5.6 Emission Inventory Data

5.6.1. Introduction

5.6.1.1 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). A portion of the Fairbanks North Star Borough (FNSB) that includes the cities of Fairbanks and North Pole as well as surrounding areas has been designated as a NAAQS $PM_{2.5}$ Moderate non-attainment area for violation of the 24-hour average standard enacted in 2006. In compliance with published EPA requirements, the inventories are provided as a part of the Alaska's State Implementation Plan (SIP) to formulate a strategy to attain the $PM_{2.5}$ NAAQS in Fairbanks.

As further described in Section III.D.5.9, a Moderate Area SIP must either demonstrate[1] that:

i. The plan will provide for attainment by the applicable attainment date (December 31, 2015 in this case); or

ii. Demonstrate that attainment by such date is impracticable.

Related to a demonstration of "impracticability," CAA Part D, subpart 4 Section 189(a)(1)(C) also requires that Moderate Area plans include provisions to assume reasonably available control measures no later than four years after the moderate area designation was made, which is addressed in Section III.D.5.7.

This section of the SIP is intended to fulfill EPA requirements for preparing the 2008 Base Year and 2015 Attainment Year emission inventories, as specified in the provisions of the CAA and EPA guidance documents. The intent of this section is to describe how emissions were first estimated for the 2008 base year and then projected forward to 2015 with technically and economically feasible controls implemented within that time to determine whether the area will reach attainment by 2015. This attainment analysis is based on atmospheric modeling that simulates the formation of ambient $PM_{2.5}$ given input emissions and meteorology and is described in detail in Section III.D.5.8 of the SIP.

The Fairbanks Moderate Area SIP emission inventory is considered a Level II inventory, as classified under the Emission Inventory Improvement Program (EIIP).[2] It is a Level II inventory

[1] CAA Part D, subpart 4, Section 189(a)(1)(B).

[2] "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.

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.

5.6.1.2 Description of Inventories and Geographic Area

There are two classes of inventories based on their intended use, as summarized below:

1. *Planning Inventories* – These inventories are developed to fulfill regulatory planning and reporting requirements and are pollutant- and area designation-specific. Under EPA terminology, they include *base year* inventories ("foundational" emission source and activity inventories upon which all others are based), *three-year cycle* inventories (submitted to EPA under periodic reporting requirements and published under the agency's National Emissions Inventory, or NEI) and *reasonable further progress (RFP)* inventories (developed and submitted to EPA to demonstrate sufficient progress toward NAAQS attainment or regional haze regulatory requirements). Planning inventories contain annual and, in some cases, seasonal emission estimates.

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 Fairbanks 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 5.6-1 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 Fairbanks $PM_{2.5}$ non-attainment area is also shown in Figure 5.6-1 and covers a small portion of the borough (county).

In conformance to 40 CFR[3] §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 particulate matter.

For this Moderate Area $PM_{2.5}$ SIP, a specific set of planning and modeling inventories were prepared to satisfy CAA and EPA regulatory requirements. Table 5.6-1 summarizes the inventories developed and submitted to satisfy these moderate area SIP requirements.

[3] Code of Federal Regulations.

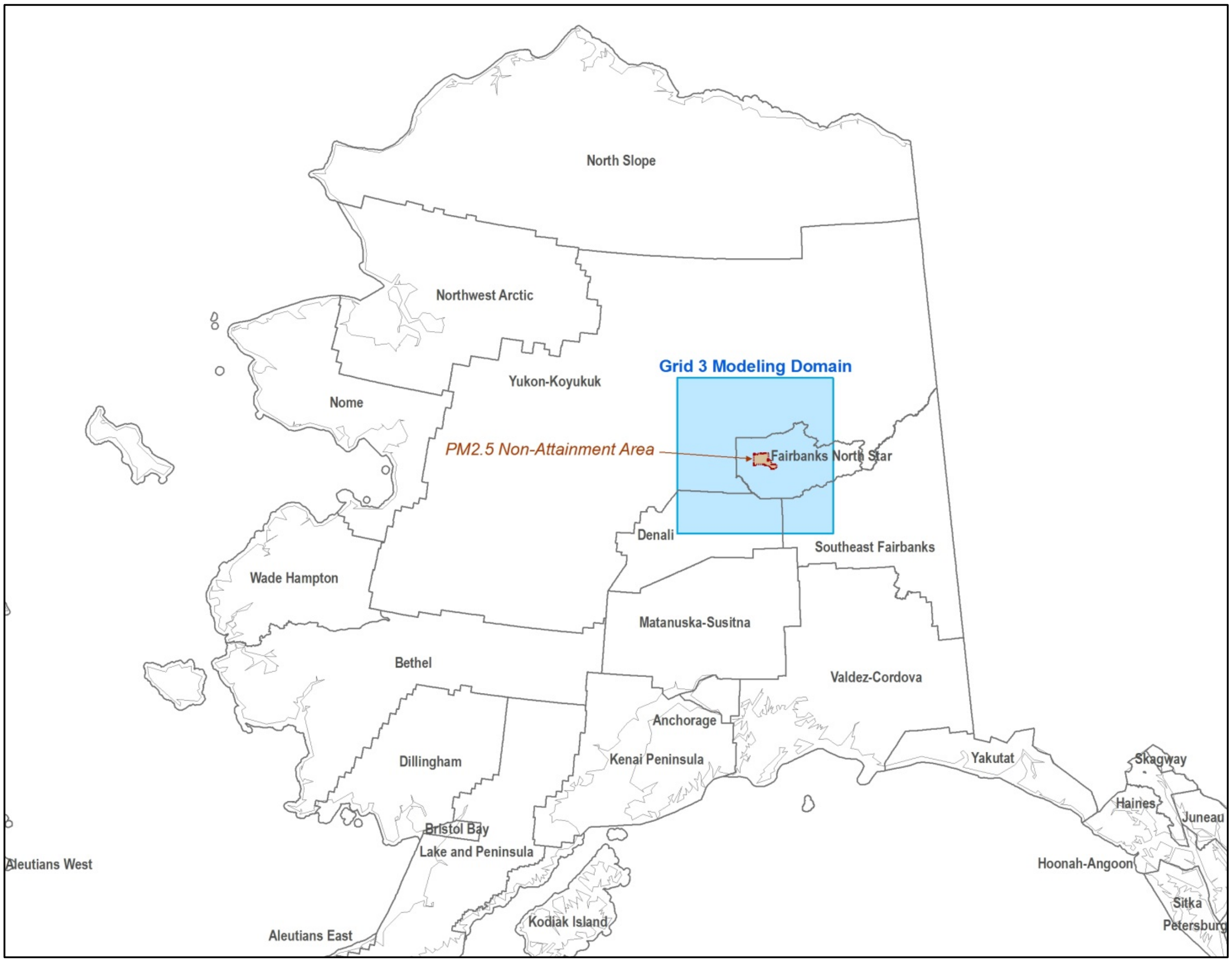

Figure 5.6-1. Fairbanks Modeling Inventory Domain and $PM_{2.5}$ Non-Attainment Area

Table 5.6-1 Summary of Applicable Inventories for Moderate Area $PM_{2.5}$ SIP

Class	Type	Geographic Area	Calendar Year	Regulatory Requirements
Planning	Base Year	Statewide	2008	EPA Regulations*
	Base Year	Non-Attainment Area	2008	CAA 172(c)(3)
	Projected, with controls	Non-Attainment Area	2015	CAA 172(c)(3)
Modeling	Baseline	Modeling Domain	2008	CAA 189(a)(1), CAA 189(b)(1)
	Projected, with controls	Modeling Domain	2015	CAA 189(a)(1), CAA 189(b)(1)

* As specified in EPA's "Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations," November 2005.

As further described in Section III.D.5.9, it was found that attainment of the 24-hour $PM_{2.5}$ NAAQS by 2015 is impracticable. Thus, in addition to the required inventories listed in Table 5.6-1, a broader set of inventories was developed out to calendar year 2019. These additional 2019 inventories serve two goals:

1. To support the primary finding of this plan—that attainment by 2015 is impracticable—and buttress this finding of impracticability by showing the progress toward attainment both by and beyond 2015 based on implementation and penetration schedules for control measures that are technologically and economically feasible.

2. To demonstrate a path toward attainment by 2019. Although this latter goal is not a requirement for this Moderate Area plan, the State of Alaska and FNSB have devoted considerable thought and resources toward identifying and funding control programs that are currently forecasted to provide sufficient emission reductions to bring Fairbanks into attainment of the 24-hour $PM_{2.5}$ NAAQS, albeit not by 2015.

Table 5.6-2 lists the complete set of emission inventories prepared for this SIP which as described above, support both a finding of impracticable attainment by 2015, but projected attainment by 2019 based on currently available data and forecasted control measures.

Table 5.6-2
Inventories Developed for Fairbanks Moderate Area $PM_{2.5}$ SIP

Class	Inventory Type	Geographic Area	Calendar Year(s)	Point Sources	Resolution		Includes Controls?	Reporting Level
					Spatial	Temporal		
Planning	Base Year	Statewide	2008	Actual	State	Annual		Emission Inventory Sector (EIS) or Tier 1
	Base Year	Non-Attainment Area	2008	Allowable	NA Area	Annual, Winter Season		
	Control	Non-Attainment Area	2015	Allowable	NA Area		Yes	
	RFP	Non-Attainment Area	2017	Actual	NA Area	Winter Season	Yes	
	MVEB	Non-Attainment Area	2017	n/a	NA Area	Winter Season		
Modeling	Baseline	Modeling Domain	2008	Actual	1.3 km Grid Cell	Episodic (day and hour)		SCC
	Projected Baseline	Modeling Domain	2015, 2019	Allowable, Actual				SCC
	Control	Modeling Domain	2015, 2019	Allowable, Actual			Yes	SCC

n/a – Not applicable.
SCC – Source Classification Code (a detailed emission source classification scheme developed by EPA)

In addition to identifying those inventories supporting either planning or modeling requirements as described earlier, Table 5.6-2 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. <u>Base Year</u> 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. For this SIP, calendar year 2008 has been designated as the base year, which coincides with the baseline year for which historical $PM_{2.5}$ episodes are evaluated in the attainment modeling. Thus the modeling inventory developed for calendar year 2008 is called the <u>Baseline</u> inventory and is used to validate the performance of the atmospheric simulation model in predicting ambient $PM_{2.5}$ concentrations compared to actual ambient measurements collected during the 2008 modeling episodes. There are two basic types of inventories for calendar years beyond the 2008 base year: (1) <u>Projected Baseline</u>, which accounts for source activity changes from forecasted population and economic growth and device turnover relative to the base year; and (2) Control, which accounts for emission reductions associated with adopted or forecasted state and local control measures (in addition to population/economic growth). The planning inventories in Table 5.6-2 listed as <u>RFP</u> and <u>MVEB</u> (for Motor Vehicle Emissions Budget) are special inventories that must be developed within the SIP to satisfy Reasonable Further Progress (RFP) requirements. The RFP inventory encompasses all source categories and as explained later in Section 5.6.5 was developed to ensure linear 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 explained in Section 5.6.6. (The MVEB inventory is described in further detail in Section III.D.5.13.)

- *Geographic Area* – The geographic area or extent of the sources included within each inventory is also listed in Table 5.6-2. Three different areas, shown earlier in Figure 5.6-1, are represented: Statewide, Non-Attainment Area, and Modeling Domain.

- *Calendar Year(s)* – The calendar years associated with each inventory are listed in this column. In addition to the 2008 base/baseline year, inventories were developed for 2015, the "attainment finding" year for this Moderate Area SIP as well as for 2019. These were developed both to strengthen the case for impracticable attainment by 2015 and to project the effects of forecasted controls toward attainment by 2019. The MVEB is required for 2017 to satisfy RFP quantitative milestone requirements specified in the particulate matter section of the 1992 general preamble section to the CAA.[4] EPA has interpreted that the three-year RFP milestone requirement counts from the due date for the SIP (December 2014 in this case). Therefore, per EPA guidance, the applicable calendar year for the MVEB was 2017.

- *Point (Industrial) Sources* – There are two different emission levels associated with stationary point source facilities that must be considered in developing SIP inventories that meet CAA requirements and satisfy EPA guidance: (1) Allowable, which refers to permitted or Potential to Emit (PTE) emission limits associated with the facility operating permit; and (2) Actual, which are estimates of actual annual or episodic emissions based on historically recorded facility operating throughput or continuous emissions monitoring systems. **As used in the inventory, Allowable emissions and PTE emissions are equivalent. EPA inventory guidance uses the term Allowable emissions, which are equal to annual PTE emission limits that are expressed on an average daily basis. From this point forward, the term "PTE" will be used to equivalently refer to allowable or permitted facility emission limits (expressed on an average daily basis).** Actual emissions are generally lower than PTE 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).

- *Spatial & Temporal Resolution* – These columns refer to the levels of spatial and temporal resolution of each inventory. As listed in Table 5.6-2, the inventories reflect three different levels of spatial resolution: (1) State, for statewide emissions; (2) NA Area, for total emissions within the Fairbanks $PM_{2.5}$ non-attainment area; and (3) 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 5.6-2 are (1) Annual, which reflects total emissions over the entire calendar year; (2) Winter Season, reflecting average emissions over the winter non-attainment season (defined as October through March); and (3) Episodic, for which emissions are resolved by individual day and hour to support the episodic attainment modeling. To simplify the SIP inventory development effort, average emissions over all modeling episode days were calculated and assumed to represent winter-season average emissions. (Given the strong dependence of wintertime emissions in Fairbanks on

[4] Federal Register, Vol. 57, No. 74, April 16, 1992, pg. 13539.

ambient temperature, this assumption is likely to result in estimates that are higher than those averaged over the entire winter season. Since these winter-season estimates serve planning purposes, this approach to representing winter-season estimates was conservative and assumed to be sufficient.)

- *Includes Controls* – This column simply identifies whether the inventory includes emission reductions resulting from state or local control measures.

- *Reporting Level* – As noted in Table 5.6-2, 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.

Most of the effort and rigor in the SIP inventory development focused on the modeling inventories that were used to support the "impracticable attainment by 2015" and "likely attainment by 2019" findings. As described later in Section 5.6.2, the planning inventories were estimated more simply, in some cases by scaling estimates from corresponding modeling inventories to represent annual or winter season (October through March) emissions.

5.6.1.3 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; or

- Sources outside the non-attainment area were not believed significant or were well removed from the non-attainment 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 non-attainment area included several specific point source facilities and stationary non-point (area) sources. As described in Technical Appendix III.D.5.6, 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.

5.6.1.4 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 – Managed overall SIP inventory development.
- Cindy Heil – Managed State-funded local data collection (including episodic point source data) and survey studies and coordinated evaluation of potential State control measures.
- Deanna Huff – Assisted in validation of episodic point source facility data, including review of stack parameter/release height data in conjunction with CALPUFF point source modeling supplementing the grid model-based attainment modeling.
- Joan Hardesty – assembled episodic point source data and facility operating permit data and assisted in review and validation of facility source coordinates.

Fairbanks North Star Borough (FNSB)

- Jim Conner and Ron Lovell – Managed Borough-funded local data collection and testing studies and coordinated review/investigation of existing and potential Borough control programs.
- Todd Thompson, Paul Simpson, 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)

- Bob Dulla – Managed Sierra Research's overall inventory support efforts, including coordination of State and local data collection, validation, and implementation within the emissions inventory; also performed source-level inventory quality assurance and control measure reduction review.
- Tom Carlson – Principal technical lead for the emissions 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.
- Mark Hixson – Responsible for development of on-road mobile source emissions and generation of attainment model-ready gridded and speciated emission inputs.
- Frank Di Genova – Performed review and analysis of State and Borough-funded space heating device emission testing studies and assimilation of validated results into emissions inventory framework and provided overall inventory quality assurance review.

- Dan Welch – Reviewed as-received episodic facility point source activity and fuel use data, flagged issues or calculation errors, and resolved/corrected these issues/errors through DEC-directed follow-up with affected facility operators.

5.6.1.5 Organization of the SIP Inventory Documentation

Beyond this introductory section, Section III.D.5.6.2 summarizes the data source and methodologies used to developed the 2008 base year and baseline inventories for the SIP. An overview of the approach used to calculate emissions for each sector is presented followed by summaries of the 2008 Base Year and 2008 Baseline inventories.

Section III.D.5.6.3 describes the sources of population and economic growth projections and the approach used to generate projected baseline emission estimates in 2015 and 2019 (before application of control measure reductions). It also provides emission summaries by source sector for each projected baseline inventory.

Control inventories in 2015 (the attainment demonstration year) and 2019 are discussed in Section III.D.5.6.4. Each of the adopted or planned state and local control programs is described separately, including assumptions regarding compliance and penetration effectiveness and the sources upon which they were based. Emission summaries are also presented for the 2015 and 2019 control inventories.

Section III.D.5.6.6 explains how the 2017 Reasonable Further Progress inventory was calculated and how it meets RFP-based “linear progress toward attainment” requirements.

Section III.D.5.6.6 outlines the approach used to develop the 2017 Motor Vehicle Emission Budgets to satisfy RFP milestone requirements and establish budgets for use in subsequent regional transportation conformity determinations.

Finally, Section III.D.5.6.7 summarizes the data validation and quality assurance procedures utilized in preparing the complete set of SIP emission inventories.

In addition to the methodology summaries and tabulated emissions presented within this section of the SIP, Technical Appendix III.D.5.6 provide 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.

5.6.2. 2008 Baseline and Base Year Inventories

This sub-section presents and summarizes the sources and methods used to develop the 2008 Baseline modeling inventory and the 2008 Base Year planning inventories. As noted earlier in Section III.D.5.6.1, emission estimates in planning and modeling inventories are compiled at different levels. The former contains estimates on an area-wide and annual or 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 2008 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 2008 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 Base Year planning inventories.

5.6.2.1 2008 Baseline Modeling Inventory

<u>Overview</u> – Considerable effort was invested in developing the modeling inventories, starting with the foundational 2008 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 2008 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[5] 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*,[6] AP-42 database.

Table 5.6-3 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 5.6-3, <u>the majority of both episodic wintertime activity and emission factor data supporting the 2008 Baseline modeling inventory was developed based on local data and test measurements</u>.

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;

[5] Assessments of source significance or relative share were not made "in isolation" but were evaluated and corroborated by other source apportionment techniques discussed in Section III.D.5.8 of the SIP, including Positive Matrix Factorization (PMF) and EPA-approved Chemical Mass Balance (CMB) statistical analysis.
[6] "Compilation of Air Pollutant Emission Factors," Fifth Edition and Supplements, AP-42, U.S. EPA, Research Triangle Park, NC. January 1995.

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 MOVES2010a (the latest version of MOVES at the time the SIP inventory work began).

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 non-attainment area as well as the broader Grid 3 modeling domain.

Table 5.6-3
Summary of Data/Methods Used in 2008 Baseline Modeling 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 Fairbanks non-attainment area residential heating device activity measurements and surveys	- Test measurements of common Fairbanks 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 and state-based estimates of annual and seasonal vehicle miles traveled	- MOVES2010a emission factors based on local fleet/fuel characteristics - Augmented with Fairbanks 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 - NONROAD2008a model-based activity for Fairbanks for other categories	- NONROAD2008a model factors for non-road equipment - EDMS model factors for aircraft - EPA factors for locomotives

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 5.6-3 for the 2008 Baseline modeling inventory. In addition to these methodology summaries, an exhaustive Inventory Technical Appendix (Appendix III.D.5.6) 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 2008 Baseline modeling inventory are presented.

Stationary Point Sources – For the 2008 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 initially included in the query to ensure that facilities within the non-attainment area just below the 100 TPY threshold were also identified to determine whether their emission levels might warrant treatment as individual stationary point sources within the SIP model inventory.

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)[7] or the fact that they were located generally downwind of the non-attainment 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 episodic point sources because they either were located outside the non-attainment area (Fort Knox and Usibelli) or exhibited insignificant wintertime activity (CMI Asphalt Plant).

(These excluded facilities 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 5.6-4. One facility, Eielson Air Force Base, is located just outside the non-attainment area boundary on the southeast edge. All other facilities listed in Table 5.6-4 are located within the non-attainment area.

[7] 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 $PM_{2.5}$ non-attainment area exhibited negligible contributions to ambient $PM_{2.5}$ concentrations in the area.

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.

DEC's contractor, Sierra Research, Inc. (Sierra) then assembled and reviewed the submitted data 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.

Table 5.6-4
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 uses HAGO, a by-product from Flint Hills Refinery.

Generally, most facilities provided hourly $PM_{2.5}$ and SO_2 emission rates by individual emission unit. As explained in greater detail below, Sierra then developed estimates of NO_x and VOC emission rates from AP-42[8] based emission factors (where fuel use data were explicitly provided) or from fuel-specific emission factor ratios.

Figure 5.6-2 through Figure 5.6-5 provides comparisons of $PM_{2.5}$, SO_2, NO_x, and VOC emissions, respectively, for each source facility for which episodic data were collected. (Episodic NH_3 data were not available.) Within each figure, four sets of daily average emissions (in tons/day) are plotted for each facility, as described below.

1. *2008 E1 Avg* – Episode 1 (Jan. 23 - Feb 10, 2008) average daily actual emissions
2. *2008 E2 Avg* – Episode 2 (Nov.2 – Nov. 17, 2008) average daily actual emissions
3. *2008 Actual* – 2008 actual annual average daily emissions (from DEC database)
4. *PTE* – Permitted annual Potential to Emit (PTE) levels, expressed on an average daily basis (from DEC database)

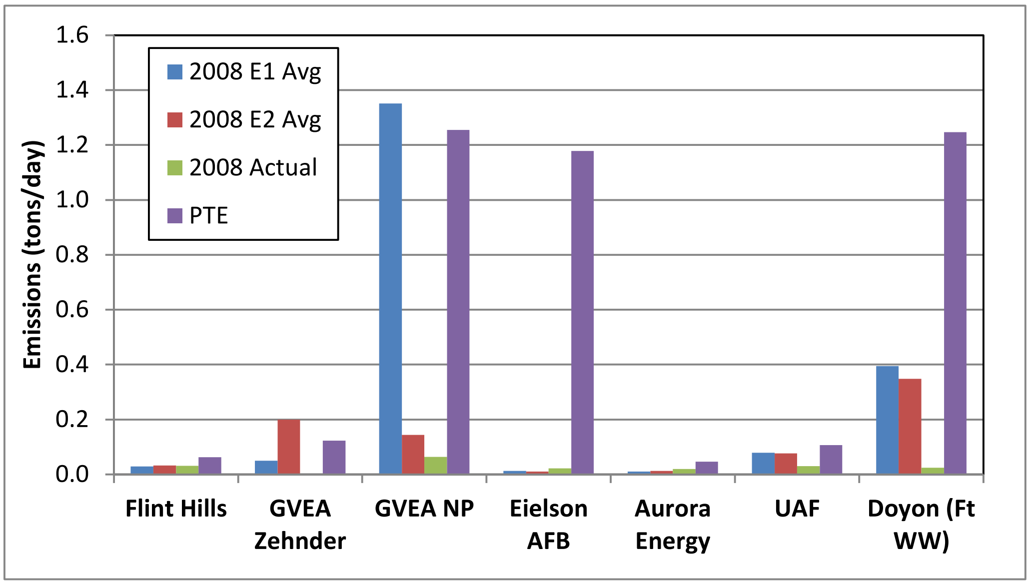

Figure 5.6-2. 2008 $PM_{2.5}$ Episodic, Actual Annual, and PTE Point Source Emissions (tons/day)

[8] "AP-42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources," Environmental Protection Agency, January 1995.

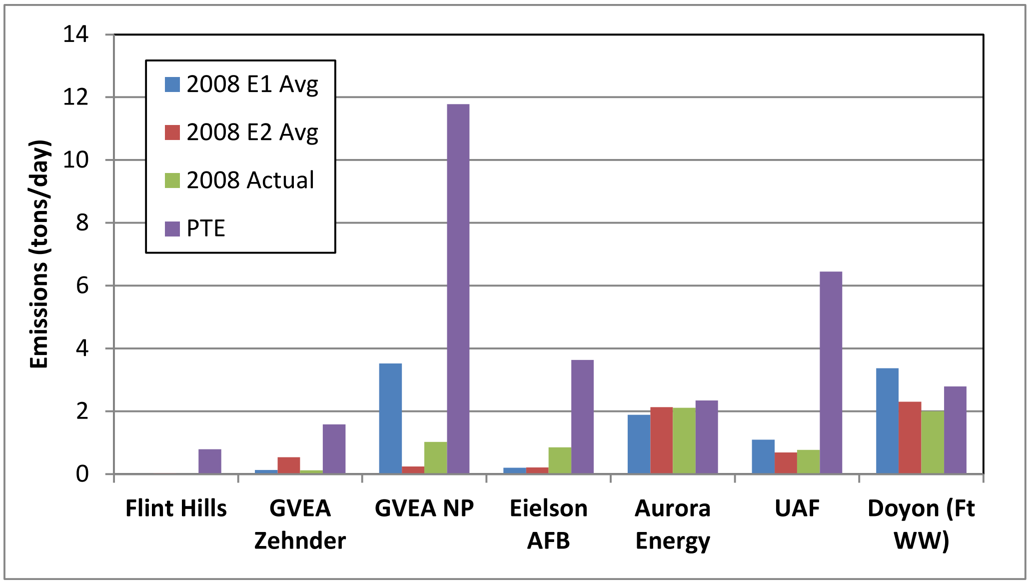

Figure 5.6-3. 2008 SO_2 Episodic, Actual Annual and PTE Point Source Emissions (tons/day)

In comparing PTE limits to the actual emissions in this set of figures, one should compare only actual annual emissions (green bars) to the PTE limits (purple bars) since all the data are plotted on an average daily basis. In other words, the fact that GVEP NP Episode 1 average daily emissions in Figure 5.6-2 (blue bar) are higher than the PTE level (purple bar) does not indicate the PTE limit was exceeded since it is an annual, rather than daily, average limit.

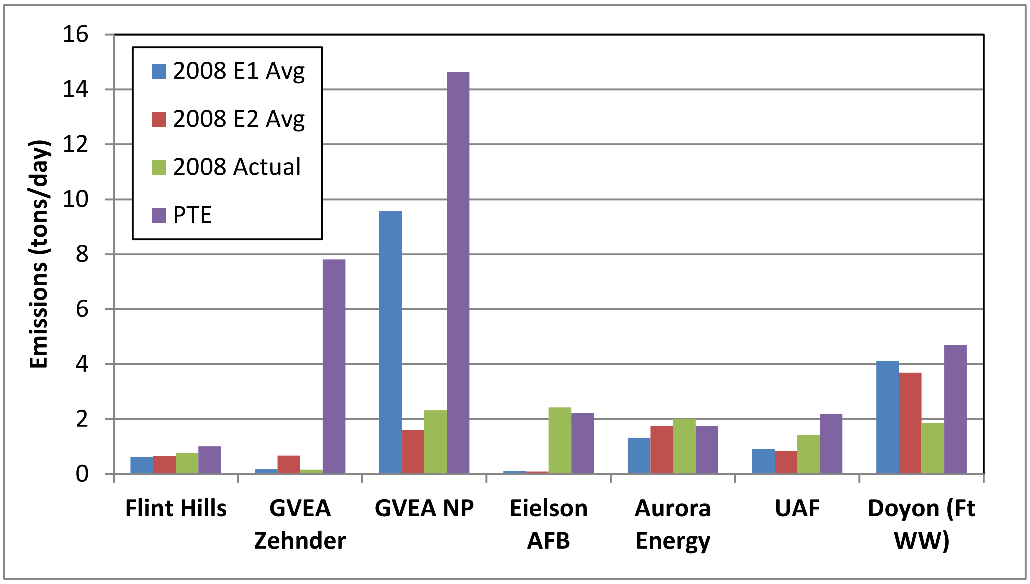

Figure 5.6-4. 2008 NO_x Episodic, Actual Annual and PTE Point Source Emissions (tons/day)

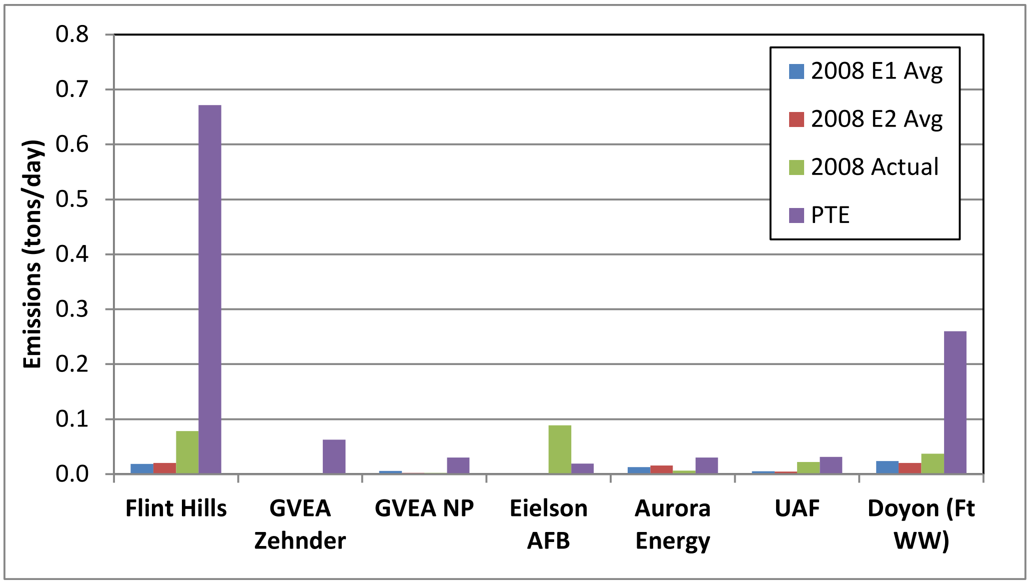

Figure 5.6-5. 2008 VOC Episodic, Actual Annual and PTE Point Source Emissions (tons/day)

As seen in Figure 5.6-2, significant differences exist for certain facilities between actual daily average $PM_{2.5}$ emissions during the winter modeling episodes and permitted (i.e., PTE) average daily emission levels. Moreover, the difference in average actual daily emissions also varied significantly between modeling episodes (and compared to actual annual average emissions) for specific facilities, notably the GVEA North Pole (NP) power plant.

Figure 5.6-3 through Figure 5.6-5 show similar comparisons for the precursor pollutants.

In comparing the facility-specific daily emission averages across this series of plots, it is noted that the PTE emissions represent emission limits based on operating permits in place in the 2008 baseline year that continue through 2014 with exceptions at UAF[9] and Flint Hills[10] that were assumed to not affect PTE emissions in the projected 2015 inventories.

In addition, the episodic actual emissions for these point sources in the modeling inventory 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.

[9] UAF received a construction permit (under Title I of the CAA) in April 2014 for replacement of its two existing coil-fired boilers with new dual fuel-fired circulating fluidized bed (CFB) boilers that will result in modest changes in facility PTE levels. As of the date of this SIP submittal, it was unknown if these boiler replacements would actually occur in 2015. Thus, pre-April 2014 PTE levels were assumed for UAF in 2015.

[10] In the first half of 2014, the Flint Hills Refinery was shut down. Production of both gasoline and other fuel products ended in early summer. The facility's actual and PTE emissions were still applied in the 2015 inventory given uncertainty about the closing/decommissioning schedule for the refinery at the time the inventory was finalized.

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 2008 Baseline modeling inventory incorporated an exhaustive set of locally collected data in Fairbanks 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 Fairbanks 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 non-attainment area, ranging in size from 300-700 households per survey. The results of these surveys were used to develop estimates of the types and number of heating devices used during winter by ZIP code within the non-attainment 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).

- *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 Fairbanks. 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 Fairbanks 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 the first and most 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 Fairbanks 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, 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.

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 5.6-5 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.

Table 5.6-5
Fairbanks Space Heating Devices and Fuel Types and Source of Emission Factors

Device Type	SCC Code	Emission Factor
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	2104007000	AP-42
Natural Gas - Residential	2104006010	AP-42
Natural Gas - Commercial, small uncontrolled	2103006000	AP-42
Coal Boiler	2104002000	OMNI
Waste Oil Burning	2102012000	OMNI

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 ZIP code-specific device distributions from the local survey data (along with wood species mix and moisture content data) and block-level GIS shapefile counts of housing units from the 2010 U.S. Census, along with emission factors for the devices listed in Table 5.6-5. These calculations are discussed in detail in Appendix III.D.5.6.

Finally, as described in further detail in Section III.D.5.8, 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. As described in Section III.D.5.8, Sierra developed a modified version of SMOKE 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.

All 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 primary data source used to estimate "Other" area source emissions was an earlier 2009 Alaska criteria pollutant inventory study[11] sponsored by DEC.

This DEC study, referred to as the "Big 3" inventories, consisted of the development of pollutant emission estimates for the three most populous counties in the state: the Municipality of Anchorage, the Fairbanks North Star Borough, and the Juneau Borough. The Big 3 inventories were developed for calendar years 2002, 2005, and 2018 using a combination of 2002 base year data and growth/control forecasts for 2005 and 2018. The inventories encompassed all source sectors (point, area, on-road, non-road) and the following criteria pollutants: VOC, NO_x, CO, SO_x, NH_3, PM_{10}, and $PM_{2.5}$. For each calendar year, annual emissions as well as winter and summer seasonal emissions were developed. The seasonal estimates reflected six-month winter (October through March) and summer (April through September) daily averages based on seasonal activity profiles developed using local data where available.

For use in this $PM_{2.5}$ SIP inventory, SCC-level summer and winter season emission estimates were extracted from National Emission Inventory (NEI) Input Format (NIF) spreadsheet structures developed under the Big 3 study to allow DEC to submit data to support the NEI. Only area source SCC records were extracted for the Fairbanks Borough in calendar year 2005, the nearest year to the SIP inventory 2008 base year.

The SCC-level winter 2005 emissions from the earlier inventory were projected to 2008 using historical year-to-year county-wide population estimates compiled by the Alaska Department of Labor and Workforce Development (ADLWD) for use in the 2008 Baseline modeling inventory for this SIP. The three-year (2005-2008) population growth factor for Fairbanks from the historical ADLWD data was 1.026, reflecting the 2.6% increase applied to the 2005 Big 3 emissions for Fairbanks in projecting emissions for other area sources to the 2008 Baseline.

In compiling these other area source emission estimates, a series of SCC-level source category comparisons were made between the Big 3 inventory and EPA's 2008 NEI inventory for Fairbanks nonpoint sources. In performing these comparisons, a gap was found in that commercial cooking emissions (e.g., from restaurant char broilers) had not been included in the Big 3 inventory. As a result, commercial cooking emissions within the Other Area Source sector of the 2008 Baseline modeling inventory were developed based on data from the 2008 NEI (Version 3).

It is also noted that a number of source categories within the Other Area Source sector 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)

[11] L. Williams, et al., "Criteria Pollutant Inventory for Anchorage, Fairbanks, and Juneau in 2002, 2005 and 2018," prepared for Alaska Department of Environmental Conservation, Sierra Research Report No. SR2009-02-01, February 2009.

- 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.

On-Road Mobile Sources – Emissions from on-road motor vehicles were developed within the 2008 Baseline modeling inventory using locally developed vehicle travel activity estimates and fleet characteristics as inputs to EPA's MOVES2010a vehicle emissions model.[12] To support the gridded inventory structure and episodic (daily/hourly) emission estimates of the modeling inventory, MOVES2010a 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 2008 Baseline inventory, MOVES inputs were based primarily on data gathered as part of the conformity analysis for the Fairbanks Metropolitan Area Transportation System (FMATS) 2012-2015 Transportation Improvement Program (TIP).[13] FMATS is the Metropolitan Planning Organization (MPO) for Fairbanks. The timing of the FMATS TIP was such that it was one of the first regional conformity analyses conducted using MOVES. Inputs for that conformity analysis were derived from local transportation modeling efforts, 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 discussed in Appendix III.D.5.6.

Regional Travel Model Vehicle Activity – Vehicle activity on the FMATS transportation network was based on the TransCAD travel demand modeling performed for the 2012-2015 TIP. The TransCAD modeling network covers the entire Fairbanks $PM_{2.5}$ non-attainment area and its major links extend beyond the non-attainment area boundary, as illustrated in Figure 5.6-6.

[12] Although EPA has released subsequent versions, MOVES2010b (initially released in May 2012 and updated in October 2012 and MOVES2014 (released on July 31, 2014), the vehicle emissions portion of the SIP inventory was initiated before these newer version release dates. Moreover, for the primary criteria pollutants contained in the modeling inventory, the differences between MOVES2010a and MOVES2010b are not significant. MOVES2014 was not considered for use in the SIP since it was released in the latter stages of the SIP's development.

[13] T. Carlson, R. Dulla, "Draft Conformity Analysis for Federally Approved 2012-2015 FMATS Transportation Improvement Program (TIP), prepared for Fairbanks Metropolitan Area Transportation System, July 18, 2011.

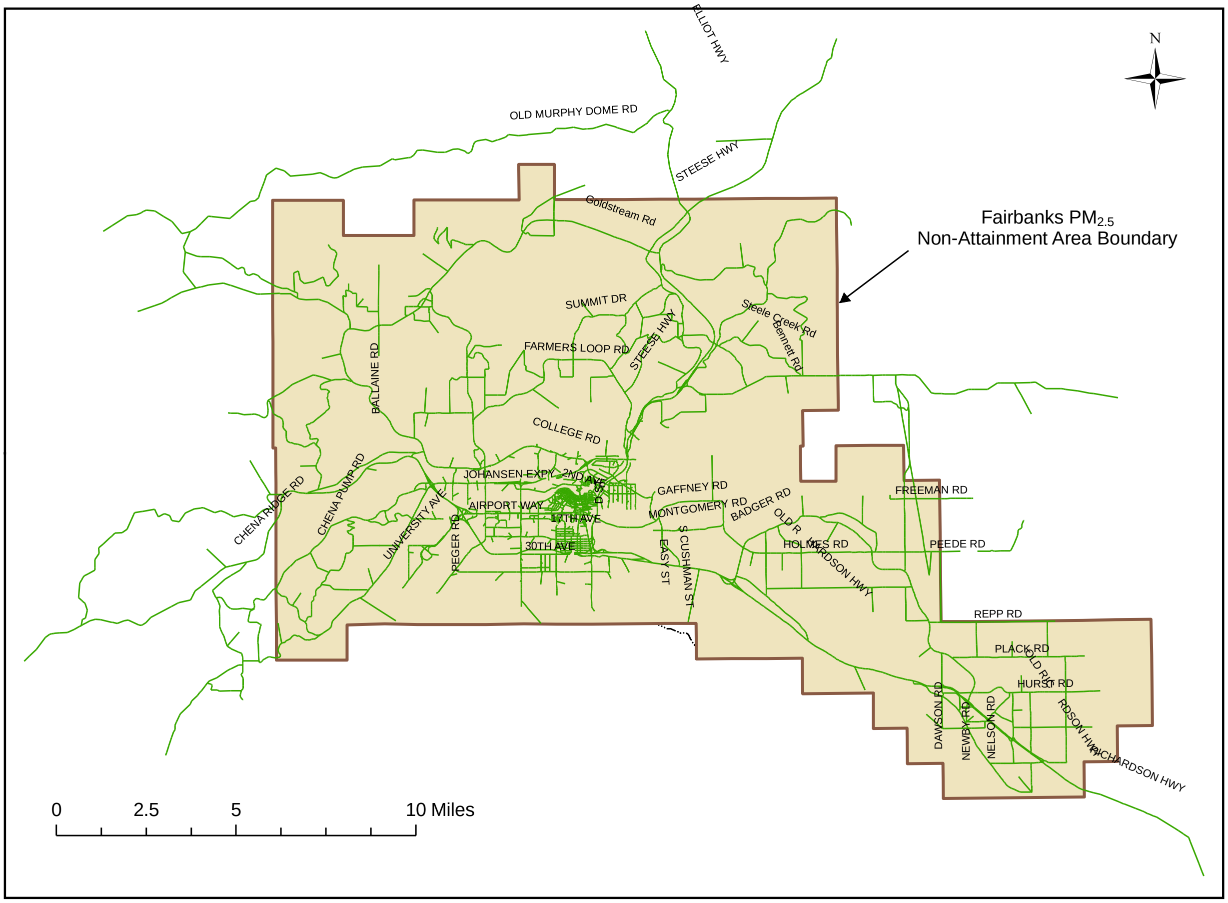

Figure 5.6-6. FMATS TransCAD Modeling Network

The TransCAD model was configured using 2010 U.S. Census-based socioeconomic data. TransCAD modeling was performed for a 2010 base year and a projected 2035 horizon year. Projected population and household data relied on Census 2010 projections and a 1% annual growth rate in forecasted employment 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 2010 base year and 2035 forecast year are presented in Table 5.6-6.

Table 5.6-6
TransCAD Average Daily VMT by Analysis Year, Daily Period and Fleet Category

Period / Vehicle Type	Entire Modeling Area (PM NA Area)		
	2010	**2035**	**% Change**
Daily Period[a]			
AM Peak (AM)	132,469	187,841	**41.8%**
PM Peak (PM)	380,135	509,440	**34.0%**
Off-Peak (OP)	1,206,159	1,587,234	**31.6%**
Vehicle Type			
Passenger VMT	1,718,763	2,284,514	**32.9%**
Truck VMT	105,132	104,201	**-0.9%**
Total VMT	**1,823,895**	**2,388,715**	**31.0%**

[a] VMT by daily period was developed for the passenger fleet; truck VMT was modeled only on a daily basis.

Vehicle Activity Beyond FMATS Network – The geographic extent of the FMATS 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 Fairbanks (and have less impact on ambient air quality in Fairbanks). Nevertheless, for completeness, link-level travel estimates for major roadways beyond the FMATS 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 5.6-7 along with the smaller FMATS 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 2007, 2008, and 2009 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.

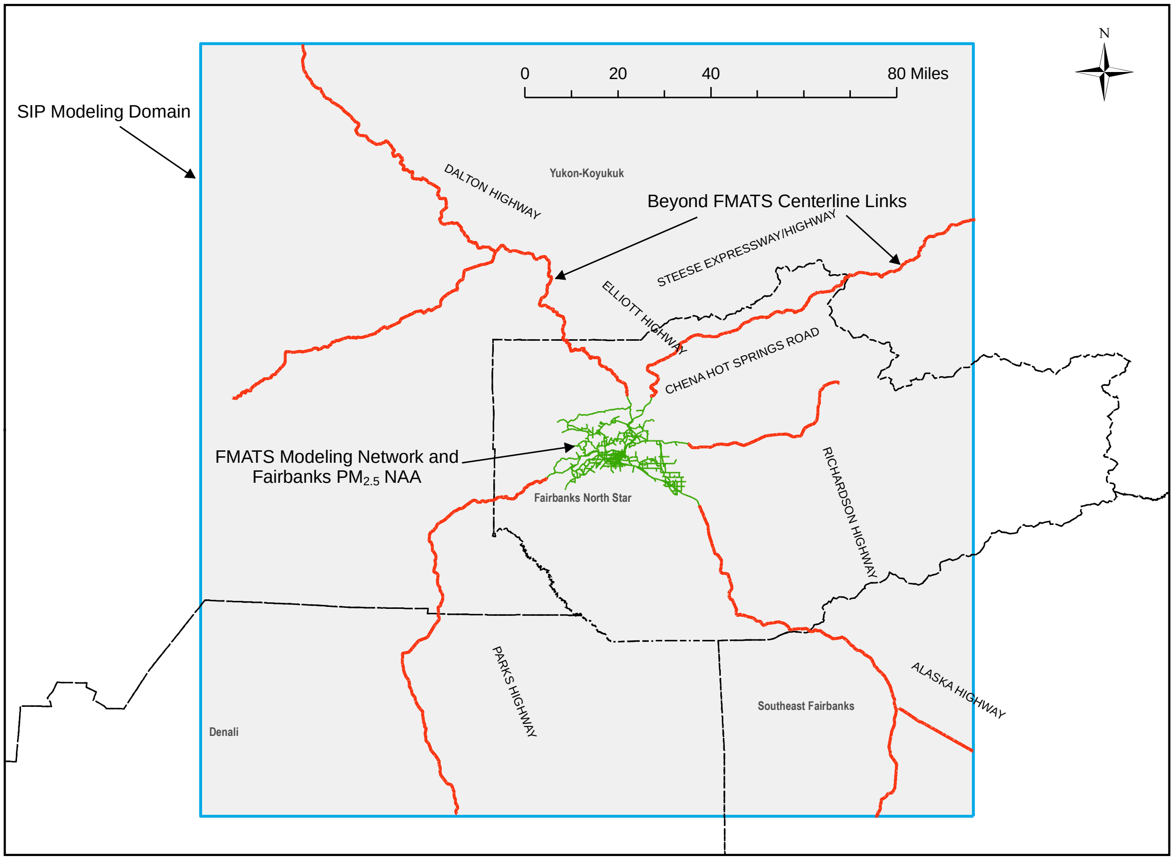

Figure 5.6-7. Additional ADOT&PF Roadway Links beyond FMATS Network

<u>Non-Road Mobile Sources</u> – Non-road sources encompass all mobile sources that are not on-road vehicles.[14] 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 modeling domain during the winter.)

NONROAD Model-Based – EPA's latest NONROAD emissions model, NONROAD2008,[15] 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);

[14] Although recent versions of EPA's NEI inventories (2008 and 2011) treat emissions for aircraft and supporting equipment and rail yard locomotive emissions as stationary point sources, emissions from these sources were "traditionally" located within the Non-Road source sector.
[15] U.S. EPA NONROAD Model, Version 2008a, released July 2009.

- 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[16] (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 noted for the last two equipment categories in the list above, the NONROAD model estimates emissions of support equipment for the rail and air sectors, but emissions from locomotives and aircraft are not addressed by NONROAD and were calculated separately using other models/methods as described in the sub-sections that follow.)

Default equipment populations and activity levels in the NONROAD model 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 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 area were substituted for EPA's default input values.

Nonexistent Wintertime Activity – Due to the severe outdoor weather conditions present in Fairbanks 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 emissions 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

[16] Although NONROAD can be configured to also estimate emissions from airport ground support equipment (GSE), GSE emissions were estimated using the EDMS model as described later.

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

Information on wintertime train activity (circa 2010) was obtained from the Alaska Railroad Corporation[17] (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[18] to estimate rail emissions within the emissions 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[19] (FBK); and (3) Eielson Air Force Base (EIL). The aircraft emissions were developed using the Federal Aviation Administration's (FAA) Emission and Dispersion Modeling System (EDMS). EDMS 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. At the time the analysis was performed, EDMS 5.1.3 was the latest available version.

The EDMS 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 EDMS 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.5.6 provides detailed descriptions of the activity inputs and NONROAD, EDMS, and locomotive emission modeling used to generate emissions for the Non-Road sector of the modeling inventory.

<u>Modeling Inventory Assembly and Pre-Processing</u> – 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

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[17] Email from Greg Lotakis, Alaska Railroad Corporation to Bob Dulla, Sierra Research, May 10, 2011.
[18] "Emission Factors for Locomotives," U.S. Environmental Protection Agency, Office of Transportation and Air Quality, EPA-420-F-09-025, April 2009.
[19] Formerly Ladd Air Force Base.

SMOKE using SCC-specific monthly, day of week and diurnal profiles based on surrogates described in Appendix III.D.5.6.

2008 Baseline Modeling Inventory Emissions – 2008 Baseline modeling 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 5.6-7 and Table 5.6-8 show 2008 Baseline emissions tabulated by source sector with actual (green shaded) and PTE (red shaded) emissions, respectively, for the Point source sector. (The Space Heating and On-Road sectors are further broken out into key subcategories.) Emissions are shown in both tables for the entire Grid 3 modeling domain and the smaller $PM_{2.5}$ non-attainment area and are presented on an average daily basis over the 35 episode days.

Table 5.6-7
2008 Baseline Episode Average Daily Emissions (tons/day) by Source Sector, Actual Point Source Emissions

	Grid 3 Domain Emissions (tons/day)					*NA Area Emissions (tons/day)*				
Source Sector	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**
Point (Actual)	1.423	8.380	13.395	0.096	n/a	1.412	8.167	13.285	0.096	n/a
Area, Space Heating	3.098	4.286	2.391	12.369	0.149	2.756	3.865	2.182	11.058	0.136
Area, Space Heat, Wood	2.986	0.095	0.421	12.207	0.110	2.656	0.084	0.373	10.914	0.098
Area, Space Heat, Oil	0.062	4.121	1.774	0.098	0.003	0.056	3.719	1.617	0.088	0.003
Area, Space Heat, Other	0.050	0.070	0.196	0.065	0.037	0.043	0.062	0.192	0.056	0.035
Area, Other	0.064	0.000	0.003	0.692	0.000	0.061	0.000	0.002	0.569	0.000
On-Road	0.811	0.057	5.743	7.439	0.088	0.676	0.046	4.625	5.725	0.071
On-Road, Running Exh	0.503	0.050	4.322	0.941	0.088	0.435	0.040	3.561	0.765	0.071
On-Road, Start & Idle Exh	0.308	0.008	1.421	6.410	0.000	0.242	0.006	1.064	4.894	0.000
On-Road, Evap	0.000	0.000	0.000	0.088	0.000	0.000	0.000	0.000	0.066	0.000
Non-Road	0.238	0.151	2.135	12.262	0.005	0.027	0.077	1.088	0.451	0.003
TOTALS	**5.633**	**12.875**	**23.667**	**32.859**	**0.242**	**4.932**	**12.155**	**21.182**	**17.898**	**0.210**

n/a – Not available.

Although 2008 Baseline inventories are shown reflecting both actual and PTE emissions within the point source sector, attainment modeling (both model validation and attainment demonstration modeling) described in later Section 5.8 was based on actual point source emissions for the 2008 baseline in accordance with CAA Section 172(c)(3).

For completeness, inventory summaries are generally presented for both actual and PTE point source emissions throughout the remainder of this chapter. Attainment modeling described in Section 5.8 was based on actual emissions for the 2008 baseline and examined both actual and PTE emissions for future years (e.g., 2015) in accordance with EPA guidance[20].

[20] "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze," U.S. Environmental Protection Agency, EPA-454/B-07-002, April 2007.

Table 5.6-8
2008 Baseline Episode Average Daily Emissions (tons/day) by Source Sector, PTE Point Source Emissions

Source Sector	*Grid 3 Domain Emissions (tons/day)*					*NA Area Emissions (tons/day)*				
	$PM_{2.5}$	**SO_2**	**NO_x**	**VOC**	**NH_3**	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**
Point (PTE)	2.773	26.612	29.609	0.845	n/a	1.595	22.973	27.393	0.826	n/a
Area, Space Heating	3.098	4.286	2.391	12.369	0.149	2.756	3.865	2.182	11.058	0.136
Area, Space Heat, Wood	2.986	0.095	0.421	12.207	0.110	2.656	0.084	0.373	10.914	0.098
Area, Space Heat, Oil	0.062	4.121	1.774	0.098	0.003	0.056	3.719	1.617	0.088	0.003
Area, Space Heat, Other	0.050	0.070	0.196	0.065	0.037	0.043	0.062	0.192	0.056	0.035
Area, Other	0.064	0.000	0.003	0.692	0.000	0.061	0.000	0.002	0.569	0.000
On-Road	0.811	0.057	5.743	7.439	0.088	0.676	0.046	4.625	5.725	0.071
On-Road, Running Exh	0.503	0.050	4.322	0.941	0.088	0.435	0.040	3.561	0.765	0.071
On-Road, Start & Idle Exh	0.308	0.008	1.421	6.410	0.000	0.242	0.006	1.064	4.894	0.000
On-Road, Evap	0.000	0.000	0.000	0.088	0.000	0.000	0.000	0.000	0.066	0.000
Non-Road	0.238	0.151	2.135	12.262	0.005	0.027	0.077	1.088	0.451	0.003
TOTALS	**6.983**	**31.107**	**39.881**	**33.607**	**0.242**	**5.115**	**26.961**	**35.290**	**18.628**	**0.210**

n/a – Not available.

To provide a clearer picture of the relative emissions contributions of each source sector, Figure 5.6-8 through Figure 5.6-12 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 non-attainment area based on <u>actual</u> point source emissions. (The breakdowns are similar for the larger Grid 3 domain and thus are not shown.)

As seen in Figure 5.6-8, space heating dominates episodic emissions of $PM_{2.5}$, representing roughly 56% of total $PM_{2.5}$ emitted within the non-attainment area. Wood-burning alone contributes nearly 54% to total $PM_{2.5}$. Point sources and on-road vehicles comprise 29% and 14% of total $PM_{2.5}$, respectively. All other area sources and non-road mobile sources combined encompass under 2%.

As shown in Figure 5.6-9 through Figure 5.6-12, 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. For NH_3, in the absence of data for point sources, wood-burning space heating is the largest contributor of those source sectors for which emission data were available.

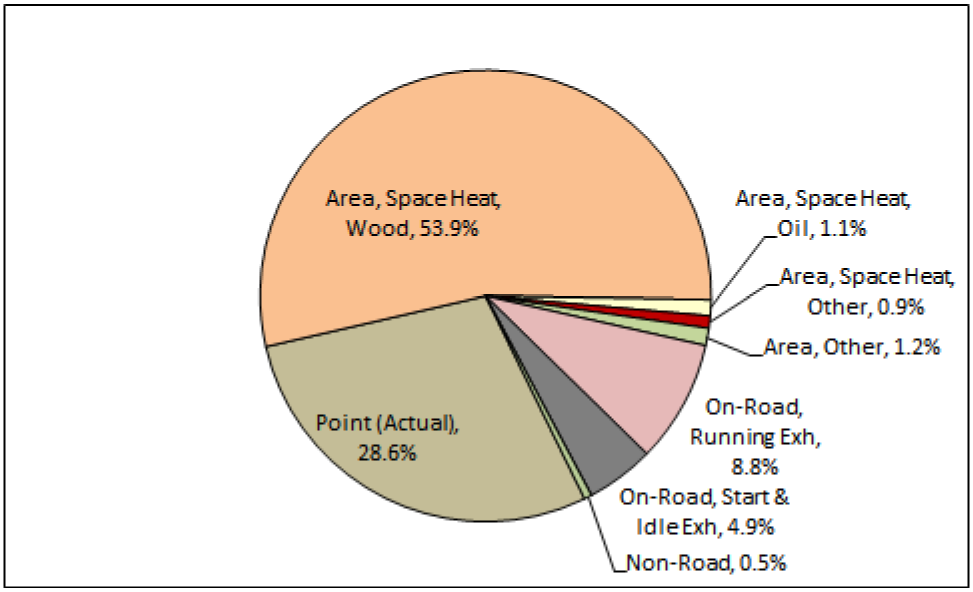

Figure 5.6-8. 2008 Baseline Episodic Non-Attainment Area Emissions, Actual Point Source Emissions, Relative $PM_{2.5}$ Contributions (%)

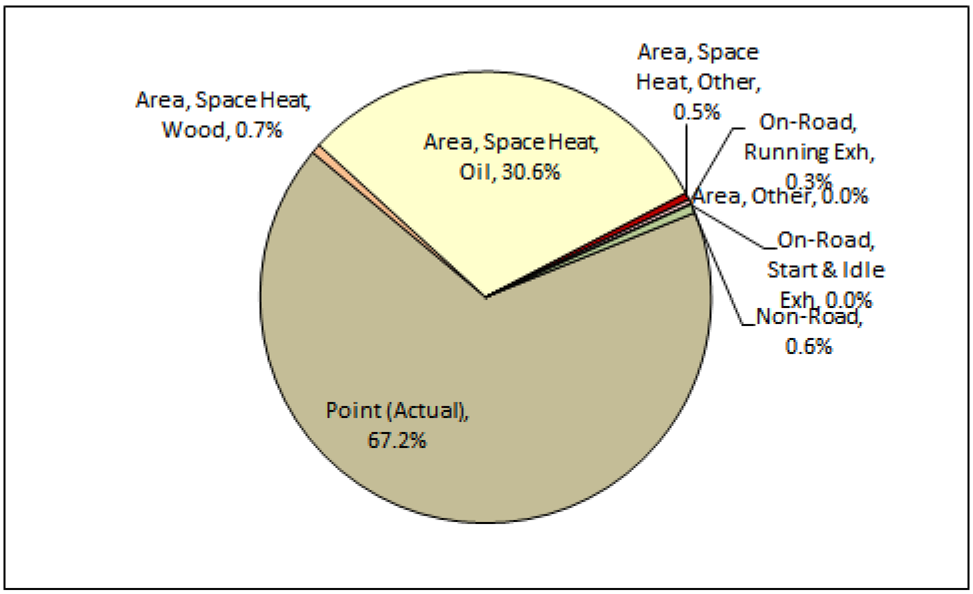

Figure 5.6-9. 2008 Baseline Episodic Non-Attainment Area Emissions, Actual Point Source Emissions, Relative SO_2 Contributions (%)

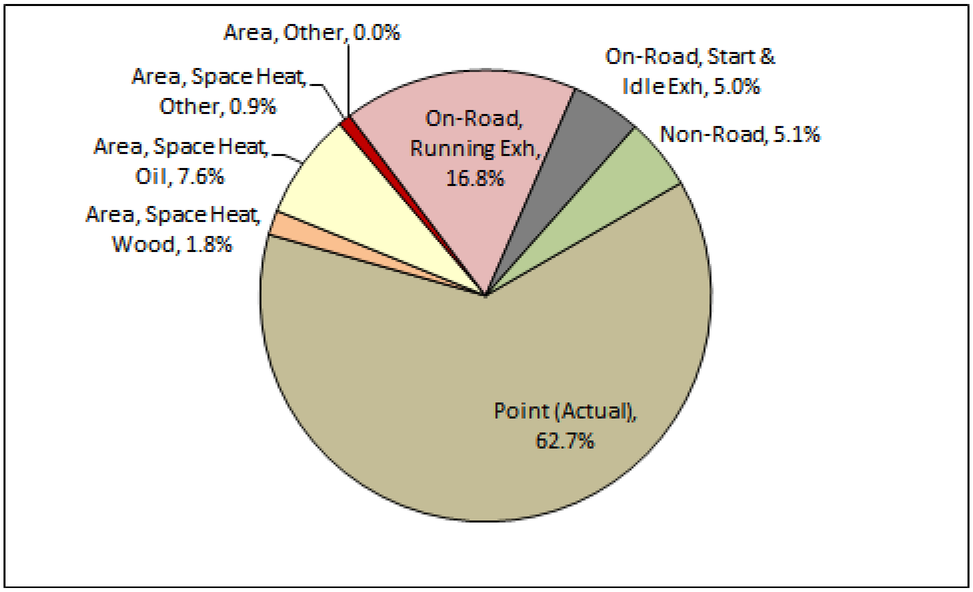

Figure 5.6-10. 2008 Baseline Episodic Non-Attainment Area Emissions, Actual Point Source Emissions, Relative NO_x Contributions (%)

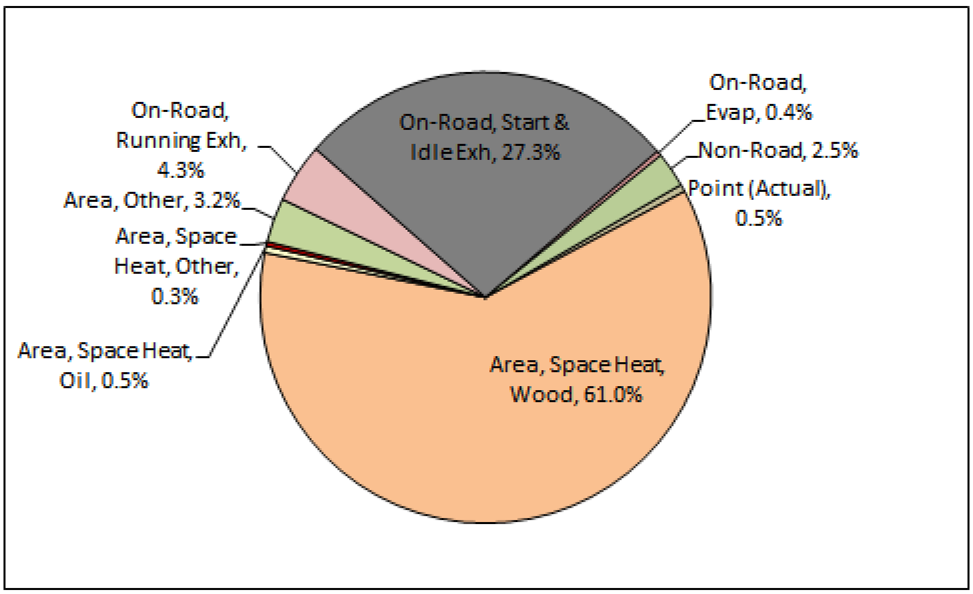

Figure 5.6-11. 2008 Baseline Episodic Non-Attainment Area Emissions, Actual Point Source Emissions, Relative VOC Contributions (%)

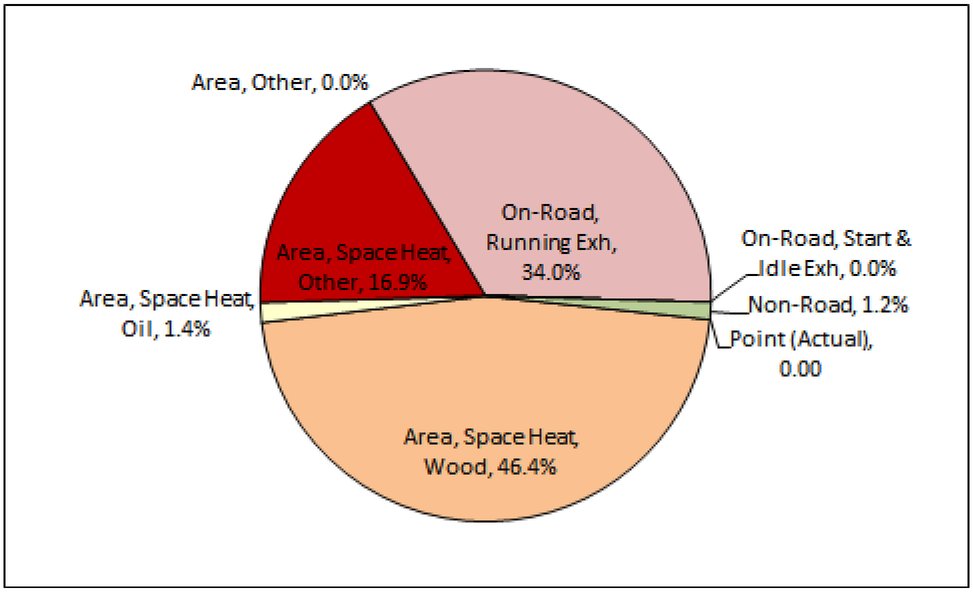

Figure 5.6-12. 2008 Baseline Episodic Non-Attainment Area Emissions, Actual Point Source Emissions, Relative NH_3 Contributions (%)

Figure 5.6-13 through Figure 5.6-17 provide similar source contribution breakdowns using PTE rather than actual point source emissions. Not surprisingly, point sources represent a larger share relative to total emissions when using their PTE, rather than actual, emissions.

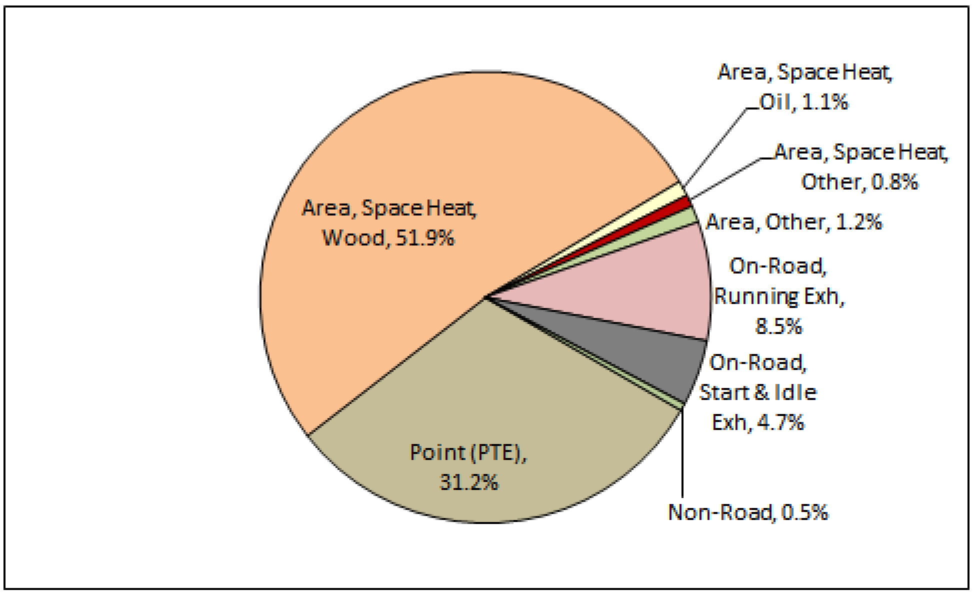

Figure 5.6-13. 2008 Baseline Episodic Non-Attainment Area Emissions, PTE Point Source Emissions, Relative $PM_{2.5}$ Contributions (%)

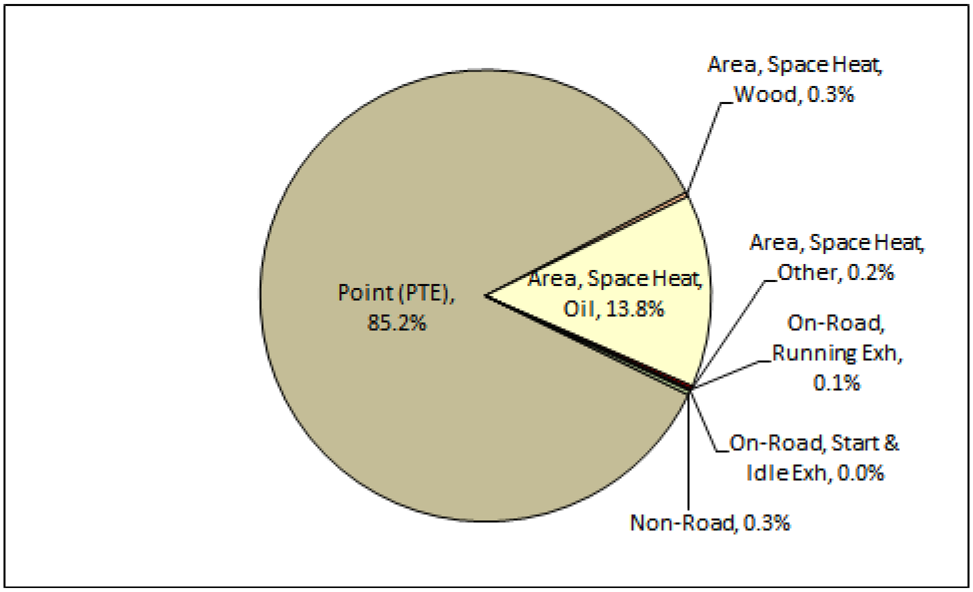

Figure 5.6-14. 2008 Baseline Episodic Non-Attainment Area Emissions, PTE Point Source Emissions, Relative SO_2 Contributions (%)

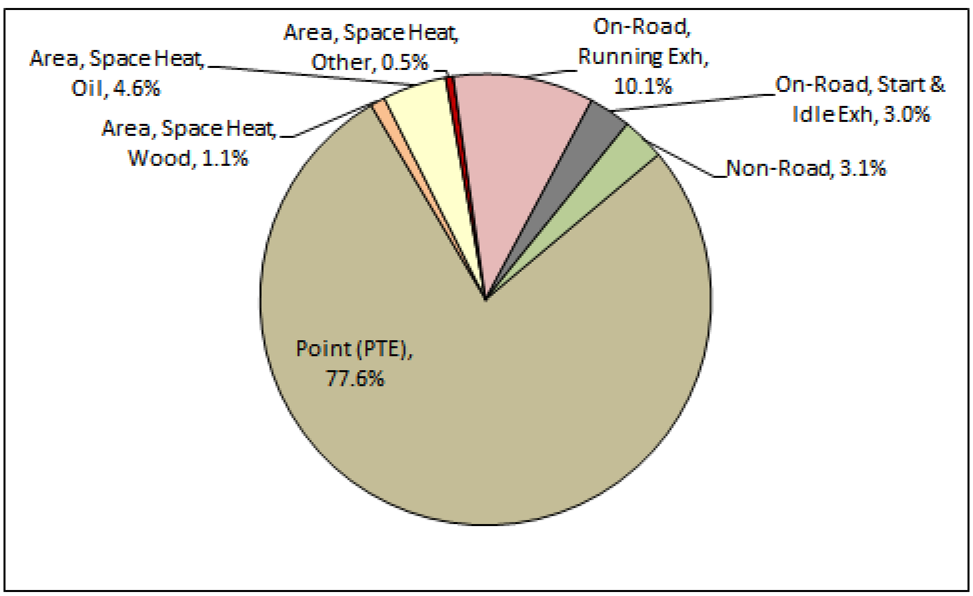

Figure 5.6-15. 2008 Baseline Episodic Non-Attainment Area Emissions, PTE Point Source Emissions, Relative NO_x Contributions (%)

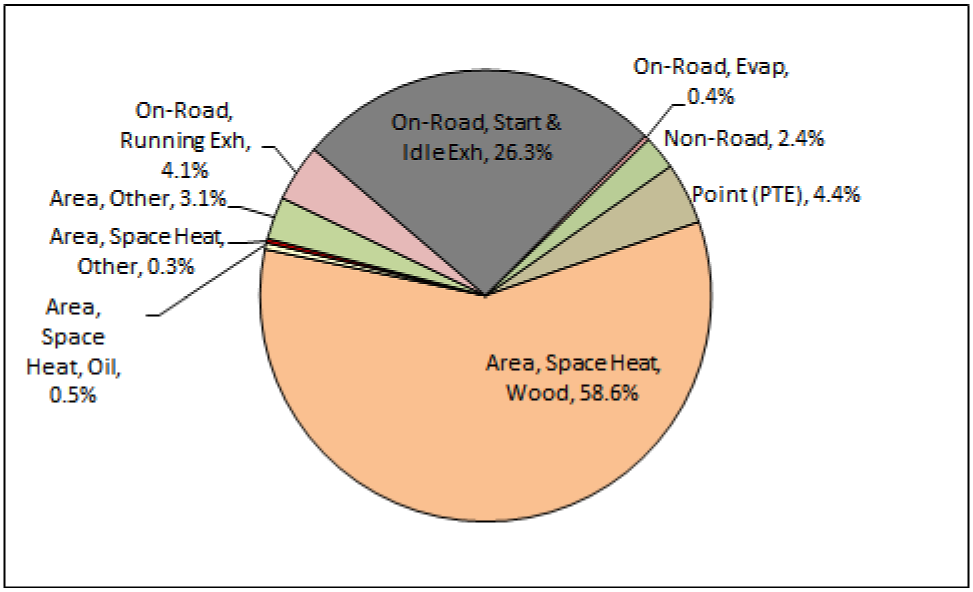

Figure 5.6-16. 2008 Baseline Episodic Non-Attainment Area Emissions, PTE Point Source Emissions, Relative VOC Contributions (%)

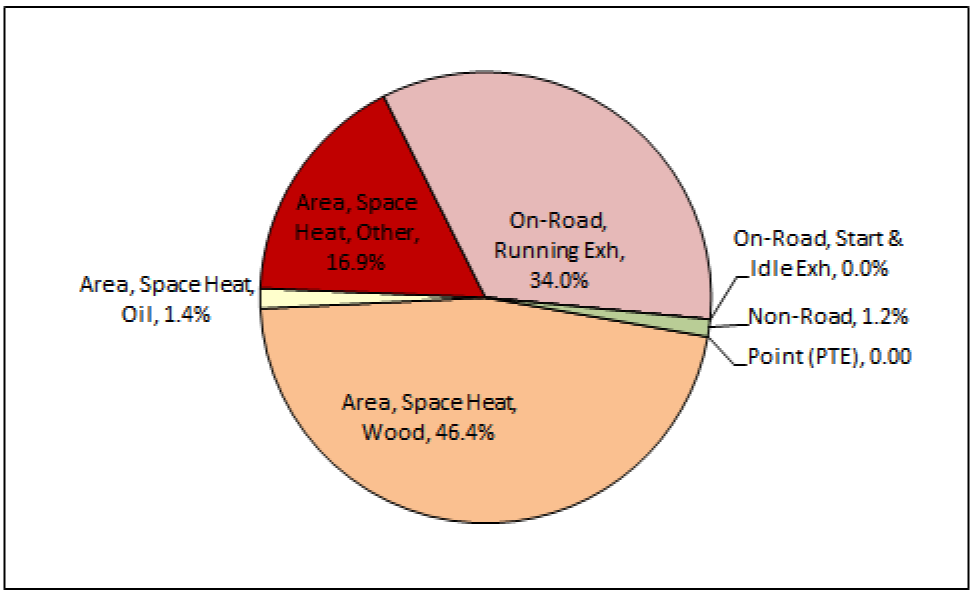

Figure 5.6-17. 2008 Baseline Episodic Non-Attainment Area Emissions, PTE Point Source Emissions, Relative NH_3 Contributions (%)

Finally, Figure 5.6-18 through Figure 5.6-22 illustrate how $PM_{2.5}$ emissions under episodic wintertime conditions are spatially distributed across the non-attainment area and immediately 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. 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 5.6-18 presents the spatial emissions distribution for all inventory sources within each grid cell. Figure 5.6-19 through Figure 5.6-22 then show individual distributions for each source sector (using some aggregation of earlier tabulations and plots) as follows:

- Figure 5.6-19 – Space Heating sources;
- Figure 5.6-20 – Point sources;
- Figure 5.6-21 – On-Road Mobile sources; and
- Figure 5.6-22 – 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.

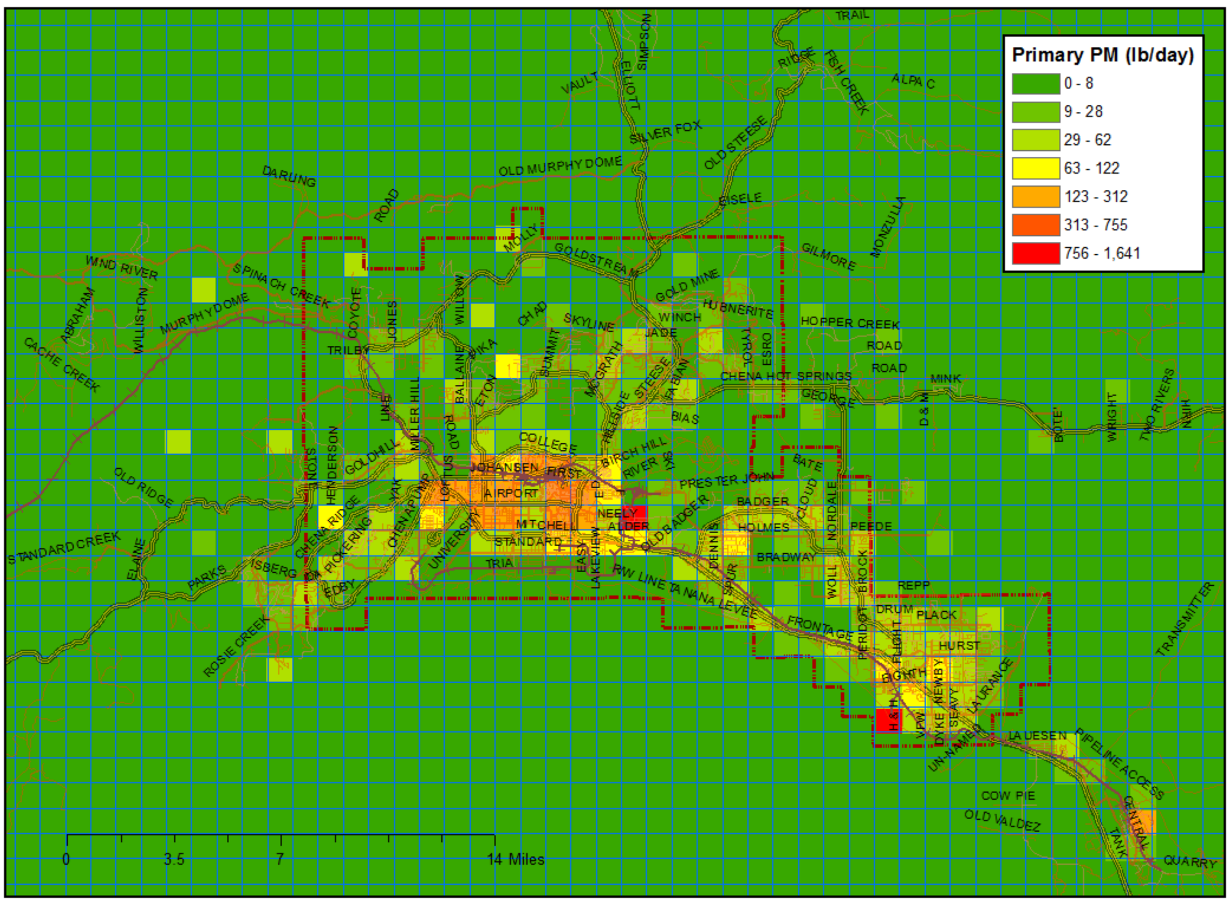

Figure 5.6-18. 2008 Baseline Gridded $PM_{2.5}$ Emissions, All Sources

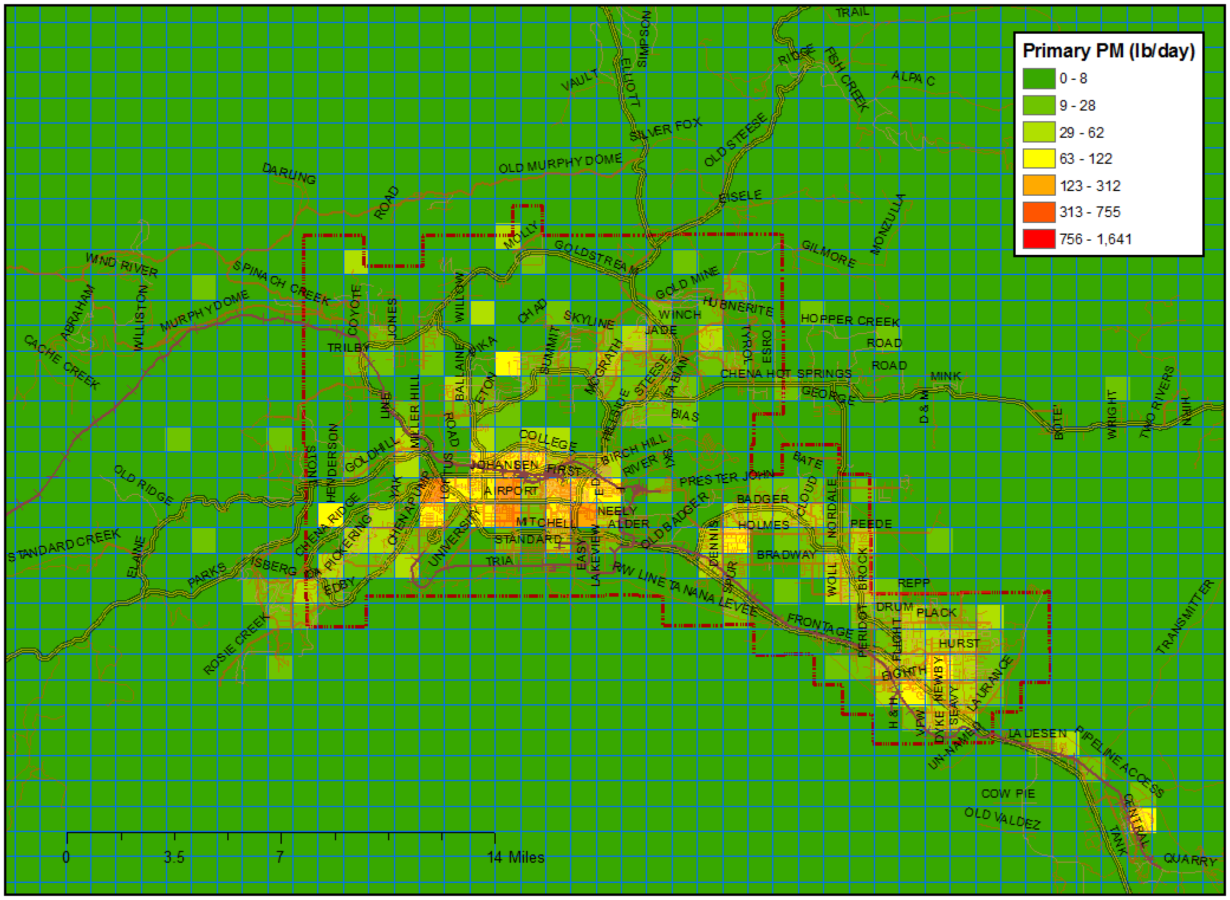

Figure 5.6-19. 2008 Baseline Gridded $PM_{2.5}$ Emissions, Space Heating Sources

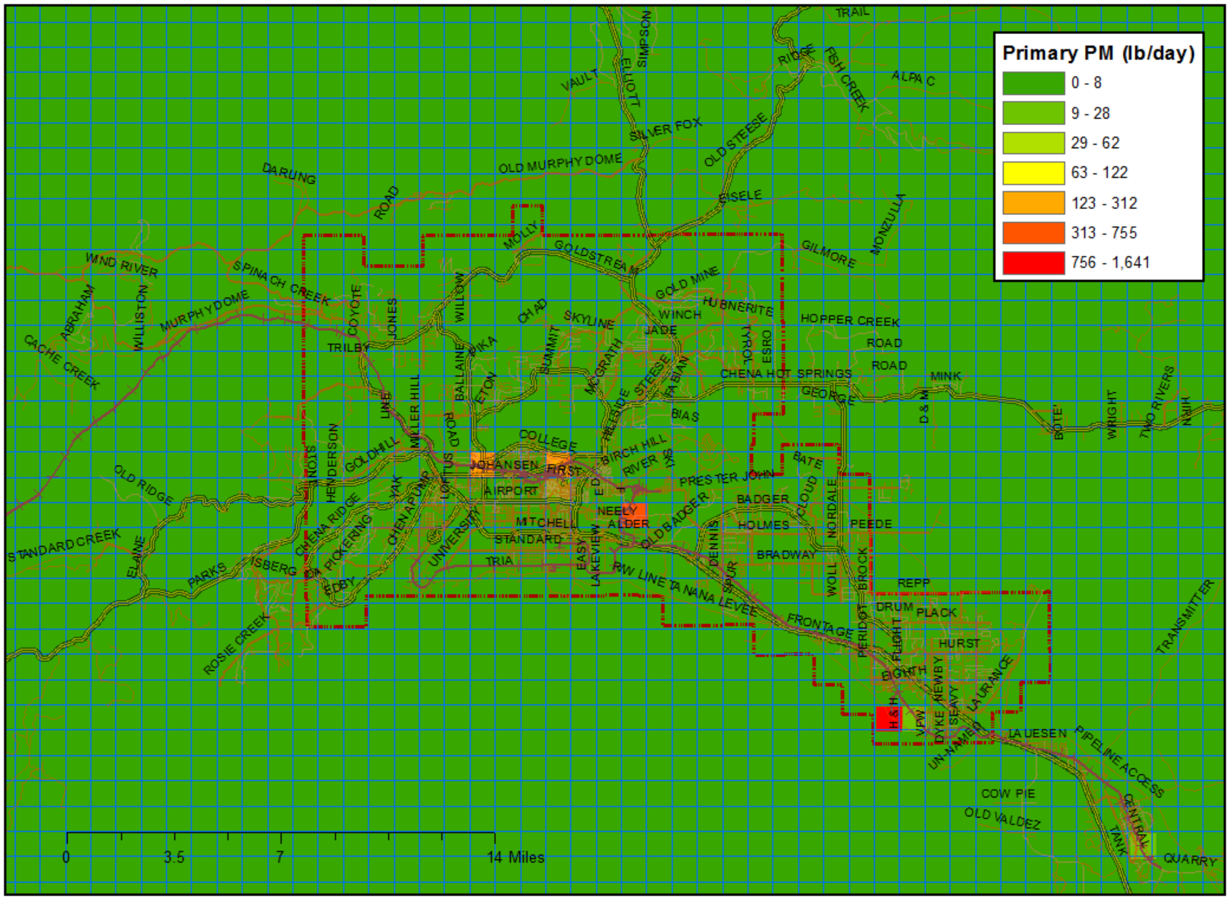

Figure 5.6-20. 2008 Baseline Gridded $PM_{2.5}$ Emissions, Point Sources

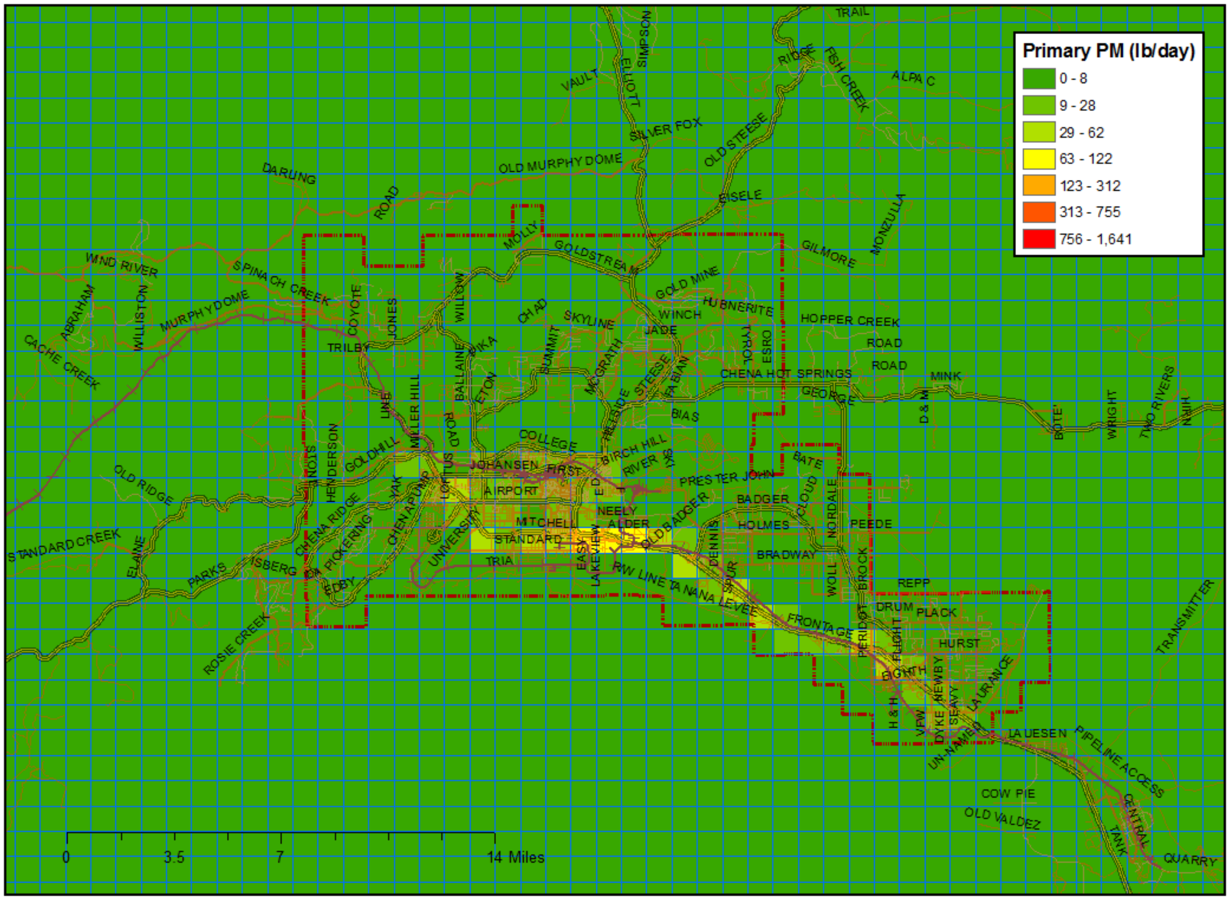

Figure 5.6-21. 2008 Baseline Gridded $PM_{2.5}$ Emissions, On-Road Sources

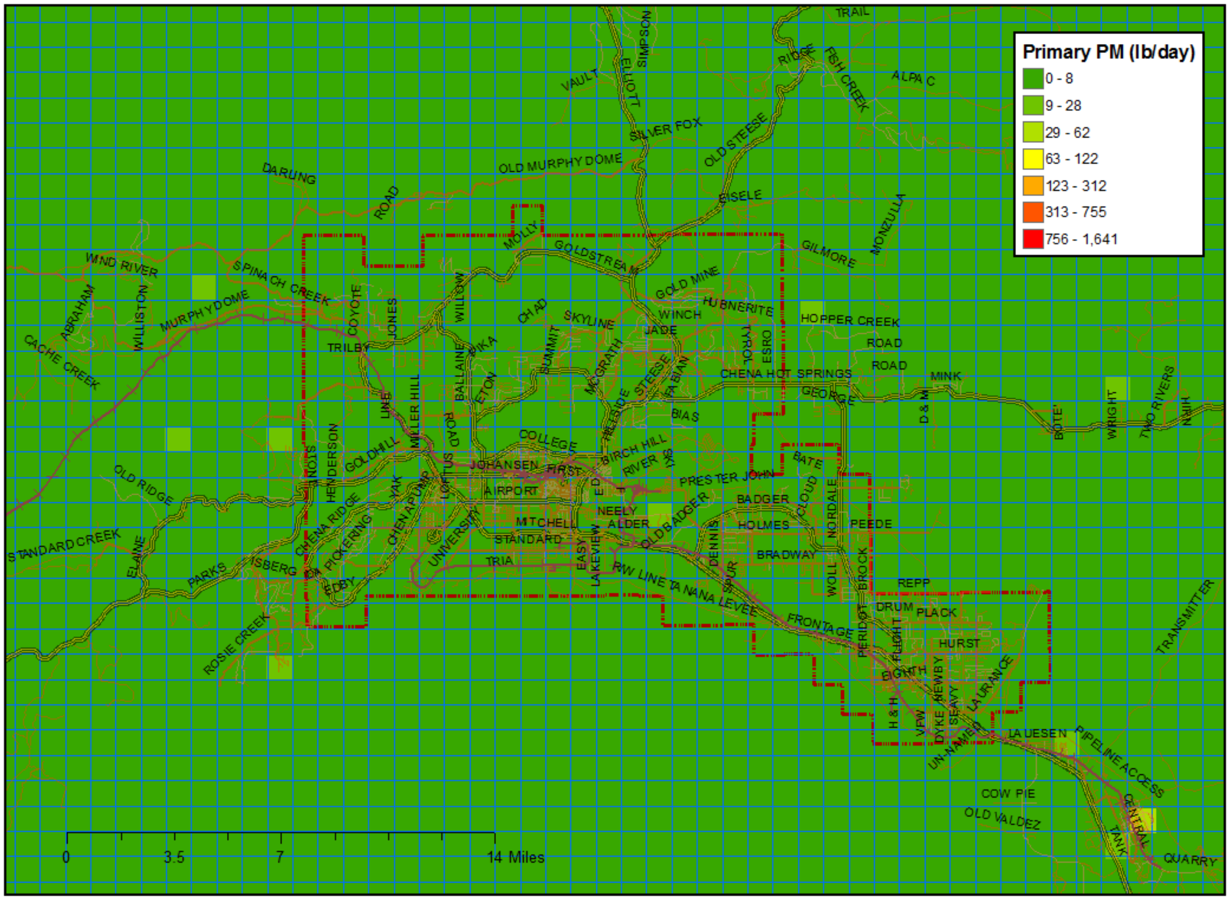

Figure 5.6-22. 2008 Baseline Gridded $PM_{2.5}$ Emissions, Other Area and Non-Road Sources

5.6.2.2 Base Year Planning Inventories

In addition to the 2008 Baseline modeling inventory used to support the attainment analysis, two 2008 base year emission inventories were developed as listed earlier in Table 5.6-1 to satisfy EPA regulatory and CAA requirements: (1) a <u>statewide</u> annual inventory to satisfy EPA regulations; and (2) a <u>non-attainment</u> area inventory to meet CAA 172(c)(3) requirements. Each of these planning inventories is described separately below.

<u>2008 Statewide Base Year Planning Inventory</u> – The statewide Base Year inventory compiled to satisfy EPA regulations was developed simply from EPA's 2008 National Emissions Inventory (NEI). The NEI is a comprehensive nationwide inventory compiled by EPA at the state and county level based on emissions data and source activity inputs provided every three years by state, local, and tribal agencies that is reviewed and supplemented with EPA's own estimates for specific source categories (e.g., on-road mobile sources).

As required under EPA regulations, the statewide Base Year inventory represents emissions on an annual (tons per year) basis, representing both summer and winter activity and emissions, and contains estimates of actual (rather than permitted or PTE) emissions from stationary point sources.

Table 5.6-9 presents Alaska statewide annual emissions for all criteria pollutants based on EPA's 2008 NEI Version 3[21] inventory. The estimates in Table 5.6-9 were developed by culling records for Alaska emission sources from the "All Sector" National-County aggregated sector database downloaded from the 2008 NEI website.[22]

These NEI emissions were compiled by EPA by Emission Inventory Sector (EIS) as shown in Table 5.6-9. The data are summarized by EIS to provide a more detailed breakdown of emissions by each of the nearly 50 sector categories and to avoid confusion with subsequent inventory estimates presented for the Fairbanks $PM_{2.5}$ non-attainment area that are summarized in the traditional "Point, Area (Nonpoint), Onroad, Nonroad" source type basis. In the 2008 NEI (and subsequent NEI inventories), EPA relocated emissions from aircraft takeoff/landing operation, airport Ground Support Equipment (GSE) and Auxiliary Power Unit (APU) activity, and rail yard locomotive emissions from the Non-Road sector to the Stationary Point sector. Thus, the NEI-based statewide 2008 Base Year inventory is summarized by EIS category rather than the traditional data category groups.

[21] Version 3 version of the 2008 NEI was released in March 2013 and included updated estimates of on-road mobile source emissions using EPA's latest (at the time) MOVES2010b vehicle emissions model.
[22] http://www.epa.gov/ttn/chief/net/2008inventory.html.

Table 5.6-9
2008 Base Year Alaska Statewide Annual Emissions Inventory

	Annual Emissions (tons/year)						
Emission Inventory Sector (EIS)	**VOC**	**CO**	**NO_x**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
Agriculture - Crops & Livestock Dust	0	0	0	0	0	0	0
Bulk Gasoline Terminals	25	4	2	0	0	0	0
Commercial Cooking	25	65	0	0	175	175	0
Dust - Construction Dust	0	0	0	0	7,954	795	0
Dust - Paved Road Dust	0	0	0	0	1,950	487	0
Dust - Unpaved Road Dust	0	0	0	0	84,484	8,401	0
Fires – Wildfires	2,159	46,498	899	247	4,499	4,149	209
Fuel Comb - Comm/Institutional - Coal	2	185	510	253	7	4	0
Fuel Comb - Comm/Institutional - Natural Gas	2	35	42	1	3	3	0
Fuel Comb - Comm/Institutional - Oil	10	84	322	122	15	13	0
Fuel Comb - Comm/Institutional - Other	16	305	39	3	1	1	0
Fuel Comb - Electric Generation - Coal	91	1,583	1,437	990	116	101	164
Fuel Comb - Electric Generation - Natural Gas	401	2,542	9,996	134	278	278	5
Fuel Comb - Electric Generation - Oil	404	1,925	14,459	1,499	308	290	0
Fuel Comb - Electric Generation - Other	0	0	0	0	0	0	0
Fuel Comb - Industrial Boilers, ICEs - Coal	14	616	676	733	14	9	0
Fuel Comb - Industrial Boilers, ICEs - Natural Gas	512	8,841	36,959	921	1,059	1,054	0
Fuel Comb - Industrial Boilers, ICEs - Oil	108	1,020	4,023	392	210	204	0
Fuel Comb - Industrial Boilers, ICEs - Other	1	2	5	2	3	3	0
Fuel Comb - Residential - Natural Gas	57	412	969	6	5	4	206
Fuel Comb - Residential – Oil	32	231	831	1,966	110	98	46
Fuel Comb - Residential – Other	226	6,157	268	215	140	86	45
Fuel Comb - Residential – Wood	1,112	6,186	94	17	899	898	51
Gas Stations	2,979	0	0	0	0	0	0
Industrial Processes - Chemical Manuf	0	1	34	0	0	0	7
Industrial Processes – Mining	0	0	0	0	5,265	673	0
Industrial Processes – NEC	40	20	35	19	621	274	0
Industrial Processes - Non-ferrous Metals	0	0	3	2	1	1	0
Industrial Processes - Oil & Gas Production	721	2,678	1,499	151	190	181	1
Industrial Processes - Petroleum Refineries	989	251	683	90	90	70	1
Industrial Processes - Storage and Transfer	1,306	0	0	0	19	16	0
Miscellaneous Non-Industrial NEC	857	0	1	0	0	0	0
Mobile – Aircraft	950	10,644	3,020	296	172	70	0
Mobile - Commercial Marine Vessels	609	3,943	24,370	5,180	1,179	1,114	11
Mobile – Locomotives	73	203	1,730	15	42	41	0
Mobile - Non-Road Equipment - Diesel	290	2,752	2,583	361	214	207	2
Mobile - Non-Road Equipment - Gasoline	18,639	65,641	731	15	491	452	5
Mobile - Non-Road Equipment - Other	40	913	187	8	11	11	0
Mobile - On-Road Diesel Heavy Duty Vehicles	453	1,923	7,516	207	695	651	13
Mobile - On-Road Diesel Light Duty Vehicles	19	72	125	5	16	15	1
Mobile - On-Road Gasoline Heavy Duty Vehicles	325	7,662	542	14	34	28	7
Mobile - On-Road Gasoline Light Duty Vehicles	5,943	108,088	7,513	265	612	500	209
Solvent - Consumer & Commercial Solvent Use	2,915	0	0	0	0	0	0
Solvent - Dry Cleaning	140	0	0	0	0	0	0
Solvent - Industrial Surface Coating & Solvent Use	4	0	0	0	0	0	0
Solvent - Non-Industrial Surface Coating	1,033	0	0	0	0	0	0
Waste Disposal	382	4,899	426	104	1,023	935	20
TOTALS	**43,902**	**286,381**	**122,530**	**14,234**	**112,905**	**22,295**	**1,003**

2008 Non-Attainment Area Base Year Planning Inventory – 2008 Base Year emission estimates were also compiled for the Fairbanks $PM_{2.5}$ Non-Attainment Area (shown earlier in Figure 5.6-1). These Fairbanks Non-Attainment Area (NA Area) planning inventory emissions were developed on both an annual average daily and a winter season average daily basis to address CAA 172(c)(3) requirements.

Two different approaches, summarized below, were considered in developing these NA Area Base Year planning emissions estimates.

1. *NEI-Based* – Spatial scaling of 2008 NEI emissions for the Fairbanks North Star Borough to the smaller NA Area and temporal scaling of annual NEI estimates to winter season average daily estimates.

2. *Modeling Inventory-Based* – Use of detailed "bottom-up" based emission estimates compiled by grid cell for both the entire modeling domain and the portion within the NA Area and temporal scaling of episodic daily emissions to annual and winter season average daily estimates.

The latter approach was determined to be the best alternative, utilizing detailed estimates of individual source category emissions based on locally collected activity data (and emission factor data for key source types) used to support the more rigorously developed modeling inventories, despite sacrificing potential consistency with the NEI.[23]

Table 5.6-10 presents estimates of 2008 Base Year NA Area annual and winter season average daily emissions (in tons/day) tabulated using the traditional "Point, Area, Onroad, Nonroad" source types. Within selected source types (Area and Onroad), emissions are further broken out into key source groups based on similar stratifications used in summarizing modeling inventory emissions. As noted in the first row of Table 5.6-10, PTE, rather than actual emissions are presented for the NA Area inventory in accordance with CAA 172(c)(3) requirements.

The annual average daily emissions shown in Table 5.6-10 were roughly estimated based on temporal scaling factors used to ratio average daily episodic emissions from the modeling inventory. The winter season average daily emissions for the NA Area planning inventory were simply estimated as equal to average daily episodic emissions. For emission sources whose activity or emission factors are dependent on ambient temperature, these simplistic estimates of winter season average daily emissions would actually be lower than those listed in the rightmost columns of Table 5.6-10.

[23] In developing the NEI, EPA has not fully accounted for Alaska-specific conditions. Although the NEI itself includes data submitted by Alaska State, local, and tribal air agencies, it often utilizes emission factors for some source categories based on Lower-48 conditions. Moreover, ancillary inventory spatial/temporal allocation databases either do not extend to Alaska or are not adequately representative of strong seasonal source activity variations (e.g., space heating) resulting from harsh Arctic winters. The purpose of this footnote is not to criticize EPA's efforts, but to clarify the underlying rationale for utilizing locally developed emission estimates.

Table 5.6-10
2008 Non-Attainment Area Base Year Planning Emissions Inventory

Source Type/Category	Annual Average Day (tons/day)					Winter Season Average Day (tons/day)				
	$PM_{2.5}$	SO_2	NO_x	VOC	NH_3	$PM_{2.5}$	SO_2	NO_x	VOC	NH_3
Point (PTE)	1.595	22.973	27.393	0.826	n/a	1.595	22.973	27.393	0.826	n/a
Area, Space Heating	1.481	2.351	1.322	5.901	0.073	2.756	3.865	2.182	11.058	0.136
Area, Space Heat, Wood	1.427	0.051	0.226	5.824	0.053	2.656	0.084	0.373	10.914	0.098
Area, Space Heat, Oil	0.030	2.262	0.980	0.047	0.002	0.056	3.719	1.617	0.088	0.003
Area, Space Heat, Other	0.023	0.038	0.117	0.030	0.019	0.043	0.062	0.192	0.056	0.035
Area, Other	22.499	0.000	3.645	13.354	0.000	0.061	0.000	0.002	0.569	0.000
On-Road	0.772	0.070	4.966	8.212	0.072	0.676	0.046	4.625	5.725	0.071
On-Road, Running Exh	0.496	0.062	3.823	1.098	0.072	0.435	0.040	3.561	0.765	0.071
On-Road, Start & Idle Exh	0.276	0.009	1.143	7.019	0.000	0.242	0.006	1.064	4.894	0.000
On-Road, Evap	0.000	0.000	0.000	0.095	0.000	0.000	0.000	0.000	0.066	0.000
Non-Road	0.019	0.073	1.112	0.270	0.003	0.027	0.077	1.088	0.451	0.003
TOTALS	**26.364**	**25.468**	**38.438**	**28.563**	**0.148**	**5.115**	**26.961**	**35.290**	**18.628**	**0.210**

n/a – Not available.

Table 5.6-11 lists the scaling factors that were developed and applied by pollutant within each source type/group to generate the estimates of annual average daily emissions shown in Table 5.6-10 by applying these factors to average daily episodic emission estimates from the modeling inventory. For Space Heating Area sources, the scaling factors were developed based on comparisons of winter, summer, and annual average Fairbanks space heating emissions generated for Fairbanks under the aforementioned Big 3 inventory study, coupled with a Heating Degree Day (HDD) adjustment to account for differences between temperature under the modeling episodes versus the six-month (Oct-Mar) winter season estimates from the Big 3 study. The On-Road Mobile scaling factors were similarly developed from earlier Big 3 estimates, but without the HDD adjustment. For the Other Area and Non-Road Mobile sectors, the scaling factors were calculated directly from winter and annual emission estimates generated for those sectors.

Table 5.6-11
Temporal Scaling Factors for Non-Attainment Area Annual Planning Emissions

Source Type/Group	Episodic/Annual Scaling Factors				
	$PM_{2.5}$	SO_2	NO_X	VOC	NH_3
Point	N/A	N/A	N/A	N/A	N/A
Area, Space Heating	1.862	1.644	1.650	1.874	1.857
Area, Other	0.003	0.000	0.001	0.043	0.000
Mobile, On-Road	0.876	0.655	0.931	0.697	0.994
Mobile, Non-Road	1.456	1.046	0.979	1.669	1.022

N/A – Not applicable.

Based on the manner in which they were calculated, the scaling factors represent ratios of winter episodic-to-annual emissions. Thus, annual emissions in Table 5.6-10 were calculated from episodic emissions by dividing by the scaling factors in Table 5.6-11. (For example, annual average daily space heating emissions for $PM_{2.5}$ were estimated as 2.756 ÷ 1.862 = 1.481 tons/day.)

5.6.3. 2015 AND 2019 PROJECTED BASELINE INVENTORIES

Emission inventories for the two future years examined in this SIP—2015 (the Moderate Area attainment target year) and 2019 (the year in which attainment is projected to occur)—were developed in two stages. The first stage, referred to as the Project Baseline inventories, consists of forecasting emissions from the baseline year (2008) into future years (2015 and 2019) based only on the effects of projected demographic/economic trends and already adopted federal, State, and local control measures that existed prior to the development of this SIP. (The second and final stage, referred to as Control inventories, incorporates incremental emission reductions from control programs and measures adopted under this SIP and are discussed in the following sub-section.)

5.6.3.1 Emissions Projection Methodology

Growth Factors – Levels of projected source activity growth can vary depending upon the type of source category. A series of potential growth factors were assembled from several sources for use in forecasting the activity component of 2008 baseline emissions forward to 2015 and 2019. Table 5.6-12 below summarizes the growth rates applied to project activity by source sector and the sources or assumptions upon which they were based.

Table 5.6-12
Summary of Growth Rates Applied in Projected Baseline Inventories

Source Type/Group	Annualized Growth Rate (% per year)	Growth Rate Source/Assumptions
Point, Actual	Zero	Assumed held constant at 2008 levels due to uncertainty of activity growth and fuel switching for specific facilities
Point, PTE	Zero	DEC Permit files, generally reflecting no significant changes in permitted emission limits from 2008 through 2014
Area, Space Heating	1.2% average over domain	Projected household growth rates (2010-2030) by Census block group developed by the FNSB Community Planning Department, annualized growth rates ranged from 0.3% to 3.5%
Area, Other	1.0%	Projected 2010-2030 population growth rate for FNSB developed by the FNSB Community Planning Department
Mobile, On-Road	1.1%	Developed from FMATS 2010 and 2035 travel model outputs supporting the 2012-2015 TIP
Mobile, Non-Road Equip.	Ranged from -0.4% to +1.6%	County-level long-term population projections developed by the Alaska Department of Labor and Workforce Development for each of four counties in Grid 3 modeling domain
Mobile, Aircraft & Rail	Zero	Assumed held constant at 2008 levels, based on discussions with local rail and airport personnel

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. These adopted control programs and how they were modeled are listed below:

- *On-Road Vehicles* – Effects of federal Motor Vehicle Control Program and Diesel Emission Reduction Programs and fuel standards, coupled with Alaska Ultra Low Sulfur Diesel (ULSD) phase in were accounted for within EPA's MOVES2010a model.

- *Non-Road Vehicles and Equipment* – Effect of federal fuel and Alaska ULSD programs for non-road fuel were modeled using EPA's NONROAD2008a model.

- *Open Burning* – The Projected Baseline (and Baseline) inventories incorporated effects from Borough and State measures that ban open burning during the winter season.

- *Space Heating and Solid Fuel Heating Programs* – Effects of the Alaska Housing Finance Corporation (AHFC) Home Energy Rebate and Weatherization programs were assumed to be implicitly accounted for through use of recently-collected residential home heating surveys. In other words, the mix of devices and usage rates obtained from these surveys were assumed to account for historical effects of device replacements and weatherization efficiency improvements from the AHFC programs. (An analysis of AHFC program data collected from program inception in 2008 through 2011[24] found very modest emission reduction benefits from four years of accumulated participation in the program based on these data. As a result, projected additional benefits beyond 2011 were excluded from the 2015 and 2019 Projected Baseline inventories.)

Other Adjustments – In addition to the effects of these adopted controls, an activity reduction factor was applied for wood-burning devices within the space heating sector in projecting 2008 baseline emissions forward to 2015 and 2019. This factor accounts for a trend toward lower average wood moisture content (which reduces wood use and per unit emissions) measured in multiple local home heating telephone surveys toward greater use of owner-cut, rather than commercially purchased, wood. From local moisture measurement studies, owner-cut wood was found to be significantly drier on average than commercially purchased wood because of longer drying times and more effective storage practices.

Table 5.6-13 shows the splits between the "Cut Own" and "Buy" wood source groups, their estimated average moisture levels, and how the shift toward greater use of owner-cut wood after 2008 affected composite moisture content and wood-burning emissions. Wood moisture was estimated to be much higher (64.2%) for commercially purchased wood compared to owner-cut and dried wood (26.6% as shown in in the Moisture Content column of Table 5.6-13).

[24] Email from Nathan Wiltse, CCHRC to Bob Dulla, Sierra Research, February 13, 2012.

Table 5.6-13
Wood Source Shift Adjustment Effects on Projected Baseline Emissions

Wood Source Group	Moisture Content (%)*	2008 Baseline Usage Mix	2015 and Later Usage Mix (from multiple 2013 surveys)
Buy	64.2%	35.0%	26.2%
Cut Own	26.6%	65.0%	73.8%
Composite Avg. Moisture Level:		39.7%	36.4%
Relative Reduction in Wood Energy Use & Emissions:			2.4%

* Moisture content on a dry basis.

From surveys conducted between 2007 and 2013, a shift has been observed in greater use of owner cut wood (73.8% from multiple 2013 surveys vs. 65.0% in 2008). The effects of this overall reduction in average moisture content (from 39.7% to 36.4%) was calculated to result in a 2.4% reduction in wood use (and emissions) due to the fact that drier wood loses less latent heat, supplying greater effective heating energy. Because the shift to a higher fraction of owner-cut wood was observed in multiple 2013 surveys (the Wood Tag and Purchase surveys), this 2.4% moisture-driven wood usage reduction was applied in calculating wood-burning device emissions in the 2015 and 2019 projected baseline inventories. The State plans to continue performing periodic surveys going forward to confirm the permanence of this shift.

A second adjustment factor was also applied for wood-burning devices in the space heating sector to account for "natural" turnover of older uncertified wood stoves and fireplace inserts over time based on clear trends observed from the residential home heating surveys that preceded the Borough's Wood Stove Change Out (WSCO) program, which began in mid-2010.

In 1988, EPA adopted[25] New Source Performance Standards (NSPS) for new residential wood-burning heaters (stoves and fireplace inserts) under 40 CFR §60.530-539b that require devices to meet EPA-certified $PM_{2.5}$ emission standards of 7.5 grams/hour (g/hr) for non-catalytic devices and 4.1 g/hr for catalytic devices. Over time, older uncertified wood heating devices are being replaced as homeowners purchase new wood heaters.[26]

Figure 5.6-23 shows the downward trend or natural turnover in the fraction of indoor wood heaters (stoves and inserts) that are uncertified. The data points shown for calendar years 2006 through 2012 represent uncertified device fractions calculated from annual residential Home Heating (HH) surveys. The black line is an exponential "best fit" curve of these data. The dashed red line represented an extension of this fitted curve out to 2019. (The data in Figure 5.6-23 have not been adjusted to account for the effect of currently sold exempted devices. However, as explained in Appendix III.D.5.6, these exempted devices are accounted for in the inventory.)

[25] Federal Register, Volume 53, pg. 5873, February 26, 1988.
[26] Not all indoor wood burning devices currently sold are EPA-certified. The 1988 (and 1998 amended) NSPS contains language that exempts certain wood-burning devices. As described in Appendix III.D.5.6, special survey data were collected to account for the fraction of the exempted wood devices that are still currently sold.

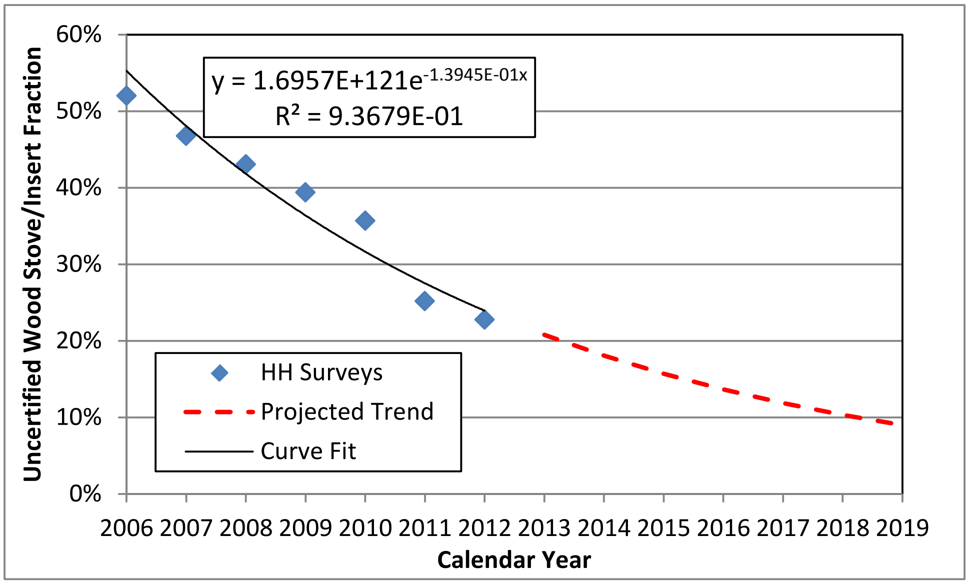

Figure 5.6-23. Fairbanks Home Heating Survey-Based Trend in Uncertified Wood Stoves/Inserts

The adjustment factor for natural turnover of uncertified wood stoves/insert was calculated based on the declining percentage of these devices over time as shown in Figure 5.6-23. Since the EPA-certified non-catalytic and catalytic stoves are projected to represent an increasing fraction of wood stoves/inserts over time and have lower emission factors than uncertified devices, average wood stove/insert emissions are projected to decrease over time due to this natural turnover. Appendix III.D.5.6 contains these detailed calculations.

5.6.3.2 Projected Baseline Inventory Summaries

Using the projected activity growth factors (and wood usage adjustment) and emission factors representing future effects of adopted mobile source control programs as summarized in the preceding sub-section, project baseline inventories were developed for 2015 and 2019.

Table 5.6-14 and Table 5.6-15 present summaries of the 2015 Projected Baseline modeling inventory with actual and PTE emissions from point sources, respectively. Even though emissions were generated at the SCC level by modeling episode day and hour, emissions are shown in the same tabulated source sector and daily average structure as the earlier 2008 Baseline inventory.

Table 5.6-14
2015 Projected Baseline Episode Average Daily Emissions (tons/day) by Source Sector, Actual Point Source Emissions

Source Sector	Grid 3 Domain Emissions (tons/day)					NA Area Emissions (tons/day)				
	$PM_{2.5}$	SO_2	NO_x	VOC	NH_3	$PM_{2.5}$	SO_2	NO_x	VOC	NH_3
Point (Actual)	1.423	8.380	13.395	0.096	n/a	1.412	8.167	13.285	0.096	n/a
Area, Space Heating	3.173	4.768	2.639	11.695	0.152	2.834	4.303	2.409	10.520	0.139
Area, Space Heat, Wood	3.048	0.104	0.466	11.515	0.111	2.723	0.093	0.414	10.359	0.099
Area, Space Heat, Oil	0.070	4.587	1.974	0.109	0.004	0.063	4.143	1.800	0.098	0.003
Area, Space Heat, Other	0.055	0.076	0.200	0.071	0.037	0.048	0.068	0.195	0.062	0.036
Area, Other	0.067	0.000	0.003	0.735	0.000	0.065	0.000	0.002	0.604	0.000
On-Road	0.552	0.022	3.127	4.424	0.063	0.461	0.017	2.503	3.405	0.051
On-Road, Running Exh	0.351	0.019	2.157	0.425	0.063	0.303	0.015	1.776	0.346	0.051
On-Road, Start & Idle Exh	0.201	0.003	0.970	3.912	0.000	0.158	0.002	0.726	2.993	0.000
On-Road, Evap	0.000	0.000	0.000	0.088	0.000	0.000	0.000	0.000	0.066	0.000
Non-Road	0.197	0.158	2.154	9.401	0.006	0.025	0.082	1.062	0.403	0.003
TOTALS	**5.413**	**13.327**	**21.318**	**26.351**	**0.221**	**4.796**	**12.569**	**19.261**	**15.027**	**0.193**

n/a – Not available.

Table 5.6-15
2015 Projected Baseline Episode Average Daily Emissions (tons/day) by Source Sector, PTE Point Source Emissions

Source Sector	Grid 3 Domain Emissions (tons/day)					NA Area Emissions (tons/day)				
	$PM_{2.5}$	SO_2	NO_x	VOC	NH_3	$PM_{2.5}$	SO_2	NO_x	VOC	NH_3
Point (Allowable, PTE)	2.773	26.612	29.609	0.845	n/a	1.595	22.973	27.393	0.826	n/a
Area, Space Heating	3.173	4.768	2.639	11.695	0.152	2.834	4.303	2.409	10.520	0.139
Area, Space Heat, Wood	3.048	0.104	0.466	11.515	0.111	2.723	0.093	0.414	10.359	0.099
Area, Space Heat, Oil	0.070	4.587	1.974	0.109	0.004	0.063	4.143	1.800	0.098	0.003
Area, Space Heat, Other	0.055	0.076	0.200	0.071	0.037	0.048	0.068	0.195	0.062	0.036
Area, Other	0.067	0.000	0.003	0.735	0.000	0.065	0.000	0.002	0.604	0.000
On-Road	0.552	0.022	3.127	4.424	0.063	0.461	0.017	2.503	3.405	0.051
On-Road, Running Exh	0.351	0.019	2.157	0.425	0.063	0.303	0.015	1.776	0.346	0.051
On-Road, Start & Idle Exh	0.201	0.003	0.970	3.912	0.000	0.158	0.002	0.726	2.993	0.000
On-Road, Evap	0.000	0.000	0.000	0.088	0.000	0.000	0.000	0.000	0.066	0.000
Non-Road	0.197	0.158	2.154	9.401	0.006	0.025	0.082	1.062	0.403	0.003
TOTALS	**6.763**	**31.559**	**37.532**	**27.100**	**0.221**	**4.979**	**27.376**	**33.369**	**15.758**	**0.193**

n/a – Not available.

Comparing emissions between these tables and those for the 2008 Baseline presented earlier in Section 5.6.2, $PM_{2.5}$ emissions decrease by roughly 3% over the Grid 3 modeling domain due to the trends of lower wood moisture and reduced fractions of uncertified wood stoves/inserts factored into the projected baseline (coupled with demographic/economic growth factors).

Similar tabulations for the 2019 Projected Baseline inventory are presented in Table 5.6-16 and Table 5.6-17.

Table 5.6-16
2019 Projected Baseline Episode Average Daily Emissions (tons/day) by Source Sector, Actual Point Source Emissions

	Grid 3 Domain Emissions (tons/day)					*NA Area Emissions (tons/day)*				
Source Sector	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**
Point (Actual)	1.423	8.380	13.395	0.096	n/a	1.412	8.167	13.285	0.096	n/a
Area, Space Heating	3.284	5.021	2.774	11.843	0.156	2.937	4.537	2.535	10.674	0.143
Area, Space Heat, Wood	3.153	0.110	0.492	11.654	0.115	2.821	0.098	0.438	10.506	0.103
Area, Space Heat, Oil	0.073	4.832	2.081	0.115	0.004	0.066	4.369	1.900	0.103	0.004
Area, Space Heat, Other	0.058	0.079	0.201	0.075	0.038	0.050	0.070	0.197	0.065	0.037
Area, Other	0.071	0.000	0.003	0.773	0.000	0.068	0.000	0.002	0.634	0.000
On-Road	0.485	0.021	2.350	2.934	0.058	0.406	0.017	1.872	2.258	0.048
On-Road, Running Exh	0.318	0.018	1.514	0.313	0.058	0.275	0.015	1.246	0.255	0.048
On-Road, Start & Idle Exh	0.167	0.003	0.837	2.533	0.000	0.131	0.002	0.626	1.937	0.000
On-Road, Evap	0.000	0.000	0.000	0.088	0.000	0.000	0.000	0.000	0.066	0.000
Non-Road	0.172	0.172	2.278	7.712	0.006	0.024	0.090	1.094	0.405	0.003
TOTALS	**5.435**	**13.594**	**20.800**	**23.358**	**0.221**	**4.846**	**12.810**	**18.788**	**14.067**	**0.194**

n/a – Not available.

Table 5.6-17
2019 Projected Baseline Episode Average Daily Emissions (tons/day) by Source Sector, PTE Point Source Emissions

	Grid 3 Domain Emissions (tons/day)					*NA Area Emissions (tons/day)*				
Source Sector	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**
Point (PTE)	2.773	26.612	29.609	0.845	n/a	1.595	22.973	27.393	0.826	n/a
Area, Space Heating	3.284	5.021	2.774	11.843	0.156	2.937	4.537	2.535	10.674	0.143
Area, Space Heat, Wood	3.153	0.110	0.492	11.654	0.115	2.821	0.098	0.438	10.506	0.103
Area, Space Heat, Oil	0.073	4.832	2.081	0.115	0.004	0.066	4.369	1.900	0.103	0.004
Area, Space Heat, Other	0.058	0.079	0.201	0.075	0.038	0.050	0.070	0.197	0.065	0.037
Area, Other	0.071	0.000	0.003	0.773	0.000	0.068	0.000	0.002	0.634	0.000
On-Road	0.485	0.021	2.350	2.934	0.058	0.406	0.017	1.872	2.258	0.048
On-Road, Running Exh	0.318	0.018	1.514	0.313	0.058	0.275	0.015	1.246	0.255	0.048
On-Road, Start & Idle Exh	0.167	0.003	0.837	2.533	0.000	0.131	0.002	0.626	1.937	0.000
On-Road, Evap	0.000	0.000	0.000	0.088	0.000	0.000	0.000	0.000	0.066	0.000
Non-Road	0.172	0.172	2.278	7.712	0.006	0.024	0.090	1.094	0.405	0.003
TOTALS	**6.784**	**31.826**	**37.014**	**24.106**	**0.221**	**5.029**	**27.617**	**32.896**	**14.797**	**0.194**

n/a – Not available.

5.6.4. 2015 and 2019 Control Inventories

The second and final stage of estimating emissions in the two future years examined under this SIP (2015 and 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. These final future year inventories are called the Control inventories and are discussed separately below.

5.6.4.1 2015 Control Modeling Inventory

Within this SIP, a Control inventory was prepared for 2015, the required attainment year, and used to support the attainment modeling analysis to find that either (1) attainment is projected to occur by 2015; or (2) attainment by 2015 is impracticable as discussed earlier in Section 5.6.1.

The control measures accounted for in this 2015 Control inventory (and that were not included in the Projected Baseline inventory) are summarized below.

<u>Hydronic Heater Retrofit Program (ARA OHH Retrofits)</u> – The Alaska Resource Agency (ARA) secured funding to identify and retrofit 40 outdoor hydronic heaters[27] (OHHs) with ClearStak or similar pollution control devices (PCDs). The retrofits were performed in late 2011 and 2012. The effects of these retrofits were not captured in the early 2011 Fairbanks Home Heating survey that was used to estimate the mix and number of devices in the SIP inventory and thus were treated as a control program with "fixed" benefits from those retrofits.

ARA estimated these retrofits provide an 80-90% reduction in particulate emissions based on testing conducted under a NESCAUM study. Based on visual observations/follow-up by Fairbanks Borough staff after retrofits were installed, a "real world" emission reduction of 30% per retrofit was assumed that accounted for imperfect compliance and use.

$PM_{2.5}$ emission reductions from these devices were estimated to be 0.2% of projected baseline space heating emissions and roughly 0.1% of total emissions in the non-attainment area. (No benefits were assumed for gaseous pollutants.)

<u>FNSB Wood Stove Change Out Program (WSCO Program)</u> – Beginning in June 2010, the Fairbanks Borough has operated a program within the non-attainment 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. Table 5.6-18 presents a historical summary of how the WSCO program was originally designed and how it has been modified over time since it began.

As summarized in Table 5.6-18, 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.

Emission control benefits were calculated for the program based on transaction data collected by the Borough since its inception, through mid-August 2014. (Data for the partial 2014 calendar year were extrapolated to the end of 2014 based on the expected number of applications projected by the Borough to be completed and change outs validated by the end of the year.)

[27] Also called outdoor wood boilers (OWBs).

Table 5.6-18
Fairbanks Borough Wood Stove Change Out Program Historical Summary

Program	Old Appliance Type	New Appliance Type Allowed	Payout
JUNE 2010 – Original program. Limited to $PM_{2.5}$ non-attainment area. Participants in the removal program signed deed restriction in which they agree they would not install another solid fuel burning appliance for 10 years.			
Removal	OHH (Outdoor Hydronic Heater)	No solid fuel burning appliances	$7,500 cash
Removal	IHH (Indoor Hydronic Heater)	No solid fuel burning appliances	$4,000 cash
Removal	Other SFBA	No solid fuel burning appliances	$3,000 cash
Replacement	HH (outdoor or indoor) – non EPA Phase II	EPA Phase II, EPA cert SFBA or any pellet	Up to $2,500
Replacement	Other SFBA – non EPA cert	EPA cert SFBA or any pellet	Up to $2,500
Repair	Catalytic Converter	n/a	Up to $750
Repair	Other Emissions Reducing Component	n/a	Up to $750
Repair	Chimney Repair	n/a	Up to $750
Repair	Retrofit Device	n/a	Up to $1,000
JANUARY 2013 – In October 2012, Citizens' Initiative Prop 3 passed (The borough shall not, in any way, regulate, prohibit, curtail, nor issue fines or fees associated with sale, distribution, or operation of heating appliances or any combustible fuel.*)* Program suspended Dec. 2012 while it was modified. Opened to all Borough properties. Devices ≤ 2.5 grams/hr eligible for higher payout. Replacement devices must be EPA certified.			
Replacement	HH (outdoor or indoor)	EPA cert SFBA or pellet	Up to $2,500
Replacement	Other SFBA – non EPA cert	EPA cert SFBA or pellet	75% of cost up to $2,500/$3,000**
Removal	Remove HH w/out replacement		$2,000
Repair	Catalytic Converter	n/a	Up to $750
Repair	Other Emissions Reducing Component	n/a	Up to $750
Repair	Chimney Repair	n/a	Up to $750
Repair	Retrofit Device		Up to $1,000
ENHANCED PROGRAM (May – Sept 2013) – Completely different program (operated in conjunction with the regular program), limited to 3 specific areas in the non-attainment area. Also, allowed for replacing EPA-certified SFBAs with emission rate ≤ 2.0 grams/hr (overall emissions reduction must be at least 50%).			
Replacement	OHH	EPA cert SFBA, any pellet, non-solid fuel burning appliances	Up to $10,000
Replacement	Other SFBA	EPA cert SFBA, any pellet, non-solid fuel burning appliances	Up to $4,000
Replacement	Fireplace	EPA cert SFBA, any pellet, non-solid fuel burning appliances	Up to $4,000
MARCH 2014 (Current Program) – Changed to limit to properties in non-attainment area, and includes $300 fuel voucher for pellets or compressed logs. Now allows for replacing EPA-certified SFBAs w/emissions of 2.5 grams/hr and greater (and requiring an emission reduction of at least 50%), and fireplaces.			
Replacement	OHH	EPA cert SFBA, any pellet, non-solid fuel burning appliances	Up to $10,000
Replacement	Other SFBA	EPA cert SFBA, any pellet, non-solid fuel burning appliances	Up to $4,000
Replacement	Fireplace	EPA cert SFBA, any pellet, non-solid fuel burning appliances	Up to $4,000
Removal	Remove HH w/out replacement	n/a	$2,000
Removal	Remove SFBA w/o replacement	n/a	$1,000
Repair	Catalytic Converter	n/a	Up to $750
Repair	Other Emissions Reducing Component	n/a	Up to $750

Source: Fairbanks North Star Borough.
SFBA – Solid Fuel Burning Appliance.

For devices that were replaced, emission reductions were calculated by replacing the emission factor for each device type (fireplace, insert, wood stove, OHH/OWB, coal stove) with an emission factor (in lb/ton of fuel) equivalent to the emission rate cutpoints (in grams/hour) based on emission factor vs. emission rate correlations developed from certification data published by EPA[28] for over 1,000 wood-burning devices. For devices that were removed, it was assumed that the heating energy from the removed device would be replaced with equivalent energy from an oil furnace or boiler (and accounting for the heating efficiency differences between the two devices). No emission reductions were assumed for repaired devices given the uncertainty of the type of repair performed and its effect on emissions. Appendix III.D.5.6 describes these calculations in greater detail.

Emission benefits from the WSCO program for the 2015 Control inventory were based on the accumulation of change outs from the start of the program through the end of 2014 (extrapolating the partial 2014 data as described above). In attainment modeling, eligible control measure benefits are those that exist at the beginning of the modeling year. Thus, in this case, WSCO program benefits accumulated through the end of 2014 (not 2015) were used to model attainment in calendar year 2015. A tabulation of the cumulative year-to-year completed transactions in the WSCO is presented below in Table 5.6-19. Within each year, transactions are broken down by operation type (Replacement or Removal) and device type.

Table 5.6-19
Fairbanks Borough Wood Stove Change Out Program Cumulative Transactions

Program Operation	Device Type	(end 2010) 2011	(end 2011) 2012	(end 2012) 2013	(end 2013) 2014	(end 2014) 2015
Replacement	Fireplace	0	0	0	0	74
Replacement	Stove/Insert	103	246	698	899	1,257
Replacement	OHH	1	3	5	22	43
Replacement	Coal Stove	0	0	1	3	10
Removal	Stove/Insert	10	44	184	190	194
Removal	OHH	8	32	68	70	74
Removal	Coal Stove	0	0	4	5	5
Replacements, Total		104	249	704	924	1,384
Removals, Total		18	76	256	265	273
Change-Outs, Total		**122**	**325**	**960**	**1,189**	**1,657**

Emission benefits from the WSCO program in 2015 were estimated to provide a 13.7% reduction in space heating $PM_{2.5}$ emissions in the non-attainment area relative to the projected baseline. Reductions for gaseous pollutants (relative to projected baseline space heating emissions) were estimated as 0.8% for SO_2, 1.4% for NO_x, 19.3% for VOC and 10.3% for NH_3.

Measures Considered But not Modeled - In addition to the ARA and WSCO program benefits, further emission reductions may be achieved through emerging use of "energy logs" which are compressed, densified logs that have just begun being manufactured locally in Fairbanks (by

[28] http://www.epa.gov/burnwise/appliances.html.

Superior Pellet Fuels, LLC). Energy logs are made from local wood species and when produced, are denser and much drier that cut cordwood, and are potentially cleaner-burning than cordwood. Since the energy logs have just begun being sold in the local market, there is not yet sufficient usage data available to support development of emission reduction estimates in the 2015 Control inventory.

2015 Control Inventory Summaries – Table 5.6-20 and Table 5.6-21 present tabulated sector and geographic area summaries of the 2015 Control inventories based on actual and PTE point source emissions, respectively.

Table 5.6-20
2015 Control Episode Average Daily Emissions (tons/day) by Source Sector, Actual Point Source Emissions

	Grid 3 Domain Emissions (tons/day)					*NA Area Emissions (tons/day)*				
Source Sector	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**
Point (Actual)	1.423	8.380	13.395	0.096	-	1.412	8.167	13.285	0.096	-
Area, Space Heating	2.779	4.733	2.606	9.642	0.138	2.440	4.268	2.376	8.467	0.125
Area, Space Heat, Wood	2.655	0.096	0.424	9.463	0.097	2.330	0.084	0.373	8.308	0.085
Area, Space Heat, Oil	0.070	4.562	1.983	0.109	0.004	0.063	4.118	1.809	0.099	0.003
Area, Space Heat, Other	0.054	0.075	0.199	0.070	0.037	0.047	0.066	0.194	0.061	0.036
Area, Other	0.067	0.000	0.003	0.735	0.000	0.065	0.000	0.002	0.604	0.000
On-Road	0.552	0.022	3.127	4.424	0.063	0.461	0.017	2.503	3.405	0.051
On-Road, Running Exh	0.351	0.019	2.157	0.425	0.063	0.303	0.015	1.776	0.346	0.051
On-Road, Start & Idle Exh	0.201	0.003	0.970	3.912	0.000	0.158	0.002	0.726	2.993	0.000
On-Road, Evap	0.000	0.000	0.000	0.088	0.000	0.000	0.000	0.000	0.066	0.000
Non-Road	0.197	0.158	2.154	9.401	0.006	0.025	0.082	1.062	0.403	0.003
TOTALS	**5.020**	**13.292**	**21.285**	**24.298**	**0.207**	**4.402**	**12.534**	**19.228**	**12.974**	**0.179**

n/a – Not available.

Table 5.6-21
2015 Control Episode Average Daily Emissions (tons/day) by Source Sector, PTE Point Source Emissions

	Grid 3 Domain Emissions (tons/day)					*NA Area Emissions (tons/day)*				
Source Sector	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**
Point (PTE)	2.773	26.612	29.609	0.845	n/a	1.595	22.973	27.393	0.826	n/a
Area, Space Heating	2.779	4.733	2.606	9.642	0.138	2.440	4.268	2.376	8.467	0.125
Area, Space Heat, Wood	2.655	0.096	0.424	9.463	0.097	2.330	0.084	0.373	8.308	0.085
Area, Space Heat, Oil	0.070	4.562	1.983	0.109	0.004	0.063	4.118	1.809	0.099	0.003
Area, Space Heat, Other	0.054	0.075	0.199	0.070	0.037	0.047	0.066	0.194	0.061	0.036
Area, Other	0.067	0.000	0.003	0.735	0.000	0.065	0.000	0.002	0.604	0.000
On-Road	0.552	0.022	3.127	4.424	0.063	0.461	0.017	2.503	3.405	0.051
On-Road, Running Exh	0.351	0.019	2.157	0.425	0.063	0.303	0.015	1.776	0.346	0.051
On-Road, Start & Idle Exh	0.201	0.003	0.970	3.912	0.000	0.158	0.002	0.726	2.993	0.000
On-Road, Evap	0.000	0.000	0.000	0.088	0.000	0.000	0.000	0.000	0.066	0.000
Non-Road	0.197	0.158	2.154	9.401	0.006	0.025	0.082	1.062	0.403	0.003
TOTALS	**6.369**	**31.524**	**37.499**	**25.047**	**0.207**	**4.585**	**27.341**	**33.336**	**13.705**	**0.179**

n/a – Not available.

Comparing tabulated emissions between the 2015 Control (Table 5.6-20 and Table 5.6-21) and 2015 Projected Baseline inventories presented earlier in Section III.D.5.6.3 (Table 5.6-14 and Table 5.6-15), the emission reductions occur entirely within the Space Heating Area source sector, reflecting controls implemented to date (i.e., through the end of 2014).

Table 5.6-22 shows how the 2015 Control modeling inventory emissions (totaled across all source sectors) compare to the 2008 Baseline emissions based on PTE emissions for the point source sector. The comparison is presented as the percentage change in emissions relative to the 2008 Baseline and is based on PTE emissions for the point source sector. Thus negative percentages reflect emission reductions from the 2008 Baseline. Direct $PM_{2.5}$ emission reductions are highlighted in bold and just exceed 10% for the non-attainment area. Emission reductions for gaseous precursors NO_x, VOC and NH_3 are 5.5%, 26.4% and 14.9%, respectively within the non-attainment area. Emissions of SO_2 increase slightly (by just over 1%) relative to the 2008 Baseline due to the fact that heating energy from wood-burning devices removed under the WSCO program was assumed to be made up for with additional heating oil burning devices, which have higher SO_2 emission factors that are roughly ten times higher than wood devices (on a lb. per unit energy basis).

Table 5.6-22
2015 Control Modeling Emissions Relative to 2008 Baseline (PTE Point Sources)

	% Change in Emissions (Relative to 2008 Baseline)				
Geographic Area	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**
Grid 3 Modeling Domain	**-8.8%**	+1.3%	-6.0%	-25.5%	-14.7%
$PM_{2.5}$ Non-Attainment Area	**-10.4%**	+1.4%	-5.5%	-26.4%	-14.9%

Again, the reductions presented in Table 5.6-22 are reductions for all inventory sources. Thus, the reductions noted earlier in this sub-section at the end of the discussions of the ARA and WSCO program do not add up to the totals in Table 5.6-22 since those reductions were relative to space heating emissions, not all emissions.

(Relative reductions are nominally higher than those shown if based on actual, rather than PTE point source emissions since actual point source emissions are lower and the control reductions occur outside the point source sector.)

5.6.4.2 2015 Control Planning Inventory

Scaling similar to that described earlier in Section III.D.5.6.2.2 was applied to the 2015 Control episodic modeling emissions using temporal scaling factors listed in Table 5.6-11 to develop estimates of annual and winter season Planning emissions within the non-attainment area for the 2015 Control inventory. Table 5.6-23 summarizes these 2015 Control Planning inventory estimates.

Table 5.6-23
2015 Non-Attainment Area Control Planning Emissions Inventory

Source Type/Category	Annual Average Day (tons/day)					Winter Season Average Day (tons/day)				
	$PM_{2.5}$	SO_2	NO_x	VOC	NH_3	$PM_{2.5}$	SO_2	NO_x	VOC	NH_3
Point (PTE)	1.595	22.973	27.393	0.826	n/a	1.595	22.973	27.393	0.826	n/a
Area, Space Heating	1.311	2.596	1.440	4.518	0.067	2.440	4.268	2.376	8.467	0.125
Area, Space Heat, Wood	1.252	0.051	0.226	4.433	0.046	2.330	0.084	0.373	8.308	0.085
Area, Space Heat, Oil	0.034	2.504	1.096	0.053	0.002	0.063	4.118	1.809	0.099	0.003
Area, Space Heat, Other	0.025	0.040	0.118	0.032	0.019	0.047	0.066	0.194	0.061	0.036
Area, Other	23.863	0.000	3.992	14.176	0.000	0.065	0.000	0.002	0.604	0.000
On-Road	0.526	0.027	2.687	4.885	0.052	0.461	0.017	2.503	3.405	0.051
On-Road, Running Exh	0.346	0.023	1.907	0.497	0.052	0.303	0.015	1.776	0.346	0.051
On-Road, Start & Idle Exh	0.180	0.003	0.780	4.294	0.000	0.158	0.002	0.726	2.993	0.000
On-Road, Evap	0.000	0.000	0.000	0.095	0.000	0.000	0.000	0.000	0.066	0.000
Non-Road	0.017	0.078	1.085	0.242	0.003	0.025	0.082	1.062	0.403	0.003
TOTALS	**27.312**	**25.674**	**36.596**	**24.647**	**0.122**	**4.585**	**27.341**	**33.336**	**13.705**	**0.179**

n/a – Not available.

5.6.4.3 2019 Potential Control Modeling Inventory

As discussed earlier in Section III.D.5.6.1, development of a 2019 Control inventory was not a mandatory requirement for this SIP because of the finding (discussed in Section III.D.5.9) that attainment of the $PM_{2.5}$ NAAQS by the required 2015 calendar year was impracticable. A 2019 "Potential" Control inventory was developed to examine the potential for attainment by 2019.

Forecasts of Existing Programs – The first step in generating the 2019 Potential Control inventory consisted of forecasting the benefits from the two existing control measures, the ARA and WSCO programs. The ARA program was a "one-time" measure based on OHH retrofits performed in 2011-2012 that were not included in the projected baselines. Thus, its emission benefits were assumed to be fixed or held constant in both 2015 and 2019 and, as summarized earlier in Section III.D.5.6.4.1, to provide a 0.2% reduction in space heating $PM_{2.5}$ emissions across the non-attainment area.

Emission benefits from continuation of the Borough's WSCO through 2019 were estimated by projecting additional annual change outs (either replacement of uncertified or higher-emitting certified devices with cleaner devices meeting a 2.5 gram/hour $PM_{2.5}$ standard, or removal of devices with their displaced heating energy replaced by heating from oil-fired units). Rather than simply assuming that annual WSCO program device replacements/removals would occur at their actual 2014 rate (or the average over the program's four-year history), a decreasing exponential curve was applied to account for the fact that as fewer and fewer uncertified devices exist over time, it will be harder to maintain existing annual participation levels or "throughput" in the program. This is depicted in Figure 5.6-24, which presents incremental annual change outs over time and shows the 2014 throughput as a constant horizontal blue line going forward and the assumed declining year-to-year trend shown below it in green. Calendar years shown reflect the start of the year, i.e., calendar year 2015 refers to change outs through the end of 2014.

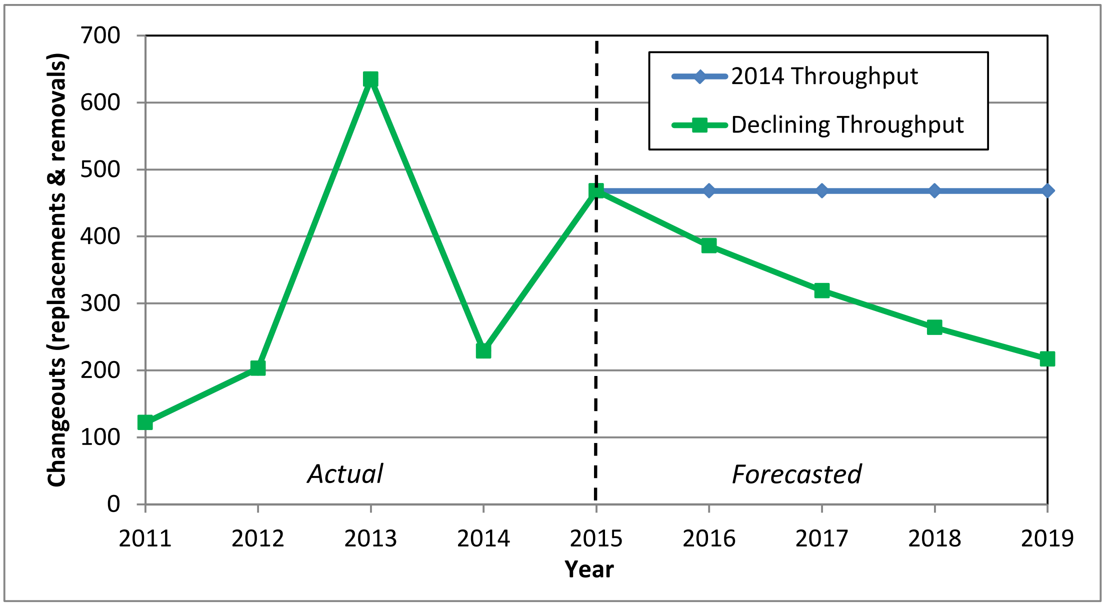

Figure 5.6-24. Incremental Annual Change Outs, Actual Through 2014 and Forecasted

To ensure that this declining throughput forecast properly accounted for the finite population of uncertified devices projected in the Borough in 2019 in the absence of the WSCO program, its rate of decline was set such that the forecasted number of uncertified wood stove and insert change outs in 2019 would approximately reach the "cap" of projected available population of those uncertified devices in that year (after accounting for natural turnover occurring outside the program). This is shown in Figure 5.6-25, which displays cumulative change outs of uncertified stoves and inserts over time and is seen where the green declining throughput forecast meets the projected uncertified stove/insert cap in 2019 (shown in red).

Figure 5.6-26 shows a similar plot of actual and forecasted cumulative annual WSCO program change outs for all uncertified devices. (All uncertified devices were represented as the sum of uncertified stoves/inserts, unqualified outdoor hydronic heaters, fireplaces, and coal heaters.) When all uncertified devices are plotted, there is still a margin between the projected number of cumulative change outs and the cap for all uncertified devices targeted under the current design of the WSCO program.

Again, calendar years shown refer to conditions as of the start of each year—i.e., calendar year 2019 refers to cumulative change outs through the end of 2018.

Using these assumptions of declining future throughput, cumulative primary $PM_{2.5}$ emission reductions in 2019 from the WSCO program were estimated to be 25.4% of projected baseline emissions in that year.

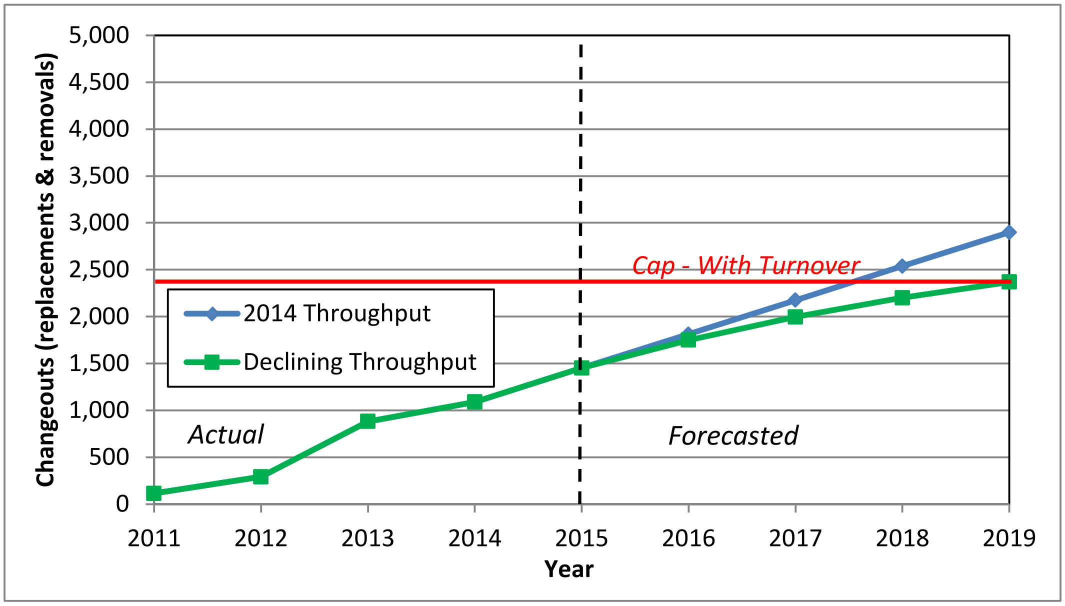

Figure 5.6-25. Cumulative Annual Change Outs, Actual Through 2014 and Forecasted, Uncertified Wood Stoves and Inserts

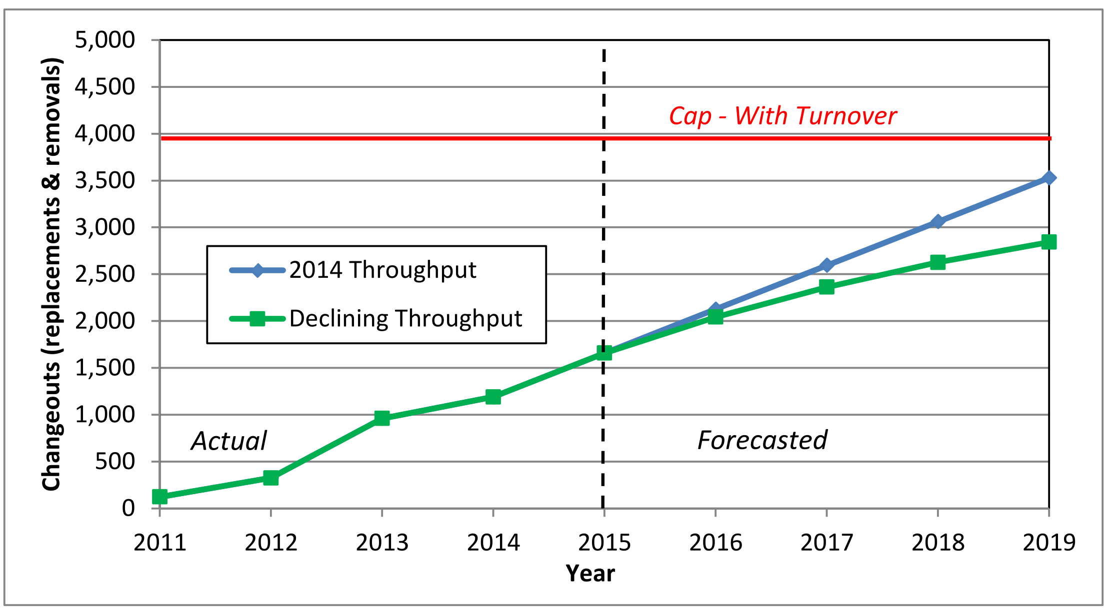

Figure 5.6-26. Cumulative Annual Change Outs, Actual Through 2014 and Forecasted, All Uncertified Devices

In addition to accounting for further benefits from continuation of the WSCO programs, the 2019 Potential Control inventory incorporated reductions from three other measures described below.

State Space Heating Device Standards in New Homes – This DEC-headed program would require that space heating devices installed in new residential homes in the Fairbanks non-attainment area be EPA-certified devices meeting a 2.5 gram/hour $PM_{2.5}$ certification standard.

Emission control benefits of such a program were developed using projections from the Borough's Community Research Quarterly publications.[29] Residential new homes were projected from 358 units in 2012 (actual) to 661 units in 2019 (start of calendar year) based on the long-term 2000-2012 trend published in the Quarterly. Emission reductions of $PM_{2.5}$ (no reductions were assumed for gaseous pollutants) were then estimated for 2.5 gram/hour devices relative to the typical mix of uncertified/certified heating devices projected in 2019 and accounting for the overlapping effects of natural turnover and the WSCO program.

$PM_{2.5}$ space heating emission reductions from the State Standards were estimated to provide an additional 1.6% in 2019 (over and above the ARA and WSCO programs).

State-Coordinated Wintertime Dry Wood Use Program – A second potential DEC-led program would consist of a coordinated program designed to promote and potentially incentivize greater use of "dry" wood (defined as wood with a moisture content [MC] that does not exceed 20% on a dry basis). The projected wood moisture content in 2019 in the absence of such as program is 36.4%, averaged across the two wood source groups: (1) Buy (those who purchase wood commercially) and (2) Cut Own (those who cut, stack, and store their own wood).

Because such a program has not yet been adopted and is currently being evaluated by DEC, a series of plausible assumptions based on existing survey data were used to develop estimates of potential emission reduction benefits. From the 2013 Wood Tag survey, 34.3% of wood-using survey respondents indicated a willingness to pay up to $50 more per cord for dry wood knowing that dry wood provides roughly 25% more heating energy than wet wood (as explained in the Tag survey question). As a result, it was assumed that a coordinated wintertime Dry Wood Use program would result in 34% more homeowners from both the Buy and Cut Own wood source groups burning dry (20% MC) wood. (The movement of both the Buy group and the Cut Own group to use greater use of dry wood comes about from additional State education efforts that span both groups. It was assumed that the same relative shift toward greater dry wood use would occur in both groups.) Under this assumption, the composite wood moisture content would drop to 30.8% and result in a heating energy reduction in wood use of roughly 4%.

This translates to an incremental $PM_{2.5}$ space heating emission reduction (on top of the preceding local and state measures) of 2.8% in 2019.

Expansion of Natural Gas Availability in Fairbanks – A portion of the non-attainment area includes a limited delivery infrastructure for residential and commercial natural gas use from the existing Fairbanks Natural Gas (FNG) private utility. Plans are being coordinated and funding made available through several state agencies, led by the Alaska Industrial Development and Export Authority (AIDEA), to provide a sufficiently expanded infrastructure and delivery via expansion of FNG's infrastructure within its service area and additional gas delivery from a new

[29] http://co.fairbanks.ak.us/communityplanning/crc/

public entity, the Interior Gas Utility (IGU), across an expanded area roughly encompassing the remainder of the non-attainment area. AIDEA is stewarding this expanded service with a goal of natural gas being priced at the retail, point of sale level of roughly half the existing cost of heating oil, or about $15-$17 per mcf (thousand cubic feet).

Estimates of emission reductions from natural gas expansion in 2019 (end of 2018) were developed based on forecasted residential and commercial penetration levels across the non-attainment area from a recent January 2014 AIDEA report prepared by Cardno-Entrix.[30] The Cardno report considered not just estimates of penetration (i.e. availability of gas at point of sale), but also addressed conversion/use for both the residential and commercial sectors and accounted for the costs of conversion for each sector. The combined residential household penetration and conversion to natural gas rate in 2019 estimated by Cardno was 36% at the end of 2018.

The Cardno report also included estimates of fuel use shifts (oil-to-gas, wood-to-gas) in converted households based on the targeted offering price for gas (about $2/gallon on a heating oil equivalent basis) and elasticity estimates that reflected a shift of roughly 77% of existing wood-burning homes to gas. This 77% estimate is very consistent with an 74% wood household shift to gas at $2/gallon oil equivalent developed from responses to a question in the 2013 Wood Tag survey. (These wood household shifts were based only on homes that had alternative heating sources beyond wood. In other words, they excluded homes solely heated using wood, which would be more difficult candidates for conversion to natural gas.)

These wood-to-gas household shifts were combined with an additional element from the 2013 Tag survey that found roughly 38% of wood users would still likely burn wood on extremely cold days (defined as days below -30°F) to produce estimates of discount shifts to gas use on those cold days.

Using these data sources and assumptions, incremental $PM_{2.5}$ emission reductions from natural gas expansion across the non-attainment area in 2019 were found to be 16.4% on cold (<-30°F) days and 18.4% on warmer (≥-30°F) days relative to the 2019 projected baseline. These incremental reductions are those above that from preceding state and local measures after accounting for overlapping effects.

<u>Other Measures Considered But not Modeled</u> – As noted earlier in Section III.D.5.6.4.1, Superior Pellet Fuels began to locally manufacture and market densified energy logs in 2014. In addition to these potential programs the State is also evaluating potential emission benefits from use of "energy logs" which are compressed, densified logs that have just begun being manufactured locally in Fairbanks (by Superior Pellet Fuels). Energy logs have roughly 20% more energy content (in BTU/lb) than the most commonly used Fairbanks cordwood species (Birch) and have an extremely low moisture content of 7% (on a dry basis).

[30] "IEP Natural Gas Conversion Analysis, Fairbanks LNG Distribution System Demand Analysis," prepared by Cardno Entrix for Alaska Industry Development and Export Authority, January 2014.

Potential emission reductions from an Energy Log Use program were not included in the 2019 Control inventory due to the fact that production of the logs just began earlier in 2014 and the market or demand for the logs is still uncertain. The State and Borough plan to conduct further evaluation of the benefits of locally manufactured energy logs before designing a program to expand and provide incentives for their use.

2019 Potential Control Inventory Summaries – Using the combined set of existing (ARA, WSCO) and potential future (State New Home Device Standards, Dry Wood, Natural Gas Expansion) programs, Table 5.6-24 and Table 5.6-25 present tabulated sector and geographic area summaries of the 2019 Potential Control inventories based on actual and PTE point source emissions, respectively.

Again, these are levels of control reduction that could be achieved by 2019 based on projected expansion of natural gas availability, coupled with State programs requiring (1) wood devices in new homes to meet a 2.5 gram/hour $PM_{2.5}$ emission standard and (2) expanded use of dry wood through education and/or incentives and continuation of the Borough's WSCO program

Table 5.6-26 shows how the 2019 Potential Control emissions compared to those of the 2008 Baseline inventory, listing emission reductions relative to the 2008 Baseline for both the entire Grid 3 modeling domain and the smaller non-attainment area. As noted in the table title, the comparisons are made based on PTE, rather than actual, point source emissions.

Table 5.6-24
2019 Potential Control Episode Average Daily Emissions (tons/day) by Source Sector, Actual Point Source Emissions

	Grid 3 Domain Emissions (tons/day)					*NA Area Emissions (tons/day)*				
Source Sector	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**
Point (Actual)	1.423	8.380	13.395	0.096	-	1.412	8.167	13.285	0.096	-
Area, Space Heating	1.952	5.677	2.695	5.957	0.184	1.606	5.193	2.456	4.788	0.171
Area, Space Heat, Wood	1.828	0.074	0.317	5.767	0.065	1.496	0.062	0.263	4.619	0.053
Area, Space Heat, Oil	0.062	5.525	1.810	0.097	0.003	0.055	5.062	1.629	0.086	0.003
Area, Space Heat, Other	0.063	0.078	0.568	0.093	0.116	0.055	0.069	0.564	0.083	0.115
Area, Other	0.071	0.000	0.003	0.773	0.000	0.068	0.000	0.002	0.634	0.000
On-Road	0.485	0.021	2.350	2.934	0.058	0.406	0.017	1.872	2.258	0.048
On-Road, Running Exh	0.318	0.018	1.514	0.313	0.058	0.275	0.015	1.246	0.255	0.048
On-Road, Start & Idle Exh	0.167	0.003	0.837	2.533	0.000	0.131	0.002	0.626	1.937	0.000
On-Road, Evap	0.000	0.000	0.000	0.088	0.000	0.000	0.000	0.000	0.066	0.000
Non-Road	0.172	0.172	2.278	7.712	0.006	0.024	0.090	1.094	0.405	0.003
TOTALS	**4.104**	**14.250**	**20.721**	**17.472**	**0.249**	**3.515**	**13.467**	**18.709**	**8.181**	**0.222**

n/a – Not available.

Table 5.6-25
2019 Potential Control Episode Average Daily Emissions (tons/day) by Source Sector, PTE Point Source Emissions

	Grid 3 Domain Emissions (tons/day)					*NA Area Emissions (tons/day)*				
Source Sector	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**
Point (PTE)	2.773	26.612	29.609	0.845	n/a	1.595	22.973	27.393	0.826	n/a
Area, Space Heating	1.952	5.677	2.695	5.957	0.184	1.606	5.193	2.456	4.788	0.171
Area, Space Heat, Wood	1.828	0.074	0.317	5.767	0.065	1.496	0.062	0.263	4.619	0.053
Area, Space Heat, Oil	0.062	5.525	1.810	0.097	0.003	0.055	5.062	1.629	0.086	0.003
Area, Space Heat, Other	0.063	0.078	0.568	0.093	0.116	0.055	0.069	0.564	0.083	0.115
Area, Other	0.071	0.000	0.003	0.773	0.000	0.068	0.000	0.002	0.634	0.000
On-Road	0.485	0.021	2.350	2.934	0.058	0.406	0.017	1.872	2.258	0.048
On-Road, Running Exh	0.318	0.018	1.514	0.313	0.058	0.275	0.015	1.246	0.255	0.048
On-Road, Start & Idle Exh	0.167	0.003	0.837	2.533	0.000	0.131	0.002	0.626	1.937	0.000
On-Road, Evap	0.000	0.000	0.000	0.088	0.000	0.000	0.000	0.000	0.066	0.000
Non-Road	0.172	0.172	2.278	7.712	0.006	0.024	0.090	1.094	0.405	0.003
TOTALS	**5.453**	**32.482**	**36.935**	**18.220**	**0.249**	**3.698**	**28.273**	**32.817**	**8.912**	**0.222**

n/a – Not available.

Table 5.6-26
2019 Control Modeling Emissions Relative to 2008 Baseline (PTE Point Sources)

	% Change in Emissions (Relative to 2008 Baseline)				
Geographic Area	**$PM_{2.5}$**	**SO_2**	**NO_x**	**VOC**	**NH_3**
Grid 3 Modeling Domain	**-21.9%**	**+4.4%**	**-7.4%**	**-45.8%**	**+2.6%**
$PM_{2.5}$ Non-Attainment Area	**-27.7%**	**+4.9%**	**-7.0%**	**-52.2%**	**+5.4%**

As seen in the highlighted column of Table 5.6-26, $PM_{2.5}$ reductions in 2019 of almost 28% relative to the 2008 baseline could be achieved within the non-attainment area.

Again, the reductions presented in Table 5.6-26 are reductions for all inventory sources. Thus, the emission benefits noted earlier in this sub-section at the end of the discussions of the ARA and WSCO programs potential 2019 control measures do not add up to the totals in Table 5.6-26 since those reductions were relative to space heating emissions, not all emissions.

5.6.5. 2017 Reasonable Further Progress (RFP) Inventory

Moderate Area RFP Planning Requirements – Section 172(c)(2) of the CAA requires that plans for non-attainment areas "shall require reasonable further progress" and include a "current inventory of actual emissions from all sources of relevant pollutants in such area … to assure that the requirements of this part are met." The goal of RFP is to achieve generally linear progress toward attainment (as opposed to deferring implementation of some of all measures until the end or projected attainment date).

The pollutants addressed in the RFP inventory were limited to $PM_{2.5}$ (direct), SO_2 and NO_x. $PM_{2.5}$ (direct) and SO_2 are the two key pollutants for which control benefits were calculated. NO_x was also included as a required precursor. (Quantified control inventory benefits were focused exclusively within the Space Heating, Area Source sector. Emission reductions for NO_x are proportional to those for $PM_{2.5}$. Space heating emissions for NO_x, however, represent a small share of total emissions.)

As noted earlier in Section 5.6.1, this Moderate Area SIP did not formally require an attainment projection once it was established that attainment by the 2015 deadline for moderate areas was impracticable. Nevertheless as explained there, a path toward attainment by 2019 was developed that incorporated additional measures and programs beyond those in effect in 2015. Thus this Moderate Area SIP included an attainment projection by 2019.

The SIP also includes an analysis that demonstrates adequate emission reductions will be achieved to comply with the goals of RFP beyond 2015.

The quantitative milestone requirements of CAA Section 189(c) dictate that the "milestone" year for this RFP progress assessment is 2017 (no later than three years from the Moderate Area SIP submittal date of December, 2014). Section 172(c)(2) indicates that the assessment be based on actual emissions. However for completeness (to be consistent with the fact that the 2015 and 2019 modeling inventory were examined both ways), the 2017 RFP inventories were also generated both ways, considering both actual episodic emission levels as well as PTE permitted levels for point sources.

<u>2017 RFP Inventory</u> – To evaluate RFP-mandated linear progress toward attainment beyond 2015, an analysis of emissions in 2017 associated with implementation of Reasonably Available Control Measures (RACM) and Reasonably Available Control Technologies (RACT) and additional reasonable measures for the area was performed to determine whether forecasted controls (and their benefits) in 2019 would be sufficient to ensure linear progress from 2015 to the projected 2019 attainment emission levels.

To address this requirement, 2015 and 2019 Control inventories for the non-attainment area were interpolated to 2017 to establish target emission levels representing a linear trajectory between the Moderate Area attainment deadline (2015) and the forecasted attainment year (2019). (Since 2017 is midway between 2015 and 2019, the linear progress target levels are simply the average of the 2015 and 2019 Control emission levels.)

Chapter 5.7 identifies and provides a detailed discussion of RACM measures for Fairbanks. (All RACT measures have already been implemented in Fairbanks.) Many of the RACM measures identified in Chapter 5.7 are either voluntary or have already been implemented prior to 2015. Thus, the remaining measures examined for the purpose of RFP are those non-voluntary measures slated for implementation or phase-in after 2015 and correspond to the list of measures for which quantitative emission benefits were calculated and incorporated into the Control inventories. These specific measures/programs are listed below:

- State Space Heating Device Standards in New Homes;
- State-Coordinated Wintertime Dry Wood Use Program; and
- Expansion of Natural Gas Availability in Fairbanks.

Since these measures were restricted to the Space Heating (Area) source sector, the RFP progress assessment was conducted by analysis of emissions at the source sector level (although areas sources were split into Space Heating and Other sub-sectors). The analysis was based on average daily episodic emissions over the non-attainment area.

Table 5.6-27 shows the resulting 2017 RFP inventory for $PM_{2.5}$, SO_2 and NO_x emissions within the non-attainment area using the same source sector stratifications presented for the Control inventories. As shown at the bottom of the table, total emissions (on an average episode day basis) are 3.91 tons/day, 12.40 tons/day and 18.95 tons/day for $PM_{2.5}$, SO_2 and NO_x, respectively.

Table 5.6-27
2017 RFP Inventory Emissions (tons/day) by Source Sector,
Actual Point Source Emissions

	NA Area Emissions (tons/day)		
Source Sector	**$PM_{2.5}$**	**SO_2**	**NO_x**
Point (Actual)	1.412	8.167	13.285
Area, Space Heating	1.976	4.137	2.398
Area, Space Heat, Wood	1.866	0.073	0.316
Area, Space Heat, Oil	0.060	3.997	1.752
Area, Space Heat, Other	0.050	0.067	0.331
Area, Other	0.066	0.000	0.002
On-Road	0.433	0.017	2.187
On-Road, Running Exh	0.289	0.015	1.511
On-Road, Start & Idle Exh	0.144	0.002	0.676
On-Road, Evap	0.000	0.000	0.000
Non-Road	0.024	0.086	1.078
TOTALS	**3.912**	**12.407**	**18.950**

Linear Progress Assessment – Figure 5.6-27 presents the results of the analysis of projected control emissions in 2017 relative to linearly-interpolated targets for $PM_{2.5}$ based on actual emissions for point sources. The vertical bars include the 2015 and 2019 Control inventory emissions (labeled "2015" and "2019") are shown at each end of the figure. The middle bar, labeled "2017-Lnr" represents the linearly-interpolated RFP-targeted emission levels in 2017. Each bar includes elements that show the breakdown of sector-specific emissions (in tons/day). Above each of these bars, the values in bold italics represent total emissions summed across all sectors. The dashed line shows the linear progress trajectory (for total emissions) from 2015 to 2019 (and this intersects the top of the "2017-Lnr" bar.

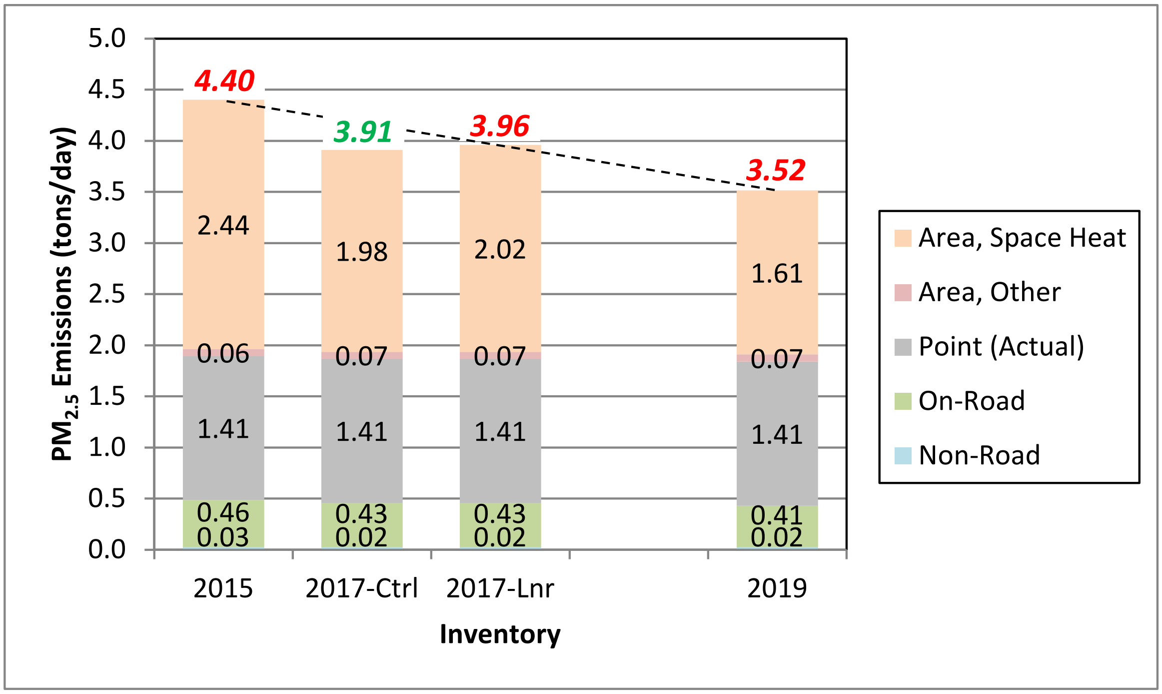

Figure 5.6-27. Comparison of 2017 $PM_{2.5}$ RFP Inventory to Linear Target in 2017, Actual Point Source Emissions

Next to this bar, a fourth bar labeled "2017-Ctrl" represents emissions by sector reflecting forecasted control measure benefits in 2017 based on expected implementation dates and/or phase-in schedules for each of the three measure listed earlier. (Since these measures are all restricted to the Space Heating sector, only the Space Heating segment is different between the 2017-Crtl and 2017-Lnr bars. As seen in comparing these two bars in Figure 5.6-27, combined control benefits from these measures are projected to result in total inventory emissions that are lower than the linear RFP target (3.91 vs. 3.96 tons/day). (The space heating emissions are 1.98 tons/day compared to the target for the sector of 2.02 tons/day.)

Figure 5.6-28 presents a similar comparison for SO_2, although the linear trend from 2015 to 2019 reflects increasing levels of SO_2. (This shift is largely the result of replacement of wood burning devices with oil devices for heating device replacements under the Borough's Wood Stove Change Out program.) Nevertheless, the 2017-Ctrl SO_2 emissions are below the linear target for 2017 (12.41 vs. 13.00 tons/day).

Finally, the linear progress assessment for NO_x is shown in Figure 5.6-29. Although the downward linear trend is less pronounced than for direct $PM_{2.5}$ shown earlier in Figure 5.6-27, the 2017-Ctrl emissions are still nominally below the linear progress target in 2017 (18.95 vs. 18.97 tons/day).

(Coupled with the direct $PM_{2.5}$ emission reductions attainment is projected in 2019 based on atmospheric/chemical modeling described in Chapter 5.8.)

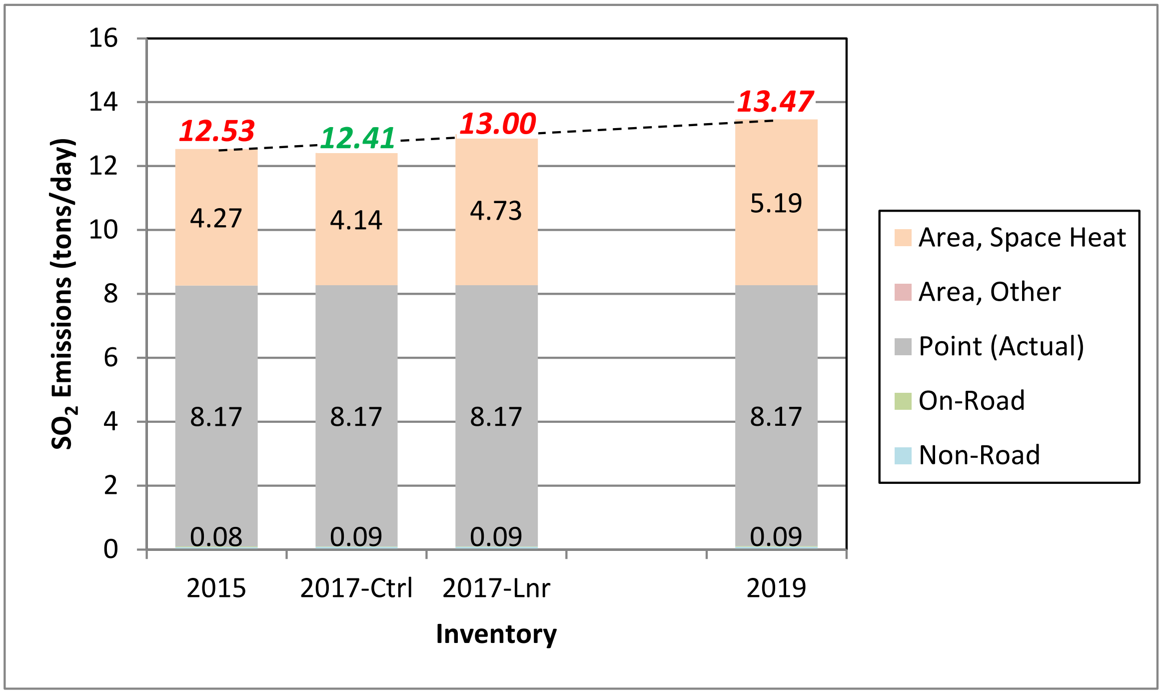

Figure 5.6-28. Comparison of 2017 SO_2 RFP Inventory to Linear Target in 2017, Actual Point Source Emissions

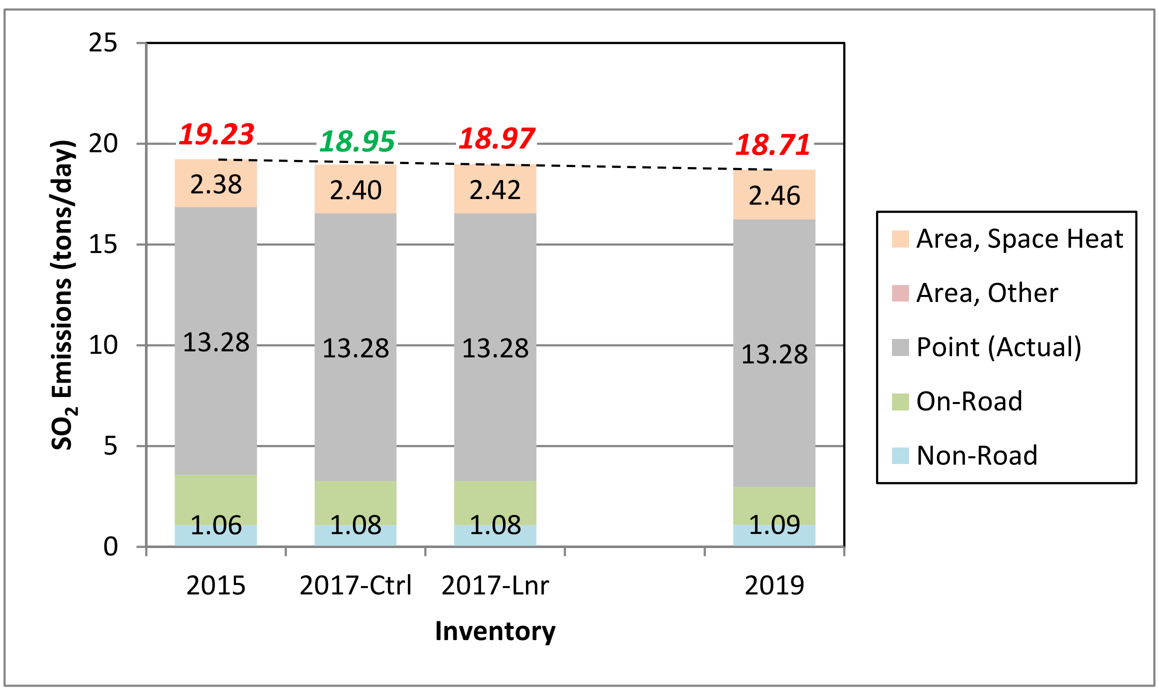

Figure 5.6-29. Comparison of 2017 NO_x RFP Inventory to Linear Target in 2017, Actual Point Source Emissions

The reason the 2017-Ctrl emissions for both $PM_{2.5}$ and SO_2 are below their linear target levels is twofold:

1. The first two measures (State Device Standards in New Homes and Dry Wood Use) were assumed to be fully phased in by 2017 with the same level of participation assumed in 2019. Most of the benefits come from the Dry Wood Use program, and as explained earlier in Section 5.6.4.3, the participation rate of 34.3% was also applied in 2017.

2. The WSCO program continues to provide "better than linear" incremental benefits between 2015 and 2019. Even though the benefits are projected to decline each year relative to the prior year, the benefits accumulated from 2015 to 2017 exceed those projected from 2017 to 2019.

The combination of these two factors is more than enough to overcome benefits from Natural Gas Expansion that are projected to increase at faster rates from 2017 to 2019. (The penetration rates for expanded natural gas availability are projected to rise from 0% in 2015 to 14% by 2017 and 36% by 2019.)

Figure 5.6-30 through Figure 5.6-32 present similar comparisons of RFP progress in 2017 for $PM_{2.5}$ and SO_2, respectively based on PTE levels for point sources. These comparisons directionally match those shown earlier in Figure 5.6-27 through Figure 5.6-29 that were based on actual emissions for the point source sector. In each case, forecasted emissions in 2017 due to projected implementation of control measures will be below the linear progress targets as seen in comparing the 2017-Ctrl and 2017-Lnr emission levels in each figure.

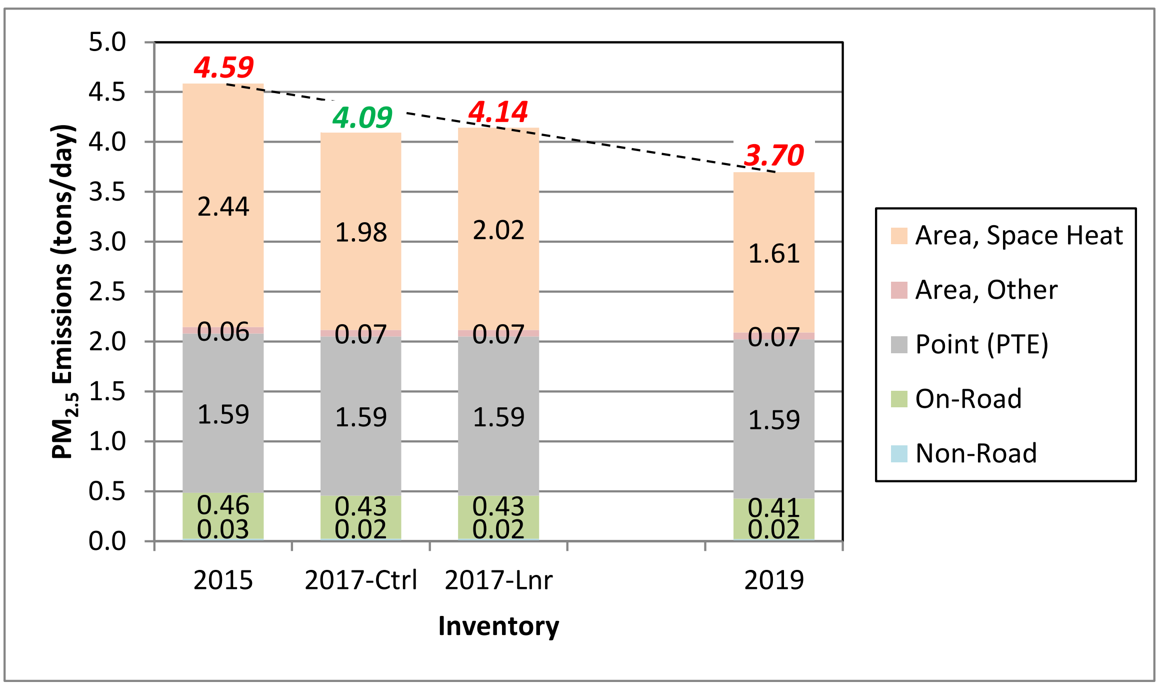

Figure 5.6-30. Comparison of 2017 $PM_{2.5}$ RFP Inventory to Linear Target in 2017, PTE Point Source Emissions

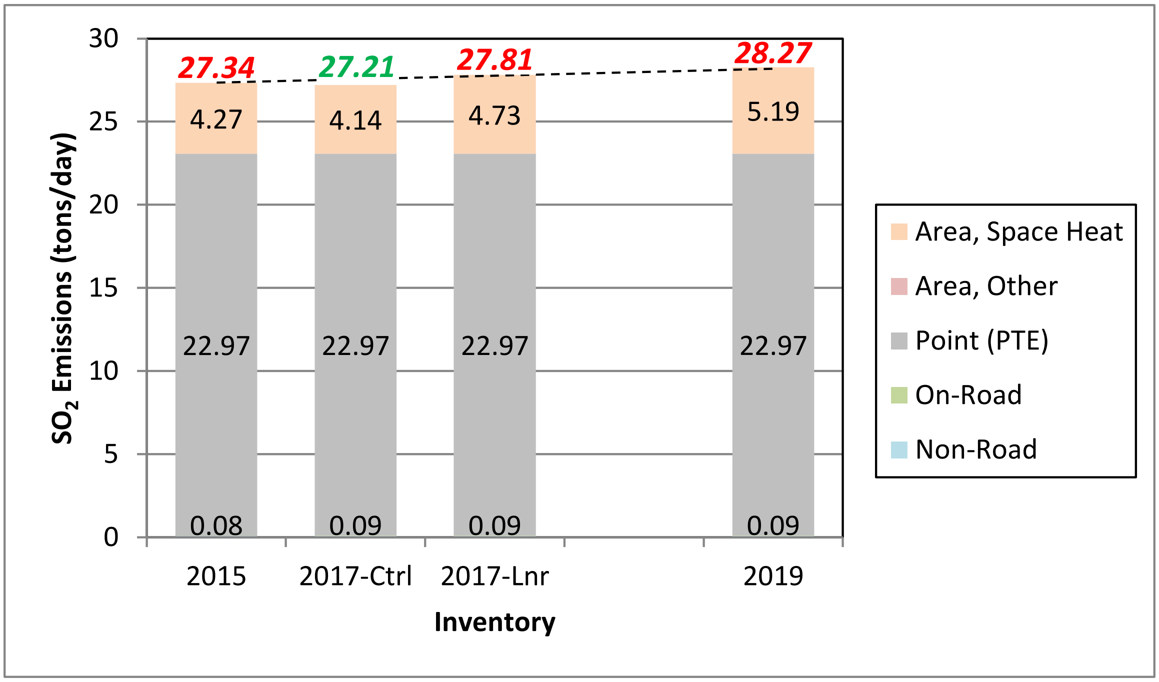

Figure 5.6-31. Comparison of 2017 SO_2 RFP Inventory to Linear Target in 2017, PTE Point Source Emissions

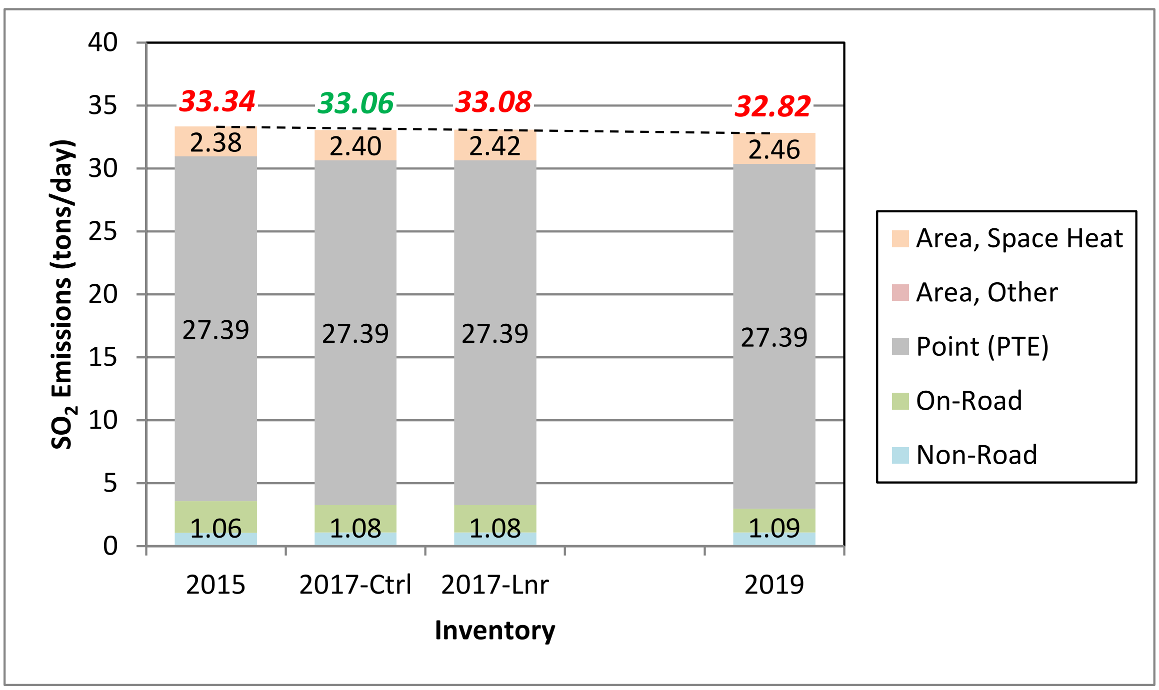

Figure 5.6-32. Comparison of 2017 NO_x RFP Inventory to Linear Target in 2017, PTE Point Source Emissions

The above analysis demonstrates that the control measures leading to attainment in 2019 will yield better than linear progress in 2017 for direct $PM_{2.5}$, SO_2 and NO_x. Therefore the RFP plan requirements are met for all applicable pollutants because the control measures they contain result in 2017 emissions that are below their respective 2017 linear progress target levels.

5.6.6. 2017 Motor Vehicle Emissions Budget

Need for MVEBs – Generally, motor vehicle emission budgets (MVEBs) must be established within a SIP for use in subsequent regional transportation conformity analysis that is tied to the SIP's attainment demonstration and the on-road vehicle emissions share of the overall attainment inventory. However as discussed in Chapter 5.9, the central finding of this Moderate Area SIP is that attainment of the $PM_{2.5}$ NAAQS by the required 2015 deadline will be impracticable in Fairbanks due to the magnitude of required reductions and the difficulty and the cost of implementing measures that achieve these reductions in the near term (i.e., by 2015).

A control strategy implementation plan revision and MVEB is defined under 40 CFR §93.101 as follows:

> *Motor vehicle emissions budget is that portion of the total allowable emissions defined in the submitted or approved control strategy implementation plan revision or maintenance plan for a certain date for the purpose of meeting reasonable further progress milestones or demonstrating attainment or maintenance of the NAAQS, for any criteria pollutant or its precursors, allocated to highway and transit vehicle use and emissions.*

EPA's Office of Transportation and Air Quality (OTAQ) and Office of Air Quality Planning and Standards (OAQPS) through EPA Region 10 were consulted to assess the need for MVEBs within this SIP. EPA confirmed the need for MVEBs within this "impracticability" SIP, citing language in the 1992 General Preamble[31] for Title I implementation of the CAA. Under the Reasonable Further Progress (RFP)/Quantitative Milestone (QM) Requirements portion of the Particulate Matter, Statutory Background section [III.C(1)(f)], the Preamble contains the following language:

> *The PM-10 non-attainment area SIP's must include quantitative emissions reductions milestones which are to be achieved every 3 years and which demonstrate RFP, as defined in section 171(1) until the area is redesignated attainment [section 189(c)].*

and

> *There is a gap in the law that the text of section 189(c) does not articulate the starting point for counting the 3-year period. The EPA believes it is reasonable to begin counting the 3-year milestone deadline from the due date for applicable implementation plan revisions containing the control measures for the area. The EPA believes it is reasonable to key the milestone clock to the SIP revision containing control measures which will give rise to emission reductions.*

[31] Federal Register, Vol. 57, No. 74, April 16, 1992.

Although this Preamble was written prior to development and implementation of separate ambient standards for $PM_{2.5}$, EPA has confirmed that the language above for PM_{10} also applies to $PM_{2.5}$ SIPs. Thus, EPA guidance was that MVEBs must be developed under this SIP pursuant to the RFP/QM requirements of Section III.C(1)(f) of the Preamble.

MVEB Calendar Year and Pollutants – As discussed in earlier in Section 5.6.5, the milestone year for RFP is 2017. Thus, RFP inventories and MVEBs were established for calendar year 2017. Separate budgets of on-road motor vehicle emissions occurring within the non-attainment area were set for both directly-emitted $PM_{2.5}$ and NO_x, the latter based on EPA's interpretation of applicable precursor requirements under 40 CFR §93.102(b)(1) and §93.102(b)(2)(iv), which applies to precursors of $PM_{2.5}$.

Summary of MVEB Methodology – The MVEBs were calculated using the same approach applied in modeling motor vehicle emissions within the SIP emission inventories. However, the 2017 MVEBs were not an interpolation of 2015 and 2019 on-road emissions as developed for RFP progress analysis as described in Section 5.6.5. Instead the 2017 MVEBs were calculated based on a calendar year 2017 emission modeling run and differ nominally from the on-road emissions presented in that section. The MVEB modeling is summarized below.

- *Emissions Model* – Emissions were calculated using the MOVES2010a vehicle emissions model, executed in county-wide "Inventory" mode. The model was run to generate emissions over the six-month non-attainment season (October through March). The Time Aggregation Level option was set to "Hour" as required for SIPs and regional emissions analysis[32].

- *Activity Inputs* – Vehicle activity inputs (VMT by vehicle type, speed distributions, road type VMT distributions) for calendar year 2017 were developed by interpolating activity between the 2010 and 2035 calendar years for which regional travel demand model outputs were available from FMATS.

- 2012-2015 TIP modeling were available. The same locally developed seasonal, weekly, and diurnal travel activity profiles used in the SIP inventories were also used to generate the MVEBs. Default MOVES activity was assumed for heavy-duty trucks (with no explicitly input extended idling).

- *Fleet Characteristics Inputs* – 2017 vehicle populations were extrapolated from actual 2010 registrations using the same growth rate assumptions used to generate the 2015 and 2019 Projected Baseline inventories. Vehicle age distribution and Alternative Vehicle and Fuel Technology (AVFT) inputs were based on the calendar year 2010 registration data, with an exception for light-duty vehicle age distributions explained as follows. Age distribution inputs for light-duty vehicles were based on wintertime parking lot survey

[32] "Using MOVES to Prepare Emissions Inventories in State Implementation Plans and Transportation Conformity: Technical Guidance for MOVES2010, 2010a and 2010b," U.S. Environmental Protection Agency, EPA-420-B-12-028, April 2012, http://www.epa.gov/otaq/models/moves/documents/420b12028.pdf.

data collected by ADEC, rather than registration data. Multiple parking lot surveys have consistently found that older vehicles are operated less during winter due to drivability concerns. In developing winter non-attainment season inputs, motorcycles were assumed to not operate during harsh winter conditions. Thus their populations were zeroed out. The source population, age distribution and AVFT inputs were supplied to MOVES using the County Data Manager importers in accordance with the modeling guidance[32].

- *Meteorology Inputs* – Based on interagency consultation guidance from EPA and FWHA, hourly ambient temperature and relative humidity profiles were developed from hourly temperatures (and humidity data) averaged across the 35 modeling episode days and used as the meteorology inputs to the MVEB modeling. The resulting hourly temperature profile exhibited a diurnal range from -14.1°F (Hour 8) to -6.4°F (Hour 15), with an average daily temperature of -11.8°F. This was consistent with episodic modeling inventory development in the SIP although the average meteorology profile across the 35 episode days was used for the MVEB while individual day meteorology (for each of the 35 days) was used to establish the MVEB and was agreed upon in consultation with EPA and FHWA.

- *Plug-In Adjustments to $PM_{2.5}$ Emissions* – Finally, starting exhaust $PM_{2.5}$ emissions for light-duty gasoline vehicles were adjusted to account for the effects of wintertime vehicle plug-in block heater use in Fairbanks. These adjustments were applied using an EPA-accepted approach that consisted of modifying the MOVES soak time distribution inputs for light-duty vehicles contained in *OpModeDistribution* table in the model's default database. Appendix III.D.5.6 provides further details on these plug-in adjustments. Note that EPA's approval of the methodology for modeling the adjustments only extends to analyses conducted using MOVES2010; additional interagency consultation will be needed to identify a methodology for use with MOVES2014.

<u>Motor Vehicle Emission Budgets</u> – Using the modeling methodology outlined above, MOVES2010a was executed with locally developed inputs representative of wintertime calendar year 2017 conditions. Table 5.6-28 summarizes the resulting regional average winter day on-road vehicle $PM_{2.5}$ and NO_x emissions, which represent the applicable MVEBs under the SIP.

Table 5.6-28
Fairbanks Non-Attainment Area Motor Vehicle Emission Budgets

	Motor Vehicle Emission Budgets (tons/day)	
Calendar Year	**$PM_{2.5}$**	**NO_x**
2017 and later	**0.33**	**2.13**

The $PM_{2.5}$ MVEB shown in Table 5.6-28 includes the plug-in adjustment effects. (As noted earlier, the plug-in adjustments are applied only to starting exhaust emissions for light-duty gasoline vehicles. Plug-ins reduced vehicle fleet-wide $PM_{2.5}$ emissions by 5.4%.) The $PM_{2.5}$ MVEB assumed zero contribution from fugitive road dust, consistent with the SIP inventory assumption that road dust emissions do not occur during winter in Fairbanks when road surfaces are snow- and ice-covered. The emissions budget also does not include construction dust for the same reason.

MVEB Context within 2017 Inventory – To provide a clear understanding for the contribution of emissions from on-road motor vehicles (i.e., the MVEBs) relative to all other emission sources within the non-attainment area, Table 5.6-29 presents a summary of 2017 $PM_{2.5}$ and NO_x emissions by major source sector. Emissions are shown on both an absolute (tons/day) and relative (% of total emissions) basis for both pollutants. On-road vehicle emissions (based on the MVEBs) are highlighted.

Table 5.6-29
2017 $PM_{2.5}$ and NO_x Emissions (tons/day) by Source Sector
Showing Motor Vehicle Emissions Contribution

Source Sector	*NA Area Emissions (tons/day)*		*Relative Emissions Contribution (%)*	
	$PM_{2.5}$	**NO_x**	**$PM_{2.5}$**	**NO_x**
Point Sources (Actual)	1.41	8.17	37.1%	63.9%
Area Sources	2.04	2.40	53.6%	18.8%
On-Road Sources (MVEBs)	**0.33**	**2.13**	**8.7%**	**16.7%**
Non-Road Sources	0.02	0.09	0.6%	0.7%
TOTALS	**3.81**	**12.78**	100.0%	100.0%

As highlighted in Table 5.6-29, the contribution of on-road vehicles to total emissions from all sources for both pollutants are relatively small, comprising under 9% and 17% of total $PM_{2.5}$ and NO_x emissions respectively. Although on-road vehicles are by no means the predominant source of these pollutants, the vehicle emission budgets established under the federal conformity regulations require that emissions associated with future federally-funded regional transportation plans do not exceed budgeted limits, thereby ensuring these plans conform to the overall attainment progress reflected in the SIP.

Differences Between On-Road Emissions in 2017 RFP Inventory and MVEBs – Emissions from on-road vehicles for $PM_{2.5}$ and NO_x shown in the 2017 RFP Inventory table (Table 5.6-27) and MVEB tables (Table 5.6-28 and Table 5.6-29) are nominally different (0.43 vs. 0.33 tons/day for $PM_{2.5}$ and 2.19 vs. 2.13 tons/day for NO_x). These differences are not the result of errors, but rather how the MOVES vehicle emissions model is required to be used for the attainment modeling-based RFP inventory versus establishment of vehicle emissions budgets. There are several reasons as explained below.

First, for the RFP inventory, MOVES was executed in “Emission Rates” calculation mode to provide highly detailed emission rates by emission process, speed and ambient temperature to support calculation of emissions by hour and grid cell for use in the attainment modeling. For the MVEBs, MOVES must be executed under a simpler “Inventory” calculation mode to estimate total vehicle emissions over a regional area (the

$PM_{2.5}$ non-attainment area in this case). In the attainment modeling inventory temperature-specific emission rates are combined with individual temperatures for each modeling grid cell. In the Inventory calculation mode for the MVEB's an average temperature profile (based on temperatures at Fairbanks International Airport) was used. Finally, the RFP inventory was based on vehicle emissions calculated by hour and day for all 35 modeling episode days. In contrast the MVEBs are based on a temperature profile than represents the average hourly temperature across all 35 days. (Since vehicular $PM_{2.5}$ emissions are more sensitive to ambient temperature (in this temperature range) than NO_x emissions, this likely explains why the difference between the RFP and MVEB vehicle emissions are greater for $PM_{2.5}$ than NO_x.)

5.6.7. Inventory Validation and Quality Assurance

5.6.7.1 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[33] developed by EPA under its Emission Inventory Improvement Program (EIIP), specifically under Volume VI (Quality Assurance Procedures).

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.

5.6.7.2 Responsible Personnel

Alice Edwards of the Alaska Department of Environmental Conservation (DEC) and Robert Dulla of Sierra Research, Inc. (Sierra)—both with emission inventory, regulatory policy, and control measure evaluation experience—served as co-Quality Assurance Coordinators. Ms. Edwards handled data prepared or obtained directly by the State, while Mr. Dulla was responsible for QA of Borough and all other externally developed or acquired data.

[33] 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/.

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

5.3.7.3 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 III.D.5.6.1, 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: MOVES2010a for on-road vehicles, NONROAD2008a for non-road vehicles and equipment, and EDMS 5.1.3 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.

5.6.7.4 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.

Data Assembly and Review – 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).

Data Tracking – 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 finalized 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 Fairbanks $PM_{2.5}$ 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
- Jim Conner, FNSB
- Ron Lovell, FNSB
- Todd Thompson, FNSB
- Rob Elleman, EPA Region 10
- Lucy Edmonson, EPA Region 10
- Jeff Houk, FWHA Resource Center (monthly)
- Kris Reisenberg, FHWA (monthly)
- Bob Dulla, Sierra Research
- Tom Carlson Sierra Research
- Mark Hixson, Sierra Research

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. Finally, preliminary reviews of EI technical documentation were provided by Rob Elleman and Bob Kotchenruther of EPA Region 10.

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.