North Carolina Division of Air Quality

Technical Support Document

Analysis of the California Low Emission Vehicle II Standards in NC

July 2006

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Disclaimer: The on-road mobile source input data (e.g. VMT) and emissions data presented herein *do not* represent North Carolina's official on-road mobile source data for purposes of State Implementation Plans or Transportation Conformity. On-road mobile source emissions presented herein were generated specifically to analyze the *relative differences* between the Federal Tier 2 and CA LEV-II standards.

Executive Summary

Introduction

The North Carolina Division of Air Quality (NCDAQ) conducted a technical emissions benefit analysis and air quality sensitivity study to evaluate whether reduced emissions from passenger cars and light-duty trucks by adoption of California Low Emission Vehicle II standards (CA LEV-II) would be realized as compared to the current Federal Tier 2 standards program.

The United States Environmental Protection Agency (USEPA) has adopted national motor vehicle and fuel standards which include the Tier 2 vehicle and gasoline standard (phase-in began in 2004), and the heavy-duty diesel vehicle and fuel standard (phase-in begins in 2006 with the release of the model year 2007 heavy-duty diesel vehicles and low sulfur diesel fuel). Beyond the federal standards, North Carolina has expanded its Inspection and Maintenance (I/M) program, which covers 48 of the State’s 100 counties, to ensure that vehicle emission controls are properly working.

The federal Clean Air Act (CAA) provides the framework for regulating emissions from on-road mobile sources. The CAA set the first federal vehicle emission standards. However, because California already had vehicle emission standards when this occurred, the CAA authorized California (and only California) to continue setting its own vehicle emission standards. Therefore all new vehicles sold in the United States (U.S.) are subject to emission standards set by either the federal government or the State of California. Other states have the option to adopt the California standards in lieu of the federal standards. This authority was granted under Section 177 of the CAA. Section 177 also guarantees the automakers that they will not have to meet more than two regulatory regimes by explicitly prohibiting any requirements that result in a “third vehicle”.

Overview of Federal Tier 2 and California LEV-II Programs

Federal Tier 2 vehicle and gasoline standards and the CA LEV-II program were each effective with model year 2004 vehicles. Both regulations set emission standards for light-duty vehicles such as passenger cars, trucks, and sport utility vehicles, which are programmed to phase in over several years and become progressively more stringent. Both programs provide significant emission reductions from evaporative and exhaust motor vehicle activity. The auto manufacturers have flexibility in how they meet the annual fleet average emissions standards. Tier 2 and CA LEV-II programs have the following differences:

Federal Tier 2 program requires all light-duty fleet averages to meet the Nitrogen Oxides (NOx) standard of 0.07 grams per mile phased-in between years 2004 and 2009. CA LEV-II fleet average standards are based on non-methane organic gases (NMOG), also referred to as hydrocarbons (HC) or volatile organic carbons (VOCs).
CA LEV-II program requires a portion of the light-duty fleet to be “zero-emission vehicles” (ZEVs) which originally mandated the electric ZEVs. This requirement has been changed to allow partial credit for vehicles with advanced technologies and fall in the categories of Partial ZEVs (PZEVs) or advance technology partial ZEVs (AT-PZEVs).

The evaporative requirements of the CA LEV-II standard appear to be lower than the Tier 2 standard, however the Tier 2 evaporative standard provides for evaporative system durability which USEPA indicates make the Tier 2 evaporative requirements identical to that of the CA LEV-II requirements.

Overview of Mobile Source Emissions

On-road mobile source emissions make up a significant portion of the total statewide NOx emissions. For 2002, this sector comprised approximately 45% of the North Carolina NOx inventory. This analysis looked at both NOx and VOCs emissions for all of North Carolina for a typical summer weekday. The impacts on future year ozone concentrations also were estimated. NOx and VOC emissions are both ozone precursor compounds however NOx controls are of particular importance for addressing higher 8 hour ozone levels in North Carolina due to the abundance of VOC from biogenic (natural) sources.

USEPA's MOBILE6.2 emission factor model was used to generate NOx and VOC emission factors for both regulatory scenarios, adoption of CA LEV-II starting in 2009 and the status quo of the federal Tier 2 program. The most current state and region specific data was applied including speeds, fuel parameters, vehicle age distribution and vehicle mix and ambient temperature. Motor vehicle activity - defined as vehicle miles traveled (VMT) - was matched with emission factors resulting in a typical summer day VOC and NOx emissions inventory. After a baseline mobile inventory was developed assuming purely a federal Tier 2 program in effect starting in 2004, future years mobile inventories for 2010, 2020, and 2030 were compared to this baseline inventory. The year 2004 was chosen because it represents the start year of the federal Tier 2 program. Then, the same future year mobile inventories were developed using CA LEV-II assumptions and compared to the existing Tier 2 results. Table ES-1 below shows the percent NOx and VOC emissions reduction expected if CA LEV-II standards were implemented in 2010.

Table ES-1. CA LEV-II Reductions Compared to Federal Tier 2: On-Road Mobile Emissions

	2010	2020	2030
NOx	0.1%	4%	10%
VOC	0.1%	3%	6%

Between 2004 and 2030 North Carolina will realize significant reductions in the on-road NOx mobile emissions on the order of 83%. This is primarily due to fleet turnover and the ongoing Federal Tier 2 program. It is noteworthy to mention that the reductions in NOx emissions are occurring even as the daily VMT (dVMT) is expected to increase by 57 %. See Figures ES-1 and ES-2 below for the inverse trend in NOx emissions for the onroad mobile sector emissions and how daily VMT is expected to grow in the future.

Figure ES-1. Estimated NOx Emissions – Federal Tier 2 vs. CA LEV-II

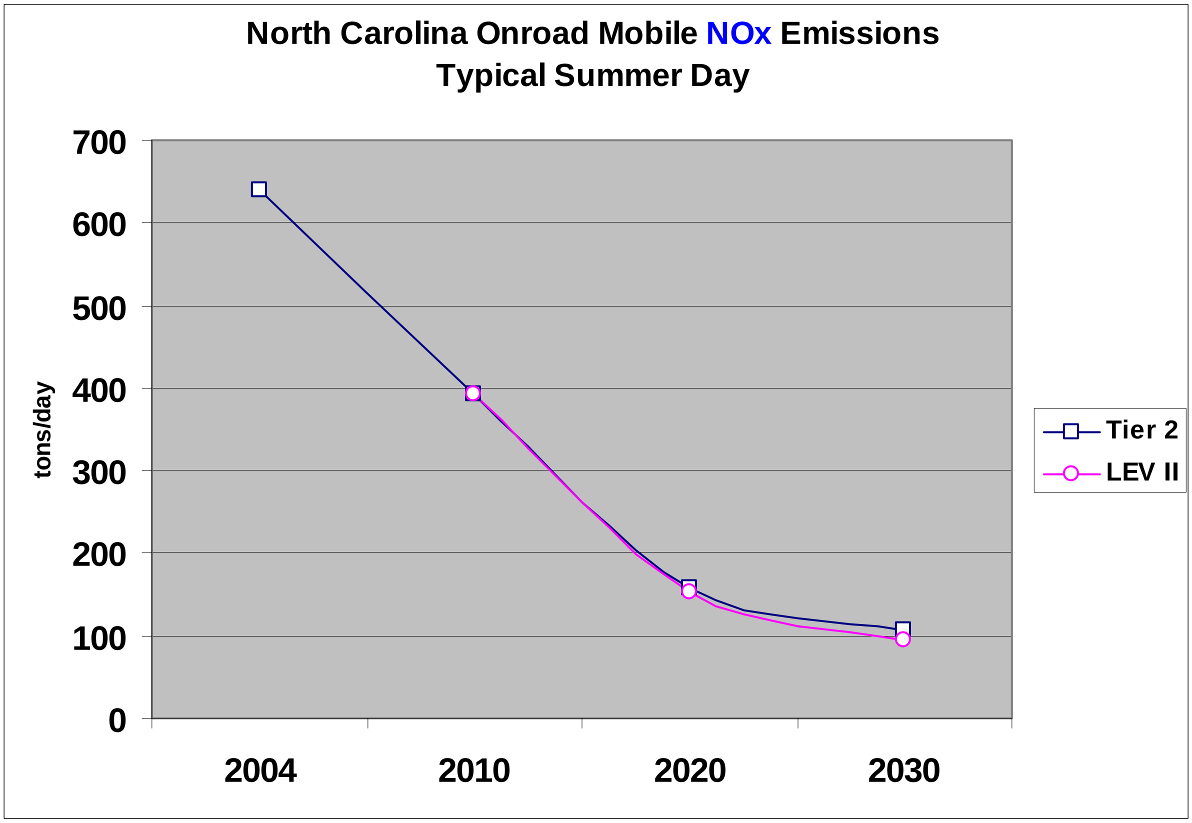
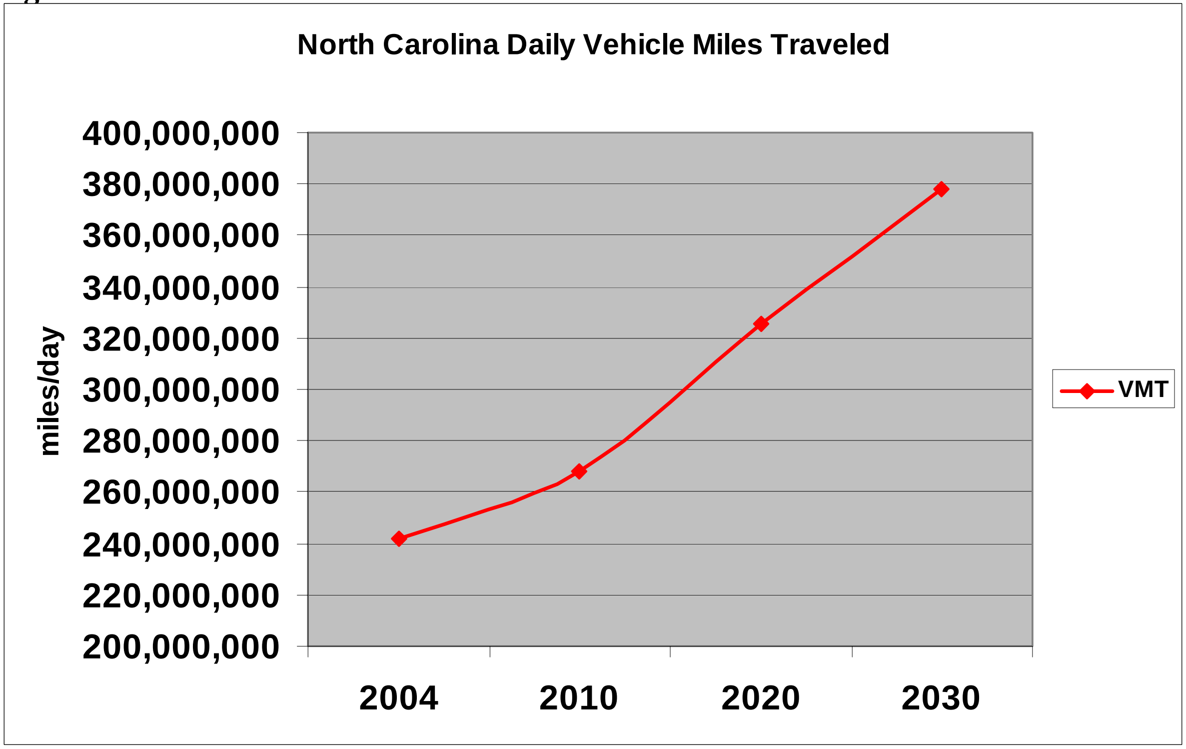


Figure ES-2. Estimated Vehicle Miles Traveled



Overview of Air Quality Impacts – Ozone Sensitivity

During the development of the 8-hour ozone State Implementation Plans (SIP) for North Carolina's nonattainment areas, the NCDAQ conducted several air quality modeling sensitivities to evaluate potential NOx control strategies to help reduce future year ozone concentrations. The emissions sensitivity used in this analysis reduced on-road mobile source NOx emissions in the Metrolina (Greater Charlotte area) 8-hour ozone nonattainment area by 10% from year 2009 emission levels. The Metrolina region was chosen because they currently show the highest ozone concentrations in North Carolina.

Results of the air quality model simulations indicated that a 10% NOx reduction in 2009 for on-road mobile source emissions was equivalent to a 10 ton/day reduction in the Metrolina region. The 10 ton/day on-road NOx reduction was then compared back to the "baseline" year 2009 emissions that included only the current federal Tier 2 level of control. Therefore these results would suggest that an additional 10% NOx reduction would basically lower the 8-hour ozone concentrations anywhere between 0.1 and 1.0 parts per billion (ppb) in year 2009.

DAQ next assessed the ozone benefits in future year 2020 with the CA LEV-II program implementation in year of 2010. The year 2020 would afford a significant fleet turnover for CA LEV-II vehicles with NOx emissions reduction on the order of 4%. A 4% NOx reduction equates to 1 ton/day in 2020 and lower 8 hour ozone levels by 0.1 ppb in the Metrolina region.

Summary of Air Quality Impacts

For the Metrolina Area…

- 2009 on-road mobile NOx ~ 100 tons/day (w/ Tier 2)
- 2020 on-road mobile NOx ~ 25 tons/day (w/Tier 2)

If a 10% NOx reduction = 10 tons/day in 2009 = 1 ppb maximum ozone benefit

Then a 4% NOx reduction = 1 ton/day in 2020 = 0.1 ppb maximum ozone benefit

DAQ concluded the 4% on-road mobile NOx reduction in year 2020 due to a CA LEV-II program would have a very limited impact on maximum 8-hour ozone.

Overview of CA LEV-II Fleet Analysis and Enforcement

Any state adopting the CA LEV-II regulation is not required to enforce measures associated with tracking vehicle sales or registration data (each auto manufacturers must comply with the fleet average NMOG emissions values). As a qualitative measure, DAQ compared several fleet demographic parameters of California versus North Carolina's fleets to estimate whether "fleet average" enforcement is critical to the program. When looking at the applicable vehicles in each state based on gross vehicle weights (GVW), North Carolina has 11% more passenger cars, 7%

fewer light-duty trucks (under 6,001 lbs.) and 6% fewer light-duty trucks (6,001-8,500 lbs.) than in California.

The second fleet demographic is vehicle age distribution expressed as a percent based on the number of vehicle within a vehicle class and model year. North Carolina has a slightly lower percentage of 1 and 2 year old passenger cars than California and equal percentages of 3-year-old passenger cars. North Carolina has a greater percentage of 4 through 12 year old passenger cars and fewer 13 to 25 year olds. Generally fleets weighted towards newer vehicles will more quickly benefit from a control program due to the acceleration toward a newer fleet.

Finally, a comparison of the fraction of VMT driven by each vehicle class in 2010 was analyzed based on USEPA guidance. California light-duty gasoline car and truck owners are projected to drive their vehicles slightly more than North Carolinians in year 2010.

Overview of Qualitative Assessment of Enforcement Options

If one generally assumes passenger vehicles are cleaner emitting vehicles than light-duty trucks, and newer vehicles generally emit less than older vehicles, then one can qualitatively assert that the light-duty gasoline vehicle fleet registered in North Carolina is cleaner than California's registered light-duty gasoline vehicle fleet. This data (i.e., especially the greater percentage of passenger cars) may be an indicator that a fleet average requirement will not be difficult to meet in North Carolina and thus a "simple certification" enforcement program might result in similar benefits, while requiring fewer state resources.

Overview of Staffing and Enforcement Resources

NCDAQ contacted several state air quality agencies including Washington State Department of Ecology, Air Quality Program to better understand staffing needs associated with implementing and enforcing a CA LEV-II program. Washington indicated both New York and Massachusetts have staffs at 2 to 3 people (not full time) on CA LEV-II tasks.

The primary point of enforcement/compliance would likely be the State's Division of Motor Vehicles (DMV) with the air quality agency staff conducting audits, monitoring program effectiveness, handling public outreach, registration, and vehicle availability issues.

Another possible resource concern considered by NCDAQ is the impact to existing tasks such as transportation conformity, SIP modeling and emission inventories. Due to more complicated mobile source emission estimation techniques involved with a CA LEV-II program, there is some concern that timelines on these core tasks could be lengthened.

Conclusions

The CA LEV-II program (assuming statewide implementation in 2010) could provide NOx reductions on the order of 0.1% in 2010, 4% in 2020 and 10% in 2030 and VOC reductions of 0.1% in 2010, 3% in 2020 and 6% in 2030 as compared to the Federal Tier 2 program already in place. It should be noted that in 2030, the estimated 10% on-road mobile NOx reduction is equivalent to only 10 tons/day of NOx reduced statewide. This is because of the overall on-road mobile NOx emissions are significantly lower by that time. NCDAQ has estimated this level of NOx reduction in these future years will impact North Carolina's ability to attain the National Ambient Air Quality Standard for 8-hr ozone insignificantly. Additionally, moderate staffing implications could result from enforcement of CA LEV-II and from the impact to tasks such as transportation conformity, SIP modeling and emission inventories.

1. Description of Project

1.1 Purpose

The objective of this project was to estimate the emissions benefits of adopting California Low-Emission Vehicle II (CA LEV-II) standards in North Carolina (NC), as compared to the Federal Tier 2 standards already in effect. Using air quality modeling sensitivities recently conducted by the North Carolina Division of Air Quality (NCDAQ), potential ozone benefits were also estimated. Additional data was collected and analyzed to better understand the impact of implementing a fleet averaging enforcement option.

1.2 Background

On-road mobile source emissions make up a significant portion of the total statewide Nitrogen Oxides (NOx) emissions. For example, in year 2002, the NCDAQ estimated that 45% of North Carolina's NOx emissions came from on-road mobile sources. NOx and volatile organic compounds (VOC) are critical ozone precursors. Because of the generally warm and moist climate of North Carolina, vegetation abounds in many forms, and forests naturally cover much of the state. This "biogenic" sector is the most abundant source of VOCs in North Carolina and accounts for approximately 90% of the total VOCs statewide. The overwhelming abundance of biogenic VOCs makes the majority of North Carolina a NO_x limited environment for the formation of ozone. Therefore, reductions of only NOx emissions are targeted in North Carolina when aiming to reduce ozone.

Federal, State and local control programs have been implemented to help control NOx emissions from on-road mobile sources. At the state level, North Carolina has expanded its Inspection and Maintenance (I/M) program. The program now covers 48 of the State's 100 counties to ensure that vehicle emission controls are properly working.

At the federal level, the United States Environmental Protection Agency (USEPA) has adopted national motor vehicle and fuel standards. The most recent standards adopted by USEPA include the Tier 2 vehicle and gasoline standard (phase-in began in 2004)[1], and the heavy-duty diesel vehicle and fuel standard (phase-in begins in 2006 with the release of the model year 2007 heavy-duty diesel vehicles and low sulfur diesel fuel)[2].

The federal Clean Air Act (CAA) provides the framework for regulating emissions from on-road mobile sources. The CAA set the first federal vehicle emission standards. However, because California already had vehicle emission standards when this occurred, the CAA authorized California (and only California) to continue setting its own vehicle emission standards. Therefore all new vehicles sold in the United States (U.S.) are subject to emission standards set by either the federal government or the State of California. Other states have the option to adopt the California standards in lieu of the federal standards. This authority was granted under Section 177 of the CAA. Section 177 also guarantees the automakers that they will not have to meet more than two regulatory regimes by explicitly prohibiting any requirements that result in a "third vehicle".

1.3 Description of the Federal Tier 2 and California LEV-II Programs

USEPA's Tier 2 vehicle and gasoline standards, adopted in December 1999, took effect beginning with model year 2004 vehicles. Meanwhile, around the same time, the California Air Resources Board (CARB) amended their Low-Emission Vehicle (LEV) regulations to a more stringent program known as the California Low-Emission Vehicle Standard (CA LEV-II)[3]. Like Tier 2, CA LEV-II took effect beginning with model year 2004 vehicles. Both the Tier 2 and CA LEV-II regulations set emission standards for light-duty vehicles such as passenger cars, trucks, and sport utility vehicles. Both the Tier 2 and CA LEV-II standards become progressively more stringent with time and both classify vehicle types into several different groupings, setting emission standards for each grouping.

Significant emission reductions are realized from both the Tier 2 and CA LEV-II programs. The emissions are reduced through exhaust and evaporative emission standards and annual fleet average emission standards. Ultimately, auto manufacturers are given the flexibility to produce vehicles that emit both more and less than the fleet average, as long as the mathematical average is within the fleet limit.

There are several important differences between the Tier 2 and CA LEV-II programs. The federal Tier 2 program requires a total light-duty fleet NOx standard of 0.07 grams per mile, which is phased-in between years 2004 and 2009. In contrast, the CA LEV-II fleet average standards are based on non-methane organic gases (NMOG), also generally referred to as hydrocarbons (HC) or VOCs. A summary of the CA LEV-II exhaust emission standards can be found in Table 1.3-1.

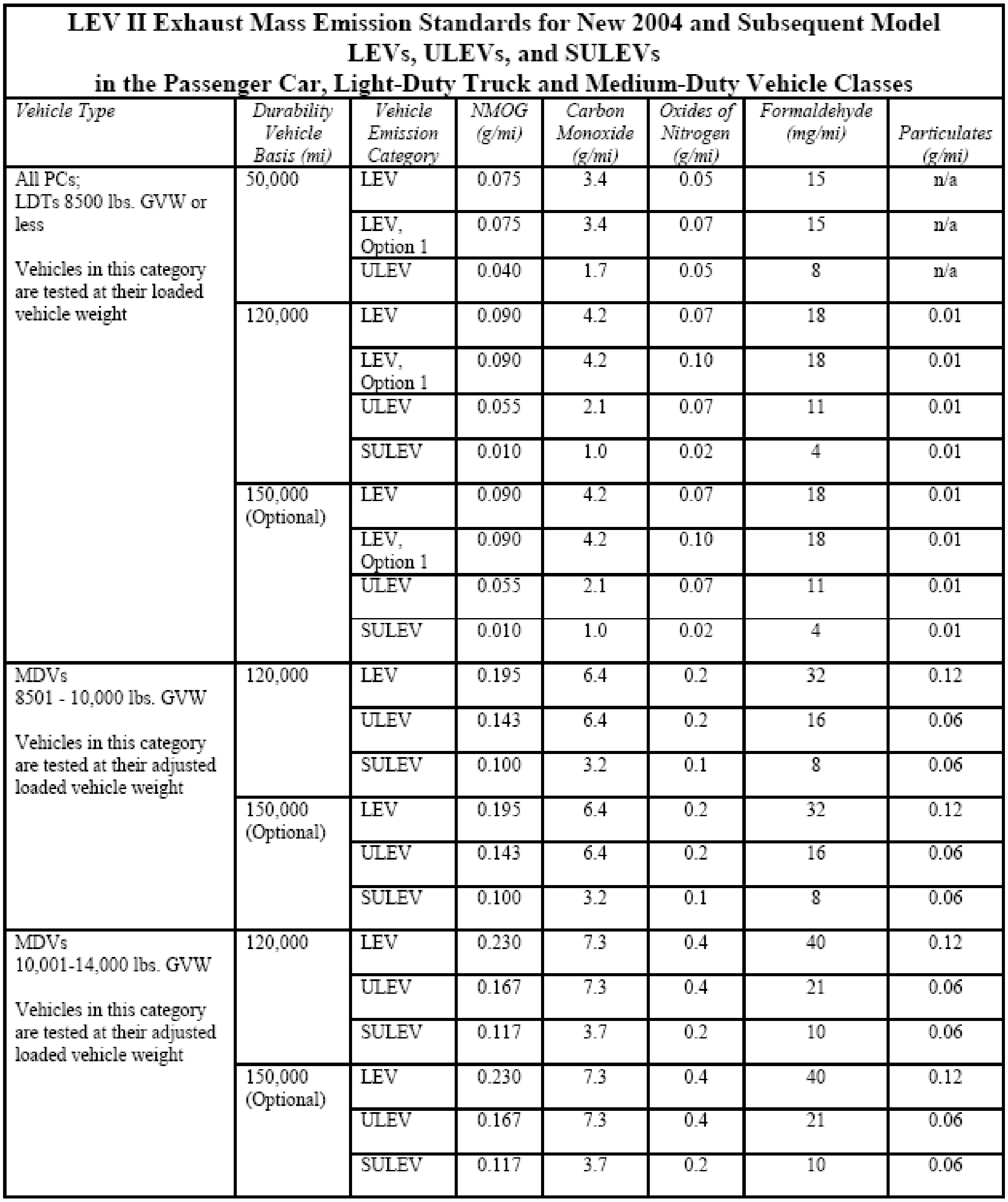
Another important feature of the CA LEV-II program that differs from the Tier 2 program is the advanced technology vehicle component. This component requires a portion of the light-duty fleet to be "zero-emission vehicles" (ZEVs). Originally designed to mandate the introduction of electric ZEVs, California's ZEV requirement has been changed to allow credit for a variety of advanced automobile technologies. Partial ZEVs (PZEVs) and advance technology partial ZEVs (AT-PZEVs) meet the ZEV zero emissions evaporative standards, the individual vehicle exhaust standards, and the extended warranty and durability requirements. The ZEV component of the CA LEV-II program is discussed further in Section 2.3.3.

Finally, the evaporative requirements of the CA LEV-II standard appear to be lower than the Tier 2 standard. However, the test procedures used to determine compliance with the Tier 2 evaporative requirement has a provision requiring that evaporative system durability be demonstrated on fuels containing the maximum allowable alcohol levels, because the permeability of system components is increased with these fuels. Manufacturers are thus held to a tighter standard of durability under Tier 2, and they have indicated to USEPA that the emission control hardware required to meet the Tier 2 evaporative requirements is identical to that needed to meet the CA LEV-II requirements. NCDAQ assumed the evaporative requirements of the Tier 2 and CA LEV-II standards to be the same in this analysis.

1.4 Emission Factors

Emission factors used in this study were generated using USEPA's MOBILE6.2 model[4]. MOBILE6.2 was designed by USEPA to address a wide variety of air pollution modeling needs. The model calculates emission factors under various conditions effecting in-use emission levels (e.g., ambient temperatures, average traffic speeds) as specified by the modeler. MOBILE models have been used by USEPA to evaluate highway mobile source control strategies; by states, local and regional planning agencies to develop emission inventories and control strategies for State Implementation Plans (SIPs) under the CAA; by metropolitan planning organizations and state transportation departments for transportation planning and conformity analysis; by academic and industry investigators conducting research; and in developing environmental impact statements. Special input files and guidance were used in MOBILE6.2 to model the CA LEV-II standards. This is described in greater detail in Section 2.

Table 1.3-1 CA LEV-II Emissions Standards[3]



LEV II Exhaust Mass Emission Standards for New 2004 and Subsequent Model LEVs, ULEVs, and SULEVs in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes

Vehicle Type	*Durability Vehicle Basis (mi)*	*Vehicle Emission Category*	*NMOG (g/mi)*	*Carbon Monoxide (g/mi)*	*Oxides of Nitrogen (g/mi)*	*Formaldehyde (mg/mi)*	*Particulates (g/mi)*
All PCs; LDTs 8500 lbs. GVW or less Vehicles in this category are tested at their loaded vehicle weight	50,000	LEV	0.075	3.4	0.05	15	n/a
		LEV, Option 1	0.075	3.4	0.07	15	n/a
		ULEV	0.040	1.7	0.05	8	n/a
	120,000	LEV	0.090	4.2	0.07	18	0.01
		LEV, Option 1	0.090	4.2	0.10	18	0.01
		ULEV	0.055	2.1	0.07	11	0.01
		SULEV	0.010	1.0	0.02	4	0.01
	150,000 (Optional)	LEV	0.090	4.2	0.07	18	0.01
		LEV, Option 1	0.090	4.2	0.10	18	0.01
		ULEV	0.055	2.1	0.07	11	0.01
		SULEV	0.010	1.0	0.02	4	0.01
MDVs 8501 - 10,000 lbs. GVW Vehicles in this category are tested at their adjusted loaded vehicle weight	120,000	LEV	0.195	6.4	0.2	32	0.12
		ULEV	0.143	6.4	0.2	16	0.06
		SULEV	0.100	3.2	0.1	8	0.06
	150,000 (Optional)	LEV	0.195	6.4	0.2	32	0.12
		ULEV	0.143	6.4	0.2	16	0.06
		SULEV	0.100	3.2	0.1	8	0.06
MDVs 10,001-14,000 lbs. GVW Vehicles in this category are tested at their adjusted loaded vehicle weight	120,000	LEV	0.230	7.3	0.4	40	0.12
		ULEV	0.167	7.3	0.4	21	0.06
		SULEV	0.117	3.7	0.2	10	0.06
	150,000 (Optional)	LEV	0.230	7.3	0.4	40	0.12
		ULEV	0.167	7.3	0.4	21	0.06
		SULEV	0.117	3.7	0.2	10	0.06

1.5 Evaluation Years

In order to evaluate the emissions benefits of adopting a CA LEV-II program over time, several years were evaluated. Baseline emissions were estimated for years 2004, 2010, 2020, and 2030 for the Tier 2 program. Emissions were estimated for years 2010, 2020, and 2030 for the CA LEV-II program. The year 2004 was picked because it represents the start year of the Tier 2 program. The year 2010 was chosen because it is assumed in this analysis to be the earliest possible start date of a CA LEV-II program in NC. The basis for determining the earliest possible start date is a requirement that manufacturers be given a two year "lead-time." This means states cannot enforce such standards until model years beginning two years after the date of adoption. "Model year" actually begins on January 2nd, of the previous calendar year. In other words, in order for a state to adopt CA LEV-II for model year 2010, the state must adopt those standards two years before January 2, 2009 (i.e., prior to January 2, 2007).

Years 2020 and 2030 were picked based on the availability of local mobile model input data, such as future projected speeds and vehicle miles traveled (VMT).

1.6 Pollutants Addressed and Spatial/Temporal Resolution

On-road mobile emissions of NOx and VOCs were estimated for the entire state of North Carolina for a typical summer weekday. The impacts on future year ozone concentrations also were estimated. This is discussed further in Section 4 and 5.

2. Approximation of CA LEV-II Standard Using MOBILE6.2

2.1 General Approach

All vehicles manufactured in the U.S. are subject to either the Federal Tier 2 or the CA LEV-II standard and as discussed earlier, states other than California have the option to adopt the CA LEV-II program in lieu of the federal standards. However, states other than California do not have the option to use the California mobile emissions model, EMFAC[5]. In order to estimate the emissions benefits of adopting CA LEV-II standards in North Carolina, the only mobile emissions modeling tool available is USEPA's MOBILE6.2. The emissions standard default for light-duty vehicles in MOBILE6.2 is the Tier 2 standard. The upcoming sections detail the approximation of the CA LEV-II program in USEPA's MOBILE6.2 model and the methodology used by NCDAQ to estimate the emissions benefits of adopting a CA LEV-II program in North Carolina.

2.2 Vehicles Subject to the CA LEV-II Standard

The CA LEV-II standard is applicable to light-duty vehicles (i.e., passenger cars), light-duty trucks up to 8,500 lbs gross vehicle weight rating (GVW), and medium-duty vehicles that are up to 14,000 lbs GVW. Because terminology about truck weight classes can be very confusing, the best way to refer to vehicle classifications is by their actual weight. In this emission analysis, NCDAQ applied CA LEV-II to only passenger cars and light-duty trucks up to 8,500 lbs GVW. The population of medium-duty trucks between 8,500 lbs and 14,000 lbs in North Carolina is very small; therefore, the impact of adopting CA LEV-II for that vehicle class would be minimal. Light-duty vehicle classes that NCDAQ applied the CA LEV-II program, in the emissions analysis defined by USEPA, are:

LDGV - light-duty gasoline vehicles (passenger cars)
LDGT1 – trucks up to 6,000 lbs GVW + 3,750 LVW
LDGT2 – trucks up to 6,000 lbs GVW + 3,751 LVW-5,750 LVW
LDGT3 – trucks between 6,001 lbs-8,500 lbs GVW + 3,751 LVW-5,750 LVW
LDGT4 – trucks between 6,001 lbs-8,500 lbs GVW + > 5,750 LVW

where GVW = maximum fully loaded vehicle weight,
LVW = nominal empty vehicle weight + 300 lbs.

2.3 Methodology: Modeling CA LEV-II using MOBILE6.2

As stated earlier, the default emission standards in MOBILE6.2 is the Federal Tier 2 standard. In order to simulate the CA LEV-II standard, NCDAQ consulted with USEPA Region IV, the USEPA Office of Transportation, and Air Quality (OTAQ). USEPA OTAQ provided much appreciated technical support during the design phases of this project, including a revised guidance document[6] that outlines the auxiliary files necessary to approximate the CA LEV-II program in MOBILE6.2. These auxiliary files were developed by OTAQ in consultation with CARB. The additional files are:

LEVIIPH.d – phase-in percentages by exhaust certification bin, vehicle class and pollutant. NCDAQ used this file as provided by USEPA OTAQ.

LEVIIEVP.d – phase-in percentages for evaporative standards by vehicle class. NCDAQ used this file as provided by USEPA OTAQ.

LEVIIST.d – the 50,000 mile standard levels by exhaust certification bin, vehicle class and pollutant. NCDAQ used this file as provided by USEPA OTAQ.

LEVII94.d – establishes the percentage of zero emitting exhaust vehicles. NCDAQ used this file as provided by USEPA OTAQ.

In conjunction with the above auxiliary files, analysis of the CA LEV-II program in MOBILE6.2 must be performed using these four commands:

T2 EXH PHASE-IN, which provides phase-in percentages by exhaust certification bin, vehicle class, and pollutant (corresponds with the LEVIIPH.d input file).

T2 CERT, which defines the 50,000 mile standard levels by exhaust certification bin, vehicle class, and pollutant (corresponds with the LEVIIST.d input file).

T2 EVAP PHASE-IN, which provides phase-in percentages for evaporative standards by vehicle class (corresponds with the LEVIIEVP.D input file).

94+ LDG IMP, which is used only to establish the fraction of ZEVs (corresponds with the LEVII94.D).

One complicating issue associated with modeling the CA LEV-II program in MOBILE6.2 is the inability to alter the start year. Working around this model limitation requires a significant post-process of the model output to “reconstruct” composite emission factors.

Implementing the post-processing technique required NCDAQ to apply the DATABASE OUTPUT commands in MOBILE6.2. This allows the user to obtain the most disaggregated output from the model. Emission factors per emission type (e.g. running exhaust, starting exhaust and evaporative), per facility type (e.g. freeway, arterial, local, ramp, none), per model year, and per pollutant were generated. This reconstruction technique was developed and successfully tested for a “Tier 2 only” approach where the post-processed emission factor matched the composite emission factor from MOBILE6.2 descriptive output.

Generally, in order to model the impacts of implementing a CA LEV-II program in year 2010 as accurately as possible, emission factors were generated for model year vehicles prior to year 2009 with Tier 2 level of control applied (noting the Tier 2 level of control would only apply to model years 2004-2009 vehicles). Those were combined with the emission factors for model year 2010 vehicles with CA LEV-II level of control applied. This method was applied to generate a composite year 2010 emission factor for each of the light-duty vehicle classes. Please see Appendix A for a detailed representation of the emission factor reconstruction post-process methodology applied by NCDAQ.

The reconstructed composite emission factors for each of the light-duty vehicle classes were combined with the emission factors from the vehicle classes not impacted by a CA LEV-II program and the VMT fraction to get the final composite NOx and VOC emission factors for each facility or roadway scenario. This data is shown in Appendix B. Comparable sets of tables with the Tier 2 emission factors are provided in Appendix C.

NCDAQ took advantage of several opportunities to implement “efficiencies” into the complex post-processing effort. One of those was modeling the State of North Carolina in four sections: Raleigh-Durham, Charlotte-Gastonia, other areas with an I/M program, and other areas without an I/M program. This was done to simply reduce the number of model input and output files to process while still taking advantage of local data sets, such as vehicle age distributions and VMT fractions in the Raleigh-Durham and Charlotte-Gastonia areas. An additional efficiency implemented was the use of weight-average speeds to limit the facilities or road types that needed to be modeled. Rural interstates, urban interstates, and other roads were the three facilities modeled. VMT was aggregated into similar groupings. This is explained further in Section 2.3.1.6.

The MOBILE6.2 input parameters used in this study represent North Carolina’s “latest planning assumptions” and are the most up-to-date data available (as of March 2006) from the North Carolina Department of Transportation (NCDOT) and the NCDAQ. This North Carolina specific data was used for the following MOBILE6.2 input parameters: speeds, VMT fractions, Reid vapor pressure, vehicle age distribution, temperatures, inspection, and maintenance program. These input parameters and others, are discussed below.

2.3.1 MOBILE6.2 Input Parameters

2.3.1.1 Evaluation Month

MOBILE6.2 can calculate emission factors that represent a January 1st or July 1st fleet age. Emissions for this project were calculated with the July 1st setting.

2.3.1.2 Vehicle Age Distribution

The vehicle age distribution comes from annual registration data for North Carolina from the NCDOT. For this analysis the data was generated from 2004. The NCDOT provided the latest available count data based on the number of vehicle types per year from 1974 through 2004. Vehicles greater than 25 years old were combined and included as the 25th model year. NCDAQ converted the data provided by the NCDOT into the MOBILE6.2 model format using a conversion utility. The count data provided by the NCDOT was converted to fractions by dividing each count per vehicle type per year by the total number of vehicles in that classification for all years. For example, the number of 2004 light-duty vehicles was divided by the total number of light-duty vehicles for all years. Comparisons of North Carolina and California vehicle age distributions are provided in Section 5.2.

2.3.1.3 Vehicle Miles Traveled Fractions

The vehicle miles traveled fractions (i.e., VMT fraction or VMT mix) refer to the percentage of different vehicle types on each of the Federal Highway Administration road types. It is critical when estimating mobile emissions in an area, to use data that accurately reflects vehicle types traveling on each different road types. The North Carolina Highway Performance Monitoring System (HPMS) information that was used to generate the statewide VMT fractions was based on years 1999 through 2001 length based counts. This is the latest North Carolina statewide count information available. The raw count information was processed consistent with USEPA methods and guidance[7] for each year in the analysis. Comparisons of the North Carolina and California VMT fractions are provided in Section 5.3

2.3.1.4 Temperatures

For this analysis, an average July 2005 minimum and maximum temperature was calculated from data at five Automated Surface Observing System (ASOS) sites as shown in Table 2.3-1 below. The overall average minimum and maximum temperatures were used in all MOBILE6.2 input files.

Table 2.3-1 July 2005 Average Minimum and Maximum Temperatures[8]

	Average Maximum	Average Minimum
Asheville	83.2	65.5
Charlotte	89.0	70.1
Greensboro	88.2	71.5
Raleigh	92.9	71.6
Wilmington	90.1	74.5
Overall Average	**88.7**	**70.6**

2.3.1.5 Vehicle Inspection and Maintenance (I/M) Program

As discussed earlier, North Carolina has implemented a vehicle emissions inspection program, onboard diagnostics (OBDII) in 48 counties. This program covers all light-duty gasoline powered vehicles that are model year 1996 and newer. The program was phased-in to include a total of 48 counties between July 2002 and January 2006. Therefore, the years 2010, 2020, and 2030, MOBILE6.2 model runs in this analysis; incorporate all of the appropriate I/M program parameters in the 48 counties. The OBDII compliance rate used in the MOBILE6.2 input files is 95 percent. In addition to applying the appropriate I/M commands in MOBILE6.2, NCDAQ applied anti-tampering commands. This statewide program ensures that emission control equipment on any vehicle model year of 1968 and newer has not been altered.

2.3.1.6 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 traveling at low speeds. Average daily annual speeds were used in this analysis for each road type. The speeds were obtained from NCDOT. The speeds for the areas other than Raleigh-Durham and Charlotte-Gastonia areas are assumed to be the Wake County off-peak speeds. This assumption is consistent with what has been recommended by NCDOT in past efforts to develop statewide mobile source emission inventories.

In the Raleigh-Durham and Charlotte-Gastonia areas, for the years 2010, 2020, and 2030 average speeds were calculated for urban and rural interstates. The speeds used in the averaging are based upon the latest available information from local travel demand models. The "other roads" speeds for the entire state represent a VMT weighted average of the non-interstate speeds from the Wake County off-peak data sets for the years 2010, 2020, and 2030. Tables 2.3-2 through 2.3-4 provide a summary of the speeds used in this analysis.

Table 2.3-2 2010 Speeds

	Rural Interstate	Urban Interstate	Other Roads
Charlotte-Gastonia	53	51	46
Raleigh-Durham	53	51	46
Other Areas	66	61	46

Table 2.3-3 2020 Speeds

	Rural Interstate	Urban Interstate	Other Roads
Charlotte-Gastonia	53	51	45
Raleigh-Durham	53	51	45
Other Areas	62	62	45

Table 2.3-4 2030 Speeds

	Rural Interstate	Urban Interstate	Other Roads
Charlotte-Gastonia	49	48	44
Raleigh-Durham	49	48	44
Other Areas	61	61	44

2.3.1.7 Reid Vapor Pressure (RVP)

Reid Vapor Pressure reflects a gasoline's volatility. Lower RVP leads to lower VOC emissions from gasoline handling and lowers vapor losses from motor vehicles. North Carolina rules require lower RVP gasoline in the most urbanized areas of the state during the summer. Therefore, an RVP of 7.8 pounds per square inch (psi) was applied in this analysis for the Raleigh-Durham and Charlotte-Gastonia areas. Due to the input file grouping explained earlier in Section 2.3, an RVP of 9.0 was applied for the "other areas."

2.3.2 Vehicle Miles Traveled

In order to calculate emissions from on-road mobile sources, emission factors were developed as discussed throughout this document. The emission factors were then multiplied by an activity level, which is average weekday vehicle miles traveled (VMT). The VMT used in this analysis was derived from the latest county-by-county HPMS data available from NCDOT. The future years were projected using a growth rate from a linear regression completed on the last 10 years of HPMS data. The same VMT was used in the generation of emissions for the Tier 2 program as the CA LEV-II program. The county specific VMT used in this analysis is provided in Appendix D for years 2010, 2020, and 2030.

2.3.3 CA LEV-II Phase-in Schedule

As mentioned earlier in Section 2.3, USEPA OTAQ provided MOBILE6.2 auxiliary files necessary to approximate the phase-in CA LEV-II program. This file represents California's assumptions on how manufacturers would meet the fleet average standards. This is the latest available CA LEV-II phase-in schedule in MOBILE6.2 format from USEPA OTAQ.

2.3.4 Zero Emissions Vehicle (ZEV) component

The CA LEV-II standards include a zero-emission vehicle (ZEV) component. This is considered an “option” for states wishing to “opt-in” to the CA LEV-II standards. Originally designed to mandate the introduction of electric ZEVs, California’s ZEV program has been changed to allow credit for a variety of advanced automobile technologies besides electric vehicles. Partial ZEVs (PZEVs) and advance technology partial ZEVs (AT-PZEVs) meet the ZEV zero emissions evaporative standards, the individual vehicle exhaust standards, and the extended warranty and durability requirements.

Generally, California’s basic ZEV rule requires that a manufacturer’s annual sales of light-duty vehicles must consist of a percentage of ZEVs. This requirement first applied only as a percentage of passenger cars and LDT1 trucks. This is referred to as the ZEV baseline. The ZEV baseline was applied by NCDAQ in this analysis using USEPA’s latest available MOBILE6.2 ready (levii94.d) auxiliary file.

CARB recognized the ZEV requirement would be difficult to meet and established a review by a technical panel every two years. The ZEV baseline has since been expanded to include LDT2 trucks to be phased in on a later schedule. Due to the fact that ZEV technology has not developed as quickly as California had hoped, they have added flexible ways to meet the requirement. Those flexibilities are discussed elsewhere[3].

3. Results: Emissions Benefits

3.1 NOx and VOC Benefits

To begin to understand the emissions benefits of adopting CA LEV-II in North Carolina, the NCDAQ applied the approach, methods and data summarized in previous sections. The emissions benefits analysis included a comparison of statewide on-road mobile source NOx and VOC emissions resulting from the current federal level of control (Tier 2), and from the CA LEV-II level of control. It should be noted that the emission differences were calculated in context of the entire on-road mobile source emissions inventory. This method for comparison enabled the NCDAQ to apply the knowledge gathered in emissions/air quality modeling studies to assess the air quality (ozone) benefits that might result from the CA LEV-II emissions benefits. The air quality benefits analysis is presented in Section 4.

As can be seen in Table 3.1-1, the statewide NOx and VOC emissions from adopting a CA LEV-II program are lower relative to the Federal Tier 2 level of control. As discussed previously, the earliest CA LEV-II can begin is in the year 2010. Since it will take time for the CA LEV-II vehicles to become a significant portion of the overall vehicle fleet, the CA LEV-II standards show an increasing emissions benefit (i.e., on a percentage basis) over time relative to the Tier 2 level of control.

Table 3.1-1. CA LEV-II Reductions Compared to Federal Tier 2: Entire Fleet

	2010	2020	2030
NOx	0.1%	4%	10%
VOC	0.1%	3%	6%

Figure 3.1-1 below presents the North Carolina statewide on-road mobile source NOx emissions inventory with a Tier 2 control program for years 2004, 2010, 2020, and 2030 (blue line), and also with a CA LEV-II control program for years 2010, 2020, and 2030 (magenta line). Figure 3.1-2 is a similar graph for VOC emissions. (It should be noted that the NOx and VOC emission estimates with a Tier 2 control program, assume there are no CA LEV-II compliant vehicles in North Carolina already. While NCDAQ does not have any official data, informal surveys have shown there are North Carolinians already driving CA LEV-II compliant vehicles. Therefore, the emission benefits of the CA LEV-II program shown in Table 3.1.1 and Figures 3.1-1 and 3.1-2 are likely over-estimated.)

Also noteworthy, these figures illustrate the tremendous reductions in on-road mobile emissions, regardless of the control program, expected over time in North Carolina. These reductions will occur despite significant estimated increases in VMT (see Figure 3.1-3).

Figure 3.1-1. Estimated NOx Emissions – Federal Tier2 vs. CA LEV-II

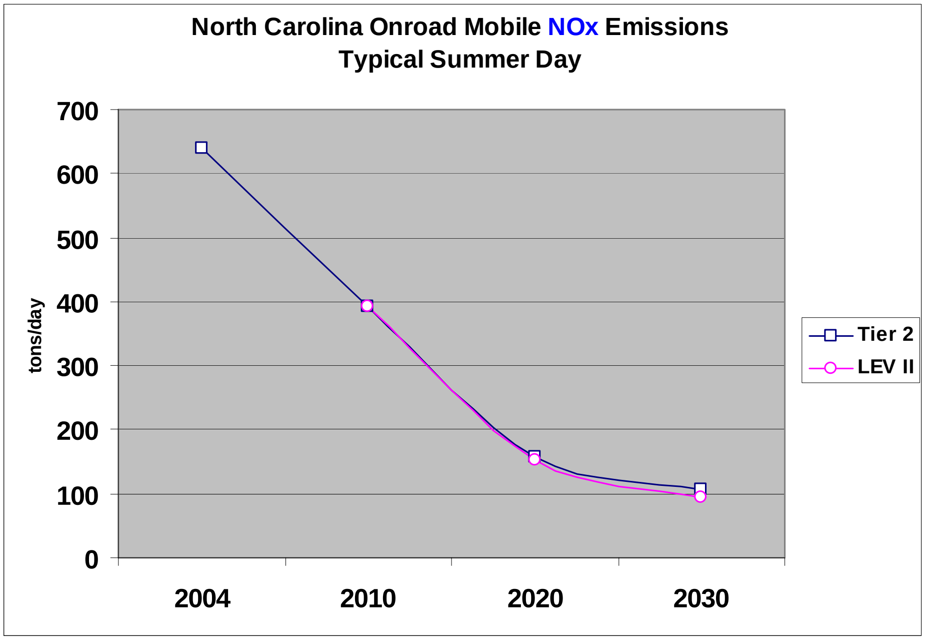


Figure 3.1-2. Estimated VOC Emissions – Federal Tier2 vs. CA LEV-II

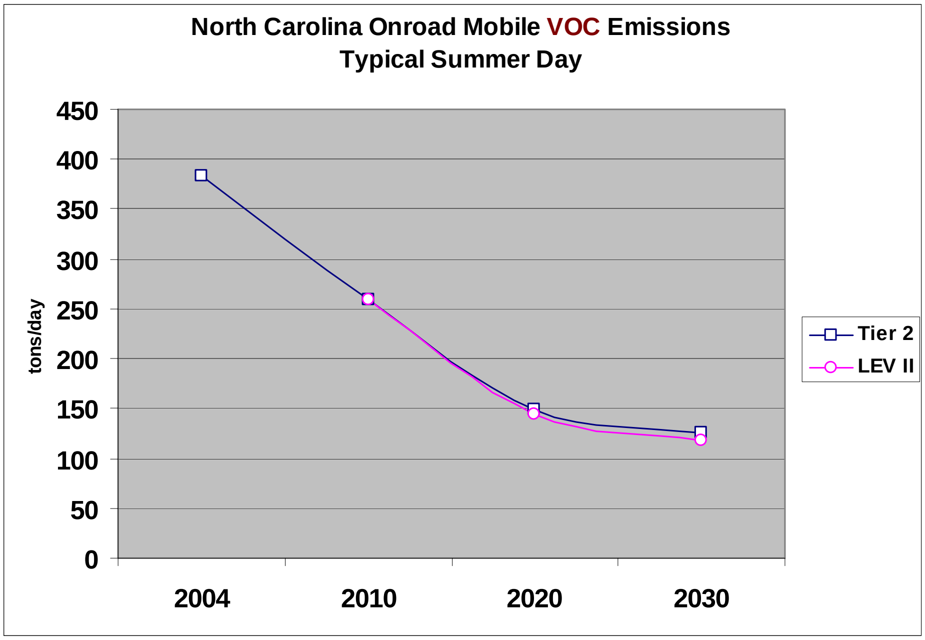
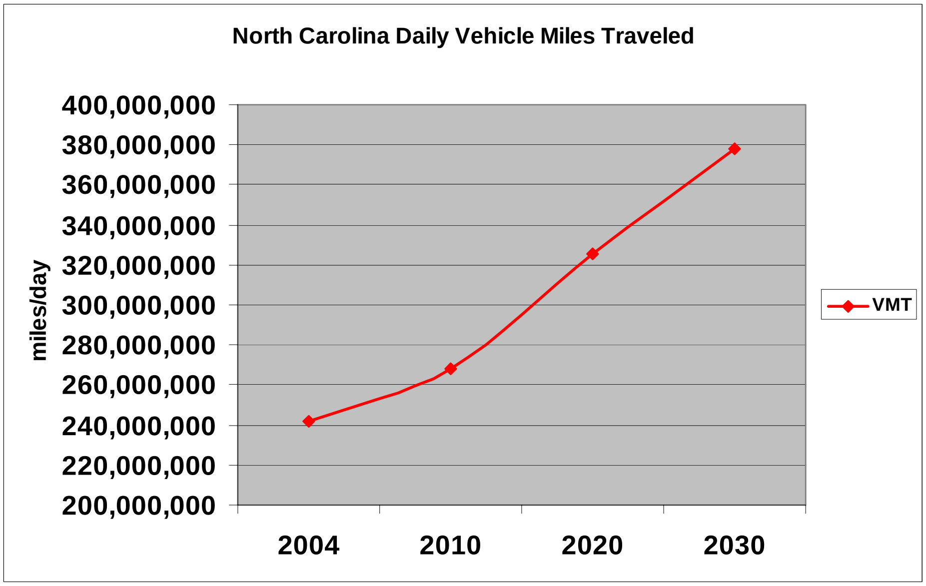


Figure 3.1-3. Estimated Vehicle Miles Traveled



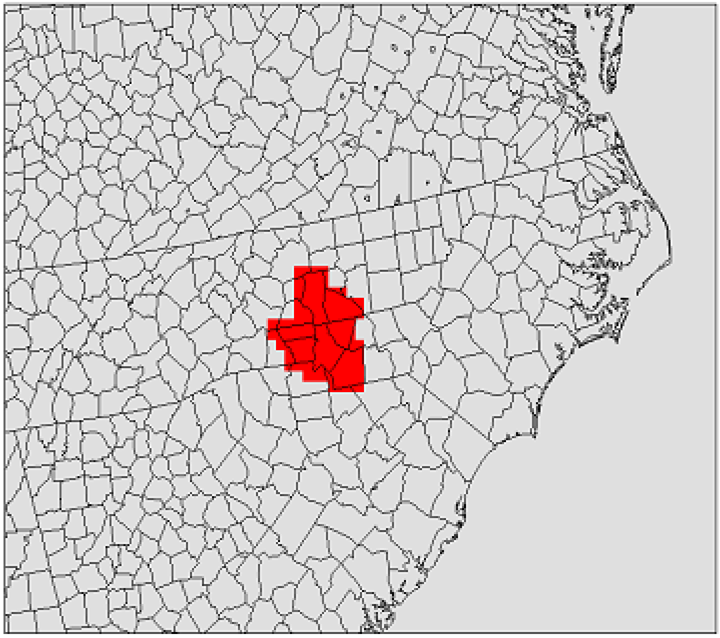
4. Results: Air Quality Impacts

4.1 Ozone Sensitivities

During the development of the 8-hour ozone SIPs for North Carolina's nonattainment areas, the NCDAQ conducted a number of modeling sensitivity tests to better understand how targeted emission reductions would impact future ozone concentrations. The modeling system used in this analysis consisted of three components: 1) the Penn State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Model (MM5 version 3.6.1+)[9]; 2) the Sparse Matrix Operator Kernel Emissions Modeling System (SMOKE version 2.1)[10]; and, 3) the Community Multiscale Air Quality model (CMAQ version 4.4)[11,12]. Model configurations, input data, and modeling methods were consistent with those suggested by USEPA in "Guidance on the Use of Models and Other Analyses in Attainment Demonstrations for the 8-hour Ozone NAAQS" [13].

The emissions sensitivities were calculated by taking the difference between two air quality modeling simulations; one with "baseline" emissions and another with reduced emission inputs. This method is known in the modeling community as the "brute force" method[14]. Brute force sensitivity analyses have been widely used to better understand source/receptor relationships and aid in the design of control strategies for ozone[15]. The emissions sensitivity used in this analysis reduces on-road mobile source NOx emissions in the Metrolina 8-hour ozone nonattainment area, by 10% from year 2009 emission levels. The Metrolina nonattainment area was chosen because they currently have the highest ozone design values in North Carolina. The counties included in the emissions sensitivity modeling are shown in Figure 4.1-1.

Figure 4.1-1. North Carolina Counties included in the Metrolina Sensitivity (Mecklenburg, Union, Gaston, Lincoln, Iredell, Cabarrus and Rowan)



The 10% NOx reduction applied to the year 2009 on-road mobile source emissions is equivalent to a 10 ton/day reduction in this region. Again, this is a 10%, or 10 ton/day, on-road mobile source NOx reduction from the "baseline" year 2009 emissions that include the Tier 2 level of control. Air quality modeling results indicated this additional 10% NOx reduction resulted in lowering 8-hour ozone concentrations anywhere between 0.1 and 1.0 parts per billion (ppb) in year 2009. Only one of the seven modeled days resulted in changes in the maximum 8-hour ozone concentration, yielding a result as high as 1.0 ppb. This is shown in Figure 4.1-2. Only two of the seven modeled days resulted in changes as high as 0.5 ppb.

Using the CA LEV-II emission benefits analysis discussed in Section 3 above, NCDAQ assessed the 8-hour ozone benefits in year 2020, assuming a CA LEV-II program was implemented starting in year 2010. NCDAQ chose to analyze year 2020 to allow for a significant portion of the fleet to be CA LEV-II vehicles. As noted in Table 3.1-1 above, a 4% reduction of on-road mobile NOx emissions would be expected in year 2020 due to a CA LEV-II program. NCDAQ assumed the maximum ozone benefit shown in the year 2009 Metrolina sensitivity in estimating the year 2020 ozone impacts due to CA LEV-II, as shown in Table 4.1-1 below.

Table 4.1-1. Summary of Air Quality Impacts

For the Metrolina Area…

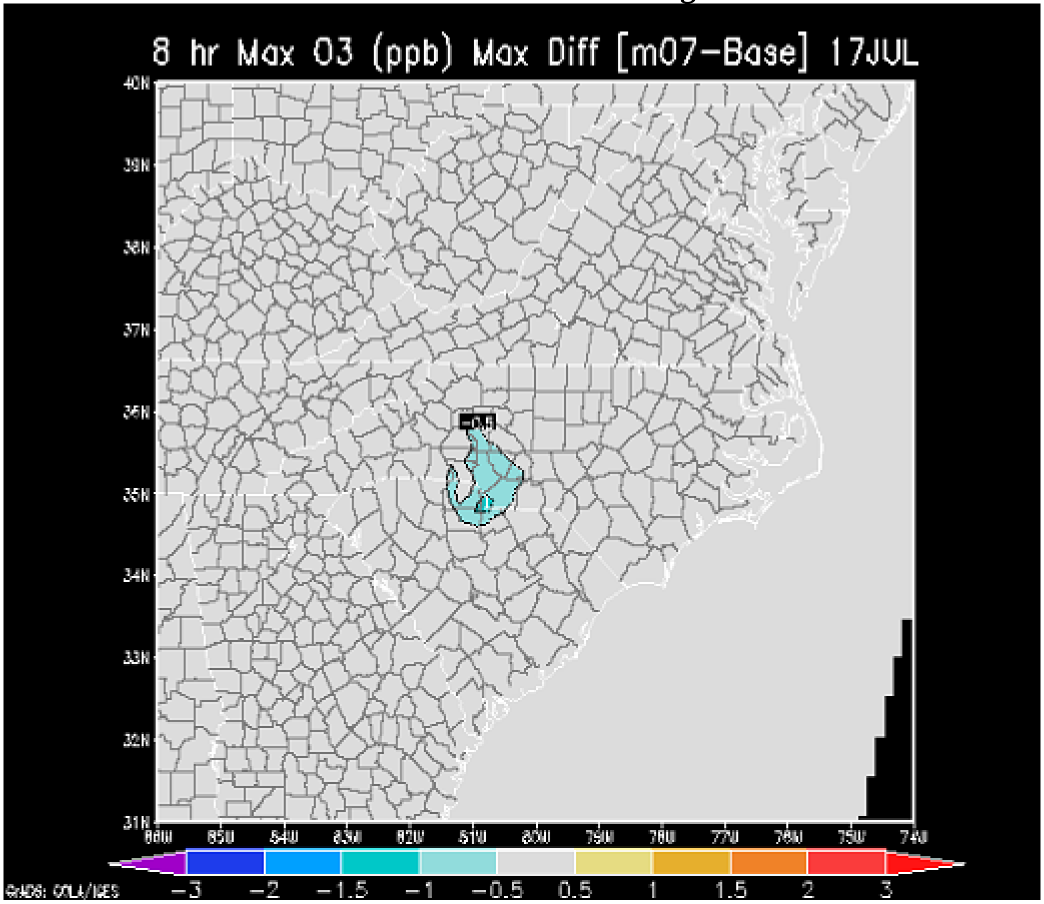
- 2009 on-road mobile NOx ~ 100 tons/day (w/ Tier 2)
- 2020 on-road mobile NOx ~ 25 tons/day (w/Tier 2)

If a 10% NOx reduction = 10 tons/day in 2009 = 1 ppb maximum ozone benefit

Then a 4% NOx reduction = 1 ton/day in 2020 = 0.1 ppb maximum ozone benefit

NCDAQ concluded the 4% on-road mobile NOx reduction in year 2020 due to a CA LEV-II program would have a very small impact on maximum 8-hour ozone concentrations (i.e., less than 0.1 ppb) in the Metrolina area. NCDAQ estimates the impact would be even less in areas where future projected ozone concentrations will be even lower.

Figure 4.1-2. Maximum 8-hour ozone reductions due to a 10% reduction of on-road mobile NOx emissions in 2009 in the Metrolina region.



5. CA LEV-II Enforcement Options – Fleet Analysis

One of the challenges put forth to NCDAQ was to assess the benefit of enforcing a fleet average requirement for the CA LEV-II control program versus simply requiring that all light-duty vehicles sold in North Carolina would have to be California certified (e.g., simple certification). A state adopting the CA LEV-II regulation is not required to undertake the additional activities associated with vehicle sales or registration enforcement.

A fleet average requirement would provide auto manufacturers the flexibility to produce vehicles that emit both more and less than the fleet average as long as their mathematical average is within the fleet average limit. This would mean state officials would work with auto manufacturers to calculate a fleet average NMOG value and check it against the applicable limits set in the rule. Details on how to offset "debits" or exceedances of the fleet average limit are discussed elsewhere[3].

While this analysis does not quantify the benefits of adopting a CA LEV-II program in North Carolina, with and without fleet averaging enforcement, several metrics were generated to better understand North Carolina's fleet demographics and how it compares to California's fleet of light-duty vehicles. This analysis of the fleet information helped NCDAQ make some qualitative estimates on whether enforcement of a fleet average option would be needed in North Carolina.

5.1 Fleet Comparisons (NC vs. CA)

5.1.1 Fleet Composition

Figure 5.1-1 presents a simple comparison of California's fleet per vehicle type versus the North Carolina fleet composition[16,17]. The fleet was binned into the 5 MOBILE5 vehicle classification bins for simplicity. Table 5.1-1 provides the mapping from MOBILE5 vehicle bins to MOBILE6.2 and a detailed description of vehicle weights that fall into each category. Several noteworthy fleet differences are immediately shown. North Carolina has about 11% more light-duty gasoline vehicles (i.e., passenger cars) than California, 7% fewer light-duty gasoline trucks 1 (i.e., pickup trucks and SUVs under 6,001 lbs. gross vehicle weight rating), and 6% fewer light-duty gasoline trucks 2 (i.e., pickup trucks and SUVs between 6,001-8,500 lbs gross vehicle weight rating).

Figure 5.1-1. NC and CA Composition of Fleet per Vehicle Type[16,17]

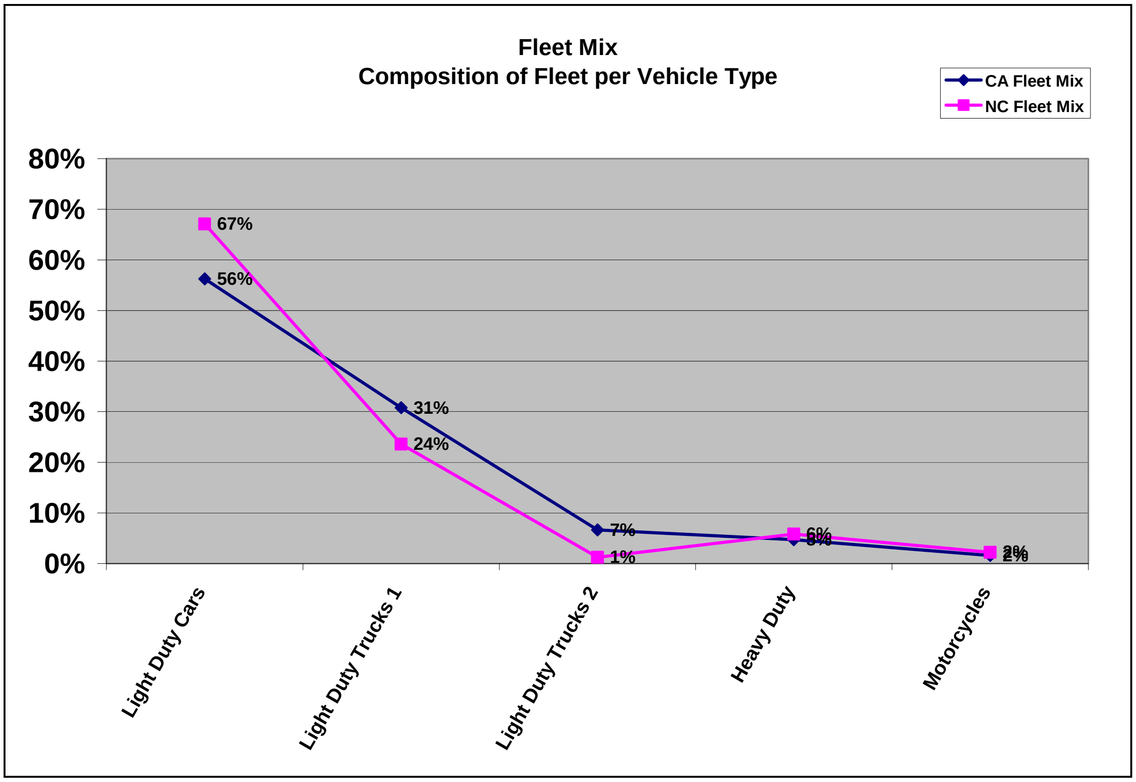


Table 5.1-1. Description of MOBILE5 and MOBILE6.2 Vehicle Classifications

MOBILE5	MOBILE6.2	Description
Light-Duty Cars	LDV	Light-Duty Vehicles (Passenger cars)
Light-Duty Trucks 1	LDT1	Light-Duty Trucks 1 (0-6,000 lbs. GVWR, 0-3750 lbs. LVW)
	LDT2	Light Duty Trucks 2 (0-6,001 lbs. GVWR, 3751-5750 lbs. LVW)
Light-Duty Trucks 2	LDT3	Light Duty Trucks 3 (6,001-8500 lbs. GVWR, 0-5750 lbs. ALVW)
	LDT4	Light Duty Trucks 4 (6,001-8500 lbs. GVWR, >5750 lbs. ALVW)
Heavy Duty Vehicles	HDV2B	Class 2b Heavy Duty Vehicles (8501-10,000 lbs. GVWR)
	HDV3	Class 3 Heavy Duty Vehicles (10,001-14,000 lbs. GVWR)
	HDV4	Class 4 Heavy Duty Vehicles (14,001-16,000 lbs. GVWR)
	HDV5	Class 5 Heavy Duty Vehicles (16,001-19,500 lbs. GVWR)
	HDV6	Class 6 Heavy Duty Vehicles (19,501-26,000 lbs. GVWR)
	HDV7	Class 7 Heavy Duty Vehicles (26,001-33,000 lbs. GVWR)
	HDV8A	Class 8a Heavy Duty Vehicles (33,001-60,000 lbs. GVWR)
	HDV8B	Class 8b Heavy Duty Vehicles (>60,000 lbs. GVWR)
	HDBS	School Buses
	HDBT	Transit and Urban Buses
Motorcycles	MC	Motorcycles (All)

5.1.2 Vehicle Age Distribution Comparison

Since light-duty gasoline vehicles (i.e., passenger cars) make up about two-thirds of North Carolina's registered fleet, NCDAQ examined the age of that vehicle class in North Carolina and California. Figure 5.1-2 shows the percent by age for passenger cars. While there is a slightly greater percentage of 1 and 2 year old passenger cars in California and equal percentages of 3 year old passenger cars, North Carolina has a greater percentage of 4 to 12 year old passenger cars and fewer 13 to 25 year olds. The yellow line on the graph represents a subset of the North Carolina statewide data for the Charlotte-Gastonia area. This subset indicates a much newer fleet of passenger vehicles in those counties. This is not unexpected however, due to Charlotte being the largest urban area in North Carolina. Generally, fleets weighted towards newer vehicles will result in quicker realization of control program benefits because of faster fleet turnover, even though the long-term benefits will be similar.

5.1.3 VMT Fraction Comparison

Finally, NCDAQ processed the California and North Carolina fleet demographic data to determine the fraction of VMT by vehicle class for the year 2010. This is often referred to as the VMT mix or VMT fraction. The methods used in determining the VMT fractions are consistent with USEPA guidance[7]. As shown in Figure 5.1-3, California light-duty gasoline car and truck owners are projected to drive their vehicles slightly more than North Carolinians in year 2010. Generally, however, there is not a great difference in the VMT fractions when using USEPA's methodology.

Figure 5.1-2. Light Duty Gasoline Vehicles, Percent by Age, NC and CA

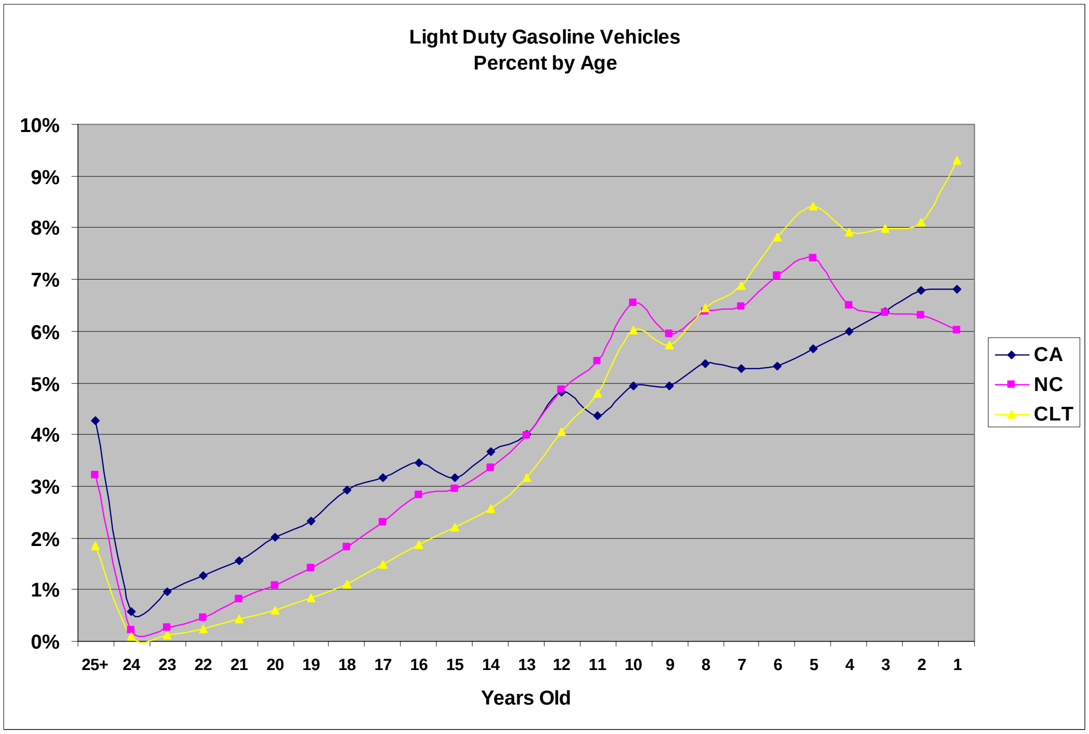
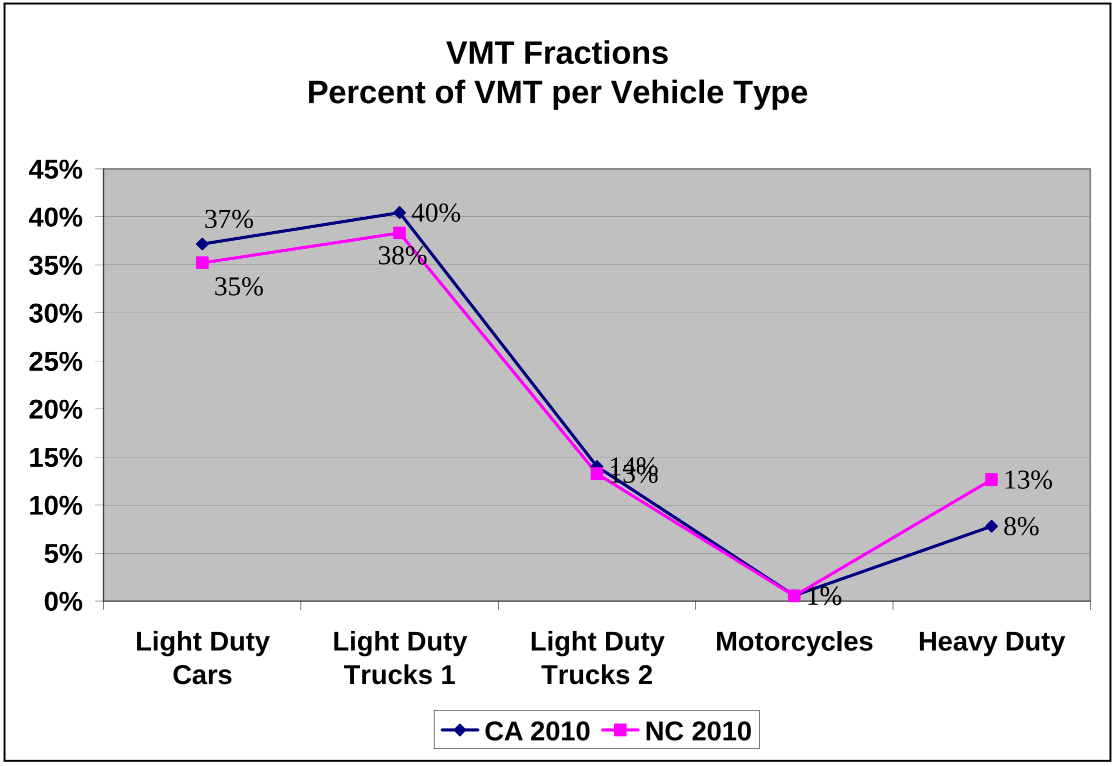


Figure 5.1-3. Percent of VMT per Vehicle



5.2 Qualitative Assessment of Enforcement Options

Based on the data summarized in Section 5.1 above, if one generally assumes passenger vehicles are cleaner emitting vehicles than light-duty trucks, and newer vehicles generally emit less than older vehicles, then one can qualitatively assert that the light-duty gasoline vehicle fleet registered in North Carolina is cleaner than California's registered light-duty gasoline vehicle fleet. This data (i.e., especially the greater percentage of passenger cars) may be an indicator that a fleet average requirement will not be difficult to meet in North Carolina and thus a "simple certification" enforcement program might result in similar benefits, while requiring fewer state resources. However, it should be noted that historical fleet demographic data would not necessarily represent future demographics, which will be impacted by short-term economic trends, long-term trends in vehicle longevity and use, and other factors such as fuel costs.

6. Staff Resource Needs

6.1 Enforcement at DMV and NCDAQ

NCDAQ collected information on state air quality agency staffing needs associated with implementing and enforcing a CA LEV-II program. Discussions with the Washington State Department of Ecology, Air Quality Program[18] revealed they had recently spoken with other states that had already adopted CA LEV-II programs to better understand staff resource needs. Washington indicated both New York and Massachusetts have staffs of two to three people (not completely full time) on CA LEV-II.

The primary point of enforcement/compliance for a CA LEV-II program would most likely be the State's Division of Motor Vehicles (DMV), while the air quality agency staff would perform audits, monitor performance of the program, handle public outreach, registration, and vehicle availability issues.

6.2 Impacts to Existing Tasks at NCDAQ

Another possible resource concern, considered by NCDAQ is the impact to existing tasks, such as transportation conformity, SIP modeling, and emission inventories. Due to the more complicated mobile source emission estimation techniques involved with a CA LEV-II program, there is some concern that timelines on these core tasks could be lengthened. This would not only impact NCDAQ, but the other groups involved in the transportation conformity process as well, such as local air quality agencies, metropolitan planning organizations, and rural planning organizations.

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Appendix A: Detailed Representation of MOBILE6.2 Emission Factor Post-Process

Definitions

POL = 1 = VOC
POL = 3 = NOx

ETYPE 1 = exhaust from running
ETYPE 2 = exhaust from start operations of light duty vehicles and motorcycles
ETYPE 3 through ETYPE 8 = evaporative emissions

FTYPE 1 = freeway
FTYPE 2 = arterial
FTYPE 3 = local
FTYPE 4 = ramp
FTYPE 5 = none (emissions independent of facility type such as start emissions and most evaporative)

Rural Interstate NOx = (ETYPE 1 + FTYPE 1) + (ETYPE 2 + FTYPE 5)

Urban Interstate NOx = (ETYPE 1 + FTYPE 1) + (ETYPE 2 + FTYPE 5)

Other roads NOx = (ETYPE 1 + FTYPE 2) + (ETYPE 2 + FTYPE 5)

Rural Interstate VOC = (ETYPE 1 + FTYPE 1) + (ETYPE 2 + FTYPE 5) + (ETYPE 3 + FTYPE 5) + (ETYPE 4 + FTYPE 5) + (ETYPE 5 + FTYPE 5) + (ETYPE 6 + FTYPE 1) + (ETYPE 7 + FTYPE 5) + (ETYPE 8 + FTYPE 5)

Urban Interstate VOC = (ETYPE 1 + FTYPE 1) + (ETYPE 2 + FTYPE 5) + (ETYPE 3 + FTYPE 5) + (ETYPE 4 + FTYPE 5) + (ETYPE 5 + FTYPE 5) + (ETYPE 6 + FTYPE 1) + (ETYPE 7 + FTYPE 5) + (ETYPE 8 + FTYPE 5)

Other roads VOC = (ETYPE 1 + FTYPE 2) + (ETYPE 2 + FTYPE 5) + (ETYPE 3 + FTYPE 5) + (ETYPE 4 + FTYPE 5) + (ETYPE 5 + FTYPE 5) + (ETYPE 6 + FTYPE 2) + (ETYPE 7 + FTYPE 5) + (ETYPE 8 + FTYPE 5)

2010

For a CA LEV-II program starting in 2010
For each vehicle type…and each roadway type
For each ETYPE and FTYPE
Using the database output option in M6.2…
EF=emission factor

travel fraction = (‘Product’) ÷ (sum of Products)

Product = (% ‘x’ yr old LDGVs) * (miles for ‘x’ yr old LDGVs)

Assuming 100% of LDGVs sold in 2010 are CA LEVII

Step 1
((CA LEV II 2010 EF for 1 yr old LDGV) * (travel fraction for 1 yr old LDGVs)+
((Tier 2 2010 EF for 2 yr old LDGV) * (travel fraction for 2 yr old LDGVs)+
((Tier 2 2010 EF for 3 yr old LDGV) * (travel fraction for 3 yr old LDGVs)+
((Tier 2 2010 EF for 4 yr old LDGV) * (travel fraction for 4 yr old LDGVs)+
((Tier 2 2010 EF for 5 yr old LDGV) * (travel fraction for 5 yr old LDGVs)+
((Tier 2 2010 EF for 6 yr old LDGV) * (travel fraction for 6 yr old LDGVs)+
((Tier 2 2010 EF for 7 yr old LDGV) * (travel fraction for 7 yr old LDGVs)+
((Tier 2 2010 EF for 8 yr old LDGV) * (travel fraction for 8 yr old LDGVs)+
((Tier 2 2010 EF for 9 yr old LDGV) * (travel fraction for 9 yr old LDGVs)+
((Tier 2 2010 EF for 10 yr old LDGV) * (travel fraction for 10 yr old LDGVs)+
((Tier 2 2010 EF for 11 yr old LDGV) * (travel fraction for 11 yr old LDGVs)+
((Tier 2 2010 EF for 12 yr old LDGV) * (travel fraction for 12 yr old LDGVs)+
((Tier 2 2010 EF for 13 yr old LDGV) * (travel fraction for 13 yr old LDGVs)+
((Tier 2 2010 EF for 14 yr old LDGV) * (travel fraction for 14 yr old LDGVs)+
((Tier 2 2010 EF for 15 yr old LDGV) * (travel fraction for 15 yr old LDGVs)+
((Tier 2 2010 EF for 16 yr old LDGV) * (travel fraction for 16 yr old LDGVs)+
((Tier 2 2010 EF for 17 yr old LDGV) * (travel fraction for 17 yr old LDGVs)+
((Tier 2 2010 EF for 18 yr old LDGV) * (travel fraction for 18 yr old LDGVs)+
((Tier 2 2010 EF for 19 yr old LDGV) * (travel fraction for 19 yr old LDGVs)+
((Tier 2 2010 EF for 20 yr old LDGV) * (travel fraction for 20 yr old LDGVs)+
((Tier 2 2010 EF for 21 yr old LDGV) * (travel fraction for 21 yr old LDGVs)+
((Tier 2 2010 EF for 22 yr old LDGV) * (travel fraction for 22 yr old LDGVs)+
((Tier 2 2010 EF for 23 yr old LDGV) * (travel fraction for 23 yr old LDGVs)+
((Tier 2 2010 EF for 24 yr old LDGV) * (travel fraction for 24 yr old LDGVs)+
((Tier 2 2010 EF for 25 yr old LDGV) * (travel fraction for 25 yr old LDGVs)

= composite 2010 EF LDGV for a given pollutant, ETYPE and FTYPE

then, sum the composites for each ETYPE and FTYPE for a given pollutant

Step 2
Repeat for each roadway type and vehicle type

2020

For a CA LEV-II program starting in 2010
For each vehicle type…and each roadway type
For each ETYPE and FTYPE
Using the database output option in M6.2…
EF=emission factor

travel fraction = (‘Product’) ÷ (sum of Products)

Product = (% ‘x’ yr old LDGVs) * (miles for ‘x’ yr old LDGVs)

Assuming 100% of LDGVs sold in 2010 are CA LEVII

Step 1

((CA LEV II 2020 EF for 1 yr old LDGV) * (travel fraction for 1 yr old LDGVs)+
((CA LEV II 2020 EF for 2 yr old LDGV) * (travel fraction for 2 yr old LDGVs)+
((CA LEV II 2020 EF for 3 yr old LDGV) * (travel fraction for 3 yr old LDGVs)+
((CA LEV II 2020 EF for 4 yr old LDGV) * (travel fraction for 4 yr old LDGVs)+
((CA LEV II 2020 EF for 5 yr old LDGV) * (travel fraction for 5 yr old LDGVs)+
((CA LEV II 2020 EF for 6 yr old LDGV) * (travel fraction for 6 yr old LDGVs)+
((CA LEV II 2020 EF for 7 yr old LDGV) * (travel fraction for 7 yr old LDGVs)+
((CA LEV II 2020 EF for 8 yr old LDGV) * (travel fraction for 8 yr old LDGVs)+
((CA LEV II 2020 EF for 9 yr old LDGV) * (travel fraction for 9 yr old LDGVs)+
((CA LEV II 2020 EF for 10 yr old LDGV) * (travel fraction for 10 yr old LDGVs)+
((Tier 2 2020 EF for 11 yr old LDGV) * (travel fraction for 11 yr old LDGVs)+
((Tier 2 2020 EF for 12 yr old LDGV) * (travel fraction for 12 yr old LDGVs)+
((Tier 2 2020 EF for 13 yr old LDGV) * (travel fraction for 13 yr old LDGVs)+
((Tier 2 2020 EF for 14 yr old LDGV) * (travel fraction for 14 yr old LDGVs)+
((Tier 2 2020 EF for 15 yr old LDGV) * (travel fraction for 15 yr old LDGVs)+
((Tier 2 2020 EF for 16 yr old LDGV) * (travel fraction for 16 yr old LDGVs)+
((Tier 2 2020 EF for 17 yr old LDGV) * (travel fraction for 17 yr old LDGVs)+
((Tier 2 2020 EF for 18 yr old LDGV) * (travel fraction for 18 yr old LDGVs)+
((Tier 2 2020 EF for 19 yr old LDGV) * (travel fraction for 19 yr old LDGVs)+
((Tier 2 2020 EF for 20 yr old LDGV) * (travel fraction for 20 yr old LDGVs)+
((Tier 2 2020 EF for 21 yr old LDGV) * (travel fraction for 21 yr old LDGVs)+
((Tier 2 2020 EF for 22 yr old LDGV) * (travel fraction for 22 yr old LDGVs)+
((Tier 2 2020 EF for 23 yr old LDGV) * (travel fraction for 23 yr old LDGVs)+
((Tier 2 2020 EF for 24 yr old LDGV) * (travel fraction for 24 yr old LDGVs)+
((Tier 2 2020 EF for 25 yr old LDGV) * (travel fraction for 25 yr old LDGVs)

= composite 2020 EF LDGV for a given pollutant, ETYPE and FTYPE

then, sum the composites for each ETYPE and FTYPE for a given pollutant

Step 2

Repeat for each roadway type and vehicle type

2030

For a CA LEV-II program starting in 2010
For each vehicle type…and each roadway type
For each ETYPE and FTYPE
Using the database output option in M6.2…
EF=emission factor

travel fraction = ('Product') ÷ (sum of Products)

Product = (% 'x' yr old LDGVs) * (miles for 'x' yr old LDGVs)

Assuming 100% of LDGVs sold in 2010 are CA LEVII

Step 1
((CA LEV II 2030 EF for 1 yr old LDGV) * (travel fraction for 1 yr old LDGVs)+
((CA LEV II 2030 EF for 2 yr old LDGV) * (travel fraction for 2 yr old LDGVs)+
((CA LEV II 2030 EF for 3 yr old LDGV) * (travel fraction for 3 yr old LDGVs)+
((CA LEV II 2030 EF for 4 yr old LDGV) * (travel fraction for 4 yr old LDGVs)+
((CA LEV II 2030 EF for 5 yr old LDGV) * (travel fraction for 5 yr old LDGVs)+
((CA LEV II 2030 EF for 6 yr old LDGV) * (travel fraction for 6 yr old LDGVs)+
((CA LEV II 2030 EF for 7 yr old LDGV) * (travel fraction for 7 yr old LDGVs)+
((CA LEV II 2030 EF for 8 yr old LDGV) * (travel fraction for 8 yr old LDGVs)+
((CA LEV II 2030 EF for 9 yr old LDGV) * (travel fraction for 9 yr old LDGVs)+
((CA LEV II 2030 EF for 10 yr old LDGV) * (travel fraction for 10 yr old LDGVs)+
((CA LEV II 2030 EF for 11 yr old LDGV) * (travel fraction for 11 yr old LDGVs)+
((CA LEV II 2030 EF for 12 yr old LDGV) * (travel fraction for 12 yr old LDGVs)+
((CA LEV II 2030 EF for 13 yr old LDGV) * (travel fraction for 13 yr old LDGVs)+
((CA LEV II 2030 EF for 14 yr old LDGV) * (travel fraction for 14 yr old LDGVs)+
((CA LEV II 2030 EF for 15 yr old LDGV) * (travel fraction for 15 yr old LDGVs)+
((CA LEV II 2030 EF for 16 yr old LDGV) * (travel fraction for 16 yr old LDGVs)+
((CA LEV II 2030 EF for 17 yr old LDGV) * (travel fraction for 17 yr old LDGVs)+
((CA LEV II 2030 EF for 18 yr old LDGV) * (travel fraction for 18 yr old LDGVs)+
((CA LEV II 2030 EF for 19 yr old LDGV) * (travel fraction for 19 yr old LDGVs)+
((CA LEV II 2030 EF for 20 yr old LDGV) * (travel fraction for 20 yr old LDGVs)+
((Tier 2 2030 EF for 21 yr old LDGV) * (travel fraction for 21 yr old LDGVs)+
((Tier 2 2030 EF for 22 yr old LDGV) * (travel fraction for 22 yr old LDGVs)+
((Tier 2 2030 EF for 23 yr old LDGV) * (travel fraction for 23 yr old LDGVs)+
((Tier 2 2030 EF for 24 yr old LDGV) * (travel fraction for 24 yr old LDGVs)+
((Tier 2 2030 EF for 25 yr old LDGV) * (travel fraction for 25 yr old LDGVs)

= composite 2030 EF LDGV for a given pollutant, ETYPE and FTYPE

then, sum the composites for each ETYPE and FTYPE for a given pollutant

Step 2
Repeat for each roadway type and vehicle type

Appendix B. CA LEV-II Emission Factors

Mecklenburg and Gaston County 2010 Emission Factors

CLT10L.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.27	0.07	0.23	0.07	0.03	0.09	0.00	0.00	0.23	0.00	1.00
Composite VOC (g/mi)	0.42	0.75	0.78	0.57	0.60	0.55	0.11	0.22	0.23	2.47	0.52
Composite NOx (g/mi)	0.37	0.49	0.70	0.56	0.78	1.99	0.35	0.49	5.93	1.39	1.89

CLT10L.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.33	0.08	0.28	0.08	0.04	0.05	0.00	0.00	0.13	0.01	1.00
Composite VOC (g/mi)	0.43	0.75	0.78	0.57	0.61	0.55	0.11	0.22	0.23	2.47	0.56
Composite NOx (g/mi)	0.37	0.49	0.69	0.56	0.78	1.96	0.34	0.46	5.63	1.34	1.27

CLT10L.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.37	0.09	0.31	0.09	0.04	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.44	0.77	0.80	0.58	0.62	0.57	0.12	0.23	0.23	2.49	0.60
Composite NOx (g/mi)	0.36	0.48	0.68	0.55	0.76	1.88	0.30	0.42	4.41	1.25	0.79

Mecklenburg and Gaston County 2020 Emission Factors

CLT20L.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.23	0.00	1.00
Composite VOC (g/mi)	0.17	0.31	0.35	0.28	0.28	0.29	0.03	0.08	0.16	2.29	0.26
Composite NOx (g/mi)	0.11	0.18	0.25	0.22	0.27	0.44	0.05	0.10	1.04	1.39	0.41

CLT20L.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.17	0.31	0.35	0.28	0.28	0.29	0.03	0.08	0.17	2.29	0.27
Composite NOx (g/mi)	0.11	0.18	0.25	0.21	0.26	0.44	0.05	0.10	0.99	1.34	0.31

CLT20L.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.04	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.18	0.31	0.35	0.28	0.29	0.30	0.03	0.09	0.17	2.31	0.29
Composite NOx (g/mi)	0.11	0.17	0.24	0.21	0.26	0.42	0.04	0.09	0.79	1.24	0.24

Mecklenburg and Gaston County 2030 Emission Factors

CLT30L.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.23	0.00	1.00
Composite VOC (g/mi)	0.14	0.20	0.25	0.21	0.21	0.24	0.02	0.05	0.16	2.20	0.20
Composite NOx (g/mi)	0.08	0.12	0.16	0.15	0.17	0.19	0.02	0.04	0.51	1.29	0.23

CLT30L.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.14	0.20	0.25	0.21	0.21	0.24	0.02	0.05	0.17	2.21	0.21
Composite NOx (g/mi)	0.08	0.12	0.16	0.15	0.17	0.19	0.02	0.04	0.51	1.28	0.18

CLT30L.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.04	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.14	0.21	0.25	0.22	0.21	0.24	0.02	0.06	0.16	2.23	0.21
Composite NOx (g/mi)	0.08	0.12	0.15	0.15	0.16	0.19	0.02	0.04	0.44	1.23	0.15

Wake and Durham County 2010 Emission Factors

RDU10L.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.27	0.07	0.23	0.07	0.03	0.09	0.00	0.00	0.23	0.00	1.00
Composite VOC (g/mi)	0.41	0.68	0.71	0.55	0.59	0.61	0.11	0.22	0.23	2.59	0.50
Composite NOx (g/mi)	0.37	0.46	0.65	0.59	0.83	2.21	0.35	0.51	6.30	1.40	1.98

RDU10L.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.33	0.08	0.28	0.08	0.04	0.05	0.00	0.00	0.13	0.01	1.00
Composite VOC (g/mi)	0.42	0.68	0.71	0.56	0.59	0.61	0.11	0.23	0.24	2.59	0.54
Composite NOx (g/mi)	0.37	0.46	0.64	0.59	0.83	2.18	0.34	0.49	5.99	1.35	1.31

RDU10L.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.37	0.09	0.31	0.09	0.04	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.43	0.69	0.72	0.57	0.60	0.64	0.12	0.23	0.25	2.61	0.57
Composite NOx (g/mi)	0.36	0.45	0.63	0.58	0.81	2.11	0.30	0.44	5.01	1.26	0.84

Wake and Durham County 2020 Emission Factors

RDU20L.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.23	0.00	1.00
Composite VOC (g/mi)	0.17	0.27	0.31	0.26	0.27	0.31	0.03	0.08	0.17	2.37	0.25
Composite NOx (g/mi)	0.11	0.16	0.23	0.21	0.26	0.49	0.05	0.09	1.15	1.40	0.43

RDU20L.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.17	0.28	0.32	0.26	0.27	0.31	0.03	0.08	0.17	2.37	0.26
Composite NOx (g/mi)	0.11	0.16	0.23	0.21	0.25	0.49	0.05	0.09	1.09	1.35	0.32

RDU20L.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.18	0.28	0.32	0.27	0.27	0.33	0.03	0.08	0.18	2.39	0.27
Composite NOx (g/mi)	0.11	0.16	0.22	0.20	0.25	0.46	0.04	0.08	0.93	1.25	0.24

Wake and Durham County 2030 Emission Factors

RDU30L.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.23	0.00	1.00
Composite VOC (g/mi)	0.14	0.19	0.23	0.21	0.21	0.25	0.02	0.05	0.16	2.29	0.20
Composite NOx (g/mi)	0.08	0.11	0.15	0.15	0.17	0.20	0.02	0.04	0.52	1.31	0.22

RDU30L.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.14	0.19	0.23	0.21	0.21	0.25	0.02	0.05	0.17	2.29	0.20
Composite NOx (g/mi)	0.08	0.11	0.15	0.15	0.17	0.19	0.02	0.04	0.51	1.29	0.18

RDU30L.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.14	0.19	0.24	0.21	0.21	0.26	0.02	0.06	0.18	2.31	0.21
Composite NOx (g/mi)	0.08	0.11	0.14	0.15	0.16	0.19	0.02	0.04	0.47	1.24	0.15

Other I/M Counties* 2010 Emission Factors

RUR10L.in - Rural Interstate

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.27	0.07	0.23	0.07	0.03	0.09	0.00	0.00	0.22	0.00	1.00
Composite VOC (g/mi)	0.65	1.08	1.12	1.10	1.14	1.05	0.16	0.35	0.25	3.57	0.80
Composite NOx (g/mi)	0.52	0.66	0.89	0.90	1.18	2.95	0.73	1.16	11.17	1.73	3.28

RUR10L.in - Urban Interstate

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.33	0.08	0.28	0.08	0.04	0.05	0.00	0.00	0.13	0.01	1.00
Composite VOC (g/mi)	0.66	1.10	1.13	1.12	1.16	1.06	0.16	0.35	0.25	3.30	0.86
Composite NOx (g/mi)	0.52	0.65	0.88	0.89	1.17	2.88	0.62	0.99	9.67	1.62	1.99

RUR10L.in - Other roads

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.37	0.09	0.31	0.09	0.04	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.70	1.16	1.20	1.19	1.23	1.14	0.17	0.37	0.29	2.90	0.96
Composite NOx (g/mi)	0.49	0.61	0.83	0.85	1.12	2.60	0.42	0.66	6.01	1.27	1.08

Other I/M Counties* 2020 Emission Factors

RUR20L.in - Rural Interstate

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.22	0.00	1.00
Composite VOC (g/mi)	0.24	0.42	0.47	0.50	0.52	0.55	0.04	0.15	0.17	3.14	0.37
Composite NOx (g/mi)	0.16	0.24	0.34	0.39	0.49	0.90	0.11	0.27	2.45	1.65	0.83

RUR20L.in - Urban Interstate

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.24	0.42	0.47	0.50	0.52	0.55	0.04	0.15	0.17	3.14	0.39
Composite NOx (g/mi)	0.16	0.24	0.34	0.39	0.49	0.90	0.11	0.27	2.45	1.65	0.60

RUR20L.in - Other roads

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.26	0.44	0.48	0.53	0.54	0.60	0.04	0.16	0.19	2.68	0.42
Composite NOx (g/mi)	0.15	0.23	0.32	0.37	0.47	0.80	0.07	0.17	1.45	1.25	0.36

Other I/M Counties* 2030 Emission Factors

RUR30L.in - Rural Interstate

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.22	0.00	1.00
Composite VOC (g/mi)	0.17	0.25	0.30	0.31	0.31	0.34	0.02	0.07	0.16	2.97	0.25
Composite NOx (g/mi)	0.10	0.15	0.19	0.23	0.25	0.24	0.03	0.07	0.91	1.62	0.35

RUR30L.in - Urban Interstate

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.17	0.25	0.30	0.31	0.31	0.34	0.02	0.07	0.16	2.97	0.26
Composite NOx (g/mi)	0.10	0.15	0.19	0.23	0.25	0.24	0.03	0.07	0.91	1.62	0.27

RUR30L.in - Other roads

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.19	0.27	0.32	0.33	0.33	0.38	0.02	0.07	0.18	2.58	0.28
Composite NOx (g/mi)	0.10	0.14	0.18	0.22	0.23	0.22	0.02	0.05	0.58	1.25	0.19

* “Other I/M Counties” include all counties subject to North Carolina’s I/M Program except Mecklenburg, Gaston, Wake and Durham Counties.

All Non-I/M Counties* 2010 Emission Factors

RUR10NL.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.27	0.07	0.23	0.07	0.03	0.09	0.00	0.00	0.22	0.00	1.00
Composite VOC (g/mi)	0.72	1.17	1.21	1.19	1.23	1.05	0.16	0.35	0.25	3.57	0.85
Composite NOx (g/mi)	0.61	0.79	1.02	1.03	1.31	2.95	0.73	1.16	11.17	1.73	3.36

RUR10NL.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.33	0.08	0.28	0.08	0.04	0.05	0.00	0.00	0.13	0.01	1.00
Composite VOC (g/mi)	0.73	1.19	1.23	1.21	1.25	1.06	0.16	0.35	0.25	3.30	0.93
Composite NOx (g/mi)	0.61	0.78	1.01	1.01	1.29	2.88	0.62	0.99	9.67	1.62	2.08

RUR10NL.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.37	0.09	0.31	0.09	0.04	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.78	1.27	1.31	1.30	1.34	1.14	0.17	0.37	0.29	2.90	1.05
Composite NOx (g/mi)	0.58	0.74	0.97	0.97	1.25	2.60	0.42	0.66	6.01	1.27	1.18

All Non-I/M Counties* 2020 Emission Factors

RUR20NL.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.22	0.00	1.00
Composite VOC (g/mi)	0.34	0.57	0.63	0.65	0.67	0.55	0.04	0.15	0.17	3.14	0.46
Composite NOx (g/mi)	0.29	0.46	0.55	0.58	0.69	0.90	0.11	0.27	2.45	1.65	0.95

RUR20NL.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.34	0.57	0.63	0.65	0.67	0.55	0.04	0.15	0.17	3.14	0.50
Composite NOx (g/mi)	0.29	0.46	0.55	0.58	0.69	0.90	0.11	0.27	2.45	1.65	0.75

RUR20NL.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.37	0.61	0.66	0.70	0.72	0.60	0.04	0.16	0.19	2.68	0.56
Composite NOx (g/mi)	0.28	0.43	0.52	0.56	0.67	0.80	0.07	0.17	1.45	1.25	0.52

All Non-I/M Counties* 2030 Emission Factors

RUR30NL.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.22	0.00	1.00
Composite VOC (g/mi)	0.26	0.40	0.46	0.46	0.46	0.34	0.02	0.07	0.16	2.97	0.34
Composite NOx (g/mi)	0.23	0.36	0.40	0.43	0.45	0.24	0.03	0.07	0.91	1.62	0.47

RUR30NL.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.26	0.40	0.46	0.46	0.46	0.34	0.02	0.07	0.16	2.97	0.37
Composite NOx (g/mi)	0.23	0.36	0.40	0.43	0.45	0.24	0.03	0.07	0.91	1.62	0.42

RUR30NL.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.29	0.44	0.49	0.50	0.50	0.38	0.02	0.07	0.18	2.58	0.42
Composite NOx (g/mi)	0.22	0.34	0.38	0.41	0.43	0.22	0.02	0.05	0.58	1.25	0.35

“All Non-I/M Counties” include those not subject to North Carolina’s I/M program.

Appendix C. Tier 2 Emission Factors

Mecklenburg and Gaston County 2010 Emission Factors

CLT10.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.27	0.07	0.23	0.07	0.03	0.09	0.00	0.00	0.23	0.00	1.00
Composite VOC (g/mi)	0.42	0.75	0.78	0.57	0.60	0.55	0.11	0.22	0.23	2.47	0.52
Composite NOx (g/mi)	0.37	0.49	0.70	0.57	0.79	1.99	0.35	0.49	5.93	1.39	1.89

CLT10.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.33	0.08	0.28	0.08	0.04	0.05	0.00	0.00	0.13	0.01	1.00
Composite VOC (g/mi)	0.43	0.75	0.79	0.57	0.61	0.55	0.11	0.22	0.23	2.47	0.56
Composite NOx (g/mi)	0.37	0.49	0.69	0.56	0.78	1.96	0.34	0.46	5.63	1.34	1.27

CLT10.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.37	0.09	0.31	0.09	0.04	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.44	0.77	0.80	0.58	0.62	0.57	0.12	0.23	0.23	2.49	0.60
Composite NOx (g/mi)	0.36	0.48	0.68	0.55	0.77	1.88	0.30	0.42	4.41	1.25	0.79

Mecklenburg and Gaston County 2020 Emission Factors

CLT20.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.23	0.00	1.00
Composite VOC (g/mi)	0.19	0.32	0.36	0.28	0.30	0.29	0.03	0.08	0.16	2.29	0.27
Composite NOx (g/mi)	0.12	0.18	0.28	0.24	0.36	0.44	0.05	0.10	1.04	1.39	0.43

CLT20.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.19	0.32	0.36	0.28	0.30	0.29	0.03	0.08	0.17	2.29	0.28
Composite NOx (g/mi)	0.12	0.18	0.28	0.24	0.35	0.44	0.05	0.10	0.99	1.34	0.33

CLT20.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.04	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.19	0.33	0.37	0.29	0.31	0.30	0.03	0.09	0.17	2.31	0.30
Composite NOx (g/mi)	0.11	0.18	0.27	0.23	0.35	0.42	0.04	0.09	0.79	1.24	0.25

Mecklenburg and Gaston County 2030 Emission Factors

CLT30.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.23	0.00	1.00
Composite VOC (g/mi)	0.16	0.23	0.27	0.22	0.23	0.24	0.02	0.05	0.16	2.20	0.22
Composite NOx (g/mi)	0.09	0.13	0.20	0.18	0.28	0.19	0.02	0.04	0.51	1.29	0.24

CLT30.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.16	0.23	0.27	0.22	0.24	0.24	0.02	0.05	0.17	2.21	0.22
Composite NOx (g/mi)	0.09	0.13	0.20	0.18	0.27	0.19	0.02	0.04	0.51	1.28	0.21

CLT30.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.04	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.16	0.23	0.27	0.22	0.24	0.24	0.02	0.06	0.16	2.23	0.23
Composite NOx (g/mi)	0.09	0.13	0.19	0.17	0.27	0.19	0.02	0.04	0.44	1.23	0.17

Wake and Durham County 2010 Emission Factors

RDU10.in - Rural Interstate

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.27	0.07	0.23	0.07	0.03	0.09	0.00	0.00	0.23	0.00	1.00
Composite VOC (g/mi)	0.42	0.68	0.71	0.55	0.59	0.61	0.11	0.22	0.23	2.59	0.50
Composite NOx (g/mi)	0.37	0.46	0.65	0.59	0.84	2.21	0.35	0.51	6.30	1.40	1.98

RDU10.in - Urban Interstate

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.33	0.08	0.28	0.08	0.04	0.05	0.00	0.00	0.13	0.01	1.00
Composite VOC (g/mi)	0.42	0.68	0.71	0.56	0.59	0.61	0.11	0.23	0.24	2.59	0.54
Composite NOx (g/mi)	0.37	0.46	0.65	0.59	0.83	2.18	0.34	0.49	5.99	1.35	1.31

RDU10.in - Other roads

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.37	0.09	0.31	0.09	0.04	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.43	0.69	0.73	0.57	0.60	0.64	0.12	0.23	0.25	2.61	0.57
Composite NOx (g/mi)	0.36	0.45	0.63	0.58	0.82	2.11	0.30	0.44	5.01	1.26	0.84

Wake and Durham County 2020 Emission Factors

RDU20.in - Rural Interstate

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.23	0.00	1.00
Composite VOC (g/mi)	0.19	0.29	0.33	0.27	0.29	0.31	0.03	0.08	0.17	2.37	0.26
Composite NOx (g/mi)	0.12	0.17	0.26	0.23	0.35	0.49	0.05	0.09	1.15	1.40	0.45

RDU20.in - Urban Interstate

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.19	0.29	0.33	0.27	0.29	0.31	0.03	0.08	0.17	2.37	0.27
Composite NOx (g/mi)	0.12	0.17	0.26	0.23	0.35	0.49	0.05	0.09	1.09	1.35	0.34

RDU20.in - Other roads

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.19	0.30	0.33	0.27	0.29	0.33	0.03	0.08	0.18	2.39	0.28
Composite NOx (g/mi)	0.11	0.16	0.25	0.23	0.34	0.46	0.04	0.08	0.93	1.25	0.26

Wake and Durham County 2030 Emission Factors

RDU30.in - Rural Interstate

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.23	0.00	1.00
Composite VOC (g/mi)	0.16	0.21	0.25	0.21	0.23	0.25	0.02	0.05	0.16	2.29	0.21
Composite NOx (g/mi)	0.09	0.12	0.19	0.18	0.28	0.20	0.02	0.04	0.52	1.31	0.24

RDU30.in - Urban Interstate

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.16	0.21	0.25	0.22	0.23	0.25	0.02	0.05	0.17	2.29	0.22
Composite NOx (g/mi)	0.09	0.12	0.19	0.18	0.28	0.19	0.02	0.04	0.51	1.29	0.20

RDU30.in - Other roads

	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.16	0.22	0.25	0.22	0.23	0.26	0.02	0.06	0.18	2.31	0.22
Composite NOx (g/mi)	0.09	0.12	0.18	0.17	0.27	0.19	0.02	0.04	0.47	1.24	0.18

Other I/M Counties* 2010 Emission Factors

RUR10.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.27	0.07	0.23	0.07	0.03	0.09	0.00	0.00	0.22	0.00	1.00
Composite VOC (g/mi)	0.65	1.09	1.12	1.11	1.14	1.05	0.16	0.35	0.25	3.57	0.80
Composite NOx (g/mi)	0.52	0.66	0.89	0.90	1.19	2.95	0.73	1.16	11.17	1.73	3.28

RUR10.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.33	0.08	0.28	0.08	0.04	0.05	0.00	0.00	0.13	0.01	1.00
Composite VOC (g/mi)	0.66	1.10	1.13	1.12	1.16	1.06	0.16	0.35	0.25	3.30	0.87
Composite NOx (g/mi)	0.52	0.65	0.88	0.89	1.17	2.88	0.62	0.99	9.67	1.62	1.99

RUR10.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.37	0.09	0.31	0.09	0.04	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.70	1.16	1.20	1.19	1.23	1.14	0.17	0.37	0.29	2.90	0.96
Composite NOx (g/mi)	0.49	0.61	0.84	0.85	1.13	2.60	0.42	0.66	6.01	1.27	1.08

Other I/M Counties* 2020 Emission Factors

RUR20.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.22	0.00	1.00
Composite VOC (g/mi)	0.26	0.43	0.48	0.51	0.54	0.55	0.04	0.15	0.17	3.14	0.38
Composite NOx (g/mi)	0.16	0.25	0.37	0.41	0.59	0.90	0.11	0.27	2.45	1.65	0.85

RUR20.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.26	0.43	0.48	0.51	0.54	0.55	0.04	0.15	0.17	3.14	0.40
Composite NOx (g/mi)	0.16	0.25	0.37	0.41	0.59	0.90	0.11	0.27	2.45	1.65	0.62

RUR20.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.28	0.45	0.50	0.53	0.56	0.60	0.04	0.16	0.19	2.68	0.43
Composite NOx (g/mi)	0.15	0.23	0.35	0.39	0.56	0.80	0.07	0.17	1.45	1.25	0.38

Other I/M Counties* 2030 Emission Factors

RUR30.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.22	0.00	1.00
Composite VOC (g/mi)	0.19	0.28	0.33	0.32	0.34	0.34	0.02	0.07	0.16	2.97	0.27
Composite NOx (g/mi)	0.11	0.16	0.24	0.26	0.38	0.24	0.03	0.07	0.91	1.62	0.37

RUR30.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.19	0.28	0.33	0.32	0.34	0.34	0.02	0.07	0.16	2.97	0.28
Composite NOx (g/mi)	0.11	0.16	0.24	0.26	0.38	0.24	0.03	0.07	0.91	1.62	0.30

RUR30.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.21	0.30	0.34	0.34	0.36	0.38	0.02	0.07	0.18	2.58	0.30
Composite NOx (g/mi)	0.10	0.15	0.22	0.24	0.36	0.22	0.02	0.05	0.58	1.25	0.22

“Other I/M Counties” include all counties subject to North Carolina’s I/M Program except Mecklenburg, Gaston, Wake and Durham Counties.

All Non-I/M Counties* 2010 Emission Factors

RUR10N.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.27	0.07	0.23	0.07	0.03	0.09	0.00	0.00	0.22	0.00	1.00
Composite VOC (g/mi)	0.72	1.17	1.21	1.19	1.24	1.05	0.16	0.35	0.25	3.57	0.85
Composite NOx (g/mi)	0.62	0.79	1.02	1.03	1.31	2.95	0.73	1.16	11.17	1.73	3.36

RUR10N.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.33	0.08	0.28	0.08	0.04	0.05	0.00	0.00	0.13	0.01	1.00
Composite VOC (g/mi)	0.73	1.19	1.23	1.21	1.25	1.06	0.16	0.35	0.25	3.30	0.93
Composite NOx (g/mi)	0.61	0.78	1.01	1.02	1.30	2.88	0.62	0.99	9.67	1.62	2.08

RUR10N.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.37	0.09	0.31	0.09	0.04	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.78	1.27	1.31	1.30	1.34	1.14	0.17	0.37	0.29	2.90	1.05
Composite NOx (g/mi)	0.58	0.74	0.97	0.97	1.26	2.60	0.42	0.66	6.01	1.27	1.19

All Non-I/M Counties* 2020 Emission Factors

RUR20N.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.22	0.00	1.00
Composite VOC (g/mi)	0.35	0.59	0.64	0.66	0.69	0.55	0.04	0.15	0.17	3.14	0.47
Composite NOx (g/mi)	0.29	0.46	0.58	0.61	0.79	0.90	0.11	0.27	2.45	1.65	0.97

RUR20N.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.35	0.59	0.64	0.66	0.69	0.55	0.04	0.15	0.17	3.14	0.51
Composite NOx (g/mi)	0.29	0.46	0.58	0.61	0.79	0.90	0.11	0.27	2.45	1.65	0.77

RUR20N.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.38	0.63	0.68	0.70	0.74	0.60	0.04	0.16	0.19	2.68	0.57
Composite NOx (g/mi)	0.28	0.44	0.55	0.58	0.75	0.80	0.07	0.17	1.45	1.25	0.54

All Non-I/M Counties* 2030 Emission Factors

RUR30N.in - Rural Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.22	0.08	0.26	0.08	0.04	0.09	0.00	0.00	0.22	0.00	1.00
Composite VOC (g/mi)	0.29	0.44	0.49	0.47	0.49	0.34	0.02	0.07	0.16	2.97	0.36
Composite NOx (g/mi)	0.24	0.38	0.45	0.46	0.59	0.24	0.03	0.07	0.91	1.62	0.49

RUR30N.in - Urban Interstate											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.26	0.10	0.32	0.10	0.04	0.05	0.00	0.00	0.13	0.00	1.00
Composite VOC (g/mi)	0.29	0.44	0.49	0.47	0.49	0.34	0.02	0.07	0.16	2.97	0.39
Composite NOx (g/mi)	0.24	0.38	0.45	0.46	0.59	0.24	0.03	0.07	0.91	1.62	0.45

RUR30N.in - Other roads											
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV	LDDV	LDDT	HDDV	MC	**All Veh**
VMT distribution:	0.29	0.11	0.35	0.11	0.05	0.03	0.00	0.00	0.06	0.01	1.00
Composite VOC (g/mi)	0.32	0.47	0.52	0.51	0.53	0.38	0.02	0.07	0.18	2.58	0.44
Composite NOx (g/mi)	0.23	0.36	0.42	0.43	0.56	0.22	0.02	0.05	0.58	1.25	0.38

“All Non-I/M Counties” include those not subject to North Carolina’s I/M program.

Appendix D. North Carolina Average Weekday VMT

County	2010	2020	2030
ALAMANCE	4,116,020	4,919,514	5,649,963
ALEXANDER	731,687	871,200	998,030
ALLEGHANY	270,468	287,763	303,486
ANSON	938,933	1,071,290	1,191,614
ASHE	762,184	973,969	1,166,501
AVERY	555,065	595,003	631,309
BEAUFORT	1,177,361	1,202,892	1,226,102
BERTIE	810,582	885,281	953,189
BLADEN	1,247,469	1,404,262	1,546,800
BRUNSWICK	3,687,147	4,977,851	6,151,217
BUNCOMBE	6,781,129	8,097,236	9,293,698
BURKE	2,854,160	3,283,996	3,674,757
CABARRUS	4,684,304	5,879,837	6,966,685
CALDWELL	1,964,704	2,253,360	2,515,774
CAMDEN	336,441	396,006	450,156
CARTERET	1,820,883	1,971,912	2,109,210
CASWELL	680,712	796,520	901,800
CATAWBA	5,237,733	6,466,425	7,583,418
CHATHAM	2,198,483	2,904,213	3,545,787
CHEROKEE	836,654	1,019,691	1,186,088
CHOWAN	361,279	414,436	462,761
CLAY	296,626	383,240	461,981
CLEVELAND	3,063,240	3,701,262	4,281,281
COLUMBUS	2,170,683	2,751,799	3,280,085
CRAVEN	3,519,621	4,882,283	6,121,067
CUMBERLAND	8,568,496	10,016,395	11,332,667
CURRITUCK	1,401,762	2,077,586	2,691,972
DARE	1,695,108	2,015,629	2,307,011
DAVIDSON	4,766,227	5,637,268	6,429,123
DAVIE	1,497,681	1,810,677	2,095,219
DUPLIN	2,157,963	2,628,142	3,055,577
DURHAM	7,167,554	8,692,585	10,078,976
EDGECOMBE	1,772,872	2,093,447	2,384,879
FORSYTH	9,287,388	11,054,174	12,660,343
FRANKLIN	1,551,945	1,980,211	2,369,544
GASTON	6,194,506	7,694,183	9,057,526
GATES	343,251	369,860	394,050
GRAHAM	183,026	193,074	202,208
GRANVILLE	1,943,046	2,334,181	2,689,758
GREENE	657,462	789,226	909,012
GUILFORD	12,253,484	14,143,803	15,862,274
HALIFAX	1,936,468	2,039,312	2,132,806
HARNETT	2,564,706	2,971,807	3,341,898
HAYWOOD	2,583,473	3,045,305	3,465,151
HENDERSON	2,710,042	3,362,210	3,955,089
HERTFORD	565,952	569,262	572,271

HOKE	**941,277**	**1,217,486**	**1,468,584**
HYDE	**259,938**	**355,006**	**441,432**
IREDELL	**5,502,505**	**6,678,388**	**7,747,373**
JACKSON	**1,579,508**	**1,978,271**	**2,340,783**
JOHNSTON	**5,955,740**	**7,525,220**	**8,952,020**
JONES	**562,943**	**632,885**	**696,469**
LEE	**1,849,101**	**2,283,644**	**2,678,682**
LENOIR	**1,810,371**	**2,027,463**	**2,224,819**
LINCOLN	**1,815,733**	**2,318,476**	**2,775,514**
MACON	**1,066,127**	**1,328,953**	**1,567,886**
MADISON	**619,995**	**763,833**	**894,595**
MARTIN	**1,016,465**	**1,182,192**	**1,332,854**
MCDOWELL	**1,849,442**	**2,181,853**	**2,484,045**
MECKLENBURG	**23,233,048**	**30,636,749**	**37,367,386**
MITCHELL	**405,428**	**469,602**	**527,943**
MONTGOMERY	**1,165,572**	**1,406,073**	**1,624,710**
MOORE	**2,373,761**	**2,844,462**	**3,272,372**
NASH	**3,898,666**	**4,387,842**	**4,832,548**
NEW HANOVER	**3,980,143**	**5,044,608**	**6,012,303**
NORTHAMPTON	**984,377**	**1,098,087**	**1,201,461**
ONSLOW	**3,915,598**	**5,175,865**	**6,321,563**
ORANGE	**4,317,447**	**5,446,241**	**6,472,417**
PAMLICO	**373,866**	**419,604**	**461,183**
PASQUOTANK	**816,396**	**994,241**	**1,155,918**
PENDER	**1,994,704**	**2,456,701**	**2,876,698**
PERQUIMANS	**456,035**	**577,222**	**687,392**
PERSON	**900,146**	**1,067,428**	**1,219,502**
PITT	**3,400,317**	**3,983,033**	**4,512,775**
POLK	**925,202**	**1,156,146**	**1,366,095**
RANDOLPH	**4,313,301**	**5,195,767**	**5,998,009**
RICHMOND	**1,647,628**	**2,001,787**	**2,323,749**
ROBESON	**4,636,309**	**5,246,393**	**5,801,015**
ROCKINGHAM	**2,640,291**	**2,864,919**	**3,069,125**
ROWAN	**3,873,570**	**4,465,386**	**5,003,400**
RUTHERFORD	**1,810,844**	**2,115,733**	**2,392,904**
SAMPSON	**2,203,095**	**2,546,108**	**2,857,938**
SCOTLAND	**1,229,827**	**1,382,587**	**1,521,461**
STANLY	**1,599,536**	**1,862,841**	**2,102,210**
STOKES	**1,117,285**	**1,343,434**	**1,549,024**
SURRY	**2,675,387**	**2,969,519**	**3,236,912**
SWAIN	**562,881**	**615,707**	**663,731**
TRANSYLVANIA	**893,248**	**1,042,179**	**1,177,571**
TYRRELL	**189,727**	**250,223**	**305,219**
UNION	**3,787,618**	**4,643,151**	**5,420,908**
VANCE	**1,531,253**	**1,857,697**	**2,154,464**
WAKE	**20,085,293**	**25,619,517**	**30,650,630**
WARREN	**717,902**	**861,911**	**992,829**
WASHINGTON	**448,283**	**483,359**	**515,245**
WATAUGA	**1,081,388**	**1,160,296**	**1,232,030**
WAYNE	**3,292,285**	**4,024,978**	**4,691,063**

WILKES	**1,993,375**	**2,286,565**	**2,553,101**
WILSON	**2,707,761**	**3,093,448**	**3,444,072**
YADKIN	**1,518,080**	**1,776,643**	**2,011,700**
YANCEY	**426,871**	**450,324**	**471,646**