## 3.0 2002 Base Year Inventory

### 3.1 Background and Requirements

The 2002 Base Year Inventory is documented in detail in Appendix B (2002 Base Year Emissions Inventory Document for Washington, DC-MD-VA $PM_{2.5}$ Nonattainment Area) of the $PM_{2.5}$ SIP document. This inventory document was prepared for the District of Columbia, Maryland, and Virginia by the Metropolitan Washington Council of Governments (MWCOG) under the auspices of MWAQC. It is available for inspection along with rest of the $PM_{2.5}$ SIP documents at the offices of the MWCOG and the District of Columbia, Maryland, and Virginia air management agencies in addition to the MWCOG Web site (http://sharepoint.mwcog.org/airquality).

The emissions inventory covers the Washington, DC-MD-VA $PM_{2.5}$ nonattainment area, Figure 1-1, which is classified as a nonattainment area for the annual $PM_{2.5}$ standard by the Environmental Protection Agency (EPA). The 2002 emissions inventory is the baseline for tracking the progress for emissions in future years, such as the attainment year 2009. It also serves as the starting point for calculating the emissions reduction requirement (for man-made sources of emissions) needed to meet the contingency requirements in case the $PM_{2.5}$ standards are not met in the attainment year 2009. Emissions reductions for attainment contingency are required for nonattainment areas by the Clean Air Act Amendments (CAAA) and EPA.

Appendix B (2002 Base Year Emissions Inventory Document for Washington, DC-MD-VA $PM_{2.5}$ Nonattainment Area) of the $PM_{2.5}$ SIP document addresses emissions of $PM_{2.5}$-Direct, oxides of nitrogen ($NO_x$), sulfur dioxide ($SO_2$), volatile organic compounds (VOCs), ammonia ($NH_3$), and $PM_{10}$-Direct on an annual basis. Included in the inventory are anthropogenic (man-made) sources, such as point, area, nonroad, and on-road mobile sources and biogenic (naturally occurring) sources of $PM_{2.5}$ precursors.

The 2002 base year annual inventories for $PM_{2.5}$ Direct, $NO_x$, $SO_2$, VOCs, $NH_3$, and $PM_{10}$ Direct can be seen in Tables 3-1 through 3-6.

**Table 3-1**
**2002 Base Year Annual $PM_{2.5}$-Direct Inventory**
**(tons/year)**

| | District of Columbia | Maryland | Virginia | Total[a] |
|---|---|---|---|---|
| Point | 126.53 | 3,497.31 | 545.71 | 4,169.55 |
| Area | 495.07 | 7,479.48 | 5,692.32 | 13,666.87 |
| Nonroad | 298.71 | 1,007.45 | 1,312.15 | 2,618.31 |
| On-Road | 156.27 | 841.18 | 727.25 | 1,724.70 |
| Biogenics | 0.00 | 0.00 | 0.00 | 0.00 |
| Total[a] | 1,076.58 | 12,825.42 | 8,277.43 | 22,179.44 |

[a] Small discrepancies may result due to rounding.

**Table 3-2**
**2002 Base Year Annual $NO_x$ Inventory**
**(tons/year)**

| | District of Columbia | Maryland | Virginia | Total[a] |
|---|---|---|---|---|
| Point | 1,317.46 | 45,829.43 | 14,195.67 | 61,342.56 |
| Area | 1,694.70 | 5,167.94 | 7,091.38 | 13,954.02 |
| Nonroad | 3,535.64 | 9,972.89 | 13,213.58 | 26,722.11 |
| On-Road | 8,827.37 | 47,640.16 | 41,107.78 | 97,575.31 |
| Biogenics | 25.91 | 430.75 | 301.22 | 757.88 |
| Total[a] | 15,401.08 | 109,041.17 | 75,909.63 | 200,351.88 |

[a] Small discrepancies may result due to rounding.

**Table 3-3**
**2002 Base Year Annual $SO_2$ Inventory**
**(tons/year)**

| | District of Columbia | Maryland | Virginia | Total[a] |
|---|---|---|---|---|
| Point | 2,467.55 | 164,784.06 | 37,400.23 | 204,651.84 |
| Area | 463.44 | 2,375.52 | 9,496.59 | 12,335.56 |
| Nonroad | 376.46 | 894.19 | 1,562.46 | 2,833.10 |
| On-Road | 289.88 | 1,734.88 | 1,515.22 | 3,539.98 |
| Biogenics | 0.00 | 0.00 | 0.00 | 0.00 |
| Total[a] | 3,597.33 | 169,788.65 | 49,974.50 | 223,360.49 |

[a] Small discrepancies may result due to rounding.

**Table 3-4**
**2002 Base Year Annual VOCs Inventory**
**(tons/year)**

| | District of Columbia | Maryland | Virginia | Total[a] |
|---|---|---|---|---|
| Point | 87.76 | 1,112.16 | 701.94 | 1,901.86 |
| Area | 6,313.88 | 31,667.71 | 34,395.80 | 72,377.39 |
| Nonroad | 2,042.83 | 14,224.36 | 14,225.08 | 30,492.27 |
| On-Road | 4,913.24 | 20,495.11 | 18,495.56 | 43,903.91 |
| Biogenics | 2,519.63 | 31,126.70 | 24,906.38 | 58,552.71 |
| Total[a] | 15,877.34 | 98,626.04 | 92,724.76 | 207,228.14 |

[a] Small discrepancies may result due to rounding.

**Table 3-5**
**2002 Base Year Annual $NH_3$ Inventory**
**(tons/year)**

| | District of Columbia | Maryland | Virginia | Total[a] |
|---|---|---|---|---|
| Point | 11.13 | 25.33 | 0.00 | 36.46 |
| Area | 12.59 | 3,113.84 | 543.72 | 3,670.14 |
| Nonroad | 0.00 | 0.00 | 0.00 | 0.00 |
| On-Road | 383.37 | 2,035.19 | 1,827.06 | 4,245.62 |
| Biogenics | 0.00 | 0.00 | 0.00 | 0.00 |
| Total[a] | 407.08 | 5,174.36 | 2,370.78 | 7,952.22 |

[a]Small discrepancies may result due to rounding.

**Table 3-6**
**2002 Base Year Annual $PM_{10}$-Direct Inventory**
**(tons/year)**

| | District of Columbia | Maryland | Virginia | Total[a] |
|---|---|---|---|---|
| Point | 181.56 | 5,208.23 | 997.63 | 6,387.42 |
| Area | 2,680.45 | 23,359.83 | 26,571.31 | 52,611.59 |
| Nonroad | 310.18 | 1,057.65 | 1,380.70 | 2,748.53 |
| On-Road | 223.62 | 1,200.36 | 1,048.21 | 2,472.19 |
| Biogenics | 0.00 | 0.00 | 0.00 | 0.00 |
| Total[a] | 3,395.81 | 30,826.06 | 29,997.85 | 64,219.72 |

[a] Small discrepancies may result due to rounding.

## 3.2 Total Emissions by Source

### 3.2.1 Point Sources

For emissions inventory purposes, point sources are defined as stationary, commercial, or industrial operations that emit more than 10 tons/year. The point source inventory consists of actual emissions for the base year 2002 and includes sources within the geographical area of the Washington, DC-MD-VA $PM_{2.5}$ nonattainment area. The states of Maryland and Virginia and the District of Columbia are responsible for compiling and submitting point source emission estimates.

In 2002, the State of Maryland also included all types of Andrews Air Force Base (AFB) emissions in their point source emissions. These sources are called quasi-point source emissions.

### 3.2.2 Area Sources

Area sources are sources of emissions that are too small to be inventoried individually and that collectively contribute significant emissions. Area sources include smaller stationary point sources not included in the states' point source inventories such as printing establishments, dry cleaners, and auto-refinishing companies as well as nonstationary sources such as evaporative emissions during transport of petroleum tank trucks and portable fuel containers.

Area source emissions typically are estimated by multiplying an emission factor by some known indicator of collective activity for each source category at the county level. An activity level is any parameter associated with the activity of a source, such as production rate or fuel consumption that may be correlated with the air pollutant emissions from that source. For example, the total amount of VOC emissions emitted by commercial aircraft can be calculated by multiplying the number of landing and takeoff cycles (LTOs) by an EPA-approved emission factor per LTO cycle for each specific aircraft type.

Several approaches are available for estimating area source activity levels and emissions. These include apportioning statewide activity totals to the local inventory area and using emissions per employee (or other unit) factors. For example, solvent evaporation from consumer and commercial products such as waxes, aerosol products, and window cleaners cannot be routinely determined for many local sources. The per capita emission factor assumes that emissions in a given area can be reasonably associated with population. This assumption is valid over broad areas for certain activities such as dry cleaning and small degreasing operations. For some other sources an employment-based factor is more appropriate as an activity surrogate.

### 3.2.3 Onroad Mobile Sources

Motor vehicles constitute onroad mobile sources. Emissions from mobile sources were derived from the use of the National Capital Region Transportation Planning Board (TPB) travel demand forecasting procedure, which simulates vehicle travel across the region's transportation system. Travel was simulated on all highways in the region, including both volume and speed of travel for each hour of the day. An EPA emissions model, MOBILE 6.2.03, was used to determine the emissions characteristics of the vehicle fleet in place in the year 2002. Input for this emissions model includes locally specific information such as age distribution of registered vehicles,

evaporation characteristics of motor fuel, and temperature data. The general equation for the estimation of mobile sources is

**Emissions = (Travel Component) x (Emission Factor).**

**Emissions accounted for in the mobile source inventory include**

| | |
|---|---|
| Origin: | Emissions include "cold start" and "hot start" emissions occurring during the first few minutes of vehicle operation. |
| Running: | Emissions occurring on local streets and on the region's network of arterial streets, freeways, and nonramp freeways. |
| Running Loss: | Emissions due to the heating of fuel and fuel lines. |
| Crankcase: | Emissions due to blow-by. |
| Destination: | Evaporative or "hot soak" emissions occurring at the conclusion of a vehicle trip after the engine is turned off. |
| Diurnal: | Evaporative emissions occurring when the vehicle is at rest due to temperature fluctuations. |
| Resting Loss: | Emissions due to the permeation of fuel through hoses and fittings. |
| Auto Access: | Emissions attributable to auto trips to Metrorail stations or to park-and-ride lots. |
| Bus: | Bus emissions, i.e., Metrobus, Ride-on, etc. |

### 3.2.4 Nonroad Mobile Sources

Emissions for all nonroad vehicles and engines except airport [aircraft, ground support equipment (GSE), and auxiliary power units (APUs)], locomotives, and diesel marine vessels were calculated using EPA's NONROAD2005 model version 2005a (February 8, 2006). This model was run with its associated graphic user interface NONROAD2005.1.0 (June 12, 2006), reporting utility version 2005c (March 21, 2006), and all geographical allocation data files updated until February 1, 2006.

Emissions from the "nonroad vehicles and engines" category result from the use of fuel in a diverse collection of vehicles and equipment, including vehicles and equipment in the following categories:

- Recreational vehicles, such as all-terrain vehicles and off-road motorcycles;
- Logging equipment, such as chain saws;
- Agricultural equipment, such as tractors;
- Construction equipment, such as graders and back hoes;
- Industrial equipment, such as fork lifts and sweepers;
- Residential and commercial lawn and garden equipment, such as leaf and snow blowers; and
- Aircraft ground support equipment.

The nonroad model estimates emissions for each specific type of nonroad equipment by multiplying the following input data estimates:

- Equipment population for base year (or base year population grown to a future year), distributed by age, power, fuel type, and application;

• Average load factor expressed as average fraction of available power;
• Available power in horsepower;
• Activity in hours of use per year; and
• Emission factor with deterioration and/or new standards.

The emissions are then temporally and geographically allocated using appropriate allocation factors.

Aircraft (military, commercial, general aviation, and air taxi) and auxiliary power units (APU) operated at airports along with locomotives and diesel marine vessels are also considered nonroad sources and are included in the nonroad category.

Metropolitan Washington Airports Authority (MWAA) provided all types of airport emissions for Dulles (Fairfax and Loudoun) and Reagan National (Arlington) airports, which are documented in *Air Pollution Emission Inventories for Washington Dulles International Airport and Ronald Reagan Washington National Airport for Calendar Years 2002, 2008, 2009*[1] (see Attachment B4 of the 2002 Base Year Inventory document). Nonroad model-generated ground support equipment emissions for Loudoun and Arlington counties were replaced by emissions provided by MWAA. While MWAA GSE emissions for Dulles airport were equally divided between Fairfax and Loudoun counties, Reagan National emissions were put into Arlington County. Aircraft and APU emissions for other counties were provided by the respective states. Emissions from locomotives and commercial diesel marine vessels were also provided by the states.

### 3.2.5 Biogenic Sources

An important component of the inventory is biogenic emissions. Biogenic emissions are those resulting from natural sources. Biogenic emissions are primarily VOCs that are released from vegetation throughout the day. Biogenic emissions of $NO_x$ include lightning and forest fires. EPA used a biogenic computer model (BEIS3.12) to estimate biogenic emissions for each county in the country for all 12 months of the year 2002. Emissions data for Washington, DC $PM_{2.5}$ nonattainment-area counties were acquired from the EPA Web site (ftp://ftp.epa.gov/EmisInventory/2002finalnei/biogenic_sector_data/). EPA has recommended that states use these emissions in case they do not have their own estimated biogenic emissions. The Washington, DC-MD-VA $PM_{2.5}$ nonattainment area decided to use the inventories provided by the EPA.

## 3.3 Annual Inventories

The 2002 base year inventories for $PM_{2.5}$-Direct, $NO_x$, $SO_2$, VOCs, $NH_3$, and $PM_{10}$-Direct in Tables 3-1 through 3-6 are for the annual emissions. A summary of the annual inventories for $PM_{2.5}$ Direct, $NO_x$, $SO_2$, VOCs, $NH_3$, and $PM_{10}$ Direct is also found in Table 1-1 of Appendix B.

[1] Metropolitan Washington Airports Authority, *Air Pollution Emission Inventories for Washington Dulles International Airport and Ronald Reagan Washington National Airport for Calendar Years 2002, 2008, 2009,* prepared by URS Corporation, Washington, DC., March 2006.