LIBBY, MONTANA, PM-2.5 ANNUAL STANDARD
2005 PM-2.5 EMISSION INVENTORY

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Electronic Files: Electronic files are available upon request showing all calculations by grid and season for each source category. They are supplied electronically to both conserve paper and provide the information in a better understood format.

LIST OF ABBREVIATIONS

ADT	Average Daily Traffic
AADT	Average Annual Daily Traffic
AP-42	Compilation of Air Pollutant Emission Factors (AP-42)
AMS	Air shed Management System
ARMB	Air Resources Management Bureau, Montana Department of Environmental Quality
BNSF	Burlington Northern and Santa Fe Railway Company
C	Centigrade
cm	Centimeter
cm^3	Cubic Centimeter(s)
CMB	Chemical Mass Balance
DEQ	Montana Department of Environmental Quality
EDMS	Emissions and Dispersion Modeling System
E_f	Emission Factor(s)
EI	Emission Inventory
EI/NAA	Emission Inventory/Nonattainment Area
EPA	United States Environmental Protection Agency
F	Fahrenheit
FAA	Federal Aviation Administration
g	Gram(s)
gal	Gallon(s)
GIS	Geographical Information System
GTM	Gross Ton Miles
GVWR	Gross Vehicle Weight Rating
HDD	Heating Degree Day(s)
hr	Hour(s)
IGAP	Low Income Energy Assistance Program
km	Kilometer(s)
km^2	Square Kilometer(s)
lb	Pound(s)
LCEHD	Lincoln County Environmental Health Department
LIEAP	Low Income Energy Assistance Program
LPG	Liquid Petroleum Gas

LTO(s)	Landing and Takeoff(s)
MDT	Montana Department of Transportation
μ	Micron(s)
$\mu g/m^3$	Micrograms Per Cubic Meter
m^2	Square Meter(s)
mi.	Mile(s)
mph	Miles Per Hour
MT	Montana
mton	Metric Ton(s)
MY	Model Year
NAA	Nonattainment Area
NAAQS	National Ambient Air Quality Standard(s)
NAD83	North American Datum 1983
NCDOT	North Carolina Department of Transportation
NEI	National Emission Inventory
NSPS	New Source Performance Standards
NWS	National Weather Service
OHH	Occupied Households
PM-10	Particulates With an Aerodynamic Diameter of 10 Microns (μ) or Less
PM-2.5	Particulates With an Aerodynamic Diameter of 2.5 Microns (μ) or Less
RFG	Reformulated Gasoline
RWBS	Residential Wood Burning Survey
SCC	Source Classification Code
SIP(s)	State Implementation Plan(s)
sL	Silt Loading
ton(s)	English Ton(s)
UTM	Universal Transverse Mercator
VKT	Vehicle Kilometers Traveled
VMT	Vehicle Miles Traveled
yd^3	Cubic yard

UNITS AND CONVERSION FACTORS

Metric and English units will be used in this document. Listed below are common conversion factors used in this document to convert English units to metric units or metric units to English units.

To convert kilogram to metric ton, divide by 1,000.

To convert English ton to metric ton, multiply by 0.9072.

To convert pound to kilogram, multiply by 0.4536.

To convert short tons to metric ton, multiply by 0.9072.

To convert kilogram to pound, multiply by 2.2040.

To convert gallon to liter, multiply by 3.7854.

To convert mile to kilometer, multiply by 1.6093.

To convert square mile to square kilometer, multiply by 2.5900.

1.0 INTRODUCTION

On December 17th, 2004, the U. S. Environmental Protection Agency (EPA) informed the State of Montana (MT) in a letter to then Governor Judy Martz that Libby, MT was in violation of the fine particulate National Ambient Air Quality Standard (NAAQS), and that a mitigation plan for particulate matter of 2.5 $\mu g/m^3$ or less (PM-2.5) *(Annual Standard)* must be developed. The units of the standard, $\mu g/m^3$ are defined as micrograms per cubic meter.

As part of the effort to develop the required control plan, a PM-2.5 emission inventory (EI) must be written quantifying the PM-2.5 emissions for all sources of the fine particulate in Libby. The objective of this EI is to accurately quantify actual seasonal and annual PM-2.5 emissions from point and area sources within the EI nonattainment area (EI/NAA), and accurately apportion those emissions geographically within the EI area.

A feature of this EI is the use of the year 2005 for the base-year. The EPA has suggested, but not required that a 2002 base-year be used in their PM-2.5 implementation plan document.[1, 2] Since critical activity information concerning residential wood combustion, as well as other home and commercial fuel use is not available for the partial-county Libby EI/NAA area for 2002, this inventory was developed for 2005. It has been suggested in conversations with the EPA (Region VIII), that wood stove use and home heating data in the 2002 National Emission Inventory (NEI) could be used.[36] While it is well beyond the scope of this document to criticize the default county level data in the 2002 NEI, reviews of the data contained in the NEI find it inaccurate at the county level, much less for the much smaller Libby nonattainment area studied here. Instead of using 2002 NEI data, data for all space heating fuels through a bottom up, effort dependant approach with an emphasis on wood burning for a 2005 base year inventory was performed. The year 2005 represents the year that the State of Montana developed a wood stove and wood burning survey as part of the Libby, MT Woodstove Changeout Program.[3] The year 2005 was also the year that data was available for on fuel use for commercial space heating, and a Chemical Mass Balance (CMB) study was undertaken to determine the source contribution of the PM-2.5 particulate.[25] The direct costs of these endeavors have totaled over 155,000 dollars to date. If the indirect costs of staff time where added, the total cost of this work to date by our agency would approach one quarter of a million dollars.

Usually the primary reason for conducting an EI is to serve as input to a dispersion model. However, since dispersion modeling will not be utilized for Libby, this EI will be written to satisfy federal State Implementation Plan (SIP) requirements and used as basis for a “roll back” calculation for an emission control plan document to bring Libby into attainment with the annual PM-2.5 NAAQS. This document is the 2005 base year EI as required by the EPA.[2]

Table 1.0 shows the magnitude and frequency of 24-hour PM-2.5 values that exceeded the 24-hour 1997 NAAQS of 65 $\mu g/m^3$, and the average annual PM-2.5 concentration from 2001 to 2003.

TABLE 1.0: 24-HOUR AND ANNUAL AVERAGE PM-2.5 CONCENTRATIONS MEASURED AT THE COURT HOUSE ANNEX, LIBBY, MT, FROM 2001 TO 2003.

Year	First Highest 24-Hour PM-2.5 Concentration ($\mu g/m^3$)	Second Highest 24-Hour PM-2.5 Concentration ($\mu g/m^3$)	Annual Average Concentration ($\mu g/m^3$)
2001	49.1	47.4	16.2
2002	64.1	48.0	15.9
2003	47.0	42.5	15.6

Historically, wood stove combustion and road dust has been found to be major contributors of PM-10 ambient levels in Libby. Since PM-2.5 emissions due to wood burning makes up nearly 100% of the PM-10 size fraction of wood combustion, wood burning is likely a major part of the PM-2.5 emissions in the Libby NAA/EI area. This was confirmed in a CMB study performed during 2005, as well as carbon 14 measurements that independently found that 82% of the PM-2.5 resulted from wood combustion.[25] PM-2.5 from diesel exhaust and oil burning for space heating in homes and commercial establishments are other sources of PM-2.5 emissions in the Libby NAA/EI area.

2.0 DESCRIPTION OF STUDY AREA

According to the 2000 U.S. Census, Libby is a small town with a population of 2,626 people within its city limits, and lies along the Kootenai River in the northwestern corner of Montana. If the growth rate from 2000 to 2005 remained at the rate of 3.71% that occurred during the ten-year period from 1990 to the year 2000, the city had a population of 2,674 people in 2005.[7] The greater "Libby Valley" in 2005 had a population of roughly 9,484 people, if the growth rate was similar to that that occurred from 1990 to 2000 within the county at 7.76%.

Libby lies in the Kootenai River Valley, which is a narrow drainage running east to west and borders the Libby city limits to the north to make up what is commonly referred to as the Libby Valley. Two smaller valleys extending both north and south of the city, along Pipe and Libby Creeks, respectively, also defines the Libby Valley. Libby lies at an elevation of 2,100 feet with the surrounding mountains rising to over 7,000 feet in elevation.

Both the climatic conditions and Libby's location in the deep mountain valley cause the community to be subjected to some of the poorest atmospheric dispersion in Montana. During the fall and winter, winds are light or nonexistent, and temperature inversions are common. Temperature inversions can last for days or weeks and trap particulate matter in the valley. Libby has recorded some of the highest total suspended particulate, particulate matter of 10 $\mu g/m^3$ or less (PM-10) and PM-2.5 concentrations ever recorded in Montana.

The Lincoln County Environmental Health Department (LCEHD) along with the Montana Department of Environmental Quality (DEQ) designed the PM-2.5 nonattainment area to cover the greater Libby Valley, which was also designated as the PM-2.5 EI area. The geographical

area of the PM-2.5 NAA/EI area is roughly the same size as of the greater Libby Valley shown in Appendix A. Using Geographic Information Systems (GIS) technology, 2000 U.S. Census block information and adjusted for the growth believed to have occurred from the Census year 2000 to the survey year, 2005, an estimated 3,888 occupied households (OHH) were within the 600 square kilometer (km^2) study area that represented the PM-2.5 nonattainment area (NAA). Appendix B contains a map of the Libby PM-2.5 NAA with each of the 600 grids numbered.

More specifically, the 2005 EI area encompasses an area running north/south 30 kilometers (km), and east/west 20 kilometers for a total spatial coverage of 600 square kilometers. The area is divided into a grid network comprised of 600 one-kilometer-square grids. Specifically, this 2005 EI will use an area bounded by lines from Universal Transverse Mercator (UTM) Zone 11 coordinate system: 600000mE, 5370000mN east to 620000mE, 5370000mN south to 620020mE, 5340000mN west to 600000mE, 5340000mN north to 600000mE, 5370000mN as shown in Appendix A, where mE, mN are meters easting and meters northing, respectively. The coordinates were defined under the North American Datum 1983 (NAD83).

As described above, DEQ will use a grid system to apportion emissions over the EI/NAA. The grid apportionment will provide the detail necessary to accurately represent the spatial differences in emissions over the area. The DEQ has concluded that the 1.0 km^2 grids would provide the resolution necessary to accurately simulate impacts from emissions within the 2005 EI area.

It should be noted that the EI area for this inventory was different from the previous Libby PM-10 EI. The gridded 1990 base year PM-10 EI area was designed to cover the Libby area encompassing 58 1.0 km^2 grids, while this EI area will cover 600-1.0 km^2 grids that make up the PM-2.5 NAA.

3.0 EMISSION INVENTORY DESIGN

Several types of information were reviewed prior to designing the format of this 2005 Libby PM-2.5 emission inventory. This information included previous Libby PM-10 emission inventory, and local air monitoring and meteorological data. Based on this background information, DEQ anticipated that the most important PM-2.5 emission sources in the Libby area were area sources such as onroad motor vehicle exhaust, onroad fugitive dust emissions, and residential wood combustion. A gridded emission inventory was used to identify the impacts of localized emission sources throughout the EI area. The use of this design also provided the necessary detail to locate high PM-2.5 concentration areas and resolve the steep concentration gradients from the location of the PM-2.5 monitoring site to the outer boundaries of the EI area.

4.0 METHODOLOGY

This plan is divided into three basic sections: general, point, and area. The first section describes the spatial and temporal characteristics that affected the estimation of the PM-2.5 emissions, regardless of the source type. The other two sections describe the specific procedures for calculating the PM-2.5 emissions based on the source type.

4.1 GENERAL PROCEDURES

Certain procedures were applied to all of the emission source categories and are described in this section. These procedures involved the temporal aspects of PM-2.5 emissions in the 2005 Libby area.

4.1.1 Base Year

This PM-2.5 emission inventory covered the period from January 1 through December 31, 2005. There were 365 days in that year.

4.1.2 Seasonal Apportionment

Summary emission data was presented on a seasonal basis in the text of the document and on a per grid basis in the appendixes. Monthly adjustment factors were reported in the text of the document or the appendixes. Overall, the seasonal analyses provided the necessary detail to select appropriate and reasonable control strategies.

The DEQ will present the emission data on a seasonal basis to illustrate seasonal changes in emissions due to corresponding changes in the various source activity levels. Seasonal average daily (24-hour) emissions will be calculated by dividing the seasonal emissions by the number of days in the respective season as indicated in Table 4.1.2. The seasonal changes in emissions for each specific source category are discussed in Section 4.3.

TABLE 4.1.2: SEASONAL APPORTIONMENT FOR THE 2005 LIBBY PM-2.5 EMISSION INVENTORY.

Quarter/ Season	Months	Number of Days
Spring	April, May, June	91
Summer	July, August ,September	92
Fall	October, November, December	92
Winter	January, February, March	90

The seasonal weighing of PM-2.5 emissions for each source category is discussed individually in the following sections. The data were entered into an EXCEL spreadsheet with the appropriate PM-2.5 emission factor and activity levels in order to calculate the PM-2.5 emissions by source.

4.1.3 Sources Included in Inventory

Sources of PM-2.5 emissions within the 2005 EI area included both point and area sources. However, DEQ had concluded that some of those sources, although present in 2005, did not have a significant impact on ambient concentrations of PM-2.5 due to their relatively low levels of emissions. The DEQ did not consider those sources "significant" and did not include them in the 2005 EI. For purposes of this 2005 EI, DEQ defined a significant source to be one with PM-2.5 emissions greater than or equal to 1.0 metric ton (mton) per year, or greater than or equal to 0.25 mton per year from any source within a single grid cell.

4.2 POINT SOURCES

Point sources for the 2005 EI were identified by a reviewing the point source information in the DEQ Air Resources Management Bureau (ARMB) Emissions Inventory Summary [4] with input from LCEHD personnel. All possible PM-2.5 sources from industrial processes and accompanying fugitive emissions were reviewed. This database is limited to point sources with the potential to emit greater than 25 tons (tons) of air pollutants per year including PM-2.5. Other minor PM-2.5 sources may have existed in the EI area during 2005; the LCEDH was contacted in order to provide the information pertaining to these sources. Potentially, these minor point sources were industries with boilers or drying units such as small lumber companies, sand and gravel crushers, fertilizer distributors, small saw mills, and incinerators. After contacting LCEHD and reviewing the permitting database maintained by DEQ ARMB, none of the above major or minor sources were discovered within the EI area.

4.3 AREA SOURCE SPECIFIC PROCEDURES

This section discusses the specific procedures that were used to calculate PM-2.5 emissions from each area source category in the EI area.

4.3.1 Selection of Area PM-2.5 Emission Sources to Inventory

A list of potentially significant PM-2.5 area sources present within the Libby EI area was developed to establish their relative contribution. The screening process generally involved determining the activity level on an annual basis for an area source of PM-2.5 emissions. An example of an activity is the amount of wood burned by a residential wood burning device (source). Then the activity level (quantity of wood burned) was multiplied by a PM-2.5 emission factor to estimate the PM-2.5 emissions for the entire EI area for a particular source.

Generally, the emission factor (E_f) was obtained from an appropriate document such as the EPA AP-42.[5] As mentioned previously for this PM-2.5 inventory, area or point sources with estimated PM-2.5 emissions less than 1.0 mton in the total emission inventory area or less than 0.25 mton in any one grid for the year 2005 were not be included. Table 4.3.1 lists the estimated PM-2.5 emissions for each potential area source category and a statement as to whether the category was included in this emission inventory.

TABLE 4.3.1: POTENTIAL PM-2.5 AREA SOURCES IN THE 2005 LIBBY EI AREA.

Source Category	Preliminary Estimated Annual PM-2.5 Emissions (mton/yr)[a]	Comments	To Be Inventoried
Aggregate Handling and Storage[c]	<1.0	Insignificant PM-2.5 Source	No
Agricultural Activity Dust[d]	<1.0	Insignificant PM-2.5 Source	No
Aircraft Exhaust	>1.0	Minor PM-2.5 Source	Yes
Coal Combustion[e]	<1.0	Insignificant PM-2.5 Source	No
Residential Construction Dust[j]	NA[b]	Minor PM-2.5 Source	Yes
Nonresidential Construction Dust[j]	NA	Minor PM-2.5 Source	No
Road Construction Dust[j]	NA	Minor PM-2.5 Source	Yes
Wildfire Prescribed Burning[f]	NA	Minor PM-2.5 Source	Yes
Fuel Oil Combustion [h]	>1.0	Minor PM-2.5 Source	Yes
Liquid Petroleum Gas[h] (LPG) Combustion	>1.0	Minor PM-2.5 Source	Yes
Natural Gas Combustion[h]	<1.0	Insignificant PM-2.5 Source	No
Railroad Locomotive Exhaust	>1.0	Minor PM-2.5 Source	Yes
Paved Road Dust	>1.0	Major PM-2.5 Source	Yes
Unpaved Road Dust	>1.0	Major PM-2.5 Source	Yes
Outdoor and Agricultural Burning[g]	NA	Minor PM-2.5 Source	Yes
Residential Wood Combustion	>1.0	Major PM-2,5 Source	Yes
Alleys and Parking Lots[i]	NA	Insignificant PM-2.5 Source	No
Unpaved and Paved Road Motor Vehicle Exhaust, Brake and Tire	NA	Minor PM-2.5 Source	Yes
Nonroad Diesel and Gasoline Motor Vehicle Exhaust	NA	Minor PM-2.5 Source	Yes[k]

a. mton/yr = metric tons per year.

b. NA = Not Available.

c. Aggregate handling occurs during the late fall, winter, and early spring. This activity involves the movement of road sanding materials to and from sanding trucks at the storage sites in the Libby EI area. The aggregate material (sand) that was handled at the Lincoln County location is washed-clean sand that would have little effect on PM-2.5 emission within the Libby EI area.

d. Estimations of emissions from the few acres of agricultural land identified with the help of the LCEHD within the EI area yielded emissions from wind erosion, harvest, tillage, and vehicle travel on agricultural roads that were below the 1 mton/yr required for inclusion in this inventory. Much of the small amount of acreage was hay or alfalfa that had a vegetative factor that resulted in no emissions from wind erosion. Dust from tillage and unpaved agricultural road travel was too small to be a source of emissions.[6]

e. The 2000 U.S. Census recorded no use of coal in Lincoln County.[7]

f. Smoke from slash burnings and prescribed wildfires occurred within the emission inventory area. Forestry slash open burning was restricted from October through March by DEQ.

g. All outdoor and agricultural burning activities required a permit to burn in Lincoln County.

h. According to U.S. Census records, fuel oil, kerosene and propane were used for home heating in the Libby area because natural gas was not available within the EI area. PM-2.5 emission factors were obtained from AP-42.[8]

i. Unpaved alleys in the Libby EI area were mostly within residential areas, and had extremely little traffic. The travel that did occur was at a low speed and usually consisted of light duty vehicles and small trucks.

j. Emission from residential and road construction occurred in the Libby EI area for the year 2005. There was no commercial construction within the EI area in 2005.

k. Emissions for nonroad equipment categories did not meet the requirement of 1 mtons/yr for the EI area or 0.25 mtons in any grid to be included within the inventory. However the emissions were quantified with the NONROAD model.

4.3.2 Aircraft Exhaust

Aircraft emissions were calculated for only the types of aircraft that utilized the Libby Airport during 2005. All of the fights were found to be from general aviation activity consisting of smaller aircraft.

The DEQ followed the procedure used by the EPA in compiling the 1999 NEI as presented in *Documentation for Aircraft, Commercial Marine Vessel, Locomotive, and Other Nonroad Components of the National Emissions Inventory Volume I – Methodology (November 11, 2002).*[9] Specifically, the DEQ used the methodology for aircraft emissions estimation as presented in Appendix A of that document titled 'Aircraft Emissions Estimation Methodology.'

4.3.2.1 Emission Factors

The DEQ used the PM-2.5 emission factor in Appendix A for general aviation presented in Table A-11.[9] That emission factor is presented as pounds of PM-10 per landing and takeoff (LTO), since no corresponding PM-2.5 factors are available for commercial or civil aircraft within the document.

It is important to note that the EPA used emission factors for carbon monoxide, nitrogen oxides, and volatile organic compounds obtained from the Federal Aviation Administration (FAA) Emissions and Dispersion Modeling System (EDMS) to estimate emissions of those pollutants from commercial aircraft for the 1999 NEI. Unfortunately, the EDMS also does not generate emissions for PM-2.5 or PM-10 and the EPA did not otherwise develop a factor to estimate those particulate emissions.

Table 4.3.2.1 shows the LTO and PM-10 emission factor used in calculating the emissions in Libby. Again, because the emissions the PM-10 fraction is mostly composed of the PM-2.5 size fraction, the PM-2.5 emission factor was similar to the PM-10 emission factor as explained above.

TABLE 4.3.2.1: PM-10/PM-2.5 EMISSION FACTOR USED IN CALCULATING EMISSIONS IN LIBBY.

Aircraft Category	LTOs/Year	PM-2.5 Emission Factor (g/LTO)
General Aviation	700	107.37

4.3.2.2 Source Activity Levels

Aircraft emissions are related to the aircraft activity, which is an index of fuel consumption. LTO cycles are the common units of activity and cover all normal flight operations. The specific operating modes are approach, taxi/idle-in, taxi/idle-out, takeoff, and climbout. A brief description of the operating modes follows:

- Approach - measured from moment aircraft enters the pollutant "mixing zone" to when it lands;
- Taxi/Idle-in – time spent after landing until aircraft is parked at the gate and engines turned off;
- Taxi/Idle-out: period from engine startup to takeoff;
- Takeoff – characterized primarily by full-throttle operation that lasts until the aircraft reaches 500 to 1,000 feet (152 to 305 meters); and
- Climbout – period following takeoff that concludes when aircraft passes out of mixing zone.

The mixing zone is the layer of the earth's atmosphere where chemical reactions of the pollutants can ultimately affect ground level pollutant concentrations. It is also the zone where PM-2.5 can be carried to the ground level by the mechanical mixing of wind.[10]

The DEQ obtained LTO data pertaining to general aviation from the Libby Airport manager. Emissions from auxiliary power sources were not a concern because smaller general aviation aircraft usually do not have auxiliary power units.

4.3.2.3 Grid Apportionment

The Libby Airport is located within the Libby EI area, and there were no other private airports or landing strips in the emission inventory area in 2005 as determined from visual observations of aerial photos and checks of aeronautical charts of the Libby area for 2005. Aircraft emissions were apportioned to the grids encompassing the Libby Airport and adjacent grids which included grids K20, K21, K22, L20, L21, L22, M20, M21, and M22.

4.3.2.4 Seasonal Apportionment

Staff at the Libby Airport provided an estimation of the number of flights during each month. Ninety percent of the fights were during the months of May to September, with the remaining flights from October to April representing the remaining 10% of the flights. The DEQ made no adjustment of time-in-mode factors for either daily or seasonal variations in aircraft

activity. The DEQ used default time-in-mode values for all averaging periods. The DEQ summed the monthly information to obtain seasonal emissions.

4.3.3 Propane and Fuel Oil Combustion

Propane and fuel oil were used to heat residential and commercial buildings in the Libby EI area during 2005. There were several local providers for either fuel oil or propane, or both fuels.

4.3.3.1 Emission Factors

Since many of the homes that did burn oil were houses built before 1950, the higher PM-2.5 emission factor of 3.0 lb/1,000 gallons of oil was used to calculate emissions.[8] The applied PM-2.5 emission factor for propane combustion was 0.6 lb/1,000 gallons of propane.[8]

4.3.3.2 Source Activity Levels

The total amount of home and commercial fuel oil and propane consumption was requested from the fuel oil and propane venders for the 2005 heating season. It was difficult to obtain information that would be limited to the EI area as the fuel vendors supplied fuel oil and propane to a geographical area that was at least as large as the county. However it was easier for venders to supply commercial oil and propane consumption information, as these deliveries were only to a few large oil or propane users in locations that were easily defined to be located within the nonattainment area.

To determine the residential oil and propane usage it was possible to obtain information on the average usage for a two to three bedroom home over a heating season from the Low Income Energy Assistance Program (LIEAP) director for the State of Montana.[11] The average usage for Libby was adjusted for any difference in heating degree days in Libby to that of the state average heating degree days.[31] The amount of oil and propane used for residential space heating was determined by multiplying the amount of oil or propane used per residence by the fraction of homes heating with propane or oil from data contained in the 2000 U.S. Census for Lincoln County.[7]

4.3.3.3 Grid Apportionment

The residential fuel oil and propane usage was adjusted based on the number of residences in each grid. Commercial fuel oil and propane usage was allocated to the grids along the main arterial roadways were the businesses were located.

4.3.3.4 Seasonal Apportionment

The PM-2.5 emissions were calculated on a monthly basis in order to estimate the various seasonal emissions for both oil and propane use. Fuel usage during each season of the year was determined based upon heating degree days within a given season as a percentage of the annual degree days as shown in Table 4.3.9.4.

4.3.4 Nonroad Gasoline and Diesel Exhaust

Ten equipment categories composed the nonroad emissions: Airport Service, Agricultural, Commercial Marine Vessels, Construction, Industrial, Lawn and Garden, Light Commercial, Logging, Recreational, and Recreational Marine. Three equipment classes were not included in the analysis: commercial marine, recreational marine; and airport service, as there were no water bodies within the emission inventory area, and the Libby Airport did not have any equipment typically thought of as airport service equipment.

After running the NONROAD model[12] it became apparent that the emissions for each of the above categories did not reach the threshold to be considered as sources in the EI area, as they did not amount to a total of 1 mton within the EI area, or 0.25 mton for any of the 600 grids that make up the EI area. The largest of the above equipment categories that did have emissions were logging emissions. After apportioning the county total emissions from logging to the amount of land that was available for logging to the EI area, the amount of emissions fell well below the one mton level or 0.25 mton for any of the 600 grids that make up the EI area.

4.3.5 Paved Road Dust

Airborne fugitive dust, resulting from entrainment of silt by vehicle traffic on paved roads is a source of PM-2.5 emissions for the spring season due to the use of friction material (sand) during the winter season. Additionally, vehicles entering from unpaved roads and parking lots deposit dirt and mud onto paved roads, which then becomes re-entrained into the air by vehicles traveling on the paved surface.

Sanding material is often applied for traction on paved roads during the wintertime. After intermittent thaws that occur in the winter and spring, these materials can become re-entrained into the air from passing motor vehicles. Within the EI boundary, there are two types of materials that could have been applied to paved roads during icy and snowy conditions: deicer and sanding material that met stringent durability requirements according to the LCEHD Air Quality Regulations.

4.3.5.1 Emission Factors

EPA released a new PM-10 emission factor equation for re-entrained road dust from paved roads in November 2006.[13] Paved road silt loadings are generally high in Montana due to the use of road sanding materials. Conversely, ADT (average daily traffic), also called annual average daily traffic (AADT) on the heaviest of traveled roadways is relatively low when compared to national information. The amount of PM-2.5 emissions from vehicle traffic on a paved road was estimated by the following equation:

$$E = k\left(\frac{sL}{2}\right)^{0.65}\left(\frac{W}{3}\right)^{1.5} - C \times \left(1 - \frac{p}{4N}\right)$$

E = PM-2.5 Emission Factor in grams per vehicle kilometer traveled (g/VKT)

Where:

VKT = vehicle kilometers traveled
k = particle size multiplier for particle size of interest (PM-2.5) and units (0.66 g/VKT)
sL = road surface silt loading (g/m^2; m^2 = square meters)
W = average weight of vehicles traveling on the road (tons)
N = number of days in the averaging period (e.g. 91 for Winter)
C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear (0.1005g/VKT)
P = number of "wet" days with at least 0.0254 cm (0.01 in) of precipitation during the averaging period, and N = number of days in the averaging period (e.g. 365 for annual and 90, 91 or 92 for the days in the season)

To convert from g/VKT to pounds per vehicle miles traveled (lb/VMT), the emissions will be divided by 281.9.

The DEQ applied the appropriate PM-2.5 adjustment factor (i.e., k = 0.66 g/VKT) from Table 13.2-1.1.[13] The silt content of road dust (sL) was determined using data collected as part of the road dust sampling program implemented by LCEHD within the 2005 EI area. Road dust samples were collected in 2005 as part of a sampling program conducted on arterials, collectors and local roads to assess the level of silt loading on those roadways during the winter quarter. The DEQ expressed those factors in terms of grams emitted per VKT (g/VKT). The DEQ converted those values to fall-equivalent emission factors by adjusting for the period during which there was greater than 0.01 inch of precipitation. For the spring and summer seasons the emission factors were based upon silt loading data obtained from the previously prepared emission inventory for Libby.[24] These emission factors were also adjusted for precipitation during the spring and summer quarter. The precipitation data was obtained from local climatological data from the National Weather Service (NWS). Table 4.3.5.1A shows the average number of days of precipitation with over 0.0254 centimeters (cm) of rain fall. The mean vehicle weight (W) was calculated using data obtained from the Montana Department of Transportation (MDT) by road classification as shown below in Table 4.3.5.1B.

TABLE 4.3.5.1A: AVERAGE NUMBER OF DAYS IN EACH MONTH FROM 1895 TO 2007 WITH SIGNIFICANT PRECIPITATION GREATER THAN 0.0254 CM MEASURED AT LIBBY, MT.

Month	Number of Days With More Than 0.0254 cm of Precipitation
January	13
February	9
March	10
April	8
May	9
June	10
July	5
August	6
September	8
October	10
November	12
December	13
Total	113

TABLE 4.3.5.1B: AVERAGE SILT LOADING VALUES USED TO CALCULATE EMISSION FACTORS BY CONTROL AREA AND ROAD TYPE.

ROAD TYPE (Vehicle Wt. tons)	Winter (g/m^2)	Spring (g/m^2)	Summer (g/m^2)	Fall (g/m^2)
Local (2.2)	15.720	3.229	15.720	3.229
Minor Collector (2.7)	7.672	2.152	7.672	2.152
Major Collector (2.7)	7.672	2.152	7.672	2.152
Minor Arterial (3.0)	20.616	2.152	20.616	2.152
Principal Arterial (3.9)	20.616	2.152	20.616	2.152

A transportable fugitive dust factor that accounts for near source capture of fugitive dust emissions was also applied to the emissions calculated by the emission factor given above. For a discussion of the development of the transportable factor for fugitive dust emissions please see the cited paper by Pace.[14, 15] Transportable dust factors vary across counties in the United States based upon the vegetative cover, urban structures, and agricultural use present. For

Lincoln County the transportable fugitive dust factor is 0.18.[15] Without the use of this factor the emissions from fugitive dust sources, especially paved and unpaved road dust have been found to be several times greater then they realistically could be based upon monitored filter determinations. [14, 15]

4.3.5.2 Source Activity Levels

VMT is a critical variable for estimating PM-2.5 emissions of paved road. Within the Libby PM-2.5 NAA, the DEQ obtained VMT information by roadway classification from the MDT. The ADT used were obtained from several traffic counting locations both within and outside of the city limits of Libby, but within the nonattainment area. This necessitated that additional counts had to be obtained from several locations. These counts were then applied to roadways of the same functional classification within the nonattainment area having similar population densities but not having actual counts. These ADT values were then multiplied by the length of road within its appropriate grid to determine the VMT for each grid.

4.3.5.3 Grid Apportionment

The MDT apportioned the VMT by grid cell based upon the length of each roadway classification in each grid cell using GIS technology. A topographical map of roads in the Libby EI area was overlaid upon the grid network and the distance of each road segment by functional class was determined. The VMT was calculated for each grid based on the length of the road segment in each grid multiplied by the ADT for that road segment.

4.3.5.4 Seasonal Apportionment

DEQ apportioned the emissions seasonally based upon seasonal variations in VMT. Seasonal variations in VMT were determined from traffic counts in areas of the state where it was thought that the seasonal variation in traffic would be similar to that in the Libby area. Other areas of the state were used because Libby had no counters that operated over the whole year that could yield a seasonal adjustment factor as shown in Table 4.3.5.4. These recorders collected traffic volume data for each month in 2005 on two types of roads: principal and minor arterials.[16] The information shown below was used to determine the principle and minor arterial seasonal adjustments for the Libby area. Local traffic and traffic on collectors were not adjusted for seasonal variations other than that of precipitation discussed above because it was felt that the traffic on these roads did not vary substantially over the year.

TABLE 4.3.5.4: MONTHLY VARIATIONS IN THE ANNUAL PERCENTAGE OF ADT OCCURRING BY MONTH OF THE YEAR USED IN DETERMINING SEASONAL CHANGES IN VMT FOR PRINCIPAL AND MINOR ARTERIAL ROADS IN LIBBY.

Month	Principal Arterial (US 93)	Percent of AADT	Minor Arterial (MT 200)	Percent of AADT
January	3006	76.26	1625	71.97
February	3136	79.55	1748	77.42
March	3459	87.75	1910	84.60
April	3494	88.64	2111	93.50
May	3974	100.81	2390	105.86
June	4515	114.54	2585	114.49
July	5685	144.22	3044	134.82
August	5374	136.33	2993	132.57
September	4409	111.85	2702	119.68
October	3839	97.39	2270	100.54
November	3210	81.43	1924	85.22
December	3199	81.15	1791	79.33
Average	3942	100.00	2258	100.00

4.3.6 Unpaved Road Dust

Unpaved roads within the Libby PM-2.5 NAA area were important to quantify, since they can at times become common routes of traffic when outlining areas develop. It is important that they are quantified as an emission source and paved in the future to decrease emissions. Also unpaved roads are a contributor to carry-on emissions from mud and dirt brought onto the travel lane of paved roads.

4.3.6.1 Emission Factors

The DEQ used the unpaved road E_f from AP-42, Section 13.2.2 (11/06), Equation 1b.[17] The DEQ used five variables in order to solve for the appropriate emission factor. Those variables are:

$$E = \frac{k(s/12)^a (S/30)^d}{(M/0.5)^c} - C \times (N - p/N)$$

E = PM-2.5 Emission Factor (lb/VMT)

Where:

k = particle size multiplier for particle

size of interest (PM-2.5) and units, (0.18 lb/VMT)
s = surface material silt content (%)
S = mean vehicle speed (in miles per hour or mph)
C = emission factor for 1980's fleet exhaust, brake wear and tire wear
M = Surface soil moisture content (%)
N = number of days in the averaging period (e.g. 90 for Winter)
p = number of days with 0.01 inches or more of
Precipitation in the season of interest.

The variables, a, c, and d are determined from Table 13.2.2-2. of AP-42, Section 13.2.2-5 (11/06) and are 1.0, 0.2,and 0.5 respectively in the units lb/VMT. The DEQ applied the appropriate PM-2.5 adjustment factor (i.e., k = 0.18 lb/VMT) from Table 13.2.2-2. The mean vehicle speed (S) was 15 miles per hour.

The DEQ used 6.6% as the default silt percentage on unpaved roads as previously used in the 2002 NEI for Montana.[36, 18] For soil moisture content (M), the DEQ used the default value of 0.5, which again was a value used for moisture content in the 2002 NEI.[36] For the variable "p," DEQ used the average number of days in a given quarter during which the NWS recorded at least 0.01 inches of precipitation in Table 4.3.5.1A. Where precipitation was greater than or equal to 0.01 inches emissions were assumed to be zero.

A transportable fugitive dust factor that accounts for near source capture of fugitive dust emissions was also applied to the emissions calculated by the emission factor given above. For a discussion of the development of the transportable dust factors for fugitive dust emissions please see the cited paper by Pace.[14, 15] Transportable factors vary across counties in the United States based upon the vegetative cover, urban structures, and agricultural use present. For Lincoln County the factor is 0.18.[15]

4.3.6.2 Source Activity Levels

VMT is a critical variable for estimating PM-2.5 emissions from unpaved roads. Within the Libby PM-2.5 NAA, the DEQ obtained VMT information by roadway classification from the MDT. The ADT used were obtained from several locations both within and outside of the city limits of Libby, but within the nonattainment area. This necessitated that additional counts had to be obtained from several locations. These counts were applied to areas within the nonattainment area having similar population densities. Each roadway was then assigned an ADT based upon its functional classification and population density. These ADT values were then multiplied by the length of road in each classification within its appropriate grid to determine the VMT for each grid.

4.3.6.3 Grid Apportionment

The MDT apportioned the VMT by grid cell based upon the length of each roadway classification in each grid cell using GIS technology. A topographical map of roads in the Libby EI area was overlaid upon the grid network and the distance of each road segment by functional class determined. The VMT was calculated for each grid based on the length of the road segment in each grid multiplied by the ADT for that road segment.

4.3.6.4 Seasonal Apportionment

The DEQ apportioned emissions equally for each season of the year after adjusting the emission factor for season-specific precipitation data. As with the paved local roads, local traffic on unpaved roads were not adjusted for seasonal variations in VMT because it was felt that the traffic on these roads did not vary substantially over the year

4.3.7 Tailpipe, Tire and Brake Wear Emissions

Tailpipe exhaust, tire and brake wear PM-2.5 emissions were determined for the EI area.

4.3.7.1 Emission Factors

Onroad motor exhaust PM-2.5 emissions were categorized according to the following road facilities: principal arterial, minor arterial, collector, minor collector, and local. The on-road PM-2.5 emission factors were determined by utilizing the latest EPA mobile vehicle emissions computer model, MOBILE6.2. To obtain the necessary input parameters for this model, the MOBILE6.2 user's guide was used.[19]

The vehicle mix fractions were determined from VMT information as reported in the 2002 NEI.[36] This approach used the VMT data reported for Lincoln County to determine the percentages of the various vehicles. It was assumed that the roadway facility vehicle mix fraction was the same in the Libby EI area as reported for 2002 in Lincoln County. Missoula county motor vehicle registration data for the year 2000 was used to determine vehicle age distribution after adjusting the Missoula data it to the year 2005. This was done as it was thought that the Missoula data better represented the traffic passing through the county which is in large part from outside the county and it has been found from previously prepared emission inventory documents that the vehicle age distribution does not differ greatly between counties in Montana. Also the Missoula County vehicle registration data represented a much larger number of vehicles which would give a more representative age distribution. The data was divided into twenty-five years of vehicle age data for MOBILE6.2 model input. The 2005 model year (MY) vehicles were grouped as Age Class 1 with the remaining model years segregated in the appropriate age classes with the 1981 and older MY vehicles as Age Class 25.

The MOBILE6.2 defaults were used to define the diesel fraction, annual mileage accumulation rates, and natural gas fraction.

Speeds utilized in the model were determined from speed limits on each road classification. The reader is referred to the MOBILE6.2 document for any further discussion of the speed command inputs used to run the mobile model or the discussion of the inputs such as VMT, VMT BY FACILITY, and VMT BY FACILITY.

In any event, it should be mentioned that the model speed inputs were not relevant to modeling PM-2.5 emissions, as the model is insensitive to this input because the algorithms within the MOBILE6.2 model for PM-2.5 are in large part the same as in the old PART5 model. Emissions were then calculated by multiplying the emission factor obtained for each roadway classification by the appropriate VMT for that road classification, as previously discussed in the paved and unpaved road sections of this document.

External environmental conditions for the model input included the absolute humidity and altitude data. The defaults were applied for the absolute humidity in addition to other parameters that influenced the use of air-conditioning (i.e., solar load) for all seasons since Montana has such a short period during the summer when vehicle air conditioning is actually used. Also as mentioned above, all these setting had no effect on the emission factor calculated with MOBILE6.2 as the algorithms were simply inserted in the model from the defunct PART5 model particulate model. For the altitude command, low altitude was selected since Lincoln County was not designated as high altitude (40 CFR 86-091-30).

Some model inputs that were used to calculating CO emission factors were not pertinent to determining PM-2.5 emissions, such as oxygenated fuel level, and as such were not needed to model PM-2.5 emission factors.

For the temperature variables, the average monthly minimum and maximum temperatures were determined by season. However again, the modeled emission factors for PM-2.5 are not affected by temperature. MOBILE6.2 commands are listed in the following table.

TABLE 4.3.7.1A: MOBILE6.2 COMMANDS TO CALCULATE THE PM-2.5 TAILPIPE, BRAKEWEAR AND TIRE WEAR EMISSION FACTORS FOR THE LIBBY 2005 PM-2.5 EI.

MOBILE6.2 Command	Utilized Command	MOBILE6.2 Input
Absolute Humidity (& Other Air-conditioning Variables)	No	Not Used due to limited period of the summer when air conditioning is actually used.
Altitude	Yes	User Input; Low (1)
Anti-Tampering Program	No	Not Used
Average Speed	Yes	User Input (Varied Table 4.3.7.1B)
Calendar Year	Yes	User Input; 2005
Diesel Fractions	No	Defaults
"Age" Distribution of Vehicle Registration	Yes	2000 Missoula County Vehicle Registration adjusted to 2005, MOBLE5b Utility Assisted.
Evaluation Month	Yes	Default
Fuel Program	Yes	User Input: Conventional Gasoline West (3)
Fuel Program (RFG) [a]	No	Not used
Fuel RVP	Yes	User Input; 12.5 for winter. For other seasons as listed in NEI document [36]
Inspection/Maintenance Program	No	Not Used; None Existed
Mileage Accumulation Rates	No	Defaults
Minimum/Maximum Temperature	Yes	User Input for Each Season
Natural Gas Fraction	No	Default; Very Insignificant Fraction
Oxygenated Fuels	No	Not used for PM-2.5 emission modeling
Soak Distribution/Activity	No	Defaults
Speed VMT [b]	No	Replaced by AVERAGE SPEED Command
Starts/Day or Distribution During the Day	No	Defaults
Sulfur Content	Yes	User input
VMT By Facility [b]	No	Replaced by AVERAGE SPEED Command
VMT Fractions	Yes	VMT Mix determined from 2005 NEI Data for Lincoln County[36]
Weekday/Weekend Information	No	Defaults

a. RFG = Reformulated Gasoline.
b. VMT = vehicle miles traveled.

TABLE 4.3.7.1B: MOBILE6.2 VEHICLE SPEED INPUTS AND RESULTING PM-2.5 EMISSION FACTORS FOR FOUR FACILITIES TYPES FOR THE PM-2.5 NAA IN LIBBY.

Facility	2005 MOBILE6.2 Average Vehicle Speed (mph) [a]	MOBILE6.2 PM-2.5 Emission Factor (g/mi.) [b]
Local	19.3	0.04
Collector (Major and Minor)	25	0.04
Minor Arterial	50	0.04
Principal Arterial	60	0.04

a. mph = miles per hour.
b. g/mile = grams per mile.

4.3.7.2 Source Activity Levels

VMT information is required in order to determine the PM-2.5 emissions from tailpipe exhaust, tire and brake wear. The VMT are determined from the length of a road segment multiplied by the ADT on that road segment. Within the Libby PM-2.5 NAA, the DEQ obtained VMT information by roadway classification from the MDT. The ADT used were obtained from several locations both within and outside of the city limits of Libby, but within the nonattainment area. This necessitated that additional counts had to be obtained from several locations. These counts were applied to areas within the nonattainment area having similar population densities. Each roadway was then assigned an ADT based upon its functional classification and population density. These population density and roadway specific ADT values were then multiplied by the length of paved or unpaved road in a given grid to determine the VMT for that grid.

4.3.7.3 Grid Apportionment

The DEQ apportioned emissions by grid cell based upon the length of road in each grid cell as previously stated in Sections 4.3.5.3 and 4.3.6.3.

4.3.7.4 Seasonal Apportionment

The DEQ adjusted for season-specific activity levels as previously stated in Sections 4.3.5.4 and 4.3.6.4.

4.3.8 Railroad Locomotive Exhaust

Railroad locomotive exhaust is a source of PM-2.5 in Libby. Railroad locomotive PM-2.5 exhaust emissions were determined by the EPA method outlined in Procedures for Emission Inventory Preparation Volume IV: Mobile Source for line haul emissions.[20] Line haul locomotives travel between locations carrying passengers and/or freight.

During 2005, Class I and II trains operated within the emission inventory area. Class I trains were railroads that earned an adjusted annual operating revenues for three consecutive years of $250 million or more. Class II (regional) railroad generated operating annual revenues of $20 to $250 million. Class III (local) railroad had an adjusted operating revenues less than $20 million.[21] Class I trains carry the majority of freight and passengers. Class II and III railroads represented the remainder of the rail transportation and were not subject to the same reporting requirements.

During 2005, the Burlington Northern and Santa Fe Railway Company (BNSF), a Class I railroad, generated the primary rail activity in the emission inventory area. Amtrak, a federal passenger train also ran through Libby on a two trains a day basis.

4.3.8.1 Emission Factors

The emission factor for line haul activity was obtained from the EPA publication, Technical Highlights: Emission Factors for Locomotives, and is listed below.[21]

$$\text{Emission Factor}_{(\text{line haul})} = 0.0067 \text{ kg PM-2.5/gal}$$

4.3.8.2 Source Activity Levels

The PM-2.5 emissions were the result of two locomotive activities, freight hauling by Burlington Northern and Santa Fe Railroad, and passenger transport by Amtrak. To determine the emission for these two types of locomotive activities required two different methodologies.

Locomotive freight hauling activity, also called line hauling, did not have fuel consumption information available which could be used to determine emissions. However the fuel used in line hauling was determined based upon the tonnage of freight hauled in English tons, and the distance the freight is hauled in miles. The distance the train travels multiplied by the amount of gross tons hauled is called the Gross Ton Miles (GTM). This activity value is also referred to as traffic density. Burlington Northern and Santa Fe Railroad were contacted to determine the amount of tons of freight hauled reported in gross tons for 2005. Below are the calculations used to determine the fuel used and subsequent PM-2.5 emissions for line haul activity in the Libby PM-2.5 EI area.

The annual gross tonnage of the line haul trains with locomotives that traveled in the Libby PM-2.5 EI area was 74,500,000 tons, and it was estimated that the primary route encompassed 34 grids, for a total distance of 16.9 miles. Therefore, the GTM was calculated in the following manner:

Calculation of Line Haul Emissions:

$$(74{,}500{,}000 \text{ Gross Tons})\ (16.9 \text{ miles of Track within Emission Inventory Area})$$

$$= 1{,}259{,}050{,}000 \text{ GTM}$$

Based on the total fuel consumption and total GTM for the whole State of Montana given in the R-1 Report for 2005 [22] that reports the amount of fuel consumed and tonnage of freight hauled in 2005, a fuel consumption index in gallons (gal) of diesel consumed per GTM was calculated.

Calculation of Fuel Consumption Index:

Fuel Consumption from R-1 Schedule 750 line 1 = 1,353,264,855 gal diesel
Gross Ton Miles from R-1 Schedule 755 line 104 = 1,161,694,804,000 (total)
Gross Ton Miles from R-1 Schedule 755 line 98 = 97,197,214,000 (locomotives)

1,161,694,804,000 GTM – 97,197,214,000 GTM (Locomotives) = 1,064,497,590,000 GTM

$$\frac{1{,}064{,}4\ 9\ 7{,}590{,}000\ \ GTM}{(1{,}353{,}264,\ 855\ \text{Gal})} = 786.61(GTM\ /\ Gal)$$

The fuel consumption was then calculated as the ratio of the traffic density to the fuel consumption index.

$$Fuel\ Consumption = Traffic\ Density/Fuel\ Consumption\ Index$$

$$(1{,}259{,}050{,}000\ GTM)\ /\ (786.61\ \ GTM/gal) = 1{,}600{,}602.6\ Gal$$

By multiplying this value by the line haul PM-10 emission factor the emissions from BNSF line haul activities was calculated.

$$(1{,}600{,}602.2\ Gal)\ (0.0067\ kg\ \ PM-2.5\ /\ Gallon) = \ 10{,}724.03\ kg\ PM-2.5\ /\ yr$$

The PM-2.5 emissions from passenger transport by Amtrak were determined based on the total amount of diesel fuel used in Montana in 2005 by Amtrak trains divided by the total amount of track in Montana. Amtrak provide a total fuel use of 696,201 gallon per year in Montana, and a distance of 561 miles of track or 1,122 miles traveled per day by both the east and west bound trains.[23] This calculates out to 1.7 gallons of diesel used per mile of track per day. By multiplying the 16.9 miles of track within the Libby EI area by 365 days per year and 2 to account for the two trains that traverse the EI area, the result is that 20,972.9 gallons of diesel were used in 2005 by the Amtrak trains within the EI area which resulted in 140.76 kg of PM-2.5 emissions a year.

4.3.8.3 Grid Apportionment

The emissions were apportioned to the grids that contained the primary rail route by determining the length of the rail track in each grid it traveled. The GTM was calculated for each grid based on the length of the track in each grid relative to the total length of the track in all of the grids in the EI area.

4.3.8.4 Seasonal Apportionment

Railroad locomotive activity is relatively constant throughout the year. Seasonal emissions will be calculated for the year, 2005, based on the number of days in each season.

4.3.9 Wood Burning

Due to availability as well as its economical cost, wood heat is a popular space heating choice in Libby. Based upon the previously prepared PM-10 EI from 1988 the amount of wood burned in cords was reported to be the highest in the nation of any area that had performed a residential wood burning survey. [24] A recently prepared CMB study and carbon 14 study by Ward et al. reports that wood combustion represents over 82% of the PM-2.5 emissions in the Libby EI area.[25]

4.3.9.1 Emission Factors

Different types of woodstoves have different PM-2.5 E_f. Woodstove surveys usually divided the wood burning devices into the following nine categories: Fireplace, Pre-certified woodstoves, EPA Catalytic Certified Phase I, EPA Non-catalytic Certified Phase I, EPA Catalytic Certified Phase II, EPA Non-catalytic Certified Phase II, Masonry Heater, and Pellet Stoves. The PM-2.5 emission factors for each of these wood burning devices were provided in AP-42 and are listed in Table 4.3.9.1.[26, 27]

TABLE 4.3.9.1: PARTICULATE EMISSION RATES AND PM-2.5 EMISSION FACTORS FOR RESIDENTIAL WOOD BURNING DEVICES.

Wood Burning Device	PM-2.5 Emission Factor (lb/ton-dry wood)
Fireplaces [a]	34.6
Pre-certified Woodstoves [b c]	30.6
EPA Catalytic Certified Phase I	19.6
EPA Non-Catalytic Phase I [d]	20.0
EPA Catalytic Certified Phase II	16.2
EPA Non-Catalytic Phase II [d]	14.0
Cord Wood Furnaces [g]	30.6
Masonry Furnace [e]	5.6
Pellet Stove/Furnace/ Insert [f]	6.6

a. Emission Factor Documentation for AP-42 Section 1.9, Residential Fireplaces.[26]

b. Exempt from EPA New Source Performance Standards (NSPS) testing and compliance regulations if manufactured before July 1, 1988.[26]

c. Pre-certified or Conventional wood stoves are considered to include all other types of wood stoves except Catalytic, Non-catalytic or Pellet, and do not use emission reduction technology.

d. Non-catalytic wood burning devices do not use catalysts, but contain emission reduction technology or features.

e. Exempt from EPA NSPS due to the device weight that is greater than 800 kg (1,764 lb).[26]

f. Exempt from EPA NSPS due to an air to fuel ratio greater than 35 to 1.[26]

g. Cord Wood Furnace PM-2.5 emission factor was obtained from Roy Huntley, Personal Communications EPA, September 26, 2005.

4.3.9.2 Source Activity Levels

Since each type of wood burning device has a unique PM-2.5 E_f, individual activity levels (kilograms of wood burned) was determined for each type of device. The Libby Residential Wood Stove Survey provided this information along with information obtained during the Libby Woodstove Changeout Program that reported the amount of wood that each applicant burned during the previous wood burning season.[3] A more complete explanation on how the data in the following table was derived from the Libby PM-2.5 Annual Standard SIP Technical Support Document, which goes into the details of how the number of appliances in each category listed below was determined.[28]

TABLE 4.3.9.2: 2005 DISTRIBUTION AND NUMBER OF STOVE TYPES IN THE 2005 LIBBY EI AREA.

Type of Device	Number of Appliances	Percent of Total Appliances
Fireplaces (no insert)	87	3.69
Pre-certified Wood Stoves	1,038	43.98
EPA Catalytic Certified Phase I	54	2.29
EPA Non-Catalytic Phase I	76	3.22
EPA Catalytic Certified Phase II	327	13.86
EPA Non-Catalytic Phase II	457	19.36
Cord Wood Furnace	92	3.9
Masonry Furnace	22	0.93
Pellet Stove/Furnace/ or Pellet Inserts	207	8.77
Total	2,360	100.00

4.3.9.2.1 Type of Wood Burned

The information pertaining to the type of wood burned was obtained from the residential wood burning survey which took place during the winter of 2004/2005.[3] Since wood burners generally measure the wood they cut or buy by the cord, the survey asked each respondent the number of cords of wood the household burned per season. In order to convert cords of wood to kilograms (emission factor unit), the density and volume of solid wood in a cord was required. The Residential Wood Burning Survey (RWBS) provides the wood species that was burned and the oven-dry specific gravity for each wood species was obtained from Wood handbook: Wood as an engineering material (The Wood Handbook).[29] The volume of solid wood in a cord excludes the air spaces between each log of wood and the density of the wood is dependent upon the specie of wood and moisture content. Table 4.3.9.2.1A displays the parameters used to calculate the weighted average specific gravity of the wood burned.

TABLE 4.3.9.2.1A: WOOD SPECIES, SPECIFIC GRAVITIES, PERCENTAGES OF SPECIES BURNED, AND CALCULATED WEIGHTED SPECIFIC GRAVITY.

Wood Specie	Specific Gravity[a, b]	Percentage of Specie Burned (%)	Fractional Specific Gravity[a, b, c]
Douglas-fir	0.46	3.0	0.0138
Ponderosa Pine	0.38	1.0	0.0038
Lodgepole Pine	0.38	3.0	0.0114
Spruce	0.41	0.0	0.0
Western Larch	0.48	34.0	0.1632
Miscellaneous	0.46	59.0	0.2714
Weighted Specific Gravity		100.00	0.4636

a. Specific gravity is based on ovendry weight and volume.
b. Specific gravity does not have unit of measurement.
c. Variance in calculations may be due to rounding differences.

According to the wood burning survey, 100 % of the wood burners said they burned wood that was well seasoned. According to The Woodburners Encyclopedia, the moisture content of seasoned (covered) cord-wood during a northwest winter cannot be less than 18% (oven-dry basis).[30] Considering both sapwood and heartwood for all of these species, an average moisture content of 20% (oven-dry basis) seems appropriate. In the survey, over 25% of the wood was uncovered, therefore, it can be assumed that this wood had higher moisture content than the covered wood. Therefore, an approximation for the uncovered wood had an overall moisture content of 25%, an increase of 7% from the covered wood. Using equation 3-5 in "The Wood Handbook," the specific gravity at 25% moisture can be determined.

$$\frac{0.4546}{(1 - 0.2650\,(\frac{30-25}{30})\,0.4545)} = G_m = 0.4638$$

Applying Table 3-7b from "The Wood Handbook" at 25% moisture content and a 0.46 specific gravity, the density of the wood is approximately 36.89 pounds per cubic feet (lb/ft^3) via interpolation.

The weight of a cord of wood was also needed since most firewood was cut or purchased by the cord. A standard cord (128 ft^3) is between 60 and 100 cubic feet of solid wood according to The Woodburners Encyclopedia.[30] Sawing the cord-wood into shorter lengths and splitting reduces the volume of a cord of wood by as much as 33%. Therefore, a cord of wood sawed into two foot lengths, split, and stacked contains about 85 cubic feet of solid wood. Since many wood burners purchased their wood in 8-foot lengths, 80 cubic feet of solid wood per cord is a good approximation. Table 4.3.9.2.1B demonstrates the method of computing the weight of a cord of wood for Libby.

TABLE 4.3.9.2.1B: WEIGHT PER CORD COMPUTATION.

Weighted Specific Gravity[c]	Moisture Content (%)	General Density (lb/ft^3)	Volume Per Cord (ft^3)	Weight Per Cord[d] (lb/cord)
0.4638	25.00	36.89	80.00	2,950.845

[a.] Specific gravity is unitless. Wood handbook: Wood as an engineering material.[29]
[b.] PM-2.5 Emissions From Residential Wood Burning in Libby, Montana.[3]
[c.] Sum of specific gravity multiplied by species composition (unitless).
[d.] Based on the following calculation: (36.885 lb/ft^3)(80.0 ft^3/cord)(0.454 kg/lb)= 1,339.68 kg/cord.

4.3.9.2.2 Total Amount of Wood Burned in the Emission Inventory Area

The average amount of wood burned per device was obtained from Libby residential wood burning survey [3], along with information obtained during the Libby Woodstove Changeout Program that reported the amount of wood that each applicant burned during the previous wood burning season. The distribution of the devices was multiplied by the average amount of wood burned per device to calculate the amount of wood burned. The number of devices, amounts of wood burned by stove type, and PM-2.5 emissions during the 2004/2005 wood burning season from late August to early May for the Libby PM-2.5 EI area are shown in Table 4.3.9.2.2.

TABLE 4.3.9.2.2: 2005 NUMBER OF STOVES BY TYPE, AMOUNT OF WOOD BURNED, AND EMISSIONS IN THE 2005 LIBBY EI AREA.

Type of Device	Number of Appliances	Percent of Total Appliances	PM-2.5 Emission Factors (lb/ton)	Number of Cords Burned	Tons of Wood Burned (tons)	PM-2.5 Emissions (tons)
Fireplaces (no insert)	87	3.69	34.6	3.6	469.17	8.12
Pre-certified Wood Stoves	1,038	43.98	30.6	4.5	6,997.16	107.08
EPA Catalytic Certified Phase I	54	2.29	19.6	3.5	283.12	2.77
EPA Non-Catalytic Phase I	76	3.22	20.0	4.2	478.16	4.78
EPA Catalytic Certified Phase II	327	13.86	16.2	3.4	1,665.48	13.49
EPA Non-Catalytic Phase II	457	19.36	14.0	3.75	2,567.20	18.74
Cord Wood Furnace	92	3.90	30.6	4.5	620.17	9.49
Masonry Furnace	22	0.93	5.6	4.75	156.54	0.44
Pellet Stove/Furnace/ or Pellet Inserts	207	8.77	6.6	3.68 Tons	761.76	2.51
Total	2,360	100.00			13,998.76	167.40

4.3.9.3 Grid Apportionment

The DEQ apportioned the wood burning emissions to each grid based upon the number of residents within each grid. The DEQ estimated there were 3,888 OHH within the 600 km^2 study area that represented the PM-2.5 EI/NAA area. This value was calculated using GIS technology and 2000 U.S. Census block information. The block data was adjusted for growth believed to have occurred from the Census year 2000 to the survey year, 2005.

Appendix A contains a map of the Libby PM-2.5 NAA and Appendix B shows the same area with each of the 600 grids numbered.

The amount PM-2.5 emissions in each grid was calculated by multiplying the fraction of housing units that burned wood by the total number of households within a particular grid and the amount of emissions per OHH.

4.3.9.4 Seasonal Apportionment

The amount of wood burned by home owners and businesses depends on the ambient air temperature. To determine monthly as well as seasonal emissions from wood burning, the emissions were apportioned based upon heating degree day (HDD) information collected at the

nearest National Weather Service location to Libby.[31] For each degree that the mean daily temperature is below 65 degrees Fahrenheit (F) a HDD occurs. Table 4.3.9.4 lists the average HDD information for Libby from 1895 to 2007, the percentage that that represents by month, and the seasonal adjustment factor that was determined based upon each season.

TABLE 4.3.9.4: AVERAGE LIBBY HEATING DEGREE DAY DATA FROM 1895 TO 2007.

Month	Degree Days[a]	Percent Degree Days Per Month (%)	Monthly Allocation	Seasonal Allocation
January	1,282	17.42	18.15	Winter = 44.06
February	999	13.57	14.00	
March	857	11.64	11.91	
April	571	7.76	7.71	Spring = 13.72
May	345	4.69	4.39	
June	156	2.12	1.62	
July	46	0.63	0.00	Summer = 3.36
August	63	0.86	0.25	
September	258	3.51	3.11	
October	600	8.15	8.14	Fall = 38.86
November	958	13.02	13.40	
December	1,225	16.64	17.32	
Total	7,360	100.00	100.00	100.00

a. Heating degree days are defined as the accumulation of days for each degree that the mean temperature is below 65.0 degrees Fahrenheit (18.3 Centigrade (C)).

For January, February and March there were 3,138 heating degree days, and 7360 HDD for the year. After subtracting the July HDD of 46 from each of the months, because in July little or no heating actually occurs, and dividing the HDD for the winter season by the annual HHD, a percentage of the HHD for the winter season can be computed.

$$\left(\frac{(3{,}138) - (46x3)}{(7{,}360) - (46x12)}\right)(100) = 44.06\%$$

This percentage of wood stove emissions that occur in winter were then multiplied by the total annual wood burning emissions per device as shown below. This reflected the actual weather conditions that occurred during the winter season.

$$\frac{0.070 \text{ tons PM-2.5 from a Wood Burning Device) (0.4407)}}{\text{(Year)}}) = 0.031 \text{ tons PM} - 2.5$$

$$\text{or } 62.0 \text{ lb PM} - 2.5 \text{ Winter season per Wood Burning Device}$$

4.3.10 Residential Open Burning

Open burning was a source of PM-2.5 emissions within the Libby airshed in 2005. Open burning was regulated by the LCEHD through an open burning permit system and telephone hotline number. Impact Zone "L" is a geographic area surrounding the greater Libby area designed to provide greater smoke management protection. Within the boundaries of Impact Zone "L", all open burners must seek alternatives to burning when reasonably available, utilize best available control technology, burn only during periods designated by the permit, call the open burning hotline before initiating a burn, and comply with any burning restrictions or bans in effect. Conditional open burning permits could have been obtained in 2005 to burn trade waste, licensed landfill, or conduct fire fighter training. Emergency open burning permits could have been issued to allow burning of a substance or under circumstances not otherwise approved for burning under these regulations.

Those wishing to conduct open burning from March 1st through October 31st could have only burned during periods specified by LCEHD. Those wishing to conduct open burning from November 1st through the end of February could have only burned with approval from LCEHD since no burning is typically allowed during this time period.

In general, “Residential Open Burning” included small brush piles, woodpiles, and a few grass fires.

4.3.10.1 Emission Factors

For general burns, an emission factor taken from the NEI, Table D-7, 17 lb/ton for yard waste-brush and land-clearing debris; Source Classification Codes (SCC) 2610000400 and 2610000500 were used.[32]

4.3.10.2 Source Activity Levels

In order to estimate the amount of material burned by minor outdoor burners within the EI area an average weight of 5.9 tons was used for the weight of each general outdoor burn. This weight was determined based upon the average weight of material burned as reported in the Missoula PM-10 Emission Inventory document.[33] The reader is referred to that document for greater detail on how the amount of material was determined for each burn.

4.3.10.3 Grid Apportionment

The DEQ apportioned emissions from outdoor burning based upon the number of OHH within a grid.

4.3.10.4 Seasonal Apportionment

The emissions were apportioned to the months of the year when burning could occur within the open burning regulations, which in 2005 were from March 1st through October 31st.

4.3.11 Wildfire Prescribed Burning

The year 2005 was used as the most complete and representative year for obtaining information on wildfire prescribed burning. Regulations involving the record keeping with a large burn require that the large burner file an "accomplishment report" with the Smoke Management Team after the burn is completed. Detailed information is contained on each report and entered into the Airshed Management System (AMS) database system including the fuel loading and area burned.

4.3.11.1 Emission Factors

The DEQ reviewed information on emission factors from a number of sources including the AP-42 factor for "Grassland" in the Rocky Mountain region as presented in Table 13.1-4 in Section 13.1, "Wildfires and Prescribed Burning for grass burning" and "Open Burning" Volume III, Chapter 16 in the Emission Inventory Improvement Program.[34] The most appropriate emission factor was obtained from the report prepared by Battye and Battye entitled: "Development of Emission Inventory Methods for Wildland Fire".[35] Table 22 of that report listed emission factors for various burning conditions and fire types. An emission factor of 15 kg of PM-10 per mton was thought to represent the conditions and fuel type burned during spring and summer, while 12.5 kg of PM-10 per mton was used for the fall.

4.3.11.2 Source Activity Levels

Activity level information as entered into the AMS database included the acreage and fuel loading for each burn. Fuel loading was expressed in mass per unit of surface area (e.g. tons per acre). The amount fuel burned was simply obtained by multiplying these two quantities.

4.3.11.3 Grid Apportionment

The LCEHD apportioned emissions from each wildfire prescribed burn based upon location information recorded in the accomplishment report. The DEQ used this data for the emission inventory. Since all grids were likely impacted in the emission inventory area when wild fire prescribed burns occurred, emissions were apportioned to all grids within the EI area.

4.3.11.4 Seasonal Apportionment

The DEQ apportioned the emissions by season based upon the date on the accomplishment report as provided by the LCEHD.

4.3.12 Residential Construction

The DEQ used the same methodology to quantify PM-2.5 emissions from residential construction as that used by the EPA in compiling the National NEI for 2002.[36]

4.3.12.1 Emission Factors

The methodology used by the EPA in compiling the NEI for 2002 relied upon two equations to calculate emissions from residential construction. Which equation EPA used depended upon whether the residence had a basement. Please note that the equations are given that calculate the PM-10 emissions, and not PM-2.5 emissions because the PM-10 emissions were multiplied by 0.1 to determine the PM-2.5 emissions (see Section 2.8.6, ref. 36, Table 2-19).[36]

For houses constructed without basements, the EPA used the following equation:

$$\text{Emission} = (E_f)\,(B)(f)(m)$$

Where:

E_f	=	*Emission factor (tons of PM-10 per acre per month)*
B	=	*Number of units constructed*
f	=	*Units-to-acres conversion factor*
m	=	*Duration of construction activity*

For houses constructed with basements, EPA used the following equation:

$$\text{Emission} = [(E_{fB})(B)(f)(m)] + [(E_{fd})(B)(d)]$$

Where:

E_{fB}	=	*Emission factor for units w/basements (tons of PM-10 per acre per month)*
B	=	*Number of units constructed*
f	=	*Units-to-acres conversion factor*
m	=	*Duration of construction activity*
E_{fd}	=	*Emission factor for basement excavation (tons of PM-10 per 1000 cubic yards (yd^3) of material excavated)*
d	=	*Cubic yards (yd^3) excavated per unit*

For the 2002 NEI, the EPA used the following emission factors to calculate emissions resulting from residential construction.

E_f	=	*0.032 tons-PM-10/acre-month*
E_{fB}	=	*0.011 tons-PM-10/acre-month*
E_{fd}	=	*0.059 tons-PM-10/1000 yd^3 excavated*

The EPA developed the E_f, E_{fB}, and E_{fd} factors based upon a soil moisture content represented by a Thornthwaite PE Index of 24 and a silt content of 9%. The DEQ used the following modification of the EPA factors in order to account for Lincoln County-specific values for Thornthwaite PE Index and silt content.

$$E_f = \left(\frac{0.032\ \ tons - PM\text{-}10}{acre - month}\right)\left(\frac{24}{PE_L}\right)\left(\frac{S_L}{9}\right)$$

$$E_{f_B} = \left(\frac{0.011\ \ tons - PM\text{-}10}{acre - month}\right)\left(\frac{24}{PE_L}\right)\left(\frac{S_L}{9}\right)$$

$$E_{f_d} = \left(\frac{0.059 \ \ tons - PM\text{-}10}{1{,}000 \ yd^3 \ \ excavated}\right)\left(\frac{24}{PE_L}\right)\left(\frac{S_L}{9}\right)$$

Where: PE_L = *Thornthwaite PE Index for the Lincoln County area*
S_L = *Lincoln County area-specific silt content (%)*

A transport factor that accounts for near source capture of fugitive dust emissions was also applied to the emissions calculated by the emission factor given above. For a discussion of the development of the transport factor for fugitive dust emissions please see the cited paper by Pace.[14] [15] Transport factors vary across counties in the United States based upon the vegetative cover, urban structures, and agricultural use present. For Lincoln County the factor is 0.18.[15]

4.3.12.2 Source Activity Levels

The EPA used the following source activity level inputs in its equations for calculating emissions from residential construction:

B	=	*Number of units constructed*
f	=	*Units-to-acres conversion factor*
m	=	*Duration of construction activity*
d	=	*Cubic yards (yd^3) excavated per house*

For the 2002 NEI, The EPA used the following source activity level values to calculate emissions resulting from residential construction.

B	=	*Area-specific value*
f	=	*0.25 acres/1-family unit;*
	=	*0.33 acres/2-family unit; and*
	=	*0.50 acres/apartment*
m	=	*6 months*
d	=	*652 yd^3 (based upon the basement for a 2,000 ft^2 house)*

The DEQ used the same source activity level values, except the number of units constructed (*B*), to quantify PM-2.5 emissions from residential. The DEQ obtained information about residential construction activity from records maintained by the LCEHD. The LCEHD issues septic system permits for residential construction within Lincoln County. The LCEHD obtained activity-level inputs from 2004, as necessary, to account for projects that began in 2004 and carried over into 2005.

4.3.12.3 Grid Apportionment

The DEQ apportioned emissions to grid cells to the gridded EI area based upon the population of occupied homes within each grid.

4.3.12.4 Seasonal Apportionment

The DEQ apportioned emissions equally over the spring, summer and fall seasons.

4.3.13 Road Construction

The DEQ used an approach similar to that used by the EPA in compiling the emissions from road construction for the 2002 NEI.[36] Please note that the equations are given that calculate the PM-10 emissions, and not PM-2.5 emissions because the PM-10 emissions were multiplied by 0.1 to determine the PM-2.5 emissions (see Section 2.8.6 of ref. 36, Table 2-19).[36]

4.3.13.1 Emission Factors

For the 2002 NEI, The EPA used the following equation to quantify emissions from road construction activities:

$$Emissions = (E_f)(\$)(f1)(f2)(m)$$

Where:

$	=	*Expenditures for capital outlay on road construction*
f1	=	*Dollars-to-miles conversion factor*
f2	=	*Miles-to-acres conversion factor*
m	=	*Duration of construction activity in months*

A transportable fraction for fugitive dust adjustment factor that accounts for near source capture of fugitive dust emissions was also applied to the emissions calculated by the emission factor given above. For a discussion of the development of the transportable factors for fugitive dust emissions please see the cited paper by Pace. [14] Transport factors vary across counties in the United States based upon the vegetative cover, urban structures, and agricultural use present. For Lincoln County the factor is 0.18.[15]

4.3.13.2 Source Activity Levels

The DEQ used essentially the same methodology to quantify PM-2.5 emissions from road construction within the 2005 EI area as given above, but instead of deriving the amount of road build from the money spent on road construction (f1), the DEQ actually determined the miles of road constructed. The amount of road construction was determined by assuming that each lot had approximately 450 feet of road frontage and that two lots, one on each side of the road abutted the road. According to the Lincoln County Environmental Planning Department roughly 100 lots per year were developed within the EI area during 2005. That would mean that 22,500 feet of new road had been developed over the year.[37]

The DEQ also used the EPA developed a miles-to-acres conversion factor, *f2* from North Carolina Department of Transportation (NCDOT) data, which indicated:

Interstate (urban and rural) and Other Arterial (urban) = 15.2 acres/mile

Other Arterial (rural)	=	12.7 acres/mile
Collectors (urban)	=	9.8 acres/mile
Collectors (rural)	=	7.9 acres/mile

The DEQ also used the EPA assumed duration-of-construction-activity input, *m* of 9 months during the year. For 2005 only local roads were built, which were associated with the development of subdivision lots. No collectors, arterial or interstate roadways were built within the EI area during 2005.

4.3.13.3 Grid Apportionment

The DEQ apportioned PM-2.5 emissions among grids according to the grids in which subdivision development could occur. This excluded any areas that were either state or federal land.

4.3.13.4 Seasonal Apportionment

The DEQ apportioned emissions over 9 months of the year during the spring, summer and fall seasons.

5.0 RESULTS

The results of this emission inventory are presented and discussed in this section. The data is presented and discussed in the order of major sources contributing to seasonal emissions and seasonal influences on emissions.

5.1 SOURCE CATEGORIES AND SEASONAL PM-2.5 EMISSIONS PRESENT IN THE LIBBY EI AREA

Table 5.1.A shows the source categories of PM-2.5 emissions in the Libby emission inventory area for the year 2005 by season. The major source contribution to PM-2.5 emissions during the winter was emissions from wood burning stoves. The next largest source of PM-2.5 emissions was emissions from motor vehicle fugitive dust from paved roads. The fugitive dust from paved roads resulted from a mechanical breakdown of sanding material laid down on the paved roads and from crustal material carried on to paved roads from unpaved parking lots, alleys, and aprons to driveways.

As shown in Table 5.1A and Figure 5.1A, 82.7% of the winter PM-2.5 emissions resulted from woodstoves. Fugitive dust from paved roads contributed the second highest winter season emissions total with 11.0% of the PM-2.5 coming from that source. The remaining sources contributed only minor amounts of the winter emissions.

TABLE 5.1A: SEASONAL PM-2.5 EMISSIONS IN LIBBY BY SOURCE CATEGORY.

Sources	Winter (mtons)	%	Spring (mtons)	%	Summer (mtons)	%	Fall (mtons)	%
Woodstoves Residential/Com.	66.65	82.7	20.74	44.6	5.08	37.2	58.76	60.3
Paved Roads Fugitive Dust	8.92	11.0	2.57	5.5	3.23	23.6	9.61	9.8
Large Prescribed Burning	0.01	0.0	0.18	0.4	0.0	0.0	12.15	12.4
General Burning	0.00	0.0	17.75	38.2	0.0	0.0	11.83	12.1
Locomotives (BNSF & Amtrak)	2.72	3.4	2.72	5.9	2.72	19.9	2.72	2.8
Unpaved Roads Fugitive Dust	1.22	1.5	1.34	2.9	1.53	11.2	1.2	1.2
Propane Heating Residential/Com.	0.13	0.2	0.04	0.1	0.01	0.1	0.11	0.1
Oil Heating Residential/Com.	0.48	0.6	0.15	0.3	0.04	0.3	0.42	0.4
Aircraft Libby Muni Airport	0.0	0.0	0.03	0.1	0.03	0.2	0.0	0.0
Road and Building Construction Dust	0.02	0.0	0.36	0.8	0.36	2.7	0.36	0.4
Motor Vehicle Tailpipe	0.48	0.6	0.55	1.2	0.66	4.8	0.51	0.5
Total	80.63	100.0	46.43	100.0	13.66	100.0	97.67	100.0

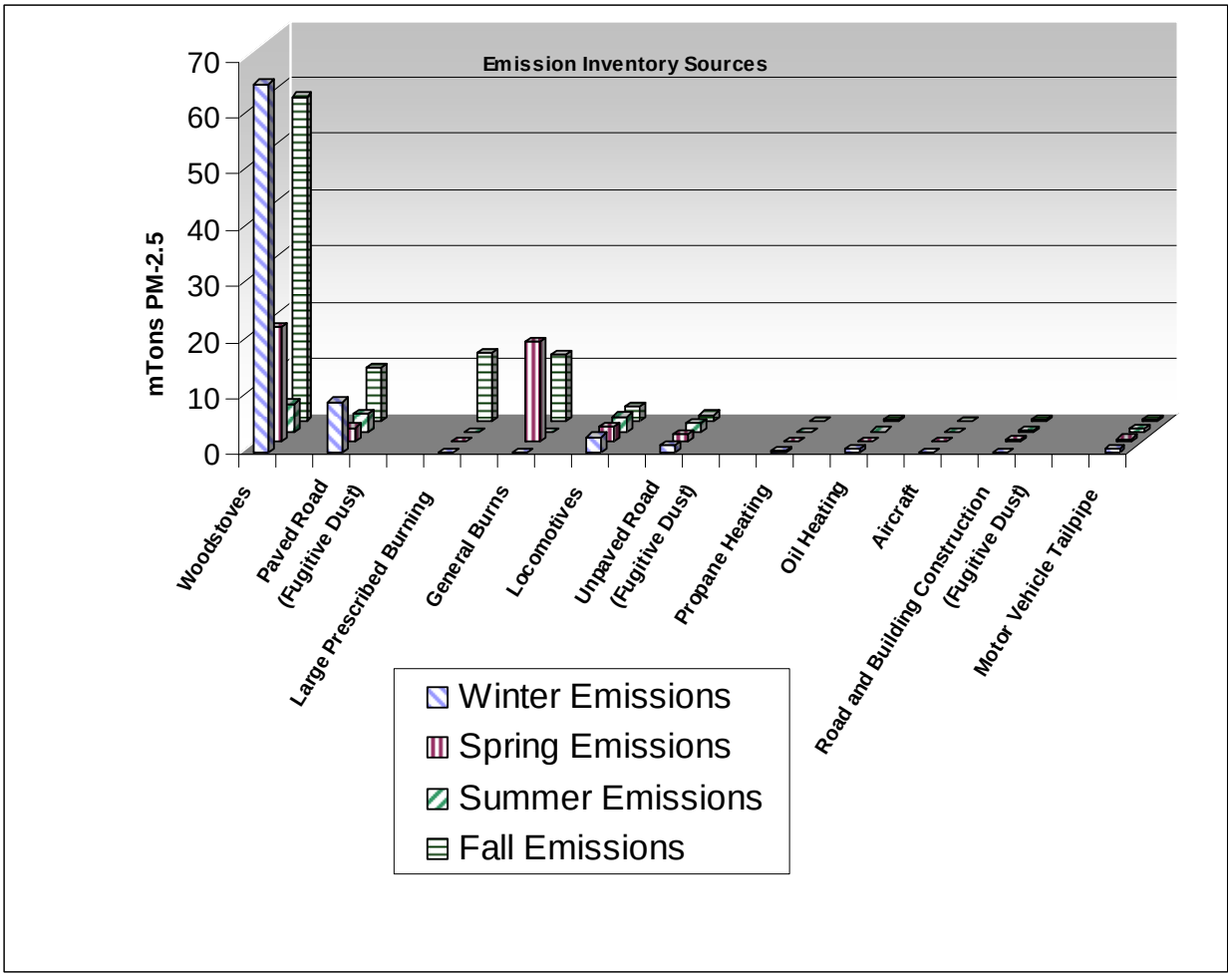


FIGURE 5.1.A: SEASONAL PM-2.5 EMISSIONS BY SOURCE CATEGORY.

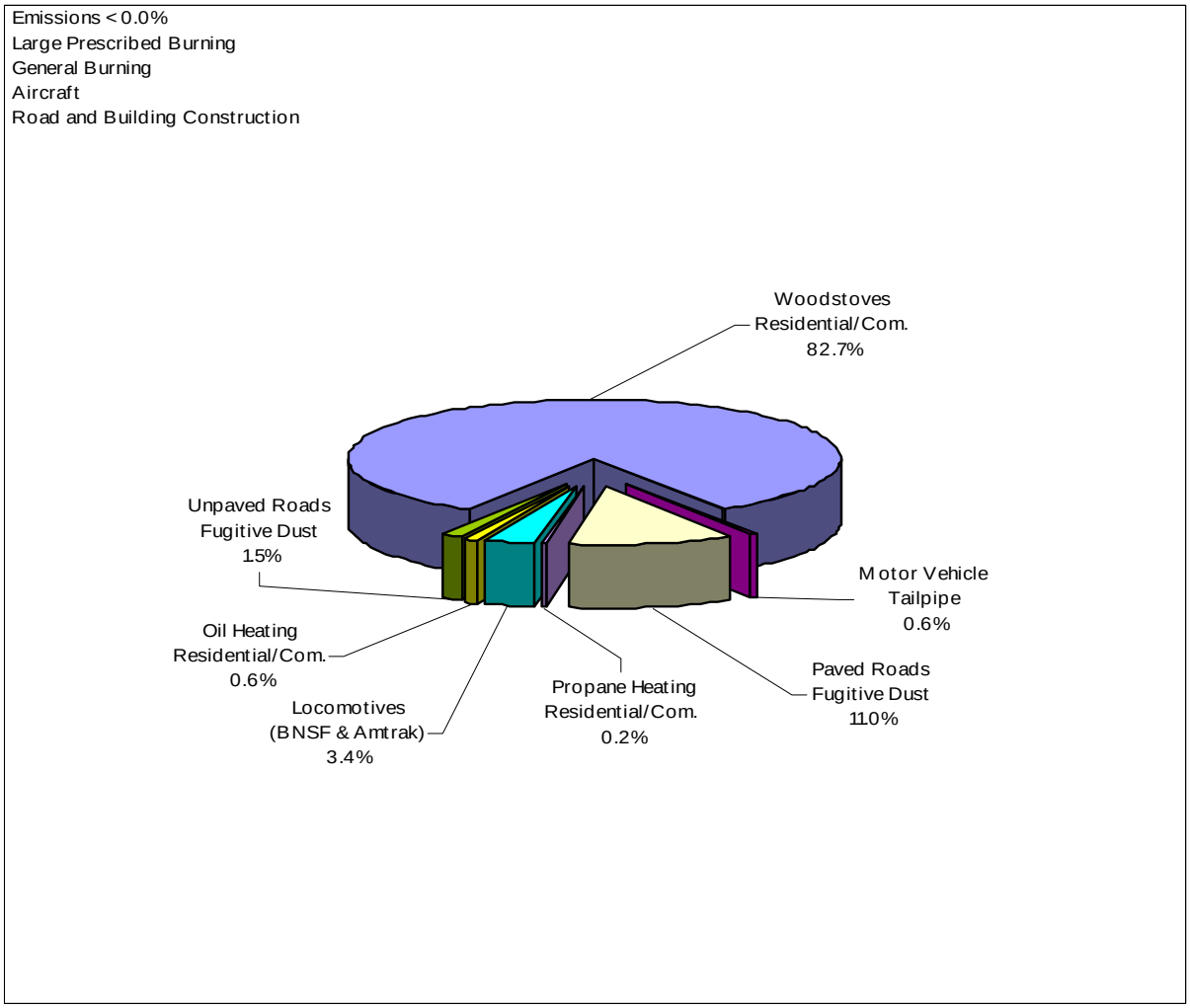


FIGURE 5.1.B: PERCENT OF WINTER PM-2.5 EMISSIONS BY SOURCE CATEGORY.

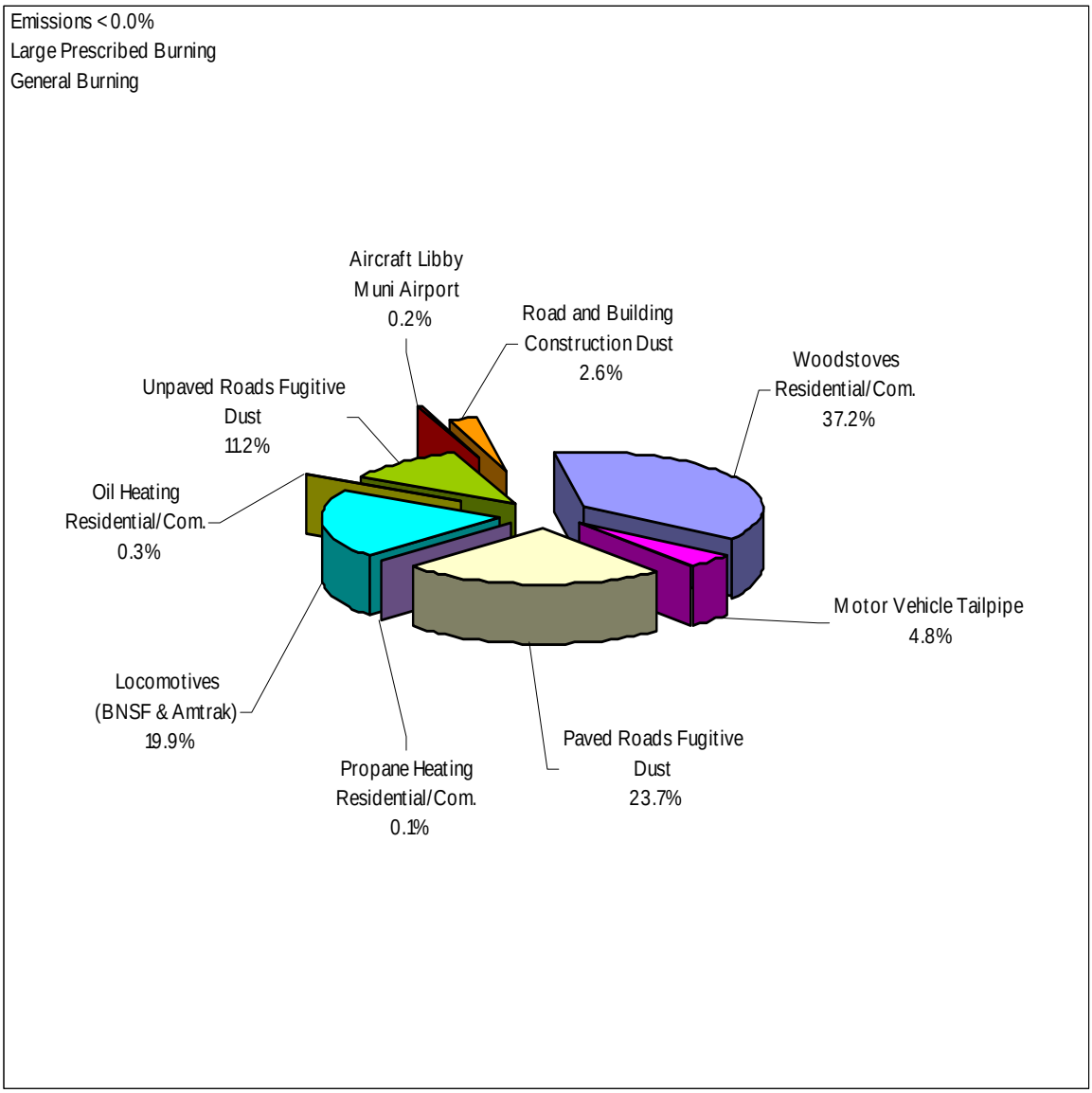


FIGURE 5.1.C: PERCENT OF SUMMER PM-2.5 EMISSIONS BY SOURCE CATEGORY.

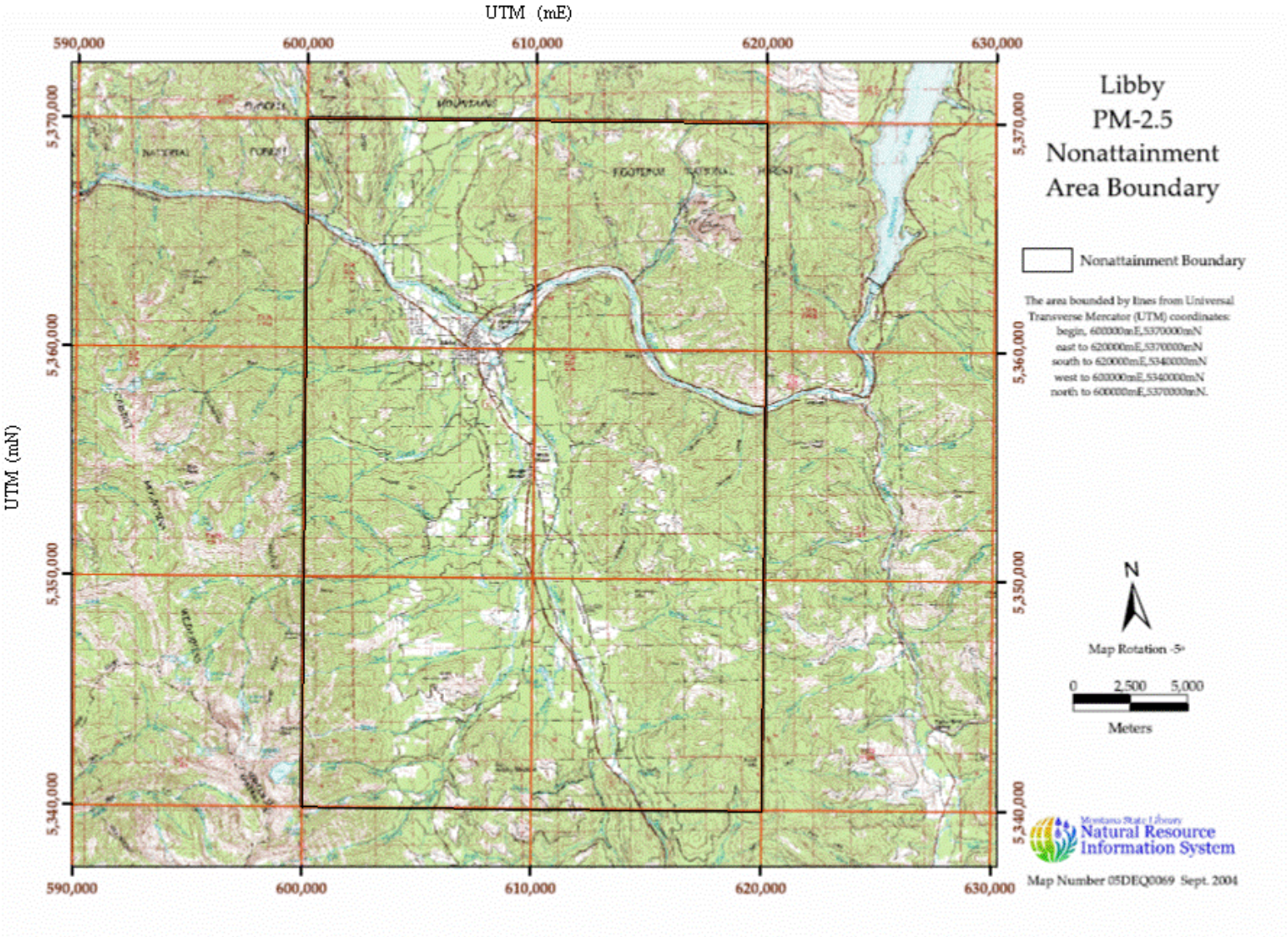
6.0 CONCLUSIONS

Based upon the results of this emission inventory document, emissions from wood burning stoves resulted in the highest emissions of any source category during the fall and winter quarters. Woodstoves represented approximately 82.7% of the PM-2.5 emissions within the nonattainment area in 2005 during the winter season. This value agrees very well with the results of a study that was performed by Ward et al. That study found woodstoves contributing about 82% of the emissions in the Libby area during a period between November 11 and February 27th using two independent methods to determine the source contributions, a CMB study and a carbon 14 study. [25] It should also be mentioned that during December and January it is not uncommon for snow to completely cover all roadways in the Libby area making it very unlikely that fugitive dust emissions play any role in PM-2.5 emissions during these time periods. Removing the fugitive dust emissions from paved and unpaved roads during the winter seasons in Table 5.1A resulted in a woodstove contribution of 94.5% of the total emissions during the days where snow covered the roadways.

APPENDICES

Appendix A: Libby PM-2.5 Nonattainment Area Boundary

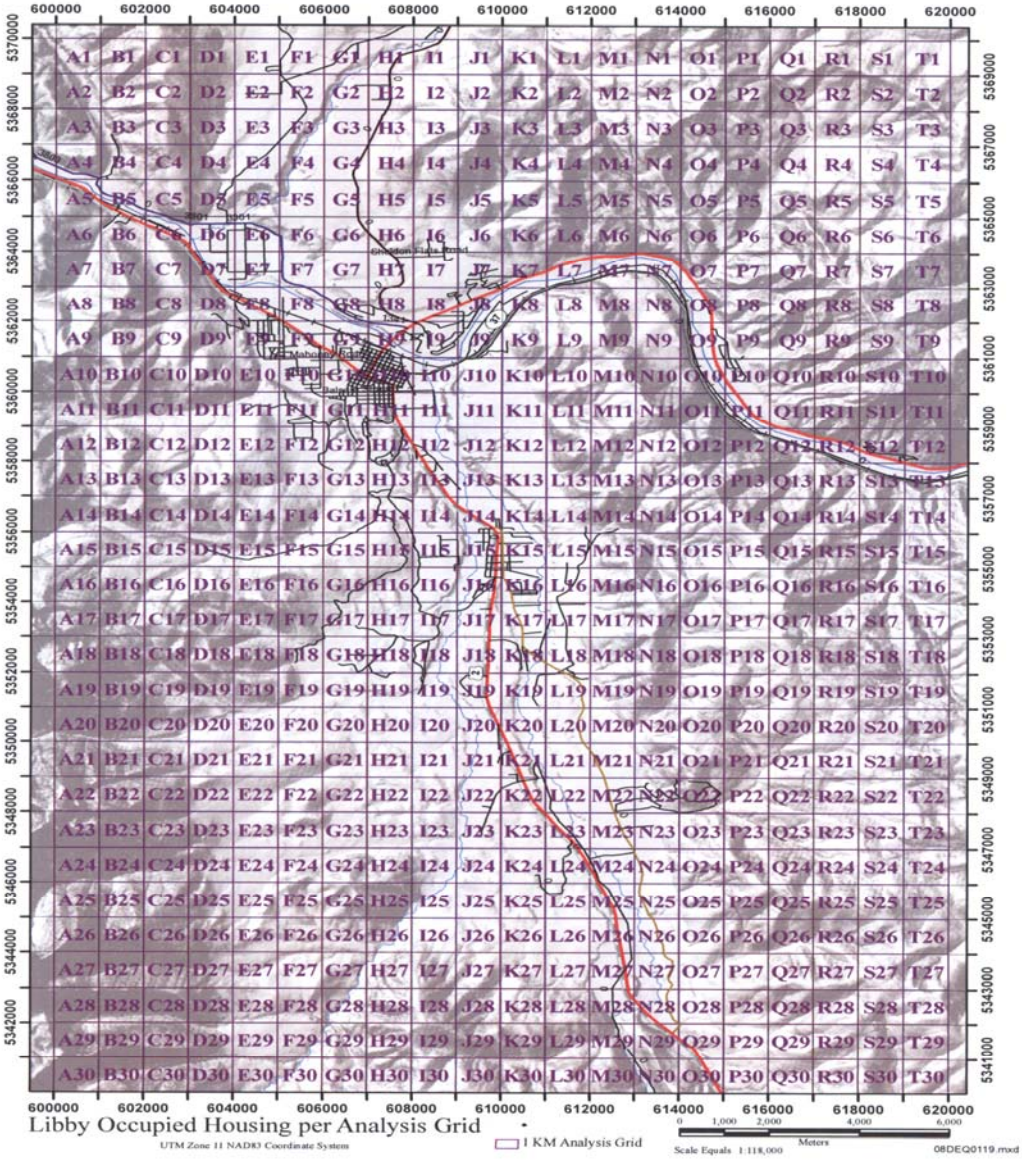
Appendix A: Libby PM-2.5 Nonattainment Area Boundary.



Appendix B: Libby PM-2.5 Nonattainment Area Grid Assignments

Appendix B: Libby PM-2.5 Nonattainment Grids.

UTM (mE)[1]



UTM (mN)

1. UTM = Universal Transverse Mercator, North American Datum 1983.

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