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CHEROKEE NATION®

Office of the Chief

Bill John Baker
Principal Chief

S. Joe Crittenden
Deputy Principal Chief

May 30, 2019

Frances Verhalen, Section Chief
Air Quality Analysis Section (6PD-Q)
U.S. EPA, Region VI
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

RE: QAPP FOR CHEROKEE NATION'S CRITERIA POLLUTANT AND METEOROLOGICAL MONITORING PROGRAM

To Whom It May Concern:

Enclosed please find the Quality Assurance Project Plan for the Cherokee Nation's Criteria Pollutant and Meteorological Monitoring Program for your review. Please sign and date the signature page and return a copy of it to me. Also, please let me know the QTRAK number for this QAPP.

Minor revisions were made to the QAPP which pertain to the discontinuation and removal of the Tahlequah air monitoring station, removal of non-operating equipment, and procurement of a new primary ozone standard. These revisions are addressed and incorporated primarily in Sections 6, 10, 13, 14, 16, and 19.

If you have any questions or concerns, please contact me at (918) 453-5098. Thanks for your time and effort in reviewing the QAPP.

Sincerely,

April Hathcoat

April Hathcoat, Director
Cherokee Nation Environmental Programs

Enclosure

Cc: CNEP Air Program Files

1 Quality Assurance Project Plan Approval

Wayne Isaacs ______________________ Date: 05/31/2019

Wayne Isaacs, Senior Director
Environmental Programs
Cherokee Nation

April Hathcoat ______________________ Date: 5-31-19

April Hathcoat, Director
Environmental Programs
Cherokee Nation

Danielle Keese ______________________ Date: 5-31-19

Danielle Keese, Environmental Specialist III
Environmental Programs
Cherokee Nation

______________________ Date: __________

Frances Verhalen, Section Chief
Air Monitoring & Grants Section
U.S. EPA, Region VI Office

______________________ Date: __________

Aunjanee Gautreaux, Project Officer
Air Monitoring & Grants Section
U.S. EPA, Region VI Office

______________________ Date: __________

Mark Sather, Environmental Engineer
Air Monitoring & Grants Section
U.S. EPA, Region VI Office

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Figures and Tables

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3 Distribution

The following persons will receive approved copies and updates of the QAPP:

April Hathcoat, Project Coordinator
Environmental Programs, Cherokee Nation

Aunjanee Gautreaux, Project Officer
Air Monitoring & Grants Section
U.S. Environmental Protection Agency, Region VI

4 Project Organization

4.1 Roles and Responsibilities

The Cherokee Nation Environmental Programs (CNEP) operates an Ambient Air Monitoring Network of sites and instruments that monitor criteria pollutants and meteorological parameters. As the lead technical agency for the Inter-Tribal Environmental Council (ITEC), the CNEP also provides technical services to ITEC-member tribes involved in monitoring of criteria pollutants and other parameters of ambient air quality. This QAPP addresses all aspects of the CNEP's monitoring of criteria pollutants and meteorological parameters, including NCore monitoring and services to ITEC tribes. Section 5 of this QAPP describes the history and goals of the CNEP's monitoring activities for criteria pollutants and meteorological parameters. [The CNEP's monitoring of particulate matter via filter-based federal reference method samplers will be covered by a separate QAPP. At this time, CNEP does not operate any of the filter-based federal reference method samplers for particulate matter.]

The CNEP, various U.S. Environmental Protection Agency (EPA) programs and offices, and independent contractors all play vital roles in the success of the Cherokee Nation Ambient Air Monitoring Network. Each is responsible for implementing various components of the monitoring network, including site setup, instrument operation and maintenance, collecting and analyzing data, audits, data management, and implementing the QA/QC standards that will meet approved EPA requirements. The key agencies, programs, offices, and independent contractors include:

- Cherokee Nation Environmental Programs (CNEP Air Program)
- U.S.EPA RTP, Office of Air Quality Planning and Standards (OAQPS)
- U.S.EPA Region VI Office (Air Monitoring & Grants Section)
- INQUEST Environmental (independent contractor)

The various responsibilities for each of the relevant agencies, programs, offices, and independent contractors are identified in the following sections.

4.2 Cherokee Nation Environmental Programs

The major responsibilities of the CNEP's Air Program personnel include operation and maintenance of monitoring station shelters and instruments; auditing instrument performance; collection, management, and reporting of data; and entering data in the EPA's Air Quality System (AQS). CNEP responsibilities also include the development and implementation of quality assurance and quality control protocols for all activities involving data collection, management, and reporting. **Figure 4.1** describes the organizational structure of the CNEP's Air Program, as well as the roles of EPA offices and contractors in the CNEP Ambient Air Monitoring Network.

4.2.1 Project Manager & Data Quality Control Review Officer

April Hathcoat (Director) is the CNEP Clean Air Program Manager and serves as the Project Manager/Data Quality Control Review Officer for the Air Program. Ultimate responsibility for all project operations, QA/QC implementation, and major project decisions rests with the Project Manager. Responsibilities for the Project Manger/Data Quality Control Review Officer include, but are not limited to, the following:

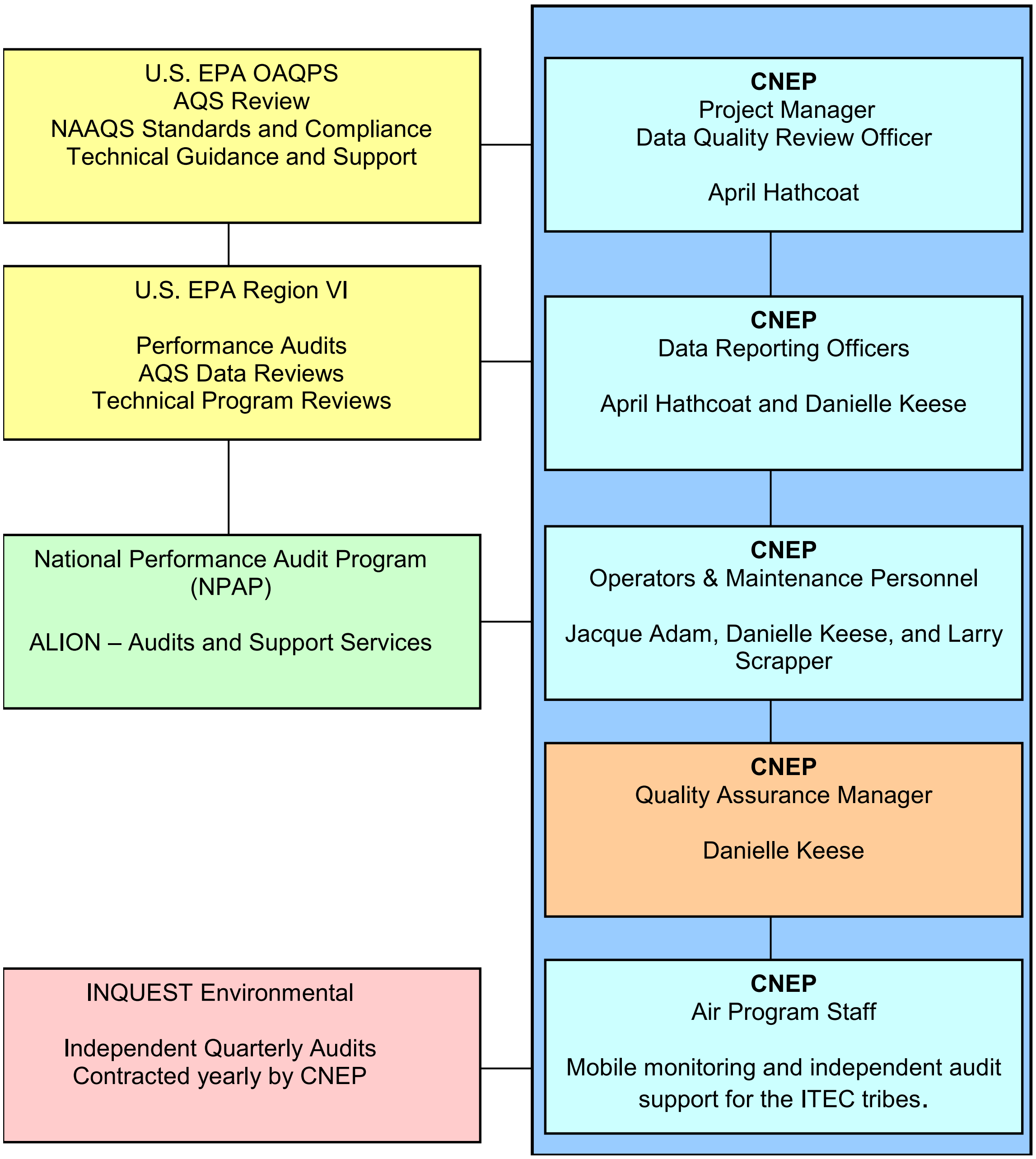
- Administrative management
- Project operations
- QA/QC development and implementation
- Final data review and validation
- Technical system audits, assessments, and reviews
- Reporting and record management
- Review and analysis of data and reports

4.2.2 QA Manager

Danielle Keese (Environmental Specialist III) serves as the QA Manager for the CNEP Air Program. The QA Manager is primarily responsible for QA/QC development and implementation, QAPP development and revision, and project management assistance. Responsibilities for the QA Manager include, but are not limited to, the following:

- Development and implementation of QA/QC protocols and SOPs
- Writing and revising Quality Assurance Project Plans (QAPPs)
- Assisting the Project Manager with project management

Figure 4.1
CNEP Air Program Staff and External Parties Involved with CNEP Air Program



4.2.3 Data Reporting Officers

April Hathcoat (Director) and Danielle Keese (Environmental Specialist III) serve as the Data Reporting Officers for the Air Program. They are responsible for the initial generation of the Air Program reports. Specific duties for the Data Reporting Officers include, but are not limited to the following areas:

- Initial preparation of Missing Data Reports & Data Validation Reports
- Precision & Accuracy Reports
- Initial data review
- Initial batch editing of AQS files
- AQS data entry
- Quarterly audits

4.2.4 Site Operator/ Maintenance Personnel

Jacque Adam (Environmental Specialist III), Danielle Keese (Environmental Specialist III) and Larry Scrapper (Environmental Specialist II) serve as the Site Operators and Maintenance Personnel for the CNEP Air Program. Specific duties include, but are not limited to, the following:

- Initial site setup
- Instrument operation, maintenance, and repair
- Level II, nightly audit reviews
- Initial data review
- Level I audits & calibrations
- Multi-point calibrations

4.3 INQUEST Environmental

INQUEST Environmental, an independent contractor hired by the CNEP, is responsible for conducting independent quarterly performance audits of CNEP instruments during the project period. INQUEST's duties include, but are not limited to:

- Independent quarterly performance instrument audits
- Preparation of independent quarterly audit results and reporting

5 Problem Definition/Background

5.1 Problem Background

The Inter-Tribal Environmental Council (ITEC) is a consortium of federally-recognized tribes (**Figure 5.1**). As a consortium, ITEC's primary goal is the protection of the health, safety and welfare of the Indian population. This goal includes the proper management of Indian environmental resources, e.g., land, air and water. As the lead technical agency for the consortium, the Cherokee Nation Environmental Programs (CNEP) is committed to providing environmental management services to the ITEC member tribes.

5.2 Problem Definition

In 1997, the EPA Office of Air & Radiation prepared a draft document titled "Strategy for Implementing the Clean Air Act in Indian Country." Within the context of the document the EPA acknowledged that there was a lack of real reservation-specific data to quantify or qualify air quality issues; an incomplete federal regulatory authority in Indian Country; an increased need for technical support in the regions; and a problem of variable tribal capacity. The document identified the following in its strategic solution for tribes: the need to develop regulatory authority; build regional agency capacity; work with tribes to build their own capacity; and provide technology information transfer. The EPA Region VI Office began to address some of these environmental issues and other concerns through the Inter-Tribal Environmental Council (ITEC) and through funding to individual tribes, such as the Cherokee Nation (CNEP).

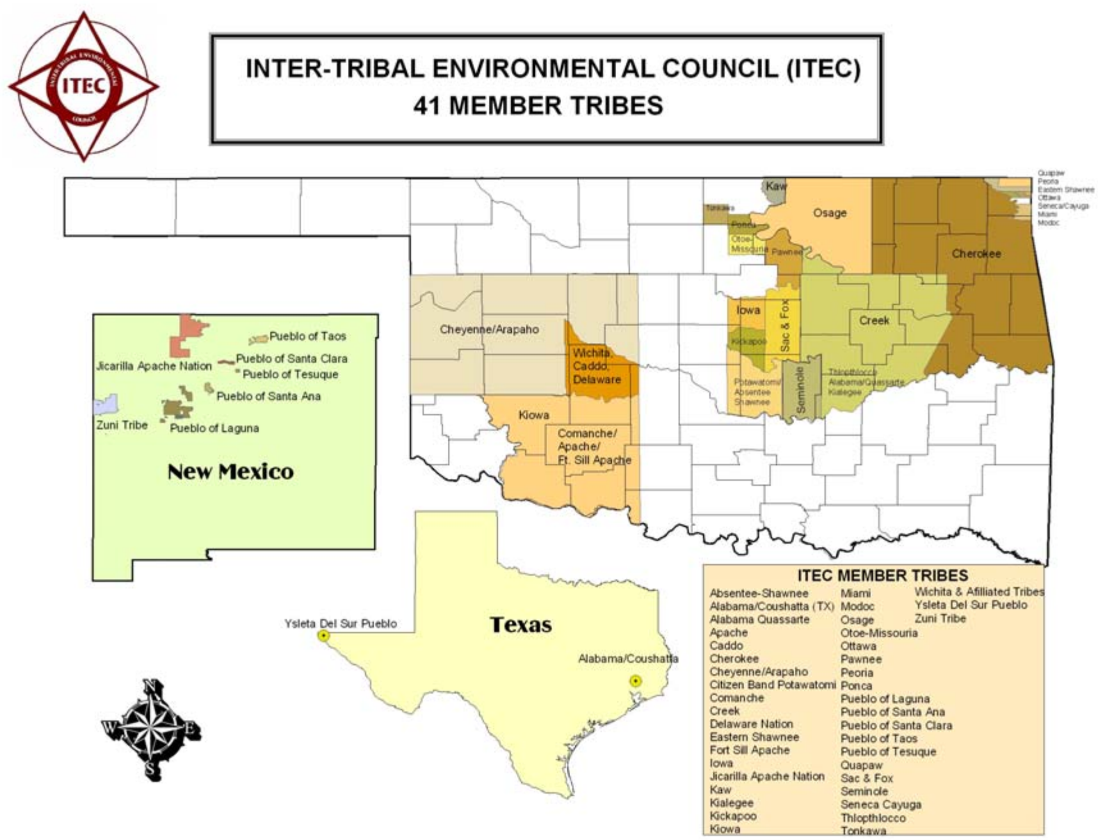
In 1997, the EPA Region VI Office provided Clean Air Act (CAA) 103 grant funding to the CNEP to begin ambient air monitoring of criteria pollutants, meteorological parameters, and some hazardous air pollutants (HAPs) on tribal lands. The criteria pollutants currently being monitored by the CNEP include five of the six principal pollutants that have established National Ambient Air Quality Standards (NAAQS). They are particulate matter (PM10, PM2.5), sulfur dioxide, carbon monoxide, nitrogen dioxide and ozone. However, at this time, our current PM network is not intended for regulatory NAAQS comparison. In addition, the CNEP is monitoring for NOy, Mercury (Hg), and Ammonia (NH3). The meteorological parameters are wind direction, wind speed, temperature, relative humidity, and precipitation. The CNEP also has instruments with the capabilities to monitor for hazardous air pollutants (HAPs) that use summa canisters, filter-based samplers, and wind vector monitoring techniques. When instruments are in operation, all HAPs monitoring performed by the CNEP will be addressed in a separate QAPP.

The primary purpose of the CNEP/ITEC ambient air monitoring network (fixed locations at Tahlequah (was discontinued in September 2018), Stilwell, Pryor, Newkirk, and Roland in Oklahoma, and mobile monitoring on lands of various tribes in Oklahoma, Texas, and New Mexico) is to collect air quality data on tribal trust and individual trust lands within the jurisdictional boundaries of the Cherokee Nation and various ITEC member tribes.

Other purposes for the ambient air monitoring network include:

- educational training and tribal air program development
- special purpose monitoring (e.g., source, local, and regional transport, trends analysis, population exposure, health impact, environmental impact, rural impact)
- tribal participation in National Air Monitoring Networks & initiatives (NCore, CASTNet, IMPROVE, CENRAP (Regional Haze), HAPs, Mercury Deposition (MDN), Mercury speciation, AirNow Ozone and PM Mapping, National Trends Network (NTN), Passive Ammonia Monitoring Network (AMon))

Figure 5.1 shows the location of the ITEC member tribes' jurisdictional boundaries.



6 Project Description

6.1 Project Background

The Cherokee Nation ambient air monitoring network originally had five air monitoring sites in Oklahoma; however, it currently has four active air monitoring sites in the network. The criteria pollutant sites are located in or near Stilwell, Pryor, Newkirk, and Roland in Oklahoma. Three of the sites are located on individual or tribal trust land while the Roland site is located on fee simple land owned by Cherokee Nation Businesses. The Tahlequah site went online in December 1998, was discontinued in September 2018, and the shelter was removed in April 2019. The Stilwell & Newkirk sites went online in March 2002. The Pryor site went online in November 2003. The Marble City site went online in March 2006; however, it has since been moved to Roland and went online in June 2010. All of the sites are designated as Special Purpose Monitoring Sites (SPMS) under the Tribal Ambient Monitoring Site (TAMS) designations with the Stilwell site serving as a national program site. The Stilwell site is designated as a CASTNet dry deposition site and an NCore site; as well as an IMPROVE regional haze site. CNEP technicians operate and maintain the sites.

The sites are designed to collect data from continuous gas analyzers. Each site has a temperature controlled shelter with analyzers that monitor for one or more of the following pollutants: SO_2, CO, NOx, NOy, NH_3, Ozone, PM2.5, and PM10. Each site continuously monitors for the following meteorological parameters: wind speed, wind direction, temperature, relative humidity, and precipitation. [Precipitation is not measured at Roland and the mobile monitoring station.] In addition, the Pryor site can be equipped to monitor for specific Hazardous Air Pollutants (HAPs) over defined time intervals using summa canisters, filter-based samplers, and regular meteorological instruments and vector directed instruments. When CNEP is sampling for HAPs, such as volatile organic compounds and metals, it will be covered in a separate QAPP.

The Stilwell site consists of two monitoring shelters, CASTNet and NCore. The Stilwell CASTNet monitoring shelter has ozone and NH_3 instruments as well as meteorological equipment. [Even though the ozone is housed in the CASTNet shelter, it is part of the NCore network.] The Stilwell site has additional meteorological monitoring for solar radiation and moisture. The CASTNet and IMPROVE monitoring is covered in separate, approved QAPPs. The CASTNet and IMPROVE programs will be responsible for updating their national QAPPs with any changes that are made to their networks. When the amendments are available, CNEP will ensure that EPA Region VI receives a copy. The ammonia monitoring is conducted for non-regulatory purposes in accordance with the operating instructions for the Ecotech 9842T continuous trace ammonia analyzer.

The Stilwell NCore shelter has trace level CO, SO_2, and NOy monitoring instruments as well as a Tekran mercury speciation monitoring system, Met One PM2.5 Federal Equivalent Method (FEM) Beta Attenuation Monitor (BAM), and Met One PM10 FEM BAM. The CNEP Tekran monitor is addressed in a separate QAPP, "Atmospheric

Mercury Monitoring OK99-AMNet Stilwell, OK."

The four currently active fixed sites are registered with the EPA's Air Quality System (AQS), and data has been reported to AQS for all active sites since the third quarter of 1999. Both criteria pollutant and meteorological data are being submitted to AQS. The collected criteria pollutant data will be used to determine compliance with the EPA's National Ambient Air Quality Standards (NAAQS) and to determine attainment/non-attainment status for each airshed. **Table 6.1** identifies the primary and secondary NAAQS for the criteria pollutants. This data will also be used in conjunction with meteorological data to determine local and regional transport trends and issues. Trace-level pollutant data from the NCore site will be used for assessment, research, and compliance with revisions to the ambient air monitoring regulations promulgated on October 17, 2006 (71 FR 61236).

The mobile shelter went online in July 2006 and monitors continuous PM2.5, continuous PM10, continuous PMcoarse, and ozone (since May 2009) as well as meteorological parameters (wind speed, wind direction, temperature, relative humidity). The mobile shelter will be stationed for 9 to 12 months at a time at a number of sites on tribal lands in Oklahoma, Texas, and New Mexico; however, the time period may be extended at the request of the host tribe. Data from the mobile shelter will also be reported to AQS. Such data will be used primarily for screening purposes; that is, to determine if future monitoring is warranted.

Table 6.1 National Ambient Air Quality Standards

National Ambient Air Quality Standards			
Pollutant	**Averaging Time**	**Standard Value**	**Standard Type**
Carbon Monoxide (CO)	8-hour average	9 ppm	Primary
	1-hour average	35 ppm	Primary
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	0.053 ppm	Primary & Secondary
	1-hour average	0.100 ppm	Primary
Ozone (O_3)	1-hour average*	0.12 ppm	Primary & Secondary
	8-hour average	0.070 ppm	Primary & Secondary
Sulfur Dioxide (SO_2)	3-hour average	0.50 ppm	Secondary
	1-hour average	0.075 ppm	Primary
Particulate Matter (PM2.5)	Annual Arithmetic Mean	12 $\mu g/m^3$	Primary
	Annual Arithmetic Mean	15 $\mu g/m^3$	Secondary
	24-hour average	35 $\mu g/m^3$	Primary & Secondary
Particulate Matter (PM10)	24-hour average	150 $\mu g/m^3$	Primary & Secondary

*EPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under that standard.

6.2 Project Site Locations

The Tahlequah, Stilwell, Newkirk and Pryor sites are located at the following coordinates and locations on Cherokee Nation trust land:

- TAMS (Tahlequah – AQS ID: 40-021-9002): Cherokee Nation jurisdiction. Cherokee County, Oklahoma, north latitude 35° 51' 14.6442", west longitude -94° 59' 9.3804", elevation 758.93 feet. Located approximately 2.3 miles (3.7 km) south of Tahlequah at the Cherokee Nation tribal complex. [Discontinued: September 2018; Removed: April 2019]

- CASTNet, NCore, and IMPROVE (Stilwell – AQS ID: 40-001-9009): Cherokee Nation jurisdiction. Adair County, Oklahoma, north latitude 35° 45' 5.0004", west longitude -94° 40' 18.9978", elevation 878 feet. Located approximately 3.9 miles (6.3 km) south of Stilwell on the Dahlonegah School grounds.

- TAMS (Newkirk – AQS ID: 40-071-9010): Cherokee Nation jurisdiction. Kay County, Oklahoma, north latitude 36° 57' 24.231", west longitude -97° 02' 3.7278", elevation 1,162 feet. Located approximately 3.0 miles (4.8 km) north of Newkirk on tribal trust lands.

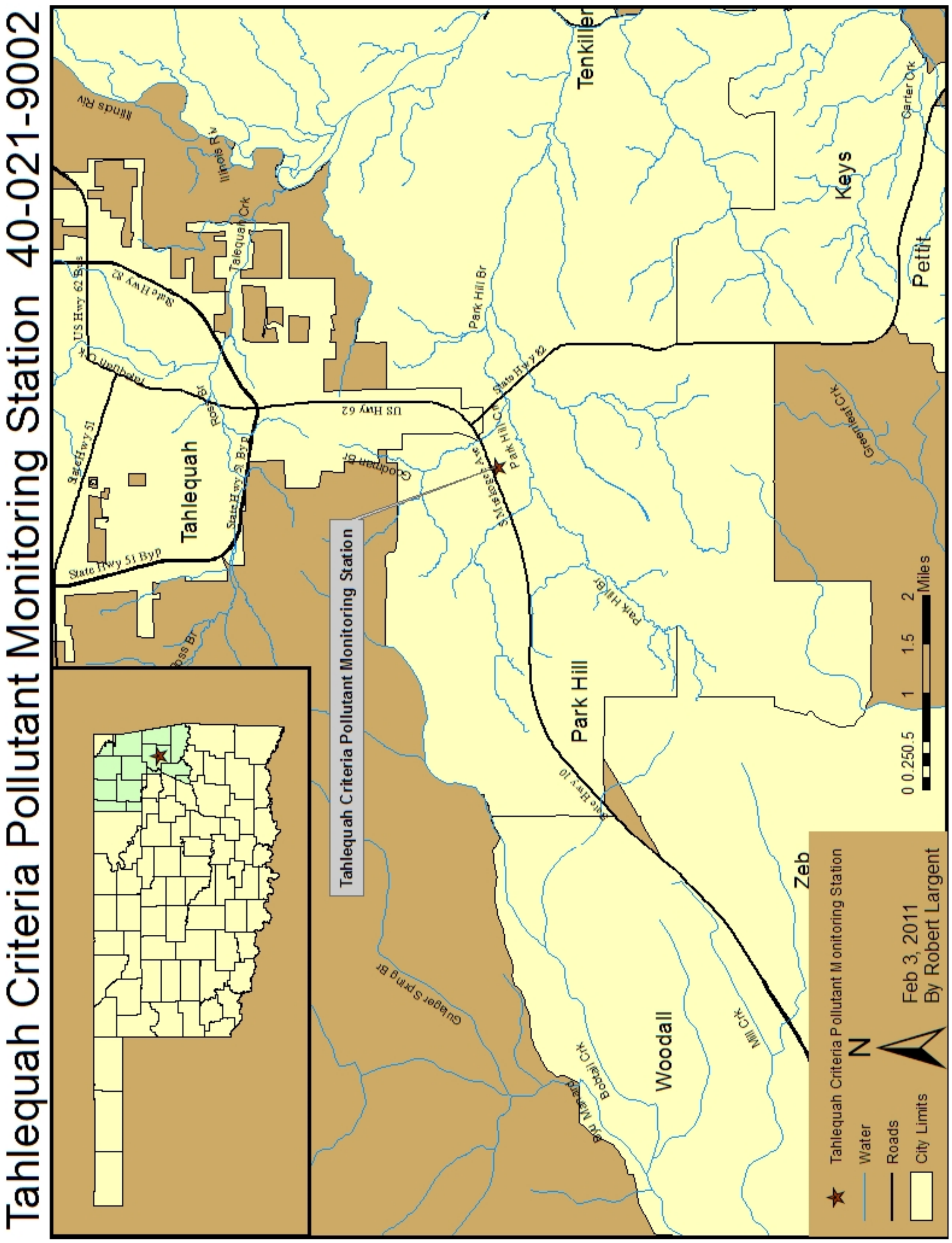
- TAMS (Pryor – AQS ID: 40-097-9014): Cherokee Nation jurisdiction. Mayes County, Oklahoma, north latitude 36° 13' 42.2292", west longitude -95° 14' 59.9316", elevation 627.28 feet. Located approximately 4.2 miles (6.7 km) southeast of Pryor on tribal trust lands.

The Roland site is located on fee land owned by Cherokee Nation Businesses at:

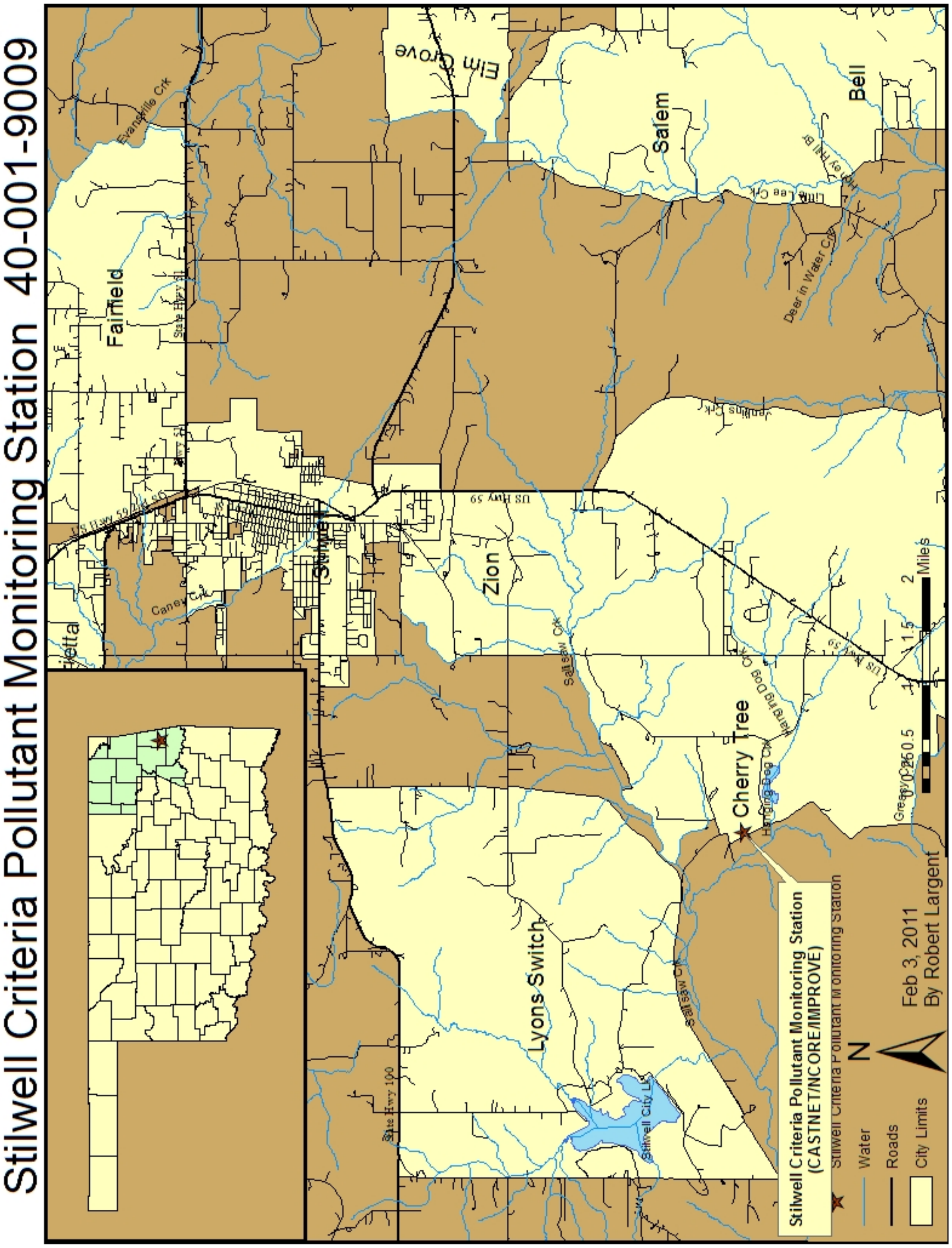
- TAMS (Roland – AQS ID: 40-135-9021): Cherokee Nation jurisdiction. Sequoyah County, Oklahoma, north latitude 35° 24' 29.304", west longitude -94° 31' 27.8862", elevation 448.98 feet. Located approximately 0.15 miles (0.24 km) southwest of Roland on individual fee land.

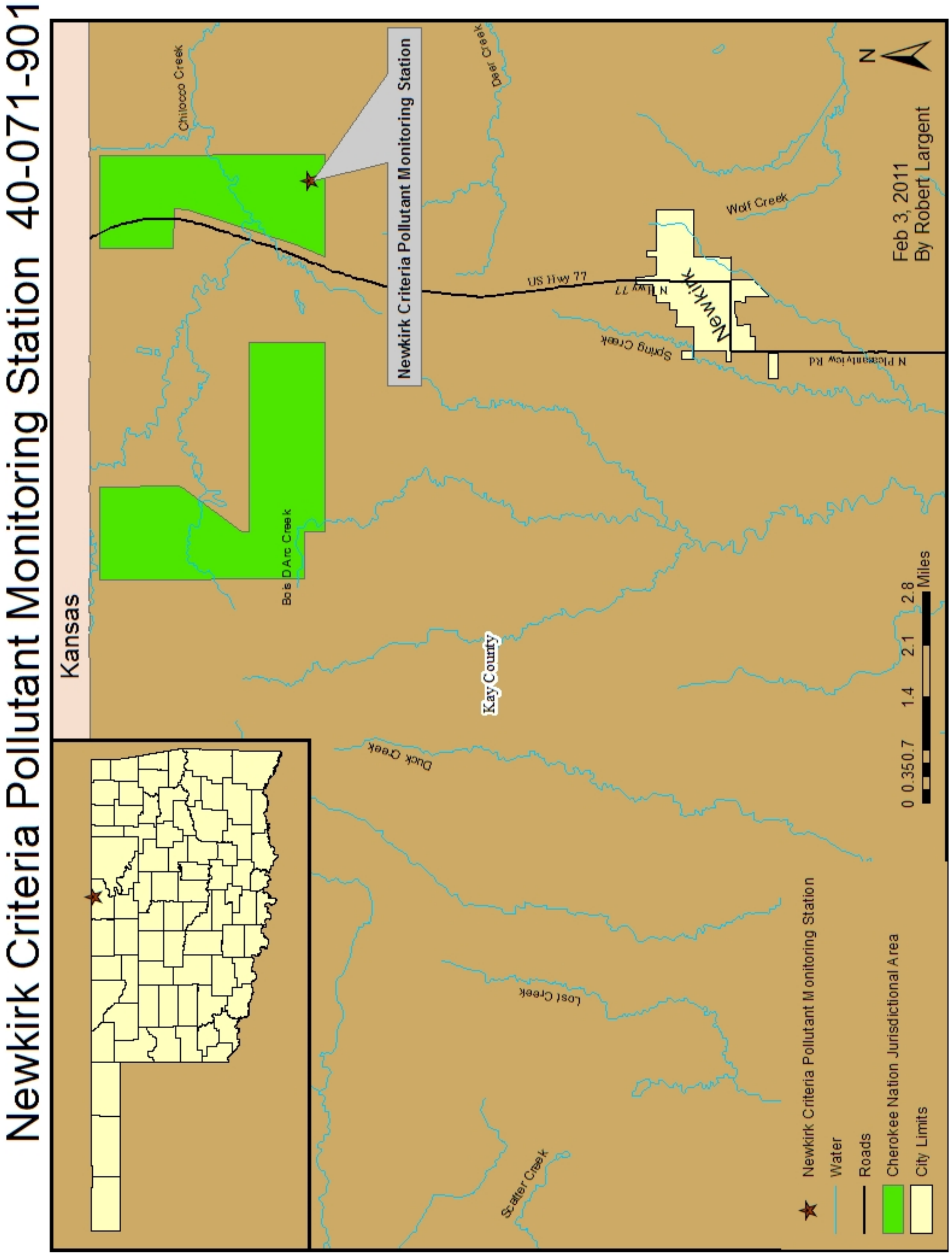
The mobile shelter will be placed at several locations for a period of 9 to 12 months; however, the time interval may be extended at the request of the host tribe. Each location will be on land of a host tribe in Oklahoma, Texas, and New Mexico. The mobile shelter went online in July 2006 and monitors continuous PM2.5, continuous PM10, continuous PMcoarse, and ozone (since May 2009) as well as meteorological parameters.

The following pages depict the five fixed site locations on maps.

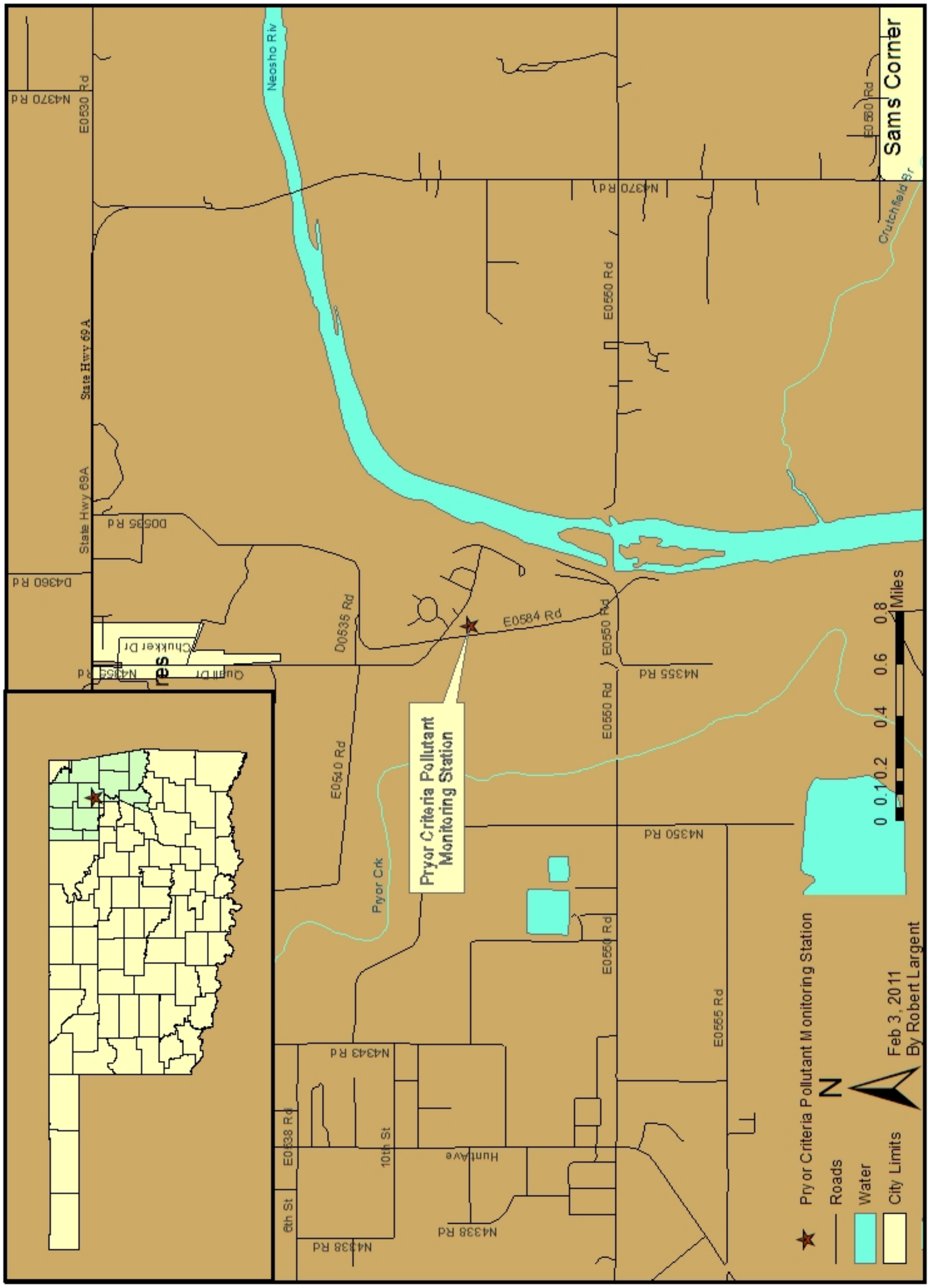


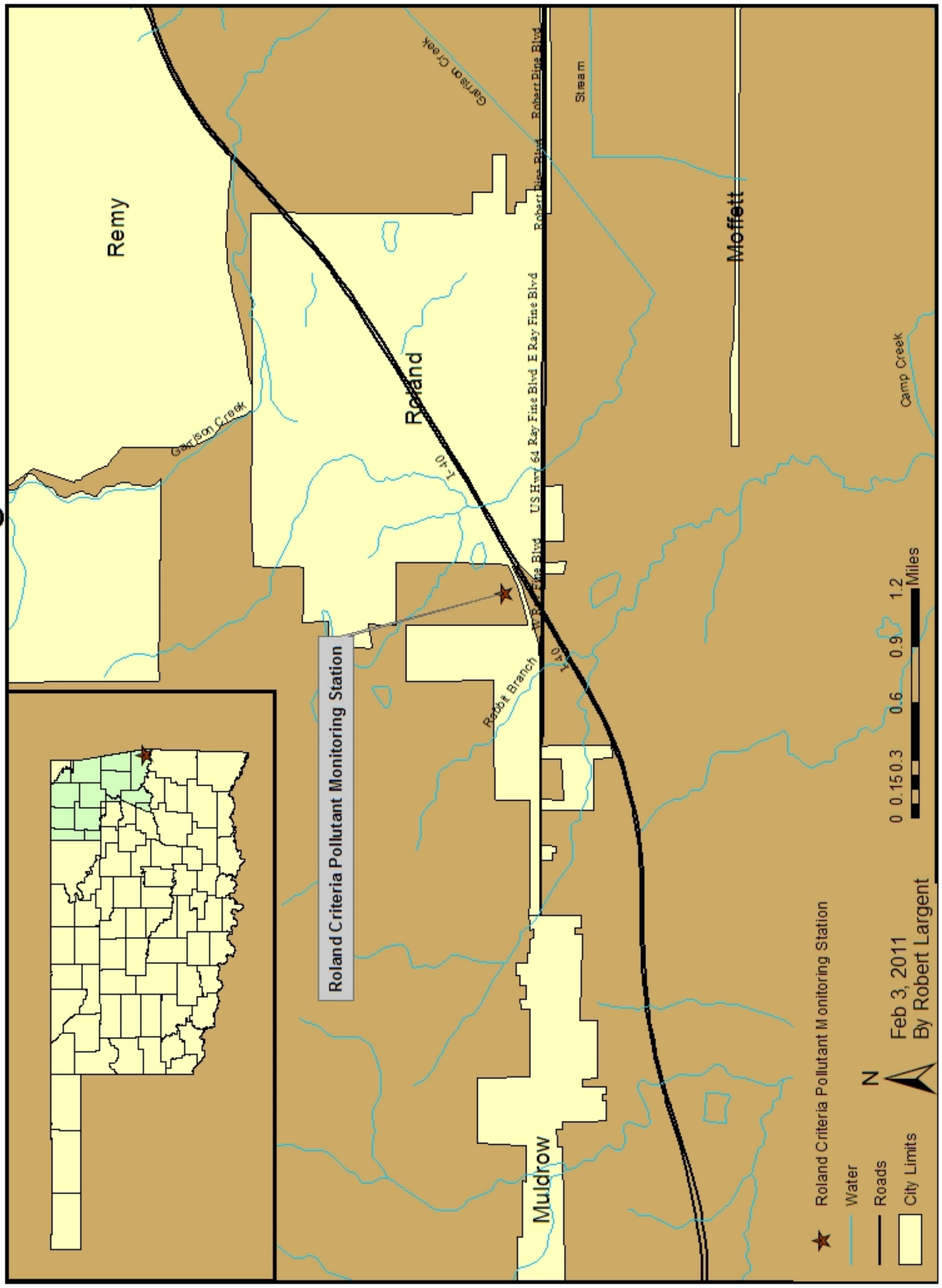
Site was discontinued in September 2018 and was removed in April 2019.


Stilwell Criteria Pollutant Monitoring Station 40-001-9009
Fairfield
Elm Grove
Salem
Bell
Stilwell
Zion
Cherry Tree
Lyons Switch
US Hwy 59
Stilwell Criteria Pollutant Monitoring Station (CASTNET/NCORE/IMPROVE)
Water
Roads
City Limits
N
Miles
Feb 3, 2011
By Robert Largent


Newkirk Criteria Pollutant Monitoring Station 40-071-901
Kansas
Newkirk Criteria Pollutant Monitoring Station
Chilocco Creek
Deer Creek
Wolf Creek
US Hwy 77
N Hwy 77
Newkirk
Spring Creek
N Pleasantview Rd
Bois D Arc Creek
Kay County
Duck Creek
Lost Creek
Scatter Creek
Feb 3, 2011
By Robert Largent
0 0.35 0.7 1.4 2.1 2.8 Miles
Newkirk Criteria Pollutant Monitoring Station
Water
Roads
Cherokee Nation Jurisdictional Area
City Limits

Pryor Criteria Pollutant Monitoring Station 40-097-9014




Roland Criteria Pollutant Monitoring Station 40-135-9021
Remy
Roland
Moffett
Muldrow
Garrison Creek
Camp Creek
Rabbit Branch
Stream
I-40
US Hwy 64 Ray Fine Blvd
E Ray Fine Blvd
Robert Fine Blvd
Roland Criteria Pollutant Monitoring Station
0 0.15 0.3 0.6 0.9 1.2 Miles
N
Roland Criteria Pollutant Monitoring Station
Water
Roads
City Limits
Feb 3, 2011
By Robert Largent

7 Data Quality Objectives and Criteria for Measurement of Data

7.1 Purpose & Background

Data Quality Objectives (DQOs) are qualitative and quantitative statements that clarify monitoring objectives, define appropriate types of data, define the most appropriate conditions in which to collect data, and specify the tolerable levels of decision errors for a particular monitoring program.

The primary DQO for the Cherokee Nation's ambient air monitoring network is to compare the monitoring data collected for criteria pollutants (SO_2, CO, NO_2, Ozone, PM2.5, and PM10) to their respective National Ambient Air Quality Standard (NAAQS) for attainment/non-attainment purposes. The collection of data for NCore trace gas analyzers (SO_2, CO, and NO_y) and for NOy, NH_3, Hg, Hg species, and meteorological parameters (wind speed, wind direction, temperature, relative humidity and precipitation) supplements the criteria pollutant data and is subject to secondary DQOs. Secondary DQOs include collecting ambient air data for use in research and in identifying trends, regional transport, and health impacts. The EPA has established a control measurement of 95% certainty or 5% uncertainty as the acceptance rate for this monitoring objective.

Another DQO is to produce data that is precise, accurate, complete, representative and comparable. This DQO can be controlled and evaluated so that it meets established acceptance criteria. Thus, Data Quality Indicators (DQIs) are designed and used to evaluate and control various phases of the measurement process. For the Cherokee Nation's ambient air monitoring network, the DQIs are defined in terms of the following: precision, accuracy, completeness, representiveness, and comparability.

7.2 Data Precision and Accuracy

The method detection limits and acceptable ranges for precision (CV) and accuracy (bias) of the ambient air analyzers and meteorological instruments used in the Cherokee Nation's ambient air monitoring network (including the mobile monitoring station) are specified by the instrument manufacturers and in the following documents:

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-17-001, January 2017.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV Meteorological Measurements Version 2.0 (Final). U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-08-002, March 2008.

Revisions to Ambient Air Monitoring Regulations, Final Rule. U.S.EPA, 40 CFR, Parts 53 and 58, October 17, 2006.

Revisions to Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards. U.S. EPA, 40 CFR, Part 58 Appendix A, March 28, 2016.

Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1. U. S. EPA Publication No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP].

Table 7.1 identifies the method detection limits and acceptable ranges for precision and accuracy of these instruments. These Measurement Quality Objectives (MQOs) meet or exceed the MQOs specified in the Data Validation Templates that are included in the latest revision of the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program* (see **Appendix F** of this QAPP). Method detection limits and acceptable ranges for precision and accuracy of NCORE trace gas analyzers are explained in the paragraphs that follow **Table 7.1**.

Table 7.1 Instrument Detection Limits, Precision and Accuracy

Instrument Detection Limits, Precision and Accuracy			
Parameter	**Measurement Detection Limits**	**Measurement Precision (CV)**	**Performance Accuracy (Bias)**
SO_2	0.2 ppb	< 10.1% CV*	< ± 10.1%*
CO	0.02 ppm	< 10.1% CV*	< ± 10.1%*
NOx, NO, NO_2	5 ppb	< 10.1% CV*	< ± 10.1%*
NOy	0.4 ppb	< 10.1% CV*	< ± 10.1%*
O_3	0.005 ppm	< 7.1% CV*	< ± 7%*
PM10	4.0 $\mu g/m^3$		± 5% design flow rate ± 2.5% mass (TEOM)
PM2.5	5.0 $\mu g/m^3$		± 5% design flow rate ± 2.5% mass (TEOM)
Wind Speed	0.5 mph	± 1% or 0.15 mph whichever is greater	± 0.5 mph < 10mph or ± 5% > 10 mph
Wind Direction	1.0 degree	± 3 degrees	± 5.0 degrees
Temperature	0.5 degree		± 0.5° C ambient
Relative Humidity	1.0 percent	± 3 percent	± 1.5° C of dew point temp
Precipitation	0.01 inches per switch closure	± 1% at 1-3" per hour	± 10% of observed

*The measurement quality objectives (MQOs) for criteria gases changed in October 2006 in accordance with 40 CFR, Parts 53 and 58, *Revisions to Ambient Air Monitoring Regulations, Final Rule*. Measurement precision is now expressed in terms of the coefficient of variance (CV) and performance accuracy is now expressed in terms of bias. The MQOs for ozone analyzers are now as follows: CV < 7.1%; bias < ± 7.1%. The MQOs for SO_2, NO_2, and CO are now as follows: CV < 10.1%; bias < ± 10.1%. Although NOx, NO, and NOy aren't criteria pollutants, EPA guidance suggests the following MQOs for those gases: CV < 10.1%; bias < ± 10.1%. The CV and bias values for each ozone, SO_2, NO_2, CO, NOx, NO, and NOy analyzer are determined by averaging the precision and accuracy values for three consecutive years of Level I checks, multipoint checks, and audits for each analyzer. The precision and accuracy values (acceptance limits) for zero, span, precision, and other points in any single Level I check, multipoint check, or audit may exceed the three-year average MQO for bias of < ± 7.1% or 10.1% without causing the invalidation of any data. The CNEP will automatically invalidate affected data for an analyzer if the measured accuracy of a zero, span, precision, or other point of a Level I check, multipoint check, or audit exceeds the acceptance limits. If the measured accuracy of such a point is between acceptance limits of 4% to 7.1% for an ozone analyzer or between 7% and 10.1% for any other gas analyzer, the CNEP will take appropriate steps (such as recalibrating the analyzer within the following two-week period) to improve the accuracy, but will NOT invalidate the affected data for that analyzer unless there are other circumstances (equipment defect, etc.) that suggest such data *should* be invalidated.

The CNEP will use the MQOs for precision (CV) and bias recommended for the NCore program by the OAQPS. These recommended MQOs are the same as for the non-trace-level gas analyzers. To the extent feasible, the CNEP will use the MQOs for method detection limits (MDLs) recommended for the NCore program by the OAQPS. The MDLs for trace level gas analyzers are as follows: SO_2 = 0.055 ppb; CO = 18 ppb; NOy [and NO] = 0.058 ppb. The CNEP can meet the MDL for total reactive oxides of nitrogen with its Ecotech trace level gas analyzer, but it may not be able to meet the MDLs for SO_2 and CO because its Ecotech trace level SO_2 analyzer has a lower detectable limit of 0.200 ppb and its Ecotech trace level CO analyzer has a lower detectable limit of 25 ppb (see **Table 16.2** of this QAPP, and see **Appendix D** of this QAPP).

7.3 Data Completeness

The completeness goal for the Cherokee Nation's ambient air monitoring network is 75% or greater for the criteria and non-criteria pollutant data for each quarter. For the meteorological data, the completeness goal is 90% or greater. Data completeness will be calculated as a percentage of the actual valid data collected compared to the amount of data that could have been obtained under normal operations. Data completeness will also be reported as a quarterly and annual average. The following table shows the minimum requirements for data completeness based on various time period averaging. This information is typical for instrument parameters throughout the network having more than one point of collection.

The OAQPS has recommended a data completeness goal of greater than 90% for NCore trace gas data, with a minimum data completeness requirement of greater than 75%.

Table 7.2 Data Completeness

Data Completeness		
Parameter	**Averaged Time Period**	**Minimum Number of Data**
SO_2, CO, NOx, NO, NO_2, NOy, O_3, PM2.5, PM10	Hourly	45 minutes of valid data
	8 Hour	6 consecutive, 1 hour averages
	Daily	18 1-hour averages
	Monthly	21 daily averages
	Quarterly	3 consecutive monthly averages
	Yearly	9 monthly averages with at least 2 monthly averages per quarter
Meteorological	15 minute average	14 consecutive minutes
	1 hour average	4 15-minute averages
	Daily	22 consecutive hours
	Monthly	28 consecutive months
	Quarterly	3 consecutive months
	Yearly	11 consecutive months

7.4 Data Representativeness

Representativeness measures the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. For the Cherokee Nation's ambient air monitoring network, it is a process condition, and all of the instruments (criteria pollutants) are either federal reference methods or equivalent methods. The instruments and their federal or equivalent methods are shown in **Table 7.3**.

Table 7.3 Instrument & Federal Reference or Equivalent Method

Instrument & Federeral Reference or Equivalent Method		
Parameter	**Manufacturer**	**EPA Method Code**
SO_2 (trace level)	Ecotech EC9850T	592
CO (trace level)	Ecotech EC9830T	588
NOx, NO, NO_2	Monitor Labs ML9841B	090
NOy (trace level)	Ecotech EC9841T	690
NH_3 (trace)	Ecotech EC9842T	592
O_3	Teledyne API 400E	087
	Monitor Labs ML9810	091
	Monitor Labs ML9810B	091
	Ecotech EC9810B	091
	Ecotech Serinus 10	187
PM10 (STP)	Met One BAM 1020	122
	Thermo 1405-D Dichotomous TEOM	792
PM2.5 (Local Conditions)	Met One BAM 1020	733
	Thermo 1405-D Dichotomous TEOM	792
PMcoarse (Local Conditions)	Met One BAM 1020	185
	Thermo 1405-D Dichotomous TEOM	208
Wind Speed (WS)	Met One Model 010C	020
Wind Direction (WD)	Met One Model 020C	020
WS/WD Sonic	Met One Model 50.5	061
Temperature	Met One Model 592	040
	Met One Model 083D-1-35	040
Relative Humidity	Met One Model 593	011
	Met One Model 083D-1-35	011
Precipitation	Met One Model 375	091

7.5 Data Comparability

Comparability is the measure of confidence with which one data set can be compared to another. The preferred units of measurements are summarized in the following table. This information is typical for all parameters throughout this network having more than one point of collection.

For comparison purposes, all gas monitors (O_3, SO_2, CO, NOx, NOy, NH_3), including NCore trace gas monitors, at all sites collect data under local (ambient) conditions of temperature and pressure. All FRM particulate monitors (PM2.5, PM10) collect data under local (ambient) conditions of temperature and pressure. All PM2.5 FEM particulate monitors (TEOM and/or BAMs at Stilwell NCore, Roland, and mobile) collect data under local (ambient) conditions of temperature and pressure. All PM10 FEM particulate monitors (TEOM and/or BAM at Stilwell NCore and mobile) collect data under EPA standard temperature and pressure (STP) conditions (25ºC, 101.3 kPa). In addition, the data will be compared to the National Ambient Air Quality Standards (NAAQS) for each specific criteria pollutant. The NAAQS are identified in **Table 6.1** of this QAPP. Finally, Stilwell site (IMPROVE and CASTNet) is considered to be a Special Purpose Monitoring Site (SPMS) under Tribal Ambient Monitoring Site (TAMS) and has been sited and registered in AQS based on EPA siting requirements. The EPA Region VI Office has approved the siting of the one SPMS, as has the EPA OAQPS.

Table 7.4 Data Comparability

Data Comparability			
Instrument Parameter	**EPA AQS Parameter Code**	**Measurement Unit**	**EPA AQS Unit Code**
SO_2 (trace level)	42401	ppb	008
CO (trace level)	42101	ppb	008
NO	42601	ppm	007
NO (trace level)	42601	ppb	008
NO_2	42602	ppm	007
NOx	42603	ppm/ppb	007/008
NOy (trace level)	42600	ppb	008
NOy-NO (trace level)	42612	ppb	008
NH_3	42604	ppb	008
O_3	44201	ppb	008
PM10 (STP)	81102	$\mu g/m^3$ / L/min	001/073
PMcoarse (Local)	86101	$\mu g/m^3$ / L/min	105/118
PM2.5 (Local)	88502	$\mu g/m^3$ / L/min	105/118
Wind Speed	61101	mph	012
Wind Direction	61102	degrees, compass	014
Temperature	62101	degrees, centigrade	017
Relative Humidity	62201	percent	019
Precipitation	65101	inches	021

8 Special Training Requirements/Certification

8.1 Training

CNEP personnel working in the Cherokee Nation's ambient air monitoring activities will meet the academic, work experience, and training requirements for their positions. The five technical positions that can be held by the CNEP staff are Environmental Specialist I, Environmental Specialist II, Environmental Specialist III, Environmental Specialist IV, and manager. At a minimum, each one of these positions requires a Bachelor of Science Degree. Progressing to an Environmental Specialist II requires three years or more experience in a science field, progressing to an Environmental Specialist III requires five years or more of experience, progressing to an Environmental Specialist IV requires seven years or more of experience and progressing to a manager requires nine years or more of experience and supervisory responsibilities. Records on personnel qualifications will be maintained in personnel files and will be accessible for review during audit activities. Personnel files for current and previous employees are retained by CNEP for an indefinite amount of time.

Adequate education and training are integral to any monitoring program that strives for reliable and comparable data. Training is aimed at increasing the effectiveness of employees and the CNEP. The general training requirements for the Environmental Specialist are:

- State of Oklahoma Sanitarian/Environmental Specialist Certification
- OSHA 40-Hour Hazardous Waste Operations Course (optional)
- Annual OSHA 8-Hour Hazardous Waste Operations Refresher Course (optional)

8.2 Ambient Air Monitoring Training

Appropriate training is provided to the Environmental Specialist involved in ambient air monitoring, commensurate with their duties. Such training may consist of classroom lectures, workshops, conferences, and teleconferences. On-the-job training does occur through review and study of instrument manuals, standard operating procedures, QAPP, and protocols. Training is obtained through the following organizations or agencies:

- EPA
- Air Pollution Training Institute (APTI-Learn)
- Instrument Manufacturers (Ecotech, Teledyne API, Thermo Fisher Scientific, IML laboratories, ESC, Agilaire, Met One)
- Consultants
- Institute for Tribal Environmental Professionals/TAMS Center/Northern Arizona University
- Air & Waste Management Association
- Central States Air Resources Agency (CENSARA-CENRAP)
- State of Oklahoma Air Monitoring Program

Such training is documented by way of training course certificates, which are kept in CNEP personnel files and/or employees personal files. CNEP requires that one or more individual be certified in quality assurance which is provided by EPA.

9 Documentation and Records

9.1 Purpose/Background

There are a number of critical documents and records that need to be kept and maintained for the Cherokee Nation's ambient air monitoring network. The following table identifies the category, record/document type, format, and agency for the documents and records management.

Table 9.1 Critical Documents, Records, Format, & Agency

Critical Documents, Records, Format & Agency			
Categories	**Record/Document Types**	**Formats**	**Agencies/Consultant**
Management & Organization	Quality Management Plan	MS Word, hard copy	CNEP, EPA
	Quality Assurance Project Plan	MS Word, hard copy	CNEP, EPA
	CAA 103 & 105 Grant Application	MS Word, hard copy	CNEP, EPA
Site Information	AQS Site Registrations	ESC datalogger, Ecotech datalogger, hard copy, EPA Oracle database	CNEP, EPA
Environmental Data Operations	Quality Assurance Project Plan	MS Word, hard copy	CNEP, EPA
	CNEP Standard Operating Procedures	MS Word, hard copy	CNEP
	EPA Standard Operating Procedures	PDF format, hard copy	CNEP, EPA
	Audit/Calibration Records	Excel, hard copy	CNEP
	Site Logbooks & Polling Logbooks	Hard copy	CNEP
	Inspection/Maintenance Records	Hard copy	CNEP
Raw Data	ESC Datalogger Memory	ASCII text file	CNEP
	Ecotech Datalogger Memory	ASCII text file	CNEP
	CNEP AQS Raw Database (quarterly)	MS Notepad, ASCII text	CNEP
	CNEP AQS Validated Database (quarterly)	MS Notepad, ASCII text	CNEP, EPA
Data Reporting	CNEP Quarterly Reports	MS Word, hard copy	CNEP, EPA
	CNEP Annual Report	MS Word, hard copy, EPA Oracle Database	CNEP, EPA
	Laboratory Data Report (non-continuous only)	Excel, hard copy	CNEP, Contractor
	INQUEST Independent Audit Report (quarterly)	Hard copy	CNEP, INQUEST
	AQS Data submittal (quarterly)	MS Notepad, ASCII text, EPA Oracle Database	CNEP, EPA
Data Management	CNEP Standard Operating Procedures	MS Word, hard copy	CNEP
	INQUEST Standard Operating Procedures	Hard copy	CNEP, INQUEST
	Laboratory Contractor SOPs	Hard copy	CNEP, Contractor
	EPA Policy & Guidance Documents	PDF format, hard copy	CNEP, EPA
	EPA AQS Standard Operating Procedures	PDF format, hard copy	CNEP, EPA
Quality Assurance	EPA QA/QC Federal Regulations	PDF format, hard copy	CNEP, EPA
	EPA Policy & Guidance Manuals	PDF format, hard copy	CNEP, EPA
	CNEP Quality Assurance Project Plan	MS Word, hard copy	CNEP, EPA

9.2 Documentation & Records Management

The CNEP maintains a filing management system for the ambient air monitoring network that includes:

- site monitoring system instrument setup specifications
- site monitoring system wiring diagrams
- EPA AQS site registration & parameter setup for each site
- EPA/CNEP correspondence
- individual site logbooks
- datalogger polling logbooks
- AQS logbooks
- ozone transfer standard audit/calibration logbooks
- daily, 1-hour instrument data print-outs for each site
- performance audit reports (Level I, multipoint, independent quarterly audits/calibrations) for each site
- continuous, raw data & valid data files for each site
- non-continuous, raw data & valid data files for each site
- monitoring instrument certifications (initial & annual)
- audit instrument certifications/calibrations
- instrument serial numbers
- instrument manufacturer manuals
- instrument specifications
- instrument maintenance records
- instrument, equipment, and site inventory lists

These documents and records are considered to be primary sources. In addition, the Project Manager/Coordinator will have responsibility for maintaining these documents and records. Hard copies of documents and records (i.e. reports, QAPPs, continuous and non-continuous data, etc.) will be maintained at the CNEP office for a minimum of three years. After this time, they are archived in labeled boxes and placed in storage. Electronic files are kept on computers, external hard drives, flash drives, and an office network server hard drive, which are maintained for an indefinite amount of time. These files are saved daily on the network server and they are backed up to external hard drives quarterly.

10 Sampling Process Design

10.1 Purpose/Background

There are two basic assumptions for the Cherokee Nation's ambient air monitoring network. First, the state of Oklahoma lacks dominating land features, which are more characteristic of the western states' basin and mountain range geomorphological features. Thus, there is only one distinct air basin in the state of Oklahoma. Second, Oklahoma's wind patterns, variable winds, and topography create conditions which are conducive to dispersing emissions from various air pollution sources on several scales of magnitude (middle, neighborhood, urban, regional). Thus, the Tribal Ambient Monitoring Sites (TAMS) and the CASTNet and IMPROVE site can be influenced by different scales of magnitude. With these assumptions in mind, the Cherokee Nation's ambient air monitoring network is designed to meet any of the following monitoring objectives:

- Determine compliance with the National Ambient Air Quality Standards
- Determine baseline data for attainment/non-attainment status
- Determine the impact of significant point sources on Indian populations and areas
- Determine the extent of regional pollutant transport
- Determine the welfare-related impacts on Indian populations and tribal lands
- Conduct air pollution trends analysis

10.2 Site Names, Zone of Representation, and Locations

There originally were five sites in the Cherokee Nation's ambient monitoring network; however, there are currently only four active sites in the network: Tahlequah, Stilwell, Pryor, Newkirk, and Roland. [The Tahlequah site was discontinued in September 2018 and was removed in April 2019.] Section 6 of this QAPP has descriptions and map locations for these sites. In addition, the CNEP has one mobile station for continuous monitoring of PM2.5, PM10, PMcoarse, O_3, and meteorological parameters on lands of ITEC-member tribes. The mobile station will be rotated from one host tribe to another, being stationed with each host for 9 to 12 months; however, the time period may be extended at the request of the host. The sites are EPA approved and registered with the EPA's Air Quality System (AQS) and are designated as to monitor type, monitoring objective, and zone of representation in **Table 10.1**

Table 10.1 Monitor Type, Objective, and Zone of Representation

Monitor Type, Objective, and Zone of Representation			
Site Name	**Monitor Type**	**Monitoring Objective**	**Measurement Scale**
Tahlequah*	Tribal	regional transport	neighborhood
Stilwell	Tribal	trace gas, acid rain dep.	regional
Pryor	Tribal	emissions impact	neighborhood
Newkirk	Tribal	regional transport	regional
Roland	Tribal	regional transport	regional
Mobile	Tribal	regional transport	neighborhood

*Site was discontinued in September 2018 and was removed in April 2019.

10.3 Monitoring Sampling Design

The one neighborhood scale site (Pryor) is designed to monitor continuously for ozone (O_3) as well as the following meteorological parameters: wind speed, wind direction, temperature, relative humidity, and precipitation.

The three regional scale sites are located near Stilwell, Newkirk, and Roland. The Stilwell (CASTNet/NCore/IMPROVE) site is set up to meet dry deposition and trace gas monitoring requirements as well as set up for regional haze monitoring requirements. The three regional scale sites have been designed to monitor continuously for one or more of the following: ozone (O_3) at Stilwell, Newkirk, and Roland; trace sulfur dioxide (SO_2), trace carbon monoxide (CO), and trace nitrogen oxide (NOy) at NCore; nitrogen oxides (NOx, NO, NO_2) at Roland; particulate matter (PM10 via BAM at NCore and PM2.5 via BAM at NCore and Roland); and meteorological parameters (wind speed, wind direction, temperature, relative humidity, precipitation). [Precipitation is not measured at Roland.] The CASTNet site is designed for continuous monitoring of ammonia (NH_3, via Ecotech 9842T trace ammonia analyzer), as well as sampling of depositional mercury for the Mercury Deposition Network (MDN), monitoring of regional haze for the Interagency Monitoring of Protected Visual Environments (IMPROVE), and passive ammonia for the Ammonia Monitoring Network (AMoN). The NCore site is also designed for continuous monitoring of mercury species (via Tekran mercury speciation instruments).

The Pryor site has design capabilities to monitor for various Hazardous Air Pollutants (HAPs) over defined time intervals using an Environmental Systems RM910A sampling instrument with summa canisters for volatile organic compounds as well as R&P 2025 sequential samplers and Tisch TE-5000 high volume samplers for filter-based sampling for metals. At this time, CNEP does not monitor for HAPs.

The mobile station provides continuous monitoring of PM2.5 (via TEOM), PM10 (via TEOM), PMcoarse (via TEOM), ozone (O_3), and meteorological parameters (wind speed, wind direction, temperature, relative humidity) on lands of ITEC-member tribes. The mobile station is rotated from one host tribe to another, being stationed with each host for 9 to 12 months; however, the time period may be extended at the request of the host tribe. The station is capable of wireless data transfers to the CNEP office.

Environmental parameters monitored at each site are summarized in **Table 10.2** while the instruments and EPA methods used for monitoring each parameter are summarized in **Table 10.3**.

Table 10.2 Environmental Parameters Monitored at Each Site

Site	Parameters **(Criteria pollutants and Meteorological parameters in boldface)** [All other parameters, except for NOy and other species of gaseous nitrogen oxides, are covered under separate QAPPs]
Stilwell (NCore, CASTNet, IMPROVE)	NCore: continuous monitoring of trace level **SO_2**, **CO**, NOy, NO, and NOy-NO; continuous monitoring of **O_3**; continuous monitoring of **PM2.5** via FEM BAM, **PM10** via FEM BAM, PMcoarse
	Mercury speciation via Tekran instrument (continuous monitoring)
	CASTNet program (dry deposition sampling for aerosol sulfate, nitrate, and ammonium; dry deposition sampling for gaseous SO_2 and nitric acid)
	Continuous monitoring of NH_3, NOx, and Nx
	Depositional mercury via MDN sampling
	Passive ammonia sampling via AMoN
	IMPROVE (speciated components affecting visibility, including PM2.5, PM10, Na, Mn, Fe, Pb, carbon, nitrate, nitrite, chloride, sulfate)
	Meteorological parameters (**wind speed, wind direction, temperature, relative humidity, precipitation**, solar radiation, moisture) via CASTNet instruments
Newkirk	Continuous monitoring of **O_3**
	Meteorological parameters (**wind speed, wind direction, temperature, relative humidity, precipitation**)
Pryor	Continuous monitoring of **O_3**
	Hazardous air pollutants (HAPs) via time-weighted average sampling methods (VOCs via summa canisters; metals, including lead, via filter-based sampling)*
	Meteorological parameters (**wind speed, wind direction, temperature, relative humidity, precipitation**)
Roland	Continuous monitoring of **O_3**, **NO_2**, NOx, NO, **PM2.5** (via BAM)
	Meteorological parameters (**wind speed, wind direction, temperature, relative humidity**)
Mobile monitor	Continuous monitoring of **O_3, PM10** (via TEOM), **PM2.5** (via TEOM), PMcoarse
	Meteorological parameters (**wind speed, wind direction, temperature, relative humidity**)

*At this time, CNEP does not monitor for hazardous air pollutants (HAPs).

Table 10.3 Continuous Network Instruments and Methods

Continuous Network Instruments and Methods		
Parameter	**Instrument Manufacturer & Model Number**	**EPA Method Code**
SO_2 (trace)	Ecotech EC9850T	592
CO (trace)	Ecotech EC9830T	588
NOx, NO, NO_2	Monitor Labs ML9841B	090
NOy (trace)	Ecotech EC9841T	690
NH_3 (trace)	Ecotech EC9842T	592
O_3	Monitor Labs ML9810, ML9810B	091
	Ecotech EC9810B	091
	Ecotech Serinus 10	187
	Teledyne API 400E	087
	Teledyne API T703	Primary Standard
	Thermo Anderson 49CPS, 49*i*-PS	Transfer Standard
	Environics 6103	Transfer Standard
PM10 (STP)	Met One BAM 1020	122
	Thermo 1405-D Dichotomous TEOM	792
PM2.5 (Local Conditions)	Met One BAM 1020	733
	Thermo 1405-D Dichotomous TEOM	792
PMcoarse (Local Conditions)	Met One BAM 1020	185
	Thermo 1405-D Dichotomous TEOM	208
Wind Speed (WS)	Met One Model 010C	020
Wind Direction (WD)	Met One Model 020C	020
WS/WD Sonic	Met One Model 50.5	061
Temperature	Met One Model 592, 083D-1-35	040
Relative Humidity	Met One Model 593, 083D-1-35	011
Precipitation	Met One Model 375	091
Datalogger	ESC 8816, 8832, 8872	N/A
	Ecotech WinAQMS	N/A
Calibrator	Ecotech GasCal 1000GPT	N/A
	Ectoech GasCal 1100GPT	N/A
	Ecotech Serinus Cal 2000	N/A
	Environics 6103 Multi-Gas	N/A
Zero Air Generator	Ecotech 8301LC	N/A
	Perma Pure ZA-750-12 (portable)	N/A
	Teledyne API 701	N/A
HAPs	RM910A (for VOCs)	TO-15

Each site has a temperature controlled shelter enclosure that is designed for the instruments to be mounted either inside the shelter in a rack or on a bench or outside the shelter on a tower or the roof. The gas analyzers, particulate monitors, gas calibrator, and datalogger are located inside the shelter. The meteorological instruments (wind speed, wind direction, temperature, and relative humidity) are located outside the shelter on a tower while the precipitation gauge is located on the shelter roof.

For the one neighborhood scale site at Pryor, the O_3 analyzer is plumbed into a glass manifold with a pump exhaust system. The glass manifold intake is located on the shelter roof.

The regional scale site at Stilwell has two shelters (CASTNet, NCore). For the CASTNet shelter, the O_3 analyzer has its own intake located at the top of a 10-meter tower, which is the design for CASTNet network sampling. The NH_3 analyzer and gas calibrator are plumbed into a glass manifold with a pump exhaust system. The glass manifold intake is located on the shelter roof. For the NCore shelter, the trace gas analyzers (SO_2, CO) are plumbed into a glass manifold with a pump exhaust system, with the glass manifold intake being located on the shelter roof. The trace NO_y analyzer has an external molycon with its own intake system that is located at the top of a 10-meter tower. The gas calibrator in the NCore shelter is plumbed into a switching valve that allows calibration gas to flow to either the glass manifold for the trace (SO_2, CO) analyzers or directly up the tower to the intake of the trace NOy analyzer.

For the regional scale sites at Newkirk and Roland, the O_3 analyzers and NOx analyzer (at Roland) are plumbed into a glass manifold with a pump exhaust system. The glass manifold intake is located on the roof of the shelter. The gas calibrator at Roland is plumbed directly into the NOx analyzer.

The meteorological instrument sensors at all four of the fixed neighborhood and regional sites are attached to a 10-meter tower at the following heights:

At Newkirk and Pryor:

- wind speed & wind direction — 10-meter level
- relative humidity & temperature — 10-meter level
- precipitation gauge — shelter roof

At Roland:

- wind speed & wind direction — 10-meter level
- relative humidity & temperature — 9-meter level

At Stilwell:

- wind speed & wind direction — 10-meter level
- relative humidity — 9-meter level
- temperature — 9-meter & 2-meter level
- precipitation gauge — 1.2-meter above ground level

The PM monitor at the mobile station has an intake located on the shelter roof. The O_3 instrument has its own intake system, which is plumbed through the shelter wall and has its inlet three feet above the shelter roof. Meteorological instruments (wind speed, wind direction, relative humidity, and temperature) at the mobile station are attached to the top of a 7-meter tower.

For audit/calibration purposes, gas calibrators and EPA protocol gas cylinders are used to conduct nightly zero/span audits (Level II checks) and zero/span/one-point QC audits (Level I checks) on the NOx, trace NH_3, trace SO_2, trace CO, and trace NOy analyzers every two weeks. [Level II checks are not conducted on the trace NH_3 analyzer.] The O_3 analyzers perform nightly zero/span audits (Level II checks) utilizing internal ozone generators that are independent of the gas calibrators. A verified ozone transfer standard instrument is used to conduct the zero/span/one-point QC audits (Level I checks) on ozone analyzers every two weeks.

CNEP staff will perform flow checks and other routine QA/QC checks on the PM2.5 and PM10 instruments at the two fixed regional sites (Stilwell NCore, Roland) every two weeks. Performance checks of the meteorological instruments at the four fixed neighborhood and region sites will be done once each year or more often if necessary.

CNEP staff will visit the mobile station every month during the duration of its residency at a host site. [The data from the mobile station is primarily used for screening purposes.] CNEP staff will perform flow checks, temperature checks, barometric pressure checks, leak checks, TEOM microbalance filter changes, and other routine QA/QC checks on the PM2.5/PM10/PMcoarse instrument. The O_3 analyzer performs nightly zero/span audits (Level II checks) utilizing an internal ozone generator. A verified ozone transfer standard instrument is used to conduct the zero/span/precision audit (Level I checks) on the ozone analyzer. A performance check of the meteorological instruments will be done at the beginning and conclusion of each residency, or more often if necessary. The host may also be trained to perform some of these QA/QC checks, including TEOM microbalance filter changes, in order to minimize the need for site visits by CNEP staff.

At each site, including the mobile station, the gas analyzers, particulate monitors, and meteorological instruments are wired directly into an ESC datalogger (Newkirk, Stilwell CASTNet, Roland, mobile) or an Ecotech datalogger (Pryor, Stilwell NCore). The datalogger is programmed to capture continuous data and is connected to either a telephone modem, cellular modem, or a wireless Ethernet allowing for remote data retrieval directly into a CNEP desktop computer.

The CNEP has an R&M 910A canister sampler for VOC (HAP) sampling and R&P 2025 sequential samplers and Tisch TE-5000 high volume samplers for filter-based sampling of HAP metals. When CNEP samples for HAPs, it will be covered in a separate QAPP.

11 Sampling Method Requirements

11.1 Purpose/Background

The sampling methods and equipment used for continuous (automated) and non-continuous (manual) monitoring will be identified in this section. Furthermore, the specific performance requirements for the continuous and non-continuous monitoring will be identified in this section.

11.2 Continuous Sampling Methods Requirements

The type of instruments and sampling methods used to monitor for criteria pollutants and meteorological parameters are identified in **Table 10.3**, Section 10.3 of this QAPP. The continuous monitoring for NOx (NO, NO_2), trace NH_3, O_3, trace SO_2, trace CO, trace NOy, PM2.5, PM10, and meteorological parameters (WS, WD, temperature, relative humidity, precipitation) will be conducted in accordance with the manufacturer's standard operating procedures (SOPs) identified in their respective instrument operational manuals. The monitoring will also be conducted in accordance with the following documents:

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume I A Field Guide to Environmental Quality Assurance. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-600/R-94/038a.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-17-001, January 2017.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV Meteorological Measurements Version 2.0 (Final). U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-08-002, March 2008.

In addition, the continuous monitoring will be conducted for CO, NOx (NO, NO_2), NOy, PM2.5, and PM10 by adhering to the requirements identified in 40 CFR, Part 50, Appendices C, F, J, and L. Continuous monitoring will be conducted for SO_2 and O_3 by adhering to 40 CFR, Part 53.

11.3 Non-Continuous Sampling Method Requirements

Sampling method requirements for Hazardous Air Pollutants (HAPs) will be covered in a separate QAPP. Sampling method requirements for non-continuous monitoring of PM2.5 and PM10 will also be discussed in a separate QAPP. At this time, CNEP does not operate the HAPs sampler or the non-continuous, filter based samplers for particulate matter.

12 Non-Continuous Sample Handling and Custody Requirements

Sample handling and custody requirements for Hazardous Air Pollutants (HAPs) will be covered in a separate QAPP. Sample handling and custody requirements for non-continuous monitoring of PM2.5 and PM10 will also be discussed in a separate QAPP. At this time, CNEP does not operate the HAPs sampler or the non-continuous, filter based samplers for particulate matter.

13 Analytical Methods Requirements

13.1 Purpose/Background

This section identifies the analytical methods required for continuous monitoring of criteria pollutants. The analytical methods are identified by parameter, instrument, federal reference method, method code, and analysis method. Continuous monitoring will be conducted for SO_2, CO, NO_2, NOy, NH_3, Ozone, PM10, PM2.5, and meteorological parameters. Non-continuous monitoring is currently not being conducted for identified Hazardous Air Pollutant (HAP) parameters; however, when CNEP decides to begin sampling for HAPs again, it will be covered under a separate QAPP.

13.2 Analytical Methods

Sulfur dioxide (SO_2) concentrations are measured by means of ultraviolet fluorescence spectrometry in both trace (NCore) and non-trace level analyzers. This analytical method continuously measures low concentrations of SO_2 when UV radiation excites SO_2 molecules and produces fluorescent radiation. A reference detector and photomultiplier tube measure the SO_2 molecules.

Carbon monoxide (CO) concentrations are measured by means of gas filter correlation and a non-dispersive infrared photometer in both trace (NCore) and non-trace level analyzers. This analytical method continuously measures low concentrations of CO by passing infrared broadband radiation through a rotating gas filter wheel filled with CO and nitrogen. The CO produces a reference beam and the nitrogen produces the measurement beam as CO sample gases pass through the filter wheel.

The concentrations of nitrogen oxides are measured by means of gas-phase chemiluminescence in both trace (NCore) and non-trace level analyzers. This analytical method continuously measures low concentrations of NO_2, NO, NOx and NOy. This method incorporates a single low pressure reaction cell and photomultiplier tube to measure the chemiluminesence (light) produced by the reaction between NO and O_3. The measurement sample is alternately switched either through or around a NO_2-NO heated converter.

Ozone (O_3) concentrations are measured continuously by means of a non-dispersive ultraviolet photometer. An instrument-generated reference sample of ozone is passed through an ozone scrubber (catalyst) and converted to oxygen. The amount of UV radiation emitted from the reference sample is then measured in an absorption cell. The actual ambient gas sample bypasses the scrubber and is measured in the absorption cell. A microprocessor uses the Beer-Lambert relationship to calculate the ambient ozone concentration by comparing the reference sample to the actual sample.

Two analytical methods are being used for continuous monitoring of particulate matter (PM2.5 and PM10). One method uses a Met One BAM 1020 Beta Attenuation Monitor and the other method uses a Thermo 1405-D Dichotomous TEOM. The Beta Attenuation method uses a radiation source to produce beta particles that correlate to either PM10 or PM2.5 concentrations. The method is based on the ability of beta particles to penetrate either PM10 or PM2.5 particles as they accumulate on filter tape. The accumulation of PM10 or PM2.5 particles decreases the amount of beta particles that can be measured in the instrument's measurement chamber. This decrease is compared to uninhibited beta particles measured in the compensation chamber (reference standard). A comparison and correlation of the decreased beta particles to the reference standard determines the PM10 or PM2.5 concentration value. The TEOM method uses a tapered element oscillating microbalance (TEOM). The frequency of oscillation of the microbalance decreases as particulate mass accumulates on the microbalance filter. Changes in the frequency of oscillation are used to calculate the PM2.5, PM10, and PMcoarse concentration.

Concentrations of ammonia are measured continuously by means of gas-phase chemiluminescence. This analytical method measures low concentrations of ammonia (NH_3), oxides of nitrogen (NO_X) and total nitrogen compounds (N_X). The analyzer utilizes an external thermal oxidizer to convert NH_3 to NO. The resulting NO reacts with O_3 and produces chemiluminesence (light) which is measured by a photomultiplier tube and a single low pressure reaction cell.

Wind speed is measured by means of a thin-film capacitor sensor coupled directly to an anemometer. A sealed magnetic reed switch that is connected to the anemometer produces a series of pulses at a rate proportional to wind speed.

Wind direction is determined by means of a potentiometer sensor coupled directly to an aluminum vane that can swivel through a 360º range of motion. Variations in wind direction produce a corresponding change of voltage that is proportional to wind direction.

A combination method for determining wind speed and wind direction involves using a sonic sensor. A sonic sensor consists of four sensors that measure changes in frequency of wind speed and wind direction. The frequencies are converted to corresponding voltages using a wind distortion algorithm and factoring process, and the voltages are converted to values for wind speed and wind direction.

Temperature is measured by means of a solid-state thermistor sensor. The sensor produces a large change in electrical resistance for each degree of temperature change.

Relative humidity is measured by means of a thin-film polymer capacitor sensor. A one-micron-thick dielectric polymer layer absorbs water molecules through a thin metal electrode, which in turn causes capacitance change proportional to relative humidity.

Precipitation (rain and snowfall) is measured by means of a heated tipping bucket. The bucket is designed to funnel precipitation to a tipping mechanism that measures 0.01 inch of precipitation with each tip. A magnet attached to the tipping mechanism actuates a magnetic reed switch with each tip of the bucket.

HAPs are sampled by methods described in Section 10.3 of this QAPP. When CNEP is sampling for HAPs, a separate QAPP will describes these sampling methods in detail.

Table 13.1 identifies the analytical methods used in criteria pollutant monitoring by the CNEP.

Table 13.1 Parameters, Instruments, Method Codes & Analysis Methods

Parameters, Instruments, Method Codes & Analysis Methods			
Parameter	**Manufacturer**	**Method Code**	**Analysis Method**
SO_2 (trace)	Ecotech EC9850T	592	UV Fluorescence Spectrometer
CO (trace)	Ecotech EC9830T	588	Infrared Photometer
NOx, NO, NO_2	Monitor Labs ML9841B	090	Chemiluminescence
NOy (trace)	Ecotech EC9841T	690	Chemiluminescence
NH_3 (trace)	Ecotech EC9842T	592	Chemiluminescence
O_3	Teledyne API 400E	087	UV Photometer
	Monitor Labs ML9810	091	UV Photometer
	Monitor Labs ML9810B	091	UV Photometer
	Ecotech EC9810B	091	UV Photometer
	Serinus 10	187	UV Photometer
PM10 (STP)	Met One BAM 1020	122	Beta Attenuation (mass)
	Thermo 1405-D Dichotomous TEOM	792	Oscillating Microbalance (mass)
PM2.5 (Local Conditions)	Met One BAM 1020	733	Beta Attenuation (mass)
	Thermo 1405-D Dichotomous TEOM	792	Oscillation Microbalance (mass)
PMcoarse (Local Conditions)	Met One BAM 1020	185	Beta Attenuation (mass)
	Thermo 1405-D Dichotomous TEOM	208	Oscillation Microbalance (mass)
WS	Met One Model 010C	020	Thin Film Capacitor Sensor
WD	Met One Model 020C	020	Potentiometer Sensor
WS/WD	Met One Model 50.5	061	Sonic Sensor
Temperature	Met One Model 592	040	Thermistor Sensor
	Met One Model 083D-1-35	040	Thermistor Sensor
RH	Met One Model 593	011	Thin Film Capacitor Sensor
	Met One Model 083D-1-35	011	Thin Film Capacitor Sensor
Precipitation	Met One Model 375	091	Tip Bucket
HAPs	RM910A	TO-15	VOC Collection System

14 Quality Control Requirements

14.1 Purpose/Background

This section describes the quality control requirements for the continuous and non-continuous monitoring instruments within the Cherokee Nation's ambient air monitoring network. The quality control requirements for the non-continuous instruments are based on the manufacturer's manuals, CNEP protocols, and the laboratory contractor's QA/QC requirements. The quality control requirements for the continuous instruments are based on manufacturer's manuals, CNEP protocols, *Revisions to Ambient Air Monitoring Regulations, Final Rule* (40 CFR, Parts 53 and 58, October 17, 2006), and the following guidance document:

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-17-001, January 2017.

This guidance document and the 2006 *Revisions to the Ambient Air Monitoring Regulations* identify the protocols, frequencies, corrective actions, and documentation process for instrument certifications, verifications, and audits. For the CNEP, these would include manufacturer certifications, EPA certifications, NIST certifications, Level II (Zero/Span) checks, Level I (Zero/Span/One-Point QC) checks, quarterly audits, independent audits, and national performance audits (through the probe audits, TTP). In addition, the audit protocols and measurement quality objectives (MQOs) described in this section of the QAPP meet or exceed the MQOs specified in the Data Validation Templates that can be found in the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program* (see **Appendix F** of this QAPP).

14.2 Instrument Certifications & Verifications

The CNEP maintains the manufacturer certifications for all of its instruments and support instrumentation. This includes the criteria instruments (SO_2, CO, NO_2, O_3, PM2.5, PM10), meteorological instruments, primary O_3 standard, transfer O_3 standards, calibrators, EPA protocol gas cylinders, RM 910A instrument, and reference standard instruments (e.g. flow, temperature). This also includes other instruments, such as the ammonia analyzer and NOy instrument. The CNEP also maintains annual verifications, re-certifications and/or maintenance records for the instruments and support instrumentation. These are limited to the:

- U.S. EPA Regional Lab annual verification for the O_3 primary standard
- replacement of EPA protocol gas cylinders
- maintenance for the primary/transfer O_3 standard instruments when needed
- annual certification for the reference standard instruments (e.g. flow, temperature)

14.3 Instrument Audits & Frequency

The CNEP or independent auditors conduct different levels of audits for the continuous and non-continuous instruments and their support instrumentation. The following table summarizes the instruments that are audited, type of audit, frequency of the audit, and who conducts the audit.

Table 14.1 Instrument, Audit Type, Frequency, and Entity

Instrument, Audit Type, Frequency, and Entity			
Instrument	**Audit Type**	**Frequency**	**Auditor**
NO_2, O_3	Level II	Nightly	CNEP
NCore trace gas (SO_2, CO, NOy)	Level II	Nightly	CNEP
NO_2, NH_3, O_3, PM2.5/10	Level I	Bi-weekly	CNEP
NCore trace gas (SO_2, CO, NOy)	Level I	Bi-weekly	CNEP
NO_2, NH_3, O_3, PM2.5/10	Quarterly	Quarterly	CNEP
NCore trace gas (SO_2, CO, NOy)	Quarterly	Quarterly	CNEP
Calibrator Checks		Quarterly	CNEP
RM 910A		Semi-annually	CNEP
NO_2, O_3, Trace (SO_2, CO, NOy), PM2.5/10	Independent*	Quarterly	Contractor
NO_2, O_3, Trace (SO_2, CO, NOy)	NPAP**	Every 5 years	U.S. EPA/Contractor
WS, WD, RH, Temperature, Precipitation		Annually	CNEP/Contractor***

*The independent audits are conducted at various rotating sites each quarter, so that each site's instruments, including NCore instruments, are audited at least once a year (gas analyzers) or twice a year (PM2.5 and PM10). Ozone is independently audited at each site at least once during the ozone season.

**The National Performance Audit Program (NPAP), "through the probe (TTP)" audits, only audits 20% of the monitoring sites in its SLAMS network each year or a minimum of one site per year. Also, the NPAP audits 20% of the National NCore network sites per year. Therefore, Cherokee Nation's NCore site may be audited once every 5 years by NPAP.

***WOOD audits meteorological instruments at the Stilwell CASTNet site semi-annually while INQUEST audits meteorological instruments at all other sites annually. CNEP audits all of its meteorological instruments once each year, excluding Stilwell CASTNet site.

Level II Checks

Automated Level II (zero/span) checks are conducted each night for the NO_2 and the NCore trace gas (SO_2, CO, NOy) analyzers using EPA Protocol gases that are NIST traceable and certified. Automated Level II checks are conducted each night for the O_3 instruments using the instrument's own internal photometer to generate ozone. An ESC datalogger (Ecotech WinAQMS at NCore and Pryor) initiates the Level II checks each day at a specified time and records the results, which are then retrieved utilizing an on-site modem system to a CNEP desktop computer and printed out the next workday. A site operator uses the Level II checks as an initial quality control check to determine if a particular instrument is operating within specification. The determination is based on how an instrument is responding to the zero and span reference gas challenges each night. For NO_2 and trace gases (SO_2, CO, NOy), the span check is 80% of full scale. For O_3, the span check is generally 20% of full scale, because it will allow for the instrument to be checked at a point closer to the typical ambient range. As a general rule, if the nightly checks are within the limits identified in **Table 14.2** then no corrective actions are required. However, if they exceed these limits, then the site operator initiates a corrective action by comparing the differences to other nightly audit records, Level I check/calibration records, independent audit reports, and maintenance records. If the comparisons reflect that an instrument may be malfunctioning, then maintenance, a Level I check, and/or recalibration are conducted for the instrument or instruments in question.

Level I Checks

Level I (zero/span/one-point QC) checks are conducted every two weeks for the NO_2, trace NH_3, O_3, and NCore trace gas (SO_2, CO, NOy) instruments using EPA Protocol gases (NIST traceable and certified) and/or an O_3 transfer standard. In the case of the mobile monitoring station, a Level I check can be performed with an O_3 transfer standard only when CNEP personnel visit the mobile monitoring station each month. The instruments are challenged by known gas concentrations that can be found in **Table 14.2** for non-trace and **Table 14.3** for trace. A site operator uses the Level I checks as a quality control check to determine if a particular instrument is operating normally or if an instrument needs maintenance, recalibration, or repairs. The Level I checks are recorded on audit/calibration forms and site logbooks that are kept at the CNEP office and at each shelter (**Appendix C** for non-trace analyzers, **Appendix D** for NCore trace gas analyzers). The documentation on each audit/calibration form includes the following information:

- site identification
- instrument and calibration system serial numbers
- date
- site operator
- instrument gains and offsets
- standard gas cylinder info (e.g. serial number, concentration, expiration date)
- expected instrument values
- actual (unadjusted) instrument values
- percent difference values
- instrument parameters (e.g. gas flow/pressure, temperatures, etc.)

If a non-trace instrument fails a Level I check it will be recalibrated and/or maintenance within the next 0 to 5 business days. An instrument fails a Level I check if the zero, span, and/or one-point QC drift values identified in **Table 14.2** are exceeded. As a general rule, if the zero, span, and one-point QC drifts for the gas analyzers (O_3, NO_2) are within the limits, then no corrective action is necessary. However, if the zero, span, and one-point QC drifts are approaching the limits (i.e. zero drift at 2.5-3.1 ppb; O_3 drift at 5-7.1%; NO_2 span drift at 8-10.1%; NO_2 one-point QC drift at 7-15.1%) or exceeding the limits (i.e. zero drift ≥ 3.1 ppb; O_3 drift ≥ 7.1%; NO_2 span drift ≥ 10.1%; NO_2 one-point QC drift ≥ 15.1%), then the site operator initiates a corrective action by comparing the differences to previous Level I audits, calibration records, and maintenance records. If the comparisons reflect that an instrument may be malfunctioning and/or out of specification, then a multipoint check, calibration and/or maintenance will be conducted on the instrument or instruments in question. The corrective actions (multipoint check, calibration, and/or maintenance) are documented on audit/calibration forms and site logbooks that are kept at CNEP office and at the site. The audit/calibration forms are maintained for a minimum of 3 years at our office while the on-site forms will be maintained for a minimum of 5 years and the logbooks are kept for an indefinite amount of time.

If a trace gas instrument fails a Level I check it will be recalibrated and/or maintenance within the next 0 to 5 business days. An instrument fails a Level I check if the zero, span, and/or one-point QC drift values specified in **Table 14.3** are exceeded. As a general rule, if the zero, span, and one-point QC drifts for trace gas analyzers (SO_2, CO, NOy, NH_3) are within the limits, then there is no action. However, if the zero, span, and one-point QC drifts are approaching the limits (i.e. zero drift at 2.5-3.1 ppb; trace gas (SO_2, CO, NH_3) drifts at 8-10.1%; trace gas (NOy) span drift at 8-10.1%; trace gas (NOy) one-point QC drift at 7-15.1%) or surpasses the limits (i.e. zero drift ≥ 3.1 ppb; trace gas (SO_2, CO, NH_3) drifts ≥ 10.1%; trace gas (NOy) span drift ≥ 10.1%; trace gas (NOy) one-point QC drift ≥ 15.1%), then the site operator initiates a corrective action by comparing the differences to previous Level I audits, calibration records, and maintenance records. If the comparisons reflect that an instrument may be malfunctioning and/or out of specification, then a multipoint check, calibration, and/or maintenance will be conducted on the instrument or instruments in question. Documentation of the corrective action taken is the same for trace and non-trace gas instruments as well as the retention time for the documents.

Table 14.2 Audit Concentration Levels and Drifts for Non-Trace Gas Analyzers

Non-Trace Gas Analyzers						
Parameter	O_3					NO_2
Site	**Newkirk**	**Pryor**	**Stilwell**	**Roland**	**Mobile**	**Roland**
Instrument	Serinus 10	Serinus 10	EC 9810B	API 400E	API 400E	ML 9841B
Level I Checks						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb
1-Point QC	30 ppb	30 ppb	30 ppb	30 ppb	30 ppb	87 ppb
1-Point QC Drift	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)
Span Point	92 ppb	88 ppb	82 ppb	82 ppb	400 ppb	400 ppb
Span Drift	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 10.1%
Multi-Point Check (at least 4 points, including zero)						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb
1-Point QC	30 ppb	30 ppb	30 ppb	30 ppb	30 ppb	87 ppb
1-Point QC Drift	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)
Span Point	92 ppb	88 ppb	82 ppb	82 ppb	400 ppb	400 ppb
Span Drift	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 10.1%
Multi-Point Calibration (at least 4 points, including zero)						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb
1-Point QC	30 ppb	30 ppb	30 ppb	30 ppb	30 ppb	87 ppb
1-Point QC Drift	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)
Span Point	92 ppb	88 ppb	82 ppb	82 ppb	400 ppb	400 ppb
Span Drift	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 10.1%

Table 14.3 Audit Concentration Levels and Drifts for Trace Gas Analyzers

Trace Gas Analyzers				
Parameter	**SO_2**	**CO**	**NOy**	**$^*NH_3$**
Instrument	EC 9850T	EC 9830T	EC 9841T	EC 9842T
Level I Checks				
Zero Drift	0.20 ppb	20 ppb	0.20 ppb	0.20 ppb
1-Point QC	6 ppb	170 ppb	20 ppb	30 ppb
1-Point QC Drift	< 10.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)
Span Point	52 ppb	600 ppb	100 ppb	190 ppb
Span Drift	< 10.1%	< 10.1%	< 10.1%	< 10%
Multi-Point Check (at least 4 points, including zero)				
Zero Drift	0.20 ppb	20 ppb	0.20 ppb	0.20 ppb
1-Point QC	6 ppb	170 ppb	20 ppb	30 ppb
1-Point QC Drift	< 10.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)
Span Point	52 ppb	600 ppb	100 ppb	190 ppb
Span Drift	< 10.1%	< 10.1%	< 10.1%	< 10%
Multi-Point Calibration (at least 4 points, including zero)				
Zero Drift	0.20 ppb	20 ppb	0.20 ppb	0.20 ppb
1-Point QC	6 ppb	170 ppb	20 ppb	30 ppb
1-Point QC Drift	< 10.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)
Span Point	52 ppb	600 ppb	100 ppb	190 ppb
Span Drift	< 10.1%	< 10.1%	< 10.1%	< 10%

* NH_3 is a trace gas analyzer but is NOT included among the NCore network

For PM2.5 and PM10, a Level I precision check for the instrument's flow rate is performed every two weeks. The check is conducted using either the instrument's internal flow meter or an external flow reference standard. In the case of the mobile monitoring station, a Level I check can be performed with an external flow reference standard only when CNEP personnel visit the mobile monitoring station each month. Level I checks performed on the mobile monitoring station instruments at other times must be performed remotely by CNEP personnel (by means of modem) or by a representative of the host tribe using only the instrument's internal flow meter. When a Level I check is performed remotely by means of a modem connection, only the PM2.5 flow rate and the PMcoarse flow rate can be checked. A minimum of three flow checks are obtained to verify that the flow rate is stable and accurate to ± 4.1%. See the Continuous PM2.5 Local Conditions Validation Template and the Continuous PM10 STP Conditions Validation Template in **Appendix F** of this QAPP for MQOs pertaining to the PM2.5 TEOMs, PM2.5 Beta Attenuation Monitor (BAMs), PM10 TEOMs, and PM10 BAMs.

In addition, third standard deviation values are determined and evaluated for each instrument. The values are recorded after each Level I check and quarterly audit and reestablished after each instrument recalibration. The 3rd standard deviation values are used to measure instrument performance, identify a need for instrument troubleshooting or maintenance, and help identify operator errors.

Quarterly Audits

The CNEP conducts a quarterly audit (multipoint check) for each of the NO_2, NH_3, O_3, and NCore trace gas (SO_2, CO, NOy) analyzers at all sites including the mobile. The quarterly audit is the same as a Level I check, but has at least two additional precision point checks (see **Tables 14.2** and **14.3** for drift values and other parameters pertaining to multipoint checks). The results are treated the same as a Level I check. The third standard deviation values are determined and evaluated for each instrument after a quarterly audit.

The CNEP also conducts PM2.5 and PM10 instrument audits each quarter at all sites including the mobile using a flow reference standard. If the flow rate of either instrument is found to be outside of a ± 4.1% tolerance limit for the expected flow rate (16.7 lpm), then the instrument is recalibrated within the next 0 to 5 business days; however, at the mobile the instrument will be recalibrated at the next available opportunity, which is dependent on location (maximum time: 1 month). If the TEOM instrument's mass transducer exceeds the expected known response by more than ± 2.5%, then it is replaced by the manufacturer. The TEOM and BAM are also audited for ambient temperature and barometric pressure. The audit results, recalibration and/or repair results are recorded on individual audit/calibration forms and in site dedicated logbooks kept at each site. The on-site forms are retained for five years at all sites excluding the mobile (retained for 3 years). The dedicated logbooks for each site are retained for an indefinite amount of time.

Independent Audits

Independent audits for the NO_2, O_3, trace gas (SO_2, CO, NOy), PM2.5, and PM10 instruments are conducted by INQUEST contractors during the scheduled quarter. Meteorological instruments are audited once each year by INQUEST at all sites except the Stilwell CASTNet site. Meteorological instruments at the Stilwell CASTNet site are audited twice each year by WOOD. INQUEST's SOPs are identified in **Appendix E** of this QAPP. These audits are conducted using independent instruments and independent EPA Protocol gases that are also NIST traceable and certified. Different shelters and their associated instruments are selected for audit during the scheduled quarter, so that all of the shelters' instruments within the Cherokee Nation's air monitoring network (6 shelters) are audited at least once each year (gas analyzers) or twice each year (PM2.5 and PM10). Ozone is audited at every site at least once during ozone season. The independent audit schedule is included in **Appendix E** of this QAPP. The audits are conducted "as is" which means that no calibrations will be performed. If an independent audit fails, then the CNEP is notified within 24 hours and its site operator conducts a Level I audit within the next 0 to 5 business days and subsequent recalibration, maintenance and/or repair if it is needed. Any subsequent instrument recalibrations or maintenance by the CNEP are recorded in the site logbooks.

The EPA Region 6 Office periodically conducts site performance audits and/or technical reviews for the air monitoring program. These audits and/or reviews will be conducted when necessary and if resources are available. The audit and/or review results will be summarized and reported to the CNEP when they are finalized by the EPA Region 6 Office. These audits and/or reviews are described in Section 20.3 of this QAPP.

At its option, the EPA may provide independent audit devices (flow audit devices and gas reference standards) each year under its contract with Alion.

In accordance with the latest revisions to 40 CFR, Part 58, Appendix A (March 28, 2016), CNEP will participate in the Ambient Air Protocol Gas Verification Program (AA-PGVP) by completing an annual survey of the gas cylinders utilized by our monitoring program using the Battelle website, https://www.sdas.battelle.org/AirQA/, and by sending one unused EPA protocol gas cylinder to a regional air verification laboratory (Region 2 or Region 7) for verification at least once every 5 years.

15 Maintenance Requirements

15.1 Purpose/Background

This section describes how preventive and/or corrective maintenance of the instruments will be performed and documented. The site operator is responsible for daily polling (by modem) of the fixed shelters and mobile shelter instruments from the CNEP office. In addition, the site operator is responsible for biweekly site inspections which are documented in the shelter logbook. Scheduled maintenance and corrective maintenance conducted by the site operator is documented in detail on a tag attached to each instrument.

The site operator maintains various spare parts at the CNEP office and has blanket purchase orders with manufacturers for instrument spare parts, instrument repair, miscellaneous supplies, and tools.

15.2 Scheduled Instrument Maintenance Requirements

The site operator conducts scheduled maintenances for each instrument. Instrument spare parts for these maintenances are inventoried and kept at the CNEP office. The following table identifies the instrument, type of maintenance, and when it is conducted.

Table 15.1 Instrument Maintenance & Interval

Instrument Maintenance and Interval		
Instrument	**Maintenance Requirement**	**Interval**
Trace SO_2	Replace charcoal scrubber	semi-annually
	Replace PMT desiccant packs	annually
	Replace DFU filter	annually
	Check UV lamp	annually
	Perform pneumatic leak check	monthly
	Test pumps	quarterly
	Check flow calibration	annually
Trace CO	Replace DFU filter	annually
	Replace sintered filter	annually
	Check CO-CO_2 converter	annually
	Adjust detector signal	annually
	Perform pneumatic leak check	monthly
	Test pumps	quarterly
	Check flow calibration	annually

Table 15.1 Instrument Maintenance & Interval (continued)

Instrument Maintenance and Interval (continue)		
Instrument	**Maintenance Requirement**	**Interval**
NOx, Trace NOy, & NH_3	Replace exhaust scrubber	semi-annually
	Replace PMT desiccant packs	annually
	Replace DFU filter	annually
	Replace sintered filter	annually
	Clean reaction cell	annually
	Perform pneumatic leak check	annually/monthly (trace)
	Test pumps	quarterly
	Check flow calibration	annually
O_3	Replace exhaust scrubber	annually
	Replace DFU filter	annually
	Replace sintered filter	annually
	Inspect purge filter/orifice	annually
	Check UV lamp	annually
	Check ozone scrubber	annually
	Perform pneumatic leak check	annually
	Replace charcoal scrubber in IZS	annually
	Test pumps	quarterly
	Check flow calibration	annually
Calibrators	Replace DFU filter	annually
	Replace desiccant in scrubbers	semi-annually
	Mass flow controller check	annually
*** PM2.5 & PM10**	Inspect inlet o-rings	quarterly
	Inspect filter tape	bi-weekly
Air Intake Unit	Clean glass manifold	quarterly
R&M 910A	Replace pump	annually
	Perform pneumatic leak check	annually
Meteorological Instruments	Replacement is dependent on annual audit results	

*See Continuous PM2.5 Local Conditions Validation Template and Continuous PM10 STP Conditions Validation Template in **Appendix F** of this QAPP for maintenance schedule and MQOs for PM2.5 TEOMs, PM2.5 BAMs, PM10 TEOMs, and PM10 BAMs.

The CNEP has an operator's manual from the manufacturer for each analyzer and instrument in its inventory. The CNEP follows the recommendations of these manuals with respect to instrument maintenance, troubleshooting, and repairs. Also, the CNEP follows the recommendations of the Data Validation Templates located in Appendix D of the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program* (see **Appendix F** of this QAPP).

15.3 Miscellaneous Supplies

The CNEP keeps adequate supplies at each shelter and at the CNEP office. These supplies may include:

- various instrument replacement parts
- Teflon tubing
- plastic ties
- tubing fittings & ferrules
- instrument cables & connectors
- electrical tape
- fuses
- filters & charcoal
- meteorological tower guy wires, anchors & toggle bolts
- pumps & pump repair kits
- gas cylinder regulator
- air conditioner air filters
- desiccant
- tools

16 Instrument Calibrations & Frequency

16.1 Purpose/Background

This section describes the standards, frequency, and procedures for calibrating the continuous and non-continuous instruments in the Cherokee Nation's ambient air monitoring network. The continuous instruments include NO_2 (NOx & NO), NH_3, O_3, PM2.5, PM10, NCore trace gas (SO_2, CO, NOy) analyzers, and meteorological instruments. The non-continuous instruments include the R&M 910A. The CNEP conducts all instrument calibrations, excluding met, with the exception of factory (initial & repair) calibrations and, if applicable, the independent contractor's initial instrument installation at each site. The CNEP's audit standard operating procedures (SOPs) and forms are identified in **Appendix C** and **Appendix D** of this QAPP. The independent contractor's calibration SOPs are identified in **Appendix E** of this QAPP.

The standards and frequencies used for calibrating the continuous instruments are identified in the following documents:

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume I A Field Guide to Environmental Quality Assurance. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-600/R-94/038a.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-17-001, January 2017.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV Meteorological Measurements Version 2.0 (Final). U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-08-002, March 2008.

Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone – Technical Assistance Document. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-13-004, October 2013.

Technical Assistance Document for the Calibration of Ambient Ozone Monitors. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-600/4-79-057.

Revisions to Ambient Air Monitoring Regulations, Final Rule. U.S.EPA, 40 CFR, Parts 53 and 58, October 17, 2006.

In addition, the calibration requirements described in this section of the QAPP meet or exceed the MQOs specified in the Data Validation Templates that can be found in the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program* (see **Appendix F** of this QAPP).

The standards and frequencies used for calibrating the non-continuous instruments are based on the manufacturers' specifications and manuals.

The CNEP conducts a multi-point calibration for the continuous instruments (5-point for NO_2, O_3, and 6-point for trace gas (SO_2, CO, NOy, NH_3) analyzers) or a single-point calibration for the non-continuous instrument (R&M 910A) for any of the following reasons:

- initial instrument installation at a site (CNEP and independent contractor)
- instrument zero/span/one-point QC drift tolerances are exceeded during a Level I check
- instrument design specifications are exceeded during an audit
- maintenance or repairs affect instrument calibration
- instrument is physically relocated
- an instrument is taken offline or placed online (e.g., ozone season, March 1-November 30); instrument recalibrated only if necessary
- O_3 transfer standard calibration (audit each quarter, recalibrate if necessary)

16.2 SO_2, CO, NO_2 & NOy Instrument Calibration & Frequency

A multi-point (5-point for non-trace, 6-point for trace) check and/or calibration is conducted for the NO_2 instrument, as well as for the trace gas analyzers (SO_2, CO, NOy, NH_3), using zero air and known EPA Protocol (G1) gas concentrations. The individual gases (CO, SO_2, NO, NH_3) are kept in high pressure cylinders that are certified and NIST traceable. The gas cylinder is connected to a two-stage regulator, which allows the gas to be supplied at a low pressure to the calibrator.

An Ecotech GasCal 1000GPT, Ecotech GasCal 1100GPT, Ecotech Serinus Cal 2000, or Environics 6103 (portable) multi-dilution calibrator is used to perform a multi-point check and/or calibration on the NO_2, NH_3, and trace gas (SO_2, CO, NOy) instruments. The calibrators have zero air supplied to them by external zero air generators, which are used to recalibrate the zero range and dilute the EPA Protocol gases at known concentrations. In addition, NOx and trace gas NOy instruments undergo a multi-point converter efficiency check using NO protocol gas in combination with various concentrations of ozone. The NH_3 instrument also undergoes a multi-point converter efficiency check using NH_3 protocol gas at various concentrations. Each multi-point check and/or calibration must have at least four points, including a zero (zero air) point. The CNEP uses five points in its multi-point checks and calibrations for non-trace gas analyzers and six points for trace gas analyzers.

If a non-trace instrument fails a Level I check, a quarterly audit, and possibly an independent audit, it will be recalibrated, maintenance and/or repaired within the next 0 to 5 business days. An instrument fails an audit if the zero, span, and/or one-point QC drift values identified in **Table 16.1** are exceeded. As a general rule, if the zero, span, and one-point QC drifts for the gas analyzers (O_3, NO_2) are within the limits, then no action is necessary. However, if the zero, span, and one-point QC drifts are approaching the limits (i.e. zero drifts at 2.5-3.1 ppb; O_3 drift at 5-7.1%; NO_2 span drift at 8-10.1%; NO_2 one-point

QC drift at 7-15.1%) or exceeding the limits (i.e. zero drifts ≥ 3.1 ppb; O_3 drift ≥ 7.1%; NO_2 span drift ≥ 10.1%; NO_2 one-point QC drift ≥ 15.1%), then the site operator initiates a corrective action by comparing the differences to previous Level I audits, calibration records, and maintenance records. If the comparisons reflect that an instrument may be malfunctioning and/or out of specification, then a multipoint check, calibration and/or maintenance will be conducted on the instrument or instruments in question. The corrective actions (multipoint check, calibration and/or maintenance) are documented on audit/calibration forms and site logbooks that are kept at CNEP office and at the site. The audit/calibration forms are maintained for a minimum of 3 years at our office while the on-site forms are maintained for 5 years and logbooks are kept for an indefinite amount of time. In addition, if an instrument is placed "online" for the first time, has had maintenance or been repaired, then it is calibrated. In any of these cases, new fixed "universal" baseline values are established each time a multi-point calibration is conducted for an instrument. The "universal" baseline values reestablish the third standard deviation values which are used to measure instrument performance, identify a need for instrument troubleshooting or maintenance, and help identify operator errors. If an instrument does not calibrate to specifications, then the CNEP site operator reviews the audit records, maintenance records, instrument logbooks, and 3rd standard deviation values. The site operator will repair the instrument or have it sent to the manufacturer for repair.

Table 16.1 Audit Concentration Levels and Drifts for Non-Trace Analyzers

Non-Trace Gas Analyzers						
Parameter	**O_3**					**NO_2**
Site	**Newkirk**	**Pryor**	**Stilwell**	**Roland**	**Mobile**	**Roland**
Instrument	Serinus 10	Serinus 10	EC 9810B	API 400E	API 400E	ML 9841B
Level I Checks						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb
1-Point QC	30 ppb	30 ppb	30 ppb	30 ppb	30 ppb	87 ppb
1-Point QC Drift	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)
Span Point	92 ppb	88 ppb	82 ppb	82 ppb	400 ppb	400 ppb
Span Drift	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 10.1%
Multi-Point Check (at least 4 points, including zero)						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb
1-Point QC	30 ppb	30 ppb	30 ppb	30 ppb	30 ppb	87 ppb
1-Point QC Drift	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)
Span Point	92 ppb	88 ppb	82 ppb	82 ppb	400 ppb	400 ppb
Span Drift	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 10.1%
Multi-Point Calibration (at least 4 points, including zero)						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb	< 3.1 ppb
1-Point QC	30 ppb	30 ppb	30 ppb	30 ppb	30 ppb	87 ppb
1-Point QC Drift	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 7.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)
Span Point	92 ppb	88 ppb	82 ppb	82 ppb	400 ppb	400 ppb
Span Drift	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 7.1%	< 10.1%

If a trace gas instrument fails a Level I check, a quarterly audit, and possibly an independent audit, it will be recalibrated and/or maintenance within the next 0 to 5 business days. An instrument fails an audit if the zero, span, and one-point QC drift values specified in **Table 16.2** are exceeded. As a general rule, if the zero, span, and one-point QC drifts for trace gas analyzers (SO_2, CO, NOy, NH_3) are within the limits, then there is no action. However, if the zero, span, and one-point QC drifts are approaching the limits (i.e. zero drift at 2.5-3.1 ppb; trace gas (SO_2, CO, NH_3) drifts at 8-10.1%; trace gas (NOy) span drift at 8-10.1%; trace gas (NOy) one-point QC drift at 7-15.1%) or surpasses the limits (i.e. zero drift ≥ 3.1 ppb; trace gas (SO_2, CO, NH_3) drifts ≥ 10.1%; trace gas (NOy) span drift ≥ 10.1%; trace gas (NOy) one-point QC drift ≥ 15.1%), then the site operator initiates a corrective action by comparing the differences to previous Level I audits, calibration records, and maintenance records. If the comparisons reflect that an instrument may be malfunctioning and/or out of specification, then a multipoint check, calibration, and/or maintenance will be conducted on the instrument or instruments in question. Documentation of the corrective action taken is the same for trace and non-trace gas instruments as well as the retention time for the documents. In addition, if an instrument is placed "online" for the first time, has had maintenance or been repaired, then it is calibrated. In any of these cases, new fixed "universal" baseline values are established each time a multi-point calibration is conducted for an instrument. The "universal" baseline values reestablish the third standard deviation values which are used to measure instrument performance, identify a need for instrument troubleshooting or maintenance, and help identify operator errors. If an instrument does not calibrate to specifications, then the CNEP site operator reviews the audit records, maintenance records, instrument logbooks, and 3rd standard deviation values. The site operator will repair the instrument or have it sent to the manufacturer for repair.

Table 16.2 Method Quality Objectives, Audit Concentrations and Drifts, And Recalibration Specifications for Trace Gas Analyzers

Per recommendations of Ecotech and EPA RTP

Trace Gas Analyzers				
Parameter	**SO_2**	**CO**	**NOy**	**$^*NH_3$**
Instrument	EC 9850T	EC 9830T	EC 9841T	EC 9842T
Level I Checks				
Zero Drift	0.20 ppb	20 ppb	0.20 ppb	0.20 ppb
1-Point QC	6 ppb	170 ppb	20 ppb	30 ppb
1-Point QC Drift	< 10.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)
Span Point	52 ppb	600 ppb	100 ppb	190 ppb
Span Drift	< 10.1%	< 10.1%	< 10.1%	< 10.1%
Multi-Point Check (at least 4 points, including zero)				
Zero Drift	0.20 ppb	20 ppb	0.20 ppb	0.20 ppb
1-Point QC	6 ppb	170 ppb	20 ppb	30 ppb
1-Point QC Drift	< 10.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)
Span Point	52 ppb	600 ppb	100 ppb	190 ppb
Span Drift	< 10.1%	< 10.1%	< 10.1%	< 10.1%
Multi-Point Calibration (at least 4 points, including zero)				
Zero Drift	0.20 ppb	20 ppb	0.20 ppb	0.20 ppb
1-Point QC	6 ppb	170 ppb	20 ppb	30 ppb
1-Point QC Drift	< 10.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)	< 15.1% or ± 1.5 ppb (whichever is greater)	< 10.1% or ± 1.5 ppb (whichever is greater)
Span Point	52 ppb	600 ppb	100 ppb	190 ppb
Span Drift	< 10.1%	< 10.1%	< 10.1%	< 10.1%
General MQOs				
Precision (CV)	< 10.1%	< 10.1%	< 10.1%	< 10.1%
Bias	< ± 10.1%	< ± 10.1%	< ± 10.1%	< ± 10.1%
Method Detection Limit (MDL), per Ecotech	200 ppt (EPA recommends 55 ppt)	25 ppb (EPA recommends 18 ppb)	50 ppt (exceeds EPA recommendation of 58 ppt)	400 ppt
Zero Air	< 0.1 ppb SO_2	< 40 ppb CO	< 0.10 ppb NOx	< 0.1 ppb NO
Gaseous Standards	10-13 ppm ± 1%	200-300 ppm ± 1%	10-13 ppm ± 1% NO_2 < 0.1% NO	50-100 ppm

$^*NH_3$ is a trace gas analyzer but is NOT included among the NCore network.

16.3 Ozone Instrument Calibration & Frequency

The calibration process for the ozone monitoring involves three principal instruments: a primary standard (API T703), an ozone transfer standard (Thermo-Anderson 49CPS, Thermo-Anderson 49*i*-PS, Environics 6103), and an ozone analyzer (API 400E, Monitor Lab 9810, 9810B, Ecotech 9810B, Ecotech Serinus 10). Any recalibration involves a multi-point (5-point) calibration using a NIST traceable zero air supply and ozone generated by the transfer standard. The ozone concentrations are approximately 0%, 30%, 50%, 65%, and 80% of the calibration scale of the ozone analyzer. The standard operating procedures for the ozone instrument audits are identified in **Appendix C** of this QAPP.

The API T703 primary standard is considered to be a bench instrument and is maintained at the CNEP office. It serves to audit and calibrate the ozone transfer standard. The primary standard is not calibrated by the CNEP. It is however, sent to a U.S. EPA Regional Lab [either Region VI (Houston Lab) or Region VII (Kansas City Lab)] for a performance verification on an annual basis. If the primary standard fails verification, the EPA Regional Lab will calibrate the instrument. CNEP has the ability to maintenance the primary standard in house; however, if we are unable then it is sent to the manufacturer for repair. If maintenance or repair has been performed on the primary standard, then it will be sent to EPA Regional Lab [either Region VI (Houston Lab) or Region VII (Kansas City Lab)] for re-verification. The verification and/or maintenance results are recorded in the ozone verification logbook that is housed at CNEP office and retained for an indefinite amount of time.

The transfer standard is transported between the CNEP and each of the monitoring sites to audit and/or calibrate the onsite ozone instruments. If the transfer standard fails a quarterly audit against the primary standard it will be pulled out of rotation, meaning it will not be used to audit/calibrate equipment, until such time corrective measures (i.e. calibration/maintenance) can be made by the CNEP. The transfer standard is also recalibrated anytime it has had maintenance or been repaired. The audit, calibration, and/or maintenance results are recorded in the ozone verification logbook.

The shelter ozone instruments are used for continuous monitoring during the ozone season (March 1 through November 30). The onsite ozone instruments are calibrated at the beginning of the ozone season, any time there is a failed Level I check or quarterly audit (**Table 16.1**), and after the instruments have had maintenance or repairs. A failed independent audit does not necessitate a recalibration of the instrument, but is considered after review of the instrument records and consultation with the auditor.

Again, new fixed "universal" baseline values are established each time a calibration is conducted for a transfer standard or an on-site instrument. The "universal" baseline values reestablish the third standard deviation values which are used to measure instrument performance, identify a need for instrument troubleshooting or maintenance, and help identify operator errors. If the instruments do not recalibrate to specifications, then the CNEP site operator reviews the audit records, maintenance records, instrument logbooks, and 3^{rd} standard deviation values. Then, the site operator will adjust or repair the instrument or have it sent to the manufacturer for repair.

16.4 Calibrator, Calibration & Frequency

Flow audits are performed each quarter by the CNEP on the Ecotech GasCal 1000GPT, Ecotech GasCal 1100GPT, and Ecotech Serinus Cal 2000, which are used as multi-dilution calibrators on site. A flow audit is also performed on the Environics 6103 portable multi-dilution calibrator (transfer standard). Each calibrator is audited using a verified reference standard flow meter (Bios DryCal Definer) at pre-selected flow rates. The mass flow controller is recalibrated on any on-site calibrators that fail a flow audit; however, if the mass flow controller will not calibrate to specifications, then it is replaced.

16.5 PM Instrument Calibration & Frequency

The PM2.5, PM10, and PMcoarse instruments [Met One BAM 1020; Thermo 1405-D Dichotomous TEOM] are designed to operate within ± 5.1% of their designed flow rate of 16.7 liters per minute (Lpm). However, recalibrations will occur anytime their designed flow rates are exceeded by ± 4.1% after a Level I check or quarterly audit has been conducted. The recalibration is accomplished by using a verified reference standard flow meter (Bios Dry Cal Definer, BGI DeltaCal, or Streamline Pro MultiCal System) and by following the manufacturer specifications and manuals.

The Met One BAM 1020 utilizes a small ^{14}C (Carbon 14) source to measure particulate matter. The ^{14}C (Carbon 14) source and beta particle detector can only be calibrated or serviced by the manufacturer; however, this service is rarely needed. The instrument's measuring system can be examined by performing a test of the reference membrane span check. This check is performed by CNEP annually. If an annual audit indicates that the instrument response exceeds the calibration mass equivalent by more than 5%, then the instrument's membrane will either be repaired or replaced by the manufacturer.

The Thermo 1405-D Dichotomous TEOM instrument utilizes two mass transducers to measure for PM2.5 and PMcoarse. The mass transducers each consists of a hollow tapered element with a natural frequency and vibration (similar to a tuning fork) that has a filter cartridge attached to it. When additional mass is added, the frequency of the vibration decreases and the instrument records the difference for the two parameters as well as calculates the PM10. A calibration verification kit consisting of pre-weighed calibration filters is used to verify the instrument's mass transducers. The manufacturer will be contacted if a quarterly audit indicates that the instrument response exceeds the calibration mass equivalent by more than ± 2.5%.

Method quality objectives (MQOs) for verification and calibration of PM2.5 TEOMs, PM2.5 BAMs, PM10 TEOMs, and PM10 BAMs are shown in the Continuous PM2.5 Local Conditions Validation Template and in the Continuous PM10 STP Conditions Validation Template in **Appendix F** of this QAPP.

16.6 Meteorological Instrument Calibration & Frequency

The CNEP has Met One meteorological instruments for measuring wind speed, wind direction, temperature, relative humidity, and precipitation at each site. [Precipitation is not measured at Roland or the mobile monitoring station.] The CNEP will replace the meteorological instruments if they fail to meet their designed measurement specifications for accuracy (**Table 7.1** of this QAPP). Their accuracy is determined by an independent audit conducted once a year for each site excluding Stilwell. [The meteorological instruments at the Stilwell site are part of the CASTNet network, which is operated by WOOD, an EPA contractor, and are audited semi-annually. WOOD is responsible for the accuracy, audits, and repair/replacement of the instruments.] CNEP will perform an audit on the newly installed instrument(s) using NIST traceable temperature/humidity/altimeter instruments as well as a motor driven calibrator for wind speed, if applicable. The failed meteorological instruments will be replaced by CNEP and sent to the manufacturer for repair.

16.7 Non-Continuous Instrument Calibration & Frequency

The calibration of instruments (R&M 910A) used for HAP monitoring will be described in a separate QAPP. The calibration of instruments used for non-continuous sampling of particulate matter will be described in a separate QAPP. At this time, CNEP does not operate the HAPs sampler or the non-continuous, filter based samplers for particulate matter.

17 Acceptance Requirements for Supplies & Consumables

17.1 Purpose/Background

This section describes where supplies and consumables will be acquired as well as any special requirements for their acceptance. It describes how they are accepted and by whom.

17.2 Acceptance Requirements

The site operator orders all instrument supplies and consumables. In addition, the site operator inspects and accepts them. Once it has been determined that the supplies and consumables are normal and have no defects, they are inventoried and stocked with the other supplies and consumables.

If monitoring or auditing instruments are received, then they are inspected and tested based on the manufacturer's certification sheets to ensure they are operating properly. If not, the site operator notifies the manufacturer and arranges for the instruments to be returned, repaired, and/or replaced.

Any consumables, pumps, or spare parts needed for the Ecotech gas analyzers, Ecotech trace gas analyzers, ML monitoring instruments, API monitoring instruments, Ecotech dilution calibrators and API zero air generator can be ordered from:

Ecotech, www.americanecotech.com
Teledyne API, www.teledyne-api.com

Any consumables, pumps, or spare parts needed for the 49C and 49*i*-PS transfer standard instruments can be ordered from:

Thermo Fisher Scientific, www.thermoscientific.com

Any consumables, pumps, or spare parts needed for the TEOM PM2.5, PM10, and PMcoarse instruments can be ordered from:

Thermo Fisher Scientific, www.thermoscientific.com

Any spare parts or software assistance needed for the dataloggers can be ordered from:

Agilaire LLC, www.agilairecorp.com
Environmental Systems Corporation (ESC), www.envirosys.com
Ecotech, www.americanecotech.com

Any spare parts and service for the portable zero air generator are available from:

Perma Pure, www.permapure.com

Any consumables, pumps, or spare parts needed for the meteorological sensors, translator, or BAM-1020 can be ordered from:

Met One Instruments, www.metone.com

Any consumables or spare parts needed for the monitoring shelters can be ordered from:

Lone Star Shelter Manufacturing, www.lonestarshelter.com

Any EPA Protocol gas cylinders can be ordered from:

OG&E Field Technical Services
P.O. Box 321
Oklahoma City, Oklahoma 73101-0321
Telephone 405-553-3000

Any Teflon tubing, exhaust tubing, Swagelok connectors and ferrules, kynar connectors and ferrules, filter housings, and other miscellaneous supplies can be ordered from:

Cole Parmer, www.coleparmer.com
Cope Plastics, www.copeplastics.com
Swagelok, www.swagelok.com

Oklahoma Fluid Solutions
Swagelok Oklahoma
1906 N. Yellowood Ave
Broken Arrow, OK 74012
(918) 258-8661

Any air intake manifolds or supplies can be ordered from:

Ecotech, www.americanecotech.com
Consolidated Analytical Systems, www.cas-en.com

Any towers or accessories can be ordered from:

Aluma Tower, www.alumatower.com
Rohn Towers, www.rohnnet.com

Any desiccant, charcoal, inlet filters, and other miscellaneous supplies can be ordered from:

Teledyne API, www.teledyne-api.com
Thermo Fisher Scientific, www.thermoscientific.com
Ecotech, www.americanecotech.com
Purafil, www.purafil.com

The reference standard instruments (e.g. flow, temperature, pressure, relative humidity) verifications are obtained from:

Chinook Engineering
A Division of Inter-Mountain Laboratories, Inc.
555 Absaraka Street
Sheridan, WY 82801

Met One Instruments
1600 Washington Blvd
Grants Pass, OR 97526

Sensidyne
1000 112th Circle North, Suite 100
St. Petersburg, FL 33716

Mesa Labs, Inc.
10 Park Place
Butler, NJ 07405

18 Data Acquisition Requirements (Non-Direct Measurements)

18.1 Purpose/Background

This section describes the types of non-direct measurements that are needed for the Cherokee Nation's ambient air monitoring network. Non-direct measurements are data and information used by the CNEP but which were not generated by the CNEP or the CNEP's contractors. Non-direct measurements are generated by agencies and entities outside, and independent of, the CNEP. For the purposes of this QAPP, data and information generated *for* the CNEP by a contractor are considered to be *direct* measurements. This section also defines the acceptance criteria for the use of data and any limitations on the use of data.

18.2 Non-Direct Measurements

The CNEP uses non-direct measurements for such purposes as identifying criteria pollutant sources, analyzing local and regional pollutant trends and migration patterns, determining the need for future monitoring by the CNEP, determining where to locate CNEP criteria pollutant monitoring stations, and analyzing direct measurement data obtained for criteria pollutants at CNEP monitoring stations.

The CNEP uses non-direct measurements from a variety of sources. Such measurements and sources may include Oklahoma Mesonet meteorological data from the Oklahoma Climatological Survey (OCS), meteorological data from neighboring states, wind current and pollutant trajectory data from the National Oceanic and Atmospheric Administration (NOAA), population data from the U. S. Census Bureau, human health data from various public health agencies, emission source permit data from the U. S. EPA, Oklahoma Department of Environmental Quality (ODEQ), and other agencies, and meteorological and criteria pollutant data from the Central Regional Air Planning Association (CENRAP) and from such internet sources as AQSWeb and AirNow.

The CNEP generally uses such non-direct measurement data "as is", relying on the agency that generated it to ensure that it is of sufficient quality for use by the general public for a wide variety of purposes. Nevertheless, the CNEP must exercise some judgment to ensure that the non-direct measurement data it uses is sufficient and appropriate to support the purposes for which the CNEP intends to use it. The CNEP Air Program Manager, Data Quality Review Officer, and Data Reporting Officer are responsible for ensuring that non-direct measurement data are used properly by the CNEP. They do this by determining if such data are acceptable for the intended use, informing CNEP staff of acceptance criteria, providing guidelines for the use of the data, and reviewing any conclusions or decisions based on such data. For example, the Air Program Manager may specify that certain kinds of non-direct measurement data are needed for regional pollutant migration analyses, while the Data Reporting Officer may determine if AQS data from a neighboring state are appropriate for use in such pollutant trajectory modeling.

19 Data Management

19.1 Purpose/Background

This section provides an overview of the CNEP's data management scheme for its ambient air monitoring network. It provides information on data recording, transformation, reduction, analysis, management, storage, and retrieval. The data management scheme also involves the CNEP's laboratory contractor (ERG, etc.) and independent quarterly audit contractor (INQUEST).

19.2 Management of CNEP Generated Data

The CNEP uses ESC dataloggers and Agilaire AirVision Version 3.3.16 Data Management and Reporting System software to collect and store ambient air data. (AirVision replaced the E-DAS Ambient software used previously.) It also uses Ecotech dataloggers and Ecotech Airodis Version 5.1.4 Build 7045 software for trace and non-trace gas data collection and storage. These two systems are maintained on one desktop computer located at the CNEP. This computer communicate with site dataloggers via telephone modems, cellular modems, or wireless Ethernet connections. Each datalogger is programmed to collect one-minute readings for the NOx (NO & NO_2), O_3, PM2.5, PM10, trace gas (SO_2, CO, NOy, NH_3), and meteorological instruments, and will store the data for approximately seven days (the Ecotech dataloggers are capable of longer storage periods). The dataloggers collect data 24 hours a day throughout the year with the exception of ozone monitoring, for which data is only collected from March 1 thru November 30. [CNEP collects ozone data throughout the year for Stilwell and the mobile monitoring station, when operable.] The site dataloggers are automatically polled hourly each day and the hourly readings and Level II nightly audits are stored as raw data in the AirVision and Airodis systems on the CNEP's desktop computer. If problems occur during the data retrieval, then it is noted in the datalogger logbook and immediate steps are taken to resolve the issue (this may involve a trip to the site to determine if the problem lies with the modem, the phone system, or if the datalogger needs to be reset). Once the connection issue is resolved, then the data is back polled to the point where the retrieval error occurred. If the problem cannot be resolved in a timely manner and data is lost due to limited storage or other problems, then it will be noted in the datalogger logbook, on the daily printouts, and on the missing data forms. The appropriate null data code will also be applied to the missing data prior to entry into the EPA AQS. The data acquisition computer is backed up nightly to the CNEP server, and the raw data is saved to an external hard drive or memory stick each quarter by one of the Data Reporting Officers.

At the end of each quarter, the Data Quality Review Officer and/or the Data Reporting Officer validate the raw data in preparation for upload into the EPA AQS system. Files loaded via the OpenNode2 application go directly from AirVision to the EPA AQS and a copy is not stored. Files loaded manually via the Exchange Network Services Center (ENSC) are pulled from Airodis or AirVision; these files are assembled into an electronic folder on the desktop computer that consists of two individual subfolders and instrument data files. The subfolders are named by the monitoring year and its subsequent quarters (1^{st}, 2^{nd}, 3^{rd} & 4^{th}). Within a quarter's subfolder, individual data files are maintained. Thus, the data management system is organized by year, quarter, and individual site raw data files.

An example of the nomenclature used for naming the folder, subfolders, and data files for a particular year and quarter would be:

- **Folder;** AQS Validated Data
  - **Subfolder;** 2018
    - **Subfolder;** 4qtr2018
      - **Files;** AQSReport TAH
        AQSReport_Mobile
        AQSReport_Newkirk
        AQSReport_Roland
        AQSReport_Stilwell
        NCore
        Pryor

In the raw data validation process, a data validation report is generated based on the Level I checks, quarterly audit and independent audit results for a particular quarter. This report is used to validate and invalidate the quarter's raw data. Subsequently, any raw data that has been invalidated is placed into a missing data report. These reports are in an excel format and are kept in individual folders on the desktop computer. The folders are named "Data Validation Reports" and "Missing Data Reports." Examples of their file names are:

- Sti Dat Val 1st 2018.xls (Data Validation Report file)
- Sti Missing 1st 2018.xls (Missing Data Report file)

These files are saved to the CNEP server and an external hard drive or memory stick each quarter by one of the Data Reporting Officers. In addition, a hard copy is maintained in the CNEP filing system.

The Data Validation Report is generated from biweekly Level I checks and a quarterly audit that are recorded on audit forms for that particular quarter. These forms serve as back up documentation for the Data Validation Report and are maintained as hard copies in the CNEP filing system. The Missing Data Report is generated from the data validation process and serves as a backup and means to reconcile raw data files if needed.

The ESC and Ecotech dataloggers record one-minute averages for each of the instruments. However, the CNEP manages the data as one-hour averages and validated data is reported to AQS in one hour averages for each instrument. Thus, data reduction is achieved by the data validation process and AQS reporting format.

19.3 CNEP Management of Other Generated Data

The CNEP receives an independent audit report from INQUEST consultants within 30 days after the audit is performed. Audits are performed at least once per year per site, but are performed more often if funds allow; audits will be performed at the end of the quarter. The report can include audit results for NOx, NO, NO_2, O_3, PM2.5, PM10, trace gases (SO_2, CO, NOy), wind speed, wind direction, relative humidity, temperature, and precipitation. Information extracted from this report is used in the data validation process of the raw data and is placed into the Data Validation Report generated by the CNEP. A hard copy of the independent quarterly audit report is maintained in the CNEP's filing system.

20 Assessment and Response Actions

20.1 Purpose/Background

This section describes the number, frequency, and type of assessment activities needed for the ambient air monitoring network. It describes the approximate schedule of activities and the involved organizations and participants. It describes who is responsible for implementing the response actions and how those actions will be verified and documented. A full discussion of the internal and external assessments is found in Section 14 of this QAPP. The CNEP's standard operating procedures (SOPs) are found in **Appendix C and Appendix D** and the independent contractor's SOPs are found in **Appendix E** of this QAPP.

20. 2 Internal Assessments

The CNEP site operator reviews the automated nightly Level II checks each day to see how the instruments are performing at the four monitoring sites as well as the mobile monitoring station. The Level II checks consists of a zero and span check and is conducted for the NOx, O_3, and trace gas (SO_2, CO, NOy) instruments. The site operator uses the Level II check as an initial quality control check to determine if a particular instrument is operating normally or may require a Level I check, maintenance, repair, or calibration to improve its performance. The determination is based on how an instrument is responding to the zero and span reference gas challenges each night. It also depends on how much variation there is between the nightly audit values over time. As a general rule, if a nightly audit is within 15% (expressed as a percent difference) and the nightly audit values are within 5% of each other over time, then no corrective actions are required. However, if they exceed these limits, then the site operator initiates a corrective action by comparing the differences of nightly audit records, Level I check/calibration records, independent audit reports, and maintenance records. If these actions reflect an instrument malfunction then the instrument will be calibrated and/or repaired. The calibration and/or repair results are recorded in the CNEP logbook and the site's logbook.

The CNEP's site operator conducts a Level I (zero/span/one-point QC) check every two weeks for the NO_2, NH_3, O_3, and trace gas (SO_2, CO, NOy) instruments. In addition, the CNEP Data Reporting Officer conducts a multi-point audit for the same instruments each quarter, even if the instruments don't require calibration. The multi-point audits on the NOx and trace gas NOy instruments include converter efficiency checks using nitric oxide gas with various amounts of ozone gas. The multi-point audit on the NH_3 instrument includes converter efficiency check using ammonia gas. The Level I checks are used as quality control checks for the instruments. The quarterly audit is used as a quality control check for the site operator as well as the instruments. The audit results are recorded on individual audit/calibration forms and in site dedicated logbooks kept at each site. The audit/calibration forms are kept on site for five years and site logbooks are kept for an indefinite amount of time.

The site operator also conducts Level I checks every two weeks for the PM2.5 and PM10 instruments. The Data Reporting Officer audits these instruments each quarter. The BAM and TEOM instruments are designed to operate within ± 5.1% of their designed flow rate of 16.7 cubic liters per minute. However, if the flow rate of either instrument is found to be outside of a ± 4.1% tolerance limit for the expected flow rate, then the instruments will be calibrated within the next 0 to 5 business days; however, at the mobile the instrument will be calibrated at the next available opportunity, which is dependent on location (maximum time: 1 month). If the TEOM instrument's calibration filter cartridge (mass) should exceed the expected known response by more than ± 2.5%, then it will be replaced by the manufacturer. The TEOM and BAM will also be audited for ambient temperature and barometric pressure. These audits are recorded on individual audit/calibration forms and in the site dedicated logbooks.

The site operator also conducts instrument audits for the RM910A non-continuous instrument twice a year, but only when the instrument is operational. Audit procedures for this instrument will be described in the "Quality Assurance Project Plan and Work Plan for the Air Toxics Monitoring Project of the Cherokee Nation Environmental Programs".

20.3 External Assessments

The INQUEST contractor conducts an independent audit at all of the CNEP sites at least once during the calendar year. These audits are conducted for the NOx, trace gas (SO_2, CO, NOy), and meteorological instruments so that each instrument is audited at least once a year. Ozone instruments are audited at least once at each site while ozone monitoring is active. Particulate matter (PM2.5, PM10) instruments are audited twice each year. The audits are conducted "as is" which means that no calibrations will be performed. If an independent audit fails, then the CNEP is notified within 24 hours and its site operator conducts a Level I check within the next 0 to 5 business days and subsequent calibration and/or repair if it is needed. The independent audit results are sent to the CNEP in a hard copy format within 30 days of the audit. The independent audit results are maintained at CNEP office for a minimum of 3 years then they are placed in a labeled box and stored. Any subsequent instrument calibrations or maintenance by the CNEP are recorded in the site logbooks.

The U.S. EPA Region VI Office also performs external assessments of CNEP gas analyzers through its National Performance Audit Program (NPAP). NPAP "through the probe (TTP)" audits are performed on all gas analyzers, including trace gas analyzers, at all sites once each year by an EPA contractor (such as Alion), if resources are available. Independent audit instruments and EPA Protocol gases that are NIST traceable and certified are utilized for these audits. The audit results are reported to the CNEP when they become available to the U.S. EPA Region VI Office. Any failed audits will result in the CNEP site operator conducting a Level I check within the next 0 to 5 business days and calibration and/or repair of the instruments and the results will be recorded in the site logbooks.

20. 4 Precision and Accuracy Data

The Level I checks and quarterly multi-point checks performed by the CNEP provide data on the precision of each monitoring instrument. Precision data for each instrument in turn provide the means of assessing the precision of the air quality parameter data (e.g., ozone concentrations) obtained with that instrument. Independent audits performed by INQUEST provide data on the accuracy of each monitoring instrument. Accuracy data for each instrument in turn provide the means of assessing the accuracy of the air quality parameter data obtained with that instrument.

21 Reports to Management

21.1 Purpose/Background

This section describes the frequency and distribution of reports for the ambient air monitoring network. It describes who prepares the reports and who the recipient of the reports is, and it describes what specific actions are expected as a result of the reports.

21.2 CNEP Reporting

The CNEP Data Review Officer and Project Manager will prepare and submit quarterly ambient air data into the U.S. EPA's AQS. These reports are also identified in Section 9 (Table 9.1) of this QAPP. The reports will contain validated data for NOx, NO, NO_2, O_3, PM2.5, PM10, trace level gases (SO_2, CO, NOy, NH_3), wind speed, wind direction, temperature, relative humidity, and precipitation for each site. The CNEP will also submit the accompanying Precision and Accuracy data each quarter. The U.S. EPA, Office of Air Quality Planning and Standards (OAQPS), is the recipient and end user of this data. Each report will be submitted within 90 days following the end of the quarter.

The CNEP will also ensure that an annual report is developed based on 40 CFR Part 58 Section 58.26. A certification letter from a senior consortium official will be submitted with the report that certifies that the air monitoring data is correct to the best of his/her knowledge. The recipient and end user of the reports will be the U.S. EPA Region VI Office, Air Monitoring & Grants Section. The report is due by May 1st following the end of the annual monitoring year.

21.3 Other Reporting

INQUEST consultants will prepare independent quarterly audit reports for the ambient air monitoring network. They will be submitted to the CNEP Project Manager within 30 days of completing the quarterly audit. The contents of these reports are identified in Section 19.3 of this QAPP. The CNEP is the recipient and end user of the reports. They are used by the CNEP to validate and invalidate ambient air data.

Reporting requirements for air toxics (HAPs, VOCs) will be described in the "Quality Assurance Project Plan and Work Plan for the Air Toxics Monitoring Project of the Cherokee Nation Environmental Programs". The lab analyzing such samples for the CNEP will prepare a report containing sample data and other relevant QA/QC data for the RM910A and other HAPs monitoring instruments. This report will be submitted to the CNEP Project Manager within 30 to 90 days of receiving the samples. The content of this report is identified in Section 19.3 of this QAPP. The CNEP is the recipient and end user of the data.

22 Data Validation

22.1 Purpose/Background

This section describes the data validation criteria for the ambient air monitoring network. It also describes the processes, personnel, forms, and any checklists that are used for data validation. In addition, it describes any project specific calculations that are required. In short, this section describes the criteria used to review, verify, and validate (that is, accept, reject, or qualify) data from continuous gas monitors and meteorological instruments in an objective and consistent manner. The CNEP's detailed process for reviewing, verifying, and validating data is described in Section 23 of this QAPP.

The principal components for the data validation process are the ambient data generated by the NOx, NO, NO_2, O_3, trace gas (SO_2, CO, NOy, NH_3), PM2.5, PM10, wind speed, wind direction, temperature, relative humidity and precipitation instruments. Other components include Level II checks, Level I checks, quarterly audits, and independent quarterly audits. The criteria for validating these components are identified in the following guidance documents:

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Quality Monitoring Program. U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-17-001, January 2017.

40 CFR, Part 58, Appendix A, Section 4 (October 17, 2006) [see **Appendix F** of this QAPP]

U. S. EPA guidance document, *Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1*, EPA Publication No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP].

22.2 Data Validation Process

The data validation process has three levels within the CNEP. The first level involves the Site Operator who conducts instrument maintenance, repairs, calibrations, Level I checks, and accompanies the independent auditors. The Site Operator also reviews the daily printouts which include the Level II nightly checks and one-hour readings (NOx, NO, NO_2, trace gases (SO_2, CO, NOy, NH_3), PM2.5, PM10, & meteorological data). In addition, the Site Operator conducts the calibrator gas flow audit and audit percent differences.

At the second level, the Data Reporting Officers conduct the quarterly instrument audits and consolidate the maintenance records, one-hour instrument readings, Level II nightly checks, Level I checks, calibrations, and independent audits into monthly data printouts, quarterly missing data reports and quarterly data validation reports. In addition, they calculate the instrument third standard deviation values for the Level I, quarterly and independent audits. They also develop the quarterly AQS data files for each instrument. The Data Reporting Officers use the site logbooks, office logbook, daily instrument reading & nightly calibration printouts, audit forms, calibration forms, and the datalogger database to consolidate the data.

At the third level, the Data Quality Control Review Officer, Data Reporting Officers, and Site Operator review the data, begin to reconcile the data and assign the appropriate flags. Next, the Data Quality Control Review Officer approves the missing data report and data validation report, and validates the AQS data files. Finally, one of the Data Reporting Officers inputs the validated AQS files into the U. S. EPA's Air Quality System (AQS) online database.

As mentioned in Section 22.1 above, the principal components that will be validated include the ambient data generated by the NOx, NO, NO_2, O_3, trace gas (SO_2, CO, NOy, NH_3), PM2.5, PM10, wind speed, wind direction, temperature, relative humidity and precipitation instruments. Other components that are used in data validation include Level II checks, Level I checks, quarterly audits, and independent quarterly audits, as well as critical criteria, operational criteria, and systematic issues described in the Validation Templates in **Appendix F** of this QAPP.

The objective criteria, acceptable ranges, standard procedures, and calculations used by the CNEP for validating (accepting), invalidating (rejecting), and qualifying gas analyzer, TEOM, and BAM data are described in 40 CFR, Part 58, Appendix A, Section 4 (October 17, 2006) [see **Appendix F** of this QAPP] and in the U. S. EPA guidance document, *Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1*, EPA Publication No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP]. Such procedures may include the use of the U. S. EPA's Data Assessment Statistical Calculator (DASC) tool to calculate the following data quality indicators (DQIs): precision estimate, bias estimate, absolute bias estimate, semi-annual flow rate, and one point flow rate, as applicable, for gas analyzer, TEOM, and BAM data. The calculated DQIs must meet the measurement quality objectives (MQOs) shown in Table 1 of the U. S. EPA guidance document, *Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1*, EPA Publication No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP] for the corresponding data to be considered valid. The CNEP will *not* aggregate gas analyzer, TEOM, and BAM data for quarterly, annual, and three-year time intervals for the purpose of data quality assessment. Instead, the CNEP will report validated data – averaged over one-hour time intervals – to the AQS database. In addition, the CNEP will utilize any U.S. EPA approved Data Qualifiers (flags) applicable to gas analyzer, TEOM, and BAM data to identify any laboratory data, field data, and systematic issues that have uncertainty associated with them or that are considered to be invalid. These flags give a brief indication of why there is uncertainty associated with the data or why the data is invalid. The CNEP will enter valid data and flagged invalid data into the AQS database. Invalid and qualified data will be described in a missing data report that the CNEP will keep on file in the CNEP office.

The objective criteria, acceptable ranges, standard procedures, and calculations used by the CNEP for validating (accepting), invalidating (rejecting), and qualifying meteorological instrument data are described in the U. S. EPA guidance document, *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV Meteorological Measurements Version 2.0 (Final)*, U.S. EPA, Research Triangle Park, North Carolina. EPA Publication No. EPA-454/B-08-002, March 2008 [see **Appendix F** of this QAPP]. The CNEP will enter valid meteorological data into the AQS database; invalid data will be flagged as appropriate before entering into the AQS database. Invalid data will be described in a missing data report that the CNEP will submit to the U. S. EPA Region VI Air Monitoring & Grants Section if requested.

22.3 Data Validation Criteria

An initial calibration or recalibration of an instrument (NOx, O_3, and trace gas (SO_2, CO, NOy, NH_3) analyzers) establishes a new fixed "Universal" baseline for determining whether the data are valid or invalid. Percent differences are calculated from an instruments' baseline, Level I checks, quarterly audits, and independent quarterly audits.

As a general rule, data is considered to be valid when the Level I checks, quarterly audits, and independent audit values are less than the zero, span, and one-point QC drift values identified in Table 22.1. If the percent differences exceed these zero, span, and one-point QC drift values, then the ambient data is considered invalid back to the last successful Level I check or quarterly audit. If the span and one-point QC drifts are greater than ±7.1% for an ozone analyzer or ±10.1% for other gas analyzers (one-point QC drifts > ±15.1% for NOx and trace NOy), then the ambient data will be considered invalid back to the last successful Level I check or quarterly audit *only* if there are other circumstances (equipment defect, etc.) that suggest such data *should* be invalidated. The allowable percent difference for independent audits checks is ±15%, as these are considered annual performance evaluations. Exceptions to these general rules may occur when ambient data concentrations are close to or exceeding the NAAQS. In these cases, the toleration limit for acceptable instrument span and precision drifts may be set at tighter levels. See Section 7.2 of this QAPP for further explanation of method quality objectives and data validation criteria.

Table 22.1 Level I, Quarterly & Independent Audit Instrument Drift Limits

Level I, Quarterly & Independent Audit Instrument Drift Limits						
Instrument	**O_3**	**NO_2**	**Trace SO_2**	**Trace CO**	**Trace NOy**	**Trace NH_3***
Level I Checks						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 0.20 ppb	< 20 ppb	< 0.20 ppb	< 0.20 ppb
Span Drift	< 7.1%	< 10.1%	< 10.1%	< 10.1%	< 10.1%	< 10.1%
1-Point QC Drift	< 7.1% or ±1.5 ppb	< 15.1% or ±1.5 ppb	< 10.1% or ±1.5 ppb	< 10.1% or ±1.5 ppb	< 15.1% or ±1.5 ppb	<10.1% or ±1.5 ppb
Quarterly Audits						
Zero Drift	< 3.1 ppb	< 3.1 ppb	< 0.20 ppb	< 20 ppb	< 0.20 ppb	< 0.20 ppb
Span Drift	< 7.1%	< 10.1%	< 10.1%	< 10.1%	< 10.1%	< 10.1%
1-Point QC Drift	< 7.1% or ±1.5 ppb	< 10.1% or ±1.5 ppb	< 10.1% or ±1.5 ppb	< 10.1% or ±1.5 ppb	< 15.1% or ±1.5 ppb	< 10.1% or ±1.5 ppb
Independent Audits						
Zero Drift	< 15 ppb	< 15 ppb	< 0.20 ppb	< 20 ppb	< 0.20 ppb	
Span Drift	< 15%	< 15%	< 15%	< 15%	< 15%	
1-Point QC Drift	< 15%	< 15%	< 15%	< 15%	< 15%	

*Independent audit is not conducted on the trace NH_3 analyzer.

In addition, third standard deviation values are determined from the instruments' baseline, Level I checks and quarterly audits. The 3rd standard deviation values are used to monitor instrument performance, identify a need for instrument troubleshooting, identify the need for maintenance or repair, identify operator error, and help in determining when an instrument may need to be recalibrated.

For the PM2.5 and PM10 data, the instrument flow rates are designed to be within a ± 5.1% tolerance limit of the design value. However, a ± 4.1% tolerance limit is used for data validation. The TEOM instrument's calibration filter cartridge (mass) should be within ± 2.5%. If any of these tolerances are exceeded during a Level I check or quarterly audit, then the instrument or instruments will be either calibrated by the CNEP or sent to the manufacturer for repair and the ambient data will be invalidated back to the last successful audit. See Section 7.2 of this QAPP for further explanation of method quality objectives and data validation criteria for PM2.5 and PM10 (TEOM and BAM) data.

For the meteorological data, independent audits are conducted each quarter so that each meteorological instrument is audited at least once a year. If an independent audit fails, then the CNEP is notified within 24 hours and an audit is conducted along with replacement of instrument(s) if it is needed. The meteorological data is compared to the data of the nearest Oklahoma Mesonet site to see if it is approximately the same. If there is no significant difference between the data, then it is considered to be valid. If there is a significant difference, then the data will be invalidated back to a date where both data sets are approximately the same or to the date of the last successful audit.

Data validation criteria for the CNEP's air toxics monitoring will be described in the "Quality Assurance Project Plan and Work Plan for the Air Toxics Monitoring Project of the Cherokee Nation Environmental Programs". For the HAPs data, lab sample data and QA/QC data will be reviewed to determine if it is valid or invalid. This will include a review of the sample concentration (ppm or ppb), laboratory calculations, laboratory QA/QC results (spikes & duplicates), method detection limits (minimum & maximum) and interferences and potential analysis problems.

22.4 Data Validation Formulas

Statistical formulas are used to validate the data collected by criteria pollutant (gas and PM) analyzers. The primary statistics used in data validation are percent difference (d_i), standard deviation (S), and third standard deviation (3S). These statistics permit the CNEP to assess the performance of its criteria pollutant analyzers as well as to assess the quality of data collected by those analyzers. The percent difference serves as the initial indicator of analyzer performance and data quality, as it is calculated for each point (zero, span, one-point QC, etc.) of a Level I check, multi-point check, and independent audit (multi-point check). The standard deviation and third standard deviation are used to assess analyzer performance and data quality over time periods of interest, including hourly, daily, quarterly, annual, and three-year intervals. Other statistics may be used to assess the precision and bias (accuracy) of data. The coefficient of variation (CV) is used to assess precision while bias is determined from a series of statistical formulas.

The CNEP will use the statistical procedures and formulas prescribed in the U. S. EPA guidance document, *Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1*, EPA Publication No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP] when assessing and validating data. For example, with respect to gas analyzer data, equation 1 in this guidance document is used for calculating percent difference while equation 9 is used for calculating standard deviation. Equations 2 through 5 are used for calculating precision and bias. The CNEP will use the EPA's *Data Assessment Statistical Calculator (DASC)* tool (which can be downloaded from http://www.epa.gov/ttnamti1/qareport.html) for calculating precision and bias, when applicable.

22. 5 Data Validation Forms

The CNEP uses various documentation records and forms for the data review and validation process. The following list identifies the documentation records and forms used by the CNEP:

- daily printouts (Level II nightly checks & one-hour instrument readings)
- logbooks
- Level I check forms
- quarterly audit forms
- calibration forms
- calibrator gas flow audit form
- third standard deviation & percent difference calculation form
- independent audit reports
- missing data report
- data validation report
- AQS data files

Some of these records and forms are identified in **Appendix C** of this QAPP.

23 Validation and Verification Methods

23.1 Purpose/Background

This section describes the process used for verifying and validating data from the gas analyzers, TEOMs, and BAMs in the Cherokee Nation's ambient air monitoring network. It identifies the persons responsible for data verification and validation; it describes the process for resolving any internal issues pertaining to the data; and it describes the process of making data available to end users through the U. S. EPA's Air Quality System (AQS) online database.

Section 22 of this QAPP described the objective criteria that the CNEP uses in reviewing, verifying, and validating its gas analyzer, TEOM, and BAM data. This chapter of the QAPP expands on this subject, describing in more detail the step-by-step process of verifying and validating data.

23.2 Validation and Verification Methods

The initial step begins when the Data Reporting Officer(s) reviews the daily printouts of the one-hour instrument readings and Level II nightly check readings at the end of each quarter. The Officer reviews all of the ambient data on the printouts to verify that the site operator has appropriately marked both the flagged and non-flagged readings. On a daily basis, the Site Operator has highlighted all of the flagged data, level II check exceedences, and any apparent erroneous readings. The Agilaire AirVision software and the Ecotech Airodis software have been programmed to flag instrument readings so that the CNEP staff can readily identify potentially valid and invalid data. The flags displayed by the Agilaire AirVision software include the following:

"P"	power failure	
"D"	channel disabled	(instrument repair or instrument offline)
"C"	calibration	(Level II, nightly check)
"M"	maintenance	(Level I check/calibration or maintenance)
"O"	instrument over range	(e.g., wind direction exceeds 360 degrees)
"U"	instrument under range	(e.g., wind speed reports a negative value)

The Ecotech Airodis software flags data with colors instead of letters. For example, a purple color may indicate that a gas analyzer was "out of service" at a given time.

In the second step, the Data Reporting Officer cross checks the daily printouts with the CNEP logbook and site logbooks to verify that the flags actually reflect maintenance, instrument repair, Level I checks, quarterly audits, independent quarterly audits, and calibration times. At this time, the Officer also verifies that the logbook audit/calibration records match the audit/calibration form records. If they do not match, then the Site Operator is consulted and the records are reconciled.

In the third step, the Data Reporting Officer uses the daily printouts to transpose the flagged and erroneous data into a missing data report. The missing data report reflects the site, quarter, AQS ID, parameter, missing data date, missing data hours, and justification (null codes) information. Next, the Officer takes all of the audit/calibration forms and the independent quarterly audit report and compiles them into a data validation report. The data validation report reflects the audit/calibration dates, parameter, zero/span/one-point QC values expressed as percent differences, and audit (pass/fail) information. Any failed audit/calibration (zero/span/one-point QC or multi-point) invalidates the ambient data back to the last successful audit/calibration. Thus, these dates and hours are placed into the missing data report to complete all of the missing data for a particular quarter.

In the fourth step, the Data Quality Control Officer and a Data Reporting Officer will batch edit the raw data files in both AirVision and Airodis to flag any data from the missing data report that was not captured in the daily printouts. Both software packages will denote any data that has been edited, and will save the original values in case of an error. Once batch editing has been completed, data files are produced from each system for the appropriate date ranges and parameters in the pipe-delimited AQS format. These files are stored on the desktop computer.

In the fifth and final step, a Data Reporting Officer takes the validated data files and enters them individually into AQS using CNEP protocols for AQS input (**Appendix C** of this QAPP). The Data Reporting Officer notifies the U.S. EPA, Region VI AQS Lead that the CNEP's AQS data has been entered for the quarter via the quarterly grant report.

23.3 Data Qualifier (Flags) Criteria

The CNEP uses U.S. EPA approved data qualifiers (flags) for data that are determined to be invalid. The data qualifier conventions are the U.S. EPA AQS "null data qualifier codes", which provide a more descriptive term for why a particular piece of data was invalidated (see list of these codes in **Appendix G** of this QAPP). The CNEP has chosen to use these codes in its missing data reports. The Data Reporting Officer uses the null data qualifier codes for the data files loaded into AQS to identify the invalidated data such as calibrations, maintenances, audits. Also, reports of the missing data are maintained and filed at the CNEP offices.

23.4 Entering Valid Data into AQS

After verification and validation of data has been completed (see Sections 23.2 and 23.3), the CNEP Data Quality Control Officer and/or his/her assistant enters the valid data and associated quality assurance data into the U. S. EPA's Air Quality System (AQS) online database.

The CNEP meets the criteria that define a Primary Quality Assurance Organization (PQAO) under the new federal regulations (40 CFR, Part 58, Appendix A, Sections 3 through 3.1.2, October 17, 2006) [see **Appendix F** of this QAPP]. Consequently, the CNEP is permitted to aggregate data from all gas analyzers and continuous (automated) PM monitors (TEOMs and BAMs) in its criteria pollutant monitoring network for the purposes of data quality assessment and AQS data entry. [Additional data quality assessment is described in Section 23.5.] Nevertheless, the CNEP does *not* aggregate its gas analyzer, TEOM, and BAM data for quarterly, annual, and three-year time intervals. Instead, the CNEP reports validated data – averaged over one-hour time intervals – to the AQS database. If data aggregation is required for the purpose of determining NAAQS compliance, then the U. S. EPA's OAQPS will perform that function using the one-hour time interval data as entered into AQS by the CNEP.

The DQIs for data completeness, detectability, and comparability are assessed as described in Section 23.5.

The CNEP Data Quality Control Officer and/or his/her assistant upload valid criteria pollutant data, meteorological data, and associated quality assurance data (e.g., flow rate data) into the U. S. EPA's AQS online database in accordance with 40 CFR, Part 58, Subpart B, §58.16, and Appendix A, Section 5, (October 17, 2006) [see **Appendix F** of this QAPP], and in accordance with AQS guidance (see **Appendix G** of this QAPP). Data is submitted on a quarterly basis. Once each year the CNEP Air Program Manager (Project Coordinator) certifies that all CNEP data submitted to AQS for the previous calendar year (January 1 through December 31) are accurate. The CNEP Project Coordinator submits a certification letter, along with a data summary report (AMP600 report for criteria pollutants and an AMP450NC report for non-criteria pollutants), to the U. S. EPA Region VI office by May 1st in accordance with 40 CFR, Part 58, Subpart B, §58.15 (see **Appendix F** of this QAPP) and the OAQPS memo, "Questions and Answers on Ambient Air Monitoring Data Certification for CY2018 Data" (May 1, 2019) (see **Appendix G** of this QAPP).

As part of the revised process that began in 2013, regional staff will be reviewing all submitted materials, including the signed letter, AMP600 report with AQS recommended and monitoring agency requested certification flags[1], any pertinent monitoring agency comments, and the AMP450NC report if needed. Based on those submitted documents, the regional staff will be responsible for setting the AQS certification concurrence flag for appropriate monitors, a task formerly handled by OAQPS.

23.5 Data Quality Assessment: Calculation of Data Statistics as an Optional Means of Validating Data

The CNEP normally completes the verification, validation, flagging, and AQS entry of data as described in Sections 23.2, 23.3, and 23.4 above. However, the CNEP has the option to perform additional data quality assessment prior to final validation and AQS entry of data. This additional data quality assessment involves the calculation of data statistics, as described in the following paragraphs. [These statistics do not apply to meteorological data.] The CNEP may elect to perform this additional data quality assessment if there are any questions about the validity of its data and about whether the data quality indicators (DQIs) for its data meet the measurement quality objectives (MQOs) described in the following paragraphs.

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[1] The evaluation criteria utilized in the AMP 600 report are available at:
http://www.epa.gov/ttn/airs/airsaqs/training/Data%20Cert%20Acceptance%20Criteria.pdf

At its option, the CNEP may perform data quality assessment of criteria pollutant data using standard procedures and calculations prescribed for such pollutants in 40 CFR, Part 58, Appendix A, Section 4 (October 17, 2006) [see **Appendix F** of this QAPP] and in the U. S. EPA guidance document, *Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1*, EPA Publication No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP]. Such procedures include the use of the U. S. EPA's Data Assessment Statistical Calculator (DASC) tool to calculate the following data quality indicators (DQIs): precision estimate, bias estimate, absolute bias estimate, semi-annual flow rate, and one point flow rate for criteria pollutant data. The calculated DQIs must meet the measurement quality objectives (MQOs) shown in Table 1 (automated methods) of the U. S. EPA guidance document, *Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1*, EPA Publication No. EPA-454/B-07-001, October, 2007 [see **Appendix F** of this QAPP] for the corresponding data to be considered valid. If the calculated DQIs meet the MQOs, then the corresponding data is confirmed as being valid. If the calculated DQIs do not meet one or more of the manual method MQOs in Table 1, then the CNEP Data Quality Control Officer consults with the CNEP Project Coordinator, other CNEP Air Program personnel, and, if necessary, with the U. S. EPA to decide if the corresponding data should be invalidated (rejected) or qualified (flagged). If the data is qualified, then the Data Quality Control Officer must decide if the data is still useful for some purposes and whether it should be entered in AQS or not.

As described in Section 23.4, the CNEP meets the criteria that define a Primary Quality Assurance Organization (PQAO) under the new federal regulations (40 CFR, Part 58, Appendix A, Sections 3 through 3.1.2, October 17, 2006) [see **Appendix F** of this QAPP]. Consequently, the CNEP is permitted to aggregate data from all gas analyzers and PM samplers in its criteria pollutant monitoring network for the purposes of data quality assessment and AQS data entry. Thus, at its option, the CNEP may aggregate data for any collocated criteria pollutant analyzers and samplers in its ambient air monitoring network for the purpose of data quality assessment. The CNEP may also aggregate criteria pollutant data for quarterly, annual, and three-year time intervals for the purpose of data quality assessment. Measurement quality check data (such as flow rate audits) may be aggregated for the purpose of calculating precision and bias DQIs in accordance with procedures described in 40 CFR, Part 58, Appendix A, Sections 4.2 and 4.3, (October 17, 2006), and in *Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1*, EPA Publication No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP].

The CNEP Data Quality Control Officer and/or his/her assistant(s) may use the U. S. EPA's Data Assessment Statistical Calculator (DASC) tool to calculate the following data quality indicators (DQIs) for criteria pollutant data: precision estimate; bias estimate; absolute bias estimate; semi-annual flow rate; and one point flow rate. The CNEP may calculate these DQIs at quarterly, annual, and three-year intervals. The DASC tool is accessed through the following U. S. EPA webpage: http://www.epa.gov/ttnamti1/qareport.html.

The procedures and equations used for calculating the DQIs for criteria pollutant data are described in 40 CFR, Part 58, Appendix A, Section 4 (October 17, 2006) [see **Appendix F** of this QAPP]. These procedures and equations are embedded in the DASC tool, as shown in *Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1*, EPA Publication No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP]. The equations and input data needed to calculate the DQIs are listed in the following paragraphs.

The percent difference (d_i) between the measured concentrations and the corresponding audit concentrations of each gas analyzer are calculated using Equation 1, as shown (equation numbers correspond to those shown in 40 CFR, Part 58, Appendix A, and in *Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1*, EPA Publication No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP]):

Equation 1

$$d_i = \frac{meas - audit}{audit} \cdot 100$$

where *meas* is the concentration indicated by the monitoring organization's instrument and *audit* is the audit concentration of the standard used in the QC check being measured.

The precision estimate (coefficient of variation upper bound, CV) is used to assess the one-point QC checks for gas analyzers and is calculated using Equation 2:

Equation 2

$$CV = \sqrt{\frac{n \cdot \sum_{i=1}^{n} d_i^2 - \left(\sum_{i=1}^{n} d_i\right)^2}{n(n-1)}} \cdot \sqrt{\frac{n-1}{\chi^2_{0.1,n-1}}}$$

where $\chi^2_{0.1,n-1}$ is the 10th percentile of a chi-squared distribution with *n-1* degrees of freedom.

The bias estimate for one point QC checks of gas analyzers is calculated using equations 3, 4, and 5. The bias estimator is an upper bound on the mean absolute value of the percent differences.

Equation 3

$$|bias| = AB + t_{0.95,n-1} \cdot \frac{AS}{\sqrt{n}}$$

where *n* is the number of single point checks being aggregated; $t_{0.95,n-1}$ is the 95th quantile of a t-distribution with n-1 degrees of freedom; the quantity *AB* is the mean of the absolute values of the d_i's (calculated by Equation 1), as expressed in Equation 4:

Equation 4

$$AB = \frac{1}{n} \cdot \sum_{i=1}^{n} |d_i|$$

and the quantity *AS* is the standard deviation of the absolute value of the d_i's, as calculated using Equation 5:

Equation 5

$$AS = \sqrt{\frac{n \cdot \sum_{i=1}^{n} |d_i|^2 - \left(\sum_{i=1}^{n} |d_i| \right)^2}{n(n-1)}}$$

The bias statistic calculated in Equation 3 uses absolute values. Thus it does not have a tendency (negative or positive bias) associated with it. Its tendency (+ or – sign) must be determined by the procedure described in 40 CFR, Part 58, Appendix A, Sections 4.1.3.1 and 4.1.3.2 (October 17, 2006) and in *Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1*, EPA Publication No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP].

The annual performance evaluations for gas analyzers are used to verify the results obtained from the one-point QC checks and to validate those results across a range of concentration levels. To quantify this annually at the site level and at the 3-year primary quality assurance organization level, probability limits must be calculated from the one-point QC checks using Equations 6 and 7:

Equation 6

$$\text{Upper Probability Limit} = m + 1.96 \cdot S$$

Equation 7

$$\text{Lower Probability Limit} = m - 1.96 \cdot S$$

where, m is the mean (Equation 8):

Equation 8

$$m = \frac{1}{k} \cdot \sum_{i=1}^{k} d_i$$

where, k is the total number of one point QC checks for the interval being evaluated, and S is the standard deviation of the percent differences (Equation 9):

Equation 9

$$S = \sqrt{\frac{k \cdot \sum_{i=1}^{k} d_i^2 - \left(\sum_{i=1}^{k} d_i\right)^2}{k(k-1)}}$$

The one point flow rate is calculated using flow rate data from the CNEP's TEOM or BAM and audit flow rate data from the CNEP's own monthly flow rate audits using its own transfer standards. The one point flow rate is calculated using Equation 1 (percent difference, d_i), followed by Equations 3 (absolute bias), 4 (mean of the absolute values of the percent differences, AB), and 5 (standard deviation of the absolute value of the percent differences, AS) as shown:

Equation 1

$$d_i = \frac{meas - audit}{audit} \cdot 100$$

Equation 3

$$|bias| = AB + t_{0.95,n-1} \cdot \frac{AS}{\sqrt{n}}$$

Equation 4

$$AB = \frac{1}{n} \cdot \sum_{i=1}^{n} |d_i|$$

Equation 5

$$AS = \sqrt{\frac{n \cdot \sum_{i=1}^{n} |d_i|^2 - \left(\sum_{i=1}^{n} |d_i|\right)^2}{n(n-1)}}$$

The bias statistic calculated in Equation 3 uses absolute values. Thus it does not have a tendency (negative or positive bias) associated with it. Its tendency (+ or – sign) must be determined by the procedure described in 40 CFR, Part 58, Appendix A, Sections 4.1.3.1 and 4.1.3.2 (October 17, 2006) and in *Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1*, EPA Publication

No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP].

The semi-annual flow rate is calculated using flow rate data from the CNEP's TEOM or BAM and audit flow rate data from the semi-annual INQUEST audit (see Section 23.6 below). The semi-annual flow rate is calculated using Equation 1 (percent difference, d_i), followed by Equations 6 and 7 (upper and lower probability limits), and by Equations 8 (mean) and 9 (standard deviation of the percent differences, S) as shown:

Equation 1

$$d_i = \frac{meas - audit}{audit} \cdot 100$$

Equation 6

$$\text{Upper Probability Limit} = m + 1.96 \cdot S$$

Equation 7

$$\text{Lower Probability Limit} = m - 1.96 \cdot S$$

where, m is the mean (Equation 8):

Equation 8

$$m = \frac{1}{k} \cdot \sum_{i=1}^{k} d_i$$

where, k is the total number of one point QC checks for the interval being evaluated, and S is the standard deviation of the percent differences (Equation 9):

Equation 9

$$S = \sqrt{\frac{k \cdot \sum_{i=1}^{k} d_i^2 - \left(\sum_{i=1}^{k} d_i \right)^2}{k(k-1)}}$$

The data completeness requirement for the CNEP's criteria pollutant monitoring is for at least 75% of all possible data to be valid (see Section 7.3 of this QAPP). Detection limits for CNEP gas analyzers and meteorological instruments are specified in Section 7.2 of this QAPP. The criteria pollutant data collected by the CNEP meets requirements described for data comparability in Section 7.5 of this QAPP. In addition, CNEP data from non-trace gas analyzers meets regulatory requirements for comparison to 8-hour, 24-hour, and annual NAAQS for criteria pollutants, as applicable (see **Table 6.1** of this QAPP).

The DQIs calculated with the DASC tool must meet the measurement quality objectives (MQOs) shown for automated sampling methods in Table 1 of *Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR Part 58 Appendix A, Version 1.1*, EPA Publication No. EPA-454/B-07-001, October 2007 [see **Appendix F** of this QAPP]. If the DQIs meet these MQOs, and if the DQIs for completeness, detectability, and comparability meet the requirements described in the previous paragraph, then the corresponding criteria pollutant data is confirmed as being valid. If the calculated DQIs do not meet one or more of the automated method MQOs in Table 1, or if the DQIs for completeness, detectability, and comparability do not meet requirements, then the CNEP Data Quality Control Officer consults with the CNEP Project Coordinator, other CNEP Air Program personnel, and, if necessary, with the U. S. EPA to decide if the corresponding data should be invalidated (rejected) or qualified (flagged). If the data is qualified, then the Data Quality Control Officer must decide if the data is still useful for some purposes and whether it should be entered in AQS or not.

[Measurement quality objectives (MQOs) are very similar to data quality objectives (DQOs) for the CNEP ambient air monitoring network. However, MQOs generally apply to data collected for any time interval (short or long) at any scale of aggregation, whereas DQOs pertain to data aggregated for a primary quality assurance organization (like the CNEP) over a time interval of three years for the purpose of determining attainment or non-attainment of criteria pollutant NAAQS.]

The CNEP Data Quality Control Officer and/or his/her assistant upload valid criteria pollutant data, valid meteorological data, and associated quality assurance data into the U. S. EPA's AQS online database in accordance with procedures described in Section 23.4 above.

23.6 Verification and Validation of INQUEST Data

INQUEST is the contractor that performs independent audits of the CNEP's criteria pollutant and meteorological monitoring equipment. The CNEP uses INQUEST's audit report in the process of verifying and validating its criteria pollutant and meteorological data. The CNEP's overall process of data verification and validation is described in detail in Sections 23.2, 23.3, 23.4, and 23.5 of this QAPP.

The CNEP combines its own monthly audit information and INQUEST's independent audit information into a single data validation report. The information in the report contains audit values for concentrations of NOx, NO, NO_2, O_3, trace SO_2, trace CO, and trace NOy; audit parameters for TEOMs and BAMs, such as temperature, pressure, and flow rate; and meteorological audit parameters. These audit values are from both the monthly and independent audits. A comparison of the audit values and the acceptable ranges criteria determines if an audit was successful (within accepted ranges) or failed (values outside the acceptable ranges). If any audit value is outside of the acceptable range for a particular criterion, then all of the data related to that value is invalidated back to the last successful audit performed by the CNEP. The invalid data is assumed to have an uncertainty associated with it or is considered to be invalid. Then an appropriate flag and explanation is attached to the data and it is excluded from AQS entry (or flagged appropriately) and placed into a missing data report.

Audit concentrations from the INQUEST report can be used in the calculation of percent difference, precision, and bias for the gas (NOx, O_3, trace SO_2, trace CO, and trace NOy) analyzers. These calculations are described in detail in Section 23.5 above. Flow rate data from the INQUEST report is used in the calculation of the semi-annual flow rate DQI, which is described in detail in Section 23.5 above.

24 Reconciliation with Data Quality Objectives

24.1 Purpose/Background

The Cherokee Nation and the U. S. EPA are the primary end users of the criteria pollutant and meteorological monitoring data collected by the CNEP. The Cherokee Nation and the U. S. EPA use this data to determine if the tribal communities covered by the CNEP's criteria pollutant monitors are in attainment or non-attainment of the annual, 24-hour, 8-hour, and/or 1-hour NAAQS, as applicable, for criteria pollutants (SO_2, NO_2, CO, O_3, PM2.5, PM10). [Lead is a criteria pollutant but is not monitored by the CNEP.] In addition, the Cherokee Nation uses the data to assess the potential impact of such pollutants on the health of tribal members and tribal resources in the monitored communities. The criteria pollutant and meteorological data collected by the CNEP must be of sufficient quality to support these determinations and assessments by the Cherokee Nation and the U. S. EPA. To this end, the data must meet data quality objectives (DQOs) developed by the U. S. EPA's Office of Air Quality Planning and Standards (OAQPS) in order to support the management decisions that must be made by the Cherokee Nation, the U. S. EPA, and any other interested end users, such as the Oklahoma Department of Environmental Quality.

Data collected with the trace gas analyzers and other criteria pollutant monitors at the CNEP's NCore multipollutant monitoring station is used by the U. S. EPA and other interested parties for a variety of purposes. As stated in 40 CFR, Part 58, Appendix D (E.1), "…NCore multipollutant stations are intended to track long-term trends for accountability of emissions control programs and health assessments that contribute to ongoing reviews of the NAAQS; support development of emissions control strategies through air quality model evaluation and other observational methods; support scientific studies ranging across technological, health, and atmospheric process disciplines; and support ecosystem assessments." To support these goals, the NCore data must meet data quality objectives (DQOs) developed by the U. S. EPA's Office of Air Quality Planning and Standards (OAQPS).

This section of the QAPP describes how the criteria pollutant data, NCore data, and meteorological data collected by the CNEP are reconciled with these DQOs and with any other data requirements of end users. It also describes the process of determining whether or not a community covered by the CNEP's criteria pollutant monitors is in attainment or non-attainment of the applicable NAAQS for criteria pollutants.

24.2 Reconciliation with Data Quality Objectives

The CNEP's processes of data verification and validation and of data quality assessment are described in detail in Sections 22 and 23 of this QAPP. The end products of those processes are valid data that meet measurement quality objectives for criteria pollutant and meteorological monitoring activities and that meet the data quality objectives of the national monitoring program. These processes ensure that the CNEP's data in the U. S.

EPA's Air Quality System (AQS) online database are of sufficient quality to support critical management decisions by end users. The most critical of these decisions is the determination of whether or not the tribal communities being monitored are in attainment or non-attainment of applicable NAAQS for criteria pollutants. Other decisions are based on the goals of the NCore program, as described in Section 24.1 above.

24.3 Process of Determining Attainment or Non-Attainment Status

The U. S. EPA's OAQPS determines whether or not a community is in compliance with applicable NAAQS for criteria pollutants. In other words, the OAQPS determines whether a community is in attainment (compliance) or non-attainment (non-compliance) status with respect to the NAAQS. The OAQPS makes this determination on the basis of three years of monitoring data (as entered in AQS) for the community in question. The OAQPS follows procedures described in 40 CFR, Part 50 in making this determination.

The OAQPS determines the attainment or non-attainment status of a community with respect to a given criteria pollutant by using valid data collected for that pollutant by the CNEP. The CNEP has elected not to make decisions about the attainment status of its monitored communities at this time. If the CNEP elects to make such decisions in the future, it will do so by following the same procedures used by OAQPS. These procedures are described in 40 CFR, Part 50.