE DAYS	1ST MAX 24-HR	2ND MAX 24-HR	3RD MAX 24-HR	4TH MAX 24-HR	98TH PERCENTILE 24-HOUR	ARITH MEAN
25-025-0002		Boston	Suffolk	KENMORE	119	16.6	14.8	14.6	13.5	14.6	6.02
25-025-0027		Boston	Suffolk	ONE CITY SQ	108	17.3	14.8	14.4	13.2	14.4	6.05
25-025-0042		Boston	Suffolk	HARRISON AVE	119	15.9	13.3	12.7	12.6	12.7	5.94
25-025-0043		Boston	Suffolk	174 NORTH ST	339	18.7	18.2	17.5	17.1	14.5	6.99
25-025-0043	colloc	Boston	Suffolk	174 NORTH ST	296	19	17.7	17.5	14.8	14.2	6.88
25-025-0044		Boston	Suffolk	19 VON HILLERN	116	15.0	14.9	14.9	14.4	14.9	6.25
25-023-0004		Brockton	Plymouth	COMMERCIAL ST	29	12.2	11.9	11.4	11.2	12.2	5.67*
25-023-0004	colloc	Brockton	Plymouth	COMMERCIAL ST	24	12.2	11.5	10.6	10	12.2	5.71
25-023-0005		Brockton	Plymouth	170 CLINTON	112	18.3	13.4	12.4	11.6	12.4	5.43
25-023-0005	colloc	Brockton	Plymouth	170 CLINTON	71	13.2	13	12	10	13	5.15*
25-013-0008		Chicopee	Hampden	ANDERSON RD AFB	119	18.9	16.5	16.5	14.4	16.5	5.46
25-013-0008	colloc	Chicopee	Hampden	ANDERSON RD AFB	100	17.8	16.2	14.7	14.1	16.2	5.32
25-005-1004		Fall River	Bristol	659 GLOBE ST	115	13.9	13.5	12.9	11.5	12.9	4.94
25-011-2005		Greenfield	Franklin	VETERANS FIELD	111	23.0	17.5	13.2	13.2	13.2	5.78
25-009-5005		Haverhill	Essex	685 WASHINGTON	114	15.6	11.8	11.8	11.6	11.8	4.85
25-009-6001		Lawrence	Essex	37 SHATTUCK	117	13.0	12.8	11.5	11.5	11.5	5.21
25-009-2006		Lynn	Essex	390 PARKLAND	119	12.9	11.9	11.8	11.7	11.8	4.59
25-003-5001		Pittsfield	Berkshire	78 CENTER ST	115	18.4	17.5	17.3	14.7	17.3	6.00
25-013-0016		Springfield	Hampden	LIBERTY STREET	118	23.6	23.3	17.5	17.4	17.5	6.42
25-013-2009		Springfield	Hampden	1860 MAIN ST	59*	21.4	19.5	16.2	15.2	19.5	6.26
25-027-0016		Worcester	Worcester	WASHINGTON ST	118	16.7	13.5	13.1	12.4	13.1	5.61
25-027-0023		Worcester	Worcester	SUMMER ST	117	16.9	15.9	15.0	14.2	15.0	5.86

STANDARDS: Annual Mean = 12.0 $\mu g/m^3$ (primary) 24-hour (98th percentile) = 35 $\mu g/m^3$

Note: * indicates that the mean does not satisfy summary criteria.

ABBREVIATIONS AND SYMBOLS USED IN TABLE

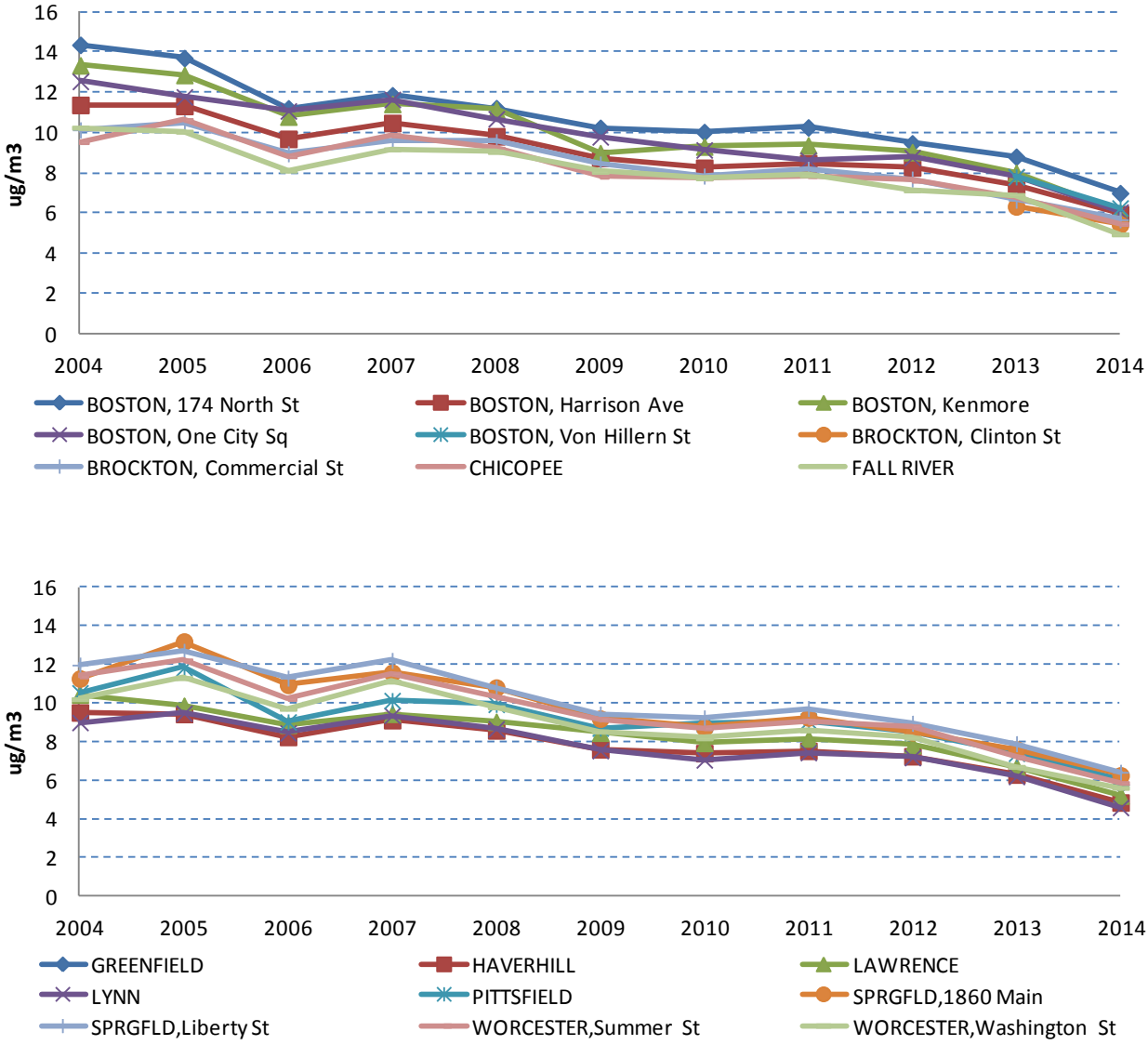
SITE ID = AIRS SITE IDENTIFICATION; **COLLOC** = COLLOCATED; #**OBS** = NUMBER OF OBSERVATIONS; **1ST, 2ND, 3RD, 4TH MAX** = 1ST, 2ND, 3RD, AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR; **98TH PERCENTILE VALUE** = 98TH PERCENTILE VALUE FOR THE YEAR; **ARITH MEAN** = ANNUAL ARITHMETIC MEAN (STANDARD = 12.0 $\mu g/m^3$)


2014 Particulate Matter < 2.5 Microns Monitoring Network
MassDEP
Maine
Vermont
New Hampshire
New York
Connecticut
Rhode Island
WASHINGTON STREET, HAVERHILL
WALL EXPERIMENT STATION, LAWRENCE
VETERAN'S FIELD, GREENFIELD
78 CENTER STREET and
1 SOUTH ST, PITTSFIELD
380 PARKLAND, LYNN
ONE CITY SQUARE,
174 NORTH STREET,
HARRISON AVENUE,
KENMORE SQUARE and
VON HILLERN ST, BOSTON
QUABBIN SUMMIT, WARE
2 WASHINGTON ST and
SUMMER ST, WORCESTER
BLUE HILL OBSERVATORY, MILTON
ANDERSON ROAD, CHICOPEE
1860 MAIN STREET and
LIBERTY ST, SPRINGFIELD
120 COMMERCIAL ST and
CLINTON ST, BROCKTON
GLOBE STREET, FALL RIVER
Particulate Matter < 2.5 Microns Monitor
Please Note: There are two distinct PM 2.5
monitors in Brockton, Pittsfield, Springfield
and Worcester, and five in Boston.
0 5 10 20 30 40
Miles

$PM_{2.5}$ FRM Trends

Long-term trends for each $PM_{2.5}$ FRM site are shown below using the annual arithmetic mean as an indicator. The data shows an overall downward trend.

Figure 8
$PM_{2.5}$ FRM Trends 2004-2014
Annual Arithmetic Mean
Primary Standard = 12 μg/m^3



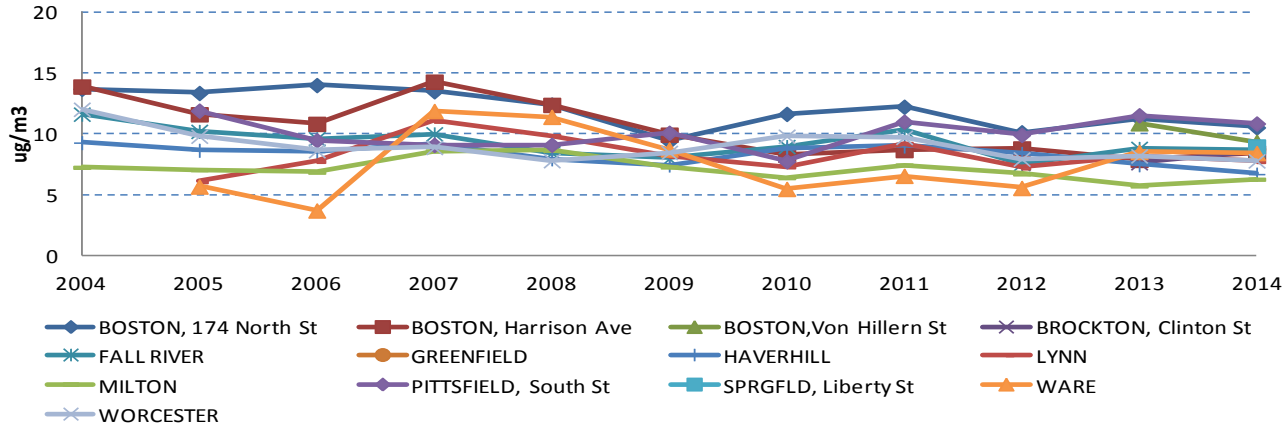
2014 $PM_{2.5}$ FEM Data Summary

A summary of the 2014 $PM_{2.5}$ FEM data is shown below (in $\mu g/m^3$).

SITE ID		CITY	COUNTY	ADDRESS	NUMBER CREDITABLE DAYS	1ST MAX	2ND MAX	3RD MAX	4TH MAX	98TH PERCENTILE 24-HOUR	ARITH MEAN
25-025-0042	*	Boston	Suffolk	HARRISON AVE	343	26.2	23.0	22.2	21.9	17.6	8.42
25-025-0043		Boston	Suffolk	174 NORTH ST	318	27.4	26	23.1	22.4	21.5	10.42
24-025-0044		Boston	Suffolk	VON HILLERN ST	345	27.5	24.7	24.3	22.8	20	9.06
25-023-0005		Brockton	Plymouth	1 CLINTON ST	338	31.8	23.3	19.9	17.7	17.1	8.29
25-005-1004	*	Fall River	Bristol	659 GLOBE ST	341	22.5	21.5	21.1	20.2	18.1	8.39
25-011-2005		Greenfield	Franklin	VETERANS FIELD	311	27.4	27.3	24.7	23.6	21.1	8.86
25-009-5005	*	Haverhill	Essex	685 WASHINGTON	346	22.4	18.6	17.2	16.4	15.1	6.62
25-009-2006	*	Lynn	Essex	390 PARKLAND	352	24.7	20.8	19.6	18.9	15.9	7.56
25-021-3003	*	Milton	Norfolk	BLUE HILL OBSERV	333	17.7	17.2	15.6	15.1	13.5	6.13
25-003-0006		Pittsfield	Berkshire	1 SOUTH ST	338	31.4	29	29	27.6	25.3	10.45
25-013-0016		Springfield	Hampden	LIBERTY ST	350	31.3	30.4	30	29.4	22.5	8.83
25-015-4002		Ware	Hampshire	QUABBIN SUMMIT	340	21.8	21.3	19.2	18.8	17.1	8.09
25-027-0023	*	Worcester	Worcester	SUMMER ST	353	27.1	25.6	24.5	23.5	18.8	7.55

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION; #**OBS** = NUMBER OF OBSERVATIONS; **1ST, 2ND, 3RD, 4TH MAX** = 1ST, 2ND, 3RD, AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR; **ARITH MEAN** = ANNUAL ARITHMETIC MEAN (STANDARD = 12.0 $\mu g/m^3$)

Figure 9
$PM_{2.5}$ FEM Trends 2004-2014
Annual Arithmetic Mean
Primary Standard = 12 $\mu g/m^3$



$PM_{2.5}$: FRM vs FEM

The FRM (Federal Reference Method) has been used to measure $PM_{2.5}$ since the beginning of the $PM_{2.5}$ monitoring program in 1999. This method requires the manual set up and collection of filters that collect 24-hour samples every three days. The filters must be weighed prior to placement in the field and then weighed again after the sample is collected by a scale in an environmentally controlled chamber. EPA has designated several Beta Attenuation Monitors (BAMs) and other continuous $PM_{2.5}$ monitors as FEM (Federal Equivalent Method) monitors, which allows states to use them to determine compliance with the $PM_{2.5}$ NAAQS, the same as FRMs. Since 2001, MassDEP has added 13 BAMs to the network that take hourly samples of $PM_{2.5}$ alongside the existing filter-based FRM $PM_{2.5}$ monitors. The hourly $PM_{2.5}$ monitors provide hourly concentrations every day of the year, which FRMs are not capable of doing.

While MassDEP is using BAMs $PM_{2.5}$ FEM monitors to determine compliance with the NAAQS, the results of FEM and FRM monitors still contain some differences. In general, FEM monitors provide slightly higher results than FRM, which may be due to hourly measurement of fresh $PM_{2.5}$ samples versus slightly aged samples via the FRM filter method. Results from the two different methods, for the same pollutant ($PM_{2.5}$) are presented separately in the preceding tables.

Speciation

MassDEP collects $PM_{2.5}$ samples for speciation in Boston (Harrison Avenue) and Chicopee. Speciation involves analysis of particulate matter to determine its chemical composition and to identity air pollution sources that affect the area around the monitoring station. Pollutants analyzed include elements (e.g., metals), sulfates, nitrates, and carbon (total and organic).

IMPROVE (Interagency Monitoring of Protected Visual Environments)

IMPROVE is a nationwide program designed to assess air quality at rural locations where air pollution may affect visibility over long distances (e.g., mountain ranges or scenic vistas). Massachusetts currently has IMPROVE samplers at the Ware and Truro sites. The Wampanoag Tribe operates a third IMPROVE sampler at its Martha's Vineyard monitoring site. These samplers acquire $PM_{2.5}$ filter samples for speciation analysis to determine effects on visibility. Data can be viewed at the IMPROVE web site at http://vista.cira.colostate.edu/improve/Data/data.htm.

Lead (Pb) Summary

2014 Pb Data Summary

MassDEP uses a low-volume PM_{10}-based methodology for measuring lead on particulates at the Boston - Harrison Avenue and Springfield - Main Street sites and Liberty Street sites. The Springfield Main Street site closed in June 2014 and monitoring was moved to the Springfield, Liberty Street site. A summary of 2014 lead data using the PM_{10}-based method is shown below (in $\mu g/m^3$). All samples (including 3-month rolling averages) were below the lead standard of 0.15 $\mu g/m^3$.

SITE ID		CITY	COUNTY	ADDRESS	NUMBER CREDITABLE DAYS	1ST MAX	2ND MAX	3RD MAX	4TH MAX	ARITH MEAN
25-013-0016		Springfield	Hampden	LIBERTY ST	27	0.014	0.009	0.007	0.007	.0029*
25-013-2009		Springfield	Hampden	1860 MAIN ST	26	0.007	0.006	0.006	0.005	.0026*
25-025-0042		Boston	Suffolk	HARRISON AVE	58	0.0142	0.0097	0.0077	0.0074	.0031
25-025-0042	colloc	Boston	Suffolk	HARRISON AVE	35	0.0077	0.0072	0.0059	0.0053	.0029*

STANDARD: 0.15 $\mu g/m^3$ (rolling 3-month average)

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION; **#OBS** = NUMBER OF OBSERVATIONS; **1ST, 2ND, 3rd, 4th MAX VALUE** = 1ST, 2ND, 3rd, 4th MAXIMUM 24-HOUR VALUES; **ARITH MEAN** = ARITHMETIC MEAN

Private Monitoring Summary

In 2014, MassDEP oversaw one private monitoring station at East First Street in Boston, originally sited to measure ambient air impacts from specific power plants in the Boston area. The data from this monitoring site is submitted by a private company to MassDEP, which then submits the data to EPA after performing quality assurance. The private monitoring site closed in June 2014.

Sulfer Dioxide - A summary of the 2014 SO_2 data is shown below.

					COMPLETED QTRS	1ST MAX 1-HR	2ND MAX 1-HR	99TH PERCENTILE 1-HR	1-HR MAX >75 PPB STD	ARITH MEAN
25-025-0040		Boston	Suffolk	531A EAST FIRST ST	2	40	28	28	0	1.74

STANDARD: 1-Hour = 75 PPB

ABBREVIATIONS AND SYMBOLS USED IN TABLE
COMPLETED QTRS = COMPLETED QUARTERS; **1ST & 2ND MAX 1-HR and MAX 24-HR** = FIRST AND SECOND HIGHEST VALUE FOR TIME PERIOD INDICATED; **99th PERCENTILE 1-HR** = 99th PERCENTILE OF THE 1-HOUR MAX; **1-HR MAX > 75 PPB STD =** # OF HOURLY EXCEEDANCES OF THE STANDARD; **ARITH MEAN** = ARITHMETIC MEAN

Nitrogen Dioxide – A summary of the 2014 NO_2 data is shown below.

					COMPLETED QTRS	1ST MAX 1-HR	2ND MAX 1-HR	98TH PERCENTILE	ARITH MEAN
25-025-0040		Boston	Suffolk	531A EAST FIRST ST	2	68	64	62	14

STANDARD: 1-HOUR = 100 PPB Annual = 0.053 PPM

ABBREVIATIONS AND SYMBOLS USED IN TABLE
COMPLETED QTRS = NUMBER OF COMPLETED QUARTERS; **1ST AND 2ND MAX 1-HR** = FIRST AND SECOND HIGHEST 1-HOUR VALUE; **98th PERCENTILE** = 98th PERCENTILE OF 1 HOUR MAXIMUM; **ARITH MEAN** = ARITHMETIC MEAN (ANNUAL STANDARD = 53 PPB)

Total Suspended Particulates (TSP) – A summary of the 2014 TSP data is shown below. TSP is not a criteria pollutant (replaced by PM_{10} in 1987), so there are no standards for it.

SITE ID		CITY	COUNTY	ADDRESS	# OBS	1ST MAX	2ND MAX	3RD MAX	4TH MAX	ARITH MEAN
25-025-0040		Boston	Suffolk	531A EAST FIRST ST	28	77	72	68	49	33.1
25-025-0040	collc	Boston	Suffolk	531A EAST FIRST ST	28	81	73	67	62	35.9

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER, **COLLOC** = COLLOCATED MONITOR; #**OBS** = NUMBER OF OBSERVATIONS; **1ST, 2ND, 3RD, 4TH MAX** = 1ST, 2ND, 3RD AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR; **ARITH MEAN** = ARITHMETIC MEAN

Sulfate (SO_4) – A summary of the 2014 SO_4 data is shown below. SO_4 is not a criteria pollutant so there are no standards for it.

SITE ID		CITY	COUNTY	ADDRESS	# OBS	1ST MAX	2ND MAX	3RD MAX	4TH MAX	ARITH MEAN
25-025-0040		Boston	Suffolk	531A E FIRST ST	28	10.2	9.6	6.6	6.3	4.03
25-025-0040	collc	Boston	Suffolk	531A E FIRST ST	28	10.2	10.2	7.6	6.3	4.18

ABBREVIATIONS AND SYMBOLS USED IN TABLE
SITE ID = AIRS SITE IDENTIFICATION NUMBER; **COLLOC** = COLLOCATED MONITOR; **#OBS** = NUMBER OF OBSERVATIONS; **1ST, 2ND, 3RD, 4TH MAX** = 1ST, 2ND, 3RD AND 4TH HIGHEST 24-HOUR VALUES FOR THE YEAR, **ARITH MEAN** = ARITHMETIC MEAN

QUALITY CONTROL AND QUALITY ASSURANCE

In order to ensure that all air quality data is of acceptable and consistent quality, MassDEP has developed standard operating procedures (SOPs) based on federal requirements that include quality control and quality assurance techniques that systematically assess the entire sample collection and data handling system on an ongoing basis. Quality Assurance requirements for ambient air monitoring are contained in the federal regulations at 40 CFR Part 58, Appendix A – E. Each year MassDEP certifies that it is in compliance with the federal requirements.

A few of the considerations that affect sample collection data quality are:

- Site Placement
- Intake Probe Material
- Intake Probe Height
- Spacing from roadways and trees

For data processing there are quantitative statistics and qualitative descriptors used to interpret the degree of acceptability or utility of data. Examples of these data quality indicators are:

- Representativeness
- Precision
- Bias
- Detectability
- Completeness
- Comparability

MassDEP's Air Assessment Branch in Lawrence maintains a Quality Assurance/ Data Management Group that reviews the monitoring data for quality, ensures that samples are collected correctly, and conducts performance audits throughout the air monitoring network to verify data validity. Another function of the Data Group is to process and report all of the Massachusetts air quality data to the EPA database in a timely manner. Computer software tools, report queries and "eyes on" data reviews are all used to detect and correct problems in the data before it is submitted to EPA. EPA also periodically conducts its own performance audits on MassDEP analyzers and samplers and conducts thorough Technical Systems Audits every three years.

Section IV
PAMS/Air Toxics Monitoring

PAMS Monitoring

Ground-level ozone is a secondary pollutant and is not discharged directly to the atmosphere from a stack or tailpipe, but forms in the atmosphere from the photochemical reactions of other pollutants such as volatile organic compounds (VOCs) and NO_x. Ozone formation can occur many miles downwind from the source of the original emissions. These reactions occur in the presence of strong sunlight and are most pronounced during the hottest days of the summer. The PAMS (Photochemical Assessment Monitoring Stations) program was established by the 1990 Clean Air Act Amendments as a way to collect data for assessing NAAQS attainment progress independent of the meteorological variation that occurs between years and for identifying appropriate pollution control strategies.

PAMS is a special designation for enhanced monitoring stations that are designed to gather information on the ozone formation process. Instruments at these sites measure pollutants and meteorological parameters that are specific to the photochemical processes by which ozone is created in the atmosphere at ground level. In addition to the pertinent NAAQS pollutants (ozone, NO_2, etc.), non-criteria pollutants, including VOCs, are measured at PAMS stations on either an hourly basis or at regular intervals during the hottest part of the summer in June, July and August. Meteorology is a critical component of ozone formation and each PAMS site has a full complement of meteorological sensors including wind speed, wind direction, temperature, relative humidity, barometric pressure, solar radiation and at some sites, total ultraviolet light and precipitation.

Since the PAMS project started in 1993, Massachusetts has conducted enhanced ozone precursor measurements in the Boston and Springfield Metropolitan Areas. MassDEP currently operates four PAMS stations, in Lynn, Newburyport, Chicopee and Ware.

Air Toxics Monitoring

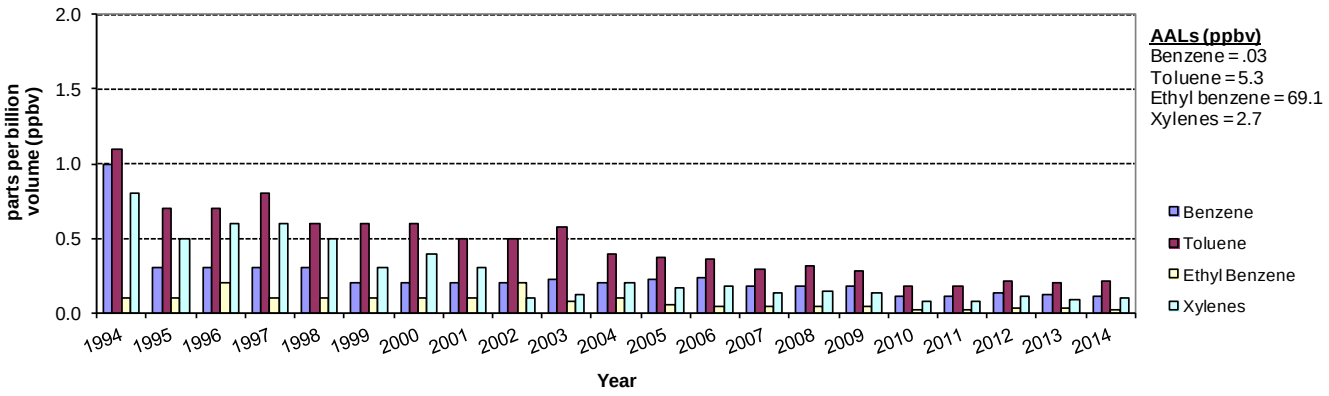
Toxic air pollutants are distinct from criteria air pollutants such as ozone and CO and are known or suspected to cause cancer or other serious health effects. Air toxics include certain volatile organic compounds (VOCs) and toxic metals (e.g., arsenic, cadmium).

MassDEP monitors VOCs as part of the PAMS monitoring program, some of which are classified as air toxics. MassDEP obtains health-relevant VOC concentration data throughout the year at the PAMS Type 2 sites.

The Boston (Harrison Avenue) monitoring site is designated as a National Air Toxics Trends Station (NATTS) designed to collect and quantify a number of toxic air pollutants, including VOCs, metals, carbonyls, black carbon and polycyclic aromatic hydrocarbons (PAHs). Data from this site is compared with data from a network of similar sites across the country to identify transport, trends and site-specific characteristics of these pollutants.

Figure 10 summarizes concentrations of 24-hour health-relevant target compounds for samples taken at the Lynn PAMS site from 1994 to 2014. Allowable Ambient Limit (AAL) values are presented next to Figure 9 for reference. AALs are health-based air toxics guidelines developed by MassDEP based on known or suspected carcinogenic and toxic health properties of individual compounds. AAL concentrations were developed for a 70-year lifetime exposure, but are used for comparison with annual averages.

Figure 10
Lynn Toxics Summary 1994 – 2014
24-hour samples



Below is a table that summarizes results from the analysis of 24-hour samples for target VOCs from the Boston - Harrison Ave and Lynn sites for 2014. Harrison Avenue serves as the central city sampling location and Lynn serves as the area background site.

Compound	BOSTON (Harrison Ave)		Lynn	
	Max Value ppb	Mean ppb	Max Value ppb	Mean ppb
1,3-butadiene	**0.090**	**0.021**	**0.032**	**0.010**
1,1,1-trichloroethane	**0.016**	**0.004**	**0.006**	**0.004**
trichloroethylene	**0.011**	**0.003**	**0.006**	**0.003**
tetrachloroethylene	**0.072**	**0.014**	**0.036**	**0.012**
Benzene	**0.403**	**0.164**	**0.261**	**0.114**
Toluene	**2.003**	**0.385**	**1.010**	**0.215**
Xylenes	**0.648**	**0.186**	**0.243**	**0.095**
Ethylbenzene	**0.147**	**0.046**	**0.065**	**0.025**

Samples collected at the Harrison Avenue site are analyzed for a suite of metals that are known to be toxic in the environment. The table below summarizes the 2014 metals data.

BOSTON (Harrison Ave)			
METAL	# of Samples	Max Value ug/m3	Mean ug/m3
Chromium	58	.03780	.00935
Antimony	58	.00478	.00151
Arsenic	58	.00105	.00039
Berylium	58	.00005	.00001
Cadmium	58	.00018	.00007
Cobalt	58	.00137	.00016
Lead	58	.01420	.00310
Manganese	58	.01670	.00546
Nickle	58	.01670	.00202
Mercury	58	.00007	.00002
Selenium	58	.00087	.00018

In addition to the air toxics monitoring activities described above, MassDEP established a monitor at Kenmore Square (late in 2014) to measure for benzene, toluene, ethyl benzene and xylene, which are health-relevant VOCs associated with vehicle emissions.

Appendix A
2014 Monitoring Station Locations

SITE ID	CITY	COUNTY	ADDRESS	DATE SITE ESTABLISHED	MONITORED
25-003-4002	ADAMS	BERKSHIRE	MT. GREYLOCK	5/1/1989	O3
25-015-0103	AMHERST	HAMPSHIRE	NORTH PLEASANT	4/1/1988	O3
TT-030-0001	*AQUINNAH	DUKES	HERRING CREEK RD	4/1/2004	O3, IMPROVE
25-025-0002	BOSTON	SUFFOLK	KENMORE SQUARE	1/1/1965	NO, NO2, NOx, SO2 trace, CO, PM2.5, PM10
25-025-0027	BOSTON	SUFFOLK	ONE CITY SQUARE	1/1/1985	PM2.5 FRM, PM10
25-025-0041	BOSTON	SUFFOLK	LONG ISLAND	12/1/1998	O3, NO, NO2, NOx, VOC, WS/WD, TEMP, Solar Rad, RH, BP
25-025-0042	BOSTON	SUFFOLK	HARRISON AVENUE	12/15/1998	O3, , NO, NO2, NOx, NOy, SO2 trace, CO trace, PM2.5 FRM, PM2.5 BAM, PM10, PM Coarse. PM2.5 Speciation, Lead, Toxics, Carbonyls, Black Carbon, WS/WD, TEMP, Solar Rad, RH, BP
25-025-0043	BOSTON	SUFFOLK	174 NORTH ST	1/1/2000	PM2.5 FRM, PM2.5 BAM, Black Carbon
25-025-0044	BOSTON	SUFFOLK	VON HILLERN ST	8/29/2013	NO, NO2, NOx, CO trace, PM2.5 FRM, PM2.5 BAM,Black Carbon, WS/WD, TEMP, Solar Rad, RH, BP
25-023-0004	BROCKTON	PLYMOUTH	120 COMMERCIAL ST	12/15/1998	PM2.5 FRM
25-023-0005	BROCKTON	PLYMOUTH	170 CLINTON ST	9/19/2013	O3, PM2.5 BAM, PM2.5 FRM
25-017-0009	CHELMSFORD	MIDDLESEX	11 TECHNOLOGY DR	4/1/2005	O3
25-013-0008	CHICOPEE	HAMPDEN	ANDERSON RD	1/1/1983	O3, NO, NO2, NOx, CO trace, PM2.5 FRM, PM2.5 speciation, VOCs, Carbonyls, WS/WD, TEMP, Solar Rad, RH, BP
25-005-1006	FAIRHAVEN	BRISTOL	HASTINGS SCHOOL	7/29/2013	O3, WS/WD, TEMP, Solar Rad, RH, BP
25-005-1004	FALL RIVER	BRISTOL	GLOBE ST	2/1/1975	O3, SO2, PM2.5 FRM, PM2.5 BAM
25-011-2005	GREENFIELD	FRANKLIN	16 BARR AVE	20140227	O3, PM2.5 FRM, PM2.5 BAM, Black Carbon, WS/WD, TEMP, Solar Rad, RH, BP
25-009-5005	HAVERHILL	ESSEX	WASHINGTON ST	7/19/1994	O3, PM2.5 FRM, PM2.5 BAM, WS/WD, TEMP, Solar Rad, RH, BP
25-009-6001	LAWRENCE	ESSEX	WALL EXPERIMENT STA	4/3/1999	PM2.5 FRM
25-009-2006	LYNN	ESSEX	390 PARKLAND	1/1/1992	O3, NO, NO2, NOx, CO trace, PM2.5 FRM, PM2.5 BAM, VOCs, Toxics, Carbonyls, WS/WD, TEMP, Solar Rad, RH, BP, PRECIP
25-021-3003	MILTON	NORFOLK	BLUE HILL	4/2/2002	O3, NO, NO2, NOx, PM2.5 BAM, VOCs, WS/WD, TEMP, Solar Rad, RH, BP
25-009-4005	NEWBURYPORT	ESSEX	HARBOR STREET	7/6/2010	O3, NO, NO2, NOx, NOy, VOCs, WS/WD, TEMP, Solar Rad, RH, BP
25-003-5001	PITTSFIELD	BERKSHIRE	78 CENTER STREET	11/6//98	PM2.5 FRM
25-003-0006	PITTSFIELD	BERKSHIRE	BERKSHIRE COMMONS	1/1/79	PM2.5 BAM
25-013-0016	SPRINGFIELD	HAMPDEN	LIBERTY STREET	4/1/1988	NO, NO2, NOx,SO2, CO, PM2.5 FRM, PM2.5 BAM, PM10, Black Carbon, Lead
25-013-2009	SPRINGFIELD	HAMPDEN	1860 MAIN STREET	1/1/2002	PM2.5 FRM, PM10, Lead
25-001-0002	TRURO	BARNSTABLE	FOX BOTTOM AREA	4/1/1987	O3, WS/WD, TEMP, Solar Rad, RH, BP, IMPROVE
25-027-0024	UXBRIDGE	WORCESTER	366 E HARTFORD AVE	11/13/2008	O3, WS/WD, TEMP, Solar Rad, RH, BP
25-015-4002	WARE	HAMPSHIRE	QUABBIN SUMMIT	6/1/1985	O3, NO, NO2, NOx, NOy, SO2 trace, PM10, VOCs, PM2.5 BAM, WS/WD, TEMP, Solar Rad, RH, BP, PRECIP, IMPROVE
25-027-0015	WORCESTER	WORCESTER	WORC. AIRPORT	5/7/1979	O3, WS/WD, TEMP, Solar Rad, RH, BP
25-027-0016	WORCESTER	WORCESTER	2 WASHINGTON ST	12/31/2002	PM2.5 FRM
25-027-0023	WORCESTER	WORCESTER	SUMMER STREET	1/1/2004	NO, NO2, NOx, SO2, CO, PM2.5 FRM, PM2.5 BAM, PM10

* Wampanoag Tribal Site

2014 Private Monitoring Station Location

SITE ID	CITY	COUNTY	ADDRESS	DATE SITE ESTABLISHED	MONITORED

25-025-0040	BOSTON	SUFFOLK	531A EAST FIRST ST		1/1/1993	NO2, SO2, TSP,SO4,WS/WD