ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Amendments to:

State Air Quality Control Plan

Vol. II: III.D.7.6

Emission Inventory Data

Adopted

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7.6 EMISSION INVENTORY DATA

7.6.1. Introduction

7.6.1.1 Purpose of the Emission Inventory

Title I of the Clean Air Act Amendments of 1990 (CAA) contains provisions requiring development of emission inventories for designated areas that fail to meet the National Ambient Air Quality Standards (NAAQS). The emission inventory (subsequently referred to as the EI or simply "inventory") is a collection of emission estimates separately compiled for each potential source of air pollutants within the nonattainment area and surrounding regions and then integrated into a combined framework. Stated simply, the inventory is used to identify the key sources of emissions and contributions from all sources in the area and serves as a basis for determining how to best reduce pollutant emissions in order to reach or attain the NAAQS.

Relevant Regulatory Actions - A portion of the Fairbanks North Star Borough (FNSB) that includes the cities of Fairbanks and North Pole as well as surrounding areas was classified as a Moderate $PM_{2.5}$ nonattainment area in November 2009[1] for violation of the 24-hour average standard (35 $\mu g/m^3$) enacted in 2006. The State of Alaska was given until December 2014 to prepare and submit a State Implementation Plan (SIP) that included a strategy to attain the $PM_{2.5}$ NAAQS in the FNSB area. In compliance with EPA requirements, the Moderate Area SIP evaluated whether attainment could be demonstrated by December 31, 2015 or if not, explain why attainment by that date was impracticable. Emission inventories were prepared, control strategies were developed and evaluated, and air quality modeling was conducted under the Moderate SIP. This analysis led the State of Alaska to conclude that the level of emission reductions required to attain the $PM_{2.5}$ NAAQS could not be practicably achieved by that December 2015 attainment date. Thus, the Moderate SIP found that attainment of the 24-hour $PM_{2.5}$ standard by 2015 was impracticable (although possible by 2019).

As a result of the FNSB area's failure to attain the 24-hour $PM_{2.5}$ standard by 2015, EPA reclassified[2] the area (effective June 9, 2017) as a Serious $PM_{2.5}$ nonattainment area, for which attainment by 2019 must be evaluated and a more stringent analysis of control measures conducted and tracked within the inventory.

On September 8, 2017, EPA approved the FNSB $PM_{2.5}$ Moderate Area SIP (effective October 10, 2017) which was originally submitted by the State of Alaska in December 2014 (and included supplemental clarifying information). EPA found that the Moderate SIP met all statutory and regulatory requirements including those for base-year and projected emissions inventories as well as those associated with Reasonable Further Progress (RFP), Quantitative Milestone (QM) and Motor Vehicle Emission Budget (MVEB) requirements.

[1] Federal Register, Vol. 74, No. 218, November 13, 2009 (74 FR 58688).
[2] Federal Register, Vol. 82, No. 89, May 10, 2017 (82 FR 21711).

On July 29, 2016, EPA also promulgated[3] the $PM_{2.5}$ Implementation Rule (subsequently referred to as the PM Rule) which interprets the statutory requirements that apply to $PM_{2.5}$ NAAQS nonattainment areas under subparts 1 and 4 of the nonattainment provisions of the CAA. These requirements govern both attainment plans and nonattainment new source review (NNSR) permitting programs and specify planning requirements that include:

- plan due dates, attainment dates and attainment date extension criteria;
- the process for determining control strategies, including Reasonably Available Control Measures/Reasonably Available Control Technology (RACM/RACT) for Moderate areas; and Best Available Control Measures/Best Available Control Technology (BACM/BACT) and Most Stringent Measures (MSM) for Serious areas;
- guidelines for attainment demonstrations for areas that can attain by the statutory attainment date, and "impracticability" demonstrations for areas that cannot practicably attain by the statutory attainment date;
- RFP and quantitative milestones for demonstrating RFP;
- contingency measures for areas that fail to meet RFP or fail to attain the NAAQS by the attainment date.

As discussed in the following sub-section, a number of these PM Rule planning requirements affect the inventories required under the Serious SIP.

This report describes how emissions were first estimated for the 2013 base year and then projected forward to 2019 with technically and economically feasible controls implemented within that time to determine whether the area will reach attainment by 2019. This attainment analysis is based on atmospheric modeling that simulates the formation of ambient $PM_{2.5}$ given input emissions and meteorology as described in detail in the "Attainment Modeling" document.

Where applicable, it will also identify key revisions to the emission inventories prepared under the Moderate SIP based on additional collected data or updated methodologies.

The FNSB Serious Area SIP emission inventory is considered a Level II inventory, as classified under the Emission Inventory Improvement Program (EIIP).[4] It is a Level II inventory because it will provide supportive data for strategic decision making under the context of the SIP and is based on a combination of locally and regionally collected data.

7.6.1.2 Description of Inventories and Geographic Area

As described in EPA's guidance for emission inventory development[5], there are two classes of inventories based on their intended use, as summarized below:

[3] Federal Register, Vol. 81, No. 164, August 24, 2016 (81 FR 58010).
[4] "Introduction to the Emission Inventory Improvement Program, Volume 1," prepared for Emission Inventory Improvement Program Steering Committee, prepared by Eastern Research Group, Inc., July 1997.
[5] "Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards," U.S. Environmental Protection Agency, EPA-454/B-17-003, July 2017.

1. *Planning Inventories* – These inventories are developed to fulfill regulatory planning and reporting requirements under CAA Section 172(c)(3). In the SIP context, they are intended to quantify emissions within the nonattainment area and they are used as a part of RFP analysis and transportation conformity. Under EPA terminology, they include base year inventories ("foundational" emission source and activity inventories upon which all others are based), reasonable further progress (RFP) inventories (developed and submitted to EPA to demonstrate sufficient progress toward NAAQS attainment) and motor vehicle emission budgets (which are used in transportation conformity to ensure growth in vehicle emission over time is consistent with SIP projections). SIP Planning inventories contain either annual or seasonal emission estimates depending on the averaging period for the NAAQS being exceeded. For annual standards, annual planning inventories are required; for the 24-hour $PM_{2.5}$ standard in the FNSB nonattainment area, a seasonal inventory is appropriate since historical exceedances have been limited to the months from October through March. As described later in this section, the PM Rule provides additional flexibility regarding the definition of a seasonal planning inventory.

2. *Modeling Inventories* – Modeling inventories are more spatially and temporally resolved in order to account for geographic- and day-specific variations in emissions that affect monitored ambient concentrations. For the FNSB SIP, modeling inventories were developed over a gridded modeling domain called "Grid 3," which encompasses an area of 201 × 201 grid cells, each 1.33 km square.

Figure 7.6-1 shows the size and location of the Grid 3 modeling domain within the state. As shown, the domain encompasses portions of four counties/boroughs: Fairbanks North Star, Denali, Southeast Fairbanks, and Yukon-Koyukuk. The FNSB $PM_{2.5}$ nonattainment area is also shown in **Figure 7.6-1**. It is much smaller than the modeling domain and covers a small portion of the Fairbanks North Star Borough, but the portion in which roughly 90% of the Borough's population resides.

In conformance to 40 C.F.R[6] § 51.1002(c), the applicable inventories include emissions estimates for the following pollutants: $PM_{2.5}$, PM_{10}, SO_2 (SO_x), NO_x, VOC, and NH_3. Emissions shown for $PM_{2.5}$ and PM_{10} refer to direct emissions of both filterable and condensable PM.

For the Serious Area $PM_{2.5}$ SIP, a specific set of planning and modeling inventories were prepared to satisfy CAA and EPA regulatory requirements. Table 7.6-1 summarizes the inventories developed and submitted to satisfy these Serious Area SIP requirements. As noted in italicized text at the bottom of Table 7.6-1, additional inventories must also be prepared if attainment cannot be demonstrated by 2019 to support a request to EPA to extend the required attainment date for a Serious Area up to five years, to 2024.

[6] Code of Federal Regulations.

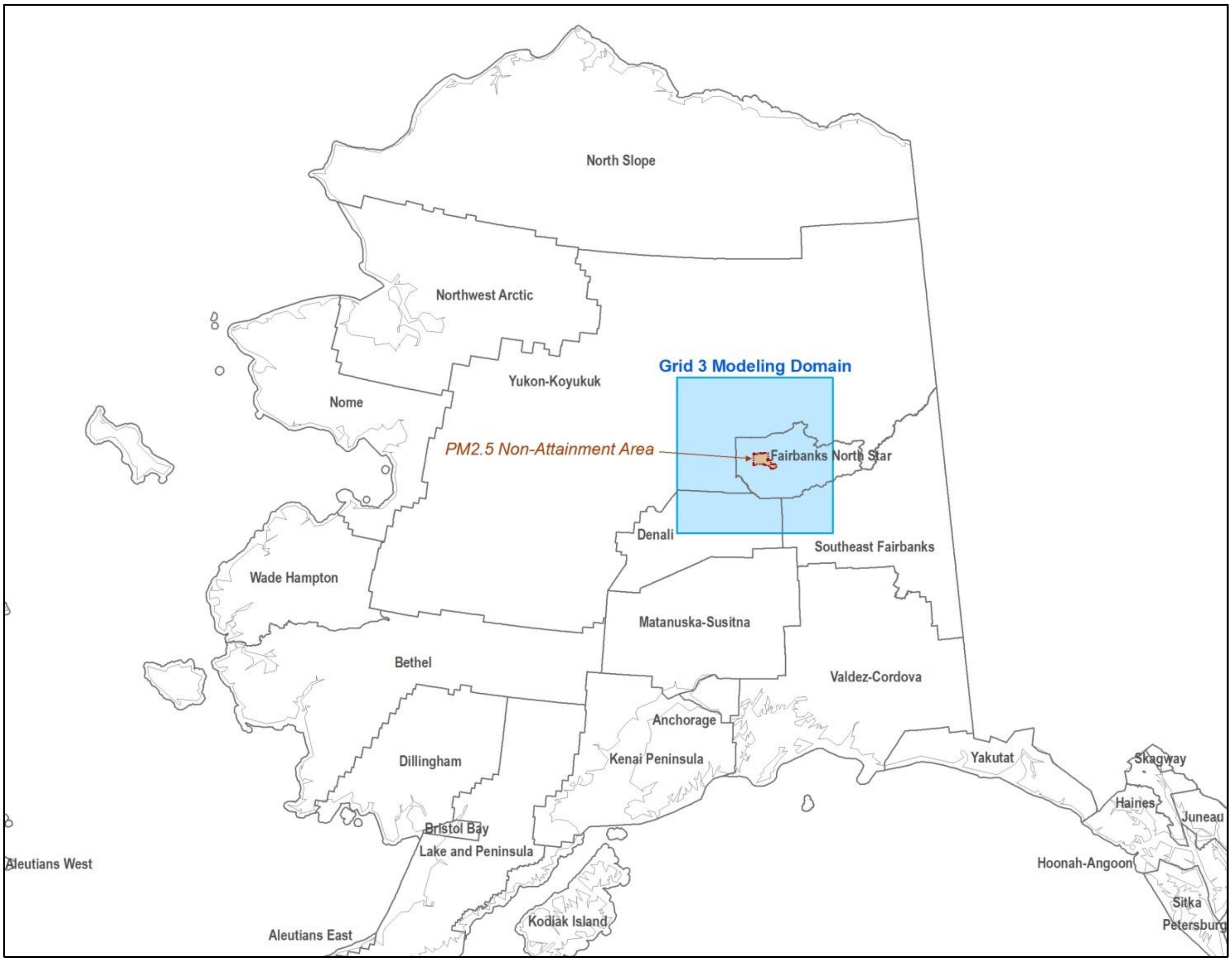

Figure 7.6-1. Fairbanks Modeling Inventory Domain and $PM_{2.5}$ Nonattainment Area

Table 7.6-1
Summary of Applicable Inventories for Serious Area $PM_{2.5}$ SIP

Class	Type	Geographic Area	Calendar Year	Regulatory Requirements
Planning	Baseline	Nonattainment Area	2013	CAA 172(c)(3)
	Projected, with controls	Nonattainment Area	2019	CAA 172(c)(3)
Modeling	Baseline	Modeling Domain	2013	CAA 189(b)(1)
	Projected, with controls	Modeling Domain	2019	CAA 189(b)(1)
Extension	*Projected, with controls*	*Modeling Domain*	*To 2024*	*CAA 189(e)*

In the event attainment cannot be demonstrated by 2019, Table 7.6-2 describes the broader set of inventories that must be developed. “Mandatory” inventories needed to evaluate attainment by 2019 are denoted in boldface in the Calendar Year(s) column. If attainment is not found to be possible by 2019, additional “contingent” inventories are required through 2024 until attainment is demonstrated. These contingent inventory years are shown in italics.

Table 7.6-2
Inventories Developed for FNSB Serious Area $PM_{2.5}$ SIP

<table>
<tr><th rowspan="2">Class</th><th rowspan="2">Inventory Type</th><th rowspan="2">Geographic Area</th><th rowspan="2">Calendar Year(s)</th><th colspan="2">Resolution</th><th rowspan="2">New Controls?</th><th rowspan="2">Reporting Level</th></tr>
<tr><th>Spatial</th><th>Temporal</th></tr>
<tr><td rowspan="4">Planning</td><td>Base Year</td><td>Nonattainment Area</td><td>2013</td><td rowspan="4">Nonattainment Area Total</td><td rowspan="2">Winter Season</td><td>No</td><td rowspan="4">Emission Inventory Sector (EIS) or Tier 1</td></tr>
<tr><td>Attainment Projected</td><td>Nonattainment Area</td><td>2019, 2020-2024*</td><td>Yes</td></tr>
<tr><td>RFP</td><td>Nonattainment Area</td><td>2017, 2020, 2023*</td><td>Winter Season</td><td>Yes</td></tr>
<tr><td>MVEB</td><td>Nonattainment Area</td><td>2019 or attainment date and RFP years*</td><td>Winter Season</td><td>Yes</td></tr>
<tr><td rowspan="3">Modeling</td><td>Base Year</td><td>Modeling Domain</td><td>2013</td><td rowspan="3">1.3 km Grid Cell</td><td rowspan="3">Episodic (day and hour)</td><td>No</td><td>SCC</td></tr>
<tr><td>Projected Baseline</td><td>Modeling Domain</td><td>2019, 2020-2024*</td><td>No</td><td>SCC</td></tr>
<tr><td>Control</td><td>Modeling Domain</td><td>2019, 2020-2024*</td><td>Yes</td><td>SCC</td></tr>
</table>

* Reflects inventories for additional years if attainment not demonstrated by 2019 and an extension is requested. Inventory years are dependent on the projected attainment date beyond 2019.
n/a – Not applicable.
SCC – Source Classification Code (a detailed emission source classification scheme developed by EPA)
TBD – To be determined.

As indicated by footnote to Table 7.6-2, additional inventories must be developed to evaluate attainment and progress toward attainment beyond 2019 to support an attainment extension request. Generally speaking, extension request inventories must be developed in successive years between 2019 and 2024 to evaluate when attainment is projected to occur. This chapter of the Serious SIP (Section III.D.7.6) focuses on development of the mandatory 2013 and 2019 inventories used to evaluate attainment by 2019. As explained later in Chapter III.D.7.8, attainment could not be demonstrated by 2019. As such, Section III.D.7.9 discusses demonstration of attainment beyond 2019, and Sections III.D.7.10 and III.D.7.14 discuss inventories developed to support the RFP and MVEB requirements listed in Table 7.6-2.

In addition to identifying those inventories supporting either planning or modeling requirements as described earlier, Table 7.6-2 identifies the other key attributes of each inventory including type, geographic area, calendar year, point source emission type, spatial and temporal resolution, and source reporting level, each of which is further explained below.

- *Inventory Type* – Indicates the type of inventory as described below:

    - Base Year - Refers to the primary inventory that was developed based on actual source activity levels for a specified year and emission factors representative of that year. Generally speaking, 2013 was the base year for inventory development. (The exception was area sources other than space heating, which were backcasted from 2014 activity to 2013 as described later in this chapter.)

    - Baseline - Refers to the specific inventory calendar year chosen to meet applicable SIP requirements. As stated in 40 C.F.R. § 51.1008(a)(1)(i), the $PM_{2.5}$ baseline inventory year must be one of the three years for which monitored data were used for designating the area. For the Serious SIP, calendar year 2013 has been designated as the baseline year, which meets this requirement. And, it coincides with the midpoint of the five-year baseline average design value period used to establish the anchor point based on existing ambient monitoring data for estimating projected future $PM_{2.5}$ concentrations in the attainment modeling. Thus, since the base year and baseline year are the same for the Serious SIP, "Baseline" and "Base Year" both refer to the historical inventory based on actual source activity in 2013 upon which future year attainment is evaluated.

    - Attainment Projected – This planning inventory represents projected emissions in the first year for which attainment is determined by a modeled attainment demonstration. It reflects both projected changes in source activity as well as emission benefits from additional control measures. The remaining planning inventories in Table 7.6-2 listed as RFP (for Reasonable Further Progress) and MVEB (for Motor Vehicle Emissions Budget) are special inventories that must be developed within the SIP to satisfy Reasonable Further Progress and transportation conformity-related requirements. The RFP inventory encompasses all source categories and is used to ensure consistent progress toward attainment. The MVEB includes only on-road motor vehicle emissions (not all source categories). It is used to establish vehicle emission budgets for use in subsequent federal regional transportation conformity determinations. As noted earlier, SIP Sections III.D.7.10 and III.D.7.14 discuss the inventories developed to fulfill RFP and MVEB requirements, respectively.

    - Projected Baseline – This is the first of two types of modeling inventories and accounts for source activity changes from forecasted population and economic growth and effects of existing and adopted federal, state, and local controls. To ensure consistency with the approved Moderate Area SIP, effects of previously adopted state and local controls through calendar year 2016 are included in the Projected Baseline inventories for the Serious Area SIP.

    - Control – This second type of modeling inventory accounts for emission reductions associated with new state and local control measures (over and above changes from population/economic growth and existing controls).

- *Geographic Area* – The geographic area or extent of the sources included within each inventory is also listed in Table 7.6-2. Two different areas, shown earlier in **Figure 7.6-1**, are represented: Nonattainment Area and Modeling Domain. Planning inventories tabulate emissions within the boundaries of the nonattainment area. Modeling inventories contain source emissions across the larger modeling domain, spatially resolved or located within 1.3-kilometer square grid cells.

- *Calendar Year(s)* – The calendar years associated with each inventory are listed in this column. In addition to the 2013 base/baseline year and the statutory 2019 attainment date year for a Serious Area and 2017 and 2020 for RFP (shown in boldface), inventories for other calendar years are contingent on the year of demonstrated attainment if after 2019. RFP requires inventories every three years as quantitative milestones to evaluate reasonable further progress toward attainment. The 2017 and 2020 RFP inventory years are established based on quantitative milestone dates of 7.5 and 10.5 years from the date of designation of the area (November 2009) for Serious SIPs as required under 40 C.F.R. § 51.1013(a)(2). If attainment cannot be demonstrated by 2019, additional RFP inventories are required at three-year milestone intervals beyond 2020 until the projected attainment year, plus one additional milestone year interval. MVEBs must be prepared for the same quantitative milestone years required for the RFP inventories in accordance with 40 C.F.R. § 51.1012(a)(2).

- *Spatial & Temporal Resolution* – These columns refer to the levels of spatial and temporal resolution of each inventory. As listed in Table 7.6-2, the inventories reflect different levels of spatial resolution: (1) Nonattainment (NA) Area, for total emissions within the FNSB $PM_{2.5}$ nonattainment area (or subareas pending a potential split of the existing nonattainment area); and (2) 1.3 km Grid Cell, representing individual 1.3 km grid cell-level emissions within the modeling domain of 201 × 201 grid cells. The levels of temporal resolution reflected in the inventories as listed in Table 7.6-2 are as follows:

  - Winter Season – refers to the “seasonal” inventory that represents daily average emissions across the baseline modeling episodes; and

  - Episodic - for which emissions are resolved by individual day and hour for each modeling episode to support the episodic attainment modeling.

  As explained in Section 7.6.1.3 (Seasonal Inventory Representation), average emissions over the historical modeling episodes were assumed to be representative of the conditions within the October-March nonattainment season that cause exceedances of the ambient $PM_{2.5}$ standard, in accordance with seasonal inventory requirements and flexibilities provided under the PM Rule. This assumption greatly simplifies the number of individual inventories needed in the SIP and provides a degree of consistency in representing relative source sector contributions across both the Planning and Modeling inventory requirements for the Serious SIP.

- *Includes Controls* – This column simply identifies whether the inventory includes emission reductions resulting from new additional state or local control measures implemented since the approved Moderate SIP or slated for adoption under the Serious SIP. Emission benefits from existing control measures (or levels of compliance/enforcement) implemented prior to this plan that occur or accrue beyond the 2013 baseline year are accounted for within the project baseline inventory.

- *Reporting Level* – Finally as noted in Table 7.6-2, the level for which individual source emissions were reported differed between the planning and modeling inventories. Emissions for all planning inventories were developed and reported at the major source sector (stationary point, stationary non-point, on-road, and non-road) or EPA "Tier 1" sector level. Emissions for all modeling inventories were compiled and reported at the individual Source Classification Code (SCC) level.

In addition to the elements listed in Table 7.6-2 and described above, it is noted that the PM Rule revised or superseded the following emission inventory requirements that applied to the Moderate SIP:

- *Statewide Planning Inventory* – The PM Rule superseded the need for a planning inventory of statewide emissions that were required based on earlier EPA regulations/guidance.[7] Under the PM Rule, EPA no longer interprets the CAA to allow emission reductions from sources outside the nonattainment area for the purposes of evaluating RFP. Thus, a statewide planning inventory is no longer required and is not included in the Serious $PM_{2.5}$ SIP.

- *Actual Point Source Emissions* – The emission inventory requirements in place at the time the Moderate SIP was submitted included development of inventories for point sources reflecting both actual and allowable emissions.[8] Regulatory revisions under the PM Rule no longer require separate inventories based on allowable emissions for point sources; inventories are to be based only on actual emissions. (It is noted here that the thresholds of annual emissions used to identify a stationary source as a point source are based on allowable or permitted emissions. In addition, Best Available Control Technologies analysis also required under the Serious SIP and described in a separate BACT document uses allowable emissions in evaluating cost effectiveness of applicable point source control technologies. However, emission reductions from BACT measures to be adopted under the Serious SIP must be translated to an actual emissions basis.)

[7] "Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations," U.S. Environmental Protection Agency, November 2005.

[8] Actual emissions are estimates of actual annual or episodic emissions based on historically recorded facility operating throughput or continuous emissions monitoring systems. Allowable emissions refer to permitted or Potential to Emit (PTE) emission limits associated with the facility operating permit. Actual emissions are generally lower than Allowable emissions (unless a facility is found to be in violation of its operating permit, which was not the case for point source facilities inventoried within the Fairbanks $PM_{2.5}$ SIP).

7.6.1.3 Seasonal Inventory Representation

Background – As codified in 40 C.F.R. 51.1008(a)(1)(iii), the 2016 PM Rule contains specific guidance related to the time period (annual vs. seasonal) upon which $PM_{2.5}$ SIP planning inventories should be based. Section IV.B.2.c of the PM Rule preamble (Seasonal Inventories) explains where the use of seasonally versus annually-based emission inventories are appropriate as well as the factors to consider in defining the duration of the seasonal inventory. First, it points out that for the $PM_{2.5}$ NAAQS, annual inventories are required for the annual form of the NAAQS, while seasonal inventories are appropriate for the 24-hour NAAQS when *"monitored exceedances of the 24-hour* $PM_{2.5}$ *NAAQS in the area occur during an identifiable season."* Second, it states that *"for some source categories, it may be advisable to limit the 'season' considered in calculating emissions to an episodic period to reflect periods of higher emissions during periods of high ambient* $PM_{2.5}$*."* This latter rationale allows seasonal inventories to be not simply representative of an average day across the entire nonattainment season (which as noted earlier spans October through March in the Fairbanks nonattainment area), but based on episodic activity/emissions in areas where nonattainment conditions are more narrowly associated with peaks in emissions within specific source sectors or atmospheric conditions that vary across the nonattainment season.

This definition of the duration of the season for development of seasonal inventories in 24-hour $PM_{2.5}$ nonattainment areas is intended to help ensure the inventory reflects the conditions that led to an area's nonattainment designation, specifically reflecting temporal emissions variations within the entire nonattainment season that lead to exceedances of the NAAQS. The PM Rule also points out that the state needs to explain the rationale for the duration of the season used for the inventory as part of the SIP submission.

The State of Alaska chooses to represent the seasonal planning inventory requirement for the 24-hour $PM_{2.5}$ NAAQS by the average of modeling episode day emissions for the three most significant source categories within the nonattainment area:

1. Space Heating (within the Stationary Nonpoint/Area source sector);
2. Stationary Point Sources; and
3. On-Road Mobile Sources.

These three categories comprise over 98% of directly-emitted $PM_{2.5}$ within the nonattainment area and similarly dominant fractions for all applicable precursor pollutants. The remainder of this section lays out the supporting rationale for use of episodic average day emissions to satisfy seasonal inventory requirements for the FNSB Serious $PM_{2.5}$ SIP.

Historical NAAQS Violations – As noted earlier, the nonattainment season consists of the six-month "winter" season from October through March based on those months within the years during which exceedances of the 24-hour $PM_{2.5}$ NAAQS were recorded in Fairbanks. To evaluate the variability of exceedances within this winter season, historical daily monitoring data from 2005 through September 2017 (the latest available data) for the nonattainment area were downloaded from EPA's Air Data website and tabulated to determine the frequency that exceedances have been recorded within each month of the six-month season. The data were filtered to Federal Reference Method (FRM) monitoring at each historical site.

The results are presented in Table 7.6-3, along with the duration or period of record (in years) for each historical monitoring site within the nonattainment area. As shown in the highlighted cells in Table 7.6-3, almost all of the recorded 24-hour $PM_{2.5}$ concentrations over 35 µg/m³ occur between November and February. Violations in October and March are rare and represent 6% or less of those observed at any of the sites listed in Table 7.6-3. December and January are the months with the highest likelihood of exceedances (for those sites with a multi-year history), although exceedances in November and February are not uncommon. No exceedances were recorded outside the months tabulated in Table 7.6-3 that were otherwise not flagged by Alaska DEC as Exceptional Events.

Table 7.6-3
Frequency of 24-Hour $PM_{2.5}$ NAAQS Violations by Monitoring Site and Month in FNSB Nonattainment Area (2005-2017)

Monitoring Site	% of Historical Violations (> 35 µg/m³) by Month						Duration (years)
	Oct	Nov	Dec	Jan	Feb	Mar	
State Office Building	0%	13%	33%	33%	19%	3%	12.7
Borough Building (NCORE)	3%	13%	41%	28%	13%	3%	7.9
North Pole Fire Station #3	3%	23%	24%	29%	16%	3%	5.6
North Pole Elementary School	0%	10%	48%	31%	10%	0%	4.3
North Pole Water	0%	33%	22%	11%	33%	0%	0.5

Source: U.S. EPA Air Data web portal, https://www.epa.gov/outdoor-air-quality-data, accessed on January 31, 2018.

As clearly seen in Table 7.6-3, the frequency or likelihood of 24-hour $PM_{2.5}$ exceedances within the six-month nonattainment season are significantly skewed toward those four months (November through February) within the middle of the season. This non-uniformity in 24-hour $PM_{2.5}$ concentrations above the NAAQS is the result of variations in ambient factors and source activity and emissions, each of which is discussed separately as follows.

Meteorological and Atmospheric Factors – At its high latitude (lying just below the Arctic Circle) and interior location, the FNSB $PM_{2.5}$ nonattainment area exhibits significant variation in meteorological and atmospheric conditions within the six-month season that helps explain why 24-hour $PM_{2.5}$ NAAQS exceedances are restricted to this period and occur more frequently during the middle of the period.

Ambient temperatures drop and then rise markedly between October and March. Figure 7.6-2 shows long-term (1929-2016) average daily maximum and minimum ambient temperatures by month recorded at the Fairbanks International Airport. The data are plotted from July through June for clarity; the six-month nonattainment season from October through March is highlighted. As seen in Figure 7.6-2, average monthly max/min temperatures vary dramatically within the nonattainment season, dropping by over 40°F to their lowest points in January and then rising again during this period.

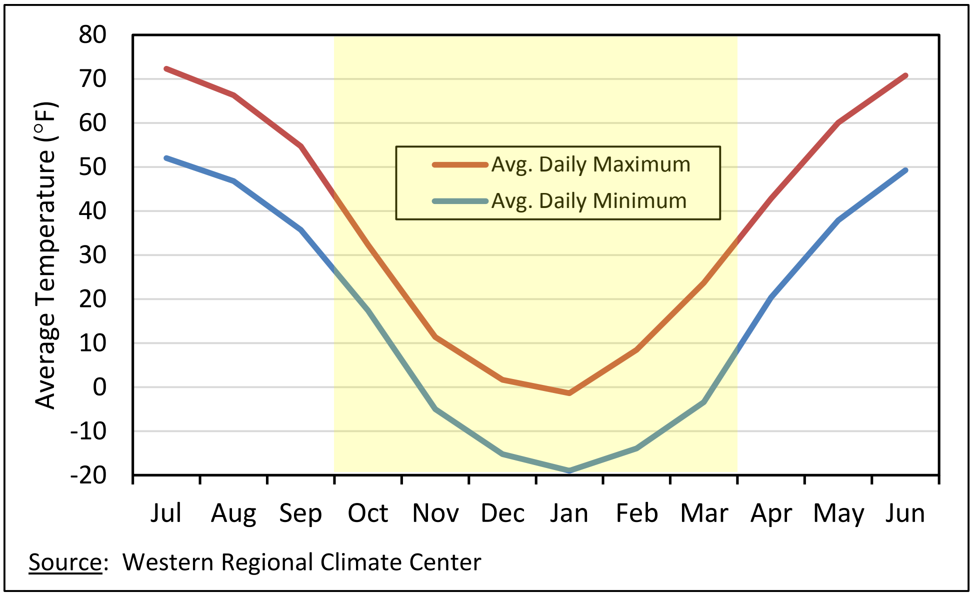

Figure 7.6-2. Fairbanks Int'l Airport Average Monthly Max/Min Temperatures

This variation in monthly ambient temperatures is driven by the dramatic differences in available sunlight at the high latitude of Fairbanks over the October-March nonattainment season, which is illustrated in Figure 7.6-3. As seen in Figure 7.6-3, there are over 11 hours of daylight on October 1 and over 13 hours by the end of March, but less than 4 hours at the winter solstice in late December. The variation in sunlight, both in terms of the amount of daylight hours and the angle of the sun above the horizon (which is low during the core winter months) directly affects average daily temperatures and explains the substantial temperature variation within the nonattainment season.

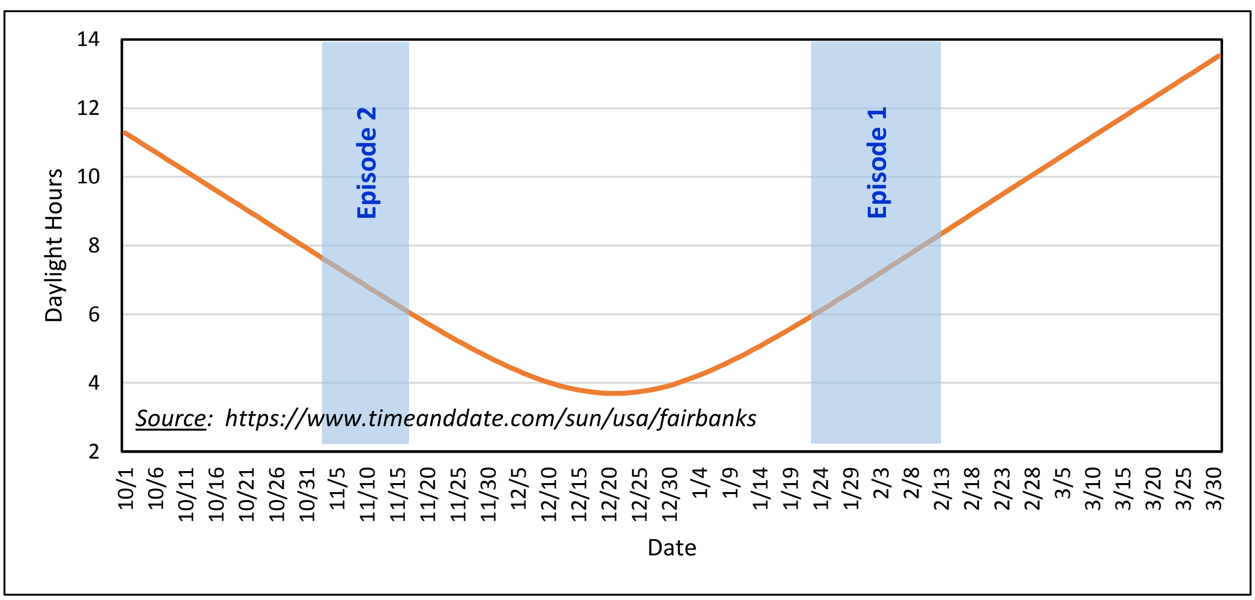

Figure 7.6-3. Fairbanks Daylight Hours vs. Calendar Day (October-March)

Figure 7.6-3 also highlights the November 2 – 17 and January 23 – February 10 time periods that correspond to the historical 2008 modeling episodes (Episodes 2 and 1, respectively) jointly selected by the Borough, DEC and EPA to represent typical conditions in Fairbanks when concentrations exceed the standard at "design day" levels (i.e., near the 98th percentile of concentrations above the 24-hour NAAQS). (These modeling episodes are further discussed under the "Modeling Episode Characteristics" heading.)

The solar intensity and daylight duration variation which drives the significant drop and ascent in monthly average temperatures within the nonattainment season also directly affects the duration and strength of temperature inversions occurring in the nonattainment area from October-March. (A temperature inversion refers to an atmospheric condition under which air temperature increases, rather than decreases with height above the ground. Ground-based inversions are common during the low-daylight winter months in Fairbanks[9,10] when radiative cooling of the ground in turn cools the air close to the ground, resulting in lower surface temperatures than the air aloft. Within a temperature inversion, the vertical mixing of air is limited by the static stability caused by the inversion. This results in a disproportionate build-up in ground-level ambient $PM_{2.5}$ concentrations relative to other times of the year when inversions are less frequent or less severe, or during the winter season when other weather patterns such as storm fronts or high wind events occur in the area and disperse pollutant build-up.

Finally, ambient temperatures also directly affect the heating demand required to keep indoor air temperatures constant above a defined base or reference level. Heating Degree Days (HDDs) are a common metric used to compare space heating loads or demand across locations or by month/season within a specific area, and represent the number of degrees that a day's average temperature is below a base or reference temperature, typically 65°F.

Figure 7.6-4 shows long-term average Heating Degree Days by month based on average temperatures for each day at Fairbanks International Airport from 1997-2017 based on a 65°F reference temperature. Annual average HDDs total 13,430. From October through March average HDDs are 10,946 or 81% of total annual HDDs. Between November and February, there are 8,038 HDDs on average, representing 60% of annual heating demand.

The HDD metric clearly shows how the variation in outdoor ambient temperatures throughout the year and even within the nonattainment season affect monthly heating demand.

[9] Brader, Jim et al, "Meteorology of Winter Air Pollution in Fairbanks," ftp://ftp.co.fairbanks.ak.us/AQ-Symposium/Symposium_Presentations_ftp/James_Brader_Weather.pdf

[10] Hartmann, Brian et al, "Climatology of the Winter Surface Temperature Inversion in Fairbanks, Alaska," Geophysical Institute, University of Alaska, Fairbanks, https://ams.confex.com/ams/pdfpapers/84504.pdf

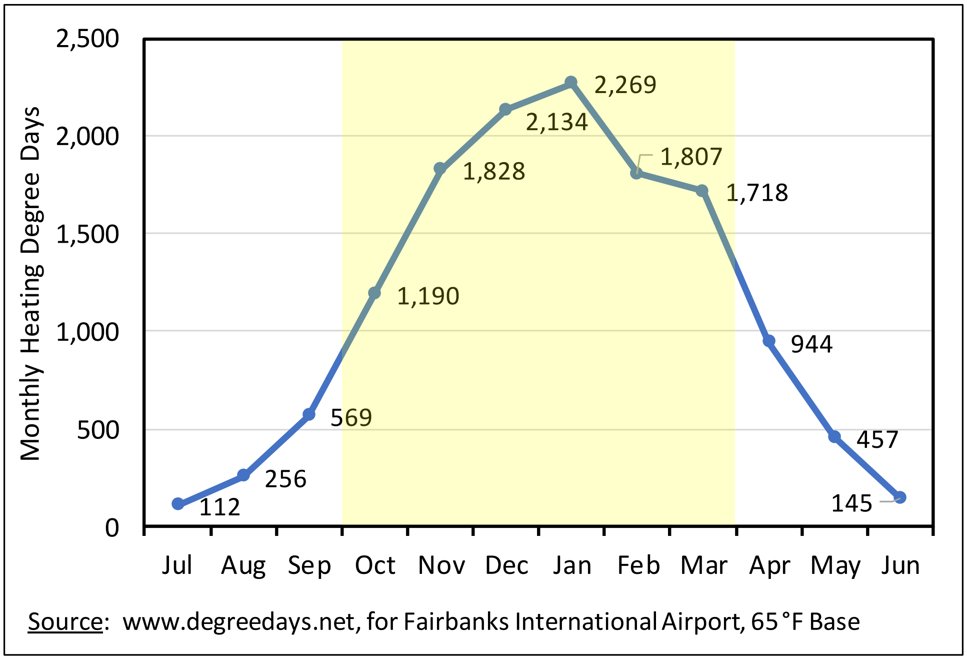

Figure 7.6-4. Fairbanks Int'l Airport Average Monthly Heating Degree Days (1997-2017)

Seasonal Patterns in Key Source Activity and Emissions – Emissions from the aforementioned three largest source categories within the nonattainment area (Space Heating, Point Sources and On-Road Mobile Sources) are all heavily driven by month-by-month variations in ambient temperature and solar intensity/daylight hours just shown.

As described earlier, space heating demand (and therefore emissions) is directly related to the HDD metric by definition. In addition, local data collected on space heating fuel use patterns in the FNSB during winter and discussed in detail later in this document indicate that daily wood use (which has higher $PM_{2.5}$ emissions that heating oil) tends to peak during the coldest months within the nonattainment season. Thus, emissions from this single largest source category are by no means constant between October and March and likely follow a steeper variation than indicated by monthly HDDs.

In addition, all of the point source facilities within the nonattainment area combust fuel to meet a combination of heating and electricity demand, which tend to track with the monthly HDD and daylight hour variations within the nonattainment season. Thus fuel-based point source activity also varies significantly from October through March.

Finally, emissions from on-road mobile source also tend to peak during mid-winter due to the fact that exhaust emissions for vehicles when they are first started increase significantly as ambient temperature decreases. Thus, even though vehicle activity (i.e., vehicle miles traveled) remains relatively stable over the nonattainment season, vehicle emissions do not.

Episodic Nature of $PM_{2.5}$ within the October-March Season - In the FNSB nonattainment area, wintertime exceedances of the 24-hour $PM_{2.5}$ NAAQS are triggered by meteorological conditions characterized by low ambient temperatures and low wind speeds. These conditions occur frequently, but not universally throughout the winter, and reflect stagnant atmospheric conditions that occur when synoptic-scale weather systems are not present in the Alaskan Interior. At times, these stagnant meteorological conditions can last for several days and end only when other meteorological conditions such as storm systems or higher wind circulation patterns move into the region and cleanse the air before the stagnation pattern begins again.

To see how these stagnant, colder temperature conditions relate to ambient $PM_{2.5}$, Figure 7.6-5 presents a scatter plot of 24-hour $PM_{2.5}$versus daily average temperature during the last three winters in the FNSB (defined as October 2014 through March 2017). The 24-hour average values were developed from DEC's continuous BAM-based $PM_{2.5}$ measurements and hourly meteorological data. The BAM measurements are "corrected-BAM" data, calibrated to filter-based regulatory measurements. The upper panel shows results for the NCore monitor in downtown Fairbanks; the lower panel contains data for the Hurst Road monitor in North Pole. As seen in Figure 7.6-5 for both monitors, higher ambient $PM_{2.5}$ levels are generally correlated with lower ambient temperatures.

Figure 7.6-6 provides a similar set of scatter plots of wintertime 24-hour average ambient $PM_{2.5}$ versus wind speed at the NCore and Hurst Road monitors. As seen from the data at both sites, elevated $PM_{2.5}$ concentrations only occur when average daily wind speeds are below a certain "cutoff" level, which is roughly 1.5 meters/second (or about 3 miles/hour) at both monitors.

Finally, Figure 7.6-7 illustrates how the stagnant atmospheric conditions characterized by low temperatures and wind speeds occur during the winter months in Fairbanks. In Figure 7.6-7, daily $PM_{2.5}$, temperature and wind speed are plotted as a continuous time series across the winter 2014-2017 period for each monitor (NCore in upper panel, Hurst Road in lower panel). In each plot, $PM_{2.5}$ and wind speed are plotted on the left axis, temperature on the right. (Wind speed is multiplied by 10 to better show its day-to-day range over the winter months.)

As seen in Figure 7.6-7, the high spikes in $PM_{2.5}$ at both monitors generally coincide with lower temperatures and very low wind speeds, but on days with more mixing/ventilation (i.e., higher wind speeds) and higher temperatures, ambient $PM_{2.5}$ levels tend to be much lower. During the winter months, 24-hour average $PM_{2.5}$ levels can vary by an order of magnitude or more at each monitor. Thus, for the FNSB area it is reasonable to construct seasonal planning inventories in a manner that focuses on the periods during which high $PM_{2.5}$ levels occur given their regularity, but not universality, during the October through March period.

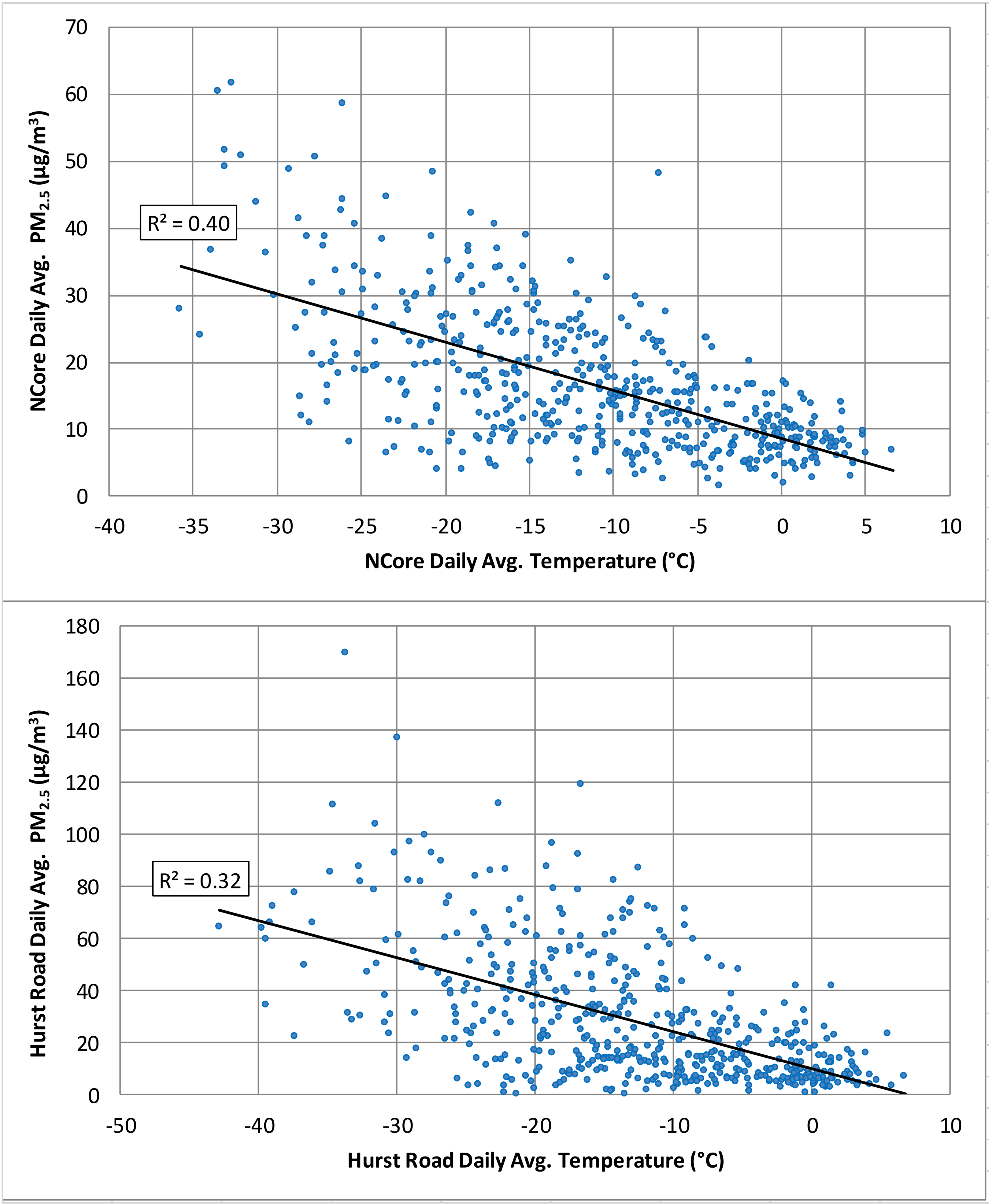

Figure 7.6-5. Fairbanks Daily $PM_{2.5}$ vs. Ambient Temperature (Winter 2014-2017)

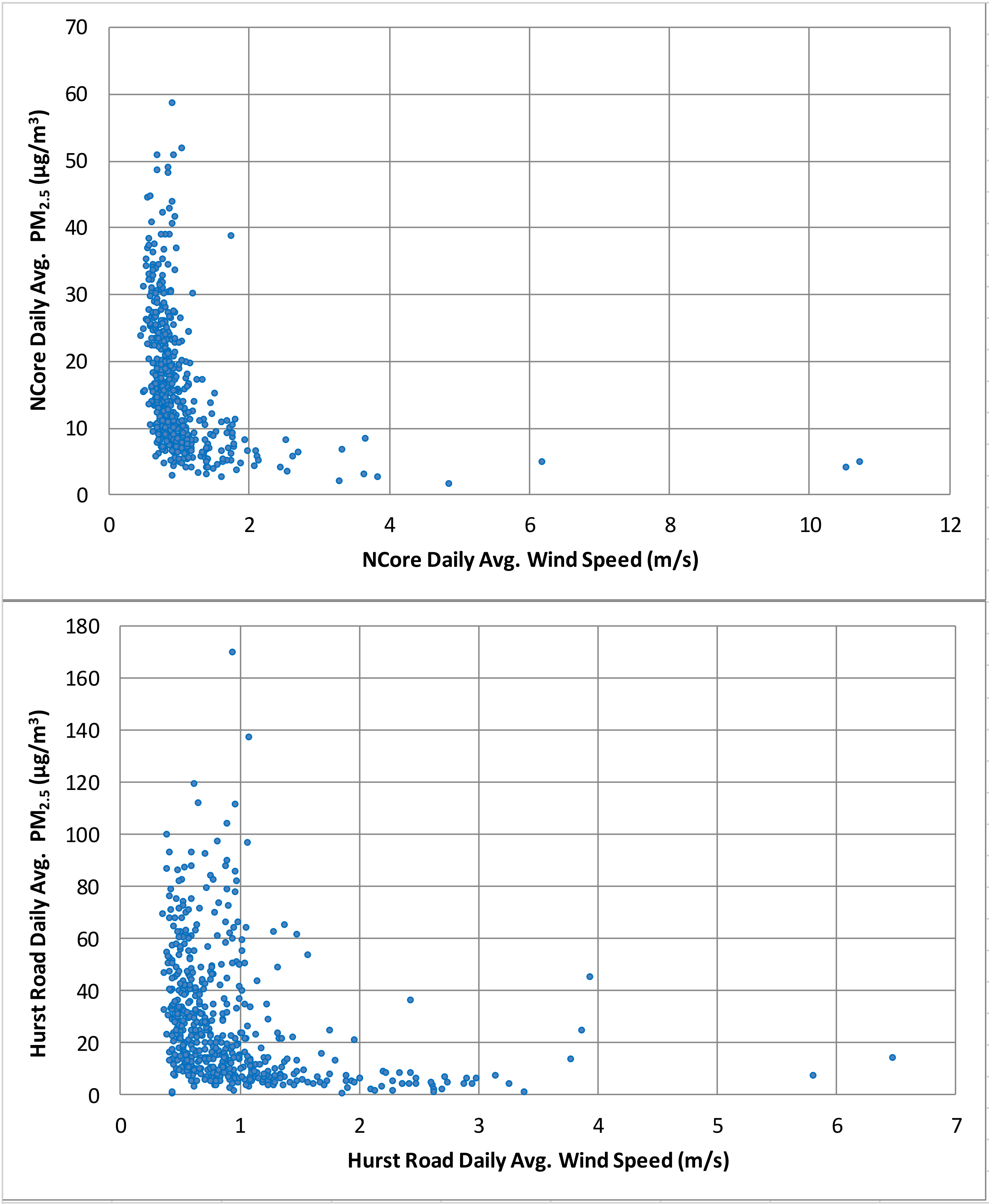

Figure 7.6-6. Fairbanks Daily $PM_{2.5}$ vs. Wind Speed (Winter 2014-2017)

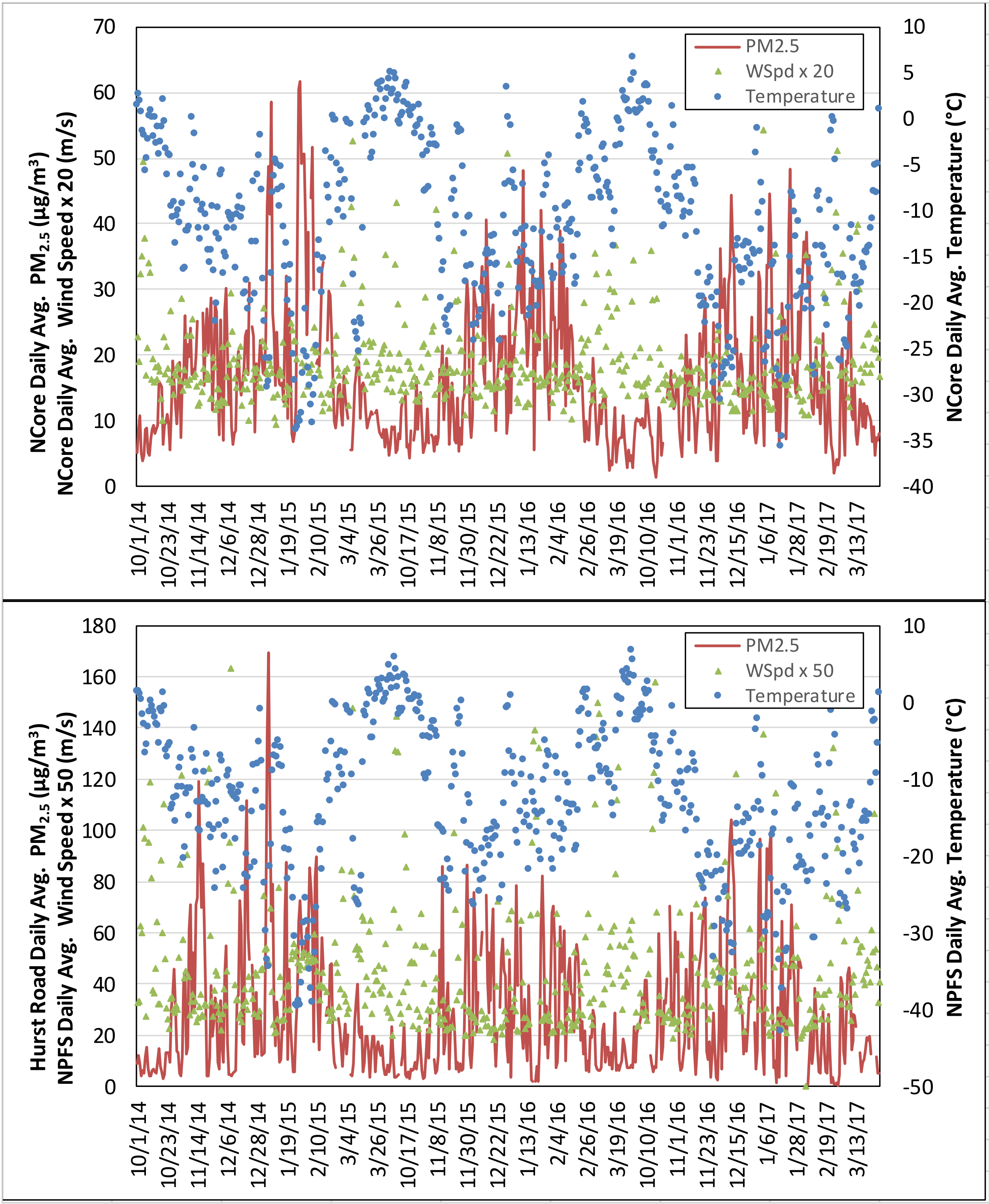

Figure 7.6-7. Fairbanks Winter 2014-2017 Time Series

<u>Modeling Episode Characteristics</u> – The attainment modeling inventories are based on day-specific emission estimates for two historical calendar year 2008 episodes:

- Episode 1 - January 23 through February 10 (19 days); and
- Episode 2 – November 2 through November 17 (16 days).

The Borough, DEC and EPA collectively determined that these modeling episodes typify atmospheric/meteorological conditions and source activity/emission patterns within the nonattainment season when ambient $PM_{2.5}$ concentrations exceed the standard at design day or high percentile levels.

Episode 1 represented a period of extremely cold ambient temperatures (at Fairbanks International Airport) ranging from daily averages of +6°F to -40°F over the 19-day episode with an episode average temperature of -12°F. Spanning late January through early February, it is indicative of near mid-winter peaks in energy/fuel demand and troughs in ambient temperature and daylight/solar intensity.

Episode 2 in early November reflects milder ambient conditions and energy/fuel demand, although it also exhibited measured ambient $PM_{2.5}$ concentrations that exceeded the standard. Its daily average temperatures ranged from +10°F to -6°F, with a mean across the 16-day episode of +3°F.

Notably, both episodes fall within the narrower November through February period during which over 94% of historically recorded NAAQS exceedances occurred as shown earlier in Table 7.6-3. And as illustrated earlier in Figure 7.6-3, these historical modeling episodes occurred during periods within the six-month nonattainment season that do not represent either extreme in daylight hours, yet they reflect both severe and milder meteorological regimes that produce exceedances of the 24-hour $PM_{2.5}$ standard. Thus, based on the earlier joint agency review and selection of these episodes as being collectively representative of the range of factors that trigger $PM_{2.5}$ exceedances within the nonattainment period, they reflect combinations of meteorological/atmospheric conditions and key source sector activity and emission variations that have historically produces NAAQS exceedances.

Conclusions – Based on their representativeness of both ambient conditions and key emission source levels that have triggered 24-hour $PM_{2.5}$ NAAQS exceedances, DEC believes that the average of emissions across the combined 35 days of the two historical episodes are well-suited not just for attainment modeling, but also to satisfy seasonal planning inventory requirements within the Serious SIP as provided in the PM Rule for 24-hour $PM_{2.5}$ nonattainment areas. The data presented earlier in this sub-section clearly shows that atmospheric conditions and emissions within the entire October through March nonattainment season are by no means constant. Based on these data, the modeling episode average emissions are more effectively representative of atmospherically-driven variations in source activity and emissions within the six-month nonattainment season that produce NAAQS exceedances than seasonal average day emissions across the entire season. Use of episode day average emissions provides a more accurate representation of the emission levels and relative contributions from the largest source categories within the nonattainment season upon which to base control measure benefit and Reasonable Further Progress evaluations within the planning inventory requirements of the Serious SIP.

For example, a planning inventory based on average daily emissions across the entire six-month nonattainment season will reflect a lower fraction of wood use-based space heating emissions than one based on the daily average across only the modeling episodes. This is because wood use for space heating in the FNSB tends to occur as a secondary heating source on top of a "base" demand typically met by cleaner home heating oil when ambient temperatures get colder. As a result, such a six-month average day inventory would likely discount or underrepresent the wood-based contribution to emissions and ambient $PM_{2.5}$ exceedances.

In addition, use of average modeling episode day emissions to meet planning inventory requirements provides a measure of consistency in source significance and emission levels across the planning and modeling inventories prepared to support the Serious SIP.

7.6.1.4 Sources Not Inventoried

All potential sources of $PM_{2.5}$ or significant precursor pollutants were evaluated for inclusion within the emission inventory. Generally speaking, sources were excluded from the inventory only under one of the following conditions:

- Data were unavailable (and these instances were noted where they occurred); or
- Sources outside the nonattainment area were not believed significant or were well removed from the nonattainment area.

Sources for which data were not available were restricted to estimates of ammonia (NH_3) emissions for some source categories, most notably actual episodic emissions for point sources. (Other sources without ammonia data consisted of airplane and area sources other than space heating).

Sources estimated to be not significant or well outside the nonattainment area included several specific point source facilities and stationary non-point (area) sources. As described in Technical Appendix III.D.7.6, area source emissions were developed only for the Fairbanks North Star Borough portion of the modeling domain. Given the sparse population density of the other three counties within the modeling domain (Denali, Southeast Fairbanks, and Yukon-Koyukuk), area source emissions for these counties were assumed to be not significant and were excluded from the inventory.

7.6.1.5 Inventory Preparation Personnel and Responsibilities

Listed below are the agencies/organizations and key personnel involved in the preparation of the emission inventory and their respective roles.

Alaska Department of Environmental Conservation (DEC)

- Alice Edwards/Denise Koch – Managed overall SIP inventory development.
- Cindy Heil – Managed State-funded local data collection and survey studies and coordinated evaluation of potential State control measures.
- Deanna Huff – Assembled and assisted in validation of annual and episodic point source facility data, including review of stack parameter data in conjunction with CALPUFF point source modeling supplementing the grid model-based attainment modeling.
- Aaron Simpson – Assisted in assembly of annual point source throughput and emissions data and facility operating permit data.
- Adeyemi Alimi – Provided general data and documentation review.

Fairbanks North Star Borough (FNSB)

- Nick Czarnecki – Managed Borough-funded local data collection and testing studies and coordinated review/investigation of existing and potential Borough control programs.
- Todd Thompson and Christina DeHaven – Provided detailed transaction and geospatial data on activity within the Borough Wood Stove Change Out program.

Sierra Research (consultant to DEC and FNSB)

- Tom Carlson – Managed Sierra Research's overall inventory support efforts and served as the principal technical lead for the emission inventory preparation and control measure benefits analysis; development of stationary point source, stationary non-point source, and non-road mobile source emissions; and quality assurance review of on-road mobile source emissions.
- Bob Dulla – Led or performed a variety of inventory support efforts, including coordination of State and local data collection, validation, and implementation within the emission inventory; also performed source-level inventory quality assurance and control measure reduction review.
- Mark Hixson, Wenxian Zhang, Jon Snoberger – Responsible for development of on-road mobile source emissions and generation of attainment model-ready gridded and speciated emission inputs.
- Matthew Malchow – Performed other area source, non-road mobile source (including aircraft and rail) emission inventory development and as needed quality assurance reviews, including comparisons with EPA-published SCC-level National Emissions Inventory (NEI) data.

7.6.1.6 Organization of the SIP Inventory Documentation

Beyond this introductory section, Section 7.6.2 summarizes the data sources and methodologies used to developed the 2013 Baseline inventories for the SIP. An overview of the approach used to calculate emissions for each sector is presented followed by summaries of the 2013 Baseline inventories.

Section 7.6.3 describes the issues and approaches used to project the baseline inventories forward to the 2019-2024 analysis period for the Serious SIP and how the Projected Baseline inventories incorporate emission benefits already credited as control reductions in the Moderate SIP. It also presents the resulting 2019 Projected Baseline inventories.

The 2019 Control inventories that account for additional controls beyond those in the Moderate SIP are discussed in Section 7.6.4, along with summaries of additional measures and methods used to account for their benefits relative to the Moderate SIP.

Finally, Section 7.6.5 provides a description of the organization roles and procedures used to validate the emission inventory and provide quality assurance checks/review.

In addition to the methodology summaries and tabulated emissions presented within this section of the SIP, Appendix III.D.7.6 provides a series of in-depth descriptions of the individual data sources and detailed methodologies used to calculate emissions for the baseline, projected baseline, and control modeling inventories.

7.6.2 2013 Baseline Emission Inventory

This subsection presents and summarizes the sources and methods used to develop the 2013 Baseline modeling and planning inventories.

These inventories were developed in a manner consistent with the EI requirements for Serious area plans specified in EPA's PM Rule. This included representation of planning inventory source activity and emissions on a seasonal, rather than annual basis as provided for under the PM Rule. As discussed in earlier Section III.D.7.3, episode average daily emissions were used to satisfy seasonal planning inventory requirements since DEC believes they better reflect atmospheric conditions and source activity/emissions that trigger exceedances of 24-hour $PM_{2.5}$ standard in the FNSB within the entire six-month (October through March) nonattainment season.

The inventory was developed using data sources and emission calculation methodologies from the approved FNSB $PM_{2.5}$ Moderate Area SIP as its starting point and then updated based on additional source and activity data collected since preparation of that inventory. The 2013 Baseline inventory supporting this Serious Area SIP is based on historical source activity data in calendar year 2013 for all source sectors. (In other words, it was not projected from the Moderate SIP 2008 Baseline inventory.)

As noted earlier in Section 7.6.2, emission estimates in planning and modeling inventories are compiled at different levels. The former contains estimates totaled across the nonattainment area on an appropriate seasonal basis; the latter is more highly resolved in space and time, representing emissions by individual 1.3 km square grid cell, day, and hour for each of the 35 winter days encompassing the two historical modeling episodes in the attainment modeling analysis listed below.

- Episode 1 – January 23 through February 10, 2008 (19 days)
- Episode 2 – November 2 through November 17, 2008 (16 days)

A detailed discussion of the 2013 Baseline modeling inventory is presented first because portions of the planning inventories were developed based on the more detailed modeling inventory. This is followed by a discussion of the Baseline planning inventory.

7.6.2.1 Sector Overview

<u>Overview</u> – Considerable effort was invested in developing the modeling inventories, starting with the foundational 2013 Baseline inventory. Because of strong variations in monthly, daily, and diurnal source activity <u>and</u> emission factors (largely driven by significant swings in ambient conditions between very cold winters and warm summers within the Alaskan interior), it was critically important to account for these effects in developing the 2013 Baseline modeling inventory for each of the 35 winter episode days.

For all inventory sectors, episodic modeling inventory emissions were calculated using a "bottom-up" approach that relied heavily on an exhaustive set of locally measured data used to support the emission estimates. For source types judged to be less significant or for which local data were not available, estimates relied on EPA-developed NEI county-level activity data and emission factors from EPA's *Compilation of Air Pollutant Emission Factors*,[11] AP-42 database.

Table 7.6-4 briefly summarizes the data sources and methods used to develop episodic modeling inventory emissions by source type. It also highlights those elements based on locally collected data. As shown by the shaded regions in Table 7.6-4, <u>the majority of both episodic wintertime activity and emission factor data supporting the 2013 Baseline inventory was developed based on local data and test measurements</u>.

[11] Compilation of Air Pollutant Emission Factors," Fifth Edition and Supplements, AP-42, U.S. EPA, Research Triangle Park, NC. January 1995.

Table 7.6-4
Summary of Data/Methods Used in the Serious SIP 2013 Baseline Inventory

Source Type/Category	Source Activity	Emission Factors
Point Sources	Episodic facility and stack-level fuel use and process throughput	Continuous emissions monitoring or facility/fuel-specific factors
Area (Nonpoint) Sources, Space Heating	Detailed wintertime FNSB nonattainment area residential heating device activity measurements and surveys	- Test measurements of common FNSB wood and oil heating devices using local fuels - AP-42 factors for local devices or fuels not tested (natural gas, coal)
Area Sources, All Others	- Seasonal, source category-specific activity from a combination of State/Borough sources - NEI-based activity for commercial cooking	AP-42 emission factors
On-Road Mobile Sources	Local estimates of seasonal vehicle miles traveled	- MOVES2014b emission factors based on local fleet/fuel characteristics - Augmented with FNSB wintertime vehicle warmup and plug-in emission testing data
Non-Road Mobile Sources	- Local activity estimates for key categories such as snowmobiles, aircraft and rail - MOVES2014b model-based activity for FNSB for other categories	- MOVES2014b model factors for non-road equipment - AEDT model factors for aircraft - EPA factors for locomotives

As evidenced by source classification structure used to highlight utilization of key local data sources, development of detailed episodic emission estimates to support the attainment modeling focused on three key source types:

1. *Stationary Point Sources* – industrial facility emissions for "major" stationary sources as defined later in this sub-section developed from wintertime activity and fuel usage;

2. *Space Heating Area (Nonpoint) Sources* – residential and commercial heating of buildings with devices/fuels used under wintertime episodic ambient conditions; and

3. *On-Road Mobile Sources* – on-road vehicle emissions based on local activity and fleet characteristics with EPA-accepted adjustments to account for effects of wintertime vehicle/engine block heater "plug-in" use in Fairbanks using MOVES2014b (the latest version of MOVES).

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As seen in emission summaries presented later in this sub-section, these three source types were the major contributors to both direct $PM_{2.5}$ emissions as well as emissions of potential precursor pollutants SO_2, NO_x, VOC, and NH_3 within both the nonattainment area as well as the broader Grid 3 modeling domain.

Following this overview, expanded summaries are presented that describe the approaches used to generate episodic emission estimates for each of the source types/categories listed in Table 7.6-4 for the 2013 Baseline modeling inventory. In addition to these methodology summaries, Appendix III.D.7.6 provides detailed descriptions of the data sources, issues considered, and step-by-step methods and workflow used to generate modeling inventory emissions at the Source Classification Code (SCC) level.

Following these summaries, a series of detail tabulations and plots of the 2013 Baseline modeling inventory are presented.

Revising Moderate SIP Estimates – The Moderate SIP contained a 2008 Baseline inventory. This inventory was re-developed for the 2013 baseline year of the Serious Plan based on new or revised activity estimates and emission factors/models for which key elements are summarized below.

- *Point Sources* – 2008 activity and emissions data were updated to 2013 based on annual fuel use/process throughput by individual facility and emission unit. Fuel-based ammonia emissions for point sources were also included in the 2013 inventory.

- *Space Heating Area Sources* – Additional home heating survey data collected in winters 2012 through 2015 were used to augment the estimates of residential space heating device/fuel mix and usage in the Moderate SIP based on the singular 2011 Home Heating survey. This broader sample of survey data was combined to more robustly reflect residential space heating activity within the nonattainment area for calendar year 2013 (which is centered in the combined 2011-2015 home heating survey period). Additional survey data were also collected from commercial businesses in the nonattainment area to estimate the extent of space heating from solid fuel burning devices (wood or coal) in commercial buildings. (The Moderate SIP assumed all commercial space heating used only liquid (heating oil) or gaseous (natural gas) fuels).

- *On-Road and Non-Road Mobile Sources* – For both on-road and non-road vehicles, EPA's latest vehicle emissions model, MOVES2014b was used to replace emission estimates from the Moderate SIP based on its predecessor, MOVES2010a.[12] On-road vehicle activity (VMT and speeds) was based on 2013 baseline travel demand model outputs from the Fairbanks Metropolitan Area Transportation System (FMATS)[13] 2040

[12] MOVES2014b models both on-road and non-road vehicles/equipment. MOVES2010a only modeled emissions from on-road vehicles; a separate model NONROAD2008 was used in the Moderate SIP to address non-road vehicle emissions.

[13] The FMATS organization transitioned to FAST Planning in 2019.

Metropolitan Transportation Plan (MTP) and 2045 MTP.[14] (The Moderate SIP used travel model estimates for 2008 from a prior transportation plan.) For non-road vehicles/equipment MOVES2014b was used to calculate 2013 calendar year emissions. The Federal Aviation Administration's AEDT model (Version 2c) was used to estimate aircraft/airfield emissions in 2013 based on activity data collected for that year. (The Moderate SIP used the predecessor model to AEDT, EDMS, based on 2008 activity).

Data sources and methodologies specific to each source sector used to estimate 2013 Baseline emissions are presented in source sector-specific sub-sections that follow.

7.6.2.2 Stationary Point Sources

For the 2013 Baseline modeling inventory, DEC queried facilities from its permits database to identify major and minor point source facilities within the modeling domain. DEC uses the definition of a major source under Title V of the Clean Air Act (as specified in 40 CFR §51.20) to define the "major source" thresholds for reporting annual emissions. These thresholds are the potential to emit (PTE) annual emissions of 100 tons for all relevant criteria air pollutants. Natural minor and synthetic minor facilities (between 5 and 99 TPY) reporting emissions under either New Source Review (NSR) or Prevention of Significant Deterioration (PSD) requirements were also included in the query to identify facilities down to the 70 TPY threshold required to classify stationary point sources under Serious Area inventory requirements.

A total of 14 facilities were identified. Of these, DEC noted that three of the facilities—the Golden Valley Electric Association (GVEA) Healy Power Plant and the heating/power plants at Fort Greely (near Delta Junction) and Clear Air Force Base (near Anderson)—were excluded from development of episodic emissions. These facilities were excluded because of their remoteness relative to Fairbanks (all are between 55 and 78 miles away)[15] or the fact that they were located generally downwind of the nonattainment area under episodic air flow patterns (Healy Power Plant and Clear AFB). Three others were identified as minor/synthetic minor sources: (1) Fort Knox Mine (26 miles northeast of Fairbanks), (2) Usibelli Coal Preparation Plant (in Healy), and (3) CMI Asphalt Plant (in Fairbanks); these were excluded from treatment as individual stationary point sources because they either were located outside the nonattainment area (Fort Knox and Usibelli) or exhibited insignificant wintertime activity (CMI Asphalt Plant). These facilities excluded from the point source sector were treated as stationary non-point or area sources within the inventory.

The names and primary equipment and fuels of the eight remaining facilities for which episodic data were collected and developed are summarized in Table 7.6-5. One facility, Eielson Air Force Base, is located just outside the nonattainment area boundary on the southeast edge. All other facilities listed in 7.6-5 are located within the nonattainment area.

[14] The FMATS 2040 and 2045 MTPs employed the same travel demand model 2013 baseline estimates of vehicle activity.

[15] Individual point source plume modeling conducted by DEC in support of the SIP using the CALPUFF model found that under the episodic meteorological conditions, emissions from facilities located outside the Fairbanks $PM_{2.5}$ nonattainment area exhibited negligible contributions to ambient $PM_{2.5}$ concentrations in the area.

Table 7.6-5
Summary of SIP Modeling Inventory Point Source Facilities

Facility ID	Facility Name	Primary Equipment/Fuels
71	Flint Hills North Pole Refinery	11 crude & process heaters burning process gas/LPG (9 operated during episodes), plus 2 natural gas fired steam generators, gas flare
109	GVEA Zehnder (Illinois St) Power Plant	Two gas turbines burning HAGO[a], two diesel generators burning Jet A
110	GVEA North Pole Power Plant	Three gas turbines, two burning HAGO, one burning naphtha (plus an emergency generator and building heaters not used during episodes)
236	Fort Wainwright	Backup diesel boilers & generators (3 each) - none operated during episodes
264	Eielson Air Force Base	Over 70 combustion units - six coal-fired main boilers only operated during episodes
315	Aurora Energy Chena Power Plant	Four coal-fired boilers (1 large, 3 small), all exhausted through common stack
316	UAF Campus Power Plant	Two coal-fired, two oil-fired boilers (plus backup generators & incinerator not operated during episodes)
1121	Doyon Utilities (private Fort Wainwright units)	Six coal-fired boilers

[a] Heavy Atmospheric Gas Oil. HAGO is a crude distillate at the heavy end of typical refinery "cuts" with typical boiling points ranging from 610-800°F. Due to geographic proximity, GVEA seasonally used HAGO, a by-product from the adjacent Flint Hills Refinery until the refinery was shut down in 2014.

DEC then requested additional actual day- and hour-specific activity and emissions data from each facility (as available) covering the two 2008 historical modeling episodes. Information was requested for both combustion and fugitive sources. Requested data elements included emission units, stack parameters (height, diameter, exit temperature and velocity/flowrate), release points (location coordinates), control devices (as applicable), seasonal and diurnal fuel properties, and throughput.

The submitted data were then assembled and reviewed for completeness, consistency, and validity prior to integrating the episodic data into the SIP inventories. Given the differences in structure and content of the submitted episodic data, the data were individually reviewed for each facility before being assembled into a consistent inventory structure.

At a minimum, facilities provided SCC codes and hourly $PM_{2.5}$ and SO_2 emission rates by individual emission unit along with daily/hourly fuel usage or process throughput data and emission factors for the remaining criteria pollutants. For facilities that did not provide emissions for all criteria pollutants, NOx, NH_3 and VOC emissions were computed from AP-42[15] based or facility source test emission factors (where fuel use data were explicitly provided) or from fuel-specific emission factor ratios.

Annual actual emissions by emission unit for each facility in calendar years 2008 and 2013 obtained from DEC permit database (including facility operating reports and permit fee assessments) were then used to scale the day/hour specific 2008 episodic data provided by each facility from 2008 to 2013. This approach essentially simulates the levels of facility-specific emissions from the 2008 modeling episodes relative to annual emissions, carried forward to 2013.[16]

Table 7.6-6 compares annual fuel use by facility between 2008 and 2013, including splits of HAGO vs. lighter distillates (distillate #2/#1, Jet A, Naphtha) at the GVEA facilities. As seen, there were generally modest changes (roughly within 10%) in annual throughput/fuel use between 2008 and 2013 for most facilities. The GVEA facilities were the biggest exception, using much less HAGO fuel in 2013 than in 2008 (although HAGO use increased at the Zehnder facility). This is important since HAGO has significantly higher $PM_{2.5}$ and SO_2 emissions per unit of fuel energy than the lighter distillate/Jet A/Naphtha fuels it also uses. Coal use at Doyon was 17% higher in 2013 than 2008.

Table 7.6-6
Comparison of 2013 vs. 2008 Annual Fuel Use by Facility and Fuel Type

Facility ID	Facility Name	Calendar Year	HAGO (1000 gal/year)	Light Distillate (1000 gal/year)	Coal (tons/year)
109	GVEA Zehnder	2008	827	8	n/a
		2013	1,200	1	n/a
		% Change	+45%	-87%	n/a
110	GVEA North Pole	2008	5,634	23,054	n/a
		2013	2,764	23,345	n/a
		% Change	-51%	+1%	n/a
315	Aurora Energy	2008	n/a	n/a	222,592
		2013	n/a	n/a	214,961
		% Change	n/a	n/a	-3%
316	UA Fairbanks	2008	n/a	935	73,900
		2013	n/a	848	68,599
		% Change	n/a	-9%	-7%
1121	Doyon (Fort Wainwright)	2008	n/a	n/a	246,250
		2013	n/a	n/a	288,702
		% Change	n/a	n/a	+17%

Note: Fuel data in both years for Flint Hills Refinery and Eielson AFB were not available, only annual emissions.

Generally, each facility provided hourly $PM_{2.5}$ and SO_2 emission rates by individual emission unit. As explained in greater detail below, estimates of NO_x, VOC and NH_3 emission rates were developed from AP-42 based emission factors[17] (where fuel use data were explicitly provided) or from fuel-specific emission factor ratios.

[16] Since day-specific 2013 modeling episodes for the Serious SI baseline year were not developed, there was no reason to obtain day- and hour-specific emissions or fuel use from facility operations in 2013.
[17] AP-42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources," Environmental Protection Agency, January 1995.

Figure 7.6-8 through Figure 7.6-12 provide comparisons of $PM_{2.5}$, SO_2, NO_x, VOC and NH_3 emissions (for facilities reporting NH_3 emissions), respectively, for each source facility for which episodic data were collected. Within each figure, three sets of daily average emissions (in tons/day) are plotted for each facility, as described below.

1. *2013 E1 Avg* – Episode 1 average daily emissions, scaled forward to 2013
2. *2013 E2 Avg* – Episode 2 average daily emissions, scaled forward to 2013
3. *2013 Annual* – 2013 annual average daily actual emissions (from DEC database)

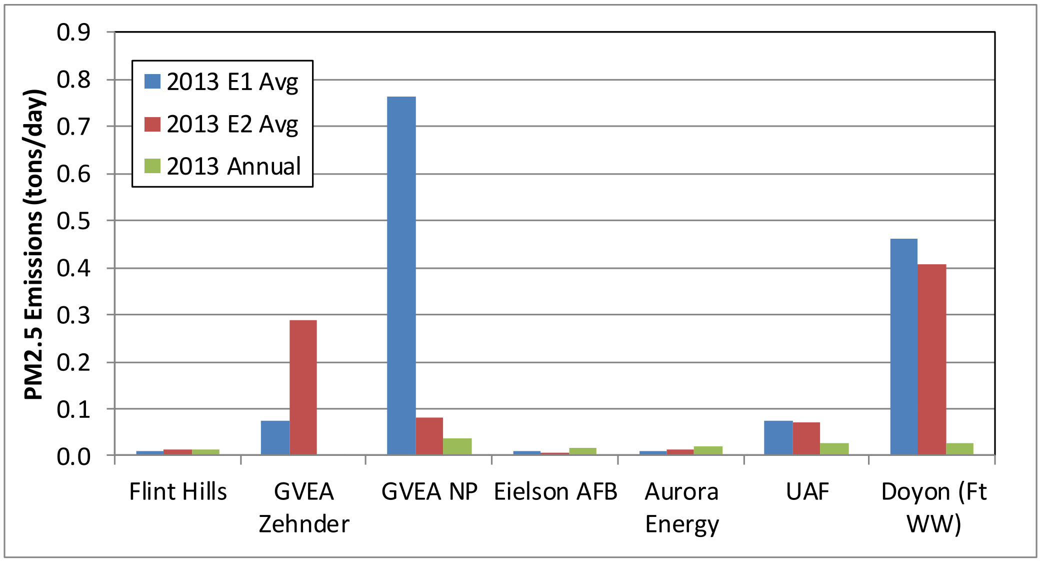


Figure 7.6-8. 2013 $PM_{2.5}$ Episodic vs. Annual Average Point Source Emissions (tons/day)

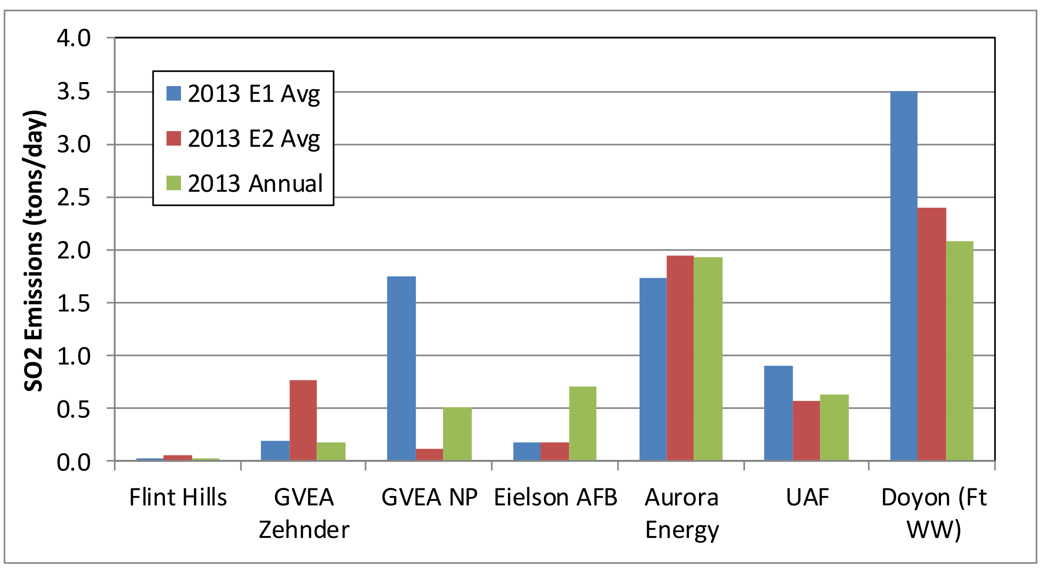


Figure 7.6-9. 2013 SO_2 Episodic vs. Annual Average Point Source Emissions (tons/day)

All five pollutant plots show two elements very clearly. First, the strong seasonal nature of emissions at many of the facilities is evidenced where episodic daily emissions are higher than annual average daily emissions. For example, as shown in Figure 7.6-8 direct $PM_{2.5}$ emissions during the wintertime modeling episodes are much higher than the daily average over the entire year at both GVEA power plants and the Doyon facilities on the Fort Wainwright Army Base. This relates to the fact that more energy is needed for electric heat and power from these facilities during winter when temperatures are colder and nights are longer. Second, each plot shows which facilities are the major point source contributors for each pollutant.

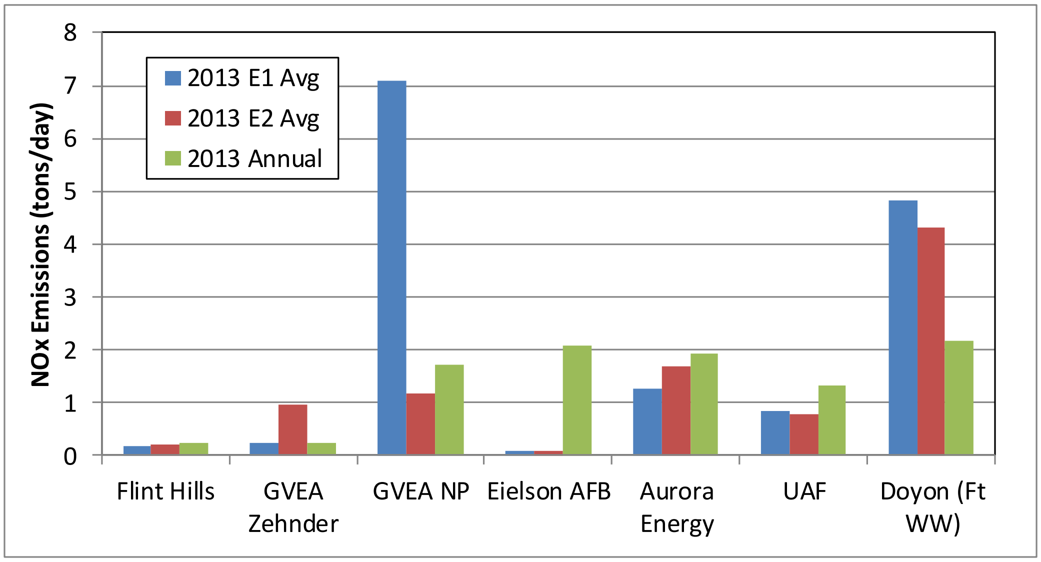


Figure 7.6-10. 2013 NO_x Episodic vs. Annual Average Point Source Emissions (tons/day)

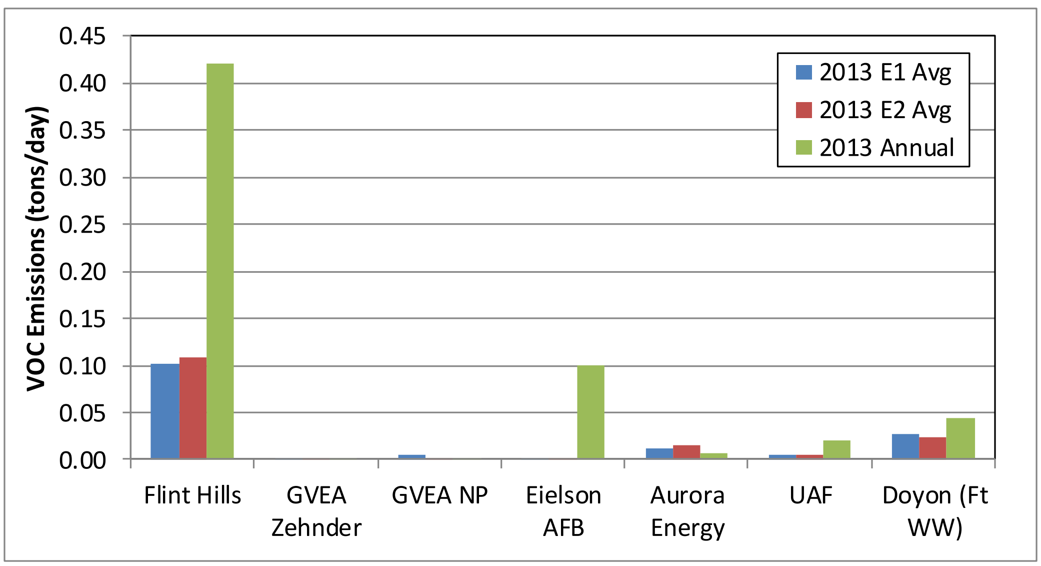
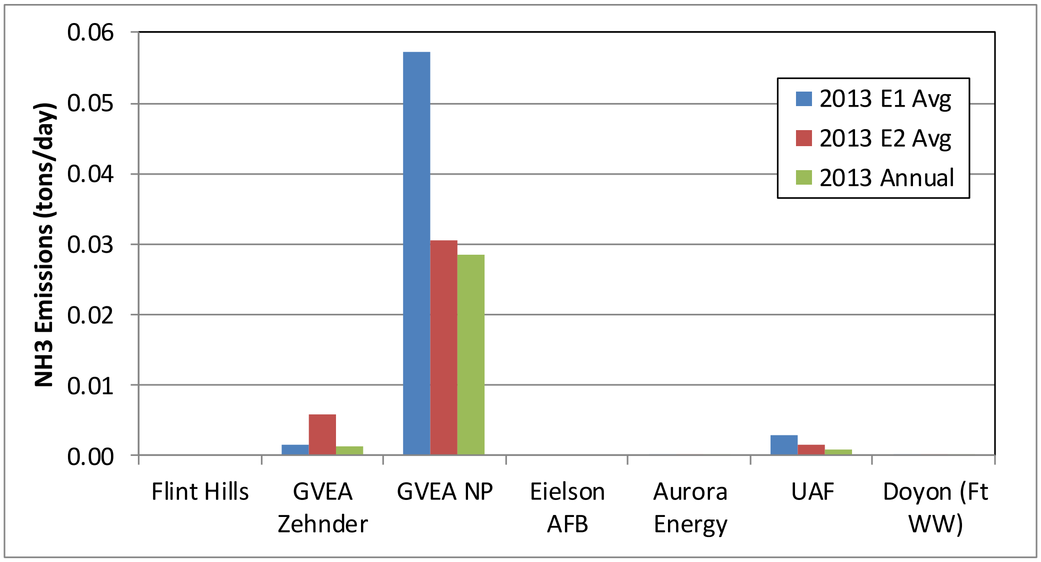


Figure 7.6-11. 2013 VOC Episodic vs. Annual Average Point Source Emissions (tons/day)



Note: NH_3 emissions were not reported from Flint Hills and Eielson AFB. Those for Aurora Energy and Doyon are too small to see on the scale of the plot.

Figure 7.6-12. 2013 NH_3 Episodic vs. Annual Average Point Source Emissions (tons/day)

Though not shown in Figure 7.6-8 through Figure 7.6-12, a cross-check of the 2008 to 2013 facility emissions scaling updates was performed to verify that scaled 2013 emissions did not exceed annual PTE limits for each facility.

In the modeling inventory, the episodic actual emissions for each point are represented on a day- and hour-specific basis. The E1 and E2 emission levels shown in the plots are averages compiled from the day- and hour-specific emissions across each modeling episode.

7.6.2.3 Space Heating Area Sources

Inventory assessments and source apportionment analysis performed to support initial development of the SIP identified space heating as the single largest source category of directly emitted $PM_{2.5}$. Thus, the 2013 Baseline modeling inventory incorporated an exhaustive set of locally collected data in the FNSB that were used to estimate episodic wintertime space heating emissions by heating device type and fuel type. These local wintertime data and their use in generating space heating emissions are summarized below.

- *Fairbanks Winter Home Heating Energy Model* – A multivariate predictive model of household space heating energy use was developed based on highly resolved (down to five-minute intervals) actual instrumented measurements of heating device use in a sample of FNSB homes during winter 2011 collected by the Cold Climate Housing Research Center (CCHRC) in Fairbanks. The energy model was calibrated based on the CCHRC measurements and predicted energy use by day and hour as a function of household size (sq ft), heating devices present (fireplaces, wood stoves, outdoor hydronic heaters, and oil heating devices) and day type (weekday/weekend).

- *Multiple Residential Heating Surveys* – Representations of area (ZIP code) specific wintertime heating device uses and practices were developed from a series of annual telephone-based surveys of residential households within the nonattainment area, ranging in size from 300-700 households per survey. DEC conducted 300-household surveys in 2006, 2007 and 2010 and more robust 700-houshold surveys in 2011, 2012, 2013, 2014 and 2015 that also proportionately sampled cell phone-only households.[18] The 2011-2015 data, which encompassed a combined sample of over 3,500 households was used to develop space heating emissions for this Serious SIP 2013 baseline inventory. These combined 2011-2015 survey results were used to develop estimates of the types and number of heating devices used during winter by 4 km square areas[19] within the nonattainment area. The survey data were also used to cross-check the energy model-based fuel use predictions as well as to identify and apportion wood use within key subgroups (certified vs. non-certified devices and purchased vs. user-cut wood, the latter of which reflects differences in moisture content that affects emissions). Special purpose surveys were also conducted that included a 2013 "Wood Tag" survey of wood-burning households that collected further detail on EPA-certified devices and a 2016 Postcard survey that sought to assess changes in wood use related to heating oil price decreases.

- *Fairbanks Wood Species Energy Content and Moisture Measurements* – CCHRC performed an additional study that measured wood drying practices and moisture content of commonly used wood species for space heating in the FNSB area. These measurements were combined with published wood species-specific energy content data and additional residential survey data (2013 Wood Tag Survey) under which respondents identified the types of wood they used to heat their homes. Birch, Spruce, and "Aspen" (i.e., Poplar) were identified as the three primary locally used wood species.

- *Laboratory-Measured Emission Factors for Fairbanks Heating Devices* – An accredited testing laboratory, OMNI-Test Laboratory (OMNI), was contracted to perform a series of heating device emission tests using a sample of wood-burning and oil heating devices commonly used in the FNSB area in conjunction with samples of locally collected wood and heating oil. The primary purpose of this testing was to evaluate and, if necessary, update AP-42-based emission factors that were generally based on heating device technology circa 1990. The OMNI study provided a comprehensive, systematic attempt to quantify Fairbanks-specific, current technology-based emission factors from space heating appliances and fuels. The laboratory-based emission testing study consisted of 35 tests of nine space heating appliances, using six typical FNSB area fuels. Both direct PM and gaseous precursors (SO_2, NO_x, NH_3) were measured, along with PM elemental profiles. All emission tests were conducted at OMNI's laboratory in Portland, Oregon. Supporting solid fuel, liquid fuel, and bottom ash analyses were performed by Twin Ports Testing, Southwest Research Institute (SwRI), and Columbia Analytical Services,

[18] Households with only with cell phones and no landline phone. Cell-only households had not been explicitly sampled in the 2010 and earlier surveys.

[19] Modeling grid cells were 1.33 km square. Device and fuel usage distributions from the 2011-2015 survey data were calculated by 4 km square areas (which consist of 3 × 3 sets of modeling grid cells) in order to achieve a minimum statistically sufficient sample size of a least 50 households per 4 km square area across the majority of the nonattainment area.

respectively. PM profiles of deposits on Teflon filters from dilution tunnel sampling were analyzed by Research Triangle Institute using XRF, ion chromatography, and thermal/optical analysis.

Residential Space Heating Device Activity - As noted above, device and fuel usage rates were based on the combined 3,500+ households from the 2011-2015 Fairbanks Home Heating (HH) surveys to represent wintertime, episodic space heating activity in the 2013 baseline year, which is centered within the five-year survey data period. Table 7.6-7 provides a summary of key results from the HH surveys by individual survey year, and for the combined 2011-2015 survey period, averaged over the nonattainment area.

Below the sample sizes of each survey, winter season (Oct-Mar) device/fuel usage fractions are presented and show the breakdown of heating energy use by fuel type (with detailed breakdown for wood-burning devices). As shown in Table 7.6-7, roughly 75% of winter season heating energy is from heating oil (Central Oil, Portable Heater and Direct Vent devices). Wood heating make up roughly 22% of winter heating energy use, and notably rose from 19.2% in 2011 to 24.1% in 2014. This coincides with a period when heating oil prices in Fairbanks hovered near $4 per gallon, and as discussed later in Section 7.6.3, appears to have encouraged residents to burn more wood (a cheaper fuel) when heating oil costs were high.

Table 7.6-7
Key Results from 2011-2015 Fairbanks Home Heating Surveys

Metric	Fuel/Device Type	Survey Year					2011-2015 Combined
		2011	2012	2013	2014	2015	
Sample Size (households)		712	700	701	700	701	3,514
Winter Season Heating Energy Use Fractions	All Wood	19.2%	22.1%	21.4%	24.1%	20.3%	21.8%
	Fireplace	0.5%	0.8%	0.8%	0.7%	0.3%	0.7%
	Insert, Cordwood	1.0%	0.7%	0.8%	1.0%	0.9%	0.9%
	Stove, Cordwood	13.4%	17.6%	15.7%	18.8%	16.4%	16.6%
	Insert, Pellet	0.8%	0.6%	1.6%	1.8%	0.8%	1.1%
	Stove, Pellet	0.6%	0.6%	1.6%	1.6%	0.8%	1.1%
	Outdoor Wood Boiler	2.9%	1.9%	0.9%	0.2%	1.0%	1.5%
	Central Oil	70.9%	65.9%	73.4%	66.9%	74.5%	70.7%
	Portable/Kerosene Heat	0.9%	0.1%	0.8%	0.4%	0.4%	0.5%
	Direct Vent	4.4%	2.8%	2.4%	3.5%	2.9%	3.3%
	Natural Gas	2.3%	2.3%	1.0%	2.0%	0.5%	1.7%
	Coal Heat	0.3%	0.2%	0.6%	2.1%	0.4%	0.7%
	District Heat	2.0%	1.4%	0.4%	1.0%	1.0%	1.2%
Stove/Insert Cert. Type	Uncertified (<1988)	25.7%	22.7%	20.1%	14.4%	13.9%	19.1%
	Certified (≥1988)	74.3%	77.3%	79.9%	85.6%	86.1%	80.9%
Stove/Insert Tech. Type	Catalytic	39.3%	37.6%	45.6%	44.7%	42.4%	42.0%
	Non-Catalytic	60.7%	62.4%	54.4%	55.3%	57.6%	58.0%
Wood Source	Buy	27.0%	36.1%	35.4%	32.3%	37.4%	33.8%
	Cut Own Wood	61.9%	49.1%	47.1%	54.3%	47.9%	51.8%
	Both (Buy & Cut Own)	11.0%	14.8%	17.5%	13.4%	14.7%	14.4%

Table 7.6-7 also presents usage splits for other key survey elements. First, uncertified vs. EPA-certified wood stove or insert fractions (based on the age of the device) are shown to steadily drop from 25.7% in 2011 to 13.9% in 2015. The HH survey asked respondents if their wood stoves or inserts were purchased/installed before or after 1988, the year of EPA's initial New Source Performance Standards (NSPS) that established certification standards for new wood-burning devices.[20] This downward trend in uncertified devices make sense as older devices are retired and new certified wood stoves/inserts are purchased, either under or outside the Borough's Wood Stove Change Out Program. (Though not reflected in Table 7.6-7, the uncertified vs. EPA-certified device fractions from the HH surveys are adjusted to reflect the fact that some devices sold after 1988 are not certified as described in Appendix III.D.7.6.) Second, the distribution of EPA-certified devices by technology type (catalytic vs. non-catalytic) is also shown in Table 7.6-7 for each survey year and indicates that most existing EPA-certified devices are non-catalytic, the fraction of catalytic technology generally increased over the 2011-2015 survey period. Finally, fractions of the sources of wood are listed at the bottom of Table 7.6-7, showing that most wood is cut by respondents, rather than commercially purchased. As explained in greater detail in Appendix III.D.7.6, this Wood Source distribution is important because "Cut Own" wood tends to have lower moisture content than commercially-purchased wood since it is generally seasoned longer before being burned.

As stated earlier in this sub-section, the combined 2011-2015 HH survey sample was used to represent residential space heating device and fuel use for the 2013 Baseline inventory, as opposed to the 2013 survey data. The rationale behind this decision was twofold:

1. Calendar year 2013 was centered within the 2011-2015 survey period, and any trends over the period (e.g., wood use, uncertified device fractions would be reasonably represented by the combined average over the period); and

2. Use of the combined data provided a roughly five-fold increase in sample size, which as explained in further detail in Appendix III.D.7.6 provided much higher statistical confidence in the usage fractions listed in Table 7.6-7, especially for smaller proportion device/fuel combinations such as Outdoor Wood Boilers.

Although the residential space heating energy use data presented earlier in Table 7.6-7 were listed as winter season usage percentages, the combined 2011-2015 HH survey data were integrated with the Fairbanks Winter Home Heating Energy Model to develop grid cell-specific estimates of day- and hour-specific heating energy use (in BTUs) for each modeling episode day. A parcel database obtained from the Borough containing building sizes within each residential, commercial, industrial and other (e.g., government) parcel was used within the framework of the Energy Model to determine the amounts of heated building space allocated within each grid cell. These calculations also incorporated the effects of wood moisture, accounting for the fact that wetter wood provides less "effective heating energy" than drier wood. The combined wood moisture content calculated for the 2013 Baseline inventory (weighting Buy and Cut Own wood use at different moisture levels) was 36.5%. Appendix III.D.7.6 describes these calculations in detail.

[20] The question was intentionally designed this way to avoid potential inaccuracies arising if respondents were not certain their device was certified, or could not easily see/identify a certification label on the wood device.

Finally, though not shown earlier in Table 7.6-7, data from the combined 2011-2015 HH surveys were tabulated to determine the usage fractions of #1 and #2 distillate heating oil in residential space heating. (One of the survey questions asked of oil-burning households was to estimate their usage of #1 and #2 in gallons.) From these responses, residential heating oil usage was estimated to be 68.2% #2 and 31.8% #1 heating oil.

Commercial Space Heating Activity – Space heating activity and emissions associated with fuel combustion in non-residential buildings were determined separately from residential space heating. (Hereafter, the term "commercial" space heating refers to that from all non-residential buildings including commercial, industrial and all other non-residential buildings.)

The aforementioned Borough parcel/building size database was used to identify the amount of non-residential building space located within each modeling grid cell. Tabulated non-residential building space was combined with an Alaska commercial building heating energy demand factor developed by CCHRC and daily Heating Degree Day (HDD) data for the historical modeling episodes to estimate commercial space heating energy demand.[21]

Under the Moderate SIP, commercial space heating energy usage was estimated to be 98% from heating oil and 2% from natural gas. This estimate was reviewed under the Serious SIP and maintained based on the fact that there was little change in the number of commercial customers using natural gas between the 2008 Moderate SIP baseline and this 2013 Serious SIP baseline inventory. However, based on information provided by one of the local heating oil suppliers in commenting on the Serious SIP Preliminary Draft inventory combined with the #1 and #2 heating oil splits in the residential sector, it was estimated that commercial fuel oil was almost entirely #1 distillate oil. So commercial heating oil was assumed to be 100% #1 distillate.

In addition, DEC conducted a survey in early 2017 of solid fuel burning (wood or coal) in commercial buildings. The survey utilized a local business database provided by the Borough's Planning Department and group businesses into categories more or less likely to utilize a solid fuel burning appliance. Roughly 30 commercial businesses were found to utilize solid fuel burning and identified the type of device used. Many also provided estimates of their solid fuel usage. For those that did not, estimates were developed based on the building size assuming solid fuel burning was a secondary, rather than primary heating source. As shown later, commercial solid fuel space heating emissions were found to be very small compared to the residential sector based on these estimates.

Space Heating Emission Factors - Space heating emissions were estimated using OMNI-based results where available for specific devices and AP-42-based estimates for devices for which OMNI tests were not conducted. Table 7.6-8 shows the device and fuel types resolved in estimating space heating emissions for the modeling inventory, their assigned SCC codes, and the source of the emission factors (OMNI testing or AP-42-based) used in calculating emissions for each device.

[21] The energy demand factor was in units of BTU/HDD/ft^2/year. Commercial space heating energy per day was then calculated by multiplying the energy demand factor by building space (in ft^2) and day-specific HDDs.

Table 7.6-8
Fairbanks Space Heating Devices and Fuel Types and Source of Emission Factors

Device Type	SCC Code	Emission Factor
Residential Wood-Burning Devices		
Fireplace, No Insert	2104008100	AP-42
Fireplace, With Insert - Non-EPA Certified	2104008210	AP-42
Fireplace, With Insert - EPA Certified Non-Catalytic	2104008220	AP-42
Fireplace, With Insert - EPA Certified Catalytic	2104008230	AP-42
Woodstove - Non-EPA Certified	2104008310	OMNI
Woodstove - EPA Certified Non-Catalytic	2104008320	OMNI
Woodstove - EPA Certified Catalytic	2104008330	OMNI
Pellet Stove (Exempt)	2104008410	OMNI
Pellet Stove (EPA Certified)	2104008420	OMNI
OWB (Hydronic Heater) - Unqualified	2104008610	OMNI
OWB (Hydronic Heater) - Phase 2	2104008640	OMNI
Other Heating Devices		
Central Oil (Weighted # 1 & #2), Residential	2104004000	OMNI
Central Oil (Weighted # 1 & #2), Commercial	2103004001	OMNI
Portable Heater: 43% Kerosene & 57% Fuel Oil	2104004000	AP-42
Direct Vent Oil Heater	2104004000	AP-42
Natural Gas - Residential	2104006010	AP-42
Natural Gas - Commercial, small uncontrolled	2103006000	AP-42
Coal Boiler – Residential	2104002000	OMNI
Coal Boiler – Commercial	2103002000	OMNI[a]
Wood Devices - Commercial	2103008000	Device Specific[b]
Waste Oil Burning	2102012000	OMNI

[a] Assumed same emission factors as residential coal heaters.

[b] Used wood burning device specific emission factors from residential sector.

Episodic day- and hour-specific emissions from space heating fuel combustion were calculated by combining heating energy use estimates from the Fairbanks Energy Model with 4 km square grid cell device distributions from the local survey data (along with wood species mix and moisture content data). Estimates were gridded to the smaller 1.33 km modeling grid cells using block-level GIS shapefile counts of housing units from the 2010 U.S. Census combined with 2013 block-group level housing unit estimates from the American Community Survey (ACS).[22] The grid cell-specific source activity estimates were then combined with emission factors for the devices listed in Table 7.6-8 to estimate space heating emissions by grid cell.

The space heating emissions were passed to the SMOKE inventory pre-processing model on an episodic daily and hourly basis. Earlier versions of the SMOKE model accepted only nonpoint or area source emissions that were temporally resolved using independent monthly, day of week, and diurnal profiles. A modified version of SMOKE was developed for the FNSB SIP to also accept area source emissions in a similar fashion to which day- and hour-specific episodic point source emissions can be supplied to the model. This was critically important in preserving the actual historical temporal resolution reflected in the space heating portion of the modeling inventory when applied in the downstream attainment modeling.

[22] The American Community Survey is an on-going annual survey of households and businesses conducted by the U.S. Census Bureau between full decadal Census counts (https://www.census.gov/programs-surveys/acs/).

7.6.2.4 Other Area Sources

Modeling inventory emissions for all other stationary area sources other than those related to space heating were calculated more simply, although still using local data where available. The data sources used to estimate "Other" area source emissions were as follows:

1. DEC's Minor Stationary Source emissions database (for calendar year 2014);
2. Locally-collected data for coffee roasting facilities within the nonattainment area; and
3. EPA's 2014 National Emission Inventory (NEI).

First, emissions for sources within the Fairbanks North Star Borough were extracted from the 2014 Minor Source database for the following source types and SCCs:

- Batch Mix Asphalt Plant (SCC 30500247);
- Drum Hot Mix Asphalt Plants (SCC 30500258);
- Gold Mine (SCC 10200502);
- Hospital (SCC 20200402);
- Refinery (SCC 30600106);
- Rock Crusher (SCC 30504030); and
- Wood Production (SCC 10300208).

Emissions for these sources from the 2014 Minor Source file were actual emissions in tons per year. They were assumed to be constant over the year.

Second, a Fairbanks Business database (with confirmation from Borough staff) was used to identify a total of four facilities within the nonattainment area that use on-site coffee roasters. These businesses were contacted and two of the four provided data on annual roasting throughput (tons of beans roasted). Throughput was conservatively estimated for the two non-reporting facilities based on the maximum from those that reported their throughput. Emission factors for PM, VOC and NOx from EPA's WebFIRE AP-42 database for batch roasters were used to calculate emissions. (No emission factors were available for SO_2 or NH_3). Uncontrolled emission factors were applied to three of the four facilities. The other facility utilizes a thermal oxidizer; its emission factors were based on WebFIRE factors for a batch roaster with a thermal oxidizer. Coffee roasting emissions were assumed to be constant throughout the year.

Third, the 2014 NEI was used to represent SCC-level annual emissions for all other remaining area source categories that included fugitive dust, commercial cooking, solvent use, forest and structural fires and petroleum project storage and transfer. A number of source categories within the Other Area Source sector from the NEI were estimated to have no emissions during episodic wintertime conditions. These "zeroed" wintertime source categories are listed below (with SCC codes in parentheses).

- Fugitive Dust, Paved Roads (2294000000)
- Fugitive Dust, Unpaved Roads (2296000000)
- Industrial Processes, Petroleum Refining, Asphalt Paving Materials (2306010000)
- Solvent Utilization, Surface Coating, Architectural Coatings (2401001000)

- Solvent Utilization, Miscellaneous Commercial, Asphalt Application (2461020000)
- Miscellaneous Area Sources, Other Combustion, Forest Wildfires (2810001000)
- Miscellaneous Area Sources, Other Combustion, Firefighting Training (2810035000)

Some of these source categories, notably those for fugitive dust and forest wildfires, have significant summer season (and annual average) emissions; however, emissions from these categories do not occur during winter conditions in Fairbanks when road and land surfaces are covered by snow and ice.

Finally, 2014 emissions from the Minor Stationary Source database and the NEI were backcasted to 2013 using historical year-to-year county-wide population estimates compiled by the Alaska Department of Labor and Workforce Development (ADLWD). The 2013-2014 population growth factor for Fairbanks from the historical ADLWD data was 1.013, reflecting a 1.3% increase from 2013 to 2014. Thus, emissions were backcasted to 2013 by dividing 2014 emissions by 1.013.

7.6.2.5 On-Road Mobile Sources

Emissions from on-road motor vehicles were developed within the 2013 Baseline modeling inventory using locally developed vehicle travel activity estimates and fleet characteristics as inputs to EPA's MOVES2014b vehicle emissions model. To support the gridded inventory structure and episodic (daily/hourly) emission estimates of the modeling inventory, MOVES2014b was used to generate detailed fleet emission rates and was combined with EPA's SMOKE-MOVES integration tool to pass the highly resolved and emission process-specific emission rates into input structures required by the SMOKE inventory pre-processing model.

For the 2013 Baseline inventory, MOVES inputs were based primarily on data gathered in support of the Fairbanks Metropolitan Area Transportation System (FMATS) 2045 Metropolitan Transportation Program (MTP). FMATS (now FAST Planning) is the Metropolitan Planning Organization (MPO) for the FNSB. Inputs were derived from local transportation modeling runs conducted to support the 2045 MTP, vehicle registration data, and other local data. The transportation and other vehicle activity data are discussed below. The remaining fleet characteristics and other MOVES inputs are summarized in Section III.D.7.14 and discussed in detail in Appendix III.D.7.6.

<u>Regional Travel Model Vehicle Activity</u> – Vehicle activity on the FMATS/FAST Planning transportation network was based on the TransCAD travel demand modeling performed for the 2045 MTP. The TransCAD modeling network covers the entire FNSB $PM_{2.5}$ nonattainment area and its major links extend beyond the nonattainment area boundary, as illustrated in Figure 7.6-13.

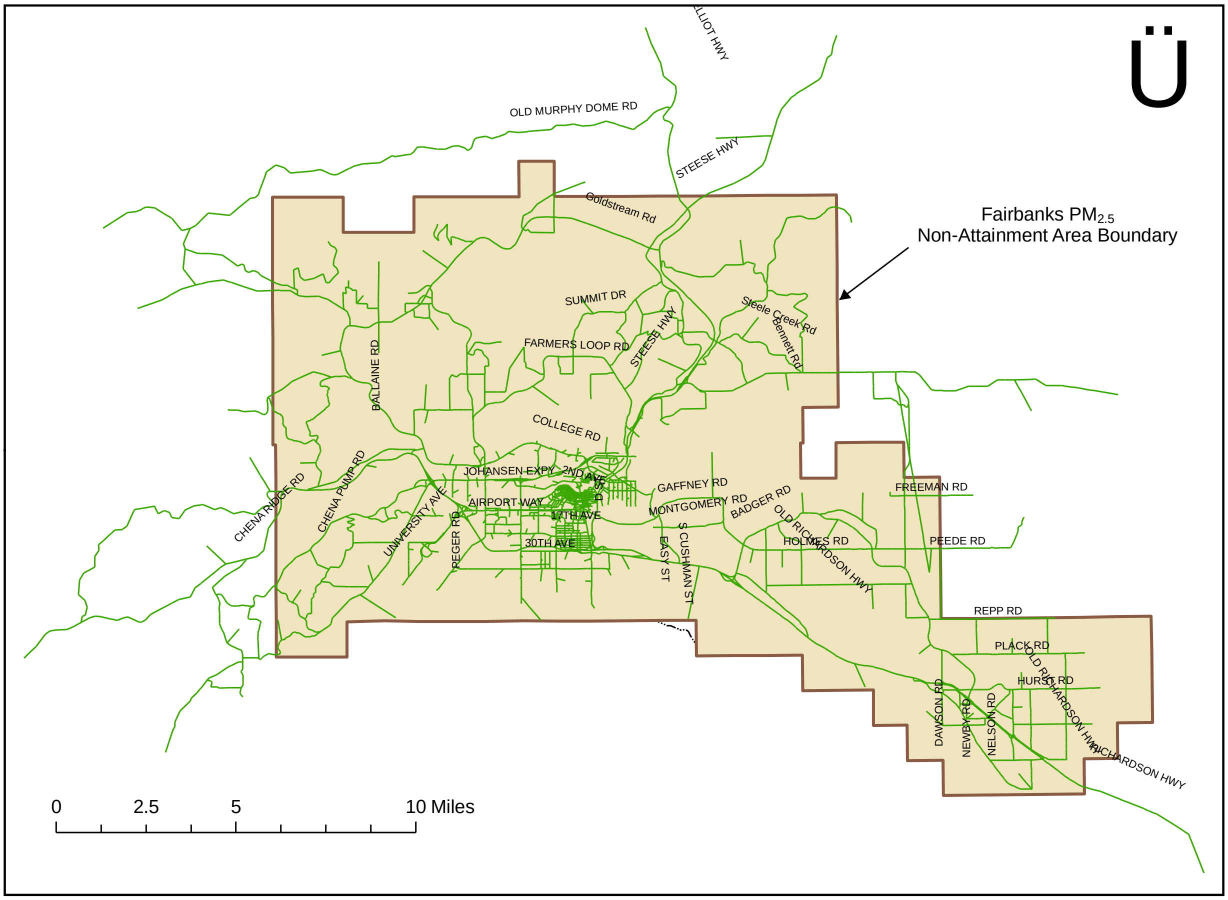


Figure 7.6-13. FMATS/FAST Planning TransCAD Modeling Network

TransCAD was configured using 2010 U.S. Census-based socioeconomic data. TransCAD modeling was performed for a 2013 base year and a projected 2045 horizon year. Projected population and household data relied on Census 2010 projections and a 1.1% annual growth rate in forecasted employment from 2010 to 2013 based on the information from the Institute of Social and Economic Research (ISER) at the University of Alaska, Anchorage.

Link-level TransCAD outputs were processed to develop several of the travel activity related inputs required by MOVES. Vehicle miles traveled (VMT) tabulated across the TransCAD network for the 2013 base year and 2045 forecast year are presented in Table 7.6-9.

Table 7.6-9
TransCAD Average Daily VMT by Analysis Year and Daily Period

Period / Vehicle Type	PM Nonattainment Area		
	2013	**2045**	**% Change**
Daily Period[a]			
AM Peak (AM)	205,465	320,515	56.0%
PM Peak (PM)	400,283	662,054	65.4%
Off-Peak (OP)	1,092,896	1,774,618	62.4%
Total Daily VMT	**1,698,644**	**2,757,187**	**62.3%**

Vehicle Activity Beyond FMATS/FAST Planning Network – The geographic extent of the FMATS/FAST Planning network covers a small portion of the entire Grid 3 attainment modeling domain. Traffic density in the broader Alaskan interior is likely to be less than that concentrated in the FNSB nonattainment area (and have less impact on ambient air quality in Fairbanks). Nevertheless, for completeness, link-level travel estimates for major roadways beyond the FMATS/Fast Planning network (and Fairbanks NA Area) were developed using a spatial (ArcGIS-compatible) "Road Centerline" polyline coverage for the Interior Alaska region developed by the Alaska Department of Transportation and Public Facilities (ADOT&PF). This GIS layer identified locations of major highway/arterial routes within the Grid 3 domain broken down into individual milepost (MP) segments.

These road centerline segments are shown in red in Figure 7.6-14 along with the smaller FMATS/FAST Planning link network (green lines) and the extent of the SIP Grid 3 modeling domain (blue rectangle). Annual average daily traffic volumes (AADT) and VMT (determined by multiplying volume by segment length) were assigned to each segment based on a spreadsheet database of calendar year 2013 traffic volume data compiled by ADOT&PF's Northern Region office. A Linear Reference System (LRS) approach was used to spatially assign volume and VMT data for each segment in the spreadsheet database to the links in the Road Centerline layer based on the route identifier number (CDS_NUM) and lineal milepost value.

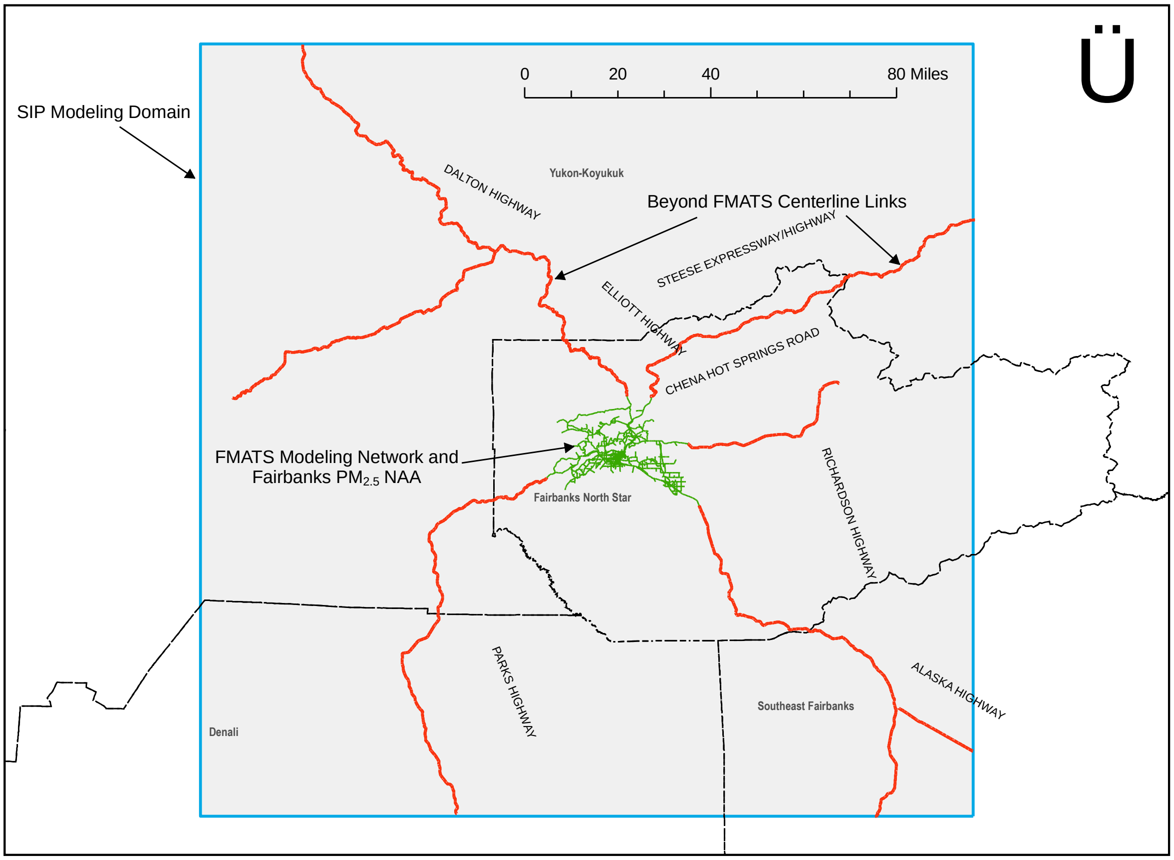


Figure 7.6-14. Additional ADOT&PF Roadway Links beyond FMATS/FAST Planning Network

Fleet Characteristics – Vehicle age distributions and fleet mix characteristics (e.g., Alternative Vehicle Fuel and Technology inputs) were developed using Alaska DMV registration data obtained in May 2014, coupled with earlier wintertime parking lot survey data collected by DEC to support the Moderate Area SIP. Multiple parking lots survey have consistently found that older vehicles are operated less in the FNSB area during winter due to drivability concerns associated with the arctic climate. The parking lot data were used to adjust the DMV-based age distributions for light-duty vehicles to reflect this lowered operation of older vehicles during winter. In developing the episodic inputs, motorcycles were also assumed to not operate during harsh winter conditions and their populations were zeroed out (consistent with the approach applied in the Moderate Area SIP.)

7.6.2.6 Non-Road Mobile Sources

Non-road sources encompass all mobile sources that are not on-road vehicles.[23] They include recreational and commercial off-road vehicles and equipment as well as aircraft, locomotives, recreational pleasure craft (boats) and marine vessels. (Neither commercial marine nor recreational vessel emissions are contained in the modeling inventory, as they do not operate in the arctic conditions experienced in the Fairbanks area modeling domain during the winter.)

MOVES2014b-Based – Non-road emissions were estimated using EPA's latest MOVES model, MOVES2014b (EPA integrated what used to be a standalone model for estimating non-road mobile source emissions, called NONROAD, into MOVES2014). According to EPA's MOVES release notes,[24] MOVES2014b contains significant improvements in estimating non-road emissions relative to its predecessor, MOVES2014a (On-road emissions are identical in MOVES2014a and MOVES2014b). The non-road emissions option within MOVES2014b was used to generate emissions from the following types of non-road vehicles and equipment:

- Recreational vehicles (e.g., all-terrain vehicles, off-road motorcycles, snowmobiles);
- Logging equipment (e.g., chain saws);
- Agricultural equipment (e.g., tractors);
- Commercial equipment (e.g., welders and compressors);
- Construction and mining equipment (e.g., graders and backhoes);
- Industrial equipment (e.g., forklifts and sweepers);
- Residential and commercial lawn and garden equipment (e.g., leaf and snow blowers);
- Locomotive support/railway maintenance equipment (but not locomotives); and
- Aircraft ground support equipment[2025] (but not aircraft).

It is important to note that none of these non-road vehicle and equipment types listed above were federally regulated until the mid-1990s. (As parenthetically indicated for the last two equipment categories in the list above, MOVES2014b estimates emissions of support equipment for the rail and air sectors, but emissions from locomotives and aircraft are not addressed by MOVES2014b and were calculated separately using other models/methods as described later within this subsection.)

Default equipment populations and activity levels in MOVES2014b are based on national averages, then scaled down to represent smaller geographic areas on the basis of human population and proximity to recreational, industrial, and commercial facilities. EPA recognizes the limitations inherent in this "top-down" approach, and realizes that locally generated inputs to

[23] Although recent versions of EPA's NEI inventories treat emissions for aircraft and supporting equipment and rail yard locomotive emissions as stationary sources, emissions from these sources were "traditionally" located within the Non-Road source sector. For consistency with the Moderate SIP, these sources are similarly grouped within the Non-Road sector.

[24] https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves

[25] Although MOVES2014b can be configured to also estimate emissions from airport ground support equipment (GSE), GSE emissions were estimated using the AEDT model as described later in this sub-section.

the model will increase the accuracy of the resulting output. Therefore, in cases where data were available (most notably snowmobiles and snow blowers), locally derived inputs that more accurately reflect the equipment population, growth rates, and wintertime activity levels in the Fairbanks nonattainment area were substituted for EPA's default input values.

Nonexistent Wintertime Activity – Due to the severe outdoor weather conditions present in the FNSB during the winter months, Fairbanks Borough staff determined that there is zero wintertime activity for a number of different equipment categories. Therefore, all activity and corresponding emissions for the following non-road equipment categories were removed from the episodic wintertime modeling inventory:

- Lawn and Garden;
- Agricultural Equipment;
- Logging Equipment;
- Pleasure Craft (i.e., personal watercraft, inboard and sterndrive motor boats);
- Selected Recreational Equipment (i.e., golf carts, ATVs, off-road motorcycles); and
- Commercial Equipment (i.e., generator sets, pressure washers, welders, pumps, A/C refrigeration units).

Locomotive Emissions – Emissions for two types of locomotive activity were included in the emission inventory:

1) *Line-Haul* – locomotive emissions along rail lines within the modeling domain (from Healy to Fairbanks and Fairbanks to Eielson Air Force Base); and

2) *Yard Switching* – locomotive emissions from train switching activities within the Fairbanks and Eielson rail yards.

Information on wintertime train activity (circa 2013) was obtained from the Alaska Railroad Corporation[26] (ARRC), the sole rail utility operating within the modeling domain, providing both passenger and freight service. These activity data were combined with locomotive emission factors published by EPA[27] to estimate rail emissions within the emission inventory.

Aircraft and Associated Airfield Emissions – Emissions were estimated from aircraft operations at three regional airfields within the modeling domain: (1) Fairbanks International Airport (FAI); (2) Fort Wainwright Army Post[28] (FBK); and (3) Eielson Air Force Base (EIL). The aircraft emissions were developed using the Federal Aviation Administration's (FAA) AEDT emissions model. AEDT considers the physical characteristics of each airport along with detailed meteorological and operations information in order to estimate the overall emissions of aircraft, ground support equipment (GSE), and auxiliary power units (APUs) at each airport.

[26] Email from Matthew Kelzenberg, Alaska Railroad Corporation to Alex Edwards, Alaska Department of Environmental Conservation, July 19, 2016.
[27] "Emission Factors for Locomotives," U.S. Environmental Protection Agency, Office of Transportation and Air Quality, EPA-420-F-09-025, April 2009.
[28] Formerly Ladd Air Force Base.

The AEDT model requires as input detailed information on landings and take-offs (LTO) for each aircraft type in order to assign GSE and estimate the associated emissions. Each LTO is assumed to comprise six distinct aircraft related emissions modes: startup, taxi out, take off, climb out, approach, and taxi in. The AEDT modeled defaults for time in mode and angle of climb out and approach were used for purposes of this analysis. In order to properly allocate aircraft emissions to each vertical layer of analysis (elevation above ground level), aircraft emissions were estimated for each mode and ascribed to a specific vertical layer.

Appendix III.D.7.6 provides detailed descriptions of the activity inputs, MOVES2014b, AEDT, and locomotive emission modeling used to generate emissions for the Non-Road sector of the modeling inventory.

7.6.2.7 Modeling and Planning Inventory Processing

Modeling Inventory Assembly and Pre-Processing – Emissions estimates across all sectors of the modeling inventory were generated at the SCC level and either directly gridded into the 1.3 km cells of the Grid 3 modeling domain (e.g., for point and space heating area sources) or assembled into spatial surrogate profiles for use within the SMOKE inventory pre-processing model.

For the three key source sectors (Point, Space Heating Area and On-Road Mobile), emissions were also temporally supplied to SMOKE on a day- and an hour-specific basis for each of the 35 historical days encompassing the two attainment modeling episodes. For the remaining two source sectors (Other Area and Non-Road Mobile), emissions were temporally supplied to SMOKE using SCC-specific monthly, day of week and diurnal profiles based on surrogates described in Appendix III.D.7.6.

Another key element in preparing the modeling inventory for processing in SMOKE consisted of the assignment of particulate matter (PM) speciation profiles to each source category (based on SCC code) in the inventory. These PM speciation profiles identify the distribution of share of each key PM component within overall direct $PM_{2.5}$ emissions and include primary organic carbon (POC), primary elemental carbon (PEC), primary sulfate (PSO_4), primary nitrate (PNO_3) and other primary (which represents all other remaining directly emitted $PM_{2.5}$ species).

With one exception, particulate matter and gaseous speciation profiles were based on EPA's SPECIATE database (circa June 2018) and 2014v7 modeling platform (which assigns profiles to specific SCC codes). The exception was the SCC codes for space heating emissions that were based on aforementioned OMNI Laboratory testing (see Table 7.6-8). For these SCC codes, speciated PM data collected by OMNI during the device testing were used since they were available and matched with the total PM emission factors developed from the testing.

Planning Inventory Processing – As explained earlier in Section 7.6.1.3, DEC has chosen to represent the seasonal planning inventory requirement for the 24-hour $PM_{2.5}$ NAAQS to be by the average of modeling episode day emissions. Thus the difference between modeling and planning inventory processing is that the planning inventory is averaged over the modeling episode days and represents emissions within the nonattainment area portion of the modeling domain, while the modeling inventory is spatially gridded over the entire domain and contains day and hour specific emissions.

7.6.2.8 2013 Baseline Emissions

2013 Baseline inventory emissions calculated using the data sources and methodologies summarized in the preceding paragraphs were tabulated by source sector and key subcategory and are presented as follows.

Table 7.6-10 shows 2013 Baseline emissions tabulated by source sector. (The Space Heating sector is further broken out into key fuel-specific subcategories.) Emissions are shown for both the entire Grid 3 modeling domain (Modeling Inventory) and the smaller $PM_{2.5}$ nonattainment area (Planning Inventory) and are presented on an average daily basis over the 35 episode days.

Table 7.6-10
2013 Baseline Episode Average Daily Emissions (tons/day) by Source Sector

	Modeling Inventory Grid 3 Domain Emissions (tons/day)					*Planning Inventory NA Area Emissions (tons/day)*				
Source Sector	**$PM_{2.5}$**	**NOx**	**SO_2**	**VOC**	**NH_3**	**$PM_{2.5}$**	**NOx**	**SO_2**	**VOC**	**NH_3**
Point Sources	1.24	10.57	7.40	0.23	0.051	1.23	10.45	7.22	0.23	0.051
Area, Space Heating	2.91	2.51	3.91	10.57	0.149	2.59	2.34	3.62	9.50	0.136
Area, Space Heat, Wood	2.74	0.46	0.09	10.34	0.102	2.43	0.40	0.08	9.29	0.091
Area, Space Heat, Oil	0.07	1.83	3.68	0.10	0.004	0.06	1.72	3.42	0.10	0.003
Area, Space Heat, Coal	0.10	0.06	0.11	0.12	0.015	0.08	0.05	0.10	0.11	0.013
Area, Space Heat, Other	0.01	0.16	0.02	0.01	0.028	0.01	0.16	0.02	0.01	0.028
Area, Other	0.22	1.75	0.04	2.36	0.046	0.22	1.72	0.03	2.27	0.045
On-Road Mobile	0.32	4.11	0.02	4.90	0.067	0.27	3.36	0.02	4.07	0.054
Non-Road Mobile	0.47	2.11	11.67	9.31	0.002	0.15	0.86	6.10	0.41	0.000
TOTALS	**5.16**	**21.05**	**23.04**	**27.37**	**0.316**	**4.46**	**18.73**	**17.00**	**16.48**	**0.286**

As seen in Table 7.6-10, directly-emitted $PM_{2.5}$ in the 2013 Baseline inventory is dominated by space heating emissions and almost entirely from wood-burning devices. Within the nonattainment area, wood-burning space heating contributes 2.43 tons/day of the total 4.36 tons/day of direct $PM_{2.5}$ from all sources, which is about 56%. For the gaseous precursor pollutants, point sources are the major contributors of NOx and SO_2 emissions. Most VOC and NH_3 emissions are produced by wood-burning space heating, with other contributions from mobile sources.

(Detailed tabulations of 2013 Baseline inventory emissions by SCC code are contained in Appendix III.D.7.6, including separate tabulations of filterable and condensable $PM_{2.5}$ components.)

To provide a clearer picture of the relative emissions contributions of each source sector, Figure 7.6-15 through Figure 7.6-19 provide “pie chart” breakdowns (as a percentage of total emissions) for $PM_{2.5}$, SO_2, NO_x, VOC, and NH_3 emissions, respectively, within the nonattainment area. (The breakdowns are similar for the larger Grid 3 domain and thus are not shown).

As seen in Figure 7.6-15, space heating dominates episodic emissions of $PM_{2.5}$, representing roughly 59% of total $PM_{2.5}$ emitted within the nonattainment area. As noted above, wood-burning alone contributes nearly 56% to total $PM_{2.5}$. Point sources and on-road vehicles comprise 28% and 6% of total $PM_{2.5}$, respectively. All other area sources and non-road mobile sources combined encompass under 7%.

As shown in Figure 7.6-16 through Figure 7.6-19, the predominant source category for each gaseous precursor pollutant varies. Emissions of SO_2 largely come from point sources and secondarily from oil-burning heating devices. Point sources are the major contributors of episodic NO_x, while wood-burning space heating is the largest source of VOC and NH_3.

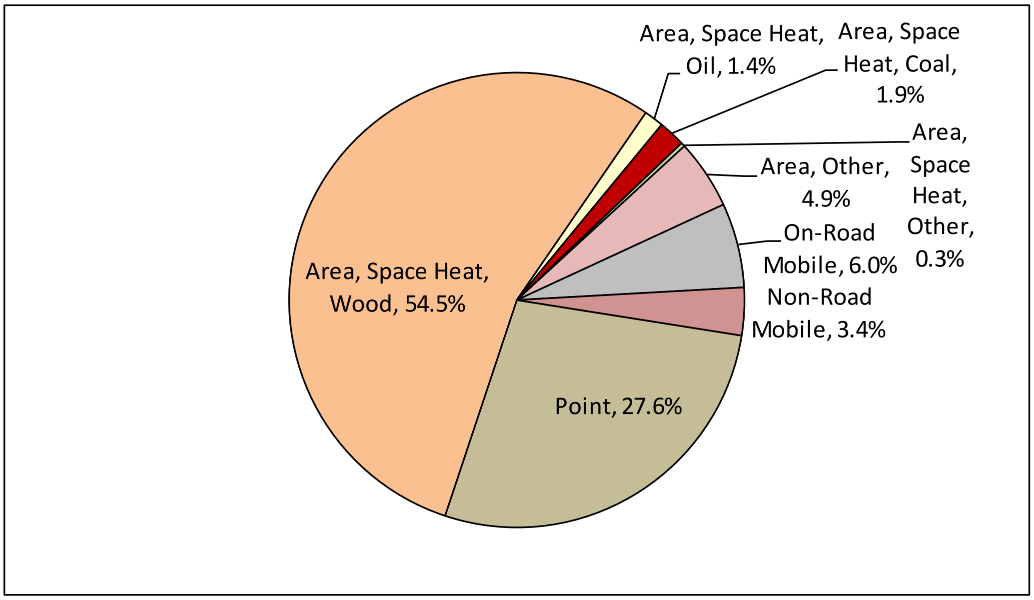


Figure 7.6-15. 2013 Baseline Episodic Nonattainment Area Emissions, Relative $PM_{2.5}$ Contributions (%)

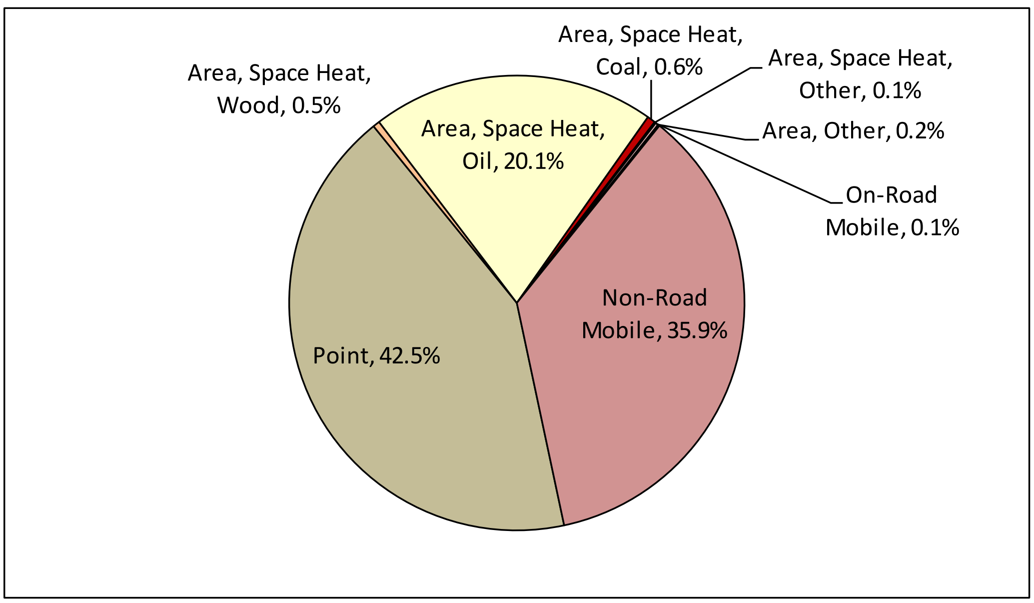


Figure 7.6-16. 2013 Baseline Episodic Nonattainment Area Emissions, Relative SO_2 Contributions (%)

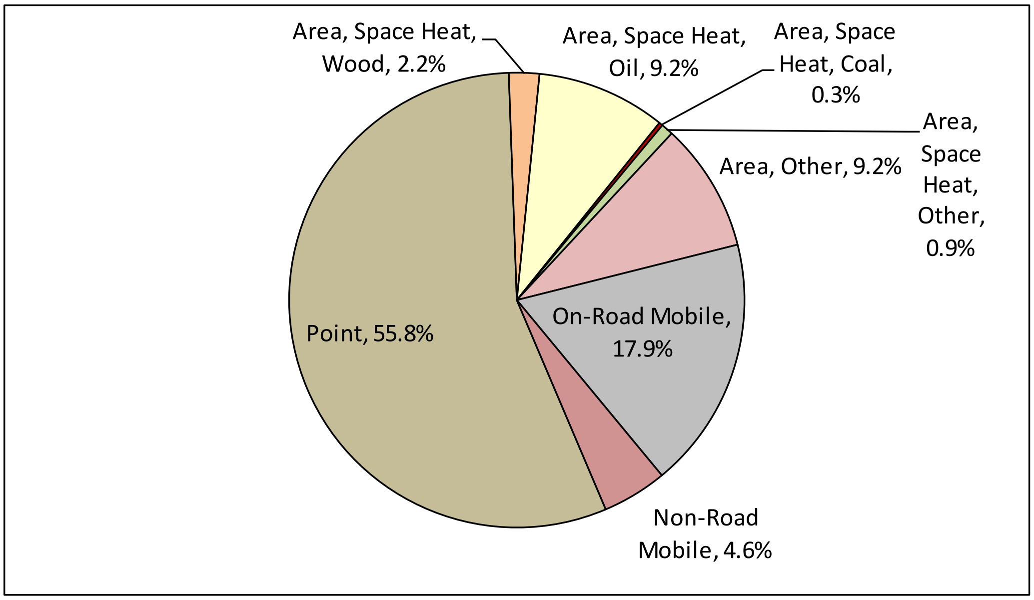


Figure 7.6-17. 2013 Baseline Episodic Nonattainment Area Emissions, Relative NO_x Contributions (%)

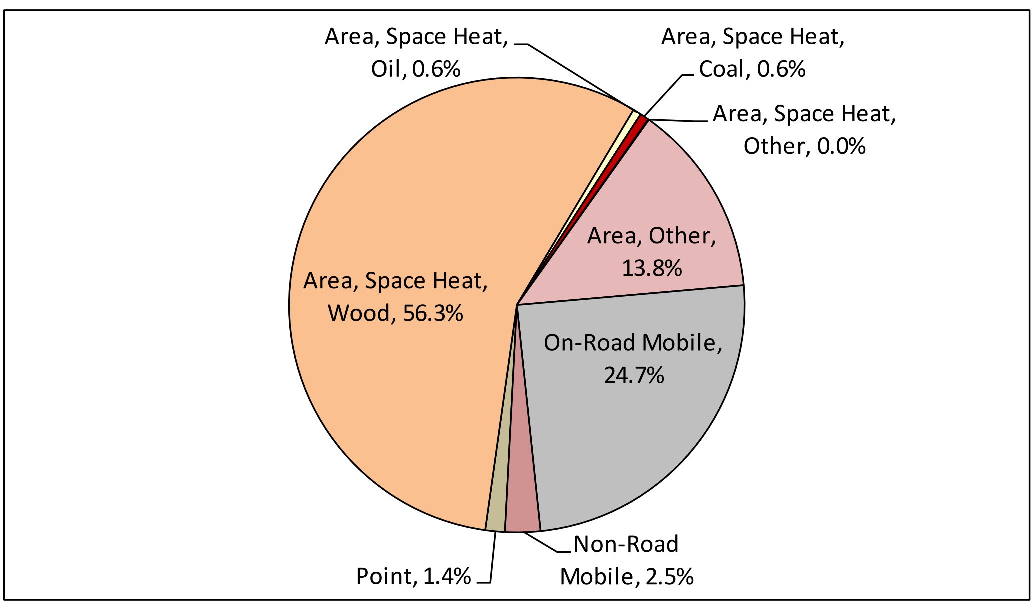


Figure 7.6-18. 2013 Baseline Episodic Nonattainment Area Emissions, Relative VOC Contributions (%)

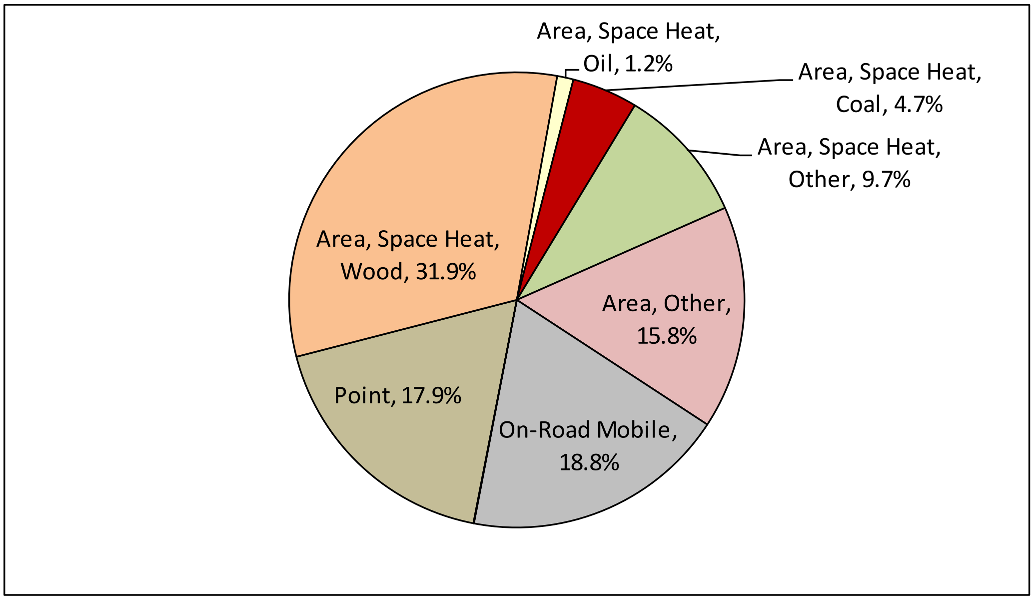


Figure 7.6-19. 2013 Baseline Episodic Nonattainment Area Emissions, Relative NH_3 Contributions (%)

Finally, Figure 7.6-20 through Figure 7.6-24 illustrate how $PM_{2.5}$ emissions under episodic wintertime conditions are spatially distributed across the nonattainment area and immediate surrounding region. In each figure, the density or amount of emissions within each 1.3 km grid cell is depicted using color shaded intervals shown on the legend of each plot. White and dark green cells represent regions of little or no emissions, ramping up through yellow and orange to red, which identifies cells with the highest $PM_{2.5}$ emissions. The emission units used are pounds (lb) per day and represent averaged values across all 35 modeling episode days.

First, Figure 7.6-20 presents the spatial emissions distribution for all inventory sources within each grid cell. Figure 7.6-21 through Figure 7.6-24 then show individual distributions for each source sector (using some aggregation of earlier tabulations and plots) as follows:

- Figure 7.6-21 – Space Heating sources;
- Figure 7.6-22 – Point sources;
- Figure 7.6-23 – On-Road Mobile sources; and
- Figure 7.6-24 – Other Area and Non-Road mobile sources.

The same color-shaded emission density intervals are used across both the “all sources” and individual source sector plots to visually identify both the areas where modeled emissions are highest as well as indicate which source sector(s) contribute to total emissions in those grid cells.

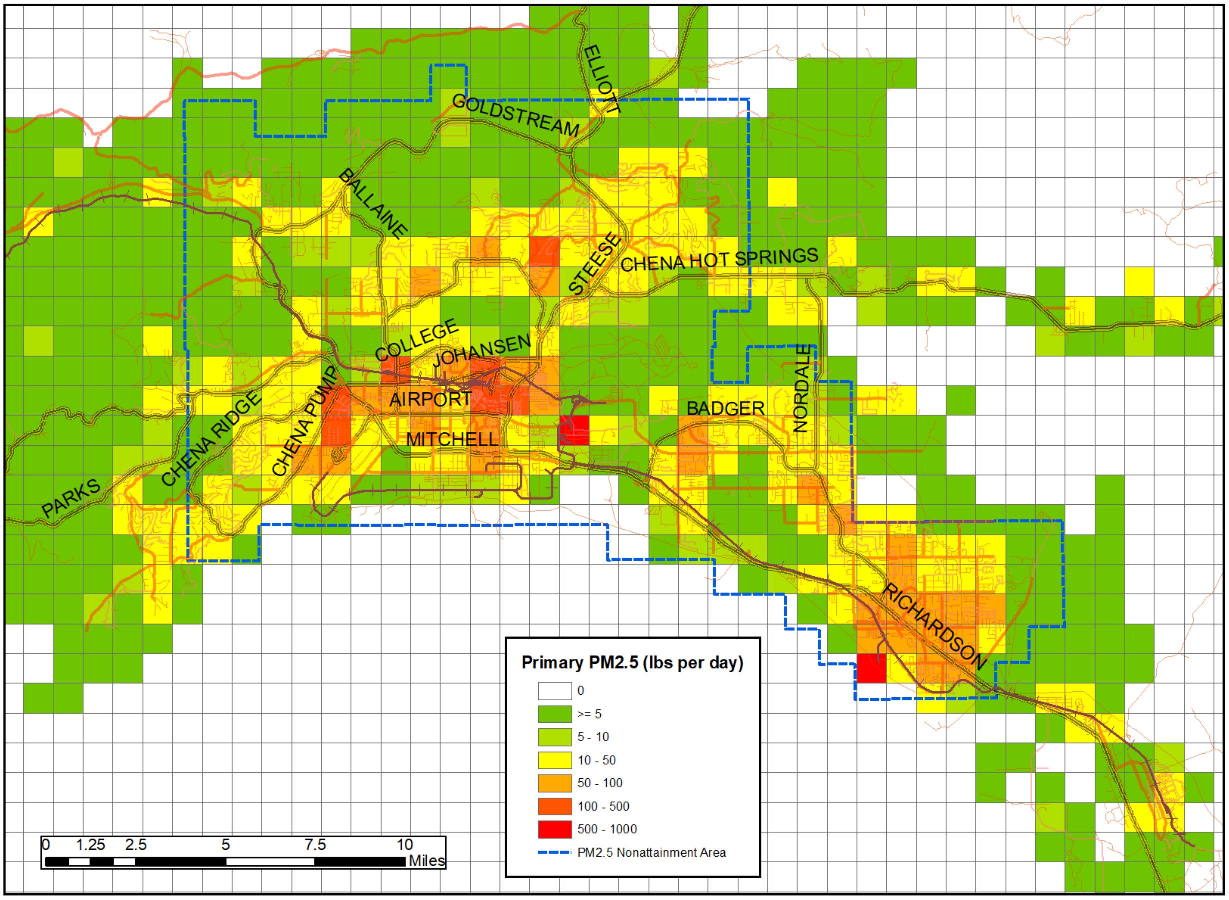


Figure 7.6-20. 2013 Baseline Gridded $PM_{2.5}$ Emissions, All Sources

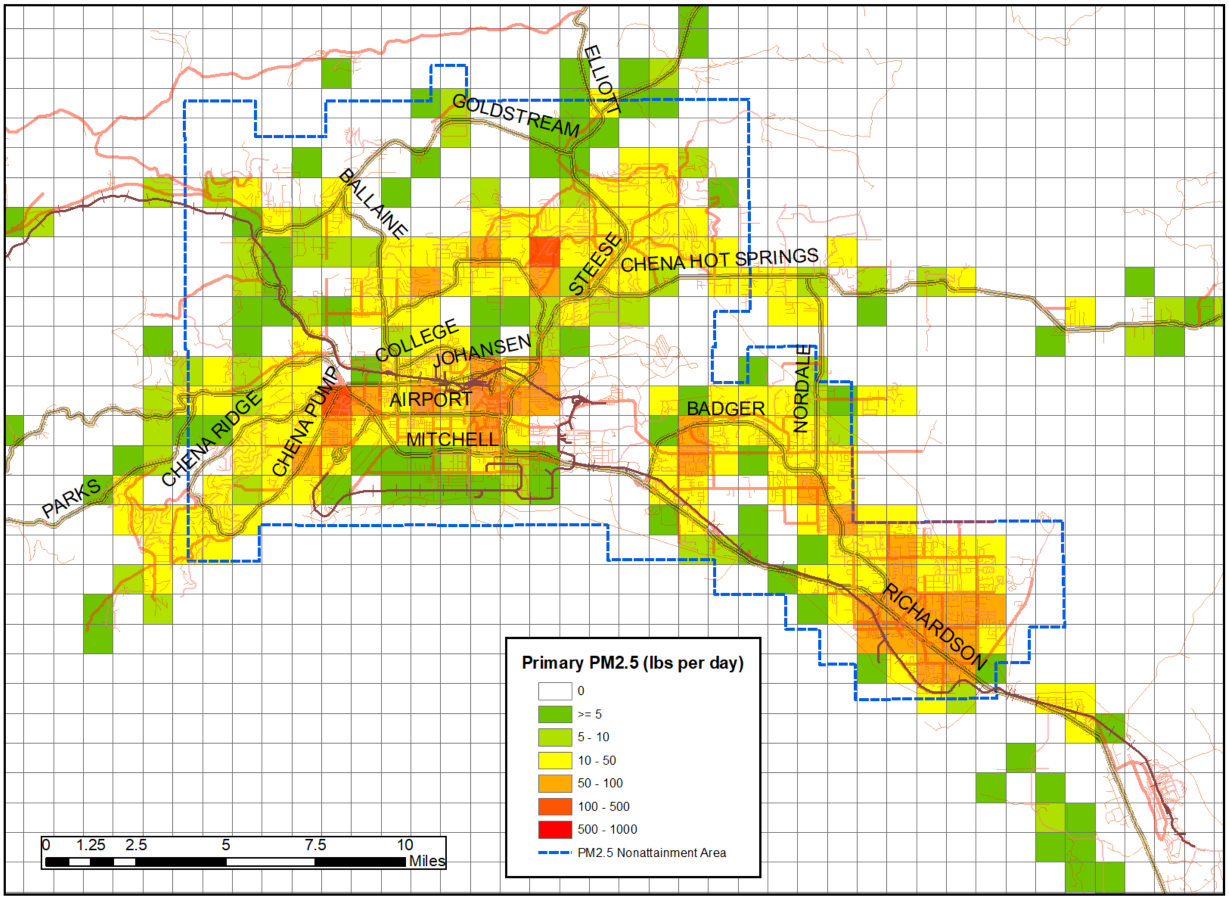


Figure 7.6-21. 2013 Baseline Gridded $PM_{2.5}$ Emissions, Space Heating Sources

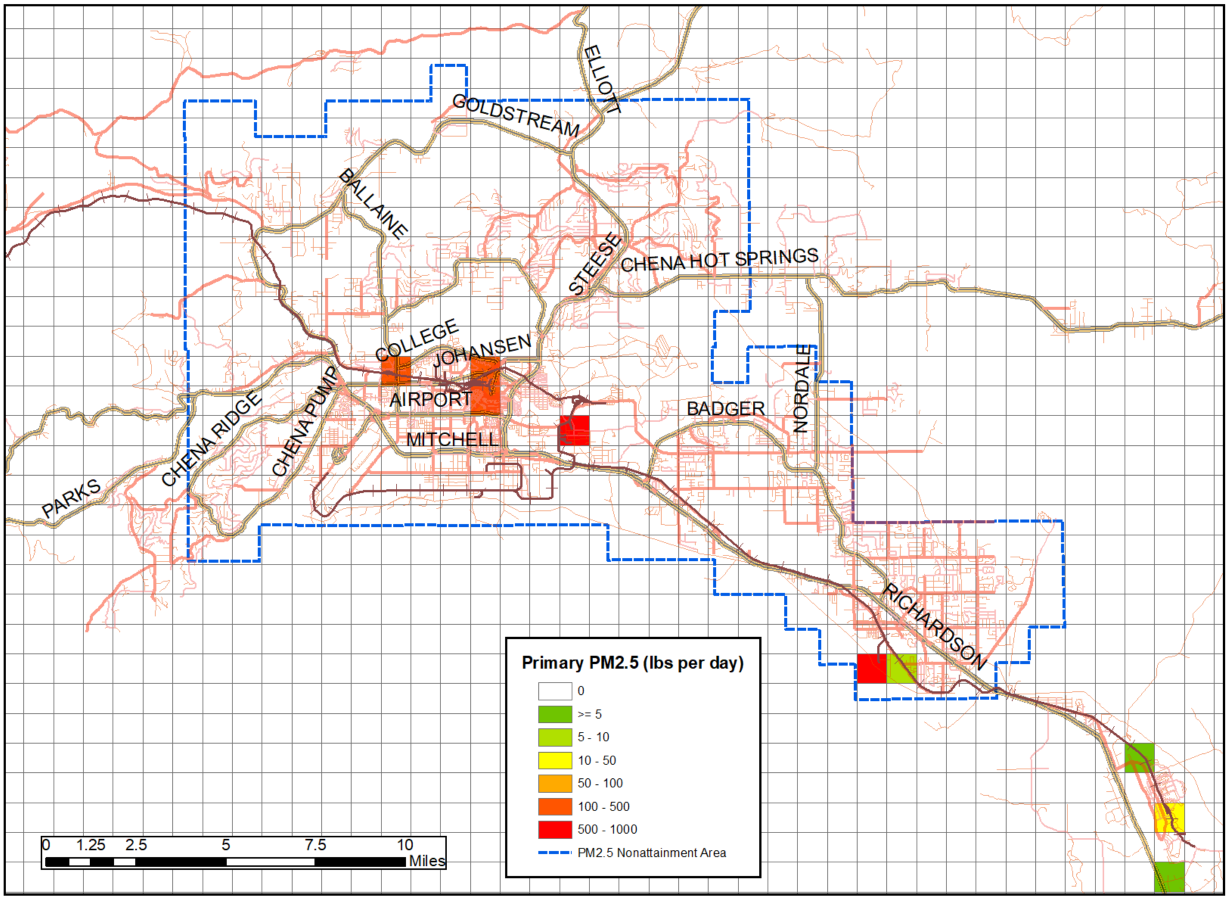


Figure 7.6-22. 2013 Baseline Gridded $PM_{2.5}$ Emissions, Point Sources

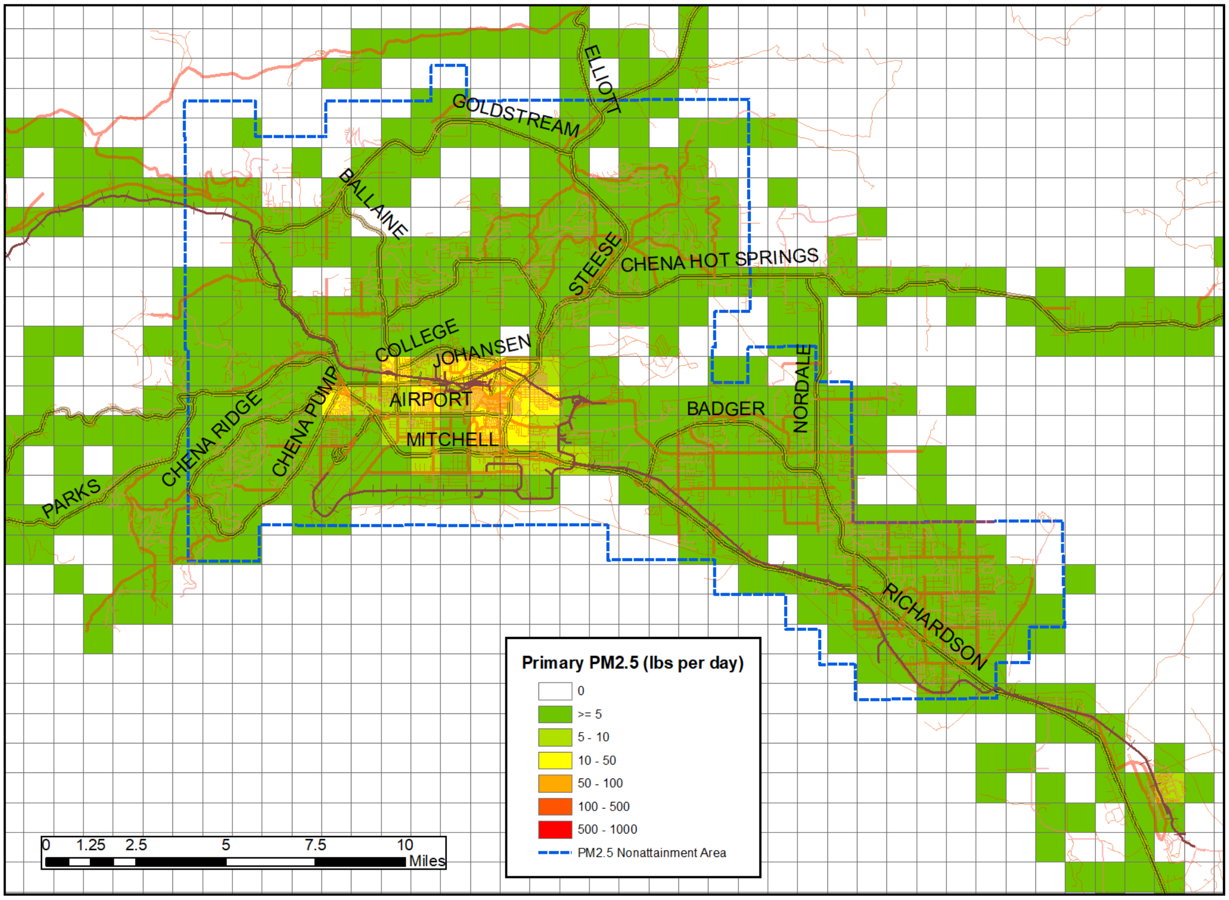


Figure 7.6-23. 2013 Baseline Gridded $PM_{2.5}$ Emissions, On-Road Sources

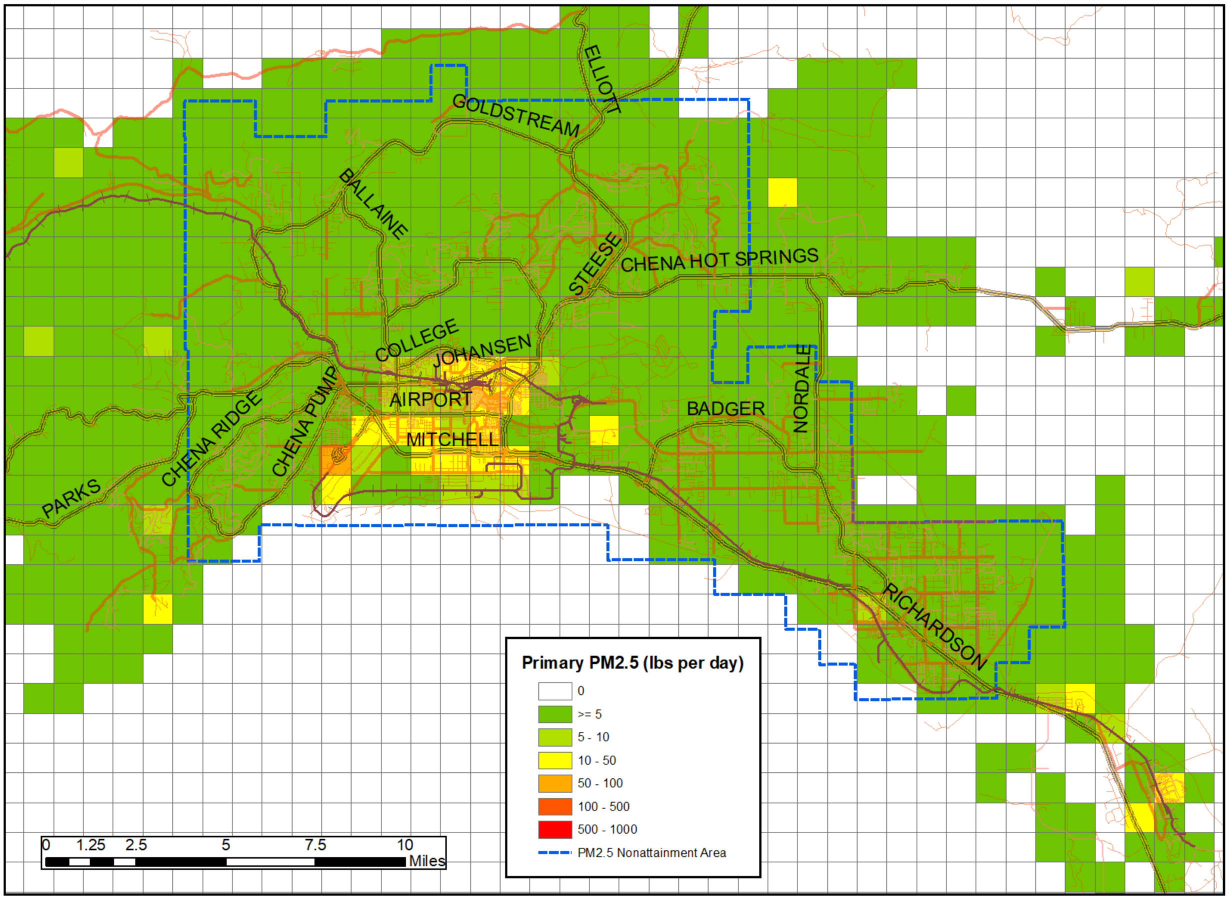


Figure 7.6-24. 2013 Baseline Gridded $PM_{2.5}$ Emissions, Other Area and Non-Road Sources

7.6.3. Projected Baseline Inventories

Projected Baseline inventories for applicable calendar years beyond the 2013 Baseline were not based on historically collected source activity data, but were projected forward to those years based on forecasted source activity growth coupled with changes in emission factors due to already adopted federal, State, and local control measures that existed prior to the development of this Serious SIP. As noted earlier, effects of adopted controls within the project baseline inventories reflect measures and data collection based emission benefits accumulated through calendar year 2016 for consistency with the earlier Moderate SIP, which was approved by EPA in September 2017. In inventory development, the effects of controls are included up to the year prior to the inventory projection year of interest. For consistency with the Moderate SIP 2017 approval, this means that on-going control program benefits through calendar year 2016 are part of the projected baseline.

Control or attainment analysis/demonstration inventories then include additional emission reductions from measures to be implemented under this Serious SIP or from on-going control programs for which emission benefits continued to accumulate after the end of calendar year

2016 (the "anchor point" to the Moderate SIP). Control inventories are discussed later in Section 7.6.4.

7.6.3.1 Emissions Projection Methodology

Growth Factors – Levels of projected source activity growth can vary depending upon the type of source category. A series of growth factors were assembled from several sources for use in forecasting the activity component of 2013 baseline emissions forward to 2019 and through 2032.[29] Table 7.6-11 below summarizes the growth rates applied to project activity by source sector and the sources or assumptions upon which they were based.

Table 7.6-11
Summary of Growth Rates Applied in Projected Baseline Inventories

Source Type/Group	Growth Rate Source/Assumptions	Annual Growth Rate (% per year)	
		2013-2019	2019-2024
Point	Population growth rates from ADOT/Kittelson socio-economic forecasts for 2045 MTP (nonattainment area avg.)	0.9%	1.6%o
Area, Space Heating	Housing Unit growth rates from ADOT/Kittelson socio-economic forecasts for 2045 MTP (by grid cell)	0.9% domain average	1.7% domain average
Area, Other	Employment growth rates from ADOT/Kittelson socio-economic forecasts for 2045 MTP (nonattainment area avg.)	1.2%	1.4%
Mobile, On-Road	Population growth rates from ADOT/Kittelson socio-economic forecasts for 2045 MTP (nonattainment area avg.) Population growth rates for other counties in modeling domain from county-level forecasts developed by Alaska Department of Labor and Workforce Development	FNSB: 0.9% Denali: -0.2% SE Fbks: 0.1% Ykn-Kyk: -1.0%	FNSB: 1.6% Denali: -0.4% SE Fbks: 0.7% Ykn-Kyk: -0.8%
Mobile, Non-Road Equip.	Population growth rates from ADOT/Kittelson socio-economic forecasts for 2045 MTP for FNSB Population growth rates for other counties in modeling domain from county-level forecasts developed by Alaska Department of Labor and Workforce Development	FNSB: 0.9% Denali: -0.2% SE Fbks: 0.1% Ykn-Kyk: -1.0%	FNSB: 1.6% Denali: -0.4% SE Fbks: 0.7% Ykn-Kyk: -0.8%
Mobile, Rail	Assumed held constant at 2013 levels, based on discussions with local rail and airport personnel	Zero	Zero
Mobile, Aircraft	Assumed constant at 2013 levels for Fairbanks International Base-specific forecasts provided by Eielson and Ft. Wainwright	FAI: 1.2% Eielson: 145%[a] Wainwright: 0%	FAI: 1.2% Eielson: 71%[b] Wainwright: 0%

[a] Reflects anomalously low Eielson airfield activity in 2013, coupled with 2019 activity estimated from annual average of recorded 2015-2018 flights at Eielson.
[b] Reflects F-35 fighter jet squadron deployment starting in 2020 and phasing in through 2022.

The Alaska Department of Transportation and Public Facilities (ADOT)/Kittelson forecasts[30] listed for a number of sectors in Table 7.6-11 were developed to support the 2045 MTP. They

[29] Although the Serious SIP horizon is 2024, source activity projections were developed through calendar year 2032 to evaluate an alternative expeditious attainment date and reasonable further progress around that alternative date as described later in Sections III.D.7.9 and III.D.7.10.
[30] Mike Aronson and Anias Malinge, Kittelson & Associates memorandum to ADOT&PF, November 22, 2017.

represent the latest projects of population, housing unit and employment growth across the Fairbanks North Star Borough. Most importantly, they include projected population growth associated with the F-35 deployment at Eielson slated to begin in 2019 (with airfield activity increasing starting in 2020). They were developed by traffic analysis zone (TAZ) and allocated to the 1.3 km modeling grid cells.

The ADOT/Kittelson socio-economic forecasts were only available within the Fairbanks North Star Borough. As noted in Table 7.6-11, county-level population forecasts from the Alaska Department of Labor and Workforce Development[31] were utilized to represent growth for mobile sources (except rail and aircraft).

Rail activity was assumed to be constant at 2013 levels. Aircraft activity growth rates (i.e., changes in landing and takeoff (LTO) cycles) were airfield specific. Fairbanks International Airport (FAI) activity was projected to increase at a constant rate of 1.2% per year from 2013 levels based on the long-term growth rate in the FAI Master Plan.[32] For the military bases, airfield-specific growth projections by aircraft type were provided by Eielson and Fort Wainwright representatives. Fort Wainwright anticipated no long-term growth. As indicated by footnotes in Table 7.6-11, Eielson's significant increase in aircraft flights relative to 2013 was the result of two factors:

1. *Anomalously Low 2013 Activity* – A review of historical annual flight data collected by the Federal Aviation Administration (FAA)[33] from 2010 through 2018 indicated that airfield LTOs at Eielson in 2013 were well below levels recorded in other surrounding years. Annual flight counts at Eielson averaged from 2015-2018 were found to be 145% higher than 2013 flights and applied in projecting Eielson activity from 2013 to 2019, given that flights in 2013 were anomalously low.

2. *Increase from F-35 Fighter Jet Activity* – F-35 flights are scheduled to begin in 2020 and increase through 2022, then remain constant in 2023 and later years. The new F-35 operations are projected to increase total flights at Eielson by 71% from 2019 through 2024.

The historical FAA flight data were also reviewed for the other two airfields, Fairbanks International and Fort Wainwright. Their 2013 flights were found to be within 10% of the surrounding six-year averages. Thus no "anomalous year" adjustments were applied for activity at these airfields in projecting from their 2013 levels.

Existing Controls – Effects of emission controls from adopted control programs (that reduce unit emission factors for specific source categories in future years) were also accounted for in the projected baseline inventories. As noted earlier, only those control programs that reflect on-

[31] http://live.laborstats.alaska.gov/pop/projections.cfm, as of June 2018.

[32] "FAI Master Plan Project, Chapter 3 Aviation Forecasts," prepared by PDC Inc. Engineers for the Alaska Department of Transportation and Public Facilities, December 2014 (Final).

[33] Federal Aviation Administration, Traffic Flow Management System Counts, downloaded on September 12, 2019 from https://aspm.faa.gov/tfms/sys/Airport.asp.

going emission reductions or were adopted under the Moderate SIP for which data-driven benefits were determined through 2016 and were included in the Projected Baseline inventories. These key control programs[34] and how they were modeled are listed below:

- *On-Road Vehicles* – Effects of the on-going federal Motor Vehicle Control Program and Tier 3 fuel standards, coupled with Alaska Ultra Low Sulfur Diesel standards were accounted for within EPA's MOVES2014b model.

- *Non-Road Vehicles and Equipment* – Effect of federal fuel and Alaska ULSD programs for non-road fuel were modeled using EPA's MOVES2014b model.

- *Wood Stove Change Out Program (2013-2016)* – Data collected by the Fairbanks North Star Borough on closed/completed transactions under the on-going Wood Stove Change Out (WSCO) Program from 2013 through 2016 were analyzed to develop estimates of emission reduction per transaction and summed over this period to account for WSCO reductions between the 2013 Baseline and the anchor point to the Moderate SIP.

- *Solid Fuel Burning Curtailment Program (2016)* – The Fairbanks Borough adopted and operated an episodic Solid Fuel Burning Appliance and Curtailment Program since winter 2015-2016. It was treated as a new measure within the Control inventories under the Moderate SIP. Under this Serious SIP, its benefits, reflecting the design of the program and its operation as of the end of 2016, are now accounted for as existing controls within the Projected Baseline inventories. At that time, the Curtailment Program operated with three alert stage levels. Stage 1 was voluntary. Stage 2 (35 µg/m^3) and Stage 3 (55 µg/m^3) required cessation of burning from specific types of solid fuel devices as follows:

    - Stage 2 - Burning was permitted in all EPA-certified SFBAs, EPA Phase II qualified hydronic heaters with emission ratings of 2.5 g/hour or less, masonry heaters, pellet-fueled appliances cook stoves and fireplaces. Burning was prohibited from all other devices including non EPA certified devices and waste oil devices.
    - Stage 3, Ambient Temperature ≥ 15°F - Burning was prohibited in all SFBAs, masonry heaters, pellet-fueled appliances, cook stoves, fireplaces and waste oil devices.
    - Stage 3, Ambient Temperature < 15°F - Burning was permitted in EPA-certified SFBAs, EPA Phase II qualified hydronic heaters with emission ratings of 2.5 g/hour or less, masonry heaters and pellet-fueled appliances. (Fireplaces were prohibited from operating under Stage 3 with temperatures < -15°F.)

  Consistent with the Moderate SIP, the Curtailment Program as of the end of 2016 had an estimated compliance rate of 20%.

[34] Effects of other state and local control measures listed in the Moderate SIP for which benefits were quantified were implicitly included in the "pre-control" Projected Baseline emissions.

Other Adjustments – Beyond the application of activity growth factors and accounting for effects of existing controls from the approved Moderate SIP, four other adjustments were applied in developing Projected Baseline inventories and are summarized separately below.

Point Source Projections/Fuel Switch Effects – As explained earlier in Section 7.6.2.2, annual emissions data from each point source facility in calendar years 2008 and 2013 were used to scale/update episodic emissions to 2013. DEC also assembled annual emissions from each facility for calendar years 2014 and 2015 and additionally for the two GVEA facilities (North Pole and Zehnder) in 2016 from their permits database to address changes in activity and emissions within the Point Source sector that could not be accounted for simply with population growth factors.

Emissions for 2015 based on annual emissions for each facility were similarly scaled from the 2008 episodic data as was done for 2013 in the Baseline inventory. The reasons for this were twofold: 1) several facilities exhibited variations in annual emissions between 2013 and 2015 that were both upward and downward and outside the range of the modest population growth factors; and 2) Flint Hills shutdown its refinery operations during 2014, so reported annual emissions through 2015 were reviewed to confirm this.

Although annual emissions changes for most facilities from 2013-2015 were typically within ±10%, there were much greater swings for Flint Hills and the GVEA facilities triggered by the refinery shutdown. As noted earlier, both GVEA facilities have historically burned HAGO in their turbines, a heavy distillate fuel produced by the nearby Flint Hills Refinery. With the refinery shutdown, HAGO was no longer produced and the GVEA facilities switched their turbine fuel to lighter and cleaner distillate oil (mostly #2 distillate).

In reviewing the reported 2015 emissions data for GVEA (available by individual emission unit), it was noted that HAGO was still being burned during that year, likely reflecting on-site storage of HAGO that was still in use after 2014. As a result, reported annual 2016 emissions data for the two GVEA facilities were obtained to confirm HAGO use ended in 2015 and to represent "post-HAGO" emissions at these facilities going forward. Annual $PM_{2.5}$ emissions dropped by 96% and 65% at GVEA North Pole and GVEA Zehnder, respectively from 2013 to 2016, largely due to the switch from HAGO triggered by the Flint Hills Refinery shutdown.

Thus for all facilities except the GVEA facilities, projected baseline emissions were based on actual 2015 emissions with population based growth factors relative to 2015. For the GVEA facilities growth factor projections were applied to 2016 actual emissions to fully reflect post-HAGO fuel use.

Wood vs. Oil Cross-Price Elasticity – A postcard (rather than telephone) survey was conducted in 2016 to assess whether large drops in heating oil prices from 2013 to 2015 had any impact on wood use. Unlike the earlier telephone-based surveys under which a random sample was drawn from all residents in the nonattainment area, the 2016 Postcard survey targeted household respondents who had participated in the 2014 and 2015 HH surveys. Use of a postcard survey instrument enabled respondents to more thoughtfully collect and estimate wood and heating oil usage data for winter 2015-2016 space heating that could be directly compared to similar data for the same set of households as sampled in the earlier 2014 and 2015 surveys. An analysis directed by DEC[35] found that winter season residential wood use dropped 30% on average in the 2016 survey for the same set of households sampled in the 2014 and 2015 surveys, and that most of this drop could not be explained by differences in heating demand due to year-to-year variations in winter temperatures.

DEC's Staff Economist then coordinated a study by University of Alaska Fairbanks[36] that evaluated the 2016 Postcard data to determine if a cross-price elasticity could be quantified between wood use and heating oil use and prices in Fairbanks. That economic study found a median cross-price elasticity between wood and heating oil of -0.318, meaning wood use drops by 0.318% for every 1% decrease in the price of heating oil. This wood vs. cross-price elasticity was then used to estimate changes in wood vs. oil use in projected baseline inventories relative to the difference between the forecasted oil price in the projection year vs. the 2013 Baseline.

Historical heating oil prices in Fairbanks were available through calendar year 2017 from the Fairbanks Community Research Quarterly published by the Fairbanks Borough Planning Department. Heating oil prices for 2019 and later projected baselines were forecasted from the actual 2017 price based on forecasted changes in heating oil prices for the Pacific Region between 2017 and the projected baseline year published by the U.S. Energy Information Administration (EIA) in their 2018 Annual Energy Outlook (AEO).

For the 2019 Projected Baseline, the forecasted heating oil price in Fairbanks was $2.89 per gallon using this approach, and the 2013 price (averaged over the 2011-2015 period corresponding to the five-year HH survey period) was $3.60 per gallon. A projected decrease in wood use from 2013 to 2019 of 6.3% was calculated as follows based on these oil prices and the cross-price elasticity of -0.318:

$$\textit{Wood Use Change}_{2013\text{-}2019} = -0.318 \times (1 - \$2.89/\$3.60) = -6.3\%$$

Turnover of Uncertified Devices – Under the Moderate SIP it was estimated that turnover or replacement of uncertified wood burning devices with new EPA-certified devices occurred both through and separate from the WSCO Program. That estimate was based on HH survey data that was only available through the 2011 survey. Since the WSCO program began in July 2010, there was little overlap between trends established from the HH surveys (dating back to 2006 and extrapolated beyond 2011) and the available WSCO Program change outs/transactions. With the data available at the time of the Moderate SIP development, it was then estimated that there was a downward trend in uncertified wood devices (reflecting replacement with EPA-certified devices) that was separate and distinct from that attributed to the WSCO Program.

35 T. Carlson, M. Lombardo, Sierra Research, R. Crawford, Rincon Ranch Consulting memorandum to Cindy Heil, Alaska Department of Environmental Conservation, January 17, 2017.

36 "Estimating FNSB Home Heating Elasticities of Demand using the Proportionally-Calibrated Almost Idea Demand System (PCAIDS) Model: Postcard Data Analysis," prepared by the Alaska Department of Environmental Conservation in collaboration with the University of Alaska Fairbanks Master of Science Program in Resource and Applied Economics, December 10, 2018.

Under this Serious SIP, additional years of HH survey data (2012-2015) and WSCO Program data (through calendar year 2016) were analyzed. Over the broader 5½-year period of overlap between the HH surveys and WSCO Program activity data now available, it was found that very little uncertified device turnover likely occurs outside the WSCO Program. What was termed "natural turnover" of uncertified devices estimated to occur outside of the WSCO Program under the Moderate SIP was found to be difficult to separately quantify based on comparisons of HH survey trends and WSCO Program activity and is likely negligible. Therefore no "natural turnover" of uncertified devices outside the WSCO Program was assumed for the Serious SIP Projected Baseline inventories. The downward trend in uncertified devices seen in the HH surveys through 2015 was attributed entirely to the on-going WSCO Program.

Appendix III.D.7.6 contains further information on the calculations behind these other adjustments.

7.6.3.2 2019 Projected Baseline Emission Inventory

Using the projected activity growth factors, emission factors representing effects of existing source control programs and other adjustments to point sources and wood usage as summarized in the preceding sub-section, a projected baseline inventory was developed for 2019, the statutorily-required attainment year for the Serious SIP.

Table 7.6-12 presents a sector-level summary of the 2019 Projected Baseline modeling and planning inventories. (Appendix III.D.7.6 contains detailed SCC-level emissions for the 2019 Projected Baseline inventories and includes separate tabulations of filterable and condensable $PM_{2.5}$ components.) And Table 7.6-13 provides sector- and pollutant-specific comparisons of the relative changes in emissions between the 2013 Baseline and the 2019 Projected Baseline inventories (both modeling and planning versions).

Table 7.6-12
2019 Projected Baseline Episode Average Daily Emissions (tons/day) by Source Sector

	Modeling Inventory Grid 3 Domain Emissions (tons/day)					*Planning Inventory NA Area Emissions (tons/day)*				
Source Sector	**$PM_{2.5}$**	**NOx**	**SO_2**	**VOC**	**NH_3**	**$PM_{2.5}$**	**NOx**	**SO_2**	**VOC**	**NH_3**
Point Sources	0.84	10.76	7.32	0.09	0.020	0.83	10.63	7.13	0.09	0.020
Area, Space Heating	2.55	2.62	4.16	9.58	0.145	2.24	2.44	3.85	8.62	0.132
Area, Space Heat, Wood	2.37	0.45	0.13	9.34	0.096	2.08	0.40	0.12	8.40	0.086
Area, Space Heat, Oil	0.07	1.95	3.90	0.11	0.004	0.07	1.83	3.61	0.10	0.004
Area, Space Heat, Coal	0.09	0.06	0.11	0.12	0.016	0.08	0.05	0.09	0.11	0.014
Area, Space Heat, Other	0.01	0.17	0.02	0.01	0.029	0.01	0.17	0.02	0.01	0.029
Area, Other	0.21	0.25	0.02	2.44	0.050	0.20	0.25	0.02	2.35	0.049
On-Road Mobile	0.18	2.32	0.01	3.61	0.048	0.14	1.83	0.01	2.86	0.038
Non-Road Mobile	0.52	2.51	15.29	6.58	0.002	0.24	1.21	10.62	0.41	0.000
TOTALS	**4.30**	**18.46**	**26.79**	**22.30**	**0.265**	**3.67**	**16.36**	**21.62**	**14.33**	**0.238**

Table 7.6-13
Relative Change (%) in Episode Average Daily Emissions (tons/day) by Source Sector, 2019 Projected Baseline vs. 2013 Baseline

	Modeling Inventory Change in Grid 3 Domain Emissions (%)					*Planning Inventory Change in NA Area Emissions (%)*				
Source Sector	**$PM_{2.5}$**	**NOx**	**SO_2**	**VOC**	**NH_3**	**$PM_{2.5}$**	**NOx**	**SO_2**	**VOC**	**NH_3**
Point Sources	-32%	+2%	-1%	-61%	-62%	-32%	+2%	-1%	-62%	-62%
Area, Space Heating	-13%	+5%	+6%	-9%	-3%	-13%	+5%	+6%	-9%	-3%
Area, Space Heat, Wood	-13%	-2%	+41%	-10%	-6%	-14%	-2%	+47%	-9%	-6%
Area, Space Heat, Oil	+6%	+6%	+6%	+6%	+4%	+6%	+6%	+6%	+6%	+6%
Area, Space Heat, Coal	-4%	+3%	-3%	+3%	+3%	-6%	+3%	-4%	+3%	+3%
Area, Space Heat, Other	+1%	+3%	-4%	+4%	+4%	+1%	+3%	-4%	+4%	+4%
Area, Other	-7%	-86%	-53%	+3%	+7%	-7%	-86%	-53%	+3%	+7%
On-Road Mobile	-44%	-44%	-67%	-26%	-28%	-46%	-46%	-68%	-30%	-30%
Non-Road Mobile	+12%	+19%	+31%	-29%	-3%	+62%	+41%	+74%	-0%	+0%
TOTALS	**-17%**	**-12%**	**+16%**	**-19%**	**-16%**	**-18%**	**-13%**	**+27%**	**-13%**	**-17%**

As highlighted at the bottom of Table 7.6-13, total $PM_{2.5}$ emissions under the 2019 Projected Baseline are 18% lower across the nonattainment area than in 2013. This is largely driven by effects of the WSCO and Curtailment programs through 2016 and the oil price driven wood use shift in the space heating sector, coupled with the effects of the shift from HAGO fuel within the point source sector.

Except for SO_2, the gaseous pollutants show similar overall reductions, driven by factors that span several sectors including federal mobile source controls and wood-burning reductions. The increase in SO_2 emissions is largely due to the change in aircraft flights at Eielson AFB between 2013 and 2019.

7.6.4 2019 Required 2019 Attainment Year Control Inventory

The second and final stage of estimating emissions in 2019 consisted of applying adjustments to the Projected Baseline inventories to reflect additional incremental effects of State and local control measures not included in those baselines that reflect emission reductions through the end of calendar year 2018. These final future year inventories are called the Control inventories and are discussed below.

7.6.4.1 2019 Control Benefits Analysis

Emission reductions for additional control measures beyond those reflected in the Moderate SIP were quantified for two on-going local programs for which data were available: 1) the Wood Stove Change Out Program; and 2) the Solid-Fuel Burning Appliance Curtailment Program. Emission benefit calculations from each of the local programs are described separately below.

Wood Stove Change Out Program (2017-2018) – As noted earlier, since June 2010, the Fairbanks North Star Borough has operated a program within the nonattainment area designed to provide incentives for the replacement of older, higher-polluting residential wood-burning devices with new cleaner devices, or removal of the old devices. The design of the WSCO

Program has evolved over time, but these changes have generally consisted of both increasing the financial incentives as well as expanding the types of solid fuel burning appliances (SFBAs) or devices that are eligible to participate in the program.

Under its current design, the WSCO program provides financial incentives as follows:

REIMBURSEMENT OPTIONS

- **Replace Other SFBA with an:**
  - appliance designed to use natural gas or propane (up to $10,000)*****
  - appliance designed to use home heating oil (excluding waste/used oil), emergency power system (i.e. generator), hot water district heat, or electricity (up to $6,000)*
  - EPA Certified pellet burning appliance with an emissions rate less than or equal to 2.0 grams/hour (up to $5,000)
  - EPA certified **CATALYTIC** SFBA with an emissions rating of 2.0 grams/hr or less, or if an EPA certified SFBA with an emissions rate of 2.5 grams/hour or greater is replaced with another EPA certified SFBA, the emission rate of the new appliance must be 2.0 grams/hour or less **AND** 50% or less than the replaced appliance (up to $4,000)
- **Replace Hydronic heater with an:**
  - appliance designed to use natural gas, propane, hot water district heat, or electricity* (up to $14,000)
  - appliance designed to use home heating oil* (excluding waste/used oil) (up to $12,000)
  - EPA certified **CATALYTIC** wood stove or an EPA certified pellet stove with an emissions rating of 2.0 grams/hr or less, or an EPA phase II certified pellet burning hydronic heater with an emissions rating of 0.1 lbs/million BTU or less, or emergency power system (i.e. generator)* (up to $10,000)
- **Removal of a:**
  - SFBA -- $2,000 cash payment*****
  - hydronic heater -- $5,000 cash payment*****
- **Repair** Catalytic converter or Other Emissions-Reducing Components (up to $750)

Incremental benefits from the WSCO program beyond its reductions accounted for in the Moderate SIP reflect change outs that occurred in calendar years 2017 and 2018. WSCO transaction data was obtained from the Borough through calendar year 2018. For each application under the program, the Borough records the following elements:

- Applicant information (including address);
- Program/transaction type (replacement, removal, repair);
- Old device type (e.g., fireplace, wood stove, OWB, etc.);
- Old device certification (uncertified or EPA-certified);
- Old device model (and certified emission rate for certified devices);
- New device type (which can include conversion to heating oil or natural gas devices);
- New device model;
- New device certification (where applicable);
- New device emission rate (where applicable); and

- Application status (pending or closed/completed).

For each completed transaction, $PM_{2.5}$ and SO_2 emission benefits were calculated using the information listed above. Emission factors (in lb/mmBTU) by device/technology/certification status used in the baseline inventory were used to represent emissions for old devices being replaced, removed or repaired.

For wood-to-wood device replacements, emission factors of new devices were estimated from regression-based translations of certification emission rates (gram/hr) to emission factors (lb/mmBTU) developed from EPA certified wood burning device database. For solid fuel to oil/natural gas conversion replacements, inventory-based heating oil or natural gas emission factors were applied to represent "after change out" emissions from the new device.

For device removal transactions, it was assumed that the heating energy associated with removing the old wood device would be replaced with equivalent heating energy of a heating oil device.

For device repair transactions, an average 10% emission reduction was assumed. (There were only a modest number of repair transactions, but some included repair of the catalyst and chimney which could provide measurable reductions or efficiency improvements).

Finally, for all device replacement or removal transactions effects of differences in old vs. new (or shifted) device heating efficiency were also accounted for.

The per-transaction emission reductions (calculated on a tons per episode day basis) were then tabulated by calendar year (based on close out date).

Table 7.6-14 presents a summary of the number and types of completed/verified WSCO Program transactions in calendar years 2017-2018 and their calculated $PM_{2.5}$ and SO_2 emission reductions (in tons/episode day) based on the methods described above. As highlighted at the bottom of

Table 7.6-14, direct $PM_{2.5}$ reductions from the WSCO program in 2017 and 2018 totaled just over 0.2 tons/episode day. SO_2 emissions nominally increase due to device removals and conversions to heating oil, which has higher per unit energy sulfur content than wood.

Table 7.6-14
Wood Stove Change Out Program Transactions and Emission Reductions, 2017-2018

Transaction Type	Completed Transactions	Reductions (tons/episode day)	
		$PM_{2.5}$	SO_2
SFBA Replacement, uncertified to certified	112	0.0339	0.0004
SFBA Replacement, certified to 2 gram/hour certified	3	0.0011	0.0000
Conversion (solid fuel to oil or natural gas)	272	0.1637	-0.0074
Other (removal or repair)	23	0.0105	-0.0004
TOTALS	**410**	**0.2039**	**-0.0074**

Curtailment Program (end of 2018) – In 2017, the Solid-Fuel Burning Appliance Curtailment Program was redesigned to a two alert stage program at 25 $\mu g/m^3$ and 35 $\mu g/m^3$ for Stages 1 and 2, respectively without a voluntary alert stage. In addition, the temperature threshold that earlier allowed some uncertified devices to operate at the highest alert stage was removed. And the burn restrictions under the new Stage 1 and Stage 2 thresholds were tightened to allow only certified devices to operate under Stage 1 and no solid fuel devices to operate under Stage 2 except those NOASH (No Other Adequate Source of Heat) households in the Fairbanks and North Pole Air Quality Control Zones (AQCZs) within the nonattainment area.

In addition, based on on-going outreach and additional and more efficient enforcement procedures, the Curtailment Program compliance rate was estimated to increase to 30% (from 20% compliance estimated under the Moderate SIP).

Benefits of the "revised" Curtailment Program as it existed/operated at the end of 2018 were calculated in a manner similar to that applied under the Moderate SIP. Reduction fractions were applied to Projected Baseline space heating emissions by device/technology type/fuel type for the inventory strata listed earlier in Table 7.6-8 (Section 7.6.3.2). These reduction fractions accounted for the fraction of devices (by stratum) operating under each curtailment stage, given the estimated compliance rate and the NOASH households fraction. The NOASH fraction within the nonattainment area was estimated from the 2011-2015 HH survey data at 4%. This fraction is higher than the annual NOASH waiver applications received by the Borough (which currently amounts to less than 1% of nonattainment area households.) The higher NOASH rate was assumed for consistency with other elements of the emission inventory, which has a conservative or understated impact on resulting emission benefits from the Curtailment Program.

In addition to accounting for emission reductions associated with curtailment of solid fuel burning devices, the analysis also accounts for emissions from "shifted" energy use under each curtailment stage to heating oil and addresses efficiency differences between the solid fuel and heating oil devices.

Finally, the emission reductions are discounted to account for the fraction of households within the nonattainment area that are outside the Fairbanks and North Pole AQCZs within which the Curtailment Program applies. The fraction of nonattainment area emissions occurring within the nonattainment area, but outside these AQCZ was estimated at 12.4% and was determined from a GIS-based analysis of block-level occupied household data from the 2010 Census.

Table 7.6-15 summarizes the resulting incremental emission benefits associated with revisions to the Curtailment Program between 2016 and 2018. For equivalency, the emission benefits are shown at the 35 $\mu g/m^3$ alert level common to both versions of the program.

Table 7.6-15
Incremental Curtailment Program Emission Reductions (2018 vs. 2016) at 35 μg/m^3 Alert Level

Program State	Reductions (tons/day)	
	$PM_{2.5}$	SO_2
2018 Curtailment Program, Stage 2 (35 μg/m^3), 30% Compliance	0.363	-0.062
2016 Curtailment Program, Stage 2 (35 μg/m^3), 20% Compliance	0.125	-0.009
Incremental Reductions: 2018 vs. 2016 Program, 35 μg/m^3 **Alert Level**	**0.238**	**-0.053**

It is important to note that in applying the benefits of the curtailment program within the downstream air quality modeling, benefits are separately calculated at each alert stage by SCC code. The incremental benefits shown above in Table 7.6-15 are higher than the average across all modeling episode days, some of which do not exceed the 35 μg/m^3 alert threshold.

7.6.4.2. 2019 Attainment Year Control Emissions

Based on the control measure analysis described in the preceding sub-section a 2019 Control Inventory was developed to evaluate attainment as statutorily required by 2019. As noted earlier, it represents incremental effects of control measures beyond that taken credit for under the Moderate SIP.

Table 7.6-16 presents a similar sector-level summary of the 2019 Control modeling and planning inventories. (Again, Appendix III.D.7.6 contains detailed SCC-level emissions for the 2019 Control inventories.) And Table 7.6-17 provides sector- and pollutant-specific comparisons of the relative changes in emissions between the 2019 Projected Baseline and the 2019 Control inventories (both modeling and planning versions).

Table 7.6-16
2019 Control Episode Average Daily Emissions (tons/day) by Source Sector

Source Sector	*Modeling Inventory Grid 3 Domain Emissions (tons/day)*					*Planning Inventory NA Area Emissions (tons/day)*				
	$PM_{2.5}$	NOx	SO_2	VOC	NH_3	$PM_{2.5}$	NOx	SO_2	VOC	NH_3
Point Sources	0.84	10.76	7.32	0.09	0.020	0.83	10.63	7.13	0.09	0.020
Area, Space Heating	2.41	2.62	4.17	9.58	0.145	2.11	2.44	3.87	8.62	0.132
Area, Space Heat, Wood	2.24	0.45	0.16	9.34	0.096	1.95	0.40	0.14	8.40	0.086
Area, Space Heat, Oil	0.07	1.95	3.90	0.11	0.004	0.07	1.83	3.61	0.10	0.004
Area, Space Heat, Coal	0.09	0.06	0.11	0.12	0.016	0.08	0.05	0.09	0.11	0.014
Area, Space Heat, Other	0.01	0.17	0.02	0.01	0.029	0.01	0.17	0.02	0.01	0.029
Area, Other	0.21	0.25	0.02	2.44	0.050	0.20	0.25	0.02	2.35	0.049
On-Road Mobile	0.18	2.32	0.01	3.61	0.048	0.14	1.83	0.01	2.86	0.038
Non-Road Mobile	0.52	2.51	15.29	6.58	0.002	0.24	1.21	10.62	0.41	0.000
TOTALS	**4.16**	**18.46**	**26.81**	**22.30**	**0.265**	**3.53**	**16.36**	**21.64**	**14.33**	**0.238**

Table 7.6-17
Relative Change (%) in Episode Average Daily Emissions (tons/day) by Source Sector, 2019 Control vs. 2019 Projected Baseline

Source Sector	*Modeling Inventory Change in Grid 3 Domain Emissions (%)*					*Planning Inventory Change in NA Area Emissions (%)*				
	$PM_{2.5}$	NOx	SO_2	VOC	NH_3	$PM_{2.5}$	NOx	SO_2	VOC	NH_3
Point Sources	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%
Area, Space Heating	-5%	+0%	+0%	+0%	+0%	-6%	+0%	+0%	+0%	+0%
Area, Space Heat, Wood	-5%	+0%	+16%	+0%	+0%	-6%	+0%	+18%	+0%	+0%
Area, Space Heat, Oil	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%
Area, Space Heat, Coal	-4%	+0%	-3%	+0%	+0%	-5%	+0%	-4%	+0%	+0%
Area, Space Heat, Other	-1%	+0%	-1%	+0%	+0%	-1%	+0%	-1%	+0%	+0%
Area, Other	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%
On-Road Mobile	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%
Non-Road Mobile	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%	+0%
TOTALS	**-3%**	**+0%**	**+0%**	**+0%**	**+0%**	**-4%**	**+0%**	**+0%**	**+0%**	**+0%**

The relative reductions shown in Table 7.6-17 are for $PM_{2.5}$ and SO_2 only and are restricted to the space heating sector within which the incremental control measures apply.

It is also noted that the control reductions reflected in Table 7.6-16 and Table 7.6-17 are lower than shown earlier for the WSCO Program and the Curtailment Program in Table 7.6-14 and Table 7.6-15 for two reasons. First, Curtailment Program benefits averaged across all modeling episode days are "diluted" from those shown which apply only at the 35 $\mu g/m^3$ alert threshold. (The modeling episodes include "spin-up" spin-down" days during which measured ambient concentrations do not exceed this threshold.) Second, the overlap of the two measures are addressed in in Table 7.6-16 and Table 7.6-17 but are not reflected in individual measure benefits reported in Table 7.6-14 and Table 7.6-15.

As further described in Section III.D.7.9, the 2019 Control Inventory was used to evaluate modeled attainment by 2019. That section also discusses the evaluation of additional control measures and implementation beyond 2019 to project the soonest possible attainment date.

7.6.5 Inventory Validation and Quality Assurance

7.6.5.1 Introduction

This sub-section describes the quality assurance (QA), quality control (QC), and data validation procedures that were applied in constructing the emission inventories for the Fairbanks $PM_{2.5}$ SIP. The QA and QC procedures used were based on guidance[37] developed by EPA under its Emission Inventory Improvement Program (EIIP), specifically under Volume VI (Quality Assurance Procedures).

[37] Emission Inventory Improvement Program (EIIP), EPA, Office of Air Quality Planning and Standards, Emission Factor and Inventory Group, Research Triangle Park, NC. Volumes I – X, http://www.epa.gov/ttn/chief/eiip/techreport/.

Under the EPA guidance, QA and QC are defined as two separate components of an integrated approach in ensuring proper emission inventory (EI) development. QA is a pre-developed system of data handling, review, and audit procedures, generally conducted by personnel not actively involved in the detailed EI calculations. QA can include development of a formally documented Quality Assurance Plan (QAP). (Although a formal QAP was not developed to support the EI work under this SIP, an earlier QAP developed by DEC and used to compile and prepare emission estimates for three-year NEI submittals to EPA was utilized and supplemented with SIP-specific procedures described later in this sub-section.)

QC is typically a subset of an overall QA system and consists of activities that include technical reviews, accuracy checks, and use of approved standardized procedures for emission calculations. Thus, QA includes both establishing QC procedures and identifying personnel to conduct the QC as well as actual QA auditing and data checking.

7.6.5.2 Responsible Personnel

Alice Edwards and Cynthia Heil of the Alaska Department of Environmental Conservation (DEC), Nicholas Czarnecki of the Fairbanks North Star Borough and Thomas Carlson of Sierra Research, Inc. (Sierra)—each with emission inventory, regulatory policy, and control measure evaluation experience—served as co-Quality Assurance Coordinators. Ms. Edwards and Ms. Heil handled or oversaw data prepared or obtained directly by the State, Mr. Czarnecki was responsible for QA of Borough data, and Mr. Carlson was responsible for review of all other externally developed or acquired data.

Robert Dulla of Sierra, who along with Mr. Carlson, was not directly involved in actual inventory data development and EI calculations, performed independent internal review of the detailed EI calculations and source methodologies.

7.6.5.3 Data Collection and Analysis

Both to ensure the comprehensive assessment of sources within the emission inventory as well as to assure properly assembled source activity and emission factor data, EPA's aforementioned EIIP QA/QC documentation was used to guide EI data collection and analysis.

As discussed in Section 7.6.2.1, the source categories were divided into stationary point source, stationary area source, non-road mobile, and on-road mobile. Stationary point source information is maintained by DEC down to 100 tons per year, so no surveys were needed to explicitly identify stationary area and point sources. Emissions from stationary point sources were calculated on the basis of 2008 production levels and the best available emission factors.

Area source emissions estimates were based on a variety of sources of activity and emission factors that maximized utilization of an extensive amount of locally collected activity data and testing measurements, especially within the space heating sector.

Within the mobile source sector, both on-road and non-road emissions were calculated using the latest (at the time) available emissions models: MOVES2014b for on-road vehicles and non-road vehicles and equipment, and AEDT Version 2c for airfield emission sources. The SMOKE

Version 2.7.5b inventory pre-processing model was used to grid, speciate, and format the EI estimates into photochemical model-ready structures.

Across all source sectors, special attention was given to strong seasonal activity and emission factor variations largely driven by the harsh Arctic climate but that differed by source category even within a source sector. Attention was also given on a source category basis to evaluation of default assumptions or activity/emission factor estimates based on "Lower-48" conditions that were clearly not applicable to wintertime Alaskan conditions.

7.6.5.4 Data Handling and Validation

Elements of the emission inventory data handling procedure are outlined below.

1. Assembly and review of various sources of external or "raw" data (including both electronic databases as well as individual data elements lifted from various publications and research materials)

2. Data tracking (coordination of different inventory elements as well as refinements of initial draft estimates with newer or updated data)

3. QA/QC and data validation, which consisted of data checking and correcting and proper substitution of corrected data.

Additional data review and validation procedures consisted of review focused on identifying gaps or double-counting of source emissions as well as separate tabulations of emissions by sector and category at several stages of the EI development, from raw and calculation spreadsheets to SMOKE processing model inputs and outputs. Each of the data handling and validation elements is further discussed below.

<u>Data Assembly and Review</u> – Initial data assembly and review was performed for each piece of external data. This included structuring data for specific source types into a unified spreadsheet structure. (For example, facility-specific episodic data were supplied in a range of spreadsheet layouts and data units.) It included explicit assignments of SCC codes to data for each category or sector. It also consisted of a preliminary review of data validity using a combination of range/unit checks and independent corroboration (e.g., Tier 1 or EIS/SCC-level comparisons to NEI estimates).

<u>Data Tracking</u> – Data obtained externally from a variety of agencies, other outside entities, and literature review sources were gathered and organized into hierarchical folders based on source sector classifications. To account for the need for data collection, EI calculation, and then QA/QC review by multiple and disparate personnel, both "working" and "final" versions of this hierarchical structure were utilized. In addition, procedures were employed whereby earlier draft estimates and supporting data were periodically offloaded to separate folders marked as "Draft" to ensure there was no confusion as to the elemental supporting files of a <u>finalized</u> EI element as well as to preserve an evolutionary archive/revision history of the EI revisions throughout the inventory development process. Daily and weekly file backups were performed using Sierra's network backup system.

QA/QC and Data Validation – The principal QA/QC methods and data validation techniques employed in development of the FNSB $PM_{2.5}$ SIP inventories included the following:

- Reality, limit and unit checks;
- Peer review;
- Sample calculations;
- Sensitivity analysis; and
- Independent audits/validation of emission estimates.

Some of these elements are further explained below.

Peer Review – Peer review was a regular and integral part of the process utilized to assure the quality and validity of the inventories. For nearly the last three years of the SIP development, weekly and monthly conference calls were held by DEC with participation by their consultant Sierra, FNSB, and EPA Region 10 staff to discuss emergent data sources or study reports and discuss analytical approaches and calculation methods/assumptions. In addition to these weekly calls, intermediate EI data elements and calculation spreadsheets were also circulated between DEC, FNSB, Sierra and Region 10 to perform independent review and evaluation. The participants in these weekly and monthly exchanges are listed below.

- Alice Edwards, DEC
- Cindy Heil, DEC
- Deanna Huff, DEC
- Adeyemi Alimi, DEC
- Nicholas Czarnecki, FNSB
- Todd Thompson, FNSB
- Rob Elleman, EPA Region 10
- Robert Kotchenruther, EPA Region 10
- Justin Spenillo, EPA Region 10
- Dan Brown, EPA Region 10
- Brett Dugan, EPA Region 10
- Matthew Jentgen, EPA Region 10
- Nicole Briggs, EPA Region 10
- Jeff Houk, FWHA Resource Center (monthly)
- Bob Dulla, Sierra Research/Trinity Consultants
- Tom Carlson Sierra Research/Trinity Consultants
- Mark Hixson, Sierra Research/Trinity Consultants
- Wenxian Zhang, Sierra Research/Trinity Consultants

In addition to these weekly and monthly calls, several coordinated in-person meetings were held either in Alaska or at EPA Region 10’s Seattle office to provide detailed technical briefings on EI and other SIP elements.

Independent Audits and Emission Estimation Validation – Independent audits largely included review of spreadsheet calculations by a second or third person beyond the initial preparer of emission estimates for each individual source category. Emission estimation validation consisted of a series of corroboratory checks at both the source category and broader source sector level. At the source category (e.g., SCC) level, NEI estimates were used to initially validate the EI estimates. Although this often proved problematic because the NEI estimates were county-wide annual averages and were often initially found to be in significant disagreement with the episodic estimates, especially those entirely developed using locally collected activity data or test measurements, it forced the data validation to back track through the calculations (including accounting for strong seasonal variations) to affirm the findings. Validation procedures applied at the broader source sector/type level included corroboration of source contributions to total inventory emissions with independent source apportionment techniques that included Positive Matrix Factorization (PMF) and Chemical Mass Balance (CMB) analyses performed to support the SIP.