SECTION 5

ON-ROAD MOBILE SOURCES

The 2002 on-road mobile source inventory is an estimate of vehicle emissions based on actual vehicle miles traveled (VMT) on Delaware roadways in 2002 combined with emission factors developed through the use of EPA's MOBILE6.2 model. Vehicles include passenger cars, light-duty trucks, including sport utility vehicles, heavy-duty trucks, buses, and motorcycles. Emissions were calculated for vehicles fueled by gasoline or diesel. Controls as of 2002 were incorporated into the MOBILE6.2 model inputs, and thus emission factors account for controls. Engine exhaust emissions for all criteria pollutants and a number of air toxics were calculated. In addition, VOC evaporative emissions were separately calculated. Annual emissions were calculated by roadway class, vehicle type, and county.

The applicable Standard Classification Codes (SCCs) comprising vehicle type, roadway class, and emission process (exhaust or evaporative) are shown in Table 5-1. As an example, the SCC applicable to exhaust emissions from a passenger car fueled by gasoline on an urban interstate would be 220100123X, with the "2201001" indicating that the vehicle is a light-duty gasoline vehicle, the "23" indicating the activity is occurring on an urban interstate, and the "X" indicating that the emissions are exhaust emissions.

Table 5-1. SCCs Included in On-road Mobile Inventory

SCC Digits	Applicable Portion of SCC Code	Portion that SCC Describes	Description
1 - 7	2201001	Vehicle type	Light-duty gasoline vehicles (passenger cars)
1 - 7	2201020	Vehicle type	Light-duty gasoline trucks 1 (0-6,000 lb gross vehicle weight rating [GVWR])
1 - 7	2201040	Vehicle type	Light-duty gasoline trucks 2 (6,001-8,500 lb GVWR)
1 - 7	2201070	Vehicle type	Heavy-duty gasoline vehicles (> 8,500 lb GVWR)
1 - 7	2201080	Vehicle type	Motorcycles (gasoline)
1 - 7	2230001	Vehicle type	Light-duty diesel vehicles (passenger cars)
1 - 7	2230060	Vehicle type	Light-duty diesel trucks (0-8,500 lb GVWR)
1 - 7	2230071	Vehicle type	Class 2b heavy-duty diesel vehicles (8,501-10,000 lb GVWR)
1 - 7	2230072	Vehicle type	Class 3, 4, and 5 heavy-duty diesel vehicles (10,001-19,500 lb GVWR)
1 - 7	2230073	Vehicle type	Class 6 and 7 heavy-duty diesel vehicles (19,501-33,000 lb GVWR)
1 - 7	2230074	Vehicle type	Class 8 heavy-duty diesel vehicles (> 33,000 lb GVWR)
1 - 7	2230075	Vehicle type	Diesel buses
8 - 9	11	Roadway type	Rural interstates
8 - 9	13	Roadway type	Rural other principal arterials
8 - 9	15	Roadway type	Rural minor arterials
8 - 9	17	Roadway type	Rural major collectors
8 - 9	19	Roadway type	Rural minor collectors
8 - 9	21	Roadway type	Rural locals

Continued next page

Table 5-1. continued

SCC Digits	Applicable Portion of SCC Code	Portion that SCC Describes	Description
8 - 9	23	Roadway type	Urban interstates
8 - 9	25	Roadway type	Urban other freeways and expressways
8 - 9	27	Roadway type	Urban other principal arterials
8 - 9	29	Roadway type	Urban minor arterials
8 - 9	31	Roadway type	Urban collectors
8 - 9	33	Roadway type	Urban locals
10	X	Emission process	Exhaust
10	V	Emission process	Evaporative
10	B	Emission process	Brake wear
10	T	Emission process	Tire wear

5.1 Activity Data

The activity data used for developing the on-road emission inventory is VMT. The Delaware Department of Transportation (DelDOT) provided 2002 link-level VMT data for each county in Delaware. The link-level VMT data file includes a link identifier, a roadway type classification code, link distance, average daily speed on the link, link volume, and daily VMT on the link. The VMT data were not provided by vehicle class. VMT by vehicle type was developed using Delaware registration data and EPA mileage accumulation rates (refer to Section 5.2.7 for more details on this method.) In developing VMT by vehicle type, the VMT from each link was split into 28 records, according to the fraction of VMT for each vehicle type. VMT by vehicle type, county, roadway class, and speed were used to match each link-level VMT record to the corresponding emission factors developed through MOBILE6.2.

5.1.1 Estimating County-level VMT Using HPMS Data

DelDOT is required to submit calendar year VMT data annually to the Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS). The VMT is estimated based on data from 40 permanent traffic count stations throughout the state. DelDOT's traffic count program provides daily and seasonal variation data. Additional temporary stations provide shorter-term counts that are expanded with factors derived from appropriate permanent count stations. Counting and expansion activities are consistent with FHWA guidelines. The traffic data submitted to HPMS are considered the most accurate VMT totals for each county. The permanent count station data are provided in the supporting documentation contained on the CD accompanying this report.

5.1.2 Estimating Link-level VMT Using Travel Demand Models

To accurately represent VMT across all roadway links within the statewide transportation network, DelDOT used two network-based travel demand models (TDMs) to estimate VMT by functional classification (i.e., roadway type.) DelDOT has developed and maintained regional TDMs that, when combined, amount to a statewide model. The New Castle County (NCC) model covers approximately the northern one-third of the state. The downstate model is

comprised of Kent and Sussex Counties (KSC). Both models are similar in content and procedure, with some variation in basic makeup.

Rather than relying solely on the HPMS data, the network models were selected to develop VMT estimates by functional classification to account for variations in travel according to purpose; to account for various movements such as internal, internal-external, and external travel; and to account for travel by auto and truck. The models are calibrated to the same traffic count base used to develop the HPMS VMT estimates. In addition, the models were validated and calibrated with 2002 population and other household data. Finally, total network model VMT was factored to be consistent with county-based HPMS VMT.

5.2 Emission Factor Development

The EPA MOBILE6.2 model was used to develop 2002 county-level emission factors by roadway class, speed, and vehicle type for each county in Delaware (EPA, 2003). The emission factors were developed on a monthly basis, using monthly temperature and fuel property data. Emissions were then calculated by applying the appropriate emission factors to link-level VMT data. Link-level data were then aggregated to the county level for each vehicle type and roadway class.

In order to use MOBILE6.2 to calculate on-road emission factors, a number of local input parameters were prepared. Some of these are required parameters, while others are optional. The Delaware-specific inputs that were used in the on-road modeling included: monthly temperature data by county, fuel data parameters by county and month, vehicle age distributions by county and vehicle type, vehicle speed distributions, inspection and maintenance (I/M) and anti-tampering program (ATP) parameters, and vehicle mix by vehicle type. Each of these input data sets are discussed separately below.

5.2.1 Temperature Data

Each scenario within the MOBILE6.2 input files was set up to be representative of conditions occurring within a specific month or season in 2002. Data on the average daily minimum and maximum temperatures for each month were obtained from the National Climatic Data Center (NCDC, 2003). One temperature data station was selected for each county in Delaware. For each of these temperature stations, this temperature database contained hourly temperatures for each day of the year in 2002. From these data, the maximum and minimum temperature for each day of the year at each station were first determined. Then, the average of the maximum daily temperature values was determined for each month by summing the maximum daily temperatures for each day in the month and then dividing by the number of days in the month. The same procedure was applied to determine the average minimum daily temperature for each month. The temperature data stations and the resulting average minimum and maximum daily temperatures by month are shown in Table 5-2.

5.2.2 Fuel Data

The entire State receives Federal reformulated gasoline. However, the fuel parameters vary seasonally as well as by county, based on information from EPA's Reformulated Gasoline Fuel Survey. This survey reports in-use gasoline parameters during winter (January) and summer

(July). Delaware is well-represented in this survey, as the Philadelphia, PA-Wilmington, DE-Trenton, NJ area is one of the surveyed areas, as is Sussex County, Delaware. Thus, it was felt that the parameters obtained from this study could be directly applied for use in the Delaware inventory. It should be noted that the survey data were actually obtained in 2000, but DNREC does not expect there will be any significant differences between 2000 and 2002 fuel parameters.

Table 5-2. Average 2002 Maximum and Minimum Daily Temperatures (^{o}F) by Month and County

County	Kent	Kent	New Castle	New Castle	Sussex	Sussex
Station	Dover AFB	Dover AFB	Wilmington	Wilmington	Salisbury Airport	Salisbury Airport
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
January	30.7	45.9	30.5	45.5	29.7	49.2
February	31.3	50.4	29.9	48.9	26.3	52.1
March	36.2	55.3	35.1	53.2	35.4	56.7
April	46.1	65.7	45.9	65.6	44.7	67.8
May	51.1	71.0	51.2	71.1	48.0	74.0
June	62.8	80.5	62.8	80.8	58.5	83.5
July	67.3	86.6	68.2	86.9	63.5	88.2
August	68.5	86.7	68.3	86.7	64.4	87.3
September	60.4	77.2	59.5	78.9	58.1	79.7
October	49.6	63.1	48.4	62.7	49.5	66.4
November	38.0	53.5	35.7	51.7	35.7	55.8
December	27.4	42.9	27.6	41.2	26.8	45.9

Source: National Climatic Data Center, 2003.

The summer fuel data were applied to the ozone season months of May through September. Fuel parameters for the remaining months were calculated from the January and July fuel parameter values using the interpolation method developed by EPA's Office of Transportation and Air Quality for use in preparing a national fuel parameter database to populate its National Mobile Inventory Model (ERG, 2003). First, a monthly interpolation factor was calculated from the January and July survey Reid Vapor Pressure (RVP) values as well as the American Society for Testing and Materials (ASTM) monthly schedule of geographical volatility class assigned to each State. The volatility class ranges from class A to class E. An RVP limit was assigned to each of these volatility classes, based on the MOBILE4 User's Guide list of the RVP limits that correspond to each ASTM class (EPA, 1989). These RVP limits are as follows:

- ASTM class A = 9.0 pounds per square inch (psi)
- ASTM class B = 10.0 psi
- ASTM class C = 11.5 psi
- ASTM class D = 13.5 psi
- ASTM class E = 15.0 psi

The monthly interpolation factor was then calculated using the equation below:

$$MIF = (IA - SA) / (WA - SA)$$

where: MIF = Monthly Interpolation Factor (unitless)
IA = Intermediate month's (not January or July) ASTM RVP limit, as listed

above by class based on the monthly ASTM class (psi)
WA = Winter (January) ASTM RVP limit (psi)
SA = Summer (July) ASTM RVP limit (psi)

After the monthly interpolation factor was calculated for each month and county, all of the necessary fuel parameters were then interpolated using this monthly interpolation factor along with the county-specific January and July values for that parameter using the following equation:

$$MFP = SFP + MIF * (WFP - SFP)$$

where: MFP = Monthly Fuel Parameter (e.g., RVP, sulfur content, etc.)
SFP = Summer (July) fuel parameter
MIF = Monthly Interpolation Factor (as calculated in previous equation)
WFP = Winter (January) fuel parameter

The resulting fuel parameters for Delaware are shown by month in Table 5-3. The MOBILE6.2 input files were set up to represent the fuel parameters occurring each month in each county in Delaware.

The diesel sulfur content is a required fuel parameter when modeling particulates. The current national diesel sulfur limit in 2002 was 500 parts per million (ppm). Based on Alliance survey data provided by EPA, the summer average sulfur content of No. 2 diesel fuel in the Philadelphia area in 2002 is 360 ppm in the summer and 310 ppm in the winter. Of the survey cities included in this study, Philadelphia is expected to be the most representative of conditions in Delaware. This summer value of 360 ppm was applied in June, July, and August. The winter value of 310 ppm was applied in January, February, and December. For the remaining spring and fall months, the average of these two values, 335 ppm, was modeled. It should be noted that in the winter, all of the surveyed cities had average diesel sulfur values below 400 ppm. In the summer survey, Kansas City and Atlanta had the highest average sulfur values of 410 ppm. These data suggest that using the diesel sulfur limit of 500 ppm would likely be an overestimation of the in-use diesel sulfur contents.

Table 5-3. 2002 Monthly Gasoline Fuel Parameters

County	Months	Reid Vapor Pressure (psi)	Sulfur Content (ppm)
Kent/New Castle	Jan - Feb, Dec	13.41	174
Kent/New Castle	Mar - Apr, Oct - Nov	10.56	155
Kent/New Castle	May - Sep	6.76	130
Sussex	Jan - Feb, Dec	13.41	225
Sussex	Mar - Apr, Oct - Nov	10.42	186
Sussex	May - Sep	6.43	134

Source: EPA Reformulated Gasoline Survey, 2000.

5.2.3 Vehicle Age Distributions

Vehicle registration data were obtained from the Delaware Division of Motor Vehicles (DMV) for each of the three counties in Delaware. The data are a snapshot of DMV's registration database as of July 1, 2002. The data show the number of vehicles registered by model year for

the 16 MOBILE6.2 vehicle classes for which registration distributions can be provided. The raw registration data provide information on the combined light-duty truck (LDT) 1 and 2 classes and the combined LDT 3 and 4 classes. These registrations were then split out into the four separate LDT classes using EPA's national average vehicle counts by model year for these four truck classes. EPA's distributions between the LDT1 and LDT2 classes by model year were applied to the combined LDT 1 and 2 registration data to separate the registration data into the LDT1 and LDT2 vehicle classes. The combined LDT3 and LDT4 registration data were similarly split.

5.2.4 Vehicle Speeds

The link-level VMT files included an average daily speed associated with each road link. For the MOBILE6.2 modeling, the speed data were converted to MOBILE6.2 speed distribution files for each county and roadway class. Each of these speed distribution files provides the fraction of VMT that occurs in each of 14 speed bins, with the bins representing 5 mile per hour (mph) increments. To accomplish this, each record in the link-level VMT database was identified according to which of the 14 speed bins that link's speed fell into. The VMT data for each county and roadway class were then totaled by speed bin, and the fractional amount of each county/roadway type's VMT falling into each bin was calculated. These data were then converted to the appropriate format required by the MOBILE6.2 "SPEED VMT" command. Although the "SPEED VMT" distributions must be entered for each hour, hourly VMT and speed data were not available for Delaware. Therefore, the same daily data were entered into each of the 24 hourly records in the SPEED VMT distributions.

Table 5-4 summarizes the resulting speed distribution files used in the MOBILE6.2 modeling by HPMS roadway class. This table includes a column labeled "MOBILE Road Type." The assignment of each of the HPMS roadway classes to one of these MOBILE model road types (freeway, arterial, or local) was based on the default assignment used by EPA in the NEI. The MOBILE6.2 road type listed in this table that corresponds to a given speed distribution was assigned 100 percent of the VMT in a given scenario. For example, in the Kent County MOBILE6.2 input file, all of the VMT in scenarios representing rural interstates would be modeled with 100 percent of the VMT assigned to the MOBILE6 interstate road type, with the VMT distribution by speed provided in the file KC_R2SV.SPD. For the MOBILE6.2 local road type, the model assumes an average speed of 12.9 mph, and no speed-based emission adjustments are made within MOBILE6.2 for local roads. Therefore, no speed distributions are assigned to the scenarios modeling urban local roadways. The speed distribution files can be found in the supporting documentation contained on the accompanying CD.

5.2.5 Inspection and Maintenance (I/M) and Anti-tampering Programs

Delaware's vehicle I/M and ATP programs were modeled using the I/M program and ATP inputs provided by AQMS. However, the I/M programs for Kent and New Castle Counties indicated that a biennial onboard diagnostic testing program began in 2002 for 1996 and later model year vehicles. Since this is a biennial program, only about half of these vehicles will receive credit for being tested in 2002. Thus, an additional test was added for these vehicles. The 2500/idle test was applied to these model year vehicles through 2001. Adding this additional test enabled these vehicles to get the necessary credit for having been tested previously. The Kent County I/M program parameters are shown in Table 5-5 and the New Castle County I/M program parameters are shown in Table 5-6. The Sussex County I/M program includes only an idle test.

This program is described in Table 5-7. Both Kent and New Castle Counties have the same ATP. This program is shown in Table 5-8. The input indicating the last model year affected by this program was adjusted to account for a five-year grace period applied to new vehicles. Sussex County did not have an ATP in 2002. Starting in 2003, Delaware began requiring on-board diagnostic (OBD II) testing of 1997 and newer diesel-fueled light-duty vehicles and trucks. This would not affect emissions in 2002, though, since this testing did not begin until 2003.

Table 5-4. Summary of Modeling Parameters by Roadway Class

County	Road Type Portion of SCC	HPMS Roadway Class	MOBILE6 Road Type	Speed Distribution File Name
Kent	110	Rural Interstate	Freeway	KC_R2SV.SPD
	130	Rural Other Principal Arterial	Arterial	KC_R3SV.SPD
	150	Rural Minor Arterial	Arterial	KC_R4SV.SPD
	170	Rural Major Collector	Arterial	KC_R5SV.SPD
	190	Rural Minor Collector	Arterial	KC_R6SV.SPD
	210	Rural Local	Arterial	KC_R7SV.SPD
	250	Urban Other Freeway & Expressway	Freeway	KC_U2SV.SPD
	270	Urban Other Principal Arterial	Arterial	KC_U3SV.SPD
	290	Urban Minor Arterial	Arterial	KC_U4SV.SPD
	310	Urban Collector	Arterial	KC_U5SV.SPD
	330	Urban Local	Local	Not Applicable
New Castle	130	Rural Other Principal Arterial	Arterial	NC_R3SV.SPD
	150	Rural Minor Arterial	Arterial	NC_R4SV.SPD
	170	Rural Major Collector	Arterial	NC_R5SV.SPD
	190	Rural Minor Collector	Arterial	NC_R6SV.SPD
	210	Rural Local	Arterial	NC_R7SV.SPD
	230	Urban Interstate	Freeway	NC_U1SV.SPD
	250	Urban Other Freeway & Expressway	Freeway	NC_U2SV.SPD
	270	Urban Other Principal Arterial	Arterial	NC_U3SV.SPD
	290	Urban Minor Arterial	Arterial	NC_U4SV.SPD
	310	Urban Collector	Arterial	NC_U5SV.SPD
	330	Urban Local	Local	Not Applicable
Sussex	130	Rural Other Principal Arterial	Arterial	SC_R3SV.SPD
	150	Rural Minor Arterial	Arterial	SC_R4SV.SPD
	170	Rural Major Collector	Arterial	SC_R5SV.SPD
	190	Rural Minor Collector	Arterial	SC_R6SV.SPD
	210	Rural Local	Arterial	SC_R7SV.SPD
	270	Urban Other Principal Arterial	Arterial	SC_U3SV.SPD
	290	Urban Minor Arterial	Arterial	SC_U4SV.SPD
	310	Urban Collector	Arterial	SC_U5SV.SPD
	330	Urban Local	Local	Not Applicable

Table 5-5. Kent County I/M Program Parameters

Test Type	2500/IDLE	FP & GC	OBD I/M	2500/IDLE
I/M Program Years	1991-2050	1995-2050	2002-2050	1991-2001
Test Frequency	Biennial	Biennial	Biennial	Biennial
Program Type	T/O	T/O	T/O	T/O
Model Years	1968-1995	1975-1995	1996-2050	1996-2050
Stringency Rate (%)	20	20	20	20
Compliance Rate (%)	96	96	96	96
Waiver Rate (%)	3	0	3	3
Grace Period (years)			5	5
Vehicles Tested				
LDGV	Yes	Yes	Yes	Yes
LDGT1	Yes	Yes	Yes	Yes
LDGT2	Yes	Yes	Yes	Yes
LDGT3	Yes	Yes	Yes	Yes
LDGT4	Yes	Yes	Yes	Yes
HDGV2B	No	No	No	No
HDGV3	No	No	No	No
HDGV4	No	No	No	No
HDGV5	No	No	No	No
HDGV6	No	No	No	No
HDGV7	No	No	No	No
HDGV8A	No	No	No	No
HDGV8B	No	No	No	No
GAS BUS	No	No	No	No

Table 5-6. New Castle County I/M Program Parameters

Test Type	2500/IDLE	FP & GC	OBD I/M	2500/IDLE
I/M Program Years	1983-2050	1995-2050	2002-2050	1983-2001
Test Frequency	Biennial	Biennial	Biennial	Biennial
Program Type	T/O	T/O	T/O	T/O
Model Years	1981-1995	1975-1995	1996-2050	1996-2050
Stringency Rate (%)	20	20	20	20
Compliance Rate (%)	96	96	96	96
Waiver Rate (%)	3	0	3	3
Grace Period (years)			5	5
Vehicles Tested				
LDGV	Yes	Yes	Yes	Yes
LDGT1	Yes	Yes	Yes	Yes
LDGT2	Yes	Yes	Yes	Yes
LDGT3	Yes	Yes	Yes	Yes
LDGT4	Yes	Yes	Yes	Yes
HDGV2B	No	No	No	No
HDGV3	No	No	No	No
HDGV4	No	No	No	No

Continued next page

Table 5-6. continued

HDGV5	No	No	No	No
HDGV6	No	No	No	No
HDGV7	No	No	No	No
HDGV8A	No	No	No	No
HDGV8B	No	No	No	No
GAS BUS	No	No	No	No

Table 5-7. Sussex County I/M Program Parameters

Test Type	IDLE
I/M Program Years	1991-2050
Test Frequency	Biennial
Program Type	T/O
Model Years	1968-2002
Stringency Rate (%)	20
Compliance Rate (%)	96
Waiver Rate (%)	3
Grace Period (years)	5
Vehicles Tested	
LDGV	Yes
LDGT1	Yes
LDGT2	Yes
LDGT3	Yes
LDGT4	Yes
HDGV2B	No
HDGV3	No
HDGV4	No
HDGV5	No
HDGV6	No
HDGV7	No
HDGV8A	No
HDGV8B	No
GAS BUS	No

Table 5-8. 2002 Anti-Tampering Program Parameters - Kent and New Castle

Program Start Year	1995
First Model Year	1975
Last Model Year	1997
Program Type	Test Only
Inspection Frequency	Biennial
Compliance Rate (%)	96
Vehicle Types	
LDGV	Yes

Continued next page

Table 5-8. continued

LDGT1	Yes
LDGT2	Yes
LDGT3	Yes
LDGT4	Yes
HDGV2B	No
HDGV3	No
HDGV4	No
HDGV5	No
HDGV6	No
HDGV7	No
HDGV8A	No
HDGV8B	No
GAS BUS	No
Inspections Performed	
Air pump system disablement	No
Catalyst removal	Yes
Fuel inlet restrictor disablement	Yes
Tailpipe lead deposit test	No
EGR disablement	No
Evaporative system disablement	No
PCV system disablement	No
Missing gas cap	Yes

5.2.6 Northeast Ozone Transport Region Low Emission Vehicle Program

Delaware belongs to the Northeast Ozone Transport Region (OTR). The States in this region have adopted a low-emission vehicle (LEV) program that began with the 1999 model year. The National LEV program, which began with the 2001 model year, is the default modeled in MOBILE6.2. Therefore, to correctly model the Northeast Ozone Transport Region LEV program in place in Delaware, the "94+ LDG IMP" command was used in the MOBILE6.2 input files. The phase-in schedule of the Northeast Ozone Transport Region LEV program is shown in Table 5-9. This phase-in schedule was applied to the MOBILE6.2 LDGV, LDGT1, and LDGT2 vehicle categories.

Table 5-9. LEV Implementation Schedule in the Northeast OTR

Model Year	Federal Tier I Standards	Transitional LEV Standards	LEV Standards	Tier 2 Standards
1999	30%	40%	30%	
2000		40%	60%	
2001 - 2003			100%	
2004 and later				100%

5.2.7 VMT Mix by Vehicle Type

VMT mix data are not collected in Delaware, so an alternate procedure was developed using the local registration data in calculating the VMT mixes rather than using the default MOBILE6.2 VMT distribution by vehicle type. This methodology uses national default MOBILE6.2 mileage accumulation and diesel sales fraction data in combination with the Delaware county-specific registration data to develop estimates of VMT by vehicle type. The number of vehicles registered in Delaware by model year, vehicle type, and county was multiplied first by the MOBILE6.2 default gasoline or diesel sales fraction corresponding to that vehicle type and model year, and then by the average number of miles accumulated annually by vehicles of the same age and vehicle type in the MOBILE6.2 default mileage accumulation database. This provided an estimate of VMT by vehicle age and vehicle type for each county. These VMT estimates were then summed over all years by vehicle type. The total VMT for each vehicle type was divided by the total calculated VMT to give VMT fractions by vehicle type. Table 5-10 reports the resulting VMT mixes by vehicle type for each county.

Table 5-10. County-Specific VMT Mixes by Vehicle Type

Vehicle Type	Vehicle Description	VMT Fraction by Vehicle Type		
		Kent County	New Castle County	Sussex County
LDV	Light Duty Vehicles (Passenger Cars)	0.4567	0.5266	0.4441
LDT1	Light-Duty Trucks 1 (0-6,000 lbs GVWR, 0-3,750 lbs LVW)	0.0651	0.0642	0.0709
LDT2	Light-Duty Trucks 2 (0-6,000 lbs GVWR, 3,751-5,750 lbs LVW)	0.2165	0.2136	0.2357
LDT3	Light-Duty Trucks 3 (6,001-8,500 lbs GVWR, 0-5,750 lbs ALVW)	0.0853	0.0702	0.0957
LDT4	Light-Duty Trucks 4 (6,000-8,500 lbs GVWR, >5,750 lbs ALVW)	0.0397	0.0327	0.0445
HDV2B	Class 2b Heavy-Duty Vehicles (8,501-10,000 lbs GVWR)	0.0371	0.0282	0.0338
HDV3	Class 3 Heavy-Duty Vehicles (10,001-14,000 lbs GVWR)	0.0099	0.0064	0.0099
HDV4	Class 4 Heavy-Duty Vehicles (14,001-16,000 lbs GVWR)	0.0053	0.0060	0.0052
HDV5	Class 5 Heavy-Duty Vehicles (16,001-19,500 lbs GVWR)	0.0016	0.0014	0.0020
HDV6	Class 6 Heavy-Duty Vehicles (19,501-26,000 lbs GVWR)	0.0042	0.0096	0.0035
HDV7	Class 7 Heavy-Duty Vehicles (26,001-33,000 lbs GVWR)	0.0066	0.0049	0.0061
HDV8A	Class 8a Heavy-Duty Vehicles (33,001-60,000 lbs GVWR)	0.0303	0.0113	0.0198
HDV8B	Class 8b Heavy-Duty Vehicles (>60,000 lbs GVWR)	0.0215	0.0155	0.0178
HDBS	School Buses	0.0031	0.0016	0.0022
HDBT	Transit and Urban Buses	0.0113	0.0033	0.0038
MC	Motorcycles	0.0059	0.0046	0.0050
Total		**1.0000**	**1.0000**	**1.0000**

5.3 Preparation of MOBILE6.2 Input Files

The input data described above were combined into MOBILE6.2 input files for each county. The input files were set up to model the 12 monthly scenarios for each roadway class present in each county. The input files can be found in the supporting documentation contained on the accompanying CD.

5.4 Controls

All on-road control measures known to be in place in Delaware in 2002 were included in the MOBILE6.2 emission factor modeling. Local control programs include Delaware's I/M program and ATP, the Federal reformulated gasoline program, and the Northeast Ozone Transport Region LEV program. The MOBILE6.2 modeling also includes all national control programs, such as the Tier 1 emission standards. Therefore, no additional control factors were applied to the on-road emissions.

5.5 Temporal Allocation of VMT Data

The emission factors generated are month-specific because the input temperature and fuel data represent monthly conditions. The average daily VMT data were first multiplied by 365 to obtain annual VMT at the link level. The annual VMT data were then allocated by month using data provided by DelDOT from 2002 permanent counter stations. These data, provided separately for each of the three counties, include monthly adjustment factors applicable on a variety of roads across each county. These data were used to determine a single set of monthly temporal allocation factors to be applied to each roadway class in each county. The annual VMT were multiplied by each of the corresponding monthly temporal factors for the appropriate roadway type to obtain monthly VMT. The monthly VMT temporal adjustment factors are shown in Tables 5-11 through 5-13.

Table 5-11. Kent County Temporal Adjustment Factors by Roadway Class

Road Type SCC	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
110	0.0597	0.0658	0.0707	0.0773	0.0714	0.1043	0.1167	0.1165	0.0918	0.0784	0.0757	0.0717
130	0.0597	0.0658	0.0707	0.0773	0.0714	0.1043	0.1167	0.1165	0.0918	0.0784	0.0757	0.0717
150	0.0768	0.0836	0.0837	0.0860	0.0860	0.0856	0.0846	0.0860	0.0852	0.0805	0.0798	0.0822
170	0.0752	0.0796	0.0813	0.0839	0.0877	0.0914	0.0896	0.0845	0.0846	0.0839	0.0804	0.0779
190	0.0752	0.0796	0.0813	0.0839	0.0877	0.0914	0.0896	0.0845	0.0846	0.0839	0.0804	0.0779
210	0.0752	0.0796	0.0813	0.0839	0.0877	0.0914	0.0896	0.0845	0.0846	0.0839	0.0804	0.0779
230	0.0597	0.0658	0.0707	0.0773	0.0714	0.1043	0.1167	0.1165	0.0918	0.0784	0.0757	0.0717
250	0.0597	0.0658	0.0707	0.0773	0.0714	0.1043	0.1167	0.1165	0.0918	0.0784	0.0757	0.0717
270	0.0597	0.0658	0.0707	0.0773	0.0714	0.1043	0.1167	0.1165	0.0918	0.0784	0.0757	0.0717
290	0.0768	0.0836	0.0837	0.0860	0.0860	0.0856	0.0846	0.0860	0.0852	0.0805	0.0798	0.0822
310	0.0752	0.0796	0.0813	0.0839	0.0877	0.0914	0.0896	0.0845	0.0846	0.0839	0.0804	0.0779
330	0.0752	0.0796	0.0813	0.0839	0.0877	0.0914	0.0896	0.0845	0.0846	0.0839	0.0804	0.0779

Table 5-12. New Castle County Temporal Adjustment Factors by Roadway Class

Road Type SCC	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
110	0.0712	0.0769	0.0820	0.0843	0.0866	0.0892	0.0920	0.0957	0.0826	0.0800	0.0814	0.0781
130	0.0715	0.0761	0.0796	0.0862	0.0920	0.0933	0.0908	0.0861	0.0842	0.0826	0.0801	0.0775
150	0.0670	0.0734	0.0769	0.0813	0.0879	0.0947	0.0986	0.1001	0.0888	0.0815	0.0768	0.0730
170	0.0645	0.0708	0.0750	0.0871	0.0983	0.1012	0.1080	0.0930	0.0917	0.0772	0.0709	0.0623
190	0.0645	0.0708	0.0750	0.0871	0.0983	0.1012	0.1080	0.0930	0.0917	0.0772	0.0709	0.0623
210	0.0662	0.0749	0.0787	0.0833	0.0877	0.0879	0.0862	0.0896	0.0930	0.0906	0.0821	0.0798
230	0.0712	0.0769	0.0820	0.0843	0.0866	0.0892	0.0920	0.0957	0.0826	0.0800	0.0814	0.0781
250	0.0712	0.0769	0.0820	0.0843	0.0866	0.0892	0.0920	0.0957	0.0826	0.0800	0.0814	0.0781
270	0.0715	0.0761	0.0796	0.0862	0.0920	0.0933	0.0908	0.0861	0.0842	0.0826	0.0801	0.0775

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Table 5-12. continued

Road Type SCC	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
290	0.0670	0.0734	0.0769	0.0813	0.0879	0.0947	0.0986	0.1001	0.0888	0.0815	0.0768	0.0730
310	0.0645	0.0708	0.0750	0.0871	0.0983	0.1012	0.1080	0.0930	0.0917	0.0772	0.0709	0.0623
330	0.0662	0.0749	0.0787	0.0833	0.0877	0.0879	0.0862	0.0896	0.0930	0.0906	0.0821	0.0798

Table 5-13. Sussex County Temporal Adjustment Factors by Roadway Class

Road Type SCC	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
110	0.0647	0.0706	0.0736	0.0787	0.0881	0.0998	0.1109	0.1112	0.0880	0.0768	0.0706	0.0670
130	0.0647	0.0706	0.0736	0.0787	0.0881	0.0998	0.1109	0.1112	0.0880	0.0768	0.0706	0.0670
150	0.0647	0.0707	0.0740	0.0787	0.0866	0.0997	0.1116	0.1095	0.0858	0.0777	0.0725	0.0685
170	0.0640	0.0688	0.0718	0.0785	0.0912	0.1003	0.1105	0.1075	0.0872	0.0785	0.0728	0.0689
190	0.0640	0.0688	0.0718	0.0785	0.0912	0.1003	0.1105	0.1075	0.0872	0.0785	0.0728	0.0689
210	0.0640	0.0688	0.0718	0.0785	0.0912	0.1003	0.1105	0.1075	0.0872	0.0785	0.0728	0.0689
230	0.0647	0.0706	0.0736	0.0787	0.0881	0.0998	0.1109	0.1112	0.0880	0.0768	0.0706	0.0670
250	0.0647	0.0706	0.0736	0.0787	0.0881	0.0998	0.1109	0.1112	0.0880	0.0768	0.0706	0.0670
270	0.0647	0.0706	0.0736	0.0787	0.0881	0.0998	0.1109	0.1112	0.0880	0.0768	0.0706	0.0670
290	0.0647	0.0707	0.0740	0.0787	0.0866	0.0997	0.1116	0.1095	0.0858	0.0777	0.0725	0.0685
310	0.0640	0.0688	0.0718	0.0785	0.0912	0.1003	0.1105	0.1075	0.0872	0.0785	0.0728	0.0689
330	0.0640	0.0688	0.0718	0.0785	0.0912	0.1003	0.1105	0.1075	0.0872	0.0785	0.0728	0.0689

5.6 Sample Calculations and Results

Emissions were calculated in the following manner:

$$EM_{exh} = (EF_{exh} * VMT * TF_m) / (453.59g/lb * 2000\ lb/ton)$$

where: EM_{exh} = Exhaust emissions on link *l* for month *m*, vehicle type *v* (tons per year)
EF_{exh} = MOBILE6.2 exhaust emission factor for month *m*, vehicle type *v*, roadway class *f* and speed *s* (grams per mile)
VMT = Annual VMT on link *l* of roadway class *f* for vehicle type *v* (miles)
TF_m = VMT temporal adjustment factor for month *m*

Link-level monthly emissions were summed over 12 months to obtain annual emissions. These link-level emissions were also summed by SCC and the emission file was then converted to NIF. After emissions were calculated at this level of detail, the emissions for each county were summed at the county/SCC level. For VOC, emission factors were calculated for the evaporative emission components in addition to the exhaust emission components. VOC emission factors for all of the evaporative components (hot soak, diurnal, resting loss, running loss, and crankcase) were added together before calculating the total evaporative emissions. Exhaust and evaporative VOC emissions were maintained as separate components in the inventory. Similarly, the particulate exhaust emission factor components (sulfate, organic carbon from diesel, elemental carbon from diesel, total carbon from gasoline, and lead) were added together before calculating emissions. However, the brake wear and tire wear components of the particulate emission factors were maintained as separate components of the emission inventory.

Finally, evaporative emissions that occur when gasoline vehicles are refueled at service stations are considered to be stationary non-point sources and, therefore, are included in Section 3.

However, the emission factors from on-road vehicle refueling were calculated with MOBILE6.2, using the same relevant inputs to the model that are discussed in this section.

An example emission calculation is shown below for NO_x emissions from LDGVs in July on link #13511471. This link is on an urban interstate in New Castle County. The corresponding MOBILE6.2 NO_x emission factor is 1.073 grams per mile. The annual VMT for LDGVs on this link is 33.012 million miles. The July VMT temporal adjustment factor for urban interstates in New Castle County is 0.092.

*$EM_{LDGV, July, 13511471}$ = (1.073 g/mi * 33.012E6 miles * 0.092) / (453.59 g/lb * 2000 lb/ton) = 3.59 tons NO_x*

Emission factors, VMT, and annual emissions are provided by county, pollutant, roadway type, and vehicle type in tables contained in the supporting documentation on CD accompanying this report.

Table 5-14. 2002 Emissions and VMT for On-road Mobile Sources by County

County	Annual Emissions (TPY)						10^6 miles
	PM_{10}	$PM_{2.5}$	SO_2	NO_x	NH_3	VOC	
Kent	118	89	105	4,182	139	1,737	1,406
New Castle	304	209	326	11,799	552	5,762	5,338
Sussex	159	117	152	5,360	211	3,065	2,091
Total	**581**	**415**	**584**	**21,341**	**903**	**10,564**	**8,835**

Table 5-15. 2002 PM Exhaust, Brake Wear, and Tire Wear Emissions by County

County	PM_{10} Emissions (TPY)				$PM_{2.5}$ Emissions (TPY)			
	Exhaust	Brake Wear	Tire Wear	Total	Exhaust	Brake Wear	Tire Wear	Total
Kent	84	19	15	118	77	8	4	89
New Castle	179	74	52	304	164	31	13	209
Sussex	109	29	21	159	100	12	5	117
Total	**371**	**122**	**88**	**581**	**341**	**52**	**22**	**415**

Table 5-16. 2002 VOC Evaporative and Exhaust Emissions by County

County	VOC Emissions (TPY)		
	Evaporative	Exhaust	Total
Kent	569	1,169	1,738
New Castle	1,861	3,900	5,761
Sussex	1,029	2,036	3,065
Total	**3,459**	**7,105**	**10,564**

Table 5-17. 2002 Statewide Emissions and VMT for On-road Mobile Sources by Vehicle Type

Vehicle Type	Annual Emissions (TPY)					
	PM_{10}	$PM_{2.5}$	SO_2	NO_x	NH_3	VOC
Light-duty Gasoline Vehicles	129	63	167	5,789	484	5,538
Light-duty Gasoline Trucks	111	57	187	5,028	386	4,195
Heavy-duty Gasoline Vehicles	28	20	25	1,423	13	319
Motorcycles	2	1	1	71	1	116
Light-duty Diesel Vehicles	2	2	< 1	9	< 1	5
Light-duty Diesel Trucks	3	3	2	23	< 1	11
Heavy-duty Diesel Vehicles	307	269	201	8,996	18	379
Total	**581**	**415**	**584**	**21,341**	**903**	**10,564**

5.7 References

DNREC, 2002: Delaware Department of Natural Resources and Environmental Control, Division of Air and Waste Management, Air Quality Management Section, *1999 Periodic Ozone State Implementation Plan Emissions Inventory for VOC, NO_x and CO*, 2002.

EPA, 1989: U.S. Environmental Protection Agency, "User's Guide to MOBILE4 (Mobile Source Emission Factor Model)," EPA-AA-TEB-89-01, Office of Mobile Sources, Ann Arbor, MI, February 1989.

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