2005

AIR QUALITY SUMMARY

STATE OF RHODE ISLAND

Department of Environmental Management
Office of Air Resources

Rhode Island Department of Health
Air Pollution Laboratory

INTRODUCTION

Ambient air quality has been monitored at a network of stations in the State of Rhode Island since 1968. The monitoring network is operated and maintained by the Rhode Island Department of Environmental Management (RI DEM) Office of Air Resources (OAR) and by the Rhode Island Department of Health (RI HEALTH) Air Pollution Laboratory via an interagency contract agreement. The ambient air quality data collected are entered quarterly in the U.S. Environmental Protection Agency's (USEPA's) Aerometric Information Retrieval System (AIRS).

PURPOSE

Monitoring data collected are used for the following purposes:

1. Determining whether the State is in attainment of national and State ambient air quality standards;
2. Tracking progress toward meeting national and State ambient air quality standards for which the State is in nonattainment;
3. Documenting maintenance of air quality standards for which the State is in attainment;
4. Providing a daily report of air quality and a forecast for the next day's air quality with appropriate health warnings, when required;
5. Providing real-time data for regional air quality maps;
6. Identifying pollution patterns and trends;
7. Assessing health and welfare effects and land use and transportation plans and evaluating the effectiveness of abatement strategies and enforcement of control regulations; and,
8. Activating emergency control procedures intended to prevent air pollution episodes.

This summary of 2005 ambient air quality data is intended to be used to provide general information about air quality in Rhode Island and as a source of statistics necessary to support modeling studies and other air quality analyses.

AMBIENT AIR QUALITY STANDARDS AND ATTAINMENT

The USEPA has set National Ambient Air Quality Standards (NAAQS) for six air pollutants: lead (Pb), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), ozone (O_3) and particulate matter (PM). Pollutants with adopted NAAQS are referred to as "criteria pollutants."

There are two types of NAAQS; primary NAAQS are designed to protect human health and secondary NAAQS are designed to protect the environment, property and aesthetics. The derivations of the NAAQS, as well as background information about the sources, chemistry and deleterious effects of the criteria pollutants, are documented in the USEPA's air quality criteria documents.

The NAAQS currently in effect are listed in Table 1. In July 1997, the USEPA promulgated a NAAQS for particulate matter with diameters less than or equal to 2.5 micrometers (PM-2.5). The State of Rhode Island has not as yet adopted those standards, but has adopted all NAAQS promulgated prior to 1997.

Areas that do not meet air quality standards are called nonattainment areas. The Clean Air Act (CAA) requires each state with a nonattainment area to submit and implement a State Implementation Plan (SIP), which documents the measures that the State will take to come into attainment with the standard. The entire State of Rhode Island is a nonattainment area for ozone. The State is in attainment of the NAAQS for the other criteria pollutants.

Since the State of Rhode Island is a nonattainment area for ozone, it, was required by the Clean Air Act Amendments of 1990 to implement a variety of measures to limit emissions of two classes of ozone precursors, volatile organic compounds and nitrogen oxides, from industrial and commercial sources such as surface coating facilities, power plants and gasoline stations, as well as from mobile sources (motor vehicles). Although these measures have reduced ozone levels, the State has still not attained the NAAQS for that pollutant. Since Rhode Island's air quality is substantially affected by transport of pollutants into the State, further reductions in emissions in upwind states will be necessary for Rhode Island to become an attainment area for ozone.

TABLE 1: NATIONAL AMBIENT AIR QUALITY STANDARDS

POLLUTANT	AVERAGING TIME	PRIMARY STANDARD	SECONADARY STANDARD
Sulfur Dioxide (SO_2)	Annual Arithmetic Mean	0.03 ppm 80 µg/m³	None
	24-Hour	0.14 ppm 365 µg/m³	None
	3-Hour	None	0.50 ppm 1300 µg/m³
Carbon Monoxide (CO)	8-Hour	9 ppm 10 mg/m³	Same as Primary Standard
	1-Hour	35 ppm 40 mg/m³	Same as Primary Standard
Ozone (O_3)	1-Hour[A]	0.12 ppm 235 µg/m³	Same as Primary Standard
	8-Hour[B]	0.08 ppm 157 µg/m³	Same as Primary Standard
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	0.053 ppm 100 µg/m³	Same as Primary Standard
Particulate Matter $\leq$ 10 micrometers (PM-10)	Annual Arithmetic Mean[C]	50 µg/m³	Same as Primary Standard
	24-Hour[D]	150 µg/m³	Same as Primary Standard
Particulate Matter $\leq$ 2.5 micrometers (PM-2.5)	Annual Arithmetic Mean[E]	15 µg/m³	Same as Primary Standard
	24-Hour[F]	65 µg/m³	Same as Primary Standard
Lead (Pb)	Calendar Quarter Arithmetic Mean	1.5 µg/m³	Same as Primary Standard

Primary standards protect against adverse health effects. **Secondary standards** protect against welfare effects such as damage to crops, vegetation, and buildings.

SO2 and CO standards must not be exceeded more than once a year.

[A] To attain the 1-hour O_3 standard, the daily maximum 1-hour average concentration must not exceed 0.12 ppm more than 3 times in 3 consecutive years. The 1-hour O3 standard was revoked on June 1st, 2005.

[B] To attain the 8-hour O_3 standard, the fourth-highest daily maximum 8-hour average each year, averaged over 3 consecutive years must not exceed 0.08 ppm. The 8-hour standard was adopted in July 1997.

[C] To attain the PM-10 annual standard, the arithmetic average of the 24-hour samples for a 1-year period, averaged over 3 consecutive years, must not exceed 50 µg/m³.

[D] To attain the PM-10 24-hour standard, the 99th percentile of the distribution of the 24-hour concentrations for a period of 1 year, averaged over 3 years, must not exceed 150 µg/m³.

[E] To attain the PM-2.5 annual standard, the 24-hour concentration must not exceed 15.0 µg/m³ more than once per year, averaged over 3 years.

[F] To attain the PM-2.5 24-hour standard, the 98th percentile of the distribution of the 24-hour concentrations for a period of 1 year, averaged over 3 years, must not exceed 65 µg/m³.

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

RHODE ISLAND AMBIENT AIR QUALITY MONITORING NETWORK

During 2005, RI DEM and RI HEALTH monitored the ambient air levels of all of the criteria pollutants except for lead. The State discontinued lead monitoring in 1992 because airborne lead concentrations in the State had been substantially lower than the NAAQS for that pollutant since 1986, when lead was removed from gasoline.

Monitoring was also conducted for nitrogen oxides (NOx), volatile organic compounds (VOCs) and carbonyls in 2005. Those pollutants are ozone precursors, which react in the atmosphere to form ground-level ozone, a criteria pollutant. In addition, some of the VOCs and carbonyls monitored are air toxics; exposure to those substances is associated with cancer and other serious health effects. Monitoring is also conducted for toxic metals and for black carbon, an indicator of diesel exhaust.

The locations of the criteria pollutant and air toxics monitoring sites are shown in Figures I - IV. Table 2 lists the parameters measured and the sampling methods employed at each of those sites.

TABLE 2: MONITORING SITES

Site Location	AIRS Code	UTM East	UTM North	Parameter Measured	Method Of Sampling	EPA Method Designation
Vernon Trailer Vernon Street Pawtucket	440070026	302.5	4638.4	PM-2.5	Lo Vol	Reference
				PM-10	Hi Vol	Reference
				VOCs	Canisters, GC/MS	Reference
Johnson & Wales 111 Dorrance Street Providence	440070027	299.2	4633.8	PM-10	Hi Vol	Reference
Hallmark Building 695 Eddy Street Providence	440070028	299.2	4633.8	PM-2.5	Lo Vol	Reference
Brown University 10 Prospect Street Providence	440070012	300.2	4633.0	Oxides of Nitrogen	Chemiluminescence	Reference
				Nitrogen Dioxide	Chemiluminescence	Reference
				Sulfur Dioxide	Simulated Fluorescence	Equivalent
Case Mead Building 76 Dorrance Street Providence	440071009	299.7	4632.8	Carbon Monoxide	Gas Filter Correlation	Equivalent
				Sulfur Dioxide	Simulated Fluorescence	Equivalent
USEPA Laboratory 27 Tarzwell Drive Narragansett	440090007	273.4	4610.4	Ozone	U.V. Photometric	Reference
				PM-2.5	Beta Attenuation/Cont	N/A
				Wind Speed	Anemometer	N/A
				Wind Direction	Wind Vane	N/A
				Temperature	Spot Reading	N/A
Francis School 64 Bourne Avenue E. Providence	440071010	303.9	4634.5	Oxides of Nitrogen	Chemiluminescence	Reference
				Nitrogen Dioxide	Chemiluminescence	Reference
				VOCs	Canisters, GC/MS	Reference
				Carbon Monoxide	Gas Filter Correlation	Equivalent
				Ozone	U.V. Photometric	Reference
				PM-2.5	Lo Vol	Reference
				PM-2.5	TEOM/Continuous	N/A
				Carbonyls	HPLC Cartridges	N/A
				Black Carbon	Aethalometer	N/A
				Wind Speed	Anemometer	N/A
				Wind Direction	Wind Vane	N/A
				Barometric Pressure	Barometer	N/A
				Temperature	Spot Reading	N/A
				Relative Humidity	Plastic Film	N/A
				Solar Radiation	Pyranometric	N/A
				UV Radiation	UV Photometric	N/A
				Precipitation	Bucket/Continuous	N/A

Site Location	AIRS Code	UTM East	UTM North	Parameter Measured	Method Of Sampling	EPA Method Designation
Urban League 212 Prairie Avenue Providence	440070022	299.4	4631.1	PM-2.5	Lo Vol	Reference
				Black Carbon	Aethalometer	N/A
				PM-2.5	Beta Attenuation/Cont	N/A
				Speciated PM-2.5	Speciation Monitor	N/A
				PM-10/Metals	Hi Vol	Reference
				VOCs	Canisters, GC/MS	Reference
				Carbonyls	HPLC Cartridges	N/A
				Wind Speed	Anemometer	N/A
				Wind Direction	Wind Vane	N/A
				Temperature	Spot Reading	N/A
				Relative Humidity	Plastic Film	N/A
Alton Jones Campus Victory Highway West Greenwich	440030002	273.4	4610.4	Ozone	U.V. Photometric	Reference
				Nitrogen Dioxide	Chemiluminescence	Reference
				Oxides Of Nitrogen	Chemiluminescence	Reference
				VOCs	Canisters, GC/MS	Reference
				PM-10	Hi Vol	Reference
				PM-2.5	Lo Vol	Reference
				PM-2.5	Beta Attenuation/Cont	N/A
				Wind Speed	Anemometer	N/A
				Wind Direction	Wind Vane	N/A
				Barometric Pressure	Barometer	N/A
				Temperature	Spot Reading	N/A
				Relative Humidity	Plastic Film	N/A
				Solar Radiation	Pyranometric	N/A

Figure 1
Air Quality Monitoring Network (2005)
Continous Monitors
Site Locations

Figure 2
PM-10 Air Pollution Monitoring Network
(2005)
Site Locations

Figure 3
PM-2.5 Air Pollution Monitoring Network
(2005)
Site Locations

Figure 4
Air Toxics Monitoring Network (2005)
Site Locations

AIR QUALITY INDEX

In 1976, the USEPA developed the Pollutant Standards Index (PSI), a readily understandable way of communicating monitored air pollutant concentrations and associated health implications to the public. In June 2000, the USEPA updated the index and renamed it the Air Quality Index (AQI). The AQI converts monitored ambient concentrations of criteria pollutants to a scale of 0 to 500. For all pollutants except for PM-2.5, an AQI level of 100 means that the monitored concentration is at the level of the short-term standard for the pollutant. Monitored levels just above the standard (AQI of 101 –150) are characterized as “unhealthy for sensitive groups” and higher levels (AQI of 151-200) are characterized as “unhealthy” by the USEPA. To avoid any confusion that might result from the interpretation of the term “sensitive group,” Rhode Island describes all AQI levels between 100 and 200 as “unhealthy” in its health advisories.

For PM-2.5, the USEPA has determined that levels below the one-hour standard of 65 $\mu g/m^3$ may cause health effects in sensitive individuals. Therefore, for that pollutant, EPA’s “unhealthy for sensitive groups” category (AQI of 101-150) represents concentrations in the range of 40 – 64 $\mu g/m^3$, which are below the standard, while all concentrations at and above the standard are characterized as “unhealthy.”

AQI subindices are calculated every day for the highest 8-hour average concentrations of ozone and CO and for the 24-hour average concentration of SO_2 and PM-2.5 recorded during the 24-hour period ending at 8:00 AM on that day. The highest of the subindices is then reported as the AQI for that date. During the summer, the AQI is based on the ozone and PM-2.5 sub index, while during the cooler months the AQI is based on CO, SO_2 and PM-2.5. .

Rhode Island DEM reports the AQI to the local news media, accompanied by an easily understood descriptor word. A forecast for the next day’s pollutant levels, consisting only of a descriptor word, is also reported.

The Rhode Island AQI descriptors are as follows:

AQI	**Descriptor**
0 to 50	Good
51 to 100	Moderate
101 to 200	Unhealthy
201-300	Very Unhealthy

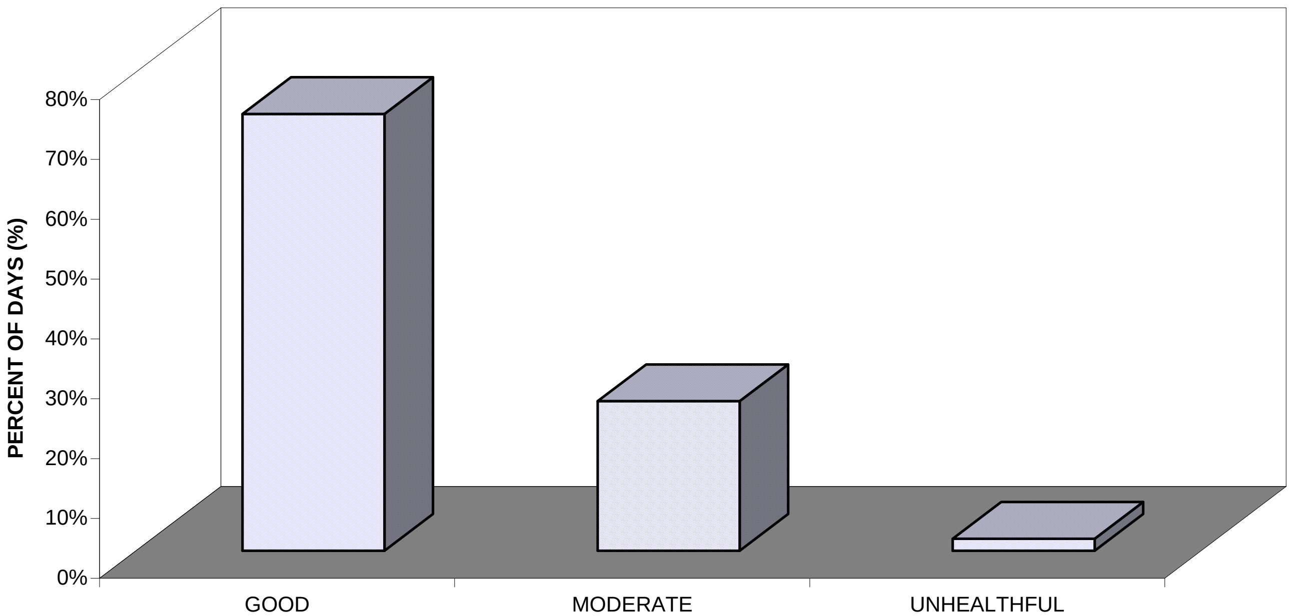
Pollutant levels measured at five monitoring sites were used for AQI reporting in 2005. The AQI pollutants measured at those sites are as follows:

Site Location	**AQI Pollutants Monitored**
Case Mead Building, 76 Dorrance Street, Providence	Carbon Monoxide, Sulfur Dioxide
Brown University, 10 Prospect Street, Providence	Sulfur Dioxide
Myron Francis School, 64 Bourne Avenue, E. Providence	Ozone
Alton Jones Campus of URI, Victory Highway. Greenwich	Ozone PM-2.5
USEPA Research Laboratory 72 Tarzwell Drive, Narragansett	Ozone PM-2.5
Urban League 212 Prairie Avenue, Providence	PM-2.5

Note that nitrogen dioxide concentrations are not used to calculate the AQI because there is no short-term air quality standard for that pollutant. PM-10 levels are also not used, because the monitoring results for those pollutants are not available the day after the samples are taken. Similarly, PM-2.5 concentrations measured using the filter-based Federal Reference Method are not used for calculating the AQI because those values are not immediately available; only PM-2.5 concentrations measured by continuous instruments are used for the AQI.

In 2005, the AQI in Rhode Island was good on 73% of the reporting days, moderate on 25%, and unhealthful on 2% (see Figure V). The daily AQI and forecast are printed in the weather section of the Providence Journal. A daily air quality report is also available on the OAR hotline at 401-222-2808 and at DEM's web site at http://www.dem.ri.gov/programs/benviron/air/pm.htm. Additional information on the AQI and the health effects associated with various index levels is available from the OAR.

Figure V
Air Quality Index (AQI)
2005 Air Quality Levels



2005 AIR QUALITY SUMMARY

The weather in the summer of 2005 was hot and dry and, as a result, the ozone concentrations were higher than those that occurred during the cool and dry summer of 2004. The 8-hour ozone standard was exceeded on eight days in 2005, as compared to four days in 2004. Ambient concentrations of the other criteria pollutants continued to stay below the National Ambient Air Quality Standards (NAAQS).

A more detailed discussion of the properties of the criteria pollutants, the concentrations of pollutants measured in 2005 and ambient air quality trends follows.

CARBON MONOXIDE (CO)

Carbon monoxide (CO) is a colorless, odorless, poisonous gas formed by the incomplete combustion of fuels by motor vehicles, aircraft, boilers, power plants, incinerators, industrial processes and other fuel-burning sources. Elevated CO levels are often found in downtown areas with heavy traffic and poor dispersion characteristics.

By binding to the hemoglobin in blood, CO reduces the amount of oxygen that is delivered to the body's organs and tissues. CO exposure is most dangerous to those who suffer from cardiovascular disease. Healthy individuals are also affected at higher levels of exposure. Exposure to elevated CO levels can cause shortness of breath, chest pain, headaches, confusion, visual impairment, reduced work capacity, reduced coordination, poor learning ability, and difficulty in performing complex tasks.

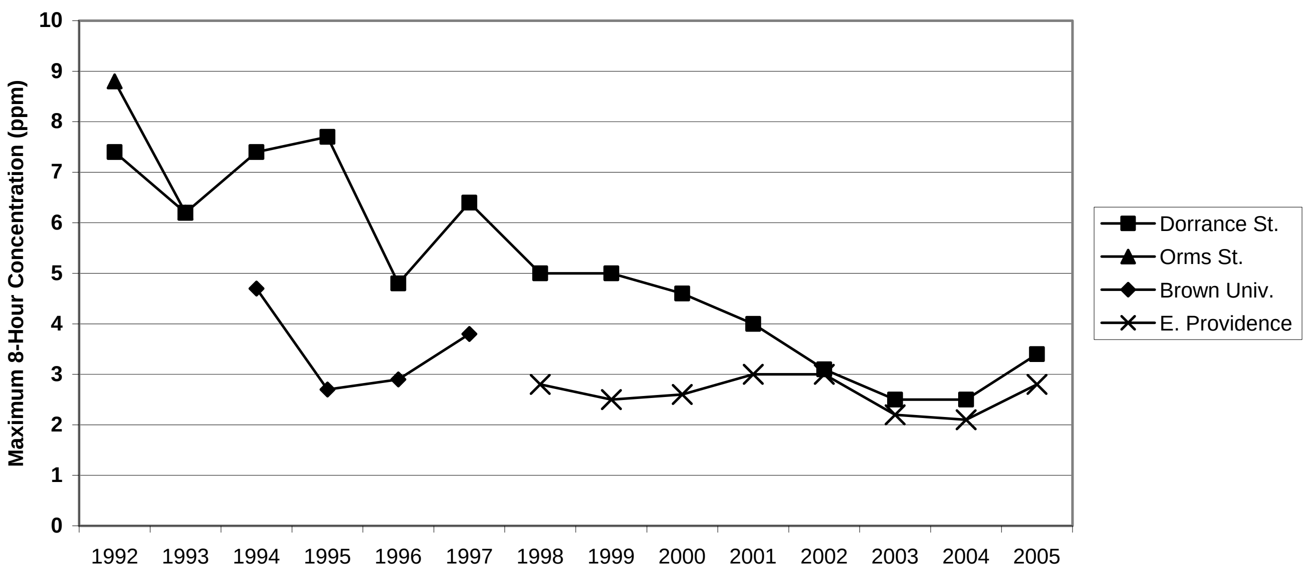
The primary and secondary NAAQS for CO are the same, 9 ppm as an 8-hour average and 35 ppm as a 1-hour average. Those standards have not been exceeded in Rhode Island since 1984. In 2005, CO was measured at two sites in the State, Dorrance Street in downtown Providence and the Francis School in East Providence... The highest 2005 CO concentrations, which were recorded at the Dorrance Street site, were 38% and 29% of the 8-hour and 1-hour NAAQS respectively, (See Table 3).

Figure VI shows CO trends in Rhode Island between 1992 and 2005. Yearly maximum 8-hour average CO concentrations at the Dorrance Street site steadily decreased in that period. Prior to 2001, the maximum CO levels recorded at the Dorrance Street site were significantly higher than those in East Providence but, due to the drop in the Dorrance Street levels, the CO levels at the two sites have been similar since 2001. The maximum 8-hour average CO concentrations at both the Providence and the East Providence sites were slightly higher in 2005 than in 2004.

Table 3 Carbon Monoxide (CO) Levels Measured in Rhode Island in 2005 (ppm)

	1-Hour Values (NAAQS is 35 ppm)				8-Hour Values (NAAQS is 9 ppm)		
Stations	# of Observations	1st Maximum	2nd Maximum	# of Exceedances	1st Maximum	2hd Maximum	# of Exceedances
Francis School 64 Bourne Ave. E. Providence	7,153	2.9	2.8	0	1.8	1.6	0
76 Dorrance St. Providence	8,272	10.1	7.9	0	3.4	2.5	0
Totals				0			0

Figure VI
CARBON MONOXIDE (CO)
Maximum 8-Hour Concentrations
Standard = 9 ppm



LEAD (Pb)

Lead is no longer monitored as a criteria pollutant in the State because, since the removal of lead from gasoline, airborne lead concentrations in the State have been substantially lower than the NAAQS. There are no major stationary sources of lead in the State.

Lead can enter the body through inhalation of lead dust or fumes and by ingestion of lead paint chips and lead-contaminated dust, water, soil, or food. Lead accumulates in blood, bone, and soft tissue. Fetuses and small children are particularly susceptible to the toxic effects of lead, which include brain damage, behavioral alterations, decreased intelligence and slowed growth. At higher levels, exposure to lead can damage the kidneys, liver, and nervous system, and cause reproductive disorders and anemia. The USEPA's health-based NAAQS for lead is 1.5 $\mu g/m^3$ as a three-month average.

Lead is one of the metals monitored in respirable particulate matter (PM-10) at the Urban League site in Providence as part of the National Air Toxics Trends Sites (NATTS) network. Lead in PM-10 was also monitored from March 2004 to March 2005 as part of a special air toxics study at the Bridgham School in the Olneyville section of Providence. The results of that study are discussed in the Air Toxics section of this document.

In addition, lead in fine particulate matter (PM-2.5) was measured at Urban League site in 2005 on a one-in three day schedule as part of the national PM-2.5 Speciation program. A summary of Rhode Island PM-10 and PM-2.5 metals data is included in the Air Toxics section of this document.

NITROGEN DIOXIDE (NO_2) and OXIDES of NITROGEN (NOx)

Nitrogen dioxide (NO_2) belongs to a family of highly reactive gases called oxides of nitrogen (NOx). NOx forms when fuel is burned at high temperatures, and is found in the exhuast emitted by motor vehicles and stationary sources such as power plants and industrial boilers. A suffocating, brownish gas, NO_2 is a strong oxidizing agent that reacts in the air to form corrosive nitric acid, as well as toxic organic nitrates.

Breathing air with elevated NO_2 levels irritates the lungs and lowers the body's resistance to respiratory infections such as influenza. Continued or frequent exposure to high concentrations of NO_2 may cause an increased incidence of acute respiratory illness in children. Emissions of NO_2, as well as other oxides of nitrogen (NOx), contribute to the formation of ground level ozone and to other adverse environmental effects, such as acid rain and the eutrophication of coastal waters.

In 2005, Rhode Island monitored NO_2 and NOx at three sites. The East Providence and West Greenwich NO_2/ NOx monitors are located at Photochemical Assessment Monitoring Sites (PAMS). The PAMS network is designed to track the movement of ozone and its precursors (like NOx) through the region, so NOx monitoring at those locations is required only during June, July and August, when ozone levels tend to be highest. In keeping with that requirement, the NO_2/ NOx monitors in West Greenwich and East Providence were operated from June through August in 2005. The third site, which is located at Brown University in Providence, operated throughout the year.

The NAAQS for NO_2 is 0.053 ppm as an annual arithmetic mean. The NAAQS has not been exceeded in Rhode Island since monitoring for NO_2 began in 1980. In 2005, the annual arithmetic mean at the Brown University site was 0.0173 ppm, or 33% of the NAAQS. There is no NAAQS for NOx. 2005 NO_2 and NOx levels are summarized in Tables 4 and 5, respectively.

As can be seen in Figure VII, NO_2 and NOx levels in the State have declined over the past ten years. NO_2 and NOx levels were both lower in 2005 than they were in 2004 and in previous years.

Table 4 Nitrogen Dioxide (NO_2) Levels Measured in Rhode Island in 2005 (ppm)

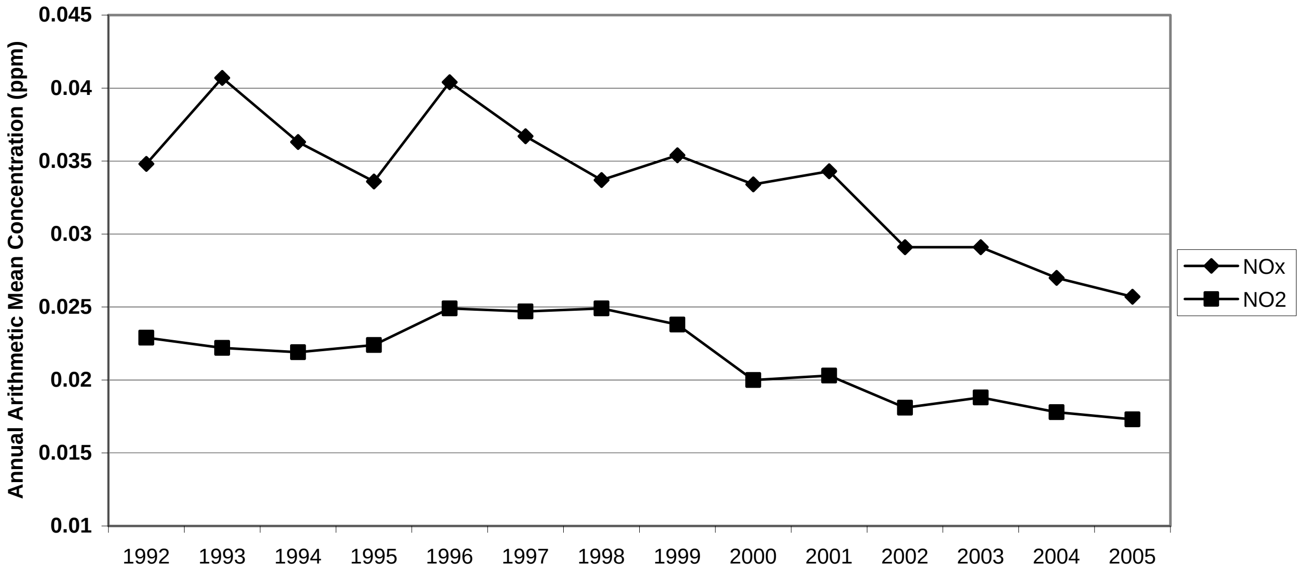
Stations	1-hour Values			Annual Mean (NAAQS = 0.053 ppm)	
	# of Observations	1st Maximum	2nd Maximum	Observed Mean	# of Exceedances
Alton Jones W. Greenwich	2,104	0.013	0.012	N/A*	N/A
Brown University 10 Prospect St. Providence	8,166	0.073	0.070	0.0173	0
Francis School 64 Bourne Ave. E. Providence	2,078	0.035	0.031	N/A*	N/A
Total					0

Table 5 Concentrations of Oxides of Nitrogen (NOx) Measured in Rhode Island in 2005 (ppm)

Stations	1-hour Values			Annual Mean
	# of Observations	1st Maximum	2nd Maximum	
Alton Jones W. Greenwich	2,104	0.013	0.013	N/A*
Brown University 10 Prospect St. Providence	8,166	0.440	0.435	0.0257
Francis School 65 Bourne Ave. E. Providence	2,078	0.056	0.049	N/A*

* N/A = Not applicable. The W. Greenwich and E. Providence NO_2/NOx monitors are operated only in June, July and August. Since those monitors do not operate for the whole year, annual means cannot be calculated for those sites.

Figure VII
NITROGEN DIOXIDE (NO_2) and OXIDES OF NITROGEN (NOx)
Annual Average Concentrations at Brown University, Providence Site
NO_2 Standard = 0.053 ppm



OZONE (O_3)

Ozone (O_3) is a photochemical oxidant, which is the major component of smog. Elevated concentrations of ground level ozone are a major health and environmental concern. Ozone is formed in the atmosphere when hydrocarbons and oxides of nitrogen (NOx) emitted by mobile and stationary sources react in the presence of elevated temperatures and sunlight.

Because airborne hydrocarbons and NOx, as well as ozone itself, can be transported over long distances, sources emitting ozone precursors in states upwind of Rhode Island contribute to the State's ozone problem. Ozone levels in Rhode Island generally are highest on hot sunny summer days when the winds are from the west or southwest. Rhode Island was previously classified as a serious nonattainment area for the one-hour average NAAQS for ozone and is a moderate nonattainment area for the current 8-hour average ozone standard.

People exposed to elevated ozone levels experience eye, nose and throat irritation; coughing; chest pain; shortness of breath; decreased lung function; headache; and fatigue. Repeated exposures can increase susceptibility to respiratory infection and lung inflammation, and can aggravate preexisting respiratory diseases, such as asthma. Long-term exposures can cause irreversible changes in the lungs, leading to chronic respiratory illnesses such as emphysema and chronic bronchitis and to premature aging of the lungs.

Children, who are frequently active outside during the summertime when ozone levels are at their highest, are at a high risk for ozone-related effects. Adults who work or exercise outside and people with respiratory and heart diseases are also at an increased risk. Elevated ozone levels also reduce agricultural and commercial forest yields; reduce the growth and survivability rates of tree seedlings; increase tree and plant susceptibility to disease, pests and other environmental stresses; and have long-term effects on forests and ecosystems.

In 1977, after a lengthy scientific review, the USEPA determined that the one-hour average ozone NAAQS, 0.12 ppm, was not sufficiently stringent to protect public health and the environment and promulgated a new ozone standard of 0.08 ppm as an 8-hour average. The 1-hour standard was revoked as of June 1, 2005 and, therefore, comparisons to that standard will not be included after this summary. One-hour average ozone concentrations are shown in Table 6a for information purposes.

Ozone monitors were operated at three Rhode Island sites, Alton Jones in West Greenwich, the Francis School in East Providence and the USEPA Laboratory in Narragansett, during the 2005 ozone season (April - September). The 8-hour ozone NAAQS was exceeded at one or more of the Rhode Island sites on eight days in 2005: April 20th, June 8th, 25th and 26th, and August 5th, 11th, 12th and 13th. Exceedances were recorded on five days at the West Greenwich and Narragansett sites and on four days at the East Providence site. The highest 8-hour concentration recorded, at the West Greenwich site, was 0.098 ppm, 122% of the NAAQS. 2005 8-hour average ozone levels are summarized in Table 6b.

A monitor is in violation of the 8-hour ozone NAAQS if the average of the fourth highest daily maximum 8-hour concentrations for each year in a three-year period, the design value, is greater than or equal to 0.085 ppm. Rhode Island design values for the 2003 – 2005 period were 0.084 ppm for the West Greenwich site, 0.082 for the East Providence site and 0.089 ppm for Narragansett. Therefore, only the Narragansett monitor violated the 8-hour NAAQS for ozone during that time period.

Since a decline in the early 1990's, there has been no clear trend in the number of days per year that the 8-hour ozone standard is exceeded in the State, as can be seen in Figure VIII. Ozone concentrations in any given year are significantly influenced by the weather patterns that occur during the summer of that year. Since the summer of 2005 was hot and dry, the number of 8-hour exceedances in 2005 was higher than during the cooler summer of 2004.

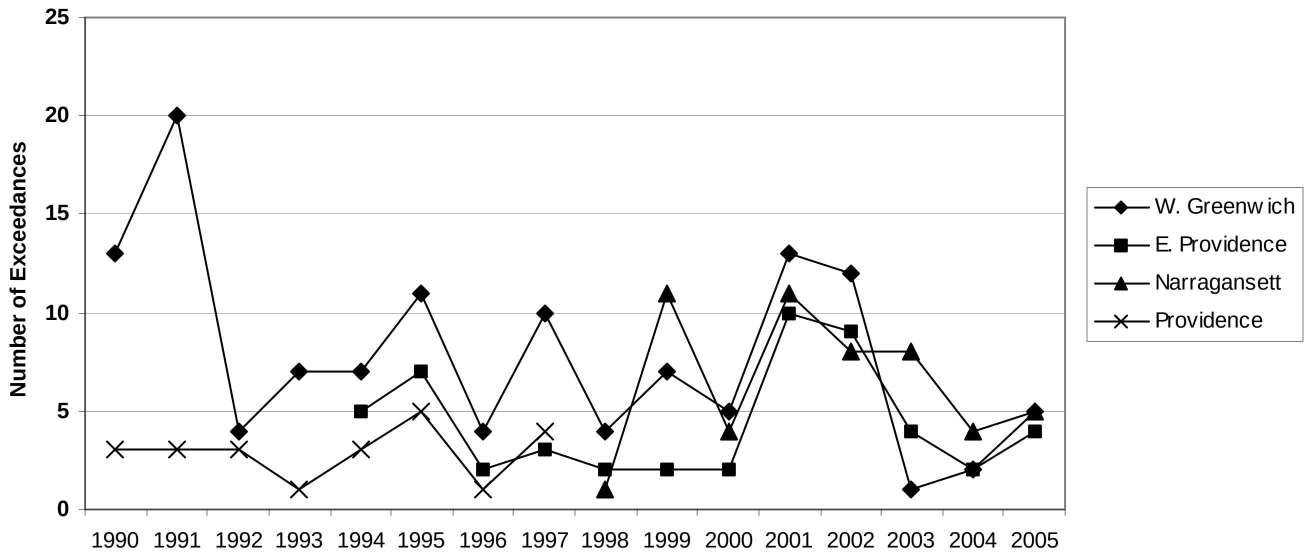
Table 6a One-Hour Average Ozone Levels Measured in Rhode Island in 2005(ppm) (No NAAQS)

Stations	# of Observations	1st Maximum	2nd Maximum	3rd Maximum	4th Maximum	# of Exceedances
Alton Jones W. Greenwich	181	0.128	0.118	0.116	0.102	1
Francis School 10 Prospect St. E. Providence	172	0.116	0.112	0.101	0.094	0
EPA Laboratory 27 Tarzwell Dr. Narragansett	179	0.112	0.102	0.100	0.099	0
Total						1

Table 6b Eight-Hour Average Ozone Levels Measured in Rhode Island in 2005(ppm) (NAAQS = 0.08 ppm)

Stations	# of Observations	1st Maximum	2nd Maximum	3rd Maximum	4th Maximum	# of Exceedances
Alton Jones W. Greenwich	174	0.098	0.097	0.096	0.090	5
Francis School 10 Prospect St. E. Providence	163	0.095	0.086	0.086	0.085	4
EPA Laboratory 27 Tarzwell Dr. Narragansett	177	0.093	0.093	0.090	0.090	5
Total						13

Figure VIII
OZONE (O3)
Exceedances of the 8-Hour Standard
8-Hour Standard = 0.08 ppm



PARTICULATE MATTER

Airborne particulate matter (PM) is generated by the operation of mobile and stationary sources, including diesel trucks, wood stoves, power plants, and industrial processes, as well as by natural and human activities. PM is both emitted directly from sources and formed in the atmosphere by chemical reactions of gaseous pollutants. The chemical and physical compositions of airborne particles vary widely.

The NAAQS for PM focus on small particles because inhaled small particles can travel to the lower regions of the respiratory tract and are therefore associated with significant health effects. The PM-10 standard regulates particles with diameters of 10 micrometers (one-seventh the width of a human hair) or less and the PM-2.5 or fine particulate standard regulates particles with diameters equal to or smaller than 2.5 micrometers.

Exposure to PM has been linked to a variety of health effects, including coughing, difficult or painful breathing, chronic bronchitis, aggravated asthma, increased respiratory-related hospital admissions and emergency room visits, and premature death. The elderly, children, and people with heart or lung diseases like emphysema, bronchitis and asthma are at particular risk for those effects. Airborne PM also impairs visibility and can soil and damage materials.

Rhode Island has monitored PM-10 since 1985 and PM-2.5 since 1999.

PM-10

In 2005, Rhode Island operated a network of four PM-10 monitoring sites: the Johnson and Wales library on Dorrance Street in downtown Providence; Vernon Street, Pawtucket, adjacent to Route I-95*;* the Urban League building in urban South Providence and the Alton Jones campus of the University of Rhode Island in West Greenwich, a background rural site. PM-10 samples collected at the Urban League, which is the State's NATTS site, are also analyzed for metals; metals results are discussed in the air toxics section of this document.

The NAAQS for PM-10 are 150 $\mu g/m^3$ as a 24-hour average and 50 $\mu g/m^3$ as an annual arithmetic mean. Those standards have not been exceeded in Rhode Island since PM-10 monitoring began in 1985. As is shown in Table 7a, the maximum 24-hour PM-10 concentration in 2005, which was measured at the Vernon Street site, was 55 $\mu g/m^3$, 35% of the NAAQS, and the maximum annual average PM-10 concentration, also at the Vernon Street site, was 24.4 $\mu g/m^3$, 49% of the corresponding NAAQS.

Figure IX shows the annual average PM-10 levels measured in the past ten years. Until 2002, the Allens Avenue monitor, which was located immediately adjacent to Route I-95 in Providence, routinely recorded the highest PM-10 levels in the State. That site reflected worst-case PM-10 levels and was not representative of neighborhood exposures. Monitoring at the Allens Avenue site was discontinued in 2002 due to extensive construction and demolition activity in the area around the monitor associated with a highway relocation project. Since the discontinuation of monitoring at the Allens Avenue site, the monitor at the Vernon Street site, which is located near Rte. I-95 in Pawtucket, records the highest annual mean PM-10 levels in the State, The annual mean PM-10 concentration at the Vernon Street site in 2005 was approximately 4-6 $\mu g/m^3$ higher than at the other urban sites and more than double that at the rural W. Greenwich site.

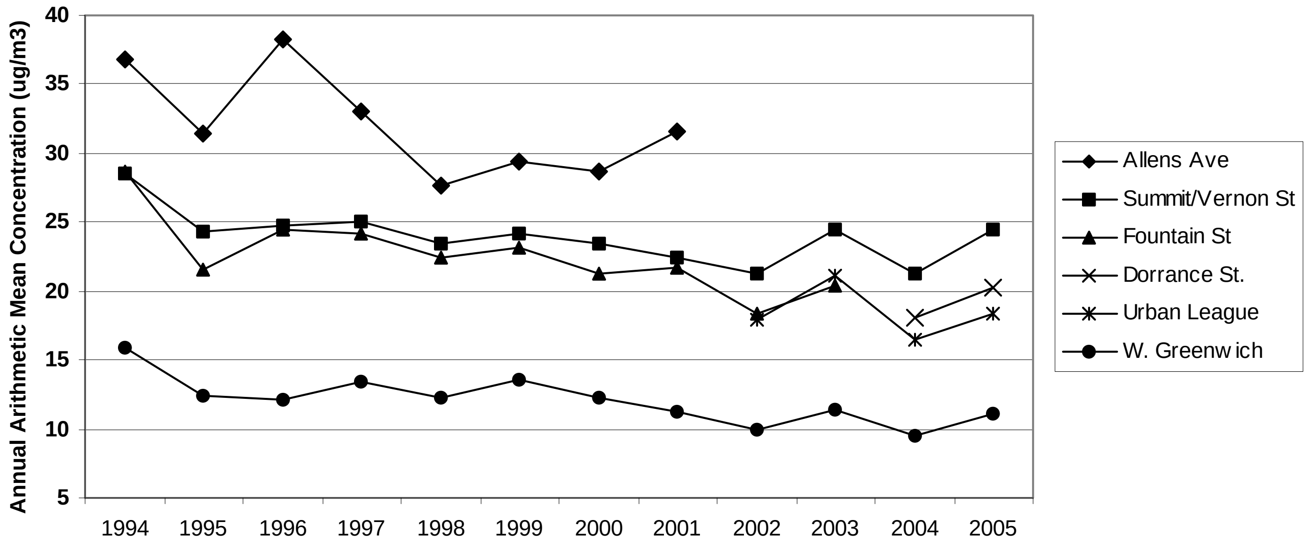
The average PM-10 concentrations at the Rhode Island sites show a slight downward trend over the past ten years. However, as can be seen in Figure IX, the annual average levels at all sites were slightly higher in 2005 than in the previous year.

Table 7a PM–10 Concentrations in Rhode Island in 2005(ug/m3)
NAAQS = 150 ug/m3 (24-hour average), 50 ug/m3 (annual mean)

Stations	24-hour Values						Annual Mean
	# Of Observations.	1st Maximum	2nd Maximum	3^{rd} Maximum	4th Maximum	# of Exceedances	
Vernon St. Pawtucket	57	55	54	46	46	0	24.4
Alton Jones W. Greenwich	56	40	38	34	27	0	11.1
212 Prairie Ave. Providence	61	48	46	39	36	0	18.3

111 Dorrance St. Providence Totals	55	49	42	36	35	0	20.2
						0	

Figure IX
PARTICULATE MATTER (PM-10)
Annual Average Concentrations
Standard = 50 ug/m^3



FINE PARTICULATE MATTER (PM-2.5)

As discussed above, an NAAQS for PM-2.5 was promulgated in July 1997. In 1999, RI DEM began operating a network of PM-2.5 monitors to determine whether Rhode Island is in compliance with those standards.

PM-2.5 was measured at six sites in the State in 2005. Urban core sites, which reflect population exposure in urban areas, are located at the Urban League building on Prairie Avenue in Providence; at the Vernon Street monitoring trailer in Pawtucket, adjacent to Route I-95; on the roof of a building on Eddy Street in Providence and at a trailer adjacent to the Francis School in East Providence, which is frequently downwind of the Providence metropolitan area. A background/transport rural site is located at the Alton Jones campus of the University of Rhode Island in West Greenwich. PM-2.5 samples are collected daily at the Urban League and East Providence sites and every 3rd day at the other sites. The West Greenwich, Pawtucket, and Urban League sites are also PM-10 sites.

Rhode Island also operates continuous PM-2.5 monitors at four sites - a TEOM continuous PM-2.5 monitor at the East Providence site, and Beta Attenuation Monitors (BAM) at the Urban League site, the West Greenwich site and at the USEPA laboratory in Narragansett, a coastal site where ozone is also measured. The continuous instrumentation does not produce data that are identical to those produced by the filter-based Federal Reference Method (FRM), and, thus, these data cannot be used for determining compliance with the NAAQS. However, the continuous monitors provide vital real-time data, which are used for forecasting PM-2.5 levels, for issuing health alerts, for calculating the AQI and for tracking hourly PM-2.5 levels.

Rhode Island has measured speciated PM-2.5 levels in the State since June 2002. Speciated PM-2.5 samples were collected at the East Providence site every 6th day from June 2002 until May 2004. Speciation sampling at the Urban League site began in June 2002 on the one in six day schedule, but the frequency was increased to one in three days in May 2004, when the East Providence speciation measurements were discontinued. Speciation monitors provide data on the composition of PM-2.5, which are useful for identifying sources and for characterizing the toxicity of this pollutant.

In 2005, the 24-hour average NAAQS for PM-2.5 was 65 $\mu g/m^3$ and the annual average NAAQS for that pollutant was 15 $\mu g/m^3$. Neither of the PM-2.5 NAAQS was exceeded in Rhode Island in 2005. As can be seen in Table 7b, the highest 24-hour concentration recorded in Rhode Island in 2005 was 42.4 $\mu g/m^3$ at the Urban League site and the highest annual average, which was measured at the Vernon Street site, was 12.37 $\mu g/m^3$.

It is generally accepted by members of the scientific and regulatory communities, including the USEPA, that exposure to concentrations of PM-2.5 concentrations substantially below the standard can cause health effects. In its Air Quality Index Reporting rule, discussed above, the USEPA classifies 24-hour average PM-2.5 levels between 40 and 64 $\mu g/m^3$ as “unhealthy for sensitive groups,” even though those levels are below the NAAQS for PM-2.5. Groups sensitive to PM-2.5 health effects include children, the elderly, and people with heart or respiratory disease. Other experts have recommended reducing the 24-hour PM-2.5 NAAQS to an even lower level. In 2005, PM-2.5 concentrations above 40 $\mu g/m^3$ were recorded in Rhode Island on two days and levels above 30 $\mu g/m^3$ were recorded on 11 days. Levels were generally highest during the summer months, although elevated levels occasionally also occurred in the colder months.

In December 2004, the USEPA designated the entire State of Rhode Island as an attainment area for the PM-2.5 NAAQS. As can been seen in Figure X, annual average PM-2.5 concentrations at the Rhode Island sites have been consistently lower than the annual average NAAQS since measurement of that pollutant began. The 24-hour concentrations measured at all sites have also consistently been below the short-term PM-2.5 standard, as shown in Figure XI.

Table 7b PM-2.5 Concentrations in Rhode Island in 2005 (ug/m3)
2005 NAAQS = 65 ug/m3 (24-hour average), 15ug/m3 (annual mean)
FRM (Federal Reference Method) DATA SUMMARY

Stations	24-hour Values							Annual Mean
	# of Observations .	1st Maximum	2nd Maximum	3rd Maximum	4th Maximum	98th Percentile	# of Exceedances of 2005 24-hr NAAQS	
Francis School E. Providence	323*	38.5	38.5	36.3	34.2	29.9	0	10.26***
Vernon St Pawtucket	105**	35.1	34.9	29.3	27.5	29.3	0	12.37***
Alton Jones W. Greenwich	85**	36.6	32.4	31.9	22.7	32.4	0	8.32***
Prairie Avenue Providence	328*	42.4	40.0	35.7	34.7	31.1	0	10.61
695 Eddy St Providence	81**	37.5	32.2	26.0	19.5	32.2	0	11.30***

*Samples collected daily at this site.
**Samples collected every 3rd day at this site.
***Data capture at this site was insufficient for calculating an accurate annual mean.

Figure X
FINE PARTICULATE MATTER (PM-2.5)
Annual Average Concentrations
Stamdard = 15 ug/m³

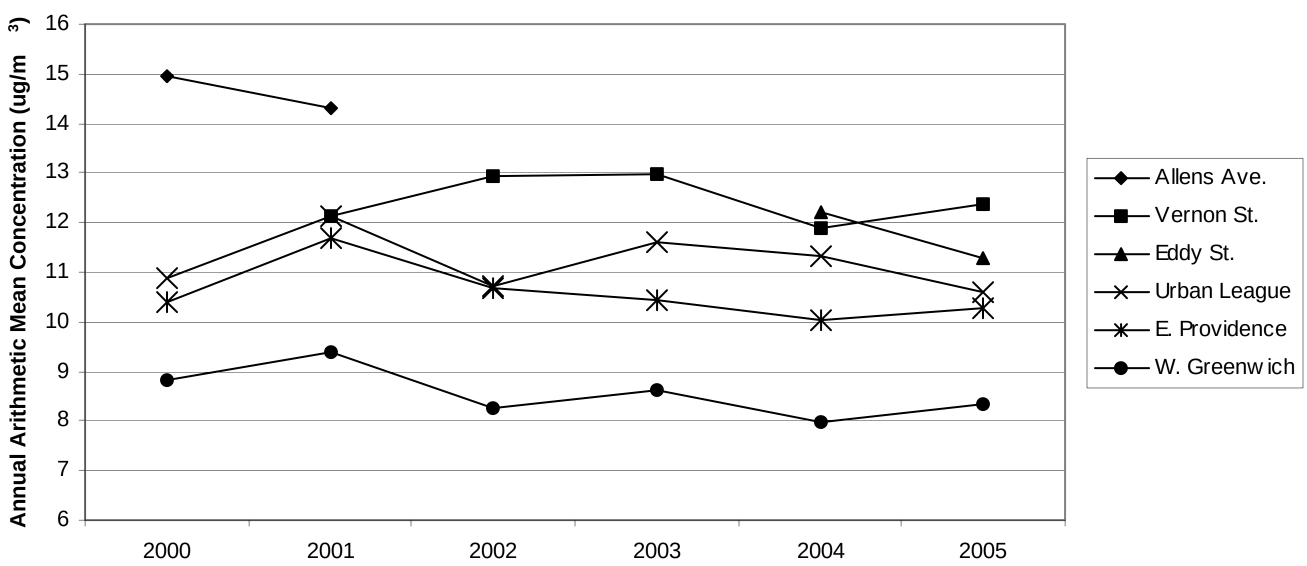
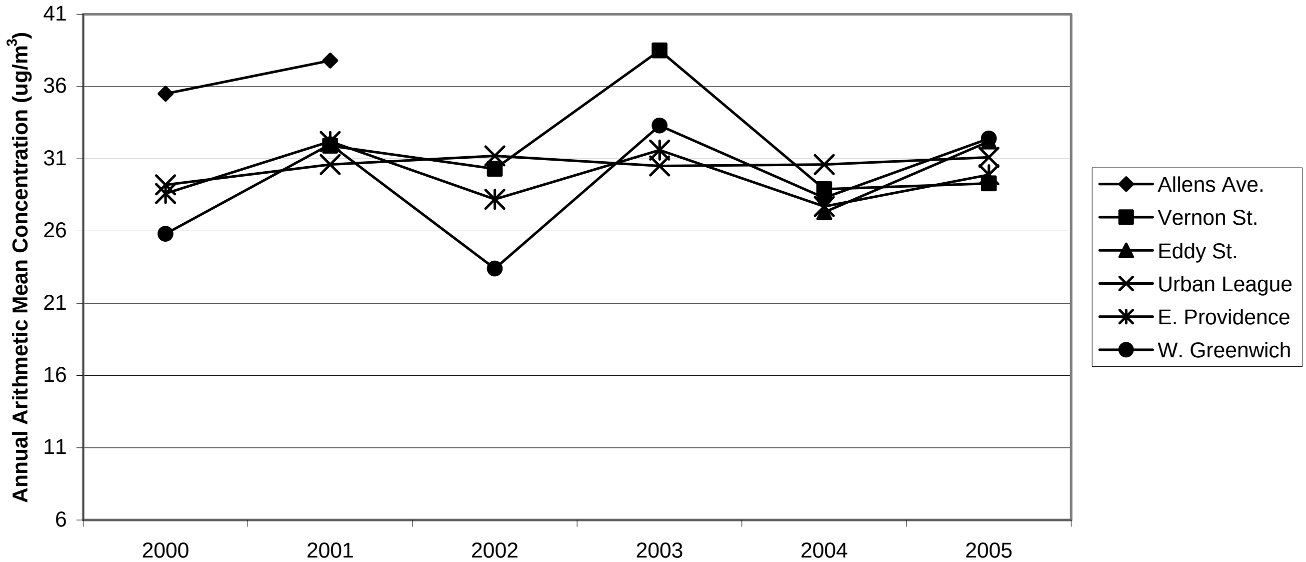


Figure XI
FINE PARTICULATE MATTER (PM-2.5)
24-Hour Concentrations (98th percentile)
2005 Stamdard = 65 ug/m^3



SULFUR DIOXIDE (SO_2)

Sulfur dioxide (SO_2) is emitted primarily by sources burning fossil fuels to produce heat or electricity. Exposures to high concentrations of SO_2 cause respiratory illness, alterations in pulmonary defenses, and aggravation of existing cardiovascular disease. Children, the elderly, and people with asthma, cardiovascular disease or chronic lung disease such as bronchitis or emphysema are most susceptible to the adverse health effects of SO_2.

SO_2 combines with water in the atmosphere to form sulfates, which can cause acidification of lakes and streams, accelerated corrosion of buildings and monuments, reduced visibility, and adverse health effects.

The primary (health-based) NAAQS for SO_2 are 0.03 ppm as an annual arithmetic mean and 0.14 ppm as a 24-hour average. The USEPA has also set a secondary NAAQS for SO_2, 0.50 ppm as a three- hour average, to protect the environment, property, and aesthetics.

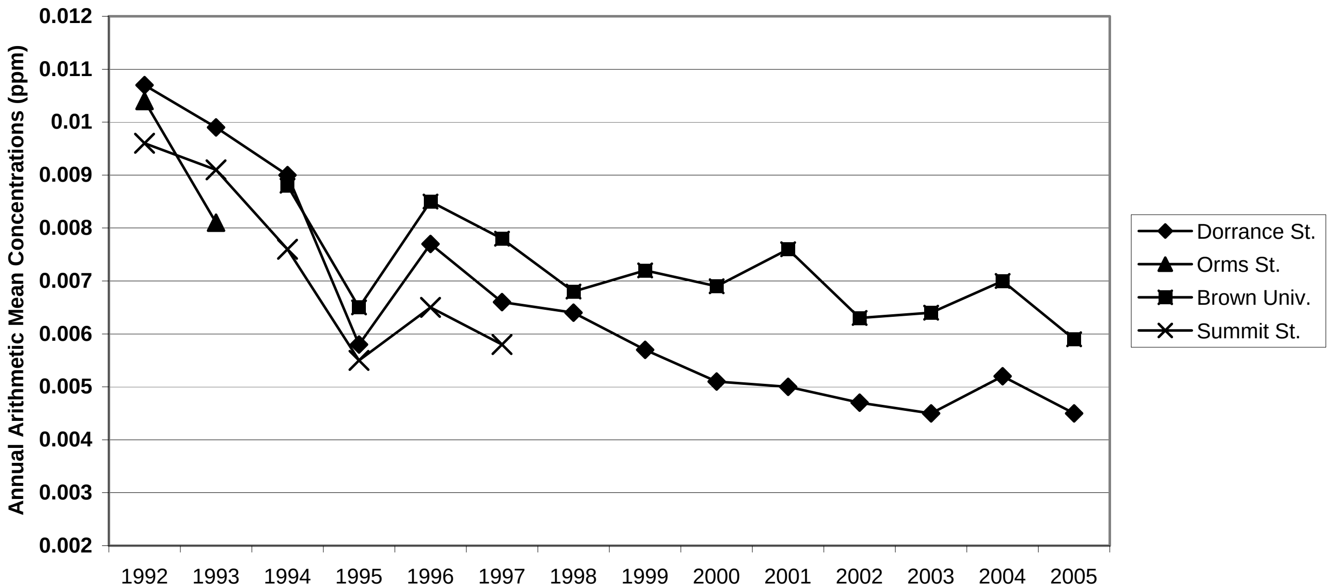
The State of Rhode Island has been in compliance with these standards since 1975. In 2005, SO_2 was monitored at two sites, Brown University and Dorrrance Street, both in Providence. In 2005, the highest annual average SO_2 concentration, measured at Brown University, was 0.0059 ppm, 20% of the NAAQS. The highest 24-hour concentration, measured at the Dorrance Street site, was 0.027 ppm, 19% of the NAAQS, and the highest 3-hour concentration, measured at both sites, was 0.051 ppm, 10% of the standard. (See Table 8).

Figure XII shows annual arithmetic mean concentrations of SO_2 at Rhode Island monitoring sites between 1992 and 2005. Annual mean SO_2 concentrations show a downward trend during that time period.

Table 8 Rhode Island 2005 Sulfur Dioxide (SO_2) Levels

Stations	1-Hour Values			3-Hour Values (NAAQS = 0.50 ppm)			24-hour Values (NAAQS = 0.14 ppm		
	# of Obser-vations	1st Maximum	2nd Maximum	1st Maximum	2nd Maximum	# o f Exceed -ances	1st Maximum	2nd Maximum	E -
Brown Univer. 10 Prospect St. Providence	8,173	0.066	0.064	0.051	0.048	0	0.026	0.023	
76 Dorrance St. Providence	8,014	0.064	0.052	0.051	0.036	0	0.027	0.019	
Totals						0			

Figure XII
SULFUR DIOXIDE (SO_2)
Annual Average Concentrations
Standard = 0.03 ppm



PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS (PAMS)

Although ground-level ozone concentrations in Rhode Island have decreased over the past ten years, the State, as well as much of the rest of the Northeast, continues to violate the ozone NAAQS.

Ground level ozone is a regional problem; ozone precursors (NOx and VOCs) emitted in one state can contribute to elevated ozone levels in states that are many miles downwind. The photochemical reactions involved in ozone formation are influenced by a number of factors, including the relative concentrations of various precursor chemicals in the atmosphere and a variety of meteorological parameters. Therefore, identifying emissions control strategies that effectively reduce ozone levels in nonattainment areas is a complex task.

In order to obtain ambient air quality data useful for evaluating such strategies, the Clean Air Act Amendments of 1990 (CAAA) required serious, severe and extreme ozone nonattainment areas to establish enhanced monitoring networks for ozone and ozone precursors. In response to that mandate, the USEPA promulgated rules in 1993 that required the establishment of a network of Photochemical Assessment Monitoring Stations (PAMS) to measure ozone, NOx, VOCs (including carbonyls), and meteorological parameters in nonattainment areas.

Rhode Island's PAMS network consists of four sites: one Type 1 site, one Type 2 site, one Type 3 site and one Type 4 site. Type 1 sites are located upwind of nonattainment areas and are used to measure concentrations of pollutants entering the area. Type 2 sites are located immediately downwind of the area of maximum precursor emissions, which in Rhode Island is the Providence metropolitan area. Type 3 sites are located 10-30 miles downwind of the urban area, and are used to track the movement of precursor pollutants and the resulting formation of ozone. Type 4 sites are located further downwind, and are used to track pollutants leaving the area.

Two of Rhode Island's PAMS sites are located within the State boundaries; the Type 1 site at the Alton Jones campus of the University of Rhode Island in West Greenwich and the Type 2 site at the Francis School in East Providence. Due to the proximity of the Providence metropolitan area to the Massachusetts border, the Type 3 and 4 sites are located in Massachusetts. In 2004, those sites were located on Blue Hill in Milton, Massachusetts and in Truro, Massachusetts, respectively. At the W. Greenwich Type I PAMS site, 24-hour samples VOC are collected every sixth day year round. At the Type 2 site in East Providence, eight three-hour VOC samples are collected daily and eight three-hour carbonyl samples are collected every third day during June, July and August, while 24-hour VOC and carbonyl samples are collected every sixth day year round. The two sites in Massachusetts collect eight three-hour VOC samples every day during June, July and August.

VOC samples are analyzed for approximately 56 substances, which are ozone precursors and/or air toxics. The carbonyl samples are analyzed for formaldehyde, acetaldehyde and acetone. The PAMS sites also measure ozone, NOx and surface meteorological conditions during the summer months. PAMS monitoring began at the East Providence site in 1994 and at the West Greenwich site in 1995.

The data from the Rhode Island PAMS sites, combined with results from similar sites in the other states, are being used to identify sources of ozone precursors, to track migration of those pollutants, to determine the concentrations of various toxic air pollutants in the region, to track changes in ambient levels over time, and to verify the inputs and results of regional ozone modeling.

AIR TOXICS

Many of the substances measured at the PAMS sites are air toxics as well as ozone precursors. Since the PAMS sites have been operated for a decade, data from those sites provide useful information about trends in concentrations of air toxics in Rhode Island. RI DEM also began operating an air toxics monitoring site in May 2001 that became a National Air Toxics Trends Site (NATTS) in 2002. That site is located at the Urban League building in Providence in an urban residential area that is not immediately impacted by localized industrial or commercial sources. In addition to VOCs and carbonyls, black carbon, PM-10, PM-10 metals, PM-2.5 and speciated PM-2.5 are monitored at that site. VOCs have also been monitored at the Vernon Street, Pawtucket site, adjacent to I-95, since 2001 on a one in six day schedule.

VOCs

One of the toxics measured in VOC samples is benzene, a constituent of gasoline, which is known to cause leukemia in humans. The average benzene concentrations measured at the PAMS and toxics sites for the years 1995 –2005 are displayed in Figure XIII. Benzene levels dropped sharply between 1995 and 1996, probably because of the implementation of rules requiring the sale of reformulated gasoline with reduced benzene content in late 1995. In the succeeding years, ambient benzene levels have continued to show a downward trend. In 2005, the average benzene levels at the two PAMS sites were lower than those in 2004 while the levels at the toxics sites were approximately equal to those in the previous year.

Due to the ubiquitous nature of motor vehicle traffic, benzene, as well as other components of motor vehicle exhaust, such as the carcinogen 1,3-butadiene, are present in the ambient air throughout the State. However, the average concentrations of those pollutants are significantly higher in urban and highly trafficked areas than in more rural areas of the State. As can be seen in Figure XIV, the mean concentration of benzene in 2005 at the suburban E. Providence site was twice as high as at the rural site in W. Greenwich. The average benzene concentrations at the urban Providence site was three times higher than at the rural site and the level at the Pawtucket site, which is in a residential area next to the highway, was four times that at the rural site.

Intrastate variations in concentrations were even more substantial for 1,3-butadiene. The 2005 average 1,3-butadiene concentration at the E. Providence site was three times higher than that in W. Greenwich. The average concentration of 1,3-butadiene at the urban Providence site was five times higher and at the Pawtucket site near the highway nine times higher than at the rural site in W. Greenwich.

Similarly, as shown in Figure XV, the concentrations of the industrial/commercial chlorinated cleaning solvents trichloroethylene and perchloroethylene were substantially higher at the urban locations than at the rural site. The average trichloroethylene concentration in 2005 at the Vernon St., Pawtucket site was 101 times higher than at the W. Greenwich site. Average trichloroethylene levels at the Urban League and E. Providence sites were 64 and 30 times that in W. Greenwich, respectively.

The difference between urban and rural levels of perchloroethylene levels was less dramatic than for trichloroethylene but was still substantial. Average perchloroethylene levels at the two urban sites (Pawtucket and Providence) in 2005 were six times that at the W. Greenwich site, while the average concentration in E. Providence was four times that in W. Greenwich.

Figure XIII
BENZENE
Annual Average Concentrations

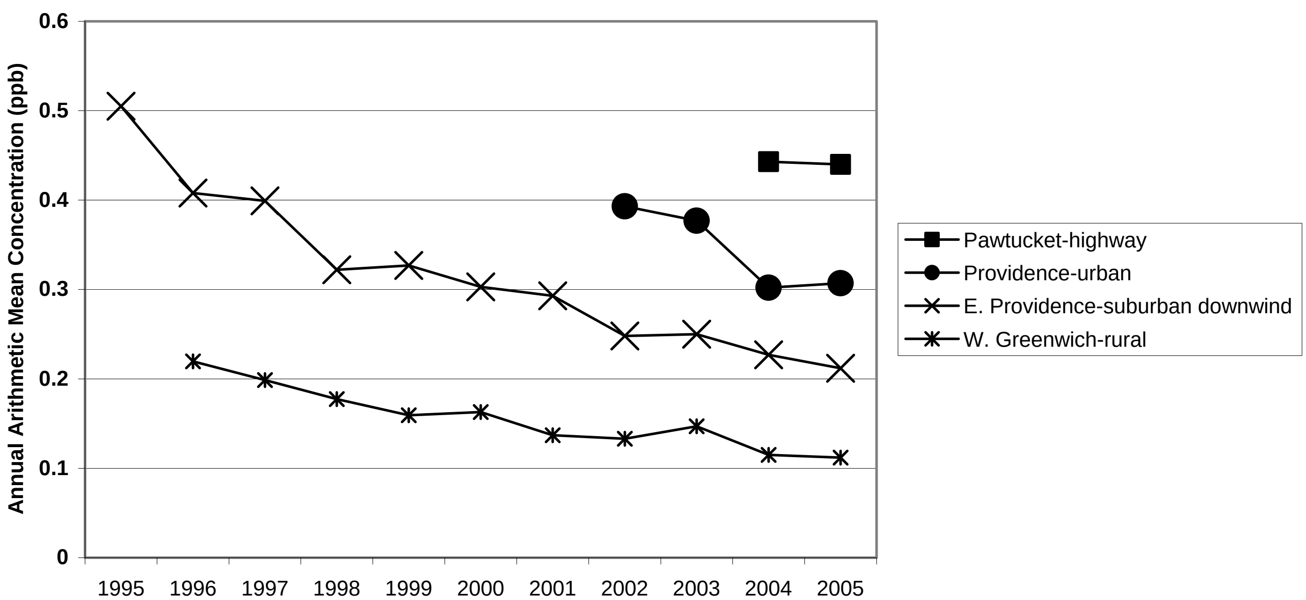


Figure XIV
MOBILE SOURCE TOXIC VOLATILE ORGANICS
2005 Annual Mean Concentrations

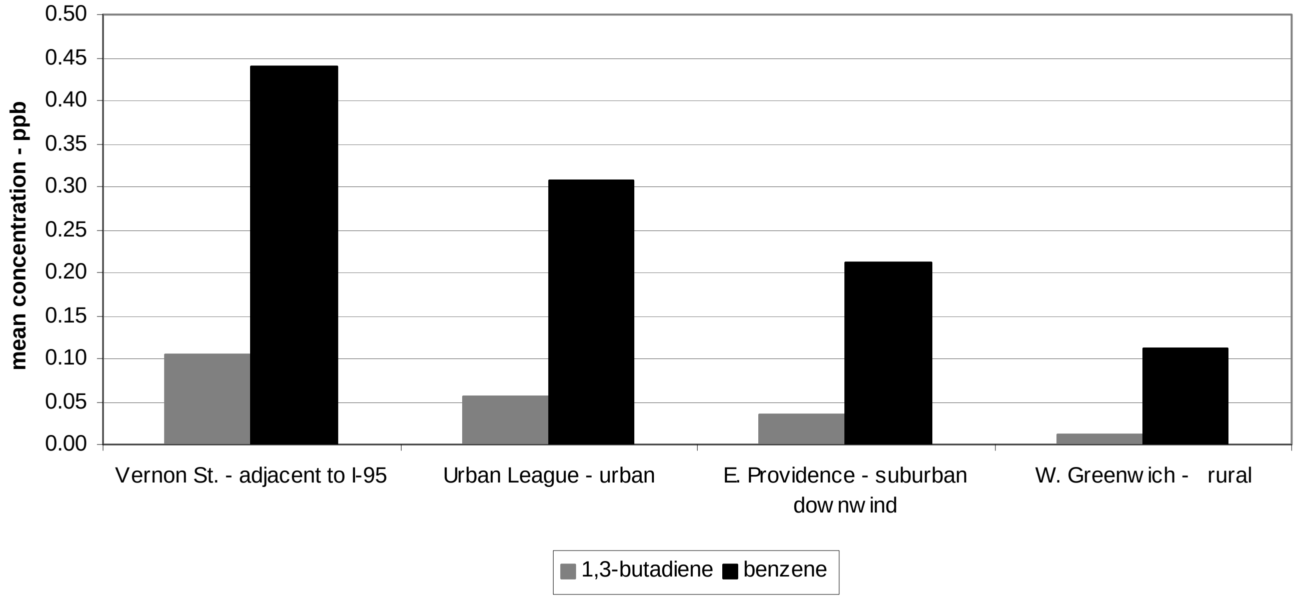
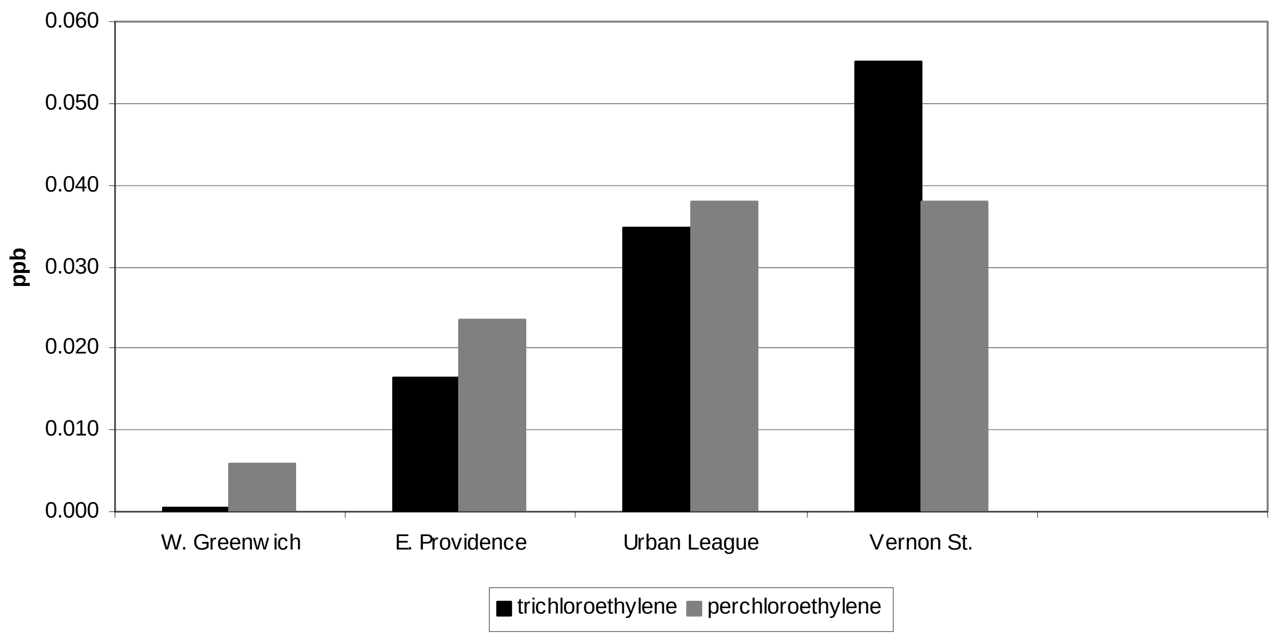


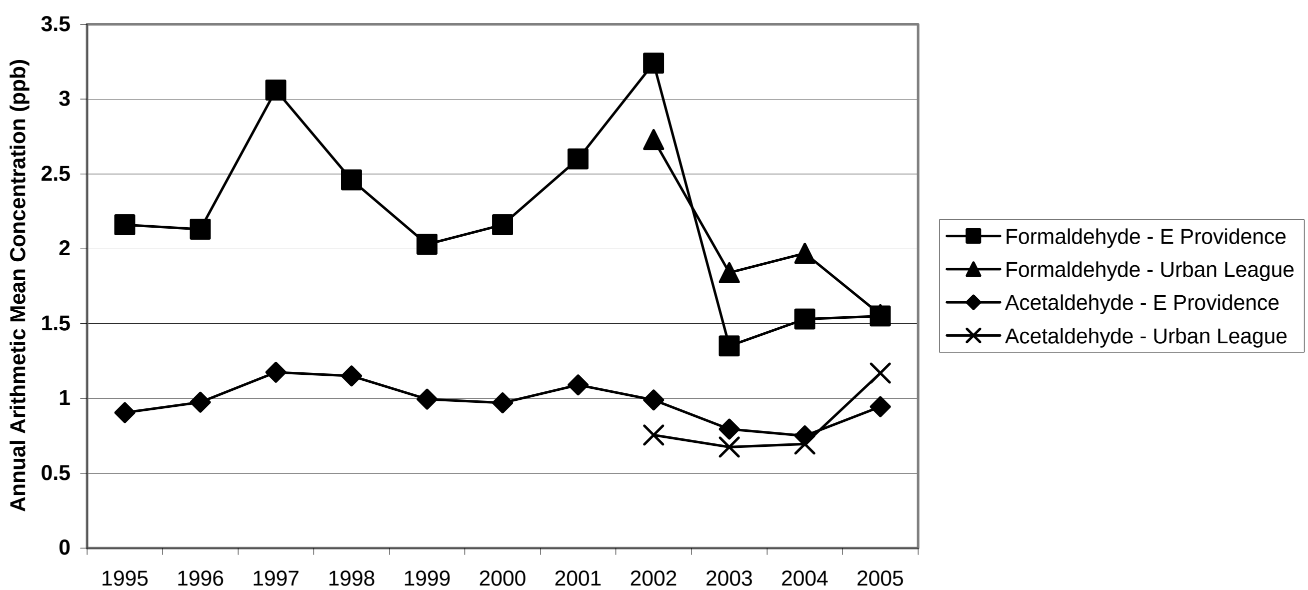
Figure XV CHLORINATED SOLVENTS
2005 Annual Mean Concentrations (ppb)



<u>Carbonyls</u>

Average ambient concentrations of the carbonyl compounds formaldehyde and acetaldehyde at the East Providence site for 1995 –2005 and at the Urban League site for 2002- 2005 are displayed in Figure XVI. Carbonyls are emitted by combustion sources but, like ozone, substantial amounts of carbonyls are also formed by photochemical reactions in the atmosphere. Therefore, carbonyl levels tend to be highest in the summer and average carbonyl concentrations in years with hot summers tend to be higher than in cooler years. The carbonyl levels measured to date do not show a clear trend.

Figure XVI
CARBONYLS
Annual Average Concentrations



Metals

At the Urban League NATTS site, RI DEM collects PM-10 samples every sixth day that are analyzed for seven metals. In 2005, the analyses of these samples was preformed by the US EPA Region I laboratory. Four of the metals, arsenic, beryllium, cadmium and chromium, were not detected or only occasionally detected in the 2005 samples. The remaining three metals, lead, manganese and nickel, were detected in most of the samples.

RI DEM also sampled for hexavalent chromium (chromium VI) in total suspended particulate matter (TSP) samples collected at the Urban League site beginning in 2005. Hexavalent chromium, the most toxic form of chromium, is a human carcinogen.

The average concentrations of lead, manganese and nickel in the Urban League PM-10 samples and of chromium VI in the Urban League TSP samples are shown in Table 9. Also listed in that table are health benchmarks for those metals. The health benchmarks for lead, nickel and chromium VI correspond to a lifetime cancer risk of one in one million and the health benchmark listed for manganese was developed by the US Agency for Toxic Substances and Disease Registry to protect for neurological effects.

Table 9 Rhode Island 2005 Metals Levels

	2005 Mean (μg/m³)	Health Benchmark (μg/m³)	Mean/Benchmark
Lead (PM-10)	0.0055	0.08	0.2
Manganese (PM-10)	0.0042	0.04	0.1
Nickel (PM-10)	0.0066	0.004	1.7
Chromium VI (TSP)	0.000021	0.00008	0.3

For all of the metals listed in Table 9 except nickel, the average concentrations measured were considerably lower than the corresponding health benchmark, and thus would not be likely to present a significant health risk. The level of nickel measured was 70% higher than its health benchmark and, therefore, long-term exposure to that level would pose a lifetime cancer risk of more than one in one million. Airborne nickel is generated by the combustion of fossil fuel by stationary and mobile sources, by incineration of metal-containing materials and by certain industrial processes.

As part of the federal PM-2.5 speciation program, lead, manganese and nickel were also measured in PM-2.5 in 2005. On days in 2005 that metals results for both PM-2.5 and PM-10 are available, the lead concentration in PM-2.5 was, on average, 70% of that in PM-10, the PM-2.5 manganese concentration was 34% of that in PM-10 and the PM-2.5 nickel concentration was 34% of that in PM-10. Therefore, lead and nickel were largely present as fine particles, while manganese was more highly concentrated on coarser particles (particles with diameters between 2.5 and 10 microns).

Olneyville Study

RI DEM received funding from the EPA to conduct a special one-year study of outdoor air toxics levels in the Olneyville neighborhood of Providence. The Olneyville neighborhood was chosen for this study because of the proximity of residences in that neighborhood to small industrial solvent users and to highly major roadways. In addition, the Olneyville neighborhood is part of the Woonasquatucket Watershed; information gained about the air quality in this neighborhood will supplement data from other sources to produce a more comprehensive picture of environmental conditions in this watershed.

For the Olneyville study, air samples for the following pollutants were collected for 24-hour periods every sixth day on the roof of the Brigham Middle School on Westminster Street:

- Volatile organic compounds (VOCs), collected January 2004 – March 2005;
- Carbonyls, collected March 2004 – March 2005; and
- Metals in PM-10, collected March 2004 – March 2005.

As can be seen in Figure XVII, average concentrations of the VOCs associated with mobile sources, including benzene and 1,3-butadiene, measured in Olneyville were similar to those at the Urban League, Providence site, which is approximately one mile southeast of the Olneyville site. Concentrations of the mobile source pollutants at both the Olneyville and the Urban Leagues sites were lower than those at the Pawtucket site, which is adjacent to I-95, but were higher than at the suburban East Providence site and considerably higher than those at the rural Alton Jones, W. Greenwich site.

Average concentrations of two common industrial solvents, trichloroethylene and dichloromethane (also known as methylene chloride) were significantly higher in the Olneyville samples than at any of the other sites, including the Urban League site, as shown in Figure XVIII. Both of these substances, which are suspect human carcinogens, are used by small industrial sources in the Olneyville area. The concentration of a third common commercial/industrial solvent, perchloroethylene, which is used primarily by dry cleaners, was the same in Olneyville as at the Pawtucket and Urban League sites. As with the other solvents, the urban levels were considerably higher than those at the East Providence and West Greenwich sites.

Average concentrations of the carbonyls formaldehyde and acetaldehyde were also higher at the Olneyville site than at the other sites that these pollutants are measured, including the Urban League site, as shown in Figure XIX. Formaldehyde levels were particularly elevated at the Olneyville site. As discussed previously, formaldehyde levels tend to be highest in the summer months, because it is both emitted directly and, on warmer days, formed in the atmosphere by photochemical reactions involving other pollutants. The source of the elevated formaldehyde levels at the Olneyville site is not known. However, it is interesting to note that the Olneyville levels stayed elevated in the cooler months, when levels at the other sites dropped, which may indicate that the monitor was influenced by a nearby source of that pollutant.

As can be seen in Figure XX, levels of metals were not elevated in the Olneyville samples as compared to those at the Urban League site. Of the three metals that are generally detected in Rhode Island PM-10 samples, manganese and lead levels were similar at the two sites, while the level of nickel in the Olneyville site was significantly lower than at the Urban League site.

In summary, the results of the Olneyville study emphasize the fact that people living in urban environments in urban areas of Rhode Island are exposed to considerably higher levels of outdoor air toxics emitted by both stationary and mobile sources than people living in suburban and rural areas. Levels of two types of pollutants, chlorinated solvents and carbonyls, were particularly elevated at the Olneyville site, indicating an even higher risk from outdoor air pollutants in that neighborhood.

Figure XVII
OLNEYVILLE STUDY
MOBILE SOURCE TOXIC VOLATILE ORGANICS
Average Concentrations 1/04 - 3/05

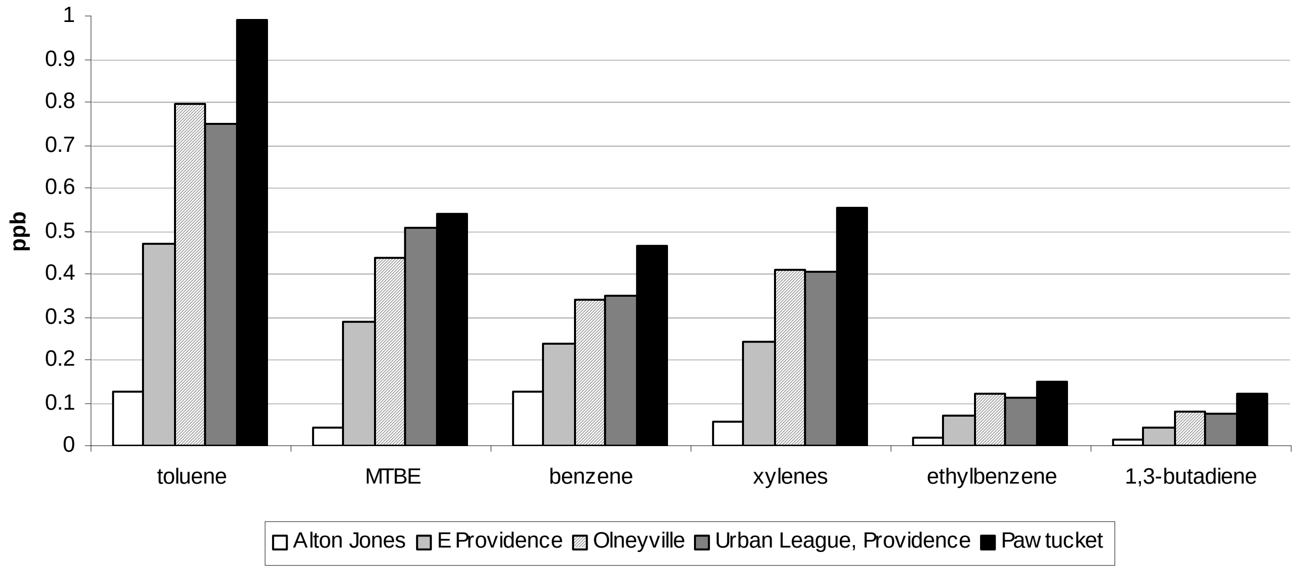


Figure XVIII
OLNEYVILLE STUDY
CHLORINATED SOLVENTS
Average Concentrations 1/04 - 3/05

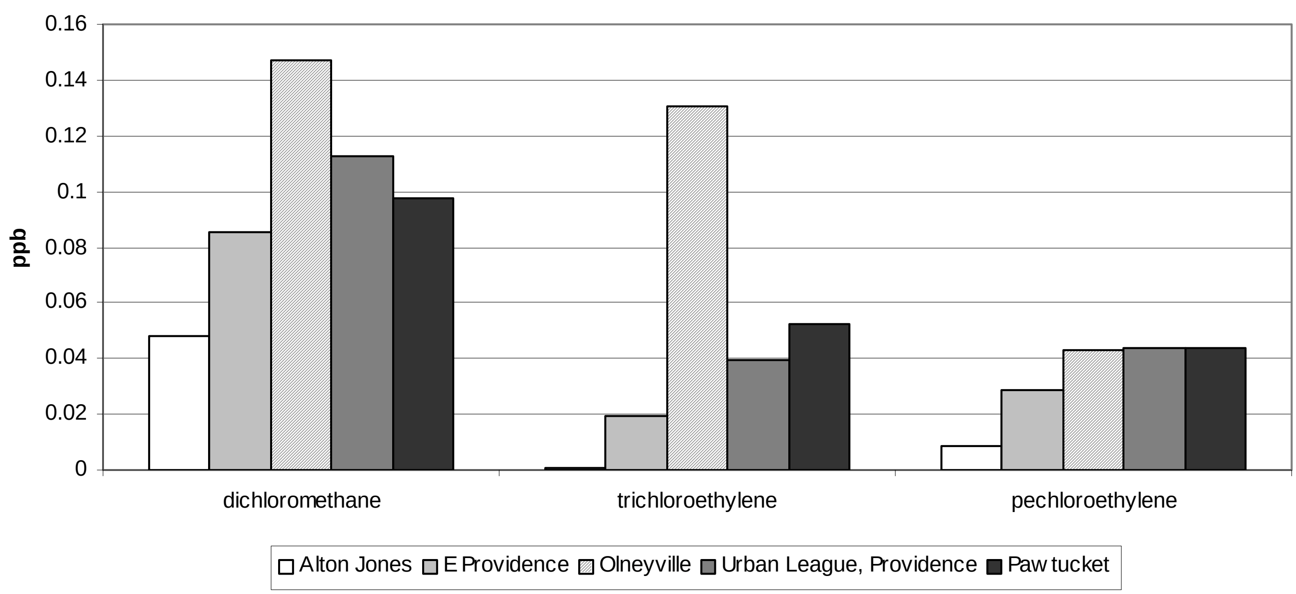


Figure XIX
OLNEYVILLE STUDY
CARBONYLS
Average Concentration 3/04 - 3/05

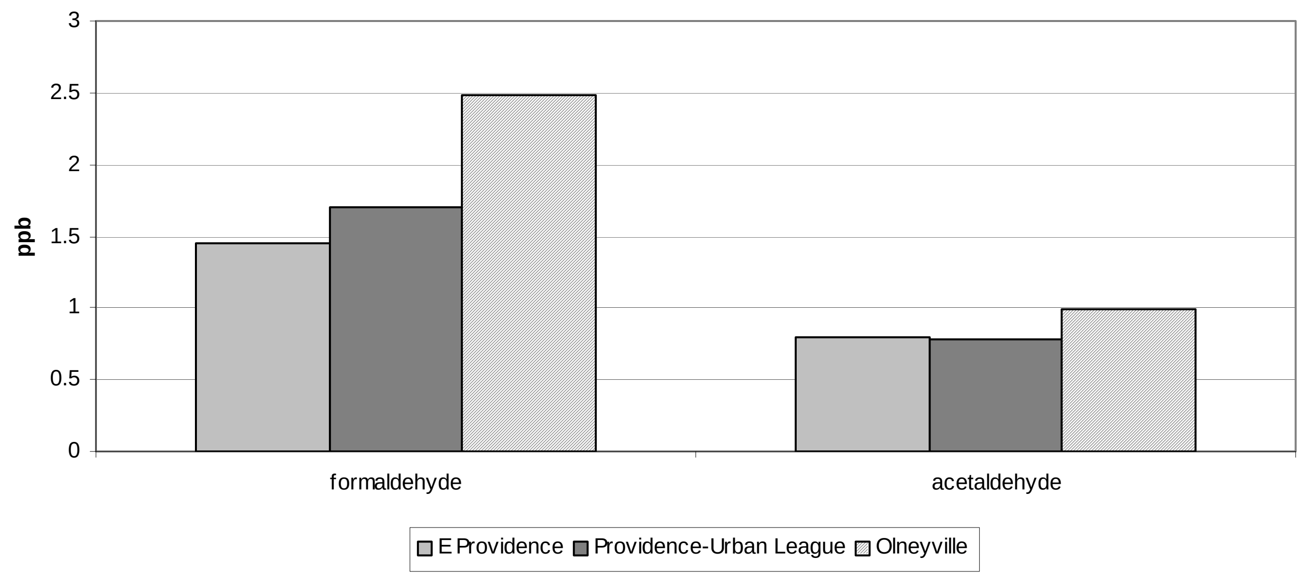


Figure XX
OLNEYVILLE STUDY
METALS
Average Concentrations 3/04 - 3/05