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# Evaluation of the EPA's Oversight of State and Local Ambient Air Monitoring Operating Schedules

September 17, 2025 | Report No. 25-E-0051


**REDACTED VERSION FOR PUBLIC RELEASE**

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OFFICE OF INSPECTOR GENERAL
U.S. ENVIRONMENTAL PROTECTION AGENCY

## Abbreviations

| | |
|---|---|
| AQS | Air Quality System |
| C.F.R. | Code of Federal Regulations |
| EPA | U.S. Environmental Protection Agency |
| $\mu g/m^3$ | Micrograms per Cubic Meter of Air |
| NAAQS | National Ambient Air Quality Standards |
| OAQPS | Office of Air Quality Planning and Standards |
| OIG | Office of Inspector General |
| $PM_{2.5}$ | Fine Particulate Matter (2.5 Micrometers or Smaller in Size) |
| PPB | Parts per Billion |
| PPM | Parts per Million |

## Key Definition

| | |
|---|---|
| Ambient Air | The portion of the atmosphere, external to buildings, to which the public has access. |

## Cover Image

$PM_{2.5}$ ambient air monitor. (EPA OIG image)

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25-E-0051
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# At a Glance

## Evaluation of the EPA's Oversight of State and Local Ambient Air Monitoring Operating Schedules

### Why We Did This Evaluation

**To accomplish this objective:**

The U.S. Environmental Protection Agency Office of Inspector General conducted this evaluation to determine whether the EPA's oversight and implementation of air quality monitoring resulted in underreported air pollution.

Under the Clean Air Act, the EPA sets standards, known as National Ambient Air Quality Standards, for air pollutants that are harmful to public health and the environment. If an area meets these standards, it is designated as an attainment area. If it does not meet these standards, it is designated as a nonattainment area.

Using thousands of air monitors at sites across the country, the EPA works with state and local air monitoring agencies to gather information about air pollution. Some air monitoring sites operate daily, but others operate on a predictable, intermittent schedule. Typically, the intermittent air monitoring sites will operate once every three, six, or 12 days. References to these air monitor sites use the terms "1-in-3," "1-in-6," and "1-in-12," respectively. The term "pollution gap" refers to the difference in average pollution measurements between an air monitoring site's online and offline days when measured by alternative, non-EPA monitoring methods.

**To support these EPA mission-related efforts:**

- *Improving air quality.*
- *Compliance with the law.*

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### What We Found

Our statistical analyses indicate that pollution levels increase when certain air quality monitoring sites are offline. When some ambient air quality monitoring sites were offline, fine particulate matter air pollution increased on average by about 4 percent for daily monitoring sites and 9 percent for 1-in-3 monitoring sites. Further analyses indicated that 35.70 percent of sites that operated intermittently rather than daily had worse air quality on average when they were offline. While the results of our analyses do not indicate malicious behavior at any specific site, they demonstrate that there is a risk of underreported air pollution. The Clean Air Act requires the EPA to protect air quality, and the Agency will struggle to achieve this statutory mission if air quality monitoring data are not representative of the actual air quality.

Two factors may contribute to underreported air pollution. First, the EPA publishes its intermittent air monitoring schedule on its website, creating an opportunity for regulated entities to time peak emissions for when a monitoring site is offline. When the EPA determines that the air quality in an area does not meet the standards, the Clean Air Act requires state and local governments to develop a plan to improve air quality. Such a plan can include costly emission controls, which may incentivize regulated entities to alter their emission patterns. Second, although EPA staff review air monitoring data, the EPA does not have the capacity to identify underreported air pollution within such a large volume of air quality data. This limitation creates opportunities for state and local air monitoring agencies to strategically turn off monitoring sites on days that they expect high pollution, potentially to avoid the EPA designating an area as in nonattainment.

When considering the pollution gap, 18 percent of the air monitoring sites in our analysis that had worse air quality when they were offline switch from indicating area attainment to indicating area nonattainment. This indicates that there is a risk that the Agency is not effectively obtaining the data it needs to make accurate attainment designations, meaning that it may incorrectly designate nonattainment areas as attainment areas. Accordingly, regulated entities in incorrectly designated areas would not be required to take measures to improve air quality, potentially resulting in poorer air quality and health outcomes for people residing and working in these areas.

> **Without data that are representative of the actual air quality, people may be exposed to harmful and hidden levels of air pollution, leading to serious health consequences.**

### Recommendations and Planned Agency Corrective Actions

We make two recommendations in this report. We recommend that the assistant administrator for Air and Radiation restrict the distribution of the intermittent monitoring schedule to state, local, and tribal air monitoring agencies and associated labs and discourage broader dissemination of and access to the intermittent monitoring schedule. In addition, we recommend that the assistant administrator implement a regular screening process using alternative air pollution measurements to detect monitoring sites that may be underreporting air pollution. The EPA agreed with our recommendations. We consider both recommendations resolved with corrective actions completed or pending.

**OFFICE OF INSPECTOR GENERAL**
U.S. ENVIRONMENTAL PROTECTION AGENCY

September 17, 2025

**MEMORANDUM**

**SUBJECT:** Evaluation of the EPA's Oversight of State and Local Ambient Air Monitoring Operating Schedules
Report No. 25-E-0051

**FROM:** Nicole N. Murley, Acting Inspector General

**TO:** Aaron Szabo, Assistant Administrator
Office of Air and Radiation

This is our report on the subject evaluation conducted by the U.S. Environmental Protection Agency Office of Inspector General. The project number for this evaluation was OSRE-FY24-0072. This report contains findings that describe the problems the OIG has identified and corrective actions the OIG recommends. Final determinations on matters in this report will be made by EPA managers in accordance with established audit resolution procedures.

The Office of Air and Radiation is responsible for the issues discussed in this report. In accordance with EPA Manual 2750, your office completed corrective actions for Recommendation 1. Your office also provided acceptable planned corrective actions and an estimated milestone date in response to Recommendation 2. All recommendations are either closed or resolved, and no final response to this report is required. If your office submits a response, however, it will be posted on the OIG's website, along with our memorandum commenting on the response. The response should be provided as an Adobe PDF file that complies with the requirements of section 508 of The Rehabilitation Act of 1973, as amended. The final response should not contain data that your office does not want released to the public; if the response contains such data, your office should identify the data for redaction or removal along with corresponding justification.

This version of our report has had information redacted because it contains certain privileged information. We will post this version of our report to our website at www.epaoig.gov.

# *Table of Contents*

## Chapters



## Appendixes

# Chapter 1
## Introduction

### Purpose

The U.S. Environmental Protection Agency Office of Inspector General initiated this evaluation to determine whether the EPA's oversight and implementation of air quality monitoring resulted in underreported air pollution.

### The Clean Air Act and National Ambient Air Quality Standards

The Clean Air Act is the cornerstone of air quality regulation in the United States and is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." The Clean Air Act achieves this goal by regulating air pollutants in the ambient air—the portion of the atmosphere, external to buildings, to which the public has access. Air pollutants are gas and particle contaminants that enter the atmosphere from fuel combustion, industrial processes, highway vehicles, and other sources. Six of the commonly found air pollutants, which the EPA calls criteria air pollutants, are carbon monoxide, lead, ozone, particulate matter, nitrogen dioxide, and sulfur dioxide.

Under the Clean Air Act, the EPA is responsible for setting standards for ambient air pollutants that are considered harmful to public health and the environment. The EPA sets National Ambient Air Quality Standards, or NAAQS, for the six criteria air pollutants. As shown in Table 1, the NAAQS reflect allowable levels of criteria air pollutants. The NAAQS identify two types of standards. Primary standards protect public health, including the health of sensitive populations, such as children and people with asthma. Secondary standards protect public welfare by targeting issues like decreased visibility and damage to animals, crops, and buildings. The units of measure for these standards are parts per million, or ppm, by volume; parts per billion, or ppb, by volume; and micrograms per cubic meter of air, or $\mu g/m^3$. The Agency must review these standards every five years to ensure that the standards reflect the most current scientific understanding of pollutant effects on public health and the environment.

**Table 1: Primary and secondary NAAQS by criteria air pollutant**

| Criteria air pollutant | Primary standard (ppm, ppb, or $\mu g/m^3$) | Secondary standard (ppm, ppb, or $\mu g/m^3$) | Exceedance Criteria |
|---|---|---|---|
| **Carbon monoxide (CO)** | 9 ppm *(8-hour average)*<br>35 ppm *(1-hour average)* | None listed | Not to be exceeded more than once per year. |
| **Lead (Pb)** | 0.15 $\mu g/m^3$ *(rolling 3-month average)* | 0.15 $\mu g/m^3$ *(rolling 3-month average)* | Not to be exceeded. |

| Criteria air pollutant | Primary standard (ppm, ppb, or µg/m³) | Secondary standard (ppm, ppb, or µg/m³) | Exceedance Criteria |
|---|---|---|---|
| **Nitrogen dioxide ($NO_2$)*** | 100 ppb *(1-hour average)*<br>53 ppb *(1-year average)* | 53 ppb *(1-year average)* | For the 1-hour primary standard:<br>• 98th percentile of 1-hour daily maximum concentrations, averaged over 3 years.<br>For the 1-year primary and secondary standard:<br>• Annual mean. |
| **Ozone ($O_3$)** | 0.07 ppm<br>*(8-hour average)* | 0.07 ppm<br>*(8-hour average)* | Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years. |
| **Particulate matter 2.5 µm or less ($PM_{2.5}$)** | 9 µg/m³<br>*(1-year average)*<br>35 µg/m³<br>*(24-hour average)* | 15 µg/m³<br>*(1-year average)*<br>35 µg/m³<br>*(24-hour average)* | For the 1-year primary and secondary standard:<br>• Annual mean, averaged over 3 years.<br>For the 24-hour primary and secondary standard:<br>• 98th percentile, averaged over 3 years. |
| **Particulate matter 10 µm or less ($PM_{10}$)** | 150 µg/m³<br>*(24-hour average)* | 150 µg/m³<br>*(24-hour average)* | Not to be exceeded more than once per year on average over 3 years. |
| **Sulfur dioxide ($SO_2$)**** | 75 ppb *(1-hour average)* | 10 ppb *(1-year average)* | For the primary standard:<br>• 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years.<br>For the secondary standard:<br>• Annual mean, averaged over 3 years. |

Source: OIG summary of the EPA's NAAQS Table. (EPA OIG table)

*Notes:* We simplified the standards in this table. For an exact version of the standards, including how the EPA calculates compliance with the standards, see the link in the source above.

* The NAAQS for nitrogen oxides are currently set using nitrogen dioxide ($NO_2$) as the indicator of the larger group of nitrogen oxides.

** The NAAQS for sulfur oxides are currently set using sulfur dioxide ($SO_2$) as the indicator of the larger group of sulfur oxides.

According to the EPA, criteria air pollutants are linked to significant adverse health effects, and scientific studies demonstrate that exposure to air pollutants may exacerbate preexisting respiratory and cardiovascular conditions. Sensitive populations, such as children, the elderly, and individuals with preexisting health conditions, are particularly vulnerable to the negative health effects of pollutant exposure. Table 2 provides examples of the health and environmental effects linked to criteria air pollutant exposure, and the following shaded box provides San Joaquin Valley, California community members' perspectives on $PM_{2.5}$ impacts.

**Table 2: Possible health and environmental effects by criteria air pollutant**

| Criteria air pollutant | Health effects | Environmental effects |
|---|---|---|
| **Carbon monoxide** | • Reduces oxygen to organs and tissues. | • Forms carbon dioxide and ozone, greenhouse gases that warm the planet. |
| **Lead** | • Damages the nervous system, resulting in lower IQ, learning deficits, and behavioral problems.<br>• Causes harmful cardiovascular effects. | • Decreases growth and reproductive rates in plants and animals. |
| **Nitrogen dioxide** | • Worsens respiratory diseases.<br>• Causes asthma. | • Contributes to soil and surface water acidification and nitrogen buildup.<br>• Forms ozone. |
| **Ozone** | • Causes coughing and difficulty breathing.<br>• Aggravates lung diseases, including asthma. | • Damages vegetation.<br>• Warms the planet as a greenhouse gas. |
| **Particulate matter** | • Causes harmful cardiovascular effects. | • Reduces visibility.<br>• Contributes to water acidification. |
| **Sulfur dioxide** | • Causes respiratory issues like asthma. | • Contributes to soil and surface water acidification. |

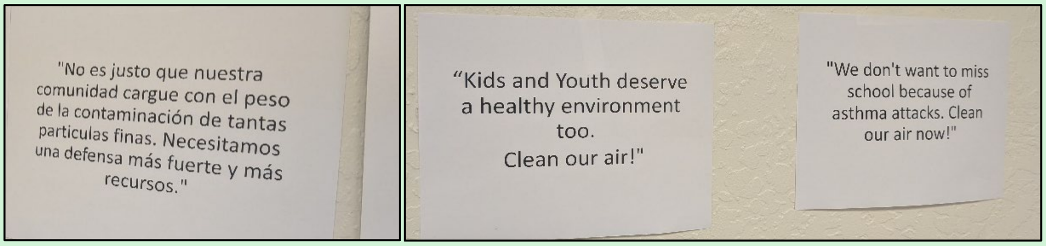
Source: OIG summary of the EPA's webpage on criteria air pollutant health and environmental effects. (EPA OIG table)

**San Joaquin Valley, California—Perspectives on $PM_{2.5}$ impacts**

While our review of data in the vicinity of the San Joaquin Valley indicated unusual monitoring site behavior, we primarily visited this area because it is faced with persistent $PM_{2.5}$ pollution and we wanted to better understand the human impacts of that pollution. Our visit revealed this community's concern about its air quality, emphasizing the importance of having data that are representative of the actual air quality.

According to the U.S. Geological Survey, the Central Valley of California, which includes San Joaquin County and the City of Fresno, is a major contributor to U.S. agriculture, producing over 250 different crops with an estimated annual value of $17 billion. The U.S. Geological Survey adds that "using fewer than 1% of U.S. farmland, the Central Valley supplies 8% of U.S. agricultural output (by value) and produces 1/4 of the Nation's food, including 40% of the Nation's fruits, nuts, and other table foods." In addition to this agricultural productivity, this region has notable public health challenges. San Joaquin County has been in nonattainment of the air quality standards for $PM_{2.5}$ since 1997 and in nonattainment of the ozone standard since 2008. According to the Centers for Disease Control and Prevention, residents in the San Joaquin Valley and in the Fresno area reported higher rates of asthma, 10.1 percent (from 2019 through 2021), compared to 8.8 percent statewide (in 2021) and 8.0 percent nationwide (in 2021).

In February 2024, the EPA strengthened the health-based NAAQS for $PM_{2.5}$ to 9µ/m$^3$. However, the state and district air agencies' most recent *2024 Plan for the 2012 Annual $PM_{2.5}$ Standard* addresses the 2012 annual $PM_{2.5}$ standard of 12 µg/m$^3$ and requests an extension until 2030 to meet this less stringent standard. In July 2024, we attended a San Joaquin Valley community meeting where we met community members who expressed concerns about the air quality in their neighborhood and about the potential link to asthma, chronic obstructive pulmonary disease, missed days of school and work, miscarriages, and cancers. Community members also expressed concern about the proximity of schools to agricultural fields and the impact of pesticides on air quality. Prior to this community meeting, the EPA had proposed approving a plan for a one-year extension of the 1997 standard for $PM_{2.5}$. The plan, which California air monitoring agencies submitted to the EPA, described an extension that would have given California additional time to meet the 1997 standard—a standard that is less stringent than the 2012 and 2024 standards at 15 $\mu g/m^3$—without implementing more stringent pollution controls.




Signs from the community meeting. The sign shown on the left is written in Spanish. Translated into English, the sign says, "It is not fair that our community bears the weight of the pollution of so many fine particles. We need a stronger defense and more resources." Source: EPA OIG site visit. (EPA OIG images)

## *Air Quality Monitoring*

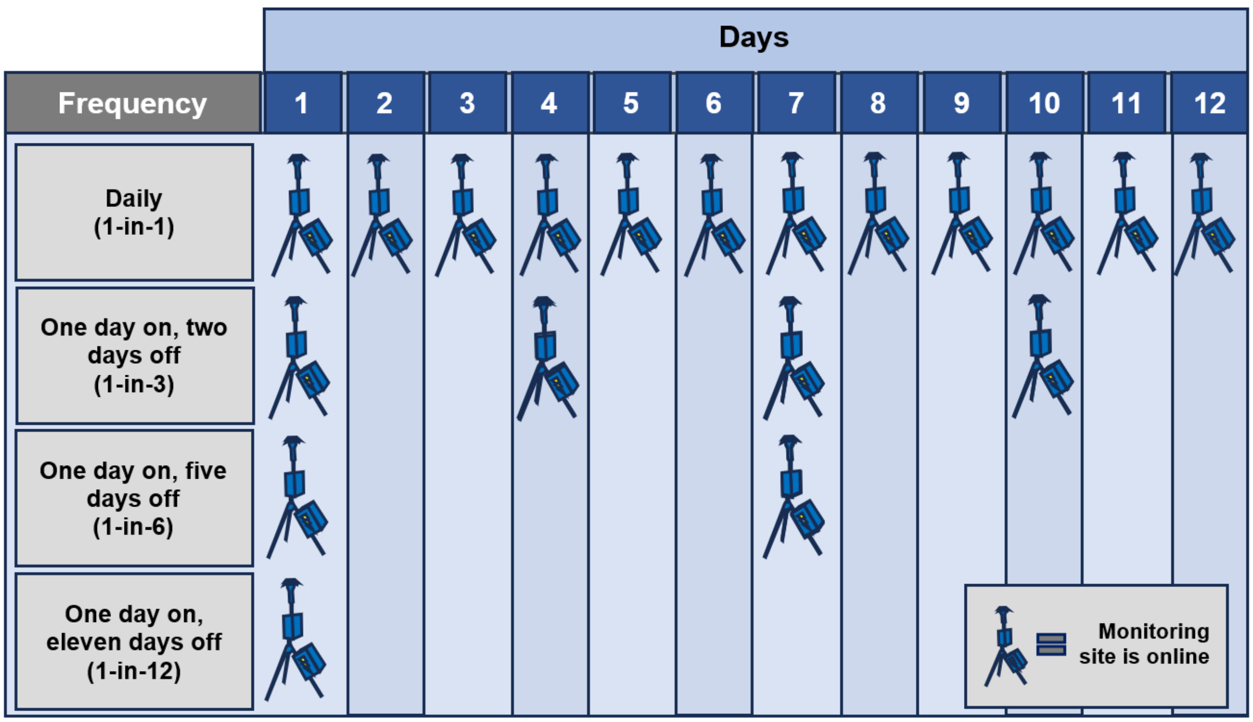
The EPA is responsible for assessing state and local air monitoring agency compliance with air quality standards. There are 140 state and local air monitoring agencies, and the EPA works with the agencies on several ambient air quality monitoring programs that gather information about the types and amounts of pollution in the air. According to the EPA, effective air quality monitoring supports actions and policy measures that mitigate the harmful effects of air pollution. The EPA provides guidance and oversight to and collaborates with state, local, and tribal air pollution control agencies to collect and measure ambient air pollution using a nationwide network of thousands of regulatory air monitors and other monitoring technologies. The EPA uses the data from those monitors to calculate design values, which describe the air quality status of a given location when compared to the associated NAAQS. Each year, the EPA publishes the calculated design values and goes through a rulemaking process to determine whether an area's air quality meets the NAAQS.

If an area meets the NAAQS, it is designated as an attainment area. Geographical locations that do not meet the standards are designated as nonattainment areas. Pursuant to the Clean Air Act, a state must adopt additional requirements into its state implementation plan to bring a nonattainment area into attainment. State implementation plans, generally, are a collection of regulations and documents used to implement, maintain, and enforce the NAAQS. State implementation plans for nonattainment areas can include more stringent permits and emission controls for industry within the nonattainment area, which can result in significant extra costs. The Clean Air Act requires the EPA to impose sanctions on a state if that state does not implement an adequate plan to return a nonattainment area to an attainment area in a timely manner. Sanctions could include prohibiting or restricting transportation projects or transportation grants. A state with a nonattainment area may incur additional costs because of the more complicated permitting and the enhanced emission inspection activities that are not typically required for attainment areas.

## Types of $PM_{2.5}$ Air Quality Monitors

State and local air monitoring agencies can use two distinct types of regulatory air monitors to determine compliance with the $PM_{2.5}$ NAAQS: filter-based monitors and continuous monitors. For the filter-based monitors, air monitoring agencies feed ambient air through a filter to retain particulate matter. The agencies then weigh the filter to determine the concentration of particulate matter. Filter-based monitors require ongoing resources because a technician must visit the monitor site to collect each sample for lab analysis. As shown in Figure 1, to mitigate this resource requirement, EPA regulations allow air agencies to collect samples on a nationally consistent but intermittent basis. Typically, the intermittent monitors will operate once every three, six, or 12 days. References to these monitors use the terms “1-in-3,” “1-in-6,” and “1-in-12,” respectively. Filter-based monitors may also operate every day; references to the monitors that do this may use the terms “daily” or “1-in-1.”

**Figure 1: Monitor site frequencies**

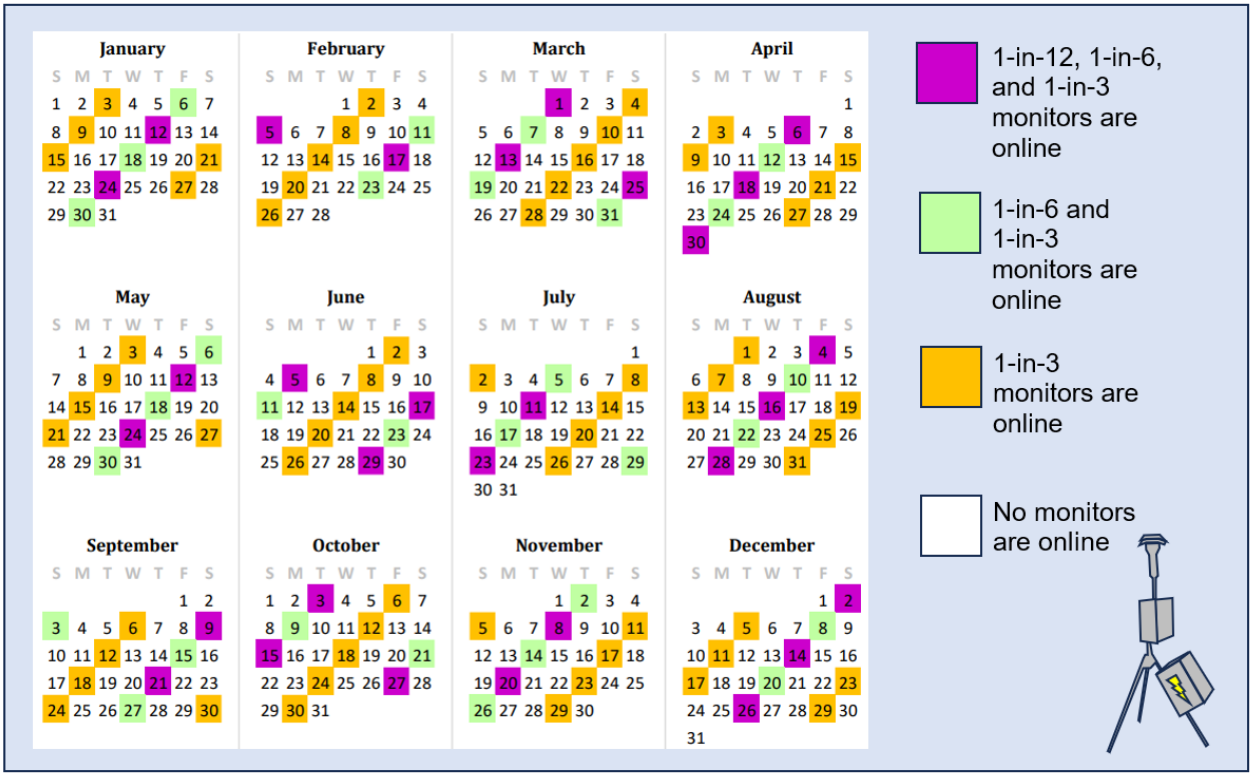



Source: OIG analysis of EPA information. (EPA OIG image)

*Notes:* The presence of a monitor in the above figure indicates that the monitor was online on that given day. For example, both daily and 1-in-3 monitors are online on Days 1, 4, 7, and 10. We treat continuous monitors and daily monitors as the same within this report.

According to an EPA Office of Air Quality Planning and Standards, or OAQPS, monitoring group team lead, the intermittent monitoring framework results in a robust dataset. The OAQPS arranges the monitoring schedule to make each day of the week appear on the schedule an equal number of times, which promotes efficiency and enables researchers to conduct detailed analyses. As early as 2001, the EPA has annually published this schedule on its website for use by state and local air monitoring agencies. Figure 2 shows the monitoring schedule for 2023.

**Figure 2: The EPA's 2023 public intermittent monitoring schedule**




Source: EPA document. (EPA image)

Compared to monitors that use filters, continuous monitors use a newer, automated approach to collect air quality data. Some continuous monitors use a rolling tape, shown in Figure 3, to collect and report hourly $PM_{2.5}$ averages. According to the OAQPS, the upfront cost of a continuous monitor is higher than that of a filter-based monitor, but the day-to-day upkeep costs of a continuous monitor are lower because a continuous monitor does not require technicians to collect every sample for lab analysis. As of January 2025, after accounting for one-time expenses and calculating operation and maintenance costs, continuous monitoring stations average $22,456 per monitor per year, while filter-based monitors average $41,151 per monitor per year. Further, continuous monitors provide air agencies and the public with near real-time air quality data because the samples typically do not need lab analysis.

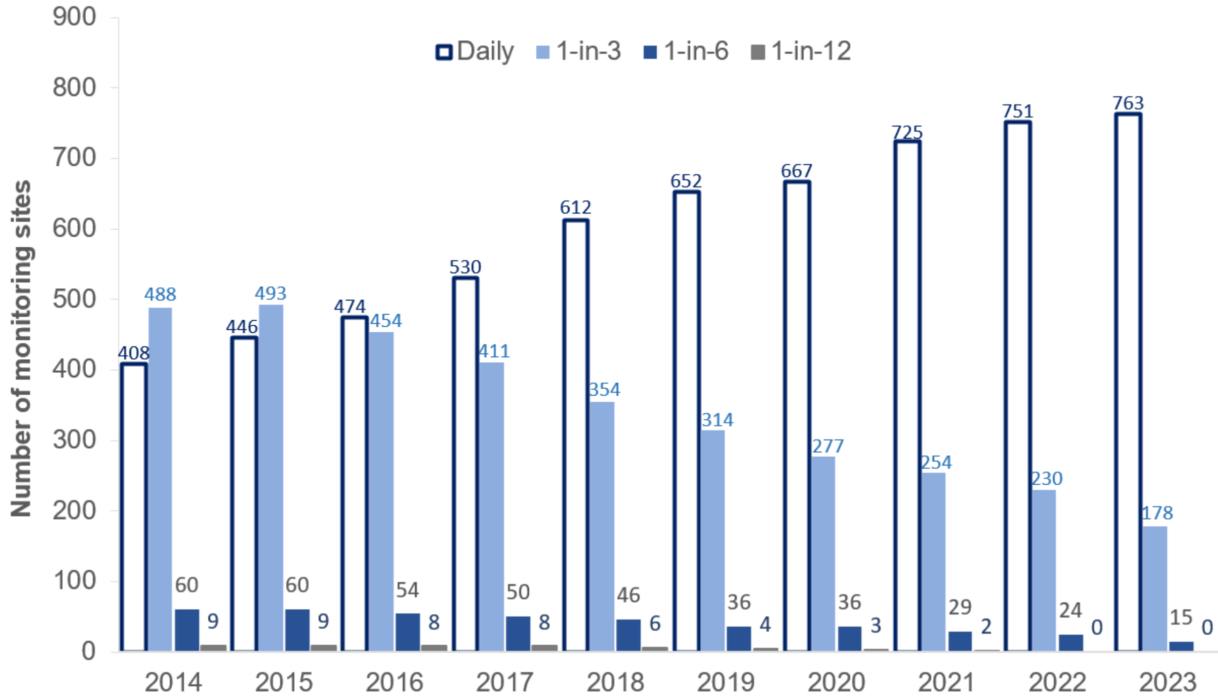
**Figure 3: Examples of ambient air monitors for $PM_{2.5}$**


Source: EPA OIG site visit. (EPA OIG images)

*Note:* The photos above are **a.** $PM_{2.5}$ ambient air monitors on top of a building; **b**. filters used for collecting and analyzing $PM_{2.5}$ samples; **c.** a continuous $PM_{2.5}$ monitor that uses tape; and **d.** the tape used to assess $PM_{2.5}$ concentrations in some continuous monitors.

Air agencies sometimes colocate multiple monitors at a given monitoring site. Some monitoring sites have monitors that operate at different frequencies. For this evaluation, we categorized each monitoring site by the monitor that operates most frequently at that site. For example, if a monitoring site had a 1-in-3 monitor and a 1-in-6 monitor, we would categorize the monitoring site as a 1-in-3 site because the 1-in-3 monitor operates more frequently than and on the same days as the 1-in-6 monitor. Given our categorization approach, the intermittent monitoring sites described in our report are not colocated with a continuous monitor. As shown in Figure 4, while the proportion of intermittent $PM_{2.5}$ monitoring sites declined as state and local air monitoring agencies adopted continuous monitors, 193 of 956 $PM_{2.5}$ monitoring sites, or 20 percent of those $PM_{2.5}$ monitoring sites, still operated on an intermittent schedule in 2023. Figure 5 shows how monitoring sites regularly go offline in a given month.

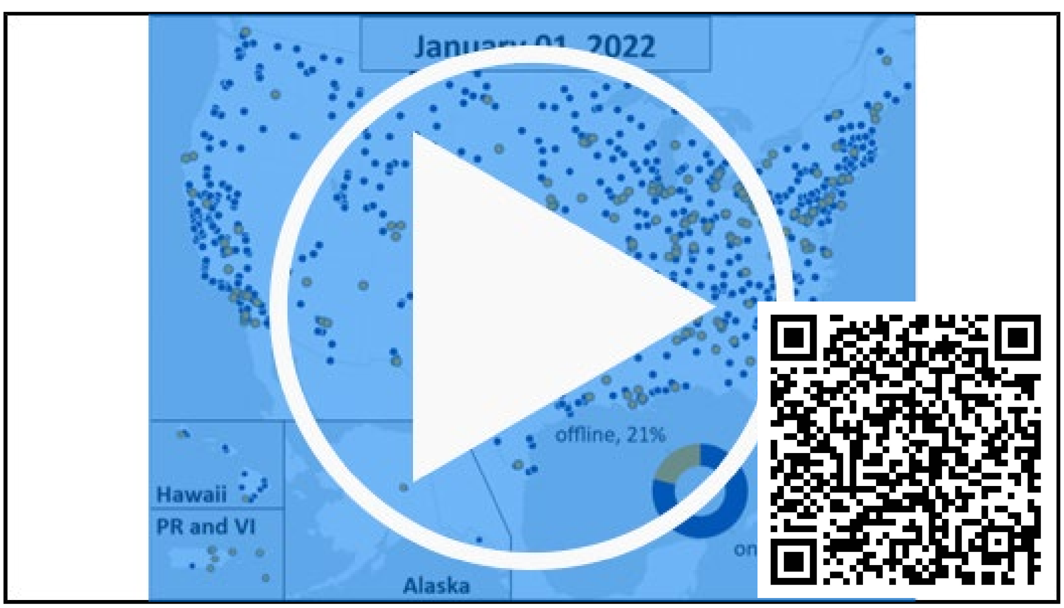
**Figure 4: Monitoring frequency of $PM_{2.5}$ ambient air quality monitoring sites**




Source: OIG analysis of EPA Air Quality System data. (EPA OIG image)

*Note*: We categorized each monitoring site by the most frequently operating monitor at that site.

**Figure 5: Monitoring sites in the United States and its territories, January 1–31, 2022**



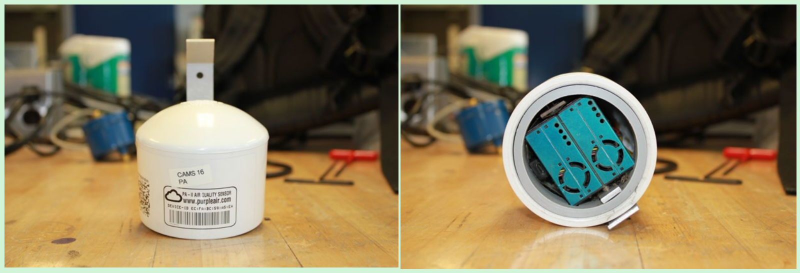

Source: OIG analysis of regulatory air monitor online-offline behavior. (EPA OIG image)

*Notes*: The image above is linked to an OIG video. Click on the image or scan the QR code to view the video. Because of monitoring schedule changes and discrepancies between the Air Quality System design value appendix and Air Quality System reported monitoring values, 1.5 percent of monitoring sites were offline for all of January 2022. PR = Puerto Rico. VI = The U.S. Virgin Islands.

### Examples of alternative forms of air quality monitoring

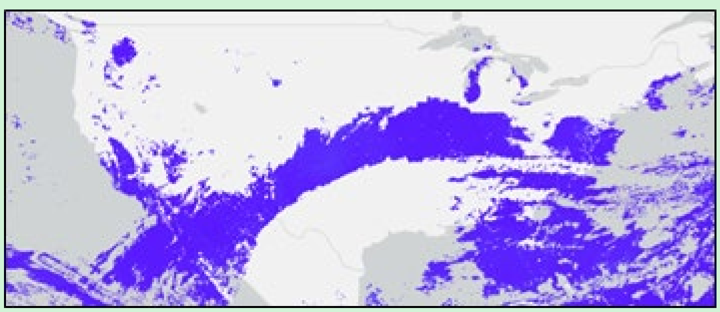
Interested parties can use a variety of technologies that are not equivalent to the EPA's regulatory air monitoring network, described above, but can cover locations and times that regulatory monitors may miss. Examples of alternative forms of air quality monitoring include low-cost air pollution monitors, satellites, and fused datasets.

**Low-cost air pollution monitors** are devices that use one or more sensors to detect, monitor, and report on specific air pollutants. These sensors are used in a variety of contexts, such as to inform community groups about air quality issues at the neighborhood level and in the EPA's Fire and Smoke map. How well the data from these sensors represent the actual air quality may be limited by whether the sensors are properly maintained and operated.



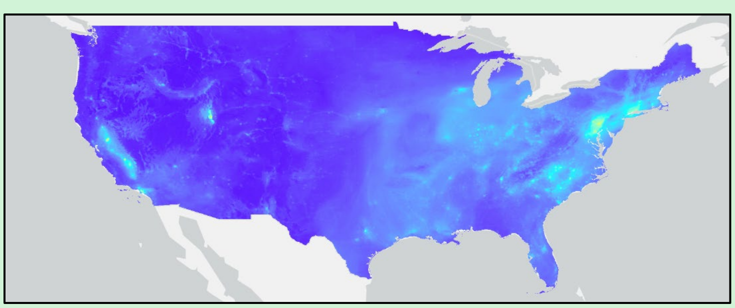
Low-cost air pollution monitor. Source: EPA OIG site visit. (EPA OIG images)

**Satellites** use remote sensing instruments, such as the Visible Infrared Imaging Radiometer Suite, to measure pollution in columns of air. For particulate matter, these instruments generate aerosol optical depth values. Aerosols are solid particles or liquid droplets suspended in the atmosphere. An aerosol optical depth value of less than 0.1 represents a clear blue sky with maximum visibility. An aerosol optical depth value of 2.5 to 3.0 represents hazy conditions at a level that the sun is obscured. Satellites cannot detect aerosols under cloud cover or the elevation of the air pollution within a column of air between the satellite and ground. The elevation limitation means that high levels of pollution in a given column might have no impact on human health because the pollution could be at such a high elevation that humans are not exposed to it.



Source: OIG visualization of aerosol optical depth. (EPA OIG image)

**Fused datasets**, such as the EPA's Downscaler, combine direct air measurements with other information, such as meteorological data, to predict daily air pollution. Fused datasets may incorporate aerosol optical depth values into their models. Similar to low-cost air pollution monitors and satellites, fused datasets do not perfectly reflect $PM_{2.5}$ values from regulatory monitors.



Source: OIG visualization of a fused dataset. (EPA OIG image)

## EPA Oversight of Ambient Air Quality Data Collection and Reporting

The EPA maintains regulatory ambient air monitoring data in a database known as the Air Quality System, or AQS. State and local air monitoring agencies have up to 90 days after the end of each calendar quarter to review and validate the monitoring data they collected before they must submit the data to the AQS. In addition, state and local air monitoring agencies must annually certify that the ambient air monitoring data are accurate and entered into the AQS, as required by 40 C.F.R. § 58.15.

Each state and local air monitoring agency must also have a quality system that provides sufficient information to assess the quality of the monitoring data, as required by Appendix A of 40 C.F.R. part 58. This quality system must include performance requirements for data precision, bias, and completeness. To help the monitoring agencies meet these requirements, the EPA established quality assurance criteria through both regulations and guidance. The regulations and guidance outline how to produce comparable data with an acceptable level of data quality for the EPA to use in making regulatory decisions about air quality.

EPA regions oversee state and local air monitoring agencies' planning and implementation of ambient air quality monitoring. For example, the EPA Office of Air and Radiation's National Program Guidance in place at the time of our evaluation tasked the EPA regions with regularly reviewing air quality data to ensure that state and local air monitoring agencies were meeting quality, timeliness, and completeness objectives.[1] Additionally, EPA regulations require the Agency to complete a detailed on-site review of each ambient air monitoring program every three years to assess the program's compliance with established regulations and guidance governing the collection, analysis, validation, and reporting of ambient air quality data.[2] During this detailed review, known as a technical systems audit, the EPA scrutinizes a limited number of specific data points across the criteria air pollutant datasets. This technical systems audit is supposed to assess the quality of the data and the effectiveness of the state or local air monitoring agency's quality system.

## Previous Research

In 2021, the University of Oregon and the National Bureau of Economic Research published a study titled *Unwatched Pollution: The Effect of Intermittent Monitoring on Air Quality*.[3] This study used 13 years of satellite air quality observations at daily, 1-in-3, and 1-in-6 air monitoring site locations to assess whether there was a relationship between the satellite air quality observations and the intermittent ambient air monitors' predictable online and offline schedules. The study compared satellite measurements of air quality when monitors were online to satellite measurements of air quality when monitors were offline. The study did not find worsened air quality on unmonitored days for all monitoring sites operating on a 1-in-3 ambient air quality monitoring schedule. However, the study

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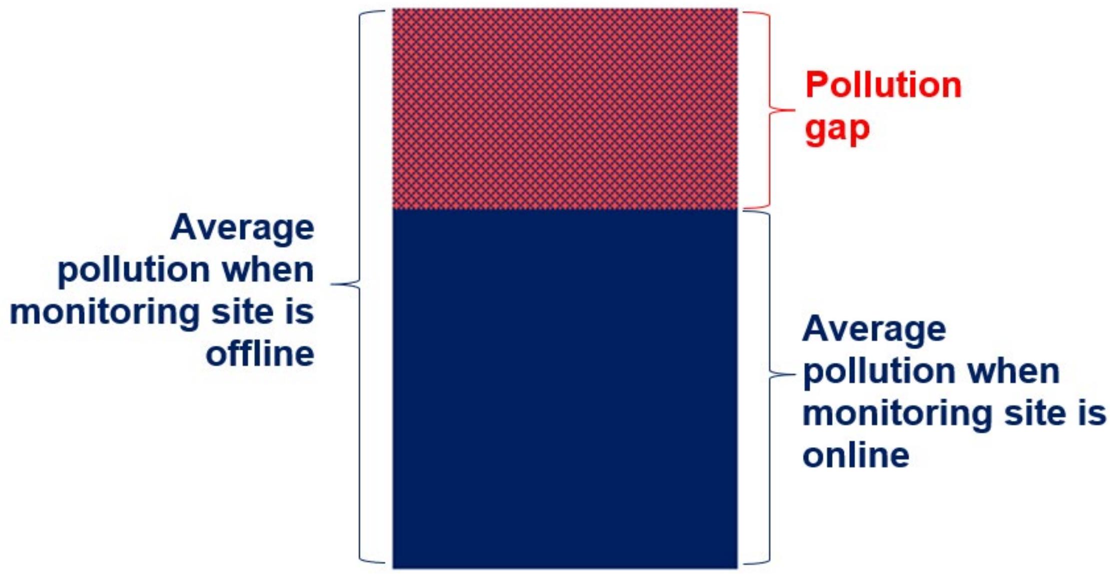
[1] EPA, Office of Air and Radiation Final (OAR) FY 2023-2024 National Program Guidance (2022).
[2] 40 C.F.R. part 58, Appendix A, paragraph 2.5.
[3] Eric Yonchen Zou, *Unwatched Pollution: The Effect of Intermittent Monitoring on Air Quality*, 111 Am. Econ. Rev. 2101 (2021).

found evidence that this schedule is linked to worsened air quality if the monitor is far away from daily monitors, which would theoretically be online and capturing pollution levels on the days the 1-in-3 monitors were offline. The study also concluded that 1-in-6 ambient air quality monitors had worsened air quality on unmonitored days.

Specifically, the study found that the satellite detected an average 1.6 percent increase in particulate matter pollution when the 1-in-6 monitors were offline. The study also found that the average difference in pollution between online and offline days, or the pollution gap, increased to over 7 percent when a county's particulate matter levels approached the regulatory standard. In other words, counties close to or in nonattainment had a greater pollution gap than all other counties. Figure 6 visualizes the pollution gap concept.

**Figure 6: Visualization of the pollution gap concept**




Source: OIG visualization of the pollution gap concept. (EPA OIG image)

*Notes:* This visualization compares average alternative air pollution measurements when an ambient air monitor is online to average alternative air pollution measurements when an ambient air monitor is offline. The pollution gap is the difference between those two averages.

The study also showed no detectable gap in pollution between online and offline days when there was no incentive to avoid pollution detection. For example, when a state or local air monitoring agency permanently shut down its monitor, the pollution gap disappeared. Further, the study found almost zero pollution gaps when counties experienced recent good air quality. The study alleged that the air quality worsening effect is explained by regulated entities suppressing their pollution on monitored days, especially during high-pollution periods when counties are at a high risk of being above the NAAQS. According to the study, the incentive to avoid monitoring is the only plausible explanation for pollution level differences during online and offline days.

In 2022, the OAQPS also conducted a preliminary analysis of missing air quality data from 2002 through 2018. This analysis found that some areas of the country have more missing air quality data on high-pollution days than on other days. We elaborate on the OAQPS's findings in Chapter 2.

## Responsible Offices

The OAQPS within the Office of Air and Radiation is charged with protecting and enhancing the quality of the nation's air resources. The OAQPS evaluates the need to regulate potential air pollutants, develops related national standards, reviews air data to assess the quality of the data, and works with state and local air monitoring agencies to develop plans for meeting national standards. Additionally, the OAQPS monitors national trends in air quality, maintains a database on air pollution and related controls, provides technical guidance and training, and monitors compliance with air pollution standards. According to the OAQPS, funding for the office was approximately $110 million in fiscal year 2023 and $107 million in fiscal year 2024. For fiscal year 2025, the EPA requested approximately $276 million for the OAQPS.

The EPA's regional offices address environmental issues related to the state and local monitoring agencies within their jurisdiction and administer and oversee regulatory and congressionally mandated programs. In addition, each region serves a rotating two-year term as the lead region for monitoring. In this role, the lead region coordinates with and communicates monitoring issues to and from EPA headquarters and the other regions. In addition to the OAQPS's quality assurance activities, the regional offices have quality assurance responsibilities and coordinate quality assurance matters among the various EPA offices and the state and local monitoring agencies.

## Scope and Methodology

We conducted this evaluation from March 2024 to April 2025 in accordance with the *Quality Standards for Inspection and Evaluation* published in December 2020 by the Council of the Inspectors General on Integrity and Efficiency. Those standards require that we perform the evaluation to obtain sufficient and appropriate evidence to support our findings.

Satellites and modeled data provide alternative forms of air quality measurements for $PM_{2.5}$, which we used to compare air quality when ambient monitoring sites were online to air quality when ambient monitoring sites were offline.[4] We conducted two analyses to determine whether $PM_{2.5}$ monitoring sites capture representative samples of their ambient air quality: an initial regression analysis on the $PM_{2.5}$ monitoring system in the continental United States and a follow-up national screening analysis

[4] "Alternative" in this sentence means the satellite and modeled data are not directly derived from a regulatory ambient air quality monitor.

that independently assessed each $PM_{2.5}$ monitoring site in the United States and its territories.[5] Both of our analyses can be improved with follow-up research. We acknowledge our analyses assumptions and limitations in Appendix A.

**Differences between ambient air quality monitors and fenceline monitors**

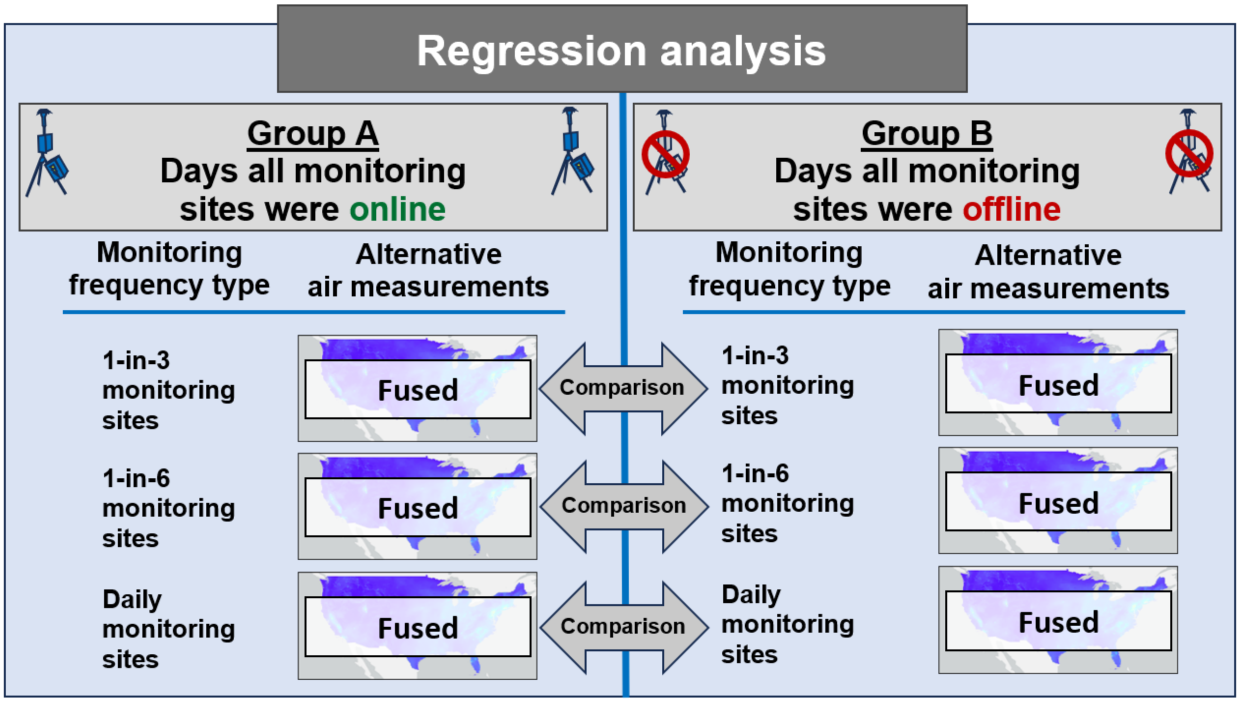
This report focuses on ambient air quality monitors, which differ from the fenceline monitors that some facilities use to determine compliance with their individual air permits. Ambient air quality monitoring sites capture a general area's air quality to determine compliance with the NAAQS. Facility fenceline air quality monitoring sites, on the other hand, ensure that a facility complies with the facility's air permit.

For our regression analysis, we compared modeled $PM_{2.5}$ concentrations when monitoring sites were online to modeled $PM_{2.5}$ concentrations when monitoring sites were offline. We did not use air quality data from the ambient air quality monitors themselves in this comparison. Our assessment of alternative air quality data involved over two million records associated with the aggregated online and offline daily activity of 1,187 $PM_{2.5}$ monitoring sites. That alternative air quality dataset fused satellite values with monitoring site observations and meteorological variables to derive the modeled $PM_{2.5}$ concentrations at a one-kilometer resolution. We compared the daily online and offline behavior of the 1,187 $PM_{2.5}$ monitoring sites to the fused air quality dataset for the years 2014 through 2020.[6] Additionally, we categorized monitoring sites by the planned frequency at which they were online: daily monitoring sites, 1-in-3 monitoring sites, and 1-in-6 monitoring sites. We did not analyze 1-in-12 monitoring sites because of insufficient data. Figure 7 visualizes our regression analysis methodology.

[5] A regression analysis is a statistical method used to determine the magnitude and structure of a relationship between two or more variables. When we use the term "continental U.S." in this report, we mean the 48 contiguous states. Our regression analysis excluded Alaska, Hawaii, and the U.S. territories because the alternative air quality measurements that we used did not cover those areas. Our national screening analysis incorporated aerosol optical depth and was, therefore, able to capture these areas.

[6] We used the EPA's AQS to determine when monitoring sites were online and offline and the frequency that those monitoring sites were online and offline. We derived the fused air quality dataset from the following study: Jing Wei et al., *Long-term Mortality Burden Trends Attributed to Black Carbon and $PM_{2.5}$ from Wildfire Emissions Across the Continental USA from 2000 to 2020: A Deep Learning Modelling Study*, 7 Lancet Planetary Health, 963 (2023). This dataset contains daily concentrations of $PM_{2.5}$ at a one-kilometer resolution in the continental United States from 2000 through 2020. The daily concentrations were created using a model trained to estimate $PM_{2.5}$ by considering a variety of data sources, including information from satellites, models, and surface observations.

**Figure 7: Regression analysis description and methodology**




Source: OIG regression analysis of ambient air monitoring site statuses compared to alternative air pollution measurements. (EPA OIG image)

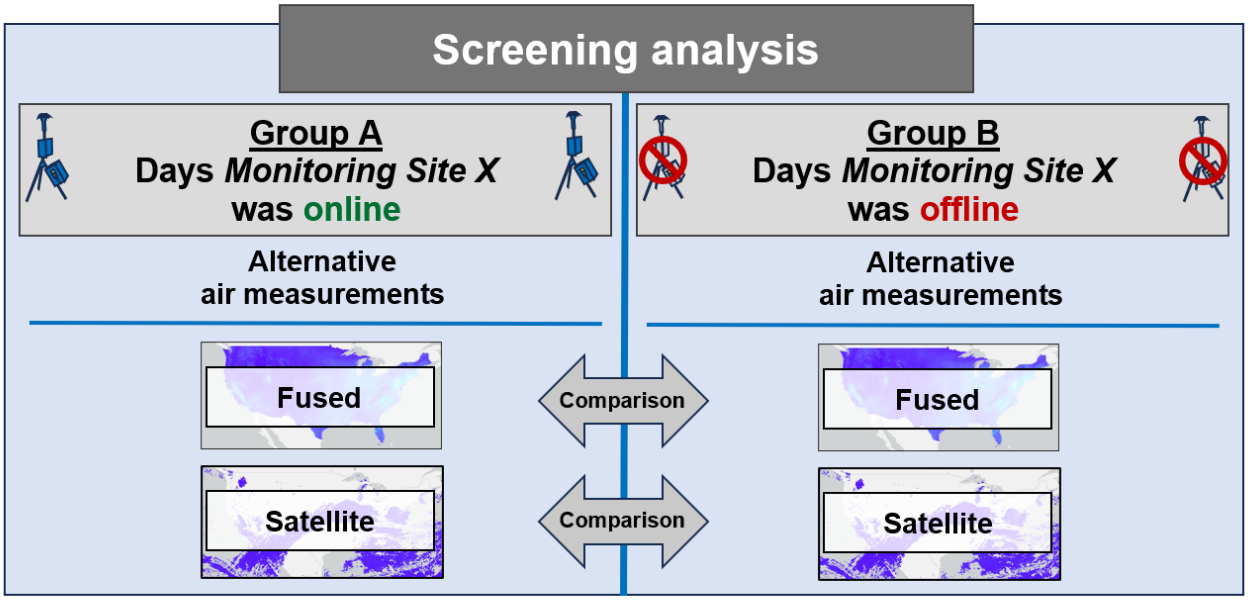
*Notes:* A regression analysis is a statistical method used to determine the magnitude and structure of a relationship between two or more variables. After categorizing each monitoring site into one of the three monitoring frequencies, we compared each of these categories' local average fused air quality data when the monitoring sites were online to the local average fused air quality data when the monitoring sites were offline. This approach aggregated the pollution gap results by monitoring frequency type. This approach did not allow us to detect the variation in pollution gaps between monitoring sites or identify where pollution gaps occur.

For our screening analysis, we assessed 877 $PM_{2.5}$ monitoring sites that were active in 2023 and that reported air quality data from 2016 through 2020. We selected sites that were operational in 2023 to increase the relevance of our findings, and we used the 2016 through 2020 air quality data because that was the latest information available to us at the time of our analysis. Our screening analysis included 423 intermittent monitoring sites, a grouping that included 1-in-3, 1-in-6, and 1-in-12 monitoring sites, and 609 daily monitoring sites.[7] Similar to our regression analysis, we used the dataset that fused satellite values with monitoring site observations and meteorological variables to model $PM_{2.5}$ concentrations at a one-kilometer resolution. To assess monitoring site behavior in Alaska, Hawaii, and the U.S. territories, we also incorporated Visible Infrared Imaging Radiometer Suite aerosol optical depth values at a 750-meter resolution into our screening analysis. We used each of these datasets to compare alternative air pollution measurements when monitoring sites were online to alternative air pollution measurements when monitoring sites were offline. To improve consistency and readability, we use the term "alternative air pollution measurements" in Chapter 2 instead of fused

[7] The number of intermittent and daily monitoring sites does not add up to 877 because 155 monitoring sites switched to a different monitoring frequency during the period we analyzed.

$PM_{2.5}$ concentrations and aerosol optical depth values. Figure 8 visualizes our screening analysis methodology.

**Figure 8: Screening analysis description and methodology**




Source: OIG screening analysis of ambient air monitoring site statuses compared to alternative air pollution measurements. (EPA OIG image)

*Notes:* Our screening analysis independently assessed each of the 877 $PM_{2.5}$ monitoring sites described above. In other words, after determining whether a monitoring site was operating daily or intermittently, we compared that monitoring site's local average fused air quality data when the monitoring site was online to the local average fused air quality data when the monitoring site was offline. We also compared that monitoring site's local average aerosol optical depth values when the monitoring site was online to the local average aerosol optical depth values when the monitoring site was offline. We then performed these calculations for each of the remaining 876 $PM_{2.5}$ monitoring sites to demonstrate the variation in pollution gaps between monitoring sites and the ability to identify where pollution gaps occur.

We interviewed staff from the U.S. National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the OAQPS, the EPA Office of Enforcement and Compliance Assurance, five EPA regional offices, and three state environmental agencies. We also visited the San Joaquin Valley, an area that the EPA designated as in nonattainment of the 1997 NAAQS annual $PM_{2.5}$ standard in 2005 and that remained above that standard until 2025. This area has not met the more stringent 2006 NAAQS 24-hour $PM_{2.5}$ standard or the 2012 and 2024 NAAQS annual $PM_{2.5}$ standards. During our site visit, we interviewed two citizen groups about air quality concerns.

## Prior Reports

U.S. Government Accountability Office Report No. GAO-21-38, *Opportunities to Better Sustain and Modernize the National Air Quality Monitoring System*, published November 12, 2020, found that air quality managers, researchers, and the public need more information to understand the health risks from air pollution. For example, they need additional information on pollutants found near industrial facilities and on the performance of low-cost air pollution monitors. The Government Accountability Office recommended that the EPA establish an asset management framework for the monitoring system that includes key characteristics and recommended that the EPA develop an air quality monitoring modernization plan that aligns with leading practices. In written comments on the report, the EPA generally agreed with the recommendations. As of October 2024, the EPA had completed one of the two corrective actions.

EPA OIG Report No. 18-P-0105, *Differences in Processing Practices Could Decrease the Reliability of Ozone Data Used for Assessing Air Quality to Protect Public Health*, issued February 28, 2018, found that there is a risk that state, local, and tribal agencies that monitor ambient air quality are not always implementing the EPA's recommended quality assurance practices for validating ozone data. This risk could reduce the quality of the data that the EPA uses to determine whether the air is healthy to breathe. We recommended that the EPA assess the risk of data adjustments impacting the ozone data used in the EPA's NAAQS determinations, issue guidance clarifying the shelter temperature criteria that should be used,[8] strengthen the EPA's oversight of state and local monitoring agencies' data processing practices by completing the quality assurance project plan review-and-approval process to confirm that state and local air monitoring agencies are including appropriate quality assurance criteria in their quality assurance project plans, use technical systems audits to verify that state and local monitoring agencies are implementing the EPA's recommended quality assurance criteria, and develop a process to confirm that the data reported to the AQS meet the EPA's recommended validation criteria for certain quality control checks. The EPA has completed all of the corrective actions.

EPA OIG Report No. 16-P-0079, *EPA Can Strengthen Its Reviews of Small Particle Monitoring in Region 6 to Better Ensure Effectiveness of Air Monitoring Network*, issued December 17, 2015, found that annual monitoring network plans in Region 6 did not include evidence to demonstrate that monitoring sites were in compliance with siting requirements. The report noted that more thorough reviews of air monitoring networks in Region 6 would better ensure that $PM_{2.5}$ monitoring is adequate to inform and protect the public. We recommended that the EPA clarify what constitutes sufficient evidence to demonstrate compliance with monitor siting and operational requirements when developing annual plans, develop a process to update analytic tools for future assessments, and emphasize the importance of network assessments. We also recommended that Region 6 address state-specific deficiencies in monitoring plans and assessments and strengthen its network assessment review process. The EPA has completed all the corrective actions.

[8] Shelter temperature criteria are criteria that are important to maintain to accommodate the most temperature-sensitive instrument in the shelter.

# Chapter 2
# The EPA May Be Relying on Data That Are Not Representative of Actual Air Quality

Alternative air pollution measurements indicate that air pollution may be underreported in certain circumstances. The Clean Air Act requires the EPA to protect air quality, and the Act lists promoting public health among the purposes for its enactment. It is difficult for the EPA to achieve this statutory mission if air quality monitoring data are not representative of the actual air quality. Underreported data may be caused by the EPA publishing its intermittent monitoring schedule. This allows regulated entities to know when monitoring will occur and to adjust their emissions accordingly. Furthermore, the amount of pollution data that state and local air monitoring agencies send to the EPA on an annual basis exceeds the amount from which the Agency can review a representative sample. This oversight limitation challenges the Agency's ability to ensure that air quality data are representative of the actual air quality and gives state and local air monitoring agencies an opportunity to strategically turn off monitoring sites during periods of high ambient air pollution. These factors may explain why we found that, on average, air pollution increased when certain ambient air quality monitoring sites were offline. Our analyses suggest that there is a risk that the Agency is not effectively obtaining the data it needs to make accurate attainment designations, meaning that the Agency may incorrectly designate nonattainment areas as attainment areas. Accordingly, regulated entities in incorrectly designated areas would not be required to take measures to improve air quality, potentially resulting in poorer air quality and health outcomes for people residing and working in these areas.

## Research and Data Indicate that Pollution Levels Increase on Unmonitored Days

Using alternative air pollution measurements, we found that average air pollution increased at ambient air quality monitoring sites that operate at daily and 1-in-3 frequencies when those monitoring sites are turned off. Through our follow-up screening analysis, we discovered that the pollution gap between online and offline days at specific ambient air quality monitoring sites was much larger or much smaller than what we found in our initial regression analysis. A 2022 OAQPS preliminary analysis of monitoring sites also found that high levels of pollution may not be detected at certain monitoring sites. Table 3 summarizes these analyses and the academic study discussed in Chapter 1.

**Table 3: Summary of four analyses regarding potentially underreported monitoring data**

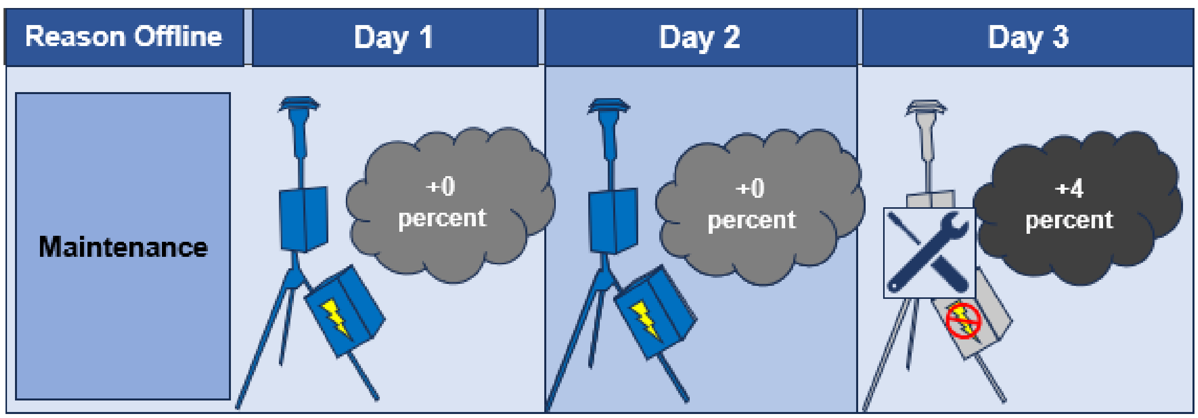
| Team | Description | Study period | Conclusion |
|---|---|---|---|
| EPA OIG | Continental U.S.-level regression analysis to determine whether alternative air pollution measurements worsened when $PM_{2.5}$ ambient air quality monitoring sites categorized by their monitoring frequency were offline. | 2014 through 2020 | When ambient air quality monitoring sites were offline, alternative air pollution measurements increased on average by about 4 percent near daily monitoring sites and about 9 percent near 1-in-3 monitoring sites. Our 1-in-6 monitoring site analysis was inconclusive. |
| EPA OIG | National site-by-site screening to determine whether alternative air pollution measurements increased when specific $PM_{2.5}$ ambient air quality monitoring sites were offline. | 2016 through 2020 | Of the 423 intermittent monitoring sites, 35.70 percent of the sites averaged worse alternative air pollution measurements when the sites were offline. Of the 609 daily monitoring sites, 3.61 percent of the sites averaged worse alternative air pollution measurements when the sites were offline. The pollution gaps varied from site to site, and some sites averaged lower pollution when the sites were offline. These results demonstrate that our continental U.S.-level regression analysis described in the row above understates the local pollution gaps near many $PM_{2.5}$ monitoring -sites. |
| EPA OAQPS | National site-by-site screening to determine whether $PM_{2.5}$ and ozone monitoring sites are more likely to be shut down when alternative air pollution measurements suggest that the pollution concentration is high. | 2002 through 2018 | Alternative air pollution measurements found that 79 of 1,343 $PM_{2.5}$ monitoring sites and 36 of 1,536 ozone monitoring sites had a higher proportion of offline statuses on high -pollution days compared to all other days. |
| Zou, *et al*. | Continental U.S.-level regression analysis and county-by-county screening of 1-in-3 and 1-in-6 air monitoring site locations to determine whether alternative air pollution measurements worsened when $PM_{2.5}$ monitoring sites were offline. | 2001 through 2013 | Satellite data detected an average 1.6 percent increase in alternative air pollution measurements when 1-in-6 monitoring sites were offline. This average pollution gap increased to over 7 percent when a county's recent fine particulate matter levels approached the regulatory standard, indicating poorer air quality, whereas there were almost zero pollution gaps when the same county experienced recent good air quality. When an air monitoring agency permanently shut down a monitor, the average air pollution near that monitor's location stopped increasing on the days that the monitor would have been offline had the agency not shut down the monitor. |

Source: OIG summary of analyses. (EPA OIG table)

## EPA OIG Analyses Indicate that Pollution Levels Increase on Unmonitored Days

Our analyses indicate that pollution levels increase when certain air quality monitoring sites are offline. There should be no statistical evidence of a difference between average pollution levels on online and offline days. However, as shown in Figures 9 and 10 below, our analysis of 1,187 monitoring sites found that, from 2014 through 2020, alternative air pollution measurements increased by an average of approximately 4 percent, or 0.28 µg/m$^3$, when daily monitoring sites were offline and by an average of approximately 9 percent, or 0.60 µg/m$^3$, when the 1-in-3 monitoring sites were offline. When viewed on a case-by-case basis, some monitoring sites will have greater differences between pollution levels on online and offline days, and other monitoring sites will have smaller or no differences. For instance, the *Unwatched Pollution* study found that the average pollution gap increased when a county's recent $PM_{2.5}$ levels approached the regulatory standard, indicating poorer air quality. In contrast, there was almost no pollution gap when the same county experienced recent good air quality.

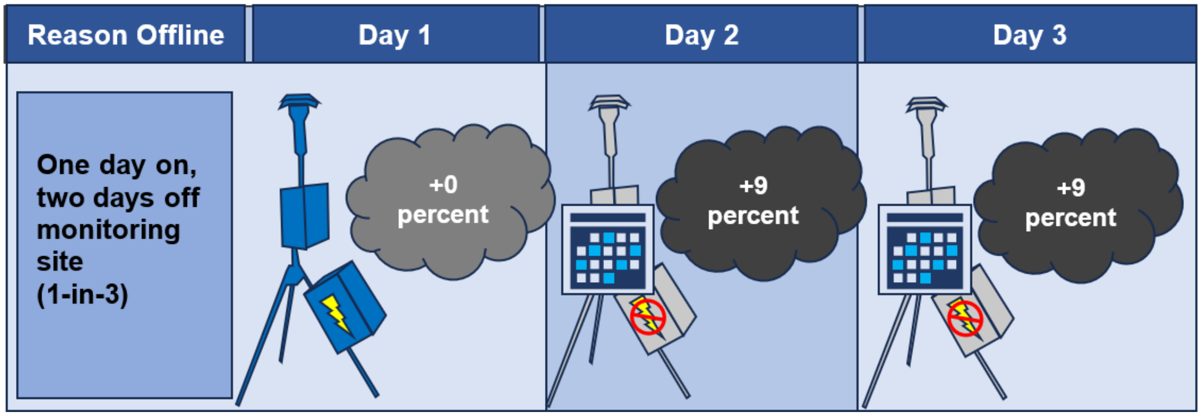
**Figure 9: Average change in alternative air pollution measurements when a daily monitoring site was offline, 2014–2020**




Source: OIG analysis of daily ambient air monitoring site statuses compared to alternative air pollution measurements. (EPA OIG image)

*Notes:* We analyzed alternative air pollution measurements at 775 daily monitoring sites that reported data to the AQS from 2014 through 2020 to determine whether pollution worsened on average when the sites were offline. Our analysis of daily monitoring sites considered whether nonregulatory monitors were operating at the same location. Colocated nonregulatory monitors can track pollution trends when a regulatory monitor is offline.

**Figure 10: Average change in alternative air pollution measurements when a 1-in-3 monitoring site was offline, 2014–2020**




Source: OIG analysis of 1-in-3 ambient air monitoring site statuses compared to alternative air pollution measurements. (EPA OIG image)

*Notes:* We analyzed alternative air pollution measurements at 555 1-in-3 ambient air quality monitoring sites that reported data to the AQS from 2014 through 2020 to determine whether pollution worsened on average when the sites were offline. We conducted two analyses on the 1-in-3 ambient air quality monitoring sites: we considered (1) whether both regulatory and collocated nonregulatory monitors at a given site were offline and (2) whether only regulatory monitors at a given site were offline. Each analysis yielded similar results, but we present the regulatory monitor results above because the regulatory monitors follow the public schedule.

To demonstrate the variation in pollution gaps between monitoring sites and the ability to identify where pollution gaps occur, we conducted a screening analysis that analyzed the 2016 through 2020 alternative air pollution measurements for the 877 $PM_{2.5}$ monitoring sites that were operational in 2023 and that recorded air quality data from 2016 through 2020. We summarize the results of our screening analysis in Table 4 below. Of the 877 $PM_{2.5}$ monitoring sites, 19.73 percent had, on average, worse air quality when they were offline. We identified 22 of 609 daily monitoring sites, or 3.61 percent, as having statistically worse average air quality on offline days. Intermittent monitoring sites were more likely to show this pollution gap, with 151 of 423, or 35.70 percent, exhibiting statistically worse average air quality when the monitoring sites were offline. We use the term "monitoring sites of interest" to refer to monitoring sites with worse average offline pollution compared to average online pollution.

**Table 4: Screening analysis results showing alternative air pollution measurement gaps at monitoring sites that were operational in 2023 and that recorded data from 2016 through 2020**

| Monitoring frequency | Total sites | Monitoring sites of interest | Percent of total sites (%) |
|---|---|---|---|
| **Daily** | 609 | 22 | 3.61 |
| **Intermittent*** | 423 | 151 | 35.70 |
| **Total** | **877**† | **173** | **19.73** |

Source: OIG analysis of ambient air quality monitor statuses. (EPA OIG table)

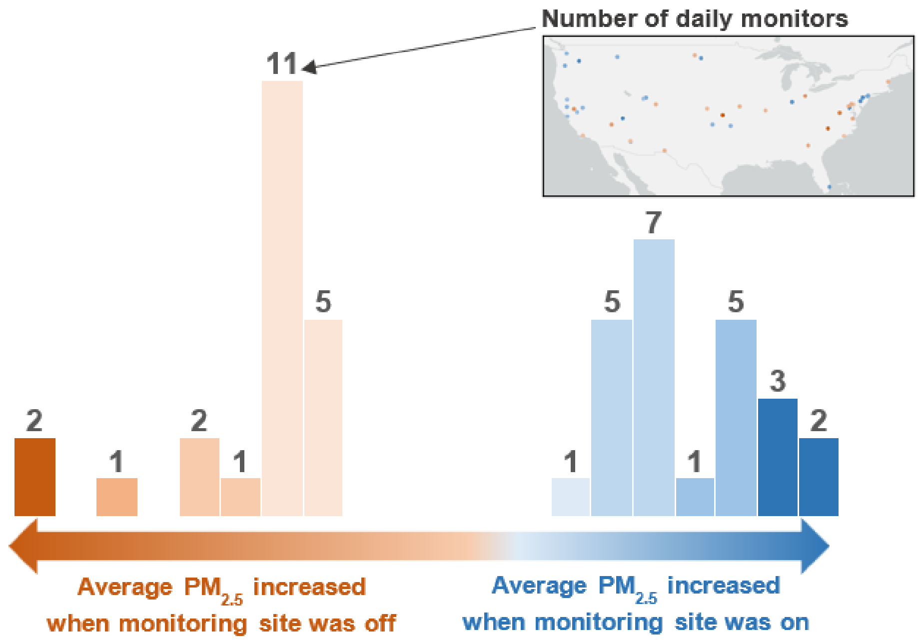
* Intermittent monitors comprise 1-in-3, 1-in-6, and 1-in-12 monitoring frequencies.

† The number of daily and intermittent monitoring sites does not add up to 877 because 155 monitoring sites switched to a different monitoring frequency in the period from 2016 through 2020.

Figures 11 and 12 arrange and aggregate the daily and intermittent monitoring sites, respectively, into categories that show whether average pollution at the sites increased when they were online or offline. As monitoring sites move further to the left or right from the center of these figures, the relationship between air quality and the monitoring sites' operational status is stronger. The left side of the distribution indicates that average $PM_{2.5}$ was higher on days when the monitoring sites were *offline*. The right side of the distribution, on the other hand, identifies the ambient air quality monitoring sites where average $PM_{2.5}$ was higher when the monitoring sites were *online*. Given our objective, we are interested in the monitoring sites on the left side of the distribution. For a detailed discussion of our screening analysis, refer to Appendix A.

**Figure 11: Distribution of daily monitoring sites that had a statistically significant difference in air quality between online days as compared to offline days**

| Category | Count |
|---|---|
| -0.22 to -0.20 | 2 |
| -0.18 to -0.16 | 1 |
| -0.14 to -0.12 | 2 |
| -0.12 to -0.10 | 1 |
| -0.10 to -0.08 | 11 |
| -0.08 to -0.06 | 5 |
| 0.04 to 0.06 | 1 |
| 0.06 to 0.08 | 5 |
| 0.08 to 0.10 | 7 |
| 0.10 to 0.12 | 1 |
| 0.12 to 0.14 | 5 |
| 0.14 to 0.16 | 3 |
| 0.16 to 0.18 | 2 |

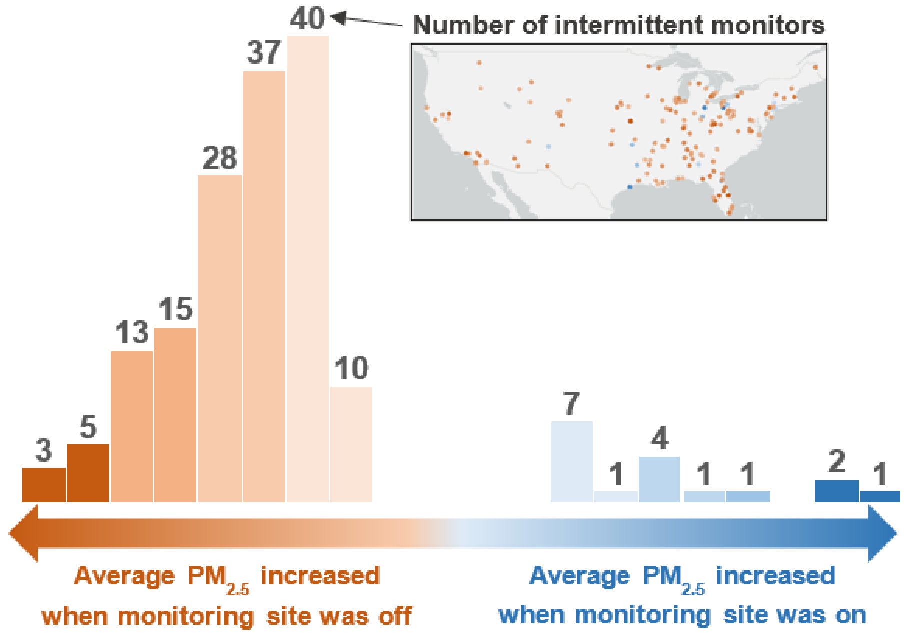



Source: OIG analysis of regulatory air monitor online-offline behavior compared to alternative air pollution measurements. (EPA OIG image)

*Notes:* As described in plain terms above, this histogram combines monitor correlation coefficients into categories of equal ranges. The correlation coefficient determines the relationship between two variables. Possible values of the correlation coefficient range from -1 to +1, with -1 indicating a perfectly linear negative and +1 indicating a perfectly linear positive correlation.

**Figure 12: Distribution of intermittent monitoring sites that had a statistically significant difference in air quality between online days as compared to offline days**

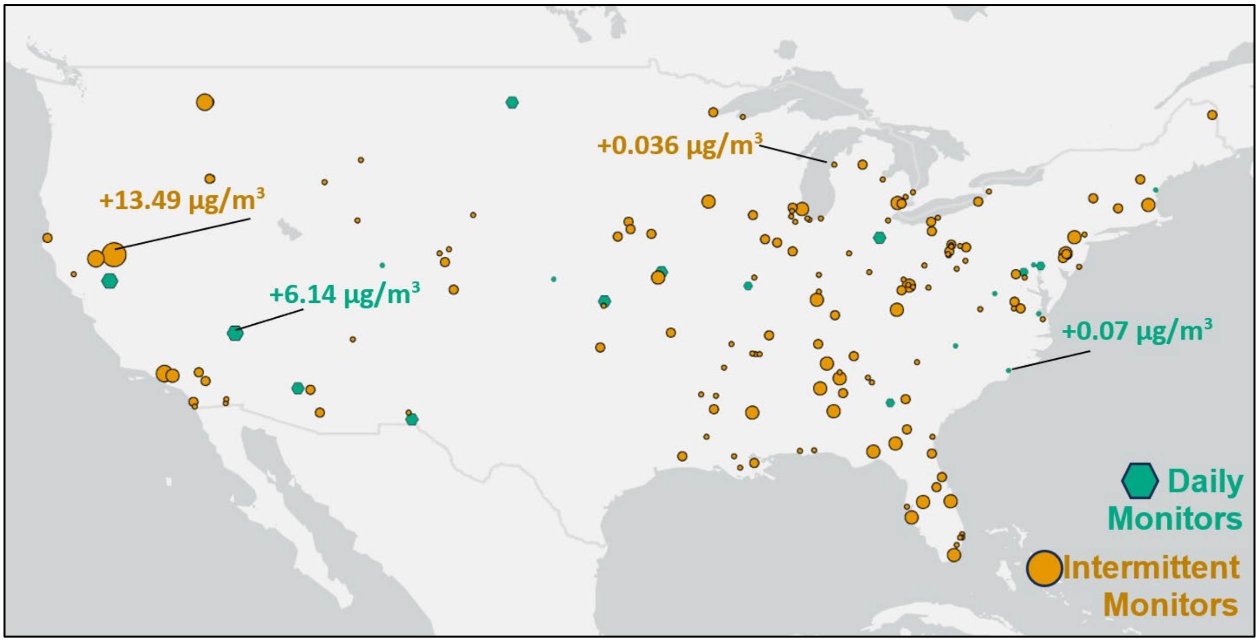
| Category | Count |
|---|---|
| -0.38 to -0.35 | 3 |
| -0.35 to -0.31 | 5 |
| -0.31 to -0.27 | 13 |
| -0.27 to -0.23 | 15 |
| -0.23 to -0.19 | 28 |
| -0.19 to -0.15 | 37 |
| -0.15 to -0.11 | 40 |
| -0.11 to -0.07 | 10 |
| 0.09 to 0.13 | 7 |
| 0.13 to 0.17 | 1 |
| 0.17 to 0.21 | 4 |
| 0.21 to 0.25 | 1 |
| 0.25 to 0.29 | 1 |
| 0.33 to 0.36 | 2 |
| 0.36 to 0.40 | 1 |




Source: OIG analysis of regulatory air monitor online-offline behavior compared to alternative air pollution measurements. (EPA OIG image)

For both daily and intermittent ambient air quality monitoring sites, Figure 13 shows the variation in the pollution gap between average air quality when monitors were online versus offline. The largest daily monitoring gap involves a Nevada monitor with an average 6.14 μg/m$^3$ increase when the monitoring site was offline compared to when the site was online. The largest intermittent monitoring gap involves a California monitor with an average 13.49 μg/m$^3$ increase when the monitoring site was offline compared to when the site was online.

**Figure 13: Average change in alternative air pollution measurements when a monitoring site of interest is offline**




Source: OIG analysis of regulatory air monitoring site online-offline behavior compared to alternative air pollution measurements. (EPA OIG image)

The results of our screening analysis demonstrate that there is a risk of underreported air pollution and that the EPA could use existing technology, data, and statistical techniques to detect unusual patterns at air monitoring sites. Although this analysis did not indicate malicious behavior at any specific site, we demonstrate in the shaded box below that there is at least one example of a state and regulated entity that may have undermined the collection of air quality data that represent the actual air quality.

**State and regulated entity actions can undermine the collection of accurate air quality data**

State actions can create opportunities for regulated entities to avoid emissions detection. For example, in 2017, the Texas Commission on Environmental Quality supplied a regulated entity with near real-time data at five-minute intervals. While the near real-time air quality data are not publicly accessible, Texas considers the data public information that any party can request, so long as that party has an external server to which the state can transfer the data. According to one national media organization, the regulated entity allegedly used the state-supplied data to alter its emission patterns to reduce the pollution detected at a nearby air monitor. [redacted]

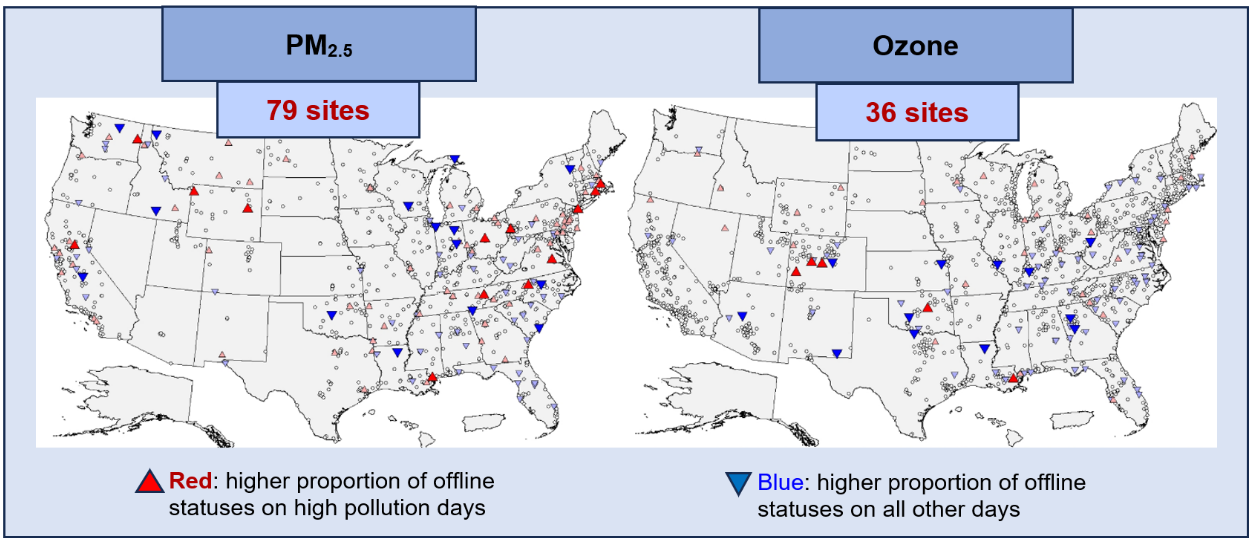
The regulated entity described above also has a facility in Oklahoma. That facility requested direct access to near real-time data at five-minute intervals; the Oklahoma Department of Environmental Quality granted the request. However, following receipt of an allegation that a regulated entity was changing its operations to avoid having its pollution readings exceed the NAAQS, the Oklahoma Department of Environmental Quality revoked the facility's access to the data.

While each state holds the responsibility under the Clean Air Act to ensure that its air quality meets the NAAQS, enhanced EPA oversight of state and local air monitoring can help ensure the collection of air quality data that is representative of actual air quality.

## An EPA Analysis Also Found that Certain Ambient Air Quality Monitoring Sites May Miss Air Pollution Data

A 2022 OAQPS preliminary analysis into missing air quality data found that some areas of the country have more missing data on high-pollution days than on other days. According to the EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems*, "completeness" is an indicator for assuring data quality. The handbook goes on to explain that completeness describes whether the data collected from a measurement system, such as an air monitor, is comparable to the expected data from the measurement system when the system is operated correctly. The OAQPS presented its preliminary completeness analysis in August 2022. The analysis identified whether $PM_{2.5}$ and ozone ambient air quality monitoring sites were more likely to be shut down when alternative air pollution measurements suggest that the pollution concentration at the sites were high. This analysis used colocated monitors, nearby monitors, and daily predictions from alternative air pollution measurements from 2002 through 2018. The OAQPS did not identify a greater likelihood that the overall monitoring system missed data when pollution was elevated. However, the OAQPS found that 79 of 1,343 $PM_{2.5}$ monitoring sites and 36 of 1,536 ozone monitoring sites had a higher proportion of missing values on high-pollution days than on all other days, as shown in Figure 14.

**Figure 14: The OAQPS preliminary completeness analysis of $PM_{2.5}$ and ozone monitoring sites**




Source: Preliminary OAQPS analysis. (EPA OIG image)

The OAQPS intended to enhance its analysis by incorporating data from satellite and low-cost air pollution monitors, and the office noted that it could use an automated, near-real-time version of its screening analysis to identify monitoring sites for further investigation by the regions and the states. According to an OAQPS presentation on its screening analysis, new technology can make it easier for the Agency and the public to identify unusual monitoring patterns. As of June 2024, however, the OAQPS had not revised its quality assurance processes to include a screening tool capable of detecting unusual monitoring site behavior.

## Underreported Air Pollution May Be Caused by Entities Hiding Elevated Emissions or Not Reporting Data on Poor Air Quality Days

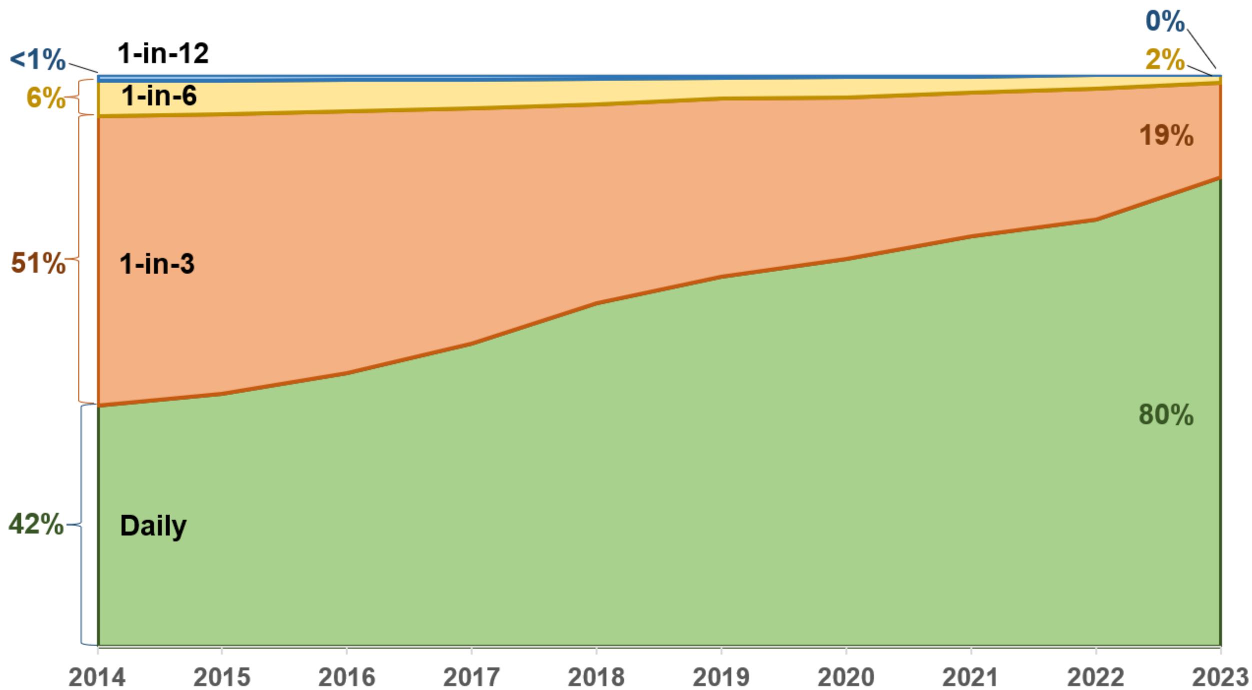
We explored two potential causes for the underreported air pollution data risk that we observed in our analyses. First, the EPA publishes its intermittent air monitoring schedule online, which allows regulated entities to know when nearby ambient air quality monitors are online and offline. Regulated entities can use this information to alter their operations so that monitors cannot detect their elevated emissions. Second, the EPA has a limited ability to ensure that all air quality data submitted by state and local air monitoring agencies are representative of the actual air quality. This presents an opportunity for state and local air monitoring agencies to avoid reporting data during anticipated periods of high pollution by scheduling maintenance and operational activities for their ambient air quality monitoring sites during these periods. However, screening technologies are available to enhance the EPA's oversight of high-risk areas.

### *The EPA's Public Schedule for Intermittent Monitoring Creates Opportunities for Regulated Entities to Hide Peak Emissions*

On its "Ambient Monitoring Technology Information Center" webpage, the EPA publishes an annual calendar with the scheduled sampling days for intermittent monitors, as shown in Figure 2 in Chapter 1. Because the intermittent monitors use filters to measure the ambient $PM_{2.5}$ values, a technician must physically visit the monitoring site to collect each sample. As a result, according to an OAQPS manager, the monitoring schedules are nonrandom to reduce the financial burden on the states related to sampling. The intermittent monitoring schedule, therefore, is the EPA's attempt to balance the required level of effort with the need for an accurate understanding of air quality over time.

Despite the financial and administrative benefits of establishing an intermittent monitoring calendar, the publication of such a calendar means that some ambient air quality monitoring sites are offline on a predictable basis, often in a one-day-on, two-days-off pattern (1-in-3 monitoring frequency). When the EPA determines that air quality in an area does not meet a national standard, the Clean Air Act requires state and local governments to develop a plan to improve air quality in that area. This plan may include more stringent and costly emission controls for industry and other sources of air pollution within the nonattainment area. Thus, the Clean Air Act framework may incentivize regulated entities to strategically alter their operations such that their peak emissions occur when ambient air quality monitoring sites are likely offline, hiding their peak emissions from the EPA. Although the proportion of intermittent ambient air quality monitoring sites decreased from 58 percent of monitoring sites in 2014 to 20 percent of monitoring sites in 2023, those intermittent monitoring sites still operated on a predictable schedule in 2023, as shown in Figure 15.

**Figure 15: Monitoring frequencies of $PM_{2.5}$ ambient air quality monitoring sites over time**




Source: OIG analysis of EPA AQS data. (EPA OIG image)

*Note:* The intermittent monitoring frequencies in this figure do not add up to 20 percent due to rounding.

According to the OAQPS, industry representatives told the EPA that it is not economical for facility operators to determine whether ambient air quality monitoring sites are online or to alter their production based on that schedule. The *Unwatched Pollution* study suggested that different types of facilities have varying capacities to adjust their operations on a day-to-day basis to align with monitoring patterns. For example, wood product manufacturers may be able to shift production schedules more easily than an electrical utility provider could adjust power production. The OAQPS also informed us that the EPA and state and local air monitoring agencies use specific monitoring, recordkeeping, and reporting requirements—which have nothing to do with the ambient air quality monitoring sites—to ensure that regulated entities comply with their permits. Our analyses, however, indicate that air pollution tends to increase in the area surrounding many of those intermittent ambient air quality monitoring sites when those sites are offline. If elevated pollution levels go undetected because ambient air quality monitoring sites are offline, NAAQS designations could be inaccurate and air pollution could remain unaddressed.

## *Incentives Exist for State and Local Air Monitoring Agencies to Underreport Air Pollution*

The EPA does not have sufficient oversight resources to manually identify underreported pollution. To calculate a valid design value for attainment designations, state and local air monitoring agencies generally must submit ambient air quality values for 75 percent of the scheduled sampling events.[9] If a state or local air monitoring agency does not report an ambient air quality value for a scheduled sampling event, the agency should submit a null value code to indicate why it did not report a value. There are 143 active qualifier codes, which include null value codes, from which air monitoring agency staff can choose, and the EPA left the interpretation of those codes to the discretion of the agencies.[10] The volume and variety of air monitoring data and null value codes create opportunities for state or local air monitoring agencies to strategically submit null value codes during periods of high ambient pollution. For example, a state or local air agency may predict an upcoming poor air quality day and then schedule maintenance and operational activities to occur on that day. A state or local air monitoring agency may be incentivized to do so to avoid the EPA designating an area as in nonattainment with the NAAQS.

**The economic cost of a nonattainment designation**

The Alamo Area Council of Governments conducted a 2017 study to determine the hypothetical cost for when San Antonio's air quality exceeds the NAAQS. The study focused on the potential loss of gross regional product and other economic impacts, such as on employment, within some relevant industries. The study concluded that costs could be as high as $27.5 billion under a marginal nonattainment designation and could reach $36.2 billion under a moderate nonattainment designation. According to the council, regulated entities that plan to expand or relocate can incur a loss ranging from $699 million to $24 billion. Entities that are required to have air quality permits were expected to spend $24 million–$60 million for those permits. Poor air quality also causes project delays that were estimated to cost regulated entities $1 billion. The Association of Central Oklahoma Governments identified similar findings for the Oklahoma City area, where an exceedance of federal air quality standards and the ensuing federal regulatory requirements were estimated to cost $9.6 billion–$15.2 billion over a 20- to 30-year period.

The EPA's guidance document, *Conducting Technical Systems Audits of Ambient Air Monitoring Programs*, advises EPA staff to review air monitoring data and supporting documentation during a technical systems audit to assess air agencies' quality assurance mechanisms and to ensure that null value codes are justified. Technical systems audits supplement quarterly data reviews so that the EPA can identify and correct data quality issues in a timely manner. The sheer volume of AQS data entries, however, presents a challenge for substantive oversight. According to Region 4 staff, "only a small fraction of reported data is investigated, typically a few data points per pollutant reviewed." The EPA technical systems audit guidance affirms this strategy, stating that because of limited time and resources, auditors should select "only a limited number of critical data points to scrutinize." For example, during a 2024 technical systems audit of the Bay Area Air Quality Management District, the

[9] The regulation governing design value calculations also allows the EPA to make valid calculations by using alternative estimates, such as substituting the highest reported values for the missing data points for some sites that do not meet this data completeness threshold.

[10] A qualifier code is an explanation for (1) why data was not collected, (2) when the data are valid but context is needed, (3) when something is wrong with the data but data are still being submitted, and (4) when the state or local air monitoring agency encountered an exceptional event. According to the EPA, an exceptional event is an unusual or naturally occurring event, such as a wildfire, that can affect air quality but is not reasonably controllable using techniques that state, local, and tribal air monitoring agencies may implement to attain and maintain the NAAQS.

EPA selected approximately 20 data points for detailed review and discussion with the district. By comparison, we estimate that the Bay Area Air Quality Management District would input 446,004 total data points, including 2,964 null value codes, into AQS for just the $PM_{2.5}$ dataset over a three-year period covered by a technical systems audit.[11] In this case, the EPA's technical systems audit accounted for approximately 0 percent of the Bay Area Air Quality Management District's $PM_{2.5}$ dataset.

When the region draws conclusions about the overall quality of an AQS dataset, samples more accurately represent the dataset as that sample size increases. Given the sheer volume of AQS data points in a three-year technical systems audit and the EPA's guidance to review a limited number of those data points, the EPA cannot provide the in-depth oversight necessary to prevent pollution gaps created by incorrect null value code use. The state and local air monitoring agency incentive to strategically submit null value codes and the EPA's limited oversight may explain our finding that average air pollution worsened during periods when daily monitoring sites were offline. While we did not identify improper use of null value codes during our evaluation, the state and local governments' ability to submit null value codes to hide poor air quality demonstrates the need for enhanced EPA oversight of state and local air monitoring agencies. A screening tool capable of detecting unusual monitoring site behavior and null code use could help EPA regions focus their efforts.

## Poor Data Quality May Result in Serious Health Consequences

Of the 173 monitoring sites of interest that we identified in our screening analysis, 31 sites, or 18 percent of all monitoring sites of interest, switch from indicating area attainment to indicating area nonattainment when we consider their respective pollution gaps. The EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems* recognizes that the data used in NAAQS determinations are not error free and always contain some level of uncertainty. Biased data create the possibility that EPA staff may declare an area as in attainment when the area's true air quality is in nonattainment. The handbook goes on to state that the EPA's incorrect designations may cause serious health consequences. An incorrect NAAQS attainment designation means that a given area will have poorer air quality, some regulated entities may be emitting air pollution beyond what is intended under the Clean Air Act, and air quality may remain worse than the health-based standard. As a result, the public in those areas will continue to be unknowingly exposed to harmful levels of air pollution.

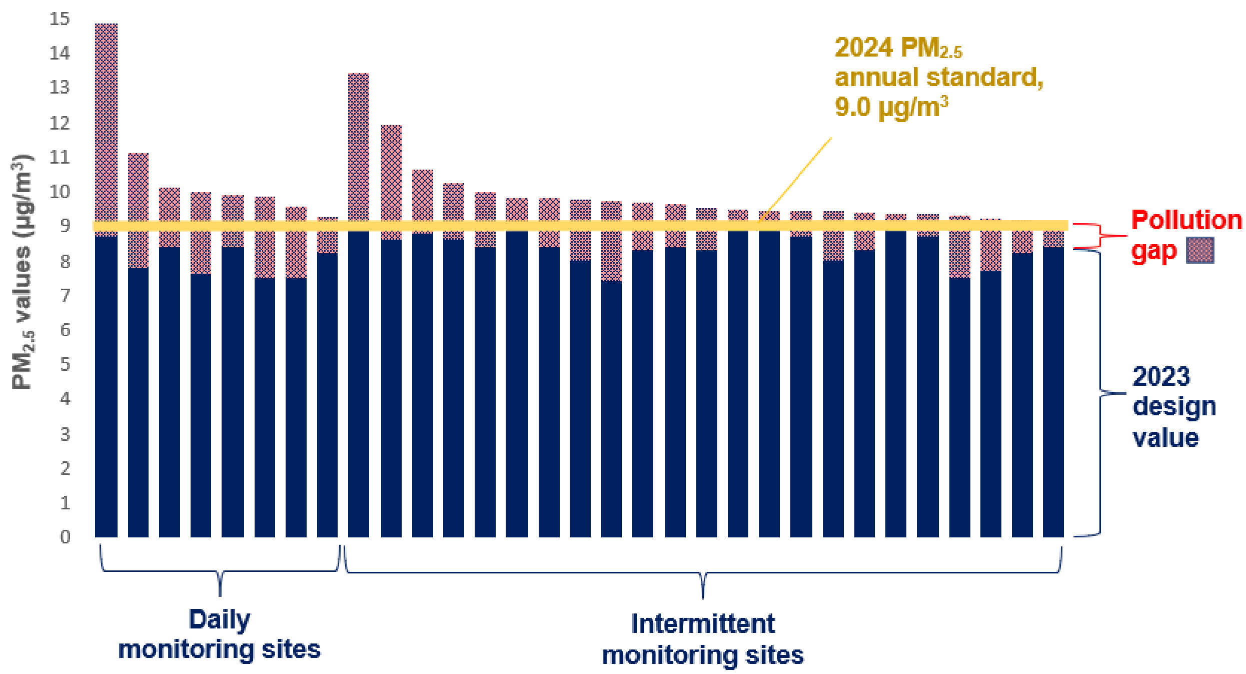
**National regression analysis results also suggest air quality in some attainment areas may exceed the nonattainment threshold**

Like our screening analysis, our nationwide regression analysis suggests underreported data could impact whether the EPA correctly designates certain areas as in attainment or nonattainment with the NAAQS. This risk is especially true for areas of the country where the design value approaches the 2024 $PM_{2.5}$ standard of 9.0 $\mu m/m^3$. In 2023, there were 66 monitoring sites close enough to the standard to indicate that the areas they cover may incorrectly be designated as in attainment when in fact they should be designated as in nonattainment with the NAAQS.

[11] A technical systems audit covers the six criteria air pollutants.

As shown in Figure 16, of the 173 monitoring sites of interest that we identified in our screening analysis, 31 sites, or 18 percent, switch from indicating area attainment to indicating area nonattainment when we consider the difference between the monitoring sites' average online and offline $PM_{2.5}$ values.

**Figure 16: Attainment area monitoring sites of interest at risk of an incorrect NAAQS attainment designation**




Source: OIG analysis of ambient air quality monitoring sites of interest compared to the 2024 $PM_{2.5}$ NAAQS. (EPA OIG image)

*Notes:* All monitoring sites displayed in the above chart exceed the 2024 $PM_{2.5}$ annual standard. Twenty-three of those monitoring sites are intermittent monitoring sites, while the remaining eight monitoring sites capture air pollution values daily.

Incorrectly designating a nonattainment area as an attainment area could have significant implications for sensitive populations, such as people with asthma, children, and the elderly. Given that the NAAQS are set to protect sensitive populations, representative air quality data in these areas is of particular importance.

## Conclusions

The EPA can better protect and enhance the quality of the nation's air resources by taking additional steps to assure that air quality data are representative of the actual air quality. If regulated entities and air agencies impede the detection of poor air quality, areas may incorrectly be designated as in attainment when, in fact, they should be designated as in nonattainment. As a result, some regulated entities may be emitting air pollution beyond what is intended under the Clean Air Act, and air quality may unknowingly remain worse than the health-based standard.

By using statistical screening methods and alternative sources of ambient air quality data to determine whether the air quality around monitoring sites worsens when monitors are offline, the EPA could mitigate the risk of air monitoring sites underreporting air pollution. Because the trend in worsening air quality when monitors are offline is not pervasive across the country, EPA regions could use the results of their screening analysis as a decision-making tool to help focus quality assurance efforts in support of protecting human health and the environment. The EPA could also mitigate its oversight resource constraints by using this screening to identify any patterns of state or local air monitoring agencies submitting null value codes on days with high ambient pollution levels. Conducting these more sophisticated analyses with more precise results would improve the effectiveness of the EPA's oversight by yielding better data to inform NAAQS designations, ultimately improving air quality and protecting human health.

## Recommendations

We recommend that the assistant administrator for Air and Radiation:

1. Restrict the distribution of the intermittent monitoring schedule to state, local, and tribal air monitoring agencies and associated labs, and work with state, local, and tribal air monitoring agencies and associated labs, as appropriate, to limit or otherwise discourage broader dissemination of and access to the intermittent monitoring schedule. This restriction and related collaboration would reduce the risk of regulated entities using the schedule to time their peak emissions for when a monitoring site is offline.

2. Implement a regular screening process that uses alternative air pollution measurements to detect monitoring sites that may be underreporting air pollution and that flags those sites for EPA region and state and local air monitoring agency follow-up, as appropriate. This process would improve Agency oversight by yielding data that cover periods when monitoring sites are offline and, therefore, better inform air quality and human health protection-related decision-making.

## Agency Response and OIG Assessment

Appendix B includes the Agency's response to our draft report. The Office of Air and Radiation also provided technical comments, which we incorporated into our report as appropriate.

For Recommendation 1, the Office of Air and Radiation committed to limiting the release of the intermittent monitoring schedule after we raised concerns about the schedule being publicly available during our fieldwork. The office completed this corrective action in December 2024. That action and the Office of Air and Radiation's commitment to not post future intermittent monitoring schedules meet the intent of our recommendation, and we consider Recommendation 1 closed with corrective actions completed.

For Recommendation 2, the Office of Air and Radiation committed to, by January 30, 2026, developing a methodology and implementing an internal data screening tool for $PM_{2.5}$ measurements. In addition, the office stated that its focus will be on $PM_{2.5}$ but that it will expand the screening process and tool to other criteria pollutants as needed. The intent of our recommendation was for the office to use a screening process on a regular basis to detect monitoring sites that may require follow-up. However, we believe the Agency's proposed corrective actions meet the intent of our recommendation, and we consider Recommendation 2 resolved with corrective actions pending. We will monitor the Agency's actions to ensure they do, in fact, fully address our intent.

In its response to our draft report, the Office of Air and Radiation asserted that its own analyses did not support our report's findings. However, the Agency did not share these analyses with us or provide insight into its specific disagreements. Our objective, scope and methodology, data collection, and two analyses focused on whether monitoring sites captured representative samples of ambient air quality relative to alternative data sources. Our analyses include a discussion of opportunities and incentives for regulated entities to engage in behavior that seeks to hide emissions. While our report includes an example that demonstrates that state and regulated entity actions can undermine the collection of data that are representative of the actual air quality, we do not use our analyses to assert that this behavior is occurring at any specific site. Further, we acknowledge in Recommendation 2 that the EPA region and state and local air monitoring agencies will need to follow up on screening process results, as appropriate. Lastly, we describe in detail the limitations of our analyses in Appendix A. We urge the EPA use this description to build upon our report findings as it develops its own processes and tools to better target potentially constrained resources and reduce the risk of underreported air pollution.

# Status of Recommendations

| Rec. No. | Page No. | Recommendation | Status* | Action Official | Planned Completion Date |
|---|---|---|---|---|---|
| 1 | 30 | Restrict the distribution of the intermittent monitoring schedule to state, local, and tribal air monitoring agencies and associated labs, and work with state, local, and tribal air monitoring agencies and associated labs, as appropriate, to limit or otherwise discourage broader dissemination of and access to the intermittent monitoring schedule. This restriction and related collaboration would reduce the risk of regulated entities using the schedule to time their peak emissions for when a monitoring site is offline. | C | Assistant Administrator for Air and Radiation | 12/17/24 |
| 2 | 30 | Implement a regular screening process that uses alternative air pollution measurements to detect monitoring sites that may be underreporting air pollution and that flags those sites for EPA region and state and local air monitoring agency follow-up, as appropriate. This process would improve Agency oversight by yielding data that cover periods when monitoring sites are offline and, therefore, better inform air quality and human health protection-related decision-making. | R | Assistant Administrator for Air and Radiation | 1/30/26 |

* C = Corrective action completed.
R = Recommendation resolved with corrective action pending.
U = Recommendation unresolved with resolution efforts in progress.

Appendix A

# Details of the EPA OIG Analyses

The purpose of this appendix is to acknowledge the limitations of our analyses. As appropriate, the OAQPS can use the information within this appendix to improve upon our work in future iterations of its quality assurance screenings of air monitoring data.

## Analysis 1: National-Level Regression Analysis on Monitoring Site Frequencies

We conducted five national-level bivariate regression analyses on three monitoring frequency types:[12] daily monitoring sites, 1-in-3 monitoring sites, and 1-in-6 monitoring sites. We did not analyze 1-in-12 monitoring sites because of inadequate data. We limited our daily monitoring site analysis to the predictor variable that indicates whether a nonregulatory or regulatory monitor was operating at a given site. For our intermittent monitors, on the other hand, we assessed two predictor variables: (1) a nonregulatory or regulatory monitor was operating at a given site and (2) a regulatory monitor was operating at a given site, irrespective of the nonregulatory monitor. Both predictor variables for our intermittent monitor analyses yielded similar results.

While each of our regression analyses were statistically significant, the alternative air pollution measurements that we used were not normally distributed for the years 2014 through 2020. As shown in Table A-1, to address the skewness in our data,[13] we used a natural logarithm transformation. While this transformation approximately normally distributed our alternative air pollution measurements, statistical tests of normality continued to indicate that our data were not normally distributed.[14]

**Table A-1: Shapiro-Wilk test of normality**

| Monitor type | Pre-transformation Shapiro-Wilk test value, $W$ | Pre-transformation normally distributed? | Post-transformation Shapiro-Wilk test value, $W$ | Post-transformation normally distributed? |
|---|---|---|---|---|
| **Daily** | 0.589 | No | 0.962 | No |
| **1-in-3** | 0.730 | No | 0.990 | No |
| **1-in-6** | 0.747 | No | 0.980 | No |

Source: OIG summary of Shapiro-Wilk tests. (EPA OIG table)

[12] A bivariate regression analysis contains one predictor variable. In our report, the predictor variable was the online status indicator.
[13] Normally distributed data will appear as a bell curve with approximately equal tails. Skewness describes the distribution of data where the one tail will be longer on the left, identified as negatively skewed, or on the right, identified as positively skewed. Our alternative air pollution measurements are positively skewed, and this distribution may undermine the validity of our regression models.
[14] In this appendix, we limit our discussion of statistical validity to the Shapiro-Wilk test, but we also conducted other tests of our model's validity, including the Breusch-Pagan test and assessments of scatterplots, kernel density plots, and various post-regression diagnostic graphs.

The non-normal distribution may be due to the presence of outliers caused by exceptional events. An exceptional event is an unusual or naturally occurring event, such as a wildfire, that can affect air quality but is not reasonably controllable using techniques that state, local, and tribal air agencies may implement to attain and maintain the NAAQS. The EPA does not use these events when it determines whether an area complies with the NAAQS. We expect daily air quality values associated with exceptional events to be anomalously higher than values on normal days during online periods because of the exceptional event pollution and the lack of regulated entity and state and local government incentive to hide elevated pollution from the EPA during these events. We discuss these incentives in greater detail within the body of our report. Because of the scope limitations for our assignment, we did not exclude the exceptional event outliers, and we therefore did not address the possibility of bias caused by exceptional events.

In addition to the non-normal data and possible outliers caused by exceptional events, our national regression analyses would also benefit from additional predictor variables. As shown in Table A-2 below, each of our regression analyses resulted in small, adjusted R-squared values. The adjusted R-squared value indicates the percent variance in our alternative air pollution measurements that is accounted for by the monitoring site being turned off and on. Future models could incorporate the monitoring sites' proximity to certain industry types, for example, or they could account for the design values' likelihood of exceeding the NAAQS.

**Table A-2: Model adjusted R-squared values**

| Monitor type | Model 1<br>"Master Online Status": Adjusted R-squared | Model 2<br>"Online Status": Adjusted R-squared |
|---|---|---|
| **Daily** | 0.0001959 | — |
| **1-in-3** | 0.0053410 | 0.0053290 |
| **1-in-6** | 0.0008444 | 0.0004674 |

Source: OIG summary of R-squared values. (EPA OIG table)

Our reliance on a bivariate regression, our data's non-normal distribution, and the presence of potentially excludable outliers may undermine the accuracy of the pollution estimates that we present in our report. Future models that address these issues can improve the quality of our pollution estimates.

## *Analysis 2: Site-by-site Screening Analysis*

We conducted 1,032 t-tests to determine whether each of the 877 monitoring sites' average online air quality data were statistically significantly different from the monitoring sites' average offline air quality data.[15] A total of 155 monitoring sites changed their frequency during our study period and were, therefore, tested on the original monitoring frequency and the updated monitoring frequency.

To minimize the risk of confirmation bias,[16] our site-by-site screening analysis tested whether the ambient air monitoring data were significantly different when the site was offline compared to when the site was online, irrespective of whether the deviation would support our objective. As shown in Table A-3, out of 877 $PM_{2.5}$ monitoring sites that were operational in 2023 and that recorded air quality data from 2016 through 2020, 24.29 percent of those sites' average 2016 through 2020 alternative air pollution measurements were statistically different on days when the monitoring sites could not detect pollution. We identified 46 of 609 daily monitoring sites, or 7.55 percent, as having statistically different air quality between online and offline days. Intermittent monitoring sites show this gap more often, with 39.72 percent of these monitoring sites exhibiting statistically different levels of air quality when they were offline.

**Table A-3: Monitoring sites active in 2023 by planned frequency**

| Monitoring frequency | Total sites | Statistically significant-difference sites | Percent of total (%) |
|---|---|---|---|
| **Daily** | 609 | 46 | 7.55 |
| **Intermittent** | 423 | 168 | 39.72 |
| **Total** | **877** | **213** | **24.29** |

Source: OIG analysis of ambient air quality monitor statuses. (EPA OIG table)

*Notes:* The total row is not a sum of the daily and intermittent values because 155 monitoring sites switched to a different monitoring frequency in the period from 2016 through 2020. One statistically significant-difference site changed to a different monitoring frequency during the same period.

As shown in Figure A-1, out of the 168 intermittent monitoring sites with statistically different air quality between online and offline days, we found that 151 intermittent monitoring sites, or 35.70 percent of all intermittent monitoring sites, have worse air quality on average when they go offline. The right side of the distribution, on the other hand, shows 17 intermittent monitoring sites where the average worse air quality occurred when they were online. Despite the presence of the latter monitoring sites, approximately 90 percent of the monitoring sites with a statistically significant difference in air quality between online and offline days provide evidence that certain monitoring sites miss air pollution. As shown in Figure A-2, the pattern we identified in the intermittent monitors is not evident in the daily monitors—24 daily monitoring sites were online when the worse air quality occurred on average.

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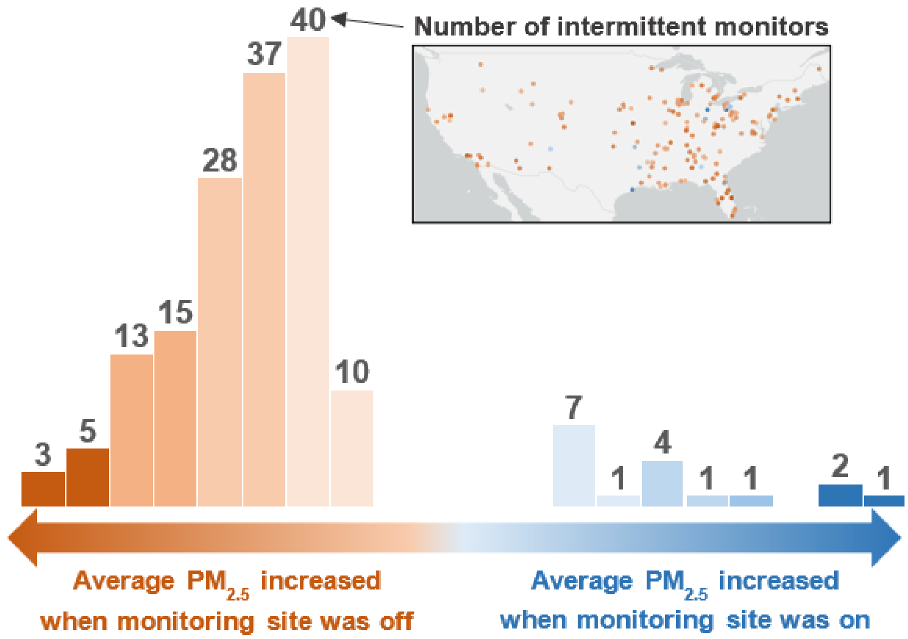
[15] A t-test is a statistic used to determine whether there is a statistically significant difference between the means of two variables. Given our finding that our alternative air quality measurements are not normally distributed, and given that t-tests are best suited to normally distributed data, a nonparametric test may result in different outcomes than the ones we describe in our report. To ensure that our overall conclusions did not change, we verified the accuracy of our t-test conclusions by testing at least 10 percent of the monitors of interest with the nonparametric Mann-Whitney U test. We did not detect a difference in outcomes between the two tests.

[16] Confirmation bias is the tendency to process information by looking only for information that is consistent with existing beliefs. In the context of our assignment, we would have been influenced by confirmation bias had we not considered whether elevated air pollution levels could be associated with the monitoring site being online—a finding that could undermine our assignment objective.

**Figure A-1: Distribution of intermittent monitoring sites with significantly different air quality between online and offline days**

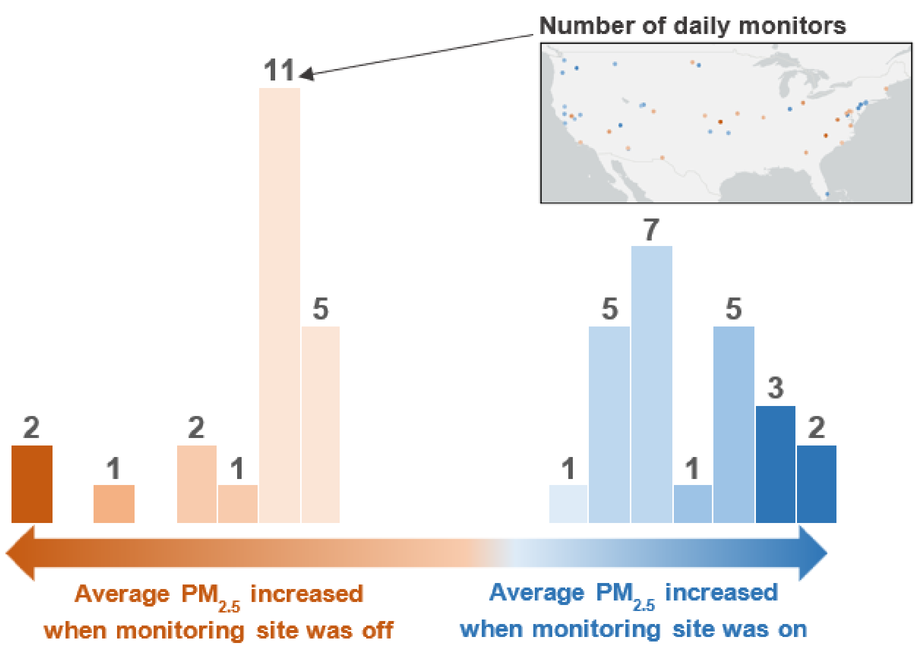
| Category | Count |
|---|---|
| -0.38 to -0.35 | 3 |
| -0.35 to -0.31 | 5 |
| -0.31 to -0.27 | 13 |
| -0.27 to -0.23 | 15 |
| -0.23 to -0.19 | 28 |
| -0.19 to -0.15 | 37 |
| -0.15 to -0.11 | 40 |
| -0.11 to -0.07 | 10 |
| 0.09 to 0.13 | 7 |
| 0.13 to 0.17 | 1 |
| 0.17 to 0.21 | 4 |
| 0.21 to 0.25 | 1 |
| 0.25 to 0.29 | 1 |
| 0.33 to 0.36 | 2 |
| 0.36 to 0.40 | 1 |




Source: OIG analysis of regulatory air monitor online-offline behavior compared to alternative air pollution measurements. (EPA OIG image)

**Figure A-2: Distribution of daily monitoring sites with significantly different air quality between online and offline days**

| Category | Count |
|---|---|
| -0.22 to -0.20 | 2 |
| -0.18 to -0.16 | 1 |
| -0.14 to -0.12 | 2 |
| -0.12 to -0.10 | 1 |
| -0.10 to -0.08 | 11 |
| -0.08 to -0.06 | 5 |
| 0.04 to 0.06 | 1 |
| 0.06 to 0.08 | 5 |
| 0.08 to 0.10 | 7 |
| 0.10 to 0.12 | 1 |
| 0.12 to 0.14 | 5 |
| 0.14 to 0.16 | 3 |
| 0.16 to 0.18 | 2 |

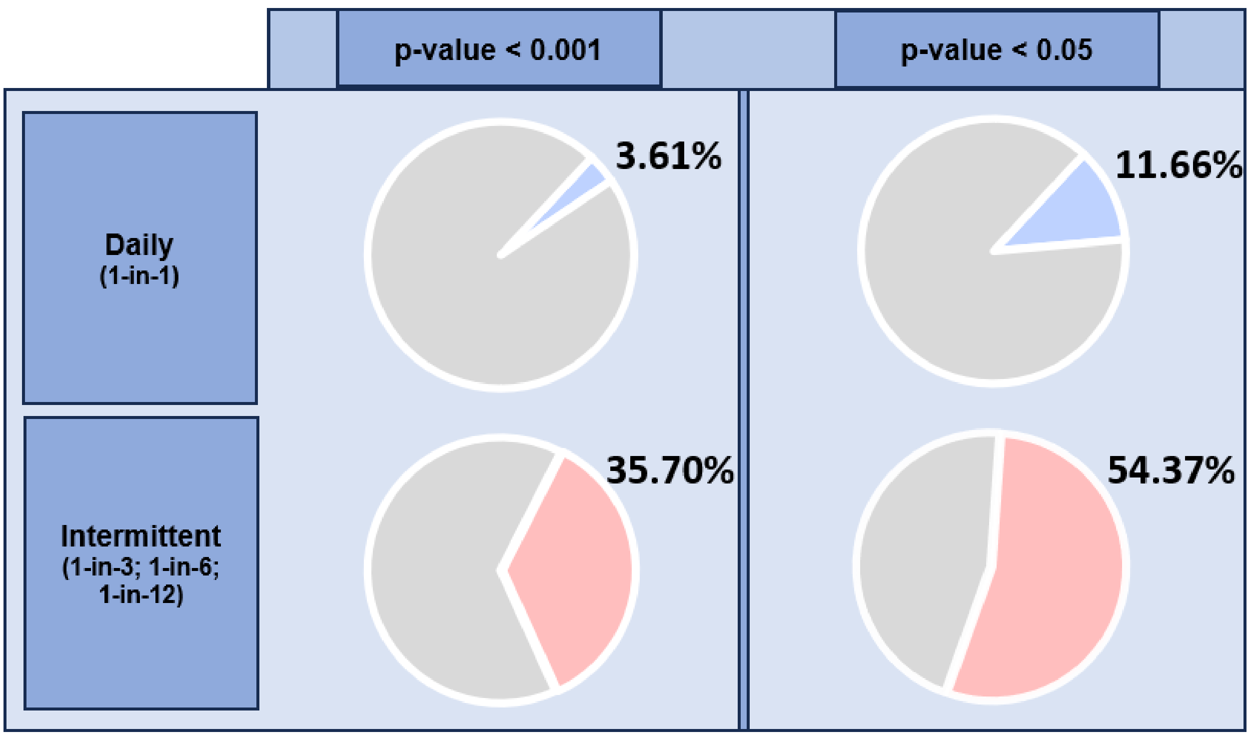



Source: OIG analysis of regulatory air monitor online-offline behavior compared to alternative air pollution measurements. (EPA OIG image)

The right side of the monitoring site distribution in the previous figures, where poor air quality increased when a monitoring site was online, may be caused by exceptional event bias, which we discussed in the previous section. Given that our analysis did not account for exceptional events, the monitoring sites on the right side of the distribution may be present due to that bias.

Further, we used a statistical technique in our screening analysis that decreases the risk that we would falsely identify non-interesting monitors as monitoring sites of interest: the Bonferroni method, using an adjusted alpha value of less than 0.001.[17] However, this rigorous method also increases the risk that we miss monitoring sites of interest. As shown in Figure A-3, a shift to a less rigorous method results in 71 monitoring sites of interest, or 11.66 percent, of 609 daily monitoring sites and 230 monitoring sites of interest, or 54.37 percent, of 423 intermittent monitoring sites. In addition to this shift, the proportion of monitoring sites shifts to pollution increasing during offline days compared to online days. For example, as shown in Figure A-4, our rigorous analysis results in 22, or 48 percent, of 46 monitoring sites with a statistically significant difference in pollution as having more pollution on offline days, while the traditional p-value of 0.05 identifies 71, or 62 percent, of 114 monitoring sites as having more pollution on offline days.

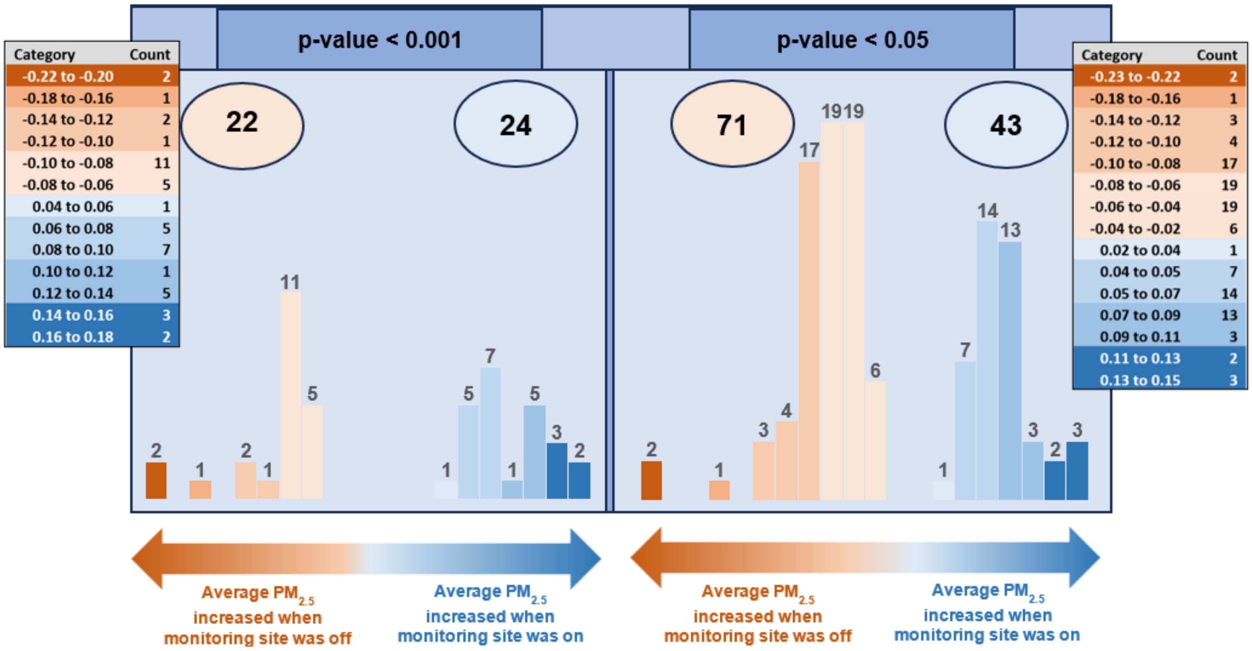
**Figure A-3: The proportion of daily and intermittent monitoring sites of interest increases when we switch from a Bonferroni-adjusted alpha value to the traditional alpha value**




Source: OIG analysis of regulatory air monitor online offline behavior compared to alternative air pollution measurements. (EPA OIG image)

[17] The Bonferroni method decreases the alpha value when the analyst is conducting multiple tests. The Bonferroni-adjusted alpha value is calculated by dividing the traditional alpha value, 0.05, by the number of tests the analyst intends to conduct.

**Figure A-4: The proportion of daily monitoring sites of interest increases when we switch from a Bonferroni-adjusted alpha value to the traditional alpha value**




Source: OIG analysis of regulatory air monitor online–offline behavior compared to alternative air pollution measurements. (EPA OIG image)

## *Future Screening Model Iterations Can Address Our Analysis Limitations*

Future screening models can use new high-resolution data for a variety of non-$PM_{2.5}$ pollutants. The OAQPS has considered use of automated screening tools that identify high-pollution episodes and missed samples in near real time. Three OAQPS staff, including the director; staff from four of five EPA regions; and one Office of Enforcement and Compliance Assurance subject matter expert expressed that this screening would be beneficial. Given the nature of our analyses, the OAQPS could improve upon our work by including these additional pollutants in a real-time or near real-time format and addressing the limitations that we identify in this appendix, as appropriate.

Appendix B

# Agency Response to the Draft Report

OFFICE OF AIR AND RADIATION
WASHINGTON, D.C. 20460

June 24, 2025

**MEMORANDUM**

**SUBJECT:** Response to the Office of Inspector General Draft Report, *Evaluation of the EPA's Oversight of State and Local Ambient Air Monitoring Operating Schedules*, Project No. OSRE-FY24-0072, dated April 25, 2025

**FROM:** Abigale Tardif, Principal Deputy Assistant Administrator
Office of Air and Radiation

ABIGALE TARDIF Digitally signed by ABIGALE TARDIF Date: 2025.06.24 12:03:35 -04'00'

**TO:** Patrick Gilbride, Director
Implementation, Execution, and Enforcement Directorate
Office of Special Review and Evaluation

Thank you for the opportunity to review and respond to the Office of Inspector General's (OIG's) draft report titled, *Evaluation of the EPA's Oversight of State and Local Ambient Air Monitoring Operating Schedules*, Project No. OSRE-FY24-0072, dated April 25, 2025. The following is a summary of the U.S. Environmental Protection Agency's (EPA's) overall position, followed by its position on the draft report's recommendations.

**AGENCY'S OVERALL POSITION**

The EPA is providing detailed feedback on the OIG's approach, assumptions, and findings in the attached technical comments. We request that the OIG make significant edits to the draft report before finalization to improve the accuracy of the information and clearly state the methodology, assumptions, and limitations for the assertions that: 1) "analyses indicate that pollution levels increase when certain air quality monitoring sites are offline"; 2)"…an opportunity [is created] for regulated entities to time peak emissions for when a monitoring site is offline"; and 3) "…[there are] opportunities for air monitoring agencies to strategically turn off monitoring sites on days that they expect high pollution, potentially to avoid the EPA designating an area as in nonattainment." In completing the EPA's own analyses to address the questions posed by this report, the EPA did not find support for the OIG report's assertions.

With respect to the recommendations, the EPA has previously addressed Recommendation #1, so we request that this recommendation either be removed or marked as completed in the final report. For Recommendation #2, the EPA will develop a methodology as the basis for a screening process or tool which will focus on PM2.5, consistent with the OIG's area of analysis in the draft report. The EPA will expand this screening process/tool to other criteria pollutants, as needed.

**AGENCY'S RESPONSE TO DRAFT AUDIT RECOMMENDATIONS**

The EPA agrees to implement the two OIG recommendations in the draft report as described below:

| Recommendation | Proposed Corrective Action | Target Completion Date |
|---|---|---|
| 1. Restrict the distribution of the intermittent monitoring schedule to state, local, and tribal air monitoring agencies and associated labs and work with state, local, and tribal air monitoring agencies and associated labs, as appropriate, to limit or otherwise discourage broader dissemination of and access to the intermittent monitoring schedule. | The EPA will not post the future sampling schedule on the public EPA website. Instead, the EPA will release the sampling schedule to state, local, and Tribal air agencies and other entities on a "need to know" basis. | December 2024 |
| 2. Implement a regular screening process using alternative air pollution measurements to detect monitoring sites that may be underreporting for EPA region and state and local air monitoring agency follow-up, as appropriate. | The EPA will develop a methodology and implement an internal data screening tool for PM2.5 measurements. | January 30, 2026 |

**CONTACT INFORMATION**
If you have any questions regarding this response, please contact the Office of Air and Radiation's Audit Follow-up Coordinator, Grant Peacock, at Peacock.Grant@epa.gov.

Appendix C

# Distribution

The Administrator
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Associate Deputy Administrator
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Agency Follow-Up Coordinator
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Deputy Assistant Administrator for Air and Radiation
Director, Office of Continuous Improvement, Office of the Chief Financial Officer
Director, Office of Air Quality Planning and Standards, Office of Air and Radiation
OIG Liaison, Office of Policy, Office of the Administrator
GAO Liaison, Office of Policy, Office of the Administrator
Audit Follow-Up Coordinator, Office of the Administrator
Audit Follow-Up Coordinator, Office of Air and Radiation
Audit Liaison, Office of Air Quality Planning and Standards, Office of Air and Radiation

# Whistleblower Protection

U.S. Environmental Protection Agency

*The whistleblower protection coordinator's role is to educate Agency employees about prohibitions against retaliation for protected disclosures and the rights and remedies against retaliation. For more information, please visit the OIG's whistleblower protection webpage.*

## Contact us:

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**EPA OIG Hotline:** OIG.Hotline@epa.gov

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