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**MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR QUALITY**

**FIVE-YEAR ASSESSMENT OF
MAINE'S AMBIENT AIR MONITORING NETWORK**

May 19, 2021

Every five years, each state must prepare and submit to the United States Environmental Protection Agency (EPA) an assessment of its monitoring network, which considers the following:

- Whether the network meets required monitoring objectives;
- Whether new sites are needed;
- Whether existing sites are no longer needed and can be terminated; and
- Whether any new technologies are appropriate for incorporation into the ambient air monitoring network.

The assessment must also consider the following:

- The ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma); and
- The effect on data users other than the agency itself for any sites that are being proposed for discontinuance.

This document is the current Five-Year Network Assessment for Maine. Comments were accepted until September 30, 2020, and could be submitted either electronically or in hard copy to:

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Executive Summary

The ambient air monitoring network in the State of Maine meets required monitoring objectives as established by the EPA and the Clean Air Act. In evaluating the monitoring network, Department of Environmental Protection staff confirmed the ability of existing and proposed monitoring sites to support air quality characterization for the state and affirmed that if any sites were to be slated for discontinuance such action should have minimal or no effect on data users. The consideration criteria as specified in federal monitoring regulations are addressed in the following summary paragraphs for each monitored pollutant. More extensive discussion of Maine's monitoring network for each specified pollutant is contained in the body of this report.

Ozone Monitoring

The ozone monitoring network in Maine, which may be envisioned as having three tiers, covers the most populated regions of the State, and areas that are expected to experience the highest levels of ozone, as well as rural and sparsely populated areas. First-tier monitoring sites are strategically located throughout the southern and central coastal areas of Maine, one of the most densely populated and fastest growing regions in Maine over the last 20 years. The second-tier ozone monitoring sites located inland from the first-tier and including the populous region along the Downeast coastline, helps to establish and determine if there is an attainment/nonattainment boundary inland and better delineate ozone forecasting. The third-tier ozone monitoring sites are in rural western and northern areas that have predominately less intense ozone levels.

Maine plans to identify and install an ozone monitoring site closer to the Phippsburg/Georgetown area (tier one). In May 2016 Maine established a site in the Bethel area (tier three) to better pick up springtime transported ozone.

No other new sites are recognized as being needed. Presently there are no plans to stop monitoring at the current sites. There are no new technologies available or appropriate for use in Maine's ozone monitoring network at this time.

Particulate Matter, Visibility/Speciation Monitoring

Particulate monitors in the state are located primarily in the most densely populated areas and in regions near sources of interest, or in regions with recorded exceedances of the standard are uncommon (the most recent exceedance occurring in **2018**.) Other sites include those located to monitor for potential wintertime wood combustion impacts. Although there are no new sites needed to meet required monitoring objectives, the Maine DEP-BAQ, with assistance from the Penobscot Tribe, operated a continuous particulate monitor in Carrabassett, Maine from November 2015 through September 2017. Analysis of the data indicated no meaningful difference between the Carrabassett site and the site in Rumford. Maine intends to employ a mobile monitoring platform to include a particulate sampler. The mobile monitoring platform will consist of an open trailer on which air quality sampling equipment will be mounted. If resources permit, sampling equipment may consist of a continuous particulate sampler, an integrated particulate sampler, and a Hazardous Air Pollutant (HAP's) sampler. The trailer will permit easy transport of sampling equipment. The objective is to facilitate short-term sampling in areas where the impacts of wood combustion, or other localized emissions sources are not well quantified. In addition, the mobile monitoring platform will permit quick response to emissions events resulting from incidents at commercial/industrial facilities. Maine will also assess a low-cost particulate monitor at the Rumford monitoring site. The purpose of this test is to evaluate the utility of such devices for use

in complaint response and in identifying “hot spots” In 2020 several PM_{2.5} FRM samplers were shut down at monitoring sites where continuous PM_{2.5} monitors operate. The Maine DEP-BAQ is evaluating possible replacement for the Met One Model 1020 BAM PM_{2.5} samplers presently in use. The replacement samplers may or may not include samplers with optical sensors. It’s expected that some of the units will be retired during the upcoming 5-year period. At this time, there are no existing sites slated for closure in Maine’s particulate monitoring network. A continuous PM10 sampler was established in Madawaska to document the severity and duration of elevated emissions from a bi-annual festive event that occurs adjacent to the monitoring station.

The visibility/speciation monitoring network meets the monitoring requirements for all three Class I areas in and near Maine. EPA considered defunding of two visibility/speciation monitoring sites in 2016. This did result in the closure of the Bridgton IMPROVE sampler. Maine located funding to keep the remaining sites operational. There are five IMPROVE monitoring sites in Maine.

Aeroallergen Monitoring

Allergic respiratory disease is quite common. Allergic rhinitis and allergic asthma are meaningful public health issues. Climate change is lengthening the “pollen/mold season” in Maine resulting in increased exposure to these aeroallergens with more frequent allergic reaction episodes amongst those afflicted with respiratory disease

Despite its pervasiveness, pollen exposure has received very little attention from the public health and air monitoring communities. This may be due in part to the fact that pollen is a naturally occurring substance, as well as the perceived lack of severity regarding its health impacts. Moreover, airborne pollen is a health concern solely because of its allergenic properties, which vary both qualitatively and quantitatively from individual to individual and with a large dependence on the particular pollen species. Mechanistically, pollen and fine particulate matter adversely impact the respiratory system through an inflammatory response. The prevalence of allergic rhinitis alone in the U.S. population has increased from 10% to 30% from 1970 to 2000 and affects approximately 40% of the children. Further, approximately 35 million people in the U.S. currently have asthma, and the numbers may grow to more than 100 million by 2025. In addition to rhinitis and asthma, pollen also contributes to sinusitis, conjunctivitis, urticarial (hives) and atopic dermatitis.

The difficulties associated with exposure assessment and establishing health criteria limit the ability to adequately define the public health problem. However, pollen health threats are real and are increasing in response to warmer temperatures and higher carbon dioxide levels. The potential effects of air pollution on pollen allergenicity are also expected to increase as the intensity, frequency and duration of air pollution episodes increase with a steadily warming climate. Winds can carry fine PM and pollen grains to locations that are away from where the air emission source(s) originated. Maine DEP-BAQ plans to stay engaged with, and wherever possible assist in, the efforts of local, state, regional and national health and scientific professionals and organizations seeking to translate the already known health impacts of pollen and a significant lack of pollen monitoring data into an effective and sustained public health action plan, establishment of a national pollen monitoring network and a health intervention strategy. Towards that end, Maine helped established and currently chairs the National Atmospheric Deposition Program’s Aeroallergen Monitoring Science Committee and provided aeroallergen monitoring input to the Maine Climate Council’s Scientific and Technical Subcommittee on Community Resilience Planning, Public Health, and Emergency Management Working Group.

Carbon Monoxide Monitoring

Carbon monoxide is currently monitored at three locations in Maine. Based on the historically low concentrations monitored to date, the only required CO monitors in the State are the monitor in Acadia National Park and the urban monitor in Portland to support the licensing program. The Micmac tribe operates the other site. The currently operated monitors meet monitoring requirements. At this time, there are no new sites needed, no sites deemed unnecessary, and no new technologies appropriate for incorporation into Maine's CO monitoring network.

Sulfur Dioxide Monitoring

There are currently three SO₂ monitoring sites in Maine. Of these three sites, only the NCORE site in Acadia National Park is required to meet mandated monitoring objectives for the State as established by the EPA. A site in Portland was operated to provide data in support of the licensing program. The Micmac tribe continues to operate an SO₂ analyzer. A monitoring station in Gardner at the Pray Street School was operated until December 2019 in support of the licensing program. A special purpose site in Eliot was operated in conjunction with the New Hampshire Department of Environmental Services at the request of the EPA until April 2016. At this time, there are no new sites needed, no unnecessary sites, and no new technologies appropriate for incorporation into Maine's SO₂ monitoring network.

Nitrogen Dioxide Monitoring

There are currently four sites in Maine where monitoring is conducted for nitrogen dioxide (NO₂) or reactive oxides of nitrogen (NO_y). Maine operated a site in Gardiner at the Pray Street School in support of the licensing program that was discontinued in December 2019. The established monitoring sites in Cape Elizabeth; Portland, Acadia National Park, and Presque Isle meet the required monitoring objectives. The monitor in Portland is non-regulatory. At this time, there are no new sites needed, no existing sites no longer needed, and no new technologies appropriate for incorporation into Maine's NO₂ monitoring network.

Lead Monitoring

Maine does not monitor for lead. National monitoring data indicates no lead (Pb) monitoring sites in Maine are necessary. EPA lead monitoring is required only at urban National Core (NCore) Multipollutant Network sites and the Acadia National Park NCore site is designated as a rural site, thus there is no lead monitoring requirement in Maine.

Hazardous Air Pollutants Monitoring

Maine samples year-round at five sites throughout the state for a suite of hazardous air pollutants. This ambitious program, constituting a major portion of the ambient air monitoring program, along with the other monitoring required in 40 CFR Part 58, *Ambient Air Quality Surveillance*, helps to increase our understanding of total air quality trends in the region and state. The main basis for selection of the pollutants monitored is an analysis of cancer risk factors associated with compounds listed in the recent National Air Toxics Assessment results, but monitoring is also constrained by the sampling technology available. Maine's target pollutants include some of the most prevalent combustion by-products, such as benzene, toluene, ethylbenzene, and certain xylenes, as well as ozone precursor compounds. Hazardous air pollutant monitoring provides background and baseline data for the pollutants monitored, a means to assess long-range transport from outside Maine and, for sites located upwind of emission sources in the State, assessment of pollution loads from in-state sources.

Atmospheric Deposition Monitoring

Maine operates monitors as part of the National Atmospheric Deposition Program's National Trends Network and the Mercury Deposition Network. While these monitors are not required under 40 CFR Part 58, the monitors within Maine are part of a nationwide program of approximately 250 other identical monitors, all operating with the same quality assurance protocols, geared toward understanding and addressing the national problem of acidic and mercury contamination of managed and natural ecosystems and cultural resources.

Regulatory Background

Five-Year Monitoring Assessment

Section 58.10(d) of Title 40 of the Code of Federal Regulations (40 CFR §58.10(d)) requires each state to prepare and submit to the U.S. Environmental Protection Agency (EPA) an assessment of its ambient air monitoring network once every five years. The third of these five-year assessments is to be submitted to EPA by July 1, 2020. In the five-year assessment, the State must determine the following:

- Whether the network meets required monitoring objectives;
- Whether new sites are needed;
- Whether existing sites are no longer needed and can be terminated; and
- Whether any new technologies are appropriate for incorporation into the ambient air monitoring network.

The assessment must also consider the following:

- The ability of existing and proposed sites to support air quality characterization for areas with relatively high populations of susceptible individuals (e.g., children with asthma); and
- The effect on data users other than the agency itself for any sites that are being proposed for discontinuance.

This document serves as Maine's third Five-Year Ambient Air Monitoring Network Assessment. The conclusions of this assessment are that Maine's ambient air monitoring network meets required monitoring objectives, except as noted and explained in the specific sections of this report, no new sites are needed and existing sites shall be maintained, and no new technologies are appropriate for incorporation at this time.

National Ambient Air Quality Standards (NAAQS)

The Clean Air Act (CAA) (<https://www.epa.gov/clean-air-act-overview/clean-air-act-text>), last amended in 1990, and 40 CFR Part 50, *National Primary and Secondary Ambient Air Quality Standards*, require the EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment (<https://www.epa.gov/naaqs>). The CAA established two types of national ambient air quality standards: primary standards to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly; and secondary standards to protect public welfare, including protection against decreased visibility and against damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards (OAQPS) has set NAAQS for six principal pollutants, called "criteria" pollutants, as given in the following table. Maine Ambient Air Quality Standards are identical to the NAAQS, as enacted in 38 M.R.S.A. §584-A. Units of measure for the standards are as follows:

$\mu\text{g}/\text{m}^3$ = micrograms per cubic meter of air

mg/m³ = milligrams per cubic meter of air
ppm = parts per million by volume
ppb = parts per billion by volume

National Ambient Air Quality Standards					
Pollutant		Type of Standard	Averaging Time	Standard	Applicable Caveats
Carbon Monoxide (CO) [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 (Pb) [73 FR 66964, Nov 12, 2008]		Primary and Secondary	Rolling 3-month average	0.15µg/m ³ ¹	Not to be exceeded
Nitrogen Dioxide (NO ₂) [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		Primary	1-hour	100 ppb	98 th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Primary and Secondary	Annual	53 ppb ²	Annual Mean
Ozone [80 FR 65292, Oct 26, 2015]		Primary and Secondary	8-hour	0.070 ppm ³	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particulate Matter (PM) [78 FR 3086, Jan 15, 2013]	PM _{2.5}	Primary	Annual	12 µg/m ³	Annual mean, averaged over 3 years
		Secondary	Annual	15 µg/m ³	Annual mean, averaged over 3 years
	PM ₁₀	Primary and Secondary	24-hour	35 µg/m ³	98 th percentile, averaged over 3 years
		Primary and Secondary	24-hour	150 µg/m ³	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO ₂) [75 FR 35520, Jun 22, 2010]		Primary	1-hour	75 ppb ⁴	99 th 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

¹ In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 µg/m³ as a calendar quarter average) also remain in effect.

² The level of the annual NO₂ standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

³ Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O₃ standards additionally remain in effect in some areas. Revocation of the previous (2008) O₃ standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards

⁴ The previous SO₂ standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2) any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO₂ standards or is not meeting the requirements of a SIP call under the previous SO₂ standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

Maine's Monitoring Network: Background and Overview

The Maine Department of Environmental Protection (the Department or DEP), in conjunction with Maine tribes and the EPA, operates a network of air monitoring stations which measure ambient concentrations of specific pollutants for which the EPA has established National Ambient Air Quality Standards (NAAQS). Those pollutants include ozone (O₃), particulate matter smaller than 10 microns (PM₁₀), fine particulate matter smaller than 2.5 microns (PM_{2.5}), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), carbon monoxide (CO), and lead (Pb). The criteria pollutant monitoring sites are part of the EPA's State or Local Air Monitoring Stations (SLAMS) network.

The majority of Maine's air monitoring sites are located in or near Maine's population centers, primarily along the coast in the south and south-central region of the State. Maine's northeast location in the continental United States and the prevailing air flow pattern make Maine particularly vulnerable to pollution generated elsewhere along the eastern U.S. seaboard, central U.S., and eastern Canada. Many pollutants, including ozone and its precursors, air toxics, heavy metals, and particulates which includes sulfates, nitrates, and organic compounds, are being transported into Maine's ambient air from upwind emissions sources. The following paragraphs describe specific public health and welfare concerns pertaining to specific monitored pollutants.

Ozone and Ozone Precursor Pollutants

Motor vehicle exhaust, industrial emissions, gasoline vapors, chemical solvents, and natural sources emit NO_x and VOC that contribute to ozone formation. Ground-level ozone has been associated with a variety of health problems including chest pain, coughing, and congestion, and the exacerbation of symptoms of bronchitis, emphysema, and asthma. Inhalation of ground-level ozone also can reduce lung function, inflame the linings of the lungs, and may permanently scar lung tissue.

Particle Pollution

Particle pollution, especially the fine particles (PM_{2.5}), has been linked to a variety of ailments including irritation of respiratory airways, coughing, or difficulty breathing; decreased lung function; aggravated asthma; development of chronic bronchitis; irregular heartbeat; and nonfatal heart attacks.

Fine particle pollution (sulfates, organic matter, nitrates, elemental carbon and soil dust) is the primary cause of reduced visibility (haze) in scenic areas such as national parks and wilderness areas and of regional haze (visibility degradation). Particle pollution can also stain and damage stone and other materials, including culturally important objects such as statues and monuments.

Particles can be carried over long distances by wind and then settle on ground or water. Effects of this settling include the following: increasing the acidity of lakes and streams; changing the nutrient balance in coastal waters and large river basins; depleting nutrients in soil; damaging sensitive forests and farm crops; and affecting the diversity of ecosystems.

Carbon Monoxide

Carbon monoxide (CO) is a colorless and odorless gas which is a byproduct of incomplete combustion of carbon-based fuels. When inhaled, CO reacts with hemoglobin in the blood, preventing uptake and transportation of oxygen. Most health effects directly associated with CO are likely due to decreases in oxygen delivery to vital organs such as the heart and brain. People with cardiovascular disease such as angina and people with asthma, emphysema, and other lung diseases which limit efficient use of inhaled oxygen may be especially sensitive to the effects of CO inhalation.⁵

Sulfur Dioxide

Sulfur dioxide (SO₂) is a colorless, irritating gas. It is emitted mainly from stationary sources that utilize fossil fuels (coal, oil) such as power plants, ore smelters, and refineries. SO₂ is linked to acid deposition. SO₂ is severely irritating to the eyes, mucous membranes, skin, and respiratory tract and can trigger bronchospasms, pulmonary edemas, pneumonitis, and acute airway obstruction. Inhalation at very low concentrations can aggravate chronic pulmonary diseases. Respiratory irritation from SO₂ can induce symptoms such as sneezing, sore throat, wheezing, shortness of breath, chest tightness, and a feeling of suffocation.⁶

Nitrogen Dioxide

Nitrogen dioxide (NO₂) can irritate the lungs and lower resistance to respiratory infections such as influenza. Continued or frequent exposure to higher NO₂ concentrations is associated with increased incidences of acute respiratory illness in children. NO₂ has also been identified as contributing to ozone formation and to the formation of acid rain.⁷

Lead

Once taken into the body via inhalation or ingestion, lead distributes throughout the body and accumulates in the bones. Depending on the level of exposure, lead can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems, and the cardiovascular system. Lead exposure also affects the oxygen carrying capacity of the blood. Lead effects most commonly encountered are neurological effects in children and cardiovascular effects in adults.⁸

In addition, to better understand potential public health and welfare impacts from airborne pollutants, the Department, Maine tribes, and the EPA monitor ambient levels in Maine of toxic air pollutants and of ozone precursors (substances that react in the atmosphere to form ground-level ozone), and conduct atmospheric deposition monitoring of mercury and ions contributing to acidic precipitation. Each of these is discussed in more detail in this report.

Maine Specific Health Impact Evaluations

Federal regulation 40 CFR §58.20(d) specifies that five-year assessments must include an evaluation of whether changes in the distribution of population within the State warrant changes in the location of population-oriented monitoring sites. Based on U.S. census records from 2000

⁵ http://www.capcoa.org/health-effects/#AIR_QUALITY_GUIDE_FOR CARBON MONOXIDE

⁶ <http://www.atsdr.cdc.gov/mmg/mmg.asp?id=249&tid=46>

⁷ World Health Organization/Europe, at

http://www.euro.who.int/_data/assets/pdf_file/0017/123083/AQG2ndEd_7_1nitrogendioxide.pdf

⁸ <https://www.epa.gov/lead-air-pollution>

and estimated for 2019 and as shown in Figure 1, the populations in Cumberland, Penobscot and York Counties in southern Maine have realized growth over those 19 years, Aroostook, Piscataquis and Washington Counties population have shown a fairly steady decline, and the populations of the rest of the counties in the State have experienced smaller changes. Overall, the State showed a 4.6% increase in population from 2000 to 2019, with a gain of over 58,000 residents. Over half of that population increase has been in Cumberland and York Counties.

Data for Maine's population age 19 and younger, and Maine's population age 65 and older, groups considered more sensitive to air pollution, shows trends different than overall population trends, as depicted in Figures 2 and 3. The State's population 19 years old and younger has decreased since 2000, a trend expected to continue at similar rates into the future. The State's population age 65 and older has been steadily increasing, and this rate of change is projected to increase as the present population ages and more retirees choose to live in Maine.

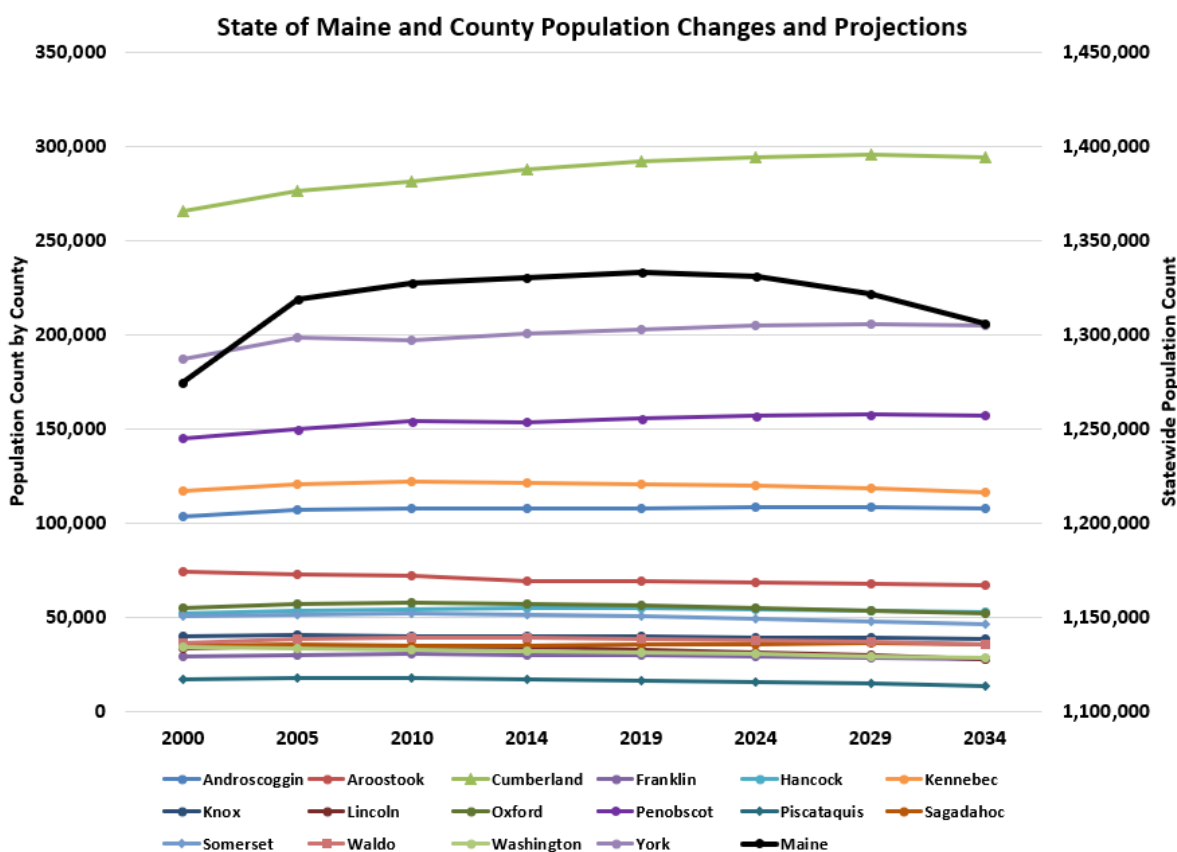


Figure 1: Maine State and County Population Changes and Projections

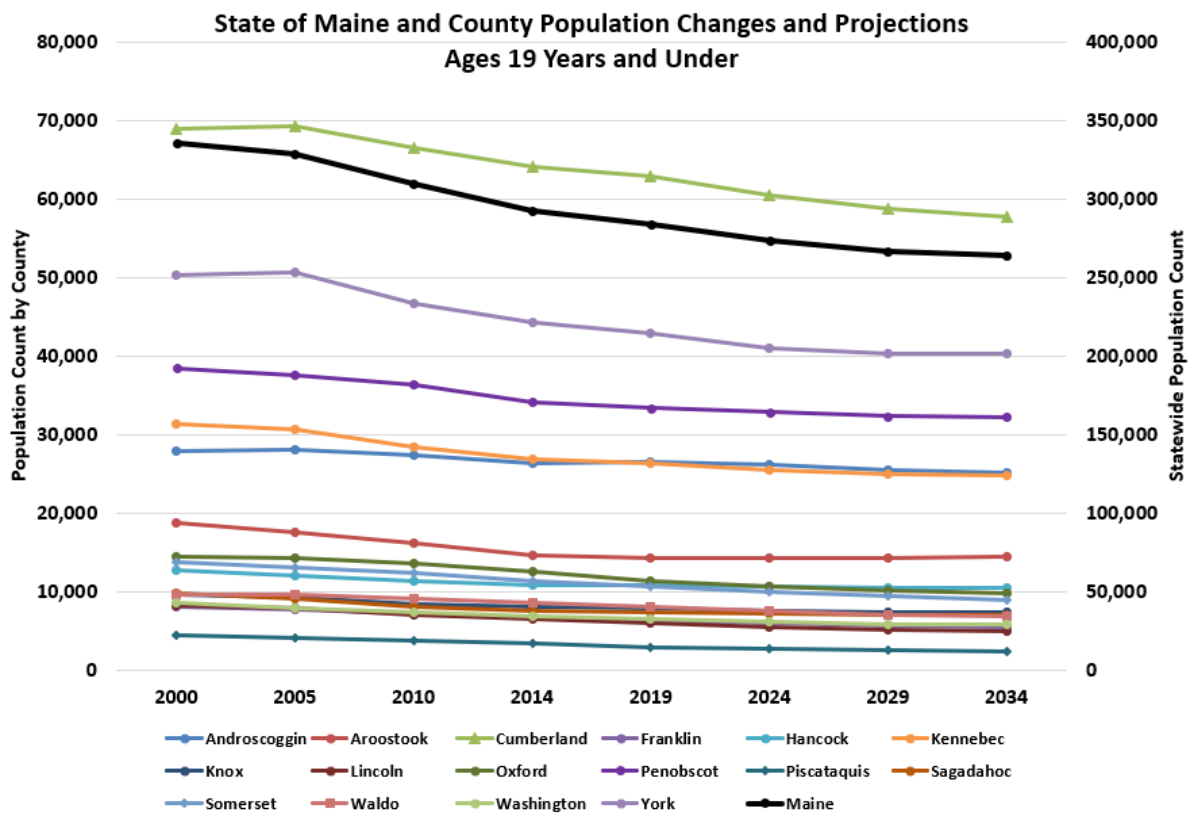


Figure 2: Maine State and County Population Changes and Projections, Ages 19 and Younger

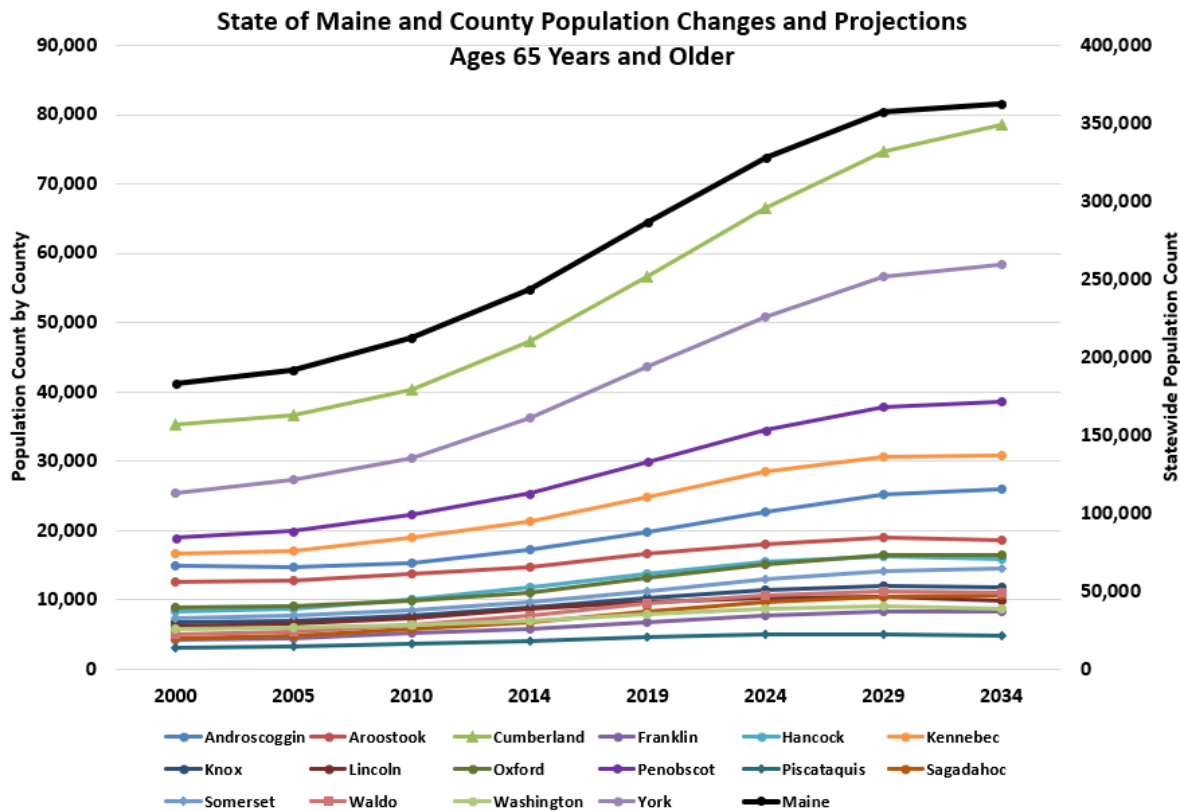


Figure 3: Maine State and County Population Changes and Projection, Ages 65 and Older

Health data was analyzed to identify areas in the State with higher concentrations of sensitive populations, recognized by higher-than-average percentages of children with asthma, incidence of heart attacks, and infants born with low birth weights. These conclusions were then used to evaluate whether the State's ambient air monitoring network adequately characterizes air quality in these areas.

Asthma

According to the Maine Center for Disease Control & Prevention (Maine CDC), Maine has some of the highest rates of asthma in the U.S. Data from the Maine Health Tracking Network data portal shows approximately 11.7% of Maine adults with asthma, compared to 7.7% of adults in the U.S. with asthma.⁹ The percentage of Maine children with asthma (8.5%) is similar to the percentage among U.S. children (8.4%).¹⁰ Asthma-related visits to emergency departments vary throughout the State, with an age adjusted rate of 76.3 visits per 10,000 people in Washington County compared to a low of 35.0 in Penobscot County.¹¹

Asthma, a chronic inflammatory disease of the airways, can be aggravated by exposures to certain substances such as microbes, allergens, airborne particle pollution, and ozone. Maintenance of the network of ozone and particulate monitors in Maine to inform accurate forecasts of air quality is important so that those with asthma can know to limit their activity during periods when high levels of ozone and/or particulates are forecast.

Heart Disease

Heart disease is the leading cause of death in the United States and second only to cancer as the leading cause of death in Maine.^{12,13} According to the American Heart Association, worldwide epidemiological studies have demonstrated consistent associations between short-term elevations in PM and increases in daily cardiovascular morbidity and mortality, particularly within certain at-risk subsets of the population. Studies have also reported adverse cardiovascular outcomes in relation to long-term PM exposure, even after adjustment for a variety of individual-level risk factors such as tobacco smoking (including exposure to second hand smoke), gender, body mass index, educational attainment, occupational exposures, hypertension, and diabetes.¹⁴ In Maine, the counties of Aroostook, Piscataquis, Somerset and Washington have higher rates of heart attacks than other Maine counties.¹⁵

Low Birth Weights

A body of evidence is emerging from several countries on the adverse consequences of ambient air pollution on fetal/birth outcomes, including pre-term birth and fetal growth restriction.¹⁶ The

⁹ Most Recent Asthma Data. (2015, April 23). National Center for Environmental Health.
https://www.cdc.gov/asthma/most_recent_national_asthma_data.htm

¹⁰ **Maine Asthma Prevention and Control Program - Asthma Burden in Maine 2006 - 2010**
https://www.maine.gov/dhhs/mecdc/population-health/mat/documents/MaineAsthmaBurden_03-30-2018.pdf

¹¹ **Maine Health Tracking data portal**
<https://data.mainepublichealth.gov/tracking/home>

¹² <http://www.medicalnewstoday.com/articles/282929.php>

¹³ From CDC 1999-2013 data: <http://www.worldlifeexpectancy.com/usa/maine-heart-disease>

¹⁴ Air Pollution and Cardiovascular Disease. (2015). AHA Scientific Statement from the American Heart Association, Inc. <http://circ.ahajournals.org/content/109/21/2655.full#content-block>

¹⁵ Maine Health Tracking data portal: <https://data.mainepublichealth.gov/tracking/home>

¹⁶ DQ Rich, et al, 2009, "Ambient air pollutant concentrations during pregnancy and the risk of fetal growth restriction," Journal of Epidemiology and Community Health, Vol. 63, pp. 488-496

percent of low birth weight rates in Maine is third lowest in New England, and that is lower than the national average. Many other factors also influence birth weights; thus, establishing any link to air pollution in Maine may be very difficult.

The table in Figure 4 presents a collection of these at-risk population statistics, by county. Analysis of Maine's population information shows that monitors in the State's monitoring network are located appropriately, and further changes in the location of monitors are not warranted at this time.

At Risk Population Statistics by County									
	Myocardial Infarction Hospitalizations (age-adjusted per 10,000) [2016]	Asthma Hospitalizations (age adjusted per 10,000) [2016]	Asthma ED Visits (age- adjusted rate per 10,000) [2016]	Adults with Asthma, percent [Maine data 2011-2014 combined; NE & US data 2008]	Low Birth Weight percent of live births [2015/US 2018.]	0-19 YRS (2019 estimate)	% of County Popula- tion	65 YRS and older (2019 estimate)	% of County Popula- tion
Androscoggin	44.7	7.3	68.6	14.0	7.7	26,568	24.6	19,794	18.3
Aroostook	64.5	NC	54.0	12.9	6.7	14,329	20.8	16,556	24.0
Cumberland	30.9	2.5	37.4	10.4	7.0	62,888	21.6	56,669	19.4
Franklin	43.1	NC	41.3	12.0	6.7	6,296	21.2	6,789	22.8
Hancock	60.9	NC	36.3	10.0	7.4	10,818	19.8	13,776	25.2
Kennebec	59.6	NC	49.0	12.1	6.0	26,426	21.9	24,782	20.6
Knox	28.7	NC	46.2	11.2	4.7	7,842	19.8	10,247	25.9
Lincoln	38.6	NC	46.6	8.4	9.0	6,022	18.4	9,622	29.3
Oxford	40.6	5.4	61.0	9.5	4.4	11,373	20.2	13,147	23.4
Penobscot	55.8	2.9	35.0	13.5	7.1	33,400	21.5	29,868	19.2
Piscataquis	65.0	NC	59.6	11.9	13.1	2,981	18.3	4,538	27.8
Sagadahoc	43.7	NC	44.8	11.9	8.2	7,435	20.9	8,280	23.3
Somerset	62.3	NC	75.2	14.5	7.4	10,583	21.0	11,271	22.3
Waldo	47.5	NC	38.5	11.3	6.2	8,024	20.8	9,412	24.4
Washington	90.9	NC	76.3	10.5	7.3	6,508	20.9	7,914	25.4
York	30.6	4.2	35.1	11.6	6.8	42,871	21.1	43,583	21.5
Maine	45.3	3.6	45.4	11.7	6.9	284,364	21.3	286,248	21.5
New England				9.7	6.6 to 7.9				
US				7.7	8.28				
Heart Attack Data: Data downloaded from the Maine Tracking Network data portal - Original source: Maine Health Data Organization (MHDO)									
Asthma Data: Data downloaded from the Maine Tracking Network data portal - Original source: Maine Health Data Organization (MHDO)									
Calculations changed for 2016. NC means not calculated									
US asthma rate from: https://www.cdc.gov/asthma/most_recent_national_asthma_data.htm									
New England asthma rate from Living with Asthma in New England - Asthma Regional Council of New England, February 2010 most recent found									
Low Birth Weight (<2500 grams) rate data: Maine Tracking Network data portal. 2018 US data: https://www.cdc.gov/nchs/fastats/birthweight.htm 2015 New England State data: https://www.cdc.gov/nchs/pressroom/sosmap/lbw_bir_his/lbw.htm									
Population data provided by the Maine Office of Policy and Management, from US Census Data.									

Figure 4: Maine At-Risk Population Statistics by County

Maine's Criteria Pollutants Monitoring Network Evaluation

The following sections present the evaluation of these considerations, by pollutant:

- The current monitoring network;
- The NAAQS and a comparison of recent measurements with the NAAQS;
- Trends in pollutant levels measured;
- Whether the network meets the EPA's monitoring criteria;
- Whether new sites are needed;
- Whether any existing sites are no longer needed;

- Whether new monitoring technologies are available that should be adopted;
- Whether the current network adequately characterizes air quality in the State; and
- Plans for modification of the network in the future.

Ozone (O₃)

Ozone (O₃), a gas at ambient conditions, is considered either “good” or “bad” depending on its location in the atmosphere. “Good” ozone is found in the stratosphere approximately 10 to 30 miles above the earth's surface in a layer where the presence of ozone serves to protect the earth from the sun's harmful ultraviolet rays. Ground-level ozone has detrimental effects both on human health and on vegetation and is therefore considered “bad” ozone. Ozone is not usually emitted from sources as a pollutant directly into the air. At ground level, ozone is formed by a reaction between oxides of nitrogen (NO_x) and volatile organic compounds (VOC) in the presence of sunlight. Sunlight and hot weather facilitate ground-level ozone formation in potentially harmful concentrations; as a result, ozone is known as a summertime air pollutant.

Under the authority of the Clean Air Act, the EPA has set protective health-based standards for ozone in the ambient air to protect both public health and the public welfare (e.g., crops and vegetation). The 2008 NAAQS for ozone was the three-year average of the fourth-high maximum daily eight-hour average not to exceed 0.075 parts per million (ppm). On October 1, 2015, the EPA revised the ozone NAAQS standard to 0.070 ppm (effective December 28, 2015). Plots indicating the current and historical NAAQS status at several sites in Maine are shown in Figure 5. All monitoring sites in Maine are currently showing attainment of both the 2008 and the 2015 ozone NAAQS as has been documented and have continued to be in attainment for most three-year periods starting with 2003-2005. The summit of Cadillac Mt. monitoring site had a design value greater than the 2015 NAAQS for the 2015-17 three - year period but has since monitored attainment during the next 2016-18 and 2017-19 three -year periods.

Though it is more likely for urban areas to have high levels of ozone, rural areas in Maine are also subject to increased ozone levels because prevailing winds carry ozone and its precursor pollutants hundreds of miles from their original sources. Figure 6 illustrates an analysis of air masses containing high levels of ozone pollution (all monitored 2015-2019 exceedances of the 70 ppb 8-hour ozone level in Maine) which were tracked backwards based on wind direction, wind speed and height to determine where that air mass may have come from, and subsequently identify possible sources of emissions resulting in the monitored high ozone levels. The back trajectories¹⁷ in the figure indicate areas that most likely contributed to the monitored 2015-2019 exceedances of the 70 ppb 8-hour ozone level in Maine.

¹⁷ The authors gratefully acknowledge the NOAA Air Resources Laboratory (ARL) for the provision of the HYSPLIT transport and dispersion model on the READY website (<http://www.ready.noaa.gov>) used in this document.

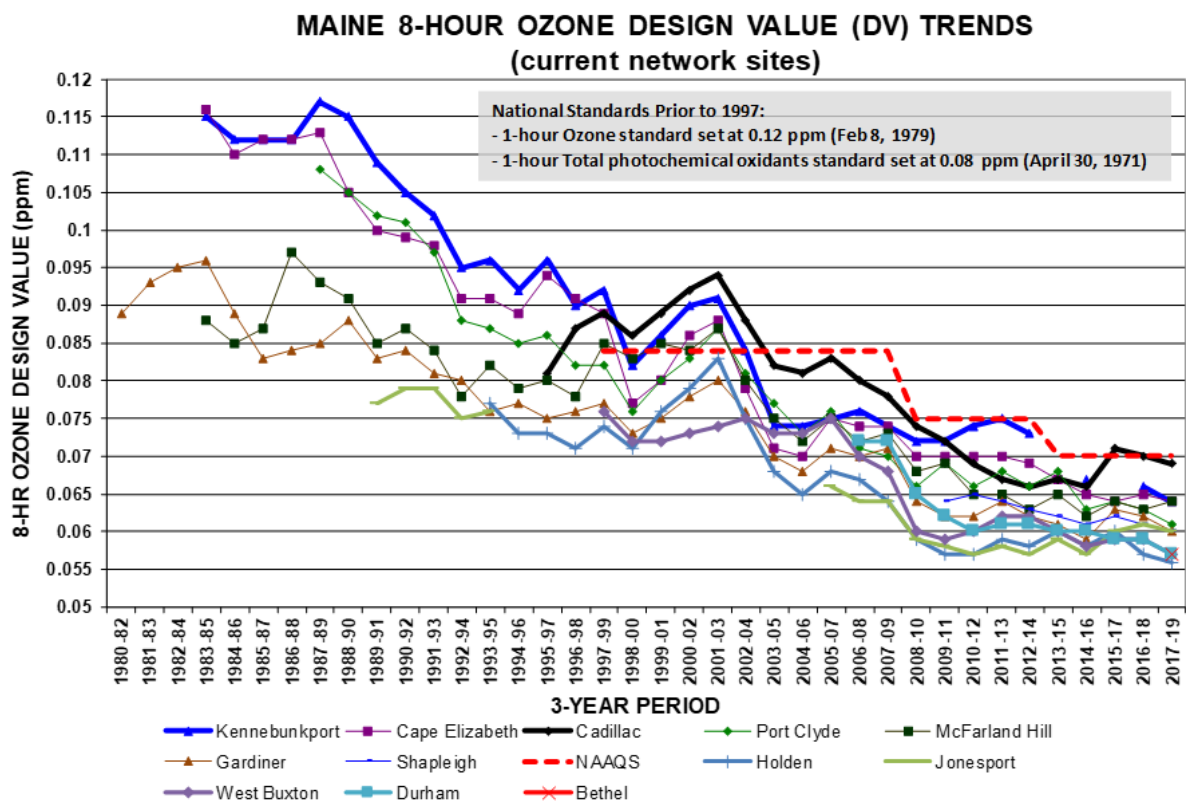


Figure 5: Maine 8-Hour Ozone Design Value Trends

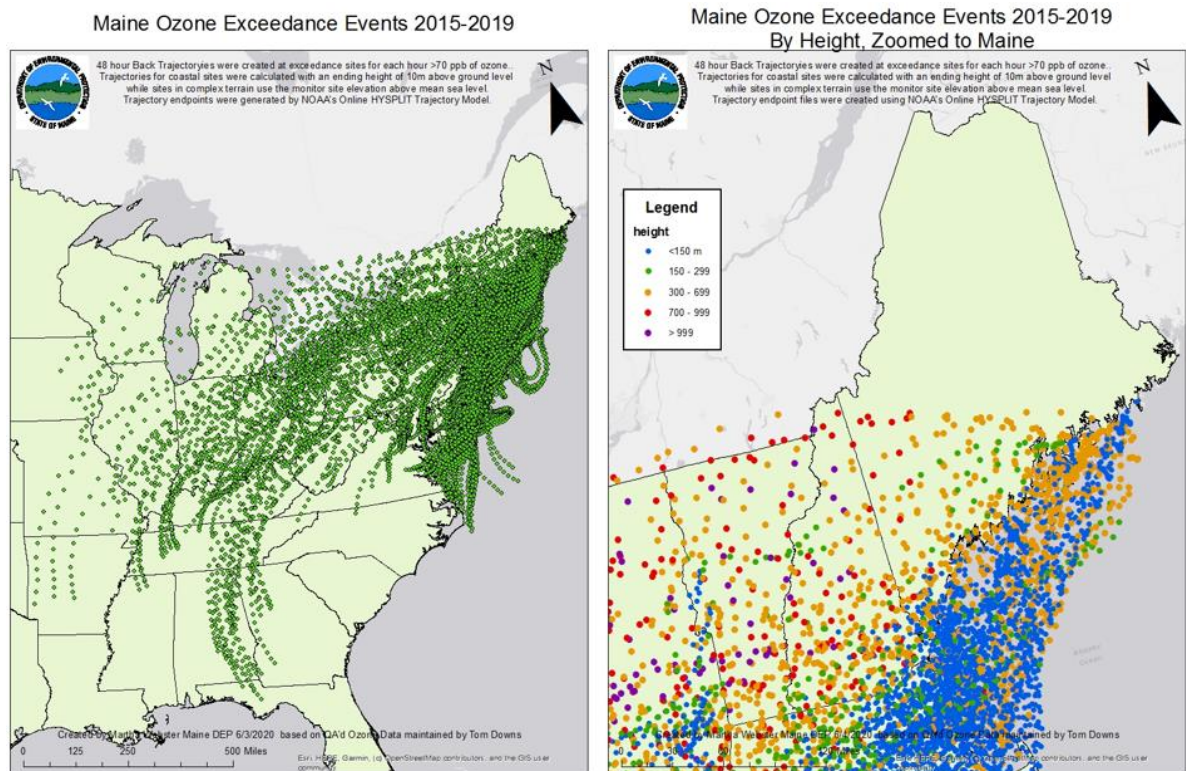


Figure 6: Hourly Endpoints from Back Trajectories for 2015 – 2019 Ozone Exceedances in Maine

Ozone Monitoring Network

Maine's program to monitor ambient levels of ozone, started in 1975, and has been expanded and modified since its initiation to most effectively identify and delineate non-attainment areas and to provide near-real-time hourly data useful for the tracking and forecasting of ozone levels throughout the State.

The Department currently operates a network of 13 sites with an additional two sites operated by Maine tribes and one site operated by the EPA. The locations of these sites in Maine are shown in Figure 7: *Maine Ozone Monitor Network*.

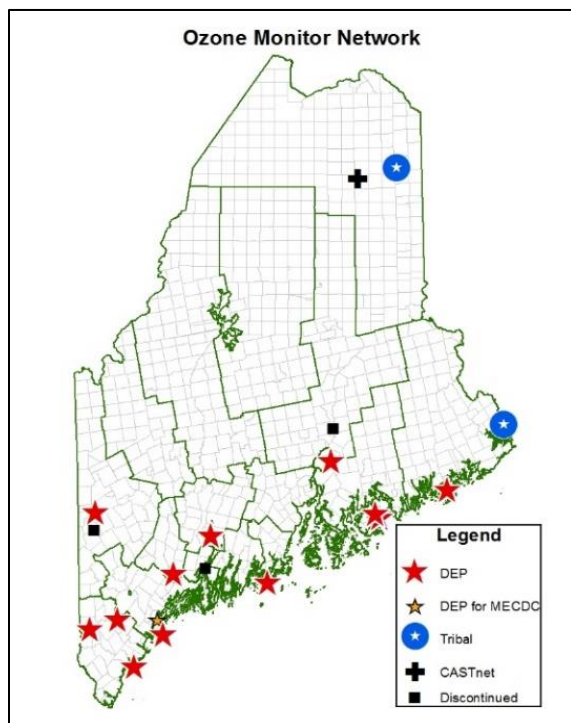


Figure 7: Ozone Monitor Network

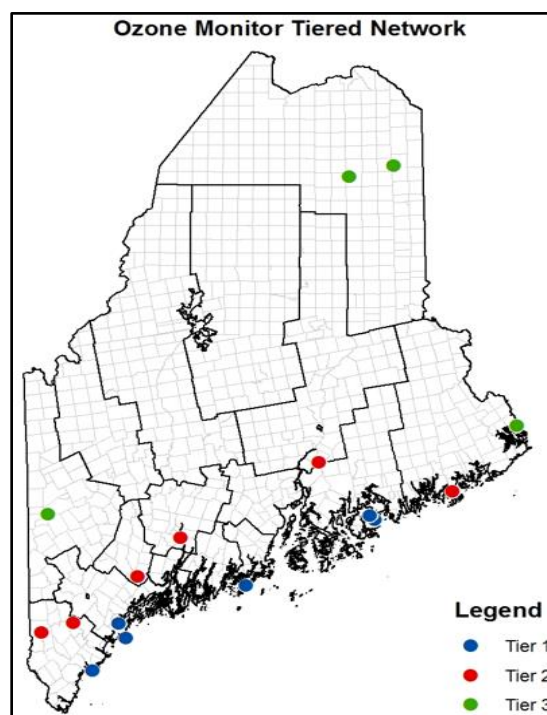


Figure 8: Ozone Monitor Tiered Network

The current Maine ozone monitoring network is essentially a three-tiered network, as depicted in Figure 8: *Ozone Monitor Tiered Network* and described in the following paragraphs. This monitoring network covers the most populated regions of the state and areas that are expected to experience the highest levels of ozone in the State. The network also covers many rural and sparsely populated areas.

The first tier is located along the southwest and mid-coastline where the highest ozone measurements in the State have historically been recorded and occasionally still occur. Monitors are located at Kennebunkport, Cape Elizabeth, Portland (non-regulatory), Port Clyde, McFarland Hill, and the summit of Cadillac Mountain in Acadia National Park. Since a number of coastal monitoring sites in Maine are presently recording concentrations below the current standard, continued operation of those monitors is important to show continued compliance (requirement in existing maintenance plans for the 1997 ozone standard) and/or a return to non-attainment in the future. This tier contains the more populated areas in the Portland-South Portland-Biddeford Metropolitan Statistical Area (MSA) and includes the Rockland Micropolitan Statistical Area

(μ SA). These monitors are strategically located throughout the southern coastal area of Maine, one of the most densely populated areas of the State and which has shown the greatest population increase over the last 20 years.

The second tier of ozone monitors is located just inland, extending from southwest and central Maine to downeast of Acadia National Park (east-northeast along the Maine coast from Acadia National Park to the Canadian border). Monitors in Tier 2 are located at Shapleigh, West Buxton, Durham, Gardiner, Holden, and Jonesport. The importance of this tier is the role it has and will continue to have in determining the attainment/nonattainment boundary and in forecasting how far inland moderate and higher air quality index (AQI) concentrations will occur. Shapleigh and Jonesport monitors were specifically added to the Tier 2 network because of the 2008 standard. This tier also contains the most densely populated areas away from the coastline, including the Bangor and Lewiston-Auburn MSAs, part of the Portland-South Portland-Biddeford MSA, and the Augusta-Waterville MSA.

The third tier of ozone monitors is located in the rural western and northern areas of the State. Maine currently operates a monitor at Bethel; the EPA operates a site at Ashland; and the Micmac and Passamaquoddy Tribes also operate sites in this tier. Tier 3 is important for ozone mapping and forecasting purposes, especially during the spring months.

Figure 9 verifies that Tier 1 contains sites with the highest ozone levels in the State, with each site having unique statistics. Of note is how much lower the Portland monitoring site data is compared with other Tier I sites. The Portland monitor is a special purpose monitor installed for the Department of Health and Human Services, Maine Center for Disease Control and Prevention and because it does not meet NAAQS siting criteria is considered a non-regulatory monitor.

Figure 9 also verifies that Tiers 2 and 3 contain sites with lower ozone levels. The only two sites that match closely are the West Buxton and Durham sites, suggesting redundancy and that better use of monitoring resources might be to relocate one of these monitors. Since the Durham site has a smaller historical record and the 2017-19 design value is the lowest in Tier 2, it could be moved to a new site location in the Phippsburg/Georgetown area. That area, since the Phippsburg, Reid State Park and Bowdoinham sites were discontinued, has been identified by stakeholders and modeling as being a possible hot spot of ozone.

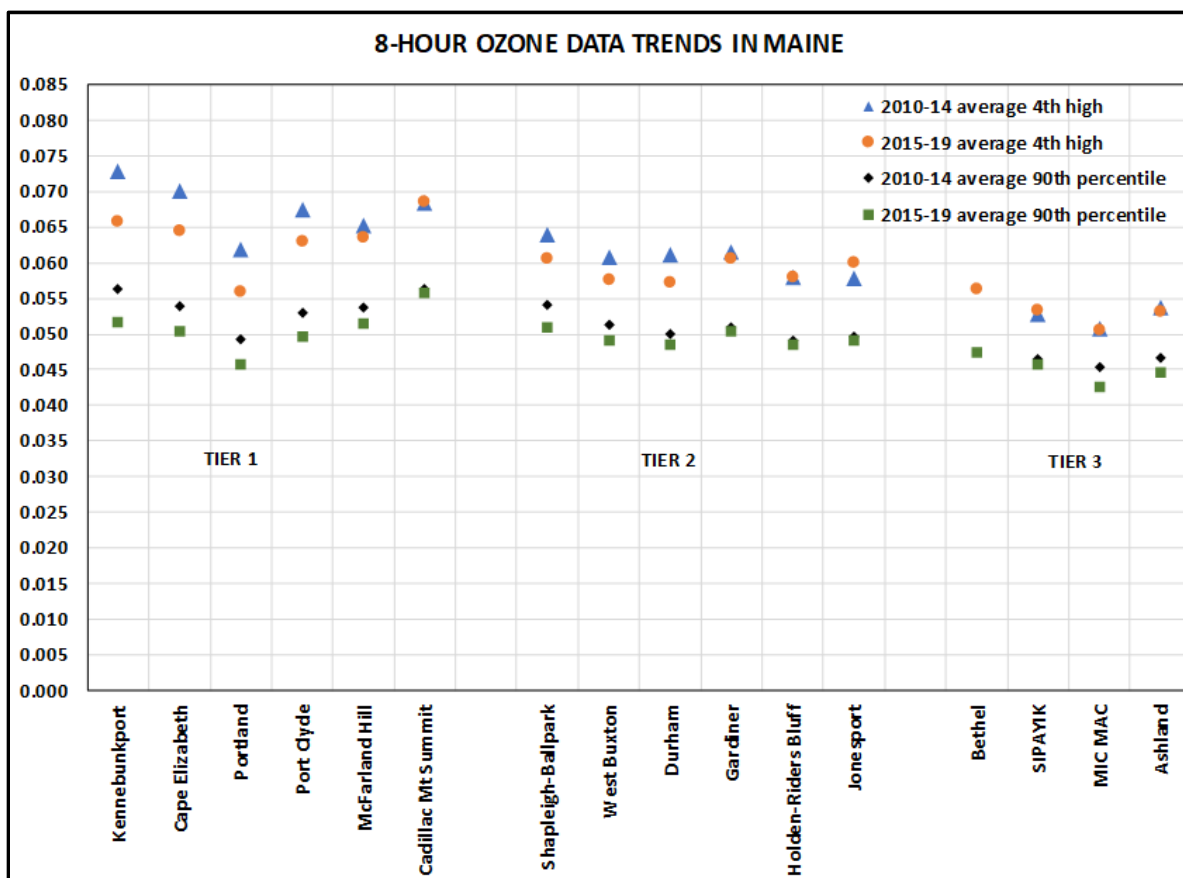


Figure 9: Maine 8-Hour Ozone Data Trends

Photochemical Assessment Monitoring Stations (PAMS) Monitoring Network

The Photochemical Assessment Monitoring Stations (PAMS) network, originally established in 1993, was designed to measure ozone precursor pollutants for Serious, Severe, or Extreme Non-attainment areas. The monitoring regulations for PAMS provide for the collection of an “enhanced” ambient air quality database which can be used to better characterize the nature and extent of ground-level ozone, aid in tracking VOC and NO_x emissions reductions, assess air quality trends, make attainment/non-attainment decisions, and evaluate photochemical grid-model performance. Maine operated two PAMS in the State, one on Cadillac Mountain and one in Cape Elizabeth, but discontinued the Cadillac Mountain site at the end of the 2014 ozone season due to significant declining trends of precursor pollutants, increasingly limited resources, and other higher priority monitoring needs. These sites were required to operate from June to August but also usually operated for the additional months of May and September.

When EPA revised the National Ambient Air Quality Standards for ozone in 2015, part of that rulemaking also changed the criteria for when and where PAMS program monitoring would be required. Under these new PAMS monitoring regulations, Maine was no longer required to operate and maintain any PAMS sites. However, they did require the submission of an Enhanced ozone Monitoring Plan, as a result of Maine being a part of the Ozone Transport Region, as defined by the Clean Air Act Amendments of 1990.

Both of Maine's former PAMS sites were originally required as a result of Serious Non-attainment areas in other upwind states. The site in Cape Elizabeth is considered an extreme downwind site for the Greater Connecticut non-attainment area, and the Cadillac Mountain site was considered an extreme downwind site for the Boston non-attainment area that is currently attaining the 2008 ozone NAAQS. Nationally, as additional controls have been implemented and air quality has improved, many of the non-attainment areas have been reduced in size and/or severity or eliminated altogether. However, with a lowering of the standard, the status of some of these areas may change, and continued monitoring of ozone precursor pollutants remains important. The Cape Elizabeth site has been identified as an enhanced monitoring site and will continue to operate during the next 5-years, or until approved otherwise in an Annual Monitoring Plan.

Future Ozone and Enhanced Ozone Monitoring Networks

Additional ozone monitoring may be justified, at a location as indicated in Figure 10, Future Ozone Network. Monitoring within the coastal area around Phippsburg had recorded some of the higher hourly concentrations in the State, but the Small Point monitor was removed after the 1999 ozone monitoring season at the request of the property owner. After that, a site was established in Reid State Park for a few years and then the monitoring was moved to a site further inland (Bowdoinham) to determine if the higher ozone concentrations were forming or being transported further inland. The Bowdoinham site was removed after the 2015 ozone season. Relocating a site in the Phippsburg area to adequately document ozone levels in that area of the Maine coast should be a priority. The ozone network should continue to exist and be evaluated and refined as needed in the future.

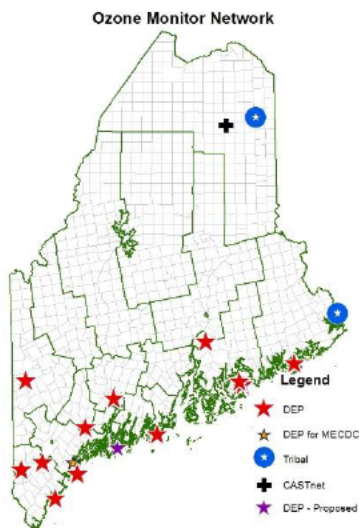


Figure 10: Future Ozone Monitor Network

The highest background ozone concentrations during the year occur in the spring months before leaf-out. Maine has recently experienced some high spring ozone concentrations at inland sites as a result of the high background, long range transport, weather patterns and the lack of vegetation to absorb ozone. Maintaining Tier 3 monitoring in Bethel is important for forecasting purposes as that site shows higher levels than other Tier 3 sites run by EPA and the Tribes.

National and regional discussions taken place to determine the PAMS and enhanced ozone monitoring networks for future, more stringent ozone standards. Future uses of the data and data analyses from these networks other than trends analyses include: State Implementation Plan requirements for a Section 126 of the CAA Petition, tracking implementation and effects of reformulated gasoline (RFG), Attainment Demonstration Ozone Conceptual Model, future enhanced monitoring requirements, and inputs for the Attainment Demonstration Modeling analyses. The former PAMS site in Cape Elizabeth at Two Lights State Park remains very useful in tracking historical VOC and NO_x control programs, through trends analyses and in documenting transport patterns. For the reasons, the Cape Elizabeth site should continue operation in the next 5-years and has been identified as an enhanced ozone monitoring site.

Particulate Matter (PM)

Particulate Matter (PM) is made up of coarse and fine particles based on size, as follows:

<u>Name</u>	<u>Label</u>	<u>Description</u>	<u>Examples</u>
Inhalable PM	PM ₁₀	Particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (10 µm)	Smoke, soot, dust, dirt, pollen
Coarse PM	PM _{10-2.5}	Particles with an aerodynamic diameter less than or equal to a nominal 10 µm but greater than 2.5 µm	
Fine PM	PM _{2.5}	Particles with an aerodynamic diameter less than or equal to a nominal 2.5 µm	Sulfates, nitrates, heavy metals

The EPA has established primary and secondary air quality standards for PM_{2.5} on an annual basis and a 24-hour basis, and for PM₁₀ on a 24-hour basis, all as identified previously in this document. There is currently no NAAQS for PM Coarse.

PM_{2.5}

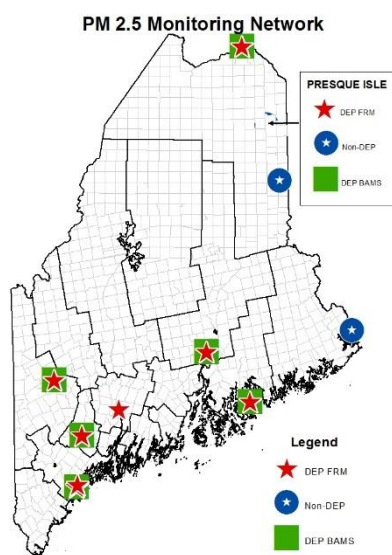


Figure 11: PM_{2.5} Monitors

The current PM_{2.5} 24-hour Federal Reference Method (FRM) monitors in Maine used to track compliance with PM_{2.5} NAAQS are primarily located in the most densely populated and source regions. An additional PM_{2.5} monitor is located in Acadia National Park at the McFarland Hill site to meet the requirements of the National Core Network (NCore), a multi-pollutant network that integrates several advanced measurement systems for particles, pollutant gases, and meteorology. Additionally, operating in the three largest cities in Maine are continuous hourly PM_{2.5} Beta Attenuation Monitors (BAMs), used to help inform the public and to track compliance with NAAQS. Additional BAMs are located at sites in Maine to monitor for potential wintertime wood smoke impacts. The types of monitors and their locations are shown in Figure 11.

PM_{2.5} Monitoring Sites by Monitoring Strategy Category:

Highest Population Areas

Portland (FRM and BAM)
Lewiston (BAM)
Bangor (BAM)

Heating Season Sites of Interest

Rumford (FRM and BAM)
Madawaska (BAM)

NCore Site

McFarland Hill (FRM and BAM/5030i)

Other Population Centers of Interest

Augusta (FRM)
Presque Isle (FRM and BAM)

In addition to depicting downward trends, Figures 12 and 13 demonstrate that all monitors are showing attainment of the 2006 24-hour PM_{2.5} NAAQS and the 2012 Annual PM_{2.5} NAAQS. Figure 14 shows that ambient concentrations of wintertime PM_{2.5} is an important issue in Maine; thus, Maine recently installed BAMs monitors in Rumford, Madawaska, and Presque Isle. The Rumford and Madawaska sites are in valleys where inversions occur during certain weather conditions trapping pollutants at ground level between valley walls and where wood smoke may cause higher PM_{2.5} concentrations in the ambient air.

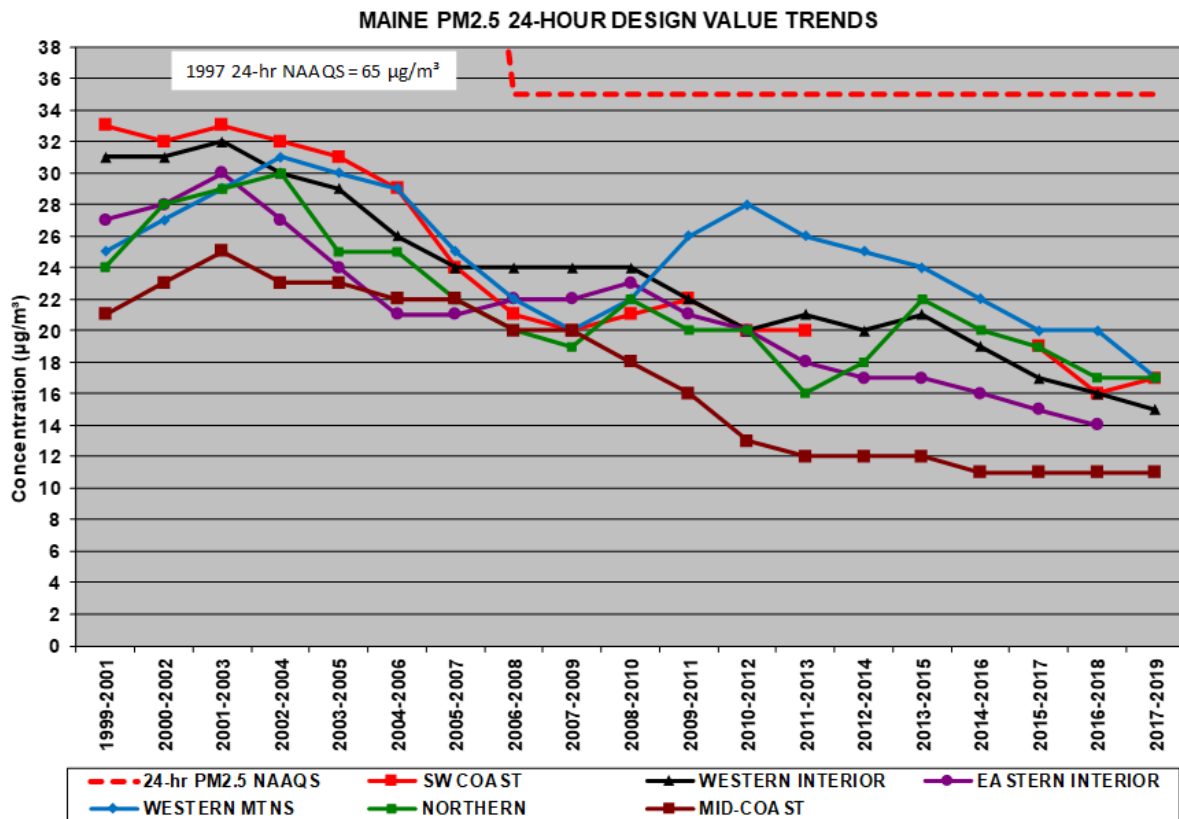


Figure 12: Maine PM_{2.5} 24-Hour Design Value Trends

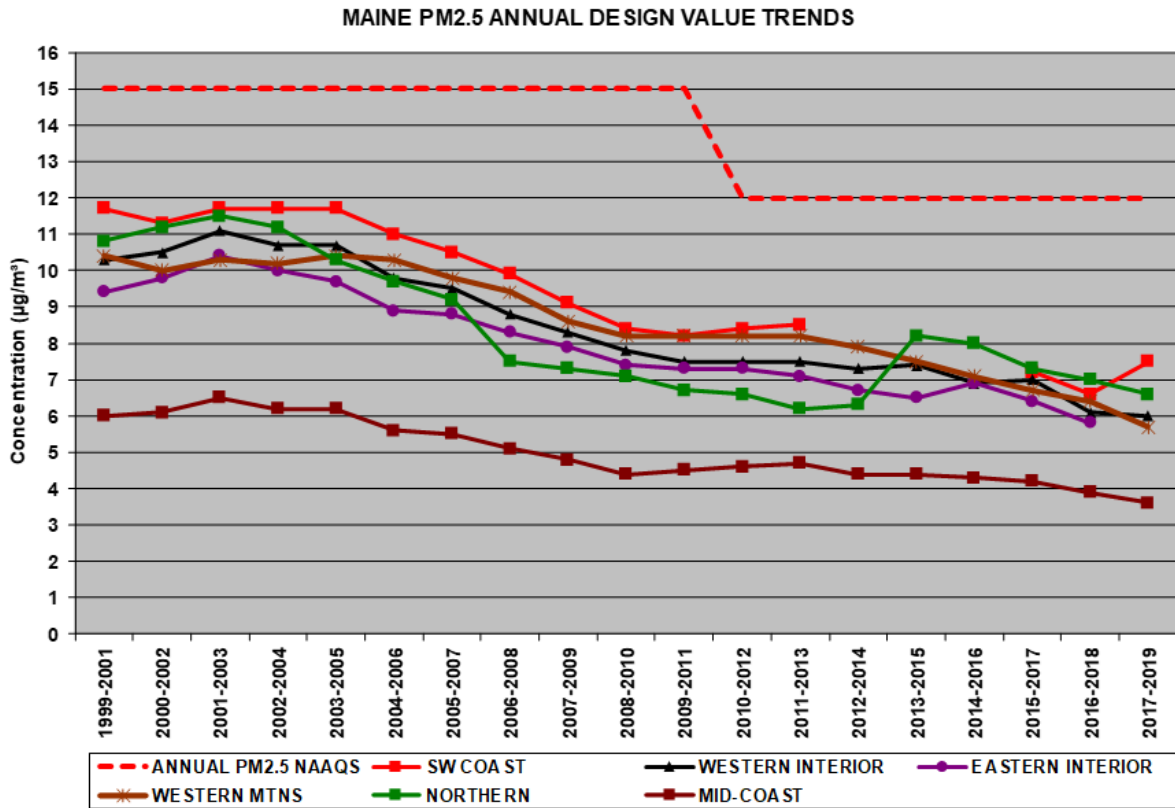


Figure 13: Maine PM_{2.5} Annual Design Value Trends

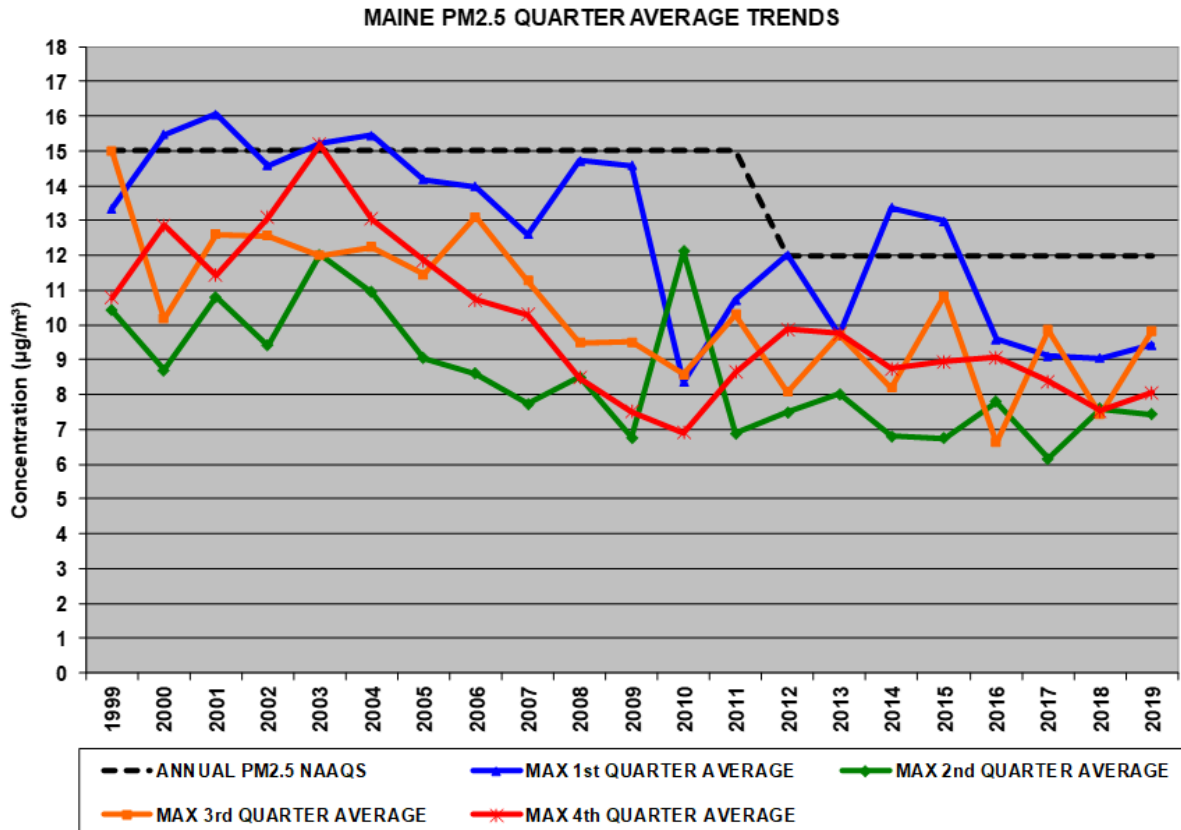


Figure 14: Maine PM_{2.5} Quarter Average Trends

Future PM_{2.5} Monitoring Network:

In January 2020 FRM (method 143) samplers were removed from Madawaska, Bangor, and Lewiston. The sampler from Lewiston was relocated to Portland to replace two FRM method 145 samplers. The samplers from Bangor and Madawaska were relocated to Bar Harbor to replace a method 145 sampler.

PM₁₀

The current PM₁₀ 24-hour filter and continuous PM₁₀ federal reference method (FRM) and federal equivalent method (FEM) monitors in the State of Maine used to track compliance with NAAQS are located in the more populated areas, at a source of interest, and in a region that has in the distant past experienced some exceedances of the standard. The types of PM₁₀ monitors and their locations are shown in Figure 15.

Figure 16 shows all sites in attainment of the current PM₁₀ NAAQS. The most recent exceedance of the 24-hour standard occurred in Madawaska in 2018. In 2020 a continuous PM₁₀ sampler will be established in Madawaska in order to document the attainment status of the area.

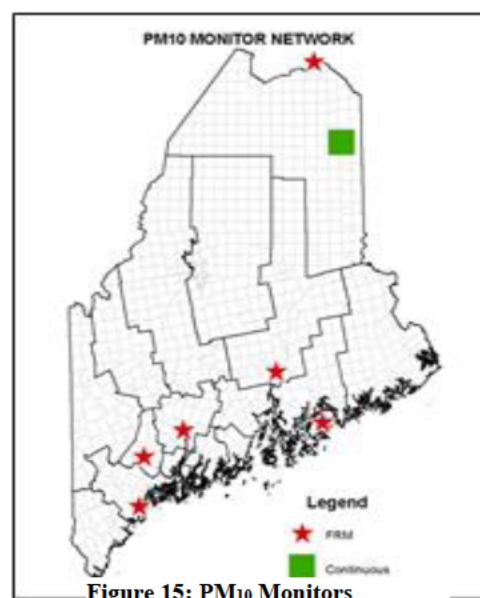


Figure 15: PM₁₀ Monitors

The following is a list of Maine's PM₁₀ sites in relative order of importance and identification of the measurement method at each:

Highest Population Areas

- Portland (FRM)
- Lewiston (FRM)
- Bangor (FRM)

Regions with Historical Exceedances

- Presque Isle (FRM and FEM) (maintenance plan area)
- Madawaska (FEM)

Other Population Center of Interest

- Augusta (FRM)

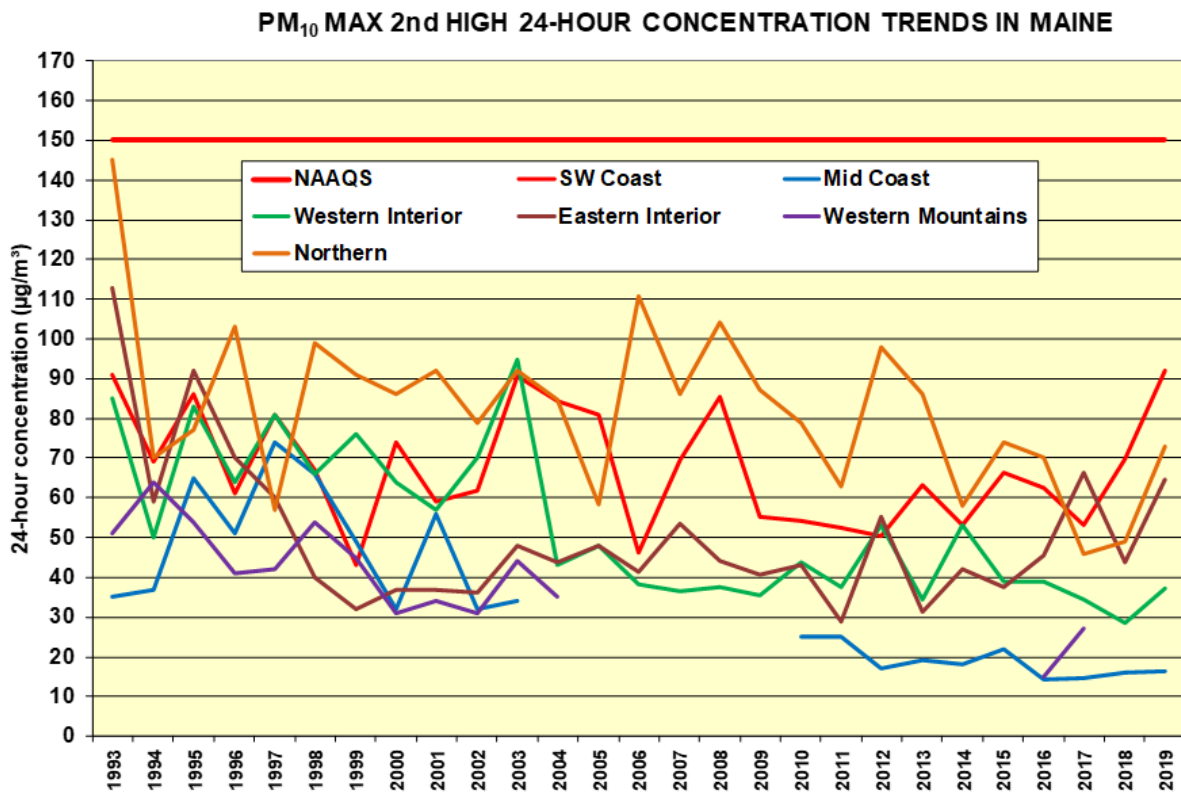


Figure 16: PM₁₀ Max 2nd High 24-Hour Concentration Trends 1993- 2014

Future PM₁₀ Monitoring Network:

The current PM₁₀ network is monitoring the highest population centers and maintenance areas of the State and satisfies federal monitoring requirements. The Maine DEP-BAQ installed a PM₁₀ BAM in Madawaska. This will be done in response to an exceedance of the NAAQS in 2018 and is intended to document the attainment status of Madawaska.

Visibility/Speciation

Maine operates a particle speciation monitoring network as part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. Maine currently operates a monitor in Freeport. The Bridgton monitor was discontinued in 2016. Monitors are also operated by the National Park Service in the Acadia National Park Class I Area, by the U.S. Fish and Wildlife Service in the Moosehorn Wilderness Class I Area, and by the Penobscot and Micmac tribes. The Moosehorn Wilderness visibility/speciation monitoring provides data representative of conditions at the nearby Roosevelt-Campobello International Park (RCIP) Class I area; thus, no monitor is needed at RCIP. Figure 17 indicates the location of the IMPROVE monitors in the State.

Figures 18 and 19 show how the IMPROVE data is used to track visibility using the deciview metric at the Acadia National Park and Moosehorn sites for the second regional haze State

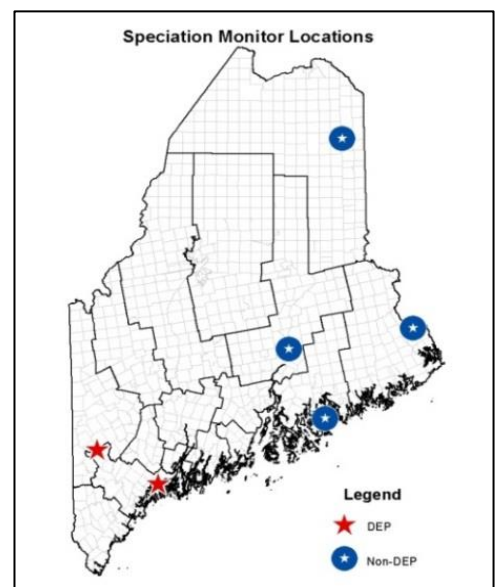


Figure 17: Speciation (IMPROVE) Monitors

Implementation Plan (SIP). Deciview is a visibility metric based on the light extinction coefficient that expresses incremental changes in perceived visibility. All other sites in Maine show similar improvements.

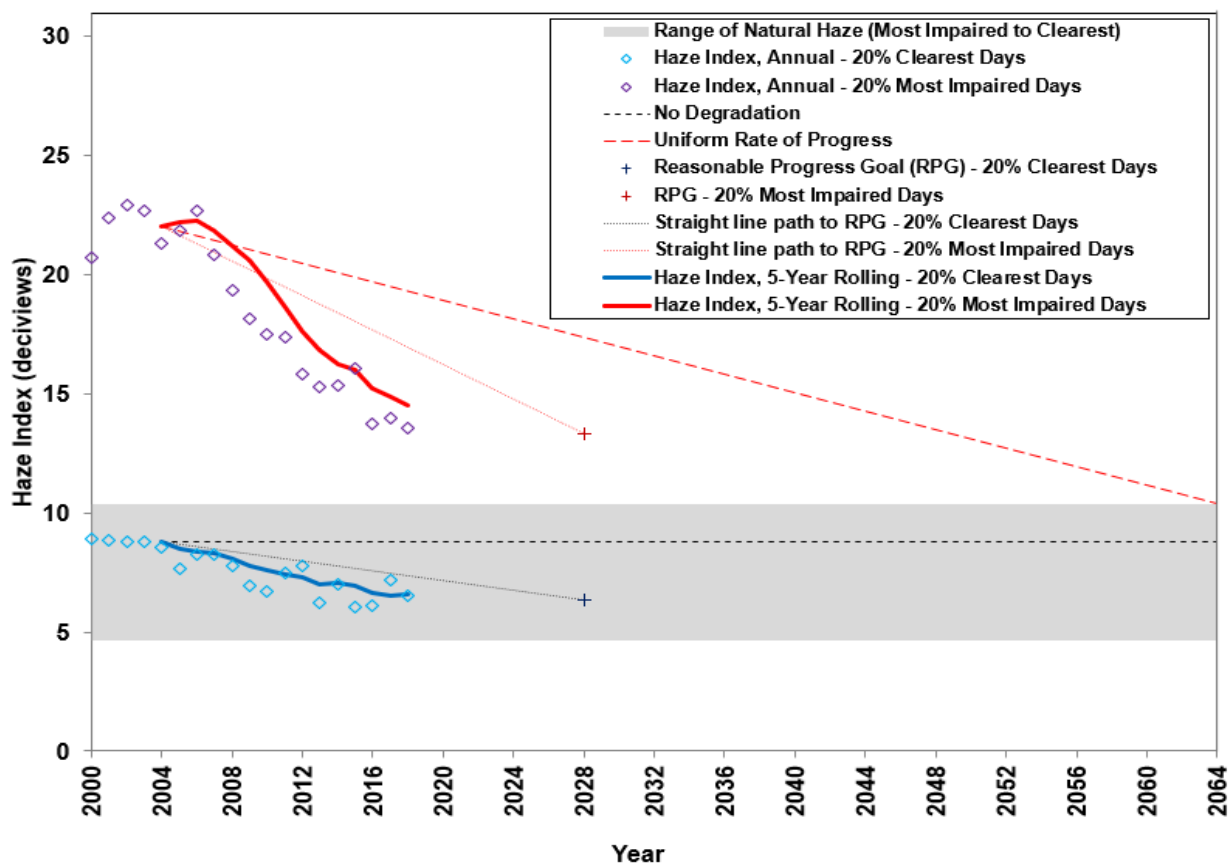


Figure 18: Acadia National Park Deciview Data

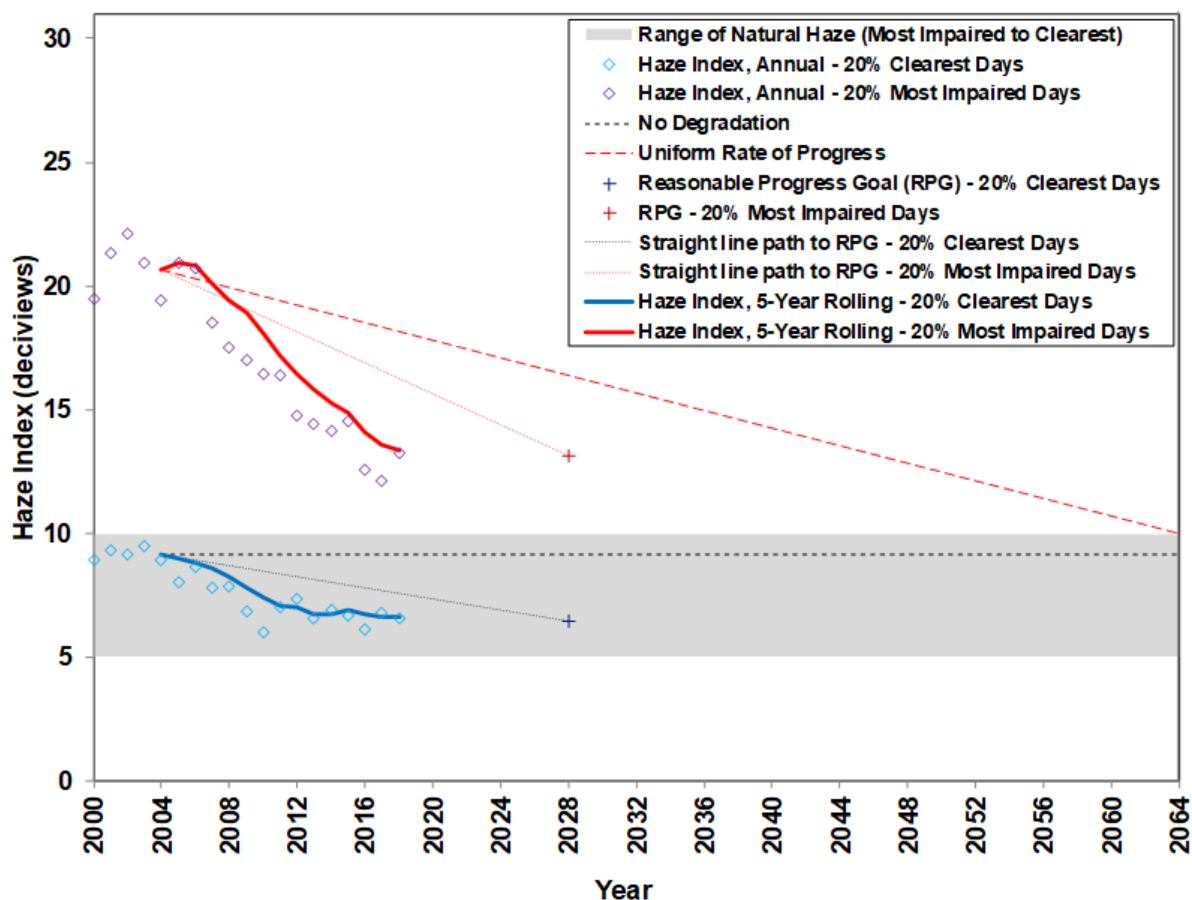


Figure 19: Moosehorn Deciview Data

The visibility/speciation network meets monitoring requirements at all three Class I areas in and near Maine. Continued monitoring at the three Class I areas to track visibility conditions is required in the Regional Haze Rule. Such monitoring is also a commitment made in Maine's annual State Implementation Plan (SIP). The Freeport site is a speciation site as required by EPA's PM_{2.5} network design criteria for Maine. The Tribes also operate speciation sites in Presque and the Penobscot Nation. Although the Freeport and tribal sites are in Class II areas and not in Class I areas, the Department and tribes opted to use IMPROVE Protocol samplers (required for Class I monitoring sites) at those sites so that all PM speciation data in the State would be generated using the same equipment and collected filters would be analyzed by the same lab.

Figure 20 shows the averages of sulfate, nitrate, and organic compound measurements and the 90th percentiles since 2009 at all sites in Maine. Results clearly show that each site is measuring different local haze conditions. The Class I sites at Acadia National Park (ACAD) and Moosehorn (MOOS) measure relatively clean rural coastal conditions. The Penobscot Nation (PENO) and Freeport (CABA) sites are measuring more polluted urban conditions, while the Micmac (PRIS) site is measuring inland rural conditions.

Future Visibility/Speciation Monitoring Network: No changes are planned.

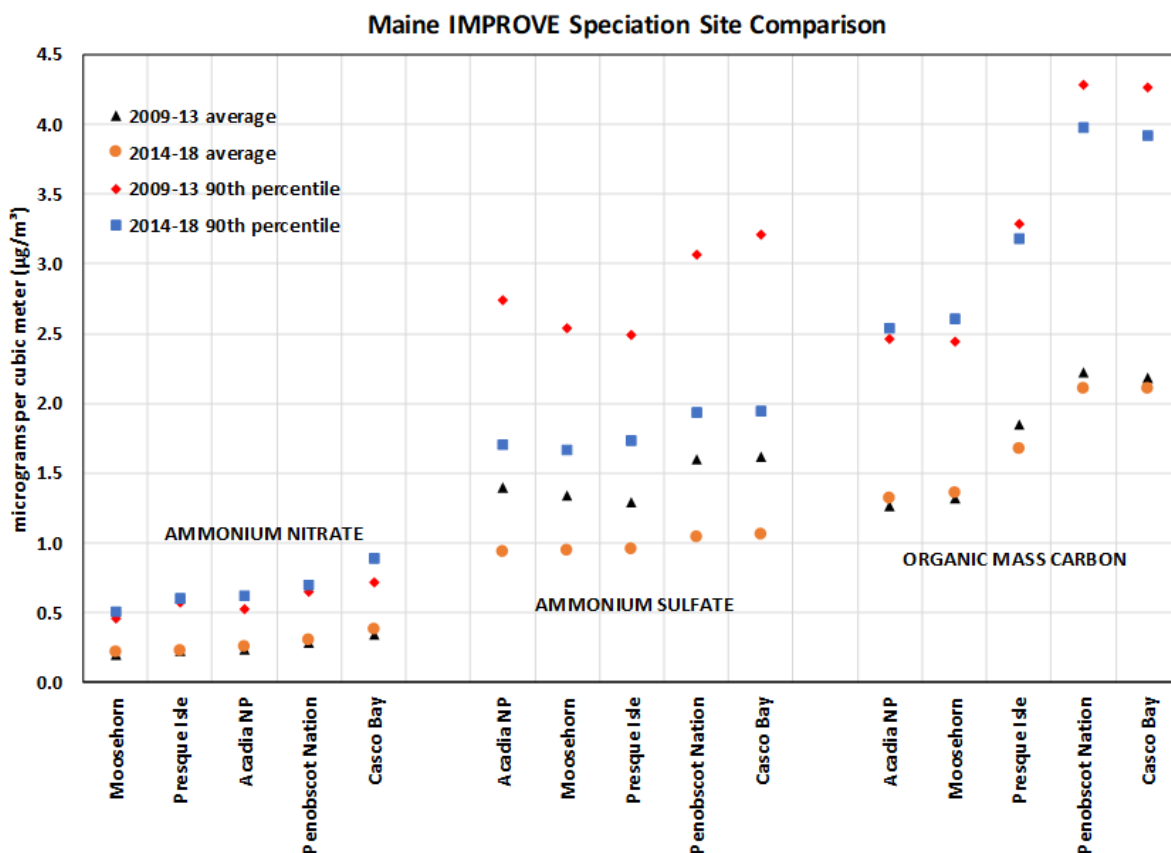


Figure 20: Speciation Site Comparisons

PM Coarse (PM_{10-2.5})

PM Coarse is the fraction of particles from 2.5 up to 10 microns in size. There is currently no regulatory standard for this size range. EPA has proposed a standard in the past but opted to do more research rather than promulgate a standard. As of January 1, 2011, PM Coarse was required to be monitored at all NCore sites.

PM Coarse is currently monitored at one site in Maine. PM Coarse data at the Acadia National Park NCore site is attained by the difference method: Two monitors at the site measure PM₁₀ and PM_{2.5}, respectively, and PM Coarse is calculated by subtracting the PM_{2.5} from the PM₁₀. At the Kenduskeag Pump Station in Bangor, a pair of collocated dichotomous samplers each measure PM_{2.5} and PM Coarse were operated up to November 15, 2016. PM₁₀ was calculated by summing the two fractions. On November 16, 2016 the Dichotomous samplers were removed and FRM samplers installed in their place. PM Coarse data was attained via the same subtraction method used at Acadia National Park. The Kenduskeag Pump Station site was shut down on May 1, 2019. PM Coarse was monitored the Bangor Mary Snow School site from late in 2017 up to when the PM 2.5 FRM sampler was shut down at the end of 2019. PM Coarse was then calculated by subtracting the PM_{2.5} from the PM₁₀.

The PM Coarse component of particulates could also be calculated from data collected at several other sites in the State using the difference method. The Lewiston, Augusta, Bangor, and Madawaska sites all had PM₁₀ and PM_{2.5} monitors that ran simultaneously. The Lewiston and Bangor sites had their PM_{2.5} samplers shut down and moved to another site at the end of 2019. The Augusta site still has both PM_{2.5} and PM₁₀ samplers operating.

Future PM Coarse Monitoring Network:

Maine plans to continue the PM Coarse monitoring at the Acadia National Park NCore site. PM Coarse data may be derived from the historical monitoring conducted at the Lewiston, Augusta, Bangor, and Madawaska sites and added to the Department's database if a standard is promulgated or there arise other reasons requiring such data collection. In addition, PM Coarse data can be derived from the Augusta site going forward.

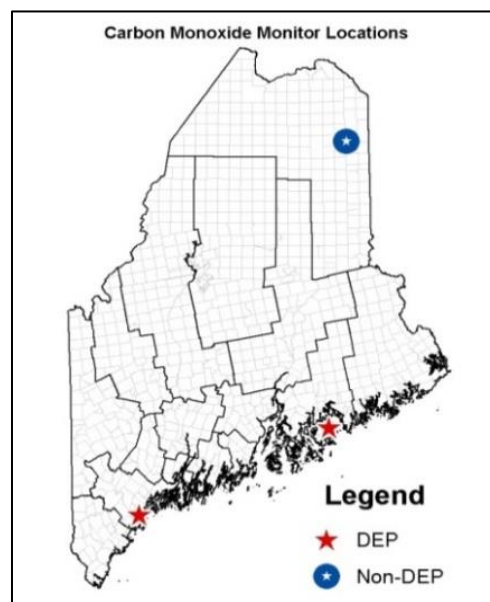
Carbon Monoxide (CO)

The current NAAQS for CO, promulgated in 1971, are as follows:

- 35 ppm as a 1-hour average, not to be exceeded more than once per year (design value is the highest annual 2nd maximum 1-hour concentration); and
- 9 ppm as an 8-hour average, not to be exceeded more than once per year (design value is the highest annual 2nd maximum non-overlapping 8-hour concentration).

There is currently no secondary standard. Since the 1970s, Maine has experienced no CO non-attainment problems.

Carbon monoxide is currently monitored by the State at the Deering Oaks site in Portland (urban location) and at the NCore site in Acadia National Park (trace level monitor). The Micmac tribe also operates a CO monitor in Presque Isle. These three locations are shown in Figure 21. The maximum 1-hour concentration recorded over the last three years at the Deering Oaks site is 2.2 ppm, and the maximum 8-hour concentration recorded over that same time period is 1.4 ppm.



2nd Highest 1-hour Carbon Monoxide Trends in Maine

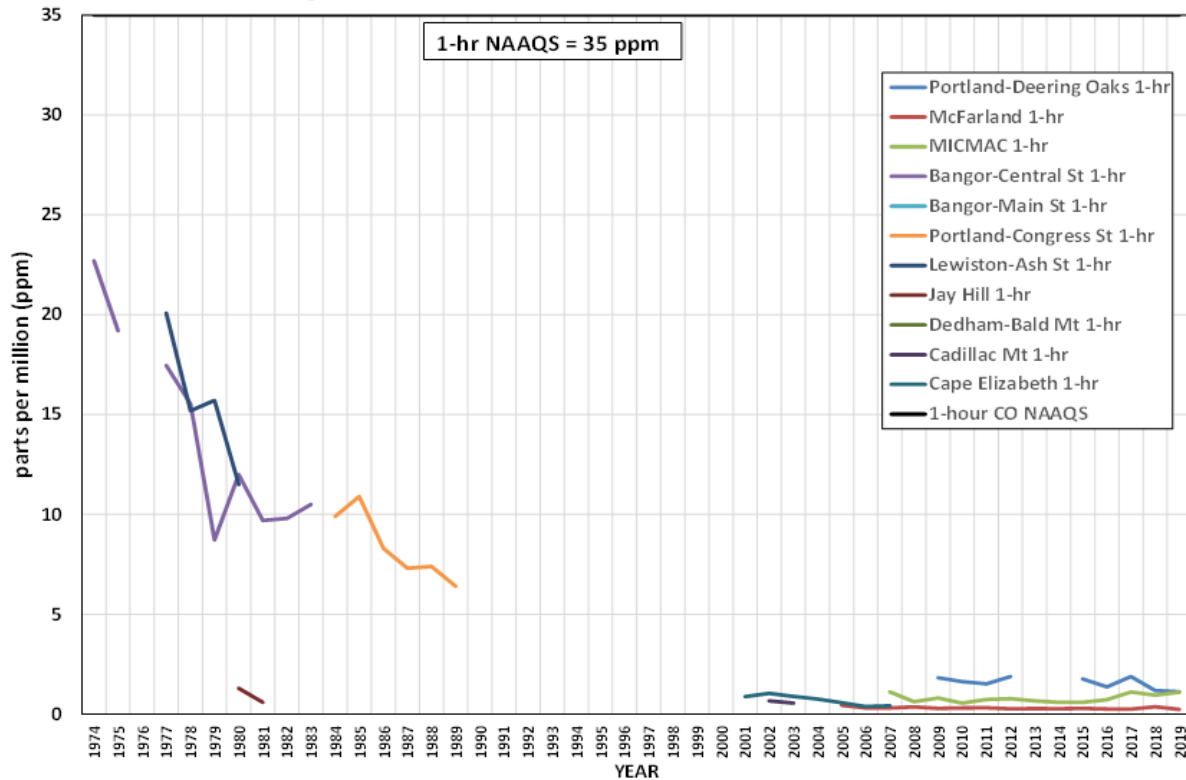


Figure 22: Maine CO 1 Hour Trends 1974 - 2019

2nd Highest 8-hour Carbon Monoxide Trends in Maine

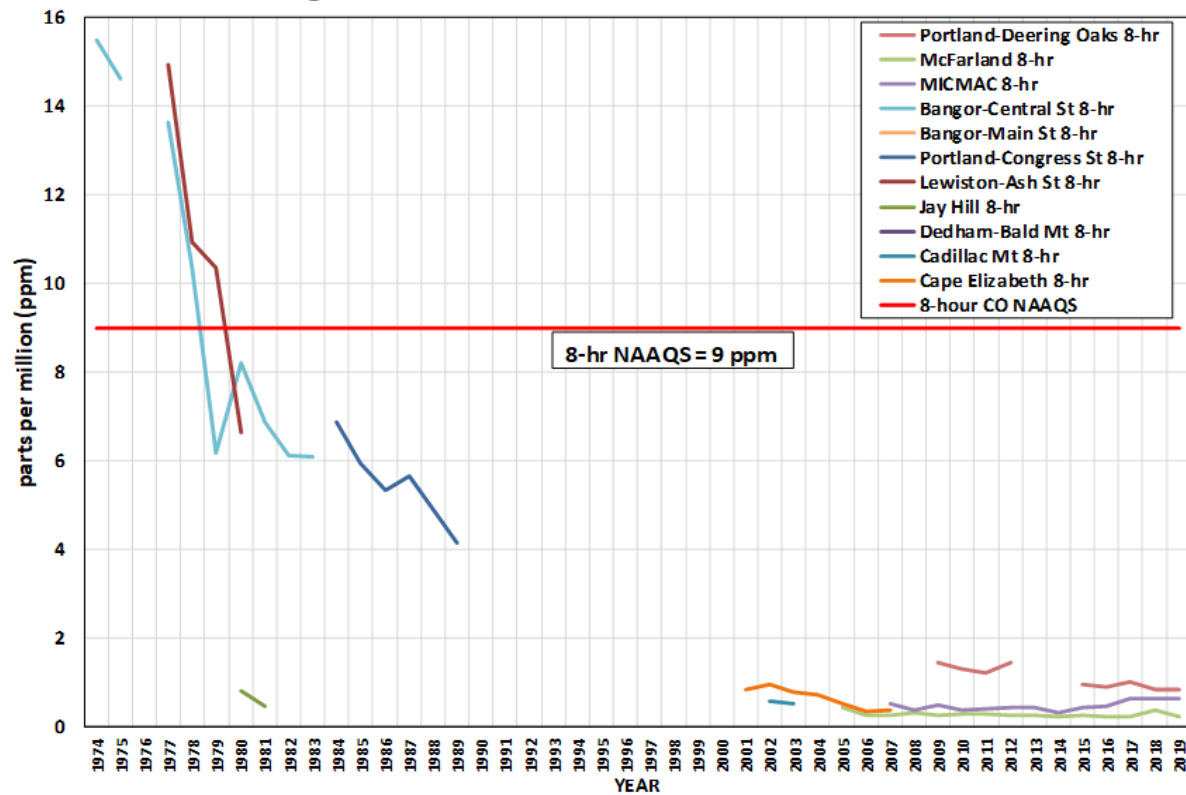


Figure 23: Maine CO 8 Hour Trends 1974 - 2019

Future CO Monitoring Network:

Given these low concentrations, the only required CO monitors in the State are the trace level monitor at the NCore site in Acadia National Park and the urban monitor in Portland. Maine may discontinue CO monitoring in Portland.

Sulfur Dioxide (SO₂)

The current NAAQS for SO₂, promulgated in 2010, is 75 ppb as a 1-hour primary standard (design value is the 3-year average of the 99th percentile of the annual distribution of daily maximum 1-hour average concentrations). The only requirement for SO₂ monitoring in Maine is the NCore site in Acadia National Park, a trace level SO₂ monitor. Other SO₂ monitors used to collect urban and background/baseline data for the licensing program were located in Portland and Gardiner. The Gardiner site was discontinued in January 2020 after a valid three-year design value was achieved. The monitor in Portland remains in operation. The Micmac tribe also operates a SO₂ monitor at their site in Presque Isle. The locations of current SO₂ monitors in Maine are indicated in Figure 24.

Figure 25 depicts 99th percentile 1-hour concentration trends at all sites in Maine. The maximum 1-hour concentration recorded in Portland in the last three years is 12.0 ppb, and the latest valid 2016-18 design value is 7 ppb, which is well below the 75 ppb NAAQS.

Future SO₂ Monitoring Network:

Maine's SO₂ monitoring network meets EPA's monitoring criteria.

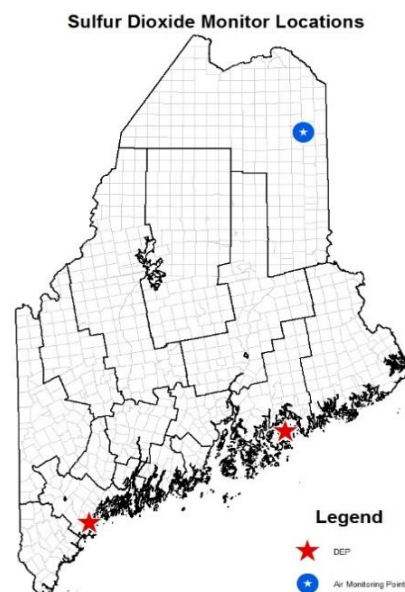


Figure 24: Sulfur Dioxide Monitors

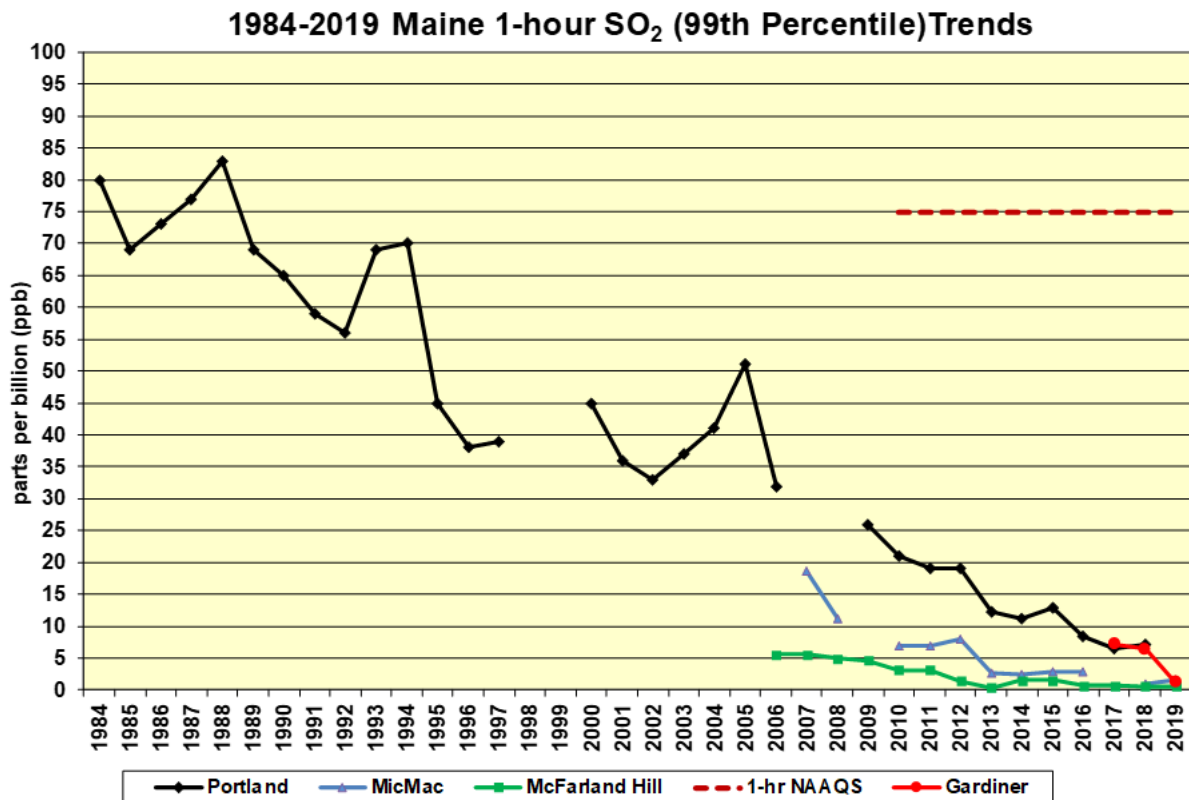


Figure 25: Maine SO₂ 1 Hour Trends 1984 - 2014

Nitrogen Dioxide (NO₂)

The current NAAQS for NO₂ are as follows:

- 53 ppb, annual average standard
- and 100 ppb as a 1-hour standard (design value is the 3-year average of the 98th percentile of the annual distribution of daily maximum 1-hour average concentrations)

The locations of monitors for nitrogen dioxide (NO₂) and reactive oxides of nitrogen (NO_y) are shown in Figure 26. NO_y is currently monitored by the State at Two Lights State Park in Cape Elizabeth and at the NCore site in Acadia National Park (trace level monitor). NO₂ is currently monitored by the State in Portland at the Deering Oaks site (urban location) and was monitored in Gardiner through 2019. The Micmac tribe also operates a NO₂ monitor in Presque Isle.

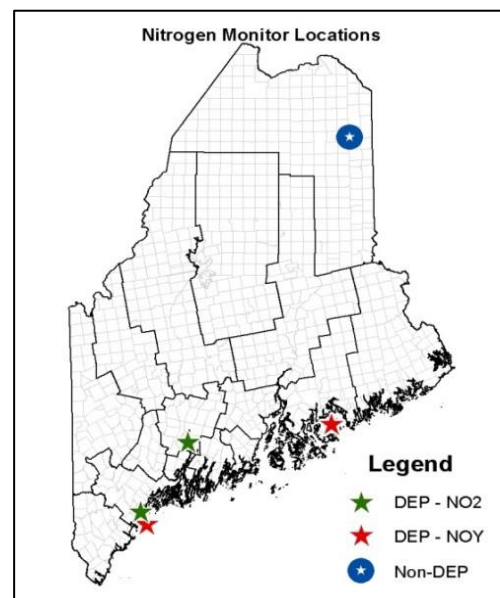


Figure 26: Nitrogen Monitors

On December 22, 2016, the U.S. Environmental Protection Agency (EPA) revised the minimum monitoring requirements for near-road nitrogen dioxide (NO₂) monitoring. Specifically, the EPA removed the requirement for near-road NO₂ monitoring stations in Core Based Statistical Areas

(CBSAs) having populations between 500,000 and 1,000,000 persons, that had been scheduled to be installed and operational by January 1, 2017.

Figure 27 depicts 1-hour concentration trends at all sites in Maine. The maximum 1-hour concentration recorded in Portland in the last three years is 87.1 ppb, and latest valid 2015-17 Design Value is 46 ppb, which is well below the 100 ppb NAAQS.

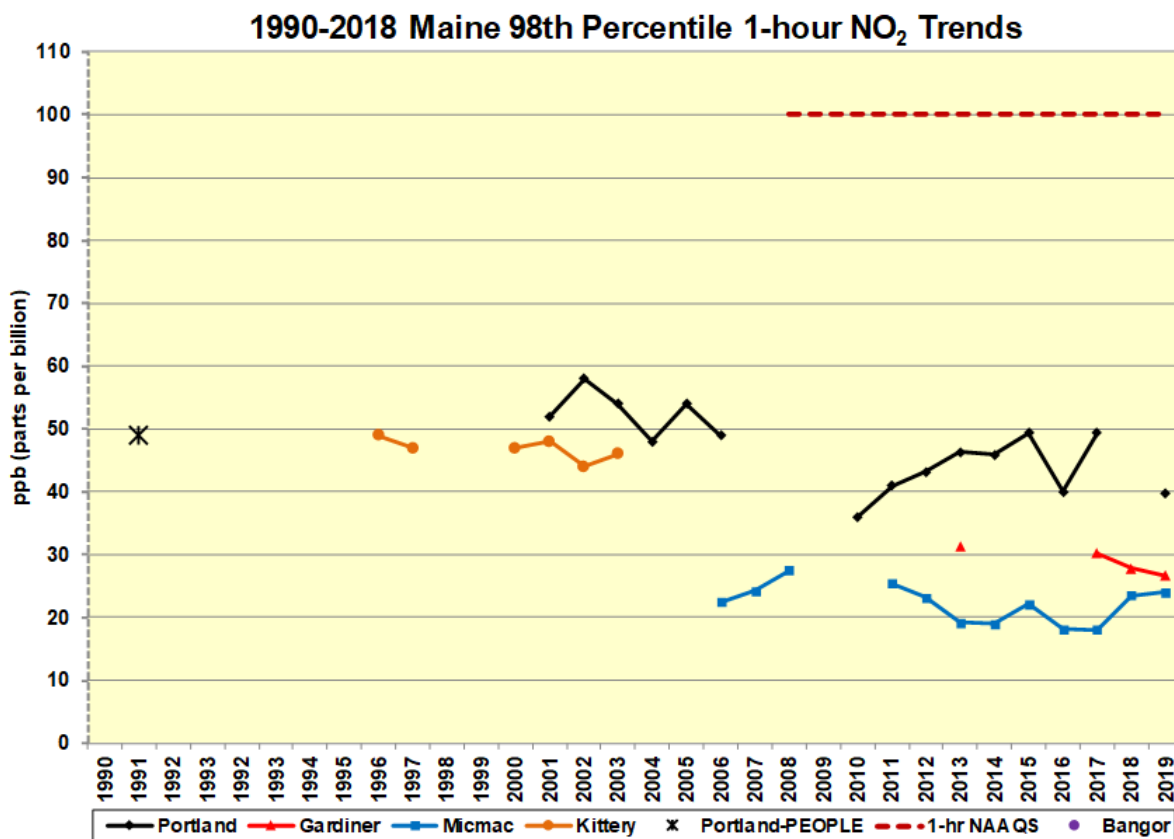


Figure 27: Maine NO₂ 1-Hour Trends, 1990 - 2019

Future NO₂ Monitoring Network:

The existing monitors meet EPA monitoring requirements and will provide the data necessary for urban and rural concentrations needed for the licensing program.

Lead (Pb)

The most recent national assessment by EPA of lead ambient air monitoring and emissions data indicated that no lead monitoring was required to be done in Maine.

In 2008, EPA promulgated a new lead standard and issued minimum monitoring requirements. At that time, Maine was to be required to operate one monitor in the Portland CBSA (Core-Based Statistical Area). In anticipation of meeting this requirement, an X-ray fluorescence (XRF) analyzer was purchased so that lead concentrations from PM₁₀ filters could be determined in-house, in lieu of contracting long-term with an outside lab. Having the XRF analyzer also provided us with the

ability to determine ambient levels of a couple dozen trace metals, many of which are on our Air Toxics Priority List (i.e. pollutants in need of ambient air quality data). The EPA lead monitoring requirement was subsequently revised to require lead monitoring at urban NCore sites only. Our Bar Harbor NCore site is designated as a rural site, so consequently there was no requirement for lead monitoring in Maine.

Since we had already acquired the XRF analyzer, it was concluded it would still be worthwhile to update our understanding of what Maine's current background levels of lead and other trace metals were, by randomly analyzing previously collected and archived PM₁₀ filter samples. This continues to be an on-gong project. In addition, to make the most and best use of our XRF capability, we offered this analytical service to other Northeast states' air monitoring programs, essentially at cost and at a much more affordable rate than that available from the very few other labs doing XRF analyses. In response, Rhode Island's Department of Environmental Management opted to have us do their lead analyses for them during their lead monitoring requirement, which was in place from 2011 – 2015 (we provided trace metals results as well).

Having lead and trace metals data determined by the same analytical method offers an opportunity within the northeast region to look for regional trends, distributions, and relevance of background concentrations using data collected and analyzed by a common set of procedures.

Future: In the future, the Department intends to conduct continued XRF analysis on random selections of Maine PM₁₀ filters to determine what the State's actual background levels might be for lead and other metals. There are no projected dates for completion of this testing and analysis program at this time.

Maine's Hazardous Air Pollutants Monitoring

Maine monitors year-round for multiple hazardous air pollutants (HAPs) including photochemical organics, in 12 Maine cities and towns. Although this is a major portion of Maine's ambient air monitoring program, it is not required by federal regulation 40 CFR Part 58, *Ambient Air Quality Surveillance*. Figure 28 indicates the locations and the type of monitoring done at these sites. EPA Method TO-15 is employed to sample and analyze selected compounds from the Maine Air Toxics Initiative's Air Toxics Priority List, selected based on the National Air Toxics Assessment (NATA) results. These monitors provide actual data to accurately inform estimates of toxic air pollutants, to guide the selection of specific toxic air pollutants for study and evaluation. The most current NATA data available is for the year 2005, which data was made available to the public on March 11, 2011. Maine did not undertake a comparison with more recent NATA data since the 2015 5-Year Network Assessment. Consideration was given to doing so, but no time frame for that comparison was set.

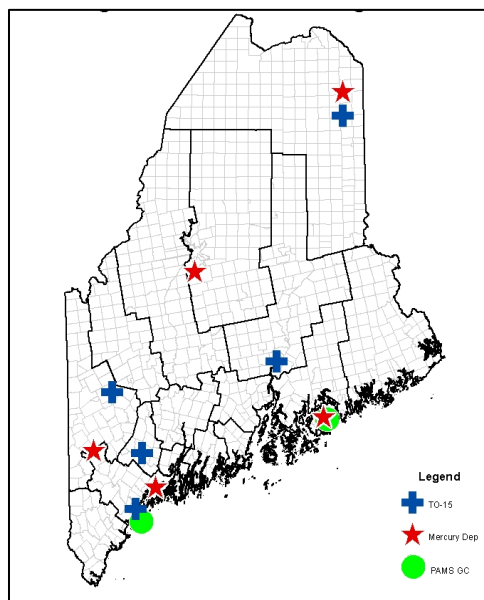


Figure 28: Hazardous Air Pollutants Monitors

The State conducts ongoing evaluation of appropriate toxic air pollutants to monitor following TO-15 National Air Toxics Trends Stations (NATTS) protocols. Maine will review the 2011 NATA data when it is released, expected later this year, to assess what this more current information reveals about changes in the occurrence and prevalence of specific toxic air pollutant compounds, their spatial distribution, and how this data compares to the ambient monitoring data collected for like compounds.

The hazardous air pollutant monitoring conducted in Maine provides background and baseline data for the pollutants monitored. Data from these sites is analyzed to determine impacts and to identify any trends in ambient air levels of these compounds, possibly identifying contributing factors to specific health problems identified in localized areas.

Since some of the PAMS program's target compounds were also considered hazardous air pollutants, Maine had been conducting continuous HAPs monitoring (via an auto-GC) during the ozone season at the Cape Elizabeth and Cadillac Mountain sites. Year-round HAPs monitoring via TO-15 at Cape Elizabeth began in 2014 and was conducted up to June 2019. In June 2019, the HAPs canister sampler was removed for use in a special purpose monitoring program in South Portland. The Cape Elizabeth PAMS/enhanced ozone site is up-wind of Maine's emission sources, and was located to assess long-range transport; thus, air pollutant measurements from this site predominantly represent transported HAPs pollution from sources out-of-state.

The Department measures some of the most prevalent combustion by-products – benzene, toluene, ethylbenzene, and xylenes (BTEX compounds) – at its enhanced ozone and all other hazardous air pollutants monitoring sites. Enhanced ozone measurements help the Department estimate local versus transported pollutant concentrations of the BTEX compounds at other sites. Enhanced ozone and PAMS data also provide more than a decade of measurements that can be used to evaluate trends. Figure 29 indicate a significant decline in overall annual average BTEX concentrations in the late 1990s and much smaller variations in recent years. Year-round monitoring data is available to be examined in conjunction with enhanced ozone data for more in-depth analyses of patterns in pollutant concentrations.

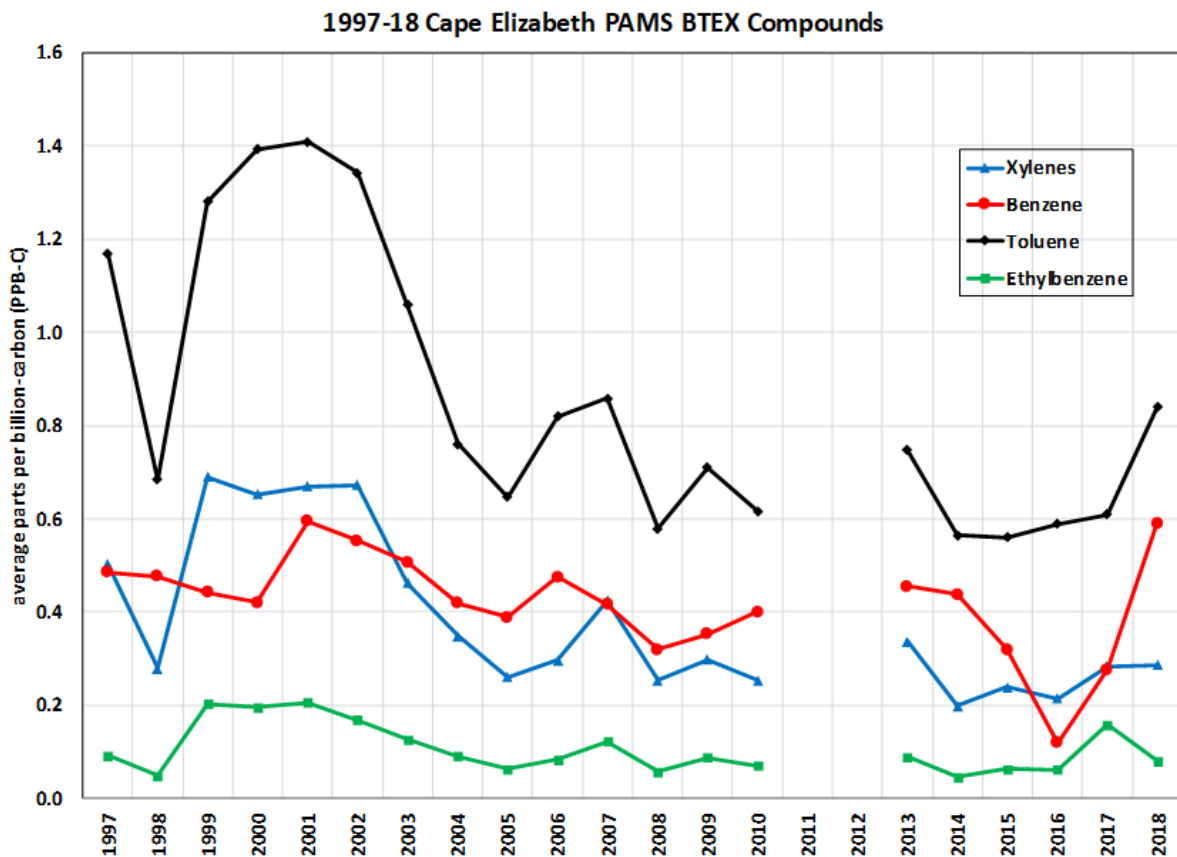


Figure 29: CETL PAMS 1997 thru 2018 BTEX Compounds

Figure 30 illustrates benzene monitoring results from five of Maine’s year-round toxic air pollutant monitoring sites during the period 2015-2019. In addition to the obvious annual cycle of measured benzene concentrations higher in the colder months and lower during the warmer months, the data plots for the individual sites indicate a decline in peak levels of benzene at the Lewiston (CKP) and Bangor (KPS) sites, but steady levels in Rumford and Presque Isle. Using the long-term data compiled from the Department’s hazardous air pollutant monitoring sites, the Department can evaluate trends for any of the monitored compounds.

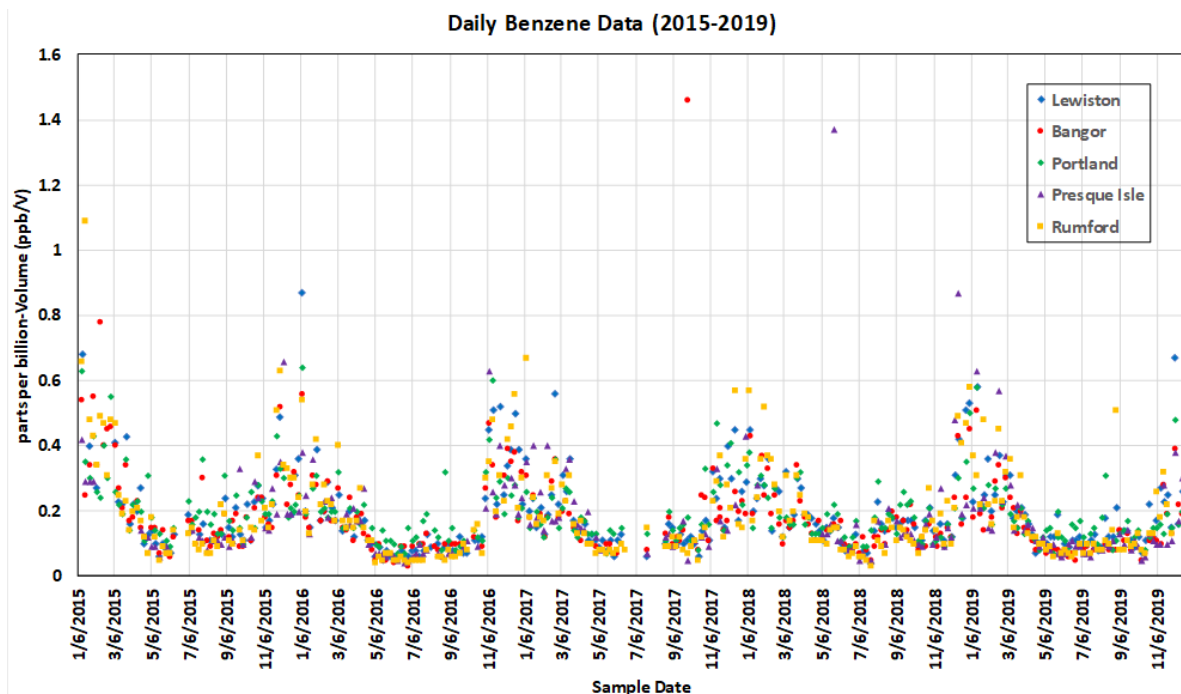


Figure 30: Daily Benzene Data (2015–2019)

Maine’s Air Toxics Strategy includes further investigation into air quality impacts from residential wood combustion. In November 2016 the Maine DEP-BAQ established a monitoring station in Farmington to quantify impacts to ambient air quality from residential wood combustion. Maine employed a black carbon analyzer, a continuous PM_{2.5} monitor, and an integrated PM_{2.5} sampler. The study was conducted through the winter of 2016 – 2017. **The results of this study were inconclusive.**

Future HAPs Monitoring Network:

The Maine DEP-BAQ re-established a HAPs sampler at Cape Elizabeth in 2020; support for the special study in South Portland and Portland will continue with the addition of PAH and HAPs sampling from equipment mounted on a mobile platform.

Maine’s Atmospheric Deposition Monitoring and Relevance

The National Atmospheric Deposition Program (NADP) was organized in 1977 under the leadership of the State Agricultural Experiment Station (SAES) program to increase understanding of the causes and effects of acidic precipitation on agricultural crops, forests, rangelands, surface waters, and other natural and cultural resources. The National Trends Network (NTN), a long-term precipitation chemistry monitoring network of wet-only deposition sites, distant from point source emission influences, began operation in 1978 collecting one-week long bulk precipitation samples. Samples were analyzed by the Central Analytical Laboratory at the University of Illinois in Champaign. In March 2018 the Central Analytical Laboratory was moved to the Wisconsin State Laboratory of Hygiene at the University of Wisconsin-Madison. The parameters listed in the table below were analyzed to determine amounts, temporal trends, and geographic distributions of the atmospheric deposition of acids, nutrients, and base cations by precipitation.

Wet Deposition Chemistry Parameters

Calcium	Magnesium	Potassium
Sodium	Ammonium	Nitrate
Chloride	Sulfate	Bromide
Free acidity (as pH)	Specific conductance	Orthophosphate (for QA purposes)

Sites in the NTN benefit from having identical siting criteria, operating procedures, a common analytical laboratory, as well as a common quality assurance program. Presently, there are approximately 250 sites nationally in the NTN. The locations of NTN sites in Maine are identified in Figure 31. Sites within this network in Maine were established as follows:

<u>Site Location</u>	<u>Year Established</u>	<u>Establishing Agency</u>	<u>Discontinued?</u>	<u>Notes</u>
Greenville	1979	University of Maine		
Caribou	4/1980	National Oceanic and Atmospheric Admin. (NOAA)		
Bridgton	9/1980	Maine DEP		
Acadia National Park, Paradise Hill	11/1980	National Park Service	Yes	Relocated to McFarland Hill
McFarland Hill	11/1981	National Park Service		
Presque Isle	6/1984	NOAA	Yes	9/30/1988
Freeport	1/1998	Maine DEP		As part of the three-year Casco Bay Estuary Air Deposition Project
Gilead (White Mtn. National Forest)	9/1999	U.S. Geological Survey		
Carrabassett Valley	3/2002	Penobscot Indian Nation		
Near Scraggly Lake	6/2002	Passamaquoddy Tribe	Yes	End of 2006; replaced by Indian Township site
Indian Township	10/2013	Passamaquoddy Tribe		

In 1996, a Mercury Deposition Network (MDN) was created within NADP to provide information on the wet deposition of this pollutant to surface waters, forested watersheds, and other receptors, helping to understand the contribution of air pollution to water pollution. Samples from this network were analyzed by a central laboratory for total mercury and may also be analyzed for methyl mercury to provide data on amounts, temporal trends, and geographic distributions of the atmospheric deposition of mercury and mercury containing compounds by precipitation. Presently, there are approximately 110 sites nationally in the MDN. Eleven upwind states have been identified as the most significant contributors to mercury deposition in Maine. The locations of MDN sites in Maine are identified in Figure 32. Monitoring sites within this network in Maine were established as follows:

<u>Site Location</u>	<u>Year Established</u>	<u>Establishing Agency</u>	<u>Discontinued?</u>	<u>Notes</u>
McFarland Hill in Acadia National Park, Bar Harbor	3/1996	Maine DEP and the National Park Service		
Greenville (collocated with the NTN site)	9/1996	Maine DEP		
Bridgton	6/1997	Maine DEP	Identified for discontinuance, but still operating at this time	
Freeport	1/1998	Maine DEP	Identified for discontinuance, but still operating at this time	As part of the three-year Casco Bay Estuary Air Deposition Project
Caribou	5/2007	Maine DEP		
Carrabassett Valley	2/2009	Maine DEP		Collocated with NTN site

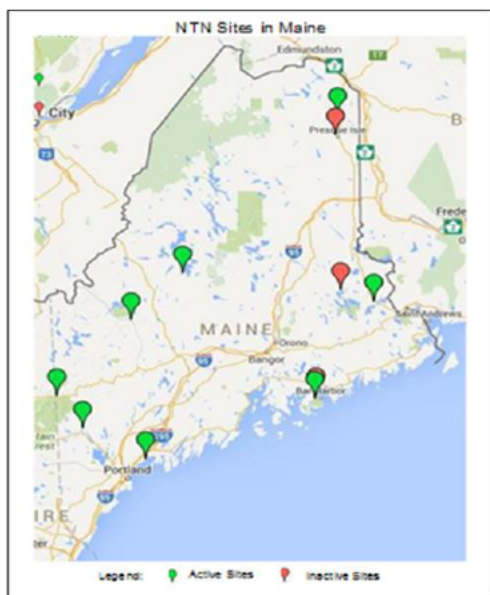


Figure 31: Maine National Trends Network (NTN)

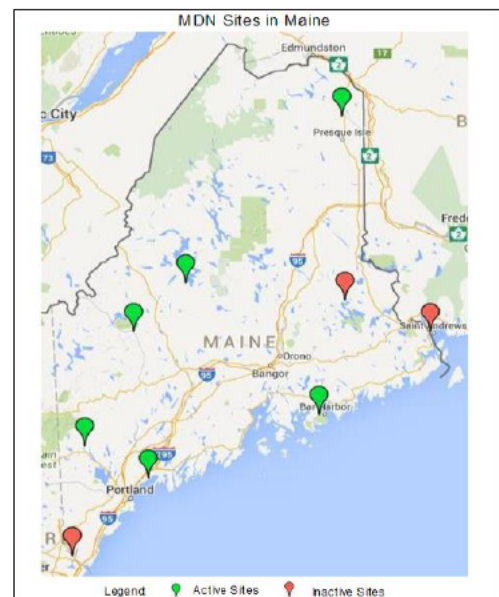


Figure 32: Maine Mercury Deposition Network (MDN)

NADP data collected from NTN and MDN sites in the U.S. are used to produce national, color-shaded contour maps of both concentrations and deposition amounts, as shown on Figures 33 and 34 below:

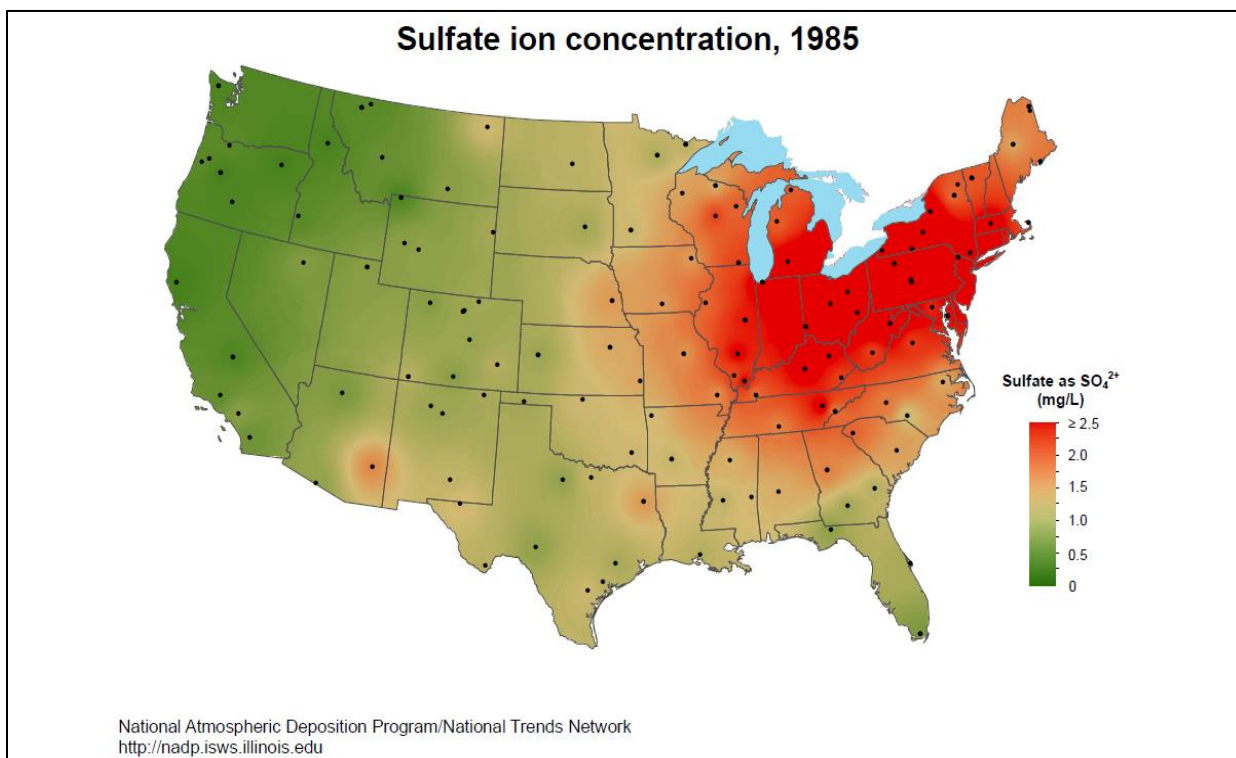


Figure 33: U.S. Annual Sulfate Ion Concentrations 1985

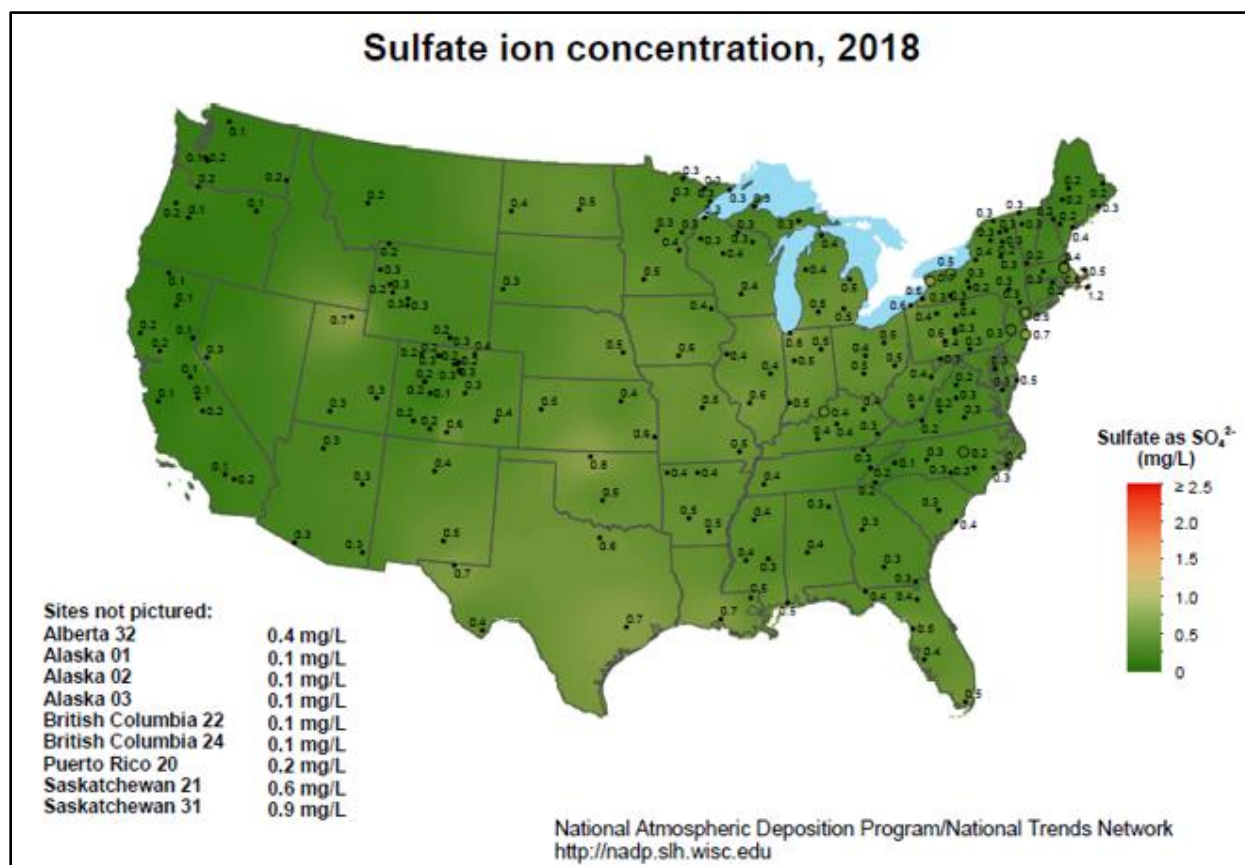


Figure 34: U.S. Annual Sulfate Ion Concentrations 2018

Comparing annual maps to one another provides the ability to look at changes over time. The comparison of Figures 33 and 34 shows a marked decrease in the concentrations of sulfate ion as measured via precipitation samples from 1985 to 2018. Figures 35 and 36 depict sulfate ion data from two of Maine's longest-term trend sites over an even longer period of time.

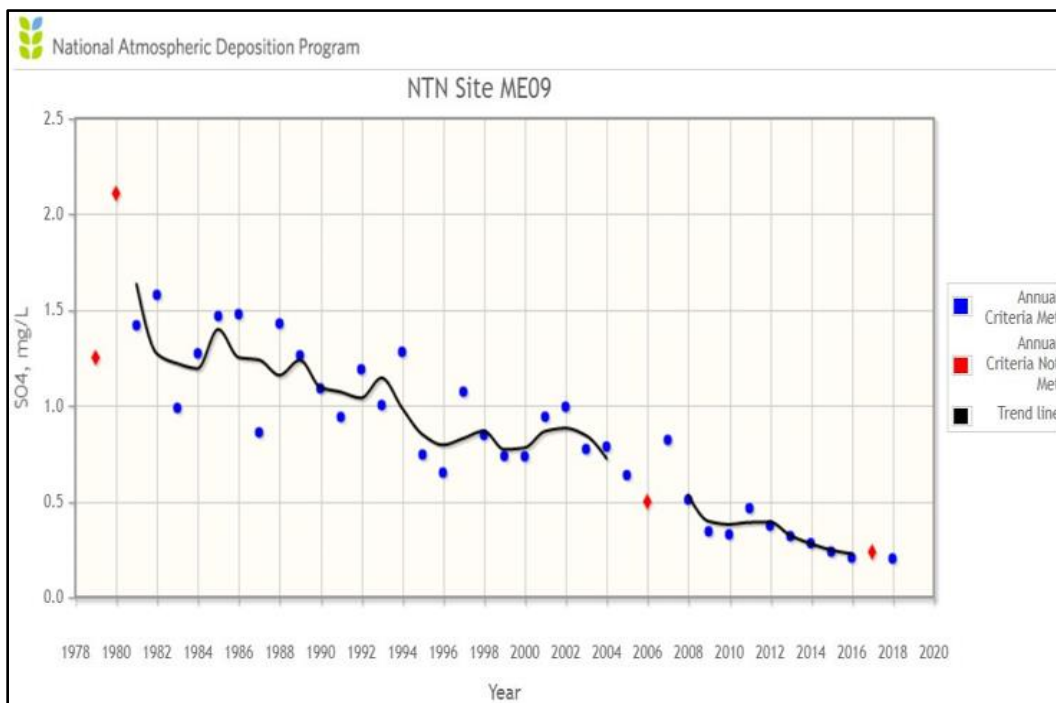


Figure 35: Annual SO₄ Concentrations ME09 1979-2018

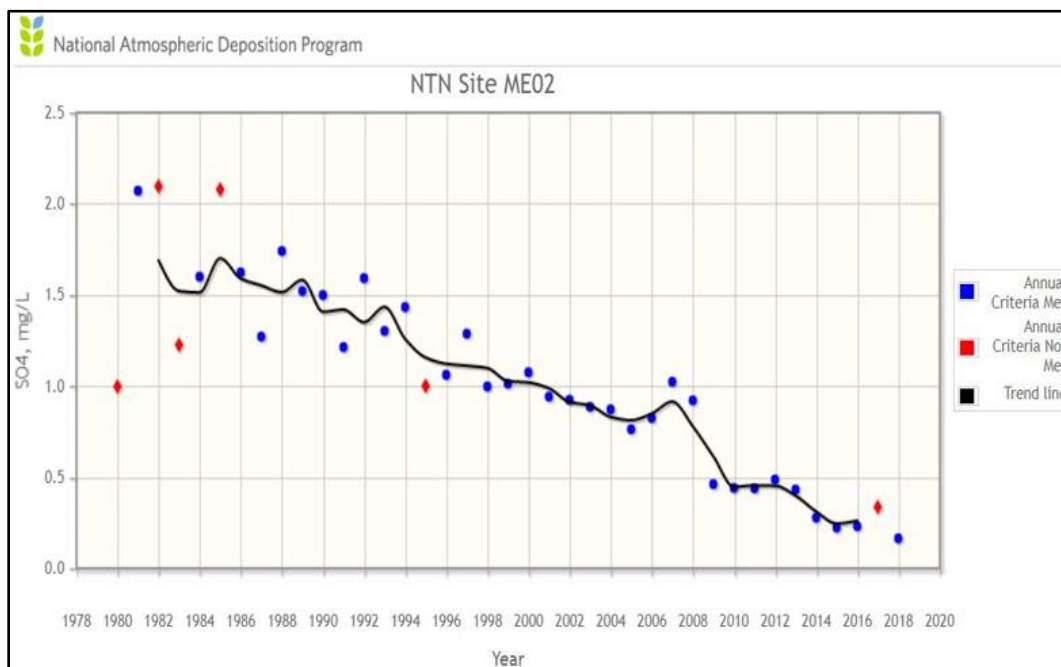


Figure 36: Annual SO₄ Concentrations ME02 1980-2018

The pH of precipitation samples, determined from hydrogen ion analyses, is another important ecological parameter measured by the NTN network. The annual maps shown in Figures 37 and 38 and the trend plots shown in Figures 39 and 40 illustrate a corresponding improving trend in pH levels.

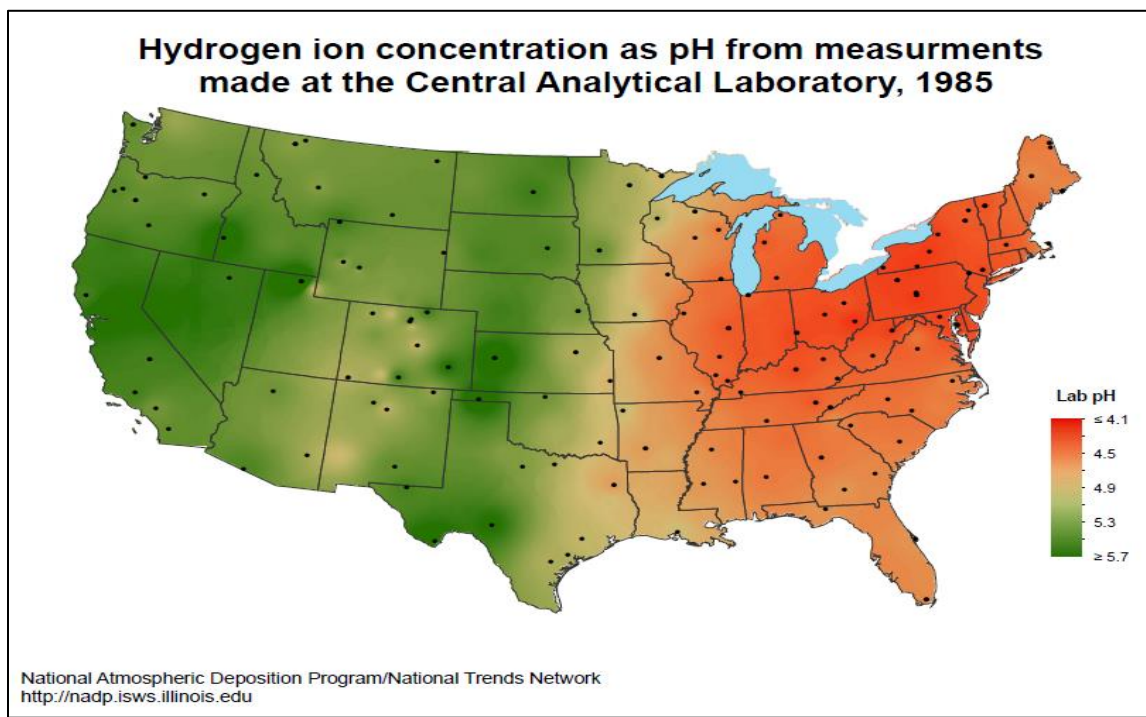


Figure 37: U.S. Annual Hydrogen Ion Concentrations, 1985

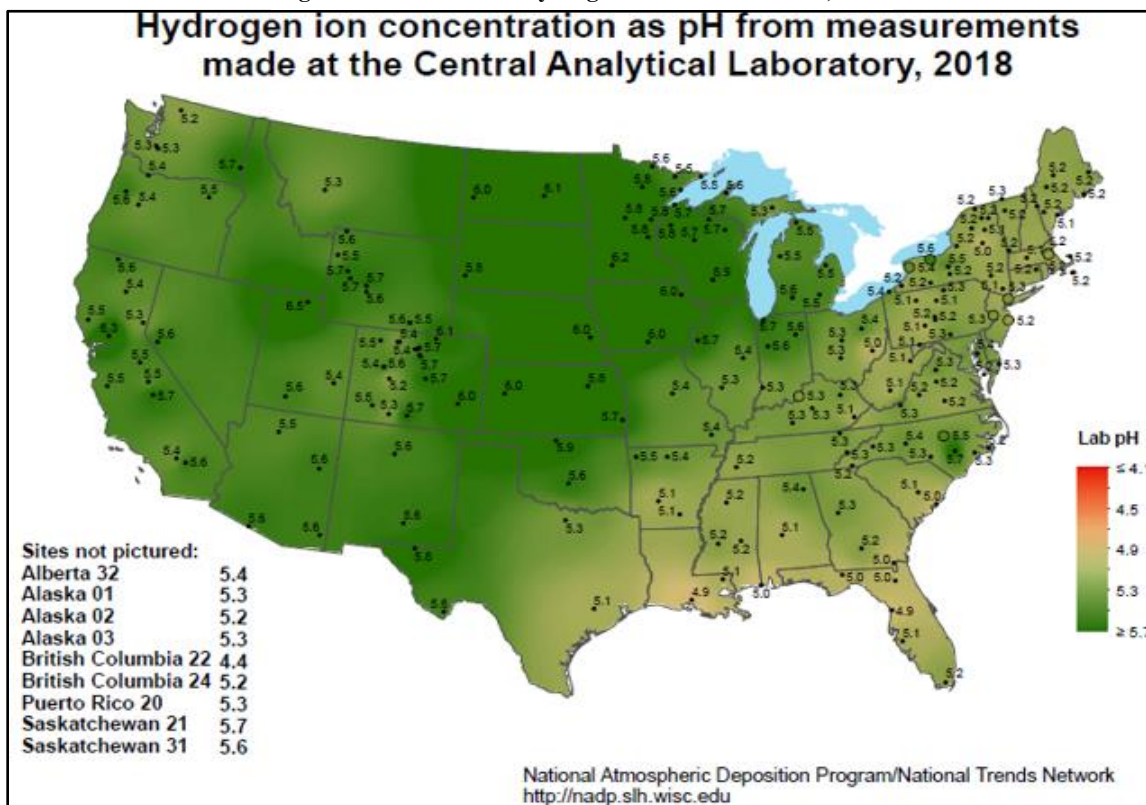


Figure 38: U.S. Annual Hydrogen Ion Concentrations, 2018

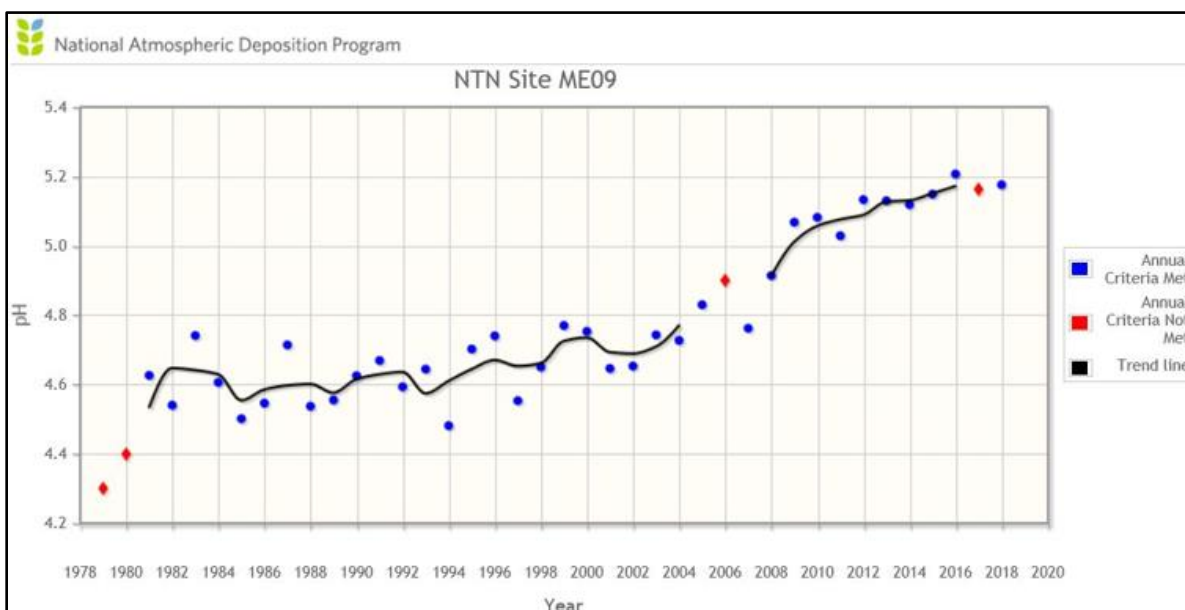


Figure 39: pH ME09 1979-2018

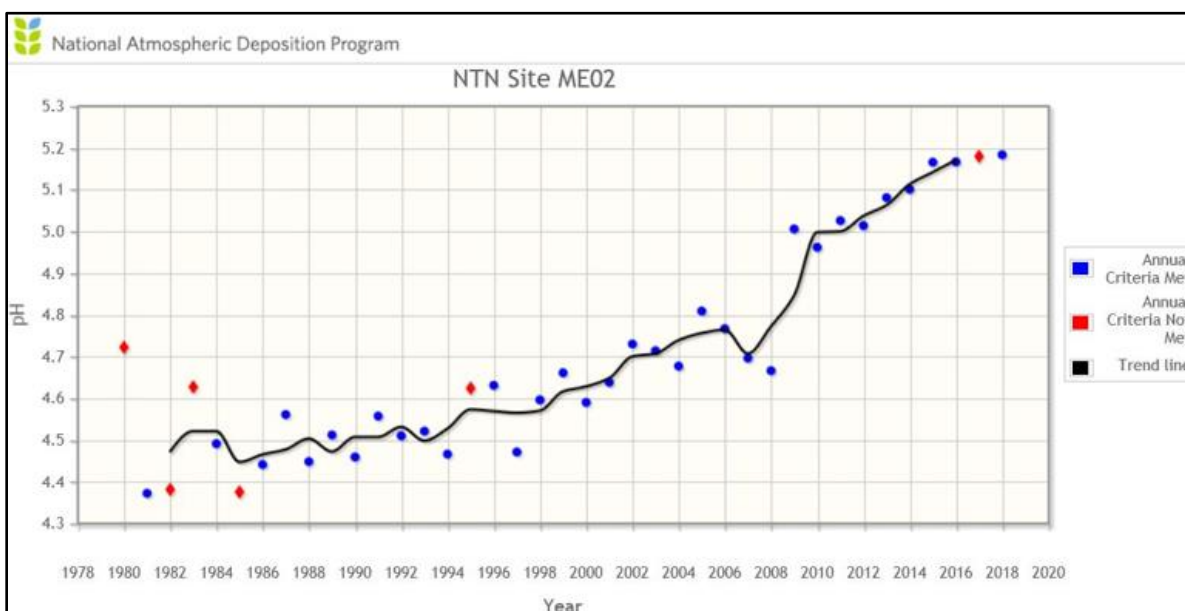


Figure 40: pH ME09 1980-2018

Nitrates also contribute to the acidity of precipitation when resulting chemical reactions create nitric acid. The nitrate ion maps, Figures 41-42, show reductions in nitrate concentrations in the eastern half of the country; however, the western half shows either no change or some slight increases. The nitrate ion trend plots for two sites in Maine, Figures 43 and 44, also illustrate a smaller magnitude of reduction – about half of that seen for sulfate over the same period of time.

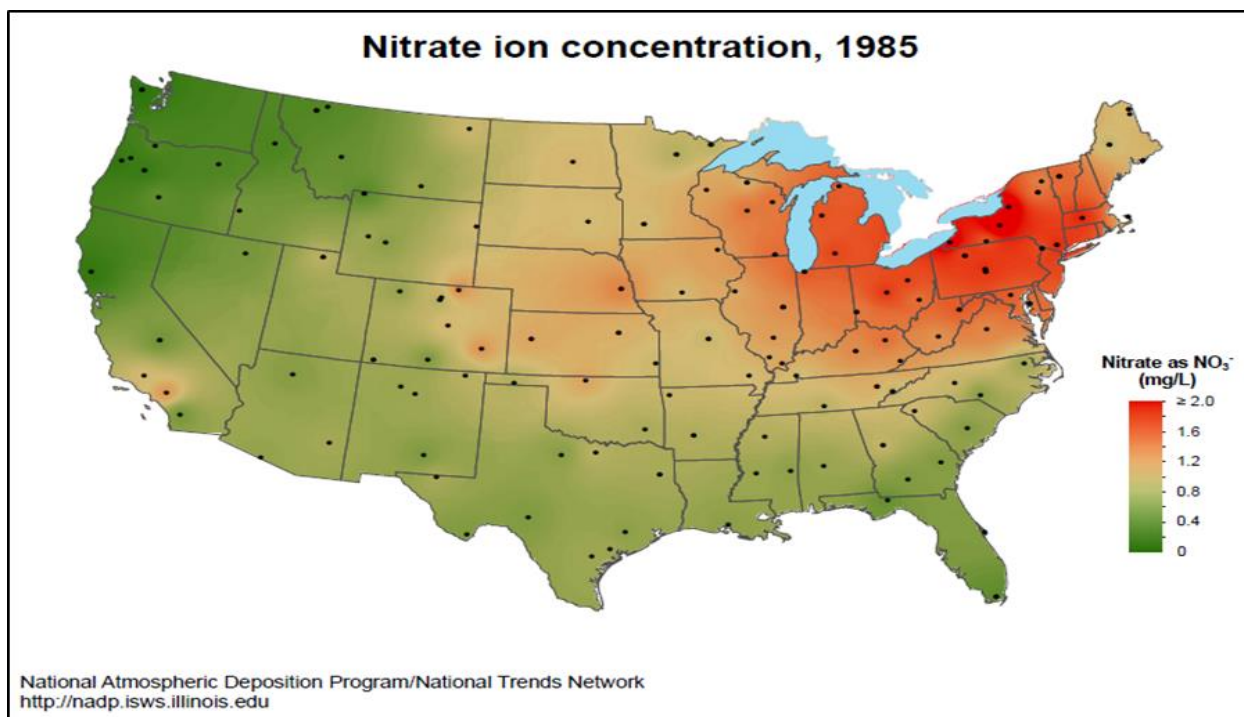


Figure 41: U.S. Nitrate Ion Concentration, 1985

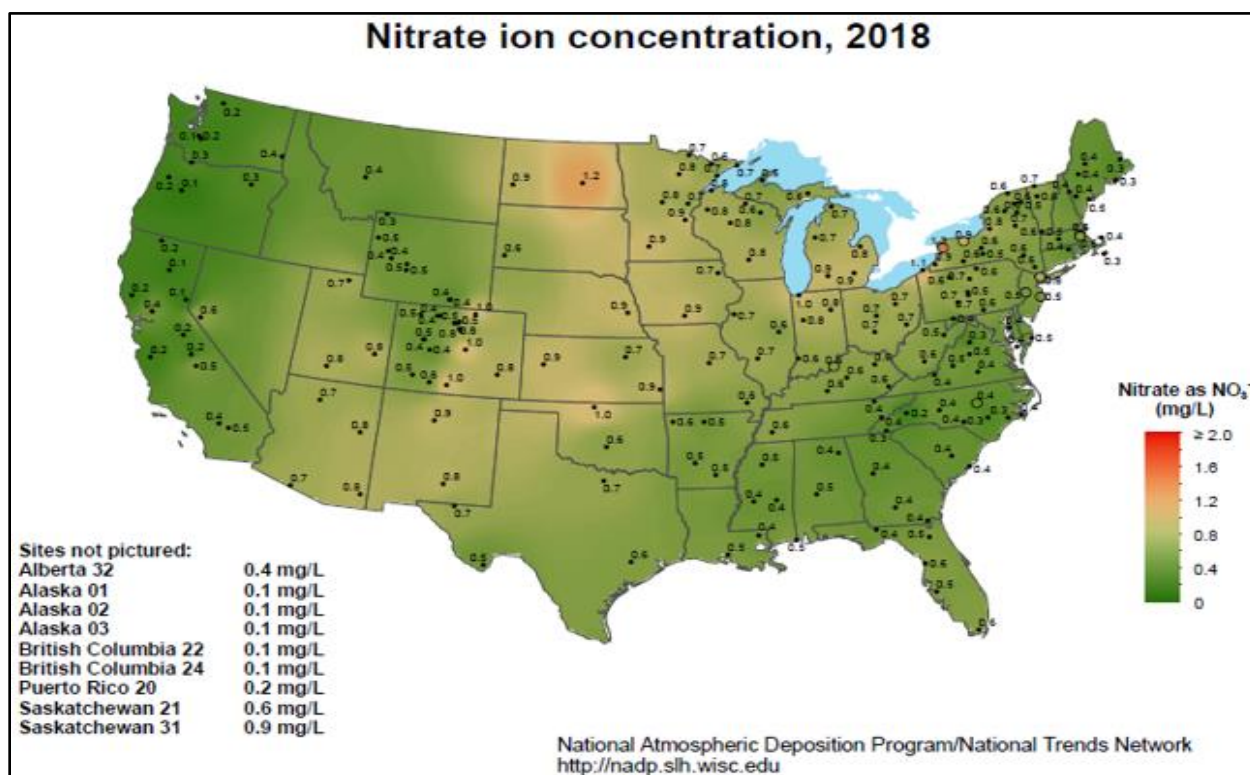


Figure 42: U.S. Nitrate Ion Concentration, 2018

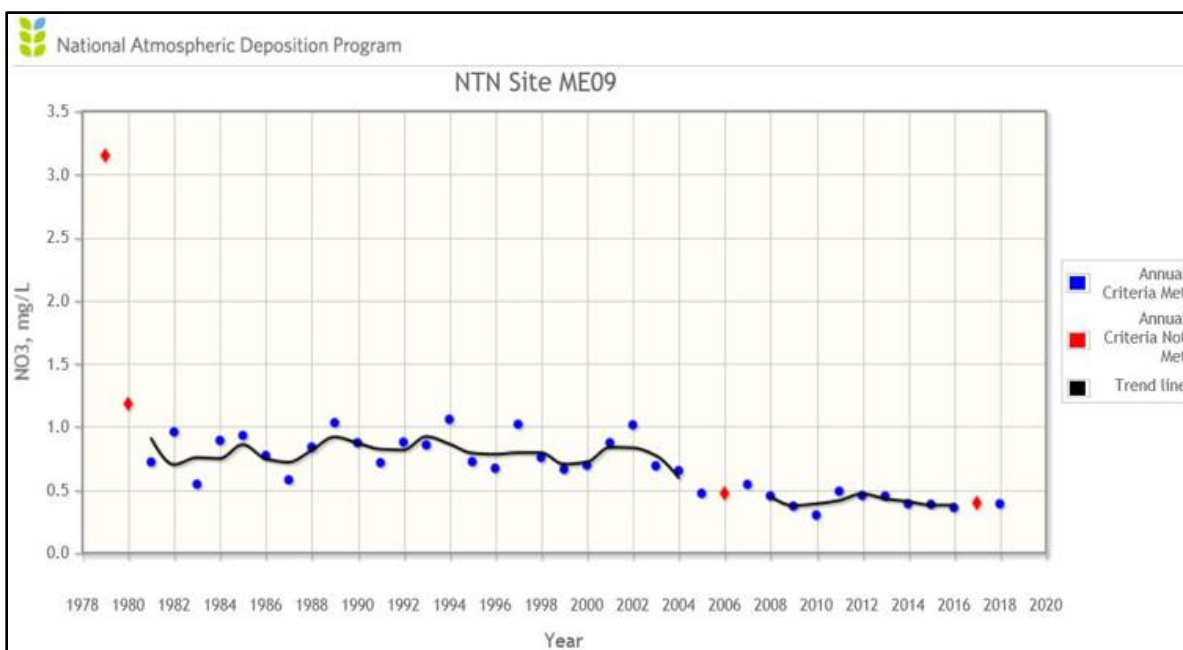


Figure 43: NO₃ ME09 1979-2018

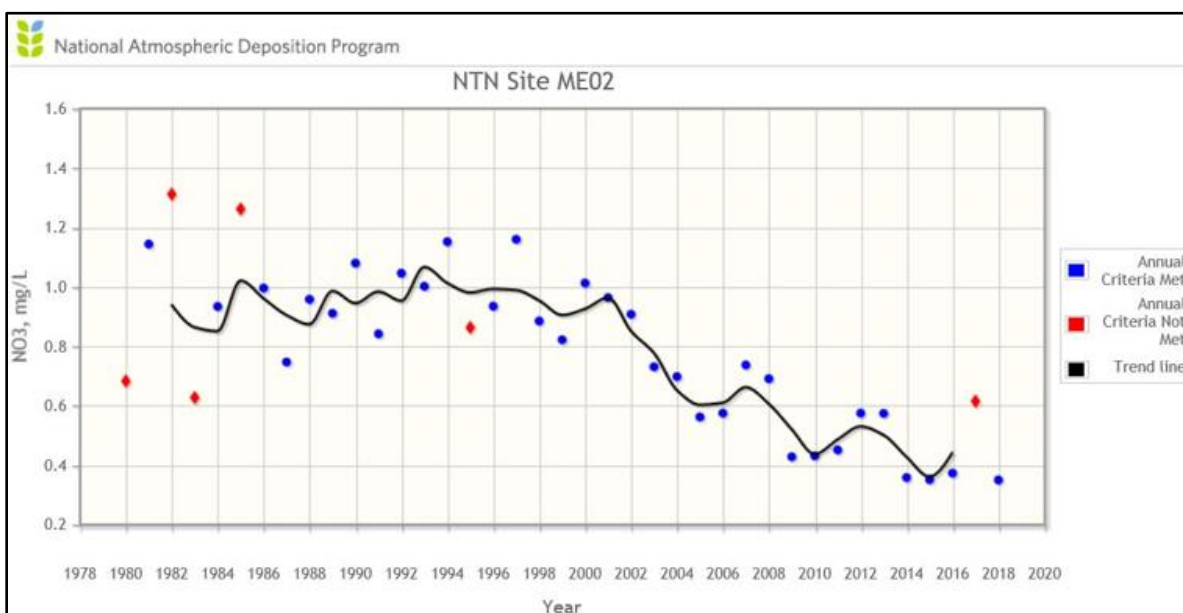


Figure 44: NO₃ ME02 1980-2018

The following Figures 45 and 46 show the annual color-shaded contour maps of the MDN sites nationally from 2003 and 2019. Trends are not as readily apparent over the 10-year time period represented by these maps. The appearance of mercury concentrations in the western half of the country between 2003 and 2019 is due in part to the increase in the spatial density of sites in the MDN, which then provides the NADP mapping software with more data source points to use in the interpolation of concentration levels between sites, which sites and data it didn't have in 2003.

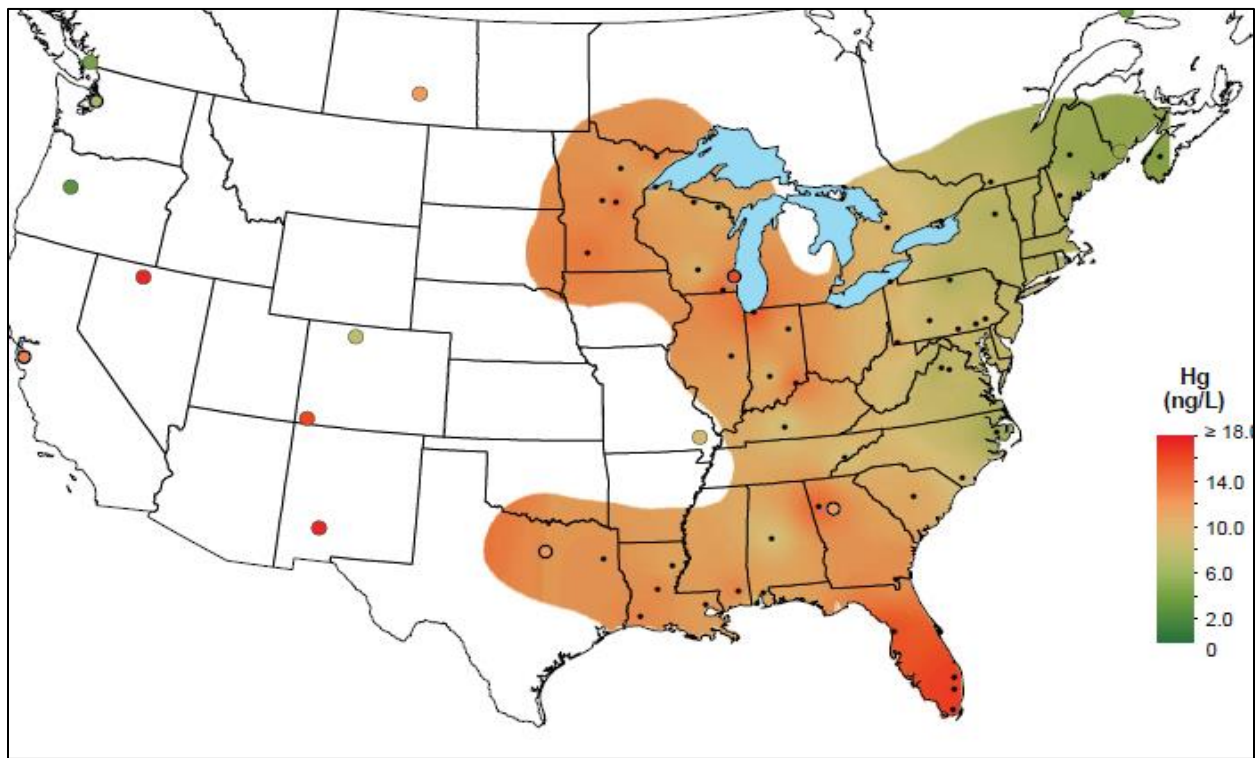


Figure 45: U.S. Total Mercury Concentration 2003

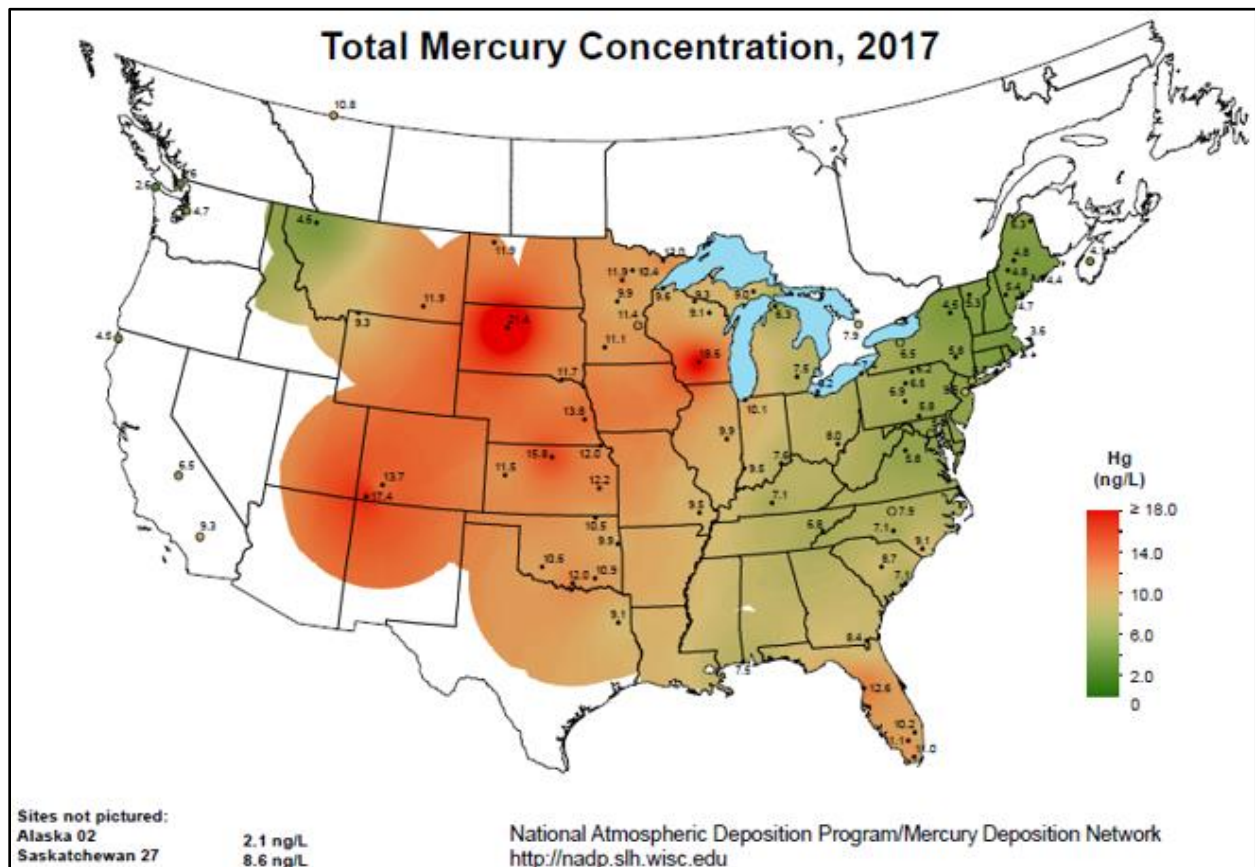


Figure 46: U.S. Total Mercury Concentration 2017

Future NTN and MDN Monitoring Plans

The State of Maine's DEP plans to continue the statewide NTN and MDN deposition monitoring networks and funding of the sites it currently sponsors. Their data are valuable not only to internal data users, policy makers, and the general public, but also to various users representing many other scientific disciplines, such as wildlife biologists, water quality specialists, epidemiologists, atmospheric chemists, government regulators, and academic researchers. In recent years, the Department has taken over both funding and operational support to some of the oldest and longest running sites in the State and the nation when the original sponsoring organizations were faced with funding cutbacks which would have meant the closing of these sites. Specifically, Maine DEP-BAQ assumed responsibility for the NTN sites at Greenville (ME09) and Caribou (ME00) when the University of Maine and NOAA, respectively, had their funding cut for continued operation of these sites. The closing down of these two sites would have represented an irreversible loss in continued documentation of long-term deposition trends in Maine and the country without confounding interruption in the dataset. As long as resources allow, Maine is committed to preserving the operational status of the sites in the State.

In response to the Governor's PFAS (perfluoroalkyl and polyfluoroalkyl substances) Task Force's final report released in January 2020, which recommended that the Department should "consider establishing an air deposition sampling program for a suite of PFAS," the Department has communicated this interest to and had conversations with the NADP Program Office and the Wisconsin State Laboratory of Hygiene. We received a favorable response from them being able to include a PFAS analysis whenever there is a sufficient sample volume in the amount of precipitation collected by the NTN sampler. We will continue to explore identifying funding resources, as well as opportunities to collaborate with other interested organizations (e.g. EPA, other states, NGOs, etc.) in pursuit of that recommendation.

Monitoring Equipment Evaluation

The existing inventory of monitoring equipment is adequate to maintain the current network at this time. The current equipment plan calls for instrument replacement after about ten years of use. Depending on available funds and inclusive costs, the actual equipment replacement cycle for monitoring and laboratory instrumentation is usually longer, approximately 15-20 years. In recent years, Maine has purchased several new continuous particulate monitors (BAMs), replaced aging particulate filter monitors, replaced several ozone monitors and calibrators, and replaced several trace level carbon monoxide, sulfur dioxide, and nitrogen dioxide monitors.

Over the years, the Department has established special monitoring sites in Eliot, Waterville, Augusta, South Portland, Portland and Thomaston in response to monitoring requests from municipal officials with specific neighborhood health concerns, and the Department will continue to provide such support for future requests. These special monitoring sites, mostly using monitors from the Department's spare equipment inventory, are often temporary arrangements and the data representative of only very small, sub-neighborhood areas. These efforts have served to provide factual data for municipalities and industrial sources to use as a common denominator in further discussion and, in some cases, resolutions.

Quality Assurance Evaluation

EPA policy requires all projects involving the generation, acquisition, and use of environmental data to be planned and documented and to have an Agency-approved quality assurance project plan (QAPP) prior to the start of data collection. The primary purpose of the QAPP is to provide an overview of the project, describe the need for the measurements, and define quality assurance/quality control (QA/QC) activities to be applied to the project, all within a single document. The QAPP is to be detailed enough to provide a clear description of every aspect of the project and include information for every member of the project staff, including samplers, lab staff, and data reviewers. The QAPP facilitates communication among clients, data users, project staff, management, and external reviewers. Effective implementation of the QAPP assists project managers in keeping projects on schedule and within the resource budget. The EPA's QA policy is described in the Quality Manual and EPA QA/R-1, *EPA Quality System Requirements for Environmental Programs*.

Maine currently has four QAPPs in place for various air monitoring programs, for which the approval and revision status of each is identified in the table below.

<u>QAPP</u>	<u>EPA Approval Date</u>	<u>Current Status</u>
Particulate Matter (PM) NAAQS Pollutants	November 30, 2016	Undergoing revision to incorporate all aspects of PM ₁₀ monitoring using low volume manual samplers and continuous PM monitoring using continuous PM samplers
Gaseous NAAQS Pollutants	November 30, 2016	Under review, additional changes expected
Photochemical Assessment Monitoring Station (PAMS)	October 28, 2005	
Air Toxic Volatile Organic Compound (VOC) Pollutants	September 28, 2004	
Trace Level Monitors, NCore Site	n/a	Effective 2016
Lead Monitoring		

Maine currently operates an extensive quality assurance program that includes auditing of all ambient monitors by staff from the Laboratory and Quality Assurance Section. To evaluate and ensure accuracy of data collected by ambient monitors, lab and QA staff conduct quarterly audits of the instruments, far exceeding minimum EPA requirements. This practice is expected to be relaxed in future revisions based on demonstrated results to date.