MEMORANDUM

TO: David Hitchcock, HARC

FROM: Rick Baker, ERG
Chris Porter, Cambridge Systematics

DATE: December 31, 2004

SUBJECT: Preliminary Assessment of LEV-II Program Benefits for Texas

1.0 OVERVIEW

The objective of this work was to review existing assessments of the emissions benefits of adopting California Low Emission Vehicle (LEV-II) emission standards, and to discuss the implications of these findings for the potential analysis and adoption of these standards in Texas. Eastern Research Group, Inc. (ERG), and its subcontractor Cambridge Systematics (CS) were contracted by the HARC to conduct this effort.

A number of assessments of the benefits of LEV-II relative to the Federal Tier 2 program have been conducted in states throughout the Northeast. These include studies for the Northeast States for Coordinated Air Use Management (NESCAUM) and the Connecticut Fund for the Environment (CFE), conducted by CS, estimating toxics, greenhouse gas, volatile organic compound (VOC), and oxides of nitrogen (NOx) emissions benefits of the LEV-II program in Massachusetts, New York, Vermont, and Connecticut; a study by the New Hampshire Public Interest Research Group (NHPIRG) estimating the toxics and VOC benefits of the LEV-II program in New Hampshire; and an analysis by the New Jersey Public Interest Research Group (NJPIRG) of LEV-II program benefits in New Jersey. These studies have looked at future year benefits of either adopting LEV-II (for states that had not yet adopted the program, including CT, NH, and NJ) or continuing to implement the program (in MA, NY, and VT) compared to maintaining or reverting to the Federal Tier 2 program. The studies have been conducted using EPA's MOBILE6 model as well as Argonne National Laboratory's GREET model, in conjunction with spreadsheet post-processing of outputs. All of these studies have found that the LEV-II program will reduce emissions from passenger vehicles compared to the Tier 2 program to greater or lesser degrees, with the benefits increasing over time.

Some of the key variables and uncertainties impacting the LEV-II program's relative benefits include:

- The "bin" sales mix of vehicles assumed under EPA's Tier 2 program, which affects VOC and toxics emissions estimates, including differences in the mix for light-duty trucks vs. passenger cars;
- The relative evaporative emissions benefits of California vs. Federal vehicles, which will also depend upon manufacturer production decisions;
- State-specific inputs such as vehicle age distribution and VMT split by vehicle class, which affect the amount and timing of benefits of the two programs;
- Adoption of the optional Zero-Emission Vehicle (ZEV) component of the LEV-II program;
- Assumptions about vehicle technology mix and penetration (e.g., hybrids, battery-electrics, hydrogen fuel cells) to satisfy the ZEV component; and
- Effects of other parameters such as fuel, temperature, and inspection and maintenance program, which could alter the potential evaporative benefit between the programs.

In this memo ERG and CS summarize the key findings of previous similar studies, and discuss key LEV-II program implementation issues in general (e.g., program start year, transition schedule, and adoption and implementation of ZEV requirement) and their potential implications for program benefits in Texas. Commentary is also provided on relative differences with respect to exhaust and evaporative emissions (which affect VOC and toxics), NOx, particulate matter (PM), and greenhouse gas emissions. ERG and CS also examined MOBILE input and other fleet parameters such as vehicle age distribution, VMT mix, temperature, and I/M programs to provide a preliminary indication of how differences in these parameters may affect the benefits of LEV-II in Texas relative to other states. In addition, we discuss the various political and administrative issues involved with implementing LEV-II.

Based on these findings ERG and CS make an independent recommendation regarding the relative merits of conducting a Texas-specific Phase 2 analysis for HARC. This recommendation considers the potential emission reductions of LEV-II adoption as well as any other implementation or administrative issues identified in this study. Finally, regardless of the recommendation itself, we provide HARC with a draft scope of work and level of effort for performing such a Phase 2 analysis.

2.0 PREVIOUS STUDIES

The following section summarizes the findings of previous studies on the benefits of adopting California LEV-II vehicle emissions regulations relative to EPA's Tier 2 standards. A number of northeast states, including Maine, Massachusetts, New York, and Vermont, adopted California's emission standards in the mid to late 1990s. Connecticut and New Jersey have signed legislation in 2004 adopting the standards in 2008 or 2009. New Hampshire and Rhode Island have also considered adopting the California standards. Studies have been sponsored by state agencies, environmental groups, and automobile manufacturers in most or all of these states to evaluate LEV-II program benefits.

The recently-conducted studies of LEV-II vs. Tier 2 program benefits in the northeast states can be grouped into the following categories:

1. CS's work for the Northeast States for Coordinated Air Use Management (NESCAUM) and Connecticut Fund for the Environment (CFE) in 2002 and 2003. These studies used MOBILE6 and the GREET model, in conjunction with spreadsheet post-processing of output, to estimate benefits in four states – Connecticut, Massachusetts, New York, and Vermont.
2. Reports by the New Jersey and New Hampshire Public Interest Research Groups (NJPIRG and NHPIRG), released in 2002, estimating benefits in these two states. These studies relied on an earlier (1999) study conducted by CS for NESCAUM using EPA's Tier 2 Model (a "transition" spreadsheet model incorporating more advanced data than MOBILE5b, but prior to the release of MOBILE6). Results were adjusted for NJ and NH based on VMT in those states, but are similar on a percentage basis. The 1999 CS study has essentially been superseded by the 2002 work for NESCAUM.
3. A study conducted by the New York Department of Environmental Conservation (NYDEC) in 2000, using MOBILE5b.
4. Studies conducted in various states and at various times for the Alliance of Automobile Manufacturers (AAM) by Air Improvement Resource, Inc. (AIR). These studies first used MOBILE5b and subsequently MOBILE6. Detailed documentation is available for AIR's MOBILE6-based 2004 study in Vermont. The methodology and assumptions for all states are similar, and results are also similar when expressed on a percentage basis. It should be noted that the modeling assumptions employed by AAM adhere to EPA's guidance for modeling the Tier 2 and LEV-II programs, whereas the CS methodology does not. However, CS and its sponsors (NESCAUM and CFE) believe that the EPA methodology understates the benefits of LEV-II relative to Tier 2, and that the alternative modeling assumptions are appropriate and realistic (see discussion below).

Note that the Connecticut study is most relevant to the Texas situation, as the study evaluated a transition from Federal to California standards beginning in 2007, evaluated NOx as well as VOC, and included an assessment of LDT classes 3 and 4. The NESCAUM study of Massachusetts, New York, and Vermont, in contrast, modeled a reversion from California to Federal standards beginning in 2004, did not evaluate NOx, and did not include the heavier light-duty trucks.

Finally, ERG also reviewed the sole previous study regarding the potential benefits of the LEV-II program in Texas. Specifically, ERG Memorandum dated November 4, 1999, "SIP Modeling Procedures for Dallas and Houston Ozone Non-Attainment Areas" to Candy Garrett (TNRCC), from Rick Baker (ERG), documents a previous analysis done for TCEQ to analyze a number of on-road mobile source control programs for Texas. The analysis included a comparison of benefits between the Federal Tier 2 and Cal LEV II certification standards. However, the analysis was based on MOBILE5a modeling runs, and only reported potential benefits on a percentage basis rather than in tons. Given the significant changes instituted in the MOBILE model since this time we concluded that these results were not informative for the current analysis.

Therefore the most relevant results can be summarized as follows:

- **The studies conducted using CS methodologies found significant benefits of LEV-II vs. Tier 2**, as expressed as a percentage reduction in emissions. The Connecticut study estimated that VOC emissions would be reduced by 7% in 2015 and 21% in 2025, compared to Tier 2; NOx emissions by 3% in 2015 and 11% in 2025; air toxics emissions by 14% in 2015 and 33% in 2025; and greenhouse gas (GHG) emissions by 0.8% in 2015 and 2.2% in 2025.
- **If LEV-II were implemented without the ZEV component, VOC and air toxics benefits would be slightly lower; NOx benefits would be significantly lower**; and there would be no GHG benefits. Most of the NOx benefits of LEV-II come from the ZEV component of the program, and are specifically related to the assumption that manufacturers will produce only the minimum number of true ZEVs necessary. Under this scenario the manufacturers would make up most of their ZEV credits through sales of PZEV (partial ZEV) and AT-PZEV (Advanced Technology PZEV) vehicles.
- **The studies conducted for AAM estimate much lower levels of benefits for the LEV-II program relative to Tier 2.** The Vermont study, in particular, (the most recent study and also the only study for which documentation was available) estimated a 1% difference between the two programs in 2012 and a 4 to 6% difference in 2020 for both NOx and VOC emissions (for all light-duty vehicles). Specific assumptions about LEV-II and Tier 2 program implementation and benefits differ significantly between the two studies, leading to the differences in results. The key differences are discussed further below.
- **Studies using both methodologies confirmed that total light-duty vehicle emissions will decrease significantly over time, as improvements in the vehicle standards will far outweigh increases in VMT in all of the states analyzed.** For example, the CS study in Connecticut found that VOC and NOx emissions would be reduced in the range of 60 to 75% in 2015 and 70 to 85% in 2025 under both programs, compared to 2003 levels.

- PM was not modeled for any of the studies. While PM standards are the same for most vehicle classes, some of the EPA Tier 2 bins allow PM standards double those of LEV-II standards (0.02 vs. 0.01 g/mi) – thus making it easier to sell diesel vehicles. On the other hand, light-duty diesels currently are not capable of meeting the California LEV-II standards. Judgments about the PM benefits of Tier 2 will rely on assumptions about: (1) if and when diesel technology will advance to be able to meet California standards, (2) total diesel sales penetration in the future, and (3) any differences in diesel sales under the two programs.
- The analysis of GHG benefits reflects only the likely impact of the existing ZEV requirement and not recent California legislation aimed at reducing greenhouse gas emissions in the state. **Benefits could be greater than modeled, if the advanced technology component of the ZEV program is successful at stimulating the introduction of high-efficiency technology (such as hybrids and fuel-cell vehicles) more rapidly or on a broader scale than required under the ZEV program.**

More detailed descriptions of the methodology and findings of the previous studies, including state program background, pollutants analyzed, methodology, results, and key program features that might affect the results, are provided in Appendix A.

3.0 KEY ISSUES AND ASSUMPTIONS AFFECTING LEV-II vs. TIER 2 BENEFITS

The Tier 2 and LEV-II program requirements are structured in very similar terms. Both programs specify emission standards for NMOG, CO, NOx, and PM, for 120,000-mile levels.[1] In addition, both programs use a "binning" approach wherein individual vehicles meet the standards of a particular bin, while fleet average production must meet the overall program standards, with sales weighted across all bins. Finally, both programs feature a phase-in period over several years.

The programs differ in other key respects however. Most notably, the Tier 2 program is based on a fleet average NOx standard, while the LEV-II program is tied to fleet average NMOG levels. In addition, the phase-in schedules for the programs are slightly different, with Tier 2 LDV and LDT1/2 standards fully phased in by 2007, and LDT3/4 standards by 2009. In contrast, LEV-II fleet average requirements continue declining through 2010. The following table summarizes the fleet average emission requirements for each program by year and vehicle class.

Tier 2 and LEV-II Program Fleet Average Emission Requirements

Model Year	Cal LEV - *NMOG*	Tier 2 - *NOx*
LDVs and LDT1s		
2004	0.053	0.243*
2005	0.049	0.185*
2006	0.046	0.128*
2007	0.043	0.070
2008	0.040	0.070
2009	0.038	0.070
2010+	0.035	0.070
LDT2s		
2004	0.085	0.243*
2005	0.076	0.185*
2006	0.062	0.128*
2007	0.055	0.070
2008	0.050	0.070
2009	0.047	0.070
2010+	0.043	0.070
LDT3-4s		
2004	0.085	0.500*
2005	0.076	0.399*
2006	0.062	0.299*
2007	0.055	0.199*
2008	0.050	0.134*
2009	0.047	0.070
2010+	0.043	0.070

* Not formal standards, but approximate average based on required Tier 1 and Tier 2 mix by year

[1] The exceptions are SULEV vehicles (under the LEV-II program), and PM (under both programs), which only have 120,000-mile standards specified.

The LEV-II program is also significantly more restrictive in terms of allowable technology bins for any given year. For example, after 2004 LEV I and ULEV I models will no longer be sold. And depending upon how manufacturers choose to meet the ZEV requirements, sales could be more heavily weighted toward SULEVs. The following table summarizes the standards by bin for the two different programs.

Tier 2 and LEV-II Program Standards by Bin

EPA - Tier 2

LDV, LDT1-2

		120K Standards				50K Standards			
Bin No.	**CA Type**	**NMOG**	**CO**	**NOx**	**PM**	**NMOG**	**CO**	**NOx**	**Comments**
11		0.280	7.3	0.900	0.12	0.195	5.0	0.600	deleted after 2006
10		0.156	4.2	0.600	0.08	0.125	3.4	0.400	deleted after 2006
9		0.090	4.2	0.300	0.06	0.075	3.4	0.200	deleted after 2006
8		0.125	4.2	0.200	0.02	0.100	3.4	0.140	
7		0.090	4.2	0.150	0.02	0.075	3.4	0.110	
6		0.090	4.2	0.100	0.01	0.075	3.4	0.080	
5	LEV II	0.090	4.2	0.070	0.01	0.075	3.4	0.050	
4*		0.070	2.1	0.040	0.01	*0.051*	*1.7*	0.029	
3*		0.055	2.1	0.030	0.01	*0.040*	*1.7*	0.021	
2*	SULEV**	0.010	2.1	0.020	0.01	*0.007*	*1.7*	0.014	**Except CO
1	ZEV	0.000	0.0	0.000	0.00	0.000	0.0	0.000	

LDT3-4

		120K Standards				50K Standards			
Bin No.	**CA Type**	**NMOG**	**CO**	**NOx**	**PM**	**NMOG**	**CO**	**NOx**	**Comments**
11		0.280	7.3	0.900	0.12	0.195	5.0	0.600	deleted after 2008
10		0.230	6.4	0.600	0.08	0.160	4.4	0.400	deleted after 2008
9		0.180	4.2	0.300	0.06	0.140	3.4	0.200	deleted after 2008
8		0.156	4.2	0.200	0.02	0.125	3.4	0.140	
7		0.090	4.2	0.150	0.02	0.075	3.4	0.110	
6		0.090	4.2	0.100	0.01	0.075	3.4	0.080	
5	LEV II	0.090	4.2	0.070	0.01	0.075	3.4	0.050	
4*		0.070	2.1	0.040	0.01	*0.051*	*1.7*	0.029	
3*		0.055	2.1	0.030	0.01	*0.040*	*1.7*	0.021	
2*	SULEV**	0.010	2.1	0.020	0.01	*0.007*	*1.7*	0.014	**Except CO
1	ZEV	0.000	0.0	0.000	0.00	0.000	0.0	0.000	

LEV II PROGRAM

		120K Standards				50K Standards			
Bin No.	**CA Type**	**NMOG**	**CO**	**NOx**	**PM**	**NMOG**	**CO**	**NOx**	**Comments**
	LEV I					0.075	3.4	0.2/0.4^	^LDV1 and 2, respectively
	ULEV I					0.040	3.4	0.2/0.4^	^LDV1 and 2, respectively
5	LEV II	0.090	4.2	0.07	0.01	0.075	3.4	0.05	
	ULEV II	0.055	2.1	0.07	0.01	0.040	1.7	0.05	

2**	SULEV*	0.010	1.0	0.02	0.01	*0.007*	*0.81*	*0.014*	**Except CO
1	ZEV	0.000	0.0	0.00	0.00				

*Standards are set only for 120K; lower (ratioed) 50K levels in italics indicated for modeling purposes

Despite the structural similarities of the programs however, the relative benefits of the LEV-II program over Tier 2 depend on a number of factors, such as program start date and the assumed sales weighting across bins. These factors are discussed in more detail below.

The findings from the northeast state studies provide a general indication of the magnitude of the potential benefits of adopting the LEV-II program in Texas. The issues that might cause LEV-II benefits in Texas to differ from these cited findings can be divided into two categories:

- **Program, fleet, and other control differences** – Differences in how the LEV-II program is implemented in Texas (e.g., start year or adoption of the optional ZEV component), as well as differences in the vehicle fleet, fuels, and other issues that could cause actual LEV-II benefits to differ in magnitude, or to be realized over a different time frame.
- **Modeling assumptions** – These are key modeling assumptions for which there has been disagreement between states and environmental groups, and the automobile manufacturers. They do not affect the relative difference of LEV-II benefits in Texas vs. other states, but they do reflect uncertainty inherent in the overall estimates of LEV-II program benefits.

3.1 Program, Fleet, and Other Control Differences

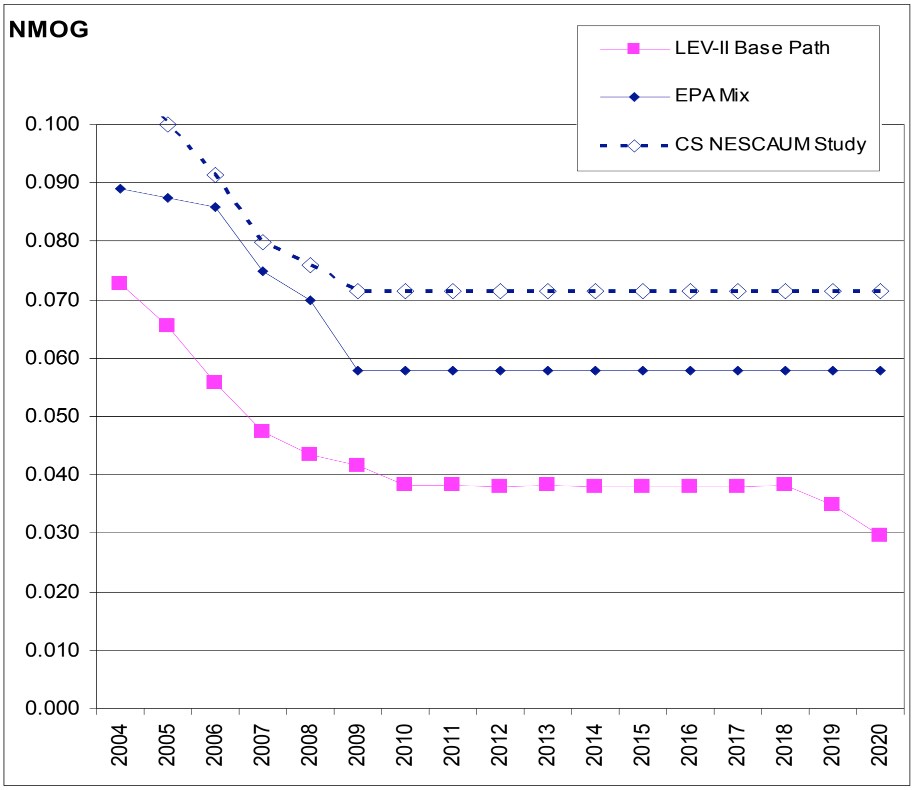
LEV-II program start year – The Connecticut analysis assumed a start year of 2007, while the NESCAUM analysis assumed a "start" year of 2004 (or rather, that the states would *not* revert to Tier 2 in 2004). Given the current stage of program planning, it is unlikely that a Texas program could start LEV-II before 2008 or 2009. This would slightly delay the timing of program benefits, although the long-term benefits would be similar. (**The benefits of LEV-II after one year of implementation are estimated to be less than a 1% VOC reduction and less than a 0.4% NOx reduction compared to levels under the Tier 2 program,[2] suggesting that the impacts of a one-year delay in program introduction will not be significant.)**

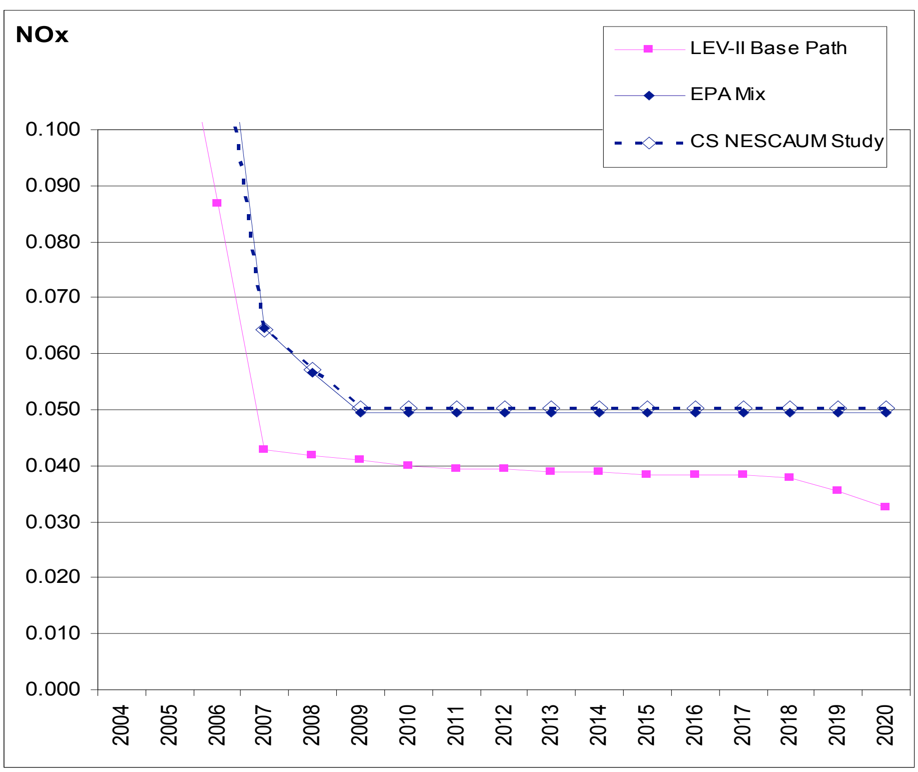
To illustrate how program impacts can vary with time, three scenarios are presented. These included a LEV-II "Base Path", and two different Tier 2 scenarios -- EPA's assumed bin mix, and the mix assumed in the CS analysis for NESCAUM. (See Appendix A for details regarding the Base Path and NESCAUM scenarios.) As indicated in the figures, full phase-in benefits are effectively achieved under both programs by about 2010. However, assumptions regarding bin sales distributions can

[2] Based on a linear interpolation of benefits between 0% (in 2007) and the percentage benefits estimated for each pollutant in 2015 from the Connecticut analysis.

have a significant effect on NMOG emissions under Tier 2, and on NOx emissions under LEV-II. Please see below for further discussion of bin distribution impacts.

New Vehicle Fleet Average Emissions by Model Year, All Light-Duty Vehicles (2004-2020)





ZEV component – While Texas would be required to adopt the same emission standards as California if it opted into the LEV-II program, it would not be required to adopt the ZEV component. The ZEV requirement contributes relatively more to NOx than to VOC reductions. While the ZEV requirement does not directly apply to light trucks over 3,750 lb. (LDT2 - 4), the sales requirements for ZEVs are based on the number of vehicles sold in all light-duty weight classes.

The Connecticut analysis showed that the ZEV component accounts for a significant fraction of LEV-II program benefits, especially with respect to NOx (**about 50% of the incremental NOx benefits in 2015, and 67% in 2025**), as a result of three factors:

- PZEVs and AT-PZEVs (which can be used to meet much of the ZEV credit requirement) must meet "zero-evaporative" emission standards that are lower than the evaporative standards for other LEV-II vehicles. Under this assumption the sale of PZEVs and AT-ZEVs will reduce VOC and air toxics emissions beyond the LEV-II baseline requirements. Under one assumed implementation scenario in Connecticut (featuring a 2% ZEV/2% AT-PZEV/6% PZEV credit), these vehicle types would make up over 25% of LDV/LDT1/LDT2 sales beginning in 2007, with this level increasing to nearly 50% by 2018. (Under this assumption evaporative emissions benefits make up about 16% of total LEV-II VOC benefits in 2025.)
- Assuming that manufacturers meet the ZEV requirement by maximizing the credits obtainable from PZEVs and AT-PZEVs, instead of selling true ZEVs, the overall fleet average emission rate is "forced" below the California program standards for NMOG because of the lower individual standards on the PZEV and AT-PZEV vehicle classes, falling as low as 0.21 g/mi for LDV/LDT1 in 2018 and later, compared to the 0.35 g/mi required level. (The NESCAUM analysis showed that if all ZEV credits were generated by true ZEVs, VOC benefits of LEV-II for the LDV/LDT1/LDT2 classes would be reduced from 17.3% to 15.3% in 2020).
- **NOx emissions are also reduced because of the higher penetration of PZEV and AT-PZEV vehicles, since tailpipe NOx standards are set at 0.02 g/mi for these vehicle classes, compared to 0.07 g/mi for other LEV II vehicles**, as well as for bin 5 Tier 2 vehicles. The Connecticut analysis showed that NOx would be reduced in 2025 by 11.1% assuming higher PZEV and AT-PZEV penetration rates.

GHG emissions are also reduced because of the introduction of hybrid vehicles and/or other more efficient technologies likely to be adopted to meet the ZEV credit requirements. Under the ZEV requirement, advanced-technology vehicles (true ZEVs and AT-PZEVs) would, at a minimum, make up over 5% of LDV/LDT1/LDT2 sales beginning in 2012, and over 10% beginning in 2018.[3] The level could be much more than this if the program is successful at stimulating hybrid or other alternative technology to the point of broad market penetration.

Vehicle age distribution – The timing of program benefits is affected by the vehicle age distribution assumptions embedded in MOBILE6, which typically vary by state. An age distribution more heavily weighted towards older vehicles will result in slower realization of program benefits (because of slower fleet turnover), even though the

[3] These percentages would be somewhat less if all of the ZEV credits were met using true ZEVs, which is unlikely.

ultimate long-term benefits will be similar. It should be noted, however, that age distributions from a given recent year are not necessarily representative of future age distributions, which will be affected by short-term economic trends, long-term trends in vehicle longevity and use, and other factors. **CS's sensitivity analysis suggested that vehicle age distribution can affect *overall* emission levels by 10 percent or more. However, the *relative* difference in LEV-II vs. Tier 2 emissions as a result of age distributions is likely to be much smaller, since the same age distribution will apply to both the LEV-II and Tier 2 programs.**

VMT mix by vehicle class – The local mix of vehicles by vehicle weight class (LDV, LDT1, etc.) also will affect the relative benefits of LEV-II. In particular, assuming adoptions of the ZEV requirement, a larger percentage of vehicles in the LDT3 and 4 classes will reduce the benefits of the program, since these classes are not subject to the requirement. **The Connecticut results show that LEV-II will reduce NOx emissions in the LDT3 and 4 classes by only 1 to 2% compared to the Tier 2 program, although VOC reductions should be more significant** (6% in 2015 and 14% in 2025). A greater proportion of LDT2 vs. the LDT1/LDV classes also may have a similar impact, although to a lesser extent, since LDT2 vehicles are included in the "sales base" used to calculate the number of ZEV credits required. The vehicle mix by type will also interact with the vehicle age distribution, as the different vehicle types will have different age distributions.

Fuel type, I/M program, ambient temperature, and other MOBILE inputs – These variables will have a significant effect on the *total* emissions under both programs, and therefore will have some effect on the absolute emissions benefits of LEV-II. For most of these parameters, the effect on the *relative* benefits of LEV-II (percent improvement over Tier 2) is likely to be marginal to non-existent, because the differences will apply in equal proportion to both programs. Parameters that have different effects on different emissions (e.g., temperature effects that increase evaporative emissions), however, could have a non-negligible effect because these emissions components are affected differently by the Tier 2 and LEV-II programs.

Electricity generation mix – The emission benefits of battery-electric (i.e., "pure ZEV") vehicles produced to fulfill the ZEV mandate will vary depending upon the local electricity generation mix. It is conceivable that use of battery-electric vehicles could actually increase certain types of emissions. However, this effect will have a relatively small impact on overall program benefits, since battery-electric vehicles are assumed to represent only a small fraction of total vehicle sales (with most ZEV credits being generated by PZEVs and AT-PZEVs).

3.2 Modeling Assumptions

"Bin" distribution under the Tier 2 program – Under the Tier 2 program, vehicles are distributed among "bins" with different pollutant standards in each bin. Any combination of bins is possible as long as the fleet average NOx standard is 0.07 g/mi. While assumptions regarding bin distribution therefore do not affect NOx emissions, they do affect VOC and PM emissions estimates. **Assuming that all vehicles are "bin 5" (the EPA "standard" bin) will result in the highest VOC (and toxics) emissions but the lowest PM emissions. A wider spread can reduce fleet-average VOCs by 10 to 20**

percent or more, but will increase PM if manufacturers choose to use the higher bins to sell diesel vehicles. (Please see the figures in Section 3.1 above for an illustration of different bin weighting assumptions.) CS' analysis assumed that 85 percent of light-duty vehicles would be "bin 5" vehicles, and this is consistent with early Tier 2 sales data from auto manufacturers.[4] The manufacturers' analysis (consistent with EPA modeling guidelines) assumed a wider spread across bins, in particular that heavier trucks in higher bins would be offset with light-duty cars in lower bins. **The assumed bin mix is significant because it could account for the majority of estimated VOC benefits under the LEV-II program.**

Evaporative emissions – Evaporative emission standards differ between the LEV-II and Tier 2 programs for all vehicle emissions classes, and PZEVs and AT-PZEVs in particular must meet so-called "zero-evaporative" standards. CS's analysis factored evaporative emissions for PZEVs and AT-PZEVs vs. Tier 2 vehicles by the ratio of the standards set under the two programs. While base LEV-II vehicles also have more stringent evaporative standards under the California program, these vehicles were assumed in the CS analysis to have the same evaporative emissions levels as Tier 2 vehicles. This practice is consistent with EPA guidance and AAM assumptions, and is based on the rationale that manufacturers will sell vehicles in all 50 states that meet the California LEV-II evaporative standards (because the cost of manufacturing vehicles to two different standards is greater than the incremental cost of making all vehicles to meet the California standards). This assumption could be questioned, however, as it fails to credit the adoption of the California program for stimulating the nationwide adoption of more stringent evaporative standards, does not reflect the full range of legal differences between the two programs, and has not yet been proven with certification data. As a result, the CS estimate of evaporative benefits from the LEV-II program is likely to be conservative.

Path of compliance with ZEV requirement – Similar to the bin distributions under Tier 2, any number of scenarios can be generated for the mix of vehicle emissions classes (PZEV, AT-PZEV, and ZEV) to meet the 10 percent ZEV credit requirement. CS's modeling for NESCAUM tested different scenarios and found that program benefits may vary somewhat, but are still significant under any ZEV implementation scenario (VOC reductions for LDV/LDT1/LDT2 in 2020 ranged from 15.3% to 17.3% under four different scenarios tested). California's credit system is nominally set up so that average criteria pollutant emissions do not differ significantly regardless of how the credits are generated. Minimizing the use of true ZEVs, though, will "force" the fleet-average NMOG below California's standard (or "overcompliance"), and will also reduce NOx emissions because the PZEV and ATPZEV classes have lower NOx standards than LEVs and ULEVs. Assumptions about the specific technologies (battery-electric, fuel cell, hybrid, etc.) as well as about the relative efficiency of these technologies compared to conventional vehicles will significantly affect the estimates of GHG emissions benefits, but not criteria pollutants or air toxics.

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[4] Source: Email from Coralie Cooper (NESCAUM) to Chris Porter (CS) dated 12/18/2003 stating: "EPA confirmed for me today that 90-95% of 2004 tier 2 certifications were in the bin 5 category." Also, the Canadian Vehicle Manufacturers' Association (CVMA) and the Association of International Vehicle Manufacturers of Canada (AIAMC) have stated "it is very likely that many manufacturers will certify the majority of their products to the Tier 2 average (bin 5) level of emissions." See: http://www.ec.gc.ca/CEPARegistry/documents/regs/OR_resp/s4.cfm

4.0 IMPLEMENTATION ISSUES RELATED TO THE LEV-II PROGRAM

There are several unique implementation issues associated with adopting the California LEV-II program, including program development, administration, and enforcement of regulations. The following summary is based on experience with implementing the LEV-II program in various Northeast states.

Staff at the Northeast States for Coordinated Air Use Management (NESCAUM) report that the Northeast states that have adopted the program typically commit between one and four full-time equivalent staff persons to program administration and implementation issues. The level of effort varies by the size of the state as well as how the state chooses to enforce the program. The primary tasks in LEV-II program implementation include:

- Program development;
- Program monitoring and enforcement; and
- Response to legal issues.

4.1 Program Development

Legal and programmatic staff work together to draft regulations, conduct public hearings, finalize regulations, and work with lawmakers to adopt regulations implementing the LEV-II program. Regulations also must be updated to maintain consistency with the California program. Some states amend their regulations every year, while others do so on an irregular basis.

4.2 Program Monitoring and Enforcement

Each year, the state must work with the automobile manufacturers to calculate the "NMOG curve" for that year's new vehicle sales. The "NMOG curve" is calculated based on vehicle sales data by certification level, which are provided by the manufacturers. These sales data are input into a spreadsheet that calculates the fleet-average NMOG emissions level. This process certifies that the actual sales mix meets the California fleet-average emissions standard for NMOG. This process is straightforward, and the spreadsheet required for the calculations exists and is easy to use.

A state adopting the LEV-II regulations is not required to undertake additional activities to monitor sales or vehicle registrations under the program. Some of the Northeast states do undertake sales and/or registration enforcement, while others (primarily smaller states that are part of the same distribution network as neighboring states) rely on the activities of their neighbors to fulfill this function. **Because the size of the vehicle market in Texas and the state's isolation from other states implementing LEV-II, Texas would most likely want to undertake its own enforcement activities to ensure that the benefits of the LEV-II program are being realized.**

"Registration denial" is one mechanism for enforcement. Registration denial requires the state department of motor vehicles (or other registering agency) to review the certificate of origin for each new vehicle registered in the state, as a requirement of issuing a registration. The certificate of origin, which comes with every vehicle, identifies the EPA emissions certification level of the vehicle. This approach would most likely require significant coordination with the TX DMV, and possibly specific enabling legislation.

A second enforcement alternative is dealer spot-checks. With this mechanism, program staff make random site visits to dealers and review the certificates of origin for a sample of new vehicles on the sales lot to ensure that they are compliant with California standards. This approach can be more flexible, with level of effort varying according to available resources.

4.3 Response to Legal Issues

LEV-II programs have been subject to various legal challenges, primarily by representatives of the automobile manufacturers. These challenges typically involve the details of how the program will be implemented in a specific state (i.e., determining whether the state's implementation regulations and approach meet the required test of "consistency" with the California program.) Examples of issues that have been subject to legal review in the past include implementation of the ZEV mandate, and whether fuel differences constitute a difference with the California program (they do not). As more states have adopted the LEV-II program, most of these legal issues have been settled and activity on this front has decreased markedly.

One issue that has not been resolved is that of greenhouse gas (GHG) emissions standards. California's so-called "Pavley" standards, which establish manufacturer-based fleet-average GHG emissions standards, are expected to be on the books by August 2005. Since Federal law requires that a state opting in to California vehicle emission regulations must adopt *all* of California's requirements (with the exception of the ZEV component), states adopting LEV-II after the California GHG standards are adopted will need to incorporate the GHG standards as part of their own LEV-II programs. States that already have adopted LEV-II will need to amend their regulations consistent with the California requirements. Additional legal activity can be expected from the automobile manufacturers regarding the GHG standards.

4.4 Other Potential Issues

NESCAUM reports that the automobile manufacturers have raised various other issues related to program implementation that could potentially increase the cost or level of effort for a state. NESCAUM reports that experience in the Northeast states has not proven any of these issues to be a major administrative cost or burden. However, they are likely to be raised by the manufacturers' associations if Texas chooses to publicly consider adopting the LEV-II program.

Development of alternative technology infrastructure – The original "ZEV mandate" of the California program, which would have required 10 percent of new vehicle sales to be true ZEVs, could have led to states making significant infrastructure investments (electric vehicle charging stations, alternative fuel delivery systems, etc.) to support the requirement. While California has chosen to make targeted investments supporting infrastructure (such as hydrogen fueling stations and demonstration electric vehicle plug-in ports), this is not a required part of the program. Furthermore, since the ZEV mandate can now be met almost entirely through PZEV or AT-PZEV vehicles that run on gasoline (at least in the program's early years), any need for alternative infrastructure investments has largely been eliminated. Furthermore, it is likely that California will continue to lead technology development in the future, and if costs for a particular technology are excessive, the program most likely will be revised to ensure that these costs are manageable and have a reasonable benefit.

Cost of incentives for alternative-technology or low-emissions vehicles – Another potential issue that has been raised is the cost of incentives to stimulate advanced technology vehicle sales, if they are more expensive than regular vehicles. While New York has chosen to offer some incentives, other Northeast states have not offered incentives and to-date, such incentives have not been required to meet the LEV-II sales targets.

Impact on Inspection and Maintenance (I/M) programs – The manufacturers have claimed that adopting LEV-II regulations will necessitate changes to state I/M programs. The arguments supporting this claim are not clear, and this experience has not been supported in the Northeast states, which have continued to implement their existing I/M programs while also implementing LEV-II.

Credit banking – Some manufacturers who do not have hybrid vehicle offerings have used banked credits from early introduction of specialty vehicles (e.g., neighborhood electric vehicles, GM's EV-1) to ensure that they do not need to sell hybrids until 2009 or 2010. Since they will not have such early introduction credits in states newly adopting the LEV-II program (such as Connecticut, Maine, New Jersey, and Rhode Island) they have argued for credits proportional to their existing California credit bank for 2007 and 2008 so that they can meet ZEV credit requirements in the early years. States have granted them this concession, because of its small impact compared to the overall program benefits. Depending upon the timing of Texas' program implementation, manufacturers are likely to ask for this concession in Texas as well.

5.0 IMPLICATIONS FOR TEXAS

It can be assumed that the benefits of adopting LEV-II in Texas will be of the same general magnitude (as expressed on a percentage reduction basis for the light-duty vehicle fleet) as the benefits forecast in Connecticut. Actual benefits may differ, though, due to one or more of the following factors:

- Benefits would be delayed slightly (i.e., smaller in any particular evaluation year) since the LEV-II program could not be implemented in Texas until at least 2008 or 2009.
- VMT growth in Texas is likely to be much greater than in the Northeast – meaning that the relative emissions reductions may be even greater for the LEV-II program in Texas as time progresses.
- A higher proportion of light trucks vs. cars in the Texas light-duty vehicle fleet could reduce the VOC and air toxics emissions benefits of LEV-II, since the reduction in California NMOG standards for the LDT vehicle classes is somewhat less (proportionally) than the reduction for the LDV class.
- Differences in vehicle age distributions could lead to differences in the timing of the benefits of the LEV-II program. For example, an older distribution would lead to slower realization of benefits, assuming the present distribution holds for the future.[5] Different distributions by vehicle weight class would also lead to different results.
- Given higher average temperatures, one might expect that evaporative emissions are higher in the base case in Texas than in Connecticut. Under the modeling assumptions used in the CS studies and recommended by EPA, a higher contribution of evaporative emissions would likely decrease the overall benefits of the LEV-II program, since the percent reductions in evaporative emissions are less than the percent reductions in tailpipe VOC emissions. It is important to note, however, that this modeling assumed that Tier 2 vehicles meet baseline LEV-II evaporative standards. To the extent that PZEVs and AT-PZEVs are introduced to meet ZEV requirements, the evaporative emissions benefits of LEV-II as well as the overall VOC benefits would be greater, as discussed above.
- Toxic reductions such as 1-3 butadiene, formaldehyde, and acetaldehyde will be proportional to reductions in exhaust VOC, while reductions of benzene will be proportional to reductions in both exhaust and evaporative VOC. The actual reduction in evaporative toxics such as benzene would depend upon how the manufacturers choose to meet the Federal and California evaporative emission standards, as discussed above.
- The "bin" mix used in the CS analysis of Tier 2 benefits may need to be updated. It is possible that model year 2005 certification data could show a different distribution than previously assumed, thereby affecting VOC and toxic benefits. This data could be obtained from EPA to validate assumptions regarding the "bin" mix of Tier 2 vehicles, which would have implications for the VOC benefits of the LEV-II

[5] This assumption is consistent with SIP and Conformity analyses which typically assume current model year distributions will stay constant in future years for the purpose of emissions projections.

program. It is possible that certification data could also be obtained to validate assumptions regarding LEV-II evaporative emissions benefits.

- Differences in regional electricity generation characteristics could lead to differences in emissions from battery-electric vehicles. Current market trends, program requirements, and CS modeling assumptions, though, do not show a significant role for battery-electric vehicles in fulfilling the California ZEV mandate.

- CO_2 emissions will vary in proportion to the penetration of ZEVs and AT-PZEVs under the LEV-II program. Greenhouse gas benefits could also be greater than modeled if the advanced technology component of the ZEV program is successful at stimulating the introduction of high-efficiency technology (such as hybrids and fuel-cell vehicles) more rapidly or on a broader scale than required under the ZEV program.

- Differences in I/M programs, temperature, fuels, and other state and local parameters will lead to differences in the magnitude of overall benefits, although only parameters specifically affecting evaporative emissions are likely to significantly alter the percentage benefits of LEV-II relative to Tier 2.

- Potential PM emissions impacts have not been evaluated in previous studies. Just like other pollutant standards, neither Tier 2 nor LEV-II PM standards differentiate between gas and diesel vehicles. However, PM standards are for all practical purposes only relevant to diesels, since gas vehicles easily meet the standards. Therefore the most relevant impact of adopting the LEV-II program might be on the sales of diesel vehicles themselves -- it is very unlikely that auto manufacturers would produce diesel engines to two different standards, especially given the low numbers of diesel models and sales volumes. Instead, they would most likely opt not to sell diesel vehicles incapable of meeting the 0.01 g/mi LEV-II PM standard. Under such a scenario, overall PM emissions might decrease under LEV-II due to a reduction in the number of diesels sold.

5.1 Comparison of Connecticut and Texas Modeling Inputs

In order to address some of the uncertainties noted above, we performed a side-by-side comparison of some of the key MOBILE6 input parameters for Connecticut and Texas.

Evaporative emissions – Surprisingly, the baseline evaporative emission rates modeled in the Connecticut analysis were quite similar to those found in Texas. First, summertime Connecticut fuel is modeled with an RVP of 6.8 (2003 base case), almost identical to the 7.0 used in Texas. In addition, the Connecticut analysis was based on a very warm summer ozone episode with a temperature range of 66 to 94 degrees. Therefore the diurnal temperature cycle was only a few degrees lower than typically used in Texas modeling (typically ~75 – 97). These two factors lead to only a minimal difference in base evaporative rates between the two areas (for the relevant modeling scenarios). This means that the estimated evaporative benefits of LEV-II estimated in the CS analysis should roughly hold for Texas as well, by vehicle type. Some differences in toxic emissions (such as benzene) might be more pronounced for non-RFG areas in Texas, however.

Model year distributions – Model year distributions were obtained for Dallas and Harris counties from the TCEQ.[6] A detailed comparison of the Connecticut, Dallas and Houston distributions in provided in Appendix B. In general terms we see that the LDV, LDT3 and LDT4 distributions are somewhat newer in Texas than in Connecticut, while LDV1 and 2 distributions are fairly similar. This would tend to accelerate the incremental benefits of LEV-II somewhat for Texas (perhaps eventually offsetting any start year delay impacts).

VMT mix – As discussed above, the incremental benefits of LEV-II are greatest for LDVs and least for LDT 3 and 4. Therefore fleets with relatively higher percentages of LDV and LDT1/2 VMT would produce greater incremental benefits for LEV-II. In order to compare the statewide Connecticut VMT mix used in the CS analysis with Texas, ERG developed an approximate statewide mix for Texas using the latest CERR data.[7] Counter-intuitively, the Connecticut fleet actually contains relatively *fewer* LDVs than the Texas fleet. These results are summarized below.

VMT Mix Comparison

	LDV	LDT1	LDT2	LDT3	LDT4
CT	0.425	0.088	0.294	0.091	0.042
151 County TX	0.617	0.055	0.184	0.037	0.017

Both VMT mix estimates are based on relatively recent registration distributions (1999 for CT, 2001 for TX), and both are projections for 2007. However, the Texas estimates are derived using a unique TTI methodology which may account for systematic differences in the figures. Regardless, the TTI estimates are used in TCEQ modeling analyses, and are therefore the relevant point of comparison. As such, we would anticipate additional percentage benefits for the Texas fleet beyond that estimated for Connecticut.

5.2 Preliminary Conclusions Regarding Potential LEV-II Impacts in Texas

Estimating actual ton per day benefits for Texas based on the Connecticut findings is difficult without detailed modeling. To provide a *rough* sense mass emission reductions, one could use available 2007 emission projections for Texas, and benefit estimates from the Connecticut study. For instance, the most recent CERR estimates for the 8-county Houston region projects about 76 tpd of NOx and 78 tpd of VOC from all gasoline light-duty vehicles.[8] Applying midpoint estimates from the Connecticut study (3.1% NOx and 7.4% VOC, assuming the ZEV component) yields a 2.4 tpd reduction in NOx, and 5.8 tpd reduction in VOC for 2015.

Since baseline emissions will fall substantially between 2007 and 2015, even with increases in VMT, these estimates provide an *upper bound* for the incremental benefits of the LEV-II program in the area at that time. Nevertheless, if the HARC and other

[6] Files obtained from Chris Kite, TCEQ Technical Analysis Division, 11/17/04.
[7] 151 counties were represented, included the Dallas, Houston, Beaumont, San Antonio, Austin, Waco, El Paso, and Corpus areas. The vast majority of state-wide VMT is accounted for in these regions.
[8] Chris Kite, TCEQ Technical Analysis Division, 11/17/04.

stakeholders determine that NOx emission reduction strategies resulting in metro area emissions reductions in the 1 to 2 tpd range are worth investigating in detail, a Phase II detailed modeling effort may be justified as a follow-on for this analysis.

The steps involved and potential level of effort associated with such a study is discussed below.

6.0 REQUIREMENTS FOR DETAILED LEV-II ANALYSIS

The following provides an overview of the data requirements for a comparison of the LEV-II and Tier 2 programs.

6.1 Texas-Specific MOBILE6.2 Inputs

The following Texas-specific MOBILE6.2 inputs and data files would be required for the analysis. These data and files already exist, and just need to be gathered and integrated.

- Vehicle registration distributions;
- Distribution of VMT by vehicle type (light-duty vehicles);
- Ambient conditions (min/max temperature, absolute humidity);
- I/M data;
- VMT distributions (by speed, facility; other optional);
- Fuel RVP; and
- Detailed fuel data (for toxics and/or PM analysis only).

In addition, the following MOBILE6.2 data files must be created and referenced in the master input file:

- 94+ LDG IMP (sales fractions by CA emissions class and model year – used only to define Tier 1 – Tier 2 transition and ZEV sales fractions under LEV-II program);
- T2 CERT (exhaust certification levels for LEV-II vehicles, as well as for Tier 2 vehicles if non-default bin mix is used); and
- T2 EXH PHASE-IN (sales fractions by Tier 2 bin or LEV-II class and model year).

MOBILE6.2 must be run to produce output by model year, so that appropriate model year-specific adjustments to evaporative and greenhouse gas emissions can be applied.

6.2 Processing of Outputs

The following additional data/assumptions are required for spreadsheet post-processing of MOBILE outputs. Again, most of these data are available from the TCEQ and/or previous CS analyses.

- Total VMT by vehicle weight class and evaluation year;
- Ratio of California to Federal hot soak and diurnal evaporative emissions by vehicle emissions class (LEV-II, LEV-II zero-evaporative), weight class (LDV, LDT1/2), and model year (VOC and air toxics analysis only);
- For greenhouse gas (GHG) analysis only, greenhouse gas emission rates (g/mi CO_2 equivalent) by vehicle weight class (LDV, LDT1/2) and emissions class (ZEV, AT-PZEV) – output from GREET model based on the following inputs:

- Regional electricity generation mix (percent by fuel type), if battery-electric vehicles are analyzed;
- Assumptions regarding method of hydrogen production, if hydrogen fuel cell vehicles are analyzed; and
- Assumed energy efficiency ratio of advanced-technology vehicles compared to conventional gasoline vehicles.

In addition, in order to evaluate the uncertainty associated with evaporative emissions, a sensitivity test could be conducted using two different assumptions regarding LEV-II evaporative benefits: one assuming that all Federal vehicles meet base LEV-II evaporative standards (per EPA guidelines), and the other assuming that base LEV-II evaporative emissions are proportionately lower than evaporative emissions from Tier 2 vehicles. This sensitivity test might show differences in toxics vs. VOC benefits because of the different effect on evaporative emissions.

6.3 Level of Effort

The most significant effort in this analysis would be the creation of sales fraction scenarios by model year, which are used as inputs to MOBILE. Additional effort is involved in the post-processing of MOBILE outputs. The level of effort required for a Texas analysis would be reduced because many of the inputs can be borrowed or adapted from previous analyses in other states (e.g., Connecticut). The overall level of effort will also vary depending upon the number of scenarios analyzed. The primary scenarios of interest may include LEV-II program implementation with or without the ZEV component; different sales fractions of ZEV, AT-PZEV, and PZEV vehicles; different ZEV vehicle technologies; and different bin sales distributions under the Tier 2 program.

The following statements can be made about the relative level of effort involved in evaluating various pollutants:

- The easiest pollutant to evaluate is NOx, since no post-processing of MOBILE6 outputs is required (aside from the application of total VMT by vehicle weight class).
- VOC requires some additional effort, since model year-specific post-processing adjustments must be made to evaporative emissions.
- Air toxics require more significant additional effort, since a greater volume of output is produced and since the evaporative post-processing adjustments must be applied separately to individual toxics.
- GHG analysis also requires some additional effort to set up the GREET model, although this is a spreadsheet model with minimal basic input requirements. Similar to the evaporative adjustments, the GHG emission rates obtained from the GREET model must be applied to model year-specific output from MOBILE6.
- Analysis of LEV-II PM impacts has not yet been performed. Since PM is a direct output of the MOBILE model, the primary effort would be in developing reasonable assumptions about diesel sales fractions under the Tier 2 and LEV-II programs.

(Again, these data have already been compiled by TTI and are available from the TCEQ.) This might also involve revisions to the bin distributions under the Tier 2 program. Fuel data, similar to that required for the toxics analysis, also would be required to analyze PM.

The following provides a cost estimate for performing the analysis for different pollutants, for both the Dallas and Houston areas (DFW/HGBA), as well as for a statewide analysis. Note that the toxics and greenhouse gas (GHG) evaluations can be performed independently. However, the toxics analysis can only be performed after developing the VOC/NOx estimates, while the GHG evaluation (using the GREET model) can proceed largely independent of the MOBILE evaluation tasks.

Estimated Phase II Component Costs

	DFW/HGBA	Statewide
VOC/NOx	$10,234	$20,312
Toxics	$4,054	$13,376
GHG		$3,496
total	**$14,288**	**$37,184**

Appendix A

Detailed Study Descriptions

Connecticut Fund for the Environment (September 2003)

States Evaluated: Connecticut

Program Background: Connecticut, like other northeast states not adopting the California program in the 1990s, had adopted the National LEV (NLEV) program, which went into effect in 1999 in the northeast states and 2001 nationwide. The NLEV program is transitioning to the Tier 2 program over the 2004-2007 period.

Study Purpose: To compare the emissions benefits of adopting LEV-II beginning in 2007, vs. continuing to follow Federal Tier 2 standards.

Pollutants Analyzed: VOC, air toxics, NO_x, GHG

Vehicle Types Analyzed: Passenger cars and light trucks less than 8,500 lbs. GVWR (LDV, LDT1, LDT2, LDT3, LDT4)

Evaluation Years: 2003, 2015, 2025

Methodology: Similar to NESCAUM study methodology.

Key Assumptions: Evaluated three different ZEV implementation scenarios with different technology assumptions. Scenario "2" is base path implementation with 2% ZEV, 2% AT PZEV, and 6% PZEV credits. Scenario "7" is LEV-II without ZEV. Scenario "6" (not shown) assumed the California "alternative compliance path," which allows token introduction of hydrogen fuel-cell vehicles in the short term rather than satisfaction of the 2% true-ZEV requirement, but also assumes that hybrids will achieve greater than required market penetration due to widespread technology adoption. Both ZEV scenarios assume that ZEVs will transition from battery-electrics to hydrogen fuel cells between 2010 and 2013.

Findings: (Percent reduction in emissions, LEV-II vs. Tier 2)

	LEV-II with ZEV		**LEV-II without ZEV**	
Pollutant	**2015**	**2025**	**2015**	**2025**
VOC	7.4%	21.1%	6.6%	15.6%
Air Toxics	13.9%	32.9%	13.4%	28.0%
NOx	3.1%	11.1%	1.5%	3.9%
GHG	0.8%	2.2%	--	--

Documentation: *The Drive for Cleaner Air in Connecticut: The Benefits of Adopting the California Low-Emission Standard for Cars and Light Duty Trucks.* September 2003, Connecticut Fund for the Environment.

Analysts and Sponsors: Analysis conducted by Cambridge Systematics for CFE.

Contacts: Charles Rothenberger, CFE; Chris Porter, Cambridge Systematics

Northeast States for Coordinated Air Use Management (NESCAUM, October 2003)

States Evaluated: Massachusetts, New York (upstate and downstate regions), Vermont

Program Background: All three states originally adopted the California LEV-I emissions standards beginning in 1994 through 1996, and have continued to implement the LEV-I and subsequent LEV-II standards. All have also adopted the zero-emissions vehicle (ZEV) component of the California program, although with somewhat different implementation (delayed phase-in) compared to California.

Study Purpose: To compare the emissions benefits of continuing to implement LEV-II in 2004, vs. reverting to Federal Tier 2 standards at this time.

Pollutants Analyzed: VOC, air toxics, greenhouse gases (GHG)

Vehicle Types Analyzed: Passenger cars and light trucks less than 6,000 lbs. GVWR (LDV, LDT1 and LDT2)

Evaluation Years: 2003, 2010, 2020

Methodology: For VOC and air toxics, MOBILE6 with post-processing of evaporative emission reductions. For CO_2, Argonne National Laboratory's GREET model.

Key Assumptions: Evaluated four different ZEV implementation scenarios with different technology assumptions (splits of battery-electric vs. AT PZEV vs. PZEV). All assume a minimum of 2 percent battery-electric vehicles. A mix of state-specific and generic MOBILE6 inputs were used.

Findings: (Percent reduction in emissions, LEV-II vs. Tier 2)

Note: Ranges reflect full range of values for different scenarios and different states.

Pollutant	**2010**	**2020**
VOC	3.2 – 4.2%	12.4 – 17.3%
Air Toxics	4.4 – 6.2%	17.3 – 28.4%
GHG	0.3 – 0.7%	2.2 – 3.5%

Documentation: White Paper, *Comparing the Emission Reductions of the LEV II Program to the Tier 2 Program*. October 2003, NESCAUM and Cambridge Systematics, Inc.

Analysts and Sponsors: Analysis conducted by Cambridge Systematics for NESCAUM, between June 2002 and March 2003.

Contacts: Coralie Cooper, NESCAUM; Chris Porter, Cambridge Systematics

New Hampshire Public Interest Research Group and New Jersey Public Interest Research Group (April 2002, May 2002)

States Evaluated: New Hampshire, New Jersey

Program Background: New Hampshire and New Jersey, like other northeast states not adopting the California program in the 1990s, had adopted the NLEV program, which went into effect in 1999 in the northeast states and 2001 nationwide. The NLEV program is transitioning to the Tier 2 program over the 2004-2007 period.

Study Purpose: To compare the emissions benefits of adopting LEV-II beginning in 2006, vs. continuing to follow Federal Tier 2 standards.

Pollutants Analyzed: NMHC, air toxics. Commentary also provided on PM and GHG.

Vehicle Types Analyzed: Passenger cars and light trucks less than 8,500 lbs. GVWR (LDV, LDT1, LDT2, LDT3, LDT4)

Evaluation Years: 2020

Methodology: Uses relative emission reductions estimated by CS for the Massachusetts Department of Environmental Protection (a 1999 analysis that used EPA's older Tier 2 and MOBILE5b models, instead of MOBILE6), and applies them to NH and NJ vehicle-miles of travel and baseline emissions rates.

Key Assumptions: Evaluated baseline ZEV implementation scenario, using California's sales mix assumptions.

Findings: (Emission reductions of LEV-II vs. Tier 2, 2020)

- NMHC - 20%
- Air toxics – 23%

Documentation: *Clean Cars, Cleaner Air…* NHPIRG Education Fund, April 2002; *Clean Cars, Cleaner Air*, NJPIRG Law and Policy Center, May 2002

Analysts and Sponsors: Analysis conducted/sponsored by NJPIRG and NHPIRG.

Contacts: Tony Dutzik, NJPIRG

New York State Department of Environmental Conservation (2000)

States Evaluated: New York

Program Background: New York originally adopted the California LEV-I emissions standards beginning in the mid-1990s, and has continued to implement the LEV-I and subsequent LEV-II standards, including the ZEV component.

Study Purpose: To compare four scenarios: LEV I/LEV II (as implemented), LEV I with transition to Tier 2, NLEV with transition to LEV II, and NLEV with transition to Tier 2.

Pollutants Analyzed: VOC, NOx.

Vehicle Types Analyzed: Passenger cars and light trucks less than 8,500 lbs. GVWR (LDV, LDT1, LDT2, LDT3, LDT4)

Evaluation Years: 2001 - 2020

Methodology: Uses EPA's MOBILE5b, with user-input emission rates.

Key Assumptions: Emission rates for LEV II vehicles (baseline and deterioration) are adjusted proportional to differences in exhaust standards. Modeling did not account for electric vehicles or for differences in evaporative emissions.

Findings: Graphs show significant emissions benefits of continued implementation of LEV I/LEV II program, compared to NLEV/Tier 2 baseline. The largest benefits (both absolute and percentage-wise) are in the mid-years (2005-2015), with the difference between the programs decreasing towards 2020. (Results shown in charts - exact numbers not available.) The largest percentage emissions benefits are in the LDGT3/4 vehicle category.

Documentation: PDF slides (June 2000) and MOBILE5b input and output files.

Analysts and Sponsors: New York Department of Environmental Conservation (NYDEC).

Contacts: Mike Keenan, NYDEC

Alliance of Automobile Manufacturers - Various States and Dates

<u>States Evaluated</u>: Vermont (March 2004) – Documentation available. Analysis also conducted in New York (February 2004), Connecticut (2003), New Jersey (year unknown), and possibly other states; detailed documentation unavailable but overall results similar.

<u>Study Purpose</u>: To compare the emissions benefits of continuing to follow LEV-II, vs. switching over to Federal Tier 2 standards in 2007 (VT, NY); to compare emissions benefits of adopting LEV-II, vs. continuing with Federal NLEV/Tier 2 standards (NJ, CT)

<u>Pollutants Analyzed:</u> VOC, NOx

<u>Vehicle Types Analyzed</u>: Passenger cars and light trucks less than 8,500 lbs. GVWR (LDV, LDT1, LDT2, LDT3, LDT4)

<u>Evaluation Years</u>: 2004 – 2020 (summary memo only reports 2007 – 2012 results for VT, but spreadsheets provide detail through 2020)

<u>Methodology</u>: Followed EPA modeling guidelines for LEV-II and Tier 2 programs, which does not assume evaporative emissions benefits of LEV-II and assumes a wider range of vehicle distribution across bins than the NESCAUM and CFE studies.

<u>Key Assumptions</u>: Examined California program with and without ZEV mandate.

<u>Findings</u>: (Percent reduction in emissions, LEV-II vs. Tier 2)

	LEV-II with ZEV		**LEV-II without ZEV**	
Pollutant	**2012**	**2020**	**2012**	**2020**
VOC	1.0%	4.1%	1.0%	3.8%
NOx	1.1%	5.5%	1.1%	5.5%

<u>Documentation</u>: "Emissions comparison between the Federal and California motor vehicle programs in Vermont." Memorandum from Jeremy Heiken, Air Improvement Resource, Inc., to Greg Dana, Alliance of Automobile Manufacturers, March 30, 2004.

Some MOBILE input files and summary results (Excel charts) are available from other states.

<u>Analysts and Sponsors</u>: Analysis conducted by Air Improvement Resource, Inc. (AIR) for Alliance of Automobile Manufacturers (AAM)

<u>Contacts</u>: Greg Dana, AAM; Jeremy Heiken, AIR

Appendix B

Model Year Distribution Comparison
(MOBILE6 input format)

CT	LDV	0.077	0.072	0.072	0.065	0.076	0.063	0.064	0.057	0.054	0.057
		0.060	0.057	0.052	0.040	0.028	0.019	0.011	0.007	0.006	0.007
		0.007	0.004	0.004	0.003	0.036					
Harris	LDV	0.076	0.093	0.093	0.080	0.075	0.071	0.064	0.069	0.056	0.053
		0.046	0.043	0.038	0.031	0.025	0.018	0.015	0.013	0.010	0.006
		0.004	0.003	0.002	0.003	0.014					
Dallas	LDV	0.077	0.099	0.085	0.076	0.073	0.067	0.078	0.063	0.058	0.050
		0.047	0.043	0.037	0.030	0.025	0.021	0.017	0.013	0.008	0.005
		0.004	0.003	0.004	0.003	0.016					
CT	LDT1	0.090	0.099	0.095	0.085	0.086	0.081	0.063	0.046	0.043	0.040
		0.050	0.055	0.046	0.035	0.023	0.015	0.008	0.006	0.005	0.002
		0.003	0.012	0.002	0.001	0.007					
Harris	LDT1	0.090	0.099	0.089	0.079	0.076	0.074	0.054	0.061	0.060	0.049
		0.040	0.034	0.029	0.028	0.023	0.017	0.016	0.015	0.013	0.007
		0.009	0.007	0.003	0.005	0.021					
Dallas	LDT1	0.082	0.092	0.077	0.074	0.076	0.056	0.066	0.067	0.051	0.043
		0.040	0.034	0.034	0.030	0.022	0.026	0.022	0.019	0.012	0.011
		0.009	0.005	0.008	0.007	0.037					
CT	LDT2	0.090	0.099	0.095	0.085	0.086	0.081	0.063	0.046	0.043	0.040
		0.050	0.055	0.046	0.035	0.023	0.015	0.008	0.006	0.005	0.002
		0.003	0.012	0.002	0.001	0.007					
Harris	LDT2	0.090	0.099	0.089	0.079	0.076	0.074	0.054	0.061	0.060	0.049
		0.040	0.034	0.029	0.028	0.023	0.017	0.016	0.015	0.013	0.007

		0.009	0.007	0.003	0.005	0.021					
Dallas	LDT2	0.082	0.092	0.077	0.074	0.076	0.056	0.066	0.067	0.051	0.043
		0.040	0.034	0.034	0.030	0.022	0.026	0.022	0.019	0.012	0.011
		0.009	0.005	0.008	0.007	0.037					
CT	LDT3	0.122	0.090	0.087	0.069	0.090	0.076	0.049	0.034	0.025	0.036
		0.054	0.062	0.044	0.040	0.031	0.022	0.015	0.009	0.005	0.005
		0.012	0.019	0.002	0.001	0.001					
Harris	LDT3	0.147	0.182	0.127	0.146	0.058	0.074	0.048	0.047	0.029	0.026
		0.019	0.015	0.012	0.012	0.009	0.005	0.007	0.007	0.007	0.004
		0.004	0.002	0.002	0.003	0.008					
Dallas	LDT3	0.171	0.149	0.172	0.067	0.084	0.055	0.057	0.035	0.030	0.022
		0.017	0.015	0.015	0.015	0.009	0.013	0.014	0.012	0.007	0.006
		0.004	0.004	0.007	0.005	0.016					
CT	LDT4	0.122	0.090	0.087	0.069	0.090	0.076	0.049	0.034	0.025	0.036
		0.054	0.062	0.044	0.040	0.031	0.022	0.015	0.009	0.005	0.005
		0.012	0.019	0.002	0.001	0.001					
Harris	LDT4	0.147	0.182	0.127	0.146	0.058	0.074	0.048	0.047	0.029	0.026
		0.019	0.015	0.012	0.012	0.009	0.005	0.007	0.007	0.007	0.004
		0.004	0.002	0.002	0.003	0.008					
Dallas	LDT4	0.171	0.149	0.172	0.067	0.084	0.055	0.057	0.035	0.030	0.022
		0.017	0.015	0.015	0.015	0.009	0.013	0.014	0.012	0.007	0.006
		0.004	0.004	0.007	0.005	0.016					