APPENDIX H

Bus Emissions Estimation

MEMORANDUM

December 12, 2007

To: Files

From: Jane Posey, MWCOG/DTP

Subject: Transit and School Bus Emissions

Background

For the development of the HDV percentage in the VMT mix for Mobile6.2, staff divided the vehicle class into trucks and buses, with the further breakdown of buses into transit bus and school bus categories. This memo discusses the collection of information from regional transit providers and the development of ozone season NOx and VOC, winter CO, and PM2.5 precursor NOx and direct PM2.5 emissions estimates for transit and school buses for various analysis years.

Approach

Data Collection

In order to obtain current regional transit data, staff developed a questionnaire for transit providers and school bus operators in the region. The technique of emailing and then conducting follow-up phone calls produced a high response rate. Staff used response data to complete tables showing total fleet distribution by age (Table 1A), and daily VMT with average operating speed, by provider (Table 1B).

Fleet Age Distribution

Staff compared the regional school bus and transit bus fleet distribution survey data to the Mobile6 default data. The resulting graphs are shown in Table 2A and Table 2B. The transit bus distribution shows a fairly regular three to four year cycle of bus purchases in the region. The school bus survey data shows variability over time, with a large purchase in several jurisdictions between 1998 and 2000. Because of the variability in the school bus data, with no clear purchasing cycle as is seen in the transit data, staff used the default data curve for school buses, with one exception. That is, staff adjusted the end of the default school bus distribution curve to reflect that no school buses in the region are older than 16 years. The resulting updated default curve is shown as "revised school bus percentage" on Table 2A. For simplification purposes, because the number of buses other than diesel is statistically insignificant, the fleet will be input to the Mobile model as 100 percent diesel. Emissions for buses that are not diesel (e.g. CNG buses) are accounted for using TERM analysis.

VMT Estimates

The annual VMT from the survey was divided by the number of service days for each provider to calculate a daily VMT. To account for bus VMT for providers in the region for which no survey data was received, staff estimated VMT by using data from providers with similar service type. In many cases, where VMT data was not provided, total number of buses was provided, making the estimate process more accurate. In Table 1B, estimated VMT values are shown in italics. Daily school bus VMT represents a school day in May.

The resulting daily 2001 VMT from the survey, including estimation values from providers for which no data was received, is 277,000 for transit buses (compared to 180,000 in the FY03-08 TIP), and 489,900 for school buses.

For estimating bus VMT for the future, staff used the HDBS (school bus) and HDBT (transit bus) values in the "National Average Vehicle Miles Traveled Fractions by Vehicle Class" table from EPA's *Technical Guidance on the use of Mobile 6 for Emission Inventory Preparation* to modify current data. This is shown as Table 3. For example, HDBS fractions increase from 0.0019 to 0.0020, or by 5.26%, between 2002 and 2005.

Emission Estimates

Using the survey data, staff created transit bus and school bus emission tables. In the tables, the daily VMT was adjusted from the base (survey) year (2001) using the method described above. The fleet age distributions as an input to the Mobile6.2 model to produce emission factors for each pollutant, by speed. Factors for PM2.5 pollutants were prepared for each of 3 seasons (Season 1:January-April, Season 2: May-September, Season 3: October-December) Using the appropriate emission factor, based on the average operating speed for each provider, staff calculated each pollutant's emissions for transit buses and school buses for each analysis year. Table 4 shows a one-year sample of bus emission factors. Table 5 shows a one-year sample of transit and school bus emissions for each of the pollutants analyzed.

Table 1A

Total Fleet Distribution by Age

Transit and Other Bus

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Transit and Other Bus Percentage	2.98	6.07	9.84	5.53	4.40	10.30	3.06	6.95	3.09	2.92	4.20	1.25	7.97	4.37	5.45	6.35	6.01	0.62	0.00	0.57	0.00	0.00	0.00	0.00	0.00
Mobile 6 Default	3.07	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.14	6.13	6.11	6.07	5.95	5.68	5.11	4.06	2.54	1.21	0.99	0.81	0.66	0.54	0.44	0.37	1.14

School Bus

Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
School Bus Percentage	6.62	10.98	11.00	12.74	13.68	8.22	3.01	4.63	3.12	0.65	1.51	6.48	5.99	3.32	4.28	3.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mobile 6 Default Percentage	3.93	7.34	6.86	6.41	5.99	5.59	5.22	4.88	4.56	4.26	3.98	3.72	3.47	3.24	3.03	2.83	2.64	2.47	2.31	2.16	2.01	1.88	1.76	1.65	7.81
Revised Default Percentage	5.22	9.75	9.11	8.51	7.95	7.42	6.93	6.48	6.05	5.66	5.28	4.94	4.61	4.30	4.02	3.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 1B
2001 Bus
Operating Statistics

Service	Contact Name	Average Speed	Daily VMT
Metrobus	Lora Byala	*10*	123,299
Fairfax Connector	Andy Szakos	*15*	18,036
PRTC Omnilink	Tim Roseboom	*15*	4038
Alexandria DASH	Cindy Modell	13	3,454
City of Fairfax CUE	Alex Verzosa	15	1,483
Arlington Co. ART	Jim Maslanka	16	794
Loudoun Transportation Assc.	Mark McGregor	15	4,532
Mont. Co. Ride-On	Phil McLaughlin	14.5	35,616
PG Co. The Bus	Frank Bell	15-20	9,723
Fredrick Co. TransiT	Sherry Burford	11.78	3,082
Corridor Transit (CTC)	Joe Gann	17.8	1,265
Crystal City Express		*15*	96
Skyline Crystal Express		*15*	144
PRTC OmniRide	Tim Roseboom	26.62	*5,700*
Loudoun Commuter Service	Sharon Affinito	*25*	1,866
MTA Commuter buses	Larry Dougherty	*45*	10,453
Lee Coaches	Joe Ann Foweler	*45*	70
Brooks Transit		*45*	750
Quicks Commuter Service	Robbie Quick	*45*	1,320
Eyre buses (under MTA)	Teri Lee Cosker	*45*	(under MTA)
Dillon buses (under MTA)	Ron Dillon Sr.	*45*	(under MTA)
Keller buses (under MTA)	Charles D. Keller	*45*	(under MTA)
National Coach Works	Jeff Bodnar	*45*	1,650
Greyhound / Trailways (VA)	David Cohen	*55*	*5000*
Peter Pan / Trailways	Christ Crean	*55*	*2000*
Carolina Trailways		*55*	*500*
Capitol Trailways	Ms.Gale Ellsworth	*55*	*500*
Martz / Grey Line sightseeing	Robert Lynch	55-68	*5000*
New World	Arnold Brown	*20*	299
Washington Flyer Coach Service	Nicholas Marshall	65	1,370
ShuttleUM (U. of MD)	Cynthia Trombly	11.1	1,864

2001 Bus
Operating Statistics

Service	Contact Name	Average Speed	Daily VMT
Georgetown U. shuttle	Diann Nock Smith	15	*100*
American U. shuttle	Thomas Leathers	20-25	83
George Washington U shuttle	John Kane	*15*	*100*
CIA Shuttle		*15*	*200*
EPA Shuttle		*15*	*200*
USDOT Shuttle	Franklin Weaver	*15*	*200*
Gallaudet Shuttle	Darnese Nicholson	*15*	100
Tourmobile	Richard Lewis	*15*	(Gas powered)
Old Town "trolley" buses		*20*	*300*
Metro Access - paratransit	Avon Mackel	15	*5000*
Fairfax Co. Fastran- paratransit	Steve Yaffe	14.53	11,427
Alexandria DOT-paratransit	Lakeshia Lewis	*15*	924
Arlington STAR-paratransit	Eric Smith	*15*	3,245
City of Ffx, City Wheels-paratransit.	Alex Verzosa	*15*	*100*
City of Falls Ch. Fare Wheels-paratransit	Letha Flippin	*15*	*100*
Loudoun Transit (LCTA)-paratransit	Mark McGregor	*15*	*100*
P.G. Co. paratransit	Frank Bell	*15*	*3000*
All buses excluding school			**277,361**
School buses - DC	Alfred Winder	14	*10000*
School buses- Mont. Co.	Qiyu C. Wu	*30*	27,000
School buses- P.G. Co.	Mark Dreszer	*30*	28,896
School buses- Fred. Co.	Richard Wandres	*30*	10,747
School buses- Alexandria	Velma Tsongos	*25*	*3520*
School buses- Arl. Co.	Daniel Roseboro	*25*	*4800*
School buses- Ffx. Co.	Tim Parker	30-35	24,112
School buses- Loud. Co.	J Michael Lunsfurg	*30*	11,906
School buses- P.W. Co.	Eward Bishop	*30*	8,144

Total for School Buses **129,126**

TABLE 2A
School Bus Age Distribution

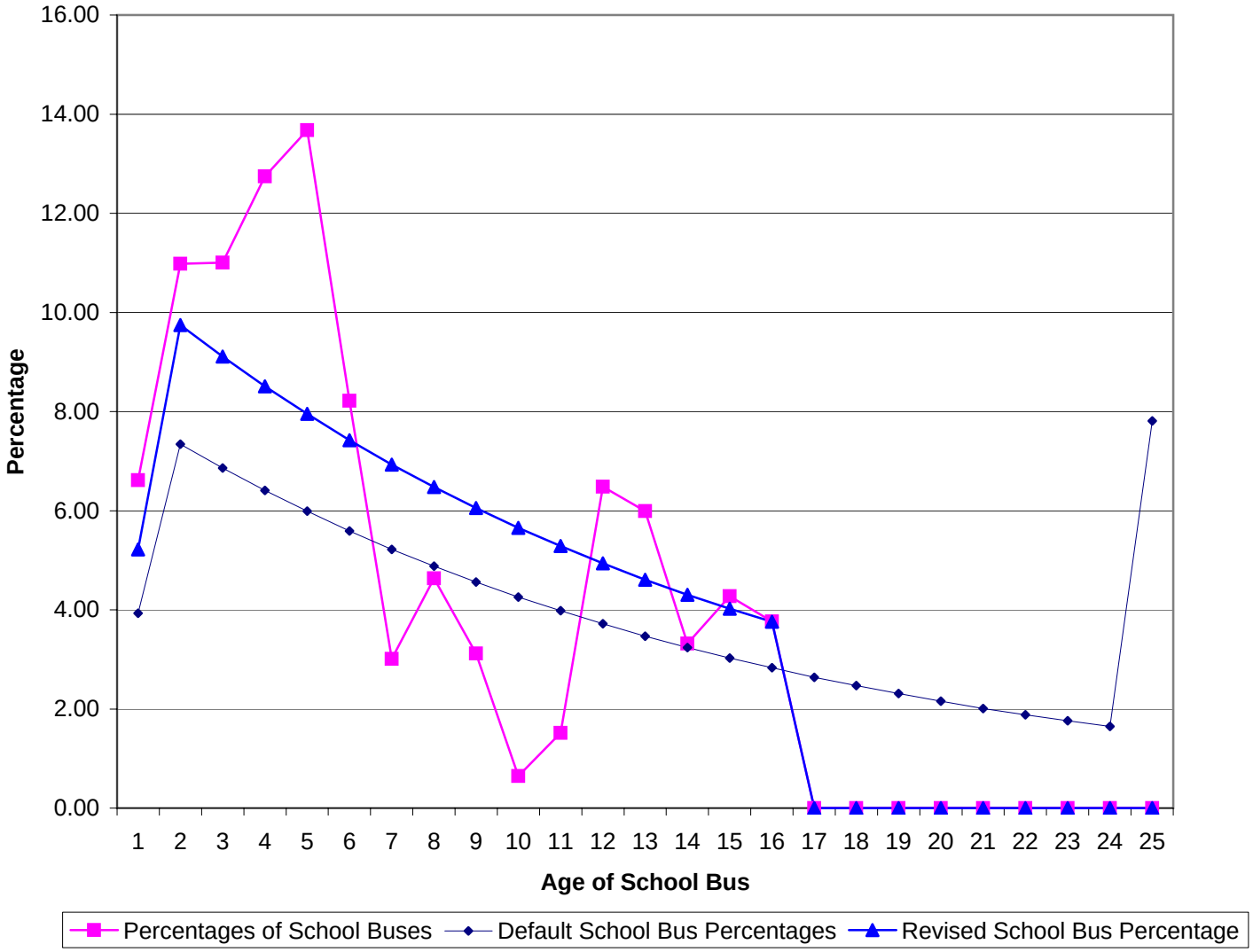

TABLE 2B
Transit Fleet Vehicle Age Distribution

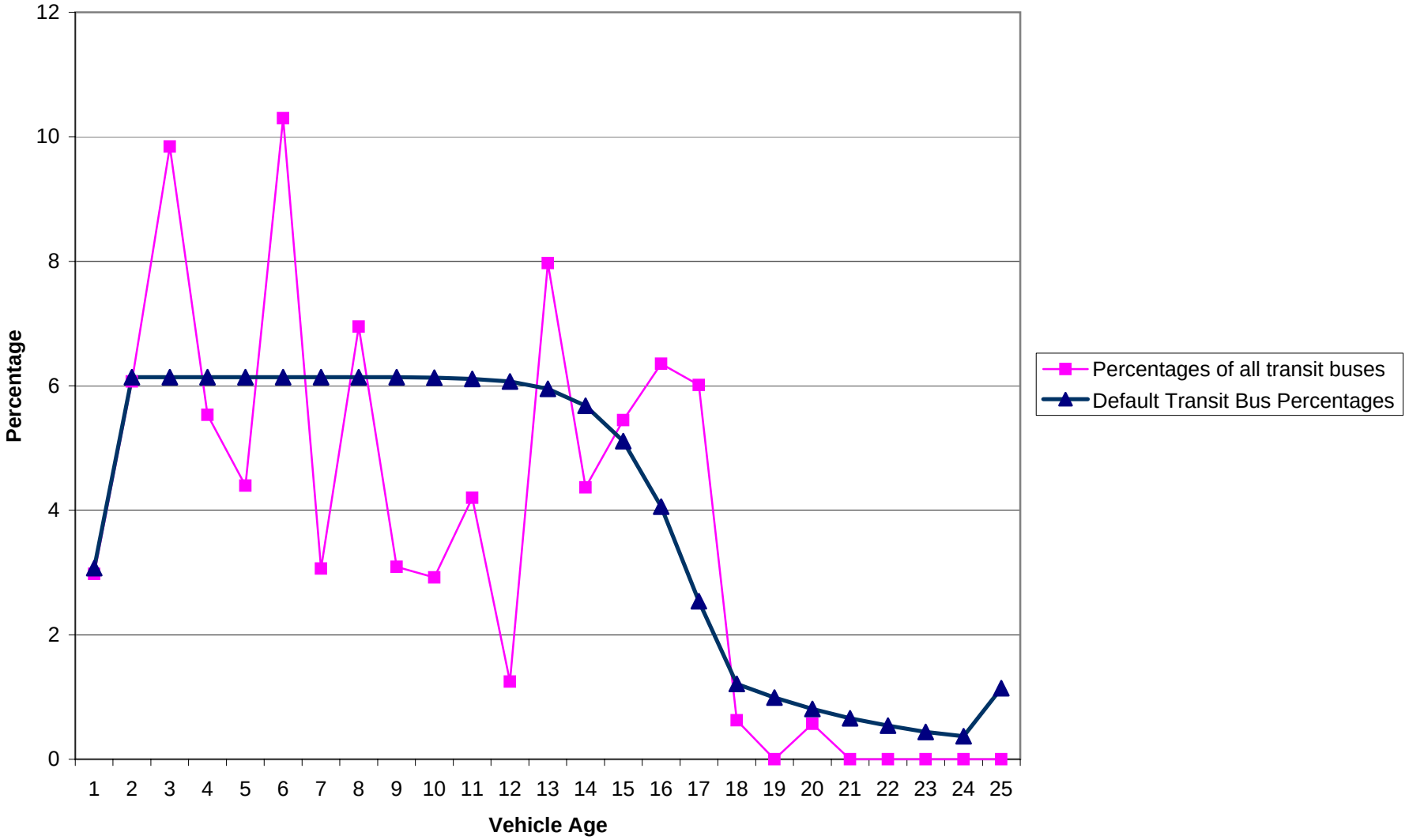

TABLE 3

National Average Vehicle Miles Traveled Fractions By Vehicle Class Using MOBILE6

Calendar Year	LDV 1	LDT1 2	LDT2 3	LDT3 4	LDT4 5	HDV2B 6	HDV3 7	HDV4 8	HDV5 9	HDV6 10	HDV7 11	HDV8A 12	HDV8B 13	HDBS 14	HDBT 15	MC 16
1990	0.6284	0.0420	0.1397	0.0566	0.0260	0.0332	0.0034	0.0020	0.0016	0.0064	0.0079	0.0094	0.0337	0.0017	0.0008	0.0073
1991	0.6212	0.0435	0.1446	0.0560	0.0257	0.0336	0.0035	0.0021	0.0017	0.0066	0.0081	0.0095	0.0341	0.0017	0.0008	0.0072
1992	0.6109	0.0456	0.1518	0.0555	0.0255	0.0342	0.0036	0.0022	0.0017	0.0068	0.0083	0.0097	0.0346	0.0017	0.0008	0.0071
1993	0.6009	0.0477	0.1587	0.0551	0.0253	0.0348	0.0036	0.0023	0.0018	0.0070	0.0085	0.0098	0.0350	0.0017	0.0008	0.0070
1994	0.5910	0.0497	0.1655	0.0546	0.0251	0.0354	0.0037	0.0024	0.0018	0.0072	0.0087	0.0100	0.0355	0.0018	0.0008	0.0070
1995	0.5815	0.0517	0.1721	0.0542	0.0249	0.0358	0.0037	0.0025	0.0019	0.0073	0.0089	0.0101	0.0360	0.0018	0.0009	0.0069
1996	0.5721	0.0534	0.1776	0.0547	0.0252	0.0362	0.0037	0.0025	0.0019	0.0075	0.0090	0.0102	0.0364	0.0018	0.0009	0.0068
1997	0.5569	0.0557	0.1853	0.0571	0.0263	0.0367	0.0037	0.0026	0.0020	0.0077	0.0092	0.0104	0.0370	0.0018	0.0009	0.0067
1998	0.5360	0.0590	0.1963	0.0605	0.0278	0.0372	0.0038	0.0027	0.0021	0.0079	0.0095	0.0106	0.0376	0.0019	0.0009	0.0065
1999	0.5153	0.0622	0.2071	0.0638	0.0294	0.0377	0.0038	0.0028	0.0021	0.0081	0.0097	0.0107	0.0382	0.0019	0.0009	0.0064
2000	0.4953	0.0655	0.2179	0.0672	0.0309	0.0380	0.0038	0.0029	0.0022	0.0082	0.0098	0.0108	0.0386	0.0019	0.0009	0.0062
2001	0.4765	0.0683	0.2273	0.0700	0.0322	0.0381	0.0038	0.0029	0.0022	0.0083	0.0099	0.0109	0.0388	0.0019	0.0009	0.0061
2002	0.4646	0.0706	0.2349	0.0724	0.0333	0.0382	0.0038	0.0030	0.0022	0.0084	0.0100	0.0109	0.0390	0.0019	0.0009	0.0060
2003	0.4507	0.0729	0.2425	0.0748	0.0344	0.0384	0.0038	0.0030	0.0023	0.0085	0.0100	0.0110	0.0392	0.0019	0.0009	0.0059
2004	0.4365	0.0752	0.2503	0.0771	0.0355	0.0386	0.0038	0.0030	0.0023	0.0085	0.0101	0.0111	0.0394	0.0019	0.0009	0.0058
2005	0.4231	0.0774	0.2577	0.0794	0.0365	0.0387	0.0038	0.0031	0.0023	0.0086	0.0102	0.0111	0.0395	0.0020	0.0009	0.0057
2006	0.4096	0.0797	0.2654	0.0818	0.0376	0.0387	0.0038	0.0031	0.0023	0.0086	0.0102	0.0111	0.0396	0.0020	0.0009	0.0056
2007	0.3952	0.0822	0.2735	0.0843	0.0388	0.0387	0.0038	0.0031	0.0023	0.0086	0.0102	0.0111	0.0396	0.0020	0.0009	0.0056
2008	0.3807	0.0846	0.2817	0.0868	0.0399	0.0388	0.0038	0.0031	0.0024	0.0087	0.0102	0.0111	0.0397	0.0020	0.0009	0.0055
2009	0.3669	0.0869	0.2894	0.0892	0.0410	0.0389	0.0038	0.0032	0.0024	0.0087	0.0103	0.0112	0.0398	0.0020	0.0010	0.0054
2010	0.3544	0.0891	0.2965	0.0914	0.0420	0.0390	0.0038	0.0032	0.0024	0.0087	0.0103	0.0112	0.0399	0.0020	0.0010	0.0054
2011	0.3428	0.0911	0.3031	0.0934	0.0430	0.0390	0.0038	0.0032	0.0024	0.0087	0.0103	0.0112	0.0398	0.0020	0.0010	0.0053
2012	0.3325	0.0928	0.3090	0.0952	0.0438	0.0390	0.0038	0.0032	0.0024	0.0087	0.0103	0.0112	0.0399	0.0020	0.0010	0.0053
2013	0.3231	0.0944	0.3143	0.0969	0.0445	0.0390	0.0038	0.0032	0.0024	0.0087	0.0103	0.0112	0.0399	0.0020	0.0010	0.0053
2014	0.3145	0.0959	0.3191	0.0983	0.0452	0.0391	0.0038	0.0032	0.0024	0.0088	0.0103	0.0112	0.0400	0.0020	0.0010	0.0052
2015	0.3071	0.0971	0.3233	0.0996	0.0458	0.0391	0.0039	0.0032	0.0024	0.0088	0.0104	0.0112	0.0400	0.0020	0.0010	0.0052
2016	0.3004	0.0982	0.3270	0.1008	0.0463	0.0392	0.0039	0.0033	0.0024	0.0088	0.0104	0.0112	0.0400	0.0020	0.0010	0.0052
2017	0.2944	0.0992	0.3304	0.1018	0.0468	0.0392	0.0039	0.0033	0.0024	0.0088	0.0104	0.0113	0.0401	0.0020	0.0010	0.0051
2018	0.2892	0.1001	0.3332	0.1027	0.0472	0.0393	0.0039	0.0033	0.0024	0.0088	0.0104	0.0113	0.0402	0.0020	0.0010	0.0051
2019	0.2846	0.1008	0.3357	0.1035	0.0476	0.0394	0.0039	0.0033	0.0025	0.0088	0.0104	0.0113	0.0403	0.0020	0.0010	0.0051
2020 - 2050	0.2793	0.1017	0.3384	0.1043	0.0480	0.0396	0.0039	0.0033	0.0025	0.0089	0.0105	0.0114	0.0405	0.0020	0.0010	0.0051

Source: Technical Guidance on the use of Mobile 6 for Emission Inventory Preparation, U.S. EPA, January 2002.

TABLE 4
MWCOG Regional 2010 Ozone Season Diesel Bus Emission Factors

		Diesel Bus Emission Factors (grams/mile)			
		School Bus		Transit Bus	
Road Type	Speed (mph)	VOC	NOx	VOC	NOx
Arterial/Freeway	1.00	1.902	16.854	1.067	19.21
Arterial/Freeway	2.00	1.902	16.854	1.067	19.21
Arterial/Freeway	3.00	1.825	16.28	1.024	18.55
Arterial/Freeway	4.00	1.729	15.563	0.97	17.725
Arterial/Freeway	5.00	1.671	15.133	0.938	17.23
Arterial/Freeway	6.00	1.551	14.265	0.871	16.231
Arterial/Freeway	7.00	1.466	13.645	0.823	15.518
Arterial/Freeway	8.00	1.402	13.18	0.787	14.983
Arterial/Freeway	9.00	1.352	12.819	0.759	14.567
Arterial/Freeway	10.0	1.312	12.53	0.736	14.234
Arterial/Freeway	11.0	1.241	12.044	0.697	13.675
Arterial/Freeway	12.0	1.182	11.64	0.664	13.209
Arterial/Freeway	13.0	1.133	11.297	0.636	12.816
Arterial/Freeway	14.0	1.09	11.004	0.612	12.478
Arterial/Freeway	15.0	1.053	10.75	0.591	12.185
Arterial/Freeway	16.0	1.006	10.452	0.564	11.842
Arterial/Freeway	17.0	0.964	10.189	0.541	11.54
Arterial/Freeway	18.0	0.927	9.955	0.52	11.271
Arterial/Freeway	19.0	0.894	9.746	0.502	11.031
Arterial/Freeway	20.0	0.864	9.558	0.485	10.814
Arterial/Freeway	21.0	0.831	9.38	0.466	10.609
Arterial/Freeway	22.0	0.8	9.218	0.449	10.422
Arterial/Freeway	23.0	0.773	9.07	0.434	10.252
Arterial/Freeway	24.0	0.748	8.934	0.42	10.096
Arterial/Freeway	25.0	0.724	8.81	0.407	9.952
Arterial/Freeway	26.0	0.701	8.719	0.393	9.848
Arterial/Freeway	27.0	0.678	8.635	0.381	9.752
Arterial/Freeway	28.0	0.658	8.558	0.369	9.662
Arterial/Freeway	29.0	0.639	8.485	0.359	9.579
Arterial/Freeway	30.0	0.621	8.418	0.348	9.501
Arterial/Freeway	31.0	0.604	8.4	0.339	9.481
Arterial/Freeway	32.0	0.587	8.383	0.33	9.461
Arterial/Freeway	33.0	0.572	8.367	0.321	9.443
Arterial/Freeway	34.0	0.558	8.353	0.313	9.426
Arterial/Freeway	35.0	0.544	8.339	0.305	9.41
Arterial/Freeway	36.0	0.532	8.389	0.298	9.468
Arterial/Freeway	37.0	0.52	8.436	0.292	9.523
Arterial/Freeway	38.0	0.508	8.481	0.285	9.574
Arterial/Freeway	39.0	0.498	8.524	0.279	9.624
Arterial/Freeway	40.0	0.488	8.564	0.274	9.67

TABLE 4
MWCOG Regional 2010 Ozone Season Diesel Bus Emission Factors

		Diesel Bus Emission Factors (grams/mile)			
		School Bus		Transit Bus	
Road Type	**Speed (mph)**	**VOC**	**NOx**	**VOC**	**NOx**
Arterial/Freeway	41.0	0.478	8.686	0.269	9.81
Arterial/Freeway	42.0	0.47	8.802	0.264	9.944
Arterial/Freeway	43.0	0.462	8.913	0.259	10.071
Arterial/Freeway	44.0	0.454	9.019	0.255	10.193
Arterial/Freeway	45.0	0.446	9.12	0.251	10.309
Arterial/Freeway	46.0	0.44	9.325	0.247	10.546
Arterial/Freeway	47.0	0.434	9.522	0.244	10.773
Arterial/Freeway	48.0	0.429	9.711	0.241	10.99
Arterial/Freeway	49.0	0.423	9.892	0.237	11.199
Arterial/Freeway	50.0	0.418	10.066	0.235	11.399
Arterial/Freeway	51.0	0.414	10.379	0.232	11.759
Arterial/Freeway	52.0	0.41	10.68	0.23	12.105
Arterial/Freeway	53.0	0.407	10.969	0.228	12.438
Arterial/Freeway	54.0	0.403	11.248	0.226	12.759
Arterial/Freeway	55.0	0.4	11.517	0.224	13.068
Arterial/Freeway	56.0	0.398	11.975	0.223	13.595
Arterial/Freeway	57.0	0.396	12.417	0.222	14.104
Arterial/Freeway	58.0	0.395	12.844	0.221	14.595
Arterial/Freeway	59.0	0.393	13.256	0.22	15.07
Arterial/Freeway	60.0	0.391	13.654	0.22	15.528
Arterial/Freeway	61.0	0.391	14.319	0.22	16.294
Arterial/Freeway	62.0	0.391	14.963	0.22	17.034
Arterial/Freeway	63.0	0.391	15.586	0.22	17.751
Arterial/Freeway	64.0	0.391	16.189	0.22	18.446
Arterial/Freeway	65.0	0.391	16.774	0.22	19.119
Fwy Ramp	34.6	0.55	8.484	0.308	9.764
Local	12.9	1.152	11.414	0.646	12.95

TABLE 5A

2007 CLRP/FY2008-2013 TIP AIR QUALITY CONFORMITY ANALYSIS

2010 SCHOOL BUS CHARACTERISTICS / EMISSIONS (8-HOUR OZONE AREA*)

Jurisdiction	2002 Daily VMT	2010 Daily VMT	Average Speed	VOC			NOx		
				factors (g/mile)	emissions (grams)	emissions (tons)	factors (g/mile)	emissions (grams)	emissions (tons)
District of Columbia	12,696	13,331	14	1.0900	14530.5720	0.0160	11.0040	146692.1232	0.1617
Montgomery	100,000	105,000	30	0.6210	65205.0000	0.0719	8.4180	883890.0000	0.9743
Prince George's	129,967	136,465	30	0.6210	84744.9824	0.0934	8.4180	1148765.3163	1.2663
Frederick	25,589	26,868	30	0.6210	16685.3075	0.0184	8.4180	226178.6121	0.2493
Charles	20,801	21,841	30	0.6210	13563.2921	0.0150	8.4180	183857.9589	0.2027
Calvert	25,653	26,936	30	0.6210	16727.0387	0.0184	8.4180	226744.3017	0.2499
Alexandria	2,028	2,129	25	0.7240	1541.6856	0.0017	8.8100	18760.0140	0.0207
Arlington	2,600	2,730	25	0.7240	1976.5200	0.0022	8.8100	24051.3000	0.0265
Fairfax	96,524	101,350	30	0.6210	62938.4742	0.0694	8.4180	853165.9836	0.9405
Prince William	36,114	37,920	30	0.6210	23548.1337	0.0260	8.4180	319208.0346	0.3519
Loudoun	28,347	29,764	30	0.6210	18483.6614	0.0204	8.4180	250556.2983	0.2762
TOTAL	480,319				319944.6674	0.3527		4281869.9427	4.7200

* MSA excluding Stafford County

TABLE 5B
2007 CLRP/FY2008-2013 TIP AIR QUALITY CONFORMITY ANALYSIS

2010 TRANSIT BUS CHARACTERISTICS / EMISSIONS (8-HOUR OZONE AREA*)

Jurisdiction	Operator	2002 Daily VMT	2010 VMT w/o Stafford	Average Speed	VOC			NOx		
					factors (g/mile)	emissions (grams)	emissions (tons)	factors (g/mile)	emissions (grams)	emissions (tons)
District of Columbia	Metrobus	50,552	56,113	*10*	0.7360	37206.2720	0.0410	14.2340	719557.1680	0.7932
District of Columbia	MTA Commuter buses	2,510	2,786	*45*	0.2510	630.0100	0.0007	10.3090	25875.5900	0.0285
District of Columbia	Peter Pan / Trailways	200	222	*55*	0.2240	44.8000	0.0000	13.0680	2613.6000	0.0029
District of Columbia	Carolina Trailways	20	22	*55*	0.2240	4.4800	0.0000	13.0680	261.3600	0.0003
District of Columbia	Capitol Trailways	100	111	*55*	0.2240	22.4000	0.0000	13.0680	1306.8000	0.0014
District of Columbia	Martz / Grey Line sightseeing	500	555	55	0.2240	112.0000	0.0001	13.0680	6534.0000	0.0072
District of Columbia	New World Tours	100	111	*20*	0.4850	48.5000	0.0001	10.8140	1081.4000	0.0012
District of Columbia	Georgetown U. shuttle	100	111	15	0.5910	59.1000	0.0001	12.1850	1218.5000	0.0013
District of Columbia	American U. shuttle	83	92	20	0.4850	40.2550	0.0000	10.8140	897.5620	0.0010
District of Columbia	George Washington U shuttle	100	111	*15*	0.5910	59.1000	0.0001	12.1850	1218.5000	0.0013
District of Columbia	EPA Shuttle	200	222	*15*	0.5910	118.2000	0.0001	12.1850	2437.0000	0.0027
District of Columbia	USDOT Shuttle	200	222	*15*	0.5910	118.2000	0.0001	12.1850	2437.0000	0.0027
District of Columbia	Gallaudet Shuttle	100	111	*15*	0.5910	59.1000	0.0001	12.1850	1218.5000	0.0013
District of Columbia	Metro Access - paratransit	5,000	5,550	15	0.5910	2955.0000	0.0033	12.1850	60925.0000	0.0672
Maryland	Corridor Transit (CTC)	1,265	1,404	18	0.5200	657.8000	0.0007	11.2710	14257.8150	0.0157
Maryland	Peter Pan / Trailways	1,800	1,998	*55*	0.2240	403.2000	0.0004	13.0680	23522.4000	0.0259
Maryland	Carolina Trailways	225	250	*55*	0.2240	50.4000	0.0001	13.0680	2940.3000	0.0032
Maryland	Capitol Trailways	400	444	*55*	0.2240	89.6000	0.0001	13.0680	5227.2000	0.0058
Maryland	Martz / Grey Line sightseeing	2,250	2,498	55	0.2240	504.0000	0.0006	13.0680	29403.0000	0.0324
Maryland	New World Tours	100	111	*20*	0.4850	48.5000	0.0001	10.8140	1081.4000	0.0012
Montgomery	Metrobus	17,262	19,161	*15*	0.5910	10201.8420	0.0112	12.1850	210337.4700	0.2319
Montgomery	MTA Commuter buses	2,180	2,420	*45*	0.2510	547.1800	0.0006	10.3090	22473.6200	0.0248
Montgomery	Mont. Co. Ride-On	35,616	39,534	15	0.5910	21049.0560	0.0232	12.1850	433980.9600	0.4784
Prince George's	Metrobus	24,660	27,373	*15*	0.5910	14574.0600	0.0161	12.1850	300482.1000	0.3312

TABLE 5B

2007 CLRP/FY2008-2013 TIP AIR QUALITY CONFORMITY ANALYSIS

2010 TRANSIT BUS CHARACTERISTICS / EMISSIONS (8-HOUR OZONE AREA*)

Jurisdiction	Operator	2002 Daily VMT	2010 VMT w/o Stafford	Average Speed	VOC			NOx		
					factors (g/mile)	emissions (grams)	emissions (tons)	factors (g/mile)	emissions (grams)	emissions (tons)
Prince George's	MTA Commuter buses	6,840	7,592	*45*	0.2510	1716.8400	0.0019	10.3090	70513.5600	0.0777
Prince George's	PG Co. The Bus	9,723	10,793	15	0.5910	5746.2930	0.0063	12.1850	118474.7550	0.1306
Prince George's	ShuttleUM (U. of MD)	1,864	2,069	11	0.6970	1299.2080	0.0014	13.6750	25490.2000	0.0281
Prince George's	P.G. Co. paratransit	3,000	3,330	*15*	0.5910	1773.0000	0.0020	12.1850	36555.0000	0.0403
Frederick	MTA Commuter buses	370	411	*45*	0.2510	92.8700	0.0001	10.3090	3814.3300	0.0042
Frederick	Fredrick Co. TransiT	3,082	3,421	12	0.6640	2046.4480	0.0023	13.2090	40710.1380	0.0449
Charles	MTA Commuter buses	2,290	2,542	*45*	0.2510	574.7900	0.0006	10.3090	23607.6100	0.0260
Calvert	MTA Commuter buses	1,080	1,199	*45*	0.2510	271.0800	0.0003	10.3090	11133.7200	0.0123
Virginia	Metrobus	30,825	34,216	*15*	0.5910	18217.5750	0.0201	12.1850	375602.6250	0.4140
Virginia	Lee Coaches	70	54	*45*	0.2510	17.5700	0.0000	10.3090	721.6300	0.0008
Virginia	Brooks Transit	750	583	*45*	0.2510	188.2500	0.0002	10.3090	7731.7500	0.0085
Virginia	Quicks Commuter Service	1,320	1,026	*45*	0.2510	331.3200	0.0004	10.3090	13607.8800	0.0150
Virginia	National Coach Works	1,650	1,282	*45*	0.2510	414.1500	0.0005	10.3090	17009.8500	0.0188
Virginia	Greyhound / Trailways (VA)	5,000	3,885	*55*	0.2240	1120.0000	0.0012	13.0680	65340.0000	0.0720
Virginia	Carolina Trailways	225	175	*55*	0.2240	50.4000	0.0001	13.0680	2940.3000	0.0032
Virginia	Martz / Grey Line sightseeing	2,250	1,748	55	0.2240	504.0000	0.0006	13.0680	29403.0000	0.0324
Virginia	New World Tours	100	78	*20*	0.4850	48.5000	0.0001	10.8140	1081.4000	0.0012
Alexandria	Alexandria DASH	3,454	3,834	13	0.6360	2196.7440	0.0024	12.8160	44266.4640	0.0488
Alexandria	Old Town "trolley" buses	300	333	*20*	0.4850	145.5000	0.0002	10.8140	3244.2000	0.0036
Alexandria	Alexandria DOT-paratransit	924	1,026	*15*	0.5910	546.0840	0.0006	12.1850	11258.9400	0.0124
Arlington	Arlington Co. ART	794	881	16	0.5640	447.8160	0.0005	11.8420	9402.5480	0.0104
Arlington	Crystal City Express	96	107	*15*	0.5910	56.7360	0.0001	12.1850	1169.7600	0.0013
Arlington	Skyline Crystal Express	144	160	*15*	0.5910	85.1040	0.0001	12.1850	1754.6400	0.0019
Arlington	Arlington STAR-paratransit	3,245	3,602	*15*	0.5910	1917.7950	0.0021	12.1850	39540.3250	0.0436

TABLE 5B
2007 CLRP/FY2008-2013 TIP AIR QUALITY CONFORMITY ANALYSIS

2010 TRANSIT BUS CHARACTERISTICS / EMISSIONS (8-HOUR OZONE AREA*)

Jurisdiction	Operator	2002 Daily VMT	2010 VMT w/o Stafford	Average Speed	VOC			NOx		
					factors (g/mile)	emissions (grams)	emissions (tons)	factors (g/mile)	emissions (grams)	emissions (tons)
Fairfax	Fairfax Connector	18,036	20,020	*15*	0.5910	10659.2760	0.0117	12.1850	219768.6600	0.2423
Fairfax	Washington Flyer Coach Service	1,370	1,521	65	0.2200	301.4000	0.0003	19.1190	26193.0300	0.0289
Fairfax	Fairfax Co. Fastran- paratransit	11,427	12,684	15	0.5910	6753.3570	0.0074	12.1850	139237.9950	0.1535
Fairfax	City of Fairfax CUE	1,483	1,646	15	0.5910	876.4530	0.0010	12.1850	18070.3550	0.0199
Fairfax	City of Ffx, City Wheels-paratransit.	100	111	*15*	0.5910	59.1000	0.0001	12.1850	1218.5000	0.0013
Fairfax	City of Falls Ch. Fare Wheels-paratransit	100	111	*15*	0.5910	59.1000	0.0001	12.1850	1218.5000	0.0013
Prince William	PRTC Omnilink	4,038	4,482	*15*	0.5910	2386.4580	0.0026	12.1850	49203.0300	0.0542
Prince William	PRTC OmniRide	5,700	6,327	27	0.3810	2171.7000	0.0024	9.7520	55586.4000	0.0613
Loudoun	Loudoun Transportation Assc.	4,532	5,031	15	0.5910	2678.4120	0.0030	12.1850	55222.4200	0.0609
Loudoun	Loudoun Commuter Service	1,866	2,071	*25*	0.4070	759.4620	0.0008	9.9520	18570.4320	0.0205
Loudoun	Loudoun Transit (LCTA)-paratransit	100	111	*15*	0.5910	59.1000	0.0001	12.1850	1218.5000	0.0013
TOTAL		273,671	299,990			156174.9460	0.1722		3411170.6920	3.7602

* MSA excluding Stafford County

Notes:
1) Used WMATA percent VMT by jurisdiction from FY03-08 AQC, Appendix I (page I-3)
2) Assumed average freeway speed of 55 mph where higher than 55 speed limit is available, and 45 mph where speed limit is 55

TABLE 5C

2007 CLRP / FY2008-2013 TIP AIR QUALITY CONFORMITY ANALYSIS

2010 SCHOOL BUS CHARACTERISTICS / EMISSIONS (PM 2.5)

WINTER (January - April)

Jurisdiction	2001 Annual VMT	2002 Daily VMT	2010 Daily VMT	Average Speed	PM 2.5 factors (g/mile)	PM 2.5 emissions (grams)	PM 2.5 emissions (tons)	precursor NOx factors (g/mile)	precursor NOx emissions (grams)	precursor NOx emissions (tons)
District of Columbia	2,800,000	12,670	13,303	14	0.5307	7059.9910	0.0078	11.0130	146507.7828	0.1615
Montgomery	19,000,000	85,973	90,271	30	0.5307	47907.0814	0.0528	8.4240	760447.0588	0.8382
Prince George's	21,000,000	95,023	99,774	30	0.5307	52949.9321	0.0584	8.4240	840494.1176	0.9265
Frederick	6,400,000	28,959	30,407	30	0.5307	16137.1222	0.0178	8.4240	256150.5882	0.2824
Charles	3,950,000	17,873	18,767	30	0.5307	9959.6301	0.0110	8.4240	158092.9412	0.1743
Alexandria	446,264	2,019	2,120	25	0.5307	1125.2214	0.0012	8.8170	18694.3220	0.0206
Arlington	571,986	2,588	2,718	25	0.5307	1442.2200	0.0016	8.8170	23960.9076	0.0264
Fairfax	18,200,000	82,353	86,471	30	0.5307	45889.9412	0.0506	8.4240	728428.2353	0.8030
Prince William	6,900,000	31,222	32,783	30	0.5307	17397.8348	0.0192	8.4240	276162.3529	0.3044
Loudoun	6,100,000	27,602	28,982	30	0.5307	15380.6946	0.0170	8.4240	244143.5294	0.2691
TOTAL	85,368,250	386,282	405,596			215249.6687	0.2373		3453081.8360	3.8064

SUMMER (May - September)

Jurisdiction	2001 Annual VMT	2002 Daily VMT	2010 Daily VMT	Average Speed	PM 2.5 factors (g/mile)	PM 2.5 emissions (grams)	PM 2.5 emissions (tons)	precursor NOx factors (g/mile)	precursor NOx emissions (grams)	precursor NOx emissions (tons)
District of Columbia	2,800,000	12,670	13,303	14	0.5284	7029.3937	0.0077	10.2280	136064.7964	0.1500
Montgomery	19,000,000	85,973	90,271	30	0.5284	47699.4570	0.0526	8.4180	759905.4299	0.8377
Prince George's	21,000,000	95,023	99,774	30	0.5284	52720.4525	0.0581	8.4180	839895.4751	0.9258
Frederick	6,400,000	28,959	30,407	30	0.5284	16067.1855	0.0177	8.4180	255968.1448	0.2822
Charles	3,950,000	17,873	18,767	30	0.5284	9916.4661	0.0109	8.4180	157980.3394	0.1741
Alexandria	446,264	2,019	2,120	25	0.5284	1120.3448	0.0012	8.8100	18679.4802	0.0206
Arlington	571,986	2,588	2,718	25	0.5284	1435.9696	0.0016	8.8100	23941.8846	0.0264
Fairfax	18,200,000	82,353	86,471	30	0.5284	45691.0588	0.0504	8.4180	727909.4118	0.8024
Prince William	6,900,000	31,222	32,783	30	0.5284	17322.4344	0.0191	8.4180	275965.6561	0.3042
Loudoun	6,100,000	27,602	28,982	30	0.5284	15314.0362	0.0169	8.4180	243969.6380	0.2689
TOTAL	85,368,250	386,282	405,596			214316.7985	0.2362		3440280.2562	3.7923

FALL (October - December)

Jurisdiction	2001 Annual VMT	2002 Daily VMT	2010 Daily VMT	Average Speed	PM 2.5 factors (g/mile)	PM 2.5 emissions (grams)	PM 2.5 emissions (tons)	precursor NOx factors (g/mile)	precursor NOx emissions (grams)	precursor NOx emissions (tons)
District of Columbia	2,800,000	12,670	13,303	14	0.4554	6058.2624	0.0067	10.2280	136064.7964	0.1500
Montgomery	19,000,000	85,973	90,271	30	0.4554	41109.6380	0.0453	7.8310	706916.0633	0.7792
Prince George's	21,000,000	95,023	99,774	30	0.4554	45436.9683	0.0501	7.8310	781328.2805	0.8613
Frederick	6,400,000	28,959	30,407	30	0.4554	13847.4570	0.0153	7.8310	238119.0950	0.2625
Charles	3,950,000	17,873	18,767	30	0.4554	8546.4774	0.0094	7.8310	146964.1290	0.1620
Alexandria	446,264	2,019	2,120	25	0.4554	965.5659	0.0011	8.1950	17375.5211	0.0192
Arlington	571,986	2,588	2,718	25	0.4554	1237.5862	0.0014	8.1950	22270.5725	0.0245
Fairfax	18,200,000	82,353	86,471	30	0.4554	39378.7059	0.0434	7.8310	677151.1765	0.7464
Prince William	6,900,000	31,222	32,783	30	0.4554	14929.2896	0.0165	7.8310	256722.1493	0.2830
Loudoun	6,100,000	27,602	28,982	30	0.4554	13198.3575	0.0145	7.8310	226957.2624	0.2502
TOTAL	85,368,250	386,282	405,596			184708.3082	0.2036		3209869.0461	3.5383

2007 CLRP / FY2008-2013 TIP AIR QUALITY CONFORMITY

2010 SCHOOL BUS CHARACTERISTICS / EMISSIONS
Wintertime CO

Jurisdiction	Daily VMT	Average Speed	Wintertime CO		
			factors (g/mile)	emissions (grams)	emissions (tons)
District of Columbia *	13,331	14	4.2040	56042.6832	0.0618
Montgomery *	105,000	30	1.9670	206535.0000	0.2277
Prince George's *	136,465	30	1.9670	268427.3435	0.2959
Frederick	26,868	30	1.9670	52850.2412	0.0583
Charles	21,841	30	1.9670	42961.3454	0.0474
Calvert	26,936	30	1.9670	52982.4236	0.0584
Alexandria *	2,129	25	2.3780	5063.7132	0.0056
Arlington *	2,730	25	2.3780	6491.9400	0.0072
Fairfax	101,350	30	1.9670	199355.8434	0.2198
Prince William	37,920	30	1.9670	74588.0499	0.0822
Loudoun	29,764	30	1.9670	58546.4765	0.0645
Stafford	10,091	30	1.9670	19848.0135	0.0219
TOTAL	514,425			1043693.0732	1.1505
TOTAL FOR CO NON-ATTAINMENT AREA*:					**0.5981**

* The non-attainment area for wintertime CO includes:

DC, ARL, ALEX, MONT, PG