Washington State Ambient Air Monitoring Quality Assurance Plan

Air Quality Program

Washington State Department of Ecology
Olympia, Washington

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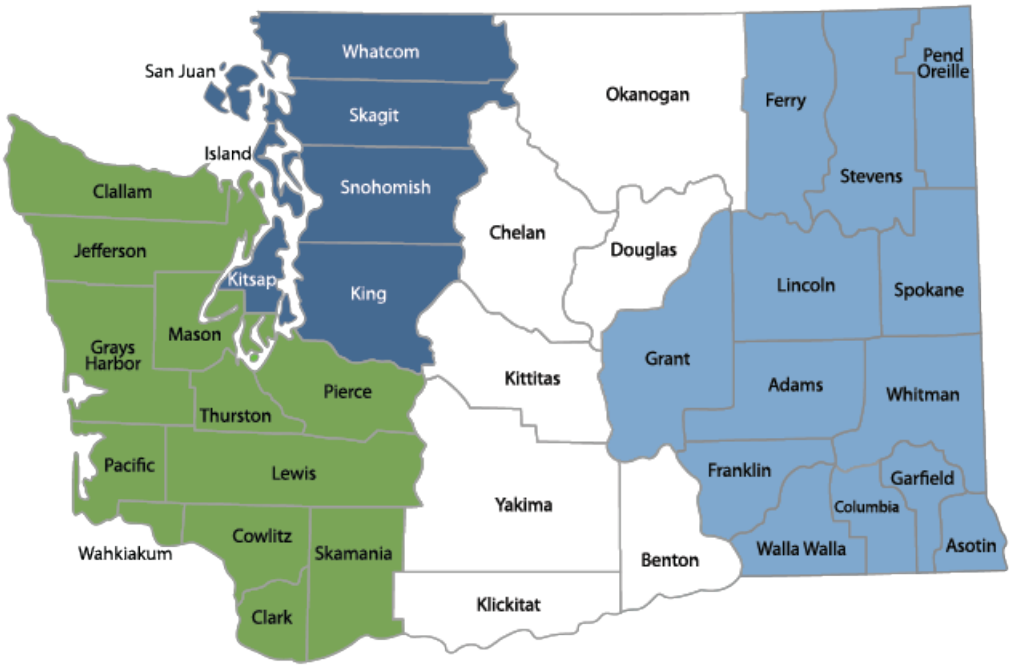
Department of Ecology's Regional Offices

Map of Counties Served



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Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	3190 160th Ave SE Bellevue, WA 98008	425-649-7000
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
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Air Quality Program
Washington State Department of Ecology
Olympia, WA

Revised January, 2021 | Publication 99-201

Washington State Ambient Air Monitoring Quality Assurance Plan

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Acronyms and Abbreviations

AAMG	Ambient Air Monitoring Group
AMTIC	Ambient Monitoring Technology Information Center
APTI	Air Pollution Training Institute
AQI	Air Quality Index
AQP	Air Quality Program
AQPLT	Air Quality Program Leadership Team
AQS	Air Quality System
ANSI	American National Standards Institute
ARM	Approved Regional Method
AWMA	Air and Waste Management Association
BAM	Beta Attenuation Monitor
CAA	Clean Air Act
CBSA	Core-Based Statistical Area
CFR	Code of Federal Regulations
CO	carbon monoxide
CSN	$PM_{2.5}$ Chemical Speciation Network
CRM	Certified Reference Material
CRO	Central Regional Office (Ecology)
DRR	Data Requirements Rule (SO_2)
DQI	Data Quality Indicator
DQO	Data Quality Objective
EAP	Washington State Department of Ecology Environmental Assessment Program
Ecology	Washington State Department of Ecology
EDO	environmental data operation
EPA	Environmental Protection Agency
ERO	Eastern Regional Office (Ecology)
FARR	Federal Air Rules for Indian Reservations
FEM	Federal Equivalent Method

FEP	fluorinated ethylene propylene
FRM	Federal Reference Method
HAP	hazardous air pollutants
HQ	Ecology Headquarters
IOS	International Organization for Standardization
IR	infrared
IUPAC	International Union of Pure and Applied Chemistry
IMPROVE	Interagency Monitoring of Protected Visual Environments
µg/m3	micrograms per cubic meter
MAC	Monitoring Action Committee
MQO	Measurement Quality Objective
MSA	Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standards
NACAA	National Association of Clean Air Agencies
NATTS	National Air Toxic Trends Stations
NCore	National Core Network
NERL	EPA National Exposure Research Laboratory
NIST	National Institute of Standards and Technology
NO_2	nitrogen dioxide
NOx	Oxides of nitrogen
NOy	Total reactive oxides of nitrogen
NPAP	National Performance Audit Program
NPEP	National Performance Evaluation Program
NWRO	Northwest Regional Office (Ecology)
O_3	Ozone
OAQPS	Office of Air Quality Planning and Standards
PE	performance evaluation
PM	particulate matter
ppb	parts per billion

ppm	parts per million
PQAO	Primary Quality Assurance Organization
PSD	Prevention of Significant Deterioration
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
SIMS	Site Information Management System
SLAMS	State and Local Air Monitoring Stations
SLT	state, local, and tribal
SOP	standard operating procedures
SPMS	Special Purpose Monitoring Stations
SRM	Standard Reference Material
SRP	standard reference photometer
SO_2	sulfur dioxide
SWRO	Southwest Regional Office (Ecology)
TEOM	Tapered Element Oscillating Microbalance
TSA	Technical Systems Audit
TSS	Technical Services Section (Ecology)
UV	ultraviolet
VOC	volatile organic compounds
WAQA	Washington Air Quality Advisory

Distribution

This plan has been distributed to the individuals currently occupying the organizational roles listed below.

Washington State Department of Ecology

- Air Quality Program Manager, Headquarters, Lacey
- Air Quality Program Deputy Manager, Headquarters, Lacey
- Air Quality Program Central Regional Office Section Manager, Union Gap
- Air Quality Program Climate Policy Section Manager, Headquarters, Lacey
- Air Quality Program Eastern Regional Office Section Manager, Spokane
- Air Quality Program Policy and Planning Section Manager, Headquarters, Lacey
- Air Quality Program Science and Engineering Section Manager, Headquarters, Lacey
- Air Quality Program Technical Services Section Manager, Headquarters, Lacey
- Environmental Assessment Program Ecology Quality Assurance Officer, Headquarters, Lacey

EPA Region 10

- Air Quality Assurance Coordinator
- Air Monitoring Administrator

1. Introduction

This plan describes the Washington State Department of Ecology's Air Quality Program (Air Quality Program) quality system governing the Washington State Ambient Air Monitoring Network (Washington Network). As such, it provides information on the organizational structure, functional responsibilities of management and staff, lines of authority, and required interfaces for those planning, implementing, and assessing activities involving environmental data collected in the Washington Network.

The Air Quality Program's mission is to enhance and protect air quality in Washington State. The federal Clean Air Act (CAA) requires EPA to set National Ambient Air Quality Standards (NAAQS) for widespread pollutants from numerous and diverse sources considered harmful to public health and the environment. The CAA sets limits to protect public health, including the health of at-risk populations such as children, older adults, and people with pre-existing heart or lung diseases.

The Washington Network is designed and maintained to collect vital air data for the purposes of fulfilling the program's mission and carrying out the provisions of the CAA.

The 1990 Amendments to the federal CAA describe the "Establishment of a national network to monitor, collect, and compile data with quantification of uncertainty in the status and trends of air emissions, deposition, air quality, surface water quality, forest condition, and visibility impairment and to ensure the comparability of air quality data collected in different states and obtained from different nations." The data collected in the Washington Network provide critical information that is used by the public, government agencies, tribal nations, the research community and others concerned with the welfare of human health and ecosystems. These data inform decisions regarding air pollution control strategies, environmental and community planning, policy creation, and are used in research applications. Therefore, it is critical that the ambient air data collected in the Washington Network are of known, acceptable, and comparable quality.

The quality assurance (QA) regulations, set forth in 40 CFR Part 58, Appendix A, have been developed to ensure that ambient air monitoring programs are well planned so that it is known what data quality is needed, what checks are included to assess data quality, and what corrective actions are in place to improve quality systems when needed. The Washington Network quality system is designed to adhere to the specifications in 40 CFR Part 58, Appendix A and follow guidance outlined in the Quality Assurance Handbooks so that data collected in the network is comparable with that collected by other organizations around the country and is of sufficient quality for intended uses.

2. Project/Task Organization

The Washington State Department of Ecology (Ecology) is a public state agency that is organized into eleven environmental programs that carry out the agency's mission to protect, preserve and enhance Washington's environment, and to promote the wise management of our air, land and water for the benefit of current and future generations. Ecology relies on its Environmental Assessment Program (EAP) to monitor quality assurance practices within the agency as a whole and improve its scientific practices, especially those involving the generation and assessment of environmental data. The agency's quality system is based on requirements established by the U.S. Environmental Protection Agency (EPA) and incorporates guidance and methodology from many standards-setting organizations worldwide. Ecology's Director administers the eleven environmental programs within the agency. The agency Deputy Director assists in the direction of the environmental programs and is responsible for the oversight of program managers.

The EAP Manager ensures that a satisfactory monitoring and quality assurance program is implemented for the field, laboratory, and data processing phases of each monitoring program with assistance from the Ecology Quality Assurance Officer.

Ecology's Executive Policy 22-01 establishes quality assurance requirements for all environmental data collection activities conducted or funded by Ecology. This policy ensures the consistent application of quality assurance principles to the planning and execution of all activities that acquire and use environmental measurement data and establishes the agency Quality Management Plan (QMP) for implementing, documenting, and assessing the effectiveness of the agency's quality system supporting environmental data operations.

2.1. Ecology Quality Assurance Officer

Ecology's Quality Assurance (QA) Officer reports to the EAP Program Manager and Ecology's Deputy Director. The QA officer provides the EAP Manager and Deputy Director with information on QA accomplishments and issues of concern throughout the agency. The QA Officer also brings issues related to QA directly to individual environmental program managers and designated quality assurance coordinators within each program.

2.2. Air Quality Program Organization

The Air Quality Program (AQP) Manager and Deputy Program Manager are located at Ecology Headquarters (HQ) in Lacey, Washington with section managers located at HQ and at regional offices in Spokane and Union Gap. Section managers oversee units of staff with specific expertise in their fields and assigned duties.

The Technical Services Section (TSS) Manager is the Air Quality Program Leadership Team (AQPLT) lead for the Monitoring Advisory Committee (MAC). As such, the TSS Manager is responsible for facilitating communication between the MAC and the AQPLT and ensuring that ambient air monitoring is consistent with the AQP's strategic plan. The TSS Manager updates the AQPLT on monitoring issues and MAC activities and decisions. The Air Monitoring

Coordinator, IT & Telemetry Unit Manager, NWRO/SWRO & Air Quality Operations Unit Supervisor report to the Technical Services Section Manager. The AQP Quality Assurance Coordinator reports to the NWRO/SWRO & Air Quality Operations Unit Supervisor.

Figure 1 below depicts the general organizational structure of the Washington Network as described in detail in this section.

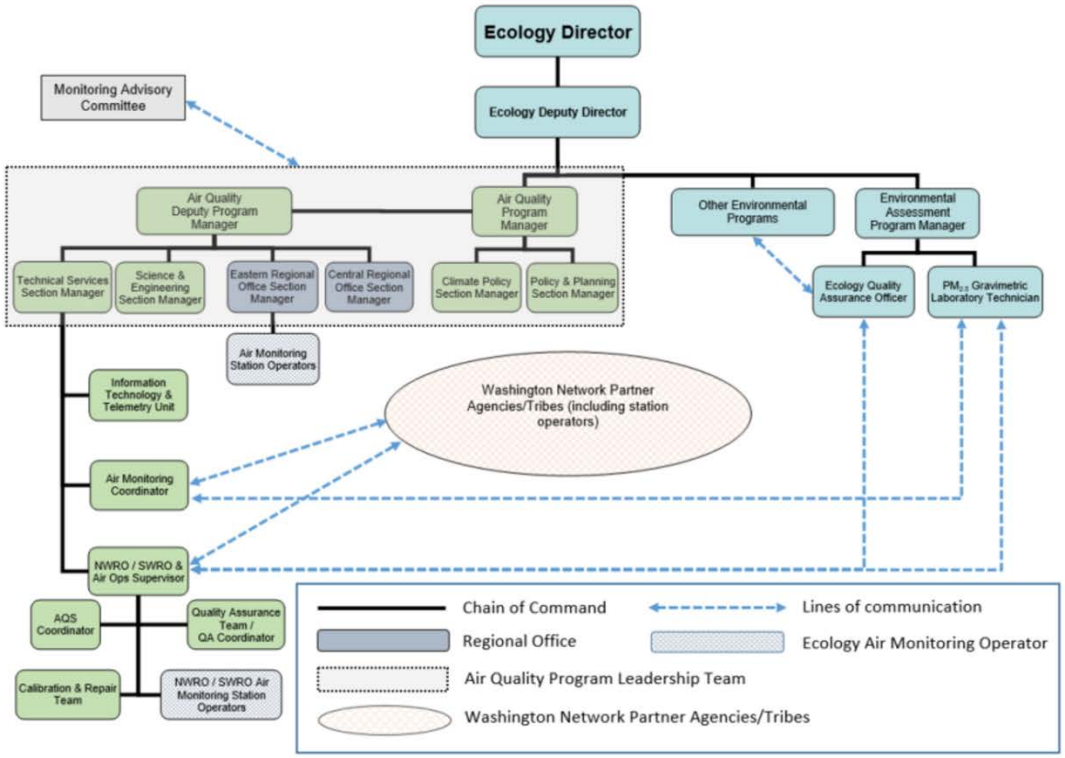

Figure 1 - Ecology and Washington Network organizational structure

2.3. Monitoring Advisory Committee

The Monitoring Advisory Committee (MAC) is the Air Quality Program's decision-making body for Washington Network monitoring efforts. The MAC is comprised of AQP managers and staff and is charged with planning the effective and efficient design and implementation of the Washington Network to help the AQP achieve its strategic goals. The AQP Strategic Plan 2020 set goals to identify, prevent, and reduce air pollution and ensure progressive management and effective leadership. In this role, the MAC advises the AQPLT regarding monitoring policy and strategic direction, identifies gaps and redundancies in network coverage, evaluates and approves/rejects monitoring projects, and defines data quality objectives for approved monitoring projects.

The MAC is comprised of the following AQP personnel:

Executive sponsor:	AQP Deputy Program Manager
AQPLT lead:	Technical Services Section Manager
MAC meeting lead:	AQP Monitoring Coordinator

Team members:

- Science and Engineering Section Manager
- NWRO/SWRO & Air Quality Operations Unit Supervisor
- AQP Quality Assurance Coordinator
- CRO Representative
- ERO Representative
- State Implementation Plan Representative
- Modeling/Meteorology Representative
- Data Analyst
- Air Monitoring Operator

2.4. Air Quality Program Quality Assurance Coordinator

The AQP Quality Assurance Coordinator (QAC) functions as the representative for quality assurance activities for the Washington Network. A Quality Assurance Coordinator is defined by EPA as "the person responsible for quality management - that aspect of the overall management system of the organization that determines and implements the quality policy. Quality management includes strategic planning, allocation of resources and other systematic planning activities (e.g., planning, implementation, assessment and reporting) pertaining to the quality system."

2.5. Organizational responsibilities

Ecology's Air Quality Program is comprised of work units within sections located in different regions of Washington State. Responsibility for the collection of air quality data and the implementation of monitoring efforts are assigned to specific individuals within the Air Quality Program or are carried out by the AQP's Washington Network partner agencies and tribes. Washington Network partners collect data in accordance with the Washington Network Quality Assurance Plan and standard operating procedures (SOPs).

2.5.1. Washington Network partners

The Washington Network is comprised of partner entities such as federal, local, and state agencies as well as tribal nations. These entities operate monitors and collect vital air quality

information for a wide variety of applications across the state. A list of Washington Network partners is shown in Table 1.

Table 1 - Washington Network partners

Local Clean Air Agencies	Tribal Nations	Federal Agencies	State Agency
Benton Clean Air Agency	Confederated Tribes of the Colville Reservation	National Park Service	Ecology
Northwest Clean Air Agency	Makah Tribe	Environmental Protection Agency	
Olympic Region Clean Air Agency	Quinault Indian Nation		
Puget Sound Clean Air Agency	Spokane Tribe of Indians		
Southwest Clean Air Agency	Tulalip Tribes		
Spokane Regional Clean Air Agency	Yakama Nation		
Yakima Regional Clean Air Agency			

The collection of air monitoring data in the Washington Network requires cooperation between the partner groups. Good communication and strong relationships are critical to a clear and mutual understanding of monitoring objectives, roles and responsibilities, and the collection of data of sufficient quality for intended uses. Table 2 below shows the basic roles and responsibilities within the Washington Network.

Table 2 - Washington Network roles and responsibilities

Position	Responsibility
Air Quality Program Manager	Assures Ecology AQP policies are in place and effective so that state and federal clean air objectives are achieved. Responsible for overall program leadership and strategic direction. Oversees Program Administration, Budget, and Communications, Climate Policy, and Policy and Planning managers

Position	Responsibility
Air Quality Deputy Program Manager	Assures Ecology AQP policies are in place and effective so that state and federal clean air objectives are achieved. Responsible for overall program leadership and strategic direction. Oversees Central, Eastern, Science & Engineering, and Technical Services managers MAC Executive Sponsor Responsible for certifying air monitoring data annually to EPA
Ecology Quality Assurance Officer	Assures agency quality assurance system policies are maintained statewide, including Manchester Environmental Lab Reviews individual program quality assurance plans
Technical Services Section Manager	Oversees Air Monitoring Coordinator as well as IT & Telemetry and NWRO / SWRO & Air Quality Operations Unit supervisors AQLPT member MAC Lead
Policy and Planning Section Manager	Oversees development of plans, policies and rules that ensure air quality meets health and environmental objectives (diesel reduction strategies, rules, and SIP programs) AQPLT member
Information Technology & Telemetry Unit Supervisor	Supervises IT & telemetry staff Oversees telemetry equipment evaluation, procurement and acceptance testing Oversees telemetry system operation and maintenance Oversees air monitoring website implementation and maintenance
Air Monitoring Coordinator	Meeting Lead for MAC Air monitoring research evaluation, design, budget, planning, and reporting Project Manager for NATTS, PAMS, and $PM_{2.5}$ (CSN, NCore, and $PM_{2.5}$) Coordination of installation of sites and operation Writes Annual Network Plan Leads 5-year Network Assessments

Position	Responsibility
Science and Engineering Section Manager	Supervises data analyst, meteorologists, modelers, toxicologists, and engineers. MAC member AQPLT member
AQS Coordinator	Coordinates data collection from Washington Network partners Submits air quality data to AQS Annual Data Certification
Quality Assurance Coordinator	Responsible for AQP quality system and oversees QA lab Responsible for Quality Assurance Plan MAC member Oversees SOP development
NWRO / SWRO & Air Quality Operations Unit Supervisor	Supervises Quality Assurance team, including Quality Assurance Coordinator Supervises instrument Calibration & Repair team Supervises NWRO / SWRO air monitoring station operators Supervises AQS Coordinator Oversees instrument procurement and acceptance testing MAC member
Central Regional Office Section Manager (Union Gap)	Works with Technical Services Section Manager to coordinate monitoring efforts in central Washington AQPLT member Designates CRO MAC member
Eastern Regional Office Section Manager (Spokane)	Coordinates monitoring efforts in eastern Washington Supervise air monitoring station operators AQPLT member Designates ERO MAC member

Position	Responsibility
Air monitoring operators from Ecology, federal and local air agencies, and tribal nations	Select and install sites Install monitors Maintain sites and monitors in the field Conduct quality control Collect samples Performs initial data review and preliminary data validation
Manchester Environmental Laboratory Quality Assurance Coordinator	Assures quality assurance system at the Manchester Environmental Laboratory (includes gravimetric laboratory)

2.5.2. EPA Center for Environmental Measurement and Modeling

The EPA's Center for Environmental Measurement and Modeling (CEMM) conducts research and development that leads to improved methods, measurements, and models to assess and predict human and ecosystem exposures to harmful pollutants and other conditions in air, water, soil, and food. The CEMM provides the following activities relative to ambient air monitoring networks:

- Develops, improves, and validates methods and instruments for measuring gaseous, semi-volatile, and non-volatile pollutants in source emissions and in ambient air
- Supports multi-media approaches to assessing human exposure to toxic contaminated media and analytical and method support for special monitoring projects for trace elements and other inorganic and organic constituents and pollutants
- Develops standards and systems needed for assuring and controlling data quality
- Assesses whether candidate sampling methods conform to accepted reference method specifications and are capable of providing data of acceptable quality and completeness for determining compliance with applicable National Ambient Air Quality Standards
- Assesses whether emerging methods for monitoring criteria pollutants are "equivalent" to accepted Federal Reference Methods and are capable of addressing EPA's research and regulatory objectives
- Provides an independent audit and review function on data collected by CEMM or other appropriate clients

2.5.3. EPA Office of Air Quality Planning and Standards

EPA's responsibility, under the Clean Air Act (CAA) as amended in 1990, includes:

- Setting National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to the public health and environment
- Ensuring that these air quality standards are met or attained through national programs and strategies to control air emissions from sources
- Ensuring that sources of toxic air pollutants are well controlled

EPA's Office of Air Quality Planning and Standards (OAQPS) is the organization charged under the authority of the CAA to protect and enhance the quality of the nation's air resources. OAQPS:

- Evaluates the need to regulate potential air pollutants
- Develops NAAQS
- Works with state and local agencies and tribes to develop plans for meeting the NAAQS
- Monitors national air quality trends
- Maintains a database of information on air pollution and controls
- Provides technical guidance and training on air pollution control strategies
- Monitors compliance with the NAAQS

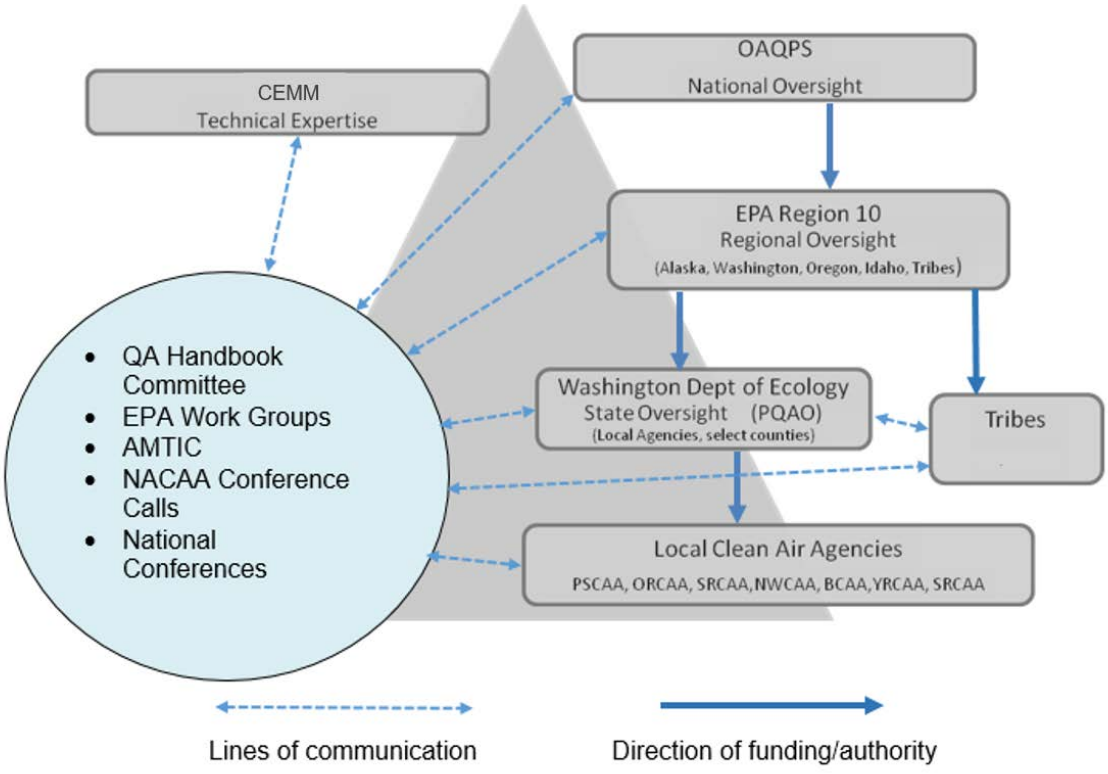

Figure 2 - Organizational oversight and input on decisions

Within the OAQPS Air Quality Assessment Division, the Ambient Air Monitoring Group (AAMG) is responsible for the implementation of the National Air Monitoring Strategy and its quality assurance program. The AAMG, relative to quality assurance, has the responsibility to:

- Develop a satisfactory quality system for the national ambient air quality monitoring network
- Ensure that the methods and procedures used in making air pollution measurements are adequate to meet the programs objectives and that the resulting data are of appropriate quality
- Manage the National Performance Evaluation Program (NPEP)
- Perform data quality assessments of organizations making air pollution measurements of importance to the regulatory process
- Ensure that guidance pertaining to the quality assurance aspects of the national ambient air quality monitoring network are written and revised as necessary
- Provide technical assistance to EPA Regional Offices and the air pollution monitoring community.

2.6. EPA Region 10

Staff at EPA Regional 10 play a critical role in addressing environmental issues related to air monitoring in Washington State by overseeing regulatory and congressionally-mandated programs.

The major quality assurance responsibilities of EPA Region 10 in regards to the National Air Monitoring Strategy are the coordination of quality assurance matters between the Region 10 office and the AQP Quality Assurance Coordinator for the Washington Network. This role requires that an assigned representative from EPA Region 10:

- Distribute and explain technical and quality assurance information to the AQP Quality Assurance Coordinator
- Identify quality assurance needs of the AQP to the Office of Air Quality Planning and Standards that are “national” in scope
- Provide the infrastructure to implement NPEP programs
- Be knowledgeable of QA regulations and possess adequate technical expertise to address ambient air monitoring and QA issues
- Ensure Ecology has an approved quality management plan (QMPs) and that the AQP has quality assurance project plans (QAPPs) prior to routine monitoring
- Conduct network reviews and Technical Systems Audits (TSA) to evaluate the capabilities of the AQP and Washington Network partners to measure criteria air pollutants
- Assess Washington Network data quality

- Assist state, local, and tribal (SLT) entities in defining Primary Quality Assurance Organizations (PQAO) within their jurisdiction and in assigning sites to a PQAO

2.7. Washington State Department of Ecology

Ecology is the principal environmental management agency for Washington State. Ecology was established in 1970 under Chapter 43.21A RCW and is headquartered in Lacey, Washington.

Ecology's mission is *to protect, preserve, and enhance Washington's land, air, and water for current and future generations*. The Air Quality Program (AQP) is one of eleven environmental programs within Ecology. The AQP's mission is to protect and improve air quality in Washington.

2.7.1. Ecology Regional Offices

In addition to its headquarters in Lacey, Ecology has four regional offices. Regional AQP staff provide information and address localized air quality issues in counties that do not support local clean air agencies. Table 3 shows the counties that fall under the jurisdiction of the Ecology regional offices.

Table 3 - Air Quality Program direct service counties

Ecology Regional Office	Counties within jurisdiction
Central Regional Office (CRO)	Chelan, Douglas, Kittitas, Klickitat, Okanagan
Eastern Regional Office (ERO)	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pond Oreille, Stevens, Walla Walla, Whitman
Northwest Regional Office (NWRO)	San Juan
Southwest Regional Office (SWRO)	All counties within region represented by local clean air agencies

2.7.2. Washington Local Clean Air Agencies

In many Washington State counties, the provisions of the federal and state clean air acts are carried out by local clean air agencies having jurisdiction over one or more counties. Local air agencies are largely funded by fees levied on air pollution sources within their jurisdictions and to a lesser degree by federal and state grants. These agencies partner with Ecology to conduct air monitoring as part of the Washington Network and to achieve specific goals that are mutually beneficial for their jurisdictions, Ecology, EPA, and the public. Local air agencies also conduct air monitoring in their jurisdictions that is not part of the Washington Network but nevertheless provides valuable information. The seven local air agencies in Washington State are:

- Benton Clean Air Agency - Benton County

- Northwest Clean Air Agency – Island, Skagit, and Whatcom Counties
- Olympic Region Clean Air Agency – Clallam, Grays Harbor, Jefferson, Mason, Pacific, and Thurston Counties
- Puget Sound Clean Air Agency - King, Kitsap, Pierce, and Snohomish Counties
- Southwest Clean Air Agency - Clark, Cowlitz, Lewis, Skamania and Wahkiakum Counties
- Spokane Regional Clean Air Agency - Spokane County
- Yakima Regional Clean Agency – Yakima County

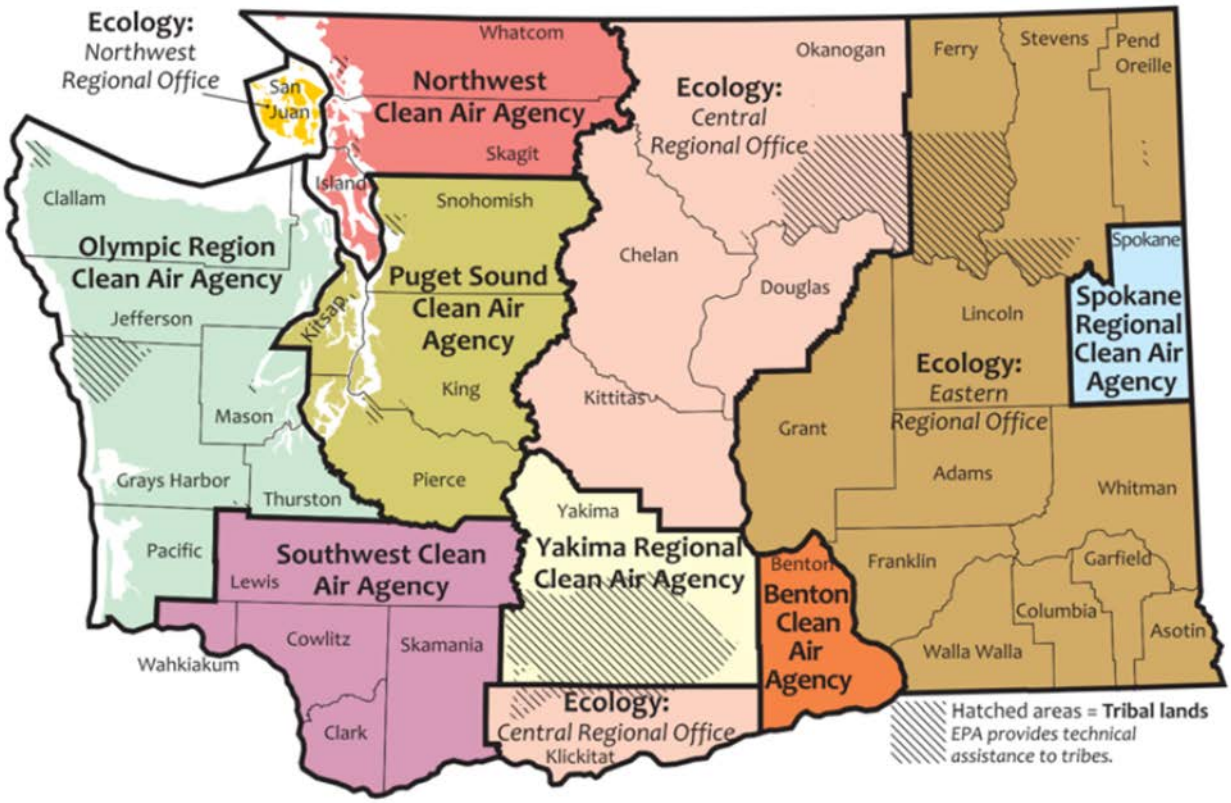

Figure 3 - Air quality jurisdictions in Washington State

2.7.3. Air monitoring on tribal land and reservations

The Federal Air Rules for Indian Reservations (FARR) apply within the exterior boundaries of 39 tribal nation reservations in Idaho, Oregon and Washington. Tribal nations have the authority involving air quality issues on their lands and several tribes conduct air monitoring programs within these boundaries. Ecology receives funding from EPA to provide technical assistance and support of air monitoring efforts on tribal lands for several tribes. Ecology's assistance includes site installation, instrument operation or operational assistance, quality assurance performance evaluations, data review and validation, and reporting of valid data to AQS. Ecology-supported tribal monitors receive the same level of quality assurance as Washington Network sites and are therefore treated as part of the state network.

2.7.4. Primary Quality Assurance Organization

A Primary Quality Assurance Organization (PQAO) is a monitoring organization or a group of monitoring organizations that share a number of common quality assurance factors. Ecology's AQP is recognized by EPA Region 10 as the PQAO for Washington State. As a PQAO, the AQP has set a priority on maintaining a reasonably homogenous network in order to minimize measurement variability and uncertainty and ensure comparability of monitored data throughout the state and with the national network. This is achieved by:

- Operation by a common team of field operators according to a common set of procedures
- Adherence to a common Quality Assurance Plan
- Common calibration facilities and standards
- Common makes and models of instruments
- Oversight by a common quality assurance organization
- Support by a common management, laboratory, and headquarters

EPA compiles many of its data quality assessments at the PQAO level, aggregating data completeness, precision, and bias based on PQAO. Monitoring organization QAPPs must also refer to the PQAO that the monitoring organization is affiliated with and EPA Region 10 must have documentation on file to this effect.

Several Washington Network air monitoring station operators are employed by federal, state, and local air agencies and tribal nations. In addition, Ecology contracts with EPA and local air agencies to provide operational and quality assurance support and technical assistance in support of ambient air monitoring activities. All contracted ambient air monitoring sites are treated by Ecology as being part of the Washington Network. Further, all air monitoring that is conducted as part of the Washington Network is required to be conducted in accordance with this Quality Assurance Plan and the Ecology-approved, Washington Network standard operating procedures.

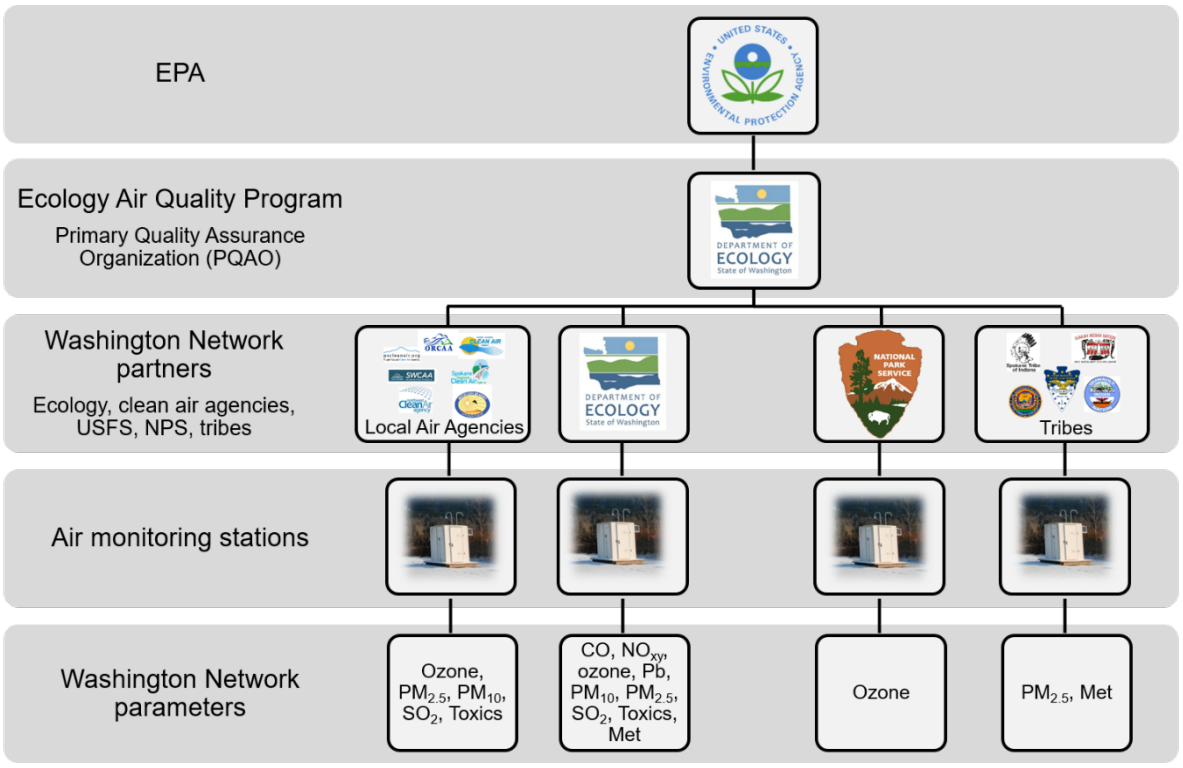

Figure 4 - Washington Network PQAO hierarchy

3. Problem Definition and Background

The Clean Air Act Extension of 1970 (CAA) is federal law that requires the EPA develop and enforce regulations to protect the general public from exposure to airborne contaminants that are known to be hazardous to human health.

The CAA, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment (40 CFR part 50). The CAA established two types of NAAQS:

- ***Primary standards*** – air pollution limits established to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly
- ***Secondary standards*** – air pollution limits established to protect public welfare, including protection against decreased visibility, damage to animals and crops, vegetation, and buildings

The EPA's Office of Air Quality Planning and Standards (OAQPS) has set NAAQS for six principal air pollutants, known as "criteria" pollutants. The criteria air pollutants are:

- Carbon monoxide (CO)
- Lead (Pb)
- Nitrogen dioxide (NO_2)
- Ozone (O_3)
- Particulate Matter
    - Particles ≤ 2.5 micrometers in aerodynamic diameter ($PM_{2.5}$)
    - Particles ≤ 10 micrometers in aerodynamic diameter (PM_{10})
- Sulfur dioxide (SO_2)

A list of the current level and form of the NAAQS for each of the criteria pollutants can be found in the most recent version of 40 CFR Part 50.

EPA is charged with enforcing the CAA but often delegates the authority to implement provisions of the CAA to individual states in exchange for funding. In order to receive delegation, states must write and submit a State Implementation Plan (SIP) to EPA for approval. To achieve EPA approval, a SIP must meet minimum criteria. An EPA-approved SIP becomes the state's legal guide for local enforcement of the CAA.

40 C.F.R. Part 58 requires states to establish air quality surveillance systems in their State Implementation Plans (SIPs). An air quality surveillance system consists of a network of State and Local Air Monitoring Stations (SLAMS), which measure ambient concentrations of the criteria pollutants. Accordingly, the primary purpose of the Washington Network is to determine compliance with the NAAQS. In addition, other monitoring within the Washington Network is carried out in order to collect information for the National Core (NCore) Multipollutant Monitoring Stations, National Air Toxics Trends Stations (NATTS), $PM_{2.5}$ Chemical

Speciation Network (CSN), Near-road national air monitoring programs as well as for Washington's agricultural smoke management program, and special-purpose studies.

Areas that violate the NAAQS may be designated by EPA as nonattainment areas. The CAA requires additional air pollution controls in these areas. EPA declares nonattainment areas for only a single pollutant. However, nonattainment areas for different pollutants may overlap each other or share common boundaries.

In the past, EPA designated 14 areas in Washington State as nonattainment based on air monitoring data. All of the former 14 nonattainment areas have subsequently been reclassified as attainment (i.e., no longer violating the NAAQS). These reclassifications resulted from control measures that led to measurable decreases in pollution levels at monitoring sites over time.

It's important to note that while Washington State is currently in attainment with the NAAQS, air pollution is still a concern in many communities. In addition, EPA reviews the most-recent epidemiological and scientific studies regarding the criteria air pollutants at five year intervals. Over the last decade the NAAQS for several criteria pollutants have been revised to be more stringent (i.e., more protective of public health) based on evidence that adverse health effects occur at lower levels than previously understood.

3.1. Quality system requirements for EPA-funded programs

EPA's national quality system requirements can be found in EPA Order CIO2105. This order requires that organizations receiving funding for the collection of environmental data develop, implement, and maintain a quality system that demonstrates conformance to the minimum specifications of ANSI/ASQC E4-1994. These requirements, and how Ecology satisfies them, are discussed in detail below.

3.2. Ecology Quality Assurance Officer

Ecology performs a multitude of environmental data collection activities for air, water, and solid waste and ambient air monitoring is only one branch of the environmental collection efforts of the agency. Ecology's Quality Assurance Officer is the highest authority for the agency's quality system and has oversight and responsibility for all agency data collection activities and resultant data.

3.3. Ecology's Quality Management Plan

EPA's QA/R-2 requires the implementation of a comprehensive Quality Management Plan (QMP). A QMP documents an organization's quality policy, describes its quality system, and identifies the environmental programs to which the quality system applies. The QMP is necessary to ensure that sufficiently accurate environmental data are available to inform decision making. If inaccurate data are used, erroneous conclusions may be drawn, leading to poor decisions. Other problems that may arise from the use of inaccurate data include wasted resources, legal liability, increased risks to health and the environment, inadequate

understanding of the state of the environment, and loss of agency credibility. It is the responsibility of the agency to have a QMP that demonstrates an acceptable quality system that is approved by EPA Region 10.

Ecology is committed to developing sound quality assurance and quality control practices and applying them to its environmental studies and activities. Ecology Executive Policy and Procedure 22-01 requires the consistent application of quality assurance principles to the planning and execution of all activities that acquire and use environmental measurement data. The development, practice, and review of a QMP are critical in meeting these goals. Ecology has an EPA-approved Quality Management Plan that can be found on Ecology's Environmental Assessment Program Quality Assurance external website. Ecology's QMP is reviewed at five year intervals and delegates air pollution monitoring Quality Assurance Project Plan and SOP review and approval authority to the Air Quality Program's Quality Assurance Coordinator.

The SIP submitted to EPA by Ecology is a strategy designed to prevent pollution, clean up pollution, and support sustainable communities and natural resources. Some of Ecology's environmental data collection efforts are not for SIP purposes and therefore may have different quality objectives dependent on the ultimate use and nature of the data. However, per Ecology's QMP and the Air Quality Program's Quality Assurance Plan, all data must have some degree of quality control consistent with their intended use.

3.4. The Washington Network Quality Assurance Plan

EPA requires that all projects involving the generation, acquisition, and use of environmental data are planned, documented, and have an agency-approved Quality Assurance Project Plan (QAPP). The QAPP is the critical planning document for any environmental data collection operation as it documents how quality assurance and quality control activities will be implemented during the project's life cycle. It serves as a blueprint for air monitoring operators, project officers, and program managers responsible for implementing, designing, and coordinating air pollution monitoring projects and provides the foundation to ensure that the data collected during the project will be the correct type and of adequate quality.

QAPPs describe in comprehensive detail, the necessary QA/QC and other technical activities that must be implemented in order to ensure that the results of work performed will satisfy the stated performance criteria, which may be in the form of a data quality objective (DQO). EPA's quality assurance policy requires that every Environmental Data Organization (EDO) funded by EPA must have an approved QAPP prior to the start of monitoring.

This programmatic Quality Assurance Plan (QAP) and its associated procedures (SOPs) describe the Washington Network quality system. The QAP covers the vast majority of ambient air monitoring conducted by the Air Quality Program and its partners as part of the Washington Network. This EPA-approved QAP has been revised at periodic intervals over several decades in order to ensure that it continues to accurately capture federal and state requirements for ambient air monitoring and reflect current policy of the AQP. At a minimum, the AQP's Quality Assurance team reviews and revises this QAP at 5 year intervals. The last revision was in 2015.

All ambient air monitoring projects outside the scope of this QAP require a project-specific QAPP. The AQP Quality Assurance Coordinator (QAC) reviews all monitoring projects to determine whether a unique QAPP is necessary. Monitoring/sampling for any project requiring a unique QAPP cannot begin until the AQP QAC has approved the project-specific QAPP.

Graded Approach to Quality Assurance Project Plans

The term graded approach appears in the EPA Quality Manual where it states that the level of detail in the QMP should be "based on a common sense, graded approach that establishes QA and QC activities commensurate with the importance of the work, the available resources, and the unique needs of the organization." The Quality Manual also states that monitoring organizations may tailor QAPP specifications to better fit their specific needs.

EPA Region 10 provides flexibility to the Air Quality Program in implementing the policy of writing a detailed QAPP for every project, allowing for use of a graded approach. EPA breaks down the level of detail and rigor of quality assurance required by a QAPP into four-project categories in order to effectively focus QA activities. The categories are listed in Table 4 below.

Category 1 involves the most stringent QA approach, utilizing all QAPP elements as described in EPA QA/R-5, whereas category 4 is the least stringent, utilizing fewer elements. The amount of detail or specificity required for each element will be less as one moves from category 1 to 4. Each type of EDO will be associated with one of these categories. The comment area of the table denotes whether QMP and QAPP can be combined and the DQO field identifies the type of data quality objectives (DQOs) required. DQOs are defined in detail in Section 8 (Data Quality Objectives and Criteria) of this document. EPA QA/R-5 provides more detail on which specific QAPP elements are required for each category QAPP. Based upon a specific project, the AQP Quality Assurance Coordinator may add/delete elements for a particular category as it relates to the project.

Table 4 - QAPP/QMP project categories

Category	Programs	QAPP/QMP Comments	DQO
Category 1 Projects include Environmental Data Operations (EDOs) that directly support rulemaking, enforcement, regulatory, or policy decisions. They also include research projects of significant national interest, such as those typically monitored by the Administrator. Category 1 projects require the most detailed and rigorous QA and QC for legal and scientific defensibility. Category 1 projects are typically stand-alone; that is, the results from such projects are sufficient to make the needed decision without input from other projects.	SLAMS, PSD, NCore, PAMS, IMPROVE, CastNet	Most agencies implementing ambient air monitoring networks will have separate QMPs and QAPPs. However, EPA regions have the discretion to approve QMP/QAPP combination for small monitoring organizations (i.e., tribes)	Formal DQOs

Category	Programs	QAPP/QMP Comments	DQO
Category 2 Projects include EDOs that complement other projects in support of rulemaking, regulatory, or policy decisions. Such projects are of sufficient scope and substance that their results could be combined with those from other projects of similar scope to provide necessary information for decisions. Category 2 projects may also include certain high visibility projects as defined by EPA management.	CSN, NATTS	Most agencies implementing ambient air monitoring networks will have separate QMPs and QAPP's. However, EPA regions have the discretion to approve QMP/QAPP combination for small monitoring organizations (i.e., tribes).	Formal DQOs for national objective
Category 3 Projects include EDOs performed as interim steps in a larger group of operations. Such projects include those producing results that are used to evaluate and select options for interim decisions or to perform feasibility studies or preliminary assessments of unexplored areas for possible future work	SPM, One time studies; community scale air toxics grants	EDOs of short duration, QMP and QAPP can be combined	Flexible DQOs
Category 4 Projects involving EDOs to study basic phenomena or issues, including proof of concepts, screening for particular analytical species, etc. Such projects generally do not require extensive detailed QA/QC activities and documentation.	Education & outreach		Project objectives or goals

Flexibility in the Systematic Planning Process

Table 4 describes four QAPP/QMP categories which require some type of statement about the program or project objectives. Three of the categories use the term data quality objectives (DQOs), but there is flexibility within the systematic planning process on how these DQOs are developed based on the particular category. For example, a category 1 project would have formal DQOs. The EPA's Office of Air Quality Planning and Standards (OAQPS) develops DQOs for category 1 projects, such as the State and Local Monitoring Stations (SLAMS). Formal DQOs may apply to category 2 QAPPs if there are national implications to the data (e.g., $PM_{2.5}$ Chemical Speciation Network, National Air Toxics Trends Stations). For projects that are local in

scope, organizations may develop less formal DQOs. Categories 3 and 4 would require less formal DQOs to a point that only project goals (category 4) may be necessary.

4. Project/Task Description

Criteria air pollutant levels in Washington State declined dramatically following the implementation of the CAA and associated 1990 amendments. Monitoring data collected in the Washington Network reveal this decrease and show the effectiveness of implemented control measures over time (Figure 5 and Figure 6 below).

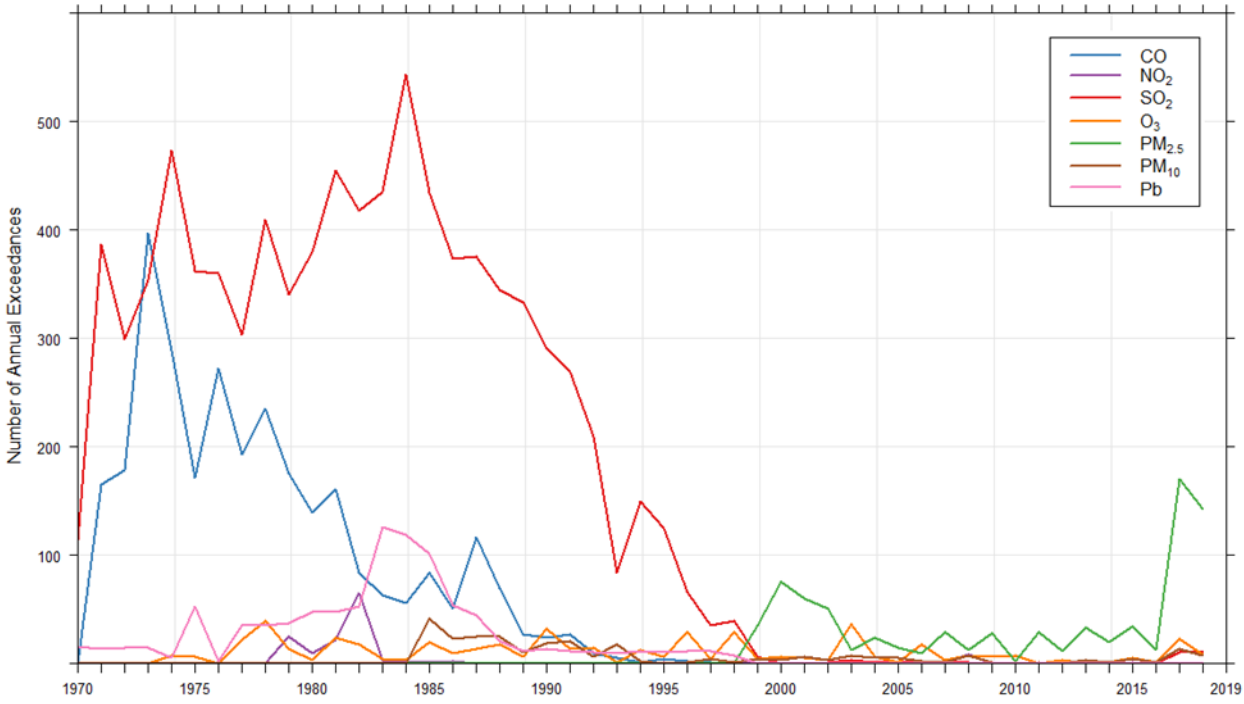

Figure 5 - Number of exceedances in Washington State by criteria pollutant (using current NAAQS), 1970-2018

Despite the overall downward trend over the last 50 years, since the late 1990s the number of NAAQS exceedances in Washington State has remained fairly constant with a marked increase in 2017. The recent increase is mostly due to primary ($PM_{2.5}$) and secondary pollution (e.g., ozone) associated with wildfires in Washington.

Scientific understanding of the adverse health and environmental impacts associated with the criteria and other air pollutants (such as air toxics) has improved over time. Recent epidemiological studies show that adverse health effects of $PM_{2.5}$, ozone, NO_2, and SO_2 occur at lower levels than previously understood. These studies provided the basis for recent EPA decisions to revise the NAAQS for these pollutants. In 2017, pursuant to the 2010 revision to the 1-hour SO_2 NAAQS and subsequent Data Requirements Rule, ambient air monitoring began around large SO_2 sources in Washington State. During 2017, 2018, and 2019 SO_2 monitors in the proximity of an aluminum smelter near the community of Ferndale, Washington recorded many exceedances, causing a violation of the 2010 1-hour SO_2 NAAQS in 2019. A decision regarding a potential nonattainment area around the smelter is pending.

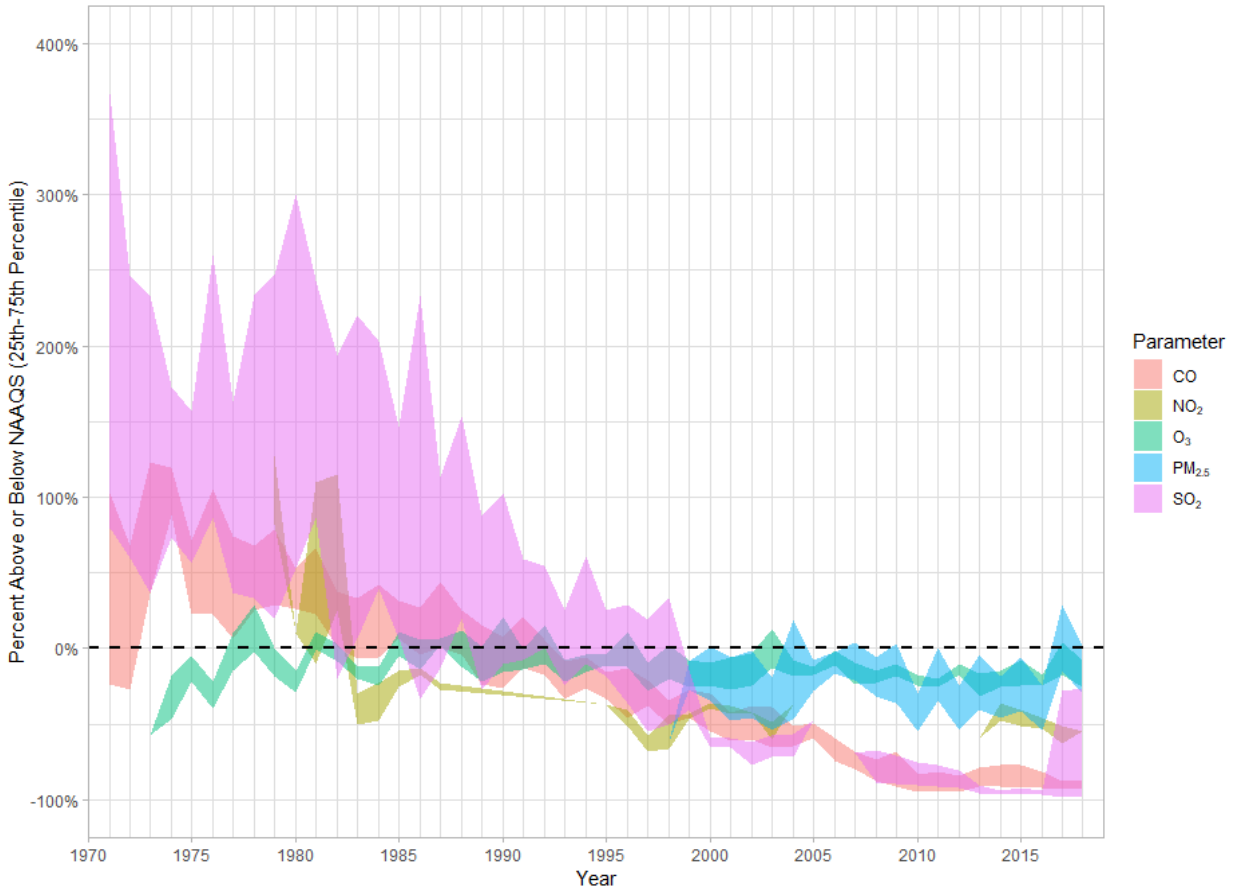

Figure 6 - Interquartile range trends for criteria pollutants (Pb and PM_{10} not shown), 1970-2018

$PM_{2.5}$ and ozone sometimes reach unhealthy levels in many communities in Washington State. While there are currently no nonattainment areas for these pollutants, as can be seen in Figure 6 above, $PM_{2.5}$ and ozone pollution levels remain fairly unchanged over time with a recent increase largely due to wildfire smoke in recent summers. For these reasons, the monitoring for $PM_{2.5}$ and ozone are the primary focus of the Washington Network. At locations where levels begin to approach the NAAQS, the AQP conducts additional monitoring of constituent species of $PM_{2.5}$ and precursors of ozone.

4.1. Fine Particle Pollution

Several communities in Washington State are close to violating the 24-hour NAAQS for fine particle ($PM_{2.5}$) pollution. $PM_{2.5}$ pollution in Washington communities comes from a variety of sources related to incomplete combustion. In general, $PM_{2.5}$ pollution on the west side of the Cascade Mountains is driven largely by home heating and mobile sources. The same is true on the east side of the Cascade Mountains, but due to the more rural nature of the terrain, agricultural and silvicultural burning play a larger role. In many communities on both sides of the Cascades, smoke from residential home heating is a major contributor to unhealthy $PM_{2.5}$ levels during winter. During summer, wildfire smoke can have significant impacts on communities. Wildfire smoke is typically more of a concern in the more arid region of the state

east of the Cascades. However, in recent summers, smoke from wildfires has also inundated the more heavily populated communities of western Washington. In the summers of 2017 and 2018, meteorological conditions allowed smoke from wildfires in British Columbia, Canada and (later in the summer) Washington State to build up and inundate most of Washington State, resulting in over 140 $PM_{2.5}$ NAAQS exceedances during each summer.

4.2. Ozone

The Air Quality Program began monitoring ozone in Western Washington the 1970s and found that ozone levels were highest in the rural areas near the foothills of the Cascade Mountains. It is now understood that precursor pollutants, largely generated by sources in the heavily-populated Interstate 5 corridor, drift on prevailing winds and form ozone on hot summer days. Several communities downwind of Seattle, Tacoma, and Vancouver experience elevated ozone concentrations from May through September when temperatures rise above 30ºC. Ozone levels also reach unhealthy levels in Spokane and Benton counties, east of the Cascades. Recent monitoring has shown the Tri-Cities area in Benton County to be near an ozone NAAQS violation.

Climate change is expected to increase the occurrence of wildfires in the Pacific Northwest which may lead to corresponding increases in ozone pollution. Many sites in the Washington Network provide long-term datasets with which to track such changes and better characterize health and environmental implications associated with ozone pollution. Wildfire smoke is believed to have contributed to dozens of ozone exceedances during the summers of 2017 and 2018.

4.3. Washington Network Monitoring

Through the process of implementing the CAA, EPA has identified several major categories of monitoring stations or networks that apply to the measurement of the criteria air pollutants. The Washington Network is comprised of stations that are part of national monitoring network program efforts, the National Air Toxics Trends Stations network, and one interagency program.

4.3.1. State and Local Air Monitoring Stations

State and Local Air Monitoring Stations (SLAMS) comprise the majority of monitoring sites within the Washington Network. Many Washington Network SLAMS sites support criteria pollutant measurements for NAAQS compliance and the satisfaction of SIP requirements through the use of Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitors. At Washington Network SLAMS sites where pollution levels are well below the NAAQS, non-FRM/FEM monitors are often used.

All SLAMS monitoring with FRM/FEM monitors must meet the requirements of 40 C.F.R. Part 58 contained in:

- Appendix A (Quality Assurance Requirements)
- Appendix C (Ambient Air Quality Monitoring Methodology)
- Appendix D (Network Design Criteria)

- Appendix E (Probe and Path Siting Criteria)

All SLAMS monitoring with non-FRM/FEMs, must meet the requirements of 40 C.F.R. Part 58 requirements contained in:

- Appendix D (Network Design Criteria)
- Appendix E (Probe and Path Siting Criteria)

SLAMS monitoring must also meet all Washington Network quality control, siting, and methodology requirements as described in this Quality Assurance Plan and the Ecology-approved, Washington Network standard operating procedures.

Non-FRM/FEM Criteria Pollutant SLAMS Monitoring

Many SLAMS sites in the Washington Network use non-FRM/FEM monitors to estimate levels of $PM_{2.5}$ pollution and inform the public of air quality conditions in communities where air pollutant monitoring is not required.

4.3.2. Near-Road Monitoring

Per the Near-road minimum monitoring requirements described in 40 CFR Part 58, Appendix D, Ecology operates two Near-road stations. The Seattle-10th & Weller Phase 1 multi-pollutant site monitors NO_2, CO, continuous FEM $PM_{2.5}$, filter-based $PM_{2.5}$ chemical speciation, and meteorology. This site also serves as a platform for occasional special studies and research projects. The Tacoma-South 36th St. Phase 2 site measures NO_2, continuous FEM $PM_{2.5}$, and meteorology.

4.3.3. National Core Monitoring Network

National Core Monitoring (NCore) is a multi-pollutant network that integrates several advanced measurement systems for particles, gaseous pollutants, and meteorology.

The NCore Network addresses the following objectives:

- Timely reporting of data to public by supporting AirNow, air quality forecasting, and other public reporting mechanisms
- Support for development of emission strategies through air quality model evaluation and other observational methods
- Accountability of emission strategy progress through tracking long-term trends of criteria and non-criteria pollutants and their precursors
- Support for long-term health assessments that contribute to ongoing reviews of the NAAQS
- Compliance through establishing nonattainment/attainment areas through comparison with the NAAQS
- Support to scientific studies ranging across technological, health, and atmospheric process disciplines

- Support to ecosystem assessments recognizing that national air quality networks benefit ecosystem assessments and, in turn, benefit from data specifically designed to address ecosystem analyses

There are two NCore stations within the Washington Network, Seattle-Beacon Hill and Cheeka Peak. Beacon Hill is designated as urban NCore while Cheeka Peak, which is located on the northwestern tip of the Olympic Peninsula, is designated a rural NCore station. The Cheeka Peak site is funded by EPA and operated by the Olympic Region Clean Air Agency and the Makah Nation Air Quality Program. The Ecology AQP and ORCAA have established contractual agreements for Ecology to provide support of monitoring operations. As such, the operations of supported NCore parameters adhere to Ecology's Quality Assurance Plan and SOPs and therefore, are part of the Washington Network.

4.3.4. Special Purpose Monitoring Stations

Special Purpose Monitoring Stations (SPMS) are designed to meet discrete, typically shorter-term, goals and are designated as such in Ecology's annual Ambient Air Monitoring Network Report and in EPA's Air Quality System (AQS). Monitoring activities at these stations are designed to supplement the longer-term SLAMS network, report near-real-time pollution information for EPA's AQI and Ecology's Washington Air Quality Advisory (WAQA), and be flexible enough to accommodate changing program needs and priorities. SPMS may collect exploratory air quality data for up to 24 months before the data is eligible for comparison to the NAAQS. At the point, the site is typically discontinued, or designated as SLAMS.

All Washington Network SPMS monitoring with FRM/FEM monitors must meet the requirements of 40 C.F.R. Part 58 contained in:

- Appendix A (Quality Assurance Requirements)
- Appendix C (Ambient Air Quality Monitoring Methodology)
- Appendix E (Probe and Path Siting Criteria)

All SPMS with non-FRM/FEMs must meet the requirements of 40 C.F.R. Part 58 contained in:

- Appendix E (Probe and Path Siting Criteria)

SPMS must also meet all Washington Network quality control, siting, and methodology requirements as described in this Quality Assurance Plan and the Ecology-approved, Washington Network standard operating procedures.

4.3.5. PM2.5 Chemical Speciation Network

The $PM_{2.5}$ Chemical Speciation Network (CSN) is an EPA-funded national network of monitors which are used to determine the chemical makeup of $PM_{2.5}$. Trends in concentration levels of selected ions, metals, carbon species, and organic compounds that comprise $PM_{2.5}$ are determined over the period of several years at fixed monitoring sites. Ecology and its partners use CSN data to conduct source apportionment studies at locations in Washington State recording $PM_{2.5}$ pollution levels near the NAAQS. The results from these studies are used to guide the development of effective control strategies.

CSN monitoring is conducted at the NCore station in Seattle – Beacon Hill and a handful of supplemental chemical speciation sites in the Washington Network. A list of the CSN and supplemental sites can be found in the current version of the annual Ambient Air Monitoring Network Report available on Ecology's website.

The CSN is a component of the National $PM_{2.5}$ SLAMS network. Although the CSN network is intended to complement SLAMS activities, CSN data is not used for determining NAAQS compliance. The objectives of the CSN network are:

- Determine the chemical makeup of $PM_{2.5}$
- Understand which sources contribute to $PM_{2.5}$ at each site
- Determine the spatial and temporal differences of $PM_{2.5}$ composition between geographical areas
- Provide representative $PM_{2.5}$ speciation data to support exposure assessments (i.e. determine health risks)
- Provide data for source apportionment and model evaluation

4.3.6. National Air Toxics Trend Stations

EPA developed the National Air Toxics Trends Station (NATTS) Network to fulfill the need for long-term Hazardous Air Pollutant (HAP) monitoring data of consistent quality. Among the principle objectives are assessing trends and emission reduction program effectiveness, assessing and verifying air quality models (e.g., exposure assessments, emission control strategy development, etc.), and as direct input to source-receptor models. The current network configuration includes 24 sites (19 urban, 5 rural) across the United States; thirteen sites were established in 2003, ten sites in 2004, and two sites each in 2007 and 2008. There are typically over 100 pollutants monitored at each NATTS (though only 19 of those are required; included are VOCs, carbonyls, PM_{10} metals, and PAHs). There is currently a single site in the Washington Network located at Seattle - Beacon Hill, which was added to the NATTS Network in 2003.

EPA's provides grants, such as the Community Scale Air Toxics Grant, that Washington Network Partners have leveraged to conduct additional toxic monitoring. Past air toxics monitoring has been conducted in Spokane, Seattle, Tacoma, Vancouver/Kelso/Longview, and Olympia/Lacey.

There is a project-specific QAPP for the NATTS monitoring at Seattle-Beacon Hill (available on Ecology's website). For all other air toxics projects, unless otherwise directed by EPA Region 10, a separate QAPP is required and must be submitted by the Project Manager to the AQP's Quality Assurance Coordinator before any sampling begins. The QAPP must provide clear monitoring objectives and a detailed description of the quality control activities pursuant to satisfying those objectives.

4.3.7. Photochemical Assessment Monitoring Stations

In October of 2015, EPA finalized changes to the Photochemical Assessment Monitoring Stations (PAMS) minimum monitoring requirements as part of its review of the ozone NAAQS.

EPA updated 40 CFR Part 58, Appendix D to require state and local monitoring agencies to collect and report Photochemical Assessment Monitoring Stations (PAMS) measurements at each NCore site located in a Core-Based Statistical Area (CBSA) with a population of 1,000,000 or greater. The Seattle-Beacon Hill NCore site meets these new criteria. PAMS monitoring for a wide array of ozone precursors and associated meteorological measurements is now slated in federal rule to begin on June 1, 2021. At a minimum, PAMS monitoring will be required June 1st through August 31st each year. Planning is currently underway to implement PAMS monitoring and an associated quality system at Beacon Hill to assure sufficient data quality to improve understanding of ozone precursors in the CBSA and add valuable information to the national PAMS network.

4.3.8. Interagency Monitoring of Protected Visual Environments

Though not an official part of the Washington Network, the AQP provides operation for the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring at its Seattle-Beacon Hill urban NCore site.

The IMPROVE program is a cooperative measurement effort governed by a steering committee comprised of representatives from federal and regional-state organizations. The IMPROVE monitoring program was established in 1985 to aid the creation of Federal and State implementation plans for the protection of visibility in Class I areas stipulated in the 1977 amendments to the Clean Air Act.

The objectives of IMPROVE are:

- To establish current visibility and aerosol conditions in mandatory class I areas
- To identify chemical species and emission sources responsible for existing man-made visibility impairment
- To document long-term trends for assessing progress towards the national visibility goal
- To provide regional haze monitoring representing all visibility-protected federal class I areas where practical

4.3.9. Contract-supported Special Purpose Monitoring Stations

The AQP enters into agreements and contracts with EPA and local air agencies for operational and quality assurance support of various supplemental monitoring activities around the state. These contract-supported sites are usually designated as SPMS and are treated as part of the Washington Network. All contract-supported monitoring activities are conducted in accordance with Ecology's quality system requirements as described in this Quality Assurance Plan and the Washington Network SOPs. Data collected from these stations that are found to meet all data quality requirements are validated and submitted to AQS. A list of the current contract-supported sites can be obtained in the most recent version of Ecology's annual Ambient Air Monitoring Network Report available through Ecology's website.

5. Data Quality Objectives and Criteria

Data are never completely error free. Therefore, it is critical that those involved in making decisions using air monitoring data understand the inherent error (uncertainty) of those data. Various metrics of data quality serve to guide the level of confidence associated with such decisions and can help inform changes to data collection processes that may reduce future uncertainty. Decision makers must establish acceptable limits on these data quality metrics and understand the quality of collected data in order to reduce the risk of making poor decisions.

EPA is responsible for developing the NAAQS, defining the quality of the data necessary to make comparisons to the NAAQS, and identifying the minimum amount and nature of quality control activities from which to evaluate data quality. The AQP is responsible for developing and implementing a quality system to ensure data quality requirements within the Washington Network are met. The AQP assesses the quality of collected data and implements corrective actions when data quality is insufficient for user needs.

5.1. Data quality objectives and the data quality objective process

The EPA Quality Assurance Handbook, Volume II, defines Data Quality Objectives (DQOs) as qualitative and quantitative statements that:

- Clarify the purpose of the study
- Define the most appropriate type of information to collect
- Determine the most appropriate conditions from which to collect that information
- Specify tolerable levels of potential decision errors

EPA developed the DQO process in the 1980s to help ensure data quality and data collection efficiency in regard to monitoring for NAAQS compliance. The DQO process has evolved over time to reflect best scientific principles and project management. It can best be thought of as a systematic planning process for efficiently generating environmental data that will be sufficient for their intended use and for managing decision errors. The underlying principles of the DQO process are:

- All collected data contain some amount of error
- No organization can afford absolute certainty (completely error free data)
- The DQO process defines tolerable error rates
- Absent DQOs, decisions are uninformed
- Uninformed decisions tend to be flawed and expensive

The DQO process (Figure 7 below) functions to identify the allowable population and measurement uncertainty for a given objective. The monitoring program is then developed and

quality control samples are identified and implemented. The results of quality control samples and supporting information allow for data quality to be assessed. When assessments reveal that data quality is not sufficient for intended uses, corrective measures are taken in order to ensure that the monitoring program is maintained within the established acceptance criteria.

Data collected in the Washington Network are used to make decisions that can have health and economic impacts on the area represented by the monitor. The MAC and AQPLT must have confidence that the data used to make environmental decisions are of sufficient quality. Therefore, the DQO process is used within the Washington Network and applied to all monitoring projects.

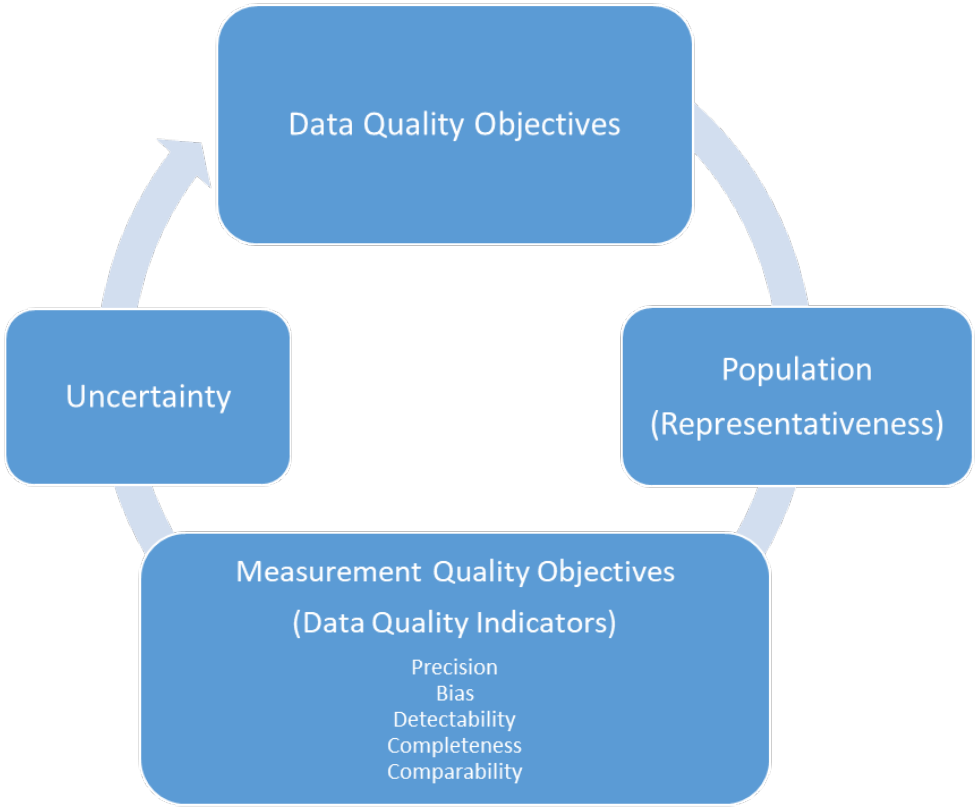

Figure 7 - The data quality objective process

Before any monitoring begins, the MAC determines the DQOs for a given project or study in order to:

- Clarify the study objective
- Identify the target population(s) of the monitoring study
- Define the most appropriate type of data to collect
- Determine the most appropriate conditions/times of year during which to collect data
- Specify limits on decision errors which will be used as the basis for establishing the quantity and quality of data needed to support the decision

DQOs are particularly important when pollution levels are near NAAQS violations due to the possibility that error in the measurements may falsely indicate a NAAQS violation when pollution levels are actually below the NAAQS, or vice versa.

For this reason, the MAC has implemented a Washington Network policy that FEM/FRM instruments will be used when monitored concentrations at a network monitoring site are consistently at or above 80% of the NAAQS.

The Quality Assurance team conducts monthly review and final level data validation to ensure that DQOs are being met. The QA team also assesses data quality at regular intervals and provides this information to air monitoring personnel and managers. Through these activities, the team identifies quality system non-conformances and recommends improvements in monitoring systems or processes in order to reduce error and provide the program and our partners with greater confidence that attainment designation recommendations are defensible and correct. When any of the DQOs are not met, the AQP QAC works with the Air Monitoring Coordinator, air monitoring station operators, and managers to implement adjustments to the project to address non-conformances and reduce uncertainty to acceptable levels. The Air Monitoring and QA Coordinators update the MAC in regard to changes in monitoring protocol at bi-monthly MAC meetings.

5.1.1. Measurement quality objectives

Measurement quality objectives (MQOs) are identified as the various quality control (QC) samples or QC activities undertaken to ensure DQOs are met. Data verification/validation is the process of reviewing information to ensure that data of unacceptable quality are identified and appropriately handled (i.e., removed from the data set or flagged) so as to not adversely impact the decision making process.

MQOs are designed to evaluate and control various phases (e.g., sampling, transportation, preparation, and analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the DQOs. MQOs can be defined in terms of the following Data Quality Indicators (DQI):

- Precision
- Bias
- Representativeness
- Detection limit
- Completeness and
- Comparability

The Air Monitoring Coordinator works with the Quality Assurance Coordinator to determine appropriate MQOs for proposed monitoring projects.

5.1.2. Data quality assessments

The Air Quality Program Quality Assurance team uses the EPA's Air Quality System (AQS) AMP256 QA Data Quality Indicator Report and AMP 430 Data Completeness Report to prepare

quarterly Ambient Air Monitoring Data Quality Assessment Reports for the AQPLT, MAC, and Washington Network partners. The Data Quality Assessments quantify how well the Washington Network is doing in terms of meeting its MQOs. The AQP Quality Assurance Coordinator also provides updates to the MAC at bi-monthly meetings as to the status of MQOs for the Washington Network and keeps decision makers informed as to whether the quality of collected data is sufficient for decision making.

5.1.3. Ecology Air Program data quality goals

A primary goal of the Air Quality Program is to collect data within the Washington Network that is of appropriate quality and quantity for intended uses. The MAC, AQPLT and Washington Network partners recognize that good decisions depend on high quality data collected for a well-defined, specific purpose.

The Washington Network quality system developed by Ecology's Air Quality Program is designed to produce results that will:

- Meet a well-defined use or purpose
- Help the program achieve its strategic goals and objectives
- Comply with federal and state quality system requirements
- Reflect consideration of cost and resources
- Match data quality needs to intended uses

6. Personnel Qualifications and Training

Ambient air monitoring personnel must have sufficient education, training, and skills in order to properly operate a variety of complex air sampling instrumentation and associated equipment. Basic knowledge of ambient air monitoring principles, meteorology, chemistry, statistics, and physics are important to ensure competency. Personnel involved in air monitoring activities often interact with the public and staff from federal and state agencies and Native American tribes. Therefore, good interpersonal, verbal, and written communication skills are also critical to successfully carrying out assigned duties. The physical ability to travel to and from monitoring sites by vehicle, occasional overnight travel, climbing of ladders, and carrying equipment of up to 50 lbs. are necessary to be an ambient air monitoring station operator.

6.1. Qualifications

All of Ecology's air monitoring personnel are hired through a competitive process and must meet minimum qualifications defined by the State of Washington and Ecology Human Resources.

To ensure proficiency of its air monitoring personnel, all Ecology air monitoring and quality assurance staff are classified at the Environmental Specialist 4 or higher. In order to qualify for these positions, staff must have commensurate education and qualifications (typically a Bachelor's degree or higher) to perform their work in air monitoring/quality assurance at a highly technical level.

6.2. Training

New Ecology air monitoring personnel are required to complete training that will prepare them for their specific Washington Network job duties. Training may be tailored slightly depending on the specialty area for the position. Below is the example of a training plan for an air monitoring operator. Typically, plans must be completed within the first calendar year. Unit supervisors (NWRO/SWRO and ERO) are responsible for ensuring new Ecology air monitoring personnel meet all training requirements and review required and recommended training during annual performance evaluations. Unit supervisors also document and keep copies of completed training plans, as well as review transcripts in Ecology's Learning Management System. Ecology has a training and development team that manages the Learning Management System and required and recommended training courses.

Table 5 - Example of Ecology station operator training plan

TRAINING ELEMENTS: **On-The-Job Training and/or Field Experience:** **ACTIVITY TO BE PERFORMED/LEARNED**
Read and become familiar with Ecology's Quality Assurance Plan and instrument standard operating procedures (SOPs)
Read and become familiar with federal 40CFR Parts 58, appendices A, D, and E and Quality Assurance Handbooks volumes 2 and 4
Job-shadow NWRO NATTS and Trace-gas operator. Accompany them on as many trips into the field as it takes to feel comfortable completing all of the following tasks: • Perform at air toxics quality control (QC) checks (recommend X 4) • Perform manual nephelometer QC checks (recommend X 4) • Perform four ozone manual QC checks (recommend X4). • Collect, document, and ship National Air Toxics Trends Site (NATTS) air toxics samples (recommend X 4)

TRAINING ELEMENTS: **On-The-Job Training and/or Field Experience:** **ACTIVITY TO BE PERFORMED/LEARNED**
Work with NWRO NATTS and Trace-gas operator and other staff to learn these – your primary areas of responsibility: Visit the NWRO and CRO monitoring sites you will operate: • Beacon Hill • Enumclaw • Wenatchee • Ellensburg Do the following activities at the above locations and become proficient in these areas: • Perform meteorological quality control (QC) checks • Perform manual nephelometer QC checks • Perform ozone manual QC checks • Perform filter-based $PM_{2.5}$ or PM_{10} QC checks • Perform CO and NO_2 manual quality control checks • Perform routine maintenance, clean parts, replace batteries and change filters. • Collect, document, and ship Federal Reference Method (FRM) $PM_{2.5}$ samples. • Collect, document, and ship speciation samples.

TRAINING ELEMENTS: **On-The-Job Training and/or Field Experience:** **ACTIVITY TO BE PERFORMED/LEARNED**
Job-shadow NWRO's Speciation and Near-road operator. Accompany them on as many trips into the field as it takes to become proficient in all of the following tasks: • Visit the NWRO monitoring sites they operate Cross-train doing the following activities: • Perform meteorological quality control (QC) checks • Perform nephelometer QC checks • Perform $PM_{2.5}$ Chemical Speciation Network QC checks • Perform ozone manual QC checks • Perform filter-based $PM_{2.5}$ or PM_{10} QC checks • Perform CO and NO_2 manual quality control checks • Perform BAM-1020 QC checks and perform routine maintenance • Collect, document, and ship at least four Federal Reference Method (FRM) $PM_{2.5}$ samples. • Collect, document, and ship speciation samples
Job Shadowing the SWRO operator. Accompany them to the Tacoma-S. 36th St. site in Tacoma: Cross-train by doing the following activities: • Perform BAM-1020 QC checks (recommend X 2). • Perform DART review

TRAINING ELEMENTS: **On-The-Job Training and/or Field Experience:** **ACTIVITY TO BE PERFORMED/LEARNED**
Late spring/early summer, Job Shadow ERO $PM_{2.5}$ and ozone operator. Accompany them on trips into the field to complete the following tasks: Accompany them to the following sites in the Central Region: • Wenatchee • Ellensburg Cross-train by doing the following activities: • Perform meteorological quality control (QC) checks • Perform manual nephelometer QC checks
Coordinate with Calibration & Repair lab staff for a day-long visit to the Calibration & Repair lab: Train with them on: • M903 nephelometer operations, calibration, and maintenance • Beta Attenuation Monitor 1020 PM2.5 monitor operations and maintenance • Ultrasonic meteorological sensor operation and recertification process • Flow and temperature standard verification processes • Ozone operations and maintenance (This will be a big part of what you'll be doing.) • Multi-gas calibrator operations and maintenance

TRAINING ELEMENTS: **On-The-Job Training and/or Field Experience:** **ACTIVITY TO BE PERFORMED/LEARNED**
Train with Quality Assurance staff: Meet with Quality Assurance Coordinator (QAC) to learn: • Quality system requirements overview • Documentation • Level 1 data review processes Coordinate with the QAC and QA staff to accompany them on audit trips. Include met, ozone and BAM audits. • Two audit trips with QA staff conducting field audits • Learn the gaseous auditing process • One audit trip with QA staff conducting field audits. • Evaluate the air monitoring site for accordance with 40 CFR 58, Appendix E siting and adherence to federal regulations and monitoring objectives.
Coordinate with the SWRO & Air Quality Operations Supervisor to meet with Telemetry Specialist and AQS Coordinator at HQ: • Learn what the Telemetry Specialist does for site communications and data polling, data logger configuration, modems and channel set up. • Learn what the AQS Coordinator does to submit data to EPA. Learn how to enter data in SIMS
Use Excel, R, or other statistical software to analyze and visually present air quality data collected at one site within the NWRO jurisdiction.

TRAINING ELEMENTS: **On-The-Job Training and/or Field Experience:** **ACTIVITY TO BE PERFORMED/LEARNED**
Become proficient with the EnvistaARM software (your NWRO teammates can give you an introduction and the manual) • Learn how to run a variety of reports to analyze and conduct level 1 data review • Station reports (1-hour and 1-minute) • Group reports (comparability of like-monitors) • Calibration reports • Log book reports • Diagnostics reports • Learn how to make new log book entries
Become proficient with Envidas Ultimate data loggers and software tools to: • Review calibration results • Make logbook entries • Disable channels • Run reports for raw data and diagnostic data • Review configurations of data channels, calibration sequences, and diagnostic information
Take available online and classroom air monitoring/QA training: • SI:471 – General Quality Assurance Considerations for Ambient Air Monitoring • APTI- SI:409 – Basic Air Pollution Meteorology • Online Chemical Speciation Training – available through AMTIC • APTI 464 – Analytical Methods for Air Quality Standards • APTI 470 – Quality Assurance for Air Pollution Measurement Systems • EPA Photochemical Assessment Monitoring Station (PAMS) training

External partner agencies and tribes within the Washington Network have their own minimum requirements for air monitoring personnel. However, there is a basic set of knowledge, ability,

and skill necessary to be a competent air monitoring operator in the Washington Network. Air monitoring personnel must be capable of performing the following basic functions independently with limited assistance from Ecology staff:

- Installing, operating, and maintaining of environmental monitoring/sampling equipment
- Calibrating environmental monitoring/sampling equipment, in accordance with manufacturer specifications and standard operating procedures
- Performing basic sampling data review to ensure data validity
- Operating a computer and using typical office software products (e.g., Microsoft Outlook, Word, PowerPoint, and Excel)
- Reviewing monitoring plans for technical accuracy
- Conducting routine sampling and testing
- Analyzing, evaluating and interpreting data, writing reports
- Ability to use environmental spreadsheets and databases in support of monitoring projects

Ecology Quality Assurance personnel help to ensure Washington Network operators are adequately trained to perform their duties through routine performance and system audits conducted in the field and through routine review and verification of operator quality control and maintenance documentation. When operators are found not to be performing duties at a level commensurate with ensuring Data Quality Objectives are met, the AQP QAC provides feedback to management at the appropriate agency/tribe. Routine feedback is provided to Washington Network partner agencies through the quarterly Data Quality Assessment reports.

6.2.1. Ecology-provided training

Ecology Calibration & Repair, Quality Assurance, and air monitoring personnel provide periodic training to local air agency, tribal, federal agency, and Ecology station operators on the proper calibration, operation, quality control, and maintenance activities for instruments used in the Washington Network. These activities are also described in detail in the instrument-specific SOPs. To the extent possible, Ecology provides training to all new network operators as well as training to all operators, regardless of years of monitoring experience, for any monitoring equipment that has not been previously used in the Washington Network.

Ecology's Environmental Assessment Program Quality Assurance Program provides additional information and training on fundamental quality assurance principals.

6.2.2. External training

Additional training is available through EPA and other external organizations and is highly recommended for both Ecology and external Washington Network partner personnel. Instructional seminars and training courses may be provided as pre-recorded videos, webinars, online presentations, and in-person classroom instruction. Several Air Pollution Training Institute (APTI) courses are offered through organizations such as the Western States Air

Resources Council (WESTAR) and the Mid Atlantic Regional Air Management Association (MARAMA).

Air Quality Program QA staff responsible for auditing the $PM_{2.5}$ Chemical Speciation Network and Supplemental sites are required to take online training provided by EPA's Office of Air Quality Planning and Standards (OAQPS).

The Air Quality Program's AQS Coordinator is required to take online AQS training available through EPA's Technology Transfer Network (TTN) and, whenever feasible, in person training provided during National Ambient Air Monitoring Conferences.

The Institute for Tribal Environmental Professionals (ITEP) and Tribal Air Monitoring Support (TAMS) Center provides a series of courses that serve as a great resource for tribal nation air monitoring operators.

Table 6 below presents a list of Ecology-recommended training for ambient air monitoring laboratory, field, and quality assurance staff as well as managers overseeing the work in the various areas.

Table 6 - Recommended training courses for ambient air monitoring personnel

Presenting Entity	Course Name	Lab/Field	QA	Managers
APTI SI-422	Air Pollution Control Orientation Course	X	X	X
APTI SI-105	Introduction to Air Pollution Control	X	X	X
APTI 452	Principles and Practices of Air Pollution	X	X	X
APTI SI-434	Introduction to Ambient Air Monitoring	X	X	X
APTI SI-473A	Beginning Environmental Statistical Techniques	X	X	X
APTI 435	Atmospheric Sampling (1983) ($PM_{2.5}$ Monitoring Update - 1998)	X	X	X
APTI SI-471	General Quality Assurance Considerations for Ambient Air Monitoring	X	X	X
APTI SI-474	Introduction to Environmental Statistics	X	X	
APTI 464	Analytical Methods for Air Quality Standards	X	X	
APTI 470	Quality Assurance for Air Pollution Measurement Systems	X	X	X
APTI SI-433	Network Design and Site Selection for Monitoring $PM_{2.5}$ and PM_{10} in Ambient Air			X
APTI SI-436	Site Selection for Monitoring $PM_{2.5}$ and PM_{10} in Ambient Air	X	X	X
APTI SI-409	Basic Air Pollution Meteorology	X	X	X
EPA online	Assessing Quality Systems		X	X
EPA online	Detecting Improper Laboratory Practices		X	X
EPA online	Introduction to Data Quality Assessment		X	X
EPA online	Introduction to Data Quality Objectives		X	X
EPA online	Introduction to EPA Quality System Requirements	X	X	X
EPA online	Introduction to Quality Assurance Project Plans	X	X	X

6.2.3. Conferences and professional organizations

Air monitoring and quality assurance personnel are strongly encouraged to attend and contribute input to professional conferences in order to benefit from the many opportunities these venues provide. Active participation and networking opportunities with colleagues from other agencies, organizations, and businesses around the states maximize the opportunity for individual professional growth and benefit for the all people in Washington State.

Several organizations provide information and professional development opportunities for staff to pursue. WESTAR, The National Association of Clean Air Agencies (NACAA), MARAMA, and the Air and Waste Management Association (AWMA) are just a few of the many organizations that provide opportunities to access the latest information on important air pollution topics, learn about the associations' positions and initiatives, and find links to other related content and websites.

6.2.4. Vendor training

Several vendors of air monitoring equipment offer specialized training courses. Many of these courses are instrument-specific (e.g. Teledyne Advanced Pollution Instrumentation, Met One Instruments) and provide technicians with hands-on instruction. Several offer customized training classes and off-site training for specific needs.

6.2.5. Other learning resources for air monitoring professionals

Monitoring objectives can differ greatly between individual states, tribes, and local agencies. EPA's OAQPS provides national oversight with limited resources and invites agencies to participate in policy making activities. Ecology's AQP encourages staff to participate in OAQPS-sponsored committees, workgroups, and conferences in order to share perspectives with others performing similar work around the nation, as well as to gain a greater understanding of how decisions impacting policy are made.

The Ambient Monitoring Technology Information Center (AMTIC) is operated by EPA's Ambient Air Monitoring Group (AAMG). AMTIC is an excellent source of information on ambient air quality monitoring programs, details on monitoring methods including QAPPs and SOPs, relevant documents and articles, information on air quality trends and nonattainment areas, and federal regulations related to ambient air monitoring.

7. Documentation and Records

By May 1st of each year, the Air Quality Program is required by EPA to submit an annual Data Certification Report (AMP600) to the EPA Administrator, through its Region 10 office. This report certifies the validity of all Washington Network SLAMS and SPMS FRM/FEM data in AQS for the previous calendar year. The report and associated letter from the Air Quality Program Manager certifies that the given year's data are accurate to the best of his/her knowledge. The certifications are based upon on the various data quality assessments and validation process performed by the organization.

7.1. Electronic and manual records

The vast majority of data collected by the Air Quality Program is collected and stored electronically, and managed by Air Quality's Informational Technology team. Electronic data are stored in databases, shared network drives, and other locations. Raw and edited ambient air quality and most quality control data are securely stored in a SQL database backed up daily at the Washington State Data Center and accessible by Ecology's Air Quality Informational Technology team. The State Data Center as well as Ecology follow best Informational Technology practices for the security of data and systems. One-hour ambient air monitoring data and, as of 2019, 1-minute ambient air monitoring data, are kept in perpetuity and backups of stored data are done daily.

Manual quality control checks for air monitoring instrumentation must be documented on the Quality Control check forms provided in the parameter-specific SOPs, as well as in the electronic log book. These forms are stored in shared network drives, and backed up daily. Further information about documentation and records can be found in Ecology's Documentation, Data Review, and Validation SOP.

Table 7 - Washington Network record storage locations

Categories	Record	File Location
Management and Organization	State Implementation Plan Reporting agency information Organizational structure Personnel qualification and training Training certification Quality management plan EPA directives Grant allocations Support contracts	Headquarters-Lacey
Site Information	Network description Site Information Management System Site meta data Site maps Site pictures	Headquarters-Lacey
Environmental Data Operations	QA Plan QA Project Plans Standard Operating Procedures Electronic field notes Calibration Standards	Headquarters-Lacey
Environmental Data Operations	Laboratory notebooks Sampling handling/custody records	Manchester Laboratory
Raw & Edited Data	Lab results (tare/gross weights); lab QC results	Manchester Laboratory
Raw & Edited Data	Ambient air monitoring data QC data and results QC forms	Headquarters-Lacey
Data Reporting	Washington Air Quality Advisory Annual Data Certifications	Headquarters-Lacey
Data Management	Nephelometer-$PM_{2.5}$ correlations/models Data management plans/flowcharts Data Acquisition System	Headquarters-Lacey
Air Monitoring Coordination	Network reviews	Headquarters-Lacey

Categories	Record	File Location
Quality Assurance	Data quality assessments QA reports System audits Response/corrective action reports Performance audits and audit standards	Headquarters-Lacey

7.2. Data acquisition system

The Air Quality Program utilizes Envitech Ltd./DR DAS (Envidas) software products for electronic data collection, review, verification, validation, and submittal to AQS. A customized off-the-shelf Envidas website is used for near-real-time display of continuous monitoring data, basic site information, and display of the Washington Air Quality Advisory. All collected data is stored in an Envidas database on a Microsoft SQL platform physically located at Ecology's Headquarters building in Lacey, WA and managed by the Air Quality Program's Information Technology staff.

More information on Ecology data acquisition and management system can be found in Section 20 of this document.

7.3. Site Information Management System

Site information is retained by the Air Quality Program to record physical changes and characterize sites through time. The Air Quality Program's Site Information Management System (SIMS) and the Ecology ambient air monitoring website are used to capture, track changes, and retain site information. This information is updated by station operators as monitored parameters and/or physical conditions at the site change. Calibration & Repair personnel and the NWRO/SWRO & Air Quality Operations Unit Supervisor update the Equipment Inventory portion of SIMS to track the location and age of air monitoring equipment.

SIMS information includes:

- Monitoring objective (e.g., population exposure, highest concentration, etc.)
- Monitor/Station type (SLAMS, SPMS, NCore, etc.)
- Instrumentation and methods (pollutant being measured, instrument manufacturer's make and model, etc.)
- Measurement scale (micro, middle, neighborhood, etc.)
- Land use (industrial, commercial, etc.)
- Location setting (urban, rural, etc.)

- Physical location and characteristics (address, latitude and longitude coordinates, elevation, etc.)
- Probe location (top of building, ground level, etc.)
- Equipment inventory

Ecology's air monitoring website information includes:

- Site photos, including the monitoring shelter 8 compass cardinal point pictures
- A map showing the location of all monitoring locations in the state

7.4. Environmental data operations

The Air Quality Program and its Washington Network partners recognize that ambient air monitoring results, and in certain types of measurements, the sample itself, may be essential elements in proving the validity of the data or the decisions made using the data. Data will not withstand scrutiny, particularly in the event of legal challenge, unless it can be shown that they are representative of the conditions that existed at the time that the data (or samples) were collected. Therefore, Washington Network partners follow several steps to assure the evidentiary phase of the quality assurance process is preserved. Failure to include, follow, and document any of the following elements in the collection and analysis of ambient air monitoring data may render the results inadmissible as evidence or seriously undermine the credibility of any report based on the data.

- **Quality Assurance Project Plans (QAPPs)** – QAPPs document how environmental data operations are planned, implemented, and assessed during the life cycle of a program, project, or task.
- **Standard Operating Procedures (SOPs)** – SOPs are detailed documents that provide instruction on how Washington Network staff will perform daily tasks in the field, laboratory, and office. SOPs are a required element of a QAPP and therefore any EDO must include these.
- **Field and laboratory documentation** – Any documentation, electronic or hard copy, that provides additional information about the environmental data operation (e.g., calibration results, visual representations of data, temperature records, site notes, maintenance records, etc.).
- **Electronic Logbook** – The Envidas Ultimate Reporter logbook is used to create electronic records of activities and sampling comments for field and other personnel. Logbook entries provide a record of monitor and site maintenance and other activities and information regarding aspects of the monitoring operations that may impact data quality.
- **Sample handling records** – These are records tracing sample and data handling from the lab, to the site, and all the way through the analysis process. These are records of transportation to facilities, sample storage, and handling between individuals within facilities.

7.5. Standard operating procedures

Standard Operating Procedures are made available to all Washington Network personnel in order to ensure that sampling and analysis operations are carried out in a consistent manner, collection errors are minimized, and comparability of data across the various pollutant networks is maximized. The SOPs detail the method for each operation, required quality control, quality control action and acceptance limits, and preventive maintenance activities. All Washington Network monitoring is required to be carried out in accordance with the SOPs.

The Washington Network's instrument-specific SOPs are written in a step-by-step format to be readily understood by a person knowledgeable in the general concept of the procedure and help ensure consistent conformance with Washington Network practices. SOPs serve as training aids, provide ready reference and documentation of proper procedures, maximize operational efficiency and minimize costs, reduce error occurrences in data, and improve data comparability, credibility, and defensibility.

Procedures are revised at three year intervals and when new methods or instruments are utilized in the Washington Network. A list of the Washington Network SOPs can be found on Ecology's website.

7.6. Record retention

In April of 2018, the Office of the Secretary of State of Washington revised the requirements for the retention and disposition of information and records relating to environmental monitoring, including ambient air monitoring. Ecology must follow the following record retention protocol for all environmental monitoring efforts:

- Retain for 25 years after date of final report or publication then
- Transfer to Washington State Archives for permanent retention

Records that fall into this record retention schedule include:

- Final reports
- Field notes, project data, analysis and summaries

To help satisfy these requirements 1-hour ambient air monitoring data are maintained in perpetuity in electronic form. As of 2019, 1-minute data are also retained in perpetuity in electronic form. In addition, records subject a litigation hold issued by the Attorney General's office are subject to additional retention pursuant to Ecology policy 20-12, throughout the period of any anticipated or ongoing litigation.

8. Monitoring Network Design

The Washington Network was designed to meet the three monitoring objectives defined in 40 CFR Part 58, Appendix D:

1. **Provide air pollution data to the public in a timely manner**. Ecology provides timely air quality data to the public in a variety of ways, including:
    - Near-real-time data are available on Ecology's monitoring website and via the EPA's AirNow.
    - Ecology conducts public outreach and issues alerts and bulletins when air quality is compromised.
2. **Support compliance with National Ambient Air Quality Standards (NAAQS) and development of pollution control strategies**. Ambient air quality data are used to:
    - Determine compliance with the NAAQS
    - Determine the location of maximum pollutant concentrations
    - Track the progress of SIPs
    - Determine the effectiveness of air pollution control programs
    - Develop responsible and cost-effective emission control strategies
    - Assist with permitting work
3. **Support air pollution research**. Ecology and its partners use ambient air quality data to improve our understanding of air pollution and its consequences. Research applications of air quality include:
    - Improving air quality forecasting
    - Evaluating the effects of air pollution on public health
    - Informing dispersion models
    - Identifying air quality trends and emerging pollution issues
    - Analyzing pollution events

In order to meet these three objectives, 40 C.F.R. Part 58 Appendix D calls for the design of SLAMS networks to include several different types of monitors. These general types are sites that:

1. Determine the highest pollutant concentrations expected in the area covered by the network.
2. Determine representative pollutant concentrations in areas of high population density.
3. Determine the impact of significant sources or source categories on pollutant concentrations in the ambient air.

4. Determine general background pollutant concentrations.
5. Determine the regional extent of pollutant transport between populated areas.
6. Determine the impacts on visibility or vegetation (welfare impacts) in more rural and remote areas.

Appendix D also provides guidance on spatial scales of representativeness for stations in a SLAMS network. Ideally, the station is located so that its sample represents the air quality across the scale that the station is intended to represent. Appendix D defines the following spatial scales:

- **Microscale**: Area dimensions between several and 100 meters.
- **Middle scale**: Areas between 100 and 500 meters, typically several city blocks.
- **Neighborhood scale**: Areas between 0.5 and 4 kilometers with relatively uniform land use.
- **Urban scale**: Areas with city-like dimensions between 4 and 50 kilometers. Urban and neighborhood scales can overlap considerably. Heterogeneous urban areas may not have a single representative site.
- **Regional scale**: Areas from tens to hundreds of kilometers with relatively homogeneous geography and no large sources.
- **National and global scales**: Scales representing the nation or globe as a whole.

A map showing the locations of all Washington Network monitoring sites as of 2020 is presented below:

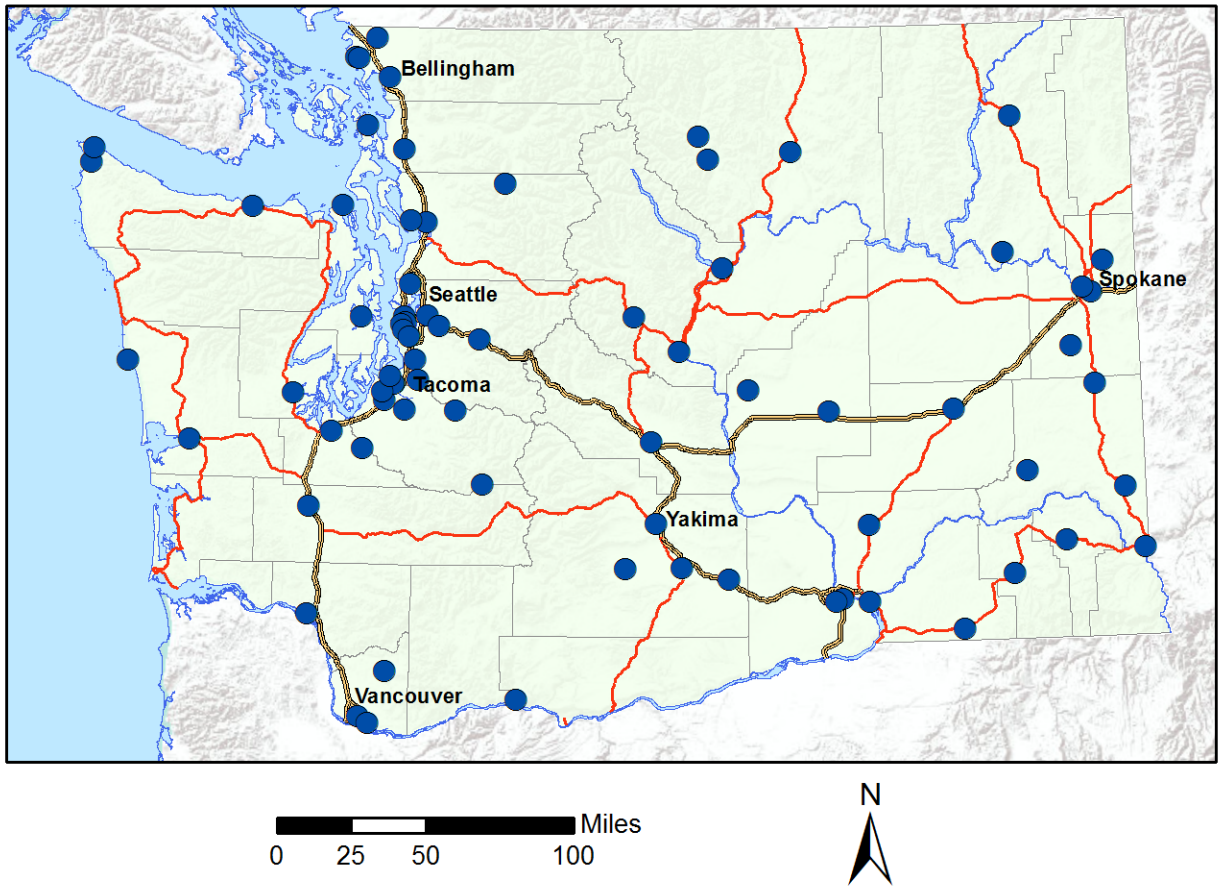

Figure 8 - Map of Washington Network monitoring sites

8.1. Monitoring for NAAQS compliance

A major objective of the Air Quality Program is to monitor in areas where the highest pollution exposures occur. Data from such monitors are used to determine compliance with and/or progress made towards meeting the NAAQS. Data collected in the Washington Network show that there are several communities where criteria air pollutants are approaching the levels of

the NAAQS.

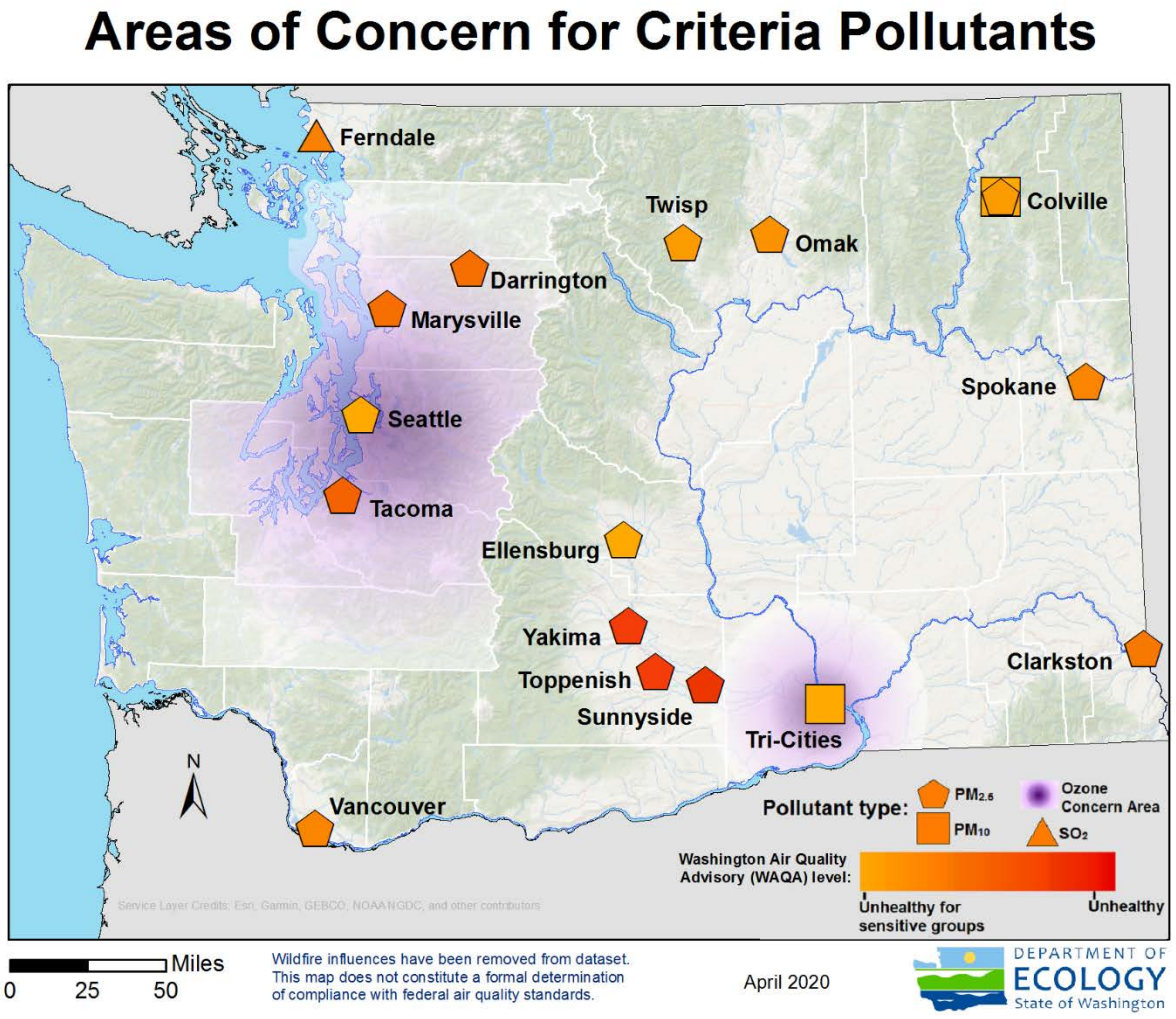

Figure 9 - Criteria pollutant areas of concern in Washington State

8.2. Minimum monitoring requirements

The minimum monitoring requirements of 40 C.F.R. Part 58 Appendix D are based on the core-based statistical areas (CBSAs) defined by the U.S. Office of Management and Budget. Washington's CBSAs are shown in Figure 10 below. Note that since publication of this map, Pend Oreille County has been removed from the Spokane-Spokane Valley MSA. The minimum monitoring requirements are subject to periodic change as part of EPA's 5 year review cycle of the NAAQS. 40 CFR Part 58, Appendix D contains the current minimum monitoring network requirements and is regularly reviewed and referenced by Ecology and its local air agency partners to ensure that the requirements are being met in the Washington Network.

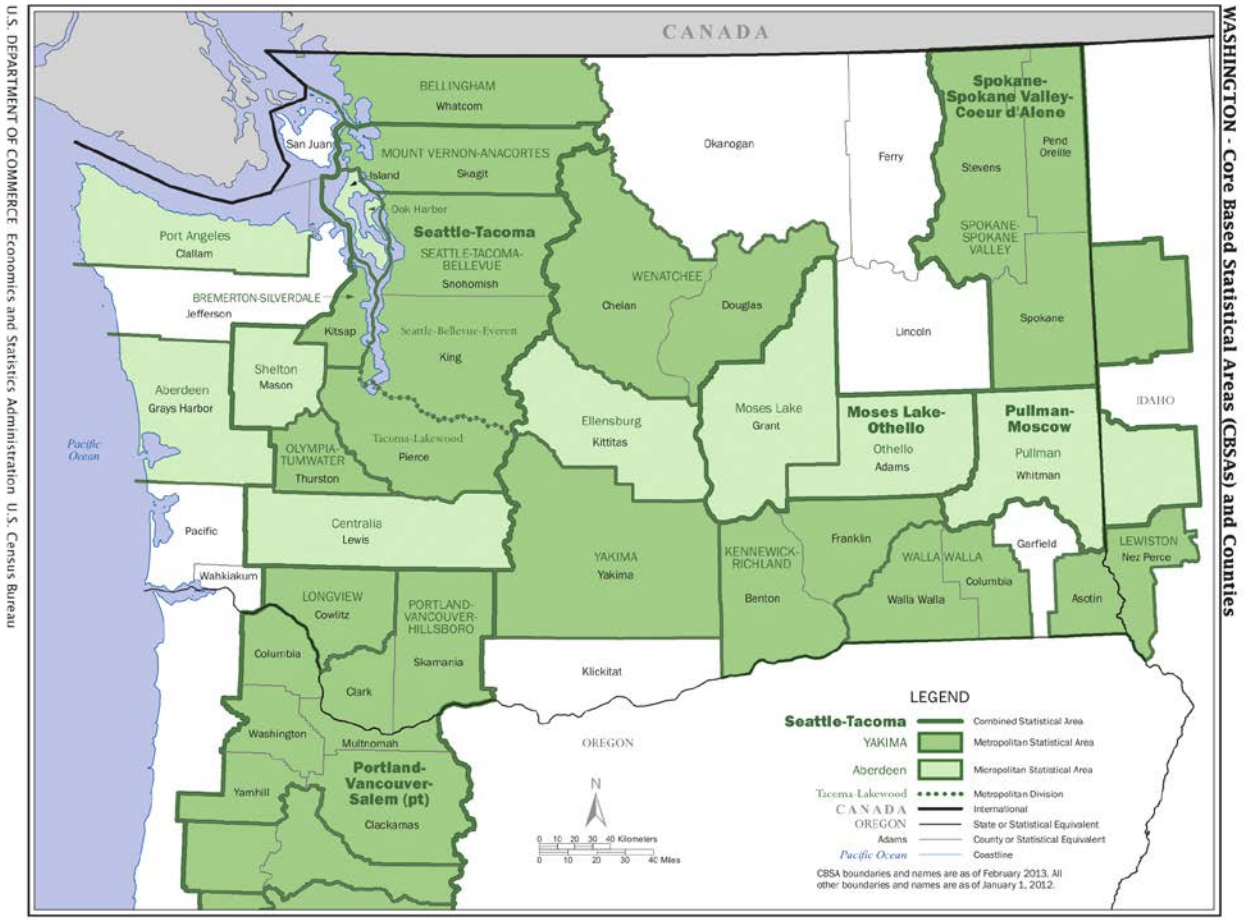

Figure 10 - Washington's Core-Based Statistical Areas (CBSAs), U.S. Census Bureau 2013

8.2.1. Design values

EPA defines a design value as "a statistic that describes the air quality status of a given location relative to the level of the National Ambient Air Quality Standards (NAAQS)." The calculation of design values is often referred to as the *form of the standard*. The calculation of NAAQS design values is described in detail in CFR Part 50.

Design values are computed and published annually by EPA's OAQPS and reviewed in conjunction with the EPA Regional Offices. Design values can be downloaded from EPA's AQS's list of standard reports (see Section 22.2).

8.2.2. Five year network assessments

40 CFR Part 58.10 requires monitoring organizations to conduct a network assessments once every five years [40 CFR 58.10(e)].

The 5-year network assessment requirement (the first was in 2010) is an outcome of implementing the National Ambient Air Monitoring Strategy (NAAMS), the purpose of which is to optimize U.S. air monitoring networks to use a finite set of resources to achieve the best possible scientific value and protection of public and environmental health and welfare.

The 5-year network assessments include:

- A re-evaluation of the objectives for air monitoring
- Evaluation of the network's effectiveness and efficiency relative to its objectives and costs
- Development of recommendations for network reconfigurations and improvements

8.2.3. Federal Reference Method and Federal Equivalent Method monitors

EPA requires the use of an approved Federal Reference Method (FRM), Federal Equivalent Method (FEM), or Approved Regional Method (ARM) monitor in order to determine compliance with the NAAQS (40 CFR 58, Appendix C 2.1). The use of FRM and FEM instruments helps ensure the reliability and credibility of air quality measurements and comparability between monitoring locations throughout the national network. However, designation as a reference or equivalent method by itself does not guarantee that a particular analyzer will always operate properly.

All reference and equivalent methods must be officially designated as such by EPA under the provisions of 40 CFR Parts 50 and 53. Notice of each designated method is published in the CFR at the time of designation. A current list of all designated reference and equivalent methods is maintained and updated by EPA whenever a new method is designated. This list can be found on EPA's Air Monitoring Technical Information Center (AMTIC). Moreover, any analyzer offered for sale as a reference or equivalent method after April 16, 1976 must bear a label or sticker indicating that the analyzer has been designated as a reference or equivalent method by EPA.

Unless a waiver is granted, all reference and equivalent method instruments used in the Washington Network are sited in accordance with the requirements of 40 CFR Part 58, Appendix E and operated in accordance with the Quality Assurance requirements of 40 CFR Part 58, Appendix A. Siting of monitors is discussed in detail in Section 9.1 of this document, in Ecology's Air Monitoring Site Selection and Installation SOP, and in the Washington Network instrument-specific SOPs.

8.2.4. PM2.5 NAAQS compliance monitoring

As of 2019, Ecology and its partners operated eighteen $PM_{2.5}$ NAAQS compliance monitoring sites across Washington State. Continuous FEM monitoring is done at each of these locations and two of these sites are also equipped with Class 1, filter-based, $PM_{2.5}$ FEM monitors in order to satisfy 40 CFR Part 58, Appendix A collocation requirements. To also meet 40 CFR Part 58, Appendix A collocation requirements, one site is collocated with a monitor of the same method designation as the FEM primary monitor. Whenever feasible, Ecology and its partners use continuous $PM_{2.5}$ FEMs. Continuous FEMs offer the advantage of near-real-time data display in addition to being less labor-intensive than filter-based methods.

A list of the current Washington Network $PM_{2.5}$ NAAQS compliance sites/monitors can be found in the most current version of Ecology's annual Ambient Air Monitoring Network Report on Ecology's website.

8.2.5. PM10 NAAQS compliance monitoring

PM_{10} NAAQS compliance monitoring is conducted at 6 locations in the Washington Network. This monitoring is largely to satisfy maintenance plan requirements, as with the notable exception of wind-blown dust storms (i.e., Exceptional Events) and wildfire events, concentrations have been well below the NAAQS. With one exception (low volume filter-based PM_{10} at Seattle-Beacon Hill) PM_{10} monitoring for NAAQS compliance in the Washington Network is conducted using continuous methods.

8.2.6. Lead NAAQS compliance monitoring

Lead monitoring for NAAQS compliance is not currently required in the Washington Network. Non-regulatory low volume PM_{10} lead Monitoring is conducted at the Seattle-Beacon Hill NCore station at part of the National Air Toxics Trends Stations (NATTS) network. This monitor records concentrations well below the NAAQS.

8.2.7. Ozone NAAQS compliance monitoring

NAAQS compliance monitoring for ozone in the Washington Network occurs at thirteen locations around the state. Ecology and its partners employ continuous FEMs at all network ozone sites. A list of the current Washington Network ozone sites can be found in the most recent version of Ecology's annual Ambient Air Monitoring Network Report. There are several CBSAs with ozone levels in Washington State that are near the ozone NAAQS.

8.2.7.1. Seattle-Tacoma-Bellevue CBSA

Past monitoring efforts in Washington State show that the highest ozone concentrations occur in at the Enumclaw-Mud Mountain monitoring station, which is part of the Seattle-Tacoma-Bellevue, WA CBSA. Ozone measurements from this and neighboring sites are used for evaluating area-wide trends and the success of control strategies. The monitor in Enumclaw typically records the highest ozone design value in the state. It is located approximately 30 miles downwind of Seattle's urban core where the highest precursor emissions originate.

8.2.7.2. Kennewick-Richland CBSA

In 2013, the AIRPACT model indicated an ozone problem in the Kennewick-Richland CBSA. Temporary and mobile monitoring during 2014 and 2015 confirmed high ozone model predictions and a permanent monitoring site was installed in June 2015. This monitor records concentrations near the ozone NAAQS.

8.2.7.3. Spokane-Spokane Valley CBSA

Two ozone monitors are located in Spokane County. The site locations were established to capture ozone concentrations during the summer and fulfill minimum SLAMS requirements for ozone.

8.2.7.4. Portland-Vancouver-Hillsborough CBSA

The Portland-Vancouver-Hillsborough CBSA spans the Oregon/Washington border. Ecology and the Oregon Department of Environmental Quality operate several ozone monitors on their respective sides of the border in order to satisfy minimum ozone monitoring requirements in

the CBSA. One of these monitors is operated by Ecology in Vancouver. A Memorandum of Understanding between Oregon Department of Environmental Quality and Ecology can be found in the most current version of Ecology's annual Ambient Air Monitoring Network Report on Ecology's website.

8.2.8. CO NAAQS compliance monitoring

Carbon Monoxide (CO) levels have declined dramatically over the last two decades and levels across Washington State are well below the NAAQS. Ecology currently operates a single CO NAAQS compliance monitor at its Seattle-10th & Weller station pursuant to Near-road monitoring requirements.

8.2.9. NO_2 NAAQS compliance monitoring

There are three permanent NO_2 NAAQS compliance monitors currently operating in the Washington Network. These satisfy monitoring requirements for area-wide monitoring (Seattle-Beacon Hill) and Near-road monitoring (Seattle-10th & Weller and Tacoma-S. 36th St.).

8.2.10. SO_2 NAAQS compliance monitoring

There are three SO_2 NAAQS compliance monitors within the Washington Network. These monitors were required pursuant to the 2010 revision to the 1-hour SO_2 NAAQS and subsequent Data Requirements Rule (DRR) which required states to characterize ambient concentrations around large sources of SO_2. Two of these monitors are located near an aluminum smelter in Whatcom County and one is located near an aluminum smelter in Chelan County.

8.2.11. Trace gas monitoring

Precursor (trace) gas monitoring is a suite of continuous instruments (CO, NOy, SO_2) that operate year-round to provide valuable information for the national effort to support advanced multiple pollutant monitoring in urban and rural areas for the National Ambient Air Monitoring Strategy. The NCore multi-pollutant stations at Seattle-Beacon Hill (NCore) and Cheeka Peak (Rural NCore) are part of this overall strategy.

Though concentrations from these two stations' CO and SO_2 monitors are far below the NAAQS, the data are used to develop emission control strategies relating to air quality model evaluation, rural monitoring of precursors for background transport, source apportionment, and other observation-based models. These monitoring efforts also support long-term health and epidemiological studies.

NAAQS SO_2 monitoring occurs at one contract-supported site in Anacortes. Concentrations measured at this site are well below the NAAQS. Because concentrations are very low, for the purposes of quality control/quality assurance, it is treated like a trace gas monitor.

8.2.12. Meteorological measurements

PSD-quality meteorological monitoring for wind speed, wind direction, and ambient temperature is conducted at over a dozen Washington Network meteorological stations. At the Seattle-Beacon Hill and Cheeka Peak NCore locations, relative humidity and ambient pressure

are also monitored. Beginning in June of 2021 at Beacon Hill, additional meteorological measurements (ceilometer, net radiometer, and precipitation) will be required as part of the PAMS program.

Meteorological measurements at Washington Network sites are often collocated at ozone monitoring locations in order to support modeling and forecasting efforts. AQP Quality Assurance staff routinely assess the accuracy of meteorological data collected at Washington Network sites and conduct annual performance audits for temperature, pressure, and relative humidity according to the methodology prescribed in the Quality Assurance Handbook for Air Pollution Measurement Systems - Volume IV: Meteorological Measurements, Version 2.0. Ultrasonic anemometers for the measurement of wind speed and wind direction are used exclusively in the Washington Network. In-the-field quality control check and performance evaluation of the ultrasonic anemometers is limited to a zero wind speed test. In order to ensure accuracy and assess past performance, Ecology sends the anemometers to an independent test laboratory (currently SOH Wind Engineering) for recertification on an annual basis.

Further information on meteorological monitoring within the Washington Network can be found in Ecology's Meteorological Monitoring Procedure available on Ecology's website.

8.2.13. Manual method operating schedules

Manual Methods which include filter-based Class 1 FEM $PM_{2.5}$ monitoring, $PM_{2.5}$ CSN, PM Coarse, and NATTS are required to follow EPA's manual method sampling schedule. EPA provides current and past sampling calendars through its AMTIC website. If a sample is missed, a make-up sample should be collected before the next required sampling day or exactly one week after the missed sampling day.

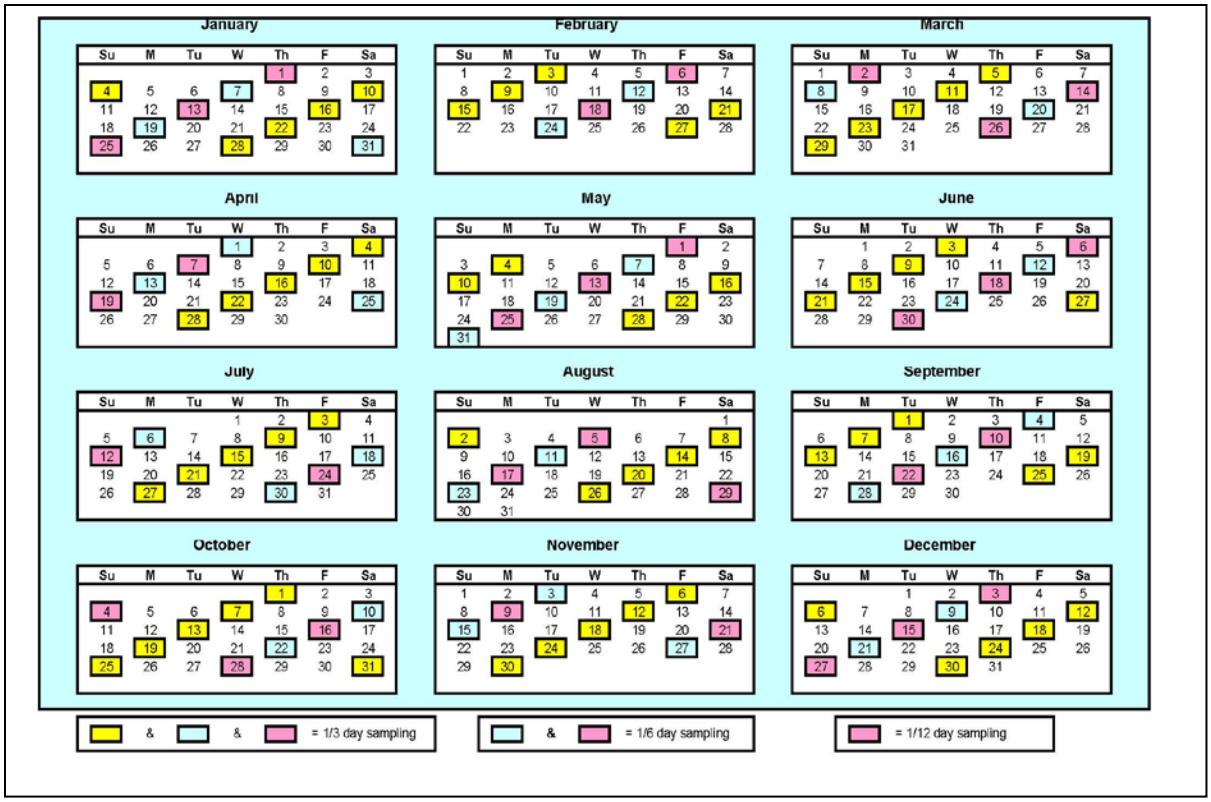

Figure 11 - Example of manual method sampling calendar

8.2.14. Data completeness requirements/goals

Data used for comparison to the NAAQS have specific completeness requirements as identified in 40 CFR Part 50. Collecting sufficiently complete data is critical to accurately characterizing air quality. Completeness requirements typically start at the lowest level of aggregation and apply to subsequently higher levels of aggregation. Although completeness requirements vary according to the pollutant-specific method for calculating design values, the general rule is that EPA requires data to be 75% complete. For example, for continuous monitors, 1-hour pollution concentrations are considered valid only when at least 75% of the 1-minute values are valid within the hour (i.e., at least 45 valid 1-minute concentrations). NAAQS compliance determinations also include completeness requirements for other levels of aggregation, including multiple-year levels of aggregation. In addition to EPA's requirements for data completeness, Ecology has established a goal for all Washington Network monitors (including non-NAAQS compliance monitors) of 80% completeness as calculated at the quarterly and annual aggregate level.

Even when data are incomplete, EPA may still calculate a design value for the purposes of comparison to the NAAQS. 40 CFR Part 50 provides critical information on how EPA may calculate design values even when completeness requirements are not met.

9. Sampling Process Design

9.1. Monitoring site location

All Washington Network FRM/FEM monitors, whether SLAMS or SPMS, as well as SPMS that measure criteria pollutants with non-FRM/FEM instruments, are sited in accordance with the pollutant-specific criteria described in detail in 40 CFR 58, App. E and in Ecology's standard operating procedures. EPA also provides technical assistance documents on NAAQS compliance monitoring available through the online Air Monitoring Technical Information Center (AMTIC) that further describe siting requirements and outline good practices for the siting of monitors. Detailed information on monitoring site placement can be found in Ecology's Air Monitoring Site Selection and Installation Procedure, available on Ecology's website.

When selecting a monitoring location, special attention should be given to the following:

Ensuring the site will provide data consistent with the monitoring objective

- Cost
- Safety
- Security
- Logistics (ensuring adequate site access, power availability, telecommunications)
- Atmospheric conditions (wind movements around the site, etc.)
- Topography (how terrain or man-made obstructions may affect concentrations)
- Pollutant considerations (such as undue influence of nearby sources)

In order to prevent sampling bias, air flow around the monitor must be such that collected data is representative of the general air flow in the area and the monitor inlet is toward the direction of predominant winds. Nearby sources that might unduly impact the sample (e.g. a rooftop air inlet near a stack or a ground-level inlet near an unpaved road) must be avoided.

Monitoring sites are never perfect. Physical and geographical constraints, particularly in urban environments, dictate that tradeoffs in siting may have to be made in choosing a monitoring location. Given this reality, sites must be chosen to optimize the fulfillment of the monitoring objective to the fullest extent possible.

The MAC evaluates the monitoring objectives in determining whether to approve monitoring projects. Once a project has been approved, the monitoring operator, or project manager, is typically responsible for selecting a suitable site location to satisfy the monitoring objective. All proposed sites must be reviewed by, and receive approval from, the Air Monitoring Coordinator and the Quality Assurance Coordinator prior to the beginning of sampling.

In order to maximize the likelihood of choosing a representative site that satisfies the monitoring objective(s), it is necessary to have a good understanding of the location and magnitude of area emission sources, geographical features, ambient pollutant concentrations, meteorological conditions, and population density.

9.2. Monitoring shelters

Washington Network monitoring sites consist of a variety of stand-alone shelters, trailers, buildings (i.e., rooms in schools and fire stations), located on the ground or on rooftops. For safety reasons, ground level installations are preferred. Figure 12 below shows examples of the various types of shelters used within the Washington Network.

Figure 12 - Examples of Washington Network monitoring shelters

9.2.1. Monitoring station maintenance

Monitoring station maintenance is an important element of ensuring collection of acceptable quality data. At a minimum, station maintenance items should be checked monthly and more often as site conditions require. For example, sweeping and cleaning of dust off floors, work surfaces, and instruments may need to be performed more often in dry/dusty environments. Examples of routine station maintenance activities include:

- Floor cleaning
- AC filter replacement
- Weed and litter abatement
- Grass cutting
- Roof/leak repair
- Inlet and manifold cleaning/replacement
- Desiccant replacement
- Cleaning of shelter exterior and interior
- Ladder, safety rail inspection

All maintenance activities should be documented in the electronic logbook.

Shelter temperature

Shelter temperatures should be recorded and consistently maintained at operating temperatures as specified by the by Ecology's instrument-specific standard operating procedures and the equipment (including monitoring instruments, data loggers, etc.) manufacturers' manuals.

Monitoring shelter temperature should be consistently maintained within 20 – 30 C (68 – 86 ºF), which is generally considered an ideal operating range for most air pollution monitoring

instrumentation and associated equipment (e.g., data loggers). Shelter temperatures may deviate somewhat from this range but only as the specifications of the onsite equipment dictates as some modern air pollution monitoring equipment is capable of operating properly outside of 20-30 C. If the monitoring site is not maintained within 20 – 30 C, the shelter temperature must be consistently maintained within the acceptable range as defined by the monitoring equipment manufacturer's manuals for the analyzers/monitors and telemetry equipment being used onsite. Out-of-control and inconsistent shelter temperatures may lead to erratic instrument operation and may result in loss of data.

Shelter temperature verification for FRM/FEM

EPA defines acceptable operating conditions, including shelter temperature ranges, when designating air monitors as FRM/FEM. To ensure that shelter temperature sensors accurately characterize shelter temperatures, operators of FRM/FEM monitors must certify their shelter temperature sensors every 180 days using a temperature standard with current NIST-traceability. Forms for documenting shelter temperature can be obtained through Ecology's Calibration & Repair lab or Quality Assurance.

9.2.2. Sampling probes and manifolds

Sampling probes and manifolds should be chosen carefully to ensure that samples are preserved through the sample train and interactions between air samples and probe/sample train material are avoided. The instrument manufacturer's manual and Washington Network SOPs must be followed to ensure that the proper material is used.

Fluoropolymer tubing is used exclusively for gaseous criteria pollutant sample probes at air monitoring stations with the exception of the Seattle-Beacon Hill NCore site, where borosilicate glass is used in combination with FEP Teflon®. Teflon reduces the likelihood of oxidation of gases as they enter the sampling train and pass through the tubing to the analyzer. This preserves the sample until it reaches the detector inside the monitor. The glass manifold at the Seattle-Beacon Hill NCore site is operated to provide adequate sample volume to several gas analyzers while minimizing sample residence time and turbulence.

9.2.3. Residence time determination

Per 40 CFR Part 58 Appendix E, Part 9, all gaseous pollutant monitors in the Washington Network are required to have a residence time of less than 20 seconds but operators should aim for a residence time under 10 seconds. Residence time is defined as the amount of time that it takes for a sample of air to travel from the opening of the sample probe to the inlet of the instrument.

$$RT = \frac{\pi * (d/2)^2 * 6 * L}{q}$$

Where:

RT = residence time in seconds

π= 3.14159

d = inside diameter of probe in centimeters (.47752 cm is the inside diameter of the Teflon® probe material commonly used)

L = length of the probe line in meters

q = analyzer/instrument flow rate in liters per minute

9.2.4. Placement of probes and manifolds

Correct probe location is critical in preventing the introduction of bias to the sample. Important considerations are probe height above the ground, probe length, and physical influences near the probe. Some general guidelines for probe and manifold placement are:

- Probes should not be placed next to air outlets such as exhaust fan openings
- Horizontal probes must extend beyond building overhangs
- Probes should not be located near physical obstructions such as chimneys which can affect the air flow in the vicinity of the probe
- Height of the probe above the ground depends on the pollutant being measured

Detailed requirements for the placement of probes can be found in 40 CFR Part 58 Appendix E.

10. Sampling Methods

Below is a list of the analytical methods that are used within the Washington Network. A more complete description of the analytical methods can be found in EPA's List of Designated Reference and Equivalent Methods available on the AMTIC website and in the manufacturer's manuals.

10.1. PM2.5 monitoring

10.1.1. Filter-based Class 1 FEM $PM_{2.5}$ monitoring

Filter-based Class 1 Federal Equivalent Method $PM_{2.5}$ monitoring is conducted at three sites in the Washington Network using the Thermo/Rupprecht & Patashnick Partisol®-Plus Model 2025 Sequential Air Sampler (Manual Equivalent Method: EQPM-0202-145).

All Washington Network $PM_{2.5}$ Sequential Samplers are operated in accordance with Ecology's $PM_{2.5}$ and PM_{10} 2025 Sequential Sampler Standard Operating Procedure, the manufacturer's manual, and the requirements of 40 CFR Part 50, Appendix L.

All gravimetric analysis (conditioning, pre-weighing, post-weighing) of $PM_{2.5}$ filters is done by Ecology's Manchester Environmental Laboratory (MEL).

10.1.2. Federal Equivalent Method $PM_{2.5}$ monitoring

The Met One Instruments Beta Attenuation Monitor (BAM), model 1020 is used for all continuous NAAQS compliance monitoring of $PM_{2.5}$ within the Washington Network (Automated Equivalent Method: EQPM-0308-170).

The Met One BAM-1020 instruments used within the Washington Network are configured according to the requirements in 40 CFR 50 Appendix L specifications and operated in accordance with Ecology's $PM_{2.5}$ and PM10 Beta Attenuation Monitor Operating Procedure, the manufacturer's manual, and the requirements of 40 CFR Part 58, Appendix A.

10.1.3. Nephelometer-$PM_{2.5}$ monitoring

Nephelometers are used to estimate $PM_{2.5}$ concentrations at over 40 Washington Network sites. Nephelometer-$PM_{2.5}$ monitoring provides a cost-effective alternative to the more resource-intensive FRM and FEM monitoring. Radiance Research/Met One M903 and Ecotech Aurora nephelometers are the only nephelometers used for estimating $PM_{2.5}$ concentrations in the Washington Network.

Typically, site-specific nephelometer-$PM_{2.5}$ correlations are developed through comparison to collocated Federal Reference Method (FRM) or Federal Equivalent Method (FEM) $PM_{2.5}$ monitors. These correlations are applied to the data via the onsite Envidas Ultimate data logger. At sites with pollution levels well below the NAAQS, generalized regional correlations that were developed at sites with similar geographic and source characteristics are used.

Nephelometers do not have FRM/FEM designation and the resulting $PM_{2.5}$ estimates cannot be used to determine compliance with the National Ambient Air Quality Standards (NAAQS). For

this reason, Ecology policy requires the use of an FRM/FEM when pollution levels routinely exceed 80% of the NAAQS.

10.1.4. Chemical Speciation Network $PM_{2.5}$ monitoring

$PM_{2.5}$ Chemical Speciation Network (CSN) monitoring is conducted at the Seattle-Beacon Hill monitoring location and at three supplemental speciation sites within the Washington Network. The Met One Instrument SASS/Super SASS and URG 3000N samplers used for the national CSN program are used exclusively in the Washington Network. These samplers do not have FRM/FEM designation.

In addition to the one permanent and three supplemental CSN/supplemental sites, Ecology and its local air agency partners sometimes conduct special chemical speciation studies using the same model samplers.

All CSN, supplemental, and special study samplers are operated in accordance with EPA's CSN QAPP and SOPs and all samples are analyzed by AMEC/Wood and UC Davis to ensure data comparability.

10.2. PM10 monitoring

10.2.1. Federal Equivalent Method PM10 monitoring

The Met One BAM-1020 (Automated Equivalent Method: EQPM-0798-122) is used for continuous PM_{10} monitoring within the Washington Network at all but the Spokane-Augusta Ave. site. At the Spokane-Augusta Ave. site, a Rupprecht & Patashnick Partisol TEOM 1400a continuous PM_{10} monitor (Automated Equivalent Method: EQPM-1090-079) is utilized. The Spokane-Augusta Ave. site will be relocated during 2021. At the time of relocation, the PM_{10} TEOM will be replaced with a Met One BAM-1020.

10.3. PM Coarse monitoring

Ecology conducts FRM PM Coarse ($PM_{10-2.5}$) monitoring (Manual Reference Method: RFPS-0509-176) at a single site in Seattle – Beacon Hill. This Federal Reference Method is known as a "subtraction method." Sampling consists of collocated 2025 Sequential Samplers with one configured as a Class 1 FEM PM2.5 sampler (Manual Equivalent Method: EQPM-0202-145) with a PM2.5 VSCC and the other configured as an FRM PM_{10} sampler with a Thermo Scientific Partisol® 2025 downtube (Manual Reference Method: RFPS-1298-127). The Sequential Samplers are operated in accordance with Ecology's $PM_{2.5}$ and PM_{10} 2025 Sequential Sampler Standard Operating Procedure. All $PM_{10-2.5}$ filters are gravimetrically analyzed by the Manchester Environmental Laboratory (MEL).

10.4. Lead monitoring

Ecology conducts non-regulatory lead monitoring at a single site in Seattle – Beacon Hill, using a low-volume Thermo Scientific Partisol®-Plus 2025 sequential sampler, configured for PM_{10}. This Sequential Sampler, and all associated samples, is also used for the PM_{10} portion of $PM_{10-2.5}$ sampling (subtraction method) at Beacon Hill. Sample filters are first sent to MEL for

determining $PM_{10-2.5}$ mass concentrations and are subsequently sent to Eastern Research Group (ERG) for Inductively Coupled Plasma- Mass Spectrometry (ICP-MS) analysis. Additional information on this method can be found in ERG's SOP, available through EPA's AMTIC website.

10.5. Continuous monitors for gaseous pollutants

Ecology and its partners use EPA FRM/FEM gaseous air pollutant analyzers for comparison to the NAAQS. All gaseous analyzers used for NAAQS compliance are operated in accordance with the requirements detailed in 40 CFR Parts 50, 53 and 58, the manufacturer's manuals, and Ecology's Ozone Monitoring Procedure and Gaseous Pollutant Monitoring Standard Operating Procedure (SO_2, NOx, NOy, NO_2, CO).

10.5.1. Carbon monoxide (CO) measurements

Teledyne Advanced Pollution Instrumentation, Inc. (TAPI) model 300EU (Automated Reference Method: RFCA-1093-093) analyzers are used at all monitoring sites (both NCore sites as well as the Seattle Near-road site) in the Washington Network.

10.5.2. Ozone (O_3) measurements

TAPI models T400 and T400U (Automated Equivalent Method: EQOA-0992-087) analyzers are used to monitor ozone at all Washington Network ozone monitoring sites.

10.5.3. Nitrogen dioxide (NO_2) measurements

Teledyne Advanced Pollution Instrumentation models 200EU and T200U (Automated Reference Method: RFNA-1194-099) are used to monitor NO_2 at both Near-road locations (Seattle-10th & Weller and Tacoma-S. 36th St.). TAPI model T500U Nitrogen Dioxide Analyzer (Automated Equivalent Method: EQNA-0514-212) is used to monitor area-wide NO_2 at the Seattle – Beacon Hill location. The T500U will also be used to meet the PAMS requirement for direct NO_2 measurements.

10.5.4. Sulfur dioxide (SO_2) measurements

TAPI model T100U (Automated Equivalent Method: EQSA-0495-100) is used for SO_2 monitoring at the NCore stations (Cheeka Peak, Seattle – Beacon Hill) and Anacortes. TAPI model T100 is used to monitor SO_2 at three sites located near aluminum smelters per EPA's SO_2 Data Requirements Rule (two sites near Ferndale and one site in Malaga).

10.5.5. Total reactive oxides of nitrogen (NOy) measurements

NOy is measured at the Cheeka Peak and Seattle – Beacon Hill NCore stations.

At Seattle – Beacon Hill, a Thermo Environmental Instruments Model 42C-Y NOy analyzer (Automated Reference Method: RFNA-1289-074) with an external molybdenum converter is used. A TAPI T200U (Automated Reference Method, RFNA 1194-099) has been purchased and is slated to be installed prior to the end of 2020.

At Cheeka Peak, a Teledyne Advanced Pollution Instrumentation model T200U analyzer (Automated Reference Method, RFNA 1194-099) with a converter is used.

10.6. Air toxics monitoring

Air Toxics Monitoring is conducted at the NCore monitoring station in Seattle-Beacon Hill as part of the NATTS network. The sampler type and laboratory methods are listed in Table 8 below.

Table 8 - NATTS samplers and laboratory methods

Pollutant Type	Equipment	Laboratory Method
VOC	Xonteck Model 901 Canister Sampler	EPA Compendium Method TO-15
Carbonyl	XonTech Model 925 Carbonyl Sampler	EPA Compendium Method TO-11A
PAH	Tisch Environmental TE-1000 PUF Poly-Urethane Foam High Volume Air Sampler	EPA Compendium Method TO-13A
PM_{10} Metals	FRM PM_{10} Thermo/Rupprecht & Patashnik model 2025 Sequential Air Sampler	EPA Compendium Method IO-3.5

11. Sample Handling and Custody

For manual method sampling (i.e., samples collected on filters or in canisters, etc.), it is critical that air monitoring samples are handled appropriately in order to preserve the integrity of the sample and ensure proper chain of custody. Custody records provide a reviewable trail for quality assurance purposes and serve as evidence in legal proceedings. Chain of custody documentation is referenced in Ecology's Air Toxics SOP, $PM_{2.5}$ & PM_{10} 2025 Sequential Sampler SOP, and the Chemical Speciation Network Quality Assurance Project Plan.

11.1. Couriers and sample shipments

The Air Quality Program contracts with FedEx to transport $PM_{2.5}$ pre- and post-sampled filters between the Manchester Environmental Laboratory and air monitoring operator offices around the state. Ecology uses United Parcel Service (UPS) for the shipment of CSN and NATTS samples.

Couriers provide tracking numbers for each shipment between labs and field offices. Information describing the enclosed filters/samples is placed on a bill of lading and copies of shipping receipts and tracking numbers are retained as part of the sample record. In the case of $PM_{2.5}$ filters, the shipping container (a small cooler filled with frozen ice-substitute packs) is secured with a wire custody lock and addressed to the specific individual authorized to receive the package.

More information on the shipment of samples can be found in the instrument-specific SOPs as well as the Air Toxics Monitoring QAPP.

12. Laboratory Methods

The Air Quality Program contracts with accredited laboratories for sample analyses. A list of these laboratories associated with each sampling program is presented below.

Table 9 - Summary of pollutants and accepted analytical methods

Network/Laboratory	Pollutant	Acceptable Method	Reference
SLAMS Manchester	PM2.5	Gravimetric	40 CFR Part 50 App L
	$PM_{10-2.5}$	Gravimetric/Subtraction	40 CFR Part 50 App O
NATTS Eastern Research Group	Lead PM_{10} Low-Vol	Energy-dispersive X-ray fluorescence spectrometry	40 CFR Part 50 App Q
	Carbonyls	High Performance Liquid Chromatography	TO-11A
	PAHs	Gas Chromatography / Mass Spectrometry	TO-13A
	VOCs	Gas Chromatography	TO-15
CSN AMEC/Wood UC Davis	Elements	EDXRF	CSN QAPP and SOPs
	Anions	Extraction/conductivity	CSN QAPP and SOPs
	Cations	Extraction/ chromatography	CSN QAPP and SOPs
	Organic, elemental, Carbonate, Total Carbon	Thermal Optical Carbon Analyzer	CSN QAPP and SOPs
	Semi-volatile Organic Compounds	Gas chromatography/Mass Spectrometry (GC/MS)	CSN QAPP and SOPs

The SLAMs network provides rigorous quality control requirements for the analytical methods.

These methods are found in 40 CFR Part 50, and described further in the associated references to the CFR.

Some of the NATTS methods are derived from the Toxics Organic Method Compendium 3. Others, like the PM2.5 Chemical Speciation Network (CSN) may be developed specifically for

the program based on the national laboratory currently performing the analysis. The NATTS and CSN networks follow the performance-based measurement process paradigm. These networks' QAPPs and technical assistance documents suggest a method, but also allow some flexibility to use other methods that meet the given network's measurement quality objectives. Various independent proficiency test samples and technical systems audits are performed by the laboratories to ensure that the data quality within these networks remain acceptable.

12.1. Laboratory activities

For ambient air samples to provide useful information or evidence, laboratory analyses must meet the following four basic requirements:

- Equipment must be frequently and properly calibrated and maintained
- Personnel must be qualified to perform the analysis
- Analytical procedures must be in accordance with accepted practice
- Complete and accurate records must be kept

The Air Quality Program requires that each laboratory should define these critical activities and ensure there are consistent methods for their implementation before any data is collected. EPA requires likewise for the national contract laboratories that support the NATTS and CSN programs.

13. Procurement of Equipment

Monitoring instrumentation is vetted by staff in Ecology's Calibration & Repair laboratory and by personnel at partner agencies prior to purchase or approval for use in the Washington Network. Ecology makes it a priority to seek opportunities to field test equipment prior to making purchases, particularly when evaluating the most expensive instrumentation. Instruments are evaluated for:

- Bias/precision
- Comparability to FRM/FEM instruments/analyzers
- Reliability
- Ease of operation
- Availability of automated quality control
- Manufacturer support
- Price (including consumables and replacement parts)

In order to maximize the effective use of available funding and ensure that prospective equipment meets all performance criteria and certifications, detailed specifications must be clearly identified in requests for quotes prior to purchase. This is especially critical when expensive or large volume purchases are made. At a minimum, purchased equipment should be accompanied by a one year warranty. Vendors must not receive payment until acceptance testing has been completed and the subsequent results are satisfactory. Instruments used in the Washington Network must meet all Ecology performance specifications and requirements before any data will be submitted to AQS.

Less expensive items (tools, extension cords, fittings, etc.) may be purchased by station operators with approval from their supervisor.

13.1. Washington Network partner procurements

Washington Network partner agencies and tribal nations may procure monitors and associated equipment (data loggers, modems, calibration equipment and standards, etc.) for use in the Washington Network. **Any such monitoring equipment must be approved by Ecology's AQP before it can be used in the Washington Network.**

Washington Network partner agencies are responsible for acceptance testing of such equipment and for ensuring that air monitors are properly calibrated as required by CFR and Ecology's SOPs before being deployed to the field.

Monitors acquired by Washington Network partners that do not meet these requirements will not be used in the Washington Network.

13.2. Inspection/acceptance of equipment and supplies

Acceptance criteria must be consistent with overall project technical and quality criteria. Some of the acceptance criteria for FRMs and FEMs are specifically detailed in 40 CFR Parts 50. Other evaluations of acceptance criteria, such as observing damage caused during shipping, can only occur after equipment has been delivered from the manufacturer.

Ecology Calibration & Repair staff will be contacted by agency Shipping & Receiving personnel located within headquarters or regional offices. The staff receiving the items must:

- Perform a rudimentary inspection of the package(s) as received
- Note any obvious problems with the shipment such as a crushed box or wet cardboard
- Open the package and inspect the contents
- Compare contents against the packing slip to determine that the order is complete
- Plug in and turn on the instrument or equipment (if applicable) to ensure it powers up correctly

If problems with the order are discovered:

- Note problems/issues on the packing list
- Notify Shipping & Receiving of missing or damaged items and immediately call the vendor

If the order is complete and in good condition:

- Sign and date the packing list and send to the AQP Purchasing Coordinator so that payment can be made in a timely manner
- Place Ecology tag on the item (if purchased with Ecology funds)
- Place ordered supplies in stock equipment/supplies in the appropriate predetermined area.
- Enter equipment receiving an Ecology tag into the Site Information Management System (SIMS) Equipment Inventory

All O_3, CO, NO_2, and SO_2 analyzers used in the Washington Network designated as either FRM or FEM are assumed to be of sufficient quality for the data collection operation. Testing of such equipment is accomplished by U.S. EPA through the procedures described in 40 CFR Part 50.

Ecology Calibration & Repair staff will perform and document multi point calibration verification checks before deploying any instrument to the field. If any of these checks are out of specification (the MQO is all points must be within ±2% of full scale of a best fit straight line), corrective action will be taken. If the instrument meets the acceptance criteria, it will be assumed to be operating properly.

Some supplies and consumables may be received by air monitoring staff located in Ecology regional offices. In these cases, regional staff are responsible for equipment inspections, noting any issues, and conducting acceptance testing and bear responsibility for ensuring equipment is properly calibrated, tagged, and operational prior to installation.

13.3. Maintenance of equipment – roles and responsibilities

The Washington Network SOPs identify specific preventive maintenance designed to limit downtime, costly repairs, and data loss. Station operators are responsible for following the SOPs, performing all routine preventive and corrective maintenance, and for recording all such activities in the station's electronic logbook. Operators are also responsible for regularly reviewing the results of all automated and manual calibrations to ensure proper instrument operation.

In addition to routine maintenance and review of quality control, other activities must be performed on a recurring basis (i.e., bi-monthly, monthly, quarterly, semi-annually, etc.) depending on the pollutant being measured and the type of monitor being used. Operators should refer to the instrument-specific SOP, manufacturers' manuals, and 40 CFR Part 58, Appendix A, for the preventive maintenance and quality control requirements and schedules.

Supervisors are responsible for ensuring that station operators carry out required preventive maintenance and quality control activities in a timely manner. Preventive maintenance is not a static process. Periodic changes to preventive maintenance schedules and SOPs are necessary in order to reflect new instrument models, any changes to the measurement method, and in the case of FRM/FEMs, changes to the CFR.

Required frequencies for preventive maintenance and quality control as defined in the CFR (FRM/FEM) and Washington Network QAPPs and SOPs must be followed regardless of whether a given task is completed earlier than scheduled. In other words, if a multi-point calibration is conducted in August, instead of September, the next multi-point calibration would be required 6 months after August. Supervisors should be aware of preventive maintenance requirements and periodically verify that station operators are meeting them.

Prior to any major maintenance and repairs, instrument "as-found" quality control checks (e.g., single or multi-point) must be conducted. If the instrument is found to be outside acceptable limits and the instrument is confirmed to be the source of failure, the instrument must be recalibrated. If the instrument is recalibrated, a verification ("as-left") quality control check must be performed.

Lists of routine maintenance activities and timetables for their recurrence are found in the instrument-specific SOPs. Operators should refer to these lists in order facilitate the organization and tracking of tasks and improve the efficiency of preventive maintenance operations.

13.4. Ecology Calibration & Repair laboratory

Ecology's Calibration & Repair laboratory provides technical assistance, calibration, and repair services for monitoring efforts associated with the Washington Network. Station operators should contact the Calibration & Repair laboratory for assistance with non-routine maintenance, in the event of an instrument or equipment failure, and for general questions regarding field calibration and operations. In the event of an equipment failure, the Calibration

& Repair laboratory works with the station operator to remove the faulty piece of equipment for troubleshooting and replace it if there is a spare available. The Calibration & Repair laboratory maintains a limited number of equipment spares that are maintained following the relevant parameter-specific SOPs. If an equipment spare is not available, the Calibration & Repair laboratory works with the vendor to either fix the faulty piece of equipment or replace it as necessary, with the goal of minimal data loss.

14. Equipment Certification and Calibration

Calibration establishes the quantitative relationship between the true value (in ppm, ppb, µg/m3, L/min, etc.) and the instrument response. This relationship is used to convert subsequent instrument response values to corresponding known values. Instrument response will change over time (drift) so regular calibration verifications (i.e., quality control checks) and periodic instrument recalibration is required to maintain an acceptable degree of accuracy. Each instrument is calibrated as directed by the instrument-specific SOP and manufacturer's manual. Detailed calibration procedures for the Federal Reference Methods for CO, NO_2, O_3, and SO_2, can be found in the appropriate appendices to 40 CFR Part 50.

Instruments are calibrated in Ecology's Calibration & Repair laboratory, or by Washington partner agency staff, before being deployed to the field to collect data. All data and calculations involved in these calibration activities are documented and retained by the Calibration & Repair laboratory electronically.

14.1. Calibration standards

All ambient monitoring instruments used within the Washington Network are calibrated and verified using calibration standards. Detailed in Table 10, cylinders of compressed gas, ozone calibrators, as well as flow, temperature, and pressure standards are all certified as traceable to a NIST primary standard. "Traceable" is defined in 40 CFR Part 58.1 (Definitions)" ... *that a local standard has been compared and certified, either directly or via not more than one intermediate standard, to a National Institute of Standards and Technology (NIST)-certified primary standard such as a NIST-traceable Reference Material (NTRM) or a NIST-certified Gas Manufacturer's Internal Standard (GMIS)*". The certification procedure includes:

- Establishing the concentration of the working standard relative to the primary standard
- Certifying that the primary standard (and hence the working standard) is traceable to an NIST primary standard
- Including a test of the stability of the working standard over several days
- Specifying a recertification interval for the working standard

14.2. Certification of calibration/audit standards

Standards used for conducting quality control checks, calibrating air monitoring instruments, and conducting quality assurance performance audits within the Washington Network must be recertified as accurate on a frequency as defined in the CFRs (FRM/FEM) and Washington

Network QAPPs and SOPs. Gaseous standards (cylinders) for use in routine quality control checks and analytical audits are obtained from vendors such as Praxair, Inc. and are certified for NIST-traceability and accuracy for a defined duration. Flow, temperature, and pressure standards, as well as other equipment used for conducting flow and other quality control operations, are certified by Ecology's Calibration & Repair staff or by qualified vendors on an annual basis. These certifications are tracked by the Calibration & Repair staff and documentation is kept in a shared network drive. Flow, temperature, and pressure standards for quality assurance audits are certified by Quality Assurance staff or by qualified vendors on an annual basis. Certifications for quality assurance audits are tracked and documented in a shared network drive by quality assurance staff.

14.2.1. EPA Protocol Gas standards

EPA Protocol gases are purchased from commercial sources and are analyzed in accordance with the *EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (EPA 600/R-12/532)*, revised May 2012. All mixtures are traceable to the National Institute of Standards and Technology (NIST) gaseous Standard Reference Materials (SRM) using EPA procedures and meet or exceed the appropriate EPA Protocol specifications for accuracy. A Certificate of Analysis (COA) is provided with each mixture. The COA contains the replicate analysis data, the NIST traceable reference standard and the analytical instrument used in the analysis. Gas that is beyond the labeled expiration date is not used for calibration or auditing.

Ecology maintains separate labs, equipment, and functionality between its Calibration & Repair and Quality Assurance laboratories in order to preserve the independence of the QA function within the Washington Network. Standards and equipment used for QA purposes are recertified by QA personnel in the Quality Assurance lab while standards and equipment used for operational purposes are recertified by different personnel in the Calibration & Repair lab.

Ecology's Calibration & Repair staff uses its primary and laboratory standards to recertify the majority of the flow, temperature, and pressure, standards used by site operators in the Washington Network. Flow standards intended to measure very low flows (<3 L/min) cannot reliably be recertified by the Calibration & Repair laboratory and should be sent back to the manufacturer for recertification at intervals specified by the manufacturer. Manufacturers often charge several hundred dollars or more for this service and turn-around times can be lengthy. Therefore, whenever possible, station operators should send their standards to the Calibration & Repair staff to decrease programmatic costs and minimize downtime.

The Calibration & Repair and Quality Assurance laboratories each maintain a set of NIST-traceable standards, some of which are primary standards. The recertification frequency for each of these standards, where applicable, is presented in Table 10 below.

Table 10 - Standards maintained by location

Standard	Laboratory	Frequency
Carbon Monoxide cylinders	Calibration & Repair Quality Assurance NWRO	As defined by supplier for the given concentration
$PM_{2.5}$ Alicat	Calibration & Repair Quality Assurance	Annually
Ozone Primary Standard	Calibration & Repair Quality Assurance	Annually
Multi-blend cylinder gas for Trace Gas and NO_2	QA NWRO	As defined by supplier for the given concentration
NIST traceable thermometer (Agency primary)	Quality Assurance	Never
Barometer (Agency primary)	Calibration & Repair Quality Assurance	Never

14.2.2. Calibration standards for ozone

In ambient air monitoring applications, precise ozone concentrations called standards are required for the calibration of ozone analyzers. Ozone standards cannot be stored for any practical length of time due to ozone's reactivity and instability. Therefore, ozone concentrations must be generated and measured on site using a separate ozone generator, known as a transfer standard.

Qualification consists of demonstrating that the transfer standard is sufficiently stable (repeatable) to be useful as a transfer standard. Repeatability is necessary over a range of variables such as temperature, line voltage, barometric pressure, elapsed time, operator adjustments, and other conditions, any of which may be encountered during use. After a transfer standard has been shown to meet the qualification requirements, certification is required before it can be used.

The EPA's *Technical Assistance Document Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone* (October 2013) states that "a verified transfer standard of Level 3 and greater must be reverified at the beginning and end of the ozone season or at least every six months whichever is less." Therefore, Ecology's Calibration & Repair staff recertifies transfer

standards prior to, and following the end of, each ozone season (May 1 – September 30) for sites that are operated seasonally. For year-round sites, transfer standards are recertified every 180 days.

Test concentrations of ozone must be traceable to a Level 1 primary standard UV photometer as described in 40 CFR Part 50 Appendix D. Uncertainty increases with each additional level. Figure 13 shows the different ozone transfer standard levels, along with the increasing uncertainty the farther the standard is removed from the primary Level 1 standard. Figure 14 illustrates the certification process that is used within the Washington Network to ensure traceability to the Level 1 standard.

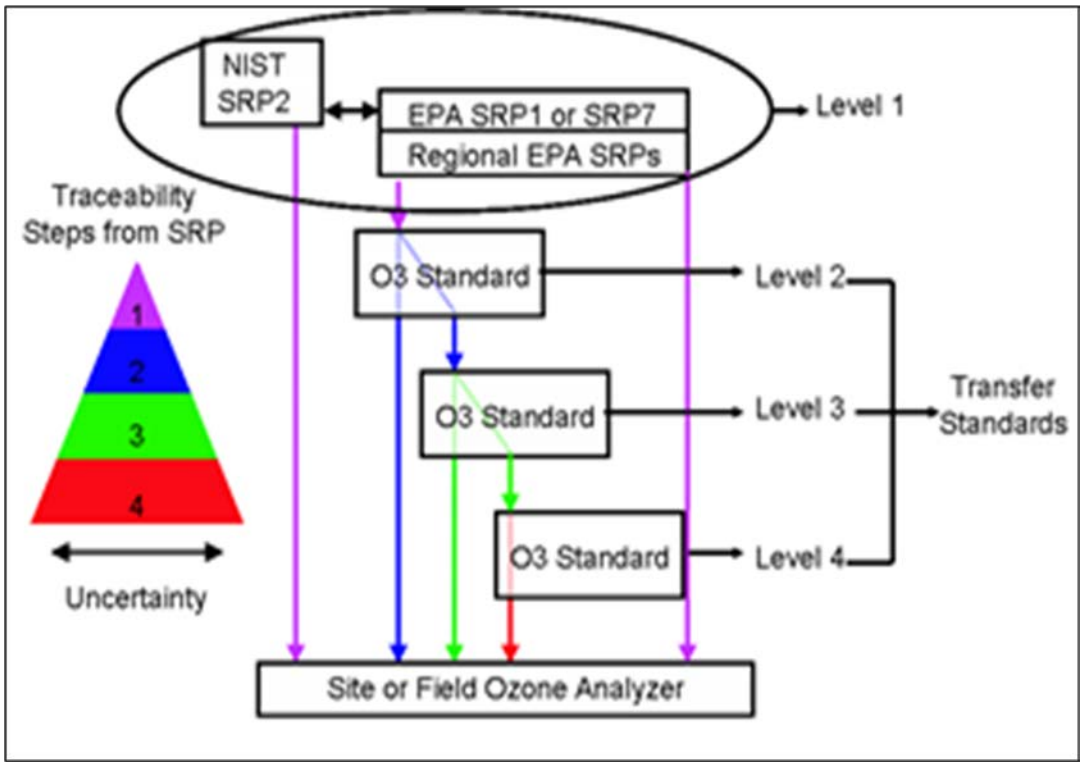

Figure 13 - Ozone transfer standard hierarchy

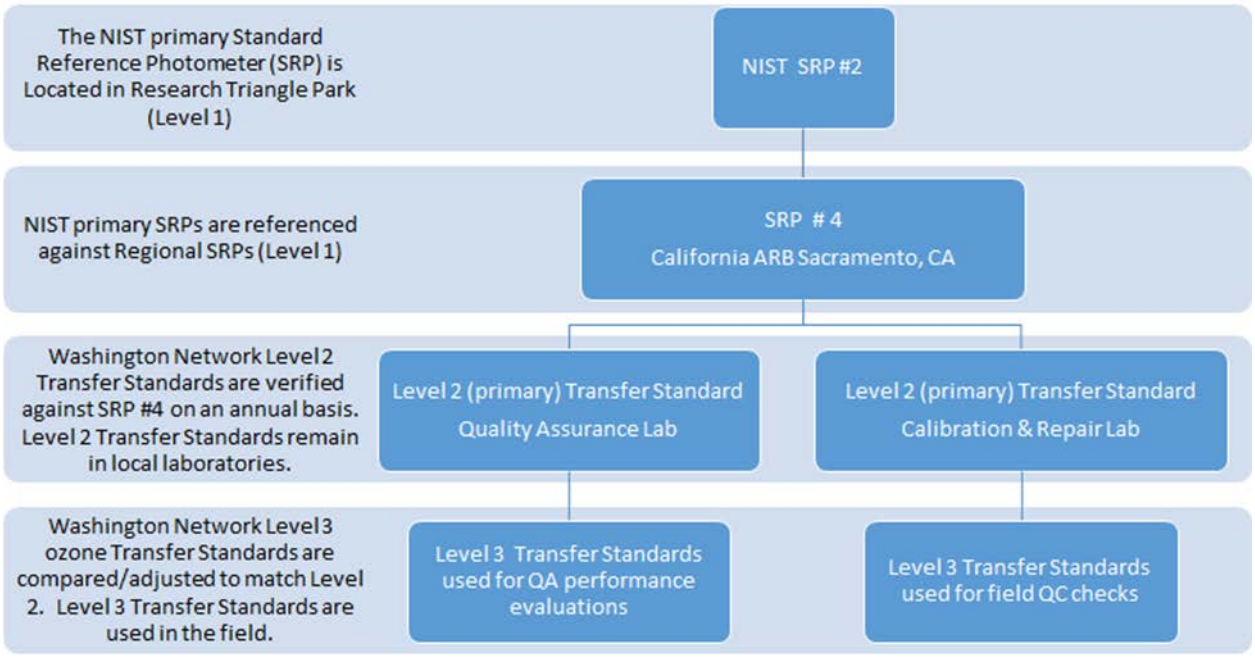

Figure 14 - Washington Network ozone transfer standards

14.2.3. Flow standards

The accuracy of flow measurements is critically important in air monitoring applications. Flow and volume measuring instruments are calibrated and certified against a primary flow meter on a yearly basis. Instruments that cannot be certified with a primary flow meter are sent to the manufacturer for recertification annually (i.e., not to exceed 365 days).

15. Quality Control

15.1. Code of federal regulations-related quality control samples

40 CFR Part 58, Appendix A, identifies a number of quality control samples that must be implemented for the SLAMS and SPMS. All SLAMS and SPMS sites within the Washington Network equipped with FRM/FEM instruments are operated according to these requirements. Current requirements for quality control samples for FRMs and FEMs can be found in 40 CFR Part 58, Appendix A. The specific ways in which the required quality control checks, as well as associated corrective actions, are performed are described in detail in the Washington Network instrument-specific SOPs.

15.1.1. Quality control checks

Automated and manual calibration verifications (quality control checks) are performed at specified intervals in the field by allowing the instrument to sample test atmospheres at known pollutant concentrations or flows (in the case of flow verifications). During quality control checks, the instrument is operated in its normal sampling mode, drawing the test atmosphere through all filters, scrubbers, conditioners, and other components used during normal air monitoring and through as much of the sampling train as practical. A quality control check is a verification of instrument calibration for past data collection ("as-found"). For this reason, ***it is critical that instruments never be adjusted prior to, or during, a quality control check, and that any adjustments be made only after a verification is performed***. Following any instrument adjustment(s), an additional quality control check ("as-left") must be performed to confirm proper calibration.

Field blank and collocated samples are also utilized for quality control checks and verifications of the laboratory methods described in Section 12 and Table 9. Field blanks provide an estimate of total measurement system contamination. Collocated samples are useful in determining the precision of the sampling process.

15.1.2. Use of computers for quality control

Computer-based data loggers equipped with Envidas Ultimate software are used exclusively in the Washington Network. All loggers are TCP/IP addressable, allowing for remote access and automation of quality control on several different types of monitors. These features facilitate quality control test replication, provide near-real-time quality control results, and decrease the number of required operator trips to monitoring stations. Among other activities, Washington Network data loggers are used by operational personnel to:

- Schedule recurring automated quality control checks at prescribed intervals
- Electronically record, store, and report quality control results (zero, precision, span)
- Electronically record all station activities (i.e., electronic logbook)
- Plot zero/precision/span results (i.e., control charts)

- Run reports on measures of linearity of calibrations (e.g., standard error or correlation coefficient)
- Automatically flag data associated with out-of-control results
- Establish email notifications for quality control failures and instrument problems
- Remotely interface with instruments in the field to diagnose operational problems

Automated quality control checks

Automated calibration checks on gaseous pollutant analyzers and nephelometers are typically scheduled for the early morning hours when pollution concentrations are often lowest. At a minimum, these tests include a zero and precision test concentration.

An example of an automated quality control check (zero, precision, and span points) on an ozone analyzer is presented in Figure 15 below.

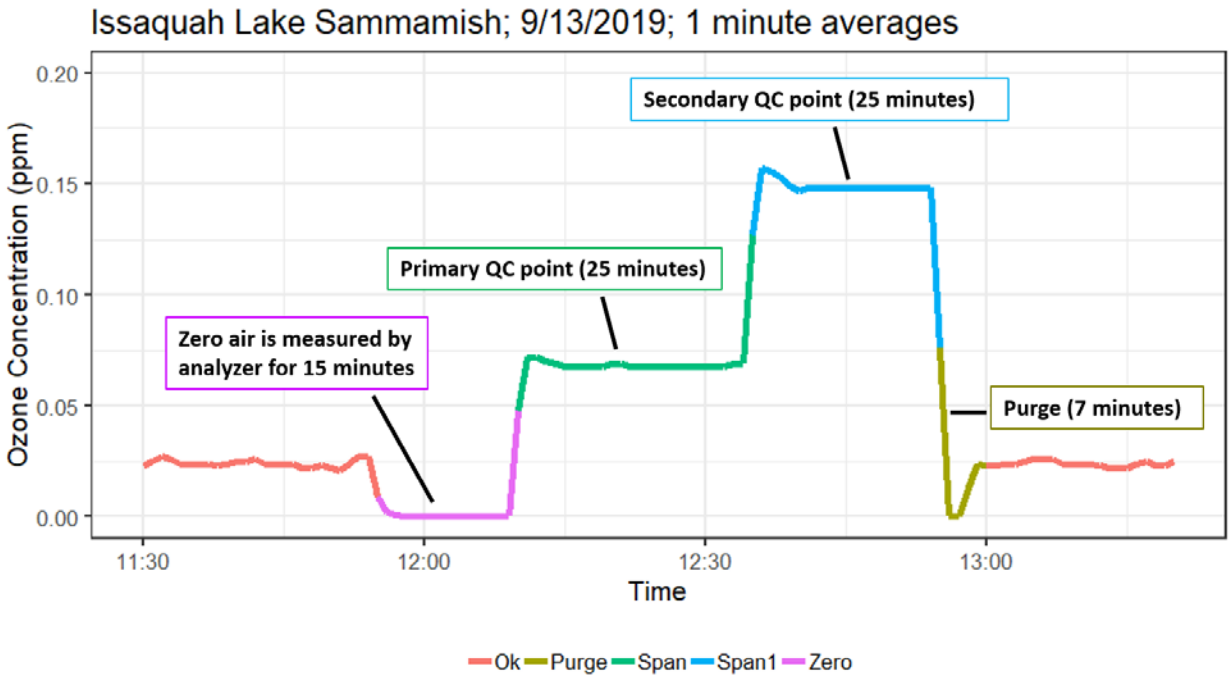

Figure 15 - Example of automated zero, precision, and span QC check

15.1.3. Single and multi-point quality control checks

A number of terms for various quality control checks and challenge points exist throughout EPA literature and the Envidas Ultimate framework. For clarification, within the Washington Network, the uniform terminology of *Primary QC Check Point* and *Secondary QC Check Point* is used to apply to the quality control checks of FRM/FEM gaseous pollutant analyzers. These terms are paired with their corresponding EPA terms in Table 11 below.

Table 11 - Ecology and EPA quality control check terms for gaseous pollutant analyzers

Ecology Term	EPA Term	QC Check Must Include
Primary Quality Control Check	One-Point QC; Precision Check	Primary point (precision) and zero
Secondary Quality Control Check	Precision and Span	Secondary point (span), primary point, and zero
Upscale Points Check	Multi-Point Calibration Upscale Points	Additional points (other than primary and secondary) necessary to verify proper calibration and analyzer linearity

Primary quality control checks on Washington Network FRM/FEM gaseous pollutant analyzers are performed on a frequency defined by the most recent version of 40 CFR Part 58, Appendix A and as described in the most recent version of the instrument-specific SOP. Primary quality control checks are used to determine gaseous pollutant analyzer precision and bias in relation to a known concentration. The CFR states that the Primary quality control checks for gaseous analyzers "*should be related to the routine concentrations normally measured at sites within the monitoring network in order to appropriately reflect the precision and bias at these routine concentration ranges*". Primary point test levels for gaseous analyzers within the Washington Network are chosen in accordance with this general guidance. The process for choosing appropriate primary and secondary points is described in detail in the Gaseous Pollutant and Ozone SOPs. Primary quality control checks of gaseous analyzers are always accompanied by a zero test concentration.

Secondary quality control checks consist of two or more test concentrations and a zero check. Multi-point calibration verifications are used to establish or verify the linearity of analyzers over the range of measured concentrations, upon initial installation, after major repairs, and at specified frequencies. Most modern analyzers have a linear or very nearly linear response. 40 CFR Part 58 states that the test concentrations chosen for multi-point quality control and performance audits "*should represent or bracket 80 percent of ambient concentrations measured by the analyzer being evaluated.*" Gaseous monitors within the Washington Network are challenged at concentrations accordingly.

All quality control checks on gaseous pollutant analyzers operated as part of the Washington Network must be triggered through the Envidas Ultimate data logger software in order to ensure consistency in quality control check procedures and to ensure that the results are captured by the data acquisition system to facilitate data review, verification, and validation as well as reporting to EPA's AQS.

15.1.4. Monthly flow rate verifications

Monthly flow rate verifications are conducted on all Washington Network FRM/FEM particulate samplers and monitors as described in 40 CFR Part 58, Appendix A and in the Washington

Network SOPs. The results of these verifications are recorded by station operators and the final results are submitted to EPA.

Monthly flow rate verifications are also conducted on all $PM_{2.5}$ CSN, NATTS samplers as defined in the national program-specific and Washington Network QAPPs and SOPs.

15.1.5. Nephelometer quality control checks

Automated quality control checks are conducted on all Washington Network nephelometers at a minimum of 14 day intervals as defined in the Washington Network nephelometer SOPs. Nephelometer quality control checks consist of challenging the instrument with a test air sample (precision point) of known coefficient of light scattering (bscat) and a zero bscat sample generated by running sampled air through a particle filter. CO_2 is used exclusively in the Washington Network for the purpose of nephelometer quality control checks. All nephelometer quality control checks (including manually initiated checks) must be conducted via the Envidas data logger software to ensure that results are automatically be recorded by the logger software. Manual checks are required every 90 days. Actual (Assessment) and Indicated (Monitor) precision results from nephelometer quality control checks are reviewed by Quality Assurance personnel as part of the final level validation.

15.2. Quality control documentation

The electronic logbook, available in the Envidas Ultimate Reporter, is considered a legal record and therefore, logbook entries must contain sufficient detail such that someone other than the station operator can verify that required quality control activities were performed. At a minimum, documentation must include the date, time, station name, equipment (E-tag or serial number) verified or calibrated, type of calibration, the initials of the technician as well as a description of quality control results. An example of a properly documented logbook entry is shown in Figure 16 below.

Additional information on documentation can be found in the Air Monitoring Documentation, Data Review, and Validation Procedure on Ecology's website.

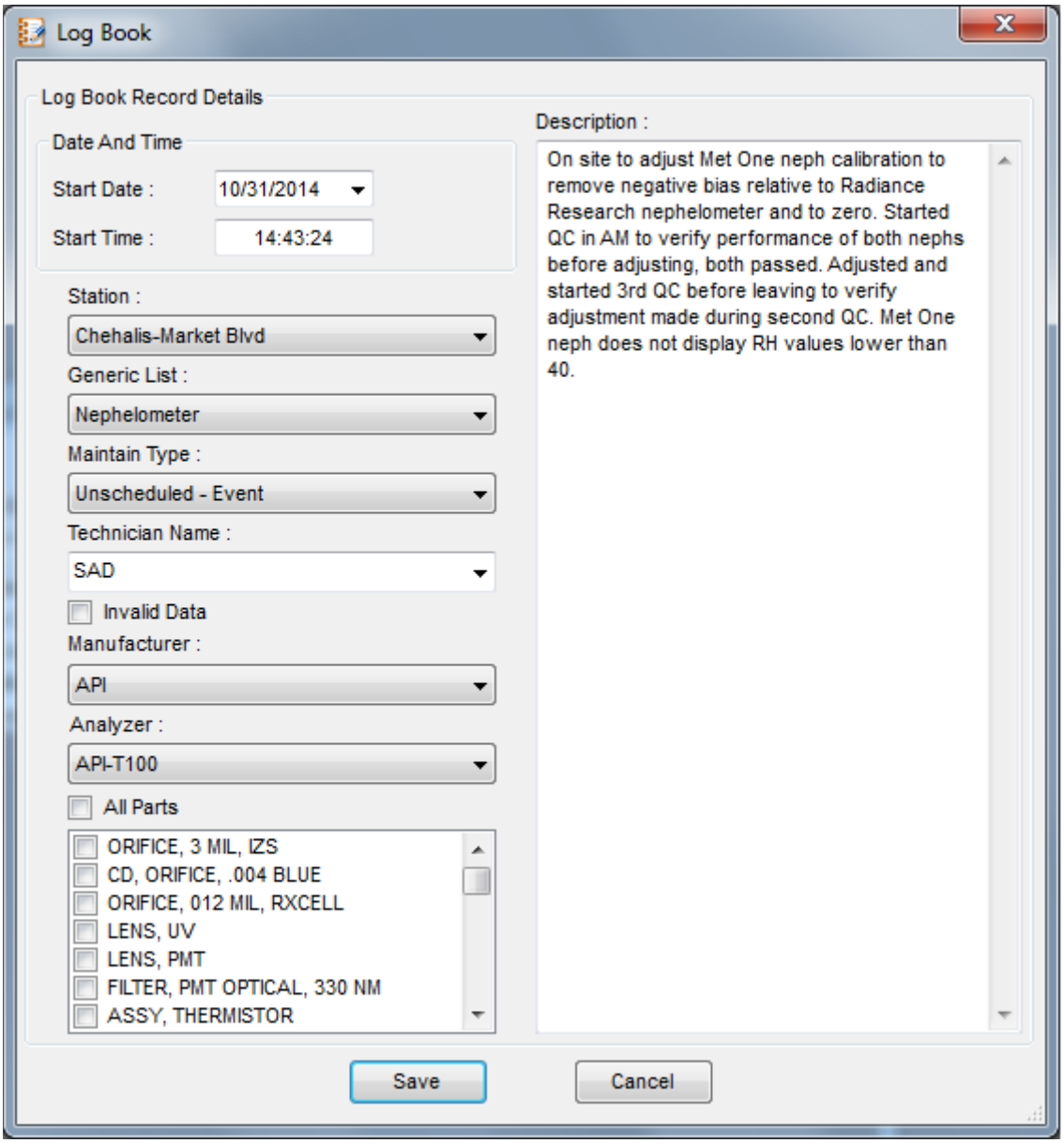

Figure 16 - Example of a properly documented logbook entry

15.3. Zero and span adjustments on analyzers and nephelometers

Gaseous pollutant analyzers as well as nephelometers allow for zero and precision/span adjustments. These adjustments (recalibrations) are used to attenuate instrument response to correct for unacceptable calibration drift.

The results of quality control checks indicate whether the analyzer/nephelometer is operating within acceptable calibration limits (also called acceptance limits). The instrument-specific SOPs define action levels (expressed in percent difference) that indicate when to adjust the zero and/or span. Action levels are closer to the true value than acceptance limits in order to allow

time for an analyzer adjustment prior to reaching unacceptable calibration drift and subsequent data invalidation. When the results of a QC equal or exceed the action level, the analyzer/nephelometer must be adjusted to bring it back into better calibration. Operators should avoid making adjustments when QC results are below action levels as a minor amount of drift is normal and doesn't impact data validity.

Any zero and/or span adjustments must always be followed by an "as-left" QC check to verify proper calibration. Operators should allow sufficient time between any adjustment and the subsequent calibration check in order to ensure that the instrument readings are stable. Stabilization times may be substantial for some analyzers. Note that many modern analyzers, such as the Teledyne API T400 ozone analyzer, provide a digital stability indicator as a diagnostic parameter that can be helpful in determining when analyzer readings are stable.

15.4. Particulate sampler/monitor adjustments

Similar to zero and span adjustments for gaseous pollutant analyzers and nephelometers, quality control check results for ambient temperature, ambient pressure, and flow indicate whether particulate samplers/monitors are operating within acceptance limits. When QC results equal or exceed action levels, recalibration of the out-of-control parameter is required.

Any adjustment must always be followed by an "as-left" QC check to verify proper calibration.

15.5. Full instrument calibrations

In addition to initial calibration, all Washington Network air monitors, analyzers, and samplers must go through a full calibration of all operational systems in the following circumstances:

- After major repairs and maintenance that affect calibration
- Upon indication of analyzer malfunction or change in calibration
- At defined intervals as required by instrument-specific SOPs and the CFRs

15.6. Quality control failure data handling

Quality control check results that are outside acceptance limits as defined in the instrument-specific SOPs will result in invalidation of collected data. Ambient measurements are invalidated back to the most recent point in time where such measurements are known to be valid. This is typically the previous passing quality control check or performance audit, whichever is more recent. Data collected following a quality control check failure, instrument malfunction, or extended downtime will be considered invalid until a subsequent passing quality control check confirms that the instrument is operating within acceptance limits.

In certain cases, it may be possible to identify a specific point in time where an instrument exceeded acceptance limits without invalidating data back to the last passing QC check or audit. A weight of evidence approach is used in such cases in order to determine data validity and identify likely causes of excessive drift, such as a power failure or other fairly obvious malfunction.

16. Non-Network and Non-Direct Measurement Data

Non direct measurements are also called 'existing data' and consist of data or information that may be used by Ecology but is not generated by the Washington Network.

16.1. Non-Washington Network data

There are many entities that conduct ambient air monitoring within Washington State that are not part of the Washington Network. Federal, state, and local air agencies and Native American tribes conduct monitoring that is not funded by Ecology. Non-network data is not subject to the requirements of the Ecology's Quality System, is not reviewed or validated by AQP Quality Assurance personnel and is therefore not submitted to AQS. While non-network data is not reviewed or validated by Ecology, when it is of known and sufficient quality, it can augment knowledge of air quality issues around the state. Data of unknown quality, regardless of the collecting entity, should be used with caution.

Meteorological data gathered by other sources is a good example of non-network data that is nevertheless used as supplemental information for understanding, managing, and controlling air pollution in Washington. The National Weather Service, National Climatic Data Center, and Regional Climate Centers collect data that can supplement information used to validate network meteorological site data, make decisions regarding where to locate monitoring sites, inform data analysis and modeling efforts, and make curtailment calls in airsheds without a Washington Network meteorological station.

16.2. Chemical and physical properties data

Chemical and physical properties data and conversion constants are often required in the processing of raw data into reporting units. This type of information that has not already been specified in the monitoring regulations will be obtained from nationally and internationally recognized sources. The following sources can be used without extensive review of their quality system requirements:

- National Institute of Standards and Technology (NIST)
- International Organization for Standardization (IOS), International Union of Pure and Applied Chemistry (IUPAC), American National Standards Institute (ANSI), and other widely recognized national and international standards organizations
- United States Environmental Protection Agency (EPA) and the most recent edition of EPA's Quality Assurance Handbooks

16.2.1. Geographic location and meta data

Geographical location information of Washington Network monitoring sites is required by EPA and must be reported in latitude and longitude. Station operators are responsible for collecting geographical coordinate information whenever a new site is installed or a site is relocated and entering the information in the Site Information Management System (SIMS). Hand-held GPS

devices and Google maps are two acceptably accurate methods that can be used to obtain monitoring site geographic coordinates.

16.2.2. Historical monitoring information

Historical monitoring data and summary information may be used in conjunction with current monitoring results to calculate and report pollutant trends. When determining historical trends, past data must be reviewed to ensure comparability to current monitoring data. In cases where different sampling methods are combined to conduct trend analyses, known error, biases, and other potentially confounding factors must be identified and noted in all reports based upon such data.

17. Data Acquisition, Management, and Reporting

Successful strategies for air pollution prevention and reduction depend upon the correct interpretation of air monitoring data. Therefore, it is critical that ambient air monitoring data are:

- Easily accessible to a variety of users
- Of known and sufficient quality for intended use
- Aggregated in manners consistent for most common use
- Secure

The Washington Network air monitoring data are collected, stored, and reported to meet these criteria. The various elements of Ecology's efforts in this regard are discussed below.

17.1. Washington Network telemetry system

The Envitech Ltd./DRDAS (Envidas) data acquisition and management software platform, commonly referred to as the telemetry system, is used exclusively in the Washington Network. Ecology's AQP Informational Technology team is responsible for testing and auditing the Envidas software platform, as well as working with Envidas to identify software bugs, updates, and potential improvements that help the Washington Network's air monitoring data further meet its criterion. Ecology ensures that data is not inadvertently modified or deleted by password protecting the telemetry system and backing up data daily in the State Data Center. Logbook entries are documented with the user's initials as well as timestamped, and electronic logbook records are reviewed and assessed for consistency between QC reports. Only quality assurance staff are able to modify data as part of the data validation process (see the Air Monitoring Documentation, Data Review, and Validation Procedure). Descriptions of the various aspects of the telemetry system are provided below. Figure 17 shows the basic structure of the Washington Network telemetry system.

Data Logger - Runs on the local logger:

- Envidas Ultimate
    - Envidas Ultimate Viewer
    - Envidas Ultimate Reporter
    - Envidas Ultimate Service Manager
    - Envidas Ultimate Setup

Central System - Runs on servers at Ecology headquarters in Lacey, WA:

- Microsoft SQL Server Database for all collected data (pollutant, metrological and related metadata)
- Envista Setup (station configuration software)
- XML Reporter (AQS data submittals)

- Communication Center (data logger collection)
- Website Manager
- Envitech API (data reporting)
- FTP Import Export

Client Server/Desktop Software - Run on Ecology and partner offices around the state:

- Envista Air Resources Manager (EnvistaARM) for producing various air quality summary reports, reviewing logbooks, and setting data validation
- Remote Desktop (for accessing loggers remotely)

Envidas Website

- Available to the public
- Near-real-time display of continuous monitoring data
- Site information and photos
- Real-time Washington Air Quality Advisory (WAQA)
- Downloadable data into Excel and other formats
- Various summary and graphical pollution reports

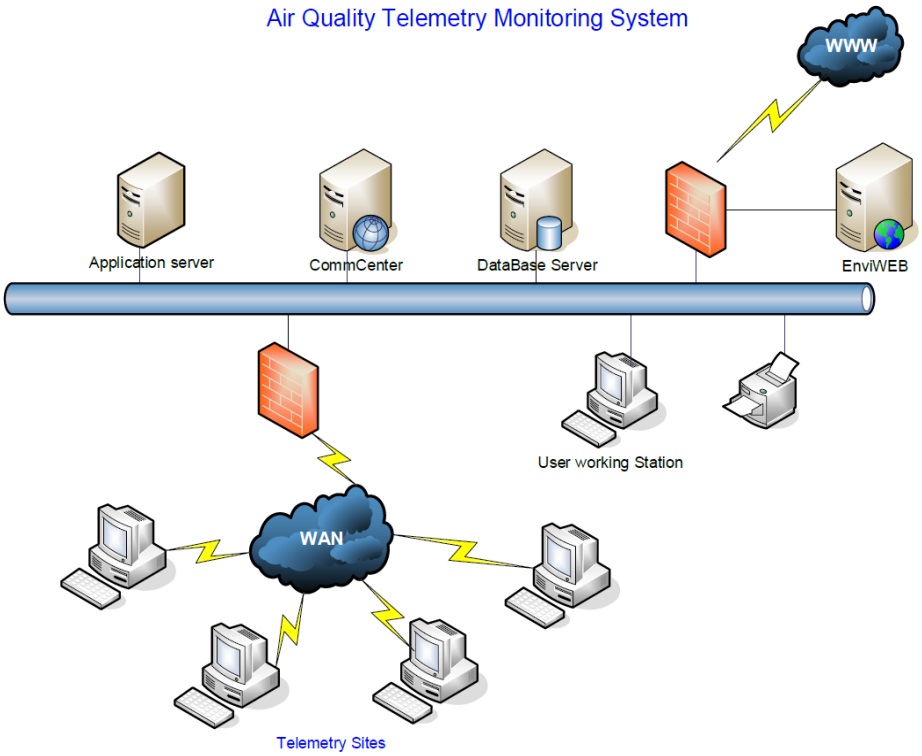

Figure 17 - Basic structure of Washington Network telemetry system

18. Assessments and Response Actions

Performance evaluations and audits are conducted at regular intervals in order to assess the performance and quality of the Washington Network. These assessments are conducted by Ecology, EPA, and third party contractors with independence from normal station operations.

18.1. Independent assessment

Figure 18 below presents EPA's recommended level of independence for the quality assurance function within monitoring organizations. The Washington Network organizational structure displayed in Figure 1. earlier in the plan illustrates the relationship between the Ecology Quality Assurance group and monitoring operations.

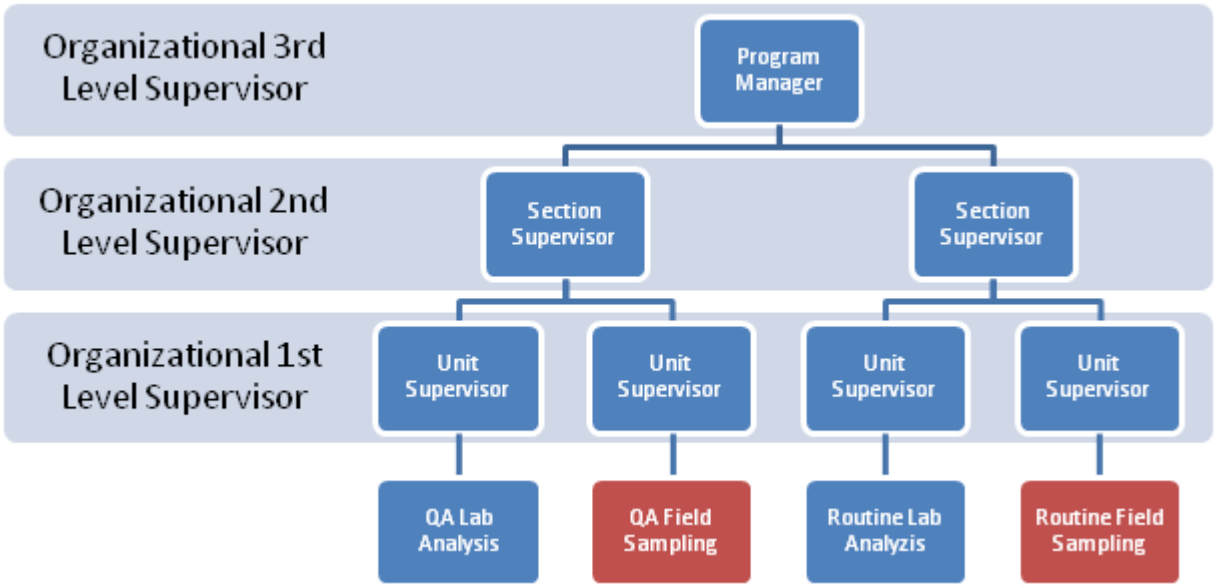

Figure 18 - EPA-recommended organizational independence of quality assurance function

Performance audits are conducted by AQP Quality Assurance personnel at routine intervals on all FRM/FEM, CSN, NATTS, and meteorological monitors. EPA Region 10 and EPA's Office of Air Quality Planning and Standards contract with third parties to provide independent performance evaluations and audits as part of its National Performance Evaluation Program and National Performance Audit Program (NPEP and NPAP).

EPA Region 10 staff conducts a technical systems audit (TSA) of the Washington Network at three year intervals.

These evaluations and audits as well as associated corrective actions are described in detail below.

18.1.1. Ecology quality assurance performance evaluations

AQP Quality Assurance personnel conduct performance evaluations (audits) on all Washington Network SLAMS and SPMS FRM/FEM monitors at intervals dictated by federal requirements in the most recent version of 40 CFR 58, Appendix A. In addition, Ecology Quality Assurance

personnel conduct performance audits on all CSN, NATTS, and meteorological monitors within the Washington Network as specified in the network-specific QAPP, SOPs, and/or EPA Quality Assurance Handbooks.

Ecology QA performance audits may be conducted with or without the station operator in attendance. During audits, QA personnel make observations, review documentation in the station's electronic logbook, review maintenance schedules, and inspect quality control results to determine how well the site, equipment, and documentation of such activities are being maintained and to evaluate whether CFR and SOP requirements are being met. Ecology Quality Assurance personnel maintain a separate lab and separate set of audit standards expressly for the purpose of conducting performance audits. In order to preserve the independence of the Quality Assurance audit and review process, all Quality Assurance audit transfer standards, multi-gas calibrators, and associated audit gear are maintained and certified by Quality Assurance personnel and/or vendors separately from day-to-day monitoring site operations.

Ecology Quality Assurance personnel record observations, audit results, and findings in the electronic logbook. Audit results are also recorded on Excel spreadsheets and emailed to the station operator, Quality Assurance and Air Monitoring Coordinators, Calibration & Repair staff, and grant/project managers. Audit results are entered manually into EPA's AQS by the Air Quality Program's AQS Coordinator.

Multi-point gaseous analyzer audits

Multi-point performance evaluations are conducted on all Washington Network gaseous analyzers at routine intervals. Ecology QA personnel select gaseous analyzer audit levels per the most recent direction and guidance found in the CFR, Quality Assurance Handbook, Vol II and EPA technical guidance. 40 CFR Part 58, Subpart G, states that audit levels should bracket 80 percent of ambient concentrations measured by the analyzer being evaluated. In order to facilitate this principle and allow for audits at precursor (trace) concentrations typically seen at NCore sites, in 2010 EPA expanded the audit levels for gaseous analyzers from 5 to 10 levels. The levels and guidance for how to determine appropriate audit levels for each pollutant can be found in EPA Quality Assurance Handbook, Vol II.

For multi-point gaseous analyzer audits, Ecology Quality Assurance personnel transport QA standards and/or multi-gas calibrators to monitoring locations to generate known pollutant concentrations at appropriate audit levels. Test concentrations are simultaneously measured by both the QA standard and the monitoring station's analyzer. After stable readings are achieved at given test levels, the responses of the station analyzer are compared against the output of the QA standard. The audit ("actual" or "assessment") concentration and the corresponding analyzer ("indicated" or "monitor") response must be within acceptance limits as defined in the CFR (for FRM/FEMs) and Washington Network SOPs. Audit results outside of acceptable limits are investigated by QA personnel in coordination with station operators in order to determine validity of results.

An example of a multi-point ozone performance audit is presented in Figure 19 below.

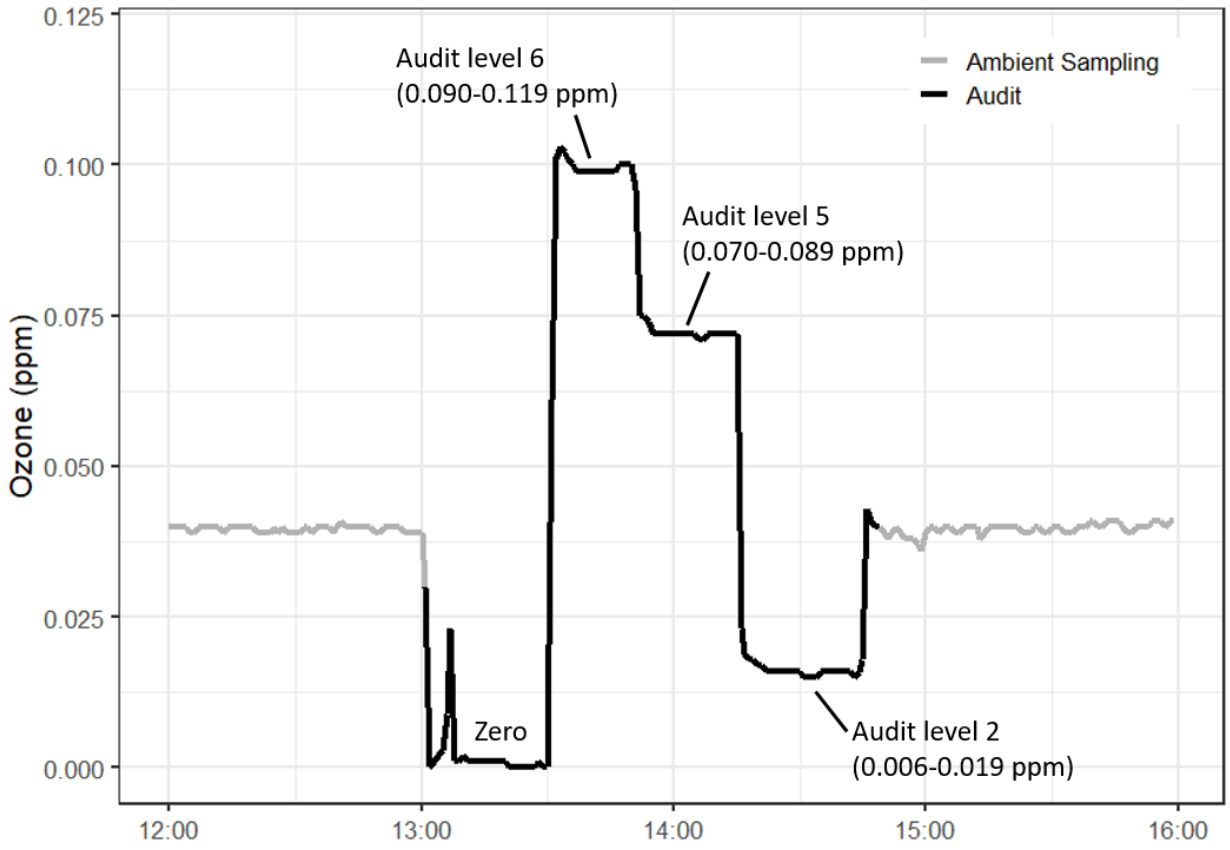

Figure 19 - Example of an ozone performance audit

Semi-annual flow audits

Ecology Quality Assurance personnel conduct semi-annual flow audits on all Washington Network FRM/FEM particulate instruments every 6 months as defined in 40 CFR 58, Appendix A. As mentioned previously, QA flow standards are recertified annually by QA personnel or vendors to ensure independence from station operations. In the event of a flow audit failure, QA personnel will use a secondary flow standard in an effort to confirm results. If passing results are achieved with a properly operating secondary flow standard, the secondary results will be used for the purposes of determining whether the station instrument is within acceptance limits.

18.1.2. Corrective action

In the event of an AQP audit failure, the QA auditor will take steps to verify that the audit standard is calibrated and operating correctly. If the standard is found to be properly calibrated and operating correctly, the QA auditor will alert the station operator and may request additional information on data validity. The site operator must investigate the cause for the questionable data, document any problems found, perform necessary corrective actions, and respond via email, to Quality Assurance staff. Quality Assurance personnel and/or the AQP QAC will make the final decision as to whether data will be invalidated. In the absence of a

response from the operator, the questionable data will be invalidated by QA personnel back to the last valid quality control check. Data will continue to be considered invalid until it can be shown to meet the Air Quality Program MQO's.

18.1.3. Percent valid data

Percent valid data (also known as data completeness) is a metric reflecting the amount of certified valid data obtained from a monitor as compared to the amount expected under ideal conditions. The metric for percent valid data is typically expressed quarterly and annually in Data Quality Assessment Reports (discussed below in section 22.1).

Data completeness (explained in section 11.16) is determined for each monitor. When calculating the metric, the sampling period and frequency (for manual methods) is taken into account and the result for a given monitor is expressed as a percentage. Monitors not meeting Ecology's 80% certified valid data goal are noted, along with an explanation, in the associated Data Quality Assessment Report (see 22.1 below) for the quarter/year in question. Data users should exercise caution when using incomplete data as incomplete datasets are associated with greater uncertainty.

18.1.4. EPA performance evaluations

Monitoring organization networks receiving funds from EPA are required to be assessed by independent parties. Federally-implemented programs using State and Tribal Assistance Grant (STAG) funds are provided to those organizations unable to support such programs due to financial or organizational constraints. The Washington Network participates in The National Performance Audit and National Performance Evaluation Programs (NPAP and NPEP) which are administered by EPA and supplement Ecology Quality Assurance activities designed to:

- Determine data comparability and usability across sites, monitoring networks (tribes, states, and geographic regions), instruments, and laboratories
- Provide a level of confidence that monitoring systems are operating within data quality limits so data users can make decisions with acceptable levels of certainty
- Help verify the precision and bias estimates performed by monitoring organizations
- Identify where improvements (technology/training) are needed
- Assure the public of non-biased assessments of data quality
- Provide a quantitative mechanism to defend the quality of data
- Provide information to monitoring organizations on how they compare with the rest of the nation in relation to the acceptance limits and to assist in corrective actions and/or data improvements

Figure 20 - EPA audit trailer at former Beacon Hill site in Seattle

18.2. Technical systems audits

A Technical Systems Audit (TSA) is a thorough systematic, on site, qualitative audit of facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of the Washington Network monitoring system. TSAs are conducted by EPA Region 10 at three year intervals.

19. Reports to Management

There are a variety of reports that the AQP QA team uses to inform program management, staff and external Washington Network partners in regard to data quality and compliance with the NAAQS. Those reports, many of which are available through EPA's AQS, are described below.

19.1. Data quality assessment reports

Data Quality Assessments (DQAs) are statistical summaries that determine if the DQOs are met and describe data uncertainty. If the DQOs are not met, the DQAs are used to determine whether modifications to the DQOs are necessary and/or whether more stringent quality control is required.

AQP Quality Assurance staff produce quarterly and annual Ambient Air Monitoring Data Quality Assessment reports. These reports provide summary statistical information on the effectiveness of data collection as well data quality indicators that serve as a metric of the appropriateness of data quality for intended uses. The AQP QAC and Quality Assurance personnel use this report to alert Washington Network managers to operational and systematic problems as well as identify options for improvements. The reports are emailed to station operators, EPA, Ecology management, and Washington Network partners.

19.2. Air Quality System reports

EPA's Air Quality System (AQS) contains many stock reports that are used by Ecology Quality Assurance personnel to assess data quality, certify data, and analyze how the Washington Network is faring in terms of the NAAQS. These reports can be generated within the AQS application. More details on these and other reports can be accessed via EPA's AMTIC website. The most commonly used reports are described briefly below.

19.2.1. AMP251 QA Raw Assessment Report

The AMP251 QA Raw Assessment Report is raw data from the following the following QC/QA activities:

- 1-Point Quality Control
- Annual Performance Evaluation
- Flow Rate Verification
- Semi-Annual Flow Rate Audit
- PMc Flow Rate Verification
- PMc Semi-Annual Flow Rate Audit
- Speciation Flow Rate Verification
- Speciation Semi-Annual Flow Rate Audit
- Performance Evaluation Program

- National Performance Audit Program
- Pb Analysis Audit
- Collocated Assessments

19.2.2. AMP256 QA Data Quality Indicator Report

The AMP256 QA Data Quality Indicator Report summarizes the precision, bias, and completeness results for the QC/QA the activities listed under the AMP251 report above. The completeness results for this report relate to whether quality control and quality assurance activities were conducted at required intervals. This report is used as a primary source for the information contained in the Ambient Air Monitoring Data Quality Assessment Reports.

19.2.3. AMP430 Data Completeness Report

The AMP430 Data Completeness Report presents percent data completeness results for each monitor. This report is used in conjunction with the AMP256 QA Data Quality Indicator Report as a primary source for the Ambient Air Monitoring Data Quality Assessment Reports.

19.2.4. AMP480 Design Value Report

The AMP480 Design Value Report is a helpful tool for quick snapshots of how the Washington Network criteria pollutant FRM/FEM monitors are faring in terms of the NAAQS. Users of this report should refer to the reference methods in 40 CFR Part 50 for information on design value calculations.

19.2.5. AMP600 Certification Evaluation and Concurrence Report

The AMP600 Certification Evaluation and Concurrence Report is used primarily by Ecology Quality Assurance personnel and the Ecology's AQS Coordinator to certify data in AQS on an annual basis.

20. Data Review, Verification, and Validation

Data review, verification, and validation are techniques used to accept, reject, or qualify data in an objective and consistent manner. Verification can be defined as confirmation, through provision of objective evidence that *specified requirements* have been fulfilled. Validation can be defined as confirmation through provision of objective evidence that the particular requirements for a specific intended use are fulfilled. For example, one could verify that for a monitor all Single-point QC checks were performed every two weeks as described in the SOP *(specified requirement)*. However, if the checks were outside acceptance limits, the validation process might determine that the data could not be used for NAAQS determinations *(intended use)*. It is important to describe the criteria for deciding the degree to which each data item has met its quality specifications. This section describes the techniques used to make these assessments. The information provided here is intended as a general overview. Additional information regarding the Washington Network data validation process can be found in Ecology's Air Monitoring Documentation, Data Review and Validation Procedure on Ecology's external Publications & forms website (https://ecology.wa.gov/About-us/Online-tools-publications/Publications-forms).

Review, verification, and preliminary data validation are performed by the station operator. A separate review, verification, and final data validation are performed by Ecology Quality Assurance personnel independent of station operations, and documented in data validation spreadsheets. These activities are done on an ongoing, routine basis. Station operators are responsible for reviewing collected data and quality control check results as often as possible to ensure errors in data collection are caught early and prevent excessive data loss.

20.1. Data review methods

A critical aspect of the Washington Network quality system involves the thorough review of all network data, the primary purpose of which is to identify and remove data that does not meet Measurement Quality Objectives.

As described in detail in the Air Monitoring Documentation, Data Review, and Validation procedure, thorough review of collected data begins with station operators in the field. Station operators are responsible for preliminary data validation which involves review collected data and automated quality control check results in order to catch errors in data collection early and prevent data loss. Station operators must notify QA personnel when erroneous data are identified.

Quality Assurance staff also conduct a thorough review of all Washington Network data as part of the final data validation process. All documentation associated with sample collection and instrument operation, quality control check results, logbook entries, and collected data are examined in order to determine whether collection errors have occurred. Any data that do not meet the AQP's MQOs or completeness requirements are described in the Ambient Air Monitoring Data Quality Assessment reports.

Graphical review of collected data facilitates the detection of outliers and other errors in measurements. The EnvistaARM software contains several graphical report options that station operators and QA personnel use for this purpose. 1-minute Station Reports often reveal errors that are "smoothed out" by longer averaging periods. Group and Multi-station Reports are extremely helpful for comparing pollutant data in a given airshed/region and can be used to quickly spot data collection errors. An example of a readily-identifiable instrument problem as revealed by a Multi-station Report is presented in Figure 21 below. It is clear that the nephelometer [NEPH(Bscat)] readings represented by the blue line radically depart from the neighboring area nephelometer readings following an initial period of reasonable agreement. This nephelometer is almost certainly malfunctioning and the site operator should investigate the problem and notify QA personnel regarding data validity.

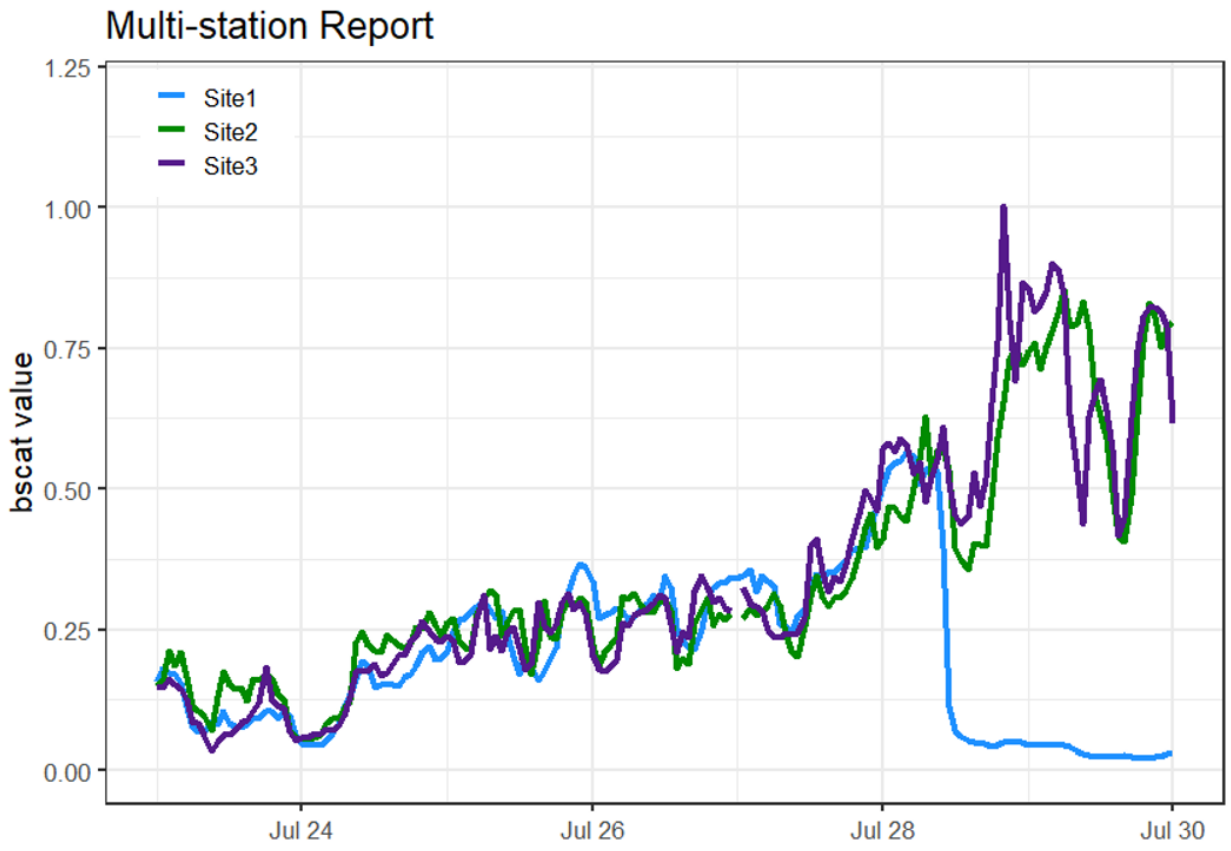

Figure 21 - Example of a Multi-Station Report

20.2. Data verification methods

Verification can be defined as confirmation through provision of objective evidence that specified requirements have been fulfilled. The data verification process involves the inspection, analysis, and acceptance of the field data or samples. These inspections can take the form of technical systems audits (internal or external) or frequent inspections by field operators and lab technicians. Questions that should be asked during the verification process include:

- Were data collection operations performed according to approved SOPs?
- Were data collection operations performed at required frequencies and within appropriate time frames? Many environmental operations must be performed within a specific time frame. For example, the NAAQS samples for filter-based particulate are collected from midnight to midnight on a pre-defined frequency and schedule set by EPA.
- Did the sampler or monitor perform correctly? Individual checks such as leak checks, flow checks, meteorological influences, and all other assessments, audits, and performance checks must have been acceptably performed and documented.
- Did the environmental sample pass an initial visual inspection? Many environmental samples can be flagged (qualified) during the initial visual inspection.
- Have manual calculations, manual data entry, or human adjustments to software settings been verified? Automated calculations should be verified and accepted prior to initial use and periodically reviewed thereafter to ensure changes have not occurred.

20.3. Data validation methods

Data validation is an ongoing process designed to ensure that collected data meet the quality system goals of the Washington Network. Data validation is further defined as an examination and provision of objective evidence that the requirements for a specific *intended use* are fulfilled. The purpose of data validation is to detect and verify data that may not represent actual ambient air quality conditions at the sampling station. Effective data validation procedures usually are handled completely independently from the procedures of initial data collection.

Certain criteria, based upon the CFR as well as field operator and laboratory technician judgment, may be used to invalidate a sample or measurement. Washington Network acceptance limit criteria are identified in Ecology's instrument-specific SOPs.

Flags or result qualifiers are applied to data in order to identify potential problems with data within the Washington Network. Flags are applied automatically by the instrument and logger and after the fact by QA personnel responsible for final level data review and validation. Flags are used to indicate the reason that a data value:

- Did not produce a numeric result (null data code)
- Is not an ambient concentration (zero, precision, span data)
- Is questionable due to instrument status (automatically flagged by the logger or monitor)
- Has been invalidated due to not meeting the requirements in the QAP/SOPs

Flags can be used both in the field and in the laboratory to signify data that may be suspect due to contamination, special events or failure of QC limits. Flags can be used to determine if

individual samples (data), or samples from a particular instrument will be invalidated. In all cases, data is thoroughly reviewed prior to any invalidation.

20.3.1. Automated methods

When zero, span, or one-point QC checks exceed acceptance limits, ambient measurements are invalidated back to the most recent point in time where such measurements are known to be valid. Usually this point is the previous passing quality control check, unless some other point in time can be identified and related to the probable cause of the excessive drift (such as a power failure or instrument/equipment malfunction). Data following a quality control check failure, instrument/equipment malfunction, or period of inoperation are considered invalid until verification can demonstrate that the instrument in question is operating within acceptance limits. Typically, this coincides with the next passing QC check.

Data may be invalidated when room or shelter temperatures exceed acceptable operating limits for a given instrument. Acceptable shelter temperature ranges are defined in the manufacturers' manuals and/or the Washington Network's instrument-specific SOPs.

20.3.2. Manual methods

The first level of data validation for manual methods is to accept or reject the sample(s) based upon results from operational checks of critical parameters in all three major and distinct phases of manual methods: Sampling, analysis, and data reduction. Laboratories (Manchester, AMEC/Wood, ERG, etc.) are the primary initial validators for manual methods within the Washington Network while the Ecology QA personnel perform final level validation of collected samples.

In addition to using operational checks for data validation, validators must observe all limitations, acceptance limits, and warnings described in the reference and equivalent methods that warrant data invalidation. Results from performance audits/evaluations as required by 40 CFR 58 Appendix A are not necessarily used as the sole criteria for data invalidation because they are intended to assess the quality of the data.

20.3.3. Validation templates

In June 1998, EPA established a national workgroup consisting of EPA staff and personnel from state, local, and other monitoring entities to develop a procedure for monitoring organizations to follow that would provide for consistent validation of criteria pollutant monitoring data across the United States. The workgroup developed three tables of criteria with each table representing a different degree of impact on the quality of the data as summarized in Table 12 below.

Table 12 - Validation template criteria

Validation Template Table	Data Quality Impact	Data Validation Action
Critical Criteria	Critical to maintaining the integrity of a sample or group of samples	Invalidate data when criteria are not met unless compelling evidence exists not to do so
Operational Criteria	Important for maintaining and evaluating the quality of the data collection system	Weight of evidence approach to determining data validity
Systematic Criteria	Important for the correct interpretation of the data	Weight of evidence approach to determining data validity

These Validation Templates can be found in the most current version of EPA's Quality Assurance Handbook, Vol. II, Appendix D and are available through EPA's AMTIC website.

Washington Network SOPs for FRM/FEM instruments are written to ensure that all 40 CFR Part 58, Appendix A requirements are met. These requirements are reflected in the Validation Templates. As such, Ecology QA personnel use the Validation Templates to inform the final level validation process. Data not meeting the Critical Criteria are typically invalidated unless there is compelling evidence to not do so. A weight of evidence approach is used for FRM/FEM data collected during times when Operational or Systematic Criteria are not consistently met.

20.4. Final Level Validation

Ecology Quality Assurance personnel verifies and reviews all station operations, documentation, quality control activities and results, and maintenance activities in determining validity of data collected in the Washington Network. Verification is confirmed by examination and provision of objective evidence that specified requirements have been fulfilled. Ecology Quality Assurance staff perform final level validation on all Washington Network data through the EnvistaARM (with the exception of CSN and NATTS data), locking the data from further editing and preparing it for submittal to AQS.

Earlier elements of this Quality Assurance Plan describe in detail how the activities in these data collection phases are implemented in order to meet the data quality objectives of the program. Review and approval of this QAP by the personnel listed on the signatory page serves as an agreement for all involved that the processes described in this QAP will provide data of adequate quality. In order to verify and validate the phases of the data collection operation, the Air Quality Program's Air Monitoring Coordinator and QA Coordinator use qualitative assessments (e.g., annual network reviews, technical systems audits) to verify that the QAP is being followed. QA personnel rely on the various quality control results, performed at specified intervals of the data collection operation, to validate that the data meet the DQOs.

21. Quality Improvement

The main goal of the reconciliation of collected data with user requirements is to determine whether the Washington Network is adequate to achieve the monitoring goals of the AQP, its data quality objectives (DQOs), and Measurement Quality Objectives (MQOs). Quarterly and annual Data Quality Assessments produced by the Quality Assurance team (Section 19.1) provide statistical summaries that determine if the DQOs and MQOs are met.

Ambient air monitoring data collected by the Washington Network is subsequently used to evaluate the adequacy of the sampling design. If the sampling design is not adequate to meet the DQOs, modifications to the DQOs and/or more stringent quality control may be required. By continuously reviewing the data and assessing whether it is consistent with the objectives of the network, Ecology and its partners in the Washington Network can evaluate the adequacy of the network in terms of meeting its goals.

The data used in decisions regarding determinations of attainment of the NAAQS are never error free and will always contain some level of uncertainty. Because of these uncertainties, there is a possibility that an area may be determined to be nonattainment when it is actually in attainment or vice versa, resulting in potentially serious political, economic, and health consequences. This plan and Ecology's SOPs help to ensure that Ecology and its partners understand the uncertainty inherent in the Washington Network ambient air monitoring data and limit the likelihood of these adverse consequences.

22. References

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