THE NEW HAMPSHIRE AMBIENT AIR MONITORING PROGRAM 2020/2021 ANNUAL NETWORK REVIEW and PLAN

New Hampshire Department of Environmental Services

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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THE NEW HAMPSHIRE AMBIENT AIR MONITORING PROGRAM 2020/2021 ANNUAL NETWORK REVIEW and PLAN

prepared by the
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Introduction

The New Hampshire Department of Environmental Services (NHDES) is pleased to submit this 2020/2021 Ambient Air Monitoring Program Annual Network Review and Plan, and 5 Year Assessment in accordance with the *Code of Federal Regulations Title 40, PART 58.* Part 1 of this Plan reviews structure, objectives, history and data trends associated with NHDES' Air Monitoring Program (AMP). Part 2 of this Plan details individual air monitoring station information. Appendix A includes comparability assessments between collocated particulate sampling stations and Appendix B is our 5 Year Assessment.

PART 1 – 2020/2021 Annual Network Review and Plan

NHDES continually revisits basic air monitoring fundamentals and efficiency initiatives to allow for reliable, high quality data capture and analysis within a tight budget. Key objectives remain to provide quality ambient air data in order to:

- Determine attainment status with the National Ambient Air Quality Standards (NAAQS, see Table 1.5).
- Guide future air quality policy decisions at the state and national level.
- Protect public health through forecasting and real-time mapping and air pollution alert initiatives.

Tables 1.6 through 1.11, presented later in this section, summarize the current status of the New Hampshire ambient air monitoring network. Appendix B includes the 5-year New Hampshire monitoring network assessment.

Monitoring Objectives

In accordance with the NHDES mission "to help sustain a high quality of life for all citizens by protecting and restoring the environment and public health in New Hampshire," NHDES operates a network of air monitoring sites throughout the state. These sites facilitate monitoring of ambient ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), volatile and semi-volatile organic compounds (VOCs), carbon monoxide (CO), lead (Pb) and particulate matter chemistry (PM, $PM_{2.5}$, PM_{10}). Air monitoring data from NHDES' network helps assess air quality within New Hampshire, evaluate the status of air quality coming from areas upwind and also helps assess our contribution to downwind areas. These data combined with similar data collected in other states allow NHDES to predict air pollution episodes, enact protective actions and warnings, develop and assess effectiveness of emission reduction strategies and support health assessments and NAAQS reviews.

Ambient air pollution monitoring began in New Hampshire in the 1970s at a few locations. Over subsequent years, it grew to the point where each of the state's 10 counties hosted monitoring stations for air pollutants known to exist in the area. Over time, local industrial facilities either established pollution controls or shut down, resulting in improvements in air quality in those counties. For example, paper mills in Coos County emitted fairly high levels of sulfur dioxide and particles, resulting in periodic unhealthy air quality. Many of these facilities have since shut down and the air quality has improved to the point that there is no longer the need for monitoring in the area. Accordingly, NHDES has reallocated monitoring resources. However, NHDES continues to track emission inventories and reports of health

concerns in these areas in order to assess any potential need to reestablish air monitoring infrastructure. In recent years, NHDES has coordinated with USEPA to streamline the monitoring network in order to meet demands for ever increasing efficiency with limited resources. NHDES has given careful consideration to how the need for efficiency would affect network consolidation while maintaining adequate public protection and the ability to track progress.

The current New Hampshire ambient air monitoring network is carefully configured based on air pollution emission patterns to provide air quality data in populated areas which are potentially at risk for unhealthy air quality of one or more pollutants. Most populated areas are represented by an air monitoring station unless previous monitoring has demonstrated that either the community is not considered to be at risk or can be adequately represented by a nearby monitor. NHDES also considered topography, geographic coverage and air pollution modeling in the current network design.

Now, in 2020, most of the major pollution sources that are in operation in New Hampshire are generally well controlled. Areas of continued concern are mobile and area emission sources where population density and highway networks are dense enough to multiply the emissions of relatively small individual sources hundreds of thousands of times over. The cumulative emissions are greatest in the southeastern portion of the state where population and highway densities are greatest. This region is generally bounded by the Massachusetts state line to the south, Nashua and Manchester to the west, Concord to the north, and Rochester and Portsmouth to the east. This same region is also the most exposed portion of the state to air pollution transport, which generally crosses the southeastern part of the state from southwest to the northeast and along the New Hampshire coastline. Populated valley communities where wood burning is commonly used for residential heating are also being closely watched for $PM_{2.5}$ during cold weather seasons and have been subject to special monitoring studies to better understand events, geographical coverage, and trends.

Pollutants of most concern in New Hampshire in 2020 include ozone, ozone precursors (nitrogen oxides (NOx) and VOCs), $PM_{2.5}$ and SO_2. The New Hampshire monitoring network is densest in the southern portion of the state to reflect potential air quality concerns in heavily populated regions with diverse geography. While the greatest risk of unhealthy air quality occurs in these portions of New Hampshire, unhealthy air quality events can occur anywhere in the state for ozone and small particles. Accordingly, the monitoring network for these pollutants extends into all portions of the state and even at higher elevations. Small particles also lead to visibility impairment, and there are federal regulations to track visibility progress with a special kind of speciation monitoring (IMPROVE) near the Class I airsheds (Great Gulf Wilderness and Presidential Dry-River Wilderness) located adjacent to Mt. Washington in northern New Hampshire. Additional IMPROVE network monitors have been added at the NHDES NCORE locations (Londonderry and Miller State Park in Peterborough).

As part of the 2015 8-hour O_3 NAAQS implementation, USEPA required states located within the Ozone Transport Region (OTR) to submit an Enhanced Monitoring Plan (EMP) by October 2019. This plan was submitted with NHDES' previous Network Review and was approved by

EPA in October, 2018. NHDES became an early adopter of some photochemical assessment monitoring (PAMS) requirements and continues to collaborate with EPA and other states in the region to apply EMP monitoring technology and to study ozone formation and transport.

Network Summary

Below is a brief summary of the New Hampshire Air Monitoring network as of May 2020 and the role each station plays for public protection. The list is presented alphabetically by community.

Concord

The Concord monitoring site is primarily intended to track ozone, the only criteria pollutant for which recent air monitoring and modeling has indicated possible population exposure to unhealthy levels. A previous Concord monitoring station was located in the valley near Interstate 93, but was moved to reduce the risks of NOx scavenging caused by nearby freeway traffic emissions and effectively lowering the measured ozone levels in the immediate area. The Hazen Drive site has the advantage of being in close proximity to the NHDES main office, for both outreach opportunities and ease of maintenance. It is also in the proximity of residential neighborhoods, retirement communities and schools. NHDES initiated SO_2 monitoring at this station in October 2010 to help quantify local SO_2 levels relative to the new SO_2 NAAQS. This monitoring was then discontinued at the end of 2016 due to the low SO_2 concentrations measured. The Concord Hazen Drive station represents population on a neighborhood scale.

Greens Grant – Mt. Washington base

The Greens Grant, Camp Dodge ozone monitor at the base of Mt. Washington is now the primary monitor representing the northern portion of New Hampshire. NHDES contracts with the Appalachian Mountain Club for general support and operation of the ozone monitoring at this station. This monitoring location is also important since it represents two federally recognized Class I airsheds, which also require IMPROVE visibility monitoring. Personnel from the US Forest Service's White Mountain National Forest operate the IMPROVE sampler. NHDES tracks $PM_{2.5}$ levels measured by the IMPROVE monitor for the purpose of estimating current exposures and the demand for more comprehensive $PM_{2.5}$ monitoring. NHDES consolidated previous monitoring in the North Country (Pittsburg and Conway) at Camp Dodge due to the high correlation between sites, low population densities, and low risk of exposure to unhealthy air quality. This station represents population exposure on a regional scale. On the other hand, **Mt. Washington summit is a research oriented station and is not representative of general public exposure in communities located in New Hampshire's northern counties**. Any attempt to apply Mt. Washington summit data in that way can result in misleading conclusions.

Keene

The monitoring station in the city of Keene tracks ozone and $PM_{2.5}$ on a continuous basis. The southwest portion of the state can experience periods each year when ozone and $PM_{2.5}$ concentrations have the potential to reach unhealthy levels. NHDES installed a continuous $PM_{2.5}$ monitor at this station in September 2007 to better track the risks of wintertime wood smoke accumulation, which is a product of residential heating in the community. Keene is a prime example of a city distinguished by the factors, such as population density, woodstove

use, and valley topography that are necessary for these winter events. Concentrations measured here may be reflective of air quality conditions in other similar valley communities. The continuous $PM_{2.5}$ equipment has been invaluable in better understanding the winter $PM_{2.5}$ events and improving air pollution forecasts for the area. The data measured for ozone and non-winter $PM_{2.5}$ are considered valuable on a regional basis, and the data for winter $PM_{2.5}$ is considered non-regional. This station represents population exposure on a neighborhood scale.

Laconia

The Laconia monitor tracks ozone and $PM_{2.5}$ in the "Lakes Region" of the state. The population of this area swells during the summer months with tourists. The monitor represents the very northern edge of the Boston CMSA (combined metropolitan statistical area) and periodically experiences elevated ozone and $PM_{2.5}$ concentrations. This station represents population exposure on a regional scale for ozone and non-winter $PM_{2.5}$, and on a neighborhood scale for winter $PM_{2.5}$. As part of a special study, a temporary monitoring station was operated at Wyatt Park from October 2016 through April 2017 and at Memorial Park from October 2017 to April 2018 to assess wood smoke concentrations in the community. Additional $PM_{2.5}$ measurements were made in and nearby Laconia with mobile monitoring technology during winter 2018-2019. The final report on $PM_{2.5}$ measurements in the Laconia (and Plymouth) area has been published in 2020 on the NHDES website. NHDES plans to work with EPA to relocate the Laconia Green Street monitoring station into a part of the City of Laconia identified by the report by October 2021.

Lebanon

The Lebanon monitoring station is sited to provide population and regional based monitoring for the Lebanon/White River Junction (VT) metropolitan area with information on regional ozone and $PM_{2.5}$. This site is also important since it represents the consolidation of the closed Claremont (ozone) and Haverhill (ozone and $PM_{2.5}$) monitoring stations. The station is located on a ridge at the Lebanon airport, just above the river valley. The site was chosen primarily to represent the regional exposure, and the station is important to the New Hampshire network for its geographic coverage. This station represents population exposure on a regional scale.

Londonderry

The Londonderry station came online January 1, 2011, as an NCore superstation measuring a wide selection of pollutants. NHDES worked closely with USEPA to carefully select this site for its central proximity to the highly populated southeastern suburban portion of New Hampshire. The site has no nearby emission sources of significance, but lies in the air pollution transport corridor that crosses the southern portion of the state. The site is expected to track a number of potentially unhealthy ozone events each year. NHDES relocated photochemical assessment monitoring (PAMS) from Nashua to this station in April 2015 and is the required PAMS site for NH. PAMS measures important precursors to the development of ozone. These precursors include a wide variety of volatile organic compounds and nitrogen oxides. Changes to the site are documented in the Network Modifications section of this report in accordance with the new PAMS site requirements and took place in time for the 2019 PAMS season. In addition, for 2020 a ceilometer is now operable at Londonderry and a Pandora Spectrometer is anticipated to be installed by NASA. Being a multi-parameter station located in an area

representative of a large population living in the northern suburbs of Boston, as well as between the major population centers of Nashua and Manchester, the data collected at this site will be ideal for future research and health-related analysis. This station also pairs with the Pack Monadnock NCore station to give the low elevation perspective as compared to Pack Monadnock's high elevation data for similar air masses transported into the area. This station represents population exposure on a regional scale.

Mt. Washington – Summit

The Mt. Washington summit monitoring site is of special value for scientific research for tracking ozone transport. The summit is located at 6,288 feet above sea level and is far away from any significant pollution sources; thus it is ideal for picking up long-range pollution transport into the northern portion of the state. The data are often compared to the data collected at Greens Grant (Camp Dodge) located at the base of the mountain, just a few miles to the east, to give a vertical gradient perspective. Ozone levels measured at the summit are normally higher than measured at the base and occasionally reach unhealthy levels. This station provides valuable high elevation data on a regional scale, but should not be considered representative of population exposure in nearby communities at lower elevation. Based on potential funding, trace level carbon monoxide measurements will be added at this location in 2020 under the Enhanced Monitoring Plan (EMP) to help differentiate ozone originating by manmade air pollution sources from ozone of natural (stratospheric) origin.

Nashua – Gilson Road

In past years, the Nashua area often saw the highest ozone concentrations in the state and thus there is an ongoing need to continue tracking ozone in this area. While this station is on the upwind side of the city of Nashua, it is critical to the network for tracking transport into the state and into the city of Nashua from the southwest. This station represents population exposure on a regional scale.

Peterborough, Pack Monadnock Mountain – Summit (Miller State Park)

NHDES has monitored several parameters at the Pack Monadnock station since 2002 and it became the state's second NCore site in 2011. The site's true value lies in the fact that it is located on a rural mountain top in the south-central portion of the state. At 2,288 feet above sea level, the station is ideally located to pick up the transport airflow from the heavily populated northeast urban corridor (Washington, D.C. to Boston) and is at the northern terminus of the low-level jet that begins near the middle of Virginia. This non-population-based monitor does not have nearby sources of significance. This site measures a wide variety of pollutants, including PAMS ozone precursors, IMPROVE, ozone, and $PM_{2.5}$. Due to its location and elevation, NHDES considers this station to be of high scientific value for transport measurements on a regional scale. When paired with data collected at Londonderry, Peterborough PAMS and $PM_{2.5}$ data provide a critical high-low cross section for regional photochemical models. Due to these unique characteristics, NHDES included continued PAMS operations at this location under the EMP.

Pembroke

The Pembroke monitoring station is located along the Merrimack River, just to the south of

Merrimack Station power plant. The power plant is a large coal burning source which until recently caused relatively high levels of SO_2 at this monitor. While the power plant recently completed pollution control upgrades for SO_2, this station tracks progress in reducing emissions and measures exposure to SO_2 in a nearby community. This station represents population exposure to SO_2 on a local scale.

Portsmouth

The Portsmouth monitoring station is located on Peirce Island on the Piscataqua River just to the east of downtown Portsmouth. NHDES has been successful in establishing a long-term agreement for siting at its current location and has found the location to be suitable for tracking emissions from around the Portsmouth and Kittery (ME) areas. The station also picks up some sea breeze ozone events that work their way up the river. This station represents population exposure on a limited regional scale.

Rye

The Rye Monitoring station is located at Odiorne State Park. Its purpose is primarily to track summertime ozone events brought ashore by sea breezes. Past experience monitoring ozone in Rye found that these events sometimes result in measurements of ozone among the highest in the state. These events affect the coastline area and rarely penetrate more than a few miles inland. The data from this site are of scientific interest for air pollution flow dynamics when compared with data from Portsmouth station. This station represents a specific and limited population along the New Hampshire coastline for these periodic high ozone events.

Beta Attenuation and Light Scattering $PM_{2.5}$ Federal Equivalency Method (FEM) Monitoring

As of June 2020, NHDES operates several Met One 1020 BAMs (Beta Attenuation Monitors) and two API 640s (light scattering particle monitor) covering a total of six permanent stations. NHDES operates API 640s in Portsmouth and Londonderry, and operates Met One 1020 BAMs (BAM) at Keene, Laconia, Lebanon and Peterborough. The BAMs and API640 are classified as Federal Equivalent Methods (FEM) for PM monitoring. NHDES also operates Federal Reference Method (FRM) filter based samplers at Londonderry, Keene, Peterborough and Portsmouth in order to flesh out data comparison assessments between the continuous and filter based methodologies.

There are a number of factors that work against good correlation between FRM and FEM data. Some of these factors can be controlled by a monitoring organization and some cannot. NHDES continually strives to get better correlations through process control and limiting variables that we can control. However, there are basic uncontrollable differences between the FRM and FEM methods that work against good correlations. One key uncontrollable factor relates to volatiles and semi-volatile components in the air mass. Key differences between filter based and other continuous methodologies are based on the time between sample collection and sample analysis. The FEM BAM collects and analyzes each sample over discrete one-hour time periods. The API 640 analyzes the air mass almost continually through light scattering technology, whereas the FRM collects the sample over an integrated

24-hour period, with analysis performed several weeks later. This extended time period between sampling and analysis for the FRM likely allows volatile and/or semi-volatile compounds (when present) to leave the sample media prior to analysis – creating a negative bias when compared to the BAM and 640. Please note information below relative to these data comparability assessments (FEM vs FRM) and declaration of primary sampler type for each station. For more information, see data Comparability Assessments in Appendix A..

Keene - The Met One 1020 BAM data at Keene remains primary toward the NAAQS. Any FRM data generated at Keene is considered secondary when BAM data are available. The 3-year data comparability assessment between FRM and FEM data is incomplete as NHDES discontinued FRM sampling in Keene during the 3rd and 4th quarters of 2017. Based on available data - winter, fall and 2008 data comparisons are within acceptable bias limits. However, data comparisons for all data (the past three years) and 2019 data are barely outside acceptable bias limits. The three-year data set correlates with an overall R = 0.84 and has an intercept of -0.92 micrograms per cubic meter ($\mu g/m^3$).

Lebanon - NHDES has not operated FRM samplers at this station since the 4th quarter of 2017 and does not plan on running FRM samplers routinely in the foreseeable future. The Met One 1020 BAM data at Lebanon remains primary toward the NAAQS. Any FRM data generated at Lebanon is considered secondary when BAM data are available. The 3-year data comparability assessment between FRM and FEM data is incomplete as NHDES discontinued FRM sampling in Lebanon. Based on available data, the FRM and FEM data for the past three years of available data falls within the additive vs. multiplicative bias acceptability limits for FEM testing. These data correlate with an overall R = 0.91 and have an intercept of 0.08 $\mu g/m^3$.

Laconia - There are no FRM vs FEM comparison data for the comparability assessment. NHDES does not plan to run FRM filters at this station in the foreseeable future. The Met One 1020 BAM data at Laconia is primary toward the NAAQS. NHDES initiated continuous FEM monitoring at Laconia during the 4th quarter of 2018 with a BAM.

Londonderry – NHDES discontinued operation of the Met One 1020 BAM at Londonderry on June 25th, 2020. The API 640, operated since May 2020 is now considered primary toward the NAAQS. Any FRM data generated at Londonderry is considered secondary when 640 data are available. The FRM and FEM data for the past three years seems to be trending back towards additive vs. multiplicative bias acceptability criteria. These data correlate with an overall R = 0.77 and have an intercept of 1.31 $\mu g/m^3$. A number of laboratory filter weighing issues may have contributed to the poor correlations in the past. Additionally, the BAMs in the network are getting aged and are beginning to show signs of instability. NHDES believes that a recent switch in PM weighing laboratories and procurement of API 640's will help bring these acceptability criteria back within limits over time.

Peterborough, Pack Monadnock Mountain – Summit (Miller State Park) - The Met One 1020 BAM at Peterborough remains primary toward the NAAQS. Any FRM data generated at Peterborough is considered secondary when BAM data are available. The FRM and FEM data from Peterborough are not within additive vs. multiplicative bias acceptability limits for FEM testing. This 3-year data set correlates with an overall R = 0.77 and has an intercept of 0.51 $\mu g/m^3$. NHDES believes that the BAM data generated at Peterborough should remain primary towards the NAAQS, however, one should view these data with some uncertainty based on a number of factors including low concentration data, aged equipment, laboratory uncertainty and method differences. Frequent high humidity at this location could also be a factor.

Portsmouth - API 640x data at Portsmouth will be primary toward the NAAQS. Any FRM data generated at this station is considered secondary when API 640x data are available. The continuous FEM PM monitor in Portsmouth, Teledyne Model 640x, started operation during 2019 and we have very few data points from FRM analyses to compare. Three-year data comparability assessment information between FRM and FEM data is incomplete at this station but NHDES has been running FRM filter based samples every 12 days to flesh-out comparative data sets.

Network Modifications

NHDES made the following modifications to the air monitoring network between July 1, 2019 and June 30, 2020.

PAMS – Starting in June, 2019 the PAMS required site in Londonderry met compliance with the monitoring requirements cited in in 40 CFR part 58. New instrumentation was purchased in 2018 with funds obtained from being an early adopter. The Markes Agilent system was operational for the 2018 PAMS season and will be used to monitor for VOCs in the future. The True NO_2 sampler was also purchased and installed in 2018.

Londonderry – NHDES installed a T640x $PM_{2.5}$ and PM_{10} analyzer at this station in May 2020. This replaced an old $PM_{2.5}$ BAM and will resurrect PM_{10} monitoring at this station. PM_{10} monitoring was discontinued due to antiquated equipment.

Portsmouth – NHDES installed and operated an API 640 light scattering PM monitor at the Pierce Island air monitoring station during the winter of 2018/2019 due to a poor performing API602 PM monitor at this site. This monitoring effort began with a loaner T640x unit from Teledyne and has resulted in NHDES procuring a new T640 unit for the station which is currently operational at this site.

Future Plans

In support of continuous efforts to improve performance and maximize network efficiency under a constrained budget, NHDES continues to seek efficiencies where possible within the network. NHDES presents the following future plans.

Enhanced Monitoring Plan (EMP) – NHDES' EMP was approved by EPA in October, 2018. As part of this plan, NHDES will continue to report VOCs at the Miller State Park NCORE site, as

well as install a trace-level CO monitor on top of Mt. Washington. NASA plans to install a Pandora Spectrometer at the Londonderry NCORE site in 2020. Additional sampling using borrowed ozone sonde equipment was outlined in the EMP but will not take place in 2020 and until financial resources and staffing are designated.

Mt. Washington Summit, Sargents Purchase – NHDES plans to install and operate a trace level carbon monoxide analyzer at this site during the summer of 2020. The unique environment at this site presents a number of challenges for this task and specific details have yet to be ironed out.

Keene – NHDES plans to procure and install a T640 non-X analyzer for $PM_{2.5}$ monitoring at this station in the Fall of 2020. This will replace the old $PM_{2.5}$ BAM at this monitoring station. NHDES will start reporting PM_{10} from this station as this T640 collects PM_{10} data. NHDES will be reporting the PM_{10} data under a non-FEM code as this analyzer is not considered an FEM for PM_{10} because it does not have an auxiliary pump to allow 16.67 lpm of flow through the PM_{10} bonnet. Besides the extra flow, the T640 non-X operates on the same principles and base flow as the T640x.

Laconia, Green Street – NHDES is considering relocating Laconia monitoring (ozone and $PM_{2.5}$) to better capture winter wood smoke within the city neighborhoods. NHDES will work with stakeholders to select a location in the vicinity identified in the recent NHDES wood smoke report in late 2020 and monitoring could begin at the new location as early as January 2021. NHDES will also assess how a change in location might affect ozone measurements and Laconia's role for ozone in the monitoring network.

Peterborough – NHDES plans to procure and install a T640 non-X analyzer for $PM_{2.5}$ and PM_{10} monitoring at this station in the Fall of 2020. This will replace the old $PM_{2.5}$ and PM_{10} BAMs at this monitoring station. NHDES is seeking a waiver from EPA to collect PM_{10} data with the non-X version of the T640 analyzer. The Non-X version of the T640 collects PM_{10} data, is generally believed to be as accurate as the T640X but is not considered an FEM for PM_{10} because it does not have an auxiliary pump to allow 16.67 lpm of flow through the PM_{10} bonnet. Besides the extra flow, the T640 non-X operates on the same principles and base flow as the T640x. Peterborough is considered a background station for NH and typically has low levels of PM in the air mass. For these reasons, NHDES is asking for a waiver to allow for PM_{10} monitoring at Peterborough with a T640 non-X analyzer.

Purchasing/Expenses

NHDES' budget cycle runs from July 1 through June 30 each year. During this budget cycle the Air Monitoring Program focused on updating antiquated air monitoring equipment by procuring five flow standards, four ozone analyzers, two data loggers, two filter based sequential samplers, two light scattering particle samplers, two SO_2 analyzers and one each of the following: hydrogen generator, ozone primary standard, meteorological sensor, ozone calibrator and CO analyzer. NHDES funded these procurements with a limited biennial state budget account. Please note that this account is not a consistent source of equipment funds for the AMP.

NHDES utilized almost all federal funding for air monitoring for personnel, consumables, parts and supplies to operate the air monitoring network. Additionally, NHDES maintains fleet vehicles, updates maintenance and station contracts, pays utilities for existing facilities, and enhances air monitoring stations as needed throughout the network. Other key expenses include calibrating, repairing and maintaining equipment to meet USEPA and safety standards. NHDES procured a Teledyne NO_Y analyzer back in 2017. This analyzer arrived from the factory and could not be installed due to electric code issues. The manufacturer was made aware and has took the instrument back for modification and has since returned it to NHDES. It has yet to be installed and operated due to further electrical concerns expressed by NHDES electricians. NHDES is working through a list of issues and hope to have it installed and operational in a safe manner soon.

Table 1.0 presents equipment, analyzer and sampler types that NHDES currently uses for ambient air quality monitoring.

Table 1.0 : Equipment – (Method)
SO_2
Teledyne – API 100A and EU – (Automated Equivalent Method EQSA-0495-100)
Teco 43A – (Automated Equivalent Method EQSA-0486-060)
Teco 43C – (Automated Equivalent Method EQSA-0486-060)
Thermo 43i – (Automated Equivalent Method EQSA-0486-060)
CO
Teco 48C - (Automated Reference Method RFCA-0981-054)
Thermo 48i – (Automated Reference Method RFCA-0981-054)
Teledyne – API 300 EU – (Automated Equivalent Method RFCA-1093-093)
O_3
Teledyne – API 400E - (Automated Equivalent Method EQOA-0992-087)
Teco 49 - (Automated Equivalent Method EQOA-0880-047)
Teco 49C - (Automated Equivalent Method EQOA-0880-047)
Thermo 49i - (Automated Equivalent Method EQOA-0880-047)
Teco 49i PS – (Lab Standard EQOA-0880-047)
NO_2
Teledyne – API 200E – (Automated Reference Method RFNA-0691-082)
Teledyne – Model T500U CAPS – (Automated Equivalent Method EQNA-0514-212)
Teco 42C – (Automated Reference Method: RFNA-1289-074)
Thermo 42i – (Automated Reference Method RFNA-1289-074)
NOy
Ecotech Model 9843 NOy
Particulate Matter
R&P Partisol Model 2025 (filter based)
BGI Model PQ200 (filter based)
Met One BAM Model 1020
API 640x
IMPROVE Visibility Speciation Monitor
Calibrator (multiple parameter)

Table 1.0 : Equipment – (Method)
TECO 165 Multi Gas Calibrator
Teledyne – API Model 700, 700E and 700U Gas Calibrators
Environics Series 6103 Multi Gas Calibrator
2B Technology Model 306 Ozone Calibrator
Data Acquisition System
Environmental Systems Corporation (ESC and Agilaire) Data Loggers Models 8816, 8832, 8864 and 8872
PAMS
Perkin Elmer Ozone Precursor System- Clarus 500 Gas Chromatograph, TurboMatrix 100 Thermal Desorber / TM50
Agilent/Markes Ozone Precursor System 7890 GC, Markes CIA Advantage (4 channel UNITY-xr)…, Kori-xr Moisture Removal system
Agilent Open Labs CDS, version 2.2, Chemstation Edition
Perkin Elmer Total Chrome Software- version 6.2.1
Parker Balston TOC Gas Generator
Parker Balston Hydrogen Generator

Table 1.1: New Hampshire State and Local Air Monitoring Stations Network – 2019/2020					
SO_2					
Town	**Name**	**AIRS #**	**Frequency**	**Scale**	**Objective**
Londonderry	Moose Hill School	33 015 0018	Continuous	Regional	Population
Pembroke	Pembroke Highway Dept.	33 013 1006	Continuous	Neighborhood	High Concentration
Peterborough	Pack Monadnock	33 011 5001	Continuous	Regional	Research
Portsmouth	Peirce Island	33 015 0014	Continuous	Neighborhood	Population
CO					
Town	**Name**	**AIRS #**	**Frequency**	**Scale**	**Objective**
Londonderry	Moose Hill School	33 015 0018	Continuous	Regional	Population
Peterborough	Pack Monadnock	33 011 5001	Continuous	Regional	Research
O_3					
Town	**Name**	**AIRS #**	**Frequency**	**Scale**	**Objective**
Concord	Hazen Drive	33 013 1007	March - Sept	Neighborhood	Population
Greens Grant	Camp Dodge	33 007 4002	March - Sept	Regional	Research
Keene	Water Street	33 005 0007	Continuous	Neighborhood	Population
Laconia	Lakes Region	33 001 2004	March - Sept	Regional	Population
Lebanon	Lebanon	33 009 0010	Continuous	Regional	Population
Londonderry	Moose Hill School	33 015 0018	Continuous	Regional	Population
Mount Washington	Mt. Washington Summit	33 007 4001	Continuous	Regional	Research
Nashua	Gilson Road	33 011 1011	March - Sept	Regional	Population
Peterborough	Pack Monadnock	33 011 5001	Continuous	Regional	Research
Portsmouth	Peirce Island	33 015 0014	Continuous	Neighborhood	Population
Rye, Odiorne	Seacoast Science Center	33 015 0016	March - Sept	Neighborhood	High Concentration

NO_2/NO_y					
Town	**Name**	**AIRS #**	**Frequency**	**Scale**	**Objective**
Londonderry NOy	Moose Hill School	33 015 0018	Continuous	Regional	Population
Londonderry NO_2	Moose Hill School	33 015 0018	Continuous	Regional	Population
Peterborough NOy	Pack Monadnock	33 011 5001	Not Operational	Regional	Research

Table 1.2: New Hampshire Particulate Matter Network – 2019/2020					
$PM_{2.5}$					
Town	**Name**	**AIRS #**	**Frequency**	**Scale**	**Objective**
Keene	Water Street	33 005 0007	1 in 6 filter	Neighborhood	Colocation
Keene	Water Street	33 005 0007	Continuous - BAM	Neighborhood	Population
Laconia	Green Street	33 001 2004	Continuous - BAM	Regional	Population
Lebanon	Lebanon Airport	33 009 0010	Continuous - BAM	Regional	Population
Londonderry	Moose Hill School	33 015 0018	1 in 3 filter	Regional	Colocation
Londonderry	Moose Hill School	33 015 0018	Continuous – API 640x	Regional	Population
Peterborough	Pack Monadnock	33 011 5001	Continuous - BAM	Regional	Research
Peterborough	Pack Monadnock	33 011 5001	1 in 3 filter	Regional	Research
Portsmouth	Peirce Island	33 015 0014	1 in 12 filter	Regional	Colocation
Portsmouth	Peirce Island	33 015 0014	Continuous – API 640x	Regional	Population
$PM_{2.5}$ Speciation					
Peterborough	Pack Monadnock	33 011 5001	1 in 3 IMPROVE	Regional	Research
Londonderry	Moose Hill School	33 015 0018	1 in 3 IMPROVE	Regional	Population
PM_{10}					
Londonderry	Moose Hill School	33 015 0018	Continuous – API 640x	Regional	Population
Peterborough	Pack Monadnock	33 011 5001	Continuous - BAM	Regional	Research
Portsmouth	Peirce Island	33 015 0014	Continuous – API 640x	Neighborhood	Audit

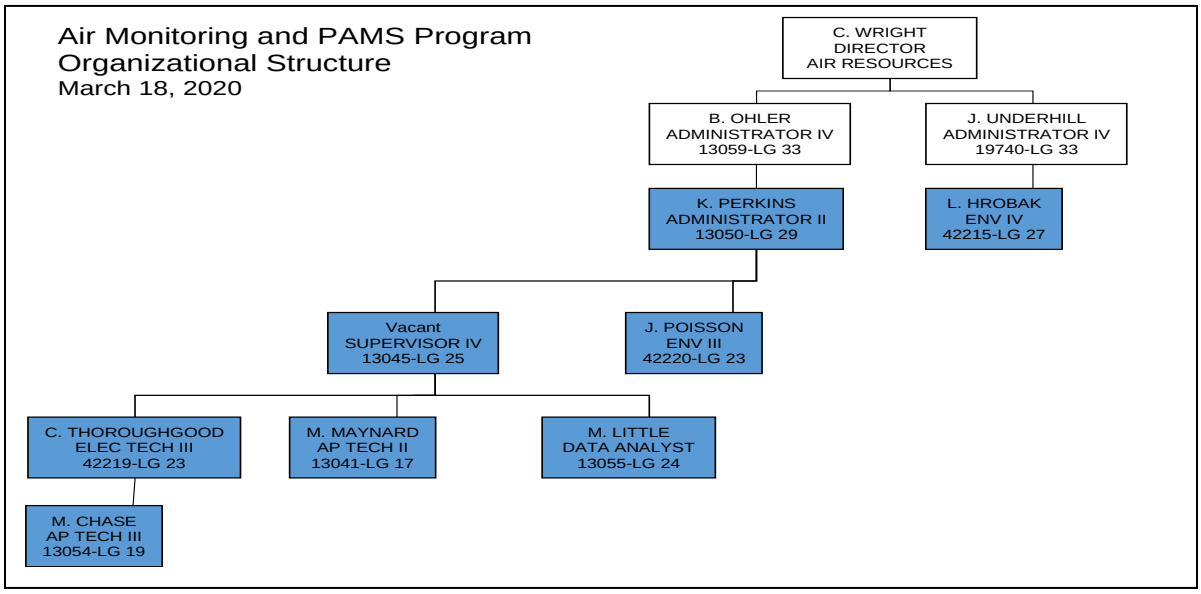
Table 1.3: New Hampshire PAMS Network – 2019/2020					
Town	**Name**	**AIRS #**	**Frequency**	**Scale**	**Objective**
Londonderry	Moose Hill School	33 015 0018	Starting 2015 June - Sept	Regional	Population
Peterborough	Pack Monadnock	33 011 5001	June - Sept	Regional	Research

Table 1.4: New Hampshire NCore Network – 2018/2019					
Town	**Name**	**AIRS #**	**Status**	**Scale**	**Objective**
Londonderry	Moose Hill School	33 015 0018	Operational on Jan 1, 2011	Regional	Population
Peterborough	Pack Monadnock	33 011 5001	Operational on Jan 1, 2011	Regional	Research

Personnel

The AMP continues to operate with one full-time technical position vacant as well as one technical position previously eliminated. In order to fulfill requirements, NHDES assigns some technical support duties to individuals outside the official AMP organizational structure, including PAMS management duties. See Figure 1.1. Atmospheric Science and Analysis section staff (of the Air Resources Division of NHDES) typically support the AMP program.

Figure 1.1: Current Air Monitoring Program Organizational Chart



Cooperative Air Monitoring Initiatives

NHDES is involved in numerous cooperative air monitoring initiatives with local, state and private entities.

For over 30 years now, the Appalachian Mountain Club (AMC) and NHDES have been joining resources to conduct ozone monitoring in Coos County. Since 1990, AMC and NHDES have been cooperatively monitoring ozone on the summit of Mount Washington to determine the exposure of hikers and other visitors to this pollutant and to quantify ozone transport from upwind areas. Significant levels of ozone have been measured on the summit during the summer months throughout this time. Also, AMC and NHDES began cooperatively managing a second monitoring station near the base of Mount Washington (Camp Dodge) in 1996, a White Mountain National Forest Class I Wilderness visibility monitoring station. AMC's involvement in air monitoring activities saves NHDES significant resources.

NHDES also partners with the US Department of Agriculture (Forest Service) in a Challenge Cost Share Agreement relative to air monitoring activities at Camp Dodge in Greens Grant. This agreement provides a framework of cooperation for station work such as upgrades, tree trimming and routine costs. The Forest Service operates an IMPROVE (Interagency Monitoring of Protected Visual Environments) sampler at this station. NHDES and AMC currently maintain ozone sampling, upkeep and routine site inspections at this station. NHDES provides critical real-time rainfall data from the Laconia station for the protection of public health. When rainfall at the Laconia station exceeds a specific amount over a specific time period, an automated notification system operated by NHDES facilitates closing of a public beach and alerts of possible bacterial dangers. Similar notification systems incorporating our real-time meteorology data have been used to enact erosion control inspections at various New Hampshire Department of Transportation road construction projects.

NHDES maintains a near real-time air quality and forecasting website and contributes to a regional air quality website maintained by USEPA). These sites provide forecast information on New Hampshire's air quality that can be used by media, medical professionals, schools and athletic coaches, and individuals, to help plan daily activities and protect public health. The air quality forecast for New Hampshire is also available on the NHDES' Air Quality Information Line at (800) 935-SMOG. The forecast is made for ground-level ozone and particle pollution.

Monitoring Trends

Each year, NHDES reviews its monitoring data and calculates design values for comparison to the National Ambient Air Quality Standards (NAAQS) – Table 1.5. USEPA establishes these standards to protect public health and welfare. In general, design values consider the three most recent years for an averaging period in the form of the NAAQS, such as looking at the three-year average of the annual fourth highest ozone 8-hour value.

New Hampshire air quality data trends reveal the important progress that has been made in improving air quality in New Hampshire. Cleaner vehicles, fuels, power plants, industry and small engines located throughout the region have all contributed to much-improved air quality since the 1980s. More recent trends show that additional progress is still being made, but the task becomes more difficult as there are becoming fewer pollution sources that remain uncontrolled. It is also important to note that while progress has been made, the NAAQS have been strengthened in some cases to be more protective, thus we have more progress to make.

Figures 1.2 through 1.15 present monitoring trends for the key criteria pollutants for the period 2000 through 2019. In all cases, air quality is significantly improved from the 1970s and 1980s. Currently monitored levels of nitrogen dioxide (NO_2), $PM_{2.5}$, PM_{10}, lead (Pb) and carbon monoxide (CO) are safely below the current levels of the NAAQS. $PM_{2.5}$ concentration reductions represent important progress over the past 10 years from levels that were very close to the standards. Ozone and $PM_{2.5}$ remain of primary focus in New Hampshire for their

potential for daily exceedances under certain weather conditions, and as a result receive significant attention by NHDES for network monitoring and SIP planning. Ozone in New Hampshire has been substantially reduced from concentrations measured in the state in the 1980s and 1990s, but has become stable at levels just below the current NAAQS since 2013.

Monitoring trends for SO_2 indicate that all areas of New Hampshire meet the 3-hour SO_2 secondary NAAQS and for the 1-hour primary SO_2 NAAQS. Current data shows significantly lower SO_2 concentrations since 2011. Table 1.6 summarizes exceedances of NAAQS thresholds for each of the criteria air pollutants in New Hampshire during recent years.

Tables 1.7 through 1.11 provide the maximum of the five most recent design values and most recent (2017-19) design values for each criteria pollutant. These are also expressed as percentages of the current NAAQS. CO, NO_2, and 1- and 3-hour SO_2 design values are all under 30% of the NAAQS during the 2017-19 design value period. The highest SO_2 site, Pembroke, last exceeded the 1-hour NAAQS for the period of 2011 to 2013, but now meets the standard. With the lower ozone standard of 0.070 ppm, Londonderry, Rye, Mt. Washington Summit and Pack Monadnock summit all meet the NAAQS by a slim margin and must continue to be watched over the next few years.

In 2019, New Hampshire operated two Photochemical Assessment Monitoring Stations (PAMS): Pack Monadnock and Londonderry. Tables 1.12 and 1.13 show that none of the toxic PAMS parameters are near their Ambient Allowable Limits (AAL) at either site. Benzene has the lowest AAL, 5.7 $\mu g/m^3$. At Londonderry and Pack Monadnock, the maximum 24-hour averages for benzene over the full period were about 0.3 and 1.3$\mu g/m^3$, respectively, or about 5%-21% of the AAL. Maximum values for all the other parameters for both sites are consistently less than 1% of their AAL. Changes in concentrations from 2018 to 2019 are also indicated.

Table 1.5: National Ambient Air Quality Standards

Pollutant [links to historical tables of NAAQS reviews]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		primary and secondary	Rolling 3 month average	0.15 µg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide (NO_2)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb (2)	Annual Mean
Ozone (O_3)		primary and secondary	8 hours	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 µg/m^3	annual mean, averaged over 3 years
		secondary	1 year	15.0 µg/m^3	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

(1) In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m3 as a calendar quarter average) also remain in effect.
(2) The level of the annual NO_2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.
(3) Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.
(4) The previous SO_2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2)any area for which implementation plans providing for attainment of the current (2010) standard have not been submitted and approved and which is designated nonattainment under the previous SO_2 standards or is not meeting the requirements of a SIP call under the previous SO_2 standards (40 CFR 50.4(3)), A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the require NAAQS.

Table 1.6: NAAQS Exceedances (Days) in New Hampshire (2014-2019)

Parameter/Location/Standard	Number of Exceedances						Most Recent (Relative to NAAQS from Each Year)
	2014	2015	2016	2017	2018	2019	
CO							
1-Hour (1971 standard)	0	0	0	0	0	0	1978
8-Hour (1971 standard)	0	0	0	0	0	0	1996
Lead							
Quarterly (2008 standard)	0	0	--	--	--	--	None
NO_2							
1-Hour (2010 standard)	0	0	0	0	0	0	None
Ozone							
8-Hour (2008 standard 2011-14; 2015 standard 2015-18)							
Camp Dodge	0	0	0	0	0	0	2004
Concord	0	1	0	0	0	0	2015
Keene	0	0	1	0	0	0	2016
Laconia	0	0	0	0	0	0	2010
Lebanon	0	0	0	0	0	0	2008
Londonderry	0	1	1	1	1	1	2019
Miller	1	2	3	1	0	0	2017
Mt. Washington[1]	0	5	2	3	2	0	2018
Nashua	0	1	1	0	0	0	2016
Portsmouth	0	1	0	0	0	0	2015
Rye	0	1	1	1	2	0	2018
Woodstock[2]	0	0	0	0	0	0	None
PM_{10}							
24-Hour (2006 standard)	0	0	0	0	0	0	1989
$PM_{2.5}$							
Annual (2012 standard)	0	0	0	0	0	0	None
24-Hour (2012 standard)							
Keene	0	0	0	0	0	0	2013
Laconia	0*	0*	0	0	0	0*	None.
Lebanon	0	0	0	0	0	0	None
Miller	0	0	0	0	0	0	2002(Exceptional Event)
Nashua	0*	--	--	--	--	--	2002 (Exceptional Event)
Pembroke	0*	--	--	--	--	--	None
Portsmouth	0	0	0	0	0	0	None
SO_2							
Annual (1971 standard)	0	0	0	0	0	0	None
1-Hour (2010 standard)							
Concord	0	0	0	0	0	0	2011
Londonderry	0	0	0	0	0	0	None
Miller	0	0	0	0	0	0	None
Pembroke	0	0	0	0	0	0	2012
Portsmouth	0	0	0	0	0	0	None

* - Denotes measured by FRM equipment; otherwise measured by FEM method. ^ - Denotes exceptional event.

Station startups/closures: Nashua ($PM_{2.5}$) and Pembroke ($PM_{2.5}$) shut down in 2015; Concord station discontinued SO_2 monitoring in 2016; lead monitoring was discontinued at end of 2nd quarter 2016.

[1] Mt. Washington ozone exceedances exclude the second of overlapping 8-hour periods (i.e. those beginning hours 00:00-06:00) per the 2015 standard final rule; the 2015 count also includes an exceedance in October, outside the ozone season.

[2] Woodstock is part of EPA's Clean Air Status and Trends Network (CASTNET) as further discussed in the Individual Station Information in Part II.

Table 1.7: 2017 – 2019 Ozone Design Values (ppb)

Ozone	Design Value (DV) Description	NAAQS	5-Year Max DV	% of NAAQS	Location	2017-19 Max DV	% of NAAQS	Location
8-Hour	3-year average of 4th- highest daily maximum 8-hour averages	70 (2015 - present)	68	96	Rye (2013-15) Peterborough (2014-16) Mt. Washington (2015-17)	65	92	Rye

Table 1.8: 2019 Carbon Monoxide Design Values (ppm)

CO	Design Value (DV) Description	NAAQS	5-Year Max DV	% of NAAQS	Location	2019 Max DV	% of NAAQS	Location
1-Hour	2nd maximum	35	0.5	1	Londonderry, Peterborough (2015), Londonderry (2016, 2018)	0.5	1	Londonderry
8-Hour	2nd maximum	9	0.4	4	Londonderry (2015, 2016, 2017, 2018, 2019)	0.4	4	Londonderry

Table 1.9: 2017 – 2019 Sulfur Dioxide Design Values (ppb)

SO_2	Design Value (DV) Description	NAAQS	5-Year Max DV	% of NAAQS	Location	2017-19 Max DV	% of NAAQS	Location
1-Hour	3-year average of 99th percentile of daily maximum 1-hour averages	75	29	39	Portsmouth (2013-15)	15	20	Pembroke
3-Hour	2nd maximum	500	20	4	Pembroke (2019)	20	4	Pembroke

Table 1.10: 2017 – 2019 Nitrogen Dioxide Design Values (ppb)

NO_2	Design Value (DV) Description	NAAQS	5-Year Max DV	% of NAAQS	Location	2017-19 Max DV	% of NAAQS	Location
1-Hour	3-year average of 98th percentile of daily maximum 1-hour averages	100	23	23	Londonderry (2015-17)	21	21	Londonderry
Annual	Annual average	53	3	6	Londonderry (2015-19)	3	6	Londonderry

Table 1.11: 2017 – 2019 Fine Particulate Matter Design Values ($\mu g/m^3$)

$PM_{2.5}$	Design Value (DV) Description	NAAQS	5-Year Max DV	% of NAAQS	Location	2017-19 Max DV	% of NAAQS	Location
24-Hour	3-year average of 98th percentile of midnight- midnight 24-hour averages	35	26	74	Keene (2013-15)	16	46	Keene
Annual	Annual average over 3 years	12	8.8	73	Keene (2013-15)	5.6	47	Lebanon

Figures 1.2 and 1.3 show how ozone concentrations in the state have stabilized just under the NAAQS after years of steady decline.

Figure 1.2: Ozone trends for the 8-hour NAAQS (2000-2019)

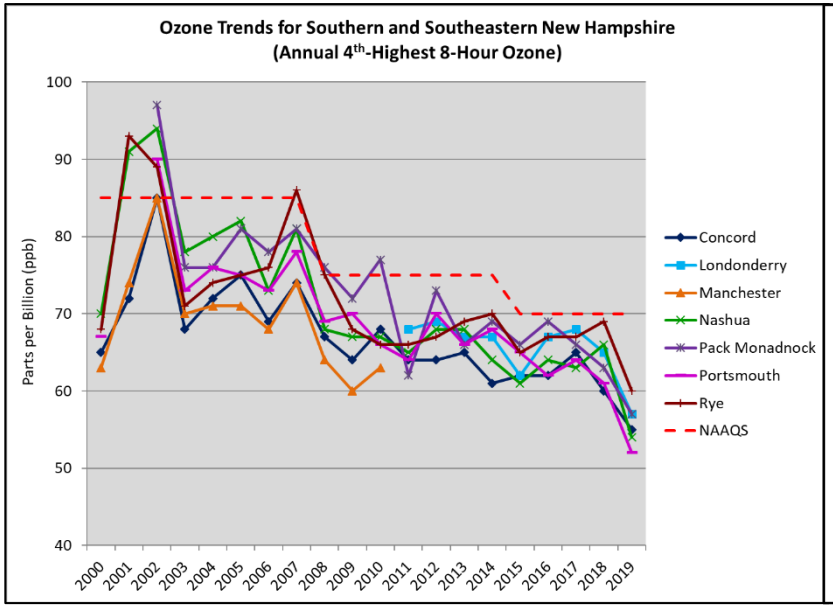
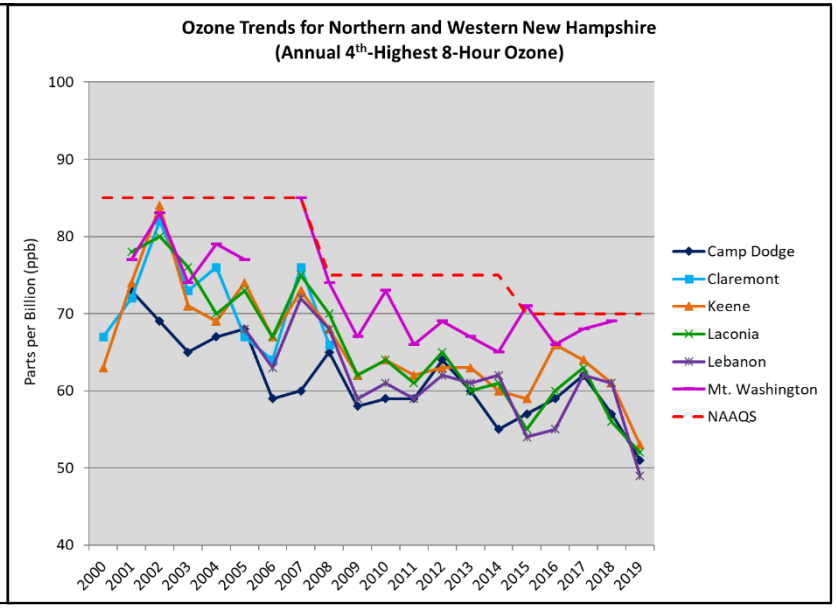


Figure 1.3: Ozone trends for the 8-hour NAAQS (2000-2019)



Figures 1.4 and 1.5 show very low carbon monoxide concentrations in the state, well below the NAAQS.

Figure 1.4: Carbon Monoxide trends for the 1-hour NAAQS (2000-2019)

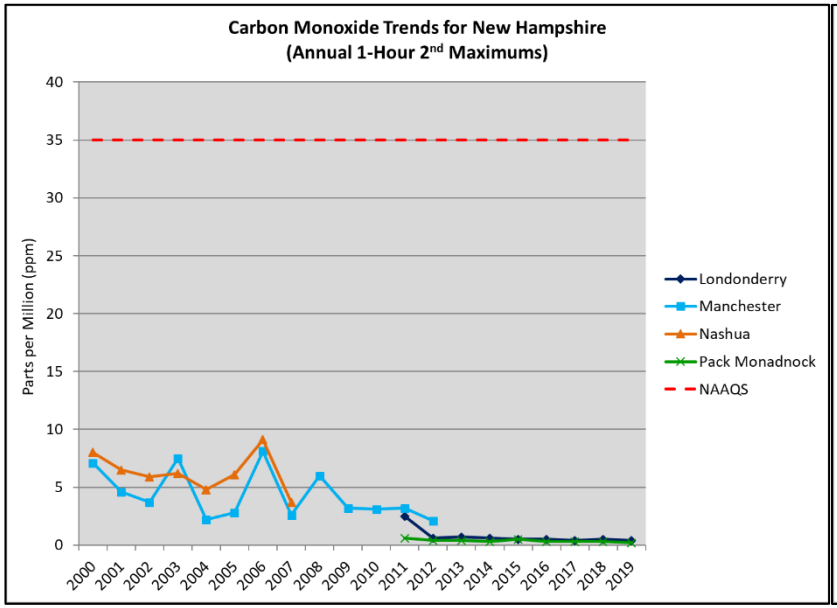
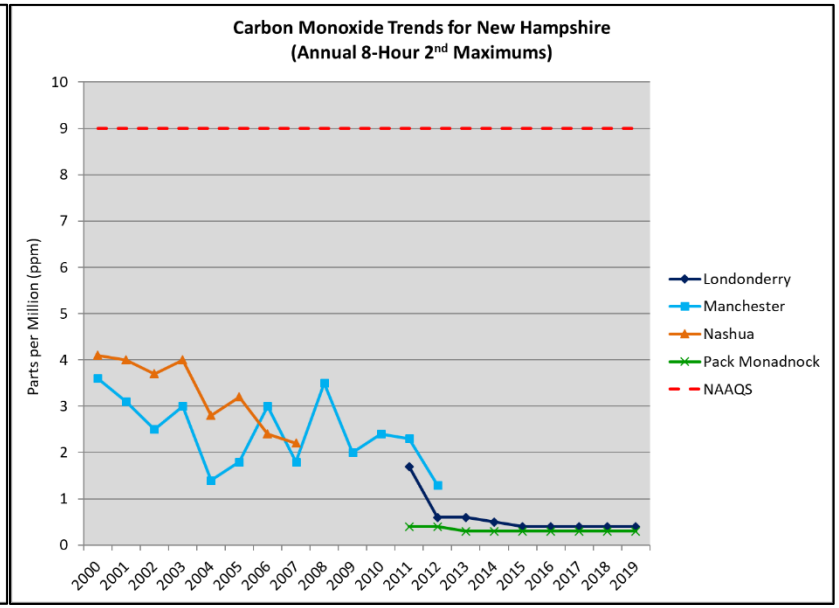


Figure 1.5: Carbon Monoxide trends for the 8-hour NAAQS (2000-2019)



Figures 1.6 and 1.7 show declining 24-hour $PM_{2.5}$ concentrations in the state with only Keene being recently near the NAAQS.

Figure 1.6: $PM_{2.5}$ trends for the 24-hour NAAQS (2000-2019)

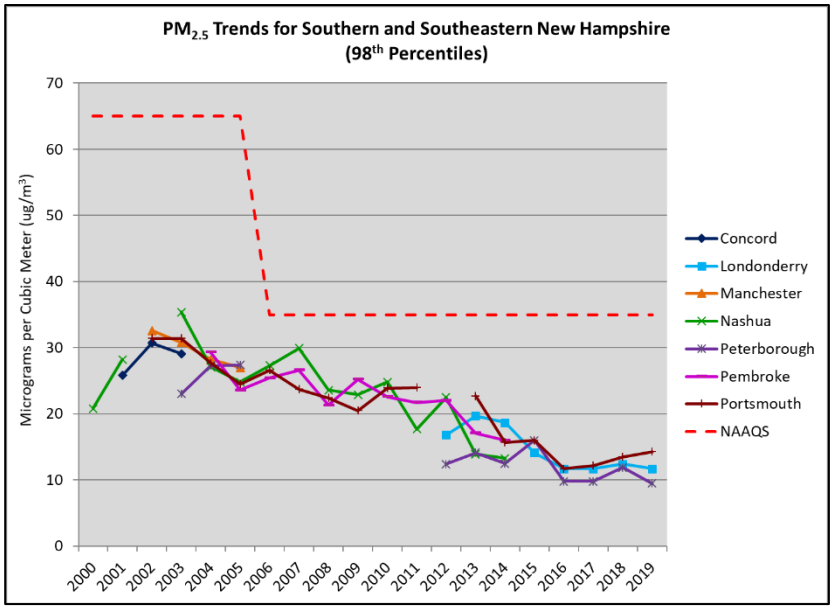
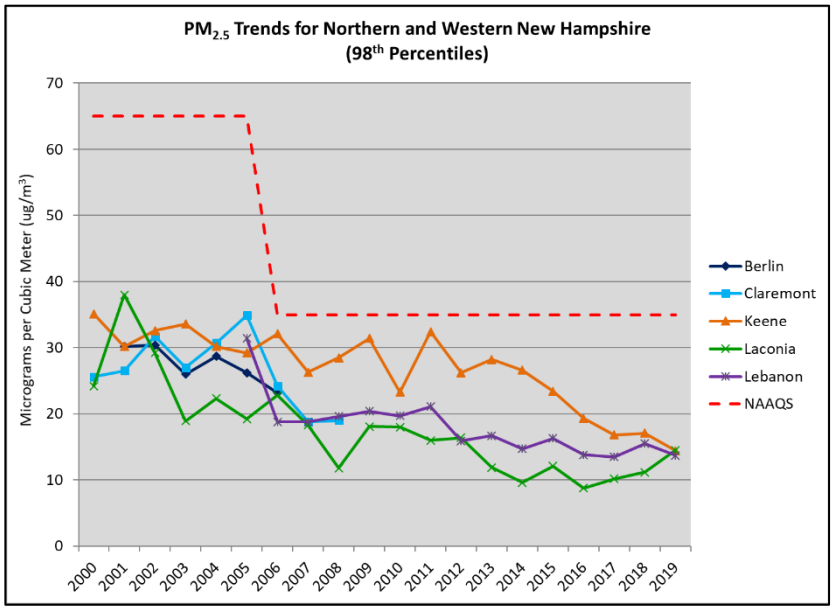


Figure 1.7: $PM_{2.5}$ trends for the 24-hour NAAQS (2000-2019)



Figures 1.8 and 1.9 show declining annual $PM_{2.5}$ concentrations, all well below the NAAQS.

Figure 1.8: $PM_{2.5}$ trends for the annual NAAQS (2000-2019)

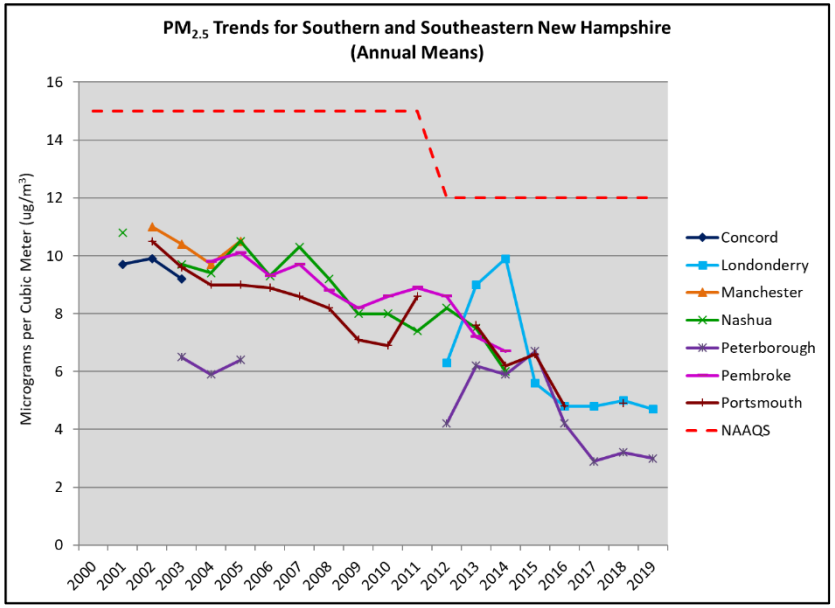
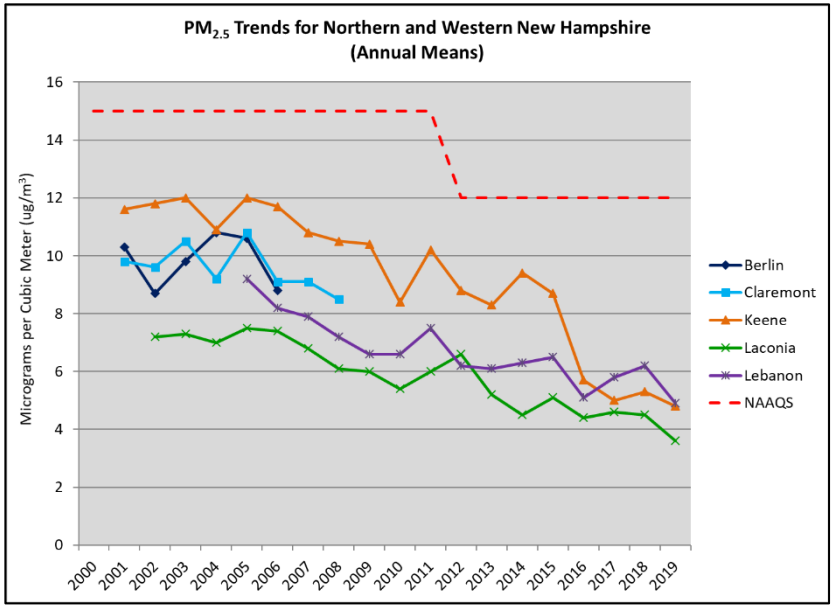


Figure 1.9: $PM_{2.5}$ trends for the annual NAAQS (2000-2019)



Figures 1.10 and 1.11 show very low nitrogen dioxide and lead concentrations in the state, well below the NAAQS.

Figure 1.10: Nitrogen Dioxide trends for the 1-hour NAAQS (2000-2019)

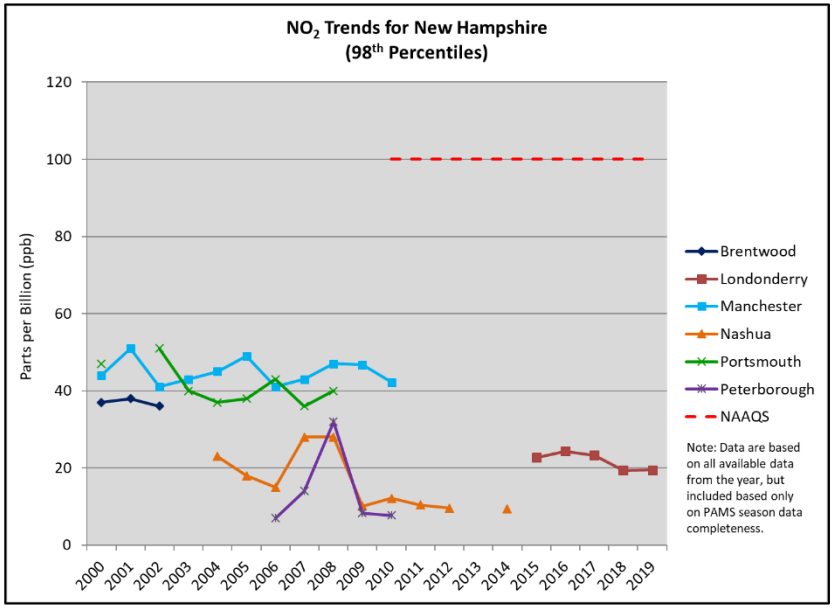
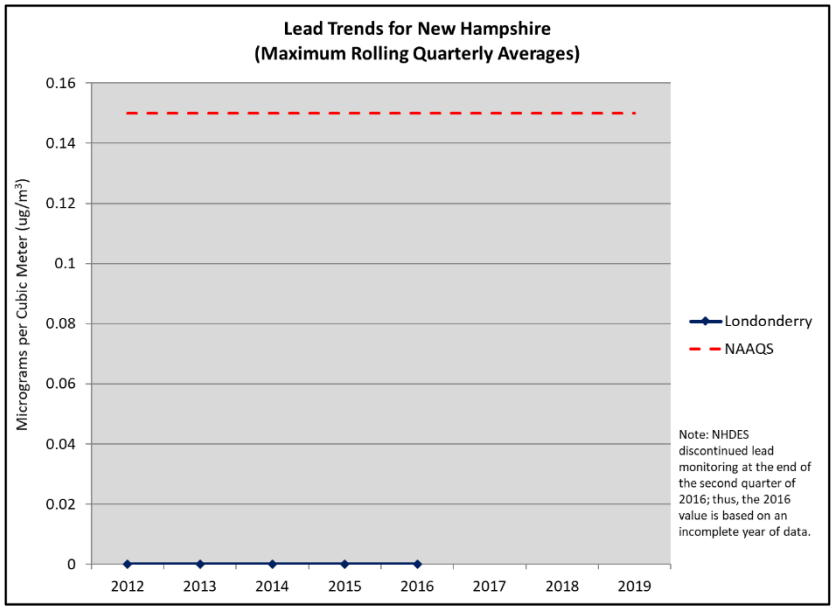


Figure 1.11: Lead trends for the annual NAAQS (2012-2019)



Figures 1.12 and 1.13 show low and declining sulfur dioxide concentrations in the state, currently well below the NAAQS.

Figure 1.12: Sulfur Dioxide trends for the 1-hour NAAQS (2000-2019)

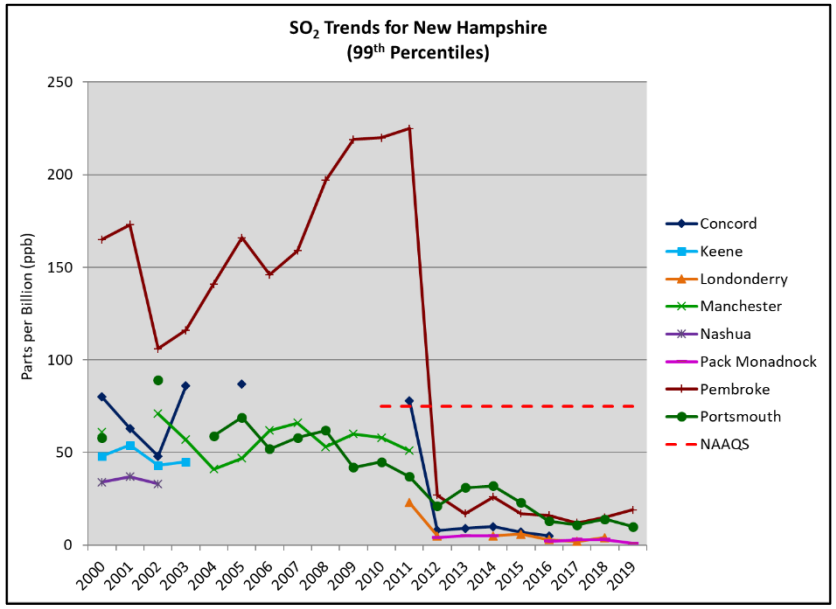
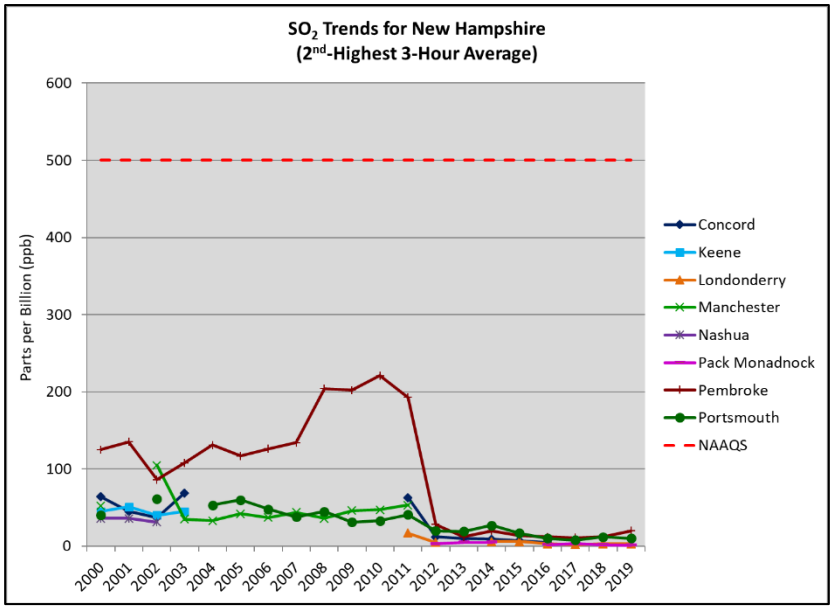


Figure 1.13: Sulfur Dioxide trends for 3-hour secondary NAAQS (2000-2019)



Figures 1.14 and 1.15 show very low and stable PM_{10} concentrations in the state, well below the NAAQS.

Figure 1.14: PM_{10} trends for the 24-hour NAAQS (2000-2019)

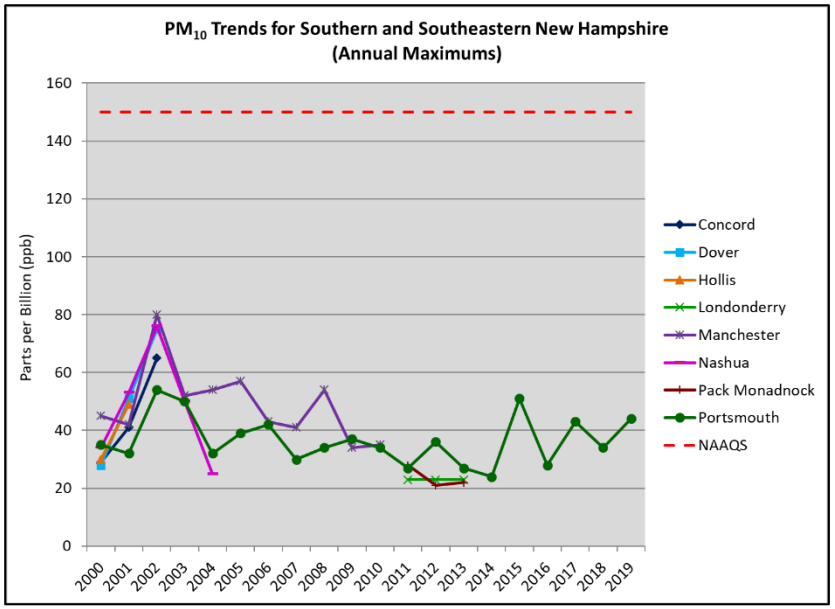


Figure 1.15: PM_{10} trends for the 24-hour NAAQS (2000-2019)

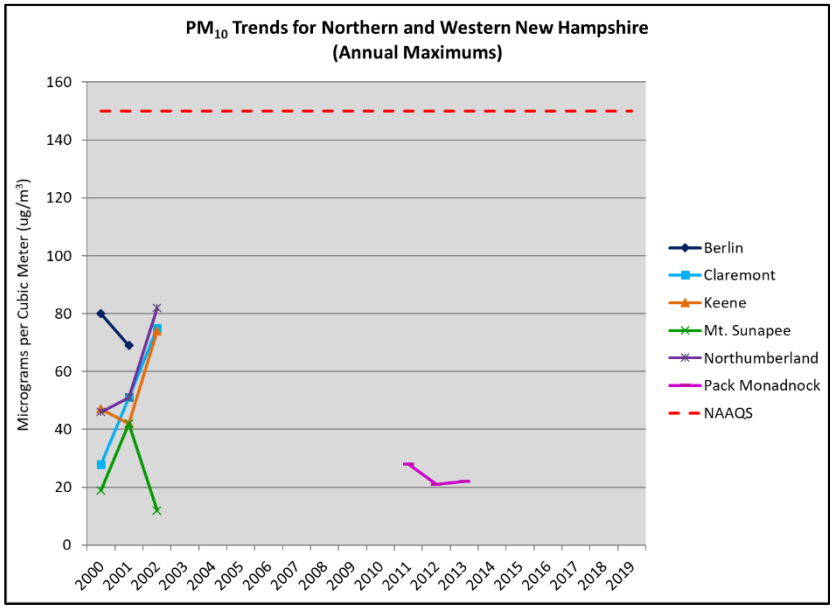


Table 1.12: Seasonal Maximum 24-hour Averages at Londonderry for Toxic PAMS Species Compared to the Ambient Allowable Limit (AAL), 2015-2019

PAMS Parameter	AAL ug/m3	Max 24 Hr. Avg. (ug/m3)					2019 Max as % of AAL	2019 Change
		2015	2016	2017	2018	2019		
PROPYLENE (43205)	35,833	0.37	0.21	0.28	0.85	0.83	0.00%	↓
CYCLOPENTANE (43242)	25,595	0.11	0.15	0.07	0.24	0.52	0.00%	↑
ISOPENTANE (43221)	36,875	1.17	1.73	1.27	1.90	2.10	0.01%	↑
PENTANE (43220)	36,875	0.59	0.73	0.73	1.44	1.51	0.00%	↑
2-METHYLPENTANE (43285)	36,875	0.16	0.25	0.13	0.76	0.92	0.00%	↑
3-METHYLPENTANE (43230)	36,875	0.16	0.29	0.11	0.60	0.80	0.00%	↑
HEXANE (43231)	885	0.44	0.64	0.5	0.97	1.08	0.12%	↑
BENZENE (45201)	6	0.53	0.27	0.33	1.28	1.00	16.67%	↓
CYCLOHEXANE (43248)	6,000	0.12	0.18	0.1	0.45	0.26	0.00%	↓
HEPTANE (43232)	8,249	0.18	0.44	0.11	0.52	0.61	0.01%	↑
METHYLCYCLOHEXANE (43261)	23,958	0.12	0.24	0.07	0.37	0.45	0.00%	↑
TOLUENE (45202)	5,000	1.11	1.65	1.17	2.06	2.14	0.04%	↑
OCTANE (43233)	7,000	0.11	0.15	0.04	0.27	0.37	0.01%	↑
ETHYLBENZENE (45203)	1,000	0.18	0.22	0.16	0.45	0.55	0.06%	↑
M & P-XYLENES (45109)	1,550	0.51	0.61	0.53	0.94	0.85	0.05%	↓
STYRENE (45220)	1,000	0.17	0.07	0.07	1.01	0.93	0.09%	↓
O-XYLENE (45204)	1,550	0.2	0.21	0.21	0.49	0.55	0.04%	↑
NONANE (43235)	15,625	0.13	0.11	0.12	0.25	0.21	0.00%	↓
1,3,5-TRIMETHYLBENZENE (45207)	619	0.1	0.12	0.07	0.13	0.07	0.01%	↓
1,2,4-TRIMETHYLBENZENE (45208)	619	0.21	0.27	0.19	0.65	0.52	0.08%	↓

*** Some data flagged for quality control purposes. All data in micrograms per cubic meter (µg/m^3).**

Table 1.13: Seasonal Maximum 24-hour Averages at Pack Monadnock in Miller State Park for Toxic PAMS Species Compared to the Ambient Allowable Limit (AAL), 2006-2019

PAMS Parameter	AAL µg/m³	Max 24 Hour Avg. (µg/m³)														2019 Max as % of AAL	2018 to 2019 Change
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		
PROPYLENE (43205)	35,833	0.28	0.25	0.46	0.15	0.20	0.59	0.38	0.17	0.16	0.28	0.29	0.23	0.61	0.47	0.001%	↓
CYCLOPENTANE (43242)	25,595	0.42	0.53	1.63	0.29	0.09	0.17	0.21	0.13	0.13	0.23	0.11	0.11	0.09	0.07	0.000%	↓
ISOPENTANE (43221)	36,875	1.03	1.09	0.70	0.89	0.75	1.84	2.32	0.95	0.73	0.96	0.68	1.34	0.74	0.50	0.001%	↓
PENTANE (43220)	36,875	45.41	7.63	0.55	0.45	0.38	0.86	0.76	0.48	0.40	0.51	0.38	0.69	0.55	0.41	0.001%	↓
2-METHYLPENTANE (43285)	36,875	0.19	0.27	0.04	0.06	0.04	0.30	0.25	0.06	0.07	0.12	0.07	0.09	0.07	0.04	0.000%	↓
3-METHYLPENTANE (43230)	36,875	0.13	0.17	0.01	0.04	0.03	0.21	0.19	0.03	0.02	0.05	0.03	0.02	0.02	0.00	0.000%	↓
HEXANE (43231)	885	0.21	0.27	0.19	0.32	1.36	1.01	0.48	0.28	0.24	0.40	0.16	0.18	0.29	0.23	0.026%	↓
BENZENE (45201)	6	0.31	0.33	0.32	0.41	0.73	1.09	0.45	0.38	0.41	0.64	0.18	0.45	0.32	0.48	8.000%	↑
CYCLOHEXANE (43248)	6,000	0.14	0.05	0.02	0.08	0.04	0.48	0.15	0.06	0.04	0.09	0.01	0.06	0.03	0.04	0.001%	↑
HEPTANE (43232)	8,249	0.71	0.16	0.15	0.17	0.13	0.79	0.21	0.14	0.11	0.14	0.04	0.04	0.03	0.03	0.000%	-
METHYLCYCLOHEXANE (43261)	23,958	1.23	0.15	0.15	0.11	0.16	0.49	0.14	0.07	0.06	0.10	0.04	0.03	0.02	0.04	0.000%	↑
TOLUENE (45202)	5,000	1.00	1.05	1.11	1.01	0.77	2.48	1.36	0.80	0.56	0.67	0.53	0.54	0.54	0.53	0.011%	↓
OCTANE (43233)	7,000	0.91	0.17	0.27	0.11	0.06	0.40	0.23	0.07	0.04	0.02	0.02	0.02	0.01	0.03	0.000%	↑
ETHYLBENZENE (45203)	1,000	0.35	0.20	0.59	0.21	0.15	0.42	0.18	0.13	0.07	0.08	0.05	0.09	0.04	0.02	0.002%	↓
M & P-XYLENES (45109)	1,550	1.88	0.37	2.38	0.46	0.23	1.22	0.42	0.42	0.19	0.25	0.13	0.12	0.20	0.14	0.009%	↓
STYRENE (45220)	1,000	1.03	1.13	1.80	0.40	0.08	0.18	0.14	0.05	0.18	0.04	0.03	0.02	0.02	0.07	0.007%	↑
O-XYLENE (45204)	1,550	0.60	0.13	0.67	0.15	0.08	0.45	0.20	0.16	0.08	0.06	0.04	0.04	0.06	0.04	0.003%	↓
NONANE (43235)	15,625	8.83	1.33	0.57	0.23	0.08	0.16	0.20	0.36	0.05	0.09	0.06	0.03	0.03	0.02	0.000%	↓
1,3,5-TRIMETHYLBENZENE (45207)	619	1.75	0.08	0.29	0.13	0.04	0.10	0.12	0.08	0.01	0.09	0.01	0.02	0.04	0.02	0.003%	↓
1,2,4-TRIMETHYLBENZENE (45208)	619	3.91	1.34	0.79	0.53	0.14	0.38	0.26	0.08	0.09	0.15	0.04	0.04	0.06	0.01	0.002%	↓

All data in micrograms per cubic meter (µg/m³).

PART 2: Individual Station Information

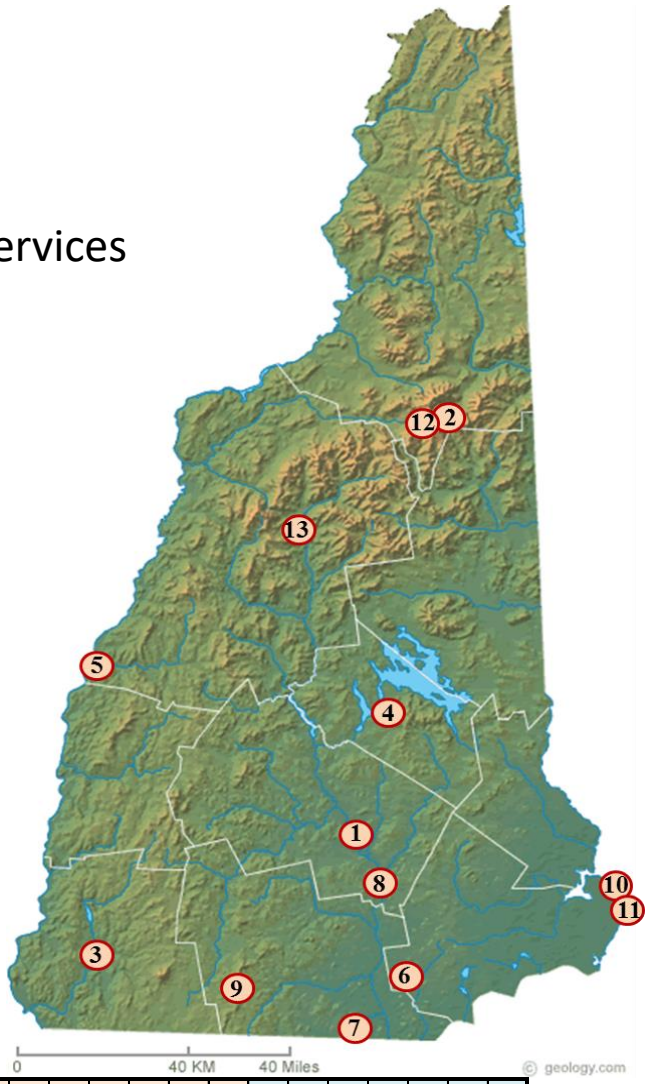
New Hampshire
Department of Environmental Services

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Air Resources Division

2020 Air Quality Monitoring Stations

NHDES Air Monitoring Station Locations and Parameter Details



Summer 2020	Ncore	IMPROVE	CASTNET	NADP	PAMS	Laboratory	Carbon Monoxide (CO)	Nitrogen Dioxide (NO2)	Nitrogen Oxides (NOy)	Ozone (O3)	PM2.5	PM2.5 co-location	PM10	PM Coarse	Sulfur Dioxide (SO2)	Wind Direction (WD)	Wind Speed (WS)	External Temperature (ETP)	Barometric Pressure (BP)	Relative Humidity (RH)	Precipitation (PT)	Solar Rediation (SolRad)
1. Concord						●				●						●	●	●				
2. Greens Grant - Camp Dodge		●								●								●				
3. Keene										●	●	●				●	●	●				
4. Laconia										●	●					●	●	●			●	
5. Lebanon										●	●					●	●	●				
6. Londonderry	●	●			●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
7. Nashua										●						●	●	●				
8. Pembroke															●	●	●	●				
9. Peterborough - Pack Monadnock	●	●			●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●
10. Portsmouth										●	●	●	●	●	●	●	●	●				
11. Rye										●						●	●	●				
12. Sargents Purchase - Mt Washington Summit							●			●												
13. Woodstock - Hubbard Brook			●	●						●								●				

● Proposed

Camp Dodge, Greens Grant

General Information			
AQS ID:	33-007-4002	Latitude:	44.308132
Town:	Greens Grant	Longitude:	-71.217639
Address:	Route 16	Elevation (m):	449
County:	Coos	Year Est.:	1995
Spatial Scale:	Regional		

Site Description

This air monitoring station is located in a rural forested area off Route 16 in Greens Grant. This wood-clad, stick-built shelter is approximately 7' wide by 10' long. This station is representative of a Class 1 Type Airshed. NHDES operates this station in cooperation with the Appalachian Mountain Club and the US Forest Service.

Pollutants/Parameters

Ozone – Temperature – IMPROVE. The US Forest Service operates the IMPROVE sampler.

Recent Changes

NHDES relocated this station during the Fall of 2018. In coordination with the USFS and AMC, NHDES placed an efficient climate-controlled structure adjacent (approximately 10 ft. away) to the current structure and relocated all monitoring equipment into and on the new structure.

Proposed/Planned Changes

NHDES is not planning any significant changes to this station into the foreseeable future.

On the left, an image of the monitoring station and on the right a Google Earth map pinpointing the station's location.

Mt. Washington Summit

General Information			
AQS ID:	33-007-4001	Latitude:	44.270093
Town:	Sargent's Purchase	Longitude:	-71.303821
		Elevation (m):	1,910
Address:	Yankee Bld.	Year Est.:	1990
County:	Coos		
Spatial Scale:	Regional		

Site Description

This air monitoring station is located at the top of Mt. Washington in the Yankee Building.

Pollutants/Parameters

Ozone

Recent Changes

NHDES did not make any significant changes to this station during this review period.

Proposed/Planned Changes

NHDES will, based on funding, add trace level CO in 2020 as part of the PAMS EMP. NHDES is also planning on working on the inlet manifold during the summer of 2020.

On the left, an image of the building housing the monitoring station and on the right a Google Earth map pinpointing the station's location.

Hubbard Brook, Woodstock

General Information			
AQS ID:	33-009-8001	Latitude:	43.944544
Town:	Woodstock	Longitude:	-71.700772
Address:	Mirror Lake Rd.	Elevation (m):	250
County:	Grafton	Year Est.:	1989
Spatial Scale:	Regional		

Site Description

This air monitoring station is located in a rural area in the White Mountain National Forest. This pre-fabricated structure is specifically designed for climate-controlled scientific operations. It measures approximately 8' wide by 10' long. NHDES is not involved in monitoring or data acquisition at this site. A USEPA Contractor operates this site.

Pollutants/Parameters

Ozone – Temperature – CASTNET

Recent Changes

NHDES did not make any significant changes to this station during this review period.

Proposed/Planned Changes

NHDES is not planning any significant changes to this station into the foreseeable future.

On the left, an image of the monitoring station and on the right a Google Earth map pinpointing the station's location.

Lebanon Airport, Lebanon

General Information			
AQS ID:	33-009-0010	Latitude:	43.629605
Town:	Lebanon	Longitude:	-72.309499
Address:	Airport Road	Elevation (m):	171
County:	Grafton	Year Est.:	2005
Spatial Scale:	Neighborhood		

Site Description

This 8' wide by 10' long insulated trailer is located at the northeast edge of the Lebanon Municipal Airport in a commercial area.

Pollutants/Parameters

Ozone - Continuous $PM_{2.5}$ (BAM) – Wind Speed - Wind Direction - Temperature

Recent Changes

NHDES did not make any significant changes to this station during this review period.

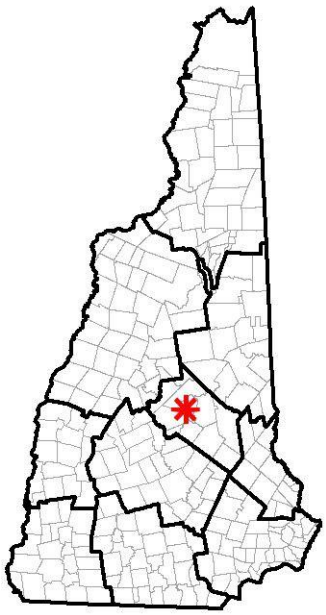
Proposed/Planned Changes

NHDES is not planning any significant changes to this station into the foreseeable future.

On the left, an image of the monitoring station and on the right a Google Earth map pinpointing the station's location.

Green Street, Laconia

General Information			
AQS ID: Town: Address: County: Spatial Scale:	33-001-2004 Laconia Green Street Belknap Regional	Latitude: Longitude: Elevation (m): Year Est.:	43.566122 -71.496335 216 2001



Site Description

This 10' wide by 12' long cedar-clad, stick-built air monitoring station is located in an open field in a rural residential area.

Pollutants/Parameters

Ozone – Continuous $PM_{2.5}$ (BAM) –Wind Speed – Wind Direction – Temperature - Precipitation

Recent Changes

NHDES installed a $PM_{2.5}$ Met One BAM at this station during November 2018 and removed the filter based samplers.

Proposed/Planned Changes

NHDES is considering relocating Laconia monitoring to better capture winter wood smoke within the city neighborhoods.

On the left, an image of the monitoring station, center is additional monitoring equipment at the site, and on the right a Google Earth map pinpointing the station's location.

Hazen Station, Concord

General Information			
AQS ID: Town: Address: County: Spatial Scale:	33-013-1007 Concord 27 Hazen Dr. Merrimack Neighborhood	Latitude: Longitude: Elevation (m): Year Est.:	43.218470 -71.514525 107 2004

Site Description

This site has the advantage of being in close proximity to the NHDES main office, for both outreach opportunities and ease of maintenance. It is also in the proximity of residential neighborhoods, retirement communities and schools. The Station measures 8' wide by 18' long. Its insulated, box-type structure is specifically designed for climate-controlled scientific functions.

Pollutants/Parameters

Ozone – Temperature – Wind Speed – Wind Direction. NHDES also uses this station as an air monitoring laboratory and a staging area for field-ready equipment.

Recent Changes

NHDES did not make any significant changes to this station during this review period.

Proposed/Planned Changes

NHDES is not planning any significant changes to this station into the foreseeable future.

On the left, an image of the monitoring station and on the right a Google Earth map pinpointing the station's location.

Exchange Street, Pembroke

General Information			
AQS ID:	33-013-1006	Latitude:	43.132460
Town:	Pembroke	Longitude:	-71.458246
Address:	Pleasant St.	Elevation (m):	74
County:	Merrimack	Year Est.:	2002
Spatial Scale:	Neighborhood		

Site Description
This station is located in a suburban residential area southeast of the coal burning Merrimack station power plant. It is the ideal location for improving our understanding of near-field emissions from the Merrimack Station power plant. This insulated, box-type structure is specifically designed for climate-controlled scientific functions and measures approximately 8' wide by 10' long.

Pollutants/Parameters

Sulfur Dioxide – Temperature – Wind Speed – Wind Direction.

Recent Changes

NHDES did not make any significant changes to this station during this review period.

Proposed/Planned Changes

NHDES is not planning any significant changes to this station into the foreseeable future.

On the left, an image of the monitoring station and on the right a Google Earth map pinpointing the station's location.

Peirce Island, Portsmouth

General Information			
AQS ID:	33-015-0014	Latitude:	43.075371
Town:	Portsmouth	Longitude:	-70.748017
Address:	Peirce Island	Elevation (m):	10
County:	Rockingham	Year Est.:	2001
Spatial Scale:	Neighborhood		

Site Description

This station is located in an urban commercial/residential area. It is strategically position to capture air quality data from the Portsmouth Shipyard (northeast), the urban center of Portsmouth (southwest), the industrialized Piscataqua River (northwest) and ocean fetch-type events (southeast) depending on wind direction. The cedar-clad, stick-built shelter is approximately 10' wide by 12' long. Filter-based samplers are located on platforms approximately 8m from the shelter.

Pollutants/Parameters

Ozone – $PM_{2.5}$ Continuous (light scattering) – filter based $PM_{2.5}$ (1 every 12 days) – PM_{10} Continuous (light scattering) – Sulfur Dioxide – Temperature – Wind Speed – Wind Direction

Recent Changes

NHDES removed the API602 particle sampler from this station and installed an API640x particle sampler in January 2019.

Proposed/Planned Changes

NHDES is not planning any significant changes to this station into the foreseeable future.

On the left, an image of the monitoring station and on the right a Google Earth map pinpointing the station's location.

Seacoast Science Center, Rye

General Information			
AQS ID:	33-015-0016	Latitude:	43.045269
Town:	Rye	Longitude:	-70.713958
Address:	Seacoast Science Ctr.	Elevation (m):	10
		Year Est.:	2003
County:	Rockingham		
Spatial Scale:	Neighborhood		

Site Description
This station is located in a rural neighborhood on the seacoast in direct exposure to the Atlantic Ocean. The station is located inside a modified corner of the main facility building at the Seacoast Science Center. NHDES established this station to measure coastal ozone episodes as well as to promote public understanding of air pollution and monitoring.

Pollutants/Parameters

Ozone - Temperature – Wind Speed – Wind Direction.

Recent Changes

NHDES did not make any significant changes to this station during this review period.

Proposed/Planned Changes

NHDES is not planning any significant changes to this station into the foreseeable future.

On the left, an image of the building housing the monitoring station and on the right a Google Earth map pinpointing the station's location.

Water Street, Keene

General Information			
AQS ID:	33-005-0007	Latitude:	42.930521
Town:	Keene	Longitude:	-72.272332
Address:	Water Street	Elevation (m):	145
County:	Cheshire	Year Est.:	1989
Spatial Scale:	Neighborhood		

Site Description

This 8' wide by 10' long air monitoring station is situated in a commercial area, close to the center of the city of Keene. The filter-based $PM_{2.5}$ sampler is located on the rooftop deck.

Pollutants/Parameters

Ozone - $PM_{2.5}$ Continuous (BAM) – filter based $PM_{2.5}$ (1 every 6 days) – Wind Speed - Wind Direction - Temperature

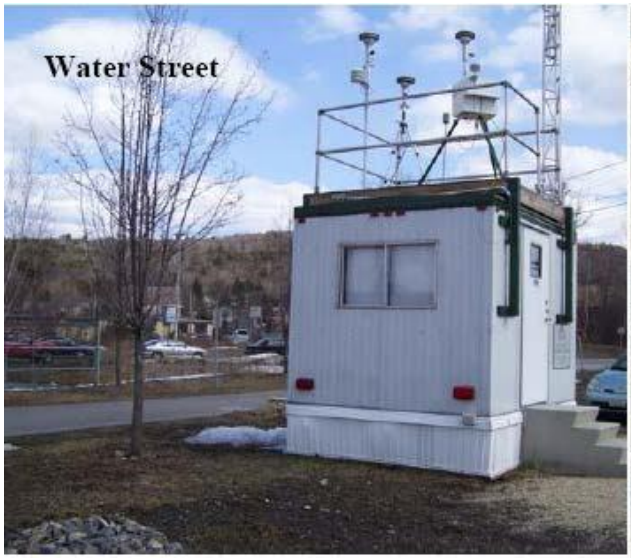
Recent Changes

NHDES discontinued filter based $PM_{2.5}$ sampling at this station from August 2017 through December 2017. NHDES resumed this sampling starting in January 2018 on 1 in 6 day schedule.

Proposed/Planned Changes

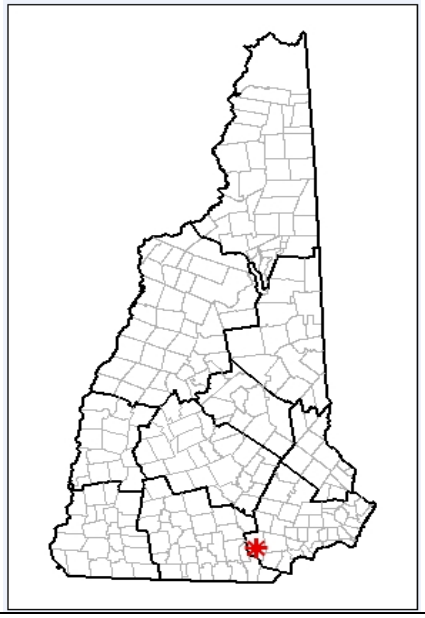
NHDES is planning to replace the BAM at this station with an API 640 non-x monitor during the Fall of 2020.

On the left, an image of the monitoring station and on the right a Google Earth map pinpointing the station's location.



Moose Hill, Londonderry

General Information			
AQS ID:	33-015-0018	Latitude:	42.862522
Town:	Londonderry	Longitude:	-71.380153
Address:	Moose Hill Sch.	Elevation (m):	104
County:	Rockingham	Year Est.:	2009
Spatial Scale:	Neighborhood		



Site Description

This 12' wide by 16' long wood clad, stick-built air monitoring station is located in a very open field in the heart of suburban New Hampshire, approximately halfway between the state's two largest cities (Manchester and Nashua). It has virtually zero local interferences from nearby pollution sources or obstructions, making it an ideal location to measure regional air quality. Filter-based $PM_{2.5}$ samplers are located on platforms approximately 15m from the structure.

Pollutants/Parameters

NCORE: $PM_{2.5}$ Continuous (BAM) – PM_{10} Continuous (BAM) - filter based $PM_{2.5}$ (Speciation) (1 every 3 days) – IMPROVE – PM Coarse (Continuous) – Oxides of Nitrogen (NOy) – Nitrogen Dioxide (NO_2) – Ozone – Sulfur Dioxide (trace) – Carbon Monoxide (trace) – Temperature – Wind Speed – Wind Direction – Relative Humidity – Precipitation – Barometric Pressure – Solar Radiation - Ceilometer– Photochemical Precursors.

Recent Changes

NHDES added a ceilometer to this station during this review period and a Pandora Spectrometer is expected from NASA summer 2019. NHDES added a T640x Particle monitor in May 2020, and discontinued the remaining BAM in June 2020.

Proposed/Planned Changes

Also NHDES plans to modify PAMS at this station in accordance with the PAMS Implementation Plan (refer to Part 3 of 2019 Annual Plan).

On the left are images of the monitoring station building, solar panels, and platform equipment. On the right a Google Earth map pinpointing the station's location.

Pack Monadnock Mountain, Peterborough

General Information			
AQS ID:	33-011-5001	Latitude:	42.861830
Town:	Peterborough	Longitude:	-71.878626
Address:	Miller State Park	Elevation (m):	694
County:	Hillsborough	Year Est.:	2002
Spatial Scale:	Regional		

Site Description

This station is located in an elevated forest environment on the summit of Pack Monadnock Mountain. NHDES recently renovated this 27' by 10' structure to include many efficiency initiatives. The location of this station is scientifically significant because it is the highest accessible peak that lies directly within the primary air pollution transport corridor into the central part of the state. This allows this site to be the ideal location for improving our understanding of air pollution transport into the heavily populated Merrimack Valley and beyond. The filter-based $PM_{2.5}$ sampler is located on a deck on top of the structure.

Pollutants/Parameters

NCORE: $PM_{2.5}$ Continuous (BAM) – PM_{10} Continuous (BAM) - filter based $PM_{2.5}$ (Speciation) (1 every 3 days) – IMPROVE – PM Coarse (Continuous) – Oxides of Nitrogen (NOy) – Ozone – Sulfur Dioxide (trace) – Carbon Monoxide (trace) – Temperature – Wind Speed – Wind Direction – Relative Humidity – Precipitation – Barometric Pressure– Photochemical Precursors.

Recent Changes

NHDES did not make any significant changes to this station during this review period.

Proposed/Planned Changes

NHDES is planning to replace the BAMs at this station with a T640 Particle monitor in the Fall of 2020. NHDES is not planning any significant changes to this station into the foreseeable future, except in accordance with the PAMS Implementation Plan (refer to Part 3 of 2019 Annual Plan).

On the left, an image of the monitoring station and on the right a Google Earth map pinpointing the station's location.

Gilson Road, Nashua

General Information			
AQS ID:	33-011-1011	Latitude:	42.718656
Town:	Nashua	Longitude:	-71.522428
Address:	57 Gilson Rd.	Elevation (m):	59
County:	Hillsborough	Year Est.:	2003
Spatial Scale:	Neighborhood		

Site Description

This air monitoring station is located in a suburban residential neighborhood near a Superfund site. NHDES requires two 8' wide by 16' long trailers to accommodate the equipment needed to measure ambient air parameters, including PAMS. NHDES collects meteorological data from a tower located on an adjacent building. Photochemical Assessment Monitoring (PAMS) was previously conducted at this station. NHDES moved PAMS to Londonderry in 2014. PAMS canister preparation still takes place at this station.

Pollutants/Parameters

Ozone – Temperature – Wind Speed – Wind Direction.

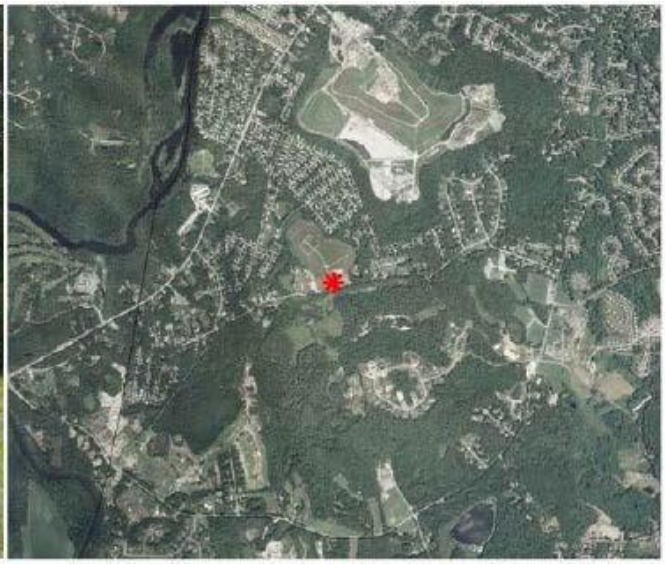
Recent Changes

NHDES did not make any significant changes to this station during this review period.

Proposed/Planned Changes

NHDES is not planning any significant changes to this station into the foreseeable future.

On the left, an image of the monitoring station and on the right a Google Earth map pinpointing the station's location.



APPENDIX A:
$PM_{2.5}$ Comparability Assessments

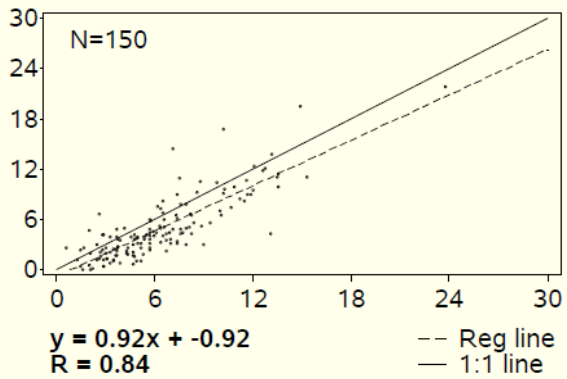
The image below compares FRM vs. FEM $PM_{2.5}$ sampling at the Keene Station

$PM_{2.5}$ Continuous Monitor Comparability Assessment

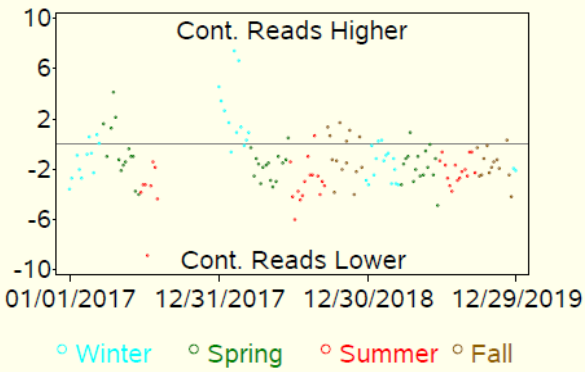
Site 33-005-0007: Keene, NH

FRM: BGI Models PQ200-VSCC or PQ200A-VSCC - Gravimetric (116,142), PM2.5 - Local Conditions (88101), POC=1
Cont: Met One BAM-1020 Mass Monitor w/VSCC - Beta Attenuation (170), PM2.5 - Local Conditions (88101), POC=3

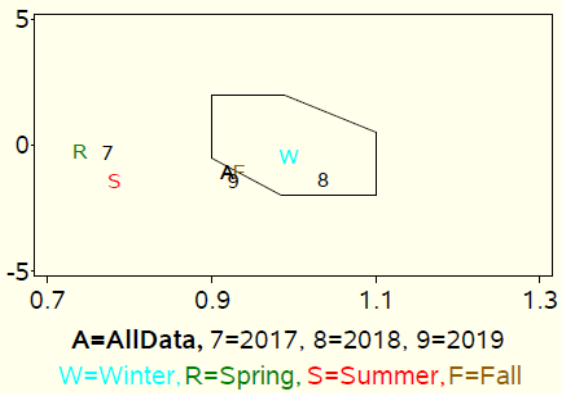
Cont. (y) vs. FRM (x) ($\mu g/m^3$)



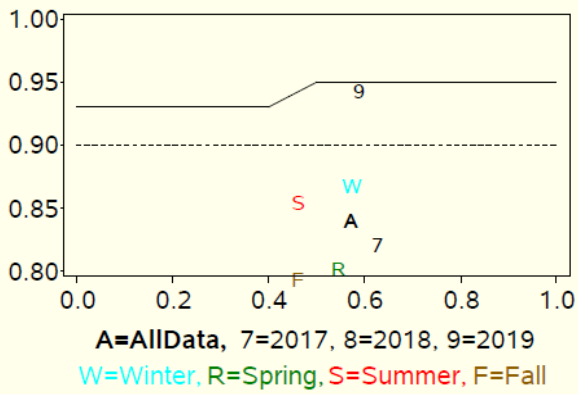
Cont. minus FRM ($\mu g/m^3$)



Additive (y) vs. Multiplicative (x) Bias



R (y) vs. FRM CCV (x)



Mean Concentration ($\mu g/m^3$)

Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	**150**	**6.2**	**4.8**	**0.77**
Winter	40	7.9	7.5	0.96
Spring	45	5.0	3.7	0.73
Summer	38	6.9	4.2	0.60
Fall	27	4.8	3.6	0.74
2017	33	6.4	4.8	0.75
2018	57	6.2	5.2	0.84
2019	60	6.2	4.4	0.72

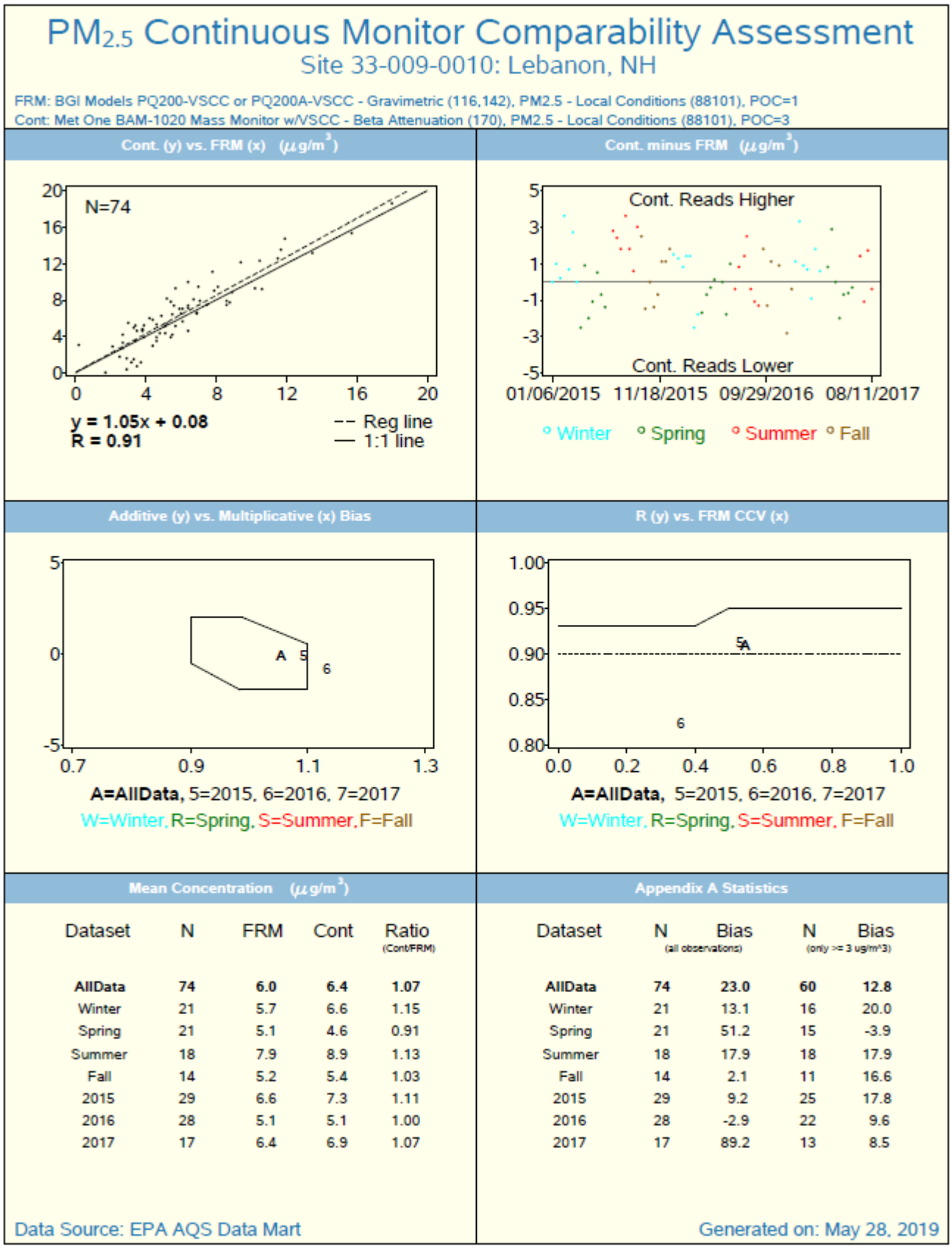
Appendix A Statistics

Dataset	N (all observations)	Bias	N (only >= 3 ug/m^3)	Bias
AllData	**150**	**-25**	**92**	**-17**
Winter	40	-4.9	31	-0.9
Spring	45	-20	20	-25
Summer	38	-46	25	-32
Fall	27	-33	16	-13
2017	33	-17	18	-23
2018	57	-22	35	-5.0
2019	60	-32	39	-25

Data Source: EPA AQS Data Mart

Generated: May 8, 2020

The image below compares FRM vs. FEM $PM_{2.5}$ sampling at the Lebanon Station



Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	**74**	**6.0**	**6.4**	**1.07**
Winter	21	5.7	6.6	1.15
Spring	21	5.1	4.6	0.91
Summer	18	7.9	8.9	1.13
Fall	14	5.2	5.4	1.03
2015	29	6.6	7.3	1.11
2016	28	5.1	5.1	1.00
2017	17	6.4	6.9	1.07

Dataset	N (all observations)	Bias	N (only >= 3 ug/m^3)	Bias
AllData	**74**	**23.0**	**60**	**12.8**
Winter	21	13.1	16	20.0
Spring	21	51.2	15	-3.9
Summer	18	17.9	18	17.9
Fall	14	2.1	11	16.6
2015	29	9.2	25	17.8
2016	28	-2.9	22	9.6
2017	17	89.2	13	8.5

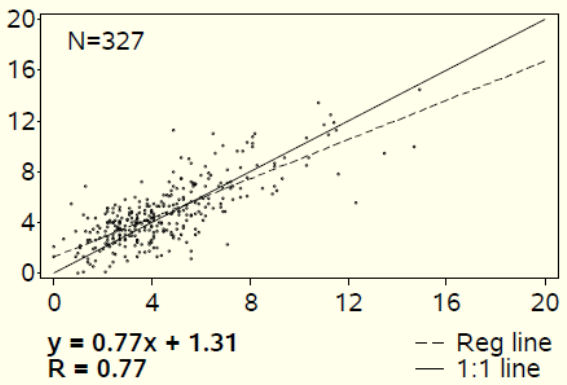
The image below compares FRM vs. FEM $PM_{2.5}$ sampling at the Londonderry Station

$PM_{2.5}$ Continuous Monitor Comparability Assessment

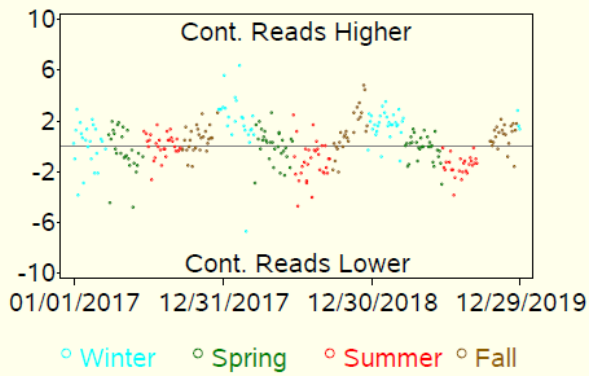
Site 33-015-0018: Londonderry, NH

FRM: R & P Model 2025 PM-2.5 Sequential Air Sampler w/VSCC - Gravimetric (118,142,145), PM2.5 - Local Conditions (88101), POC=1,2,4
Cont: Met One BAM-1020 Mass Monitor w/VSCC - Beta Attenuation (170), PM2.5 - Local Conditions (88101), POC=3

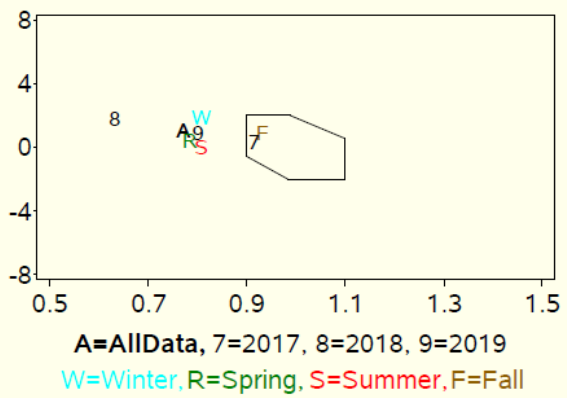
Cont. (y) vs. FRM (x) ($\mu g/m^3$)



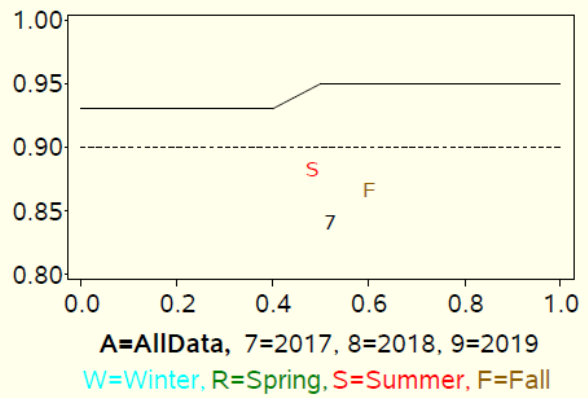
Cont. minus FRM ($\mu g/m^3$)



Additive (y) vs. Multiplicative (x) Bias



R (y) vs. FRM CCV (x)



Mean Concentration ($\mu g/m^3$)

Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	**327**	**4.5**	**4.7**	**1.06**
Winter	80	4.0	5.4	1.34
Spring	86	3.8	3.7	0.97
Summer	87	5.9	5.1	0.86
Fall	74	4.1	4.9	1.21
2017	109	4.7	4.9	1.04
2018	111	4.4	4.8	1.09
2019	107	4.3	4.6	1.06

Appendix A Statistics

Dataset	N	Bias (all observations)	N (only >= 3 ug/m^3)	Bias (only >= 3 ug/m^3)
AllData	**327**	**18.9**	**202**	**8.1**
Winter	80	48.1	47	32.5
Spring	86	2.8	43	2.5
Summer	87	-12	69	-10
Fall	74	42.7	43	16.0
2017	109	8.9	72	9.0
2018	111	34.2	66	6.9
2019	107	13.4	64	8.2

Data Source: EPA AQS Data Mart

Generated: May 6, 2020

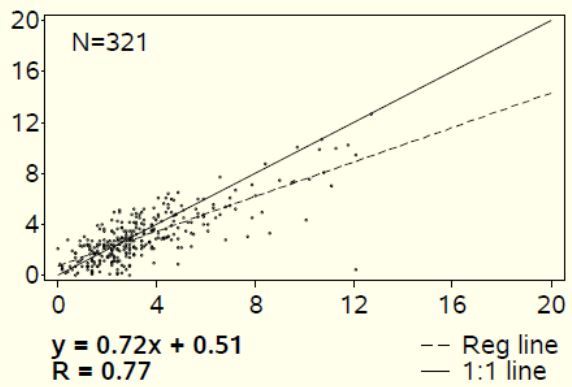
The image below compares FRM vs. FEM $PM_{2.5}$ sampling at the Peterborough Station

$PM_{2.5}$ Continuous Monitor Comparability Assessment

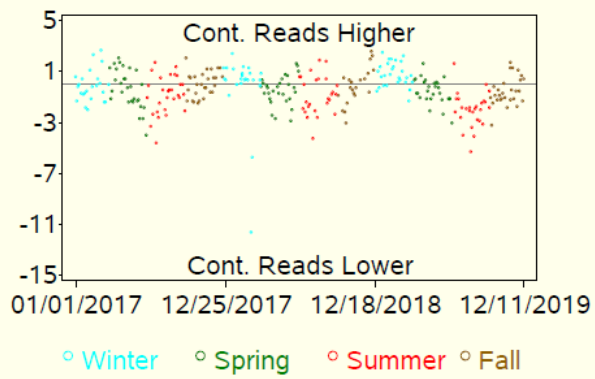
Site 33-011-5001: Peterborough (Peterboro), NH

FRM: R & P Model 2025 PM-2.5 Sequential Air Sampler w/VSCC - Gravimetric (116,118,145), PM2.5 - Local Conditions (88101), POC=1
Cont: Met One BAM-1020 Mass Monitor w/VSCC - Beta Attenuation (170), PM2.5 - Local Conditions (88101), POC=3

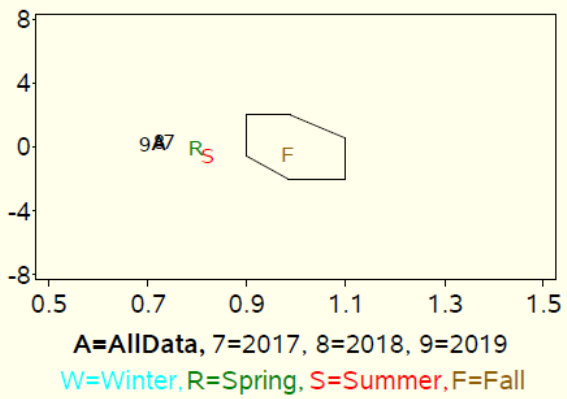
Cont. (y) vs. FRM (x) ($\mu g/m^3$)



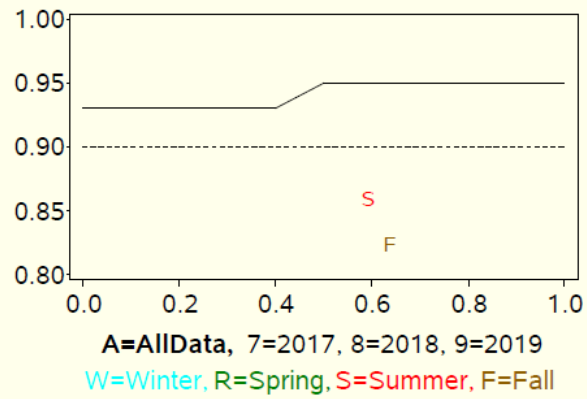
Cont. minus FRM ($\mu g/m^3$)



Additive (y) vs. Multiplicative (x) Bias



R (y) vs. FRM CCV (x)



Mean Concentration ($\mu g/m^3$)

Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	**321**	**3.4**	**2.9**	**0.87**
Winter	76	2.8	3.0	1.07
Spring	86	2.8	2.4	0.84
Summer	82	5.0	3.8	0.76
Fall	77	2.7	2.5	0.92
2017	114	3.2	2.9	0.91
2018	100	3.5	3.1	0.88
2019	107	3.3	2.8	0.82

Appendix A Statistics

Dataset	N (all observations)	Bias (all observations)	N (only >= 3 ug/m^3)	Bias (only >= 3 ug/m^3)
AllData	**321**	**-3.9**	**110**	**-2.2**
Winter	76	35.8	24	14.8
Spring	86	-13	19	0.0
Summer	82	-23	44	-16
Fall	77	-13	23	4.5
2017	114	-4.1	43	-1.1
2018	100	-1.9	33	-2.9
2019	107	-5.6	34	-3.1

Data Source: EPA AQS Data Mart

Generated: May 6, 2020

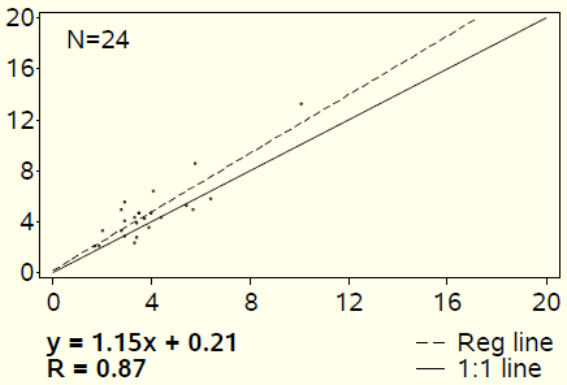
The image below compares FRM vs. FEM $PM_{2.5}$ sampling at the Portsmouth Station

$PM_{2.5}$ Continuous Monitor Comparability Assessment

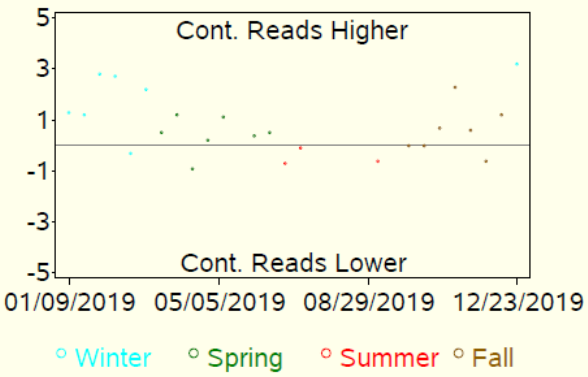
Site 33-015-0014: Portsmouth, NH

FRM: BGI Models PQ200-VSCC or PQ200A-VSCC - Gravimetric (116,118,142), PM2.5 - Local Conditions (88101), POC=1
Cont: Teledyne T640X at 16.67 LPM - Broadband spectroscopy (238), PM2.5 - Local Conditions (88101), POC=6

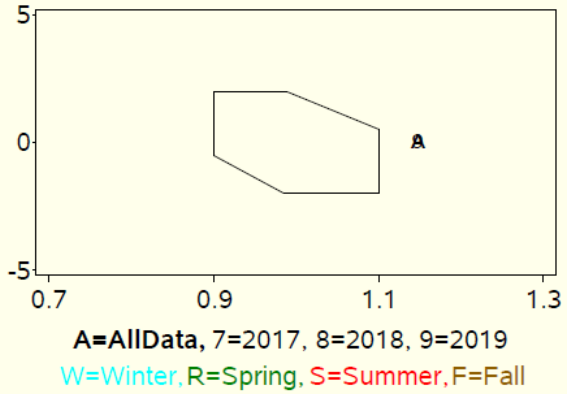
Cont. (y) vs. FRM (x) ($\mu g/m^3$)



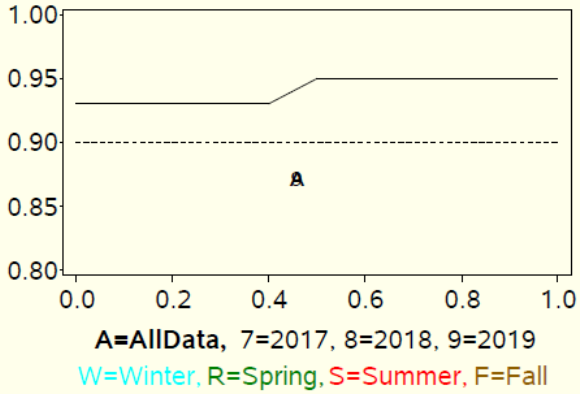
Cont. minus FRM ($\mu g/m^3$)



Additive (y) vs. Multiplicative (x) Bias



R (y) vs. FRM CCV (x)



Mean Concentration ($\mu g/m^3$)

Dataset	N	FRM	Cont	Ratio (Cont/FRM)
AllData	**24**	**3.9**	**4.7**	**1.20**
Winter	7	4.3	6.2	1.43
Spring	7	2.8	3.3	1.15
Summer	3	5.8	5.4	0.92
Fall	7	3.7	4.3	1.16
2017	0	.	.	.
2018	0	.	.	.
2019	24	3.9	4.7	1.20

Appendix A Statistics

Dataset	N	Bias (all observations)	N	Bias (only >= 3 ug/m^3)
AllData	**24**	**22.5**	**14**	**18.2**
Winter	7	50.0	3	24.1
Spring	7	15.3	3	27.4
Summer	3	-7.8	3	-7.8
Fall	7	15.2	5	24.8
2017	0	.	.	.
2018	0	.	.	.
2019	24	22.5	14	18.2

Data Source: EPA AQS Data Mart

Generated: May 6, 2020

APPENDIX B:
Monitoring Network Assessment

Monitoring Network Assessment

Network Assessment Tools
Applied to New Hampshire Ozone and $PM_{2.5}$ Networks

B.1. Overview

According to 40 CFR part 58.10(d), NHDES is required to conduct a detailed monitoring network assessment every five years. The last network assessment was conducted by NHDES in 2015, thus an updated review is due in 2020 as part of the annual monitoring program review and plan. The primary objective of the network assessment is to determine if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network.

EPA provides the Ambient Air Monitoring Network Assessment Tool (NetAssess) to help states consider whether to remove or add sites in their monitoring networks. The latest version, NetAssess2020 v1.1, was obtained by NHDES to conduct the 2020 analysis. While this report presents each tool's output for New Hampshire ozone and $PM_{2.5}$ sites, it is only as a supplemental aid to the full network assessment. The NHDES analysis in section B.5. of this report includes factors beyond the tool's capability, including topography, historical value, and other considerations. Also, while NetAssess was run using data from 2011 through 2016, NHDES included data through 2019 in its full assessment.

B.2. NetAssess Analysis Configuration Detail

The section details NetAssess model configuration, datasets used for model input, and what each module of the model is capable of providing. Modeling results are discussed in section B.3.

B.2.1 Exceedance Probability

- Data used: 2014-2016 EPA/CDC downscaler data estimates for daily maximum eight-hour ozone and 24-hour $PM_{2.5}$.
- Output: Creates a map of probability that any given area is likely to exceed the NAAQS threshold as a daily maximum; these probabilities apply to maximum values and do not predict actual NAAQS violation.
- Purpose: Identify un-monitored regions where extreme values near or over the standard may occur.

B.2.2 Area Served

- Data used: 2010 Decennial Census; Voronoi (or Thiessen) polygons form tract boundaries; user may use current network or add new sites before running the tool.
- Output: Shows the area represented by each monitoring site, where the points within the area are closer to that monitor than any other (including out-of-state monitors).
- Purpose: Assess the areas served by the current monitors and how new sites in the network would alter geographic representation.

B.2.3. Correlation Matrix

- Data used: 2011-2013 monitoring data, via the AQS AMP435 Daily Summary Report
- Output: Creates a matrix comparing each site within the selected area to every other site in that area and reports the R (not R^2) correlation factor and the average relative difference in concentration for each site pair.
- Purpose: Identify redundant sites for removal or unique sites that should be preserved.

B.2.4. Removal Bias

- Data used: 2011-2013 monitoring data, via the AQS AMP435 Daily Summary Report.
- Output: Calculates differences between daily measured values and what the value would be based on interpolation from nearby sites.
- Purpose: Evaluate the impact of removing a site and whether that removal would yield an over or under estimate of concentrations in that location.

B.3. NetAssess Analysis Results

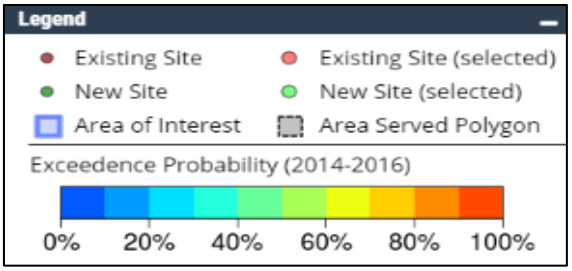
The section details NetAssess analysis results for $PM_{2.5}$ and ozone portions of the NHDES monitoring network.

B.3.1. Exceedance Probability

The maps shown in Figures B1 and B2 present the NetAssess calculated exceedance probabilities for $PM_{2.5}$ and ozone based on data from 2014-2016. The $PM_{2.5}$ map shows exceedance probabilities for the current National Ambient Air Quality Standard (NAAQS) of 35 micrograms per cubic meter ($\mu g/m^3$) for the 24-hour standard and the ozone map shows the exceedance probability for the current 8-hour NAAQS of 70 parts per billion (ppb). The assessment suggests that based on recent data, all portions of New Hampshire are at very low risk of $PM_{2.5}$ and ozone violations of their respective NAAQS. Interestingly, the southwest portion of New Hampshire, including Keene where NHDES monitors occasionally recorded hours of $PM_{2.5}$ concentrations in the category of "unhealthy for sensitive groups" (USG) levels during recent winters, shows no discernable risk in this map.

Figure B1: $PM_{2.5}$ Exceedance Probability (35 $\mu g/m^3$)

Figure B2: Ozone Exceedance Probability (70 ppb)

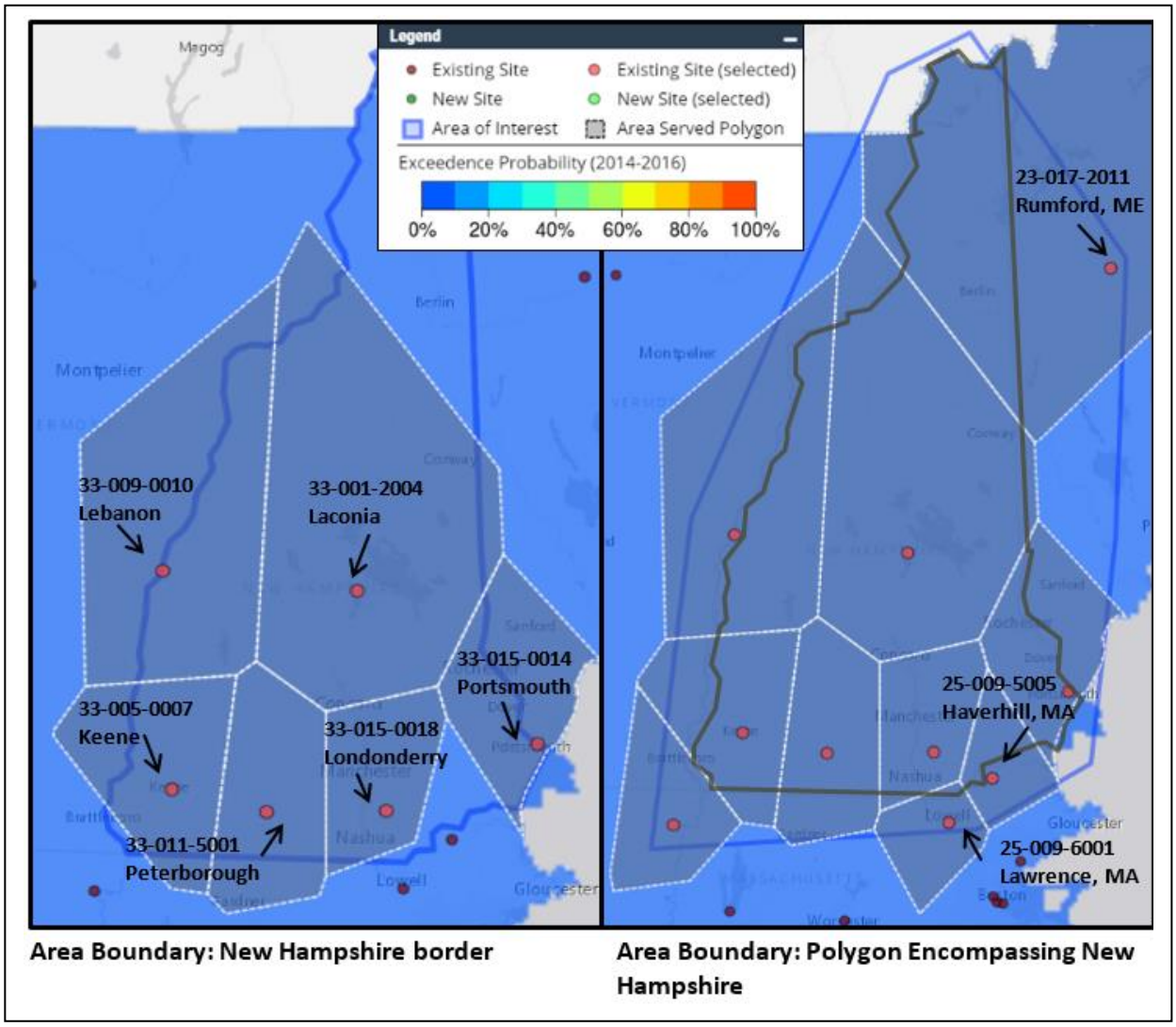


B.3.2. Area Served

The maps in Figures B3 and B4 show the areas the model suggests is served by each $PM_{2.5}$ and ozone monitor in the New Hampshire air monitoring network. This model predicted area served for each site is determined by proximity and monitor data, even if the nearest site is in a bordering state (as an option). Topographical factors are not considered and is left to the final NHDES assessment. In the left map, the area of interest is bounded by the New Hampshire border, and the map only shows the areas served by New Hampshire monitors. Some parts of New Hampshire, including the northernmost part of the state and the interior southeast, are closer to sites in neighboring states than sites in New Hampshire. The map on

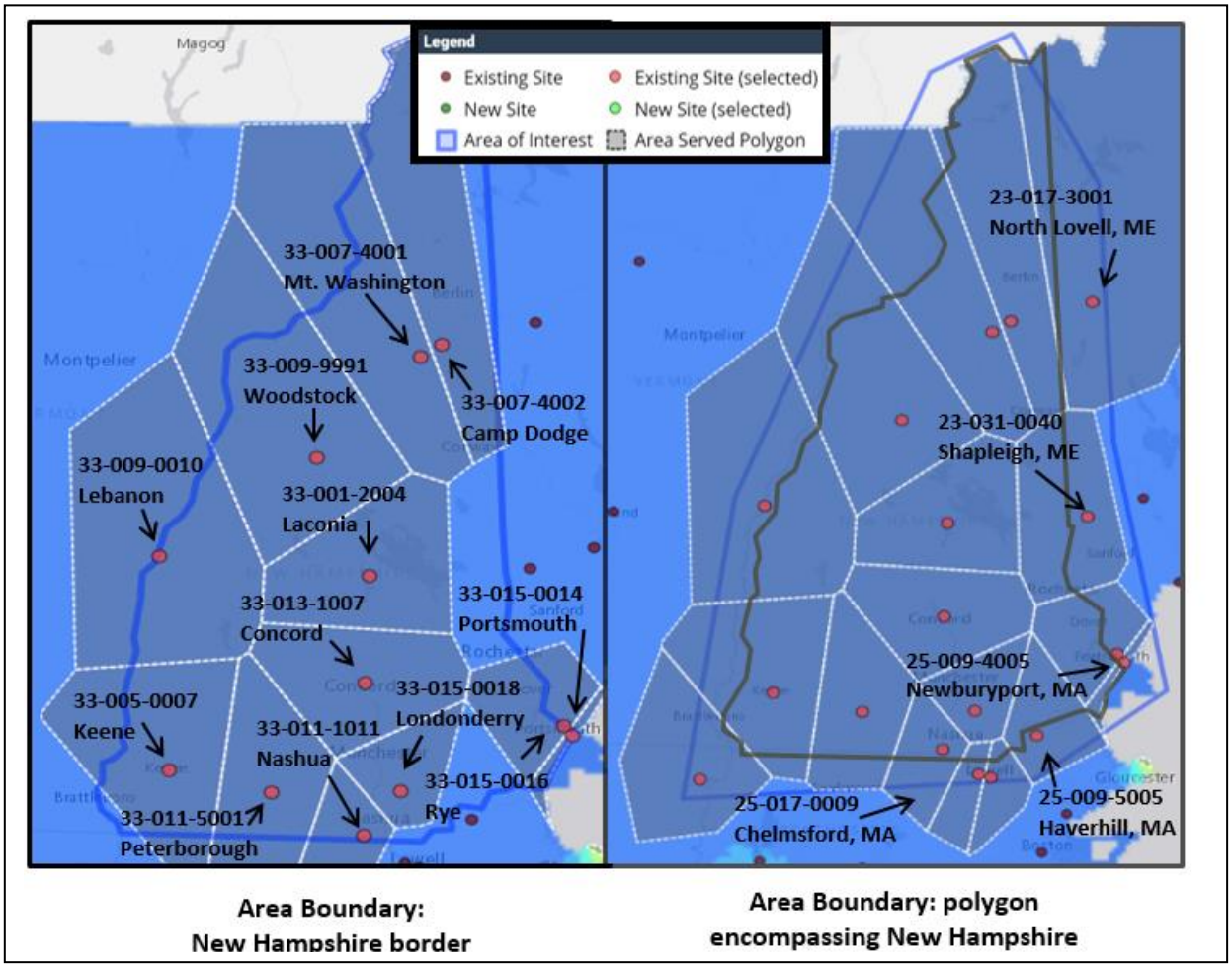
the right shows the areas served by the Maine and Massachusetts monitors that fill these gaps. For $PM_{2.5}$, the model suggests that northernmost New Hampshire could be served by a monitor in Rumford, Maine, and portions of the southern part of New Hampshire could be served by monitors in Massachusetts.

Figure B3: Areas Served by $PM_{2.5}$ Monitors in and near New Hampshire



For ozone, NetAssess in Figure B4 suggests that monitors in Maine and Massachusetts could again represent portions of eastern and southern New Hampshire. Demonstrating the model's inability to interpret topography, NetAssess carves out a large area that could be represented by the Summit of Mt. Washington, despite the large differences in elevation, wind patterns, and ragged terrain.

Figure B4: Areas Served by Ozone Monitors in and near New Hampshire



B.3.3. Correlation Matrix

The correlation matrix was run with 2014-2016 data for:

- 24-hour and annual $PM_{2.5}$ measured at FEM and FRM monitor locations
- 8-hour Ozone

NetAssess outputs calculated are produced in graphic (matrix) and tabular format. The matrix pairs each site with other sites in the selected geographic area, such as New Hampshire and neighboring areas. Each square of the matrix matches one monitor with another, organized in a pattern of row and columns allowing easy determination of other monitors in which it may correlate well. Darkening shade of blue and red are used to display increasing concentration pattern deviation of the pair of monitors based on correlation and average concentration differences, respectively. The darker the shading of blue, the worse the correlation (lower R); and the darker the shade of red, the greater the average mean concentration difference. The value inside the square represents the distance in kilometers between the sites. The squares along the diagonal (upper left corner down to the bottom right corner) show the most recent annual/24-hour $PM_{2.5}$ design values for that particular site.

This graphic output is meant to facilitate a visual assessment of which sites exhibit a unique role in the network and which may provide redundant information. Sites with a high correlation and low average relative difference compared to other sites may be redundant. Sites with a low correlation or high average relative difference may occupy a unique niche in the air quality landscape.

B.3.3.1. Correlation Matrix: $PM_{2.5}$

The correlation matrix was run for all $PM_{2.5}$ sites. The matrix for each case is shown in Figure B5 and Table B1 presents of all correlations and relative differences for $PM_{2.5}$ sites.

Using the correlation matrix in Figure B5 to look for potential redundancy entails minimizing the mean absolute difference (lighter shades of red) and maximizing correlation (lighter shades of blue). While the NCore site of Londonderry tracks relatively well with Chelmsford, MA, there are no ideal matches of this criteria. However, since the area served map for $PM_{2.5}$ in Figure B3 suggests considering Rumford, Maine to represent portions of Northern New Hampshire and the matrix below indicates a distinctiveness of its monitoring data (darker reds) from any New Hampshire monitor, this option will be considered in the NHDES follow-up analysis (section B.4. of this report).

Figure B5: Correlation Matrix for $PM_{2.5}$ Monitors in and near New Hampshire

	230172011 Rumford, ME	250095005 Haverhill, MA	250112005 Greenfield, MA	250170010 Chelmsford, MA	330012004 Laconia	330050007 Keene	330090010 Lebanon	330115001 Peterborough	330150014 Portsmouth	330150018 Londonderry
230172011 Rumford, ME	6.5/21	202	272	224	133	227	174	216	164	199
250095005 Haverhill, MA	976	5.2/13	123	24	94	97	136	64	44	25
250112005 Greenfield, MA	1003	994	5.9/16	105	139	45	116	65	159	103
250170010 Chelmsford, MA	185	189	196	NA/NA	107	86	139	54	69	28
330012004 Laconia	174	173	174	32	4.5/11	94	66	84	81	79
330050007 Keene	999	990	1023	192	174	6.4/18	78	33	125	73
330090010 Lebanon	1017	1007	1037	199	173	1038	6/15	92	140	114
330115001 Peterborough	1016	1007	1033	199	173	1035	1050	3.6/11	95	41
330150014 Portsmouth	963	960	979	184	168	982	997	999	5.4/14	57
330150018 Londonderry	885	892	918	202	174	902	923	912	863	5.1/12

Mean Absolute Difference (ug/m3): Inf, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0

Pearson Correlation (R): 1, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, 0.1, 0, -1

Values in lower triangle = # of obs used in correlation
Values in upper triangle = Distance in km between sites
Values along the diagonal = Most recent design values

Pollutant = PM2.5
Area of Interest = Custom
To save chart, right-click and select 'Save image as...'

Table B1 presents the same information as found in Figure B5 in a tabular format. Instead of identifying shades of blue and red, the table highlights $PM_{2.5}$ monitor pairs in shades of yellow when they show a higher degree of correlation (0.75) or a low relative difference (<2.0 µg/m^3). Darker orange is used for monitor pairings that have even higher correlations (>0.8) or relative difference of less than 1.5 µg/m^3. Monitor sites located outside of New Hampshire are shown in grey.

Table B1: NetAssess Calculated $PM_{2.5}$ Correlation and Mean Differences

$PM_{2.5}$ Site Pairs		Distance (km)	# Observations	Correlation (R)	Mean Difference (ug/m^3)
Site 1	Site 2				
Rumford, ME	Laconia, NH	133	174	0.4567	3.4609
Rumford, ME	Keene, NH	227	999	0.6407	2.8927
Rumford, ME	Lebanon, NH	174	1017	0.6212	2.7495
Rumford, ME	Peterborough, NH	216	1016	0.3941	3.6904
Rumford, ME	Portsmouth, NH	164	963	0.4775	3.1495
Rumford, ME	Londonderry, NH	199	885	0.5687	2.8624
Haverhill, MA	Laconia, NH	94	173	0.5995	1.9775
Haverhill, MA	Keene, NH	97	990	0.5087	2.8126
Haverhill, MA	Lebanon, NH	136	1007	0.6350	2.1213
Haverhill, MA	Peterborough, NH	64	1007	0.5941	2.3958
Haverhill, MA	Portsmouth, NH	44	960	0.7096	1.7517
Haverhill, MA	Londonderry, NH	25	892	0.7413	1.6863
Greenfield, MA	Laconia, NH	139	174	0.5922	2.2753
Greenfield, MA	Keene, NH	45	1023	0.7623	2.0553
Greenfield, MA	Lebanon, NH	116	1037	0.7376	2.0063
Greenfield, MA	Peterborough, NH	65	1033	0.5802	2.6257
Greenfield, MA	Portsmouth, NH	159	979	0.6050	2.3563
Greenfield, MA	Londonderry, NH	103	918	0.7659	1.8309
Chelmsford, MA	Laconia, NH	107	32	0.7338	3.1344
Chelmsford, MA	Keene, NH	86	192	0.6627	3.3250
Chelmsford, MA	Lebanon, NH	139	199	0.7773	2.0864
Chelmsford, MA	Peterborough, NH	54	199	0.7206	4.1859
Chelmsford, MA	Portsmouth, NH	69	184	0.7862	2.4505
Chelmsford, MA	Londonderry, NH	28	202	**0.852**	2.6332
Laconia, NH	Keene, NH	94	174	0.5101	2.8236
Laconia, NH	Lebanon, NH	66	173	0.7115	1.9087
Laconia, NH	Peterborough, NH	84	173	0.6910	1.5925
Laconia, NH	Portsmouth, NH	81	168	0.7094	1.7518
Laconia, NH	Londonderry, NH	79	174	0.7476	1.4253
Keene, NH	Lebanon, NH	78	1038	0.7181	2.2484
Keene, NH	Peterborough, NH	33	1035	0.4995	2.7664
Keene, NH	Portsmouth, NH	125	982	0.5193	2.7678
Keene, NH	Londonderry, NH	73	902	0.6499	2.2376
Lebanon, NH	Peterborough, NH	92	1050	0.5899	2.6547
Lebanon, NH	Portsmouth, NH	140	997	0.6653	2.0090
Lebanon, NH	Londonderry, NH	114	923	0.7792	1.6932
Peterborough, NH	Portsmouth, NH	95	999	0.6340	2.2662
Peterborough, NH	Londonderry, NH	41	912	0.7127	2.0185
Portsmouth, NH	Londonderry, NH	57	863	0.7714	1.5236

Solely considering New Hampshire sites, no $PM_{2.5}$ monitor pairs stand out with correlations greater than 0.8 and all mean differences are greater than 1.4 µg/m^3. There are two site pairs with a relative difference between 0.75 and 0.8: Lebanon-Londonderry and Portsmouth-Londonderry. The mean difference for these sites are 1.7 and 1.5 µg/m^3, respectively.

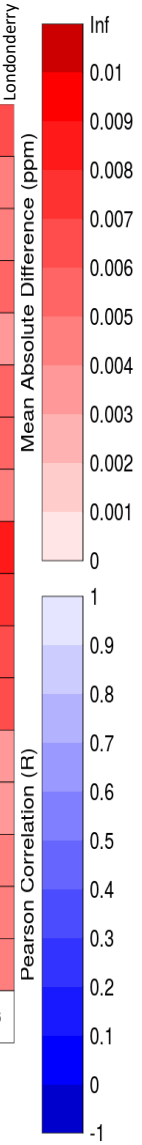
No pairing of $PM_{2.5}$ monitoring sites within New Hampshire demonstrate an extreme variation with other sites; most have moderate correlations and relative differences. The most distinct site pairs include Keene-Peterborough, with a correlation of 0.50 and relative difference of 2.8 µg/m^3, and Keene-Laconia, with a correlation of 0.51 and relative difference of 2.8 µg/m^3. The correlation matrix results suggest that most of the NHDES $PM_{2.5}$ monitoring sites are mostly distinct and share similar concentration patterns on some days and exhibit unique air quality conditions on other days.

B.3.3.2. Correlation Matrix: Ozone

The correlation matrix was run for all ozone sites. The matrix for each case is shown in Figure B6 and Table B2 presents all correlations and relative differences for $PM_{2.5}$ sites. Again, the matrix uses colors to aid the analysis where minimizing mean absolute difference uses lighter shades of red and maximizing correlation uses lighter shades of blue.

Figure B6: Correlation Matrix for Ozone Monitors in and near New Hampshire

	230173002 West Bethel, ME	230310040 Shapleigh, ME	250095005 Haverhill, MA	250112005 Greenfield, MA	250170009 EPA Region 1 Lab, MA	250170010 Chelmsford, MA	330012004 Laconia, NH	330050007 Keene, NH	330074001 Mt. Washington	330074002 Camp Dodge	330090010 Lebanon	330099991 Woodstock	330111011 Nashua	330115001 Peterborough	330131007 Concord	330150014 Portsmouth	330150016 Rye	330150018 Londonderry
230173002 West Bethel, ME	0.057	88	179	242	198	199	104	197	38	30	143	83	192	187	139	145	148	173
230310040 Shapleigh, ME	554	0.061	92	177	114	114	50	134	83	84	115	77	110	114	66	58	62	90
250095005 Haverhill, MA	676	655	0.064	123	27	24	94	97	167	171	136	139	35	64	60	44	44	25
250112005 Greenfield, MA	685	659	1049	0.066	101	105	139	45	212	219	116	165	89	65	111	159	161	103
250170009 EPA Region 1 Lab, MA	672	652	1012	1027	0.065	5	105	82	182	187	135	149	17	50	67	71	70	26
250170010 Chelmsford, MA	106	105	193	194	162		107	86	184	188	139	151	21	54	69	69	68	28
330012004 Laconia, NH	536	604	589	598	585	104	0.059	94	80	85	66	45	94	84	39	81	86	79
330050007 Keene, NH	679	661	1046	1059	1025	186	595	0.063	168	175	78	121	65	33	69	125	127	73
330074001 Mt. Washington	669	646	892	904	894	106	581	902	0.067	8	107	48	173	163	118	140	144	156
330074002 Camp Dodge	535	592	577	586	573	106	592	583	569	0.059	115	56	178	169	123	142	146	161
330090010 Lebanon	678	669	1047	1060	1024	195	603	1058	901	591	0.059	60	119	92	79	140	144	114
330099991 Woodstock	685	663	1045	1058	1022	196	600	1056	900	588	1057	0.056	137	121	82	123	128	123
330111011 Nashua	532	600	585	594	581	106	600	591	577	588	599	596	0.064	33	55	74	75	20
330115001 Peterborough	686	665	1050	1063	1029	194	600	1061	907	588	1062	1061	596	0.066	49	95	97	41
330131007 Concord	687	663	906	919	907	106	605	916	893	593	916	913	601	921	0.062	64	68	41
330150014 Portsmouth	689	667	1058	1071	1035	197	601	1069	911	589	1070	1068	597	1073	925	0.062	4	57
330150016 Rye	536	604	589	598	585	106	604	595	581	592	603	600	600	600	605	601	0.067	58
330150018 Londonderry	649	641	1013	1026	992	171	575	1031	867	563	1028	1024	571	1029	881	1035	575	0.066



Values in lower triangle = # of obs used in correlation
Values in upper triangle = Distance in km between sites
Values along the diagonal = Most recent design values

Pollutant = Ozone
Area of Interest = Custom
To save chart, right-click and select 'Save image as...'

Table B2 uses grey location titles to indicate monitoring location outside of New Hampshire, and shades of yellow and orange to represent monitors with a higher degree of correlation and low relative differences. Correlations greater than 0.75 and relative differences less than 0.01 part per million (ppm or 10 ppb) are yellow; correlations greater than 0.8 and relative differences less than 0.005 ppm (or 5 ppb) are light orange; correlations greater than 0.9 and relative differences less than 0.005 ppm are dark orange with bolded values.

Table B2: NetAssess Calculated Ozone Correlation and Mean Differences

Ozone Site Pairs		Distance (km)	Results		
Site 1	Site 2		# Observations	Correlation	Mean Difference (ppm)
West Bethel, ME	Laconia, NH	104	536	0.8884	0.0035
West Bethel, ME	Keene, NH	197	679	0.7318	0.0053
West Bethel, ME	Mt Washington, NH	38	669	0.5873	0.0114
West Bethel, ME	Camp Dodge, NH	30	535	**0.9246**	0.0029
West Bethel, ME	Lebanon, NH	143	678	0.8250	0.0044
West Bethel, ME	Woodstock, NH	83	685	**0.9177**	0.0035
West Bethel, ME	Nashua, NH	192	532	0.7441	0.0059
West Bethel, ME	Peterborough, NH	187	686	0.7169	0.0065
West Bethel, ME	Concord, NH	139	687	0.7912	0.0046
West Bethel, ME	Portsmouth, NH	145	689	0.7065	0.0055
West Bethel, ME	Rye, NH	148	536	0.6575	0.0070
West Bethel, ME	Londonderry, NH	173	649	0.7088	0.0064
Shapleigh, ME	Laconia, NH	50	604	**0.9298**	0.0031
Shapleigh, ME	Keene, NH	134	661	0.8546	0.0038
Shapleigh, ME	Mt Washington, NH	83	646	0.5927	0.0095
Shapleigh, ME	Camp Dodge, NH	84	592	0.8287	0.0047
Shapleigh, ME	Lebanon, NH	115	669	0.8747	0.0042
Shapleigh, ME	Woodstock, NH	77	663	0.8573	0.0052
Shapleigh, ME	Nashua, NH	110	600	0.8650	0.0039
Shapleigh, ME	Peterborough, NH	114	665	0.8382	0.0047
Shapleigh, ME	Concord, NH	66	663	**0.9244**	0.0026
Shapleigh, ME	Portsmouth, NH	58	667	0.8625	0.0037
Shapleigh, ME	Rye, NH	62	604	0.8013	0.0047
Shapleigh, ME	Londonderry, NH	90	641	0.8737	0.0045
Haverhill, MA	Laconia, NH	94	589	0.7960	0.0053
Haverhill, MA	Keene, NH	97	1046	0.8489	0.0042
Haverhill, MA	Mt Washington, NH	167	892	0.4720	0.0111
Haverhill, MA	Camp Dodge, NH	171	577	0.6379	0.0070
Haverhill, MA	Lebanon, NH	136	1047	0.7539	0.0056
Haverhill, MA	Woodstock, NH	139	1045	0.6284	0.0065
Haverhill, MA	Nashua, NH	35	585	0.8833	0.0038
Haverhill, MA	Peterborough, NH	64	1050	0.8147	0.0057
Haverhill, MA	Concord, NH	60	906	0.8856	0.0035
Haverhill, MA	Portsmouth, NH	44	1058	0.8657	0.0038
Haverhill, MA	Rye, NH	44	589	0.8590	0.0040
Haverhill, MA	Londonderry, NH	25	1013	**0.9040**	0.0044
Greenfield, MA	Laconia, NH	139	598	0.8090	0.0050
Greenfield, MA	Keene, NH	45	1059	**0.9305**	0.0029
Greenfield, MA	Mt Washington, NH	212	904	0.4834	0.0115
Greenfield, MA	Camp Dodge, NH	219	586	0.6690	0.0068
Greenfield, MA	Lebanon, NH	116	1060	0.8455	0.0043
Greenfield, MA	Woodstock, NH	165	1058	0.7079	0.0057
Greenfield, MA	Nashua, NH	89	594	0.8914	0.0039
Greenfield, MA	Peterborough, NH	65	1063	0.8268	0.0055
Greenfield, MA	Concord, NH	111	919	0.8771	0.0038
Greenfield, MA	Portsmouth, NH	159	1071	0.7465	0.0053
Greenfield, MA	Rye, NH	161	598	0.6835	0.0065
Greenfield, MA	Londonderry, NH	103	1026	0.8719	0.0050

Ozone Site Pairs		Distance (km)	Results		
Site 1	Site 2		# Observations	Correlation	Mean Difference (ppm)
EPA Region 1 Lab, MA	Laconia, NH	105	585	0.8009	0.0055
EPA Region 1 Lab, MA	Keene, NH	82	1025	0.8867	0.0037
EPA Region 1 Lab, MA	Mt Washington, NH	182	894	0.4668	0.0106
EPA Region 1 Lab, MA	Camp Dodge, NH	187	573	0.6266	0.0074
EPA Region 1 Lab, MA	Lebanon, NH	135	1024	0.8142	0.0050
EPA Region 1 Lab, MA	Woodstock, NH	149	1022	0.6801	0.0060
EPA Region 1 Lab, MA	Nashua, NH	17	581	**0.9425**	0.0028
EPA Region 1 Lab, MA	Peterborough, NH	50	1029	0.8685	0.0043
EPA Region 1 Lab, MA	Concord, NH	67	907	**0.9090**	0.0032
EPA Region 1 Lab, MA	Portsmouth, NH	71	1035	0.8459	0.0040
EPA Region 1 Lab, MA	Rye, NH	70	585	0.8029	0.0047
EPA Region 1 Lab, MA	Londonderry, NH	26	992	**0.9546**	0.0031
Chelmsford, MA	Laconia, NH	107	104	0.8321	0.0045
Chelmsford, MA	Keene, NH	86	186	0.8614	0.0037
Chelmsford, MA	Mt Washington, NH	184	106	0.4395	0.0132
Chelmsford, MA	Camp Dodge, NH	188	106	0.5968	0.0064
Chelmsford, MA	Lebanon, NH	139	195	0.7872	0.0049
Chelmsford, MA	Woodstock, NH	151	196	0.6695	0.0054
Chelmsford, MA	Nashua, NH	21	106	**0.9086**	0.0040
Chelmsford, MA	Peterborough, NH	54	194	0.7600	0.0078
Chelmsford, MA	Concord, NH	69	106	0.8637	0.0050
Chelmsford, MA	Portsmouth, NH	69	197	0.7673	0.0052
Chelmsford, MA	Rye, NH	68	106	0.7352	0.0097
Chelmsford, MA	Londonderry, NH	28	171	0.8977	0.0050
Laconia, NH	Keene, NH	94	595	0.8753	0.0039
Laconia, NH	Mt Washington, NH	80	581	0.6602	0.0103
Laconia, NH	Camp Dodge, NH	85	592	0.8820	0.0036
Laconia, NH	Lebanon, NH	66	603	**0.9137**	0.0033
Laconia, NH	Woodstock, NH	45	600	**0.9276**	0.0037
Laconia, NH	Nashua, NH	94	600	0.8856	0.0040
Laconia, NH	Peterborough, NH	84	600	0.8434	0.0057
Laconia, NH	Concord, NH	39	605	**0.9410**	0.0029
Laconia, NH	Portsmouth, NH	81	601	0.7832	0.0049
Laconia, NH	Rye, NH	86	604	0.7105	0.0061
Laconia, NH	Londonderry, NH	79	575	0.8614	0.0056
Keene, NH	Mt Washington, NH	168	902	0.5358	0.0110
Keene, NH	Camp Dodge, NH	175	583	0.7513	0.0057
Keene, NH	Lebanon, NH	78	1058	0.8917	0.0037
Keene, NH	Woodstock, NH	121	1056	0.7681	0.0051
Keene, NH	Nashua, NH	65	591	**0.9027**	0.0036
Keene, NH	Peterborough, NH	33	1061	0.8450	0.0052
Keene, NH	Concord, NH	69	916	**0.9199**	0.0029
Keene, NH	Portsmouth, NH	125	1069	0.8093	0.0045
Keene, NH	Rye, NH	127	595	0.7181	0.0058
Keene, NH	Londonderry, NH	73	1031	**0.9042**	0.0046
Mt Washington, NH	Camp Dodge, NH	8	569	0.6560	0.0114
Mt Washington, NH	Lebanon, NH	107	901	0.5691	0.0124
Mt Washington, NH	Woodstock, NH	48	900	0.5781	0.0131
Mt Washington, NH	Nashua, NH	173	577	0.5463	0.0095
Mt Washington, NH	Peterborough, NH	163	907	0.6030	0.0078
Mt Washington, NH	Concord, NH	118	893	0.5466	0.0107
Mt Washington, NH	Portsmouth, NH	140	911	0.4849	0.0110
Mt Washington, NH	Rye, NH	144	581	0.4883	0.0092
Mt Washington, NH	Londonderry, NH	156	867	0.5111	0.0088
Camp Dodge, NH	Lebanon, NH	115	591	0.8455	0.0042
Camp Dodge, NH	Woodstock, NH	56	588	**0.9207**	0.0034
Camp Dodge, NH	Nashua, NH	178	588	0.7209	0.0063

Ozone Site Pairs		Distance (km)	Results		
Site 1	Site 2		# Observations	Correlation	Mean Difference (ppm)
Camp Dodge, NH	Peterborough, NH	169	588	0.7170	0.0074
Camp Dodge, NH	Concord, NH	123	593	0.7897	0.0049
Camp Dodge, NH	Portsmouth, NH	142	589	0.6715	0.0062
Camp Dodge, NH	Rye, NH	146	592	0.6195	0.0074
Camp Dodge, NH	Londonderry, NH	161	563	0.6882	0.0074
Lebanon, NH	Woodstock, NH	60	1057	0.8617	0.0037
Lebanon, NH	Nashua, NH	119	599	0.8411	0.0052
Lebanon, NH	Peterborough, NH	92	1062	0.7933	0.0068
Lebanon, NH	Concord, NH	79	916	0.8924	0.0036
Lebanon, NH	Portsmouth, NH	140	1070	0.7781	0.0049
Lebanon, NH	Rye, NH	144	603	0.7046	0.0069
Lebanon, NH	Londonderry, NH	114	1028	0.8363	0.0062
Woodstock, NH	Nashua, NH	137	596	0.7875	0.0065
Woodstock, NH	Peterborough, NH	121	1061	0.7216	0.0071
Woodstock, NH	Concord, NH	82	913	0.8111	0.0047
Woodstock, NH	Portsmouth, NH	123	1068	0.6930	0.0055
Woodstock, NH	Rye, NH	128	600	0.6458	0.0081
Woodstock, NH	Londonderry, NH	123	1024	0.7375	0.0066
Nashua, NH	Peterborough, NH	33	596	0.8851	0.0042
Nashua, NH	Concord, NH	55	601	**0.9331**	0.0030
Nashua, NH	Portsmouth, NH	74	597	0.7998	0.0048
Nashua, NH	Rye, NH	75	600	0.7405	0.0056
Nashua, NH	Londonderry, NH	20	571	**0.9528**	0.0032
Peterborough, NH	Concord, NH	49	921	0.8634	0.0047
Peterborough, NH	Portsmouth, NH	95	1073	0.7902	0.0054
Peterborough, NH	Rye, NH	97	600	0.7306	0.0054
Peterborough, NH	Londonderry, NH	41	1029	0.8920	0.0032
Concord, NH	Portsmouth, NH	64	925	0.8407	0.0037
Concord, NH	Rye, NH	68	605	0.7549	0.0051
Concord, NH	Londonderry, NH	41	881	**0.9350**	0.0040
Portsmouth, NH	Rye, NH	4	601	**0.9561**	0.0028
Portsmouth, NH	Londonderry, NH	57	1035	0.8624	0.0046
Rye, NH	Londonderry, NH	58	575	0.7723	0.0049

High scoring ozone monitor pairings suggesting the greatest likelihood of redundancy due to high correlations (>0.9) and low relative differences (<0.005 ppm):

Out-of-State Pairings

1. West Bethel, ME - *Camp Dodge, NH*
2. West Bethel, ME - *Woodstock, NH*
3. Shapleigh, ME - Laconia, NH
4. Shapleigh, ME - Concord, NH
5. Haverhill, MA - Londonderry, NH
6. Greenfield, MA - Keene, NH
7. EPA Region 1 Lab, MA - Nashua, NH
8. EPA Region 1 Lab, MA - Concord, NH
9. EPA Region 1 Lab, MA - Londonderry, NH
10. Chelmsford, MA - Nashua, NH

In-State Pairings

11. Laconia, NH - Lebanon, NH
12. Laconia, NH - *Woodstock, NH*
13. Laconia, NH - Concord, NH
14. Keene, NH - Nashua, NH
15. Keene, NH - Concord, NH
16. Keene, NH - Londonderry, NH
17. *Camp Dodge, NH - Woodstock, NH*
18. Nashua, NH - Concord, NH
19. Nashua, NH - Londonderry, NH
20. Concord, NH - Londonderry, NH
21. Portsmouth, NH - Rye, NH

Of these 21 ozone monitor pairings, those that include Camp Dodge or Woodstock (numbers 1, 2, 12, and 17) are removed from potential elimination because they serve special purposes. Woodstock is an EPA CASTNET trends site and Camp Dodge represents a Class 1 airshed.

Of the remaining 17 pairs, Concord, Nashua and Londonderry each appear in five, and Keene in four. Concord is paired with Shapleigh, ME (41 miles away), EPA Region 1 Lab, MA (42 miles), Laconia (24 miles), Keene (43 miles), and Londonderry (25 miles). Nashua's paired sites include; Greenfield, MA (28 miles), EPA Region 1 Lab, MA (11 miles), Londonderry (12 miles), Concord (34 miles, Keene (43 miles)). Londonderry's distances to its paired sites are Haverhill, MA (16 miles), EPA Region 1 Lab, MA (16 miles), Keene (45 miles), Concord (25 miles) and Nashua (12 miles). Keene is paired with Concord, Nashua, and Londonderry as described above and with Greenfield, MA (28 miles). Other pairings include Laconia to Lebanon (41 miles) and Portsmouth to Rye (2.5 miles). Each of these pairing is investigated further in Section B.4.

New Hampshire ozone sites demonstrating clear distinction from other ozone monitors include Mount Washington summit, Miller State Park (Peterborough), Portsmouth, and Rye. Portsmouth and Rye only seem to track strongly with each other and are only 2.5 miles apart.

B.3.4. Removal Bias

Daily removal bias is determined by subtracting the actual concentration measured at a site from a calculated concentration interpolated from surrounding site data. A positive bias means the interpolated value is higher than the actual value; thus, the concentration at that location would be over predicted if the site were removed. Conversely, a negative bias means interpolation would under predict that location's concentration.

Removal bias maps and tables are provided below for $PM_{2.5}$ and ozone. NetAssess provides mean, minimum, and maximum in terms of percentage and $\mu g/m^3$ of all daily samples should a given monitor be removed, based on data from 2011-2013. The model calculates the difference between measured and interpolated concentrations for a potentially removed monitor (calculated for every day with data).

B.3.4.1. Removal Bias: $PM_{2.5}$

Three of the $PM_{2.5}$ sites in New Hampshire, Laconia, Keene, and Peterborough, are color coded a dark pink or blue in Figure B7, meaning the average removal bias is fairly large (positively or negatively, respectively). These darker colors suggest removing these sites would produce a significant over- or under estimate of the concentrations in these locations. The three remaining sites (Lebanon, Portsmouth, and Londonderry) are much lighter in color, and their data reveal average removal biases less than 0.5 $\mu g/m^3$: Table B3 provides the data in tabular format.

$PM_{2.5}$ measured at Lebanon has a slightly negative average removal bias of -0.10 $\mu g/m^3$, meaning this site's values would be slightly under predicted based on interpolation. The average bias for this site is the closest to zero of all six sites.

For Portsmouth, the average removal bias is slightly positive, 0.31 $\mu g/m^3$, so the location's values would be slightly over predicted based on interpolation. Portsmouth's minimum and maximum differences are -6.4 and 7.4 $\mu g/m^3$, respectively, which are similar to the minimum and maximum for Lebanon.

Figure B7: Mean Removal Biases for New Hampshire's PM2.5 Sites

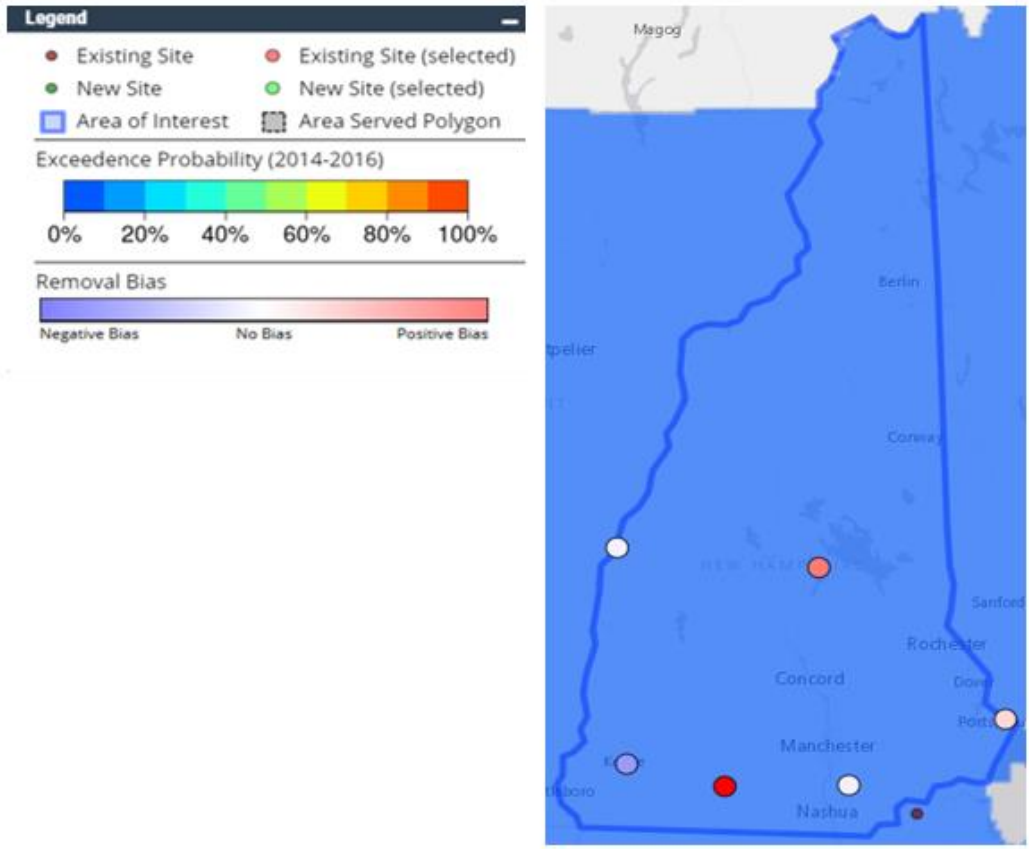


Table B3: NetAssess Calculated Removal Bias Results for $PM_{2.5}$

$PM_{2.5}$ Sites				Removal Bias (μg/m³)				Removal Bias (%)		
Site ID	Site Location	Neighbors Included	Daily Observations (#)	Mean	Min	Max	Standard Deviation	Mean	Min	Max
330012004	Laconia, NH	7	175	0.99	-8.5	7.6	1.66	41.7	-76	990
330050007	Keene, NH	7	1056	-0.76	-22.3	5.6	2.92	24.0	-82	2422
330090010	Lebanon, NH	5	1073	-0.10	-6.6	7.3	1.90	24.0	-86	5508
330115001	Peterborough, NH	7	1073	1.91	-6.5	15.3	2.54	115.5	-89	7144
330150014	Portsmouth, NH	6	1018	0.31	-6.4	7.4	1.74	20.6	-92	788
330150018	Londonderry, NH	5	934	-0.12	-5.6	11.6	1.65	4.7	-89	647

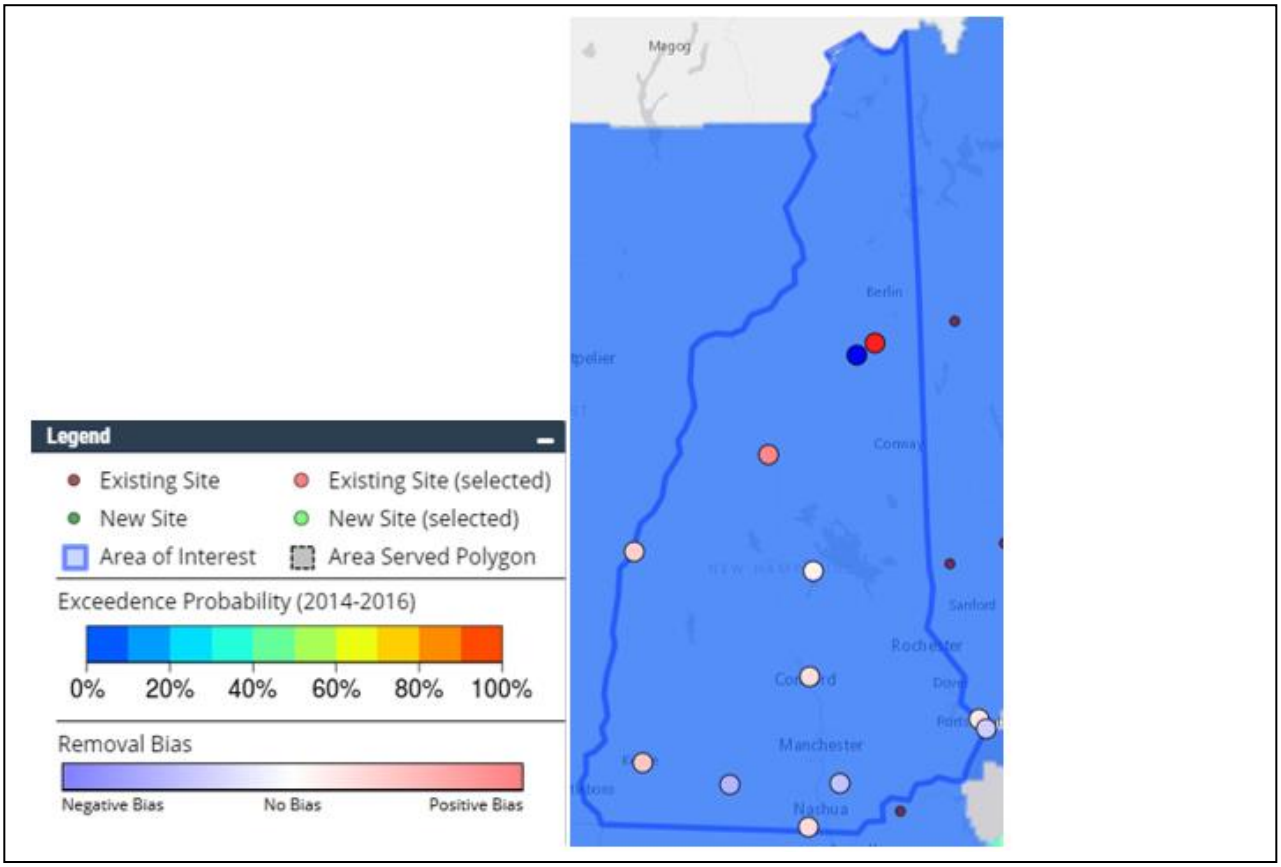
Londonderry $PM_{2.5}$ also has a slightly negative average bias, -0.12 μg/m³. Its minimum is similar to Lebanon, only -5.6 μg/m³, but its maximum is much higher at 11.6 μg/m³. Londonderry's standard deviation is 2.25 μg/m³. These variations are large enough to potentially make a significant difference when concentrations approach national standards or the thresholds of the air quality index.

The goal of the removal bias is to help assess the consequences of removing a site suspected to be redundant based on other tools, such as the correlation matrix. Lebanon-Londonderry and Portsmouth-Londonderry were the only site pairs to have correlations greater than 0.75 and their average differences are 1.69 and 1.52 μg/m³, respectively. This suggests that, despite their removal biases, these sites provide unique datasets within the network. Also, Portsmouth is the only $PM_{2.5}$ site on the New Hampshire seacoast, representing a fairly large population area.

B.3.4.2. Removal Bias: Ozone

In contrast to $PM_{2.5}$, many of the ozone monitoring sites in New Hampshire are color coded a very light pink or blue in the results map (Figure B8). Exceptions to this are the Mt. Washington summit and Camp Dodge sites in the north and this is not surprising given the extreme elevation of Mt. Washington (dark blue) compared to the remote Camp Dodge (dark red) site at its base. The lightest colored sites are in the southern half of the state, which is also the most populated and most at risk of exceeding the current or a future ozone standard. The mean removal bias for all of the sites range from -0.001 to 0.005 ppm, with the exception of Mt. Washington and Camp Dodge which have mean removal biases of -0.12 and 0.01 ppm, respectively. Tabulated results are located in Table B4.

Figure B8: Mean Removal Biases for New Hampshire's Ozone Sites



Of the sites operated by NHDES (excludes Woodstock) and not including the high elevations (Mt. Washington and Peterborough) or a Class 1 area (Camp Dodge), Portsmouth and Lebanon have the largest differences between their minimums and maximums. These two ozone monitors also appeared only once in the site pairs identified by the correlation matrix in section B.3.3.2, and therefore suggesting that they are both considered more unique compared to other locations.

Ozone measured at Concord and Nashua have low average relative differences and good correlations with several other sites, however, they both have relatively high maximum removal biases and larger standard deviations. The removal bias tool suggests that removal of either site would result in a minimum positive bias, where interpolation would most often over estimate concentrations, and sometimes under estimate by less 0.010 ppm. The overestimates, however, could be fairly significant.

Table B4: NetAssess Calculated Removal Bias Results for Ozone

Ozone Sites				Removal Bias (ppm)				Removal Bias (%)		
Site ID	Site Location	Neighbors Included	Daily (#) Observations	Mean	Min	Max	Standard Deviation	Mean	Min	Max
330012004	Laconia	5	606	0.001	-0.009	0.008	0.0023	2.7	-20	44
330050007	Keene	6	1075	0.003	-0.008	0.021	0.0037	11.2	-19	347
330074001	Mt. Washington	5	914	-0.012	-0.042	0.005	0.0081	-24.5	-79	34
330074002	Camp Dodge	4	594	0.010	-0.006	0.039	0.0081	35.6	-22	236
330090010	Lebanon	7	1076	0.002	-0.012	0.021	0.0034	10.9	-35	615
330099991	Woodstock	4	1074	0.005	-0.012	0.031	0.0055	21.3	-50	457
330111011	Nashua	5	602	0.002	-0.007	0.016	0.0031	5.4	-16	55
330115001	Peterborough	7	1079	-0.003	-0.027	0.007	0.0043	-8.8	-67	18
330131007	Concord	6	931	0.002	-0.010	0.018	0.0030	6.4	-28	153
330150014	Portsmouth	6	1087	0.001	-0.016	0.022	0.0038	3.7	-49	69
330150016	Rye	5	606	-0.002	-0.022	0.009	0.0029	-5.7	-30	33
330150018	Londonderry	7	1041	-0.003	-0.015	0.009	0.0024	-7.3	-42	65

B.4. NHDES Follow-up Analyses

NHDES uses NetAssess as a screening tool to help identify potentially redundant monitoring, or places where gaps in the network might exist. As part of an enhanced analysis, NHDES considers factors beyond the capabilities of Net Assess, including: topography, population centers, sensitive populations, strategic research and analysis needs, areas of current and/or historical high pollution areas, nonattainment and maintenance needs, state regulation or legislation requirements, and federal requirements. NHDES also considers more recent monitoring data than NetAssess currently contains.

B.4.1. $PM_{2.5}$ Monitors

NetAssess did not strongly flag any $PM_{2.5}$ monitoring stations in New Hampshire for potential removal, however statistics for two pairings were suggestive enough to explore further. These include: Londonderry – Lebanon and Londonderry – Portsmouth. To investigate further, daily maximum 24-hour $PM_{2.5}$ average relative differences for more recent years (2015 through 2019) were calculated and are shown in Table B5. In addition, scatter plots of this more recent data were also prepared showing all data (blue) and data where at least one site had a 24-hr average above 10 µg/m^3 (purple). Relative differences and scatter plots were only calculated when both sites had valid daily maximum 24-hour concentrations, which are presented and discussed below.

Table B5 shows the average relative differences between $PM_{2.5}$ monitoring stations in New Hampshire. Keene was excluded in this analysis for potential removal because of its importance for tracking wood smoke. Of the four stations remaining, Miller State Park (Peterborough) is distinctively lower than the others due to its elevation. Nonetheless, this monitor is important for tracking $PM_{2.5}$ concentrations at “transport elevation” and is required as part of the NCORE network. The $PM_{2.5}$ monitors that appear to have the lowest average relative difference are Portsmouth and Lebanon, which are at opposite sides of the state. This pairing will be added as a third set for analysis in this section of the report. It should be noted that $PM_{2.5}$ concentration trends show a steady decline across the state. Data for 2019 shows that $PM_{2.5}$ concentrations at Lebanon are emerging as one of the highest in the state by decreasing more slowly than other portions of the state.

Table B5: Average Relative $PM_{2.5}$ Differences (2015-2019) (µg/m³)

(Black - Blue)	Lebanon	Londonderry	Portsmouth	Miller
Lebanon	0	0.6	0.2	-0.8
Londonderry	-0.6	0	-0.5	-1.3
Portsmouth	-0.2	0.5	0	-0.9
Miller	0.8	1.3	0.9	0

Beyond average relative differences, NHDES performed daily $PM_{2.5}$ concentration correlation analyses for monitor pairs.

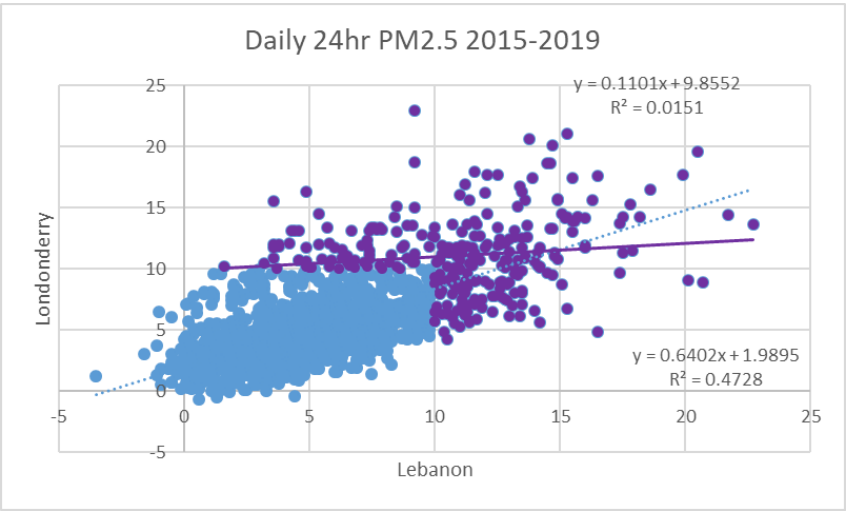
Londonderry – Lebanon

The NetAssess calculated removal bias for Londonderry was significantly lower than that for Lebanon, so the consideration here would be the potential removal of Londonderry and depending largely on data measured at Lebanon in its place. Concentrations of $PM_{2.5}$ at both locations get high enough to be of interest for population exposure tracking, thus reliable data covering both locations are strongly desired. Londonderry and Lebanon are 71 miles apart.

Recent monitoring data for the two locations indicate a reasonably strong correlation where 24-hour average concentrations rarely exceed 20 µg/m³, and neither site is at a large risk for $PM_{2.5}$ exceedances or violations for the NAAQS (Figure B9). Updated data show a fairly scattered pattern (R^2=0.47), especially at higher concentrations, indicating that the best correlation takes place at lower concentrations, which could be dominated by background levels. The pattern of higher concentration data suggests that Lebanon really should not replace Londonderry since they do not show a strong tendency to increase together in any reliable pattern. Further, the data suggest that Londonderry be the site removed, but Londonderry is an NCORE site where $PM_{2.5}$ monitoring is required.

The best way for Lebanon to be considered for $PM_{2.5}$ monitoring shutdown would be to demonstrate strong data correlation with the Laconia site, but Laconia only has partial data to work with and has not settled on a permanent location.

Figure B9: Updated $PM_{2.5}$ Monitoring at Lebanon and Londonderry (2015-2019)



Note: Purple data points indicate that at least one site had a 24-hr average above 10 µg/m³.

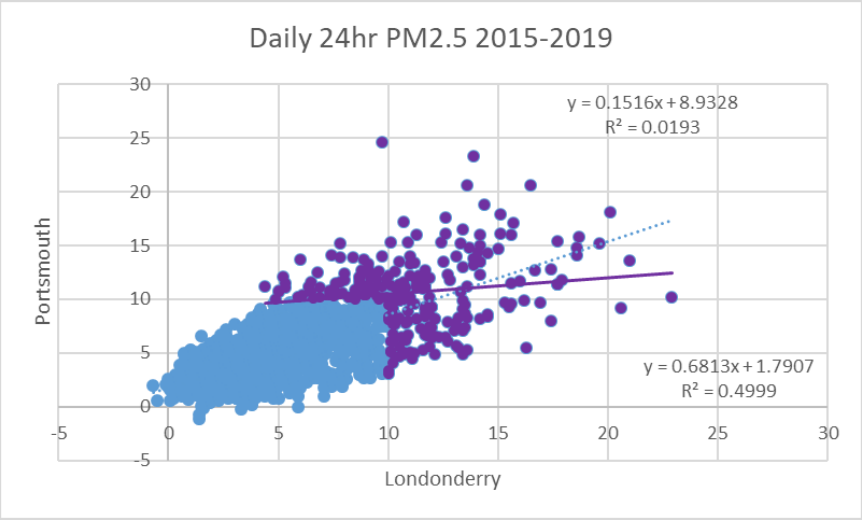
Londonderry – Portsmouth

This is another pairing of monitors that both had relatively low removal biases in the NetAssess analysis. Both monitors infrequently exceed 20 µg/m^3 for 24-hour averages with updated monitoring data (Figure B10) and have reasonably low average relative concentration differences. Londonderry and Portsmouth are 35 miles apart and share the southeast corner of the state. Both Londonderry and Portsmouth have strong populations within their area of representation, and because $PM_{2.5}$ concentrations are high enough that having high quality monitoring data is important to represent their respective populations for health impact tracking. Based on updated monitoring data, neither site is at large risk for $PM_{2.5}$ exceedances or violations for the NAAQS and again show a tendency for elevated concentrations to occur on different days.

Londonderry is located inland in rolling farm and suburban neighborhoods and Portsmouth is located near the Atlantic Ocean and directly adjacent to the Piscataqua River. Wind patterns at the Portsmouth monitor are heavily influenced by air flow up and down the river. As such, there may be low commonality of emission sources in the vicinity of each monitor.

The removal bias for Londonderry was lower than that for Portsmouth, suggesting that Londonderry be considered for shutdown, but as stated before, Londonderry is a NCORE site and $PM_{2.5}$ monitoring is required. Similar to the Londonderry – Lebanon pairing, the Londonderry – Portsmouth pairing shows a low correlation (R^2=0.50) with a larger scatter pattern at higher concentrations when it is most important.

Figure B10: Updated $PM_{2.5}$ Monitoring at Londonderry and Portsmouth (2015-2019)



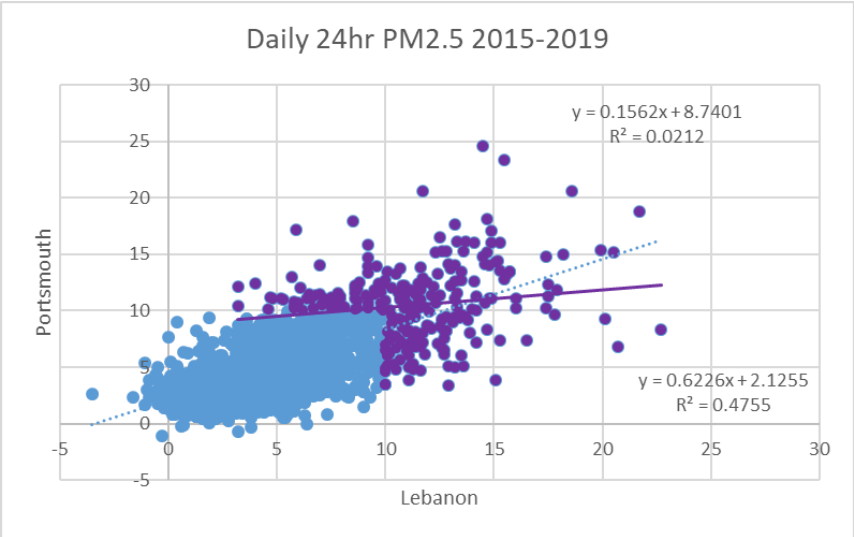
Note: Purple data points indicate that at least one site had a 24-hr average above 10 µg/m^3.

Lebanon – Portsmouth

This pairing of monitors both had a higher degree of removal bias and average relative concentration difference, but had a stronger average concentration difference score with updated data. Lebanon and Portsmouth are 87 miles apart and are geographically distinct with Portsmouth located in the relatively flat coastal plain and Lebanon in a hilly mountain valley area.

While the average concentration difference is favorable, Lebanon – Portsmouth correlation analysis with updated monitoring data is a weak (R^2) 0.47 and shows a wide scatter of data at higher concentrations (Figure B11).

Figure B11: Updated $PM_{2.5}$ Monitoring at Lebanon and Portsmouth (2015-2019)



Note: Purple data points indicate that at least one site had a 24-hr average above 10 µg/m³.

Monitor Representation Addition

The NetAssess Area Served tool identified the possibility of using data for Rumford, Maine, to represent a portion of northern-most New Hampshire, which does not have a nearby in-state $PM_{2.5}$ monitor. NHDES intends to look more closely at this option and will compare data from the NHDES mobile $PM_{2.5}$ monitoring study to Rumford data. In addition, the demographics and topography will be compared, and if there is sufficient similarity, NHDES will consider using Rumford data to represent population exposure in northern New Hampshire.

B.4.2. Ozone Monitors

Based on the NetAssess ozone correlation matrix and relative bias results, Concord, Laconia, Nashua Portsmouth, and Rye may be redundant with nearby sites. To investigate further, daily maximum 8-hour ozone average relative differences for more recent years (2015 through 2019) were calculated and shown in Table B6. In addition, scatter plots of this more recent data were also prepared showing all data (blue) and data where at least one monitoring site had an 8-hr average above 50 ppb (purple). Relative differences and scatter pots were only calculated when both sites had valid daily maximum 8-hour concentrations. Only days with at least 18 valid eight-hour averages (75% completeness) were included in these plots, which are presented and discussed below.

Table B6: Average Relative Ozone Differences (2015-2019) (ppb)

(Black - Blue)	Camp Dodge	Concord	Keene	Laconia	Lebanon	Londonderry	Nashua	Portsmouth	Rye	Woodstock
Camp Dodge	0	3.1	2.8	1.2	-0.1	6.1	8.2	2.6	5.5	-2.2
Concord	-3.1	0	-0.3	-1.9	-3.2	3.1	5.1	-0.4	2.5	-5.3
Keene	-2.8	0.3	0	-1.6	-2.9	3.3	5.5	-0.1	2.8	-5.0
Laconia	-1.2	1.9	1.6	0	-1.3	4.9	7.0	1.5	4.4	-3.4
Lebanon	0.1	3.2	2.9	1.3	0	6.2	8.3	2.8	5.7	-2.2
Londonderry	-6.1	-3.1	-3.3	-4.9	-6.2	0	2.2	-3.5	-0.7	-8.4
Nashua	-8.2	-5.1	-5.5	-7.0	-8.3	-2.2	0	-5.6	-2.7	-10.5
Portsmouth	-2.6	0.4	0.1	-1.5	-2.8	3.5	5.6	0	2.9	-4.9
Rye	-5.5	-2.5	-2.8	-4.4	-5.7	0.7	2.7	-2.9	0	-7.8
Woodstock	2.2	5.3	5.0	3.4	2.2	8.4	10.5	4.9	7.8	0

(Black - Blue)	Camp Dodge	Concord	Keene	Laconia	Lebanon	Londonderry	Nashua	Portsmouth	Rye	Woodstock	Miller	Mt Washington
Miller	-11.1	-8.0	-8.3	-9.9	-11.2	-5.0	-2.8	-8.4	-5.5	-13.3	0	4.8
Mt Washington	-16.5	-13.0	-13.3	-15.0	-16.2	-9.8	-7.8	-13.1	-10.4	-18.6	-4.8	0

Lowest recalculated relative differences with updated data (Table B6) were found for Concord – Keene, Lebanon – Camp Dodge, Concord – Portsmouth, Keene – Portsmouth, and Londonderry – Rye. Because Camp Dodge represents a Class 1 area and Keene and Londonderry had large removal bias, those pairings are being removed, leaving Concord – Portsmouth to be added to the original list of sites for additional analysis.

NetAssess calculations identified several potential pairings of ozone monitors to study further. Starting with this list of high scoring ozone monitor pairings that have high correlations (>0.9) and low relative differences (<0.005 ppm), a refined list can be prepared. This includes removing monitors that showed fairly large removal biases; Keene, Lebanon, and Londonderry:

Out-of-State Pairings

1. Shapleigh, ME - Laconia, NH
2. Shapleigh, ME - Concord, NH
3. EPA Region 1 Lab, MA - Nashua, NH
4. EPA Region 1 Lab, MA - Concord, NH
5. Chelmsford, MA - Nashua, NH

In-State Pairings

6. Concord - Portsmouth
7. Laconia - Concord
8. Nashua - Concord
9. Portsmouth- Rye

Based on these pairings, the most likely sites to be discontinued in New Hampshire include:

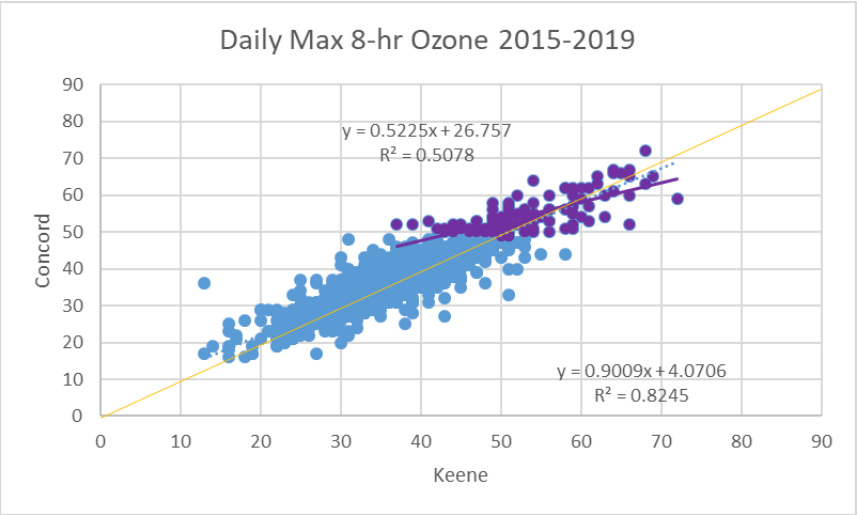
- Nashua (to be represented by Concord, Londonderry, Chelmsford, MA, or EPA Region 1 Lab),
- Concord (to be represented by Keene, Laconia, Lebanon, Londonderry, Nashua, or Portsmouth),
- Laconia (to be represented by Concord, Lebanon, Woodstock, or Shapleigh, ME),
- Portsmouth (to be represented by Concord or Rye), and
- Rye (to be represented by Portsmouth)

Concord – Keene/Laconia/Lebanon/Londonderry/Nashua/Portsmouth

The Concord ozone monitoring station appears on the potential duplication list more often than any other New Hampshire location. NetAssess and Table B6 suggest that it could be replaced with any of six other New Hampshire monitoring stations; Keene, Laconia, Lebanon, Londonderry, Nashua, and Portsmouth. Scatter plots with updated monitoring data for each of these pairings are included below. In summary of Figures B12 through B17:

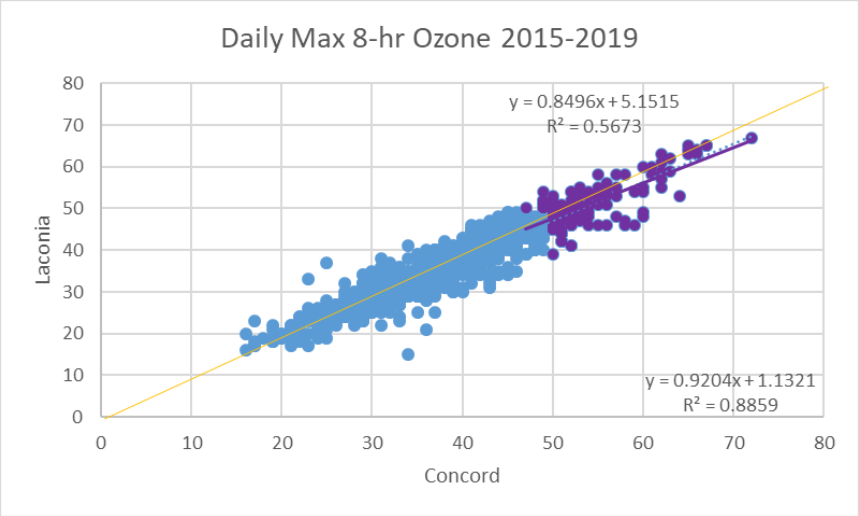
B12	Concord	Keene	43 miles	R^2=0.82	Small scatter at higher concentrations
B13	Concord	Laconia	24 miles	R^2=0.89	Little scatter at higher concentrations
B14	Concord	Lebanon	49 miles	R^2=0.79	Some scatter at higher concentrations
B15	Concord	Londonderry	25 miles	R^2=0.86	Little scatter at higher concentrations
B16	Concord	Nashua	40 miles	R^2=0.77	More scatter at higher concentrations
B17	Concord	Portsmouth	34 miles	R^2=0.64	More scatter at higher concentrations

Figure B12: Updated Ozone Monitoring at Concord and Keene (2015-2019)



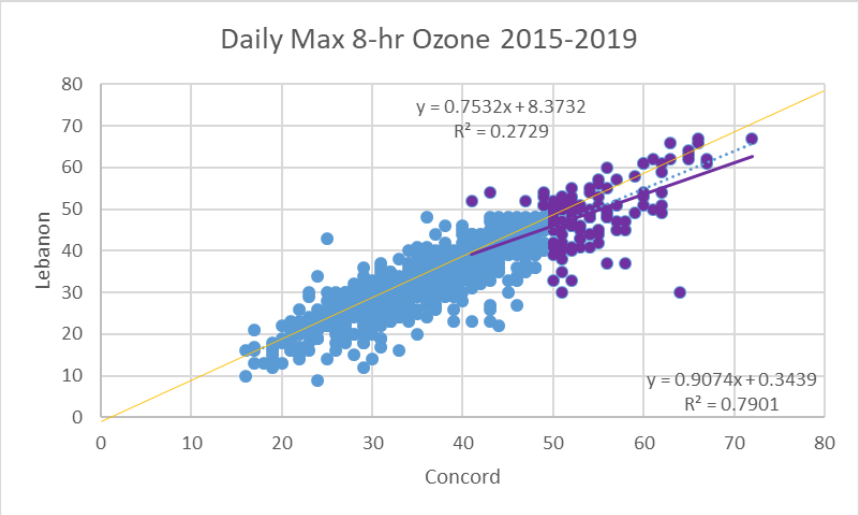
Note: Purple data points indicate that at least one site had a maximum daily 8-hr average above 50 ppb.

Figure B13: Updated Ozone Monitoring at Concord and Laconia (2015-2019)



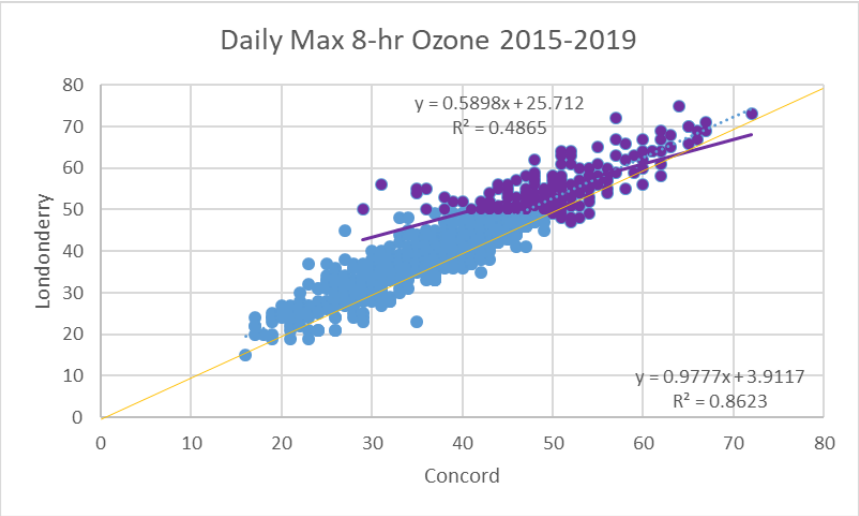
Note: Purple data points indicate that at least one site had a maximum daily 8-hr average above 50 ppb.

Figure B14: Updated Ozone Monitoring at Concord and Lebanon (2015-2019)



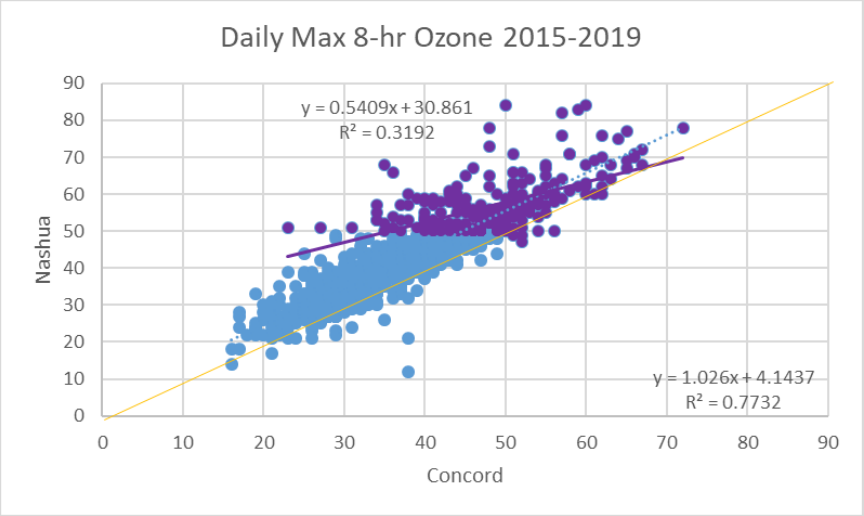
Note: Purple data points indicate that at least one site had a maximum daily 8-hr average above 50 ppb.

Figure B15: Updated Ozone Monitoring at Concord and Londonderry (2015-2019)



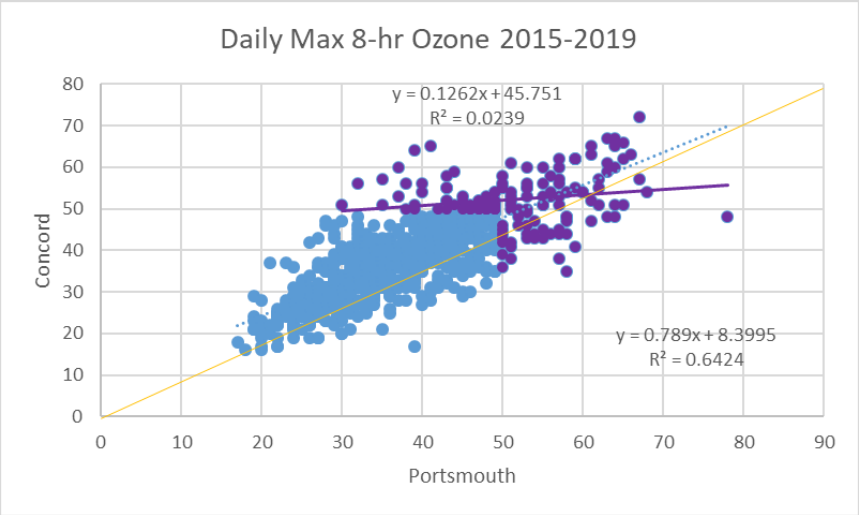
Note: Purple data points indicate that at least one site had a maximum daily 8-hr average above 50 ppb.

Figure B16: Updated Ozone Monitoring at Concord and Nashua (2015-2019)



Note: Purple data points indicate that at least one site had a maximum daily 8-hr average above 50 ppb.

Figure B17: Updated Ozone Monitoring at Concord and Portsmouth (2015-2019)



Note: Purple data points indicate that at least one site had a maximum daily 8-hr average above 50 ppb.

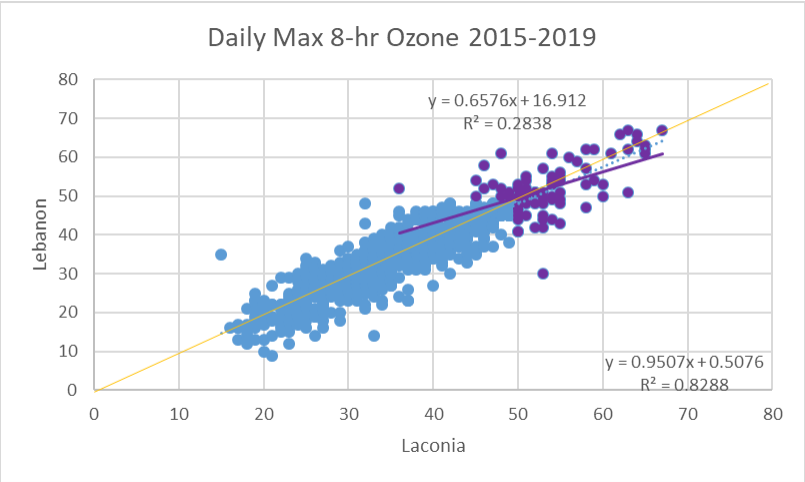
Based on this analysis, if Concord were to be removed from the NHDES ozone monitoring network, it could be best represented by monitoring at Laconia or Londonderry. NetAssess suggested another option to be Shapleigh, ME, but at 41 miles, there are closer in-state options.

<u>Laconia – Lebanon/Woodstock</u>

The Laconia ozone monitoring station appears on the potential duplication list three times, paired with Concord, Lebanon, and Woodstock as potential representative monitors. Scatter plots with updated monitoring data for each of these pairings are included in Figures B13, B18 and B19:

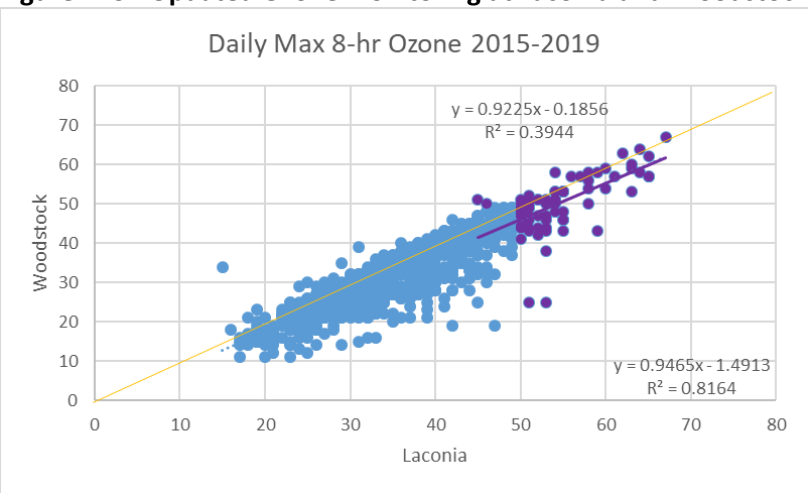
B13	Laconia	Concord	24 miles	R^2=0.89	Little scatter at higher concentrations
B18	Laconia	Lebanon	41 miles	R^2=0.83	Some scatter at higher concentrations
B19	Laconia	Woodstock	28 miles	R^2=0.82	Some scatter at higher concentrations

Figure B18: Updated Ozone Monitoring at Laconia and Lebanon (2015-2019)



Note: Purple data points indicate that at least one site had a maximum daily 8-hr average above 50 ppb.

Figure B19: Updated Ozone Monitoring at Laconia and Woodstock (2015-2019)



Note: Purple data points indicate that at least one site had a maximum daily 8-hr average above 50 ppb.

Both Concord and Woodstock are located relatively close to the Laconia monitoring station, but Concord data correlates most reliably with data at Laconia. Woodstock has some tendency to have lower ozone than Laconia. Based on this analysis, if Laconia were to be removed from the NHDES ozone monitoring network, it would be best represented by monitoring at Concord. NetAssess suggested another option to be Shapleigh, ME, but at 31 miles, there are closer in-state options including Concord at 24 miles.

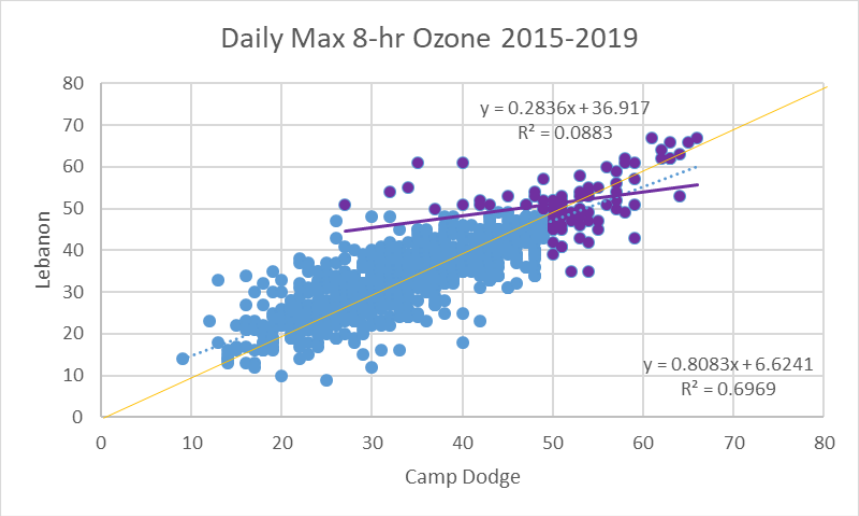
Lebanon – Camp Dodge

Lebanon was not identified by NetAssess as a location for downsizing, but there has been interest in further evaluating the value of the location in the monitoring network. It was reviewed for $PM_{2.5}$ above and the only other pollutant monitored at the location is ozone. The location is remote in the network and has never recorded an ozone exceedance.

The Lebanon ozone monitoring station potentially pairs well with Concord, Lebanon, and Camp Dodge as potential representative monitors. Scatter plots with updated monitoring data for each of these pairings are included in Figures B14, B18 and B20:

B14	Lebanon	Concord	49 miles	R^2=0.79	Some scatter at higher concentrations
B18	Lebanon	Laconia	41 miles	R^2=0.83	Some scatter at higher concentrations
B20	Lebanon	Camp Dodge	71 miles	R^2=0.70	Some scatter at higher concentrations

Figure B20: Updated Ozone Monitoring at Lebanon and Camp Dodge (2015-2019)



Note: Purple data points indicate that at least one site had a maximum daily 8-hr average above 50 ppb.

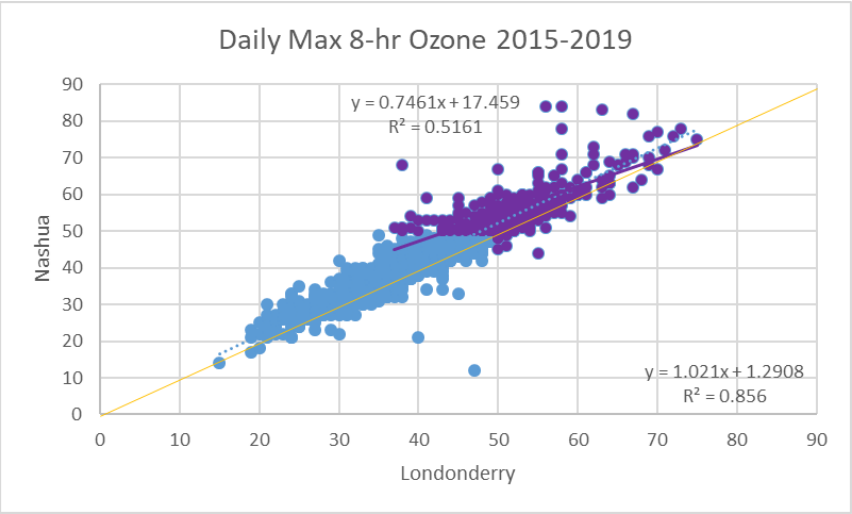
Based on this analysis, none of the paired monitors show as strong a correlation as some other options in the network. If Lebanon were to be removed from the NHDES ozone monitoring network, it would be best represented by monitoring at Laconia.

Nashua – Londonderry

The closest site to Nashua is 12 miles away at Londonderry. NetAssess suggests that Nashua could be replaced with either Londonderry or Concord, but analysis with updated data demonstrates that Concord is not as strong a candidate as Londonderry. Nashua has a record as a high ozone monitor in New Hampshire and it demonstrates several periods where ozone concentrations exceed 70 ppb at Nashua but not at Londonderry. Scatter plots with updated monitoring data for each of these pairings are included in Figures B16 and B21:

B16	Nashua	Concord	40 miles	R^2=0.77	More scatter at higher concentrations
B21	Nashua	Londonderry	12 miles	R^2=0.86	More scatter at higher concentrations

Figure B21: Updated Ozone Monitoring at Londonderry and Nashua (2015-2019)



Note: Purple data points indicate that at least one site had a maximum daily 8-hr average above 50 ppb.

Despite the close proximity to other monitors, it is not recommended that Nashua be replaced in the NHDES monitoring network. While options exist for replacing Nashua in favor of data from Chelmsford or EPA Region 1 Lab in Massachusetts, NHDES prefers to maintain Nashua for in-state representation of potential ozone exceedances. When Nashua routinely avoids ozone NAAQS exceedances, this option can be reevaluated.

Portsmouth - Rye

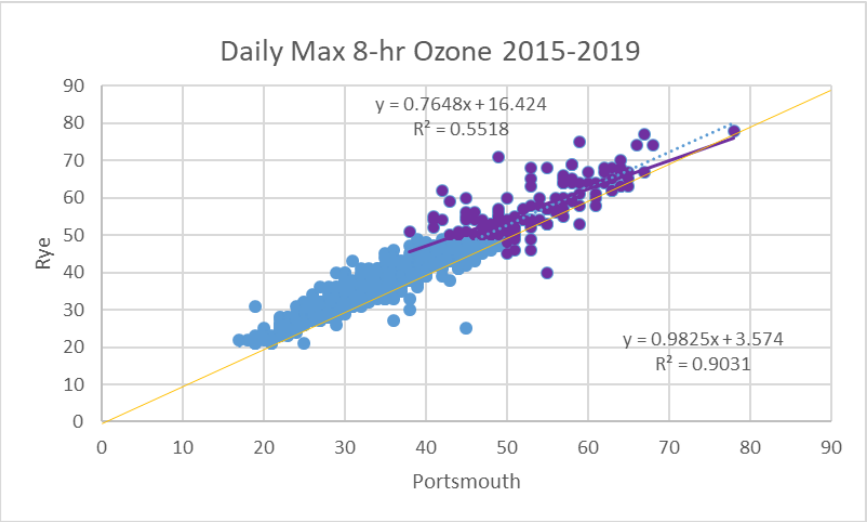
These two coastal sites are only 2.5 miles apart and are located in a highly populated region with some of the highest risk of ozone exceedances in the state. Compared to the correlation between Portsmouth and Rye, the pairing of Portsmouth with Concord is much weaker.

Figure B22 shows that Portsmouth and Rye ozone data tracks well with the 1:1 line, except at concentrations above 0.065 ppm where higher ozone concentrations tend to occur at Rye. Rye has a history of being a high ozone location due to its location along the seacoast downwind of the Boston Metropolitan area. Ozone and its precursor emissions concentrate over the ocean water where mixing heights are reduced, and receives stronger ultraviolet sunlight exposure due to reflection from the water surface. Under certain favorable conditions, a sea breeze can pull high ozone concentrations on-shore along the coastline. The Portsmouth monitor and its greater population, even though just a short distance away, does not experience the sea breeze and its ozone plume. As a result, more ozone exceedances occur at Rye.

Scatter plots with updated monitoring data for each of these pairings are included in Figures B17 and B22:

B17	Portsmouth	Concord	34 miles	R^2=0.64	More scatter at higher concentrations
B22	Portsmouth	Rye	2.5 miles	R^2=0.90	Some scatter at higher concentrations

Figure B22: Updated Ozone Monitoring at Portsmouth and Rye (2015-2019)



Note: Purple data points indicate that at least one site had a maximum daily 8-hr average above 50 ppb.

Despite being only 2.5 miles apart, NHDES does not currently recommended removing either Portsmouth or Rye from its monitoring network.

B.5. Conclusion

$PM_{2.5}$

The NHDES $PM_{2.5}$ monitoring network includes two required locations at Londonderry and Miller State Park (Peterborough). It also includes Keene which has a track record of recording high wood smoke concentrations and is very important to the network. Of the remaining locations (Lebanon, Laconia, and Portsmouth), none demonstrate reliable correlations with other network monitors at higher concentrations. While $PM_{2.5}$ concentrations are declining in New Hampshire, NHDES is still fine tuning its ability to reliably monitor wood smoke concentrations in the state during colder months of the year. Further, the health impacts of $PM_{2.5}$ are significant, even at concentrations well below the NAAQS, thus $PM_{2.5}$ monitoring data remains vital to the NHDES mission of public protection.

NHDES will further examine using Rumford, Maine to represent northernmost New Hampshire rather than an in-state $PM_{2.5}$ monitor and will work with EPA to implement any potential changes.

Ozone

Because New Hampshire has a long track record of measuring ozone exceedances throughout the state, NHDES has a relatively robust ozone monitoring network. As concentrations continue to decline and the likelihood of exceedances becomes further removed, options for thinning the ozone monitoring network could be pursued more aggressively.

The New Hampshire ozone monitoring network has two locations with distinctively lower concentrations than the rest of the network, Camp Dodge and Woodstock. Camp Dodge represents a Class I airshed and Woodstock is part of EPA's CASTNET trends network, thus neither is currently a candidate for removal, and neither is capable of representing another NHDES ozone monitor. This ozone network analysis identifies some other options for thinning the ozone network including Concord or Laconia. Of these two, Concord is a single parameter monitoring location and would make the most sense for removal. Lebanon, Portsmouth and Rye were also examined and each still have their place in the network due to either the uniqueness of its ozone patterns or the potential for ozone exceedances. Should concentrations at these monitors continue to decline relative to the National Ambient Air Quality Standard, the uniqueness of each monitor will blend into background levels, becoming less important.

Options for using non-New Hampshire ozone monitors will not be pursued at this time because either there is a closer in-state option, or because of the importance of monitoring ozone exceedances within the state, rather than relying on an out-of-state monitor. NHDES will work with EPA to implement any potential changes to the ozone monitoring network and how they represent the geographic regions of New Hampshire.