State of the Air Report 2025

City of Alexandria
Transportation & Environmental Services
Environmental Quality

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SECTION 1 – INTRODUCTION

Alexandria's Air Quality

Since its founding in 1749, the City of Alexandria has faced various air pollution challenges. Over time, the City has steadily reduced its pollution levels through a combination of local, regional, and national efforts and regulations. These improvements occurred even as Alexandria experienced significant economic development, population growth, and urbanization. The City has established and achieved its own air quality goals and initiatives while also meeting the increasingly rigorous ambient air quality standards set by the U.S. Environmental Protection Agency (EPA) and the Virginia Department of Environmental Quality (VDEQ).

In 2009, the City prepared the report, *Alexandria's State of the Air Report: Past, Present and Future* (herein referenced as *2009 ALX Report*). The report provided an assessment of air quality in the city from 1980 – 2008, summarized the City's criteria pollutants and greenhouse gas emission inventory, and reviewed strategies under consideration to help Alexandria achieve and maintain healthy air quality and help mitigate climate change. The *2009 ALX Report* showed 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 purpose of this report is to provide a 2025 update and addendum to the *2009 ALX Report* for the City. This addendum includes data from 1980 through 2020, which is the most updated, quality-controlled data currently available. This report also includes information from VDEQ's *Air quality and Air Pollution Control Policies of the Commonwealth of Virginia: A Report to the Honorable Glenn Youngkin, Governor and the General Assembly of Virginia* (2024), *Improving the Region's Air: Air Quality Trends for Metropolitan Washington* (2020), and the *2009 ALX Report*. This report provides a current assessment of Alexandria's air quality, criteria pollutants and greenhouse gas emission inventory, discusses environmental improvements over the last 15 years, and reviews ongoing strategies under consideration to help ensure that Alexandria maintains healthy air quality and continues to mitigate climate change. Further, the *Environmental Action Plan 2040* (2019) lists updating the *2009 ALX Report* as a mid-term action item.

The Clean Air Act & National Ambient Air Quality Standards

The 20th Century smog episodes of 1959 and 1960 caused discomfort to residents and reduced visibility, causing local government agencies to receive numerous complaints and resulted in action from local and federal jurisdictions. These actions focused on air quality studies, improved policies, and environmentally focused initiatives to address the expected rapid increase in air pollution unless adequate control measures were taken. In the 1970s, the federal Clean Air Act (CAA) and the 1977 Amendments were a driving force for better air quality. The City's air pollution control program became firmly established in the 1970s following these legislative mandates. Specifically, federal automotive emission standards began to take effect, and the Potomac River Generating Station (PRGS), formerly PEPCO, installed additional electrostatic precipitators and began to use low-sulfur coal to reduce air pollution. Federal grants and City funding allowed the Health Department to establish a strong, local air pollution program.

The CAA required EPA to set National Ambient Air Quality Standards (NAAQS) for six criteria air pollutants: carbon monoxide, lead, nitrogen dioxide, sulfur dioxide, particulate matter, and ozone. For each pollutant, they can either meet the standards (being in attainment) or not meet them (non-attainment).

Today, Alexandria's air quality meets the federal air quality standards for all six criteria pollutants. Air quality levels for ozone, however, remain "marginal" based on federal requirements. The periodic tightening of the ozone standards can offset the continuously improving air quality in the Metropolitan Washington region. According to the *Air quality and Air Pollution Control Policies of the Commonwealth of Virginia: A Report to the Honorable Glenn Youngkin, Governor and the General Assembly of Virginia* (2024), Virginia is developing a redesignation request for ozone to be in attainment (versus marginal) for the Northern Virginia, Metropolitan Washington, D.C., ozone non-attainment area that includes the City of Alexandria.

While there is still room for improvement, the region has made significant progress in air quality since 2008, when it was designated a maintenance area under the 2008 Ozone NAAQS. Today, the region meets all current NAAQS standards, including several that are more stringent than those in place in 2009.

SECTION 2 - AIR QUALITY STANDARDS & SOURCES OF POLLUTION

Overview of NAAQS Limits for Criteria Pollutants

This section describes the six criteria air pollutants, their sources, and the associated health effects that led to their designation as monitored pollutants.

The NAAQS were initially established in 1971, shortly after the CAA was initiated. The six criteria pollutants are carbon monoxide, lead, nitrogen dioxide, sulfur dioxide, particulate matter, and ozone. Table 1 shows the criteria pollutants and current NAAQS values.

Table 1: Criteria Pollutants & Current NAAQS Standards (EPA, 2024c)

Pollutant	Primary Standards	
	Level	Averaging Time
Carbon Monoxide (CO)	9 ppm	8-hour
	35 ppm	1-hour
Lead (Pb)	0.15 µg/m3	Rolling 3-month period
Nitrogen Dioxide (NO_2)	53 ppb	Annual
	100 ppb	1 hour
Particulate Matter (PM_{10})	150 µg/m3	24-hour
Particulate Matter ($PM_{2.5}$)	9.0 µg/m3	Annual
	35 µg/m3	24-hour
Ozone (O_3)	0.070 ppm	8-hour
Sulfur Dioxide (SO_2)	75 ppb	1-hour

As noted in the *2009 ALX Report*, EPA calls these pollutants “criteria” air pollutants because they are regulated by developing human health-based (primary NAAQS standards) and/or environmentally based (secondary NAAQS standards) criteria for setting permissible exposure levels. EPA periodically revises the NAAQS based on new information related to health and welfare effects. In Section 3, there is a summary of the health impacts of each criteria pollutant, how each limit has changed since it was initiated, and current trends seen over time for each pollutant.

Where do these pollutants come from?

There are several emission sources located within the City that are likely to affect air quality. These include industrial sources such as Reworld Alexandria, the waste-to-energy facility (previously Covanta), Virginia Paving hot mix asphalt plant, and the previously operational Mirant’s coal-fired PRGS. 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 by emissions transported into Alexandria from sources out of state and sometimes out of country.

Five (5) pollutant source categories were provided in the *2009 ALX Report* and are summarized below for reference. Trends in these five pollutant sources will be considered more in Section 4 of this report.

Point Sources are comprised of stationary facilities that emit pollutants above a certain threshold, from a stack, vent or similar discrete point of release. Point sources are issued air quality permits to protect public health and air quality.

Area Sources are sources of air pollutants that are diffused over a wide geographical area. Area sources include sources that by themselves are insignificant, but in aggregate may comprise significant emissions. Examples would be emissions from small dry cleaners, home heating boilers, and volatile organic compounds (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 EPA 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, or portable generators.

Biogenic emissions are created by natural sources, such as plants, trees, and soil. EPA has developed models that estimate emissions of biogenic VOCs from vegetation for natural areas, crops, and urban vegetation (ALX, 2009).

Significant Improvements of Alexandria's Industrial Polluters

In Alexandria, the Mirant cold-fired PRGS (now closed), Reworld waste-to-energy plant (previously Covanta), and Virginia Paving hot asphalt plant, shown in Section 2, Figure 3, are the largest point sources of emissions. Each is regulated with air quality permits, which are issued to industries to prevent emissions from causing public health concerns or cause significant deterioration in areas that presently have clean air. The permits also ensure that facilities make adequate provisions to control their emissions. Many improvements and operational changes have occurred in these facilities from 2009 to present, significantly decreasing the amount of each criteria pollutant emitted from these point sources.

Potomac River Generating Station (PRGS):
The GenOn PRGS, formerly known as the Mirant PRGS, started operating in North Old Town in 1949. By 2008, the City was able to bring scientific evidence to appropriate authorities on its violations of the NAAQS, leading to improvements in plant operations and significant reductions in this plant's emission of pollutants, including sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and particulate matter (PM) emissions (City of Alexandria, 2008). Despite the improvements, PRGS's production records continued to show high amounts of NO_x, PM_{10}, and carbon dioxide (CO_2) being emitted into the environment. On September 30, 2012, after many years of litigation, PRGS closed its operations, successfully resolving the biggest and most urgent air quality issue in the City (City of Alexandria, 2012).

Virginia Paving:
The City approved Virginia Paving's 2006 Special Use Permit (SUP), SUP2005-0042, mandating innovative projects to enhance environmental aspects in and around the facility. These improvements include the installation of blue smoke emission control units, procurement of new dump trucks fitted with green emission technology, establishment of an underground stormwater management system, and the dedication of two acres of green space enhanced with trees and underbrush.

By 2005, NO_x emissions were reduced with the Low NO_x Burner installation. In 2006, condensers, designed to minimize emissions and odors from asphalt cement storage tanks, were installed. In 2007, the Blue Smoke Control Unit installation was completed. This technology, considered the best available control technology (BACT), was specifically designed to minimize emissions and odors from the plant's most exposed areas and exceeded state and federal requirements for odor minimization systems. In 2007, Virginia Paving also started replacing their facility's fleet and including only machinery with reduced emissions engines, which became available after 2004 when the EPA released regulations requiring off-road diesel engine companies to manufacture engines with reduced emissions. In 2010, the City granted Virginia Paving a minor amendment to the 2006 SUP that allowed for natural gas to be the primary, approved fuel source for the plant and hot oil heater operations, replacing the use of fuel oil. Operations continued to allow use of fuel oil when natural gas supply was limited or shut off in favor of higher priority uses.

Despite these improvements, the City issued Virginia Paving a new SUP in 2009 that called for more stringent air pollution control limits than required by state counterparts. Requirements included all onsite plant equipment to be outfitted with diesel particle traps, designed to remove diesel particulate matter or soot from exhaust gas of the diesel engine.

Furthermore, Virginia Paving's permit to operate their Alexandria facility expires on January 1, 2027, and is not anticipated to be reissued. This will remove another major industrial point source pollution contributor from the city.

Reworld™ (previously Covanta)
Reworld™ provides the City with renewable energy by converting waste-to-energy. Reworld™ produces enough electrical power to supply about 15,000 homes in the City. In 2000, Reworld™ underwent a $46.1 million retrofit of emission control technology to meet more stringent federal requirements. This included replacing electrostatic precipitators with bag houses. The retrofit dramatically lowered emissions of criteria pollutants. Air pollution control equipment improvements consisted of semi-dry flue gas scrubbers injecting lime, fabric filter baghouses, a nitrogen oxide control system, mercury control system, and continuous emissions monitoring (CEM) system. In 2022, Reworld™ Alexandria completed planned enhancements to its state-of-the-art pollution control technology, to further reduce NO_x emissions. This installation was part of a multi-year project and has reduced NO_x emissions by nearly 50%.

Air Quality in Alexandria

The information in Section 2 on the NAAQS, pollutant sources, and discussion of the City's major point-source polluters will be used throughout the remainder of the report to illustrate air quality trends in Alexandria, highlight actions the City has taken to mitigate air pollution, and connect these efforts to current and future programs aimed at protecting air quality. While air quality for all criteria pollutants have shown improvements from 2009 to the present, ozone and particulate matter have historically been the most challenging from a compliance perspective. Also, preliminary air quality data for 2023 shows out-of-state forest fires significantly degraded air quality for $PM_{2.5}$ and ozone throughout the summer of 2023 (VDEQ, 2024). Therefore, a greater emphasis will be placed on these pollutants throughout the report.

Impacts of Forest Fires on Air Quality

The *2024 VDEQ Report* discusses how out-of-state forest fires impacted the level of particulate matter across the Commonwealth, and large portions of the United States, resulting in exceedances of federal health-based air quality standards on numerous days. Virginia air monitors reported exceedances on nine (9) days for particulate matter and five (5) days for ozone in 2023. Compared to 2022, where Virginia recorded no $PM_{2.5}$ exceedances and only two (2) ozone exceedance days; and in 2024, where there were only seven (7) recorded exceedances for ozone and no $PM_{2.5}$ exceedances (MWCOG, 2024c). See the *2024 VDEQ report* for more detailed information related to the impacts of forest fires on air quality.

SECTION 3 – AMBIENT AIR QUALITY ASSESSMENT

This section presents a brief discussion of the health and welfare effects of air pollution, a brief history of how regulated limits have changed, and an ambient air quality data analysis for all criteria pollutants from 1980 to 2020.

The City of Alexandria had monitored air quality for many years and had one of the most sophisticated air monitoring networks in the Metropolitan area. Regional partnerships to monitor air quality and decreased funding led to the discontinuation of air quality monitoring in Alexandria, previously located at 3200 Colvin Street. In 2022, the Cameron Station PM_{10} monitoring station at Armistead Boothe Park, near Samuel Tucker Elementary School, was also taken offline. Based on its proximity to one of the City's most significant industrial polluters, the city subsequently installed a Purple Air Community Air Quality Sensor at the same location in December 2022. This air monitor measures real-time PM_{10} and $PM_{2.5}$ but is not a VDEQ approved monitor for enforcement purposes.

Residents of Cameron Station expressed concerns about the health effects from potential exposure to high levels of particulate matter in their community, specifically, from emissions generated at the Virginia Paving hot mix asphalt facility located on Van Dorn Street. The City conducted a short-term monitoring study in 2004, using two monitors at Armistead Boothe Park and Ben Brenman Park. Results met the NAAQS, leading to the installation of a new long-term PM_{10} monitoring station at Armistead Boothe Park, near Samuel Tucker Elementary School in Cameron Station in 2006. This monitor has since been shut down and replaced with the Purple Air Monitor for real-time PM_{10} and $PM_{2.5}$ data.

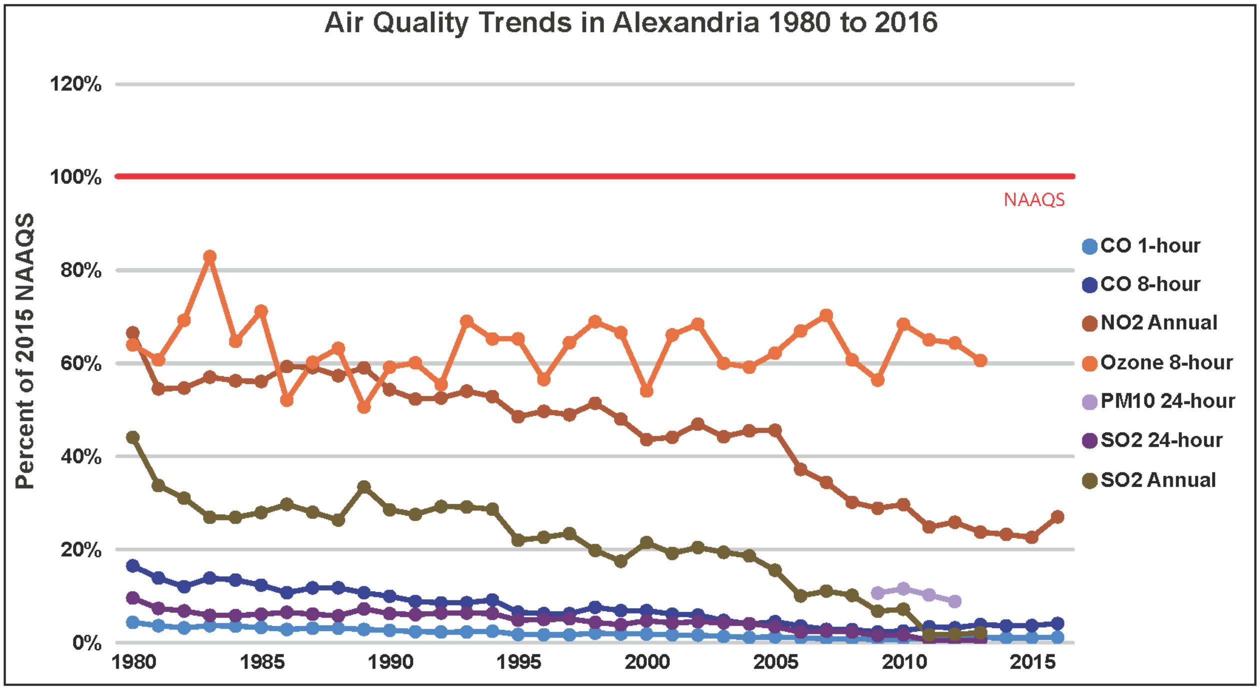
PM_{10} air monitoring station at Cameron Station

Air pollution knows no boundaries and local air quality is affected by local, regional, and sometimes national air quality events. Alexandria is included in the Metropolitan Washington regional air quality monitoring program and relies on regional air monitoring to identify the City's air quality. The Metropolitan Washington region, including Alexandria, continues to show similar trends in each jurisdiction and is evaluated for attainment as the Metropolitan Washington region.

Figure 1 shows that air quality has generally improved since the early 1980s, with significant improvements over the past decade, even as the NAAQS values have become more stringent. This is a result of the emissions reductions from a variety of control programs and improved emissions from nearby states (VDEQ, 2024).

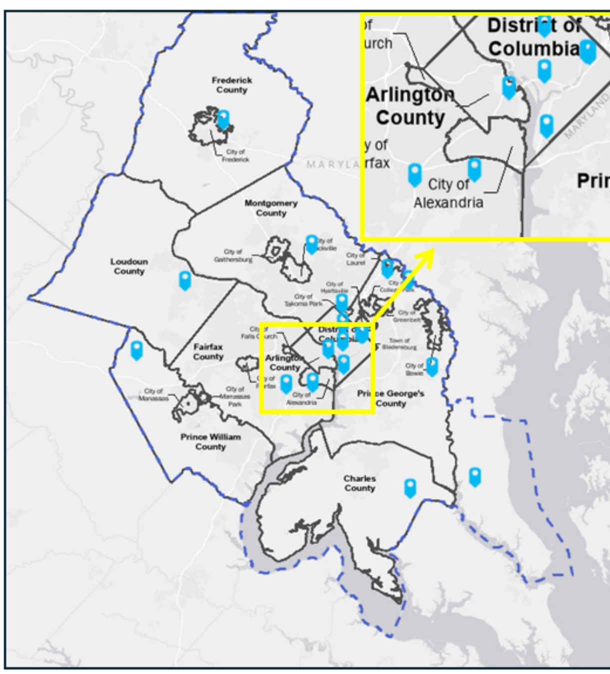
Today Alexandria, and the whole Metropolitan Washington region is considered in attainment for all criteria pollutants.

Figure 1: Air Quality Trends in Alexandria 1980 to 2016 (EPA, 2024a & 2024b)



The Metropolitan Washington region currently has 19 ambient air monitoring sites spread across the District of Columbia, Maryland, and Virginia that measure a variety of pollutants for different purposes. Figure 2 shows these regional air monitoring locations (MWCOG, 2024a). For reference, Figure 3 is included to show the Alexandria specific air quality monitoring site noted above and significant emissions sources that were discussed earlier in this report.

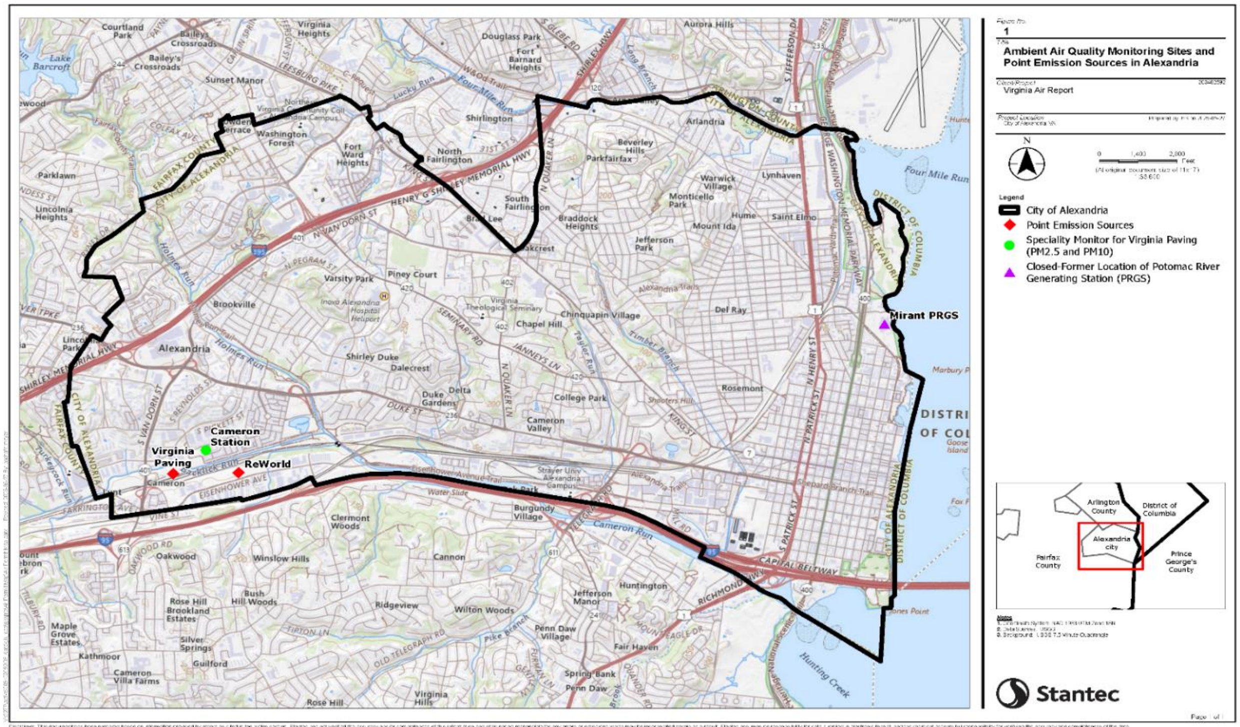
Figure 2: Metropolitan Washington's Air Monitors



	Monitor Name	Pollutants Currently Monitored					
		O_3	$PM_{2.5}$	PM_{10}	CO	NO_2	SO_2
1	Takoma Park	1	0	0	0	1	0
2	McMillan NCore	1	1	1	1	1	1
3	DC Near Road	0	1	0	1	1	0
4	River Terrace	1	1	0	0	1	0
5	King Greenleaf	0	1	0	0	0	0
6	Bald Eagle	1	1	0	0	1	0
7	Frederick Airport	1	0	0	0	0	0
8	Rockville	1	1	0	0	0	0
9	Beltsville (Howard University Site)	1	1	1	1	1	1
10	Beltsville	1	0	0	0	0	0
11	Prince George's Equestrian Center	1	0	0	0	0	0
12	Calvert	1	0	0	0	0	0
13	Southern Maryland	1	0	0	0	0	0
14	James S. Long Park	1	0	0	0	1	0
15	Ashburn	1	1	1	0	1	0
16	Springfield Near Road	0	1	0	1	1	0
17	Franconia	1	1	1	0	0	1
18	Aurora Hills	1	1	0	1	1	0

NOTE: One (1) means monitored and zero (0) means not monitored

Figure 3: Ambient Air Quality Monitoring Sites and Point Emission Sources in Alexandria



Regional Air Monitoring Committees

Regional committees include the Metropolitan Washington Air Quality Committee (MWAQC) at the MWCOG and the Technical Advisory Committee (TAC). MWAQC is the regional policy committee responsible for regional air quality planning activities, reviewing policies, and adopting air quality plans for the District of Columbia, Maryland, and Virginia. MWAQC-TAC advises and assists MWAQC in planning for and maintaining the region's air quality.

This section reviews the City's air quality from a regional perspective, using the Metropolitan Washington regional monitors located closest to Alexandria for the criteria pollutant being discussed and evaluating air quality compared to the current NAAQS. Alexandria does not currently have any air monitors located within the city boundaries that are used for compliance and enforcement purposes.

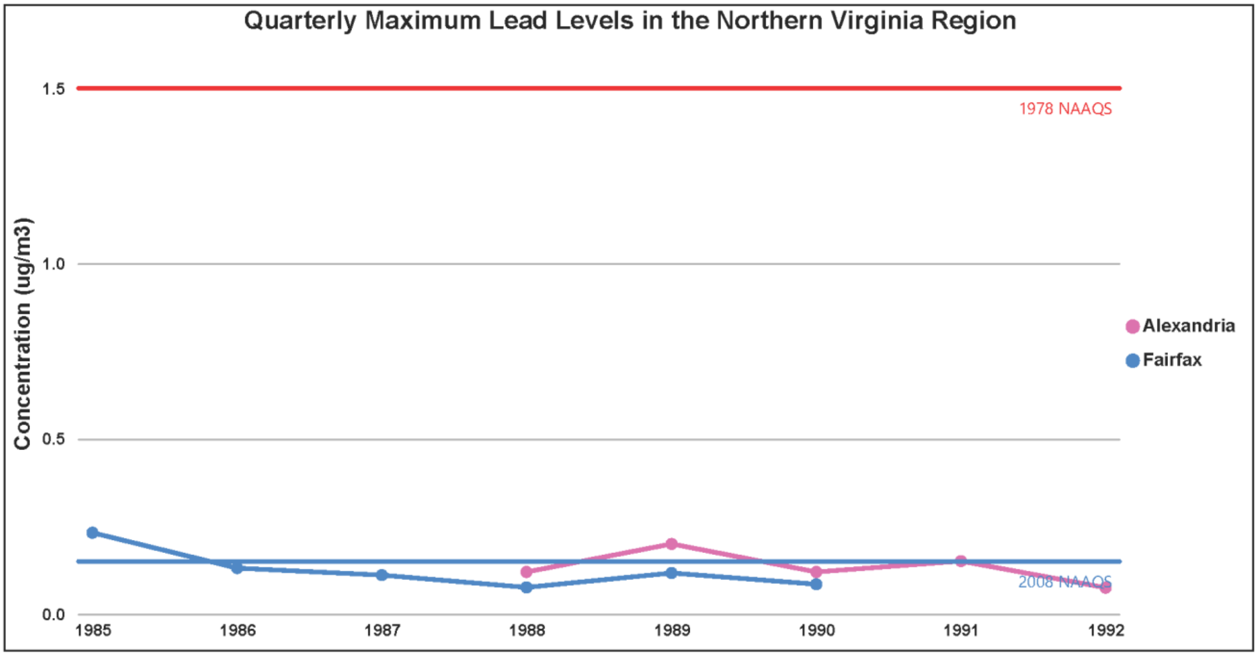
Lead

Lead (Pb) is a metal found naturally in the environment as well as in manufactured products. Lead exposure can lead to behavioral problems and learning disabilities, as well as seizures and death. Lead exposures were most significantly associated with motor vehicles using leaded gasoline, as well as contamination of urban soil and dust, but also including contamination from lead-based paint. The NAAQS for lead went into effect in 1978, with a value of 1.5 micrograms/meter cubed ($\mu g/m^3$) and was revised to its current value of $0.15 \mu g/m^3$ in 2008

(EPA, 2025c). By 1999, after lead was removed from gasoline products, lead emissions declined by 95%. No ambient monitoring for lead has occurred in Northern Virginia since 1998.

Figure 4 shows the trend of lead levels in the Northern Virginia Region is well below the NAAQS values the EPA deemed safe to protect human health and the environment.

Figure 4: Quarterly Maximum Lead Levels in the Northern Virginia Region

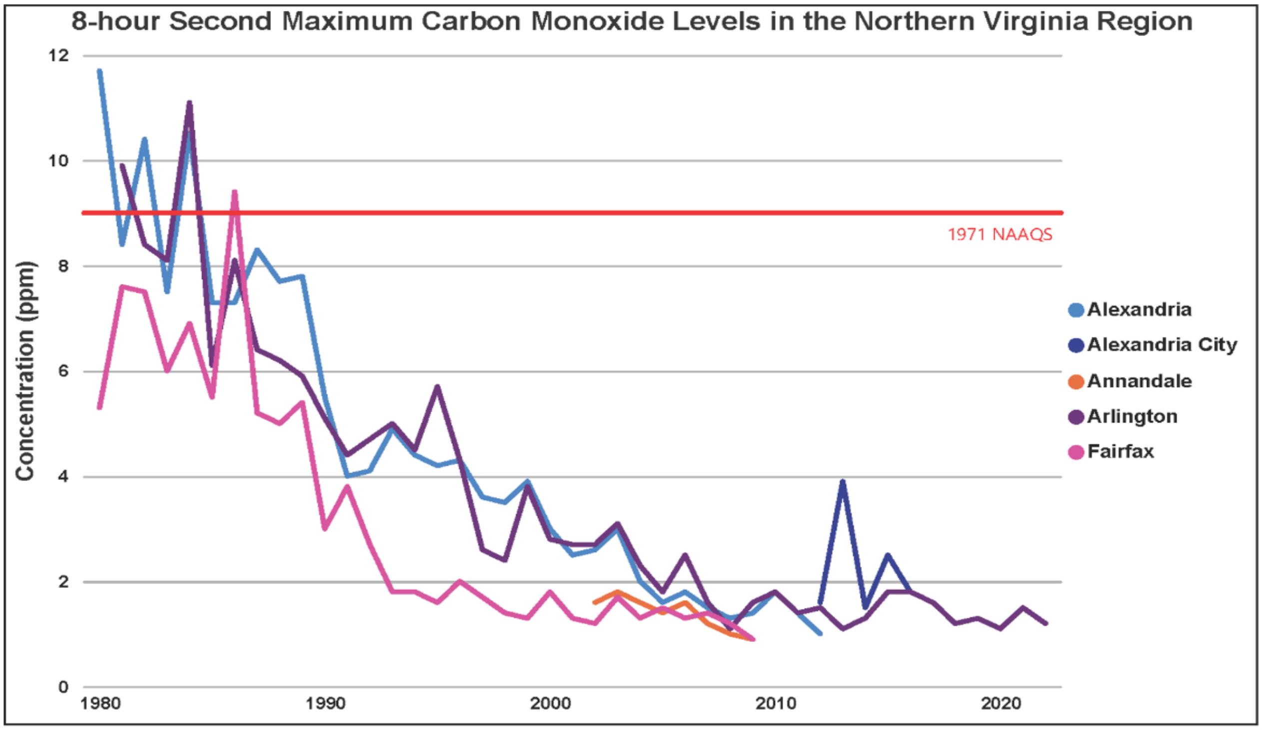


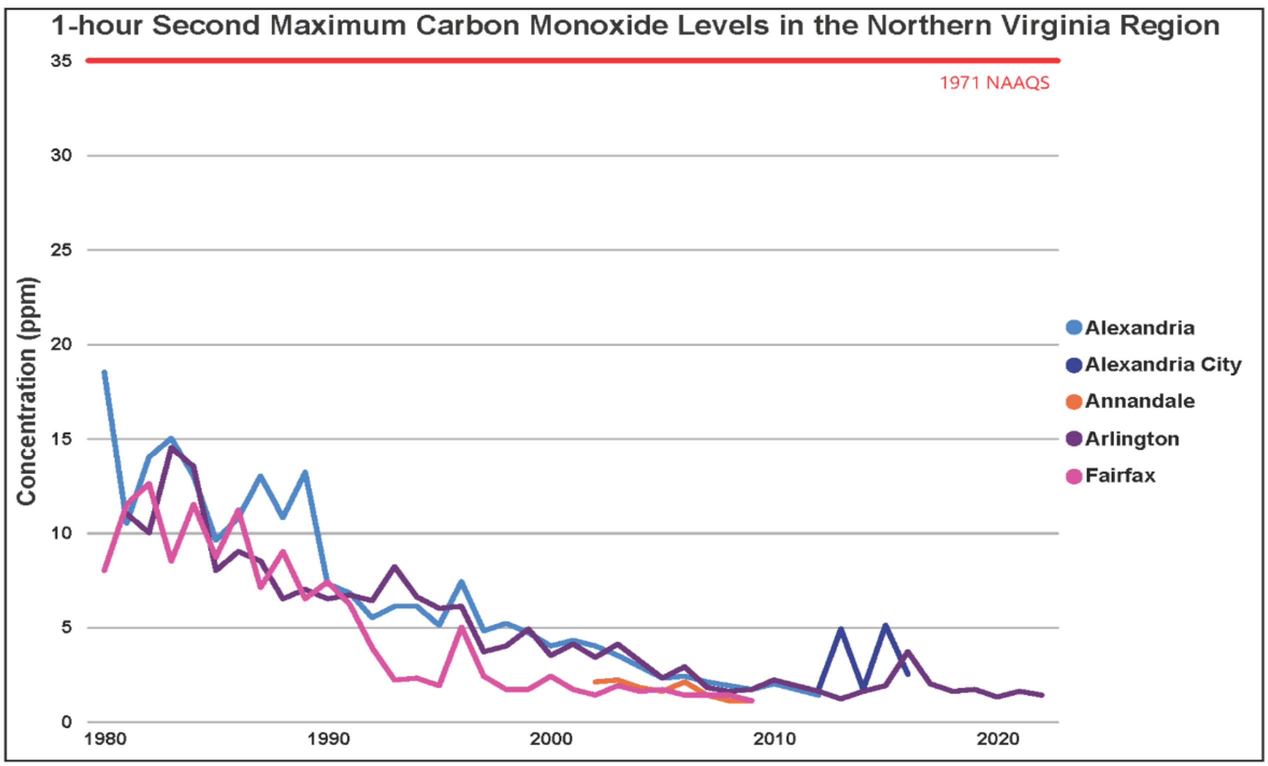
Carbon Monoxide

Carbon Monoxide (CO) is a colorless, odorless gas that is formed when carbon contained in fuel is not completely burned. It is one component of exhaust from motor vehicles and non-road engines/equipment, such as gas-powered lawn mowers, leaf blowers, and construction equipment. Another source of CO emissions is wood burning. CO exposure can lead to reduced levels of oxygen getting to organs and tissues, depriving the body of an essential for life. Elevated CO levels can lead to visual impairment, reduced work capacity, poor learning ability, and difficulty completing complex tasks. Exhaust from motor vehicles, especially during heavy traffic, is the major source of CO emissions. The NAAQS CO standard went into effect in 1971, including an 8-hour standard of 9 parts per million (ppm) and 1-hour standard of 35ppm. These values have been retained through all current revisions (EPA, 2025b).

Figure 5 shows a steady decrease in carbon monoxide levels in the Northern Virginia Region for both standards. These graphs show that the monitors in the Northern Virginia region have, and continue to show, values well below the standard since 1990.

Figure 5: Carbon Monoxide (CO) Levels in Northern Virginia Region from 1980 to 2020



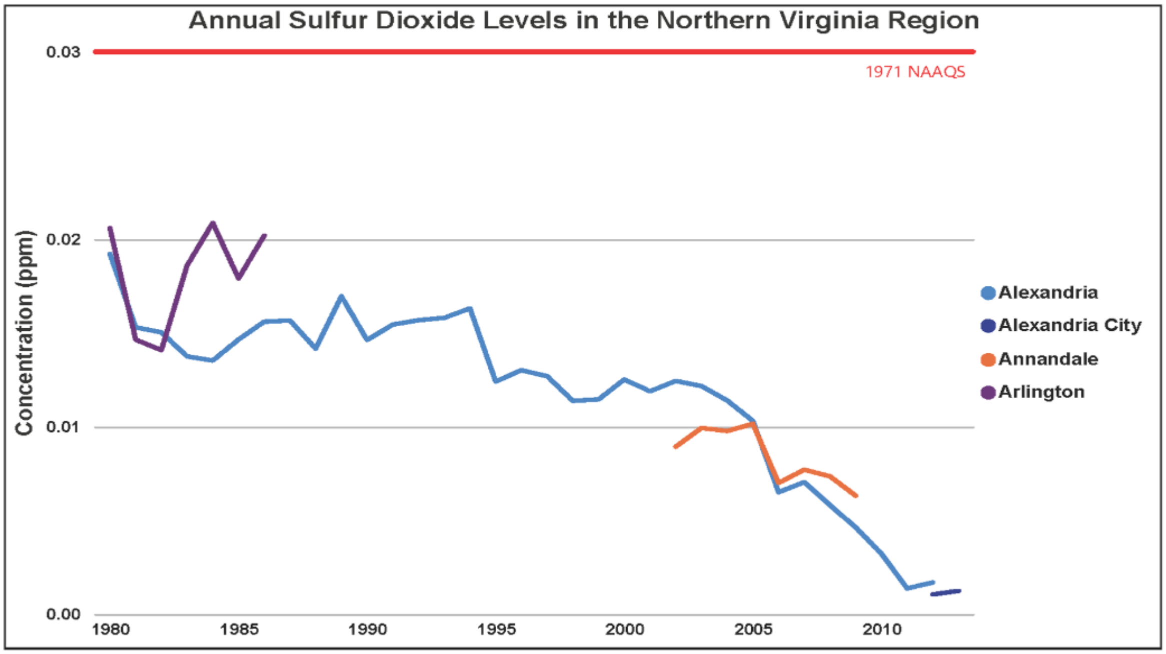


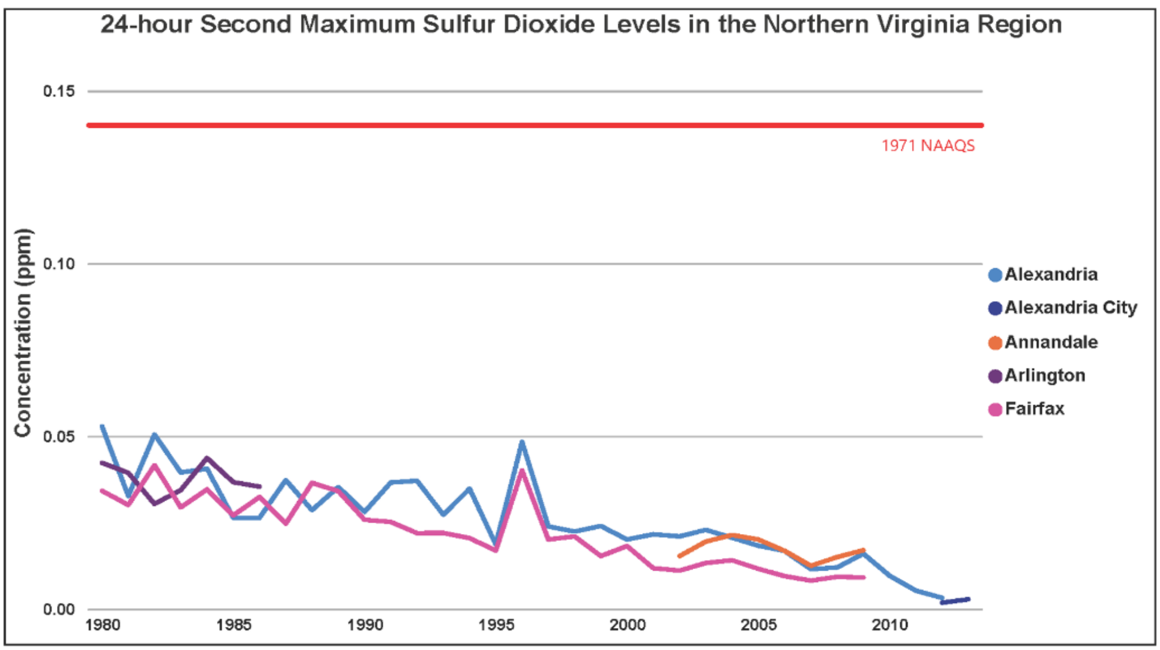
Sulfur Dioxide

Sulfur Dioxide (SO_2) is a gas formed when sulfur-containing fuel is burned, gasoline is extracted from oil, or metals are extracted from ore. Sulfur dioxide causes many health problems, including respiratory problems, visibility impairment, and environmental problems, such as acid rain and aesthetic damage to buildings and monuments. The major source of SO_2 in the Metropolitan Washington area is coal-fired power plants. The NAAQS SO_2 24-hour standard of 0.14ppm, established in 1971, and the annual standard of 0.03ppm were revoked in 2010 and replaced by the new 1-hour standard of 75 parts per billion (ppb), which remains unchanged today (EPA, 2025g).

Figure 6 shows the trend of sulfur dioxide in the Northern Virginia Region for both standards is well below the NAAQS values the EPA deemed safe to protect human health and the environment. Significant decreases are a result of the EPA implementing more stringent regulations for coal-fired power plants from 1995 through 2010 as well as decommissioning PRGS in September 2012.

Figure 6: Sulfur Dioxide (SO_2) Levels in Northern Virginia Region from 1980 to 2013





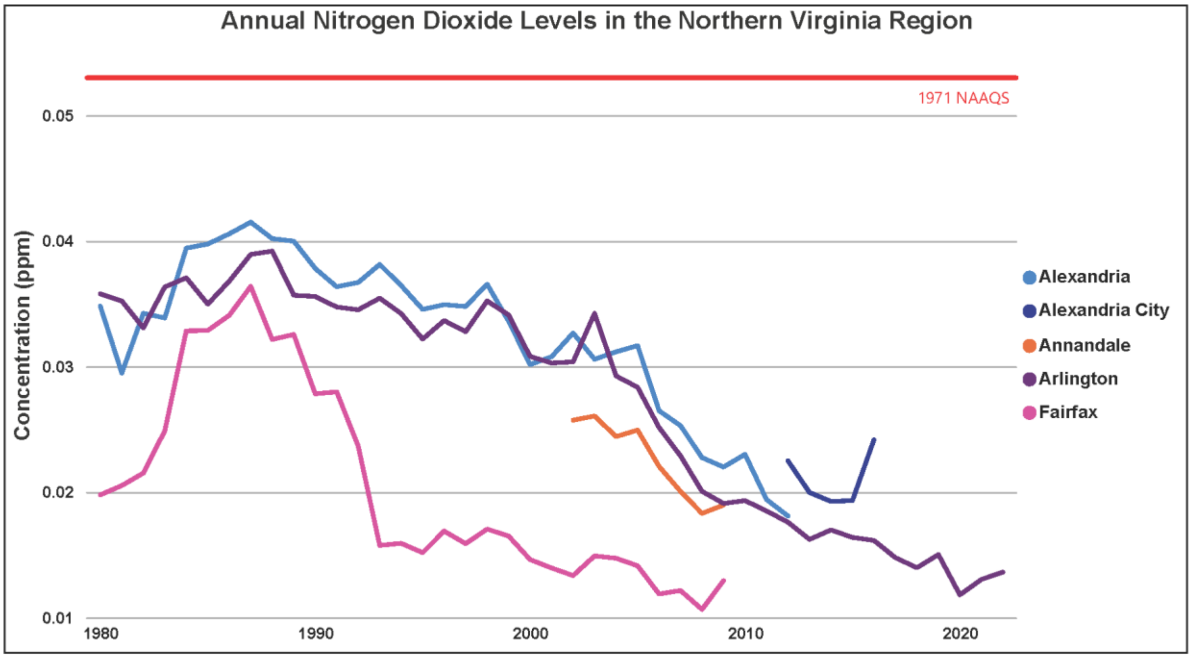
NOTE 1: Monitors located at the Alexandria Health Department were closed down
NOTE 2: The new standard of 75ppb was promulgated in 2010 and not represented in the data provided on this figure.

Nitrogen Dioxide

Nitrogen Dioxide (NO_2) is a brownish, highly reactive gas in the class of compounds called nitrogen oxides (NO_x). Nitrogen dioxide exposure primarily affects the lungs and respiratory system, causing irritation, damage and reduced lung function and resistance to respiratory infections. NO_2 is also a major component of ground-level ozone formation in warmer months. It is formed during combustion of fuels in vehicle engines and industrial facilities. The NO_2 NAAQS annual standard value of 53ppb went into effect in 1971 and the 1-hour standard value of 100ppm, established in 2010 (not pictured in Figure 7), are retained without change today (EPA, 2025d). The 2010 standard included a requirement to install and operate monitoring stations near heavily traveled roadways, one of which is on Backlick Road in Springfield and started monitoring in 2016 (VDEQ, 2024).

Figure 7 shows the trend of nitrogen dioxide in the Northern Virginia Region is well below the NAAQS values the EPA deemed safe to protect human health and the environment. Significant decreases are primarily a result of controls on point sources and mobile sources.

Figure 7: Nitrogen Dioxide (NO_2) Levels in Northern Virginia Region from 1980 to 2020



Ground-level Ozone

Ozone is a highly reactive gas composed of three oxygen atoms, formed at ground level when nitrogen oxides (NO_x) react with volatile organic compounds (VOCs) in the presence of strong sunlight, particularly ultraviolet radiation. Consequently, ozone levels are typically highest during the summer months and during the hottest parts of the day. Exposure to ozone can irritate the lungs, causing discomfort when taking a deep breath, and can worsen asthma, emphysema, bronchitis, and other respiratory conditions. Ozone also harms forests, crops, and other vegetation by impairing a plant's ability to photosynthesize and resist disease, leading to leaf discoloration, premature aging, leaf loss, and reduced growth and crop yields. Ozone remains one of the most challenging air pollutants to address locally and nationally, prompting increasingly stringent NAAQS over time.

Ozone Trends.

Originally monitored in 1971 as total photochemical oxidants, ozone was later regulated under a 1-hour standard of 0.12ppm in 1979, replaced by an 8-hour standard of 0.08ppm in 1997, further tightened to 0.075ppm in 2008, and revised to the current 0.070ppm standard in 2015 (EPA, 2025e).

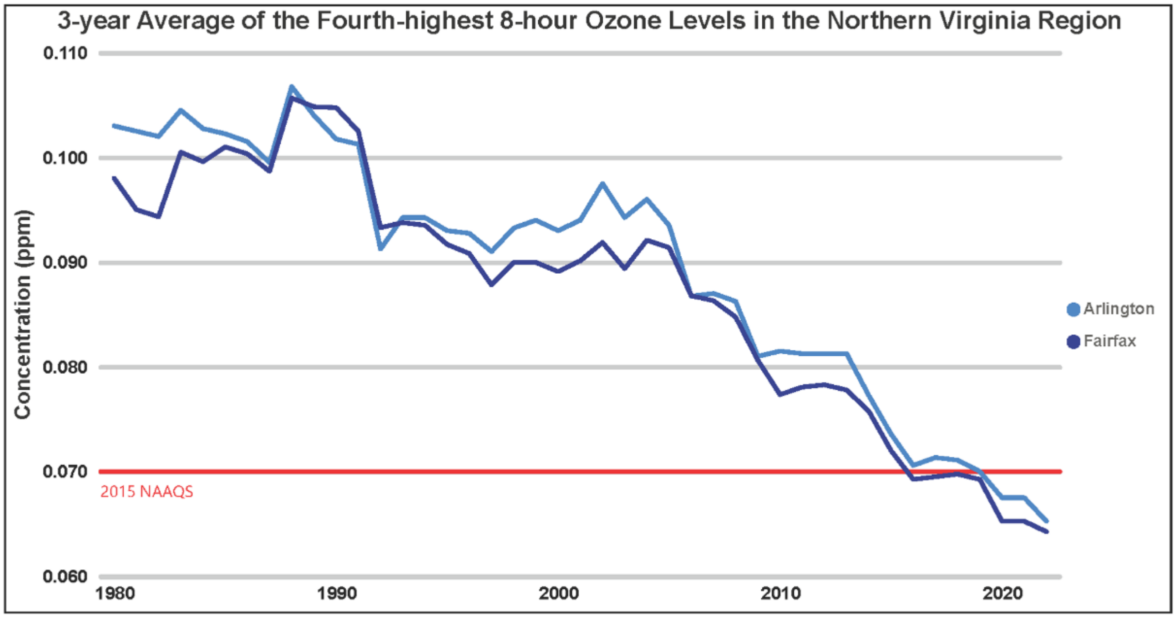
The ozone air quality trends from 1980 through 2020 show continual improvements in air quality over time. This trend can be observed in different ways.

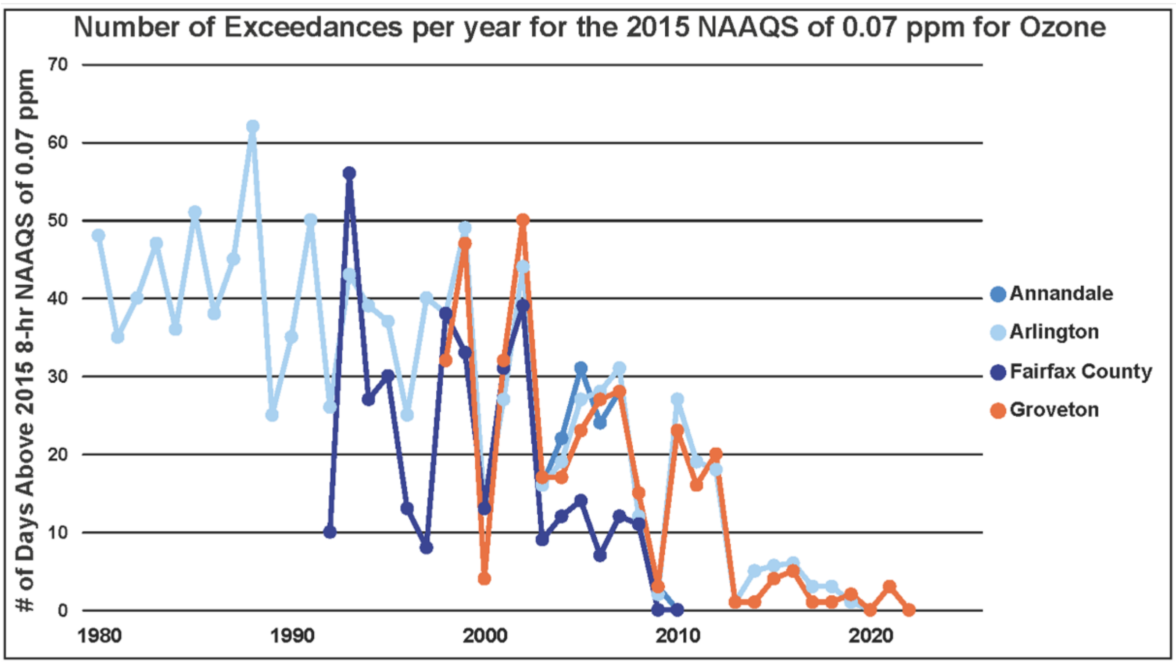
Shown in top graph of Figure 8 is the 3-year average of the fourth highest 8-hour ozone levels, also known as the design value, for the Northern Virginia region, which encompasses both Arlington and Fairfax Counties. The design value for ozone is used as a comparison between the concentrations in ambient air and the NAAQS for ozone. An area is considered in attainment for the NAAQS when the design value is less than or equal to 0.070ppm.

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, using the most current NAAQS value of 0.070ppm as the standard. This trend, seen in the bottom graph of Figure 8, shows exceedances ranging from 40 – 50 days per year in the 1980s, followed by small improvements over the next 30 years and a larger overall improvement around 2015, when the standard was most recently lowered again to the current 0.070ppm standard. It's important to note that the number of exceedances per year when regulated by the 1997 or 2008 standards is significantly greater than the number of exceedances noted in the most recent years, despite the more stringent regulations, clearly indicating air quality continues to improve.

Figure 8 shows the continual improvement in ozone levels and ability to meet the NAAQS values the EPA deemed safe to protect human health and the environment. This resulted in Alexandria being designated as in attainment for ozone.

Figure 8: Ozone Levels in the Northern Virginia Region





Particulate Matter

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

Particulate Matter 10 (PM_{10}): The size of particles is directly linked to their potential for causing health problems. Particles that are 10 micrometers in diameter or smaller, called particulate matter 10 (PM_{10}), generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect respiratory health, making issues like asthma or chronic obstructive pulmonary disorder (COPD) even worse.

Fine Particulate 2.5 ($PM_{2.5}$): Particles less than 2.5 micrometers in diameter are termed fine particulate 2.5 ($PM_{2.5}$). They are so small that they are not visible with the naked eye. Fine particles tend to pose the greatest health concern because they can be inhaled deep into the lungs and accumulate in the respiratory system.

Particulate Formation. Particle pollution is generally produced through two separate processes, mechanical and chemical. Mechanical processes are those in which bigger bits break into smaller bits with the material itself remaining essentially the same, such as from dust storms, construction and demolition, and coal and oil combustion. They generally create coarse particulate and are already formed as particles when they enter the air. These are emitted directly from a source, such as construction sites, unpaved roads, fields, smokestacks or fires (VDEQ, 2024).

Chemical processes are initiated by combustion sources burning fuels or through reactions with other gases in the atmosphere. Sources are the combustion of burn fuels or the reaction of elemental carbon (soot), ammonia, SO_2, NO_x and VOCs with water and other compounds in the atmosphere which are emitted from power plants, industries, and automobiles (VDEQ, 2024).

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 or 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.

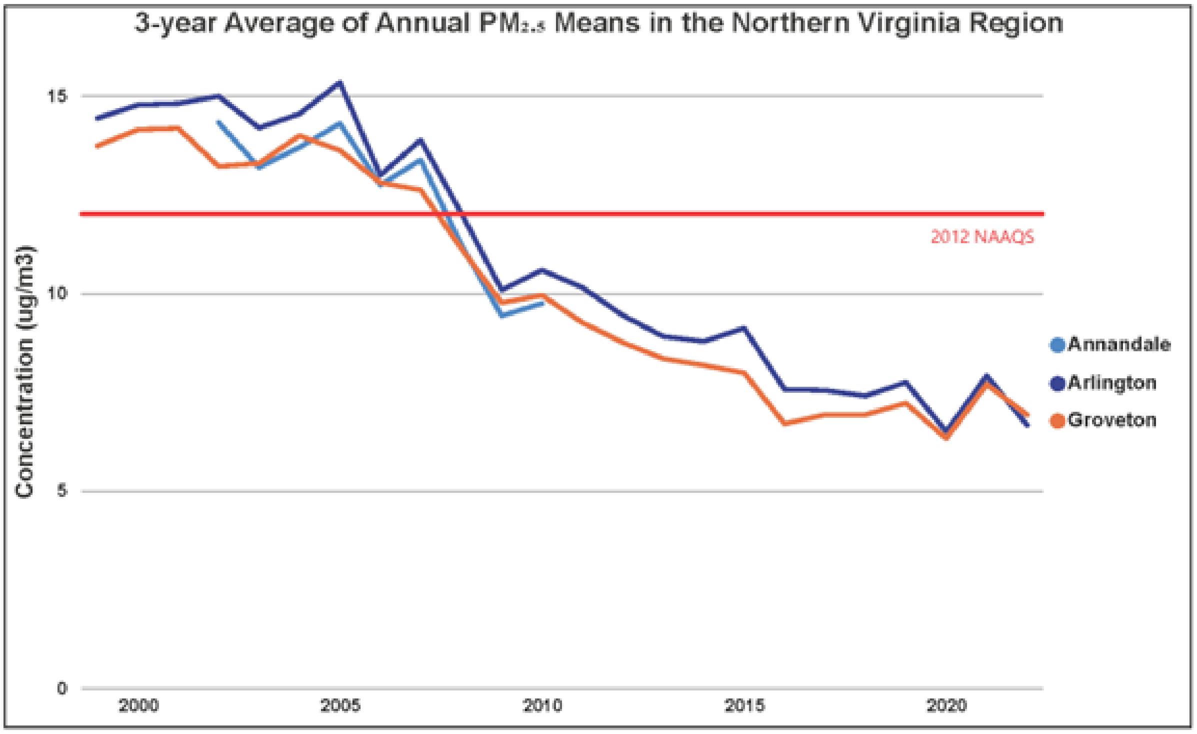
Exposure to particulate matter (PM) can lead to a range of serious health impacts, as fine particles are able to penetrate deep into the lungs and, in some cases, enter the bloodstream, posing greater health risks than larger particles that remain in the upper respiratory system. Short-term exposure (over hours or days) has been linked to reduced lung function, increased respiratory symptoms, cardiac arrhythmias, heart attacks, hospital or emergency room visits for heart and lung diseases, and premature death. Long-term exposure, such as living for years in areas with elevated PM levels, is associated with decreased lung function, the development of chronic bronchitis, and increased risk of premature death. Beyond health effects, fine particles are a major contributor to visibility impairment, scattering and absorbing light to create haze that diminishes color, clarity, and long-distance visibility across the United States, including in Alexandria. Particulate matter can also harm vegetation and ecosystems by depositing on soil and water and disrupting nutrient and chemical balances, and it contributes to the soiling and erosion of buildings, monuments, and other culturally significant structures.

Particulate Matter Air Quality Trends.

The NAAQS standard for PM was established in 1971 and was based on total suspended particles (TSP) from 1971 – 1987. In 1987, two new standards replaced the existing TSP standard, a 24-hour and an annual PM_{10} standard of 150µg/m^3 and 50µg/m^3, respectively. Ten years later, in 1997, the PM_{10} standard remained unchanged and new 24-hour and annual $PM_{2.5}$ standards were developed. The 24-hour $PM_{2.5}$ standard had a value of 65µg/m^3. The annual $PM_{2.5}$ standard had a value of 15.0µg/m^3. In 2006, the annual PM_{10} standard was removed and more strict limits were imposed with the 24-hour $PM_{2.5}$ standard, reducing it to a 35µg/m^3 value. Additional changes to the $PM_{2.5}$ annual standard were seen in 2012 and 2024, when the value was reduced to 12.0µg/m^3 and then 9.0µg/m^3, respectively (EPA, 2025f). In general, there is a positive correlation between $PM_{2.5}$ and PM_{10} concentrations, where $PM_{2.5}$ typically ranges from 50 to 75% of the PM_{10} concentration. The strength and nature of this correlation can vary depending on factors such as emission sources, meteorological conditions, season, and time of day. For instance, combustion sources can lead to $PM_{2.5}$ being nearly 99% of PM_{10}, while mechanical dust sources like construction might show $PM_{2.5}$ as low as 21% of PM_{10}.

Figure 9 and Figure 10 show the continual improvement in particulate matter levels $PM_{2.5}$ and PM_{10}, respectively, and their ability to meet the NAAQS value, which results in Alexandria being designated as in attainment for particulate matter.

Figure 9: Particulate Matter, $PM_{2.5}$, in the Northern Virginia Region



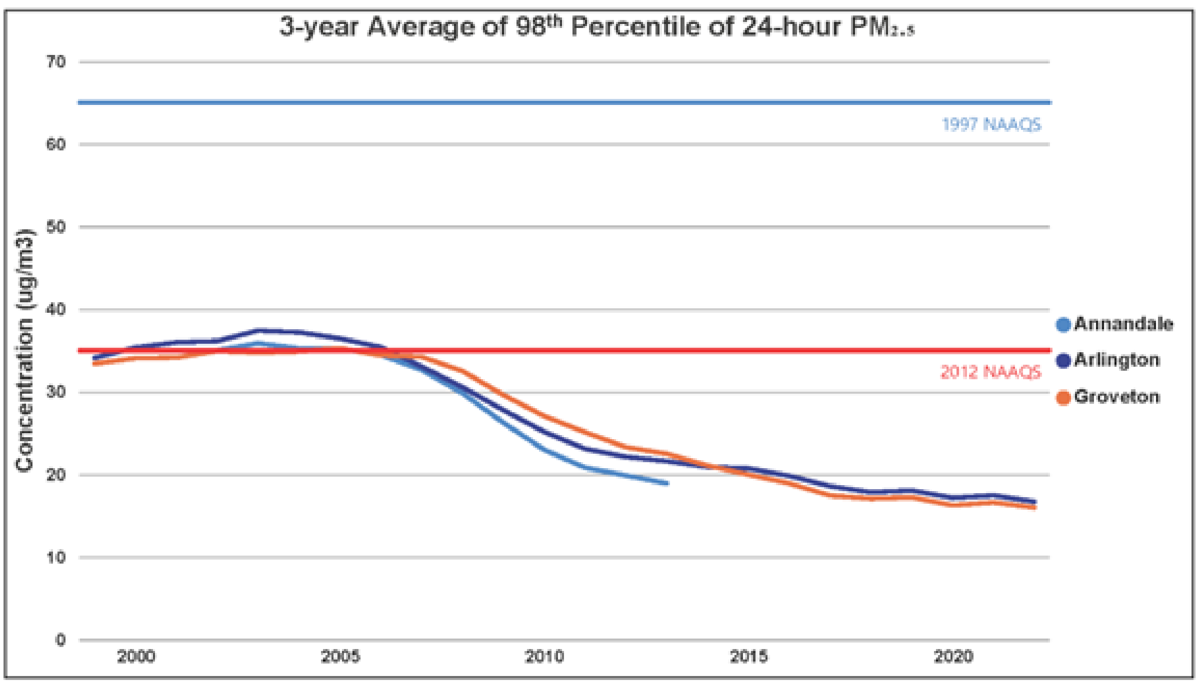
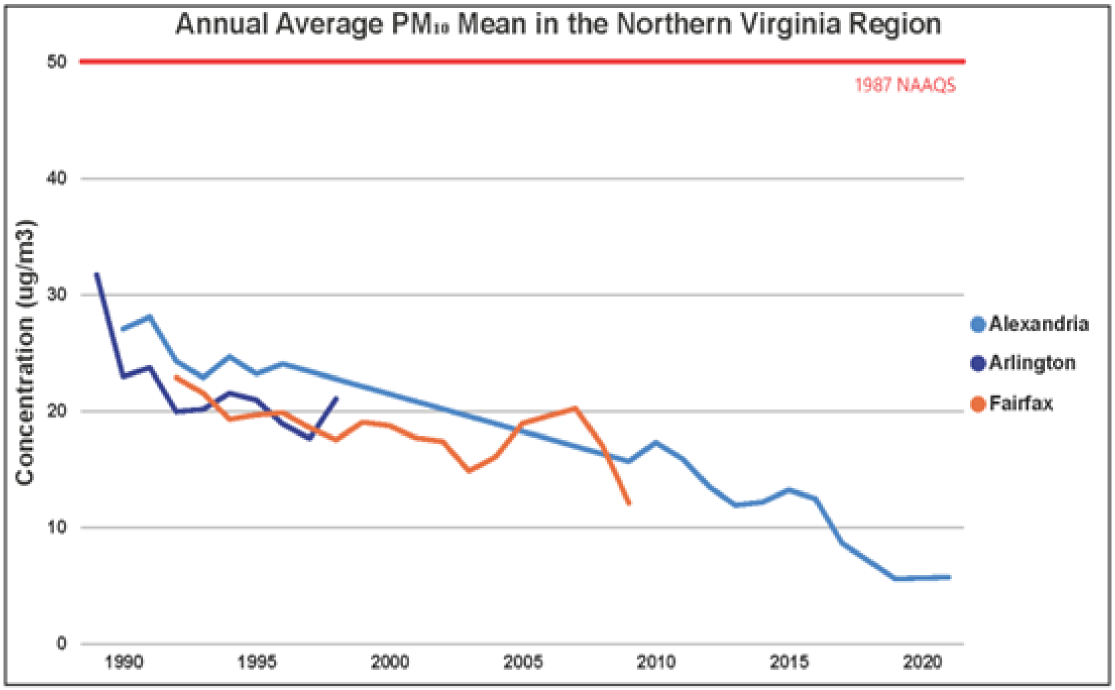
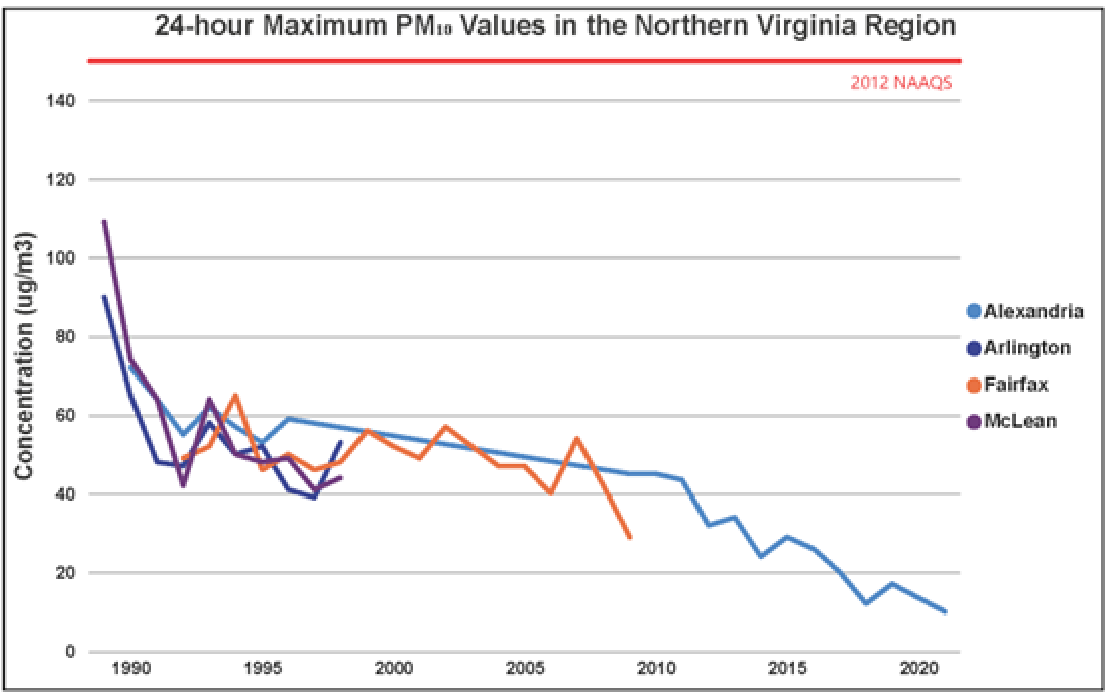


Figure 10: Particulate Matter, PM_{10}, in the Northern Virginia Region





The top graph of Figure 9 shows a 3-year average for annual $PM_{2.5}$ in the Northern Virginia region. The bottom graph shows a 3-year average of the 98th percentile for 24-hour $PM_{2.5}$ (the design value) in the Northern Virginia region. The $PM_{2.5}$ graphs consist of data from $PM_{2.5}$ hourly concentrations taken at monitors located in Annandale, Arlington, and Groveton. The sites are showing recent values below the NAAQS, which indicates an improvement in overall air quality.

The top graph of Figure 10 shows the annual average for PM_{10} in the Northern Virginia region. The bottom graph shows the 24-hour maximum for PM_{10} in the Northern Virginia region. The PM_{10} concentration values consist of data from PM_{10} hourly concentrations taken at monitors located in Alexandria, Arlington, Fairfax, and McLean. These monitoring sites are showing recent values below the NAAQS standard which indicates an improvement in overall air quality.

SECTION 4 – CRITERIA POLLUTANT EMISSIONS

This section presents an emission trends analysis for all criteria pollutants from 1990 – 2020. Data tables and graphs are used to present the more recent (2008 – 2020) emissions trends in the City of Alexandria. All data was compiled from a variety of sources, including the EPA, VDEQ, and MWCOG. Emissions from the City's three major stationary sources, as identified in the *2009 ALX Report*, will also be discussed in this section.

This 2025 Update and Addendum will focus on the emissions trends for criteria pollutants. Information related to toxic and hazardous air pollutant emissions can be found in the *2009 ALX Report* and the *2024 VDEQ report*.

Criteria Pollutant Emission Trends in Alexandria

Emissions trends in Alexandria have continued to decrease since 1990, despite the continued increase in population. According to the Transportation Planning Board's Regional Travel Survey (2018) bicycling increased dramatically since the previous 2007/2008 survey was completed. During that time, the region's core, including the District of Columbia, Arlington, and Alexandria, showed a three-fold increase in trips by bicycle. Overall, the survey showed the portion of commute trips by car, including driving alone or in carpool, significantly decreased during that decade as commuters used other transit options, such as the bus, bikes, and walking. This is primarily due to overall changes in land use and development, as well as investments in transit and walk/bike infrastructure. (MWCOG, 2021)

This section looks at the emissions trends of each criteria pollutant with data tables and graphs. Data tables were combined with those from the *2009 ALX Report*, which showed trends from 1990 – 2008, for reference. Data in this section of the report is collected from the following sources:

- Toxics Release Inventory (TRI) Program | US EPA (2024d)
- TRI Data and Tools | US EPA (2024e)
- NEI Search | Envirofacts | US EPA (2024f)

Carbon Monoxide (CO) Emission Trends

Trends in CO emissions in the City of Alexandria are summarized in Table 2. According to the *2009 ALX Report*, CO emissions are mainly from on-road vehicles, with smaller contributions from non-road equipment like gas-powered lawn and garden tools. Area sources of CO emissions are primarily from wood burning fireplaces and stoves.

Table 2: CO Emission Trends (tons/year), 1990-2020, City of Alexandria

Sector	1990	1993	1996	1999	2002	2005	Projected in 2009	2008	2011	2014	2017	2020
Point	328	288	248	339	368	286*	392	174	128	58	63	51
Area	2,650	2,549	2,447	2,641	1,378	1,222	1,015	1,108	1,079	586	572	652
Nonroad	5,165	5,601	6,036	5,872	6,631	7,493	8,643	5,111	4,089	3,801	3,713	3,698
Onroad	51,060	42,028	32,996	20,189	17,033	14,744	11,693	6,121	4,662	5,592	4,372	3,283
Total	**59,203**	**50,466**	**41,727**	**29,041**	**25,410**	**23,745**	**21,743**	**12,514**	**9,957**	**10,037**	**8,720**	**7,683**

Figure 11: CO Emission Trends (tons/year), 2008-2020, City of Alexandria

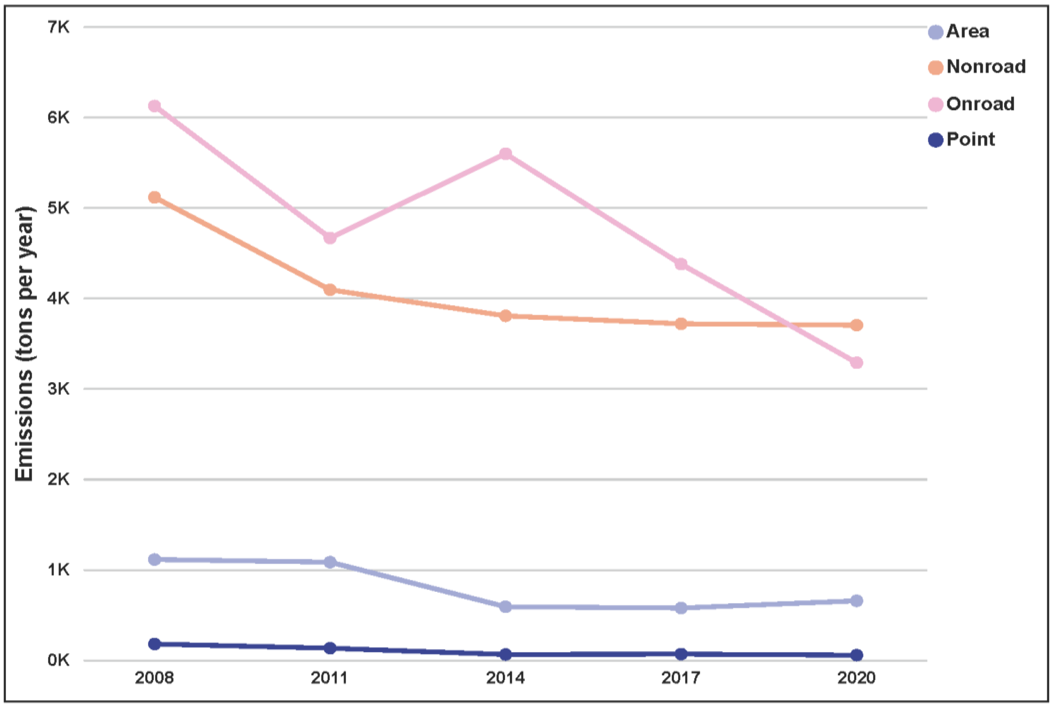


Table 2 and Figure 11 show a steady decrease in CO emissions overall. In the previous *2009 ALX Report*, CO emissions from onroad vehicles decreased by about eighty-two percent (82%) as a result of federal, state, and local control measures being implemented. From 2009 through 2020, the decreasing trend in onroad emissions continued. The drastic decrease from 2017 to 2020 could be a result of the COVID pandemic decreasing traffic and overall use of vehicles. As normal vehicle use returns, CO emissions levels may increase, with possible offset of emissions from the continued removal of older vehicles being replaced by newer, cleaner vehicles with more efficient emissions controls and better fuel economy as well as the replacement of gas-powered vehicles by electric vehicles entering the market.

Nonroad emissions showed a slight increase over the 1990 to 2009 data trends but showed a continued decrease from 2009 through 2020. This trend is expected to continue decreasing as more stringent local regulations are enforced for construction sites and with the anticipated decrease in use of gas-powered lawn and garden equipment in the City.

Point source and area contributions to CO emissions remained minimal from 1990 through 2020. Section 6 of this report includes discussion on the City's efforts in reducing CO emissions, including new development conditions for electrification, increasing the available multi-model means of transportation throughout the City, and movement toward banning gas-powered leaf blowers in the City.

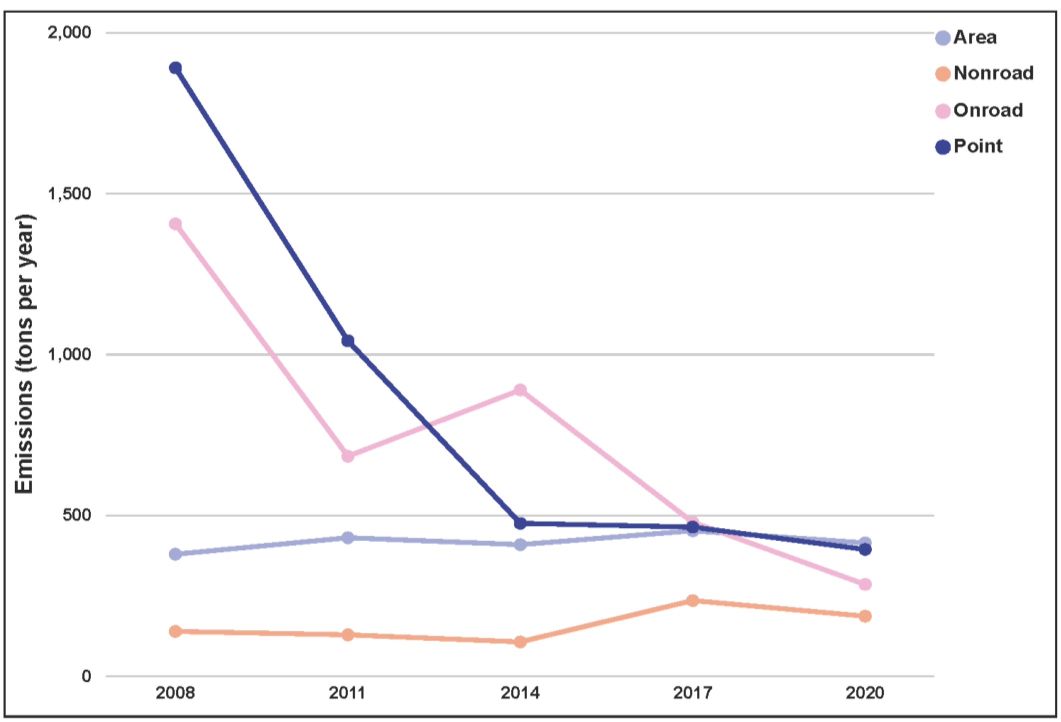
Nitrogen Oxide (NO_x) Emission Trends

Trends in NO_x emissions in the City of Alexandria are summarized in Table 3 and Figure 12. The largest source of NO_x emissions in the City of Alexandria was attributed to point source emissions from PRGS. 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.

Table 3: NO_x Emission Trends (tons/year), 1990-2020, City of Alexandria

Sector	1990	1993	1996	1999	2002	2005	Projected in 2009	2008	2011	2014	2017	2020
Point	7,445	7,620	7,794	7,622	6,342	3,141*	2,358	1,889	1,041	473	462	392
Area	1,921	1,262	603	674	528	545	567	377	428	407	450	412
Nonroad	502	518	534	165	162	154	144	137	127	105	233	185
Onroad	4,387	3,976	3,566	2,103	2,174	1,745	1,174	1,404	682	888	477	283
Total	**14,255**	**13,376**	**12,497**	**10,564**	**9,206**	**5,585**	**4,243**	**3,807**	**2,278**	**1,873**	**1,622**	**1,273**

Figure 12: NO_x Emission Trends (tons/year), 2008-2020, City of Alexandria



As noted in the *2009 ALX Report*, PRGS emitted about 65% of the City's total NO_x in 2002, prior to its partial shutdown. From there, NO_x emissions trends showed dramatic decreases in point source emissions by 2005, as seen in Table 3. This significant downward trend in point source emissions continued from 2005 through 2014, when PRGS continued a phased shutdown that culminated with plant closure on September 30th, 2012. Removing the most significant NO_x emissions contributor from Alexandria.

Section 2 of this report discussed improvements in the Virginia Paving hot mix asphalt plant and Reworld^{TM} emission control technology and pollution control technology, which also reduced NO_x emissions from these facilities.

Additionally, a significant decrease in emissions from onroad sources is seen from 2008 to 2020. This is attributed to the federal, state, and local control measure for onroad vehicles mentioned in the previous section. Requirements for cleaner emissions regulations, improvements in commuter transportation options available, and the most recent integration of electric vehicles contribute to the decline in onroad emissions. Trends in area and nonroad emissions show a decrease from 1990 through 1996 but have leveled out and remained relatively constant through 2020. Altogether, the city has seen an overall decrease in NO_x emissions from 2008 to 2020.

Section 6 of this report includes further discussion of the City's efforts in reducing NO_x emissions, including fleet electrification.

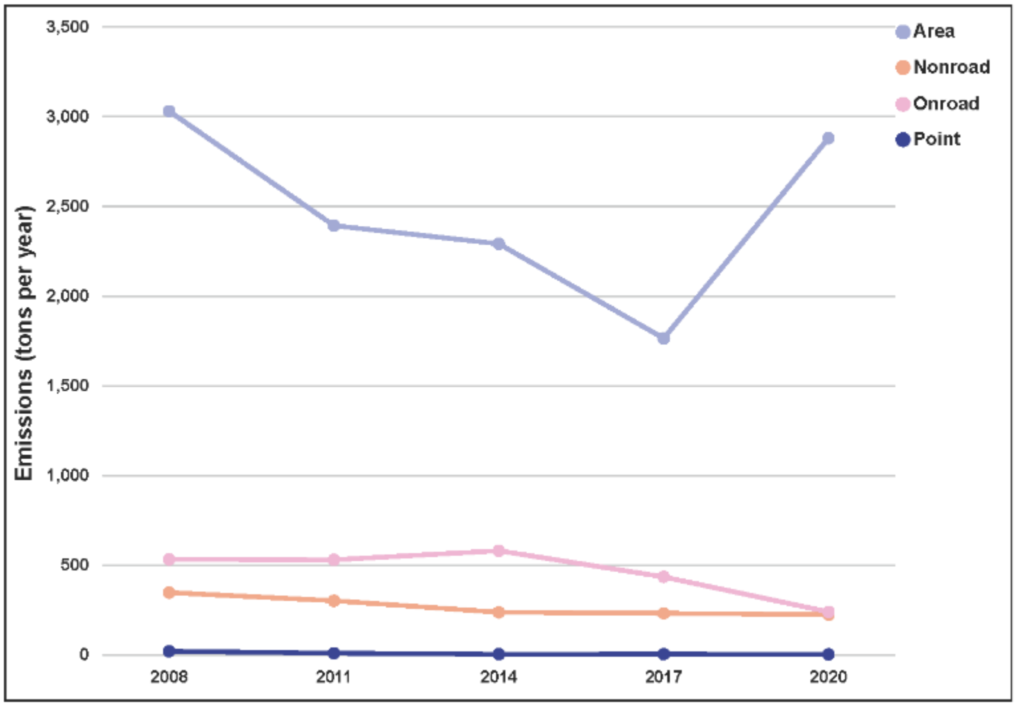
Volatile Organic Compounds (VOC) Emission Trends

Trends in VOC emissions in the City of Alexandria are summarized in Table 4 and Figure 13. As noted in the *2009 ALX Report*, 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.

Table 4: VOC Emission Trends (tons/year), 1990-2020, City of Alexandria

Sector	1990	1993	1996	1999	2002	2005	Projected in 2009	2008	2011	2014	2017	2020
Biogenic	2,420	2,420	2,420	2,420	2,420	2,420	2,420					
Point	41	47	53	66	47	39*	42	17	6	.06	1.5	0.1
Area	2,739	2,682	2,625	2,308	2,285	2,193	2,070	3,027	2,389	2,287	1,761	2,877
Nonroad	457	474	491	388	514	445	353	344	299	235	229	222
Onroad	4,606	3,670	2,735	1,713	1,133	934	668	529	527	577	432	236
	10,263	**9,293**	**8,324**	**6,895**	**6,399**	**6,031**	5,553	**3,918**	**3,221**	**3,100**	**2,423**	**3,335**

Figure 13: VOC Emission Trends (tons/year), 2008-2020, City of Alexandria



Overall, VOC emissions trends show a slight decrease from 2008 to 2020. As noted in the *2009 ALX Report*, more stringent regulations to lower fuel volatility and reduce VOC emissions were implemented and showed an 80% decrease in onroad emissions from 1990 to 2005. This decreasing trend for onroad emissions continued through 2020, resulting from stringent regulations and replacement of older, less efficient vehicles with newer, more efficient vehicles with more effective emission control and greater fuel economy. With the addition of electric vehicles and increasing commuter or alternate transportation options available, it is hoped this decrease in VOCs from onroad vehicles will continue.

VOCs from area sources remained relatively consistent from 1990 to 2014, showed a decrease in 2017, but increased again in 2020. The city is unsure of the exact reason for this marked increase in 2020.

Point source VOC emissions from 2005 to 2020 decreased to almost no contribution to the overall VOC emissions in the region. Nonroad emissions remained relatively constant.

Section 6 of this report includes further discussion on how the City and Metropolitan Region work toward reducing VOC emissions, including fleet electrification, limiting idling of heavy equipment, and continual improvements in providing multi-model means of transportation throughout the city.

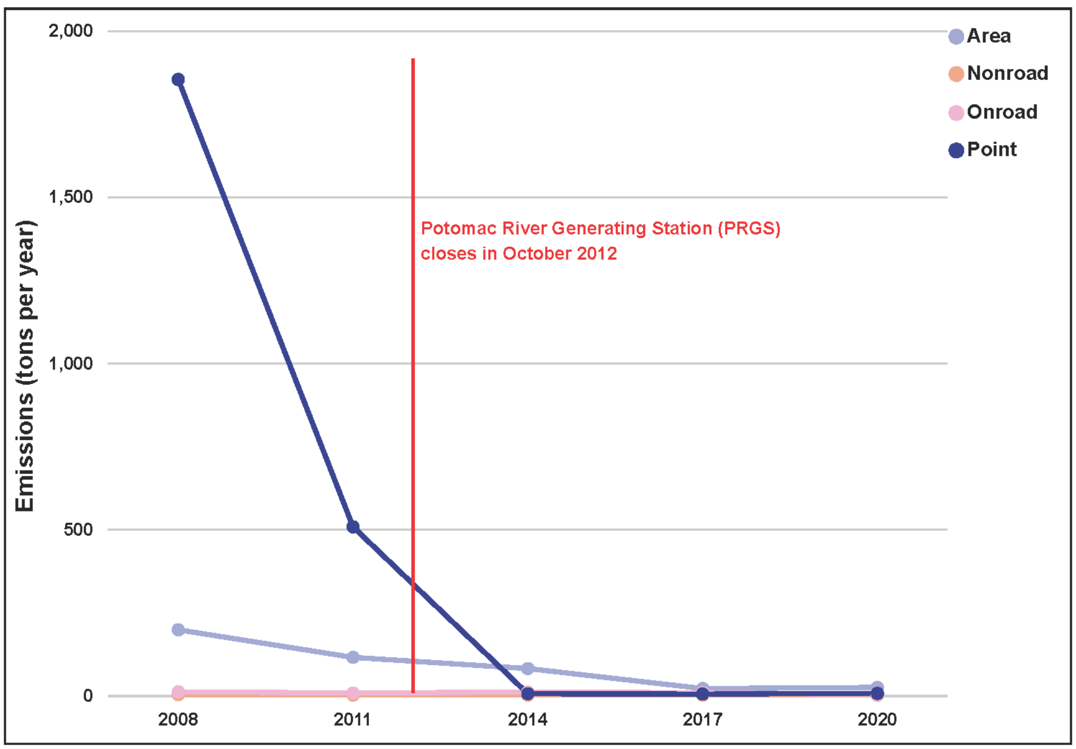
Sulfur Dioxide (SO_2) Emission Trends

Trends in SO_2 emissions in the City of Alexandria are summarized in Table 5 and Figure 14. As noted in the *2009 ALX Report*, nearly all the SO_2 emissions in the city were generated by the coal-fired PRGS plant. In addition, a small amount of SO_2 is generated by combustion of fossil fuels in residential, commercial, and industrial heating units.

Table 5: SO_2 Emission Trends (tons/year), 1990-2020, City of Alexandria

Sector	1990	1993	1996	1999	2002	2005	Projected in 2009	2008	2011	2014	2017	2020
Point	13,770	12,310	10,850	17,747	16,145	8,516*	3,850	1,852	507	4.6	3.8	5.5
Area	1,232	954	676	719	638	659	686	197	114	80	20	24
Nonroad	33	35	37	42	10	10	3	1.9	0.45	0.39	0.55	0.22
Onroad	203	166	129	93	79	21	12	10	6.9	9.7	7.6	2.5
	15,238	**13,465**	**11,692**	**18,601**	**16,872**	**9,206**	**4,551**	**2,062**	**628**	**95**	**32**	**32**

Figure 14: SO_2 Emission Trends (tons/year), 2008-2020, City of Alexandria



As noted in the *2009 ALX Report*, point source emissions from PRGS constituted the majority of SO_2 emissions in the City. Fluctuations in the SO_2 emissions were related to the amount of electricity generated at the plant each year. The first significant decrease in SO_2 from PRGS was in 2005, when PRGS was partially shutdown and implemented upgrades to their system that would inject a naturally occurring mineral into the exhaust gas to form a particle that was removed by the existing emissions control equipment. This significant downward trend in point source emissions continued from 2005 through 2014, when PRGS continued a phased shutdown that culminated with plant closure on September 30, 2012 and removed the most significant SO_2 emissions contributor from Alexandria.

From 2008 to 2020, all emissions sectors continued to decrease, and all sectors show low levels of SO_2 emission.

Section 6 of this report includes further discussion on how the City and Metropolitan Region work toward reducing SO_2 emissions, including new development conditions for sustainability.

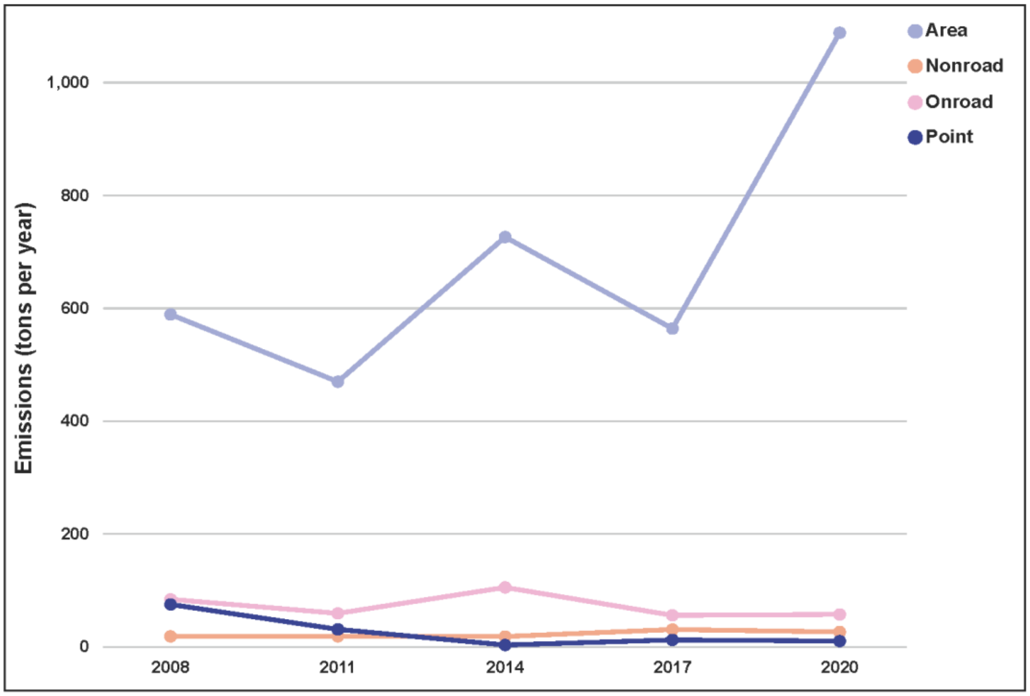
Particulate Matter (PM_{10}) Emission Trends

Trends in PM_{10} emissions in the City of Alexandria are summarized in Table 6 and Figure 15. From 1990 to 2005, the largest sources of PM_{10} emissions in the city were area sources. This includes dust from construction sites and vehicle traffic on city streets. As noted in the *2009 ALX Report*, 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.

Table 6: PM_{10} Emission Trends (tons/year), 1990-2020, City of Alexandria

Sector	1990	1993	1996	1999	2002	2005	Projected in 2009	2008	2011	2014	2017	2020
Point	563	558	554	540	505	236*	338	74	30	2.3	11	9
Area	1,398	1,398	1,398	1,221	1,138	1,156	1,180	588	469	725	563	1,087
Nonroad	25	26	28	30	19	19	19	18	18	17	30	26
Onroad	149	127	106	60	55	43	26	83	58	104	55	57
	2,135	**2,109**	**2,086**	**1,851**	**1,717**	**1,454**	**1,563**	**763**	**575**	**849**	**659**	**1,178**

Figure 15: PM_{10} Emission Trends (tons/year), 1990-2020, City of Alexandria



Point source emissions for PM_{10} showed a significant decrease in value between 2002 and 2005, when PRGS was in partial shutdown. This significant downward trend in point source emissions continued from 2005 through 2014, when PRGS continued a phased shutdown that culminated with plant closure on September 30, 2012. Removing one of the largest PM_{10} emissions contributors from Alexandria.

As noted in Section 2, Virginia Paving was also required, as part of their 2009 SUP approval, to outfit all onsite plant equipment with diesel particle traps, designed to remove diesel particulate matter or soot from exhaust gas of the diesel engine.

Nonroad and onroad emissions for PM_{10} showed fluctuations during different time periods, but overall, have remained somewhat steady from 1990 to 2020. Area emissions remain the most significant source of PM_{10}, showing an increase from 2017 through 2020. The city is unsure of the exact reason for this increase in 2020, but it could be attributed to an increase in construction during this time period. When considering all sources for PM_{10}, the trend shows overall marginal decrease from 2005 to 2020.

Section 6 of this report includes further discussion on how the City and Metropolitan Region are working toward reducing particulate matter emissions, including new light, medium, and heavy-duty vehicles emissions requirements, sediment and dust control for construction sites, and limiting allowable idling times.

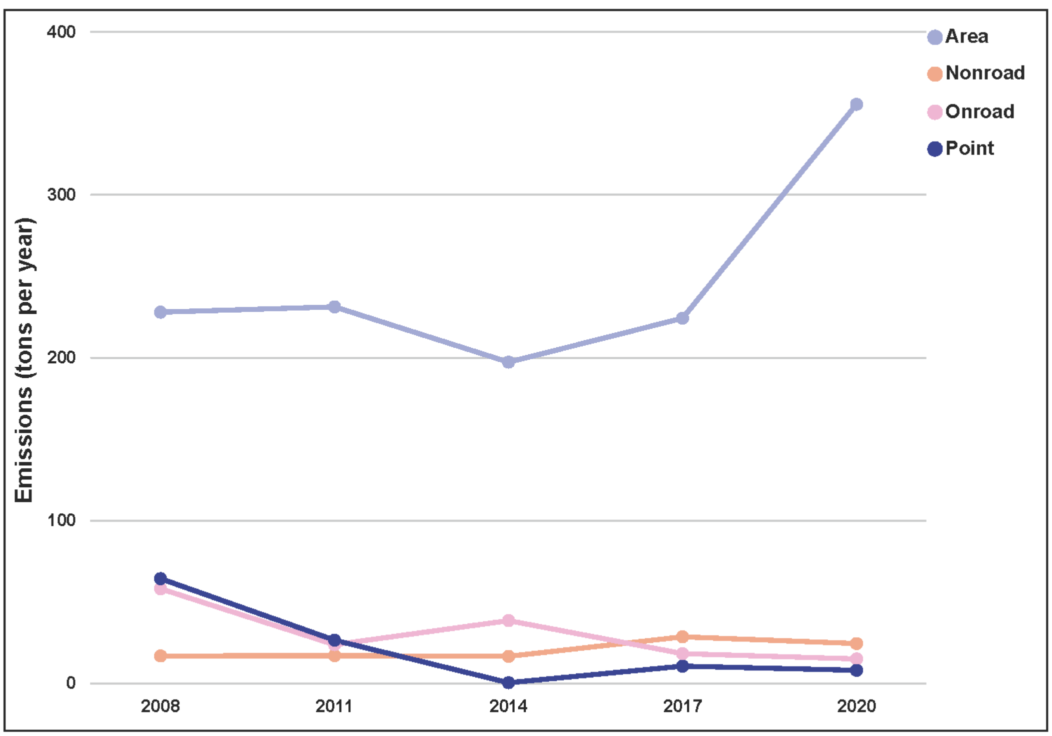
Particulate Matter ($PM_{2.5}$) Emission Trends

Trends in $PM_{2.5}$ emissions in the City of Alexandria are summarized in Table 7 and Figure 16. As noted in the *2009 ALX Report*, the largest source of $PM_{2.5}$ emissions was the PRGS plant. In 2002, PRGS emitted approximately 54% of the City's total $PM_{2.5}$. Area sources include combustion processes such as those occurring in onroad/offroad engines and residential, commercial, and industrial heating units as well as regional wildfire smoke transport. Other area sources include dust particles generated at construction sites and from vehicle traffic on city streets.

Table 7: $PM_{2.5}$ Emission Trends (tons/year), 1990-2020, City of Alexandria

Sector	1990	1993	1996	1999	2002	2005	Projected in 2009	2008	2011	2014	2017	2020
Point	283	279	274	257	326	139*	220	64	26	0.02	10	7.7
Area	389	389	389	323	217	220	225	228	231	197	224	355
Nonroad	23	24	25	27	19	18	17	16	17	16	28	24
Onroad	120	101	81	43	39	31	20	58	23	38	18	15
	815	**793**	**769**	**650**	**601**	**408**	**482**	**366**	**297**	**251**	**280**	**402**

Figure 16: $PM_{2.5}$ Emission Trends (tons/year), 2008-2020, City of Alexandria



Point source emissions for $PM_{2.5}$ showed a significant decrease from 2002 through 2005, when PRGS was in a partial shutdown. This significant downward trend in point source emissions continued from 2005 through 2014, when PRGS continued a phased shutdown that culminated with plant closure on September 30, 2012. Removing one of the largest point source contributors of $PM_{2.5}$ emissions in Alexandria.

Onroad $PM_{2.5}$ emissions trends also showed a decrease, most significantly between 1990 and 1999 due to new engine technologies and cleaner fuels. Area source emissions have decreased due to decreases in emissions from residential wood combustion and improved air quality controls associated with construction activity.

Section 6 of this report includes further discussion on how the City and Metropolitan Region are working toward reducing particulate matter emissions, including new light, medium, and heavy-duty vehicles emissions requirements, sediment and dust control for construction sites, and limiting allowable idling times. Additionally, previous sections of this report also addressed how state requirements and the City have implemented more stringent permit limits requiring further control of stack and fugitive $PM_{2.5}$ emissions from city industries.

SECTION 5 – GREENHOUSE GAS EMISSIONS

Gases that trap heat in the Earth's atmosphere are called greenhouse gases (GHGs). The main GHGs in the atmosphere are CO_2, methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. Of these, CO_2 is the most common greenhouse gas emitted through human activities, which in 2022, accounted for approximately 80% of all U.S. greenhouse gas emissions (EPA, 2025a).

Since 2005, the City has invested in planning, programming, and projects that mitigate greenhouse gas emissions and reduce energy use in City operations and across the community. The City's *2019 Environmental Action Plan 2040 (EAP 2040)* and *2023 Energy and Climate Change Action Plan (ECCAP)* lay out strategy, targets, goals, and potential actions for addressing the causes of climate change and its ongoing impacts.

This section presents the results of the most recent inventory of the City's greenhouse gas emissions for both the community as a whole and for the City's operations.

2020 Community-Wide Inventory Breakdown & Contribution Analysis

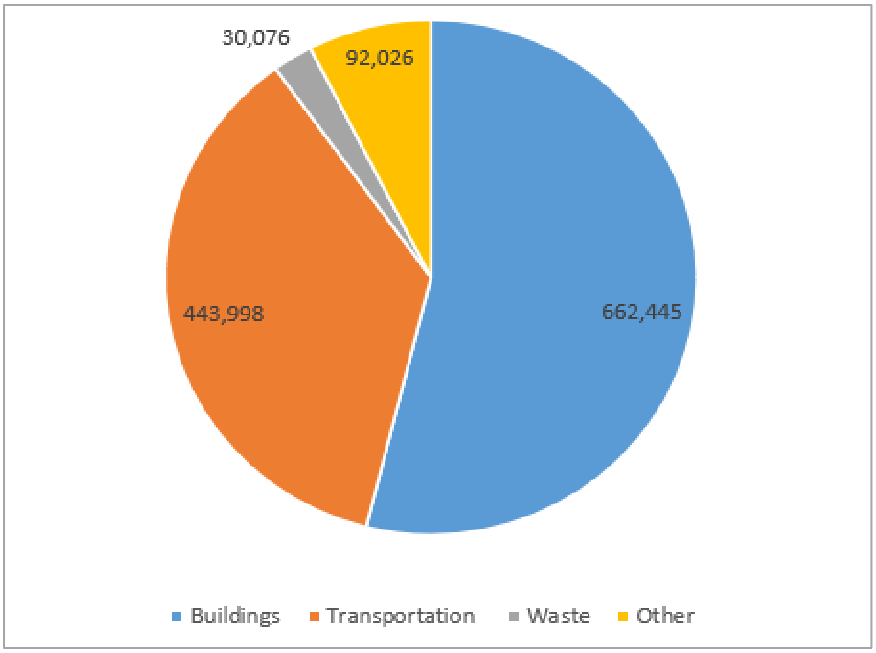
The MWCOG Community Greenhouse Gas Inventory for Alexandria, VA measures all GHG-emitting activities in the City during a given year. Figure 17 shows the 2020 GHG emissions by sector in the City.

The largest portion of the community's GHG emissions in 2020 came from buildings, accounting for 54% of total emissions. These emissions resulted from electricity consumption and onsite fossil fuel combustion within buildings. Drilling down into the buildings sector further, emissions from commercial buildings accounted for approximately 60% of the total emissions in this sector.

The next largest source of community-wide emissions in the City was from transportation, which accounted for 36% of total emissions in 2020. These emissions include onroad, offroad, aviation, and rail transportation. Of these, onroad transportation was the largest source of emissions, comprising approximately 80% of the total emissions from the transportation sector.

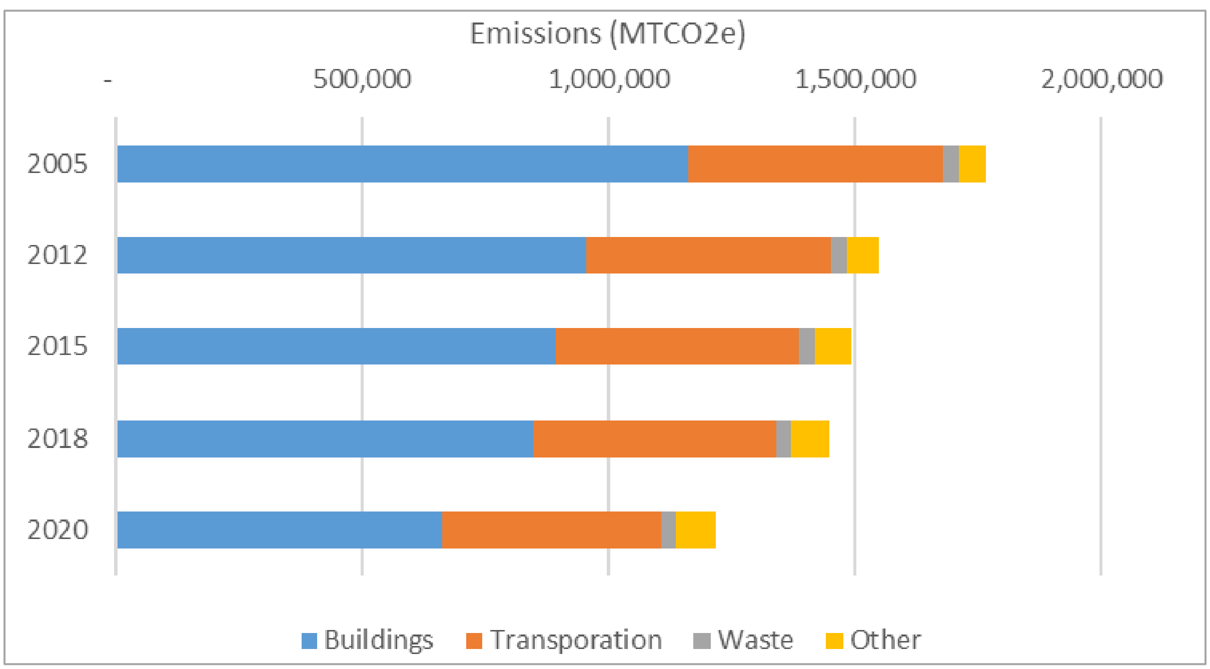
Waste, including solid waste and wastewater emissions, accounted for 2% of the City's total emissions. The category "other", comprised of process and fugitive emissions as well as agricultural emissions, accounted for 8% of total emissions in 2020.

Figure 17: 2020 GHG Emissions by Sector (MTCO2e)



COG and local governments across the broader Metropolitan Washington region collaboratively established the regional GHG emission reduction goals of 10% below business-as-usual projections by 2012 (back down to 2005 levels); 20% below 2005 levels by 2020; 50% by 2030; and 80% below 2005 levels by 2050. Metropolitan Washington met both the 2012 and 2020 goals. Emissions from buildings and transportation saw a greater reduction than anticipated due to reduced activity in all sectors from the 2020 pandemic. Figure 18 shows the GHG emissions trends in the City from 2005 – 2020.

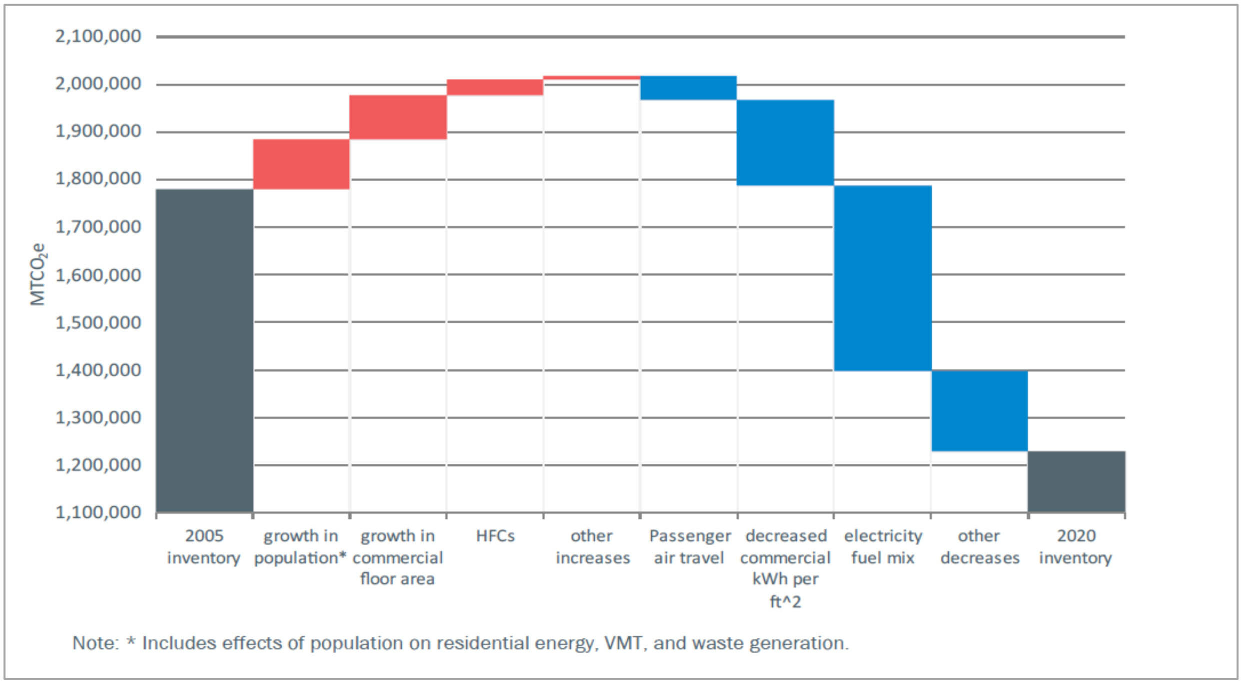
Figure 18: GHG Emissions Trend from 2005 to 2020



Drivers of Emissions Increases & Reductions

Figure 19 shows the main drivers of emissions increases and reductions. The main drivers of increasing emissions (red bars) are population growth, the growth of commercial building floor area, and HFCs. Drivers of emissions reduction (blue bars) are primarily a cleaner electricity grid (electricity fuel mix), decreased commercial electricity energy intensity, and reduced passenger air travel (MWCOG, 2022).

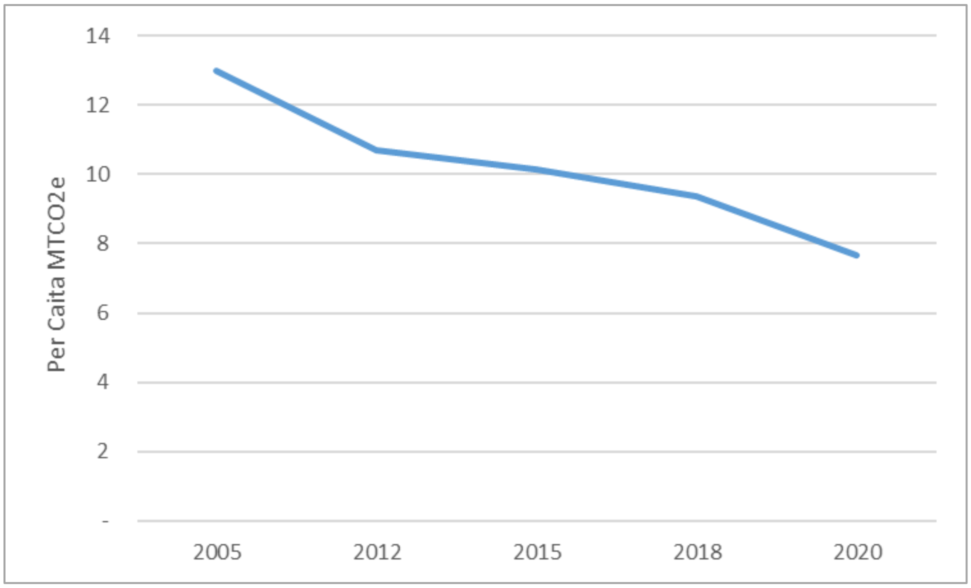
Figure 19: Drivers of Emissions Increases and Emissions Reduction



Per capita Emissions

The community had a per capita emissions rate of 7.7 MTCO2e in 2020. Despite a growing population, Figure 20 demonstrates that total emissions have decreased since 2005. While the 2020 pandemic most likely caused a larger than anticipated decrease in emissions, the overall trend of declining emissions and a growing population are a positive sign of steady progress toward reducing per capita emissions in the community.

Figure 20: Per Capita Emissions



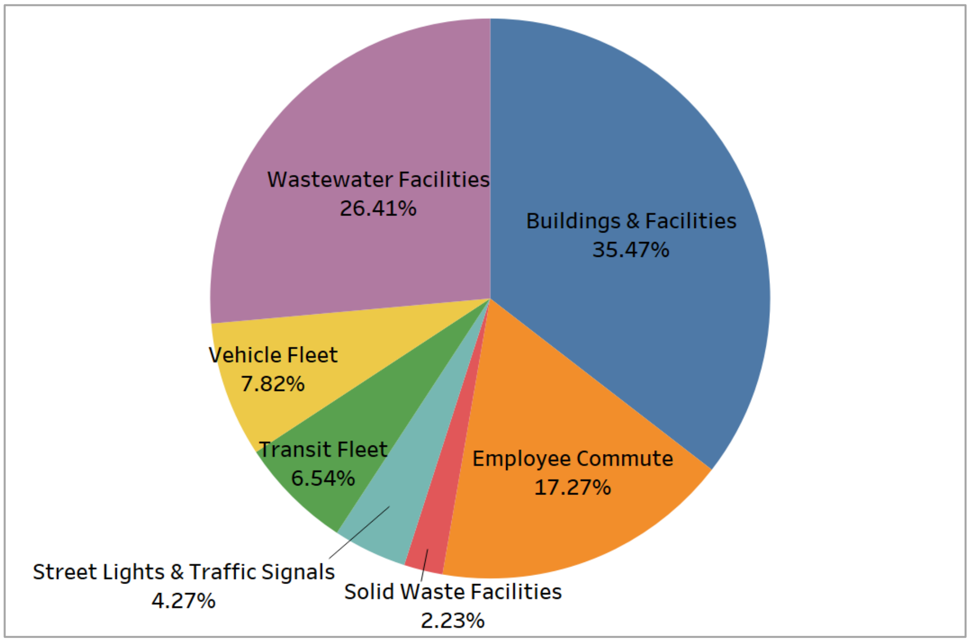
2020 City Operations GHG Inventory

The City Operations GHG Inventory was compiled by staff with the best available data utilizing the Local Government Operations Protocol (LGOP)[1].

In 2020, GHG emissions from City Operations, including Alexandria City Public Schools (ACPS), Alexandria Redevelopment and Housing Authority (ARHA), and AlexRenew, totaled an estimated 63,539 MTCO2e. The breakdown of relative contributions toward that total is in Figure 21. Similar to the MWCOG Community Greenhouse Gas Inventory, buildings contributed the most to GHG emissions, and electricity consumption within those buildings was the single largest driver of these emissions.

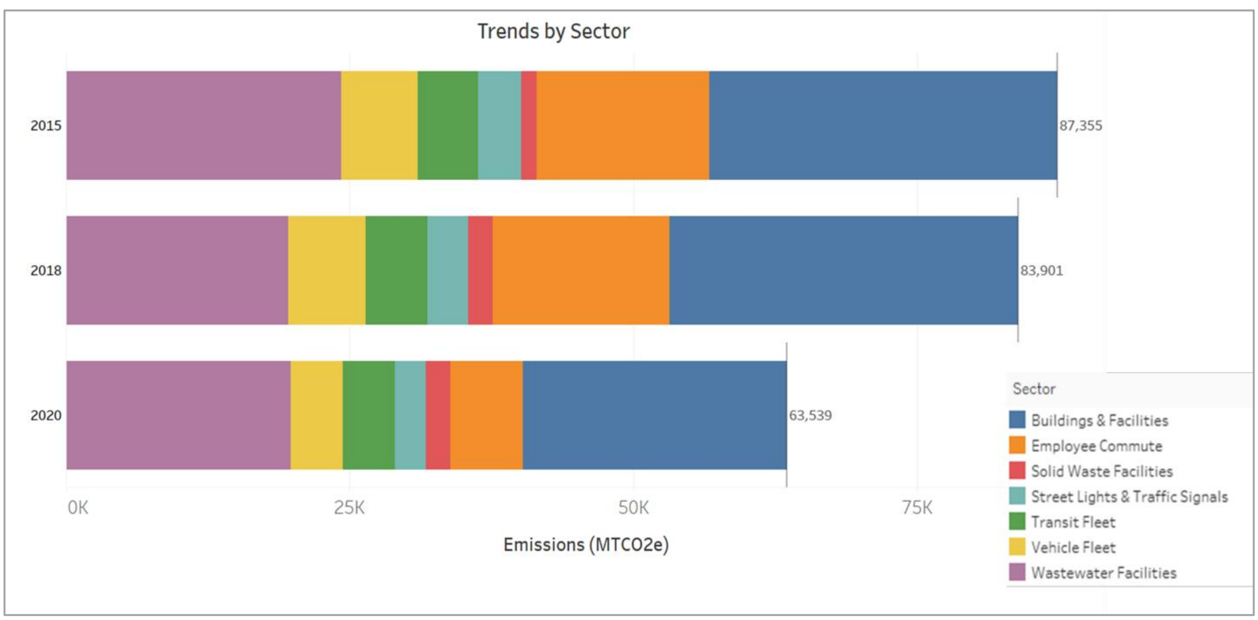
[1] https://ww2.arb.ca.gov/sites/default/files/classic/cc/protocols/lgo_protocol_v1_1_2010-05-03.pdf

Figure 21: 2020 City Operations GHG Inventory Summary



Between 2015 and 2020 there was an estimated 27% reduction in GHG emissions from City operations, as seen in Figure 22. Most of that estimated reduction was due to modeled reductions in employee commuting due to the COVID-19 pandemic. Since the FY06 inventory, the 2015 inventory is the most recent inventory year for City operational GHG emissions and, therefore, 2015 data was used in this report.

Figure 22: Trend from 2015



SECTION 6 – CITY INITIATIVES AND PROGRAMS

Air quality continues to improve, but there is still work to be done. Federal, state and local governments continue to review health and environmental impacts of pollutants, leading to new, stricter regulations and initiatives. The City has also remained committed to doing its share to continue to improve air quality, reduce greenhouse gas emissions, and move Alexandria towards sustainability. This section describes some of the steps the City has taken since the *2009 ALX Report* and continues to take as the City strives to meet its air quality and climate change commitments identified in the Eco-City Charter, EAP 2040, and ECCAP.

The Environmental Action Plan

The Alexandria City Council approved the City's Eco-City Charter at a public hearing on Saturday, June 14, 2008. The Eco-City 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.

City Council approved the EAP 2030 in June 2009 and the updated EAP 2040 in July 2019. The EAP serves as a 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. Prior to the EAP 2040 update, the City fulfilled or exceeded a majority of its 363 actions. Alexandria also became a Virginia Municipal League leader in regional sustainability for 11 years in the Go Green Virginia challenge, which is a recognition of local government programs and policies to promote sustainability at the highest level (ALX, 2017).

The updated EAP 2040 builds on the 2008 Eco-City Charter and the EAP 2030, covering the same ten topic areas as the original plan. It acknowledged and included updates on what has been achieved; considered the changing global, regional, and state issues; identified the fiscal resources required; and created a responsive environmental road map and new recommendations to further advance sustainability for the City of Alexandria. The new EAP 2040 plan focuses on climate change mitigation and adaptation (ALX, 2019).

The goals and action items associated with air quality and climate change are listed on the following page.

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

Air Quality Goal: Improve ambient air quality	Climate Change Goal: Increase the City's preparedness to respond to the impacts of climate change and environmental emergencies
Action 1: Evaluate potential methods for reducing air pollution and incorporate into standard development conditions. Action 2: Expand the City's Air Quality Action Day, including outreach. Action 3: Develop strategies to reduce air pollution from dispersed, non-point sources. Action 4: Promote use of battery-powered leaf blowers and lawn mowers, including possible incentives. Action 5: Develop methods to quantify air pollution impacts and benefits of major transportation projects. Action 6: Prepare a "State of the Air" report, including recommendations for further air quality improvement opportunities. Action 7: Complete recommended measures identified in the "State of the Air" report.	Action 1: Establish a task force to guide the update of the Energy and Climate Change Action Plan (ECCAP). Action 2: Determine policies/guidelines for estimating projected greenhouse gas emission impacts from operations and capital improvement programs. Action 3: Establish sustainability criteria for investments made by city-controlled pension funds. Action 4: Complete a climate vulnerability assessment of community and infrastructure systems. Action 5: Update ECCAP to evaluate the benefits of policies and programs. Action 6: Update the City's Emergency Operations Plan and Continuity of Operations Plan to include infrastructure resilience. Action 7: Develop/Implement a state-level engagement strategy to identify and support policy opportunities to reduce GHG emissions from the community. Action 8: Implement ECCAP action #4 and include climate action measures.

The Energy and Climate Change Action Plan (ECCAP)

The City's 2023 Energy and Climate Change Action Plan (ECCAP), completed in May 2023, builds off the City's 2011 ECCAP 2012-2020 and EAP 2040. It was developed in partnership with the Alexandria Department of General Services and the Department of Transportation and Environmental Services. The ECCAP Task Force was initiated by City Council under Resolution 2958. This resolution established the Task Force and its purpose of providing guidance to the City of Alexandria during the process of updating the ECCAP. The task force was comprised of 12 members appointed by the City, including general community representatives, environmental advocates, technical experts, representatives from Alexandria's youth, members representing equity issues, and those representing Alexandria's businesses and institutional partners.

The ECCAP describes a pathway and specific actions for the city to reduce greenhouse gas emissions as well as strategies to minimize the potential impacts of increasing extreme heat and flooding risks. It provides an understanding of how the city is addressing climate change and serves as a guidebook for how City resources will be prioritized (ALX, 2023).

This State of the Air Report is consistent with and complementary to the City's 2023 ECCAP. The ECCAP provides a forward-looking framework for reducing greenhouse gas emissions across the buildings, transportation, electricity, and industrial sectors, while this report evaluates historical and current trends in criteria pollutants regulated under the Clean Air Act. Many of the sectoral shifts identified in the ECCAP—such as coal-plant retirement, improved vehicle emission controls, and the transition to cleaner electricity—are the same drivers responsible for the long-term reductions in ozone precursors, particulate matter, carbon monoxide, and other pollutants documented here.

While the ECCAP emphasizes climate mitigation and future planning, the State of the Air Report demonstrates the measurable air-quality benefits that have resulted from past and ongoing policy actions. Together, these documents show a coherent and aligned strategy: reducing fossil-fuel combustion improves both climate outcomes and local public health. The two reports therefore reinforce each other and illustrate the City's integrated approach to managing greenhouse gas emissions and criteria air pollutants.

Air Quality Action Day Program

The City of Alexandria continues to participate in the Air Quality Action Days volunteer public awareness program sponsored by Clean Air Partners. This program is designed to focus on changing individual behavior and increasing awareness about the health and environmental dangers of ground-level ozone (or smog) and $PM_{2.5}$.

Prolonged exposure to ozone and $PM_{2.5}$ can cause inflammation and irritation of the respiratory tract, as well as other health concerns. The most susceptible groups are children, seniors, and individuals with respiratory ailments; however, individuals of any age can be affected.

The Air Quality Action Day program uses color-coding to identify how air quality could impact one's health on a given day. Each air quality index category is associated with ozone and particulate pollution ppm values. From May through September, air quality is forecasted for the following day on a region-wide basis and is coded as maroon, purple, red, orange, yellow, or green, with maroon, purple and red being most unhealthy.

Recently, the breakpoint between a Code Green (Good) and Code Yellow (Moderate) decreased from 12ppm to 9ppm to reflect the updated annual $PM_{2.5}$ standard value. This will likely result in less Code Green and more Code Yellow days. Additionally, the EPA updated the breakpoints at the upper end of the unhealthy (red), very unhealthy (purple), and hazardous (maroon) categories to address scientific evidence related to particle pollution and health. Tougher standards will result in more Code Purple and Code Maroon days and is expected to result in significant public health net benefits ($46 billion in 2032). Health benefits will include up to 4,500 avoided premature deaths, 800,000 avoided cases of asthma symptoms, and 290,000 avoided lost workdays (in 2032). The costs of controls applied toward this standard were estimated to be $590 million in 2032. Changes to the category breakpoints are shown in Table 8 (MWCOG, 2024b).

Table 8: AQI Category Color-Coding Table for Air Quality

2023 AQI for Fine Particle Pollution *(Breakpoints are in micrograms per cubic meter)*			
AQI Category and Index Value	**Previous AQI Category Breakpoints**	**Updated AQI Category Breakpoints**	**What changed?**
Good (0 – 50)	0.0 to 12.0	0.0 to 9.0	EPA updated the breakpoint between Good and Moderate to reflect the updated annual standard of 9 micrograms per cubic meter
Moderate (51 – 100)	12.1 to 35.4	9.1 to 35.4	
Unhealthy for Sensitive Groups (101 – 150)	35.5 to 55.4	35.5 to 55.4	No change, because EPA retained the 24-hour fine PM standard of 35 micrograms per cubic meter.
Unhealthy (151 – 200)	55.5 to 150.4	55.5 to 125.4	EPA updated the breakpoints at the upper end of the unhealthy, very unhealthy, and hazardous categories based on scientific evidence about particle pollution and health. The Agency also collapsed two sets of breakpoints for the Hazardous category into one.
Very Unhealthy (201 – 300)	150.5 to 250.4	125.5 to 225.4	
Hazardous (301+)	250.5 to 350.4 and 350.5 to 500	225.5+	

Participants in the Air Quality Action Day program are notified by 4 p.m. the day before an air quality Code Red day, an unhealthy air day, so you can take action to protect your health and the environment. The City of Alexandria also shares Air Quality Action Day alerts/notifications on the City of Alexandria's Air Quality website and City's Homepage and monitors air quality through the Emergency Management team.

You can find many ways to protect your health and our air with the Clean Air Partners Action Guide, by understanding the recommended do's and don'ts for Air Quality Action Days and taking individual actions to reduce the release of VOCs, NO_x and PM, especially during the hottest parts of the day.

Office of Climate Action

The City of Alexandria declared a Climate Emergency on October 22, 2019; and the Office of Climate Action was created in 2023 to engage the community, challenge them to make changes in their homes, how they travel, and other sustainable choices.

The Office of Climate Action includes three new staff positions to meet this mission – Climate Action Officer, Community Engagement and Climate Justice Manager, and Electric Vehicle Planner. These positions are joined by the Energy Manager, Sustainability Coordinator, Green

Building Manager, and an Energy Management Analyst.

The Office of Climate Action is implementing several programs and initiatives to improve indoor and outdoor air quality and reduce greenhouse gas emissions. For example, the Eco-City Homes program promotes the electrification of appliances and other energy efficiency measures, and the City's electric vehicle (EV) program promotes increased EV adoption in the community.

The City's first Green Building Policy was adopted in 2009 and updated in 2019. The 2019 Policy is currently being updated. Nearly all development projects in the City comply with or meet the intent of the Policy. Additionally, sustainability-related conditions have been incorporated into development plan approvals. These conditions address demonstrating compliance with the Green Building Policy, building solar-readiness, limiting combustion in buildings and on building sites, and electric vehicle charging infrastructure. These standard development conditions are reviewed and updated annually.

Revised, More Health-Protective NAAQS

This report includes information related to the changes in NAAQS values over the years, leading to stricter federal, state, and local efforts to improve air quality for human health and the environment.

Since the *2009 ALX Report*, there were updates in 2010 where the NAAQS SO_2 annual standard was replaced by the new 1-hour standard of 75ppb and a new NO_2 1-hour standard of 100ppb was established. Not surprisingly, ozone showed the most revisions, ultimately decreasing the NAAQS 8-hour standard value to 0.070ppm, and particulate matter showed the most recent update to the NAAQS standards. In May 2024, the $PM_{2.5}$ annual standard was reduced to 9.0μg/m^3 as the health effects of fine particulate matter continue to become more well-known.

More Stringent Standard Development Conditions

Each year the City reviews the list of standardized development conditions that are applied, as applicable, to each new development plan submitted for the City's review and approval. Standards have become more robust and focused on sustaining our communities for generations to come. In general, the requirements for a construction management plan have improved and include elements of mitigating airborne dust, increasing erosion and sediment control measures, and restricting allowable times for construction vehicles and trucks to idle. Additionally, specific air quality conditions are in place to reduce odors and other air pollution resulting from operations at a site and minimize idling of refrigerated delivery trucks by requiring installation of electrical plugs within loading docks.

To promote alternative means of transportation, versus using gas-powered single occupancy vehicles (SOV), the City has included various standard conditions that can be applied to each development. To make the City more walkable or safe for biking, 2023 standard conditions require sidewalks to comply with the City's Green Streets and Sidewalks guidance and upgrade any transit stops near the site. The conditions also require the developer to provide bicycle facilities on the site per the City's Alexandria Mobility Plan and provide a contribution to the Capital Bikeshare program. In 2023, the Council adopted a new Transportation Management Plan (TMP) Policy that requires new developments to contribute funding to the GO Alex Fund which will be used for projects and programs that encourage non-SOV travel.

As part of the initiative to move from gas-powered vehicles to electric vehicles, the City added standard conditions where new construction of multi-family and commercial properties must install EV chargers in 5% of the parking spaces and at least 50% are required to be EV charger ready. Townhouses, duplexes, and single-family homes must accommodate a future Level 2 EV charger for garaged parking spaces.

Energy focused conditions include the requirement to comply with the Green Building Policy, provide electrified buildings (versus gas powered), and ensuring the roofs are solar-ready. These development conditions are updated as necessary, approximately annually.

Multi-Modal Transportation Initiatives

Most of the City's planned improvements in air quality are connected to the transportation sector and associated initiatives. As transportation is made easier and cleaner, air quality is expected to continue improving.

Like most cities, Alexandria has historically relied on gas-powered single occupancy vehicles for transportation. Over the years, the City has updated city code, master plans, and initiatives to provide residents and visitors with innovative options for transportation.

Alexandria Mobility Plan (AMP)

The Alexandria Mobility Plan (AMP) was adopted in 2021 as a strategic update to the 2008 Transportation Master Plan. This plan focuses on putting Alexandrians first, reducing dependance on the automobile, and encouraging the use of alternative modes of environmentally friendly transportation options. It launched the city into more than a decade of innovative transportation improvements that help protect our air quality in addition to reducing congestion, improving transit, cut-through traffic, and making the transportation system safer.

ACPS Bus Fleet Upgrades

VDEQ awarded ACPS a grant to retrofit approximately 40 diesel powered school buses with emission control devices. Improving air quality by reducing diesel PM, VOCs, and CO emissions.

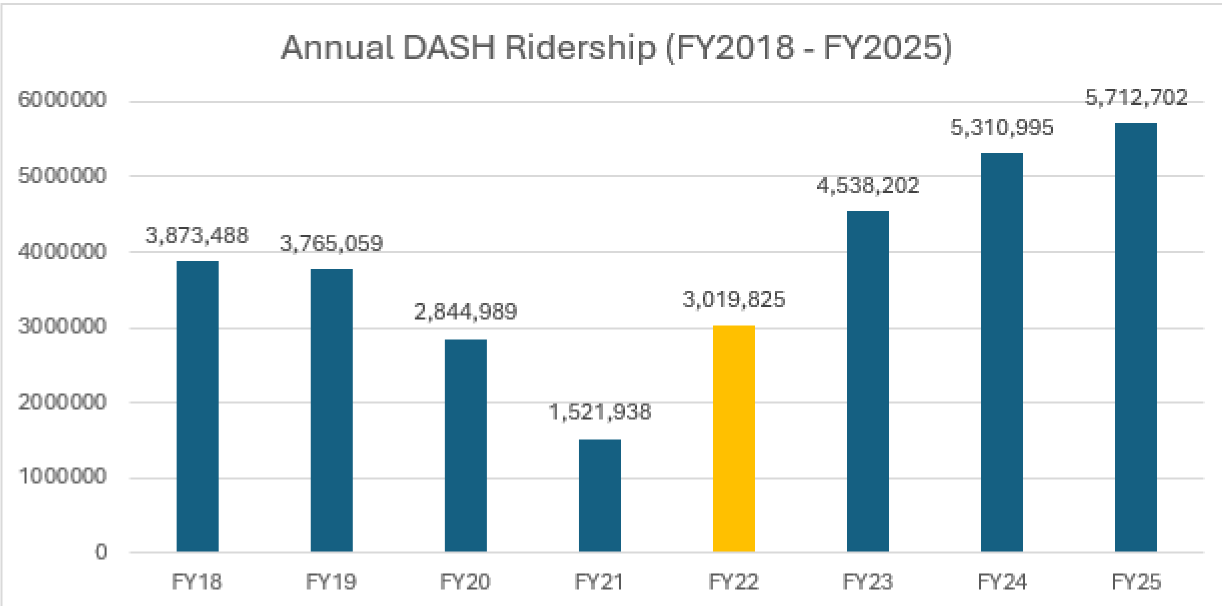
DASH Bus Fleet Upgrades

DASH started moving toward more environmentally friendly options in 2006, when the city amended the transportation code, requiring DASH to use ultra-low sulfur fuel with continuously regenerating technology exhaust filters by 2009. In subsequent years, DASH continued to implement improved technology. The DASH Gold Leadership in Energy and Environmental Design (LEED) Certified operating building was completed in 2009, which uses daylight illumination in regularly occupied spaces and the bus washer recycles 86% of all water used. DASH started moving its fleet toward hybrid buses by purchasing 10 hybrid buses in 2011 and when the city purchased 5 hybrid trolleys, operated by DASH. By 2019, 60% of the DASH bus fleet was energy efficient and environmentally friendly hybrid electric buses (54 buses).

Fare Free Transit with DASH

In September 2021, the City worked with DASH to eliminate fares on all buses making transit free for everyone in Alexandria. This provides an attractive and cost-effective transportation option for residents, employees, and visitors, which has led to record-breaking ridership in 2024, as seen in Figure 23.

Figure 23: Annual DASH Ridership (FY2018 – FY2025)



Transitway Investments

- Metroway – Bus Rapid Transit Lane was constructed in the corridor from the Braddock Road Metro to Crystal City in the median of Route 1. This project was completed in 2014. The City is actively looking at expanding this project.
- West End Transitway – The City is currently finalizing designs on Phase I of a comprehensive transitway project which will connect the Van Dorn Street Metrorail station to the Pentagon and several key locations along the West End of Alexandria, including, but not limited to, Landmark Mall, Mark Center, Southern Towers, and Shirlington.
- Duke Street in Motion – The City is currently designing a transitway project which will create efficient transit options connecting the West End to the King Street Metro Station and all of the destinations along the Duke Street Corridor.

Bike Infrastructure Investments

The City continues to make investments to support bicycling as a viable form of transportation. Numerous protected bike lane projects are in design or pre-design, including South Pickett Street, Holland Lane, East Abingdon Drive, Eisenhower Avenue, and King Street. In 2024, the City also upgraded for existing bicycle lanes with vertical barriers, totaling over 4 miles of protected bicycle lanes.

Capital Bikeshare

In 2012, Alexandria joined the regional bikeshare program, Capital Bikeshare. As of 2024, the City had 62 stations with plans to add 10 more stations in 2025. The entire bikeshare network has grown to nearly 800 stations across the region and had over 6 million trips in 2024. Regionally, Capital Bikeshare trips have offset 9,000 tons of carbon emissions since 2010. Of all Capital Bikeshare riders:

- 43% do not own or lease a personal vehicle
- 46% who do own or lease a personal vehicle drive less because of access to shared micromobility
- 68% would drive more without access to shared micromobility

Dockless Mobility

The City's Dockless Mobility program permits and regulates dockless shared micromobility operators in Alexandria. Approved operators may deploy for-rent electric scooters and bikes around the City. Scooters and e-bikes are useful for short trips and for providing first/last mile connections to transit. In 2024, there were a total of 270,869 dockless trips taken within the City. Approximately 78,000 kilograms of carbon dioxide equivalent (kg-CO_2eq) of greenhouse gas emissions have been saved from car trips being replaced by dockless scooter and e-bike trips.

GO Alex

The City's Transportation Demand Management (TDM) program, GO Alex, helps residents, employees, and visitors make non-SOV transportation choices. Through this program, GO Alex provides transportation information to help educate people about the different transportation options available in Alexandria. GO Alex also manages incentive programs to encourage people to use non-SOV modes and encourage employers to create transportation benefit programs for their employees.

Updated Parking Standards

In 2015, the City approved a maximum parking requirement for multi-family development. In 2018, the City approved a maximum parking requirement for commercial development, including retail, office, and commercial uses. By establishing a parking maximum for these uses, the City ensures that new developments do not over-construct parking for their uses and prioritizes other modes of transportation besides SOVs at their sites.

Electric Vehicle & Electric Vehicle Charging Investments

The City has begun converting its municipal fleet and currently has close to 40 electric vehicles. A fleet transition plan is underway to provide the city a roadmap for the most efficient and cost-effective approach to fully transition the fleet to 100% zero-emission vehicles by FY2040. In Alexandria, at the end of 2024, 2.9% of all registered vehicles were electric or plug-in hybrid electric, which is higher than the national average of about 1.4%. The City is considering various approaches to facilitate publicly accessible charging in the City, such as a franchise to install public chargers on City property, offering technical and financial incentives to multi-family communities, and curbside charging.

Open Space & Tree Canopy

The Open Space Plan was adopted in 2003, providing a framework of 15 goals addressing the City's short and long-term open space needs, including a goal of reaching 100-acres of open space in Alexandria. By December 2012, the City acquired 69-acres of open space, using funds allocated for the Open Space Master Plan (Rev #5). Alexandria achieved the 100 open space acre goal in 2013.

In 2005, the City approved the Pocket Park Program, allotting a minimum of 20% of the City's Open Space Fund towards acquiring pocket parks, or small tracts of land that could be converted to open space; and signed the United States Conference of Mayor's Climate Protection Agreement, committing Alexandria to accomplish a number of actions related to improving air quality and protecting the climate from catastrophic change. Among these actions were to meet or exceed the Kyoto Protocol targets through use of local land use planning, urban forest restoration or public information.

In 2009, the City adopted the Urban Forestry Master Plan that aims to protect and enhance the City's tree canopy by setting a goal of 40% tree canopy for the city.

In 2024, to celebrate the City's 275th Birthday, the City planted 275 trees throughout the city. These tree plantings, funded through the Stormwater Utility Fee, will help improve water quality, reduce nutrient runoff, and absorb stormwater to mitigate flooding for many years to come. Additional goals of this tree planting initiative are to provide shade in high heat index areas of the city, replenish communities with canopy cover, provide trees along roadways, were practical, and eliminate community disparities where feasible.

Regionally, MWCOG initiated strategic tree planting and tree conservation practices as a voluntary measure to help communities meet federal air quality standards related to ozone formation after 2006. Trees improve air quality and atmospheric composition by (1) directly absorbing pollutants, such as CO, NO_2, ozone, PM, and SO_2; (2) reducing energy consumption in buildings and (3) reducing ambient air temperature via shade, helping avoid the heat island effect. Reducing ambient temperatures reduces the potential for ground level ozone formation. Subsequently, the regional MWCOG team formed a workgroup in 2012 and a Tree Canopy Subcommittee in 2019 to develop regional support materials related to meeting the regional tree canopy goals. (MWCOG, 2024d)

Ongoing and Future Initiatives

On May 17, 2025, the City Council adopted a regulation change to ban the use of gas-powered leaf blowers in the City of Alexandria. This ordinance was approved with an 18-month phase out period, with enforcement starting on November 17, 2026. City staff have committed to transitioning to electric leaf blowers by May 17, 2026. Approval of this ban makes Alexandria the first jurisdiction in the state of Virginia to move away from gas-powered lawn & garden equipment. The ban will reduce noise concerns, but also have a positive impact on emissions, as most leaf blowers are 2-stroke engines that emit significant amounts of pollutants, including CO and PM into the environment.

Current federal emissions rules for light-, medium-, and heavy-duty vehicles reduce harmful air pollutants and greenhouse gases, improving public health and air quality. They lower fuel use and can save drivers and fleet operators money over the life of a vehicle. The rules encourage innovation by pushing manufacturers to develop cleaner and more efficient technologies. Communities near major roads and freight corridors benefit from reduced exposure to pollution. Overall, the rules support climate goals, reduce energy reliance on fossil fuels, and deliver long-term economic and environmental benefits

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 500 cubic feet of air each 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 on how to protect our environment can be found at the EPA website https://www.epa.gov/report-environment/what-you-can-do.

Individuals also release greenhouse gases by 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 to more energy efficient light bulbs and properly inflating tires. The EPA 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.

The City's Environmental Quality and Eco-City websites also provide additional information on the City's air quality and climate change programs. They can be found at alexandriava.gov/OEQ and alexandriava.gov/Eco-City.

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