



Quality Assurance Project Plan  
Air Quality Sensors  
Air Quality Program  
Confederated Tribes of the Colville Reservation

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## Section 1- Program Management Elements

Project Name: Using Air Quality Sensors on the Colville Reservation

Responsibility of Agency: Air Quality Program, Office of Environmental Trust

Date: June 2, 2022

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## Section 3: Distribution List

New or updated version of QAPPs will be tracked by date on the document name and stored on the Environmental Trust server. All updates will be provided to everyone on the distribution list in Table 1.

**Table 1: Distribution List for this Quality Assurance Project Plan**

Name	Email	Organization
Thomas DellaRocco	thomas.dellaroccojr.env@colvilletribes.com	Confederated Tribes of the Colville Reservation
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## Section 4: Project/Task Organization

### 4.1 Project Description

Air quality sensors provide a flexible, affordable means to help understand emissions issues within the exterior boundaries of the Colville Reservation and surrounding areas. These sensors are used to investigate discrete emission events, wildfire smoke intrusion into buildings, as screening for criteria pollutants, and for saturation studies. Sensors will be used for ozone, fine particulate matter, coarse particulate matter, carbon monoxide, and carbon dioxide. Data gathered through the uses of sensors are for informational purposes only and are subject to the limitation of each model and manufacturer.

### 4.2 Project Organization

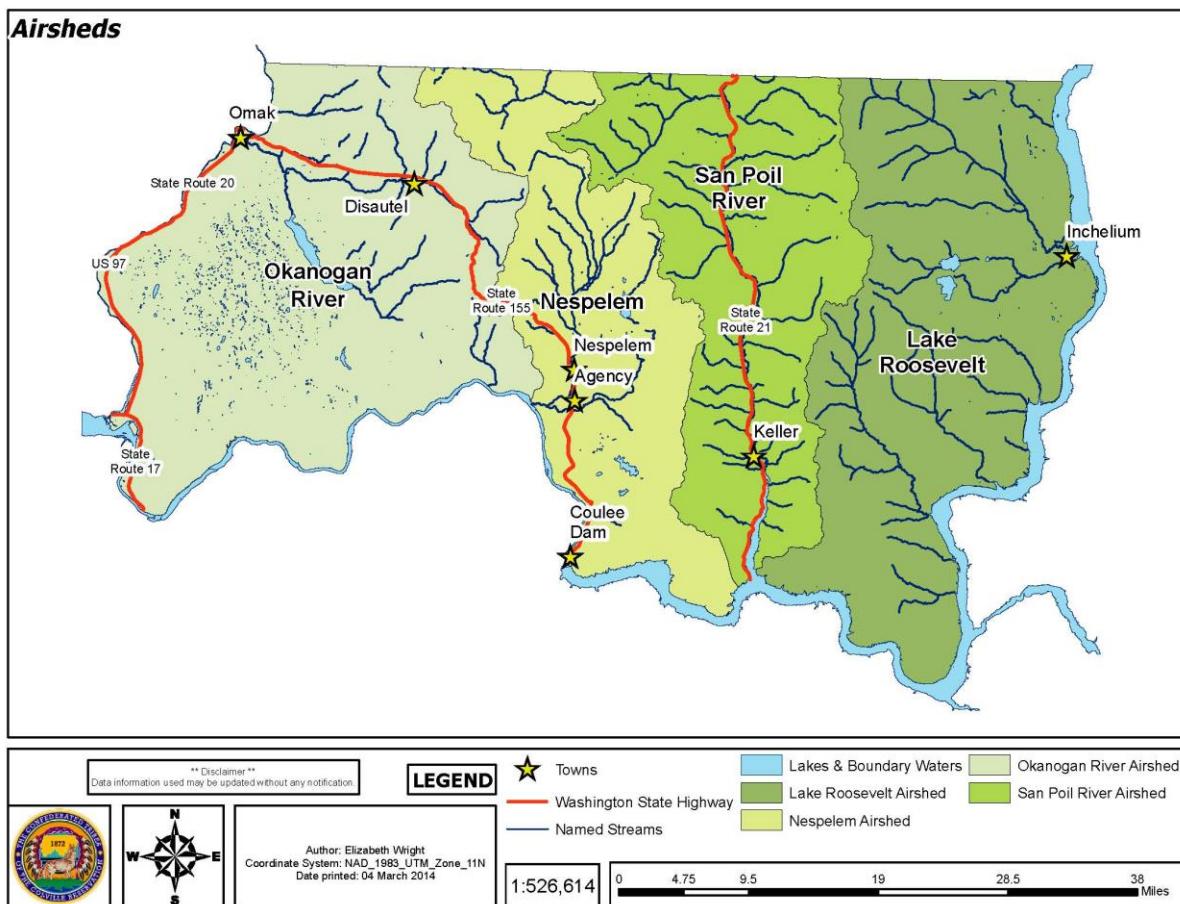
The procurement, installation, maintenance, operation and data management of sensors covered in this QAPP are the sole responsibility of the Air Quality Program (AQP) in the Office of Environmental Trust of the Confederated Tribes of the Colville Reservation. The Air Quality Program Manager acts as the lead individual for all tasks identified in this QAPP.

## Section 5: Problem Definition/Background

The Colville Reservation consists of 1.4 million acres of diverse natural environments. The AQP identified four distinct airsheds for management purposes (Figure 1). The AQP operates permanent continuous PM<sub>2.5</sub> monitors in three of the airsheds; Okanogan River, Nespelem and Lake Roosevelt. These monitoring sites are located in the population centers and may not represent other areas of concern. Using an array of sensors, the AQP will bridge the data collection gap for a better understanding of the dynamics of air quality. Most of the sensors covered in this QAPP are deployed to help the program understand the effects of smoke on the

health of residents on and off the Reservation. In the Okanogan River Airshed, particulate matter sensors are deployed to inform smoke concentrations from wildfires, vegetation debris burning, woodstove use and smoke intrusion into buildings. The AQP utilizes an ozone sensor to screen for elevated concentrations during summer months and smoke events. The other airshed sensors deployed are used to monitor ambient wildfire smoke, prescribed fire smoke and intrusion into building. Sensors can also be utilized to monitor discrete events that result in localized concerns. The AQP has experience deploying, operating and managing data for all sensors covered in this QAPP.

**Figure 1: Airsheds of the Colville Reservation**



## Section 6: Project/Task Description

A variety of sensors will be used to investigate indoor and ambient air quality (Table 2). PurpleAir PA-II sensors are primarily for ambient air but will be utilized to help understand smoke intrusion into buildings, facilities and homes. This will be accomplished by installing a sensor in the buildings of concern and another outside of it. These paired sensors are targeted for schools across and adjacent to the Colville Reservation. Comparison of the data will help in the understanding the dynamics of intrusions. PurpleAir sensors will be located at facilities building and home throughout the greater Omak/Okanogan area year round to gain insight into wood

smoke emissions from woodstove use and vegetation debris burning. Data from the PurpleAir sensors are easily retrieved from the manufacturer's website. The Aeroqual 500 ozone sensor will be deployed during the summer months each year to determine ozone concentrations in the Okanogan River airshed and to determine if smoke increases the concentrations ozone above what could be considered the normal range. Data from the Aeroqual can only be downloaded directly to a computer using the software provided.

The three remaining sensors listed in the table are highly portable handheld devices that produce reliable data. These sensors are primarily used to help understand smoke intrusion into our indoor environments. Concentrations will be determined at several locations in buildings and recorded on paper data sheets. Occasionally, these sensors may be utilized outdoors to collect data about discrete events. Data from the three sensors will be recorded on a paper field form and transcribed to an Excel workbook for analysis. Table 3 provides information on the emissions measured, concentration units and sampling intervals

**Table 2: Sensors, Emissions and location**

<b>Sensor</b>	<b>Emission of Concern</b>	<b>Indoor Use</b>	<b>Ambient Use</b>
PurpleAir	PM <sub>2.5</sub> , PM <sub>10</sub>	Secondary	Primary
Aerocet 831	PM <sub>2.5</sub> , PM <sub>10</sub>	Primary	Secondary
CO Amprobe	Carbon Monoxide	Primary	Secondary
CO <sub>2</sub> Amprobe	Carbon Dioxide	Primary	Secondary
Aeroqual 500	Ozone	None	Primary

**Table 3: Sensor Units and Sampling Intervals**

<b>Sensor</b>	<b>Concentration Units</b>	<b>Sampling Intervals</b>	<b>Use</b>
PurpleAir	micrograms/cubic meter	continuous 80 seconds intervals	fixed
Aerocet 831	micrograms/cubic meter	manual 1 minute intervals	mobile
CO Amprobe	parts per million	manual discrete	mobile
CO <sub>2</sub> Amprobe	parts per million	manual discrete	mobile
Aeroqual 500	parts per million	continuous 15 minute intervals	fixed

Data collected from sensors can also be used for the following purposes

- As educational tools to help people understand the basic principles of air quality
- As a component of presentations explaining sensors and the data collected
- To provide community members an easy way to view current air quality conditions (PurpleAir only)
- To identify additional indoor and outdoor air quality concerns

## Section 7: Quality Objectives and Criteria for Measurement Data

Data collected indoors and outdoors will provide information for decision makers that can affect people's health. The main Data Quality Objectives are to collect data which can be compared to background levels and or standards to determine if mitigation or further investigation is needed (Table 4).

Measurement Quality Objectives (MQO) is a set of quality control criteria, which assure that the DQOs are met. For the instrumentation covered in this QAPP, there are no specified MQOs but there are basic QC checks that need to be conducted to ensure that the sensors are operating properly. These QC checks are explained in Section 14 "Quality Control Requirements".

Table 4: Sensor Data Quality Parameters

Sensor	Detection Range	Confidence	Other
PurpleAir	0 – 500 $\mu\text{g}/\text{m}^3$	$\pm 10 \mu\text{g}/\text{m}^3$ at 0 to 100 $\mu\text{g}/\text{m}^3$	Resolution 1 $\mu\text{g}/\text{m}^3$
Aeroceet 831	0 – 1,000 $\mu\text{g}/\text{m}^3$	$\pm 10\%$ to calibration aerosol	Resolution 0.1 $\mu\text{g}/\text{m}^3$
CO Amprobe	0 – 999 ppm	$\pm 20\%$ at 0 to 100 ppm; $\pm 15\%$ at 100 to 500 ppm	Resolution 1 ppm
CO <sub>2</sub> Amprobe	0 – 999 ppm	$\pm 30 \text{ ppm}$ , $\pm 5\text{rp}d$ at 0 to 500 ppm	Resolution 1 ppm
Aeroqual 500	0 to 10 ppm	$<\pm 0.01 \text{ ppm}$	Minimum detection limit 0.01 ppm

## Section 8: Training

AQP staff will not need specific, targeted training on sensor installation, operation, maintenance, or data management. Staff has extensive experience using the sensors mentioned in this QAPP. All manuals and use-specific Standard Operating Procedures are available and reviewed before deployment as well as yearly for updates.

## Section 9: Documentation and Records

All documentation associated with this QAPP will be stored on AQP computer and backed up on the Office of Environmental Trust server with origination dates attached to the file or folder name. Documents stored will include: Sensor QAPP, SOPs, sensor owner's manuals, raw data, data sheets (blank and completed forms) analyzed data and reports.

## Section 10: Sampling Process Design

Sensor location depends on the factors identified in Tables 2 and 3. PurpleAir sensors are placed at fixed locations, and would rarely be moved, although individual sensors could be replaced if malfunctions occur. A record of location for each sensor will be kept on the ETD server and updated as needed. The AeroQual 500 will continue to be installed at the Omak monitor site

because of the access to electricity, security and meteorological data. All hand held sensors can be used anywhere across the Reservation as needed. Sampling will be conducted based on the AQP written SOPs and the manufacture's guidance.

## **Section 11: Sampling Methods**

Placement of PurpleAir sensors depends on several factors, identification of a partner to host the device, outdoor electricity availability and Wi-Fi access. These sensors collect data every 80 seconds and report it to the public website - <https://www2.purpleair.com/>. Concentrations can be retrieved for multiple time periods including real time, 10 minute, 30 minute, 1 hour, 1 day and 1 week averages. The website reports non-functioning sensors as a gray dot including a time period. Many times these will clear after a short while, if the gray dot persists then a site visit may need to occur. Additional details concerning PurpleAir sensors can be found in the Air Quality Monitoring, Standard Operating Procedures for PurpleAir Particulate Matter Sensor.

Locations for sampling with the handheld sensors depend on smoke concentrations levels, and the degree of intrusion into buildings. The handheld sensor can and will be deployed to locations due to discrete air quality concerns.

Sample intervals for the Amprobe CO and CO2 are instantons discrete concentration recorded on a paper sample collection data sheet. Data will be taken multiple times throughout a building. All information will be recorded on a paper sample data sheet and later transcribe to an Excel workbook for analysis. Procedures to utilize these sensors can be found in – Measuring Indoor air Quality During Wildfire, Standard Operating Procedures.

The Aerocect 831 particulate matter sensor will be used to collect 1 minute data in multiple locations in buildings and other locations. All information will be recorded on a paper data sheet and transcribe to an Excel workbook for analysis. Details of utilizing this sensor can be found in – Air Quality Monitoring Standard Operating Procedures for Aerocect 831 Particulate Matter Sensor.

All data collection, managements and storage is the sole responsibility of the Air Quality Program.

## **Section 12: Sample Handling and Custody**

No physical samples will be collected by the sensors identified in this QAPP.

## **Section 13: Analytical Methods**

No laboratory work will be performed under the QAPP. Measurements taken are not designed to be replicable, are not in accordance with published methods, and are meant only as part of an investigation.

## **Section 14: Quality Control Requirements**

Sensors have very little user QC options for adjustment and calibration. PurpleAir sensors can be checked in several simple ways. The sensor has matching components that use light scattering to estimate particulate matter; these devices can be compared for agreement in real time or during data analysis. If multiple units are deployed in an area where air quality is uniform, then concentrations between sensors can be compared. Both of these methods can be used to determine if a unit is malfunctioning. When a FEM or FRM are located nearby and air quality appears uniform in the area then a comparison can be made. No provisions are being made to conduct a collocation study to determine correction factors. The Aeroqual 500 firmware will provide a warning if the diagnostics do not meet programmed parameters.

**Table 5: Sensor Quality Control Recommendations**

Sensor	Requirement	Frequency	Acceptance	Reference
PurpleAir	No user Adjustments Available			
	Agreement Between Channels A and B	During Data Analysis or Observing Real Time Data	Greater than 75%	AQP SOP
Aerocet 831	Zero Test	Before Use	Pass Indicator	Smoke Intrusion Sampling SOP
	Factory Calibration	Yearly		
CO Amprobe	Automatic Self-Test when turned on	Every time powered up	Meter beeps to indicate self-test passed	Amprobe CM100 CO User's Manual
	Calibration Mode	Before extended use	When display shows 0 ppm	
CO <sub>2</sub> Amprobe	Calibration Mode	Before extended use	When display stops blinking	Amprobe CO2-100 CO2 Meter User's Manual
Aeroqual 500	No user Adjustments Available			
All Hand Held Sensors	Battery Check	Before Use	Charged Full	Owner's Manual

## Section 15: Instrument/Equipment Testing, Inspection, and Maintenance Requirements

The guidance provided in the following Standard Operation Procedures will be followed.

Standard Operating Procedures for all sensors are listed below

1. Measuring Indoor Air Quality During Wildfires SOP, June 2016, updated March 2020
2. Air Quality Monitoring Network Standard Operating Procedures for Met One Aerocet 831, March 2020
3. Air Quality Monitoring Network Standard Operating Procedures for Aeroqual 500 Ozone and Carbon Monoxide Sensors, March 2016, updated March 2020
4. Air Quality Monitoring Standard Operating Procedures for PurpleAir Particulate Matter Sensor, March 2020

## **Section 16: Instrument Calibration and Frequency**

The Aerocet 831 manual requests an annual factory calibration and a user performed zero test be completed. The other sensors covered in this QAPP do not have field calibration capacities other than those described in Table 5. All sensors are inspected before use and cleaned after each sampling season.

## **Section 18: Non-Direct Measurements**

The data from the three permanent continuous PM<sub>2.5</sub> monitoring sites can be used for comparison to the PurpleAir and Aerocet 831 sensors to determine comparability and reasonableness. Comparison can be made utilizing the EPA Sensor Macro Analysis Tool between the sites and sensors.

## **Section 19: Data Management**

Data from investigations using the Aerocet 831 and the Amprobe CO and CO<sub>2</sub> meters are entered on a field forms provided in the Measuring Indoor Air Quality During Wildfires SOP. Data from the Aeroqual 500 can be downloaded to a computer using a program provided with the sensor. Purple Air sensor data is easily obtainable from the manufacturer's website following the procedures provided in the SOP.

## **Section 20: Data Review, Verification and Validation Requirements**

Data verification is the process for evaluating the completeness and correctness of the data set against the methods and procedures. Data validation is sample-specific process that extends the evaluation of data beyond methods and provides procedures to determine the quality of the data set relative to the end use. It focuses on the project's specifications or needs, designed to meet the needs of the decision makers/data users and should note potentially unacceptable departures from the QA Project Plan. The potential effects of the deviation can be evaluated during the data quality assessment. Table 6 provides sensor specific verification and validation limits to use by decision makers of data acceptance. The AQP is responsible for all data review, verification and validation conducted under this QAPP.

**Table 6: Sensor Specific Verification and Validation Criteria**

<b>Criteria</b>	<b>Purple Air PA II PM Sensor</b>
Maximum Highest Acceptable Value	500 $\mu\text{g}/\text{m}^3$ , values above this still indicate extreme smoke concentration, but may not reflect a true value
Minimum Lowest Acceptable Value	0.0 $\mu\text{g}/\text{m}^3$ , the sensor cannot produce a negative value. The BAM 1020s used for comparisons can return a negative number which still indicates extremely good air quality
Individual Sensors Above Expected	If emissions are perceived as being uniform in the sample area then all sensors should be returning comparable concentrations. Check agreement between channels A and B. Determine if site specific emissions are near affected sensor.
Individual Sensors Below Expected	If emissions are perceived as being uniform in the sample area then all sensors should be returning comparable concentrations. Check agreement between channels A and B. Determine if sensor location contributes to low value.
All Sensors Show Similar Concentrations	Sensor data can be used for decisions making within limits of data quality
Data Recording Method	Data will be accessed from <a href="https://www2.purpleair.com/">https://www2.purpleair.com/</a> following the methods provided in the CTCR PurpleAir Sensor SOP. All data will be handled electronically.
Data Analysis	Data from each sensor can be entered into a Excel Workbook as 1 hour and 24 hour averages. The EPA Macro Analysis Tool can be used to compare with FEM or FRM site nearby.
<b>Criteria</b>	<b>Aerocet 831 PM<sub>2.5</sub> Sensor</b>
Maximum Highest Acceptable Value	1000 $\mu\text{g}/\text{m}^3$ , values above this still indicate extreme smoke concentration, but may not reflect a true value
Minimum Lowest Acceptable Value	0.0 $\mu\text{g}/\text{m}^3$ , sensor does not produce negative value.
Zero Test Passed	Test conducted and passed before smoke season
Data Recording Method	One minute data will be entered on a form as shown in the Measuring Indoor Air Quality During Wildfires SOP.
Data Analysis	Data will be entered in to an Excel Workbook for summary and analysis
<b>Criteria</b>	<b>AeroQual 500 Ozone Sensor</b>
Maximum Highest	If concentrations exceed 105 ppb then the cause and duration should be determined before using data.
Sensor Error Message	If the sensor reports errors then data should not be used for decision making.
Data Recording Method	Data will be downloaded to a laptop using an RS232 cable and the Aeroqual software. Files will be kept on the laptop and transferred to the AQP server for storage. Data summaries are available using the software.
Data Analysis	Data will be entered in to an Excel Workbook for summary and analysis
<b>Criteria</b>	<b>Amprobe CO Sensor</b>
Decision Levels	At 50 ppm actions should be taken to lower the level

	At 100 ppm people should be removed from building and the cause of the high level should be determined
High ppm Point Sample	In a building with a room that has high CO ppm, it should be investigated to determine source
Data Recording Method	Data will be entered on a form as shown in the Measuring Indoor Air Quality During Wildfires SOP.
Data Analysis	Data will be entered in to an Excel Workbook for summary and analysis
<b>Criteria</b>	<b>Amprobe CO2 Sensor</b>
Decision Levels	If levels are measured at 20,000 ppm or higher determine source and consider removing people from the building.
High ppm Point Sample	In a building with a room that has high CO ppm, it should be investigated to determine source
Data Recording Method	Data will be entered on a form as shown in the Measuring Indoor Air Quality During Wildfires SOP.
Data Analysis	Data will be entered in to an Excel Workbook for summary and analysis

## Appendix

- Measuring Indoor Air Quality During Wildfires SOP, June 2016, updated March 2020
- Air Quality Monitoring Network Standard Operating Procedures for Met One Aerocet 831, March 2020
- Air Quality Monitoring Network Standard Operating Procedures for Aeroqual 500 Ozone and Carbon Monoxide Sensors, March 2016, updated March 2020
- Air Quality Monitoring Standard Operating Procedures for PurpleAir Particulate Matter Sensor, March 2020