UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4

Laboratory Services & Applied Science Division
980 College Station Road
Athens, Georgia 30605-2720

Mr. Patrick Butler, Chief
Ambient Monitoring Section
Division of Air Quality (NC DAQ)
North Carolina Department of Environmental Quality
217 West Jones Street
Raleigh, North Carolina 27603

LSASD Project Number: 22-0045

Mr. Butler:

We have reviewed the following document that you submitted for approval:

Quality Assurance Project Plan (QAPP) for the North Carolina Division of Air Quality Near-Road Monitoring Program, Revision No. 1.0, November 1, 2022.

The quality assurance and technical elements within this QAPP were compared to EPA regulations and current guidance. The stated procedures appear to be clear, sound, and appropriate as written, to the extent they can be evaluated. EPA approval of this document is granted. Please be aware that approval of this QAPP does not constitute a waiver from any regulatory requirements. Your agency remains accountable for ensuring the near-road ambient air monitoring project adheres to all the applicable requirements detailed in 40 CFR Parts 50, 53, and 58, and that the data generated is of sufficient quality to be used for regulatory decision-making purposes. This QAPP should be reviewed internally by NC DAQ on an annual basis and revised when procedures change; at a minimum, the QAPP must be revised within five years.

If you have any questions, please contact Tony Bedel at 706-355-8552 or via email at bedel.anthony@epa.gov.

Sincerely,

KEITH HARRIS

Digitally signed by KEITH HARRIS
Date: 2022.11.01 14:30:13 -04'00'

Keith Harris, Supervisor
Quality Assurance Section

Roy Cooper
Governer
Elizabeth Biser
Secretary
Michael A. Abraczinskas
Director

NORTH CAROLINA
Environmental Quality

Quality Assurance Project Plan
for the North Carolina Division of Air Quality
Near-Road Monitoring Program

Prepared for:

Caroline Freeman

EPA Region IV Director ARD
United States Environmental Protection Agency
Region IV
Atlanta Federal Building
61 Forsyth Street
Atlanta, GA 30303-8960

Submitted by:

Michael Abraczinskas, Director

North Carolina Division of Air Quality
North Carolina Department of Environmental Quality
1641 Mail Service Center
Raleigh, NC 27699-1641

NORTH CAROLINA
Department of Environmental Quality

DISCLAIMER

This Quality Assurance Project Plan, or QAPP, covers the near-road monitoring network for the North Carolina Department of Environmental Quality, or DEQ, Division of Air Quality, or DAQ.

Quality Assurance Project Plan Acronym Glossary

AADT – Annual average daily traffic
ABS - acrylonitrile-butadiene-styrene
ADQ - Audit of data quality
AQI – Air Quality Index
AQS - Air Quality System (EPA's Air database)
AMS – Ambient Monitoring Section
AMTIC – Ambient Monitoring Technology Information Center
ARD – U.S. EPA's Air and Radiation Division
ARM – Air Resources Manager
BAM – Beta attenuation monitor
CBSA – Core-based statistical area
CE – converter efficiency
CFR – Code of Federal Regulations
Chief – Ambient Monitoring Section chief
CO – Carbon monoxide
Coordinator – Raleigh Regional Office Monitoring Coordinator
CV – Coefficient of variation
DAQ - North Carolina Division of Air Quality
DAS – Data acquisition system
° C – degrees Celsius
DEQ – North Carolina Department of Environmental Quality
Director – Division of Air Quality Director
DIT – North Carolina Department of Information Technology
DOT – North Carolina Department of Transportation
DQA - Data quality assessment
DQI - Data quality indicators
DQO - Data quality objectives
ECB – Electronics and Calibration Branch
e-log – electronic logbook
EPA – United States Environmental Protection Agency
FEM – Federal equivalent method
FEP – Fluorinated ethylene propylene
FRM – Federal reference method
FTS – flow transfer standard
GPS – global positioning system
HOBO - HOBO
IBEAM – Internet-Based Enterprise Application Management
IDL – Instrument detection limit
IR – Infrared
LC – Local conditions
LMS – North Carolina Learning Management System
LPM -Liters per minute
LS – Lab Standard
LSASD – Laboratory Services and Applied Science Division
MDL – Method detection limit
MQO – Measurement quality objective
MSA – Metropolitan Statistical Area
NAAQS - National ambient air quality standards
NIST - National Institute of Standards and Technology
NO – Nitric oxide
NO_2 – Nitrogen dioxide
NO_x – Oxides of nitrogen (NO plus NO_2)
NPAP - National Performance Audit Program
OAQPS – EPA's Office of Air Quality Planning and Standards
ORD – EPA's Office of Research and Development
PC – personal computer
PEP – Performance evaluation program
PFA - Perfluoroalkoxy
± - plus or minus
PM – Particulate matter
$PM_{2.5}$ – Particles with an average aerodynamic diameter of 2.5 microns or less, also known as fine particles
PM_{10} – Particles with an average aerodynamic diameter of 10 microns or less
ppb – Parts per billion
PPB – Projects and Procedures Branch
ppm – Parts per million
PQAO – Primary quality assurance organization
psi – pounds per square inch
QA – Quality assurance

QA Handbook - EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II
QA/QC - Quality assurance/quality control
QAM – Quality assurance manager
QAPP - Quality assurance project plan
QC – Quality control
QMP – Quality management plan
RCO – Raleigh central office
RRO – Raleigh Regional Office
RTMS – remote traffic microwave sensor
SLAMS - State and local air monitoring station
SO_2 – Sulfur dioxide
SOP - Standard operating procedure
SQL – Structured Query Language
Statistician – Raleigh central office statistician
TAD – Technical assistance document
TLE – Trace Level-Enhanced
TSA - Technical systems audit
$\mu g/m^3$ – micrograms per cubic meter
USB – universal serial bus
VIP – Value in performance
VSCC – Very sharp cut cyclone
ZPS – Zero/precision/span

1.0 Approval Sheet

Title: Quality Assurance Project Plan for the North Carolina Division of Air Quality Near-Road Monitoring Program (Revision 1.0)

The Division of Air Quality hereby recommends the attached Qu*ality Assurance Project Plan for the North Carolina Division of Air Quality Near-Road Monitoring Program* for approval and commits the State of *North Carolina*, Department of Environmental Quality Division of Air Quality to follow the elements described within.

1) Signature: DocuSigned by: Michael Abraczinskas D5013FED0218423... Date 10/31/2022
Air Quality Division Director

2) Signature: DocuSigned by: Patrick Butler 4290A7E2D2A0429... Date 10/31/2022
DAQ Quality Assurance Manager
(Ambient Monitoring Section Chief)

3) Signature: DocuSigned by: B278F8186CEC4DC... Date 10/31/2022
Projects and Procedures Branch Supervisor

4) Signature: DocuSigned by: Kay Roberts BE4009EE242941D... Date 10/31/2022
Primary QAPP Author
RCO Environmental Chemist

5) Signature: KEITH HARRIS Digitally signed by KEITH HARRIS Date: 2022.11.01 14:33:50 -04'00' Date _____
EPA Region 4 Designated Approving Official

2.0 Table of Contents

2.1 List of Tables

2.2 List of Figures

3.0 Distribution

Table 3.1 lists the primary recipients of this quality-assurance project plan, or QAPP. The people on this distribution list have the responsibility to ensure and document that the Raleigh Regional Office, or RRO, monitoring technicians and coordinator, Electronics and Calibration Branch, or ECB, electronics technicians, Raleigh Central Office, or RCO, chemists, audit chemist and statistician and any other personnel involved with this project have read and understood this QAPP. The Ambient Monitoring Section chief, or chief, will post the official QAPP after it receives United States Environmental Protection Agency, or EPA, approval on the Department of Environmental Quality, or DEQ, website and email a link to it to everyone on this distribution list.

TABLE 3.1 DAQ AMBIENT AIR QUALITY NEAR-ROAD MONITORING PROGRAM QAPP DISTRIBUTION LIST

Name/Position	Address	Telephone/email
Michael Abraczinskas, Director	DAQ 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 707-8447 michael.abraczinskas@ncdenr.gov
Dawn Reddix, Acting RRO Air Quality Supervisor	Raleigh Regional Office 3800 Barrett Drive Raleigh, NC 27609	(919) 791-4282 dawn.reddix@ncdenr.gov
Patrick Butler, Ambient Monitoring Section Chief and Quality Assurance Manager	DAQ, Ambient Monitoring Section 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 707-8719 patrick.butler@ncdenr.gov
Joette Steger, PPB Supervisor	DAQ, Projects and Procedures Branch 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 707-8449 joette.steger@ncdenr.gov
Derrick House, ECB Supervisor	DAQ, Electronics and Calibration Branch 1730 Mail Service Center Raleigh, NC 27699-1730	(919) 715-1761 derrick.house@ncdenr.gov
Steven Rice, Database Manager	DAQ, Mobile Sources Branch 1641 Mail Service Center Raleigh, NC 27699-1641	(919) 715-7220 Steven.rice@ncdenr.gov
Richard Shores, Branch Chief	United States Environmental Protection Agency (MD-E343-02) 109 T.W. Alexander Dr. Durham, NC 27711	(919)-541-4983 Shores.Richard@epa.gov

TABLE 3.1 DAQ AMBIENT AIR QUALITY NEAR-ROAD MONITORING PROGRAM QAPP DISTRIBUTION LIST

Name/Position	Address	Telephone/email
Caroline Freeman, EPA Region 4 Director, Air and Radiation Division	EPA Region 4 Director ARD United States Environmental Protection Agency, Region 4 Atlanta Federal Building 61 Forsyth Street Atlanta, GA 30303-8960	(404) 562-8975 Freeman.Caroline@epa.gov
Darren Palmer, EPA Region 4 North Carolina State Contact	United States Environmental Protection Agency, Region 4 Air and Radiation Division 61 Forsyth Street SW Atlanta, Georgia 30303-8960	(404) 562-9052 Palmer.Darren@epa.gov
Keith Harris, Quality Assurance Section Manager	United States Environmental Protection Agency, Region 4 Laboratory Services and Applied Science Division 980 College Station Road Athens, GA 30605-2720	(706) 355-8624 Harris.Keith@epa.gov

4.0 Project/Task Organization

The EPA is responsible for developing the national ambient air quality standards, also referred to as NAAQS, defining the quality of data necessary to make comparisons to the NAAQS and identifying a minimum set of quality control, or QC, samples from which to judge the data quality. The state and local air monitoring organizations are responsible for taking this information and using it to develop and implement a quality assurance program that will meet the data quality requirements. It is the responsibility of the EPA and the monitoring organizations to assess the quality of the data and take corrective action, when appropriate.

The State of North Carolina Division of Air Quality (DAQ) ambient air monitoring program is an independent primary quality assurance organization (PQAO) as defined in 40 Code of Federal Regulations, or CFR, Part 58, Appendix A, Section 1.2. The DAQ operates the near-road monitoring program as part of the DAQ PQAO. The DAQ director has organized the Ambient Monitoring Section into three main branches: the Projects and Procedures Branch (PPB), the Laboratory Analysis Branch, and the ECB. The Ambient Monitoring Section chief, or chief, has responsibility for managing these branches per stated policy. The chief delegates the responsibility and authority to develop, organize, and maintain and implement quality programs to the supervisors of each branch, in accordance with the EPA-approved quality management plan (QMP). These supervisors have direct responsibility for assuring data quality. The DAQ currently does not use the services of the Laboratory Analysis Branch to implement the near-road monitoring program. The Ambient Monitoring Section shares the monitoring responsibilities with the RRO monitoring coordinator and technicians.

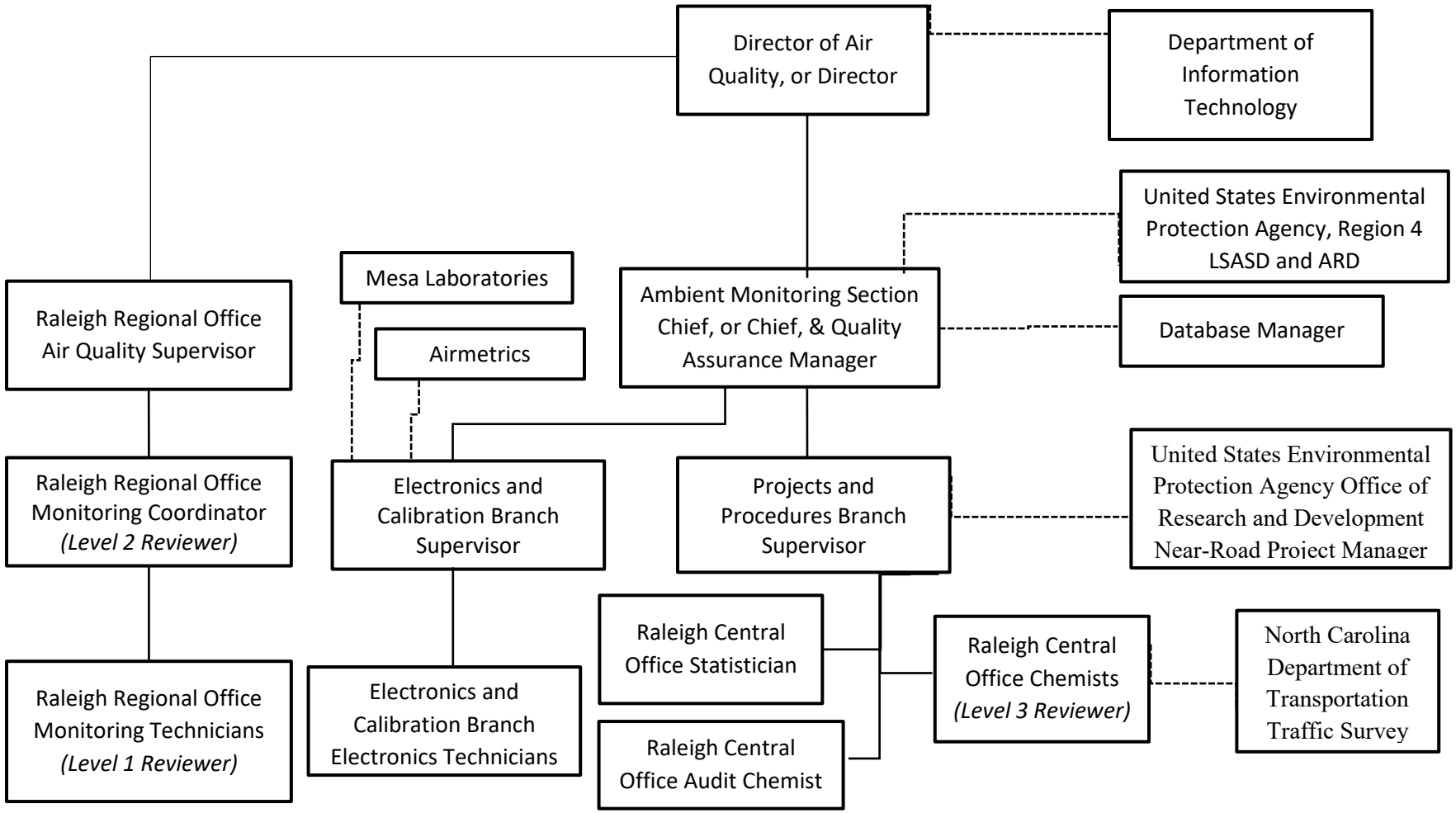
The EPA's Office of Research and Development (ORD) and DAQ jointly established a long-term study site as part of EPA's near-road research into air pollution control strategies and exposure assessment and to serve as a long-term near-road monitoring site for DAQ. The EPA provided an 8-foot by 20-foot monitoring building to house the monitoring instruments and associated equipment as well as paid all necessary expenses associated with maintaining the site in accordance with North Carolina's Department of Transportation (DOT) and local government codes. The EPA also provides routine maintenance to the building, including painting, pest control and lawn care as well as servicing of the heating, ventilation, and air conditioning systems. The DAQ provides keys to gates and other obstructions and pays for electrical utilities at the site.

Figure 4.1 shows the organizational structure for the implementation of the monitoring program. The following information lists the specific responsibilities of each significant position within DAQ, North Carolina Department of Information Technology (DIT), ORD and EPA, Region 4.

4.1 DAQ Director

The DAQ director, or director, supervises the chief and RRO supervisor. The director is responsible for ensuring adequate human and financial resources are available to support DAQ's near-road monitoring program. The director has ultimate responsibility and final authority on all aspects of the near-road monitoring program. The director has authority to stop or resume work. In the event of an emergency or inclement weather, the director implements the Continuity of Operations Plan, including the hurricane

FIGURE 4.1 PROJECT ORGANIZATIONAL CHART



readiness procedures. The director also serves as a liaison with other divisions in DEQ, with the North Carolina General Assembly, DIT, and with other regional air-monitoring agency organizations.

4.2 DAQ Ambient Monitoring Section

The Ambient Monitoring Section contains the PPB, the Laboratory Analysis Branch (not involved in near-road monitoring) and ECB and is responsible for coordinating the quality assurance, or QA, data collection and data processing aspects of DAQ's near-road monitoring program.

Ambient Monitoring Section Chief: The Ambient Monitoring Section chief, or chief, serves as the QA manager, or QAM, and reports to and has direct access to the director on all matters relating to DAQ's near-road ambient monitoring operation. The chief has ultimate authority for the program's data quality. The chief's duties include, but are not limited to the following:

- Serving as the QAM and maintaining oversight of all QA activities;
- Supervising the ambient monitoring staff and delegating responsibilities as appropriate;
- Serving as the liaison to EPA Region 4 monitoring staff;
- Maintaining overall responsibility for the monitoring network design and review, subject to the director's approval, including oversight and approval of the annual network plan and five-year assessment;
- Authorizing the installation and discontinuation of monitors within the network;
- Approving and distributing division standard operating procedures (SOPs) and QAPPs to the personnel listed in Table 3.1;
- Serving as the tie-breaker in the event of an impasse on how to handle corrective actions or make a final judgment call on data validity;
- Collaborating with DEQ staff in developing, administering, and maintaining the QMP;
- Overseeing training for the ambient monitoring staff;
- Certifying the data every year in accordance with 40 CFR Section 58.15;
- Reviewing the quarterly QA reports and the QC summaries to ensure the bias and precision limits are attained;
- Overseeing the management of the agency's documents and records;
- Tracking corrective actions and determining their success;
- Participating in systems audits;
- Assuring that QAPPs are established and effectively implemented for each project as applicable; and
- Reviewing budgets, contracts, grants, and proposals.

If the section chief (or designee) is unavailable to perform these duties, the chief will assign someone to fulfill these duties, or if the chief is unable to make that assignment, the director will assign someone to fulfill these duties.

Database Manager: Although the database manager does not report directly to the chief, he has direct access to the chief on all matters relating to the management of DAQ's near-road ambient-air monitoring database. The database manager's duties include, but are not limited, to the following:

- Maintaining the RCO data polling station (i.e., Envista Air Resources Manager, or ARM), ensuring it polls hourly and minute data for each hour of every day, as well as automated check data for each day;
- Ensuring correct data is being transferred to the DAQ Internet-Based Enterprise Application Management (IBEAM) database and DAQ real-time air quality data webpage;
- Participating in systems audits;
- Uploading environmental data to the EPA's Air Quality System (AQS) and AirNow-Tech databases;
- Serving as the AQS administrator for DAQ;
- Maintaining and updating the RCO data polling software and AQS database when sites and monitors are established or shut down; and
- Other duties as assigned.

4.2.1 Projects and Procedures Branch

Projects and Procedures Branch Supervisor: The PPB Supervisor reports to the chief. This supervisor's duties include the following:

- Directing and supervising the activities of the branch staff;
- Supporting and assisting the QAM in providing oversight of all QA activities;
- Communicating with the QAM to bring to the attention of the QAM QA matters needing attention;
- Verifying implementation of all Ambient Monitoring Section QAPPs and procedures;
- Assisting the chief with preparing the annual network plan and 5-year network assessment;
- Responding to public records requests and statistical consulting requests;
- Participating in systems audits;
- Ensuring training availability and utilization;
- Approving and implementing procedures; and
- Other duties as assigned.

Raleigh Central Office Chemists: The RCO chemists report to the PPB supervisor and are responsible for the oversight of the DAQ near-road monitoring program. The RCO chemists' duties include the following:

- Assessing the effectiveness of the network system;
- Coordinating with the RRO regional monitoring technicians and coordinator and ECB electronics technicians to write and ensure timely and appropriate SOP and QAPP updates, including documenting annual SOP and QAPP reviews;
- Validating data by serving as the level 3 reviewers;
- Uploading traffic data into the IBEAM database;
- Verifying that all required quality assurance/quality control (QA/QC) activities are performed and that measurement quality standards are met;
- Maintaining QA/QC records, flagging suspect data, and assessing and reporting on data quality;
- Participating in systems audits;

- Identifying data quality problems and initiating corrective actions that result in solutions;
- Providing training and certification to appropriate personnel; and
- Completing other duties as assigned.

Raleigh Central Office Audit Chemist: The RCO audit chemist reports to the PPB supervisor and is responsible for assessing, auditing, and evaluating the DAQ near-road monitoring program. The RCO audit chemist's duties include the following:

- Assessing the effectiveness of the network system;
- Tracking and ensuring RCO chemists document SOP and QAPP annual reviews and updates;
- Verifying that all required quality QA/QC activities are performed, that measurement quality standards are met, and decisions are documented;
- Maintaining QA/QC records and assessing and reporting on data quality;
- Conducting quarterly completeness evaluations and audits of data quality;
- Planning and conducting data quality assessments, or DQAs, based on interpretation of data;
- Participating in systems audits;
- Conducting internal systems audits, as needed;
- Identifying data quality problems and initiating corrective actions that result in solutions;
- Providing training and certification to appropriate personnel; and
- Completing other duties as assigned.

Raleigh Central Office Statistician: The RCO statistician, or statistician, reports to the PPB supervisor and provides statistical programming support to the PPB supervisor and other RCO, ECB and RRO staff, including:

- Assisting the branch supervisor with responding to consulting and data requests;
- Participating in training and certification programs to keep current on technology;
- Interpreting data;
- Developing each business day and maintaining statistical reports that include tabulations of the previous day's hourly raw data;
- Preparing statistical analysis and summaries of the data, including graphs, for QA and reporting;
- Consulting on statistical analyses and approaches with the RRO and RCO;
- Participating in systems audits;
- Preparing and delivering data and statistical interpretation of the data to the RRO and RCO;
- Responding to public records requests and statistical consulting requests;
- Serving as a backup to the database manager;
- Uploading data to AQS; and
- Completing other duties as assigned.

4.2.2 Electronics and Calibration Branch

Electronics and Calibration Branch Supervisor: The ECB supervisor reports to and has direct access to the chief. The ECB supervisor has the responsibility and authority to:

- Identify quality problems and initiate corrective action which results in solutions;

- Schedule and document annual performance evaluations and standard certifications;
- Review and approve QAPPs and SOPs;
- Supervise the ECB electronics technicians;
- Participate in systems audits;
- Provide and document training and certification of ECB electronics technicians; and
- Other duties as assigned.

Electronics and Calibration Branch Electronics Technician: The ECB electronics technicians report to the ECB supervisor and have the following responsibilities:

- Installing all field equipment and monitoring sites;
- Purchasing, maintaining, and tracking an inventory of spare parts, spare equipment, and consumable supplies to prevent unnecessary downtime;
- Calibrating, certifying, and tracking transfer standards or sending them to the vendor to be recertified;
- Returning "local primary standards" to the vendor or EPA for recertification and periodically checking the calibration of backup "local primary standards" to ensure quality calibrations;
- Ordering calibration gases and ensuring DAQ participation in the gas verification program operated by the EPA;
- Maintaining documentation on all transfer standard, "local primary standard" and calibration gas certifications;
- Conducting annual performance evaluations on all gaseous monitors;
- Assisting in prescribing corrective actions;
- Participating in systems audits;
- Recommending changes, when needed, in the QA/QC program;
- Performing and documenting all major maintenance and repair of field equipment as described by SOPs 2.17.1, section 9 and 2.36.1, section 7; and
- Other duties as assigned.

4.3 Raleigh Regional Office

Raleigh Regional Office Air Quality Supervisor: The RRO air quality supervisor reports to the director and has direct access to the chief and director on all matters relating to DAQ's near-road monitoring program. The RRO supervisor's duties include:

- Assuring that division policies are maintained at the regional office level;
- Acquiring needed regional monitoring resources;
- Verifying implementation of quality programs;
- Recommending changes when needed in the QA/QC program;
- Providing regional input for the design of the monitoring network;
- Reviewing and approving the network plan as far as it affects the region;
- Supervising and delineating duties for the RRO monitoring coordinator and technicians; and
- Completing other duties as assigned.

Raleigh Regional Office Ambient Monitoring Coordinator: The RRO ambient monitoring coordinator, referred to as the RRO monitoring coordinator or coordinator in this QAPP, reports directly to the RRO supervisor. The RRO monitoring coordinator has the overall responsibility of ensuring the implementation of the QA/QC program at the regional level. He or she coordinates the activities of the RRO monitoring technicians. His or her responsibilities include:

- Coordinating and reviewing the collection of environmental data;
- Implementing the DAQ QA/QC program within the region;
- Acting as a conduit for information to the RRO monitoring technicians;
- Training other regional monitoring coordinators and regional monitoring technicians in the requirements of the QAPP and SOPs;
- Providing a backup to the regional monitoring technicians;
- Participating in systems audits;
- Recommending changes, when needed, in the QA program;
- Providing regional input on the design and documentation of the monitoring network;
- Performing level 2 data verification activities and flagging suspect data;
- Reviewing electronic logbooks, or e-logs, other documentation, and the work of the monitoring technicians to ensure they follow the QAPP and associated SOPs;
- Overseeing transfer standard certifications to ensure equipment is returned for recertification before expiration and that all certification documents are appropriately filed and archived;
- Documenting and assessing corrective actions to ensure they are appropriate and effective; and
- Completing other duties as assigned.

Raleigh Regional Office Monitoring Technicians: The RRO monitoring technicians also referred to as site operators or operators in this QAPP report directly to the RRO air quality supervisor and work under the coordination of the RRO monitoring coordinator to ensure DAQ meets all monitoring requirements. The RRO monitoring technician's duties include:

- Performing all required QC activities to ensure measurement quality objectives, or MQOs, are met as prescribed in the QAPP and SOPs;
- Performing corrective actions to address any activities that do not meet acceptance criteria as prescribed in the QAPP and SOPs;
- Participating in and providing hands-on training as needed of new regional coordinators, monitoring technicians and RCO chemists in the requirements of the SOPs;
- Calibrating and verifying the gaseous monitoring equipment;
- Calibrating, verifying, and auditing PM monitoring equipment;
- Operating and completing preventative maintenance on all monitoring equipment;
- Performing preventative maintenance and small repairs on PM monitoring equipment;
- Sending all PM flow transfer standards (FTSs) to ECB for calibration and certification and for checking calibration of primary standards to ensure quality calibrations;
- Ensuring all transfer standards used are within their expiration date;
- Maintaining a supply of expendable monitoring items;
- Participating in training and certification activities;
- Documenting deviations from established procedures and methods;

- Reporting nonconforming conditions and corrective actions to the RRO monitoring coordinator and air quality supervisor;
- Performing level 1 data verification activities and flagging suspect data;
- Conducting 40 CFR Part 58, Appendix E siting criteria evaluations annually as part of the annual network review process;
- Participating in systems audits;
- Recommending changes, when needed, in the QA program;
- Preparing corrective action reports, when needed, for the Ambient Monitoring Section; and
- Completing other duties as assigned.

4.4 Department of Information Technology

The DIT provides security for the ambient monitoring computers. They manage, in cooperation with the RRO monitoring and ECB electronics technicians and database manager, the computer located at the monitoring site and the primary server that houses the Envista ARM database. Their responsibilities include ensuring the security of the computers and network, updating of the operating system and other standard software on the computer and ensuring that the RRO monitoring and ECB electronics technicians maintain adequate access to the computers to perform all necessary monitoring functions.

4.5 North Carolina Department of Transportation

The DOT Traffic Survey Group collects traffic data statewide to analyze and support planning, design, construction, maintenance, operation, and research activities required to manage North Carolina's transportation system. One of the group's main deliverables is the Annual Average Daily Traffic (AADT) volume map and data counts, which presents the traffic average for a specific year at specific points on the state's roads. Requests for AADT are made monthly by an RCO Chemist via DOT's webpage Traffic Data Request.

4.6 EPA ORD Near-Road Project Manager

The EPA ORD near-road project manager works with the PPB supervisor, RRO coordinator and monitoring technicians and ECB electronics technicians to ensure maintenance of the monitoring shelter and the availability of adequate space for the required state and local air monitoring station (SLAMS) monitors.

4.7 United States Environmental Protection Agency, Region 4

The DAQ will operate the near-road monitors as SLAMS monitors following the procedures in 40 CFR Part 58. As a result, the chief will include information on these monitors in the annual network-monitoring plan and the five-year network assessment and the EPA Region 4 Air and Radiation Division (ARD) director (or his/her designee) will review, comment on, and respond to the network plan each year. Likewise, the chief will include the data from these monitors in the annual certification request and the EPA Region 4 ARD director (or his/her designee) will review and apply concurrence codes in AQS in response to DAQ's data certification request. The chief will also submit a QAPP to the EPA Region 4 Laboratory Services and Applied Science Division, or LSASD, for EPA approval. The EPA Region 4 LSASD will include the near-road monitors in the Performance Evaluation Program (PEP) and National Performance Audit Program (NPAP).

5.0 Problem Definition and Background

The enactment of the Clean Air Act of 1970 resulted in a major shift in the federal government's role in air pollution control. This legislation authorized the development of comprehensive federal and state regulations to limit emissions from both stationary or industrial sources and mobile sources. It also established the NAAQS (40 CFR Part 50). The Clean Air Act, or CAA, and its amendments provide the framework for protecting air quality. To protect air quality, active environmental data collection operations were established and operated in a manner that assures the collection of the most applicable and highest quality data.

The EPA sets primary standards at a level adequate to protect public health within an acceptable margin of safety, while it sets secondary standards at the level needed to protect public welfare. The CAA and its amendments provide the framework for the monitoring of criteria pollutants (e.g., nitrogen dioxide [NO_2], CO, and $PM_{2.5}$) by state, local, and tribal air monitoring organizations. Under the area designations process, the EPA and states typically use data from ambient air monitors to characterize air concentrations for identification of areas that either meet or violate the standard for a specific pollutant.

Monitors used for comparisons against a NAAQS are typically designated as SLAMS monitors and must meet the requirements stipulated in 40 CFR Parts 50, 53, and 58. Pursuant to 40 CFR 58.14, any proposed addition or discontinuation of a SLAMS monitor is subject to EPA approval. For NO_2 and $PM_{2.5}$, three consecutive years of valid, quality-assured data are needed for comparison against the NAAQS.

The near-road monitoring network started as part of the 2010 NO_2 NAAQS review and became a multi-pollutant monitoring network in 2017. In 2010, the EPA established a new 1-hour standard for NO_2 at a level of 100 parts per billion (ppb), based on the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations, to supplement the existing annual standard. The EPA also established requirements for an NO_2 monitoring network that included monitors at locations where the EPA expected maximum NO_2 concentrations to occur, including within 50 meters of major roadways. In the rulemaking process leading to the 2010 NO_2 NAAQS revision, it was established that the combination of higher urban population densities with increased vehicle miles traveled, which correspond to on-road mobile source emissions, can result in an increased potential for exposure and associated risks to human health and welfare. The primary objective of the required near-road NO_2 network is to focus monitoring resources on near-road locations where peak, ambient NO_2 concentrations are expected to occur because of on-road mobile source emissions.

Initially, near-road NO_2 monitoring stations were required in core-based statistical areas, or CBSAs, having populations of 500,000 or more. On Dec. 30, 2016, the EPA removed the requirement to establish near-road NO_2 monitoring stations in CBSAs having populations between 500,000 and 1,000,000.[1] Current requirements found in 40 CFR Part 58, Appendix D, Section 4.3.2 are that within the NO_2 network, there must be one microscale near-road NO_2 monitoring station in each CBSA with a population of 1,000,000 or more to monitor a location of expected maximum hourly concentrations sited near a

[1] Revision to the Near-road NO_2 Minimum Monitoring Requirements, Federal Register, Vol. 81, No. 251, Dec. 30, 2016, available on the worldwide web at https://www.gpo.gov/fdsys/pkg/FR-2016-12-30/pdf/2016-31645.pdf.

major road with high AADT counts. An additional near-road NO_2 monitoring station is required for any CBSA with a population of 2,500,000 or more, or in any CBSA with a population of 1,000,000 or more that has one or more roadway segments with 250,000 or greater AADT counts to monitor a second location of expected maximum hourly concentrations. The EPA requires agencies to base CBSA populations on the most recent available census figures.

The DAQ selected its near-road NO_2 monitoring site by first ranking all road segments within the Raleigh CBSA by AADT. Then DAQ identified a location or locations adjacent to those highest ranked road segments, considering fleet mix, roadway design, congestion patterns, terrain, and meteorology, where DAQ expected maximum hourly NO_2 concentrations to occur and siting criteria to be met in accordance with 40 CFR Part 58, Appendix E. When DAQ identified multiple acceptable candidate sites with expected maximum hourly NO_2 concentrations, DAQ considered the potential for population exposure as well as ease of access and safety of monitoring personnel and equipment in the criteria used to select the final site location. The regulations at 40 CFR Section 58.13 required the monitor to be up and operational by Jan. 1, 2014. [2]

On Aug. 31, 2011, during its review of the carbon monoxide, or CO, NAAQS, the EPA made changes to the ambient air monitoring requirements for CO, requiring agencies to add CO monitors to near-road sites located in CBSAs with a population of 1,000,000 or more[3] (40 CFR Part 58, Appendix D, Section 4.2.1). These monitors were required to be operational on Jan. 1, 2017.[4] On Jan. 15, 2013, during its review of the NAAQS for particulate matter, or PM, the EPA made changes to the ambient air monitoring requirements for fine particles, or $PM_{2.5}$, requiring state and local agencies to add $PM_{2.5}$ monitors to near-road sites located in CBSAs with a population of 1,000,000 or more[5] (40 CFR Part 58, Appendix D, Section 4.7.1). These monitors were also required to be operational on Jan. 1, 2017. [6] Table 5.1 provides the standards for NO_2, CO and PM.

TABLE 5.1 NATIONAL AMBIENT AIR QUALITY STANDARDS FOR NO_2, CO AND PM

Pollutant	Averaging Time	Standard Value [a]		Standard Type	Form
Nitrogen Dioxide (NO_2)	1-hour average	100 ppb [b]		Primary	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years

[2] 40 CFR Section 58.13, available on the worldwide web at https://www.ecfr.gov/cgi-bin/text-idx?SID=e7065c87e875da9ba352fa4d2696e7b6&mc=true&node=pt40.6.58&rgn=div5#se40.6.58_113.
[3] Review of National Ambient Air Quality Standards for Carbon Monoxide, Federal Register, Vol. 76, No. 169, Aug. 31, 2011, available on the worldwide web at https://www.gpo.gov/fdsys/pkg/FR-2011-08-31/pdf/2011-21359.pdf.
[4] 40 CFR Section 58.13, available on the worldwide web at https://www.ecfr.gov/cgi-bin/text-idx?SID=e7065c87e875da9ba352fa4d2696e7b6&mc=true&node=pt40.6.58&rgn=div5#se40.6.58_113.
[5] National Ambient Air Quality Standards for PM, Federal Register, Vol. 78, No. 10, Jan. 15, 2013, available on the worldwide web at https://www.gpo.gov/fdsys/pkg/FR-2013-01-15/pdf/2012-30946.pdf.
[6] Title 40 CFR Section 58.13, available on the worldwide web at https://www.ecfr.gov/cgi-bin/text-idx?SID=e7065c87e875da9ba352fa4d2696e7b6&mc=true&node=pt40.6.58&rgn=div5#se40.6.58_113.

TABLE 5.1 NATIONAL AMBIENT AIR QUALITY STANDARDS FOR NO_2, CO AND PM

Pollutant	Averaging Time	Standard Value [a]		Standard Type	Form
	One Year Mean	0.053 ppm [c]	(100 µg/m^3) [d]	Primary and Secondary	Annual mean
Carbon Monoxide (CO)	8-hour average	9 ppm [b]	(10 mg/m^3) [e]	Primary	Maximum, not to be exceeded more than once in a year
	1-hour average	35 ppm	(40 mg/m^3)	Primary	Maximum, not to be exceeded more than once in a year
Particulate Matter ($PM_{2.5}$) Particulates with diameters of 2.5 micrometers or less	One Year Mean	12 µg/m^3		Primary	Annual mean, averaged over 3 years
		15 µg/m^3		Secondary	Annual mean, averaged over 3 years
	24-hour Average	35 µg/m^3		Primary and Secondary	98th percentile, averaged over 3 years

[a] parenthetical value is an approximately equivalent concentration.
[b] parts per billion
[c] parts per million
[d] micrograms per cubic meter
[e] milligrams per cubic meter

Thus, DAQ is required to operate one near-road monitoring station at Triple Oak Road along I-40 in the Raleigh CBSA. The EPA approved the Triple Oak Road near-road site for the Raleigh CBSA in 2012.[7] For details on the selection of Triple Oak Road and other considered locations, see the **2012 Annual Monitoring Network Plan for DAQ.**[8] Table 5.2 provides information about the near-road monitoring station. In addition, at least one near-road monitoring station is required within the Charlotte-Gastonia-Concord CBSA. A separate PQAO within North Carolina (i.e., Mecklenburg County Air Quality local agency) operates the required near-road monitoring station(s) in this CBSA. The near-road monitoring project is a long-term project with no currently projected end date. EPA policy requires that all projects involving the generation, acquisition, and use of environmental data be planned and documented and have an agency approved QAPP. The QAPP is the critical planning document for any environmental data collection operation because it documents how DAQ will implement QA/QC activities during the project's life cycle.

TABLE 5.2 NORTH CAROLINA NEAR-ROAD LOCATION AND MONITORS

Site Name	AQS Identifier	Types of Monitors	Date Started	Operator
Triple Oak Road	37-183-0021	NO_2	Jan. 8, 2014	
		CO	Dec. 1, 2016	

[7] United States Environmental Protection Agency, 2012 State of North Carolina Ambient Air Monitoring Network Plan, The U. S. EPA Region 4 Comments and Recommendations, p5, available at http://xapps.ncdenr.org/aq/documents/DocsSearch.do?dispatch=download&documentId=4599.
[8] The network plan is available at Annual Network Plan | NC DEQ

TABLE 5.2 NORTH CAROLINA NEAR-ROAD LOCATION AND MONITORS

Site Name	AQS Identifier	Types of Monitors	Date Started	Operator
		PM2.5 BAM 1022	Jan. 4, 2017	Raleigh Regional Office

The purpose of this QAPP is to prescribe requirements, procedures and guidelines for the DAQ near-road monitoring program. The DAQ intends this QAPP to serve as a reference document for implementing and expanding the QA program and to provide detailed operational procedures for measurement processes used by DAQ. The QAPP should be particularly beneficial to the RRO monitoring technicians and coordinator and RCO chemists responsible for implementing, designing and coordinating the near-road monitoring project. The QAPP is a compilation of QA requirements, procedures and guidelines applicable to air pollution measurement systems. The EPA and DAQ designed these requirements, procedures and guidelines to achieve a high percentage of valid data (greater than or equal to 75 percent) while maintaining integrity and accuracy. This QAPP clearly and thoroughly establishes QA protocols and QC criteria required to successfully implement and maintain the near-road monitoring program. Additional details and technical specifications are set forth in SOPs utilized by DAQ for each aspect of the near-road monitoring program, such as instrument operations (see Table 11.2). It is the responsibility of the chief to ensure the RRO technicians and coordinator, ECB electronics technicians and RCO chemists implement and adhere to the QA programs for the field and data processing phases of the monitoring program.

The RCO chemists will review the QAPP and its associated SOPs annually and update them as needed or at least every five years. The RCO chemist will document the annual review of the QAPP by recording his or her name, signature, date and review results on the QAPP Annual Review Documentation form. Grant commitments also require that annual QAPP reviews be recorded in email correspondence to EPA Region 4. QAPP revisions are subject to the approval of EPA's Region 4 QA staff.

The DAQ will adhere to the principles and procedures herein, unless a special project requires more stringent requirements. If any special project requires more stringent requirements, the QAPP will be revised or, depending on the purpose and scope of the project, a separate QAPP will be developed to address the requirements of the special project.

This version of the QAPP is the first revision to the original document, conditionally approved by EPA on July 9, 2019. DAQ amended the QAPP by adding an addendum and EPA approved the addendum on July 29, 2020. On July 9, 2021, EPA granted DAQ an extension for submitting a revised QAPP. A copy of the original QAPP is retained in IBEAM and Laserfiche. Before DAQ implemented the Near-Road QAPP, the near-road monitoring program was included in the Criteria Pollutant QAPP, which EPA approved on Nov. 6, 2006. A copy of the Criteria Pollutant QAPP is archived in IBEAM and Laserfiche.

6.0 Project/Task Description

DAQ developed this QAPP to ensure that DAQ's near-road monitoring network collects ambient pollutant data that meet or exceed EPA QA requirements. The EPA and DAQ use the criteria pollutant data collected by DAQ for regulatory decision-making purposes (i.e., determining compliance with the NAAQS). The database manager uploads these data into the EPA AQS database.

Pursuant to 40 CFR Part 58, Appendix D, Section 1.1, SLAMS monitoring networks must be designed to meet three basic monitoring objectives: provide air pollution data to the general public in a timely manner; support compliance with ambient air quality standards and emissions strategy development; and support for air pollution research studies. The DAQ near-road ambient air quality monitoring site is designed to support these objectives. In addition, the EPA and DAQ established the near-road monitoring station to characterize maximum hourly NO_2 concentrations in the immediate vicinity of a heavily traveled roadway. Sections 7.1 and 10.1 provide additional objectives for the near-road monitoring network. The coordinator assigns the monitors operated at this site a scale of representativeness based on the definitions of 40 CFR Part 58, Appendix D. The spatial scale of representativeness describes the physical dimensions of a parcel of air, in which pollutant concentrations are reasonably homogeneous throughout. Based on the monitoring objective and site location, the data collected at the near-road site will be representative of the expected maximum-hourly source-oriented NO_2 concentrations on a microscale. This scale defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters. The collocated CO analyzer and $PM_{2.5}$ monitor also collect data representative of the microscale. Table 5.2 provides a list and description of all monitors at the near-road monitoring site.

The work required to collect, document, and report these data includes, but is not limited to:

- Establishing a monitoring network that has:
    - Appropriate density, location, and sampling frequency; and
    - Accurate and reliable data recording equipment, procedures and software.
- Developing encompassing documentation for:
    - Data and report format, content, and schedules;
    - Quality objectives and criteria; and
    - SOPs providing activities and schedules for:
        - Equipment operation and preventative maintenance; and
        - Instrument calibrations, zero and span, precision and accuracy evaluations.
- Establishing assessment criteria and schedules.
- Verifying and validating data, according to the criteria and schedules established in this QAPP.
- Certifying data.

Towards this end, the DAQ work products also include a series of assessments and reports to ensure the network and resulting data continuously meet or exceed regulatory requirements as specified in 40 CFR Parts 50 and 58. The DAQ also maintains this QAPP and the associated SOPs reviewing them every year

and revising them as needed but at least once every five years to ensure they continuously reflect the requirements of DAQ and the EPA.

6.1 Field Activities

DAQ personnel will perform those activities that support continued successful operation of the DAQ near-road monitoring network. Personnel will perform field activities that include, but are not necessarily limited to, conducting calibrations, routine QC checks, semi-annual flow rate verifications, periodic preventative maintenance and servicing equipment located at the near-road air-monitoring site. Operational servicing activities may include, but may not be limited to, recording pertinent field data and restocking consumables at the monitoring site. Additional field activities could include relocating the site or locating an additional suitable monitoring site when DOT widens or repaves I-40 at the current location or when the population of the Raleigh CBSA exceeds 2.5 million. Section 4.3 Raleigh Regional Office provides a more complete description of the field activities that RRO monitoring technicians may perform. The ECB electronics technicians also perform annual performance evaluations on the deployed gaseous monitors.

6.2 ECB Activities

The DAQ ECB electronics technicians will perform those activities necessary to support the successful operation of the near-road monitoring network. They will perform electronic laboratory activities consistent with certifying, calibrating, and testing all equipment before installing it in the field. In addition, ECB electronics technicians will perform any functions necessary to support the deployed field equipment. Section 4.2.2 Electronics and Calibration Branch provides a more complete description of the activities the ECB electronics technicians may perform.

6.3 Project Assessment Techniques

An assessment is an evaluation process used to measure the performance or effectiveness of a system and its elements. As used here, “assessment” is an all-inclusive term used to denote any of the following: audit, performance evaluation, peer review, inspection or surveillance. Section 20.0 Assessments and Response Actions discusses the details of assessments. Table 6.1 provides information on the parties implementing assessments and their frequency.

TABLE 6. 1 ASSESSMENT SCHEDULE

Assessment Type	Assessment Agency	Frequency
EPA Technical Systems Audit	EPA Region 4	Every 3 years
Internal Systems Audit	State	As needed
Network Assessment	EPA Region 4 State	Every 5 years
Network Review (40 CFR Part 58, Appendix A, D and E evaluations)	EPA Region 4 State	Annually
Network Plan	EPA Region 4 State	Annually

TABLE 6. 1 ASSESSMENT SCHEDULE

Assessment Type	Assessment Agency	Frequency
Quarterly Data Completeness	State	Quarterly
Annual Data Certification	State	Annually
Quality Assurance Project Plan Review and Updates	State	Review annually and update as needed and at least every 5 years
Standard Operating Procedures Reviews	State	Review annually and update as needed and at least every 5 years
Data Quality Assessment	State	AMP256 and AMP600 review quarterly and annually; control chart review daily for CO and NO_2 and monthly for $PM_{2.5}$
Quarterly Data completeness and Audit of Data Quality	State	Quarterly
National Performance Audit Program	EPA-designated contractor	20 percent of sites per year/each site once every six years
$PM_{2.5}$ Performance Evaluation Program	EPA-designated contractor	8 valid audits per year within the DAQ PQAO/each DAQ PQAO primary monitor audited every 6 years.
Annual Performance Evaluation for Gaseous Monitors	State	At least once per calendar year and every 365 days
Semi-annual Flow Rate Audits for PM Monitors	State	Twice per year, separated by 5 to 7 months, preferably every quarter

6.4 Project Records

DAQ will establish and maintain procedures for the timely preparation, review, approval, issuance, use, control, revision and maintenance of documents and records. Table 6.2 presents the categories and types of records and documents that are applicable to document control for ambient air quality information. Section 9.0 Documentation and Records explains information on key documents in each category in more detail.

TABLE 6.2 CRITICAL DOCUMENTS AND RECORDS

Categories	Record/Document Type
Site Information	Network Descriptions Site Files Site Maps Site Pictures
Environmental Data Operations	Quality Assurance Project Plans Standard Operating Procedures Field Notebooks and Logbooks Inspection/Maintenance Records

TABLE 6.2 CRITICAL DOCUMENTS AND RECORDS

Categories	Record/Document Type
Raw Data	Any Original Data (routine and QC) including Data Entry Forms
Data Reporting	Air Quality Index Reports Annual Data Certification Data/Summary Reports
Data Management	Data Algorithms Data Management Plans/Flowcharts Data Management Systems
Quality Assurance	Network Reviews and Assessments Control Charts Data Quality Assessments Internal Systems Audit Reports EPA Technical System Audit Reports Response/Corrective Action Documentation Annual Performance Evaluations Certification Documentation E-mails related to QA activities and assessments

7.0 Quality Objectives and Criteria for Measurement Data

The DAQ operates under an EPA-approved QMP that describes the agency's system for communicating and implementing quality within the agency.

A quality system is a structured and documented set of management activities in which an organization applies sufficient QC practices to ensure the data produced by an operation will be of the type and quality needed and expected by the data user. Quality control defines the procedures implemented to assure that the RRO monitoring technicians obtain and maintain acceptability in the generated data set. Quality control procedures, when properly executed, provide data that meet or exceed the minimally acceptable quality criteria established to assist management in making confident decisions. The policy of DAQ is to implement a QA program to assure the RRO monitoring technicians collect data of known and acceptable precision, bias, sensitivity, completeness, comparability, and representativeness within its ambient air-quality monitoring program.

Section 7.2 defines precision, bias, sensitivity, completeness, comparability and representativeness, the principal data quality indicators, or DQIs, that provide qualitative and quantitative descriptions used in interpreting the degree of acceptability of data. Establishing acceptance criteria for these DQIs sets quantitative goals for the quality of data generated in the measurement process. Of the six principal DQIs, precision, sensitivity and bias are the quantitative measures, representativeness and comparability are qualitative measures, and completeness is a combination of both qualitative and quantitative measures (US EPA QA/G-5, Appendix B). The DAQ establishes the specific requirements of these six DQIs before data collection starts. The goal is to locate and eliminate (or minimize) bias, so the data collected show the true conditions of the sampled area. This includes consideration of siting criteria, spatial scales, monitoring objectives, climatic change, source configurations and the duration of the study.

All individuals must adhere to the written procedures and methods in the QAPP and associated SOPs (see Table 11.2) for operating air monitoring instruments and handling data to assure quality data for purposes of DAQ's air quality designations concerning attainment of the NAAQS. EPA-approved federal reference methods, or FRMs, are the designated methodologies and basis for operating pollutant-monitoring equipment, although the EPA allows agencies to use federal equivalent methods, or FEMs, as well.

7.1 Data Quality Objectives

This section provides a description of the data quality objectives, or DQOs, for the near-road monitoring program for the state of North Carolina. The DQOs are qualitative and quantitative statements that:

- Clarify the intended use of the data;
- Define the type of data needed; and
- Specify the tolerable limits on the probability of making an erroneous decision due to uncertainty in the data.

In general, the goal of the near-road monitoring program is to determine the highest one-hour concentrations of NO_2 expected to occur in the Raleigh CBSA near a highly traveled roadway. Additional

goals of the near-road monitoring program are to determine the concentrations of CO and $PM_{2.5}$ near a highly traveled roadway and to ensure that the air quality near a highly traveled roadway meets the NAAQS.

The data necessary to meet the goals of the near-road monitoring program are:

- Continuous hourly averaged NO_2 (including nitric oxide [NO] and oxides of nitrogen [NO_x]), CO and $PM_{2.5}$ concentration data collected by FRMs or FEMs;
- Continuous shelter temperature measurements for ensuring conformity to environmental requirements of the CO and NO_2 monitors;
- Precision measurements;
- Bias measurements;
- Site and monitoring metadata for AQS;
- Locational measurements (geographical, topographical, etc.);
- Traffic measurements; and
- Minute data for the gaseous pollutants.

The type of data needed is determined by its intended use. Because the DAQ near-road monitoring data are used for comparison to the NAAQS, data must be collected in accordance with 40 CFR Parts 50, 53, and 58 requirements, and be of such quality that decision-makers can make comparisons to the NAAQS with confidence and certainty. The DAQ near-road monitoring network will operate and collect data in accordance with the schedules codified in 40 CFR 58.12. The ambient NO_2, CO, and $PM_{2.5}$ concentration data will be collected by monitors that have been designated as FRM or FEM, in accordance with 40 CFR Part 58, Appendix C, Section 2.1. Collocation of $PM_{2.5}$ monitors will occur as needed within the DAQ PQAO, in accordance with 40 CFR Part 58, Appendix A requirements. The appendices to 40 CFR Part 50 explain the data reporting and handling conventions for the individual pollutant parameters. DAQ will adhere to those reporting conventions.

The following bullet lists provide more detail regarding the specifications on the types of criteria pollutant data needed for this project. This information summarizes the data needed to compare DAQ design values (DVs) to the NO_2, CO, and $PM_{2.5}$ NAAQS.

Nitrogen Dioxide

- Keep each hourly data point (at least 45 valid minutes of the hourly data are needed) with at least one decimal place in units of ppb, with additional digits to the right truncated with no further rounding.
- Calculate 24 hourly average values for a day and determine the maximum. Daily maximum 1-hour values are not rounded.
- The 1-hour DV is the mean of the 3 consecutive annual 98th percentile daily maximum values, rounded to the nearest whole number.
- The annual DV is simply the arithmetic average of all the reported 1-hour values, rounded to the nearest whole number.

Specific information on NO_2 NAAQS calculations is found in 40 CFR Part 50, Appendix S.

Carbon Monoxide

- Keep each hourly data point (at least 45 valid minutes of the hourly data are needed) with at least one decimal place in units of ppm, with additional digits to the right truncated with no further rounding.
- Calculate 24 hourly average values for a day and determine the maximum. Daily maximum 1-hour values are not rounded.
- Calculate average values for every rolling 8-hour period.
- An 8-hour average shall be considered valid if at least 6 of the hourly averages for the 8-hour period are available.
- If the 1-hour value does not exceed 35 ppm more than once per year, the 1-hour NAAQS has been achieved.
- If the 8-hour value does not exceed 9 ppm more than once per year, the 8-hour NAAQS has been achieved.

Specific information on CO NAAQS calculations is found in 40 CFR 50.8.

Particulate Matter ($PM_{2.5}$)

For continuous $PM_{2.5}$ sampling, keep each hourly data point (at least 45 valid minutes of the hourly data are needed) with at least one decimal place in units of micrograms per cubic meter ($\mu g/m^3$) with additional digits to the right of the tenths decimal place truncated.

- Calculate a 24-hour period in a day from midnight to midnight (local standard time) for the daily average.
- A 24-hour average concentration shall be considered valid if at least 18 hourly values for the 24-hour period are available.
- 24-hour periods with 7 or more missing hours shall also be considered valid if, after substituting zero for all missing hourly concentrations, the resulting 24-hour average daily value is greater than the level of the 24-hour $PM_{2.5}$ NAAQS.
- 24-hour average $PM_{2.5}$ mass concentrations that are averaged in AQS from hourly values will be truncated to one decimal place, consistent with the data handling procedure for the reported hourly (and 24-hour filter-based) data.
- The 3-year average of $PM_{2.5}$ annual mean mass concentrations for each eligible monitoring site, referred to as the annual $PM_{2.5}$ NAAQS DV, is compared to the annual standards.
- The 3-year average of annual 98th percentile 24-hour average $PM_{2.5}$ mass concentration values recorded at each eligible monitoring site, referred to as the 24-hour (or daily) $PM_{2.5}$ NAAQS DV, is compared to the daily standards.

Specific information on $PM_{2.5}$ NAAQS calculations is found in 40 CFR Part 50, Appendix N.

The EPA and the director will use these data to:

- Evaluate compliance with the NAAQS;
- Determine trends over time;
- Determine effects on air quality from adjustments to automobile emissions systems;
- Verify air quality modeling programs for traffic emissions; and
- Provide real-time data to the public.

The DQO process defines tolerable limits on the probability of making a wrong decision because of uncertainty in the data (that is, limits on the probability of coming up with a false positive or a false negative error). A decision maker encounters a false positive error when the data indicate a monitor exceeded the NAAQS when in fact, due to random deviations in the data, the monitor did not exceed it. Alternately, a decision maker encounters a false negative error when the data indicate the monitor did not exceed a NAAQS when in fact, due to random deviations in the data, the monitor did exceed the NAAQS. Using the formal DQO process, EPA determined the objectives to control precision and bias to reduce the probability of decision errors. The regulations at 40 CFR Part 58, Appendix A, Section 2.3.1 provide the DQOs. The EPA has not completed a formal DQO process for CO; however, EPA has provided DQOs for this pollutant in its Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, or QA Handbook. The DAQ has adopted for the near-road monitoring program EPA's DQOs listed in Table 7.1 with the acceptable precision, as measured by coefficient of variation (CV), and acceptable bias for each pollutant. For the PM2.5 monitor, DAQ will determine precision at the near-road site based on precision measured at other collocated beta attenuation monitor, or BAM, 1022 sites in the PQAO.

TABLE 7.1 ACCEPTABLE PRECISION AS MEASURED BY COEFFICIENT OF VARIATION (CV) AND BIAS FOR THE NEAR-ROAD MONITORING PROGRAM

Pollutant	Acceptable Precision	Acceptable Bias
$PM_{2.5}$	upper 90 percent confidence limit of ≤10 percent CV	Within ±10 percent
NO_2	upper 90 percent confidence limit for the CV of ≤15 percent	Upper 95 percent confidence limit for the absolute bias of ≤15 percent
CO	Upper 90 percent confidence limit for the CV of ≤ 10 percent	Upper 95 percent confidence limit ≤ ±10 percent

The DAQ calculates CV and absolute bias using the procedures in 40 CFR Part 58, Appendix A, Section 4.

7.2 Measurement Quality Objectives

As air pollution measurement systems increase in both cost and complexity, it becomes essential to have a methodology that will, in a cost-effective manner, increase the completeness and precision and decrease the bias of the data produced by the air-pollution measurement systems.

Once a DQO is established, the DAQ evaluates and controls the quality of the data to ensure the DAQ maintains data quality within the established acceptance criteria. The EPA designed the MQOs to evaluate and control various phases (sampling, preparation, analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the DQOs. The DAQ defines the MQOs for North Carolina's near-road monitoring program in terms of the following DQIs:

- **Precision -** "Precision is a measure of agreement between two replicate measurements of the same property, under prescribed similar conditions (US EPA QA/G-5, Appendix B)." This is the random component of error. The DAQ calculates this value using percent differences as described in 40 CFR Part 58, Appendix A, Section 4.

- **Bias -** "Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction (US EPA QA/G-5, Appendix B)." Bias is determined by estimating the positive and negative deviation from the true value as a percentage of the true value.
- **Comparability -** "Comparability is the qualitative term that expresses the confidence that two data sets can contribute to a common analysis and interpolation. Comparability must be carefully evaluated to establish whether two data sets can be considered equivalent regarding the measurement of a specific variable or groups of variables (US EPA QA/G-5, Appendix B)."
- **Representativeness -** "Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point or for a process condition or environmental condition. Representativeness is a qualitative term that DAQ evaluates to determine whether in situ or other measurements are made in such a manner that the resulting data appropriately reflect the media and phenomenon measured or studied (US EPA QA/G-5, Appendix B)."
- **Completeness -** Completeness is a metric quantifying the amount of valid data obtained from a measurement system compared to the expected amount obtained under correct, normal conditions. The DAQ expresses completeness as a percentage. Data completeness requirements are included in 40 CFR Part 50, Appendix N (Sections 4.1 and 4.2) for $PM_{2.5}$, 40 CFR Section 50.8(c) for CO and 40 CFR Part 50, Appendix S for NO_2.
- **Sensitivity** – "Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest (US EPA QA/G-5, Appendix B)." The DAQ determines sensitivity by using the Single Point Precision and Bias Report on the EPA's outdoor air quality site. Currently, the DAQ does not perform annual method detection limit, or MDL, studies but relies on the manufacturers' specifications for instrument detection limit (IDL) or something similar.

For each of these attributes, the RCO chemists developed acceptance criteria using various parts of 40 CFR Parts 50, 53 and 58 and EPA-supplied guidance documents. Tables 7.2 through 7.4 list the MQOs for North Carolina's near-road monitoring program. The RCO chemists based these tables on the validation templates in the QA Handbook. As described in the QA Handbook and implemented here, for each criteria pollutant, Tables 7.2 through 7.4 list three validation criteria: critical, operational and systematic. The tables discriminate between:

- Criteria that must be met to ensure the quality of the data, i.e., critical criteria,
- Criteria that indicate there may be issues with the quality of the data and further investigation is warranted before determining the validity of the datum or data, i.e., operational criteria, and
- Criteria that indicate a potentially systematic problem with the environmental data collection activity that may influence the ability to make decisions with the data, i.e., systematic criteria.

For each criterion, the tables include: (1) the requirement, (2) the frequency with which compliance is to be evaluated, (3) the acceptance criteria, and (4) information where the requirement can be found or additional guidance on the requirement.

North Carolina has adopted and implemented EPA Region 4 LSASD's recommended warning limits or an even stricter warning limit for CO and NO_2 monitoring. The RCO chemists define warning limits as the level of allowable imprecision before a RRO monitoring technician must calibrate an analyzer or take other corrective action. The RCO chemists set the warning limits lower than the MQOs or control limits to reduce imprecision and bias and enhance data recovery.

The RCO chemists define control limits as the level of allowable imprecision before data invalidation is required (corrective action is required at the warning or action limit). The RCO chemists cannot set control limits higher than the MQOs. The RCO chemists use these limits when validating ambient air measurements against single point precision checks. The use of both warning and control limits strengthens the precision of these measurements and improves the data validation practices ensuring regulatory requirements are met. Tables 7.2 through 7.4 include both the EPA-established control limits and DAQ-established warning or action limits.

Other elements, as well as the SOPs associated with this QAPP that are specific to each monitor type, provide more detailed descriptions of these MQOs and how they will be used to control and assess measurement uncertainty.

7.3 Type of Data Needed

The DAQ collects the near-road pollutant data using hourly concentration data (with each hour considered valid if the monitor has reported at least 45 valid 1-minute readings) and 24-hour $PM_{2.5}$ averages obtained from hourly concentration readings. For each of these pollutants, the EPA requires quarterly data capture of greater than or equal to 75 percent completeness. The collection of precision and bias data is also required. In addition to these requirements, the data needed for the DAQ near-road monitoring program will meet the following quality objectives:

- All data should be traceable to a National Institute of Standards and Technology (NIST) primary standard.
- All data shall be of a known and documented quality. Two major measurements used to define quality are precision and bias. Refer to Section 7.2 Measurement Quality Objectives for definitions of the metrics precision and bias.
- All data shall be comparable. This means the DAQ shall produce all data in a similar and scientific manner. The use of the standard methodologies for sampling, calibration, auditing, etc. referenced in the QAPP and associated SOPs should achieve this goal.
- All data shall be representative of the parameters measured with respect to time, location, and the conditions from which DAQ obtains the data. The use of approved standard methodologies should ensure that the data generated are representative. Support in achieving representativeness is also provided through adhering to the requirements prescribed in 40 CFR Part 58, Appendices D and E.
- All data shall be as complete as possible and DAQ will supplement the data, as needed, using either a collocated data logger for shelter temperature or data stored in the monitor for the CO, NO_2 (including NO and NO_x) and $PM_{2.5}$.
- The QAPP and its associated SOPs must be dynamic to continue to achieve its stated goals as techniques, systems, concepts and project goals change.

TABLE 7.2 NITROGEN OXIDES MEASUREMENT QUALITY OBJECTIVES.

Measurement Quality Objective Parameter –Nitrogen Dioxide (NO_2) (Chemiluminescence).

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA- NO_2			
Sampler/Monitor	***Not applicable***	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
1-Point-QC Check Single analyzer	***1/ 14 days***	Warning limit ≤ ± 10.0 percent (percent difference) Control limit ≤ ±15.0 percent (percent difference) or <±1.5 ppb difference, whichever is greater	1 and 2) 40 CFR Part 58, Appendix A, Section 3.1.1 3) Recommendation based on DQO in 40 CFR Part 58, Appendix A, Section 2.3.1.4 (see DAQ NO_2 SOP for details) QC check concentration range 0.005 - 0.080 ppm and 05/05/2016 Technical Note on AMTIC. Relative to routine concentrations
Zero/span check	1/ 14 days	Zero drift ≤ ± 1.0 ppb (24 hour) ≤ ± 5.0 ppb (> 24hr-14 day) Span drift ≤ ± 10.0 percent	1 and 2) QA Handbook Volume 2 Section 12.3 3) Recommendation and related to DQO (see DAQ NO_2 SOP for details)
Converter Efficiency	During multi-point calibrations, span and audit 1/ 14 days	***(≥96 percent)*** 96 – 104.1 percent	1) 40 CFR Part 50, Appendix F Section 1.5.10 and 2.4.10 2) Recommendation (see DAQ NO_2 SOP) 3) 40 CFR Part 50, Appendix F Section 1.5.10 and 2.4.10 Regulation states ≥ 96 percent, 96 – 104.1 percent is a recommendation.
Shelter Temperature Range	Daily (hourly values)	20.0 to 30.0 ° C. (hourly average)	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
OPERATIONAL CRITERIA- NO_2			
Shelter Temperature Control	Daily (hourly values)	≤ ± 2.0 ° C Standard Deviation over 24 hours	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Shelter Temperature Device Check	1/182 days and 2/calendar year	≤ ± 2.0 ° C of standard	1, 2 and 3) QA Handbook Volume 2 Section 7.2.2
Annual Performance Evaluation Single Analyzer	***Every site 1/365 days and 1/ calendar year***	Percent difference of audit levels 3-10 ≤ ±15.0 (DAQ goal is ±10.0) percent; Audit levels 1 and 2 ≤ ± 1.5 ppb difference or < ±15.1 percent, whichever is greater	1) 40 CFR Part 58, Appendix A, section 3.1.2 2) 40 CFR Part 58, Appendix A, section 3.1.2 3) Recommendation - 3 audit concentrations not including zero. (See DAQ NO_2 SOP for details.) AMTIC guidance 5/3/2016
Federal Audits (NPAP)	100 percent of PQAO sites every 6 years; 20 percent of PQAO sites audited each calendar year	Audit levels 1 and 2 < ± 1.5 ppb difference all other levels percent difference < ± 15.1 percent	1) 40 CFR Part 58, Appendix A, section 3.1.3 2) NPAP adequacy requirements on AMTIC 3) NPAP QAPP/SOP

TABLE 7.2 NITROGEN OXIDES MEASUREMENT QUALITY OBJECTIVES.

Measurement Quality Objective Parameter –Nitrogen Dioxide (NO_2) (Chemiluminescence).

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving/failure of zero/span or 1-point-QC check 1/182 days and 2 per calendar year	> 10.0 percent excess NO Span within ± 3.0 percent of expected Precision point within ± 5.0 percent of expected Zero within ± 1 ppb of expected *(Instrument residence time ≤ 2 minutes. All points <± 2.1 percent or ≤ 1.5 ppb difference of best-fit straight line whichever is greater and Slope 1± 0.05)*	1) 40 CFR Part 50, Appendix F 2 and 3) Recommendation based on instrument manual and experience (see DAQ NO_2 SOP) Multi-point calibration (0 and 2 upscale points) *(NOTE: DAQ-08-006.2 (a revision of 2.17.2) is in draft at the time of this QAPP submittal. The revision will include 4 upscale points for routine multi-point calibrations/verifications.*
Gaseous Standards	All gas cylinders	**NIST[a] Traceable** (e.g., EPA Protocol Gas) 10-25 ppm [b] of NO in Nitrogen with < 1 ppm NO_2	1) 40 CFR Part 50, Appendix F Section 1.3.1 and 01/30/2018 EPA Technical Note 2) Not applicable Green Book 3) 40 CFR Part 50, Appendix F Section 1.3.1 requires 50 -100 ppm but to successfully calibrate the photolytic monitor DAQ found using 10 to 25 ppm works better Guidance Document Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program 40 CFR Part 58, Appendix A, section 2.6.1
Zero Air/ Zero Air Check	Chemicals changed 1/365 days and 1/ calendar year	Concentrations below lower detectable level [c]	1) 40 CFR Part 50, Appendix F Section 1.3.2 2 and 3) Recommendation
Gas Dilution Systems	1/365 days or after failure of 1-point-QC check or performance evaluation; 1/calendar year	Accuracy < ± 2.1 percent	1,2 and 3) Recommendation based on SO_2 requirement in 40 CFR Part 50, Appendix A-1 Section 4.1.2
Detection (FEM/FRMs) Noise and lower detectable limits are part of the FEM/FRM requirements.			
Noise	Determined by manufacturer at purchase	***≤ 0.005 ppm***	1) 40 CFR Part 53.23 (b) (definition and procedure) 2) Not applicable 3) 40 CFR Part 53.20, Table B-1
Lower detectable level	Determined by manufacturer at purchase	***≤ 0.01 ppm***	1) 40 CFR Part 53.23 (c) (definition and procedure) 2) Recommendation 3) 40 CFR Part 53.20, Table B-1
SYSTEMATIC CRITERIA - NO_2			
Standard Reporting Units	***All data***	***ppb [d] (final units in AQS)***	1,2 and 3) 40 CFR Part 50, Appendix S, Section 2 (c)
Rounding convention for data reported to AQ S	***All data***	***1 place after decimal with digits to right truncated***	1, 2 and 3) 40 CFR Part 50, Appendix S, Section 4.2 (a)

TABLE 7.2 NITROGEN OXIDES MEASUREMENT QUALITY OBJECTIVES.

Measurement Quality Objective Parameter –Nitrogen Dioxide (NO_2) (Chemiluminescence).

1) Requirement (NO_2)	2) Frequency	3) Acceptance Criteria	Information /Action
Completeness	***Annual Standard***	***≥ 75 percent hours in year***	1) 40 CFR Part 50, Appendix S Section 3.1(b) 2) 40 CFR Part 50, Appendix S Section 3.1(a) 3) 40 CFR Part 50, Appendix S Section 3.1(b)
	1-hour standard	***1) 3consecutive calendar years of complete data 2) 4 quarters complete in each year 3) ≥75 percent sampling days in quarter 4) ≥ 75 percent of hours in a day***	1) 40 CFR Part 50, Appendix S, Section 3.2(b) 2) 40 CFR Part 50, Appendix S, Section 3.2(a) 3) 40 CFR Part 50, Appendix S, Section 3.2(b) More details in 40 CFR Part 50, Appendix S
Sample Residence Time Verification	1/365 days and 1/calendar year	***≤ 20 seconds***	1) 40 CFR Part 58, Appendix E, section 9 (c) 2) Recommendation 3) 40 CFR Part 58, Appendix E, section 9 (c)
Sample Probe, Inlet, Sampling train	***All sites***	***Borosilicate glass (e.g., Pyrex®) or Teflon™***	1, 2 and 3) 40 CFR Part 58, Appendix E section 9 (a) The EPA accepts FEP and PFA as equivalent material to Teflon™. DAQ replaces the probe line every two years and more frequently if pollutant load or contamination dictate
Siting	1/365 days and 1/calendar year	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58, Appendix E, sections 2-6 2) Recommendation (See DAQ Annual Network Review SOP) 3) 40 CFR Part 58, Appendix E, sections 2-6
Precision (using 1-point-QC checks)	***Calculated annually and as appropriate for DV[e] estimates***	***90 percent confidence limit CV <15.1 percent***	1) 40 CFR Part 58, Appendix A, Section 2.3.1.4 and 3.1.1 2) 40 CFR Part 58, Appendix A, section 4 (b) 3) 40 CFR Part 58, Appendix A, section 4.1.2
Bias (using 1-point-QC checks)	***Calculated annually and as appropriate for DV estimates***	***95 percent confidence limit < ± 15.1 percent***	1) 40 CFR Part 58, Appendix A, section 2.3.1.4 and 3.1.1 2) 40 CFR Part 58, Appendix A, section 4 (b) 3) 40 CFR Part 58, Appendix A, section 4.1.3

[a]-National Institute of Standards and Technology [b]-parts per million [c]-Lower Detection Limit [d]-parts per billion [e] design value

TABLE 7.3 CARBON MONOXIDE MEASUREMENT QUALITY OBJECTIVES.
Measurement Quality Objectives Parameter – Carbon Monoxide (CO) (Non-Dispersive Infrared Photometry)

1) Requirement (CO)	2) Frequency	3) Acceptance Criteria	Information /Action
CRITICAL CRITERIA-CO			
Sampler/Monitor	Not applicable	***Meets requirements listed in FRM/FEM designation***	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
One Point QC Check Single analyzer	***1/ 14 days***	Warning limit ≤ ±7.0 percent (percent difference) Control limit ≤ ±10.0 percent (percent difference)	1 and 2) 40 CFR Part 58, Appendix A, Section 3.1.1 3)Recommendation based on DQO in 40 CFR Part 58, Appendix A, Section 2.3.1. (See DAQ CO SOP for details) QC Check Concentration range 0.5 - 5 ppm relative to routine concentrations
Zero/span check	1/ 14 days	Zero drift < ± 0.041 ppm (24 hour) ≤ ± 0.060 ppm (>24hr-14 day) Span drift ≤ ± 5.0 percent	1 and 2) QA Handbook Volume 2, Section 12.3 3) Recommendation (See DAQ CO SOP for details)
Shelter Temperature range	Daily (hourly values)	20.0 to 30.0 ° C. (Hourly average)	1, 2 and 3) QA Handbook Volume 2, Section 7.2.2
OPERATIONAL CRITERIA-CO			
Shelter Temperature Control	Daily (hourly values)	≤ ± 2.0 ° C Standard Deviation over 24 hours	1, 2 and 3) QA Handbook Volume 2, Section 7.2.2
Shelter Temperature Device Check	1/182 days and 2/calendar year	≤ ± 2.0 ° C of standard	1, 2 and 3) QA Handbook Volume 2, Section 7.2.2
Annual Performance Evaluation Single Analyzer	***Every site 1/365 days and 1/calendar year***	Audit levels 1 & 2 ≤ ±0.030 ppm or ≤ ±15.0 percent difference, whichever is greater. Audit levels 3-10 ≤ ±15.0 percent difference (DAQ goal is ±10.0 percent difference)	1 and 2) 40 CFR Part 58, Appendix A, section 3.1.2 3) Recommendation- 3 audit concentrations not including zero. (See DAQ ECB CO SOP) AMTIC guidance 5/3/2016
Federal Audits (NPAP)	100 percent of PQAO sites every 6 years; 20 percent of PQAO sites audited each year	Audit levels 1 and 2 ≤ ± 0.030 ppm difference all other levels percent difference ≤ ± 15.0 percent	1) and 2) 40 CFR Part 58, Appendix A, section 3.1.3 3) NPAP QAPP/SOP
Verification/Calibration	Upon receipt/adjustment/repair/ installation/moving 1/365 days and 1/calendar year *Verification during Calibration and within 182 days of most recent calibration*	All points <± 2.1 percent or ≤ ± 0.03 ppm difference of best-fit straight line whichever is greater and slope 1 ± 0.05	1) 40 CFR Part 50, Appendix C, Section 4 2 and 3) Recommendation (See DAQ CO SOP for details) Multi-point calibration (0 and 4 upscale points)

TABLE 7.3 CARBON MONOXIDE MEASUREMENT QUALITY OBJECTIVES.
Measurement Quality Objectives Parameter – Carbon Monoxide (CO) (Non-Dispersive Infrared Photometry)

1) Requirement (CO)	2) Frequency	3) Acceptance Criteria	Information /Action
Gaseous Standards	All gas cylinders	**NIST Traceable** (e.g., EPA Protocol Gas)	1) 40 CFR Part 50, Appendix C, Section 4.3.1 2) Not applicable Green Book 3) 40 CFR Part 50, Appendix C, Section 4.3.1 See details about CO_2 sensitive instruments Gas producer used must participate in EPA Ambient Air Protocol Gas Verification Program 40 CFR Part 58, Appendix A, Section 2.6.1
Zero Air/Zero Air Check	Chemicals changed 1/365 days and 1/calendar year	***< 0.1 ppm CO***	1) 40 CFR Part 50, Appendix C, Section 4.3.2 2) Recommendation 3) 40 CFR Part 50, Appendix C, Section 4.3.2
Gas Dilution Systems	Certified 1/365 days and 1 / calendar year or after failure of 1-point-QC check or performance evaluation	Accuracy ≤± 2.0 percent	1,2 and 3) Recommendation based on SO_2 requirement in 40 CFR Part 50, Appendix A-1, Section 4.1.2
Detection (FEM/FRMs) Noise and lower detectable limits are part of the FEM/FRM requirements.			
Noise	Determined by manufacturer at purchase	***≤ 0.2 ppm (standard range)*** ***≤ 0.1 ppm (lower range)***	1) 40 CFR Part 53.23 (b) (definition and procedure) 2) Recommendation- information obtained from lower detectable limit 3) 40 CFR Part 53.20 Table B-1
Lower detectable level	Determined by manufacturer at purchase	***≤ 0.4 ppm (standard range)*** ***≤ 0.2 ppm (lower range)***	1) 40 CFR Part 53.23 (c) (definition and procedure) 2) Recommendation 3)40 CFR Part 53.23 Table B-1
SYSTEMATIC CRITERIA-CO			
Standard Reporting Units	***All data***	***ppm (final units in AQS)***	1, 2 and 3) 40 CFR Part 50.8 (a)
Rounding convention for data reported to AQS	***All routine concentration data***	***1 decimal place***	1, 2 and 3) 40 CFR Part 50.8 (d)
Completeness	***8-hour standard***	***75 percent of hourly averages for the 8-hour period***	1) 40 CFR Part 50.8(c) 2) 40 CFR Part 50.8(a)(1) 3) 40 CFR Part 50.8(c)
Sample Residence Time Verification	1/365 days and 1/ calendar year	< 20 seconds	1, 2, and 3) Recommendation. (See DAQ-04-001.2) CO is not a reactive gas but suggest following same methods as other gaseous criteria pollutants.
Sample Probe, Inlet, Sampling train	All Sites	Borosilicate glass (e.g., Pyrex®) or Teflon™	1, 2, and 3) Recommendation. CO not a reactive gas but suggest following same methods as other gaseous criteria pollutants. The EPA has accepted FEP and PFA as an equivalent material to Teflon™. The DAQ replaces the probe line every other year and more frequently if pollutant load dictate.

TABLE 7.3 CARBON MONOXIDE MEASUREMENT QUALITY OBJECTIVES.
Measurement Quality Objectives Parameter – Carbon Monoxide (CO) (Non-Dispersive Infrared Photometry)

1) Requirement (CO)	2) Frequency	3) Acceptance Criteria	Information /Action
Siting	1/365 days and 1/ calendar year	***Meets siting criteria or waiver documented***	1) 40 CFR Part 58, Appendix E, Sections 2-6 2) Recommendation (See DAQ Annual Network Review SOP) 3) 40 CFR Part 58, Appendix E, Sections 2-6
Precision (using 1-point-QC checks)	***Calculated annually and as appropriate for DV estimates***	***90 percent confidence limit CV ≤ 10.0 percent***	1) 40 CFR part 58, Appendix A, Section 3.1.1 2) 40 CFR Part 58, Appendix A, Section 4 (b) 3) 40 CFR Part 58, Appendix A, Section 4.1.2
Bias (using 1-point-QC checks)	***Calculated annually and as appropriate for DV estimates***	***95 percent confidence limit ≤ ± 10.0 percent***	1) 40 CFR Part 58, Appendix A, Section 3.1.1 2) 40 CFR Part 58, Appendix A, Section 4 (b) 3) 40 CFR Part 58, Appendix A, Section 4.1.3

CV = coefficient of variation DV = design value

TABLE 7.4 $PM_{2.5}$ MEASUREMENT QUALITY OBJECTIVES: $PM_{2.5}$ (CONTINUOUS MET ONE BAM 1022, LOCAL CONDITIONS)			
1) Criteria (PM 1022 LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
CRITICAL CRITERIA - $PM_{2.5}$ Continuous, BAM 1022, Local Conditions			
Sampler/Monitor	Not applicable	Meets requirements listed in FRM/FEM designation. Confirm method designation on front panel or just inside instrument.	1) 40 CFR Part 58, Appendix C, Section 2.1 2) Not applicable 3) 40 CFR Part 53 and FRM/FEM method list
Firmware of monitor	At setup	1. Must be the firmware (or later version) as identified in the published method designation summary. 2. Firmware settings must be set for flowrate to operate and report at "local conditions" (i.e., not STP).	1, 2 and 3) 40 CFR Part 50, Appendix N. Section 1(c)
Data Reporting Period	Report every hour	1. The calculation of an hour of data is dependent on the design of the method. 2. A 24-hour period is calculated in AQS if 18 or more valid hours are reported for a day	See operator's manual. Hourly data are always reported as the start of the hour on local standard time 40 CFR Part 50, Appendix N, Section 3(c)
Sampling Instrument			
PM10 Inlet (if applicable to method designated)	At setup	Must be a Louvered PM_{10} size selective inlet as specified in 40 CFR Part 50, Appendix L, Figures L-2 through L-19	1, 2 and 3) 40 CFR Part 50, Appendix L, Figures L-2 through L-19
PM2.5 second stage separator (if applicable to method designated)	At setup	Must be a BGI Inc. Very Sharp Cut Cyclone (VSCC™) or equivalent second stage separator approved for the method.	1,2 and 3) FRM/FEM method list The other approved second stage separator option for select FEMS is the Dichot+.
Average Flow Rate	every 24 hours of operation, each hour can be checked	average within 5 percent of 16.67 liters/minute at local conditions	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.1
Variability in Flow Rate	every 24 hours of operation	CV ≤ 2 percent	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 7.4.3.2
One-point Flow Rate Verification	1/30 days, separated by 14 days	<±4.1 percent of transfer standard (DAQ's warning limit is ≤± 3 percent of transfer standard); <±5.1 percent of flow rate DV (DAQ's warning limit is ≤± 4 percent of flow rate DV)	1, 2 and 3) 40 CFR Part 50, Appendix L, Section 9.2.5 and 7.4.3.1 and 40 CFR Part 58, Appendix A, Section 3.2.3 and 3.3.2 3) DAQ's warning limit for percent of transfer standard and flow DV is 3 and 4 percent respectively, *DAQ BAM SOP, Section 7.0.*
Design Flow Rate Adjustment	After multi-point calibration or verification	< ± 2.1 percent of design flow rate	1,2 and 3) 40 CFR Part 50, Appendix L, Sec. 9.2.6
External Leak Check	Before each flow rate verification/calibration and before and after $PM_{2.5}$ separator maintenance	Method specific. See operator's manual.	1) 40 CFR Part 50, Appendix L, Section 7.4.6.1 2) 40 CFR Part 50, Appendix L, Section 9.2.3 and Method 2-12, Section 7.4.3 3) 40 CFR Part 50, Appendix L, Section 7.4.6.1

TABLE 7.4 $PM_{2.5}$ MEASUREMENT QUALITY OBJECTIVES: $PM_{2.5}$ (CONTINUOUS MET ONE BAM 1022, LOCAL CONDITIONS)			
1) Criteria (PM 1022 LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Internal Leak Check	If failure of external leak check	Method specific. See operator's manual.	1) 40 CFR Part 50, Appendix L, Section 7.4.6.2 2) Method 2-12, Section 7.4.4 3) 40 CFR Part 50, Appendix L, Section 7.4.6.2
OPERATIONAL CRITERIA - PM BAM 1022, Local Conditions			
Annual Multi-point Verifications/Calibrations			
Leak Check	1/30 days	< 1.5 liters per minute (LPM)	1) 40 CFR Part 50, Appendix L, Section 7.4.6.1 2) Recommendation 3) Met One BAM 1022 Operation Manual, Revision G, Section 6.2.
Temperature multi-point Verification/Calibration	on installation, then every 365 days and 1/ calendar year	< ± 2.1ºC	1) 40 CFR Part 50, Appendix L, Sec. 9.3 2 and 3) Method 2.12, Section 6.4.4
One-point Temperature Verification	1/30 days	<± 2.1°C	1) 40 CFR Part 50, Appendix L, Sec. 9.3 2) Method 2.12 Sec. 7.4.5 and Table 6-1 3) Recommendation
Pressure Verification/Calibration	on installation, then every 365 days or 1/ calendar year	± 10.1 millimeters mercury	1) 40 CFR Part 50, Appendix L, Section 9.3 2) Recommendation 3) DAQ BAM SOP Section 4.1
Flow Rate Multi-point Verification/Calibration	Electromechanical maintenance or transport or every 365 days and 1/calendar year	<± 2.1 percent of transfer standard	1) 40 CFR Part 50, Appendix L, Section 9.2. 2) 40 CFR Part 50, Appendix L, Section 9.1.3, Method 2.12 Table 6-1 and Section 6.3 3) Recommendation
Other Monitor Calibrations/checks	per manufacturers' operations manual	Annual zero test on Met One BAM 1022	Per manufacturers' operating manual. Note: more frequent zero tests may be appropriate in areas with seasonal changes in dew points.
Precision			
Collocated Samples	every 12 days for 15 percent of sites by method designation for the PQAO	CV < 10.1 percent of samples ≥ 3 µg/m^3	1) and 2) 40 CFR Part 58, Appendix A, Section 3.2.3 3) Recommendation based on DQO in 40 CFR Part 58, Appendix A, Sec. 2.3.1.1
Accuracy			
Temperature Audit	every 180 days and at time of flow rate audit	< ± 2.1ºC	1, 2 and 3) Method 2.12, Section 11.2.2
Pressure Audit	every 180 days and at time of flow rate audit	< ± 10.1 mm Hg	1, 2 and 3) Method 2.12, Section 11.2.3

TABLE 7.4 $PM_{2.5}$ MEASUREMENT QUALITY OBJECTIVES: $PM_{2.5}$ (CONTINUOUS MET ONE BAM 1022, LOCAL CONDITIONS)			
1) Criteria (PM 1022 LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Semi Annual Flow Rate Audit	Twice a calendar year and 5-7 months apart (the DAQ goal is every quarter)	< ± 4.1 percent of audit standard; < ± 5.1 percent of design flow rate (DAQ's warning limit for percent of transfer standard and flow DV is ≤ ± 3.0 and ≤ ± 4.0 percent, respectively)	1 and 2) 40 CFR Part 58, Appendix A, Section 3.2.2 3) Method 2.12 Sec. 11.2.1, NC's action limit goal for percent of transfer standard and flow DV is ±3 and ±4 percent respectively, DAQ BAM 1022 SOP, Section 7.1 Table 5
Monitor Maintenance			
$PM_{2.5}$ Separator (VSCC)	every 30 days	cleaned/changed	1,2 and 3) Method 2.12, Section 8.3.3
Inlet Cleaning	every 30 days	cleaned/changed	1,2 and 3) Method 2.12, Section 8.3
Downtube Cleaning	every 90 days	cleaned	1,2 and 3) Method 2.12, Section 8.4
Filter Housing Assembly Cleaning	every 30 days	cleaned	1,2 and 3) Method 2.12, Section 8.3
Circulating Fan Filter Cleaning	every 30 days	cleaned	1,2 and 3) Method 2.12, Section 8.3
Manufacturer-Recommended Maintenance	per manufacturers' SOP	per manufacturers' SOP	
Met One 1022 BAM Specific Operational Criteria			
BAM check of membrane span foil	Quarterly	Average. < ± 5.1 percent of ABS	1, 2 and 3) Applies on the BAM 1022
Electrical grounding	At setup	Check to see if the BAM chassis is grounded and the downtube is grounded to the chassis at the collar (i.e., with setscrews)	1, 2 and 3) BAM 1022 Operations Manual
Nozzle cleaning	Every 30 days, or more often as needed	cleaned	1, 2 and 3) BAM 1022 Operations Manual
Zero test	Yearly	Standard deviation of the data from a 72-hour zero test < 2.4 µg/m3	1, 2 and 3) BAM 1022 Operations Manual
SYSTEMATIC CRITERIA- $PM_{2.5}$ Continuous, Local Conditions			
Siting	1/365 days and 1/calendar year	meets siting criteria or waiver documented	1) 40 CFR Part 58, Appendix E, Sections 2-6 2) Recommendation (See DAQ Annual Network Review SOP) 3) 40 CFR Part 58, Appendix E, Sections 2-6
Data Completeness	24-hour averages	≥ 75 percent of hours in a day	1), 2), and 3) 40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
	Annual standard	≥ 75 percent of sampling days in each quarter; four complete quarters each year	1), 2), and 3) 40 CFR Part 50, Appendix N, Section 4.1 (b) 4.2 (a)
	24-hour standard		
Reporting Units	all hourly and 24-hour values	µg/m^3 at ambient temperature/pressure ($PM_{2.5}$)	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b)

TABLE 7.4 $PM_{2.5}$ MEASUREMENT QUALITY OBJECTIVES: $PM_{2.5}$ (CONTINUOUS MET ONE BAM 1022, LOCAL CONDITIONS)			
1) Criteria (PM 1022 LC)	**2) Frequency**	**3) Acceptable Range**	**Information /Action**
Rounding convention for data reported to AQS	all hourly averages	to one decimal place, with additional digits to the right being truncated	1. 2 and 3) 40 CFR Part 50, Appendix N, Section 3.0 (b)
Annual 3-yr average	all concentrations	nearest 0.1 µg/m^3 (≥ 0.05 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Sections 3 and 4 Rounding rule for AQS data is a recommendation
24-hour, 3-year average	all concentrations	nearest 1 µg/m^3 (≥ 0.5 round up)	1,2 and 3) 40 CFR Part 50, Appendix N, Sections 3 and 4 Rounding rule for AQS data is a recommendation
Re-certifications of Verification and Calibration Standards - All standards should have multi-point certifications against NIST-Traceable standards			
Flow Rate Transfer Standard	1/365 days and once per year	<± 2.1 percent of NIST Traceable Standard	1) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2 2) Method 2.12 Section 4.2.3 and 6.3.3 3) 40 CFR Part 50, Appendix L, Section 9.1 and 9.2
Field Thermometer	1/365 days and once per year	± 0.1° C resolution, ± 0.5° C accuracy	1, 2 and 3) Method 2.12, Section 4.2.2
Field Barometer	1/365 days and once per year	± 1-millimeters mercury resolution, ± 5 millimeters mercury accuracy	1, 2 and 3) Method 2.12, Section 4.2.2
Field Manometer	1/365 days and once per year	± 0.1 in H_2O resolution, ± 1.0 in H_2O accuracy	1, 2 and 3) Method 2.12, Section 4.2.2
Clock/timer Verification	1/30 days	1 minute/month	1and 2) Method 2.12, Section 4.2.1 3) 40 CFR Part 50, Appendix L, Section 7.4.12
Precision			
Single analyzer (collocated monitors)	1/91 days.	CV <10.1 percent for values ≥ 3.0 µg/m^3	1, 2 and 3) Recommendation to provide early (quarterly) evaluation of achievement of DQOs.
Primary Quality Assurance Organization	Annual and 3-year estimates	90 percent confidence limit of CV < 10.1 percent for values ≥ 3.0 µg/m^3	1, 2 and 3) 40 CFR Part 58, Appendix A, Section 4.2.1 and 2.3.1.1.
Bias			
Performance Evaluation Program (PEP)	5 audits for PQAOs with < 5 sites, 8 audits for PQAOs with > 5 sites, each PQAO primary monitor audited every 6 years	<±10.1 percent for values > 3.0 µg/m^3	1,2 and 3) 40 CFR Part 58, Appendix A, Section 3.2.4, 4.2.5 and 2.3.1.1

8.0 Training Requirements

Adequate education and training are integral to any monitoring program that strives for reliable and comparable data. DAQ personnel will meet the educational requirements, accountability standards and training requirements for their positions. Section 4 of the QMP describes the DEQ training program. DAQ requires all staff to take specific, mandatory governmental training courses, such as safety training, defensive driving, and harassment awareness courses, among others. The DAQ maintains records on personnel qualifications and training in several locations, dependent upon the applicability of the information. For example, staff may maintain copies of certificates received from classes or workshops, whereas human resources will keep records of personnel qualifications. The DAQ uses the North Carolina Learning Management System, or LMS, to track training by DIT and the Office of State Human Resources.

The DAQ aims ambient air monitoring training at increasing the effectiveness of employees as well as the effectiveness of DAQ as a whole. In general, training for the ambient-air monitoring program consists of a combination of required reading, ambient monitoring monthly meetings, active cross training amongst staff, completion of EPA-led training classes and attendance at DAQ and EPA workshops and conferences. Currently, no recurring annual training is required for the near-road monitoring staff other than attendance at the annual ambient monitoring workshop. Observations made during internal systems audits or TSAs may result in the need for specific refresher training provided by DAQ staff. All staff are encouraged to complete additional training – such as self-instructional air monitoring courses and EPA-provided webinars.

Specific air monitoring personnel training consists of required reading before implementing the requirements of this QAPP. Documents monitoring personnel must read shall include this QAPP and the SOPs and instrument manuals specific to the equipment personnel will be working with or servicing. Employee supervisors or trainers typically document required reading on a form indicating the employee has read and understood the QAPP and SOP. These forms are archived in IBEAM and Laserfiche. Specific training requirements are provided in SOP DAQ-15-003 (*in draft and under review at this time*). DAQ continually revises the training program and updates the training forms used to document training as needed.

All positions have a training guide that provides suggested training for employees to complete to achieve competency in that position. Staff are encouraged to also read applicable parts of the CFR (e.g., 40 CFR, Part 50 and 58), the QA Handbook, Vol. II, and EPA's data validation guidance documents and policy memoranda. See Table 11.2 for relevant SOPs to review.

The DAQ makes efforts to ensure all employees receive timely training and periodic refreshers in accordance with the established training guide. Experienced staff members provide on-the-job training. As the RRO has the largest ambient monitoring staff with the most diversified monitoring equipment, the chief often calls upon the RRO to provide hands-on training when needed. The chief, PPB supervisor or equivalent typically arranges for this training. In some cases, the chief calls upon other regional offices, the ECB electronics technicians and RCO chemists to provide hands-on training. The employee documents this training on the provided training forms (obtained from Laserfiche), which are archived in

Laserfiche as well in the employee's valuing individual performance (VIP). Before 2021, the employee may also have archived training records in the LMS.

The DAQ supervisors actively encourage all employees to pursue training opportunities whenever possible and as needed, because the chief continually evaluates DAQ's near-road monitoring network to ensure it continues to meet its objectives. Because of these evaluations, the chief could add new equipment, procedures or new personnel to the project. DAQ provides vendor-based training for its personnel when DAQ obtains new equipment. The employees document this training on the provided training form and archive it in Laserfiche. The employee may also archive the training records in the LMS, if he or she chooses to do so. Additionally, personnel are encouraged to periodically identify, request, and attend pertinent courses and seminars. The DAQ may provide these courses and seminars as videotapes, closed circuit transmissions, web-based real-time interactive formats, live instructions or a combination of one or more. Organizations that provide these training opportunities include local and regional universities, the Air and Waste Management Association, the Mid Atlantic Regional Air Management Association and EPA. The employees document this training on the appropriate training form and archive it in Laserfiche. Air monitoring personnel have enough training to currently perform necessary functions at an acceptable level.

The DAQ supervisors also evaluate employee proficiency, based on performance and feedback from peers and other coworkers. During the VIP review, the supervisors recommend any refresher training the employee may need and develop a plan for the employee to receive the needed training. The LMS provides and archives certificates of completion for any course work taken through LMS.

Prior to the start of on-site work, DAQ provides all field personnel instruction specific to the project covering the following areas:

- Organization and lines of communication and authority,
- Overview of the QAPP, including monitoring maintenance, calibration, and QC activities,
- Quality assurance / quality control, or QA/QC, requirements, and
- Health and safety requirements.

Monitoring staff provide new monitoring personnel and the near-road monitoring station technicians, who operate these sites, necessary on-the-job training for their individual monitoring tasks, including data review, verification, and validation. Upon completion of training, the trainee will be performance tested on knowledge, skills, and abilities in the field and at the office. Upon successful demonstration of initial competency, the trainer will complete Form DAQ-16-022 DAQ Initial Demonstration of Competency. Continuing demonstration of competency is noted during VIP reviews and internal TSAs and documented using Form DAQ-16-019 DAQ Continuing Demonstration of Competency. The employee documents all on-the-job training on the appropriate form and archives it in Laserfiche. Ongoing proficiency is reviewed on an as needed basis. No certificates are provided to the trainee and trainee proficiency is documented as part of the on-the-job training process and documentation.

The chief invites the RRO monitoring coordinator and monitoring technicians to the North Carolina DAQ ambient monitoring workshop held each year. This workshop provides an opportunity to discuss and train on monitoring and the QC and QA processes, including data review and verification, to ensure the collection of valid data. A senior member provides hands-on instruction with the analyzers as on the job

training when new employees are hired. The vendor provides training when DAQ purchases new monitors and other equipment. The DAQ and EPA staff provides training annually during the monitoring workshop. All available presentations and materials generated at the workshop are maintained on the RCO group drive or in SharePoint for archival purposes. No formal evaluation forms are collected during or after the workshop.

DEQ - DAQ Training Links

Air Monitoring:	https://www.epa.gov/amtic/conferences-and-training
Professional Skills:	http://oshr.nc.gov/state-employee-resources/training

9.0 Documentation and Records

The following information describes DAQ's management of documents and records, including this QAPP, for the near-road monitoring program. Currently, the Division of Air Quality does not have a single designated position responsible for policing documents and/or records for the entire Ambient Monitoring Section (AMS). A dedicated document and records custodian would be a tremendous asset; however, such a position is not going to be created anytime in the foreseeable future due to a lack of funding. Also, this huge responsibility cannot be assigned to a single position within the already overburdened monitoring staff. Therefore, the AMS has established that the individual staff members who generate the original document and/or record are responsible for the placement, maintenance and archival of their respective documents and records. DAQ-14-003 provides additional details on document retention procedures.

DIT maintains a shared group drive for use by Ambient Monitoring personnel in the RCO and regional offices. Access to this drive is restricted to DAQ personnel and assigned DIT personnel. Although it is commonly referred to as the "P" drive, the group drive may have different letter designations in the regional offices. To reduce confusion, the group drive will be referred to as the "RCO group drive" in this QAPP.

Microsoft SharePoint is utilized as an access-restricted document and records storage repository by the seven regional offices. The regional ambient monitoring coordinator is responsible for all ambient monitoring documents and/or records stored on their specific SharePoint site. Access to each SharePoint page is restricted to its respective regional office personnel. Regional records and/or documents are stored on the regional SharePoint sites and the regions retain their records and/or documents according to the retention schedule. RCO chemists do not have access to the regional SharePoint sites. Therefore, any document and/or record requiring RCO review is placed on the RCO group drive for the RCO chemist to review and approve. The RCO chemists are assigned specific program areas for which they are responsible. For instance, each chemist is responsible for a specific criteria pollutant, such as ozone, particulate matter, sulfur dioxide, nitrogen oxides, and carbon monoxide. Also, a specific RCO chemist is assigned to meteorology data and a specific RCO Chemist is assigned to air toxics data. These chemists are responsible for the final approved records that are stored on the RCO group drive.

Documents and records are also archived in the internal access restricted Laserfiche. The RCO staff also utilize SharePoint to share information such as reference materials, meeting notes, draft copies of documents, news articles, workshop materials, presentations, and other miscellaneous information. The RCO SharePoint page is for internal division usage by the AMS and access is restricted to specific North Carolina air quality and DAQ staff, but it is not the official location of the approved QMP, QAPPs and SOPs. The approved QMP, QAPPs and SOPs are posted to the DEQ/DAQ website for the ease of access for all State, Local and Tribal staff at any location where internet access can be utilized, such as the monitoring sites. All approved documents are posted to the website under strict approval processes and protocols.

DIT routinely creates backups of all data stored on the RCO group drive and Laserfiche. Files stored in the "Ambient Monitoring" module of Laserfiche are protected from deletion; any file a user attempts to delete remains in the database but is hidden from view. A supervisor can restore that file to its previous

location via a request to the Laserfiche administration staff. As a cloud-based file storage location, SharePoint file backups are facilitated by Microsoft, Inc.; all files are backed up twice daily and Microsoft provides a 90-day window for recovery of documents from inadvertent editing or deletion.

The DAQ secures all electronic documents by utilizing encrypted laptops or password protected computers and by storing paper documents in limited access areas. Additionally, SOPs must not conflict with any part of this QAPP or with any other relevant local, state, or federal regulation.

Table 9.1 lists the documents and records pertaining to all data the EPA requires DAQ to collect and all other data deemed important by DAQ's policies and records management procedures, including documents and records required to support the concentration data reported to EPA.

Table 9.1 Documentation and Records Information

Categories	Record / Document Type	File Location
Management and Organization	State Implementation Plan Reporting agency information EPA directives Grant allocations Support contracts	Raleigh, North Carolina – Raleigh Central Office
	Quality Management Plan	DEQ Website
	Organizational structure	Ambient Monitoring Administration Page on SharePoint
	Personnel qualifications and training	DEQ HR and DAQ Training page on SharePoint
	Training records and certification	Learning Management System, Laserfiche Ambient Monitoring Module and Valuing Individual Performance
Site Information	Network descriptions Site files Site maps Site pictures	Raleigh Central Office group drive, Regional Office SharePoint page, Laserfiche Ambient Monitoring Module
Environmental Data Operations	Quality Assurance Project Plans	DEQ Website for official repository. Other file locations may include Laserfiche Ambient Monitoring Module for archived versions, North Carolina Ambient Monitoring Section QAPP page on SharePoint or Raleigh Central Office group drive (see below)
	Standard Operating Procedures QA bulletins and technical notes	DEQ Website, Laserfiche Ambient Monitoring Module (see below)
	Field and site notebooks	Raleigh Central Office group drive, Regional Office SharePoint page, monitoring site

Table 9.1 Documentation and Records Information

Categories	Record / Document Type	File Location
	Inspection, Equipment and Maintenance Records	Raleigh Central Office group drive, Regional Office SharePoint page, ECB
Raw Data	Any original data (routine and QC) Including data entry forms	Raleigh, North Carolina – Raleigh Central Office, Regional Offices, ECB
Data Reporting	Air Quality Index Reports	DAQ Website, Laserfiche Ambient Monitoring Module
	Annual Certification Report	Laserfiche Ambient Monitoring Module
	Data Summary Reports	DAQ Website, Laserfiche Ambient Monitoring Module
	Journals/ articles/ papers/ presentations	Raleigh Central Office group drive, Laserfiche Ambient Monitoring Module
Data Management	Data Algorithms Data Management Plans/ Flow Charts Data Management Systems	Raleigh, NC – Raleigh Central Office
	Pollutant Data Minute Data	Envista ARM database
	Meteorological Data (from State Climate Office)	Raleigh Central Office group drive
	Monthly Traffic Data from DOT	IBEAM PM2.5 FRM Module
Quality Assurance	Network Reviews and Assessments Control Charts Certification Documentation Data Quality Assessments Quality Assurance Reports Response/ Corrective Action reports Site Audits Internal / EPA Technical Systems Audit Reports Emails relating to QA activities and assessments	Raleigh, NC – Raleigh Central Office, Regional Offices, and ECB Laserfiche Ambient Monitoring Module

The state of North Carolina considers all e-mails official records, and the state of North Carolina retains all email correspondence for a minimum of 10 years. In addition, DAQ archives e-mails that are critical in documenting official decisions regarding network decisions and data quality decisions in Laserfiche.

Most documentation and records produced by DAQ's near-road monitoring program consist of data and information gathered to support the data collection activities. Documentation and records include:

- QAPPs;
- SOPs;
- Logbooks and data collection records in electronic and written format;
- Instrument and equipment calibration information;

- QA documentation in electronic and written format; and
- Documentation that supports data review, validation and certification activities.

Upon assuming a new role working with DAQ documents and/or records, personnel are trained on the appropriate specific locations for each of the document and record types listed in Table 9.1, how to access the various locations, and proper procedures for maintaining those documents and/or records for which they are responsible. If DAQ personnel require access to documents or records outside of their sphere of responsibility, they may contact the appropriate RCO branch supervisor or regional monitoring coordinator for more information.

Section 19.0 Data Management contains detailed information regarding how DAQ will manage data from the near-road network, including information on data recording, transmittal, storage and retrieval.

9.1 Statewide Policy and Procedure Documentation

DAQ maintains records of program policy and procedure documentation. Documents in this category include:

- QAPPs,
- SOPs,
- Electronic QA/QC data forms that technicians must use to document their work, and
- QA and technical notes, which provide air monitoring policy interpretations or best practices.

The DAQ ensures that document numbers and revision numbers and dates are clearly discernible, generally in the header and on the cover page. The DAQ generates document numbers for these documents using the DAQ Document ID Builder, which can be found on the RCO SharePoint page. Detailed instructions for drafting SOPs can be found in DAQ-14-001 - Standard Operating Procedure (SOP) for Preparing SOPs for the North Carolina Division of Air Quality (NCDAQ).

As of this QAPP revision, DAQ has purchased and is in the process of implementing a new document and record storage database, which may result in changes to these procedures and locations. When these changes are made, this QAPP and relevant SOPs will be revised to reflect new procedures and document and record locations.

The DAQ currently uses Laserfiche for a controlled internal locale for archiving all QA/QC forms, SOPs and QAPPs. PPB chemists are responsible for the blank QA/QC forms and final records concerning their assigned pollutant(s). Intermediate records are the responsibility of the regional ambient monitoring coordinator. In Laserfiche, documents that are archived are marked as *OBSOLETE* in the title so that staff know not to use them for current procedures. The QAM or his designee is responsible for changing the title to *OBSOLETE* when a new version is approved. QA/Tech Notes are also stored in Laserfiche. The DEQ website is the official DAQ repository for controlled QMPs, QAPPs and SOPs, i.e., current approved versions. All other QMPs, QAPPs and SOPs not on the website or in Laserfiche are uncontrolled and therefore not considered official. Personnel are responsible for obtaining and utilizing current versions of documents.

Also, at the time of this QAPP revision, RCO uses the RCO group drive and SharePoint as repositories for working documents. Regional offices use SharePoint as a repository for working documents, and transfer completed documents to the RCO group drive. Draft documents will be watermarked as

DRAFT so that no confusion arises as to the finality of the document. The QAM or designee receives final versions for review and approval. Once all approvers sign the QAPPs and SOPs, the QAM or designee will upload or assign someone to upload the document to the website and Laserfiche. The QAM will notify staff of the issuance of the new document via email and on the next ambient monitoring work group call. The chief and RCO chemists may change these procedures as the new document and record storage database is implemented and will revise the QAPP as changes are made.

9.2 Data Collection Records and Logbooks

Table 9.1 lists the documents and records DAQ must retain. The appropriate sections of this QAPP will discuss the details of these various documents and records. The DAQ will collect all raw data required for calculations, the submissions to the AQS database and QA/QC data electronically, in e-logs, spreadsheets or on data forms recorded in the field; see Section 11.0 Sampling Methods Requirements for additional information.

All RRO monitoring technicians, coordinators, ECB electronics technicians, RCO chemists and other DAQ personnel shall fill out information in the site visit logbook in indelible ink. In addition, the ECB electronics technicians will fill out instrument maintenance logs and Air Quality Section Maintenance Order or AQ-109 forms and Continuous Monitor Performance Audit Report or AQ-121 forms in indelible ink. They shall make corrections by inserting one line through the incorrect entry, initialing and dating this correction and placing the correct entry alongside the incorrect entry, if they can accomplish this legibly, or by providing the information on a new line if the above is not possible.

9.2.1 Logbooks

Each RRO monitoring technician will be responsible for obtaining, maintaining and documenting the appropriate logbooks or associated QA/QC data forms. Each near-road monitor type has an e-log created for that specific monitor type. The e-log contains all data entry forms required by a RRO monitoring technician to document all routine operations. After each use, the RRO monitoring technician uniquely numbers these e-logs by giving them a specific file name before saving them to a storage device such as a laptop computer. From the laptop computer, the RRO monitoring technician will transfer the e-log to the RRO SharePoint page for the RRO monitoring coordinator to review. The RRO monitoring technician will use these e-logs to record information about the site operations, as well as document routine operations. The e-logs are editable, but the original e-logs remain on the access-restricted RRO SharePoint page, which tracks changes and edits and are recoverable in the event of inadvertent deletion. Once the RRO monitoring coordinator has reviewed and approved an e-log, they upload it to the RCO group drive, which is the official repository of these records. The ECB electronics technicians will fill out instrument maintenance logs, Air Quality Section Maintenance Order or AQ-109 forms, and Continuous Monitor Performance Audit Report or AQ-121 forms. The original AQ-109 forms are retained at the ECB facility. The AQ-121 forms are scanned and stored in Laserfiche; hard-copies are stored in a filing cabinet at RCO.

The RRO monitoring and ECB electronics technicians must complete e-logs, instrument maintenance logbooks and Air Quality Section Maintenance Order or AQ-109 forms associated with all routine environmental data operations, even when the site logbooks contain all appropriate and associated information required for the routine operation performed.

Field Logbooks **–** The DAQ uses a combination of bound paper logbooks and e-logs for recordkeeping for each sampling site, sampling instrument, specific program or individual. Each paper logbook should be hardbound and paginated. The RRO monitoring and ECB electronics technicians use the paper site logbooks to document site visits and other activities, including who is at a site, when and why. Every visitor must sign the site logbook. In addition, the near-road monitoring site contains a bound paper logbook, generated and maintained by EPA ORD. The logbooks generated and maintained by RRO office staff are filed and archived at the appropriate regional office once completed. Logbooks generated and maintained by ECB staff are filed and archived at the ECB once completed. The e-logs capture monitor maintenance and QA/QC activities, including calibrations.

9.2.2 Electronic Data Collection

All instrument types currently used in the DAQ near-road network can provide an automated means for collecting information that DAQ would otherwise record on data entry forms. Section 19.0 Data Management provides detailed information on these systems. To reduce the potential for data entry errors, the DAQ will use automated systems where appropriate and will record the same information the regional monitoring technician would record on data entry forms. To provide a backup, the PPB staff will store electronic copies of the automated data collection information (daily poll) for an appropriate period on the RCO group drive. Electronic backup copies of automated data collection information will also be stored on the site computers.

9.3 QA/ QC Records

The DAQ achieves QA/QC through the performance of periodic activities such as:

- Internal / EPA technical systems audits,
- One-point QC checks,
- Zero and span checks,
- Verification/calibration procedures,
- Maintenance activities,
- Performance evaluations,
- EPA performance audits such as the NPAP and PEP,
- Traceability certifications and calibrations and
- Corrective actions.

The EPA and DAQ document TSAs and internal systems audits, respectively, in the form of a written report. The DAQ typically documents and maintains most of the other QA/QC activities using a variety of activities, including emails, Excel spreadsheets, fillable PDF data forms, worksheets and data management systems such as Envidas Ultimate and Envista ARM, both developed by the software developer, Envitech. The associated SOPs describe the use of these methods to create air monitoring QA/QC records. The DAQ retains and archives these records according to the procedures identified in Section 9.5 Data Archiving and Retrieval.

However, for some of the QA/QC activities described above – such as the traceability certifications – the ECB retains many of those records at the ECB. Currently, the vendors typically provide the certificates of analyses that accompany gas cylinders in paper format, which the ECB stores in a file in the office. If

DAQ personnel require information related to these documents, they may contact the ECB for assistance. The RRO monitoring coordinator stores certifications for PM equipment provided by the vendors in file cabinets at the appropriate regional office and in Laserfiche. Paper records of these documents are stored at the ECB in a file cabinet. Any electronic records of these documents are stored on the RCO group drive and additionally on local computer hard drives in the certification rooms. Records for calibrators used in the field and for audits are stored electronically on the computers in the certification room. The division has purchased a database for generating and archiving these types of records and is in the process of implementing it. When the database is fully implemented, the chief and RCO chemists will review the new record generating and retention processes and will revise the QAPP.

9.4 Reference Materials

Because of the technical nature of ambient air monitoring, DAQ requires numerous reference materials to administer the near-road monitoring program effectively. This category includes publications such as instrument operation manuals, troubleshooting guides, EPA guidance documentation, EPA technical memoranda and various other reports. DAQ maintains access to applicable reference materials if DAQ has an administrative need for them. DAQ retains these documents at the RCO, in the Laserfiche Ambient Monitoring module, or on the RCO group drive.

9.5 Data Archiving and Retrieval

The DAQ classifies documentation according to its intended use, future applicability and regulatory requirement for retention. DAQ follows the state of North Carolina's functional schedules for files. Files used and created by DAQ will be kept for a minimum amount of time set by these functional schedules. To meet DAQ's contractual obligation to the EPA, DAQ will retain all the information listed in Table 9.1 for a minimum of four complete calendar years from the date of collection in accordance with 2 CFR Part 200.334. However, if any litigation, claim, negotiation, audit or other action involving the records has been started before the expiration of the four-year period, DAQ will retain the records until completion of the action and resolution of all issues that arise from it, until the end of the regular four-year period, or until the minimum time required by the state of North Carolina functional schedules, whichever is later. The records custodians are responsible for ensuring these retention times are met and disposing of records after their retention period has elapsed.

DAQ stores electronic records within the data management systems located at the near-road site, or Envidas Ultimate, the RCO, or Envista ARM, and on network servers in the RRO and RCO. The database manager regularly backs up the Envista ARM database following the procedures in Section 5.7 of DAQ-05-001.5 Ambient Monitoring Section Database Manager Standard Operating Procedure.

10.0 Network Description

The primary function of the near-road monitoring program is to verify compliance with the NAAQS in a high-traffic-near-road environment. Other purposes for the program possibly include (1) determining trends over time, (2) determining effects on air quality from adjustments to automobile emissions systems, (3) verifying air-quality modeling programs for traffic emissions and (4) providing real-time data to the public.

Sampling network design and monitoring site selection comply with the following appendices of 40 CFR Part 58 and guidance documents:

- Near-Road Technical Assistance Document,
- 40 CFR Part 58, Appendix A - Quality Assurance Requirements for Monitors Used in Evaluations of National Ambient Air Quality Standards,
- 40 CFR Part 58, Appendix D - Network Design Criteria for Ambient Air Quality Monitoring, and
- 40 CFR Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring.

10.1 Network Objectives

DAQ near-road monitoring network SLAMS monitors are intended to address specific air quality management interests. The three basic monitoring objectives of the DAQ near-road monitoring network are listed in Section 6.0 of this QAPP. The chief designed the near-road monitoring network to determine the highest concentrations expected to occur in the area covered by the network. The near-road monitoring network uses the network design criteria specified in 40 CFR Part 58, Appendices D and E to establish the appropriate network configuration necessary to meet these objectives. The chief has assigned the SLAMS monitors within DAQ's near-road monitoring network the monitoring objective designation of source-oriented. Data collected within the network must be representative of the spatial area under study. The goal in siting a monitoring station is to match the spatial scale represented by the data obtained with the spatial scale most appropriate for the monitoring objective of the station. For a discussion of the representative measurement scale for the near-road site, see Section 6.0 Project/Task Description.

10.2 Site Selection

The current near-road site is Triple Oak Road, AQS ID 37-183-0021, located at latitude 35.8652 and longitude -78.8197. Figure 10.1 shows an aerial view of the location. The monitoring probe is located 18 meters from the edge of I-40 and 4.3 meters above the ground. The monitoring station is approximately one kilometer from I-540 and 0.5 kilometers from Airport Boulevard. The Airport Boulevard ramp ends approximately 300 meters southeast from the monitoring site. The location is at grade with the roadway. There are no barriers between the road and the monitoring station. The annual network monitoring plan contains additional information on the site.

FIGURE 10.1 WAKE COUNTY NEAR-ROAD MONITORING STATION LOCATION, RED CIRCLE

When selecting a site, the chief adheres to the site selection criteria specified in 40 CFR Part 58, Appendix D. The selection of a specific monitoring site includes the following activities:

- Developing and understanding the monitoring objective and appropriate DQOs;
- Identifying the spatial scale most appropriate for the monitoring objective of the site;
- Identifying potential locations where the monitoring site could be placed; and
- Identifying the specific monitoring site.

EPA established the protocols for the near-road monitoring network and developed the Near-Road Technical Assistance Document, or TAD, to assist states, locals and tribes with network design and monitor placement. The DAQ followed this guidance to select the current Triple Oak site and will follow the guidance again should DAQ have to relocate the near-road site or expand the network.

The RRO monitoring technician evaluates the monitoring site each year to assure it adheres to the site selection criteria specified in 40 CFR Part 58, Appendix E.

10.2.1 Site Location

The chief considered four criteria when evaluating potential near-road sites:

- Amount of AADT on the roadway,
- Topography of the area and relationship of the roadway to the ground,
- Predominant wind direction in relation to the roadway and monitor, and
- Potential population exposure.

Selection per these criteria requires detailed information concerning the amount and type of traffic on the roadway, geographic variability of ambient pollutant concentrations in the near-road environment, meteorological conditions and population density. The EPA specifies the number of near-road sites and CBSAs requiring near-road sites in 40 CFR Part 58, Appendix D. The EPA also provides guidance on navigating the complex process of selecting geographic locations and types of near-road stations. The chief also considers the following factors in the sampling site selection process:

- **Economics -** The quantity of resources required to accomplish all data collection activities, including instrumentation, installation, maintenance, data retrieval, data analysis, QA, and data interpretation, must be established
- **Security -** In some cases, a preferred location may have associated problems that compromise the security of monitoring equipment (i.e., high risk of theft, vandalism, etc.). If such problems cannot be remedied using standard measures such as additional lighting, fencing, etc., then an attempt to locate the site as near to the preferred location as possible shall be made.
- **Logistics -** This process includes procurement, maintenance and transportation of material and personnel for the monitoring operation. The logistics process requires full knowledge of all aspects of the data collection operation: planning, reconnaissance, training, scheduling, safety, staffing, procuring goods and services, communications, and inventory management.
- **Atmospheric Considerations -** These considerations may include spatial and temporal variability of pollutants and their transport. Effects of buildings, terrain, and heat sources or sinks on air trajectories can produce localized anomalies of pollutant concentrations. The chief considered meteorology in determining the geographic location of the site as well as the height, direction, and extension of sampling probes. Evaluation of a local wind rose is essential to locate near-road monitoring sites properly.
- **Topography –** The chief completed an evaluation of the local topography based upon land use maps, U.S. Geological Survey topographic maps and other available resources. The chief also identified and evaluated minor and major topological features that influence both the transport and diffusion of air pollutants. Minor features may include an adjacent forested privately owned property or tall structures either upwind or downwind of the roadway, each of which may exert small influences on pollutant dispersion patterns. Major features include raised roadways, steep slopes and large lakes. Major features significantly influence the prevailing wind patterns or create their own local weather such as katabatic or anabatic winds.
- **Pollutant Considerations** – The monitoring site location for a specific pollutant may or may not be appropriate for another pollutant. The chief evaluated the changes that pollutants undergo temporally and spatially to determine the applicability of the near-road site for each specific pollutant.

An interdependence exists between all the factors listed above. Consequently, the chief employed an iterative procedure to select successfully appropriate sites that can provide the data necessary to

accomplish the stated objectives of this project. In situations where the sites do not specifically meet the requirements necessary to obtain the project objectives, reevaluation of the project priorities may be necessary before the final monitoring site selection. Experience in the operation of air quality measurement systems; estimates of air quality, field, and theoretical studies of air diffusion; and considerations of atmospheric chemistry and air pollution effects make up the required expertise needed to select the optimum sampling site for obtaining data necessary to fulfill the monitoring objectives. The Ambient Monitoring Section staff as well as other DAQ staff share these responsibilities amongst themselves.

10.2.2 Monitor Placement

General inlet siting criteria for monitors at the DAQ near-road site shall adhere to the requirements in 40 CFR Part 58, Appendix E. Final placement of a monitor at a selected site is dependent on physical obstructions and activities in the immediate area. The ECB electronics technicians must place monitors away from obstructions such as trees and fences to avoid their effects on airflow. To prevent sampling bias, airflow around monitor sampling probes must be representative of the general airflow in the area. In addition, the availability of utilities (i.e., electricity and telephone services) is critical.

10.3 Sampling Frequency

The EPA establishes the minimum sampling frequencies of the monitors. The DAQ follows the EPA's requirements for the sampling frequencies of monitors. The monitors used in the near-road monitoring project collect data continuously. The DAQ ensures each monitor acquires the minimum amount of data required for appropriate summary statistics. At least 75 percent of the total possible observations must be present before summary statistics are calculated. The exact requirements appear in 40 CFR 50.8, 40 CFR Part 50, Appendices N and S and in Table 10.1. Table 10.2 and 40 CFR Section 58.12 provides the sampling schedule and frequency for each near-road method.

TABLE 10.1 REQUIREMENTS FOR CALCULATING SUMMARY STATISTICS

Pollutant	Completeness Requirement	Time Frame
NO_2 (Including NO and NO_x)	75 percent	Per hour, day, days per quarter and hours per year and quarter
	4	Complete quarters per year
$PM_{2.5}$	75 percent	Hours per day and days per quarter
	4	Complete quarters per year
CO	75 percent	Per hour, 8-hour and quarter

TABLE 10.2 NEAR-ROAD SAMPLING SCHEDULE AND FREQUENCY

Pollutant	Time Frame	Frequency	Monitor Type
NO_2, NO and NO_x	Hourly (60 minutes/hour)	24 hours a day / 7 days a week	continuous
CO	Hourly (60 minutes/hour)	24 hours a day / 7 days a week	continuous
$PM_{2.5}$	Hourly	24 hours a day / 7 days a week	continuous
Shelter Temperature	Hourly (60 minutes/hour)	24 hours a day / 7 days a week	continuous
Traffic data	Hourly	24 hours a day / 7 days a week	continuous

10.4 Rationale for DAQ's Near-Road Monitoring Network

The primary rationale for the operation of the DAQ near-road monitoring network is to meet 40 CFR Part 58, Appendix D requirements, determine compliance with the NAAQS and provide the public with information on current air quality at a near-road environment.

11.0 Sampling Methods Requirements

11.1 Analyzer or Sensor Methodology

In accordance with 40 CFR Part 58, Appendix C, Section 2.1, a criteria pollutant monitoring method used for making NAAQS decisions at a SLAMS site must be a FRM or FEM. Towards that end, the DAQ uses only EPA-approved FRM or FEM instrumentation to measure criteria pollutants at the near-road site. Criteria pollutant analyzer methods that have received FRM or FEM status have been rigorously tested, in accordance with 40 CFR Part 53 requirements, and found to meet or be comparable to the EPA reference methods codified in 40 CFR Part 50, Appendices C, F and L. For the detailed specifications upon which a specific monitoring method has received its FRM or FEM status, see the List of Designated Reference and Equivalent Methods, issued by the ORD, which can be found on the Ambient Monitoring Technology Information Center, or AMTIC, website (https://www.epa.gov/amtic/air-monitoring-methods-criteria-pollutants). The DAQ will operate each analyzer in accordance with these designation specifications. To ensure the monitors meet these specifications, DAQ uses the criteria in the validation templates in Section 7.0 and will follow procedures set forth in the associated SOPs (see Table 11.2 of this QAPP). These data collection methods use real-time or near real-time, that is, continuous, data collection and analysis. As a result, the RRO monitoring technicians do not collect physical samples. The analyzers perform "in situ" analysis of the composition of the ambient air sample within the analyzer itself using a specific method. The following subsections describe the data collection methods used in the DAQ near-road monitoring network. DAQ maintains copies of manuals for the Thermo, API Teledyne and Met One instruments at the sites, at the regional offices and at the ECB facility.

Table 11.1 lists the specific analyzers and methods used. The methods for NO_2 and $PM_{2.5}$ are FEMs. The method for CO is an FRM. When the current monitors used in the network become obsolete, the ECB supervisor and electronics technicians in consultation with the chief, RCO chemists and regional monitoring staff will select a new monitor type to replace the existing monitor type used throughout the network. Rollout of the new monitor type will be coordinated by the chief with input from the ECB, RCO and regional monitoring staff.

TABLE 11.1 DAQ NEAR-ROAD MONITORING NETWORK ANALYZERS

Pollutant	Analyzer	AQS Method Code	EPA Reference or Equivalent Method
Nitrogen Dioxide	Teledyne-Advanced Pollution Instruments T200UP	200	EQNA-0512-200
Carbon Monoxide	Thermo Electron/ Thermo Environmental Instruments Model 48i TLE	554	RFCA-0981-054
$PM_{2.5}$ local conditions, continuous	Met One BAM 1022 (with PM_{10} head and VSCC)	209	EQPM-1013-209
Indoor Shelter Temperature	Comet Temperature Sensor Model T0310	013	No FRM or FEM
Traffic	EIS Electronic Integrated Systems Inc. traffic sensor	Not applicable	No FRM or FEM

11.1.1 Nitrogen Oxides (Chemiluminescence)

Nitrogen oxides (NO_x) is the sum of NO and NO_2. The measurement principle uses the reaction of a NO molecule with an internal source of ozone in an evacuated reaction cell that results in the emission of light. Single channel instruments divide the ambient air sample into two streams. The first stream passes the ambient air sample directly to the evacuated reaction cell. A reaction between the NO present in the ambient air sample and the analyzer-supplied ozone occurs. The detector in the analyzer monitors the resulting light emitted by the reaction and the software in the monitor correlates it to the concentration of NO in the ambient air.

The second stream of ambient air sample gas passes through a converter. For NO_x, a photolytic converter selectively reduces the NO_2 to NO. This second stream, now containing NO from both the reduction of NO_2 and the original NO, cycles through the evacuated reaction cell where the new augmented concentration of NO is measured. The measurement of the untreated ambient air sample provides a NO concentration, while the measurement of the converted ambient air sample provides a measurement of the NO_x concentration. Subtracting the NO concentration from the NO_x concentration yields the NO_2 concentration.

11.1.2 Particulate Matter (Continuous Operation, BAM 1022)

A BAM is composed of sensing and control units. At the heart of the sensing unit is the carbon 14 beta radiation source and glass-fiber filter tape, which combine in a measurement technique for making near-real-time direct measurement of particle mass collected on the filter tape. This measuring equipment can determine the fine changes in mass that accumulate on the filter tape as a constant stream of air passes through it.

The Met One Instruments Model BAM 1022 Continuous PM Monitoring System uses the principle of beta ray attenuation to accurately measure and report the concentration of airborne PM in ambient air at local conditions of temperature and atmospheric pressure. The centerpiece of the measurement system is a small, carbon 14 source that emits a consistent supply of electrons, in the energy of the Beta spectrum to the mass to be measured, and a sensitive detector that counts the incident electrons. A vacuum pump draws air, at a rate of 16.67 liters per minute (LPM), through a size selective inlet, down the inlet tube, and deposits the airborne PM on a filter tape that is located between the beta source and detector. The accumulation of mass onto the filter tape increasingly attenuates beta ray transmission through the media. The detector continuously monitors the beta attenuation through the filter tape throughout the measurement cycle. The software in the monitor uses the degree of beta ray attenuation to determine the mass of PM deposited on the filter tape. During sampling, the BAM control unit precisely controls the flow rate. Having determined both mass and sample volume, the BAM 1022 calculates and reports the ambient PM concentration, expressed as µg/m3 or milligrams per cubic meter.

11.1.3 Carbon Monoxide (Trace Level Nondispersive Infrared Analyzer)

The trace-level nondispersive infrared, or IR, analyzer uses the absorption of IR radiation to detect and measure CO. The analyzer generates broadband IR radiation using a high-energy heated element. The IR radiation is modulated using gas filter correlation technology. Gas filter correlation uses a rotating wheel containing two gas-filled cells that selectively modulate the IR radiation. One cell contains nitrogen (the

measure cell), while the other contains CO (the reference cell). This configuration modulates the IR radiation into reference and measure pulses.

During the reference pulse, the CO in the gas filter wheel effectively strips the beam of all IR energy at wavelengths susceptible to CO absorption, resulting in a beam that is unaffected by any CO in the sample cell being evaluated.

During the measure pulse, the nitrogen in the filter wheel does not affect the IR radiation beam. The CO subsequently absorbs the IR radiation in the sample cell. The attenuation of the IR radiation is directly proportional to the quantity of CO present in the evaluated sample.

The IR beam enters the multi-pass sample cell after the gas filter wheel. This sample cell uses folding optics to extend the absorption path through the sample, which causes the reference and measure beams to pass multiple times through the sample in the cell. The length of the absorption path directly relates to the sensitivity of the instrument in measuring CO concentrations.

Upon exiting the sample cell, the beam passes through a band-pass interference filter to limit the light to the wavelength of interest. Finally, the beam strikes a thermoelectrically cooled, solid-state photoconductor. This solid-state device, coupled with its support circuitry, amplifies the signal generated by the modulated IR radiation beam, and outputs a modulated voltage. This voltage is de-modulated resulting in two voltage signals associated with the reference and measurement pulses. The ratio of the de-modulated voltage signals is indirectly proportional to the concentration of CO in the evaluated sample.

11.1.4 Indoor Shelter Temperature

The DAQ measures shelter temperature using a Comet temperature transmitter. The sensor measures temperature in the range of - 30 to + 80 °C with an accuracy of ± 0.4 °C and resolution of 0.1 °C. The DAQ collects shelter temperature measurements every minute. The DAQ collects backup temperature measurements using a HOBO data logger and temperature sensor. The RRO monitoring technician downloads data from the HOBO at least once a month and archives the data. The data verifiers and validators only use the HOBO data when the Comet data are unavailable.

11.1.5 Traffic

The DAQ obtains traffic data collected at the site from the DOT. The DOT uses an EIS Electronic Integrated Systems Inc. RTMS (Remote Traffic Microwave Sensor) Model X3 traffic sensor. According to DOT, the sensor is mounted on a roadside pole, aimed perpendicular to the lanes. The RTMS receives reflected signals from all surfaces within its beam. Vehicles are detected when their reflected signal comes back. The signals reflected depend on the time the signal is detected. The longer the time takes to detect the signals the further away the vehicles are (Lane 1 to 8). The sensor will calculate the lane, speed and length on each vehicle that passes through the sensor. The RCO chemists request traffic data from the DOT on a monthly basis and archive the data in IBEAM.

11.2 Data Collection Methodology

Table 11.2 lists the specific SOP titles used in the network.

TABLE 11.2 LIST OF SOPS ASSOCIATED WITH THIS QUALITY ASSURANCE PROJECT PLAN

Calibration of the Dwyer and SPER Manometers, Revision 2020, February 18, 2020
Section 2.17.1 Teledyne Model T200UP Nitrogen Dioxide Monitoring System SOPs for the Electronics and Calibration Branch, Revision 1.1, April 22, 2016
Section 2.17.2 Model T200UP Nitrogen Dioxide Monitoring System SOPs for Operators, Revision 1.1, Nov. 15, 2016 *
Section 2.36.1 Thermo Environmental 48i Trace Level Carbon Monoxide SOPs for the Electronics and Calibration Branch, Revision 10.7, April 21, 2016
Section 2.39.4 SOP for Quarterly Completeness Data Review, Revision 1.0, June 12, 2020
Section 2.43.2 SOP for Completing the Annual Network Review for DAQ, Revision 2, Sep. 29, 2017
Section 2.46.2 Met One BAM 1022 Standard Procedures for Operators, Revision 2020, Dec. 3, 2019
Section 2.49.2 BGI TetraCal Standard Procedures for Operators, Revision 2020, Dec. 16, 2019
Section 2.63.4 Standard Operating Procedures for Validation of Particulate Matter, Revision 0.0, Aug. 15, 2020
DAQ-04-001.2 Thermo Environmental Model 48*i* Trace Level Carbon Monoxide Monitoring System Operator Responsibilities, Revision 7.0, April 1, 2022 (*previously Section 2.36.2*)
DAQ-05-001.5 Ambient Monitoring Section Database Manager Standard Operating Procedure, Version 0.0, March 5, 2021
DAQ-13-001.1 Standard Operating Procedure (SOP) for the BGI TetraCal Flow Transfer Standards ECB Responsibilities, Revision 0.0, May 7, 2021
DAQ-13-002.1 Standard Operating Procedure (SOP) for the DryWell 3101 Temperature Generator, ECB RESPONSIBILITIES, Revision 0, May 5, 2021
DAQ-13-006.1 Standard Operating Procedure for Field Barometer Certification, Electronics and Calibration Branch Responsibilities, Revision 0, Sept. 20, 2022
DAQ-13-007.1 Teledyne-API Model T700U Calibrator Certification / Verification, Revision 2.0, June 3, 2022
DAQ-14-001 SOP for Preparing SOPs for the DAQ, Revision 2.0, May 21, 2021
DAQ-14-002.5 Quality Assurance Project Plan And Standard Operating Procedure Tracking Database Procedure, Revision 0, Dec. 1, 2020
DAQ-14-003 Document Retention Procedure, Revision 1, Nov. 1, 2022
DAQ-15-001.1 Verification of Ambient Monitoring Thermometers, Version 0.0, Nov. 13, 2020
DAQ-15-002 North Carolina Division of Air Quality Corrective Action Process, OPERATOR RESPONSIBILITIES, Revision 0, Dec. 1, 2021
DAQ-15-003.5 Procedure for Training Ambient Monitoring Staff and Documenting and Tracking Training, Version 0.0 **
DAQ-15-004.5 PAMS Shakedown Audits and TSA's**
DAQ-15-005.5 Data Validation for Continuous Gaseous Monitors and Meteorological Data, RCO Responsibilities, Revision 2.0, May 1, 2022

** SOP is in the process of being revised*
***SOP is being drafted at this time*

Electronic data collection is possible for the continuous monitors through the network's data acquisition system, or DAS, which is currently Envidas Ultimate, and wireless modems. This equipment is in a shelter where the DAS records the data history, and the modem provides a path to download the data for analysis. The database manager configures the computers in the state's RCO, managed by DIT, to connect automatically to the station at least hourly to retrieve these data for analysis. Monitoring personnel can contact the station manually to retrieve data or determine the status of the systems. The Envista ARM data software sends all data automatically to AirNow-Tech and the IBEAM database for real-time reporting of ambient concentrations and the AQI to the public via EPA's AirNow-Tech website and the DEQ real-time web page

11.3 Support Facilities

This subsection describes the monitoring shelters used in the DAQ near-road monitoring network.

11.3.1 Monitoring Station Design

The monitoring station design must encompass the operational needs of the equipment, provide an environment that supports sample integrity and allow the RRO monitoring technicians, who operate the site, to safely and easily service and maintain the equipment. The chief considers winter and hurricane weather conditions during site selection to meet the station safety and serviceability requirements.

11.3.2 Shelter Criteria

The ECB electronics technicians house air pollution analyzers in a shelter capable of fulfilling the following requirements:

- The RRO monitoring technicians must maintain the shelter temperature at a temperature that meets the reference or equivalency method requirements for all instrumentation that it contains;
- The shelter power supply should not vary more than ±10 percent from 117 alternating current voltage. The ORD contractors or ECB electronics technicians should provide some type of voltage regulation to accomplish this, if needed;
- The shelter must protect the instrumentation from precipitation and excessive dust and dirt, provide third wire grounding as in modern electrical codes and meet federal Occupational Safety and Health Administration regulations;
- The RRO monitoring technician must clean the shelter regularly to prevent a buildup of dust; and
- The shelter must protect the instrumentation from any environmental stress such as vibration, corrosive chemicals, intense light or radiation.

At the Triple Oak near-road site, the DAQ uses an Ecotech shelter, supplied by the EPA, to shelter the CO and NO_2 monitors and their supporting equipment. The Ecotech shelter has roof access, so the DAQ placed the $PM_{2.5}$ monitor on the roof. The BAM 1022 $PM_{2.5}$ monitor, which operates unprotected from ambient conditions, has no need for a shelter capable of fulfilling the above requirements.

The ECB electronics technicians use insulated heat-tape wrapped single sample lines to provide ambient air to the CO and NO_2 monitors. In addition, the ECB electronics technicians attach the probe lines to a PM filter to prevent contaminants from entering the analyzer. They typically locate the filter within the protected shelter, between the probe inlet and the analyzer. The analyzers are calibrated through the PM filter and the 1-point QC checks also enter the analyzer via the PM filter. The analyzer draws sample from the probe inlet. The probe material must be either borosilicate glass or an acceptable inert plastic, such as polytetrafluoroethylene, perfluoroalkoxy (PFA), or other Teflon™-type materials.

The ECB electronics technicians use Teflon™ probe lines to ensure the probe material is non-reactive with NO_2. The probe, intake vent and interconnecting tubing design must provide a minimum number of bends to avoid particles hitting and adhering to the surfaces. Impacted particles may provide surfaces to which NO_2 may adsorb or, if the impacted particle is metallic, catalyze to a non-criteria species. Additionally, the ECB electronics technicians use part of a Teflon™ filter holder on the end of the probe to prevent rainwater from entering the gaseous analyzers. Any liquid water will absorb pollutants, influencing the NO_2 concentration by removing it from the sample, and consequently, yielding inaccurate environmental data.

Residence time is defined as the amount of time it takes for a sample of air to travel from the opening of the probe inlet to the inlet of the instrument. The residence time in the probe must be less than 20 seconds. Although CO is not a reactive gas DAQ's goal is to meet the less than 20 seconds residence time for the CO monitor. The RRO monitoring technician evaluates the residence time at every site visit and documents it in the e-log. If the physical configuration of the probe restricts the flow such that the probe configuration cannot meet the residence time, then the ECB electronics technicians modify the physical configuration to fix this deficiency. They may accomplish this by reducing the length of interconnecting tubing, using tubing with a smaller inner diameter, and/or decreasing the bends in the tubing between the probe and analyzer, or other alterations that allow the system to meet the residence time requirements.

The ECB electronics technicians replace all probe sample lines at least once every two years or as needed when the line is damaged or contaminated. Based on years of monitoring experience and evaluation of the data, DAQ has not observed any problems with probe lines between one and two years except in situations where other problems occurred. Issues that cause probe problems include the monitor pulling rain or other precipitation into the probe, insects getting into the probe or a cold spot developing along the probe that causes condensate to form in the probe.

12.0 Sample Handling and Custody

The near-road monitoring program does not require the RRO regional monitoring technician to take any samples that would warrant a sample custody procedure. The instrumentation located at the near-road monitoring station directly analyzes all ambient air samples.

13.0 Analytical Methods

The near-road monitoring program does not use any laboratory analytical methodologies to complete the analysis of any NO_2, CO or $PM_{2.5}$ samples. The respective operation manuals provide specifics on the NO_2, CO and $PM_{2.5}$ monitor's analytics. Section 11.1 Analyzer or Sensor Methodology provides a summary of the operation principles used for each monitor.

14.0 Quality Control Requirements and Procedures

The DAQ must perform two distinct and important interrelated functions to assure the quality of data from air monitoring measurements. One function is the control of the measurement process through broad QA activities, such as establishing policies and procedures, developing DQOs, assigning roles and responsibilities, conducting oversight and reviews and implementing corrective actions. The other function is the control of the measurement process through the implementation of specific QC procedures, such as audits, calibrations, checks, replicates, routine self-assessments, etc.

Quality control is the overall system of technical activities that measure the attributes and performance of a process, item or service against defined standards to verify they meet the stated requirements established by the end user. For the near-road monitoring network, the DAQ uses QC activities to ensure DAQ maintains measurement uncertainty, as discussed in Section 7 Quality Objectives and Criteria for Measurement Data, within acceptance criteria for the attainment of the DQOs. The SOPs (see Table 11.2) and the specific instruments' operation manuals provide lists of pertinent QC checks.

The DAQ achieves QC through:

- Daily automated calibration checks, consisting of a zero, span and 1-point-QC check;
- Daily review of instrument measurements;
- Annual, or as needed, multipoint calibrations;
- Verifications following calibration of CO monitors;
- Verifications within 182 days of the most recent calibration for CO and NO_2 monitors;
- Monthly operational checks by the RRO monitoring technician;
- Performance evaluations;
- Periodic maintenance;
- Flow rate audits;
- Acceptance test procedures;
- Accuracy, bias, and precision checks, including collocated instruments in the PQAO;
- Control charts; and
- Other verification techniques.

Data analyzed from monitors in the DAQ near-road network do not undergo routine post-processing to correct for zero and span drift. In the sections that follow, the RCO chemists embedded the calculations for the following QC procedures in e-log books. The RRO monitoring and ECB electronics technicians do not compute any calculations by hand. The RCO chemists derived the formulas from relevant sections of 40 CFR Part 58 and appendices to 40 CFR Part 50. Tables 7.2 thru 7.4 provide specific QC procedures and associated acceptance criteria.

14.1 Calibrations

Adjusted calibration, which DAQ calls calibration, is the process used to verify and rectify an instrument's measurements to minimize deviation from a standard. This multiphase process begins with certifying a calibration or transfer standard against an authoritative standard, such as a NIST-traceable standard. The RRO monitoring technician compares the instrument's measurements to this calibration or

transfer standard. If significant deviations, as described in Tables 7.2 thru 7.4, exist between the instrument's measurements and the calibration/transfer standard's measurements, the RRO monitoring technician adjusts the instrument's response to rectify the analytical instrument's measurements.

SOPs 2.17.2, DAQ-04-001.2, 2.46.2, and the specific instruments' operations manuals provide calibration requirements for the critical field equipment. For the PM monitors, the operator adjusts flow rate during a calibration, upon installation, after a failed verification, after major maintenance, and annually.

The design (desired) flowrate of low-volume particle samplers is 16.67 LPM which is equivalent to 1 cubic meter per hour. The measurement principle separates particles by size and then collects them onto a specified sample medium (e.g., filter tape). Therefore, the flow rate is set higher than human air intake (normally 0.5 LPM) to collect a quantity of PM that is sufficient for a reliable and repeatable measurement. One benefit of such a comparatively high flow rate is that it minimizes diffusion losses of the smallest particles and allows for a sharp cut-off curve at the upper limit for coarse particles.

Calibration of the sampler's flow rate measurement device must consist of at least three separate flow rate measurements (a multi-point calibration). For the BAM 1022, the set points for a flow calibration are 14.0, 16.7, and 17.5 LPM (See Section 6.4 on pages 50-51 of the BAM 1022 9805 Revision F operations manual). The sampler's flow control system shall allow for operator adjustment of the operational flow rate of the sampler over a range of at least ±15 percent of the targeted flow rate (40 CFR Part 50, Appendix L, Section 7.4.2).

After the RRO monitoring technician has adjusted the flow rate, the operator performs a post-calibration verification of the flow rate to ensure the calibration is successful. Using a certified FTS, flow rate is measured and a comparison between the known (transfer standard) and the measured (sampler) is calculated using percent difference. This calibration verification must be within 2 percent for the calibration to be successful.

To calibrate the gaseous analyzers within the near-road network, the DAQ uses a gas dilution system to generate specific upscale calibration points. The ECB electronics technicians established the calibration scales for the CO and NO_2 monitors based on the highest average minute concentrations expected to occur at the site. In Table 14.1 below, the zero and span represent the calibration scale. The RRO monitoring technicians perform calibrations at installation, when the 1-point-QC check fails, when the monitor is without power for 72 hours, after major maintenance and annually. For the CO and NO_2 analyzers, the DAQ follows the calibration frequencies in the QA Handbook.

According to the Principles of Operation on pages 1 and 2 of the Thermo 48i manual, the Model 48*i* Trace Level-Enhanced (TLE) monitor operates on the principle that CO absorbs infrared radiation at a wavelength of 4.6 microns. Because infrared absorption is a non-linear measurement technique, it is necessary to transform the basic analyzer signal into a linear output. To accomplish this, the RRO monitoring technician adjusts the zero and three upscale points during a calibration. The Model 48*i* TLE monitor uses an internally stored calibration curve based on the zero and three upscale points to accurately linearize the instrument output up to a concentration of 4000 ppb at the near road site.

For the NO_2 monitor, the ozone generated as part of the photolytic process back titrates the converted NO. This phenomenon is non-linear and leads to a situation where the calculated converter efficiency (CE) value is less at higher concentrations of NO_2. The software allows calibration of the CE value at two NO_2

concentration points, A and B. Thereafter, the software corrects the measured NO_2 concentration based on a calculated slope and offset. Concentration values entered for the B parameter are higher than those entered for A. Thus, the RRO monitoring technician adjusts the zero and two upscale points during a calibration. In addition, the regional monitoring technician does a two-point gas-phase titration to confirm the linearity of the photolytic converter of the NO_2 monitor. These adjusted points and gas-phase titration points have tight acceptance ranges, between which the analyzers' measured values must fall. For both the CO and NO_2 monitors, manual performance checks are used as a bracketing point before calibrations and extended planned monitor inactivity (such as shutting a site down due to a hurricane).

After the RRO monitoring technicians calibrate the monitors, they verify the calibration by repeating the points and doing additional points. SOP 2.17.2 (under revision to include verifying the calibration of the monitor), DAQ-04-001.2, and the instruments' operation manuals provide specific calibration requirements for the NO_2 and CO analyzers. Table 14.1 shows a summary of calibration requirements as well as QC requirements, which the next section will discuss in detail.

TABLE 14.1 ACCEPTANCE CRITERIA FOR CALIBRATIONS OR VERIFICATIONS AND 1-POINT-QC CHECKS

Nitrogen Dioxide (NO_2) Nitric Oxide (NO) and Oxides of Nitrogen (NO_x) Channels					
Operation	Concentration / Acceptance Criteria	Span			
		Zero	Span	Precision	Mid-Range
1-Point-QC Check (1/14 days)	Concentration (ppb)	0	425	60	Not applicable
	Acceptance (±)	1 ppb	10 percent	10 percent	
Calibration	Concentration (ppb)	0	425	60	
	Acceptance (±)	1 ppb	3 percent	5 percent	
Carbon Monoxide (CO)					
Operation	Concentration / Acceptance Criteria	Span			
		Zero	Span	Precision	Mid-Range
1-Point-QC Check (1/14 days)	Concentration (ppb)	0	4000	500	2000
	Acceptance (±)	40 ppb	5 percent (200 ppb)	7 percent (35 ppb)	5 percent (100 ppb)
Multi-point Verification	Concentration (ppb)	0	4000	3000	2000 1000
	Acceptance (±)	All points < ± 2.1% or ≤± 30 ppb difference of the best-fit straight line generated during a multi-point verification, whichever is greater. The slope of the best-fit straight line should be 1 ± 0.05.			

Currently, for NO_2, the DAQ calibration criteria differ from the EPA criteria of the slope being 1 ± 0.05 and each point being within 2 percent of the best-fit line. Also, for NO_2, the DAQ calibrations do not use four upscale points as recommended by the EPA or required by some of the appendices in 40 CFR Part 50. For NO_2, the DAQ uses zero and two upscale points for the NO and NO_x calibration and does two gas-phase titrations to calibrate the NO_2 channel as described in the instrument manual. The DAQ is currently reviewing and revising these procedures. The chief will submit QAPP revisions to LSASD for approval after the RCO chemists and ECB electronics technicians develop these new procedures.

14.2 Precision Checks

Precision is the measure of agreement among individual measurements of the same property, usually under prescribed similar conditions. To meet the DQOs for precision, DAQ will ensure the entire measurement process is within statistical control and will employ various tools to evaluate and monitor precision measurements. For the gaseous monitors, to measure precision the RRO monitoring technician challenges the instrument with a manual 1-point-QC check at least every 14 days to provide evidence of deviations from the required precision measurement as described in 40 CFR, Part 58, Appendix A, Section 3. SOPs 2.17.2 and DAQ-04-001.2, the specific instruments' operations manuals and Table 14.1 provide the 1-point-QC check and precision requirements for the NO_2 and CO analyzers. Precision calculations follow the procedures described in 40 CFR, Part 58, Appendix A, Section 4. For PM monitoring, viewing data integrity with control charts will provide evidence of deviations from the required precision measurement. A check may be invalid due to a problem with the calibrator or zero air system, a bad solenoid, or a problem with the monitor. The SOPs and instrument operations manual provides 1-point QC checks and precision requirements for the CO and NO2 monitors.

14.2.1 One-Point QC Checks

Pursuant to 40 CFR Part 58, Appendix A, Section 3.1.1, a one-point QC check or auto-precision/zero/ span or PZS must be performed at least once every 2 weeks on each continuous analyzer used to measure the gaseous criteria pollutants. The RRO monitoring technicians make the QC check by challenging the trace-level analyzer with a QC check gas of a known concentration that is representative of the mean or median concentrations at the site. At DAQ's near-road site the QC check gas concentration must be between the prescribed range of 5 and 80 ppb for NO_2 and between 0.5 and 5 parts per million (ppm) for CO, per 40 CFR Part 58, Appendix A. The near-road air-monitoring network performs both automated and manual checks. While the RRO monitoring technicians perform manual checks or one-point quality control checks every 14 days for CO and NO_2, they typically refer to the automated check as either an "auto-ZPS" or "PZS", which are terms used in the statewide instrument SOPs. Automated checks must include a precision measurement but also include the span and zero. For each check, Envista ARM calculates a percent difference (or absolute difference for the zero check), the results of which the RRO monitoring technicians compare to the acceptance criteria established in Tables 7.2 and 7.3, and as specified in the SOPs. Table 14.1 summarizes this information.

For the CO and NO_2 monitors, DAQ performs a nightly "diagnostic auto–ZPS" or "PZS." For these PZS checks, Envista ARM calculates the percent difference for each point; each point (or absolute difference for the zero check) must be within the specifications in Tables 7.2 and 7.3 for the check to pass. Due to the limitations of the current version of software being used to collect PZS data for the CO and NO2 monitors, the DAQ considers these checks diagnostic and does not report them to AQS. DAQ is working with the software provider to resolve the issues at which time the automated nightly PZS may be reported to AQS. Until such time, manual QC checks are performed at least every 14 days by the regional monitoring technician. The manual checks include a zero, precision and span point and are reported to AQS. The regulations at 40 CFR Part 58, Appendix A, Section 4.1.1 provides the calculation for the precision measurement (i.e., percent difference). The RCO chemists have embedded this calculation in the e-logs used by the RRO monitoring technicians. Precision checks (1-point-QC and PZSs) verify (confirm) the analyzer is in good working order, and, therefore, support the defensibility of the data.

The RRO monitoring technicians must perform a calibration if the 1-point-QC check or PZS fails, and they find the instrument to be in good working order. Normally if either check fails, a problem exists within the monitoring system that needs addressing (i.e., results in equipment maintenance and/or repair). If the zero check or span check exceed the specifications in Tables 7.2 and 7.3, then the monitoring technician will do a calibration after the equipment failure is diagnosed, repaired, and the instrument is cleared for normal operation.

However, if a typical slow drift causes the check to fail, no routine maintenance may be necessary – it simply indicates it is time to recalibrate the analyzer. The DAQ staff do not adjust ambient concentration data to correct for zero drift. However, the CO monitor automatically corrects for zero drift in the monitor at a set period. A failure at the zero or span points will require investigation and if deemed appropriate (based on a weight-of-evidence approach), the data will be invalidated based on the failed check.

14.2.2 Collocated Monitoring

In accordance with 40 CFR Part 58, Appendix A, Section 3.2.3, DAQ operates collocated $PM_{2.5}$ monitors within its $PM_{2.5}$ air monitoring network. Although collocated monitoring frequency is only required on a 1-in-12-day frequency, DAQ has set a goal to complete collocated monitoring on at least a one-in-six-day frequency. For a collocated data pair to be considered valid for the precision estimate, both monitors must report a concentration of at least 3 µg/m3. The acceptance criterium for individual collocated sample pairs is less than plus or minus 10.1 percent. A collocated monitor is not operated at the near road site because the required collocated monitors for the BAM 1022 are operated elsewhere within the DAQ's $PM_{2.5}$ air monitoring network. For network details, see the network plan.

14.2.3 Flow Rate Verifications

In accordance with 40 CFR Part 58, Appendix A, Section 3.2, the RRO monitoring technician must perform a one-point flow rate verification check at least once every month on each sampler used to measure $PM_{2.5}$. DAQ has set a goal to complete these verifications every 14-18 days, except during audit months. The RRO monitoring technician makes the verification by checking the operational flow rate of the sampler. If the RRO monitoring technician makes the verification in conjunction with a flow rate adjustment or calibration, the technician must complete the verification before making the adjustment. The technician compares the flow rate reported by the transfer standard to the flow rate measured by the sampler. The technician calculates percent difference for the two readings and compares the results to the acceptance criteria in Table 7.4 and SOP 2.46.2 using the calculations embedded in the e-log. The technician also calculates percent difference between the design flow rate of the sampler (i.e., 16.67 LPM) and the flow rate measured by the transfer standard during the check for $PM_{2.5}$ using the calculations embedded in the e-log. These QC checks verify (confirm) the PM sampler is in good working order and, therefore, support the defensibility of the data.

14.3 Accuracy or Bias Checks

The EPA defines accuracy as the degree of agreement between an observed value and an accepted reference value. Accuracy is a combination of random error (precision), and systematic error (bias). For the $PM_{2.5}$ monitor, percent difference measurements, obtained during flow rate verifications, are used to assess the bias in lieu of concentrations, as described in 40 CFR Part 58, Appendix A, Section 4. The ZPS checks can also provide data capable of identifying bias for gaseous monitors.

The DAQ currently monitors data integrity with control charts to provide evidence of deviations from the required precision measurement. Accuracy and bias requirements for the applicable instrumentation are found in the SOPs 2.17.2, DAQ-04-001.2 and 2.46.2 and in the specific instruments' operations manuals. Bias calculations follow the procedures described in 40 CFR Part 58, Appendix A, Sections 4.1.3 and 4.2.2.

14.3.1 Annual Performance Evaluations

For the gaseous instruments, ECB electronics technicians will perform an annual performance evaluation at least every 365 days and once per calendar year and whenever requested by the chief. The ECB electronics technicians perform these evaluations by comparing the analyzer measurements to independent standards or references. The ECB electronics technicians determine the audit concentrations following requirements in 40 CFR Part 58, Appendix A, Section 3.1.2.1. The audit concentrations selected for evaluation include a value at or near the detection limit of the monitor, a value near the level of the primary NAAQS, and a value that is less than the 99th percentile of the data within the network. The ECB electronics technician uses a different gas cylinder and calibrator to complete the audit than the gas cylinder and calibrator used to calibrate the monitor and complete the biweekly QC checks. However, the ECB may reference both the calibration standard and the audit standard to the same primary standard. The DAQ designates the ECB electronics technicians, who are not normally involved in the routine operational activities of the NO_2 and CO monitors, to do the annual performance evaluations using dedicated QA equipment. The applicable instruments' operations manuals and SOPs 2.17.1 and 2.36.1 (see Table 11.2 for SOP titles) provide details for implementing annual performance evaluations. The EPA has designed these checks to access the accuracy and measure the bias.

14.3.2 Flow Rate Audits

For the $PM_{2.5}$ instrument, a RRO monitoring technician other than the regular operator must perform a flow rate audit at least every 6 months and preferably every quarter. The auditor completes the audit by measuring the analyzer's normal operating flow rate using a certified flow-rate transfer standard. The flow rate standard used for auditing must not be the same flow rate standard used to calibrate the analyzer. However, the ECB may reference both the calibration standard and the audit standard to the same primary flow rate or volume standard. The applicable instruments' operations manuals and SOP 2.46.2 provides details for implementing flow audits. The RRO monitoring technician uses the calculations embedded in the e-log to determine the percent differences. See Table 14.2 for example corrective actions for failed flow rate audits.

14.3.3 External Agency Audits

The DAQ participates in the EPA PEP and NPAP. Information on the PEP and NPAP is available here. See Table 6.1 and Tables 7.2 – 7.4 for information regarding the frequencies and acceptance criteria related to PEP and NPAP audits. The DAQ also participates in the EPA Ambient Air Protocol Gas Verification Program. Information on the EPA's Ambient Air Protocol Gas Verification Program is available at https://www.epa.gov/amtic/ambient-air-protocol-gas-verification-program.

14.4 Reference Membrane Span Foil Verification

For the BAM 1022 instruments, the operator must perform a reference-membrane span foil verification every 90 days. See SOP 2.46.2 for additional details. The reference-membrane span foil verification monitors the stability and performance of the beta counter. If the verification fails, the operator will call the ECB to have the BAM 1022 replaced.

14.5 BAM Background Tests

The operator must perform a zero-background test on the BAM 1022, after the initial installation and calibration as soon as the weather conditions meet the minimum weather requirements: 72 hours of clear weather with no precipitation forecasted. The ECB electronics technicians may also perform a zero-background test indoors before they install the monitor: there are no weather requirements in this circumstance, yet use of the smart heater is still required. This test corrects the background value to compensate for minor variations caused by local conditions such as grounding and shelter characteristics. The RRO monitoring technicians will perform subsequent background tests on an annual basis in early spring (March/April/May) or fall (September/October/November) when dew points are generally at a low point. The test collects data for 72 consecutive hours having the PM_{10} and $PM_{2.5}$ inlets replaced with a high-efficiency particulate air filter (BX-302) on a flow audit adapter. At the end of a completed 72-hour period, the RRO monitoring technician must download the data and statistically analyze it using a spreadsheet template. After the new background value has been calculated and compared with the factory zero, the DAQ procedures recommend that the person performing the background test audit the new coefficient for 24 hours prior to installing the monitor or resuming normal data collection; especially if the BAM is close to failing the background test. See Table 7.4 for the acceptance criteria. If a failing test occurs, repeat the test in another window of suitable weather. If the unit fails to pass, call ECB and the RCO PM Chemist. See SOP 2.46.2 for additional information regarding this procedure.

14.6 Corrective Actions

All DAQ personnel take corrective action measures as needed to ensure DAQ attains the MQOs. Given the diversity of monitoring activities and complexity of the instruments, a potential exists for issues to arise with analytical measurement systems. In the near-road monitoring network, the DAQ has anticipated several issues in advance to prepare and equip the staff to address the issues as they arise.

However, the staff will encounter unexpected or unforeseen circumstances, such as a failed QA/QC check, so they will also need to implement corrective actions on an "as-necessary" basis. The DAQ SOPs in Table 11.2 contain examples of corrective actions that the staff may need to complete under certain circumstances. The RRO monitoring technicians should consult SOPs 2.17.2, DAQ-04-001.2 and 2.46.2 for technique-specific checks, required frequency of checks, acceptance criteria and additional corrective action guidance. Table 14.2 is an abridged list for typical problems that require corrective action. According to DAQ policy the RRO monitoring and ECB electronics technicians and RCO chemists must report the need for corrective actions to the RRO monitoring coordinator or appropriate supervisor within two business days and address the issue as soon as possible, ideally within five business days. The RRO monitoring and ECB electronics technicians and RCO chemists can resolve most problems within one or two business days, but occasionally it takes longer to identify what caused the problem and find a solution. When equipment is down, staff must work to repair the problem as quickly as possible to limit the amount of data loss.

TABLE 14.2 CORRECTIVE ACTIONS

Activity	Problem	Likely Actions
QA/QC Check	Out of specification; flow rate check or failed flow rate audit exceeds acceptance criteria	1) Verify / reproduce performance check findings (e.g., Zero, Span and Precision). Use an alternate transfer standard to confirm failures. 2) Perform alternate performance checks to determine cause (for example – leak tests to aid in flow rate issues). 3) Recalibrate the monitor using SOPs. 4) Identify any required procedural changes to prevent reoccurrence. 5) Document actions on audit worksheet, e-log, or site logbook as appropriate. 6) For CO and NO_2 monitors, replace the solenoid and send the old solenoid to ECB for testing. 7) Notify the chief of performance audit failures as soon as practical.
Probe Line Integrity Check	Probe wet or contaminated	1) Verify probe inlet is intact and protectors from rain, insects and dirt are in place. 2) Check line for cold spots and bends or low points where water could accumulate. 3) Blow line out with zero air and dry for several hours if needed. 4) Document cause and any actions in the e-log or site logbook as appropriate.
Power	Loss or interruptions	1) Verify power supply integrity. 2) Verify circuit breaker and fuse integrity. 3) Document cause and actions taken in the e-log or site logbook as appropriate.
Annual Performance Evaluation	Out of specification	1) Verify integrity of the audit equipment. 2) If a problem exists with the audit equipment, repair the equipment and repeat the audit. 3) If the audit equipment is good, verify the monitor is operating correctly and if problems exist, fix them. 4) If no problems exist with the audit equipment or monitor, notify the operator so the operator can recalibrate the monitor. 5) Document cause and actions taken on the audit datasheet or site logbook as appropriate.
Data Review	Data missing from data acquisition system (DAS)	1) Verify DAS operation. 2) Ensure monitor polling is current. 3) Isolate telecommunications problem by connecting to the monitor using alternate processes. 4) Verify monitor operations remotely. 5) Notify the database manager or ECB, as appropriate. 6) Perform site visit to resolve monitor or telecommunication issues.

14.7 Documentation

The RRO monitoring technicians will document all events including routine site visits, calibrations and analyzer maintenance in e-logs or site logbooks. The ECB electronics technicians will document all events including site visits, annual performance evaluations, equipment installs and removals and monitoring and calibration equipment maintenance on 109 forms and in site logbooks. The ECB electronics technicians will also record field maintenance activities associated with equipment used by the

RRO monitoring technicians in dedicated instrument logbooks as well, which are stored at the ECB. The records generated by the RRO monitoring technicians or at the monitoring site will normally be controlled by the RRO monitoring coordinator and located in the field site when in use or at the regional office when being reviewed or used for data verification. The coordinator transfers these records to the RCO group drive for RCO chemists to use to validate the data.

15.0 Equipment Testing, Inspection, and Maintenance Requirements

15.1 Purpose/Background

Preventative maintenance is a foundational element to an effective QA program. The ECB in the Maywood facility houses the maintenance and repair shop, referred to as the "shop," for off-site repair, maintenance, and field-readiness certification of equipment. This section discusses the procedures RRO monitoring, and ECB electronics technicians use to maintain all instruments and equipment, including spare analyzers, in sound operating condition and verify they can operate at acceptable performance levels. Refer to the instrument-specific SOPs (SOPs 2.17.2, DAQ-04-001.2 and 2.46.2) listed in Table 11.2 for more details on the specific preventative maintenance and repair activities. The RRO monitoring and ECB electronics technicians must document and file all instrument inspection and maintenance activities. See Section 9.0 Documentation and Records for document and record details.

15.2 Testing

For all criteria pollutant monitors used in the monitoring network, the DAQ shall purchase equipment listed on the EPA's List of Reference or Equivalent Methods. Therefore, the DAQ assumes the monitors and procedures used to be of sufficient quality for the data collection operation. Table 11.1 identifies the model designations for the monitors used in the near-road program. For indoor shelter temperature, where EPA equivalent or reference methods do not exist, DAQ will follow EPA guidance. Currently when the DAQ purchases new monitors, the DAQ makes every effort to evaluate the monitor as soon as possible after receipt to ensure the monitor is working so DAQ can address any problems while the monitor is still under warranty. The ECB electronics technicians will create a new maintenance logbook for each new piece of equipment.

Before the ECB electronics technicians install the monitors at the near-road site, the ECB electronics technicians assemble and operate newly purchased or repaired monitors at the ECB. For the gaseous monitors and spares (CO and NO_2), the analyzers shall successfully undergo at least one zero/span calibration and multi-point verification and must meet the specifications in SOPs 2.17.2 and DAQ-04-001.2. If the monitor meets the acceptance criteria, the ECB electronics technician allows it to operate in the shop until he can confirm functionality. Functionality is determined by the analyzers undergoing at least one zero, span and multi-point calibration using the criteria found in Table 14.1. If these checks are out of specification, the ECB electronics technician will contact the vendor for initial corrective action. Often these contacts are documented via email. The ECB electronics technician will not deploy an analyzer to the field until it has successfully passed all required checks. SOPs 2.17.1 and 2.36.1 provide further information on the instrument specific testing that new and recently repaired CO and NO_2 analyzers must undergo. Following site installation of the CO and NO_2 monitor, the RRO monitoring technicians will initiate, observe, and document the successful completion of a zero/span cycle by the ECB electronics technicians installing the equipment. If the analyzers meet the zero/span acceptance criteria (see Tables 7.2 and 7.3), the ECB electronics technicians will assume the monitors are operating properly and ready for calibration by the RRO monitoring technician. The ECB electronics technicians will properly document and file these tests in the instrument maintenance logbooks stored at the ECB.

For the $PM_{2.5}$ monitor and spares, the ECB electronics technicians will perform external and internal leak checks and temperature, pressure, and flow rate multi-point verification checks until the monitor passes. If the monitor meets the acceptance criteria, it operates outside the shop in a secured area until the ECB electronics technician can confirm the monitor is operating properly by observing the recorded $PM_{2.5}$ measurements and ensuring that they fluctuate as expected and appear reasonable and that all diagnostic parameters fall within recommended ranges prescribed in the instrument manual. See Table 7.4 for the criteria the monitor must meet. If any of these checks are out of specification, the ECB will contact the vendor, and initiate corrective action. Any communications with the vendor may be documented in an email, invoice, service request or instrument logbook. The ECB electronics technicians may also perform a background test on the monitor before installing it at the site. Although the designation of the FRM/FEM status ensures the make/model of the instrument meets EPA requirements for use in the network, DAQ must still ensure individual instruments perform as expected before deployed in the field. In general, the ECB electronics technician performs the following acceptance/testing activities upon receipt of new monitors and samplers:

- Verify that the instrument contains its EPA equivalent or reference method decal and meets the specifications of the purchase request.
- Verify that all expected parts arrived with the instrument and that nothing is physically broken. Contact the vendor if there are issues.
- Perform field readiness “certification” testing, summarized as follows:
    - Check the diagnostics of the sampler, looking for any fault lights or warnings, and document the status.
    - Check, and if need be, calibrate, the temperature and pressure sensors.
    - Perform flow rate checks and make sure they fall within the acceptance criteria.
    - For continuous PM samplers, the ECB electronics technician runs the sampler in the lab and observes the ambient concentration values; they should be low (as this is indoor air) and track steadily.

If the equipment is new and fails to meet the field readiness certification described above, the ECB electronics technician will contact the vendor. If an instrument has undergone significant repair and fails to meet the field readiness certification (testing), the ECB electronics technician will contact the vendor. If after working with the vendor, the ECB electronics technician cannot repair the instrument such that it passes performance testing, then he will shelve the instrument (i.e., discontinue its field use). At that point, the ECB electronics technician tags the instrument as inoperable and uses it for spare parts. If the shelved and tagged instrument was a back-up instrument, then the ECB will begin the process to purchase a new instrument to replace it, such that a spare is once again available for use.

Once installed at the site, the regional monitoring technicians will again run the tests mentioned above. If the sampling instrument meets the acceptance criteria, the ECB electronics technician will assume the monitor is operating properly. The BAM1022 Operation Manual provides detailed information on the instrument specific testing that $PM_{2.5}$ monitors must undergo before field deployment. The ECB electronics technician will properly document and file these tests in the instrument maintenance logbooks stored at the ECB.

15.3 Inspection

Several items periodically require field inspection. The applicable equipment SOPs 2.17.1, and 2.36.1 (see Table 11.2 for SOP titles) and equipment operations manuals present greater detail on these items and procedures. In general, the following inspection activities are used:

- The RRO monitoring technicians inspect monitoring shelters, sample inlets and other enclosures during each site visit and at least once a month to ensure conditions do not adversely affect monitor operation or data integrity. The ECB electronics technicians inspect monitoring shelters, sample inlets and other enclosures during annual performance evaluations to ensure conditions do not adversely affect monitor operation or data integrity.
- A zero-air system is a vital piece of support equipment maintained at any near-road monitoring station. The calibrator blends zero air with calibration gases to dilute them to the necessary concentrations for conducting routine calibrations, precision checks, including 1-point-QC checks and zero-span-precision checks, and performance evaluations or audits. Zero air systems used by DAQ for conducting these QA/QC checks and audits should be able to deliver 10 LPM of air that is free of ozone, NO, NO_2, SO_2, CO and non-methane hydrocarbons to below the instruments' method detection limits. Zero air supplies do not have to be NIST traceable but will be inspected and serviced annually by the ECB electronics technicians to ensure they remain free of contaminants.
- The RRO monitoring technicians, coordinator and RCO chemists and statistician review data collection and data quality each business day. They inspect the data for trends and signs of problems. Data trends that signal a need for further inspection would include issues such as frozen numbers for multiple hours in a row or erratic spikes or valleys in concentrations obtained.
- Inspections on equipment also occur during site visits to verify the entire system is in good working order. Site visit checklists are available to the RRO monitoring and ECB electronics technicians, who document the equipment operating parameters on the zero-span-precision, calibration and maintenance tracking forms within the e-logs, as well as on performance-evaluation audit forms.
- The ECB electronics technicians test and inspect spare equipment at the time of purchase or after major repairs and before deployment to the field. The ECB electronics technicians certify equipment as field ready and store it on a shelf or monitoring bench (typically at the ECB) until deployment.
- An RRO monitoring technician reviews the site and monitors annually to ensure continuing compliance with 40 CFR Part 58, Appendices A, D and E. The RRO monitoring technician documents the review on the DAQ site review form.

During the site visits to complete14-day checks, all monitors also undergo routine maintenance, if needed. If necessary, the RRO monitoring technicians may contact the ECB electronics technicians for specific non-routine maintenance.

15.4 Routine Maintenance

The following are general routine maintenance protocols:

- The ECB electronics technicians maintain a limited supply of critical spare parts in the ECB maintenance / repair shop to aid in rapid response to issues. For example, pump rebuild kits, spare pumps, filters, and other expendable supplies are routinely on hand.
- The RRO monitoring and ECB electronics technicians schedule preventative maintenance ahead of time, so they can have all parts and tools easily available to complete the tasks and thereby minimize data loss.
- The RRO monitoring technicians typically perform preventative maintenance activities in the field, although the ECB electronics technicians may complete some activities in the shop.

The specific equipment SOPs 2.17.1, 2.17.2, 2.36.1, DAQ-04-001.2, and 2.46.2 (see Table 11.2 for SOP titles) detail the routine preventive activities and schedules and the equipment user manuals supplement these procedures. The RRO monitoring technicians perform diagnostic checks and document them before and after preventive maintenance. They document these diagnostic checks in the e-log. The RRO monitoring technicians service the PM inlet heads monthly, VSCC monthly, and down-tubes at least quarterly. They also replace gaseous instrument filters for NO_2 every 14-days and for CO at least monthly.

16.0 Instrument Calibration and Frequency

The EPA defines “calibration” as the comparison of a measurement standard, instrument or item with a standard or instrument of higher accuracy to detect and quantify inaccuracies and to report or eliminate those inaccuracies by adjustment. Use of the term "calibration" indicates that an adjustment in either the instrument or the software occurred. The EPA recommends that RRO monitoring technicians minimize adjustments to prevent introducing measurement uncertainty and verifications, "i.e., checks without correction (adjustment)," be used to confirm whether an instrument is operating within its acceptance range. Thus, the purpose of calibration is to minimize bias. Section 14.0 Quality Control Requirements and Procedures discusses calibrations in more detail. SOPs 2.17.2, DAQ-04-001.2 and 2.46.2 (see Table 11.2) describe calibration procedures for each specific pollutant analyzer.

Title 40 CFR Part 58, Appendix A, Section 2.6 requires that gaseous standards (i.e., gas cylinders) and flow rate standards used in the ambient-air monitoring network be traceable to NIST. The ECB electronics technicians procure and maintain dedicated traceable standards for the certification of the ambient air quality monitoring systems. These standards provide a direct link to established national standards (i.e., NIST) and are the foundation for the collection of the highest quality ambient air pollution data possible in accordance with current procedures and existing federal regulations and guidelines. Traceable is defined in 40 CFR Parts 50 and 58 as meaning that a local standard (i.e., one maintained by a monitoring organization) has been compared and certified, either directly or via not more than one intermediate standard, to a primary standard such as a NIST Standard. Similarly, traceability is the property of a measurement result whereby DAQ or an auditor can relate the result to a stated reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty. Standard traceability, therefore, is the process of transferring the accuracy or authority of a primary standard to a field-usable standard, resulting in a documented unbroken chain of calibrations/ certifications. The applicable SOPs (see Table 11.2) or operation manuals provide specific calibration procedures and timeframes for certifications of field equipment. See Tables 7.2 thru 7.4 for applicable equipment certification frequencies and acceptance criteria.

To achieve and ensure traceability, DAQ adheres to the following principles:

- Devices are re-certified at least annually. The DAQ keeps records of these certifications at the ECB and in the RRO.
- Where applicable, in-house certification procedures (i.e., certifying a transfer standard against a certified primary standard - i.e., one of higher authority) are performed using SOPs DAQ-13-002.1, DAQ-13-007.1, DAQ-15-001.1, 2.3.3, 2.3.5 and 2.3.6. The ECB maintains the documentation of these procedures in the ECB shop on appropriate forms.
- The coordinator maintains records of all instrument calibrations, using the traceable standards (with instrument identification numbers clearly documented), on the appropriate group network drives in the RRO and RCO.

In this manner, documentation exists that provides a documentation trail that links all DAQ calibrations back to NIST.

The following subsections summarize the standards used in the DAQ network and their recertification process. The RRO monitoring and ECB electronics technicians monitor all certification periods to ensure the regional monitoring technicians do not use equipment beyond the documented certification expiration dates. The regional monitoring technician is responsible for verifying the equipment he or she is using is within certification and contacting the ECB at least 30 days before the certification expires.

16.1 Calibration of "Local Primary Standards"

A primary standard is a standard that is sufficiently accurate such that it is not calibrated by or subordinate to other standards. The ECB electronics technicians or vendors use primary standards to calibrate other standards referred to as working standards. The DAQ uses "local primary standards" or standards certified against NIST-traceable standards and kept in the ECB shop for the sole purpose of certifying transfer standards used in the field to calibrate equipment and verify equipment calibrations. The DAQ owns two "local primary standards" for each type of device. The ECB sends each "local primary standard" to the vendor for recertification in alternate years ensuring that one local primary standard is always available for use and has been certified within 365 days. DAQ staggers the rotation of standards such that one device always remains in certification. The ECB electronics technician compares the "local primary standard" that did not return to the vendor to the one that did return to the vendor to certify it and uses it to certify equipment for the next year. Procedures for doing these comparisons are provided in SOPs DAQ-13-002.1, DAQ-15-001.1 and 2.3.3.

The ECB is responsible for procuring and maintaining dedicated traceable standards and gases for the calibration of the ambient air quality monitoring systems. These standards provide a direct link to established national standards (NIST) and are the foundation for the collection of the highest quality ambient air pollution data possible in accordance with current procedures and existing federal regulations and guidelines.

16.1.1 "Local Primary Temperature Standard"

The ECB uses an Omega Digital Thermometer DP-41 (with resistance temperature detectors) RTD-805-Lab Standard (LS) as a "local primary temperature standard" to verify the accuracy of the field-temperature transfer standards. An ECB electronics technician sends the "local primary standard" to the vendor for recertification against a NIST primary standard every 365 days.

16.1.2 "Local Primary Pressure Standard"

The ECB uses a Mensor Model # 2500 as a "local primary pressure standard" used to verify the accuracy of the field-barometer transfer standards. An ECB electronics technician sends it to the vendor for recertification against a NIST-traceable standard every 365 days.

16.1.3 "Local Primary Flow Rate Standard"

The ECB uses Alicat mass flow meters as "local primary flow standards" used to certify the accuracy of the calibrator mass flow controllers. An ECB electronics technician sends them to the vendor for recertification against a NIST-traceable standard every 365 days.

16.1.4 "Local Primary Time Standard"

The ECB and regional monitoring technicians use the WWV NIST atomic clock in Boulder, CO (telephone number: 1-303-499-7111) as a primary time standard. They can also obtain the correct time via the website http://nist.time.gov. Regional monitoring technicians can also call the ECB electronics technicians to request the NIST Time. The DIT configures all state network resources and devices, including the site computer at the near-road monitoring site, to receive time settings from the web clock at Nist.gov (primary) and the Internet Time Service at bldroc.gov (backup). The DIT also configures the site computer at the near-road monitoring site to remain on Eastern Standard Time throughout the year, which is the local standard time for Wake County.

16.2 Calibration of Transfer Standards

Either the vendor or the ECB electronics technicians certify all transfer standards against either a primary standard or the "local primary standard." This establishes the traceability of the calibration.

16.2.1 Flow Transfer Standards

The field flow-transfer standards used for $PM_{2.5}$ monitor flowrate calibration will have their own certifications and will be NIST-traceable to the factory primary flow rate standard. The ECB will supply streamline FTS or Tetra-Cal (or equivalent) for field calibrations and flow rate verifications of the flow rates of the near-road sampler. The ECB electronics technicians will also provide an additional set of field flow-transfer standards to conduct independent performance audits. Both devices have the advantage of providing volumetric flow rate values directly, without requiring conversion for mass flow measurements, temperature, pressure, or water vapor content. The manufacturer establishes (and verifies as needed) a calibration relationship for the flow rate standard, such as an equation, curve, or family of curves, as accurate to within 2 percent over the expected range of ambient temperatures and pressures at which the flow rate standard is used. The vendor shall recalibrate and recertify the flow rate standards at least annually. An ECB electronics technician sends them to the vendor for recertification against a NIST-traceable standard every 365 days.

16.2.2 Temperature Transfer Standards

The RRO monitoring technicians use either mineral thermometers or Tetra-Cals as field-temperature transfer standards. The Tetra-Cals have their own certification by the vendor. The ECB electronics technicians are responsible for returning the Tetra-Cals to the vender for annual certification. The mineral thermometers will be re-verified or recertified at least annually, by ECB electronics technicians, against the "local primary temperature standard," or auditor's transfer standard, to within 1 degree Celsius, or ° C, over the expected range of ambient temperatures at which the temperature standard is to be used. The ECB electronics technicians audit the shelter temperature during each internal performance evaluation. They record the results of their audits on the AQ-121 forms.

16.2.3 Pressure Transfer Standards

The field-pressure transfer standards will be handheld digital barometers or Tetra-Cals that will have their own certification by the vendor. The ECB electronics technicians will reverify or recertify the handheld digital barometers at least annually against the "local primary pressure standard."

16.2.4 Calibrators

The field calibrators are transfer standards that will have their own certification against "local primary standards." The ECB electronics technicians use the Teledyne (Model T700U) calibrators as the field calibration device and as the audit device for CO and NO_2 monitoring. The ECB electronics technician certifies the mass flow controllers within field calibrators and audit calibrators every 12 months using Alicat flow measurement units. SOP DAQ-13-007.1 contains further details on the certification procedures.

16.3 Calibration Gases

All NO and CO calibration gases must be EPA-protocol (NIST-traceable) and include the following information:

- Cylinder serial number;
- NO or CO concentration;
- Recertification status;
- Gas type;
- Cylinder pressure (double checked upon receipt);
- Impurity concentration; and
- Expiration date.

The ECB electronics technicians service the zero-air generator used at the near-road monitoring site annually or more frequently if needed. The ECB electronics technicians maintain independent gas standards purchased from the same vendor, which they designate for independent NO_2 and CO performance audits. They also designate a zero air generator as an independent source of zero air for independent gas monitor performance evaluations. These zero air generators are also serviced annually by the ECB electronics technicians. The calibration gas standards have their own certifications. The vendor will reverify or recertify the NO calibration gas after three years and the CO standards after eight years.

16.4 Documentation

See the appropriate SOP for field QC checks that include frequency and acceptance criteria and references for calibration and verification tests of analyzer concentration responses, sampler flow rates, temperature, pressure, and time synchronization. The analyzer verification checks include 1-point-QC check for NO_2, NO, NO_x and CO at least every 14 days (DAQ does daily diagnostic auto-checks for NO, NO_x and CO) and multipoint calibrations or verifications at least semi-annually, as documented by tracking on control charts.

The $PM_{2.5}$-field analyzer flowrate, temperature- and pressure-sensor verification checks include one-point checks at least monthly. All these events, as well as sampler and calibration equipment maintenance, will be documented in field data records and logbooks and annotated with the flags required in Appendix L of 40 CFR Part 50 and the manufacturer's operating instruction manuals. The RRO monitoring technicians will keep field activities associated with equipment they use in record logbooks as well. The coordinator normally controls these records. The records are located at the field site when in use or at the RRO when being reviewed or used for data validation.

The ECB electronics technicians will retain calibrator certification documentation at the ECB facility in Raleigh, North Carolina. Please reference Table 9.1 for the storage location of all documentation.

17.0 Inspection/Acceptance of Supplies and Consumables

DAQ SOPs (see Table 11.2) itemize the apparatus, equipment, materials and supplies required for various monitoring equipment. In general, the ECB electronics technicians procure supplies and consumables directly from the vendor manufacturing the monitors used by DAQ. Most manufacturers' operating manuals itemize parts lists, including recommended replacement schedules, as well. DAQ uses this information to determine the appropriate procurement schedule and volume of consumables required to support continuing operations.

The RRO monitoring technicians track supplies and consumables, e.g., BAM filter tape and gas analyzer in line PM filters; when the RRO monitoring technician needs replacements, he or she notifies the ECB. The ECB then supplies the needed items out of its inventory or purchases what the RRO monitoring technician needs. The ECB electronics technicians maintain an inventory of supplies in the ECB shop for later distribution. The ECB electronics technicians inspect received materials to ensure they received the proper part number as ordered. They also perform a general inspection to identify any damaged products. They do not retain supplies deemed unsuitable. The ECB electronics technicians date parts received so they can easily determine storage duration. The ECB uses a revolving inventory system (first in, first out) to ensure storage times do not affect the material's integrity. If a manufacturer or EPA requirement indicates a specific expiration period for supplies, the ECB discards those supplies exceeding expiration dates if not used within the acceptable period.

Sample lines and fittings are important supplies. If used in the sampling train of a reactive gaseous analyzer, they must be fluorinated ethylene propylene, or FEP, Teflon™ or equivalent. Consumables that are critical to the successful operation of the gaseous monitors are the gas cylinders used for calibration and QC checks of NO_2 and CO analyzers, as well as gas cylinders used to conduct internal performance audits. Gas cylinders ordered by DAQ are EPA Protocol Cylinders. The ECB electronics technicians review certificates of analyses upon receipt of new gas cylinders to ensure the cylinders meet purchase specifications. The certificates indicate the expiration date of the gases contained within the cylinders. DAQ abides by these expiration dates; the ECB electronics technicians track dates and usage, replacing cylinders when the regional monitoring technicians notify them that less than 500 pounds per square inch (psi) remains in the cylinder or before they expire. Additionally, DAQ participates in the EPA Ambient Air Protocol Gas Verification program (https://www3.epa.gov/ttn/amtic/aapgvp.html). This program allows the independent assessment of gas cylinders to ensure their integrity and that of the supplier.

18.0 Non-Direct Measurements

This section addresses data not obtained by direct measurement from the near-road monitoring program. This includes data from outside sources and historical monitoring data. The EPA has defined some types of data needed for the near-road monitoring program in the Near-Road NO_2 Monitoring Technical Assistance Document. These types of data include the following:

- Core-based statistical area boundaries;
- Census data;
- Roadway traffic volumes, that is AADT;
- Fleet mix;
- Congestion data;
- Roadway design;
- Topological data; and
- Meteorological data.

The TAD provides details on how to obtain and evaluate these types of data.

In addition to the above types of data, DAQ may also need the following types of data to support the near-road monitoring program:

- Chemical and physical properties data;
- Sampler manufacturers' operational literature;
- Geographic location data (e.g., site metadata for AQS);
- Historical monitoring information;
- External monitoring databases; and
- MOtor Vehicle Emission Simulator or other mobile sources emissions modeling data.

Any use of outside data will be quality-controlled and documented to the extent possible following QA procedures outlined in this document and in applicable EPA guidance documents.

19.0 Data Management

19.1 Purpose/Background

The primary work product of the DAQ near-road monitoring program is data. Thus, DAQ established formalized procedures to ensure successful data management. Data management describes an inter-related set of standardized processes used to acquire, transmit, transform, reduce, analyze, store and retrieve data. When documented and followed, a data management system helps maintain the data integrity and validity of the data throughout its entire life cycle. DAQ's air monitoring data follows a documented flow path. The data life cycle starts before data collection begins and ends with use of the data. The following subsections identify the processes and procedures DAQ follows to acquire, transmit, transform, reduce, analyze, store and retrieve data. These processes and procedures maintain the data integrity and validity through application of the identified data custody protocols.

Figures 19.1 and 19.2 display the generalized flow path of the DAQ ambient air monitoring data, as well as the QA/QC data collected within the near-road network. The DAQ follows procedures in DAQ-05-001.5. The RRO monitoring technicians, coordinator, ECB electronics technicians, RCO chemists, statistician and database manager acquire and process the near-road ambient air monitoring data. Section 4.0 Project/Task Organization describes staff responsibilities.

19.2 Data Collection and Recording

The DAQ only uses ambient air monitoring analyzers designated by EPA as FRMs or FEMs to collect data used for NAAQS compliance. At installation and regular intervals as specified, the RRO monitoring technicians calibrate the ambient air monitoring instrumentation following the specific pollutant SOPs identified in Table 11.2 of this QAPP. Note: When DAQ establishes a new site, the RRO coordinator and ECB electronics technicians manually collect metadata for the site (global positioning system [GPS] coordinates, etc.). The database manager maintains the metadata and uploads it into AQS, as appropriate. The RRO monitoring technician and coordinator review the metadata annually during the network review and update it as needed.

For the DAQ near-road network, DAQ records all data electronically. The site computer is equipped with a DAS, called Envidas Ultimate, and a wireless modem that transmits data to the master polling system, i.e., the Envista ARM data storage database, a separate software package located on a state server. The DAS and site computer records the output of the monitors at the site, performs any needed data transformation and formats the resulting data for downloading to the Envista ARM database. The Envidas Ultimate and Envista ARM databases do not allow the deletion of raw (i.e., original) data. The DAQ uses the Envista ARM database for data verification, validation, and reporting and it is capable of producing plots of the minute data. The database uses replicate versions of the raw data to avoid violating the integrity of the original dataset. The Envidas Ultimate and Envista ARM database do not allow the deletion of data and track all changes made to the data. The RRO monitoring technicians, coordinator, RCO chemists and database manager can modify, flag or void data stored in the Envista ARM “edit” database, as needed; the DAS records and makes available an edit history to track changes made to the data. The procedure(s) to test/audit the acceptability of the hardware and software used for data management at the near-road site are delineated in SOP DAQ-05-001.5.

FIGURE 19.1 NEAR-ROAD DATA FLOW PATH

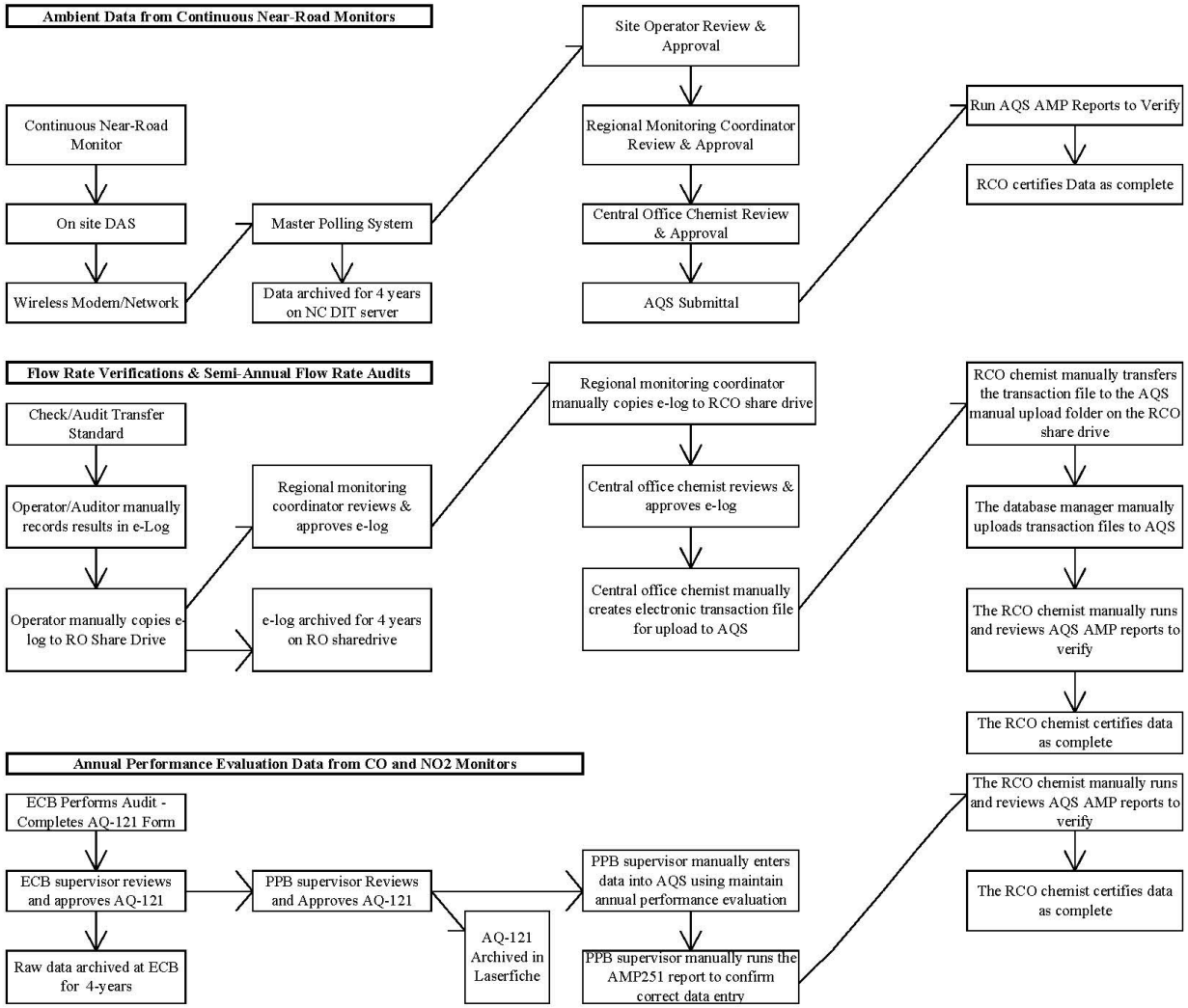
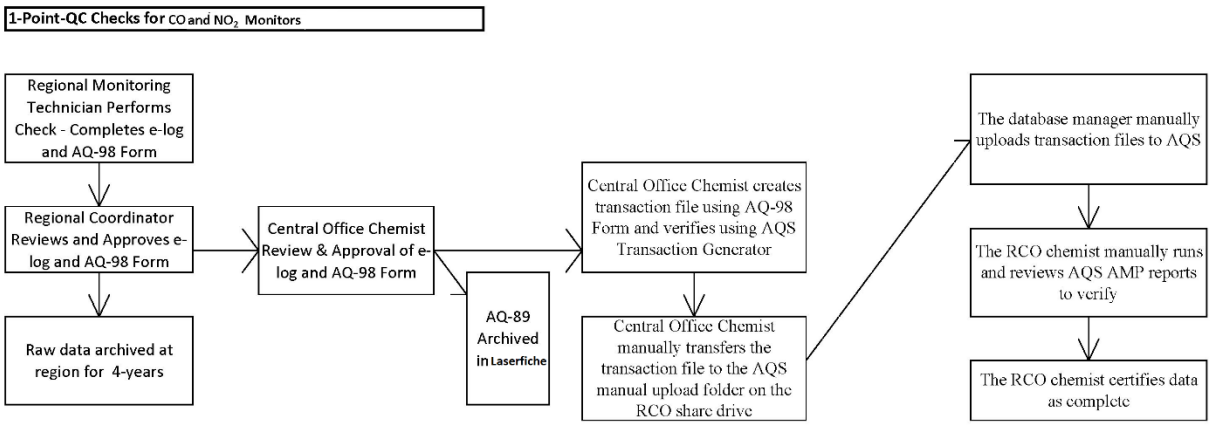


FIGURE 19.2 DATA FLOW PATH FOR 1-POINT-QC CHECK DATA



For the AQ-121 reports from the performance evaluations, which are paper documents, the PPB supervisor manually creates the records to upload to AQS as described in DAQ-15-005.5, archives a scanned copy of the paper document in Laserfiche and files the paper copy in a secured file cabinet in the RCO. The PPB supervisor or database manager electronically uploads the data to AQS as described in DAQ-15-005.5.

IBEAM uses a Java-based web application system used by DAQ as a primary repository and tracking system for many of the division's business processes including facility tracking, permits, mobile sources, emission source inventories, ambient monitoring data, forecast data, compliance and enforcement actions, and source tests.

The DAQ modeled the design architecture of IBEAM after the standard n-tier architecture supported by Tomcat Application Server running on a Windows Server. The system uses a thin client interface for presenting information, via HTML and Java Server Pages, or JSP's, in Internet Explorer. The DAQ designed the system in a modular format with each module containing sub-categories as appropriate. The DAQ defined security at the module level with a range of security options appropriate to staff requirements. Although IBEAM displays systems in modular format, it stores the data in the background in an integrated data structure managed by the Oracle Relational Database Management System, or RDBMS. This means no duplication of data or data entry and a single point source for reporting and information dissemination.

For 1-Point-QC checks for NO_2 and CO, every 14-days or less, the RRO monitoring technician manually runs a zero, span and precision point. The RRO monitoring technician records the result in the e-log and on an AQ-98 form. At the end of the quarter, the RRO monitoring coordinator reviews the e-logs and AQ-98 forms and transfers the documents to the RCO. The RCO chemist reviews the documents and submits the transactions created by the AQ-98 form to the database manager to upload to AQS. The RCO chemist archives the AQ-98 forms in Laserfiche.

19.3 Data Transmittal and Transformation

Data transmittal is accomplished using wireless communication to access the site modem. Downloading collected data does not delete data from the DAS. The Envidas software removes data from the site computer by overwriting data on a first-in, first-out basis. This configuration requires the Envista ARM software to extract data from the site computer on a regular basis to prevent any data loss (hourly for minute data and hourly data, and the following hour after the data is collected for nightly checks). If communications problems arise, the Envista ARM software retrieves the data from the Envidas system when it can once again communicate with the site. The RRO monitoring technician must make a site visit if the database manager or ECB electronics technician informs him or her that he cannot correct the communications problems in a timely fashion.

For the gaseous monitors, the DAS reads instantaneous NO, NO_x, NO_2 and CO values from the monitor and averages each 60-second interval to create a one-minute average. The DAS stores each minute average, and this average acts as the base unit for all measurements taken by the NO_2 and CO monitors within the DAQ near-road monitoring network. The data are reviewed daily by RCO chemists as well as regional monitoring technicians. There exists a dynamic ongoing open communication with the monitoring staff to discuss anomalies, missed data, or observed errant issues with respect to the daily data. In addition, at least once a month, the statistician downloads the instantaneous data for at least one hour for three different days from at least one of the site monitors and compares the values to the data captured in Envista to verify the data for accuracy. The monitors, themselves, as well as the Envidas system averages the stored 1-minute averages to form averaged hourly values, which are the blocks of ambient NO_2 and CO measured concentrations that the database manager submits to the EPA. Envidas Ultimate transmits all these values to Envista ARM for retention.

For the $PM_{2.5}$ monitor, the DAS reads hourly PM values from the continuous PM monitor. The DAS stores each hour and this acts as the base unit for all measurements taken by the continuous PM monitor at the near-road monitoring site. The PM monitor stores/calculates hourly averages. The Envidas Ultimate system stores hourly averages to form averaged 24-hour values. Envidas Ultimate transmits all these values to the Envista ARM database for retention. The database manager only submits 1-hour ambient PM concentrations to the EPA AQS database for the continuous PM monitor. The AQS database also averages the submitted hourly averages to form 24-hour values. The RRO monitoring technician downloads data directly from the continuous $PM_{2.5}$ monitor to a universal serial bus (USB) flash drive, personal computer (PC) or laptop or via Comet software in the field twice a month. These data downloads serve as a backup.

19.4 Data Verification and Validation

Data verification and validation is an important routine process that involves several steps to ensure the RRO monitoring technicians, coordinator and RCO chemists have correctly carried out the field and data processing operations. The verification and validation process will identify data with errors, biases and physically unrealistic values before DAQ or the EPA uses them for the identification of NAAQS exceedances, for further analysis or for modeling. Once the RRO or RCO have identified these problems, the RRO monitoring technicians, coordinator and RCO chemists can correct, flag, or invalidate the data. If necessary, the RRO monitoring, and ECB electronics technicians can take corrective actions. Section

23.0 Verification and Validation Methods contains additional information on data verification and validation.

Each of the network's analytical instruments employed to measure the ambient concentrations of the criteria pollutants undergoes periodic audits, 1-point-QC checks (NO_2 and CO) or monthly flow rate verifications ($PM_{2.5}$), and calibrations. SOPs 2.17.1, 2.17.2, 2.36.1, DAQ-04-001.2, and 2.46.2 (see Table 11.2 for SOP titles) outline these procedures. Audits and verification checks ascertain the accuracy, precision and repeatability of each instrument in performing its required function.

The instrument-generated data are stored on site in the DAS. When Envista ARM accesses the data through the wireless modems, it downloads the data into its database where the data undergo verification, reduction and analysis (Level 0). The RRO monitoring technician using Envista ARM performs data verification electronically by searching the data for status flags and comparing reported values to acceptable range criteria (Level 1). After the RRO monitoring technician flags data as questionable, level 2 (preliminary) and 3 (final) reviewers evaluate the flagged data to identify underlying causes and decide whether the data are valid. If the data are invalid, DAQ and the EPA do not use them in calculations. If the data are valid, but flagged due to some extenuating circumstance, then DAQ and the EPA may use the data in calculations, accompanied by a comment documenting the situation.

SOPs DAQ-15-005.5 and 2.63.4 contain further details on the data verification and validation procedures.

19.5 Data Reduction and Analysis

As described in the subsections above, data reduction activities take place throughout the entire data management process. The on-site DAS gathers data from the monitors at each site each hour and transmits them to the Envista ARM database. The data are gathered and transmitted in response to a poll via the wireless modem. The NO_2 and CO data do not require special aggregation. The Envista ARM system can aggregate hourly $PM_{2.5}$ data into the 24-hour averages, as appropriate; once validated, the database manager uploads the data into the AQS database. The EPA compares submitted results to the NAAQS for the criteria pollutants.

The regulations at 40 CFR Part 50 define the quantity of valid data points required within a data set. For most pollutants, the EPA requires a minimum data capture of 75 percent of the interval – hour, day, quarter – for the EPA to consider the interval valid for use in NAAQS comparisons. Tables 7.2 through 7.4 summarize these completeness requirements as well as provide specific references to the CFR. For information on how the near-road site data is used to calculate DVs, please see Section 7.1.

The DAQ analyzes data periodically throughout the data collection and validation process. For example, the RRO monitoring technicians and coordinator, RCO chemists, audit chemist and statistician can download data from Envidas Ultimate directly into Microsoft Excel spreadsheets. The RRO monitoring technicians, RRO coordinator, RCO chemists and statistician use Microsoft Excel spreadsheets solely for data analysis and in-depth study of the data. For example, each business day, the statistician prepares a tabulation of the raw hourly data from the previous day, evaluating it for missing data, data higher or lower than Tukey's fences for that day, trends and to ensure it is within specifications. The RCO chemist and statistician also review all validated data looking for trends, data outside of three times the interquartile range, etc. to establish the reasonableness of the data sets. The RCO chemist and statistician

accomplish these tasks by retrieving several reports from the AQS database, such as the AMP256, AMP430, AMP450 and AMP600, and analyzing the results.

19.6 Data Submission

After the RRO monitoring technicians, coordinator and RCO chemists complete all three levels of verification and validation for a month of data, as described in Section 23.0 Verification and Validation Methods, the database manager or statistician uploads the data to the AQS. This submittal must occur no later than 90 days following the close of each calendar quarter, as specified in 40 CFR Section 58.16.

At the end of each quarter, an RCO chemist runs the AMP251, AMP256, AMP350, AMP430 and AMP600 (for regulatory monitors) reports in AQS and verifies that the database manager and statistician successfully entered all hourly, internal performance evaluation, and 1-point QC check data. The DAQ will also notify the EPA if a monitor does not meet the completeness requirements summarized in Tables 7.2 through 7.4.

The RCO chemist assigned to this task shall certify to the chief that the data are complete to the best of his or her knowledge. The quarterly data submittal shall contain the following summary data:

- The AQS site code, monitoring method code and parameter occurrence code;
- The results of all valid precision, bias and accuracy tests performed during the quarter for CO, $PM_{2.5}$, and NO_2 (including NO and NO_x); and
- The ambient air quality data obtained for CO, $PM_{2.5}$, and NO_2 (including NO and NO_x).

Every year before the annual data certification due date, the chief reviews the data from the EPA AQS summary reports, along with internal performance evaluation and audit reports, to confirm the data meet the required criteria. The RCO chemists address any concerns with the data.

DAQ shall submit to the EPA an annual AMP600 summary report of all the near-road monitoring data, in accordance with 40 CFR Section 58.15. DAQ will also submit a signed certification letter on DAQ agency letterhead signed by the chief. The chief will submit the report by May 1 of each year for the data collected from Jan. 1 through Dec. 31 of the previous year. The chief, or designee, must certify the report as accurate to the best of his or her knowledge. The chief will base this certification on the various assessments and reports performed by DAQ, including the AMP600 report.

19.7 Data Storage and Retrieval

Once collected, data are stored in a variety of ways and for varying periods. Initially, data are stored in the monitor and/or the station-specific DAS. The monitors keep an unalterable record of instrument measurements for a period of days to weeks, depending on the amount of information stored. The on-site DAS also keeps an unalterable record of instrument measurements for a period of months to years depending on the number of monitors operated at the site. The RCO Envista ARM database system automatically accesses data stored in the on-site Envidas system.

Because of the DAQ archiving system, the DAQ can store and retrieve the air quality monitoring data. Backup and recovery procedures exist to ensure the RRO monitoring, and ECB electronics technicians and database manager can recover data in the event of a catastrophic failure. The database manager

manually executes a backup of the full database every Friday. Due to the lack of a second structured query language (SQL) database in which to import the backup files, the database manager has not routinely tested procedures for using the backup files; however, he has used backup files to import data into the virtual server's database. The DAQ has recently established a backup computer with SQL software installed to continue data polling operation in the event of a catastrophic failure of the server. When storage space limits the amount of data that DAQ can keep in the database, procedures exist for moving the data into an archive database. Presently, the database manager backs up data weekly using a Zip File. The database manager keeps the most recent copy available on SharePoint. Envidas polls data older than one week old directly from the site computer. DAQ keeps all data in real time.

Note: The RRO monitoring technicians also download data directly from instruments to USB flash drives, PC or laptops in the field for the continuous $PM_{2.5}$ FEM twice a month; these data downloads serve as a backup, as the RRO monitoring technicians upload them to the RRO group drive for archival. The monitoring technicians also download backup site temperature data and store it on the RRO group drive for archival purposes.

The DAQ retains all supporting electronic and written information, such as logbooks, maintenance logs, certifications and diagnostic information worksheets for a minimum period of four years, unless any litigation, claim, negotiation, audit or other action involving the records started before the expiration of the four-year period. When this type of situation occurs, DAQ will retain the records until completion of the action and resolution of all issues that arise from it or until the end of the regular four-year period, whichever occurs later. The DAQ shall store the data on electronic media or in hard copy, whichever format proves most advantageous. Envitech software updates have no impact on data accessibility. After the storage period has passed, the database manager may dispose of storage media or recycle it. However, the database manager uploads the validated dataset to the EPA AQS for long-term storage.

20.0 Assessments and Response Actions

An assessment is the process used to measure the performance or effectiveness of the quality system, the near-road monitoring network and its site, the pertinent QAPP and various measurement phases of the data operation. The DAQ also uses assessments to determine whether the monitoring staff has implemented the ambient-air quality program in accordance with the approved QAPP. Although not all of these assessments are required the DAQ follows 40 CFR Part 58, which calls for network plans as well as some of the other assessments listed here. DAQ also evaluated these monitors according to the requirements in Appendix A to 40 CFR Part 58. To ensure the adequate performance of the quality system, DAQ will perform the following assessments:

- Network reviews and assessments;
- DAQ internal and EPA external TSAs;
- External performance evaluations;
- Internal performance evaluations;
- Semi-annual flow rate audits;
- Quarterly completeness assessments;
- Annual data certification;
- Data quality audits; and
- Data quality assessments;

Table 6.1 provides information on the parties implementing assessments and their frequency.

20.1 Network Reviews and Assessments

Conformance with network requirements of the near-road monitoring network as set forth in 40 CFR Part 58, Appendices A, C, D and E are determined through annual network reviews of the ambient air quality monitoring systems, as required by 40 CFR Section 58.10(a). The chief uses the network review to determine if the near-road monitoring network collects adequate, representative and useful data in pursuit of its air monitoring objectives. Additionally, the annual network review may identify possible network modifications to enhance the system or correct deficiencies in attaining network objectives.

Before implementing an annual network review, the RRO monitoring technician compiles and evaluates significant data and information pertaining to the network and near-road monitoring site. Such information might include:

- Network files (including metadata, updated site information and site photographs);
- AQS reports, especially the AMP380 and AMP390 reports;
- Network monitors' five-year air quality summaries;
- Raleigh MSA area emissions trend reports;
- Traffic data at or near the near-road monitoring site; and
- National Weather Service or State Climate Office summaries from the Raleigh-Durham Airport next to the near-road monitoring site.

Upon receiving the information, the RRO monitoring technician will check it to ensure it is current. The RRO monitoring technician will note discrepancies and resolve them during the review. The RRO

monitoring technician will also identify and update files and photographs that need updating during the review. The DAQ emphasizes several categories during network reviews, such as the monitor location, the traffic on the roadway, potential changes to the roadway, population density, changes in nearby land use and other pertinent information.

During the annual network review, the RRO monitoring technician will reconfirm the stated objective for the monitoring site and re-verify the location's spatial scale. If the site location does not support the stated objectives or the designated spatial scale, the RRO monitoring technician will propose changes to rectify the discrepancy. The RRO and RCO monitoring staff will then act to correct the information in AQS, relocate the monitors or site, or move the site to a more suitable location, if needed.

In addition to the items included in the checklists, other subjects for discussion as part of the network review and overall adequacy of the monitoring program will include:

- Installation of new monitors;
- Relocation of existing monitors;
- Siting criteria problems and suggested solutions;
- Problems with data submittals and data completeness;
- Maintenance and replacement of existing monitors and related equipment;
- Quality assurance problems;
- Air quality studies and special monitoring programs; and
- Other issues such as proposed regulations and funding.

20.1.1 Near-road Monitoring Site Annual Network Review

The RRO monitoring technician completes a network review of the near-road site and submits a network review form to the RCO every year. EPA regions are also required to perform these reviews. The RRO monitoring technician considers the following criteria during the review:

- Date of last review;
- Areas where attainment/non-attainment re-designations are likely to take place, or did take place;
- Results of special studies, saturation sampling, point source oriented ambient monitoring, etc.; and
- Proposed network modifications since the last network review.

The regulations at 40 CFR Part 58, Appendix D discuss the number of near-road monitors required, depending upon the population in the CBSA and the amount of traffic on the roadways.

Once the annual network plan is updated based on the annual network review, latest census and traffic data and other pertinent information, the network plan is posted on the DAQ website for a 30-day public comment period. The plan is prepared by DAQ and submitted to EPA Region 4 by July 1 each year.

20.1.2 Five-Year Network Assessment

The five-year network assessment is a more extensive evaluation of the air-monitoring network. This assessment is prepared by the chief with assistance by the PPB supervisor or his/her designee(s). The assessment determines at a minimum:

- If the near-road network meets the monitoring objectives defined in 40 CFR Part 58, Appendix D,
- Whether DAQ must add another near-road site,
- Whether the existing near-road site is no longer needed and can be terminated, and
- Whether new technologies are appropriate for incorporation at the near-road site.

During the 5-year network assessment, the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals, for example, children with asthma, as well as the potential impact any sites proposed for discontinuance may have on other data users is considered. The 5-year network assessment may also include information related to applicable waivers for the DAQ near-road site. The DAQ submits a copy of the five-year assessment, along with a revised annual network plan, to the EPA Region 4. These assessments began in 2015 for the near-road network and are due to EPA every five years on July 1.

For more information about the five-year network assessment requirements, please see 40 CFR 58.10(d).

For more information about the near-road monitoring location, please see the annual network plan at: https://deq.nc.gov/about/divisions/air-quality/air-quality-data/annual-network-plan.

20.2 External Performance Evaluations

DAQ addresses performance evaluation activities by participating in the EPA's NPAP and PEP. Only qualified and authorized personnel execute performance audits. In general, the NPAP is a performance evaluation where quantitative data are collected independently to evaluate the accuracy of the monitoring equipment. In Region 4, a mobile laboratory arrives at the DAQ near-road monitoring site and generates known concentrations of audit gases, used to challenge the on-site CO or NO_2 analyzer. See 40 CFR Part 58, Appendix A, Section 2.4 and 3.13. for more information regarding NPAP audits. The NPAP program audits 20 percent of an agency's sites per year and each site every six years.

The PEP is an independent assessment used to estimate total measurement system bias. During $PM_{2.5}$ PEP audits, an EPA contractor sets up an FRM $PM_{2.5}$ sampler such that it is collocated with a DAQ $PM_{2.5}$ monitor. The FRM PEP sampler is programed to collect a 24-hour sample for analysis by the EPA Region 4 laboratory. Since a continuous method, FEM $PM_{2.5}$ monitor is operated at the DAQ near-road site, the FRM PEP sample will later be compared to the continuous data collected at the near-road site. See 40 CFR Part 58, Appendix A, Sec 2.4 and 3.2.4 for additional information regarding $PM_{2.5}$-PEP audits.

Since DAQ has 35 sites, including the near-road site, the EPA may only audit the near-road site once every six years. For PEP, the EPA contractor must collect, and report eight valid performance evaluation audits each year for $PM_{2.5}$ and must evaluate each $PM_{2.5}$ method designation each year. EPA must evaluate all $PM_{2.5}$ monitors at least once every six years.

EPA contractors typically provide the results of NPAP audits immediately following the NPAP audit. The NPAP audit results are also reported to AQS by EPA or its support contractor(s). Acceptance criteria applicable to NPAP audits may be found in Tables 7.2-7.3. If a monitor does not pass an NPAP evaluation, the RRO and RCO monitoring staff will take appropriate action to identify why the monitor failed the evaluation and to correct the situation. Since DAQ has 15 $PM_{2.5}$ sites, including the near-road site, and operates four method designations, the EPA may audit the near-road $PM_{2.5}$ site more frequently than once every six years. Acceptance criteria applicable to PEP audits may be found in Table 7.4. Because the EPA reports the PEP results directly to AQS after the national laboratory completes the analysis, the RRO and RCO monitoring staff will initiate corrective actions, when needed, after the results become available in AQS.

DAQ also participates in EPA's Ambient Air Protocol Gas Verification Program when it is available. See Section 17.0 of this QAPP and 40 CFR Part 58, Appendix A, Section 2.6.1 for more information.

20.3 Annual Performance Evaluations

The ECB electronics technicians, who do not operate the monitors, conduct annual performance evaluations at least once each calendar year and every 365 days on the gaseous monitors by challenging the monitor with known concentrations of gas using an independent calibrator and gas standard. The ECB electronics technicians certify the audit system and the monitor's calibration system using the same primary standard for both. Likewise, the ECB purchases the gas standards for the audit system and monitor's calibration system from the same vendor at the same time, so both come from the same lot of gas. The ECB electronics technicians follow the audit procedures in SOP 2.17.1 and 2.36.1. They document the results of these audits on the Continuous Monitor Performance Audit Report AQ-121 form. Acceptance criteria applicable to CO and NO_2 monitor performance evaluations may be found in Tables 7.2 – 7.3. If a monitor does not pass the evaluation, the RRO monitoring, and ECB electronics technicians will take appropriate action to identify why the monitor failed the evaluation and to correct the situation. See 40 CFR Part 58, Appendix A, Sec 3.1.2 for more information regarding performance audits.

20.4 Semi-annual Flow Rate Audits

A RRO monitoring technician other than the RRO monitoring technician who routinely operates the $PM_{2.5}$ monitor completes a flow rate audit on the monitor at least once every 182 days and preferably once every quarter or 91 days. This RRO monitoring technician uses different equipment to conduct the audit than the equipment used to calibrate the monitor and do the monthly or semi-monthly flow verification checks. The RRO monitoring technician follows the audit procedures in SOP 2.46.2. The RRO monitoring technician documents the semi-annual flow rate audit in the e-log. Acceptance criteria applicable to $PM_{2.5}$ semi-annual flow rate audits may be found in Table 7.4. If a monitor does not pass the evaluation, the RRO monitoring staff will take appropriate action to identify why the monitor failed the evaluation and to correct the situation. See CFR 40 Part 58, Appendix A, Sec. 3.2.2 for more information regarding required $PM_{2.5}$ semi-annual flow rate audits.

20.5 Quarterly Completeness Assessment

After the database manager uploads to AQS the data for a quarter, the RCO audit chemist assesses the data to ensure all data made it through the upload process and into AQS. The RCO chemist accomplishes the quarterly completeness assessment by running the AMP430 Completeness Report, the AMP350 Raw

Data Report and the AMP251 QA Data Report. The RCO chemist compares the data in AQS with the data that should be in AQS based on the monitoring schedule. When the RCO chemist identifies missing data or some other problem, he or she informs the Level 3 reviewer and database manager who act to resolve the issue. The RCO chemist archives the AMP251, AMP350 and AMP430 reports used for the quarterly completeness review in Laserfiche. If the monitor does not meet 75 percent completeness requirements, the chief contacts EPA Region 4, providing information on what occurred and what actions DAQ plans to take to keep the event from reoccurring.

20.6 Annual Data Certifications

In accordance with 40 CFR Section 58.15, the EPA requires an annual air monitoring data certification letter to certify that the regulatory data collected by the FRM and FEM monitors at the near-road site from Jan. 1 to Dec. 31 of the previous year, meet the criteria in 40 CFR Part 58, Appendix A. Along with the certification letter, the chief must submit to EPA an annual summary report of all the ambient air quality data collected by the monitors, as well as a summary of the precision and accuracy data, for the previous year.

Data certification is the final process of assessing the near-road data for the previous calendar year. The DAQ verifies and validates data monthly, as discussed in Section 23.0 Verification and Validation Methods. Additionally, the chief or designee assesses the data on a quarterly basis when the RCO audit chemist generates specific AQS reports to assess the DQIs as discussed in Section 20.8 Data Quality Assessments. With these assessments ongoing throughout the year, annual data certification, then, serves as the last assessment of the data – looking at it from an all-inclusive, annual perspective – to see if any unidentified anomalies or trends exist in the data that the RCO audit chemist or statistician had not previously identified. The annual data certification process starts with running and reviewing AMP reports contained in AQS. The reports typically queried include the following:

- AMP350 Raw Data
- AMP251 QA Data
- AMP430 Data Completeness
- AMP600 Certification Evaluation
- AMP256 Data Quality Indicator
- AMP504 Extract QA Data
- AMP450 Quicklook Criteria Parameters
- AMP450NC Quicklook All Parameters

The RCO audit chemist and the PPB supervisor review these reports and confirm everything is complete and accurate. The RCO audit chemist and PPB supervisor also review the reports to ensure the statistical results indicate the monitoring data were in control over the course of the entire year and met the DQOs. If they identify problems, the RCO audit chemist investigates them in accordance with Section 24.0 Reconciliation with Data Quality Objectives.

Ultimately, this process verifies that the near-road monitoring data submitted to AQS are correct and complete. Once the RCO chemists, statistician and database manager complete any necessary corrections, additions or deletions in AQS and the RCO chemists and PPB supervisor finalize the dataset, the chief officially recommends the data for certification to EPA Region 4. The data certification package provided

to EPA includes a signed copy of the AMP600 report, along with a letter signed by the chief, certifying that the ambient concentration and QA data in AQS are complete and accurate, taking into consideration the QA findings, to the best of his or her knowledge.

The annual data certification package is due to EPA Region 4 by May 1 of each year.

20.7 Audit of Data Quality

The RCO audit chemist who does not validate the data conducts the audit of data quality (ADQ), which reveals how the level 1 to 3 reviewers handled data, what judgments they made, whether they made uncorrected mistakes and what records exist to support the decisions made. An ADQ can often identify the means to correct systematic data reduction errors. Sufficient time and effort will be devoted to this activity so that the RCO audit chemist has a clear understanding and complete documentation of data flow. The RCO audit chemist shall perform this assessment quarterly in accordance with the quarterly data review as described in SOP 2.39. The DAQ ensures the level 1 to 3 reviewers maintain data collection and handling integrity via the quarterly data review. If the RCO audit chemist finds a problem during the ADQ, the RCO audit chemist will work with the level 1 to 3 reviewers to correct the situation and modify the procedures to ensure the problem does not reoccur. See Section 23.0 of this document for more information related to the data review process that occurs monthly and quarterly.

20.8 Data Quality Assessments

The DQA is the statistical analysis of environmental data to determine whether the data meet the assumptions under which the DQOs and data collection design were developed and whether the total error in the data is tolerable. Calculations for DQA activities shall follow the requirements and equations identified in 40 CFR Part 58, Appendix A, Section 4. The regulations at 40 CFR Part 58, Appendix A provide terminology associated with measurement uncertainty.

An RCO chemist will evaluate the data quality on a quarterly basis using the AQS AMP256 and AMP600 reports. Since the near-road network has only one site, the DAQ bases the evaluation of the data quality on single monitors for this network. The DQAs will be sent to the QAM via email, for information and to allow corrective action to be taken. Copies of the AQS AMP256 and AMP600 files in PDF format are provided upon request. For the annual data certification, the near-road site is combined with monitors from other DAQ-supported networks to determine an estimate of data quality for the agency or PQAO overall. The chief reports the individual results of these tests for each method or analyzer to the EPA annually as part of the AQS AMP600 report.

Level 1 data reviewers use the BAM flow rate control chart in the e-log semi-monthly to identify unusual variations in the flow rates. The Level 1 data reviewers must take corrective action when the control chart shows the flow rate reaching the action level. The RCO chemist reviews control charts of the daily auto zero, span and 1-point-QC check for NO, NO_2, NO_x and CO every business day. When the control chart indicates the zero, span or 1-point-QC check drifted out of range, the RCO chemist contacts the RRO monitoring technician and asks him or her to take corrective action as specified in each monitor's SOP. (Table 11.2 lists associated SOPs.) In addition, box and whisker plots are viewed at least twice a year for the 1-point-QC checks.

20.9 Internal Technical Systems Audits

The DAQ is implementing internal technical systems audits on the near-road monitoring network. These audit procedures, complete with audit checklists, are detailed in SOP DAQ-15-004.5, currently under development. Assigned RCO chemists will be responsible for conducting the systems audits.

20.10 EPA Technical Systems Audits

An EPA TSA is a thorough, independent, and systematic on-site qualitative assessment, where EPA auditors examine facilities, equipment, personnel, training procedures, protocols and recordkeeping for conformance with the regulatory requirements and this QAPP. The EPA Region 4 QA staff conducts a TSA of DAQ every 3 years, in accordance with 40 CFR Part 58, Appendix A, Section 2.5. The EPA reports its findings to the DAQ director and chief. The chief regularly monitors progress on corrective actions required by TSA findings and communicates progress to the director and EPA Region 4.

An EPA TSA team or an individual TSA auditor may segregate TSA activities into multiple categories. The auditor may audit each category independently or may combine them. Possible categories may include:

- Field activities – monitor installation, calibration and sampling;
- Data management activities – collecting, flagging, editing and uploading data and providing data security.

During the audit, the auditors will interview key personnel with responsibilities for planning, field operations, equipment certification, QA/QC, data and document management and reporting.

Upon completion of the audit, EPA verbally alerts the DAQ director and chief of any deficiencies or findings during an on-site TSA exit briefing. This briefing allows DAQ staff to begin formulating or implementing corrective actions. The EPA typically distributes a draft TSA report within 30 days of the completion of the audit. EPA Region 4 allows a brief comment period of the draft report for factual accuracy. After EPA receives comments from DAQ, EPA finalizes the TSA report and resubmits the report to the director and chief. The director and chief must complete and submit to EPA Region 4 within 30 days a formal response to address the TSA findings. The chief will communicate with EPA routinely after submitting the corrective action plan to provide progress updates on a periodic basis until DAQ has completed the corrective actions.

EPA shall conduct TSAs once during every three-year period that the near-road monitoring program collects data verifying compliance with the NAAQS.

20.11 Reporting and Resolution of Issues

The communication process regarding necessary corrective actions within DAQ's near-road monitoring program because of the previously mentioned assessments is detailed in SOP DAQ-15-002. The NC DAQ Ambient Monitoring Section – Hurricane Readiness Task List provides emergency/contingency plans that should be implemented when a hurricane or tropical storm is approaching North Carolina.

21.0 Reports to Management

This section describes the quality-related reports and communications to management necessary to support near-road network operations and the associated data acquisition, validation, assessment and reporting. Besides the reports discussed in this section, staff meetings occur regularly on either a weekly, biweekly or a monthly schedule depending on the part of the organization involved. In addition, DAQ holds as-needed meetings with the affected parties to address any additional issues that may arise. See Section 20.0 of this QAPP for additional information regarding the types of reports generated from AQS used to inform management of QA issues. Unless otherwise indicated, all reports will contain monitoring data for the list of pollutants provided in Table 5.2. Raw data reports may also contain data for shelter temperature.

Reports to management required for the near-road program are the same as those for the SLAMS program which are discussed in various sections of 40 CFR Parts 50, 53 and 58. The EPA's Air Quality Assessment Division within the Office of Air Quality Planning and Standards (OAQPS) provides guidance for management report format and content. The subsections below describe the reports to management used by DAQ.

21.1 Quarterly Data Reports

The DAQ monitoring staff will edit, validate and upload air quality data submitted for each reporting period to AQS using the procedures described in the EPA's AQS User Guide, EPA's *AQS Data Coding Manual*[9] and DAQ's data handling and validation SOPs DAQ-15-005.5 and 2.63.4. The level 1 to 3 reviewers review and validate the concentration data in the Envista ARM database. When a monitor's data capture falls below 75 percent, an RCO chemist prepares for the chief a memo explaining why and the corrective action taken.

Each quarter, DAQ uploads to AQS the results of all valid precision, bias and accuracy tests it carried out during the previous quarter. The database manager submits data to AQS consistent with the data reporting requirements specified for air quality data as set forth in 40 CFR Part 58, Appendix A, Section 5. DAQ reports the required QA data on the same schedule as quarterly monitoring data submittals. The chief is responsible for ensuring that the level 1 to 3 reviewers use the results of QA data to validate concentration data.

In accordance with 40 CFR Section 58.16(b), DAQ submits data to the AQS database no later than 90 days following the end of the quarter in which DAQ collected the data. Table 21.1 provides the dates by which the DAQ must upload the previous quarter's data. After the database manager uploads all data for the quarter to AQS, an RCO chemist retrieves and reviews the following quarterly reports from AQS: the AMP251, AMP256, AMP350, AMP350MX, AMP430 and AMP600. After reviewing the reports, the RCO chemist archives the reports in the Laserfiche general documents module and sends an email to the Level 3 reviewer summarizing the review and any corrective action needed.

[9] Available at https://www.epa.gov/aqs/aqs-manuals-and-guides.

TABLE 21.1 REQUIRED AQS DATA REPORTING PERIODS

Quarter	Reporting Period	Last Day to Upload Data to AQS
Q1	Jan. 1 to March 31	June 29
Q2	April 1 to June 30	Sept. 28
Q3	July 1 to Sept. 30	Dec. 29
Q4	Oct. 1 to Dec. 31	March 30 or 31 (of following year)

21.2 Performance Evaluations

The ECB electronics technicians conduct performance evaluations, sometimes referred to as audits, of the CO and NO_2 monitors at least once each calendar year, using specially designated audit equipment. All gaseous transfer standards used in the air-monitoring network must be traceable to a primary standard such as a NIST standard reference material or an EPA/NIST-approved certified reference material.

The ECB electronics technicians document the results of each performance evaluation on the AQ-121 form. After the ECB supervisor reviews and approves the form, he routes the form to the PPB supervisor for review and approval. After the PPB supervisor reviews and approves the form, the PPB supervisor distributes the form to the RRO supervisor, coordinator and RCO chemists.

The RRO monitoring technician conducts flow rate audits, sometimes referred to as audits, of the $PM_{2.5}$ monitors at least once each quarter, using designated audit equipment that was not used to calibrate the monitors or do the flow rate verifications. All transfer standards used in the air-monitoring network must be traceable to a primary standard such as a NIST standard.

The RRO monitoring technician documents the results of each flow rate audit in the monitor e-log. After the coordinator reviews and approves the e-log, the coordinator transfers the e-log to the PM chemist for review and approval. After the PM chemist reviews and approves the e-log, the PM chemist converts the audit information into a transaction file and submits it to the database manager who uploads it to AQS.

21.3 Annual Network Review

By Oct. 31 of each year, the RRO monitoring technicians conduct an annual site review, documenting the information requested on the annual site review forms, which is part of DAQ's overall annual network review. SOP 2.43.2 describes this process. The network review determines if the monitoring site and probe locations meet the siting requirements and monitoring objectives defined in 40 CFR Part 58, Appendices A, D and E. The review identifies any needed modifications to the site and network including termination or relocation of unnecessary stations or monitors or establishment of new stations or monitors. The RRO monitoring technician completes the annual network review form described in SOP 2.43.2. The RRO regional monitoring coordinator reviews the form and submits it to the RCO by Dec. 31. The PPB supervisor or a designee archives the network review forms in the Laserfiche Ambient Monitoring module and provides them to the public and the EPA as appendices to the annual network-monitoring plan.

21.4 Annual Data Certification

The chief will prepare a data certification package for his or her signature by May 1 of each year, which is submitted to the Director, ARD, US EPA Region 4. The report will consist of a letter, for signature, along with AQS-generated summaries of near-road concentration data collected during the previous year, and all applicable QA data. The OAQPS and EPA Region 4 specify the exact AQS reports for the chief to submit. Generally, the chief submits an AMP600 and AMP450NC report.

21.5 Annual Network Monitoring Plan

Following the requirements in 40 CFR Section 58.10(a), the DAQ prepares and submits to the EPA Region 4 administrator an annual monitoring network plan by July 1 of each year. The plan is reviewed and submitted by the chief. It is composed by the regional air quality supervisors and coordinators, RCO chemists, the Ambient Monitoring Section supervisors and the chief. The plan provides for the establishment and maintenance of an air-quality surveillance system consisting of a network of SLAMS and special purpose monitoring stations. The plan includes: (1) a statement of purpose for each monitor and (2) evidence that siting and operation of each monitor meets the requirements of 40 CFR Part 58, Appendices A, C, D and E, where applicable. Before submitting the plan to the EPA, the DAQ makes the annual monitoring network plan available for public inspection for at least 30 days.

As required by 40 CFR Part 58, Appendix A, Section 5.1, DAQ provides a list of all monitoring sites and their AQS site identification codes to EPA Region 4 each year in the network plan. DAQ keeps AQS up to date by creating site data records with the date DAQ established a site and other pertinent info. DAQ also sends any appropriate data to AirNow-Tech. Whenever there is a change in this list of monitoring sites or in a reporting organization between network plans, DAQ reports this change to EPA Region 4 via email and to AQS and AirNow-Tech by updating the appropriate site records.

21.6 Five-Year Network Assessment

DAQ conducts and submits to the EPA regional administrator an assessment of the air-quality surveillance system every 5 years, which is due on July 1. At a minimum, this assessment determines whether the network achieves the monitoring objectives defined in 40 CFR Part 58, Appendix D, whether DAQ needs to add new sites, whether DAQ no longer needs existing sites and can terminate them, and whether new technologies are appropriate for incorporation into the ambient-air monitoring network. In the network assessment, DAQ considers the ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma). For any sites that DAQ proposes for discontinuance, DAQ also considers the effect on users of the data, other than the agency itself, such as nearby states and tribes or health effects studies. For $PM_{2.5}$, the assessment also identifies needed changes to population-oriented sites. The chief submits a copy of this 5-year assessment, along with a revised annual network plan, to the regional administrator.

21.7 Internal Systems Audit Reports

SOP DAQ-15-004.5, currently under development describes DAQ's internal systems audit program. An RCO auditor or audit team will perform an internal systems audit to verify that the near-road program meets the data measurement quality objectives outlined in section 7.2. When completed, the RCO auditor

or audit team will distribute copies of the annual systems audit report to the RRO, RCO chemist, ECB, the PPB supervisor and the chief.

21.8 Response/Corrective Action Report

Currently, the RRO monitoring technicians document any corrective action taken at the site in an e-log. The RRO monitoring technicians do not send these e-logs to management, but the RRO monitoring coordinator and RCO chemists review them. When the corrective action needed is beyond what the RRO monitoring technician can handle at the site, the RRO monitoring technician contacts the RRO monitoring coordinator and ECB electronics technicians. The ECB electronics technicians document all corrective actions taken on a 109 Form, which the ECB and PPB supervisors review. When the level 1, 2 or 3 reviewers need to correct data reported to AQS, they document the changes on a data correction form (see DAQ-15-005.5 Appendix A). If the corrective action affects several days or a month or more of data, involves a systemic issue, or endangers meeting completeness, an RCO chemist documents the corrective action in a memo to the chief and carbon copies the DAQ RRO air quality supervisor. SOP DAQ-15-002, describes when a need exists for a formal corrective action preventative action (CAPA) process that documents the root cause analysis, investigates solutions, and confirms that the solution was effective.

22.0 Data Validation and Usability

Data review is the in-house examination to ensure that DAQ has recorded, transmitted and processed the data correctly. It includes completeness checks to determine if there are any deficiencies such as missing data or lost integrity. The Level 1 to 3 reviewers should compare the data under evaluation to actual events, as per guidance (*Guidance on Environmental Data Verification and Data Validation* (EPA QA/G-8)). In addition, DAQ expects that some of the QC checks will indicate that the data fail to meet the acceptance criteria. The Level 1 to 3 reviewers shall flag data identified as suspect, or that does not meet the acceptance criteria, with AQS codes prior to upload to AQS.

Data verification is the process for evaluating the completeness, correctness, and conformance/ compliance of the data set against method, procedural and contractual specifications. The EPA further defines verification as confirmation, through provision of objective evidence, that the data has fulfilled all of the specified requirements for that type of data.

Data validation is a routine process designed to ensure that reported values meet the quality goals of the environmental data operations. The EPA further defines data validation as examination and provision of objective evidence that the data fulfilled the particular requirements for a specific *intended use*. The primary intended use for the DAQ data set is NAAQS compliance. The DAQ must use a progressive, systematic approach to data validation to ensure and assess the quality of the data. Data validation includes the review of the DAQ data sets against the individual pollutant MQOs listed in Tables 7.2 – 7.4. Reviewing data long-term (over a monthly or quarterly period) provides information about the structure of the data and may identify patterns, relationships, or potential anomalies. If the RCO chemist finds a problem or discrepancy, he or she will conduct further investigations to find the source of the error and then correct it. Deviations from operational procedures or QA requirements that do not result in data invalidation may require that data be qualified with QA qualifier flags prior to upload to AQS.

22.1 Sampling Design

Sampling network and monitoring site selection must comply with the following:

- 40 CFR Part 58, Appendix A - Quality Assurance Requirements for Monitors Used in Evaluations of National Ambient Air Quality Standards
- 40 CFR Part 58, Appendix D - Network Design Criteria for Ambient Air Quality Monitoring
- 40 CFR Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring
- Near-Road NO_2 Monitoring Technical Assistance Document[10]

The location of the DAQ near-road monitoring site has received EPA approval; thus, data from each near-road criteria pollutant monitor will be considered spatially representative if the near-road site continues to meet the requirements set forth in 40 CFR Part 58, Appendix E and in this QAPP.

[10] Near-Road NO_2 Monitoring Technical Assistance Document, Nealson Watkins and Richard Baldauf, US EPA, EPA-454/B-12-002, June 2012, available on the worldwide web at https://www.epa.gov/sites/default/files/2020-09/documents/nearroadtad.pdf.

Guidance for Choosing a Sampling Design for Environmental Data Collection (EPA QA/G-5S)[11] provides additional guidance.

The RRO monitoring technician shall thoroughly document any deviations from the minimum siting criteria (e.g., shelter location, probe placement and/or monitor sight path requirements) in the site's QC documentation. Examples of deviations include, but are not limited to, insufficient distance from roadways (i.e., marginal terrain criteria) and insufficient distance from influencing objects (e.g., dripline of an adjacent tree or a cell phone tower installed after the monitoring site was established).

22.2 Data Collection Procedures

Section 11.0 Sampling Methods Requirements outlines data collection procedures. The near-road site monitors used by DAQ are designated as FRM/FEM; thus, the methodologies/technologies are considered acceptable for regulatory use. The Envidas Ultimate DAS routinely identifies potentially unacceptable data points in the database through electronic application of Envidas-applied status flags. The database manager has associated each instrument-specific flag with a unique error. The level 1 to 3 reviewers routinely review these Envidas-applied status flags as part of the data validation process. This activity assists in identifying suspect or potentially bad data points that could invalidate the resulting averaging periods. Table 22.1 presents a compilation of the AQS error flags and null codes (as of September 15, 2021). A current list of AQS error flags and null codes can be found at EPA's AQS webpage. The monitoring technician must document any deviation from the established data collection plan in the e-log or site logbook. Accurate and complete documentation of any data collection deviations will assist in any subsequent investigations or evaluations.

TABLE 22.1 AQS QUALIFIER CODE DESCRIPTION AND TYPE

Flag	Flag Description	Flag Qualifier Type	Purpose
IA	African Dust	Informational Only	To provide information on events that influenced the measured values.
IB	Asian Dust	Informational Only	
IC	Chem. Spills and Industrial Accidents	Informational Only	
ID	Cleanup After a Major Disaster	Informational Only	
IE	Demolition	Informational Only	
IF	Fire - Canadian	Informational Only	
IG	Fire - Mexico/Central America	Informational Only	
IH	Fireworks	Informational Only	
II	High Pollen Count	Informational Only	
IJ	High Winds	Informational Only	
IK	Infrequent Large Gatherings	Informational Only	
IL	Other	Informational Only	
IM	Prescribed Fire	Informational Only	
IN	Seismic Activity	Informational Only	
IO	Stratospheric Ozone Intrusion	Informational Only	
IP	Structural Fire	Informational Only	
IQ	Terrorist Act	Informational Only	
IR	Unique Traffic Disruption	Informational Only	

[11] Available at: Guidance on Choosing a Sampling Design for Environmental Data Collection

TABLE 22.1 AQS QUALIFIER CODE DESCRIPTION AND TYPE

Flag	Flag Description	Flag Qualifier Type	Purpose
IS	Volcanic Eruptions	Informational Only	
IT	Wildfire-U. S.	Informational Only	
J	Construction	Informational Only	
1C	A 1-Point-QC check exceeds acceptance criteria but there is compelling evidence that the analyzer data is valid	Missing QA/QC Audit	Void the data and submit the code in its place.
1F	No 1 Point QC but need to count for completeness	Missing QA/QC Audit	
AA	Sample Pressure out of Limits	Null Data Qualifier	
AB	Technician Unavailable	Null Data Qualifier	
AC	Construction/Repairs in Area	Null Data Qualifier	
AD	Shelter Storm Damage	Null Data Qualifier	Void the data and submit the code in its place.
AE	Shelter Temperature Outside Limits	Null Data Qualifier	
AF	Scheduled but not Collected	Null Data Qualifier	
AG	Sample Time out of Limits	Null Data Qualifier	
AH	Sample Flow Rate or CV out of Limits	Null Data Qualifier	
AI	Insufficient Data (cannot calculate)	Null Data Qualifier	
AJ	Filter Damage	Null Data Qualifier	
AK	Filter Leak	Null Data Qualifier	
AL	Voided by Operator	Null Data Qualifier	
AM	Miscellaneous Void	Null Data Qualifier	
AN	Machine Malfunction	Null Data Qualifier	
AO	Bad Weather	Null Data Qualifier	
AP	Vandalism	Null Data Qualifier	
AQ	Collection Error	Null Data Qualifier	
AR	Lab Error	Null Data Qualifier	
AS	Poor Quality Assurance Results	Null Data Qualifier	
AT	Calibration	Null Data Qualifier	
AU	Monitoring Waived	Null Data Qualifier	
AV	Power Failure	Null Data Qualifier	
AW	Wildlife Damage	Null Data Qualifier	
AX	Precision Check	Null Data Qualifier	
AY	QC Control Points (zero/span)	Null Data Qualifier	
AZ	QC Audit	Null Data Qualifier	
BA	Maintenance/Routine Repairs	Null Data Qualifier	
BB	Unable to Reach Site	Null Data Qualifier	
BC	Multi-point Calibration	Null Data Qualifier	
BD	Auto Calibration	Null Data Qualifier	
BE	Building/Site Repair	Null Data Qualifier	
BF	Precision/Zero/Span	Null Data Qualifier	
BG	Missing ozone data not likely to exceed level of standard	Null Data Qualifier	
BH	Interference/co-elution/misidentification	Null Data Qualifier	
BI	Lost or damaged in transit	Null Data Qualifier	
BJ	Operator Error	Null Data Qualifier	

TABLE 22.1 AQS QUALIFIER CODE DESCRIPTION AND TYPE

Flag	Flag Description	Flag Qualifier Type	Purpose
BK	Site computer/data logger down	Null Data Qualifier	
BL	QA Audit	Null Data Qualifier	
BM	Accuracy check	Null Data Qualifier	
BN	Sample Value Exceeds Media Limit	Null Data Qualifier	
BR	Sample Value Below Acceptable Range	Null Data Qualifier	
CS	Laboratory Calibration Standard	Null Data Qualifier	
DA	Aberrant Data (Corrupt Files, Aberrant Chromatography, Spikes, Shifts)	Null Data Qualifier	
DL	Detection Limit Analyses	Null Data Qualifier	
EC	Exceeds Critical Criteria	Null Data Qualifier	
FI	Filter Inspection Flag	Null Data Qualifier	
MB	Method Blank (Analytical)	Null Data Qualifier	
MC	Module End Cap Missing	Null Data Qualifier	
QV	Quality Control Multi-Point Verification	Null Data Qualifier	
SA	Storm Approaching	Null Data Qualifier	
SC	Sampler Contamination	Null Data Qualifier	
ST	Calibration Verification Standard	Null Data Qualifier	
SV	Sample Volume out of limits	Null Data Qualifier	
TC	Component Check and Retention Time Standard	Null Data Qualifier	
TS	Holding Time or Transport Temperature Is Out of Specs.	Null Data Qualifier	
XX	Experimental Data	Null Data Qualifier	
1	Deviation from a CFR/Critical Criteria Requirement	Quality Assurance Qualifier	Flag indicating the quality of the data. In some cases, the data may not meet all the criteria but is still valid.
1V	Data Reviewed and Validated	Quality Assurance Qualifier	
2	Operational Deviation	Quality Assurance Qualifier	
3	Field Issue	Quality Assurance Qualifier	
4	Lab Issue	Quality Assurance Qualifier	
5	Outlier	Quality Assurance Qualifier	
6	QAPP Issue	Quality Assurance Qualifier	
7	Below Lowest Calibration Level	Quality Assurance Qualifier	
9	Negative value detected - zero reported	Quality Assurance Qualifier	
CB	Values have been Blank Corrected	Quality Assurance Qualifier	
CL	Surrogate Recoveries Outside Control Limits	Quality Assurance Qualifier	
DI	Sample was diluted for analysis	Quality Assurance Qualifier	
EH	Estimated; Exceeds Upper Range	Quality Assurance Qualifier	
FB	Field Blank Value Above Acceptable Limit	Quality Assurance Qualifier	
FX	Filter Integrity Issue	Quality Assurance Qualifier	
HT	Sample pick-up hold time exceeded	Quality Assurance Qualifier	
LB	Lab blank value above acceptable limit	Quality Assurance Qualifier	
LJ	Identification of Analyte is Acceptable; Reported Value Is an Estimate	Quality Assurance Qualifier	

TABLE 22.1 AQS QUALIFIER CODE DESCRIPTION AND TYPE

Flag	Flag Description	Flag Qualifier Type	Purpose
LK	Analyte Identified; Reported Value May Be Biased High	Quality Assurance Qualifier	
LL	Analyte Identified; Reported Value May Be Biased Low	Quality Assurance Qualifier	
MD	Value less than MDL	Quality Assurance Qualifier	
MS	Value reported is 1/2 MDL substituted.	Quality Assurance Qualifier	
MX	Matrix Effect	Quality Assurance Qualifier	Flag indicating the quality of the data. In some cases, the data may not meet all the criteria but is still valid.
ND	No Value Detected, Zero Reported	Quality Assurance Qualifier	
NS	Influenced by nearby source	Quality Assurance Qualifier	
QX	Does not meet QC criteria	Quality Assurance Qualifier	
SQ	Values Between SQL and MDL	Quality Assurance Qualifier	
SS	Value substituted from secondary monitor	Quality Assurance Qualifier	
SX	Does Not Meet Siting Criteria	Quality Assurance Qualifier	
TB	Trip Blank Value Above Acceptable Limit	Quality Assurance Qualifier	
TT	Transport Temperature is Out of Specs.	Quality Assurance Qualifier	
V	Validated Value	Quality Assurance Qualifier	
VB	Value below normal; no reason to invalidate	Quality Assurance Qualifier	
W	Flow Rate Average out of Spec.	Quality Assurance Qualifier	
X	Filter Temperature Difference or Average out of Spec.	Quality Assurance Qualifier	
Y	Elapsed Sample Time out of Spec.	Quality Assurance Qualifier	
RA	African Dust	Request Exclusion	Flags data influenced by an exceptional event for which the agency plans to submit a data exclusion request.
RB	Asian Dust	Request Exclusion	
RC	Chemical Spills and Industry Accidents	Request Exclusion	
RD	Cleanup After a Major Disaster	Request Exclusion	
RE	Demolition	Request Exclusion	
RF	Fire - Canadian	Request Exclusion	
RG	Fire - Mexico/Central America	Request Exclusion	
RH	Fireworks	Request Exclusion	
RI	High Pollen Count	Request Exclusion	
RJ	High Winds	Request Exclusion	
RK	Infrequent Large Gatherings	Request Exclusion	
RL	Other	Request Exclusion	
RM	Prescribed Fire	Request Exclusion	
RN	Seismic Activity	Request Exclusion	
RO	Stratospheric Ozone Intrusion	Request Exclusion	
RP	Structural Fire	Request Exclusion	
RQ	Terrorist Act	Request Exclusion	
RR	Unique Traffic Disruption	Request Exclusion	
RS	Volcanic Eruptions	Request Exclusion	
RT	Wildfire-U. S.	Request Exclusion	

Data collection procedures must adhere to those procedures documented in the SOPs listed in Table 11.2. EPA and internal auditors verify adherence to data collection procedures and the associated SOPs during EPA TSAs and internal systems audits. Any time the RRO monitoring technician or coordinator uses a code to void or flag data, he or she should document the reason for using the code in the appropriate logbook. Accurate and complete documentation of any flagged or voided data will assist in any subsequent investigations or evaluations.

22.3 Quality Control

Section 14.0 Quality Control Requirements and Procedures specifies the QC checks that RRO monitoring technicians must perform during data collection and analysis. These include the analysis of 14-day 1-point-QC checks and monthly or semi-monthly flow rate verifications, which provide indications of the quality of the data produced by specified components of the measurement process. SOPs 2.17.2, DAQ-04-001.2 and 2.46.2 (see Table 11.2 for SOP titles) specify the procedure, acceptance criteria and corrective action (and changes) for each QC check. Data validation should document the corrective actions taken, affected sampling days or hours and the potential effect of the actions on the validity of the data. The level 1, 2 and 3 data reviewers will:

- Code missing $PM_{2.5}$, CO, and $NO/NO_2/NO_x$ data with appropriate AQS null codes,
- Invalidate hourly CO and $NO/NO_2/NO_x$ data if less than 45 minutes of valid data are collected within the hour,
- Invalidate CO and $NO/NO_2/NO_x$ data when the FRM or FEM shelter temperature requirements are not met,
- Bracket valid CO and $NO/NO_2/NO_x$ data with valid, 1-point QC checks that meet the MQOs and control limits,
- Invalidate CO and $NO/NO_2/NO_x$ data back to the most recent valid, passing 1-point QC check and forward to the completion of appropriate corrective actions and calibration when a valid 1-point QC check exceeds critical criteria,
- Report all valid QA/QC data to AQS, with valid 1-point QC checks that exceed acceptance criteria reported with the "1F" null code and invalid 1-point QC checks reported with the "1C" null code,
- Bracket valid $PM_{2.5}$ data with valid, flow rate verification checks that meet the MQOs and control limits, and
- Invalidate $PM_{2.5}$ data back to the most recent valid, passing flow rate verification check and forward to the completion of appropriate corrective actions and calibration when a valid flow rate verification check exceeds critical criteria.

Tables 7.2 – 7.4, along with SOPs 2.17.2, DAQ-04-001.2 and 2.46.2 provide further information about 1-point-QC checks and monthly flow rate verifications.

22.4 Calibration

Section 14.0 Quality Control Requirements and Procedures addresses the calibration of the monitors, along with the information RRO monitoring technicians should present to demonstrate they performed the calibrations correctly, and that the results are acceptable. When a level 1 to 3 reviewer identifies calibration problems, he or she should flag or void any data produced between the suspect calibration

event and any subsequent recalibration to alert data users. SOPs 2.17.2, DAQ-04-001.2 and 2.46.2 (see Table 11.2 for SOP titles) provide further information about calibrations.

22.5 Data Reduction and Processing

As mentioned in the above sections, the EPA will perform external TSAs to ensure the level 1 to 3 data reviewers follow the data reduction and processing activities mentioned in the QAPP. The level 1 to 3 data reviewers will review data monthly to ensure that associated flags or any other data qualifiers have been appropriately associated with the data. An RCO audit chemist will review the data quarterly to ensure that RRO monitoring technicians and coordinator, ECB electronics technicians and the RCO chemists doing the level 3 review took appropriate corrective actions.

22.6 Exceptional Events

The regulations in 40 CFR Section 50.14 allow the EPA Administrator to exclude certain data from use for determinations of exceedances and violations of a NAAQS, so long as a state or local agency demonstrates to the Administrator's satisfaction that an "exceptional event" caused the exceedance or violation. The regulations in 40 CFR Section 50.1 define an "Exceptional Event" as an event or events, in which:

- The resulting emissions affect air quality in such a way that there exists a clear causal relationship between the specific event(s) and the monitored exceedance(s) or violation(s);
- The event(s) is not reasonably controllable or preventable; and
- The event(s) is caused by a human activity that is unlikely to recur at that location or is a natural event(s).

An exceptional event does not include:

- Air pollution relating to source noncompliance;
- Stagnation of air masses or meteorological inversions; and
- Meteorological events involving high temperatures or lack of precipitation.

Conditions involving high temperatures or a lack of precipitation may promote occurrences of some types of exceptional events, such as wildfires or high wind events, which do directly cause emissions.

The EPA does not consider data impacted by an exceptional event "representative" of air quality for NAAQS comparison purposes, or calculation of certain summary statistics. The RCO chemist should flag all concentration data impacted by an exceptional event with an AQS information code linked within AQS to an event description. The RCO chemist should add exceptional event codes and descriptions to AQS during the monthly data review or as soon thereafter as possible, but no later than the schedule established by federal rulemaking.

It is the responsibility of the RCO chemist with the assistance of the regional office staff and air quality forecasters to analyze the data for potential exceptional events and to add the necessary flags and descriptions into AQS by the applicable regulatory due dates.

To obtain concurrence with an exceptional event the RCO must notify and cooperate with EPA Region 4 to prepare a demonstration package for the EPA Administrator. When the chief submits a demonstration

package, the RCO chemist working with the database manager will change the informational flags in AQS to request exclusion flags.

Exceptional event data in AQS must receive concurrence from the EPA Administrator. Data that does not receive a concurrence is still eligible for NAAQS comparisons, regardless of the application of request exclusion flags.

23.0 Verification and Validation Methods

Data verification is the process of evaluating the completeness, correctness, and conformance of a specific data set against the method, procedural, or contractual requirements, as specified in both the SOPs and 40 CFR Part 58. Data validation is a routine process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to ensure that reported values meet the quality goals of the environmental data operations and that the data can be used for its intended purpose.

The DAQ uses the validation templates provided in Tables 7.2 to 7.4 for the weight of evidence approach afforded to PQAOs within 40 CFR Part 58, Appendix A. The DAQ follows the guidance in the QA Handbook regarding the use of these templates and handles the criteria as follows:

- Critical criteria are criteria deemed critical to maintaining the integrity of an ambient air concentration value or group of values. The level 1 to 3 reviewers should invalidate observations that do not meet each criterion on the critical table unless there are compelling reasons and justification for not doing so. Basically, the concentration value or group of concentration values that do not meet one or more of these criteria is invalid until proven otherwise. In most cases, the CFR dictates the requirement, the implementation frequency of the criteria and the acceptance criteria so these criteria are therefore regulatory in nature.
- Operational criteria are situations in which violations of a criterion or criteria may be cause for invalidation of the data. The level 1 to 3 reviewers should consider other QC information that may or may not indicate the data are acceptable for the parameter they want to control. Therefore, the data, which do not meet one or more of these criteria, are suspect, unless other QC information demonstrates otherwise, and the reviewers have adequate documentation of that information. The level 1 to 3 reviewers should investigate, mitigate, or justify the reason for not meeting the criteria.
- Systematic criteria include those criteria which are important for the correct interpretation of the data, but do not usually change the validity of a datum or data. An example criterion is that at least 75 percent of the days for each quarter should successfully collect 18 or more hours of valid concentration values. The DQOs are also included in this table. If the data do not meet the DQOs, this does not invalidate any of the data, but it may reduce the confidence in the attainment or non-attainment decision.
- The designation of QC checks as operational or systematic does not imply that the RRO monitoring, and ECB electronics technicians do not need to perform these QC checks. Not performing an operational or systematic QC check required by regulation can be a basis for invalidation of all associated data. The DAQ applies the validation templates only to small datasets of single values or a few weeks of information and does not allow a criterion to be in non-conformance simply because it is operational or systematic.

23.1 Validating and Verifying Data

The validation and verification procedures that DAQ will employ for this operation shall conform to the validation SOPs listed in Table 11.2. *Guidance on Environmental Data Verification and Data Validation,* (EPA QA/G-8) also discusses verification and validation issues at length. The RRO monitoring

technicians and coordinator shall perform all verification activities. The RCO chemists shall provide additional support through a final review of all data, reconciling any anomalies through discussions with the RRO. Following the final review, the RCO chemists will provide a final validation of all data. The RCO chemists will also provide QA/QC support.

The level 1 to level 3 data reviewers should compare data under evaluation to actual events as specified in applicable SOPs. However, significant or unusual field events may occur, and field activities may negatively affect the integrity of data. In addition, the DAQ expects that some of the QC checks will indicate the data fail to meet the acceptance criteria in Tables 7.2 – 7.4. The level 1 to level 3 data reviewers shall void or flag data identified as suspect, or does not meet the acceptance criteria, as indicated in Table 22.1.

The DAQ verifies and validates the routine and the associated QC data monthly. Presently, monthly review is the most efficient period for these verification and validation activities. The DAQ finds that if DAQ can control the measurement uncertainty each month, then the DAQ will maintain the overall measurement uncertainty for the one-year and three-year periods within the precision and bias DQIs.

23.2 Verification

After the previous month of data is available, the level 1 and 2 reviewers conduct a thorough review of the data for completeness and accuracy. Once the database manager enters the data into the Envista ARM database, the RRO monitoring technician will review the data for routine data outliers and conformance to acceptance criteria. The RRO monitoring technician will void or flag appropriately unacceptable or questionable data. The RRO coordinator will verify all flagged data again to ensure that the RRO monitoring technician entered the flags and voids correctly and that the data are acceptable for use. The level 1 and 2 reviewers document their review in Envista ARM along with their data review decisions.

23.3 Validation

Validation of continuously obtained data requires two stages, one at the measurement value level and another after the previous month of data becomes available. The Envista ARM database retains records of all invalid data. Information shall include a summary of why the level 1 to 3 reviewers invalidated the measurement along with the associated null codes or flags. Logbook notes shall have more detailed information regarding the reason a reviewer voided or flagged a measurement.

The DAQ brackets all gaseous pollutant data by 1-point-QC checks or manual calibration checks before and after any invalidated period. When a monitor fails, the level 1, 2 or 3 reviewers invalidate any data after the last passing 1-point QC check. For the NO_2 and CO, the DAQ generally brackets all data by 1-point QC checks, but since the 1-point QC checks are performed every 14-days, in cases where weight of evidence exists that the data are valid, the DAQ may choose to invalidate data back to the last passing overnight diagnostic check instead of the last 1-point QC check. The requirement to bracket the data helps to ensure that the NO_2 and CO monitors were in proper operating condition before and after the incident. In the same way, the DAQ brackets PM data by flow rate verifications or a calibration before and after any invalidated period.

Data validation occurs monthly. DAQ does not use EPA's Data Assessment Statistical Calculator (DASC) tool to evaluate data collected at the near-road monitoring site. The discussion below outlines the

review, verification and validation processes. The organizational chart in Figure 4.1 labels the specific roles for review level 1 through 3 within the organization.

Level 0 Review – The Envidas DAS does the level 0 review.

- Acquire minute averages from instantaneous averages and hourly averages from minute averages.
- Flag missing and irregular data with pre-programmed, user-defined status flags.

Level 1 Review – The RRO monitoring technician does the level 1 review.

- Review daily for anomalies and completeness and acquire missing data if available.
- Verify that all daily precision checks fall within acceptable ranges.
- Invalidate data collected during an hour where the shelter temperature was not within the acceptable range.
- Evaluate automated nightly and 14-day PZS checks and take appropriate corrective action if necessary.
- Review minute data.
- Verify maximum daily values for validity and take appropriate action if necessary.
- Assess data for values or outliers outside of the acceptable ranges.
- Review the hourly values for any exceedances and take appropriate action if necessary.
- Review minute data as needed when completing the level 1 review procedures.
- Flag data as necessary for further investigation.
- Apply necessary AQS codes from Table 22.1 for hours in which maintenance or calibrations were occurring.

Level 2 Review (Verification) – The RRO monitoring coordinator does the level 2 review.

- Review site records (operator logbook, site logbook).
- Review operator checks (leak checks, filter changes, monthly flow verifications, VSCC cleaning and maintenance).
- Assess data for values or outliers outside of the acceptable ranges.
- Review minute data as needed when completing the level 2 review procedures.
- Determine if mobile or area source specific emissions caused any irregularities.
- Flag data as necessary for further investigation.
- Ensure level 1 reviewers used consistent reasons for data invalidation throughout the monitoring period to indicate calibrations, audits, etc.
- Resolve any inconsistencies, anomalies, or systemic issues.
- Verify that all daily and 14-day precision checks fall within acceptable ranges.

Level 3 Review (Validation) – The RCO chemist does the level 3 review.

- Ensure the proper null codes are used.
- Ensure that level 1 and level 2 reviewers bracketed all invalidated data with the appropriate void codes and the correct checks of analyzer accuracy.
- Ensure all data falls within the acceptable ranges as stated in the MQOs in Tables 7.2 – 7.4.

- Ensure all data is acceptable and can be used for its intended purpose.
- Review minute data to confirm that 45 minutes of data are available within an hour.
- Add informational AQS flags (from Table 22.1) to describe data that is out of the ordinary but may be considered "valid."
- Provide final validation signature.

The DAQ uses a weight of evidence approach in validating data. After level 1 and 2 verifications, the independent level 3 reviewer determines the validity of the data by reviewing:

- The one minute and hourly values;
- Daily automatic QC checks, flow verifications, any manual checks and the 14-day checks;
- Leak checks;
- e-logs and the information documented therein;
- Correspondence with the RRO monitoring technicians and coordinator and ECB electronics technicians; and
- The results of DAQ and EPA performance evaluations and semi-monthly flow rate audits.

The level 3 reviewer compares all available information to the specifications in Tables 7.2 through 7.4. The weight the reviewer should give to the available evidence depends on factors such as the quality of the data, consistency of results, nature and severity of effects, and relevance of the information. The weight of evidence approach requires use of scientific judgment and, therefore, it is essential to provide adequate and reliable documentation.

As a general principle, the more information the RRO monitoring technician provides, the stronger the weight of evidence. The RRO monitoring technician and coordinator should present the information in a structured and organized way and the data validator should consider the robustness and reliability of the different data sources to support any justification for validating or invalidating data.

The Envidas software completes the level 0 review daily. The RRO monitoring technicians and coordinator will complete the level 1 and 2 reviews within 20 calendar days from the end of the monitoring month. (Example: The month ends on February 28th. The level 1 and 2 reviews must be complete by the 20th day of March). The RCO chemist will complete the level 3 review 20 calendar days after the level 2 review is completed. (Using the prior example, the level 3 review must be complete by April 10th).

An independent RCO chemist will complete a review of the validated data after the database manager uploads it to AQS and within 40 calendar days after the level 3 review is complete.

As discussed earlier, the EPA and DAQ have developed certain criteria based upon federal requirements and RRO monitoring technicians' judgment that the level 1 to 3 reviewers will use to invalidate a datum or measurement. The level 1 to 3 reviewers shall use the null data codes listed in Table 22.1 to indicate they have invalidated individual measurements or groups of measurements from an instrument.

24.0 Reconciliation with Data Quality Objectives

Section 6.0 Project/Task Description describes the objectives of the near-road monitoring program. Section 7.0 Quality Objectives and Criteria for Measurement Data describes the DQO's for the near-road monitoring program.

The AQS AMP256 and AMP600 reports are automated reports based on data uploaded to AQS. These reports provide summary statistics for the data collected. Because the DAQ uses warning limits that are more stringent than EPA's control limits for its data and implements EPA's critical criteria for all monitoring, DAQ should not have to directly calculate confidence intervals annually because all data should statistically meet the DQOs.

An RCO chemist will analyze the results of both the AQS AMP256 and AMP600 reports on a quarterly and annual basis to ensure all near-road monitors meet the required DQO's. This chemist documents this review by archiving the AMP256 and AMP600 reports in the Laserfiche Ambient Monitoring module. (see Sections 20.6 and 20.8, also.) If the data from any of the monitors at the near-road site violate the DQI bias and/or precision limits, then the RCO chemist will investigate to uncover the cause of the violation. Depending on the severity of the violation and weight of evidence, the level 3 reviewer will either void or flag the data in AQS. The RCO chemist may compare data from the monitors at the near-road site to other monitors operated by DAQ to determine if the cause is at the agency level (RRO monitoring training) or higher (problems with method designation). If only the monitor at the near-road site violates the DQO, the cause is more likely specific to the site (RRO monitoring technician, problem with the site). Tools for determining the cause include reviewing:

- Data from a local or tribal program or nearby reporting organizations;
- Data from performance audits (DAQ, NPAP, or PEP); and
- QC trends.

Once DAQ has identified a cause, DAQ will implement an appropriate corrective action. Some courses of action include:

- Determining the level of aggregation at which DAQ violated the DQOs: Results of the DQA process tell which monitors have problems, since the EPA developed the DQOs at the monitor level. To determine the level at which to take corrective action, the DAQ must determine whether the violations of the DQOs are unique to the near-road site, multiple sites or a network of similar monitors, or caused by a broader problem. The AQS generates QA reports summarizing bias and precision statistics at the national and reporting organization levels by method designation. Examination of these reports may assist in determining the level at which the DQOs are being violated.
- Communicating with EPA Region 4: If DAQ finds a violation of the bias and precision DQOs, the chief will remain in close contact with EPA for both assistance and for communication.
- Extensively reviewing quarterly data until DAQ achieves the DQOs: The chief will continue to review extensively the quarterly QA reports and the QC summaries until the DAQ attains the bias and precision limits.

- Updating MQOs and quality assurance documents: If the cause indicates that the MQOs, SOPs associated with this QAPP, or this QAPP need to be updated, the RCO chemists will inform the chief and PPB supervisor of the needed changes and either the chief or PPB supervisor will assign staff to make the necessary updates. Should staff not be readily available to make these updates in a timely fashion, the chief or PPB supervisor will assign staff to make a QA Bulletin addressing the change until such time that the documents associated with this QAPP can be updated.

Ultimately, specifying tolerable error limits reduces the probability of making an error in a decision due to uncertainty in the data. Decision makers, such as EPA and the director, need to determine if the data collected within the DAQ monitoring network are adequate for meeting the monitor objectives listed earlier in Section 6.0 Project/Task Description. The annual data certification process and reports generated as part of the certification provide a quantitative assessment of the measurement uncertainty within the DAQ criteria pollutant data set. By controlling uncertainty in the data to the extent prescribed by the DQOs, decision makers can use DAQ's ambient air monitoring data with confidence.

Revision History

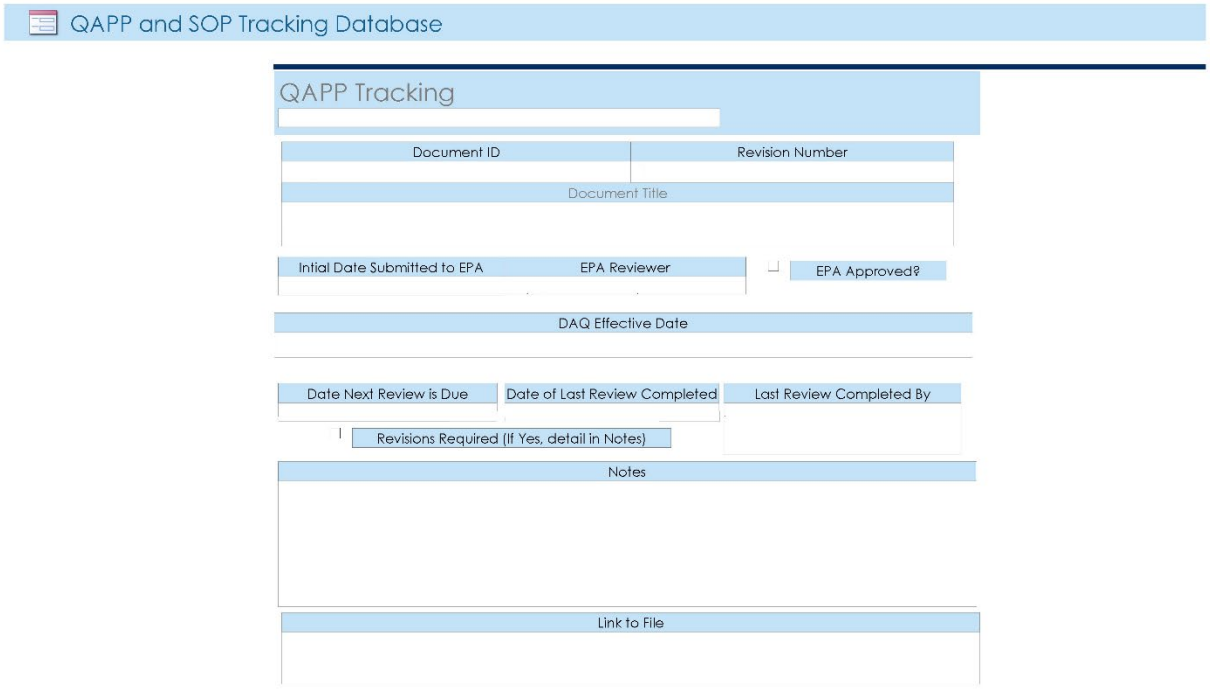
The Near-road monitoring network was removed from the Criteria Pollutant QAPP in Revision 0 in 2019.

The following revisions have been made to Revision 0:

Date	Person Revising Document	Revision	Page No.	Approved by/Date
10/20/2021	Kay Roberts	Updated addressee and acronym list	1, 3-4	Joette Steger/ 11/4/2021
		Table 3.1, the distribution list was updated	11-12	
		Minor grammatical and editorial changes were made throughout the document.	28-30, 32, 61-63, 65-71, 74-81, 93-95, 98, 106, 108-109	
		Table 7.2 was revised to correct for differences from the EPA validation template or DAQ practice	33-35	
		Table 7.3 was revised to correct for differences from the EPA validation template or DAQ practice	36-38	
		Table 7.4 was revised to correct for differences from the EPA validation template or DAQ practice	39-42	
		Section 8 was revised to be accordant with current DAQ policies and procedures	43-44	
		Section 9 was revised to be accordant with current DAQ policies and procedures	45-52	
		Shelter temperature was added to Table 10.2	56	
		The traffic counter methodology was updated in Table 11.1 and section 11.1.5	58, 60	
		Table 11.2 was revised to list the most current SOPs	60-61	
		Table 14.1 and Section 14.1 were updated with new calibration information for CO	68	
		Section 14.3 was edited to remove the discussion about a collocated monitor	70	
		Section 15.2 was updated to remove the requirement for final testing of a monitor by collocating it at the site with the existing monitor	75	
		Section 19 was revised to be accordant with current DAQ policies and procedures	84, 86-90	
		Section 20 was revised to be accordant with current DAQ policies and procedures	91, 95-96	
		Section 21 was revised to be accordant with current DAQ policies and procedures	97-100	

Date	Person Revising Document	Revision	Page No.	Approved by/Date
		Table 22.1 was updated to contain the new qualifier and null data codes	102-105	
		Section 23 was revised to be accordant with current DAQ policies and procedures	109-11	
June 2022	Kay Roberts	Changes made per comment made by Tony Bedel (US EPA, Region4) during his review of this QAPP.	All Sections of Document	Joette Steger/ 8/23/2022
October 2022	Kay Roberts	Changes made per comment made by Tony Bedel (US EPA, Region4) during his review of this QAPP.	21, 68, 87	Joette Steger/ 28 Oct. 2022
26 October 2022	Joette Steger	Changed IBEAM to Laserfiche as storage location for electronic documents	Primarily Sections 8, 9 and 19	

QAPP Annual Review Documentation



Document ID	DAQ-01-006
Name of Document:	Near Road
Revision Number:	
Effective Date:	

#	Date of Review	Review Completed By
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		