THE NEW HAMPSHIRE
AMBIENT AIR MONITORING PROGRAM
2015/2016 ANNUAL
NETWORK REVIEW, PLAN and
5 YEAR ASSESSMENT

July 2015

New Hampshire Department of Environmental Services

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

R-ARD-15-2

THE NEW HAMPSHIRE AMBIENT AIR MONITORING PROGRAM 2015/2016 ANNUAL NETWORK REVIEW, PLAN and 5 YEAR ASSESSMENT

prepared by the
Air Monitoring Program

Thomas S. Burack, Commissioner
H. Keith DuBois, Acting Assistant Commissioner
Craig Wright, Air Resources Division Director

State of New Hampshire
Department of Environmental Services
Air Resources Division
29 Hazen Drive
Concord, NH 033020095
(603) 271-3503
www.des.nh.gov

Table of Contents

List of Tables

List of Figures

Introduction

The New Hampshire Department of Environmental Services (NHDES) is pleased to submit this 2015/2016 Ambient Air Monitoring Program Annual Network Review, 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 and Part 3 is NHDES' 5 Year Air Monitoring Assessment.

PART 1 – 2015/2016 Annual Network Review and Plan

NHDES continually revisits and stresses basic air monitoring fundamentals and efficiency initiatives to allow for reliable, high quality data capture and analysis within a strained 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 1.1),
- guide future air quality policy decisions at the state and national level, and
- protect public health through forecasting and real-time mapping and air pollution alert initiatives.

Tables 1.8 through 1.11, presented later in this section summarize the current status of the New Hampshire ambient air monitoring network – July 2014 through June 2015.

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 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 ten 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. Most 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 EPA 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 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 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 2015, 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 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.

Pollutants of most concern in this area include ozone, ozone precursors (nitrogen oxides (NOx) and VOCs), $PM_{2.5}$ and SO_2. The monitoring network is most dense in the southeastern New Hampshire region to reflect these air quality concerns and the dense population. While the greatest risk of unhealthy air quality occurs in this portion 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. 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.

Network Summary

Below is a brief summary of the New Hampshire Air Monitoring network 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 and sulfur dioxide, the only criteria pollutants for which recent air monitoring and modeling have indicated possible population exposure to unhealthy levels. A previous Concord monitoring station was located in the valley near I-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 during October 2010 to help quantify local SO_2 levels relative to the new SO_2 NAAQS. This 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 United States 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 research oriented station also represents population exposure on a regional scale.

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 experiences a few days per year when ozone levels have the potential to reach unhealthy levels. Similarly, NHDES is concerned about $PM_{2.5}$ levels at this station, especially during the winter months. NHDES installed a continuous $PM_{2.5}$ monitor at this station in September 2007 to better track the risks of wintertime wood smoke buildup. 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, and other nearby communities may be similarly affected. 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 levels. This station represents population exposure on a regional scale.

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 EPA 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. PAMS measures important precursors to the development of ozone. These precursors include a wide variety of volatile organic compounds and nitrogen oxides. 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.

Nashua – Gilson Road

In recent years, the Nashua area has often seen the highest ozone concentrations in the state and 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 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, MA.) 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.

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.

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

NHDES operates several Met One 1020 BAMs and one API 602 BAM covering a total of five stations. To date, NHDES operates BAMs and Federal Reference Method (FRM) filter based samplers at Keene, Lebanon, Londonderry, Peterborough and Portsmouth stations. Please note the following relative to data comparability assessments (FEM vs FRM) and declaration of primary sampler type for each station. For more information, see data comparability assessments at the following link: http://www.epa.gov/airquality/airdata/ad_rep_frmvfem.html.

Keene - The Met One 1020 BAM at Keene will remain primary toward the NAAQS. Any FRM data generated at Keene will be considered secondary when BAM data are available. Individual seasonal data comparisons (spring, summer and winter) are outside acceptability limits, but when looking at the complete sets of data, all valid FRM and FEM data for the past three years (2012 – 1014) falls within additive vs. multiplicative bias acceptability limits for FEM testing. These data sets correlate with an overall R = 0.87 and an intercept of 0.11 micrograms per cubic meter (µg/m^3).

Lebanon - The Met One 1020 BAM at Lebanon will remain primary toward the NAAQS. Any FRM data generated at Lebanon will be considered secondary when BAM data are available. Individual yearly data set comparisons are outside acceptability limits, but when looking at the complete data set, the FRM and FEM data for the past three years falls very close to the additive vs. multiplicative bias acceptability limits for FEM testing. These data sets correlate with an overall R = 0.87 and an intercept of -0.89 µg/m^3. Of particular interest is that the latest (2014) FRM and FEM data sets are very close to being within FEM testing acceptability limits. NHDES will monitor this data set closely and restore the FRM as primary if appropriate.

Londonderry - The FRM (PQ200) at Londonderry will be primary toward the NAAQS. Any FEM data generated at Londonderry should be excluded from NAAQS comparisons. All seasonal and yearly data comparisons between FRM and FEM are well outside additive vs.

multiplicative bias acceptability limits for FEM testing. This data set correlates with an overall R = 0.56 and an intercept of 4.22 μg/m^3.

Peterborough, Pack Monadnock Mountain – Summit (Miller State Park) - The Met One 1020 BAM at Peterborough will remain primary toward the NAAQS. Any FRM data generated at Peterborough will be considered secondary when BAM data are available. Unfortunately, this decision is based primarily on resources and not comparability assessment testing. All valid FRM and FEM data sets from Peterborough for the past three years are outside additive vs. multiplicative bias acceptability limits for FEM testing, although the latest two years (2013, 2014) are very close. This data set correlates with an overall R = 0.78 and an intercept of 1.88μg/m^3. NHDES would prefer to use the FRM (Partisol 2025) as primary toward the NAAQS at this station, but doing so would require collocation of another Partisol 2025. NHDES does not have the resources for the additional sampling. Since $PM_{2.5}$ data at Peterborough are typically lower than all other stations and well below the NAAQS, there is little concern that this decision would introduce a public $PM_{2.5}$ exposure risk or a failure capture a violation of the NAAQS.

Portsmouth - API 602 BAM data at Portsmouth will be primary toward the NAAQS. Any FRM data generated at this station will be considered secondary when BAM data are available. The API 602 BAM has correlated quite well with the FRM when operational. All valid FRM and API602 FEM data sets from Portsmouth for the past three years are well within additive vs. multiplicative bias acceptability limits for FEM testing. This data set correlates with an overall R = 0.96 and an intercept of -0.53 μg/m^3.

<u>Network Modifications</u>

NHDES made a few modifications to the air monitoring network between July 1, 2014 and June 30, 2015 as follows:

Move Photochemical Assessment Monitoring Station (PAMS) from Gilson Road in Nashua to Moose Hill School in Londonderry **–** NHDES relocated PAMS monitoring from the Gilson Road, Nashua station to the Moose Hill School, Londonderry NCore station at the conclusion of the 2014 ozone season. NHDES became fully operational for PAMS monitoring in Londonderry for the 2015 ozone season. This move further builds the Londonderry NCore site and which when paired with the Pack Monadnock Station creates a unique high-low elevation monitoring capacity for nearly all NCore parameters at the northern edge of the low-level-jet air pollution transport phenomenon. This pairing of PAMS monitoring stations is vital to the New England states for the purpose of providing photochemical modeling observations at two elevations and there is a general void of aloft PAMS data. The Northeast portion of the country has already enacted strict emissions regulations on most sources of VOCs and this targeting information is much needed. Further, the urbanized nature of the region makes for a very complex airshed where having enhanced measurements is critical to attaining and maintaining clean air in New England. This PAMS realignment also improves operational efficiencies for the NHDES network. The Gilson Road location will continue to monitor ozone and meteorology during the near-term.

Portsmouth, Market Street **–** NHDES completed and shut down special monitoring associated with metal dust complaints around Market Street in Portsmouth during October 2014.

Pembroke, Exchange Street **–** NHDES shut down all $PM_{2.5}$ sampling at the Exchange Street in Pembroke on January 1, 2015.

Nashua, Crown Street **–** NHDES shut down all $PM_{2.5}$ sampling at the Crown Street in Nashua on January 1, 2015.***Eliot, ME, Sawgrass Circle* –** In coordination with EPA, the Maine Department of Environmental Protection and the town of Eliot, NHDES setup and is currently operating a temporary SO_2 monitoring station in Eliot. This monitoring began in November 2014 and is scheduled for completion in October 2015.

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. To this effect, NHDES has performed a monitoring network assessment with the NetAssess tool for ozone and $PM_{2.5}$ monitoring, however given that EPA will be announcing it intentions for the 2015 ozone NAAQS in October, NHDES intends to wait for it before making any significant decisions regarding modifications to the ozone monitoring network. NHDES would like to use the full current ozone monitoring network to assist in designation for the 2015 NAAQS update. After that time, NHDES intends to review the analysis and the network need for continuing ozone monitoring in Rye, Nashua, and Laconia. These stations have experienced reduced pollution concentrations and may be reasonably represented by other nearby stations, but a decision to discontinue ozone monitoring at any of these locations depends, in part, on how close these stations measure ozone concentrations as compared to the 2015 revised ozone NAAQS, and funding considerations at that time.

With regard to $PM_{2.5}$, FRM monitoring in Laconia is being considered for discontinuation during the next 5 years. While the network assessment did not find Laconia $PM_{2.5}$ monitoring to be strongly correlated with another nearby site, its recent $PM_{2.5}$ monitoring has been well under the current annual and 24-hour $PM_{2.5}$ NAAQS. However, because mobile monitoring conducted in 2012 indicated higher particle concentrations closer to the center of Laconia that the FRM monitor is located, NHDES will explore temporary $PM_{2.5}$ monitoring during a winter season before making any long-term decisions regarding particle monitoring in the Laconia area.

NHDES intends to discontinue lead monitoring at the Londonderry station, as lead data and design values continue to be significantly below the NAAQS.

At this time, no other network changes covering the next five years are foreseen at this time, including PM_{10}, carbon monoxide, nitrogen dioxide, sulfur dioxide and PAMS. Most of these parameters have been streamlined to NCore monitoring stations.

Purchasing/Expenses

NHDES' budget cycle runs from July 1 through June 30 each year. NHDES did not have any funding for significant equipment procurement during this budget cycle. Instead, DES focused its limited resources 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 EPA and safety standards.

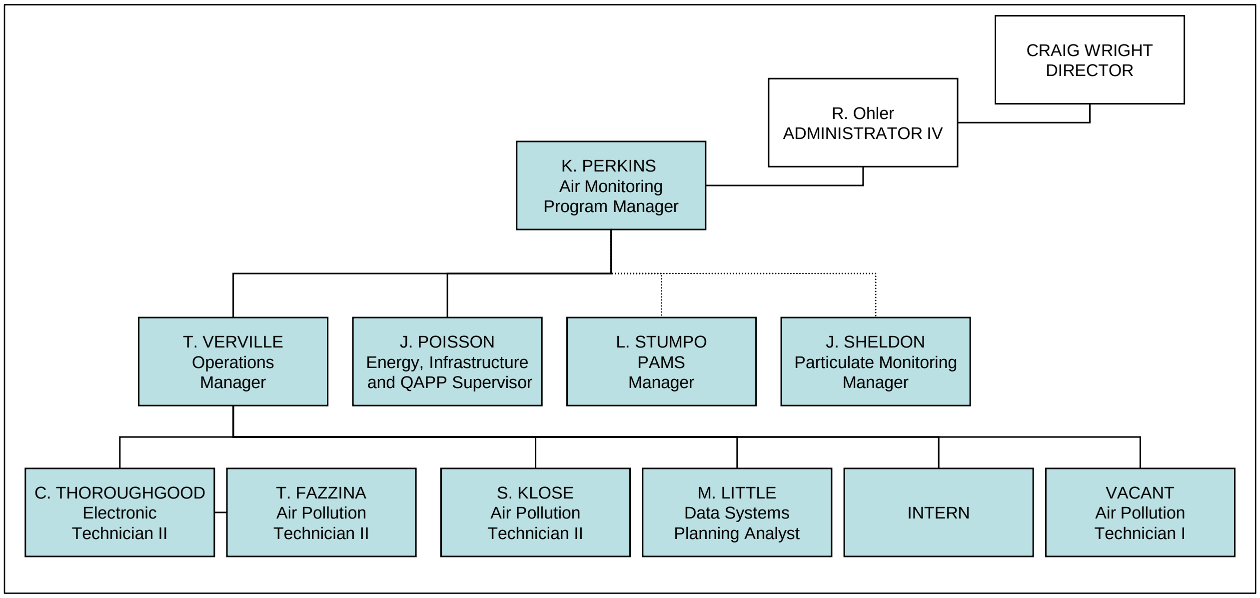
Please note that a number of analyzers and samplers in NHDES' network are old and require frequent maintenance in order to assure adequate data capture. Of note, most of NHDES' filter based particle samplers are near the end of their lifetime. Table 1.0 presents equipment, analyzers, and samplers that NHDES currently uses for ambient air quality monitoring.

Table 1.0 : Equipment – (Method)
SO2
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)
O3
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 49C PS – (Lab Standard EQOA-0880-047)
NO2
Teledyne – API 200E – (Automated Reference Method RFNA-0691-082)
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 2000 (filter based)
R&P Partisol Model 2025 (filter based)
BGI Model PQ200 (filter based)
R&P TEOM Model 1400
Met One BAM Model 1020
API 602 BAM
IMPROVE Visibility Speciation Monitor
Calibrator (multiple parameter)
Monitor Labs Model 8500
TECO 165 Multi Gas Calibrator
Teledyne – API Model 700, 700E and 700U Gas Calibrators
Environics Series 6103 Multi Gas Calibrator
Data Acquisition System
Environmental Systems Corporation (ESC) Data Logger Model 8816
ESC Data Logger Model 8832
Agilaire Software and support Agreement
PAMS
Perkin Elmer Ozone Precursor System- Clarus 500 Gas Chromatograph, TurboMatrix 100 Thermal Desorber / TM50
Perkin Elmer Total Chrom Software- version 6.2.1
Parker Balston TOC Gas Generator
Parker Balston Hydrogen Generator
Uninterrupted Power Supply- APC Model SURT8000XLT

Personnel

The AMP continues to operate with one full-time technical position vacant as well as one technical position previously eliminated. Due to limited budget, NHDES is unable to fill the vacant position during the next year. In order to fulfil requirements, NHDES assigns some technical support duties to individuals outside the official AMP organizational structure, including continuous $PM_{2.5}$ management and PAMS management duties which are supported by the Atmospheric Science and Analysis section of the Air Resources Division, as illustrated in Figure 1.1.

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 25 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 United States Department of Agriculture (Forest Service) in a Challenge Cost Share Agreement relative to air monitoring activities at Camp Dodge in Green's 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.

Monitoring Trends

Each year, NHDES reviews its monitoring data and calculates design values for comparison to the National Ambient Air Quality Standards (NAAQS) – Table 1.1. EPA 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 3-year average of the annual 4th 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 lowered in some cases to be more protective, thus we have more progress to make.

Figures 1.2 through 1.16 present monitoring trends for the key criteria pollutants for the period 1995 through 2014. In all cases, air quality is significantly improved from the 1970s and 1980s. Currently monitored levels of nitrogen dioxide (NO_2), PM_{10}, lead (Pb) and carbon monoxide (CO) are safely below the current levels of the NAAQS. However, the NAAQS for ozone, $PM_{2.5}$, and SO_2 have all recently been tightened (lowered) to levels near what is currently being measured in New Hampshire. Two of these pollutants (ozone and $PM_{2.5}$) have drawn significant attention by NHDES as a focus for network monitoring and SIP planning. For SO_2, 1-hour NAAQS was recently added with a threshold of 0.075 parts per million (ppm) and NHDES is assessing its monitoring focus on a source-specific basis in order to address attainment requirements.

Existing SO_2 monitoring indicates that all areas of New Hampshire meet the 3-hour sulfur dioxide secondary NAAQS. Monitoring also indicates that Londonderry[1], Pack Monadnock, Manchester and Portsmouth are below the new 1-hour primary SO_2 NAAQS. The Pembroke monitoring station historically measured 1-hour SO_2 concentrations above the 0.075 ppm threshold until 2012. This station was sited as a source-specific monitor, located near a coal- burning power plant. In 2012 the power plant began operations of a new SO_2 scrubber which has significantly lowered its SO_2 emissions. As a result, the Pembroke monitor recorded a decrease from 57 daily maximum 1-hour SO_2 exceedances of 0.075 ppm in 2011 to just one exceedance of the same threshold in 2012 and none in 2013. Exceedances of NAAQS thresholds during recent years are summarized in Table 1.2.

Tables 1.3 through 1.7 provide the five-year maximum and most recent (2013) design values for each criteria pollutant. These are also expressed as percentages of the current NAAQS. CO, NO_2, and 3-hour SO_2 design values are all under 50% of the NAAQS. The highest SO_2 site, Pembroke, exceeded the 1-hour NAAQS for the period of 2011 to 2013, but met the standard for the period of 2012 to 2014. With the lower ozone standard of 0.075 ppm, Rye and Pack Monadnock summit just barely exceeded the standard during the period of 2007 to 2009, but since then these and all other sites have been under the standard, including in 2014.

[1] Data capture for the 3rd quarter of 2013 was 67%, which is below the 75% data completeness requirement. Londonderry 2013 SO2 data is presented in the chart based on data available and is believed to be a reliable representation as nearby SO2 source emissions did not show unusual fluctuations during this period.

In 2014, New Hampshire operated two Photochemical Assessment Monitoring Stations (PAMS): Pack Monadnock and Nashua. 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 µg/m3. At Nashua and Pack Monadnock, the maximum 24-hour averages for benzene over the full period were about 0.2 and 0.4 µg/m3, respectively, or about 4-7% of the AAL. Maximum values for all the other parameters for both sites are consistently less than 1% of their AAL.

Table 1.1: National Ambient Air Quality Standards

Pollutant [final rule cite]	Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]	primary	8-hour	9 ppm	Not to be exceeded more than once per year
		1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]	primary and secondary	Rolling 3 month average	0.15 µg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]	primary	1-hour	100 ppb	98th percentile, averaged over 3 years
	primary and secondary	Annual	53 ppb (2)	Annual Mean
Ozone [73 FR 16436, Mar 27, 2008]	primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution Dec 14, 2012 — $PM_{2.5}$	primary	Annual	12 µg/m3	annual mean, averaged over 3 years
	secondary	Annual	15 µg/m3	annual mean, averaged over 3 years
	primary and secondary	24-hour	35 µg/m3	98th percentile, averaged over 3 years
Particle Pollution Dec 14, 2012 — PM_{10}	primary and secondary	24-hour	150 µg/m3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]	primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

as of October 2011

(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m^3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.
(2) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.
(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.
(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO_2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Table 1.2: NAAQS Exceedences (Days) in New Hampshire (2009-2014)

Parameter/Location	Number of Exceedances						Most Recent
	2009	2010	2011	2012	2013	2014	
CO							
1-Hour (1971)	0	0	0	0	0	0	None
8-Hour (1971)	0	0	0	0	0	0	1996
Lead							
Quarterly (2008)	0	0	0	0	0	0	None
NO_2							
1-Hour (2010)	//	0	0	0	0	0	None
Annual (1971)	0	//	//	//	//	//	None
Ozone							
8-Hour (2008)							
Camp Dodge	0	0	0	0	0	0	None
Claremont	--	--	--	--	--	--	2008
Concord	0	1	0	0	0	0	2010
Keene	0	0	0	0	0	0	2008
Laconia	0	2	0	0	0	0	2010
Lebanon	0	0	0	0	0	0	2008
Londonderry	--	--	2	2	0	0	2012
Manchester	0	1	0	--	--	--	2010
Miller	0	4	0	2	0	1	2014
Mt. Washington	0	2	0	0	2	0	2013
Nashua	0	2	1	2	0	0	2012
Portsmouth	1	2	1	1	1	0	2013
Rye	2	1	2	2	0	0	2012
Woodstock	0	0	0	0	0	0	None
PM_{10}							
24-Hour (1987)	0	0	0	0	0	0	None
$PM_{2.5}$							
Annual (1997)	0	0	0	0	0	0	None
24-Hour (2006)							
Keene	1*	1*	4*	1*	3*	0*	2013
Laconia	0	0	0	0	0	0	2005
Lebanon	0*	0*	0*	0*	0*	0*	None
Manchester	--	--	--	--	--	--	2005
Miller	0*	0*	0*	0*	0*	0*	2002
Nashua	0	0	0	0	0	0	2007
Pembroke	0	1	0	0	0	0	2010
Portsmouth	0*	1*	0*	0*	0*	0*	2010
SO_2							
Annual (1971)	0	0	0	0	0	0	None
24-Hour (1971)	0	//	//	//	//	//	1980
1-Hour (2010)	//						
Concord	--	--	4	0	0	0	2011
Londonderry	--	--	0	0	0	0	None
Manchester	--	1	1	--	--	--	2011
Miller	--	0	0	0	0	0	None
Pembroke	--	95	57	1	0	0	2012
Portsmouth	--	0	0	0	0	0	2008

** - Denotes measured by FEM equipment. Otherwise measured by FRM methods*
// - Denotes NAAQS cited is not valid for this period
Notes: Claremont station closed in late 2008, Manchester closed in 2012, and Londonderry opened January 1, 2011. Concord station began SO_2 monitoring in 2011.

Table 1.3: 2012 – 2014 Ozone Design Values (ppb)

Ozone	Design Value (DV) Description	NAAQS	5-Year Max DV	% of NAAQS	Location	2012-14 Max DV	% of NAAQS	Location
8-Hour	3-year average of 4th-highest daily maximum 8-hour averages	75	75	100%	Pack Monadnock	70	93%	Pack Monadnock

Table 1.4: 2012 – 2014 Carbon Monoxide Design Values (ppm)

CO	Design Value (DV) Description	NAAQS	5-Year Max DV	% of NAAQS	Location	2012-14 Max DV	% of NAAQS	Location
1-Hour	2nd maximum over 2 years	35	3.2	9%	Manchester	0.7	2%	Londonderry
8-Hour	2nd maximum over 2 years	9	2.5	28%	Manchester	0.6	7%	Londonderry

Table 1.5: 2012 – 2014 Sulfur Dioxide Design Values (ppb)

SO_2	Design Value (DV) Description	NAAQS	5-Year Max DV	% of NAAQS	Location	2012-14 Max DV	% of NAAQ	Location
1-Hour	3-year average of 99th percentile of daily maximum 1-hour averages	75	221	295%	Pembroke	28	37%	Portsmouth
3-Hour	2nd maximum	500	193	39%	Pembroke	27	5%	Portsmouth

Table 1.6: 2012 – 2014 Nitrogen Dioxide Design Values (ppb)

NO_2	Design Value (DV) Description	NAAQS	5-Year Max DV	% of NAAQS	Location	2012-14 Max DV	% of NAAQS	Location
1-Hour	3-year average of 98th percentile of daily maximum 1-hour averages	100	45	45%	Manchester	10*	10%	Nashua
Annual	Annual average	53	8	15%	Manchester	1	2%	Nashua

* The only NO_2 design value available for 2012-14 is based on incomplete data.

Table 1.7: 2012 – 2014 Fine Particulate Matter Design Values ($\mu g/m^3$)

$PM_{2.5}$	Design Value (DV) Description	NAAQS	5-Year Max DV	% of NAAQS	Location	2012-14 Max DV	% of NAAQS	Location
24-Hour	3-year average of 98th percentile of midnight-to-midnight 24-hour averages	35	29	83%	Keene	27	77%	Keene
Annual	Annual average over 3 years	12	9.8	82%	Keene	8.8	73%	Keene

Figure 1.2: Ozone trends for the 8-hour NAAQS (1997-2014)

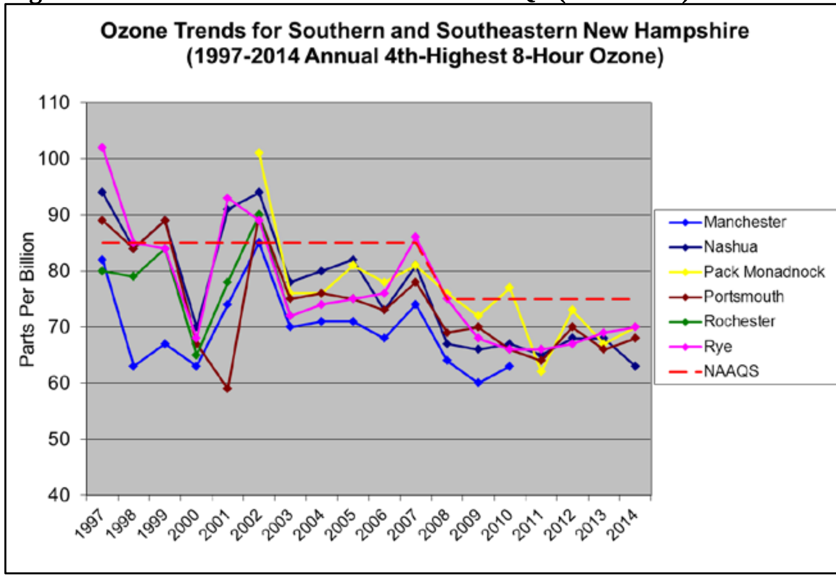


Figure 1.3: Ozone trends for the 8-hour NAAQS (1997-2014)

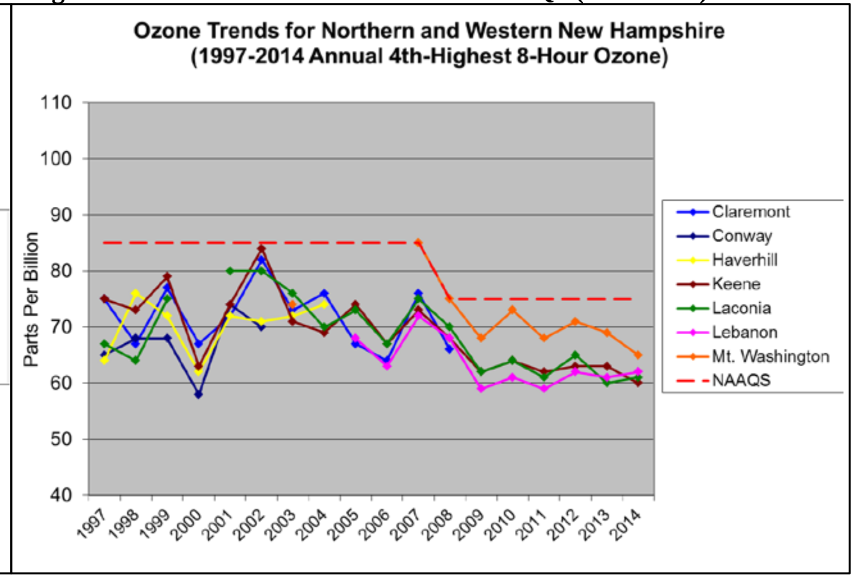


Figure 1.4: Carbon Monoxide trends for the 1-hour NAAQS (1997-2014)

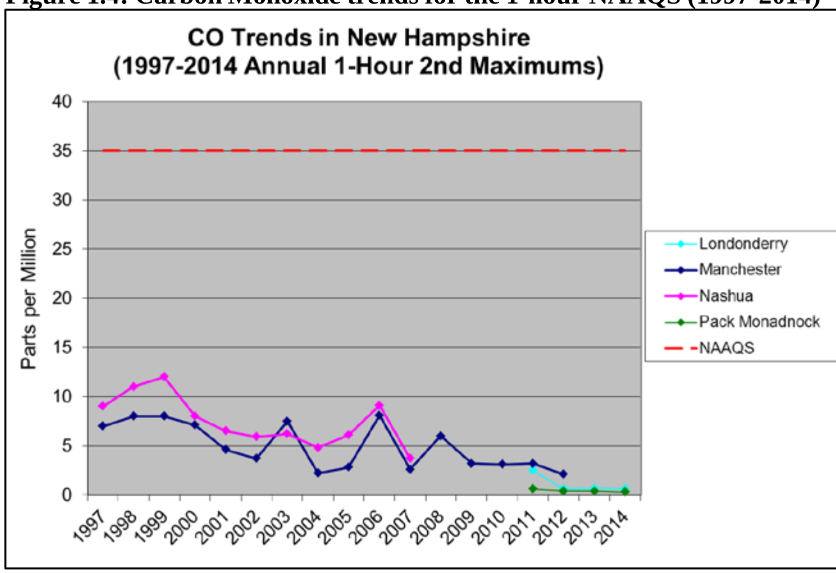


Figure 1.5: Carbon Monoxide trends for the 8-hour NAAQS (1997-2014)

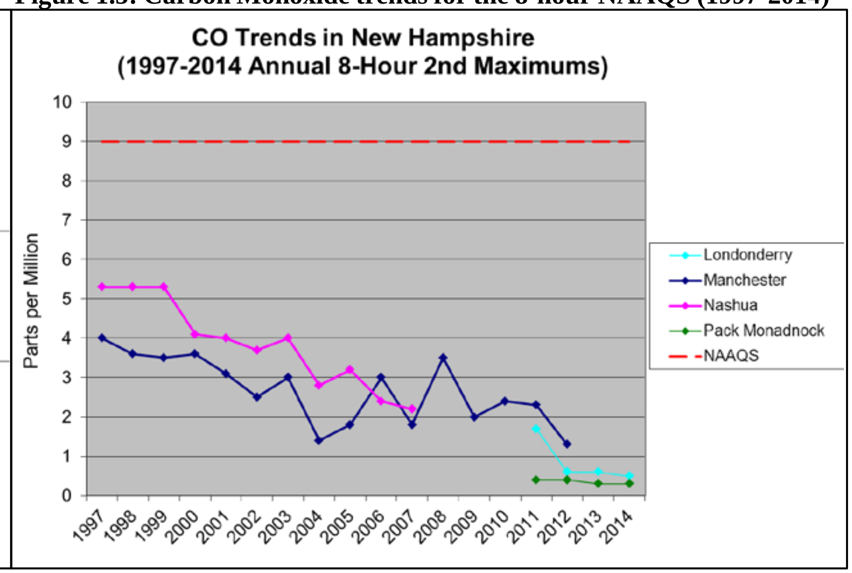


Figure 1.6: $PM_{2.5}$ trends for the 24-hour NAAQS (2001-2014)

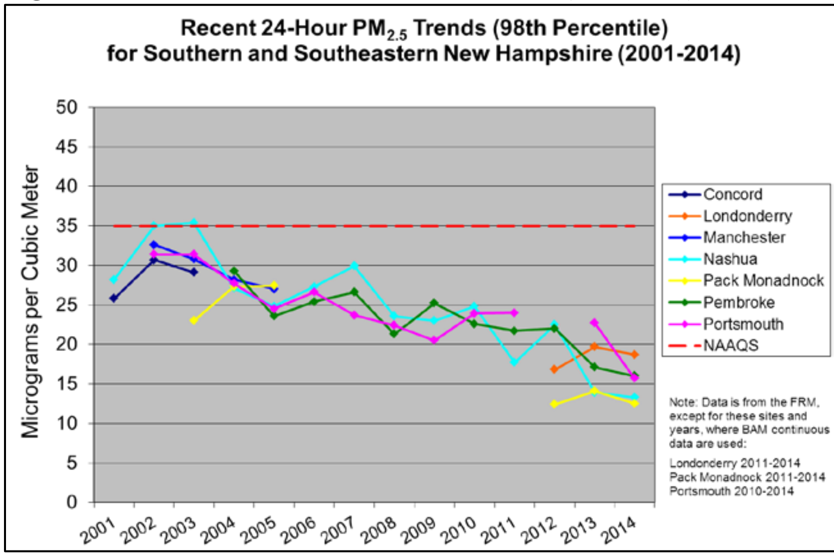


Figure 1.7: $PM_{2.5}$ trends for the 24-hour NAAQS (2001-2014)

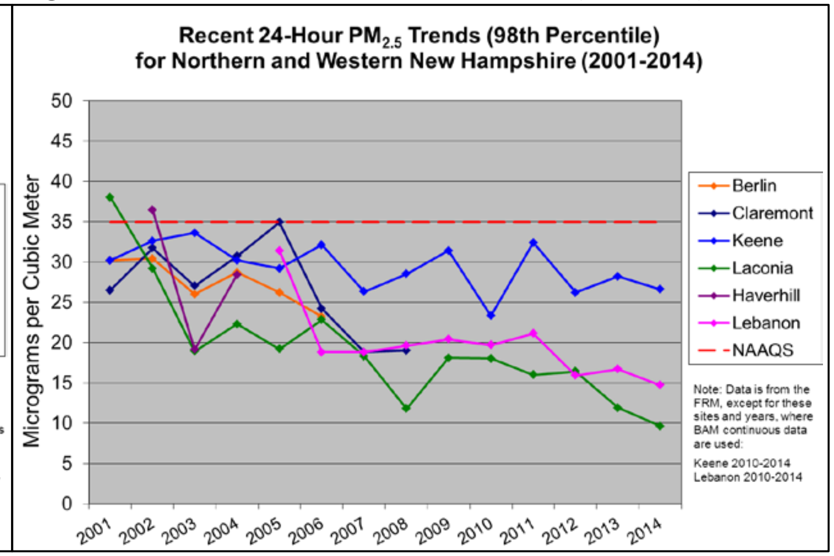


Figure 1.8: $PM_{2.5}$ trends for the annual NAAQS (2001-2014)

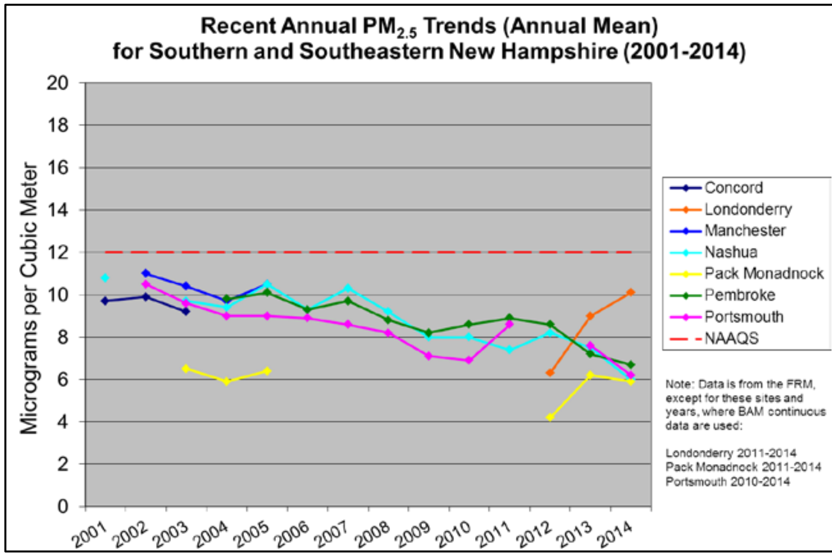


Figure 1.9: $PM_{2.5}$ trends for the annual NAAQS (2001-2014)

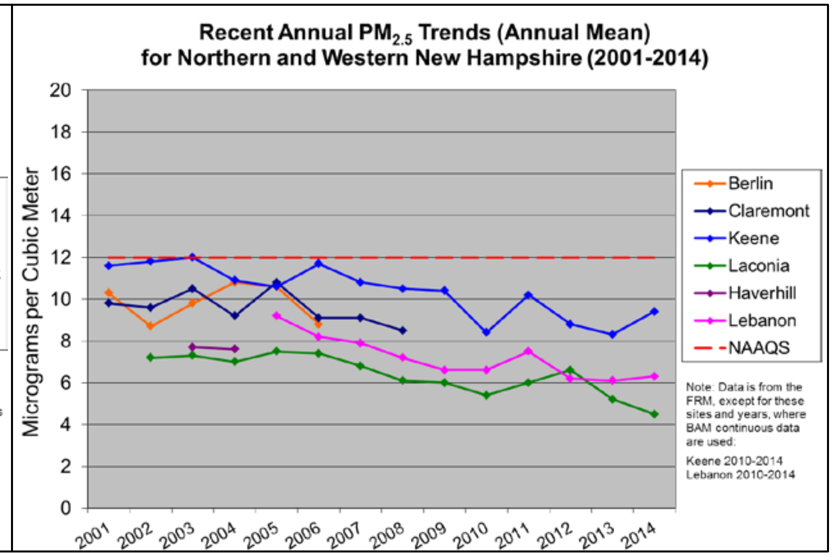


Figure 1.10: Nitrogen Dioxide trends for the 1-hour NAAQS (2001-2014)

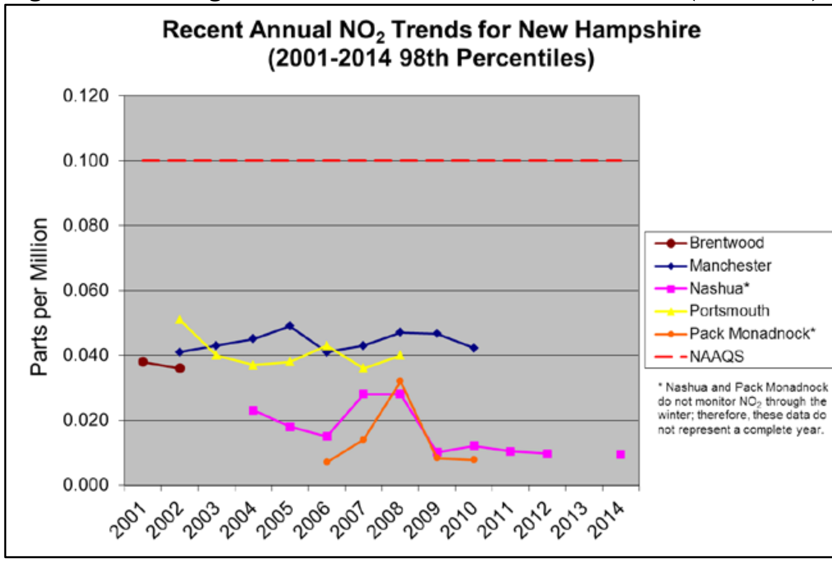


Figure 1.11: Nitrogen Dioxide trends for the annual NAAQS (2001-2014)

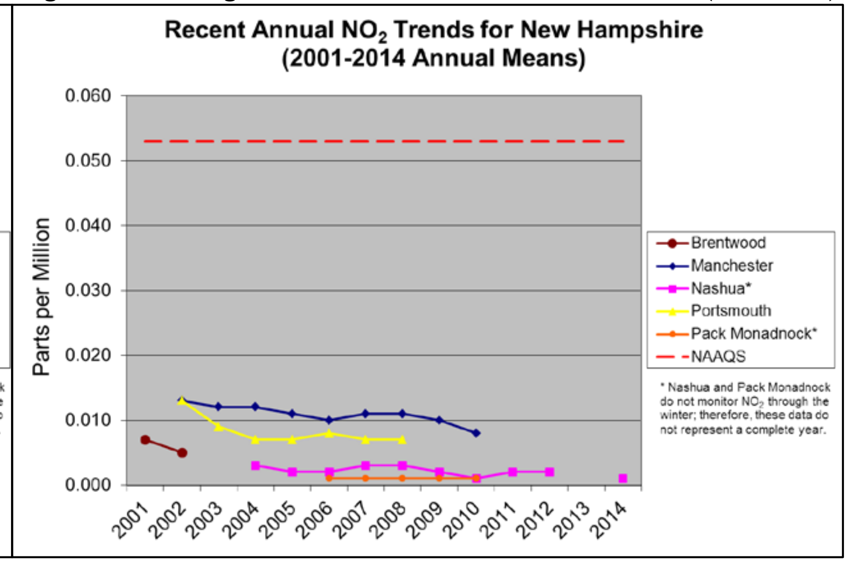


Figure 1.12: Sulfur Dioxide trends for the 1-hour NAAQS (2001-2014)

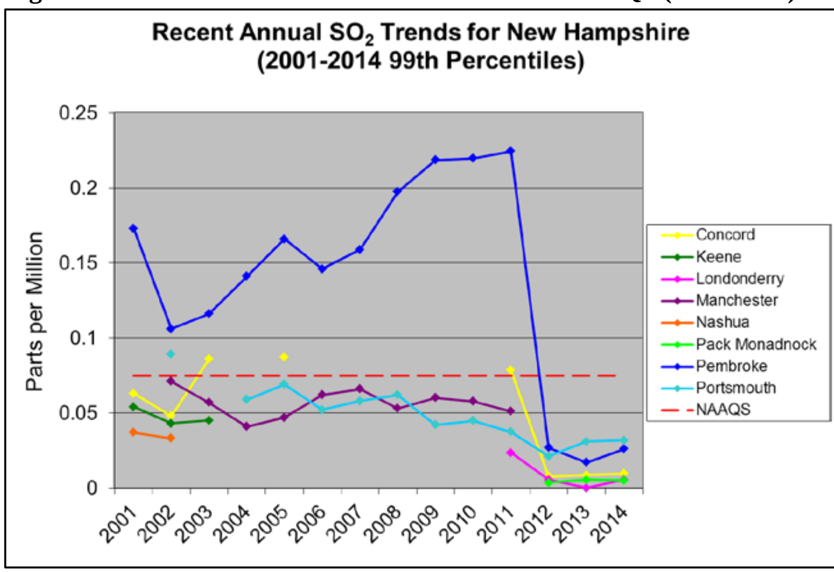


Figure 1.13: Sulfur Dioxide trends for the 3-hour NAAQS (2001-2014)

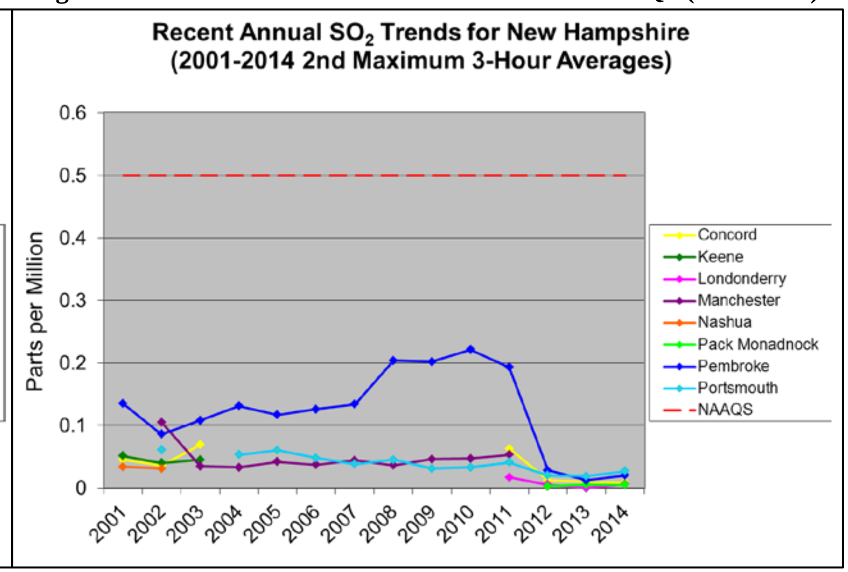


Figure 1.14: PM_{10} trends for the 24-hour NAAQS (2001-2014)

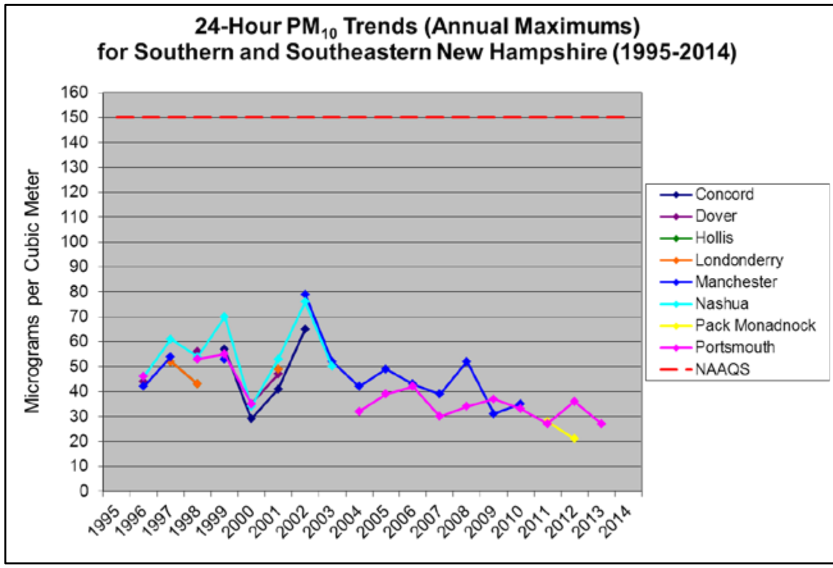


Figure 1.15: PM_{10} trends for the 24-hour NAAQS (2001-2014)

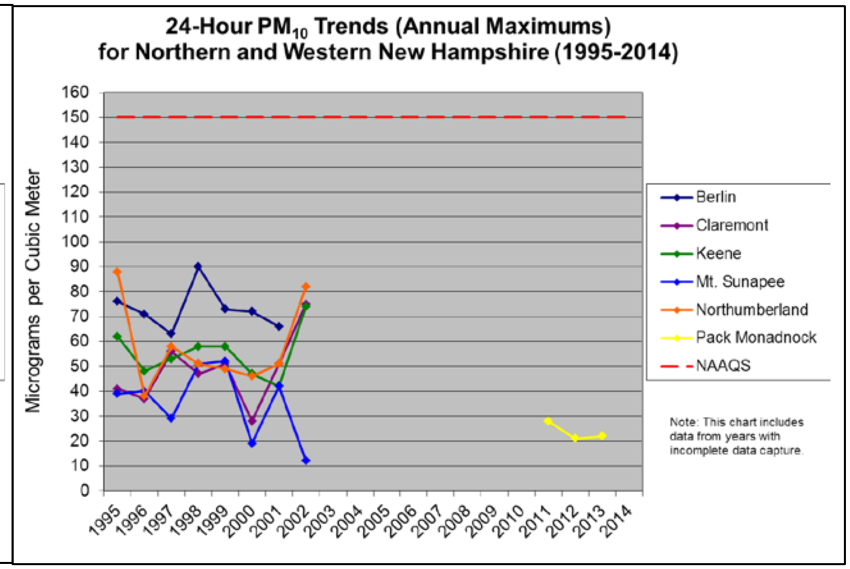


Figure 1.16: Lead trends for the primary NAAQS (2012-2014)

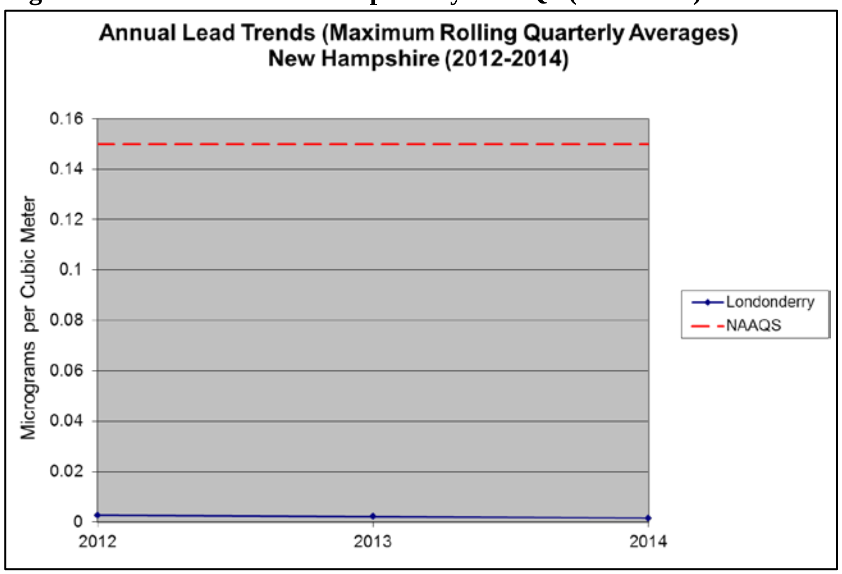


Table 1.8: New Hampshire State and Local Air Monitoring Stations Network – 2014/2015					
		SO_2			
Town	**Name**	**AIRS #**	**Frequency**	**Scale**	**Objective**
Londonderry	Moose Hill School	33 015 0018	Continuous	Regional	Population
Pembroke	Pembroke Highway Dept.	33 013 1006	Continuous	Neighborhood	High Concentration
Peterborough	Pack Monadnock	33 011 5001	Continuous	Regional	Research
Portsmouth	Pierce Island	33 015 0014	Continuous	Neighborhood	Population
Concord	Hazen Drive	33 013 1007	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	April - Sept	Neighborhood	Population
Greens Grant	Camp Dodge	33 007 4002	April - Sept	Regional	Research
Keene	Water Street	33 005 0007	Continuous	Neighborhood	Population
Laconia	Lakes Region	33 001 2004	April - 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	April - Sept	Regional	Population
Peterborough	Pack Monadnock	33 011 5001	Continuous	Regional	Research
Portsmouth	Pierce Island	33 015 0014	Continuous	Neighborhood	Population
Rye, Odiorne	Seacoast Science Center	33 015 0016	April - 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	Continuous	Regional	Research

Table 1.9: New Hampshire Particulate Matter Network – 2014/2015					
			$PM_{2.5}$		
Town	**Name**	**AIRS #**	**Frequency**	**Scale**	**Objective**
Keene	Water Street	33 005 0007	1 in 12 filter	Neighborhood	Population
Keene	Water Street	33 005 0007	Continuous - BAM	Neighborhood	Population
Laconia	Green Street	33 001 2004	1 in 6 filter	Regional	Population
Lebanon	Lebanon Airport	33 009 0010	1 in 12 filter	Neighborhood	Population
Lebanon	Lebanon Airport	33 009 0010	Continuous - BAM	Regional	Population
Londonderry	Moose Hill School	33 015 0018	1 in 3 filter	Regional	Population
Londonderry	Moose Hill School	33 015 0018	Continuous - BAM	Regional	Population
Londonderry	Moose Hill School	33 015 0018	1 in 6 filter	Regional	CoLocate Audit
Peterborough	Pack Monadnock	33 011 5001	Continuous - BAM	Regional	Research
Peterborough	Pack Monadnock	33 011 5001	1 in 3 filter	Regional	Research
Portsmouth	Pierce Island	33 015 0014	1 in 12 filter	Regional	Population
Portsmouth	Pierce Island	33 015 0014	Continuous - BAM	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
			PM10		
Londonderry	Moose Hill School	33 015 0018	1 in 3 filter	Regional	Population
Peterborough	Pack Monadnock	33 011 5001	Continuous - BAM	Regional	Research
Portsmouth	Pierce Island	33 015 0014	1 in 6 filter	Neighborhood	Population
Portsmouth	Pierce Island	33 015 0014	1 in 6 filter	Neighborhood	Audit
Portsmouth	Pierce Island	33 015 0014	Continuous - BAM	Neighborhood	Audit

Table 1.10: New Hampshire PAMS Network – 2014/2015					
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 1.11: New Hampshire NCore Network – 2014/2015					
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

Table 1.12: Seasonal Maximum 24-hour Averages at Gilson Road in Nashua for Toxic PAMS Species Compared to the Ambient Allowable Limit (AAL), 2005-2014

PAMS Parameter	AAL ug/m3	Max 24 Hour Avg. (ug/m3) 2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Max as % of AAL
PROPYLENE (43205)	35,833	0.55	0.34	0.30	0.33	0.35	0.20	1.29	1.49	0.28	0.33	0.00%
CYCLOPENTANE (43242)	25,595	0.23	0.23	0.16	0.13	0.15	0.10	0.30	1.12	0.07	0.18	0.00%
ISOPENTANE (43221)	36,875	2.04	2.50	1.56	1.41	1.23	1.13	4.58	11.95	0.75	1.30	0.03%
PENTANE (43220)	36,875	3.13	1.39	0.85	0.74	0.76	0.61	1.99	6.05	0.47	0.84	0.02%
2-METHYLPENTANE (43285)	36,875	0.60	0.78	0.21	0.35	0.25	0.18	0.45	2.26	0.09	0.15	0.01%
3-METHYLPENTANE (43230)	36,875	0.41	0.48	0.20	0.30	0.20	0.25	0.44	1.65	0.09	0.13	0.00%
HEXANE (43231)	885	0.59	0.58	0.47	0.74	0.51	1.18	1.17	1.89	0.21	0.54	0.21%
BENZENE (45201)	6	0.51	0.74	0.36	0.42	0.37	0.29	1.11	1.23	0.21	0.86	21.65%
CYCLOHEXANE (43248)	6,000	0.25	0.21	0.21	0.48	0.19	0.29	0.41	0.47	0.06	0.16	0.01%
HEPTANE (43232)	8,249	0.56	0.34	0.18	0.32	0.25	0.12	0.43	1.37	0.07	0.21	0.02%
METHYLCYCLOHEXANE (43261)	23,958	0.21	0.21	0.11	0.16	0.10	0.06	0.30	0.85	0.03	0.15	0.00%
TOLUENE (45202)	5,000	2.37	2.67	1.39	1.97	1.60	1.77	2.18	5.10	0.67	1.75	0.10%
OCTANE (43233)	7,000	0.32	0.13	0.10	0.13	0.09	0.07	0.25	2.04	0.03	1.88	0.03%
ETHYLBENZENE (45203)	1,000	0.36	0.36	0.18	0.39	0.57	0.14	0.47	1.14	0.09	0.56	0.11%
M & P-XYLENES (45109)	1,550	0.88	0.96	0.68	1.15	2.04	0.45	1.22	3.49	0.24	1.07	0.22%
STYRENE (45220)	1,000	0.88	0.13	0.22	0.07	0.06	0.13	0.19	0.89	0.06	0.07	0.09%
O-XYLENE (45204)	1,550	0.32	0.36	0.26	0.40	0.40	0.16	0.56	1.26	0.10	0.51	0.08%
NONANE (43235)	15,625	0.21	0.13	0.21	0.10	0.11	0.07	0.33	0.35	0.04	2.08	0.00%
1,3,5-TRIMETHYLBENZENE (45207)	619	0.11	0.12	0.09	0.32	0.17	0.09	0.44	0.61	0.08	0.30	0.10%
1,2,4-TRIMETHYLBENZENE (45208)	619	0.32	0.39	0.32	0.39	0.31	0.18	0.47	1.25	0.19	0.21	0.20%

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), 2006-2014

PAMS Parameter	AAL ug/m3	Max 24 Hour Avg. (ug/m3) 2006	2007	2008	2009	2010	2011	2012	2013	2014	Max as % of AAL
PROPYLENE (43205)	35,833	0.28	0.25	0.46	0.15	0.20	0.59	0.38	0.17	0.16	0.00%
CYCLOPENTANE (43242)	25,595	0.42	0.53	1.63	0.29	0.09	0.17	0.21	0.13	0.13	0.01%
ISOPENTANE (43221)	36,875	1.03	1.09	0.70	0.89	0.75	1.84	2.32	0.95	0.73	0.01%
PENTANE (43220)	36,875	45.41	7.63	0.55	0.45	0.38	0.86	0.76	0.48	0.40	0.12%
2-METHYLPENTANE (43285)	36,875	0.19	0.27	0.04	0.06	0.04	0.30	0.25	0.06	0.07	0.00%
3-METHYLPENTANE (43230)	36,875	0.13	0.17	0.01	0.04	0.03	0.21	0.19	0.03	0.02	0.00%
HEXANE (43231)	885	0.21	0.27	0.19	0.32	1.36	1.01	0.48	0.28	0.24	0.15%
BENZENE (45201)	6	0.31	0.33	0.32	0.41	0.73	1.09	0.45	0.38	0.41	19.18%
CYCLOHEXANE (43248)	6,000	0.14	0.05	0.02	0.08	0.04	0.48	0.15	0.06	0.04	0.01%
HEPTANE (43232)	8,249	0.71	0.16	0.15	0.17	0.13	0.79	0.21	0.14	0.11	0.01%
METHYLCYCLOHEXANE (43261)	23,958	1.23	0.15	0.15	0.11	0.16	0.49	0.14	0.07	0.06	0.01%
TOLUENE (45202)	5,000	1.00	1.05	1.11	1.01	0.77	2.48	1.36	0.80	0.56	0.05%
OCTANE (43233)	7,000	0.91	0.17	0.27	0.11	0.06	0.40	0.23	0.07	0.04	0.01%
ETHYLBENZENE (45203)	1,000	0.35	0.20	0.59	0.21	0.15	0.42	0.18	0.13	0.07	0.06%
M & P-XYLENES (45109)	1,550	1.88	0.37	2.38	0.46	0.23	1.22	0.42	0.42	0.19	0.15%
STYRENE (45220)	1,000	1.03	1.13	1.80	0.40	0.08	0.18	0.14	0.05	0.18	0.18%
O-XYLENE (45204)	1,550	0.60	0.13	0.67	0.15	0.08	0.45	0.20	0.16	0.08	0.04%
NONANE (43235)	15,625	8.83	1.33	0.57	0.23	0.08	0.16	0.20	0.36	0.05	0.06%
1,3,5-TRIMETHYLBENZENE (45207)	619	1.75	0.08	0.29	0.13	0.04	0.10	0.12	0.08	0.01	0.28%
1,2,4-TRIMETHYLBENZENE (45208)	619	3.91	1.34	0.79	0.53	0.14	0.38	0.26	0.08	0.09	0.63%

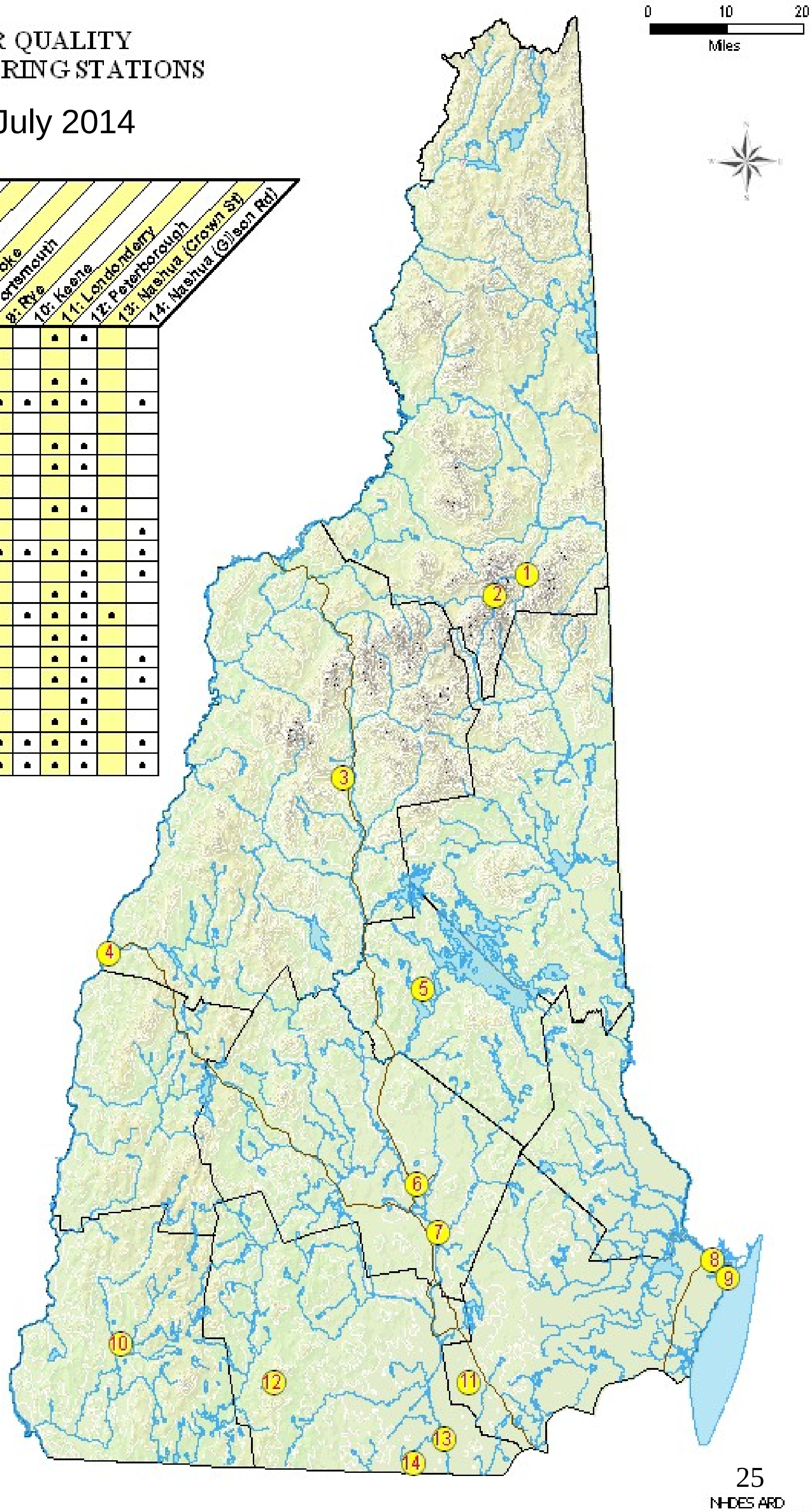
PART 2: Individual Station Information

NH Department of Environmental Services
Air Resources Division

AIR QUALITY MONITORING STATIONS

July 2014

PARAMETER	1: Greens Grant	2: Sargents Purchase	3: Woodstock	4: Lebanon	5: Laconia	6: Concord	7: Pembroke	8: Portsmouth	9: Rye	10: Keene	11: Londonderry	12: Peterborough	13: Nashua (Crown St)	14: Nashua (Gilson Rd)
BP											•	•		
CASTNET			•											
CO											•	•		
ETP	•	•	•	•	•	•	•	•	•	•	•	•		•
Lab						•								
IMPROVE	•										•	•		
NCore											•	•		
NADP			•											
NOy											•	•		
NO_2														•
Ozone (O_3)	•	•	•	•	•	•		•	•	•	•	•		•
PAMS												•		•
PM10								•			•	•		
PM2.5				•	•		•	•		•	•	•	•	
PM Coarse											•	•		
RH											•	•		•
RF					•						•	•		•
Solrad												•		
SO_2						•	•	•			•	•		
WD				•	•	•	•	•	•	•	•	•		•
WS				•	•	•	•	•	•	•	•	•		•

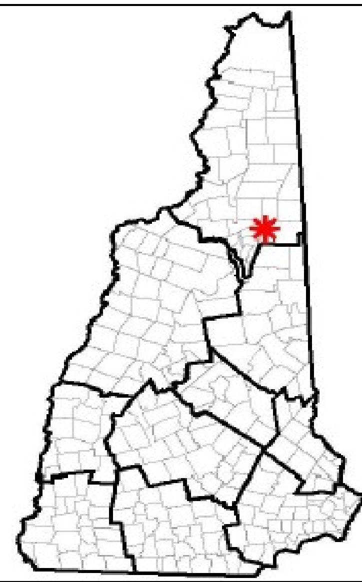


New Hampshire Department of Environmental Services

Camp Dodge, Green's Grant

General Information

AQS ID:	33-007-4002	Latitude:	44.308119
Town:	Green's Grant	Longitude:	-71.217658
Address:	Route 16	Elevation (m):	335
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 Green's 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

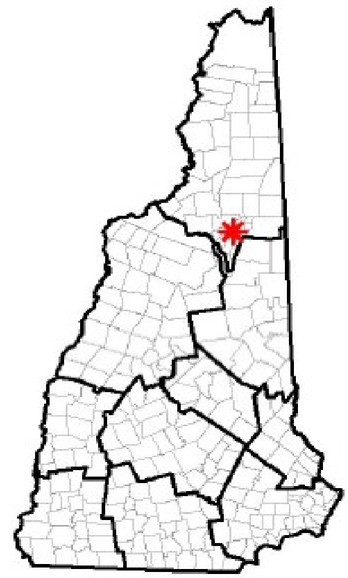
NHDES did not make any significant changes to this station during this review period.

Proposed/Planned Changes

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

Mt. Washington Summit

General Information			
AQS ID: Town: Address: County: Spatial Scale:	33-007-4001 Sargents Purchase Yankee Bld. Coos Regional	Latitude: Longitude: Elevation (m): Year Est.:	44.270086 -71.303844 1,917 1990



Site Description

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

Pollutants/Parameters

Ozone – Temperature

Recent Changes

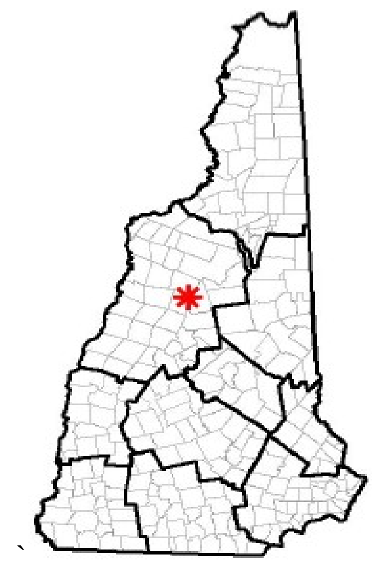
NHDES did not make any significant changes to this station during this review period.

Proposed/Planned Changes

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

Hubbard Brook, Woodstock

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



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. An EPA 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.

Lebanon Airport, Lebanon

General Information			
AQS ID: Town: Address: County: Spatial Scale:	33-009-0010 Lebanon Airport Road Grafton Neighborhood	Latitude: Longitude: Elevation (m): Year Est.:	43.6296 -72.309533 167 2005

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. The filter based $PM_{2.5}$ sampler is located on a deck on top of the trailer.

Pollutants/Parameters

Ozone - Continuous $PM_{2.5}$ (BAM) – filter based $PM_{2.5}$ (1 every 12 days) - Wind Speed - Wind Direction - Temperature

Recent Changes

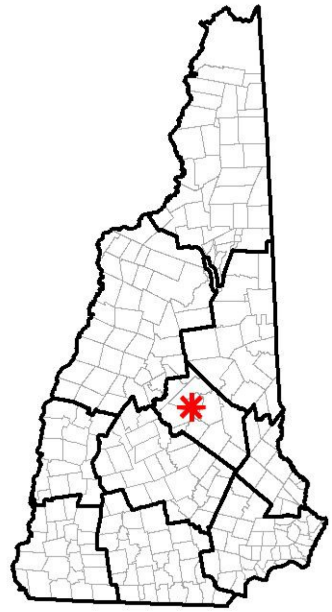
NHDES did not make any significant changes to this station during this review period.

Proposed/Planned Changes

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

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.:	43.566111 -71.496322 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. The filter-based $PM_{2.5}$ sampler is located on a platform approximately 30m from the structure.

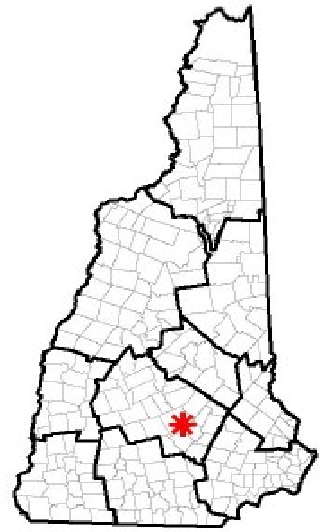
Pollutants/Parameters
Ozone – filter based $PM_{2.5}$ (1 every 6 days) – Wind Speed – Wind Direction – Temperature - Precipitation

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.

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.:	43.218478 -71.514533 100 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 – Sulfur Dioxide – 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

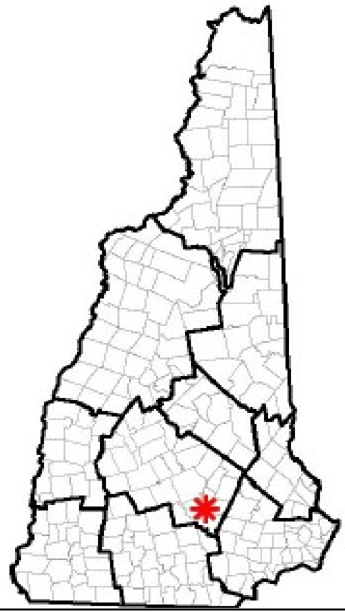
NHDES did not make any significant changes to this station during this review period.

Proposed/Planned Changes

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

Exchange Street, Pembroke

General Information			
AQS ID:	33-013-1006	Latitude:	43.132444
Town:	Pembroke	Longitude:	-71.458270
Address:	Pleasant St.	Elevation (m):	100
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. The filter based $PM_{2.5}$ samplers are located on a deck on top of the structure.

Pollutants/Parameters

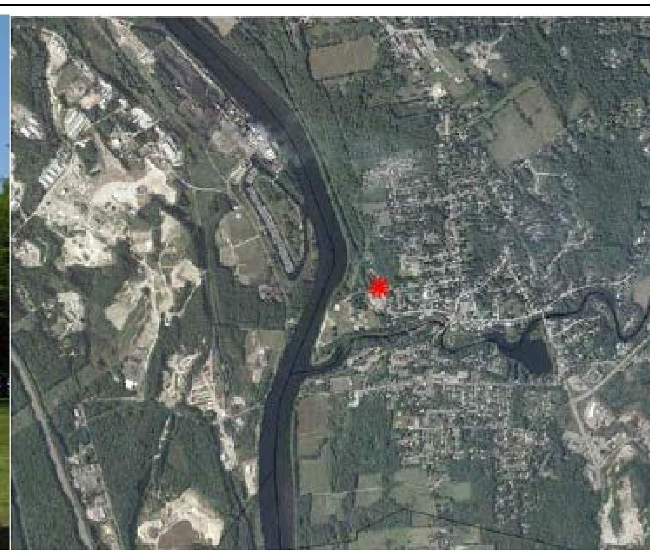
Sulfur Dioxide – Temperature – Wind Speed – Wind Direction.

Recent Changes

NHDES discontinued particulate sampling at this station on December 31, 2014

Proposed/Planned Changes

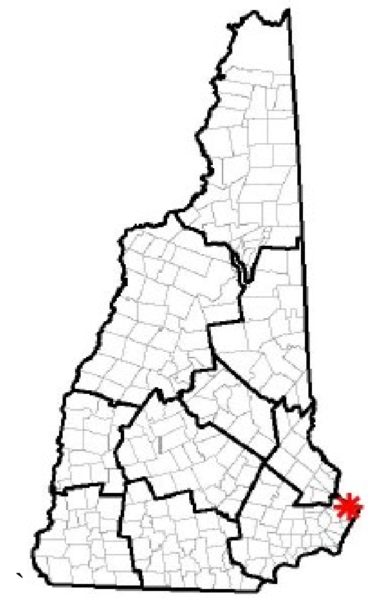
NHDES is not planning any significant changes to this station into the foreseeable future.



Pierce Island, Portsmouth

General Information

AQS ID:	33-015-0014	Latitude:	43.075367
Town:	Portsmouth	Longitude:	-70.748014
Address:	Pierce Island	Elevation (m):	4
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 $PM_{2.5}$ samplers are located on platforms approximately 8m from the shelter.

Pollutants/Parameters

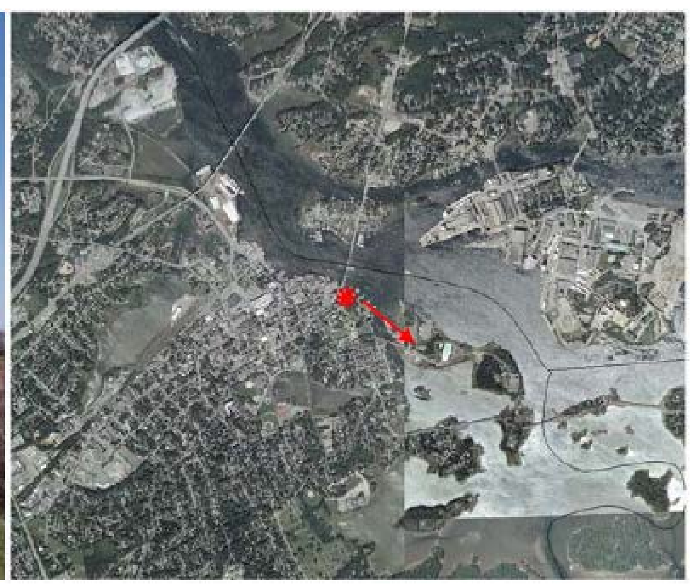
Ozone – $PM_{2.5}$ Continuous (BAM) – filter based $PM_{2.5}$ (1 every 12 days) – PM10 Continuous (BAM) – filter based PM_{10} (1 every 6 days) – filter based PM_{10} Colocation (1 every 6 days) – Sulfur Dioxide – Temperature – Wind Speed – Wind Direction

Recent Changes

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

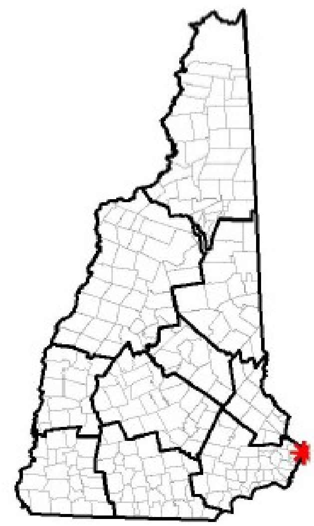
Proposed/Planned Changes

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



Seacoast Science Center, Rye

General Information			
AQS ID: Town: Address: County: Spatial Scale:	33-015-0016 Rye Seacoast Science Ctr. Rockingham Neighborhood	Latitude: Longitude: Elevation (m): Year Est.:	43.045267 -70.713953 10 2003



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

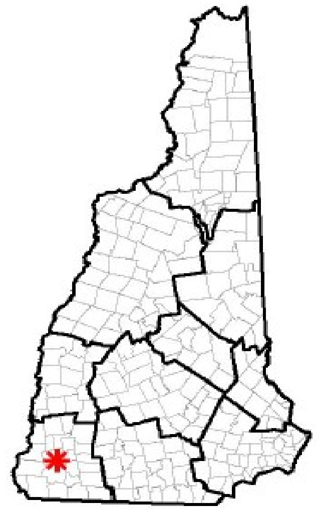
NHDES did not make any significant changes to this station during this review period.

Proposed/Planned Changes

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

Water Street, Keene

General Information			
AQS ID: Town: Address: County: Spatial Scale:	33-005-0007 Keene Water Street Cheshire Neighborhood	Latitude: Longitude: Elevation (m): Year Est.:	42.930517 -72.272372 145 1989



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

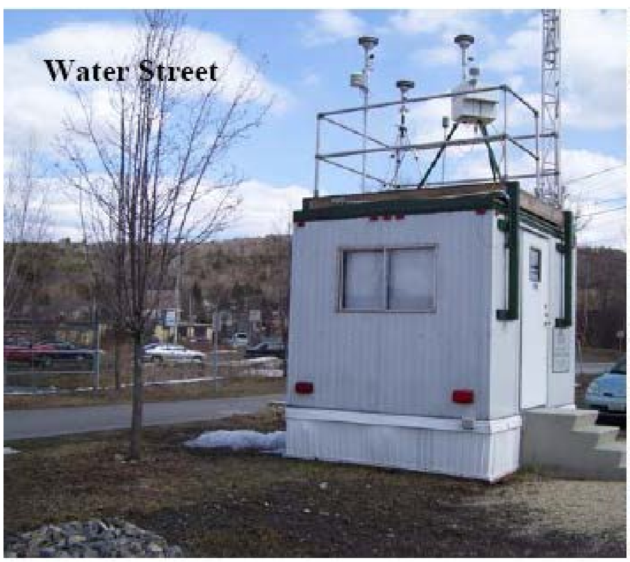
Ozone - $PM_{2.5}$ Continuous (BAM) – filter based $PM_{2.5}$ (1 every 12 days) – Wind Speed - Wind Direction - Temperature

Recent Changes

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

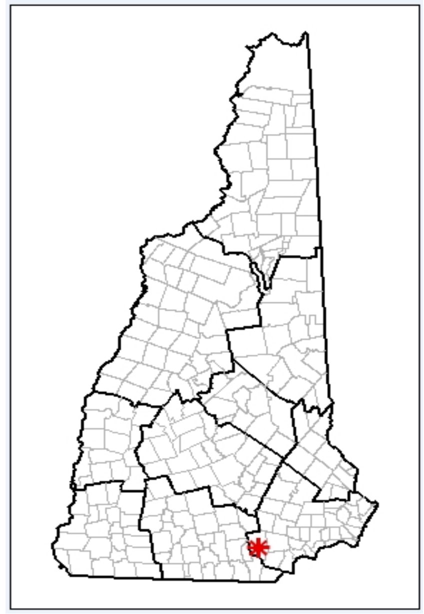
Proposed/Planned Changes

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



Moose Hill, Londonderry

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



Site Description

Proposed:

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 15 m from the structure.

Pollutants/Parameters

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

Recent Changes

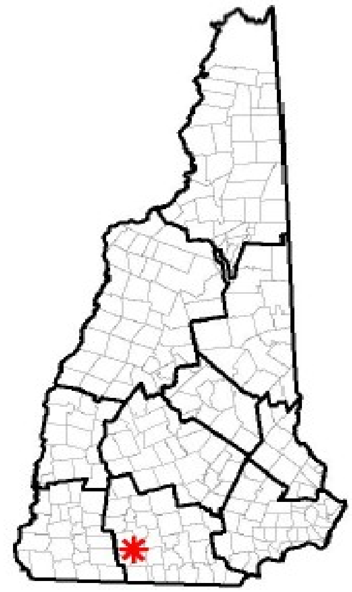
NHDES initiated PAMS monitoring (from Nashua) and PM2.5 filter based colocation monitoring (from Pembroke) at this station on June 1, 2015 and January 1, 2015, respectively.

Proposed/Planned Changes

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

Pack Monadnock Mountain

General Information			
AQS ID:	33-011-5001	Latitude:	42.861901
Town:	Peterborough	Longitude:	-71.878613
Address:	Miller State Park	Elevation (m):	694.6
		Year Est.:	2002
County:	Hillsborough		
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) - filter based $PM_{2.5}$ (1 every 3 days) – IMPROVE – PM Course (1 every 3 days) – filter based PM_{10} (1 every 3 days) – Oxides of Nitrogen (NOy) – Ozone – Sulfur Dioxide (trace) – Carbon Monoxide (trace) – Temperature – Wind Speed – Wind Direction – Relative Humidity – Precipitation – Barometric Pressure – Solar Radiation.

Recent Changes

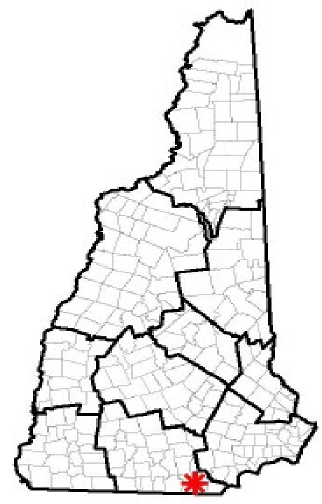
NHDES started a continuous PM10 BAM at this station in the 1st Quarter 2015 and subsequently shut down PM10 filter based sampling.

Proposed/Planned Changes

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

Crown Street, Nashua

General Information			
AQS ID:	33-011-1015	Latitude:	42.762028
Town:	Nashua	Longitude:	-71.444572
Address:	Crown Street	Elevation (m):	33.5
County:	Hillsborough	Year Est.:	2005
Spatial Scale:	Urban		



Site Description

This air monitoring station is located in an urban commercial and residential neighborhood. It is located approximately 30 meters from the Merrimack River and consists of a small fenced-in platform approximately 12’ long by 8’ wide.

Pollutants/Parameters

Filter based $PM_{2.5}$ (1 every 6 days)

Recent Changes

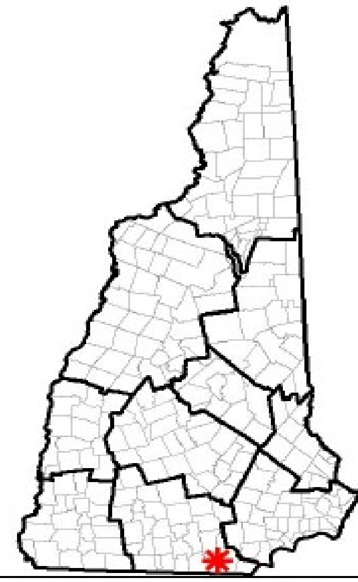
NHDES discontinued this station as of December 31, 2014.

Proposed/Planned Changes

Station is gone

Gilson Road, Nashua

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



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.

Pollutants/Parameters

Ozone - Nitrogen Dioxide – PAMS – Temperature – Wind Speed – Wind Direction.

Recent Changes

NHDES discontinued the PAMS monitoring at this station at the end of the 2014 PAMS season and moved it to the Londonderry site before the 2015 PAMS season.

Proposed/Planned Changes

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

Part 3: 5 Year Assessment

NHDES respectfully presents this 5 Year Network Assessment in accordance with the *Code of Federal Regulations Title 40, PART 58.* Again, NHDES would like to thank the United States Environmental Protection Agency (EPA) staff for working with NHDES to improve and maintain New Hampshire's Air Monitoring Network. In coordination with EPA, and in concert with our Annual Network Review Plans, NHDES has been persistently assessing and modifying the ambient monitoring network over the last 15 years. For this assessment, NHDES focused on $PM_{2.5}$ and Ozone, two key risk parameters in New Hampshire. However, NHDES is continually assessing the entire ambient air monitoring network as an ongoing process and implements change as appropriate.

Network Assessment Tools Overview

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, NetAssess v0.6b, is available at http://ladco.github.io/NetAssessApp/. The user runs each tool and assesses the outputs; the user does not need to supply any data. Each tool has its own purpose and parameters, as described below.

Exceedance Probability Tool

- Data used: 2007-2011 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.

Area Served Tool

- 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.

Correlation Matrix Tool

- 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.

Removal Bias Tool

- 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.

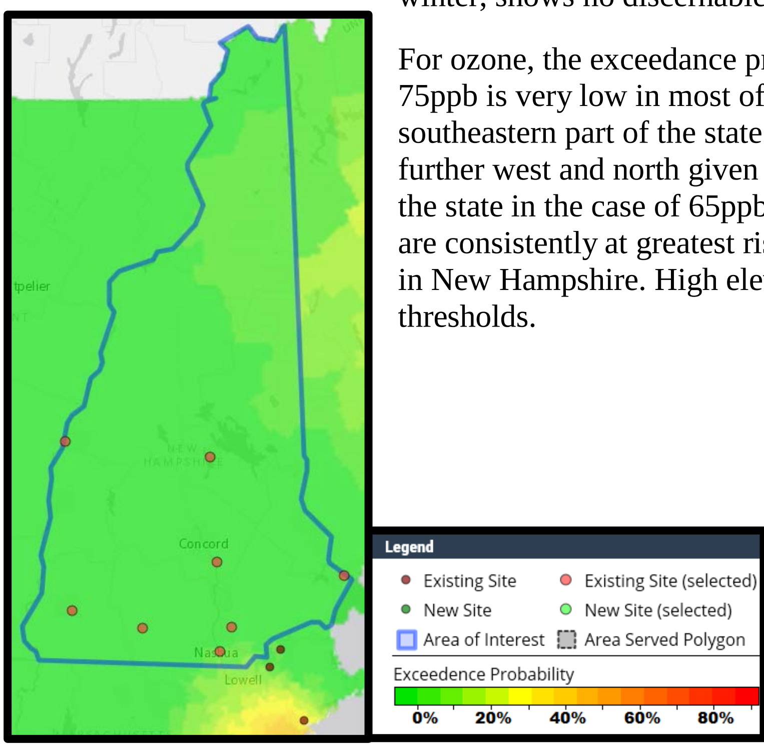
These tools are based on data at least a year old (2013 is the most recent year of data used). The primary consequence for New Hampshire is that the $PM_{2.5}$ monitor on Crown Street in Nashua appears in these NetAsses datasets, but this monitor was discontinued at the end of 2014. The following discussions treat this site as though still in existence, but the conclusion revisits its removal in light of the NetAssess results. Note, the ozone monitor in Nashua continues to operate at the Gilson Road station.

This report presents each tool's output for New Hampshire ozone and $PM_{2.5}$ sites. However, these tools are designed only as a supplemental aid to network assessment. Even taken together, they do not account for many important factors, such as topography, historical value, and other considerations.

Exceedance Probability

Figures 3.1 and 3.2 show the calculated exceedance probabilities for $PM_{2.5}$ and ozone. Figure 3.2 includes exceedance probabilities for the current standard 75ppb and the proposed standards 70ppb and 65ppb. These are the probability of high values exceeding the NAAQS threshold, not design values actually violating the NAAQS.

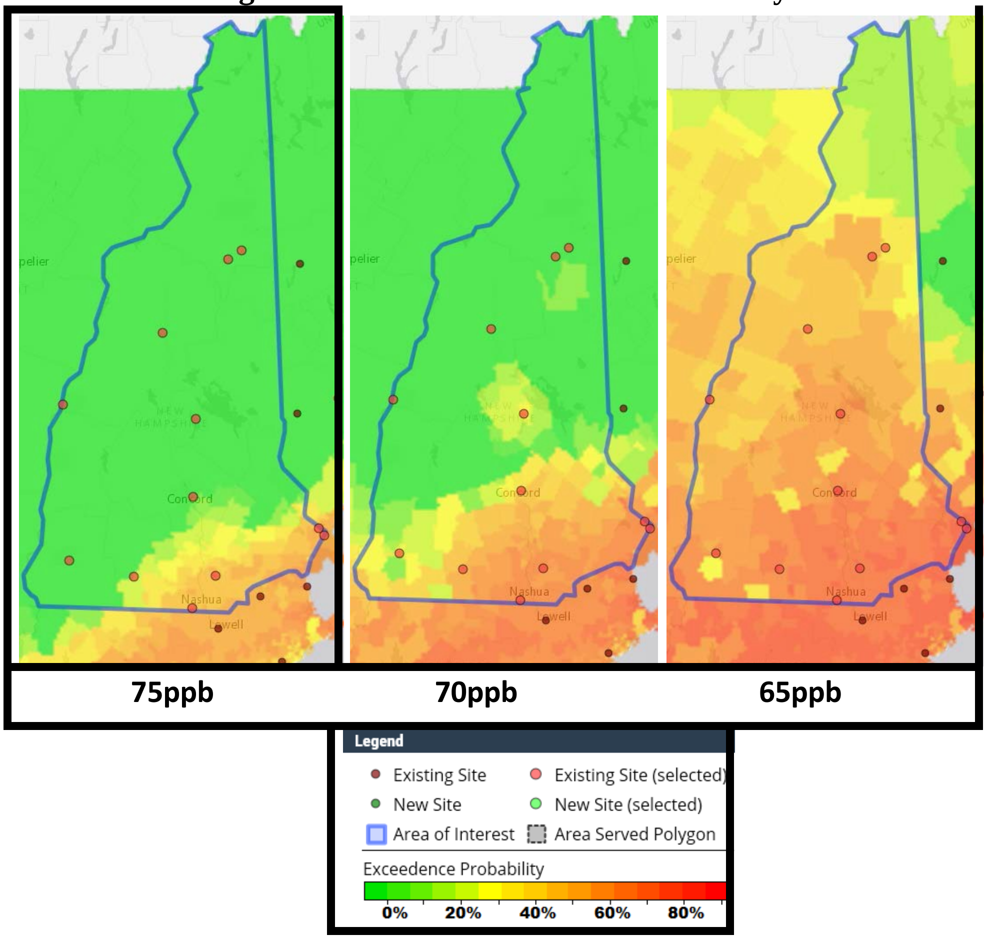
Figure 3.1: $PM_{2.5}$ Exceedance Probability (35µg/m^3)



For $PM_{2.5}$, all parts of New Hampshire are at very low risk of exceedance. Interestingly, the southwest region around Keene, where New Hampshire monitors have recorded unhealthy levels in winter, shows no discernable risk in this map.

For ozone, the exceedance probability for the current NAAQS of 75ppb is very low in most of the state, but moderate in the southeastern part of the state. The area of higher probability extends further west and north given a 70 ppb standard and covers nearly half the state in the case of 65ppb. The coastal and south-central regions are consistently at greatest risk of high ozone relative to other areas in New Hampshire. High elevations also stand out at the lower thresholds.

Figure 3.2: Ozone Exceedance Probability



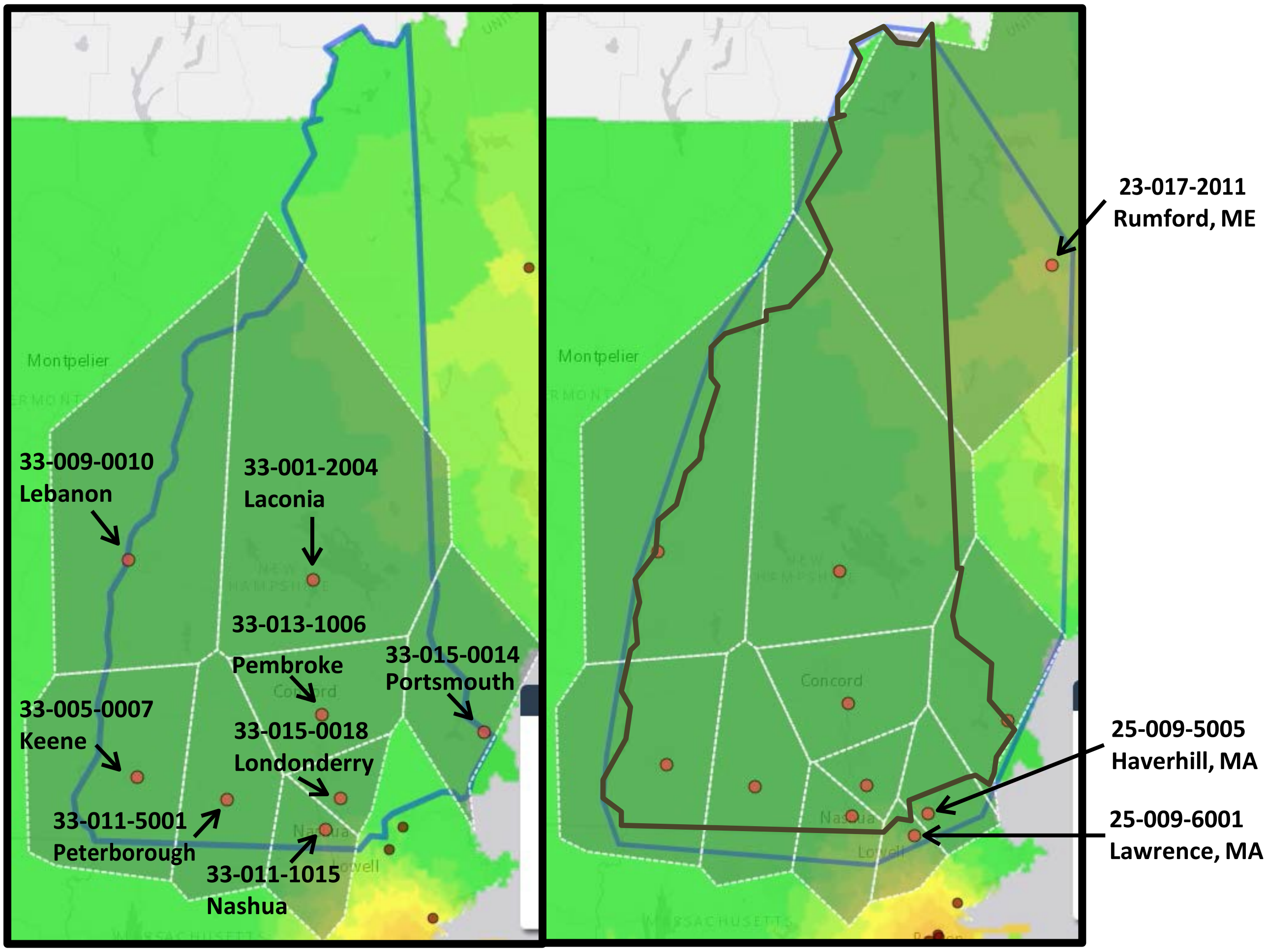
Area Served

Figures 3.3 and 3.4 show the areas served by each $PM_{2.5}$ and ozone monitor in the New Hampshire air monitoring network, respectively. The area served by a site includes any location closer to that site than another, even if the nearest site is in a bordering state.

Selection of the area within which monitoring sites are considered may be accomplished in more than one way. For this analysis, the state of New Hampshire was selected as the initial area of interest. A second area was set by drawing a polygon to include some sites in neighboring states.

In each figure the left map represents the area of interest bounded by the New Hampshire border, and 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 right map in each figure includes areas served by the Maine and Massachusetts monitors that fill these gaps.

Figure 3.3: Areas Served by $PM_{2.5}$ Monitors in and near New Hampshire



Area Boundary: New Hampshire border

Area Boundary: polygon encompassing New Hampshire

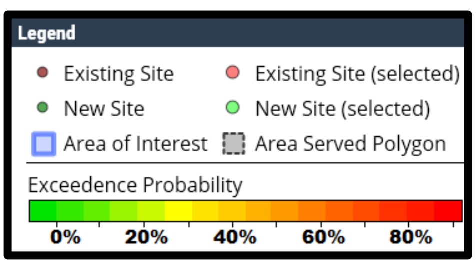
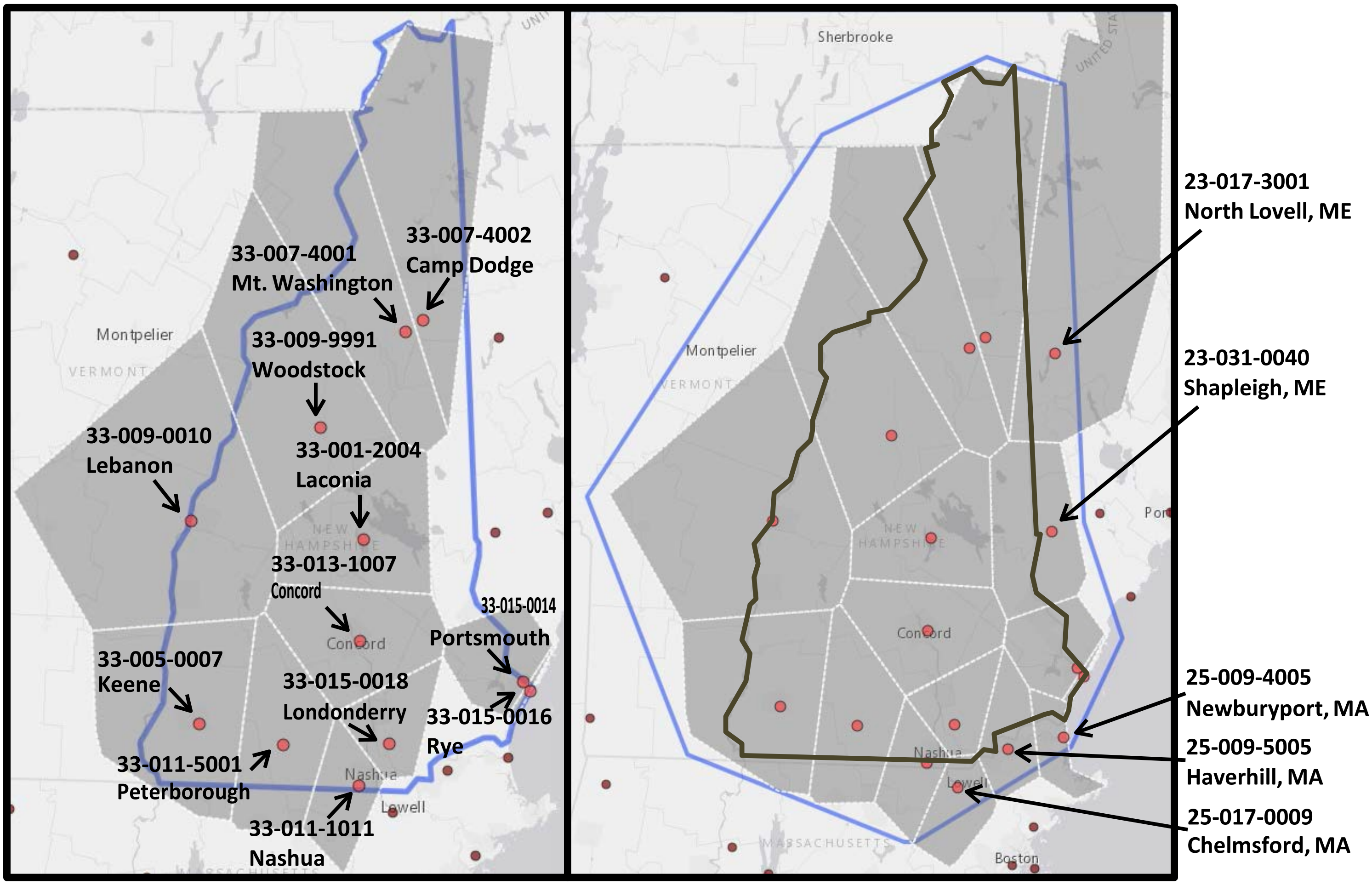


Figure 3.4
Areas Served by Ozone Monitors
in and near New Hampshire



Area Boundary:
New Hampshire border

Area Boundary: polygon
encompassing New Hampshire

Correlation Matrix

We applied the correlation matrix tool to 2011-2013 data for:

- All $PM_{2.5}$ (FEM and FRM)
- FRM $PM_{2.5}$
- FEM Continuous $PM_{2.5}$
- Continuous Ozone

Outputs calculated for the sites in these areas come in graphic (matrix) and tabular format.

The matrix pairs each site with other the sites in the selected area. In the graphical display, an ellipse is drawn for each site pair. The number inside the ellipse represents the distance in kilometers between the sites. The shape of the ellipse indicates the degree of correlation: the more circular the shape, the worse the correlation (lower R); the more ovular the shape, the better the correlation (higher R); a straight line is a perfect correlation (R=1). Finally, the color of the shape illustrates the average relative difference in concentration: the lighter the color, the lower the difference; the darker the color, the greater the difference.

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.

The following pages present the graphic output and tabular results from the correlation matrix tool. The tables are color coded as follows: sites outside New Hampshire are gray; correlations greater than 0.8 and relative differences less than 0.2 are medium orange; correlations greater than 0.9 and relative differences less than 0.1 are dark orange with bolded values. Thus, orange suggests possible redundancy. On the other end, no $PM_{2.5}$ or ozone correlations fall under 0.2, and no relative differences are greater than 0.8.

Correlation Matrix: $PM_{2.5}$

The correlation matrix was run for $PM_{2.5}$ using (1) all $PM_{2.5}$ sites – Figure 3.5; (2) only FRM sites – Figure 3.6; and (3) only FEM sites – Figure 3.7. The matrix for each case and a table of all correlations and relative differences (Table 3.1) are presented below.

Solely considering New Hampshire FRM sites, six pairs stand out with correlations greater than 0.8 and relative differences between 0.2 and 0.3 (none are less than 0.2): Laconia-Lebanon, Laconia-Londonderry, Nashua-Pembroke, Nashua-Portsmouth, Nashua-Londonderry, and Portsmouth-Londonderry.

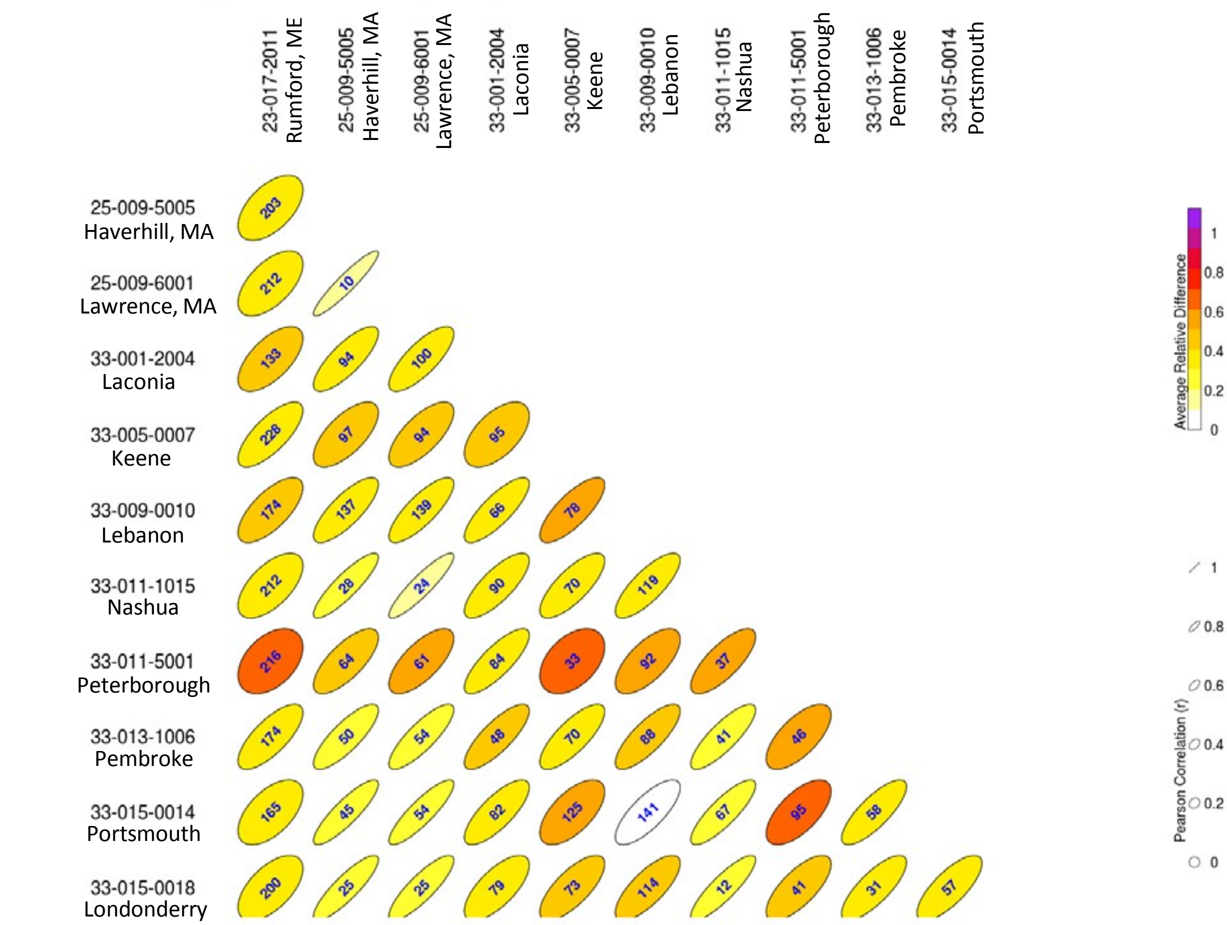
Of these, Portsmouth-Londonderry is the only pair in which both sites also have FEM data. Using both FRM and FEM data, these sites look more distinct; the correlation drops to between 0.761, and the relative difference increases to nearly 0.4. Similarly, for two of the above six site pairs where one has FEM data (Laconia-Lebanon and Laconia-Londonderry), accounting for both datasets lowers the correlation to 0.7-0.8 and raises the relative difference to 0.3-0.5.

For only two site pairs where one has FEM data does the correlation remain over 0.8 and the relative difference below 0.3 when taking FRM and FEM together: Nashua-Portsmouth and Nashua-Londonderry. Since only one site in each of these pairs has FEM data, the comparative dataset is still limited by the frequency of FRM sampling. Nashua-Pembroke shares similar values, but with no FEM data for comparison.

In summary, the only site where the correlation matrix encourages further investigation of potential redundancy is Nashua. Nashua demonstrates potential redundancy with several other sites, including Londonderry only 12 miles away and Lawrence only 24 miles over the Massachusetts border.

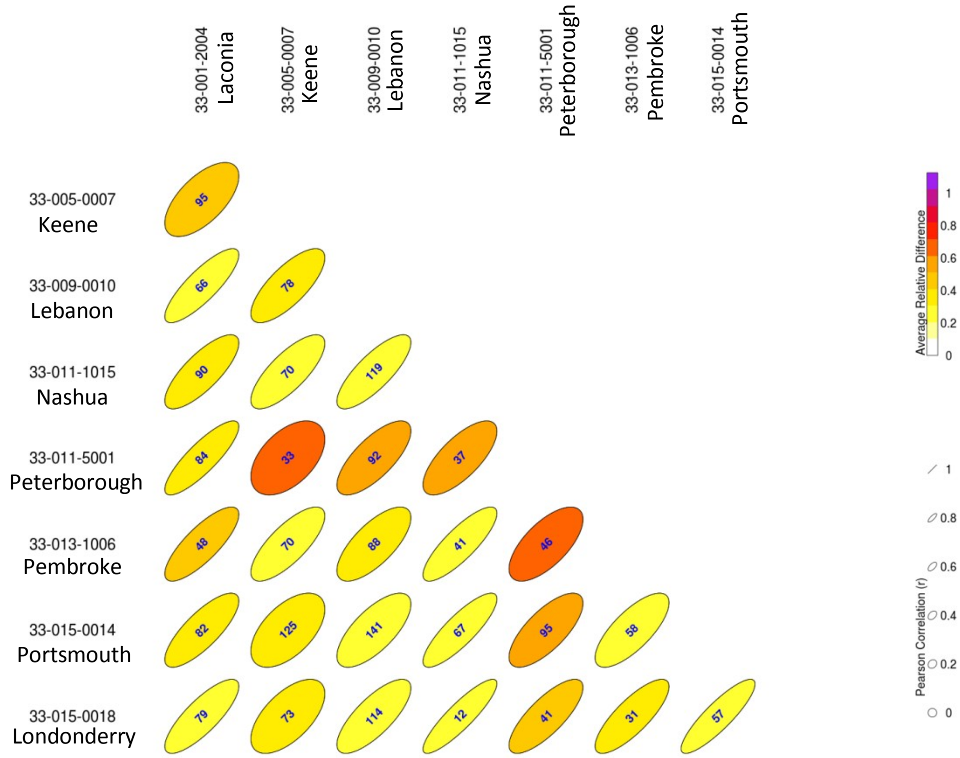
No sites demonstrate extreme variation with other sites; most have moderate correlations and relative differences. The most distinct site pair is Keene-Peterborough, with a correlation of 0.443 and relative difference of 0.659. Sites are spread out fairly evenly over the lower half of the state and include niche environments, such as the mountaintop of Pack Monadnock in Peterborough, the Keene valley, and the Portsmouth coast. The correlation matrix results suggest these sites share similar concentration patterns on some days and exhibit unique air quality conditions on other days.

Figure 3.5: Daily PM2.5 FRM/FEM (88101) Correlation Matrix - All Valid Pairs



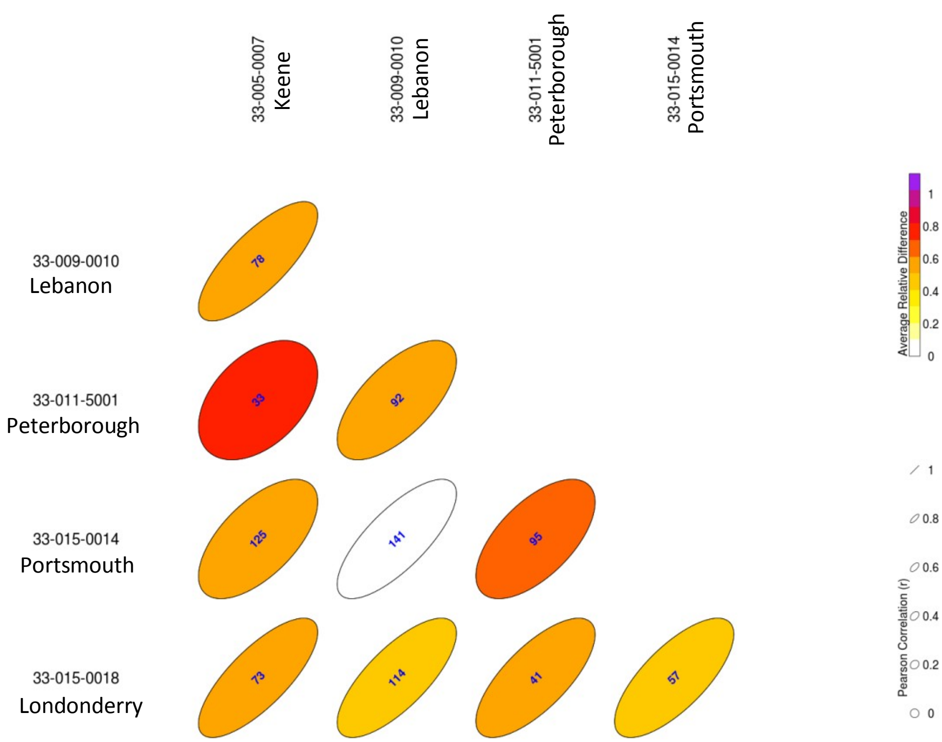
values in ellipse = distance in kilometers

Figure 3.6: Daily PM2.5 FRM Only (88101) Correlation Matrix - All Valid Pairs



values in ellipse = distance in kilometers

Figure 3.7: Daily PM2.5 FEM Only (88101) Correlation Matrix - All Valid Pairs



values in ellipse = distance in kilometers

Table 3.1: Correlation Matrix Results for $PM_{2.5}$												
$PM_{2.5}$ Site Pairs			All $PM_{2.5}$			FRM $PM_{2.5}$			FEM $PM_{2.5}$			
Site 1	Site 2	Dist. (km)	n	Correlation (R)	Rel. Diff	n	Correlation (R)	Rel. Diff	n	Correlation (R)	Rel. Diff
Rumford, ME	Haverhill, MA	203	176	0.549	0.365	176	0.549	0.365			
Rumford, ME	Lawrence, MA	212	184	0.589	0.372	184	0.589	0.372			
Rumford, ME	Laconia, NH	133	159	0.637	0.431	159	0.637	0.431			
Rumford, ME	Keene, NH	228	180	0.742	0.351	144	0.710	0.349			
Rumford, ME	Lebanon, NH	174	178	0.695	0.413	84	0.683	0.359			
Rumford, ME	Nashua, NH	212	159	0.614	0.347	159	0.614	0.347			
Rumford, ME	Peterborough, NH	216	180	0.430	0.605	167	0.372	0.669			
Rumford, ME	Pembroke, NH	174	185	0.742	0.309	185	0.742	0.309			
Rumford, ME	Portsmouth, NH	165	171	0.566	0.383	119	0.510	0.382			
Rumford, ME	Londonderry, NH	200	183	0.592	0.358	172	0.536	0.393			
Haverhill, MA	Lawrence, MA	10	347	**0.932**	0.164	347	**0.932**	0.164			
Haverhill, MA	Laconia, NH	94	161	0.795	0.333	161	0.795	0.333			
Haverhill, MA	Keene, NH	97	332	0.673	0.480	146	0.621	0.363			
Haverhill, MA	Lebanon, NH	137	332	0.790	0.364	83	0.700	0.311			
Haverhill, MA	Nashua, NH	28	159	0.877	0.218	159	0.877	0.218			
Haverhill, MA	Peterborough, NH	64	343	0.732	0.467	314	0.730	0.527			
Haverhill, MA	Pembroke, NH	50	346	0.817	0.289	346	0.817	0.289			
Haverhill, MA	Portsmouth, NH	45	303	0.870	0.267	122	0.870	0.225			
Haverhill, MA	Londonderry, NH	25	345	0.868	0.241	327	0.900	0.230			
Lawrence, MA	Laconia, NH	100	169	0.777	0.346	169	0.777	0.346			
Lawrence, MA	Keene, NH	94	341	0.702	0.454	153	0.711	0.331			
Lawrence, MA	Lebanon, NH	139	340	0.808	0.377	88	0.736	0.304			
Lawrence, MA	Nashua, NH	24	167	**0.906**	0.191	167	**0.906**	0.191			
Lawrence, MA	Peterborough, NH	61	351	0.702	0.517	322	0.702	0.583			
Lawrence, MA	Pembroke, NH	54	354	0.833	0.262	354	0.833	0.262			
Lawrence, MA	Portsmouth, NH	54	311	0.872	0.270	127	0.861	0.226			
Lawrence, MA	Londonderry, NH	25	353	0.852	0.268	334	0.885	0.262			
Laconia, NH	Keene, NH	95	171	0.574	0.456	147	0.632	0.449			
Laconia, NH	Lebanon, NH	66	168	0.811	0.368	83	0.834	0.268			
Laconia, NH	Nashua, NH	90	156	0.779	0.366	156	0.779	0.366			
Laconia, NH	Peterborough, NH	84	169	0.805	0.386	155	0.849	0.380			
Laconia, NH	Pembroke, NH	48	170	0.801	0.404	170	0.801	0.404			
Laconia, NH	Portsmouth, NH	82	160	0.772	0.340	120	0.791	0.321			
Laconia, NH	Londonderry, NH	79	172	0.703	0.375	159	0.811	0.295			
Keene, NH	Lebanon, NH	78	953	0.774	0.501	83	0.752	0.331	939	0.771	0.564
Keene, NH	Nashua, NH	70	171	0.765	0.340	142	0.765	0.300			
Keene, NH	Peterborough, NH	33	865	0.443	0.659	138	0.500	0.691	779	0.438	0.795
Keene, NH	Pembroke, NH	70	343	0.778	0.371	154	0.761	0.285			
Keene, NH	Portsmouth, NH	125	839	0.632	0.527	117	0.561	0.373	808	0.623	0.554
Keene, NH	Londonderry, NH	73	908	0.734	0.474	144	0.608	0.388	851	0.766	0.501
Lebanon, NH	Nashua, NH	119	167	0.790	0.368	82	0.794	0.249			
Lebanon, NH	Peterborough, NH	92	888	0.670	0.515	81	0.730	0.505	817	0.654	0.524
Lebanon, NH	Pembroke, NH	88	341	0.794	0.438	89	0.713	0.348			
Lebanon, NH	Portsmouth, NH	141	847	0.764	Inf	86	0.703	0.284	825	0.758	Inf
Lebanon, NH	Londonderry, NH	114	914	0.757	0.407	83	0.762	0.264	864	0.748	0.462
Nashua, NH	Peterborough, NH	37	171	0.758	0.527	157	0.722	0.595			
Nashua, NH	Pembroke, NH	41	168	0.832	0.243	168	0.832	0.243			
Nashua, NH	Portsmouth, NH	67	162	0.841	0.251	119	0.844	0.225			
Nashua, NH	Londonderry, NH	12	172	0.868	0.255	160	0.886	0.248			
Peterborough, NH	Pembroke, NH	46	354	0.675	0.575	323	0.668	0.648			
Peterborough, NH	Portsmouth, NH	95	760	0.651	0.608	117	0.727	0.564	668	0.616	0.628

Peterborough, NH	Londonderry, NH	41	858	0.730	0.482	308	0.781	0.468	752	0.725	0.503
Pembroke, NH	Portsmouth, NH	58	314	0.796	0.343	128	0.743	0.294			
Pembroke, NH	Londonderry, NH	31	355	0.784	0.329	335	0.805	0.325			
Portsmouth, NH	Londonderry, NH	57	801	0.761	0.397	120	0.874	0.228	738	0.730	0.432

Correlation Matrix: Ozone

NHDES prepared a correlation matrix for ozone sites (Figure 3.8). The matrix and a table of all correlations and relative differences (Table 3.2) are presented below.

Excluding sites outside New Hampshire or not operated by NHDES (Woodstock) and the high elevation sites Mount Washington and Pack Monadnock (Peterborough), the 36 remaining site pairs have a relative difference lower than 0.2. Over half of these also have a correlation greater than 0.8. This suggests a good deal of consistency in the ozone measurements of ground-level sites in New Hampshire.

Seven site pairs stand out with the greatest likelihood of redundancy due to very high correlations (>0.9) and very low relative differences (<0.1): Laconia-Concord, Keene-Nashua, Keene-Concord, Nashua-Concord, Nashua-Londonderry, Concord-Londonderry, and Portsmouth-Rye.

Concord appears in four of these pairs, Nashua in three, and Keene in two. Concord data bear similarity to four other sites from 39 (Laconia) to 69 (Keene) miles away. Nashua's most similar sites are from 20 (Londonderry) to 66 (Keene) miles away. Keene is over 60 miles away from its most similar site. Portsmouth and Rye are only four miles apart.

Mount Washington is the most unique ozone site, with the lowest correlations and highest relative differences compared to most other locations. Mount Washington's correlations are nearly all under 0.6, and its maximum correlation is 0.645 with Laconia; most of its relative differences are above 0.2.

The correlations from the top of Pack Monadnock in Peterborough are higher, ranging from 0.645 to 0.870, and the relative differences fall between 0.1 and 0.3. Interestingly, Peterborough data agrees best with the city of Nashua and other populated areas in southern New Hampshire and least with New Hampshire's other high elevation site, Mount Washington, and remote sites in the north. This is likely because Peterborough and other southern sites are largely influenced by the same air masses transported into New Hampshire from the southwest.

Figure 3.8: **8-Hour Daily Max Ozone Correlation Matrix - All Valid Pairs**

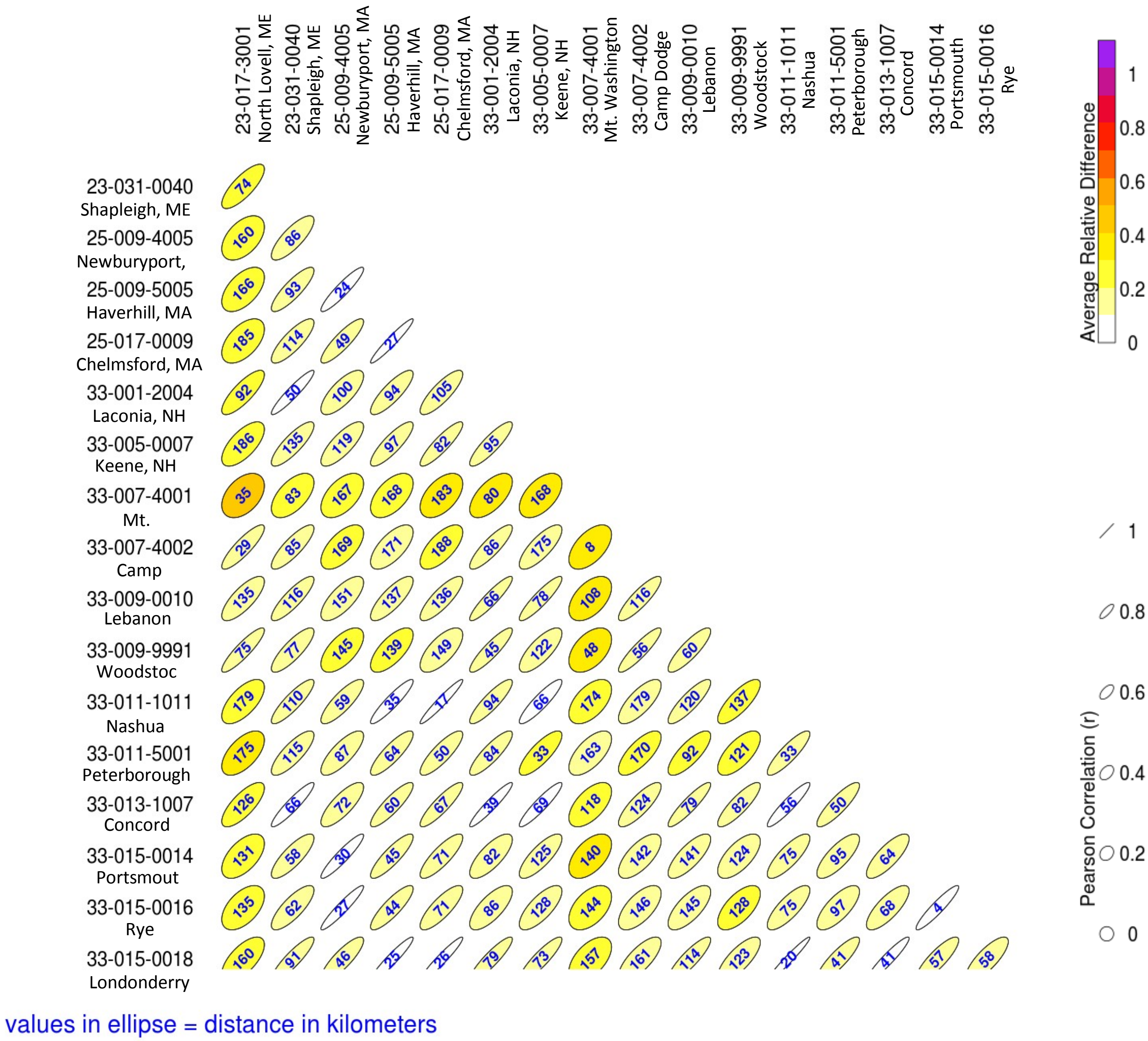


Table 3.2: Correlation Matrix Results for Ozone					
Ozone Site Pairs			**Results**		
Site 1	**Site 2**	**Dist. (km)**	**n**	**Correlation (R)**	**Rel. Diff**
North Lovell, ME	Shapleigh, ME	74	587	0.783	0.202
North Lovell, ME	Newburyport, MA	160	594	0.492	0.278
North Lovell, ME	Haverhill, MA	166	603	0.548	0.260
North Lovell, ME	Chelmsford, MA	185	599	0.536	0.277
North Lovell, ME	Laconia, NH	92	531	0.808	0.201
North Lovell, ME	Keene, NH	186	605	0.668	0.231
North Lovell, ME	Mt. Washington, NH	35	605	0.439	0.445
North Lovell, ME	Camp Dodge, NH	29	532	0.869	0.159
North Lovell, ME	Lebanon, NH	135	607	0.769	0.182
North Lovell, ME	Woodstock, NH	75	515	0.894	0.132
North Lovell, ME	Nashua, NH	179	528	0.650	0.283
North Lovell, ME	Peterborough, NH	175	605	0.593	0.323
North Lovell, ME	Concord, NH	126	524	0.753	0.232
North Lovell, ME	Portsmouth, NH	131	602	0.570	0.243
North Lovell, ME	Rye, NH	135	529	0.527	0.261
North Lovell, ME	Londonderry, NH	160	597	0.655	0.270
Shapleigh, ME	Newburyport, MA	86	583	0.796	0.134
Shapleigh, ME	Haverhill, MA	93	592	0.850	0.118
Shapleigh, ME	Chelmsford, MA	114	588	0.824	0.131
Shapleigh, ME	Laconia, NH	50	531	**0.938**	**0.080**
Shapleigh, ME	Keene, NH	135	594	0.834	0.123
Shapleigh, ME	Mt. Washington, NH	83	594	0.583	0.284
Shapleigh, ME	Camp Dodge, NH	85	530	0.840	0.138
Shapleigh, ME	Lebanon, NH	116	596	0.859	0.132
Shapleigh, ME	Woodstock, NH	77	513	0.832	0.156
Shapleigh, ME	Nashua, NH	110	528	0.872	0.122
Shapleigh, ME	Peterborough, NH	115	596	0.807	0.162
Shapleigh, ME	Concord, NH	66	524	**0.927**	**0.086**
Shapleigh, ME	Portsmouth, NH	58	591	0.815	0.125
Shapleigh, ME	Rye, NH	62	529	0.792	0.136
Shapleigh, ME	Londonderry, NH	91	586	0.892	0.111

Table 3.2: Correlation Matrix Results for Ozone (continued)					
Ozone Site Pairs			Results		
Site 1	Site 2	Dist. (km)	n	Correlation (R)	Rel. Diff
Newburyport, MA	Haverhill, MA	24	717	**0.923**	**0.089**
Newburyport, MA	Chelmsford, MA	49	720	0.873	0.107
Newburyport, MA	Laconia, NH	100	532	0.745	0.167
Newburyport, MA	Keene, NH	119	728	0.782	0.158
Newburyport, MA	Mt. Washington, NH	167	727	0.535	0.246
Newburyport, MA	Camp Dodge, NH	169	531	0.622	0.214
Newburyport, MA	Lebanon, NH	151	730	0.726	0.198
Newburyport, MA	Woodstock, NH	145	624	0.626	0.228
Newburyport, MA	Nashua, NH	59	529	0.833	0.128
Newburyport, MA	Peterborough, NH	87	728	0.778	0.137
Newburyport, MA	Concord, NH	72	525	0.790	0.148
Newburyport, MA	Portsmouth, NH	30	724	**0.929**	**0.074**
Newburyport, MA	Rye, NH	27	531	**0.945**	**0.083**
Newburyport, MA	Londonderry, NH	46	720	0.847	0.111
Haverhill, MA	Chelmsford, MA	27	734	**0.958**	**0.067**
Haverhill, MA	Laconia, NH	94	536	0.836	0.134
Haverhill, MA	Keene, NH	97	742	0.849	0.127
Haverhill, MA	Mt. Washington, NH	168	741	0.549	0.273
Haverhill, MA	Camp Dodge, NH	171	534	0.671	0.197
Haverhill, MA	Lebanon, NH	137	743	0.800	0.165
Haverhill, MA	Woodstock, NH	139	625	0.692	0.205
Haverhill, MA	Nashua, NH	35	532	**0.923**	**0.089**
Haverhill, MA	Peterborough, NH	64	741	0.851	0.140
Haverhill, MA	Concord, NH	60	529	0.872	0.111
Haverhill, MA	Portsmouth, NH	45	738	0.865	0.102
Haverhill, MA	Rye, NH	44	534	0.857	0.116
Haverhill, MA	Londonderry, NH	25	734	**0.947**	**0.086**
Chelmsford, MA	Laconia, NH	105	531	0.828	0.144
Chelmsford, MA	Keene, NH	82	1072	0.888	0.135
Chelmsford, MA	Mt. Washington, NH	183	1061	0.524	0.301
Chelmsford, MA	Camp Dodge, NH	188	529	0.668	0.209
Chelmsford, MA	Lebanon, NH	136	1070	0.826	0.172
Chelmsford, MA	Woodstock, NH	149	899	0.685	0.200
Chelmsford, MA	Nashua, NH	17	528	**0.961**	**0.061**
Chelmsford, MA	Peterborough, NH	50	1060	0.841	0.151
Chelmsford, MA	Concord, NH	67	524	0.884	0.112
Chelmsford, MA	Portsmouth, NH	71	1067	0.834	0.131
Chelmsford, MA	Rye, NH	71	529	0.813	0.142
Chelmsford, MA	Londonderry, NH	26	1065	**0.955**	**0.084**

Table 3.2: Correlation Matrix Results for Ozone (continued)

Ozone Site Pairs			Results		
Site 1	**Site 2**	**Dist. (km)**	**n**	**Correlation (R)**	**Rel. Diff**
Laconia, NH	Keene, NH	95	539	0.872	0.116
Laconia, NH	Mt. Washington, NH	80	539	0.624	0.313
Laconia, NH	Camp Dodge, NH	86	535	0.859	0.122
Laconia, NH	Lebanon, NH	66	541	**0.915**	0.103
Laconia, NH	Woodstock, NH	45	465	0.893	0.129
Laconia, NH	Nashua, NH	94	533	0.878	0.130
Laconia, NH	Peterborough, NH	84	541	0.860	0.177
Laconia, NH	Concord, NH	39	530	**0.945**	**0.080**
Laconia, NH	Portsmouth, NH	82	533	0.751	0.154
Laconia, NH	Rye, NH	86	535	0.729	0.156
Laconia, NH	Londonderry, NH	79	532	**0.904**	0.124
Keene, NH	Mt. Washington, NH	168	1067	0.537	0.363
Keene, NH	Camp Dodge, NH	175	537	0.781	0.161
Keene, NH	Lebanon, NH	78	1076	**0.905**	0.123
Keene, NH	Woodstock, NH	122	904	0.758	0.189
Keene, NH	Nashua, NH	66	535	**0.901**	**0.100**
Keene, NH	Peterborough, NH	33	1066	0.806	0.212
Keene, NH	Concord, NH	69	532	**0.926**	**0.086**
Keene, NH	Portsmouth, NH	125	1073	0.797	0.164
Keene, NH	Rye, NH	128	537	0.742	0.152
Keene, NH	Londonderry, NH	73	1071	0.892	0.158
Mt. Washington, NH	Camp Dodge, NH	8	537	0.563	0.364
Mt. Washington, NH	Lebanon, NH	108	1064	0.511	0.391
Mt. Washington, NH	Woodstock, NH	48	894	0.483	0.382
Mt. Washington, NH	Nashua, NH	174	535	0.545	0.255
Mt. Washington, NH	Peterborough, NH	163	1056	0.645	0.191
Mt. Washington, NH	Concord, NH	118	532	0.595	0.292
Mt. Washington, NH	Portsmouth, NH	140	1061	0.539	0.312
Mt. Washington, NH	Rye, NH	144	537	0.493	0.299
Mt. Washington, NH	Londonderry, NH	157	1059	0.549	0.252
Camp Dodge, NH	Lebanon, NH	116	539	0.864	0.129
Camp Dodge, NH	Woodstock, NH	56	464	0.899	0.114
Camp Dodge, NH	Nashua, NH	179	532	0.745	0.187
Camp Dodge, NH	Peterborough, NH	170	540	0.724	0.241
Camp Dodge, NH	Concord, NH	124	528	0.826	0.144
Camp Dodge, NH	Portsmouth, NH	142	532	0.685	0.187
Camp Dodge, NH	Rye, NH	146	533	0.648	0.189
Camp Dodge, NH	Londonderry, NH	161	530	0.749	0.193

Table 3.2: Correlation Matrix Results for Ozone (continued)					
Ozone Site Pairs			**Results**		
Site 1	**Site 2**	**Dist. (km)**	**n**	**Correlation (R)**	**Rel. Diff**
Lebanon, NH	Woodstock, NH	60	903	0.855	0.147
Lebanon, NH	Nashua, NH	120	538	0.860	0.161
Lebanon, NH	Peterborough, NH	92	1064	0.777	0.241
Lebanon, NH	Concord, NH	79	534	**0.909**	0.113
Lebanon, NH	Portsmouth, NH	141	1071	0.770	0.177
Lebanon, NH	Rye, NH	145	539	0.707	0.180
Lebanon, NH	Londonderry, NH	114	1069	0.874	0.182
Woodstock, NH	Nashua, NH	137	462	0.789	0.214
Woodstock, NH	Peterborough, NH	121	897	0.677	0.233
Woodstock, NH	Concord, NH	82	460	0.856	0.162
Woodstock, NH	Portsmouth, NH	124	902	0.665	0.190
Woodstock, NH	Rye, NH	128	466	0.640	0.222
Woodstock, NH	Londonderry, NH	123	899	0.766	0.180
Nashua, NH	Peterborough, NH	33	538	0.870	0.125
Nashua, NH	Concord, NH	56	527	**0.929**	**0.095**
Nashua, NH	Portsmouth, NH	75	530	0.809	0.142
Nashua, NH	Rye, NH	75	531	0.788	0.150
Nashua, NH	Londonderry, NH	20	529	**0.972**	**0.056**
Peterborough, NH	Concord, NH	50	534	0.866	0.156
Peterborough, NH	Portsmouth, NH	95	1062	0.775	0.170
Peterborough, NH	Rye, NH	97	539	0.733	0.183
Peterborough, NH	Londonderry, NH	41	1059	0.864	0.112
Concord, NH	Portsmouth, NH	64	526	0.790	0.140
Concord, NH	Rye, NH	68	528	0.769	0.145
Concord, NH	Londonderry, NH	41	526	**0.941**	**0.092**
Portsmouth, NH	Rye, NH	4	531	**0.932**	**0.072**
Portsmouth, NH	Londonderry, NH	57	1067	0.852	0.128
Rye, NH	Londonderry, NH	58	531	0.797	0.143

Removal Bias

The next pages show removal bias maps (Figures 3.9 and 3.10) and tables (Tables 3.3 and 3.4) for $PM_{2.5}$ and ozone. These are provided as the mean, minimum, and maximum of all daily samples. 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.

The NetAssess tool expresses removal bias in the same units as the pollutant, representing the difference between interpolated and measured concentrations (calculated for every day with data), and as a percentage, representing the percent by which the interpolated concentration differs from the measured value. Below, results are discussed and compared to the correlation matrix results.

Removal Bias: $PM_{2.5}$

Most of the $PM_{2.5}$ sites in New Hampshire are color coded a dark pink or blue in the results map, meaning the average removal bias is fairly high or low, respectively. These darker colors suggest removing these sites would produce a significant over or under estimate of the concentrations in these locations. Three sites are much lighter in color, and their data reveal average removal biases less than one µg/m^3: Nashua, Londonderry, and Portsmouth.

For Portsmouth, the average removal bias is slightly positive, so the location's values would be slightly over predicted based on interpolation. Portsmouth's average bias is closest to zero, and the standard deviation is 2.7 µg/m^3, meaning the daily biases average out to within 2.7 µg/m^3 of the mean bias of 0.1389 µg/m^3. However, Portsmouth's minimum and maximum differences are about 14 and 12 µg/m^3. These variations could make a significant difference when comparing the concentrations to the national standards or the thresholds of the air quality index.

Londonderry also has a slightly positive average bias, 0.7271 µg/m^3. Its minimum is lower than Portsmouth's, only -7.3 µg/m^3, but its maximum is similar at 11.2 µg/m^3. Londonderry's standard deviation is 2.25 µg/m^3.

Nashua's mean relative bias is -0.7302 µg/m^3. It has a minimum of -10.7 µg/m^3, but a small maximum of 3.74 µg/m^3. The standard deviation is only 1.82 µg/m^3, the lowest of all the New Hampshire sites, except that of Laconia.

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. Based on FEM and FRM data, neither Portsmouth nor Londonderry have a correlation greater than 0.8, with the exception of Portsmouth compared to Nashua (0.841). Both also have relative differences of at least 0.3, again with the exception of Portsmouth and Nashua (0.25). 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.

Correlation matrix results indicate Nashua is the $PM_{2.5}$ site most likely to be redundant. With Nashua's very low relative bias and relatively low standard deviation, the removal bias tool indicates removing Nashua would not lead to significant misrepresentation of the area's $PM_{2.5}$ levels. However, the bias, though small, is negative, so removing this site may more often err on the side of an underestimate.

Figure 3.9:
Mean Removal Biases for New Hampshire's $PM_{2.5}$ Sites

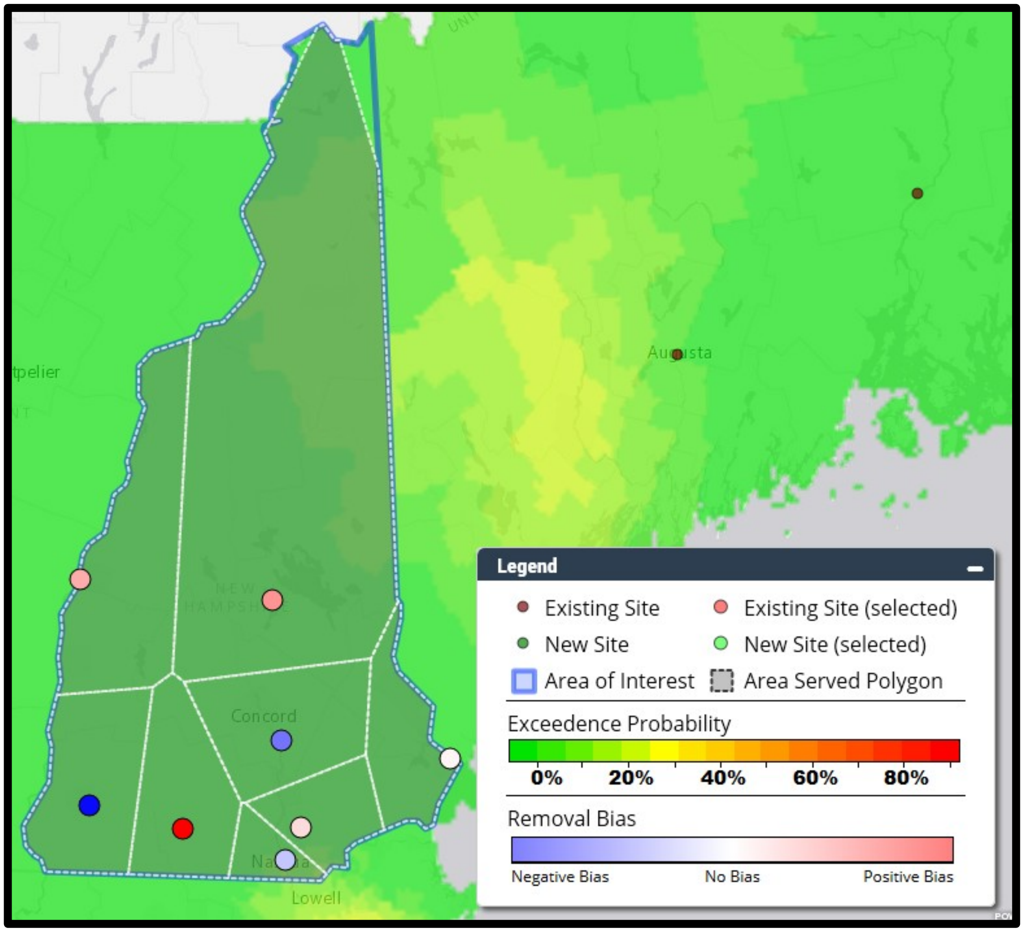


Table 3.3: Removal Bias Results for $PM_{2.5}$									
$PM_{2.5}$ Sites		Neighbors Included	Removal Bias ($\mu g/m^3$)				Removal Bias (%)		
Site ID	Site Location		Mean	Min	Max	Standard Deviation	Mean	Min	Max
23-017-2011	Rumford, ME	7	-0.979	-16.9	5.74	3.02	-4	-71	134
25-009-5005	Haverhill, MA	5	0.4246	-2.95	5.95	1.28	9	-48	180
25-009-6001	Lawrence, MA	6	-0.3799	-7.02	2.29	1.33	-2	-66	137
33-001-2004	Laconia, NH	7	1.3467	-3.95	7.48	1.77	35	-31	190
33-005-0007	Keene, NH	6	-3.1779	-30.4	7.29	5.46	-21	-2065	1778
33-009-0010	Lebanon, NH	5	1.0851	-6.6	19.3	3.06	26	-3200	1221
33-011-1015	Nashua, NH	6	-0.7302	-10.7	3.74	1.83	-5	-62	78
33-011-5001	Peterborough, NH	6	3.3005	-7.13	29.1	4.98	105	-2670	10097
33-013-1006	Pembroke, NH	6	-1.7333	-12.8	8.94	2.60	-12	-74	1277
33-015-0014	Portsmouth, NH	6	0.1389	-13.7	11.7	2.71	16	-874	800
33-015-0018	Londonderry, NH	4	0.7271	-7.3	11.2	2.25	23	-854	1237

Removal Bias: Ozone

In contrast to $PM_{2.5}$, many of the ozone sites in New Hampshire are color coded a very light pink or blue in the results map. Mount Washington and Camp Dodge in the north are the clear exception, and this is not surprising given the extreme elevation of Mount Washington compared to the remote Camp Dodge site at its base. The lightest colored sites are in the south-central and southeastern regions, which are also the most populated and most at risk of exceeding the current or a future ozone standard. Concord, Laconia, Nashua, Portsmouth, and Rye have a mean removal bias of about 0.001 ppm, and Londonderry's is about -0.001 ppm.

Of these, Portsmouth and Rye have the largest swing in minimum and maximums, though the standard deviation is only about 0.004 ppm. These sites also appeared somewhat redundant in the correlation matrix. These results suggest data from these sites should be considered in more detail to determine whether they are likely to be significantly different on days when ozone is high at either coastal location.

Concord, Laconia, and Nashua all have standard deviations of 0.001 ppm. Concord and Nashua have minimum differences less than 0.010 ppm, but maximum differences over 0.010 ppm; for Laconia, minimum and maximum differences are greater than 0.010 ppm. According to the correlation matrix, Laconia agrees very well with Concord, but is fairly distinct from other sites.

Concord and Nashua, however, both agree well with several other sites based on the correlation matrix. For Nashua, one of the closest correlations is with Londonderry, only 20 miles away. 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, up to 0.016 or 0.013 ppm for Concord and Nashua, respectively.

Figure 3.10: Mean Removal Biases for New Hampshire's Ozone Sites

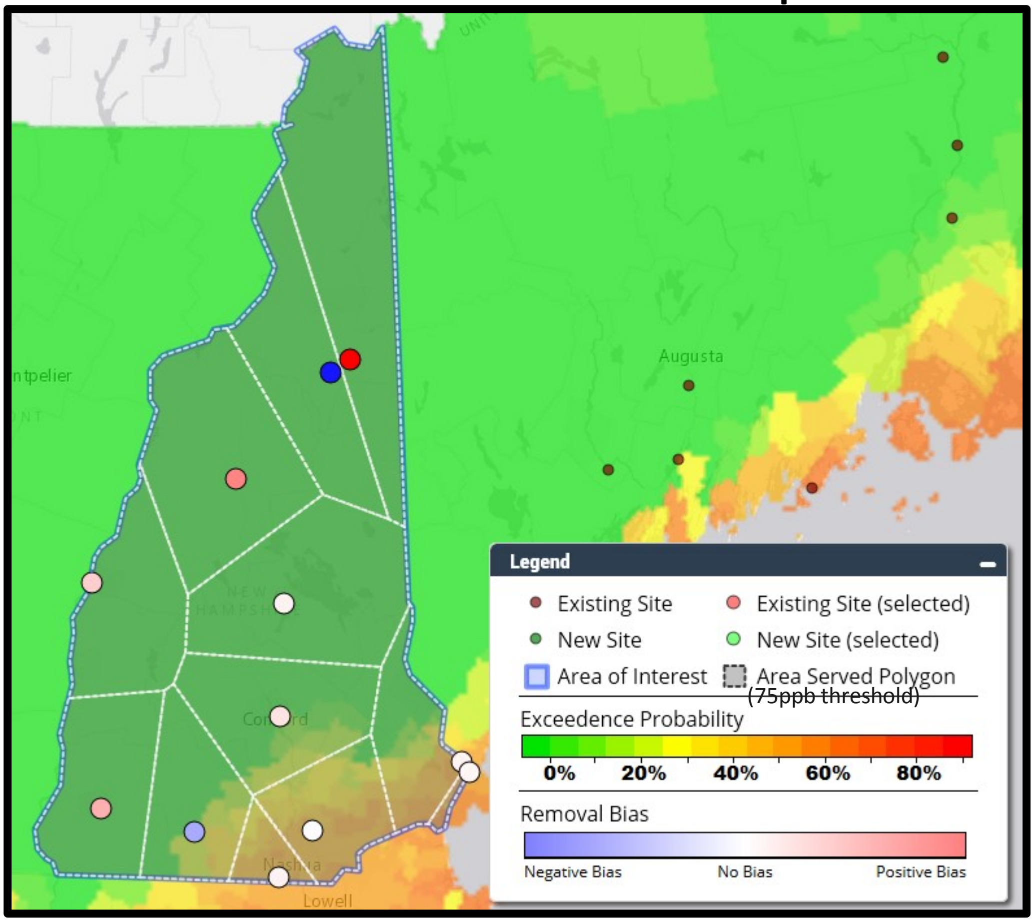


Table 3.4: Removal Bias Results for Ozone									
Ozone Sites		Neighbors Included	Removal Bias (ppm)*				Removal Bias (%)		
Site ID	Site Location		Mean	Min	Max	Standard Deviation	Mean	Min	Max
23-017-3001	North Lovell, ME	7	0.004	-0.009	0.030	0.005	16	-32	156
23-031-0040	Shapleigh, ME	8	0.000	-0.012	0.013	0.003	0	-21	43
25-009-4005	Newburyport, MA	5	-0.001	-0.018	0.008	0.003	-3	-43	21
25-009-5005	Haverhill, MA	5	0.001	-0.017	0.011	0.003	5	-21	375
25-017-0009	Chelmsford, MA	7	0.000	-0.012	0.018	0.003	1	-31	502
33-001-2004	Laconia, NH	5	0.001	-0.012	0.010	0.003	3	-21	45
33-005-0007	Keene, NH	6	0.005	-0.017	0.029	0.006	22	-56	794
33-007-4001	Mt. Washington, NH	5	-0.013	-0.048	0.001	0.009	-27	-88	2
33-007-4002	Camp Dodge, NH	5	0.013	-0.009	0.046	0.009	48	-18	921
33-009-0010	Lebanon, NH	7	0.003	-0.007	0.023	0.004	16	-25	825
33-009-9991	Woodstock, NH	4	0.007	-0.012	0.033	0.006	29	-30	1093
33-011-1011	Nashua, NH	5	0.001	-0.006	0.013	0.003	4	-11	66
33-011-5001	Peterborough, NH	7	-0.005	-0.028	0.009	0.005	-12	-74	49
33-013-1007	Concord, NH	6	0.001	-0.008	0.016	0.003	5	-19	74
33-015-0014	Portsmouth, NH	7	0.001	-0.019	0.024	0.004	3	-53	300
33-015-0016	Rye, NH	4	0.001	-0.023	0.023	0.004	2	-37	54
33-015-0018	Londonderry, NH	6	-0.001	-0.010	0.013	0.002	-3	-35	187

* Removal biases have been rounded to the nearest thousandths in ppm.

Follow-up Analyses

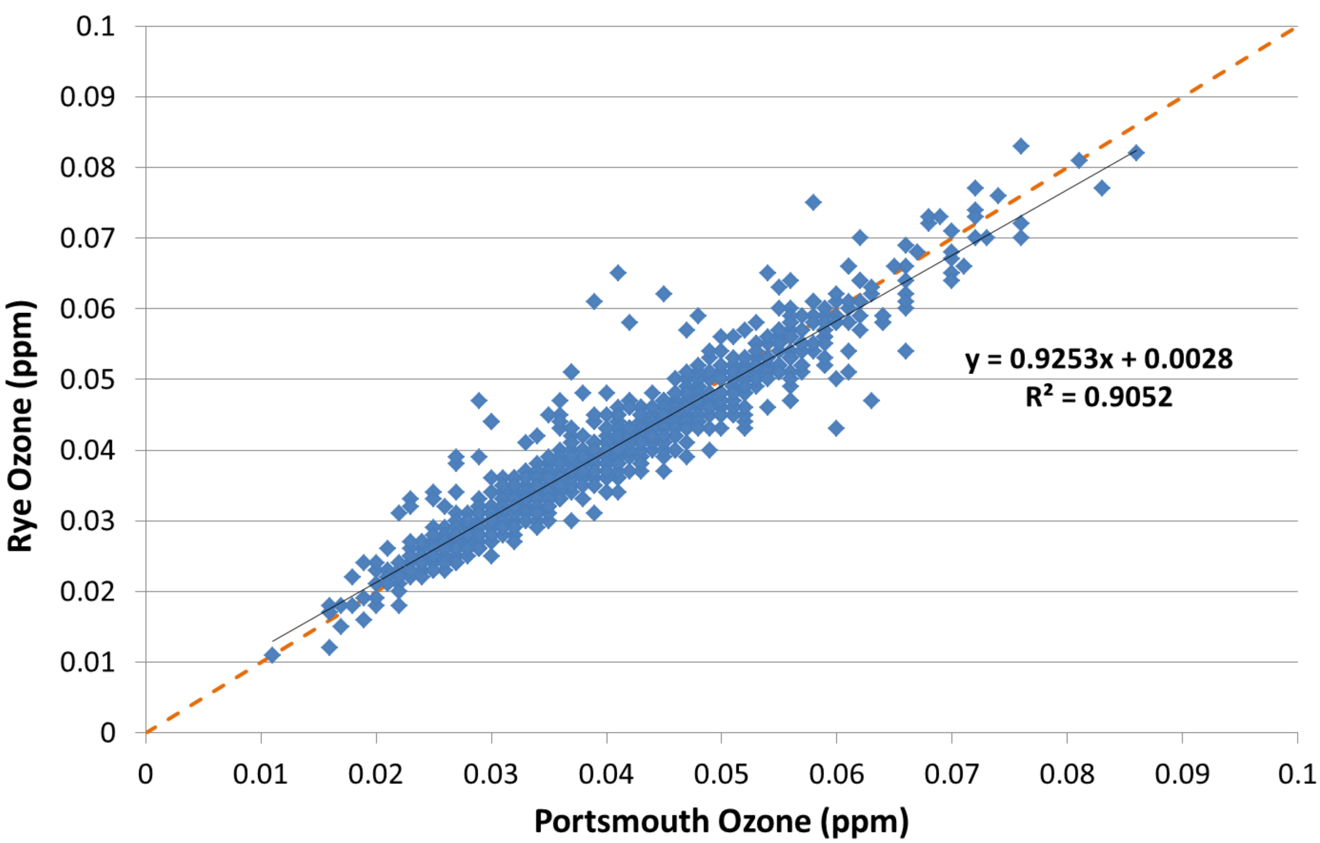
Based on the NetAssess ozone correlation matrix and relative bias results, Portsmouth, Rye, Concord, and Nashua may be redundant with nearby sites. To investigate further, scatter plots were created for each of these sites with their nearest neighbors using five years of daily maximum eight-hour averages (2009-2014). Only days with at least 18 valid eight-hour averages (75% completeness) were included in these plots, which are presented and discussed below.

Portsmouth and Rye

These two coastal sites are only four miles apart, though located in a highly populated area at high risk of ozone exceedances. Figure 3.11 reinforces that, as suggested by the correlation matrix, these sites correlate very well. The trend line stays very close to the 1:1 line, except at concentrations above 0.065 ppm. Below this threshold, the two often agree, but frequent outliers do appear; when the sites differ significantly, Rye tends to be higher than Portsmouth.

Above the moderate threshold are fewer data points, and either site may be above the other. No distinct outliers appear over 0.07 ppm at either site, and the greatest difference at this end of the dataset is 0.007 ppm on a day when Rye reached 0.083 ppm and Portsmouth 0.076 ppm. Though Portsmouth's ozone does frequently exceed Rye's, Rye more often exceeds Portsmouth by a significant amount. The R^2 of 0.9052 is quite high, though still well below 1.0. These data suggest the sites are often quite similar, but variability exists, with Rye being the most conservative site.

Figure 3.11: **Daily Max 8-Hour Ozone 2009-2014 Portsmouth and Rye**



Concord

A scatter plot (not shown) of Concord and Nashua daily maximum eight-hour ozone values produce a trend line with an R^2 of only 0.85. Shown in Figures 3.12 and 3.13, Concord has an R^2 of about 0.88, though still under 0.90, with its two nearest neighbors: Laconia (39 miles) and Londonderry (41 miles). The Concord-Londonderry plot contains more outliers, and the trend line runs parallel to and above the 1:1 line, indicating Londonderry consistently experiences higher ozone. Concord's best correlation is with Laconia. At values above the moderate threshold, differences are usually in the single digits ppb.

Figure 3.12: Daily Max 8-Hour Ozone 2009-2014 Concord and Londonderry

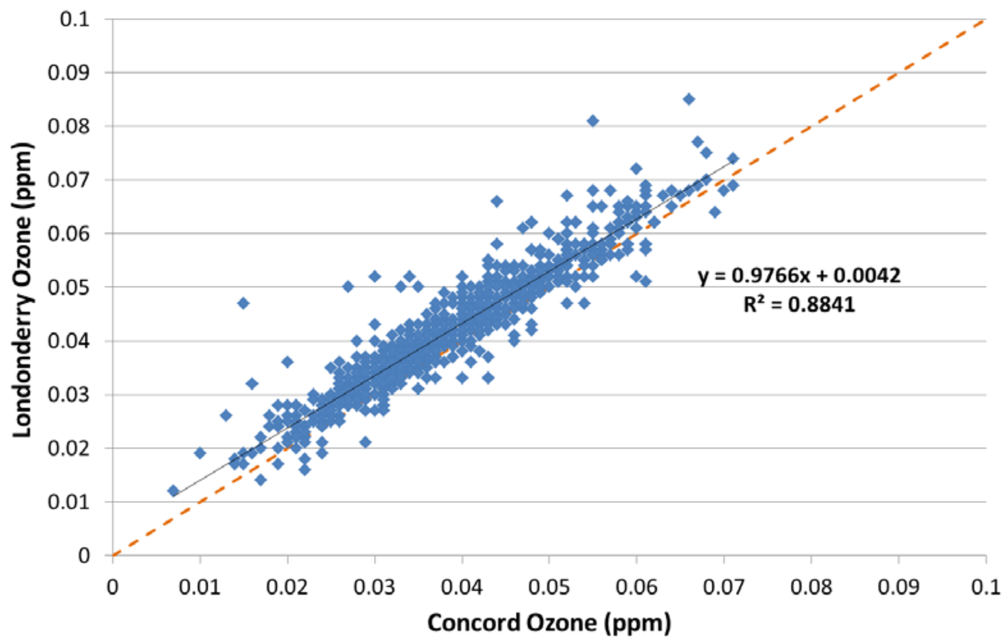
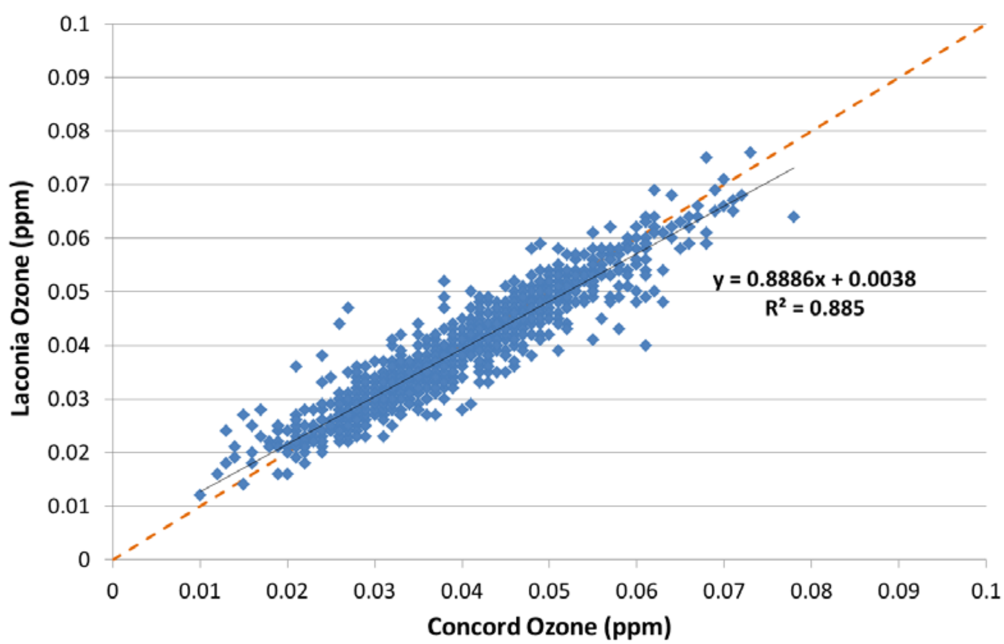


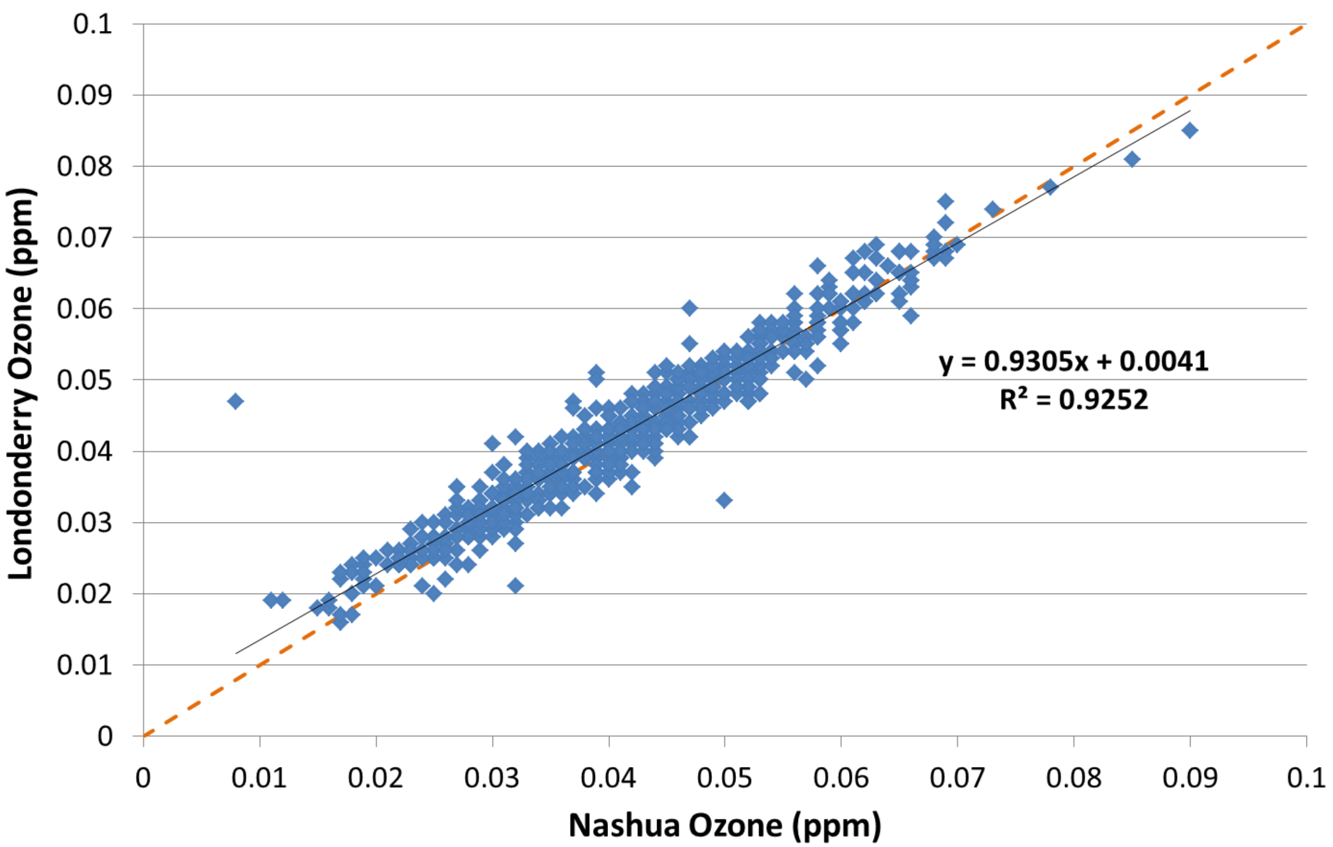
Figure 3.13: Daily Max 8-Hour Ozone 2009-2014 Concord and Laconia



Nashua

The closest site to Nashua is Londonderry, about 20 miles away. As shown in Figure 3.14, these two sites agree very well through most of the range of values, hugging the 1:1 line with very few outliers and an R^2 of 0.9252. These data are consistent with the NetAssess tools suggesting redundancy in these two ozone sites.

Figure 3.14: Daily Max 8-Hour Ozone 2009-2014 Nashua and Londonderry



Conclusions

PM$_{2.5}$

The NetAssess correlation matrix highlights Nashua as the site with the most redundancy compared with other sites. New Hampshire discontinued $PM_{2.5}$ monitoring in Nashua at the end of 2014, now relying on the new NCORE site in nearby Londonderry (12 miles away) to represent $PM_{2.5}$ in this area. The removal bias indicates Nashua's FRM discontinuation could lead to a slight underestimate of concentrations in the Nashua area, but the most recent measured concentrations were well below the NAAQS and the average bias by using nearby monitors is very small. Pembroke $PM_{2.5}$ FRM monitoring was also discontinued during 2014. The NetAssess results support this shift in $PM_{2.5}$ monitoring in southern New Hampshire. Other sites are well distributed, and overall, the network achieves the desirable $PM_{2.5}$ monitoring coverage.

Ozone

Ozone sites demonstrated consistency in the coastal and southern interior sites. The NetAssess tools and additional analyses suggest two potentially redundant sites: Portsmouth (with Rye) and Nashua (with Londonderry). The R^2 values from five years of data for these site pairings are 0.9052 and 0.9252, respectively. Other sites are very distinct or represent a distinct region or environment, such as the high elevation site Mount Washington.

Portsmouth and Rye on the seacoast are close in distance (4 miles) and concentrations. Rye tends to be more likely to experience the highest ozone levels on days when the two sites differ significantly. During the 1980's and 1990's, ozone concentrations in Rye were often significantly higher than those measured in Portsmouth during certain seasbreeze events. These high ozone events have not occurred in recent years and the two nearby monitors have tracked each other more consistently.

Nashua and Londonderry ozone monitors are about 20 miles apart and their data agree very well, even at concentrations above the moderate and unhealthy for sensitive groups (USG) thresholds. Londonderry holds particular value being an NCORE site. Because both locations measure ozone concentration in the range proposed by EPA for a revised ozone NAAQS, neither will be considered for discontinuation at this time.

One other site, Laconia, also shows a fair ozone correlation with Concord. The Concord monitoring station represents a larger population than Laconia and is logistically simple to operate and maintain, being located at NHDES offices, which makes it a good candidate to continue over the long- term, but again both sites will be maintained at least until the 2015 NAAQS is established.

Though some potential redundancy occurs in ozone sites in southern New Hampshire, this is also an area of high population and risk for ozone exceedances that warrants special consideration, especially in light of EPA's pending October 2015 announcement regarding a revised ozone NAAQS. This and other considerations are necessary to fully evaluate the role of each monitor in the network.

Acknowledgements

NHDES would like to thank the United States Environmental Protection Agency (EPA) for their continued grant funding and staff support for efforts to operate, maintain, and improve New Hampshire's Air Monitoring Network. NHDES offers a special thanks to Alan VanArsdale, Robert Judge and Chris St. Germain for their continued help and support with air monitoring in New Hampshire. NHDES acknowledges the Appalachian Mountain Club and White Mountain National Forest for their continued support with air monitoring operations at Camp Dodge in Green's Grant. NHDES would also like to acknowledge the efforts of our staff for their dedication and efforts to operate New Hampshire's network and collect quality data in all types of conditions, data analysis, and contributions to this report:

- Jessica Sheldon for her steadfast work analyzing AMP data, using Assessment Tools, and her review of and contribution to preparation of this report.
- Thanks to all staff of the AMP including Tim Verville, Jim Poisson, Tom Fazzina, Craig Thoroughgood, Mike Little, Scott Klose, Lara Stumpo and Kendall Perkins for overall program operations.
- Dr. Jeff Underhill for overall program technical analysis and direction