JULY 2020

DISTRICT OF COLUMBIA

AMBIENT AIR QUALITY TRENDS REPORT

1996-2019

MONITORING AND ASSESSMENT BRANCH
AIR QUALITY DIVISION
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GOVERNMENT OF THE DISTRICT OF COLUMBIA
MURIEL BOWSER, MAYOR

EXECUTIVE SUMMARY

Air quality in the District of Columbia (District) has improved significantly in the last two decades, meeting the National Ambient Air Quality Standards for all criteria pollutants except for ground-level ozone. Because the District is an urban environment with little industry, air quality issues in the District are primarily due to emissions from vehicles and air pollution transported from other states. This Air Quality Trends Report demonstrates that despite population, employment, and housing increases and other related activities in the District, ambient concentrations of all criteria pollutants and pollution emissions have dropped since the late 1990s. This report serves as an update to the 2014 Air Quality Trends Report[i].

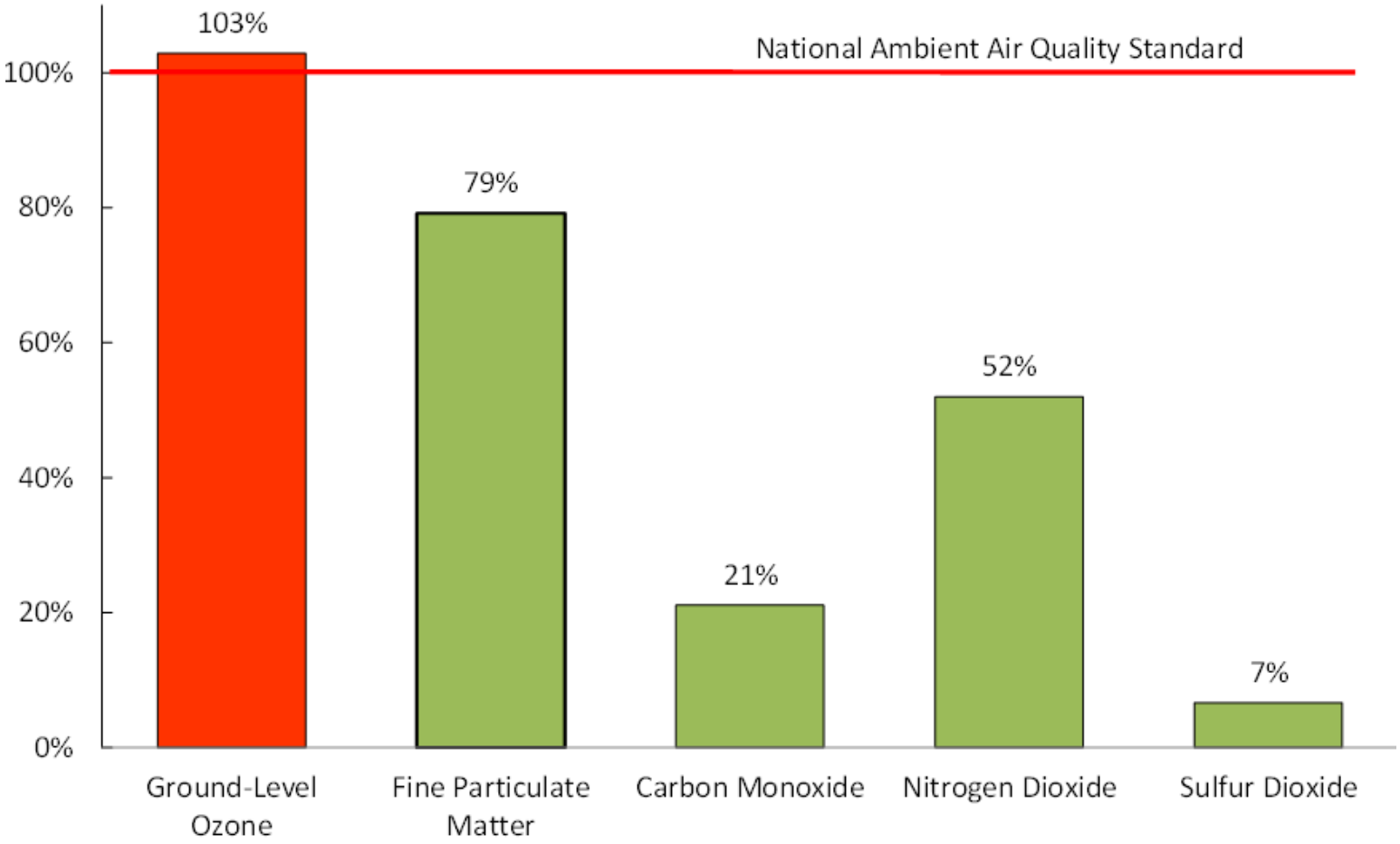

Figure 1: The District's Air Quality in 2019 as a Percent of the National Ambient Air Quality Standards (NAAQS)

Figure 1 illustrates that the District is meeting the Environmental Protection Agency's (EPA) National Ambient Air Quality Standards for fine particulate matter, carbon monoxide, nitrogen dioxide, and sulfur dioxide. The District is in marginal nonattainment of the standard for ground-level ozone pollution.

Improvements in air quality can be attributed to the ongoing work at both the state and national level. The District has adopted several air pollution reduction regulations and has coordinated with neighboring states to help control transported pollution. There is a push for low-emission vehicles across the nation, with several grants and programs currently underway to replace aging fleets and invest in electric vehicle infrastructure. The EPA has also passed several regulations limiting emissions from polluting sources. However, there is still work to be done to protect public health and welfare, particularly as EPA continues to revise the NAAQS based on improved understandings of the relationship between air pollutants and health.

NAAQS IN THE DISTRICT OF COLUMBIA

- **Ozone** – The District and nearby counties in Maryland and Virginia are in "marginal" nonattainment of the 2015 national ambient air quality standards (NAAQS) for the 8-hour average of ground-level ozone (O_3) of 70 parts per billion (ppb). The "marginal" designation classifies the region as being within 11 ppb of the standard. Ozone continues to be the biggest air pollution challenge the region faces, primarily due to emissions from mobile sources and transported pollution from upwind states. Reducing emissions from these two sources is essential to improving air quality and protecting public health. The District recently attained the former 2008 8-hr ozone NAAQS of 75 ppb and is currently under maintenance to ensure the District stays below the standard.

UNDERSTANDING DESIGNATIONS

Once a new standard is formulated for a pollutant, the EPA will designate areas as having either reached attainment or nonattainment of the standard.

Attainment designations indicate that the area has met the standard and is measuring concentrations at or below the standard, which is the allowable amount or threshold of that pollutant.

Nonattainment designations indicate that the area has not met the standard and is measuring concentrations above the standard.

- **Particulate Matter** – The District is in attainment of the 2012 annual NAAQS for fine particulate matter ($PM_{2.5}$ or fine PM) of 12 micrograms/cubic meter ($\mu g/m^3$). Fine PM is inhalable PM smaller than 2.5 micrograms. The District was previously in nonattainment of the 1997 annual standard but has since attained that standard. A new, reduced, fine PM standard was finalized by EPA in 2012, which the District had already attained by the time EPA designated areas for the standard. The region has since been in compliance.

- **Carbon Monoxide** – The District is in attainment for the carbon monoxide (CO) 2010 8-hour NAAQS of 9 parts per million (ppm) and the ambient air quality levels have been below the standards since 1996. In February 2010, EPA retained the existing CO standard from 1994.

- **Sulfur dioxide, Nitrogen dioxide** – The District has always attained both the sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) standards, with monitored levels far below the NAAQS. New, stricter, NAAQS were developed for each pollutant in 2010. The District is in attainment of the 2010 1-hour SO_2 NAAQS of 75 ppb and the 2010 annual NO_2 NAAQS of 53 ppb. In 2019, EPA retained the 2010 SO_2 NAAQS without revision.

- **Lead** – In 2016, the District stopped monitoring for lead (Pb) because levels were consistently very low compared to the NAAQS. Lead NAAQS were first established in 1978 and, in 2008, EPA updated the standard to be ten times more stringent. Monitoring for lead began in January 2012 to determine compliance with the new standard. Due to consistently low readings (about 3% of the NAAQS) for four consecutive years, the District discontinued the lead monitor in 2016.

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PART 1: BACKGROUND INFORMATION

1.0 BRIEF HISTORY OF AIR POLLUTION AND CONTROL IN THE UNITED STATES

As population hubs developed, the release of chemicals and matter into the air, commonly known as air pollution, became pervasive in the United States. As early as the 1880s, pollution from the burning of coal and wood became impediments to public wellbeing. As a consequence, cities like Chicago and Cincinnati passed the nation's first smoke ordinances.

As industries expanded globally, several alarming incidents heightened concerns about the impact air pollution had on people's health. In Belgium in 1930, an air pollution episode – when persistent meteorological conditions kept emissions trapped near the earth's surface – killed at least 60 people and caused over 600 to become ill. In 1947, summer smog events in Los Angeles, California, significantly affected the health of residents and visibility, resulting in the passage of the nation's first state air pollution law. In 1948, a strong temperature inversion occurred in Donora, Pennsylvania, while a nearby factory continued to contaminate the air. This resulted in nearly 20 deaths and 14,000 of the town's population fell ill. A similar event in London, England, known as the "London Fog" of 1952, resulted in more than 4,000 premature deaths.

In the United States, the first nationwide air pollution control law was passed in 1955. The Air Pollution Control Act (APCA) mandated and funded research on air pollution and authorized the federal government to provide states with technical assistance to prevent and control emissions. This prompted the study of air quality criteria as well as the meteorological and topographical aspects of air pollution. A national continuous air quality monitoring program (CAMP) emerged[ii] in the late 1950s. The District was one of six cities in the national CAMP network of ambient air quality stations.

The APCA was amended several times to consider motor vehicle exhaust and air pollution issues that extended across state and country borders. Increased awareness and concern about air pollution led to Congress's passage of the first prominent Clean Air Act (CAA) in 1970 and the creation of the U.S. Environmental Protection Agency (EPA). EPA was authorized to establish national ambient air quality standards (NAAQS) for pollutants shown to threaten human health and public welfare. The national approach with statutory deadlines for meeting standards represented a shift in thinking. With it came a belief that economic growth could be accomplished without the sacrifice of human health and the environment.

The CAA was amended in 1977, and then again in 1990. The changes in legislation focused on curbing three major threats: acid rain, urban air pollution, and toxic air emissions. The CAA and the 1990 amendments establish authority and a framework for the permitting and enforcement of air pollution sources to achieve compliance with NAAQS. As a result, federal, state and local governments have been able to work together to design, implement, and enforce measures that have improved air quality substantially.[iii]

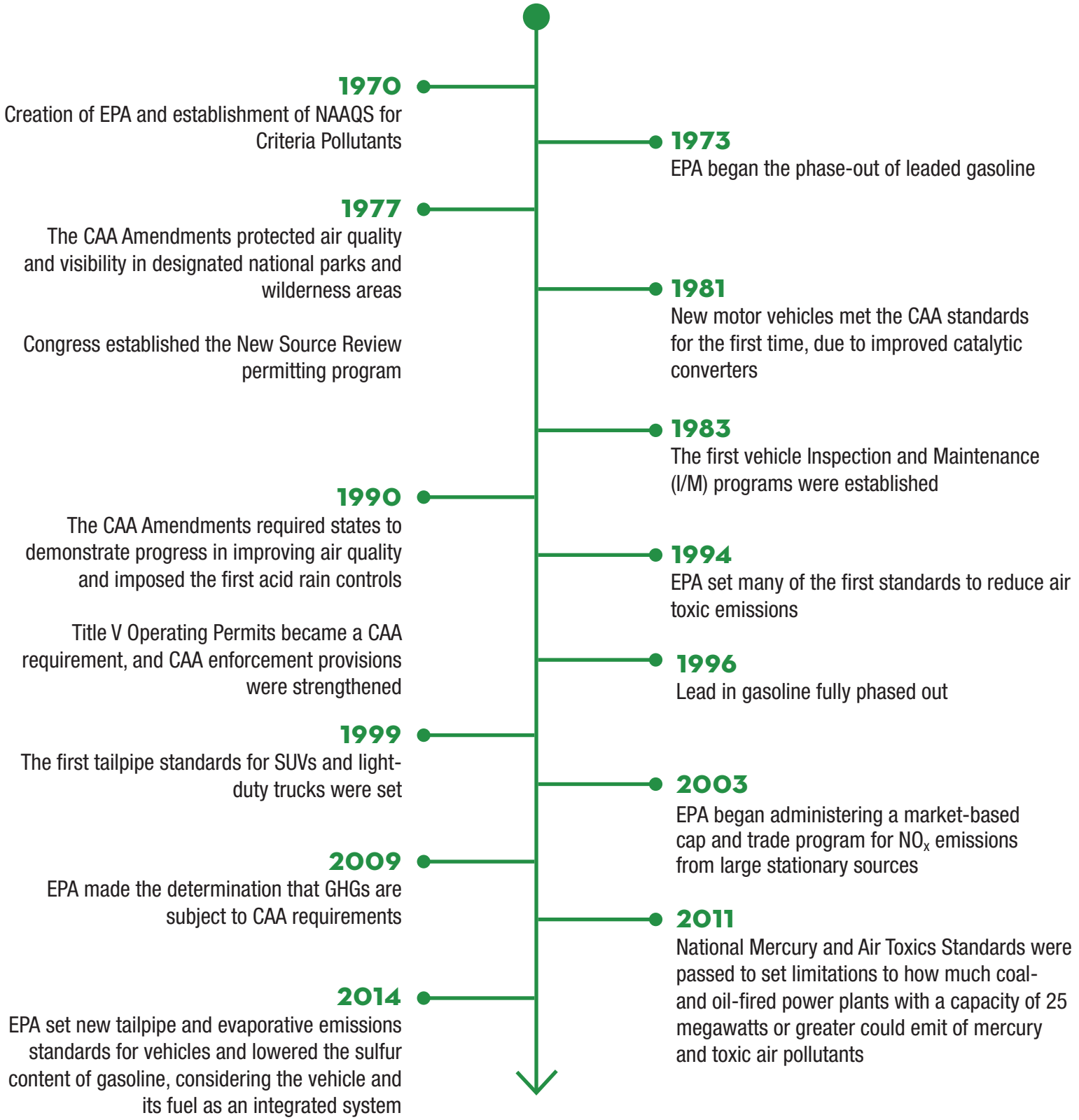


Figure 2: Timeline of Significant Clean Air Act Achievements[iv]

2.0 CRITERIA POLLUTANTS AND AIR QUALITY STANDARDS

The federal Clean Air Act authorized EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants that threaten human health and public welfare throughout the country. EPA established NAAQS for the six most common pollutants called "criteria" air pollutants: ozone (O_3), particulate matter [particles less than 10 micrometers in aerodynamic diameter (PM_{10} or coarse PM) and particles less than 2.5 micrometers in diameter ($PM_{2.5}$) or fine PM], carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and lead (Pb). EPA periodically revises the standards based on new science. When ambient air quality in a jurisdiction exceeds the NAAQS for a criteria pollutant, the area is said to be in "nonattainment" for that pollutant.

There are two types of NAAQS: primary and secondary. Primary NAAQS are established according to criteria designed to protect the health of people who breathe the air. They include an adequate margin of safety to protect sensitive populations, including children and the elderly. Secondary NAAQS are set to protect public welfare by preventing decreased visibility, damage to crops or buildings, and other impairment of the natural environment. The CAA requires that the NAAQS be revisited every five years based on up-to-date scientific research findings. Appendix A includes a table of the existing NAAQS.

Pollutant levels in the air are measured using a network of air quality monitors. Once the measurements for a pollutant are quality-assured, this data is analyzed to calculate a design value (DV). The DV is a statistical value based on ambient air monitoring measurements that capture the air quality status of an area or region relative to the NAAQS. The DV is a statistically-derived average of a specified number of measurements over a specific period of time. DVs are used to more accurately represent exposures to air pollution. DVs from a jurisdictional network of monitors are compared to NAAQS to determine the air quality status.

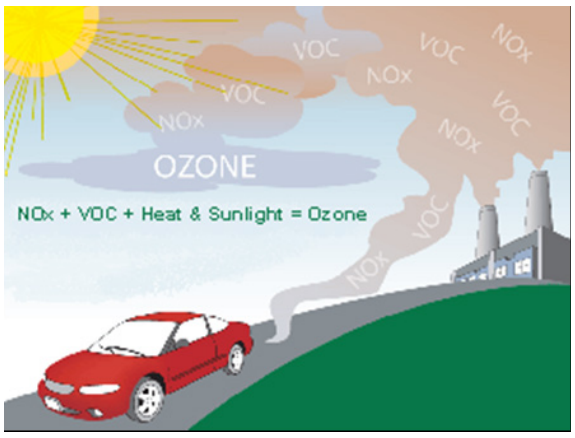
UNDERSTANDING THE NAAQS

Averaging Time of the Standard – The time period over which air pollutant concentrations are collected and averaged. The averaging times are for one hour, eight (8) hours, daily, quarterly, and annual, depending on the pollutant.

Level of the Standard – The allowable concentration of air pollutants. The unit of measurement for most pollutants is parts per million (ppm) or parts per billion (ppb) by volume. Due to the nature of pollutants, the unit of measurement for some pollutants, such as lead and particulate matter, is mass of pollutant per unit volume of air and is expressed as micrograms of pollutant per cubic meter of air ($\mu g/m^3$).

Form – The methodology for summarizing actual concentrations. The form can be directly compared to the NAAQS to determine compliance.

2.1 GROUND-LEVEL OZONE



Depiction of ozone formation. Photo from EPA

Ground-level ozone, also known as smog, is the most widespread criteria pollutant. Ozone is a colorless, odorless gas composed of three oxygen atoms. It exists naturally in the stratosphere, the Earth's upper atmosphere, where it shields the Earth from the Sun's ultraviolet rays. It is also found close to the Earth's surface in the troposphere where we live and breathe. Ground-level ozone is not emitted directly into the air by specific pollution sources, but rather is created by a chemical reaction between precursor pollutants, volatile organic compounds (VOCs) and oxides of nitrogen (NO_x), in the presence of sunlight and high temperatures. NO_x and VOC sources include power plants, industrial processes, vehicle exhaust (onroad and nonroad), and commercially available products such as paints, insecticides, and cleaning solvents. VOCs also come from natural sources such as trees and plants.

Because ground-level ozone is the result of photochemical reactions, ozone takes time to form. Concentrations generally become

elevated during the hotter, drier days of warmer months of the year when there is little wind. Daily ozone levels generally peak during afternoon and early evening hours, when precursor pollutants are most exposed to sunlight and higher temperatures. "Ozone season" in the Washington, DC, region is between May 1st and September 30th. Ozone is transported through the air into the District from other areas, and then mixes with precursor emissions from local sources of air pollution.

2.1.1 OZONE NAAQS REVIEW

The first ozone NAAQS from 1979 were set based on a daily maximum 1-hour average concentration. Shortly after passage of the Clean Air Act Amendments (CAAA) of 1990, EPA classified the DC-MD-VA region (see Figure 3) as a "serious" nonattainment area for the 1-hour NAAQS. The region failed to achieve the 1-hour standard by the CAA mandated deadline and was bumped up by EPA to a "severe" nonattainment area in 2003. At that time, EPA set an attainment deadline of 2005, and the District and the metropolitan area were able to meet the standard by this deadline. To continue meeting CAA requirements, regulations and policies that reduce emissions must remain in place. Table 1 below shows the designation classification levels for each ozone standard. The standard unit of measure for ozone is parts per million (ppm). However, ozone will be expressed in parts per billion (ppb) in this report.

Table 1: Designation Classifications for each Ozone NAAQS

Classification	2015 8-hr Standard (70 ppb)	2008 8-hr Standard (75 ppb)	1997 8-hr Standard (80 ppb)	1979 1-hr Standard (120 ppb)
Marginal	71 ≤ DV < 81 ppb	76 ≤ DV < 86 ppb	85 ≤ DV < 92 ppb	121 ≤ DV < 138 ppb
Moderate	81 ≤ DV < 93 ppb	86 ≤ DV < 100 ppb	92 ≤ DV < 107 ppb	138 ≤ DV < 160 ppb
Serious	93 ≤ DV < 105 ppb	100 ≤ DV < 113 ppb	107 ≤ DV < 120 ppb	160 ≤ DV < 180 ppb
Severe 15[1]	105 ≤ DV < 111 ppb	113 ≤ DV < 119 ppb	120 ≤ DV < 127 ppb	180 ≤ DV < 190 ppb
Severe 17	111 ≤ DV < 163 ppb	119 ≤ DV < 175 ppb	127 ≤ DV < 187 ppb	190 ≤ DV < 280 ppb
Extreme	163 ppb ≤ DV	175 ppb ≤ DV	187 ppb ≤ DV	280 ppb ≤ DV

In 1997, EPA revised the ozone NAAQS to better reflect new scientific health studies that demonstrated cumulative effects from exposure over an entire day. The 1997 NAAQS was the first ozone standard based on an 8-hour averaging period. In 2004, EPA officially designated the region as a "moderate" nonattainment area for the 1997 standard. In June 2005, EPA revoked the 1-hour ozone standard while implementing the 1997 8-hour standards.

The 8-hour ozone standard was revised again in 2008. Based on the monitored air quality data, EPA designated the DC-MD-VA region as a "marginal" nonattainment area for the 2008 standard. The District and the metropolitan area submitted a redesignation request and maintenance plan in 2017. EPA approved the maintenance plan for the metropolitan area in 2018. On July 16, 2019, the District was redesignated to attainment for the 2008 8-hour ozone NAAQS.

In 2015, EPA further revised the 8-hour standard to 70 ppb. On August 3, 2018, the DC-MD-VA region (Figure 3) was designated as "marginal" nonattainment based on the 2016 design value of 72 ppb. The designations were based off the 2016 design value because 2016 was the most recent three-year period with fully-certified data. The region has a total of three years, or until August 3, 2021, to attain the 70 ppb standard.

1. Severe 15 and Severe 17 indicate that an area has 15 and 17 years to attain the standard, respectively

Figure 3: Metropolitan Washington 8-hour Ozone Nonattainment Region (Washington, DC-MD-VA)

Image courtesy of the Metropolitan Washington Council of Governments

2.2 PARTICULATE MATTER

Particulate matter is comprised of a broad class of extremely small airborne solid particles and liquid droplets, from fine smoke and soot (products of incomplete fuel combustion) to larger-sized dusts and industrially generated particles. Particulate matter also includes particles formed by complex reactions of gaseous pollutants in the atmosphere. Precursors for fine inhalable PM include ammonia, SO_2, and NO_x. Sulfates, nitrates, organic carbon, and elemental carbon contribute to the make-up of condensable fine PM. Particulates can be different sizes and shapes. The size of particles measured over time has decreased with improvements in monitoring technology, as researchers have found that smaller particles have potential for causing more complex health or visibility problems. Particles less than 2.5 micrometers (microns) in diameter ($PM_{2.5}$ or fine PM) can travel deep into the lungs and move into the bloodstream. As shown in Figure 4 below, they are about 1/30th the average width of a

Fireworks contribute to short-term PM pollution. Photo from DCRA

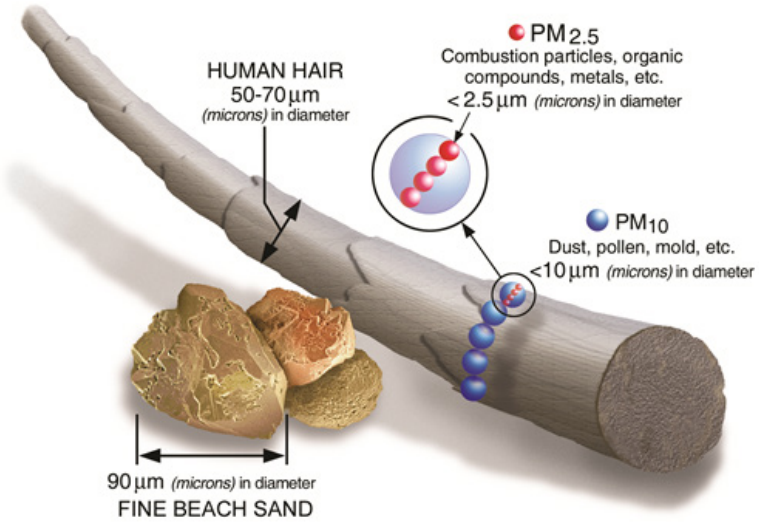


Figure 4: Size and comparisons of PM_{10} and $PM_{2.5}$ µg/m³
(Image from EPA)

human hair and are invisible to the human eye. Their smaller size is hazardous to human health and makes them a major focus for regulation and policy.

Fine PM concentrations vary daily and sometimes hourly, as they tend to be higher during peak traffic times. The physical and chemical compositions of fine PM vary seasonally, since these characteristics are influenced by meteorological conditions, such as temperature, humidity, wind flow, etc.

2.2.1 PM NAAQS REVIEW

The first PM standards were set in 1971. They addressed total suspended particulates (TSP), which are non-respirable particles. In 1987, annual and daily NAAQS were set for inhalable particles with an aerodynamic diameter of 10 microns, called PM_{10}, or less.

In 1997, the PM_{10} standards were slightly revised to regulate inhalable "coarse" particulates that account for particles greater than 2.5 microns and less than 10 microns in diameter.

EPA also established two more refined health standards for annual and 24-hour average inhalable "fine" particulates less than 2.5 microns in diameter, or $PM_{2.5}$. The $PM_{2.5}$ standards account for emissions that are filterable (directly emitted) and condensable (secondarily formed in the atmosphere from gaseous pollutants). The region was officially designated as being in nonattainment of the $PM_{2.5}$ annual standard in April 2005, but was redesignated to attainment in 2014.

In 2006, the annual PM_{10} standard was revoked due to a lack of evidence linking health problems to long-term exposure, leaving only a daily PM_{10} standard. A new daily standard for $PM_{2.5}$ was also established that same year. EPA determined that the District metro area was in attainment for both the daily PM_{10} and $PM_{2.5}$ standards.

In 2012, EPA revised the annual $PM_{2.5}$ standard to make it more stringent. The existing $PM_{2.5}$ ambient air monitors in the District and metropolitan area have been measuring concentrations below the new 2012 standards. However, the new standards required monitoring near major roadways. By 2015, the District, Maryland, and Virginia had all established new near-road monitoring stations. Given the adequate data collection from the new near-road monitoring network, EPA has designated the DC-MD-VA region as an attainment area for the 2012 $PM_{2.5}$ NAAQS. Table 2 outlines the District's attainment status for each standard for both $PM_{2.5}$ and PM_{10}.

Table 2: Current Attainment Status of $PM_{2.5}$ and PM_{10} NAAQS

Current Attainment Status of $PM_{2.5}$ NAAQS			Current Attainment Status of PM_{10} NAAQS		
$PM_{2.5}$ - fine	1997 24-hour	attainment	**PM_{10} - coarse**	1997 24-hour	attainment
	1997 annual	redesignated to attainment in 2014		1997 annual	attainment
	2006 24-hour	attainment		2006 24-hour REMANDED	attainment
	2006 annual	attainment		2006 annual	standard revoked
	2012 24-hour	attainment[2]		2012 24-hour	attainment

2.3 CARBON MONOXIDE

Carbon monoxide is a colorless, odorless gas that can be poisonous in high concentrations. When it enters the bloodstream, it reduces the capacity of the body to deliver oxygen to organs and tissues. Concentrations tend to be highest during winter months due to the "cold starting" of automobile engines. In some areas, inefficient or poorly maintained space heating systems, residential wood burning, or industrial processes (metals processing and chemical manufacturing) are prominent sources. Improvements in motor vehicle emissions controls and the use of oxygenated fuels have reduced CO levels significantly (although oxygenated fuels have not been used in the District since 1996).

2.3.1 CO NAAQS REVIEW

The first CO standards were set in 1971. In 1985, EPA revoked the secondary CO standards due to a lack of evidence that ambient concentrations adversely affect public welfare. Both the 1-hour and 8-hour primary CO standards were retained after EPA's review in 1994. The DC-MD-VA region attained the 8-hour NAAQS in 1996. Attainment areas are required to demonstrate that ambient levels will "maintain" design value concentrations that are under the NAAQS for 20 years after redesignation. In February 2010, EPA retained the existing CO standards while expanding the ambient air monitoring requirements. All parts of the country currently meet the CO NAAQS.

2.4 SULFUR DIOXIDE

Sulfur dioxide (SO_2) is a highly reactive gas that forms both from the burning of fuels containing sulfur (mainly coal and oil) and during industrial processes, such as metal smelting and oil refining. It is one of a group of oxides of sulfur. When combined with other pollutants and chemicals, SO_2 can react with oxygen and water in the atmosphere to form acid rain.

2.4.1 SO_2 NAAQS REVIEW

EPA first set both primary and secondary SO_2 NAAQS in 1971. During the next NAAQS review in 1996, the standards were not revised.

In June 2010, EPA issued and revised the primary NAAQS to establish a new 1-hour standard to protect against short-term exposures. The existing annual and daily standards were revoked. EPA also proposed to revise the SO_2 monitoring rule to require both monitoring and refined modeling of local pollutant dispersion from upwind sources to determine compliance. In 2012, the 1971 secondary 3-hour average standards were retained without revision. EPA retained the 2010 primary 1-hour standards in 2019.

2. EPA designates attainment areas and unclassifiable areas as both "attainment/unclassifiable"

2.5 NITROGEN DIOXIDE

Nitrogen dioxide (NO_2) is a brownish and highly chemically reactive gaseous pollutant. It is the indicator of a class of compounds called nitrogen oxides (NO_x), which contribute to ground-level ozone and fine particulate pollution. NO_2 is formed during high-temperature combustion of fuels and by vehicle engines and industrial processes, such as electricity generation. All areas in the country currently meet the annual NO_2 standards. Mobile source regulations are expected to continue reducing NO_2 concentrations into the future. NO_2 can exasperate asthma and respiratory issues.

DID YOU KNOW?

SO_2 is considered to be a main contributor to regional haze in federally designated "Class I" national parks and wilderness areas, such as the nearby Shenandoah National Park. These photos show views from the park on a clear day compared to a hazy day.

Views from Dickey Ridge (split image). Photo from NPS

2.5.1 NO_2 NAAQS REVIEW

The first primary and secondary NO_2 NAAQS were set by EPA in 1971. They were reviewed twice but never revised. In its January 2010 revision, EPA retained the current annual NO_2 standards, while setting a new 1-hour NO_2 standard to protect against short-term exposures. The existing NO_2 ambient air monitors in the District and metropolitan area have been measuring concentrations below the 2010 standards. However, the new standards required an expanded monitoring within 50 meters of major roadways and additional monitors in large urban areas. By 2016, the District, Maryland, and Virginia had all established new near-road monitoring stations. Given the adequate data collection from the new near-road monitoring network, EPA has designated the DC-MD-VA region as an attainment region for the 2010 NO_2 standard. EPA retained the secondary annual NO_2 standards without revision in 2012.

2.6 LEAD

Lead is a metal found naturally in the environment and in manufactured products. Soils and dusts can be contaminated with lead from older paints, deposited emissions from mobile sources, construction materials, and industrial processes such as smelters or battery plants. Lead levels dropped dramatically after 1973 when, following regulations promulgated by EPA, the country began phasing out the use of leaded gasoline. Today, lead levels in ambient air are very low. Current inhalable lead exposure results mainly from disturbed soils and dusts contaminated with lead, older paints and other lead-containing construction materials, and aviation gasoline. The highest levels are usually found near lead smelters, where lead is extracted from ores. High exposure to lead can result in serious neurological damage.

2.6.1 LEAD NAAQS AND MONITORING REVIEW

Ambient lead monitoring in the District has a long history. Through the 1960s and 1970s, the District's air monitors reported high concentrations of lead. In 1976, the phase-out of leaded gasoline caused monitors to report a significant drop in ambient lead concentrations. The first lead NAAQS were established in 1978 and the country continued to see reduced lead levels and by the 1990s, lead concentrations consistently measured below five percent of the standard.

In 2008, EPA revised and replaced the lead NAAQS with a standard that was ten times more stringent than the previous standard. The District's air program revived the population-based ambient lead measurements in January of 2012, as required by the new standard. Due to consistently low concentrations, at about 3% of the standard, the District ceased measurements of lead in 2016 under the provisions of 40 C.F.R.

3.0 AIR POLLUTION IMPACTS

Air pollution is a result of the combustion of fuels (gasoline, natural gas, oil, diesel, coal, wood, etc.), release of vapors, suspension of aerosols, disturbance of matter, and other commercial or industrial processes. Some pollutants are directly harmful to the public or the environment, while others undergo chemical reactions in the air that make them more harmful. While impacts of criteria pollutants on each individual can vary and be pollutant-specific, short-term and long-term exposure to air pollution is linked to heart and lung disease as well as premature death. Air pollution can also negatively impact natural and built environments, which can in turn affect human health.

3.1 HEALTH IMPACTS

Health impacts of air pollution include the following:

- Inflammation and irritation of the respiratory tract;
- Coughing, throat irritation, difficulty breathing;
- Aggravated asthma and other lung (respiratory) diseases leading to increased medication use, hospital admissions, emergency department visits, and premature mortality;
- Aggravated heart (cardiovascular) diseases leading to increased medication use, hospital admissions, emergency department visits, and premature mortality; alterations in pulmonary defenses;
- Lung or heart disease;[v]
- (Carbon monoxide) – Visual impairment, reduced work capacity, poor learning ability, difficulty in performance of complex tasks; headaches and nausea;[vi]
- (Lead) – Damage to the developing nervous system, resulting in IQ loss and impacts on learning, memory, behavior, and growth in children[vii]; kidney (renal) effects in adults; anemia; reproductive disorders; neurological impairments;[viii]
- (Ozone) Increased risk of pre-eclampsia and preterm birth from high exposure of ozone during the first trimester;[ix]
- (PM) high exposure to particulate matter can be linked to low birth weight and an increased risk of the child developing asthma later in life since particulate matter can travel into the placenta;[x] and
- Recent research suggests that air pollution may be linked to mental health and neuropsychiatric disorders.[xi]

According to the 2016 National Survey of Children's Health, the 2016 childhood asthma rate in DC was 12.1% compared to a national average of 8.4%.[xii] Based on 2017 and 2018 data, there were an estimated 13,885 cases of asthma in children under age 18 and 67,121 cases of adult asthma in the District.[xiii] Asthma is the leading cause of school absences from a chronic illness in children aged five to seventeen, and accounts for roughly 1.8 million emergency room visits in the United States each year.[xiv]

3.2 ENVIRONMENTAL IMPACTS

Air pollution impacts on the natural and built environment include:

- Damage to vegetation such as visible injury to leaves, reduced photosynthesis, impaired reproduction and growth, and decreased crop yields;
- Damage to physical structures and property, especially marble and limestone;
- Acid rain and acidification of lakes and streams; and eutrophication (a reduced amount of oxygen) in coastal waters, which is destructive to fish and other wildlife;
- Reduced visibility;

According to the U.S. National Park Service, green streaks are evidence of acid rain's effects. Photo from NPS

- Formation of greenhouse gases such as carbon dioxide (CO_2) and ozone; and
- Decreased plant uptake of CO_2 and soil, which can harm plants and wildlife.

3.2.1 WATER QUALITY

The Chesapeake Bay, the largest estuary in the United States and one of the most polluted, is affected by air pollutants, particularly nitrogen that enters its waters when it rains. Roughly one third of all nitrogen compounds in the Bay are deposited from the air.[xv]

3.2.2 CLIMATE CHANGE

Climate change is another serious impact of emissions. Emissions of greenhouse gases (GHGs) gather in the atmosphere and slow the loss of heat from the earth to space, resulting in warming of the earth.[xvi] Climate change is altering the timing and location of traditional rainfall and other weather patterns, ecosystem structure, biodiversity, and numerous other systems, negatively impacting human health and wildlife.

Climate change also contributes to an increase in pollution. Due to the chemical nature of how ozone forms in the atmosphere, ozone is more likely to form when temperatures are high and in the presence of sunlight. As GHGs are warming the planet, ozone production increases due to more prevalent higher temperatures. In addition to temperature, pollution is strongly influenced by a number of meteorological conditions such as humidity, wind flow, atmospheric stability, and cloud coverage. High temperatures are usually accompanied with weak winds and stagnant conditions, which will allow pollutants to accumulate and ozone levels to rise. In addition to this, during high temperature days, there is increased use of power consumption from air conditioners, which requires more energy production from power plants, and thus more emissions. Due to climate change, the number of high ozone days (days above 75 ppb) is expected to increase by 6-9 days annually in the District by 2050.[xvii] Figure 5 illustrates these changes throughout the nation.

As climate change continues to affect global climate and increase temperatures, meeting ozone standards and ensuring healthy air throughout the District will become even more challenging.

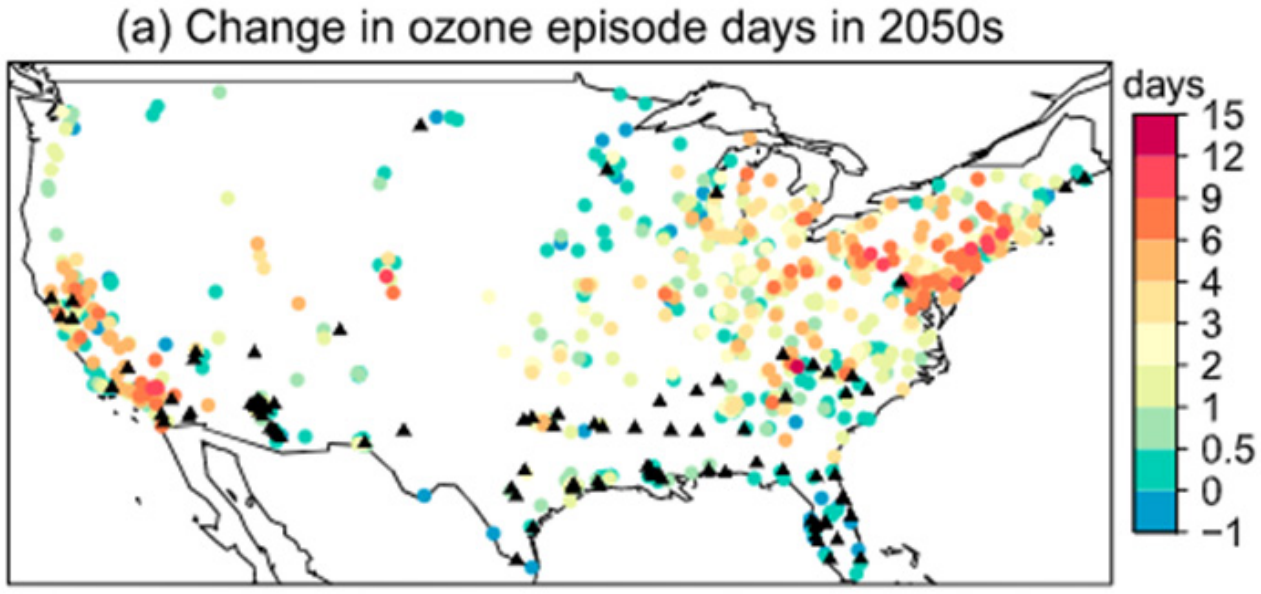


Figure 5: The mean change in number of high ozone days above 75 ppb by 2050

3.3 FACTORS THAT IMPACT AIR QUALITY IN THE DISTRICT

Pollutants are emitted by sources referred to as "stationary sources," which are in fixed locations, and "mobile sources," which do not have a fixed location and are generally propelled by or operated using an internal combustion engine.

Natural "biogenic" sources such as trees, crops, soils, and vegetation, also emit volatile organic compounds that can influence the formation of ground-level ozone.

Air pollution emissions can be minimized using technology at a source or by adapting how or when a source is used. The costs and effectiveness of an air pollution control measure is often inherent in decisions to use them. Additional factors are integral to the quality of the District's ambient air, as discussed below.

STATIONARY POINT SOURCES
Larger stationary "point" sources are individual facilities with smoke stacks (factories, power plants), generally classified as electric generating units (EGUs) or non-EGUs. Non-EGUs include facilities such as universities, large hotels, hospitals, etc.


USGS

STATIONARY NONPOINT SOURCES
Smaller stationary "nonpoint" or nonpoint sources are not identified individually because they have more impact collectively (such as small industrial or commercial facilities, gas stations, printing operations, auto maintenance facilities, painting operations, use of consumer products, and fires).


Simon Law


Shuttershock

MOBILE ONROAD
Mobile "onroad" highway vehicles include cars, trucks, buses, and motorcycles.

Jason Reed/Reuters

RaksyBH/Shutterstock

MOBILE NONROAD
Mobile "nonroad" or offroad vehicles or equipment include locomotives, boats, aircraft, construction equipment, and lawn and garden equipment


J. Jakuta


Rainer Dittrich via Getty Images

3.3.1 METEOROLOGY AND TOPOGRAPHY

Chemical and physical interactions can occur between elements naturally in the air and emissions produced by human activity.

The District is predominantly a built urban environment scattered with forested parks and open spaces. It is situated close to sea level at the confluence of the Anacostia and Potomac Rivers. There are four seasonal temperature fluctuations per year. Average temperatures (in degrees Fahrenheit) range from the low 20s in January to the high 80s in July. Precipitation distribution is uniform at roughly 40 inches annually in the form of rain or snow throughout the year.

The District is located in the Mid-Atlantic region, between more rigorous climates in the north and warm temperate climates in the south. Weather patterns are influenced by the Chesapeake Bay and Atlantic Ocean to the east and the Appalachian Mountains to the west and north. Since the District is near the average path of the low pressure systems that move across the country, changes in wind direction are frequent. During the summer, the area is influenced by large semi-permanent high pressure system commonly known as the Bermuda High, which is typically centered over the Atlantic Ocean near the coast of Florida that brings warm humid air to the Washington area. Downtown areas often experience a heat island effect. The proximity of large bodies of water and the inflow of winds from the south contribute to high relative humidity during much of the year.

DID YOU KNOW?

Paints, solvents, adhesives, cleaners, and other household products often contain volatile organic compounds (VOCs), which contribute to formation of ground-level ozone (smog), particularly on hot days.

3.3.2 EMPLOYMENT, POPULATION, AND HOUSEHOLDS

Employment, population, and household estimates are often used as indicators of emissions activity. More activity in an area means more people are driving, more energy is used, and more goods are produced and consumed. The Metropolitan Washington Council of Governments (MWCOG) projects how much change will occur in the region and periodically publishes a "cooperative forecast".

The number of jobs, people, and households in the District dropped in the 1990s. The drop in population was accompanied by a rise in population in surrounding areas. As indicated in Figure 6, there has been growth in employment, population, and the number of households in the District in the past decade. The District currently has over 700,000 residents. Its population doubles in size each day due to commuters and the millions of national and international tourists that visit the Nation's Capital on an annual basis.

Between 2013 and 2023, employment is projected to increase by one percent per year, or about 10 percent for the 10-year period, which is slightly higher than anticipated during the 2011 to 2021 and 2009 to 2019 time periods. The District will see a 31% increase in job growth between 2015 and 2045. In the region as a whole, employment will reach 4.2 million jobs by 2045. The highest gains expected by 2045 include professional and business services, construction, and information sectors (86%, 66%, and 65% respectively).[xviii]

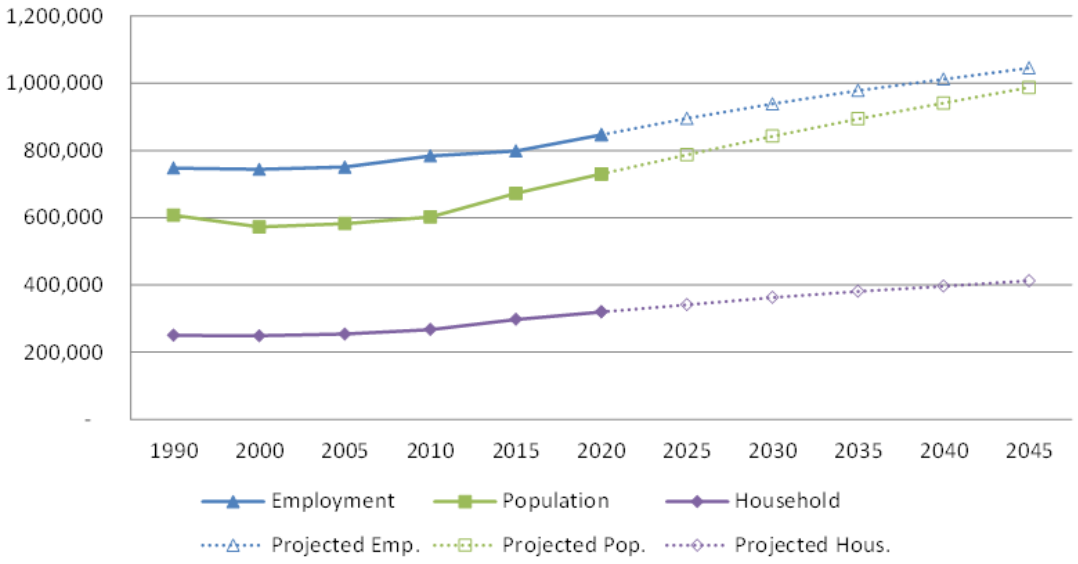


Figure 6: Employment, Population, and Household Trends in the District
(Based on MWCOG Cooperative Forecast Round 9.1a)

3.3.3 INTERSTATE TRANSPORT OF OZONE POLLUTION

Air quality in the District is primarily driven by incoming pollution from other jurisdictions. According to modeling performed in support of EPA's proposed rulemakings, nearly 90 percent of ozone pollution in the DC-MD-VA region is transported in the wind from other states.[xix]

University of Maryland (UMD) and Maryland Department of the Environment (MDE) have conducted extensive research over the past 20 years using airplanes, balloons, mountaintop monitors, and other devices to measure pollution that enters the State of Maryland, a close neighbor of the District. They have identified at least three predominant types of air pollution transport:

- Long-range Transport: pollution travels hundreds of miles, typically from the west or northwest. This pollution will accumulate in the upper atmosphere and will move eastward from the predominant eastward winds over the United States. This "elevated ozone reservoir" of air is trapped at about 2,000 feet above the earth's surface at night by a nocturnal temperature inversion that acts as a barrier between the surface and the reservoir. During morning hours, the sun will heat the ground which will then heat the air directly above the surface causing the air to rise and mix, thus the inversion layer will break down and the upper-level ozone will mix down to the surface. Ozone from the reservoir reacts with local pollutants by the afternoon.
- Medium-range Transport: pollution travels within the Mid-Atlantic, typically from the southwest and along the I-95 corridor (east of the Appalachian Mountains in what is termed the lee-side trough). The air mass is typically found at about 2,000 feet above the earth's surface and is transported by a "nocturnal low level jet" that moves an average of 30 miles per hour.
- Local Transport: pollution travels ten to a few dozen miles from city to city, also along the I-95 corridor.[xx]

In Maryland, and likely in the District, pollution that is transported from other states alone can exceed the NAAQS. Likewise, emissions generated in the District can harm public health and welfare in downwind states. Local as well as regional and national efforts are required to fully address the ozone problem.

The District works with several regional groups to improve air quality. The smallest geographically focused group is the Metropolitan Washington Air Quality Committee (MWAQC) that is managed by the Council of Governments (MWCOG). This group is made up of representatives of the District, Maryland, Virginia, and the local jurisdictions in the Washington, DC nonattainment area and is focused on achieving clean air standards in the Washington area. Larger geographically-focused groups are the Ozone Transportation Commission (OTC) and Mid-Atlantic Regional Air Managers Association (MARAMA). OTC was created under the 1990 Clean Air Act Amendments and is tasked with ensuring that the 11 states from Maine to Maryland, the District, and Northern Virginia meet ozone standards and does so through coordinating air policies across the region. MARAMA is made up of Pennsylvania, New Jersey, Delaware, Maryland, Virginia, West Virginia, and North Carolina, in addition to the District and provides technical expertise needed to successfully meet air quality standards.

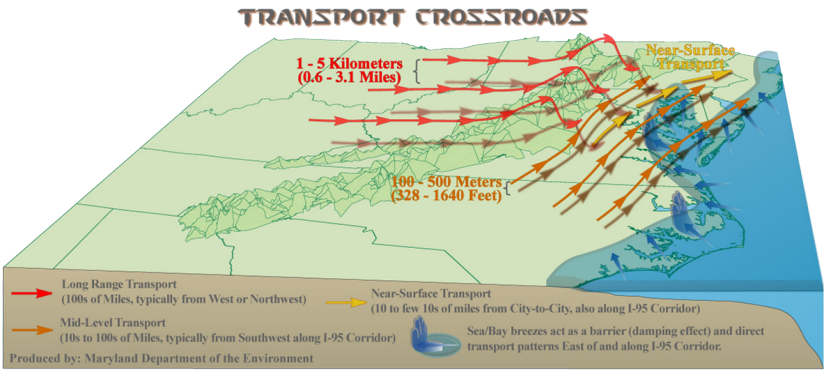
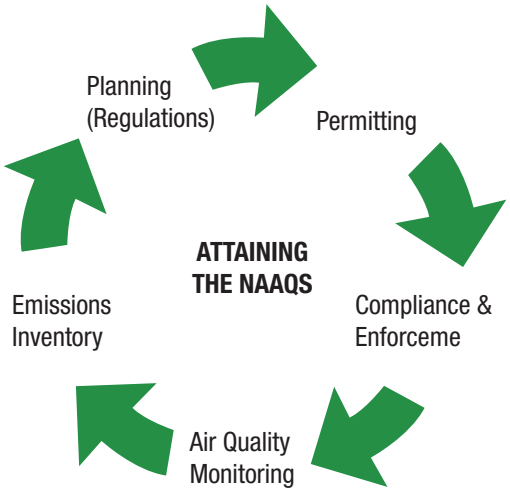


Figure courtesy of the Maryland Department of the Environment

4.0 OVERVIEW OF THE DISTRICT'S AIR QUALITY IMPROVEMENT PROGRAM

The CAA requires establishment and operation of air monitoring networks to measure the ambient air quality. EPA compares air quality data from these networks to the NAAQS. Once EPA formally concludes that criteria pollutant levels in a defined area exceed the standards, state and local agencies such as DOEE engage in an air quality improvement process.



Planning and Regulatory Development – Under the CAA, areas in nonattainment of the NAAQS for a particular pollutant are required to develop long-term plans (called "state implementation plans," or SIPs) to meet the NAAQS. SIP strategies to control emissions from specific types of sources must be quantifiable, surplus[3] , permanent, and enforceable. The District develops both mandatory regulations and voluntary policies, often in collaboration with neighboring states, to maintain existing air quality and further reduce emissions. These plans must be approved by EPA and once in effect are enforceable by both the District and EPA.

Permitting – The largest sources of pollution are required by law to acquire permits that allow them to pollute based on a mutual agreement that specified conditions will be met. Emissions limits in permits can initiate the installation of control technologies or necessitate operational or work practice changes. Noncompliance with final permits is enforceable.

Enforcement and Compliance – DOEE ensures that the regulated community complies with applicable permits and other legal and regulatory requirements by inspecting facilities, reviewing reports, and issuing fines for noncompliance.

Monitoring & Assessment – Ambient air quality monitoring is the "litmus test" that reveals the effectiveness of the air quality program. Monitoring results are compared with air quality projections to influence decision-making.

INSPECTION AND MAINTENANCE PROGRAM

One local control measure that has reduced CO and ozone emission levels is the District's Vehicle Emissions Inspection and Maintenance Program ("I/M Program"). I/M programs ensure emission control systems on individual vehicles are functioning, or repaired if they are not working. DOEE ensures that the program operates efficiently and effectively by reviewing data collection procedures, testing instrument, and conducting station performance reviews.

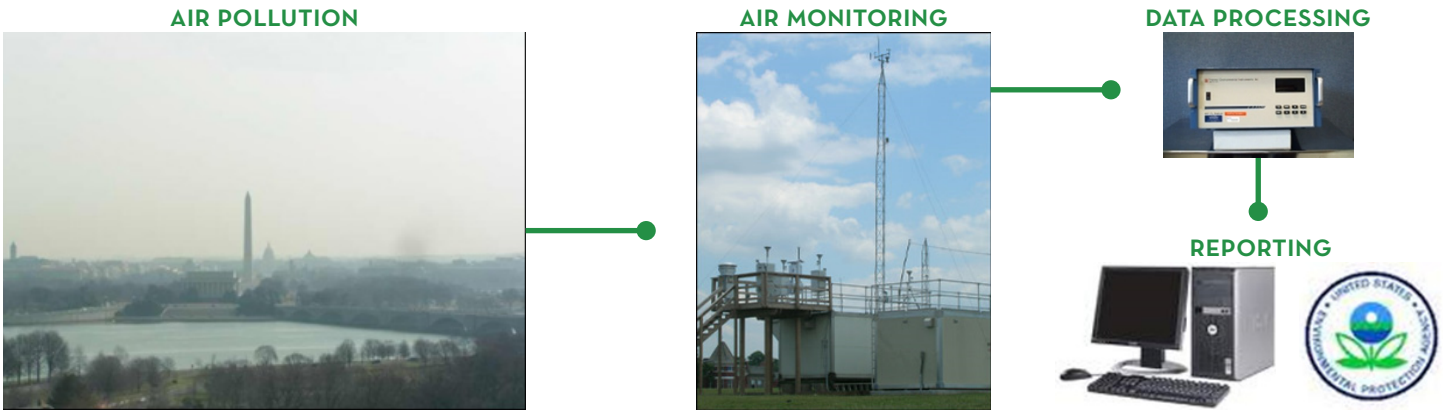
(The District's vehicle inspection facilities are operated and maintained by the Department of Motor Vehicles and DOEE provides regulatory air agency oversight.)

3. EPA designates attainment areas and unclassifiable areas as both "attainment/unclassifiable"

IN FOCUS: THE DISTRICT'S MONITORING NETWORK

Air quality monitoring has evolved since its beginnings in the late 1950s. The earliest monitors were simple mechanisms or passive collectors such as dust-fall buckets and tape samplers. These were followed by wet-chemistry instruments in the 1960s, which were soon replaced by more advanced electronic automated instruments. Advancements in computer technology in the late 1970s and early 1980s led to the development of the modern network.

The District was home to one of the first ambient air monitoring stations in the nation in the 1960s. Today, the District operates and maintains a network of monitors to measure outdoor air quality. Raw data is collected using an air sampling device and stored in a data logger. Some analyzers collect air samples on a filter medium, which must then be analyzed in a lab. The measurement equipment requires regular calibrations and scheduled maintenance. The collected data is moved to the District's database computers, where it is further processed and checked to ensure that accurate measurements are taken (through quality assurance audits and quality control investigations) before reporting to the EPA's Air Quality System (AQS) database on a schedule set forth in the federal regulations of CAA.

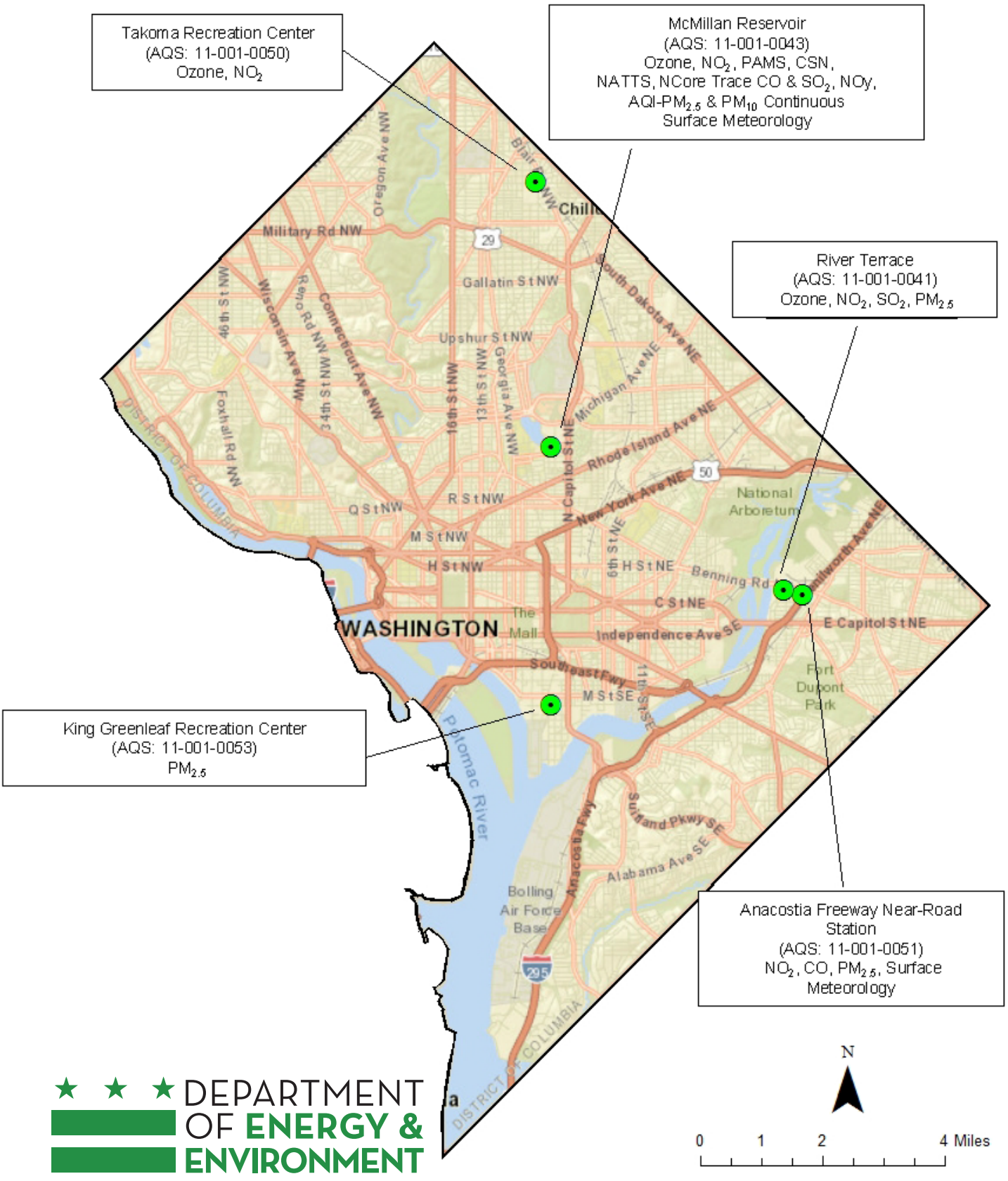


Federal regulations require that air monitors are located in areas of general background concentrations, expected high concentrations, high population density, significant pollution sources, transported air from other areas, and potential impact. Land use, traffic patterns, and pollution source locations can impact the placement of monitoring sites. On a regular basis, particularly upon the adoption of a new NAAQS, changes or modifications to the monitoring sites, sampling schedules, sampling equipment, and technologies are identified to ensure that evolving regulatory requirements (siting criteria, boundary definitions) are met. There are often tradeoffs between data needs and available resources.

The District's ambient air monitoring network consists of five stations: McMillan Reservoir, River Terrace, Takoma Recreation Center, King Greenleaf Recreation Center, and the Anacostia Freeway Near-road Monitor. Hains Point was temporarily closed down in 2016 for building renovation and permanently in 2017 due to inaccessibility of the site. King Greenleaf Recreation center officially became part of the ambient air monitoring network in January 2018. Figure 7 illustrates the current locations and details of each monitoring station in the District.

Each monitor in the District's network is also part of a nationwide network of monitors. Each nationwide network is designed to measure particular pollutants or types of pollutants based on detailed data collection methods and goals. Some networks are intended to collect data on a long-term basis, while others are more pertinent in the short term. Some networks include several monitors to capture information on pollution affecting a population at an urban scale, and others, such as the District's River Terrace monitor, gather neighborhood-scale data.

DOEE's most recent Ambient Air Monitoring Network Plan[xxi] has more information about the current monitoring network in the District.



DEPARTMENT OF ENERGY & ENVIRONMENT

Figure 7: Locations of air quality monitors in the District

5.0 PUBLIC OUTREACH

Air quality predictions and conditions are communicated to the public using a color-coded Air Quality Index (AQI) that rates pollutant levels on a given day based on the measured concentration of pollutants in the air and the corresponding potential health impacts. AQI levels correspond with the NAAQS. The most common AQIs are for ground-level ozone and particulate matter, since pollutant levels for these two pollutants tend to hover near the NAAQS. AQI forecasts alert the public when local weather conditions may contribute to unhealthy air.

Information about air quality can promote changes in daily activities. For example, some organizations implement telework policies on Code Red Days. Code Orange days can be a regular occurrence in the District during summer months.

"State of the Air"

The American Lung Association (ALA) grades cities throughout the country based on the number of Code Orange and Code Red days per summer. The ALA's 2020 State of the Air report ranked the Washington-Baltimore-Northern Virginia, DC-MD-VA-WV, metropolitan statistical area at number 20 out of the 25 most ozone-polluted cities in the U.S.[xxii]

CLEAN AIR PARTNERS

AIR QUALITY ACTION GUIDE

Your "how to" guide for cleaner air

Air Quality Rating	Steps to Protect Your Health and Our Environment
GOOD 0-50	Enjoy the great outdoors. · Rather than drive - bike or walk when possible. · Conserve energy. Replace incandescent bulbs with CFLs. · Plant a tree to improve health and air quality.
MODERATE 51-100	Some pollution. Even moderate levels pose risks to highly sensitive groups. · Bundle errands. Eliminate unnecessary trips. · Check AirAlerts to see if tomorrow's forecast is unhealthy. · Perform regular maintenance on your car.
UNHEALTHY For Sensitive Groups 101-150	Pollution levels are harmful to children, older adults and anyone with a respiratory or heart condition. Limit physical outdoor activity. · Don't drive alone. Carpool, take public transit. · Refuel your car in the evening. · Put off lawn care until air quality improves. · Use a gas or electric grill instead of charcoal.
UNHEALTHY 151-200	Everyone should limit strenuous outdoor activity when the air is unhealthy to breathe. · Telework and take public transit. · Turn off lights and electronics when not in use. · Avoid lawn mowing or use an electric mower. · Sign up for health alerts at cleanairpartners.net. · Don't use chemicals on your lawn and garden.
VERY UNHEALTHY 201-300	Pollution levels are very unhealthy for everyone. Avoid any physical outdoor activity. · Follow all of the action steps above.

PART 2: TRENDS ANALYSIS

1.0 AIR QUALITY TRENDS

To date, the District has always been in compliance with the federal standards for three of the six criteria air pollutants: nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and lead (Pb). As demonstrated in the following chart, ambient air concentrations remain in nonattainment of the NAAQS for one pollutant: ground-level ozone (O_3). In recent years, the District has consistently attained the NAAQS for particulate matter ($PM_{2.5}$). The District came into attainment of the carbon monoxide (CO) standard in 1996 and was required to continue demonstrating attainment until 2016, which the District has both completed and is still in compliance. There are small differences in air quality between the District itself and the DC-MD-VA nonattainment region as a whole. How the District's air quality compares to each primary NAAQS can be seen in Figure 8.

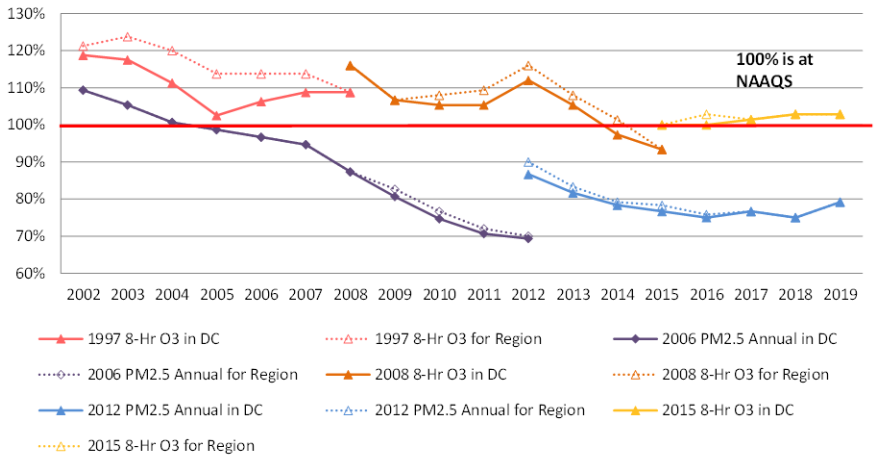


Figure 8: Normalized Ambient Air Quality Levels for Ozone (warm colors) and Fine Particulate Matter (cool colors) in the District compared to the DC-MD-VA Region

Since 2002, ozone levels have been similar but have usually been lower in the District compared to the region. Since 2008, fine PM levels have generally been slightly lower in the District compared to the region.

Monitored air quality values can at least partially be understood by considering source emissions. Emissions in the District are low compared to emissions from other parts of the ozone nonattainment region as a whole.

The District is one jurisdiction, while the nonattainment portion of Maryland includes five separate jurisdictions (Calvert, Charles, Frederick, Montgomery, and Prince George's counties) and the nonattainment portion of Virginia includes nine jurisdictions (Arlington, Fairfax, Loudoun, and Prince William counties plus Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park cities). How emissions of NO_x and VOCs break down among these three jurisdictions in the Washington, DC nonattainment area can be seen in Figure 9.

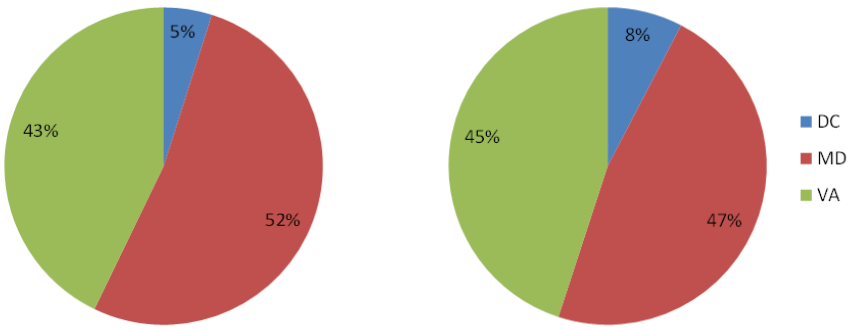


Figure 9: 2017 Emissions of VOC (left) and NO_x (right) in the DC Nonattainment Area

2.0 EMISSIONS TRENDS

Air pollution can result from human (anthropogenic) activities as well as natural sources. Examples of anthropogenic activities include fuel combustion in industries and vehicles, and examples of natural sources include volcanic eruptions and forest fires. Air quality improvement strategies aim to mitigate anthropogenic emissions. These emissions are calculated using data about how much activity occurs in a sector, along with technical information about the emissions source (such as a typical emissions rate). Emissions measurements from a particular source or activity are not always possible; hence, air pollution emission estimates based on proven methods are typically used. Estimation methodologies can change over time as new information becomes available.

EPA gathers and develops emissions data for the following criteria pollutants and their precursors: NO_x and VOC (ozone precursors), CO, PM (primary, condensable, and filterable emissions data for both coarse and fine PM), NH_3 (a fine PM), SO_2, and Pb in short tons per year (tpy). Based on official EPA National Emissions Inventory (NEI) estimates (not including natural biogenic sources)[xxiii], emissions of criteria pollutants and their precursors in the District have dropped gradually since 1996 despite increases in population, employment, and households over time as can be seen in Figure 10.

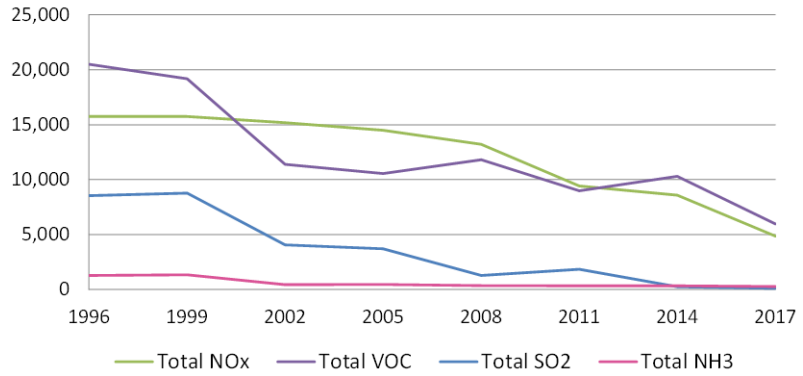


Figure 10: Criteria Pollutant Emissions in the District over Time (tpy)

Such evidence suggests that measures to control pollution have been successful to date. There are similar overall trends for CO and $PM_{2.5}$-primary, but on different scales.

Air quality and emissions trends per pollutant and per sector are discussed in chapters 3-5.

3.0 POLLUTANT-SPECIFIC TRENDS

Air quality and emissions trends per pollutant and per sector are analyzed in the following sections. Even though averaging methodologies of the NAAQS may change, monitored results (design values) do not.

3.1 OZONE MONITORING RESULTS AND EMISSIONS

Ground-level ozone levels are measured at three monitoring sites in the District: McMillan, River Terrace, and Takoma Rec Center. A fire at the Takoma monitoring station occurred in 2011 and as a result measurements ceased at that location. In 2013, a replacement station was established nearby at the Takoma Recreation Center. However, measurements ceased for several months in 2013 due to construction at the site, thus the monitor did not have a complete design value (DV) until 2016. The River Terrace monitor was temporarily shut down for renovation in March 2014, but continued operation starting May 2016. Since the monitor was deployed before the start of the ozone season, 2016 counts as a valid year. The monitor did not have a complete and valid DV calculation until 2018.

The 2015 8-hour ozone NAAQS is based on the fourth highest maximum reading in one year. Data is collected hourly, with 8-hour forward-rolling averages established for every hour in a day. There are 24 8-hour averages per day. An arithmetic mean of the fourth highest maximum reading in one year over three consecutive years is used to determine the DV.

Figure 11 demonstrates how, over time, 8-hour ozone concentrations have generally dropped at all three monitoring stations that measure ozone in the District. The McMillan station consistently measures the highest levels of ozone.

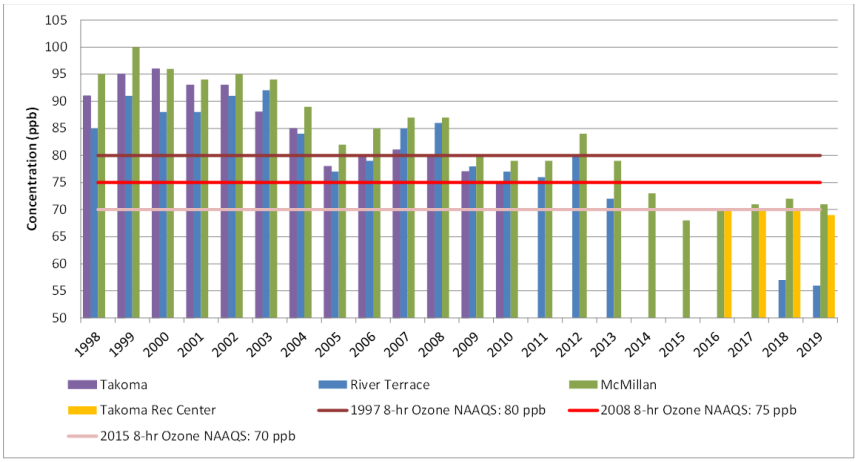


Figure 11: 8-hour Ozone design values for each monitor in the District compared to several Ozone NAAQS

NO_x emissions began dropping after 2004 throughout the region in step with implementation of EPA's NO_x SIP Call (2004) and Clean Air Interstate Rule (CAIR, 2009), which controlled emissions of NO_x from large facilities such as power plants. The downward trends in both NO_x and VOC emissions were also influenced by the "Tier 2" light-duty vehicle rule (2004 to 2007), heavy-duty highway diesel rules (2007), and federal standards for nonroad engines beginning in 2008.

Figure 12 shows the number of days that ozone levels exceeded the 2015 8-hour ozone NAAQS of 70 ppb. Since the standard did not go into effect until 2015, the chart does not portray exceedances of the specific standard from each year.

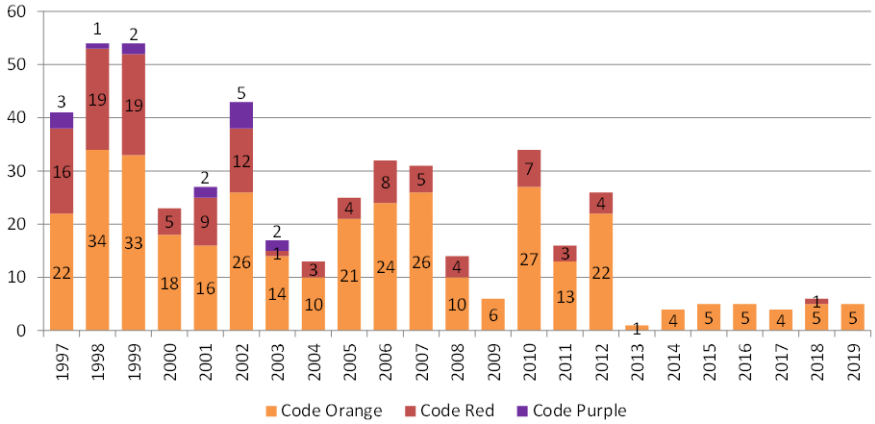


Figure 12: Number of exceedance days in the District compared to the 2015 8-hour Ozone NAAQS

High temperatures coupled with sunlight likely accelerate the formation of ozone, and hotter days are therefore correlated with high-ozone days. Before 2009, a 90 degree day was an indicator of an exceedance day in the Washington, DC metropolitan region, as shown in Figure 13.

Figure 13: Days over 90ºF (Dulles) and 8-hour ozone exceedance days in Metropolitan DC Region (2015 NAAQS) (Regional analysis by MWCOG)

Figure 13 also shows that although there is still a strong relationship between temperature and high ozone, the number of ozone exceedance days have waned over time. This is primarily due to implementation of controls and regulations put in place to reduce ozone and its precursors.

Despite this success, the DC-MD-VA region remains in marginal nonattainment of the 2015 8-hour NAAQS. However, the region is in maintenance and has been redesignated to attainment for the 2008 8-hour NAAQS. The District emits less than ten percent of all NO_x and VOCs emitted by all 15 separate jurisdictions in the region.

Even with emissions reductions in all 15 jurisdictions, the area may remain in nonattainment into the foreseeable future. EPA's modeling analysis for the draft Cross-State Air Pollution Rule (CSAPR) suggested that nearly 90% of all ozone pollution in the region is from out-of-state[xxiv], and actual monitored values for 2017 were higher than the EPA model predictions[xxv], which can be seen in Table 3.

The continued nonattainment in the District does come with a cost to residents in terms of increased mortality and other adverse health effects. Work conducted by the Ozone Transport Commission using EPA's BenMap model found that had the Washington

Table 3: Modeled 2017 and monitored (2016-2018) design values (ppb) at three monitors in the District[xxvi]

Monitor Site	2017 Base Case Modeled Values		Monitored Design Values		
	Average	Maximum	2016	2017	2018
110010043 (McMillan)	66.9	69.7	70	71	72
110010041 (River Terrace)	63	66.4	-	-	57
110010050 (Takoma Rec Center)*	N/A	N/A	70	70	70

** The Takoma Rec Center was not in service at the time of EPA modeling*

Table 4: Health outcomes modeled to not occur if the District had attained the 2015 Ozone Standards in 2016, 2017, 2018

	2016			2017			2018		
	Mean	-2σ	2σ	Mean	-2σ	2σ	Mean	-2σ	2σ
Mortality	10	5	14	7	4	11	9	5	14
Hospital Admissions									
All Respiratory	19	4	34	15	3	27	19	4	34
Pneumonia	6	2	9	4	2	7	6	2	9
Acute Respiratory Symptoms	25,262	11,297	39,227	19,410	8,639	30,181	24,448	10,348	37,949
School Loss Days	5,393	2,179	8,607	4,177	1,688	6,665	5,444	2,200	8,688

region been below the threshold of 70 ppb from 2016 to 2018, the region could have avoided up to 14 deaths, 8,688 lost school days, and 37,949 cases of acute respiratory illness.[xxvii] Table 4 details the health impacts that could have been avoided annually from 2016 to 2018 if the region had been in attainment of the 2015 NAAQS.

3.2 $PM_{2.5}$ MONITORING RESULTS AND EMISSIONS

Particulate matter is measured at four monitoring sites in the District: River Terrace, Near Road, McMillan, and King Greenleaf Recreation Center. As mentioned in Section 4 of Part I, Hains Point was shut down from August 2016 to December 2016 for building renovation. It went online again in January 2017 but was permanently shut down in July 2017 due to inaccessibility. No DVs can be calculated for 2016 and 2017 due to incomplete data. The River Terrace monitor was shut down due to building renovations of the site location from March 2014 to May 2016. Due to this, the station did not have a complete and valid $PM_{2.5}$ DV until 2019. The Near Road monitor has been reporting since June 2015. However, the $PM_{2.5}$ analyzer was down for most of the third quarter of 2016, which resulted in an incomplete data collection for that year. The Near Road monitor did not have a complete and valid DV until 2019. Also, since the King Greenleaf monitor did not become part of the network until January 2018, it will not have a complete design value until 2020, which will become available in 2021.

The annual $PM_{2.5}$ NAAQS is measured using the arithmetic mean of four quarterly averages per year. The 24-hour standard is based on the 98th percentile reading per year, where data is ranked from highest to lowest. Each station collects data using one 24-hour filter per day.

Annual $PM_{2.5}$ levels have gradually declined each year since 2004. Figure 14 shows that the region has been attaining the standards since 2010.

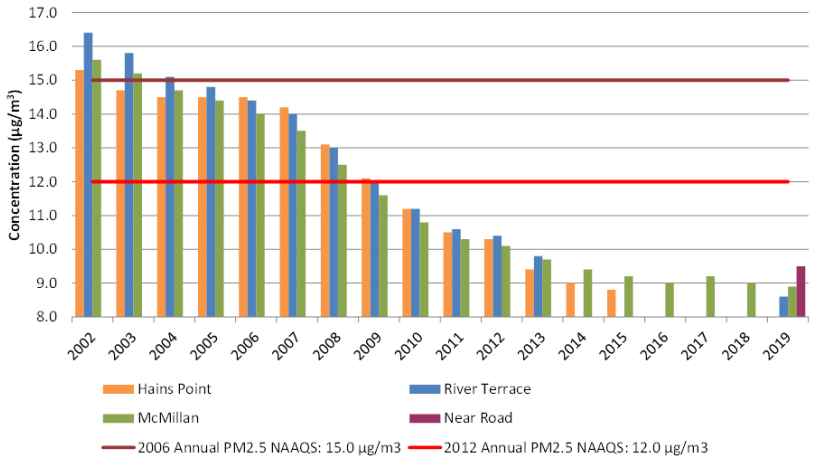


Figure 14: Annual $PM_{2.5}$ design values for each monitor in the District compared to the NAAQS

Since 2004, 24-hour $PM_{2.5}$ levels have also declined. Shorter-term daily exposures are meeting the standards as shown in Figure 15.

These downward trends are likely because of federal control programs that limit emissions from nonroad gasoline and diesel engines, locomotives, and heavy-duty diesel trucks.

PM emissions are estimated as PM-primary, which are particulates that are directly emitted by a source; PM-filterable, which are emissions that are collectable using a filter; and PM-condensable, which are formed after they are emitted. Filterable plus condensable emissions equate to PM-primary emissions.

$PM_{2.5}$ precursors include ammonia, sulfates, nitrates, organic carbon, and elemental carbon. Ammonia emissions in the District have remained relatively constant. The drop in primary $PM_{2.5}$ emissions, as shown in Figure 16, in 2002 occurred primarily in the area source sector. There have been slight increases since then, not because of actual emissions increases but because of changes in the calculation methodologies for residential wood combustion and paved roads that began with EPA's 2008 National Emissions Inventory. Reductions since 2008 appear to be an accumulation of small changes to emission calculation methodologies in the onroad sector.

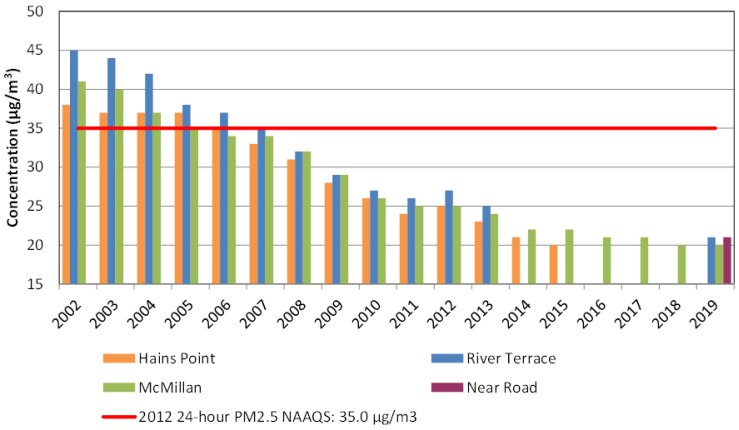


Figure 15: 24-hour $PM_{2.5}$ design values for each monitor in the District compared to the NAAQS

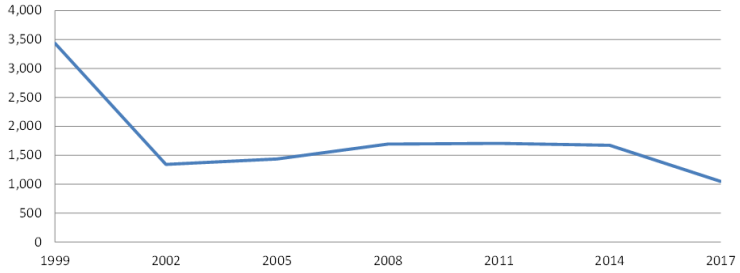


Figure 16: $PM_{2.5}$-Primary Emissions over time (tpy)

3.2.1 PM_{10} MONITORING RESULTS

PM_{10} is currently measured at one location in the District because levels are generally very low. Concentrations are collected using a continuous hourly Federal Equivalent Method (FEM) monitor. The DV is calculated by taking the second highest daily mean max concentration in a calendar year averaged over three consecutive years. PM_{10} data is shown in Figure 17.

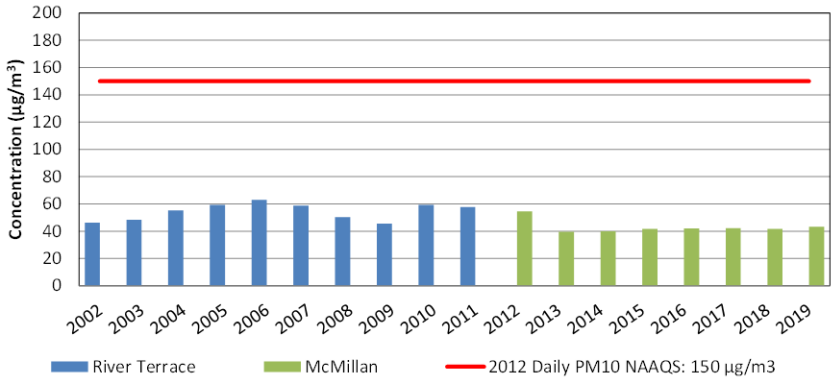


Figure 17: 24-hour PM_{10} design values for each monitor in the District compared to the NAAQS

3.3 CO MONITORING RESULTS AND EMISSIONS

Historically, there have been two monitors for CO in the District. A third monitor was added in 2011 to meet requirements of the 2010 CO NAAQS at the McMillan site, and a fourth monitor was added in 2015 at the Near Road site. For the 8-hour standards, hourly measurements are averaged over eight hours on a backward-rolling basis to establish the daily 8-hour averages. The second highest maximum reading is taken per year to determine an annual estimate, and the DV is the highest annual estimate over two consecutive years.

The District's CO concentration levels have remained well below the NAAQS since 1996, as can be seen in Figure 18.

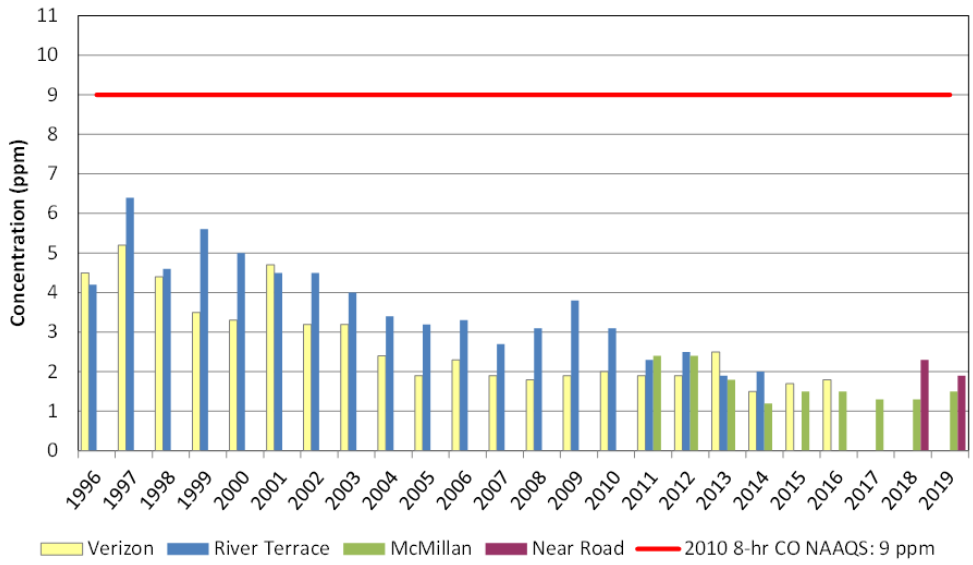


Figure 18: 8-hour CO design values for each monitor in the District compared to the NAAQS

The River Terrace and Near Road "urban" scale monitors generally show more CO pollution than the Verizon Center and McMillan "neighborhood" scale monitors, presumably because of the differences in traffic, the movement of air in each location, and the scale of measurement.

CO emissions have decreased steadily during this time with improvements in motor vehicle emissions controls and fleet turnover and primarily come from the mobile source sector (Figure 19).

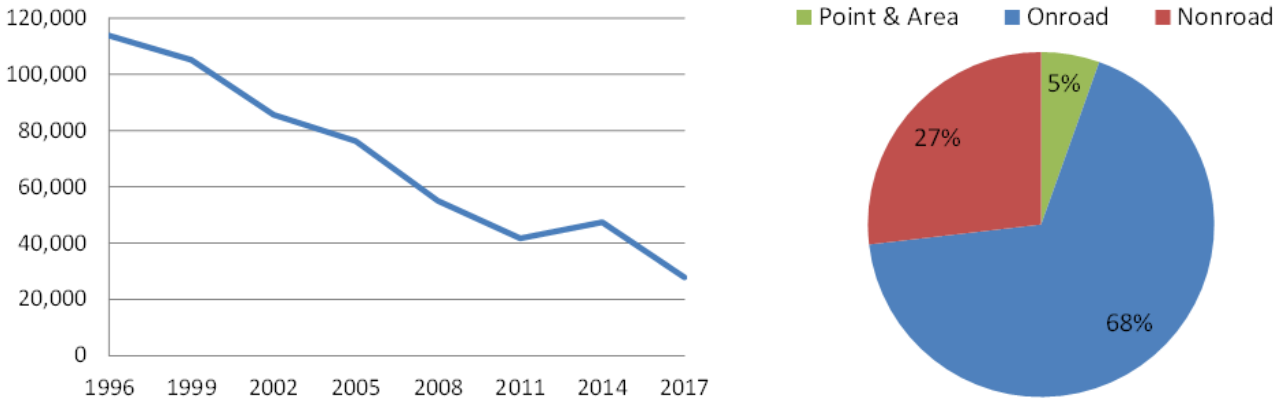


Figure 19: Total CO emissions in the District over time (tpy) (left) and by sector in 2017 (right)

3.4 SO2 MONITORING RESULTS AND EMISSIONS

SO_2 has been measured historically only at the River Terrace monitor. Hourly measurements are taken to comply with the 2010 standard. A trace-level SO_2 analyzer was deployed at the McMillan national core (NCore) station in 2011. The 99th percentile reading averaged over three consecutive years determines the SO_2 DV concentration. For the 1996 24-hour NAAQS, an average of hourly measurements per day is averaged per year, and the DV is the highest of the three annual values over three consecutive years.

The District's SO_2 levels have consistently remained below the NAAQS and have dropped since the highest readings in 2000. Figure 20 shows that existing SO_2 monitoring results are still below the federal standards, even compared to the new 2010 NAAQS.

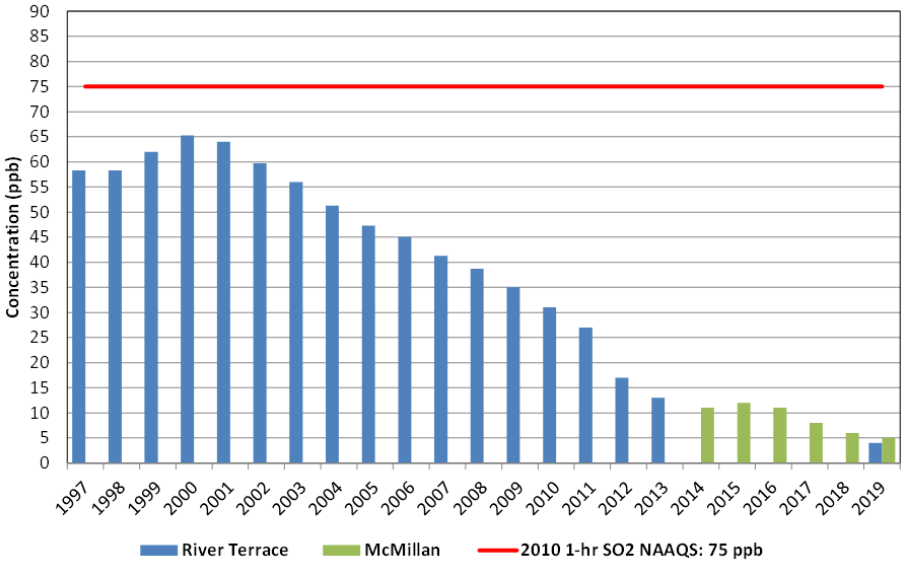


Figure 20: 1-hour SO_2 design value for each monitor compared to the NAAQS

Figure 21 shows how the changes in fuel consumption have contributed to SO_2 levels in the District. SO_2 emissions have been linked to the use of coal at the District's one coal-burning facility, which has generally waned since the 1990s, and the combustion of oil at the District's two electric generating units (EGUs), which both shut down in 2012. In 2011, the spike in SO_2 emissions was due to the increased consumption of #4 oil by the remaining two EGUs in the District. However, the shutdown of both facilities in 2012 resulted in a significant decrease in SO_2, as shown in 2014.

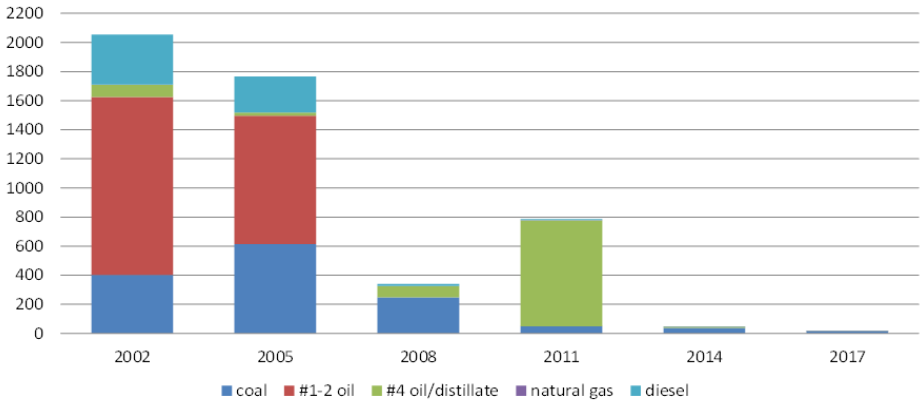


Figure 21: Point source SO_2 emissions by fuel type (tpy)

3.5 NO_2 MONITORING RESULTS

For the 2010 1-hour NO_2 standard, an annual estimate is the 99th percentile reading of hourly measurements ranked from high to low. The annual NAAQS is the average of hourly measurements per year. For both, the DV is the highest estimate over two consecutive years. NO_2 is measured at four locations: River Terrace, McMillan, Takoma Rec, and the Near Road monitor.

Over the past fifteen years, the maximum annual average NO_2 levels have remained at approximately half of the federal standard at all monitoring stations. They continue to remain well below the NAAQS (see Figure 22).

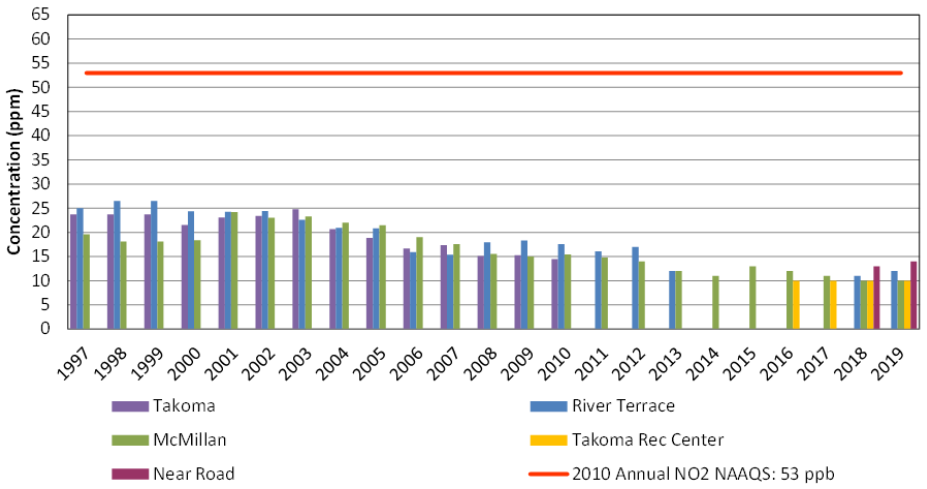


Figure 22: Annual NO_2 design Vvalues for each monitor in the District compared to the NAQQS

The Near Road and Takoma Rec Center monitors have met the requirements for the 2010 1-hour standard for NO_2. NO_x emission data is collected for inventory purposes as a surrogate for NO_2.

3.6 LEAD MONITORING RESULTS

The District's air program began operating population-based ambient lead monitors in January of 2012, as required by the 2008 lead NAAQS revision. As shown in Figure 23, data collected from 2012 through 2015 showed consistently low concentrations, measuring at about 3% of the NAAQS. DOEE discontinued the lead monitor at the end of 2016, under the provisions of 40 C.F.R.

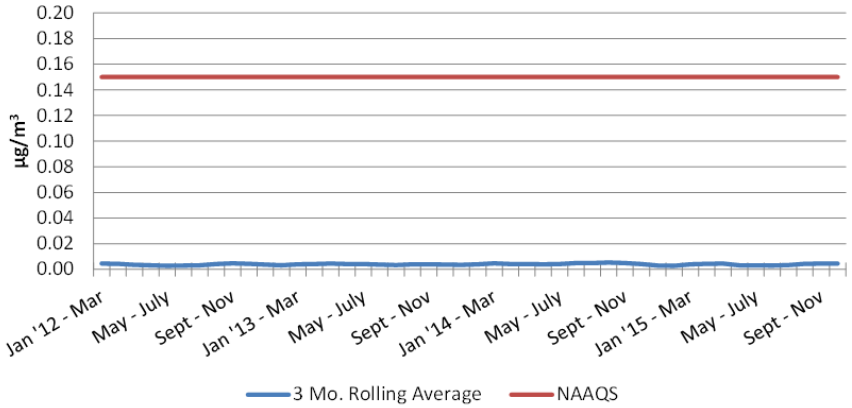


Figure 23: Lead concentrations recorded at the McMillan Monitoring Station

4.0 SECTOR-BY-SECTOR ANALYSIS

Emission sources are broken up into four sectors between point sources, nonpoint or area sources, nonroad, and onroad sources. These emissions are reported to EPA every three years to be included in the National Emissions Inventory (NEI), which is a national database of emissions provided by state, local, or tribal air agencies from their jurisdiction combined with supplemented national default data estimates provided by EPA. The latest NEI available for public view is from 2017. Figure 24 displays each sector's contribution to the total emissions per year in the District.

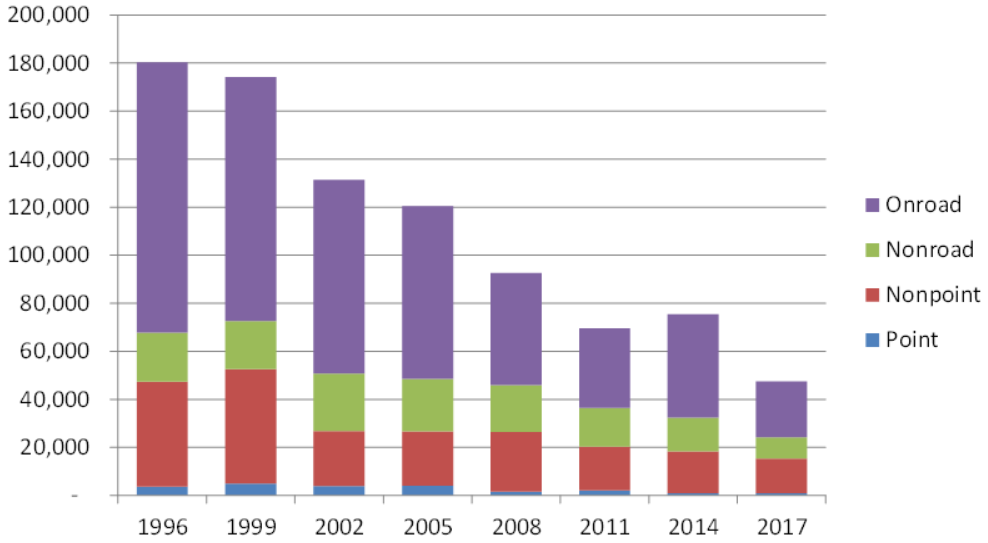


Figure 24: Total Emissions by Sector and Year (tpy)

Roughly half of the air pollution in the District comes from vehicles. Onroad mobile emissions are the primary source of the ozone precursor NO_x, followed by the nonpoint sector. The nonpoint source sector is the main emissions source of the ozone precursor VOCs, followed by the onroad sector. How NO_x and VOCs have changed over time is shown in Figure 25 and Figure 26, respectively.

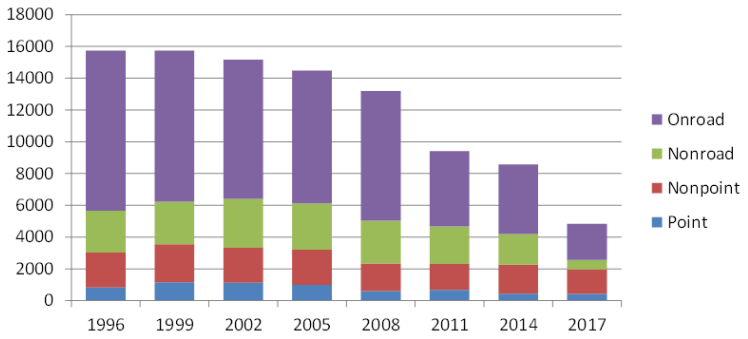


Figure 25: NO_x Emissions by Sector and Year (tpy)

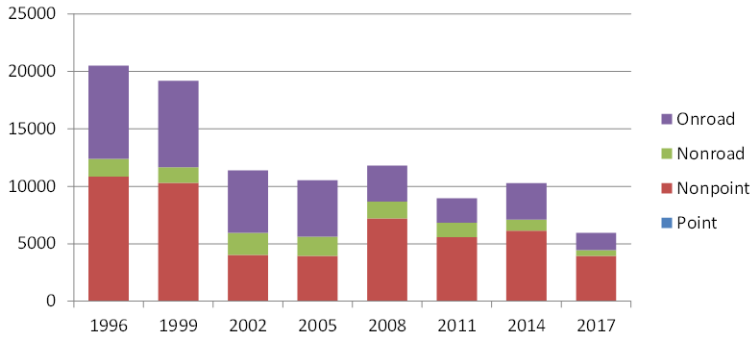


Figure 26: VOC Emissions by Sector and Year (tpy)

4.1 STATIONARY POINT SOURCES

Major point sources with the potential to emit high levels of pollutants [for example, over 25 tons per year (tpy) of NO_x or CO, or over 10 tpy of VOC] are required to report emissions to DOEE annually. In the District, they include universities, hotels, and government establishments that have large fuel-burning boilers. NO_x is the most dominant criteria pollutant from the point source sector though has decreased over time as shown in Figure 27. VOC emissions from point sources are somewhat constant.

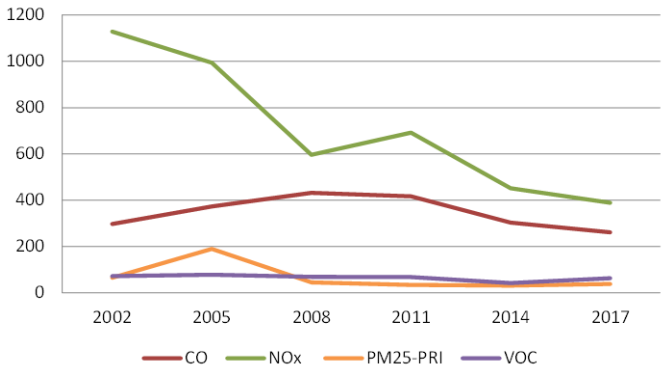


Figure 27: Point source emissions in the District (tpy)

4.2 STATIONARY NONPOINT SOURCES

All other stationary sources such as dry cleaners, auto body shops, and consumer products are inventoried as area (nonpoint) sources. Figure 28 demonstrates that fuel combustion is the primary cause of area source emissions for most pollutants (not including PM or VOCs).

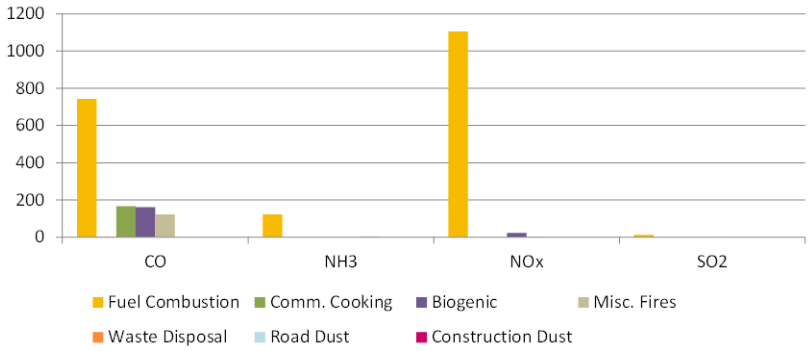


Figure 28: 2017 nonpoint emissions in the District by sector (tpy)

The largest source of VOC emissions from area sources is solvent use, followed by biogenics as shown in Figure 29.

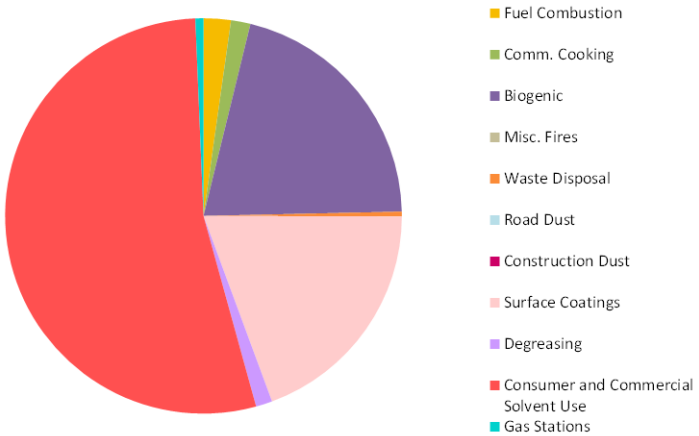


Figure 29: 2017 nonpoint source emissions of VOCs (tpy)

The largest sources of course PM (PM_{10}) and fine PM ($PM_{2.5}$) emissions are construction and road dust (Figure 30).

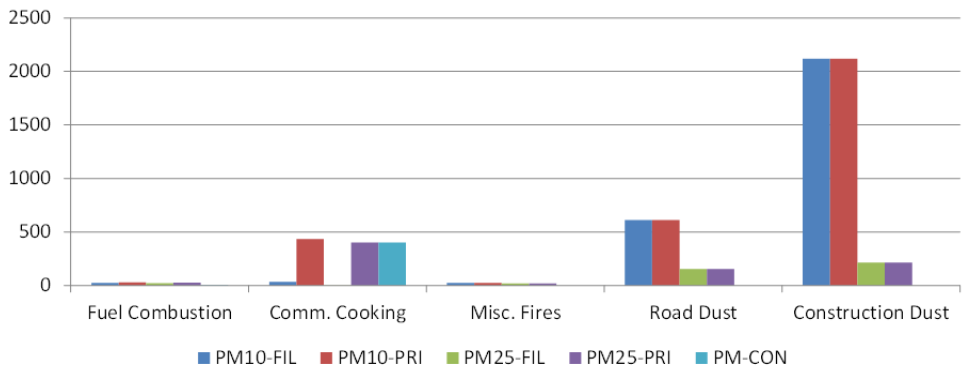


Figure 30: 2017 nonpoint source emission of particulate matter (tpy)

There was a steep increase in estimated CO emissions from area source fuel combustion activities in 2008, as well as in VOC and $PM_{2.5}$ emissions. The observed increase is mainly due to improvements in emissions estimation methodologies made during the Eastern Regional Technical Advisory Committee (ERTAC) effort to coordinate and update data sources and assumptions used throughout the eastern part of the country. Changes were particularly noticeable in the solvent use and residential wood combustion categories. How nonpoint emissions changes for all pollutants is shown in Figure 31.

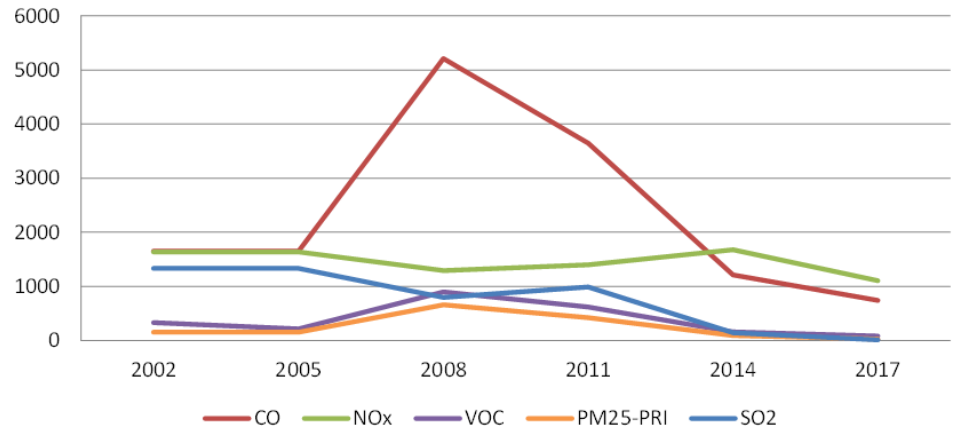


Figure 31: Nonpoint source fuel combustion emissions (tpy)

4.3 NONROAD MOBILE SOURCES

The nonroad emissions calculated in this document were estimated using the official regulatory National Mobile Inventory Model (NMIM) or NONROAD versions at the time of estimation. Nonroad emissions are currently estimated using the NONROAD Model. The NONROAD database includes information on nonroad equipment populations and about each type of equipment such as age, fuel type, available horsepower, hours of activity, and pollution controls or standards. Emissions based on national defaults are then allocated temporally (to specific times of the day, week, or year) and geographically.

Figure 32 indicates that CO, NO_x, and VOCs were the most prevalent pollutants emitted by the District's nonroad sector in 2017. Gas and diesel were the main fuel sources used to power nonroad engines. NO_x emissions in the nonroad sector primarily come from equipment that runs on diesel fuel. Roughly 86 percent of VOC emissions come from gas-powered equipment.

CO emissions are primarily emitted from 4-stroke gasoline engines and are on a downward trend. In general, liquefied petroleum gas (LPG) is used more than compressed natural gas (CNG) in nonroad equipment, although both fuels are much less common than gas and diesel (Figure 33).

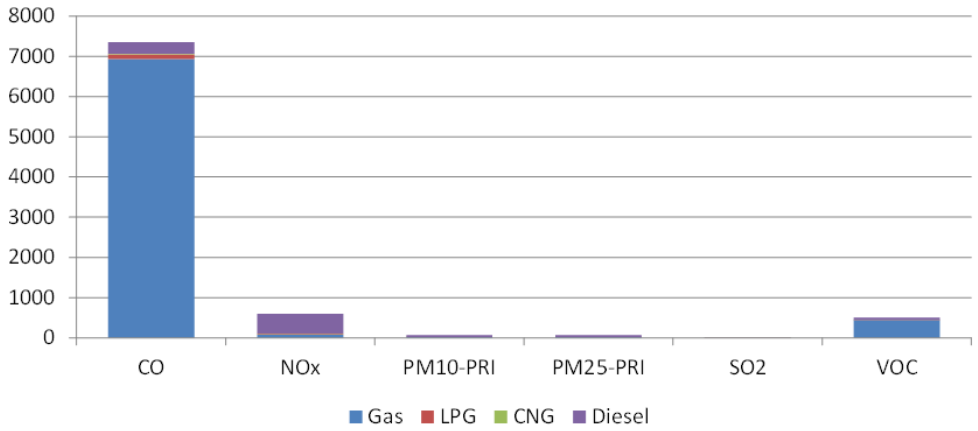


Figure 32: 2017 nonroad emissions by fuel type (tpy)

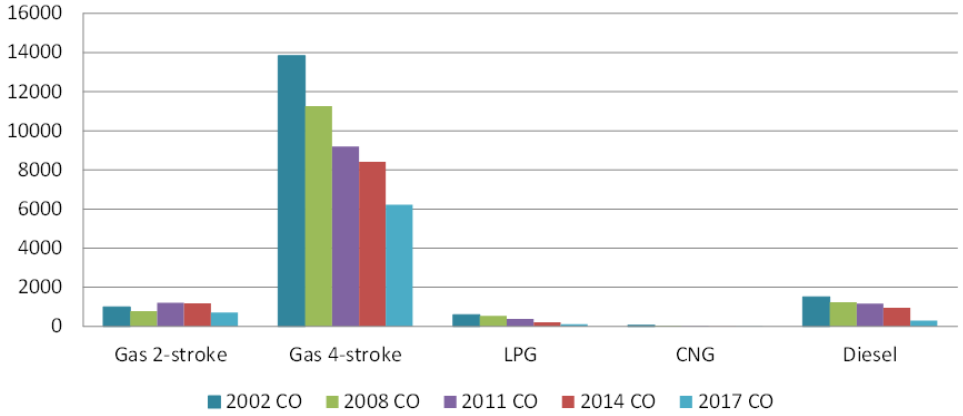


Figure 33: CO emissions from nonroad sources by fuel type (tpy)

In 2017, most diesel NO_x emissions were from the construction sector. VOCs from diesel equipment were also primarily from the construction sector. VOC emissions from gas-powered equipment were prominent in the lawn and garden sector, where 4-stroke gas engines such as residential and commercial lawn mowers and leaf blowers emitted the most. A breakdown is in Figure 34.

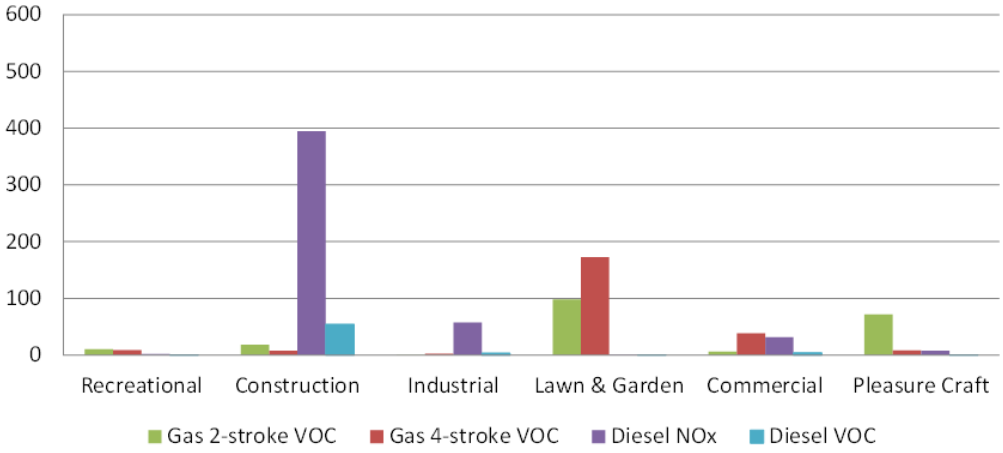


Figure 34: 2017 NO_x and VOC emissions by fuel and sector (tpy)

NO_x and VOC emissions from nonroad sources are also dropping. Reductions since 2002 are likely due to a myriad of exhaust and evaporative emissions standards on nonroad engines such as compression-ignition engines and spark-ignition engines.

4.4 MAR – MARINE, AIRCRAFT, AND RAILROADS

Starting with the 2008 NEI, EPA no longer includes emissions data for commercial marine vessels (CMV), aircraft, and rail locomotives (collectively referred to as "MAR") in the nonroad category. According to EPA's website:

- Aircraft engine emissions occurring during Landing and Takeoff operations (LTO) and the Ground Support Equipment and Auxiliary Power Units associated with the aircraft are included in the point data category at individual airports.
- In-flight aircraft emissions, locomotive emissions, and commercial marine vessel emissions (both underway and port emissions) are included in the nonpoint data category.

For the sake of this document and to get a better understanding of how much each of the MAR sources emit, these emissions have been separated out for this section.

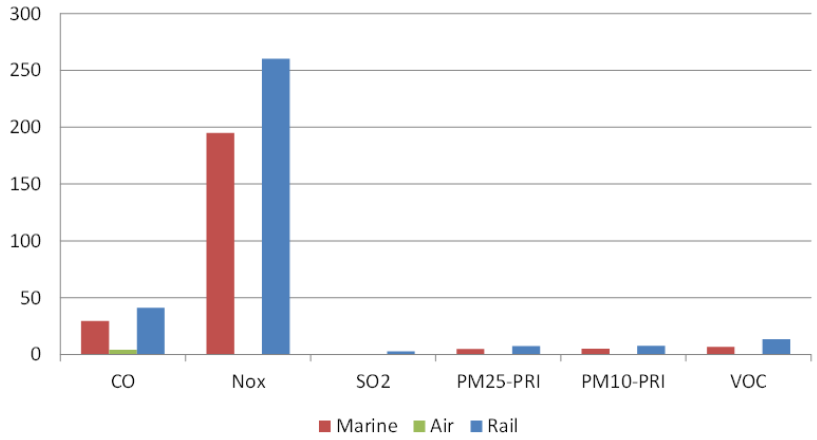


Figure 35: 2017 MAR sources in the District (tpy)

As seen in Figure 35, NO_x is the major of pollutant of concern in regards to MAR sources, specifically from rail and CMV sources. This is mostly due to the use of diesel fuel and less stringent emission standards for rail and marine engines. Emissions from airports are low because there are no major airports in the District like in other states.

4.5 ONROAD MOBILE SOURCE

Onroad emissions from cars, trucks, and motorcycles are estimated using models. With the 2017 NEI, EPA used the state-of-the-art model called Motor Vehicle Emission Simulator (MOVES). The MOVES model incorporates a large body of additional research on emission factors and new source groupings. Model inputs include vehicle population, vehicle age, vehicle miles traveled, vehicle speeds, road types, formulation and supply of fuels, and meteorological data. The most recent version was released in August 2018 as MOVES2014b. The emissions calculated in this document were estimated using the official regulatory MOVES version at the time of estimation.

Based on EPA estimates, onroad mobile emissions of all pollutants have dropped over time. Reductions can be attributed to lower emissions standards, cleaner fuels, and vehicle fleet turnover. CO emissions are the highest and are not included in the following chart of emissions because tons per year (tpy) quantities are on a different scale than other criteria pollutants. The primary pollutant of concern from the mobile sector is NO_x.

The drop in heavy-duty emissions after 2008 is a result of EPA's Heavy Duty Diesel Rule, which required emissions reductions of more than 90 percent beginning with the 2007 model year. It may also partially be attributed to EPA's transition to the MOVES model. Emissions from gasoline vehicles are generally higher than emissions from diesel vehicles.

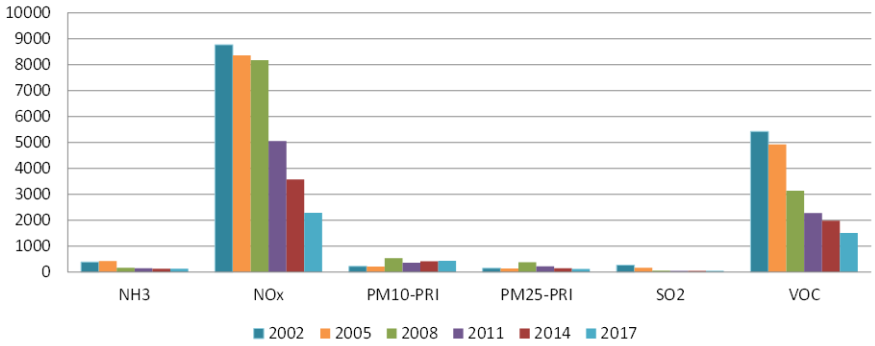


Figure 36: Onroad mobile emissions in the District over time (tpy)

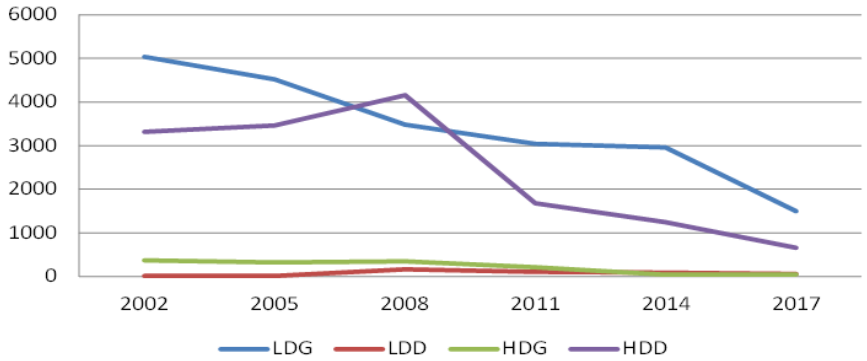


Figure 37: Annual NO_x emissions by vehicle type (tpy)

5.0 OTHER AIR POLLUTANTS

Other gaseous emissions such as greenhouse gases (GHGs) and pollutants such as air toxics are regulated under the Clean Air Act (CAA), and are briefly summarized below in this Report.

5.1 AIR TOXICS

Section 112 of the CAA addresses hazardous air pollutants (HAPs), or air toxics. There are 187 identified HAPs. HAPs come from the same types of sources as criteria pollutants such as vehicle exhaust, gasoline vapors, and commercial and industrial sources that use chemical solvents, paint thinners, or other chemical compounds.

HAPs are known to cause or possibly cause serious health effects even in very small amounts. Potential human impacts include cancer; damage to the immune system; neurological, reproductive, developmental, and respiratory problems; and disturbances to the hormonal or endocrine system. In the environment, HAPs deposit onto soils and into water and eventually accumulate in the food chain and cause birth defects, reproductive failure, and disease in animals. HAPs also contribute to the formation of criteria pollutants.

EPA began controlling HAPs based on pollutant-specific risks to human health. A technology-based strategy was developed with passage of the CAAA in 1990. EPA now addresses HAPs by adopting emissions limit standards for specific source categories of polluters.

EPA's Air Toxics monitoring program began with one ambient air toxics station in each EPA region. The District's McMillan station was a part of this pilot program. The goal was to determine the feasibility of operating a multi-station network across regions as part of a national program. As a result, EPA expanded the program of National Air Toxics Trends Stations (NATTS). In addition, EPA

Region 3 developed a regional air toxics monitoring network to look at ambient air toxic concentration gradients within a more densely populated urban area. The District currently collects air toxics samples at one monitoring station.

EPA also periodically conducts a National Air Toxics Assessment (NATA) to identify which geographic areas, pollutants and types of emission sources of HAPs might need closer investigation. The NATA characterizes potential risks based on cancer and non-cancer toxicity, determines if actions may need to be taken to protect public health, and identifies priorities for expanding the air toxics monitoring network.

EPA's Toxics Release Inventory (TRI) is a database of information about actual releases of toxic chemicals from manufacturing facilities, accessible by zip code.

Once risks are fully characterized, state air agencies decide if steps should be taken locally to reduce air toxics emissions.

5.1.1 HAPS MONITORING/MODELING RESULTS

Exposure to toxic pollutants increases the risks of developing certain diseases or illnesses. An individual's chances of developing a certain disease or illness after exposure is dependent on a multitude of factors, including age, genetics, and the amount of a pollutant they have been exposed to and over what timeframe.

EPA's 2014 NATA, an exercise that combines emissions inventories, monitoring, and modeling, found in all the total cancer risk in the District from air toxics exposure is 40 in one million. A risk level of 40 in a million implies a likelihood that up to 40 people, out of one million equally exposed people, would contract cancer if exposed continuously to these pollutant concentrations over 70 years (an assumed lifetime). In the District, a cancer risk of 40 in one million translates to approximately 28 additional deaths due to air toxics exposure over a 70-year period. The 2014 NATA found the following pollutants to be most prevalent in the District.

Table 5: Risk associated with long- and short-term exposure hazardous pollutants to HAPs in the District from the 2014 NATA

Pollutants of Highest Concern for Long-Term Exposure (may cause cancer)	Pollutants of Highest Concern for Short-Term Exposure (may cause acute illness)
Formaldehyde	Formaldehyde
Benzene	Acetaldehyde
Carbon Tetrachloride	Acrolein
Acetaldehyde	Diesel PM
1,3-Butadiene	Trichloroethylene
Napthalene	PAH POM
Ethylbenzene	1,3-Butadiene
Ethylene oxide	Benzene
Arsenic, PM	Naphthalene
Hexavalent Chromium	Xylenes

5.2 REGIONAL HAZE

A Federal Regional Haze Rule was published in 1999 to improve visibility in 156 designated "Class I" national parks and wilderness areas. States and the District are required to coordinate with Federal agencies to reduce pollution that causes visibility impairment, also known as regional haze. The closest Class I areas to the District are Shenandoah National Park and James River Face Wilderness Area in Virginia, Dolly Sods and Otter Creek Wilderness Areas in West Virginia, and Brigantine Wilderness Area in New Jersey. Haze-causing pollutants are typically a combination of criteria pollutants and their precursors, primarily secondary aerosols that from when ammonia combines with emissions of sulfur dioxide or oxides of nitrogen.

A Regional Haze Plan for the District was completed in 2010 and approved by EPA in 2012, resulting in a permit condition to close the District's remaining electric generating units (EGUs) to minimize the District's contribution to haze in Class I areas. This SIP covered the first implementation period of 2008-2018. With partner agencies, the District will continue evaluating regional haze progress and goals and potential control measures with the aim of eliminating visibility problems by 2064. The District has submitted a revised Regional Haze Plan to cover the period of 2018-2028 to EPA for review.

5.3 GREENHOUSE GASES

Greenhouse gases (GHGs) are pollutants that trap heat in the upper atmosphere and influence the global climate. Since the Industrial Revolution, there's been a steady increase in CO_2. Figure 38 illustrates the recorded CO_2 levels at Mauna Loa Observatory since 1958.[xxviii] The red line indicates the mole fraction of CO_2 in dry air and the black line indicates the seasonally corrected data.

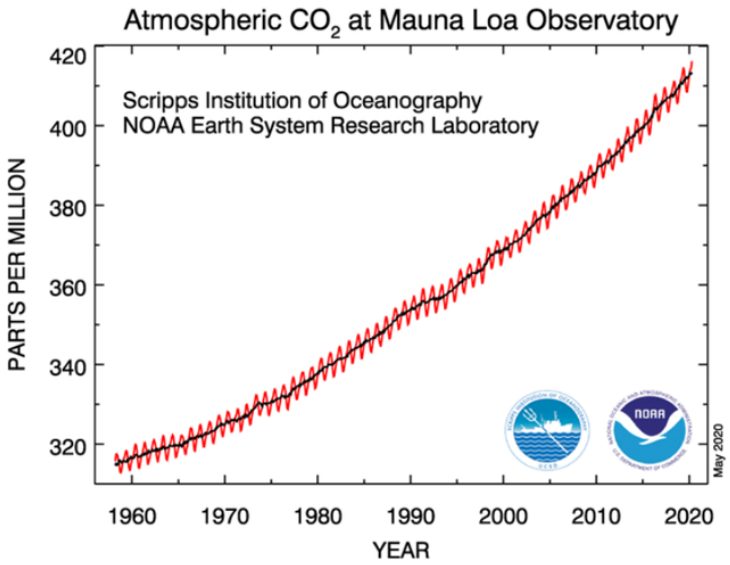


Figure 38: Atmospheric CO_2 at Mauna Loa Observatory from 1958 to 2020

This increase in CO_2 has led to warming temperatures and thus, extreme weather. The World Meteorological Organization published a report in 2019 stating that 2019 was the second warmest year on record. It also stated that 2015-2019 were the five warmest years on record, and 2010-2019 was the warmest decade on record.[xxix] Globally, warmer temperatures can directly and indirectly lead to more destructive hurricanes, flooding, forest fires, drought, and sea level rise.[xxx] The local effects from this can be seen in the increasing frequency of warmer than average days and intense storms and flooding.

The District has remained committed to reducing its impact on the atmosphere and preparing for the changing climate. DOEE released the Sustainable DC 2.0 plan which established the District's commitment to reduce GHG emissions by 50 percent below

2006 levels by 2032.[xxxi] In addition to this, Mayor Bowser pledged to make the District carbon neutral and climate resilient by 2050. The District also released the Climate Ready DC Plan, which lays out how the District is preparing for and adapting to climate change.[xxxii] DOEE is also in the process of implementing many portions of the 2018 Clean Energy Omnibus Act that was passed by the District Council.

DOEE's Air Program remains interested in energy sector opportunities to reduce GHG emissions because of air quality co-benefits.

5.4 ACID RAIN PRECURSORS AND STRATOSPHERIC OZONE DEPLETING SUBSTANCES

Stratospheric ozone, which is the "good" upper ozone layer 10 km above the surface that protects life on Earth from the sun's ultraviolet rays, is depleted when man-made chemicals, such as chlorofluorocarbons (CFCs), mix high in the atmosphere and react. The chemicals degrade the ozone layer and are then deposited with higher than normal levels of nitric and sulfuric acids as "acid rain." Title IV of the CAA implements the country's commitment under the Montreal Protocol, an international treaty, to phase out the production of ozone-depleting substances.

6.0 DISTRICT'S AIR QUALITY STATUS – SUMMARY

DOEE's Air Program works diligently to realize air quality improvements in the District. Progress has been made since the program began, yet more can be done:

- **Ozone** – The District and the metropolitan area are in **marginal nonattainment** of the 2015 8-hour ground-level ozone (O_3) standards. Ozone continues to be the biggest air pollution challenge the region faces. Controlling emissions from mobile sources and working with upwind states and regions to address transported pollution are necessary to improve public health.
- **Particulate Matter** – The District is in **attainment** of the 2012 annual $PM_{2.5}$ NAAQS. The U.S. Environmental Protection Agency (EPA) has also redesignated the region as an **attainment** area for the 1997 annual standard. The monitored air quality levels have been below the standards for the past several years.
- **CO** – The District is in **attainment** for the 2010 8-hour carbon monoxide (CO) standards and the ambient air quality levels have been below the standards since 1996. In February 2010, EPA retained the existing CO standard.
- **SO_2, NO_2** – The District continues to **attain** both the sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) standards, with monitored levels far below the NAAQS. New standards were developed for each pollutant in 2010.
- **Lead** – The District is in **attainment** of the 2008 lead NAAQS. Due to consistently low measured values below the 1978 standard, the District stopped monitoring for lead in 2002. The new lead standard that was established in 2008 is ten times more stringent than the previous standard, which required the District to continue monitoring lead. In 2016, the District ceased monitoring again as it had been measuring consistently low concentrations at about 3% of the new standard. It was discontinued under the provisions of 40 C.F.R.

Efforts will persist to protect public health and welfare, particularly as EPA continues to revise the NAAQS and improve its understanding of how policies can impact the environment.

APPENDIX A

Pollutant [links to historical tables of NAAQS reviews]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		primary and secondary	Rolling 3 month average	0.15 µg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide (NO_2)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb (2)	Annual Mean
Ozone (O_3)		primary and secondary	8 hours	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 µg/m^3	annual mean, averaged over 3 years
		secondary	1 year	15.0 µg/m^3	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

National Ambient Air Quality Standard for each Criteria Pollutant
Figure courtesy of EPA at: https://www.epa.gov/criteria-air-pollutants/naaqs-table

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