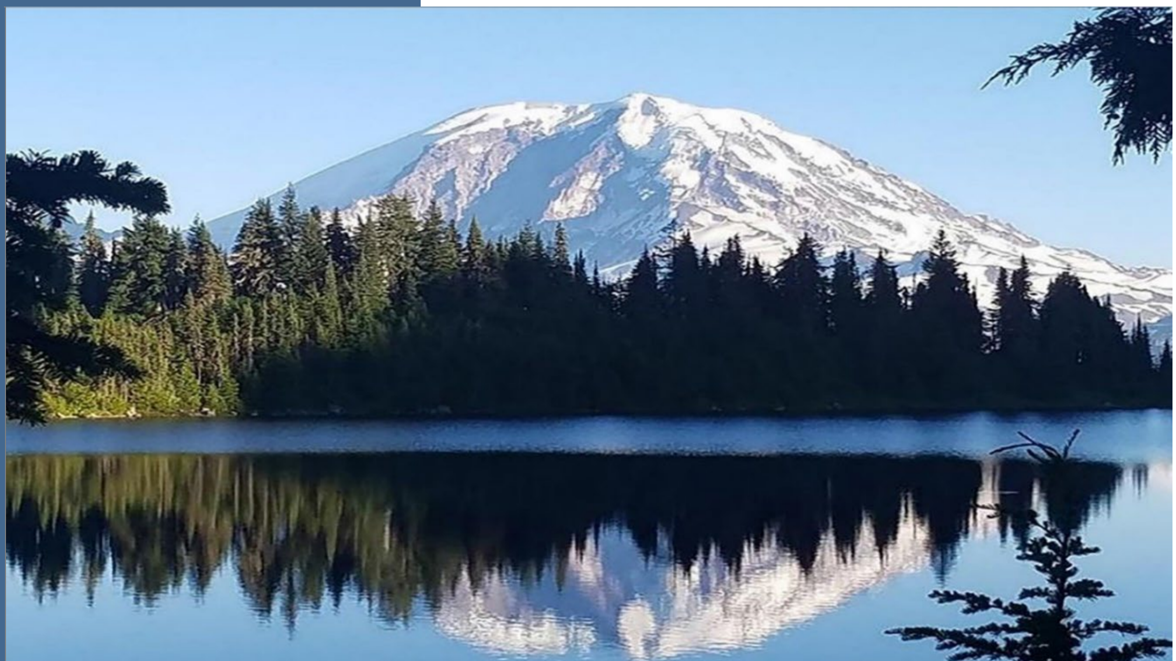

Strategy for Expanded Air Monitoring in Overburdened Communities Highly Impacted by Air Pollution

Air Quality Program

Washington State Department of Ecology

Olympia, Washington

August 2026, Publication 26-02-018

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Contact Information

Air Quality Program

P.O. Box 47600
Olympia, WA 98504-7600
Phone: 360-790-6800
Website[1]: Washington State Department of Ecology

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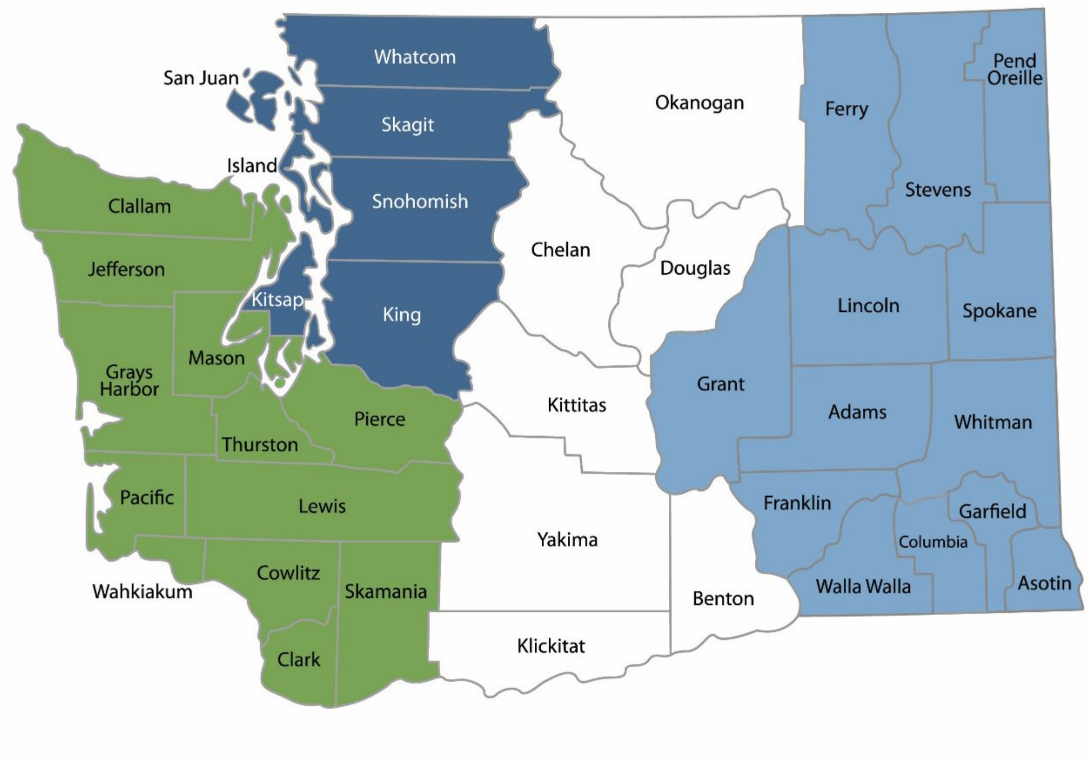
[1] www.ecology.wa.gov/contact

Department of Ecology’s Regional Offices

Map of Counties Served



Southwest Region 360-407-6300

Northwest Region 206-594-0000

Central Region 509-575-2490

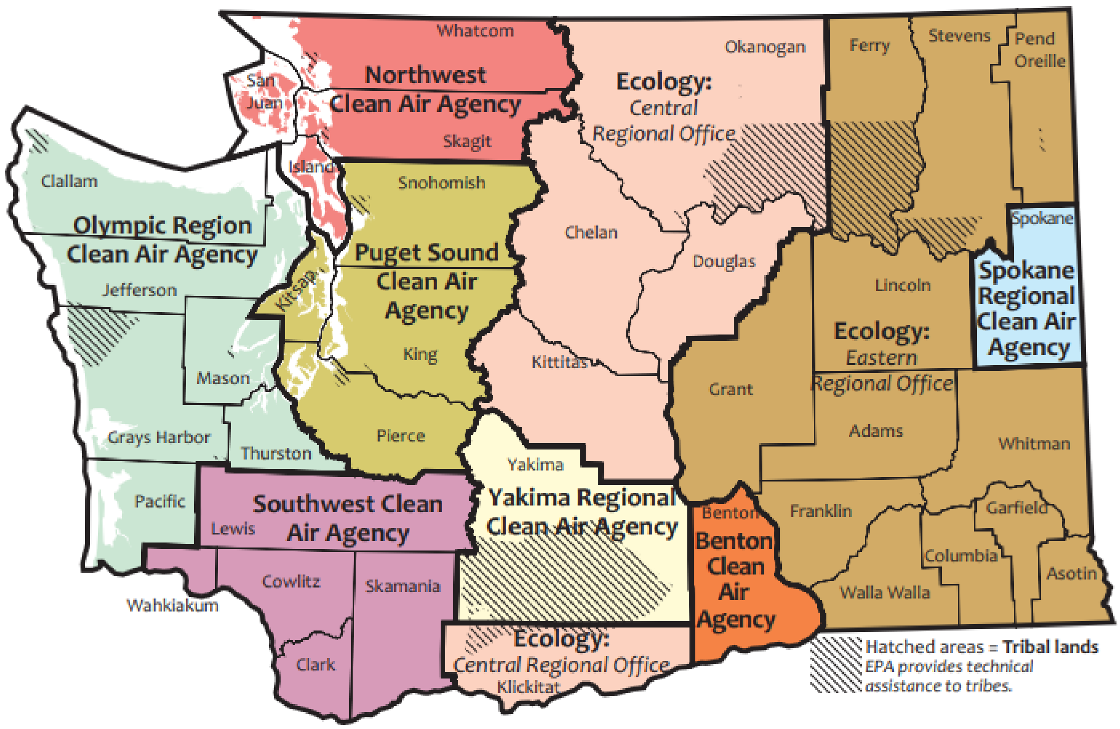
Eastern Region 509-329-3400

Region	Counties served	Mailing Address	Phone
Southwest	Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Mason, Lewis, Pacific, Pierce, Skamania, Thurston, Wahkiakum	PO Box 47775 Olympia, WA 98504	360-407-6300
Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	PO Box 330316 Shoreline, WA 98133	206-594-0000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 W Alder St Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 N Monroe Spokane, WA 99205	509-329-3400
Headquarters	Across Washington	PO Box 46700 Olympia, WA 98504	360-407-6000

Local Clean Air Agencies

Washington's Clean Air Act in Chapter 70A.15 of the Revised Code of Washington (RCW) established procedures for counties to create local clean air agencies (LCAA) in 1967. Currently, there are seven Local Clean Air Agencies serving 22 counties. Their jurisdictional boundaries are shown on the map below.

Map of Areas Served by Local Clean Air Agencies



Download printable map and contact list at:
https://apps.ecology.wa.gov/publications/SummaryPages/1402010.html

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Table of Contents

List of Figures and Tables

Figures

Tables

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Glossary

Definitions

Air Quality Index (AQI) is a U.S. Environmental Protection Agency (EPA) tool for communicating about outdoor air quality and its health impacts. The AQI is a unitless index that assigns concentrations of the different criteria air pollutants to a common scale with defined levels of concern.

Background levels or concentrations of air pollutants are levels typically found in the absence of anthropogenic activity or significant nearby sources.

Climate Commitment Act (CCA) is a 2021 Washington law codified in Chapter 70A.65 RCW that created the state's cap-and-invest program and associated environmental justice review requirements.

Criteria air pollutants are six common air pollutants known to be harmful to human health and the environment: photochemical oxidants, particulate matter, oxides of sulfur, oxides of nitrogen, carbon monoxide, and lead. Criteria air pollutants are regulated under the federal Clean Air Act, and EPA sets National Ambient Air Quality Standards (NAAQS) for concentrations of their indicator pollutants in ambient air.

Design values are summary statistics calculated from air monitoring data following the defined form and averaging time in the NAAQS in order to compare data from a monitoring site to the level of the NAAQS.

Federal Reference Method (FRM) monitors are a class of monitors designated by EPA as the reference standard for measurement of a criteria air pollutant.

Federal Equivalent Method (FEM) monitors meet defined standards for precision and accuracy relative to FRMs. FEMs use different sampling and/or analysis methods than FRMs but can be used for the same range of regulatory decisions.

Fenceline monitoring refers to air monitoring at the perimeter or property line of a stationary source of air pollution, such as an industrial facility.

Indicator pollutants are specific, singular, and measurable pollutants selected by EPA in the NAAQS review process to represent each criteria air pollutant.

Interpolation of air pollutant concentrations is the estimation of values at unmonitored locations based on monitored values from surrounding locations.

National Ambient Air Quality Standards (NAAQS) are standards set by EPA for concentrations of criteria air pollutants in ambient air. EPA defines the indicator pollutant, form, level, and averaging time for each NAAQS.

Overburdened Communities Highly Impacted by Air Pollution (OBCs) are communities identified by the Department of Ecology (Ecology) where people vulnerable to health, social, and environmental inequities may also be highly impacted by criteria air pollutants.

Regulatory and non-regulatory monitors: Both FRMs and FEMs monitors are considered *regulatory* monitors. Other monitors that are not designated as FRMs or FEMs are referred to as *non-regulatory* monitors. Only regulatory monitors can be used to demonstrate compliance with the NAAQS and Washington Ambient Air Quality Standards.

Washington Network refers to the Washington Ambient Air Monitoring Network, a network of ambient air monitors operated by Ecology, local clean air agencies, and Tribal Nations as part of Ecology's Primary Quality Assurance Organization. Washington Network monitors follow Ecology's Standard Operating Procedures and Quality Assurance Plans. They undergo routine maintenance, calibration, quality control, data review, and data validation, in order to ensure that their data are comparable and of known and acceptable quality.

Acronyms

AIRPACT	Air Indicator Report for Public Awareness and Community Tracking
AQI	Air Quality Index
ASIL	Acceptable Source Impact Level
BCAA	Benton Clean Air Agency
CCA	Climate Commitment Act
CFR	Code of Federal Regulations
CMAQ	Community Multiscale Air Quality Model
CO	Carbon Monoxide
CSN	Chemical Speciation Network
Ecology	Washington State Department of Ecology
EI	Emissions Inventory
EPA	U.S. Environmental Protection Agency
FEM	Federal Equivalent Method
FRM	Federal Reference Method
HRMM	High-Resolution Mobile Monitoring
LCAA	Local Clean Air Agency
NAAQS	National Ambient Air Quality Standard
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_X	Oxides of Nitrogen
NO_y	Total Reactive Oxides of Nitrogen
NSR	New Source Review
O_3	Ozone
OBC	Overburdened Community Highly Impacted by Air Pollution
Pb	Lead
$PM_{2.5}$	Particulate matter ≤ 2.5 micrometers in diameter
PM_{10}	Particulate matter ≤ 10 micrometer in diameter
$PM_{10-2.5}$	Particulate matter between 2.5 and 10 micrometers in diameter
ppb	parts per billion
ppm	parts per million
PQAO	Primary Quality Assurance Organization
PSCAA	Puget Sound Clean Air Agency
RCW	Revised Code of Washington
QAP	Quality Assurance Plan
QAPP	Quality Assurance Project Plan
SO_2	Sulfur Dioxide
SOP	Standard Operating Procedure
SRCAA	Spokane Region Clean Air Agency
$\mu g/m^3$	micrograms per cubic meter
VOC	Volatile Organic Compound
WAC	Washington Administrative Code

Executive Summary

This document describes the Washington Department of Ecology (Ecology) strategy for expanded air monitoring in Overburdened Communities Highly Impacted by Air Pollution, pursuant to the environmental justice review requirements of the Climate Commitment Act, codified as [RCW 70A.65.020].

The Washington Climate Commitment Act of 2021 ([Chapter 70A.65 RCW]) requires Ecology to expand its existing statewide monitoring network by first identifying overburdened communities highly impacted by air pollution and then deploying an air monitoring network sufficient to inform a biennial review of criteria air pollutant levels in these communities.

In 2023, Ecology identified sixteen Overburdened Communities Highly Impacted by Air Pollution (OBCs). Since its inception as the first environmental protection agency in the country in 1970, Ecology has prioritized monitoring the air where levels of criteria air pollutants are elevated. As a result, most of these sixteen communities already had existing air monitoring sites. To meet the requirements of RCW 70A.65.020, Ecology added new monitors in OBCs that lacked any prior air monitoring and is increasing the density of air monitors in the remaining OBCs.

Ecology's expanded monitoring strategy is informed by many sources of supporting data and air quality information, including:

- Historical air monitoring data
- Emissions information
- Modeling and interpolation
- Air monitoring studies
- Outreach and public engagement

Due to siting, logistical, and resource constraints, it is not possible to monitor all criteria air pollutants in all locations. Ecology uses the above sources of supporting data and air quality information to determine how to use monitoring resources most efficiently and effectively to maximize public benefit while meeting the requirements and intent of RCW 70A.65.020.

The strategy for expanded monitoring described in this document details how Ecology abides by the following guiding principles:

1. Each OBC has a representative monitor for any criteria air pollutant expected to be routinely elevated above the Good range of EPA's Air Quality Index (AQI).
2. In areas where supporting data and air quality information do not indicate a reason that concentrations of a specific criteria air pollutant could be routinely elevated above the Good range of the AQI, there is not a sufficient basis to support expanded monitoring for that pollutant.
3. Monitors are sited in locations that meet EPA siting criteria and operated according to Ecology's Standard Operating Procedures and Quality Assurance Plans. These

frameworks ensure the collection of high-quality data that can be compared within and across communities.

4. The density of monitors and their specific locations are selected based on the monitoring objective and spatial scale applicable to each pollutant.
5. Most monitors are sited to capture population exposure at the neighborhood- to urban-scale. The density of these monitors is adequate to ensure representative coverage across the populated areas of the OBC.
6. Some monitors are sited to capture the highest concentrations of a pollutant in the OBC at the micro-scale. When data from these monitors are within the Good range of the AQI, monitoring is not extended beyond highest-concentration areas.
7. Representative monitors may be located outside OBCs and still represent air quality conditions inside OBCs, especially in the case of regional pollutants and monitors close to OBC boundaries.

Frequently Asked Questions

Why doesn't Ecology monitor all criteria air pollutants in all Overburdened Communities Highly Impacted by Air Pollution?

Ecology's air monitoring network is focused in areas where concentrations of specific criteria air pollutants are elevated and where population impacts from air pollution exposure are greatest. All criteria air pollutants are monitored in Washington, but some (such as sulfur dioxide and carbon monoxide) rarely exceed trace levels even at sites designed to capture the highest pollution levels. As emissions of these pollutants declined throughout the past half-century, monitored ambient concentrations dropped to levels well below current health-based standards. Most historical monitoring sites for these pollutants have been discontinued due to low concentrations. Ecology continues to track emissions of these pollutants, which continue to decline. Without increases in emissions or new emissions sources, there is no basis to reestablish broad monitoring networks for these pollutants.

Ecology has identified seven guiding principles for expanded monitoring described in this document. These principles ensure that expanded monitoring provides useful air quality data for public health information and protection. These principles also prevent the direction of air monitoring resources toward redundant or low-value monitoring.

Why doesn't Ecology monitor all criteria air pollutants in "neighboring communities" near OBCs for comparison?

RCW 70A.65.020 directs Ecology to "deploy an air monitoring network in overburdened communities." While this statute lists "the air quality experienced in neighboring communities" as one option for air quality targets in OBCs, it does not direct Ecology to monitor air quality in these communities. Ecology also does not have specific funding for monitoring air quality in neighboring communities. As a result, expanded air monitoring in neighboring communities would reduce the monitoring resources available for expanded air monitoring in OBCs. Ecology determined that directing air monitoring resources to neighboring communities at the expense of OBCs would be inconsistent with the intent of the environmental justice review provisions of the statute.

Why doesn't Ecology use regulatory-quality monitors at all monitoring sites?

Installing regulatory-quality monitors at a high density within OBCs would be neither feasible nor practical. Regulatory monitors require more space and supporting infrastructure, such as electrical access and a fenced area. Many of the new air monitoring sites Ecology established in OBCs using small air sensors would simply not have the space, access, or capacity to house regulatory monitors. Restricting expanded monitoring to only regulatory monitors would considerably reduce the number of locations available for monitoring sites.

Since EPA is responsible for designating monitoring methods as regulatory-quality, monitors using these methods are subject to federal oversight. States must request EPA approval to install, relocate, or discontinue regulatory monitors, and EPA approval is based on a strict set of criteria defined in federal rules. Since the expanded monitoring under the Climate Commitment Act is a Washington state program, Ecology determined that it was important to maintain flexibility and oversight over the expanded monitoring at the state level. Many OBCs do already contain regulatory monitors that are part of federal monitoring programs. Ecology has added some regulatory monitors in OBCs where these additions were consistent with Ecology's monitoring strategy.

Why doesn't Ecology do fenceline monitoring next to stationary sources of air pollution?

"Fenceline monitoring" refers to air monitoring at the perimeter or property line of a stationary source of air pollution, such as an industrial facility. Fenceline monitoring is generally conducted by permitted facilities as a condition of their permits, not by ambient air monitoring programs such as Ecology's. Since people do not typically live or spend time at the fenceline of an industrial facility, fenceline monitoring data do not generally represent air pollution exposure within a community. Ecology does conduct some monitoring to capture the highest concentrations of pollution near significant sources, such as Interstate-5. However, Ecology's ambient air monitoring program is primarily designed to provide public health information and protection within communities, not to assess air quality impacts of specific sources.

Introduction

The Department of Ecology (Ecology) has monitored air quality in Washington since the agency was established in 1970. Ecology serves as the Primary Quality Assurance Organization for the Washington Ambient Air Monitoring Network (Washington Network), which Ecology operates in partnership with Washington's seven local clean air agencies, several Tribal Nations, the National Park Service, and the U.S. Environmental Protection Agency (EPA).

As the state agency responsible for air monitoring in Washington, Ecology is required to fulfill the federal monitoring requirements described in [40 C.F.R. Part 58](https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-58).[2] Historically and currently, the Washington Network far exceeds these minimum monitoring requirements established by EPA. This is particularly true for fine particulate matter ($PM_{2.5}$) and ozone, which are elevated in many Washington communities and are the criteria pollutants that pose the greatest risk to public health in Washington.

The primary objectives of the Washington Network are to provide air pollution data to the public in a timely manner, to support compliance with National Ambient Air Quality Standards (NAAQS) and development of pollution control strategies, and to support air pollution research. Federal requirements and Ecology's longstanding monitoring priorities both direct air monitoring resources toward areas where concentrations of pollutants are known to be elevated and where population impacts from air pollution exposure are greatest.

Climate Commitment Act

The Washington Climate Commitment Act (CCA) of 2021, codified in [Chapter 70A.65 RCW](https://app.leg.wa.gov/RCW/default.aspx?cite=70A.65),[3] requires Ecology to do the following:

> **"Environmental justice review.**
>
> (1) To ensure that the program created in RCW 70A.65.060 through 70A.65.210 achieves reductions in criteria pollutants as well as greenhouse gas emissions in overburdened communities highly impacted by air pollution, the department must:
>
> (a) Identify overburdened communities, which may be accomplished through the department's process to identify overburdened communities under chapter 70A.02 RCW;
>
> (b) Deploy an air monitoring network in overburdened communities to collect sufficient air quality data for the 2023 review and subsequent reviews of criteria pollutant reductions conducted under subsection (2) of this section".

---

[2] https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-58
[3] https://app.leg.wa.gov/RCW/default.aspx?cite=70A.65

Ecology's Air Quality Program is responsible for implementing these environmental justice provisions of the CCA. This document describes Ecology's strategy for implementing RCW 70A.65.020(1)(b), which is referred to as "expanded monitoring."

Criteria air pollutants

Criteria air pollutants[4] are six common air pollutants known to be harmful to human health and the environment. Criteria air pollutants are regulated under the federal Clean Air Act, and EPA sets National Ambient Air Quality Standards (NAAQS) for their concentrations in ambient air. For criteria air pollutants that are collective groups of pollutants, *indicator pollutants* are specific, singular, and measurable pollutants chosen by EPA to represent each criteria air pollutant. The indicator pollutants are subject to EPA review and revision during the NAAQS review process.

The criteria air pollutants and the current corresponding indicator pollutant(s) for which NAAQS are set are shown in Table 1.

Table 1. Criteria air pollutants and their current indicator pollutants.

Criteria air pollutant	Indicator pollutant
Photochemical oxidants	O_3
Particulate matter (PM)	$PM_{2.5}$ and PM_{10}
Oxides of sulfur (SO_x)	SO_2
Oxides of nitrogen (NO_x)	NO_2
Carbon monoxide (CO)	CO
Lead (Pb)	Pb

While other pollutants, such as air toxics, are also monitored and regulated at the local, state, and federal levels, Ecology's expanded monitoring work under the Climate Commitment Act is limited to the six criteria air pollutants.

EPA defines the form, level, and averaging time of each NAAQS for criteria air pollutants and the calculation methods for criteria air pollutant design values in 40 C.F.R. Part 50.[5] *Design values* are summary statistics calculated from air monitoring data following this defined form and averaging time in order to compare data from a monitoring site to the level of the NAAQS. The averaging time, level, and form of the primary (health-based) NAAQS are summarized in Table 2.

[4] Additional information on criteria air pollutants, including their dominant sources and their health and environmental effects, is available on Ecology's website.
[5] https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50

Table 2. Summary of primary NAAQS.

Pollutant	Averaging Time	Level	Form
Carbon Monoxide (CO)	8 hours	9 ppm	Not to be exceeded more than once per year
Carbon Monoxide (CO)	1 hour	35 ppm	Not to be exceeded more than once per year
Lead (Pb)	Rolling 3-month average	0.15 µg/m3	Maximum arithmetic mean of 3 consecutive monthly means in a 3-year period
Nitrogen Dioxide (NO_2)	1 hour	100 ppb	Annual 98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
Nitrogen Dioxide (NO_2)	1 year	53 ppb	Annual Mean
Ozone (O_3)	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution ($PM_{2.5}$)	1 year	9.0 µg/m3	Annual mean, averaged over 3 years
Particle Pollution ($PM_{2.5}$)	24 hours	35 µg/m3	98th percentile, averaged over 3 years
Particle Pollution (PM_{10})	24 hours	150 µg/m3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)	1 hour	75 ppb	Annual 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years

Overburdened communities highly impacted by air pollution

In 2023, Ecology identified sixteen Overburdened Communities Highly Impacted by Air Pollution (OBCs), based on a combination of socioeconomic, health, and environmental indicators. Additional information on the process and criteria used to identify these OBCs can be found in the Policy Statement, Community Summary Report, Technical Support Document, and Story Map describing the identification of OBCs. Ecology will re-evaluate the list of communities every six years. More information is available on the Improving air quality in overburdened communities website.

Sources of Air Quality Information

Ecology uses the following sources of data and air quality information to identify priority areas and pollutants for expanded air monitoring:

- Historical air monitoring data
- Emissions information
- Modeling and interpolation
- Air monitoring studies
- Outreach and public engagement

Historical air monitoring data

The size and composition of the Washington Network have fluctuated over the past half-century, following trends in pollutant-specific emissions and changes in air quality regulation. In the 1970s and 1980s, Ecology's air monitoring program was focused on monitoring CO, SO_2 and Pb, which were primarily emitted from industrial and mobile sources. These pollutants routinely recorded exceedances of current NAAQS. Stricter emissions regulations across a variety of sources and industries reduced concentrations of these pollutants by large margins. New research also emerged on health impacts of particulate matter and ozone pollution in the 1990s and 2000s. Consequently, the focus of Ecology's air monitoring program in those decades shifted to $PM_{2.5}$ and ozone, which remain the two pollutants with the largest number of monitoring sites and the greatest monitoring investments by Ecology. Figure 1 shows the number of monitoring sites by pollutant from 1970 through 2024.

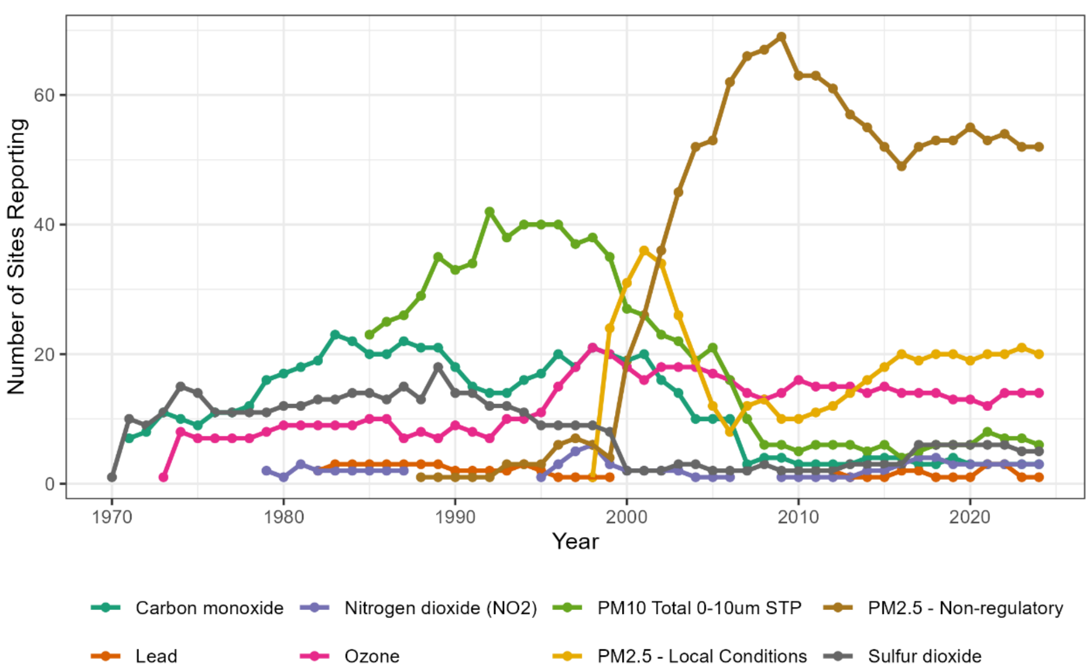

Figure 1. Number of Washington Network monitoring sites by pollutant, 1970-2024.

Prior to 2000, exceedances of the current CO and SO_2 NAAQS were frequent. Since the early 2000s, the Washington Network has generally recorded more NAAQS exceedances for $PM_{2.5}$ than any other parameter. The number of exceedances of the 24-hour $PM_{2.5}$ standard rose sharply in the past 5-10 years due to the increased intensity of wildfire smoke impacts. Figure 2 shows the number of exceedances of current NAAQS by criteria pollutant from 1970 through 2024.

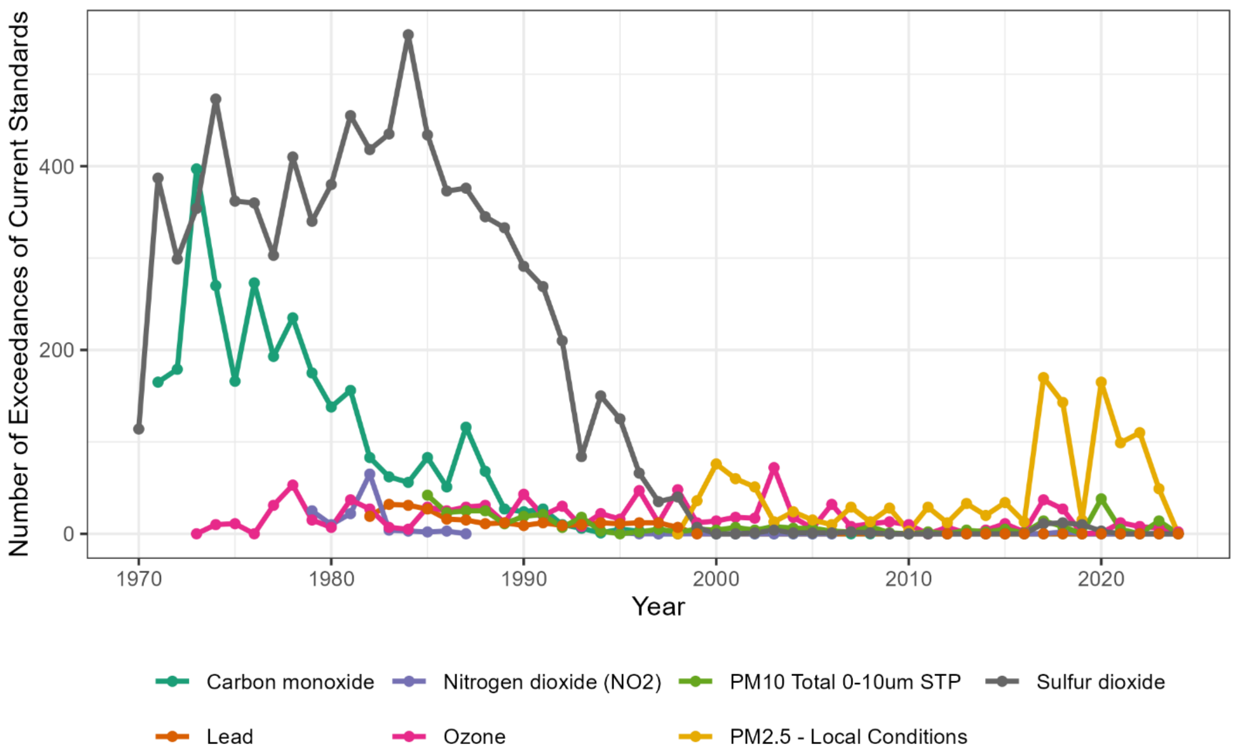

Figure 2. Number of exceedances of current NAAQS by parameter, 1970-2024.

Similar trends are evident when comparing criteria pollutant design values to their respective NAAQS. Figure 3 shows the range of criteria pollutant design values as a percentage of their respective current NAAQS as the mean (lines) and 5th-95th percentiles (shading). While CO, SO_2, and NO_2 design values were well over current NAAQS in the 1970s and 1980s, they are now much lower than current NAAQS. Though ozone exceedances are not as common as $PM_{2.5}$ exceedances in recent decades, ozone design values are generally quite close to the level of the NAAQS largely due to elevated background ozone in the western U.S. These trends in both exceedances and criteria pollutant design values inform Ecology's monitoring priorities and account for the shift in monitoring resources toward ozone and PM, and away from other criteria pollutants.

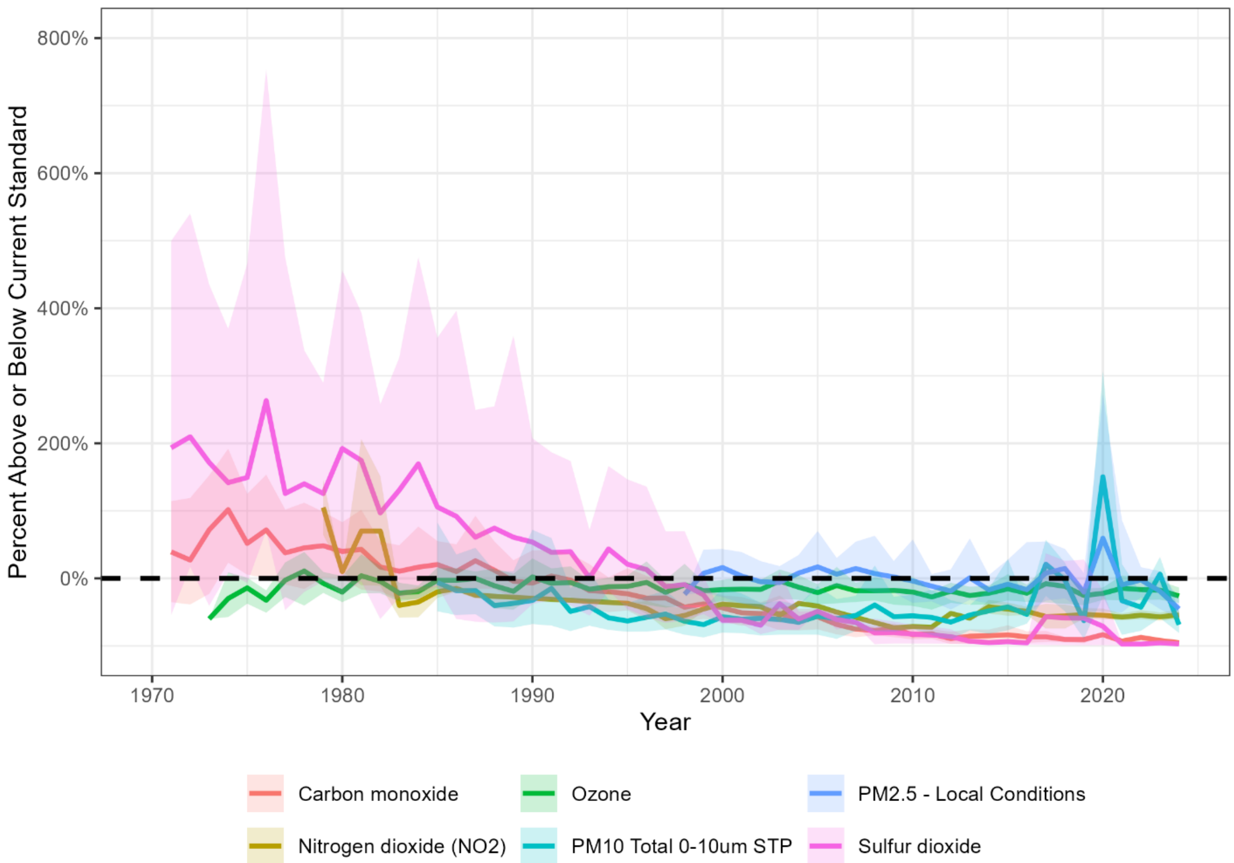

Figure 3. Criteria pollutant design values relative to the NAAQS. Mean (lines) and 5th-95th percentile (shading) design values as a percentage of their corresponding NAAQS, 1970-2024.

Emissions information

Monitoring needs and priorities in Washington are informed by data on sources of criteria air pollutant emissions, their trends over time, and their spatial distribution throughout the state. Ecology maintains a point source emissions inventory (EI) of all permitted and registered facilities as well as a Comprehensive EI that also includes mobile, biogenic, and area sources.[6] The Comprehensive EI summarizes emissions of criteria pollutants and key precursors at the county level, in coordination with the EPA National Emissions Inventory (NEI). Emissions estimates are calculated using a variety of tools, including EPA models, published emissions factors, population and vehicle information, and facility reports. The Comprehensive EI provides a broad overview of Washington's dominant sources of criteria air pollution and is thus a key source of information in the identification of monitoring priorities in Washington's diverse regions.

[6] Additional information about the air emissions inventory is available on Ecology's website.

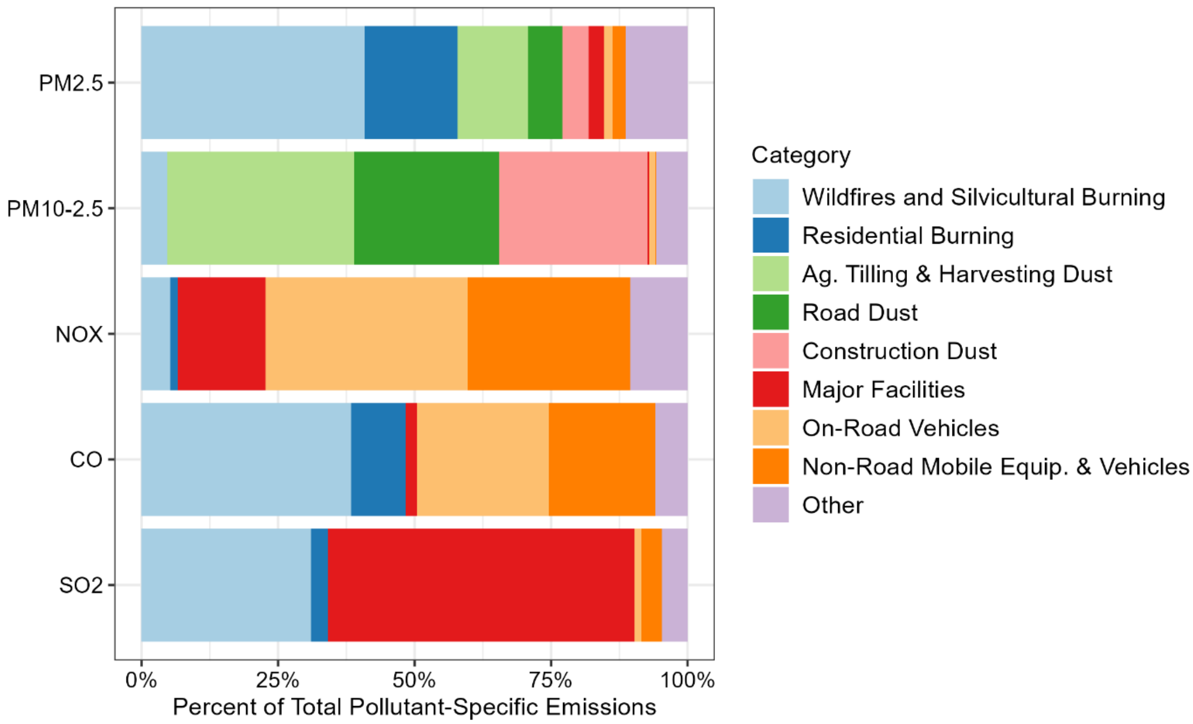

Figure 4. Washington Comprehensive Emissions Inventory (2020) summary for available criteria pollutants.

Figure 4 summarizes the largest emissions source categories for the criteria pollutants with available data from the most recent (2020) Comprehensive EI. This graphic excludes sources such as fireworks and wind-blown dust that are not captured in the Comprehensive EI. Though NO_2 is the indicator pollutant for NO_x under the NAAQS, emissions inventories catalogue emissions of total NO_x.

Examples of how emissions information guides Washington's monitoring priorities include:

- The largest sources of $PM_{2.5}$ emissions are wildfires and residential wood combustion. Priority communities for $PM_{2.5}$ monitoring are those with high rates of residential wood heating and communities with frequent wildfire smoke impacts, particularly where those overlap with population centers.
- The largest sources of $PM_{10\text{-}2.5}$ are dust from agricultural tilling and harvesting, roads, and construction. Most of the Washington Network's PM_{10} monitors are in eastern Washington, where agricultural activities are concentrated and where high winds can cause sporadic dust events.
- On-road and non-road vehicles are the dominant sources of NO_x and CO. On-road vehicles are cars and trucks that travel on roads, while non-road vehicles include locomotives, airplanes, ships, and construction equipment. These pollutants are primarily measured at near-road monitoring sites where concentrations are expected to be highest.

- Most SO_2 is emitted by major stationary sources, though facilities with high SO_2 emissions (such as smelters) are no longer common in Washington. In the absence of these facilities, the remaining few SO_2 monitors in the Washington Network typically record background levels.
- Emissions modeling platforms use many of the same estimates that are in the Comprehensive EI. Models can predict locations where ambient concentrations are elevated, which can inform the need for new monitoring sites. One such model is the [Air Indicator Report for Public Awareness and Community Tracking (AIRPACT)] model in the Pacific Northwest, which identified a previously unknown area of elevated ozone concentrations in the Tri-Cities in 2012. AIRPACT output is often evaluated by Ecology's modeling and forecasting team for any new areas with elevated concentrations, which can then be assessed using targeted air monitoring studies.

Emissions trends

There are strong parallels between historical trends in ambient concentrations of criteria air pollutants and trends in criteria air pollutant emissions as documented in Washington's emissions inventories. Figure 5 shows annual emissions of CO, NO_x, and SO_2 from Washington's major point sources from 1978-2022. There is a gap in reported data in 1987 due to federal changes in reporting requirements. Emissions of these pollutants from major point sources in Washington have reached their lowest point since the 1970s.

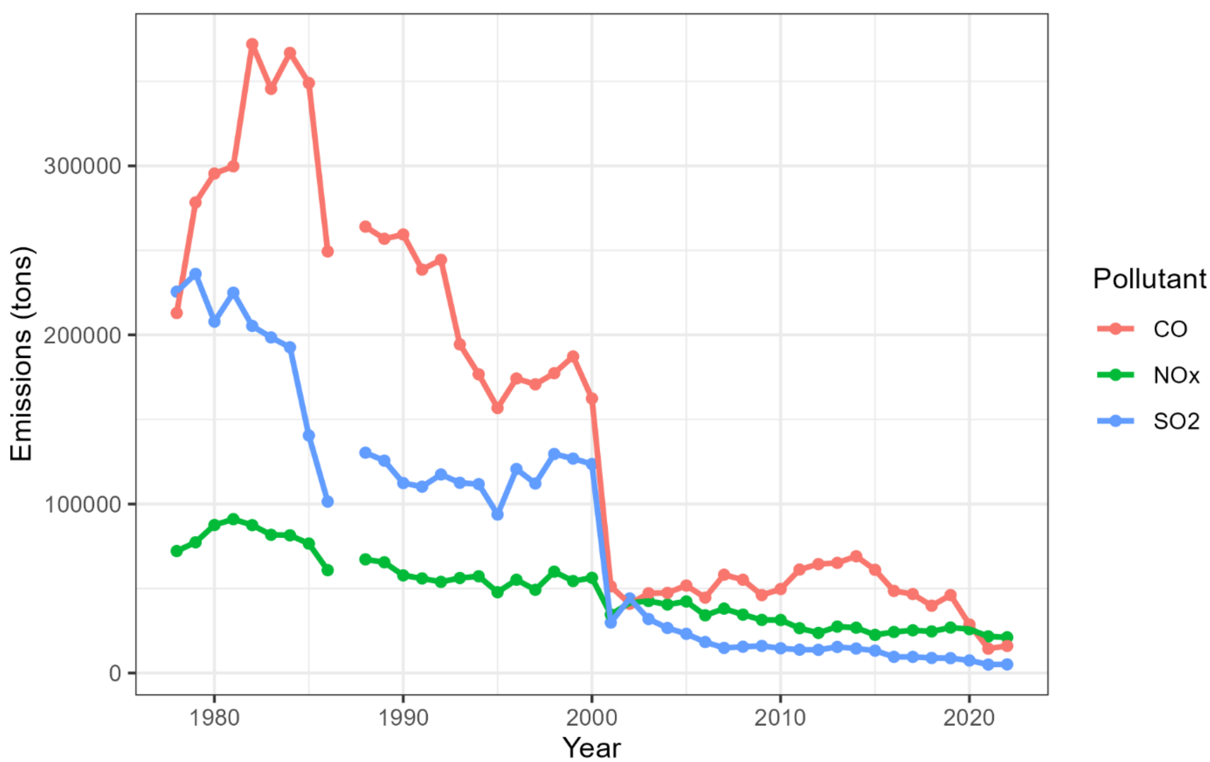

Figure 5. Trends in Washington's major point source emissions, 1978-2022.

Trends in emissions of criteria air pollutants by source category further illustrate how declining emissions reflect shifts in dominant sources over time. Figure 6, Figure 7, and Figure 8 show how emissions of CO, NO_x, and SO_2 have declined over the past 20-25 years, particularly from industrial sources. Emissions of CO and NO_x have been steadily reduced over this time period and remain dominated by highway and off-highway vehicles. Emissions of SO_2, once dominated by fuel combustion and metals processing, are now a small fraction of their total from the early 2000s, with no significant major sources remaining in Washington. The emissions information in Figures 6-8 was obtained from EPA's [Air Pollutant Emissions Trends Data](). The Wildfire, Prescribed Fire, and Miscellaneous categories were excluded from these graphs due to methodological changes during this time period.

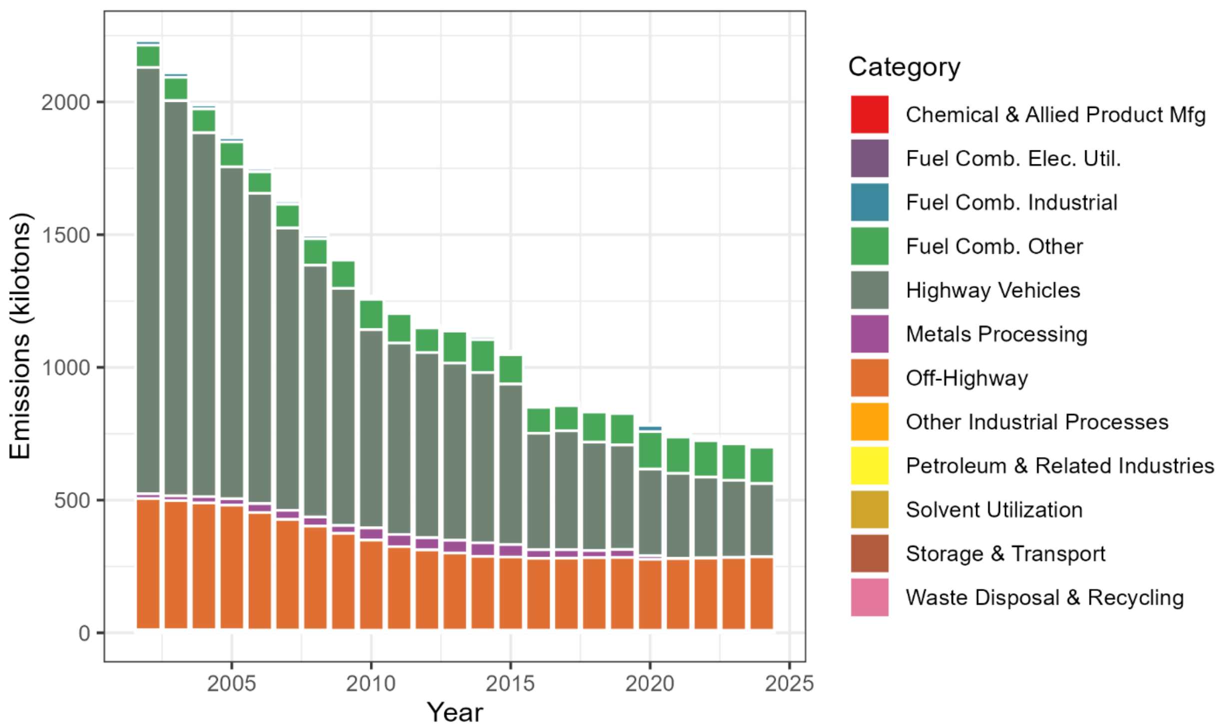

Figure 6. Total Washington CO emissions by category, 2002-2024

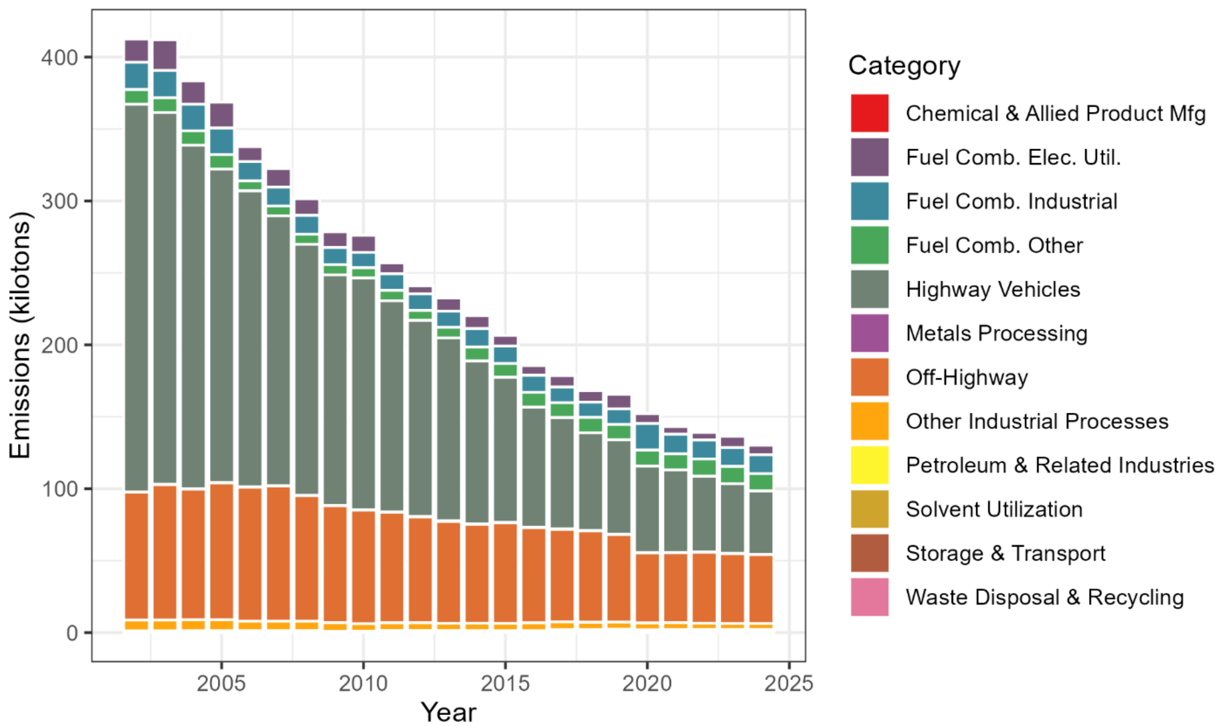

Figure 7. Total Washington NO_x emissions by category, 2002-2024

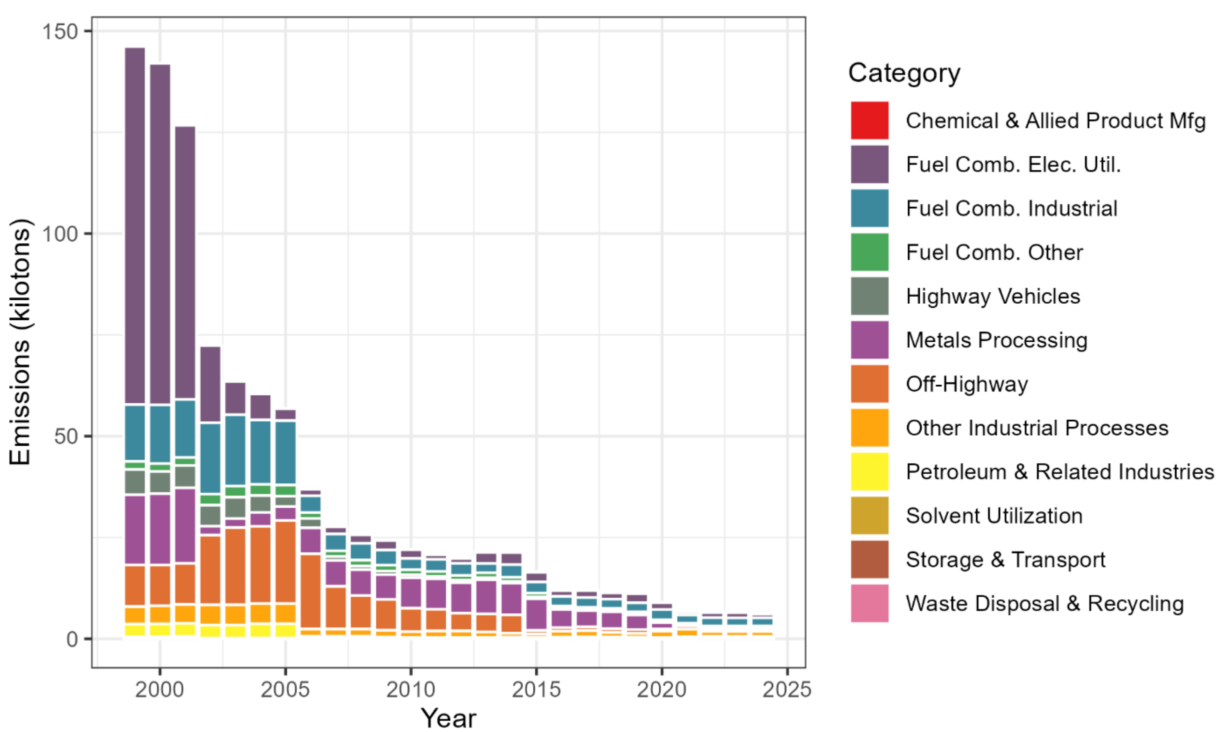

Figure 8. Total Washington SO_2 emissions by category, 1999-2024

The historical emissions information and ambient concentration data provide important context behind Ecology's strategy for expanded air monitoring. As emissions of CO, NO_x and SO_2 declined throughout the past 50 years, monitored ambient concentrations dropped in parallel to levels well below current health-based standards. By the early 2000s, most historical monitoring sites for these pollutants were discontinued due to low concentrations. Ecology continues to track emissions of these pollutants, which continue to decline. In the absence of new sources or increases in emissions, there is not a sufficient scientific basis to support broad expanded monitoring of these pollutants.

Management of stationary sources

Ecology and local clean air agencies are aware of any increases in stationary source emissions because of the registration, permitting and reporting requirements that apply to any new or modified stationary source. Ecology and local clean air agencies implement the federal New Source Review (NSR) permitting program and have inspection and compliance policies and procedures to protect air quality and public health. The NSR program requires new or modified stationary pollution sources to obtain permits prior to construction. Permitting requirements apply to new or modified sources whose emissions will be over established pollutant exemption levels, which in Washington are among the lowest in the nation.

Under the NSR program, applicants and agencies use modeling to verify emissions will meet the national ambient air quality standards (NAAQS) at the property boundary of the proposed project. A key purpose of permitting review is to ensure that any increase in emissions from the project will not cause or contribute to any exceedance of health-based standards.

Air permits specify how sources must operate their pollution control equipment, operational limits, the pollutant limits they must meet, and how they must monitor and report their emissions. Ecology and local clean air agencies regularly inspect sources and review their submitted reports to ensure compliance.

Ecology and local clean air agencies also regulate facilities under Title V of the federal Clean Air Act. Title V permits include requirements from NSR permits and include additional monitoring, record keeping and reporting requirements since emissions from the facilities are large. These permits also require Ecology and local clean air agencies to perform additional compliance oversight.

Ecology and local clean air agencies also implement a registration program to maintain a current record of air pollution sources. The registration program consists of permitted facilities and air pollutant sources within specific classifications, some of which are not required to obtain an air permit. The registration program requires sources to submit emissions inventory reports for regulatory review so that agencies can ensure that the sources comply with rules and regulations. In addition, Ecology and local clean air agencies implement compliance programs to investigate complaints regarding permitted, unpermitted, and unregistered sources.

The framework of the registration, permitting, and compliance programs[7] allows Ecology to rely on stationary source emissions as a key piece of supporting information behind monitoring network design. Permitting, modeling, emissions inventory, and monitoring are complementary programs that together provide a more complete picture of air quality conditions than monitoring alone can do.

Modeling and interpolation

Ecology relies on air quality modeling and interpolation tools to identify areas where elevated concentrations of $PM_{2.5}$ and ozone may occur. Areas where modeling and interpolation predict elevated concentrations are prioritized for expanded monitoring.

WA-Fuse is Ecology's primary interpolation tool used for statewide $PM_{2.5}$ and ozone prediction. WA-Fuse combines model output with monitored concentrations to interpolate daily bias-corrected $PM_{2.5}$ and ozone concentrations at a five kilometer (km) gridded resolution across Washington. As a gridded, statewide tool, WA-Fuse is particularly useful for understanding expected concentrations in unmonitored areas.

WA-Fuse uses daily $PM_{2.5}$ and ozone forecasts driven by EPA's Community Multiscale Air Quality Model (CMAQ) and NOAA's Air Quality Forecast Guidance, fused with monitored concentrations from the Washington Network. At monitoring site locations, WA-Fuse computes the ratio of daily measured to forecast values. It interpolates these ratios across the 5 km x 5km grid using a Voronoi nearest-neighbor approach, then multiplies the interpolated ratios by the gridded forecast values. In fusing modeled and monitored concentrations, WA-Fuse benefits from the advantages of both data sources. The underlying forecast model accounts for emissions, meteorology, and topography at a consistent resolution across the state, including unmonitored areas. By adjusting the gridded model forecasts based on the model/monitor relationship at nearby monitoring sites, WA-Fuse uses monitoring data to improve the accuracy of the model forecasts and minimize model bias.

Ecology calculates $PM_{2.5}$ and ozone design values from daily WA-Fuse interpolated values. Ecology prioritizes $PM_{2.5}$ and/or O_3 monitoring in OBCs where their respective interpolated design values are above the Good range of the AQI.

[7] Additional information on air quality permitting and registration is available on Ecology's website.

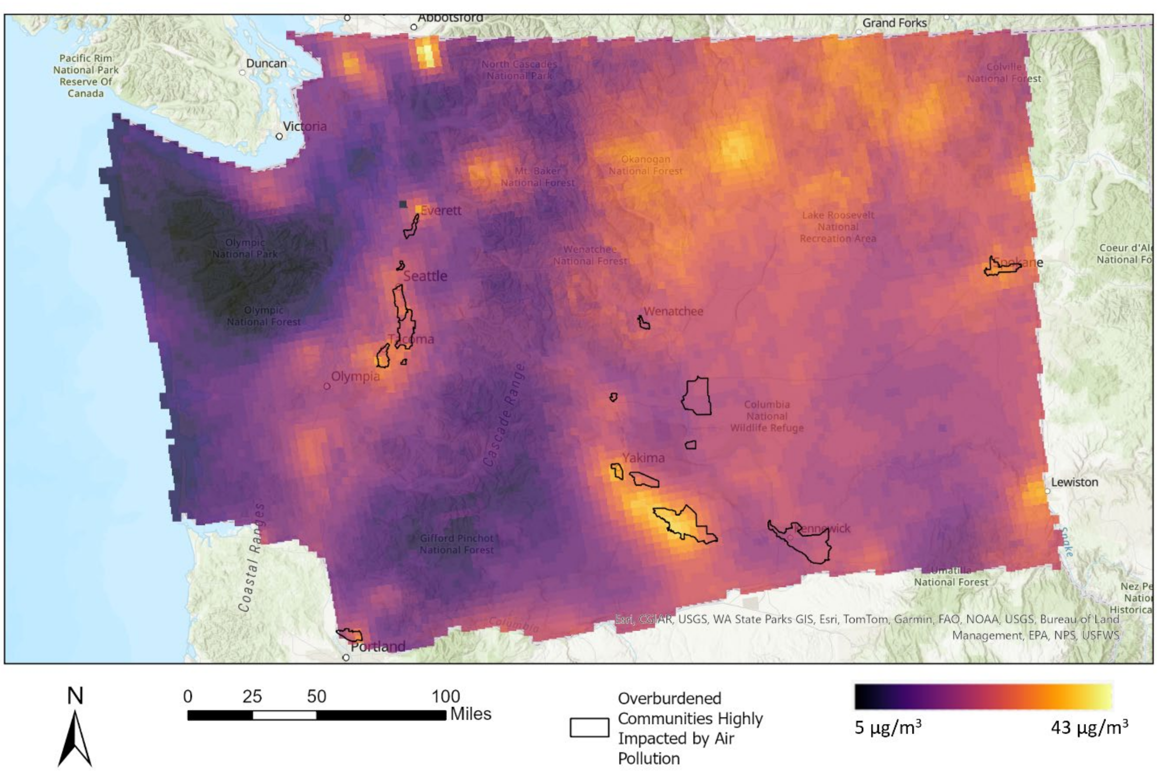

Figure 9. WA-Fuse interpolated 24-hour $PM_{2.5}$ design values, 2022-2024

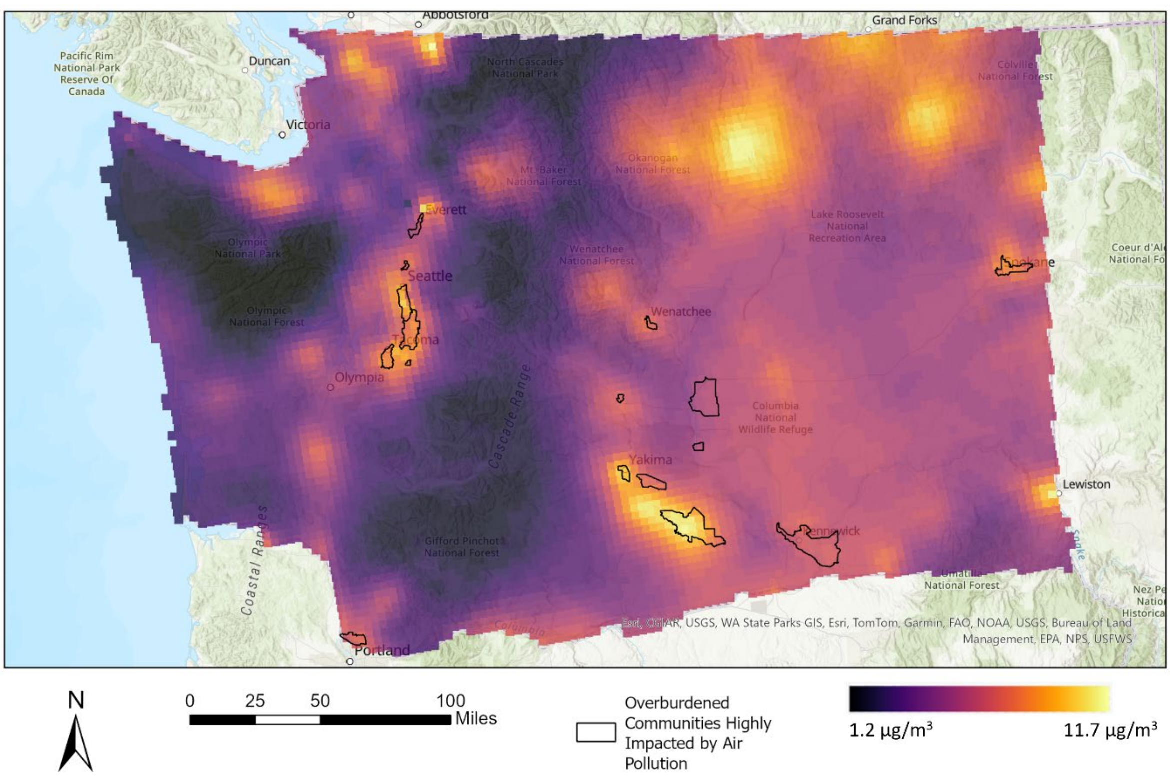

Figure 10. WA-Fuse interpolated annual $PM_{2.5}$ design values, 2022-2024

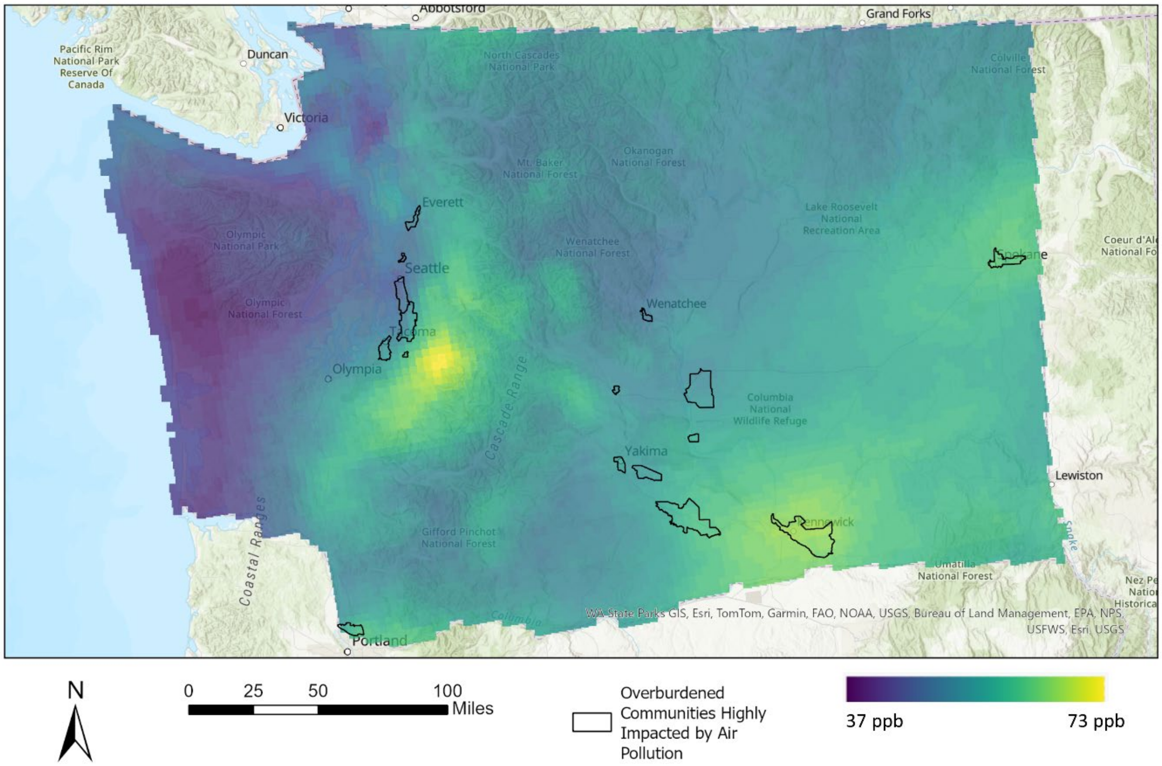

Figure 11. WA-Fuse interpolated ozone design values, 2022-2024.

Air monitoring studies

Ecology and local clean air agencies have conducted many limited-term air quality monitoring studies in or representative of OBCs. The results of these studies are a useful screening tool to evaluate ongoing monitoring needs. Air monitoring studies can identify elevated concentrations of criteria air pollutants that merit ongoing monitoring, or they can establish that criteria air pollutant concentrations are well within the Good range of the AQI so that further monitoring is not warranted. Table 3 describes the air monitoring studies evaluated as part of this expanded monitoring strategy.

Table 3. Air monitoring studies evaluated as part of expanded monitoring strategy.

Study (Agency)	Sampling Years (Publication Year)	OBC(s) Represented	Description
Airport Lead Study (Ecology)	2012 (2013)	South King County; results broadly applicable to near-airport communities	EPA required states to conduct a one-year study of ambient lead concentrations at airports with the highest lead emissions nationwide, including two in Washington (Harvey Field and Auburn Municipal). The study objective was to identify the highest concentrations of lead in ambient air at these highest-emission airports. Concentrations measured during the study were less than 50% of the lead NAAQS, so Ecology and EPA determined that no further monitoring was needed. Lead emissions at these and other Washington airports have since declined.
Puget Sound Clean Air Agency (PSCAA) Wintertime Monitoring Studies (2012-2013, 2013-2014, 2014-2015) (PSCAA)	2012-2015 (2013, 2014, and 2015)	South King County; Northeast Puyallup; North Seattle and Shoreline; South and East Tacoma	PSCAA used mobile and temporary monitors and sensors to conduct special winter intensive monitoring programs over several winter seasons to evaluate $PM_{2.5}$ concentrations and unmet monitoring needs in unmonitored areas of their jurisdiction. Results showed broad $PM_{2.5}$ impacts from residential wood combustion and led to the establishment of PSCAA's Auburn monitoring site in the South King County OBC.
Yakima Area Wintertime Nitrate Study (Ecology)	2013 (2014)	East Yakima; Lower Yakima Valley	Ecology worked with Washington State University and Central Washington University to study $PM_{2.5}$ and precursors leading to secondary $PM_{2.5}$ formation in Yakima and the Lower Yakima Valley (including CO and NO_x). This study found elevated levels of particulate nitrate as well as $PM_{2.5}$ impacts from wood burning and wintertime stagnation. Concentrations of CO and NO_2 were well within the Good range of the AQI throughout the study.
Source apportionment of $PM_{2.5}$ at Washington monitoring sites (Seattle; Seattle, Tacoma, and Yakima) (Ecology)	2014-2018 (2020)	South Seattle; South and East Tacoma; East Yakima	Ecology analyzed speciated $PM_{2.5}$ data, including lead, collected from 2014-2018 at four Washington monitoring sites to quantify source contributions to concentrations of $PM_{2.5}$ by category. $PM_{2.5}$ associated with wood smoke was a dominant factor in Yakima and Tacoma, while $PM_{2.5}$ associated with vehicles were the largest contributing source category in Seattle. Concentrations of lead were well below screening levels and health-based standards.
Tri-Cities Ozone Precursor Study (Ecology and Benton	2016 (2017)	Tri-Cities to Wallula	Ecology, Washington State University, and BCAA measured precursors of ozone, including nitrogen oxides (NO_x) and volatile organic compounds (VOCs), at two sites in the Tri-Cities as well as from

Study (Agency)	Sampling Years (Publication Year)	OBC(s) Represented	Description
Clean Air Agency, BCAA)			a mobile platform that drove throughout the region. Concentrations of NO_2 were well within the Good range of the AQI throughout the study. O_3 was broadly elevated across the southern and eastern portions of the Tri-Cities (Kennewick, Richland, Pasco).
Near-Road Air Toxics Study in the Chinatown-International District (PSCAA)	2017 (2018)	South Seattle	PSCAA conducted an EPA-funded Community-Scale Air Toxics Study to evaluate health risks from air toxics, including lead and other chemical components of $PM_{2.5}$ and PM_{10}, as well as NO_x and CO in Seattle's Chinatown-International District. This study found the greatest cancer risk is from diesel particulate matter. Concentrations of lead were well below screening levels and health-based standards.
Port of Tacoma Source Apportionment Study (Ecology)	2018-2022 (2023)	South and East Tacoma	Ecology collected speciated $PM_{2.5}$ data, including lead, at a monitoring site adjacent to the Port of Tacoma to quantify the contributions of different source categories to concentrations of $PM_{2.5}$. $PM_{2.5}$ associated with wood smoke was the greatest contributor to annual average $PM_{2.5}$; source categories associated with diesel $PM_{2.5}$ components comprised about 29% of annual average $PM_{2.5}$. Concentrations of lead were well below screening levels and health-based standards
Tacoma and Seattle Air Toxics Trends (PSCAA)	2021-2022 (2023)	South Seattle; South and East Tacoma	PSCAA conducted an EPA-funded Community-Scale Air Toxics Study to evaluate health risks from air toxics, including lead and other chemical components of $PM_{2.5}$ and PM_{10}, in Tacoma and Seattle. This study found the greatest cancer risk is from diesel particulate matter across all monitoring sites. This study found that ambient concentrations of lead were well below screening levels and health-based standards and concluded that re-entrained road dust was the most likely source of lead in ambient particulate matter.
Source apportionment of $PM_{2.5}$ at Washington monitoring sites	2023-2024 (Yakima and Toppenish); 2007-2024 (Tacoma) (2025)	East Yakima; Lower Yakima Valley; East Tacoma	Ecology analyzed speciated $PM_{2.5}$ data, including lead, collected at three Washington monitoring sites to quantify contributions of source categories to concentrations of $PM_{2.5}$. Results showed that $PM_{2.5}$ in Yakima and Toppenish was dominated by organic carbon in summer and particulate nitrate in winter. $PM_{2.5}$ associated with wood smoke was a dominant factor in Tacoma. Concentrations of lead were well below screening levels and health-based standards.

Study (Agency)	Sampling Years (Publication Year)	OBC(s) Represented	Description
Spokane Fall/Winter 2023-24 Black Carbon Survey (Spokane Regional Clean Air Agency, SRCAA)	2023-2024 (2025)	Spokane and Spokane Valley	SRCAA conducted a mobile air monitoring survey of black carbon and $PM_{2.5}$ in central Spokane in the fall and winter of 2023-24 and fall of 2024. This study evaluated relative contributions to $PM_{2.5}$ from wood burning and vehicle traffic. SRCAA found that wood burning emissions contribute more than traffic-related emissions to $PM_{2.5}$ in residential areas of central Spokane.
Tri-Cities Ozone Study (Ecology)	2024 (2025)	Tri-Cities to Wallula	Ecology conducted a multi-site survey of ozone concentrations to inform site selection for a second permanent ozone monitoring site in the Tri-Cities. This study found elevated concentrations of ozone in eastern Kennewick and Finley but lower ozone concentrations in Pasco and Burbank.
Yakima Ozone Study (Ecology)	2024 (2025)	East Yakima	Ecology conducted a three-week study of ozone concentrations in central Yakima. Results indicated that ozone concentrations above 60 ppb are relatively common in Yakima, with hourly concentrations routinely reaching 65 ppb when meteorological conditions are favorable. Results showed a low likelihood of concentrations reaching or exceeding the NAAQS of 70 ppb.

High-Resolution Mobile Monitoring Study

Ecology is planning a High-Resolution Mobile Monitoring (HRMM) Study[8] to measure a wide range of criteria pollutants and air toxics in overburdened communities and participating Tribal communities in 2026-2027. This study will use a fleet of specialized vehicles equipped with a suite of air monitors. Monitors will continuously sample for pollutants as vehicles are driven along pre-designated routes on public roadways. Driving passes will occur at different times of day and night, days of the week, and seasons to best capture a representative snapshot of air pollution in each study area. The results of the HRMM Study will be used to identify any potential gaps in stationary monitoring data and to verify that pollutants without ongoing monitoring in OBCs are within the Good range of the AQI.

Outreach and public engagement

Ecology also conducted extensive outreach and engagement efforts as part of the implementation of the CCA. These efforts focused on building strong relationships with the 16 OBCs. Ecology attended local community events such as street fairs and neighborhood nights

[8] https://apps.ecology.wa.gov/publications/SummaryPages/2402050.html

out, hosted community meetings, and partnered with local organizations to share information about the work Ecology is doing to address air quality in Washington. Ecology shared clear, easy to use air quality information and materials translated into multiple languages, provide practical tools like furnace filters and instructions to build indoor air filters, and encourage participation in an Air Quality Survey.

Ecology consistently hears concerns about wildfire smoke, traffic pollution, industrial impacts, dust, and ozone. At outreach and engagement events, Ecology also consistently hears that community members want simple, clear information about how to check air quality and protect their health, especially for children, seniors, and people with asthma and other health conditions. Ecology learned that ongoing presence, transparency, and trust are essential for meaningful engagement, which will inform future outreach and engagement efforts.

Feedback from community members guided the implementation of this monitoring strategy in several ways. In some OBCs, Ecology sited new monitors or sensors in specific neighborhoods identified by community organizations, local clean air agencies, or elected officials, where those locations were consistent with the guiding principles in this strategy. Ecology also added monitors for additional pollutants to some existing monitoring sites where community members raised specific concerns about that pollutant, again where consistent with the guiding principles in this strategy.

In several cases, outreach and engagement events provided an opportunity to connect directly with community groups who could host sensors on their property. In other cases, these groups were able to connect Ecology with potential sensor hosts in their community, such as school districts, parks, or fire stations.

Monitoring strategy

Ecology identified seven principles to guide expanded monitoring under the CCA. These principles ensure that monitoring resources are used efficiently and effectively to meet the requirements and intent of RCW 70A.65.020. They ensure that expanded monitoring provides useful air quality data for public health information and protection, and they prevent the direction of resources toward redundant or low-value monitoring.

Guiding principles for expanded air monitoring

1. Each OBC has a representative monitor for any criteria air pollutant expected to be routinely elevated above the Good range of EPA's Air Quality Index (AQI).
2. In areas where supporting data and air quality information do not indicate a reason that concentrations of a specific criteria air pollutant could be routinely elevated above the Good range of the AQI, there is not a sufficient basis to support expanded monitoring for that pollutant.
3. Monitors are sited in locations that meet EPA siting criteria and operated according to Ecology's Standard Operating Procedures and Quality Assurance Plans. These frameworks ensure the collection of high-quality data that can be compared within and across communities.
4. The density of monitors and their specific locations are selected based on the monitoring objective and spatial scale applicable to each pollutant.
5. Most monitors are sited to capture population exposure at the neighborhood- to urban-scale. The density of these monitors is adequate to ensure representative coverage across the populated areas of the OBC.
6. Some monitors are sited to capture the highest concentrations of a pollutant in the OBC at the micro-scale. When data from these monitors are within the Good range of the AQI, monitoring is not extended beyond highest-concentration areas.
7. Representative monitors may be located outside OBCs and still represent air quality conditions inside OBCs, especially in the case of regional pollutants and monitors close to OBC boundaries.

These principles and their application are described in greater detail in the following sections.

Air Quality Index (AQI) comparison

Guiding principle 1: Each OBC has a representative monitor for any criteria air pollutant expected to be routinely elevated above the Good range of EPA's Air Quality Index (AQI).

Guiding principle 2: In areas where supporting data and air quality information do not indicate a reason that concentrations of a specific criteria air pollutant could be routinely elevated above the Good range of the AQI, there is not a sufficient basis to support expanded monitoring for that pollutant.

The *Air Quality Index (AQI)* is an EPA tool for communicating about outdoor air quality and its health impacts. The AQI is a unitless index that translates concentrations of the different criteria air pollutants to a common scale with defined levels of concern. Higher AQI values indicate higher levels of air pollution and greater health concerns. An AQI value of 100 (the breakpoint between Moderate and Unhealthy for Sensitive Groups) corresponds to the level of the short-term NAAQS for each pollutant.

The AQI categories and their health messaging are summarized in Table 4, adapted from Ecology's Air Quality Index webpage.

Table 4. EPA's Air Quality Index levels and health messaging.

Color (Values)	Meaning – What You Can Do
Green (0-50)	**Good** – Air pollution is low. There is little health risk. Make a plan if air quality is forecasted to get worse.
Yellow (51-100)	**Moderate** – Some people are more sensitive to lower levels of particle pollution. These people should: Spend less time outside. Reduce strenuous outdoor activity. Watch for symptoms to reduce your exposure.
Orange (101-150)	**Unhealthy for sensitive groups (USG)** – Sensitive groups should: Spend less time outside. Reduce strenuous outdoor activity. Watch for symptoms to reduce your exposure.
Red (151-200)	**Unhealthy** – Everyone should reduce exposure. Spend less time outside. Reduce strenuous outdoor activity. Watch for symptoms to reduce your exposure. Follow tips for cleaner indoor air.
Purple 201-300)	**Very unhealthy** – Everyone should reduce exposure. Avoid outdoor activity. Stay inside. Filter indoor air to keep it cleaner. Go somewhere else for cleaner air, if you need to.
Maroon (301+)	**Hazardous** – Everyone should reduce exposure. Stay inside. Filter indoor air to keep it cleaner. Do only light indoor activities. Keep windows and doors closed if it's not too hot. Go somewhere else for cleaner air, if you need to. If you must be outside, wear an N95 mask.

In the Good range of the AQI, air pollution is low and there is little health risk. Ecology prioritizes expanded monitoring for pollutants whose short-term design values exceed the Good range of the AQI. Ecology evaluates whether short-term design values are likely to exceed the Good range of the AQI using historical air monitoring data, WA-Fuse, and results of the air quality studies listed in Table 3.

Siting criteria, instrument selection, and quality assurance

1. **Guiding principle 3:** Monitors are sited in locations that meet EPA siting criteria and operated according to Ecology's Standard Operating Procedures and Quality Assurance Plans. These frameworks ensure the collection of high-quality data that can be compared within and across communities.

Washington Network air monitoring data are used by a wide range of partners to inform decisions on pollution control strategies, community planning, policy development, and research. As the Primary Quality Assurance Organization for the Washington Network, Ecology has the responsibility to ensure that these data are of known, acceptable, and comparable quality. For the implementation of RCW 70A.65.020, high-quality and comparable data are needed in order to reliably compare air quality conditions within and across OBCs.

Siting criteria, instrument selection, and a comprehensive data quality system are essential to the collection of high-quality, representative, and comparable data.

Siting criteria

Ecology follows the EPA siting criteria for ambient air quality monitors described in 40 C.F.R. Part 58 Appendix E. These requirements define acceptable distances between monitor inlets and sources or obstacles that might unduly influence monitored concentrations. These interferences include obstructions such as walls or buildings, trees, and roadways. Ecology must also ensure that monitors are not influenced by localized sources of pollution or airflow, such as building exhaust vents or fans. Siting criteria also define acceptable inlet height to ensure that monitored concentrations are representative of air quality at ground level where people breathe. Ecology allows for limited exceptions to EPA siting criteria on a case-by-case basis only when deviations from these criteria are not expected to have a significant influence on monitored concentrations.

Adherence to siting criteria can limit the areas available for monitoring sites. Monitoring sites must also meet many logistical requirements, such as the availability of electrical power, site security, safe access, and a willing facility host. These siting and logistical needs often mean that monitoring is not possible in every location where community members may request it. Identifying monitoring site locations that meet these requirements is particularly challenging in dense urban areas where obstructions are common and buildings are too tall for rooftop sites to be feasible.

Instrument selection and quality assurance

Ecology develops Standard Operating Procedures (SOPs) for all air monitoring instruments operated as part of the Washington Network. Air monitoring operators are required to adhere to SOPs so that instruments are operated consistently across the state. SOPs define quality control and maintenance requirements to ensure that monitored data are reliable and meet defined, acceptable limits for accuracy and precision.

Ecology also provides quality assurance oversight of data collected as part of the Washington Network. Quality assurance oversight includes data validation, review of quality control and maintenance records, monitor performance assessments, and siting evaluations.

Ecology only develops SOPs for instruments that have been thoroughly evaluated for their reliability and performance in Washington's different aerosol environments. For all criteria air pollutants except PM, Ecology only uses monitoring methods that have been designated by EPA as Federal Reference Method or Federal Equivalent Method monitors.

Federal Reference Method (FRM) monitors are a class of monitors designated by EPA as the reference standard for measurement of a criteria air pollutant.

Federal Equivalent Method (FEM) monitors are evaluated relative to FRMs and must meet defined standards for precision and accuracy. FEMs use different sampling and/or analysis methods than FRMs but can be used for the same range of regulatory decisions.

Both FRMs and FEMs monitors are considered *regulatory* monitors. Other monitors that are not designated as FRMs or FEMs are referred to as *non-regulatory* monitors. Only regulatory monitors can be used to demonstrate compliance with the NAAQS and for other regulatory applications.

$PM_{2.5}$ monitoring

The Washington Network is heavily invested in $PM_{2.5}$ monitoring, since $PM_{2.5}$ is routinely elevated across Washington and thus represents an ongoing and widespread public health concern. Every site in the Washington Network monitors for $PM_{2.5}$, and every OBC contains at least one $PM_{2.5}$ monitor.

It is not feasible to conduct FEM monitoring at every $PM_{2.5}$ monitoring site. FEM monitors are considerably more resource-intensive to operate than non-regulatory monitors, and they require more space and supporting infrastructure. Federal oversight over FEM monitoring can also limit state and local agencies' flexibility in relocating or modifying monitoring sites, processes which require EPA approval.

Ecology has identified three tiers of $PM_{2.5}$ monitoring needs in Washington, which correspond to the instruments selected for monitoring and the treatment of their data. FEM monitors are used at sites with design values greater than 80% of the $PM_{2.5}$ NAAQS, at sites that participate in national monitoring programs (such as near-road and urban National Core network sites), and at sites required to meet federal minimum monitoring requirements.

The next tier of sites use non-regulatory $PM_{2.5}$ monitors. These non-regulatory monitoring sites have design values between 50-80% of the $PM_{2.5}$ NAAQS, are used for specific air quality management applications such as burn permitting or smoke management or have been identified by Ecology or local clean air agencies as priority monitoring sites for providing AQI information to the public in populated areas.

At the remaining monitoring sites, Ecology uses a custom $PM_{2.5}$ sensor device called a SensWA designed and built by Ecology to report the $PM_{2.5}$ AQI. The SensWA is a relatively low-cost tool Ecology used to expand the $PM_{2.5}$ monitoring network to previously unmonitored areas, to add $PM_{2.5}$ monitoring to sites for other pollutants that lacked $PM_{2.5}$ monitors, and to increase the density of $PM_{2.5}$ monitors in OBCs. A SensWA has a small footprint, flexible mounting options, and can be operated on solar power, so it can operate in locations where installation of an FEM would be logistically prohibitive.

Ecology ensures the accuracy of the SensWA data by conducting routine maintenance and collocation of SensWA, developing region-specific correlations to minimize sensor bias, and conducting quality assurance review of all SensWA data. However, data from the SensWA and non-regulatory monitors should be used and interpreted in a manner that accounts for the additional uncertainty of non-regulatory methods. Data from the SensWA are intended to augment regulatory $PM_{2.5}$ measurements within OBCs or, in cases where concentrations of $PM_{2.5}$ measured by SensWA are low, to rule out the need for FEM monitoring. While air sensor data cannot be used to demonstrate compliance with state and federal air quality standards, it is essential for communicating local air quality to the public, identifying potential pollution problems that are missed at a coarser resolution of monitors, and informing Ecology's efforts to track and reduce pollution levels within these communities.

Additional information about the SensWA is available in the following Ecology documents: Focus on SensWA, SensWA Quality Assurance Project Plan, and SensWA Correlations for $PM_{2.5}$ Reporting Technical Document.

Representative monitoring

> **Guiding principle 4:** The density of monitors and their specific locations are selected based on the monitoring objective and spatial scale applicable to each pollutant.
>
> **Guiding principle 5:** Most monitors are sited to capture population exposure at the neighborhood- to urban-scale. The density of these monitors is adequate to ensure representative coverage across the populated areas of the OBC.
>
> **Guiding principle 6:** Some monitors are sited to capture the highest concentrations of a pollutant in the OBC at the micro-scale. When data from these monitors are within the Good range of the AQI, monitoring is not extended beyond highest-concentration areas.
>
> **Guiding principle 7:** Representative monitors may be located outside OBCs and still represent air quality conditions inside OBCs, especially in the case of regional pollutants and monitors close to OBC boundaries.

Monitors are sited to represent a defined spatial scale, which refers to the size of the area around the monitor expected to have similar concentrations. Different monitoring spatial scales are appropriate for each pollutant, since pollutants follow different patterns in how they travel, dissipate, and chemically react once they are emitted. EPA defines the following six spatial scales in 40 C.F.R. Part 58 Appendix D:

1. **Microscale**: Area dimensions between several and 100 meters.
2. **Middle scale**: Areas between 100 and 500 meters, typically several city blocks.

3. **Neighborhood scale**: Areas between 0.5 and 4 kilometers with relatively uniform land use.
4. **Urban scale**: Areas with city-like dimensions between 4 and 50 kilometers. Urban and neighborhood scales can overlap considerably.
5. **Regional scale**: Areas from tens to hundreds of kilometers with relatively homogeneous geography and no large sources.
6. **National and global scales**: Scales representing the nation or globe as a whole.

Monitoring spatial scales also vary by the objective of the monitor. EPA defines the following six site types and monitoring objectives:

1. **Highest concentration:** To determine the highest pollutant concentrations expected in the area covered by the network.
2. **Population exposure:** To determine representative pollutant concentrations in areas of high population density.
3. **Source impact:** To determine the impact of significant sources or source categories on pollutant concentrations in the ambient air.
4. **General/background:** To determine general background pollutant concentrations.
5. **Regional transport:** To determine the regional extent of pollutant transport between populated areas.
6. **Welfare-related impacts:** To determine the impacts on visibility or vegetation in more rural and remote areas.

Different spatial scales are appropriate for different pollutants and monitoring objectives, as summarized in Table 5.

Table 5. Summary of applicable spatial scales for criteria air pollutants and monitoring objectives.

Scale	SO_2	CO	O_3	NO_2	Pb	PM_{10}	$PM_{2.5}$	Monitoring objective
Micro	✓	✓		✓	✓		✓	Highest concentration; source impact
Middle	✓	✓		✓	✓	✓	✓	Highest concentration; source impact
Neighborhood	✓	✓	✓	✓	✓	✓	✓	Highest concentration; population; source impact; general/background
Urban	✓		✓	✓			✓	Highest concentration; population; general/background; regional transport; welfare-related impacts
Regional	✓		✓				✓	General/background; regional transport; welfare-related impacts

Neighborhood-scale monitoring

In Washington, $PM_{2.5}$ monitoring is generally conducted at the neighborhood scale with the objective of population exposure. Where possible, Ecology installs monitors at a sufficient density within OBCs so that all the populated areas of each OBC have a representative monitor at the neighborhood scale (within 0.5-4km). As an example, Figure 12 shows a map of the density of $PM_{2.5}$ monitors in the Spokane and Spokane Valley OBC. The color gradient shows the distance from the nearest monitoring site. The monitors in this OBC represent middle- and neighborhood-scale $PM_{2.5}$

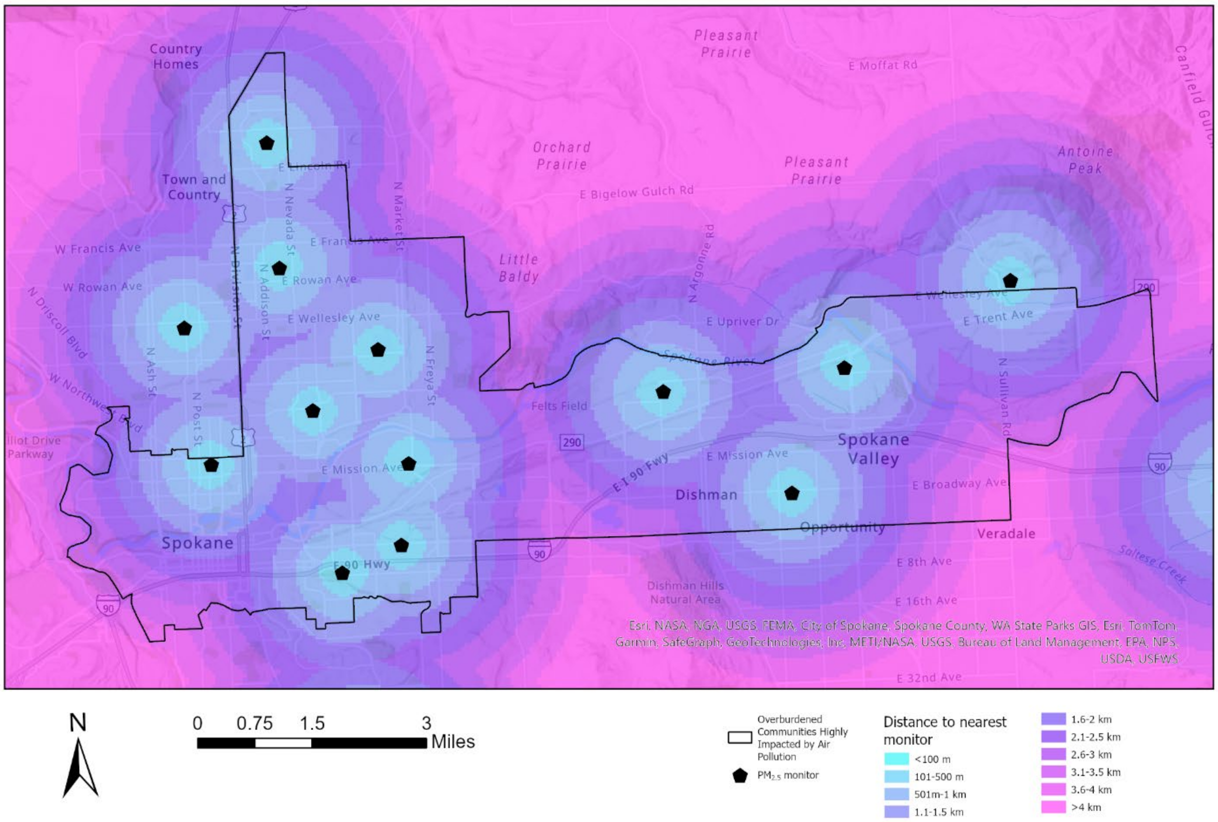

Figure 12. Spokane and Spokane Valley OBC distance to nearest $PM_{2.5}$ monitor.

Neighborhood-scale monitors may be located outside the boundaries of an OBC and still represent conditions in the OBC within a neighborhood-scale distance (0.5-4km). As shown in Figure 12, the Spokane Valley-E Wellesley Ave monitor is the easternmost monitor in the OBC and is located less than 200 meters north of the OBC boundary. Despite being just outside the OBC boundary, this monitor represents a neighborhood-scale area that extends well into the northeast portion of the OBC. Spokane Valley-E Wellesley Ave is one of several examples of monitors where options for monitor siting in OBCs were limited, and the most favorable locations for monitor siting were located just outside OBC boundaries. These monitors can be considered reasonably representative of OBCs following the principles of monitoring spatial scales described in 40 C.F.R. Part 58 Appendix D.

Urban-scale monitoring

Ozone monitoring in Washington is generally conducted at the urban scale, since concentrations of ozone vary across broader geographic areas. In many cases, ozone monitors are located outside of OBCs because the highest concentrations of ozone are typically found downwind of urban areas. An example of this visible in Figure 11 is that the highest ozone concentrations statewide (yellow) are downwind of the greater Seattle area near Enumclaw. Ecology considers data from monitors downwind of urban areas to be representative of the highest concentrations expected in their broader metropolitan areas.

Micro-scale monitoring

In select OBCs, CO and NO_2 monitors are sited at the micro-scale to capture the highest concentrations of these pollutants and are used to rule out the need for broader monitoring. The South Seattle and East Tacoma OBCs contain near-road monitors for NO_2, and South Seattle also contains a near-road monitor for CO. These near-road monitors are sited adjacent to Interstate 5 and are operated as part of the national Near-road monitoring program.[9] Since vehicles are the dominant source of CO and NO_x emissions in Washington, near-road monitors represent "worst case" conditions adjacent to the largest source of these pollutants. Where highest concentration monitors report conditions in the Good range of the AQI, then surrounding areas are not considered at risk for elevated concentrations.

[9] https://www.epa.gov/amtic/near-road-monitoring

Expanded Monitoring Implementation

Since 2023, Ecology has added additional monitors in OBCs following these guiding principles. As of the time of publication, Ecology and local clean air agencies have installed over 50 monitors and sensors as part of the expanded monitoring effort. The expanded monitoring has nearly tripled the number of monitoring sites in and representing OBCs. Figure 13 shows the number of monitoring sites in or representing OBCs each year since 2010. The green bars show monitoring sites that were funded by the CCA monitoring expansion starting in 2023.

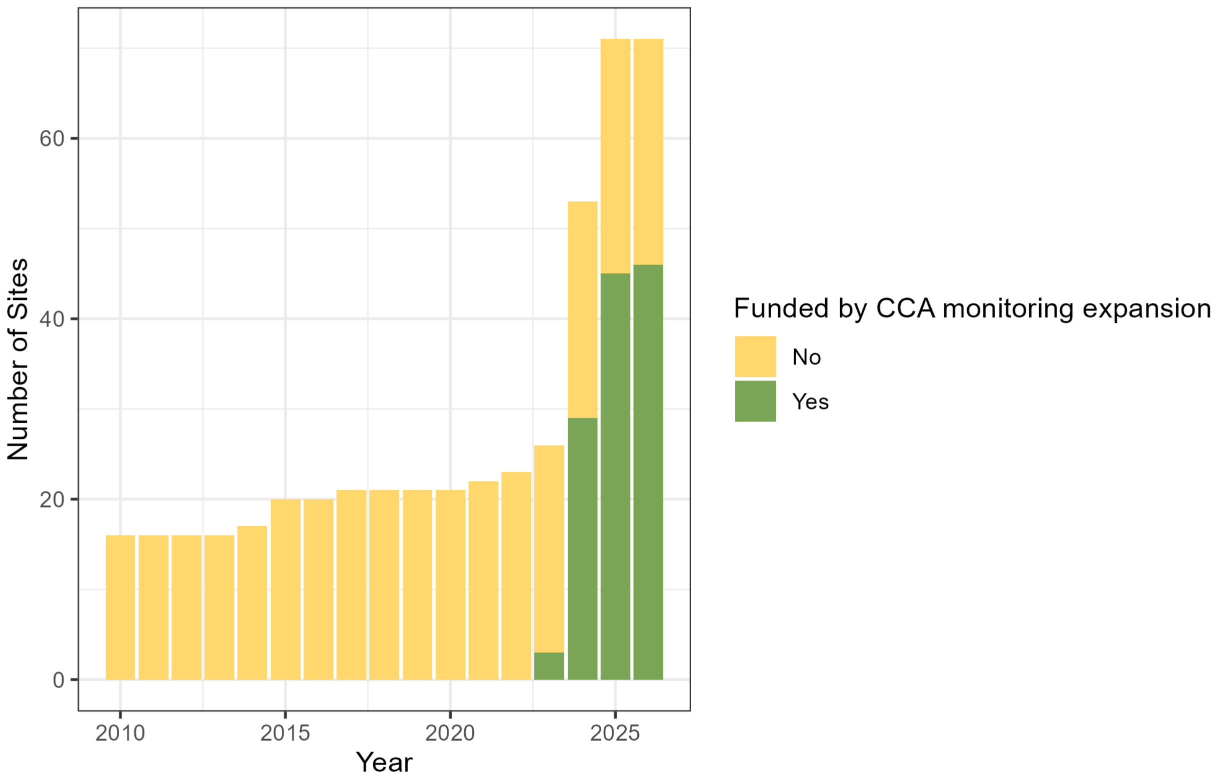

Figure 13. Number of monitoring sites in or representing OBCs by year and whether or not installation was funded by the CCA monitoring expansion.

Table 6 summarizes the pollutants monitored in each OBC prior to passage of the CCA and the pollutant monitors added or planned as part of the expanded monitoring. Table 6 includes regional O_3 monitors located outside of OBCs that are considered representative of areas within OBCs.

The expanded monitoring has primarily focused on $PM_{2.5}$ as the pollutant of greatest public health concern in OBCs, but Ecology and local clean air agencies have also added or planned monitors for PM_{10}, O_3, and NO_2. For the current locations, pollutants, and number of monitors in each community, refer to Ecology's Washington Air Quality Map[10] and toggle the CCA Overburdened Communities overlay.

Table 6. OBCs, pollutants monitored prior to the CCA, and pollutant monitors added through expanded monitoring at the time of publication. Pollutant monitors planned but not yet added are included in parenthesis.

OBC	Pollutants monitored prior to CCA	Pollutant monitors added as part of CCA expanded monitoring
Ellensburg	$PM_{2.5}$	$PM_{2.5}$
Everett	None	$PM_{2.5}$, PM_{10}
George and West Grant County	None	$PM_{2.5}$
King County, South	$PM_{2.5}$	$PM_{2.5}$
Mattawa	None	$PM_{2.5}$
Moxee Valley	None	$PM_{2.5}$
Puyallup, Northeast	None	$PM_{2.5}$
Seattle, North and Shoreline	None	$PM_{2.5}$
Seattle, South	O_3, $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, Pb	$PM_{2.5}$, PM_{10}, NO_2
Spokane and Spokane Valley	O_3, $PM_{2.5}$, PM_{10}	$PM_{2.5}$
Tacoma, South and East	$PM_{2.5}$, NO_2, Pb	$PM_{2.5}$, NO_2
Tri-Cities to Wallula	O_3, $PM_{2.5}$, PM_{10}	O_3, $PM_{2.5}$
Vancouver	O_3, $PM_{2.5}$	$PM_{2.5}$
Wenatchee and East Wenatchee	$PM_{2.5}$	$PM_{2.5}$
Yakima Valley, Lower	$PM_{2.5}$, Pb	$PM_{2.5}$
Yakima, East	$PM_{2.5}$, PM_{10}, Pb	O_3 (planned), $PM_{2.5}$

$PM_{2.5}$

Ecology considers $PM_{2.5}$ to be the pollutant of greatest concern for public health, in OBCs and across Washington. Each OBC contains at least one $PM_{2.5}$ monitor, and most contain several to ensure adequate coverage at the neighborhood scale. Larger OBCs have up to 12 $PM_{2.5}$ monitors. Figure 14 shows $PM_{2.5}$ monitors installed as part of CCA expanded monitoring and other $PM_{2.5}$ monitors in Washington.

[10] Washington Air Quality Map

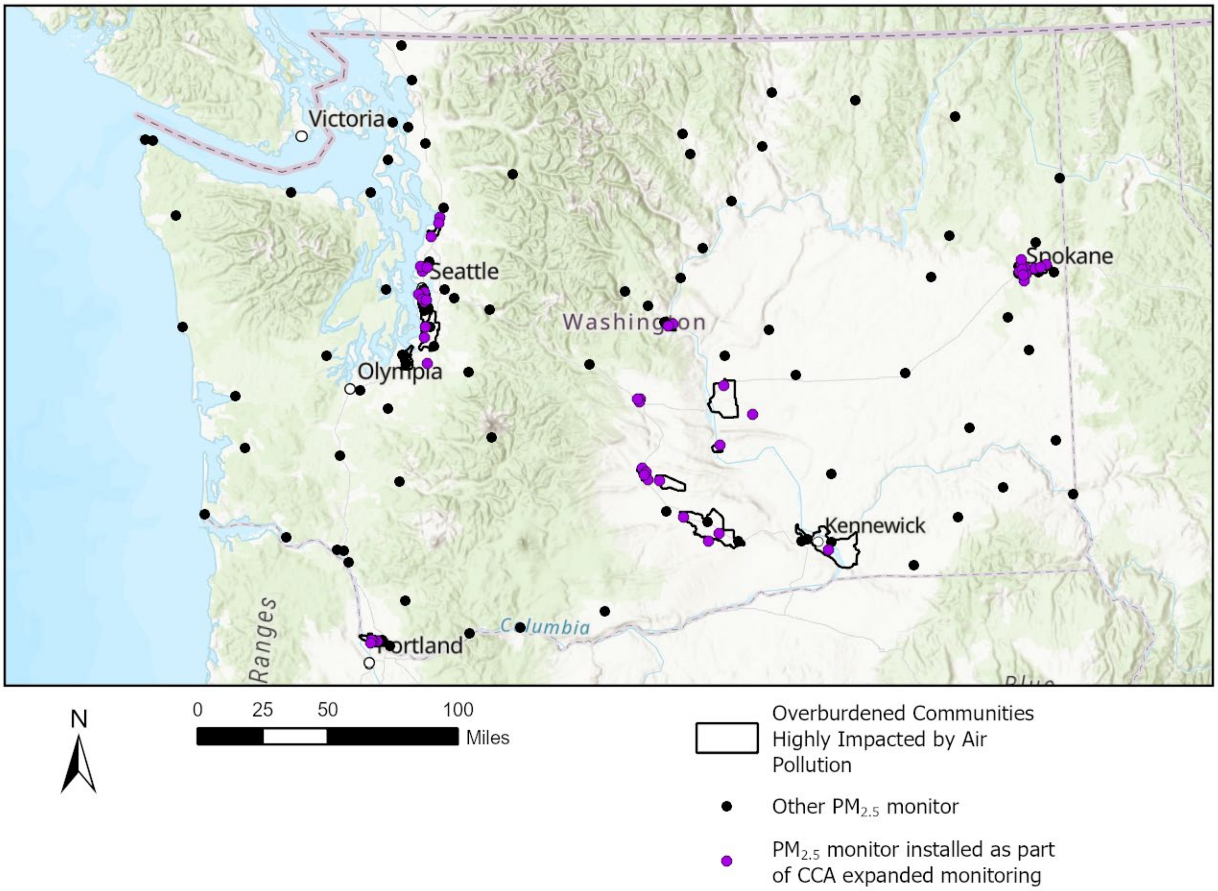

Figure 14. Map of Washington Network $PM_{2.5}$ monitors installed as part of CCA expanded monitoring and other $PM_{2.5}$ monitors.

PM_{10}

Elevated concentrations of PM_{10} in Washington are generally caused by either wildfire smoke or dust. Since particle pollution in wildfire smoke is generally in the fine particle ($PM_{2.5}$) size range, wildfire smoke events are captured by the larger and more robust $PM_{2.5}$ monitoring network. PM_{10} monitors in Yakima, Kennewick, and Spokane are sited to capture the impacts of regional dust storms that occasionally cause elevated PM_{10} concentrations across eastern Washington.

As part of the CCA expanded monitoring, Ecology added two new PM_{10} monitors to the Washington Network in western Washington OBCs. In the South Seattle OBC, Ecology collaborated with PSCAA to install a PM_{10} monitor at PSCAA's Seattle-Duwamish monitoring site. This installation was prompted by the results of PSCAA's Tacoma and Seattle Air Toxics Trends study described in Table 3. In this study, PSCAA found that re-entrained road dust was the most likely source of lead in ambient particulate matter in the surrounding neighborhood. Ecology identified expanded PM_{10} monitoring at this monitoring site as a priority to better understand trends and levels of dust in this OBC.

Ecology also added a PM_{10} monitor in the Everett OBC where there were local concerns about dust impacts from an aggregate yard on nearby sensitive receptors such as schools.

Ozone

With the exception of the East Yakima OBC, every OBC where concentrations of ozone are expected to exceed the Good range of the AQI (based on WA-Fuse interpolation) had at least one representative ozone monitor within the urban scale range prior to the passage of the CCA. Ecology plans to add a second ozone monitor in the Tri-Cities to Wallula OBC following the results of the 2024 Tri-Cities Ozone Study described in Table 3. Ecology also plans to conduct a multi-site survey of ozone concentrations in Yakima in 2026 to evaluate the spatial gradient in ozone concentrations across the Yakima area and to inform site selection for a potential future permanent ozone monitor.

CO and NO_2

The South Seattle and East Tacoma OBCs contain near-road monitors for NO_2, and South Seattle also contains a near-road monitor for CO. These micro-scale monitoring sites are sited to capture the highest concentrations of these pollutants and are used to rule out the need for broader monitoring.

The existing near-road monitors for CO and NO_2 in the South Seattle OBC are located at the Seattle-10th & Weller monitoring site, next to the highest-traffic segment of Interstate 5 in Washington where monitoring was possible. They are sited to represent the highest concentrations of CO and NO_2 found in ambient air anywhere in the state. The near-road monitors at the Tacoma-S 36th St monitoring site in the East Tacoma OBC are also next to I-5, but along a segment with lower traffic than in Seattle.

Concentrations of CO at Seattle-10th & Weller are so far below the federal CO standards that it has never exceeded 25% of either CO NAAQS since it was established. Since concentrations are expected to be even lower elsewhere in Washington outside of the near-road environment, Ecology does not consider additional CO monitoring to be warranted.

One-hour NO_2 design values at Seattle-10th & Weller have declined steadily since the site was established in 2014 and have fallen within the Good range of the AQI since 2022. NO_2 design values at Tacoma-S 36th have been within in the Good range of the AQI since monitoring began, as shown in Figure 15.

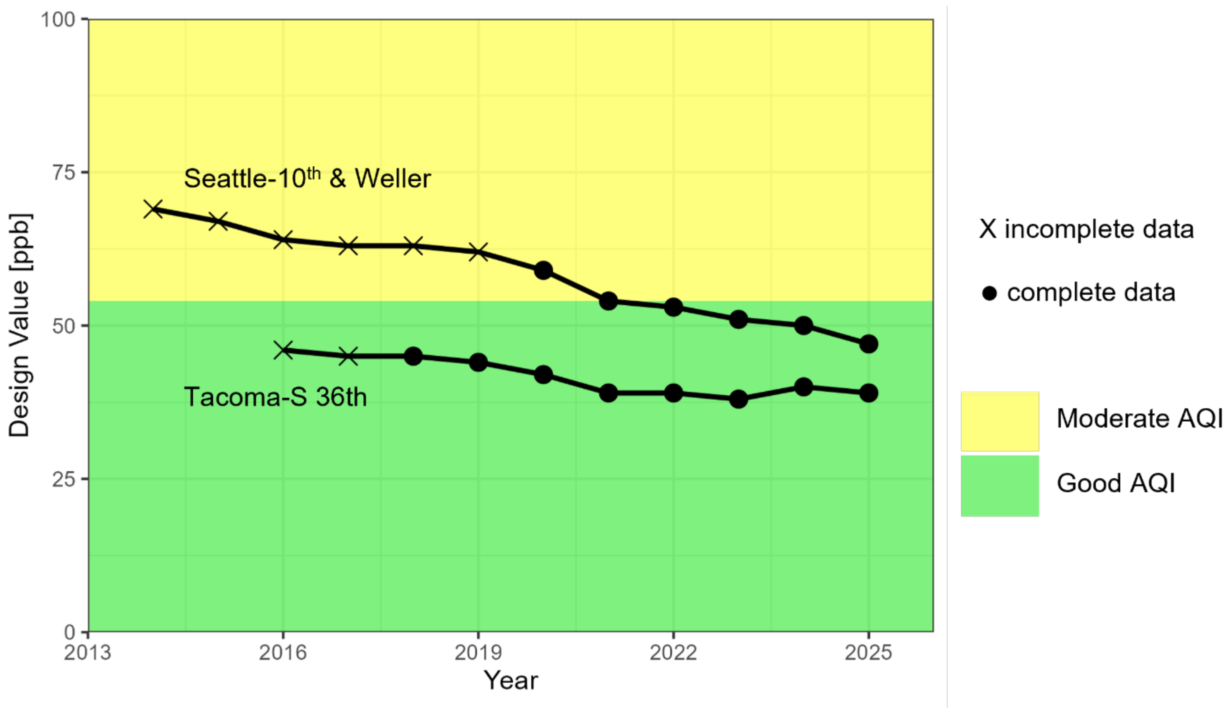

Figure 15. One-hour NO_2 design values at Seattle-10th & Weller, 2014-2025.

Since the design value at the highest-concentration NO_2 site is within the Good range of the AQI, concentrations of NO_2 elsewhere in OBCs and broadly across Washington are expected to fall within the Good range as well. For additional validation of this approach, Ecology worked with the Puget Sound Clean Air Agency to establish an additional NO_2 monitor in the South Seattle OBC as part of the expanded monitoring. This monitor is located at PSCAA's Seattle-Duwamish monitoring site, next to a major urban commercial truck route (State Route 99). Though traffic volumes on this road segment are lower than traffic volumes on I-5, the site is in a location of interest for NO_2 impacts because of its proximity to diesel truck traffic serving the Port of Seattle and other industrial areas. Ecology plans to evaluate concentrations measured by this new monitor in the coming years, particularly in comparison to the data from the Seattle-10th & Weller near-road site. This comparison may confirm whether established near-road monitors adequately capture the NO_2 impacts of on-road mobile sources in the highest-concentration areas.

SO_2

Washington no longer has industrial facilities with high rates of SO_2 emissions. In the absence of significant emissions sources, the remaining two SO_2 monitors in the Washington Network typically record background levels. As a point of comparison, EPA's 2015 SO_2 Data Requirements Rule required SO_2 monitoring or modeling near sources emitting 2,000 tons per year or more of SO_2. The largest point sources of SO_2 in OBCs emit less than 200 tons per year of SO_2, which is less than 10% of the federal screening threshold. Since no sources of data or air quality information indicate a reason SO_2 could be elevated above the Good range of the AQI in any OBC, there is no basis for expanded monitoring.

Lead

EPA does not define AQI thresholds for lead. In the absence of AQI thresholds, Ecology considers screening levels such as [Acceptable Source Impact Levels] (ASILs) and EPA monitoring requirements. EPA requires lead monitoring near facilities that emit greater than 1.0 tons per year of lead, or 0.5 tons per year for airports, where ambient concentrations also exceed 50% of the NAAQS (40 C.F.R. Part 58 Appendix D). Washington has no facilities whose emissions exceed these thresholds. As described in Table 3, previous monitoring by Ecology at Washington's two highest-emitting airports showed ambient concentrations below 50% of the NAAQS in 2012, and emissions at these airports have since decreased.

Ecology conducts ongoing monitoring for lead in the South Seattle, East Tacoma, East Yakima, and Lower Yakima Valley OBCs as part of the federal Chemical Speciation Network. All monitored concentrations of lead in ambient particulate matter at these sites are well below the ASIL and 50% of the NAAQS. In light of the low concentrations in these OBCs, the results of previous studies, and inventories of lead emissions, Ecology finds that there is not a scientific basis to support monitoring for lead in other OBCs.

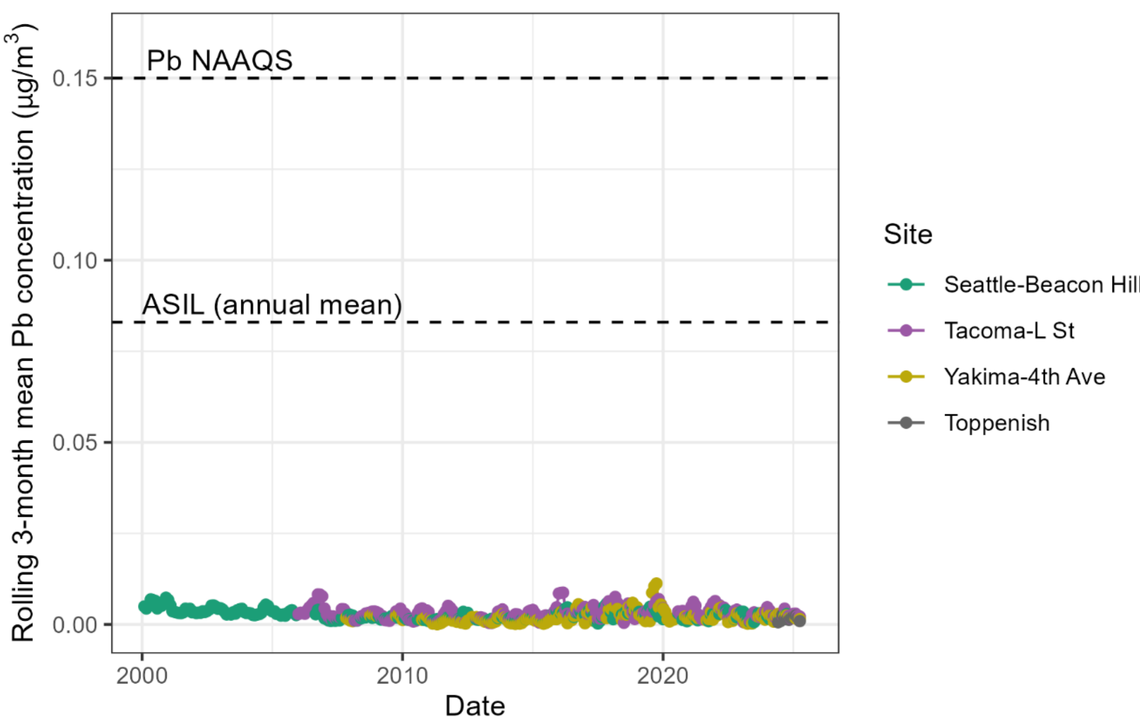

Figure 16. Lead concentrations at Chemical Speciation Network monitoring sites in OBCs relative to NAAQS and ASIL, 2000-2025.

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