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Puget Sound Clean Air Agency

QUALITY ASSURANCE PROJECT PLAN

Community Scale Air Toxics Ambient Monitoring Grant
XA01J10401

NEAR ROAD AIR TOXICS MONITORING ASSESSMENT IN A HIGHLY IMPACTED COMMUNITY – SEATTLE CHINATOWN INTERNATIONAL DISTRICT

Prepared by and for

Puget Sound Clean Air Agency
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1 Project Plan Identification and Approval

The NEAR ROAD AIR TOXICS MONITORING ASSESSMENT IN A HIGHLY IMPACTED COMMUNITY – SEATTLE CHINATOWN INTERNATIONAL DISTRICT quality assurance project plan is approved.

Approved by

1) Signature: [signature] Date: 7/6/16
Matt Harper – Project Manager, Puget Sound Clean Air Agency

2) Signature: [signature] Date: 7/7/16
Kathy Strange – Technical Analysis Manager, Puget Sound Clean Air Agency

3) Signature: [signature] Date: 8-2-2016
Sean Lundblad – Quality Assurance Coordinator, Department of Ecology, Washington

4) Signature: Debbie Kline Date: 8/25/16
Debbie Kline – EPA Grant Project Officer, USEPA Region 10

5) Signature: [signature] Date: 8/23/16
EPA QA Manager or Designee, USEPA Region 10

DISCLAIMER

This Quality Assurance Project Plan has been prepared specifically to address the environmental data operations on behalf of EPA through grant agreement XA01J10401. The contents have been prepared in accordance with EPA QA/R-5, "EPA Requirements for Quality Assurance Project Plans". EPA/240/B-01/003 March 2001.

2 Acronyms and Abbreviations

AQS Air Quality System
ANSI American National Standards Institute
APTI Air Pollution Training Institute
ASTM American Society for Testing and Materials
CID Chinatown International District, Seattle, Washington
CFR Code of Federal Regulations
COC chain of custody
DAS data acquisition system
DNPH 2,4 Di-Nitro-Phenyl Hydrazine (Brady's Reagent)
DQA data quality assessment
DQOs data quality objectives
EDO environmental data operation
EMAD Emissions, Monitoring, and Analysis Division
EPA Environmental Protection Agency
GIS geographical information systems
GLP good laboratory practice
HAP Hazardous Air Pollutants
IO Inorganic
LAN local area network
LIMS Laboratory Information Management System
MQOs measurement quality objectives
NAAQS National Ambient Air Quality Standards
NATTS National Air Toxics Trends Network
NCORE NCore Multipollutant Monitoring Network
NIST National Institute of Standards and Technology
NRNO2TAD Near Road NO2 Technical Assistance Document
OAQPS Office of Air Quality Planning and Standards
ORD Office of Research and Development
PM2.5 Particle Matter – 2.5 microns or less
PQAO Primary Quality Assurance Organization
PUF poly-urethane foam
QA quality assurance
QAC quality assurance coordinator
QAPP quality assurance project plan
QMP quality management plan
PSCAA Puget Sound Clean Air Agency
SLAMS state and local monitoring stations
SOP standard operating procedure
SPMS special purpose monitoring stations
SVOC Semi-Volatile Organic Compounds
TO Toxic Organic
TSA technical system audit
USEPA United States Environmental Protection Agency
UATS Urban Air Toxics Strategy
VOC volatile organic compound

Table of Contents

3 List of Figures

4 Distribution

This Quality Assurance Project Plan has been distributed to the individuals listed in Figure 1. The document is also available upon request from the Project Manager.

FIGURE 1 QAPP Distribution Plan

NAME	ROLE	CONTACT
Erik Saganic	Air Resource Specialist, PSCAA	eriks@pscleanair.org
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Julie Swift	Senior Program manager ERG	Julie.swift@erg.com

5 Project Task Organization

The following paragraphs will demonstrate the plan for project roles and participant responsibilities.

PROJECT MANAGER – Responsible for all aspects of completing project tasks including accurate operational financial activities reporting, choosing fixed monitoring sites and contracting for their use, contracting with the analysis laboratory, providing oversight for installation and operation of monitoring equipment, completing the fixed site air toxics sampling, mobile monitoring, and providing support for community directed sampling. (Matt Harper)

CID OUTREACH/ENGAGEMENT TEAM MANAGER – Responsible for managing the PSCAA outreach/engagement team for the Chinatown International District community activities associated with the grant. The engagement team responsibilities include partnering with community leaders, conducting community air quality and air toxics education sessions, soliciting, advising, and collaborating with the community leaders to provide input on monitoring site selections, make decisions about community directed sampling, following through with post sampling data evaluations, risk assessments, and collaborating with the community leaders to design mitigation strategies and action steps with the overall goal of authentic engagement with the community to help reduce community burdens to toxic air pollutants. (Tania Tam Park)

Community leaders – Responsible for communicating and collaborating with community members, and PSCAA outreach team members. The leaders are responsible for helping to provide information flow so that as members of the community outreach team identify opportunities for engagement, leaders can effectively share information with community members within their neighbor networks. Finally, the community leaders are responsible for collaborating with project partners to guide mitigation strategies, processes, and action steps. (To be determined)

USEPA REGION 10 PROJECT OFFICER – Responsible for ensuring that project budgets and expenses are reported on time, and that the project achieves the desired outcomes. (Debbie Kline)

CID OUTREACH TEAM – The team is a cross-functional team that is charged with being the primary PSCAA contact touch point for the community. The team is responsible for communicating and responding to the community. The team is responsible for engaging community members about air quality concerns, providing education, and air quality risk information, and providing an interface for community leaders and community members to engage in air quality improvement actions. The team does have reach-back capability so that if there are appropriate engagements that can happen with air quality experts (for example Engineering, Monitoring, Analysis, or Inspections), the team can pair community members with experts from the PSCAA staff. (Landon Bosisio, Julio Sanchez, Phil Swartzendruber, Steve Fry)

PSCAA TECHNICAL ANALYSIS AND MONITORING TEAM – The analysis team is responsible for the data analysis and air toxics risk assessment that will be generated after the data has been collected. This analysis information and risk assessment will be available in the final report, and the community will have an opportunity to receive and process this information as the Community Team and PSCAA Engagement team work on outcomes from the grant associated with air quality education, risk mitigation strategies, and air quality action steps. The monitoring team is an experienced, specialized, professional team that is charged with installation, operation, quality assurance, and initial analysis of air monitoring data that is collected during this project. The team consists of three air resource specialists, data specialist, two air monitoring specialists, a quality assurance specialist and an air monitoring team lead. (Greg Sandau, Adam Petrusky, Mary Hoffman, Walter Zylowski, Phil Swartzendruber, Erik Saganic, Sara Conley)

QUALITY ASSURANCE OVERSIGHT – WA Department of Ecology is normally the PQAO for air monitoring activities at the Puget Sound Clean Air Agency. Ecology has written a Quality Assurance Project Plan for its NATTS sampling at the Beacon Hill NCORE site in Seattle, Washington. PSCAA shall follow the Ecology QAPP while conducting NATTS-style sampling. Ecology will be providing a review/approval step of this project QAPP and will provide audit services of the main air toxics samplers (VOC, carbonyl samplers). However, there are monitors that are being used for this study which Ecology will not be auditing. Ecology may not have all of the equipment or sufficient knowledge of every device to properly perform a performance evaluation. For this project, because it is unique and not part of the Washington State approved network, PSCAA will perform quality assurance oversight for all NON-NATTS-style sampling.

Puget Sound Clean Air Agency technical analysis and monitoring teams are responsible for quality assurance oversight of all activities not covered by Ecology. This document describes in detail, all of the quality assurance activities and requirements that are necessary to achieve project results.

CONTRACT LABORATORY – The contract laboratory consists of a Program manager, Program QA Officer, and various other technical advisors. The Program manager and QA Officer work together to implement the laboratory QA system according to the laboratory analysis QAPP. The QA Officer is s responsible for ensuring the overall integrity and quality of the laboratory contracted results. He or she reviews the ERG and PSCAA QAPPs and determines whether procedures are executed in accordance with the QAPPs. The lines of communication between the Program manager and Program QA Officer are formally established and allow for discussion of real and potential problems, preventative actions, and corrections. At any time during the program, additional QA/QC measures may be initiated upon consultation between the Program manager and QA Officer. (Julie Swift)

FIGURE 2

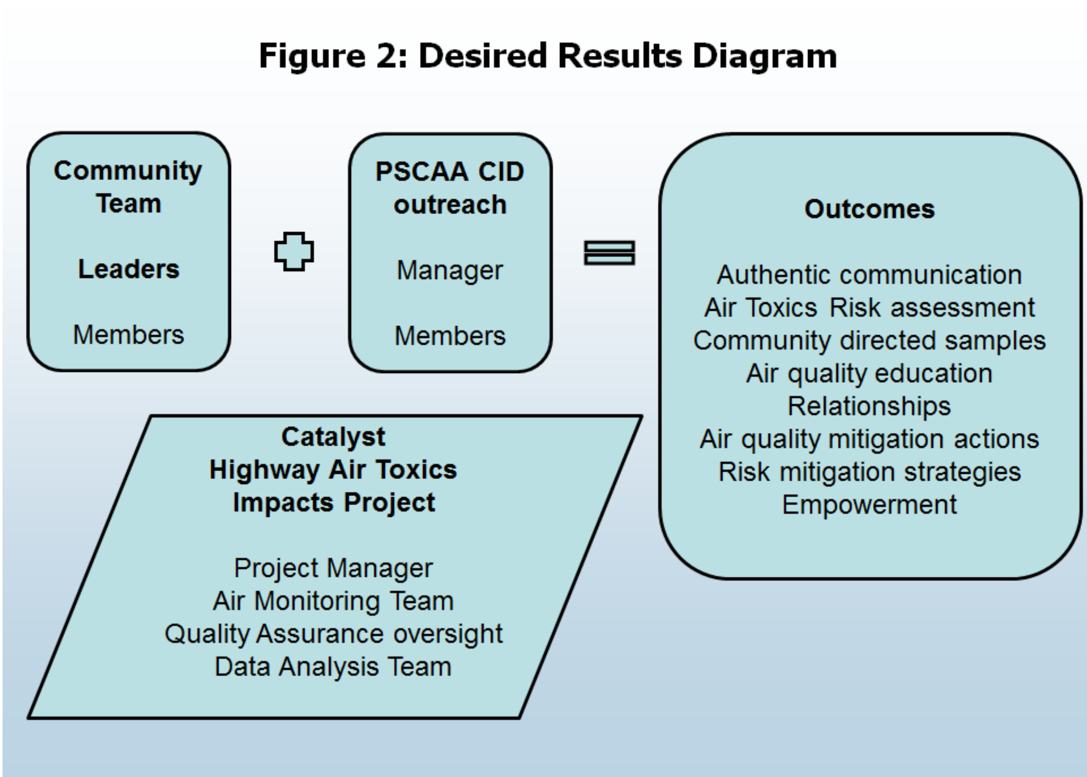


Figure 2 describes the chemical equation that will be required to make this grant work. The main ingredients will be the community team, and the Chinatown-International District (CID) outreach team working to provide the desired outcomes. The Near Road Monitoring Project team will provide the catalyst for the reaction to occur. The Project team consists of at least two functional PSCAA employees who will also be part of the engagement team. The project team provides the sampling, air quality data, risk assessment expertise, and air quality education products to allow the Community Team and the CID Outreach team to connect in a meaningful way based on credible scientific work. This quality assurance project plan will put in place the elements necessary to ensure that the scientific work performed is credible, with known quality.

6 Problem Definition and Background

Hundreds of thousands of people live near highways in the state of Washington. Local and national studies show that air quality is significantly degraded near congested highways. More and more health studies are identifying congested highways as an important air pollution source which causes negative health effects. The CID is the center of Seattle's Asian American community, and the neighborhood is intersected by I-5 and I-90, which is one of the highest traffic areas in the Pacific Northwest. There are other important air pollution sources near the CID.

Community leaders in the CID have told us that air quality is a significant concern, especially with sensitive subpopulations.

Throughout the history of the CID, disadvantaged people have always lived in and along this important corridor in Seattle. People who have disadvantages may not have the knowledge or resources necessary to protect the air quality. The Puget Sound Clean Air Agency is responsible for protecting the air quality for ALL people in this area. Therefore, the CID is an important area to work on air quality issues with the ultimate goal of helping protect Seattle air quality.

For those reasons, in 2013, the Puget Sound Clean Air Agency and the Washington Department of Ecology collaborated and installed an air pollution station which is in the national NRNO2 air monitoring network. The station is located in the heart of the CID, and collects data on an hourly basis for important criteria pollutants NO2, CO, and PM2.5, meteorology, as well as other parameters.

In fall 2014, the PSCAA conducted a very limited local pilot study to test small portable sensors in the near road environment. Our data confirmed results from previous studies which concluded that there were air pollutant concentration gradients for pollutants such as NO2, CO, and PM2.5. The different pollutants did have different gradient curves. This means that pollutants were measured at higher concentrations near the road, than they were in neighborhoods, and generally, levels were observed to be lower the further away they were from the highway, but the results varied by pollutant.

After studying the analysis from the local pilot study, agency leaders wanted to know more about how air toxic pollutants varied from highway to neighborhood. What was the gradient seen by pollutants that drive local air toxics risk? After initial engagements with community members about the pilot study, community members wanted to know more about air pollutant risk, and how it varied through the neighborhood? And what health effects are associated with these risks? What can be done to reduce these risks?

Therefore, this project will study the following aspects of air quality:

- Estimate the potential cancer and non-cancer risks for three fixed monitoring sites in the area.
- Estimate air toxics concentration gradients with proximity to the highway.
- Compare air toxics concentrations and risks to the national NATTS network.
- Compare air toxics concentrations to nearby 2011 NATA census tract estimates.
- Identify & quantify air toxics sources through factor analysis and other analyses.

- <u>Extrapolate risks from the gradient study to quantify potentially exposed populations and their potential risk.</u>

Measuring air toxics components is a very tricky and expensive activity, because ambient levels of air toxic chemicals can often times be very low. For example, in similar studies in Tacoma, we found that often, many of the HAPs would often fall below detection levels. This document will describe what it will take to measure risk-driving HAPs, and to try and help the community get to the bottom of these important air quality issues. The design of this study will result in an efficient, transferrable, and scientifically defensible method to get answers to these important questions about air toxics risks, and what can be done about them.

7 Project Description and Tasks

The PSCAA monitoring team will sample air toxics in the CID using leveraged monitoring, and several project specific approaches. The leveraged monitoring already exists, or supports another project or program directly. It can support this project indirectly. Project specific approaches are Fixed site sampling, community directed sampling, and mobile monitoring.

There are several important monitoring activities that are already in place that we are leveraging that are not covered as part of this project, but are worth noting.

<u>LEVERAGED (EXISTING) MONITORING:</u>

Beacon Hill Air Monitoring Site – This monitoring site is nearby, and is monitoring air toxics under the Quality Assurance Project Plans that are already implemented in the State of Washington under the Department of Ecology's Air Quality Program's quality system:

- Air Monitoring Quality Assurance Plan document 99-201 (Rev. 4/2010)
- Air Toxics Monitoring Quality Assurance Project Plan (Rev. 3/2012)

Seattle 10th & Weller Monitoring Site – This monitoring site already has important air monitoring activities ongoing that are under the Quality Assurance Project Plans implemented under the Department of Ecology's air quality system. These activities include Nitrogen Dioxide and Carbon Monoxide Reference Method sampling, meteorological monitoring (WS, WD, T), Particulate Matter Speciation sampling, Particulate Matter (PM2.5) sampling with a Federal Equivalent method, and Black Carbon sampling using the Aethalometer™. Recently in 2015, EPA Region 10 staff conducted a TSA on the monitoring activities at the Seattle 10th & Weller Monitoring site. Therefore, existing monitoring has been rigorously assessed.

<u>PROJECT MONITORING:</u>

Fixed site sampling:

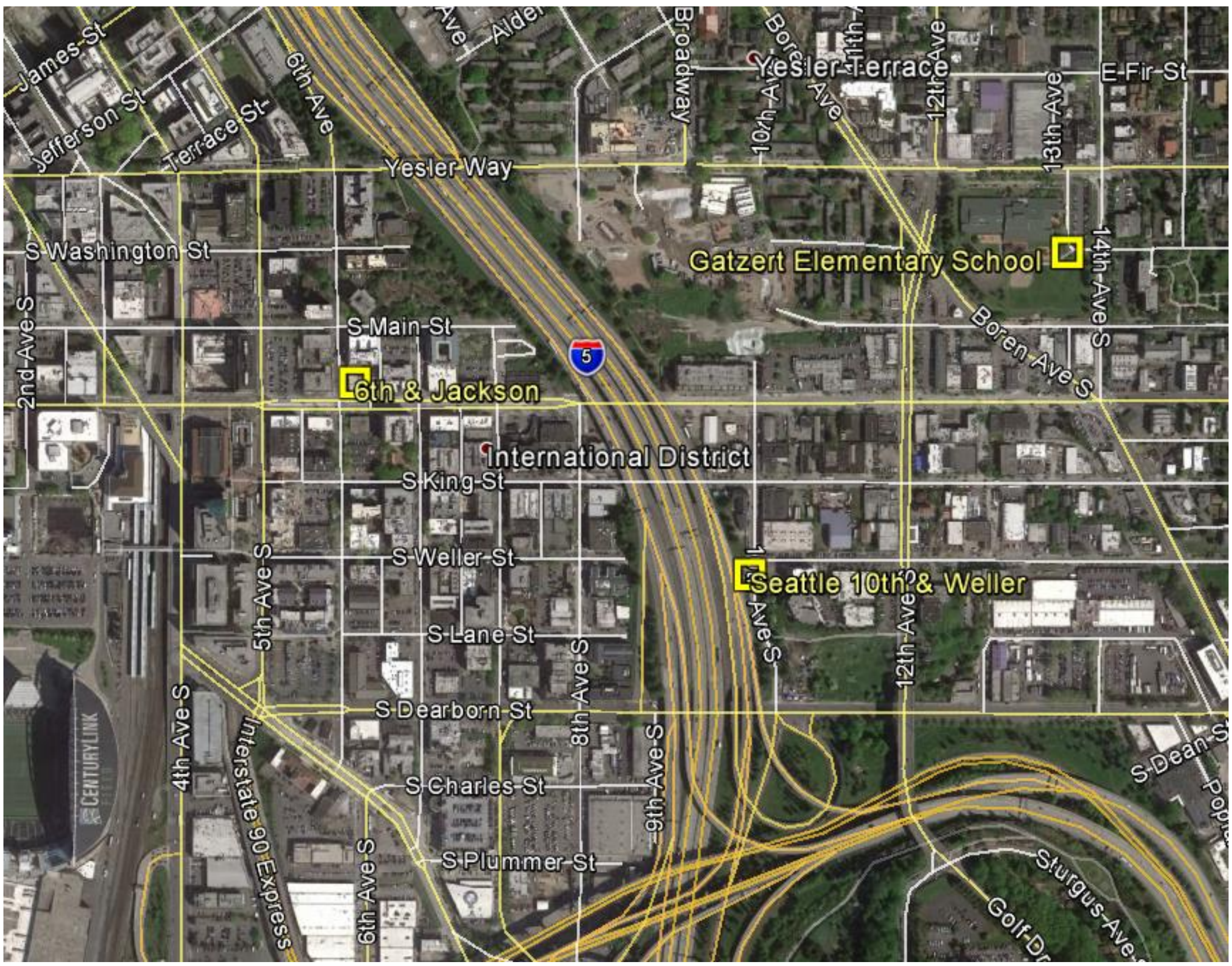
Three monitoring sites will be chosen in accordance with project goals, air toxics monitoring siting criteria, community input, and logistical considerations.

Fixed site monitoring methods are used at these three sites:

- Seattle 10th and Weller
- Seattle Gatzert Elementary Yesler Way
- Seattle International District (6th and Jackson)

The monitoring sites must have one site that is considered near road (less than 50 meters from the road), one monitoring site that is located approximately 500 meters (at the Bailey-Gatzert Elementary School Campus), and one site that is located between 50 and 500 meters on the West side of the highway (location near the intersection of 6th & Jackson).

FIGURE 3 Map of Fixed sites



<u>Seattle 10th and Weller:</u> This site is located about 20 meters from the I-5 highway in the heart of the CID. The site will support project monitoring for one year. The site is predicted to be the "maximum concentration" of Highway air toxics pollutants. The site is a Near Road, Microscale monitoring site. The site is already operating, and has enough space and power to support the project monitoring to include the parameters:

- VOC using TO-15a method, full suite of VOC's to include Benzene and 1,3-Butadiene.
- Aldehydes using TO-11a, full suite of aldehydes including formaldehyde and acetaldehyde.
- Metals using PM10 47 mm filters, includes lead and other HAP metals.
- PAH using TO-13a PUF samplers, to monitor for Polycyclic aromatic hydrocarbons.

These parameters are to be measured 1 in 6, meaning one daily sample for every six days. Along with the project specific sampling, the continuous monitors, and the PM2.5 chemical speciation samplers will provide this monitoring site with a full suite of air toxics parameters, so that a credible, technical risk assessment can be performed.

Seattle Gatzert Elementary Yesler Way: This site is located about 500 meters from the I-5 highway in the Yesler Terrace neighborhood, across the street from the Little Saigon area of the CID. The site will be a temporary one year site, which will support project monitoring. The site is predicted to represent the "general neighborhood ambient concentration" exposure. The site is a neighborhood scale monitoring site. The site is designed to be able to support the following project monitoring methods:

- Continuous PM2.5 Black Carbon and UV Carbon monitoring by Aethalometer™.
- VOC using TO-15a method, only Benzene and 1,3-Butadiene (1 in 6).
- Aldehydes using TO-11a, only formaldehyde and acetaldehyde (1 in 6).
- CO, NO, T, RH sensors, and fine particle count via micro-sensor monitor built for the project.

Seattle International District (6th & Jackson): This site is located West of I-5 in the heart of the CID, and will be placed such that it will be able to monitor for pollutants coming from the Highway at a distance farther than the "maximum concentration" site, but closer than the 500 meter ambient concentration site. The site is a middle scale monitoring site. The site is designed to be able to support the following project monitoring methods:

- Continuous PM2.5 Black Carbon and UV Carbon monitoring by Aethalometer™.
- VOC using TO-15a method, only Benzene and 1,3-Butadiene (1 in 6).
- Aldehydes using TO-11a, only formaldehyde and acetaldehyde (1 in 6).
- CO, NO, T, RH sensors, and fine particle count via micro-sensor monitor built for the project.

Community Directed Sampling

In addition to the fixed sites, we will sample air with 20 passive VOC canisters. The purpose of these canisters is for community use for targeted sampling. This will allow the community to identify locations of interest, actively participate in collecting samples, and learn VOC concentrations at those locations. We will sample on the same days that fixed sites are operating to provide greater spatial gradient information. We will allow community members to collocate samplers if they choose to assess precision of the data being collected. If community members want to pursue understanding better information spatially, then we will allow the samples to be taken at various locations throughout the area under study. The laboratory will give us passive regulators to use for these samplers (up to 5), so we will be able to assess at least five locations at any one time in addition to the fixed site sampling. The sampling will be directed by interested community members, and NOT by the air monitoring team. The monitoring team will most likely set up the samplers, and collect the samples for the monitoring, but there may be interested community members who would like to conduct the sampling themselves.

If community members do desire to conduct the sampling, then community members need to be given training on the use. The air monitoring team will offer training on the SOP's of these samplers with the interested community members. Only monitoring team members, or supervised and trained community members will be allowed to sample these 20 VOC canisters. If community members actually operate the samplers, then the monitoring team will document the operators for each of the samples taken.

Mobile monitoring

In addition to the community directed sampling, and the fixed site sampling, the PSCAA monitoring team will include at least 10 monitoring runs using mobile monitoring tools. The purpose of this monitoring is to more fully cover the geography of the study area, while also understanding the capabilities and limitations of mobile sampling techniques. Mobile monitors can measure parameters including, but not limited to:

- Fine Particle count and light scattering using nephelometers.
- Temperature and Relative Humidity.
- GPS positional and speed information.
- Nitric Oxide (NO) and Carbon Monoxide (CO) using micro-sensors.
- Total VOC measurement using Aeroqual monitors.
- Ultrafine particle count using an Enmont PUFP-C100.
- Black Carbon by using Micro- Aethalometer™.

These monitoring techniques can be included together, or used separately. The mode of data capture may be a motor vehicle, a bicycle, walking with a backpack, or using other mobile technologies.

The method of quality assessment will always be twofold: (a) To include measurements taken at each fixed monitoring site as the mobile platform is moved around the study area. (b) To include quality checks before and after the sampling runs (if possible). The Agency has techniques for data ingestion, alignment, and cropping, so that mobile data can be stored in a database and analyzed. The Agency has further developed techniques to temporally adjust data captured on mobile platforms. The analysis team will create grid cells with multiple passes, so that a time adjustment curve can be created to correct all the data to make more meaningful comparisons.

Mobile monitoring techniques are being developed across the country, and there are now at least two laboratories which are testing and publishing device capabilities. The monitoring team will review and utilize guidance documents from the following sources:

US EPA Sensor Toolbox, http://www.epa.gov/air-research/air-sensor-toolbox-citizen-scientists

South Coast AQMC, http://www.aqmd.gov/aq-spec/home

Corollary benefits of using mobile monitoring techniques include the ability to use small, inexpensive tools to assist in explaining environmental measurement concepts to community members. The benefits of using micro-sensors for outreach and education are particularly well-suited to be successful for the efforts in this project. Community members will be encouraged to utilize these mobile sensors, and community data will be used in the analysis conducted by the analysis team.

For each micro-sensor sampling system used, a second identical set will be needed to assess the instrument to instrument precision. The number of precision measurements should be approximately 10% of the total samples measured for each of the mobile systems used.

Intended Use of the Data

The project will identify and more accurately define air toxics risks in a community near a major highway and a newly-established NO2 and PM2.5 near-road monitor. The project will involve and educate community members about these risks, and provide broader information about how these risks apply to other near-roadway communities across the Northwest.

8 Sampling Design and Objectives

There are six data analysis objectives and a seventh, non-data driven qualitative objective which the sampling plan is designed to inform.

1) Estimate potential cancer and non-cancer risks for fixed sites.
2) Estimate air toxics concentration gradients with proximity to the highway.
3) Compare air toxics concentrations and risks to the national NATTS network.
4) Compare air toxics concentrations to nearby 2011 NATA census tract estimates.
5) Identify & quantify air toxics sources through factor analysis and other analyses.
6) Extrapolate risks from the gradient study to quantify potentially exposed populations and their potential risk.
7) Members of the very diverse and highly impacted Chinatown-International District community have told us that air quality is a significant concern, especially with sensitive subpopulations. This project is designed to help to put that concern into a broader context, and place solutions into the hands of community members.

In order to meet these objectives, the sampling design is set up to sample in Three Fixed Site locations, mobile monitoring, and community directed sampling.

As discussed in section 5, Project Task Organization, we have set up a team of professionals who will perform various engagements in the CID in order to understand and react to the concerns in the community over air quality.

In order to meet the data quality objectives, the monitoring team will take a standard approach to quality assurance. For example, the quantities measured for VOC's, and Aldehydes are important because they involve measuring risk drivers, such as 1,3-Butadiene, Benzene, and Formaldehyde. For these programs, the monitoring team will be using TO-15a, and the most comprehensive, most recent versions of the Standard Operating Procedures for organizations who are also doing this sampling. The standard, stringent approach will allow the monitoring team to have a very good idea of Minimum Detection Levels, and the data set should result in a quantitative set of HAP levels, which can then be used to calculate risks using unit risk factors. A summary of methods is found in figure 4 on page 19.

Another example of the graded approach to quality assurance lies with the combined use of Aethalometers and the use of Micro-sensor monitors at some fixed sites to estimate levels of BC, CO, NO, and fine particulate matter counts. The Aethalometers are used with the SOP (provided in the appendix), because Diesel particulate matter can be estimated from Aethalometer BC measurements, and DPM is a significant risk driver. These Micro-sensor samplers (CO, NO and fine PM counts) will be used without a structured stringent SOP, because these techniques are new, and used in tandem with other more reliable techniques (Federal Reference Methods for Trace CO, and NO) to take similar measurements. We will be using Micro-sensor samplers side by side for a period of at least two weeks, so that we can evaluate performance characteristics. Also, the individual sensors used in these samplers have undergone laboratory assessments at EPA and SCAQMD sensor laboratories. Data quality of these Micro-sensor samplers may be lower because of the sensing technology, lack of formalized SOP, and they may not have the sensitivity in the low ambient measurement range. We are confident that we will meet the study objectives. Our important risk drivers (TO-15a, TO-11A, BC) are going to be measured with tried and true systems that have been in place for many years and have mature quality systems. And risk estimates rely more heavily on the standard, tried and true monitoring methods, than the micro-sensor systems.

9 Quality Objectives and Criteria for Measurement Data

The purpose of the quality objectives and criteria for measurement data is to define what quality systems and requirements already exist for air monitoring data sets proposed for collection in this study, and to define what parameters need to have quality systems defined in this document.

The Plan is written using guidance from EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations (EPA QA/R5) and Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Quality Monitoring Program (QA Handbook).

This plan also references two key Quality Assurance Project Plans that are already implemented in the State of Washington under the Department of Ecology's Air Quality Program quality system:

- "Ecology Air Program QAP": Air Monitoring Quality Assurance Plan document 99-201 (Rev. 4/2010)
- "Ecology Toxics QAPP": Air Toxics Monitoring Quality Assurance Project Plan (March 2012)

Further, this plan references Quality Assurance Project Plans that already are implemented by EPA in the United States under the EPA's National Monitoring Programs. Under Contract Number EP-D-14-030 from 2016, the Category 1 Quality Assurance Project Plan for UATMP, NATTS, CSATAM, PAMS, and NMOC support is used by the contract laboratory.

- "ERG Toxics QAPP": Support for the EPA National Monitoring Programs (UATMP, NATTS, CSATAM, PAMS, and NMOC Support) Contract Number EP-D-14-030 Quality Assurance Project Plan for Eastern Research Group, Inc. 601 Keystone Park Drive, Suite 700, Morrisville, NC 27560.

Finally, this plan does use the Graded Approach to Quality Assurance. For example, the data collected with a mobile monitor during the mobile monitoring phase will likely not have the same quality level as data collected with a Federal Equivalent monitor at a stationary monitoring site. This is because for smaller lighter sensors, there is not a built-in designed quality assurance calibration system that is utilized on a daily or weekly basis. We will approach data results with caution from sensors that don't have as comprehensive a quality system. We will also build in time that each micro-sensor stops at or near a fixed site, for a collocated sampling time. The collocated sampling times will be identified, and analyzed, so that the mobile data quality can be better measured.

The study is based on comparison to other, well established monitoring sites in the state of Washington where air toxic pollutants are also collected. Therefore, our data quality objectives are based in the same science as the already established monitoring sites and methods. Data quality objectives (DQOs) have been established for completeness, accuracy, and precision based on:

- Scientific requirements needed to address the major objectives;
- Knowledge of the measurement system;
- Experience with the sampling methods and other validation studies, such as the use of duplicate samples, blank samples, and collocated samples; and
- Analyses of the data collected.

DQO's for NATTS style monitoring (VOC, carbonyl, etc) are already established in the Department of Ecology's QAPP, so we will use the same process as Ecology in assessing these DQO's.

10 Special Training Requirements/Certification

Adequate education and training are critical to any monitoring program that strives for reliable and comparable data. EPA National Monitoring programs are performed using accepted EPA, NIOSH, and OSHA sampling and analytical protocols and requiring the efforts of field sampling personnel and analytical laboratory staff. Training is aimed at increasing the effectiveness of employees involved in the project. Personnel assigned to ambient air toxics monitoring activities and for laboratory analysis activities will meet the educational, work experience, responsibility, personal attributes, and training requirements for their positions.

The Puget Sound Clean Air Agency monitoring team has experience and training with all of the sampling methods that will be employed by the study. There may be occasion for community leaders or members to participate in data collection, or mobile monitoring. In these instances, the community members will be closely supervised by monitoring team members, and data will be reviewed during the analysis phase, so that the conditions under which the data were collected will not negatively impact the overall analysis or conclusions of the study. Later in this QAPP we will discuss recordkeeping requirements for this project. These requirements are in place so that data with unacceptable error are excluded from use in study conclusions.

The Quality Assurance Coordinator of the Washington State Department of Ecology will conduct courtesy audits of the NATTS style monitoring equipment to be used in this study. For Non-NATTS style monitors, the PSCAA staff will conduct audits. These audits will be conducted, and the monitoring team will ensure that data that is not bracketed by passing audits is not allowed to be used in study conclusions. This step will assist technical data collection in ensuring that the data used in the study will be of known quality.

The contract laboratory utilized in this project has trained technicians and supervisors who complete analyses according to the Compendium methods for Toxic Organic and Inorganic compounds, and who report data to the AQS system. The data reported to the AQS system will be of known quality because data is accompanied by appropriate flags, minimum detection levels, and metadata. Analytical laboratory personnel involved in this project have been trained in their tasks and have many years of experience in the duties they will be performing. Training of ERG laboratory personnel is recorded in the ERG Training Records in an Access database. It is the responsibility of the trainee and the laboratory's System Administrator to keep the Training Records up to date. Special certification is not needed for the analysis of the ambient samples through the contract.

The contract laboratory maintains appropriate SOPs for each of the analytical methods. These SOPs are presented in Appendix C of "SUPPORT FOR THE EPA NATIONAL MONITORING PROGRAMS" under Contract Number EP-D-14-030as presented in the Category 1 QAPP, approved by EPA in 2016.

11 Documentation and Records

All records produced during and throughout this work are of public record, and will be retained by the Puget Sound Clean Air Agency under standard retention record laws. The Puget Sound Clean Air Agency will utilize several different types of records, and will make any and all records available to the public. There will be a Final Report that will be submitted by the Puget Sound Clean Air Agency to the EPA, and the community. Puget Sound Clean Air Agency will post this report on its website, and will take steps to ensure that this report is readily available in multiple formats, so that persons of every ability can review the report.

The resulting report from this work will be a highly technical report that will outline data collected, observations, analysis, recommended actions, and conclusions. The report will have a very technical Appendix that summarizes all of the data collected during the study. The following figure will be used by project participants in planning for document and record storage. Additionally, in order to communicate more effectively with the community, the Agency may summarize the technical findings into easier to read Information Sheets.

FIGURE 4 Reports Plan

RECORD TYPE	FORMAT	DESCRIPTION
Grant quarterlies	Electronic or Paper	Available on demand by contacting Project Manager
Final Report	Electronic or Paper	Available on www.pscleanair.org or by contacting PM
Agreements	Electronic or Paper	Available on demand by contacting PM
Finances	Electronic or Paper	Available on demand by contacting PM
Data - Network	Electronic	Available via WA Department of Ecology
Data – Lab	Electronic	Available via AQS or by contacting PM
Data – Mobile	Electronic	Available on demand by contacting PM
SOP QC checks	Electronic or Paper	Available on demand by contacting PM
Logs	Electronic	Available on demand by contacting PM
All Records	Electronic or Paper	Available by contacting PSCAA Public Records

12 Standard Operating Procedures for Sampling

This project requires the use of many different Standard Operating Procedures for Sampling and Analysis. This section focuses on Sampling SOP's, because the contract laboratory will be using the library of SOP's for analysis of samples. Much of the sampling techniques used in this project will already have WA Department of Ecology approved SOP's to draw from. Some of the micro-sensing sampling techniques do not yet have SOP's, and these will be developed from existing guidance, and existing doctrine used in the monitoring field. The following Figure summarizes the Method, and the reference used by the operators as the SOP. Developed from these SOP's are Field procedures in the Appendix.

FIGURE 5 Reference Standard Operating Procedures

METHOD	REFERENCE SOP
TO-15a	ECOLOGY AIR TOXICS QUALITY ASSURANCE PROJECT PLAN, March 2012, AQSB SOP 805, XONTECK 901 & 910PC Canister, April 2015 and WA DOE CANISTER sampling for VOC's using XONTECK 910 PC
TO-11a	ECOLOGY AIR TOXICS QUALITY ASSURANCE PROJECT PLAN, March 2012, WA DOE CARBONYLS with 2,4-Dinitro-phelyl hydrazine (DNPH) coated cartridges
PAH - PUF	EPA Schools Air Toxics, SVOC/PAH SOP August 24, 2009
PM-10 Metals	WA DOE PM-10 Metals with R & P Partisol Samplers using the PM2.5 Sequential Sampling Procedure modified with EPA method RFPS-0509-176 using WINS impactor bypass downtube to capture PM-10 rather than PM2.5. (Same method as the Beacon Hill PM10 Metals monitor).
PM2.5 BC	WA DOE Aethalometer SOP with modification for AE-33 upgraded model (7 channel)
CO, NO, fine particle count Micro-Sensors	ALPHASENSE and SHINYEI micro-sensor operating procedures
Community Directed Sampling	EPA Schools Air Toxics, VOC SOP August 5, 2009
Mobile Monitoring Techniques	SOP under development. Must include collocated sampling time with fixed site monitoring, and the use of side by side analysis, and laboratory assessments of sensors into quality assessment.

12.1 Sampling Custody

Custody of samples is handled in the individual SOP's for TO-15a, TO-11a, PAH-PUF, and PM-10 Metals. For each of these systems, the contract laboratory has sample sheets that we use to track sample custody, and individual sample environmental conditions. We will follow already established Field procedures and protocols to assess this quality component. Sample custody sheets are used in the Field Procedures provided in this document's appendix. Samples will be mailed in between the PSCAA office and the Analytical Laboratory utilizing standard FEDEX methods. If the samples need to be shipped in a cooler, then PSCAA and the ERG lab will coordinate.

12.2 Analytical Methods Requirements

Under Contract Number EP-D-14-030 from 2016, the Category 1 Quality Assurance Project Plan for UATMP, NATTS, CSATAM, PAMS, and NMOC support is used by the laboratory. The reference is:

- Support for the EPA National Monitoring Programs (UATMP, NATTS, CSATAM, PAMS, and NMOC Support) Contract Number EP-D-14-030 Quality Assurance Project Plan for Eastern Research Group, Inc. 601 Keystone Park Drive, Suite 700, Morrisville, NC 27560.

Specifically, the laboratory contractor is required to follow all of the steps in the above QAPP.

12.3 Quality Control Requirements

Quality Control Requirements are outlined in the individual SOP's for TO-15a, TO-11a, PAH-PUF, and PM-10 Metals. For these sampling techniques, the contract laboratory will send us blanks, and we will use blanks and collocated samples in order to make an assessment of quality for these sampling methods. For the continuous monitoring methods, such as PM2.5 BC, the Washington State Department of Ecology SOP does require a monthly QC leak check and flow verification. We will be following the SOP requirements for QC. For each of the systems that does not have an established SOP (Mobile monitoring sampling systems, or Micro-Sensor samplers), we will be using manufacturers procedures to establish methods to complete quality control assessments. An example is the AE-51 mobile, hand-held Micro-Aethalometer. This sampling system does recommend that a flow check be conducted periodically. We will conduct a flow verification prior to use in the study, and after use in the study.

Additionally, all data will be screened in accordance with established monitoring data protocols.

12.4 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Sampler and equipment testing, inspection, and maintenance requirements are generally listed in the established SOP's. For this particular study, older XONTECK 910 and 925 samplers will be used for the TO-15a and TO-11a methods respectively. These samplers will be repaired, and we will utilize blank and collocated data in order to ensure quality control. Other testing and inspection requirements will be handled through normal troubleshooting and repair operations by the Puget Sound Clean Air Agency monitoring specialists. For all systems, when indications that maintenance needs to take place, the equipment will be taken out of service, and sampling resumed when the sampler is retested satisfactorily.

12.5 Instrument Calibration and Frequency

Sampler and instrument calibration will be conducted in accordance with established SOP's. In the case of the micro sensor systems that are being developed with fine particle count, CO, and NO sensors, PSCAA will use manufacturer's procedures. In this case, the sensors will undergo a calibration procedure initially, and then quality control checks will establish the system's measurement quality indicators, and finally, the calibration will be checked at the end of the study.

12.6 Inspection/Acceptance for Supplies and Consumables

Supplies and consumables will be visually inspected by the Air Monitoring Specialists. Any abnormalities will be promptly corrected, and noted for the analysis phase of the study. Cases where supplies and consumables affect data integrity will be cause for data to be invalidated. Cases where samples are shipped in coolers, then both the sending and receiving entity will conduct temperature checks, and these will be recorded on the sample data sheets as indicated in the SOP.

12.7 Data Acquisition Requirements

Data will be acquired primarily by the Envidas Ultimate system. Data will be recorded in the PSCAA air quality database through either the traditional FTP import method, or will be acquired using the PSCAA

Air Quality Drop Application. Black Carbon Data at the temporary study sites (Gatzert Elementary and 6th&Jackson) will be obtained from USB drive, and then imported to the PSCAA air quality database via air quality drop application. PSCAA will format this data so that Ecology can submit to AQS in one batch at the end of the study.

The PSCAA Air Quality Drop application is a tool that is designed to import and export data files into a geographical as well as temporally keyed database. The system is capable of uploading a single file, or a package of files in a zip format. The Air Quality Drop can read data from the following file formats: *AeroqualVoc, AirBeam, CarClipCo, CarClipO3No2, Dylos, Enmont, GPS, GPX, HourlyTelemetry, MicroAeth, Package, RadianceResearch, SenonicsMinnow, and TsiNanoScan*.

All data files used for the project will be organized in the Projects folder under the internal PSCAA Server using the following Master Guidance:

Master Guidance for Special Project Folder and File Naming Conventions

Folder naming:

- Chinook\TechServices\Projects\
  Inside project folder there are files for each year that hold folders for individual projects that started in that year:
  - …\YYYY\ProjectName\
  - Each individual project folder will have the following:
  - Activity Log/About/ReadMe for the project (.xlsx)
    - …\raw mobile data (these are completely unaltered files)
    - …\raw fixed site data (these are completely unaltered files)
    - …\working mobile data
    - …\working fixed data
    - …\combined working reports and presentations, please also place a copy of the final report and copies of presentations in the proper folders in Chinook\New Public Documents

Naming conventions for raw data:
dataID_LocationID_YYYYMMDDThhmmss_R#[_comments].csv
e.g.
CPCO_PSBike_20140502T163000_R1_PSCAAToHome.csv
DyCt_GtS001_20150612T124000_R1_CXLmeasure.csv

Fields are described as follows:

- dataID: 4 character abbreviation of measured parameter/species, instrument, and model (e.g., CPO3, CPCO, RHum, VOCs, DyCt, MiAt,) A reference table is located in Chinook\TechServices\Projects\
- locationID: 6 character description of site, station, platform, laboratory, institute, or individual collecting (ergo the different route) e.g., ShrBrk, Shr10t, PSBike, CrbFix. We'll need to develop a reference table.
- YYYY: four-digit year

- MM: two-digit month
- DD: two-digit day
- hh: optional two-digit hour
- mm: optional two-digit minute
- ss: optional two-digit second
- R: revision number of data
- comments: optional additional information

Where the only allowed characters are: a-z A-Z 0-9_.- (that is, upper case and lower case alphanumeric, underscore, period, and hyphen). No Spaces. All fields not in square brackets are required. All times used in file names should reflect the start time in the raw file. Notes about time zone and other time/data issues should be noted in the project's Activity Log/About/Read Me file.

All Air toxics data obtained through the Contract Laboratory will undergo a coordinated data review process, and will be uploaded to the AQS system by the Contract Laboratory.

All AQS data is publically available. All study data is publically available, upon request.

12.8 Data Validation, Verification and Analysis

EPA has defined the terms "data verification" and "data validation" and those definitions shall be used for purposes of this project. "The term "data verification" means the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements." *See* EPA QA G-8 GUIDANCE ON ENVIRONMENTAL DATA VERIFICATION AND DATA VALIDATION. The term "data validation" means the routine process designed to ensure that reported values meet the quality goals of the environmental data operations. Data validation is further defined as examination and provision of objective evidence that the particular requirements for a specific *intended use* are fulfilled. *Id*. For the purposes of this grant data, PSCAA will perform both "data verification", and Level 1 "data validation." Department of Ecology personnel will conduct a Level 2 data validation process for all project data associated with the Washington network. Data submitted by the contract laboratory to EPA's AQS will be subject to a level 2 review. In the event of an audit failure using NATTS style equipment, Ecology will work with PSCAA to identify invalid data and remove it from AQS.

Data Analysis will be primarily conducted by the Puget Sound Clean Air Agency analysis team, who will produce the final technical report. Other data users may analyze data collected from this study. Other users are urged to use this data with caution. We will be using the Graded Approach to Quality Assurance. As such, the following figure can be used to guide data users as to the anticipated quality level of the data collected as part of this study.

FIGURE 6 Methods and Anticipated Quality Levels

Parameter	Method	Quality Level *	Site(s)
Volatile Organic Compounds	TO-15	Regulatory	A,B,C,T
Aldehydes	TO-11A	Regulatory	A,B,C
PM2.5 BC and UV carbon	Aethalometer AE-33	High	A,B,C
PM 2.5 TEOM FEM	FEM Method EQPM-0609-181	Regulatory	A
PM 10 Metals	IO 3.5/FEM EQL-0512-202	Regulatory	A
PAH	TO-13A ASTM method D6209	Regulatory	A
PM2.5 BC mobile	Micro-Aeth AE-51	Medium	M
Fine particle count mobile	Air Beam	Low	M
Fine/Total particle count	Dylos DC-1700	Low	A,B,C,M
CO	Alphasense CO-B4	Low	A,B,C,M
NO	Alphasense NO-B4	Low	A,B,C,M
Ultrafine Particle Count	Enmont PUFP-C100	Medium	M
Total VOC	Aeroqual sensor	Low	M

* Anticipated quality level – actual level may prove to be better or worse based on Data Quality Indicators.

A. Seattle 10th & Weller site
B. Seattle Gatzert Elementary Yesler Way site
C. Seattle Chinatown International District site (6th & Jackson)
M. Mobile monitoring technique
T. Community Directed monitoring sites

The Data Analysis Team is responsible for reviewing all of the data collected in this study. PSCAA shall submit to the EPA administrator, through the Region 10 Office, summary reports of the monitoring data collected in the study. The report will be a summarized account of the observations and recommendations that will be available in Draft form initially. After final Technical reviews are complete, the report will be finalized. We will evaluate the data in a multi-step process.
First, we will complete a full and ongoing evaluation of the data including a full quality assurance assessment. This entails checking data completeness, trends, temporal patterns, and potential interferences. Data Quality Indicators will be used to describe the actual quality of the data sets, to evaluate the data usability. Additional review will help in the analysis, including reviewing detection limits to determine the best statistical estimation techniques needed. We will calculate summary statistics such as averages, medians, percentiles, for all the measured air toxics.

1) *Estimate potential cancer and non-cancer risks for fixed sites*

Based on statistical summaries described above, we will calculate potential cancer and non-cancer risk estimates based on unit risk factors and hazard indices as adopted by Washington State Acceptable Source Impact Levels.[i] Based on these estimates, we will provide a ranking of air toxics, which will help us quantify the health hazards attributed to air toxics that are now only roughly estimated through surrogate methods.

2) *Estimate air toxics concentration gradients with proximity to the highway*

Using all data from fixed sites, community directed sites, and mobile sampling, we will derive concentration gradients with distance to the highway. This will provide us with a local study to reference when discussing risk due to transportation in our region.

3) *Compare air toxics concentrations and risks to the national NATTS network*

We will aggregate three years of the National Air Toxics Trends Site data across the country, average results, and apply the same unit risk factors to make risk comparisons across the country (especially the local NATTS at Seattle Beacon Hill three miles to the south).

4) *Compare air toxics concentrations to nearby 2011 NATA census tract estimates*

We will compare our results to the 2011 National Air Toxics Assessment model. We will do a comparison across a number of neighboring census tracts using ArcGIS.

5) *Identify & quantify air toxics sources through factor analysis and other analyses*

For our analysis, we will use both collected data from our sensors and leverage collocated data from the near-road nitrogen dioxide site. The leveraged data includes speciation, black carbon, and fine particle information. Our additional sensors will provide carbon monoxide, particle counts, and nitric oxide concentrations, which are “markers” for vehicle pollution.

We will use the results in a factor analysis to identify and quantify air toxics sources. The factor analysis will include monitored concentrations of air toxics, daily black carbon, fine particles, particle number, carbon monoxide, nitric oxide, and traffic counts, temperatures, wind speeds, and humidity data. We will also include organic carbon, elemental carbon, and many other particle fractions from collocated speciation data provided by the Washington State Department of Ecology. We will attempt to estimate concentrations of diesel particulate matter, an important mobile source air toxic, so that we may include its estimated levels and risk (at least qualitatively) as we communicate results.

6) *Extrapolate risks from the gradient study to quantify potentially exposed populations and their potential risk*

We will look at how the gradient data compares to the NATA, and based on traffic volume, we will assess what air toxics concentrations could be near highways. If the total VOC monitor does appear to provide relatively consistent ratios to benzene, 1,3-butadiene, and formaldehyde, we will use the total VOC data to extrapolate the air toxics levels beyond the fixed sites (with uncertainties indicated prominently). We will explore ratios of total VOCs to specific air toxics, as well as ratios of air toxics to criteria pollutants. Using both mobile and fixed site data, we will infer gradient curves and maps for measured air toxics like formaldehyde, benzene, and 1,3-

butadiene scaled to distance to traffic volume. To compensate for potential biases, we will factor in wind directions and speed sensitivity into our analysis. We will also analyze other potential impacts to help explain unexpected anomalies, possibly with line dispersion modelling of nearby I-90, side streets, or other non-road sources of air toxics.

Data verification refers to the daily work that the air monitoring specialists will perform to ensure that data is collected according to the QAPP. Data validation refers to those activities performed after the data have been collected. The difference between the data validation and quality control techniques is that the quality control techniques attempt to minimize the amount of bad data being collected, while the data validation seeks to prevent any bad data from getting through the data collection and storage systems – to prevent incorrectly collected data from informing the results. Data validation is a combination of checking that data processing operations have been carried out correctly and of monitoring the quality of the field operations. Data validation can identify problems in either of these areas. Once problems are identified, the data can be corrected or invalidated, and corrective actions can be taken for field or laboratory operations. If possible, flags denoting error conditions or QA status are saved as separate fields in any databases, so that it is possible to recover the original data. The following table will be used to plan the types of data checks, and the people responsible for the checks.

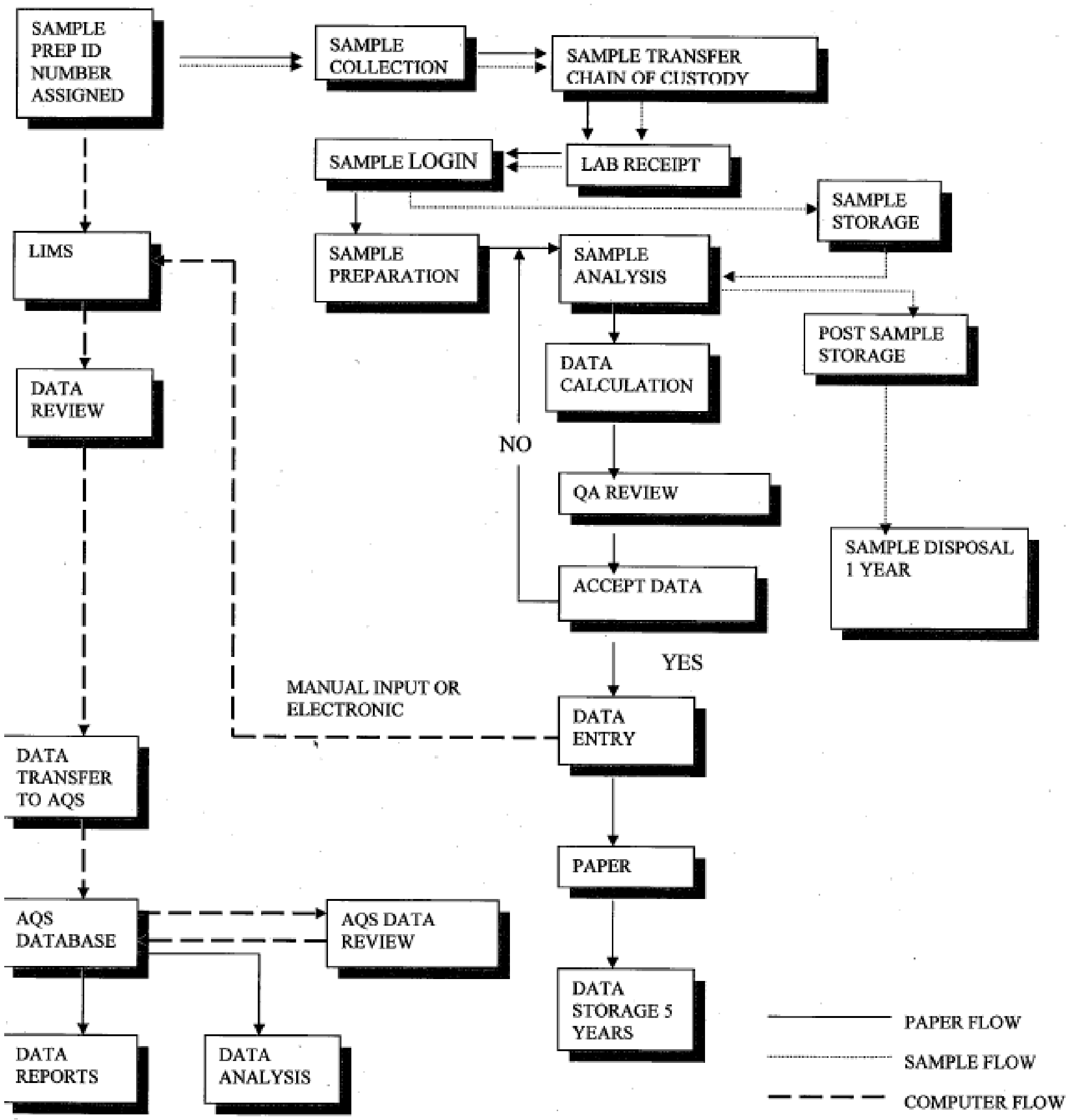
FIGURE 7 Validation Check Summaries

Type of Data Check	Responsible Team member	Manual Checks	Automated Checks
Date and Time Consistency	PSCAA Air monitoring specialist	X	
Completeness of required sample fields	Lab receiving personnel	X	X
Statistical outlier checking	PSCAA Project Manager and Analysis Team	X	X
Manual inspection of charts and reports	Lab personnel	X	
Field and Lab blank checks	Lab personnel	X	

13 Data Management

This section describes all the aspects of data management necessary for this project. This includes an overview of the mathematical operations and analyses performed on raw, “as-collected” data. These operations include data recording, validation, transformation, transmittal, reduction, analysis, management, storage and retrieval, and reporting. Data Processing activities for air toxics data are described in the below figure.

FIGURE 8 Data Management and Sample Flow Diagram



Data processing steps are integrated, to the extent possible, into the existing data processing system used for criteria pollutant monitoring. The air monitoring database resides on a dedicated database Central server at the State Department of Ecology, and a dedicated SQL database at the Puget Sound Clean Air Agency.

Sample tracking and chain of custody information is entered into a Laboratory Information Management System at two points as shown in the figure. Managers are able to obtain reports on status of samples, location of specific samples, etc. using LIMS. Different access privileges are given each authorized user depending on that person's need. The following privilege levels are defined:

- Data Entry Privilege – The individual may see and modify only data within LIMS that he or she has entered. After a data set has been “committed” to the system by the data entry operator, all further changes will generate entries into the system audit trail.
- Reporting Privilege – The individual may generate reports.
- Data Administration Privilege – Data Administrators for the LIMS are allowed to change data as a result of QA screening and related reasons. All operations resulting in changes to data values are logged to the audit trail.

The Data Administrators are responsible for performing the following tasks on a regular basis:

- Merging or correcting duplicate data entry files;
- Running verification/validation routines, and correcting data as necessary;
- Generating summary data reports for management, and
- Uploading validated data to EPA-AQS.

All other study data will be entered into the PSCAA air quality database using tools such as automated data-loggers, and/or the Air Quality Drop tool.

Mobile Data must be uploaded using the Air Quality Drop tool, because of its dependency on spatial positioning.

Stationary site data collected by the Aethalometers, and the CO-NO-Micro-Sensor monitors will be collected by using the following methods:

- Manual (Aethalometer)– Operators will use the USB key provided to the AE33 monitors to collect the data for the project data files. Data can then be automatically uploaded to the Air Quality Database.
- Automatic (CO-NO-Micro-sensor monitor) – The monitors will have GSM modems installed in the circuit boards. The Air Quality Database can collect these files in using a File Transfer Protocol (FTP) method.

The following table lists the routine documents and records that will be kept for this project. These documents and records will normally be kept in centralized folder structures so that the documents can be recalled later.

FIGURE 9 List of Routine Documents and Records collected

Record/Document Types	Categories
Reporting agency information Organizational structure EPA Directives Grant allocations Support Contract	Management and Organization
Network description Site characterization file Site maps Site Pictures	Site Information
QA Project Plans Standard operating procedures (SOP) Field and laboratory notebooks Sample handling/custody records Inspection/Maintenance records	Environmental Data Operations
Any original data (routine and QC data) including data entry forms	Raw Data
Air quality index report Annual SLAMS air quality information Data/summary reports Journal articles/papers/presentations	Data Reporting
Data algorithms $PM_{2.5}$ Data	Data Management
Network reviews Data quality assessments QA reports System audits Response/Corrective action reports Site Audits	Quality Assurance

14 Assessments and Response Actions

Our analysis and results will help us better understand near-road pollution sources and health risk. We will better understand air toxics levels at different distances to the highway, the risk context through comparisons against national monitoring sites (including the nearby Seattle NATTS site), and the NATA model. Additionally, we will engage the community to explore potential mitigation strategies to reduce exposure to near-road air pollution beyond the time horizon of this grant.

Our agency's environmental justice map, the Community Air Tool, shows that the Chinatown-International District and Yesler Terrace neighborhoods experience high traffic volumes, have median incomes around $15K per year, have 40% limited English proficiency, and are in the worst 1% for three types of air pollution-related hospitalizations (asthma, COPD, and cardiac-related).

In this study we will provide the community the unique opportunity to direct air toxics sampling based on their own concerns. Sampling will be geared toward near-road pollution, but the community will have the latitude to identify a variety of locations and sources (for example bus stops, parking lots, intersections, loading docks, or highways).

We have already started building relationships in this community through our fall 2014 monitoring pilot study. We also plan to continue to work in this community to provide information and the tools to take next steps. This air toxics study provides an important part of taking action against air pollution by helping to fill in identified data gaps. Initial conversations with Chinatown-International District community members indicate that the study could play a powerful role in providing potential evidence of air pollution in the area. Residents seem to be particularly interested in using the study's results to validate their own air quality experiences and utilizing the data to eventually help protect their community from pollution.

Ultimately this project will impact the community by informing stakeholders about the air pollution levels, the risk levels, and the potential mitigation strategies that can be employed to reduce pollution in the area over the long-term.

15 Reports to Management

PSCAA will produce a final technical report, which will be drafted, then routed to stakeholders. Feedback will be solicited, and then the final technical report will be finalized. When the report is finalized, then the report will be given to EPA, as part of the Grant Closeout Package. PSCAA will share this final technical report with all stakeholders, and will post the report to the Agency website, so that it can be publically accessible.

Quarterly reports on the grant progress will be forwarded to the Grant Project Officer, and will be retained as part of the grant record.

16 Appendices

APPENDIX	TITLE
A	Canister Routine Sampling Procedure
B	Carbonyl Routine Sampling Procedure
C	PUF Routine Sampling Procedure
D	The EPA 1 in 6 Sampling Calendar
E	AE-33 "7 Channel" Aethalometer Sampling Procedures
F	AE-51Micro-Aeth Quick Start Guide Procedure
G	Air-beam Operating Procedures
H	Community Directed Canister Sampling Procedures
I	PM2.5 Partisol Procedure Link and PM-10-2.5 Designation
J	Enmont Ultrafine Particle Counter Procedure
K	Air Quality Web: Air Drop Procedure

A. Canister Routine Sampling Procedure

Detailed procedures are outlined in the EPA TO method TO-15. This is a description for regular field runs for canister samplers.

ERG ships the required materials in a box to PSCAA. PSCAA then ships the collected samples back to ERG for analysis.

In summary, a field technician needs to go out to the field to setup the run. The technician needs to then pick up the canister from the field after the run. The samples are collected once every 6 days.

Currently, XonTech 910 instruments are now supported by Xonteck (805-547-2022, sales@xonteck.com or http://www.xonteck.com/ .

Required Materials:

- 2 Crescent Wrenches
- Black or Blue Pen
- Canister and a backup in case of a faulty canister
- Chain of Custody Sheet
- Cell Phone

Sample Drop-off:

- Record the city and state on the chain of custody sheet.
- Record the AQS code for the site as in the table below:

Site	AQS Code	Four Digit Site Code
Seattle 10th&Weller	05303300301	BKWA
Seattle 10th&Weller Collo	05303300302	BKWB
Seattle Yesler Gatzert Elem	0530330034	TSWA
Seattle 6th&Jackson	0530330035	TTWA

- Record the date that the sampler will run on in the chain of custody sheet for the respective canister.
- Write "N" for SNMOC, "Y" for Toxics.
- If this is a duplicate event, record the duplicate canister number on the custody sheet.
- Record the date of the sample set up.
- To toggle on the interface, use the arrow keys. "Select" is similar to "Enter" on a keyboard, and "Exit" confirms a selection. "Clear" will clear the item.
- On the sampler control module, move from main screen #1 (Default Screen) to main screen #6 (Schedule Unit Display) by pressing ⇐ key six times.
- The screen displays the "Schedule Canister" screen. The screen displays start date, start time and duration.

- Press SELECT. Unit # will be underlined. Press SELECT. Unit # will blink. Enter the required unit # using the arrow key. Enter appropriate start date, e.g. 11/02/08. Press EXIT to enter the sampling date. Press EXIT twice to return to main screen #1.
- The time and duration should be entered in military time PST (Pacific Standard Time - not daylight savings). The canister samples are to run from midnight to midnight, 00:00 to 24:00. The sample is collected to achieve a typical 10-13 psi final canister pressure. Based on this, the flow rate is determined to be 10 ccm over the 24-hour sampling period. Synchronize the time to a cell phone or computer at the site in PST.
- Attach the canister with 2 wrenches. When attaching the canister, ensure that there is little to no resistance when in connecting the fittings. If so, try reseating the fittings as they may be cross-threaded. The wrenches are for a last tightening.
- Open the valve until there is noticeably less resistance.
- On the instrument interface, the can should show a vacuum in the high 20's of inches of Hg. Watch the pressure to ensure that it does not start dropping (no matter how slow) as there may be a leak.
- Record this starting pressure on the instrument receipt. Also record this on the custody sheet. Check the pressure again 15 minutes later and see if the pressure dropped by 0.1 PSI or greater. If so, this indicates a leak in the system. Do the following:
    - Try to tighten the connection further and recheck the pressure in 15 minutes.
    - If there is still a leak, close the valve and perform a leak check.
    - If the leak continues, try a back-up canister.
    - Always call PSCAA and try to get a hold of Matt, Adam, or Erik if this is occurring (206-321-6663, 206-619-4829, 206-619-4830 respectively).
- Ensure that the receipt is fed past the lip so that it does not jam when it prints after the run. Also note if there is enough papers for the next receipt.
- Record the mass flow controller (MFC) setting. Ensure that the instrument is set at 10cc/min.
- Reset the sample scheduled date and ensure that the sample duration is for 24 hours.
- Call Mary before leaving the site and also let her know if anything is unusual about the sampler or site.

Sample Pickup:

- Record the date on the sample custody sheet.
- Record the final canister pressure from the interface.
- Record elapsed time.
- Check the receipt against the actual data and anticipated date of analysis to ensure that everything matches. Record the site on the back of the receipt.
- Call someone at PSCAA immediately if the final pressure is < 1.0 PSI.
- Close the valve.
- Remove the canister with 2 wrenches.
- Record anything unusual that you may notice in the "Comments" section of the provided custody sheet. This may include instrument behavior, nearby emission sources, etc.
- Call Mary before leaving the site. Call anyone at PSCAA if anything is unusual about the sampler or site.

Duplicate Samples:

- Once per month, ERG will ship an extra canister for the collocated sampler in Seattle 10th & Weller.

Shipping

- All canisters from ERG will be shipped back to ERG in the same boxes with a postage paid FedEx return label included.
- ERG does not accept shipments on the weekends, so **shipments must be sent Monday through Thursday only**.
- In case of emergency, the lab address and phone contact is: 919-468-7923, Randy Bower, 601 Keystone Park Dr., Suite 700, Morrisville, NC 27560
- All labels should be marked “Priority Overnight” shipping if not already.

ERG

ERG Lab ID #

TOXICS/SNMOC SAMPLE DATA SHEET

Lab Pre-Sampling

Site Code: ____ Canister Number: ____
City/State: ____ Lab Initial Can. Press. ("Hg): ____
AQS Code: ____ Date Can. Cleaned: ____
Collection Date: ____ Cleaning Batch # : ____
Options
SNMOC (Y/N): ____ Duplicate Event (Y/N): ____
TOXICS (Y/N): ____ Duplicate Can # : ____

Field Setup

Operator: ____ Sys. #: ____ MFC Setting: ____
Setup Date: ____ Elapsed Timer Reset (Y/N): ____
Field Initial Can. Press. ("Hg): ____ Canister Valve Opened (Y/N): ____

Field Recovery

Recovery Date: ____ Sample Duration (3 or 24 hr): ____
Field Final Can. Press. ("Hg): ____ Elapsed Time: ____
Canister Valve Closed (Y/N): ____

Lab Recovery

Received by: ____ Date: ____ Lab Final Can. Press. ("Hg): ____
Status: Valid Void (Circle one)
If void, why: ____

SNMOC

Analyst: ____ Date: ____
Batch I.D.: ____

Toxics

Analyst: ____ Date: ____
Batch I.D.: ____

Comments: ____

White: Sample Traveler Canary: Lab Copy Pink: Field Copy

General Sampling Calendar:

If Sample run is on a:	Take out to field on:	Return from the field on:	Ship out with FedEx by 4:30PM on:
Monday	Friday	Tuesday	Tuesday
Tuesday	Monday	Wednesday	Wednesday
Wednesday	Tuesday	Thursday	Thursday
Thursday	Wednesday	Friday	Monday
Friday	Thursday	Monday	Monday
Saturday	Friday	Monday	Monday
Sunday	Friday	Monday	Monday

B. Carbonyl Routine Sampling Procedure

Detailed procedures are outlined in the EPA TO method TO-11A. This is a description for regular field runs for carbonyl samplers.

ERG ships the required materials in a cooler to PSCAA. PSCAA then ships the collected samples back to ERG for analysis.

In summary, the field technician needs to go out to the field to setup the unit before the run. A technician then needs to go to the field to pick up the sample as quickly as possible after the run. The sampler runs every 6 days.

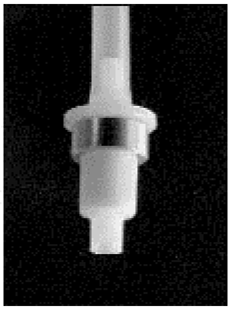
Currently, XonTech instruments Model 925 are now supported by Renata Elder (805-547-2022, renataelder@xonteck.com or http://www.xonteck.com/ .

As these samples are collected using a DNPH (2,4-Dinitrophenylhydrazine) filled cartridge, the medium is sensitive to temperature and degrades if not refrigerated. This will cause low-biased results. Therefore, **it is very important that the medium be stored in a refrigerator or in an ice cooled cooler (at < 4ºC) whenever the sample is not being sampled on.** Make sure to not store the sample in a freezer and store them refrigerated until the sample is ready for shipping. Pickup and drop-off should be made as near the sample date as possible.

DNPH is similarly UV-sensitive, and should also be kept away from all light and be stored in the original silver bag supplied by ERG. They should only be out of the bags for sample loading and pickup from the sampler.

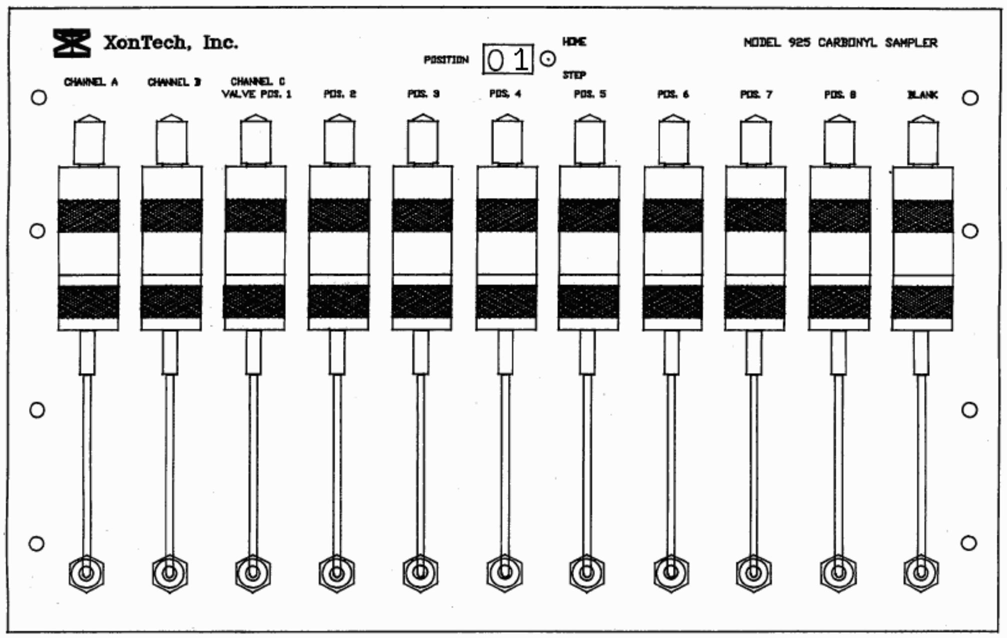
Setup of the Adsorbent Cartridge:

- Setup a clean work space. A work bench disposable cover is a good option.
- Open the contents of the ERG shipment.
- Put on nitrile gloves.
- Cut open the sealed silver bag with the cartridge.
- Place the cartridge as the image below with the thinner side up into the black capsule of the A channel.



- If there is a duplicate or “collocated” sample, it is placed in the B channel.
- Place the blank into the blank channel.

- While loading, ensure that the washer that resides on the top part of the capsule is still in place as they tend to fall out. Make sure you have spare washers around or remove some from the other unused channels on the instrument (position 2-8) if they are missing.
- Ensure that the sampler tube unit is set to position "1" as in the image below.



MODEL 925 TUBE UNIT FRONT PANEL
(Figure 2)

- To toggle on the interface, use the arrow keys. "Select" is similar to "Enter" on a keyboard, and "Exit" confirms a selection. "Clear" will clear the item.
- Set and record the sample setup date on the chain of custody form with your initials.
- Set and record the sample volume at 1000 ccm.
- Enter "Y" when prompted to clear E-term data and record that on the sheet.
- The time and duration should be entered in military time PST (Pacific Standard Time - not daylight savings). The canister samples are to run from midnight to midnight, 00:00 to 24:00. Synchronize the time to a cell phone or computer at the site in PST.
- For any duplicate samples on channel B, make sure that the procedure is repeated as for channel A.
- Ensure that the receipt is fed past the lip so that it does not jam when it prints after the run. Also note if there is enough papers for the next receipt.
- Bring back the icepacks so that they can be refrozen for pickup of the cartridges.
- Call Mary before leaving the site. Call anyone at PSCAA if anything is unusual about the sampler or site.

Cartridge Pickup:

- Record the recovery date on the sample custody sheet. Put 24 hours under "Sample Duration".
- Record the post sampling Rotameter reading on the custody sheet.
- Record elapsed time.
- Check the receipt against the actual data and anticipated date of analysis to ensure that everything matches.
- Remove the cartridge(s) and cap them with the provided caps.
- Place them in the RTI provided silver colored bags. Ensure that the washer is still in the black capsule.
- Record anything unusual that you may notice in the "Comments" section of the provided custody sheet. This may include instrument behavior, nearby emission sources, etc.
- Ensure that the custody sheet is fully filled in.
- Call Mary before leaving the site. Call anyone at PSCAA if anything is unusual about the sampler or site.
- When in the lab, calculate the average flow rate and total collection volume on the custody sheet as in the calculations section below.
- Store the sample at < 4ºC until shipping in the cooler, which should also be < 4ºC.
- This sample must be extracted for analysis within 14 days of sample collection, so ship the cooler out as quickly as possible.

Duplicate Samples:

- Once per month, ERG will ship an extra sample for the collocated sampler in Seattle Duwamish.
- The duplicate samples will be setup at 500 ccm for both channels instead of 1000 ccm to ensure proper sample flow. Be careful to reset the flows back to 1000 when the duplicate analysis is over.

Applicable AQS Codes for the chain of custody:

Site	**AQS Code**	**ERG Code**
Seattle 10th&Weller	0530330030	BKWA
Seattle Yesler Gatzert Elem	0530330034	TSWA
Seattle 6th&Jackson	0530330035	TTWA

In Case of Receipt Printing Issues/No Receipt:

- If a receipt is lost or missing, check the sampling date, start time, and duration in the schedule to ensure that it ran.
- If it was scheduled correctly,
  - Go to the main screen, press "Select", and the date will be underlined.
  - Then press the back arrow, until the screen reads, "Print full report?"
  - Press "Select", and then the arrow key until it reads, "Y", then exit.

  - The receipt with the necessary data should be printed.
- If the receipt still hasn't printed, check that the printer status light is red and press switch to turn on the printer if necessary. Repeat as necessary.

Shipping:

- All samples from ERG will be shipped back to ERG in the same coolers with a postage paid FedEx return label included.
- All that is required is a replacement cold icepack prior to shipping.
- ERG does not accept shipments on the weekends, so **shipments must be sent Monday through Thursday only**. If it appears that shipment will not be picked up (too late), put the sample back in the refrigerator until the shipment can be made.
- In case of emergency, the lab address and phone contact is: Randy Bower, 919-468-7923, 601 Keystone Park Dr., Suite 700, Morrisville, NC 27560

General Sampling Calendar:

If Sample run is on a:	Take out to field on:	Return from the field on:	Ship out with FedEx by 4:30PM on:
Monday	Friday	Tuesday	Tuesday
Tuesday	Monday	Wednesday	Wednesday
Wednesday	Tuesday	Thursday	Thursday
Thursday	Wednesday	Friday	Monday
Friday	Thursday	Monday	Monday
Saturday	Friday	Monday	Monday
Sunday	Friday	Monday	Monday

ERG

ERG Lab ID # ____________

CARBONYL COMPOUNDS DATA SHEET

Lab Pre-Samp.

Site Code: ____________ Collection Date: ____________

City/State: ____________ Cartridge Lot #: ____________

AQS Code: ____________ Duplicate Event (Y/N): ____________

Field Setup

Set-Up Date: ____________ Operator: ____________ Sys. #: ____________

Pre-Sampling Rotameter Reading (cc/min): ____________ Elapsed Timer Reset (Y/N): ____________

Field Recovery

Recovery Date: ____________ Sample Duration (3 or 24 hr): ____________

Post Sampling Rotameter Reading (cc/min): ____________ Elapsed Time: ____________

Cartridges Capped (Y/N): ____________

Lab Recovery

Received by: ____________ Date: ____________ Refrigerator No: ____________

Status: Valid Void (Circle one)

If void, why: ____________

Sample Volume (total Liters): ____________

	Sample Date	Sample Time	Sample Duration	Sample Volume	Cartridge Lot #	Sample ID	Lab ID
PAMS							

Comments: ____________

White: Sample Traveler Canary: Lab Copy Pink: Field Copy

C. PUF Routine Sampling Procedure

Detailed procedures are outlined in the EPA TO method TO-13A. This is a description for regular field runs for PUF samplers.

ERG ships the required materials in a cooler to the PSCAA office. PSCAA then ships the collected samples back to ERG for analysis.

If there is an extra PUF sampling module available, the setup of the filter can be completed in the lab. Otherwise, the preparation needs to be done with the module in the field.

In summary, the field technician needs to go out to the field to setup the unit before the run. A technician then needs to go to the field to pick up the sample as quickly as possible after the run. The sampler runs every 6 days.

Setup of the Module:

- Setup a clean work space. A work bench disposable cover is a good option.
- Open the contents of the ERG shipment.
- Disassemble the module.
- Put on nitrile gloves.
- Open the Petri-dish containing the quartz filter so that the filter is facing “up” (the more textured surface).
- Place the filter in the module with the 2 white Teflon gaskets on either side with the filter facing “up” on the module (See Figure 3). Use the lab supplied tweezers for this step as they are cleaned for each use for this purpose. Avoid all contact of the filter with anything else. Secure the filter retaining ring and filter in place using the 3 plastic thumb screws. If the unit requires transport to the site, put on the module shield before tightening the thumb screws.
- Open the jar shipped from ERG with the glass PUF cartridge. Remove the aluminum foil and insert the cartridge into the lower chamber (frit on the bottom) and tightly screw the top and bottom of the module together.
- If assembled in the lab, cap the bottom with aluminum foil to avoid potential diffusion of semi-volatiles.

Module Installation into Sampler:

- Remove the foil from the bottom of the module if there is any.
- Place the module into the sampler and lower the 2 clamps to secure the unit.
- Inspect the exhaust hose and check to see if it is clogged or plugged.
- If the sampler is a duplicate sampler, make sure it is plugged in.
- Open the ball valve all the way open (arm pointing downward).
- Turn the unit on with the manual switch.

- Read the magnehelic gauge and record the result on the chain of custody sheet (an example chain of custody is at the end of this document). If there is no reading on the magnehelic gauge, make sure that the aluminum cap on the top of the filter was removed.
- Adjust the timer to the necessary start day at midnight using only PST (Pacific Standard Time - not daylight savings). Also set the timer to run for 24 hours.
- Record the start time on the timer on the chain of custody sheet.
- Turn the manual switch off.
- Make sure that everything is locked at the site, that samplers are shielded from rain.
- Call Mary before leaving the site.

Module Pickup:

- Record the end sample time on the timer on the chain of custody sheet.
- Turn the unit on with the manual switch.
- Record the final magnehelic gauge reading.
- Turn off the unit with the manual switch.
- From a Partisol sampler nearby, retrieve the average pressure and average temperature for the sampling duration on the custody sheet. To retrieve the data:
    - Hit any button to "awake" the interface.
    - Press "Data".
    - Then Press "More Data" 3 times and record the average temperatures and not the maximum 1 hour data.
    - Press "Esc" until the main screen appears.
- Record the recovery date on the custody sheet.
- Record anything unusual that you may notice in the "Comments" section of the provided custody sheet. This may include instrument behavior, nearby emission sources, etc.
- Remove the module and if being transported to the lab, cover the bottom with foil and cover the top with the aluminum plate. Try to keep the module in a cold, dark place until it is in the laboratory. Label the module for simplicity of processing in the lab.
- Call Mary before leaving the site.
- When in the lab, calculate the average flow rate and total collection volume on the custody sheet as below:

Calculations:

Flow Rate

$$Y5 = [\text{Average Magnehelic Reading } (\Delta H)\ (P_a/T_a)(T_{std}/P_{std})]^{1/2}$$

$$X2 = \frac{Y5 - B2}{M2}$$

where:

Y5 = Corrected average magnehelic reading
X2 = Instant calculated flow rate, scm

P_a = Average Pressure in mmHg
P_{std} = 760 mmHg
T_a = (Average Temperature in ºC + 273)
T_{std} = 298 K
B2 = Calibration Intercept
M2 = Calibration Slope

Total Collection Volume

$$V_{std} = \text{elapsed time} * X2$$

The B2 and M2 (calibration intercept and slope respectively) can be found at the site and PSCAA will have the original copy in their office. Calibrations are done with every motor replacement, which is done quarterly. PSCAA will provide you with these numbers for each site after any change.

Below are the current values (TBD):

Site	Sampler ID	M2 (Slope)	B2 (Intercept)
Seattle 10th&Well	tbd	tbd	tbd
Seattle 10th&We Dup	tbd	tbd	tbd

Module Disassembly:

- Disassemble the top quartz filter first.
- Fold the filter with the particulate on the inside. Place the filter on top of the PUF/XAD inside of the thimble. Then, cover it with aluminum foil.
- Unscrew the bottom half of the module and remove the glass PUF cartridge, avoiding as much UV-light as possible. Put the thimble in the cooler.
    - Be careful not to ship the 2 white gaskets that retain the quartz filter to the lab.
- Cap the ends of the glass cartridge with the included Teflon caps. Then, wrap the cartridge in foil and put it in the provided bubble wrap, and put the wrapped cartridge into the plastic shipping jar.
- Store the sample at < 4ºC until shipping in the cooler, which should also be < 4ºC.
- This sample must be extracted for analysis within 14 days of sample collection, so ship the cooler out as quickly as possible.

Duplicate Samples:

- Once per month, ERG will ship an extra sample for the collocated sampler in Tacoma Alexander.
- Follow the routine procedures for this sampler, but remember to plug in the unit on setup and unplug the unit for sample pickup. This will reduce unnecessary wear on the motor.

Applicable AQS Codes for the chain of custody:

Site	AQS Code	Four Digit Site Code
Seattle 10th&Weller	05303300301	BKWA
Seattle 10th&Weller Collo	05303300302	BKWB

Shipping:

- All samples from ERG will be shipped back to ERG in the same coolers with a postage paid FedEx return label included.
- All that is required is a replacement cold icepack prior to shipping.
- ERG does not accept shipments on the weekends, so **shipments must be sent Monday through Thursday only**. If it appears that shipment will not be picked up (too late), put the sample back in the refrigerator until the shipment can be made.
- If not already checked off, mark the shipping label as "Priority Overnight".
- In case of emergency, the lab address and contact is: Randy Bower, 919-468-7923, 601 Keystone Park Dr., Suite 700, Morrisville, NC 27560

General Sampling Calendar:

If Sample run is on a:	**Take out to field on:**	**Return from the field on:**	**Ship out with FedEx by 4:30PM on:**
Monday	Friday	Tuesday	Tuesday
Tuesday	Monday	Wednesday	Wednesday
Wednesday	Tuesday	Thursday	Thursday
Thursday	Wednesday	Friday	Monday
Friday	Thursday	Monday	Monday
Saturday	Friday	Monday	Monday
Sunday	Friday	Monday	Monday

The Module Assembly and Parts

Method TO-13A PAHs

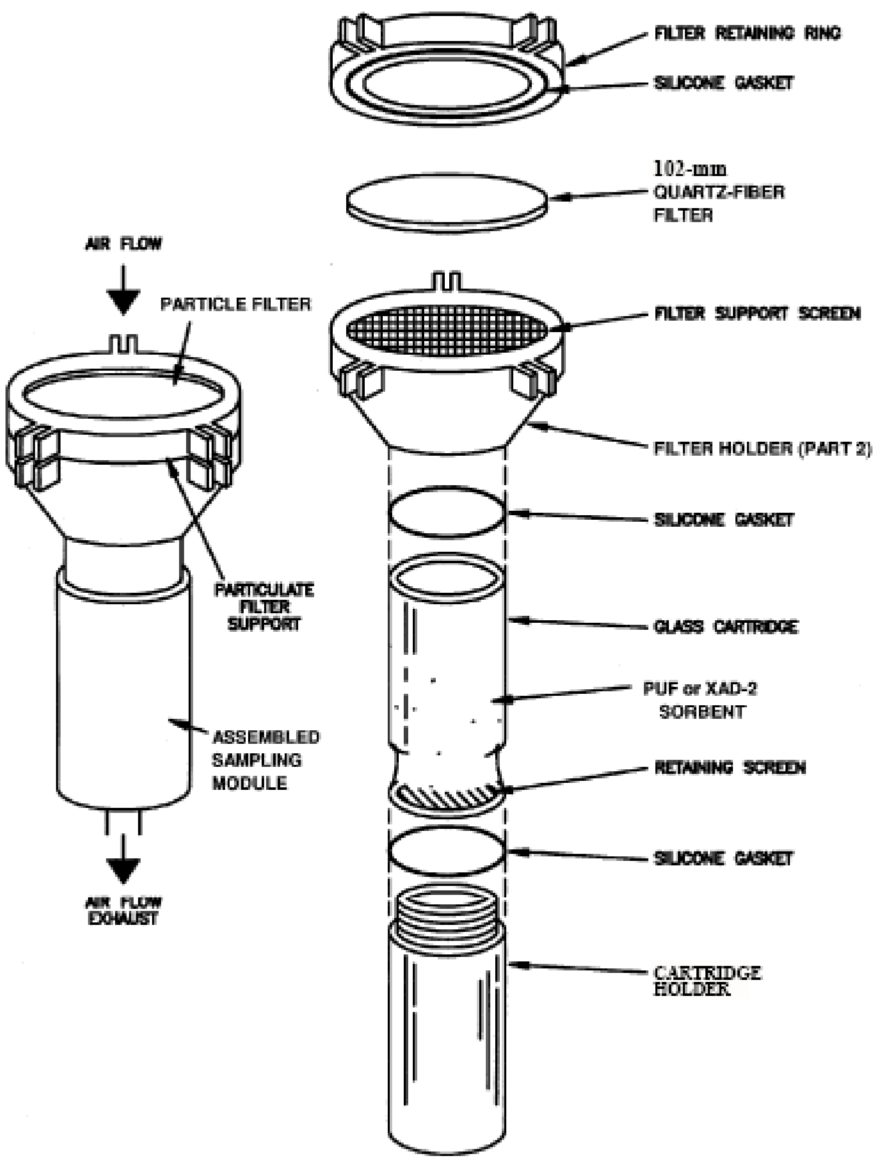


Figure 3. Typical absorbent cartridge assembly for sampling PAHs.

ERG

ERG Lab ID #

SVOC SAMPLE DATA SHEET

Lab Pre-Sampling

Site Code: ____________ Collection Date: ____________

City/State: ____________ Collocated Event (Y/N): ____________

AQS Code: ____________

Field Setup

Site Operator: ____________ Sampler ID: ____________

Set-Up Date: ____________ Elapsed Timer Reset (Y/N): ____________

Collection Date: ____________

Batch I.D. No.: ____________

Batch Certification Date: ____________

Field Recovery

Collection System Information:

	Elapsed Time	Temp (°C)	Barometric ("Hg)	Magnehelic ("H_2O)	Flowrate (std. m^3/min)
Start					
End					
Average					

Total Collection Time (Minutes) ____________ Total Collection Volume (std. m^3) ____________

Lab Recovery

Received by: ____________ Date: ____________ Refrigerator No.: ____________

Status: Valid Void (Circle one)

If void, why: ____________

Comments: ____________

White: Sample Traveler Canary: Lab Copy Pink: Field Copy

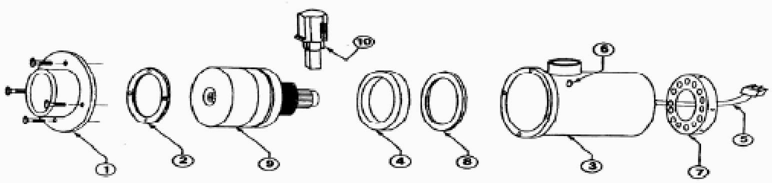
POLY URETHANE FOAM SAMPLER

	TE-1000PUF	**P**oly Urethane **F**oam Sampler for Pesticide Particulate/Vapor. Includes anodized aluminum shelter, 4" particulate/vapor sampling module, flow venturi, blower motor assembly, Magnehelic® pressure gage, motor speed control/elapsed time indicator and 7-day mechanical timer. Complete system.	$2,645.00
	TE-1000-BL	**Brushless Poly Urethane Foam PUF system Same as TE-1000**	$3,525.00
	TE-1008-9-2.5	PUF 2.5 Dual Cyclone Kit	$1,650.00
	TE-1001	PUF Anodized Aluminum Shelter w/Gabled Roof	$780.00
	TE-1002	Particulate/Vapor Sampling Module less Glass Cartridge	$485.00
1)	TE-1008-1	4" Hold Down Frame	$60.00
2)	TE-1008-2	4" Filter Holder Body w/Stainless Steel Screens	$95.00
3)	TE-1008-8	Filter Holder Gasket (Silicone 4 1/2" OD)	$11.00
4)	TE-1002-2	Module Reducer	$140.00
5)	TE-1008-5	Teflon Gasket each (2 required)	$11.00
6)	TE-1002-14	Plastic Thumb Nut, Brass Bolt, Washer and S/S Bolt each (3 required)	$15.00
7)	TE-1002-3	Module Body	$150.00
8)	TE-1002-6	Upper Module Gasket (Silicone 2 7/8" OD)	$11.00
9)	TE-1008-9	Aluminum Cover for 4" Filter Holder	$17.00
10)	TE-1009	Glass Cartridge w/Stainless Steel Screens	$25.00
11)	TE-1002-8	Lower Module Gasket (Silicone 2 9/16" OD)	$11.00
12)	TE-1010	3" Long Polyurethane Vapor Collection Substrate, (unwashed) package of 10 "FR" free	$37.00
	TE-1011	2" Long Polyurethane Vapor Collection Substrate, (unwashed) package of 10 "FR" free	$26.00
	TE-1012	1" Long Polyurethane Vapor Collection Substrate, (unwashed) package of 10 "FR" free	$19.00
	TE-1014	PUF DISK 5 ½" Long X 1/2" thick, Use with TE-200 Passive Sampler	$6.00
13)	TE-QMA4	Micro-Quartz Filter Media 4" Round for PUF (100 per box)	$270.00
14)	TE-1002-4	Module Plug Coupler	$20.00
	TE-1008	4" Round Filter Holder Complete	$160.00
	TE-1003	Flow Venturi & Calibration Valve System	$285.00
	TE-1003-1	Quick-Disconnect (between floor flange and module)	$29.00
	TE-1003-1-1	Gasket for Quick Disconnect	$3.00
	TE-1003-4	Flow Venturi	$250.00
	TE-1003-6	Calibration Valve	$70.00
	TE-1005	Magnehelic® Pressure Gage (0-100" of water)	$122.00
	TE-5010	Motor Speed Voltage Control/Elapsed Time Indicator	$275.00
	TE-5010BL	Brushless Voltage control/ETI	$385.00
	TE-5007	7-Day Mechanical Timer	$197.00
	TE-1023	Exhaust Hose, 10 Ft. Length with Hose Clamp	$55.00
	TE-5040	PUF Calibration Kit w/Calibration Orifice, Slack-Tube® Manometer, NIST Traceable Calibration Certificate and Carrying Case.	$610.00
	TE-5040A	PUF Calibration Orifice Only w/ NIST Traceable Calibration Certificate and Tubing	$435.00
	TE-P-Recal	**Re-Calibration of Calibration Orifice for PUF System (Required Annually)**	$195.00

Tisch Environmental, Inc. – 145 South Miami Avenue, Cleves, OH 45002 U.S.A.
Tel: 513 467 9000 Toll Free: 877 263 7610 Fax: 513 467 9009 E Mail: sales@Tisch-env.com 2

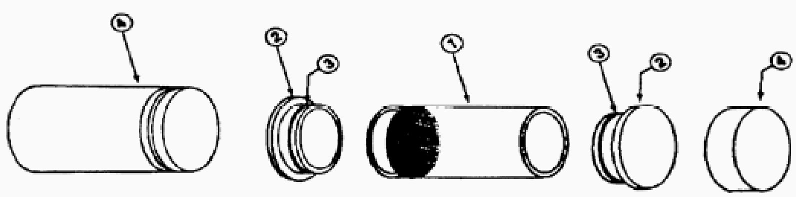
PUF BLOWER MOTOR ASSEMBLY

	TE-1004	PUF Blower Motor Assembly	$490.00
	TE-1004BL	Brushless PUF Blower Motor Assembly	$1,295.00
1)	TE-1004-1	Blower Motor Flange	$65.00
2)	TE-1004-2	Flange Gasket	$10.00
3)	TE-1004-3	Aluminum Blower Motor Housing with Integral Side Exhaust	$156.00
4)	TE-5005-4	Motor Cushion	$10.00
	TE-5005-4BL	Silicone Cushion, Use with Brushless Blower	$40.00
5)	TE-5010-4	Power Cord	$12.00
6)	TE-5005-8	Pressure Tap with Nut	$5.00
7)	TE-1004-7	Back Plate	$42.00
8)	TE-1004-8	Motor Spacer Ring	$14.00
9)	TE-116336	Motor for 110V PUF System	$97.00
	TE-116125	Motor for 220V PUF System	$112.00
10)	TE-33384	Motor Brushes (2 per set) for 110V Motor TE-116336	$9.00
	TE-33378	Motor Brushes (2 per set) for 220V Motor TE-116125	$10.50



GLASS CARTRIDGE AND TEFLON END CAPS

	TE-1009	Glass Cartridge w/Stainless Steel Screens	$25.00
2)	TE-1026	Teflon End Cap with Silicone "O" Ring each (2 required)	$23.00
3)	TE-1026-1	Silicone End Cap "O" Ring each (2 required)	$4.00
4)	TE-1027	Aluminum Screw Top Shipping Container	$19.00



MASS FLOW CONTROLLED PUF SAMPLING SYSTEM

TE-PNY1123	**Mass Flow** Controlled **PUF** PolyUrethane Foam Sampler. Includes 8" x 10" stainless steel filter holder with probe hole, 6" long spool piece, with endcaps, blower motor assembly, 8" well type manometer, 7-day mechanical timer, filter media holder filter paper cartridge, elapsed time indicator, mass flow controller with 20 to 30 SCFM air flow probe, and anodized aluminum shelter.	$3,450.00
TE-PNY1123BL	Same as above but BRUSHLESS	$4,950.00
TE-5004PNY	PNY Special Filter Holder to use with glass cartridge	$325.00
TE-1123-1	6" Long Spool Piece with end caps (To Hold Foam)	$398.00
TE-1123-2	Female End Cap (For Spool Piece)	$71.00
TE-1123-3	Male End Cap (For Spool Piece)	$71.00
TE-1123-4	Foam 3" by 3 3/8" Dia. Poly Urethane Vapor Collection Substrate (10 per pack)	$48.00
TE-1123-5	Glass Cartridge w/Stainless Steel Screens	$48.00
TE-1123-6	Foam 3" x 3" Dia. to fit Glass Cartridge (10 per package)	$48.00
TE-1123-7	Silicone Gasket to Fit Glass cartridge 2 ½" id x 2 3/8" od x 1/8"	$10.00
TE-1123-8	Silicone Gasket Between 8 x 10 and Glass 4" id x 2 ¾" od x 1/8"	$10.00

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Tel: 513 467 9000 Toll Free: 877 263 7610 Fax: 513 467 9009 E Mail: sales@Tisch-env.com

D. The EPA 1 in 6 Sampling Calendar

2016 6-Day Sampling Calendar

January

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5	6	FB	8	9
10	11	12	**13**	14	15	16
17	18	D	20	21	22	23
24	**25**	26	27	28	29	30
31						

February

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	4	5	FB
7	8	9	10	11	**12**	13
14	15	16	17	M	19	20
21	22	23	**24**	25	26	27
28	29					

March

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		FB	2	3	4	5
6	**7**	8	9	10	11	12
D	14	15	16	17	18	**19**
20	21	22	23	24	**25**	26
27	28	29	30	**31**		

April

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5	FB	7	8	9
10	11	**12**	13	14	15	16
17	M	19	20	21	22	23
24	25	26	27	28	29	**30**

May

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	FB	7
8	9	10	11	**12**	13	14
15	16	17	D	19	20	21
22	23	**24**	25	26	27	28
29	**30**	31				

June

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
FB	6	7	8	9	10	**11**
12	13	14	15	16	M	18
19	20	21	22	**23**	24	25
26	27	28	**29**	30		

July

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	FB	6	7	8	9
10	**11**	12	13	14	15	16
D	18	19	20	21	22	**23**
24	25	26	27	28	**29**	30
31						

August

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	FB	5	6
7	8	9	**10**	11	12	13
14	15	M	17	18	19	20
21	**22**	23	24	25	26	27
28	29	30	31			

September

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	FB
4	5	6	7	8	**9**	10
11	12	13	14	**15**	16	17
18	19	20	D	22	23	24
25	26	**27**	28	29	30	

October

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	FB	4	5	6	7	8
9	10	11	12	13	14	**15**
16	17	18	19	20	D	22
23	24	25	26	**27**	28	29
30	31					

November

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	FB	3	4	5
6	7	**8**	9	10	11	12
13	M	15	16	17	18	19
20	21	22	23	24	25	**26**
27	28	29	30			

December

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	FB	3
4	5	6	7	**8**	9	10
11	12	13	M	15	16	17
18	19	**20**	21	22	23	24
25	**26**	27	28	29	30	31

Standard Sample Collection

FB Field Blank Collection

D Duplicate Sampling Collection

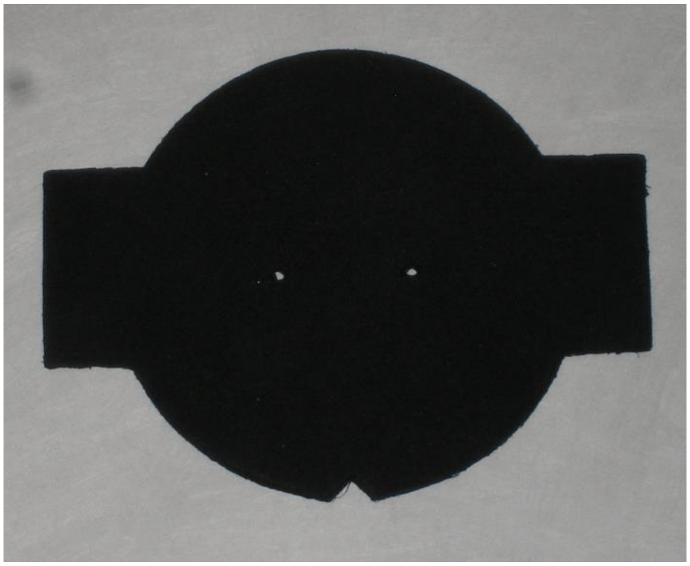
M Makeup Duplicate Collection or normal sample

E. AE-33 “7 Channel” Aethalometer Sampling Procedures

Instrument Settings
1. Time base: 1-minute (default), never 1-second
2. Max Attn: 120 (default)
3. Flow: usually 5 lpm (with BGI 1.829 cyclone for PM2.5)
4. Other settings (see setup file)
“DST off” is important, DateFormat=US
“Measure Time Stamp” = before
Recommend 1-minute “warmup” (default is 3)
Flow Standards for reporting data - Use EPA “STP” (25C) defaults are (70F or 21.1 C)
==> Settings are not saved until you start a run
Prompt to save changes

Operational Checks and the Leak Test / Flow Verification (LT/FV) Done Monthly:
1. Instrument date/time check/set: monthly and after power failure
SET clock monthly even if time is ok
Time may change on reboot
2. Tape visual inspection check: at least monthly (each LT/FV)
Look for neat, evenly grey, evenly spaced spots with sharp edges. Also: how much tape left?
. USB thumb drive data download: Use USB Key, and bring files back to the designated Folder.
Monthly - QC files can be useful (log [FVRF], FV, LT, setup, etc)
Data/Export menu, enter date of last download
Thumb drive must not have other files on it
a “.exe” file in the root dir will cause the Aeth to stop
All data are stored internally (50 years’ worth) on CF card

3. Perform Leak Test and Flow Verification together
Stop the AE33 by pressing OPERATION > STOP
Take the time to inspect and clean the sampling head, removing carbon, debris, or bugs from the cyclone.
CAUTION: DO NOT BLOCK THE INLET FOR A LEAK TEST, this will only shut down the variable pump.
Perform the wizard in the instrument for the LEAKAGE TEST.
Use flowmeter without pressure pulses (TSI-4100)
For all flow verification, leak test or flow verifications, remember to always re-enter 25C for the Temperature of the flow measurement. Also note that the flow is entered into the instrument in milliliters per minute, not LPM (so use 5100 mlpm for 5.1 LPM).
Follow the steps that the instrument provides to measure the flow through the filter, and then the flow through the FLOW PAD, (shown below).
Some leakage is normal: 7% filter “lateral” leak assumed and used in data calculations
AE33 Flow Pad: goes in with notch facing out towards you



(Picture of the LT/FV Pad)

Example of filter leak test report (LT*.dat file)

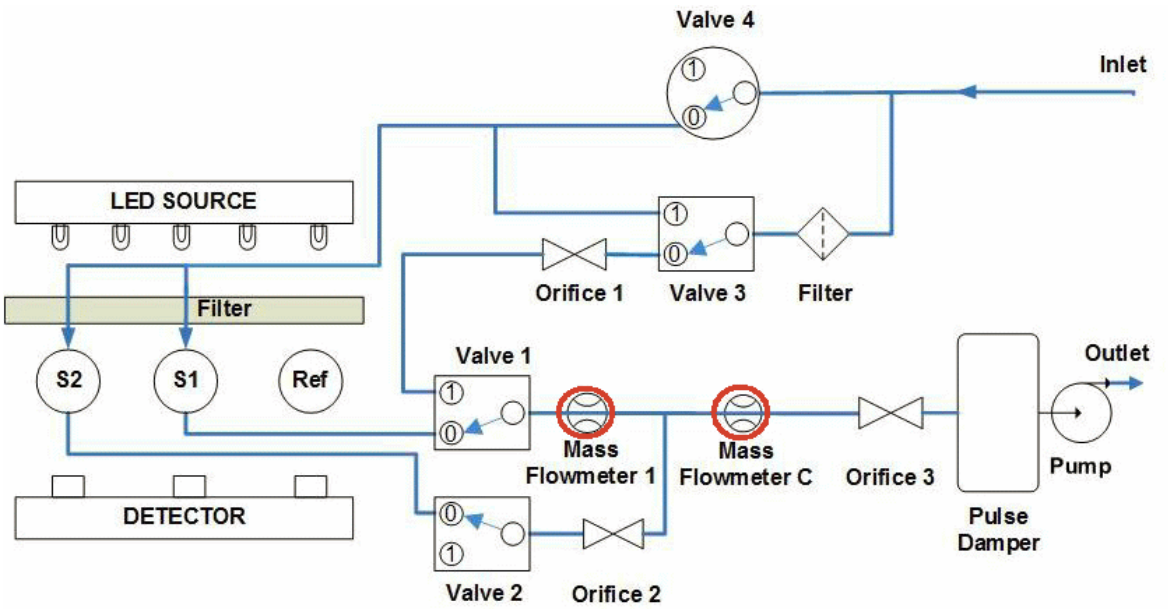
Manual leakage test report
Serial number: AE33-S02-00XXX
Date and time: 06 Mar 2015 10:12:15
Selected flow: 5000 mlpm
Flow through tape: 4920
Flow through calibration pad: 5140
Instrument leakage is: 4.3 %
Result should be ~3 to 7% and if you have leak > 10%: then take corrective action [new tape roll, mechanical problems]

AE33 Flow Check (If Flow calibration is needed, then follow procedures in the Magee Scientific Operator's Manual).

Once LT is complete, keep the Flow Verification Pad in the chamber, and then proceed onto the Wizard for the FV, which then happens at three flow levels.

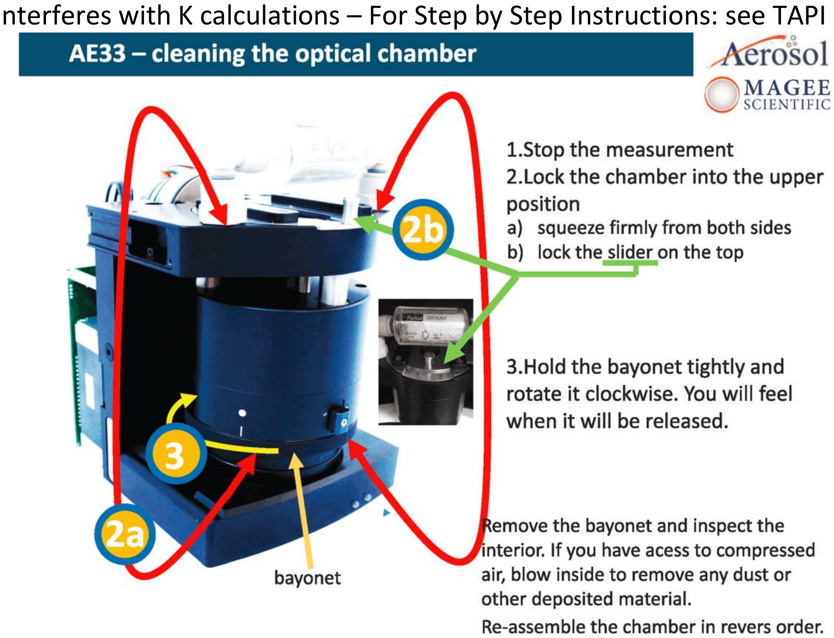
Example of AE33 / 633 Flow Verification result.
Fin" is external flow measurement (at the inlet)
F1" is flow for sensor 1 (higher loading)
Fc" is total ("control") flow, or "Flow 3" – controls the pump
Flow reporting standard: EPA 101325 Pa 25 °C
Fin F1 (%) Fc (%)
736 746 (101) 742 (101)
2470 2394 (97) 2387 (97)
4120 4190 (102) 4190 (102)

Explaining F1 and Fc: instrument flow diagram



=1 for flow cal (adjustable - sets F2/F1 ratio)
Note location of F1 and Fc flowmeters (in series for flow cal) - red circles
Fc is controlled to total flow set point
Spot 2 (Sensor 2) flow not measured directly (only used for K calc)

4. TAPE CHANGE. When you do a Tape change, then perform an Optical Chamber Clean according to the Magee Scientific Manual. (Or AS NEEDED).
About Every 3 months months
AE33 / 633 Optical Chamber Cleaning - Easy, Important - AE33 is more sensitive to “stuff” in chamber
Interferes with K calculations – For Step by Step Instructions: see TAPI 633 Manual, section 5.6



Aethalometer Model 633 QC Check Data Sheet

Station #
Location:
Sampler #

Date: ______________
Time: ______________
Operator: ______________

Instrument S/N: ______________

Flow Standard Serial # ______________

- Certification Date: ______________

QC Check

1. Perform the leak verification prior to the flow verification.
2. Set any Temperature inputs to 25 degrees C.

Leak Verification:

Selected Flow		ml/m
Flow through tape		ml/m
Flow through calibration pad		ml/m
Instrument Leak is		%

7% leak is normal. Leak Action is >10%.

Manual Flow Verification:

Pressure	Temp	Fin	F1	%	F2	%
1013	25					
1013	25					
1013	25					

Normal Flow % is 95-105%. Flow Action is <95 or >105. Flow Invalidation is <90 or >110.

As Needed:

1. Assess the status of the tape and the spots on the tape.
2. If the tape needs to be changed, then perform both an Optics Clean procedure, and a Tape Change procedure.
3. The tape will need to be changed about once every quarter.

Notes:

PSCAA Tech Services Form 62-128 wjz 3/23/16 (3).docx 62-128_Aeth 633 Monthly Quality Control Check

F. AE-51 Micro Aeth Quick Start Guide

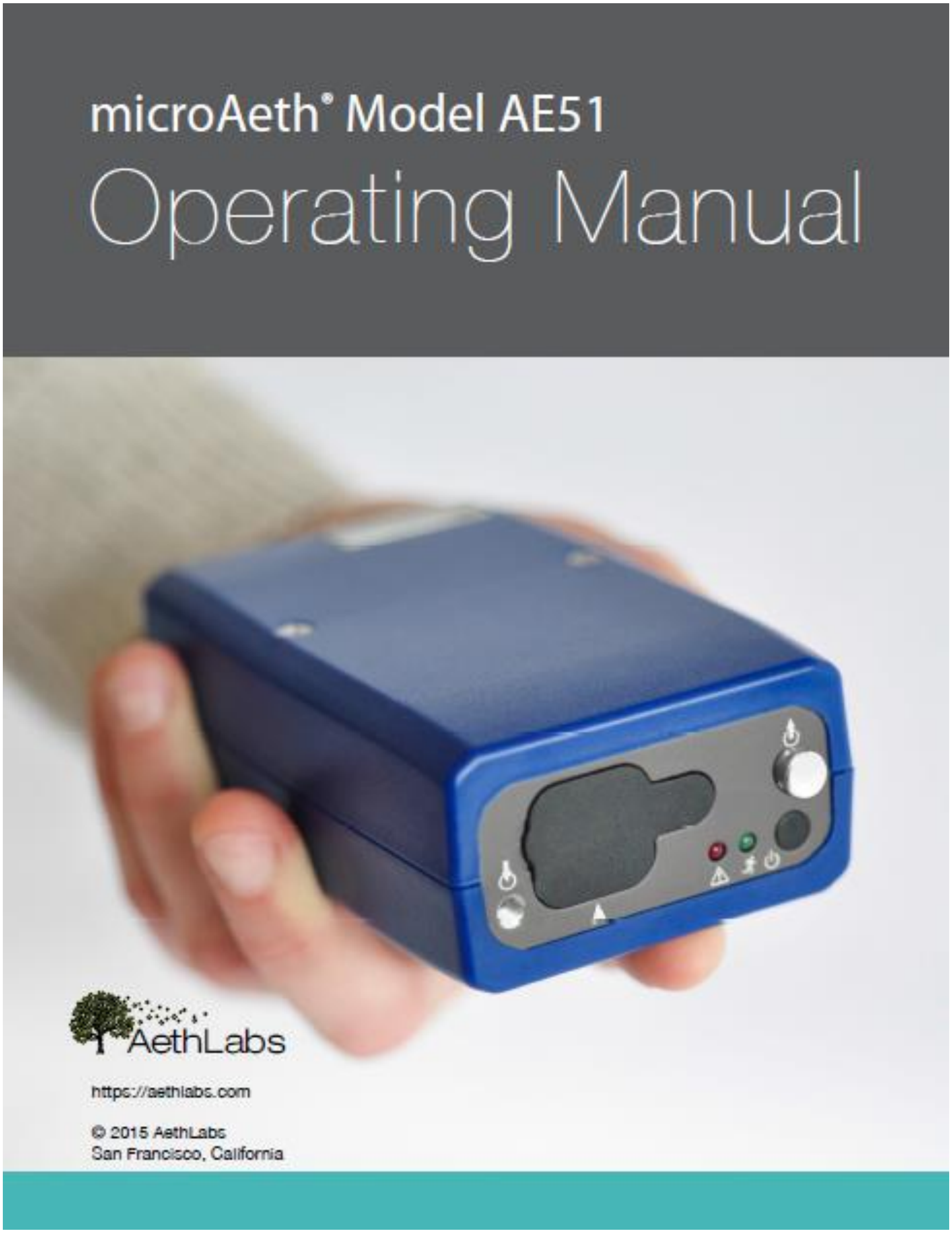


TABLE OF CONTENTS

1. INTRODUCTION

1.1 Serial Number

The model and serial number are located on the back panel. Record the serial number in the space provided below. Refer to these numbers whenever you call for service.

Model No.: microAeth® Model AE51
Serial number: AE51-S__-_____-_____

1.2 Overview

Real-time Aerosol Black Carbon Personal Exposure Measurement Device

- Pocket-size, lightweight Aethalometer (250 g)
- Fast response: 1 second measurement timebase
- Low power consumption: 24 hour run time on one charge
- Onboard data processing, logging and diagnostics
- Flexible sampling options and wide dynamic range
- Filter strips for accurate sample tracking

The microAeth Model AE51 is designed specifically for investigation of personal exposure to carbonaceous particles found in ambient air. The instrument is based on Aethalometer technology that is widely used for studying indoor or outdoor air quality, and for the mobile mapping of the air quality impacts of localized sources. The instrument provides high quality, short time resolved data essential for assessing the real-time concentration of Black Carbon aerosols in a micro-environment.

The package includes:

- microAeth Model AE51 Personal Exposure Monitor
- Self-powered, LED source (880nm-IR), user-selectable measurement timebase settings of 1, 10, 30, 60, 300 seconds, flow rate settings of 50, 100, 150, 200 ml/min with internal active mass flow measurement and control
- Sample collected and analyzed on a filter strip consisting of a T60 Teflon coated borosilicate glass fiber media housed in a protective casing
- USB-based power charger with AC adapter (100-500mA) for internal 5VDC lithium ion battery.
- USB charging / interconnect cable
- Flexible conductive sample tubing (40 inches) with swivel tube connector
- Pack of 5 sample filter strips
- CD containing
  - microAethCOM communications software and USB driver
  - Operating Manual
- Quick Start Guide (hard copy)

For further information on this instrument or Black Carbon measurement, please contact:

AethLabs
San Francisco, California
https://aethlabs.com

1.3 Instrument Diagram

Figure 2: Filter strip slot

Figure 1: microAeth front panel

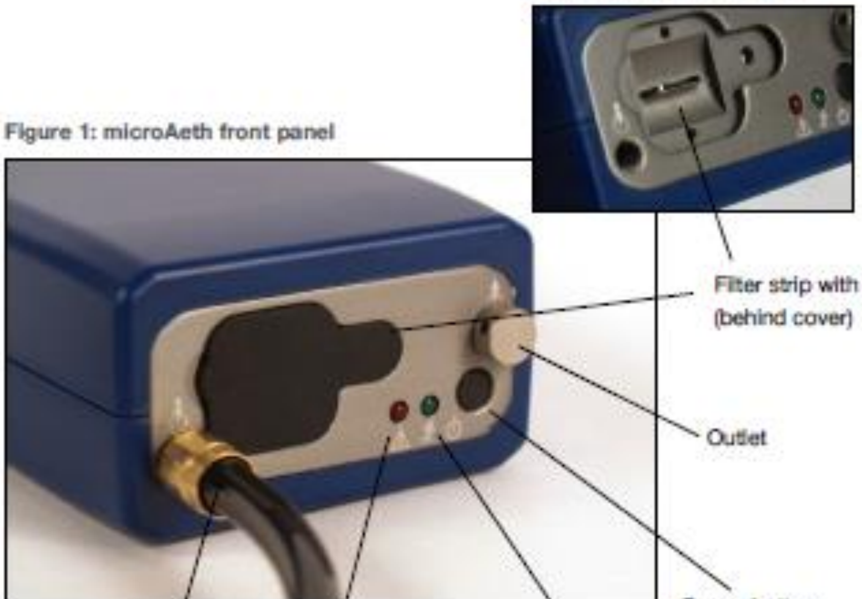


Figure 3: microAeth rear panel

1.4 Technical Specifications

Measurement Principle
Real-time analysis by measuring the rate of change in absorption of transmitted light due to continuous collection of aerosol deposit on filter. Measurement at 880 nm interpreted as concentration of Black Carbon ("BC").

Measurement Range
0-1 mg BC/m³, filter life time dependent on concentration and flow rate setting:
avg. 5 µg BC/m³ for 24 hours @ 100 ml/min
avg. 100 µg BC/m³ for 3 hours @ 50 ml/min
avg. 1 mg BC/m³ for 15 minutes @ 50 ml/min

Measurement Resolution
0.001 µg BC/m³

Measurement Precision
±0.1 µg BC/m³, 1 min avg., 150 ml/min flow rate

Measurement Timebase (User setting)
1, 10, 30, 60, or 300 seconds

Flow Rate (User setting)
Internal pump provides 50, 100, 150, or 200 ml/min, monitored by mass flow meter and stabilized by closed-loop control.

Sampling
3 mm spot created on filter strip containing insert of T60 Teflon-coated borosilicate glass fiber filter material. PM2.5 size selective inlet available.

Consumables
Filter strip: 1 filter strip per sampling event, typically one per day. High concentration sampling may require more than one filter per day.

Data Storage
4 MB internal flash memory, providing up to 1 month data storage when operating on a 300 second timebase, and 1 week when operating on a 60 second timebase.

Communications
USB connectivity to Windows®-based PC with microAethCOM.

Data Output
Internal data files are uploaded to microAethCOM PC software and stored on local disk.

PC Software
microAethCOM software is included. Provides visual interface including real-time BC mass concentration values. Facilitates settings configuration, calibration routines, downloading data, and uploading new instrument firmware.

Dimensions
4.6 in (117 mm) L x 2.6 in (66 mm) W x 1.5 in (38 mm) D

Weight
Approximately 0.62 lbs (280 g).

Power
Internal rechargeable lithium-ion battery.

Power Supply Adapter
Input: 100~240 VAC 50/60 Hz 0.2 A
Output: 5VDC / 0.5A

Charging Time
4 hours to full charge (using AC adapter, instrument turned off).

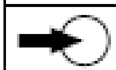
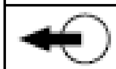
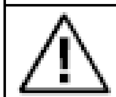
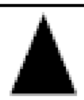
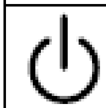
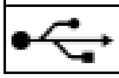
Total Run Time (Single battery charge)
Minimum 24 hours @ 300 second timebase at 100 ml/min flow rate. Run time may vary due to PM concentrations.

Operation Environment
0 ~ 40 °C operating, non-condensing.

Specifications are subject to change without notice.

1.5 Symbols and Cautions

1.5.1 Explanation Operation Symbols

	Operation indicator
	Charging indicator
	Aerosol inlet
	Aerosol outlet
	System alert indicator
	Filter strip orientation arrow (point indicates orientation of upstream face of filter strip)
	On/Off
	USB port

1.5.2 Important Safeguards

Please read these safety instructions completely before operating the instrument, and keep this manual for future reference. Carefully observe all warnings, precautions and instructions on the instrument, or as described in the operating manual and product literature.

Do not expose the microAeth or its batteries to sources of excessive heat such as sunshine or fire.

1.5.2.1 Power Source

The microAeth should be operated only from the type of power source indicated in the instrument specifications. If you are not sure of the type of electrical power supplied to your home, consult your dealer or local power company. For those devices designed to operate from battery power, or other sources, refer to the operating instructions. Also, the connections on both ends of the USB interface cable are designed to be inserted into the AC power/charger adapter or the microAeth only one way. These are safety features. If you are unable to insert the AC plug fully into the outlet, try reversing the plug. If the plug should still fail to fit, contact AethLabs.

1.5.2.2 Object and Liquid Entry

Never push objects of any kind into the AC power/charger adapter or into the microAeth (except for the filter ticket) through openings as they may touch dangerous voltage points or short out parts that could result in a fire or electric shock. Never spill liquid of any kind on the microAeth or its electrical accessories. This instrument should not be exposed to rain or moisture, and objects filled with liquids, such as vases, should not be placed on this instrument.

1.5.2.3 Accessories

Do not use accessories not recommended by the manufacturer, as they may cause hazards.

1.5.2.4 Servicing

Use extra care when servicing the instrument yourself as opening or removing covers exposes sensitive internal hardware to potential damage. Refer to all service documentation and trained, authorized service personnel for assistance.

1.5.2.5 Replacement Parts

Only genuine AethLabs parts should be used in the microAeth. Only trained, authorized service personnel should make repairs or install replacement parts.

Lithium-Ion batteries are recyclable and should be disposed of properly. **Caution:** Do not handle damaged or leaking Lithium-Ion batteries.

2. CONFIGURATION AND OPERATION

2.1 Overview

The AethLabs microAeth® Model AE51 is a high sensitivity, miniature, portable instrument designed for measuring the optically-absorbing Black Carbon ('BC') component of aerosol particles. The instrument is based on the well-established Aethalometer principle used for over 30 years in laboratory-sized analyzers.

The microAeth draws an air sample at a flow rate of 50, 100, 150 or 200 ml/min through a 3 mm diameter portion of filter media. Optical transmission through the 'Sensing' spot is measured by a stabilized 880 nm LED light source and photo diode detector. The absorbance ('Attenuation, ATN') of the spot is measured relative to an adjacent 'Reference' portion of the filter once per timebase period. The gradual accumulation of optically-absorbing particles leads to a gradual increase in ATN from one period to the next. The air flow rate through the spot is measured by a mass flow sensor which is also used to stabilize the pump. The electronics and microprocessor measure and store the data each period to determine the increment during each timebase. This is then converted to a mass concentration of BC expressed in nanograms per cubic meter (ng/m^3) using the known optical absorbance per unit mass of Black Carbon material.

The instrument's operating parameters are set up by an external software application (microAethCOM) and uploaded to the microAeth by a USB interface cable. Operation is completely automatic after the instrument is switched on. During operation, the microprocessor performs the optical measurements, measures and stabilizes the air flow, calculates the BC mass concentration and records data to internal non-volatile memory. The data may be downloaded at a later time by the same external software package.

The microAeth derives its power from an internal rechargeable battery. The same USB interface cable serves to recharge the battery from either the USB port of a connected external computer, or an AC power supply. The instrument will operate for 6 to 24 hours on a single charge, depending on operational settings.

2.2 Recommendations for Best Use Practices

The small size and light weight of the microAeth® Model AE51 allow it to be used to gather data in a wide range of operational scenarios, not always possible using larger instruments. Optimization of performance across this breadth of applications requires an understanding of operational settings, precautions, and maintenance procedures. The following recommendations provide general guidelines.

2.2.1 Instrument Settings: Measurement Timebase and Flow Rate

In order to get the best data from the microAeth for the sampling campaign, we highly recommend that the **instrument warm up for approximately 10-15 minutes** so that it can equilibrate to its environment. The microAeth can aquire data on five timebase settings: 1, 10, 30, 60, and 300 seconds. The 1 second timebase should only be used under special circumstances where a decreased signal-to-noise ratio is acceptable. At this setting, instrumental noise is larger and typically requires post-processing. The microAeth pump can operate at four sampling flow rate settings: 50, 100, 150, and 200 ml/min. The choice of these parameters affects the operation and data as follows.

Battery Run Time on Single Charge: Affected by flow rate and timebase.

NOTE: Battery life will gradually diminish after many cycles (~ 1 year of use). The following are approximate runtimes which can vary based on individual microAeth instruments and specific environments.

	50 ml/min	100 ml/min	150 ml/min	200 ml/min
1 second	> 21 hours	> 18 hours	> 14 hours	> 12 hours
10 seconds	> 21 hours	> 19 hours	> 15 hours	> 12 hours
30 seconds	> 23 hours	> 19 hours	> 15 hours	> 13 hours
60 seconds	> 28 hours	> 24 hours	> 20 hours	> 15 hours
300 seconds	> 30 hours	> 24 hours	> 21 hours	> 15 hours

Individual Data Point Noise: At 150 ml/min, primarily affected by timebase setting.

1 second	60 seconds	300 seconds
< 5 ug/m³	< 0.1 ug/m³	< 0.05 ug/m³

Effects of Contamination, Vibration, and Impact: Primarily affected by timebase setting.

1 second	10 seconds	30 seconds	60 seconds	300 seconds
very large	large	moderate	moderate	least effect

2.2.2 Recommended Settings of microAeth® Model AE51 for Different Scenarios

Different Black Carbon measurement scenarios require different operational settings for optimum performance. The 1 second timebase setting is a 'Data Acquisition Mode' intended for subsequent processing, and should NOT be used for routine monitoring. Data collected on a 1 second timebase should always be smoothed or averaged over longer periods, in order to optimize the signal-to-noise ratio at the desired time resolution.

	Longest ←	Filter Life		→ Shortest
	50 ml/min	**100 ml/min**	**150 ml/min**	**200 ml/min**
1 s	'Data Acquisition Mode' for immediate emissions and impacts at high concentrations.	'Data Acquisition Mode' for emissions and impacts in typical urban and traffic environments.	'Data Acquisition Mode' for higher time resolution at lower BC concentrations.	'Data Acquisition Mode' for higher time resolution at lower BC concentrations or shorter sampling durations.
10 s	Traffic and transporation impacts in high BC concentrations.	Traffic and transporation impacts.	Traffic and transporation impacts at lower BC concentrations.	Traffic and transporation impacts at lower BC concentrations.
30 s	Personal Exposure Monitoring in high BC concentrations. Occupational Exposure.	Recommended Setting for General Applications. Personal Exposure Monitoring. Traffic impact. High time resolution ambient monitoring.	Personal Exposure Monitoring. Traffic impact. High time resolution ambient monitoring.	Personal Exposure Monitoring. Traffic impact. Ambient monitoring. Higher sensitivity for low BC concentrations.
60 s	Personal Exposure Monitoring. Occupational Exposure. High BC concentrations.	Personal Exposure Monitoring. Indoor Air Quality.	Personal Exposure Monitoring. Indoor Air Quality. Low BC concentration.	Personal Exposure Monitoring. Higher sensitivity for low BC concentrations.
300 s	Epidemiology. Area monitoring. Indoor air quality. High BC concentration.	Epidemiology. Area monitoring. Indoor air quality.	Epidemiology. Area monitoring. Indoor air quality. Low BC concentration.	Epidemiology. Area monitoring. Indoor air quality. Lowest BC concentration. Lowest data noise.

2.2.3 Contamination, Maintenance & Cleaning of Sample Chamber

If a loose particle of contamination enters the microAeth's sample chamber or the instrument experiences vibration or impact, the data will be degraded. Shaking or tapping a "dirty" instrument will create data excursions that are far larger than those of a "clean" unit. These effects are amplified greatly at the shorter timebase settings. Our recommendations for cleaning are based upon the likelihood of contamination and the nature of use.

Contamination Probability for Various Use Scenarios

Sampling Scenario	Contamination Probability
Dry, dusty environment	High
Occupational settings with combustion exhaust	High
Exposure to "oily" smokes such as biomass-burning plumes, 2-cycle engine exhaust	High
Presence of suspended fluff, fibers, pollen	High
Immediate vicinity of traffic and roadways	Medium
Outdoor urban environments	Medium
Outdoor rural environments (without dust, fluff, pollen)	Low
Residential indoor environments	Low

Recommended Hours of Operation Between Cleaning & Maintenance

Sampling Scenario	Contamination Probability		
	High	**Medium**	**Low**
Mobile sampling with impacts: on person or in vehicle	100	200	400
Mobile sampling on cushioned support	150	300	500
Stationary sampling, relocated during operation	500	800	1200
Stationary sampling, not moved during operation	800	1200	2000

NOTE: If a microCyclone™ is being used with your microAeth, please clean it on a frequent basis, depending on sampling environment and concentrations.

2.3 Filter Media

IMPORTANT NOTE:

- **Always make sure that a filter strip is installed in the microAeth when it is operating.**
- **Whenever the filter strip is exchanged, the microAeth should be turned off to prevent dust or debris from being drawn into the inlet and analysis chamber.**

2.3.1 General

The sample collection and analysis is performed on a filter strip, consisting of a small section of filter material held between and supported by a specially designed filter holder to create the filter strip assembly. As the aerosol sample is drawn through the filter media by the instrument's integrated, internal sample pump, the aerosol sample collects gradually on the filter medium to create a gray spot 3 mm in diameter. The microAeth determines the attenuation of the source light as the accumulated black carbon increases the optical density of the filter spot. After the optical density reaches a certain level, the filter strip must be replaced to maintain measurement integrity.

To maintain a leak-free sample path, the filter strip is clamped between two halves of the spring-loaded sampling head. A release button opens the clamp to allow the filter strip to be inserted and removed. A locating pin in the head engages in a matching hole in the filter strip holder to ensure correct placement.

2.3.2 Filter Strip Installation and Removal

1. The sample deposit side of the filter strip is the white side. When the filter strip is installed in the sample chamber, the white side of the filter strip should be facing the same direction as indicated by the white arrow on the faceplate of the microAeth.

Figure 5: Top of microAeth

Figure 6: Bottom of microAeth with filter strip release button.

Figure 7: White sample deposit side of filter strip faces the top.

Figure 8: Metal side of filter strip faces the bottom.

2. Hold the microAeth in one hand so that the filter chamber release button is on the bottom of the enclosure (Figure 9) (all of the icons will be right side up).

3. Loosen the rubber cover on the front of the microAeth by pulling the tab away from the instrument. This will expose the filter strip slot.

Figure 9: Inserting and removing filter strip while depressing filter release button on bottom of microAeth.

4. If there is a filter strip already installed, depress the release button with your thumb and pull the filter strip out of the sampling head.

5. Install a new filter strip by pressing and holding the release button and then inserting the new filter strip into the sample chamber opening with the white plastic side facing up (Figure 9).

6. Make sure to push the new filter strip all the way into the slot and that the locating pinhole on the filter strip is not visible.

7. Release the release button and verify the locating pin has registered properly in the filter strip locating hole.

8. Replace the rubber cover. A tight fit is essential to prevent the entry of contamination and stray light into the sample chamber.

2.4 Power

The power switch is located on the front panel of the instrument. There are two options for recharging:

- USB to PC-USB port (500mA): 4 hours to full charge
- USB to AC-USB wall adapter (500mA): 4 hours to full charge.

The instrument uses a USB-based power charger (100-500mA) for internal 5VDC lithium ion battery. The yellow charging light illuminates when the microAeth is connected to an external power source and is recharging the battery. When the battery is fully charged, the yellow light turns off.

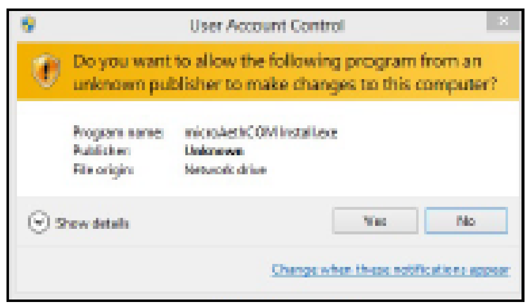
2.5 microAethCOM PC Software Installation

The microAethCOM software application is designed to install and operate on a PC using Windows® XP with Service Pack 3, Windows® 7, and Windows® 8. All software components are included in the installer named microAethCOM Install.exe which is located on the CD included with the microAeth or can be downloaded from the AethLabs website. This installer will install the microAethCOM, manual flow calibration software and the firmware file.

1. Do not connect the microAeth to the USB port on the computer until the software installation is complete.

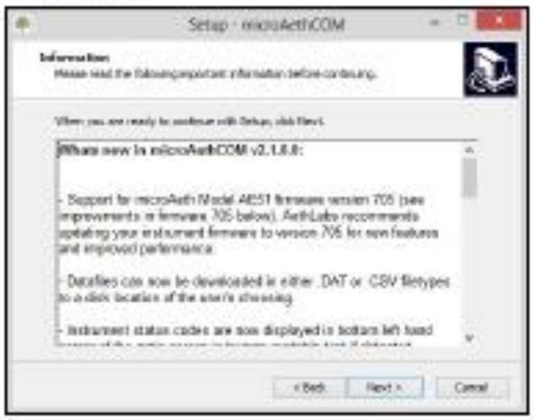
2. Make sure that you have the necessary user privileges on your computer to install software.

3. Locate and double click microAethCOM Install.exe to start the install. The installer will prompt you through the setup.

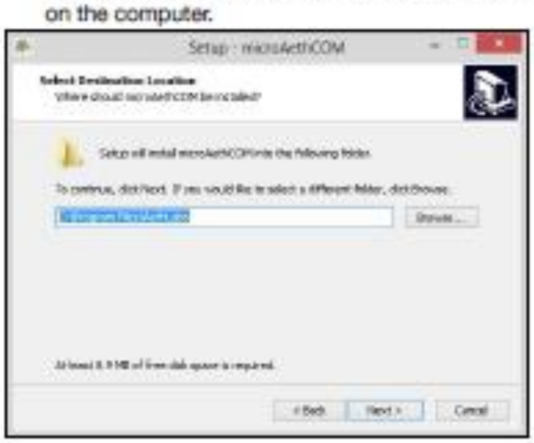


4. In order to install the microAethCOM software, please read and accept the license agreement.

5. Please review changes to microAethCOM and firmware.



6. Select the directory location where microAethCOM, manual flow calibration software and the firmware file should be installed on the computer.



7. The communication drivers will need to be installed next. The installer will prompt you through this section of the setup.

8. Once all the correct drivers are installed, the setup will be complete.

2.6 Operation and Communication

Before starting a sampling run, it is recommended that the user verify all parameter settings. A description of each operating parameter and its configuration is described in section 2.6.2 Configuration of Instrument Operating Parameters.

The microAeth startup sequence automatically begins when the power is turned on. Sampling and data collection begin starting the next minute after the startup process is complete. A new measurement data file is created for the new sampling session. The microAeth will continue sampling and storing data until the instrument is shutdown. At shutdown, the data file is closed. Any active sampling session and data file will also be closed if data is downloaded or erased or if settings are saved to the microAeth. In order to start a new sampling session, the microAeth must be restarted.

Status indicator lights located on each end panel of the microAeth provide information regarding the instrument operating status. Please read section 2.6.8.1 LED Status Indications for more information.

2.6.1 microAeth Operation

IMPORTANT NOTE:

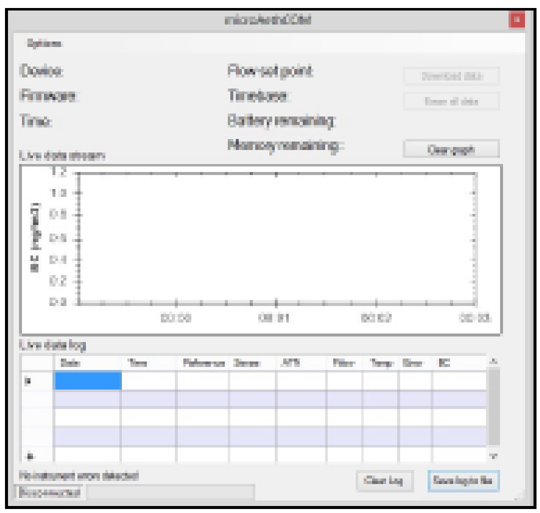
- **Always make sure that a filter strip is installed in the microAeth when it is operating.**
- **Whenever the filter strip is exchanged, the microAeth should be turned off to prevent dust or debris from being drawn into the inlet and analysis chamber.**
- **A new sampling session and data file is created each time the microAeth is turned on and completes the automatic startup sequence.**
- **Any active sampling session and data file will be closed if the microAeth is shutdown, data is downloaded or erased, or if settings are saved to the microAeth. In order to start a new sampling session, the microAeth must be restarted.**

1. Make sure that a filter strip is installed in the microAeth. Turn on the microAeth by depressing the power button for 4 seconds until the microAeth beeps for the second time and the red and green LEDs illuminate together.

2. Release the power button and wait for a few seconds. The pump will turn on and the LEDs will then begin to blink on and off in unison about every second until the beginning of the next minute. When the LEDs stop blinking, the instrument will chirp indicating the start of data collection.

3. While the unit is operating, the green LED will blink periodically. If the unit is set to store data to its internal memory, the green LED will emit single blinks every few seconds. If it has been set to store data internally and stream data, the green LED will blink twice every few seconds.

4. Start the microAethCOM software.

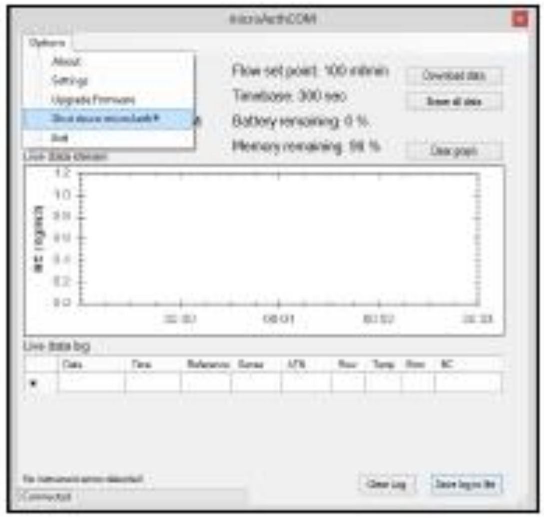


5. Connect the USB cable to the microAeth and your computer.

6. After the microAeth establishes communication with the microAethCOM software, the connection status in the bottom left corner of the main screen will change to Connected and the microAeth serial number, status, and settings will be displayed.

7. If the serial number, status, and settings are not displayed, disconnect the USB cable and reinsert it.

8. To shut down the microAeth through the microAethCOM software, click Options then Shut down microAeth. Depending on the current settings of the microAeth, the power button on the front of the instrument can be used to shut down the instrument.



2.6.2 Configuration of Instrument Operating Parameters

IMPORTANT NOTE:

- **The microAeth will not collect data with new saved settings until it has been restarted.**

All instrument parameters are configured through the microAethCOM user interface. The various parameters are accessed through Settings in the Options menu on the tool bar.

1. Turn on the microAeth.

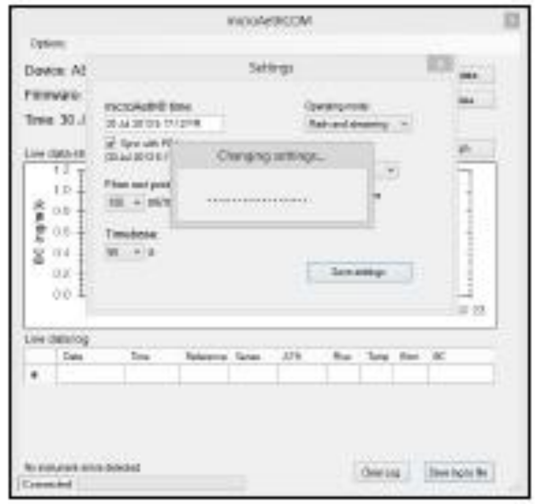
2. Start the microAethCOM software.

3. Connect the USB cable to the microAeth and the computer. Wait until the microAeth establishes communication with microAethCOM.

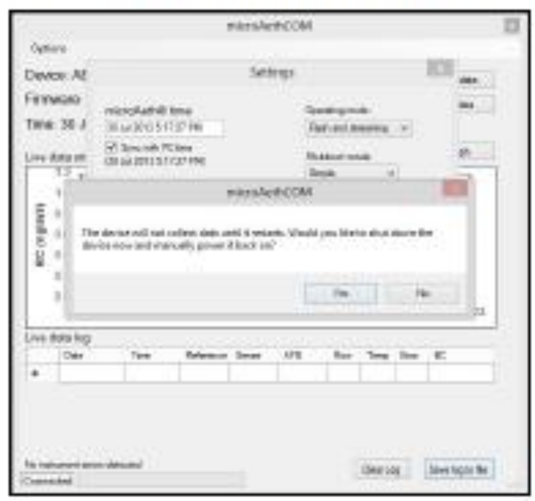
4. Click Options then Settings

5. On the Settings screen, the microAeth can be configured.

6. When all settings are selected as desired, click the Save settings button.



7. Once the settings have been saved, you will be prompted to shut down the microAeth. **The microAeth will not collect data with the new saved settings until it has been restarted.**



2.6.2.1 microAeth Time & Time Sync

The time on the microAeth is displayed. In order to sync the time on the microAeth with the PC time, click the Sync with PC time check box.

It is very important to confirm the date and time of the PC prior to synchronizing to the microAeth. Once confirmed, it is good operating practice to always synchronize the date and time when configuring the microAeth before starting a new sample session.

2.6.2.2 Flow Set Point

The flow set point permits the user to select a flow rate set point of 50, 100, 150, or 200 ml/min.

We recommend using lower flows in areas with high BC concentrations, and higher flow rates when maximum sensitivity is required in areas of low BC concentration. A lower flow rate should also be selected for longer run times and extended battery life. Please read section 2.2 Best Use Practices Recommendations for more information.

2.6.2.3 Timebase

The timebase permits the user to select an analysis timebase period of 1, 10, 30, 60, or 300 seconds.

We recommend 30 or 60 seconds for most 'human exposure' or 'ambient monitoring' use. Faster timebases will result in higher noise on each measurement point, and are most useful either for direct source monitoring (tailpipe analysis) or for other applications requiring extremely rapid data. A 300 second timebase can be used to extend battery life and run time. Please read section 2.2 Best Use Practices Recommendations for more information.

2.6.2.4 Operating Mode

The operating mode permits the user to configure data storage and streaming options.

- **Store to flash** saves data to the internal memory only.
- **Flash and streaming** saves data to the internal memory and outputs a continuous data stream through the USB port.

2.6.2.5 Shutdown Mode

The shutdown mode permits the user to configure how the instrument is shutdown.

- **Simple** mode will allow the microAeth to be shut down by depressing the power button for 3 seconds.
- **USB only** mode will only allow the microAeth to be shut down using the microAethCOM software.
- **Secure** mode will allow the microAeth to be shut down by pressing and releasing the power button three times in succession. The smoothly-timed sequence is coordinated by a simultaneous beep and blink of the red and green LED indicator lights.

  Each cycle of the Secure mode takes about 1 second as follows:

  1. Press and hold the power button.
  2. When you hear/see the first 'beep/blink' release the button quickly.
  3. When you hear/see the next 'beep/blink' quickly press and hold the power button.
  4. When you hear/see the next 'beep/blink' release the button quickly.
  5. When you hear/see the next 'beep/blink' quickly press and hold the power button.
  6. When you hear/see the next 'beep/blink' release the button quickly.
  7. The microAeth will then shut down.

2.6.2.6 Sound Notifications

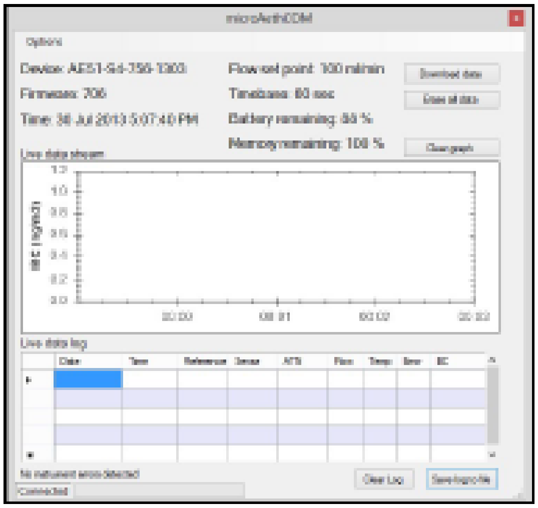
The sound notifications setting permits the user to select if the audible notifications issued by the microAeth are turned On or Off.

2.6.3 Downloading Data

1. Turn on the microAeth.

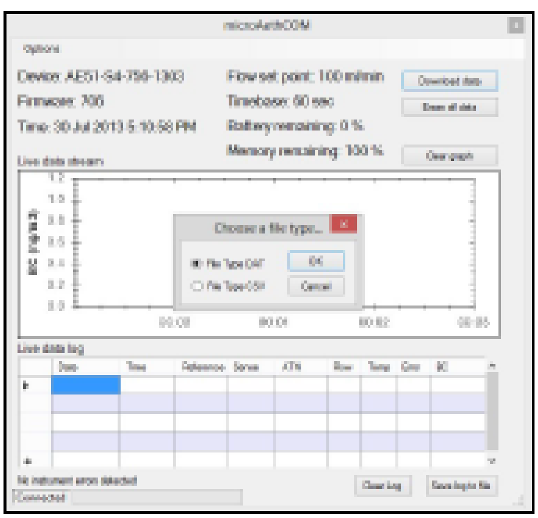
2. Start the microAethCOM software.

3. Connect the USB cable to the microAeth and the computer. Wait until the microAeth establishes communication with microAethCOM.

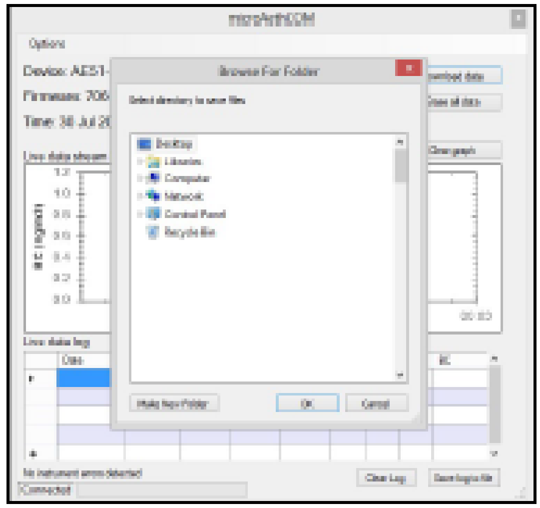


4. Click the Download data button to download the data stored on the internal memory of the microAeth.

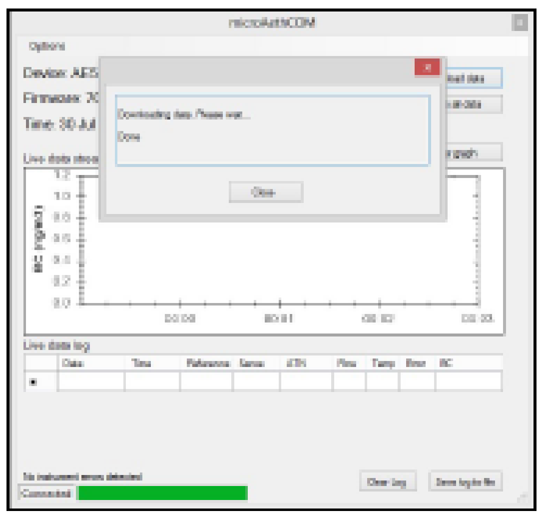
5. Select .DAT or .CSV data file type to download.



6. Select the directory to save the data. The data will be saved in a folder named **AE51-SX-XXX-YYMM** in this directory.

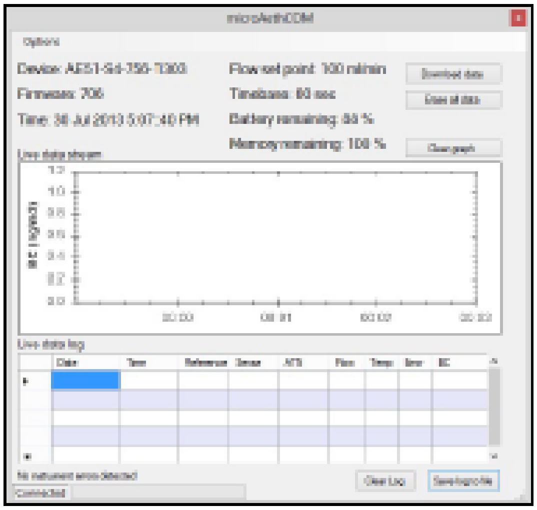


7. Wait until the download has completed. The progress bar in the bottom left corner of the main screen will show you the progress of the download. The status window will also inform you when the download is complete.

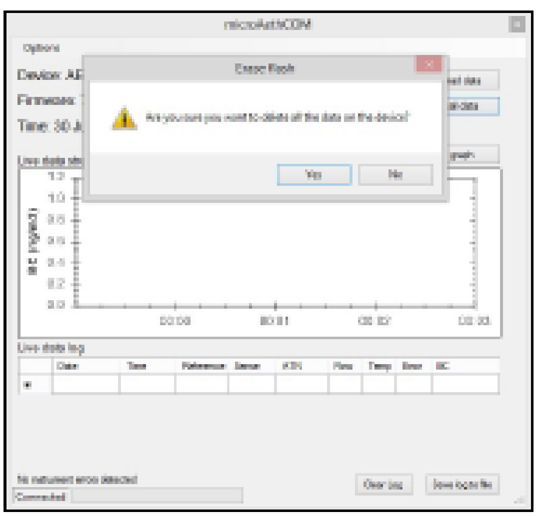


2.6.4 Erasing Data

1. Turn on the microAeth.
2. Start the microAethCOM software.
3. Connect the USB cable to the microAeth and the computer. Wait until the microAeth establishes communication with microAethCOM.



4. Click the Erase all data button to erase all the data stored on the internal memory of the microAeth.
5. You will be prompted to confirm to erase all the data stored on the microAeth.



6. Wait until the data erase has completed. The status window will show that the memory is being erased.

7. The status window will disappear when the memory has been erased.

2.6.5 Viewing and/or Analyzing Measurement Data

Data files are named using the following naming convention: AE51-SX-XXX-YYYYMMDD, where XXX is the instrument unique indentifer number. Data files are formatted such that they can be imported directly into Microsoft Excel® or can be uploaded to the AethLabs website. Please note that when opening data files in Microsoft Excel®, formatting may automatically be changed, making it difficult to upload to the website.

2.6.6 Data File Structure

The data files are plain text with the extension .dat or .csv. The file consists of a header containing descriptive information; a line identifying the columns; and then a number of data lines with each item separated by a semicolon or comma depending on the file format chosen at the time of download.

An example of the header is:

"Delimiter = ;"
AethLabs
Device ID = AE51-S4-558-1204
Application version = 2.2.4.0
Flow = 100 ml/min
Timebase = 60 s
Start date = 2015/05/07
Start time = 18:10:00
Original date format = yyyy/MM/dd
Original time format = hh:mm:ss
Flow units = ml/min
PCB temp units = deg C
Battery units = %
BC units = ng/m^3

Date;Time;Ref;Sen;ATN;Flow;PCB temp;Status;Battery;BC

The first line of data does not contain the final BC calculation; all subsequent lines show this expressed in units of ng/m³ of BC. A typical excerpt of data lines is shown below:

2015/05/07;18:10:00;922087;869206;5.906;100;30;0;74;
2015/05/07;18:11:00;922264;869322;5.912;100;30;0;74;332
2015/05/07;18:12:00;922279;869287;5.917;100;29;0;74;321
2015/05/07;18:13:00;922294;869215;5.927;100;29;0;74;563
2015/05/07;18:14:00;922301;869151;5.935;100;29;0;73;461
2015/05/07;18:15:00;922399;869175;5.943;100;29;0;73;447
2015/05/07;18:16:00;922409;869110;5.952;100;29;0;73;486
2015/05/07;18:17:00;922388;869037;5.958;100;28;0;73;348
2015/05/07;18:18:00;922336;868932;5.964;100;28;0;73;366
2015/05/07;18:19:00;922458;868999;5.970;100;28;0;73;313
2015/05/07;18:20:00;922424;868920;5.975;100;28;0;73;307

2.6.7 Status Indications

2.6.7.1 LED Status Indications

The microAeth has one yellow LED located on the rear panel that turns on when the microAeth is charging. The microAeth has two LED indicators, one green and one red, located on the front panel immediately to the left of the filter chamber. These lights indicate the instrument's current operating status. The green LED generally indicates that the instrument is functioning properly and is or is not collecting data. The red LED indicator generally indicates that the unit is not operating in a normal sampling state. The status indications signaled by the LEDs are given in the following table.

Run Modes		
Green	1 long blink & beep sound	Start of data storing to internal memory.
Green	1 blink every 3 sec	Acquiring data to internal memory.
Green	2 blinks every 3 sec	Acquiring data to internal memory and streaming.
Green	1 long blink every 1 or 5 min	Data write to internal memory (1, 5 min timebase).
Status Warnings during Run Modes (see above)		
Green indicates Run Mode (see above), Red indicates Warning (see below)		
Red	1 blinks every 1 sec	Warning - Change filter strip
Red	2 blinks every 1 sec	Warning - Battery low
Red	3 blinks every 1 sec	Warning - Flow error
Stop Modes		
Red & Green	synchronous 1 blink every 1 sec	Startup - Beeping, Not collecting data until ready. Idle - No Beeping, Not collecting data, Restart Req'd
Red Only	Repeat blink on/off sequence; on time is same as off time. Emits one series of 3 triple beeps.	Critical hardware error: • Main supply voltage too high or too low • Light source current too high or too low • Light source feedback circuit error.

2.6.7.2 Data File Status Codes

Reported Status Code in Data File	Reason / Indication
1	Battery Low
2	Flow out of range
4	Change filter ticket / Sense signal out of range
8	Optical signal feedback out of range
16	Power supply 5V out of range
32	LED current out of range
64	Flash memory full
128	Automatic shutdown occurred on configured schedule
0	OK - Instrument operating within specifications

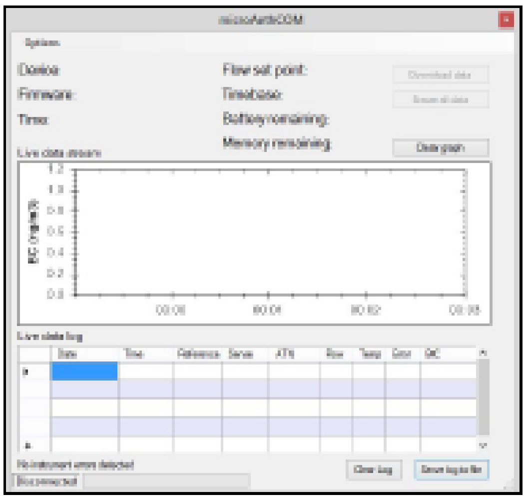
NOTE: If more than one status error code is active simultaneously, the resulting code written to the data file is the sum of the error codes shown in the table above. For example, if the battery is low (status code = 1) and the flow is out of range (status code = 2), the status code shown in the data file will be 3.

2.7 Upgrading microAeth Operating System Firmware

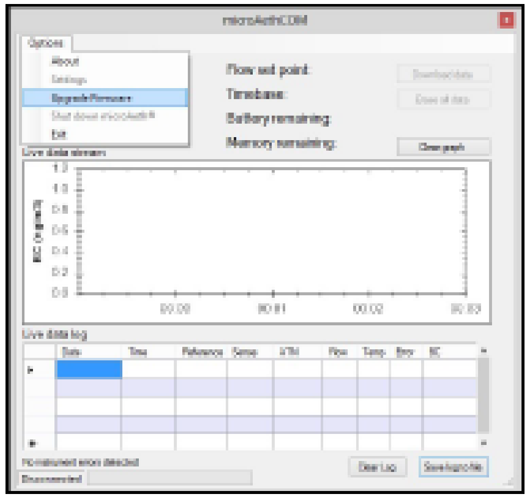
Before upgrading the microAeth operating system firmware, make sure that all data on the instrument has been downloaded. After the new firmware has been installed, the memory of the microAeth will need to be erased.

1. Start the microAethCOM software.

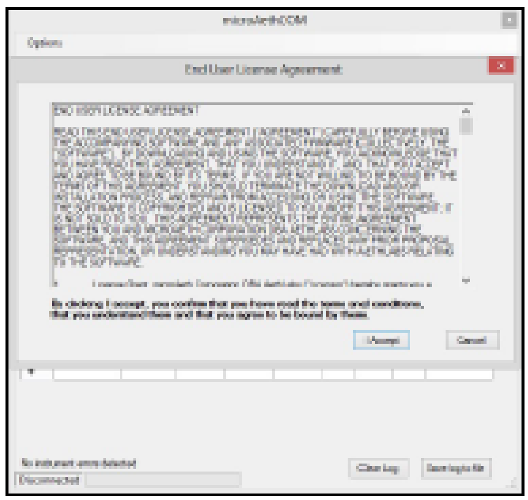
2. Connect the USB cable to the microAeth and the computer. **Do not turn on the microAeth.** The microAethCOM software will show that the microAeth is Disconnected.



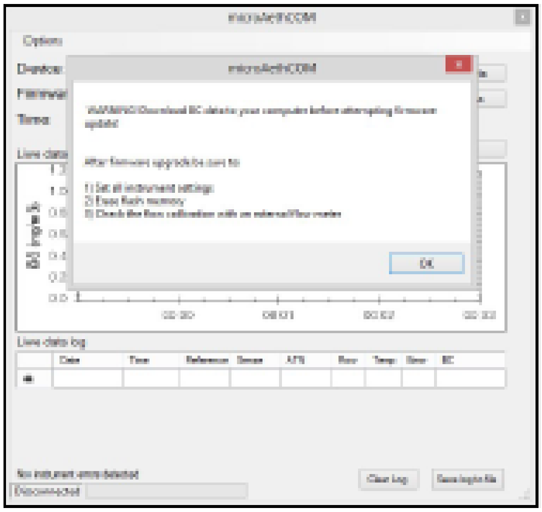
3. Click Options then Upgrade Firmware



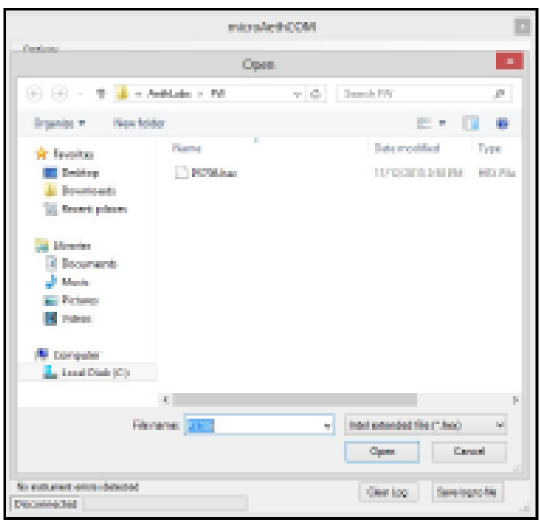
4. In order to install the firmware on the microAeth, please read and accept the license agreement.



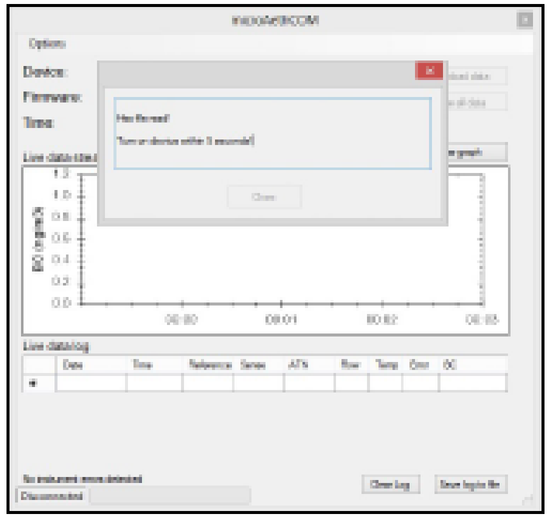
5. A warning window will appear to make sure that all data on the device has been downloaded and to inform the user of what should be completed after the upgrade.



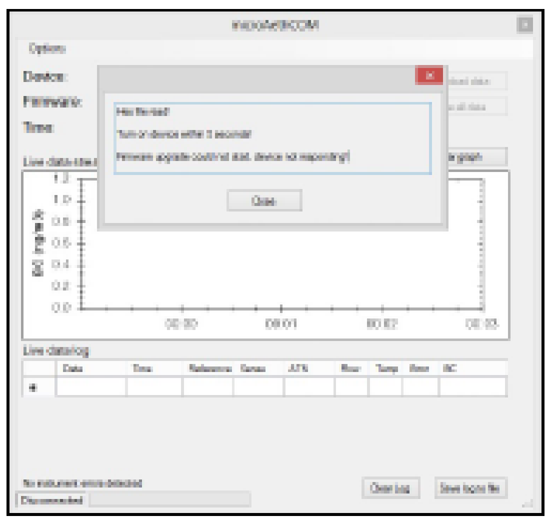
6. Select the hex file PSxxx.hex where xxx refers to the version number to install on the microAeth.



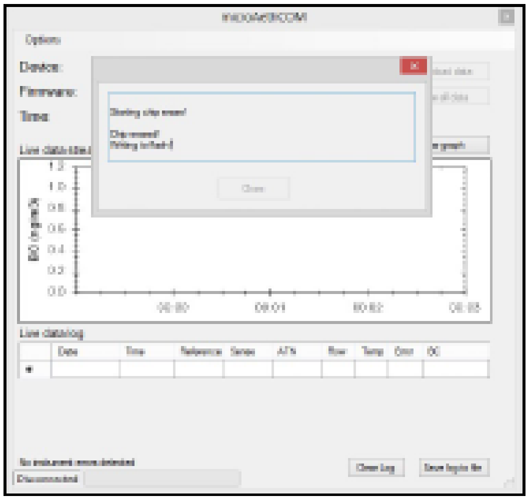
7. When prompted, turn on the microAeth within 5 seconds.



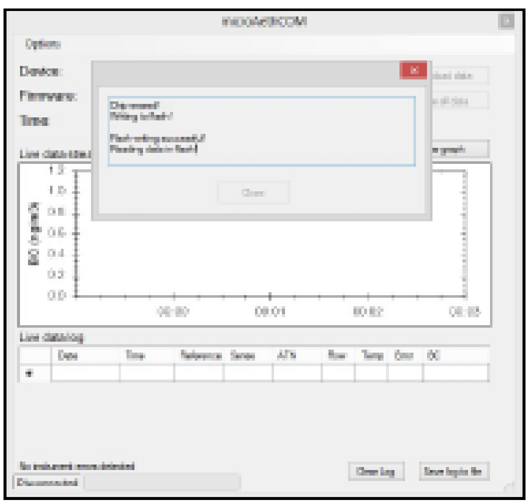
8. If the microAeth is not turned on within 5 seconds, the user will be told that the device did not respond. The user will have to close the window and start the firmware upgrade over again. If this occurs, go back to step 3.



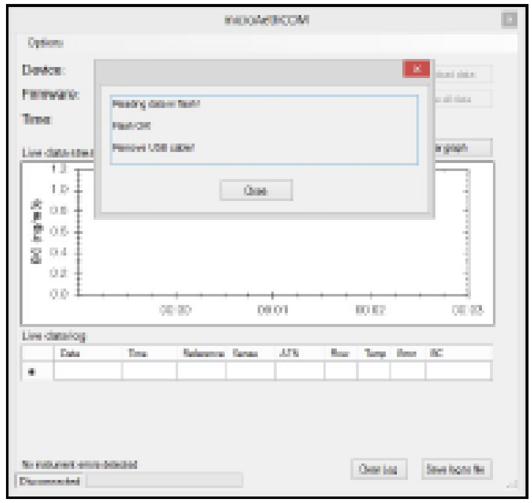
9. If the microAeth is turned on within 5 seconds, the firmware installation will begin. The memory will be erased and the new firmware will be written to memory.



10. Once the firmware has been installed, the microAethCOM software will check the memory for errors.



11. If no errors are found, the firmware installation will complete and the user will be prompted to unplug the microAeth.



12. After a successful firmware upgrade, the following should be completed before using the microAeth for a new sampling session:

- **Set all instrument settings.** Please read section 2.6.2 Configuration of Instrument Operating Parameters for more information.
- **Erase all data on flash memory.** Please read section 2.6.4 Erasing Data for more information.
- **Check the flow calibration with an external flowmeter.** Please read section 2.8 Flow Calibration Procedure for more information.

2.8 Manual Flow Calibration Procedure

In order to complete a manual flow calibration of the microAeth, you will need to use the AE51 FlowCal software. The installation of the microAethCOM PC software automatically installs the AE51 FlowCal software into the directory chosen by the user during the installation process. Please read section 2.5 microAethCOM PC Software for more information about the installation process.

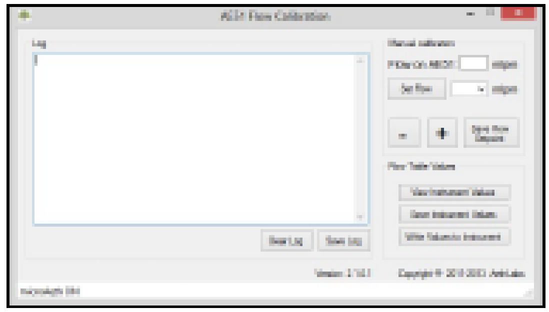
1. **Install a clean, unused filter strip into the microAeth.** Please read section 2.3.2 Filter Strip Installation and Removal for more information. **NOTE:** A pre-used filter strip with heavy loading may create an offset in the flow calibration table of the microAeth.

2. Connect the external flowmeter to the inlet of the microAeth.

3. Turn on the microAeth and the external flowmeter. Let the flowmeter stabilize for at least 10 minutes before use.

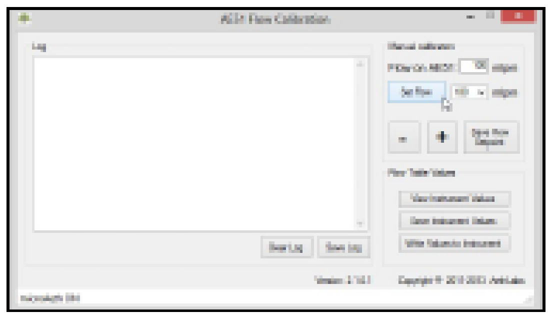
4. Start the AE51 FlowCal software.

5. Connect the USB cable to the microAeth and the computer. Wait until the microAeth establishes communication with AE51 FlowCal software. The status bar in the bottom left corner of the software will show the connection status of the microAeth and AE51 FlowCal software. If the status bar does not show microAeth ON status, check your connections and ensure that communication with the microAeth has been initiated as previously described and disconnect the USB cable from the computer and reinsert it.



6. Select the flow setpoint to calibrate from the dropdown menu in the Manual calibration section of the software. Then click the Set Flow button.

7. The flow rate of the microAeth will change and the text box to the right of Flow on AE51: should be populated with the desired flow setpoint.



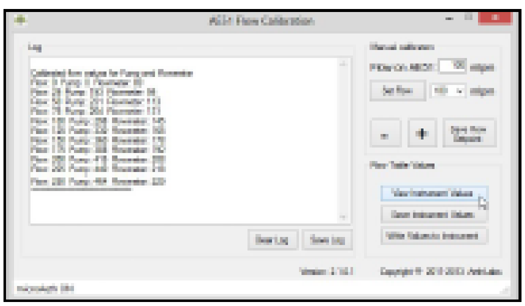
8. Use the + and - buttons to adjust the pump speed of the microAeth until the flow rate on the external flowmeter closely matches the selected flow setpoint in the software.

9. Then click the Save Flow Setpoint button to save the setpoint calibration in the microAeth flow calibration table stored in the instrument.

10. Repeat steps 6-9 for all flow setpoints in the dropdown menu in the Manual calibration section of the software.

    NOTE: If the internal pump of the microAeth cannot reach the highest flow rate setpoint, contact AethLabs for further assistance.

11. Click the View Instrument Values button. This will display all the values of the flow calibration table.



12. **Please check the values to make sure that as the flow setpoint increases from 0 to 250 ml/min, the pump drive and internal flowmeter values also increase.** If this is not the case, please try again to calibrate the microAeth. If this issue persists, please contact AethLabs for further assistance.

View Instrument Values
The View Instrument Values button requests the contents of the flow calibration table stored in the microAeth.

The flow calibration table shows the pump drive values and internal flowmeter values for the specified flow setpoints.

VERY IMPORTANT: As the flow setpoint increases from 0 to 250 ml/min, the pump drive and internal flowmeter values should increase. If this is not the case, please try again to calibrate the microAeth. If this issue persists, please contact AethLabs for further assistance.

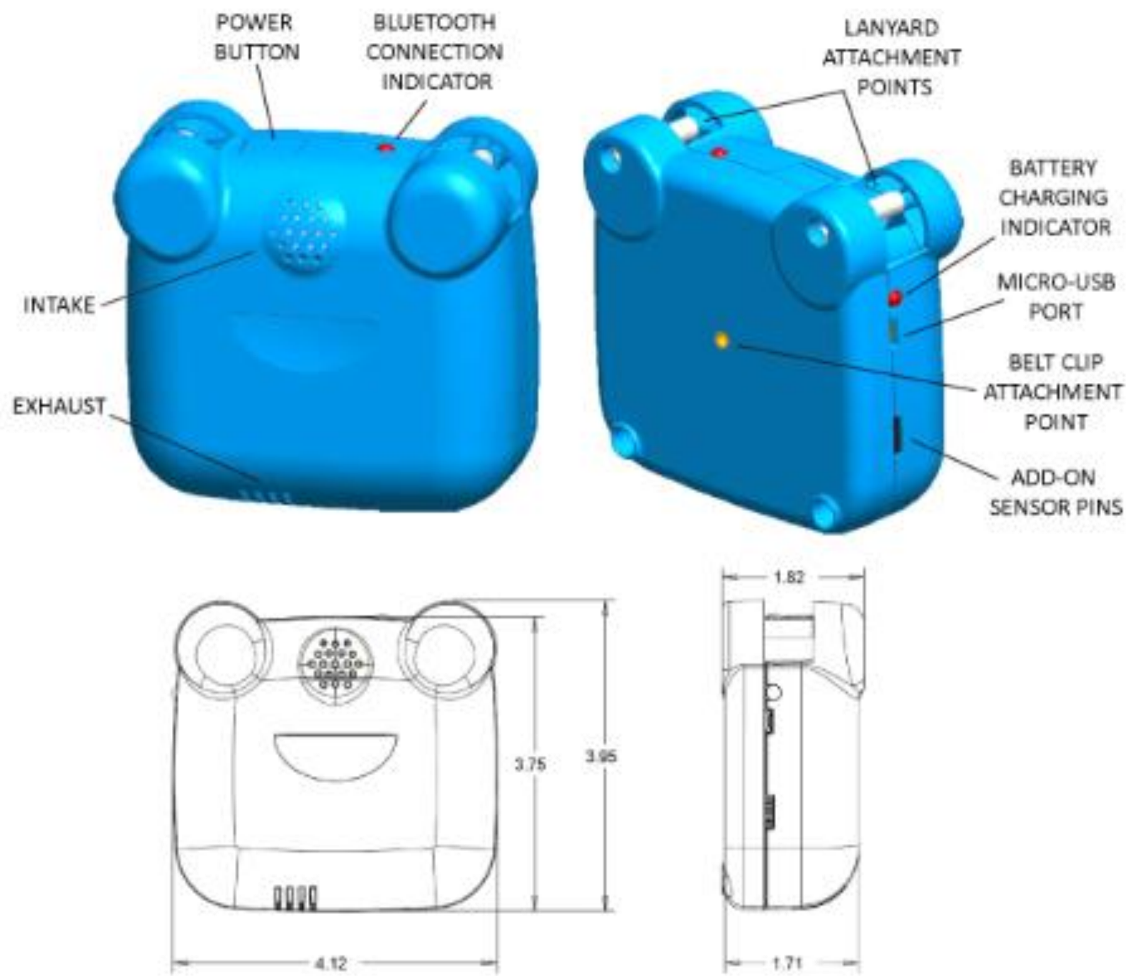
Save Instrument Values
The Save Instrument Values button will prompt the user to select a location to save the flow calibration table file.

The flow calibration table values will be read from the microAeth and saved to a selected location where it can be kept for archival purposes and comparison, or can be retrieved and uploaded to the microAeth at a later time.

Write Values to Instrument
The Write Values to Instrument button will prompt the user to select a previously saved flow calibration table file for upload to the microAeth.

G. AirBeam Operating Procedures

AirBeam Technical Specifications, Operation & Performance



<u>Hardware Specifications</u>

Weight: 7 ounces

Particle Sensor: Shinyei PPD60PV

Temperature & Relative Humidity Sensor: MaxDetect RH03

Bluetooth: Nova MDCS42, Version 2.1+EDR

Microcontroller: Atmel ATmega32U4

Bootloader: Arduino Leonardo

About the AirBeam

HabitatMap worked with a community of scientists, educators, engineers, and other non-profits to create the AirBeam. The AirBeam measures fine particulate matter (PM2.5), temperature, and relative humidity. The AirBeam uses a light scattering method to measure PM2.5. Air is drawn through a sensing chamber wherein light from an LED bulb scatters off particles in the airstream. This light scatter is registered by a detector and converted into a measurement that estimates the number of particles in the air. Via Bluetooth, these measurements are communicated approximately once a second to the AirCasting Android app, which maps and graphs the data in real time on your smartphone. At the end of each AirCasting session, the collected data is sent to the AirCasting website, where the data is crowdsourced with data from other AirCasters to generate heat maps indicating where PM2.5 concentrations are highest and lowest. As an open-source platform, modifying our components to take other measurements and or transmit the data to other websites or apps is easy and encouraged. We've even included *Add-on Sensor Pins* on the AirBeam to make adding sensors simple.

Power

The AirBeam has a 2000 mAh 3.7V rechargeable lithium battery. When the battery is fully charged, the AirBeam can operate for 10 hours. The battery charges via the micro-USB port, which can also be used to power the AirBeam directly. The *Battery Charging Indicator* turns solid green when the AirBeam is charging and turns off when the AirBeam is either fully charged or unplugged.

Power On/Off

To power on the AirBeam, press down on the *Power Button*. The AirBeam is on when the *Bluetooth Connection Indicator* blinks red. Push the *Power Button* a second time to power off the AirBeam.

Intake & Exhaust

While operating the AirBeam, be sure to keep the *Intake* and *Exhaust* free from obstructions.

Connect the AirBeam to the AirCasting Android App

Download the AirCasting app from the Google Play store. Launch the app, then navigate: menu button > "Settings" > "External devices" > "Pair with new devices" > "Search for Devices" > pair with the device labeled "AirBeam . . . " (note that you only need to pair once) > return button > press "AirBeam . . . " > press "Yes" when prompted to connect. The AirBeam is connected to the AirCasting Android app via Bluetooth when the *Bluetooth Connection Indicator* is solid red and the AirBeam sensor streams appear on the AirCasting App Sensors Dashboard.

Acquire AirBeam Data via Serial Monitor

You can acquire the AirBeam data via the *Micro-USB Port* or Bluetooth using a serial monitor.

Programming

The AirBeam board is based on the Arduino Leonardo, so you can reprogram your AirBeam using the Arduino IDE.

Add Another Sensor

You can add another sensor to the AirBeam using the *Add-on Sensor Port*. When the AirBeam is resting on it's back the five pins, from left to right, are: Ground, 5V, 3.3V, Analog 2, Analog 1. Note that you must insert a tiny screwdriver into the slot above the pin to release the pin.

Open Source

The AirBeam firmware and electronic schematics are available on GitHub. The STL files for 3D printing the AirBeam enclosure can be downloaded from Shapeways.

FCC Compliance Statement

This device complies with part 15 of the FCC Rules. Operating is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Caution: Modifying or tampering with internal components can cause a malfunction and will void FCC authorization to use these products.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the manufacturer's instructions, may cause interference harmful to radio communications. There is no guarantee, however, that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: reorient or relocate the receiving antenna; increase the separation between the equipment and receiver; connect the equipment to an outlet on a circuit different from that to which the receiver is connected; and/or consult the dealer or an experienced radio or TV technician for help.

Performance Data

The below claims and disclaimers are based on comparisons between the AirBeam, a Thermo Scientific pDR-1500 with a PM2.5 cut-point inlet, and teflon filter samples subjected to gravimetric analysis. The pDR-1500 is a $5,000, 2.5 lb air quality monitor frequently used by government and academic researchers to evaluate personal exposure to fine particulate matter or PM2.5. Teflon filter samples were taken with a Leland Legacy 10L pump and PM2.5 cut-point inlet and weighed at the NYU School of Medicine's filter weighing room, which meets EPA guidelines for filter conditioning, storage, and gravimetric measurement of PM2.5 and PM10 filters. Filters subjected to gravimetric analysis are the "gold standard" for measuring PM2.5. Additional research is required to fully characterize the performance of the AirBeam and we look forward to working with the AirCasting community to "fill in the gaps".

When presenting our performance data on the AirBeam below, we include R2 or R-squared values to indicate how the AirBeam compares with other methods for measuring PM2.5. R2 is a statistical measure that indicates how well data fit a statistical model, in this case, the prediction of the Y-axis (AirBeam) from the X-axis (pDR-1500) using a linear (straight) or nonlinear (curved) line. The R2 value is a fraction that ranges from 0.0 to 1.0 with higher values indicating that the regression came more closely to the points. An R2 value of 1.0 means that the predictive power of the model is perfect, that all the points lie along the line or curve with no scatter.

Below 100 micrograms per cubic meter (µg/m³), samples collected in ambient air in Manhattan (samples were collected on 11 different occasions and averaged over 12 hour periods) and while burning cardboard indoors (samples were collected over a 1 hour period and averaged every minute) both showed a strong linear relationship between the AirBeam and pDR-1500 measurements. As illustrated in Figure 1, the R2 values below 24 µg/m³ for two AirBeams in ambient air in Manhattan were .98 or better.

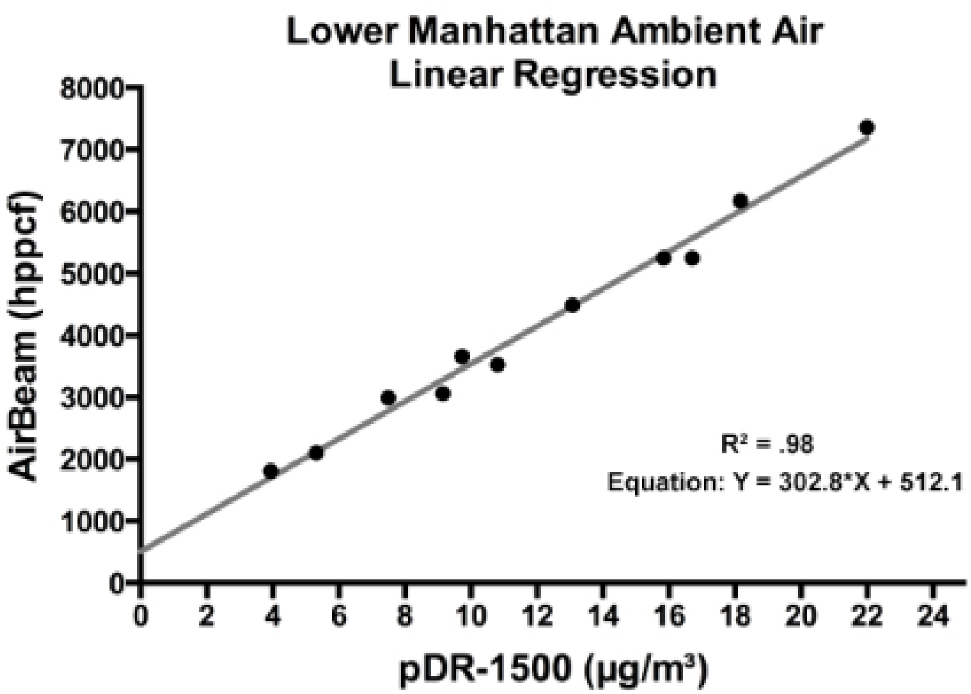


Figure 1

As illustrated in Figure 2, the R2 values below 100 µg/m³ for four AirBeams while burning cardboard indoors were .94 or better. Also shown in Figure 2, "out-of-the-box" variability between AirBeams is more pronounced as the measurements climb above 30 µg/m³. Meaning that measurements recorded by two AirBeams exposed to identical air samples may begin to drift apart as PM2.5 concentrations increase. Out-of-the-box variability can be substantially reduced by using the AirCasting app calibration feature (still in beta) and adjusting the side-facing potentiometer on the Shinyei PPD60PV.

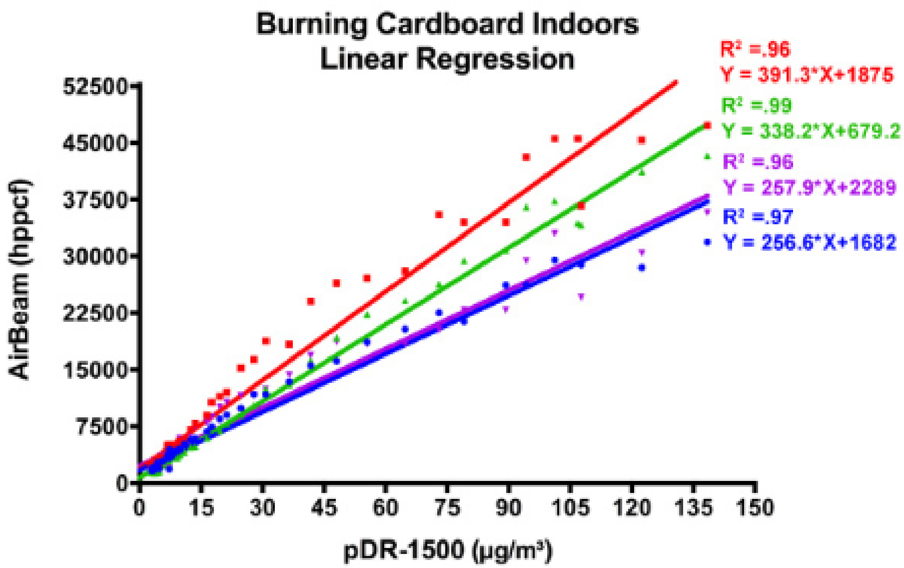


Figure 2

Because the relationship between the AirBeam and pDR-1500 measurements becomes increasingly non-linear above 100 µg/m³, a nonlinear regression curve was used to determine the relationship between the AirBeam and pDR-1500 measurements at higher concentrations, see Figure 3 (samples were collected over a 1 hour period and averaged every minute). During separate sampling runs, we calculated R2 values for the nonlinear regression curve ranging from 0.60 to 0.80. The decrease in R2 values as compared to the linear regression is likely attributed to higher variability near and above the AirBeam's maximum limit of detection, which we estimate to be approximately 400 µg/m³.

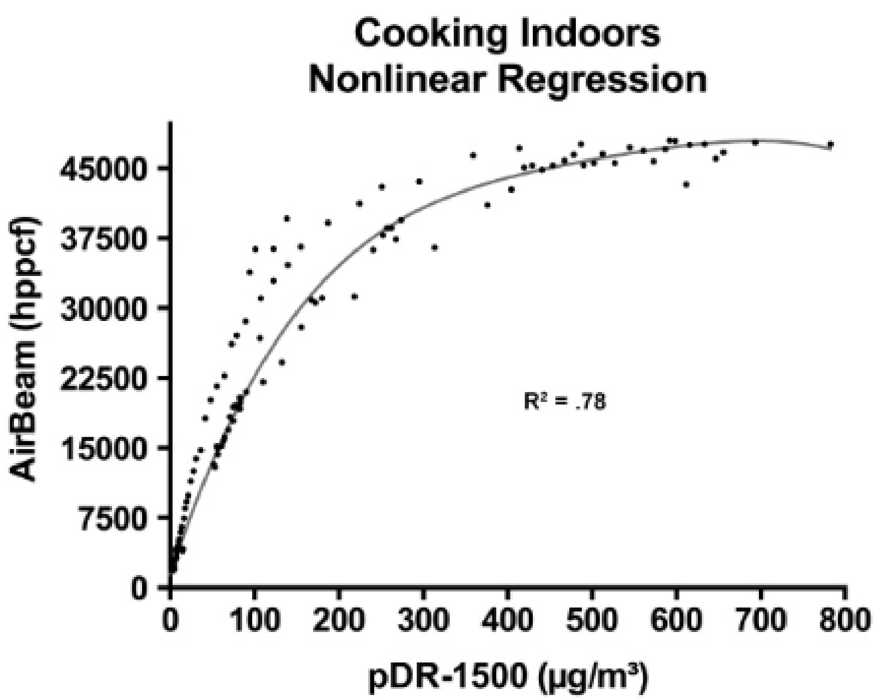


Figure 3

Additional research is required to see how the maximum limit of detection is impacted by the reflectivity of the aerosol being sampled. The relative reflectivity of aerosols impacts the AirBeam measurements. Highly reflective aerosols, like wood smoke, bias the AirBeam measurements upwards, whereas less reflective aerosols, like diesel exhaust, bias the AirBeam measurements downwards.

During ambient air sampling in Lower Manhattan during the summer months, measurements from a pDR-1500 and two Airbeams were compared against a teflon filter subjected to gravimetric analysis, see Figure 4. Sampling was done in 12-hour averages each day for 11 days and averaged to compare the real time instruments against the gravimetric filters. When compared against the gravimetric filters, the R2 value of AirBeams was found to be 0.70 compared to 0.76 for the pDR-1500. Time weighted averages of the gravimetric filter data showed consistently higher values as compared to the pDR-1500 at ambient levels. We assume this downward bias is also in effect with the AirBeam, since both are light scattering particle counters. Further, we assume part of this this bias can be attributed to the relative reflectivity of the aerosol being measured. The R2 value of the pDR-1500 measured against the AirBeams during these 12-hour day averages was found to be 0.98.

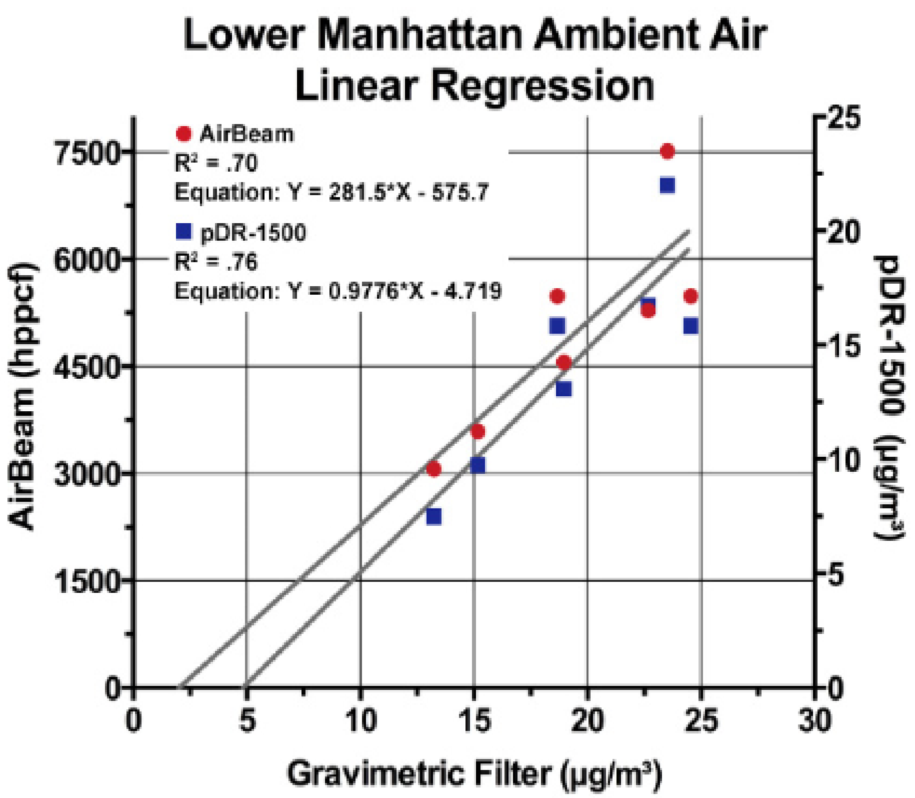


Figure 4

Research conducted by others on light scattering particle counters indicates that high relative humidity (>80%) is likely to have a negative impact on the accuracy of the AirBeam. When relative humidity is high, aerosols take on water becoming more reflective. Additional research is required to better characterize this effect as it applies to the AirBeam.

AirBeam performance data collection, analysis, and findings are the work of Alex Besser and Michael Heimbinder. Alex is a graduate student in Environmental Toxicology at New York University. Michael is the Founder and Executive Director of HabitatMap and AirBeam Lead Developer. Dr. George Thurston, Alex's academic adviser and professor of Environmental Medicine at New York University School of Medicine, provided the material resources and guidance that made this research possible.

PSCAA Comments about the purpose and use of the AIRBEAM monitor

CAUTION: The Air Beam monitors are used for primarily educational purposes. The Air Beam monitor measurement is NOT regulatory in nature. This data CANNOT be used as evidence to force regulatory change. However, the Air Beam monitors can be very useful as screening tools, and as educational tools.

This particular light scattering measurement technique is highly susceptible to bias associated with the nature of the aerosol, as noted in the operating notes from the manufacturer. Further, the technique is also sensitive to Relative Humidity. As RH goes up, hygroscopic growth can occur, and the measurements can be biased high.

For this study, the Air Beam monitor is to be used for Educational purposes. The data may also be used to confirm other measurements, but shall not be used to draw any conclusions, or primarily drive any recommendations.

H. Community Directed Canister Sampling Procedures

School Air Toxics, VOC SOP
August 5, 2009

STANDARD OPERATING PROCEDURE FOR THE COLLECTION OF VOLATILE ORGANIC COMPOUNDS FOR THE EPA SCHOOL AIR TOXICS PROGRAM

U.S. Environmental Protection Agency
Region 4, Science and Ecosystem Support Division
Athens, Georgia, 30605

Page 1 of 16

Acknowledgement

This Standard Operating Procedure (SOP) was developed by EPA Region 4, Science and Ecosystem Support Division. This SOP is based on the Commonwealth of Kentucky's ambient monitoring SOP template. Special thanks to the State of South Carolina and ERG for operational content.

For questions or comments please contact:

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Table of Contents

I. INTRODUCTION

This document is designed to provide instruction on collecting volatile organic compounds in air using an evacuated canister and a passive air sampling kit.

The procedure presented is designed for sampling volatile organic compounds (VOCs) in ambient air, based on the collection of whole air samples in SUMMA® treated canisters to final pressures below atmospheric. The samples are then analyzed using EPA Compendium Methods TO14A or TO15 *Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)* using the EPA National Monitoring Program's contract laboratory (i.e. ERG).

The canisters are 6-liter stainless steel vessels whose internal walls are SUMMA® treated with an inert pure chrome-nickel oxide compound to reduce the reactivity of the air sample in the canister. The canisters are outfitted with a stainless steel bellows valve, equipped with a 1/4" Swagelock® fitting on the inlet. Prior to use, all canisters are cleaned in accordance with the specifications presented in the EPA NATTS Technical Assistance Document Rev. 2 (April 2009). Once certified as clean, the canisters are evacuated to approximately 29.5 inches of mercury ("Hg) and are ready for use. The collection approach is passive, meaning no 110 volt AC power is required. The canister is attached to a programmable timer/solenoid, a veriflow vacuum regulator, and a sample probe. Figure 1 presents the complete VOC sampling system. When the programmable timer opens the solenoid at a preset time, the canister is filled with ambient air at an integrated collection rate across the 24-hour sampling duration.

This SOP is designed to be a step by step procedure for operating the sampling system described, and is to be used in conjunction with the manufacturer's operator's manual(s). Laboratory Analysis Methodology using the TO-15 method may be referenced by contacting the Eastern Research Group (ERG) directly at 919-468-7800 or by email Julie.Swift@erg.com. Maintenance and troubleshooting should be conducted using the relevant operator's manual(s).

FIGURE 1. Photograph of Total VOC Sampling System
With Timer and Probe

II. INSTALLATION

A. Sampler Siting

Inspect the site area to ensure there will be enough physical space for the operator to move freely while working, and ensure there is nothing at the location that will negatively impact the safety of the operator.

The sampler should be mounted in a location that is unobstructed on all sides. There should be no tree limbs or other hanging obstructions above the sampler. It is suggested that the horizontal distance from the sampler to the closest vertical obstruction higher than the sampler be at least twice the height of the vertical obstruction. The inlet of the sampling system must be positioned at least 2 meters above grade (ideal), but not more than 15 meters above grade.

B. Sampler Installation

1. The sampling system consists of three components: a sample canister, a programmable timer/solenoid (Nutech 2701), and a passive vacuum regulator (Veriflow with gauge and sample inlet probe). All components will be received from the ERG laboratory where: the cans will have been cleaned, tested for contamination and evacuated; flow controllers will have been cleaned, tested for contamination, and calibrated for 24 hour sampling; and the sample inlet will have been tested for contamination.

2. The complete sampling system must be securely mounted on a support structure which ensures that the sample inlet meets the siting criteria (at least 2 meters above grade, but not more than 15 meters above grade).

   Note: If the support structure is to be located on a roof top, efforts must be made to protect the roof covering (i.e. membrane, etc.). This can be accomplished by securely attaching the support structure to a wooden frame and then using weight (i.e. sandbags) to hold the entire mounting structure in place.

3. For collocated samplers, horizontal spacing should be between one (1) and four (4) meters, and inlet heights within one (1) meter vertically. .

III. OPERATING PROCEDURE

A. Equipment and Supplies

6 liter sample collection canister
Veriflow vacuum regulator/gauge/inlet probe
Nutech 2701 programmable timer/solenoid
Support structure with holder for assembled sampling apparatus
Logbook
ERG sample paperwork

B. Sampler and Sample Media Receipt Activities

Complete Sampling System

1. Check parts and components against the packing list.
2. Ensure all fittings are present and in good condition.
3. Prior to sampling keep all components in a clean area free of contamination.

Nutech 2701 Programmable Timer/Solenoid – Battery Charge

1. Charge the internal battery by opening the front cover and plugging the supplied USB adapter cable into the labeled USB port located on the bottom right of the front panel (mini USB).
2. Plug the other end of the USB cable into a USB port on a computer (standard USB). Allow the timer to charge for at least 12 hours. A battery charge indicator is located at the top center left of the display. The battery will display after a full charge is reached.

   Note: The display will show when the battery is drained. To ensure that there is always a sufficient charge on the battery, recommend recharging every six days.

Sample Collection Canister

1. The sample collection canister and associated sample data sheet will arrive from ERG in a cardboard box.

   Note: The canisters do not need to be refrigerated after receipt or during return shipping.

2. Ensure the canister is not damaged. Confirm that the valve remained in the closed position during shipping and that the top plug is secured on the bellows valve inlet fitting.

C. Preparing for a Sampling Event

Initial Steps

1. Ensure the Nutech 2701 timer battery is fully charged. If there are not at least two (2) bars displayed, the timer must be recharged before conducting the sampling event.
2. Prepare sample paperwork. On the ERG Toxics/SNMOC Sample Data Sheet, supply all required information in the "Lab Pre-Sampling" section. Record any pertinent observations in the notes section at the bottom of the form.
3. Remove the plug attached to the bellows valve inlet. Retain the plug in a clean place so that it can be used to reseal the bellows valve inlet after the sampling event.
4. Assemble the complete sampling system.
   a. Attach the outlet fitting of the Nutech 2701 timer/solenoid to the canister bellows valve inlet.

      Note: Do not over tighten the nut. When the nut feels snug, another quarter turn should be sufficient to secure the timer inlet to the can.

   b. Attach the outlet fitting of the Veriflow vacuum controller to the inlet fitting of the Nutech 2701 timer/solenoid.

      Note: Again, do not over tighten the nut. When the nut feels snug, another quarter turn should be sufficient to secure the timer inlet to the can.

Measuring and Documenting the Pre-Collection (Set-up) Canister Pressure

The following steps are to be performed prior to programming the Nutech 2701 timer/solenoid for the initial/subsequent collection event:

1. On the timer control panel, press the bubble switch labeled "Enter" once. This will take the timer out of the power-saving/hibernation mode.

2. On the timer control panel, press the bubble switch labeled “Manu” once. This places the timer in the manual operation mode. On the display in the center of the bottom zone, the word “Open” should be present. If the word “Closed” is present, press the “Manu” bubble switch again and it should shift to the word “Open”. This action manually opens the solenoid and clears a flow/pressure path between the canister valve and the Veriflow control orifice and pressure gauge.

3. Fully open the canister bellows valve. Observe the pressure (i.e., “Hg vacuum) indicated on the gauge. Fully close the canister bellows valve.

   Note: The bellows valve should be kept open for as short of a duration as possible – 10 seconds or less.

4. Record the Pre-collection Canister Pressure in the appropriate space on the supplied Chain-of-Custody.

Programming the Timer

At this point, the Nutech 2701 timer/solenoid is ready to be programmed to automatically conduct the next scheduled collection event. Follow the programming steps provided below.

1. Set the current time *(local standard time)*

   a. Push the “Set” key twice.

   b. The LCD will show flashing digits that can be changed by pushing the left or right arrow keys. When finished, press the set button to move to the day of the week.

   c. Change the day by pushing the left or right arrow keys. An arrow will be present above the selected day. When finished, press the “Enter” key to finish the time and day setting.

2. Set the sample start and end date / times

   a. Program the sampling event by pushing the “set” button once to enter event setting.

   b. Set event number (SEG on the display). Select 1 as your event number using the arrow keys. Once the event number is set, "Open" will be flashing to set the valve function.

c. Press "Enter" to confirm the open function. The time will flash. Set the sampling start time, followed by the day of the week using the arrow keys. Confirm the settings by pressing "Enter" to complete the program.

*Note: It's critically important that **00:01** be entered for the event start time (the timer will not recognize a start time of 00:00 and will not actuate).*

d. The valve icon on the timer should appear as indicating that the valve is in the closed position. During the sampling event, the icon on the timer will appear as .

3. To set the event stop time, push "Set" once to enter event setting. Set event number (SEG) first. Select 1 as your event number. Once you set the event number the (Open) will flash. Using right arrow key to move flashing to (Close), now (Close) is flashing for you to set the valve function. Push (Enter) to confirm the close function. Then the time will be flashing. You now set your sampling stop time [use **23:50**], followed by day of the week. Select the day of the week then push (Enter) to finish.

D. **Sample Recovery and Data Collection**

1. Activate the timer display by pressing the "Enter" button once. This will activate the screen with the current day of the week and current time of day (in Standard Time not Daylight Savings Time). The valve icon on the timer should appear as indicating that the valve is in the closed position. The display will also indicate the total elapsed time for the previous sampling event.

2. Record the total elapsed time on the ERG Toxics/SNMOC Sample Data Sheet in the "Elapsed Time" blank in the "Field Recovery" section.

3. Open the solenoid valve by pressing the "Manu" button once.

4. Fully open the canister bellows valve.

5. Read the gauge and record the remaining pressure left in the can on the ERG Toxics/SNMOC Sample Data Sheet and record the reading in the "Field Recovery", "Field Final Can. Press. ("Hg)" blank. If the pressure is zero, note the lack of pressure in the "Comments" section of the form.

6. Close the canister bellows valve by turning the knob until it is snug.

   Note: The canister bellows valve should not be opened for any longer than is required to get an accurate pressure measurement (i.e. approximately 10 seconds).

7. Close the timer solenoid valve by pressing the "Manu" button again.

8. Disconnect the canister from the Nutech 2701 timer/solenoid by unfastening the bellows valve inlet fitting from the timer outlet fitting.

9. Replace and secure the retained plug on the canister bellows valve.

10. On the ERG Toxics/SNMOC Sample Data Sheet, supply all required information in the "Field Recovery" section. Be sure to record any observations that were made during the run period.

11. Sample Shipping

    a. Remove the pink copy of the ERG Toxics/SNMOC Sample Data Sheet and file in a site record.

    b. Pack the can and the completed white copy of the ERG Toxics/ SNMOC Sample Data Sheet in the original cardboard shipping box and tape it closed. The can does NOT need to be shipped cold.

    c. Use the pre-filled out FedEx label provided by ERG, and fill out the Sender" section with the sampling agency's address and phone number. Send priority overnight to ERG at the address below.

       ERG
       601 Keystone Park Drive
       Suite 700
       Morrisville, NC 27560
       919-468-7924

       Note: if the shipping form is lost, use the address below for shipping to ERG, and contact them directly for the FedEx accounting.

IV. QUALITY ASSURANCE

To ensure that quality data is being collected the following checks should be considered:

A. Flow Calibration

Prior to deployment each Veriflow must be calibrated to a collection flow rate of approximately 3.2 cc/min to insure that the final pressures obtained over a 24-hour collection duration are appropriate. This calibration will be performed by EPA Contract Laboratory prior to shipment of each Veriflow to the field. Ideally, with a collection flow rate set-point of 3.2 cc/min, a 6L canister will attain a final volume of approximately 4,700 cc over a 24-hour (i.e. 1440 min) collection duration. The final volume of 4,700 cc equates to a final sample pressure in the canister of between 6 and 7 "Hg, which is the target final pressure for the EPA SAT program.

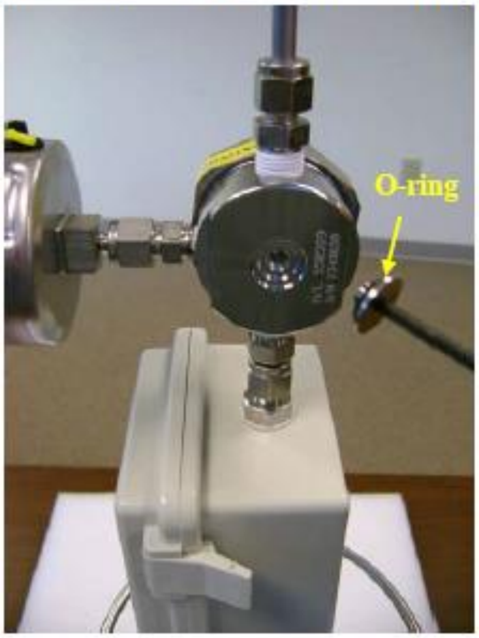
Because the Veriflows were calibrated at the EPA Contract Laboratory in Research Triangle Park, NC, variations in elevation, temperature, and barometric pressure between the calibration site and the field deployment site can cause variations in the final flow rate set-point realized. This variation in flow rate may necessitate adjustment of the collection flow rate set-point in the field. The following procedure presents the steps to accomplish the in-the-field set-point adjustment.

1. On the right hand side of the Veriflow unit, locate the adjustment screw protective cover (1/2 inch diameter disk with a 1/8 inch hex port located in the center) as shown in Figure 2.

Figure 2. Veriflow adjustment screw protective cover

2. Insert a 1/8 inch hex key into the hex port and rotate the protective cover counter-clockwise until it can be removed from the protective cover. Please note that the protective cover has an o-ring attached to it, as shown in Figure 3. The purpose of the o-ring is to ensure that the unit remains weather-tight while deployed. It is important that the o-ring be present when the protective cover is reattached to the Veriflow.

Figure 3. Removed protective cover with o-ring

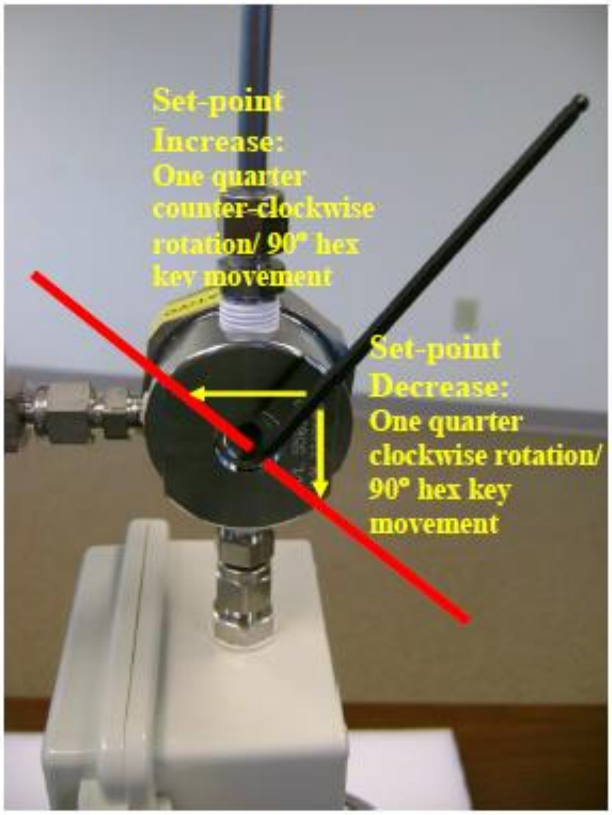


3. Under the cover is the actual flow rate adjustment screw (3/16 inch black circle with hex port located in the center), as shown in Figure 4.

Figure 4. Flow rate adjustment screw

4. To make adjustment to the flow rate set-point, insert a 1/8 inch hex key into the hex port on the adjustment screw. The Veriflow unit utilizes 5 full rotations to take the set-point from the bottom of its operational range (i.e. approximately 2 cc/min) to the top of its operation range (i.e. approximately 4 cc/min). As stated earlier, the units have been pre-calibrated for approximately 3.2 cc/min and should yield a final sample pressure is between 6 and 7 "Hg. However, it should be noted that final pressures between 1 and 10 "Hg are considered valid samples. If a final sample pressure between 1 and 10 "Hg is achieved, no adjustment is required. If the final sample pressure achieved is outside the acceptable range, or if a final pressure closer to the ideal set-point of 6 to 7 "Hg is desired a set-point adjustment will need to be made. To increase the flow rate, insert a 1/8 inch hex key into the hex port located in the center of the adjustment screw. Rotate the adjustment screw counter-clockwise. To decrease the flow rate, rotate the adjustment screw clockwise. It is recommended that adjustments be made in one quarter rotation increments between collection events, until the desired final sample pressure is achieved. The quarter turn adjustment can be easily gauged by observing the handle of the hex key so that it is positioned 90 degrees before or past its original position. See Figure 5.

Figure 5. Flow rate set-point adjustment



5. After adjustment replace the o-ring and protective cover. The Veriflow unit is now ready for use on the next sample collection episode.

B. System Cleanliness

All equipment, with the exception of the timer, will be cleaned by ERG before shipment to the agency. If anomalies are observed, the ERG laboratory will notify the agency and a course of action will be identified. The operator should take care not to touch or contaminate the inlet, fittings, and other parts of the sampling train. These areas should be kept covered if possible when sampling is not occurring.

V. DATA FORMS

All sample related run data forms will be supplied by ERG. Check the data sheets for completion after every setup or retrieval event. The operator is expected to keep a logbook to document all site activities, quality assurance activities, and sampling activities. Figure 6 presents the ERG Toxics / SNMOC Sample Data Sheet.

FIGURE 6. ERG Toxics/SNMOC Sample Data Sheet

ERG

ERG Lab ID #

TOXICS/SNMOC SAMPLE DATA SHEET

Lab Pre-Sampling	Site Code: ______	Canister Number: ______
	City/State: ______	Lab Initial Can. Press. ("Hg): ______
	AQS Code: ______	Date Can. Cleaned: ______
	Collection Date: ______	Cleaning Batch # : ______
	Options	
	SNMOC (Y/N): ______	Duplicate Event (Y/N): ______
	TOXICS (Y/N): ______	Duplicate Can # : ______
Field Setup	Operator: ______ Sys. #: ______	MFC Setting: ______
	Setup Date: ______	Elapsed Timer Reset (Y/N): ______
	Field Initial Can. Press. ("Hg): ______	Canister Valve Opened (Y/N): ______
Field Recovery	Recovery Date: ______	Sample Duration (3 or 24 hr): ______
	Field Final Can. Press. ("Hg): ______	Elapsed Time: ______
	Status: Valid Void (Circle one)	Canister Valve Closed (Y/N): ______
Lab Recovery	Received by: ______ Date: ______	Lab Final Can. Press. ("Hg): ______
	Status: Valid Void (Circle one)	
	If void, why: ______	
SNMOC	Analyst: ______	Date: ______
	Batch I.D.: ______	
Toxics	Analyst: ______	Date: ______
	Batch I.D.: ______	

Comments: ______

White: Sample Traveler Canary: Lab Copy Pink: Field Copy

I. PM2.5 Partisol Procedure Link and PM-10-2.5 Designation

The link below goes to the PM2.5 Partisol sampling procedure for sequential sampling. The PSCAA has been using this procedure since 1999, and is very familiar with this sampling equipment.

PSCAA will modify this equipment to sample for PM-10 rather than PM-2.5 by installing the WINS bypass downtube (RFPS-1298-127). This method replicates the sampling method for PM-10 metals at the Beacon Hill monitoring site, so this procedure is chosen to maintain the ability to compare data from the fixed study site (10^{th} & Weller) to the Beacon Hill monitoring site, which is sampling that is already in place due to the NCORE requirements.

https://fortress.wa.gov/ecy/publications/documents/99205.pdf

Thermo Scientific Partisol®-Plus 2025 Sequential PM10-2.5 Air Sampler Pair or Thermo Fisher Scientific Partisol® 2025i Sequential PM10-2.5 Air Sampler Pair
Manual Reference Method: RFPS-0509-176
"Thermo Scientific Partisol®-Plus 2025 Sequential PM10-2.5 Air Sampler Pair" or "Thermo Fisher Scientific Partisol® 2025i Sequential PM10-2.5 Air Sampler Pair," for the determination of coarse particulate matter as PM10-2.5, consisting of a pair of Thermo Scientific Partisol®-Plus 2025 sequential samplers or a pair of Thermo Fisher Scientific Partisol® 2025i sequential samplers, with one configured as a PM2.5 sampler (RFPS-0498-118) and the other configured as a PM10c sampler with the PM2.5 separator replaced with a Thermo Scientific Partisol® 2025 downtube (RFPS-1298-127). Partisol®-Plus 2025 to be operated with any software version 1.003 through 1.5 and Partisol® 2025i with firmware version 2.0 or greater, with the modified filter shuttle mechanism. Method to be operated in accordance with the Partisol®-Plus 2025 or Partisol® 2025i instruction manual supplement, as appropriate.
Federal Register: Vol. 74, page 26395, 06/02/2009
Latest modification: 06/ 2011

J. Enmont Ultrafine Particle Monitor Procedure

PUFP

Personal Ultrafine Particle Counter

Contents

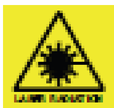
Notes and Cautions

Notes are helpful information that can help you make better use of the PUFP Sensor and its components.

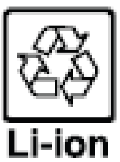
Cautions are warning about potential damage to the PUFP Sensor if used improperly.

Safety Information

Important safety messages are provided in this manual for the purpose of avoiding personal injury or instrument damage.



Laser Radiation: This device contains a Class I laser product. To avoid harmful laser radiation DO NOT open or perform services on the PUFP sensor.



Rechargeable Battery: This device contains a lithium-polymer battery pack with capacity of 7.4V and 10A. To avoid fire, keep the PUFP sensor away from high heat areas (≥ 60°C). When the battery power is low, charge PUFP with the included power cable and power adapter (12 VCD and 5A). Do not charge or use PUFP in any area with a potentially explosive atmosphere, such as a fueling area, or in areas where the air contains chemicals.

The PUFP sensor contains sensitive electronics and should not be operated in the rain or snow.

Repairing: Don't open PUFP and don't attempt to repair PUFP by yourself. Disassembling PUFP may damage it or may cause injury to users. If PUFP is damaged, malfunctions, or comes in contact with liquid, contact Enmont (enmont@enmont.com).

Operating and Storing Temperature: One of the internal components of the sensor is a water cartridge. To avoid damage to the PUFP sensor, do not store PUFP in temperatures below freezing. PUFP is designed to work and be stored in ambient temperatures between 10° and 35 °C.

Unpacking & Parts Identification

1 PUFP C100
2 Optional Silicon Exhaust Tube
3 Syringe to refill water cartridge
4 USB cord
5 EView Software
6 Water bottle
7 Power adapter and cord
8 Additional Aerosol Inlet Fitting

1 Air intake
2 Water refill OUTLET
3 Water refill INLET
4 Micro SD card port
5 USB connection
6 Charging port
7 Exhaust
8 Air Outlet
9 Fan / Air Inlet

PUFP Sensor Setup

Battery and Charging

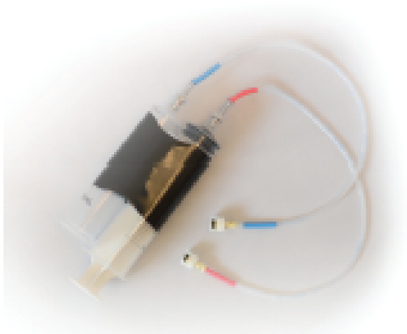
A battery pack is installed in a PUFP. The battery allows up to 6 hours of continuous operation. Operation hours can shorten over time. The length of operating hours is dependent on the age of the battery. The percentage of battery remaining is shown on the bottom of the sensor display screen. When fully discharged, the battery will take approximately 8 hours to charge fully. To charge the sensor, attach the power cord to the charging port on the sensor and plug the cord into an electrical outlet. When connected to a power source the sensor display screen will show "CHG" during operation. The screen will display "DSG" when the sensor is in operation and not connected to a power source.

Refilling Water

⚠ Caution: Purified water like distilled or de-ionized water should be used in the PUFP sensor. Using tap or other types of water may result in damage to the sensor.

The device for filling the sensor with water consists of two syringes, one with a plunger, and one without. The syringe with the plunger is used to transport water into the sensor. Small tubes are connected to each syringe.

To refill the sensor with water, submerge the end of the small tube attached to the syringe with the plunger in water. Pull the plunger back to draw the desired



amount of water into the syringe. Once the desired amount of water is achieved, pull the tube out and remove excess water on the tube and plastic tip with a paper towel or other absorbent material.

Position the sensor on a flat surface such that the air intake and IN and OUT water ports are pointing skyward. Connect the tube (blue) of the syringe with the plunger to the IN port by pressing downward and turning the plastic tip clockwise. You will hear a click when the tip is locked in position with the IN port. ⚠ DO NOT PRESS THE PLUNGER DOWN YET TO FILL THE SENSOR.

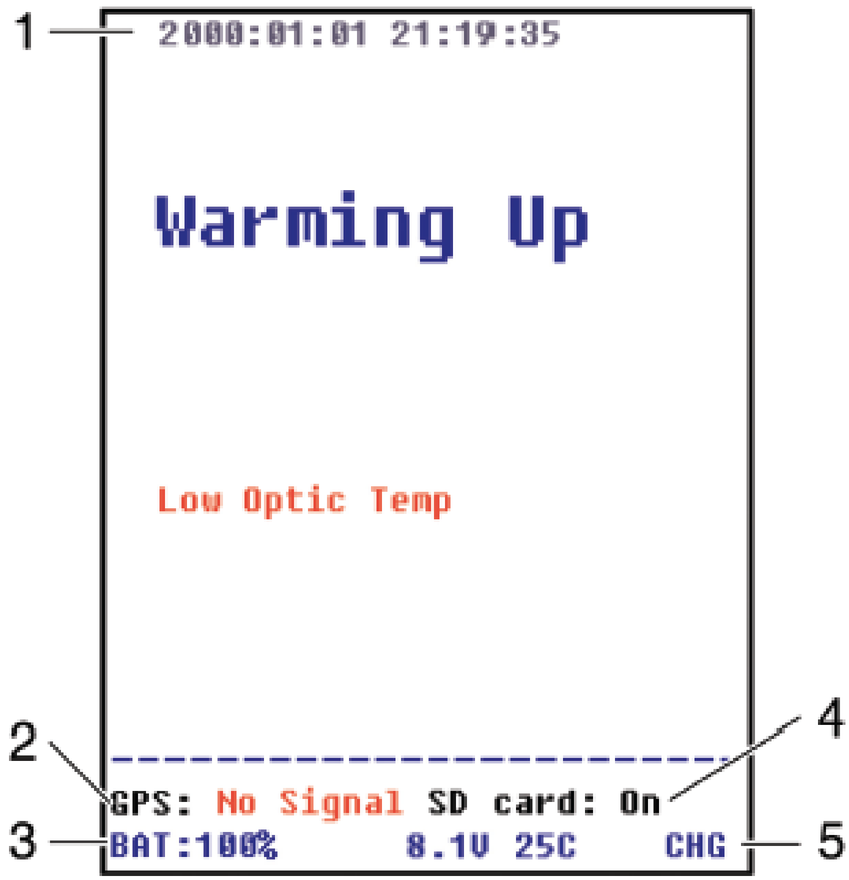
Connect the plastic tip of the tube (red) without the plunger to the OUT port by pressing down. Lock the tube into position by turning clockwise. Gently and slowly push the plunger down to move water into the sensor. When the sensor is completely refilled, water will begin to accumulate in the side without a plunger. ⚠ DO NOT REMOVE THE TUBES FROM THE WATER PORTS YET.

To avoid dripping water and damaging the sensor, turn the sensor on its side so that the air intake and water ports are pointing horizontally near the edge of the flat surface. Hold the water filling device level with or below the water ports. Remove the IN tube by turning the plastic tip counter clockwise and pulling gently. Remove the OUT tube and keep tip pointed upward. ⚠ Caution, water will leak out of the OUT tube if left to hang.

Replace excess water in container. Remove excess water from IN and OUT ports with a paper towel or absorbent material. Water level should be monitored carefully. A warning will appear if the amount of water is low. However, it is recommended that the PUFP sensor be refilled prior to each use. ⚠ Caution, sensor may be damaged if run while dry.

Sensor Display

Information regarding GPS signal, battery life, date and time, PUFP concentration, and amount of water is shown on the display screen.



Display information:

1 Date and time
2 GPS Status
3 Battery life
4 SD Card notification
5 Charging (CHG) or Discharge (DSG)

Operating the PUFP Sensor

Caution: During operation, keep objects clear of the air intake, fan, and air outlet. Obstructing these ports will result in damage to the sensor.

Caution: The PUFP sensor is assembled with a protective black plastic covering on the air intake. This must be removed before operation to avoid damage to the PUFP sensor.

Turning on the sensor

Turn on the PUFP sensor by pressing and holding the power button ( ) at the center of the key pad (about 2 seconds). The sensor must operate for a short period of time (~10 minutes) before measurements can be made in order heat to the internal components of the sensor. During this period, the sensor display will show “Warming Up.” The time remaining for the warm up process will appear on the sensor display.

When the warm up is complete “Measuring” will appear on the sensor display. The sensor will begin making measurements and recording data. During operation, it is normal for water to drip from the air outlet. Water can be directed away from the sensor by attaching the provided 1/8” silicon tubing.

User Settings

To adjust the settings of the sensor, press down and hold the right arrow (▶) approximately two seconds. A screen will appear, showing "SELECT KEY"—press down (▼). Date and time, screen brightness, and resetting options will appear. Use the up (▲) and down (▼) keys to scroll through menu options. As you scroll downward, the selected menu item will be highlighted blue. Continuing to scroll up or down will take you to a new page that shows "GPS Time Difference." This is covered in the next section.

To select a parameter, press the right arrow (▶). Selected parameters will appear in red. Use the up (▲) and down (▼) keys to adjust the parameter. To save the desired settings, press the right arrow key (▶) and the parameter will again turn blue. Press the left (◀) arrow to exit to the main display.

GPS Status

The PUFP sensor will indicate whether a GPS signal has been received. The sensor display will show "GPS Active" when GPS data is being recorded. When the GPS signal is inactive, "GPS No Signal" will be shown at the bottom left side of the display screen.

Date and Time Setting

The PUFP provides two ways for the user to set the date and time: 1) Manual setting and 2) GPS-based setting. The PUFP has an internal clock to track the date and time, which is powered by a token battery on an electronic board. The format is YYYY:MM:DD HH:MM:SS.

Manual Setting: The date and time of the PUFP sensor can be modified manually. To manually manage the time and date, set "GPS Time Difference" to 13. Date and time parameters will then need to be adjusted to the desired time at the user settings screen.

The time and date for the sensor can automatically sync when the GPS signal is active. Time and date are calculated based on Greenwich Mean Time (GMT). In order sync properly, the time difference must be specified to indicate the current time zone. To do this, first press and hold the right arrow (▶) to get to the user settings menu. Scroll through all options (year, month, day ect.) until a new screen appears and "GPS Time Difference" is highlighted blue. Press the right arrow (▶) key to select the parameter and use the up and down arrows on the keypad to specify the time difference (hours) from GMT respective to the current time zone. Press the right arrow (▶) to save the settings.

Turning off the PUFP Sensor

The sensor must go through a short shut down process to clear moisture from and cool down the internal components (~3 min). Begin the shutdown process by pressing and holding the ⏻ button in the center of the keypad for two seconds. The display screen will indicate when the shutdown has begun and the time remaining for the process to be complete. The sensor will automatically turn off.

In case of emergency, the sensor can be turned off immediately without going through the shutdown process by pressing and holding down the up (▲) and down (▼) arrow keys simultaneously for two seconds.

Reset the PUFP Sensor

There is a user option to reset the PUFP sensor. When the PUFP is reset, all the parameters are reset to the original factory setting.

Data Management

Measurements taken by the PUFP sensor are recorded on a micro SD card as tab delimited text files. A new file is created each time the sensor is turned on. The names of the data files correspond to the date and time at which the sensor began operation. For example, a file named "07300826" means that data recording began on July 30th at 8:26 AM. Real time and previously recorded data can be displayed directly on a computer using EView software. EView software will generate graphs, tables and Google Earth KML files.

Micro SD Card Recording

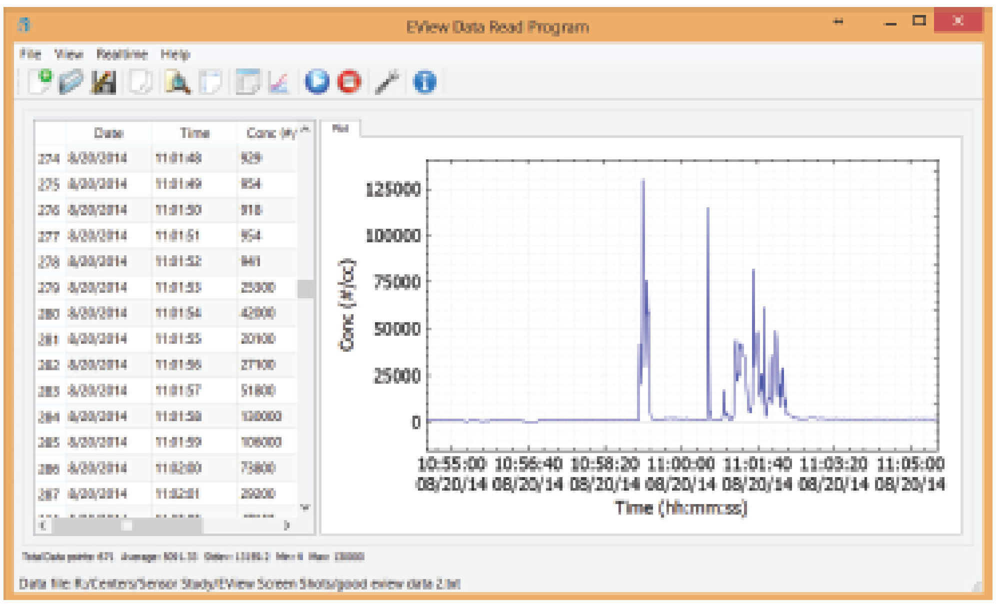
The PUFP sensor comes equipped with a micro SD card and adapter. If not connected to a computer using EView software, the micro SD card must be inserted into the PUFP sensor for data to be recorded. Gently press the SD card into the port until it clicks into place. To remove the SD card, gently press down until it clicks and release.

Data from the micro SD card can be downloaded to a computer or other electronic device by using the adapter. Insert the micro SD card into the adapter, and insert the adapter into the SD port of your electronic device.

EView Software

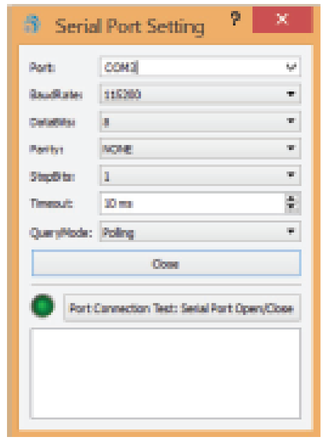
EView software can be installed on either Mac or Windows computers. Graphs and charts can be generated from previously recorded data or can be used to record and show real time UFP measurements.

Previously measurements can be opened by going to File>Open. When the desired file is opened, a chart and graphed data will appear. The data can be navigated by clicking on the graph area and dragging up and down and side to side.



To record data in real time, connect the PUFP sensor with the USB cable to your Mac or Windows computer while EView software is running. Driver software from the PUFP sensor will begin to install on your computer. Once complete, click on the wrench icon on the toolbar at the top of the EView screen. A screen will appear named "Serial Port Setting."

Turn on the port connection by selecting "Port Connection Test: Serial Port Open/Close." Measurements should begin to appear in the dialogue box. If text does not appear, adjust the port options. When text begins to appear, close the window.



To begin recording data, select the blue play button on the toolbar or select the "Realtime" option on the menu bar and then "Realtime Mode." To stop recording data, select the red stop button.

Save data by selecting File> Save/Save As. Data can be saved in multiple formats. For example, data can be kept as tab delimited or CSV files and imported into statistical software for analysis. Graphs can be saved as picture files (PDF, JPEG, PNG). Exposure data can also be saved as KML files and loaded into Google Earth software to show the spatial distribution of measured UFP concentrations.

Maintenance

Air intake nozzle with dust-mesh filter

The PUFP sensor comes equipped with an additional air intake nozzle. The air intake nozzle has a mesh covering to catch large particles and dust. This should be cleaned periodically by using an air canister.

Enmont
environmental monitoring technology

K. Air Quality Web: Air Drop Procedure

Air Quality Web: Air Drop

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Puget Sound Clean Air Agency

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Document Revisions

Date	Version Number	Document Changes
6/18/16	1.0.0	Initial draft

Air Drop Overview

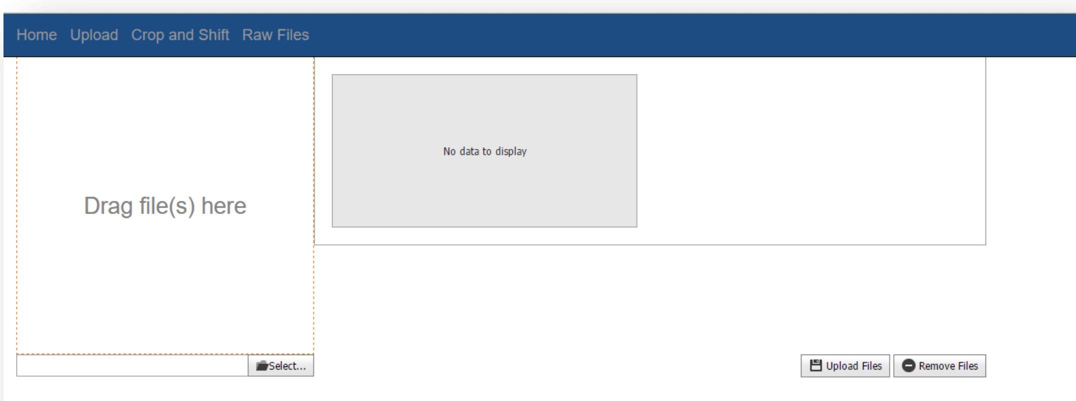
Air Drop is a tool that can be used to upload, crop, and shift data from mobile air quality studies. Once you have uploaded your data and made any necessary changes to the observation times, your data will be ready for review in our Telemetry database. You can retrieve your raw files from this application at any time.

Navigating to Air Drop

Air Drop is a web app that is available via this URL: https://secure.pscleanair.org/AirQualityWeb/. While this app is responsive to different screen sizes, it is for intended desktop and not optimized for mobile use.

Uploading Data

Overview



Accepted formats

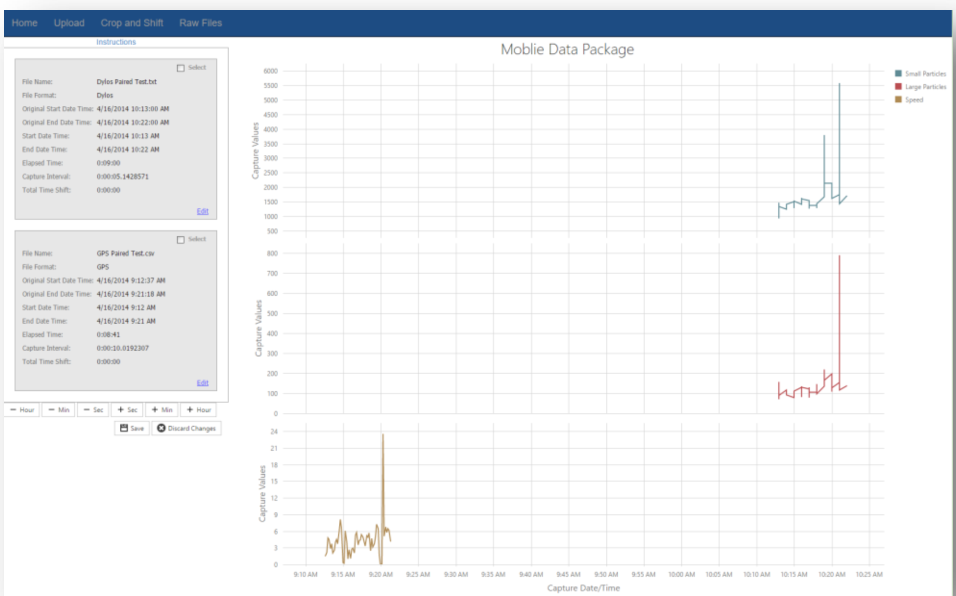
You can upload a single file or a package of files in a .zip file. The current version of Air Drop can read data from these file formats: *AeroqualVoc, AirBeam, CarClipCo, CarClipO3No2, Dylos, Enmont, GPS, GPX, HourlyTelemetry, MicroAeth, Package, RadianceResearch, SenonicsMinnow, and TsiNanoScan*. **If additional formats need to be supported please let Ross or Nate know so the work can be planned**.

Uploading

You can upload your file(s) via the drag and drop feature or by browsing for them. To use the drag and drop feature, drag your file(s) from their file location to the drop zone on the web page. If you wish to use the browsing feature, click the select button under the drop zone and navigate to your file(s). After a successful upload you will be taken to the page where you may crop and shift your data.

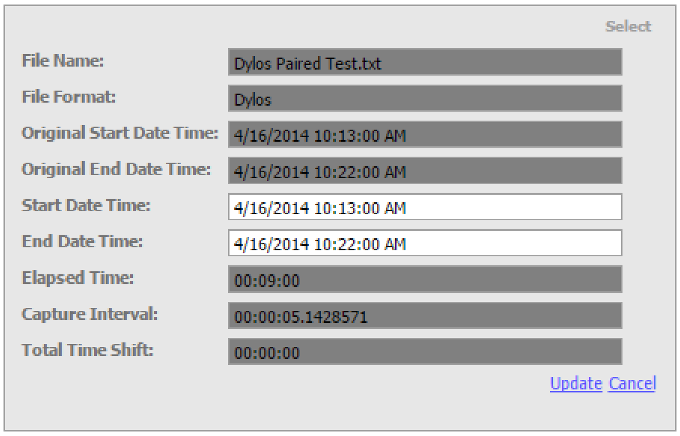
Cropping and Shifting Data

Overview

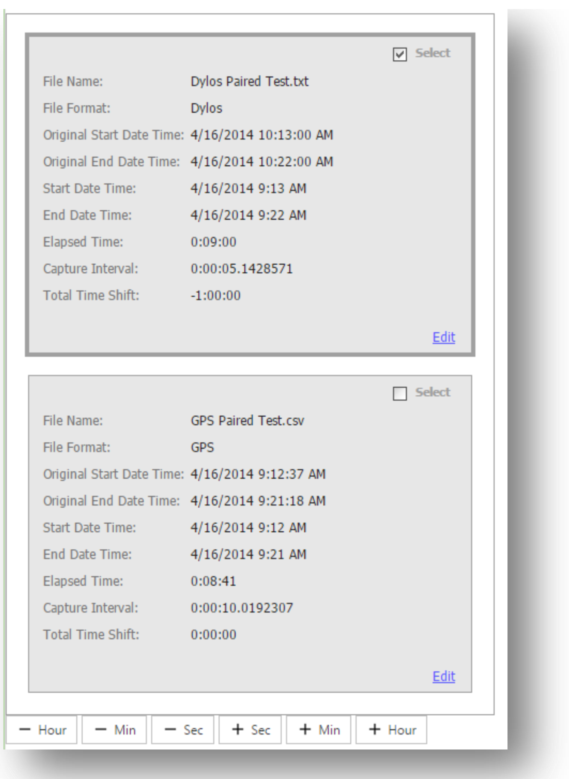


On this page, your data will be displayed on a line chart. If you have multiple QMUs in your data set, they will be displayed on separate panes. This allows you to visualize any time discrepancies in your data. You can see details about your files on the left side of the page. Each file will have a separate "card view". This view allows you to edit the start and end date/times of your files, thereby cropping your data set. By selecting the file's card view, you can use the shift buttons to adjust the observation times of your study.

Crop

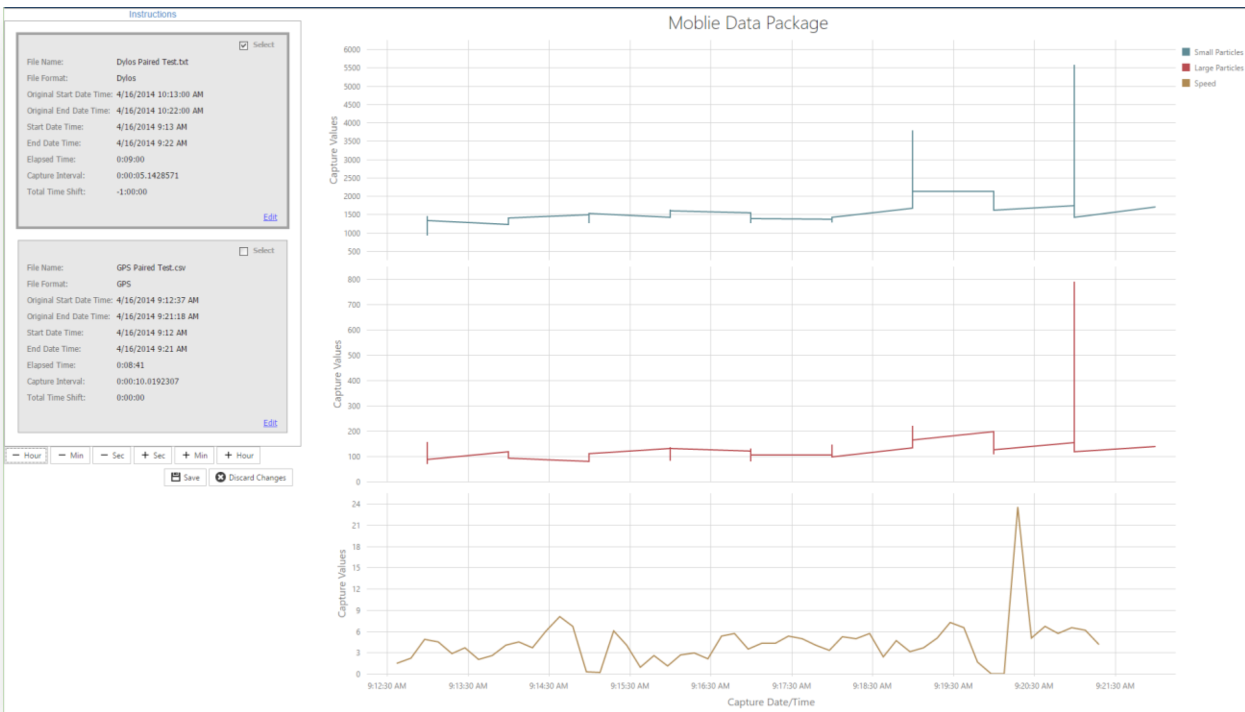


If not all sensors started or ended at the same time and you would like to trim remaining data points from display, you can do that with this card view. Select edit in the bottom right and you will see what is displayed in the screen shot to the right. As you can see, only the start and end date fields are editable. Select update after you have made your changes and you will see your modified data displayed. Please note: your data is not being deleted when it is cropped. It will still exist in our database and ignored in display.



Shift

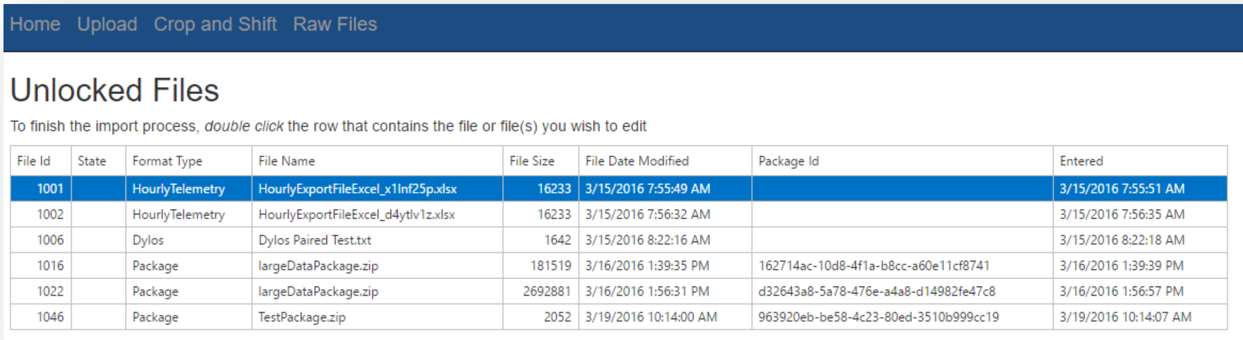
If your sensors' internal clocks are not in sync, you can shift all of the observation times in a file by hour, minute, or second. To do this, select one or more files by checking *Select* in the upper right of the card view and clicking the time adjustment buttons below the card view(s). In this example you can see the Dylos monitor was an hour ahead of the GPS device. I have applied a one hour shift and the screen shot below is the result. The Dylos file recorded two QMUs and the time shift was applied to both since they are contained in the same file. Now you can visualize this data set is in sync.



Save and Discard

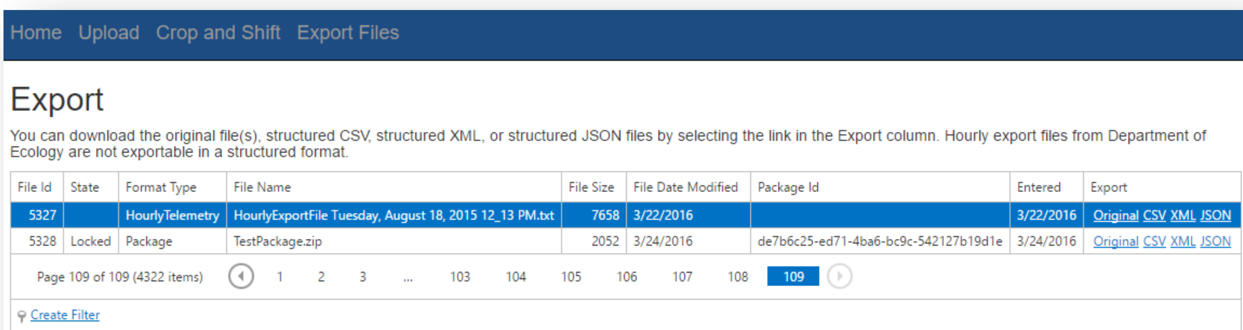
Once you are satisfied with your changes simply select the save button that is also located below the card view. At this point, your raw data is being adjusted according to your changes and moved into a permanent structure. Depending on your data size this may take a few moments. After saving, your raw files will become locked, preventing any adjustments to the time shift as well as the start and end dates. If you wish to discard changes you may do so my clicking the discard changes button.

Unlocked Files



If you upload your file(s) and were not able to complete the crop and shift process you can pick your file(s) from this list and continue. You can navigate here by selecting the *Crop and Shift* link in the header. Simply find your file or package and double click to be directed to the crop and shift page.

Exporting Files



You can retrieve your files at any time via this page. You can get the original unmodified data or structured CSV, XML, and JSON formats.