# Quality Assurance Project Plan:

Confederated Tribes of the Umatilla Indian Reservation

Regional PurpleAir Air Quality Monitoring Network
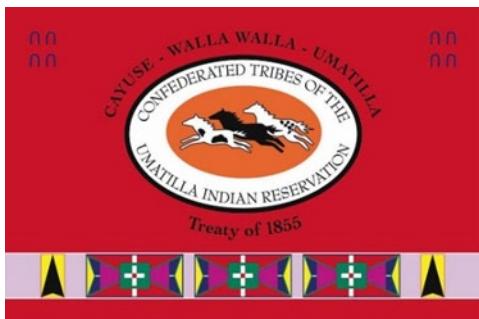
Prepared for:

United States Environmental Protection Agency, Region 10

Prepared by: CTUIR Energy and Environmental Sciences Program, Office of Air Quality, through EPA Tribal Grant #A-02J31401-1

Date: April 2024

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1: Project Plan Identification and Approval

The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Regional PurpleAir Air Quality Monitoring Network Quality Assurance Project Plan (QAPP), written by the CTUIR Energy and Environmental Sciences Program (EESP) staff, serves as a Level IV QAPP for regional air quality education and outreach.

The undersigned have read, understand, and agree to this Plan.

CTUIR Air Quality Project Officials

_____   _____

Caleb Minthorn, Project Manager   Date

_____   _____

Mason Murphy, EESP Program Manager   Date

_____   _____

Matthew Campbell, Quality Manager   Date

U.S. Environmental Protection Agency, Region 10

_____   _____

Destiny Hollowed, Project Officer   Date

_____   _____

Don Matheny, Quality Assurance Coordinator   Date

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2. Definitions:

AQI: Air Quality Index. A U.S. EPA (Environmental Protection Agency)-developed index for reporting daily (24-hour average) air quality and relating it to health effects. More information on the AQI and how it works: https://airnow.gov/aqi/aqi-basics.

AirNow: A web-based (https://www.airnow.gov/) source for air quality information including interactive maps of local air quality. AirNow presents air quality information in the form of a NowCast of the AQI.

AirNow Fire and Smoke Map: The AirNow Fire and Smoke Map offers data to safeguard health during wildfires. The Map displays current particle pollution air quality information for a specific location; fire locations and smoke plumes; smoke Forecast Outlooks (where available); and recommended actions to protect oneself from smoke. These recommendations were developed by EPA scientific experts in air quality and health. The Map is a collaborative effort between the U.S. Forest Service (USFS)-led Interagency Wildland Fire Air Quality Response Program and the U.S. EPA.

Air Monitor: Air monitor (or simply "monitor") is a simplified way of referring to a class of technology that has expanded on the market in recent years and has common traits of directly reading a pollutant in the air, being smaller in size, and often sold at a price that supports a wider number of monitoring locations than possible in the past. Many groups refer to this class of technology as "low-cost air monitors," "air monitoring devices," and "air quality monitors." Also referred to as "Air Sensors."

Camp Crier: an in-development phone app created for the CTUIR community that includes an air quality notification interface from the CTUIR PurpleAir monitor network in the Mission/Pendleton area.

Environmental Justice: the just treatment and meaningful involvement of all people regardless of income, race, color, national origin, tribal affiliation, or disability, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

EPA Correction Factor: a multi-linear correction equation (*including temperature and relative humidity*) for PurpleAir $PM_{2.5}$ data. This U.S.-wide correction equation, developed by EPA scientists, reduces the bias in the sensor data to correct for overestimation. The corrected data are more comparable to the permanent and temporary monitor data. More information here: https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=349513&Lab=CEMM.

Fine Particulate Matter ($PM_{2.5}$): fine inhalable particles with diameters that are generally 2.5 µm and smaller. For context, the average human hair is about 70 µm in diameter – making it 30 times larger than the largest fine particle. See: https://www.epa.gov/pm-pollution/particulate-matter-pm-basics.

NAAQS: National Ambient Air Quality Standards. The EPA sets limits for ambient levels of several air pollutants known to be harmful to human health: lead (Pb), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), coarse particulate matter (PM_{10}), and fine particulate matter ($PM_{2.5}$).

NowCast: The real-time weighted average that AirNow applies to the air quality data displayed on its maps. AirNow uses this weighted average to balance the need to be responsive to rapidly changing air quality conditions with the longer exposure time (24 hours) used in studies on air pollution and health. The NowCast is not available on the PurpleAir Map.

PurpleAir: A Utah based company that designs and builds the PurpleAir Monitors and maintains the digital infrastructure that supports the PurpleAir Map.

PurpleAir Map: a web application that displays a network of community owned, PurpleAir monitors. Each monitor uploads data to the PurpleAir map and is displayed in real time. See: https://community.purpleair.com/t/map-start-up-guide/90.

PurpleAir Monitor: PurpleAir Monitors use laser counters to measure particulate matter in real time. A laser counter assembly uses a fan to draw a continuous sample of air past a laser beam. Any particles in the air will reflect some light from the laser beam onto a detection plate, like dust shimmering in a sunbeam. The reflection is measured as a pulse by the detection plate, and the length of the pulse determines the size of the particle while the number of pulses determines the particle count. These particle counts are used to calculate the mass concentrations of $PM_{1.0}$, $PM_{2.5}$, and PM_{10} for standard indoor and outdoor particles. A PurpleAir Monitor contains two laser counters which reference each other as a data quality check.

Regulatory monitor: in the context of air quality monitoring, a regulatory monitor is an air monitoring instrument that has gone through a formal review process and been approved by the EPA as a Federal Reference Method (FRM) or a Federal Equivalent Method (FEM). Data collected by these monitors can be compared to the NAAQS, if the monitor siting, operation, and data handling meet regulatory requirements

Regulatory monitoring: monitoring using a regulatory monitor that also meets all the requirements for siting, quality assurance, data handling and storage, and other regulations. When all the requirements for regulatory monitoring are met, there is high confidence that the measurements accurately represent a locations air quality, and thus the data is usable to determine if the area is meeting or exceeding the NAAQS.

3. Project Organization and Roles & Responsibilities

Figure 1: PurpleAir Project Organizational Flowchart
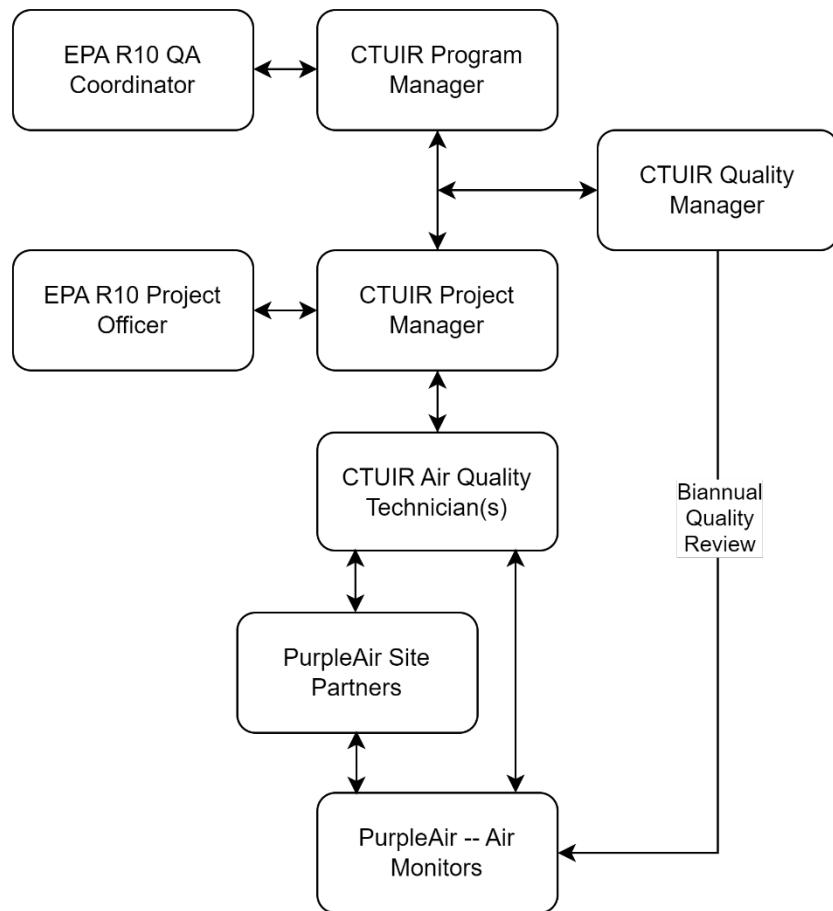
Project Manager; Caleb Minthorn [CalebMinthorn@ctuir.org]:

- Oversees Air Quality Technician(s) work in deployment, maintenance and quality checks.
- Provides project reporting to EPA R10.
- Plans monitor replacement/expansion initiatives.
- Implements public outreach initiatives.

EPA Region 10 Project Officer; Destiny Hollowed [Hollowed.Destiny@epa.gov]:

- Facilitates EPA funding and support through the CTUIR Tribal Clean Air Act 105 Grant.

Program Manager; Mason Murphy [MasonMurphy@ctuir.org]:

- Oversees project and alignment with CTUIR/EESP mission and goals, and EPA requirements.
- Approves final QAPP documents and project reports.

EPA Region 10 Quality Assurance Coordinator; Don Matheny [Matheny.Don@epa.gov]:

- Final approval of QAPP

- Federal quality oversight

Air Quality Technicians(s); TBD

- Assists the Project Manager as directed.
- Deploys and maintains monitors either in person or in coordination with Site Partners.
- Perform monthly virtual quality checks of monitors, and coordinates maintenance and/or replacement in person or in coordination with Site Partners.

Quality Manager; Matthew Campbell [MatthewCampbell@ctuir.org]:

- Completes biannual quality audits of the project.
- Coordinates with Project Manager and Program Manager.
- Updates QAPP, SOPs, and other project documents.
- Implements corrective actions as needed.
- Is independent from laboratory and data collection operations.
- Performs audits and oversite roles without outside (managerial) influence.

Site partners; Various host site individuals, businesses, and public organizations:

- Provide a safe physical location for the PurpleAir Monitor along with power and wi-fi internet.
- Install the monitor as directed by the Air Quality Technician and/or Project Manager
- Coordinate with the Air Quality Technician(s) and/or Project Manager
- Perform minor maintenance activities under the direction of the Air Quality Technician(s) and/or Project Manager.

4. Problem Definition and Background

Problem:

It is critical for CTUIR Tribal Members to have access to real-time outdoor air quality information across Usual and Accustomed lands so that they may determine the safety of exercising treaty rights.

Background information:

CTUIR tribal members exercising treaty-protected rights in traditional use areas lack real-time air quality data, a critical gap exacerbated by the increasing prevalence of wildfire smoke impacts. Treaty protected usual and accustomed lands span multiple regional airsheds, leading to varied air quality throughout the year. Some examples include:

- Summer smoke accumulation in the Columbia Basin may contrast with smoke-free areas at higher elevations.
- Localized fires or transported smoke can affect specific airsheds.
- Winter temperature inversions and seasonal dust storms further contribute to localized degradation.

Existing air quality monitoring is minimal, especially in rural areas with insufficient population to support Federal Regulatory Monitor installations. Even where installed, these regulatory monitors provide limited coverage compared to the diverse airsheds in the region, and the data is geared towards National Ambient Air Quality Standards (NAAQS) verification rather than real-time updates.

Access to real-time air quality data would fill current data gaps and empower Tribal members to make actionable decisions about where to visit within their traditional use lands.

5. Project Description

This grant-funded project will address the problem as defined in section 4, through the deployment of a network of low-cost, real-time reporting air monitors across the region. The monitoring network will allow CTUIR community members to access real-time air quality data for informational and educational use, and aligns with the CTUIR CAA 105 Grant Work Plan Project Outcomes:

- *Real-time Air Quality (AQ) data available to the Tribal community and decision makers through a regional CTUIR deployed and maintained PurpleAir network.*
- *CTUIR members have access to AQ data across traditional use lands to inform the exercising of treaty rights.*

Figure 2: Data Flow Representation
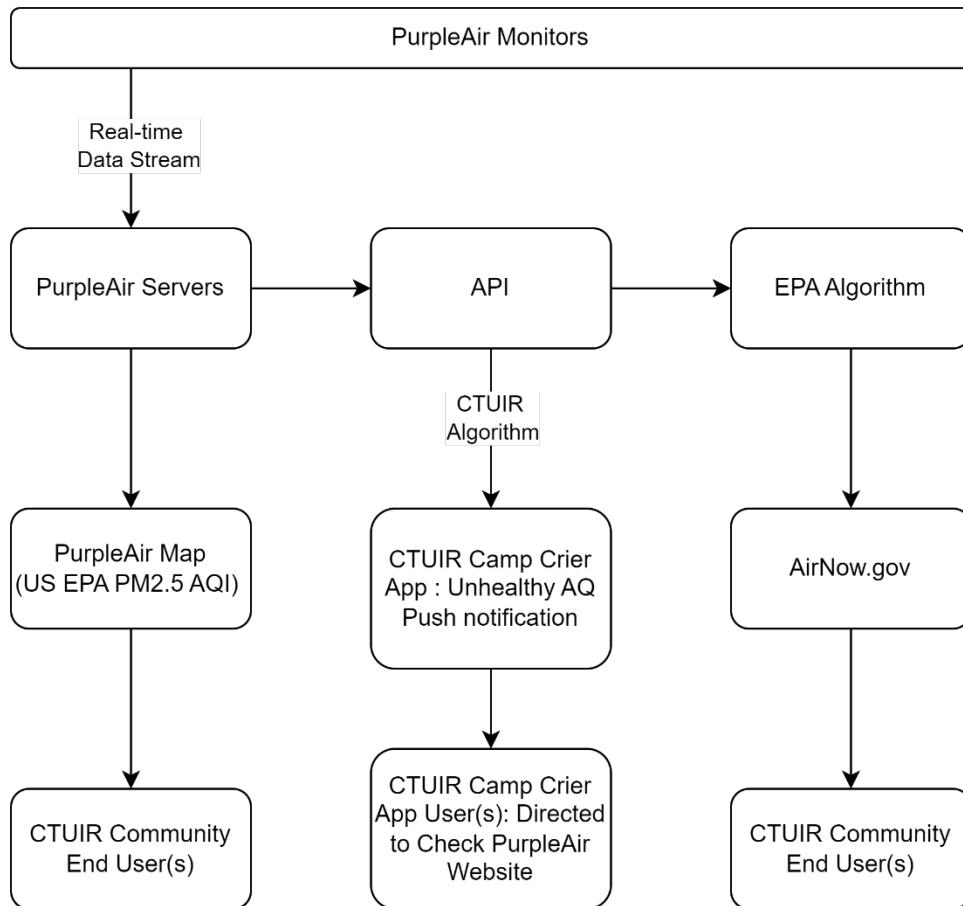
This project will utilize Outdoor PurpleAir monitors. Tribal Community members can access the data via the AirNow Fire and Smoke Map or the PurpleAir Map to plan their outdoor activities based on air quality information. Educational outreach about the availability and usage of these online maps will be conducted through advertisements in the Tribal newspaper, the Confederated Umatilla Journal.

The Camp Crier App, as listed in the Data Flow Representation above, is sparsely used and only provides a warning during degraded AQI events across lower-elevation tribal lands near the Mission area. This push notification directs users to check the PurpleAir Map for current AQI information. CTUIR-deployed PurpleAir monitors in Mission, Athena, and Pilot Rock are used to inform the notification, which is initiated when PM2.5 60-minute values are 55.5µg/m3 or above.

Project Objectives:

1. Provide actionable near real-time air quality data across usual and accustomed lands for Tribal Community use, enabling informed outdoor activity planning.
2. Enhance AirNow Fire and Smoke Map and PurpleAir Map coverage by situating monitors in areas where there currently are none, improving overall usability over time.
3. Encourage community engagement and utilization of this air quality monitoring resource.

Study area:

EESP staff will collaborate with both public and private entities throughout the region to facilitate the placement of PurpleAir monitors and will provide installation and maintenance support. The deployment will be concentrated in areas within or in proximity to the Aboriginal Title Lands (as depicted in Figure 3), specifically targeting locations without existing public real-time PurpleAir monitors.

Figure 3: CTUIR Aboriginal Title Lands with PurpleAir Monitor placement added (red dots)
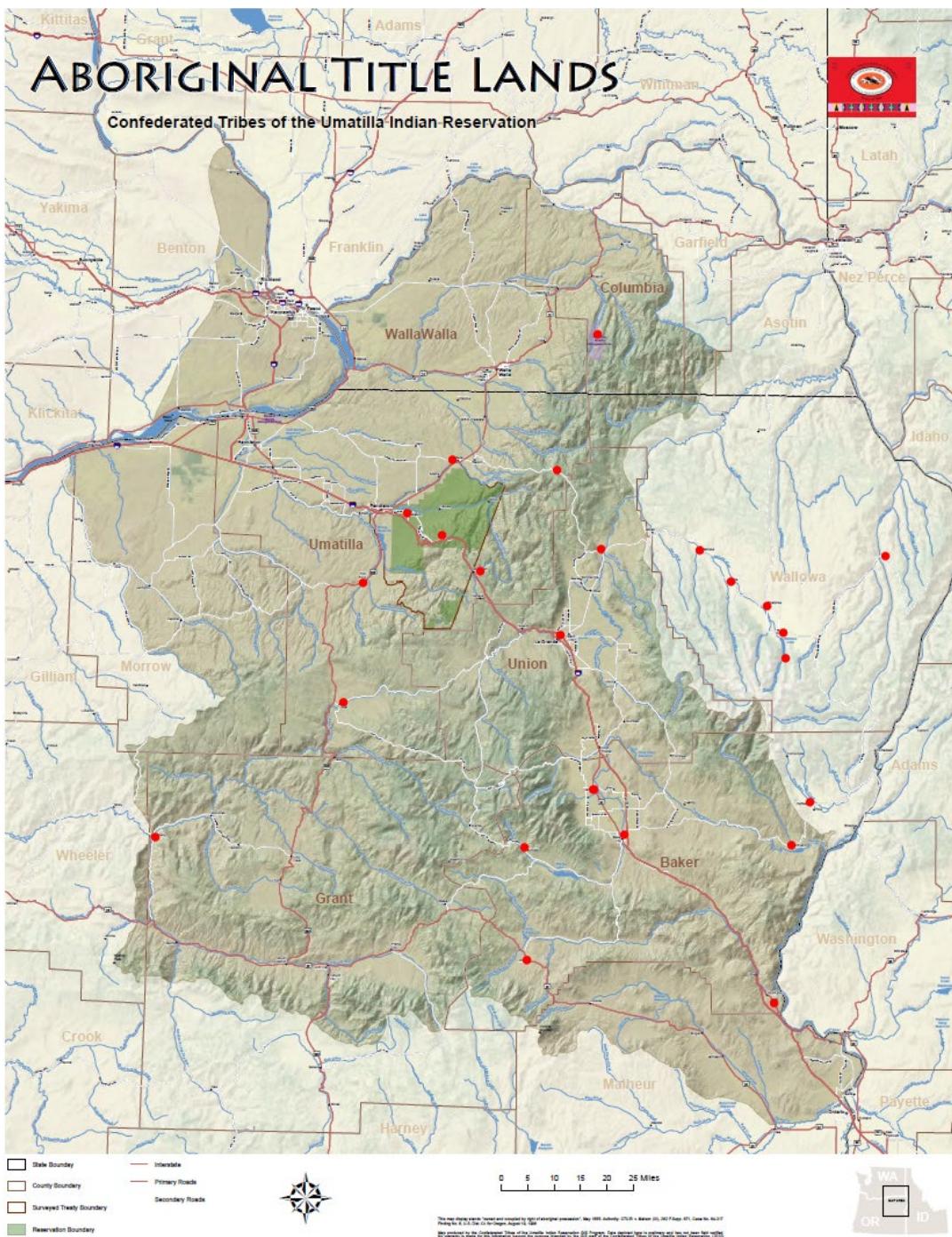
Data Users:

The CTUIR PurpleAir Monitor Network will be used by the Tribal Community and the general public.

Time Period:

The CTUIR PurpleAir network will be deployed year-round to monitor regional $PM_{2.5}$ trends. Seasonal $PM_{2.5}$ sources include:

- Spring: agricultural and silvicultural burns, wood heating appliances
- Summer: wildfire and agricultural burns
- Autumn: lingering wildfire, silvicultural and agricultural burns, wood heating appliances
- Winter: wood heating appliances, localized temperature inversions

Disclaimer:

The data generated by these non-regulatory air monitors is intended solely for informal evaluations, education, and awareness. PurpleAir sensors are not regulatory devices, and the data they collect should not inform or be compared to the NAAQS. These monitors are not suitable for confined space evaluations due to safety considerations. It is important to note that the EPA explicitly does not endorse the use of this equipment to fulfill any requirements related to health and safety.

6. Data Quality Objectives and Indicators

6.1: Problem and Resources
Access to real-time $PM_{2.5}$ measurements from PurpleAir monitors across the region will provide CTUIR Tribal Members with actionable air quality information so that they may safely exercise treaty-protected rights on Usual and Accustomed lands, such as harvesting First Foods.

Resources:

- PurpleAir Monitor Network (publicly available non-CTUIR and CTUIR deployed)
- AirNow Fire and Smoke Map
- PurpleAir Map
- EPA Grant Funding – equipment and staffing
- Site Partners
- CTUIR Camp Crier App

6.2: The Decision
Where in the region is the outdoor air quality safe for collecting First Foods?

Other factors that may influence the decision:

- Time of year and food resources to be collected
- Individuals from sensitive groups participating (elders, children, etc.)
- Collecting locations: how many and where
- Availability of personal protective equipment (N95 respirators/masks)
- Proximity of collecting areas to active emission sources

6.3: Data needed
To plan for outdoor activities, Tribal Members need access to the following data and graphical representations:

- Outdoor real-time atmospheric $PM_{2.5}$ measurements.
    - Map representation on the publicly available AirNow Fire and Smoke Map
    - Map representation on the publicly accessible PurpleAir Map
    - Associated AQI number and color for each monitor

A moderate amount of data uncertainty is acceptable for this application, as AQI colors are applicable to a range of 50 actual AQI number values. For example, "Good" AQI is between and inclusive of 0 and 50 and "Moderate" is between and inclusive of 51 and 100.

Figure 4: AQI Index Values
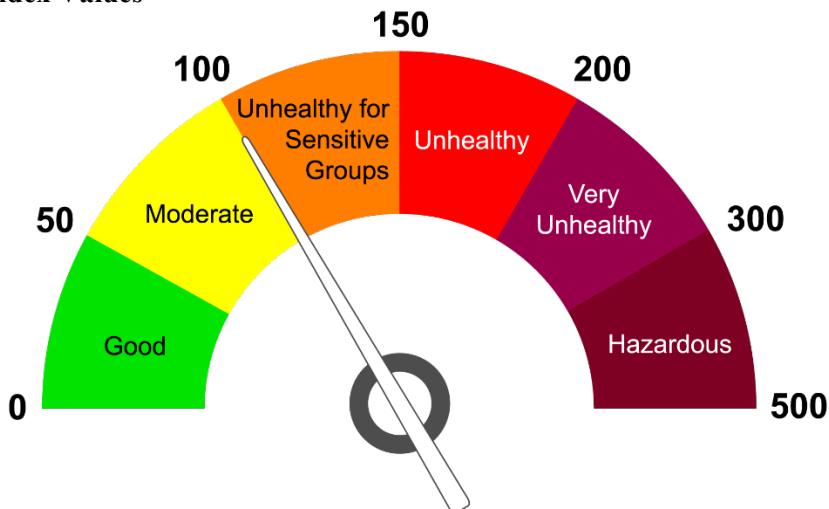
PurpleAir monitors use sensors that measure the light scattering of particles in the air. These sensors function differently from regulatory monitors as they are small and mass-produced, operate at a lower flowrate, and do not dry samples before measurements are taken. This leads to PurpleAir sensors reporting data that may overestimate or underestimate concentrations of $PM_{2.5}$.

The EPA created a correction equation to address this over and underestimation, allowing PurpleAir sensors to better report similar $PM_{2.5}$ concentrations as collocated regulatory monitors. This equation is applied on the AirNow Fire and Smoke map, which reports hourly averages rather than real-time but is adequate for most uses.

The PurpleAir Map also displays data with the EPA correction factor applied when specific settings are selected.

6.4: Study boundaries

Spatial boundaries:

The study area includes Aboriginal Title Lands, as depicted in Figure 1, and surrounding areas where treaty-protected rights are likely to be exercised by CTUIR Tribal Members. This region represents a small subset of the usual and accustomed lands which CTUIR Tribal Members depend on for harvesting First Foods.

Temporal boundaries:

Year round. CTUIR Tribal Members may exercise treaty rights across usual and accustomed lands at any time. Each season brings its own traditionally collected or hunted foods, with some being harvested all year. The Seasonal Round, as in Figure 5, provides an example of some foods that would typically be harvested within each season.

Figure 5: Seasonal Round

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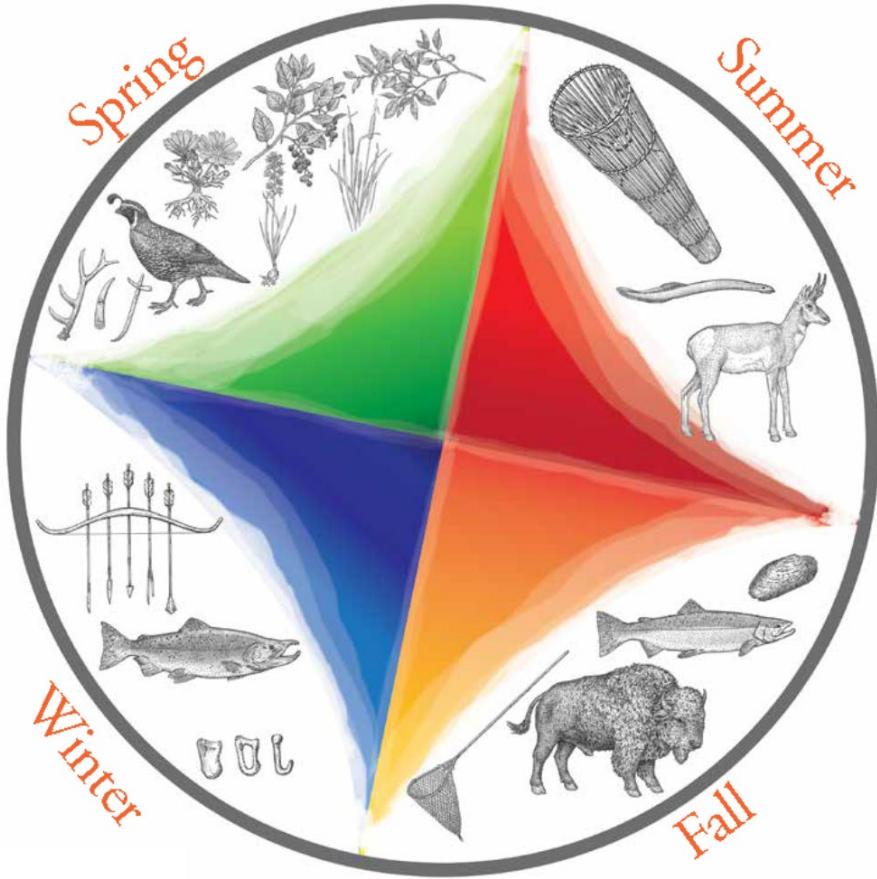
Credit: Donna Nez & Stephanie Kaping

6.2: Data Quality Indicators

Data Quality Indicator (DQI) checks are in place for all end user data access streams to verify that the information provided is meaningful and actionable.

Precision refers to the random error of a given measurement. One way of quantifying precision is by comparing multiple measurements of the same thing, in this case of the level of $PM_{2.5}$ in the ambient air. PurpleAir sensors make duplicate measurements of ambient $PM_{2.5}$ which are recorded as two "channels": A and B. The precision can be determined by calculating the difference in these two channels.

Bias is a systematic error in a set of measurements, or the difference between the measurements and the true value. EPA scientists have quantified the typical bias of PurpleAir sensors and developed a correction equation (see definitions: EPA Correction Factor).

Data completeness is a measure of the data coverage over time. Since $PM_{2.5}$ levels often have patterns over time (e.g., more elevated at night or during inversion events), it is important that the measurements are not fragmented over the course of a 24-hour day or a season.

6.3: Measurement Quality Objectives:

Applying the DQIs to actual sensor measurements allows for information deemed reasonable and correct

to be accessible to the CTUIR community, while flagging and withholding data that may not be representative of the current outdoor air quality conditions. This provides high-value data for CTUIR members to make an informed decision with respect to air quality factors on a given day.

As there are three potential sources of information for community members to access, the process in which the DQIs are applied is slightly different for each, yet the output information is, in each case, much better than unprocessed sensor values.

1. *AirNow Fire and Smoke Map*: this EPA product automatically applies the EPA correction equation and performs a check to verify that the two particulate sensors within the PurpleAir Monitor, Sensor A and Sensor B, are within 70% agreement before displaying on the map. Users can also click on a monitor box on the map and scroll down the pop-up data menu to view the Recent History data set completeness.
2. *PurpleAir Map with "US EPA PM2.5 AQI" selected*: The data display selection from PurpleAir monitors is processed through the US EPA Correction Equation before being displayed on the map. Also, if there is a perceived lack of confidence in the data displayed on the PurpleAir Map the AQI number will appear in a lighter shade than other displayed monitors. This occurs when A and B particle sensors are not in close agreement. CTUIR community members will be educated on PurpleAir Map data interpretation best practices as part of the EESP Office of Air Quality education and outreach initiatives.
3. *Camp Crier App*: This phone app does not provide an AQI value. It only provides a warning of possible poor air quality and directs users to the PurpleAir Map for more information. The background algorithm operates as follows:
   a. Check the current time every 30 minutes.
   b. If a high AQI notification has not been sent in the past 24 hours, the algorithm proceeds to the next step. (Considered the "blackout time" so only one notification is sent each day during poor air quality events)
   c. Check PurpleAir API data
   d. For each monitor, check if channel B is between 70% and 130% of channel A. If so, proceed to next step.
   e. For each monitor, check if $PM_{2.5}$ 60-minute values are 55.5µg/m3 (150 AQI or "unhealthy") or above
   f. Create a list of Zip Codes matching the sensors that were above the 55.5µg/m3 threshold.
   g. Send a push notification alerting users of the app with Zip Codes matching the list from the previous step.

Table 1: Summary of DQIs from 1-3:

DQI	Acceptance/Performance Criteria	AirNow Fire and Smoke Map	Purple Air Map	Camp Crier App
Precision	The two sensor channel measurements (A and B) are within 70% or 5 ug/m3 of each other.	Precision check applied by website	User must check precision manually	Precision check applied by app
Bias	The EPA correction equation must be applied to PurpleAir sensor data.	Correction applied by website	User must select correction factor	N/A: Threshold notification at 55 µg/m³

| Data Completeness | An hour is considered complete if at least four of the six (67%) 10-minute windows in an hour are reported by the sensor.

A day is considered complete if 80% of the hourly data are complete. | Check applied by website | User must check | N/A |
|---|---|---|---|---|

7. Documents, Records, and Deployment

The most current QAPP will be provided to all sampling personnel prior to PurpleAir Monitor deployments.

- The most current QAPP will reside within the EESP Quality Systems project folder: P:\6_Policies, Plans, and Procedures\Quality Assurance Project Plans (QAPPs)
- The Quality Manager is responsible for verification that all project staff have the approved QAPP and subsequent updates
- The Program Manager will be responsible for final QAPP approval and updates, in coordination with US EPA R10 Quality Assurance.

Master Spreadsheet

A master spreadsheet for tracking CTUIR-managed PurpleAir Monitors supports tracking of monitor deployment and maintenance status.

- Spreadsheet location: P:\3_Facilities and Equipment\3_Air Monitors\PurpleAir Monitor Network
- Columns on this spreadsheet include:
    o Monitor Name
    o Location/Place Name
    o Type (IISD or FLEX)
    o Device serial number
    o Lat-Long
    o Map Sensor ID
    o Date Purchased
    o Date Deployed
    o PO#
    o Wi-Fi Network
    o Wi-Fi Password
    o Associated Email (for monitor registration)
    o Last date monitor was physically inspected
    o Inspector Name
    o Site Contact
    o Email/Phone
    o Additional Notes
- Any substantiative changes, maintenance, or site communication is updated on the spreadsheet as needed to facilitate future work with that site or monitor.

- When new monitors are received, they are added to the Master Spreadsheet prior to moving to the inventory storage area.

Pre-install registration & Bench Test

Prior to field deployment, a monitor on hand will be pre-registered on the PurpleAir website. This includes naming the monitor and assigning its latitude and longitude on the PurpleAir map. During this pre-registration, the master spreadsheet is updated. Pre-registration allows EESP to ship a monitor to a host site and provides the host with a simplified installation process.

Pre-install registration & Test is performed by the Project Manager or Instrument Technician when a monitor is close to deployment. **See Appendix C**

On-site Installation
- Install the monitor outside:
  - Away from woodsmoke or gas furnace exhaust sources
  - In an area with access to free air movement
  - Use the zip tie and/or wood screw to secure the monitor in place
  - Standard electrical outlet at the location
  - Within the range of the wi-fi router signal
- With a smartphone, directing the monitor to connect to the local wi-fi network
- Verify monitor appearance on PurpleAir Map

Site Partner Installation Letter

A letter thanking the site partner and detailing the installation procedure is included with the shipment of a pre-registered and bench tested monitor assigned to that site. General letter templates are available here for customization: P:\3_Facilities and Equipment\3_Air Monitors\PurpleAir Monitor Network\Canned Letters The template can be viewed as **Appendix D**.

Installation Criteria

Guidance for installation of PurpleAir Monitors will follow EPA sighting criteria in the Air Sensor Toolbox Guide: https://www.epa.gov/air-sensor-toolbox/guide-siting-and-installing-air-sensors

Outdoor Siting Considerations

- Site away from pollution sources or sinks
  Building exhausts
  Barbecue grills
  Dusty roads

- Allow free air flow around the sensor
  Ideally 270 degrees unobstructed flow at sensor

- Install about 3-6 ft above ground
  Breathing zone height better represents exposure

- Keep away from structures
  If must be next to building, place on up wind side

- Look for sites that supports your needs
  Within Wi-Fi range
  Power available

Low risk of tampering
Safe to install

8. Experimental Design

As an informational/educational project, the main task is to deploy the monitors into the field and make them operational, then provide multi-year long-term support and maintenance. To guide this and to fulfill the project objectives outlined in Section 5, the following elements will be applied with the physical monitors and communication with the Tribal community:

Monitor placement criteria:

- Prioritize locations:
    - Near areas where CTUIR Tribal members collect First Food resources and exercise treaty-protected rights.
    - Without existing monitors populating the AirNow Fire and Smoke Map, PurpleAir Map
    - With a site partner organization that is established (library, city hall, business, etc.)
- Wi-Fi and power needs met
- Monitors placed outside with free air movement
- Monitors placed away from wood burning or gas appliance exhaust vents
- Monitors set to publicly report data
- Located within the Aboriginal Title Lands map area or nearby
    - Placement outside this map area possible depending on Tribal community need
- Approximately 20 monitors deployed initially
    - Additional monitors installed over time as necessary, and workload permitting for deployment and long-term support/maintenance

Community Engagement:

- Twice annual advertisements in the local Tribal newspaper, the Confederated Umatilla Journal
    - promote the CTUIR PurpleAir monitoring system
    - promote the AirNow Fire and Smoke Map and PurpleAir Map for planning outdoor activities.
- Community outreach will also highlight recommended data access for PurpleAir Map
    - Use of *"US EPA PM2.5 AQI"* map setting
    - AQI Number font density related to data quality (A and B sensor agreement)

Monitor Verification:

- Monitors will be verified operational monthly as outlined in Section 10. Quality Control Requirements.

9. Sampling Methods Requirements

PurpleAir Sensors make measurements in situ, in contrast to environmental measurements where physical samples are collected and then analyzed in a lab. The air quality measurements made by the PurpleAir Sensors are "samples."

The PurpleAir monitors used in this study are the PA-II and the Flex. Both of these monitors have two sensors for detecting particles in the air. No other sampling methods or equipment will be used in this study.

The paragraph below is from the PurpleAir website (*https://www2.purpleair.com/*).

> PurpleAir Sensors use laser counters to measure particulate matter in real time. A laser counter uses a fan to draw a sample of air past a laser beam. Any particles in the air will reflect some light from the laser beam onto a detection plate, like dust shimmering in a sunbeam. The reflection is measured as a pulse by the detection plate, and the length of the pulse determines the size of the particle while the number of pulses determines the particle count. These particle counts are used to calculate the mass concentrations of $PM_{1.0}$, $PM_{2.5}$, and PM_{10} for standard indoor and outdoor particles.

> Most PurpleAir models (PurpleAir Classic, Flex, and Zen) are equipped with two sensors which measure and report particle concentrations in six sizes between 0.3μm and 10μm diameter. Temperature, relative humidity, and pressure values are also recorded. The sensors are calibrated by the manufacturer to associate a particle size with particle mass and estimate total mass for $PM_{1.0}$, $PM_{2.5}$ and PM_{10}. Readings are then uploaded to the cloud approximately every 80 seconds where they are stored for download and display on the PurpleAir Map.

10. Quality Control Requirements

Quality Control (QC) encompasses technical procedures aimed at assessing the attributes and performance of a process, item, or service against predefined standards to ensure compliance with specified requirements. These activities are essential for estimating and minimizing measurement uncertainty to meet DQOs.

There are various quality control checks that occur prior to PurpleAir monitor data being used or published for public use. These checks depend on where an end user will contact the data stream.

Air now Fire and Smoke Map:
Data published on the AirNow Fire and Smoke Map is processed through an automated quality control process. Part of this process includes filtering the raw sensor data through a correction equation developed by US EPA scientists. This US Wide Correction equation adjusts PurpleAir reported values closer to expected Federal Equivalency Monitor values. It uses the A and B particle counters in the PurpleAir as well as the temperature and humidity sensors (to calculate relative humidity, RH). The correction equation:

$PM_{2.5}$ corrected= 0.52*[PA_cf1(avgAB)] - 0.085*RH +5.71

- $PM_{2.5}$= $\mu g\ m^{-3}$
- RH= Relative Humidity (%)
- PA_cf1(avgAB)] =PurpleAir higher correction factor data averaged from the A and B channels

An additional check before publishing on the Air Now Fire and Smoke Map involves verifying that the A and B particle counters (sensors) within the PurpleAir are within 70% agreement. If this verification passes, the monitor appears as a green square on the map. If this verification does not pass the monitor still appears on the map, but as a grey square.

Clicking on the green or grey square will show expanded information, along with a bar graph that shows data quality completeness over the past week of measurements.

PurpleAir Map:
There are many possible settings available for viewing data through the PurpleAir Map interface. All community outreach done will highlight the use of the "US EPA PM2.5 AQI" map setting. This particular setting applies the EPA correction equation used for the Fire and Smoke Map, thus providing an output value closer to an AQI of a Federal Equivalency Monitor.

The PurpleAir Map also provides a data confidence determination which shows up visually on the map. If the A and B sensors are not in close agreement, the AQI number of that particular monitor will show in a much lighter shade of black.

Camp Crier App:
This app does not provide an AQI reading, but a recommendation for users to check the PurpleAir Map for more information if the AQI in the area reaches "Unhealthy" (a $PM_{2.5}$ 60-minute average value of 55.5μg/m^3). For this push notification to be produced various checks occur including a determination that the A and B sensors of the PurpleAir monitor are between 70% and 130% agreement. Once a high confidence level is reached for monitor operation and Unhealthy air quality, the push notification recommends the user to access a AQI source that has additional quality control: the PurpleAir Map.

EESP OAQ QC Activities:
The Air Quality Technician or Project Manager with check and maintain monitors as described below to meet the reporting criteria in Section 6.3, recording findings in the notes section of the master spreadsheet: "P:\3_Facilities and Equipment\3_Air Monitors\PurpleAir Monitor Network\PAir Monitor Locations & Maintenance Data.xlsx"

These checks will typically be virtual with most required follow-up performed by host site staff. However, a checklist for monitor field visits can be found in Appendix B and modified as needed.

- Monthly Basis
  - Verify that monitors are reporting to the PurpleAir Map
    - Sensor A and Sensor B within 70% or better agreement
    - Temperature and humidity sensor both reporting
  - Verify that monitors are reporting to the Air Now Fire and Smoke Map
    - Verify that data completeness on the bar graph is 80% or greater
  - Compare monitor readings to nearby regulatory monitors when possible
  - Quality concerns will be recorded on the master spreadsheet and follow-up tasks scheduled

- Issues found during monthly check and associated corrective actions
  - Monitor not reporting to PurpleAir or Air Now Fire and Smoke Map
    - AQ Technician makes a site visit to verify power and wi-fi availability
    - AQ Technician contacts site partner to troubleshoot power and wi-fi
      - Cord plugged in
      - Lights inside unit
      - Electrical circuit live
      - Wi-fi operating & in range
      - Wi-fi password and network correct

- - - o Monitor data completeness less than 80% of AirNow Fire and Smoke map
        - Continue observation of monitor on subsequent days to verify consistent sensor A and Sensor B agreement at 70% or better
            - If sensor agreement varies below 70% follow procedures for troubleshooting/fixing under "Sensor A and B agreement degraded below 70%"
        - Look for patterns in data gaps & troubleshoot or work with site partner as needed
            - Power outages
            - Wi-fi outages
            - Other potential issues
    - Sensor A and B agreement degraded below 70%
        - AQ Technician cleans monitor of debris and treats sensor inlets with vacuum and compressed air. If this is ineffective, the monitor is fixed or replaced
        - AQ Technician contacts site partner and advises to clean monitor of debris and to treat sensor inlets with vacuum and compressed air, shipping a can of compressed air to the site partner if needed. If the treatment is ineffective, a new monitor will be registered and sent to the site partner.
    - Temperature not reporting
        - Fix or Replace monitor
    - Humidity not reporting
        - Fix or Replace monitor
- Yearly Basis
    - Site check by AQ Technician or Site Partner
        - Monitor free of debris
        - Monitor securely mounted
        - Any necessary maintenance needed
        - Does the monitor need relocation on/off site

EESP Quality Manager Activities
Every six months, the Quality Manager will review the PurpleAir monitoring network and assess:

- Master Spreadsheet use and current reported state each monitor
- Current monitors reporting to the PurpleAir Map and Fire and Smoke Map
- Current outstanding maintenance issues, date issue recognized, and progress toward resolution
- Monitors in inventory ready for deployment

11: Data Management, Review, and Verification

Data management:

Sensor data will be used solely for education/awareness and accessed via the AirNow Fire and Smoke Map or PurpleAir Map in real-time or translated as a push notification via the Camp Crier App.

This project does not involve data storage and management since it is focused on real-time data. Data will be stored soley via the PurpleAir server and historic data is not relevant to this project.

Data review and verification:

The method for applying the QC requirements to the data is described in Section 10. In addition, sensor data should also be compared to other nearby sensors/monitors on the Map as applicable. Users should always verify local sensor readings with whether they can see or smell smoke, especially during wildfire season. If sensor data does not pass these tests, the information should not be used to make decisions on outdoor activities.

Appendix A: Additional Resources

Resource Description	URL:
EPA's Sensor Toolbox guide to siting and installing air sensors	https://www.epa.gov/air-sensor-toolbox/guide-siting-and-installing-air-sensors
The Enhanced Sensor Guidebook, Clements, A., R. Duvall, D. Greene, AND T. Dye. The Enhanced Air Sensor Guidebook. U.S. Environmental Protection Agency, Washington, DC, 2022	https://www.epa.gov/air-sensor-toolbox/how-use-air-sensors-air-sensor-guidebook
AirNow Fire and Smoke Map Technical Q&A:	https://document.airnow.gov/airnow-fire-and-smoke-map-questions-and-answers.pdf
PurpleAir's Guide	https://www.purpleair.com/sensors

Appendix B: PurpleAir Field Sheet

Sensor Log	
PurpleAir Serial no.	
Receiving and Setup:	
Date sensor(s) received	
All expected parts received?	
Any noticeable damage?	
Does the LED light turn on when the sensor is connected to power?	
Sensor deployment:	
Deployment date	
Address or latitude and longitude of sensor	
Deployment height	
Any obstructions near the sensor?	
Picture taken that shows sensor and surroundings?	
Sensor registered and set to public?	
Sensor maintenance	
Sensor showing up on the fire and smoke map?	
Indicate dates when you confirmed the sensor is reporting to the Fire and Smoke map:	
Site visit date, issue, and whether the issue was resolved:	
Site visit date, issue, and whether the issue was resolved:	

Appendix C: PurpleAir Pre-Registration & Bench Test

- Navigate to the PurpleAir registration page: https://www.purpleair.com/register
- With the Master Spreadsheet open: ("P:\3_Facilities and Equipment\3_Air Monitors\PurpleAir Monitor Network\PAir Monitor Locations & Maintenance Data.xlsx")
  - Select a monitor from inventory to deploy, and check on the Master Spreadsheet to make sure it is listed with the Device-id (MAC)
    - If not on the Master Spreadsheet, add the monitor to the bottom of the spreadsheet
  - Enter Device-id, separated by colons, into the registration page Device-id field.
  - Enter the Associated Email from the Master Spreadsheet. (if unknown, this will most likely be the email address used to order that specific device from PurpleAir)
    - Correct errors if needed. *The website will do an automatic check to make sure the Device-id and the Associated Email match.*
  - For "Installed" choose "Outside."
  - Location Name: "CTUIR 018 Elgin Public Library"
    - CTUIR XXX (Three digit code from Master Spreadsheet")
      - Write this on the side of the monitor in permanent market if not done already.
    - Then add the name of the place deployed, and add that to the Master Spreadsheet
  - Visibility: Set as "Public (everyone)"
  - Map Location: either drop the marker in a map location, or enter the Latitude and Longitude directly into the required fields.
  - Onboard LED Options: Pre-filled settings are fine
  - Data Processors: Pre-filled settings are fine
  - Device Owner's Information
    - Name
    - Email (must match email previously entered into the form)
    - SMS Alert Phone Number
  - Check "yes" on agreement to the terms and conditions
  - Click the "Register" button
  - Verify that a registration email is received at the associated email address

The <u>Bench Test</u> phase makes sure that the monitor is showing up correctly on the PurpleAir Map:

- Navigate to the PurpleAir Map: https://map.purpleair.com/
  - Zoom in on where the monitor should show up on the map
  - Plug the power cord into the outlet, and connect the power cord to the PurpleAir monitor
    - There should be a red and blue light inside that turns on.
  - After about 5 minutes, the PurpleAir monitor will begin broadcasting a Wi-Fi network signal.
  - Connect to the PurpleAir monitor Wi-Fi network with a smart phone or tablet.
  - Once the network is selected, a screen will appear that allows you to direct the PurpleAir monitor to connect with a local Wi-Fi network.
  - Choose an available local network and enter a passkey if required.
  - The PurpleAir monitor will connect to the network and will become visible on the PurpleAir Map within a few minutes.
  - Once operation is confirmed and placement on the map is correct:

- Click on the monitor on the PurpleAir Map
- Verify that the "A" and "B" sensor agree within 70% or higher
- Verify that temperature and humidity readings are believable based on the conditions where the monitor is being tested.
- Unplug monitor
- Package monitor and power supply into a plastic zipper bag
- Add a wood screw and zip tie to the bag, as provided by PurpleAir for each monitor. (An extra zip tie or two added to the bag can be helpful)
- Mark the bag with the location that the monitor will be deployed
  - The monitor is ready for shipment to a host site or deployment by an EESP Air Quality Technician.

Appendix D: Partner Site Setup Instruction Letter

Confederated Tribes of the
Umatilla Indian Reservation
Department of Natural Resources
Energy & Environmental Sciences Program

46411 Timíne Way
Pendleton, OR 97801
www.ctuir.org   email: info@ctuir.org
Phone 541-276-3165   Fax: 541-276-3095

[Name]
[Company]
[Street Address]
[City, ST Zip]

[Date]

Hello [name]

Thank you for hosting a PurpleAir air quality monitor at your {home/business/town hall/library/etc.}

The monitor is already registered to the PurpleAir network. Once plugged in, it only needs to connect to Wi-Fi. Please follow these steps to install and get the monitor online:

- Make sure the monitor is:
    - Installed outside
        - *Please use the attached sighting criteria to help guide placement*
    - Within range of the Wi-Fi router
    - Plugged in
- Once plugged in, use your smartphone to search for Wi-Fi signals nearby.
- A few minutes after powering on, there should be a "PurpleAir____" or similar Wi-Fi network cast by the monitor.
- Connect to the "PurpleAir____" Wi-Fi.
- When connected, you will be able to direct the monitor to connect to the local Wi-Fi network, and enter password credentials if required.
- The monitor will then connect to the local Wi-Fi.
- Once the monitor is connected to local Wi-Fi, it will stop broadcasting the "PurpleAir____" Wi-Fi.
- Check the map at https://map.purpleair.com, and you should be able to see the monitor and live air quality data.

We hope the installation and setup go smoothly. Thank you again for hosting the monitor. Each one truly makes a difference by providing valuable community-accessible air quality information.

Best,

[EESP Person]

[EESP Person Title]
[EESP Person email address]
[Phone1] (office)
[Phone2] (mobile)

Treaty June 9, 1855 ~ Cayuse, Umatilla and Walla Walla Tribes

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