ECO-CITY ALEXANDRIA

Alexandria's State of the Air Report

Past, Present, and Future

April 2009

Office of Environmental Quality
Department of Transportation and Environmental Services

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REPORT HIGHLIGHTS

Ambient Air Monitoring

- Beginning with Alexandria's Air Pollution Control Code Ordinance No. 1545 in 1969 and the Federal Clean Air Act of 1970, the City government has established a strong local air pollution control program.
- The City's program, coupled with Federal and State regulations, has resulted in many improvements in the quality of the air in Alexandria despite rapid growth in population, employment, and vehicle traffic.
- Ozone concentrations measured in 1962 were nearly four times as high as values measured today. Ozone concentrations measured in 1975 were twice as high as values measured today. Since the early 1980's, the number of days with unhealthy ozone air quality has decreased from an average of 12 days per year to just 3 days in 2006/2007.
- Concentrations of other pollutants have decreased dramatically since 1980. Carbon monoxide concentrations measured in the early 1980s were five times as high as values measured today; sulfur dioxide was four times as high; and nitrogen dioxide was twice as high. Lead in the ambient air has virtually been eliminated with the phase-out of lead in gasoline.

Criteria Air Pollutant Emissions

- Emissions also have decreased dramatically. Since 1990, emissions of criteria air pollutants have generally decreased by about 50 percent, while population, employment, and vehicle traffic have increased by about 30 percent.
- Despite this progress, residents in the Washington Metro area (including Alexandria) still experience unhealthy air quality on occasion. And new scientific evidence necessitates that air quality standards become more stringent to protect human health, especially the health of children, asthmatics, and the elderly who are the most susceptible to the effects of air pollution.
- While local controls have improved air quality, greater emphasis needs to be placed on controlling pollution that transported into the city from sources hundreds of miles away in order to meet new, more stringent air quality standards.

Greenhouse Gas Emissions and Climate Change

- Emerging issues – such as climate change – present real and urgent threats to the environmental and economic sustainability of the community. The City is committed to doing its share to continue to improve air quality, reduce greenhouse gas emissions, and move the city towards sustainability. There will continue to be a need for the community to do its share.
- Many of the strategies for air quality and climate change improvement will require continued coordinated efforts between the City government and surrounding jurisdictions, State governments, and the federal government as well as business and community organizations.

SECTION 1 – INTRODUCTION TO AIR QUALITY

The purpose of this report is to provide the Mayor, City council, policy-makers, the media, the public and other stakeholders with the facts about air pollution in the City of Alexandria, Virginia. The report provides a current assessment of air quality in the city, summarizes the city's criteria pollutant and greenhouse gas emission inventory, and reviews strategies under consideration to help ensure that Alexandria achieves and maintains healthy air quality and reduces it climate change footprint.

The Past

Over the past 40 years, the City of Alexandria has appreciably reduced its level of air pollution. This has occurred even with economic development, population growth and urban expansion. We can safely say that the city has moved a long ways toward meeting the rigorous overall ambient air quality goals set by the United States Environmental Protection Agency (USEPA) and Virginia Department of Environmental Quality (VADEQ).

Playing an important role has been the significant improvements in stationary and mobile air emissions control technology and business practices; the development of demanding clean air policy at the national, state, and regional level; and the creation of a strong local air pollution control program tasked with monitoring and implementing clean air policy. The City's air pollution control program is the oldest local air program in the State.

The Present

Alexandria's air quality is meeting the federal air quality standards for five pollutants – carbon monoxide, lead, nitrogen dioxide, sulfur dioxide, and coarse particles (i.e., PM_{10}). The USEPA has recently determined that air quality levels for fine particles (i.e., $PM_{2.5}$) also meet all federal requirements. Air quality levels for ozone, however, exceed federal requirements. Alexandria, in partnership with other jurisdictions in the Washington Metropolitan region, has just completed a detailed plan to bring the region into attainment with the ozone air quality standard.

The Future

But while air quality has improved, we now face additional challenges in the form of a new, more protective federal ozone standard and a newly-revised federal standard for fine particulate matter (i.e., $PM_{2.5}$).

And emerging issues – such as climate change – present real and urgent threats to the environmental and economic sustainability of the community. The City government is committed to doing its share to reduce greenhouse gas emissions and move the city towards sustainability. Action by the community will also be needed to achieve climate change goals.

Despite the significant progress, we have a long way to go to comply with these new requirements and emerging issues, and the City government must continue to develop strategies to address them.

A Brief History of Air Pollution in Alexandria

Colonial Times Air pollution is certainly not a new problem. Since its founding in 1789, Alexandria has had air pollution issues of one kind or another. In colonial times, the winter air was scented with smoke from wood burning fireplaces and pot-belly Franklin stoves. The blacksmith's forge and brick hearth were outfitted with bellows to feed its soft-coal fire and a hood to carry away the smoke into the city's air. Colonial backyards were dotted with smokehouses, places where a fire could be kept smoldering for weeks.

19th Century Throughout the 19th century, the Industrial Revolution quickly spread through Virginia. Coal was the primary source of heat, power, and pollution. With the drilling of the first commercial oil well in Pennsylvania in 1859, another cheap energy source became readily available to further industrial growth. By the end of the century, Karl Friedrich Benz developed the first true automobile powered by a gasoline-fueled internal combustion engine.

Alexandria Air Pollution Memories - 1900 to 1950

"*The industries that we had built...Arthur Brian had a place on 100 block of King Street manufacturing fertilizer, that type of thing. He brought oyster shells up from the … Chesapeake Bay area … and in the summer time the fumes from that place were terrible.*" Sigmund Bernheimer

"G*rowing up in this house ... I used to put the coal in the stove. Yeah. And then, when we lived there, then they converted it to oil. But, no, I remember, the coal man used to come and put the coal in the shed and we used to go out and get it … So everybody needed coal to heat ... Everyone in Old Town had a coal bin, a chute going into the basement.*" Robert Fischman

"*In Potomac Yards … my brother-in-law was a stoker on one of the engines… there was always black smoke over Potomac Yards. That's when they used coal on it. If it was white smoke you knew it was steam. You were OK with that…*" Edward Gailliot

"*… to the east of St. Asaph St., was all a great big swamp. They filled it in as the city dump; burned 24 hours a day, 7 days a week. Stink. Smoke everywhere, everything. But they finally got rid of that. Got incinerators, I guess.*" Harold Payne

Source: Oral Histories of Alexandria; http://oha.alexandriava.gov/oha-main/oralhistory/oha-oralhistories.html

Smog Episodes of 1959 and 1960 The Washington Metropolitan area experienced three separate smog episodes on June 8-11, 1959, September 23-27, 1960, and December 5-6, 1960. A portion of the population experienced eye-irritation and other discomforts, visibility was noticeably reduced, and numerous complaints were made to local government agencies.

Air Quality Studies of the Early 1960s In May 1960, the Automotive Nuisance Abatement Committee of the Metropolitan Area Traffic Council was formed to control obnoxious smoke and fumes from vehicles in the metropolitan area. In 1961, the Metropolitan Council of Governments established an oxidant sampling network to monitor the air on a routine basis, including a site at the Alexandria City Health Department. The maximum measured oxidant level was 0.41 parts per million, nearly ***four times as high*** as values measured today. In July 1962, U.S. Public Health Service found that while air pollution in the Washington area is better than in most cities of comparable size, excessive pollutant concentrations did occur. Further, air pollution was expected to increase rapidly unless adequate control measures were taken.

1969 City Ordinances In January 1969, the City Council approved Ordinance No. 1545 commonly referred to as the "Air Pollution Control Code." Concurrently it also approved Ordinance No. 1546 commonly referred to as the "Smoke Control Code." The City established programs to develop an emission inventory, develop and train staff, acquire laboratory and field equipment, establish control requirements for open burning and industrial heating plants, control odors, and require dust abatement in construction and demolition.

Early Results from Ordinance No. 1545

In implementing the code, the Director of Public Health reported that "we contacted the major industrial contributors to air pollution…19 companies…all agreed to cooperate and have either started installation of air pollution control equipment or have studies underway as to ways and means to achieve pollution control…open burning has been stopped…we have also been able to stop the further use of fly ash from PEPCO for landfill purposes…this has helped significantly in reducing the blowing of particulates."

Source: "Air Pollution Control Report", Alexandria Public Health Department, January 1970.

1970 Establishment of the Environmental Policy Commission (EPC) The EPC was established in 1970 to "advise and make recommendations to the City Council and, where appropriate, to the Planning Commission and City Manager." The EPC considers matters relating to clean air and other matters relating to the conservation and protection of the city's environment. The EPC currently consists of 13 members, including five members from the environmental field, five citizen-at-large members, one member from the field of urban planning, one student attending high school in Alexandria and one member with experience in Federal or state environmental statues, regulations, and procedures. The Commission is supported by the City's Office of Environmental Quality.

1970s Help from the Feds With help from the federal Clean Air Act (CAA) of 1970 and the 1977 Amendments, the City's air pollution control program became firmly established. Federal grants and City funding allowed the Health Department to establish a strong air pollution code. The City worked to eliminate or modernize inefficient incinerators used in commercial and multi-dwelling units, which proved costly and time-consuming but was very effective in reducing air pollution. Federal automotive emission standards began to take effect. The Potomac River Generating Station (formerly PEPCO) installed additional electrostatic precipitators and began to use low-sulfur coal. The City implemented one of the first and most sophisticated air monitoring networks in the area, including a mobile laboratory used for monitoring vehicle emissions. Air pollution in the early 1970s was nearly ***twice as high*** as levels measured today.

1980–2008 Continued Progress As explained in detail in Sections 2 and 3 of this report, ambient air quality has improved since 1980 and emissions have declined dramatically, even in the face of growth of people and vehicles. The 1990 Clean Air Act Amendments provided a major overhaul of the Federal air quality regulations, and established more stringent goals for healthy air. The benefits of the 1990 CAA programs are being realized today.

2009 and Beyond – New Challenges While the air is much cleaner now than at any time since measurements have been taken, the work of protecting Alexandria's air continues. Our increased scientific understanding of the adverse health effects of air pollution has led to increasingly more stringent levels of protection. And the potential environmental effects from greenhouse gas emissions still need to be addressed. The City is committed to a sustainable future – which includes clean air for all citizens.

What are the Pollutants?

Air Pollutant Category	Health and Environmental Effects	Overview of Regulatory Framework
National Ambient Air Quality Standard (NAAQS) / Criteria Air Pollutant (CAP) Carbon Monoxide Lead Nitrogen Dioxide Ozone (ground level) Coarse Particulate Matter (PM_{10}) Fine Particulate Matter ($PM_{2.5}$) Sulfur Dioxide Volatile Organic Compounds (VOCs)	♦Long-term exposure is linked to lung cancer, heart disease, asthma attacks, increased mortality and other health problems. ♦Short-term exposure has been linked to headaches and nausea, increased hospital visits for asthma and respiratory problems, and eye irritation. ♦People with lung disease, children, older adults, and people who are active can be affected when ozone and fine particle levels are unhealthy. ♦Some CAPs can also have effects on aquatic life, vegetation, and animals.	**USEPA** sets NAAQS based on "Criteria Documents" that lay out the latest scientific evidence of the adverse effects to human health and public welfare. **USEPA** established national emission standards for new source and mobile sources. **State and local agencies** monitor ambient air quality to determine whether an area violates the NAAQS. **State and local agencies** develop state implementation plans (SIPs) to reduce air pollutant emissions and ensure healthy air. **State and local agencies** monitor compliance with emission standards.
Hazardous Air Pollutant (HAP) Includes 188 chemicals, such as arsenic, benzene, formaldehyde, mercury, and dioxins.	♦Some HAPs are known or suspected to cause cancer. ♦Other HAPs may cause respiratory effects, birth defects, and reproductive and other serious health effects. ♦Some HAPs can even cause death or serious injury if accidentally released in large amounts.	**USEPA** developed "technology based" regulations - MACT standards - requiring sources to meet specific emissions limits based on emissions levels already achieved in practice by similar sources. **USEPA** may use a "risk-based" approach to implement additional standards to address any significant remaining, or residual, health or environmental risks.
Haze and Visibility Precursors Particulate Matter and precursors (including sulfur dioxide and oxides of nitrogen which react in the air to form sulfate and nitrate particles)	♦These pollutants absorb and scatter light, reducing the clarity and color of what we see. ♦Scenic and historic vistas in urban areas, national parks and wilderness areas can be obscured during certain times of the year by a veil of white or brown haze.	**Regional Planning Organizations (RPOs) and State agencies** are putting together plans to reduce regional haze in national parks and wilderness areas. These are the first steps in meeting the national goal of eliminating the manmade pollution that impairs visibility.
Acid Deposition (Acid Rain) Precursors Including sulfur dioxide and oxides of nitrogen which react in the air to form sulfate and nitrate particles)	♦Acid rain causes acidification of lakes and streams and contributes to the damage of trees at high elevations and sensitive soils. ♦Acid rain accelerates the decay of building materials and paints, including irreplaceable buildings, statues, and sculptures that are part of our nation's cultural heritage.	**USEPA** set up a cap-and trade system for power plant emissions. Allowances may be bought, sold, or banked. However, regardless of the number of allowances a source holds, it may not emit at levels that would violate federal or state limits set to protect public health.
Greenhouse Gases Primarily carbon dioxide and methane	♦Some observed changes include shrinking of glaciers, thawing of permafrost, earlier break-up of ice on rivers and lakes, lengthening of growing seasons, shifts in plant and animal ranges and earlier flowering of trees.	**USEPA** developed voluntary and incentive-based programs. No federal regulatory program exists at this time. **State and local agencies** are beginning to develop Action Plans to reduce emissions
Ozone Depleting Chemicals Chemicals such as CFCs, halons, and methyl chloroform	♦Ozone depletion can cause increased amounts of UV radiation to reach the Earth which can lead to more cases of skin cancer, cataracts, and impaired immune systems.	**USEPA** has established regulations to phase out ozone-depleting chemicals in the United States.
Indoor Air Quality Pollutants Asbestos, mold, lead, radon, second hand smoke	♦Exposure can result in allergic reactions, asthma, and other respiratory complaints similar to effects from CAPs and HAPs.	**USEPA** and **State and local agencies** jointly administer a variety of programs to reduce exposure to indoor air pollution.

For further information, see: http://www.epa.gov/air/basic.html

What are the Sources?

Point Sources are comprised of stationary facilities that emit pollutants above a certain threshold, from a stack, vent or similar discrete point of release. Air quality permits are issued to industries and facilities to ensure that these emissions do not harm public health or cause significant deterioration in areas that presently have clean air. The permit also ensures that facilities make adequate provisions to control their emissions. In Alexandria, the Mirant Potomac River Generating Station and the Covanta energy-from-waste plant are the top-emitting point sources.

Area Sources are sources of air pollutants that are diffused over a wide geographical area. Area sources include sources that in and of themselves are insignificant, but in aggregate may comprise significant emissions. Examples would be emissions from small dry cleaners, home heating boilers, and VOCs volatizing from house painting or consumer products.

Mobile Onroad Sources are sources of air pollution from internal combustion engines used to propel cars, trucks, buses, and other vehicles on public roadways. Emissions are typically estimated using USEPA emission factor and transportation planning models. Emissions are calculated by road type, vehicle type, and fuel type.

Mobile Offroad Sources are sources of air pollution from internal combustion engines used to propel trains, airplanes, and marine vessels, or to operate equipment such as forklifts, lawn and garden equipment, portable generators, etc.

Biogenic emissions are created by natural sources, such as plants, trees, and soils. The sharp scent of pine needles, for instance, is caused by monoterpenes, which are among the group of VOCs. The USEPA has developed models that estimate emissions of biogenic VOCs from vegetation for natural areas, crops, and urban vegetation. The models take into account the geographic variations in vegetation land cover and species composition, as well as seasonal variations in leaf cover.

What are the NAAQS?

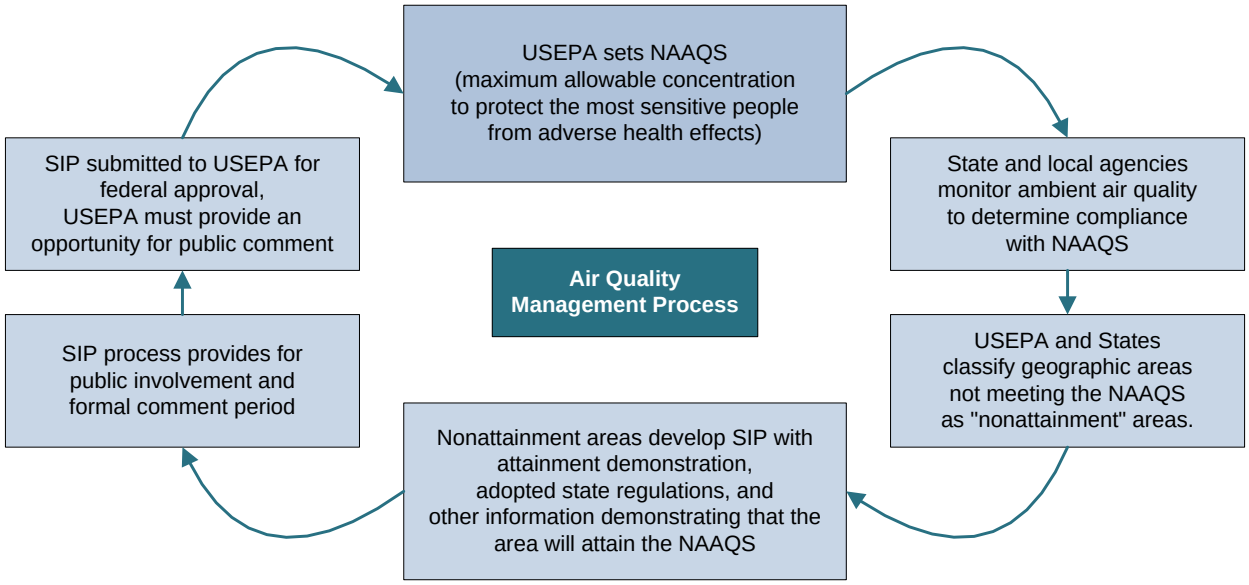
The Clean Air Act requires USEPA to set National Ambient Air Quality Standards (NAAQS) for six common air pollutants. USEPA calls these pollutants "criteria" air pollutants because it regulates them by developing human health-based and/or environmentally-based criteria (science-based guidelines) for setting permissible exposure levels. USEPA periodically revises the NAAQS based on new information on health and welfare effects.

Pollutant	Primary Standards*	
	Level	Averaging Time
Carbon Monoxide (CO)	9 ppm (10 mg/m^3)	8-hour
	35 ppm (40 mg/m^3)	1-hour
Lead (Pb)	0.15 µg/m^3	Rolling 3-month period
Nitrogen Dioxide (NO_2)	0.053 ppm (100 µg/m^3)	Annual
Particulate Matter (PM_{10})	150 µg/m^3	24-hour
Particulate Matter ($PM_{2.5}$)	15.0 µg/m^3	Annual
	35 µg/m^3	24-hour
Ozone (O_3)	0.075 ppm	8-hour
Sulfur Dioxide (SO_2)	0.03 ppm	Annual
	0.14 ppm	24-hour

** The set of limits based on human health is called primary standards. Another set of limits intended to prevent environmental and property damage is called secondary standards. See Appendix A for secondary standards and explanatory notes on the NAAQS.*

What is a SIP?

The State Implementation Plan (SIP) is the major mechanism for implementing the variety of air programs to meet most Clean Air Act requirements.



Who Prepares the SIP?

The Metropolitan Washington Air Quality Committee (MWAQC) is the entity certified to prepare the SIP for the DC-MD-VA Metropolitan Statistical Area. MWAQC members are elected officials of Metropolitan Washington Council of Governments (MWCOG) member jurisdictions plus members from Charles, Calvert, and Stafford counties; the air management and transportation directors; members of the General Assemblies; and the chair of the Transportation Planning Board. Vice Mayor Redella S. "Del" Pepper continues to represent the City on MWAQC and is one of the most active members. MWAQC coordinates air quality planning activities, reviews policies and resolves policy differences, and adopts an air quality plan for transmittal to the District of Columbia, Maryland, and Virginia. City staff members actively participate on MWAQC subcommittees including the Technical Advisory Committee (TAC). For further information on the SIPs, see http://www.mwcog.org/environment/air/SIP/default.asp

What is Alexandria's Attainment Status?

Alexandria is in attainment of the NAAQS for five pollutants – carbon monoxide, lead, nitrogen dioxide, sulfur dioxide, and coarse particles (PM_{10}). The USEPA recently determined that air quality levels for fine particles ($PM_{2.5}$) also meet federal requirements. Alexandria is part of the Metropolitan Washington where air quality for ozone does not meet the NAAQS.

MWAQC developed and submitted a SIP to address the 1997 8-hour ozone NAAQS. Public hearings were held in April 2007, the plan was adopted in May 2007, and the final SIP was submitted on June 12, 2007. The plan has not yet received final approval from USEPA.

In March 2008, the USEPA strengthened the NAAQS for ozone, effectively reducing the levels from 0.084 ppm to 0.075 ppm. States must make recommendations to USEPA in 2009 for areas to be designated attainment, nonattainment and unclassifiable. The USEPA will make final determinations in 2010. The region is likely to be designated as nonattainment for the 2008 ozone standard.

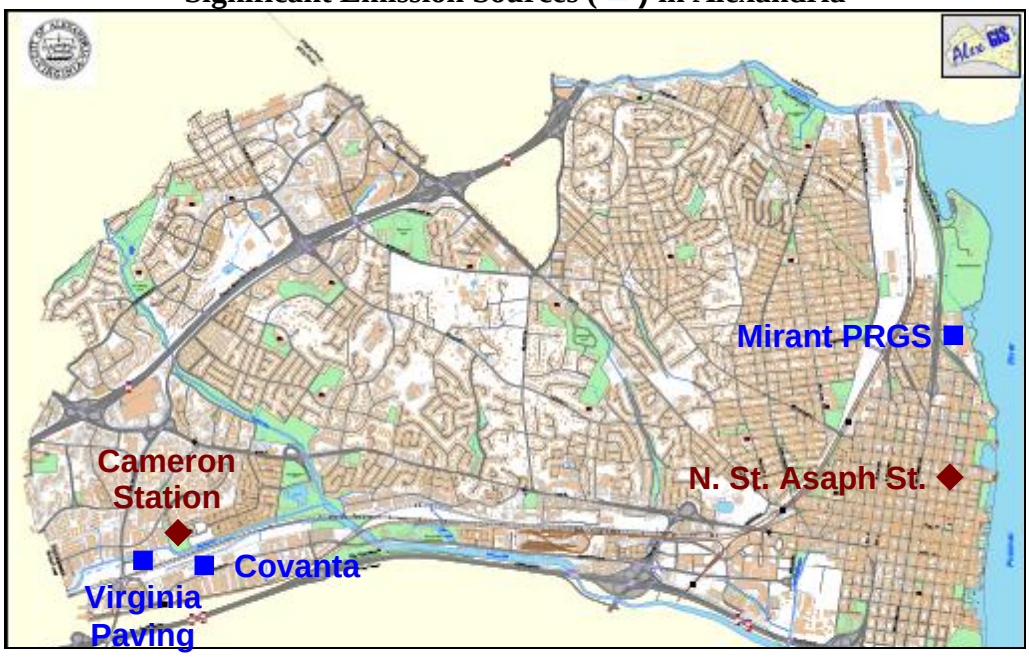
MWAQC also prepared a SIP to address the 1997 annual $PM_{2.5}$ NAAQS. MWAQC adopted the plan in March 2008 and the SIP was submitted in April 2008. On January 12, 2009, the USEPA determined that region has attained the 1997 annual $PM_{2.5}$ NAAQS, based on air quality data for 2004 to 2008. As a result, the requirements to submit a SIP will be suspended as long as the region continues to attain the 1997 annual standards.

In December 2006, USEPA revised the 24-hour NAAQS for $PM_{2.5}$ from 65 to 35 $\mu g/m^3$. On December 7, 2007, VA DEQ urged USEPA to classify all of Virginia as an attainment area for this standard. In December 2008, USEPA determined that all of Virginia attained the revised 2006 24-hour NAAQS for $PM_{2.5}$.

SECTION 2 – AMBIENT AIR QUALITY ASSESSMENT

This Section presents a brief discussion of the health and welfare effects of air pollution and an ambient air quality data analysis for all criteria pollutants for the 1980 to 2007 time period. Data for monitor sites in Alexandria and other monitoring sites in Northern Virginia were used in preparing the data summaries. The measured concentrations are presented in graphical format in a manner that permits direct comparison to the National Ambient Air Quality Standards.

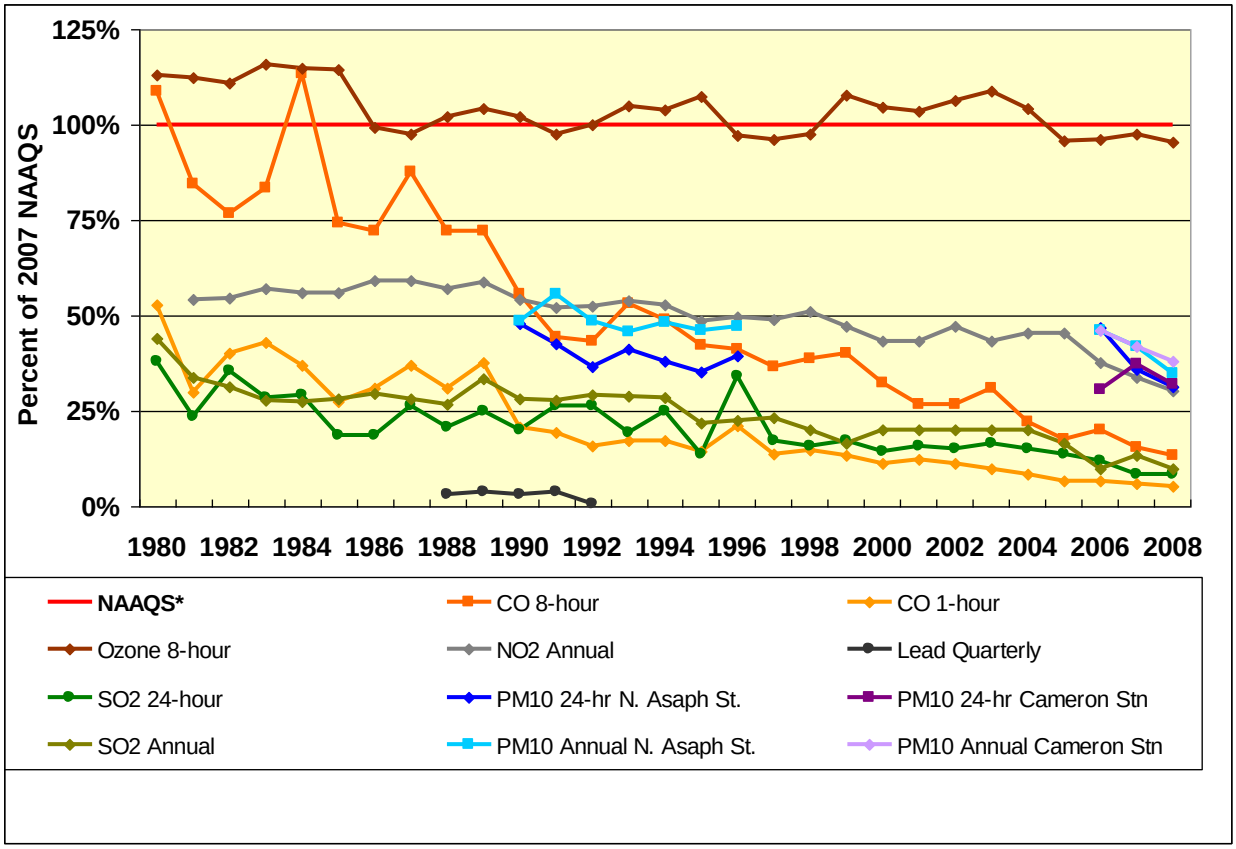
Ambient Air Quality Monitoring Sites (◆) and Significant Emission Sources (■) in Alexandria



The City of Alexandria has been taking measurements of air quality for nearly 50 years. Alexandria participated in the MWCOG's Oxidant Sampling Network beginning in October, 1961. By the mid-1970s, Alexandria had one of the most sophisticated air monitoring networks in the Metropolitan area. The Office of Environmental Quality (OEQ) currently maintains and operates an ambient air monitoring station at 517 North St. Asaph Street. Carbon monoxide, sulfur dioxide, nitrogen dioxide, and particulate matter (PM_{10}) are measured year round. Ozone is continuously measured during the months of April through September. The City also began monitoring PM_{10} concentrations at a site in Cameron Station in 2006.

As discussed in more detail in Section 3, there are several emission sources located within the city that are likely to affect air quality. This includes industrial sources such as Covanta Energy-from-Waste facility, Mirant's coal-fired Potomac River Generating Station, and the Virginia Paving hot mix asphalt plant. Air quality is also affected by emissions generated from vehicular traffic and off-road fuel-burning equipment such as lawn and garden equipment, as well as natural sources such as wind blown dust. Finally, air quality is affected emissions transported into Alexandria from sources as far away as the Ohio River Valley.

Air Quality Trends in Alexandria 1980 to 2008



Notes: (1) Percent of NAAQS based on NAAQS as of Dec. 31, 2007 (does not reflect revised 2008 ozone or lead standards)
(2) Lead was monitored at Cameron Station from 1988-1992. Measured values were much better than the NAAQS. For that reason, lead monitoring was discontinued in 1992.
(3) PM_{10} monitoring in the City was conducted from 1991 to 1996, discontinued in 1997, and reinstated in 2006.

Data collected in Alexandria at show that air quality has generally improved since the early 1980s. Since 2005, measured concentrations of all criteria pollutants were better than the NAAQS. Although the ozone concentrations measured in Alexandria were better than the 1997 NAAQS in 2005-2008, Alexandria is part of the Metropolitan Washington region and violations of the NAAQS have been measured at other monitors in the region. Thus, Alexandria is considered to be nonattainment for ozone under the 1997 NAAQS. The USEPA strengthened the NAAQS for ozone in 2008, effectively reducing the levels from 0.084 ppm to 0.075 ppm. Alexandria's ozone levels in 2008 exceeded the new 2008 ozone standard.

There is no VADEQ $PM_{2.5}$ monitor operating in the city; however, the State operates $PM_{2.5}$.monitors at nearby sites in Arlington and Fairfax that adequately characterize fine particulate air quality in the city. Mirant also monitors $PM_{2.5}$ near its facility. Since Alexandria is part of the Metropolitan Washington region and violations of the NAAQS have been measured at other monitors in the region, Alexandria was initially considered to be nonattainment for $PM_{2.5}$. On January 12, 2009, the USEPA determined that region has attained the 1997 annual $PM_{2.5}$ NAAQS, based on air quality data for 2004 to 2008. In December 2006, USEPA revised the 24-hour NAAQS for $PM_{2.5}$ from 65 to 35 $\mu g/m^3$. In December 2008, USEPA determined that all of Virginia attained the revised 2006 24-hour NAAQS for $PM_{2.5}$.

Ground-level Ozone

Ozone is an extremely reactive gas comprised of three atoms of oxygen. Ozone exists naturally in the earth's upper atmosphere, the stratosphere, where it shields the earth from the sun's harmful ultraviolet rays. However, ozone found close to the earth's surface, called ground-level ozone, is a component of smog and a harmful pollutant.

Ozone, Your Health, and the Environment

The most common symptom that people have when exposed to ozone is pain when taking a deep breath. Long-term effects may include reduced lung function and scarring of lung tissue. Ozone can aggravate asthma, emphysema, bronchitis, and other respiratory diseases.

Children are at greater risk for ozone-related respiratory problems because their lungs are still developing, they breathe more rapidly, and they play outside during the afternoons when ozone is at its highest levels. They inhale more pollution per pound of body weight than adults do. Ground-level ozone is a summer time problem when children spend most of the summer outside playing at camps, ball fields, parks and in backyards.

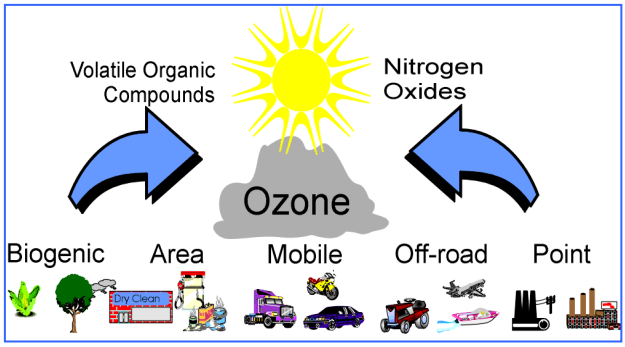
Additionally, anyone suffering from lung disease has even more trouble breathing when air is polluted with high levels of ozone. People with existing lung disease already suffer from reduced lung function and, therefore, cannot tolerate an additional reduction due to ozone exposure. Healthy adults, as confirmed by many laboratory and "real world" ozone exposure studies are also at risk. Prolonged exposure, even to relatively lower levels of ozone, can reduce a healthy adult's lung function by 15 to 20%.

Ozone can also damage forests and other vegetation Adverse effect ozone exposure to vegetation include discoloration of leaves, light flecks, dark stipples, yellow spots, premature aging, leaf loss, and reduced growth rates and crop yields. Ozone is responsible for $500 million in reduced crop production in the U.S. each year.

How Is Ozone Formed?

Unlike many other pollutants, ground-level ozone is not directly emitted into the atmosphere from a specific source. Instead, ground- level ozone is formed when nitrogen oxides (NO_x) chemically react with volatile organic compounds (VOCs) through a series of complicated chemical reactions in the presence of strong sunshine (ultraviolet light).

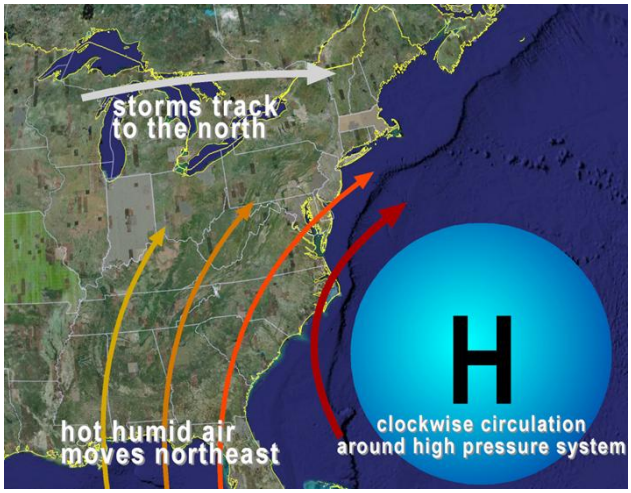
VOC + NOx + Sunlight = Ozone



Because ozone formation is greatest when the sunlight is most intense, the peak ozone levels typically occur during hot, dry, stagnant summertime conditions generally referred to as the ozone season (May 1 to September 30). The formation of ozone is not an instantaneous process, nor is it limited in geographical scope. While many urban areas tend to have high levels of ozone, even rural areas are subject to increased ozone levels because wind carries ozone and pollutants that form it hundreds of miles away from their original sources.

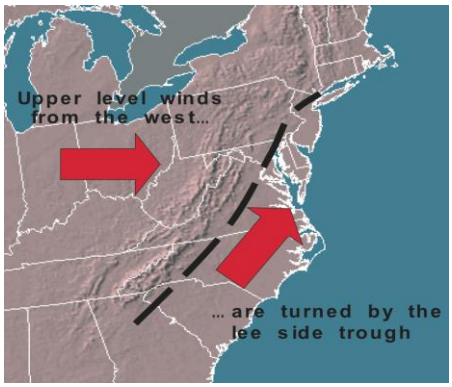
How Is Ozone Transported?

Alexandria is part of the Ozone Transport Region (OTR) of the eastern U.S. which covers a large territory from Maine to northern Virginia. Each summer, the OTR is subject to episodes of poor air quality. The scale of the problem can extend beyond the OTR's borders and include over 200,000 square miles across the eastern U.S. Contributing to the problem are local sources of air pollution as well as air pollution transported hundreds of miles from distant sources outside the OTR.



Scientists have developed a conceptual model that explains the role of transported pollution in the metropolitan area. Ozone episodes often begin with the passage of a large high pressure area from the Midwest, where it assimilates into and becomes an extension of the Atlantic (Bermuda) high pressure system. During its passage east, the air mass accumulates air pollutants emitted by large coal-fired power plants and other sources located outside the OTR. Later, local air pollution sources make their own contribution. In the worst cases, the system stalls for days, creating ozone episodes of strong intensity and long duration.

Other meteorological phenomena known as the nocturnal jet and lee-side trough can also convey air pollution several hundreds of miles from the southwest to the northeast and can extend the entire length of the corridor from Virginia to Maine. The nocturnal jet is a regional scale phenomenon of higher wind speeds that often forms at night during ozone events a few hundred meters above the ground. The Appalachian lee side trough, although formed by a different mechanism, is the day-time companion to the low-level jet.



To improve air quality, pollutant emissions must be reduced from all sources affecting polluted areas. This includes local sources as well as distant sources. In particular, emission reductions from the industrialized Midwest will greatly aid Alexandria's air quality. Local emissions are significant as well, and all the blame for our air pollution problems cannot be laid at the doorstep of the Midwest – local emissions must also be reduced.

The above description of ozone transport is based on *The Nature of the Ozone Air Quality Problem in the Ozone Transport Region: A Conceptual Description (October, 2006)*. For more information, please see: http://www.nescaum.org/topics/air-pollution-transport

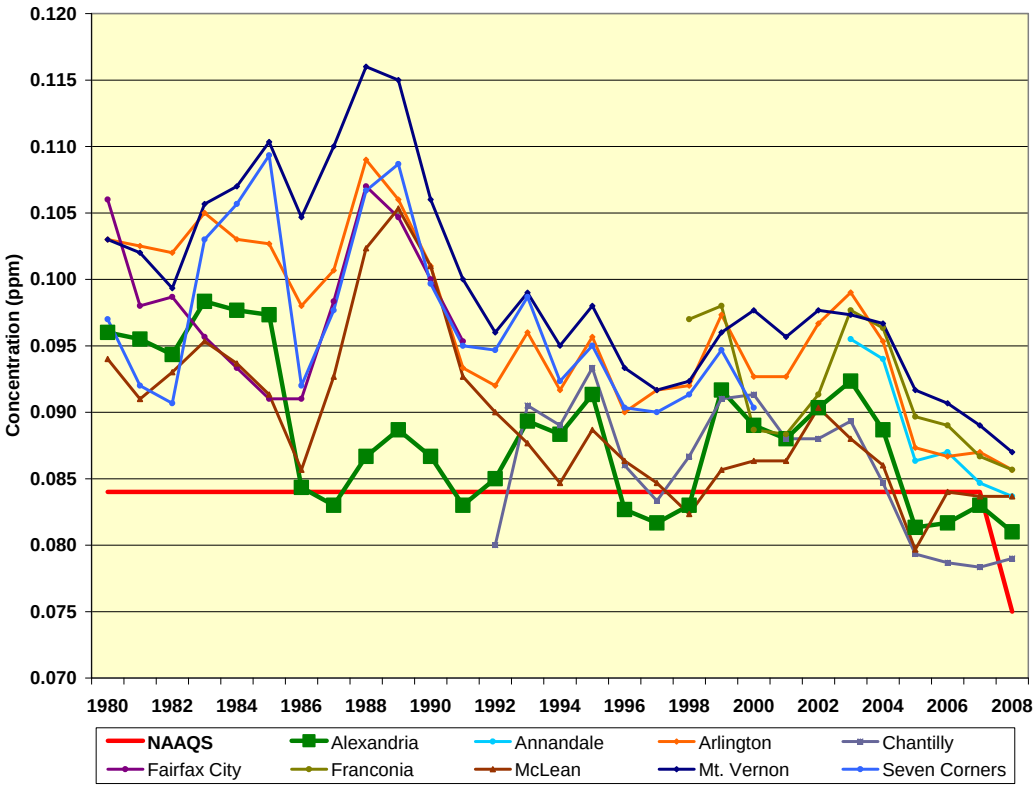
Ozone AQ Trends

On March 12, 2008, the USEPA strengthened the NAAQS for ground-level ozone to improve both public health protection and the protection of sensitive trees and plants. The USEPA revised the 8-hour standard to a level of 0.075 ppm. To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm.

The previous standard, set in 1997, was 0.08 ppm. Because ozone is measured out to three decimal places, the standard effectively became 0.084 ppm as a result of rounding. Prior to 1997, the NAAQS was a 1-hour standard at a level of 0.12 ppm. On June 15, 2005, the USEPA revoked the 1-hour ozone standard.

Shown below are the three-year averages of the fourth-highest 8-hour ozone levels in the Northern Virginia region. The USEPA developed this averaging method as a means to remove some of the variability in ozone concentrations caused by the changing weather patterns.

While the 1997 NAAQS continues to be exceeded at many Northern Virginia monitors, the data show tremendous progress since the 1980's in reducing ozone, and even more significant progress over the past 5 years. In fact, three monitors (Alexandria, Chantilly, and McLean) had measured ozone concentrations that were better than the 1997 NAAQS in 2005-2008. However, complying with the tougher 2008 ozone standard will present new challenges.

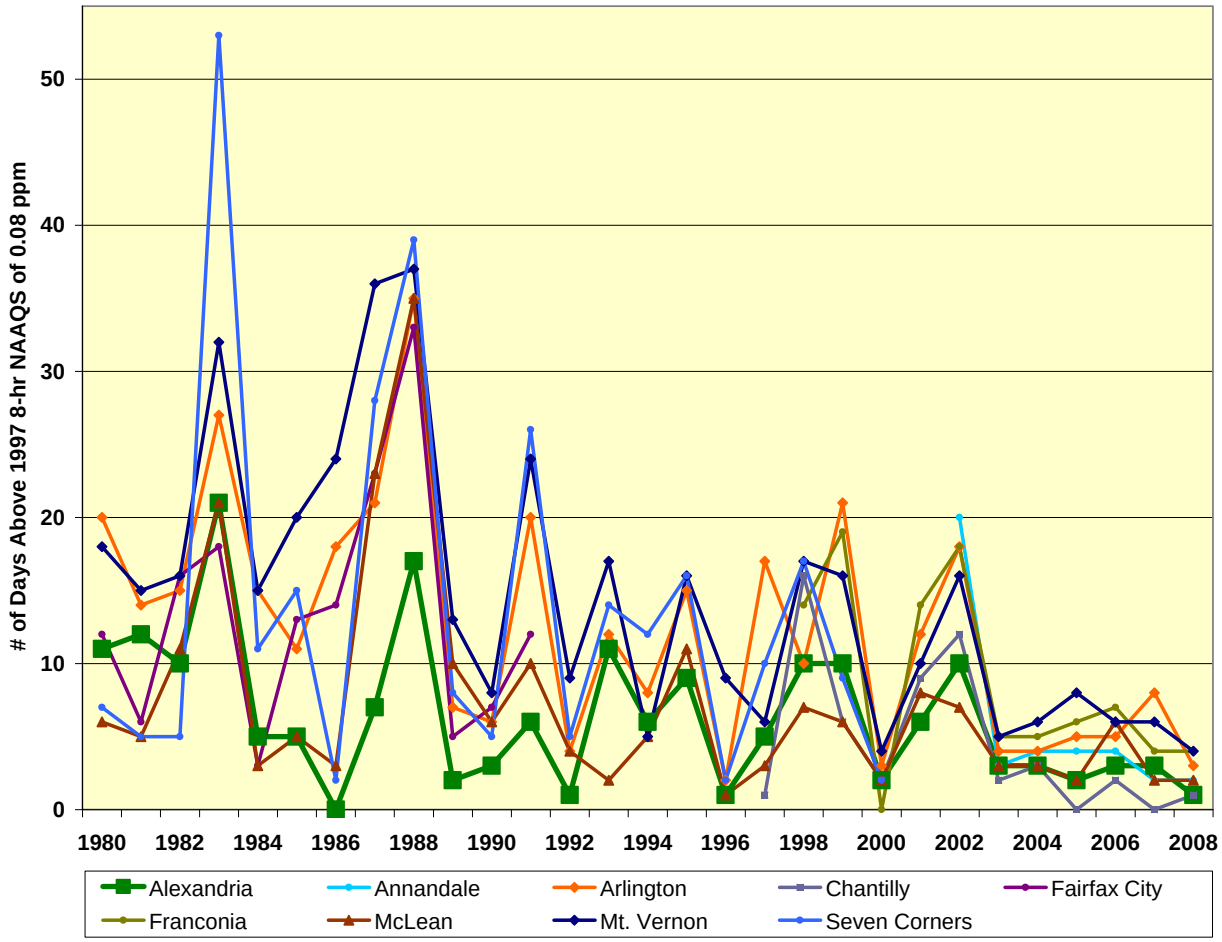


3-year Average of the Fourth-highest 8-hour Ozone Levels in the Northern Virginia Region

Another way to look at the ozone data is the number of days per year when the 8-hour NAAQS was exceeded at each monitor. During the 1980s, the 8-hour ozone NAAQS was routinely exceeded over 20 days each summer and over 30 days each summer during the worst years. In the 1990s, there was some improvement but the number of days exceeding the standard generally stagnated in the 5 to 15 day range.

Since 2003, the number of days exceeding the standard was 8 or less at every Northern Virginia monitor. Implementation of the stricter 8-hour ozone standard began in 2008 and will likely have an impact on the number of exceedance days recorded in future years.

In 2003, the USEPA began to administer the NO_x Budget Trading Program under the "NO_x SIP Call." The program resulted in the installation of a large number of selective catalytic reduction (SCR) units at power plants in 2003-2004, reducing NO_x emissions (an ozone precursor) from power plants and other large combustion sources in the eastern US. The rapid decline in NO_x emissions appears to coincide with a decrease in ground-level ozone across the region during 2003-2008.



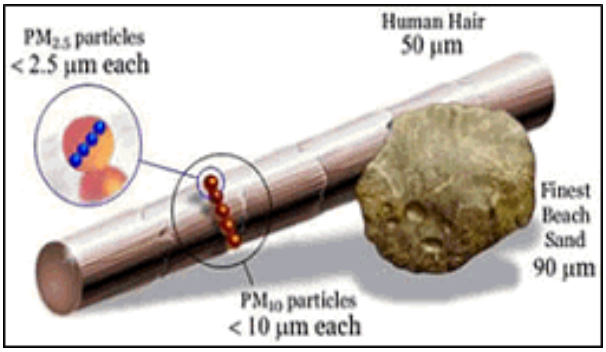
Number of Days Exceeding 1997 NAAQS of 0.08 ppm

Fine Particles

Particulate matter is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Many manmade and natural sources emit PM directly or emit other pollutants that react in the atmosphere to form PM. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

The size of particles is directly linked to their potential for causing health problems. Particles that are 10 micrometers in diameter or smaller generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects.

Particles less than 2.5 micrometers in diameter are termed "fine particles" and "$PM_{2.5}$". They are so small that several thousand of them can fit within the period at the end of this sentence. Fine particles tend to pose the greatest health concern because they can be inhaled deep into the lungs and accumulate in the respiratory system.



$PM_{2.5}$, Your Health, and the Environment

Exposure to particles can lead to a variety of serious health effects. The largest particles do not get very far into the lungs, so they tend to cause fewer harmful health effects.

Fine particles pose the greatest problems because they can get deep into the lungs, and some may even get into the bloodstream. Scientific studies show links between these small particles and numerous adverse health effects.

Long-term exposures to PM, such as those experienced by people living for many years in areas with high particle levels, are associated with problems such as decreased lung function, development of chronic bronchitis, and premature death.

Short-term exposures to particle pollution (hours or days) are associated with a range of effects, including decreased lung function, increased respiratory symptoms, cardiac arrhythmias (heartbeat irregularities), heart attacks, hospital admissions or emergency room visits for heart or lung disease, and premature death. Sensitive groups at greatest risk include people with heart or lung disease, older adults, and children.

Fine particles are the major source of haze that reduces visibility in many parts of the United States, including Alexandria. Visibility impairment occurs when fine particles scatter and absorb light, creating a haze that limits the distance we can see and that degrades the color, clarity, and contrast of the view.

Fine particles also affect vegetation and ecosystems by settling on soil and water, upsetting delicate nutrient and chemical balances.

Finally, particles also cause soiling and erosion damage to structures, including culturally important objects such as monuments and statues.

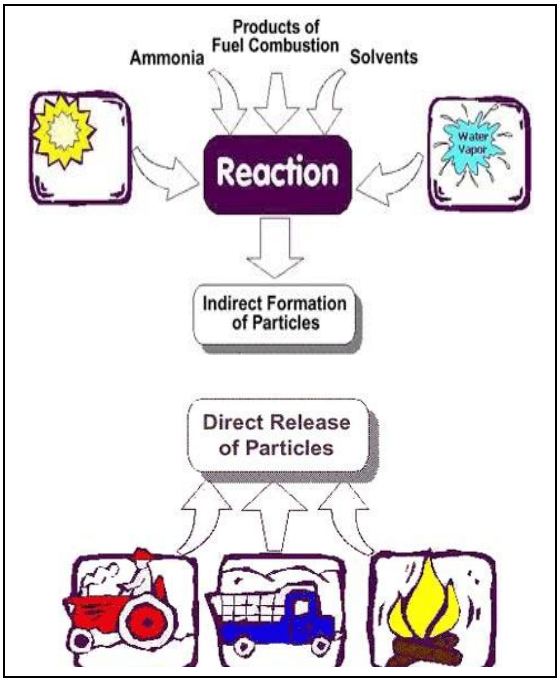
How Are Fine Particles Formed?

Particle pollution is complex in part because its components come from many sources. It is generally produced through two separate processes: mechanical and chemical. Both processes can produce particles of a range of sizes, but the each procedure produces predominantly one size.

The simplest process is mechanical, which means the breaking down of bigger bits into smaller bits with the material remaining essentially the same, only becoming smaller. Dust storms, construction and demolition, mining operations, agriculture, and coal and oil combustion are among the activities that produce coarse particles. They generally are already formed as particles when they enter the air.

By contrast, chemical processes in the atmosphere create most of the tiniest fine and ultrafine particles. Combustion sources burn fuels and emit gases. These gases can simply vaporize and then condense to become a particle of the same chemical compound. Or, they can react with other gases or particles in the atmosphere to form a particle of a different chemical compound. Particles formed by this latter process come from the reaction of elemental carbon (soot), ammonia, sulfur dioxide, nitrogen oxides and volatile organic compounds with water and other compounds in the atmosphere.

Burning fossil fuels in factories, power plants, steel mills, smelters, diesel- and gasoline-powered motor vehicles (cars and trucks) and equipment generate a large part of the raw materials for fine particles. So does burning wood in residential fireplaces and wood stoves and burning agricultural fields or forests.



In the atmosphere, coarse and fine particles behave differently. Larger coarse particles settle out from the air more rapidly than fine particles and usually are found close to their emission sources. Fine particles can be transported long distances by wind and can be found in the air thousands of miles from where they were formed.

Fine particle pollution in Alexandria is caused mainly by secondary pollution from the following mechanisms:

Sulfates formed from SO_2 emissions from power plants and industrial facilities

Nitrates formed from NO_x emissions from cars, trucks, and power plants

Carbon formed from reactive organic gas emissions from cars, trucks, industrial facilities, and forest fires.

Ammonia reacts with sulfur dioxide and nitrogen oxides to form sulfates and nitrates. Ammonia is emitted from agricultural activities such as fertilizer application.

Particulate Matter AQ Trends

The NAAQS for particulate matter were first established in 1971. The form of particulate matter was called Total Suspended Particulate (TSP) and included particles 30 micrometers in diameter and smaller. In 1987, the USEPA changed the standards to regulate inhalable particles smaller than, or equal to, 10 micrometers in diameter.

Ten years later in 1997, the USEPA revised the PM standards, setting separate standards for fine particles ($PM_{2.5}$) based on their link to serious health problems ranging from increased symptoms, hospital admissions and emergency room visits for people with heart and lung disease, to premature death in people with heart or lung disease. The 1997 standards also retained but slightly revised standards for PM_{10} which were intended to regulate "inhalable coarse particles."

The USEPA again revised the air quality standards for particle pollution in 2006. The 2006 standards tightened the 24-hour fine particle standard from 65 $\mu g/m^3$ to 35 $\mu g/m^3$, and retained the current annual fine particle standard at 15 $\mu g/m^3$. The USEPA decided to retain the existing 24-hour PM_{10} standard of 150 $\mu g/m^3$. The USEPA revoked the annual PM_{10} standard, because available evidence did not suggest a link between long-term exposure to PM_{10} and health problems.

There is no VADEQ operated $PM_{2.5}$ monitor operating in the city; however there are nearby monitors in Arlington, Annandale, Franconia, and Seven Corners which adequately characterize Alexandria's air quality. Additionally, Mirant operates source-specific $PM_{2.5}$ monitors near

$PM_{2.5}$ monitoring did not begin until 1999. The 3-year average of the annual mean $PM_{2.5}$ concentrations (the statistic used to determine compliance with the annual NAAQS) shows that all monitors in Northern Virginia are currently in compliance with the annual NAAQS.

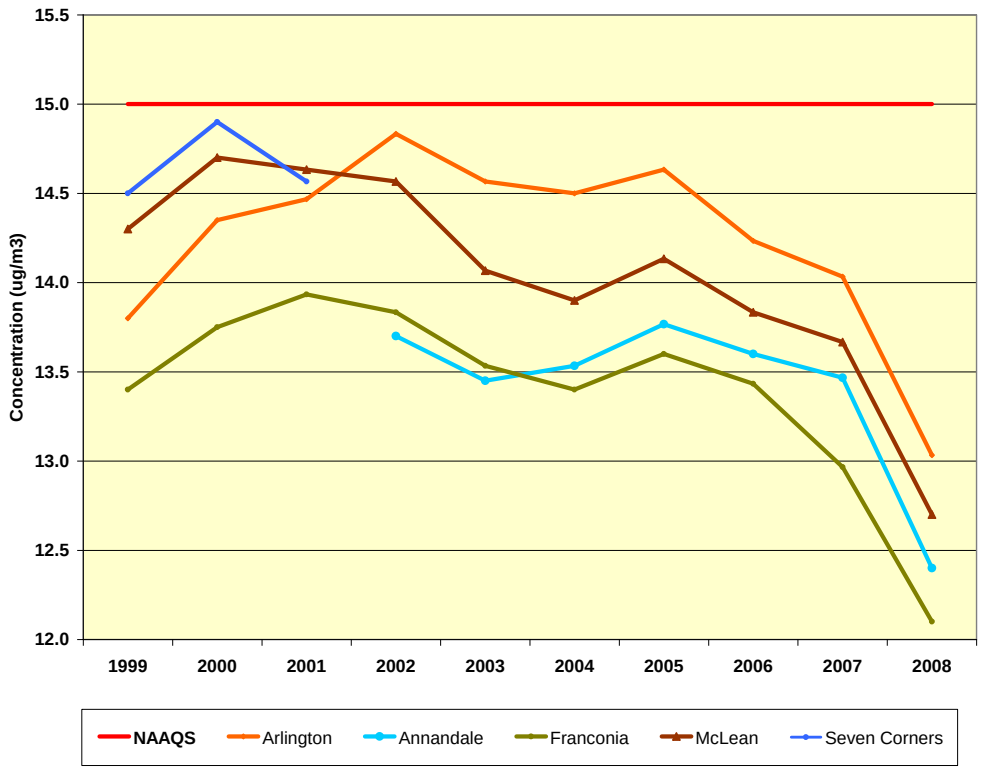
The 3-year average of the 98th percentile of the 24-hour $PM_{2.5}$ concentrations (the statistic used to determine compliance with the 24-hour NAAQS) also is in compliance. Prior to the NAAQS revision in 2006, measured concentrations were about one-half of the NAAQS. With the tightening of the standard in 2006, all monitors in the area are measuring concentrations that are just below the 24-hour $PM_{2.5}$ NAAQS.

Since the changes to the PM_{10} NAAQS in 1997, ambient monitoring of PM_{10} has been reduced. The site at 517 N Asaph Street monitored PM_{10} from 1990-1996. Monitoring was discontinued from 1997 to 2005 because USEPA changed the NAAQS from the PM_{10} form to the $PM_{2.5}$ form. PM_{10} monitoring resumed in 2006 due to concerns expressed by citizens related to the emissions from the Mirant power plant.

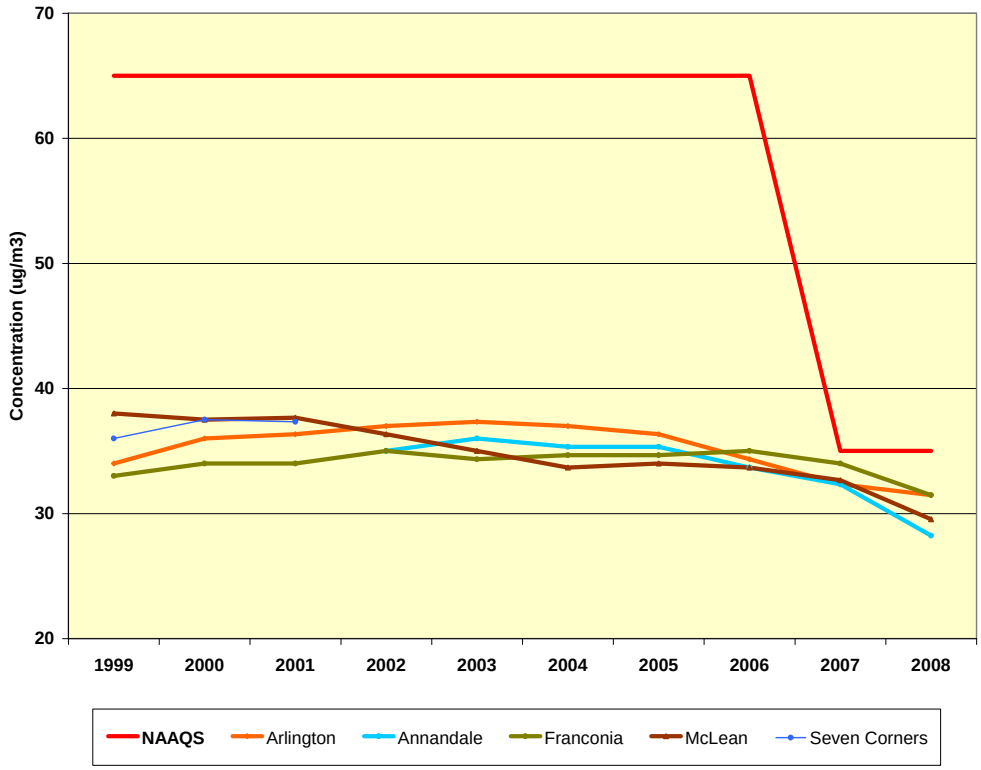
In June 2006, the City in partnership with VADEQ began monitoring ambient concentrations of PM_{10} at Armistead Boothe Park in Cameron Station, near the Virginia Paving hot mix asphalt facility. PM_{10} concentrations measured at both Alexandria sites are well in compliance with the PM_{10} 24-hour standard of 150 $\mu g/m^3$.

There is generally a correlation between $PM_{2.5}$ and PM_{10} concentrations, with $PM_{2.5}$ typically ranging from 50 to 75% of the PM_{10} concentration.

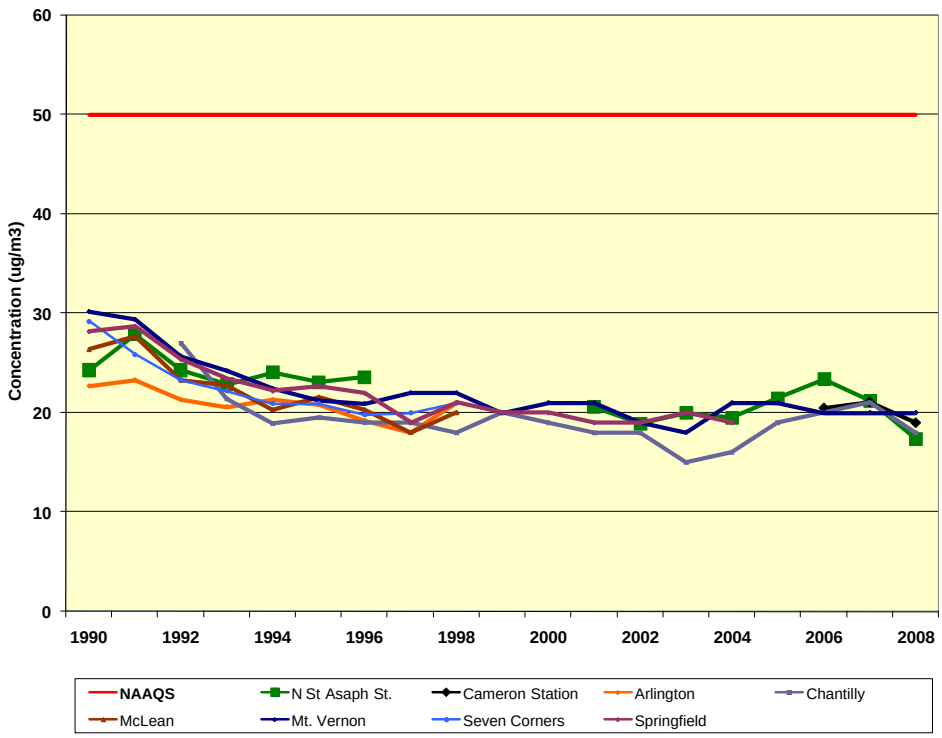
The charts on the following pages show trends PM_{10} and $PM_{2.5}$ concentrations in Northern Virginia.



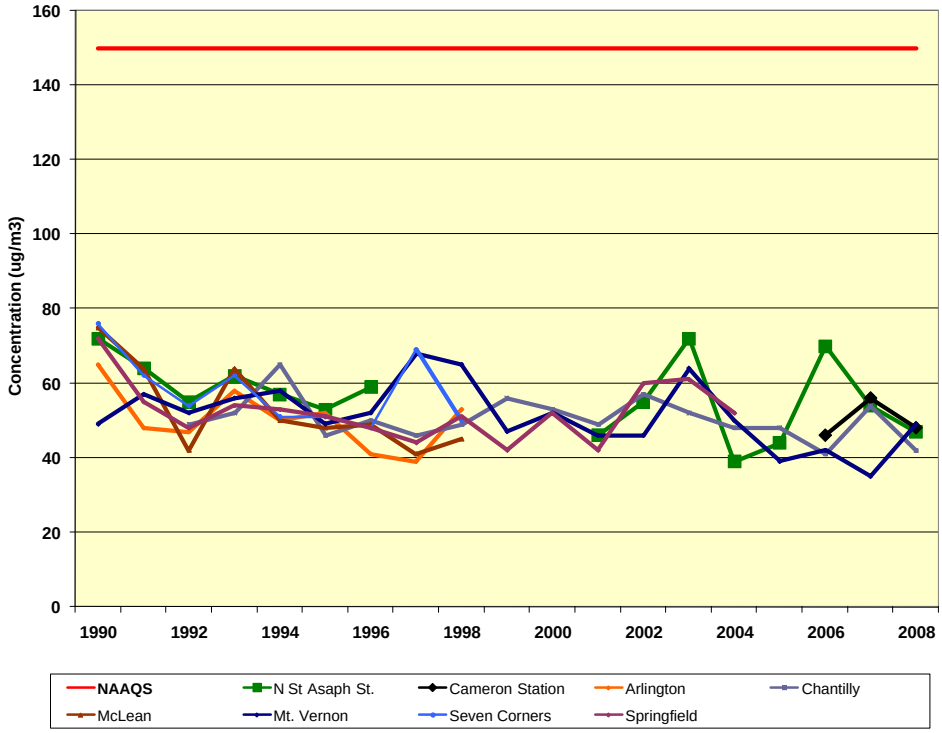
3-year Average of Annual $PM_{2.5}$ Means in the Northern Virginia Region



3-year Average of 98th Percentile of 24-hour $PM_{2.5}$ Values in the Northern Virginia Region



Annual Average PM_{10} Mean in the Northern Virginia Region*



24-hour Maximum PM_{10} Values in the Northern Virginia Region*

* Monitoring was discontinued in Alexandria from 1997 to 2005 because USEPA changed the NAAQS from the PM_{10} form to the $PM_{2.5}$ form. PM_{10} monitoring resumed in 2006 due to concerns expressed by citizens related to the emissions from the Mirant power plant.

PM_{10} Monitoring at Cameron Station

PM_{10} air monitoring station at Cameron Station

The City began monitoring ambient air for particulate matter in June of 2004 at a new monitoring station located at Armistead Boothe Park, near the Samuel Tucker Elementary School in Cameron Station. The monitoring was conducted to measure the ambient air concentrations of PM_{10} in the air surrounding Cameron Station.

Residents of Cameron Station have expressed concerns about the health effects from potential exposure to high levels of particulate matter in their community. Specifically, the residents have raised concerns about emissions generated at the Virginia Paving hot mix asphalt facility located on Van Dorn Street. This facility is located a short distance from the residents of Cameron Station, to the west and south of Cameron Station.

To address these concerns, the City conducted a short term monitoring study in August of 2004. Two monitors were used for this study - one located in the Armistead Boothe Park and another located in the Ben Brenman Park. The study was designed to monitor PM_{10} levels on days when its levels were anticipated to be the highest. This was based on engineering best practice analysis of weather conditions and predicted wind direction. Monitoring on days when rainfall was predicted was avoided.

The results from this short monitoring period in 2004 met the NAAQS However, because they were higher than expected, the City installed a new long term monitoring station to measure PM_{10} at Armistead Boothe Park, near Samuel Tucker Elementary School.

Long-term monitoring at this location started in June of 2006. A comparison of the monitoring results with the NAAQS shows that the ambient PM_{10} concentrations at Cameron Station are well in compliance with the NAAQS. The highest 24-hour concentration measured to date was 56 $\mu g/m^3$, well below the 24-hour PM_{10} standard of 150 $\mu g/m^3$.

For the purpose of demonstrating compliance with 24-hour NAAQS, Special Use Permit (SUP) condition 28a states that the City shall continue operating the PM_{10} monitor near Tucker Elementary School until three years of valid data have been collected. Once three years of data is collected, the City shall determine the 98th percentile of this data, per the NAAQS, and then multiply that value by 75%, to impute a 98th percentile value for $PM_{2.5}$.

Compliance with the annual NAAQS is not required since the USEPA revoked the annual PM_{10} standard base on available evidence that did not suggest a link between long-term exposure to PM_{10} and health problems.

Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas that is formed when carbon in fuel is not burned completely. It is a component of motor vehicle exhaust and non-road engines and vehicles (such as lawn mowers and construction equipment). Another source of CO emissions is residential wood burning.

Because motor vehicle traffic is the major source of CO, daily concentration peaks coincide with morning and evening rush hours. The worst problems are found where large numbers of slow moving cars congregate.

The highest levels of CO in the outside air typically occur during the colder months of the year when inversion conditions are more frequent.

CO Health Effects

High CO levels can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues. When CO enters the bloodstream, it reduces the capacity of the body to deliver oxygen to its organs and tissues, thus depriving the body of an essential for life.

The health threat from ambient CO is most serious for those who suffer from particular cardiovascular diseases. Elevated CO levels can lead to visual impairment, reduced work capacity, poor learning ability, and difficulty in the performance of complex tasks. At still higher levels, levels that can occur in the indoor environment, CO can lead to headaches and nausea, even in healthy persons.

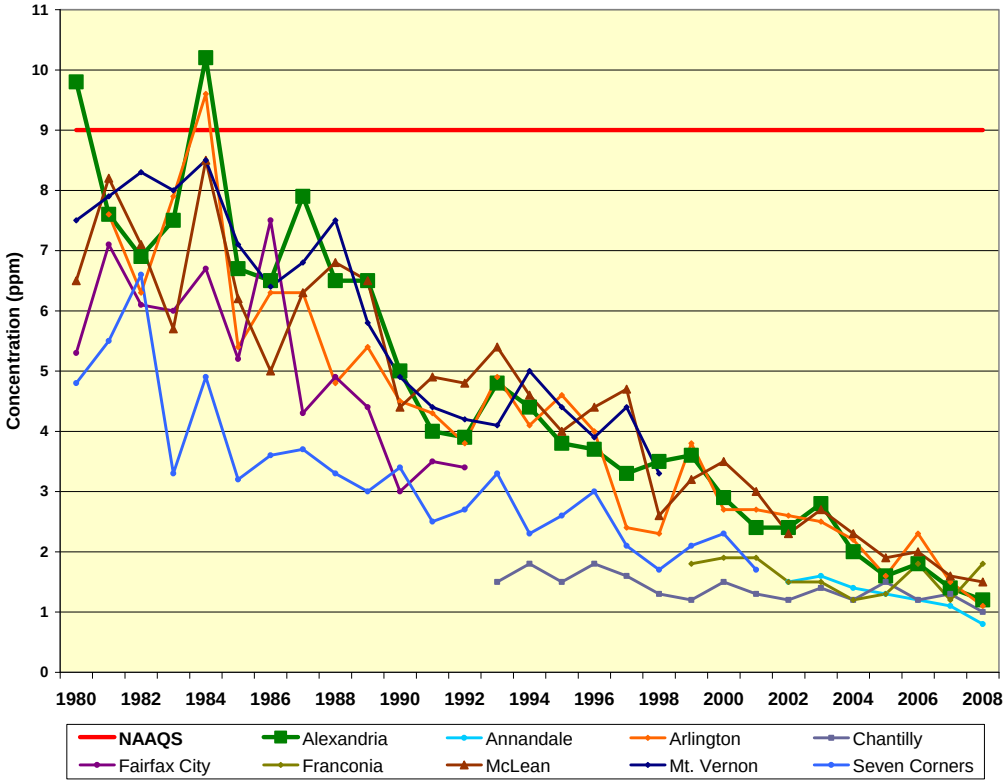
The CO NAAQS include both an 8-hour and 1-hour standard. The 2nd highest 8-hour and 1-hour average concentrations are used because the NAAQS permits one occurrence each year at each monitoring site to exceed the 8-hour NAAQS for CO (9 ppm). The NAAQS requires that the 2nd highest be less than 9 ppm averaged over 8 hours and 35 ppm averaged over 1 hour at all area monitors in order for the region to be in attainment.

CO AQ Trends

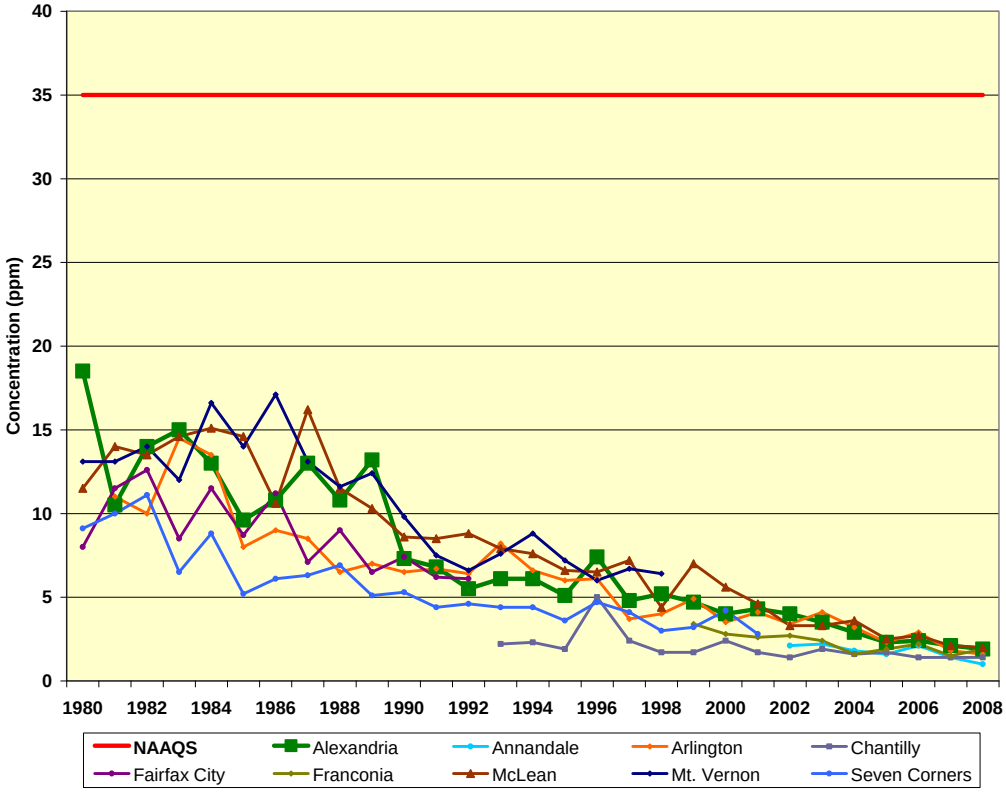
The 8-hour averaged CO levels in the Northern Virginia region have been steadily declining since the late 1980s and the region is currently in attainment of the 8-hour standard. In the early 1980s, 8-hour CO levels exceeded the NAAQS and certain portions of Arlington and Alexandria were in violation of the NAAQS. CO levels have dropped dramatically due to tighter emission standards for new motor vehicles and better inspection and maintenance of vehicle emission control systems. Currently, the 2nd highest 8-hour average CO levels at the highest regional monitor are approximately 20% of the NAAQS for CO.

Another measure of progress is the 2nd highest 1-hour average CO concentrations. Currently, the peak 1-hour concentrations are about one-tenth the magnitude of the 1-hour CO NAAQS.

Both the 8-hour and 1-hour data illustrate that carbon monoxide levels in the Northern Virginia region have been steadily improving for the past two decades. Since 1985, both 1-hour and 8-hour averaged CO concentrations are better than the health standards at all monitors in the region.



8-hour Second Maximum Carbon Monoxide Levels in the Northern Virginia Region



1-hour Second Maximum Carbon Monoxide Levels in the Northern Virginia Region

Sulfur Dioxide

Sulfur dioxide (SO_2) is prevalent in crude oil, coal, and ore that contain common metals like aluminum, copper, zinc, lead, and iron. SO_2 gases are formed when fuel containing sulfur is burned, when gasoline is extracted from oil, or metals are extracted from ore. Most of the SO_2 emitted in the Washington metropolitan region is from coal-fired power plants.

SO_2 Health Effects

SO_2 causes a wide variety of health and environmental impacts because of the way it reacts with other substances in the air. Particularly sensitive groups include people with asthma who are active outdoors and children, the elderly, and people with heart or lung disease. Peak levels of SO_2 in the air can cause temporary breathing difficulty for people with asthma who are active outdoors.

SO_2 AQ Trends

A general characterization of SO_2 concentrations in the region is that levels are low and declining. The annual average and 24-hour second maximum SO_2 concentrations are plotted on the following page. The data show that in recent years the levels are approximately one-seventh of the NAAQS. There have been no recorded exceedances of the SO_2 NAAQS at any of the VADEQ operated SO2 monitors since 1980; however there has been a recorded exceedances of the SO_2 NAAQS by the Mirant source specific monitors.

Primarily to help reduce acid rain, the USEPA implemented a program to reduce the releases of SO_2 and other pollutants from coal-fired power plants. The first phase began in 1995 and targets the highest emitting power plants. The second phase started in 2000 and sets tighter restrictions on smaller coal-, gas-, and oil-fired plants. The Clean Air Interstate Rule of 2005 was designed to further reduce SO_2 from power plants beginning in 2010.

Effects of Chemical Reaction of SO_2 in the Atmosphere

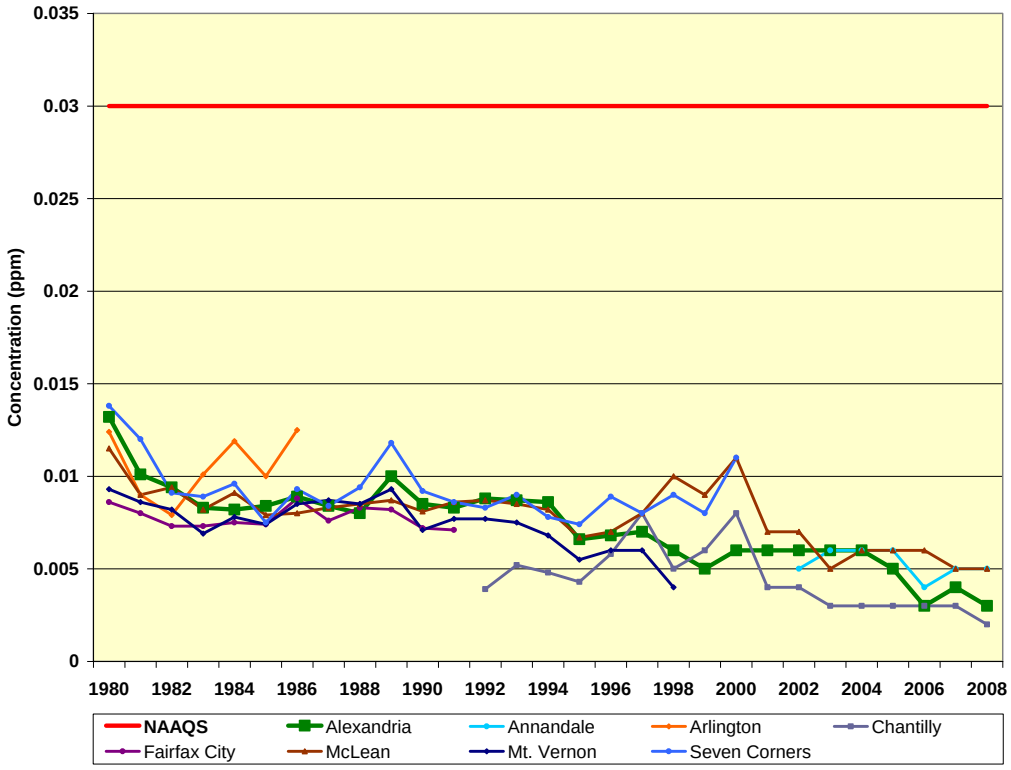
As SO_2 emissions are transported long distances by winds, they react in the atmosphere to form secondary pollutants such as sulfuric acid and sulfates.

Respiratory Effects - SO_2 reacts with other chemicals in the air to form tiny sulfate particles. When these are breathed, they gather in the lungs and are associated with increased respiratory symptoms and disease, difficulty in breathing, and premature death.

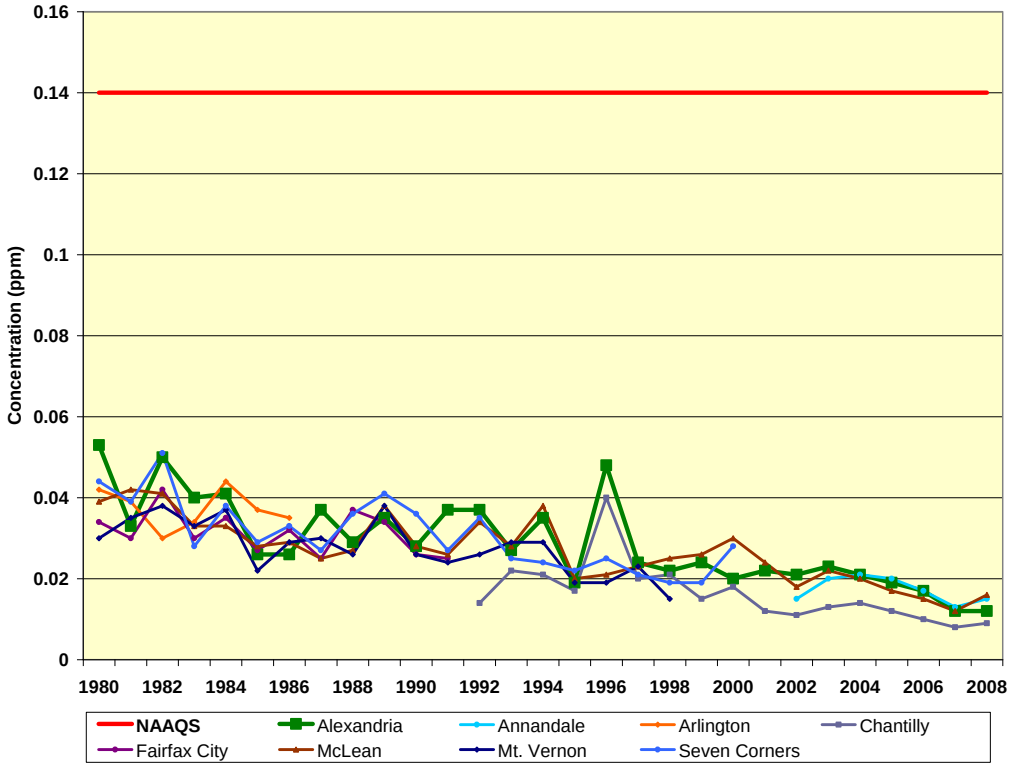
Visibility Impairment - Sulfate particles are the major cause of reduced visibility in many parts of the U.S., including our national parks. Haze occurs when light is scattered or absorbed by particles and gases in the air.

Acid Rain - SO_2 reacts with other substances in the air to form acids, which fall to earth as rain, fog, snow, or dry particles. Some may be carried by the wind for hundreds of miles. Acid rain damages forests and crops, changes the makeup of soil, and makes lakes and streams acidic and unsuitable for fish.

Aesthetic Damage - SO_2 accelerates the decay of building materials and paints, including irreplaceable monuments, statues, and sculptures that are part of our nation's cultural heritage.



Annual Sulfur Dioxide Levels in the Northern Virginia Region



24-hour Second Maximum Sulfur Dioxide Levels in the Northern Virginia Region

Nitrogen Dioxide

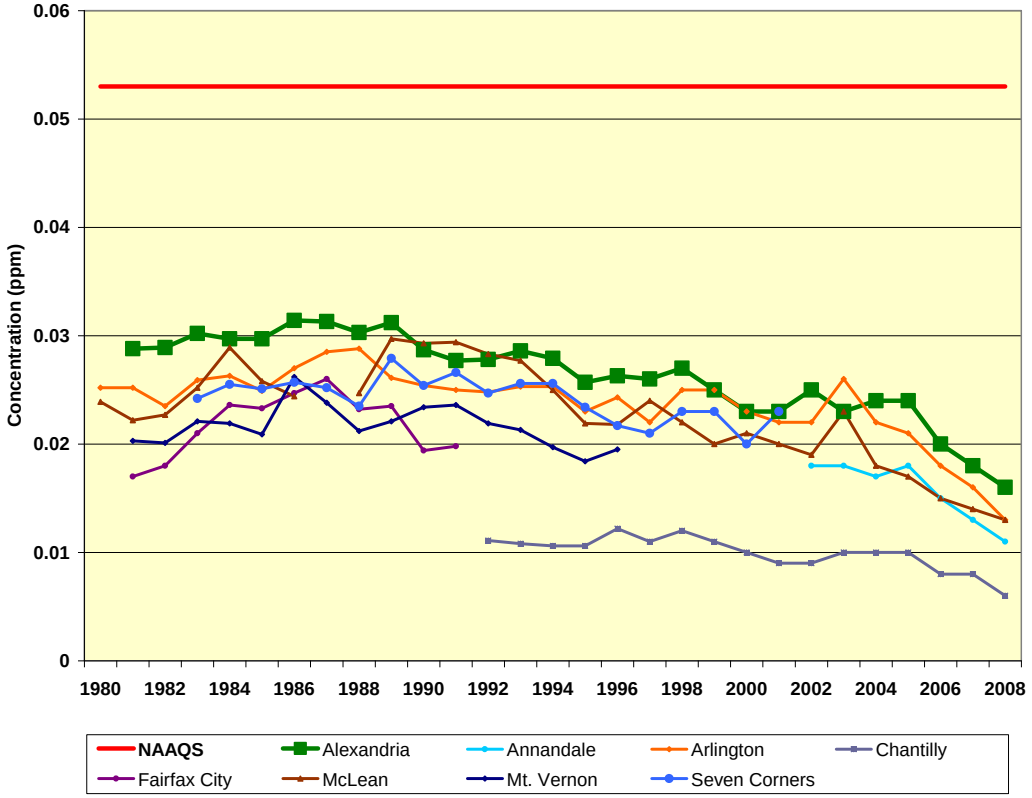
Nitrogen dioxide (NO_2) is a gaseous pollutant, one of a class of compounds called nitrogen oxides (NO_x). NO_2 can irritate the lungs and lower resistance to respiratory infections. NO_2 is a brownish and highly chemically reactive gas. It is formed during the high-temperature combustion of fuels, in vehicle engines and industrial facilities (primarily electric generating power plants).

Children, people with lung diseases such as asthma, and people who work or exercise outside are susceptible to adverse effects such as damage to lung tissue and reduction in lung function.

The NO_2 NAAQS is an annual standard of 0.053 ppm. The figure below shows that the annual average NO_2 concentration in the region is much better than the NAAQS. There seems to be a slight downward trend since 1990, possibly due to tighter emission standards for new motor vehicles and fossil fuel-fired electric utilities.

NO_2 plays a major role in the atmospheric reactions that produce ground-level ozone in the warmer months.

NO_2 also contributes to the formation of acid rain, visibility impairment, fine particle formation, and nitrogen deposition in the Chesapeake Bay.



Annual Nitrogen Dioxide Levels in the Northern Virginia Region

Lead

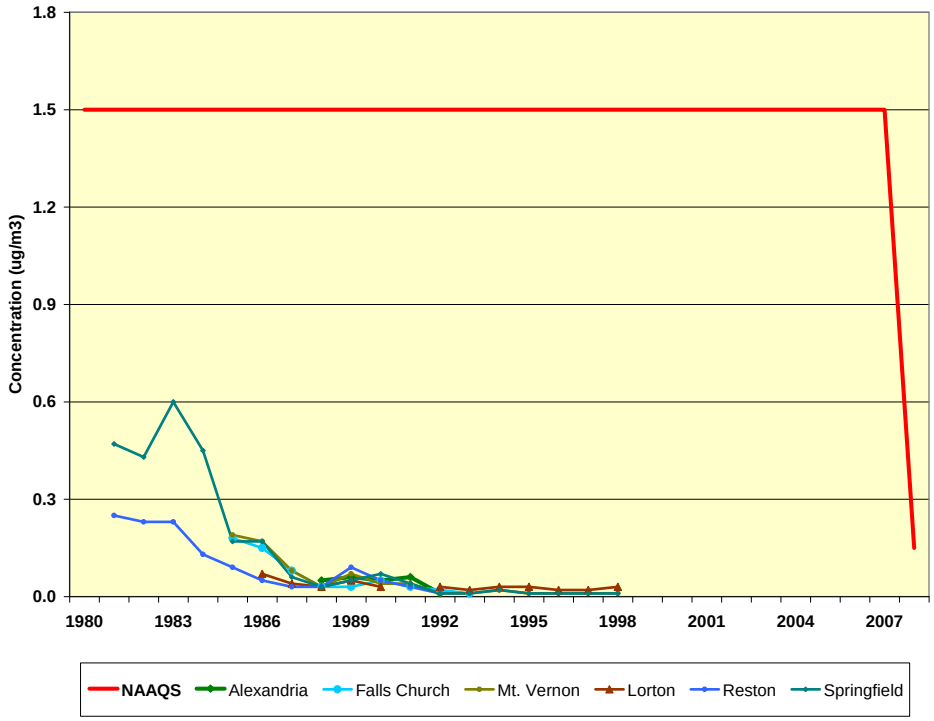
Lead (Pb) is a metal found naturally in the environment as well as in manufactured products. In the past, motor vehicles were the major contributor of lead emissions to the air. As a result of USEPA's regulatory efforts to reduce lead in gasoline, air emissions of lead from the transportation sector, and particularly the automotive sector, have greatly declined over the past two decades. Lead emissions declined by 95 percent between 1980 and 1999.

In addition to a fuel additive, lead was also used for many years in products found in and around our homes. Many homes built before 1978 have lead-based paint and plumbing materials containing lead.

Exposure to lead can be by breathing or swallowing lead dust, or by eating soil or paint chips containing lead. Lead may cause a range of health effects, from behavioral problems and learning disabilities, to seizures and death. Children six years old and under are most at risk.

Since the lead concentrations measured in the 1990s were much better than the NAAQS, most lead monitoring has been discontinued except around hot spots such as near lead smelters and lead-acid battery manufacturers, none of which are located in Northern Virginia. No ambient monitoring for lead has been conducted in Northern Virginia since 1998.

In November 2008, USEPA revised the lead NAAQS from 1.5 to 0.15 µg/m3 to provide increased protection for children and other at-risk populations. USEPA is requiring monitoring agencies to conduct ambient monitoring at sources which emit lead at a rate of 1.0 or more tons per year, the rate that under reasonable worst-case conditions could lead to lead concentrations exceeding the NAAQS. No sources in Alexandria meet this emission monitoring threshold.



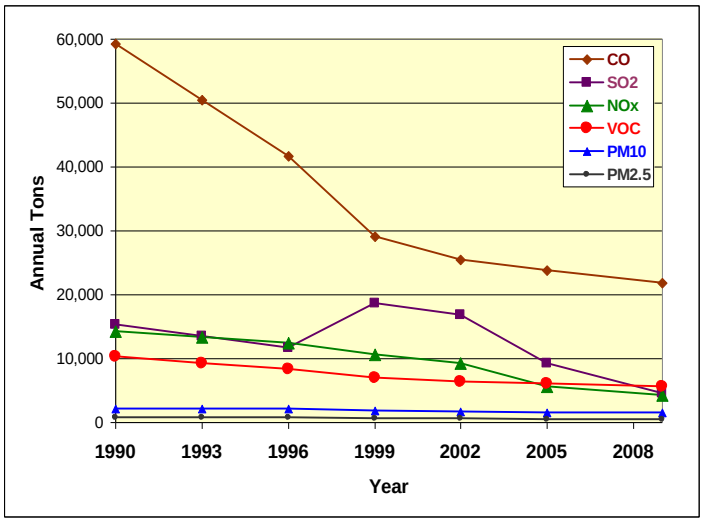
Quarterly Maximum Lead Levels in the Northern Virginia Region

SECTION 3 – CRITERIA POLLUTANT EMISSIONS

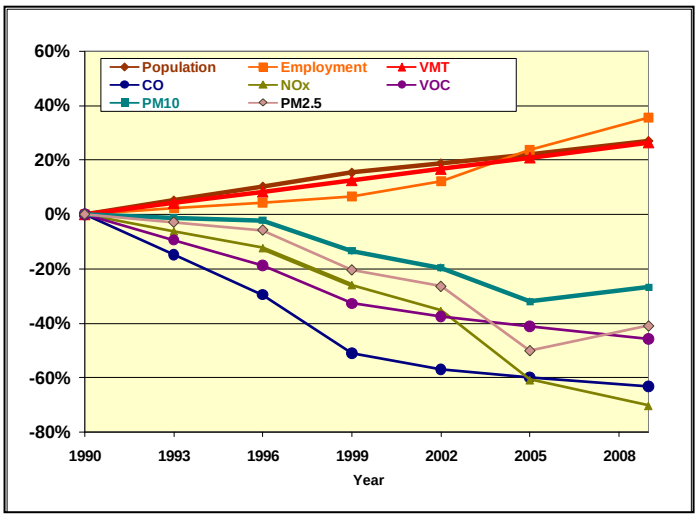
This Section presents an emission trends analysis for all criteria pollutants. Data from 1990 to 2005 were used to analyze emission trends in the City of Alexandria, along with projections of emission levels in 2009. The emissions estimates were compiled from a variety of sources, including the USEPA, VA DEQ, and MWCOG as documented in Appendix B. Additional information is provided on hazardous air pollutants. Finally, emissions from major stationary sources (Mirant, Covanta, and Virginia Paving) are discussed.

Criteria Pollutant Emission Trends in Alexandria

The graph to the right shows that emissions in Alexandria for most criteria pollutants have been decreasing steadily since 1990. The decreases in CO, NO_x, and VOC are predominantly due to motor vehicle controls and reductions in evaporative emissions from gasoline stations and consumer products. Emissions of SO_2 are almost entirely due to a single source – the Mirant Potomac River Generating Station – whose emissions have been capped at 3,813 tons per year, which is a reduction of about two-thirds from historical emission levels. PM_{10} and $PM_{2.5}$ emissions show a slight downward trend from 1990 to 2009



While population, employment, and VMT have increased significantly in Alexandria since 1990, emissions of CO and ozone precursors have declined dramatically. The graph to the right shows the growth in 2009 from 1990 levels in population (27%), employment (35%), and VMT (26%). At the same time, emissions have decreased for CO (-63%), NO_x (-70%), VOC (-46%), and $PM_{2.5}$ (-40%) from 1990 levels. Aggressive emission control programs at the Federal, State, and local level have resulted in emission decreases. As shown in the previous section, the emission decreases have lead directly to a continuing improvement in air quality in Alexandria.



Carbon Monoxide (CO) Emission Trends

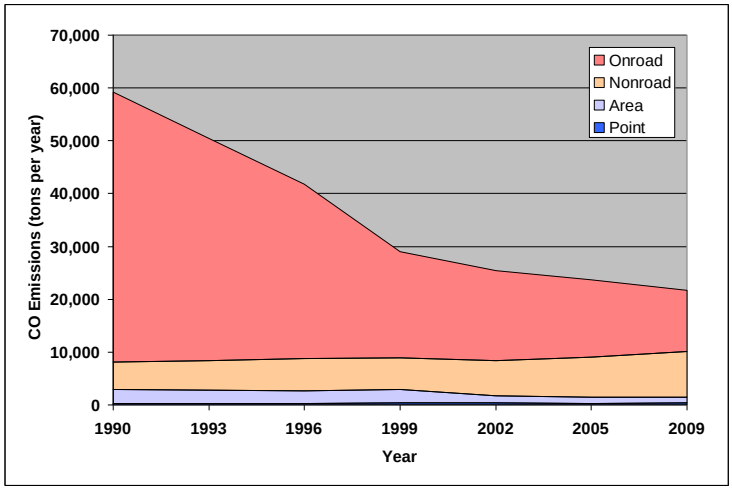
Trends in CO emissions in the City of Alexandria are summarized below. CO emissions are generated primarily by onroad vehicles (cars, trucks, buses, and other vehicles on public roadways). The nonroad equipment sector, primarily gasoline-powered lawn and garden equipment, is the next largest sector. Area sources of CO emissions are primarily wood burning fireplaces and stoves. Very little CO is emitted from power plants or other industrial facilities.

CO Emission Trends (tons/year), 1990-2009, City of Alexandria

Sector	1990	1993	1996	1999	2002	2005	Projected in 2009
Point	328	288	248	339	368	286*	392
Area	2,650	2,549	2,447	2,641	1,378	1,222	1,015
Nonroad	5,165	5,601	6,036	5,872	6,631	7,493	8,643
Onroad	51,060	42,028	32,996	20,189	17,033	14,744	11,693
	59,203	**50,466**	**41,727**	**29,041**	**25,410**	**23,745**	**21,743**

* Point source emissions were abnormally low in 2005 because the Mirant Potomac River Generating Station was partially shut down and the amount of coal consumed at the plant was about 40% lower than in a typical year.

From 1990 to 2005, CO emissions from onroad vehicles have decreased by about 82%, despite large increases in the number of vehicles on the road and the number of miles they travel. The decrease in emissions is due to a combination of Federal, State, and local control measures. At the national level, these measures include national standards for tailpipe emissions, new vehicle technologies, improved fuel economy, and clean fuels programs. State and local emissions measures include inspection and maintenance (I/M) programs and transportation management programs.



CO emissions are projected to decrease slightly between 2005 and 2009. Although VMT is project to increase between 2005 and 2009, CO emission from onroad vehicles are projected to decrease as older, less efficient vehicles are replaced by newer, cleaner vehicles with more effective emission controls and greater fuel economy. The projected increase in the use of gasoline-powered lawn and garden equipment will somewhat offset the reductions expected from onroad vehicle emission control programs.

Oxides of Nitrogen (NO_x) Emission Trends

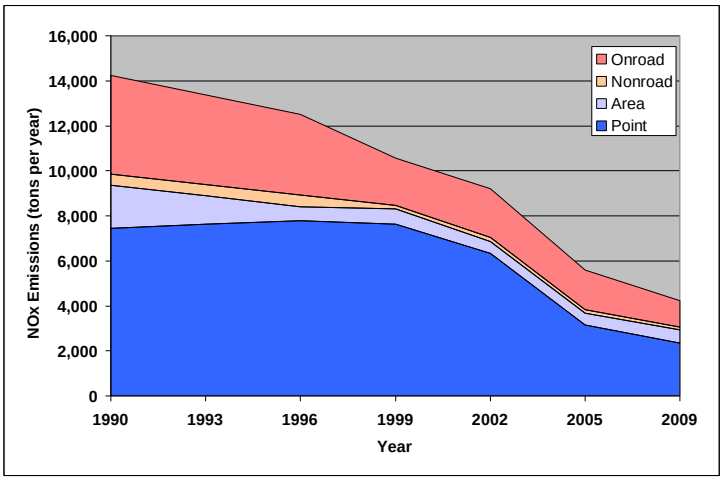
Trends in NO_x emissions are shown below. The largest source of NO_x emissions is the Mirant Potomac River Generating Station. In 2002, Mirant emitted about 65% of the city's total. Other important sources of NO_x emissions are combustion processes such as those occurring in automobile engines, solid waste incinerators and residential/commercial heating units.

NO_x Emission Trends (tons/year), 1990-2009, City of Alexandria

Sector	1990	1993	1996	1999	2002	2005	Projected in 2009
Point	7,445	7,620	7,794	7,622	6,342	3,141*	2,358
Area	1,921	1,262	603	674	528	545	567
Nonroad	502	518	534	165	162	154	144
Onroad	4,387	3,976	3,566	2,103	2,174	1,745	1,174
	14,255	**13,376**	**12,497**	**10,564**	**9,206**	**5,585**	**4,243**

* Point source emissions were abnormally low in 2005 because the Mirant Potomac River Generating Station was partially shut down and the amount of coal consumed at the plant was about 40% lower than in a typical year.

From 1990 to 2005, NO_x emissions have decreased by about 45%. One of the reasons for the decline in NO_x emissions was the installation emission controls at the Mirant power plant. In 1997, Mirant began using a computerized control system to optimize combustion and minimize NO_x formation. In 2004/2005, Mirant installed low NO_x burners on all units and separated over-fire air (SOFA) systems on Units 3-5 that further inhibit NO_x formation.



The second reason for the decline in NO_x emissions was the combination of Federal, State, and local control measures for onroad vehicle mentioned in the previous section. Despite large increases in the number of vehicles on the road and the number of miles they travel between 1990 and 2005, NO_x emissions from onroad vehicles decreased by 60% during that time.

NO_x emissions are projected to continue to decline between 2005 and 2009. The primary reason for the continued decline is the reduction of NO_x emissions from the Mirant Potomac River Generating Station. The State Air Pollution Control Board (SAPCB) had adopted EPA's Clean Air Interstate Rule (CAIR) in Virginia's regulations. Although CAIR is under judicial review, Virginia DEQ considers Mirant's annual NOx allocations under CAIR to be a legally enforceable requirement beginning in 2009. The CAIR limitation of 1,711 tons per year is much lower than the currently permitted level of 3,700 tons per year.

Volatile Organic Compounds (VOC) Emission Trends

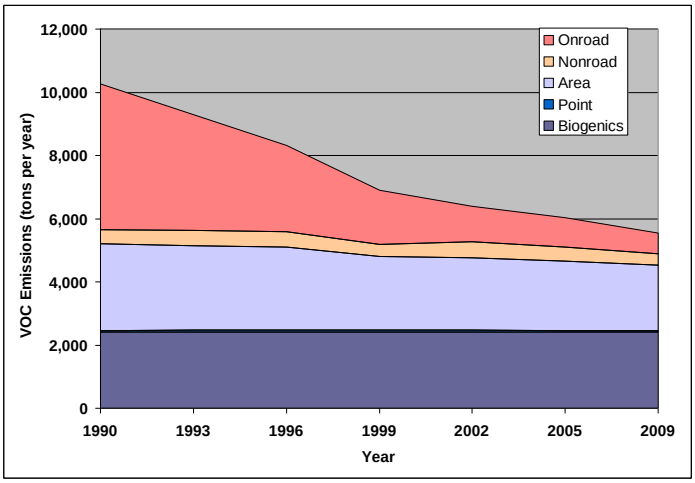
Trends in VOC emissions in the City of Alexandria are shown below. VOC emissions are generated by a variety of human activities as well as natural sources. Area sources include solvent evaporation from consumer products (e.g., paints, cleaners, pesticides, hairsprays) and gasoline evaporation during refueling of vehicle fuel tanks and portable fuel containers. VOC vapors are also created during the operation of onroad and nonroad engines. Biogenic emissions are emissions from natural sources, such as plants and trees. The sharp scent of pine needles, for instance, is caused by monoterpenes, which are among the group of VOCs.

VOC Emission Trends (tons/year), 1990-2009, City of Alexandria

Sector	1990	1993	1996	1999	2002	2005	Projected in 2009
Biogenic	2,420	2,420	2,420	2,420	2,420	2,420	2,420
Point	41	47	53	66	47	39*	42
Area	2,739	2,682	2,625	2,308	2,285	2,193	2,070
Nonroad	457	474	491	388	514	445	353
Onroad	4,606	3,670	2,735	1,713	1,133	934	668
	10,263	**9,293**	**8,324**	**6,895**	**6,399**	**6,031**	**5,553**

* Point source emissions were abnormally low in 2005 because the Mirant Potomac River Generating Station was partially shut down and the amount of coal consumed at the plant was about 40% lower than in a typical year.

VOC emissions have declined significantly since 1990. Control measures to reduce onroad emissions include regulations to lower fuel volatility and to reduce VOC emissions from tailpipes. State regulations went into effect in 1992 that required special gasoline dispensing nozzles and vapor recovery hoses to collect gasoline vapors at service stations during vehicle refueling. Virginia also adopted regulations limiting the VOC content of a variety of commercial and consumer products, further reducing VOC emissions.



VOC emissions are projected to decrease slightly from 2005 to 2009. Slight decreases in area source emissions are expected due to more stringent VOC content limits for consumer products and improved portable fuel containers that reduce evaporation and spillage. Reductions are also projected for onroad vehicles as older, less efficient vehicles are replaced by newer, cleaner vehicles with more effective emission controls and greater fuel economy.

Sulfur Dioxide (SO_2) Emission Trends

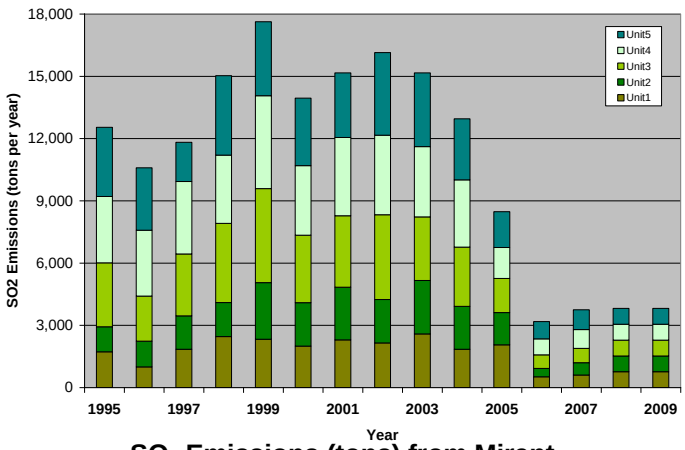
Trends in SO_2 emissions in the City of Alexandria are shown below. Nearly all of the SO_2 emissions in the City are generated by the coal-fired Mirant Potomac River Generating Station. In addition, a small amount SO_2 is generated by combustion of fossil fuels in residential/ commercial/ industrial heating units.

SO_2 Emission Trends (tons/year), 1990-2009, City of Alexandria

Sector	1990	1993	1996	1999	2002	2005	Projected in 2009
Point	13,770	12,310	10,850	17,747	16,145	8,516*	3,850
Area	1,232	954	676	719	638	659	686
Nonroad	33	35	37	42	10	10	3
Onroad	203	166	129	93	79	21	12
	15,238	**13,465**	**11,692**	**18,601**	**16,872**	**9,206**	**4,551**

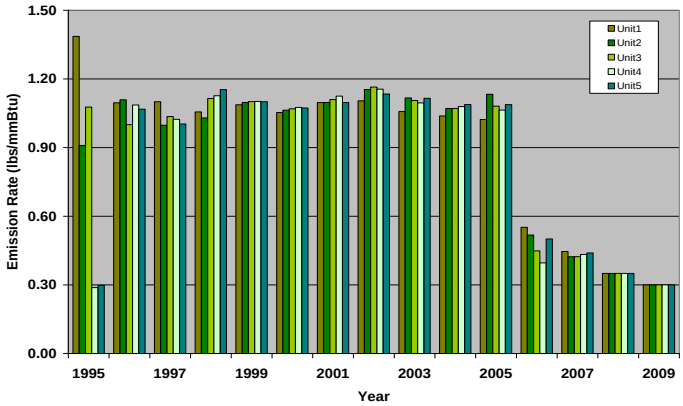
* Point source emissions were abnormally low in 2005 because the Mirant Potomac River Generating Station was partially shut down and the amount of coal consumed at the plant was about 40% lower than in a typical year.

From 1995 to 2005, SO_2 emissions from have fluctuated because of year-to-year differences in the amount of electricity generated at the Mirant plant in response to variability in both demand and supply. But while the amount of coal combusted (and hence SO_2 emissions) during the 1995 to 2005 period varied from 8,476 to 17,627 tons per year. During the 1995 to 2005 period, the rate that SO_2 was emitted was relatively constant, averaging about 1.1 pounds per million Btu.



SO_2 Emissions (tons) from Mirant

Beginning in 2005, Mirant started injecting Trona into the exhaust gas to reduce SO_2 emissions. Trona is a naturally occurring mineral similar to baking soda that reacts with the gaseous SO_2 to form a particle which is removed from the exhaust gas by existing emissions control equipment and collected with the ash. Trona reduces the emission rate by about 75%. The 2008 permit for Mirant limits annual emission to 3,813 tons per year with an emission rate of 0.30 lbs per million BTU.



SO_2 Emission Rate (lbs/mmBtu) for Mirant

Particulate Matter (PM_{10}) Emission Trends

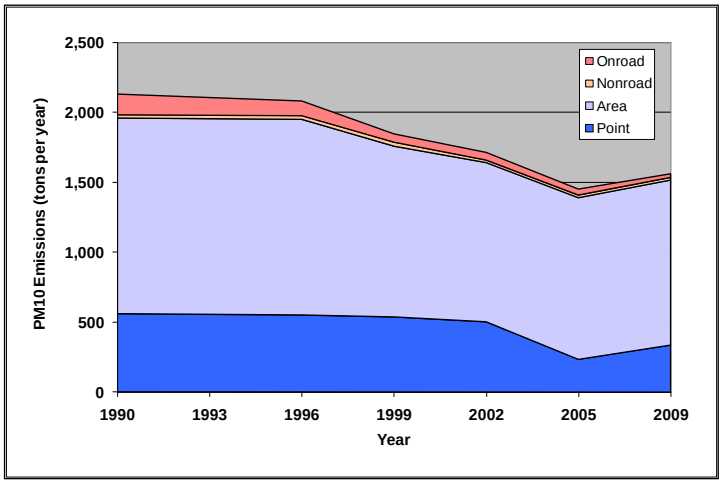
Trends in PM_{10} emissions in the City of Alexandria are shown below. In 2005, the largest sources of PM_{10} emissions in the city were area sources, including dust particles generated at construction sites and from vehicle traffic on city streets. Construction activities generated about 42% of the city-wide PM_{10} emissions, while dust from paved roadways accounted for another 24% of the city-wide PM_{10} emissions.

PM_{10} Emission Trends (tons/year), 1990-2009, City of Alexandria

Sector	1990	1993	1996	1999	2002	2005	Projected in 2009
Point	563	558	554	540	505	236*	338
Area	1,398	1,398	1,398	1,221	1,138	1,156	1,180
Nonroad	25	26	28	30	19	19	19
Onroad	149	127	106	60	55	43	26
	2,135	**2,109**	**2,086**	**1,851**	**1,717**	**1,454**	**1,563**

* Point source emissions were abnormally low in 2005 because the Mirant Potomac River Generating Station was partially shut down and the amount of coal consumed at the plant was about 40% lower than in a typical year.

PM_{10} emissions have decreased between 1990 and 2005. Point source emissions were abnormally low in 2005 because the Mirant Potomac Rive r Generating Station was partially shut down and the amount of coal consumed at the plant was about 40% lower than in a typical year. Area source emissions have decreased slightly from 1990 to 2002 due to decreases in emissions from residential wood combustion and construction activity. PM_{10} emissions from onroad and offroad engines have also decreased due to new engine technologies and cleaner fuels.



The long term trend shows that PM_{10} emissions are projected to continue to decrease in 2009. Actual emissions from Mirant are expected to be lower in 2009 than in 1999 or 2002 due to a more stringent permit limit and agreement with the City government to further control stack and fugitive $PM_{2.5}$ emissions. Actual emissions from Mirant are expected to be higher in 2009 than in 2005 because the plant will be operating at a higher rate than in 2005 when the plant was partially shut down.

Particulate Matter ($PM_{2.5}$) Emission Trends

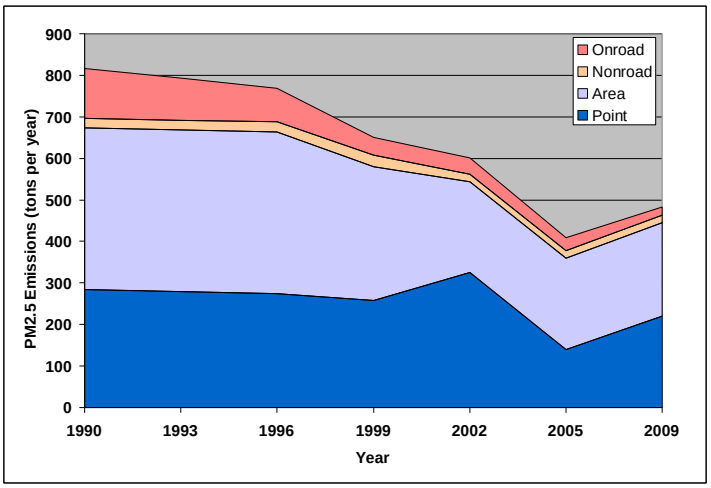
Trends in $PM_{2.5}$ emissions are shown below. In 2002, the largest source of $PM_{2.5}$ emissions was the Mirant Potomac River Generating Station. In 2002, Mirant emitted approximately 54% the city's $PM_{2.5}$ total. Areas sources include combustion processes such as those occurring in onroad/offroad engines and residential/ commercial/ industrial heating units. Other area sources include dust particles generated at construction sites and from vehicle traffic on city streets.

$PM_{2.5}$ Emission Trends (tons/year), 1990-2009, City of Alexandria

Sector	1990	1993	1996	1999	2002	2005	Projected in 2009
Point	283	279	274	257	326	139*	220
Area	389	389	389	323	217	220	225
Nonroad	23	24	25	27	19	18	17
Onroad	120	101	81	43	39	31	20
	815	**793**	**769**	**650**	**601**	**408**	**482**

* Point source emissions were abnormally low in 2005 because the Mirant Potomac River Generating Station was partially shut down and the amount of coal consumed at the plant was about 40% lower than in a typical year.

$PM_{2.5}$ emissions have decreased between 1990 and 2005. Point source emissions were abnormally low in 2005 because the Mirant Potomac River Generating Station was partially shut down and the amount of coal consumed at the plant was about 40% lower than in a typical year. Area source emissions have decreased due to decreases in emissions from residential wood combustion and construction activity. $PM_{2.5}$ emissions from onroad and offroad engines have decreased due to new engine technologies and cleaner fuels.



Due to a more stringent permit limit and agreement with the City government requiring further control of stack and fugitive $PM_{2.5}$ emissions, future $PM_{2.5}$ emissions beyond 2009 are expected to be lower than the permitted level in 2009.

Particulate matter can be directly emitted into the air (referred to as primary PM) or it can be formed in the atmosphere (secondary PM) from the reaction of gaseous precursors such as NO_x, SO_2, VOC, and ammonia. Most observed ambient $PM_{2.5}$ matter in the Washington region originates from precursor gases. About 65% of the average annual composition of $PM_{2.5}$ in the ambient air in the Washington region is due to precursor emissions (sulfates form SO_2 and nitrates from NO_x). The remainder is directly emitted in the form of carbon, crustal material, and trace elements.

Toxic and Hazardous Air Pollutant Emissions

In addition to criteria air pollutants, there are hundreds of specific chemicals that may have acute human health risks, cancer or chronic (non-cancer) human health effects, and/or environmental effects. These pollutants are referred to as toxic or hazardous air pollutants. The two primary federal regulatory programs addressing toxic or hazardous air pollutants are:

- Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) requires certain facilities manufacturing, processing or otherwise using listed chemicals to report their environmental releases annually. The list of reportable chemicals was originally comprised of more than 300 individual chemicals and 20 chemical categories. In November 1994, USEPA issued a rule which added 286 new chemicals and chemical categories to the EPCRA section 313 list.
- The Clean Air Act regulates Hazardous air pollutants (HAPs) - those pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects. USEPA is required to control 188 HAPs such as benzene, which is found in gasoline; perchlorethlyene, which is emitted from some dry cleaning facilities; mercury, which is emitted from coal-fired power plants.

Note that nearly all HAPs are also reportable as TRI chemicals if the TRI reporting thresholds are exceeded. Two databases that contain information on toxic or hazardous pollutant emissions are the USEPA's Toxic Release Inventory and the USEPA's National Emission Inventory for Hazardous Air Pollutants (NEI-HAP). Information about emissions sources in Alexandria as reported to these to two databases are presented in the following subsections.

Toxic Release Inventory

USEPA's TRI program applies only to certain large point sources which manufacture, process, or use toxic chemicals above specified amounts. The Mirant PRGS is the only source in Alexandria that submits TRI reports. The TRI does not contain any information on toxic releases from small point, area, or mobile sources. Listed on the following page are the reported air releases from Mirant for the period 2001-2007. Reductions in 2005-2007 were due to the use Trona in the dry sorbent injection system (DSI). Trona reacts with acid gases (sulfuric acid and hydrochloric acid) to form a waste product that is removed from the exhaust gas by the plants particulate matter control system.

National HAP Inventory

Unlike criteria air pollutants, HAPs are not subject to the SIP process. Rather, USEPA was required to develop maximum achievable control technology (MACT) requirements for HAP stationary sources and to develop national regulations for controlling HAP emissions from highway vehicles and nonroad equipment. Emission inventories for HAPs are not routinely developed. To characterize HAP emissions from all sources in Alexandria, we extracted data from USEPA's 2002 National Emission Inventory (NEI). USEPA developed the NEI to support its rule development efforts. The NEI includes all 188 HAPs, including individual HAPs reported for compound groups listed in the Clean Air Act, for all source category sectors. Listed on the following page are the 2002 NEI HAP emissions for sources in Alexandria.

Mirant Toxic Air Emissions (tons/year) as Reported in the TRI from 2003 to 2007

Toxic Chemical	2003	2004	2005	2006	2007
Barium Compounds	0.7	0.4	0.3	0.1	0.0
Chromium Compounds	0.2	0.1	NR	NR	0.0
Copper Compounds	0.1	0.1	0.1	NR	0.0
Hydrochloric Acid	1,280.0	1,131.0	747.5	6.8	8.7
Hydrogen Fluoride	46.9	41.4	27.4	4.7	6.0
Lead Compounds	0.1	0.1	0.1	0.0	0.0
Manganese Compounds	0.2	0.1	0.1	NR	0.0
Mercury Compounds	0.0	0.0	0.0	0.0	0.0
Nickel Compounds	0.2	0.1	NR	NR	NR
Sulfuric Acid	45.7	39.1	15.5	6.0	7.0
Vanadium Compounds	0.3	0.2	0.1	0.0	0.0
Zinc Compounds	0.4	0.2	NR	NR	NR
Total	**1,374.7**	**1,212.9**	**790.9**	**17.6**	**21.9**
Dioxin and Dioxin-Like Compounds are Reported in grams, not tons					
Dioxin and Dioxin-Like Compounds	0.183	0.159	0.105	NR	0.113

NR – Chemical was not reported by Mirant to TRI for that year

City of Alexandria Hazardous Air Pollutant Emissions (tons/year) for 2002

HAP	Mirant PRGS	Covanta Plant	Area Sources	Onroad Mobile Sources	Nonroad Mobile Sources	Total All Sectors
2,2,4-trimethylpentane	0	0	3.3	36.9	11.6	51.9
Benzene	0.6	0	45.5	33.6	12.0	91.7
Formaldehyde	0.1	0.3	1.1	16.8	5.6	23.8
Hexane	0.032	0	5.2	9.5	5.6	20.3
Hydrochloric Acid	572.9	14.2	287.7	0	0	874.8
Hydrogen Fluoride	71.6	0	35.7	0	0	107.3
Lead	0.006	0.165	0.096	0	0.0009	0.27
Mercury	0.036	0.003	0.002	0	0	0.042
MTBE	0.02	0	24.1	41.9	62.6	128.6
Nickel	0.14	0.52	0.3	0.0036	0.2	1.2
Toluene	0.12	0	34.8	85.3	28.2	148.4
Xylenes	0.18	0	34.6	49.3	29.9	113.9
Other HAPs	4.3	0.14	91.1	28.2	15.9	139.6

Mirant Potomac River Generating Station

Mirant Potomac River, LLC (Mirant) owns and operates the Potomac River Generating Station (PRGS) in the City of Alexandria. The PRGS is a coal-fired electric generating plant with a generating capacity of 482 megawatts. It is the largest industrial facilities in Alexandria. Constructed in 1949, the plant had not undergone major upgrades to improve air quality since the 1970s. There were continuing concerns about outdated emissions control equipment, short boiler stacks, and the health impacts on the local community from its emissions.

In June 2004, the Alexandria City Council passed a resolution calling for clean up of the plant in the short term and closure in the long term. Also in 2004, the City Council established the Mirant Community Monitoring Group (MCMG) to monitor on-going operations at the plant and work to address the health and environmental issues resulting from its pollutant emissions.

In late 2004, a group of citizens identified the "downwash" issue that resulted in exceedingly high concentrations of SO_2 near the plant under certain atmospheric conditions - concentrations that exceed the NAAQS health-based limits. The City dedicated resources to engage in discussions with the Virginia DEQ, USEPA, and different level of government pushing for health-protective emission limits to ensure compliance with the NAAQS.

In June 2007, the State Air Pollution Control Board issued a sulfur dioxide permit for this facility that included an annual limit of 3,813 tons of SO_2 per year – roughly a 75% reduction compared to the SO_2 emissions during the 2002-2004 time period.

On July 1, 2008, the City Council approved a settlement agreement between the City and Mirant. The approval followed a unanimous recommendation from the City's MCMG that the City approve the terms of the settlement agreement. The agreement represents significant progress toward the goals established in June 2004 by providing for the following actions:

- Requires the investment of $34 million by Mirant on new pollution control technology for $PM_{2.5}$ and PM_{10} emissions, including baghouses or a combination of modern technologies
- Imposes a $PM_{2.5}$ emission limit that complies with the NAAQS
- Requires Mirant to drop its legal challenge to the SO_2 annual emissions limit of 3,813 tons.
- Requires installation of CO and PM continuous emissions monitors.
- Gives the City access to the plant during the design and installation of the new controls, and to critical monitoring data including stack and ambient data.
- Requires immediate installation of additional fugitive dust controls.
- Requires installation and operation of an additional $PM_{2.5}$ ambient monitor.

On July 31, 2008, the VA DEQ issued Mirant a permit to operate the plant. This permit contains legally enforceable conditions consistent with the above settlement agreement. City staff is closely monitoring Mirant's operations to ensure compliance with the permit conditions. Mirant is also required to comply with the Clean Air Interstate NO_x ozone season and annual NOx limitations beginning in 2009.

Covanta Energy-from-Waste Facility

Since February 1988, Alexandria's residential trash has been delivered to the Covanta Energy-from-Waste Facility at 5301 Eisenhower Avenue. The waste is incinerated and the heat is converted into electricity and sold to the Dominion Virginia Power grid. The facility supplies enough electricity to power approximately 20,000 homes in Northern Virginia. The City of Alexandria and Arlington County co-own the energy-from-waste facility, which is operated under contract by Covanta Energy.

In response to Clean Air Act requirements, Arlington County funded a $45 million pollution control upgrade in 2000. The retrofit dramatically lowered emissions of both criteria and hazardous air pollutants (see table below). The air pollution control equipment improvements consisted of semi-dry flue gas scrubbers injecting lime, fabric filter baghouses, a nitrogen oxide control system, a mercury control system, and a continuous emissions monitoring (CEM) system. The facility operates under a Title V operating permit that sets emission limitations and all emissions parameters are measured continuously against those limits. The facility achieves emission results that are in compliance with the permitted levels.

Covanta Emission Levels Before and After 2000 Emission Control System Retrofit

Pollutant	Pre-Retrofit Concentration	Post-Retrofit Concentration	Percent Reduction
Lead	34.2 $\mu g/m^3$	1.9 $\mu g/m^3$	94.4%
NO_x	284 ppm	183.1 ppm	35.5%
PM	16.9 mg/m^3	1.8 mg/m^3	89.3%
SO_2	19.7 ppm	0.8 ppm	95.9%
Dioxins/Furans	66 ng/m^3	14.2 ng/m^3	78.5%
Hydrogen Chloride	175 ppm	1.8 ppm	99.0%
Mercury	106.2 $\mu g/m^3$	0.6 $\mu g/m^3$	99.4%

The Covanta energy-from-waste facility helps prevent climate change in several ways:

- **Avoids Landfill GHG Emissions** – the facility avoids methane production that would occur if the trash was sent directly to a landfill.
- **Avoids Fossil Fuel GHG Emissions** – the facility generates cleaner energy and reduces the amount of electricity generated from fossil fuels.
- **Avoids Raw Material Mining GHG Emissions** – By recovering steel from the waste stream, the facility reduces the quantity of fossil fuels and energy used for mining and manufacturing raw materials.

It is estimated that for every ton of trash combusted, nearly one ton less of carbon dioxide equivalent is released into the air due to avoided methane from land disposal, fossil fuel power generation, and metals productions.

Virginia Paving Company

Typical Hot Mix Asphalt Plant

The Alexandria branch of the Virginia Paving Company produces asphalt for projects in and around the City of Alexandria and on projects such as the new Woodrow Wilson Bridge, the Springfield Interchange, I-395, and the Beltway. The Alexandria facility is a hot mix asphalt plant that was constructed prior to 1960. Hot mix asphalt is produced by heating and mixing liquid asphalt with various aggregates such as rocks, sand, and crushed recycled asphalt pavement. The facility maintains aggregate storage piles and operates aggregate handling equipment such as a crusher, front end loaders, conveyors and trucks. Aggregate is delivered primarily by rail cars, while some aggregate is delivered by trucks. The facility operates two hot oil heaters for liquid asphalt, and two drum dryer mixers (Plants No. 1 and 2) for producing hot mix asphalt. The final product is conveyed to asphalt storage silos for temporary storage prior to shipping off-site via trucks.

The City began to receive an increase in complaints at residential properties in the general vicinity of plant, initially regarding odors and later about soot, noise, smoke and air quality. In October 2004, the City undertook a comprehensive inspection of the plant and communicated concerns to plant regarding compliance with environmental, fire code and other items, as well as issues regarding night-time operations.

It was determined that night time operation was a violation of the existing Special Use Permit (SUP). As a result, Virginia Paving applied for and the City issued a revised SUP in November of 2006. The SUP amended the hours that vehicles could enter and exit the facility, and included 78 conditions to improve operational conditions at the facility, enhance environmental protection, and provide the City with the authority to enforce compliance with those conditions.

The SUP includes a series of improvements to reduce total emissions from the facility. These projects address not only the emissions from the drum dryer stacks, but also fugitive emissions from material transfer areas, and emissions from diesel powered machinery. Several of these pollution control projects were completed in 2007/2008 and are summarized below:

- Low NO_x burners installed on Plant 1 drum dryer mixers to reduce NO_x emissions; low NO_x burners were added to Plant 2 in 2006
- Blue smoke control technology for the Plant 1 silo tops in February 2007 and Plant 2 in 2008
- Asphalt storage tank vent condensers to reduce VOC emissions and odors
- Diesel particulate filters on all onsite diesel offroad equipment (e.g., Caterpillar loader, crane) to remove diesel particulate matter from the exhaust gas of a diesel engine
- Water sprays and enclosures on all material transfer points to minimize dust emissions

The City began routinely monitoring ambient air for particulate matter in 2006 at Armistead Boothe Park in Cameron Station. Monitoring is being conducted to measure the ambient PM_{10} concentrations. A comparison of the monitoring results with the NAAQS shows that the ambient PM_{10} concentrations measured at Cameron Station are well in compliance with the NAAQS.

SECTION 4 – GREENHOUSE GAS EMISSIONS

Global warming refers to an average increase in the earth's temperature that in turn, causes changes in the global climate. Most scientists agree that the observed increase in global temperature is attributable to rise in atmospheric concentrations of greenhouse gases (GHG) such as carbon dioxide, methane, nitrous oxides, and fluorinated gases. Human activities that contribute to the release of these gases are fossil fuel combustion, industrial processes, and agricultural byproducts.

In February 2005, Mayor Euille endorsed and signed the 2005 U.S. Mayors Climate Protection Agreement along with 278 other mayors from 43 states representing a total population of 48.5 million citizens. This agreement committed Alexandria to meet or exceed the Kyoto Protocol GHG reduction targets through the use of local land use planning, urban forest restoration, public outreach campaigns, and other reduction strategies.

In November 2005, the Sierra Club recognized the City of Alexandria as a "Cool City." Being designated as a "Cool City" means the City has committed to prepare a GHG emission inventory and a climate action plan with concrete steps for reducing GHG emissions.

In January 2007, the City initiated a strategic planning process called Eco-City Alexandria, in order to develop an *Eco-City Charter* (adopted June 2008) and *Environmental Action Plan* (adopted January 2009) to guide the city toward sustainability.

In 2008, the City joined ICLEI, a group of over 1000 local governments committed to advancing climate protection. The City uses ICLEI software and methodologies to create a GHG emissions inventory. The inventory is a critical first step in assessing the city's contribution to GHG emissions. It identifies the largest sources of GHG emissions, shows trends that may need correction, and provides City government and residents with information to inform policy decisions.

This section summarizes the results of two separate analyses: an inventory of all greenhouse gases emitted in the City of Alexandria and an inventory of just those emissions resulting from the operations of the Alexandria City government. The government inventory results represent a subset of the larger city-wide total. The City used ICLEI's *Local Government Operations Protocol* - a standardized set of guidelines to assist local governments in quantifying and reporting GHG emissions. The Clean Air and Climate Protection (CACP) software was also used to develop a greenhouse gas emissions inventory and forecast. The software translates data on energy use, transportation patterns, solid waste disposal, and other inputs into greenhouse gas emissions.

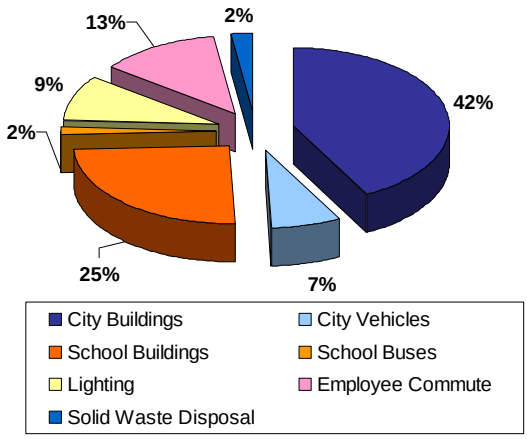
The full GHG emissions inventory report is available at: http://alexandriava.gov/tes

City Operations GHG Inventory

The City Government Operations inventory provides an estimate of GHG emissions produced by City government activities, including fuel use, electricity use, and waste production resulting from City government operations during the fiscal year 2006 baseline year.

In FY 2006, City government operations produced about 79,820 metric tons (tonnes) of greenhouse gas emissions, primarily from fossil fuel and electricity consumption in City buildings and schools. These emissions are a subset of the city-wide community total GHG emissions, representing approximately 3 percent of the city-wide total of 2.6 million tonnes.

The consumption of electricity and the combustion of natural gas in City buildings resulted in the majority of emissions in FY2006 - approximately 33,729 tonnes of CO_2e. School buildings were the second largest source and made up 25 percent of the total government CO_2e emissions. Gasoline fuel used by City employees commuting to work was the third largest category of emissions.



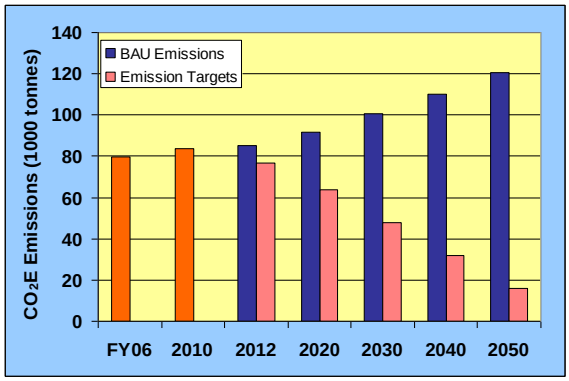
FY2006 (July 1, 2005 to June 30, 2006) Government CO_2e Emissions by Sector (79,820 tonnes)

A business-as-usual (BAU) emissions forecast scenario was developed for local government operations. Projections were made and emission reduction targets were set for the short-term (2010, 2012), medium term (2020, 2030), and long-term (2040, 2050). It was estimated that by 2020, if energy use continued to follow existing patterns, City government operations would result in approximately **91,767 tonnes**, or a 15 percent increase from the baseline year emissions.

The MWGOG Climate Change Steering Committee recommended goals to reduce regional greenhouse gases. These targets represent the consensus of U.S. scientists who say that greenhouse gas emissions must be reduced to avoid the consequences of global warming.

Year	MWCOG Proposed Reduction Target
2012	Reduce Business As Usual (BAU) Emissions by 10 Percent Below 2012 Levels
2020	20 Percent Below 2005 Levels
2050	80 Percent Below 2005 Levels

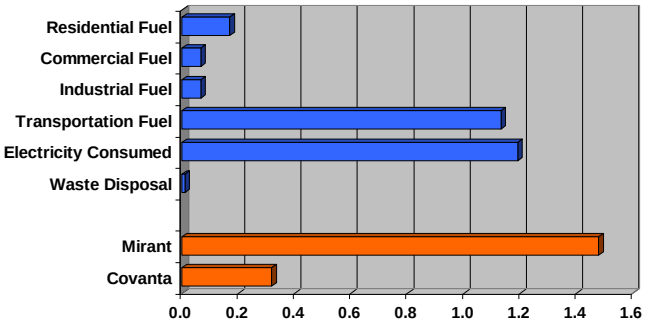
The City is considering using the MWCOG emission reduction percentage targets for reducing the City's government operations GHG emissions.



City Operations Emission Reduction Targets

Community GHG Inventory

The Community inventory includes emissions produced by residents, by businesses/agencies, and by commuters traveling within the city. It useful for public awareness and target setting to frame emissions based on energy consumption. The blue bars on the figure below show the GHG emissions for fossil fuel and electricity consumption, which totaled 2.6 million metric tons (tonnes) in 2005.

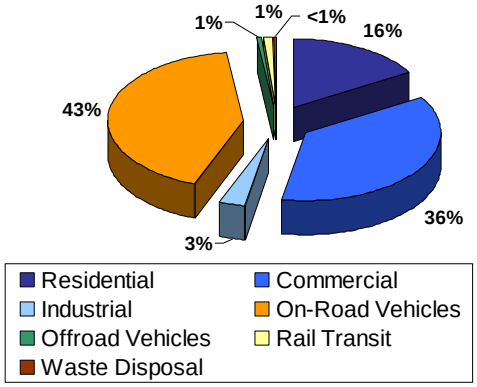


CY05 Community CO_2e Emissions (million tonnes)

Electricity is also generated in the city by the Mirant Potomac River Generating Station and the Covanta energy-from-waste plant. The orange bars in the graph above show the GHG emissions from electricity generation, which totaled 1.8
4 million tonnes in 2005. Some of this electricity is consumed within the city, while most is transmitted for sale in other areas. The total demand within the city therefore differs from the total generation.

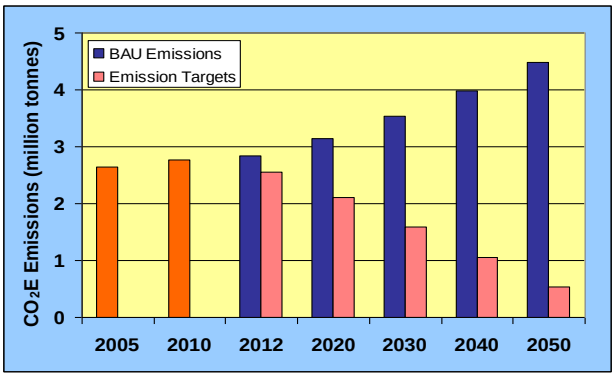
To avoid double counting, we have subtracted grid-based generation to assign responsibility for electricity usage to the end-user, which will help in targeting policies to reduce emissions. Using this formula, the GHG consumption-based emissions in 2005 were **2.6 million tonnes,** which does not include emissions from Mirant and Covanta because the City does not have the authority to control GHG emissions from these sources.

Onroad vehicle traffic in the city accounts for 43 percent of the 2.6 million tonnes. DASH buses are included in this total but are not accounted for separately. The operation of commercial and residential buildings account for 36 percent and 16 percent of the total, respectively.



CY05 Community Consumption-Based CO2e Emissions by Sector (2.6 million tonnes)

Future GHG emissions under a "business-as-usual (BAU)" scenario were developed to account for the anticipated growth in energy consumption resulting from projected growth in population, employment, and vehicle traffic. The City government is considering using the MWCOG emission reduction percentage targets for reducing the city's community-wide GHG emissions.



Community-Wide Consumption-Based Business-as-Usual Emissions and MWCOG Reduction Targets

SECTION 5 – WHERE DO WE GO FROM HERE?

While air quality has improved considerably over the past three decades, the City now faces additional challenges in the form of a new, stricter federal ozone, fine particulate matter, and lead air quality standards. And emerging issues – such as climate change – present real and urgent threats to the environmental and economic sustainability of the community. The City is committed to doing its share to continue to improve air quality, reduce greenhouse gas emissions, and move the city towards sustainability. This section describes some the activities the City will undertake to meet its air quality and climate change commitments.

The Environmental Action Plan

The Alexandria City Council approved the Eco-City Alexandria Environmental Charter at a public hearing on Saturday, June 14, 2008. The Eco-City Environmental Charter outlines the City's guiding principles, vision, and overall environmental future. The Charter established 10 guiding principles to provide a systematic and integrated approach to sustainability. Two principles directly address air quality and climate change.

ECO-CITY ALEXANDRIA

Principle: Air Quality

"Alexandria faces significant challenges in improving air quality including those presented by emissions from vehicles, older industrial facilities, and the regional transport of air pollution. Given that one in eight residents has a respiratory illness, the City should influence and control emission sources in a manner that reflects the choices and wishes of the community."

Principle: Global Climate Change and Other Emerging Threats

"Alexandria must be adaptive and responsive to emerging and unforeseen environmental threats – such as climate change – that could strain infrastructure, deplete natural resources, disrupt the economy, and threaten public health. Failure to respond quickly and appropriately to such threats will likely have severe consequences for the health and economy of Alexandria and its citizens. "

Environmental Action Plan
Phase I (FY2009 – FY2011)
Adopted January 24, 2009

Alexandria's Environmental Action Plan (EAP) serves as the road map for City leaders, staff, and citizens to implement Alexandria's Eco-City Charter. The EAP establishes general policy goals, identifies specific action steps, sets tentative timelines and develops measures of success. The Phase One Action Plan includes goals and action steps that cover all ten principles of the Eco-City Charter. The goals and action items associated with air quality and climate change are listed on the following page. Actions flagged with an "*" denotes work already in progress.

Air Quality and Global Climate Change Phase One Goals and Action Items

Air Quality Goal 1: **Improve ambient air quality**	**Air Quality Goal 2:** **Reduce off-road/mobile emissions by promoting more environmentally efficient lawn care and construction equipment**
Action 1: Continue efforts to comply with NAAQS to reduce exposure to ambient air pollution.* Action 2: Continue existing compliance efforts with major point sources to reduce air pollution.* Action 3: Produce an easy-to-read publication that detail existing emission inventory data on stationary source emissions in the City.* Action 4: Continue/expand education for City staff in the use of City vehicles/equipment by establishing an Air Quality Action Day Plan for City operations.* Action 5: Post "NO IDLING" educational signs at or near Metro or other drop-off locations and transportation hubs where idling is prevalent. Action 6: Encourage the development of a Green Taxi fleet by setting tight miles per gallon standards for new vehicles.	Action 1: Convene a work group of City staff and equipment providers/businesses to discuss the pending U.S. Environmental Protection Agency (EPA) regulation of two- and 4-stroke engines, with the long-term goal of banning the sale and use of gas-powered garden equipment. Action 2: Educate citizens on the environment impacts of old lawn/mobile equipment using existing City and community outreach activities and publications (e.g., FYI, web sites, civic association newsletters, etc.).
Climate Change Goal 1: **Adopt targets for reducing greenhouse gas emission reductions for 2012 and 2020**	**Climate Change Goal 2:** **Institutionalize the consideration of the effects of possible climate changes into long-term planning**
Action 1: Adopt the proposed greenhouse gas emission reduction targets outlined in the MWCOG's July 2008 draft Climate Change Report.* Action 2: Continue to inventory greenhouse gas emissions within the city using ICLEI computer program and finalize the emission reduction targets.* Action 3: Assign the Environmental Coordinating Group (ECG) to propose methods to achieve the emission reduction targets and to begin drafting a Climate Action Plan that will include exploring methods for making the targets binding.	Action 1: The City shall carry out a risk analysis of the effects of global warming on Alexandria. Action 2: Empower the ECG to develop adaptation planning strategies within the city.
Climate Change Goal 3: **Prepare and educate city residents and business owners for a carbon-constrained economy**	**Climate Change Goal 4:** **Develop a strategic planning process for improving and maintaining environmental quality**
Action 1: The City will disseminate educational materials on the causes of climate change, how people can reduce their climate impact, and how greenhouse gas reduction policies may affect the availability and prices of energy and other goods. Action 2: The City Council will emphasize the benefit of increasing development density as a method for reducing greenhouse gas emissions in its discussions with citizens and business.	Action 1: City management, staff, Environmental Policy Commission (EPC) members, and others will begin to regularly participate in long-term (i.e. 5, 20, and 50 years) planning activities such as scenario exercises and retreats. Action 2: Continue institutional and funding support for the Eco-City process, including maintaining a collaborative relationship between the City, EPC, Virginia Tech, and the public to secure the advancement of the principles agreed to and adopted in the Eco-City Charter.*

Alexandria's Environmental Policy Commission (EPC) has been working with city staff, with assistance from Virginia Tech's Urban Planning Program, to design the strategic planning process and the content for the city's new EAP, which was divided into two phases:

- Phase One is a preliminary action plan that includes existing programs and those actions that can be taken between now and the end of Fiscal Year 2011 (June 30, 2011);
- Phase Two is to be completed by the end of the current fiscal year (June 2009) and will include mid-term and longer range environmental programs and action steps that would start in Fiscal Year 2012 (July 1, 2011).

The Office of Environmental Quality will be closely involved in further developing and implementing the EAP, as well as continually monitoring results to determine whether actions are being executed and goals are being achieved.

Local Climate Action Plan

In 2009, the City will be drafting a Climate Action Plan with public input from stakeholders. The Plan will detail the policies and measures that the City will take to reduce greenhouse gas emissions and achieve its emissions reduction target. The plan will include a timeline, establish goals, and assign responsibility to departments and staff. The Climate Action Plan will feed into the City's Environmental Action Plan and include mid-term and longer range programs and action steps. The City's plan will consider the recommendations in the MWCOG's *Climate Change Report* as well as the *Virginia Climate Change Action Plan* and the *Virginia Energy Plan*.

Revised, More Health-Protective NAAQS

The 8-hour ozone NAAQS was revised in March 2008 from 0.08 ppm to 0.075 ppm based on a three-year average of the annual fourth highest daily maximum 8-hour average reading at each monitoring location. States are to recommend to USEPA which areas will not attain the 0.075 ppm ozone NAAQS by March 2009. The Metropolitan Washington area (which includes Alexandria) is likely to be classified as a nonattainment area for ozone. USEPA will propose nonattainment areas in the summer of 2009 and finalize nonattainment areas in March 2010. A SIP for the 2008 ozone NAAQS will be due in March 2013, 2014, or 2016, depending on the designation date and severity classification. City staff will work with the Metropolitan Washington Air Quality Committee (MWAQC) in preparing the new ozone SIP.

The NAAQS for fine particulate matter (particles with a diameter less than 2.5 micrometers – known as $PM_{2.5}$) includes an annual limitation of 15 micrograms per cubic meter ($\mu g/m^3$) set in 1997 and a daily limitation of 35 $\mu g/m^3$ set in 2006. A SIP demonstrating attainment of the annual $PM_{2.5}$ NAAQS for the Washington Metropolitan area was submitted to USEPA in April 2008. On January 12, 2009, the USEPA determined that region has attained the 1997 annual $PM_{2.5}$ NAAQS, based on air quality data for 2004 to 2008. As a result, the requirements to submit a SIP will be suspended as long as the region continues to attain the 1997 annual standards.

In December 2006, USEPA revised the 24-hour NAAQS for $PM_{2.5}$ from 65 to 35 µg/m^3. On December 7, 2007, VA DEQ urged USEPA to classify all of Virginia as an attainment area for this standard. In December 2008, USEPA determined that all of Virginia attained the revised 2006 24-hour NAAQS for $PM_{2.5}$.

On October 15, 2008, USEPA substantially strengthened the NAAQS for lead. The revised standards are 10 times tighter than the previous standards and will improve health protection for at-risk groups, especially children. USEPA revised the level of the primary (health-based) standard from 1.5 µg/m^3 to 0.15 µg/m^3. USEPA may require the City to operate a monitor to gather information on the general population's exposure to lead in air and ensure protection against sources of airborne dust containing lead. New monitoring, if required, will begin in 2010. Monitoring and other data will be used to identify nonattainment areas. If Alexandria is determined to be nonattainment, a SIP will be required no later than June 2013.

Stationary Source Compliance Tracking

The City has recently worked to significantly improve the air pollution control systems at major stationary sources, particularly the Mirant Potomac River Generating Station and the Virginia Paving asphalt plant. This work resulted in new permits with numerous conditions that include specific completion dates for pertinent projects and improvements. The Office of Environmental Quality will be closely monitoring compliance with these permit conditions over the next several years to ensure that the expected results are achieved according to the agreed upon schedules. City Staff will also be involved in reviewing State permitting activities, stack testing and continuous emission monitoring data, and ambient air quality data near these facilities.

Air Quality Action Day Program

The City will continue the "Air Quality Action Days" program, a voluntary public outreach program aimed at changing individual behavior to reduce ozone and particulate matter pollution. As a participant, City staff is notified by 4 p.m. the day before an Air Quality Code Red Day - an unhealthful air day - to encourage employees to use an alternative form of transportation the following day. Additionally, e-mail notifications are sent to all City employees and City Council on the afternoon before the Air Quality Action Day. This notification has the recommended do's and don'ts for Air Quality Action Days.

Notifications are also sent to Clean Air Partners who are encouraged to consider modifying their company operations (such as limiting painting, mowing, etc.) when Air Quality Action Days are in effect. Employers are also asked to inform employees and customers about individual actions they should take to reduce the release of VOCs, NO_x and particulate matter, especially during the hottest parts of the day. Some participants fly Air Quality Action Day flags at their places of business.

In 2001, the City received the Metropolitan Washington Region Government Program of the Year award for it air quality action day program. The number of air quality action days is expected to rise in 2009 due to the more stringent ozone standard that was issued by USEPA in March 2008 – effectively changing the ozone standard from a level of 0.084 ppm to 0.75 ppm.

What You Can Do to Reduce Air Pollution and GHG Emissions

Air pollution is a problem for all of us. The average adult breathes about 3,400 gallons of air a day. Children are at greater risk because they are more active outdoors and their lungs are still developing. The elderly are also more sensitive to air pollution because they often have heart or lung disease. Although much of the pollution in our air comes from power plants, industrial sources and motor vehicles, the choices that individuals make every day can increase or decrease air pollution. Alexandria's citizens have the power to change home, transportation, and consumer habits to help reduce air pollution. More information and specific actions can be found at the USEPA website http://www.epa.gov/air/actions and are summarized in Appendix C.

Individuals also release greenhouse gases as a result of using energy to drive, using electricity to light and heat homes, and through other activities that support the quality of life like growing food, raising livestock and throwing away garbage. Greenhouse gas emissions can be reduced through simple measures like changing light bulbs and properly inflating tires. The USEPA Climate Change website: http://www.epa.gov/climatechange/wycd/index.html provides over 25 easy steps that individuals can take to not only reduce greenhouse gas emissions, but also reduce air pollution, increase the nation's energy independence and save money. Appendix D summarizes these actions.

Appendix E identifies additional websites and reports related to general information related to air pollution and climate change. The City's Office of Environmental Quality's website http://alexandriava.gov/tes/oeq also provides additional information on the City's air quality and climate change programs.

GLOSSARY OF TERMS

This glossary provides definitions of terms pertaining to the laws, regulations, programs, and government agencies involved in assuring healthful air quality for Alexandria's citizens. Moreover, this glossary explains some of the scientific terms used to describe air pollutants, the processes that form them, and their effects on the environment and the population.

Acid rain: Sulfur dioxide (SO_2) and nitrogen oxides (NO_x), along with other chemical compounds, are released during the combustion of fossil fuels. When these gases react in the atmosphere with water, oxygen, and other chemicals, they form acidic compounds. Sunlight increases the rate of most of these reactions. The resulting substances are wet (acid rain, snow, or fog) or dry (acidic gases or particulates) and may drift far from the original source before falling to the earth. The negative effects of these acidic deposits include damage to forests, soil, and aquatic ecosystems, damage to infrastructure and human health, and reduced visibility.

Adverse Health Effect: A health effect from exposure to air contaminants that may range from relatively mild temporary conditions, such as eye or throat irritation, shortness of breath, or headaches, to permanent and serious conditions, such as or damage to lungs, heart, or other organs, hospital admissions, or premature death.

Air Pollution Transport: A term commonly applied to the movement of air pollution across jurisdictional boundaries such as state borders. Pollution transport may range from 100 to more than 600 miles in the mid-Atlantic. Transported air pollution from large emission sources to the west and south of Alexandria is a significant factor in efforts to achieve attainment of ambient air quality standards.

Air Quality Index (AQI): A color coded and numerical index used for reporting severity of air pollution levels to the public. The higher the index, the higher the level of pollutants and the greater the likelihood of health effects.

Attainment Area: A geographical area identified to have air quality as good as, or better than, the national ambient air quality standards (NAAQS). An area may be an attainment area for one pollutant and a nonattainment area for others.

Carbon Dioxide (CO_2): Carbon dioxide is a greenhouse gas that enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement). Carbon dioxide is also removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.

Carbon Dioxide Equivalent (CO_2e): This is a common unit for combining emissions of greenhouse gases with different levels of impact on climate change. It is a measure of the impact that each gas has on climate change and is expressed in terms of the potency of carbon dioxide. For carbon dioxide itself, emissions in metric tons of CO_2 and metric tons of CO_2e are the same, whereas for nitrous oxide and methane, stronger greenhouse gases, one tonne of emissions is equal to 310 tonnes and 21 tonnes of CO_2e respectively.

Clean Air Act (CAA): A federal law passed in 1970 and amended in 1974, 1977 and 1990 which forms the basis for the national air pollution control effort. Basic elements of the act include national ambient air quality standards, mobile and stationary control measures, air toxics standards, acid rain control measures, and enforcement provisions.

Climate Change: A term that refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). The term climate change is often used interchangeably with the term global warming, but according to the National Academy of Sciences, "the phrase 'climate change' is growing in preferred use to 'global warming' because it helps convey that there are changes in addition to rising temperatures."

Criteria Pollutants: A group of common air pollutants regulated by the USEPA. These pollutants are carbon monoxide, lead, nitrogen oxide, ozone, particulates and sulfur dioxide.

Conformity: A process to assess the consistency of any transportation plan, program or project with State air quality implementation plans. The transportation conformity process is defined by the Clean Air Act, and implemented by 40 CFR 51 and 93.

Covanta Energy-from-Waste Facility: The Resource Recovery Facility which began commercial operation in February 1988 and serves about 300,000 residents of the County of Arlington and the City of Alexandria, which jointly own the site. The facility's three, 325 ton-per-day furnaces process 975 tons of non-hazardous municipal and commercial solid waste, generating up to 23 megawatts of renewable energy that is sold to Dominion Virginia Power Company.

Department of Transportation and Environmental Services (T&ES): The City Department responsible for multimodal transportation services and facilities and protection and enhancement of natural environment to improve the quality of life for those who live in, work in, and visit the City of Alexandria." T&ES is responsible for the engineering, design, construction, inspection, surveying and maintenance of streets, bridges, sewers, fire hydrants and traffic control mechanisms. The department also oversees environmental regulation and management, including air and water quality, transit and refuse and recycling collection

Environmental Policy Commission (EPC): The City Commission established in 1970 under Chapter 4, Article M, of the City Code to "advise and make recommendations to the City Council and, where appropriate, to the Planning Commission and City Manager." The EPC advises and makes recommendations on matters relating to the following: clean air; land use; Noise pollution and abatement; pesticides, herbicides and contaminants; solid waste; water quality and supply; and other matters referred to the EPC by the City and citizens relating to the conservation and protection of Alexandria's environment. The EPC consists of 13 members, including five members from the field of environmental sciences, five citizen-at-large members, one member from the field of urban planning, one student attending high school in the City of Alexandria and one member with experience in Federal or state environmental statues, regulations, and procedures. The Commission is supported by the City of Alexandria Department of Transportation and Environmental Services (T&ES), Office of Environmental Quality.

Fluorinated Gases: Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances (i.e., CFCs, HCFCs, and halons). These gases are typically emitted in smaller quantities, but because they are potent greenhouse gases.

Global Warming: A term describing the average increase in the temperature of the atmosphere near the Earth's surface which can contribute to changes in global climate patterns.

Greenhouse Gases: Any of the atmospheric gases that contribute to the greenhouse effect by absorbing infrared radiation produced by solar warming of the Earth's surface. They include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_2), fluorinated gases, and water vapor. Although greenhouse gases

occur naturally in the atmosphere, the elevated levels especially of carbon dioxide and methane that have been observed in recent decades are directly related, at least in part, to human activities such as the burning of fossil fuels and the deforestation of tropical forests.

Maintenance Area: Any geographic region of the United States previously designated nonattainment pursuant to the CAA Amendments of 1990 and subsequently redesignated to attainment subject to the requirement to develop a maintenance plan under section 175A of the CAA, as amended.

Methane (CH4): Methane is a greenhouse gas emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.

Metropolitan Washington Air Quality Committee (MWAQC): The entity certified by the mayor of the District of Columbia and the governors of Maryland and Virginia to prepare an air quality plan for the DC-MD-VA Metropolitan Statistical Area under Section 174 of the federal Clean Air Act Amendments of 1990.

Metropolitan Washington Council of Governments (MWCOG): The regional planning organization for 21 Washington area governments, including Alexandria. MWCOG works to resolve regional problems such as growth, transportation, air pollution, water supply, water quality, economic development, and other environmental issues.

Mirant Potomac River Generating Station: The electric generating facility originally built in 1949 located along the Potomac River in the northeast corner of Alexandria. The plant operates five coal-fired boilers capable of generating 482 megawatts of electricity and providing base load, intermediate and peak level generation. Other processing equipment includes the coal receiving/storage area, pollution control equipment, ash disposal processing, and other equipment necessary to generate electricity. Mirant acquired the Potomac River Generating Station from PEPCO in 2000.

National Ambient Air Quality Standards (NAAQS): Standards established by the USEPA that apply for outdoor air throughout the country. There are two types of NAAQS. Primary standards set limits to protect public health and secondary standards set limits to protect public welfare.

Nitrogen Oxides (Oxides of Nitrogen, NO_x): A general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO_2) and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes, and are major contributors to smog formation and acid deposition.

Nitrous Oxide (N2O): Nitrous oxide is a greenhouse gas emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.

Nonattainment Area: a geographic area in which the level of a criteria air pollutant is higher than the level allowed by the federal standards. A single geographic area may have acceptable levels of one criteria air pollutant but unacceptable levels of one or more other criteria air pollutants: thus, an area can be both attainment and nonattainment at the same time. It has been estimated that 60% of Americans live in nonattainment areas.

Office of Environmental Quality (OEQ) – An office within T&ES responsible for monitoring and maintaining environmental quality thus preserving and protecting public health and welfare and the environment.

Ozone: Ozone can be either good or bad for living things, depending upon where it is located. However, an ozone layer that exists naturally in the stratosphere keeps out most of the dangerous ultraviolet rays from the sun that can cause health and environmental problems. Ground level ozone is a principal component of smog and can cause adverse health effects. Ozone is a unique emission because it is not directly produced by human sources. Instead, it is created as a result of chemical reactions between human-produced emissions and other gases in the atmosphere. Ground level ozone is typically created in the summer months when VOCs and NO_x react with other atmospheric gases in the presence of strong sunlight.

Particulate matter (PM, PM_{10}, $PM_{2.5}$): Air pollution consisting of very small liquid and solid particles floating in the air. Of greatest concern to public health are the particles small enough to be inhaled into the deepest parts of the lung. These particles are less than 10 microns in diameter - about 1/7th the thickness of the a human hair and are known as PM_{10}. This includes fine particulate matter known as $PM_{2.5}$, the fraction of particulate matter that penetrates most deeply into the lungs.

Regional Haze: The haze produced by a multitude of sources and activities which emit fine particles and their precursors across a broad geographic area. National regulations require states to develop plans to reduce the regional haze that impairs visibility in national parks and wilderness areas.

Smog: A combination of smoke, particulates, ozone, and other chemically reactive compounds which, under certain conditions of weather and sunlight, may result in a murky brown haze that causes adverse health effects.

State Implementation Plan (SIP): a detailed description of the programs a state will use to carry out its responsibilities under the Clean Air Act. State implementation plans are collections of the regulations used by a state to reduce air pollution. The Clean Air Act requires that USEPA approve each state implementation plan. Members of the public are given opportunities to participate in review and approval of state implementation plans. SIPs include the technical foundation for understanding the air quality (e.g., emission inventories and air quality monitoring), control measures and strategies, and enforcement mechanisms.

Virginia Department of Environmental Quality (VA DEQ): VA DEQ, though it's Division of Air Quality, is responsible for carrying out the mandates of the Virginia Air Pollution Control Law, as well as meeting Virginia's federal obligations under the federal Clean Air Act.

Virginia Paving Company: The hot mix asphalt plant located in the southwest corner of Alexandria that produces asphalt for projects in and around the City of Alexandria and on projects such as the new Woodrow Wilson Bridge, the Springfield Interchange, I-395, and the Beltway.

Visibility: A measurement of the ability to see and identify objects at different distances. Visibility reduction from air pollution is often due to the presence of sulfur and oxides of nitrogen, as well as particulate matter.

Volatile Organic Compounds (VOCs): Carbon-containing compounds that evaporate into the air (with a few exceptions). VOCs contribute to the formation of smog and/or may be toxic. VOCs often have an odor, and some examples include gasoline, alcohol, and the solvents used in paints.

Appendix A – National Ambient Air Quality Standards

Pollutant	Primary Standards		Secondary Standards	
	Level	Averaging Time	Level	Averaging Time
Carbon Monoxide (CO)	9 ppm (10 mg/m^3)	8-hour [a]	None	
	35 ppm (40 mg/m^3)	1-hour [a]		
Lead (Pb)	0.15 µg/m^3 (2008 standard*)	rolling 3-month period	Same as Primary	
	1.5 µg/m^3 (1978 standard)	Quarterly Average	Same as Primary	
Nitrogen Dioxide NO_2	0.053 ppm (100 µg/m^3)	Annual	Same as Primary	
Particulate Matter (PM_{10})	150 µg/m^3	24-hour [b]	Same as Primary	
Particulate Matter ($PM_{2.5}$)	15.0 µg/m^3	Annual [c]	Same as Primary	
	35 µg/m^3 (2006 standard**)	24-hour [d]	Same as Primary	
	65 µg/m^3 (old standard**)			
Ozone (O_3)	0.075 ppm (2008 standard***)	8-hour [e]	Same as Primary	
	0.08 ppm (1997 standard)	8-hour [f]	Same as Primary	
	0.12 ppm applies in limited areas	1-hour [g]	Same as Primary	
Sulfur Dioxide (SO_2)	0.03 ppm	Annual	0.5 ppm	3-hour [a]
	0.14 ppm	24-hour [a]		

(a) Not to be exceeded more than once per year.

(b) Not to be exceeded more than once per year on average over 3 years.

(c) To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m3.

(d) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m3 (effective December 17, 2006).

(e) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective May 27, 2008)

(f) (1) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.

(2) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as USEPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.

(g) (1) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is < 1.

(2) As of June 15, 2005 USEPA revoked the 1-hour ozone standard in all areas except the 8-hour ozone nonattainment Early Action Compact (EAC) Areas.

* The lead NAAQS was revised on November 12, 2008.

** The 24-hour $PM_{2.5}$ NAAQS became effective on December 17, 2006

*** The 8-hour ozone NAAQS became effective on May 27, 2008

Appendix B – References for Emission Inventory Data

Year	Source of Data
1990	U.S. EPA National Emission Inventory 1990, Criteria Pollutant Emissions Summary Files http://www.epa.gov/ttn/chief/net/critsummary.html (1990Tier3Summarymade09082005.txt) With adjustments for consistency of PM10/PM2.5 paved/unpaved road calculations and residential wood combustion.
1993	Interpolated Values from 1990 and 1996 data
1996	U.S. EPA National Emission Inventory 1996, Criteria Pollutant Emissions Summary Files http://www.epa.gov/ttn/chief/net/critsummary.html (1996Tier3Summarymade09082005.txt) With adjustments for consistency of PM10/PM2.5 paved/unpaved road calculations and residential wood combustion.
1999	U.S. EPA National Emission Inventory 1999, Criteria Pollutant Emissions Summary Files http://www.epa.gov/ttn/chief/net/critsummary.html (1999Tier3Summarymade09082005.txt) With adjustments for consistency of PM10/PM2.5 paved/unpaved road calculations.
2002 CO, NO_x, VOC	"Plan to Improve Air Quality in the Washington, DC-MD-VA Region. State Implementation Plan (SIP) for 8-Hour Ozone Standard", May 23, 2007. http://sharepoint.mwcog.org/airquality/Shared%20Documents/Forms/AllItems.aspx File Name: VA_2002 Point.Area.NR.OR.NIF3.0.zip
2002 PM_{10}, $PM_{2.5}$, SO_2	"Plan to Improve Air Quality in the Washington, DC-MD-VA Region. State Implementation Plan (SIP) for Fine Particle ($PM_{2.5}$) Standard and 2002 Base Year Inventory for the Washington DC-MD-VA Nonattainment Area", March 8, 2008. http://sharepoint.mwcog.org/airquality/Shared%20Documents/Forms/AllItems.aspx Appendix B - Base Year 2002 Emissions Inventory Files_02.21.08.zip
2002 HAPs	U.S. EPA National Emission Inventory 2002, Hazardous Air Pollutant Emissions Summary Files http://www.epa.gov/ttn/chief/net/2002inventory.html
2005 Point	Virginia DEQ http://www.deq.virginia.gov/air/emissions/inventory.html) 2005_criteria_emissions.xls
2005 Area, Onroad, Nonroad	Interpolated values from 2002 and 2009 COG ozone and PM2.5 SIP values.
2009 Point	$PM_{2.5}$, NO_x, SO_2 "Plan to Improve Air Quality in the Washington, DC-MD-VA Region. State Implementation Plan (SIP) for 8-Hour Ozone Standard", May 23, 2007. http://sharepoint.mwcog.org/airquality/Shared%20Documents/Forms/AllItems.aspx File Name: Appendix C 2009 Point Source Emissions Summary *No annual estimates for PM_{10}, CO, VOC - assumed to be same as 2005* Permit limits used for Mirant and 2005 actual emissions used for other sources.

Year	Source of Data
2009 Area, Nonroad	$PM_{2.5}$, NO_x, SO_2 "Plan to Improve Air Quality in the Washington, DC-MD-VA Region. State Implementation Plan (SIP) for 8-Hour Ozone Standard", May 23, 2007. http://sharepoint.mwcog.org/airquality/Shared%20Documents/Forms/AllItems.aspx File Name: Appendix D - Round 7.0a Cooperative Forecast Projections &2009 Area and Nonroad Source Emissions Summary VOC calculated by multiplying the 2002 emissions by the ratio of the 2009/2002 emissions for Virginia jurisdictions, as reported in Chapters 3 (2002 Base Year Inventory) and 4 (2009 Projected Uncontrolled and Controlled Inventories) of the 8-hr ozone SIP *No annual estimates for PM_{10}, CO - assumed to be same as 2005*
2009 Onroad	No annual estimates for City of Alexandria are available. $PM_{2.5}$, NO_x, and SO_2 calculated by multiplying the 2002 emissions by the ratio of the 2009/2002 emissions for Virginia jurisdictions, as reported in Chapters 3 (2002 Base Year Inventory) and 4 (2009 Projected Uncontrolled and Controlled Inventories) of the $PM_{2.5}$ SIP VOC calculated by multiplying the 2002 emissions by the ratio of the 2009/2002 emissions for Virginia jurisdictions, as reported in Chapters 3 (2002 Base Year Inventory) and 4 (2009 Projected Uncontrolled and Controlled Inventories) of the 8-hr ozone SIP *No annual estimates for PM_{10}, CO - assumed to be same as 2005*
Biogenics All Years VOC only	USEPA web-site (ftp://ftp.epa.gov/EmisInventory/2002finalnei/biogenic_sector_data/). USEPA has recommended that states use these emissions in case they do not have their own estimated biogenic emissions. Emissions assumed not to vary by year.

Appendix C – What You Can Do to Clean the Air

Reference: USEPA website http://www.epa.gov/air/actions

At Home

- Use compact fluorescent lights with energy-efficiency lighting and other energy-efficient appliances. To learn more about energy-efficient appliances visit the Energy Star web site.
- Turn off appliances and lights when you leave the room.
- Use the microwave to cook small meals. (It uses less power than an oven.)
- Plant deciduous trees in locations around your home to provide shade in the summer, but to allow light in the winter.
- Recycle paper, plastic, glass bottles, cardboard and aluminum cans. (This conserves energy and reduces production emissions.)
- Reuse materials like paper bags and boxes when you can.
- Properly dispose of household paints, solvents and pesticides. Store these materials in airtight containers. For information on handling solid waste visit the Office of Solid Waste Concerned Citizens webpage at http://www.epa.gov/epaoswer/osw/citizens.htm For questions about solid waste management call 1-800-424-9346.
- Paint with a brush, not a sprayer.
- Keep woodstoves and fireplaces well maintained.
- Purchase "Green Power" for you home's electricity. (Contact your power supplier to see where and if it is available.)
- Have leaky air conditioning and refrigeration systems repaired.
- Cut back on air conditioning and heating use if you can.
- Turn thermostat down in the winter and up in the summer.
- Insulate your home, water heater and pipes.
- Have air conditioning systems checked in the Spring and heating systems in the Fall.
- Follow professional advice on how to check filters monthly. These tips can save money from more serious repairs down the road as well as insure cleaner air.

Buy Smart

- Buy ENERGY STAR products, including cars and houses. They are environmentally friendly products approved by EPA. For more information visit the ENERGY STAR website- http://www.energystar.gov/ or call 1-888-STAR-YES.
- Choose efficient, low-polluting models of vehicles. For more information visit the Vehicle Emissions Guide- http://www.epa.gov/autoemissions/
- Choose recycled products.
- Choose products that have less packaging and are reusable.

For Your Health

- Check daily air pollution forecasts and the Air Quality Index (AQI), which tells how clean or polluted your air is, and the associated health concerns. Plan your outdoor activities accordingly. For air quality forecasts visit http://www.epa.gov/airnow/ For information on ozone, the AQI, and how it affects you visit http://www.epa.gov/airnow/consumer.html
- Minimize sun exposure- seek shade. Wear sun block and UV protection sunglasses. For more information visit Individual Actions to Protect the Ozone Layer at http://www.epa.gov/ozone/resource/indiv.html For more information on what you can do to protect yourself visit http://www.epa.gov/sunwise/actionsteps.html

Drive Wise

- Drive less, especially during peak traffic periods or hot days.
- Use public transportation, walk, or ride a bike.
- Shop by phone, mail or Internet.
- Telecommute. Even one day a week will make a big difference.
- Combine your errands into one trip.
- Avoid revving or idling engine over 30 seconds.
- Avoid waiting in long drive-thru lines, for example, at fast-food restaurants or banks. Park your car and go in.
- Accelerate gradually, maintain speed limit and use cruise control on the highway.
- Follow your owner's manual on recommendations for maximum economic efficiency.
- Use an energy-conserving (E.C.) grade of motor oil.
- Minimize use of air conditioning if you can.
- Get regular engine tune ups and car maintenance checks (especially for the spark plugs).
- Use EPA-certified facilities for air conditioner repair.
- Find out if materials are recycled when you change your tires, "throw away" your car or change car fluids. Ask before your car is serviced and consider going to someone who is environmentally friendly.
- Replace your car's air filter and oil regularly. For information of how to do this correctly and environmentally visit http://www.epa.gov/epaoswer/non-hw/recycle/recy-oil.pdf
- Keep your tires properly inflated and aligned.
- Repair all vehicle leaks promptly.
- Fill gas tank during cooler evening hours to cut down on evaporation. Avoid spilling gas and don't "top off" the tank. Replace gas tank cap tightly.
- Look for the most efficient, lowest-polluting model of vehicle. For more information visit the Green Vehicles Guide Web page - http://www.epa.gov/greenvehicles/
- Don't ignore the "check engine" or "service engine soon" light if it comes on. Make an appointment with your repair technician for diagnosis soon. For more information, read our fact sheet at: http://www.epa.gov/otaq/obd-faq.htm.

Be Informed

- Knowledge is power. Share what you know with your family and friends. You can also contact your state or local air pollution agency about how to become involved in local air pollution control issues.

Appendix D – Climate Change: What You Can Do

Reference: USEPA Climate Change website: http://www.epa.gov/climatechange/wycd/index.html

At Home

- **Change 5 lights**
  Change a light, and you help change the world. Replace the conventional bulbs in your 5 most frequently used light fixtures with bulbs that have the ENERGY STAR and you will help the environment while saving money on energy bills. If every household in the U.S. took this one simple action we would prevent greenhouse gases equivalent to the emissions from nearly 10 million cars.
- **Look for ENERGY STAR qualified products**
  When buying new products, such as appliances for your home, get the features and performance you want AND help reduce greenhouse gas emissions and air pollution. Look for ENERGY STAR qualified products in more than 50 product categories, including lighting, home electronics, heating and cooling equipment and appliances.
- **Heat and cool smartly**
  Simple steps like cleaning air filters regularly and having your heating and cooling equipment tuned annually by a licensed contractor can save energy and increase comfort at home, and at the same time reduce greenhouse gas emissions. When it's time to replace your old equipment, choose a high efficiency model, and make sure it is properly sized and installed.
- **Seal and insulate your home**
  Sealing air leaks and adding more insulation to your home is a great do-it-yourself project. The biggest leaks are usually found in the attic and basement. If you are planning to replace windows, choose ENERGY STAR qualified windows for better performance. Forced air ducts that run through unconditioned spaces are often big energy wasters. Seal and insulate any ducts in attics and crawlspaces to improve the efficiency of your home. Not sure where to begin? A home energy auditor can also help you find air leaks, areas with poor insulation, and evaluate the overall energy efficiency of your home. By taking these steps, you can eliminate drafts, keep your home more comfortable year round, save energy that would otherwise be wasted, and reduce greenhouse gas emissions.
- **Use green power**
  Green power is environmentally friendly electricity that is generated from renewable energy sources such as wind and the sun. There are two ways to use green power: you can buy green power or you can modify your house to generate your own green power. Buying green power is easy, it offers a number of environmental and economic benefits over conventional electricity, including lower greenhouse gas emissions, and it helps increase clean energy supply. If you are interested, there are a number of steps you can take to create a greener home, including installing solar panels and researching incentives for renewable energy in your state.
- **Reduce, Reuse, and Recycle**
  If there is a recycling program in your community, recycle your newspapers, beverage containers, paper and other goods. Use products in containers that can be recycled and items that can be repaired or reused. In addition, support recycling markets by buying products made from recycled materials. Reducing, reusing, and recycling in your home helps conserve energy and reduces pollution and greenhouse gases from resource extraction, manufacturing, and disposal.
- **Be green in your yard**
  Use a push mower, which, unlike a gas or electric mower, consumes no fossil fuels and emits no greenhouse gases. If you do use a power mower, make sure it is a mulching mower to reduce

grass clippings (PDF, 8 pp., 1.59 MB, About PDF). Composting your food and yard waste reduces the amount of garbage that you send to landfills and reduces greenhouse gas emissions. See EPA's GreenScapes program for tips on how to improve your lawn or garden while also benefiting the environment. Smart Landscaping can save energy, save you money and reduce your household's greenhouse gas emissions.

- **Use water efficiently**
  Saving water around the home is simple. Municipal water systems require a lot of energy to purify and distribute water to households, and saving water, especially hot water, can lower greenhouse gas emissions. Look for products with EPA's WaterSense label; these products save water and perform as well or better than their less efficient counterparts. There are also simple actions you can take to save water: Be smart when irrigating your lawn or landscape; only water when needed and do it during the coolest part of the day, early morning is best. Turn the water off while shaving or brushing teeth. Do not use your toilet as a waste basket - water is wasted with each flush. And did you know a leaky toilet can waste 200 gallons of water per day? Repair all toilet and faucet leaks right away. See EPA's WaterSense site for more water saving tips.
- **Spread the Word**
  Tell family and friends that energy efficiency is good for their homes and good for the environment because it lowers greenhouse gas emissions and air pollution. Tell 5 people and together we can help our homes help us all.

On the Road

- **Buy smart**
  Before buying a new or used vehicle (or even before renting a vehicle), check out EPA's Green Vehicle Guide and the jointly-run EPA/DOE Fuel Economy Guide. These resources provide information about the emissions and fuel economy performance of different vehicles. The Green Vehicle Guide provides detailed information on emissions (including Air Pollution and Greenhouse Gas scores for each model) and the Fuel Economy Guide focuses on fuel efficiency (including side-by-side fuel economy comparisons and a customized fuel cost calculator). These Web sites are designed to help you choose the cleanest, most fuel-efficient vehicle that meets your needs. There are a wide range of cleaner, more fuel-efficient vehicles available on the market today that produce fewer greenhouse gas emissions.
- **Drive smart**
  Many factors affect the fuel economy of your car. To improve fuel economy and reduce greenhouse gas emissions, go easy on the brakes and gas pedal, avoid hard accelerations, reduce time spent idling and unload unnecessary items in your trunk to reduce weight. If you have a removable roof rack and you are not using it, take it off to improve your fuel economy by as much as 5 percent. Use overdrive and cruise control on your car if you have those features.
- **Tune your ride**
  A well-maintained car is more fuel-efficient, produces fewer greenhouse gas emissions, is more reliable, and is safer! Keep your car well tuned, follow the manufacturer's maintenance schedule, and use the recommended grade of motor oil. Also check and replace your vehicle's air filter regularly
- **Check your tires**
  Check your tire pressure regularly. Under-inflation increases tire wear, reduces your fuel economy by up to 3 percent and leads to higher greenhouse gas emissions and releases of air pollutants. If you don't know the correct tire pressure for your vehicle, you can find it listed on the door to the glove compartment or on the driver's-side door pillar.

- **Give your car a break**
  Use public transportation, carpool or walk or bike whenever possible to avoid using your car. Leaving your car at home just two days a week will reduce greenhouse gas emissions by an average of 1,600 pounds per year. Whenever possible, combine activities and errands into one trip. For daily commuting, consider options like telecommuting (working from home via phone or over the Internet) that can reduce the stress of commuting, reduce greenhouse gas emissions, and save you money.
- **Use Renewable Fuels**
  Both E85 and biodiesel are renewable fuels that can reduce greenhouse gas emissions from your vehicle. E85 is a fuel blend containing 85% ethanol that can be used in certain vehicles called Flex Fuel Vehicles (FFVs). FFVs can be fueled with E85 or with traditional gasoline. There are approximately 6 million FFVs on the road today. To find out if you own one of them, check the inside of your car's fuel filler door for an identification sticker or consult your owner's manual. If you own a diesel vehicle, consider filling up with a biodiesel blend such as B5, a fuel blend containing 5% biodiesel. Biodiesel is a renewable fuel made from agricultural resources such as vegetable oils. The Department of Energy's Alternative Fueling Station Locator can help you locate both E85 and biodiesel fuel stations in your area.

At the Office

- **Manage office equipment energy use better**
  Office equipment and electronics use energy even when idle or on stand-by. To save energy and reduce greenhouse gas emissions at work, always activate the power management features on your computer and monitor, unplug laptop power cords when not in use and turn off equipment and lights at the end of the day. Consider using a power strip that can be turned off when you're done using your computers, printers, wireless routers and other electronics.
- **Look for ENERGY STAR qualified products for the Office**
  When buying new products for your office at work or at home, get the features and performance you want and help reduce greenhouse gases and emissions of air pollutants. Look for ENERGY STAR qualified office equipment, such as computers, copiers, and printers, in addition to more than 50 product categories, including lighting, heating and cooling equipment and commercial appliances.
- **Ask your office building manager if your office building has earned the ENERGY STAR.**
  ENERGY STAR-labeled buildings provide safe, healthy, and productive environments that use about 35 percent less energy than average buildings. Their efficient use of energy also reduces the total operational cost of the building.
- **Use less energy for your commute**
  Switch to public transportation, carpooling, biking, telecommuting and other innovative ways to save energy and reduce greenhouse gas emissions on your way to and from work. Encourage your employer to offer commuter benefits that address limited or expensive parking, reduce traffic congestion, improve employee recruiting and retention and minimize the environmental impacts associated with drive-alone commuting. If you do drive, find out the fuel efficiency of your vehicle using EPA's and DOE's fuel economy Web site, and make more environmentally-informed choices when purchasing your next vehicle by using EPA's Green Vehicle Guide.
- **Reduce, Reuse, Recycle**
  Recycle office paper, newspapers, beverage containers, electronic equipment and batteries. Reducing, reusing, and recycling in your office helps conserve energy, and reduces pollution and greenhouse gas emissions from resource extraction, manufacturing, and disposal. You can reduce, reuse and recycle at the office by using two-sided printing and copying; buying supplies made with recycled content; and recycling used printer cartridges.

At School

- **Bring science to life**
  Explore the Climate Change Kids Site and watch Climate Animations that bring to life the science and impacts of climate change. The site also provides games that help students, their parents and their teachers learn about both the science of climate change and what actions they can take to reduce greenhouse gas emissions.
- **High school students check your school's climate impact**
  High school students can investigate the link between everyday actions at their high school, greenhouse gas emissions and climate change. Using EPA's Climate CHange Emission Calculator Kit (Climate CHECK) (WinZip of Excel spreadsheet, 3.4 MB) students can learn about climate change, estimate their school's greenhouse gas emissions and conceptualize ways to mitigate their school's climate impact. Students gain detailed understandings of climate-change drivers, impacts, and science; produce an emission inventory and action plan; and can even submit the results of their emission inventory to their school district. You can also use Portfolio Manager to compare the energy use of your school with other schools nationwide, and earn the ENERGY STAR for your school if it qualifies as a top performer.
- **Get Involved at your College or University**
  College students can play an important role in reducing greenhouse gas emissions at their colleges or universities by reducing their emissions from energy they use in dorm rooms. Students can also work with school administrators to: increase energy efficiency on campus, reduce their school's greenhouse gas emissions by using green power, create a campus climate action plan, or develop an inventory of their school's greenhouse gas emissions.
- **Teach students about climate change and ecosystems**
  Use the Climate Change, Wildlife and Wildlands: A Toolkit for Formal and Informal Educators to learn about the science of climate change and its potential effects on our nation's wildlife and their habitats.
- **Engage middle school students in estimating emissions**
  Enhance critical thinking skills by introducing the Global Warming Wheel Card Classroom Activity Kit to middle school students. A hand-held wheel card and other resources help students estimate household greenhouse gas emissions in order to encourage students to think about ways to reduce their personal, family, school and community contributions to climate change. If you are an informal educator, simply use the Global Warming Wheel Card as a part of your field activities.
- **Learn from other educators**
  Investigate what other schools and organizations are doing to educate their audiences on climate change by clicking on Educators' Links, a searchable database offering links to resources such as lesson plans, videos, books and toolkits.
- **Save money and the environment**
  The least efficient schools use three times more energy than the best energy performers. By partnering with the highly successful ENERGY STAR for K-12 program and using Portfolio Manager to track and rate the energy performance of your portfolio of school buildings, school districts can serve as environmental leaders in their community, become energy efficient, reduce greenhouse gas emissions and save money!
- **Estimate your emissions and take the challenge**
  School Administrators can also work to reduce their school's greenhouse gas emissions by developing an inventory of their school's emissions or by taking the 2006 College and University Green Power Challenge.

Appendix E – Bibliography and Suggested Reading

City of Alexandria Web Site and Reports

Alexandria's Office of Environmental Quality site: http://alexandriava.gov/tes/oeq

Environmental Policy Commission and the Urban Affairs and Planning Program of the Virginia Polytechnic & State University, Alexandria Center; *ECO-City Alexandria: A Green-Ventory of City Environmental Policies, Plans, and Programs*; Fall 2007.

Environmental Policy Commission and the Urban Affairs and Planning Program of the Virginia Polytechnic & State University, Alexandria Center; *ECO-City Charter 2008*; June 14, 2008.

Environmental Policy Commission and the Urban Affairs and Planning Program of the Virginia Polytechnic & State University, Alexandria Center; *Environmental Action Plan Phase I (FY2009 – FY2011)*; November 2008.

What You Can Do to Reduce Air Pollution and Greenhouse Gas Emissions

USEPA Air Pollution website: http://www.epa.gov/air/actions

USEPA Climate Change website: http://www.epa.gov/climatechange/wycd/index.html

General Air Quality Web Sites and Reports

Metropolitan Washington Council of Governments' Air Quality site: http://www.mwcog.org/environment/air

Mid-Atlantic Regional Air Management Association site: http://www.marama.org/index.html

National Association of Clean Air Agencies site: http://www.4cleanair.org

USEPA's General Air Pollution information site: www.epa.gov/air/urbanair/6poll.html

USEPA's Air Quality site: http://airnow.gov

VADEQ's Air Quality site: http://www.deq.virginia.gov/air/homepage.html

Mid-Atlantic Regional Air Management Association (MARAMA); *A Guide to Mid-Atlantic Regional Air Quality*; October 2005.

Northeast States for Coordinated Air Use Management; *The Nature of the Ozone Air Quality Problem in the Ozone Transport Region: A Conceptual Description*; October 2006.

U.S. Environmental Protection Agency; *Ozone and Your Health*; EPA-452/F-99-003; September 1999.

U.S. Environmental Protection Agency; *Particle Pollution and Your Health*; EPA-452/F-03-001; September 2003.

Climate Change Web Sites and Reports

ICLEI's Local Governments for Sustainability website: http://www.iclei-usa.org

Intergovernmental Panel on Climate Change site: http://www.ipcc.ch

Mayor's Climate Protection Center site: http://www.usmayors.org/climateprotection

MWCOG's Climate Change site: http://www.mwcog.org/environment/climate

USEPA's Climate Change site: http://www.epa.gov/climatechange

USEPA's Climate Change for Kids site: http://epa.gov/climatechange/kids

VADEQ's Climate Change site: http://www.deq.virginia.gov/info/climatechange.html

Climate Change Steering Committee for the Metropolitan Washington Council of Governments; *National Capital Region Climate Change Report*; November 12, 2008.

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ICLEI - Local Governments for Sustainability; *U.S. Mayors' Climate Protection Agreement – Climate Action Handbook;* 2007.

Intergovernmental Panel on Climate Change; *Climate Change 2007: Synthesis Report*; November 2007.

Natural Capitalism Solutions; *Climate Protection Manual for Cities*; February 2007.

The National Academies; *Understanding and Responding to Climate Change: Highlights of the National Academies Reports*; 2008 Edition.

Virginia Governor's Commission on Climate Change; *Final Report: A Climate Change Action Plan;* December 15, 2008.

Appendix F – Acknowledgements

The Technical Team responsible for preparing this report included:

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Jeff King, Metropolitan Washington Council of Governments

Thomas Foster, Virginia Department of Environmental Quality

ECO-CITY ALEXANDRIA

10 THINGS YOU CAN DO TO CLEAN THE AIR

1) When buying your next vehicle, consider choosing efficient, low-polluting models

2) Drive less, especially during peak traffic periods or hot days

3) Use public transportation, walk, ride a bike, or consider carpooling to work one day a week or more

4) Combine shopping errands into one trip

5) Recycle paper, plastic, glass bottles, cardboard, and aluminum cans

6) Conserve energy - and save money – by using compact fluorescent light bulbs and buying energy-efficient appliances when you replace old ones

7) Purchase an electric mower when you replace your gasoline-powered model, or use a rake instead of a gasoline-powered blower

8) Purchase "Green Power" for your home's electricity

9) When painting or cleaning homes, choose products that contain little or no smog-forming pollutants identified as volatile organic compounds or VOCs

10) Plant deciduous trees around your home to provide shade in the summer and allow sunlight in the winter

LEARN MORE ABOUT WHAT YOU CAN DO AT:

http://alexandriava.gov/Environment
Office of Environmental Quality
Department of Transportation and Environmental Services