# Quality Assurance Project Plan

## EPA Category I

**Filter Handling, Acceptance Testing and Gravimetric Analysis for Chemical Speciation Network, Special Studies and State, Local and Tribal Site $PM_{2.5}$ Federal Reference Method Filter Samples**

**FINAL**

**Prepared for:**
U.S. Environmental Protection Agency Office of
Air Quality Planning and Standards Research
Triangle Park, NC 27711

USEPA Contract No.: EP-D-15-001


**Prepared by:**
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**Revision 1.0**

May 2018

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## List of Acronyms and Abbreviations

| | |
|---|---|
| AA | Associate of Arts degree |
| ACS | American Chemical Society |
| ADQs | Audits of Data Quality |
| AKEA | AKEA, Inc. |
| AS | Associate of Sciences degree |
| AQS | Air Quality System |
| CAL | Cations/Anions Laboratory |
| CAR | corrective action request |
| CCV | Continuing Calibration Verification |
| COC | Chain of custody |
| CSN | Chemical Speciation Network |
| CSV | comma separated value |
| CV | coefficient of variation |
| DART | Data analysis and reporting tool |
| DBMS | Database management system |
| DOPO | Delivery Order Project Officer |
| DQI | data quality indicator |
| DQO | data quality objective |
| DRI | Desert Research Institute |
| DRL | Denuder Refurbishment Laboratory |
| EC | elemental carbon |
| EDD | Electronic data deliverable |
| EIT | Engineer in training |
| ETL | Extraction, transformation and loading |
| FID | flame ionization detector |
| FiSH | Filter Shipping and Handling Unit |
| FRM PEP | Federal Reference Method Performance Evaluation Program |
| FSCOC | Field Sample Chain of Custody |
| GML | Gravimetric Mass Laboratory |
| IC | Ion chromatography |
| ICP/MS | inductively coupled plasma/mass spectrometry |
| ID | identification number |
| IMPROVE | Interagency Monitoring of Protected Visual Environments |
| LCOC | Laboratory Chain of Custody |
| LIMS | Laboratory information management system |
| MDLs | method detection limits |
| MQOs | measurement quality objectives |
| NAAQS | National Ambient Air Quality Standards |
| NCAF | non-conformance/corrective action form |
| NIST | National Institute of Standards and Technology |
| NVLAP | National Voluntary Lab Accreditation Program |

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|---|---|
| OAQPS | Office of Air Quality Planning and Standards |
| OC | organic carbon |
| OD | optical density |
| PE | Performance evaluation |
| PM | particulate matter |
| QA | quality assurance |
| QA/QC | quality assurance/quality control |
| QAPP | Quality Assurance Project Plan |
| QMP | Quality Management Plan |
| RH | Relative Humidity |
| RL | Reporting Limit |
| RPD | Relative percent difference |
| RSD | Relative standard deviation |
| SIP | State Implementation Plan |
| SLT | State, local, and Tribal |
| SOP | standard operating procedure |
| SQL | Structured query language |
| SRM | Standard reference material |
| STN | Speciation Trends Network |
| SVOC | Semivolatile organic compound |
| TC | Total carbon |
| TL | Transmissometer Laboratory |
| TOR | Thermal Optical Reflectance |
| TOT | Thermal Optical Transmittance |
| UCCSN | University and Community College System of Nevada |
| USEPA | United States Environmental Protection Agency |
| Wood | Wood Environment & Infrastructure Solutions, Inc |

# Quality Assurance Project Plan Identification and Approval

## Quality Assurance Project Plan
## Filter Handling, Acceptance Testing and Gravimetric Analysis for Chemical Speciation Network, Special Studies and State, Local and Tribal Site $PM_{2.5}$ Federal Reference Method Filter Samples

**Prepared for:**

U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

Approvals:

____________________________ ______________________
Elizabeth Landis Date
USEPA OAQPS Technical Project Manager

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Jenia McBrian Date
USEPA OAQPS Quality Assurance Officer

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Jeff Yane Date
USEPA OAQPS Project Officer

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Wood Environment & Infrastructure Solutions, Inc., Quality Specialist

Bill.Barnard Digitally signed by Bill.Barnard DN: cn=Bill.Barnard Date: 2018.05.30 14:47:03 -04'00' May 30, 2018
William R. Barnard Date
Wood Environment & Infrastructure Solutions, Inc., CSN Database Manager

# 1.0 Distribution

Upon finalization, controlled copies of this Quality Assurance Project Plan (QAPP) will be distributed in hard copy and electronically to the individuals listed in **Table 1-1.** The latest version of each Standard Operating Procedure (SOP) will also be available at the laboratory where it is used and published online. The Quality Assurance (QA) Manager will oversee control and update of the QAPP and SOPs.

**Table 1-1 QAPP Distribution List**

| Copy Number | Recipient Name | Position | Organization |
|---|---|---|---|
| 1 | Jeff Yane | Project Officer | USEPA/OAQPS |
| 2 | Elizabeth Landis | Technical Project Manager | USEPA/OAQPS |
| 3 | Jenia McBrian | Quality Assurance Officer | USEPA/OAQPS |
| 4 | Katie Naylor | CSN Regional Representative | USEPA/Region 1 |
| 5 | Irene Neilson | CSN Regional Representative | USEPA/Region 2 |
| 6 | Loretta Hyden | CSN Regional Representative | USEPA/Region 3 |
| 7 | Keith Harris | CSN Regional Representative | USEPA/Region 4 |
| 8 | Scott Hamilton | CSN Regional Representative | USEPA/Region 5 |
| 9 | Frances Verhalen | CSN Regional Representative | USEPA/Region 6 |
| 10 | Leland Grooms | CSN Regional Representative | USEPA/Region 7 |
| 11 | Joshua Rickard | CSN Regional Representative | USEPA/Region 8 |
| 12 | Anna Mebust | CSN Regional Representative | USEPA/Region 9 |
| 13 | Chris Hall | CSN Regional Representative | USEPA/Region 10 |
| 14 | Justin Knoll | Program Manager | Wood |
| 15 | Anne Glubis | Quality Assurance Manager | Wood |
| 16 | Morgan Edwards | Quality Specialist | Wood |
| 17 | William R. Barnard | Database Manager | Wood |
| 18 | Katherine W. Barry | Laboratory Manager | Wood |
| 19 | Mark Diblin | Office Manager | Wood |
| 20 | Ricky Tropp | DRI Quality Assurance Manager | DRI |
| 21 | Katrine Gorham | U.C. Davis Quality Assurance Manager | U.C. Davis |

Note:

Wood = Wood Environment & Infrastructure Solutions, Inc.
DRI = Desert Research Institute
OAQPS = Office of Air Quality Planning and Standards
USEPA = United States Environmental Protection Agency

# 2.0 Project/Task Organization

This QAPP describes quality planning for contract number EP-D-15-001 with the U.S. Environmental Protection Agency (USEPA) Office of Air Quality Planning and Standards (OAQPS). Work on this contract in support of the $PM_{2.5}$ Chemical Speciation Network (CSN) program, special studies and state, local and Tribal (SLT) Federal Reference Method (FRM) samples is performed by Wood staff. The work effort under this contract involves filter acceptance testing, denuder refurbishment, shipping and handling of filter samples to field sites and to laboratories for analysis, data entry of sampler operational data, data flagging and gravimetric analysis of select filters, refurbishment of denuders, leak testing of URG 3000N cassettes and (if required) optical density measurements of filters. Optical density analysis is included as an optional analysis type under this contract.

Wood utilizes two subcontractors on this contract; AKEA, Inc. (AKEA) and Desert Research Institute (DRI). AKEA personnel are utilized as supplemental staff to assist in the filter loading, unloading and shipping operations and were selected to assist Wood in meeting our small disadvantaged business goals based on their ability to provide technical staff who can be trained to perform those operations. AKEA has a long history of providing staff for a variety of technical operations for government agencies. Since AKEA staff work side-by-side with Wood staff on the filter shipping and handling operations (including training), they are governed by the Wood quality management system. Responsibilities, training, and positions referring to Wood staff are inclusive of supplemental staff.

DRI is utilized for acceptance testing and pre-firing of quartz filters. Acceptance testing is performed by DRI on quartz filters using thermal/optical transmittance and/or reflectance (TOR/TOT) carbon analysis for total carbon. DRI also pre-fires quartz filters used in the program and provides them to Wood for loading into sample modules. The SOP for pre-firing and acceptance testing (DRI SOP 2-106r8) can be found in Appendix A. DRI was qualified for acceptance testing by determining their ability to provide high quality analyses on a timely basis using an approved quality management system. DRI was chosen for the quartz filter acceptance testing due to their long history of providing carbon analyses for ambient samples for the previous and current CSN analytical laboratory contracts as well as on the Interagency Monitoring of Protected Visual Environments (IMPROVE) network and their history of development of the methodology used for the acceptance testing and their quality management program previously approved for the CSN and IMPROVE networks.

Sound management requires a clear understanding of the roles, functions, and assignments of each position within the project structure. **Table 2-1** shows the responsibilities and lines of communication for each of the positions in this program.

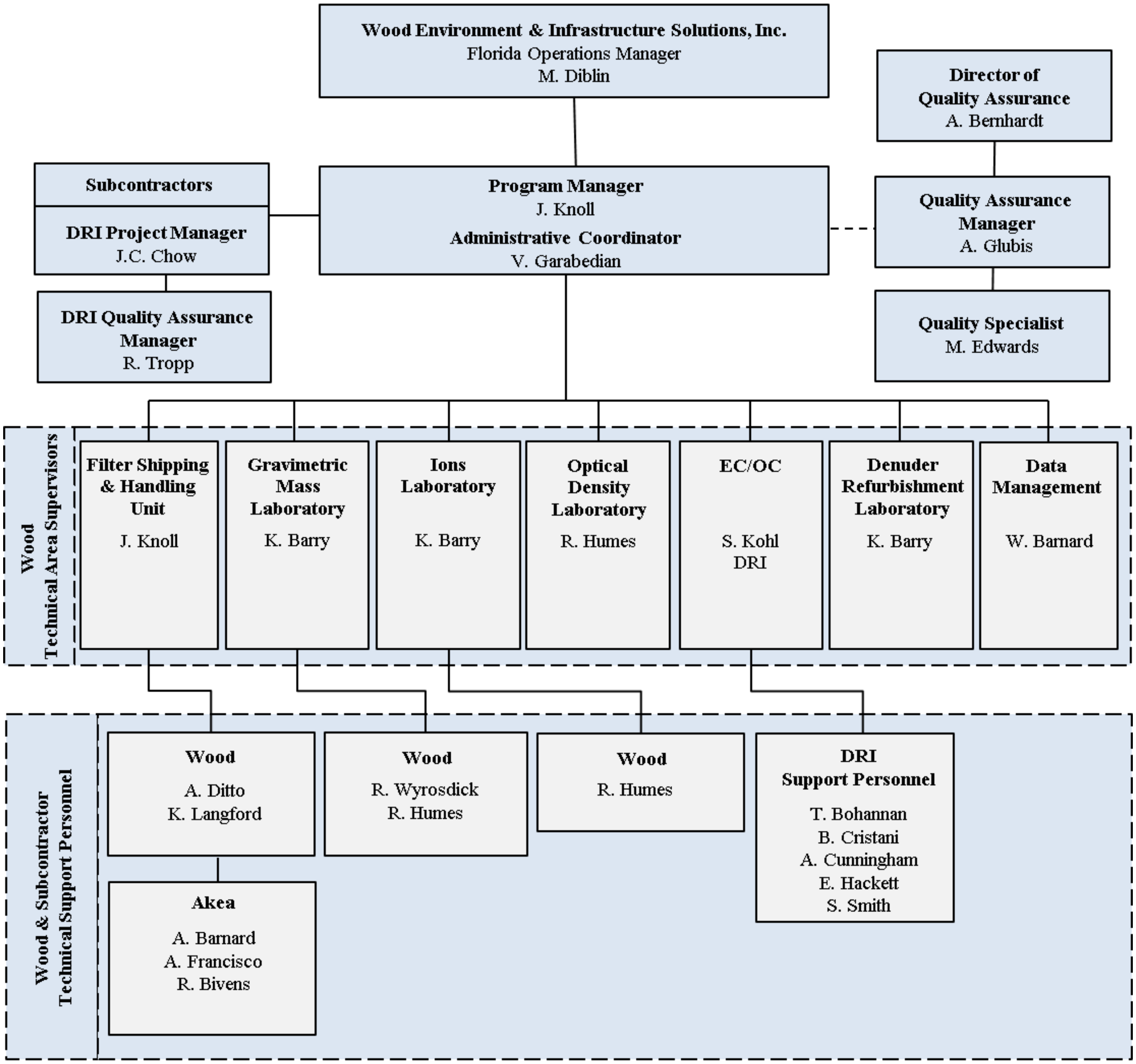
**Table 2-1 Personnel Responsibilities and Lines of Communication**

| Position | Responsibilities | Lines of Communication |
|---|---|---|
| Program Manager/ Justin Knoll | Accountable to corporate management for successful accomplishment of the project objectives. | Supervises project. Coordinates project activities with client and subcontractors. Reports to Gainesville, FL office Manager Mark Diblin. |
| Quality Assurance Manager/ Anne Glubis | Responsible for monitoring the Quality Program. | Reports to Wood's Director of Quality Assurance. Works with the Quality Specialist, technical area supervisors and staff to ensure quality program is effective. Maintains the official QAPP. Coordinates with subcontractor QA staff as needed. |
| Quality Specialist Morgan Edwards | Responsible for monitoring QA/QC at Wood's Gainesville, FL Filter Shipping and Handling Unit (FiSH), gravimetric, denuder refurbishment and acceptance testing laboratories; tracks corrective actions, coordinates SOP updates, maintains training records, and manages controlled documents for the program. | Reports to the QA Manager. Works closely with technical area supervisors and staff. She will also assist in reviewing and commenting on proposed changes to QAPP and SOPs, assist in qualifying subcontractor laboratories (if necessary) and help conduct audits and prepare audit reports. |
| Database Manager/ William R. Barnard | Responsible for maintaining and updating CSN Tracking Database. | Reports to Program Manager. Works closely with technical and QA staff |
| Lab Manager/ Katherine Barry | Responsible for Gravimetric Lab, Denuder Refurbishment and Nylon filter acceptance testing. | Reports to Program Manager. Works closely with technical and QA staff. |
| Technical Staff | Performs technical tasks. | Interacts with other team members. Reports to Technical Area Supervisors. |
| DRI | Responsible for performing acceptance testing of quartz filters for Organic Carbon/ Elemental Carbon OC/EC by IMPROVE method. | Reports to Wood Program Manager. |

Wood coordinates its laboratory support activities with USEPA/OAQPS and with the State, Local, and Tribal (SLT) agencies. Lab QA auditing and technical assistance are provided by USEPA/OAQPS as described in the Field QAPP (Quality Assurance Project Plan: PM2.5 Chemical Speciation Sampling at Trends, NCore, SLAMS, and Tribal Sites, USEPA/OAQPS, October 2011).

**Figure 2-1** shows Wood team members. As indicated above, DRI is included solely for pre-firing and acceptance testing of quartz filters. Thus, the staff included in the OC/EC box on the organization chart and all DRI staff are solely related to the acceptance testing and pre-firing requirements for quartz filters. Similarly, staff shown in the Ions Laboratory box is solely responsible for the acceptance testing related to nylon filters. Nylon filters are evaluated for anion and cation concentrations using ion chromatography (IC) on filters extracted by Wood's Gainesville, FL analytical laboratory. As specified in the contract, Teflon filters are not acceptance tested other than visual inspection for pinholes or other deformities. Staff connected to the Ions Laboratory box only perform acceptance testing and no routine analyses of CSN filter samples.

Figure 2-1 CSN Shipping and Handling Operations Personnel




* Dashed lines represent independent reporting lines of authority.

## 2.1 Program Manager and Administrative Program Coordinator

The Wood component of the CSN program, special studies, and SLT FRM filters performed under this contract is led by Justin Knoll, who provides overall supervision to ensure that the technical program is being performed in accordance with the USEPA statement of work and according to this QAPP. Mr. Knoll has 18 years experience working in Air Pollution Monitoring, including 13 years working on EPA ambient monitoring networks. Most recently he was the Assistant Program Manager for the CSN FiSH Unit.

The Wood Program Manager's responsibilities include:

1. Maintaining cooperative working relationships with the USEPA Project Manager, Technical Project Manager, CSN Regional Representatives, and QA Manager in the following ways: Conference calls to be held biweekly initially, or as frequently as needed. Meetings with USEPA staff in RTP will be held on an as-needed basis. Additional written communications and e-mails to document planning and decisions will also be provided.
2. Facilitating interaction among team personnel.
3. Ensuring that proper techniques and procedures are followed.
4. Ensuring that reporting requirements are satisfied.
5. Maintaining cost and schedule control.
6. Adjusting schedules to meet the needs of the client.
7. Reviewing and approving deliverables submitted to the client.

Virginia Garabedian is the Administrative Contract Accountant for the CSN program and is responsible for financial project coordination activities within Wood, she has worked as a project accountant on Wood EPA contracts since 2014.

## 2.2 Quality Assurance Manager

Anne Glubis is the Wood Quality Assurance Manager for this project. She reports to Wood's Director of Quality Assurance, Ann Bernhardt, and will provide oversight of the contract QA responsibilities. She will have direct access to Justin Knoll, the Program Manager, to provide overall guidance to the contract QA program. She will monitor quality assurance/quality control (QA/QC) for the project, along with selected staff members investigate problems and recommend corrective actions, perform periodic in-lab and data review audits, host external auditors during anticipated visits, distribute USEPA-provided Performance Evaluation (PE) samples (if required) and summarize the results of analysis of PE samples (if required). Ms. Glubis has experience in the quality assurance/quality control of laboratory, field, and data operations; analytical method development; QA program development; and development and streamlining of data validation and audit procedures.

In addition, Ms. Glubis is responsible for:

- Maintaining the QAPP
- Reviewing and approving changes to the QAPP and SOPs
- Qualifying subcontractor laboratories
- Reconciling test results with data quality objectives (DQO) via attainment of Data Quality Indicators (DQIs)

- Conducting systems audits, including Audits of Data Quality (ADQ), and preparing audit reports

## 2.3 QA Specialist

Morgan Edwards will serve as the QA Specialist for this contract. For the purposes of this project, she will report to Ms. Glubis and will provide on-site oversight for QA operations in Wood's Gainesville, FL office. She will assist Ms. Glubis with monitoring of QA/QC operations, review and provide comments on revisions to SOPs and updated QAPP sections, assist with the calculation and reporting of data quality indicators (DQIs) and perform other QA/QC activities as needed. She will review data deliverables to ensure that quality parameters are reported correctly. She will assist Ms. Glubis and selected staff members in required investigation of problems and recommend corrective actions, assist in performing periodic in-lab and data review audits, and help host external auditors during anticipated visits.

In addition, Ms. Edwards is responsible for:

- Helping maintain the QAPP
- Reviewing and commenting on proposed changes to the QAPP and SOPs
- Assisting in qualifying subcontractor laboratories
- Helping conduct audits, including ADQ and preparation of audit reports

## 2.4 Database Manager

William Barnard is the Wood Database Manager for this project. Mr. Barnard developed a large part of the CSN Tracking Database and was the previous Program Manager. Mr. Barnard will work with Mr. Knoll to maintain the operation of the CSN Tracking Database along with developing and implementing new database tools to make FiSH database operations as efficient and accurate as possible.

## 2.5 Laboratory Manager

Katherine Barry is the Wood Lab Manager for this project. Ms. Barry oversees the Gravimetric Weighing Lab operations, Nylon filter acceptance testing and the refurbishment of denuders.

## 2.6 Analytical Subcontractors

Wood will be using only one analytical subcontractor for this project, DRI. DRI will be utilized to perform filter pre-firing on all quartz filters and filter acceptance testing on 2% of the quartz filters. DRI will evaluate total carbon (TC), EC and OC on selected filters chosen for acceptance testing to ensure that filter batches meet the contractual requirements for acceptability of the filter media for sampling purposes. The acceptance testing limits are 1.5 $\mu g/cm^2$ OC, 0.5 $\mu g/cm^2$ EC, and 2.0 $\mu g/cm^2$ TC, or the lot will be flagged and the cleaning (pre-firing) process repeated. Should the filters fail again, then the lot will be rejected. The acceptance testing SOP (DRI SOP 2-106r8) can be found in Appendix A.

### 2.6.1 Desert Research Institute (DRI)

DRI is the nonprofit research campus of the University and Community College System of Nevada (UCCSN). Their main campuses are located in Las Vegas, NV (Southern Nevada Science Park) and Reno, NV (Dandini Research Park), with subsidiary campuses in Boulder

City, NV, and Steamboat Springs, CO. DRI's environmental research programs are directed from three core divisions (Atmospheric Sciences, Earth and Ecosystem Sciences, and Hydrologic Sciences) and two interdisciplinary centers (the Center for Arid Lands Environmental Management and the Center for Watersheds and Environmental Sustainability).

# 3.0 Problem Definition/Background

In 1997, the USEPA promulgated the new National Ambient Air Quality Standards (NAAQS) for particulate matter (PM). The regulations (given in 40 CFR Parts 50, 53, and 58) apply to the mass concentrations (g/m$^3$ of air) of particles with aerodynamic diameters less than 10 micrometers (the $PM_{10}$ standard) and to particles with aerodynamic diameters less than 2.5 micrometers (the $PM_{2.5}$ standard). To support these standards, a 1500-site mass measurements network and a smaller $PM_{2.5}$ CSN were established. Gravimetric mass and chemical speciation analyses may be performed for $PM_{10}$ and coarse PM as part of the NCore program and for research studies as part of the CSN contract. Coarse PM, total mass and individual chemical species, will be determined either as $PM_{10}$ minus $PM_{2.5}$ ($PM_{10-2.5}$) based on separate $PM_{10}$ and $PM_{2.5}$ filter samples, or as coarse PM obtained by dichotomous sampling.

The ambient air data from the network, which measures solely the mass of particulate matter, are used for NAAQS comparison purposes in identifying areas that meet or do not meet the NAAQS criteria and in supporting designation of an area as attainment or non-attainment. Because some of the filters collected under this contract (special studies and SLT FRM samples) support NAAQS decision-making, gravimetric analyses are performed in accordance with 40 CFR Part 50, Appendix L and *Quality Assurance Guidance Document 2.12, Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods.*

The CSN consists of a set of approximately 50 core Speciation Trends Network (STN) sites and additional non-core (supplemental) sites. Several CSN sites are collocated with NCore sites. All STN and NCore sites in the CSN operate on a 1-in-3 day sample frequency. The remaining supplemental CSN sites operate on a 1-in-6 day sample frequency. Chemically speciated data are used to serve needs associated with development of emission mitigation approaches to reduce ambient PM concentration levels. Such needs include emission inventory establishment, air quality model evaluations, and source attribution analysis. Other uses of the data sets will be regional haze assessments, estimating personal exposure to PM and its components, evaluating potential linkages to health effects, and support for setting a secondary NAAQS for PM.

Prior to operation of the STN and supplemental sites, USEPA ran a prototype network, informally known as the “mini-trends” network, in early 2000. That network was comprised of 13 monitoring stations in the continental U.S. Each site had two or more $PM_{2.5}$ chemical speciation monitors to enable various sampler inter-comparisons. The mini-trends network ran from February 2000 to August 2000.

Initially, the CSN used the NIOSH-type thermal optical transmittance (TOT) analytical method and one of five sampler types (predominantly the MetOne SASS) to measure carbon. Beginning in May 2007, the CSN began operation of 57 URG 3000N samplers, which are used to obtain samples on quartz filters that are comparable to those being sampled by the IMPROVE network. The filter samples obtained using the URG3000N sampler are analyzed by the IMPROVE_A thermal optical reflectance and transmittance (TOR/TOT) method. Outfitting the remaining sites in the CSN with URG 3000N samplers was completed in FY10.

Beginning with the laboratory contract that began in 2009, gravimetric and chemically speciated measurements were added for $PM_{10}$ and coarse PM filters. The XRF method was modified to omit 15 rarely seen elements, and several new measurements were incorporated, including, for selected filters, inductively coupled plasma/mass spectrometry (ICP/MS), semivolatile organic compound (SVOC) analysis, and optical density (OD); as well as determination of gas phase ammonia, nitric acid, and $SO_2$ using denuder technology.

Wood supports the CSN, Special Studies and supplemental Federal Method (FRM) Tribal sites by shipping ready-to-use filter packs and denuders to the field sites and conducting visual inspection and gravimetric analyses of Teflon filters used in the samplers at some selected sites. In addition, Wood performs acceptance testing on nylon filters prior to use in the field sampling effort and (via our analytical laboratory subcontractor DRI) performs filter pre-firing and acceptance testing on quartz filters. Teflon filters are not required to be acceptance tested other than to be visually inspected for pinholes, loose material, separation of the reinforcing ring, discoloration, physical non-uniformity, and other physical defects (e.g., wrinkling) by FiSH technicians during filter loading operations. Finally, Wood is responsible for denuder refurbishment/recoating and for pressure testing URG 3000N cassettes at least once annually. Although not currently implemented on this contract, Wood could also be tasked to perform optical density analyses.

This QAPP focuses on the QA activities associated with Wood’s role in the activities listed above as well as data validation and reporting the sampler operational data (e.g., flow, temperature, etc.).

# 4.0 Project/Task Description

Wood's component of this contract involves several broad areas:

## 4.1 Filter Procurement

The Program Manager and Assistant Program manager will have the responsibility for determining project materials and supply requirements, including those of filters needed for collecting ambient aerosol samples. The number of filters ordered will be sufficient for planned field activities, planned acceptance testing protocols, and field and laboratory quality assurance and quality control activities. Due to extended lead times often required for large filter procurements and the accompanying acceptance testing, Wood will procure a minimum 6 month supply from the vendor and will put in place a standing order filled every 3 months to purchase a 6 month supply. The procedure for ordering filters is as follows:

- Contact the filter supplier and obtain a written (or documented verbal) price quote for the intended quantity of filters required. The quote should include per unit price, expected ship date, and expected delivery date. Ensure that the quote is based on the vendor's understanding that all procured filters will be from the same manufacturing lot.
- Work with Wood's purchasing department to ensure that, for new orders, competitive bids are received for all filter types.
- Once the competitive bidding process is complete work with Wood to select a vendor and initiate the purchase order required to purchase the filters. The purchase order will contain the following information:
  - Filter manufacturer's product number.
  - Supplier's product number.
  - Complete product description and specifications.
  - Unit size.
  - Number of units required.
  - Unit price and extended price.
  - Specification that all filters must be supplied from the same manufacturer's lot number.
  - Statement that the supplier can ship partial orders.
  - Required receipt date for a completed order.
  - Copy of written price quote.
  - Supplier's name, address, telephone number, fax number, and contact name.
  - Wood project number.
  - Names of individuals requesting and approving the procurement.

- Review the procurement request and initiate approval through Wood's procurement system.
- Upon receipt of each filter shipment, inspect the shipment to verify that the items appear to be in good condition and that the receiving order accurately represents the shipment's actual contents. If so, sign and date the receiving order. Approve the invoice through Wood's electronic procurement system. If a discrepancy in shipment contents or condition is noted, disapprove the invoice and notify Wood's procurement group so that defective materials can be returned to the supplier and so that ordered parts requiring replacement can be obtained.

- Store acceptable procured filters in their original bulk containers in a climate-controlled environment until required for use.

### 4.2 Performing required filter acceptance testing

Performing required filter acceptance testing on quartz and nylon filters. Wood performs acceptance testing on nylon filters by taking 2% of the filters, extracting them in deionized water and measuring the resultant anion and cation concentrations using ion chromatography. Filters not meeting the acceptance criteria of 1.0 µg/filter for any ionic species will be marked and the box will be marked as not acceptable. Additional details on the acceptance testing procedure are described in Appendix A and SOP GLM3180-010 *Acceptance Testing of Nylon Filters by Ion Chromatography for the Chemical Speciation Network*. Wood's subcontractor DRI will also perform acceptance testing on the quartz filters and pre-fire quartz filters prior to use. As with the nylon filters, 2% of the filters will be acceptance tested to determine if filters are within the required limits for the contract. The acceptance testing limits are 1.5 µg/cm$^2$ OC, 0.5 µg/cm$^2$ EC, and 2.0 µg/cm$^2$ TC, or the lot will be rejected and the cleaning (pre-firing) and testing process repeated. DRI will then ship pre-fired quartz filters from filter lots that have passed the acceptance testing to Wood. Wood will log in the received filters and immediately place them into a freezer for storage until required for shipment to the sampling sites. A Chain of Custody (COC) form for receipt of the filters from DRI will be obtained and marked as received. Detailed information regarding the acceptance testing procedure for quartz filters is provided in Appendix A and DRI SOP #2-106r8, *Pre-firing and Acceptance Testing of Quartz Fiber Filters for Aerosol and Carbonaceous Material Sampling*. Acceptance testing of Teflon filters is not required, other than visual inspection for tears, pinholes, deformities, etc– see Appendix A and SOP GLM3180-009 *Determination of Particulate Matter (PM) Gravimetric Mass For The Chemical Speciation Network*.

Teflon filters will be checked for defects during loading and prior to gravimetric analysis. The procedures for these checks are detailed in the FiSH SOP GLO3110-002 and the SOP covering gravimetric analysis (SOP GLM3180-009).

### 4.3 Shipping and receiving of samples from sites and / or contract laboratories

Wood will supply each site or monitoring agency with sample collection media that have met the acceptance testing criteria in loaded filter cassettes and/or Met One SASS/SuperSASS modules (and, when required, accompanied by magnesium oxide denuders) and field sampling chain of custody (FSCOC) and data flagging forms as explained in GLO3110-002 *Field Shipping and Handling* SOP. Wood will ship the collection media to the sites or other designated locations specified by the monitoring agencies on a 1-in-3 or 1-in-6 day schedule specified by the CSN Regional Representative and/or the USEPA Technical Project Manager. A list of sites and laboratories that Wood ships to can be found in Appendix B. Because the list is subject to change frequently, the current list is available from the USEPA Technical Project Manager upon request. Samples are received from the sampling sites generally within a few days after the sampling event. Using the Level 0 Validation form, the samples are checked against the FSCOC to ensure that the box contains the same equipment that was shipped to the site, the temperature of the sample modules are measured and recorded, and then the shipping containers are stored in a walk-in refrigerator by sample set until they can be unloaded. Prior to unloading, the samples are removed and allowed to equilibrate to room temperature.

**During the unloading process**, filter IDs are entered in the CSN Tracking database, sampling modules are cleaned and allowed to dry and then are reloaded for the next sample event. Components are reloaded with unexposed filter media and are then shipped to the sites. Details of the procedure for sample loading and unloading and shipment of new sample materials to sites can be found in Appendix A and SOP GLO3110-002 Section 8. During the unloading process, received samples are checked against the accompanying FSCOC forms, sample receipt temperatures and general conditions are recorded, and the forms are evaluated and signed in and copies of the forms are provided to the data entry staff.

**Data entered on the FSCOC by the site operators are entered** into a CSN Tracking database, as are corresponding null and validity flags based on site operator notes and comments on field documentation forms. Details on the data entry process can be found in Appendix A and SOP GLO3110-002.

### 4.4 Shipment of filter batches to the Network analytical laboratories

Following entry of the operational data, samples from various sample sets are compiled for shipment to the analytical laboratories. The filters are shipped to the analytical laboratory accompanied by a laboratory chain of custody (LCOC) transmittal form, as well as electronic data files containing the operational parameters for each sampling event, information on null and valid flags, comments by either field site operators or Wood staff and information on whether or not the filter sample is considered valid. Additional details including examples of above referenced forms on the process for shipping filters to the analytical laboratory can be found in Appendix A and SOP GLO3110-0003 *Analysis Batch Preparation and Shipment.*

**Performing gravimetric mass determinations** on select Teflon filters from select sampling sites in accordance with 40 CFR Part 50, Appendix L and *Quality Assurance Guidance Document 2.12, Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods.* Additional details on the conditioning, pre-weighing, post-weighing and data entry and validation for filters undergoing mass analysis can be found in Appendix A and SOP GLM3180-009 *R0 Determination of Particulate Matter (PM) Gravimetric Mass for the Chemical Speciation Network*.

### 4.5 Refurbishment of denuders, leak testing of URG 3000N cassettes and optical density evaluations

Approximately once a year, Wood will refurbish the denuders used with the SASS/SuperSASS sampling modules using a magnesium oxide (MgO) solution. Denuder refurbishment is tracked in CSN Tracking Database by sample set. Details of the denuder refurbishment process can be found in Appendix A SOP GLO3180-040, *Cleaning and Coating Of Aluminum Honeycomb Denuders*. In addition, on an annual basis, Wood will perform leak testing of actively used URG 3000N cassettes. Details of the process used for leak checking the 3000N cassettes can be found in Appendix A, SOP GLO3110-005 *Standard Operating Procedures for Leak Checking the URG 3000N Filter Cassette*. Finally, under this contract, USEPA has the option of optical density measurements. SOP GLM3180-011 *Standard Operating Procedure for Dual-Wavelength Optical Transmission Analysis* describes the process and instrumentation used to perform optical density measurements for this contract.

**Providing monthly, quarterly, and annual data reports** and establishing and applying a comprehensive QA/QC system that includes Wood's Quality Management Plan, this QAPP, and associated SOPs that provide the documentation for Wood's quality system. Information on the data provided in these reports can be found in Appendix A, SOP GLO3110-006, *Database Operations for the Chemical Speciation Network*.

Wood and our subcontractors will provide the staff, facilities, analytical instrumentation, computer hardware and software, and consumable supplies necessary to carry out tasks from these work areas and will ensure that contractual specifications are met.

### 4.6 Schedule

The present contract option period started on September 3, 2015 and lasts for one year. Additional options can be exercised by USEPA in subsequent years, through September 2, 2020.

- Analysis Batch filters and data ideally shipped to analytical lab within 30 days of receipt.
- Quarterly Metadata delivered within 15 days of the end of the quarter.
- Scheduled conference calls with EPA, UCD, DRI and TAMS.
- Sample Shipping Schedule for coming year finalized and ready to deliver by December 15.

# 5.0 Data Quality Objectives and Criteria

Data quality objectives (DQOs) are project level goals associated with data users that establish the full set of specifications for the design of data collection to ensure that data are of sufficient quantity and quality for their intended use. DQOs are established in a formal process allowing an experimental design to be developed to meet decision criteria specified by stakeholders, as described in USEPA QA/G-4, *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006). DQOs typically incorporate requirements for total data uncertainty which are used to establish quality criteria.

Data quality indicators (DQIs) are the quantitative parameters (accuracy/bias, representativeness, comparability, sensitivity, and completeness) that characterize the uncertainty of the project's measurement systems.

The quality criteria established to meet the project DQOs are qualitatively or quantitatively expressed as measurement quality objectives (MQOs) for significant components of total variability. These criteria reflect the level of measurement system capabilities, and are associated with data collectors. MQOs are specific goals for DQIs and must be verifiable by measurements or observations made during the project.

## 5.1 CSN Data Quality Objectives

A Chemical Speciation DQO Workgroup established that the primary DQO for detection of trends in the chemical speciation data, is: "*to be able to detect a 3%–5% annual trend in the concentrations of selected chemical species with 3–5 years of data on a site-by-site basis after adjusting for seasonality, with power of 0.80*". (USEPA, 1999a). Non-gravimetric precision measurements for sulfate, nitrate, calcium, and total carbon collected from collocated samplers at six STN sites are used to support this DQO (for more information, please refer to *Data Quality Objectives for the Trends Component of the $PM_{2.5}$ Speciation Network, posted to EPA's website at https://www3.epa.gov/ttn/amtic/files/ambient/pm25/spec/dqo3.pdf*).

### 5.1.1 Data Quality Indicators (DQIs)

The principal DQIs for this program are precision, accuracy (as bias), and completeness. Precision is the level of agreement among multiple measurements of the same parameter and is typically expressed as relative percent difference (RPD) for duplicate measurements or relative standard deviation (RSD) for replicate measurements. Bias is the difference between an observed value and the "true" or "target" value of the parameter being measured and is typically expressed as %Bias from a known standard or %Recovery of a spiked quantity. The typical equations are:

**Precision:**

Between duplicate measurements: $$RPD = \left(\frac{2|x_2 - x_1|}{x_1 + x_2}\right) \cdot 100$$ Equation 1

where $x_1$ is the initial measurement and $x_2$ is the duplicate measurement

Between replicate measurements: $$\%RSD = CV = \left(\frac{\sigma}{\bar{x}}\right) \cdot 100$$

Equation 2

where $CV$ is the coefficent of variation, $\sigma$ is the standard deviation of the replicate measurements and $x$ bar is the average of the replicate measurements.

**Bias:** $$\%Bias = \left(\frac{\bar{x}-T}{T}\right) \cdot 100 \textbf{ or } \%Recovery = \left(\frac{\bar{x}}{T}\right) \cdot 100$$ Equation 3

where $T$ is the true value and x bar is the average of a measurement.

**Completeness:** $$\%C = \left(\frac{D_v}{D_p}\right) \cdot 100$$ Equation 4

Where $D_V$ is the number of valid data collected and $D_p$ is the number of planned data

### 5.1.2 Measurement Quality Objectives for Gravimetry

Because some of the filters analyzed under this QAPP support NAAQS decision making, gravimetric analyses are performed in accordance with 40 CFR Part 50, Appendix L and *Quality Assurance Guidance Document 2.12*, *Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods*. Tables 5-1, 5-2, and 5-3, below, outline the laboratory requirements for $PM_{2.5}$ gravimetric measurements, found in the USEPA document *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Ambient Air Quality Monitoring Program*.

For each criterion the tables include: the requirement; the frequency with which compliance is to be evaluated; acceptance criteria; and information where additional guidance on the requirement can be found.

Criteria that are deemed critical to maintaining the integrity of a sample or group of samples are outlined in Table 5-1. Observations that do not meet each and every criterion on the Critical Criteria should be invalidated unless compelling reasons and justification for not doing so can be demonstrated. The cause of not operating in the acceptable range for each of the violated criteria must be investigated and corrective action taken to reduce the likelihood that additional samples will be invalidated.

Criteria that are important for maintaining and evaluating the quality of the data collection system are included under Operational Criteria in Table 5-2. Violation of a criterion or a number of criteria may be cause for invalidation. USEPA and/or SLT should consider other quality control information that may or may not indicate the data are acceptable for the parameter being controlled. Therefore, the sample or group of samples for which one or more of these criteria are not met are suspect unless other quality control information demonstrates otherwise. The reason for not meeting the criteria must be investigated, mitigated or justified, and corrective action taken to reduce additional suspect data points.

**Table 5-1 Gravimetric Analysis Critical Criteria**

| Critical Criteria | Frequency | Acceptance Limits | Reference |
|---|---|---|---|
| CSN Post Sampling Weighing (Hold Time)[a] | All Filters | ≤30 days from sample end date if sample receipt temperature < 4° C, or<br>≤30 days from sample end date if sample receipt temperature >4° C but < average ambient temperature during sampling (TT AQS flag also applied), or<br>≤10 days if sample receipt temperature > 4° C and > average ambient temperature during sampling (apply TT AQS flag also applied) | 40 CFR part 50 Appendix L § 8.3.6 and § 10.13 |
| Tribal, FRM and Special Studies Weighing (Hold Time)[a] | All Filters | ≤30 days from sample end date if sample receipt temperature < average ambient temperature during sampling, or<br>≤30 days from sample end date if sample receipt temperature > average ambient temperature during sampling but <4° C, or<br>≤10 days from sample end date if sample receipt temperature > 4°C and > average ambient temperature during sampling | 40 CFR part 50 Appendix L § 8.3.6 and § 10.13 |
| Unexposed filter visual defect check | All Filters | Correct type & size; for pinholes, particles or imperfections | 40 CFR Part 50, App. L § 10.2 |
| Filter equilibration time | All Filters | 24 hours minimum | 40 CFR Part 50, App. L § 8.2.5 |
| Filter equilibration temperature range | All Filters | 24-hr mean 20.0-23.0° C | 40 CFR Part 50, App. L § 8.2.1 |
| Filter equilibration temperature control | All Filters | < 2.1° C Δ over 24 hr | 40 CFR Part 50, App. L § 8.2.2 |
| Filter equilibration humidity range | All Filters | 24-hr mean 30.0% - 40.0% Relative Humidity (RH) | 40 CFR Part 50, App. L § 8.2.3 |
| Filter equilibration humidity control | All Filters | < 5.1 % Δ per hr | 40 CFR Part 50, App. L § 8.2.4 |

| Critical Criteria | Frequency | Acceptance Limits | Reference |
|---|---|---|---|
| Filter pre/post sampling RH difference | All Filters | Difference in 24-hr means < + 5.1% RH | 40 CFR Part 50, App. L § 8.3.3 |
| Microbalance location | All Filters | Located in filter conditioning environment | 40 CFR Part 50, App. L § 8.3.2 |
| Microbalance auto-calibration | Prior to each weighing session | Manufacturer's specification | 40 CFR Part 50, App. L § 8.1 and Method 2.12 § 10.6 |

[a]Sampled filters must be protected from exposure to temperatures above 25° C from sample retrieval to conditioning. See technical note on holding time requirements at [EPA's website](https://www3.epa.gov/ttn/amtic/pmpolgud.html) [ttps://www3.epa.gov/ttn/amtic/pmpolgud.html](https://www3.epa.gov/ttn/amtic/pmpolgud.html). Should filters arrive > 25° C, then the TS (holding time or transport temperature is out of specs) null code should be applied in AQS.

**Table 5-2 Gravimetric Analysis Operational Criteria**

| Operational Criteria | Frequency | Acceptance Limits | Reference |
|---|---|---|---|
| Lot Blanks | 9 filters per lot | < ±15.1 µg change between weighings | Method 2.12 § 10.5 |
| Exposure Lot Blanks | 3 filters per lot | < ±15.1 µg change between weighings | Method 2.12 § 10.5 |
| Filter Integrity (exposed) | All filters | No visual defects | Method 2.12 § 10.7 and 10.3 |
| Field Filter Blank (Lab QC) | 10% or 1 per weighing session | < ±30.1 µg change between weighings | 40 CFR Part 50, App. L § 8.3.7.1 2 and Method 2.12 Table 7-1 & § 10.5 |
| Lab Filter (Batch) Blank | 10% or 1 per weighing session | < ±15.1 µg change between weighings | 40 CFR Part 50, App. L § 8.3.7.2 2 and Method 2.12 § 10.5 |
| Balance Check (working standards) | Beginning, 10th sample, end | < ±3.1 µg from certified value | Method 2.12 § 10.6 Standards used should meet specifications in Method 2.12, § 4.3.7 |
| Routine filter reweighing | 1 per weighing session | < ±15.1 µg change between weighings | Method 2.12 § 10.8 |
| Microbalance audit | Annually (every 365 days) | < ±0.003 mg or manufacturers specs, whichever is tighter | Method 2.12 § 11.2.7 |
| Lab temperature logger check | Every 90 days | < ±2.1° C | Method 2.12 § 11.2.8 |
| Lab humidity logger check | Every 90 days | < ±2.1 % | Method 2.12 § 11.2.8 |

| Operational Criteria | Frequency | Acceptance Limits | Reference |
|---|---|---|---|
| Microbalance calibration | At installation, and annually (every 365 days) | Manufacturer's specification | 40 CFR Part 50, App. L, § 8.1 and Method 2.12 § 10.11 |
| Lab temperature certification | Annually (every 365 days) | < ±2.1° C of certifying standard | Method 2.12 § 4.3.8 and 9.4 |
| Lab humidity certification | Annually (every 365 days) | < ±2.1 % RH of certifying standard | Method 2.12 § 4.3.8 and 9.4 |
| Working mass standards certification | Annually (every 365 days) | 0.025 mg tolerance (ASTM Class 2) | Method 2.12 § 4.3.7 & 9.7 |
| Working mass standards comparison to primary standards | Every 90 days | 0.025 mg tolerance (ASTM Class 2) | Method 2.12 § 4.3.7 & 9.7 |
| Primary mass standards certification | Annually (every 365 days) | 0.025 mg tolerance (ASTM Class 2) | Method 2.12 § 4.3.7 & 9.7 |

Systematic Criteria are important for the correct interpretation of the data, but do not usually impact the validity of a sample or group of samples, and are included Table 5-3.

**Table 5-3 Gravimetric Analysis Systematic Criteria**

| Systematic Criteria | Frequency | Acceptance Limits | Reference |
|---|---|---|---|
| Microbalance readability | At purchase | 1 µg | 40 CFR Part 50, App. L § 8.1 |
| Working mass standards | At purchase | 0.025 mg tolerance (ASTM Class 2) | |
| Primary mass standards | At purchase | 0.025 mg tolerance (ASTM Class 2) | |

The gravimetric MQOs for Teflon filters also include a 90% completeness goal. Completeness is based on the number of filters successfully exposed and returned to Wood for gravimetric analysis.

### 5.1.3 Measurement Quality Objective for FiSH Procedures

The MQO for FiSH procedures is for applied AR codes to have an occurrence rate no greater than 10 percent annually.

### 5.1.4 Measurement Quality Objectives for Optical Density Analyses

Optical density measurement error will be determined as data are gathered under the proposed effort. The completeness goal for optical density is 90%. In addition, the MQOs for optical density analyses related to precision, accuracy, and lower quantifiable limit are:

- Precision – from replicate measurements - ± 5%
- Accuracy – from calibration standards - ± 5%
- Lower quantifiable limit – ± 0.02 OD units

### 5.1.5 Measurement Quality Objectives for Filter Acceptance Testing

Filter acceptance testing criteria are evaluated on a pass/fail basis. Filters that are acceptance tested essentially either meet the acceptance criteria or do not. If they do not, then the box and/or lot fails and the filters are not deemed acceptable. With respect to analyzing filters for acceptance testing, the acceptance criteria are defined by the contract. For ion analysis on nylon filters, the acceptance criteria is less than or equal to 1 µg/filter of any ion evaluated. For carbon analysis on quartz filters, the acceptance criteria is 1.5 $\mu g/cm^2$ for total carbon.

Details on the criteria for calibration curves, duplicates, blanks, and quality assurance requirements for acceptance tests are included in SOP GLM3180-010, *Acceptance Testing of Nylon Filters by Ion Chromatography for the Chemical Speciation Network;* SOP #2-106r8, *"Pre-firing and Acceptance Testing of Quartz Fiber Filters for Aerosol and Carbonaceous Material Sampling" (DRI, 2017),* SOP #2-23 1r0 *"ORI Model 2015 Multiwavelength Thermal/Optical Carbon Analysis (TOR/TOT) of Aerosol Filter Samples -Method IMPROVE_A for the Chemical Speciation Network"(DRI 2017)* , found in Appendix A.

## 6.0 Special Training Requirements/Certification

New analysts, with appropriate educational background, will be required to be experienced with the basic measurement techniques relevant to the analyses that they are to perform. For this portion of the CSN program (and this contract in particular) those techniques include only the operation of an analytical microbalance, ion chromatography (for acceptance testing only), OC/EC determination (for acceptance testing only) and transmissometer operation. Training will include development of an understanding of how changes in certain parameters (e.g., temperature and relative humidity) can influence or interfere with potential measurements. Subcontractor staff training will be ensured by evaluating the subcontractor's training and certification requirements in their QAPP and by examining their training records.

With the necessary background experience in the basic methodology, as well as the appropriate educational background, the analyst in training (hereafter referred to as the 'trainee') will be required to read and understand the relevant SOP(s) (see Appendix A for specific SOPs related to gravimetric mass, ion acceptance testing for nylon filters, pre-firing and acceptance testing of quartz filters and optical density analyses). Under the direction of an experienced analyst, the trainee will follow the SOP and use the method to analyze reference samples and, if available, samples that have been analyzed previously by an experienced analyst. These samples might include split filters, filter extracts, and whole filters. This effort will be continued until the analyst achieves MQOs for recovery (or bias) and precision. The Technical Area Supervisor or mentor will also monitor the performance of the trainee, checking such operations as calibration, data treatment, system maintenance, and record keeping. With both acceptable analytical results and a successful systems audit (see Section 18), the trainee will be considered ready to perform program sample analyses for the methodology for which they were trained. Even then, the trainee (now referred to as 'new analyst') will work under the direction of a mentor until the mentor concludes the new analyst is ready to work independently. Ongoing performance will be monitored by the program QA Manager through review of analytical data that have been generated by the new analyst. For specific details of the review procedure please refer to Section 18 of this QAPP.

Wood will require gravimetric analysts to be trained in similar aspects as those required for the certification test administered to analysts working on the USEPA's $PM_{2.5}$ Federal Reference Method Performance Evaluation Program (FRM PEP). In particular, laboratory personnel involved in gravimetric analysis will be trained to the guidance provided in 40 CFR Part 50, Appendix L and Quality Assurance Guidance Document 2.12, Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods.

Laboratory personnel will be trained on the following topics:

- General laboratory preparation
- Equipment inventory and maintenance
- Communications
- Filter handling including loading and unloading of filter media
- Filter conditioning
- Calibrations
- Filter weighing
- Filter shipping

- Using the gravimetric internal laboratory COC Form
- Data entry and data transfer
- Using the FSCOC form
- Storage and archiving
- QA/QC

CSN Staff are trained, certified and documented according to each task for which they perform.

Permanent, already trained, Wood employees, including high-level personnel and Technical Area Supervisors, are eligible to attend training courses relevant to the project areas. Both in-house and extramural training opportunities are provided to Wood employees at the company's expense. Project staff will be encouraged to attend courses such as manufacturers' training sessions or method-specific courses that are relevant to this program. Appropriate subcontractor training will be evaluated during audits (see Section 18).

Training and associated proficiency test results will be documented in the analysts' training folder. This will include a record of reading and utilizing the appropriate SOP(s) (see Appendix A for potentially applicable SOPs) and verification by the Technical Area Supervisor and/or mentor that acceptable method performance has been demonstrated. For non-laboratory analyst personnel, these folders (which will be available for review and maintained by the on-site QA Manager) will include records of formal training and in-house training and testing. For Wood laboratory analysts (gravimetric, acceptance testing and optical density), the training folders will be maintained by the Laboratory Manager in a designated location and will be available for review by both the analysts and on-site QA Manager.

Wood and AKEA FiSH staff will be trained according to SOP GLO3110-001 standards.

## 6.1 Current Personnel

Wood staff who have previously demonstrated acceptable recovery and precision from analysis of reference samples, field samples, and performance evaluation (PE) samples will not require additional training for chemical and gravimetric analyses. Analysts and other personnel will receive copies of the QAPP and relevant SOPs necessary to perform their duties. These documents will contain the requirements applicable for the performance of each analyst's job. Position titles are Wood classifications (see **Table 6-1**).

### 6.1.1 Program Manager

The program manager for the contract will have education and experience qualifications equivalent to that of Senior Engineer/Scientist or above.

### 6.1.2 Analytical Laboratory Staff

Analytical procedures (gravimetric mass determination**,** optical density determination, denuder refurbishment or the method used for nylon filter ion chromatography acceptance testing) will utilize staff at Laboratory Technician (Laboratory) II or higher. Work will be performed under supervision of the Wood Laboratory Manager who is classified as a Technician (Laboratory) IV or higher. Education and experience requirements for those labor categories are detailed in Table 6-1. Wood analytical laboratory staff meet these requirements.

**Quart Filter Pre-firing and Acceptance Testing**

Quartz filter pre-firing and acceptance testing will be performed by Wood’s subcontractor, DRI. Staff used for routine analyses will have training equivalent to Wood’s Technician II labor category. Work will be supervised by a laboratory manager with training/education equivalent to or greater than Wood’s Technician IV labor category.

### 6.1.3 FiSH (Filter Shipping and Handling Unit) Staff

**Sample Handling**

FiSH staff, with the exception of the FiSH supervisor (Wood Program Manager), are Technicians (Environmental) I through III. The required qualifications for these positions are shown in Table 6-1. FiSH staff will be Technician I or above.

The FiSH Supervisor is required to have education and experience equivalent to or greater than Wood’s Scientist I labor category. Experience and educational requirements for that labor category are included in table 6-1. Further explanation of FiSH training is found in SOP3110-001.

### 6.1.4 Database Development/Management Staff

Database development and management staff are required to have education and experience equivalent to or greater than Wood’s Software Engineer labor category. The education and experience qualifications for that labor category are included in table 6-1. Mr. Barnard is at or above this labor category.

### 6.1.5 Quality Assurance Staff

The QA Manager for this contract is organizationally independent from the Wood Program Manager and as such is supervised by Wood’s corporate Director of Quality Assurance. The QA Manager has knowledge of QA standards and the applicability of these standards; produces Quality Management Plans (QMP), SOP’s and project plans for review and approval by the Program Manager; possesses the skills necessary to independently evaluate, select and apply techniques and procedures to perform technical tasks, field studies and analysis with on-going review from project management staff; and provides guidance to data and lab personnel. Their education and experience requirements are equivalent to or greater than that of Wood’s Senior Scientist 2 QA. Ms. Glubis is in this labor category.

The QA Specialist assists the QA Manager in evaluating, preparing and reviewing the QAPP and SOPs that relate to this project. The education and experience qualifications are equivalent to the Wood labor category of Professional Engineering / Scientist 3. Ms. Edwards is in this labor category.

**Table 6-1 Labor Category Qualifications**

| Title of Labor Category | Knowledge, Skills, Ability | Minimum Education | Minimum Experience | Allowable Substitution of Experience for Education |
|---|---|---|---|---|
| Associate Engineer/Scientist | ▸ Has the knowledge to manage and supervise medium to large groups of staff or exercise authority over a small group of highly professional personnel engaged in complex technical applications. Has technical skills and ability necessary to lead large consulting projects.<br>▸ May possess professional registration or certification. | BS or MS Engineering, Science or related technical field; professional registration or certification a plus. | 15 years of related experience | 2 years post BS experience = MS |
| Software Engineer | ▸ Has knowledge of database design, software programming, including an understanding of a variety of programming languages and data query languages and tools. Can design and create databases and data warehouses. Provides technical direction to application development and production operations staff with regards to database design, development and technical problem resolution. Has the skills to design/write scripts/supporting data extraction, transformation and loading (ETL) required for custom and ad-hoc reporting in enterprise-wide areas. Possesses sufficient programming skills necessary to develop computer code for components of projects while ensuring adherence to programming standards and documentation. Skills include development of solutions and writing of detailed program requirements and specifications. Writes code, tests, debugs, documents and deploys custom applications and database systems and their components. | BS in Computer Science or Information Technology | 2 years minimum work experience | Associate's degree in Computer Science or Information Technology or other scientific degree and 4 minimum years of experience or 8 minimum years directly related full-time work experience.<br>2 yr experience = Associate of Arts (AA)/Associate of Science (AS)<br>4 yr experience = BS<br>6 yr experience = MS |

| Title of Labor Category | Knowledge, Skills, Ability | Minimum Education | Minimum Experience | Allowable Substitution of Experience for Education |
|---|---|---|---|---|
| Principal Engineer/Scientist QA | ▸ Has a thorough understanding of QA procedures and processes. Can organize and prepare QA management plans and project plans. Has the skills necessary to independently evaluate, select and apply techniques and procedures to evaluate QA measures from a statistical perspective for field, laboratory and data management perspectives. Provides independent review and feedback on project QA performance to upper management and to project managers. Provides guidance to Senior Scientist 2 QA<br>▸ May possess professional registration or certification. | BS or MS Engineering, Science or related technical field; professional registration or certification a plus | 15 years of related experience | 2 years post BS experience = MS |
| Senior Scientist 2 QA | ▸ Has knowledge of QA standards and applicability. Produces QA management plans, project plans and standard operating procedures for review and approval by Principal Engineer/Scientist QA. Has the skills necessary to independently evaluate, select and apply techniques and procedures to perform technical tasks, field studies and analysis with on-going review from project management staff. Provides guidance to field, data and lab personnel. | BS or MS Engineering, Science or related technical field; professional registration or certification a plus. | 10 years of related experience with BS | 8 years of related experience with MS |
| Senior Engineer/Scientist 2 | ▸ Has the knowledge and skills necessary to perform significant components of work on tasks on large and/or technically complex projects with minimal oversight. Has the ability to prepare reports, calculations and analyses for project tasks. Produces non-routine plans and report sections.<br>▸ Directs and supervises technical assignments. | BS or MS Engineering, Science or related technical field; professional registration or certification a plus. | 10 years of related experience with BS Engineer in Training (EIT) for engineers | 8 years of related experience with MS<br><br>EIT for engineers |

| **Title of Labor Category** | **Knowledge, Skills, Ability** | **Minimum Education** | **Minimum Experience** | **Allowable Substitution of Experience for Education** |
|---|---|---|---|---|
| Senior Engineer/Scientist 1 | ▸ Has the knowledge and skills necessary to perform work on tasks on large and/or technically complex projects with minimal oversight. Has the ability to prepare reports, calculations and analyses for project tasks. Produces non-routine plans and report sections.<br>▸ Directs and supervises technical assignments. | BS or MS Engineering, Science or related technical field; professional registration or certification a plus. | 5 years of related experience with BS EIT for engineers | 3 years of related experience with MS |
| Professional Engineer/Scientist 3 | ▸ Has the ability and knowledge to independently evaluate, select and apply techniques and procedures to perform technical tasks, field studies and data analysis with on-going review from project management. Supervises field technicians. Develops procedures and modifies instrumentation necessary to support special studies and analyses. Provides guidance to field and data personnel. | BS or MS Engineering, Science or related technical field | 3 plus years of related experience with BS EIT for engineers | 1 years of related experience with MS EIT for engineers |
| Technician 4 | ▸ Has knowledge sufficient to perform assignments which are generally complex or of a non-routine nature. May gather and prepare cost estimates for proposals for routine programs of work, equipment purchases and/or field studies. Prepares draft sections of reports and standard operating procedures related to investigations, testing programs, inspection or analysis. Performs field testing; uses equipment and instrumentation. May supervise up to 12 other technicians. | High School Diploma, AA or AS degree | 12 years of related experience. | 2 years of experience = AA/AS |

| Title of Labor Category | Knowledge, Skills, Ability | Minimum Education | Minimum Experience | Allowable Substitution of Experience for Education |
|---|---|---|---|---|
| Technician 3 | ▸ Has skills and ability to solve problems requiring some professional judgment. May supervise the work of up to five technicians and may deal directly with clients on routine matters. Performs field testing; uses equipment and instrumentation. Works under limited supervision. | High School Diploma | 7 years of related experience. | 2 years of experience = AA/AS |
| Technician 2 | ▸ Performs a wide variety of simple tests or procedures, routine analysis or calculations to check accuracy, applicability and reasonableness of data. Writes daily reports. Performs field testing; uses equipment and instrumentation. | High School Diploma | 2-5 years of related experience; | 2 years of experience = AA/AS |
| Technician 1 | ▸ Performs standard and some non-standard tests. Collects data. Performs routine and some non-routine calculations and measurements. Writes daily reports. Performs field testing; uses equipment and instrumentation. | High School Diploma | 0-2 years of related experience; | 2 years of experience = AA/AS |

### 6.2 Summary of Experience and Training

The qualifications of each analyst are maintained in training folders by area supervisors, along with a record of courses taken, special in-house training, and results of proficiency tests.

### 6.3 New Personnel

Wood will integrate and train new personnel as necessary to meet the needs of this program. Wood's approach to assessing and training new hires (and cross-training of existing employees) is as follows:

- New personnel are interviewed and their credentials carefully assessed with regard to prior experience and aptitude for the assigned task. Candidates are interviewed by the Technical Area Supervisor and by at least one other senior-level project participant, such as the Program Manager, QA Manager, or a Technical Area Supervisor in another area.
- Wood's regular and temporary personnel to be hired for sample shipping and receiving in the FiSH must have excellent work habits and must be particularly careful and attentive to detail. These individuals must also be comfortable with working under tight deadlines imposed by contractual turnaround times. References will be contacted to verify that the applicant meets these particular qualifications with regard to work habits.
- New personnel hired specifically to conduct procedures in the analytical laboratories (e.g., gravimetric or acceptance testing via IC) will have 2 years of experience or equivalent aptitude. Individuals are assessed on a case-by-case basis by the Technical Area Supervisor. References are contacted to verify that the applicant has the required laboratory skills and aptitude. Wood subcontractors utilize a similar approach for new hires involved in analytical endeavors under this contract, which is verified during audits.
- For individuals hired as permanent Wood employees, a probationary period of 6 months is provided, at which time the employee may be terminated for failing to meet required job standards; temporary employees may be dismissed at any time. The majority of training is on-the-job and is provided by the Technical Area Supervisor or by a staffer who has already mastered the task area. The specific SOPs are the main training material used.
- SOPs will be written in sufficient detail to allow a new staff member with the requisite training and experience to perform the task. Departures from the written SOPs will require consultation with the Technical Area Supervisor for that area, documentation of the deviance from approved procedures, and corrective actions. Departures from SOPs necessitated by systematic or recurring problems shall result in corrective actions, which may include revision of the SOP.
- New hires will work under close supervision of the Technical Area Supervisor. The individual may work unsupervised only after the Technical Area Supervisor provides a memo to the individual's training file. Analysts must demonstrate proficiency with analyzing standards and duplicates of previously analyzed samples. These results will be included in the training file.

# 7.0 Documentation and Records

**Table 7-1** provides a summary of the documentation and records that will be maintained in each functional area for this program. Management records will include monthly data reports to USEPA, correspondence with the USEPA Project Officer and Technical Project Manager, and correspondence with the CSN Regional Representatives. Consolidated Delivery Order requests from the USEPA Project Officer will be received and examined by the Program Manager and will be circulated for advanced planning and materials procurement. Wood will ensure that only the most recent approved QAPP and SOP revisions are available to the appropriate personnel. Documents will contain the effective date, revision number, control number, and document title. Documents will be posted in a master list and also have documented distribution. Project documents will be reviewed annually.

**Table 7-1 Management Documentation and Records**

| Document Name | Brief Description | Format | Storage Location |
|---|---|---|---|
| Monthly Data Reports | Monthly data reports to USEPA | Electronic | Wood Server |
| Quarterly Metadata Reports | Quarterly network information | Electronic | Wood Server |
| Correspondence | Contractual correspondence with USEPA | Electronic | Wood Server |
| Purchase Requisitions | Copies of approved purchase orders | Electronic | Wood Server |
| E-mail | The Program Manager’s project-related e-mail correspondence | Electronic | Wood Server |

## 7.1 QA/QC Documentation and Records

**Table 7-2** shows the QA/QC records that will be maintained.

**Table 7-2 QA/QC Documentation and Records**

| Document Name | Brief Description | Format | Storage Location |
|---|---|---|---|
| Training Files | Records substantiating the training and proficiency of analysts/personnel relevant to this program | Hard Copy | Program Office |
| Audits, and results | Results of internal QA surveys and audits (including ADQ and subcontractor audits) | Hard Copy or electronic | Program Office or Wood Server |
| QAPP | Master version of QAPP | Hard Copy and electronic | Program Office, Wood Server and laboratories |

| Document Name | Brief Description | Format | Storage Location |
|---|---|---|---|
| SOPs | Current version of SOPs | Hard Copy and electronic | Program Office, Wood Server and appropriate laboratories |
| Analytical Results | Calibration and QC check data. Sample analysis results. | Hard Copy and electronic | Program Office and Wood Server |
| Corrective Action Response Memoranda | Results of identified QA problems and their resolutions | Hard Copy | Program Office and Wood Server |

## 7.2 FiSH Documentation and Records

**Table 7-3** shows the records that will be maintained by the FiSH.

**Table 7-3 FiSH's Documentation and Records**

| Document Name | Brief Description | Format | Storage Location |
|---|---|---|---|
| Delivery Order | Instructions from the USEPA Project Officer for sampling module needs | Hard Copy and electronic | Program Office and FiSH |
| Chain-of-Custody/Measurement Request Form | Forms used to track sample module shipments and details of the assembly of a module for a specific sampling event between Wood and the state and local agencies | Electronic (database) and Hard copy (duplicate form – original to Wood, copy 2 to field site) | FiSH /Database and Hardcopy |
| Laboratory Chain-of-Custody Transmittal Forms | Forms used to track groups of aliquots shipped from Wood to the Network analytical laboratories | Hard Copy and electronic | FiSH and laboratory |
| FiSH Schedule | Schedules shipments, receipt of containers, and assembly and disassembly of modules according to Delivery Orders supplied by the USEPA Project Officer. | Hard Copy | FiSH |
| Equipment Inventory Form | Lists current inventory of module parts for a specific site stored in a bin in the FiSH | Electronic | Database |
| Container Checklist Form | Inventory of contents sent in a shipping container to a specific sampling site | Hard Copy | FiSH |

| Document Name | Brief Description | Format | Storage Location |
|---|---|---|---|
| Level 0 Validation Form | Identifies containers received at the FiSH at a particular date/time and details modules received in a container returned from a sampling site and documents sample condition, integrity and temperature. | Hard Copy | FiSH |
| Analysis List for Sampling Event | Details the requested analysis for a particular sampling event | Electronic | Database |
| Analysis Batch Checklist | Documents tasks performed to ensure proper delivery of Analysis Batch filters and data. | Hard Copy | Analysis Batch Files |
| Filter Shipment Chain of Custody Form | Matches filters/pieces of filters to analysis and provides cross reference to sampling events. Details filters that are shipped to analytical laboratories for analysis. | Hard Copy and Electronic | FiSH/Database |
| URG Flash Card Data From URG 3000N | Continuous record of flow and other operational information | Flash Memory Cards | Database/File Server |
| Current QAPP and relevant SOPs | Copies of the current QAPP and SOPs relevant to the FiSH operations | Electronic | File Server |

### 7.3 Gravimetric Mass Laboratory Documentation and Records

The gravimetric mass laboratory will maintain records shown in **Table 7-4.**

In addition to the records in table 7-4, the gravimetric mass laboratory will receive a monthly filter order from the FiSH to accommodate program sampling requests. The CSN Regional Representative receive the sampling requests from the various state agencies and provides these requests to the Technical Project Manager who consolidates these requests into Delivery Orders, which are sent to Wood by the USEPA Project Officer. Information derived from the Delivery Orders is distributed to the FiSH, data management, and the gravimetric laboratory, so that the FiSH operations, materials (e.g., filters and reagents), and laboratory personnel can be scheduled as necessary. Each month, the FiSH supervisor will calculate the projected number of Teflon filters that will be needed to meet that month’s sampling and field blank requirements. This projection is sent to the gravimetric mass laboratory via e-mail so that a sufficient number of filters can be ordered in advance.

### Table 7-4 Gravimetric Mass Laboratory Documentation and Records

| Document Name | Brief Description | Format | Location |
|---|---|---|---|
| Filter Inventory and Inspection Logbook | Completed upon receipt of filter lots from the vendor; indicates the order to use filter boxes, date inspected, and number of filters rejected | Hard copy and spreadsheet | Gravimetric mass laboratory/Database |
| Filter Conditioning Information | Indicates the dates filters were conditioned and stability test results | Hard Copy | Gravimetric mass laboratory |
| Calibration Certificates and Records | Includes certificates of National Institute of Standards and Technology (NIST) traceability and similar records | Hard Copy | Gravimetric mass laboratory |
| Gravimetric Filter Database | Includes filter ID, initial weighing information (including date, RH, temperature, filter analysis ID), final weighing information (date, RH, temperature, and weight), and mass loading of the filter, and all QC information for each weighing session including standard weights, duplicates, field blanks, and laboratory blanks | Electronic | Spreadsheet and laboratory information management system (LIMS) |
| Weighing Room Environmental Data | Recorded to spreadsheet over 24 hour periods or at least 24 hours prior to every weighing session. | Spreadsheet | Project site server |
| Internal Tracking Forms | Forms used to track samples batches between the FiSH and the laboratory | Hard Copy and Laboratory LIMS | Copy retained by gravimetric mass laboratory |
| Laboratory Logbooks | Individual analyst' comments; instrument maintenance logs | Hard Copy | Laboratory |
| Control Charts | Graphical QC results; usually includes acceptance limits that are periodically recomputed | Hard Copy and Laboratory LIMS | Copy retained by gravimetric mass laboratory and LIMS |
| QAPP and relevant SOPs | QAPP and SOPs related to gravimetric mass determinations | Electronic | File server project directory |

| Document Name | Brief Description | Format | Location |
|---|---|---|---|
| *For a description of the Laboratory Information Management System (LIMS) as well as for more details on the documentation referenced in this table please refer to section 11 of this QAPP.* | | | |

### 7.4 IC Laboratory Documentation and Records

The IC laboratory will maintain records shown in Table 7-5. For more information on these records and IC procedures in general please refer to section 12.2 of this QAPP.

**Table 7-5 IC Laboratory Documentation and Records**

| Document Name | Brief Description | Format | Location |
|---|---|---|---|
| Calibration Certificates and Records | Includes certificates of NIST traceability and similar records | Hard Copy | IC laboratory |
| "Method" Database | Contains information required to automate the analyses | Computer Files | IC laboratory |
| QC Records | Results of calibrations, standard reference material (SRM) recoveries, and replicate precision | Computer Files, spreadsheets, database files | IC laboratory and database |
| Raw Data Records | Results of acceptance testing analyses | Computer files, spreadsheets, database files | Instrument PC, analysts' PC, database computer |
| Laboratory Notebooks | Individual analysts' comments; instrument maintenance logs | Hard Copy | IC laboratory |
| Instrument User's Manual | Information for setting up, using, and troubleshooting the IC instruments | Hard Copy | IC laboratory |
| QAPP and relevant SOPs | QAPP and SOPs related to IC acceptance testing of nylon filters | Electronic | File server project directory |

### 7.5 Denuder Refurbishment Laboratory Records

The Denuder Refurbishment Laboratory will maintain records shown in Table 7-6.

**Table 7-6 Denuder Refurbishment Laboratory Records**

| Document Name | Brief Description | Format | Location |
|---|---|---|---|
| Personnel Training Records | Date and description of training or inspection | Hard copy | Denuder Lab |
| Denuder Refurbishment Information | Date, number, and type of denuders refurbished and technician name | Hard copy | Denuder Lab |
| SOP | SOPs for magnesium oxide coating of denuders | Hard copy, loose-leaf binder and electronic | Denuder Lab/File Server |
| Reagent Purity Records | Reagent lot numbers and purity analyses | Hard copy, notebook | Denuder Lab |
| QAPP and relevant SOPs | QAPP and SOPs related to denuder refurbishment | Electronic | File server project directory |

## 8.0 Sampling Process Design (Experimental Design)

The experimental design, including design of the sampling network and sampling locations, is outside the program scope and is not addressed in this QAPP. Refer to USEPA planning documents available on the USEPA's AMTIC Web site. For details of the overall process (i.e filter acceptance testing, gravimetric analysis, sample handling and processing system, etc.) that takes place at the FiSH and Wood's analytical laboratory please refer to section 11 of this QAPP and the relevant SOPs in Appendix A.

# 9.0 Sampling Methods Requirements

Actual collection of samples is outside the scope of this QAPP and is not addressed herein. The CSN Field QAPP prepared for OAQPS contains a full description of sample acquisition, including sample COC, which meshes closely with operations of the FiSH. The Field QAPP is available on the AMTIC web site (http://www3.epa.gov/ttn/amtic/).

Procedures for acceptance testing of filters used in sampling media as well as procedures performed before filters and/or sampling media are deployed for use in the field are addressed below.

## 9.1 Teflon Filters

Acceptance testing for 47-mm Teflon filters consists of visual inspection for defects, tears, and pin holes. Teflon filters designated for gravimetric analysis are visually inspected by Gravimetric Lab staff before the start of the weighing procedure. Teflon filters that are loaded directly into sampling cartridges, (i.e. do not undergo gravimetric analysis) are visually inspected by FiSH staff for visible defects such as pinholes and tears before being loaded into the components.

Please refer to Appendix A, SOP GLO3110-002 for further information regarding Teflon filter visual inspection.

## 9.2 Nylon Filters

Forty-seven mm Nylon filters to be used for sampling for the CSN are acceptance tested for:

- Anions: Chloride ($Cl^-$), Nitrate ($NO_3^-$), Sulfate ($SO_4^{2+}$).
- Cations: Sodium ($Na^+$), Ammonium ($NH_4^+$), Potassium ($K^+$).

Please refer to Appendix A, SOP GLM3180-010, *Acceptance Testing of Nylon Filters by Ion Chromatography for the Chemical Speciation Network* for a detailed description of Wood's acceptance testing procedures.

## 9.3 Quartz Fiber Filters

Quartz fiber filters for use in sampling for the CSN are pre-fired and acceptance tested by DRI. The filters are pre-fired first in order to reduce gases absorbed from ambient air and artifacts from the manufacturing process.

DRI will provide pre-firing of 25-mm quartz filter media (typically used in URG 3000N samplers) prior to use by Wood's shipping and handling operations. Pre-firing involves heating of the filters anticipated for use in the network to 900˚C for a period of at least four (4) hours.

Purchased filter batches will be sent to DRI for acceptance testing prior to samples being obtained in the field using the URG 3000N sampler or for filter blanks following the same analysis method as employed by the IMPROVE program. This analytical protocol, known as IMPROVE_A, was developed by DRI using the DRI Model 2001 Thermal/Optical Carbon Analyzer (manufactured by Atmoslytic, Calabasas, CA) and was placed in service in the IMPROVE program beginning January 1, 2005. The method is based on the technical requirements given in DRI's SOP 2-106r8 *"Pre-firing and Acceptance Testing of Quartz-Fiber*

*Filters for Aerosol and Carbonaceous Material Sampling,"* (September 27, 2017), located in Appendix A.

### 9.4 Pre- and Post-Sampling Gravimetry

Gravimetric analysis is conducted for the Tribal sites and a few regular CSN sites. Please refer to Appendix A, SOP GLM3180-009, *Determination of Particulate Matter (PM) Gravimetric Mass for the Chemical Speciation Network* for a detailed explanation of procedures.

### 9.5 Denuder Refurbishment

Magnesium Oxide (MgO) denuders are used in the Met One SASS/SuperSASS module that contains the Nylasorb (nylon) filter. Denuder use is for scrubbing acid gases only. Therefore, denuders are not extracted after sampling as extracts are not required for further analyses. The denuder coating, however, does require refurbishment after approximately 30 exposures (which is tracked in the CSN Tracking Database) in order to effectively scrub out gases. Denuders are refurbished on an annual basis, which is within the approximate 30 exposures recommended. Please refer to Appendix A, GLO-03180-040, *Cleaning and Coating of Aluminum Honeycomb Denuders* for details of the cleaning and coating procedure.

### 9.6 URG Filter Pack Leak Checking

Leak checking for URG 3000N filter packs is performed annually. For details on the methodology, please refer to Appendix A, GLO3110-005, *Standard Operating Procedures for Leak Checking the URG 3000N Filter Cassette* for details of the procedure.

### 9.7 Optical Density Analyses

While not currently being performed, optical density analyses may be requested under the contract. For details on the methodology for optical density analyses, please refer to Appendix A, GLM-3180-011, *Procedure for Dual-Wavelength Optical Density Analyses*.

# 10.0 Sample Handling and Custody Requirements

**Note:** This section relies heavily on the design of Wood's sample handling system, including the FiSH. Please refer to SOP GLO3110-002, *Field Shipping and Handling*, in Appendix A for more details.

This section describes the sample handling and custody process for sampling modules to be provided to the sites, as well as sample tracking internally and between Wood and the external Network analytical laboratories. In this document, the term "sampling module" is used in a generic sense to denote the sampling media and holder associated with a specific sampled air stream in a single speciation sampler. A sampling module is the smallest unit (in one or several pieces) shipped back and forth between Wood and a sampling site.

A sampling module may include denuders (in addition to filter media) and transport hardware if either (or both) is required. Sampling modules and associated sample media will be tracked individually in the CSN Tracking Database. Information on the CSN Tracking Database can be found in SOP GLO3110-006, *Database Operations for the Chemical Speciation Network.*

## 10.1 Sample Handling Delivery Order Process

Wood prepares and ships appropriate sampling media (including the required filters) to each state or local agency (or sampling site within the state) as needed to meet the sampling schedule for each site covered in the delivery order(s) received from the USEPA Project Officer.

### 10.1.1 Sampling Schedule Development

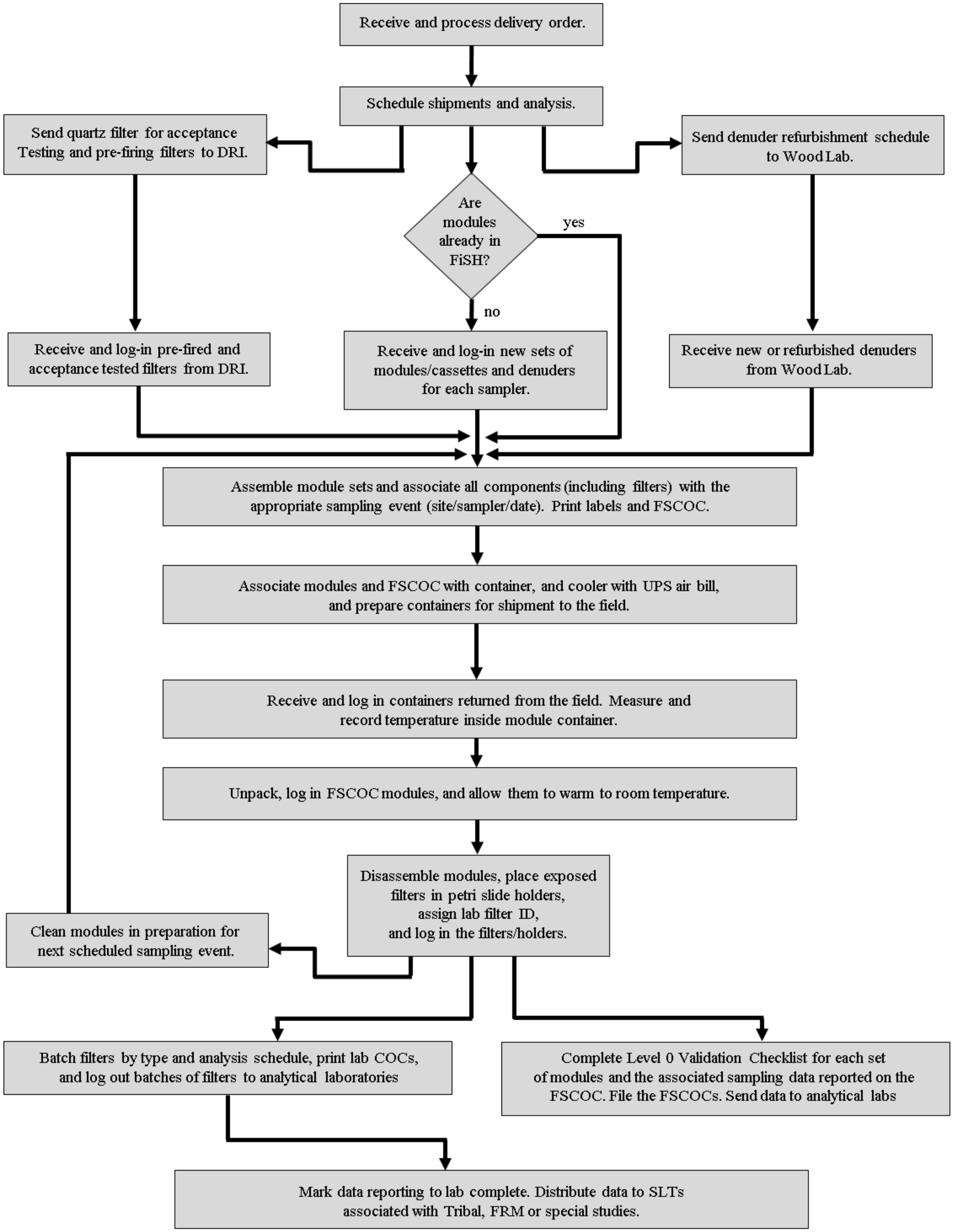
Wood develops a calendar of shipping and sampling dates for distribution to the CSN sampling sites. This calendar is distributed to CSN stakeholders prior to the beginning of a new calendar year. The Program Manager checks the delivery order and distributes it to the FiSH for planning purposes. Based on the schedule defined by the delivery order(s), Wood schedules and sends modules to the addresses indicated for the SLT monitoring agencies. Please see Appendix B for a list of the CSN sampling sites by state and their sampling schedule.

### 10.1.2 Return Shipments

SLT monitoring agency personnel collect and return the required samples to the Wood FiSH. At the FiSH the samples are logged into the database management system (DBMS) (See Section 17), filters requiring gravimetric or optical density analyses are routed to the appropriate internal laboratories, and operational data necessary for the Network analytical laboratories to determine concentration information are entered and validated. This process is described in SOP GLO3110-003 *Analysis Batch Preparation and Shipment*. The exposed CSN filters and associated data, including PM2.5 gravimetric analytical data, are then sent to the appropriate Network analytical laboratories. The CSN Network analytical laboratories are responsible for providing the data to the state and local monitoring agencies for review and validation, as well as upload of the data into the Air Quality System (AQS). The Program Manager forwards gravimetric analytical data and ancillary information collected for Tribal, FRM and special studies to the SLT agency that requested the analyses.

The following subsections describe the processes associated with filter and sample handling and shipping, the physical analyses required for select Teflon filters, and the data handling necessary to record and transmit the sampler operational data and apply null and valid flags based on site operator recordings of null and valid flag documents. The ultimate goal of these processes is to obtain concentration data of known quality. The sample handling and tracking process is described in more detail in the FiSH SOP GLO3110-002 *Field Shipping and Handling* and FiSH SOP GLO3110-003 *Analysis Batch Preparation and Shipment*, in Appendix A.

## Figure 10-1 Overview of Sample Handling and Custody System



### 10.2 Chain of Custody (COC)

Wood will provide FSCOC documentation to the sites with sample shipments to track and ensure that samples are collected and transferred by authorized personnel. In addition, Laboratory Chain of Custody (LCOC) documentation transferring filters following sample collection to the Network analytical laboratories will also be prepared by authorized personnel. The ultimate goal is to ensure an accurate record is maintained of sample handling and treatment from the time the filter is loaded into the module, through the sampling event, and final transmittal of the sample media to the Network analytical laboratories. An example of the FSCOC form, ancillary forms sent along with the FSCOC, and forms used at the FiSH can be found in Appendix C.

The FSCOC documentation that accompanies the sampling modules to and from the field will include a two-part carbonless form for sending and receiving samples from the field sites. The FSCOC forms are computer generated so that they are customized for each type of sampler and each sampling event. Media types (filters and other types of sampling media, if any) will be listed on the FSCOC form for each sampling event. The FSCOC form will include areas in which the field operators can enter critical operational data, including the total sample volume, average flow, and flow CV for each filter channel, and start and end times, ambient temperature and barometric pressure. In addition to the multi-part form, an electronic version of the FSCOC is stored in the DBMS.

Upon return of the samples from the field, the filters will be assigned a laboratory analytical filter ID number and assembled into lots for transfer to the Network analytical laboratories. Teflon and quartz filters are shipped to UC Davis and nylon filters are shipped to DRI. Each lot of filters will be transmitted to the Network analytical laboratory for analyses and for determination of concentration information. Forms (including LCOC) and electronic files will be transmitted with the filter lots. These forms are computer generated based on information already entered into the CSN Tracking Database, such as the assigned filter numbers. In addition to the filter transfer, operational data for each sampler/sampling event will be transmitted to the Network analytical laboratories in an electronic file format.

### 10.3 Processing System for PM Chemical Speciation Modules

Wood has designated five laboratories that are involved in the program, and these are described below:

1) **Filter Shipping and Handling Unit (FiSH)**. Personnel in the FiSH will be responsible for visual acceptance testing of the Teflon filters, assembly of components (including clean filters and refurbished denuders) into sampling modules, shipment of sampling media and modules to the SLTs (or sampling sites within the states), receipt of samples from the states, disassembly and cleaning of sampling modules and filter cassettes, and distribution of filters (and other sampling media, if applicable) to the individual laboratories for analysis. FSCOC and the Field Sampling Null Code and Validity Coding forms (used to flag data using AQS flag codes by field site operators) are generated by FiSH personnel, who will also log out and log in filter samples (going to the field or to internal or Network laboratories for analyses). Flash memory card data from the URG 3000N samplers is downloaded and stored on network drive as part of the FiSH disassembly procedure, this data can be used as a

supplement to hard copy. FiSH personnel will also be responsible for leak testing URG 3000N filter cassettes. Associated SOPs, found in Appendix A:
   a) GLO3110-002, *Field Shipping and Handling*
   b) GLO3110-005, *Standard Operating Procedures for Leak Checking the URG 3000N Filter Cassette*
   c) GLO3110-006, *Database Operations for the Chemical Speciation Network*

2) **Denuder Refurbishment Laboratory (DRL)**. Personnel in the DRL are responsible for refurbishment of denuders deployed in the Network to strip acidic and basic gases out of the sampled air for nylon filters in SASS/SuperSASS modules. The DRL has a hood and sink for work with volatile solvents and for cleaning spent denuders. The DRL will coordinate with the FiSH staff to prepare and track denuders as they are needed. Associated SOPs:
   *a)* GLO3180-040, *Cleaning and Coating of Aluminum Honeycomb Denuders*
3) **Gravimetric Mass Laboratory (GML)**. Personnel in the GML are responsible for activities associated with $PM_{2.5}$ gravimetric mass determinations on Teflon filters. Associated SOP's:
   a) GLM3180-009, *Determination of Particulate Matter (PM) Gravimetric Mass for the Chemical Speciation Network*
4) **Cations/Anions Laboratory (CAL)**. Personnel in the CAL are responsible for ion analyses for nylon filter acceptance testing only. This will include both anions (sulfate, nitrate and chloride) and cations (ammonium, sodium, and potassium) on filters selected for acceptance testing. Associated SOP's:
   a) GLM3180-010, *Acceptance Testing of Nylon Filters by Ion Chromatography for the Chemical Speciation Network*
5) **Transmissometer Laboratory (TL)**. Personnel in the TL are responsible for performing optical density evaluations of selected filters, if requested by USEPA. Associated SOP's:
   a) GLM3180-011, *Procedure for Dual-Wavelength Optical Density Analyses*

**Figures 10-2 through 10-4** show flow diagrams for filter processing by filter type. Some Teflon filters are used for determination of gravimetric mass and most Teflon filters are analyzed by XRF for trace element (sodium through lead) concentrations by UC Davis; potentially, some Teflon filters may be analyzed for ions. Quartz filters are used for determination of total, organic, elemental, and fractional carbon concentrations by DRI. Nylon filters are used for determination of cations (ammonium, sodium, and potassium) and anions (sulfate, chloride and nitrate), also by DRI. Analyses other than gravimetric mass are performed under the Network analytical laboratory contract for CSN, which has a separate QAPP entitled *Laboratory Analysis and Data Processing/Validation for Chemical Speciation of PM2.5 Filter Samples* and are not discussed in this QAPP.

After final weighing in the gravimetric mass laboratory, custody of the exposed Teflon filters is transferred to UC Davis if XRF analyses are required. If only mass is required, the filters are maintained by Wood. The filters are stored in the CSN cooler at 4º C.

Wood analytical laboratory capabilities will only be employed for Teflon filters (visual acceptance testing, mass and optical density analyses) or for acceptance testing of nylon filters for ions or quartz filters for OC/EC (by Wood's subcontractor DRI). The sampler models in the network use at least one of the three types of filters (Teflon, nylon, and quartz) used in the $PM_{2.5}$ speciation program.

**Figure 10-2 Diagram of Teflon Filter Processing and Analysis Activities**

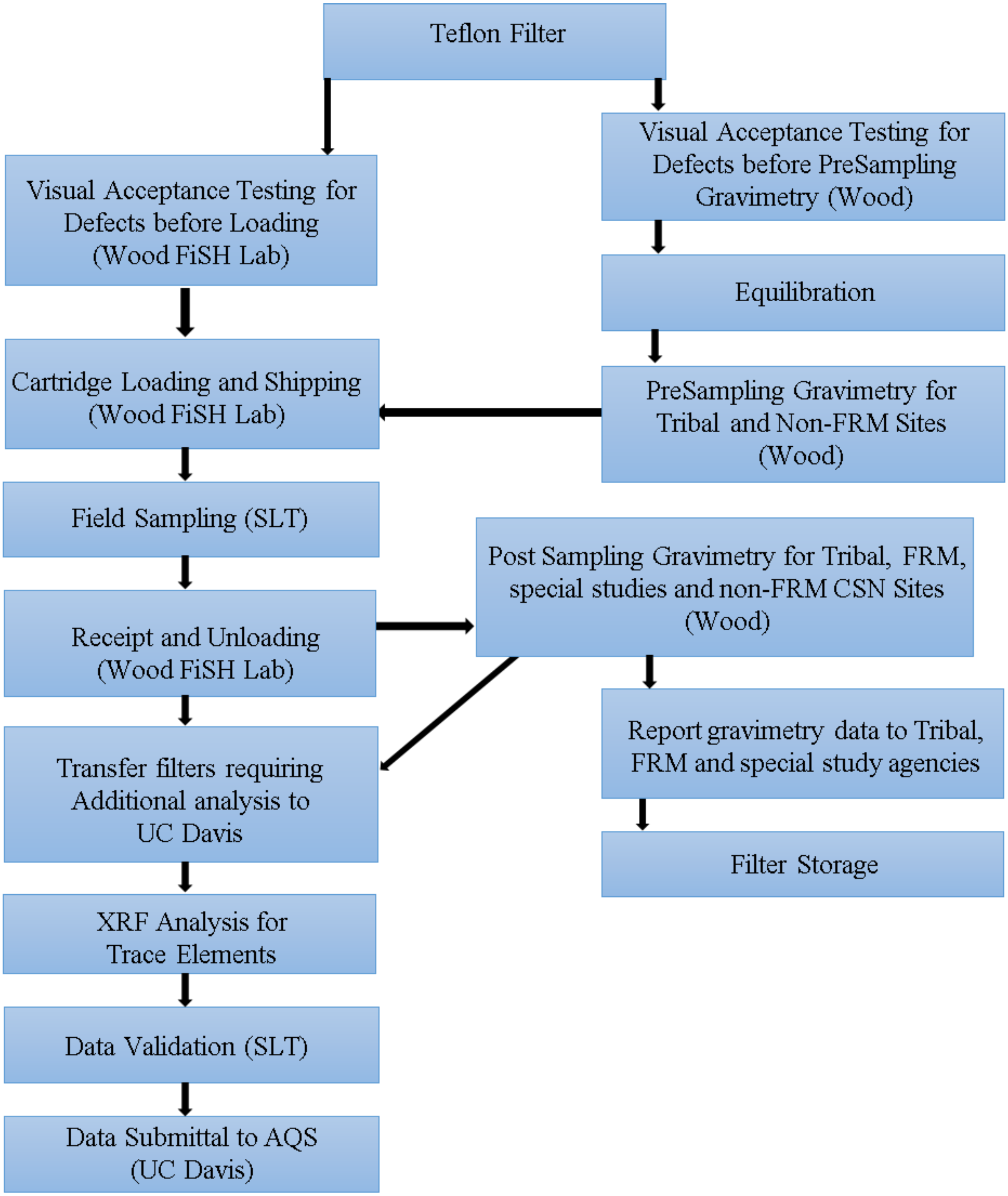


**Figure 10-3 Diagram of Nylon Filter Processing and Analysis Activities**

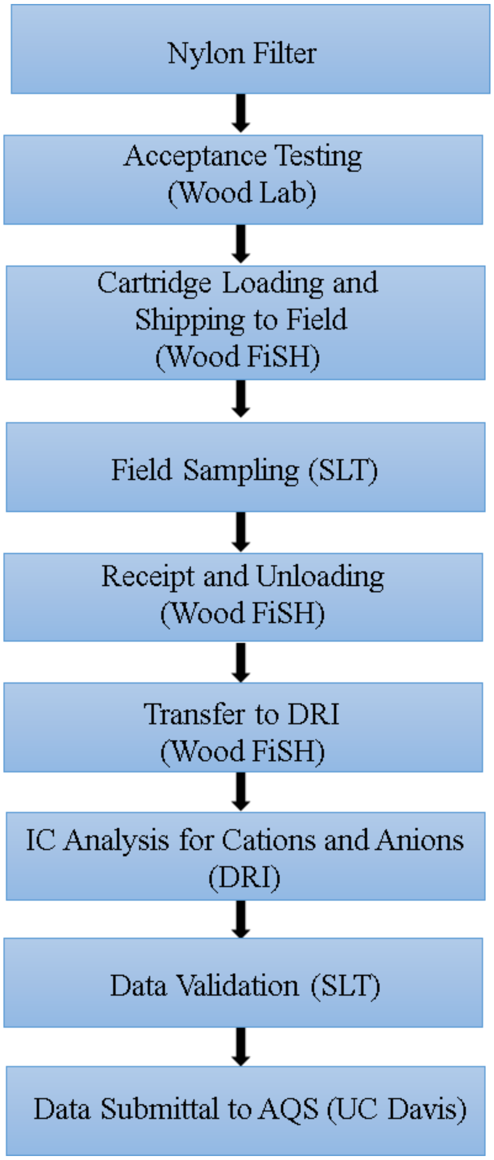


**Figure 10-4 Diagram of Quartz Filter Processing and Analysis Activities**

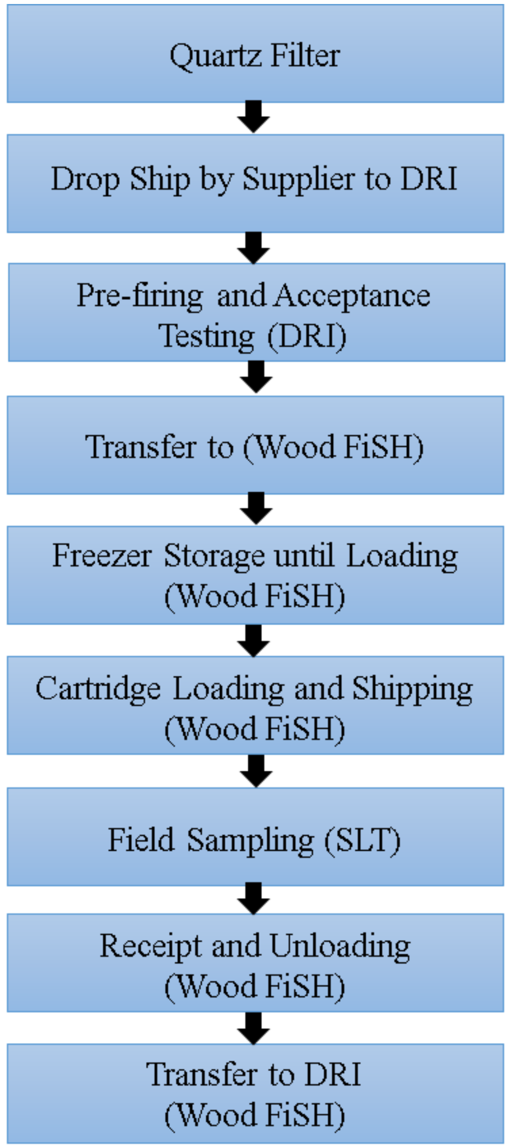
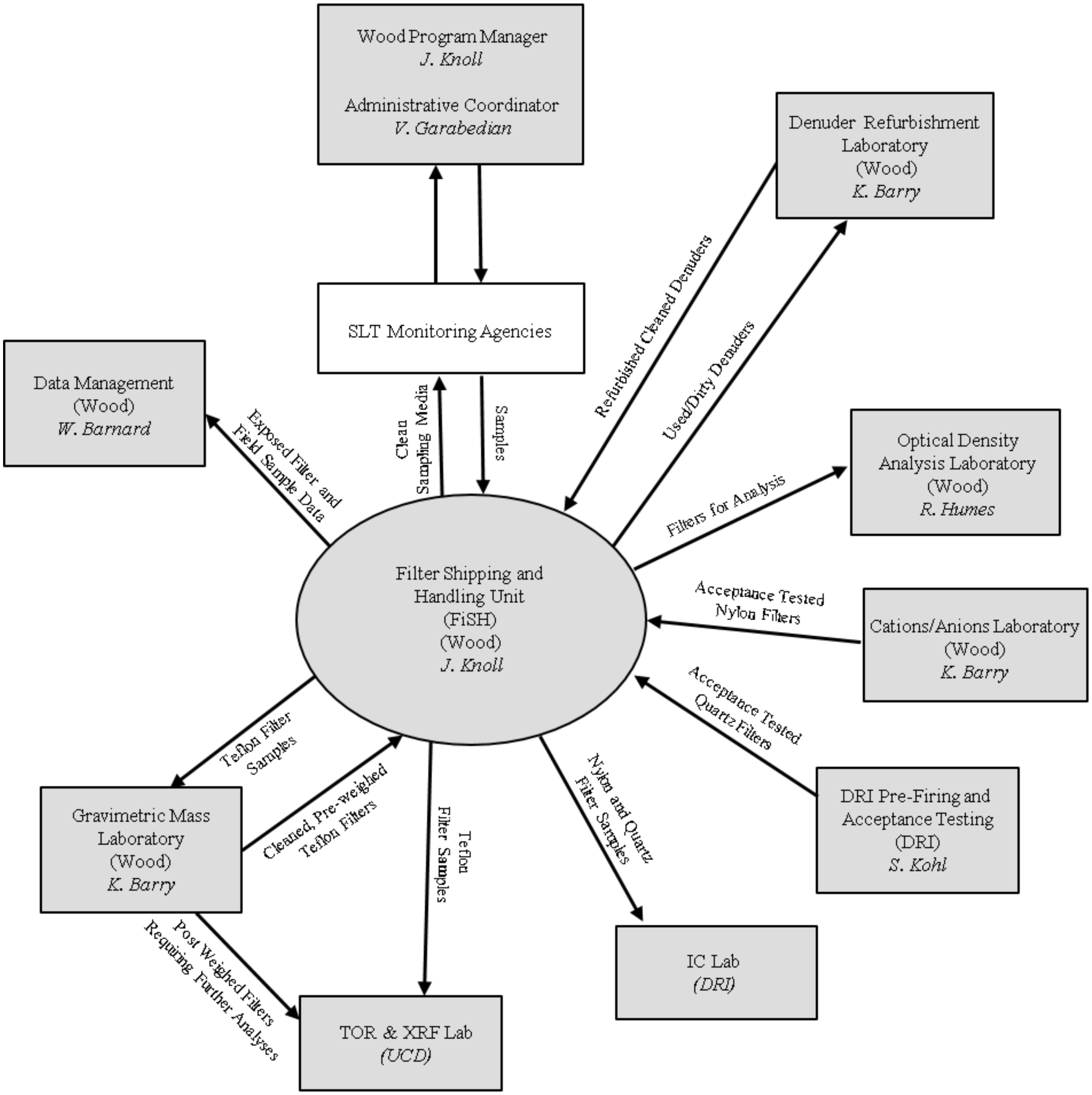



**Figure 10-5** shows the anticipated movement of filters through Wood laboratories (and our subcontractor DRI) described above. The focal point for shipping and receiving sampling media is the FiSH. The other laboratories listed in items 1 through 5 in Section 10.3 above are responsible for acceptance testing of new filters, denuder refurbishment, and for limited types of analyses of samples collected on those filters. The main processes for moving between the various laboratories are shown in the figure. Exceptions for specific events may be made as needed.

The process for delivering filters to Network analytical laboratories is included in SOP GLO-3110-002, *Field Shipping and Handling* in Appendix A.

# Figure 10-5 Movement of Filters through Wood and Subcontractor Laboratories



### 10.3.1 Assembly of Sampling Modules

Sampling modules sent to the field must be clean, properly assembled with clean and unflawed filters and denuders, and shipped in a timely manner. Assembly/disassembly procedures are conducted in a module processing room where access is limited only to FiSH personnel and sticky mats are placed on the floor by the door. Handling of sample media are conducted with gloves and filters are only handled with clean, disposable nylon tweezers. FiSH personnel clean and inspect hardware associated with sampling modules, and visually inspect each filter (for a pinhole or crease, evidence of chaffing or flaking, discoloration, or any other defect) and each denuder as each module is assembled. Items that appear flawed are rejected. FiSH personnel carefully pack modules for a given sampler at a given location in the same shipping container for shipment to the appropriate destination. Modules are assembled according to the manufacturer's instructions and with the sampling components requested in the USEPA Delivery Orders. These operations are fully described in the SOP GLO-3110-002 *Field Shipping and Handling* in Appendix A.

### 10.3.2 Shipping to and from the Field

Filter cartridges, sampling modules, and additional required components are shipped in specially designed insulated shipping containers to each sampling site or other location designated by the state and local agencies through the USEPA Project Officer and the Delivery Orders. USEPA has established an account for shipping with a national provider (UPS).

Scheduling of shipping dates to and from the state agencies is a key part of the FiSH's operation. Wood will continue to prepare shipping schedules for network sampling locations, and the shipping schedules will be distributed via the Technical Project Manager and the CSN Regional Representative.

Sufficient commercially available, leak-proof, ice packs are added to each cooler so that filters returned from sites to Wood can maintain a transit temperature at or below 4°C. Each state agency is responsible for freezing the ice packs and packaging the shipment so that it maintains a temperature at or below 4°C. Shipments are returned to Wood overnight by UPS as described above. The temperature of each shipment is determined upon delivery at the FiSH using a NIST traceable infrared thermometer with digital readout. Temperature upon receipt is recorded on a Level 0 validation form. See SOP GLO3110-002.

### 10.3.3 Disassembly of Sampling Modules

Upon their return to Wood, sampling modules are logged into the CSN Tracking Database and disassembled by FiSH personnel in the restricted access room in Wood's air laboratory using the same handling procedures described in SOP GLO-3110-002 *Field Shipping and Handling* in Appendix A. Each filter is sealed in a new, clean, labeled petri slide holder and stored in either a refrigerator (Teflon and nylon filters) maintained at 4°C ± 2 °C or freezer (quartz filters) maintained at -16 °C ± 4 °C prior to being sent to the appropriate laboratory for analysis. Denuders used in the module will be refurbished, if required, and the other components will be cleaned prior to reuse. NIST traceable digital thermometers are used to measure temperature daily. Measured temperatures are recorded in a logbook kept with the freezer or cold storage room. The thermometers include maximum and minimum temperature capability.

### 10.3.4 Tracking of Analytical Samples

An LCOC form is used to transfer batches of filters removed from the sampling modules in the FiSH to the respective Network analytical laboratories. Multiple filters are transferred in a typical batch, so there is not a one-to-one correspondence between the FSCOC form (which corresponds to a set of modules for a single field exposure) and the LCOC. An example LCOC is found in SOP GLO3110-003 *Analysis Batch Preparation and Shipment*.

### 10.3.5 Archiving of Filters

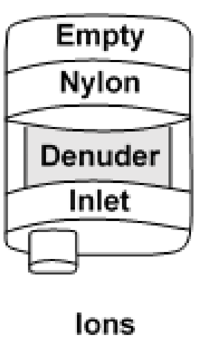
Only Teflon filters that are evaluated for mass for Tribal, FRM and special study sites will be archived for the life of the contract by Wood unless alternative arrangements are provided by the SLT agency. Wood will also archive (if requested) filters not selected for chemical analyses by the Network analytical laboratory. Filters maintained by Wood will be archived for the life of the contract in petri-slide holders, sorted by site into petri-slide trays, and sorted by sampling date within a tray. Full trays of Teflon filters are placed in heavy-duty plastic zippered bags and placed in plastic bins in a refrigerator or cold room maintained at or below 4°C (but not below freezing). Individual filters are indexed for rapid retrieval by Archive Bin ID, Tray ID, and Filter ID. See SOP GLO3110-007 for further information.

### 10.3.6 Denuder Preparation

Magnesium Oxide (MgO) denuders are part of the routine sampling configuration in the SASS/SuperSASS samplers. All active sites employ SASS/SuperSASS samplers. The channel that utilizes nylon filters includes the MgO coated denuder, as shown in Figure 10-6, below. The USEPA Project Officer (through Delivery Orders) notifies Wood's Program Manager of the number of sites that require MgO denuders for routine operation of the network. Should new denuders be required, the state or local agency (or the USEPA) provides Wood a sufficient number of denuders and accessories to meet the demands of the sampling schedule.

Denuders are placed upstream of sample filters in SASS/SuperSASS cartridges containing nylon filters to remove interfering gases. The acidic gases of concern to the CSN include nitric acid and $SO_2$. The reason for removal of such gases is to eliminate their collection on the nylon filter as reaction product artifacts.

**Figure 10-6 Denuder orientation within Nylon SASS Module**




Upon receipt of the new denuders and accessories, and after 30 sampling events, Wood cleans and coats the denuder devices according to SOP GLO3180-040.

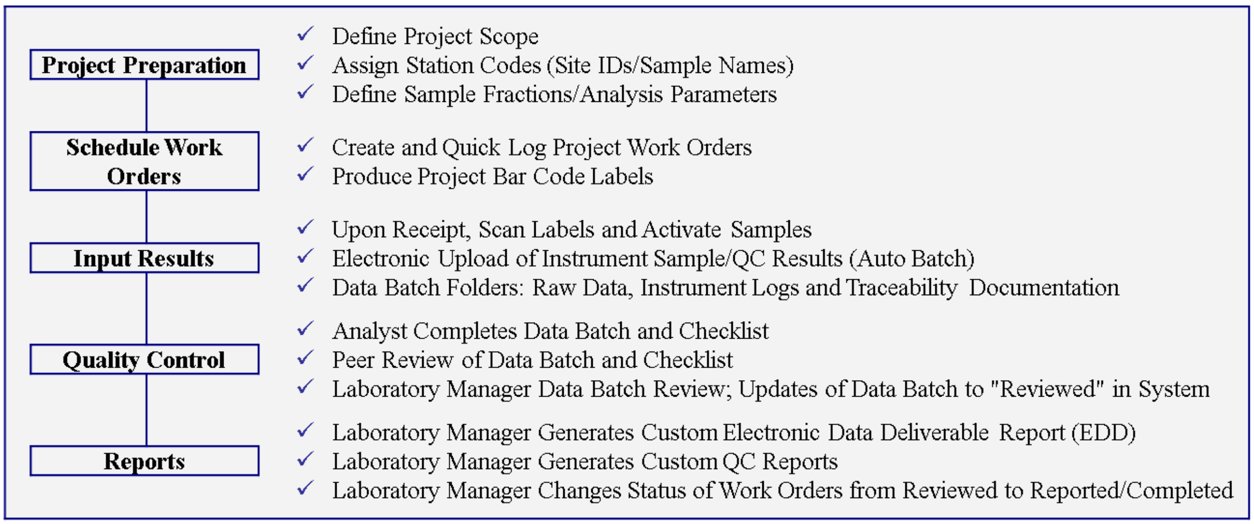
Prepared, refurbished, or purchased denuders are sealed airtight and stored in a secure location free of acidic or basic gases until they are required in the field. When needed, denuders are installed in the sampling module with a nylon filter before shipment to the requesting SLT. After sampling, the denuders, nylon filters, FSCOC forms, and Null Flag and Validity Coding Forms are returned with the filter samples to Wood from the sampling sites by UPS. Upon receipt, the denuders are inspected for damage. A record of the number of uses or length of time in use of a particular denuder is maintained by the FiSH so that the denuder is refurbished or replaced according to schedule. MgO denuders are refurbished after approximately one year. The denuders are then cleaned and/or refurbished for the next round of use according to their in-use time. Unless otherwise directed, Wood does not save extracts from rinsing or cleaning the denuder surfaces and does not analyze the extracts for components.

USEPA is responsible for replacement or repair of denuder components damaged in the field; and the shipping company is responsible for damage caused during transit. Wood repairs or replaces items damaged during handling in its laboratory.

# 11.0 Analytical Methods Requirements

Wood uses automated data acquisition, automated data transfer, and a full-featured Laboratory Information Management System (LIMS) called Element. Element is used to manage, control, report sample analyses and provide feedback on project performance for gravimetric mass, nylon filter acceptance testing and denuder refurbishment. Data are transferred from the laboratory instruments to the secure Wood internal network. This process is described in Wood SOP GLO3180-035 *Element Batch Preparation*. The data are uploaded into the Element database via DataTool, a custom data program that creates a unique data batch sequence, assigns the appropriate analysis method codes, and populates the data batch with laboratory sample ID sequences. DataTool incorporates several QC elements intended to detect errors prior to data completion. Figure 11-1 illustrates the Element program.

**Figure 11-1 Flow Chart of an Element Project**




The data transfer file is saved as a database file to a server on the Gainesville, FL network for storage, retrieval, and backup. Once the data are uploaded, the analyst initiates the Element batch finalization procedure. This automated procedure:

- ✓ Identifies the QC samples
- ✓ Calculates the precision and accuracy data
- ✓ Determines if the appropriate number of QC samples have been analyzed
- ✓ Cross-references the analyte/method code combination between the data batch and the sample record to ensure the correct data are entered and reports any conflicts
- ✓ Prints out a copy of electronic data in a consistent data batch report format

The data batch report includes the following information:

- ✓ Unique data batch sequence
- ✓ Project chemist's name
- ✓ Detailed QC report
- ✓ Final data report

Copies of run log pages, calibration certificates, certificates of analysis, chromatographs, and the data batch report are included in the batch folder to provide documentation of the entire analytical process. The project chemist signs the batch check list inside the flap of the data folder, to affirm the validity of the work and submits the data batch for peer review.

Data batch review is the responsibility of a senior chemist. This review includes the following checks:

- ✓ Completeness
- ✓ QC acceptance
- ✓ Appropriate signatures

Once the reviewer is satisfied with the acceptability of the data batch, he affirms this by signature and submits the batch to the laboratory manager. Once the batch is reviewed and the data are locked it will require written laboratory manager approval for any updates. Any updates performed are documented electronically in Element. The batch history may be reviewed using the Audit Trail feature in Element.

During the data transfer and reduction process, Element calculates:

- ✓ Relative percent differences for replicates
- ✓ Spiked recoveries
- ✓ Reference sample concentrations (percent recoveries)
- ✓ Sample concentrations

Completed batch folders are stored in a secured central location and arranged numerically by batch number.

### 11.1 Gravimetric Mass Determination

Gravimetric mass analyses are performed in accordance with 40 CFR Part 50, Appendix L and Quality Assurance Guidance Document 2.12, *Monitoring PM2.5 in Ambient Air Using Designated Reference or Class I Equivalent Methods*. Wood SOP GLM-3180-009, *Determination of Particulate Matter Gravimetric Mass* describes the procedure to be used for gravimetric mass determination in Wood's laboratory.

The gravimetric laboratory is maintained at a mean relative humidity between 30 – 40%, with a standard deviation of not more than ± 5%, and a mean temperature from 20 – 23 °C (68 – 73.4 °F) with a variability of not more than ± 2 °C (± 3.6 °F) over a 24 hour period. These conditions are monitored in real time so out of specification conditions can be identified and corrected in a timely manner.

A light table is used to visually inspect all filters for defects prior to initial weighing. Any found to have defects are discarded and the filter number is recorded in the Rejected Filter Logbook. Examples of defects are as follows:

- Pinholes – small holes visible as bright points of light when viewed over a light table.
- Chaff or flashing – extra material found on the polyolefin reinforcing ring or on the heat-seal area that inhibits an air-tight seal.
- Filter discoloration – obvious discoloration may be a sign of filter contamination.

- Loose material –extra material or dirt particles on the filter surface.
- Filter non-uniformity –visible indication of gradation in porosity or density across the filter surface.
- Other imperfection such as irregular filter surface that would indicate poor workmanship.

After moisture equilibration in the controlled atmosphere, each filter is weighed before and after exposure to determine the net weight (mass) increase on an exposed $PM_{2.5}$ filter. This method uses an electronic microbalance to make precision measurements in the microgram range in a controlled environment. Data are captured into an Access© database (AutoWeight v36) and then exported into spreadsheet files and uploaded into Element.

### ~~11.2~~ Extraction and Analysis of Anions and Cations from Nylon Filters for Acceptance Testing

An overview of Wood's laboratory facility and procedures for extraction and analysis of nylon filters for anions (nitrate, sulfate and chloride) and cations (sodium, ammonium and potassium), can be found in the Appendix A SOP: GLM-3180-010 *Acceptance Testing of Nylon Filters by Ion Chroma*tography.

- Standing orders are in place with approved vendors for critical laboratory solutions. Solutions, standards, and QC check samples will be verified against previously tested materials before they are placed in service. In addition, standards and control samples will be NIST-traceable. Certificates of Analysis will be maintained, and copies will be included with each data batch generated. Chemicals are segregated from areas where filter handling, extraction, and analyses are performed to prevent contamination of the samples. The deionized water system used by the laboratory is monitored each weekday to verify that the quality of the water produced meets the requirements specified in SOP GLO3180-022.
- Two filters from each box to be used for the project will be extracted with deionized water and separate anion and cation analysis will be performed. An aliquot of the extract is injected onto columns containing ion exchange resins. The ions of interest are separated on the basis of their relative affinities for the exchange resin and their molecular weights. The separated ions are directed onto an electrolytic suppressor where the counter ions are removed from the eluent stream and only the highly conductive analytes remain in an aqueous mobile phase. Detection is by electrical conductivity. The resulting chromatographic peaks are identified on the basis of retention time compared to known standards. Quantitation is performed by comparison of peak area to the calibration curve areas.
- A Sample Analysis Log Book will be used to document the basic analytical information. The log also includes lists of QC samples in the precise order of analysis. At the end of analytical cycle, the project chemist will determine the acceptability of the raw data, and if acceptable, generate a transfer file and upload to Element LIMS. A batch folder will be created for each run containing the raw data, reagent and standard preparation log sheets, sample extraction worksheet, instrument logbook copies, and the Element batch printout
- If the measured concentration for any of the analytes of interest exceeds 1 ug/filter, the corresponding box of filters will not be used for sampling.

### 11.3 Optical Density (Transmissometer)

Wood will provide optical density measurements for characterization of particulate samples, if requested by USEPA. Wood has adopted DRI's SOP for determining optical density. The procedure used to perform optical density measurements using a transmissometer can be found in GLM3180-011 *Dual-Wavelength Optical Transmission Analysis*.

Wood will provide transmissometer analysis on filter samples as requested by USEPA. A dual-wavelength optical transmissometer will be used-to measure transmittance before and after filter exposure. The difference in the logarithms of the transmitted light is proportional to the absorption of the particle deposit.

### 11.4 Elemental, Organic and Total Carbon Determination for Quartz-Fiber Filter Acceptance Testing

Wood's subcontractor DRI will follow DRI SOP 2-106r8 *Pre-firing and Acceptance Testing of Quartz-Fiber Filters for Aerosol and Carbonaceous Material Sampling*, (September 27, 2017) for performing OC/EC /TC acceptance testing and pre-firing of quartz-fiber filters.

The DRI Model 2015 analyzer used by DRI consists of a system that includes a sample oven fitted with a laser-photodiode sensor, an oxidizer oven, a methanator, a flame ionization detector (FID), other components used to control oven temperature and gas composition and flows, and a computer workstation running software through which analysis parameters are controlled and data from the FID, photodiode sensor, and oven thermocouples are collected. Carbon volatilized from the filter is converted to $CO_2$ in the oxidizer, and the $CO_2$ is converted to methane ($CH_4$) in the methanator before passing into the FID, where it is measured. The laser is used to track and correct for the pyrolysis of OC that occurs during the inert combustion phase. The laser shines on the quartz filter section in the oven, and some of the light is reflected or scattered back onto a photodiode located on the same side of the filter and some of the light is transmitted through the filter. The laser photodiode sensors are used to monitor reflectance and transmittance of laser light from the filter section during analysis.

# 12.0 Quality Control Requirements

Laboratory personnel have specific responsibilities and a general requirement to adhere to the requirements of the QA program. The Laboratory Manager coordinates closely with the QA Manager and Quality Program Manager to ensure that the QA program is followed. Program SOPs are provided as Appendix A of this QAPP.

The analytical QC checks utilized for nylon filter acceptance testing, gravimetric mass and denuder refurbishment are listed in Tables 12-1, 12-2 and 12-3. Laboratory accuracy is determined by analyses of reference standards and laboratory precision is assessed by replicate sample analyses. All laboratory standards and reference samples are NIST traceable and have certificates of analysis available for review. For IC analyses, internal standards are used to assess shifts in retention time and sample injection volume. If QC results exceed criteria, a laboratory analyst will perform certain corrective actions at the laboratory bench, as outlined in the following subsections, before the data has been submitted for review also as noted in the tables in this section.

The Element LIMS automatically verifies fulfillment of QC requirements for each data batch. During data processing, the analyst and peer reviewers are notified if any criterion is exceeded via color coded flagging. The Element criteria tables include analyte-specific requirements for accuracy, precision, and QC sample analysis frequency. Laboratory analysts are required to address situations that exceed the limits of acceptability as outlined in this QAPP.

## 12.1 Quality Criteria for Gravimetric Analyses

QA/QC procedures and processes employed by Wood in the performance of gravimetric analysis of filters will meet or exceed the requirements outlined in USEPA's QA Handbook and Guidance Document 2.12.

QC samples, acceptance criteria and corrective actions are listed in Table 12-1.

**Table 12-1 QC Criteria for Gravimetric Analysis**

| QC Sample | Acceptance Criteria | Corrective Actions |
|---|---|---|
| ASTM Class 1 Working Standards (min of 2 bracketing the filters to be weighed)* | ±3 µg of the certified range. | Recalibrate, re-zero, and reweigh filters not bracketed by acceptable standard weight checks. |
| Laboratory (Method) Blanks (10%) | ±15 µg of the initial filter weight. | Do not weigh samples. New blanks must be conditioned before weights can be taken. Also, check room conditions. If conditions are outside of criteria, adjust the air-conditioning and/or dehumidifier. Allow 24 hours to elapse prior to further weighing. |
| Field Blanks | ±30 µg of the initial filter weight. | Review environmental conditions and batch QC. If any are outside of criteria, re-establish control and re-analyze the sample. If QC checks are within criteria and the field blank still exceeds its acceptance criterion, notify the Program Manager and flag the result. |
| Sample Replicates** (20%) | ±15 µg of the previous filter weight. | Recalibrate, re-zero, and reweigh. |

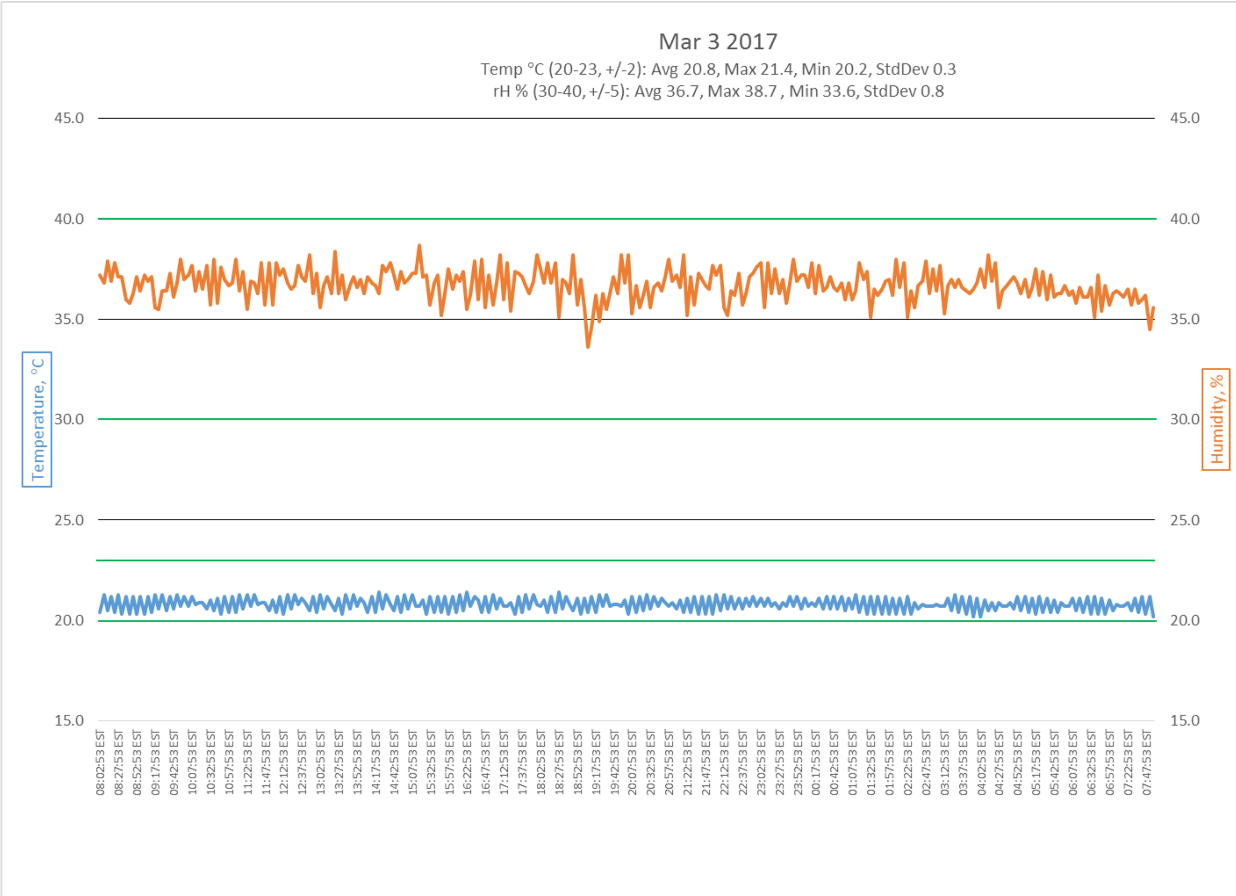
* Note: Weigh each working standard at the beginning and end of each weighing session and after every 10 samples. Re-weigh all filter samples directly preceding any failed standard. If the results are unacceptable after re-weighing, contact the Laboratory Operations Manager.

**Note: Re-weigh all filter samples since the last acceptable replicate. If the results are still unacceptable after reweighing, contact the Laboratory Manager.

In addition, the following checks will be performed:

1) The working standards will be verified against a matching set of primary standards every three months.
2) Mass reference standards (working and primary) will be re-certified annually at a NIST or National Voluntary Lab Accreditation Program (NVLAP) accredited calibration laboratory.
3) The microbalance will be calibrated annually, or more frequently if indicated, by a qualified ISO accredited vendor.
4) The $^{210}$Po strips will be replaced every six months.
5) Temperature and humidity measurements will be reported as five minute averages with a Dickson TSB datalogger. A daily chart of the results will be printed and maintained in the laboratory (see example in Figure 13-1 below). The datalogger sensor will be recalibrated annually.
6) Control charts will be generated for the mass references, laboratory blanks and duplicate samples.

**Figure 12-1 Datalogger Temperature and Humidity Results**




### 12.1.1 Gravimetric Disaster Recovery Plan

Raw weighing data, including internal QC checks, are recorded in Element LIMS. That system is based on database management using Microsoft SQL Server. For backup and archiving purposes, the raw data are backed up as part of Wood's standard backup procedures by Wood's IT department. Database backup and restore procedures are described in greater detail in Section 17.2.7 of this QAPP. Hard copies of raw data will also be printed for backup purposes.

In addition, in order to minimize the impact of unavoidable weather events or utilities interruption on laboratory operation, sample throughput, and data quality, the laboratory maintains its own uninterruptable power supply system for maintaining electrical power to the laboratory.

## 12.2 Quality Criteria for Ion Analysis

The quality criteria applicable to analysis of cations and anions are provided in **Table 12-2.**

**Table 12-2 QC Criteria for Ion Chromatography (Anions and Cations)**

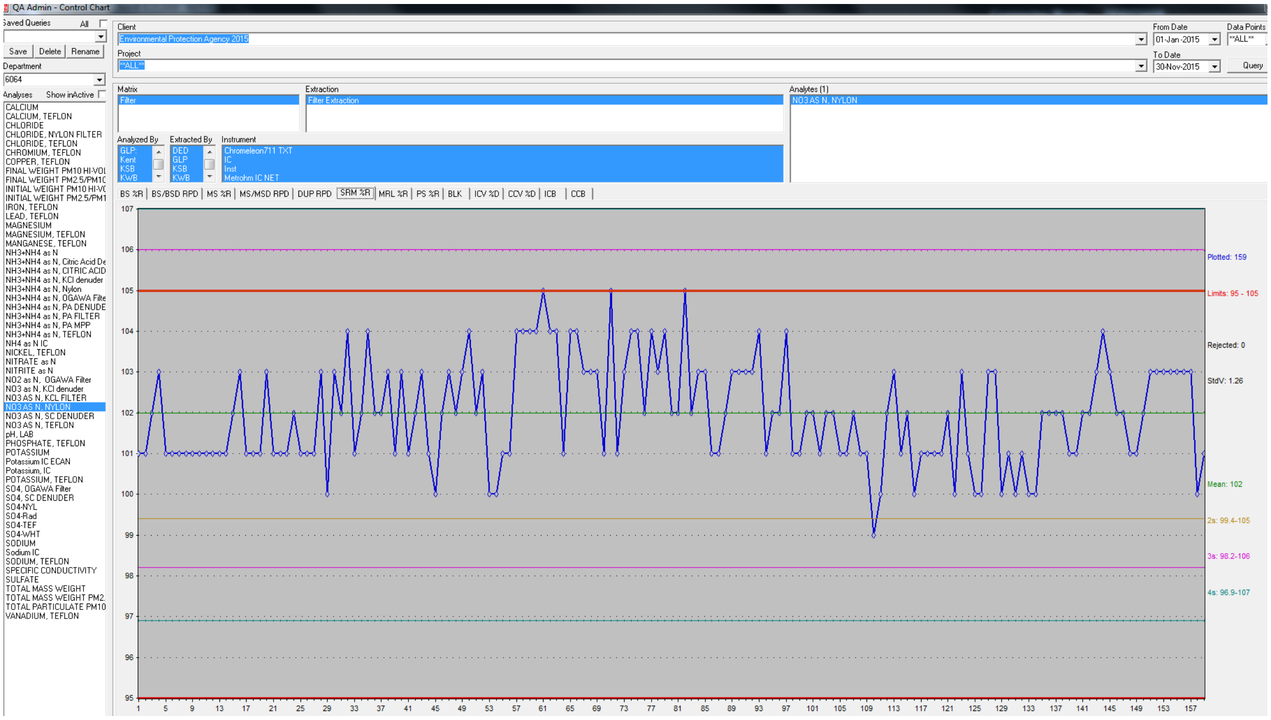
| Quality Control | Acceptance Criteria | Frequency | Corrective Action |
|---|---|---|---|
| Calibration curve correlation coefficient | ≥ 0.995 | Daily | Rerun calibration standards. If still unacceptable, prepare new calibration standards and recalibrate the instrument, or document why data are acceptable. |
| Reference standard (SRM) | ± 10% of the certified true value | Bracket beginning and ending of sample analysis batch | Rerun standard. If still out of control, recalibrate instrument and reanalyze samples, or document why data are acceptable. |
| Control standard (CCV) | ± 10% of the certified true value | Every 10 samples and bracketing analysis batch | Rerun standard. If still out of control, recalibrate instrument and reanalyze samples run since last acceptable CCV, or document why data are acceptable. |
| MB | ≤ 2 times the RL | Daily | Determine the cause of blank problem. Reanalyze the sample, if necessary, or document why data are acceptable. |
| Sample Replicate | ± 20% RPD if the sample is greater than 5 times the RL | 5% of samples | Determine the cause of the problem. Reanalyze the sample, if necessary, or document why data are acceptable. |

**Notes:** RL = Reporting limit
RPD = Replicate percent difference

Source: Wood

Quarterly control charts are generated by Element LIMS. An example of the charts that are generated is presented in Figure 12-2 below.

## Figure 12-2 Control Chart for Nylon Reference




### 12.2.1 Ion Disaster Recovery Plan for Data

The Ion Lab supervisor or analyst utilizes the Element LIMS system for data storage including raw data (.txt) and calculated data (.csv) files. The underlying MS SQL Server database is backed up by Wood's IT department and is available to be restored from backup should a disaster strike. The backups are on off-site cloud based servers. External files are also stored on an Wood network server which is also backed up as part of the Wood IT department backup system.

### 12.3 Quality Criteria for Denuder Refurbishments

Denuders are used routinely for the CSN program. Wood's responsibilities include refurbishment of MgO denuders and installation upstream of nylon filters in the SASS/SuperSASS samplers' modules. The MgO denuders are not analyzed after use, and QC criteria relate primarily to adequacy and uniformity of coating the denuders. SOP GLO3180-040 details the procedure used to clean and coat the denuders. Quality control steps applicable to acid gas denuder refurbishment are provided in Table 12-3.

### Table 12-3 QC Criteria for Denuder Refurbishments

| QC Element | Frequency | Acceptance Criteria | Corrective Action |
|---|---|---|---|
| Coating Solution Storage | After each coating session | MgO slurry to be stored tightly capped while stirring | Prepare fresh coating solution if not refrigerated or if MgO has dried |
| Absence of MgO-clogged denuder passage | After each coating | Visually inspect each denuder for clogged passage ways | Remove the obstructions; use nitrogen gas to clean debris; if necessary clean and recoat. |
| Final inspection | After each coating | As applicable, check each denuder for damage, O-ring quality and absence of debris affecting proper seating of denuder | Remove damaged denuders from service; replace aged, cracked, or missing O-rings; clean O-ring surfaces with lab wipe dampened with deionized water. |
| Denuder Storage | After denuder coating is dry | To protect denuders from exposure before installation in module, cap or bag them | Reclean and recoat denuders exposed to room air for more than 4 days |
| Reagent Purity | Upon opening new containers of coating material | American Chemical Society (ACS) grade | Use different reagent source; optionally recrystallize in the laboratory |

## 12.4 Quality Criteria for OC/EC Acceptance Testing

DRI routinely prepares quartz filters for use in the CSN field program. The filters are acceptance tested and pre-fired prior to use. Table 12-4 shows the quality criteria for OC/EC acceptance testing. Refer to DRI SOP -2-106r8 for additional information.

**Table 12-4 QC Criteria for OC/EC Acceptance Testing**

| QA/QC Activity | Calibration Standard and Range | Calibration Frequency[b] | Acceptance Criteria | Corrective Action |
|---|---|---|---|---|
| Laboratory Blank Check | NA[a] | Beginning of analysis day. | <0.2 µg C/cm$^2$. | Check instrument and filter lots. |
| Leak Check | NA | Beginning of analysis day. | Oven pressure drops less than 0.1 psi per second | Locate leaks and fix. |
| Laser Performance Check | NA | Beginning of analysis day. | 635 nm laser transmittance 100-300; Reflectance 350-550; No saturation at EC stage | Check light pipes and filter holder position; adjust reflectance or transmittance trim pot. |
| Calibration Peak Area Check | NIST 5% $CH_4$/He gas standard; 20 µg C (6-port valve injection loop, 1000 µl). | Every analysis. | Counts >17,000 and 95-105% of average calibration peak area of the day. | Void analysis result; check flowrates, leak, and 6-port valve temperature; conduct an auto-calibration; and repeat analysis with second filter punch. |
| Auto-Calibration Check | NIST 5% $CH_4$/He gas standard; 20 µg C (Carle valve injection loop, 1000 µl). | Alternating beginning or end of each analysis day. | 95-105% recovery and calibration peak area 90-110% of weekly average. | Troubleshoot and correct system before analyzing samples. |
| Manual Injection Calibration | NIST 5% $CH_4$/He or NIST 5% $CO_2$/He gas standards; 20 µg C (Certified gas-tight syringe, 1000 µl). | Four times a week (Sun., Tue., Thu., and Sat.) | 95-105% recovery and calibration peak area 90-110% of weekly average. | Troubleshoot and correct system before analyzing samples. |

| QA/QC Activity | Calibration Standard and Range | Calibration Frequency[b] | Acceptance Criteria | Corrective Action |
|---|---|---|---|---|
| Sucrose Calibration Check | 10µL of 1800 ppm C sucrose standard; 18 µg C. | Thrice per week (began March, 2009). | 17.1-18.9 ug C/filter | Troubleshoot and correct system before analyzing samples. |
| Potassium Hydrogen Phthalate (KHP) Calibration Check | 10µL of 1800 ppm C KHP standard; 18 µg C. | Twice per week (Tue. And Thu.) | 17.1-18.9 ug C/filter | Troubleshoot and correct system before analyzing samples. |
| System Blank Check | NA | Once per week. | <0.2 µg C/cm2. | Check instrument. |
| Multiple Point Calibrations | 1800 ppm C Potassium hydrogen phthalate (KHP) and sucrose; NIST 5% CH4/He, and NIST 5% CO2/He gas standards; 9-36 µg C for KHP and sucrose; 2-30 µg C for CH4 and CO2. | Every six months or after major instrument repair. | All slopes ±5% of average | Troubleshoot instrument and repeat calibration until results are within stated tolerances. |
| Sample Replicates (on the same or a different analyzer) | NA | Every 10 analyses. | ±10% when OC and TC >10 µg C/cm2<br>±20% when EC > 10µg C/cm2 or <±1 µg/cm2 when OC and TC <10 µg C/cm2<br><±2 µg/cm2 when EC <10µg C/cm2 | Investigate instrument and sample anomalies and rerun replicate when difference is > ±10%. |

| QA/QC Activity | Calibration Standard and Range | Calibration Frequency[b] | Acceptance Criteria | Corrective Action |
|---|---|---|---|---|
| Temperature Calibrations | Tempilaq® G (Tempil, Inc., South Plainfield, NJ, USA); Three replicates each of 121, 184, 253, 510, 704, and 816 °C. | Every six months, or whenever the thermocouple is replaced. | Linear relationship between thermocouple and Tempilaq® G values with R2>0.99 | Troubleshoot instrument and repeat calibration until results are within stated tolerances. |
| Oxygen Level in Helium Atmosphere (using GC/MS)c | Certified gas-tight syringe; 0-100 ppmv. | Every six months, or whenever leak is detected. | Less than the certified amount of He cylinder | Replace the He cylinder and/or O2 scrubber. |
| Interlaboratory comparisons | NA | Once per year. | NA | Review and verify procedures. |
| External systems audits | NA | Once every two years. | NA | Take action to correct any deficiencies noted in audit report. |

[a] NA: Not Applicable.

[b] Calibration performed by carbon analyst, except for interlaboratory comparisons and external systems audits, which are conducted by the U.S. Environmental Protection Agency (EPA) National Air and Radiation Environmental Laboratory (NAREL).

[c] Gas chromatography/mass spectrometer (Model 5975, Agilent Technology, Palo Alto, CA, USA).

### 12.5 Uncertainty Determination

Uncertainty values reported to AQS with each concentration record will include components of both analytical and the volumetric uncertainty. The reported uncertainties are estimated “1-sigma” valued (one standard deviation). No blank corrections are assumed other than laboratories’ instrumental baseline corrections, which are an integral part of each analysis. Under this QAPP, the only uncertainty required to be reported to AQS is the uncertainty associated with gravimetric mass. That uncertainty is reported by UC Davis during their AQS submittal process.

The analytical uncertainty for gravimetric mass is determined as [sqrt(2)*standard deviation of replicate weighings] and varies by balance. Total mass uncertainty is calculated by assuming a 5% flow uncertainty (the maximum allowable deviation from the design flow rate) coupled with the analytical uncertainty according to the following formula:

$$\sigma_{Mi,j} = \sqrt{\sigma_{Ai}^2 + \sigma_{Vk}^2 * M^2}$$

where

$$\text{Total uncertainty} = \sqrt[2]{(Anal.Uncertainty)^2 + (Vol.Uncertainty * Mass)^2}$$

- $\sigma_{Mi,j}$ = Std. dev. of mass for analyte i for event j (micrograms per filter)
- $\sigma_{Ai}$ = Analytical uncertainty
- $\sigma_{Vk}$ = Relative std. dev. of sampler volume (dimensionless) [typically 5%]
- M = Analytical mass (micrograms per filter)

### 12.6 Method Detection Limits (MDLs)

Method detection limits (MDLs) for mass and ion testing are currently being determined and will be included in this QAPP as an addendum (if they are not available when the QAPP is finalized). Equations used to determine the MDL for each analysis type will be included in the Addendum. Gravimetric MDLs are determined by multiple re-weighings of blank filters. The Wood laboratory typically operates 1-2 balances during the course of a year and MDLs will be determined for both balances. MDL procedures for IC and OC/EC acceptance testing will be described in the Addendum.

# 13.0 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

## 13.1 Gravimetric Mass Laboratory

Relative humidity and temperature recording devices are used in the gravimetric mass laboratory to verify that measurements are correct and that variances around the chamber are taken into account. Table 13-1 details chamber environment inspection criteria, including how to appropriately document the inspection and troubleshoot if the inspection fails when they become available. In some cases these may be identical to those for $PM_{2.5}$.

**Table 13-1 Inspection Criteria for Gravimetric Mass Laboratory**

| Item | Inspection Frequency | Inspection Parameter | Action if Item Fails Inspection | Documentation Requirement |
|---|---|---|---|---|
| Weigh Chamber Temperature | Daily | 20-23ºC | 1) Contact Wood HVAC contractor<br>2) Call service provider that holds maintenance agreement | 1) Document in weigh room log book<br>2) Notify Lab Manager |
| Weigh Chamber Humidity | Daily | 30% - 40% | 1) Contact Wood HVAC contractor<br>2) Call service provider that holds maintenance agreement | 1) Document in weigh room log book<br>2) Notify Lab Manager |

USEPA Quality Assurance Document 2.12 "*Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods*" Section 10.4.1.3 states that filters will not be weighed if the relative humidity and temperature measurements in the weighing environment are not within acceptance criteria (RH = 30%–40% with humidity control of ±5% and temperature = 20˚–23˚C with a temperature control of ±2˚) for the preceding 24 hours. Gravimetric lab personnel will ensure that filters are equilibrated for at least 24 hours before weighing. The conditioning period for final weighing of filters must be within ± 2ºC and ± 5% RH of the conditions for the initial conditioning session. In the event of protracted chamber downtime that would cause the laboratory holding time to be exceeded, the analyst must decide whether to weigh the filters without the full 24 hours of equilibration, to weigh the filters when relative humidity and/or temperature measurements in the weighing environment have exceeded acceptance criteria, or to wait until the chamber controls are functional, thus exceeding holding time limits. This choice has little impact on overall data validity, as the consequence of each choice is the same: an AQS validity status flag of 2, "operational criteria exceeded." In each case, the analyst must specify the data flag and insert a brief explanation of the problem in the spreadsheet that is sent to data management.

Table 13-2 details the weigh room schedule and who will be responsible for performing the maintenance.

**Table 13-2 Gravimetric Mass Laboratory Maintenance Schedule and Responsibility**

| Item | Maintenance Frequency | Responsible Party |
|---|---|---|
| ▪ Multipoint Microbalance<br>▪ Internal Calibration<br>▪ Maintenance<br>▪ External Calibration | Daily<br>Yearly or as needed<br>Yearly or as needed<br>Yearly or as needed | Balance Analyst<br>Sartorius Service representative |
| Comparison of NIST standards to laboratory working and primary standards | Yearly or as needed | Laboratory Supervisor |
| Cleaning weigh room* | Daily, Monthly, and Annually | Balance Analyst |
| Sticky floor mat (just outside the weigh room) | Monthly or as needed | Balance Analyst |
| HVAC system preventative maintenance | Yearly | Wood HVAC Contractor |

*EPA Quality Assurance Guidance Document 2.12, section 9.2

## 13.2 Ion Chromatographic Laboratory

In the ion chromatographic laboratory, several different instruments are routinely tested and maintained**.** Table 13-3 details the items to inspect, how frequently they should be inspected, the inspection parameter, action items if the inspection fails, and how to appropriately document the inspection. The analyst is responsible for performing the maintenance.

**Table 13-3 Inspection Criteria for Ion Analysis Laboratory**

| Item | Inspection Frequency | Responsible Party | Action if Item Fails Inspection | Documentation Required |
|---|---|---|---|---|
| IC Column back pressure (Column specific; supplied by Thermo Dionex) | Each day of use | Analyst | 1) Check for blockage<br>2) Replace column if necessary | Record pressure in instrument log book |
| IC Background conductivity (Eluent specific; within historical limits) | Each day of use | Analyst | 1) Check eluent flow<br>2) Check suppressor<br>3) Call Thermo Dionex tech support if necessary | Record conductivity in instrument log book |
| Baseline (Steady, no "pulsing" or steady increase or decrease) | Each day of use | Analyst | 1) Check for leaks<br>2) Check for air bubbles in conductivity cell<br>3) Call Thermo Dionex tech support | Record corrective action in instrument maintenance log book |

| Item | Inspection Frequency | Responsible Party | Action if Item Fails Inspection | Documentation Required |
|---|---|---|---|---|
| Check for leaks at valves and column fittings | Each day of use | Analyst | Tighten or replace Valve or fitting | Record corrective action in instrument maintenance logbook. |
| IC system preventative maintenance (Check valves, fittings, flows, needles, syringes.) | Yearly | Thermo Dionex representative | Replace as needed. | Service recorded in instrument maintenance logbook. |

### 13.3 OC/EC Laboratory

**Table 13-4 Inspection Criteria for OC/EC Laboratory**

| Item | Inspection Frequency | Responsible Party | Documentation Required |
|---|---|---|---|
| Check Compressed gas supply | Each day of use | Analyst | Record pressure in instrument log book |
| Clean Filter Punching Tool | Between each sample | Analyst | Record activity in instrument log book |
| Back up data files | Each day of use | Analyst | Record activity in instrument log book |
| Temperature Calibration | Semiannually | Analyst | Record activity in instrument log book |
| Check O2 Diffusion levels | Semiannually | Analyst | Record activity in instrument log book |

Regular maintenance for the analyzer involves daily checking of compressed gas supplies, cleaning the punching tool and tweezers between each sample with dry KIMTECH wipes, ensuring that the lab is clean, and backing up data files to disc on a daily basis (unless files are automatically backed up to server). Temperature calibrations for the six temperature plateaus (140, 280, 480, 580, 580, 740, and 840°C) need to be performed semiannually. Checks of laser adjustments and leaks are made at least monthly or on an as needed basis. Additional leak tests are performed with a He leak detector each time a part is replaced, or whenever the analyzer fails the leak check during the daily routine. The system should show no He leaks at the various connections of the quartz cross oven. Since He has high diffusivity, freedom from He leaks will safeguard against $O_2$ diffusion into the system. These $O_2$ levels are determined semi-annually using a gas chromatography/mass spectrometry (GC/MS) instrument on the analyzer. Quarterly levels are determined using an $O_2$ detector that is calibrated against the GC/MS. This is also used when a fresh He cylinder is installed to assure the quality of the gas supply and the condition of the $O_2$ scrubber. If the AutoCalib command is used for calibration, the condition of the $MnO_2$ oxidizer will be indicated and appropriate action can be taken (such as $MnO_2$ replacement). All calibrations, repairs, and checks must be recorded in the Carbon Analyzer Logbook maintained by DRI. Flow rates of all operating gases should be checked and adjusted (if needed) whenever a new quartz oven is installed or serviced. Additionally, a flow check and balance should be performed as well.

# 14.0 Instrument Calibration and Frequency

## 14.1 Gravimetric Mass Laboratory

The microbalances are externally calibrated and serviced, if necessary, at least annually or as needed when problems are detected. Wood keeps records on the service dates and calibration results. NIST-traceable standards are tracked to determine if bias is entering into the system. These standards are recertified annually. Control charts based on a standard weight are maintained to track long-term drift and other time-dependent changes in microbalance performance.

Calibrations in Wood's analytical laboratories are performed on each day of analysis. See the respective SOPs for more details.

## 14.2 Ion Chromatography Laboratory

Multipoint calibration is performed daily. Calibration is followed by analysis of QA/QC samples. Included are:

- QC samples containing anions/cations at concentrations typical of those found in the mid-range of actual filter extract concentrations
- A commercially prepared NIST-traceable QA sample containing known concentrations of anions/cations.

Table 14-1 lists the typical values for each QC sample.

**Table 14-1 Typical QC Sample Target Values (ug/mL)**

| Analyte | CCV | SRM |
|---|---|---|
| Chloride | 0.50 | 0.04 |
| Nitrate | 2.2 | 0.04 |
| Sulfate | 2.5 | 0.04 |
| Sodium, | 0.5 | 0.04 |
| Ammonium | 0.5 | 0.04 |
| Potassium | 0.5 | 0.04 |

## 14.3 OC/EC Laboratory

Instrument calibration occurs every 6 months or whenever a major component is changed on the analyzer. If a calibration is unsuccessful the instrument is returned to the manufacturer for repair and replacement and re-calibration.

## 15.0 Inspection/Acceptance Requirements for Supplies and Consumables

Supplies and consumables are inspected by the laboratory supervisor or laboratory technicians to determine if they are acceptable for use on the project.

### 15.1 Filters

Wood will purchase, inspect, and verify filter lots to be used for the CSN according to specific procedures applicable to each type of filter and for other sampling media such as reagents used to prepare denuders.

Wood will purchase the appropriate number of filters and other sampling media to supply the needs of the monitoring organizations, as directed by the USEPA Project Officer through the Delivery Orders. Teflon and nylon filters are shipped directly to Wood, while quartz fiber filters are sent directly to DRI for pre-firing, inspection and acceptance testing. The quantity of filters ordered will be sufficient to provide spares to replace defective filters and to satisfy QA/QC needs (e.g., laboratory blanks and field blanks). Cassettes, if required, are provided by the state sampling authority responsible for field monitoring. The number of cassettes must be sufficient to allow for shipments to the sampling sites as well as preparation of upcoming shipments from Wood.

Regardless of the filter type or the project's specific analytical requirements, filters of all types must be examined individually prior to use and upon receipt from the field to ensure that one or more of the following defects does not exist:

- **Pinholes.** A small hole or tear in the filter matrix that appears when examined over a light table.
- **Loose material.** Any loose material or particulate contamination on the filter surface.
- **Separation of reinforcing ring.** Any separation or discontinuity of the seal between the filter matrix and the outer retaining or reinforcing ring.
- **Discoloration.** Any visible discoloration that indicates problems during the filter's manufacture or packaging.
- **Filter non-uniformity.** Any obvious difference in the spatial uniformity of the filter matrix structure or color. Analytical techniques that rely on the uniformity of aerosol deposition (e.g., XRF) are particularly sensitive to filter defects of this type.
- **Other.** Defined as any other defect (e.g., wrinkling, warping) that might prevent a filter from providing accurate measurement data.

The other acceptance criteria applicable to the different filter types are described in the following subsections.

#### 15.1.1 Teflon Filters

Wood will purchase the appropriate number of Teflon filters (MTL Catalog No. PT47AN or other equivalent brand) to support the contract. The quantity of filters ordered will be sufficient to provide spares to replace defective filters and to satisfy QA/QC needs (e.g., laboratory blanks and field blanks). Cassettes, if required, must be provided by the SLT sampling authority. The number of cassettes should be sufficient to allow for shipments to the sampling sites as well as preparation of upcoming shipments from Wood. Acceptance testing of Teflon filters by Wood (and other filter types) to be used for ion sampling (if any) should be based on analysis of a minimum of 2% per lot (or two filters per 100 filters). Lots must be rejected when the levels of individual anion or cation species exceed 1µg/filter.

### 15.1.2 Nylon Filters

Nylon filters (47 mm diameter, 1 micron pore size) are purchased from a vendor capable of supplying sufficient stock of filters. Specified background levels of the ions quantified by the CSN IC instruments shall be low enough such that washing of the filters is not required. IC analysis will be performed to confirm that nitrate, sulfate, chloride, sodium, ammonium, and potassium levels in each filter lot are less than 1µg/filter each, based on 2% analysis per lot. Acceptable lots of nylon filters will be sealed and refrigerated until needed for field sampling. The quantity of filters ordered will be sufficient to provide spares to replace defective filters and to satisfy QA/QC needs (e.g., laboratory blanks and field blanks).

Acceptable lots of nylon filters should be sealed and refrigerated until needed for field sampling.

### 15.1.3 Quartz Filters

The Pall Tissuquartz 25mm (Pall 7200) diameter filters (and any Whatman 47 mm diameter [Pall 7202] quartz filters if required) are prepared by DRI. Quartz filters are pre-fired before elemental, organic and total carbon acceptance testing. The procedure for performing pre-firing and acceptance testing is described in *Pre-firing and Acceptance Testing of Quartz-Fiber Filters for Aerosol and Carbonaceous Material Sampling*, DRI SOP 2-106r8. Briefly, quartz filters are typically pre-fired in batches of 100, in a muffle furnace at 900°C for a minimum of 4 hours. After pre-firing and cooling, 2% of the quartz filters (2 from each lot of 100) or a minimum of 2 (whichever is more) are randomly selected from the cleaned batch for total carbon testing. The results of the acceptance testing may show evidence of inadequate cleaning or contamination that may have occurred during transport. The quartz-fiber filters are rejected or re-cleaned if any filter analyzed gives a measured blank total carbon level exceeding 1.5µg/cm$^2$ for the 25mm filters, or 1 µg/cm$^2$ for 47 mm filters, the lot is rejected.

The reason for the difference in the acceptance criteria is the size of the filter punch used for the analysis: The 25mm diameter filter used for the IMPROVE_A OC/EC method requires a punch that has an area of about 0.5 cm$^2$, and the 47 mm diameter filter used for the CSN/TOT OC/EC method requires a punch that has an area of about 1.5 cm$^2$.

Filters meeting the acceptance criteria outlined above are assigned a Batch Number. Batches of acceptance-tested filters are placed individually in the containers that the filters originally were shipped in, and sealed in plastic until ready for use. Each container contains the batch number. They are stored in a freezer at ≤-15˚C until the filters are used. Filters are kept in a freezer until just prior to loading into modules.

Wood will store batches of prepared filters in a freezer until they are needed in preparation for field sampling. Before loading onto the cartridges or modules for field sampling, each quartz filter is carefully inspected for uniformity in size, shape, thickness, and appearance. Any filters that are visually flawed will be discarded.

#### 15.1.4 Criteria for other Materials

Wood and their subcontractor DRI will use the quality of reagents, purified water, and other materials specified in their respective SOPs.

## 16.0 Data Acquisition Requirements (Non-direct Measurements)

This work does not involve the use of any historical databases, literature files, etc. Supplemental, non-direct measurement data supplied by the monitoring organizations or subcontractors for inclusion in the database will be subject to limited validation to ensure that data have been correctly entered and identified.

# 17.0 Data Management

This section describes Database Management System (DBMS) Quality Control/Quality Assurance (QC/QA) as well as how the DBMS promotes overall QC/QA program activities.

## 17.1 Overview

The core of the DBMS is a custom database, using Microsoft Access 2013 as a relational database front-end with Microsoft SQL Server as the back-end data tables. Custom user programs for data entry and processing were written in Access 2013. To minimize data entry errors, the system imports data directly from electronic data files produced by instruments or other devices whenever possible. For example, data generated from the gravimetric laboratory used to deliver the concentration information to UC Davis for upload to AQS for those CSN sites without FRM samplers is directly uploaded into the CSN Tracking Database.

Wood created preset sampling configurations to ensure that samples were scheduled, prepared, and processed consistently. Each sampling event is scheduled for a specific sampling configuration. These configurations specify which sampling media are used by specific sampler channels, what flow rates are appropriate for sampling, and which analyses are to be performed on each sampling medium. Documentation of this configuration can be found in the SOP GLO3110-006 *Database Operations for the Chemical Speciation Network*, found in Appendix A.

The system tracks each sampling module, event, and sampling medium with a unique identification number (ID). To prevent data entry errors, barcode readers are used extensively to read 1D barcodes.

Electronic files and limited hard copy reports are used to transmit pertinent information related to the sampling events, the filter media and the operational data required to prepare concentration information to the Network analytical laboratory.  These files are generated from the MS Access front-end using stored queries.

Further examples of QA/QC may be found in the QA/QC sections of SOPs located in Appendix A.

## 17.2 CSN Tracking Database Design Features

Careful identification of each sampling module and sampling event is essential in combining the correct analytical results with the correct sampling event. Many features have been designed into the DBMS to prevent common data entry errors. Unique identifiers are generated for each sampling event, module, and sampling medium. These identifiers are used to link modules with various filter type configurations, sampling events, and analyses. Barcode scanners are used for data entry to reduce the chance of data entry errors. Database referential integrity also prevents linkage of a sampling module, event, or sampling medium that has not been previously created in the DBMS.

### 17.2.1 Sample Identifiers

Each item that is tracked by the DBMS is assigned a unique identification number (ID). Tracked items include record sheets such as the Field Sampling Chain-of-Custody Form, as well as equipment such as sampler modules, shipping containers, and analysis aliquots in storage. ID numbers that are not automatically generated at the time of data entry (i.e., those that are entered from a local workstation) are obtained from preprinted barcode stickers. The stickers are generated with a unique leading character that specifies the type of item being generated. The leading character is used by data entry applications to prevent entry of a data item's ID into the wrong field on a form. As an example, a module ID cannot be entered into the aliquot (analytical sample) ID field because module IDs begin with "I" and aliquot IDs begin with "A." Table 17-1 shows the labels in use by the CSN Program.

**Table 17-1 Label Identifiers for Tracking CSN Records and Equipment**

| Prefix | Label Type |
|---|---|
| Q | Field Sampling Chain of Custody |
| F | Filter Sample Identifiers |
| I | Sampler Module ('Inventory") |
| M | Measurement Request ID |
| B | Storage Bins |
| A | Aliquot Shipment Batches to Laboratories |

### 17.2.2 Barcode Scanners

Handheld laser scanning barcode readers are used at FiSH processing stations to read 1D barcode ID labels. These readers are inserted into the client workstation's keyboard connection and provide a rapid and reliable means of entering ID labels used in sample processing.

### 17.2.3 Relational Integrity

Microsoft Access permits establishment of foreign key constraints between fields in related tables. These constraints provide automatic enforcement of database referential integrity. Enforcement occurs at the server level and is not dependent on application-level programs. Referential integrity constraints prevent entry of a record in a dependent (child) record without a corresponding record in the independent (parent) table. This prevents entry of records that are not linked to other database items. Similarly, an independent (parent) record cannot be deleted while records that depend on that record exist. This prevents the creation of orphaned records.

As an example of referential integrity, data flags for a sampling event cannot be entered unless the sample event ID was previously entered into the Sample Events Table (at the time the flags were being added). Thus, attempts to enter sample event flags from programs that have incorrect sample event identification would be prevented.

### 17.2.4 Secondary Confirmation of Hand-Entered Field Data

Sample event information (such as elapsed sample time, volume, barometric pressure, temperature, and sampler QC information) for scheduled events are transmitted from the field on the FSCOC Form. Information on these forms are entered and then double checked visually by a separate individual who had no role in the primary entry of the data. Visual cues alert data entry personnel of any parameter that is out of specification, they must check the entry with hard copy to determine if the value is correct. Discrepancies are resolved before transfer of the data to the end user. Wherever possible, electronic data available from sampling devices is used to transfer data into the appropriate database tables.

### 17.2.5 Direct Transfer of Laboratory Data

Electronic laboratory data are sent from Element LIMS to the DBMS as an electronic file via e-mail. The laboratory data are obtained directly from instrument data system outputs that contain the sample identifier and the measured value. Laboratory personnel add additional QC information during their QC review process. The resulting laboratory data files are directly transferred into the database using custom import programs. This direct transfer prevents data entry errors that could result from manually retyping data into the DBMS.

Data are also transferred from the DBMS to the analytical Network laboratories in specified formats (typically comma separated value [CSV] files) via email. For transmittance of information on filters, a printed LCOC form is also provided. An example of the LCOC form is found in Appendix C.

### 17.2.6 Training and Development Databases

Separate training and development databases have been established for operator training and program development purposes, respectively. This permits us to train operators and develop new software without risk of modifying the actual program database. Output (forms, reports, etc.) from these databases contain clear labels to identify them as training or development reports. This prevents their accidental usage in the actual program.

### 17.2.7 Database Backup and Recovery

The information contained in the Microsoft Access and Microsoft SQL Server databases are backed up to the local Wood file server every 24-48 hours. The file server is backed up to the cloud on a nightly basis. Backup copies are generated automatically by Wood’s IT department.

## 17.3 Automated and Semi-Automated Limit Checks

The DBMS contains provisions to add data quality flags to most data records. These data flags allow the annotation of data to indicate specific problems and or conditions that might affect data quality. Flags may be added to entire sampling events, individual sampler flow channels, or filter samples. The flags are expanded during the reporting process so that flags that reflect an entire sampling event apply to all results in that event, flags affecting a sampler flow channel apply to all results using that channel, etc.

At the present time, gravimetric mass values that are found to be below the MDL are not flagged. The MDL is currently being established for the CSN contract due to the switch from Whatman to MTL Teflon filters. Once established, values below MDL may be flagged if requested by USEPA.

If there are additional strategies for establishing acceptance limits for data recorded during the shipping and handling phase of the contract, they will be discussed between Wood and USEPA.

In addition to flagging outliers, Wood will also be applying both AQS Null Value Codes and Validity Codes to events or channels (or both). Conversion of some outlier codes to AQS can be found in Table 17-2. There is no one-to-one correspondence between the Internal Flags and the AQS Codes, so the QC reviewer or FiSH supervisor will assign the AQS Codes based on the identified reason for the violation of the screening limits. Because the causes for outliers is often unknown even after careful review of the available documentation, “generic” AQS codes must be used in these cases, as shown in the table.

**Table 17-2 Mapping of Outlier Flags onto AQS Codes**

| Objective Cause Found for Level 1 Outlier | If NOT Invalid (Suspicious) | If Invalid |
|---|---|---|
| Lab Error | [1] | AR |
| Filter Damage | [1] | AJ |
| Module Assignment Error | (N/A) | AQ or AR |
| Sampler Malfunction | (N/A) | AN |
| Unusual Conditions noted by Operator | [1] | [2] |
| Unknown Cause | 5 | AS or AM |
| Range Checks | (N/A) | 5 |

[1] = Use applicable AQS validity code listed in Table 17-3
[2] = Use applicable AQS null value code listed in Table 17-4
(N/A) = Not Applicable

## 17.4 Report Preparation and QA Screening

Monthly data reports are screened carefully as described in the following sections prior to delivery to the USEPA Contract Technical Representative and UC Davis.

### 17.4.1 Dataset Completeness and Integrity

During Analysis Batch preparation for shipment of filter media and data to labs, multiple queries are run to flag data that is out of specification and to check for erroneous entries. For further reference see SOP GLO3110-003 located in Appendix A.

### 17.4.2 Entry and Verification of Data Changes from the States

Changes requested by the state agencies are entered into Wood’s database by the data processing staff as the comments are received from the respective CSN Regional Representative. These changes are generally related to incorrect entries on FSCOC forms related to the sample events or mix-ups related to use of different equipment than was specified on the FSCOC.

After anomalies are corrected, the information required to be reported to AQS will be generated and transferred to UC Davis as a CSV text file. Wood transmits available operational data, mass information where appropriate and Null and Validity flags applied as a result of field/shipping and handling operations. UC Davis will transmit all data to AQS (including mass) when they transmit the analytical chemistry results.

## 17.5 AQS Data Flagging

Wood provides data to UC Davis related to the operational parameters and to the Null and Validity qualifier codes (flags). As a consequence, since Wood does not report data directly to AQS, the only information provided to UC Davis is operational data and validity status codes.

The validity status of AQS data is reported in two ways: Data that are qualified in some way but still may be useful for some purposes are assigned Validity Status Codes. These codes, shown in

Table 17-3**,** do not invalidate the data value, which provides SLTs and data users with the option to include the data in their analyses. Alternatively, data that are judged to be invalid receive an AQS Null Value Code. In the AQS system, the Null Value Code flags the data value such that the AQS user cannot access the data. The Null Value Codes applicable to the CSN Program are shown in Table 17-4**.** UC Davis will transmit all data to AQS (including mass) when they transmit the analytical results. Wood will provide field data and applicable AQS flags to UC Davis for entry into AQS. Field and flag data are provided to UC Davis as a CSV file with each transferred batch of filters sent for analysis. Separate files are provided for Null and Validity status codes. The process of creating these files is described in SOP GLO3110-003, *Analysis Batch Preparation and Shipment.*

**Table 17-3 AQS Validity Data Status Codes**

| AQS Validity Status Codes | Flag Name |
|---|---|
| A1 | Modified or Changed by Wood |
| 2 | Operational Deviation |
| 3 | Field Issue |
| 4 | Lab Issue |
| 5 | Outlier |
| 6 | QAPP Issue |
| IA | African Dust |
| IB | Asian Dust |
| IC | Chem. Spills and Industrial Accidents |
| ID | Cleanup After a Major Disaster |
| IE | Demolition |
| IF | Fire - Canadian |
| IG | Fire - Mexico/Central America |
| IH | Fireworks |
| II | High Pollen Count |
| IJ | High Winds |
| IK | Infrequent Large Gatherings |
| IL | Other |
| IM | Prescribed Fire |
| IN | Seismic Activity |
| IO | Stratospheric Ozone Intrusion |
| IP | Structural Fire |
| IQ | Terrorist Act |
| IR | Unique Traffic Disruption |
| IS | Volcanic Eruptions |
| IT | Wildfire - U.S. |
| QP | Pressure Sensor Questionable |
| QT | Temperature Sensor Questionable |
| T | Multiple Flags: Misc |
| TT | Transport Temperaure is Out of Specs. |
| V | Validated Value |
| W | Flow Rate Average Out of Spec |

| AQS Validity Status Codes | Flag Name |
|---|---|
| X | Filter Temperature Difference Out of Spec |
| Y | Elapsed Sample Time Out of Spec |

**Table 17-4 AQS Null Qualifier Codes**

| AQS Code | Flag Name |
|---|---|
| AB | Technician Unavailable |
| AC | Construction/Repairs In Area |
| AD | Shelter Storm Damage |
| AE | Shelter Temperature Outside Limits |
| AF | Scheduled But Not Collected |
| AG | Sample Time Out Of Limits |
| AH | Sample Flow Rate Out Of Limits |
| AI | Insufficient Data (Can't Calculate) |
| AJ | Filter Damage |
| AK | Filter Leak |
| AL | Voided By Operator |
| AM | Miscellaneous Void |
| AN | Machine Malfunction |
| AO | Bad Weather |
| AP | Vandalism |
| AQ | Collection Error |
| AR | Lab Error |
| AS | Poor Quality Assurance Results |
| AU | Monitoring Waived |
| AV | Power Failure (Powr) |
| AW | Wildlife Damage |
| AZ | QC Audit (Audt) |
| BA | Maintenance/Routine Repairs |
| BB | Unable To Reach Site |
| BE | Building/Site Repair |
| BI | Lost Or Damaged In Transit |
| BJ | Operator Error |
| DA | Aberrant Data |
| SA | Storm Approaching |
| TS | Holding Time Is Out Of Specs |

### 17.6 Data Management in the Laboratories

The individual analytical laboratories are responsible for managing their data prior to its entry into the Data Analysis and Reporting Tool (DART) for eventual upload to AQS. The procedures for data management vary significantly between the Network analytical laboratories and are described in their respective SOPs and quality systems documentation.

# 18.0 Assessments and Response Actions

Wood will participate in laboratory audits and/or proficiency programs established by USEPA. Internal technical systems audits will be performed by Wood for key project activities that affect achievement and maintenance of the project DQO. This section describes internal assessments to ensure that:

- Elements of this QAPP are correctly implemented as prescribed;
- The data collected meets project DQO and DQI measurement criteria; and
- Corrective actions are implemented in a timely manner and their effectiveness is confirmed.

The QA Manager and/or the Quality Specialist will perform annual technical systems audits of the Wood activities and biennial subcontractor audits. These audits will include sample receipt, custody, conditioning, weighing, analysis, shipping, and data reduction and reporting as applicable to each laboratory and facility. Prior to each audit, a checklist will be prepared, based on this QAPP and SOPs.

The QA Manager will summarize audit results in a report to the Wood Program Manager within two weeks. If there are audit findings, a completed non-conformance/corrective action form (NCAF) will be appended to the report. The NCAF will include applicable root cause analysis and a schedule for closure. If serious problems are identified that require immediate action, such as a large, systematic analytical bias, the QA Manager will convey these to the Wood Program Manager the day that such problems are identified. Corrective actions are the responsibility of the Wood Program Manager. Response actions will be documented in a memorandum to the file and relevant project staff, including the QA Manager. The QA Manager will verify the effectiveness of formal response actions and document their acceptability on the NCAF with the concurrence of the Wood Program Manager. A summary report outlining findings and corrective actions of each audit will be provided to USEPA one month after completion.

Formal corrective action documentation, including the audit report, NCAF, and objective evidence for response actions will be retained in the QA Manager's files and available for review.

Internal performance evaluations will be conducted by analyzing reference materials with values traceable to NIST (where available) with each batch of reported samples. The results of reference material measurements must be within their established acceptance criteria for associated sample results to be reported as valid.

The internal data assessment process is ongoing with routine assessments incorporated into the data review and data validation processes described in Sections 18 and 19. The data validation process involves each level of data processing from data collection and entry into the MS Access DBMS through data delivery.

Periodic monitoring of project status is performed to ensure that project requirements are being fulfilled. Surveillance is conducted through project meetings conducted at a minimum frequency of once per month. During these project meetings, action items, upcoming events, deliverable schedules, status of corrective actions, and project deadlines may be identified and discussed. At a minimum, the following personnel are present at the meetings: the Program Manager, Technical Area Supervisors and QA Manager or their designated representatives. Subcontractors are present as requested. Meeting summary notes are taken, distributed, and saved in the project files.

Assessments are summarized in Table 18-1.

**Table 18-1 Assessments Summary**

| Assessment Type | Frequency | Assessment Personnel | Assessment Record |
|---|---|---|---|
| Technical Systems Audit | Annual | Quality Assurance Manager, Quality Specialist | Audit Report |
| Audit of Data Quality* | Annual | Quality Assurance Manager, Quality Specialist | Audit Report |
| Method Audit | Annual | Quality Assurance Manager, Quality Specialist | Audit Report |
| Subcontractor Audit | Biennial | Quality Assurance Manager | Audit Report |
| Gravimetric Laboratory Conditions Verification | Quarterly | Quality Assurance Manager, Quality Specialist | Audit Report |
| Performance Evaluation | Per Laboratory Instrument Run \| Quarterly** | Laboratory Analysts \| Quality Assurance Manager, Quality Specialist | Laboratory Data Report \| Audit Report |
| Analysis Batch Verification/Validation | Per Analysis Batch (Shipments of Exposed Filters) | FiSH Technicians, Laboratory Analysts, Technical Area Supervisor, Quality Specialist | Analysis Batch Checklist |
| Project Surveillance | Monthly | Technical Area Supervisor, Program Manager, Quality Assurance Manager, EPA, Subcontractors | Call Notes† |
| Review of Project Documents†† | Annual | Quality Assurance Manager, Quality Specialist, Technical Area Supervisor | Audit Report |

* "Audits of data quality (ADQs) are conducted on verified data to document the capability of a project's data management system (hardcopy and/or electronic) to collect, analyze, interpret, and report data as specified in the QA Project Plan." - USEPA QA/G-7
**Verified quarterly by quality personnel using control charts.
†To document occurrence.
††QAPP and SOPs

## 18.1 External Quality Assurance Assessments

Wood's gravimetric laboratory, FiSH and our acceptance testing facilities (both Wood and our subcontractor DRI), will participate in external QA assessments as requested by the USEPA.

These assessments will include on site Quality Systems and Technical Systems Audits, and the analysis of performance evaluation samples.

### 18.2 Reports to Management

Following shipment of Analysis Batches to the contract labs, Wood provides the results of gravimetric filter analyses together with the level 0 and level 1 validation flags to UC Davis, who then processes the data and provides it to parties including the USEPA Technical Project Manager, and State or local data validation contacts. Upon approval by the State or local agency contacts, UC Davis then posts the data to AQS.

The Wood Program Manager or designee approves the Analysis Batch Data Reports, Quarterly Metadata Reports and the Annual Data Summary Reports. The Program Manager and the QA Manager are notified whenever there is a QA problem and will be apprised of corrective actions taken to solve the problem. The QA Manager will perform yearly technical systems audits and will submit a report to the program manager within two weeks of the audits. A summary report of findings and corrective actions will also be submitted to the EPA QAO. Annual determinations of the MDL, precision, and accuracy, and a summary of results from the analysis of internal and external (if received) performance evaluation samples will also be submitted as part of the Annual Data Summary Report to the USEPA Project Officer.
The following is a list of regularly scheduled technical and quality-related reports that will be provided to USEPA:

1) **Analysis Batch Data Reports (Electronic and hard copies).**
   **A. Data Reports (Electronic and hard copies).** Data for this report are generated from Wood's CSN Tracking Database using the field and analytical data and the flags produced during Level 0 and Level 1 validation. Wood has developed SQL queries to produce the reports and spreadsheets. Electronic copies of these reports are provided to UC Davis for entry into DART following completion of the analytical component of the CSN program. These data are provided by email in CSV files shipped to UC Davis with each filter shipment that is sent to the Network analytical laboratory. At a minimum, the analysis batch reports shall include the following fields for each sampling day and for all filter types:
      a. AQS site identification
      b. SLT monitoring agency name
      c. Filter number
      d. Analysis type
      e. Start date and time
      f. End date and time
      g. Run time
      h. Retrieval date and time
      i. Sample volume
      j. Average ambient temperature for the duration of the sampling event
      k. Average barometric pressure for the duration of the sampling event
      l. Date received
      m. Analysis date (if reweighed, both dates and respective results should be posted)

n. Final concentration of gravimetric mass in $\mu g/m^3$
o. Method detection limits and uncertainties
p. Comments

**B. Level 0 Validation**. Data entry checking of the FSCOC forms and Level 0 validation checklist is performed manually. Data flags generated during the Level 0 validation process - discussed in Section 21 with validation flags listed in Tables 17-2, 17-3 and 17-4 - are attached to each data record and are provided with every analysis batch shipment, emailed in electronic format to UC Davis for entry into DART for SLT agency review, as part of regular analysis batch reporting

**C. Level 1 Validation.** Operational data and information on gravimetric mass determinations are validated using automated QA routines in the CSN Tracking Database during the validation process to identify problems. Data flags (if any) generated during the Level 1 validation process are attached to each data record and are reported in electronic data files to UC Davis as part of the Analysis Batch Shipment process

2) **Quarterly Metadata Reports** of laboratory/field changes and issues that impact data quality will be prepared by Wood with input from its subcontractors if required. These reports will include a complete listing of field changes (e.g., sites that shut down or changes to sampler types and dates of operation), laboratory changes (e.g., changes to lab procedures or operations); and data collection or analysis issues and dates for samples affected or invalidated. Reports will be chronological and will succinctly describe the issues or changes, and associated samples if any were affected. One electronic copy of the report will be prepared and delivered to USEPA OAQPS.

3) **Annual Data Quality Report**. Wood will provide the USEPA with a report that provides a comprehensive overview of performance and summarizes quality issues, corrective actions, data completeness, MDLs, operational problems, blank levels, laboratory QC results, and precision estimated using data from sites where collocated samplers are situated. Other information such as reports of internal and external TSAs and performance audits will also be included when applicable.

# 19.0 Data Review, Validation, and Verification Requirements

The following describes Wood's approach to data review, validation, and verification for $PM_{2.5}$ filter analysis. The QC criteria given elsewhere in this QAPP will be used as the data validation requirements. Data that fails routine validation checks will be flagged for review by the monitoring agencies. Large or systematic exceedance criteria may also trigger a corrective action investigation by the Wood's QA Manager.

Analytical data generated during the filter acceptance testing are validated using data from laboratory blanks, calibration checks, standard spikes, and laboratory duplicates. Based on QC verification data, filter lots may be invalidated or the result may be flagged. Reasons for invalidation may include, but are not limited to, damaged filter, laboratory or field blank contamination, balance or weigh room malfunction, and missed holding times.

## 19.1 Validation and Verification

Wood is responsible for validating analytical data produced in its laboratories and those of its subcontractors. Subcontractor laboratories will be responsible for validating and screening data produced in their laboratories. Wood's is responsible for performing Level 0 and Level 1 validation and verification and for data reporting for CSN $PM_{2.5}$ mass and field sampling operational data and flags. Data are reported to UC Davis, who enters the data into DART along with other analytical analysis data for final review by the SLT agencies, CSN Regional Representatives and the USEPA Technical Contract Representative.

## 19.2 Level 0 Validation

Level 0 data sets contain available ambient data and may contain non-ambient data in the form of QC checks and/or flags indicating missing or invalid data. Missing data will be retrieved from the source, if available, and problems related to chain of custody, shipping integrity, sample identifications, and inspections will be rectified to the extent possible. The initial identification of these problems will be the responsibility of the FiSH Technicians, who works closely with the Program Manager and other data entry personnel to document systematic problems and to take or recommend corrective actions. Data will be flagged or invalidated if problems are identified during Level 0 validation but cannot be rectified.

Sources for the information used to screen data for Level 0 validation include the analyst's notes (logbooks and data forms), sample labels, COC forms, package shipping labels, and inspection results for filters and other sample media. Validation flags in the Level 0 data will also include the data flags for items such as power failures, temperature flags, and insufficient data for the averaging period generated by the speciation sampler in the field.

Occasionally, Wood's personnel may become aware of an excessive rate of problematic samples from a particular monitoring organization. Such problems might include inadequate packing, excessive numbers of damaged filter media, and incorrectly or inadequately completed forms. Wood will work with the monitoring organization to bring about corrective action. Also, the Wood PM will contact the USEPA Technical Project Manager and appropriate CSN Regional Representatives to inform him/her of the problem.

### 19.3 Level 1 Validation

Level 1 data are reviewed more fully for technical acceptability and reasonableness based on information such as routine QC sample results, DQIs, PE samples, internal and external audits, statistical screening, internal consistency checks, and range checks. Unacceptable long-term performance of the analytical system can also be uncovered in the process of documenting the DQIs of completeness, precision, accuracy, and detection limits, and comparing those indicators with the program's goals.

In response to major or systematic problems identified by these procedures, corrective actions will be taken and data may be flagged or invalidated. Corrective actions based on Level 1 screening results will include, for example, the following:

- Investigating the specific conditions that contributed to an anomalous results for a single laboratory sample or related group of samples
- Contacting the site operator or monitoring agency to find out if there were meteorological or other conditions that might lead to anomalous results
- Increasing the number of routine instrument checks such as multipoint calibrations, blanks, duplicates, and spikes
- Repeating analyses for the affected samples, if possible
- Reviewing logs and other records for transcription errors and evidence of operational problems or equipment malfunction.

Level 1 screening is conducted primarily after the data have been loaded into the CSN Tracking Database but before the data sets are transmitted to UCD. Initial screening of data is performed by data management personnel as described in SOP GLO3110-003 *Analysis Batch Preparation and Shipment*. Data validation flags generated during Level 1 screening are reviewed by the QA Manager or Quality Specialist with input from Technical Area Supervisors as needed. Data problems that originate outside the scope of Wood's operations are reported to the USEPA Technical Project Manager and appropriate CSN Regional Representative.

Wood will take any necessary corrective actions on problems identified during Level 0 and Level 1 data review activities and input from the SLT monitoring agencies during their review cycle.

Level 1 designation will be assigned to a set of data after the laboratory has performed QC activities and has addressed identified issues. Level 1 data will be transmitted to UCD along with AQS codes generated during the data validation process, as well as the changes requested by the monitoring agencies during their review.

### 19.4 Screening of Subcontractor Data

Although DRI will conduct their own screening and validation of data as part of the quartz-fiber filter acceptance testing, Wood will further verify and review the data submitted as part of the acceptance testing submittal from DRI. This includes ensuring that the sample identifications and COC information from the subcontractor are consistent with Wood's records. This process will consist primarily of comparing the original lot numbers, transmittal dates, filter types, etc., with the data received from the subcontractor. Of particular importance is ensuring that lot numbers from the subcontractor match up exactly with those from the filters provided by Wood.

Discrepancies in lot number attribution uncovered during the screening process will be investigated and rectified before the filter acceptance testing results are accepted.

Wood will not perform detailed Level 1 screenings on the subcontractor's OC/EC data from acceptance testing because this would duplicate efforts already expended. Wood's screening of DRI's OC/EC includes review of laboratory control blank results, instrument calibration control sample results, assignment checks based on lot number, ship date, and any additional ID numbers assigned to filters.

### 19.5 Data Corrections

Wood will investigate and attempt to make corrections to all laboratory problems. Corrections to quantitative data such as concentrations will not be applied unless they are defensible and are based on documented information. Questionable data will be flagged appropriately. The following paragraphs briefly discuss the types of data corrections that are typically encountered in this work.

#### 19.5.1 Mass

Mass measurements will not be corrected for blank levels. Early in the development of the fine particulate program, a problem was encountered with Teflon filters with rings in which the manufacturer used an adhesive to attach the rings. Solvent continued to volatilize from the adhesive over several weeks, making it difficult to achieve constant weight. The filter manufacturer has since corrected this problem. If other examples of time-dependent variances in mass measurements are found through analysis of blank filters, Wood will address these in consultation with the USEPA Technical Project Manager.

#### 19.5.2 OC/EC

Data corrections do not apply to the acceptance testing of quartz fiber filter performed by DRI.

## 20.0 Reconciliation with User Requirements

Wood will ensure that its measurement data meet requirements as expressed in this QAPP. Wood and its subcontractors will work closely with the USEPA to ensure that required performance characteristics are met. Wood will do the following to ensure that our performance meets contract requirements and client expectations:

- Regular communications between the Wood Program Manager and the CSN Regional Representatives, the USEPA Project Officer, and USEPA Technical Project Manager. Communications will include conference calls scheduled biweekly or as needed, e-mail and written correspondence, and meeting with USEPA/OAQPS personnel in the Research Triangle Park, NC, area.
- An organized system of corrective action notification and follow-through. Significant quality-related problems will be assigned corrective action request (CAR) numbers. The CARs will be tracked by the on-site QA Manager and the QA Manager to ensure that quality problems are addressed in a systematic way. This system will enable the Program Manager to allocate the resources necessary to resolve problems, to prioritize corrective actions, and to track the accomplishment of corrections.

Another key aspect of ensuring the smooth operation of the CSN laboratories is the handling of communications with the various participants in the program. Most programmatic communications with outside participants including USEPA/OAQPS, the CSN Regional Representatives, and the SLT agencies flow through the Program Manager. The only exceptions to this rule will be dealings on a technical level with USEPA personnel (e.g., to define data delivery formats for AQS) and contacts between shipping/receiving personnel at Wood and the SLT agencies for the purpose of expediting or locating specific shipments. No one at Wood other than the Program Manager is authorized to alter schedules, increase or decrease the number of samples to be analyzed, or change the schedule of shipments to/from a SLT agency. All such requests must go through the Wood Program Manager.

## 21.0 References

Flanagan, J.B., R.K.M. Jayanty, E.E. Rickman, Jr., and M.R. Peterson. (2006). PM2.5 Speciation trends network: evaluation of whole-system uncertainties using data from sites with collocated samplers. *Journal of the Air and Waste Management Association 56*:492– 499. April.

USEPA (1999a). Particulate Matter (PM2.5) Speciation Guidance Document (Third Draft), USEPA, Research Triangle Park, NC. January 5, 1999.

USEPA (1999b). Strategic Plan: Development of the Particulate Matter (PM2.5) Quality System for the Chemical Speciation Monitoring Trend Sites, USEPA, Research Triangle Park, NC, April 16, 1999.

USEPA (1998). *Data Quality Objectives for the Trends Component of the PM2.5 Speciation Network*, USEPA, Research Triangle Park, NC, 1999. Available on AMTIC at http://www.epa.gov/ttn/amtic/files/ambient/pm25/spec/dqo3.pdf. (Accessed 08/09/2011)

USEPA (1994). *Guidance for the Data Quality Objectives Process: USEPA QA/G-4*, Report No. USEPA/600/R-96/055, USEPA, Washington, DC.

Watson, J.G, and J.C. Chow (November 8, 1988). The 1987–1988 Metro Denver Brown Cloud Study, Vol. II: Measurements. DRI Document No. 8810 1F2. Final Report.

# Appendix A
# Standard Operating Procedures

# Appendix B
# CSN Sites

**Appendix B. CSN Sites**

| Site ID | Site Name | AQSSID | State | Sample Frequency | Tribal |
|---|---|---|---|---|---|
| Q001 | Birmingham - North Birmingham | 010730023 | AL | Seq 1-in-3 | No |
| Q002 | Wylam | 010732003 | AL | 1-in-6 | No |
| Q003 | Phenix City | 011130001 | AL | 1-in-6 | No |
| Q004 | Alaska Ncore | 020900034 | AK | 1-in-3 | No |
| Q005 | Phoenix Supersite | 040139997 | AZ | Seq 1-in-3 | No |
| Q006 | Children's Park | 040191028 | AZ | Seq 1-in-3 | No |
| Q007 | NLR Parr | 051190007 | AR | 1-in-3 | No |
| Q008 | Fresno - Garland | 060190011 | CA | 1-in-3 | No |
| Q009 | Bakersfield - California Ave. | 060290014 | CA | Alt 1-in-3 | No |
| Q010 | Bakersfield California Ave (collocated) | 060290014 | CA | 1-in-6 | No |
| Q011 | Los Angeles - North Main Street | 060371103 | CA | Seq 1-in-3 | No |
| Q012 | Rubidoux - Riverside | 060658001 | CA | Seq 1-in-3 | No |
| Q013 | Rubidoux (collocated) | 060658001 | CA | 1-in-6 | No |
| Q014 | Sacramento - Del Paso Manor | 060670006 | CA | Seq 1-in-3 | No |
| Q015 | El Cajon - Floyd Smith Dr (temporary relocation) | 060731018 | CA | Alt 1-in-3 | No |
| Q016 | San Jose - Jackson Street | 060850005 | CA | Alt 1-in-3 | No |
| Q017 | Commerce City | 080010006 | CO | 1-in-6 | No |
| Q018 | La Casa | 080310026 | CO | Alt 1-in-3 | No |
| Q019 | Platteville | 081230008 | CO | 1-in-6 | No |
| Q020 | Criscuolo Park | 090090027 | CT | Seq 1-in-3 | No |
| Q021 | Wilmington - MLK | 100032004 | DE | 1-in-3 | No |
| Q022 | Washington DC - Station 43 PAMS | 110010043 | DC | 1-in-3 | No |
| Q023 | Broward County NCore | 120110034 | FL | Seq 1-in-3 | No |
| Q024 | Sydney | 120573002 | FL | 1-in-3 | No |
| Q025 | Tallahassee Community College | 120730012 | FL | 1-in-6 | No |
| Q026 | Macon | 130210007 | GA | 1-in-6 | No |
| Q027 | Douglas (GA fund) | 130690002 | GA | 1-in-6 | No |
| Q028 | South Dekalb | 130890002 | GA | Alt 1-in-3 | No |
| Q029 | Rome - Elementary School | 131150003 | GA | 1-in-6 | No |
| Q030 | Columbus | 132150011 | GA | 1-in-6 | No |
| Q031 | Augusta | 132450091 | GA | 1-in-6 | No |
| Q032 | Rossville | 132950002 | GA | 1-in-6 | No |
| Q033 | Kapolei/Pearl City | 150030010 | HI | 1-in-3 | No |
| Q034 | St Lukes Hospital - Meridian Near Boise | 160010010 | ID | Seq 1-in-3 | No |
| Q035 | Chicago Springfield Pumping Station | 170310057 | IL | 1-in-6 | No |
| Q036 | Chicago Com Ed | 170310076 | IL | Seq 1-in-3 | No |
| Q037 | Northbrook | 170314201 | IL | Seq 1-in-3 | No |

| Site ID | Site Name | AQSSID | State | Sample Frequency | Tribal |
|---|---|---|---|---|---|
| Q038 | Naperville | 170434002 | IL | 1-in-6 | No |
| Q039 | Granite City (Missouri) | 171190024 | IL | 1-in-6 | No |
| Q040 | Jeffersonville/Walnut street | 180190006 | IN | 1-in-6 | No |
| Q041 | Jasper Post Office | 180372001 | IN | 1-in-6 | No |
| Q042 | Shenandoah High School Mechanicsburg | 180650003 | IN | 1-in-6 | No |
| Q043 | Gary | 180890022 | IN | 1-in-6 | No |
| Q044 | Indianapolis Washington Park | 180970078 | IN | Seq 1-in-3 | No |
| Q045 | Evansille Buena Vista Road | 181630021 | IN | 1-in-6 | No |
| Q046 | Jefferson Elementary (10th and Vine) | 191630015 | IA | Seq 1-in-3 | No |
| Q047 | Wichita Dept. of Environmental Health | 201730010 | KS | 1-in-6 | No |
| Q048 | JFK Center | 202090021 | KS | Alt 1-in-3 | No |
| Q049 | Louisville - Cannon's Lane | 211110067 | KY | 1-in-3 | No |
| Q050 | Shreveport Airport | 220150008 | LA | 1-in-6 | No |
| Q051 | Capitol | 220330009 | LA | Seq 1-in-3 | No |
| Q052 | Essex | 240053001 | MD | Seq 1-in-3 | No |
| Q053 | HU-Beltsville | 240330030 | MD | Seq 1-in-3 | No |
| Q054 | Chicopee | 250130008 | MA | Seq 1-in-3 | No |
| Q055 | Roxbury (Boston) | 250250042 | MA | Seq 1-in-3 | No |
| Q056 | Roxbury (Boston) - Collocated | 250250042 | MA | 1-in-6 | No |
| Q057 | Grand Rapids | 260810020 | MI | Seq 1-in-3 | No |
| Q058 | Tecumseh | 260910007 | MI | 1-in-6 | No |
| Q059 | Allen Park | 261630001 | MI | 1-in-3 | No |
| Q060 | Southwest High School | 261630015 | MI | 1-in-6 | No |
| Q061 | Dearborn | 261630033 | MI | 1-in-6 | No |
| Q062 | BlaineAnoka Airport | 270031002 | MN | Seq 1-in-3 | No |
| Q063 | Minneapolis - Philips | 270530963 | MN | Seq 1-in-3 | No |
| Q064 | Jackson NCore (new site, moved from Jackson UMC) | 280490020 | MS | Alt 1-in-3 | No |
| Q065 | Arnold West | 290990019 | MO | 1-in-6 | No |
| Q066 | St. Louis - Blair Street | 295100085 | MO | 1-in-3 | No |
| Q067 | Seiben Flats | 300490004 | MT | Seq 1-in-3 | No |
| Q068 | Butte-Greeley School | 300930005 | MT | 1-in-6 | No |
| Q069 | Woolworth Street | 310550019 | NE | Alt 1-in-3 | No |
| Q070 | Jerome Mack Middle School | 320030540 | NV | Alt 1-in-3 | No |
| Q071 | Reno | 320310016 | NV | Seq 1-in-3 | No |
| Q072 | Camden (NJ Fund) | 340070002 | NJ | 1-in-6 | No |
| Q073 | Newark | 340130003 | NJ | Alt 1-in-3 | No |
| Q074 | New Brunswick | 340230006 | NJ | Alt 1-in-3 | No |
| Q075 | New Brunswick (Collocated) | 340230006 | NJ | 1-in-6 | No |
| Q076 | Chester (NJ Fund) | 340273001 | NJ | 1-in-6 | No |

| Site ID | Site Name | AQSSID | State | Sample Frequency | Tribal |
|---|---|---|---|---|---|
| Q077 | Elizabeth Lab | 340390004 | NJ | Alt 1-in-3 | No |
| Q078 | Del Norte | 350010023 | NM | Seq 1-in-3 | No |
| Q079 | Albany Co HD | 360010005 | NY | 1-in-6 | No |
| Q080 | Bronx - IS52 | 360050110 | NY | Seq 1-in-3 | No |
| Q081 | Buffalo | 360290005 | NY | 1-in-6 | No |
| Q082 | Whiteface | 360310003 | NY | 1-in-6 | No |
| Q083 | Rochester Primary | 360551007 | NY | Seq 1-in-3 | No |
| Q084 | New York - Division Street | 360610134 | NY | Seq 1-in-3 | No |
| Q085 | Queens College | 360810124 | NY | Seq 1-in-3 | No |
| Q086 | Pinnacle State Park | 361010003 | NY | Seq 1-in-3 | No |
| Q087 | Winston-Salem - Hattie Ave | 370670022 | NC | 1-in-6 | No |
| Q088 | Garinger High School | 371190041 | NC | Seq 1-in-3 | No |
| Q089 | Fargo NW | 380171004 | ND | 1-in-3 | No |
| Q090 | Cleveland St. Theo | 390350038 | OH | 1-in-6 | No |
| Q091 | G.T. Craig | 390350060 | OH | Alt 1-in-3 | No |
| Q092 | G.T. Craig (collocated) | 390350060 | OH | 1-in-6 | No |
| Q093 | Cinncinnati Taft | 390610040 | OH | 1-in-3 | No |
| Q094 | Steubenville | 390810017 | OH | 1-in-6 | No |
| Q095 | Lorain | 390933002 | OH | 1-in-6 | No |
| Q096 | Sinclair Community College | 391130038 | OH | 1-in-6 | No |
| Q097 | Dayton National Trail High School | 391351001 | OH | Seq 1-in-3 | No |
| Q098 | Canton Fire Station | 391510017 | OH | 1-in-6 | No |
| Q099 | Akron 5 Points | 391530023 | OH | 1-in-6 | No |
| Q100 | OCUSA Campus | 401091037 | OK | 1-in-6 | No |
| Q101 | Peoria Site 1127 (North Tulsa) | 401431127 | OK | Seq 1-in-3 | No |
| Q102 | Portland - SE Lafayette | 410510080 | OR | 1-in-3 | No |
| Q103 | Arendtsville | 420010001 | PA | 1-in-6 | No |
| Q104 | Lawrenceville | 420030008 | PA | Alt 1-in-3 | No |
| Q105 | Liberty | 420030064 | PA | 1-in-6 | No |
| Q106 | Johnstown | 420210011 | PA | 1-in-6 | No |
| Q107 | New Garden | 420290100 | PA | 1-in-6 | No |
| Q108 | Chester (PA) - temp move from State College - 6 mo | 420450002 | PA | 1-in-6 | No |
| Q109 | Marcus Hook - temp move from York - 6 mo study | 420450109 | PA | 1-in-6 | No |
| Q110 | Lancaster | 420710007 | PA | 1-in-6 | No |
| Q111 | Freemansburg | 420950025 | PA | 1-in-6 | No |
| Q112 | NE Wastewater Treatment Plant | 421010048 | PA | 1-in-3 | No |
| Q113 | Philadelphia - Ritner | 421010055 | PA | 1-in-6 | No |
| Q114 | East of Pittsburgh- Florence | 421255001 | PA | 1-in-6 | No |
| Q115 | Greensburg | 421290008 | PA | 1-in-6 | No |
| Q116 | East Providence | 440071010 | RI | Seq 1-in-3 | No |

| Site ID | Site Name | AQSSID | State | Sample Frequency | Tribal |
|---|---|---|---|---|---|
| Q117 | Sioux Falls School of Deaf | 460990008 | SD | 1-in-3 | No |
| Q118 | Knoxville - Spring Hill Elementary School | 470931020 | TN | 1-in-6 | No |
| Q119 | Hinton | 481130069 | TX | Seq 1-in-3 | No |
| Q120 | Chamizal | 481410044 | TX | Seq 1-in-3 | No |
| Q121 | Deer Park | 482011039 | TX | 1-in-3 | No |
| Q122 | Deer Park (Collocated) | 482011039 | TX | 1-in-6 | No |
| Q123 | Karnack | 482030002 | TX | 1-in-6 | No |
| Q124 | Bountiful | 490110004 | UT | 1-in-6 | No |
| Q125 | Salt Lake City - Hawthorne | 490353006 | UT | 1-in-3 | No |
| Q126 | Lindon | 490494001 | UT | 1-in-6 | No |
| Q127 | Burlington | 500070012 | VT | Alt 1-in-3 | No |
| Q128 | Henrico Co. | 510870014 | VA | Alt 1-in-3 | No |
| Q129 | Seattle 10th Ave | 530330030 | WA | 1-in-6 | No |
| Q130 | Seattle - Beacon Hill | 530330080 | WA | Seq 1-in-3 | No |
| Q131 | Tacoma | 530530029 | WA | 1-in-6 | No |
| Q132 | Yakima - 4th Ave | 530770009 | WA | 1-in-6 | No |
| Q133 | Charleston Ncore | 540390020 | WV | Seq 1-in-3 | No |
| Q134 | Moundsville Armory | 540511002 | WV | 1-in-6 | No |
| Q135 | Green Bay East High School | 550090005 | WI | 1-in-6 | No |
| Q136 | Horicon Marsh | 550270001 | WI | 1-in-3 | No |
| Q137 | SERDNR Headquarters | 550790026 | WI | 1-in-3 | No |
| Q138 | Perkinstown CASTNET | 551198001 | WI | 1-in-6 | No |
| Q139 | Cheyenne | 560210100 | WY | Seq 1-in-3 | No |
| Q152 | East Millbrook Middle School | 371830014 | NC | Seq 1-in-3 | No |
| Q153 | Chesterfield | 450250001 | SC | 1-in-6 | No |
| Q154 | Parklane (Columbia) | 450790007 | SC | 1-in-3 | No |
| Q155 | Shelby Farms | 471570075 | TN | Seq 1-in-3 | No |
| Q156 | Bayamon Regional Jail | 720210010 | PR | Seq 1-in-3 | No |
| Q157 | Morongo Band of Mission Indians | NA | CA | 1-in-6 | Yes |

**Laboratories that Wood Ships Filters to:**
**UC Davis (Teflon filters for XRF analyses):**
Attn: Lab Operations
Jungerman Hall - Crocker Nuclear Laboratory
UC Davis
430 Bainer Hall Bikeway
Davis, CA 95616-5270

**Desert Research Institute (nylon and quartz filters and filters for quartz pre-firing and acceptance testing):**
Desert Research Institute
Attn: EAF
2215 Raggio Parkway
Reno, NV 89512

# Appendix C
# CSN Forms