Appendix C.3

Mobile Source Inventory

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1.0 INTRODUCTION AND SCOPE

Mobile sources comprise about 50% of the man made emissions. However, the emissions from mobile sources are widely dispersed like that of area source emissions. Mobile sources can be subdivided into two subcategories, highway mobile sources and non-highway mobile sources. Non-highway mobile sources are further divided into non-road mobile, railroad locomotives and aircraft engines. The larger contributor to the mobile source emissions is from highway mobile sources.

2.0 OVERALL METHODOLOGY

2.1 SOURCE CATEGORY IDENTIFICATION

Highway mobile sources were identified from the U. S. Environmental Protection Agency (USEPA) highway mobile model MOBILE6.2.

Non-highway mobile sources were identified from the USEPA guidance document EPA-450/4-91-016, Procedures for the Preparation of Emissions Inventories for Carbon Monoxide and Precursors of Ozone (Procedures document); EPA-450/4-81-026d (Revised) Procedures for Emission Inventory Preparation, Volume IV; Mobile Sources (Mobile Source Precedures); and from the USEPA's non-road mobile model NONROAD2002 released .

2.2 EMISSION ESTIMATION APPROACH

Mobile source emissions are estimated by the methodologies provided in the Mobile Source Procedures document. The estimation of emissions from mobile sources, like area sources, involves multiplying an activity level by an emission factor.

For highway mobile sources, the USEPA mobile model MOBILE6.2 was used to generate emission factors which were multiplied by the vehicle miles traveled (VMT) in order to estimate the emissions.

The non-road mobile emissions were estimated by using the USEPA non-road mobile model NONROAD2002. Direct emissions are generated with this model. For aircraft engine emissions, the Federal Aviation Administration (FAA) model EDMS was used. Aircraft operations were inputted into the model and the model predicts the engine emissions based on average landing and take-off practices for the aircraft type. For railroad locomotive emissions, emission factors were obtained from the Mobile Source Procedures document and the activity level was obtained from the various railroad companies.

When appropriate the activity levels were seasonally adjusted using the basic methodologies contained in the Procedures document. The equation for this adjustment is:

$$\text{Emissions/Typical Day} = \frac{\text{Yearly Emissions (tons)} \times \text{Seasonal Adjustment Factor}}{(\text{Number of Activity Days per Week}) \times (52\ \text{Weeks})}$$

where the Seasonal Adjustment Factor (SAF) is calculated as follows:

$$SAF = \frac{(\text{Peak Ozone Season Activity}) \times (12 \text{ months})}{(\text{Annual Activity}) \times (\text{Peak Ozone Season months})}$$

where the number of months in the peak ozone season is three (3). Some of the seasonal adjustment factors are provided in the Procedures document. In cases where the SAF has to be calculated, assumptions are made about the monthly and weekly activity levels of the source or source category during the ozone season. Many of the assumptions are based on familiarity with the typical practices in the county.

3.0 QUALITY ASSURANCE MEASURES

The quality assurance procedures for the non-highway mobile source categories were conducted in the same manner as the area source categories. That is, for each category, the completed emission estimate (including a discussion of the methodology) was given to an individual who was not involved with the compilation of emissions for that category. This individual reviewed the information and commented to the emissions inventory developer on any needed modifications.

Due to the importance of the highway mobile source category, more emphasis was placed on the quality assurance of this portion of the inventory. The mobile model inputs, defaults and model outputs were reviewed in detail. Also, the calculational procedures regarding VMT data manipulation and emission calculations were scrutinized.

4.0 DISCUSSION OF MOBILE SOURCE CATEGORIES

Mobile sources are producers of volatile organic compounds (VOCs) and nitrogen oxides (NOx). Emissions of these pollutants are estimated in the mobile source inventory required for the maintenance plan update. There are two major source categories comprising of a number of individual mobile source types. Sections 4.1 and 4.2 addresses for highway mobile sources and off-road mobile sources, respectively. The objective of each section is to describe the source category and the emissions estimation procedures. Each section also includes tables summarizing the estimated emissions for a typical summer day by maintenance area. In Section 5 are copies of the data used in the calculation of the estimated emissions, such as the MOBILE6.2 mobile model input and output files and the NONROAD2002 model input files.

4.1 HIGHWAY MOBILE SOURCE EMISSIONS

4.1.1 Introduction and Scope

Highway mobile sources are considered those vehicles that travel on the roadways and comprise over 30 percent of the emissions of NOx emissions in North Carolina. Emissions from motor vehicles occur throughout the day while the vehicle is in motion, at idle, parked, and during refueling. Each of these emissions sources needs to be estimated in order to properly reflect the total emissions from this source category. In its simplest terms emissions from highway mobile sources are calculated by multiplying an activity level, in this case daily vehicle miles traveled (VMT) as provided by the North Carolina Department of Transportation (NCDOT), by an emission factor.

The U. S. Environmental Protection Agency (USEPA) developed the MOBILE model to estimate emission factors based on information on the way vehicles are driven in a particular area. The newest version of the MOBILE model was used MOBILE6.2. This model was released by the USEPA in 2002 and differs significantly from previous versions of the model. Key inputs for MOBILE include information on the age of vehicles on the roads, the average speed of those vehicles, what types of roads those vehicles are traveling on, any control technologies in place in an area to reduce emissions for motor vehicles (e.g., emissions inspection programs), and ambient temperature.

4.1.2 Quality Assurance Measures

In order to ensure that the estimates that are used in this analysis are reasonable, mobile input files, output files, and calculations used to manipulate the data into the summary format provided in this report were reviewed by several staff members of the North Carolina Division of Air Quaility (DAQ) that were not involved in the preparation of the data and running of the model.

4.1.3 MOBILE6.2 Input Assumptions

The MOBILE6.2 input files and output files are compiled in Section 5 – Data.

Speed Assumptions

Emissions from motor vehicles vary with the manner in which the vehicle is operated. Vehicles traveling at 65 miles per hour (mph) emit a very different mix of pollutants than the car that is idling at a stoplight. In order to estimate emissions from vehicles for a typical day, NCDOT provided speeds for each of the urban areas.

In Wake, Durham, and Granville Counties the latest conformity reports were used to obtain the necessary speeds. The conformity reports provide both peak traffic time, i.e., rush hour speeds and off-peak speeds. Modeling runs were completed for each of the three periods and emission factors generated by peak. The speeds were provided for the following years: 1995, 2005, and 2015. Since these years do not match the analysis years for this maintenance plan update, the 1995 speeds were used for 2000, the 2005 speeds were used for 2004 and 2007, and the 2015 speeds were used for 2010, 2012, and 2015 (this corresponds to the recommendation provided by David Hyder of NCDOT dated January 2, 2003 (see Section 4.1.7).

In Forsyth, Guilford, and Davidson Counties the speeds were provided in the February 7, 2003 e-mail from NCDOT for 2000 and 2014 (see Section 4.1.7). No disaggregating of speeds by time of day was provided; therefore single modeling runs for each year were completed. Again, these years did not correspond to the SIP analysis years; therefore the 2000 speeds were used for 2000, 2004, and 2007 and 2014 speeds were used for 2010, 2012 and 2015.

Since no travel demand model (TDM) is run for Davie County, area specific speeds were not available. Therefore, NCDAQ used the same speed assumptions that were used for non-TDM area in its 8-hour modeling effort. This assumptions was based on the off-peak speeds from the Wake County TDM since these speeds are not influenced by the rush hour speeds for typical roadways. NCDAQ believes that the off-peak speed assumptions are better represented of average speeds in North Carolina then the default speed assumptions in the MOBILE model.

Tables 4.1.3-1 and 4.1.3-2 provide a summary of the speeds used in this analysis for the Greensboro/Winston-Salem/High Point and Raleigh/Durham maintenance areas, respectively. The column headings in these Tables represent the road types used in the modeling and are listed below.

RI	Rural Interstate	UI	Urban Interstate
RPA	Rural Other Principle Arterial	UF	Urban Freeway & Expressway
RMA	Rural Minor Arterial	UPA	Urban Other Principal Arterial
RMjC	Rural Major Collector	UMiA	Urban Minor Arterial
RMiC	Rural Minor Collector	UC	Urban Collector
RL	Rural Local	UL	Urban Local

Table 4.1.3-1 Speeds for One-Hour Maintenance Plan Update for Greensboro/Winson-Salem/High Point Area

County	UI	UF	UPA	UMiA	UC	UL	RI	RPA	RMA	RMjC	RMiC	RL
For 2000												
Davidson	60	55	30	32	34	22	62	52	40	43	43	37
Davie	--	--	--	--	--	--	64	57	50	46	43	44
Forsyth	55	51	32	21	27	21	55	55	44	41	40	33
Guilford	45	50	28	31	32	23	55	53	42	44	44	31
For 2004												
Davidson	60	55	30	32	34	22	62	52	40	43	43	37
Davie	--	--	--	--	--	--	64	57	46	42	42	44
Forsyth	55	51	32	21	27	21	55	55	44	41	40	33
Guilford	45	50	28	31	32	23	55	53	42	44	44	31
For 2007												
Davidson	60	55	30	32	34	22	62	52	40	43	43	37
Davie	--	--	--	--	--	--	64	57	46	42	42	44
Forsyth	55	51	32	21	27	21	55	55	44	41	40	33
Guilford	45	50	28	31	32	23	55	53	42	44	44	31
For 2010												
Davidson	60	55	29	31	34	22	62	51	39	43	42	38
Davie	--	--	--	--	--	--	60	53	43	38	41	44
Forsyth	55	50	27	18	24	20	55	55	44	41	40	32
Guilford	45	46	25	28	30	23	55	53	41	44	44	31
For 2012												
Davidson	60	55	29	31	34	22	62	51	39	43	42	38
Davie	--	--	--	--	--	--	60	53	43	38	41	44
Forsyth	55	50	27	18	24	20	55	55	44	41	40	32
Guilford	45	46	25	28	30	23	55	53	41	44	44	31
For 2015												
Davidson	60	55	29	31	34	22	62	51	39	43	42	38
Davie	--	--	--	--	--	--	60	53	43	38	41	44
Forsyth	55	50	27	18	24	20	55	55	44	41	40	32
Guilford	45	46	25	28	30	23	55	53	41	44	44	31

Table 4.1.3-2 Speeds for One-Hour Maintenance Plan Update for Raleigh/Durham Area

County	UI	UF	UPA	UMiA	UC	UL	RI	RPA	RMA	RMjC	RMiC	RL
For 2000												
AM Peak												
Durham	52	47	39	34	38	34	56	0	55	52	45	44
Granville	--	--	--	--	--	--	64	0	0	42	46	48
Wake	55	48	38	40	36	36	56	53	48	46	43	44
PM Peak												
Durham	55	50	39	34	38	34	56	0	54	52	46	45
Granville	--	--	--	--	--	--	64	0	0	43	47	46
Wake	55	47	39	40	36	36	59	52	47	46	43	44
Off Peak												
Durham	61	53	43	37	37	34	56	0	55	52	46	45
Granville	--	--	--	--	--	--	64	0	0	43	46	47
Wake	55	54	44	43	36	37	64	57	50	46	43	44
For 2004												
AM Peak												
Durham	51	47	36	33	36	33	53	0	54	50	47	41
Granville	--	--	--	--	--	--	55	0	0	43	45	48
Wake	56	49	40	40	36	36	61	53	42	40	41	43
PM Peak												
Durham	53	48	35	34	37	34	52	0	54	51	47	43
Granville	--	--	--	--	--	--	55	0	0	43	45	47
Wake	57	50	39	40	37	36	61	54	41	40	40	43
Off Peak												
Durham	63	58	44	37	41	35	56	0	54	52	47	44
Granville	--	--	--	--	--	--	55	0	0	44	45	47
Wake	64	57	46	41	37	36	64	57	46	42	42	44
For 2007												
AM Peak												
Durham	51	47	36	33	36	33	53	0	54	50	47	41
Granville	--	--	--	--	--	--	55	0	0	43	45	48
Wake	56	49	40	40	36	36	61	53	42	40	41	43
PM Peak												
Durham	53	48	35	34	37	34	52	0	54	51	47	43
Granville	--	--	--	--	--	--	55	0	0	43	45	47
Wake	57	50	39	40	37	36	61	54	41	40	40	43
Off Peak												
Durham	63	58	44	37	41	35	56	0	54	52	47	44
Granville	--	--	--	--	--	--	55	0	0	44	45	47
Wake	64	57	46	41	37	36	64	57	46	42	42	44

Table 4.1.3-2 Speeds for One-Hour Maintenance Plan Update for Raleigh/Durham Area (continued)

County	UI	UF	UPA	UMiA	UC	UL	RI	RPA	RMA	RMjC	RMiC	RL
For 2010												
AM Peak												
Durham	53	47	36	33	36	33	51	0	53	49	48	43
Granville	--	--	--	--	--	--	55	0	0	44	46	47
Wake	52	46	38	37	36	34	51	47	38	37	40	42
PM Peak												
Durham	51	50	37	34	38	35	50	0	52	50	48	44
Granville	--	--	--	--	--	--	55	0	0	45	46	47
Wake	53	46	37	37	35	34	55	48	38	36	39	42
Off Peak												
Durham	63	59	42	38	41	36	58	0	55	51	48	44
Granville	--	--	--	--	--	--	56	0	0	45	46	46
Wake	60	52	42	40	39	35	60	53	43	38	41	44
For 2012												
AM Peak												
Durham	53	47	36	33	36	33	51	0	53	49	48	43
Granville	--	--	--	--	--	--	55	0	0	44	46	47
Wake	52	46	38	37	36	34	51	47	38	37	40	42
PM Peak												
Durham	51	50	37	34	38	35	50	0	52	50	48	44
Granville	--	--	--	--	--	--	55	0	0	45	46	47
Wake	53	46	37	37	35	34	55	48	38	36	39	42
Off Peak												
Durham	63	59	42	38	41	36	58	0	55	51	48	44
Granville	--	--	--	--	--	--	56	0	0	45	46	46
Wake	60	52	42	40	39	35	60	53	43	38	41	44
For 2015												
AM Peak												
Durham	53	47	36	33	36	33	51	0	53	49	48	43
Granville	--	--	--	--	--	--	55	0	0	44	46	47
Wake	52	46	38	37	36	34	51	47	38	37	40	42
PM Peak												
Durham	51	50	37	34	38	35	50	0	52	50	48	44
Granville	--	--	--	--	--	--	55	0	0	45	46	47
Wake	53	46	37	37	35	34	55	48	38	36	39	42
Off Peak												
Durham	63	59	42	38	41	36	58	0	55	51	48	44
Granville	--	--	--	--	--	--	56	0	0	45	46	46
Wake	60	52	42	40	39	35	60	53	43	38	41	44

Vehicle Age Distribution

The vehicle age distribution comes from annual registration data specific to the maintenance areas from NCDOT. For this analysis the data was from 2000. NCDOT provides the data by vehicle type; however, these types do not match the USEPA MOBILE types. USEPA has an utility that will

convert MOBILE5 vehicle type information to the MOBILE6 vehicle types. Therefore, the data is manipulated to match the input requirements for MOBILE 5 as follows:

- NCDOT provides at least 25 years for all vehicle types, however MOBILE5 only recognizes 12 years for motorcycles. Therefore, the first 13 years are combined into one number.

- If more than 25 years are provided, the early years are combined and included in the 25th model year.

- NCDOT does record model years beyond the year of the report, for this set of data, 2001 model year was added to the 2000 model year information.

- The same registration distribution by age must be entered for LDGV, LDDV, and for LDGT1 and LDGT2 according to the MOBILE5 User's Guide.

Then using the MOBILE6 utility, the vehicle types were distributed across the 16 types in MOBILE6. A separate age distribution was created for the Triangle and the Triad and used for all analysis years. See Section 5 for the vehicle age distribution that was used for each maintenance area.

Vehicle Mix Assumptions

The vehicle mix refers to the percentage of different vehicle types on each of the 12 Federal Highway Administration (FHWA) road types. These road types are listed above in the speed assumptions section. It is critical for estimating mobile emissions in an area to use data that accurately reflects the vehicles types traveling on each of these different road types.

For all of North Carolina vehicle mix has incorporated the increase in sales of sport utility vehicles and minivans for all years of evaluation. To calculate the vehicle mix to account for the large percentage of sport utility vehicles and minivans being purchased, DAQ used the following documentation from the USEPA, EPA420-P-99-011: Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates, and Projected Vehicle Counts for Use in MOBILE6. This document includes a breakdown by year from 1983 to 2050 of the number of light duty vehicles (according to MOBILE6 five vehicle types) on the roads on a national basis. DAQ used this data and combined vehicle types to reflect the three MOBILE5 light duty vehicle types. These calculated values for LDGT1 and LDGT2 are used for all road types. Each of the road type mix assumptions was processed through the MOBILE6 utility provided by EPA to convert the vehicle types to those reflected in MOBILE6. A separate vehicle mix was created for each analysis year based on the sales projections. Section 5 provides the vehicle mix for North Carolina.

Temperature Assumptions

In MOBILE6 the temperature inputs are minimum and maximum ambient temperatures for a particular day. For this emission inventory effort DAQ reviewed the temperatures from the 1996 episode to determine an average minimum and maximum temperature for the 11 days of the episode. These temperatures were acquired from the National Oceanic and Atmospheric Administration's National Climatic Data Center website. Each urban area was analyzed in this manner. Table 4.1.3-2 provides the minimum and maximum temperatures used in this analysis.

Table 4.1.3-2 Ambient Temperatures

Area	Minimum Temperature (F)	Maximum Temperature (F)
Triangle	66	91
Triad	66	89

Vehicle Inspection and Maintenance Program Assumptions

In the early 1990's, North Carolina adopted emissions inspection requirements for vehicles in 9 urban counties. This program tests emissions at idle for 1975 and newer gasoline powered light duty vehicles. The program is a basic, decentralized tailpipe test for hydrocarbons (HC) and carbon monoxide (CO) only. The waiver rates are consistent with the SIP. However, the compliance rates have been changed to more accurately reflect what is happening at the stations. Compliance rates have been changed from 98 percent in the previous attainment/maintenance SIP to 95 percent. In addition, the inspection stations are required to administer an anti-tampering check to ensure that emissions control equipment on any vehicle 1968 and newer has not been altered.

In 2002, North Carolina implemented a new vehicle emissions inspection program referred to as onboard diagnostics (OBDII). This program covers all gasoline powered vehicles that are model year 1996 and newer. However, heavy duty vehicles are not tested due to the lack of the necessary equipment not being required on these vehicles. The program is being phased-in original 9 counties and expanded to 48 counties by the end of 2006. Therefore, in the 2004 run, three separate programs are modeled in Wake, Durham, Forsyth, and Guilford counties. In order to accurately reflect these OBDII tests, two separate programs must be incorporated into the input files. The implementation dates of each program are also included in the input files. Waiver rates and compliance rates have been assumed to be consistent with the idle test, as described above. Also, in the original 9 counties, the idle test will be phased-out in 2006.

RVP Assumptions

Reid vapor pressure (RVP) reflects a gasoline's volatility, so as a control measure North Carolina has adopted the Phase II RVP of 7.8 psi. Lower RVP leads to lower volatile organic compound emissions from gasoline handling and lowers vapor losses from motor vehicles.

4.1.4 VMT Assumptions

In order to calculate emissions from mobile sources first the emission factors are developed as discussed throughout this document. The emission factors are then multiplied by an activity level, which for mobile sources is daily vehicle miles traveled (VMT).

The daily VMT for the Greensboro/Winston-Salem/High Point area analysis was provided in the February 7, 2003 e-mail from NCDOT for 2000 and 2014 (see Section 4.1.7). A linear interpolation was conducted for the interim years. Davie County does not have a travel demand model; therefore the VMT was derived from the 2000 and 2001 Highway Performance Maintenance System (HPMS) data provided by NCDOT. The future years were projected using a growth rate from the linear regression completed on the last 10 years of HPMS data. For Davidson County, VMT was reported as inside the Metropolitan Planning Organization (MPO) boundaries and outside the MPO. This definition is to distinguish the High Point urban area (and under the jurisdiction of the MPO) from the remaining rural portion of the county.

The daily VMT for Durham and Granville County was provided in the June 2003 conformity report for the area for 1995, 2005, and 2015. As with the speeds, the VMT was reported by peak period, i.e. morning peak, afternoon peak, and off peak. The daily VMT for Wake County was provided in the June 2002 conformity report for the area for 1995, 2005, and 2015. Wake County VMT was also reported by peak period. Again a linear interpolation was conducted for the interim years.

Tables 4.1.4-1 and 4.1.4-2a-c summarize the VMT used in this analysis for Greensboro/Winston-Salem/High Point and Raleigh/Durham areas, respectively.

Table 4.1.4-1 Vehicle Miles Traveled for the Greensboro/Winston-Salem/High Point Area

Road Type	2000 VMT	2004 VMT*	2007 VMT*	2010 VMT*	2012 VMT*	2015 VMT*
Davidson County (Inside MPO)						
Urban Interstate	372,187	390,004	403,367	416,729	425,638	439,000
Freeway & Expressway	218,406	242,393	260,383	278,373	290,367	308,357
Urban Other Principle Arterial	206,944	221,444	232,319	243,193	250,443	261,318
Urban Minor Arterial	240,679	266,980	286,705	306,430	319,581	339,306
Urban Collector	41,719	46,097	49,381	52,665	54,854	58,138
Urban Local	113,438	118,451	122,212	125,972	128,478	132,238
Rural Interstate	0	0	0	0	0	0
Rural Other Principle Arterial	0	0	0	0	0	0
Rural Minor Arterial	40,468	45,526	49,320	53,113	55,642	59,436
Rural Major Collector	56,459	63,422	68,644	73,866	77,348	82,570
Rural Minor Collector	48,423	54,821	59,620	64,418	67,617	72,416
Rural Local	89,834	128,293	157,137	185,980	205,210	234,054
Davidson County (Outside MPO)						
Urban Interstate	372,830	420,626	456,474	492,321	516,219	552,066
Freeway & Expressway	208,470	241,348	266,007	290,665	307,104	331,763
Urban Other Principle Arterial	325,190	364,142	393,357	422,571	442,047	471,261
Urban Minor Arterial	319,360	352,831	377,935	403,038	419,773	444,877
Urban Collector	45,970	52,312	57,068	61,824	64,995	69,751
Urban Local	132,050	146,050	156,550	167,050	174,050	184,550
Rural Interstate	451,070	506,828	548,646	590,465	618,343	660,162
Rural Other Principal Arterial	277,780	311,351	336,529	361,707	378,492	403,670
Rural Minor Arterial	330,060	360,353	383,072	405,791	420,938	443,657
Rural Major Collector	403,610	455,302	494,071	532,840	558,686	597,455
Rural Minor Collector	225,680	250,403	268,945	287,487	299,849	318,391
Rural Local	163,210	181,719	195,600	209,481	218,736	232,617
Davie County						
Rural Interstate	584,530	659,230	706,156	753,081	784,333	831,259
Rural Other Principal Arterial	0	0	0	0	0	0
Rural Minor Arterial	333,950	366,347	392,424	418,502	435,869	461,947
Rural Major Collector	162,680	163,129	174,741	186,353	194,086	205,698
Rural Minor Collector	90,010	111,664	119,612	127,561	132,855	140,803
Rural Local	73,910	66,531	71,267	76,003	79,157	83,893

Table 4.1.4-1 (continued) Vehicle Miles Traveled for the Greensboro/Winston-Salem/High Point Area

Forsyth County						
Urban Interstate	1,055,357	1,151,143	1,222,983	1,294,822	1,342,715	1,414,555
Freeway & Expressway	2,278,010	2,489,044	2,647,319	2,805,594	2,911,111	3,069,386
Urban Other Principle Arterial	403,029	436,588	461,757	486,925	503,705	528,874
Urban Minor Arterial	864,420	953,535	1,020,371	1,087,206	1,131,764	1,198,600
Urban Collector	936,983	1,031,467	1,102,331	1,173,194	1,220,436	1,291,299
Urban Local	1,730,028	1,895,715	2,019,981	2,144,247	2,227,090	2,351,356
Rural Interstate	997,794	1,065,075	1,115,537	1,165,998	1,199,638	1,250,099
Rural Other Principal Arterial	369,676	386,282	398,736	411,190	419,493	431,947
Rural Minor Arterial	118,909	131,559	141,047	150,534	156,859	166,347
Rural Major Collector	393,979	438,313	471,564	504,815	526,982	560,233
Rural Minor Collector	190,944	217,595	237,584	257,573	270,898	290,887
Rural Local	256,304	289,708	314,762	339,815	356,517	381,570

Guilford County						
Urban Interstate	2,608,351	2,803,840	2,950,457	3,097,074	3,194,818	3,341,435
Freeway & Expressway	1,881,445	2,048,577	2,173,926	2,299,275	2,382,841	2,508,190
Urban Other Principle Arterial	1,575,602	1,722,545	1,832,752	1,942,958	2,016,430	2,126,637
Urban Minor Arterial	2,902,591	3,159,930	3,352,935	3,545,939	3,674,608	3,867,613
Urban Collector	619,757	678,466	722,498	766,530	795,884	839,916
Urban Local	1,347,849	1,470,509	1,562,504	1,654,499	1,715,829	1,807,824
Rural Interstate	1,048,143	1,099,234	1,137,553	1,175,872	1,201,417	1,239,736
Rural Other Principal Arterial	744,403	809,774	858,802	907,830	940,516	989,544
Rural Minor Arterial	201,036	217,898	230,544	243,190	251,621	264,267
Rural Major Collector	577,559	641,047	688,663	736,278	768,022	815,638
Rural Minor Collector	410,440	458,810	495,088	531,366	555,551	591,829
Rural Local	432,008	486,530	527,421	568,312	595,573	636,464

* Linear interpolation between available data for 2000 and 2014.

Table 4.1.4-2a AM Peak Vehicle Miles Traveled for the Raleigh/Durham Area

Road Type	2000 VMT*	2004 VMT*	2007 VMT*	2010 VMT*	2012 VMT*	2015 VMT
Durham County						
Urban Interstate	554,942	630,655	671,109	703,399	724,925	757,214
Freeway & Expressway	430,524	488,394	549,219	618,754	665,111	734,646
Urban Other Principle Arterial	298,844	315,870	337,017	362,351	379,241	404,575
Urban Minor Arterial	364,758	390,966	405,740	418,073	426,295	438,628
Urban Collector	165,526	201,596	214,435	220,169	223,991	229,725
Urban Local	241,210	260,100	271,516	281,557	288,250	298,290
Rural Interstate	21,000	26,792	30,064	32,800	34,624	37,360
Rural Other Principal Arterial	0	0	0	0	0	0
Rural Minor Arterial	37,433	41,790	45,596	49,673	52,390	56,466
Rural Major Collector	12,855	14,241	14,471	14,298	14,182	14,009
Rural Minor Collector	14,610	17,837	19,977	21,978	23,311	25,311
Rural Local	87,988	105,140	110,550	112,232	113,354	115,036
Granville County (Dutchville Township)						
Rural Interstate	70,708	82,274	90,318	98,046	103,197	110,925
Rural Other Principal Arterial	0	0	0	0	0	0
Rural Minor Arterial	0	0	0	0	0	0
Rural Major Collector	45,333	53,308	58,025	62,109	64,832	68,916
Rural Minor Collector	9,822	9,667	9,945	10,420	10,736	11,211
Rural Local	16,650	17,227	17,711	18,220	18,560	19,069
Wake County						
Urban Interstate	989,842	1,637,350	1,950,534	2,177,495	2,328,802	2,555,762
Freeway & Expressway	390,358	274,320	261,563	285,940	302,192	326,569
Urban Other Principle Arterial	880,767	953,992	1,012,661	1,073,207	1,113,570	1,174,115
Urban Minor Arterial	678,467	739,942	814,135	902,370	961,194	1,049,429
Urban Collector	287,717	330,174	371,050	416,443	446,705	492,098
Urban Local	354,436	387,014	428,818	479,307	512,966	563,455
Rural Interstate	331,467	225,863	219,079	248,505	268,122	297,548
Rural Other Principal Arterial	306,623	297,976	323,562	365,185	392,933	434,555
Rural Minor Arterial	241,872	270,395	302,367	339,628	364,468	401,729
Rural Major Collector	148,555	162,730	179,373	199,023	212,122	231,771
Rural Minor Collector	151,438	168,811	193,115	223,057	243,018	272,960
Rural Local	332,337	433,935	509,708	585,268	635,641	711,201

* Linear interpolation between available data.

Table 4.1.4-2b PM Peak Vehicle Miles Traveled for the Raleigh/Durham Area

Road Type	2000 VMT*	2004 VMT*	2007 VMT*	2010 VMT*	2012 VMT*	2015 VMT
Durham County						
Urban Interstate	560,842	640,347	693,384	743,126	776,287	826,029
Freeway & Expressway	414,480	478,231	534,063	593,905	633,799	693,641
Urban Other Principle Arterial	305,738	323,596	345,576	371,848	389,363	415,635
Urban Minor Arterial	373,062	403,529	423,944	443,142	455,940	475,138
Urban Collector	161,684	202,032	216,106	222,086	226,073	232,053
Urban Local	242,326	265,095	276,185	284,282	289,679	297,776
Rural Interstate	24,227	30,451	33,923	36,798	38,714	41,589
Rural Other Principal Arterial	0	0	0	0	0	0
Rural Minor Arterial	44,255	48,587	53,036	58,085	61,451	66,500
Rural Major Collector	14,816	16,330	16,225	15,500	15,017	14,292
Rural Minor Collector	14,426	17,467	19,195	20,648	21,616	23,069
Rural Local	93,620	109,378	116,119	120,321	123,122	127,323
Granville County (Dutchville Township)						
Rural Interstate	81,162	94,016	103,151	112,035	117,957	126,841
Rural Other Principal Arterial	0	0	0	0	0	0
Rural Minor Arterial	0	0	0	0	0	0
Rural Major Collector	51,469	59,558	64,489	68,853	71,762	76,126
Rural Minor Collector	10,197	9,902	10,477	11,451	12,100	13,073
Rural Local	17,952	18,227	18,770	19,480	19,954	20,664
Wake County						
Urban Interstate	1,005,868	1,661,775	1,982,160	2,216,772	2,373,179	2,607,791
Freeway & Expressway	408,645	286,009	271,493	295,709	311,852	336,067
Urban Other Principle Arterial	915,536	993,316	1,058,221	1,126,411	1,171,870	1,240,060
Urban Minor Arterial	712,455	766,843	845,583	943,297	1,008,440	1,106,154
Urban Collector	296,590	327,840	376,045	436,636	477,029	537,619
Urban Local	367,843	394,193	439,548	497,699	536,467	594,618
Rural Interstate	340,143	237,839	230,996	259,095	277,827	305,926
Rural Other Principal Arterial	330,968	312,588	337,492	381,741	411,240	455,488
Rural Minor Arterial	257,840	282,105	314,499	353,992	380,320	419,813
Rural Major Collector	159,640	169,273	186,867	209,647	224,833	247,613
Rural Minor Collector	169,340	181,042	205,443	237,658	259,134	291,349
Rural Local	352,765	446,289	537,611	639,524	707,465	809,377

* Linear interpolation between available data.

Table 4.1.4-2c Off Peak Vehicle Miles Traveled for the Raleigh/Durham Area

Road Type	2000 VMT*	2004 VMT*	2007 VMT*	2010 VMT*	2012 VMT*	2015 VMT
Durham County						
Urban Interstate	772,946	879,861	954,669	1,026,788	1,074,867	1,146,985
Freeway & Expressway	642,150	767,856	858,835	948,164	1,007,717	1,097,046
Urban Other Principle Arterial	387,056	405,952	428,764	455,896	473,984	501,116
Urban Minor Arterial	453,208	478,340	500,482	524,271	540,130	563,918
Urban Collector	183,127	223,003	244,762	262,448	274,238	291,923
Urban Local	276,749	304,262	317,239	326,388	332,487	341,635
Rural Interstate	32,921	41,179	46,082	50,342	53,181	57,440
Rural Other Principal Arterial	0	0	0	0	0	0
Rural Minor Arterial	64,373	72,450	78,743	85,154	89,428	95,839
Rural Major Collector	14,144	13,658	13,570	13,621	13,654	13,705
Rural Minor Collector	14,854	16,619	18,292	20,141	21,373	23,221
Rural Local	115,436	131,212	140,101	147,519	152,464	159,881
Granville County (Dutchville Township)						
Rural Interstate	111,478	128,387	141,234	154,164	162,784	175,714
Rural Other Principal Arterial	0	0	0	0	0	0
Rural Minor Arterial	0	0	0	0	0	0
Rural Major Collector	67,755	78,100	85,193	91,954	96,461	103,221
Rural Minor Collector	12,168	11,378	11,707	12,498	13,025	13,816
Rural Local	22,290	22,059	22,793	23,981	24,772	25,960
Wake County						
Urban Interstate	1,466,368	2,457,366	2,916,313	3,233,108	3,444,304	3,761,099
Freeway & Expressway	597,309	395,695	370,525	408,374	433,606	471,455
Urban Other Principle Arterial	1,245,889	1,339,609	1,421,690	1,509,667	1,568,318	1,656,295
Urban Minor Arterial	854,066	867,129	956,421	1,085,459	1,171,485	1,300,523
Urban Collector	331,155	359,015	413,090	483,756	530,866	601,532
Urban Local	437,531	463,085	513,407	579,307	623,241	689,141
Rural Interstate	468,685	316,010	313,252	366,369	401,780	454,897
Rural Other Principal Arterial	641,002	705,440	697,581	661,629	637,661	601,709
Rural Minor Arterial	257,197	221,710	275,149	368,615	430,926	524,392
Rural Major Collector	233,647	284,360	298,286	300,158	301,406	303,278
Rural Minor Collector	192,289	215,043	248,220	289,454	316,943	358,176
Rural Local	274,655	270,804	404,828	607,309	742,296	944,777

* Linear interpolation between available data.

4.1.5 Off Model Calculations

Not all 100 counties in North Carolina have a motor vehicle emission inspection program to address mobile emissions. As a direct result, such a control measure must be evaluated based on commuting activities to account for the vehicles that are not subject to such a program traveling throughout the maintenance counties. In the original maintenance plan a methodology was developed to take into account the commuting of vehicles. This methodology was approved by the USEPA and will be used in this updated analysis.

The methodology uses accident data that is tracked by NCDOT as a surrogate for commuting patterns. The accident data used in this analysis is for 2001.

In 2000, the inspection and maintenance program is only in the original 9 counties (Cabarrus, Durham, Forsyth, Gaston, Guilford, Mecklenburg, Orange, Union, and Wake Counties). Due to the phase in of the new OBDII program the number of counties will increase with each analysis year. To conservatively estimate the fraction in 2004, NCDAQ will use the Phase 2 fraction (which reflects counties brought into the program as of July 1, 2003) will include 15 counties. The final counties will be incorporated into the program by January 1, 2006 so the 2007, 2010, 2012, and 2015 runs will include all 48 counties. Table 4.1.5-1 summarizes the I/M fractions used to calculate the tons per day emissions for each of the counties being analyzed.

Table 4.1.5-1 I/M Fractions

County	2000	2004	2007, 2010, 2012 and 2015	County	2000	2004	2007, 2010, 2012 and 2015
Durham	0.83	0.85	0.93	Davidson	0.10	0.89	0.96
Granville	0.13	0.14	0.83	Forsyth	0.78	0.84	0.93
Wake	0.80	0.86	0.96	Guilford	0.76	0.81	0.96

The calculation of tons per day is as follows:

$$\text{Emissions} = \frac{(\text{I/M EF x I/M fraction x VMT}) + (\text{Non I/M EF x (1-I/M fraction) x VMT})}{C}$$

Where:

I/M EF = all vehicle emission factor from M6 inspection and maintenance run output for each road type (grams/mile)

I/M fraction = calculated I/M fraction for the analysis year

VMT = daily vehicle miles traveled (miles/day)

Non I/M EF = all vehicle emission factor from M6 non-inspection and maintenance output for each road type

C = conversion factor from grams to tons = 907185 grams per ton

Each road type will have a different emission factor, which is then summed for each county for each year evaluated. A summary of emissions by county is provided in Tables 4.1.5-2 and 4.1.5-3 for VOC and NOx emissions, respectively. The emissions for Granville County were calculated using VMT data for Dutchville Township only (the portion of the County that is in the maintenance area) which was provided by NCDOT. For Davie County, the emission estimates for the county was apportioned by population. The portion of Davie County in the maintenance area is 0.7% of the total County population. In Tables 4.1.5-3 and 4.1.5-4 the VOC and NOx emissions, respectively, are listed by county and road type. Since the total emissions are so small for Davie County, the road type emissions are not included in these tables.

Table 4.1.5-2. County VOC Mobile Emissions by Year

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	8.37	6.49	5.44	4.46	3.91	3.43
Davie	0.02	0.01	0.01	0.01	0.01	0.01
Forsyth	17.00	13.77	11.38	9.37	8.14	7.08
Guilford	25.00	20.21	16.56	13.51	11.70	10.14
Total	50.39	40.48	33.39	27.35	23.76	20.66
Raleigh/Durham maintenance area						
Durham	10.76	8.74	7.09	5.69	4.95	4.31
Granville	0.73	0.61	0.47	0.39	0.34	0.30
Wake	24.95	20.36	17.13	14.59	13.03	11.76
Total	36.44	29.71	24.69	20.67	18.32	16.37

Table 4.1.5-3. County NOx Mobile Emissions by Year

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	16.23	12.78	9.90	7.35	5.94	4.29
Davie	0.05	0.04	0.03	0.02	0.02	0.01
Forsyth	31.50	24.18	18.42	13.67	11.06	7.99
Guilford	44.70	34.03	25.74	18.97	15.36	11.07
Total	92.48	71.03	54.09	40.01	32.38	23.36
Raleigh/Durham maintenance area						
Durham	22.38	17.99	13.65	9.96	7.90	5.55
Granville	2.65	1.80	1.30	0.99	0.77	0.53
Wake	55.28	46.86	36.95	26.23	21.23	15.30
Total	80.31	66.65	51.9	37.18	29.9	21.38

Table 4.1.5-4 VOC Road Type Emissions by County

Road Type	2000	2004	2007	2010	2012	2015
Davidson County						
Urban Interstate	1.20	0.91	0.74	0.61	0.53	0.47
Freeway & Expressway	0.73	0.57	0.48	0.40	0.35	0.31
Urban Other Principle Arterial	1.05	0.80	0.67	0.54	0.47	0.41
Urban Minor Arterial	1.09	0.84	0.70	0.57	0.50	0.43
Urban Collector	0.17	0.13	0.11	0.09	0.08	0.07
Urban Local	0.54	0.40	0.33	0.26	0.23	0.19
Rural Interstate	0.67	0.53	0.44	0.37	0.33	0.29
Rural Other Principal Arterial	0.47	0.36	0.31	0.25	0.22	0.20
Rural Minor Arterial	0.67	0.51	0.42	0.34	0.30	0.26
Rural Major Collector	0.83	0.65	0.55	0.45	0.40	0.35
Rural Minor Collector	0.49	0.38	0.32	0.26	0.23	0.20
Rural Local	0.47	0.40	0.36	0.30	0.27	0.25
Total VOC for Davidson	8.38	6.48	5.43	4.44	3.91	3.43
Durham County						
Urban Interstate	2.54	2.08	1.69	1.36	1.20	1.05
Freeway & Expressway	2.10	1.76	1.48	1.24	1.11	0.99
Urban Other Principle Arterial	1.47	1.13	0.91	0.73	0.64	0.55
Urban Minor Arterial	1.84	1.43	1.13	0.88	0.75	0.64
Urban Collector	0.78	0.69	0.56	0.44	0.37	0.32
Urban Local	1.18	0.93	0.74	0.57	0.48	0.41
Rural Interstate	0.10	0.09	0.08	0.06	0.06	0.05
Rural Other Principal Arterial	0.00	0.00	0.00	0.00	0.00	0.00
Rural Minor Arterial	0.20	0.16	0.13	0.11	0.10	0.09
Rural Major Collector	0.06	0.05	0.03	0.03	0.02	0.02
Rural Minor Collector	0.06	0.05	0.05	0.04	0.03	0.03
Rural Local	0.44	0.37	0.30	0.23	0.20	0.17
Total VOC for Durham	10.77	8.74	7.10	5.69	4.96	4.32
Forsyth County						
Urban Interstate	1.63	1.31	1.08	0.88	0.77	0.67
Freeway & Expressway	3.71	2.99	2.46	2.01	1.75	1.52
Urban Other Principle Arterial	0.73	0.59	0.48	0.41	0.35	0.30
Urban Minor Arterial	1.81	1.48	1.24	1.06	0.92	0.80
Urban Collector	1.81	1.48	1.23	1.03	0.89	0.77
Urban Local	3.62	2.94	2.45	2.00	1.73	1.50
Rural Interstate	1.44	1.14	0.92	0.74	0.65	0.56
Rural Other Principal Arterial	0.58	0.45	0.36	0.28	0.25	0.21
Rural Minor Arterial	0.20	0.16	0.14	0.11	0.10	0.08
Rural Major Collector	0.68	0.56	0.46	0.38	0.33	0.29
Rural Minor Collector	0.33	0.28	0.24	0.20	0.17	0.15
Rural Local	0.46	0.39	0.33	0.27	0.24	0.21
Total VOC for Forsyth	17.00	13.77	11.39	9.37	8.15	7.06

Table 4.1.5-4 (Continued) VOC Road Type Emissions by County

Road Type	2000	2004	2007	2010	2012	2015
Granville County						
Rural Interstate	0.34	0.30	0.23	0.19	0.17	0.16
Rural Major Collector	0.25	0.22	0.17	0.13	0.12	0.10
Rural Minor Collector	0.05	0.03	0.03	0.02	0.02	0.02
Rural Local	0.09	0.06	0.05	0.04	0.03	0.03
Total VOC for Granville	0.73	0.61	0.48	0.38	0.34	0.31
Guilford County						
Urban Interstate	4.18	3.35	2.72	2.18	1.89	1.64
Freeway & Expressway	3.08	2.48	2.03	1.67	1.45	1.26
Urban Other Principle Arterial	2.98	2.42	1.99	1.65	1.43	1.24
Urban Minor Arterial	5.38	4.36	3.58	2.95	2.55	2.20
Urban Collector	1.14	0.93	0.77	0.63	0.54	0.47
Urban Local	2.73	2.22	1.83	1.46	1.26	1.09
Rural Interstate	1.51	1.18	0.94	0.75	0.65	0.56
Rural Other Principal Arterial	1.18	0.95	0.78	0.63	0.55	0.48
Rural Minor Arterial	0.34	0.27	0.22	0.18	0.16	0.14
Rural Major Collector	0.98	0.81	0.67	0.55	0.48	0.42
Rural Minor Collector	0.70	0.58	0.48	0.39	0.35	0.30
Rural Local	0.79	0.67	0.56	0.46	0.40	0.35
Total VOC for Guilford	24.99	20.22	16.57	13.50	11.71	10.15
Wake County						
Urban Interstate	4.66	5.51	4.92	4.20	3.76	3.40
Freeway & Expressway	1.98	0.96	0.68	0.57	0.51	0.45
Urban Other Principle Arterial	4.52	3.50	2.80	2.26	1.95	1.69
Urban Minor Arterial	3.37	2.58	2.14	1.82	1.62	1.46
Urban Collector	1.41	1.13	0.97	0.84	0.75	0.69
Urban Local	1.77	1.38	1.16	0.99	0.88	0.80
Rural Interstate	1.43	0.70	0.52	0.46	0.42	0.39
Rural Other Principal Arterial	1.76	1.30	1.00	0.80	0.69	0.58
Rural Minor Arterial	1.08	0.81	0.71	0.64	0.59	0.56
Rural Major Collector	0.79	0.66	0.54	0.44	0.38	0.33
Rural Minor Collector	0.76	0.61	0.52	0.46	0.42	0.38
Rural Local	1.41	1.23	1.17	1.11	1.05	1.02
Total VOC for Wake	24.94	20.37	17.13	14.59	13.02	11.75

Table 4.1.5-5 NOx Road Type Emissions by County

Road Type	2000	2004	2007	2010	2012	2015
Davidson County						
Urban Interstate	3.74	2.80	2.13	1.52	1.19	0.82
Freeway & Expressway	1.45	1.14	0.89	0.67	0.55	0.40
Urban Other Principle Arterial	1.24	1.01	0.78	0.60	0.50	0.37
Urban Minor Arterial	1.17	0.96	0.75	0.58	0.49	0.37
Urban Collector	0.17	0.15	0.11	0.09	0.08	0.06
Urban Local	0.58	0.47	0.36	0.27	0.22	0.17
Rural Interstate	3.41	2.61	2.03	1.45	1.12	0.76
Rural Other Principal Arterial	1.08	0.82	0.63	0.46	0.37	0.27
Rural Minor Arterial	1.00	0.80	0.62	0.46	0.38	0.27
Rural Major Collector	1.13	0.94	0.74	0.57	0.47	0.36
Rural Minor Collector	0.67	0.55	0.43	0.33	0.27	0.20
Rural Local	0.59	0.53	0.44	0.36	0.30	0.24
Total NOx for Davidson	16.23	12.78	9.91	7.36	5.94	4.29
Durham County						
Urban Interstate	8.82	6.89	5.21	3.69	2.84	1.91
Freeway & Expressway	4.66	3.85	3.01	2.30	1.86	1.34
Urban Other Principle Arterial	2.21	1.71	1.29	0.96	0.78	0.56
Urban Minor Arterial	2.33	1.86	1.37	1.01	0.81	0.59
Urban Collector	0.95	0.88	0.67	0.49	0.40	0.29
Urban Local	1.58	1.28	0.94	0.68	0.54	0.39
Rural Interstate	0.51	0.41	0.32	0.23	0.18	0.12
Rural Other Principal Arterial	0.00	0.00	0.00	0.00	0.00	0.00
Rural Minor Arterial	0.43	0.35	0.28	0.20	0.16	0.12
Rural Major Collector	0.11	0.08	0.06	0.04	0.03	0.02
Rural Minor Collector	0.10	0.09	0.07	0.06	0.05	0.03
Rural Local	0.68	0.58	0.44	0.32	0.25	0.18
Total NOx for Durham	22.38	17.98	13.66	9.98	7.90	5.55
Forsyth County						
Urban Interstate	4.87	3.61	2.73	1.97	1.55	1.08
Freeway & Expressway	7.40	5.60	4.25	3.10	2.52	1.83
Urban Other Principle Arterial	0.93	0.75	0.57	0.44	0.37	0.27
Urban Minor Arterial	1.94	1.62	1.26	1.02	0.86	0.65
Urban Collector	1.90	1.58	1.23	0.98	0.83	0.63
Urban Local	4.12	3.40	2.63	2.04	1.70	1.28
Rural Interstate	6.54	4.62	3.44	2.39	1.83	1.22
Rural Other Principal Arterial	1.48	1.06	0.78	0.55	0.43	0.30
Rural Minor Arterial	0.33	0.27	0.21	0.16	0.13	0.09
Rural Major Collector	0.95	0.79	0.61	0.47	0.39	0.29
Rural Minor Collector	0.46	0.39	0.31	0.24	0.20	0.15
Rural Local	0.59	0.50	0.39	0.31	0.26	0.19
Total NOx for Forsyth	31.51	24.19	18.41	13.67	11.07	7.98

Table 4.1.5-5 (Continued) NOx Road Type Emissions by County

Road Type	2000	2004	2007	2010	2012	2015
Granville County						
Rural Interstate	2.05	1.30	0.94	0.71	0.55	0.37
Rural Major Collector	0.39	0.34	0.24	0.19	0.16	0.11
Rural Minor Collector	0.08	0.06	0.04	0.03	0.02	0.02
Rural Local	0.13	0.10	0.07	0.05	0.04	0.03
Total NOx for Granville	2.65	1.80	1.29	0.98	0.77	0.53
Guilford County						
Urban Interstate	10.82	7.72	5.74	4.10	3.24	2.26
Freeway & Expressway	6.04	4.55	3.44	2.44	1.98	1.43
Urban Other Principle Arterial	3.69	3.01	2.31	1.80	1.49	1.11
Urban Minor Arterial	6.03	4.94	3.78	2.95	2.47	1.86
Urban Collector	1.22	1.01	0.78	0.61	0.51	0.39
Urban Local	3.14	2.58	1.98	1.51	1.26	0.94
Rural Interstate	6.87	4.77	3.51	2.41	1.83	1.21
Rural Other Principal Arterial	2.91	2.17	1.64	1.19	0.95	0.67
Rural Minor Arterial	0.54	0.44	0.33	0.25	0.20	0.15
Rural Major Collector	1.42	1.18	0.91	0.70	0.58	0.43
Rural Minor Collector	1.00	0.84	0.65	0.50	0.42	0.31
Rural Local	1.01	0.84	0.66	0.51	0.43	0.32
Total NOx for Guilford	44.69	34.05	25.73	18.97	15.36	11.08
Wake County						
Urban Interstate	15.61	19.49	16.28	10.99	8.69	6.04
Freeway & Expressway	4.37	2.12	1.40	0.98	0.79	0.57
Urban Other Principle Arterial	6.79	5.48	4.11	2.98	2.40	1.73
Urban Minor Arterial	4.46	3.52	2.73	2.13	1.79	1.37
Urban Collector	1.70	1.42	1.14	0.92	0.79	0.62
Urban Local	2.42	1.92	1.51	1.18	0.99	0.75
Rural Interstate	8.19	3.95	2.72	1.74	1.37	0.94
Rural Other Principal Arterial	4.99	3.53	2.54	1.63	1.25	0.84
Rural Minor Arterial	2.07	1.48	1.21	0.97	0.82	0.63
Rural Major Collector	1.29	1.05	0.80	0.58	0.47	0.34
Rural Minor Collector	1.19	0.96	0.77	0.62	0.52	0.40
Rural Local	2.20	1.95	1.74	1.52	1.34	1.08
Total NOx for Wake	55.28	46.87	36.95	26.24	21.22	15.31

4.1.6 Motor Vehicle Emissions Budget for Conformity

Transportation Conformity

Transportation conformity is used to ensure that Federal transportation actions occurring in the maintenance areas do not hinder the area from maintaining the 1-hour ozone standard. This means that the level of emissions estimated by the NC Department of Transportation (NCDOT) or the Metropolitan Planning Organizations (MPOs) for the Transportation Implementation Plan (TIP) must not exceed the on-road motor vehicle emissions budget (MVEB) defined in the maintenance SIP for motor vehicles.

Safety Margin

A safety margin is the difference between the attainment level of emissions from all source categories (i.e., point, area, mobile and biogenic) and the projected level of emissions from all source categories. The State may choose to allocate some of the safety margin to the MVEB, for transportation conformity purposes, so long as the total level of emissions from all source categories remains below the attainment level of emissions.

North Carolina has decided to allocate a portion of the safety margin to the MVEB to allow for unanticipated growth in VMT, changes to vehicle mix assumptions, etc. that will influence the emission estimations. In coordination with NCDOT, NCDAQ has developed a separate methodology for the safety margin for the two maintenance areas (i.e. the Triad and the Triangle).

In the Triad, the travel demand model has been updated to include the latest socio-economic data and therefore the projected VMT generated by the model reflects reasonable VMT growth into the near future. Therefore, the safety margin for 2007 and 2010 in the Triad maintenance area reflects MOBILE6.2's sensitivity to changes in vehicle mix and vehicle age distribution. A sensitivity analysis was completed using MOBILE6.2 to determine the percentages that would be used for the safety margin for each of the years of this plan. It was determined through this sensitivity that the emissions consistently changed for each year, therefore the percentages stayed the same for each pollutant through the analysis years (6 percent for VOC, and 6 percent for NOx). In 2012 and 2015, the Triad safety margin also includes potential changes in population and thus changes in the VMT. The population impact was estimated by comparing the county populations from the 1990 census to the 2000 census for each of the out years. The percent difference was added to the sensitivity percentages to develop the total safety margin by year.

In the Triangle, the current travel demand model does not reflect the most recent update to the census data (2000). Therefore, it was determined that the safety margin in the Triangle would reflect both the potential changes in population and changes to vehicle mix and vehicle age distribution. The same percentages were used for the vehicle mix and vehicle age distribution sensitivities as

those used for the Triad. A comparison of the 1990 to 2000 census data was completed for 2007, 2010, 2012, and 2015 and the resulting percentages were added to the sensitivity percentages.

Table 4.1.6-1 summarizes the percent increase to the MVEB for purposes of transportation conformity for each of the maintenance areas.

Table 4.1.6-1 Percent Increase To Mobile Vehicle Emissions Budget

County	2004	2007	2010	2012	2015
Greensboro/Winston-Salem High Point					
VOC	0%	6%	6%	12%	15%
NOx	0%	6%	6%	7%	10%
Raleigh Durham					
VOC	9%	17%	19%	20%	22%
NOx	9%	12%	14%	15%	17%

Motor Vehicle Emission Budgets

NCDOT requested that the MVEB, for transportation conformity purposes, be split out by county since the conformity timetable may vary county by county within a maintenance area. NCDAQ has agreed to set the MVEB, for transportation conformity purposes, as county budgets within a maintenance area. This will allow the flexibility of an area to either meet only the county budget or to combine the county budgets for a maintenance area and meet the regional budget. The tables below list out the MVEB, for transportation conformity purposes, by county.

Greensboro/Winston-Salem/High Point Maintenance Area

Tables 4.1.6-2 through 4.1.6-5 explicitly provide county-by-county sub-area MVEB for counties (or portion thereof) that comprise the 1-hour ozone maintenance area for the Greensboro/Winston-Salem/High Point area for the years 2004, 2007, 2010, 2012, and 2015 for both volatile organic compounds and nitrogen oxides. Upon EPA's affirmative adequacy finding for these sub-area MVEB, these MVEB will become the applicable MVEB for each county. The MVEB for Davie County is only for the portion of Davie County that is within the maintenance area.

Table 4.1.6-2 Davidson County MVEB

	2000	2004	2007	2010	2012	2015
VOC Emissions (tons/day)						
Base Emissions	8.37	6.49	5.44	4.46	3.91	3.43
Safety Margin Allocated to MVEB	0.00	0.00	0.33	0.27	0.47	0.51
VOC Conformity MVEB	**8.37**	**6.49**	**5.77**	**4.73**	**4.38**	**3.94**
NOx Emissions (tons/day)						
Base Emissions	16.23	12.78	9.90	7.35	5.94	4.29
Safety Margin Allocated to MVEB	0.00	0.00	0.59	0.44	0.42	0.43
NOx Conformity MVEB	**16.23**	**12.78**	**10.49**	**7.79**	**6.36**	**4.72**

Table 4.1.6-3 Davie County* MVEB

	2000	2004	2007	2010	2012	2015
VOC Emissions (tons/day)						
Base Emissions	0.02	0.01	0.01	0.01	0.01	0.01
Safety Margin Allocated to MVEB	0.00	0.00	0.00	0.00	0.00	0.00
VOC Conformity MVEB	**0.02**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
NOx Emissions (tons/day)						
Base Emissions	0.05	0.04	0.03	0.02	0.02	0.01
Safety Margin Allocated to MVEB	0.00	0.00	0.00	0.00	0.00	0.00
NOx Conformity MVEB	**0.05**	**0.04**	**0.03**	**0.02**	**0.02**	**0.01**

*The Davie County MVEB is for the portion of Davie County in the maintenance area.

Table 4.1.6-4 Forsyth County MVEB

	2000	2004	2007	2010	2012	2015
VOC Emissions (tons/day)						
Base Emissions	17.00	13.77	11.38	9.37	8.14	7.08
Safety Margin Allocated to MVEB	0.00	0.00	0.68	0.56	0.98	1.06
VOC Conformity MVEB	**17.00**	**13.77**	**12.06**	**9.93**	**9.12**	**8.14**
NOx Emissions (tons/day)						
Base Emissions	31.50	24.18	18.42	13.67	11.06	7.99
Safety Margin Allocated to MVEB	0.00	0.00	1.11	0.82	0.77	0.80
NOx Conformity MVEB	**31.50**	**24.18**	**19.53**	**14.49**	**11.83**	**8.79**

Table 4.1.6-5 Guilford County MVEB

	2000	2004	2007	2010	2012	2015
VOC Emissions (tons/day)						
Base Emissions	25.00	20.21	16.56	13.51	11.70	10.14
Safety Margin Allocated to MVEB	0.00	0.00	0.99	0.81	1.40	1.52
VOC Conformity MVEB	**25.00**	**20.21**	**17.55**	**14.32**	**13.10**	**11.66**
NOx Emissions (tons/day)						
Base Emissions	44.70	34.03	25.74	18.97	15.36	11.07
Safety Margin Allocated to MVEB	0.00	0.00	1.54	1.14	1.08	1.11
NOx Conformity MVEB	**44.70**	**34.03**	**27.28**	**20.11**	**16.44**	**12.18**

Raleigh/Durham Maintenance Area

Tables 4.1.6-6 through 4.1.6-8 explicitly provide county-by-county sub-area MVEB for counties (or portion thereof) that comprise the 1-hour ozone maintenance area for the Raleigh/Durham area for the years 2004, 2007, 2010, 2012, and 2015 for both volatile organic compounds and nitrogen oxides. Upon EPA's affirmative adequacy finding for these sub-area MVEB, these MVEB will become the applicable MVEB for each county. The MVEB for Granville County is only for the portion of Granville County that is within the maintenance area.

Table 4.1.6-6 Durham County MVEB

	2000	2004	2007	2010	2012	2015
VOC Emissions (tons/day)						
Base Emissions	10.76	8.74	7.09	5.69	4.95	4.31
Safety Margin Allocated to MVEB	0.00	0.79	1.21	1.08	0.99	0.95
VOC Conformity MVEB	**10.76**	**9.53**	**8.30**	**6.77**	**5.94**	**5.26**
NOx Emissions (tons/day)						
Base Emissions	22.38	17.99	13.65	9.96	7.90	5.55
Safety Margin Allocated to MVEB	0.00	1.62	1.64	1.39	1.19	0.94
NOx Conformity MVEB	**22.38**	**19.61**	**15.29**	**11.35**	**9.09**	**6.49**

Table 4.1.6-7 Granville County* MVEB

	2000	2004	2007	2010	2012	2015
VOC Emissions (tons/day)						
Base Emissions	0.73	0.61	0.47	0.39	0.34	0.30
Safety Margin Allocated to MVEB	0.00	0.05	0.08	0.07	0.07	0.07
VOC Conformity MVEB	**0.73**	**0.66**	**0.55**	**0.46**	**0.41**	**0.37**
NOx Emissions (tons/day)						
Base Emissions	2.65	1.80	1.30	0.99	0.77	0.53
Safety Margin Allocated to MVEB	0.00	0.16	0.16	0.14	0.12	0.09
NOx Conformity MVEB	**2.65**	**1.96**	**1.46**	**1.13**	**0.89**	**0.62**

*The Granville County MVEB is for the portion of Granville County in the maintenance area.

Table 4.1.6-8 Wake County MVEB

	2000	2004	2007	2010	2012	2015
VOC Emissions (tons/day)						
Base Emissions	24.95	20.36	17.13	14.59	13.03	11.76
Safety Margin Allocated to MVEB	0.00	1.83	2.91	2.77	2.61	2.59
VOC Conformity MVEB	**24.95**	**22.19**	**20.04**	**17.36**	**15.64**	**14.35**
NOx Emissions (tons/day)						
Base Emissions	55.28	46.86	36.95	26.23	21.23	15.30
Safety Margin Allocated to MVEB	0.00	4.22	4.43	3.67	3.18	2.60
NOx Conformity MVEB	**55.28**	**51.08**	**41.38**	**29.90**	**24.41**	**17.90**

4.1.7 Correspondence with NCDOT

TRIAD VMT AND SPEED

Subject: TRIAD VMT AND SPEED
Date: Fri, 07 Feb 2003 14:11:03 -0500
From: Behshad Norowzi <bnorowzi@dot.state.nc.us>
Organization: North Carolina Department of Transportation
To: "Jill.Vitas@ncmail.net" <Jill.Vitas@ncmail.net>,
Lisa Grosshandler <Lisa.Grosshandler@ncmail.net>,
"Vicki.chandler@ncmail.net" <Vicki.chandler@ncmail.net>,
"Phyllis D. Jones" <Phyllis.D.Jones@ncmail.net>
CC: Laura Cove <lcove@dot.state.nc.us>, Mike Bruff <mbruff@dot.state.nc.us>,
"Jamal Alavi, PE" <jalavi@dot.state.nc.us>, Jerry Dudeck <dudeck@dot.state.nc.us>,
James Upchurch <jhupchurch@dot.state.nc.us>,
Kimberly Drew Hinton <khinton@dot.state.nc.us>,
Edward Dancausse <Edward.Dancausse@fhwa.dot.gov>,
"sheila.Holman@ncmail.net" <sheila.Holman@ncmail.net>

```
Hi Jill,
Please see the attached file for the Triad speed and VMT and let
me know if there is any question.
Thanks,
Behshad
```

Triad1-hr VMT.xls	**Name:** Triad1-hr VMT.xls **Type:** Microsoft Excel Worksheet (application/vnd.ms-excel) **Encoding:** base64

DAVIDSON 2000	Average Speed	Vehicle Miles of Travel		
Functional Classification		Inside MPO	Outside MPO	Total
Urban Interstate	60	372,187	372,830	745,017
Freeway & Expressway	55	218,406	208,470	426,876
Urban Other Principle Arterial	30	206,944	325,190	532,134
Urban Minor Arterial	32	240,679	319,360	560,039
Urban Collector	34	41,719	45,970	87,689
Urban Local	22	113,438	132,050	245,488
Rural Interstate	62	-	451,070	451,070
Rural Other Principal Arteria	52	-	277,780	277,780
Rural Minor Arterial	40	40,468	330,060	370,528
Rural Major Collector	43	56,459	403,610	460,069
Rural Minor Collector	43	48,423	225,680	274,103
Rural Local	37	69,034	193,210	253,044
Total		**1,428,557**	**3255280**	4,683,837

DAVIDSON 2014	Average Speed	Vehicle Miles of Travel		
Functional Classification		Inside MPO	Outside MPO	Total
Urban Interstate	60	434,545	540,117	974,663
Freeway & Expressway	55	302,360	323,543	625,903
Urban Other Principle Arterial	29	257,693	461,523	719,216
Urban Minor Arterial	31	332,731	436,509	769,240
Urban Collector	34	57,043	68,166	125,209
Urban Local	22	130,985	181,050	312,035
Rural Interstate	62	-	646,222	646,222
Rural Other Principal Arteria	61	-	395,277	395,277
Rural Minor Arterial	39	58,171	436,084	494,255
Rural Major Collector	43	80,829	584,532	665,361
Rural Minor Collector	42	70,816	312,210	383,026
Rural Local	38	224,439	227,990	452,429
Total		**1,949,613**	**4,613,224**	6,562,837

FORSYTH 2000 Functional Classification	Average Speed	Vehicle Miles of Travel
Urban Interstate	55	1,055,357
Freeway & Expressway	51	2,278,010
Urban Other Principle Arterial	32	409,029
Urban Minor Arterial	21	864,420
Urban Collector	27	936,980
Urban Local	21	1,730,028
Rural Interstate	55	997,794
Rural Other Principal Arterial	55	369,676
Rural Minor Arterial	44	118,000
Rural Major Collector	41	383,979
Rural Minor Collector	40	190,944
Rural Local	33	256,304
Total		**9,595,433**

FORSYTH 2014 Functional Classification	Average Speed	Vehicle Miles of Travel
Urban Interstate	55	1,390,608
Freeway & Expressway	50	3,016,628
Urban Other Principle Arterial	27	520,484
Urban Minor Arterial	18	1,176,321
Urban Collector	24	1,267,676
Urban Local	20	2,309,934
Rural Interstate	55	1,233,279
Rural Other Principal Arterial	55	427,796
Rural Minor Arterial	44	165,184
Rural Major Collector	41	549,149
Rural Minor Collector	40	284,224
Rural Local	32	373,219
Total		**12,712,504**

Guilford 2000 Functional Classification	Average Speed	Vehicle Miles of Travel
Urban Interstate	45	2,606,351
Freeway & Expressway	50	1,001,445
Urban Other Principle Arteria	28	1,575,602
Urban Minor Arterial	31	2,902,591
Urban Collector	32	619,757
Urban Local	23	1,347,049
Rural Interstate	55	1,046,143
Rural Other Principal Arterial	53	744,403
Rural Minor Arterial	42	201,030
Rural Major Collector	44	577,559
Rural Minor Collector	44	410,440
Rural Local	31	432,008
		14,349,184

Guilford 2014 Functional Classification	Average Speed	Vehicle Miles of Travel
Urban Interstate	45	3,292,563
Freeway & Expressway	45	2,466,407
Urban Other Principle Arteria	25	2,089,901
Urban Minor Arterial	28	3,806,278
Urban Collector	30	825,299
Urban Local	23	1,777,159
Rural Interstate	55	1,226,963
Rural Other Principal Arterial	53	970,201
Rural Minor Arterial	41	260,052
Rural Major Collector	44	799,766
Rural Minor Collector	44	579,736
Rural Local	31	622,004
		18,717,099

NCDOT – Office of Human Environment

Memo

To: Jill Vitas

From: David Hyder, P.E.

CC: Laura Cove, P.E., Carl Goode, P.E. Eddie Dancausse, Sheila Holman, Behshad Norowzi

Date: January 2, 2003

Re: Recommended Speed Assumptions for Triangle and Triad Area 1-Hour Ozone SIP Revision

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This memorandum describes the thought process I used to make recommendations regarding what speeds to use in MOBILE 6 to develop emissions factors for each functional classification. I used engineering judgement to make the recommendations at our meeting. Generally, I included the effect of changes in travel and changes in the available network capacity to choose the year that 'best' matched the conditions for your milestone years. The equivalence table below shows the model years I suggest you use to estimate travel speeds for Wake County. As discussed in our meeting CAMPO should review these assumptions. Given the uncertainty of the current travel estimates for Durham County and for the Triad I am not providing a speed equivalence table for either of those areas. When the travel modeling is complete for Durham County and the Triad, we should probably meet and discuss the speed assumption for those areas.

Table 1 : Wake County Speed Equivalence Table

Milestone Year	2000	2004	2007	2010	2012	2015
Travel Model	1995	2005	2005	2015	2015	2015

In making these suggestions, I considered two criteria against one another. These criteria are the growth in VMT compared to the capacity of the transportation system. Both of these criteria are in CAMPO's most recent conformity determination report. If VMT grew without significant increases in network capacity, I recommended the year with the lower travel speed. If we anticipated a new regionally significant facility to be open by the milestone year, I recommended the year with the higher travel speeds.

If I can help in any way please let me know.

4.2 NON-HIGHWAY MOBILE SOURCES

Non-highway mobile sources, sometimes referred to as off-road mobile, are those sources that can move but do not use the highway system. Examples include lawn mowers, agricultural equipment, construction equipment, aircraft engines and railroad locomotives. All but the aircraft engine and railroad locomotive emissions are estimated using the USEPA non-road mobile model NONROAD2002a. The emissions from aircraft engines are estimated using the Federal Aviation Administration (FAA) model EDMS and the emissions from railroad locomotives are estimated in a more traditional way of using activity levels and emission factors. The methodology used to calculate the emissions from these sources are described in detail in the subsections that follow. Table 4.2-1 and 4.2-2 summarize the total VOC and NOx, respectively, emissions from all non-highway mobile source categories.

Table 4.2-1 Non-Highway Mobile Source VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	2.19	1.99	1.76	1.62	1.61	1.64
Davie	0.01	0.01	0.01	0.01	0.01	0.01
Forsyth	5.65	4.96	4.18	3.83	3.85	3.97
Guilford	11.99	10.56	8.85	8.08	8.15	8.40
Total	19.84	17.52	14.80	13.54	13.62	14.02
Raleigh/Durham maintenance area						
Durham	5.07	4.61	4.05	3.81	3.82	3.92
Granville	0.30	0.28	0.24	0.23	0.23	0.24
Wake	15.66	13.40	10.76	9.61	9.61	9.89
Total	21.03	18.29	15.05	13.65	13.66	14.05

Table 4.2-2 Non-Highway Mobile Source NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	4.27	4.10	3.92	3.76	3.68	3.61
Davie	0.02	0.01	0.01	0.01	0.01	0.01
Forsyth	7.03	6.97	6.81	6.58	6.49	6.52
Guilford	14.71	15.22	14.84	14.29	14.07	14.03
Total	26.03	26.30	25.58	24.64	24.25	24.17
Raleigh/Durham maintenance area						
Durham	9.64	9.39	9.04	8.58	8.37	8.27
Granville	0.44	0.42	0.40	0.38	0.37	0.37
Wake	19.05	18.39	17.54	16.44	15.93	15.58
Total	29.13	28.20	26.98	25.40	24.67	24.22

4.2.1 Non-Road Mobile Sources

The nonroad mobile source category includes a diverse collection of equipment such as lawn mowers, chain saws, tractors, all terrain vehicles, fork lifts and construction equipment. The USEPA included more than 80 different types of equipment in the NONROAD model. To facilitate analysis and reporting, USEPA grouped the equipment types into ten equipment categories. These include:

Agricultural equipment	Lawn and garden equipment
Airport ground support equipment	Loggin equipment
Commercial equipment	Railroad maintenance equipment
Construction equipment	Recreational marine equipment
Industrial equipment	Recreational equipment

Additionally, the emissions are broken out by five different engine types. These include: 2-stroke and 4-stroke spark engines, diesel engines, and liquid propane gas (LPG) and compressed natural gas (CNG) fueled engines.

The version of the NONROAD model used to estimate emissions for the 1-hour ozone maintenance plan updates was the draft NONROAD2002a. This version of the model was released to the public in April 2003.

NONROAD2002a is an updated version of the USEPA NONROAD model that was first released in June 2000, and incorporates many revisions to improve the model's predictive ability. The new draft model also incorporates all USEPA final nonroad engine emission standards, except for the recreational and large spark-ingintion engines rules that were promulgated in September 2002. This model is still considered a draft model and will eventually be revised to incorporate additional promulgated nonroad engine standards.

The NONROAD model generate emissions directly. A few of the default input files were edited to reflect North Carolina specific information. The first file edited was the "SEASON.DAT" file. In this file the region representative of North Carolina was changed from Mid-Atlantic to Southeast.

The other files updated were allocation files, which are files used to allocate the emissions from the State down to the county level. The airport, wholesale establishments and landscape servies allocation files were adjusted to represent North Carolina specific information. Copies of the revised allocation files are in Section 5.

The options files used in the NONROAD2002a model were tailored to reflect North Carolina specific information also. Copies of the options input files are in Section 5.

For the two partial Counties, Davie and Granville, the emissions generated within the NONROAD model were adjusted by the percent population located within each maintenance area, 0.7% and 28.5%, respectively. For reporting purposes, the emissions were totaled for each equipment category by county. The summary of these results are tabulated in Tables 4.2.1-1 through 4.2.1-20. In Table 4.2.1-21 and Table 4.2.1-22 summaries of the nonroad category emissions for each county and nonattainment area.

Table 4.2.1-1 Agricultural Equipment VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.04	0.03	0.03	0.02	0.02	0.02
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.02	0.01	0.01	0.01	0.01	0.01
Guilford	0.04	0.04	0.03	0.03	0.03	0.02
Total	0.10	0.08	0.07	0.06	0.06	0.05
Raleigh/Durham maintenance area						
Durham	0.01	0.00	0.00	0.00	0.00	0.00
Granville	0.01	0.01	0.01	0.01	0.01	0.01
Wake	0.05	0.04	0.04	0.03	0.03	0.03
Total	0.07	0.05	0.05	0.04	0.04	0.04

Table 4.2.1-2 Agricultural Equipment NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.24	0.23	0.21	0.20	0.19	0.18
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.10	0.10	0.09	0.09	0.08	0.08
Guilford	0.28	0.26	0.25	0.23	0.22	0.21
Total	0.62	0.59	0.55	0.52	0.49	0.47
Raleigh/Durham maintenance area						
Durham	0.04	0.04	0.03	0.03	0.03	0.03
Granville	0.06	0.05	0.05	0.05	0.05	0.04
Wake	0.34	0.33	0.31	0.28	0.27	0.25
Total	0.44	0.42	0.39	0.36	0.35	0.32

Table 4.2.1-3 Airport Ground Support Equipment VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.00	0.00	0.00	0.00	0.00	0.00
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.00	0.00	0.00	0.00	0.00	0.00
Guilford	0.01	0.01	0.01	0.00	0.00	0.00
Total	0.01	0.01	0.01	0.0	0.0	0.0
Raleigh/Durham maintenance area						
Durham	0.00	0.00	0.00	0.00	0.00	0.00
Granville	0.00	0.00	0.00	0.00	0.00	0.00
Wake	0.02	0.02	0.02	0.02	0.02	0.02
Total	0.02	0.02	0.02	0.02	0.02	0.02

Table 4.2.1-4 Airport Ground Support Equipment NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.00	0.00	0.00	0.00	0.00	0.00
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.01	0.01	0.01	0.01	0.01	0.01
Guilford	0.05	0.05	0.05	0.04	0.04	0.04
Total	0.06	0.06	0.06	0.05	0.05	0.05
Raleigh/Durham maintenance area						
Durham	0.00	0.00	0.00	0.00	0.00	0.00
Granville	0.00	0.00	0.00	0.00	0.00	0.00
Wake	0.15	0.15	0.15	0.14	0.13	0.12
Total	0.15	0.15	0.15	0.14	0.13	0.12

Table 4.2.1-5 Commercial Equipment VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.24	0.21	0.19	0.16	0.17	0.18
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.64	0.57	0.51	0.44	0.46	0.49
Guilford	1.72	1.52	1.38	1.19	1.23	1.30
Total	2.60	2.30	2.08	1.79	1.86	1.97
Raleigh/Durham maintenance area						
Durham	0.34	0.30	0.27	0.24	0.24	0.26
Granville	0.01	0.01	0.01	0.01	0.01	0.01
Wake	1.58	1.40	1.27	1.10	1.13	1.20
Total	1.93	1.71	1.55	1.35	1.38	1.47

Table 4.2.1-6 Commercial Equipment NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.16	0.17	0.18	0.18	0.18	0.19
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.43	0.46	0.48	0.49	0.50	0.52
Guilford	1.15	1.24	1.28	1.31	1.34	1.38
Total	1.74	1.87	1.94	1.98	2.02	2.09
Raleigh/Durham maintenance area						
Durham	0.23	0.25	0.25	0.26	0.26	0.27
Granville	0.01	0.01	0.01	0.01	0.01	0.01
Wake	1.06	1.14	1.18	1.21	1.23	1.27
Total	1.30	1.40	1.44	1.48	1.50	1.55

Table 4.2.1-7 Construction Equipment VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.21	0.18	0.14	0.13	0.12	0.11
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.60	0.50	0.40	0.35	0.33	0.31
Guilford	1.33	1.12	0.90	0.78	0.74	0.69
Total	2.14	1.80	1.44	1.26	1.19	1.11
Raleigh/Durham maintenance area						
Durham	1.05	0.88	0.70	0.61	0.58	0.54
Granville	0.03	0.02	0.02	0.02	0.02	0.01
Wake	2.12	1.79	1.43	1.25	1.17	1.10
Total	3.20	2.69	2.15	1.88	1.77	1.65

Table 4.2.1-8 Construction Equipment NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	1.15	1.09	1.01	0.90	0.85	0.81
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	3.24	3.06	2.83	2.54	2.39	2.27
Guilford	7.20	6.81	6.30	5.65	5.32	5.05
Total	11.59	10.96	10.14	9.09	8.56	8.13
Raleigh/Durham maintenance area						
Durham	5.66	5.34	4.94	4.44	4.18	3.97
Granville	0.15	0.15	0.13	0.12	0.11	0.11
Wake	11.49	10.86	10.04	9.02	8.48	8.06
Total	17.3	16.35	15.11	13.58	12.77	12.14

Table 4.2.1-9 Industrial Equipment VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.37	0.37	0.37	0.37	0.37	0.38
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.66	0.65	0.65	0.66	0.66	0.68
Guilford	0.91	0.91	0.91	0.91	0.92	0.94
Total	1.94	1.93	1.93	1.94	1.95	2.00
Raleigh/Durham maintenance area						
Durham	0.74	0.73	0.74	0.74	0.75	0.77
Granville	0.03	0.03	0.03	0.03	0.03	0.03
Wake	0.49	0.48	0.48	0.48	0.49	0.50
Total	1.26	1.24	1.25	1.25	1.27	1.30

Table 4.2.1-10 Industrial Equipment NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	1.34	1.43	1.48	1.52	1.56	1.63
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	2.39	2.54	2.64	2.71	2.77	2.90
Guilford	3.32	3.53	3.66	3.76	3.85	4.04
Total	7.05	7.50	7.78	7.99	8.18	8.57
Raleigh/Durham maintenance area						
Durham	2.65	2.82	2.94	3.02	3.09	3.24
Granville	0.12	0.13	0.13	0.13	0.14	0.14
Wake	1.85	1.96	2.03	2.07	2.12	2.21
Total	4.62	4.91	5.10	5.22	5.35	5.59

Table 4.2.1-11 Lawn and Garden Equipment VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.93	0.79	0.61	0.53	0.52	0.54
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	3.35	2.80	2.13	1.85	1.85	1.92
Guilford	6.97	5.80	4.33	3.77	3.79	3.95
Total	11.25	9.39	7.07	6.15	6.16	6.41
Raleigh/Durham maintenance area						
Durham	2.26	1.89	1.43	1.24	1.24	1.29
Granville	0.15	0.12	0.09	0.08	0.08	0.08
Wake	10.38	8.61	6.44	5.62	5.65	5.89
Total	12.79	10.62	7.96	6.94	6.97	7.26

Table 4.2.1-12 Lawn and Garden Equipment NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.16	0.15	0.15	0.14	0.14	0.15
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.59	0.58	0.57	0.56	0.57	0.59
Guilford	1.23	1.22	1.22	1.19	1.21	1.25
Total	1.98	1.95	1.94	1.89	1.92	1.99
Raleigh/Durham maintenance area						
Durham	0.38	0.38	0.38	0.37	0.38	0.39
Granville	0.03	0.03	0.03	0.03	0.03	0.03
Wake	1.87	1.86	1.86	1.82	1.85	1.91
Total	2.28	2.27	2.27	2.22	2.26	2.33

Table 4.2.1-13 Logging Equipment VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.00	0.00	0.00	0.00	0.00	0.00
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.00	0.00	0.00	0.00	0.00	0.00
Guilford	0.03	0.03	0.02	0.02	0.02	0.02
Total	0.03	0.03	0.02	0.02	0.02	0.02
Raleigh/Durham maintenance area						
Durham	0.01	0.01	0.01	0.01	0.01	0.01
Granville	0.01	0.01	0.01	0.01	0.01	0.01
Wake	0.05	0.05	0.03	0.03	0.03	0.03
Total	0.07	0.07	0.05	0.05	0.05	0.05

Table 4.2.1-14 Logging Equipment NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.00	0.00	0.00	0.00	0.00	0.00
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.00	0.00	0.00	0.00	0.00	0.00
Guilford	0.05	0.04	0.03	0.03	0.02	0.02
Total	0.05	0.04	0.03	0.03	0.02	0.02
Raleigh/Durham maintenance area						
Durham	0.02	0.01	0.01	0.01	0.01	0.01
Granville	0.02	0.01	0.01	0.01	0.01	0.01
Wake	0.08	0.07	0.05	0.04	0.04	0.03
Total	0.12	0.09	0.07	0.06	0.06	0.05

Table 4.2.1-15 Railroad Maintenance Equipment VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.00	0.00	0.00	0.00	0.00	0.00
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.00	0.00	0.00	0.00	0.00	0.00
Guilford	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00
Raleigh/Durham maintenance area						
Durham	0.00	0.00	0.00	0.00	0.00	0.00
Granville	0.00	0.00	0.00	0.00	0.00	0.00
Wake	0.01	0.01	0.01	0.00	0.00	0.00
Total	0.01	0.01	0.01	0.00	0.00	0.00

Table 4.2.1-16 Railroad Maintenance Equipment NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.01	0.01	0.01	0.01	0.01	0.01
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.01	0.01	0.01	0.01	0.01	0.01
Guilford	0.02	0.02	0.02	0.02	0.02	0.01
Total	0.04	0.04	0.04	0.04	0.04	0.03
Raleigh/Durham maintenance area						
Durham	0.01	0.01	0.01	0.01	0.01	0.01
Granville	0.00	0.00	0.00	0.00	0.00	0.00
Wake	0.02	0.02	0.02	0.02	0.02	0.02
Total	0.03	0.03	0.03	0.03	0.03	0.03

Table 4.2.1-17 Recreational Equipment VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.13	0.17	0.20	0.22	0.23	0.24
Davie	0.00	0.00	0.01	0.01	0.01	0.01
Forsyth	0.32	0.38	0.43	0.48	0.50	0.52
Guilford	0.73	0.89	1.04	1.15	1.20	1.26
Total	1.18	1.44	1.68	1.86	1.94	2.03
Raleigh/Durham maintenance area						
Durham	0.51	0.67	0.78	0.87	0.91	0.96
Granville	0.03	0.05	0.05	0.06	0.06	0.07
Wake	0.46	0.55	0.63	0.70	0.73	0.77
Total	1.00	1.27	1.46	1.63	1.70	1.80

Table 4.2.1-18 Recreational Equipment NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.00	0.00	0.01	0.01	0.01	0.01
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.03	0.02	0.02	0.02	0.02	0.03
Guilford	0.05	0.04	0.04	0.05	0.05	0.05
Total	0.08	0.06	0.07	0.08	0.08	0.09
Raleigh/Durham maintenance area						
Durham	0.02	0.02	0.02	0.02	0.02	0.02
Granville	0.00	0.00	0.00	0.00	0.00	0.00
Wake	0.04	0.03	0.03	0.03	0.03	0.03
Total	0.06	0.05	0.05	0.05	0.05	0.05

Table 4.2.1-19 Recreational Marine Equipment VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.21	0.19	0.17	0.15	0.14	0.13
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.05	0.04	0.04	0.03	0.03	0.03
Guilford	0.11	0.10	0.09	0.08	0.07	0.07
Total	0.37	0.33	0.30	0.26	0.24	0.23
Raleigh/Durham maintenance area						
Durham	0.11	0.10	0.09	0.08	0.07	0.07
Granville	0.02	0.02	0.02	0.02	0.01	0.01
Wake	0.35	0.31	0.27	0.24	0.23	0.22
Total	0.48	0.43	0.38	0.34	0.31	0.30

Table 4.2.1-20 Recreational Marine Equipment NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.01	0.01	0.01	0.01	0.02	0.02
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.00	0.00	0.00	0.00	0.00	0.00
Guilford	0.01	0.01	0.01	0.01	0.01	0.01
Total	0.02	0.02	0.02	0.02	0.03	0.03
Raleigh/Durham maintenance area						
Durham	0.01	0.01	0.01	0.01	0.01	0.01
Granville	0.00	0.00	0.00	0.00	0.00	0.00
Wake	0.02	0.02	0.02	0.02	0.02	0.03
Total	0.03	0.03	0.03	0.03	0.03	0.04

Table 4.2.1-21 Total NONROAD Model Engines VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	2.13	1.94	1.71	1.58	1.57	1.60
Davie	0.01	0.01	0.01	0.01	0.01	0.01
Forsyth	5.64	4.95	4.17	3.82	3.84	3.96
Guilford	11.85	10.42	8.71	7.93	8.00	8.25
Total	19.63	17.32	14.60	13.34	13.42	13.82
Raleigh/Durham maintenance area						
Durham	5.03	4.58	4.02	3.79	3.80	3.90
Granville	0.29	0.27	0.23	0.23	0.23	0.24
Wake	15.51	13.26	10.62	9.47	9.48	9.76
Total	20.83	18.11	14.87	13.49	13.51	13.90

Table 4.2.1-22 Total NONROAD Model Engines NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	3.06	3.09	3.05	2.96	2.96	3.00
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	6.80	6.78	6.65	6.43	6.35	6.41
Guilford	13.36	13.22	12.86	12.29	12.08	12.06
Total	23.22	23.09	22.56	21.68	21.39	21.47
Raleigh/Durham maintenance area						
Durham	9.02	8.88	8.59	8.17	7.99	7.95
Granville	0.38	0.37	0.36	0.34	0.34	0.34
Wake	16.92	16.44	15.69	14.65	14.19	13.93
Total	26.32	25.69	24.64	23.16	22.52	22.22

4.2.2 Aircraft Engines

Aircraft engines, like other engines, emit pollutants whenever the engines are in operation. However, the only emissions that are of concern for this inventory are the portion of the operation that occurs below the mixing layer. This is because the emissions tend to disperse whenever the aircraft is above the mixing layer and therefore has little or no effect on ground level ozone.

The aircraft operations of interest are termed the landing and takeoff (LTO) cycle. The cycle begins when the aircraft approaches the airport, descending below the mixing layer, lands and taxis to the gate. It continues as the aircraft idles at the gate and then taxis back out to the runway for the subsequent takeoff and climbout as it heads back to cruising altitudes, above the mixing layer.

Aircrafts can be categorized by use into four classifications: commercial, air taxis, general aviation and military. Commercial aircraft include those used for scheduled service transporting passengers, freight or both. Air taxis, or commuter aircraft, also fly scheduled service carrying passengers and/or freight but usually are smaller aircraft and operate on a more limited basis than commercial carriers. General aviation include all other non-military aircraft used for recreational flying, personal transportation, and various other activities. Military aircraft cover a wide range of sizes, uses and operating missions. The military aircraft are treated as a separate classification since the LTO operations reported at the airports group all military aircraft together.

The airports in the nonattainment counties were identified from a technical report prepared for the NCDOT, Division of Aiviation entitled North Carolina Airport System Plan, 1992 Technical Report. In this report, on page II-71, there is a map of North Carolina indexing all of the airports in the State. From this map, it is determined that there are six airports located in the maintenance areas. These include: Lexington Municipal Airport in Davidson County; Smith Reynolds Airport (Winston-Salem) in Forsyth County; Piedmont Triad International Airport (Greensboro) in Guilford County; and the Raleigh-Durham International Airport, the Triple W Airport (Raleigh) and the Raleigh East Airport all in Wake County. There are no airports in Durham County or in the maintenance areas of the two partial Counties of Davie and Granville.

The airport activity for the general aviation and military operations were obtained from the FAA Form 5010-1, “Airport Master Record” for the airports in the maintenance areas for the year 2000. These forms were obtained from the internet at www.gcr1.com/5010web/. The activity data represented on these forms is the number of operations, where a LTO represents two operations. Therefore, the activity data were divided by two in order to determine the number of landing and takeoff cycles.

FFA Form 5010-1 does not specify the type of aircraft. Since the military operations component is small, it was summed with the general aviation operations and the emissions were estimated using

the emission factors found in the Mobile Source Procedures document. Since VOCs are required to be reported, the hydrocarbon emission factor was converted to VOC by multiplying by 0.9708 as dictated by the Mobile Source Procedure document. The emission factors used were:

VOC = 0.382 lbs per LTO
NOx = 0.065 lbs per LTO

The following equation was used to calculate general aviation and military aviation average day emissions:

$$VOC = \frac{(LTO_{GA} + LTO_{M}) \times 0.382 \text{ lbs}}{(2000 \text{ lbs/ton}) \times (365 \text{ days/year})}$$

$$NOx = \frac{(LTO_{GA} + LTO_{M}) \times 0.065 \text{ lbs}}{(2000 \text{ lbs/ton}) \times (365 \text{ days/year})}$$

Emissions from commercial operations were evaluated by using the FAA Emissions and Dispersion Modeling System (EDMS), version 4.0. The Piedmont Triad Airport Authority and the RDU Airport Authority provided the number of LTO cycles for all aircraft types, e.g. 737-200, 757, etc. for the year 2000 for their respective airports. Copies of this data may be found in Section 5. The inventory of aircraft type and the number of respective LTOs was inputted into the model. The default aircraft engine emission factors within the EDMS program were used. The emissions are reported by the program as tons per year; which where converted to tons per day by dividing by 365. Tables 4.2.2-1 and 4.2.2-2 summarizes the VOC and NOx emissions, respectively, for aircraft engines.

Table 4.2.2-1 Aircraft Engine VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.00	0.01	0.01	0.01	0.01	0.01
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.00	0.00	0.00	0.00	0.00	0.00
Guilford	0.08	0.09	0.10	0.11	0.11	0.12
Total	0.08	0.10	0.11	0.12	0.12	0.13
Raleigh/Durham maintenance area						
Durham	0.00	0.00	0.00	0.00	0.00	0.00
Granville	0.00	0.00	0.00	0.00	0.00	0.00
Wake	0.05	0.06	0.07	0.07	0.07	0.08
Total	0.05	0.06	0.07	0.07	0.07	0.08

Table 4.2.2-2 Aircraft Engine NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.00	0.00	0.00	0.00	0.00	0.00
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.00	0.00	0.00	0.00	0.00	0.00
Guilford	0.34	1.16	1.25	1.33	1.39	1.46
Total	0.34	1.16	1.25	1.33	1.39	1.46
Raleigh/Durham maintenance area						
Durham	0.00	0.00	0.00	0.00	0.00	0.00
Granville	0.00	0.00	0.00	0.00	0.00	0.00
Wake	0.71	0.77	0.81	0.84	0.87	0.91
Total	0.71	0.77	0.81	0.84	0.87	0.91

4.2.3 Railroad Locomotives

Railroads are categorized by size (Class I, Class 2) and passenger service (Amtrak and NCDOT Rail Division). Class I railroads are long haul operations, consisting of Norfolk Southern Corporation and CSX Corporation. The emissions from Class I railroads were determined by the following procedure.

Class I Railroads:

Traffic Density (Gross Ton-miles (GTM)) per county was obtained from each Class I railroad for the year 2000. CSX reported GTM/county, whereas Norfolk Southern (NS) reported traffic density data for a given track segment. The NS data was modified to represent geographical county boundaries.

A fuel consumption index was determined on a system wide basis by dividing system wide GTM by system wide fuel consumption for the year 2000 (See Table 4.2.3-1 Class I Fuel Consumption Index). Fuel consumption was calculated by the following equation:

Gallons of fuel /county = GTM/county ÷ GTM/gal of fuel.

Table 4.2.3-1 Class I Fuel Consumption Index

	Norfolk Southern	CSX
System Wide GTM	4.094 E+11	4.920 E+11
Diesel Consumption (Gallons)	4.770 E+8	5.029 E+8
Fuel Consumption Index (GTM/Gal.)	858	978

Fleet averaged emission factors were determined based on a weighted average of the long haul locomotive inventories. Locomotive emission factors are from Mobile Sources Procedures document, Vol.4, pg 222-224. See Table 4.2.3-2 for fleet averaged emission factors for Class I railroads. Locomotive inventories for Norfolk Southern and CSX were obtained from the following web pages, respectively, www.nspics.railfan.net and www.trainweb.org. HC was converted to VOC by multiplying by 1.005 per Mobile Sources, Vol.4, pg. 214.

Table 4.2.3-2 Class I Long Haul Fleet Average Emission Factors

	Fraction	HC lbs/Gal	VOC lb/Gal	NOx lbs/Gal
Norfolk Southern				
C39 – C40	0.39	0.0302	0.030	0.4851
GP 38 – SD40	0.38	0.0198	0.020	0.4744
GP/SD 50	0.06	0.0153	0.015	0.6687
GP/SD 60	0.17	0.0170	0.017	0.4986
NS System Average		0.0231	0.023	0.495
CSX				
C40 – C60	0.67	0.0302	0.030	0.4851
SD 50	0.07	0.0153	0.015	0.6687
SD 70	0.07	0.017	0.017	0.4986
GP/SD 40	0.19	0.0198	0.020	0.4851
CSX System Average		0.0263	0.026	0.4965

Emissions for long haul operations were calculated by the following equation:

$$EM = \frac{(\text{Gallons of fuel}) \times (\text{Fleet Average } EF_a)}{(2000 \text{ lbs/ton}) \times (365 \text{ days/year})}$$

Where EM = Emissions from source (either VOC or NOx)
EF_a = Emission Factor for pollutant (a)

The default fuel consumption value and emission factors for yard locomotives, given in Mobile Sources Procedures document, Vol. 4, pg. 208, were used to calculate emissions for yard operations. These values are listed in Table 4.2.3-3 below. As with the long haul operations the hydrocarbon emission factor was converted to VOC by multiplying by 1.005. Yard locomotives are assumed to run 365 days per year.

Table 4.2.3-3 Yard Locomotive Default Values

Fuel Consumption (gal/yr/yard locomotive)	NOx EF (lb/gal of fuel)	HC EF (lb/gal of fuel)	VOC EF (lb/gal of fuel)
82,490	0.5044	0.0506	0.0508

Emissions for yard operations were calculated by the following equation:

$$EM = \frac{(\text{\# if yard Locomotive}) \times (82{,}490 \text{ Gal/yr}) \times (EF_a)}{(2000 \text{ lbs/ton}) \times (365 \text{ days/year})}$$

Where EM = Emissions from source (either VOC or NOx)
EF_a = Emission Factor for pollutant (a)

Class II and III Railroads

Class II and Class III railroads are short lines, serving localized markets. The emissions for Class II and Class III railroads were determined by the following procedure:

Traffic Density (GTM) per county was estimated by multiplying the total system tonnage per year by the track mileage within the county. Total tonnage and track mileage data were obtained from the Railway Association of North Carolina web page: www.ncrailways.com. The data from the Railway Association was representative of years 2000 and 2001. This method was used to estimate traffic densities; because, traffic density data is not normally maintained by short lines. Furthermore, it is reasonable to assume that most of the system tonnage would have traveled a majority of the short lines track mileage.

Fuel consumption information from Class II railroads was difficult to obtain. However, fuel consumption data was obtained from the Carolina Southern (CS) and the Chesapeake and Albemarle (CA). A fuel consumption index was calculated for these two railroads by dividing the estimated GTM by the reported fuel consumption. The calculated fuel consumption indexes were averaged. Although these short line railroads are not in the inventory area, the average was assumed to be representative of the Class II or Class III railroads within the inventory area. Table 4.2.3-4 lists the fuel consumption values for CS and CA as well as the average used for the Class II and Class III railroads in the maintenance area.

Table4.2.3-4 Class II/III Fuel Consumption

Railroad	estimated GTM	Fuel Usage	GTM/Gal of fuel
CA	56.8 E+06	293,000	194
CS	114.7 E+06	172,000	667
Average GTM/Gal of fuel:			432

Fuel consumption was calculated by the following equation:

Gallons of fuel /county = GTM/county ÷ 432 GTM/gal of fuel.

Emission factors were based on the locomotive models GP38 and GP40 with a GM engine model no. of 16-645E. A phone survey of short line railroads indicated GP38/40's locomotive were the dominant units in short line service. According to the Mobile Source Procedures document, the emission factors for this locomotive are 0.0192 lbs HC/gal. fuel (0.0193 lb VOC/gal.) and 0.5443 lbs NOx/gal. fuel. The emissions were calculated as follows:

$$EM = \frac{(\text{Gallons of fuel}) \times (EF_a)}{(2000 \text{ lbs/ton}) \times (365 \text{ days/year})}$$

Where EM = Emissions from source (either VOC or NOx)
EF_a = Emission Factor for pollutant (a)

Passenger Service Railroads

Passenger service is provided by Amtrak and the NCDOT Rail Division. These entities lease trackage from Class I railroads. The emissions from passenger service were determined by the following procedure:

Fuel usage for the NCDOT passenger service operation for the year 2000 was reported at 215,069 gallons per year. Fuel consumption was allocated to counties by track mileage using the following equation:

$$\text{Gallons of Fuel}_{\text{County}} = \frac{(215{,}069 \text{ gal/yr}) \times (\text{track mileage}_{\text{County}})}{(365 \text{ days/yr}) \times (161 \text{ total State track miles})}$$

Emission factors were based on locomotive model F59PHI, engine type EMD 12-710G3. The emission factors are 0.0155 lbs HC/ Gallon of fuel (0.0164 lb VOC/gal) and 0.4306 lbs NOx/gallon of fuel, as referenced in the Mobile Sources Procedures document, pg.219.

Emissions were calculated by the following equation:

$$EM = \frac{(\text{Gallons of fuel}) \times (EF_a)}{(2000 \text{ lbs/ton}) \times (365 \text{ days/year})}$$

Where EM = Emissions from source (either VOC or NOx)
EF_a = Emission Factor for pollutant (a)

Amtrak did not respond to requests for information. As an alternative, fuel efficiency was calculated from data provided by the NCDOT Rail Division. It was assumed that the fuel efficiency for Amtrak passenger service is similar to that of NCDOT passenger service. A fuel efficiency value of 0.55 Miles/Gal was obtained by dividing 589 gallons per day by twice the track mileage between Charlotte and Raleigh, NC (162 miles).

Fuel consumption was allocated to counties by track mileage multiplied by the number of times per day of the Amtrak service (reference Amtrak time tables) multiplied by the fuel efficiency, and multiplied by 2 for the number of locomotives per passenger train consist. The following Amtrak trains serve the Raleigh/Durham area daily: Palmetto, Silver Meteor, Silver Star, and the Auto-train. Gallons of fuel were calculated by the following equation:

$$\text{Gallons/day Fuel}_{\text{County}} = \frac{(2 \text{ locomotives/train}) \times (4 \text{ Amtrak trains/day}) \times (\text{track mileage}_{\text{County}})}{0.55 \text{ Miles/Gallon of fuel}}$$

Emission factors were based on locomotive model P40 Genesis, engine type GE 16-4100; 0.0302 lbs HC/Gallon of fuel (0.0303 lb VOC/gal) and 0.4851 lb NOx/Gallon of fuel, as referenced in the Mobile Sources Procedures document, pg.224. The emissions were calculated by the following equation:

$$EM = \frac{(\text{Gallons/day of fuel}) \times (EF_a)}{(2000 \text{ lbs/ton})}$$

Where EM = Emissions from source (either VOC or NOx)
EF_a = Emission Factor for pollutant (a)

The summary of emissions from all railroad locomotives in each County are in Tables 4.2.3-5 and 4.2.3-6.

Table 4.2.3-5 Railroad Locomotive Engine VOC Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	0.06	0.05	0.04	0.04	0.04	0.03
Davie	0.00	0.00	0.00	0.00	0.00	0.00
Forsyth	0.01	0.01	0.01	0.01	0.01	0.01
Guilford	0.06	0.05	0.04	0.04	0.04	0.03
Total	0.13	0.11	0.09	0.09	0.09	0.07
Raleigh/Durham maintenance area						
Durham	0.04	0.03	0.03	0.02	0.02	0.02
Granville	0.00	0.00	0.00	0.00	0.00	0.00
Wake	0.10	0.08	0.07	0.06	0.06	0.05
Total	0.14	0.11	0.10	0.08	0.08	0.07

Table 4.2.3-6 Railroad Locomotive Engine NOx Emissions by County

County	2000	2004	2007	2010	2012	2015
Greensboro/Winston-Salem/High Point maintenance area						
Davidson	1.21	1.01	0.87	0.79	0.73	0.61
Davie	0.01	0.01	0.01	0.01	0.01	0.01
Forsyth	0.23	0.19	0.16	0.15	0.14	0.11
Guilford	1.01	0.85	0.73	0.67	0.61	0.51
Total	2.46	2.06	1.77	1.62	1.49	1.24
Raleigh/Durham maintenance area						
Durham	0.62	0.51	0.45	0.41	0.38	0.32
Granville	0.05	0.04	0.04	0.04	0.03	0.03
Wake	1.42	1.18	1.04	0.94	0.87	0.74
Total	2.09	1.73	1.53	1.39	1.28	1.09