2002 PM_{10} EMISSION INVENTORY FOR THE SPOKANE NONATTAINMENT AREA

FINAL

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TABLES

CHAPTER I. SUMMARY OF SPOKANE COUNTY PM_{10} EMISSIONS

This report presents the 2002 inventory prepared for particulate matter less than 10 microns (PM_{10}) emissions in Spokane County. Table I-1 presents a summary of 2002 PM_{10} emissions for Spokane County and the Spokane PM_{10} NAA.

The general approach to developing the emission estimates provided in Table I-1 was to start with an annual Spokane County emission estimate. These emission estimates were developed by Pechan, obtained from the Washington State Department of Ecology (Ecology), obtained from the Spokane Regional Transportation Council (SRTC), or taken from the U.S. Environmental Protection Agency's (EPA's) 2002 National Emissions Inventory, Version 1 (NEI). The annual emission estimates were then temporally allocated to planning period daily (PPD) emission estimates. A planning period day is an average weekday during the months of November through February. The temporal allocation was performed by using available information on seasonal/monthly source activity and weekly source activity (i.e., weekday versus weekend day). The county-level emission estimates were allocated to the NAA using available spatial information (e.g., point locations, geographic information system shape files).

Point source emissions exclude emissions from the Kaiser-Mead facility. This facility last operated in 2000, so no emissions were included from the 2002 inventory. Further, the Spokane County Air Pollution Control Authority (SCAPCA) does not expect that this facility will resume operation.

Significant contributors to 2002 PPD emissions in the PM_{10} NAA include fugitive dust from unpaved roads (49%) and residential wood combustion (24%). The next highest contributors are fugitive dust from construction (6%), paved roads (3%), and emissions from land clearing debris burning (3%). All other source categories each contribute 2% or less to the NAA PPD emissions. Following discussions with Ecology and EPA, Pechan did not apply transport factors to the fugitive dust emission estimates (e.g., paved and unpaved road dust, agricultural tilling). Pechan had indicated in the Inventory Preparation Plan that transport factors would be applied.

The following sections of this report provide details on the data sources, methods used to estimate county-level emissions, methods used to temporally and spatially allocate emissions to the NAA, and the application of any controls, as needed. Section 2 covers area sources. Section 3 provides information on point sources. Section 4 covers nonroad sources, and Section 5 covers the onroad source sector. More details on the methods used to estimate emissions from the onroad sector are provided in the write-up from SRTC, which is provided as Appendix C.

Table I-1. 2002 PM_{10} Emission Estimates

Source Sector	2002 Spokane County Annual (tons)	2002 Spokane County PPD (tons)	Data Source[a]	2002 PM_{10} NAA Annual (tons)	2002 PM_{10} NAA PPD (tons)
AREA SOURCES					
Stationary Source Fuel Combustion					
Non-Residential	77.0	0.25	Pechan	67.8	0.22
Residential Non-Wood	43.3	0.18	Pechan	34.0	0.14
Residential Wood	2,685	9.3	CERR Submittal	2,052	7.1
Waste Disposal, Treatment and Recovery					
Land Clearing Debris Burning	324	0.89	2002 NEI V1	291	0.80
Residential Open Burning					
Yard Waste	37.3	0.11	CERR Submittal	29.3	0.09
Household Waste	263	0.77	CERR Submittal	206	0.60
Fugitive Dust[b]					
Agricultural Tillage	5,988	20.4	CERR Submittal	201	0.68
Paved Roads	441	1.12	Pechan	326	0.83
Unpaved Roads	8,818	22.1	Pechan	5,855	14.7
Construction	647	2.5	Pechan	479	1.8
Other Area Sources					
Wildfires	47.6	0.13	2002 NEI V1	0.000	0.000
Prescribed Burning	187	0.60	CERR Submittal	7.0	0.03
Slash Burning	6.3	0.02	Pechan	6.3	0.02
Structure Fires	4.8	0.01	2002 NEI V1	3.8	0.01
Firefighting Training	0.21	0.001	Pechan	0.21	0.001
Agricultural Field Burning	0.95	0.000	Pechan	0.03	0.000
Mining and Quarrying	174	0.48	2002 NEI V1	174	0.48
Commercial Cooking	155	0.43	2002 NEI V1	142	0.39
NON-ROAD MOBILE SOURCES					
Aircraft	16.2	0.04	Pechan	16.2	0.04
Locomotives	182	0.50	CERR Submittal	65.9	0.18
NONROAD model sources	296	0.52	Pechan	128	0.29
ON-ROAD MOBILE SOURCES	274	0.75	SRTC	202	0.56
POINT SOURCES					
Controlled Emissions	183	0.66	Ecology	55.8	0.15
Uncontrolled Process Fugitives	32.8	0.09	Ecology	32.4	0.09
Other	57.1	0.21	Ecology	26.2	0.21
Totals	**20,941**	**62.1**		**10,401**	**29.4**

Note: totals may not add exactly due to rounding.

[a] Pechan = Estimate developed by Pechan; CERR Submittal = 2002 Consolidate Emissions Reporting Rule submittal from Ecology to EPA; 2002 NEI V1 = EPA's 2002 National Emissions Inventory, Version 1; SRTC = Spokane Regional Transportation Council.

[b] These estimates have not been adjusted to account for the amount of PM_{10} that is actually transported from the source.

CHAPTER II. AREA SOURCES

A. FOSSIL FUEL COMBUSTION

1. Annual PM_{10} Emission Estimation Methods

State-level fuel consumption estimates for Washington State were obtained from the U.S. Department of Energy's Energy Information Administration (EIA) for coal, distillate oil, residual oil, kerosene, natural gas, and LPG. Coal consumption by sector is presented in the publication *State Energy Data 2001* (EIA, 2004a). 2002 state energy data will not be available until late in 2004. Therefore, 2002 coal consumption was estimated using the ratio of 2002 to 2001 total coal consumption estimates for Washington, obtained from EIA's *Annual Coal Report 2002* and *Annual Coal Report 2001* (EIA, 2003a; EIA, 2002a). Year 2002 distillate and residual fuel oil and kerosene sales by sector are presented in the EIA report *Fuel Oil and Kerosene Sales 2002* (EIA, 2003c). Natural gas consumption by sector for 2002 is available from EIA's *Natural Gas Navigator* (EIA, 2003d). LPG consumption by sector was obtained from EIA's *State Energy Data 2001* (EIA, 2004a). 2002 LPG consumption was estimated by multiplying 2001 LPG consumption by the ratio of 2002 to 2001 total propane consumption data for Washington, presented in the 2001 and 2002 editions of the EIA's *Petroleum Marketing Annual* (EIA, 2003e and EIA, 2002b).

Point source data provided by Ecology included only Title V sources for some districts and Title V sources plus other minor sources for other districts, including Spokane County. Therefore, the point source throughput was subtracted in two parts. First, throughput data associated with Title V sources was subtracted from the state-level consumption data. After allocation to the county (see below), throughput associated with non-Title V sources in Spokane was subtracted from the county-level consumption. For some point sources, the throughput was reported in units that could not be converted (e.g., tons for natural gas). Where possible, throughput values were either confirmed by Ecology or estimated using the reported NO_x emissions and NO_x emission factors from EPA's Factor Information Retrieval Data System (FIRE) database (EPA, 2000).

State-level fuel consumption estimates were allocated to Spokane County using data from the Bureau of Census (BOC, 2002a). Residential fuel was allocated using county and state level data on the number of households using each type of fuel as the primary heating fuel. Commercial/institutional and industrial fuel was allocated using 2001 employment data (North American Industry Classification System [NAICS] 42-45, 51-92 for commercial/institutional and NAICS 31-33 for industrial) from County Business Patterns (BOC, 2001).

Emission factors were obtained from AP-42, FIRE, and an EPA guidance document on residential fuel combustion (EPA, 1998a; EPA 2000; EPA, 2002). Activity and emission factors for fuel combustion are shown in Appendix A.

2. Planning Period Daily Emission Estimates

County-level emissions were allocated to the nonattainment area using several spatial surrogates. Residential fuel was allocated using housing data from the 2000 census (census tract level housing units). Industrial fuel was allocated using manufacturing (standard industrial classification [SIC]

code 20-39) employment, and commercial/institutional fuel was allocated using all non-manufacturing employment. Spatial surrogate data is shown in Appendix B.

Daily emissions for the October-February season were estimated based on several different sources of monthly data. For residential, commercial/institutional, and industrial natural gas emissions, monthly consumption data were obtained from the EIA's Natural Gas Navigator (EIA, 2003d). Residential and commercial/institutional coal and kerosene are assumed to be primarily used for space heating, so monthly heating degree day (HDD) data from the National Climatic Data Center were used to estimate seasonal emissions. Residential and commercial/institutional distillate fuel oil, residual fuel oil, and liquefied petroleum gas (LPG), like natural gas, were assumed to be used for both water heating and space heating. Monthly data by sector were not available for these fuels; therefore, seasonal emissions were estimated using the same seasonal percentages developed for residential and commercial/institutional natural gas. Industrial coal, LPG, and distillate oil were assumed to be uniform throughout the year. Residential emissions were assumed to occur 7 days per week, commercial/institutional were assumed to occur 6 days per week, and industrial emissions were assumed to occur 5 days per week. Temporal factors are shown in Table B-1 of Appendix B.

B. RESIDENTIAL WOOD COMBUSTION

1. Annual PM_{10} Emission Estimation Methods

Residential wood combustion emission estimates were taken from Ecology's 2002 Consolidated Emissions Reporting Rule (CERR) submittal (WSDE, 2004). These emissions were estimated based on information from a recent Washington State University (WSU) study (Tarni and Allen, 2001). The fraction of households using wood burning devices by device and geographic area are shown in Table II-1, and the tons of wood burned per device is shown in Table II-2. The unincorporated portion of Spokane County was assigned to the eastern Washington with forest area. The incorporated portion of Spokane was assigned to the "incorporated area" geographic region. The number of households in Spokane in 2002 was 87,901 in the incorporated area and 79,001 in the unincorporated area.

Emission factors in pounds of pollutant per ton of wood burned were taken from AP-42. These are shown in Table II-3. Certified stoves and inserts were assumed to be 50% catalytic and 50% non-catalytic.

2. Planning Period Daily Emissions

County-level annual emissions were allocated to the PM_{10} nonattainment area using housing data from the 2000 census (census tract level housing units), shown in Appendix B. Emissions for the planning period were estimated based on the seasonal percentages developed from the survey data. The winter season fraction plus two-thirds of the fall season fraction were used to estimate the October-February planning period. Daily emissions were then estimated by multiplying the seasonal emissions by the weekday fraction and dividing by the number of weekdays in the planning period (109 days). Since weekly allocation data were not available, the weekly temporal profile was taken from a residential wood survey conducted in the Mid-Atlantic/Northeast Visibility (MANE-VU) region (Roe and Lindquist, 2004). Weekly profiles were developed for several types of households; therefore, for this inventory, the average of all the profiles was used. Temporal allocation factors are shown in Table B-1 of Appendix B.

Table II-1. Wood Burning Device Usage[a]

Device Type	WSU Survey Region	
	Eastern WA Incorporated	East WA w/forest
Central Furnace	0.013	0.012
Fireplaces	0.381	0.161
Non-certified Insert	0.039	0.048
Certified Insert, Phase I	0.000	0.000
Certified Insert, Phase II	0.067	0.039
Non-certified Pellet stove	0.017	0.042
Certified Pellet stove, 1988 stds	0.004	0.000
Non-certified Woodstove	0.039	0.073
Certified Woodstove, Phase I	0.000	0.024
Certified Woodstove, Phase II	0.032	0.036
Total Equipment	**0.591**	**0.436**

Table II-2. Tons Burned per Wood Burning Device

Device Type	Eastern WA Incorporated	East WA w/forest Unincorporated
Central Furnaces	1.4	10.5[a]
Fireplaces	1.5	1.4
Inserts	2.6	2.7
Pellet stoves	4.3	2.5
Woodstoves	3.5	4.1

Table II-3. Residential Wood Combustion Emission Factors (lb/ton)

Equipment Type	PM_{10}
Central Furnace	30.6
Fireplaces	34.6
Non-certified Insert	30.6
Certified Insert, Phase I	19.8
Certified Insert, Phase II	15.4
Non-certified Pellet stove	8.8
Certified Pellet stove, 1988 stds	4.2
Non-certified Woodstove	30.6
Certified Woodstove, Phase I	19.8
Certified Woodstove, Phase II	15.4

Table II-4. Seasonal Activity Fractions, Residential Wood Combustion

Area	Winter	Spring	Summer	Fall
Incorporated	0.44	0.20	0.03	0.34
Eastern WA w/forest	0.40	0.26	0.03	0.30

C. PRESCRIBED BURNING

1. Annual PM_{10} Emission Estimation Methods

Prescribed burning emission estimates were taken from Ecology's 2002 CERR submittal (WSDE, 2004). The WA Department of Natural Resources (DNR), U.S. Forest Service (USFS), Bureau of Indian Affairs (BIA), and private industry perform prescribed burning. DNR permits and tracks all burns, except those done by the BIA. Using models developed by the USFS, DNR estimated the tons burned and resulting air emissions. DNR provided Ecology with the entire 2002 burn permit database, which was queried for activity level (in tons burned) and emissions by county and season.

2. Planning Period Daily Emissions

Ecology indicated that the 2002 DNR records showed 107 burns in the NAA. Annual emissions in the NAA were 7 tons, and 4.5 of the 7 tons were emitted by 50 burns that occurred during the planning period (Otterson, 2004a).

D. SLASH BURNING

1. Annual PM_{10} Emission Estimation Methods

The number of slash burns (414) was provided by SCAPCA. Each burn pile was assumed to be 10 ft by 10 ft by 4 ft. This volume was converted to mass using a density of 170 lb/yd^3 for yard waste burning (Tchobanoglous et al). The emission factor for logging slash (8 lb/ton burned for PM_{10}) was taken from the EIIP chapter on open burning (EIIP, 2001).

2. Planning Period Daily Emissions

All burns took place inside the boundaries of the nonattainment area. Of the 414 burns, 192 burns occurred during the planning period. Planning period daily emissions were estimated by multiplying the total emissions by the fraction of burns occurring during the planning period and assuming that burning occurs 7 days/week.

E. AGRICULTURAL BURNING

1. Annual PM_{10} Emission Estimation Methods

The number of acres burned in 2002 was provided by SCAPCA. Twenty acres of wheat were burned in the spring, and 3 acres were burned in the fall. There was also 27 acres of grass burned, and 13 spot burns of 1 acre or less each. The spot burns were assumed to be 0.5 acre each.

Fuel loading data were not available. Therefore, the average of the fuel loading factors from each county in the 2002 CERR submittal (WSDE, 2004) was taken and applied to the acreage data for Spokane County. The average fuel loading from the "other" category was used for the spot burns. These average fuel loading factors are 3.79 tons of residue/acre for wheat, 3.11 tons of residue/acre for grassland, and 1.93 tons of residue/acre for other.

The same fuel consumption factors and emission factors used for the CERR submittal were used for the Spokane inventory. The consumption factors for wheat were 0.59 in the spring and 0.60 in the fall. For all other crop types, the consumption factor was assumed to be 1.00 due to lack of any specific information. This will tend to overestimate emissions. Emission factors are shown in Table II-5.

Table II-5. Agricultural Burning Emission Factors

Crop Description	Season	PM_{10} EF (lb/ton burned)
cereal grains (wheat, oats, barley)	fall	12.3
cereal grains (wheat, oats, barley)	spring	6.8
grassland, pasture, and CRP*	all	15.7
weed control	all	14.8

2. Planning Period Daily Emissions

Pechan allocated county level PM_{10} emissions to the PM_{10} NAA based on agricultural land use data provided by SRTC (note that these are not specific to the type of crops grown in the NAA). Spatial data is shown in Appendix B. Only about 3% of the agricultural land use occurs in the PM_{10} NAA. The number of acres burned was provided by month. Therefore, planning period emissions were calculated by multiplying annual emissions by the proportion of acres burned during the October-February season. Planning period daily emissions were then calculated by dividing the October-February emissions by the number of days in the planning period (151).

F. RESIDENTIAL YARD AND HOUSEHOLD WASTE BURNING

1. Annual PM_{10} Emission Estimation Methods

Residential yard waste burning emission estimates were taken from Ecology's 2002 CERR submittal (WSDE, 2004). Like residential wood combustion emissions, residential yard waste burning emissions were estimated based on information from a recent Washington State University study (Tarni and Allen, 2001).

The fraction of households burning yard waste and the number of piles burned are shown in Table II-6 below. The unincorporated portion of Spokane County was assigned to the eastern Washington with forest area.

Table II-6. Residential Yard and Household Waste Burning Statistics

Area	Spokane Co. Households	Fraction Burning Yard Waste	Yard Waste Piles per Year	Fraction Burning Household Waste
Incorporated	87,901	0.077	2.56	0.050
Eastern WA w/forest	79,001	0.184	3.64	0.122

Ecology estimated that the weight of a legal size pile was approximately 125 lbs. The activity data (tons of material burned) was estimated using the following equation:

Activity (tons) = HH x (fraction burning waste) x (piles/HH) x (lbs burned/pile) x (1/2000)

where: HH = the number of households
1/2000 = conversion from pounds to tons

Ecology estimated PM_{10} emissions using an emission factor for total particulate matter emissions from "unspecified forest burning" (AP-42 Table 2.5-5 10/92) and size fraction information from the California Air Resources Board (CARB).

Ecology took the amount of trash burned per household from an Emission Inventory Improvement Program (EIIP) recommendation (EIIP, 2001). The EIIP reported that the amount of trash actually burned was approximately 50% of the combustible trash produced. Ecology used this EIIP value, which was 5.4 lbs per household per day.

The activity (tons of material burned) was estimated using the following equation:

Activity (tons) = HH x (fraction burning trash) x (5.4 lbs/HH-day) x (365 days) x (1/2000)

where: HH = the number of households; and
1/2000 = conversion from pounds to tons.

2. Planning Period Daily Emissions

County-level emissions were allocated to the nonattainment area using housing data from the 2000 census (census tract level housing units), shown in Appendix B. Daily emissions were estimated using seasonal activity fractions developed from the survey data, shown in Table II-7. The winter season fraction plus two-thirds of the fall season fraction were used to estimate the October-February season. Household waste (trash) burning is considered uniform year-round. Both yard and household waste burning was assumed to have a uniform weekly temporal profile.

Table II-7. Seasonal Activity for Residential Yard Waste Burning

Area	Fall	Winter	Spring	Summer
Incorporated	0.25	0.25	0.21	0.29
Eastern WA w/forest	0.23	0.31	0.17	0.29

G. LAND CLEARING DEBRIS BURNING

1. Annual PM_{10} Emission Estimation Methods

Local data on land clearing debris burning was not available; therefore, emissions were taken from the 2002 Preliminary NEI (2004a). Emissions for this category were carried forward from EPA-estimated emissions in the 1999 NEI (EPA, 2004b).

2. Planning Period Daily Emissions

County-level emissions were allocated to the nonattainment area using the fraction of total employment in the NAA, shown in Appendix B. Emissions were assumed to be uniform year-round and to occur 6 days/week.

H. WILDFIRES

1. Annual PM_{10} Emission Estimation Methods

Emissions from wildfires were taken from the 2002 Preliminary NEI (EPA, 2004a). Emissions for 2002 were estimated by EPA using state-level acres burned data obtained from the following sources: U.S. Department of Interior (DOI), Bureau of Land Management (BLM), the National Parks Service (NPS), the U.S. Fish and Wildlife Service (FWS), U.S. Forest Service (USFS), and State/private lands (from USFS). Regional-level acres burned data from DOI's Bureau of Indian Affairs (BIA) were allocated to the State-level by determining the NICC region for each State with tribal land and then developing a region-to-State proportion using the number of acres of tribal land in each State.

State-level activity data were allocated to the county-level using acreage data for rural and urban forest categories and from brush and grass in the miscellaneous category, obtained from Version 2 of the Biogenic Emissions Land Cover Database (BELD2) within EPA's Biogenic Emission Inventory System (BEIS).

Emissions were calculated using the following equation:

$$E = A \times C \times EF \times (1 + S)$$

where:
- E = wildfire emissions (lb);
- A = acres burned (acres);
- C = fuel consumption factor (ton/acre);
- EF = emission factor (lb/ton);
- S = smoldering augmentation factor.

The state-level fuel consumption factor for Washington was 26 tons/acre. The smoldering augmentation factor for Washington was 0.117. The emission factor for PM_{10} (28.1 lb/ton) was taken from a 2003 report (EC/R, 2003).

Historical data on the number of wildfires occurring specifically within Spokane County is difficult to obtain. There is a multi-agency team currently gathering wildfire data, which is composed of many of the agencies listed above and others. It is referred to as GeoMAC (Geospatial Multi-Agency Coordination), and information can be found at www.geomac.gov. Data are available on current wildfires, as well as wildfires in 2002 and 2003. In August of 2002, the Spokane Complex Fire burned about 1,950 acres. This fire occurred outside of the NAA. Another fire occurred in July of 2003; however the acreage burned was not available. Thus far in 2004, no wildfires have been recorded into the GeoMAC database within Spokane County. Based on the number of fires that occurred in the previous 3 years, 2002 appears to be representative of typical conditions in Spokane County.

2. Planning Period Daily Emissions

Pechan did not identify any information that indicated that any of the Spokane County wildfires occurred within the NAA boundaries. None of the wildfires identified in the GeoMAC database occurred within the boundaries of the NAA. In addition, the wildfire activity is typically limited to the months outside of the planning period (i.e., Summer). Therefore, the planning period daily emissions are zero.

I. FIREFIGHTER TRAINING

1. Annual PM_{10} Emission Estimation Methods

Data on the number of firefighter training fires in Spokane County in 2002 were obtained from SCAPCA. There were 44 training fires; 38 of these were piles of material, and six were structure fires. Piles were assumed to be 0.25 cords each, which is 0.45 tons/burn using a conversion factor of 1.8 tons/cord (piles were assumed to be primarily hard wood pallets). For the structure fires, a default fuel loading factor of 1.15 tons per fire was taken from the EIIP (EIIP, 2001a).

The PM_{10} factor was taken from an EPA document on open burning of land clearing debris (EPA, 1996). Emission factors for structure fires were taken from the EIIP (EIIP, 2001a).

2. Planning Period Daily Emissions

According to SCAPCA, all burns took place inside the boundaries of the nonattainment area (Edgar, 2004a). The number of burns was provided by month. Therefore, planning period daily emissions were estimated by multiplying the total emissions by the fraction of burns occurring during the planning period and assuming that burning occurs 5 days/week. This method for temporal allocation had to be used, since information on the actual dates of each burn were not available.

J. COMMERCIAL COOKING

1. Annual PM_{10} Emission Estimation Methods

Emissions for commercial cooking were taken from the 2002 Preliminary NEI (EPA, 2003). Emissions were calculated for the following types of equipment: chain-driven charbroilers, underfired-charbroilers, deep-fat fryers, flat griddles, and clamshell griddles. The activity data for commercial cooking are the total tons of meat cooked with each type of cooking device. The total tons of meat is estimated using the number of each type of restaurant, the fraction of each restaurant type using each cooking device, the average number of pieces of equipment used in each restaurant, and the average pounds of meat cooked on each piece of equipment. These four activity data elements are shown in Tables II-8 through II-11 below. The number of restaurants by type and county was obtained from Dun & Bradstreet (D&B, 2002). Emission factors specific to each type of equipment and each type of meat were taken from several sources and are shown in Table II-12. Additional details can be found in the EPA methods document (Roe, 2003).

Table II-8. Number of Restaurants in Spokane County in 2002 by Type

Restaurant Type	Number
Ethnic	120
Fast food	200
Family	39
Seafood	4
Steak and BBQ	11

Table II-9. Percent of Restaurants with Each Type of Cooking Equipment

Restaurant Category	Chain-Driven Charbroilers	Underfired Charbroilers	Deep-Fat Fryers	Flat Griddles	Clamshell Griddles
Ethnic	3.5	47.5	81.9	62.7	4
Family	10.1	60.9	91.4	82.9	1.4
Fast Food	18.6	30.8	96.8	51.9	14.7
Seafood	0	52.6	100	36.8	10.5
Steak & BBQ	6.9	55.2	82.8	89.7	0

Table II-10. Average Number of Equipment Pieces by Restaurant Type[a]

Restaurant Category	Chain-Driven Charbroilers	Underfired Charbroilers	Deep-Fat Fryers	Flat Griddles	Clamshell Griddles
Ethnic	1.62	1.54	1.63	1.88	1.8
Family	1.71	1.29	2.34	2.03	--
Fast Food	1.07	1.58	3.1	1.43	2.09
Seafood	--	1.1	2.47	1.11	1.5
Steak & BBQ	--	1.63	2.42	1.35	--

[a]Average number for equipment pieces only for the segment of restaurants estimated as having such equipment.

Table II-11. Meat Cooked on Each Equipment Type

Meat Type	Average Mass of Meat Cooked (lb/week)				
	Chain-Driven Charbroilers	Underfired Charbroilers	Deep-Fat Fryers	Flat Griddles	Clamshell Griddles
Steak	236	180	181	166	94
Hamburger	798	270	274	362	1314
Poultry, With Skin	147	144	365	88	113
Poultry, Skinless	266	179	208	111	108
Pork	57.6	148	58.6	112	118
Seafood	119	143	159	92.1	632
Other	--	41.5	274	57.5	--

Table II-12. PM_{10} Emission Factors by Meat and Equipment Type

Meat Type	PM_{10} Emission Factor (lb/ton meat)				
	Chain-Driven Charbroilers	Underfired Charbroilers	Deep-Fat Fryers	Flat Griddles	Clamshell Griddles
Steak	14.6	34.4	n/a	10.0	1.70
Hamburger	14.6	65.4	n/a	10.0	1.70
Poultry, With Skin	21.0	21.0	n/a	n/d	n/a
Poultry, Skinless	21.0	21.0	n/a	n/d	n/a
Pork	21.0	21.0	n/a	n/a	n/a
Seafood	6.6	6.6	n/a	n/d	n/a
Other	n/a	34.4	n/a	10.0	n/a

n/a = not applicable (no activity data apply or no EF available). n/d = emissions below detection limit.
Source – Roe, 2003.

2. Planning Period Daily Emissions

Emissions were assumed to be uniform year-round and to occur 7 days/week. County emissions were allocated to the nonattainment area using non-manufacturing employment, shown in Appendix B.

K. PAVED ROADS

1. Annual PM_{10} Emission Estimates

Emissions were estimated based on the AP-42 emission factor equation (EPA, 1998a) and weekday ADVMT estimates by ADT class, shown in Table II-13, provided by SRTC (Ragaza-Bourassa, 2004). The ADVMT values based on an average weekday were converted to average day ADVMT using weekday to weekend conversion factors and seasonal factors provided by SRTC: 0.83 for highways and 0.94 for interstates. The following equation was used to calculate average weekday to average day factors:

$$AD = (WD*5 + WE*2)/7$$

where:
- AD = average day factor;
- WD = weekday fraction (1);
- 5 = number of weekday days;
- WE = weekend day fraction (0.83 for highways, 0.94 for interstates);
- 2 = number of weekend days; and
- 7 = total number of days per week.

The interstate factor was used for >10,000 ADT and the highway factor was used for the other ADT classes, shown in Table II-13. Monthly VMT was calculated by multiplying the average day ADVMT by the number of days in the month.

The PM_{10} emission factor in grams per mile was calculated using the equation below. This equation, which incorporates a precipitation correction factor, was used to calculate monthly emission rates.

$$E = [k\ (sL/2)^{0.65}\ (W/3)^{1.5} - C][1-(P/4N)]$$

where: E = the emission factor in g/VMT;
k = particle size multiplier (7.3 for PM_{10});
sL = silt loading in g/m^2;
C = material from exhaust, brake and tire wear in g/mi (0.2119 for PM_{10});
W = mean vehicle weight (tons);
P = number of days with at least 0.01 inches of precipitation in the month; and
N = number of days in the given month.

AP-42 defaults were used for mean vehicle weight (2.2 tons) and the "C" term. AP-42 default silt loading values for each ADT class were also used. These default silt loading values are shown in Table II-13. The number of precipitation days per month was taken from the documentation for Ecology's 2002 CERR submittal (WSDE, 2004). The number of days each month with at least 0.01 inches of precipitation is shown in Table II-14.

Table II-13. ADVMT and Silt Loading by ADT Class

ADT	ADVMT (winter weekday)	Silt Loading (g/m^2)
>500	1,969	0.6
500-5,000	709,533	0.2
5,000-10,000	1,645,974	0.06
>10,000	6,460,003	0.03

Table II-14. 2002 Days with Greater Than 0.01 Inches of Precipitation

Month	Days
January	13
February	10
March	14
April	6
May	11
June	7
July	2
August	3
September	6
October	2
November	11
December	15

During winter months with frozen precipitation, anti-skid materials, such as salt or sand, are added to roadways in Spokane County, raising the silt loading of the roads. Street sweeping conducted within the incorporated portions of Spokane County returns the roads to normal silt levels. A control efficiency of 70% is often assumed for the street sweeping program. However, since the affects of anti-skid materials on silt loading were not included in this inventory, no control efficiency was assumed. It is assumed that anti-skid materials are immediately swept up when the roads have dried at the end of the winter season. Note that transport factors were not applied to the emission estimates.

2. Planning Period Daily Emissions

Emissions were allocated to the nonattainment area using the fraction of ADVMT for the NAA to the ADVMT for the county, shown in Appendix B. Monthly emissions were calculated by accounting for the monthly precipitation days and by adjusting the ADVMT by seasonal allocation factors provided by SRTC (0.985 for interstates and 0.960 for non-interstate VMT). Planning period daily emissions were calculated by summing the emissions for the months of October through February and dividing by the number of days in the planning period (151).

L. UNPAVED ROADS

1. Annual PM_{10} Emission Estimation Methods

Fugitive emissions from unpaved roads were estimated using ADVMT and the AP-42 emission factor equation. Average daily VMT on unpaved roads in Spokane County for 2002 was provided by Ecology, 160,248 miles (Otterson, 2004b).

The AP-42 emission factor equation is shown below. The equation includes an adjustment for rainfall which acts as a control efficiency term by assuming that emissions occur only on days where there is no measurable rainfall (i.e., below 0.01 inches).

$$E = \{[k\ (s/12)*(S/30)^{0.5} / (M_{dry}/0.5)^{0.2}] - C\} \times [(d-p)/d]$$

where:
- E = the emission factor (lb/VMT);
- k = particle size multiplier (1.8 for = PM_{10});
- s = silt content of surface material (%);
- S = speed;
- C = material from exhaust, brake and tire wear (0.00047 lb/mi for PM_{10});
- d = number of days in given month;
- p = number of days with at least 0.01 inches of precipitation per month; and
- M_{dry} = surface material moisture content (%).

Values for vehicle speed, silt content, moisture content, and precipitation data were taken from the documentation for Ecology's 2002 CERR submittal (WSDE, 2004). The VMT-weighted speed average on local roads for Spokane in 2002 was 30 mph. The surface material silt content (3.2%) and moisture content (1%) were obtained from the Western Regional Air Partnership (WRAP). The number of days each month with at least 0.01 inches of precipitation is shown in Table II-13. Note that transport factors were not applied to the emission estimates.

2. Planning Period Daily Emissions

County emissions were allocated to the nonattainment area using the ratio of unpaved roadway miles in the NAA to unpaved roadway miles for the entire county, provided by SRTC, shown in Appendix B. Monthly emissions were calculated using the month precipitation and assuming uniform ADVMT. Planning period daily emissions were calculated by summing the emissions for the months October through February and dividing by the number of days in the planning period (151).

M. AGRICULTURAL TILLAGE

1. Annual PM_{10} Emission Estimation Methods

Agricultural tilling emission estimates were taken from Ecology's 2002 CERR submittal (WSDE, 2004). Activity data (acres planted by crop type) were obtained from the Washington Agricultural Statistics Service. For those crop types where acres planted were not available, acres harvested were substituted as the measure of activity. For some crop types within a county, the acreage is considered confidential information and is not available except as a composite "other counties" total. In most cases, the acreages in this category were not large, and these values were not included in the inventory. An adjustment was made to the alfalfa acreage. Alfalfa is typically grown as a perennial crop and is replanted every 3-4 years (seed) or every 7 years (forage). To account for this, alfalfa acreage was multiplied by 0.25. Table II-15 provides the estimated agricultural tilling acreage for 2002 in Spokane County.

Table II-15. 2002 Tilling Acreage for Spokane County

Crop	Acres
Spring Cereal Grains	88,600
Winter Cereal Grains	86,400
Corn	0
Hay - Alfalfa	10,000
Hay - Other	19,500
Other	19,000

EPA has provided an equation for calculating emissions from tilling operations in the National Emissions Trends (NET) documentation. The equation is:

$$E = (c)(k)(s^{0.6})(p)(a)$$

where:
- E = PM emissions (lb);
- c = constant (4.8 lbs/acre-pass);
- k = particle size multiplier (TSP = 1, PM_{10} = 0.21, PM_{25} = 0.042);
- s = silt content of surface soil (% mass of particles smaller than 75 µm in diameter);
- p = number of tillings (passes) per year (or season); and
- a = number of acres planted.

The Conservation Technology Information Center (CTIC) provided information (for year 2000) on the number of acres tilled using conventional practice and conservational practices for each county for fall seeded grains, spring seeded grains and corn. This information was used to develop the percentage of acres tilled using each method for each county. The percentage of conservation tilling in Spokane County was 40% for spring seeded grains, 35% for fall seeded grains, and 15% fallow.

Agricultural soils in Spokane County are classified as silt-loams. The NET guidance gave silt-loams a default silt content of 52%.

The number of tilling passes (p) by crop type and tilling practice was available in the NET guidance (see Table II-16). Local knowledge was substituted for winter and spring seeded cereal grains, alfalfa and corn. Local knowledge was also used to determine the seasonality of these crops. Tilling for all other crops was assumed to occur in the spring. Note that transport factors were not applied to the emission estimates.

Table II-16. Number of Tilling Passes and Seasonal Distribution

Crop	Tilling Passes		Seasonal Distribution (percent)			
	Conventional	Conservation	Spring	Summer	Fall	Winter
Alfalfa, hay, grasses	7	7	72	0	14	14
Spring cereal grains	6	1	0	0	17	83
Corn	3	2	34	0	33	33
Winter cereal grains	7	3	43	0	29	14
Other	3	3	100	0	0	0

2. Planning Period Daily Emissions

Only a small amount of agricultural land use occurs within the PM_{10} NAA. Based on land use data from SRTC, it is estimated that only about 3% of the county agricultural acreage falls within the NAA. Planning period day emissions were calculated using these land use data (shown in Appendix B), the seasonal distributions shown in Table II-16, and an assumption that tilling occurs 7 days per week.

N. CONSTRUCTION

1. Annual PM_{10} Emission Estimation Methods

Emissions were estimated for both road construction and housing construction. Road construction emissions are estimated using two basic construction parameters, the acres of land disturbed by the construction activity and the duration of the activity. Data on the actual acres disturbed by road construction are generally not available, so a surrogate is used. The 1999 NEI emission estimation methods for road construction use the following road mile to acres conversions by roadway type:

- Interstate, urban and rural; Other arterial, urban – 15.2 acres/mile;
- Other arterial, rural – 12.7 acres/mile;
- Collectors, urban – 9.8 acres/mile; and
- Collectors, rural – 7.9 acres/mile.

The number of miles of roads constructed in 2002 was estimated based on SRTC geographic information system (GIS) data for road networks in 2002 and 2003. Pechan estimated that 13.7 miles of new roads were constructed in 2002 within the PM_{10} NAA based on the difference in the roadway mileage between the two years. For the county, a total of 38.3 miles were constructed. A conversion factor of 9.8 acres/mile was assumed for all roads.

Emissions were calculated using the total acres disturbed, the PM_{10} emission factor of 0.42 tons/acre/month, and the activity duration, estimated to be 12 months. Adjustments were made to the PM_{10} emissions to account for conditions in Spokane County including correction parameters for soil moisture level and silt content (MRI, 1999). The corrected emissions were calculated using the following equation (MRI, 1999):

$$E_{corr} = E\left(24/PE\right)\left(s/9\right)$$

where: E_{corr} = emissions corrected for soil moisture and silt content;
E = uncorrected emissions;
PE = PE index (moisture level, unitless); and
s = surface silt content (%).

Soil moisture levels were estimated using precipitation-evaporation values from Thornthwaite's PE Index. The PE value for Spokane County is 127.9. A silt content value of 52 percent was used. This value was used to calculate 1999 NEI emissions for Spokane County and was determined by comparing the U.S. Department of Agriculture surface soil map with the county map.

Housing construction PM_{10} emissions were calculated using an emission factor of 0.032 ton PM_{10}/acre/month, the number of housing units constructed, a units-to-acres conversion factor, and the duration of construction activity (MRI, 1999). The number of single-family, two-family, and apartment buildings and warehouses constructed in 2002 was obtained from the U.S. Census Bureau's 2002 Building Permits Data (BOC, 2002b). The total acres disturbed by construction is estimated by applying conversion factors to the housing start data for each category as follows:

- Single family - 1/4 acre/building;
- Two family - 1/3 acre/building; and
- Apartment - ½ acre/building or 1/20 acre/unit.

The equation for calculating emissions from residential construction is:

$$\text{Emissions} = (0.032 \text{ tons } PM_{10}\text{/acre/month}) * B * f * m$$

where: B = number of buildings constructed;
f = conversion factor (acre/building); and
m = duration of construction activity in months.

The duration of construction activity for single and two-family homes is assumed to be 6 months (MRI, 1999).

For single-family houses with basements, an alternative emission factor is used. The emission factor is calculated as 0.011 ton PM_{10}/acre/month plus 0.059 tons PM_{10}/1000 cubic yards of on-site cut/fill (MRI, 1999). The cubic yards of dirt moved is estimated as the size of the basement plus 10% to account for peripheral dirt. Single family homes are assumed to be 2000 ft^2, and basements are assumed to be 8 ft deep. These dimensions plus 10% yields 652 yd^3 of dirt moved. The percentage of one family houses in the western region with basements is obtained from the U.S. Census Bureau in the report *Characteristics of New Houses,* Type of Foundation in

New One Family Houses Completed (BOC, 2002c). The percentages are applied to 1-unit structures to obtain the number of structures with basements.

Apartment construction emissions were computed separately using an emission factor that is more representative of emissions from apartment building construction (0.11 tons PM_{10}/acre/month). A 12-month duration is assumed for apartment construction (MRI, 1999).

Following the NEI method, a control efficiency of 50 percent was assumed for the nonattainment area (EPA, 2004b). A rule penetration (RP) value of 100% was applied along with the EPA default rule effectiveness (RE) value of 80%. Note that transport factors were not applied to the emission estimates.

2. Planning Period Daily Emissions

Road construction emissions were allocated to the NAA using the ratio of miles constructed in the NAA to the miles constructed in the entire county. Housing construction emissions were allocated using housing data from the 2000 census (census tract level housing units) (BOC, 2002a). Spatial surrogate are shown in Appendix B. Construction emissions were assumed to be uniform year-round. A five day work week was assumed.

CHAPTER III. POINT SOURCES

A. ANNUAL PM_{10} EMISSIONS

Point sources are defined as any stationary source having the potential to emit 50 tons per year of PM_{10}. All point sources above this threshold are included in the inventory. Sources below this threshold, yet tracked as point sources ("area" point sources), are also included in the inventory for completeness. The base year inventory includes actual emissions from all sources for 2002. These emissions are shown in Table III-1. Included in this table are the sums of Spokane County point source emissions both inside and outside of the NAA. In addition, the sums of point source

Actual point source emissions data for Spokane County were provided by Ecology (Stipek, 2004). The Kaiser-Mead facility, a major emitter PM_{10}, did not operate in 2002. According to SCAPCA, this facility has been sold and it does not appear that the new owners will operate it (Edgar, 2004a). Therefore, emissions were excluded from the 2002 inventory.

B. PLANNING PERIOD DAILY EMISSION ESTIMATES

Pechan plotted the location of each point source to determine which sources were located in the NAA. These sources are identified in Table III-1. Planning period day emissions were estimated using the seasonal throughput percentages and average days/week provided for each process. The planning period day emissions were calculated using the following equation:

$$((\%Dec\text{-}Feb/100) + (2/3)*(\%Sept\text{-}Nov/100))/N$$

where: %Dec-Feb = the percentage of throughput occurring in the months Dec. to Feb.;
%Sept-Nov = the percentage of throughput occurring in the months Sep. to Nov.; and
N = the number of days of operation in the planning period.

The number of days of operation in the planning period was determined from the days/week provided with the point source data (i.e., 7 days/week = 151 days in planning period). If seasonal throughput percentages were not available, 25% was assumed for each season. If the days/week of operation was not available, 6 days/week (130 days in the planning period) was assumed.

Table III-1. 2002 Actual PM_{10} Emissions for Plants in Spokane County

Plant Name	Actual PM_{10} Emissions (tpy)
ACME ASPHALT PLANT (HAWTHORNE RD)[a]	4.16
AFFORDABLE CUSTOM CABINETS	0.22
ALTEK INCORPORATED	0.06
AVISTA CORP	0.02
CENTRAL PREMIX GRAVEL PLANT[b]	7.99
COLUMBIA LIGHTING	0.10
COLUMBIA PAINT & COATINGS	0.01
CXT-PRECAST PLANT	0.08
DEACONESS MEDICAL CENTER	0.53
DEPT OF VETERANS AFFAIRS MEDICAL CENTER	0.77
FIBER-TECH INDUSTRIES	0.41
HOLY FAMILY HOSPITAL	0.18
HUNTWOOD INDUSTRIES	1.03
INLAND ASPHALT	4.16
INLAND EMPIRE PAPER[b]	18.0
KAISER TRENTWOOD[b]	46.5
KAISER MEAD[c]	0.0
NORTHSIDE LANDFILL	1.00
PURINA MILLS[a,b]	9.90
REARDAN GRAIN GROWERS	0.48
SACRED HEART MEDICAL CENTER	0.82
SAINT LUKES REHABILITATION INSTITUTE	0.13
SELECT FARMS	0.02
SHAMROCK PAVING INC[b]	6.27
SPOKANE SEED[a,b]	19.3
SPOKANE STEEL[a]	1.30
THE BOEING COMPANY	0.07
TRAVIS PATTERN	12.5
VALLEY HOSPITAL & MEDICAL CENTER	0.11
WASTE TO ENERGY	11.5
NAA TOTAL	**148**
DEPT OF SOCIAL & HEALTH SERVICES	0.46
EASTERN WASHINGTON UNIVERSITY	1.01
FAIRCHILD AFB	0.58
MUTUAL MATERIALS	121
PG&E GAS TRANSMISSION NORTHWEST	1.70
UNITED COATINGS	0.61
OVERALL COUNTY TOTAL	**273**
Point Source Total	108
"Area" Point Total	165

[a] Actual emissions for Acme Asphalt , Purina Mills, Spokane Seed, and Spokane Steel were obtained from SCAPCA.
[b] Sources with PTE>50 tons/year.
[C] Kaiser Mead last operated during 2000. Actual emissions were 150 tons.

CHAPTER IV. NONROAD SOURCES

A. NONROAD MODEL SOURCES

1. Annual PM_{10} Emission Estimates

Annual and monthly emissions for Spokane County were generated by running EPA's draft NONROAD2004 model (EPA, 2004c). Monthly and seasonal NONROAD model option files were prepared that account for 2002 temperatures and fuel input values for Spokane County (WSDE, 2004). Table IV-1 presents the fuel input and temperature data by season, and in some cases, by month, used in the model runs.

Pechan also used a revised NONROAD allocation file prepared by Ecology to more accurately represent the distribution of recreational marine vessel activity by county in the state. In all other cases, default model data for population, activity, and emission factors were used.

Table IV-1. 2002 Input Parameters for Spokane County NONROAD Model Runs

Parameter	Winter[a]	Spring	Summer	Fall		
				September	October	November
Gasoline RVP	13.8	11	8.5	8.5	10.1	12.2
Oxygen wt %	3.5	0	0	0	3.5	3.5
Gasoline Sulfur %	0.0279	0.0279	0.0279	0.0279	0.0279	0.0279
Diesel Sulfur %	0.34	0.34	0.34	0.34	0.34	0.34
CNG/LPG Sulfur %	0.003	0.003	0.003	0.003	0.003	0.003
Minimum Temperature	24	35	53	45.8	36	28.8
Maximum Temperature	38	57	80	72	58.6	41.4
Average Temperature	31	46	66	58.9	47.3	35.1

[a]Three monthly files were prepared (Dec, Jan, Feb), all containing the same input values.

2. Planning Period Daily Emission Estimates

Planning period day emissions were estimated by adding the results for each of the five planning period months (October, November, December, January, and February), and then multiplying the planning period emissions by the weekday activity fraction during the week for each source classification code (SCC), obtained from the NONROAD model (EPA, 1999). This value was then divided by the number of weekdays in the 2002 planning period (109 weekdays).

County emissions from NONROAD were allocated to the nonattainment area using the spatial surrogates in the Table IV-2. Airport equipment and recreation equipment emissions were based on the actual locations of airports (all inside the NAA) and off-road parks (all outside the NAA), respectively. Lawn and garden equipment emissions were allocated using housing data and commercial equipment emissions were allocated using population from the 2000 census (BOC, 2002a). Industrial equipment emissions were allocated based on employment data provided by SRTC. Spatial data are shown in Appendix B.

Table IV-2. Nonroad Mobile Source Spatial Surrogates

Equipment	Surrogate Activity Indicator for Nonattainment area
Agricultural Equipment	Land use data
Airport Ground Support Equipment	Airport locations
Commercial	Population
Construction and Mining	Households
Industrial	Manufacturing and wholesale employment
Lawn/Garden	Households
Logging Equipment	Assumed all outside PM10 NAA
Recreational Equipment	ORV park locations

B. LOCOMOTIVES

1. Annual PM_{10} Emission Estimates

Locomotive emissions were taken from Ecology's 2002 CERR submittal (WSDE, 2004). Emissions were calculated for Class 1 railroads based on EPA guidance (EPA, 1992b). Class 2 and 3 railroad locomotive emissions were not inventoried; because they were found to be a small percentage of total locomotive emissions (the majority of the activity takes place on Class 1 railroads).

Locomotive activity is measured in gallons of diesel fuel consumed by locomotives. Three Class 1 railroads operate in Washington: Burlington Northern Santa Fe (BNSF), Union Pacific (UP), and Amtrak. All three provided fuel consumption for 2002. Most of the activity information was obtained by county; therefore, state to county spatial adjustments were not necessary in most cases. Where activity data were not available by county, track mileage and trip information was used to assign activity to counties. Locomotive fuel consumption in Spokane County was estimated to be 23,746,097 gallons for line haul locomotives, 243,966 gallons for yard locomotives, and 494,925 for passenger locomotives. The emission factor for PM_{10} was extracted from EPA's regulatory support document developed during the 1997 locomotive emissions standards rulemaking (EPA, 1998b).

2. Planning Period Daily Emission Estimates

Locomotives were assumed to operate uniformly year-round per EPA guidance (EPA, 1992a). Emissions were allocated to the nonattainment area by multiplying the county-level emissions by the ratio of feet of railway in the NAA to the total county feet of railway, determined using using GIS coverage of railroad tracks in Spokane County from the National Transportation Atlas. Spatial data is shown in Appendix B.

C. AIRCRAFT {tc "H. AIRCRAFT " \l 2}

1. Annual PM_{10} Emission Estimates

For the aircraft category, Pechan estimated emissions for two airports in the Spokane area, Spokane International and Spokane/Felts Field. For Spokane International Airport, Pechan obtained 1999 emission estimates based on its *Airport Master Plan* (Edgar, 2004b). These emissions were reported by specific aircraft within the Federal Aviation Administration's

(FAA's) Emission Dispersion and Modeling System (EDMS). To assign SCC codes, Pechan classified each aircraft into one of four categories (commercial air carrier, air taxi/commuter, general aviation, and military). A summary of the aircraft types, their reported annual CO emissions, and their estimated PM_{10} emissions are listed in Table IV-3.

PM_{10} emissions were based on PM_{10}/CO emission factor ratios, since EDMS does not generate PM_{10} emissions. Commercial aircraft used the same PM_{10}/CO emission factor ratios as air taxi and military aircraft. These 1999 emission estimates were then grown to 2002 based on growth rates calculated from facility-level landing/takeoff operations (LTOs) as reported by FAA (FAA, 2004).

For Spokane/Felts Field, fleet average emission rates were applied to annual 2002 LTO data reported by FAA's *Air Traffic Activity Data System (ATADS)* (FAA, 2004). The LTO data and PM_{10} emission rates are presented in Table IV-4.

2. Planning Period Daily Emission Estimates

Both airports are located in the NAA. For both airports, planning period daily emissions were estimated based on the fraction of planning period LTO activity, as reported by month for 2002 in FAA's ATADS. Planning period emissions were then multiplied by a weekday activity fraction (0.90 for commercial aircraft, and 0.71 for all other aircraft). This value was then divided by the number of weekdays in the 2002 planning period season (109 weekdays). Temporal allocation fractions are shown in Table B-1 of Appendix B.

Table IV-3. 1999 EDMS Results for Spokane International Airport

Aircraft Name	Identification	Annual LTO's	Aircraft Category	CO (ton/yr)	PM_{10}[a] (ton/yr)
EMB-120	1999 Regional (Embraer EM2)	3,106	Air Taxi and Commuter	3.04	0.07
Swearingen Metro 2	1999 Regional (Swearingen Metro)	2,069	Air Taxi and Commuter	2.84	0.06
Beechjet 400	1999 Regional (used for all Beechcraft)	1,035	Air Taxi and Commuter	5.26	0.11
Dash 7	1999 Regional (used for all Dash 8's)	6,469	Air Taxi and Commuter	7.02	0.15
F-28-2000	1999 Regional	9,058	Air Taxi and Commuter	26.3	0.56
B757-200	1999 Freighter	1,658	Commercial	7.14	0.15
A310	1999 Freighter	431	Commercial	2.62	0.06
A300-600	1999 Freighter	129	Commercial	0.62	0.01
DC10-30	1999 Freighter	53	Commercial	0.46	0.01
MD-80	1999 Freighter	636	Commercial	2.04	0.04
B727-200	1999 Freighter	2,559	Commercial	10.1	0.22
EMB-120	1999 Freighter (used for DC-3)	250	Commercial	0.25	0.01
Swearingen Merlin	1999 Added for Air cargo feeder/utility	7,928	Commercial	10.6	0.23
B727-100	1999 Freighter	734	Commercial	2.91	0.06
B747-100F	1999 Freighter	0	Commercial	2.08	0.04
DC9-10	1999 Freighter	636	Commercial	1.63	0.03
DC8-70	1999 Freighter	167	Commercial	9.91	0.21
B737-300	1999 Airline	31,011	Commercial	179	3.84
MD-80	1999 Airline	6,329	Commercial	20.3	0.44
A319	1999 Airline	1,265	Commercial	16.5	0.35
B727-200	1999 Airline	1,270	Commercial	5.03	0.11
Cessna 208 Caravan	General Aviation	41,114	General Aviation	10.1	0.20
C-135	1999 Used for all military	3,200	Military	73.0	1.57
	Total	**121,107**		**399**	**8.53**

NOTE: Totals may not add exactly due to rounding.
[a]PM_{10} estimated by multiplying CO by fleet average PM_{10}-to-CO emission factor ratio; commercial aircraft used same ratio as air taxi and military aircraft types.

Table IV-4. Fleet-Average Emission Factors for Spokane/Felts Field				
SCC	**Aircraft Category**	**2002 LTOs**	**CO Emission Rate (lb/LTO)**	**PM_{10} Emission Rate (lb/LTO)**
2275001000	Military	265	28.130	0.603
2275050000	General Aviation	60,636	12.014	0.237
2275060000	Air Taxi and Commuter	7,603	28.130	0.603

CHAPTER V. ONROAD SOURCES

A. ANNUAL PM_{10} EMISSION ESTIMATES

Onroad mobile source emissions were estimated by SRTC. SRTC used EPA's MOBILE6 model to estimate annual and PPD emissions. Details on the methods used by SRTC to calculate emissions are provided in Appendix C. Daily emissions values based on an average winter weekday were converted to annual emissions using weekday to weekend conversion factors (0.83 for highways and 0.94 for interstates) and seasonal factors (0.960 for non-interstates and 0.985 for interstates) provided by SRTC. The following equation was used to calculate average weekday to average day factors:

$$AD = (WD*5 + WE*2)/7$$

where:
- AD = average day factor;
- WD = weekday fraction (1);
- 5 = number of weekday days;
- WE = weekend day fraction (0.83 for highways, 0.94 for interstates);
- 2 = number of weekend days; and
- 7 = total number of days per week.

A weighted average weekday to average day factor was calculated using weekday ADVMT by ADT class provided by SRTC (shown in Table V-1). The interstate factor was used for >10,000 ADT and the highway factor was used for the other ADT classes. A weighted seasonal adjustment factor (SAF) was also calculated using the ADVMT by ADT class. Annual emissions were estimated using the following equation:

$$AE = (WWDE / SAF) * AD * 365$$

where:
- AE = annual emissions;
- WWDE = winter weekday emissions;
- SAF = seasonal adjustment factor;
- AD = average day factor; and
- 365 = number of days per year.

Table V-1. 2002 Winter Season Day and Annual Mobile Source Emissions

	Annual Emissions[a] (tpd)	Daily Emissions (ppd)
County	274	1,508
NAA	202	1,115

[a] Annual emissions calculated from winter season daily emissions provided by SRTC.

B. PLANNING PERIOD DAILY EMISSION ESTIMATES

SRTC provided 2002 county and NAA emission estimates for PM_{10}. Winter season weekday emissions calculated by SRTC are assumed to be representative of the planning period. As mentioned above, Pechan used the winter season daily emission estimates to estimate the annual emissions provided in Tables I-1 and V-1.

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APPENDIX A. FUEL COMBUSTION ACTIVITY AND EMISSION FACTORS

Table A-1. Point and Area Fuel Consumption by Fuel Sector for Spokane County

Fuel Sector		State Consumption	Title V Point Sources	State Cons. Less Title V	Spokane Consumption (less Title V)	Other Spokane Point Sources	Spokane Area Consumption
Coal (tons)							
2104002000	Residential	2,475	0	2,475	575	0	**575**
2103002000	Commercial	20,025	0	20,025	1,541	0	**1,541**
2102002000	Industrial	130,981	58,662	72,319	4,511	0	**4,511**
Distillate Fuel Oil (E3GAL)							
2104004000	Residential	81,914	0	81,914	7,839	0	**7,839**
2103004000	Commercial	49,915	50	49,865	3,836	19,956	**0**
2102004000	Industrial	25,310	13,261	12,049	752	1,348	**0**
Residual Fuel Oil (E3GAL)							
2104005000	Residential	0	0	0	0	0	**0**
2103005000	Commercial	154	0	0	0	0	**0**
2102005000	Industrial	7,005	30,746	0	0	0	**0**
Natural Gas (E6FT3)							
2104006000	Residential	73,347	0	73,347	8,424	0	**8,424**
2103006000	Commercial	46,455	9,855	36,600	2,816	848	**1,968**
2102006000	Industrial	67,717	40,063	27,654	1,725	254	**1,471**
LPG (E3GAL)							
2104007000	Residential	2,051	0	2,051	73	0	**73**
2103007000	Commercial	362	4	358	28	0	**28**
2102007000	Industrial	4,007	0	4,007	250	0	**250**
Kerosene (E3GAL)							
2104011000	Residential	1,451	0	1,451	139	0	**139**
2103011000	Commercial	972	0	972	93	0	**93**

Table A-2. Fuel Combustion PM10-FIL and PM-CON Emission Factors

Residential Emission Factors				
SCC	**SCC Desc**	**PM10-FIL**	**PM-CON**	**Source**
2104002000	Bituminous/Sub-Bituminous Coal (LB/TON)	6.2	0.04	EPA, 2002
2104004000	Distillate Oil (LB/E3GAL)	1.08	1.3	EPA, 2002
2104006000	Natural Gas (LB/E6FT3)	1.9	5.7	EPA, 2002
2104007000	Liquified Petroleum Gas (LB/E3GAL)	0.4	0.506	EPA. 1998a
2104011000	Kerosene (LB/E3GAL)	1.08	1.3	EPA, 2002
Commercial Emission Factors				
2103002000	Bituminous/Sub-Bituminous Coal (lb/ton)	61.59[a]	0.04	EPA, 2000
2103004000	Distillate Oil (LB/E3GAL)	1.08	1.3	EPA. 1998a
2103006000	Natural Gas (LB/E6FT3)	1.9	5.7	EPA. 1998a
2103007000	Liquified Petroleum Gas (LB/E3GAL)	0.4	0.506	EPA. 1998a
2103011000	Kerosene (LB/E3GAL)	1.08	1.3	EPA, 2002
Industrial Emission Factors				
2102002000	Bituminous/Subbituminous Coal (LB/TON)	6.16[b]	0.95[c]	EPA. 1998a
2102004000	Distillate Oil (LB/E3GAL)	1	1.3	EPA, 2000
2102006000	Natural Gas (LB/E6FT3)	1.9	5.7	EPA. 1998a
2102007000	Liquified Petroleum Gas (LB/E3GAL)	0.6	0.506	EPA. 1998a

[a]PM10-FIL = 2.6*A (A = 23.69)
[b]PM10-FIL = 0.26*A (A = 23.69)
[c]PM10-CON = 0.04*A (A = 23.69)

APPENDIX B. TEMPORAL AND SPATIAL ALLOCATION DATA

Table B-1. Temporal Allocation Data

Category	Oct-Feb Fraction	Weekday Fraction	PPD Fraction[a]
Area Source Fossil Fuel Combustion			
Residential Coal	0.6566	0.7143	0.0043
Residential Distillate Oil	0.6309	0.7143	0.0041
Residential Natural Gas	0.6309	0.7143	0.0041
Residential LPG	0.6309	0.7143	0.0041
Residential Kerosene	0.6566	0.7143	0.0043
Commercial Coal	0.4137	0.8571	0.0033
Commercial Natural Gas	0.5376	0.8571	0.0042
Commercial LPG	0.5376	0.8571	0.0042
Commercial Kerosene	0.6566	0.8571	0.0052
Industrial Coal	0.4137	0.8571	0.0033
Industrial Natural Gas	0.4528	0.8571	0.0036
Industrial LPG	0.4528	0.8571	0.0036
Residential Wood Combustion			
Incorporated	0.6667	0.6398	0.0039
Unincorporated	0.5000	0.6398	0.0029
Aircraft			
Felts Field - Military	0.2453	0.7143	0.0016
Felts Field - General Aviation	0.3167	0.7143	0.0021
Felts Field - Air Taxi and Commuter	0.3539	0.7143	0.0023
Spokane Intl - Military	0.3439	0.7143	0.0023
Spokane Intl - Commercial	0.4019	0.7143	0.0026
Spokane Intl - General Aviation	0.3291	0.7143	0.0022
Spokane Intl - Air Taxi and Commuter	0.4249	0.7143	0.0028

[a]PPD Fraction = Oct-Feb Fraction * Weekday Fraction / 109 Weekdays

Table B-2. Spatial Surrogate Data Used to Allocate Emissions to the Nonattainment Area

Surrogate Description	County Value	PM NAA Value	Units	PM NAA Factor	Source
Population	420,509	315,684	People	0.7507	Census Data
Housing	175,005	137,365	Households	0.7849	Census Data
Railroad	1,505,532.58	546,088.48	Feet	0.3627	GIS Data, National Transportation Atlas
Total Employment	177,904	159,851	Employees	0.8985	SRTC
Manuf. Employment	19,202	15,105	Employees	0.7866	SRTC
Non-manuf. Emp.	158,702	144,746	Employees	0.9121	SRTC
ADVMT	8,817,479	6,517,389	Weekday VMT	0.7391	SRTC
Roads Constructed	38.3	13.7	Miles	0.3577	SRTC GIS Data
Unpaved Roads	1,256	834	Miles	0.6640	SRTC GIS Data
Ag. Land	713,392.64	23,960.53	Acres	0.0336	SRTC

APPENDIX C. ONROAD MOBILE EMISSIONS METHODS

1. EMISSIONS SUMMARY

Table C-1. Mobile Source PM_{10} Emissions Summary in Pounds per Day

Evaluation Year	PM_{10} NAA pounds per day	County-wide pounds per day	Mobile Emissions Model
2002	1115	1508	Mobile 6.2

2. EMISSIONS ESTIMATION PROCESS

Onroad mobile source emissions were calculated by multiplying the number of average daily vehicle miles traveled (ADVMT) by an emission rate in grams per mile. One emission rate of 0.0776 grams/mile was used.

Regional Travel Demand Model

Spokane Regional Transportation Council (SRTC) is responsible for long-range transportation planning models. TModel2 is the travel demand model this project. TModel2 data was adjusted to include appropriate projected land-use, transportation projects, employment and population.

Activity Level and Temporal Adjustment

The activity measurement for onroad mobile sources is the number of miles driven. The units are typically given in ADVMT. SRTC using Tmodel2 provided ADVMT for this maintenance plan. Table C-2 reports the ADVMT for Spokane County and the PM_{10} NAA.

All of the ADVMT was provided for Spokane County and/or the PM_{10} NAA by roadway link. The length of each link and the traffic volumes on that link are used to compute VMT. TModel2 produces the weekday, p.m. peak hour VMT. Therefore, VMT must be aggregated from the peak hour into a 24-hour total. SRTC uses a factor of 11 to convert hourly VMT to ADVMT. The "11" is derived from a local 24-hour traffic count variations file.

Table C-2. Area ADVMT

Evaluation Year	PM_{10} NAA	Spokane County
2002	6,517,389	8,817,479

3. EMISSION RATES: MOBILE6.2

PM_{10} emission rates in grams per mile were generated using the EPA model MOBILE6.2. Local data was used for the following input parameters: evaluation month, registration distribution, temperature, humidity, Reid vapor pressure (RVP), diesel sulfur content, oxygenated fuel program, inspection and maintenance (I/M) program, speed, and facility type. Below is a copy of the 2002 input file.

```
*Header Section
MOBILE6 INPUT FILE

SPREADSHEET:
POLLUTANTS:
PARTICULATES: SO4 OCARBON ECARBON GASPM LEAD BRAKE TIRE
RUN DATA

*Run Section
REG DIST: c:\mobile62\reg2002.txt
EXPAND EXHAUST:
EXPAND EVAPORATIVE :
FUEL PROGRAM: 3
NO REFUELING:
I/M DESC FILE: im2002.spk

*Scenario Section
SCENARIO RECORD: 2002,Arterial
CALENDAR YEAR: 2002
EVALUATION MONTH: 1
MIN/MAX TEMP: 24.0 38.0
ABSOLUTE HUMIDITY: 20.0
FUEL RVP: 13.8
PARTICLE SIZE: 10.0
DIESEL SULFUR: 310
PARTICULATE EF: PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
OXYGENATED FUELS: 0.000 1.000 0.000 0.035 1
AVERAGE SPEED: 35.0 Arterial
```

Evaluation Month

The MOBILE6.2 model can calculate emission factors that represent a January 1 or July 1 vehicle registration distribution. The winter season was modeled as a January 1 distribution.

Registration Distribution

Washington State Department of licensing (DOL) registration information for 2002 was used in the year 2002 evaluation. The distributions for MOBILE6 vehicle types, except school buses and transit buses was developed using DOL individual licensing records. The school bus distribution came from a 2001 dataset of all school buses in the state[1], and the transit distribution was developed from Federal Transit Authority report data[2].

Temperature and Humidity

Minimum and maximum temperatures and humidity were calculated according to EPA guidance and have not changed since the 2001 State Implementation Plan submittal. Winter conditions that were used to create the PM_{10} emission factor, included a minimum temperature of 24 degrees and a maximum temperature of 38 degrees[3].

Absolute humidity for Spokane was modeled at 20[4]. It should be noted that ratios developed for Spokane were lower than acceptable (i.e., values under 20). All values lower than 20 should be set at 20 in MOBILE6.

RVP

Fuel surveys to determine RVP are conducted periodically. For this inventory, a RVP value of 13.8 was used. This value is from a Seattle 1999 winter survey reported by the American Automobile Manufactures' Association[5].

Oxygenated Fuel Program

The oxygenated fuel program began in 1993 in Spokane County via of local regulation. Since 1995-1996 oxygenated fuels have been instituted at 3.5% oxygen content. For 2002, oxyfuels were modeled at 3.5%.

Diesel Sulfur Content

Spokane County uses a diesel sulfur content at 310 parts per million. The Western Regional Air Partnership contracted with Environ to prepare onroad mobile source inventories for 1996. Environ collected information on summer and winter diesel sulfur content for each county[6].

I/M Program

A vehicle I/M program is operated in the Spokane region. The program has seen changes over the years and input parameters have been tracked to allow modeling of the program in place for in a given year. Table C-3 includes each of the possible I/M program parameters used in the emission factor input files.

Table C-3. I/M Program Parameters for Evaluation Year 2002

Parameter	set 1	set 2	set 3	set 4	set 5
Prog Start Yr	1985	2002	1985	2002	1985
Prog End Yr	2050	2050	2050	2050	2050
Test Freq	biennial	biennial	biennial	Biennial	biennial
Program Type	test only	test only	test only	test only	test only
Test Type	ASM 2525 phase-in[a]	gas cap	OBD exhaust[b]	OBD Evap + gas cap	2500/idle
Model Yrs	1968-1995	1968-1995	1996-2050	1996-2050	1968-2050
Vehicle Types	light duty gasoline	light duty gasoline	light duty gasoline	light duty gasoline	heavy duty gasoline
Stringency	32%	n/a	32%	32%	32%
Compliance	96%	96%	96%	96%	96%
Waiver pre-81	6%	6%	6%	6%	6%
Waiver 1981+	10%	10%	10%	10%	10%
Exempt Age	25 yrs	25 yrs	25 yrs	25 yrs	25 yrs
Grace Age	5 yrs	5 yrs	5 yrs	5 yrs	5 yrs
Tech Training	yes	yes	yes	Yes	yes

[a]ASM = acceleration simulation mode
[b]OBD = on-board diagnostics

Facility Type and Speed

For PM_{10} emission factors, the facility type of arterial was used. The speed reflected and average speed of 35 miles per hour. The MOBILE6.2 emission rate of 0.0776 grams/mile was used. This PM_{10} emission rate reflects the addition of particulates ten microns or smaller from exhaust, evaporation, brake wear, and tire wear.

4. EMISSIONS ESTIMATES

Daily emissions in pounds per day were calculated for each evaluation year using the following equation:

$$\sum_{i=1}^{n} ADVMT_i \times E_i \times (1lb/453.59g)$$

where: ADVMT = ADVMT over roadway link;
E_i = emission factor (g/mi); and
n = total number of roadway links in PM_{10} NAA.

The mobile source PM_{10} emissions summary in pounds per day can be found in Table C-1.

[1] Spreadsheet schoolbuses2001.xls. Registration data provided by the Puget Sound Clean Air Agency.

[2] National Transit Database Data Tables. Table titled Age Distribution of Active Revenue Vehicle Inventory: Details by Transit Agency Directly Operated Service. Federal Transit Administration. Data table for 2001. http://www.ntdprogram.com/NTD/ntdhome.nsf/Docs/NTDPublications?OpenDocument.

[3] Local Climatological Data, Monthly Summary." National Oceanic and Atmospheric Administration. Reports for Spokane International Airport, Yakima International Airport, SeaTac International Airport, and Portland International Airport. Individual monthly reports from 1988-1992.

[4] Spreadsheet Rel_hum1.xls. U.S. Environmental Protection Agency. Spreadsheet dated Jan 16, 2002.

[5] Personal conversation with Maureen Mullen, Pechan and Associates (under contract to EPA). 1996 and 1999 winter and summer survey data from the American Automobile Manufacturers' Association. January 4, 2001.