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Minimum Sound Requirements for Hybrid And Electric Vehicles

Final Environmental Assessment

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LIST OF ACRONYMS AND ABBREVIATIONS

AEO	Annual Energy Outlook
ANSI	American National Standards Institute
CAFE	Corporate Average Fuel Economy
CFR	Code of Federal Regulations
CEQ	Council on Environmental Quality
dB	decibel
dB(A)	decibel, A-weighted
DOT	U.S. Department of Transportation
EA	Environmental Assessment
EIA	Energy Information Administration
EPA	U.S. Environmental Protection Agency
EV	electric vehicle
FHWA	Federal Highway Administration
FMVSS	Federal Motor Vehicle Safety Standard
FRIA	Final Regulatory Impact Analysis
HV	hybrid vehicle
Hz	hertz
ICE	internal combustion engine
IRR	Indian Reservation Road
ISO	International Organization for Standardization
km/h	kilometers per hour
L_{dn}	day-night sound level
LDV	light-duty vehicle
L_{eq}	sound energy averaged over a 24-hour period
MHEV	micro hybrid electric vehicle
mph	miles per hour
MY	model year
NCSA	National Center for Statistics and Analysis
NEPA	National Environmental Policy Act
NHTS	National Household Travel Survey
NHTSA	National Highway Traffic Safety Administration
NPRM	Notice of Proposed Rulemaking
NPS	National Park Service
NOI	Notice of Intent
NYC	New York City
OICA	Organisation Internationale des Constructeurs d'Automobiles (International Organization of Motor Vehicle Manufacturers)
PRIA	Preliminary Regulatory Impact Analysis
PSEA	Pedestrian Safety Enhancement Act
SAE	Society of Automotive Engineers
SPL	sound pressure level
TTI	Travel Time Index
U.S.C.	United States Code
VMT	vehicle miles traveled

GLOSSARY OF SELECTED TERMS

Acoustic pressure: A pressure variation from the mean pressure of a given medium, such as the atmosphere or water, caused by a sound wave.

Ambient sound (also called ambient noise or background noise): Relating to the immediate environment or surroundings. In an acoustic measurement, after the main sound being studied is suppressed or removed, this is the remaining sum of sounds taken from the environment.

Amplitude: The value of sound pressure at a given time.

Attenuation: A decrease in sound intensity due to absorption or damping of noise.

A-weighting: A filter that attenuates low and high frequencies and amplifies some mid-range frequencies to approximate the human perception of sound.

Bandwidth: A range of frequencies. For example, a speaker may have an effective bandwidth from 150 to 5000 Hz. Alternatively, bandwidth is the minimum frequency subtracted from the maximum frequency. For the above example, this would be 5000 – 150 or 4850 Hz.

Band pressure level: The pressure level of a sound wholly contained within a particular frequency band.

Band sum: The combination of sound pressure levels from selected bands that produce an SPL representing the sound in all of these bands.

Broadband: A sound with a spectrum that covers a broad range of frequencies.

Crossover speed: The speed at which tire noise, wind resistance, or other factors eliminate the need for a separate alert sound.

Decibel: The logarithmic scale, defined as 10 times the logarithm of the ratio of a physical quantity to a standard reference value, used to express sound pressure measurements.

Electric vehicle: A vehicle that uses a battery system to provide power, therefore reducing or even eliminating liquid fuel consumption during vehicle operation. The term "electric vehicle" covers a range of different vehicle types, including battery electric vehicles, hybrid electric vehicles, and plug-in hybrid electric vehicles.

Equal loudness principle: To be perceived by a person as equally loud, a lower (20 to 320 Hz) or higher frequency (5000 to 20,000 Hz) sound must be of greater intensity than a mid-range frequency (approximately 320 to 5120 Hz) sound.

Filter: A system that selectively passes some elements and attenuates others as a function of frequency.

Frequency: Number of times a particle in a medium contracts and expands (cycles) per unit of time. Typically expressed in hertz; one cycle per second is equal to 1 Hz. Humans can detect sound waves with a wide range of frequencies, nominally ranging between 20 and 20,000 Hz.

Frequency response: The response of a system to an input as a function of frequency.

Hertz: One cycle per second. The unit of measurement associated with frequency.

Hybrid electric vehicle: Type of electric vehicle that incorporates a battery and electric motor system coupled with an internal combustion engine.

Hybrid vehicle: A vehicle with an internal combustion engine and one of several possible alternate sources of propulsion, such as hydraulics or electric battery.

Light-duty vehicles: Vehicles having a gross vehicle weight rating of 8,500 pounds or less, including light trucks, passenger cars, motorcycles, and low speed vehicles.

Line Source: A sound source that geometrically forms a line and radiates sound cylindrically. One example is roadway noise; another is a stack of speakers at a concert. Line sources attenuate by a factor of two (that is, by 3 dB) per doubling of distance from the source.

Longitudinal wave: Wave moving in the same direction as it is being propagated. Sound waves are longitudinal.

Loudness: Subjective attribute of an auditory sensation that humans can use to judge sound volume.

Masking: Phenomenon when the perception of a sound is diminished by the presence of another sound.

Micro-hybrid/mild hybrid: A hybrid vehicle with an electric motor that only operates concurrently with the internal combustion engine to provide additional propulsion. This may also include hybrid vehicles with an electric motor that is used only during automatic shut-off of the internal combustion engine when in a stationary position ("idle-stop" technology).

Motor vehicle: A vehicle driven or drawn by mechanical power and manufactured primarily for use on public streets, roads, and highways, but does not include a vehicle operated only on a rail line. Conventional motor vehicles are vehicles powered by a gasoline, diesel, or alternative fueled internal combustion engine as its sole means of propulsion.

Noise: Sound waves perceived as undesirable sound.

Octave (also called octave band): Interval between two frequencies that have a ratio of 2:1. For example, if the first octave is 20 to 40 Hz, the next octave is 40 to 80 Hz, the next is 80 to 160 Hz, etc. The range of human hearing covers approximately 10 octaves.

One-third octave band: Frequency band that is one-third of an octave band whose upper frequency is $2^{1/3}$ times its lower frequency, as defined by their half-power points. For example, a one-third octave band centered at 1000 Hz has upper and lower cutoff frequencies at about 890 and 1120 Hz and a bandwidth of 230 Hz. A one-third octave band centered at 4000 Hz has upper and lower cutoff frequencies at about 3560 and 4490 Hz and a bandwidth of 930 Hz.

Pascal: Unit used to measure pressure; standard atmospheric pressure at sea level is 101,325 Pa.

Pedalcyclist: A road user traveling on a bicycle, defined as a non-motorized vehicle with at least two wheels and pedals or hand-cranks, designed to carry one or several persons.

Period: The time interval during which successive occurrences of a recurring or cyclic phenomenon occur. The reciprocal of frequency.

Pitch: Attribute of an auditory sensation that humans can use to order sounds on a musical scale from low to high, based primarily on their frequency. A high-pitch sound corresponds to a high-frequency sound wave. A low-pitch sound corresponds to a low-frequency sound wave. Pitch itself is a subjective perception of frequency and therefore is not associated with a unit.

Pitch strength: Perception of how prominent a pitch seems to be according to a listener. Two sounds with equal frequencies can be perceived to have different strengths.

Plug-in hybrid electric vehicle: A hybrid vehicle with a large capacity rechargeable battery that can be recharged by plugging into the electricity grid as well as by using the on-board charging capabilities of normal hybrids (e.g., regenerative braking). Like other hybrid electric vehicles, a plug-in hybrid also uses an internal combustion engine as a backup when battery life is depleted.

Point source: A sound source whose dimensions are sufficiently small that it can be treated as a point from which sound radiates uniformly in all directions. Point sources attenuate by a factor of four (or by 6 dB) for each doubling of distance from the source to the listener.

Power: A measure of energy supplied or consumed per unit of time, usually expressed in watts (W). A sound with a power of only one-trillionth of one W can be audible in an otherwise quiet environment. A jackhammer has an acoustic power output of about 1 W.

Propagation: The advancement of a sound wave in a particular direction traveling through a medium.

Quiet: Causing little to no noise perceptible to humans.

Recognizability: Requirement that added sound under the action alternatives must include acoustic characteristics common to all vehicles in operation that make those vehicles recognizable as motor vehicles in operation based on the public's experience and expectations.

Reflection: A change in the direction of propagation of a wave due to a boundary, such as pavement.

Sound intensity: The sound power passing through an area in a sound field, expressed as Watts per square meter.

Sound pressure level: Level of a sound relative to a reference pressure and measured in decibels.

$$\mathrm{SPL} = 10 \log_{10}(P^2/P_{ref}^2)$$

where P is the root mean square of the acoustic pressure and P_{ref} is equal to 20 microPascals (μPa) for air. Examples of A-weighted sound pressure levels include: threshold of human hearing (0 dB[A]), quiet office (40 dB[A]), noisy restaurant (70 dB[A]), rock concert (110 dB[A]), pain (140 dB[A])

Unweighted spectrum: A spectrum recorded with uniform amplification at all frequencies. In contrast, many spectra are recorded after the signal is processed through filters that approximate the variation in sensitivity with frequency that occurs in human hearing (e.g., the A-weighted filter).

EXECUTIVE SUMMARY

Introduction

The National Highway Traffic Safety Administration has prepared this Final Environmental Assessment to analyze the potential environmental impacts of its rulemaking to implement the Pedestrian Safety Enhancement Act of 2010. In this Final EA, NHTSA discusses the purpose and need for the rulemaking, outlines a reasonable range of alternatives, and analyzes the potential environmental impacts of the action and alternatives.

Under the PSEA, NHTSA is required to issue a performance standard for electric vehicles and hybrid vehicles, which tend to be quieter than internal combustion engine vehicles, to ensure that they emit an alert sound that meets certain minimum requirements in order to aid visually impaired and other pedestrians in detecting vehicle presence, direction, location, and operation. EVs/HVs pose greater potential risks to pedestrians while operating under electric propulsion at slow speeds, when tire and wind noise are less dominant. The PSEA mandates that the new performance requirement enable a pedestrian to reasonably detect a nearby EV or HV operating at constant speed, accelerating, decelerating, and operating in any other scenarios that NHTSA deems appropriate. Under the PSEA, the added sound must also be "recognizable" as that of a motor vehicle in operation. NHTSA's Final Rule is projected to reduce the number of incidents in which EVs/HVs strike pedestrians.

Description of Alternatives

In this EA, NHTSA analyzes the environmental impacts associated with three alternative actions. Alternative 1 is the No Action Alternative, under which NHTSA would not establish any regulatory sound requirements for EVs/HVs. The National Environmental Policy Act requires agencies to consider a "no action" alternative as a baseline against which to compare the environmental effects of reasonable alternative actions. Since the PSEA directs NHTSA to issue a Federal Motor Vehicle Safety Standard that would establish minimum sound requirements for EVs/HVs, the statute does not permit NHTSA to adopt Alternative 1.

Alternatives 2 and 3 present different approaches to implementation of a minimum sound requirement. Both action alternatives under consideration allow manufacturers flexibility in meeting this requirement. Alternative 2, NHTSA's Preferred Alternative (and the Final Rule), contains acoustic elements designed to enhance vehicle detection and recognition of the sound as that of a motor vehicle. It establishes minimum sound requirements for EVs/HVs when stationary (in gear) through 30 kilometers per hour, as well as when in reverse. Alternative 2 includes two approaches for manufacturer compliance: a four-band option and a two-band option. Alternative 3 also contains acoustic elements for enhanced vehicle detection, but with several differences from the Preferred Alternative: no minimum sound is required when stationary or above 20 km/h; fewer one-third octave bands are specified; and the overall resulting minimum sound level is lower. A summary comparison is provided in Table ES-1, indicating key differences among the three alternatives considered in this EA.

Table ES-1: Comparison of Alternatives Considered in This EA

Sound Parameters	**Alternative 1 (No Action)**	**Alternative 2 (Preferred Alternative)**	**Alternative 3**
Min. Sound Required	No	Yes	Yes
Applicable Speed	N/A	Stationary to 30 km/h, reverse	> 0 to 20 km/h, reverse
Broadband Low Frequency Sounds	N/A	N/A	N/A
One-Third Octave Bands	N/A	Minimum sound pressure levels for four non-adjacent band sets between 315 and 5000 Hz, or alternative two-band with overall requirement.	At least two with SPL of 44 dB(A). One band each in the ranges of 150-3000 and 500-3000 Hz.
Acceleration and Deceleration	N/A	Relative volume change – increase of 3 dB per 10 km/h increase in speed.	15 percent monotonic frequency shift between 5 and 20 km/h.
Total Minimum Sound Level Anticipated to Result from the Individual Minimum Sound Requirements	N/A	For Four-Band Alert: Stationary – 47-50 dB(A) Reverse – 50-53 dB(A) 10 km/h – 53-56 dB(A) 20 km/h – 59-62 dB(A) 30 km/h – 63-67 dB(A) For Two-Band Alert: Stationary – 48 dB(A) Reverse – 52 dB(A) 10 km/h – 55 dB(A) 20 km/h – 61 dB(A) 30 km/h – 66 dB(A)	48 dB(A)
Anticipated Manufacturer Exceedance of Requirement to Ensure Compliance	N/A	4 dB	N/A

In this EA, the Preferred Alternative reflects one of two different compliance specifications that manufacturers may select under NHTSA's Final Rule. Specifically, it reflects NHTSA's four-band compliance requirement. The Final Rule also includes a two-band compliance requirement that manufacturers may select at their option. The overall sound levels associated with the two-band requirement are less than or equal to those of the four-band requirement. Consequently, any change in environmental noise resulting from selection of the two-band requirement is expected to be equal to or less than the environmental noise resulting from selection of the four-band approach. This EA does not conduct a separate analysis of the NHTSA two-band compliance specification, but instead takes the more conservative approach of basing the Preferred Alternative analysis on the four-band compliance specification.

Affected Environment and Environmental Consequences

This EA describes the current and projected environmental conditions relevant to the deployment of a minimum sound emission requirement for EVs/HVs. This EA discusses, for each of the three alternatives analyzed, anticipated environmental impacts and cumulative impacts. Impacts are examined for both urban and non-urban areas, reflecting the differences in vehicle density, deployment of EVs/HVs, travel speeds, and the overall sound level in these two environments. For the purposes of this EA, “non-urban” areas are equivalent to areas designated as “rural” areas by the U.S. Census. Due to their predominantly non-urban nature, National Parks and tribal lands are considered to be “non-urban” areas for purposes of this analysis.

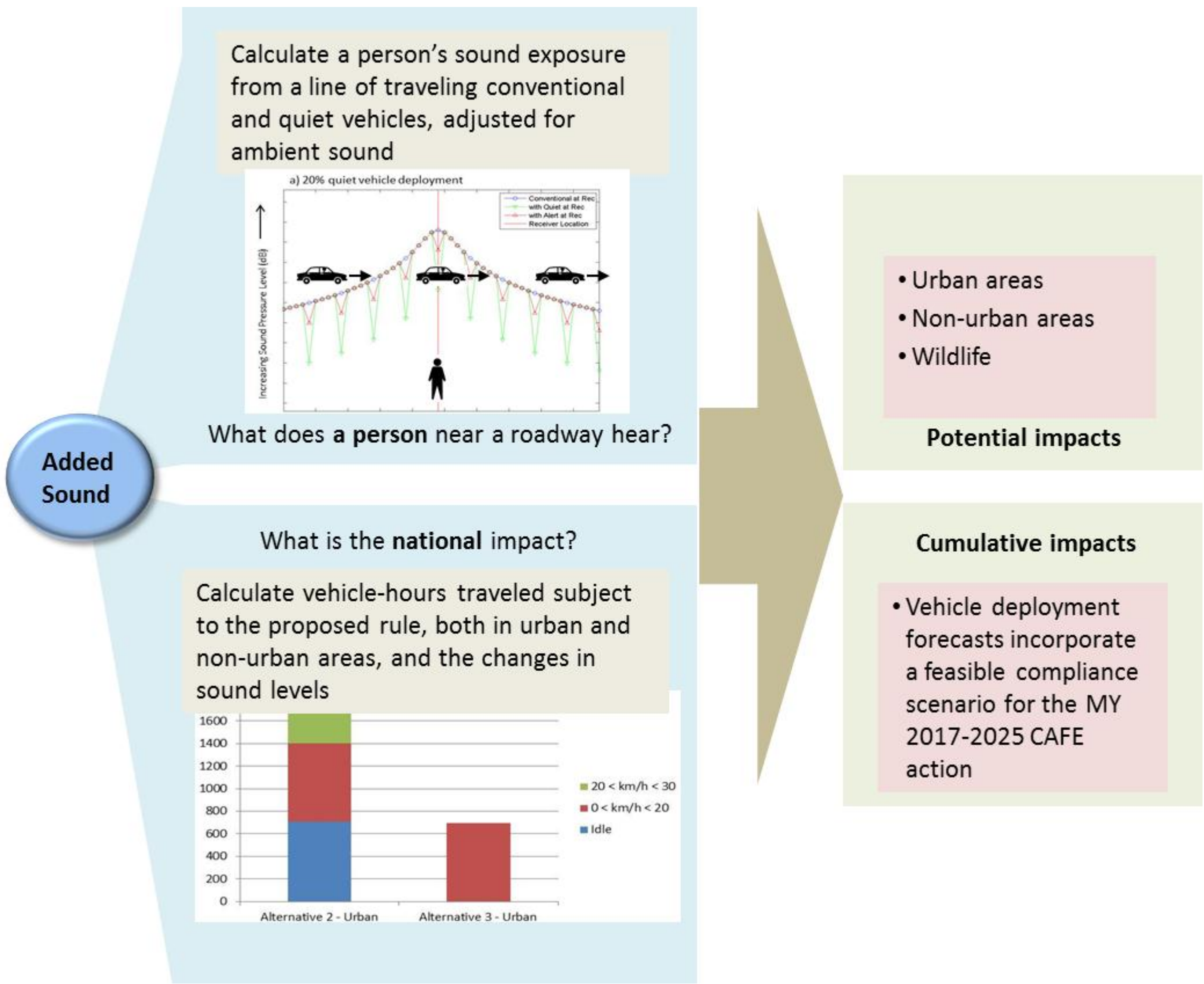
As depicted in Figure ES–1, this EA uses two different methodologies for calculating the potential noise impacts of the alternatives on the environment. For the first analysis, NHTSA analyzed the potential change in sound levels as a result of the final regulatory alternatives as they would be experienced by an individual listener standing either 7.5 or 15 meters (25 or 50 feet, respectively) from a roadway. This analysis is based on the noise modeling of average vehicle traffic conditions (saturation traffic flow, where multiple vehicles are passing the listener in rapid succession). For various percentages of EV/HV deployment, NHTSA compared sound levels when these vehicles were assumed to have no minimum sound requirement versus when producing the sound level specified under each of the action alternatives. NHTSA also conducted this analysis assuming a single EV/HV passing the listener with or without the minimum sound level required under each alternative.

The results from the saturation model show that changes in overall sound levels near a busy roadway for either action alternative compared to the No Action Alternative would not exceed 3 dB, the commonly used threshold for noticeability by human listeners, even assuming that up to 20 percent of vehicles on the road are EVs/HVs, which is nearly three times the deployment level currently projected for 2035. When non-urban or urban ambient sound levels are taken into account, the perceived sound level change is further reduced to well under the 3 dB threshold.

Single vehicle pass-by analyses for both action alternatives suggest that in urban environments, no noticeable difference would be perceived by a listener 7.5 meters from the roadway compared to the No Action Alternative. In a non-urban environment, no noticeable difference would be experienced by a listener under Alternative 3, but the change in sound level in the single-vehicle pass-by scenario under the Preferred Alternative compared to the No Action Alternative would be 3.5 to 6.6 dB depending on vehicle speed, or 10.4 dB when stationary, at a distance of 7.5

meters from the source, a noticeable increase. However, this change in sound level would be comparable to the existing variation in the sound levels among different ICE vehicles, and the perceived sound level would still be lower than that of an average ICE vehicle.

Figure ES–1: Schematic of Noise Analyses Performed for This EA



For the second analysis in this EA, NHTSA computed the magnitude of the change in sound levels nationally as a result of the alternatives. This analysis takes into account the National Household Travel Survey distribution of trip miles, the Annual Energy Outlook forecast of the deployment of EVs/HVs, and Environmental Protection Agency drive cycle speed distributions. Because the action alternatives would only affect specific vehicles in certain operating conditions, this analysis calculates the total U.S. vehicle operations affected by the action alternatives as a proportion of total U.S. vehicle operations, and analyzes the overall change in sound levels projected to occur as a result of the action alternatives.

Based on this analysis of national impacts, NHTSA projects that under the Preferred Alternative, 2.3 percent of all urban U.S. light-duty vehicle hours traveled and 0.3 percent of all non-urban U.S. light-duty vehicle hours traveled would be impacted by the minimum sound requirement.

Under Alternative 3, NHTSA projects that 0.9 percent of all urban U.S. light-duty vehicle hours and 0.1 percent of all non-urban U.S. light-duty vehicle hours would be impacted by the minimum sound requirement.

In addition to the two quantitative analyses described above, NHTSA also qualitatively analyzed the potential environmental impacts of the action alternatives on wildlife. There are no established noise thresholds for wildlife because species vary widely in ability to tolerate noise and can exhibit very different responses to changes in noise levels. Wildlife is present in both non-urban and urban areas, and, therefore, has likely already adapted to current sound levels, allowing wildlife to continue to inhabit these areas in the presence of noise associated with these environments. Under either action alternative, sound levels would be very similar to the No Action Alternative, and overall vehicle sounds would be slightly lower than those of existing ICE vehicles; therefore, neither action alternative is likely to adversely impact wildlife.

This EA also considers the potential cumulative impacts of the action alternatives by taking into account the potential increase in deployment of EVs/HVs that could occur in future years in response to NHTSA's separate action regarding fuel economy standards for model year 2017-2025 light-duty vehicles. Taking into account these cumulative impacts, NHTSA projects slightly higher percentages of vehicle hours potentially would be impacted by a minimum sound requirement than under the direct and indirect impacts analysis. Specifically, NHTSA projects that under the Preferred Alternative, 3.3 percent of all urban U.S. light-duty vehicle hours and 0.4 percent of all non-urban U.S. light-duty vehicle hours would be impacted by the minimum sound requirement. Under Alternative 3, NHTSA projects that 1.3 percent of all urban U.S. light-duty vehicle hours and 0.14 percent of all non-urban U.S. light-duty vehicle hours would be impacted by the minimum sound requirement.

In summary, under the Preferred Alternative, noise impacts are anticipated to not be noticeable to humans, with the exception that in non-urban environments, single-vehicle pass-by events would be noticeable to humans at a distance of 7.5 meters from the source. In these infrequent occurrences, the anticipated noise levels would be below average ICE vehicle sound levels, and the perceived change would be comparable to existing ICE vehicle sound variation. Under Alternative 3, no noticeable impacts are anticipated due to the small sound level changes and the low percentage of vehicle hours of operation that potentially would be impacted by the minimum sound requirement.

1 PURPOSE OF AND NEED FOR ACTION

1.1 Introduction

The National Highway Traffic Safety Administration has prepared this Final Environmental Assessment in accordance with the National Environmental Policy Act of 1969, the Council on Environmental Quality's regulations implementing NEPA, Department of Transportation Order 5610.1C, and NHTSA regulations[1] to analyze the potential environmental impacts of its rulemaking to implement the Pedestrian Safety Enhancement Act of 2010.[2] The PSEA mandates that NHTSA conduct a rulemaking to establish a performance standard requiring electric vehicles and hybrid vehicles, which tend to be quieter than internal combustion engine vehicles, to emit an alert sound that meets certain minimum requirements in order to aid visually impaired and other pedestrians in detecting vehicle presence, direction, location, and operation.

This Final EA and NHTSA's Final Regulatory Impact Analysis both inform NHTSA's decision-making and regulatory process, resulting in the Final Rule that is being issued together with these documents. The Final Rule and FRIA include a summary of the research indicating the safety need for the action, a summary of the acoustic and human testing research performed to evaluate regulatory alternatives, the details of the minimum sound NHSTA is requiring, an analysis of the costs and benefits associated with the rulemaking, and a summary of comments received on the Notice of Proposed Rulemaking along with responses to those comments. Those documents are hereby incorporated by reference.

This Final EA discusses the purpose and need for the rulemaking, outlines a reasonable range of alternative actions NHTSA considered adopting (including a preferred alternative), and analyzes the potential environmental impacts of the action and alternatives.

1.2 Background

1.2.1 Identification of the Issues and Research

NHTSA began collaborating with a working group within the Society of Automotive Engineers International (which included representatives from the Alliance of Automobile Manufacturers, Global Automakers, and the visually impaired community) in August 2007 to identify effective ways to address the safety issue of quiet EVs/HVs. On May 30, 2008, NHTSA published a notice in the Federal Register[3] announcing a public meeting on June 23, 2008, to bring together government policymakers, stakeholders from the visually impaired community, industry representatives, and public interest groups to discuss the technical and safety policy issues

[1] NEPA is codified at 42 U.S.C. §§ 4321-4347, CEQ's implementing regulations are codified at 40 CFR Parts 1500–1508, and NHTSA's regulations are codified at 49 CFR Part 520.
[2] Pub. L. No. 111-373, 124 Stat. 4086 (2011).
[3] Quiet Cars Notice of Public Meeting and Request for Comments, 73 FR 31187 (May 30, 2008).

associated with hybrid vehicles, all-electric vehicles, and quiet internal combustion engine vehicles, and the possible risks from these vehicles for pedestrians and bicyclists (NHTSA, 2008a, 2008b). In April 2009, NHTSA issued a research plan to investigate EVs/HVs and pedestrian safety (NHTSA, 2009a)

In October 2009, NHTSA issued a report, *Research on Quieter Cars and the Safety of Blind Pedestrians, A Report to Congress* (NHTSA, 2009b). The report briefly discussed the issue of vehicle noise and implications for pedestrians, how NHTSA's research plan would address the issue, and NHTSA's progress on implementing the research plan. Separately, in an effort to evaluate the problem of EV and HV crashes with pedestrians, NHTSA examined the incidence rates for crashes involving hybrid-electric vehicles and pedestrians under different circumstances, using data from 12 States, and compared the results to those for ICE vehicles (Hanna, 2009). This study, while based on a relatively small sample size, found an increased rate of accidents involving pedestrians with hybrid-electric vehicles compared to their peer ICE vehicles.

From 2010 to 2014, NHTSA continued relevant quiet car research as discussed in the Final Rule preamble and summarized here. NHTSA issued a research report in April 2010 documenting the overall sound levels and general spectral content (i.e., the characteristics of the sound such as frequency, phase, and amplitude values of the sound) for a selection of hybrid-electric and ICE vehicles in different operating conditions (Garay-Vega, Hastings, Pollard, Stearns, & Michael, 2010). The report also evaluated vehicle detectability for two background (or ambient) noise levels and considered vehicle-based, infrastructure-based, and vehicle-pedestrian communications-based countermeasure concepts. The report discussed a wide range of potential candidate countermeasures in terms of types of information provided to pedestrians, warning time, user acceptability, and barriers to implementation. In addition to providing baseline data on the acoustic characteristics and auditory detectability of a vehicle when a single vehicle is tested at a time, the report's findings included the following:

- Overall sound levels for the hybrid-electric vehicles tested were lower at low speeds than for the internal combustion engine vehicles tested.
- Human subjects demonstrated significant differences in response times to hybrid electric and ICE vehicles when operating at 10 km/h, braking, and backing up, for both lower and higher levels of ambient sound.

These findings were updated in an October 2011 report by NHTSA's National Center for Statistics and Analysis that included additional years of State crash file data as well as data from additional States (Wu, Austin, & Chen, 2011). Further corroboration is provided by an NCSA Research Note from 2015 using larger sample sizes (Wu, 2015).

In October 2011, NHTSA also released a second report examining issues involving EVs/HVs and blind pedestrians (Hastings, Pollard, Garay-Vega, Stearns, & Guthy, 2011). The Phase 2 research developed various methods to specify a sound to be used as a vehicle-based audible alert signal that could be used to provide information at least equivalent to the cues provided by ICE vehicles, including speed change, and evaluated sounds using human factors testing to examine whether the sounds could be tested and recognized as vehicle sounds. In its Phase 3 research, NHTSA sought to develop an objective, repeatable test procedure and objective specifications for minimum sound requirements.

After the NPRM was issued, NHTSA conducted research to examine additional aspects of minimum sound requirements for EVs/HVs. The research involved human factors testing and acoustic modeling to examine the detectability of sounds with different acoustic characteristics. The research also involved acoustic measurement of heavy-duty vehicles and motorcycles, analysis of indoor testing conducted by Transport Canada, and additional light vehicle testing to refine the test procedure proposed in the NPRM. The research is documented in multiple separate research reports, which are cited and summarized in the preamble to the Final Rule. That discussion is incorporated here by reference.

NHTSA has included in the rulemaking docket the FRIA prepared by NCSA that thoroughly analyzes the projected costs and benefits of the Final Rule (NHTSA, 2016). The FRIA estimates the number and severity of pedestrian and pedalcyclist injuries that would be avoided based on existing data about the frequency and severity of crashes between vehicles and pedestrians and pedalcyclists. The FRIA updates the Preliminary Regulatory Impact Analysis (NHTSA, 2013), which was released with the NPRM, and it is incorporated here by reference.

1.2.2 The Pedestrian Safety Enhancement Act of 2010

The PSEA directs NHTSA[4] to conduct a rulemaking to establish a Federal Motor Vehicle Safety Standard mandating a minimum sound requirement for all types of motor vehicles[5] that are EVs[6] or HVs[7] that would allow pedestrians to detect and recognize those vehicles. The Final Rule only applies to hybrid and electric passenger cars, light trucks, and vans with a GVWR of 4,536 kg (10,000 pounds) or less and low speed vehicles. The Final Rule does not apply to medium and heavy duty trucks and buses with a GVWR over 4,536 kg (10,000 pounds) or to motorcycles.

[4] NHTSA is delegated authority by the Secretary of Transportation to implement 49 U.S.C. chapter 301 (including the authority to issue Federal Motor Vehicle Safety Standards) and the PSEA. *See* 49 CFR §§ 1.95(a), (o) and 501.2.
[5] Under section 2(4) of the PSEA, "motor vehicle" has the same meaning as in 49 U.S.C. § 30102(a)(6), except that under the PSEA, the term does not include a trailer (as defined in 49 CFR § 571.3). Under 49 U.S.C. § 30102(a)(6), "motor vehicle" means "a vehicle driven or drawn by mechanical power and manufactured primarily for use on public streets, roads, and highways, but does not include a vehicle operated only on a rail line."
[6] Section 2(10) of the PSEA defines "electric vehicle" as "a motor vehicle with an electric motor as its sole means of propulsion."
[7] Section 2(9) of the PSEA defines "hybrid vehicle" as "a motor vehicle which has more than one means of propulsion." As a practical matter, this term is essentially synonymous with "hybrid electric vehicle."

While the PSEA applies to motorcycles and to medium and heavy duty trucks and buses, consideration of these vehicles in the Final Rule has been postponed due to the need for further evaluation.[8]

Under the PSEA, NHTSA must provide a phase-in period; however, full compliance with the standard must be achieved for all vehicles manufactured on or after September 1 of the calendar year beginning 3 years after the date of publication of the Final Rule. Based on comments received to the NPRM, NHTSA is adopting a 1-year, 50-percent phase-in. Under this phase-in, 50 percent of the total production volume of each manufacturer's EVs/HVs to which the safety standard applies, and which are produced by the manufacturer for sale in the United States, must comply by no later than September 1 one year prior to the full compliance date.[9] This phase-in does not apply to multi-stage and small volume manufacturers, who have until the full compliance date to comply.

Under the PSEA, EVs/HVs must emit an "alert sound," which is defined as a vehicle-emitted sound that enables pedestrians to discern the presence, direction,[10] location, and operation of the vehicle.[11] The PSEA specifies several performance requirements for a minimum sound that would enable visually impaired and other pedestrians to reasonably detect EVs/HVs operating below their crossover speed,[12] including the following:

- It must be sufficient to allow a pedestrian to reasonably detect a nearby EV or HV operating at constant speed, accelerating, decelerating, and operating in any other scenarios that NHTSA deems appropriate.[13]

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[8] The Final Rule applies to EVs/HVs that have a GVWR of 10,000 pounds or less and low speed vehicles. However, for purposes of the annual noise impacts analysis in this EA, LDVs are defined as having a GVWR of 8,500 pounds or less, including light trucks, passenger cars, motorcycles, and low speed vehicles. Further, for this EA, medium duty vehicles are defined as having a GVWR of 8,500 to 26,000 pounds, and heavy duty vehicles are defined as having a GVWR over 26,000 pounds. We note that these definitions differ from the definitions used in the preamble to the Final Rule and the final regulations themselves. NHTSA uses the 8,500 pound GVWR cutoff for LDVs in the annual noise impacts analysis in this EA to align with the light-duty/heavy-duty cutoff used in its fuel economy/fuel efficiency programs. This provides a conservative estimate of the impacts of the Final Rule because few vehicles in the 8,500-10,000 pound GVWR range are anticipated to be affected by this rulemaking.
[9] The NPRM proposed a phase-in schedule that required each manufacturer of EVs/HVs to begin meeting the requirements of the final rule with 30 percent of the hybrid and electric vehicles they produce three years before the date for full compliance established in the PSEA. In addition, this percentage increased annually until full compliance was required. NHTSA modified the phase-in schedule for the Final Rule to provide additional time for compliance for manufacturers of light vehicles.
[10] The PSEA does not specify whether vehicle "direction" is to be defined with reference to the vehicle itself (thus meaning forward or backward) or the pedestrian.
[11] *See* PSEA § 2(2).
[12] Section 2(3) of the PSEA defines ''crossover speed'' as the speed at which tire noise, wind resistance, or other factors make an EV or HV detectable by pedestrians without the aid of an added sound. The definition requires NHTSA to determine the speed at which an added sound is no longer necessary.
[13] *See* PSEA § 3(a).

- It must reflect NHTSA's determination of the minimum sound level emitted by a motor vehicle that is necessary to allow visually impaired and other pedestrians to reasonably detect a nearby EV or HV operating below the crossover speed.[14]
- It must reflect NHTSA's determination of the performance requirements necessary to ensure that each vehicle's sound is recognizable to pedestrians as that of a motor vehicle in operation.[15]

In addition, the PSEA requires the following:

- The sound must not be dependent on either driver or pedestrian activation.[16]
- Manufacturers must be allowed to provide each vehicle with one or more sounds that comply, at the time of manufacture, with the safety standard. Each vehicle of the same make and model must emit the same sound or set of sounds.[17]
- Manufacturers must be prohibited from providing any mechanism for anyone other than the manufacturer or dealers to disable, alter, replace, or modify the sound or set of sounds emitted from the vehicle. Under the PSEA, a manufacturer or a dealer, however, is allowed to alter, replace, or modify the sound or set of sounds in order to remedy a defect or non-compliance with the safety standard.[18]

Because the PSEA directs NHTSA to issue these requirements as an FMVSS under the National Traffic and Motor Vehicle Safety Act (Vehicle Safety Act) (49 U.S.C. chapter 301), the requirements must comply with the Vehicle Safety Act as well as the PSEA. The following elements of the Vehicle Safety Act apply to this rulemaking:

- The safety standard must be performance-oriented, practicable,[19] and objective[20] and meet the need for safety.[21]
- NHTSA must consider whether the standard is reasonable, practicable, and appropriate for each type of motor vehicle covered by the standard.[22]
- Vehicle manufacturers, distributors, dealers, rental companies, and motor vehicle repair businesses must be prohibited from rendering the sound inoperative.[23]

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[14] *See id*. § 3(b)(1).
[15] *See id*. § 3(b)(2).
[16] *See id.* § 3(a).
[17] *See id.* § 3(a).
[18] *See id.* § 3(a).
[19] NHTSA must consider public reaction in assessing the practicability of required safety equipment like an ignition interlock for seat belts. *Pacific Legal Foundation v. Department of Transportation*, 593 F.2d 1338 (D.C. Cir. 1978). *cert. denied*, 444 U.S. 830 (1979).
[20] Regarding the objectivity requirement, the U.S. Circuit Court of Appeals for the 6th Circuit has stated that "objective criteria are absolutely necessary so that 'the question of whether there is compliance with the standard can be answered by objective measurement and without recourse to any subjective determination.'" *Chrysler v. Department of Transportation*, 472 F.2d 659 (6th Cir. 1972) (quoting the House Report for the original Vehicle Safety Act (H.R. 1776, 89th Cong. 2d Sess.1966, p. 16)).
[21] *See* 49 U.S.C. § 30111(a).
[22] *See id.* § 30111(b)(3).

1.2.3 Consultation and Scoping Process

As part of the rulemaking process, the PSEA requires NHTSA to consult with:

- The U.S. Environmental Protection Agency to assure that any added sound required by the rulemaking is consistent with existing noise regulations overseen by that agency;
- Consumer groups representing visually impaired individuals;
- Automobile manufacturers and trade associations representing them; and
- Technical standardization organizations responsible for measurement methods such as:
    - The Society of Automotive Engineers,
    - The International Organization for Standardization, and
    - The United Nations Economic Commission for Europe, World Forum for Harmonization of Vehicle Regulations.[24]

Since 2009, NHTSA has hosted a series of five roundtable meetings with industry, technical organizations, and groups representing people who are visually impaired. The following organizations have participated in these meetings: Alliance of Automobile Manufacturers, Global Automakers (formerly Association of International Automobile Manufacturers), American Council of the Blind, American Foundation for the Blind, the National Federation of the Blind, ISO, SAE, International Organization of Motor Vehicles Manufacturers, and Japan Automobile Manufacturers Association.

NHTSA has also included representatives from EPA in aforementioned activities with outside (non-Federal) organizations and informed EPA of NHTSA's research activities regarding quiet vehicles. NHTSA has also stayed informed of EPA's activities in this area on the international front through the United Nations Economic Commission for Europe Working Party on Noise.

NHTSA has provided the public and industry with three opportunities to comment on the research and rulemaking process:

- NHTSA held a public meeting on June 23, 2008, to discuss technical and safety policy issues associated with EVs/HVs, and the potential risks from these vehicles to visually impaired pedestrians (described in Section 1.2.1 above).
- NHTSA published a Notice of Intent to prepare an EA for this rulemaking ("scoping notice")[25] on July 12, 2011, announcing a 30 day comment period (*see* Section 1.5 for more information on the public scoping process).

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[23] *See id.* § 30122.
[24] NHTSA officials have been participating in the meetings of the World Forum informal working group charged with addressing potential safety issues regarding quiet cars.
[25] Notice of Intent to Prepare an Environmental Assessment for Pedestrian Safety Enhancement Act of 2010 Rulemaking, 76 FR 40860 (July 12, 2011).

- NHTSA published an NPRM, a PRIA, and a Draft EA[26] on January 14, 2013, offering a 60-day comment period (*see* Section 1.6 for more information on comments received on the Draft EA).

NHTSA has established three dockets to facilitate cooperation with outside entities, including international organizations. The first docket (NHTSA-2008-0108) was created after the 2008 public meeting and includes all materials associated with that meeting. The second docket (NHTSA-2011-0100) is the docket for the Environmental Assessment (including the NOI, Draft EA, and Final EA), its supporting documents, and public comments on the environmental analysis. The third docket (NHTSA-2011-0148) was created for the NPRM and public comments on the Proposed Rule.

1.2.4 Definition of Quiet Vehicles

Under NHTSA's Final Rule, the new requirements would apply only to EVs/HVs that are capable of propulsion in any forward or reverse gear without operation of the vehicle's ICE. These vehicles have been shown to create lower sound emissions at low speeds than vehicles propelled by an ICE, owing to the absence of mechanical vibrations generated by the ICE.[27] For the purposes of the rulemaking, "hybrid vehicles" are not limited to hybrid electric vehicles, although those are the most common HVs. They also include, for example, some vehicles powered by hydraulics or other propulsion sources in addition to the ICE. All HVs have two propulsion sources: one propulsion source typically uses a consumable fuel like gasoline, while the other is rechargeable, e.g., electric or hydraulic power.

The PSEA applies to all EVs/HVs, including light-duty vehicles, low-speed vehicles, motorcycles, buses, and medium and heavy duty vehicles. However, the Final Rule does not apply to electric motorcycles or EVs/HVs with a GVWR of over 10,000 pounds; consideration of motorcycles, buses, and medium and heavy duty vehicles has been postponed pending further evaluation. Therefore, the analyses in this Final EA are based on sound levels associated with light-duty passenger EVs/HVs.

There are various sources of sound in an operating vehicle, including the engine, driveline, tire contact patch and road surface, brakes, and wind. Noise from cooling fans, the HVAC, alternator, and other engine accessories is also fairly common. However, at lower speeds (below 30 km/h), wind and tire noise diminish, and the main source of vehicle sound is the engine. EVs/HVs operating in electric-only mode have been shown to create lower sound emissions than

[26] Available at http://www.regulations.gov/, Document ID: NHTSA-2011-0100-0046 (in Docket No. NHTSA-2011-0100).

[27] Some automotive manufacturers that produce EVs for the U.S. market have already developed added sounds, recognizing that those vehicles, when operating at low speeds, could pose a risk to pedestrians. These include driver activated and automated sounds.

vehicles propelled by an ICE, owing to the absence of mechanical vibrations and combustion generated by the ICE. Electric motor propulsion systems generate minimal vibration and sound compared to ICEs.

Because the sound differences between ICE and EVs/HVs occur at low speeds, the minimum sound requirements associated with the action alternatives would only be required between a stationary position and 30 km/h (for the Preferred Alternative) or 20 km/h (Alternative 3), and would be quieter than the sounds associated with traffic at higher speeds. An explanation of NHTSA's determination of the appropriate crossover speed is included in the preamble to the Final Rule.

1.2.5 Units

Throughout this EA, including in the description of alternatives, speed is reported in km/h rather than miles per hour in order to be consistent with the Final Rule. Since some of the data cited in this EA were originally in mph, they have been converted to km/h in all cases to provide easier comparison with the requirements of the two action alternatives, which differ in their sound requirements based on km/h intervals (*see* Table 1.1 for sample conversions).

Table 1.1: Kilometers Per Hour to Miles Per Hour Conversion Chart

Kilometers per hour (km/h)	**Miles per hour (mph)**
10	6.2
20	12.4
30	18.6

1.3 Purpose and Need

As discussed above, several studies by NHTSA indicate that as EVs/HVs proliferate, they may pose a safety risk for pedestrians, in particular the blind and visually impaired who rely on auditory cues from vehicles to navigate. When EVs/HVs are operating under electric propulsion at low speeds, when tire and wind noise are less dominant, they produce less sound than ICE vehicles. As a result, it can be difficult for pedestrians and pedalcyclists to detect these vehicles. As described above, a 2009 NHTSA-sponsored study suggested that HVs are significantly more likely to be involved in accidents involving pedestrians than ICE vehicles in certain situations (e.g., low speed situations when the vehicle is turning, stopping, slowing, or backing up) (Hanna, 2009). NHTSA's research determined that when operating under all conditions, such vehicles are 1.18 times more likely to be involved in a collision with a pedestrian than an ICE vehicle and 1.51 times more likely to be involved in a collision with a pedalcyclist. NHTSA assumes that this difference in collision rates is mostly attributable to the pedestrians' inability to detect the presence of these vehicles through hearing.

The statutory requirements laid out in the PSEA, as well as the need to address this safety issue, form the purpose and need for the range of alternatives considered in this NEPA analysis. The PSEA directs NHTSA to issue a performance standard for EVs/HVs, which tend to be quieter than ICE vehicles, to ensure that they emit a sound that meets certain minimum requirements when the vehicles are operating below the “crossover speed” to aid visually impaired and other pedestrians in detecting vehicle presence, direction, location, and operation. Pursuant to the PSEA, the performance requirements must enable a pedestrian to reasonably detect a nearby EV or HV operating at constant speed, accelerating, decelerating, and operating in any other scenarios that NHTSA deems appropriate without being dependent on either driver or pedestrian activation. The requirements must also ensure that each vehicle’s added sound is recognizable to pedestrians as that of a motor vehicle in operation. The PSEA requires NHTSA to consider the overall community noise impact of any added sound required by the new safety standard.

1.4 Incomplete and Unavailable Information

CEQ’s regulations implementing NEPA require that when there is incomplete or unavailable information, the agency should include a statement that such information is incomplete or unavailable and a statement of the relevance of such information.[28] The following information was incomplete or unavailable for this analysis:

- Pedestrian detection time data (seconds to arrival of a vehicle) are available for low speeds but not for speeds above 10 km/h (6 mph). Human testing for detectability was limited to a vehicle speed of 10 km/h, which is the speed at which the sound level difference between HVs and vehicles with ICEs is greatest. Testing was also performed for vehicles backing up (i.e., a situation where arrival of the vehicle might be unexpected) and braking (i.e., as if preparing to turn).
- There are limited acoustic data for electric and hybrid heavy duty vehicles operating at low speeds as compared to heavy vehicles with ICEs.

1.5 EA Scoping Process

On July 12, 2011, NHTSA published its NOI to prepare an EA for the PSEA rulemaking, initiating the NEPA scoping process for its forthcoming proposal.[29] The NOI described the statutory requirements for the minimum sound requirement under the PSEA, provided initial information about the NEPA process, outlined the scope of the environmental analysis and the significant issues to be analyzed, and initiated a 30-day comment period to allow public participation in the scoping process by requesting public input on the scope of NHTSA’s environmental analysis. It also invited the public to submit peer-reviewed scientific studies,

[28] 40 CFR § 1502.22.
[29] Notice of Intent to Prepare an Environmental Assessment for Pedestrian Safety Enhancement Act of 2010 Rulemaking, 76 FR 40860 (July 12, 2011).

reports analyzing potential environmental impacts in the United States, and suggestions on how to reduce unfavorable sound emissions while achieving the safety goal of the PSEA. The alternatives described in the NOI were developed based on NHTSA's research contained in the report *Quieter Cars and the Safety of Blind Pedestrians, Phase 2,* (Hastings, Pollard, Garay-Vega, Stearns, & Guth, 2011) and the other information NHTSA had collected in the reports described in Section 1.2.

During the comment collection period, NHTSA received comments in response to the NOI from over 30 individuals and organizations (*see* Appendix G). These comments addressed a wide variety of topics. NHTSA summarized those comments and responded to them in Section 1.5 of the Draft EA.[30] Those summaries and responses are incorporated by reference here rather than being reprinted in full.

1.6 Draft EA Comments

On January 14, 2013, NHTSA published an NPRM[31] and a Notice of Availability of its Draft EA,[32] offering a 60-day comment period to allow public participation in the NEPA process. During the comment period, NHTSA received numerous comments in response to the NPRM and Draft EA from individuals and organizations (*see* Appendix G for comments relevant to the Draft EA). These comments addressed a variety of topics and are available for public review on http://www.regulations.gov/ in Docket Nos. NHTSA-2011-0100 and NHTSA-2011-0148. NHTSA has reviewed these comments and considered them in preparation of this Final EA. Below is a summary of the comments NHTSA received related to the environmental review process and potential environmental impacts of the rulemaking. NHTSA's responses are in italics.

1.6.1 Draft EA and NPRM Comments Relating to Environmental Review Process and Potential Environmental Impacts

a. One commenter noted that the detectability of tonality allows the volume to be lower, reducing community noise impacts. Tonality causes significantly more annoyance than its dB(A) volume suggests. Introducing tonality ignores masking research. Once HV vehicles are plentiful, the tonality that causes an HV to stick out from current ICEs becomes a detriment. Increased masking will take place as a result, reducing effectiveness. From both an effectiveness and noise impact point of view, trading tonality for ICE broadband sound is a bad swap.

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[30] The Draft EA is available at http://www.regulations.gov/, Document ID: NHTSA-2011-0100-0046 (in Docket No. NHTSA-2011-0100).
[31] Federal Motor Vehicle Safety Standards; Minimum Sound Requirements for Hybrid and Electric Vehicles, 78 FR 2798 (January 14, 2013).
[32] Draft Environmental Assessment for Rulemaking to Establish Minimum Sound Requirements for Hybrid and Electric Vehicles, 78 FR 2868 (January 14, 2013).

Response: *The Final Rule provides manufacturers with some flexibility to design their alert sounds. While a specific tone requirement was included in the NPRM, that requirement has been removed in the Final Rule. NHTSA does not believe that manufacturers will develop sounds that are annoying to pedestrians, as that could negatively impact sales of their vehicles. Regarding the issue of masking, the EA noise modeling takes into account noise from ICE vehicles combined with ambient community noise. NHTSA's research in support of the rulemaking and EA evaluated detectability and suitability of various sounds to ensure pedestrians are able to detect EVs/HVs within 2.5 meters of the source. However, this EA analysis shows that bystanders at 7.5 meters or greater distance from the vehicle will not experience a noticeable increase in overall noise levels.*

b. One commenter stated that selecting "comparable" vehicles for sound analysis predisposes the results to severe bias.

Response: *NHTSA believes that selecting comparison vehicles for the sound analysis is important to avoid bias. NHTSA selected comparison vehicles that it believes fall in the middle of the range of ICE noise in order to provide a reasonable representation of the potential environmental impacts. Selecting quieter or louder comparison vehicles could provide biased results when aggregated. While the real-world impact of the Final Rule on any one vehicle will depend on that vehicle's unique characteristics, the variation in impacts is not anticipated to be outside the range of current variation in ICE noise.*

c. One commenter noted that if a different peer vehicle was selected, the crossover speed results would be different.

Response: *NHTSA's determination of the crossover speed is discussed extensively in the preamble to the Final Rule. NHTSA incorporates that discussion by reference and refers the reader there for how the crossover speed was determined.*

d. Another commenter stated that the standard does not account for the design buffer that manufacturers will introduce. This is extremely important because manufacturers always introduce a buffer to ensure certification. The standard should have been adjusted downward to reflect this. Moreover, the environmental analysis did not investigate the community noise impacts of higher noise levels resulting from the design buffer.

Response: *NHTSA agrees with the commenter that manufacturers may introduce a "design buffer" to ensure certification. In light of this, the minimum standards for detection selected in the Final Rule have been reduced by 4 dB to account for the margin for compliance that manufacturers are likely to design into their alert systems. In this Final EA, noise levels have been evaluated at levels 4 dB higher than the minimum standards selected in the Final Rule to account for the anticipated real world impacts of the rulemaking.*

e. One commenter noted that the data supports a 20 km/h cutoff, not 30 km/h, for the crossover speed.

Response: *NHTSA's determination of the crossover speed is discussed extensively in the preamble to the Final Rule. NHTSA incorporates that discussion by reference and refers the reader there for how the crossover speed was determined.*

f. Another commenter stated that the HV saturation rate in the study should be 100 percent. The commenter argues that all vehicles will eventually be something other than ICE, so 100 percent is the appropriate saturation level to study long-term masking and noise effects. The EA focuses primarily on interim vehicle saturation levels.

   Response: *NHTSA disagrees with the commenter's assertion that "all vehicles will eventually be something other than ICE." Current vehicle sales forecasts do not envision 100 percent penetration of EVs/HVs. In addition, NHTSA's forecasts of feasible compliance scenarios for recently promulgated Corporate Average Fuel Economy (CAFE) standards do not predict 100 percent deployment of EVs/HVs. This EA includes an analysis of potential impacts based on a 20 percent deployment rate, which is approximately 3 times higher than the currently projected deployment rate for 2035. Furthermore, Appendix F of this EA includes deployment rate scenarios up to and including 100 percent of EVs/HVs.*

g. One commenter noted that as EVs/HVs produce sufficient noise emission levels at around 20 km/h, it is believed that the proposed technical specifications are expected to increase the overall traffic noise levels as well as to create discomfort to pedestrians and the vehicle passengers. The commenter goes on to ask whether NHTSA plans to carry out additional traffic tests where the noise emission effects of EVs/HVs will be assessed in combination with traffic of regular ICE vehicles.

   Response: *This EA takes into account noise from ICE vehicles combined with ambient community noise in evaluating the overall potential noise impacts from regulated EVs/HVs across various levels of penetration in the on-road fleet. The purpose of the rulemaking is to improve safety by ensuring EVs are detectable to pedestrians. Research conducted to support the analysis evaluated detectability and suitability of proposed sounds to ensure pedestrians are able to detect EVs/HVs within 2.5 meters of the source. However, the Final Rule allows manufacturers flexibility to ensure that interior noise levels are not an issue for drivers and passengers of EVs/HVs. The EA generally finds that the overall increase in traffic noise levels to pedestrians is not discernible.*

h. Another commenter stated that independent studies indicated that consumers in many cases consider the low noise emissions of EVs/HVs as the deciding factor for purchasing them. In this manner, the potential advantages of the increasing market penetration of EVs/HVs with respect to the future decrease in the overall traffic noise emissions are expected to be nullified. The commenter asked whether NHTSA considered such a development and the possible implications to the long-term consumer acceptance of EVs/HVs.

   Response: *NHTSA is mandated by the Pedestrian Safety Enhancement Act of 2010 to adopt minimum sound requirements for EVs/HVs. This EA shows that in most circumstances, the increases in overall traffic noise emissions anticipated by this rulemaking are not discernible. Further, NHTSA does not anticipate long-term* *implications on consumer acceptance of EVs/HVs, as they still offer several benefits to consumers, such as improved fuel economy.*

i. One commenter stated that it is clear that environmental and interior noise will be increased. The study commissioned by the European Commission [TNO report: MON-RPT-2010-02103 VENOLIVA - Vehicle Noise Limit Values - Comparison of two noise emission test methods – Final Report Specific Contract No SI2.545143 implementing Framework Contract No ENTR/05/18], table 37 indicates that a 0.9 dB decrease in community noise has a 11.6 billion Euro benefit for the European Union population.

   Response: *As the deployment level of EVs/HVs increases, the overall projected noise levels resulting from this rulemaking are still expected to be less than those resulting from an on-road fleet composed entirely of conventional ICE vehicles. The difference between a community noise level with and without the added sound is not anticipated to be noticeable to bystanders at 7.5 meters or greater from the centerline of the roadway except in cases of a single vehicle pass-by in a quiet rural environment, where the increased sound level is anticipated to be within the bounds of current ICE vehicle variation.*

j. One commenter wrote that the EU expects that the proposed Sound Pressure Level of the signal transmitted by the Approaching Vehicle Audible System may have an adverse effect on overall traffic noise, especially in view of the increasing market penetration of these vehicles.

   Response: *The forecast for EV/HV deployment rate in the Annual Energy Outlook 2012 Early Release (EIA 2012) projected that EVs/HVs will account for 4.1 percent of all new LDV sales in 2017 and 8.2 percent of all LDV sales in 2035. As a result, the total fleet-wide percentage of EVs/HVs is projected to be 6.6 percent in 2035. NHTSA has reviewed more recent Annual Energy Outlook projections, and the EV/HV deployment forecast is largely in line with the AEO 2012 Early Release. Furthermore, the Cumulative Impacts section took into account the potential increase in adoption rates of EVs/HVs as a result of recent CAFE actions, which were projected in that rulemaking at approximately 13 percent of new vehicle sales in 2025, resulting in a total fleetwide percentage of EVs/HVs of approximately 10.5 percent. Therefore, while the EA included projected results for EV/HV deployment rates up to 100 percent (*see *Appendix F of the EA), the range of projected deployment in the foreseeable future is likely to be much less than 20 percent. In addition, the Final Rule requires a less complex alert, using four one-third octave bands instead of eight, which will provide manufacturers more flexibility in alert levels and designs.*

k. One commenter noted a belief that: (1) NHTSA is adding to noise pollution, and (2) NHTSA is targeting specific types of cars, rather than a generic "anything capable of a noise level below x, when traveling under x mph." For the latter, the commenter believes this does not create a level playing field. Further, the commenter believes that NHTSA is creating an issue where none currently exists, and that if an action is taken, it should at least be evenly applied to any type of car, not just ones with specific drivetrains.

Response: *This EA cites to studies undertaken by NHTSA identifying the increased risk of EVs/HVs being involved in collisions with pedestrians as compared to ICE vehicles under certain operating conditions. More information is included in the preamble to the Final Rule and the FRIA as well. The PSEA requires NHTSA to establish minimum sound requirements for EVs/HVs in order to ensure pedestrian safety. NHTSA has determined that the added sound will allow pedestrians to detect individual EVs/HVs while limiting unnecessary increases in overall ambient noise levels. This is anticipated to reduce pedestrian injuries and fatalities. As the deployment rate of EVs/HVs increases, overall projected on-road noise levels are expected to be less than noise levels of traffic based on 100 percent conventional ICE vehicles even after the Final Rule goes into effect. The Final Rule would establish minimum sound levels for EVs/HVs that are traveling below 30 km/h and would not noticeably add to community noise levels for pedestrians at 7.5 meters or greater from the source. Should an EV/HV already meet those requirements, no additional sound would be required. The minimum detection distances are based on providing enough time for the driver to stop. The PSEA specifically mandates a minimum sound requirement for EVs/HVs. As for conventional ICE vehicles, the question of whether they should be regulated will be addressed in NHTSA's required report to Congress after the Final Rule is issued.*

l. One commenter wrote that the rule suffers from an insufficient analysis of the consequences of increased noise pollution and noise related impacts. Recent research has shown that traffic noise harms human health and interferes with people's daily activities at school, at work, at home, and during leisure time. According to the World Health Organization, it can disturb sleep, cause cardiovascular and psychophysiological effects, reduce performance, and provoke annoyance responses and changes in social behavior.

   Response: *This EA has analyzed the overall impact of the Final Rule and compared it to current conditions. Overall noise on the roadways will decrease due to the deployment of additional EVs/HVs, but that impact will be partially offset by the additional noise produced by these vehicles in response to the Final Rule. Therefore, the impacts of traffic noise on human health are not anticipated to worsen, and may in fact improve from current conditions.*

m. Another commenter stated that the detectability parameters determined for EVs/HVs may also necessitate the installation of Approaching Vehicle Audible Systems in other quiet vehicles such as electric motorcycles and mopeds as well as in electrically assisted bicycles. The commenter asks whether the expected cost per vehicle has been estimated for these vehicle categories and how this is expected to impact the usability of the vehicles, as the drivers will be exposed to noise and signals of sound pressure level in the order of +55 dB. In this context, the commenter mentions that the 55 dB noise emission level has been identified by the WHO as the onset of noise related health impacts on individuals.

   Response: *EPA's Federal sound limits for on-road motorcycles range from 80-83 dB(A) depending on year, and sound limits for off-road motorcycles range from 80-83 dB(A) for off-road motorcyles with engines less than 170 cc (40 CFR § 205.152). Most off-highway motorcycles and ATVs produce sound levels in the range of 83 to 97 decibels at 20 inches* *away from the tailpipe (Motorcycle Sound Working Group 2005), which would be slightly lower (approximately 6 dB) for the rider. The additional sound requirements NHTSA proposed in the NPRM were in the range of 47-68 decibels at 2 meters away, which would conservatively amount to 59-80 decibels for the rider. Therefore even with the added sound, electric motorcycles would still have lower sound emissions on average than off-highway ICE motorcycles both for the rider and for bystanders. Furthermore, design elements implemented by the manufacturers would be likely to maintain directionality to the sound (outward) and could include shielding behind the speaker to reduce driver-experienced noise. Still, NHTSA has postponed consideration of a minimum sound requirement for electric motorcycles due to the need for further evaluation. Standards for motorcycles are not included in the Final Rule.*

n. One commenter found the premise for adding noise to motor vehicles to be absurd. Moreover, the commenter wrote that being blindfolded and crossing the street is not in any way a scientific measurement of either effectiveness or need. The commenter believed that the statistics about pedestrian accidents fail to distinguish among accidents related to pedestrian disability, inattentiveness, and driver error. The commenter argues that raising the ambient noise level by 15 db is not insignificant. Further, the commenter writes that the measurements were done only for those at ground level, at 7.5 meters from the source of the sound, and doesn't consider that sound rises and, depending on conditions, that noise disperses and travels often long distances and over a wide area.

   Response: *Should EVs/HVs achieve 50 percent deployment (far beyond the deployment levels anticipated in 2035), the difference between the Preferred Alternative and No Action Alternative is projected to reach a maximum of 0.9 dB in non-urban environments and 0.7 dB in urban environments (*see *Appendix F of the EA). Differences in sound levels of less than 3 dB are generally not noticeable to humans. In practical cases, as sound propagates over distance, the level decreases. Because ambient levels are caused by geographically diverse sources, ambient levels tend to have the same level over wide areas. This means that as a specific source's sound propagates, it will become masked by the ambient sound. Therefore, the sound level due to a specific source is generally less noticeable further from the source. The analysis did not apply extra attenuation to subjects at ground level compared to those at higher elevations. Because greater heights for the same horizontal distances allow a greater overall distance for the sound to attenuate, the sound levels at greater heights will be lower than at ground level.*

o. Several commenters noted their general opposition to the noise requirement and stated that this will increase noise pollution. Commenters referred to various studies that highlight the detrimental effects increased noise has on the quality of human life. Several commenters also noted that the minimum noise level is louder than many ICE vehicles, stating that as EV/HV vehicles replace ICE vehicles, noise levels in our communities will increase as a result of the rule.

   Response: *The PSEA requires NHTSA to establish minimum sound levels that EVs/HVs must emit in order to ensure pedestrian safety. NHTSA has determined that the added sound will allow pedestrians to detect individual EVs/HVs while limiting unnecessary increases in overall ambient noise levels. As the deployment rate of EVs increases,* *overall projected on-road noise levels are expected to be less than noise levels of traffic based on 100 percent conventional vehicles even after the Final Rule goes into effect. The Final Rule would establish minimum sound levels for EVs/HVs that are traveling below 30 km/h and would not noticeably add to community noise levels for pedestrians at 7.5 meters or greater from the source. Should an EV/HV already meet those requirements, no additional sound would be required.*

1.6.2 Non-Environmental Comments

A majority of comments received by NHTSA addressed requirements of the rulemaking rather than environmental concerns. These comments are not addressed specifically in this Final EA, but were considered in the development of the Final Rule and are addressed in the preamble of the Final Rule as appropriate.

2 DESCRIPTION OF ALTERNATIVES

2.1 Overview of Alternatives

This section provides an overview of the three alternatives NHTSA analyzed in this EA. Alternative 1 is the No Action Alternative, under which NHTSA would not establish any regulatory sound requirements for EVs/HVs. The two action alternatives take different approaches to balancing the potentially competing considerations of recognizability, detectability, effectiveness, environmental noise impact, and cost. For example, Alternative 2 (NHTSA's Preferred Alternative) and Alternative 3 differ in the target sound levels and frequency ranges that would be required. Both action alternatives would allow manufacturer flexibility to meet a set of objective criteria for compliance testing.[33]

2.2 Alternative 1: No Action

Under the No Action Alternative, NHTSA would not establish minimum sound requirements for electric or hybrid motor vehicles. Since the PSEA directs NHTSA to issue a minimum sound requirement for EVs/HVs, the statute does not permit NHTSA to adopt the No Action Alternative. However, CEQ regulations implementing NEPA require that agencies consider a "no action" alternative in their NEPA analyses in order to compare the magnitude of the effects of the action alternatives.[34] The No Action Alternative serves as a baseline for that comparison.

In defining this baseline alternative, NHTSA must take into account anticipated conditions in the absence of action by NHTSA. Before passage of the PSEA, manufacturers of hybrid vehicles were generally not equipping vehicles with pedestrian warning sounds. However, NHTSA notes that some vehicles that would be affected by the proposal are currently being equipped with technologies that provide for various types of pedestrian warning sounds. These voluntary systems vary in sound level, activation requirements, and sound quality. However, because NHTSA is unable to predict the deployment of pedestrian alert sounds and the characteristics of such voluntary sound systems in future vehicle models, the No Action Alternative assumes that EVs/HVs would not be equipped with added sound in the absence of action by NHTSA. This is a conservative approach to the noise analysis, allowing NHTSA to model the greatest potential environmental impacts of the two action alternatives, because voluntary efforts by manufacturers

[33] Required testing conditions (e.g., microphone positioning and environmental conditions) for evaluating compliance with the proposed sound requirements are defined in the Final Rule and are harmonized with the requirements of the SAE testing requirements J2889-1.

[34] CEQ has explained that "[T]he regulations require the analysis of the no action alternative even if the agency is under a court order or legislative command to act. This analysis provides a benchmark, enabling decision makers to compare the magnitude of environmental effects of the action alternatives. … [See 40 CFR § 1502.14(c).] Inclusion of such an analysis in the [EA] is necessary to inform the Congress, the public, and the President as intended by NEPA. [See 40 CFR § 1500.1(a).]" *Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations.* 46 FR 18026 (1981). *See also* 40 CFR 1502.14(d) (requiring that agencies include a no action alternative).

to equip vehicles with sound systems could reduce the difference between the No Action Alternative and the action alternatives.

2.3 Alternative 2: Preferred Alternative

Alternative 2 is the Final Rule and NHTSA's Preferred Alternative. The Preferred Alternative will establish minimum sound requirements for specific one-third octave bands between 315 and 5000 Hz for EVs/HVs when in a stationary position or traveling up to 30 km/h, including when in reverse. Under the Preferred Alternative, a vehicle subject to the Final Rule will be required to produce a sound meeting the requirements of the standard when the vehicle is stationary, the propulsion system has been activated, and the vehicle's gear selector is in any gear position other than Park (or, for manual transmission vehicles, when the parking brake is not applied).

The NHTSA Final Rule is based on a "detection model" that determines the detectability of a vehicle based on minimum sound pressure levels in specific sets of four one-third octave bands for stationary, for reverse, and for vehicle speeds up to and including 30 km/h. In addition to the four-band acoustic specification, NHTSA has decided to include a "two-band plus overall" alert requirement as a compliance option in response to comments on the NPRM. By including both a four-band specification and a two-band specification in the Final Rule, NHTSA is providing vehicle manufacturers with the flexibility to choose either option for compliance with the new safety standard. The Final Rule also requires a relative volume change of 3 dB of the vehicle sound for each 10 km/h increase or decrease of vehicle speed to ensure that pedestrians will be able to determine whether an EV/HV is accelerating or decelerating. The minimum detection thresholds which are contained in the Final Rule increase with speed. The detection model is based on an assumed ambient sound profile with a total sound level of 55 dB(A), which NHTSA considers to be both representative of a moderate suburban to urban environment and a sound level at which pedestrians who are blind will expect to be able to detect vehicles at an intersection by auditory cues.

The Preferred Alternative does not include detectability requirements for frequencies below 315 Hz because ambient sounds present in urban and suburban environments are likely to mask sounds at these frequencies, reducing their effectiveness for the detection of EVs/HVs and requiring greater overall increases in sound level to achieve the same levels of detectability. Furthermore, NHTSA expects that the speakers that manufacturers will use for alert systems may not be able to produce high quality low frequency sounds (below 315 Hz).

Table 2.1 summarizes the minimum SPLs for detection for the four-band requirement. For this requirement, under each scenario, vehicles must emit a sound having at least the A-weighted SPL in the table in each of four non-adjacent bands spanning no fewer than 9 of the 13 bands from 315 to 5000 Hz.

Table 2.1: Alternative 2 (Preferred Alternative) Minimum Sound Pressure Levels (in A-Weighted Decibels) for Detection (Four-Band Specification)

One-Third Octave Band Center Frequency, Hz	Stationary	Reverse	10 km/h	20 km/h	30 km/h
315	39	42	45	52	56
400	39	41	44	51	55
500	40	43	46	52	57
630	40	43	46	53	57
800	41	44	47	53	58
1000	41	44	47	54	58
1250	42	45	48	54	59
1600	39	41	44	51	55
2000	39	42	45	51	55
2500	37	40	43	50	54
3150	34	37	40	47	51
4000	32	35	38	45	49
5000	31	33	36	43	47

For the two-band requirement, the vehicle must emit sound with two-nonadjacent one-third octave bands from 315 to 3150 Hz each having at least the A-weighted SPL in Table 2.2 spanning no fewer than three one-third octave bands from 315 to 3150 Hz. One of the two bands meeting the minimum requirements in the table must be the band that has the highest SPL of the 315 to 800 Hz bands, and the second band meeting the minimum requirements in the table must be the band that has the highest SPL of the 1000 to 3150 Hz bands. In addition, the two bands used to meet the two-band minimum requirements must also meet the band sum requirements specified in Table 2.2.

Table 2.2: Alternative 2 (Preferred Alternative) Minimum Sound Pressure Levels (in A-Weighted Decibels) for Detection (Two-Band Specification)

	A-weighted SPL, dB(A)	
Vehicle Speed	**Minimum in each band**	**Band Sum**
Reverse	40	48
Stationary and up to but not including 10 km/h	40	44
10 km/h up to but not including 20 km/h	42	51
20 km/h up to but not including 30 km/h	47	57
30 km/h	52	62

Table 2.3 indicates the overall SPLs in A-weighted decibels anticipated for each speed as calculated by the band sum of the minimum sound requirements. The overall SPLs presented in this table are not a requirement for vehicles under Alternative 2. However, given the flexibility built into the Preferred Alternative and Alternative 3 (*see* next section), aggregation of the minimum sounds into an overall minimum SPL is the only way to generalize the effects and allow for environmental impact evaluation and comparison among alternatives. The noise modeling for this EA assumes that automobile manufacturers' design targets will exceed the minimum requirements by approximately 4 dB to ensure compliance after accounting for variation in compliance measurements; therefore, Table 2.3 and the noise modeling for this EA assume an additional 4 dB for the overall SPLs associated with the NHTSA Final Rule.[35] For the purposes of this NEPA analysis, NHTSA assumes that vehicles emit added sound whenever the ignition is on, the transmission is not in Park, and the vehicle speed is not greater than 30 km/h.

Table 2.3: Overall Anticipated SPLs (in A-Weighted Decibels) Measured According to SAE J2889-1

	Stationary	Reverse	10 km/h	20 km/h	30 km/h
Four-Band Option*	47-50	50-53	53-56	59-62	63-67
Two-Band Option	48	52	55	61	66

Note: The total SPLs in this Table are not requirements of the Final Rule, but a result of the summing of the minimum sound requirements from the one-third octave band sets in addition to anticipated manufacturer exceedance of the standards.
* A range is indicated because overall SPL depends on which four bands are selected by the OEM.

[35] NHTSA notes that the SPLs required under the Final Rule were adjusted to reflect the anticipated manufacturer exceedance to ensure compliance.

NHTSA has revised Alternative 2 (the Preferred Alternative) in this Final EA and the Final Rule based on comments received on the Draft EA and NPRM. For more information regarding these revisions, please see Section 2.5 below and the preamble to the Final Rule.

2.4 Alternative 3

Alternative 3 addresses a set of requirements suggested by several commenters to the NOI, including the Alliance of Automobile Manufacturers, and is consistent with in-use international guidelines such as that of the Japanese Ministry of Land, Infrastructure, Transport and Tourism. This alternative would require that the sound emitted by EVs/HVs have at least two one-third octave bands with a sound pressure level of 44 dB(A) within the range of 150 to 3000 Hz, with one of the one-third octave bands being above 500 Hz (*see* Table 2.4). The rationale for this range is to avoid masking of the required sound by other vehicle sounds (under 500 Hz) and to ensure that the sound is detectable to pedestrians with age related hearing loss, which occurs most frequently above 3000 Hz (TRB, 2010, Hastings, Pollard, Garay-Vega, Stearns, & Guthy, 2011). The total minimum sound level of EVs/HVs under this alternative would be 48 dB(A) as a result of the summing of the logarithmic decibels of the two required one-third octave band sets of at least 44 dB(A). Alternative 3 would require sound from the beginning of vehicle movement through 20 km/h and in reverse, but would not include minimum sound requirements when stationary or above 20 km/h. This alternative would require a 15-percent change in pitch frequency from 5 to 20 km/h to indicate acceleration or deceleration of the vehicle.

Table 2.4: Alternative 3 Minimum Sound Pressure Levels (in A-Weighted Decibels) for Detection

One-Third Octave Band Ranges, Hz	Stationary	Reverse	10 km/h	20 km/h	30 km/h
150-3000	N/A	44	44	44	N/A
500-3000	N/A	44	44	44	N/A
Overall A-weighted SPL measured according to SAE J2889-1	N/A	48	48	48	N/A

Some guidelines for designing pedestrian alert systems in other countries allow for a driver-activated temporary override. Because temporary override is not allowed under the PSEA, it is not permitted in NHTSA's Final Rule and therefore not analyzed in this EA. By not including such an override, NHTSA is also taking a conservative approach to estimating potential environmental impacts. By assuming the vehicle continuously emits sound from the beginning of vehicle movement through 20 km/h and in reverse, the analysis of this alternative provides the maximum potential environmental impact when compared to the No Action Alternative.

2.5 Development of Alternatives

In developing the range of action alternatives, NHTSA considered the PSEA's provisions for minimum sound requirements for EVs/HVs. In addition, these alternatives are based on agency research (NPRM, 2013; Hastings, Pollard, Garay-Vega, Stearns, & Guthy, 2011) seeking to determine, with due concern for environmental considerations, which sound types most effectively and appropriately aid pedestrians in detecting, identifying, and localizing[36] the sound of EVs/HVs as their percentage in the vehicle fleet increases. NHTSA measured the sound produced by EVs, HVs, and ICE vehicles and the ability of pedestrians to detect approaching EVs/HVs versus ICE vehicles.

To develop the Preferred Alternative, NHTSA used acoustic detection models (*see* the NPRM and the Final Rule for more details) to determine the frequency composition of sounds that best allow pedestrians to detect approaching vehicles without contributing undesirably to surrounding ambient noise levels. The Preferred Alternative proposed in the NPRM established minimum sound requirements within specific one-third octave band ranges between 160 and 5000 Hz for EVs/HVs that are stationary or traveling up to 30 km/h, including in reverse. The NPRM proposed requiring a sound that included one tone at a frequency below 400 Hz, and at least one of the tones used must be 6 dB(A) above the EV/HV's existing sound level in that band. Alternative 3 was developed in response to several scoping comments suggesting, for example, harmonization with existing international guidelines such as the Japanese Ministry of Land, Infrastructure, Transport and Tourism guidelines.

Based on comments received during the public comment period and a follow up study, *Detectability of Alert Signals for Hybrid and Electric Vehicles: Acoustic Modeling and Human Subjects Experiment* (Hastings & McInnis, 2015), NHTSA has revised Alternative 2 (the Preferred Alternative) as described below. More information on these changes is provided in the Final Rule.

a. Number of Bands/Frequencies:

   The NPRM proposed minimum thresholds in eight total bands. In contrast, the Final Rule requires either four bands or two bands. In the case of four bands, the selected bands must be non-adjacent and must span nine bands within a thirteen band range from 315 to 5000 Hz. To allow for additional flexibility, additional frequencies were added, to include the range of one-third octave bands from 630 to 1600 Hz. As another compliance option that manufacturers may select, the Final Rule also specifies a two-band specification which incorporates a minimum overall SPL specification. Both the four-band and two-band specifications provide the same level of detectability.

[36] Sound localization refers to determining the distance and direction of a detected sound.

With regard to the two compliance options in the Final Rule, we note that the Preferred Alternative in this EA reflects only the four-band compliance requirement. The overall sound levels associated with the two-band requirement are less than or equal to those of the four-band requirement. Consequently, any change in environmental noise resulting from selection of the two-band requirement is expected to be equal to or less than the environmental noise resulting from selection of the four-band approach. This EA does not conduct a separate analysis of the NHTSA two-band compliance specification, but instead takes the more conservative approach of basing the Preferred Alternative on the four-band compliance specification.

b. Minimum Levels:

In order to best match average subject detection times, the Final Rule will set sound levels at each frequency using a detection threshold of 0.079 sones/erb as opposed to 0.03 sones/erb documented in the NPRM. While many pedestrians have good detection in the high-frequency bands, some pedestrians with significant age-related hearing loss may have difficulty detecting high-frequency signals (>2000 Hz).

c. Stationary Sounds:

Under Alternative 2, NHTSA would continue to require EVs/HVs to emit a sound while stationary with the vehicle propulsion system activated. In the Final Rule, this requirement would not apply to vehicles that are parked with the propulsion system activated (i.e., the vehicle’s gear selector is in the “Park” position or, on a vehicle with a manual transmission, the parking brake is applied).

d. Recognition Specification:

NHTSA has determined that the tone is not needed for recognition. The proposal to require broadband content in every band from 160 Hz to 5000 Hz has also been removed for not being essential for recognition. In addition, the requirement in the NPRM for frequency (pitch) shifting as a vehicle changes speed has been removed. Instead, the Final Rule requires a “relative volume change” (increase or decrease in sound level emitted from the vehicle) as a vehicle changes speed.

e. Compliance Buffer:

NHTSA recognizes that due to variability in compliance testing and equipment performance, automobile manufacturers are likely to intentionally exceed the requirement of the Final Rule by approximately 4 dB to ensure that their vehicles comply (i.e., the manufacturers will design in a margin of compliance of about 4 dB). To offset this margin, NHTSA has lowered the actual requirement by 4 dB compared to the levels dictated by the acoustic modeling effort so that production vehicles equipped with alert systems will not greatly exceed the levels necessary for detectability.

f. Scope of Vehicles Covered:

Although the PSEA applies to motorcycles as well as medium and heavy duty trucks and buses, consideration of these vehicles has been postponed due to the need for further evaluation. As a result, the Final Rule would apply to four-wheeled hybrid and electric passenger cars, light trucks, and vans with a gross vehicle weight rating of 4,536 kg (10,000 pounds) or less and low speed vehicles.

In light of the adjustments described above, a summary comparison is provided in Table 2.5 describing the three alternatives considered in this EA.

Table 2.5: Comparison of Alternatives Considered in This EA

Sound Parameters	Alternative 1 (No Action)	Alternative 2 (Preferred Alternative)	Alternative 3
Min. Sound Required	No	Yes	Yes
Applicable Speed	N/A	Stationary to 30 km/h, reverse	> 0 to 20 km/h, reverse
Broadband Low Frequency Sounds	N/A	N/A[37]	N/A
One-Third Octave Bands	N/A	Minimum SPLs for four non-adjacent band sets between 315 and 5000 Hz, or alternative two-band with overall requirement.	At least two with SPL of 44 A-weighted dB. One band each in the ranges of 150-3000 and 500-3000 Hz.
Acceleration and Deceleration	N/A	Relative volume change – increase of 3 dB per 10 km/h increase in speed.	15 percent monotonic frequency shift between 5 and 20 km/h.
Total Minimum Sound Level Anticipated to Result from the Individual Minimum Sound Requirements	N/A	For Four-Band Alert: Stationary – 47-50 dB(A) Reverse – 50-53 dB(A) 10 km/h – 53-56 dB(A) 20 km/h – 59-62 dB(A) 30 km/h – 63-67 dB(A) For Two-Band Alert: Stationary – 48 dB(A) Reverse – 52 dB(A) 10 km/h – 55 dB(A) 20 km/h – 61 dB(A) 30 km/h – 66 dB(A)	48 dB(A)
Anticipated Manufacturer Exceedance of Requirement to Ensure Compliance	N/A	4 dB	N/A

2.6 Alternatives Considered But Not Analyzed in Detail

In the NOI, NHTSA outlined several alternatives it was considering for inclusion in the EA. NHTSA received comments in response to the NOI recommending other alternatives it should include. Because of considerations of efficacy, enforceability, and practicality, the alternatives

[37] In the NPRM and Draft EA, NHTSA's Preferred Alternative included specifications for low frequency one-third octave bands because NHTSA believed they would assist pedestrians in recognizing sounds that conform to the requirements as being produced by a motor vehicle. Based on comments received to the NPRM, NHTSA now believes that such requirements are not necessary for recognition. For this and other reasons explained in the preamble to the Final Rule, Alternative 2 in the Final EA does not include specifications for low frequency sounds.

analyzed in this EA differ from the alternatives initially proposed in the NOI (*see* Section VIII of the NPRM for additional detail). In particular, the action alternatives presented here are based upon a combination of the preferred aspects of several of the original alternatives. In addition, this EA provides additional detail about the acoustic properties of the proposed alternatives. For example, the Preferred Alternative is similar to Alternative 4 proposed in the NOI but provides greater detail about the sound pressure level and acoustic profile of the sound. This Final EA also reflects a refinement of the preferred alternative based on comments received on the NPRM and the Draft EA. This section discusses alternatives or aspects of alternatives NHTSA considered but eliminated from further consideration.

2.6.1 Requiring Vehicle Sound to Be Playback of an ICE Recording

NOI Alternative 2 would have required that a recording of an ICE peer vehicle be used as an alert sound.[38] NHTSA eliminated this option from further consideration because it believes that a recording based on an ICE vehicle would not ensure sufficient detectability. Additional concerns included the enforceability of such a standard and the added expense of creating and replaying the recording. In addition, manufacturers have expressed a desire for flexibility in developing vehicle sounds, and this approach would unnecessarily restrict such flexibility.

2.6.2 Requiring That the Added Sound Adapt to the Ambient Noise Level

In the NPRM, NHTSA discussed requiring that the sound level of the minimum sound requirement vary based on the ambient noise level in the environment surrounding the vehicle, not unlike certain back-up alarms available for construction vehicles. Based on research regarding the cues used by visually impaired individuals to cross noisy intersections, NHTSA decided not to pursue this approach because NHTSA does not believe it is justified based on the safety needs of visually impaired pedestrians. Additionally, this option could have resulted in greater noise impacts since the proliferation of ambient-adaptive sound systems could create a positive feedback loop and drive the ambient sound levels higher. The type of technology required under this option is likely not sufficiently mature to avoid this feedback loop and the ensuing noise pollution.

2.6.3 Acoustic Profile Designed Around Sounds Produced by ICE Vehicles

In the NPRM, NHTSA discussed minimum sound levels for EVs/HVs based on the sounds produced by current ICE vehicles, specifically for one-third octave bands based on the mean ICE vehicle sound level produced and on levels based on 1, 2, and 3 standard deviations lower than the mean. NHTSA was hesitant to set the minimum sound level requirements for quiet vehicles at mean sound levels produced by ICE vehicles, since NHTSA had not determined that such a

[38] 76 FR 40864 (July 12, 2011).

sound level was necessary for the safe detection of vehicles. Such a requirement could also serve to unnecessarily increase the overall level of vehicle noise emissions.

At the same time, NHTSA was hesitant to set the minimum sound levels for EVs/HVs at any standard deviation below the mean sound level produced by ICE vehicles because such a requirement might not ensure sound levels high enough to allow pedestrians to detect these vehicles. The PSEA requires NHTSA to study whether quiet ICE vehicles pose an increased risk of collisions with pedestrians, and without the results of this research, NHTSA cannot yet assume that very quiet ICE vehicles provide safe detection for pedestrians.

2.7 Summary of Environmental Consequences

Chapter 3 outlines the affected environment and projected environmental consequences for relevant resources and impact categories, as affected by each of the alternatives, including the Preferred Alternative. For ease of comparison, Table 2.6 summarizes the impacts of each alternative. This EA analyzes impacts in terms of potential impacts on urban and non-urban areas.

Table 2.6: Summary of Environmental Consequences

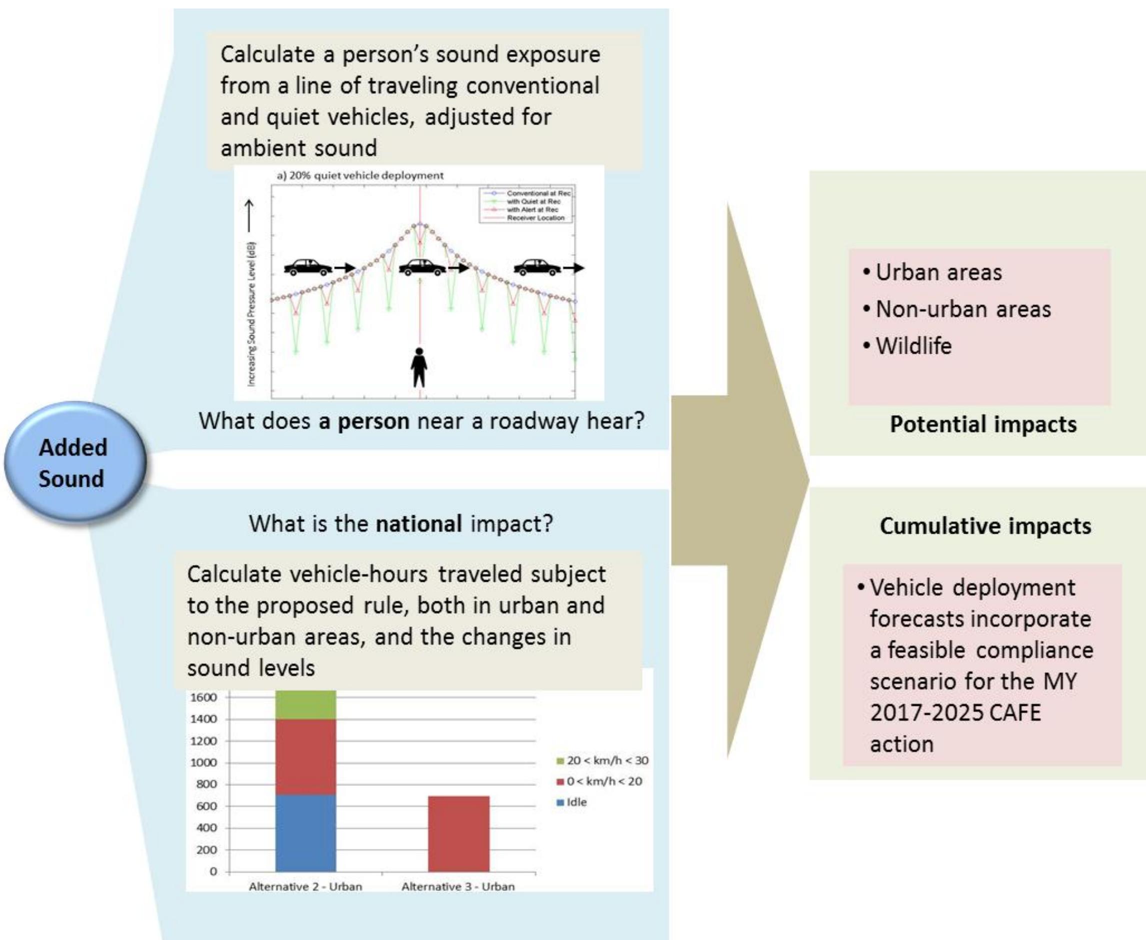
Resource	Alternative 1 (No Action)	Alternative 2 (Preferred Alternative)	Alternative 3
Noise Pollution			
Urban	N/A	< 3 dB	< 3 dB
Non-Urban	N/A	< 3 dB in most scenarios, 3.1-10.4 dB for single vehicle pass-by	< 3 dB
Wildlife	N/A	Negligible adverse impacts anticipated	Negligible adverse impacts anticipated

As compared to the No Action Alternative, the environmental impacts of the action alternatives are less than 3 dB, which is not noticeable to humans, except in one case, that of a single vehicle pass-by in a non-urban environment. For this case, impacts would range from 3.1 to 10.4 dB, which is considered noticeable; however, the difference is comparable in scale to the variation among ICE vehicles on the road today. Even with added sound, the sound level of the individual EV/HV would still be lower than an average ICE vehicle, and single vehicle pass-by events are anticipated to be relatively infrequent. In addition, neither action alternative is likely to adversely impact wildlife.

3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes the current and projected conditions of the affected environment as it relates to the Final Rule regarding a minimum sound emission requirement for EVs/HVs. This chapter describes NHTSA's modeling of the potential change in community sound levels as experienced by a single listener as a result of implementation of the action alternatives, estimates the amount of travel that would be affected, and evaluates the projected direct and indirect impacts on the environment, human health, and specific resources. CEQ regulations define direct impacts as those that "are caused by the action and occur at the same time and place" and indirect impacts as those that "are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable."[39] This chapter also discusses the projected cumulative impacts of the action alternatives. The cumulative impacts discussion is in Section 3.5. Figure 3-1 provides an overview of the analyses performed in this chapter.

Figure 3-1: Schematic of Noise Analyses Performed for This EA



[39] 40 CFR § 1508.8.

3.1 Unaffected Resources and Impact Categories

NHTSA anticipates that the action alternatives would have no impact on several resources and impact categories discussed below and has therefore not analyzed these further.

- **Topography, Geology, and Soils.** The action alternatives will not require any construction or other ground-disturbing activities that would affect topography, geology, or soils.

- **Hazardous Materials, Hazardous Waste, and Solid Waste.** NHTSA's action alternatives are performance-oriented and technology neutral; manufacturers may choose any method of compliance which produces a sound that complies with the acoustic specifications laid out in the Final Rule. The drivetrain or other engine components of some HVs could be specifically modified to add sound, allowing them to meet the requirements in the Final Rule without the use of a speaker system. However, NHTSA acknowledges that many manufacturers may choose to install a speaker system to comply with the action alternatives . To the degree to which some vehicle manufacturers already install speaker systems, those vehicles would not be associated with any additional impacts in these resource areas. To the extent that the remaining vehicle manufacturers choose to use speaker systems to meet the minimum sound requirements of the Final Rule, the action alternatives could lead to an increase in waste (both hazardous and solid), generated through the increased use of speakers. Beryllium is a material used in some, but not all, speakers for the diaphragm component and is a listed hazardous material when included in a component (Stones Sound Studio, 2004). Processing beryllium can cause potential respiratory health risks if workers inhale any dust, and beryllium also requires proper hazardous waste disposal (OSHA, n.a.). However, the processing of beryllium requires compliance with the National Emission Standards for Hazardous Air Pollutants.[40] Factories that produce speaker systems would be expected to have the necessary permits and procedures in place to manage this type of waste or potential health risks. Thus, the manufacturers that choose to install speaker systems specifically to meet the minimum sound requirement of the Final Rule would cause a *de minimus* impact on human health related to hazardous material processing.

- **Water Resources (including Wetlands and Floodplains).** The action alternatives will not require any construction or other ground-disturbing activities or result in any emissions that would affect water resources, wetlands, and floodplains.

- **Historical and Archeological Resources.** The action alternatives will not require any construction or other ground-disturbing activities that would affect cultural resources, and because the sound levels associated with the proposal are comparable to ICE vehicles, no vibrational impacts on historical or archaeological resources are expected.

[40] 40 CFR § 61.32.

- **Farmland Resources.** The action alternatives will not require any construction or other ground-disturbing activities or result in any emissions that would affect farmland.

- **Air Quality and Climate.** In general, EVs/HVs have lower emissions and fuel use than ICE vehicles. The action alternatives will require EVs/HVs to emit a minimum sound, though NHTSA does not expect this to result in a material change in the demand for EVs/HVs or in vehicle usage patterns. Therefore the proposal is not anticipated to affect air quality or climate change and its associated impacts.

- **Environmental Justice.** NHTSA does not expect that the minimum sound requirements under either of the action alternatives would impact the geographic distribution or rate of deployment of EVs/HVs. In addition, Environmental Justice populations in urban and non-urban environments are not expected to be affected any differently than the general population in the same or similar environments. Furthermore, because the analysis in this document generally projects that any noise impacts would not be detectable to the average person 7.5 meters or greater from the source, Environmental Justice populations are not expected to be affected. Consequently, consistent with Executive Order 12898 and DOT Order 5610.2a, NHTSA does not anticipate that the action alternatives will result in disproportionately high and adverse human health or environmental effects on minority or low-income populations.

3.2 Urban and Non-Urban Environments

For the purposes of the analysis presented in this EA, the affected environment is separated into urban and non-urban areas. This distinction allows NHTSA to take into account the variability in the usage patterns of EVs/HVs in these environments due to differences in population, average vehicle density, deployment of EVs/HVs, ambient sound level, and travel speeds. As used in this EA, the term "urban" is used to encompass the U.S. Census Bureau's "Urbanized Areas (50,000 or more people) and "Urban Clusters" of 2,500 to 49,999 people. The term "non-urban" in this EA is equivalent to the term "rural" as used in the U.S. Census, which encompasses all areas outside of the urban areas and urban clusters (U.S. Census Bureau, 2010b). NHTSA considers these two categories to be representative of the geographic areas nationwide where EVs/HVs will be deployed under the Final Rule.

Urban areas include a range of environments with high traffic, high-density conditions. Urban areas may have high levels of ambient noise emitted from a variety of sources, including vehicles. Non-urban areas include a range of environments with low traffic, low-density conditions, and generally low ambient noise conditions; these include areas such as forestland, parks, and farmland. Two resource areas commonly considered under NEPA are national parks lands and tribal lands. For the purposes of this EA, these two resources are considered to be part of the non-urban environment.

The majority of National Parks are located in non-urban areas.[41] The U.S. National Park Service manages the National Park System, which covers more than 84 million acres. An important part of the NPS mission is to preserve or restore the natural soundscapes (also referred to as natural quiet) associated with units of the National Park System (NPS, 2004). An appropriate soundscape is also an important element in how park visitors experience National Parks, as unwanted or inappropriate sounds can detract from the overall enjoyment of their experience (NPS, n.a.). NPS is taking measures to reduce the amount of noise pollution through implementation of the NPS Soundscape Management Policy 4.9. Thus, the evaluation of potential noise impacts is important for these areas.

In addition, most tribal areas and roads owned by tribal governments are in non-urban areas. There are approximately 56 million acres of Federal Indian reservation land in the United States. The Federal Highway Administration's Indian Reservation Road Program estimates that nearly 33,000 miles of public roads and 940 bridges are owned by tribal governments. The IRR program also consists of more than 61,000 miles of public roads owned by State and local governments. Over 2 billion vehicle miles are traveled annually on the entire IRR system (FHWA, 2011b).

3.3 Noise

3.3.1 Affected Environment

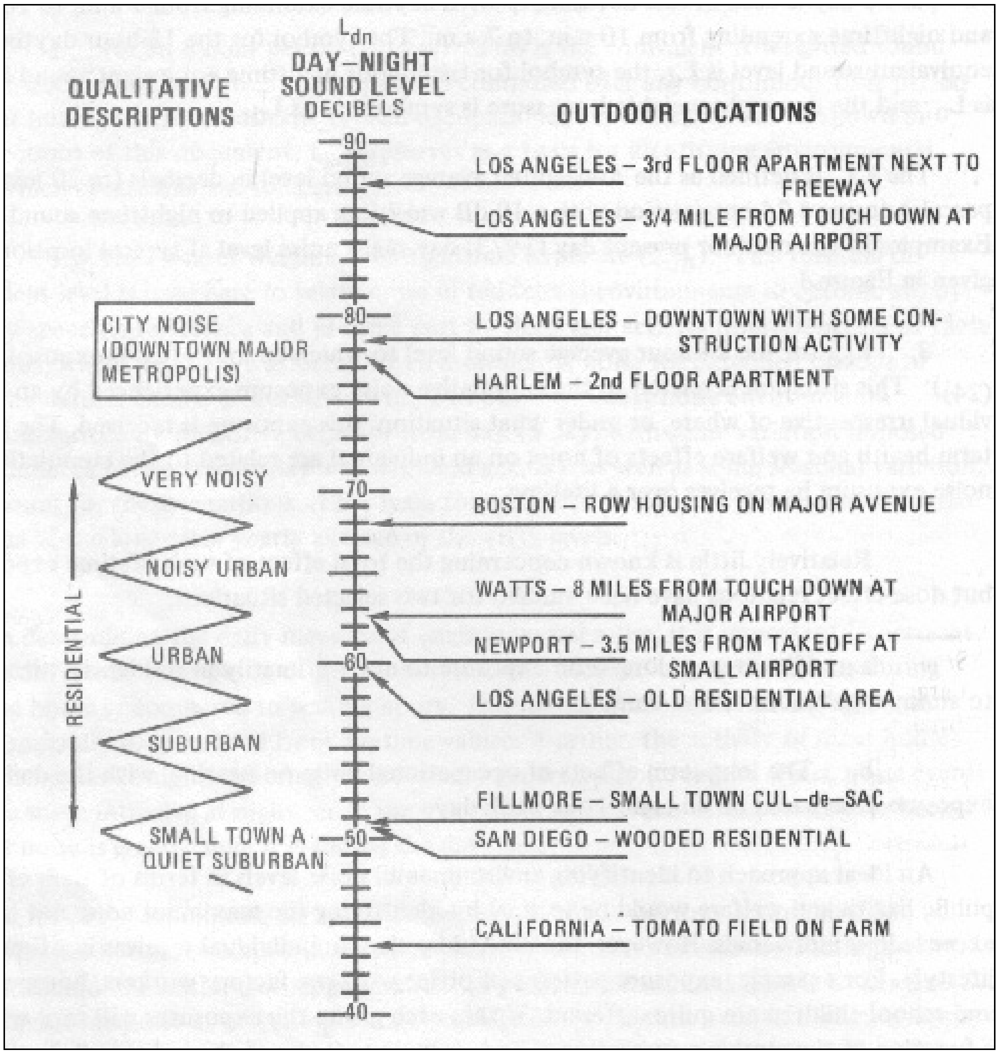
Noise can be defined as sound that disrupts normal activities or that diminishes the quality of the surrounding environment. Sound is generally measured in decibels, which is a logarithmic scale (*see* Appendix A for further introductory sound information). An increase in sound of 3 dB represents a doubling of sound energy, and it is often considered the point at which a sound level change is likely to be noticeable for a human (Rossing, 2007).

Under the Noise Control Act of 1972 (42 U.S.C. § 4901, *et seq.*), EPA is directed to coordinate the programs of all Federal agencies relating to noise research and control to promote a healthy noise environment for all Americans. EPA has estimated the ambient sound levels associated with various environments (Figure 3-2) in dB(A) (EPA, 1974). The "Day-Night Sound Level" shown in Figure 3-2, is the A-weighted (adjusted for human hearing) average sound level for a 24-hour period with an additional 10-dB penalty imposed for sound during nighttime hours (10 pm to 7 am). EPA considers approximately 70 dB(A) to be the threshold level for human hearing loss and approximately 45 dB(A) to be the threshold for annoyance and activity interference indoors (55 dB[A] outdoors). Since these characterizations include a penalty for nighttime noise, the values are higher than the actual sound level experienced in most of these

[41] Within the National Park System, a limited number of national park land units can be found in urban areas, such as Golden Gate National Recreation Area in San Francisco and Statue of Liberty National Monument in New York. To the extent that parkland falls in an urban environment, the projected environmental impacts of the proposed rule for that area would be expected to be consistent with the analysis for urban areas.

environments. A day-night sound level of 65 dB(A) is the level above which the Federal Aviation Administration considers mitigation for aircraft noise around an airport and is also the level at which the Department of Housing and Urban Development deems a building site "unacceptable" for a residence without noise abatement incorporated (Cavanaugh & Tocci, 1998).

Figure 3-2: Outdoor Average Sound Levels at Various Locations



Note: The Day-Night Sound Level (L_{dn}) is the A-weighted average sound level for a 24-hour period with an additional 10-dB penalty imposed for sound during nighttime hours (10 pm to 7 am). Source: (EPA, 1974)

Noise sensitive locations include residential areas, schools, hospitals, churches, and other locations with typically higher pedestrian activity. EPA has identified appropriate noise levels to protect health and welfare for various types of human activities (Table 3.1).

Table 3.1: Summary of Noise Levels That Protect Public Health and Welfare With an Adequate Margin of Safety

EFFECT	LEVEL	AREA
Hearing Loss	$L_{eq(24)} \leq 70$ dB	All areas
Outdoor activity interference and annoyance	$L_{dn} \leq 55$ dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use
	$L_{eq(24)} \leq 55$ dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	$L_{dn} \leq 45$ dB	Indoor residential areas
	$L_{eq(24)} \leq 45$ dB	Other indoor areas with human activities such as schools, etc.

Source: (EPA, 1974)
Notes adapted from original: $Leq_{(24)}$ represents the sound energy averaged over a 24-hour period while L_{dn} represents the L_{eq} with a 10 dB penalty for sounds occurring between 10 pm and 7 am.
EPA has determined that for purposes of hearing conservation alone, the sound level that will protect the entire population has been calculated to be an L_{eq} of 70 dB over a 24-hour day.

3.3.2 Overview of Noise Analyses

The action alternatives will result in a change in the sound level of EVs/HVs in order to make them more detectable and recognizable to pedestrians at a distance of up to 15 meters (for 20 km/h). Thus, the main potential environmental impact of the two action alternatives compared to the No Action Alternative is a change in the overall community noise level when such vehicles are in operation.

Noise is considered to be a local problem in that it dissipates rapidly as distance from the source increases. Therefore, the increase in sound level of a vehicle or vehicles in a neighborhood could have local effects on community sound levels. Because NHTSA's action will require nationwide implementation of a sound requirement for EVs/HVs, this EA includes an analysis at both the community level and the national level. Specifically, this Final EA addresses both the potential for local change in sound levels near a roadway and the magnitude of the change in sound levels nationally on an annual basis. It addresses the resulting impacts on urban and non-urban areas and on wildlife.

The first noise analysis approach, the community noise impact analysis (Section 3.3.3), models changes in overall community sound level experienced by an individual listener resulting from various hypothetical EV/HV deployment levels under either of the action alternatives compared to the same deployment levels under the No Action Alternative. The same model is also applied to evaluate the difference in sound level experienced by a listener for a single vehicle pass-by event (Section 3.3.4).

The second approach, the annual noise analysis (Section 3.3.5), accounts for vehicle operations affected by the action alternatives as a proportion of total national, annual vehicle operations. Sections 3.3.5.1 through 3.3.5.5 provide the background information on NHTSA's assumptions regarding the vehicle operations affected by the action alternatives and taken into account for the annual noise impact analysis. The results of the annual noise impact analysis of the projected sound changes under the action alternatives are presented in Section 3.3.5.6.

Section 3.3.6 summarizes the projected noise impacts presented in these sections.

3.3.3 Impacts on Community Noise near Roadways: Saturation traffic flow

NHTSA created a basic sound model to assess the potential change in overall community sound level experienced by an individual standing near a roadway on which the base saturation flow of traffic is passing. "Base saturation flow rate" is defined by the Transportation Research Board (TRB) as the average expected number of vehicles per hour per lane of traffic for a through-lane (no turns) (TRB, 2010). The TRB's 2010 Highway Capacity Manual (TRB, 2010) provides default base saturation flow rates for urban (≥250,000 people) and non-urban (<250,000 people) settings. These values for non-turning lanes are 1,900 and 1,750 passenger cars per lane per hour, respectively. Using these values, it is possible to determine headways (spacing between vehicle center lines in seconds) and thereby calculate the linear spacing between vehicles for a given speed. This is important for evaluating sound attenuation by distance when calculating total sound levels from a set of vehicles.

The "saturation traffic flow analysis," presented in the analysis of community noise impacts in this EA, takes into account three different ambient sound levels: (1) no ambient sound; (2) a quiet non-urban environment (ambient sound level of 35 dB[A]); and (3) a moderate urban environment (ambient sound level of 55 dB[A]). EPA has designated an ambient sound level of 55 dB(A) level as corresponding to a moderate urban environment and also the level below which public health and safety are protected during outdoor activities. NHTSA has also determined that 55 dB(A) is an ambient sound level representative of an environment in which visually impaired pedestrians expect to be able to detect vehicles based on hearing alone, and therefore this level provides the basis for the minimum sound requirements promulgated in the Final Rule. For comparison, a quiet environment, such as a non-urban area, has an average ambient sound level of approximately 35 dB(A).

For this analysis, NHTSA calculated the environmental impacts of sound emissions for a person hearing the sound (the "receiver") either 7.5 or 15 meters (25 or 50 feet, respectively) away from the source. These distances mirror the voluntary standards for environmental measurement of sound established by the American National Standards Institute (ANSI, 1992, 1994). Sound levels are expected to be higher at 7.5 meters from the source than at 15 meters due to sound attenuation. Sound attenuation is the reduction in sound intensity as sound waves travel through a medium. Sound attenuation over a distance can be affected by many factors, such as topography, buildings and other structures, vegetation, foliage, wind, and temperature. Because the 7.5 meter distance results in the most conservative (highest) estimate of potential noise impacts for receivers close to the roadway, results for this distance are presented below. Results from the 15 meter distance are presented in Appendix F.

For the community noise impact analysis, NHTSA analyzed a range of EV/HV deployment rates, reflecting the uncertainty in projecting the makeup of the future vehicle fleet. The forecast for EV/HV deployment rate in the *Annual Energy Outlook 2012 Early Release*[42] (EIA, 2012) projects that EVs/HVs will account for 4.1 percent of all new LDV sales in 2017 and 8.2 percent of all LDV sales in 2035. As a result, the total fleet-wide percentage of EVs/HVs is projected to be 6.6 percent in 2035. Therefore, while this EA includes projected results for EV/HV deployment rates up to 100 percent (*see* Appendix F), the range of projected deployment in the foreseeable future is likely to be much less than 20 percent. The analyses presented in this chapter focus on 10- and 20-percent deployment of EVs/HVs, which is close to, but greater than, the EV/HV deployment rate projected by the Annual Energy Outlook, thereby maximizing the potential impacts in the analysis. In effect, this analysis demonstrates the likely upper bound of possible environmental impacts of the action alternatives.

The following explains the assumptions underlying the saturation traffic flow analysis:

- The person hearing the vehicles (the “receiver”) is 7.5 or 15 meters (approximately 25 or 50 feet, respectively) away from the roadway at a point equidistant from the ends of the line of vehicles (results from 7.5 m are presented in this section; results from 15 m are presented in Appendix F).
- Vehicles pass by the receiver in a line with each vehicle consistently spaced from one another (line source or pseudo-line source) at urban or non-urban saturation flow rates (distances calculated based on saturation flow at a given speed).
- Base saturation flow rate is 1,900 vehicles per hour per lane for urban areas and 1,750 for non-urban areas (TRB, 2010).
- Vehicle pass-by is at a single constant speed (or all vehicles are stationary).
- The line contains 50 vehicles. The number of vehicles in the line was calculated to determine the vehicle line length at which additional sound from the next car was 0.1 dB

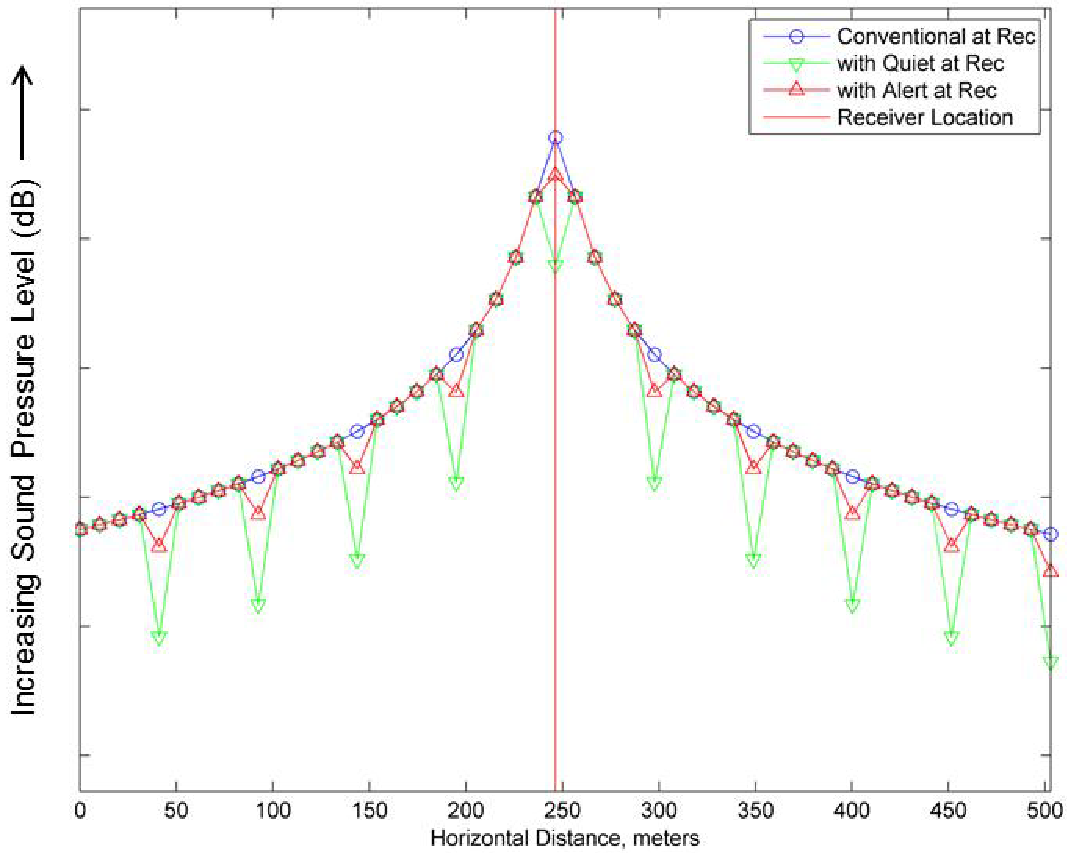
[42] At the time NHTSA performed the analysis in the Draft EA, the AEO 2012 Early Release was the most up-to-date forecast publicly available. Consistent with the Draft EA, this Final EA analyzes the effects of the MY 2017-2025 CAFE standards on EV/HV deployment in the Cumulative Impacts analysis in Section 3.5. As a result, because the other sections must rely on a forecast that precedes the issuance of that Final Rule in order to exclude the impact of CAFE, NHTSA has not updated the analyses that rely on AEO 2012 Early Release to reflect a newer version of the AEO. Nevertheless, NHTSA has reviewed AEO 2016 and calculated that the total LDV fleet-wide percentage of EVs/HVs is projected to be 8.0 percent in 2035. This EV/HV deployment forecast is roughly proportionate with the AEO 2012 Early Release, which projects 6.6 percent in 2035. NHTSA has therefore determined that the analyses in this EA are accurate and valid for its environmental analysis.

or less (i.e., not perceptible), even with zero attenuation of sound for distance. Because the resulting line length was 43 vehicles, 50 vehicles were used for the modeling effort in order to capture the maximum potential environmental impacts as well as to provide an easy method to adjust percentages of quiet/sound alert vehicles in the model by whole vehicle increments (1 vehicle change = 2 percent change in deployment rate).

- EVs/HVs are uniformly distributed in the line based on the percentage of EVs/HVs anticipated to be present in a given scenario of vehicle deployment, ambient sound level, and vehicle spacing.
- EVs/HVs are represented in the analysis by the sound generated by a 2010 Toyota Prius, which is quieter than the other two hybrids (2009 Highlander and 2009 Civic) measured (Garay-Vega, Hastings, Pollard, Stearns, & Michael, 2010). This assumption provides a conservative estimate of quiet vehicle sound level compared to the actual anticipated deployment of a range of EV/HV types, thus providing an estimate of the maximum potential impact of the action alternatives. ICE and EV/HV vehicle sound levels are based on existing OICA data and data from the NHTSA Phase 2 and Vehicle Research and Test Center reports (Hastings, Pollard, Garay-Vega, Stearns, & Guthy, 2011, Hastings, Guthy, Pollard, & Garay-Vega, 2012).

Figure 3-3 shows an example schematic of the saturation traffic flow model at 20 percent deployment of EVs/HVs. Note that the sound level of a vehicle closest to the receiver is highest and that the sound level drops with distance. The sound levels from each vehicle along a given line have been summed and then compared to evaluate the difference in overall sound among sets with and without EVs/HVs and with and without the minimum sound requirement.

Figure 3-3: Schematic Representation of Saturation Traffic Flow Noise Model



Note: This figure shows a schematic representation of saturation traffic flow noise model showing the sound levels at the receiver ("at Rec.") as a result of a line of vehicles passing an individual receiver located 7.5 meters away from the closest vehicle (shown by the vertical center line). Example shows 20 percent deployment of EVs/HVs. Sound exposure is calculated by adding the sound from each vehicle in the line.

To model the impacts of the Preferred Alternative, NHTSA adjusted the sound profile of the representative EV/HV (Toyota Prius) by adding sound to meet the minimum sound requirements of the Final Rule. Because the Final Rule allows for a range of potential overall SPLs depending on the selection of the individual four one-third octave bands for the four-band approach, or individual two one-third octave bands for the two-band approach, the modeling for this EA used the highest SPL in the range for each speed, and then added 4 dB to that level to account for likely manufacturer exceedance of the requirement, in order to conservatively estimate the greatest likely difference between the no action and Alternative 2. For Alternative 3, the minimum sound requirement of 48 dB(A) was assumed to apply to the 400 Hz range because this range contributes significantly to detectability due to low ambient sound levels in this range, and because it is within the frequency range suitable for the two minimum sound requirements specified. Thus, sound was added to the representative EV/HV profile to ensure a 48 dB(A) contribution for the 400 Hz frequency at speeds between zero and 20 km/h.

Table 3.2 shows the scenarios NHTSA analyzed using the saturation traffic flow noise model to identify the change in ambient sound level projected to occur under the action alternatives.

Table 3.2: Scenarios Analyzed Using the Added Sound Saturation Traffic Flow Model for a Receiver Near a Roadway

Operating condition (km/h)	Percent deployment of EVs/HVs within the set of 50 vehicles analyzed	Vehicle gap (m) – urban	Vehicle gap (m) – non-urban	ICE vehicle dB(A) [+]	Alt. 1 EV/HV dB(A)[+]	Alt. 2 EV/HV dB(A) [+*]	Alt. 3 EV/HV dB(A) [+*]
Stationary	2, 4, 10, 20, 50, 80, 90 96, 98, 100	0	0	54.2	not detectable	49.9	not detectable
10		5.3	5.7	59.3	49.4	56.7	51.8
20		10.5	11.4	66.1	59.5	64.0	59.8
30		15.8	17.1	69.7	65.7	69.2	65.7

Other Model Parameters Applied to the Scenarios Described in Table:
Number of vehicles: 50. Vehicle length: 5 meters.
Performed for two receiver distances (7.5 and 15 m).
Performed without ambient and with ambient sound level for urban environment (55 dB[A]) and non-urban environment (35 dB[A]). When ambient sound is included, the baseline EV/HV sound level stationary is set equal to the ambient sound level.
+Vehicle decibel levels are indicated for the standard distance of 2 m from the centerline of the vehicle. The model accounts for sound attenuation depending on the receiver distance used and adjusts the modeled sound level accordingly.
*dB(A) presented in this table and modeled are different from the minimum sound requirements because they encompass total vehicle sound as well as the minimum sound requirements for specific frequency regions. Note also that the values for Alternative 2 include the addition of 4 dB to the required sound to address potential exceedance of those requirements by automobile manufacturers to ensure compliance.

The output of the saturation traffic flow analysis, shown in Table 3.3, is the difference in overall noise level in decibels for a person 7.5 meters away from the roadway under each of the action alternatives, as compared to the No Action Alternative. As noted above, differences smaller than 3 dB are unlikely to be noticeable to a receiver (listener) (Rossing, 2007).

In order to provide context for these results, Table 3.4 shows the difference between each of the three alternatives and a scenario of zero EV/HV deployment. These results allow the reader to understand how EV/HV deployment will continue to reduce overall vehicle sound levels experienced by a listener under the No Action Alternative (baseline) or either action alternative when compared with a scenario in which the fleet is comprised of all ICE vehicles.

Table 3.3: Sound Level Differences Between the Action Alternatives and the No Action Alternative as Experienced by a Listener 7.5 Meters From the Roadway

Vehicle spacing	Ambient sound level	Percent EVs/HVs	Speed (km/h)	Alt. 2 vs. Alt. 1 (No Action Alternative) (dB)	Alt. 3 vs. Alt. 1 (No Action Alternative) (dB)
Non-urban vehicle spacing	No ambient sound (0 dB[A])	10	0	0	0
			10	0.1	0
			20	0.1	0
			30	0.2	0
		20	0	0.1	0
			10	0.2	0
			20	0.2	0
			30	0.3	0
	Non-urban (35 dB[A])	10	0	0	0
			10	0.1	0
			20	0.1	0
			30	0.2	0
		20	0	0.1	0
			10	0.2	0
			20	0.2	0
			30	0.3	0
Urban vehicle spacing	No ambient sound (0 dB[A])	10	0	0	0
			10	0.1	0
			20	0.1	0
			30	0.2	0
		20	0	0.1	0
			10	0.2	0
			20	0.2	0
			30	0.3	0
	Urban (55 dB[A])	10	0	0	0
			10	0	0
			20	0.1	0
			30	0.1	0
		20	0	0	0
			10	0.1	0
			20	0.2	0
			30	0.3	0

Model parameters are described in Table 3.2.
See Appendix F for additional results for higher and lower EV/HV deployment levels.

Table 3.4: Sound Level Differences Between the Alternatives and a Scenario With Zero EVs/HVs as Experienced by a Listener 7.5 Meters From the Roadway

Vehicle spacing	Ambient sound level	Percent EVs/HVs	Speed (km/h)	Alt. 1 vs. Zero EV/HV Scenario (dB)	Alt. 2 vs. Zero EV/HV Scenario (dB)	Alt. 3 vs. Zero EV/HV Scenario (dB)
Non-urban vehicle spacing	No ambient sound (0 dB[A])	10	0	-0.1	-0.1	-0.1
			10	-0.2	-0.1	-0.2
			20	-0.2	-0.1	-0.2
			30	-0.2	0	-0.2
		20	0	-0.2	-0.2	-0.2
			10	-0.4	-0.2	-0.4
			20	-0.5	-0.2	-0.5
			30	-0.4	-0.1	-0.4
	Non-urban (35 dB[A])	10	0	-0.1	-0.1	-0.1
			10	-0.2	-0.1	-0.2
			20	-0.2	-0.1	-0.2
			30	-0.2	0	-0.2
		20	0	-0.2	-0.1	-0.2
			10	-0.4	-0.1	-0.3
			20	-0.5	-0.2	-0.4
			30	-0.4	-0.1	-0.4
Urban vehicle spacing	No ambient sound (0 dB[A])	10	0	-0.1	-0.1	-0.1
			10	-0.2	-0.1	-0.2
			20	-0.2	-0.1	-0.2
			30	-0.2	0	-0.2
		20	0	-0.2	-0.2	-0.2
			10	-0.4	-0.2	-0.3
			20	-0.4	-0.2	-0.4
			30	-0.4	-0.1	-0.4
	Urban (55 dB[A])	10	0	0	0	0
			10	-0.1	0	-0.1
			20	-0.1	-0.1	-0.1
			30	-0.2	0	-0.2
		20	0	-0.1	0	-0.1
			10	-0.2	-0.1	-0.1
			20	-0.3	-0.1	-0.3
			30	-0.3	-0.1	-0.3

Model parameters are described in Table 3.2.
See Appendix F for additional results for higher and lower EV/HV deployment levels.

Alternative 1 (No Action)

Under the No Action Alternative, the sound level for a receiver near a roadway would be slightly quieter than would be anticipated if there were no EV/HV deployment. This difference is no greater than 0.5 dB for all the scenarios at 10 and 20 percent deployment of EVs/HVs (Table 3.4) and therefore is unlikely to be noticeable to the average listener.

Alternative 2 (Preferred Alternative) compared with Alternative 1 (No Action)

As shown in Table 3.3, using the traffic flow analysis described above for urban saturation flow and vehicle spacing, but no ambient sound, and assuming a deployment of 10 percent EVs/HVs, a receiver 7.5 meters from a roadway would be expected to experience no increase in sound level at stationary, and increases of 0.1 dB at 10 and 20 km/h and 0.2 dB at 30 km/h under the Preferred Alternative as compared to the No Action Alternative. At 20 percent EV/HV deployment, there would be an expected difference of 0.1 dB at stationary, 0.2 dB at 10 and 20 km/h, and 0.3 dB at 30 km/h. Note that the analyses performed for the EA took a conservative approach to estimating potential environmental impacts by assuming compliance using the upper value of the overall sound levels used for the four-band option. The overall levels of the two-band approach fall within the range of the four-band approach and therefore the worst-case scenario (highest overall sound levels) modeled herein addresses both options.

The experienced increase in sound level is lower when the urban ambient sound level is included in the analysis because the higher ambient sound would add a significant amount of energy to the overall sound pressure level, thus reducing the perceived difference due to the added sound. When the urban ambient sound level is incorporated into the model, the difference in overall sound between the Preferred Alternative and the No Action Alternative at 10 percent EV/HV deployment is projected to be between zero and 0.1 dB at all analyzed operating conditions. At 20 percent deployment the range is projected to be between zero and 0.3 dB.

In a non-urban environment (non-urban saturation flow and vehicle gap, but without ambient sound incorporated), the sound level would be zero to 0.2 dB higher than the No Action Alternative at 10 percent deployment and zero to 0.3 dB higher at 20 percent deployment. This result is not projected to change when the non-urban ambient sound level (35 dB[A]) is included in the analysis.

Even if EVs/HVs were to achieve 50 percent deployment (far beyond the deployment levels anticipated in 2035), the difference between the Preferred Alternative and No Action Alternative is projected to reach a maximum of 1.0 dB in non-urban environments and 0.8 dB in urban environments (*see* Appendix F for these and more results). In all cases, the perceived difference for a receiver 15 meters from the roadway would be lower than that for a receiver at 7.5 meters due to the effects of sound attenuation.

As stated above, sound level changes of less than 3 dB are not readily noticeable (Rossing, 2007). FHWA guidance also indicates that L_{eq} changes of less than 3 dB are not discernible (FHWA, 2011a).

Alternative 3 compared with Alternative 1 (No Action)

For the saturation flow analysis presented above, under Alternative 3, there would be no difference in overall sound level at 10 or 20 percent EV/HV deployment compared to the No Action Alternative at all speeds subject to the Final Rule. The difference between Alternative 3 and the No Action Alternative is zero in all cases because the difference in sound level of EVs/HVs between the two alternatives are small enough that in a set of 50 vehicles, as used for this analysis, the sound of the ICE vehicles dominates the overall sound level in both alternatives.

Even assuming 50 percent EV/HV deployment, the difference between Alternative 3 and the No Action Alternative is projected to reach a maximum of 0.1 dB (*see* Appendix F for more results). In all cases, the perceived difference for a receiver 15 meters from the roadway would be lower than that for a receiver at 7.5 meters.[43]

3.3.4 Impacts on Community Noise near Roadways: Single vehicle pass-by

The modeling and results described in Section 3.3.3 apply to the overall sound level experienced near a busy roadway (i.e., saturation flow rate). However, in quiet neighborhoods, it may be more common for a receiver to experience the pass-by of a single vehicle. Therefore, NHTSA used a modified version of the model described in Section 3.3.3 to calculate the sound level change experienced by a receiver 7.5 or 15 meters away from the roadway as a result of the pass-by of a single ICE vehicle, a single EV/HV without added sound, or a single EV/HV emitting the minimum sound that would be required under each of the action alternatives.

In addition to applying to EVs/HVs in non-urban neighborhoods, the analysis in this section would apply to the use of low speed vehicles in communities that value quiet, such as resort communities. In such communities, ambient sound levels may be lower than in the average non-urban community. When the ambient sound levels are lower, the sound of any vehicle will be more prominent than it is when the ambient sound levels are higher. To accommodate this, the analysis includes results for a single vehicle pass-by with no ambient sound. While the impact in

[43] The National Park Service has a protective noise regulation for all motorized equipment (including motor vehicles), which requires sound levels at a 15 meter (50 foot) distance to be below 60 dB(A) (36 CFR § 2.12). Based on modeling shown above, in low ambient sound environments, vehicles equipped with the minimum sound required under the Preferred Alternative or Alternative 3 never exceed 60 dB(A) at any speed at a 15 meter (50 foot) distance. Therefore, neither action alternative is projected to interfere with compliance with NPS's protective noise regulation.

these areas may be greater, single vehicle pass-by events likely would be less frequent than in the average non-urban community.

We note that the proposal was designed to increase the detectability of individual vehicles under the action alternatives and, therefore, EV/HV sound levels from vehicles emitting the minimum required sound at 7.5 and 15 meters are intended to be higher than those of existing EVs/HVs. In this analysis, changes due to single-vehicle pass-by are compared to existing variation in vehicle sound levels to provide context for the potential impacts. Single vehicle pass-by results are summarized in Table 3.5.

Table 3.5: Sound Level Differences in dB(A) for the Single-Car Pass-by of a EV/HV With or Without the Minimum Sound Requirement

		Alt. 1	*Alt. 2*		*Alt. 3*	
Ambient sound level	**Speed (km/h)**	**EV/HV without added sound vs. ICE**	**Alt. 2 EV/HV vs. EV/HV without added sound**	**Alt. 2 EV/HV vs. ICE**	**Alt. 3 EV/HV vs. EV/HV without added sound**	**Alt. 3 EV/HV vs. ICE**
No ambient sound (0 dB[A])	0	*	*	-4.4	0	*
	10	-9.9	7.3	-2.6	2.4	-7.5
	20	-6.6	4.4	-2.2	0.3	-6.3
	30	-4	3.6	-0.4	0	-4
Non-urban (35 dB[A])	0	-14.6	10.4	-4.2	0	-14.6
	10	-9.1	6.6	-2.5	2	-7.1
	20	-6.5	4.2	-2.3	0.3	-6.2
	30	-4	3.5	-0.5	0	-4
Urban (55 dB[A])	0	-1.5	0.6	-1	0	-1.5
	10	-2	1.1	-0.9	0.2	-1.8
	20	-3.5	2.1	-1.4	0.1	-3.4
	30	-3	2.7	-0.3	0	-3

*Non-calculable difference, because the original measurement could not distinguish an actual sound level as it was below the ambient at which the measurements were taken (35 dB[A]). Therefore, when no ambient is included in the analysis, it is not possible to calculate an accurate difference between the vehicles. When ambient is included in the analysis, the sound of the EV/HV at zero km/h is assumed to be the same as ambient.

Alternative 1 (No Action)

For purposes of analyzing the No Action Alternative, NHTSA compared a single vehicle pass-by event of an EV/HV without added sound to a similar event by an ICE vehicle, as experienced by a listener 7.5 meters away from the roadway. With no ambient sound, the difference between a single-vehicle pass-by of an EV/HV without added sound and an ICE vehicle would be 4 to 9.9 dB at speeds above stationary. This is a noticeable decrease due to the significantly reduced engine noise of EVs/HVs at lower speeds. The benefit tapers off at higher speeds due to the increase in wind and tire noise resulting from operation. Assuming a quiet (non-urban) ambient sound level of 35 dB(A), the single-vehicle pass-by of an EV/HV without added sound is 4 to 14.6 dB quieter than an ICE vehicle. With an urban ambient sound level of 55 dB(A), the single-vehicle pass-by of an EV/HV without added sound is 1.5 to 3.5 dB quieter than an ICE vehicle. These results indicate that EVs/HVs do have the potential to reduce noise levels perceived by a listener resulting from a single-vehicle pass-by event. The following discussion indicates the impacts of the action alternatives on this reduction in noise levels that would otherwise result from use of an EV/HV not subject to additional noise regulation.

<u>Alternative 2 (Preferred Alternative) compared with Alternative 1 (No Action)</u>

For a single vehicle pass-by event, a listener 7.5 meters away from the roadway passed by an EV/HV emitting the sound required under the Preferred Alternative would experience an increase in sound level of between 3.6 and 7.3 dB, depending upon the vehicle's speed (assuming no ambient sound), compared to an EV/HV not emitting additional sound to comply with the minimum sound requirement. Thus, without accounting for existing noise, the difference would be noticeable. However, incorporation of the 55 dB(A) ambient sound environment reduces the perceived increase to 1.1 to 2.7 dB at speeds above stationary and 0.6 dB when stationary, because when the ambient sound level is high, there is a smaller difference between the overall sound level with a just-detectable alert signal and the overall sound level with a quiet vehicle. Therefore, in a moderate urban environment, there would be no readily noticeable change in pass-by sound from a single vehicle, although the increase is nonetheless expected to make the vehicles more detectable to intent listeners using vehicle sound to guide roadway crossing.

Assuming a quiet (non-urban) ambient sound level of 35 dB(A), the difference between the single-vehicle pass-by for an EV/HV meeting the minimum sound requirement and one without the added sound would be 3.5 to 6.6 dB, depending on speed, and 10.4 dB when stationary, a noticeable increase in sound level. NHTSA developed the proposal in order to make individual EVs/HVs more detectable by pedestrians in an ambient environment of approximately 55 dB(A); therefore, detectability is inevitably somewhat higher in quieter environments.

It is important to note that, even among ICE vehicle models, perceived sound levels vary. The OICA dataset for ICE vehicles shows a standard deviation of 5.4 dB when stationary and between 3.1 and 3.5 dB at speeds up to 32 km/h for ICE vehicles (Hastings, Guthy, Pollard, & Garay-Vega, 2012). Therefore, although the difference in sound between a single vehicle pass-by of an EV/HV emitting the minimum required sound under the Preferred Alternative compared to one that doesn't will be noticeable, the difference will be similar to the existing variation that results from differences among ICE vehicles.

Further, the absolute sound level of a single EV/HV emitting the added sound when passing by or when stationary will be 0.3 to 4.4 dB below the sound level of an average ICE vehicle, depending on vehicle speed and ambient noise conditions. Regardless of ambient sound level and speed, EVs/HVs emitting the added sound to meet the minimum requirements (plus 4 dB likely exceedance) are anticipated to be quieter than the sound level of an average ICE vehicle.

Single-car pass-by events in very quiet conditions, such as nighttime, are likely to be infrequent. Furthermore, as the added sound only applies to vehicles traveling at up to 30 km/h (18 mph), the sound will only occur in cases in which a single vehicle pass-by occurs at low speed. Finally, although an individual pass-by event may be noticeable, the noise impacts will be similar to current conditions in terms of both average sound levels and anticipated levels of variation.

Alternative 3 compared with Alternative 1 (No Action)

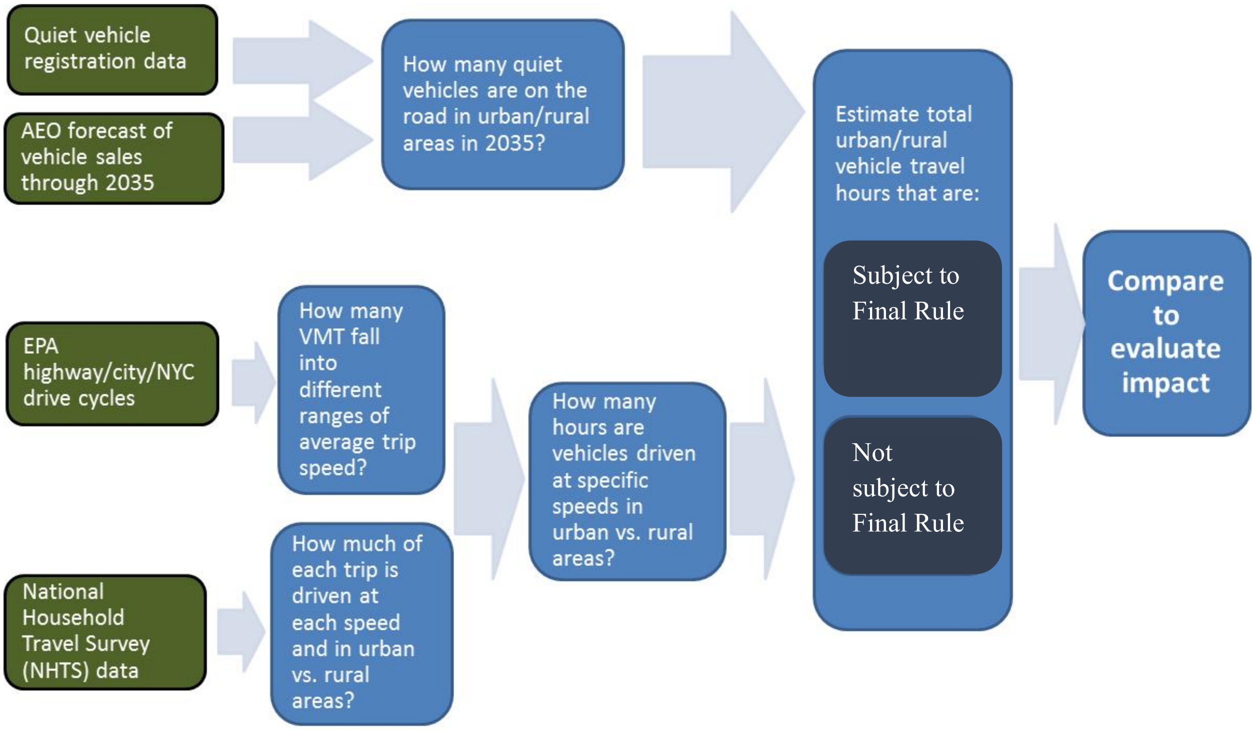
Comparing the single vehicle pass-by under Alternative 3 to the pass-by of an EV/HV without added sound indicates that the increase in sound level under Alternative 3 without any ambient sound taken into account would be 0.3 to 2.4 dB, depending on speed. With the 55 dB(A) ambient sound level incorporated, that difference would be reduced to between zero and 0.2 dB. With the 35 dB(A) ambient sound level incorporated, that difference would be reduced to between 0.3 and 2 dB. In all cases, changes in sound are projected to be less than the 3 dB threshold for sound differences noticeable by people. At most ambient sound levels and most speeds, an EV/HV emitting added sound meeting the requirements of Alternative 3 would be noticeably quieter than an average ICE vehicle.

3.3.5 Annual Noise Impacts Analysis

3.3.5.1 Affected Vehicle Operations

This section describes conditions under the No Action Alternative and the proportion of U.S. light-duty vehicle travel that would be affected by minimum sound requirements under the two action alternatives. This forms the basis for an annual noise analysis and incorporates the total vehicle sound levels used in sound level modeling in Section 3.3.3 to inform the analysis. In order to estimate the proportion of light-duty vehicle travel that would be affected by the proposal annually, this section uses forecasts of EV/HV penetration into the fleet, predictions of vehicle operations, and data regarding the average distribution of vehicle operation time by speed in order to calculate annual hours of vehicle operation subject to the action alternatives. The "annual noise analysis" presented in this EA uses a projection of EV/HV deployment based on the AEO, published by the Energy Information Administration of the U.S. Department of Energy (*see* summary diagram in Figure 3-4).

Figure 3-4: Schematic Diagram of Annual Noise Impact Analysis



This annual noise analysis relies on AEO 2012 Early Release[44] forecasts of new light-duty vehicle sales and vehicle miles traveled for 2017 through 2035. VMT is the number of miles that vehicles are driven and is used in this EA to provide an estimate of total EV/HV operations affected by the action alternatives. Instances of LDV operations not subject to or affected by the action alternatives includes VMT and stationary time for all passenger cars and light trucks sold before 2017,[45] plus all ICE vehicles sold after 2016, including micro-hybrid vehicles (ICE vehicles that turn the engine off when stationary but do not use electric power for propulsion) and a small number of alternative fuel vehicles (e.g., natural gas LDVs). EV/HV operations that are not subject to the action alternatives (e.g. stationary [Alternative 3], operations above 20 km/h [Alternative 3], and operations above 30 km/h [Alternative 2]) are calculated separately from the other LDVs.

[44] See footnote 42.

[45] In the Draft EA, NHTSA assumed that the minimum sound requirements would be made effective in calendar year (CY) 2017. As a result, the annual noise model used in this EA assumes that sound additions would apply to all EVs/HVs sold in CY 2017 or later, based on the AEO forecast for EV/HV sales by calendar year. This simplifying assumption was made to accommodate available AEO data, and it was assumed to only slightly overstate the number of EVs/HVs with sound additions sold in CY 2017. Under the Final Rule, sound addition requirements will be phased in after CY 2017. However, this difference in CYs 2017 through 2019 does not substantially affect the forecast through 2035, when vehicles sold in these years would account for only a small fraction of EVs/HVs in use. Regardless, assuming early deployment of the minimum sound requirements in this Final EA would only overstate the potential environmental impact.

As illustrated in Figure 3-4 and described in more detail below, the annual noise model estimates direct and indirect national sound impacts by combining data on:

- EV/HV and other LDV sales in model years 2017-2035;
- Estimated VMT and vehicle survival rates for EV/HV and other LDVs by vehicle age;
- Estimated urban and non-urban shares of travel for EVs/HVs and other LDVs and VMT for those vehicles in MYs 2017-2035;
- Percent of total VMT in specific speed ranges for both urban and non-urban travel by EVs/HVs and other LDVs in MYs 2017-2035; and
- Estimated total time stationary and in specific speed ranges for EVs/HVs and other LDVs associated with specific average trip speed ranges.

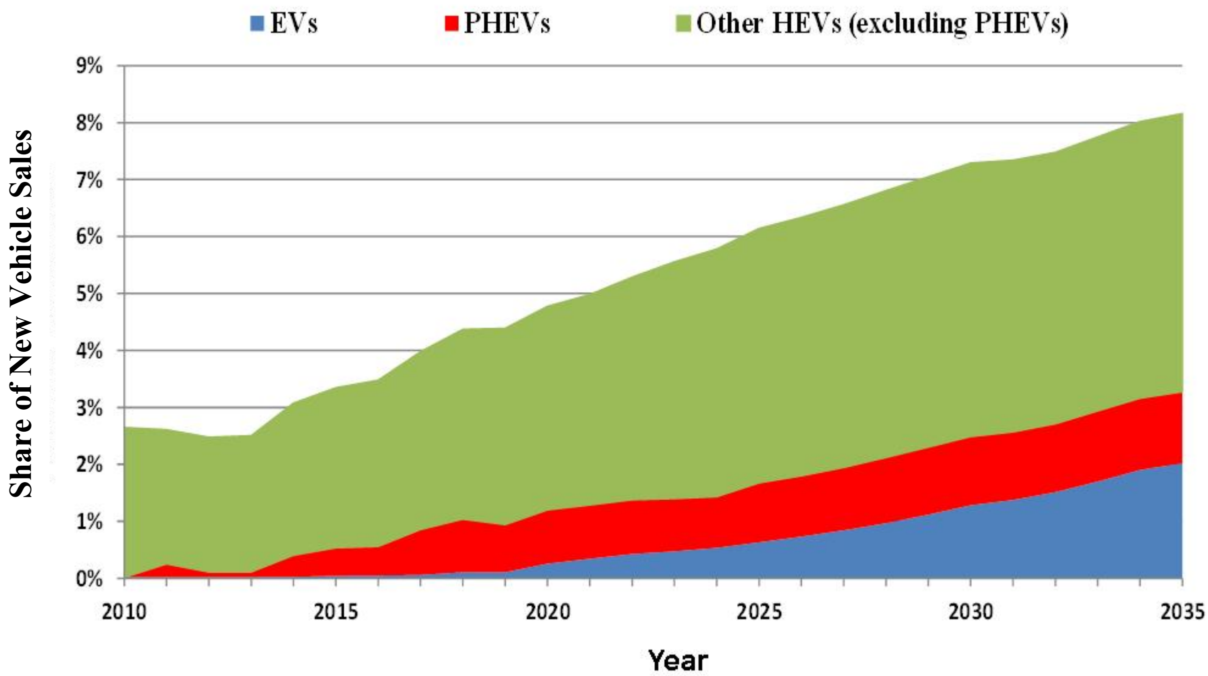
3.3.5.2 EV/HV and other LDV Sales from 2017-2035

To estimate total vehicle operations that would be subject to the action alternatives, it is important to first understand how many EVs/HVs are likely to be in the national fleet when the Final Rule would be in effect. Current trends in EV/HV ownership and use can be combined with projections of future vehicle deployment to provide estimates of EV/HV deployment and distribution between urban and non-urban areas.

U.S. EV/HV sales increased from near zero in 1999 to 352,274 in 2007, and then declined to 274,210 vehicles sold in 2010, reflecting the broader decline in annual vehicle sales since 2007.[46] In total, 1.9 million EVs/HVs were sold from 1999 through 2010. HVs accounted for almost all EVs/HVs sold through 2010, but ongoing growth is now forecast for EVs as well as HVs. AEO 2012 Early Release (EIA, 2012) forecasts that EVs/HVs will account for 4.1 percent of all new LDV sales in 2017 and 8.2 percent of all LDV sales in 2035 (*see* Figure 3-5). Based on the AEO forecast, the total percentage of EVs/HVs in the fleet is projected to be about 6.6 percent in 2035.[47] This forecast does not take into account NHTSA's MY 2017-2025 CAFE action, which could result in a greater market share for EVs/HVs (*see* Section 3.5 Cumulative Impacts).

[46] These figures also include some MHEVs, accounting for approximately 1 percent of these annual sales.
[47] As described in footnote 42, NHTSA has reviewed AEO 2016 (which takes into account NHTSA's MY 2017-2025 CAFE action) and calculated that the total LDV fleet-wide percentage of EVs/HVs is projected to be 8.0 percent in 2035. This EV/HV deployment forecast is roughly proportionate with the AEO 2012 Early Release.

Figure 3-5: AEO 2012 Early Release Forecast for EV/HV Share of New Vehicle Sales

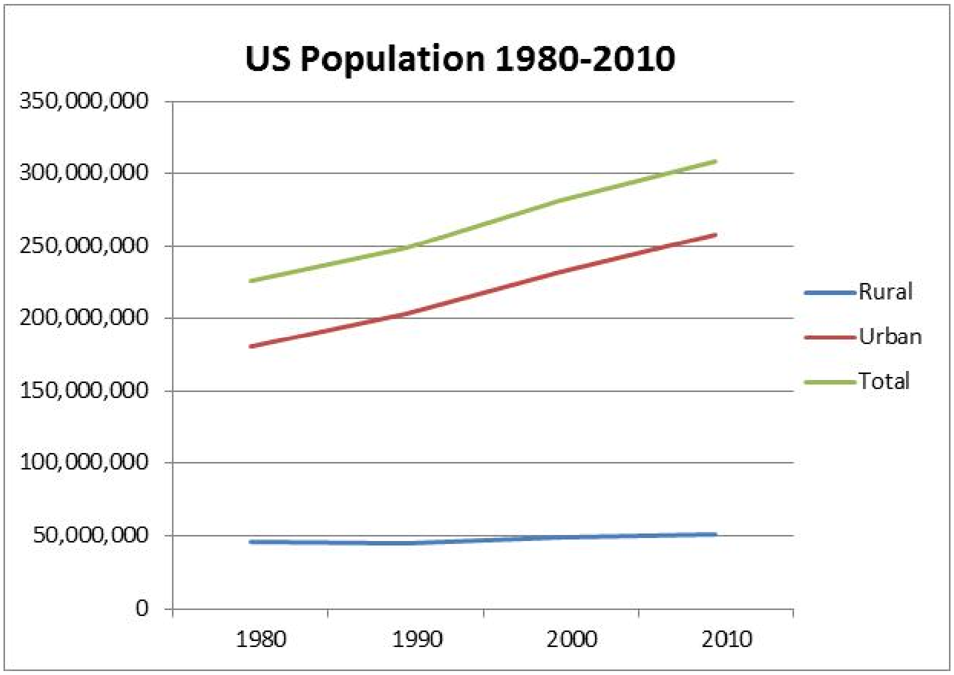


Source: (EIA, 2012)

3.3.5.3 Urban and Non-Urban VMT Estimates for EVs/HVs and other LDVs

The current U.S. population is 308.7 million people, a nine percent increase from 2000 (U.S. Census Bureau, 2010a). As shown in Figure 3-6, the population living in urban areas is increasing at a much faster pace than in non-urban areas. In 2000, the U.S. population living in non-urban areas was almost 48.9 million, but by 2010, this number had increased to almost 52 million. In 2000 the U.S. population living in urban areas was almost 232.3 million; in 2010, this number had increased to 257.7 million. The minimum sound requirements would apply to low speed traffic traveling at 30 km/h or less for the Preferred Alternative and 20 km/h or less for Alternative 3. Traffic at these speeds is mostly associated with urban locations.

Figure 3-6: U.S. Population 1980-2011



Source: (USDA, 2012)

New vehicle registrations by metro area show that EVs/HVs are disproportionately concentrated in large metro areas. Table 3.6 shows the 17 metro areas that were among the top 15 EV/HV markets in at least one year from 2006 to 2009 (with empty cells showing the two out of 17 metro areas that did not rank in the top 15 in any specific year). From 2006 to 2009, the top 15 metro area markets for EV/HV sales accounted for more than 50 percent of total U.S. EV/HV sales, whereas those same metro areas accounted for less than 30 percent of the 2010 U.S. population. (The last two rows of Table 3.6 show the total EV/HV share for the top 15 metro areas in that year, and the percent of U.S. population for those same 15 metro areas.)

The greater concentration of EVs/HVs in larger urban areas is likely to continue. In part, this may be due to the higher fuel savings for these vehicles in areas with more traffic congestion. Fuel economy ratings based on EPA city and highway drive cycles show that highway fuel economy is greater than city fuel economy for ICE vehicles, but city fuel economy is greater than highway fuel economy for many EVs/HVs. This is because EVs/HVs can operate in all-electric mode at slower speeds, and regenerative braking recharges the vehicles' batteries more often in stop-and-go traffic. Therefore, EVs/HVs have a greater economic advantage in areas that have more congested stop-and-go traffic at slower speeds. Other variables, such as usage patterns (less need for four-wheel-drive vehicles, shorter trip distances) and driving/parking conditions (e.g., desire for smaller vehicles), as well as different socioeconomic patterns, may also result in greater EV/HV deployment in urban areas.

Table 3.6: Share of Annual New EV/HV Registrations by Metro Area

	% of U.S New EV/HV/MHEV Registrations			
	2006	**2007**	**2008**	**2009**
Atlanta	1.4%			1.4%
Boston	3.1%	3.0%	3.0%	3.0%
Chicago	3.0%	3.0%	3.3%	3.1%
Dallas/Ft. Worth	1.4%	1.5%	1.6%	1.7%
Denver	2.0%	1.9%	1.9%	1.6%
Los Angeles	12.3%	11.5%	10.8%	9.2%
Minneapolis-St. Paul		1.5%	1.8%	1.4%
New York	5.6%	5.9%	6.7%	7.3%
Orlando				1.4%
Philadelphia	2.7%	2.5%	2.6%	2.5%
Phoenix	1.7%	2.2%	2.4%	1.7%
Portland, OR	1.8%	1.9%	1.6%	
Sacramento	1.9%	2.2%	2.1%	
San Diego	2.0%	2.1%	2.2%	1.6%
San Francisco	8.2%	7.7%	6.7%	5.4%
Seattle	2.9%	3.2%	2.7%	2.7%
Washington, DC	4.5%	3.6%	3.5%	4.0%
Quiet Vehicle Sales Share for Top 15 Metro Areas	**54.5%**	**53.8%**	**52.6%**	**48.1%**
2010 U.S. Population Share for Same 15 Metro Areas	**29.4%**	**28.8%**	**28.8%**	**29.8%**

Sources: (HybridCars, 2007, HybridCars, 2008, HybridCars, 2009, HybridCars, 2010)

One measure for comparing traffic congestion in different cities, a potential indicator of the extent of stop-and-go traffic that makes EVs/HVs more economical, is the *Urban Mobility Report* Travel Time Index, calculated as the ratio of average peak period travel time (work commute hours) compared to free-flow travel time (off-peak weekdays and weekends between 6 a.m. and 10 p.m.) (Shrank, Lomax, & Eisele, 2011). For example, a TTI of 1.20 means that average peak travel times are 20 percent longer than free-flow travel times for the same distance traveled. The average 2010 TTI was: 1.27 in urban areas with over 3 million population; 1.17 in urban areas with population over 1 million and less than 3 million; 1.11 in urban areas with population over 500,000 and less than 1 million; and 1.08 in urban areas with less than 500,000 population. The 2010 TTI values in the 17 urban areas with the highest 2006-2009 shares of

EV/HV registrations range from 1.18 in Orlando to 1.38 in Los Angeles. The TTI index only measures the extent of traffic congestion during peak commuting hours relative to non-peak congestion in the same urban area, but these data are consistent with EV/HV registrations being disproportionately concentrated in larger metro areas where consumers realize the greatest economic value of higher fuel economy at slower speeds.

According to the 2010 census, just 16 percent of the Nation's population lives in non-urban areas. National Household Travel Survey data (FHWA, 2009) show that non-urban households account for 31 percent of all VMT but just 14 percent of VMT associated with trips at an average speed of less than 20 km/h, indicating that non-urban households spend a much smaller proportion of travel time at slow speeds associated with congested traffic. The annual noise model estimates the direct and indirect impacts of the action alternatives for non-urban versus urban areas based on the differences between urban and non-urban percentage of total VMT, low speed VMT, and percent of EV/HV sales.

The higher concentration of EVs/HVs in the largest metro areas through 2009, and the socioeconomic factors and incentives for more EV/HV use in urban areas (where there is more traffic congestion), suggest that the percentage of EVs/HVs in non-urban areas in 2035 will continue the current pattern of reflecting about half the share of the population that is located in non-urban areas.[48] Given that 16 percent of the population lives in non-urban areas, and assuming that the same incentives that drive higher EV/HV ownership in cities continue in the future, this analysis therefore assumes that 8 percent of all EV/HV sales after 2016 would be to non-urban households and 92 percent of EVs/HVs would be sold to households in urban areas. NHTSA applied this assumption only to EVs/HVs sold in calendar year 2017 or later[49] to quantify the growth in VMT associated with EVs/HVs subject to the minimum sound requirements.

The growth forecast for EV/HV VMT after 2016 also reflects the fact that newer vehicles account for a disproportionate share of all VMT, since older vehicles still in use are used less intensively (i.e., less VMT/year) and are gradually retired over time. New LDV survival rates are close to 100 percent in the first few years after a new vehicle is sold, but only 78 percent of light trucks and 84 percent of cars are still in use after 10 years. For those vehicles still in use after 10 years, the average VMT/year declines from 15,000 miles for cars in year 1 to 9,900 miles in year 10, and for trucks, VMT/year declines from 17,500 miles in year 1 to 9,200 miles in year 10 (U.S. Department of Energy, 2012). Therefore, the annual noise model combines the AEO forecasts for VMT and new vehicle sales with both the vehicle survival rates and the VMT per year intensity of use in estimating the EV/HV share of total VMT from 2017 through 2035, with other LDVs accounting for the remainder of forecast VMT.

[48] This rough estimate assumes that the disproportionately high percent of EVs/HVs in large metro areas is indicative of a higher concentration of EVs/HVs in urban areas in general, offset by an especially low concentration of EVs/HVs in non-urban areas.
[49] See footnote 45.

3.3.5.4 VMT by Average Trip Speed

The AEO 2012 Early Release projection of vehicle miles traveled can provide an estimate of total EV/HV operations subject to the action alternatives compared to total LDV operations not subject to the action alternatives. However, in order to understand the potential noise impacts of the action alternatives, it is also necessary to estimate the amount of time vehicles are traveling at speeds that would be subject to the action alternatives.

The Preferred Alternative would require a minimum sound for EVs/HVs at speeds of up to 30 km/h and when stationary, while Alternative 3 would require a minimum sound for speeds up to 20 km/h with no minimum sound requirement at stationary. Therefore, in order to compare among the alternatives, the environmental analysis must differentiate between stationary, activity at speeds up to 20 km/h, and activity between 20 and 30 km/h. NHTSA's analysis involved two steps. First, NHTSA separated travel into average trip speed categories, as this indicates the type of driving that is likely involved in the trip (i.e., congested city, city, or highway). Second, NHTSA used this information to estimate within-trip distribution of time at different speeds and when stationary, based on EPA test procedures used to estimate average fuel economy in these different settings. This subsection addresses the first step (establishing the distribution of trip types according to average trip speed), and the next subsection addresses the use of that information to estimate within-trip distribution of travel time among speeds and when stationary.

NHTS data do not include vehicle speed, but do include trip distance (miles) and time (minutes) that can be used to calculate average km/h for each trip (*see* Table 3.7). NHTS data on trip distance by average trip speed include some stationary time (e.g., at stoplights). As expected, the 2009 NHTS data on the distribution of trip distance indicate that non-urban trips are associated with faster average trip speeds than urban trips.[50]

Table 3.7: Share of NHTS VMT by Average Trip Speed

	NHTS VMT by Trip	
Average Speed	**Non-urban**	**Urban**
< 20 km/h	1.8%	4.9%
20-39 km/h	10.0%	18.0%
39 ≤ km/h < 97	76.2%	63.0%
97 ≤ km/h < 160	12.0%	14.1%

These 2009 NHTS data likely understate the percent of miles driven at slower speeds during a normal year since the recession reduced traffic congestion in 2009. The recession's impact on traffic was also apparent in Urban Mobility Reports, which showed that hours of delay per

[50] NHTSA omitted short-distance trips showing average trip speeds above 160 km/h, most likely due to reporting errors in distance or time.

commuter declined by about 20 percent in 2009 compared with 2006. This reduction in traffic delays was largely associated with faster highway speeds in 2009. Pre-recession 2006 highway commuting speeds were slower than 2009, but still generally well above the maximum speed subject to the proposal. Therefore, the recession's impact on the 2009 NHTS data is not expected to substantively affect this analysis of the sound requirements.

3.3.5.5 Estimated Travel Hours by Speed

For the analysis reported in this EA, NHTSA combined the forecast for total VMT and the calculation of NHTS trip miles by average trip speed with estimates of the percent of travel time drivers spend at specific speeds during a trip. NHTSA used the estimates of travel time spent at specific average trip speeds that EPA uses to calculate miles per gallon (mpg) ratings for new vehicles. EPA "city" mpg reflects a lab test "drive cycle" with 23 stops, 18 percent idling time, and an average speed of 34 km/h. EPA "highway" mpg reflects a drive cycle with no stops, a very small amount of idling time (at the beginning and end of the drive cycle), and an average speed of 77 km/h. The joint NHTSA/EPA city and highway fuel economy ratings that appear on the fuel economy label on new vehicles reflect adjustments to drive cycle results to provide fuel economy estimates closer to the actual fuel economy achieved. These "window sticker" mpg ratings for new vehicles reflect a weighted average of 55 percent city and 45 percent highway mpg. EPA also uses a New York City drive cycle, not reflected in vehicle fuel economy ratings, that has an average trip speed of just 11 km/h, with 35 percent of drive cycle time stationary, designed to characterize congested urban traffic.

For the analysis in this EA, NHTSA used the city, highway, and NYC drive cycles described above in the annual noise model to estimate the nationwide aggregate number of hours spent at different speeds relevant to the sound requirements under the action alternatives. Table 3.8 shows the average speed and the distribution of time associated with each of these three drive cycles. For example, this table shows that travel at speeds above zero but less than or equal to 20 km/h accounts for 40.0 percent of the NYC drive cycle time, 12.2 percent of city drive cycle time, and just 1.5 percent of highway drive cycle time.

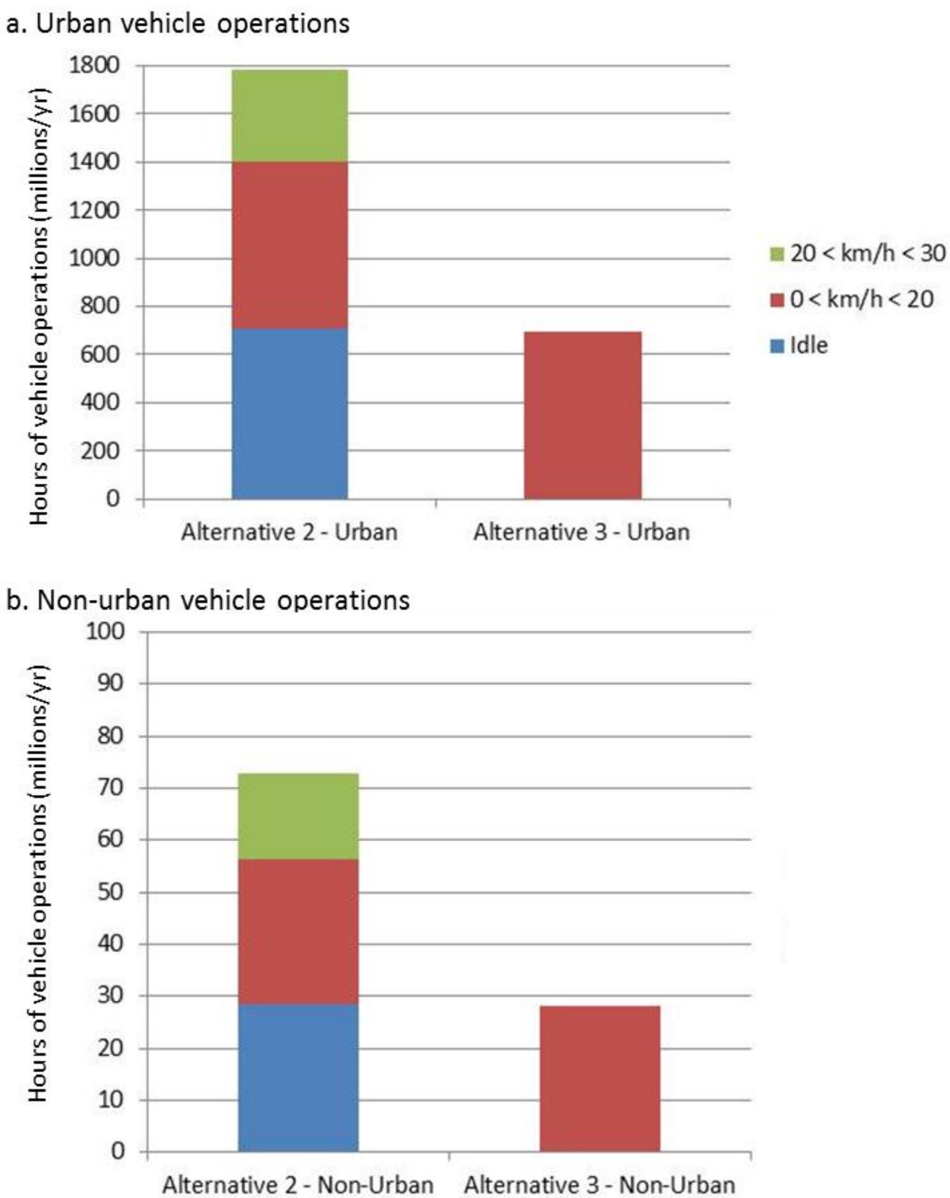
Table 3.8: Average Speed (km/h) and Percent of Vehicle Test Time by Speed for NYC, City, and Highway Drive Cycles

	NYC	**City**	**Highway**
Average Trip (km/h)	11.4	34.1	77.7
Percent of Travel Time			
Stationary	34.9	19.0	0.7
0 < km/h ≤ 20	40.0	12.2	1.5
20 < km/h ≤ 32	15.2	12.2	0.8
32 < km/h ≤ 97	9.9	56.6	97.0

NHTSA assumed that the NYC test cycle in Table 3.8 is representative of the VMT associated with NHTS trips in Table 3.7 with an average speed of up to 20 km/h; the city test cycle in Table 3.8 is representative of the VMT associated with NHTS trips in Table 3.7 with an average speed of 20 to 39 km/h; and the highway test cycle in Table 3.8 is representative of the VMT associated with NHTS trips in Table 3.7 with an average speed above 39 km/h. This information allows NHTSA to translate the NHTS data into available speed categories that most closely match the categories that differentiate the alternatives (i.e., stationary, speeds up to 20 km/h, speeds over 20 km/h and up to 30 km/h, and speeds over 30 km/h).

Based on these assumptions, NHTSA estimated the national aggregate number of vehicle hours of operation per year by speed category. Figure 3-7 shows the annual number of forecast urban and non-urban EV/HV hours of operation at speeds subject to the proposal in 2035. For Alternative 3, vehicle hours subject to the proposal are reflected in the 0-20 km/h category only, as added sound would not be required when stationary or 20-30 km/h under this alternative.

Figure 3-7: Estimated Aggregate EV/HV Hours of Operation (million hours/year) in 2035 at Speeds Subject to Each Alternative for Urban Areas and Non-Urban Areas



Based on the assumptions described above, in urban areas, 2.3 percent of all LDV travel hours would be affected by the minimum sound requirements in 2035 under the Preferred Alternative, as compared to 0.9 percent of all LDV travel hours under Alternative 3. In non-urban areas, 0.3 percent of all LDV travel hours would be affected by the minimum sound requirements in 2035 under the Preferred Alternative, and 0.1 percent of all LDV travel hours would be affected by the minimum sound requirements under Alternative 3. See Appendices B through E for additional information on vehicle hours subject to the Final Rule in years prior to 2035 and vehicle hours for the same years for those vehicles not subject to the Final Rule.

3.3.5.6 National Annual Impact on Noise

The analysis in this section synthesizes the vehicle operations information (Sections 3.3.5.1-5) and the community noise analyses presented in Section 3.3.3 to provide a summary of potential national changes in vehicle sound resulting from the action alternatives.

Table 3.9 shows the number of LDV hours of operation in 2035 by speed for urban and non-urban areas, the associated sound levels for ICE vehicles and for EVs/HVs under each alternative, and the percentage of hours with added sound under each action alternative.[51] The last row of Table 3.9 shows that the Preferred Alternative minimum sound requirements would apply to 1.7 percent of all LDV hours of operation in 2035, and Alternative 3 minimum sound requirements would apply to 0.7 percent of all LDV hours of operation in 2035. Urban and non-urban hours of operation are also evaluated separately. The subtotal rows in this table (in bold) show that the Preferred Alternative and Alternative 3 minimum sound requirements would apply to 2.3 percent and 0.9 percent of all urban LDV hours of operation, respectively, and 0.3 percent and 0.1 percent of all non-urban LDV hours of operation.

Given the low percentage of vehicle hours of operation affected by the action alternatives, and the community sound analyses presented previously, this national analysis suggests that the overall effect of the action alternatives on national noise levels would be very small. Under the No Action Alternative, EV/HV sound levels of 75 dB(A) are expected at speeds above 30 km/h (assuming an average speed of 65 km/h in this speed range). Under both of the action alternatives, no minimum sound is required in this speed range because, in this range, EV/HV sound is equivalent to other LDV sound. Accordingly, the sound levels emitted during the EV/HV operation in this speed category are the same for the No Action Alternative and the action alternatives. The data indicate that 67 percent of urban EV/HV operation hours and 81 percent of non-urban EV/HV operation hours are expected to be at speeds above 30 km/h, where there are no minimum sound requirements under either action alternative, and where the sound per vehicle is already significantly higher than the minimum sound that would be required at slower speeds.

[51] The sound levels under each alternative associated with speeds of zero to 30 km/h reflect the sound levels reported in Table 3.2.

Table 3.9: Annual National Sound Level Impacts of Action Alternatives in 2035

Speed	Million Hours of Operation for All LDVs in 2035	ICE Sound Level dB(A)[52]	Alternative 1 (No Action) EV/HV Sound Level dB(A)	Alternative 2 (Preferred Alternative)		Alternative 3	
				Percent of Hours With Increased Sound	**EV/HV Sound Level dB(A)**	**Percent of Hours With Increased Sound**	**EV/HV Sound Level dB(A)**
Urban							
Stationary	10,251	54.2	Undetectable	6.9%	49.9	0.0%	No increase
0 < km/h < 20	10,021	59.3 – 66.1	49.4 – 59.3	6.9%	56.7 – 64	6.9%	51.8 – 59.8
20 < km/h < 30	5,489	66.1 – 69.7	59.3 – 66.1	6.9%	64 – 69.2	0.0%	No increase
> 30 km/h	52,089	75	75	0.0%	No increase	0.0%	No increase
Total Urban	**77,850**			**2.3%**		**0.9%**	
Non-Urban							
Stationary	2,121	54.2	Undetectable	1.3%	49.9	0.0%	No increase
0 < km/h < 20	2,088	59.3 – 66.1	49.4 – 59.3	1.3%	56.7 – 64	1.3%	51.8 – 59.8
20 < km/h < 30	1,232	66.1 – 69.7	59.3 – 66.1	1.3%	64 – 69.2	0.0%	No increase
> 30 km/h	23,026	75	75	0.0%	No increase	0.0%	No increase
Total Non-Urban	**28,467**			**0.3%**		**0.1%**	
Total Urban and Non-Urban	**106,317**			**1.7%**		**0.7%**	

[52] Sound level shown for ICE vehicles stationary is for non-MHEV ICE vehicles.

3.3.6 Summary of Environmental Consequences (Community and Annual Noise Analyses)

This section summarizes the environmental consequences for each alternative based on all three noise modeling approaches: the community noise level analyses of both saturation flow and single vehicle pass-by effects on sound levels experienced by a listener 7.5 meters from the sound source, as well as the annualized analysis that addresses the percent of vehicle hours of operation that would be subject to the changes identified in the community noise analyses.

Guidelines for evaluating transportation noise impacts, such as those issued by FHWA, recommend measuring impacts based on change in the average sound level over a given amount of time (L_{eq}) (FHWA, 2011a). The saturation traffic flow model analysis provides a decibel level sound difference that would be experienced by an individual near a road during constant traffic flow under the action alternatives. If traffic flow is assumed to be continuous all day and night, the decibel level difference can be assumed to approximate the average sound level change over a 24 hour period (i.e., change in L_{eq}). According to FHWA, traffic noise impacts occur when absolute levels of noise are unacceptably high or when a "substantial" increase in L_{eq} occurs. FHWA considers a substantial increase to be within the range of 5 to 15 dB over existing noise levels (though States may define their own levels within this range) (FHWA, 2011a). FHWA considers changes less than 3 dB to not be discernible. Likewise, NHTSA considers a change of 3 dB to be unlikely to be noticed (Rossing, 2007, NHTSA, 2015).

Because NHTSA has developed minimum sound requirements that would reduce frequency overlap with existing ambient sound, vehicular sound level changes of less than 3 dB as a result of the minimum sound requirement are not anticipated to substantially mask other vehicle sounds in a way that would hinder detection. Although it is possible that even small sound level changes may mask some sounds, those sounds would need to be both near the threshold of noticeability/detectability and overlapping in frequency with the added sound. Therefore NHTSA anticipates that for vehicle sound level changes of less than 3 dB, the risk of masking of other sounds would be low.

3.3.6.1 Alternative 1 (No Action)

The No Action Alternative assumes that NHTSA would not issue the Final Rule requiring a minimum sound for EVs/HVs, and therefore represents the baseline condition to which the action alternatives are compared. Due to the quieter operation of EVs/HVs at low speeds, greater deployment of these vehicles in the future fleet would be expected to result in an overall decrease in vehicle sound levels under the No Action Alternative compared to current levels, although, based on the results of the noise modeling presented in this EA, those changes are likely to be relatively small under most conditions. As noted above, the AEO 2012 Early Release projects a 6.6 percent penetration of EVs/HVs into the fleet by 2035. Under the saturation flow noise modeling analysis, the difference in overall sound levels for a listener 7.5 meters from a roadway assuming either 10 or 20 percent deployment of EVs/HVs (maximizing the potential impacts and encompassing both the forecast deployment rate and a liberal range of uncertainty) versus a scenario in which all vehicles are conventional is projected to be 0.5 dB(A) or less, which is considered a non-noticeable difference for humans. Therefore, under the No Action Alternative, future sound levels would be projected to be slightly lower than current levels, even at EV/HV deployment rates exceeding those currently forecast. However, this decrease is likely to be negated by projected increases in VMT and population, resulting in increased noise overall compared to current levels.

3.3.6.2 Alternative 2 (Preferred Alternative)

In both urban and non-urban environments, using the saturation flow model and assuming either a 10 or 20 percent deployment rate of EVs/HVs, the Preferred Alternative would be expected to result in maximum noise level increases of 0.3 dB(A) for a listener near a roadway as compared to the No Action Alternative. This is below the 3 dB(A) threshold at which changes in sound level are likely to be noticeable. As described above, this change would affect only 2.3 percent of total urban LDV hours of operation in CY 2035 and 0.3 percent of total non-urban LDV hours of operation. In the case of single-vehicle pass-by events, the sound level differences in urban environments due to a single vehicle event are anticipated to be 0.6-2.7 dB, which is unlikely to be noticeable. In non-urban environments, the sound level difference would be 3.1-10.4 dB, which is considered noticeable; however, the difference is comparable in scale to the variation among ICE vehicles on the road today. Even with added sound, the sound level of the individual EV/HV would still be lower than an average ICE vehicle, and single vehicle pass-by events are anticipated to be relatively infrequent.

3.3.6.3 Alternative 3

In either urban or non-urban environments, at EV/HV deployment rates of both 10 and 20 percent, Alternative 3 would cause no perceived overall community noise level increase for a listener near a roadway at any speed. Under Alternative 3, 0.9 percent of urban and 0.1 percent of non-urban overall LDV hours of operation are projected to be driven by vehicles in conditions that would be affected by the Final Rule. Therefore, impacts on overall sound levels in urban and non-urban environments under Alternative 3 are expected to be negligible. Single vehicle pass-by analyses suggest that no increases greater than 3 dB would be experienced by people 7.5 meters from the roadway under Alternative 3 compared to the No Action Alternative.

3.4 Wildlife

An evaluation of the action alternatives' potential impact on wildlife takes into account whether the increase in sound due to minimum sound emissions from EVs/HVs would generate a response that could affect an animal's feeding, breeding, habitat use, or communications. This section describes common noise impacts on wildlife and qualitatively evaluates potential impacts on wildlife due to the Final Rule. A quantitative analysis of noise impacts was not conducted due to the small amount of data available on noise thresholds for wildlife and the national scope of this rulemaking. In an attempt to better understand highway noise impacts on wildlife, FHWA has conducted a review of studies related to noise impacts on wildlife and estimated broad ranges of noise thresholds for different wildlife groups (*see* Table 3.10); this review informed NHTSA's analysis.

3.4.1 Affected Environment

The affected environment for wildlife includes all urban and non-urban areas where suitable wildlife habitat is found adjacent to roadways. Wildlife that may be affected by the action alternatives vary depending on the environment (e.g., urban versus non-urban). Species found in urban environments can vary but typically include birds, deer, and small mammals, such as rodents (mice, rats, and squirrels), rabbits, raccoons, opossums, and bats. Species that might be found in the affected environment in non-urban areas vary widely depending on many factors such as geographic location, habitat quality, and anthropogenic disturbances. Roads in non-urban environments can pass through habitat for many wildlife species, and some may pass through foraging and migration routes. Other roads may pass through agricultural areas where natural habitat has been removed, resulting in the presence of species that have adapted to the agricultural environment. In a comparable setting, a lower density of species would likely be found in the vicinity of roads in the urban environment compared to the non-urban environment due to the fragmentation and removal of habitat in urban areas.

The impact of added EV/HV sound on wildlife would depend on where and how long the added sound occurs, whether or not wildlife are present within a distance the sound can be detected, and the sensitivity of wildlife to the noise level of the added sound. Noise from vehicles generally affects wildlife within close proximity to roads, as noise levels attenuate over distances. Even taking account of the fact that speed limits are often lower on smaller roads in non-urban environments, the vast majority of those roads have posted speed limits above the speed range in which the vehicle would be required to emit sound under either of the action alternatives. Because NHTSA's action would affect vehicles traveling across roads throughout the Nation, this analysis focuses on the general sensitivities of wildlife to noise and how added sound could affect wildlife.

Most wildlife relies on sounds for communicating, navigating, avoiding danger, and finding food. It is well established that human-generated noise can affect wildlife, including changing habitat use and activity patterns, increasing stress response, decreasing immune response, reducing reproductive success, increasing predation risk, degrading conspecific communication, and damaging hearing if the sound is sufficiently loud (Bowles, 1995, Larkin, Pater, & Tazik, 1996). While noise can have an effect on wildlife, the effect is not always adverse. For example, as wildlife is exposed to many different noises in the environment, it can adapt to those noises. Even without human-generated noise, natural habitats have particular patterns of ambient noise resulting from, among other things, wind, animal and insect sounds, and other noise-producing environmental factors such as streams and waterfalls (Dooling & Popper, 2007).

Noise standards in the United States primarily focus on annoyance to humans. Noise exposure thresholds do not exist for wildlife, (U.S. Fish and Wildlife Service, 2008), except for marine mammals and fish, as established by the National Marine Fisheries Service. Some Federal agencies set noise levels to protect a variety of resources on lands under their jurisdiction. For example, the National Park Service implements a noise standard (60 dB at 50 feet) to protect soundscapes, wildlife, aquatic and marine life, cultural resources, and visitors. This noise standard is a best estimate based on the best science available to protect a variety of resources, not just wildlife. It is difficult to establish sharply defined noise thresholds for wildlife because species vary widely in ability to tolerate introduced noise and can exhibit very different responses to altered acoustic environments (Blickley & Patricelli, 2010). Generalizations regarding even a single species can be hard to make since the ability to tolerate noise may vary with reproductive status, prior exposure to noise, and the presence of other stressors in the environment (Blickley & Patricelli, 2010).

In an attempt to better understand highway noise impacts on wildlife, FHWA conducted a review of more than 125 studies relating to noise effects on wildlife (FHWA, 2011c). While there are no established exposure thresholds for wildlife, FHWA was able to summarize sensitivities of various wildlife groups based on the studies and literature reviewed.

Table 3.10: Noise Sensitivities of Various Groups of Wildlife

Wildlife Group	**Frequencies (Hz)**	**Sound Pressure (dB)**[1]
Mammals	< 10 Hz – 150,000 Hz	-20 dB
Birds	100 Hz – 8 to 10,000 Hz	0-10 dB
Reptiles	50 Hz – 2,000 Hz	40-50 dB
Amphibians	100 Hz – 2,000 Hz	10-60 dB
Humans	20 Hz – 20,000 Hz	0 dB

[1] Sound pressures reported are the minimum level at which noise can be detected and not an impact threshold. The dB scale is relative to the point at which humans can detect noise (0 dB).

As Table 3.10 indicates, birds, reptiles and amphibians all have narrower audible ranges of frequency than humans. Some mammals have a wider audible frequency range than humans and are able to hear noises that humans cannot hear. Reptiles and amphibians begin to detect noise at higher sound pressures (louder noises) than humans, and birds begin to detect noise at or above the same level as humans. Some mammals begin to detect noise at the same sound pressure as humans or at higher sound pressures (louder noises), whereas other mammals begin to detect noise at lower sound pressures (quieter noises) than humans. A California Department of Transportation study on highway noise impacts on birds found that birds hear best in the 2-4 kHz range, and that the typical human will be able to hear a single vehicle, traffic noise, or construction noise at a much greater distance from the roadway than will a typical bird (Dooling & Popper, 2007).

3.4.2 Environmental Consequences

Under the No Action Alternative, vehicular sound levels are likely to increase compared to current levels due to growth in population and VMT, although this may be mitigated to some degree by greater deployment of EVs/HVs in the future. As a result, under the No Action Alternative, overall vehicle noise experienced by wildlife is likely to increase in the future compared to current conditions.

As discussed in Section 3.3.6, in either urban or non-urban environments at EV/HV deployment rates of up to 20 percent, the Preferred Alternative is projected to result in maximum noise level increases of 0.3 dB(A) and Alternative 3 would cause no noise level increase for a listener near a roadway (*see* Table 3.3). These noise level increases are below 3 dB(A), a level which is not generally noticeable by humans. As noted above, noise exposure thresholds do not generally exist for wildlife. Under both the Preferred Alternative and Alternative 3, for a single vehicle pass-by event, comparing a quiet EV/HV to a vehicle meeting the minimum noise requirement for either alternative, the difference would be either not noticeable or similar to the existing variation among ICE vehicles, and the perceived sound level would still be lower than that of an average ICE vehicle. Wildlife species in urban environments are generally acclimated to urban noise, including ICE vehicle traffic noise and noise that exceed the levels of normal vehicle noise (e.g., emergency vehicle sirens, heavy construction, etc.).

Based on this analysis, no significant impacts are anticipated for wildlife due to the noise generated by the added sounds for both the Preferred Alternative and Alternative 3, with relatively low exposure at low speeds for short periods of time.

3.5 Cumulative Impacts

In addition to direct and indirect effects, CEQ regulations require agencies to consider cumulative impacts of major Federal actions. CEQ regulations define cumulative impacts as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.”[53]

3.5.1 Existing and Reasonably Foreseeable Future Actions

NHTSA reviewed past, present, and reasonably foreseeable future actions that could result in potential impacts to the same resources and environment as the action alternatives. This review identified NHTSA’s CAFE program as having the potential to contribute to the cumulative impacts of this action. Under the CAFE program, NHTSA sets fuel economy standards for the

[53] 40 CFR § 1508.7.

U.S. light-duty vehicle fleet pursuant to the Energy Policy and Conservation Act, as amended by the Energy Independence and Security Act of 2007.[54]

The affected vehicle operations and associated noise impacts analyses discussed in Section 3.3 reflect the reasonably foreseeable LDV sales and market trends associated with the AEO 2012 Early Release projections. In addition, the projections through 2035 reflect AEO 2012 Early Release forecast annual gains in VMT associated with increases in population and vehicle use. The AEO 2012 Early Release forecast for EV/HV sales also takes into account MY 2012-2016 CAFE standards and anticipated increases in EV/HV sales associated with market trends and with higher fuel economy standards required by MY 2020 under the Energy Independence and Security Act of 2007.[55]

However, the AEO 2012 Early Release forecast does not include the higher sales rate for EVs/HVs that could result from the MY 2017-2025 CAFE action. This section discusses the potential cumulative impacts of NHTSA's action alternatives for a minimum sound requirement for EVs/HVs, taking into account a feasible compliance scenario for manufacturers with the MY 2017-2025 CAFE action. In November 2011, NHTSA issued a Notice of Proposed Rulemaking to develop CAFE standards for MY 2017–2025 vehicles.[56] NHTSA issued a Final Rule on August 28, 2012.[57] Because the analysis conducted in the Draft EA proceeded simultaneously with the CAFE rulemaking, NHTSA's analysis for the Draft EA used data from the proposed, rather than final, CAFE standards. The CAFE standards NHTSA finalized are substantially similar to the levels of the standards it proposed. More importantly, the forecast deployment of EVs/HVs in future years as described in the compliance scenario outlined in the CAFE Final Rule was similar to the forecast in the CAFE proposal.[58]

In its CAFE proposal, NHTSA estimated that the combined average required fuel economy level would be 40.9 mpg in MY 2021 and 49.6 mpg in MY 2025. In order to comply with the proposed fuel economy standards, manufacturers would need to raise their fleet fuel economy,

[54] In considering cumulative impacts, this EA does not consider NHTSA's Phase 1 or Phase 2 fuel efficiency standards for medium- and heavy-duty vehicles and engines. The Final Rule applies only to light-duty vehicles; consideration of motorcycles, medium- and heavy-duty trucks, and buses in the Final Rule has been postponed due to the need for further evaluation. Regardless, NHTSA's projections indicate only minimal growth in the degree of vehicle electrification in the medium- or heavy-duty vehicle sectors.
[55] 49 U.S.C. § 32902(b)(2)(A),
[56] 76 FR 74854 (Dec. 1, 2011).
[57] 77 FR 62624 (Oct. 15, 2012). We note that because NHTSA's authority to set CAFE standards is, in fact, limited to five-year increments (*see* 49 U.S.C. § 32902(b)(3)(B)), NHTSA's Final Rule only established final standards for MYs 2017-2021. The standards presented in the Final Rule documents for MYs 2022-2025 are not final or legally binding, but rather augural, representative of what NHTSA would have finalized for those model years had its statutory authority allowed it to do so in a single rulemaking action. The final CAFE standards for MYs 2022-2025 will ultimately be determined in a separate *de novo* rulemaking action.
[58] On July 18, 2016, NHTSA and EPA issued a Draft Technical Assessment Report as part of its mid-term evaluation of the CAFE standards for MYs 2022-2025. The Draft Technical Assessment Report evaluates fuel economy improvements made in response to CAFE and GHG emissions standards so far, and how auto manufacturers could improve their fleets to meet more stringent standards in the future.

generally by adding fuel economy-improving technologies. When NHTSA evaluates potential fuel economy standards, it considers the technologies available to manufacturers and adds them to their fleets in successive model years to see what levels and combinations of technologies would allow the manufacturers to meet those proposed standards. We note, however, that CAFE standards are performance standards, and NHTSA does not require manufacturers to use any particular technologies to meet the standards. Therefore, the technology analysis accompanying the MY 2017-2025 CAFE action represents only one "path" that the industry could follow, and NHTSA does not intend for it to be a forecast of future technology levels. NHTSA's technology analysis assumed, among other things, that some manufacturers would introduce more EVs/HVs into their fleets in the future. This would have the effect of improving overall fleet-wide fuel economy and would increase the number of EVs/HVs that would be subject to the action alternatives for minimum sound requirements.

NHTSA's technology analysis for the MY 2017-2025 CAFE action also assumed that manufacturers would improve fuel economy by making stationary stop technology available on more ICE vehicles, thereby increasing sales of MHEVs that are effectively silent at idle. The sound addition requirements do not include any minimum sound level for MHEVs as they are not capable of forward propulsion without operation of a conventional engine, so any increase in MHEV sales resulting from potential future CAFE standards would reduce national annual noise impacts associated with vehicles in a stationary position under the No Action and action alternatives.

Another way that CAFE standards can affect noise on the roads is by affecting the number of miles driven. CAFE standards that require vehicles to get more miles per gallon effectively reduce the cost of fuel consumed per mile driven, because the vehicle can go farther on each gallon of gas than it otherwise would have. Therefore, requiring increased fuel economy could create an incentive for additional vehicle use, a phenomenon known as the "rebound effect." As an effect of the potential CAFE standards, NHTSA assumes that the total amount of car and light truck VMT would increase slightly. Increasing VMT would also increase vehicle hours of operation subject to sound addition requirements.

The CAFE standards for MYs 2017 to 2025 do not require manufacturers to achieve any specific level of EV/HV sales. Nonetheless, the impacts of the action alternatives addressed by this EA would be affected by the reasonably foreseeable impacts of the MY 2017-2025 CAFE rulemaking. To estimate this cumulative impact, NHTSA has estimated cumulative national annual noise effects for this EA by incorporating into this analysis the assumptions about how EV/HV sales and VMT would change as a result of the MY 2017-2025 CAFE rulemaking action. In particular, the analysis for the MY 2017-2025 CAFE action assumes that EVs/HVs would account for 13 percent of LDV sales in 2025.[59] This assumption is reflected in the

[59] According to the July 2016 Draft Technical Assessment Report, NHTSA estimates that full hybrids, plug-in hybrid electric vehicles, and electric vehicles will account for less than 17 percent of LDV sales in MY 2025 to meet

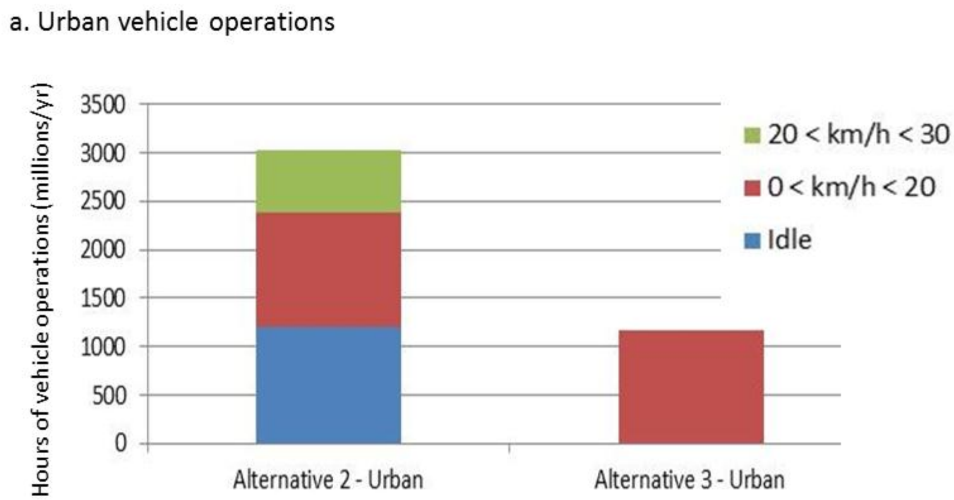
forecast for vehicle sales under the Preferred Alternative in the MY 2017-2025 CAFE NPRM. Therefore, this analysis of cumulative sound impacts, which takes into account the CAFE action as proposed, assumes that this share continues through 2035, whereas the AEO forecast used in the direct and indirect impacts analysis described above anticipates that EVs/HVs will account for 6.1 percent of LDV sales in 2025 and 8.2 percent in 2035. Incorporating the assumptions about EV/HV penetration and VMT growth from the CAFE modeling into the cumulative impacts analysis for this EA measures the combined impact of the minimum sound requirements and the higher EV/HV market share forecast in the MY 2017-2025 CAFE NPRM. As mentioned above, the modeling analysis used in the CAFE proposal is intended to represent only one feasible compliance path for manufacturers, not a strict requirement for specific technology adoption. Thus, actual technology use may differ in the future.

3.5.2 Environmental Consequences

Because the MY 2017-2025 CAFE standards may result in the production and sale of greater numbers of EVs/HVs, they could impact the number of hours of total vehicle operation that are subject to minimum sound requirements. Figure 3-8 shows the number of forecast urban and non-urban EV/HV hours of operation at speeds subject to the Final Rule in 2035, taking into account the potential impact of the MY 2017-2025 CAFE action. This figure can be compared with Figure 3-7 in Section 3.3.5.5, which shows the same analysis without consideration of the CAFE action. As shown in Figure 3-7, the Preferred Alternative for this rulemaking alone is forecast to affect almost 1800 million hours of urban EV/HV operation in 2035; when the cumulative impact of the CAFE action is taken into consideration, this is projected to increase to 3000 million urban EV/HV hours (Figure 3-8). Similarly, the Preferred Alternative alone is forecast to affect 73 million hours of non-urban EV/HV operation in 2035; when the cumulative impact of the CAFE action is taken into account, this is projected to increase to 123 million non-urban EV/HV hours.

MY 2025 CAFE standards under its primary analysis. Meanwhile, EPA estimates that these vehicles will account for less than 8 percent of LDV sales in MY 2025 to meet MY 2025 GHG standards under its primary analysis. The assumption of 13 percent in the CAFE proposal is roughly proportionate to the estimates in the more recent Draft Technical Assessment Report. As a result, NHTSA believes the analysis in this EA remains adequate and valid for environmental review.

Figure 3-8: Estimated Aggregate EV/HV Hours of Operation (million hours/year) in 2035 at Speeds Subject to Each Alternative for Urban Areas and Non-Urban Areas (Taking Into Account One Feasible Compliance Scenario for the MY 2017-2025 CAFE Action)



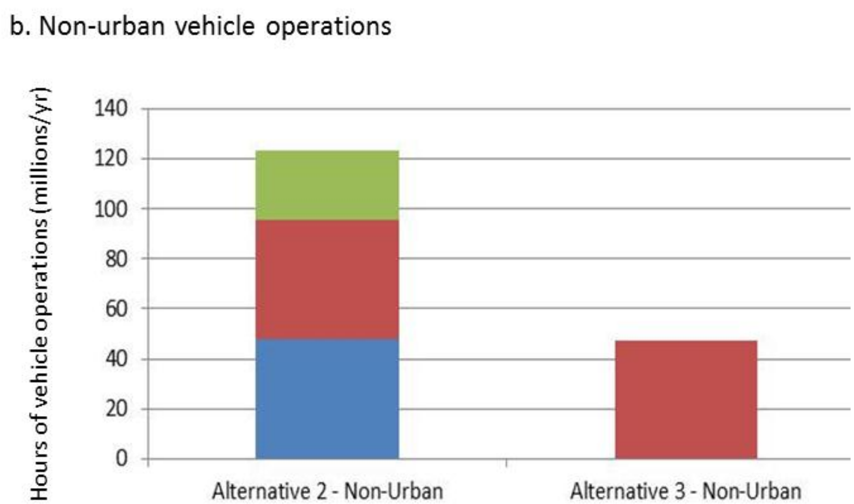


Table 3.11 can be compared with Table 3.9 to see the differences between the direct and indirect effects and the cumulative effects for the number of LDV hours of operation in 2035 by speed for urban and non-urban areas, associated sound levels for ICE vehicles and for EVs/HVs under each alternative, and the percentage of hours that would be affected by a minimum sound requirement under each action alternative. The sound levels for ICE vehicles and for EVs/HVs under each alternative are the same in both tables, but cumulative effects in Table 3.11 show that, assuming the technology path modeled for the CAFE action, there would be more LDV hours of operation in 2035 and a larger percentage of LDV hours with sound additions. The higher forecast for total LDV hours results from the rebound effect (more VMT associated with fuel economy gains that reduce fuel cost per VMT), and the increase in the percentage of LDV

hours of operation with sound additions reflects the forecast that, under the technology path modeled, a greater proportion of EVs/HVs would be sold in response to the MY 2017-2025 CAFE action.

Table 3.11 shows that the cumulative impacts of the Preferred Alternative, together with the reasonably foreseeable impacts of the MY 2017-2025 CAFE action, is projected to result in sound additions for 2.5 percent of all LDV hours of operation in 2035 (as compared to 1.7 percent under the direct and indirect effects analysis shown in Table 3.9). The cumulative effect of Alternative 3, together with the CAFE action, is projected to result in sound additions for 1.0 percent of all LDV hours of operation in 2035 (as compared to 0.7 percent under the direct and indirect effects analysis shown in Table 3.9).

The cumulative impacts of the proposal on community noise levels, taken together with the CAFE action, would also likely be slightly greater than those reported in the analysis of direct and indirect impacts on community noise described above. Under the No Action Alternative, vehicular sound levels are likely to increase due to increases in VMT, although greater deployment of EVs/HVs in response to future CAFE standards may result in a lower baseline condition.

Even when taking into account the forecast fleet assumed in the MY 2017-2025 CAFE NPRM, deployment of EVs/HVs is projected to remain below 20 percent in 2035. Although the overall percentage of LDV hours subject to the Final Rule would increase from 1.7 percent to 2.5 percent for the Preferred Alternative and from 0.7 percent to 1.0 percent under Alternative 3 when considering the MY 2017-2025 CAFE action, given the few instances of noticeable noise impacts identified in Section 3.3.6 and the small percentage of the LDV hours that would be affected, specific impacts on resource areas are not expected to change under the action alternatives when cumulative actions are taken into account.

Table 3.11: Annual National Sound Level Impacts of Action Alternatives in 2035
(Taking into Account One Feasible Compliance Scenario for the MY 2017-2025 CAFE Action)

				Alternative 2		Alternative 3	
SPEED	**Million Hours of Operation for All LDVs in 2035**	**ICE Sound Level dB(A)**	**Alternative 1 EV/HV Sound Level dB(A)**	**Percent of Hours With Increased Sound**	**EV/HV Sound Level dB(A)**	**Percent of Hours With Increased Sound**	**EV/HV Sound Level dB(A)**
Urban							
Stationary	12,204	54.2	undetectable	9.8%	49.9	No increase	No increase
0 < km/h < 20	11,930	59.3 - 66.1	49.4 – 59.3	9.8%	56.7 – 64	9.8%	51.8 - 59.8
20 < km/h < 30	6,535	66.1 – 69.7	59.3 – 66.1	9.8%	64 – 69.2	No increase	No increase
> 30 km/h	62,015	75	75	No increase	No increase	No increase	No increase
Total Urban	**92,684**			**3.3%**		**1.3%**	
Non-Urban							
Stationary	2,526	54.2	undetectable	1.9%	49.9	No increase	No increase
0 < km/h < 20	2,486	59.3 - 66.1	49.4 – 59.3	1.9%	56.7 – 64	1.9%	51.8 - 59.8
20 < km/h < 30	1,466	66.1 – 69.7	59.3 – 66.1	1.9%	64 – 69.2	No increase	No increase
> 30 km/h	27,413	75	75	No increase	No increase	No increase	No increase
Total Non-Urban	**33,891**			**0.4%**		**0.14%**	
Total Urban and Non-Urban	**126,575**			**2.5%**		**1.0%**	

4 CONSULTATION AND COORDINATION

4.1 49 U.S.C. § 303

Title 49 U.S.C. Section 303 (commonly referred to as "Section 4(f)") limits the ability of DOT agencies to approve the use of land from publicly owned parks, recreational areas, wildlife and waterfowl refuges of national, State, or local significance, or historical sites of national, State, or local significance unless certain conditions apply. Because the action alternatives are not a transportation program or project requiring the use of 49 U.S.C. § 303 properties, NHTSA has not prepared a Section 4(f) evaluation.

4.2 Endangered Species Act

Section 7(a)(2) of the Endangered Species Act (ESA) requires Federal agencies, in consultation with the National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) and/or the U.S. Fish and Wildlife Service (FWS, and, with NOAA Fisheries, the Services), to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of Federally listed threatened or endangered species, or result in the destruction or adverse modification of designated critical habitat of such species.[60] Under relevant implementing regulations, consultation is required for actions that "may affect" listed species or critical habitat.[61] Consultation is not required where the action has "no effect" on such listed species or critical habitat. Under this standard, the Federal agency taking an action evaluates the action and determines whether consultation is required.[62] Under Section 7, the effects of an action include both direct and indirect effects on species or critical habitat.[63] Federal agencies are not required to consider *all* effects of an action; in order to be considered, effects must be reasonably certain to occur and not speculative or remote.[64]

Pursuant to Section 7(a)(2) of the ESA, NHTSA has considered the effects of the action and has reviewed applicable ESA regulations and guidance to determine what, if any, impact there may be to listed species or designated critical habitat. Based on this assessment, NHTSA has determined that its action, which would result in negligible impacts and noise levels within the current range of variation, does not require consultation under Section 7(a)(2). As outlined

[60] 16 U.S.C. § 1536(a)(2)
[61] 50 CFR § 402.14
[62] *See* 51 FR 19926, 19949 (June 3, 1986)
[63] 50 CFR § 402.02
[64] 51 FR at 19932-19933. *See also Ground Zero Center for Non-Violent Action v. U.S. Department of the Navy*, 383 F.3d 1082 (9th Cir. 2004) (where the likelihood of jeopardy to a species is extremely remote, consultation is not required); *Center for Biological Diversity v. United States Dept. of Housing and Urban Development*, 541 F.Supp.2d 1091, 1100 (D.Arizona 2008) (agency action too far down the causal chain and thus not "reasonably certain to occur" did not require consultation).

below, NHTSA does not believe that any impacts to listed species or designated critical habitat are reasonably certain to occur as a result of setting this standard.

Based on the percentage of EVs/HVs in the fleet and the limited application of the proposal, NHTSA forecasts that the Preferred Alternative minimum sound requirements would affect only 1.7 percent of all light-duty vehicle hours of operation in 2035. In addition, NHTSA's modeling shows that, in simulated high traffic conditions, across a wide range of possible rates of EV/HV deployment, the Preferred Alternative would result in non-noticeable changes to existing noise levels. For example, assuming EV/HV deployment rates of up to 20 percent in the existing fleet (well in excess of the 6.6 percent deployment rate projected in 2035), NHTSA's saturation traffic flow model indicates that the minimum sound requirement would result in noise increases of no more than 0.3 dB(A) when measured by a receiver 7.5 meters from a roadway. On the other extreme, when compared to a scenario that assumes no EVs/HVs in the existing fleet (e.g., where all vehicles have internal combustion engines) under similar conditions, the Preferred Alternative would result in reductions in sound levels of no more than 0.2 dB(A). These levels are far below levels considered noticeable to humans (3 dB[A]). In the event of a single vehicle pass-by in a rural area, EVs/HVs with the added sound would emit noise at noticeably different levels than EVs/HVs without the added sound. However, this noise increase is within the range of existing variation that results from differences between ICE vehicles already on the road today, and the total sound level would still be below the average sound level for an ICE vehicle.

The minimum sound requirement is not expected to affect vehicle deployment rates, VMT, or vehicle travel patterns. As a result, the minimum sound requirements will not impact the frequency by which threatened or endangered species, as well as their critical habitats, come into contact with motor vehicles. Though the Final Rule would affect sound emitted by individual vehicles, the result of those impacts is noise levels within the range that these species and habitats currently experience. Thus, if a species or habitat would be affected by a regulated EV/HV, it would be affected similarly if that motor vehicle were instead a random, unregulated ICE. Accordingly, NHTSA has determined that this action will not impact threatened or endangered species, or their critical habitats.

5 REFERENCES

Federal Statutes, Regulations, and Notices:

16 U.S.C. § 1536(a)(2).

42 U.S.C. §§ 4321–4347.

42 U.S.C. § 4901, *et seq*.

49 U.S.C. chapter 301.

49 U.S.C. § 303.

49 U.S.C. § 32902(b)(2)(A).

36 CFR § 2.12.

40 CFR § 61.32.

40 CFR § 205.152.

40 CFR parts 1500–1508.

50 CFR §§ 402.02 and 402.14.

46 Fed. Reg. 18026 (Mar. 23, 1981).

51 Fed. Reg. 19926 (June 3, 1986).

73 Fed. Reg. 31187 (May 30, 2008).

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APPENDIX A – Noise Technical Information

A *sound* is said to exist when the static pressure of a medium (typically air) is disturbed by periodic pressure variations (sound waves) that propagate through the medium and are perceived by a listener. The pressure variations in the medium are due to the compression and rarefaction (reduction of density) of molecules in the medium. Over time, the pressure in a given region will increase and decrease as the sound wave propagates through the medium. The change in pressure relative to the static pressure is called the acoustic or sound pressure.

In the simplest case, sound pressure can be represented as a function of time by a sinusoidal wave for a specific location in space, as shown in Figure A-1.[65] Here, the baseline represents the static pressure. The difference in pressure from the baseline to the peak of the wave is the peak amplitude of the acoustic pressure; the higher the amplitude, the louder the sound. As time passes, the pressure increases and decreases cyclically for this location. The period of the wave can be defined by the time that it takes to go from one peak to the next; a longer period indicates a lower pitch. Another way to quantify the wave is by its frequency. The frequency of a wave is the inverse of the period and the unit is hertz; the lower the frequency, the lower the pitch.

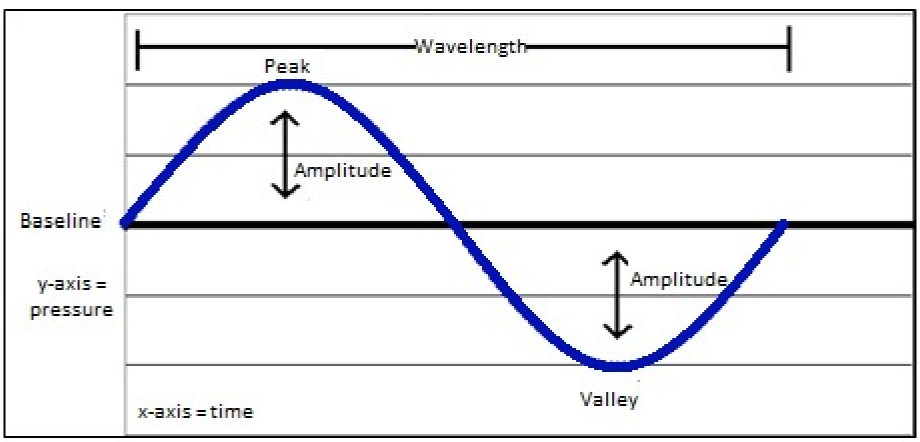

Figure A-1: Graphical representation of a sinusoidal wave.

The relative location of sound source and listener in an environment can have a strong effect on the final sound that is received by the listener. As a sound propagates away from the source, the acoustic energy[66] is spread over a greater area in a manner similar to ripples in a pond. In a pond, the ripple's diameter becomes larger but the amplitude becomes smaller the further they travel from the source. Similarly, the further a sound propagates from a source, the quieter the sound will tend to be. For a point source radiating sound into free space, the intensity of that sound will

[65] While it is convenient to represent sound waves as transverse waves, where the motion is perpendicular to the wave propagation, they are in fact longitudinal waves; the motion is parallel to the wave propagation.
[66] Acoustic energy is equal to the acoustic intensity integrated over the area. In an environment with no reflecting boundaries, the acoustic intensity is proportional to the acoustic pressure squared.

diminish by a factor of four for each doubling of distance from the source to listener (inverse square law). However, in typical environments, reflections and atmospheric absorption also affect the sound level. The latter effect is greatest for high frequencies, so when a sound propagates long distances, the high frequency components of a sound will tend to decrease more than the low frequency components. This effect is most noticeable for distances greater than a hundred meters, as familiarly experienced with thunder from near versus far lightning strikes.

Sound volume is most commonly quantified in decibels, with higher decibels indicating louder sounds. A decibel is a logarithmic unit of magnitude based on the ratio of two powers. In terms of acoustics, the ratio, commonly referred to as the sound pressure level, is between the mean-squared acoustic pressure and a reference mean-squared acoustic pressure. The reference for SPL measurements in air is typically 20 micro-Pascals, which is considered the threshold of human hearing. The lower limit of audibility is therefore defined as a SPL of 0 dB. In addition to a sound wave's amplitude, the frequency is also important for the human sound perception of loudness. Human hearing does not have a uniform spectral sensitivity or frequency response, in that humans do not perceive low- and high-frequency sounds as well as sounds at about 1,000-2,000 Hz. The relationship between perceived loudness and the physical acoustic pressure of a sound is non-linear in both amplitude and frequency, as illustrated in Figure A-2. This means that the relative loudness (and detectability) of two sounds with the same SPL value can change substantially depending on their amplitude and frequency. To account for this, acoustic equipment used for measurements of moderate loudness sounds is typically "A-weighted," which approximates the frequency response of human hearing. An increase of 3 dB represents a doubling of sound energy, and is often considered the point at which a sound level change is likely to be noticeable for a human.

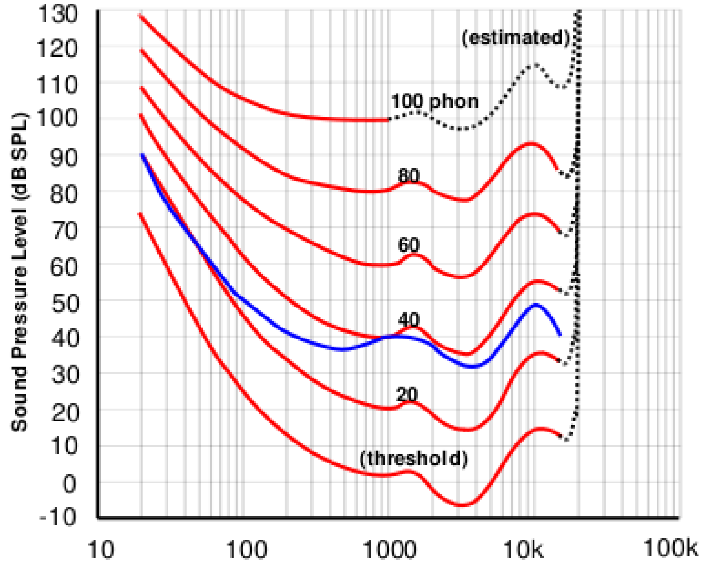

Figure A-2: Equal Loudness Contours (red) (from ISO 226:2003 revision) and Original ISO Standard (blue) for 40 Phons. Logarithic horizontal axis is frequency in hertz.

The distribution of acoustic energy in a sound can be represented graphically with a full spectrum plot, like that shown in Figure A-3. Also, a sound's spectral content can be more compactly shown by binning the audible spectrum (100 Hz - 20 kHz) into a relatively small number of bands, usually 30 for a one-third octave analysis, as shown in Figure A-4.

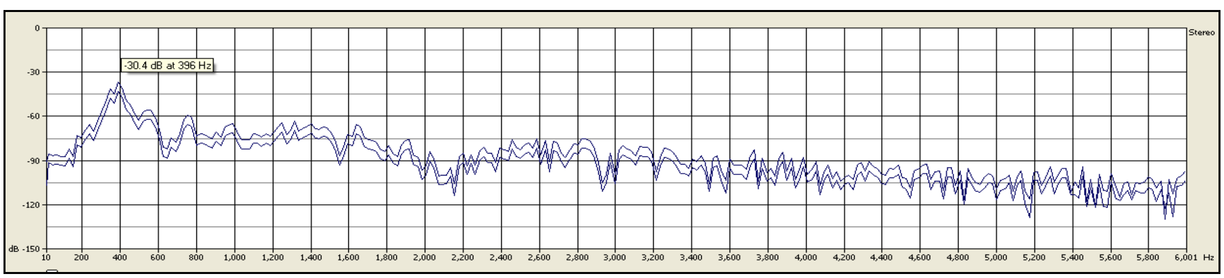

Figure A-3. Full Spectrum of an Additional Sound (vertical scale in dB referenced to 0; linear horizontal axis in hertz)

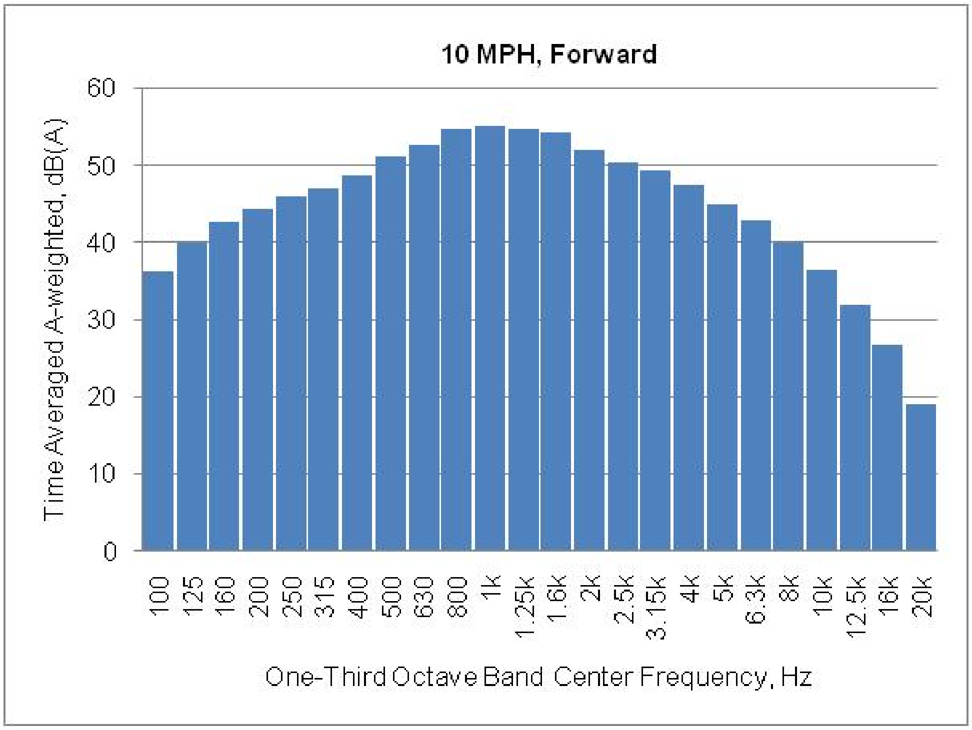

Figure A-4. Example of an A-Weighted, One-Third Octave Plot of Noise Emission from a Vehicle Passing at 10 mph

The perception of a sound's *pitch* is directly related to frequency. A sound wave with a high frequency produces the sensation of a high, sharp pitch and a low frequency produces a low, dull pitch.

It is rare that humans hear only one sound at a time. This is because one sound may overshadow, very closely resemble, or interfere with the perception of another sound that does not share the same physical characteristics. When one sound (or the collective background noise, that is, the *ambient*) interferes with the perception of another sound, it is called *masking*. The masking threshold is the point at which one sound's audibility or detectability is lost because of the masking sound.

Functionally, *noise* can be defined as undesirable sound that disrupts normal activities or that diminishes the quality of the surrounding environment. Criteria have been established at the Federal, State, and local levels to protect individuals from traffic noise annoyance and disruption of daily activities. These criteria are usually specified in dB(A), accounting for the normal human frequency response, and are further discussed in Chapter 3.

See the glossary of selected technical acoustical terms at the beginning of this document for further information (NHTSA, 2009, Hastings, Pollard, Garay-Vega, Stearns, & Guthy, 2011).

APPENDIX B – Estimated Aggregate Annual Vehicle Operation (million hours/year)

Table B-1 shows the annual number of forecast urban and non-urban vehicle hours of operation by speed for selected years from 2017 to 2035 for EVs/HVs MY 2017 or later and for MHEVs and other LDVs (including vehicle hours of operation for all vehicles MY 2017 or earlier). The shaded rows under post-2016 EV/HV hours highlight the relatively few vehicle hours of operation that would require sound addition under the Preferred Alternative. For Alternative 3, vehicle hours subject to the Final Rule are reflected in the 0 to 20 km/h line category only, as added sound is not required when stationary or 20 to 30 km/h in this alternative. For the Preferred Alternative, 2.34 percent of all urban LDV travel hours in 2035 would have sound additions; this would decrease to 0.90 percent under Alternative 3. In non-urban areas, 0.26 percent of all LDV travel hours in 2035 would have sound additions under the Preferred Alternative, and 0.10 percent would have sound additions under Alternative 3.

Table B-1: Estimated Aggregate Annual Vehicle Operation by Speed (million hours/year)

Location	Speed	2017	2020	2025	2030	2035
Post-2016 EV/HV Hours by Speed						
Urban	Stationary	35	146	346	546	710
	0 < km/h ≤ 20	34	143	339	534	694
	20 < km/h ≤ 30	19	78	185	292	380
	km/h > 30	178	742	1760	2773	3606
Non-urban	Stationary	2	6	14	22	28
	0 < km/h ≤ 20	2	6	14	22	28
	20 < km/h ≤ 30	1	3	8	13	17
	km/h > 30	19	63	151	237	309
Post-2016 MHEV Hours by Speed						
Urban	Stationary	47	219	441	582	644
	0 < km/h ≤ 20	46	214	432	569	629
	20 < km/h ≤ 30	25	117	236	312	345
	km/h > 30	237	1112	2243	2958	3272
Non-urban	Stationary	2	9	18	23	26
	0 < km/h ≤ 20	2	9	17	23	25
	20 < km/h ≤ 30	1	5	10	14	15
	km/h > 30	26	95	192	253	280
Other LDV Hours by Speed						
Urban	Stationary	7908	7984	8198	8506	8897
	0 < km/h ≤ 20	7731	7805	8014	8315	8698
	20 < km/h ≤ 30	4234	4275	4390	4554	4764
	km/h > 30	40184	40572	41657	43220	45212
Non-urban	Stationary	1649	1713	1828	1948	2067
	0 < km/h ≤ 20	1624	1687	1800	1918	2035
	20 < km/h ≤ 30	958	995	1061	1131	1200
	km/h > 30	17901	18595	19841	21148	22437

Table B-2 shows the direct and indirect impacts of action alternatives versus the No Action Alternative in terms of annual hours of operation by vehicle sound level for EVs/HVs sold in calendar year 2017 or later (when a majority of new EVs/HVs would be subject to the Proposed Rule).[67] This table shows how relatively few annual hours of EV/HV operations would be subject to a sound addition requirement under the two action alternatives, resulting in only a small shift of sound levels to a slightly higher sound category, relative to the No Action Alternative:[68]

- When stationary, sound levels for EVs/HVs under the No Action Alternative are expected to average 0.1 dB(A). EV/HV sound when stationary would increase to a sound level of 49.9 dB(A) under the Preferred Alternative, but not under Alternative 3.
- At speeds above zero but less than or equal to 20 km/h, EV/HV sound levels of 49.4 to 59.5 dB(A) are projected under the No Action Alternative, depending on speed. Sound levels in this speed category would shift to 56.7 to 64 dB(A) under the Preferred Alternative, and to levels of 51.8 to 59.8 dB(A) under Alternative 3.
- At speeds above 20 km/h but less than or equal to 30 km/h, EV/HV sound levels of 59.5 to 65.7 dB(A) are expected under the No Action Alternative, depending on speed. EV/HV sound in this speed category would shift to sound levels of 64 to 69.2 dB(A) under the Preferred Alternative, but not under Alternative 3.
- At speeds above 30 km/h, EV/HV sound levels of 75 dB(A) are expected under the No Action Alternative (assuming an average speed of 65 km/h in this speed range). No sound addition is required in this speed range, where EV/HV sound is equivalent to other LDV sound, so the sound associated with EV/HV operation in this speed category is the same for the No Action Alternative and both of the action alternatives.

The data in Table B-2 indicate that 67 percent of forecast EV/HV hours of operation in urban areas and 81 percent of non-urban EV/HV operation hours are expected to be at speeds above 30 km/h, where there are no sound addition requirements under either action alternative, and where the sound per vehicle is already significantly higher than the sound that would be required at slower speeds with sound addition. The growth over time in hours of sound in each speed category reflects the growth in VMT and associated hours of vehicle operation, as well as the forecast growth in the EV/HV share of VMT.

The first row under the Preferred Alternative in Table B-2 shows that the Preferred Alternative would result in an increase in the sound levels for urban EVs/HVs when stationary from 0.1 dB(A) to 49.9 dB(A). This sound addition would apply to 146 million hours of EV/HV operation when stationary in 2020, 346 million hours in 2025, 546 million hours in 2030, and

[67] See footnote 45.
[68] The sound levels under each alternative associated with speeds of zero to 30 km/h reflect the sound levels reported in Table 3.2.

710 million hours of vehicle operation in 2035. The first row under Alternative 3 in Table B-2 shows no increase in the 0.1 dB(A) sound for hours of urban EV/HV operation stationary (146 million in 2020, 346 million in 2025, 546 million in 2030, and 710 million in 2035).

The second row under the Preferred Alternative shows that the Preferred Alternative would result in an increase of the sound levels for urban EVs/HVs traveling at speeds between zero and 20 km/h from a range of 49.4-59.5 dB(A) to a range of 56.7-64 dB(A). This sound addition would apply to 143 million hours of EV/HV operation in 2020, 339 million hours in 2025, 534 million hours in 2030, and 694 million hours in 2035. The sound ranges associated with this km/h range reflect average sound levels for EVs/HVs traveling at 10 km/h and at 20 km/h with and without the sound addition that would be required under the Preferred Alternative. The second row under Alternative 3 shows a sound increase for those same hours of urban EV/HV operation (143 million in 2020, 339 million in 2025, 534 million in 2030, and 694 million in 2035) from a range of 49.4-59.5 dB(A) to a range of 51.8-59.8 dB(A), reflecting the sound additions that would be required under Alternative 3 sound at 10 km/h and 20 km/h.

The third row under the Preferred Alternative shows that the Preferred Alternative would result in an increase in the sound associated with EVs/HVs traveling in urban areas at speeds of 20 to 30 km/h from a range of 59.5-65.7 dB(A) to a range of 64-69.2 dB(A). This sound addition would apply to 78 million hours of EV/HV operation in 2020, 185 million hours in 2025, 292 million in 2030, and 380 million hours in 2035. The sound ranges associated with this km/h range reflect average sound levels for EVs/HVs traveling at 20 km/h and at 30 km/h with and without the sound addition that would be required under the Preferred Alternative. The third row under Alternative 3 in Table B-2 shows no increase in the sound range of 59.5-65.7 dB(A) for those same hours of urban EV/HV operation (78 million in 2020, 185 million in 2025, 292 million in 2030, and 380 million in 2035).

Table B-2: Direct and Indirect Impacts of Action Alternatives versus No Action Alternative Aggregate Annual Post-2016 EV/HV Operation by Sound Level (millions hours/year)[69]

Location	Speed	Increase in EV/HV dB(A) Compared to No Action	Million Hours/Year EV/HV Operation			
			2020	2025	2030	2035
Alternative 2 (Preferred Alternative)						
Urban	Stationary	From 0.1 to 49.9	146	346	546	710
	0 < km/h ≤ 20	From 49.4-59.5 to 56.7-64	143	339	534	694
	20 < km/h ≤ 30	From 59.5-65.7 to 64-69.2	78	185	292	380
	km/h > 30	75: No Increase	742	1760	2773	3606
Non-urban	Stationary	From 0.1 to 49.9	6	14	22	28
	0 < km/h ≤ 20	From 49.4-59.5 to 56.7-64	6	14	22	28
	20 < km/h ≤ 30	From 59.5-65.7 to 64-69.2	3	8	13	17
	km/h > 30	75: No Increase	63	151	237	309
Alternative 3						
Urban	Stationary	0.1: No Increase	146	346	546	710
	0 < km/h ≤ 20	From 49.4-59.5 to 51.8-59.8	143	339	534	694
	20 < km/h ≤ 30	59.5-65.7: No Increase	78	185	292	380
	km/h > 30	75: No Increase	742	1760	2773	3606
Non-urban	Stationary	0.1: No Increase	6	14	22	28
	0 < km/h ≤ 20	From 49.4-59.5 to 51.8-59.8	6	14	22	28
	20 < km/h ≤ 30	59.5-65.7: No Increase	3	8	13	17
	km/h > 30	75: No Increase	63	151	237	309

[69] The shift in sound levels shown in this table reflect overlapping sound ranges associated with each km/h range.

APPENDIX C – Aggregate Annual Forecast LDV Operation by Sound (millions hours/year)

Table C-1 shows estimated annual hours of operation for all LDVs by sound level and alternative.[70] This table, in conjunction with Table B-1, provides context for how the quantity of annual EV/HV hours of sound change in each sound category under both action alternatives:

- The second row under Alternative 1 in Table C-1 shows that urban hours stationary, with a sound level of 0.1 dB(A) under the No Action Alternative, are projected to increase from 365 million hours in 2020, to 788 million hours in 2025, 1128 million hours in 2030, and 1354 million hours in 2035. The first row under Alternative 1 shows that other LDV urban hours stationary, with a sound level of 54.2 dB(A) (reflecting the standard vehicle stationary sound in Table 3.2), are projected to increase from 7984 million in 2020, to 8198 million in 2025, 8506 million in 2030, and 8897 million in 2035.
- Under the Preferred Alternative, EVs/HVs stationary would have a minimum required sound level of 49.9 dB(A). The first row under the Preferred Alternative shows the projected urban hours when stationary for those vehicles in addition to all of the other LDV vehicles with a sound level of 54.2 dB(A). However, the shaded rows in Table C-1 show that the majority of forecast vehicle hours that are quieter when stationary are for vehicles with idle-stop technology (that turns the engine off when the vehicle is not moving), which would not be affected by the Final Rule. The majority of urban LDV hours of operation at the quieter stationary sound level would not change under the Preferred Alternative. Because Alternative 3 would not specify a sound when stationary, no vehicle sound would change when stationary under that alternative.
- EV/HV sound levels at speeds above zero but less than or equal to 20 km/h would increase under both the Preferred Alternative and Alternative 3, and EV/HV sound levels at speeds above 20 km/h but less than or equal to 30 km/h would increase under the Preferred Alternative only. The annual hours of EV/HV sound affected by these small increases in sound levels account for a very small percentage of total LDV hours of operation.

[70] The sound levels under each Alternative associated with speeds of zero to 30 km/h reflect the sound levels reported in Table 3.2.

Table C-1: Aggregate Annual Forecast LDV Operation by Sound (millions hours/year)

Location	Speed	dB(A)	Million Hours/Year LDV Operation			
			2020	2025	2030	2035
Alternative 1(No Action)						
Urban	Stationary	54.2	7984	8198	8506	8897
		0.1	365	788	1128	1354
	0 < km/h ≤ 20	59.3-66.1	8019	8446	8884	9327
		49.4-59.5	143	339	534	694
	20 < km/h ≤ 30	66.1-69.7	4392	4626	4866	5109
		59.5-65.7	78	185	292	380
	km/h> 30	75	42425	45661	48951	52089
Non-urban	Stationary	54.2	1713	1828	1948	2067
		0.1	15	32	45	54
	0 < km/h ≤ 20	59.3-66.1	1695	1817	1941	2060
		49.4-59.5	6	14	22	28
	20 < km/h ≤ 30	66.1-69.7	1000	1072	1145	1215
		59.5-65.7	3	8	13	17
	km/h> 30	75	18754	20184	21638	23026
Alternative 2 (Preferred Alternative)						
Urban	Stationary	49.9-54.2	8130	8544	9051	9607
		0.1	219	441	582	644
	0 < km/h ≤ 20	56.7-66.1	8162	8784	9417	10021
		49.4-59.5	0	0	0	0
	20 < km/h ≤ 30	64-69.7	4471	4811	5158	5489
		59.5-65.7	0	0	0	0
	km/h> 30	75	42425	45661	48951	52089
Non-urban	Stationary	49.9-54.2	1719	1842	1970	2096
		0.1	9	18	23	26
	0 < km/h ≤ 20	56.7-66.1	1701	1831	1963	2088
		49.4-59.5	0	0	0	0
	20 < km/h ≤ 30	64-69.7	1003	1080	1157	1232
		59.5-65.7	0	0	0	0
	km/h> 30	75	18754	20184	21638	23026
Alternative 3						
Urban	Stationary	54.2	7984	8198	8506	8897
		0.1	365	788	1128	1354
	0 < km/h≤ 20	51.8-66.1	8162	8784	9417	10021
		49.4-59.5	0	0	0	0
	20 < km/h ≤ 30	59.8-69.7	4392	4626	4866	5109
		59.5-65.7	78	185	292	380
	km/h> 30	75	42425	45661	48951	52089
Non-urban	Stationary	54.2	1713	1828	1948	2067
		0.1	15	32	45	54
	0 < km/h ≤ 20	51.8-66.1	1701	1831	1963	2088
		49.4-59.5	0	0	0	0
	20 < km/h ≤ 30	59.8-69.7	1000	1072	1145	1215
		59.5-65.7	3	8	13	17
	km/h> 30	75	18754	20184	21638	23026

APPENDIX D – Estimated Aggregate Annual Vehicle Operation by Speed (million hours/year) Associated With the Cumulative Impacts of the MY 2017-2025 CAFE Action

Table D-1 shows the annual number of forecast urban and non-urban vehicle hours of operation by speed for selected years between 2017 and 2035 for EVs/HVs built and sold after 2017 (assuming they are all subject to the Final Rule) and for MHEVs and other LDVs (including vehicle hours of operation for all vehicles built before 2017), after taking account of the assumed cumulative impacts associated with the MY 2017-2025 CAFE action. The shaded rows under Post-2016 EV/HV Hours highlight the vehicle hours of operation that would require sound addition under the Preferred Alternative (Alternative 2). For Alternative 3, vehicle hours subject to the Final Rule are reflected in the 0-20 km/h line category only, as added sound is not required when stationary or 20-30 km/h in this alternative.

This table can be compared with Table B-1 to see how the MY 2017-2025 CAFE action would be expected to shift more vehicle hours of operation to EVs/HVs and MHEVs from other LDVs, and also increase the total vehicle hours of operation due to increases in VMT associated with the rebound effect.

Under the Preferred Alternative, 2.29 percent of all urban vehicle hours would be subject to NHTSA's action, but when the projected impacts of the MY 2017-2025 CAFE action are taken into account this number increases to 3.26 percent. Similarly, the percentage of non-urban hours affected under the Preferred Alternative increases from 0.26 percent to 0.36 percent. Under Alternative 3, 0.89 percent of all urban vehicle hours would be subject to the proposal, but when the projected impacts of the MY 2017-2025 CAFE action are taken into account this number increases to 1.27 percent. Similarly, the percentage of non-urban hours affected under Alternative 3 would increase from 0.10 percent to 0.14 percent.

Table D-1: Estimated Aggregate Annual Vehicle Operation by Speed (million hours/year) Associated With the Cumulative Impact of the MY 2017-2025 CAFE Action

Location	Speed	2017	2020	2025	2030	2035
Post-2016 EV/HV hours By Speed						
Urban	Stationary	35	146	444	893	1201
	0 < km/h ≤ 20	34	143	434	873	1174
	20 < km/h ≤ 30	19	78	238	478	643
	km/h > 30	178	742	2256	4539	6105
Non-urban	Stationary	2	6	18	36	48
	0 < km/h ≤ 20	2	6	18	35	47
	20 < km/h ≤ 30	1	3	10	21	28
	km/h > 30	19	63	193	388	522
Post-2016 MHEV hours By Speed						
Urban	Stationary	47	368	1555	2546	3146
	0 < km/h ≤ 20	46	360	1520	2489	3076
	20 < km/h ≤ 30	25	197	832	1363	1685
	km/h > 30	237	1872	7900	12939	15986
Non-urban	Stationary	2	15	62	102	126
	0 < km/h ≤ 20	2	15	61	100	124
	20 < km/h ≤ 30	1	9	36	59	73
	km/h > 30	26	160	676	1107	1368
Other LDV hours By Speed						
Urban	Stationary	8142	8236	7952	7786	7857
	0 < km/h ≤ 20	7959	8051	7774	7612	7681
	20 < km/h ≤ 30	4359	4410	4258	4169	4207
	km/h > 30	41371	41850	40409	39566	39923
Non-urban	Stationary	1698	1790	1979	2185	2351
	0 < km/h ≤ 20	1671	1762	1948	2151	2315
	20 < km/h ≤ 30	986	1039	1149	1269	1365
	km/h > 30	18426	19431	21483	23721	25523

APPENDIX E – Cumulative Impacts of Action Alternatives versus No Action Alternative Aggregate Annual Post-2016 EV/HV Operation by Sound (million hours/year)

Table E-1 shows the cumulative impacts of the action alternatives versus the No Action Alternative in terms of annual hours of operation by vehicle sound level for EVs/HVs built after 2016. This table shows how a small number of annual hours of EV/HV operations would be subject to a sound addition requirement under the two action alternatives, resulting in only a small shift of sound levels to a slightly higher sound category, relative to the No Action Alternative. Table E-1 can be compared with the direct and indirect impacts in Table B-2 to see how the technology assumptions associated with the MY 2017-2025 CAFE action would be expected to result in more EV/HV vehicle hours of operation subject to sound addition requirements.

The first row under the Preferred Alternative in Table E-1 shows that the Preferred Alternative would increase the sound levels for urban EVs/HVs when stationary from 0.1 dB(A) to 49.9 dB(A). This sound addition would apply to 146 million hours of EV/HV operation when stationary in 2020, 444 million hours in 2025, 893 million hours in 2030, and 1201 million hours of vehicle operation in 2035. When compared to Table B-2, these results in Table E-1 show that the forecast increase in EV/HV sales associated with the MY 2017-2025 CAFE action is projected to increase total EV/HV operation when stationary by 98 million hours in 2025, 347 million hours in 2030, and 491 million hours of vehicle operation in 2035.

The second row under the Preferred Alternative shows that the Preferred Alternative would be expected to increase the sound levels for urban EVs/HVs at speeds between zero and 20 km/h from a range of 49.4-59.5 dB(A) to a range of 56.7-64 dB(A). This sound addition would apply to 143 million hours of EV/HV operation in 2020, 434 million hours in 2025, 873 million hours in 2030, and 1174 million hours in 2035. When compared to Table B-2, these results in Table E-1 show that the forecast increase EV/HV sales associated with the MY 2017-2025 CAFE rulemaking proposal is projected to increase EV/HV operation at these speeds by 95 million hours in 2025, 339 million hours in 2030, and 480 million hours of vehicle operation in 2035. The second row under Alternative 3 shows that, when taking into consideration NHTSA's CAFE action, Alternative 3 would result in a sound increase for those same hours of urban EV/HV operation from a range of 49.4-59.5 dB(A) to a range of 51.8-59.8 dB(A), reflecting the Alternative 3 sound required at 10 km/h and 20 km/h.

The third row under the Preferred Alternative shows that the Preferred Alternative would increase the sound for urban EVs/HVs at speeds of 20 to 30 km/h from a range of 59.5-65.7 dB(A) to a range of 64-69.2 dB(A). This sound addition would apply to 78 million hours of EV/HV operation in 2020, 238 million hours in 2025, 478 million hours in 2030, and 643 million hours in 2035. When compared to Table B-2, these results in Table E-1 show that the forecast increase EV/HV sales associated with the MY 2017-2025 CAFE action is projected to increase EV/HV operation at speeds of 20 to 30 km/h by 53 million hours in 2025, 186 million hours in

2030, and 263 million hours of vehicle operation in 2035. The third row under Alternative 3 in Table E-1 shows that NHTSA's CAFE action is expected to result in no increase in the sound range of 59.5-65.7 dB(A) for those same hours of urban EV/HV operation (78 million in 2020, 185 million in 2025, 292 million in 3020, and 380 million in 2035).

Table E-1: Cumulative Impacts of Action Alternatives versus No Action Alternative Aggregate Annual Post-2016 EV/HV Operation by Sound (million hours/year)

Location	**Speed**	**Increase in EV/HV dB(A) Compared to No Action**	**Million Hours/Year EV/HV Operation**			
			2020	**2025**	**2030**	**2035**
Alternative 2 (Preferred Alternative)						
Urban	Stationary	From 0.1 to 49.9	146	444	893	1201
	0 < km/h ≤ 20	From 49.4-59.5 to 56.7-64	143	434	873	1174
	20 < km/h ≤ 30	From 59.5-65.7 to 64-69.2	78	238	478	643
	km/h > 30	75: No Increase	742	2256	4539	6105
Non-urban	Stationary	From 0.1 to 49.9	6	18	36	48
	0 < km/h ≤ 20	From 49.4-59.5 to 56.7-64	6	18	35	47
	20 < km/h ≤ 30	From 59.5-65.7 to 64-69.2	3	10	21	28
	km/h > 30	75: No Increase	63	193	388	522
Alternative 3						
Urban	Stationary	0.1:No Increase	146	444	893	1201
	0 < km/h ≤ 20	From 49.4-59.5 to 51.8-59.8	143	434	873	1174
	20 < km/h ≤ 30	59.5-65.7: No Increase	78	238	478	643
	km/h > 30	75: No Increase	742	2256	4539	6105
Non-urban	Stationary	0.1:No Increase	6	18	36	48
	0 < km/h ≤ 20	From 49.4-59.5 to 51.8-59.8	6	18	35	47
	20 < km/h ≤ 30	59.5-65.7: No Increase	3	10	21	28
	km/h > 30	75: No Increase	63	193	388	522

APPENDIX F – Detailed Noise Modeling Results for a Receiver Near Roadway

AEO 2012 Early Release Forecast (without MY 2017-2025 CAFE action) estimates 2035 EV/HV deployment at 6.6 percent of the total fleet. The primary analysis in NHTSA's recent Draft Technical Assessment Report for its mid-term evaluation of the MY 2017-2025 CAFE standards estimated the proportion of sales of MY 2025 LDVs that would be EVs/HVs to be less than 17 percent. On-road EV/HV deployment in that year would therefore be much less, as the vast majority of on-road vehicles would predate MY 2025 vehicles.

In the following results tables, Alternative 2 is presented with the 4 dB exceedance predicted for manufacturers to ensure compliance. In addition, NHTSA also analyzed Alternative 2 with a 7 dB exceedance as a "worst case" scenario. The results for Alternative 2 from the Draft EA are also presented in this Appendix.

Alternative 2 (+4 dB): Preferred Alternative												
Vehicle Spacing	*Non-urban*				***Ambient Level***				*None*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			17.1		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.9			56.7			64			69.2		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	-0.1	0	0	-0.1	0	0	-0.1	-0.1	0
10	-0.1	0	-0.1	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.2	-0.2	0
20	-0.2	-0.1	-0.2	-0.4	-0.2	-0.2	-0.5	-0.2	-0.2	-0.4	-0.3	-0.1
50	-1.3	-0.5	-0.8	-1.4	-0.8	-0.6	-1.5	-0.8	-0.7	-1.2	-1	-0.2
80	-4.9	-2.5	-2.5	-4.6	-2.9	-1.7	-3.9	-2.4	-1.5	-2.7	-2.3	-0.4
90	-8.6	-5.2	-3.5	-6.8	-4.6	-2.2	-5.2	-3.3	-1.8	-3.4	-2.9	-0.5
96	-13.4	-9.3	-4.1	-8.5	-6.1	-2.4	-6	-4	-2	-3.8	-3.3	-0.5
98	-16.8	-12.6	-4.2	-9.2	-6.7	-2.5	-6.3	-4.2	-2.1	-3.9	-3.4	-0.5
100	-54.2	-49.8	-4.4	-9.9	-7.3	-2.6	-6.6	-4.5	-2.1	-4	-3.5	-0.5

Alternative 2 (+4 dB): Preferred Alternative												
Vehicle Spacing	*Urban*				***Ambient Level***				*None*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.9			56.7			64			69.2		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	-0.1	0	0	-0.1	0	0	-0.1	-0.1	0
10	-0.1	0	-0.1	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.2	-0.2	0
20	-0.2	-0.1	-0.2	-0.4	-0.2	-0.2	-0.4	-0.2	-0.2	-0.4	-0.3	-0.1
50	-1.3	-0.5	-0.8	-1.4	-0.7	-0.6	-1.4	-0.8	-0.6	-1.2	-1	-0.2
80	-4.9	-2.5	-2.5	-4.6	-2.9	-1.7	-3.9	-2.4	-1.5	-2.7	-2.3	-0.4
90	-8.6	-5.2	-3.5	-6.8	-4.6	-2.2	-5.2	-3.3	-1.8	-3.4	-2.9	-0.5
96	-13.4	-9.3	-4.1	-8.5	-6.1	-2.4	-6	-4	-2	-3.8	-3.3	-0.5
98	-16.8	-12.6	-4.2	-9.2	-6.7	-2.5	-6.3	-4.2	-2.1	-3.9	-3.4	-0.5
100	-54.2	-49.8	-4.4	-9.9	-7.3	-2.6	-6.6	-4.5	-2.1	-4	-3.5	-0.5

Alternative 2 (+4 dB): Preferred Alternative												
Vehicle Spacing	*Non-urban*				***Ambient Level***				*Non-urban (35 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			17.1		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.9			56.7			64			69.2		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	-0.1	0	0	-0.1	0	0	-0.1	-0.1	0
10	-0.1	0	-0.1	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.2	-0.2	0
20	-0.2	-0.1	-0.1	-0.4	-0.2	-0.2	-0.5	-0.2	-0.2	-0.4	-0.3	-0.1
50	-1.2	-0.5	-0.7	-1.4	-0.7	-0.6	-1.4	-0.8	-0.7	-1.2	-1	-0.2
80	-4.6	-2.3	-2.3	-4.5	-2.8	-1.7	-3.9	-2.4	-1.5	-2.7	-2.3	-0.4
90	-7.8	-4.5	-3.3	-6.5	-4.3	-2.1	-5.1	-3.3	-1.8	-3.4	-2.9	-0.5
96	-11	-7.2	-3.8	-8	-5.6	-2.4	-5.9	-3.9	-2	-3.7	-3.2	-0.5
98	-12.6	-8.6	-4	-8.5	-6.1	-2.4	-6.2	-4.2	-2	-3.9	-3.4	-0.5
100	-14.6	-10.4	-4.1	-9.1	-6.6	-2.5	-6.5	-4.4	-2.1	-4	-3.5	-0.5

Alternative 2 (+4 dB): Preferred Alternative												
Vehicle Spacing	*Urban*				***Ambient Level***				*Urban (55 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.9			56.7			64			69.2		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	-0.1	0	0	-0.1	-0.1	0
10	0	0	0	-0.1	0	0	-0.1	-0.1	-0.1	-0.2	-0.1	0
20	-0.1	0	0	-0.2	-0.1	-0.1	-0.3	-0.2	-0.1	-0.3	-0.3	-0.1
50	-0.3	-0.1	-0.2	-0.5	-0.3	-0.2	-0.9	-0.5	-0.4	-1	-0.8	-0.2
80	-1	-0.4	-0.6	-1.4	-0.7	-0.6	-2.3	-1.3	-1	-2.1	-1.8	-0.3
90	-1.3	-0.5	-0.8	-1.7	-0.9	-0.8	-2.9	-1.7	-1.2	-2.5	-2.2	-0.4
96	-1.5	-0.6	-0.9	-1.9	-1.1	-0.8	-3.3	-2	-1.3	-2.8	-2.4	-0.4
98	-1.5	-0.6	-0.9	-2	-1.1	-0.9	-3.4	-2	-1.3	-2.9	-2.5	-0.4
100	-1.5	-0.6	-0.9	-2	-1.1	-0.9	-3.5	-2.1	-1.4	-3	-2.6	-0.4

Alternative 2 (+7dB): Preferred Alternative												
Vehicle Spacing	*Non-Urban*				***Ambient Level***				*Non-urban (35 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	52.9			59.2			65.7			70.9		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	-0.1	0
4	0	0	0	-0.1	-0.1	0	-0.1	-0.1	0	-0.1	-0.1	0
10	-0.1	-0.1	0	-0.2	-0.2	0	-0.2	-0.2	0	-0.2	-0.3	0.1
20	-0.2	-0.2	-0.1	-0.4	-0.4	0	-0.5	-0.4	-0.1	-0.4	-0.6	0.2
50	-1.2	-0.9	-0.3	-1.4	-1.3	0	-1.4	-1.3	-0.2	-1.2	-1.7	0.5
80	-4.6	-3.8	-0.9	-4.5	-4.4	-0.1	-3.9	-3.5	-0.3	-2.7	-3.6	0.9
90	-7.8	-6.6	-1.1	-6.5	-6.3	-0.1	-5.1	-4.7	-0.4	-3.4	-4.4	1
96	-11	-9.7	-1.3	-8	-7.8	-0.1	-5.9	-5.5	-0.4	-3.7	-4.9	1.1
98	-12.6	-11.3	-1.3	-8.5	-8.4	-0.1	-6.2	-5.8	-0.4	-3.9	-5	1.1
100	-14.6	-13.2	-1.3	-9.1	-9	-0.1	-6.5	-6.1	-0.4	-4	-5.2	1.2

Alternative 2 (+7dB): Preferred Alternative												
Vehicle Spacing	*Non-Urban*				***Ambient Level***				*Non-urban (35 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	52.9			59.2			65.7			70.9		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	-0.1	0
4	0	0	0	-0.1	-0.1	0	-0.1	-0.1	0	-0.1	-0.1	0
10	-0.1	-0.1	0	-0.2	-0.2	0	-0.2	-0.2	0	-0.2	-0.3	0.1
20	-0.2	-0.2	-0.1	-0.4	-0.4	0	-0.4	-0.4	-0.1	-0.4	-0.6	0.2
50	-1.3	-1	-0.3	-1.4	-1.3	0	-1.4	-1.3	-0.1	-1.2	-1.7	0.5
80	-4.9	-4	-0.9	-4.6	-4.5	-0.1	-3.9	-3.5	-0.3	-2.7	-3.6	0.9
90	-8.6	-7.4	-1.2	-6.8	-6.7	-0.1	-5.2	-4.8	-0.4	-3.4	-4.4	1
96	-13.4	-12.1	-1.3	-8.5	-8.4	-0.1	-6	-5.6	-0.4	-3.8	-4.9	1.1
98	-16.8	-15.5	-1.4	-9.2	-9.1	-0.1	-6.3	-5.9	-0.4	-3.9	-5	1.1
100	-54.2	-52.8	-1.4	-9.9	-9.8	-0.1	-6.6	-6.2	-0.4	-4	-5.2	1.2

Alternative 2 (+7dB): Preferred Alternative												
Vehicle Spacing	*Urban*				***Ambient Level***				*Urban (55 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	52.9			59.2			65.7			70.9		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	-0.1	-0.1	0	-0.1	-0.1	0
10	0	0	0	-0.1	-0.1	0	-0.1	-0.1	0	-0.2	-0.2	0.1
20	-0.1	-0.1	0	-0.2	-0.1	0	-0.3	-0.3	0	-0.3	-0.5	0.2
50	-0.3	-0.3	-0.1	-0.5	-0.5	0	-0.9	-0.8	-0.1	-1	-1.4	0.4
80	-1	-0.7	-0.2	-1.4	-1.3	0	-2.3	-2.1	-0.2	-2.1	-2.9	0.8
90	-1.3	-1	-0.3	-1.7	-1.7	-0.1	-2.9	-2.7	-0.3	-2.5	-3.4	0.9
96	-1.5	-1.1	-0.4	-1.9	-1.8	-0.1	-3.3	-3	-0.3	-2.8	-3.7	0.9
98	-1.5	-1.1	-0.4	-2	-1.9	-0.1	-3.4	-3.1	-0.3	-2.9	-3.9	1
100	-1.5	-1.2	-0.4	-2	-1.9	-0.1	-3.5	-3.2	-0.3	-3	-4	1

Alternative 3												
Vehicle Spacing	*Non-urban*				***Ambient Level***				*None*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			17.1		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	0.1			51.8			59.8			65.7		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	-0.1	0	-0.1	-0.1	0	-0.1	-0.1	0	-0.1
10	-0.1	0	-0.1	-0.2	0	-0.2	-0.2	0	-0.2	-0.2	0	-0.2
20	-0.2	0	-0.2	-0.4	0	-0.4	-0.5	0	-0.5	-0.4	0	-0.4
50	-1.3	0	-1.3	-1.4	-0.1	-1.3	-1.5	0	-1.4	-1.2	0	-1.2
80	-4.9	0	-4.9	-4.6	-0.6	-4	-3.9	-0.1	-3.8	-2.7	0	-2.7
90	-8.6	0	-8.6	-6.8	-1.2	-5.6	-5.2	-0.2	-5	-3.4	0	-3.4
96	-13.4	0	-13.4	-8.5	-1.8	-6.8	-6	-0.2	-5.8	-3.8	0	-3.8
98	-16.8	0	-16.8	-9.2	-2	-7.2	-6.3	-0.3	-6	-3.9	0	-3.9
100	-54.2	0	-54.2	-9.9	-2.4	-7.5	-6.6	-0.3	-6.3	-4	0	-4

Alternative 3												
Vehicle Spacing	*Urban*				***Ambient Level***				*None*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	0.1			51.8			59.8			65.7		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	-0.1	0	-0.1	-0.1	0	-0.1	-0.1	0	-0.1
10	-0.1	0	-0.1	-0.2	0	-0.2	-0.2	0	-0.2	-0.2	0	-0.2
20	-0.2	0	-0.2	-0.4	0	-0.3	-0.4	0	-0.4	-0.4	0	-0.4
50	-1.3	0	-1.3	-1.4	-0.1	-1.2	-1.4	0	-1.4	-1.2	0	-1.2
80	-4.9	0	-4.9	-4.6	-0.6	-4	-3.9	-0.1	-3.7	-2.7	0	-2.7
90	-8.6	0	-8.6	-6.8	-1.2	-5.6	-5.2	-0.2	-5	-3.4	0	-3.4
96	-13.4	0	-13.4	-8.5	-1.8	-6.8	-6	-0.2	-5.8	-3.8	0	-3.8
98	-16.8	0	-16.8	-9.2	-2	-7.2	-6.3	-0.3	-6	-3.9	0	-3.9
100	-54.2	0	-54.2	-9.9	-2.4	-7.5	-6.6	-0.3	-6.3	-4	0	-4

Alternative 3												
Vehicle Spacing	*Non-urban*				***Ambient Level***				*Non-urban (35 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			17.1		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	0.1			51.8			59.8			65.7		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	-0.1	0	-0.1	-0.1	0	-0.1	-0.1	0	-0.1
10	-0.1	0	-0.1	-0.2	0	-0.2	-0.2	0	-0.2	-0.2	0	-0.2
20	-0.2	0	-0.2	-0.4	0	-0.3	-0.5	0	-0.4	-0.4	0	-0.4
50	-1.2	0	-1.2	-1.4	-0.1	-1.2	-1.4	0	-1.4	-1.2	0	-1.2
80	-4.6	0	-4.6	-4.5	-0.6	-3.9	-3.9	-0.1	-3.7	-2.7	0	-2.7
90	-7.8	0	-7.8	-6.5	-1.1	-5.4	-5.1	-0.2	-4.9	-3.4	0	-3.4
96	-11	0	-11	-8	-1.6	-6.4	-5.9	-0.2	-5.7	-3.7	0	-3.7
98	-12.6	0	-12.6	-7.3	-1.3	-5.9	-6	-0.2	-5.7	-3.8	0	-3.8
100	-14.6	0	-14.6	-7.7	-1.5	-6.2	-6.2	-0.3	-6	-3.9	0	-3.9

Alternative 3												
Vehicle Spacing	*Urban*				***Ambient Level***				*Urban (55 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	0.1			51.8			59.8			65.7		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	-0.1	0	-0.1	-0.1	0	-0.1
10	0	0	0	-0.1	0	-0.1	-0.1	0	-0.1	-0.22	0	-0.22
20	-0.1	0	-0.1	-0.22	0	-0.1	-0.3	0	-0.3	-0.3	0	-0.3
50	-0.3	0	-0.3	-0.5	0	-0.5	-0.9	0	-0.9	-1	0	-1
80	-1	0	-1	-1.4	-0.1	-1.2	-2.3	-0.1	-2.3	-2.1	0	-2.1
90	-1.3	0	-1.3	-1.7	-0.2	-1.5	-2.9	-0.1	-2.8	-2.5	0	-2.5
96	-1.5	0	-1.5	-1.9	-0.2	-1.7	-3.3	-0.1	-3.2	-2.8	0	-2.8
98	-1.5	0	-1.5	-2	-0.2	-1.8	-3.4	-0.1	-3.3	-2.9	0	-2.9
100	-1.5	0	-1.5	-2	-0.2	-1.8	-3.5	-0.1	-3.4	-3	0	-3

Alternative 2 (+4 dB): Preferred Alternative												
Vehicle Spacing	*Non-urban*				***Ambient Level***				*None*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	15			15			15			15		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			17.1		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.9			56.7			64			69.2		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
10	-0.1	0	0	-0.1	0	0	-0.1	-0.1	-0.1	-0.1	-0.1	0
20	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.3	-0.1	-0.1	-0.3	-0.2	0
50	-1.2	-0.5	-0.8	-1.1	-0.6	-0.5	-1.1	-0.6	-0.5	-0.9	-0.7	-0.2
80	-4.5	-2.2	-2.3	-4.1	-2.5	-1.6	-3.5	-2.1	-1.4	-2.5	-2.2	-0.4
90	-7.8	-4.6	-3.3	-6.5	-4.4	-2.1	-5	-3.2	-1.8	-3.3	-2.9	-0.5
96	-12.8	-8.8	-4	-8.4	-6	-2.4	-6	-4	-2	-3.8	-3.3	-0.5
98	-16.7	-12.4	-4.2	-9.2	-6.7	-2.5	-6.3	-4.2	-2.1	-3.9	-3.4	-0.5
100	-54.2	-49.8	-4.4	-9.9	-7.3	-2.6	-6.6	-4.5	-2.1	-4	-3.5	-0.5

Alternative (+4 dB): Preferred Alternative												
Vehicle Spacing	*Urban*					***Ambient Level***				*None*		
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	15			15			15			15		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.9			56.7			64			69.2		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
10	-0.1	0	0	-0.1	0	0	-0.1	-0.1	-0.1	-0.1	-0.1	0
20	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.3	-0.1	-0.1	-0.3	-0.2	0
50	-1.2	-0.5	-0.8	-1.1	-0.6	-0.5	-1	-0.6	-0.5	-0.9	-0.7	-0.1
80	-4.5	-2.2	-2.3	-4.1	-2.5	-1.6	-3.5	-2.1	-1.4	-2.5	-2.2	-0.4
90	-7.8	-4.6	-3.3	-6.5	-4.4	-2.1	-5	-3.2	-1.8	-3.3	-2.9	-0.5
96	-12.8	-8.8	-4	-8.4	-6	-2.4	-6	-4	-2	-3.8	-3.3	-0.5
98	-16.7	-12.4	-4.2	-9.2	-6.7	-2.5	-6.3	-4.2	-2.1	-3.9	-3.4	-0.5
100	-54.2	-49.8	-4.4	-9.9	-7.3	-2.6	-6.6	-4.5	-2.1	-4	-3.5	-0.5

Alternative (+4 dB): Preferred Alternative												
Vehicle Spacing	*Non-urban*				***Ambient Level***				*Non-urban (35 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	15			15			15			15		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			17.1		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.9			56.7			64			69.2		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
10	-0.1	0	0	-0.1	0	0	-0.1	-0.1	-0.1	-0.1	-0.1	0
20	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.3	-0.1	-0.1	-0.3	-0.2	0
50	-1.1	-0.5	-0.7	-1.1	-0.6	-0.5	-1.1	-0.6	-0.5	-0.9	-0.7	-0.2
80	-4	-1.9	-2.1	-3.8	-2.3	-1.5	-3.5	-2.1	-1.4	-2.5	-2.1	-0.4
90	-6.5	-3.6	-3	-5.9	-3.9	-2	-4.9	-3.1	-1.8	-3.3	-2.8	-0.4
96	-9.3	-5.7	-3.6	-7.4	-5.1	-2.3	-5.8	-3.8	-2	-3.7	-3.2	-0.5
98	-10.4	-6.7	-3.8	-7.9	-5.6	-2.4	-6.1	-4.1	-2	-3.8	-3.3	-0.5
100	-11.5	-7.6	-3.9	-8.4	-6	-2.4	-6.4	-4.3	-2.1	-4	-3.5	-0.5

Alternative (+4 dB): Preferred Alternative												
Vehicle Spacing	*Urban*				***Ambient Level***				*Urban (55 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	15			15			15			15		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.9			56.7			64			69.2		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	-0.1	0	0	-0.1	-0.1	0
20	0	0	0	-0.1	0	0	-0.1	-0.1	-0.1	-0.2	-0.1	0
50	-0.2	-0.1	-0.1	-0.3	-0.1	-0.1	-0.5	-0.3	-0.2	-0.6	-0.5	-0.1
80	-0.5	-0.2	-0.3	-0.7	-0.4	-0.3	-1.5	-0.8	-0.7	-1.5	-1.2	-0.2
90	-0.7	-0.3	-0.4	-0.9	-0.5	-0.4	-1.9	-1.1	-0.8	-1.9	-1.6	-0.3
96	-0.8	-0.3	-0.5	-1.1	-0.6	-0.5	-2.1	-1.2	-0.9	-2.1	-1.8	-0.3
98	-0.8	-0.3	-0.5	-1.1	-0.6	-0.5	-2.2	-1.2	-0.9	-2.1	-1.8	-0.3
100	-0.8	-0.3	-0.5	-1.1	-0.6	-0.5	-2.3	-1.3	-1	-2.2	-1.9	-0.3

Alternative 3												
Vehicle Spacing	*Non-urban*				***Ambient Level***			*None*				
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	15			15			15			15		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			17.1		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	0.1			51.8			59.8			65.7		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
10	-0.1	0	-0.1	-0.1	0	-0.1	-0.1	0	-0.1	-0.1	0	-0.1
20	-0.2	0	-0.2	-0.2	0	-0.2	-0.3	0	-0.3	-0.3	0	-0.3
50	-1.2	0	-1.2	-1.1	-0.1	-1	-1.1	0	-1	-0.9	0	-0.9
80	-4.5	0	-4.5	-4.1	-0.5	-3.6	-3.5	-0.1	-3.4	-2.5	0	-2.5
90	-7.8	0	-7.8	-6.5	-1.1	-5.4	-5	-0.2	-4.8	-3.3	0	-3.3
96	-12.8	0	-12.8	-8.4	-1.7	-6.7	-6	-0.2	-5.7	-3.8	0	-3.8
98	-16.7	0	-16.7	-9.2	-2	-7.1	-6.3	-0.3	-6	-3.9	0	-3.9
100	-54.2	0	-54.2	-9.9	-2.4	-7.5	-6.6	-0.3	-6.3	-4	0	-4

Alternative 3												
Vehicle Spacing	*Urban*				***Ambient Level***				*None*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	0.1			51.8			59.8			65.7		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
10	-0.1	0	-0.1	-0.1	0	-0.1	-0.1	0	-0.1	-0.1	0	-0.1
20	-0.2	0	-0.2	-0.2	0	-0.2	-0.3	0	-0.3	-0.3	0	-0.3
50	-1.2	0	-1.2	-1.1	-0.1	-1	-1	0	-1	-0.9	0	-0.9
80	-4.5	0	-4.5	-4.1	-0.5	-3.6	-3.5	-0.1	-3.4	-2.5	0	-2.5
90	-7.8	0	-7.8	-6.5	-1.1	-5.4	-5	-0.2	-4.8	-3.3	0	-3.3
96	-12.8	0	-12.8	-8.4	-1.7	-6.7	-6	-0.2	-5.7	-3.8	0	-3.8
98	-16.7	0	-16.7	-9.2	-2	-7.1	-6.3	-0.3	-6	-3.9	0	-3.9
100	-54.2	0	-54.2	-9.9	-2.4	-7.5	-6.6	-0.3	-6.3	-4	0	-4

Alternative 3												
Vehicle Spacing	*Non-urban*				***Ambient Level***				*Non-urban (35 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	15			15			15			15		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			17.1		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	0.1			51.8			59.8			65.7		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
10	-0.1	0	-0.1	-0.1	0	-0.1	-0.1	0	-0.1	-0.1	0	-0.1
20	-0.2	0	-0.2	-0.2	0	-0.2	-0.3	0	-0.3	-0.3	0	-0.3
50	-1.1	0	-1.1	-1.1	-0.1	-1	-1.1	0	-1	-0.9	0	-0.9
80	-4	0	-4	-3.8	-0.5	-3.3	-3.5	-0.1	-3.4	-2.5	0	-2.5
90	-6.5	0	-6.5	-5.9	-0.9	-4.9	-4.9	-0.2	-4.7	-3.3	0	-3.3
96	-9.3	0	-9.3	-7.4	-1.4	-6	-5.8	-0.2	-5.6	-3.7	0	-3.7
98	-10.4	0	-10.4	-7.9	-1.5	-6.4	-6.1	-0.3	-5.8	-3.8	0	-3.8
100	-11.5	0	-11.5	-8.4	-1.7	-6.7	-6.4	-0.3	-6.1	-4	0	-4

Alternative 3												
Vehicle Spacing	*Urban*				***Ambient Level***				*Urban (55 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	15			15			15			15		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	0.1			51.8			59.8			65.7		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 3 vs. Alt. 1**	**Alt. 3 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	-0.1	0	-0.1	-0.1	0	-0.1
20	0	0	0	-0.1	0	-0.1	-0.1	0	-0.1	-0.2	0	-0.2
50	-0.2	0	-0.2	-0.3	0	-0.2	-0.5	0	-0.5	-0.6	0	-0.6
80	-0.5	0	-0.5	-0.7	-0.1	-0.7	-1.5	0	-1.4	-1.5	0	-1.5
90	-0.7	0	-0.7	-0.9	-0.1	-0.9	-1.9	0	-1.9	-1.9	0	-1.9
96	-0.8	0	-0.8	-1.1	-0.1	-1	-2.1	-0.1	-2.1	-2.1	0	-2.1
98	-0.8	0	-0.8	-1.1	-0.1	-1	-2.2	-0.1	-2.1	-2.1	0	-2.1
100	-0.8	0	-0.8	-1.1	-0.1	-1	-2.3	-0.1	-2.2	-2.2	0	-2.2

Alternative 2 from Draft EA: Preferred Alternative												
Vehicle Spacing	*Non-urban*				***Ambient Level***				*None*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			17.1		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.5			56.4			63.8			68.9		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	-0.1	0	0	-0.1	0	0	-0.1	-0.1	0
10	-0.1	0	-0.1	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1
20	-0.2	-0.1	-0.2	-0.4	-0.2	-0.2	-0.5	-0.2	-0.2	-0.4	-0.3	-0.1
50	-1.3	-0.5	-0.8	-1.4	-0.7	-0.7	-1.5	-0.7	-0.7	-1.2	-0.9	-0.3
80	-4.9	-2.3	-2.6	-4.6	-2.7	-1.9	-3.9	-2.2	-1.7	-2.7	-2.1	-0.7
90	-8.6	-4.9	-3.7	-6.8	-4.4	-2.5	-5.2	-3.1	-2	-3.4	-2.6	-0.8
96	-13.4	-9	-4.4	-8.5	-5.8	-2.7	-6	-3.8	-2.2	-3.8	-2.9	-0.8
98	-16.8	-12.2	-4.6	-9.2	-6.4	-2.8	-6.3	-4	-2.3	-3.9	-3	-0.9
100	-54.2	-49.4	-4.8	-9.9	-7	-2.9	-6.6	-4.3	-2.4	-4	-3.2	-0.9

Alternative 2 from Draft EA: Preferred Alternative												
Vehicle Spacing	*Urban*				***Ambient Level***				*None*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.5			56.4			63.8			68.9		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	-0.1	0	0	-0.1	0	0	-0.1	-0.1	0
10	-0.1	0	-0.1	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1
20	-0.2	-0.1	-0.2	-0.4	-0.2	-0.2	-0.4	-0.2	-0.2	-0.4	-0.3	-0.1
50	-1.3	-0.5	-0.8	-1.4	-0.7	-0.7	-1.4	-0.7	-0.7	-1.2	-0.9	-0.3
80	-4.9	-2.3	-2.6	-4.6	-2.7	-1.9	-3.9	-2.2	-1.6	-2.7	-2.1	-0.7
90	-8.6	-4.9	-3.7	-6.8	-4.4	-2.5	-5.2	-3.1	-2	-3.4	-2.6	-0.8
96	-13.4	-9	-4.4	-8.3	-5.6	-2.7	-5.9	-3.7	-2.2	-3.7	-2.9	-0.8
98	-16.8	-12.2	-4.6	-9.2	-6.3	-2.8	-6.3	-4	-2.3	-3.9	-3	-0.9
100	-54.2	-49.4	-4.8	-9.9	-7	-2.9	-6.6	-4.3	-2.4	-4	-3.2	-0.9

Alternative 2 from Draft EA: Preferred Alternative												
Vehicle Spacing	*Non-urban*				***Ambient Level***			*Non-urban (35 dB(A))*				
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			17.1		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.5			56.4			63.8			68.9		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	-0.1	0	0	-0.1	0	0	-0.1	-0.1	0
10	-0.1	0	-0.1	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1
20	-0.2	-0.1	-0.2	-0.4	-0.2	-0.2	-0.5	-0.2	-0.2	-0.4	-0.3	-0.1
50	-1.2	-0.4	-0.8	-1.4	-0.7	-0.7	-1.4	-0.7	-0.7	-1.2	-0.9	-0.3
80	-4.6	-2.1	-2.5	-4.5	-2.6	-1.9	-3.9	-2.2	-1.6	-2.7	-2.1	-0.7
90	-7.8	-4.2	-3.5	-6.5	-4.1	-2.4	-5.1	-3.1	-2	-3.4	-2.6	-0.8
96	-11	-6.9	-4.1	-8	-5.3	-2.7	-5.9	-3.7	-2.2	-3.7	-2.9	-0.8
98	-12.6	-8.3	-4.3	-8.5	-5.8	-2.7	-6.2	-3.9	-2.3	-3.9	-3	-0.8
100	-14.6	-10.1	-4.5	-9.1	-6.3	-2.8	-6.5	-4.2	-2.3	-4	-3.1	-0.9

Alternative 2 from Draft EA: Preferred Alternative												
Vehicle Spacing	*Urban*				***Ambient Level***				*Urban (55 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	7.5			7.5			7.5			7.5		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.5			56.4			63.8			68.9		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	-0.1	0	0	-0.1	0	0
10	0	0	0	-0.1	0	0	-0.1	-0.1	-0.1	-0.22	-0.1	0
20	-0.1	0	0	-0.22	-0.1	-0.1	-0.3	-0.1	-0.22	-0.3	-0.2	-0.1
50	-0.3	-0.1	-0.2	-0.5	-0.2	-0.3	-0.9	-0.5	-0.5	-1	-0.7	-0.3
80	-1	-0.4	-0.6	-1.4	-0.7	-0.7	-2.3	-1.2	-1.1	-2.1	-1.6	-0.5
90	-1.3	-0.5	-0.8	-1.7	-0.9	-0.8	-2.9	-1.6	-1.3	-2.5	-1.9	-0.6
96	-1.5	-0.5	-0.9	-1.9	-1	-0.9	-3.3	-1.8	-1.4	-2.8	-2.1	-0.7
98	-1.5	-0.6	-0.9	-2	-1	-1	-3.4	-1.9	-1.5	-2.9	-2.2	-0.7
100	-1.5	-0.6	-1	-2	-1	-1	-3.5	-2	-1.5	-3	-2.3	-0.7

Alternative 2 from Draft EA: Preferred Alternative												
Vehicle Spacing	*Non-urban*				***Ambient Level***				*None*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	15			15			15			15		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			17.1		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.5			56.4			63.8			68.9		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
10	-0.1	0	0	-0.1	0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0
20	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.3	-0.1	-0.1	-0.3	-0.2	-0.1
50	-1.2	-0.5	-0.8	-1.1	-0.6	-0.6	-1.1	-0.5	-0.5	-0.9	-0.6	-0.3
80	-4.5	-2.1	-2.5	-4.1	-2.4	-1.8	-3.5	-2	-1.5	-2.5	-1.9	-0.6
90	-7.8	-4.3	-3.5	-6.5	-4.1	-2.4	-5	-3	-2	-3.3	-2.6	-0.8
96	-12.8	-8.5	-4.3	-8.4	-5.7	-2.7	-6	-3.8	-2.2	-3.8	-2.9	-0.8
98	-16.7	-12.1	-4.6	-9.2	-6.3	-2.8	-6.3	-4	-2.3	-3.9	-3	-0.9
100	-54.2	-49.4	-4.8	-9.9	-7	-2.9	-6.6	-4.3	-2.4	-4	-3.2	-0.9

Alternative 2 from Draft EA: Preferred Alternative												
Vehicle Spacing	*Urban*				***Ambient Level***				*None*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	15			15			15			15		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.5			56.4			63.8			68.9		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
10	-0.1	0	0	-0.1	0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0
20	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.3	-0.1	-0.1	-0.3	-0.2	-0.1
50	-1.2	-0.5	-0.8	-1.1	-0.6	-0.6	-1	-0.5	-0.5	-0.9	-0.6	-0.2
80	-4.5	-2.1	-2.5	-4.1	-2.3	-1.8	-3.5	-2	-1.5	-2.5	-1.9	-0.6
90	-7.8	-4.3	-3.5	-6.5	-4.1	-2.4	-5	-3	-2	-3.3	-2.5	-0.8
96	-12.8	-8.5	-4.3	-8.4	-5.7	-2.7	-6	-3.8	-2.2	-3.8	-2.9	-0.8
98	-16.7	-12.1	-4.6	-9.2	-6.3	-2.8	-6.3	-4	-2.3	-3.9	-3	-0.9
100	-54.2	-49.4	-4.8	-9.9	-7	-2.9	-6.6	-4.3	-2.4	-4	-3.2	-0.9

Alternative 2 from Draft EA: Preferred Alternative												
Vehicle Spacing	*Non-urban*				***Ambient Level***				*Non-urban (35 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	15			15			15			15		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.7			11.4			17.1		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.5			56.4			63.8			68.9		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
10	-0.1	0	0	-0.1	0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0
20	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.3	-0.1	-0.1	-0.3	-0.2	-0.1
50	-1.1	-0.4	-0.7	-1.1	-0.5	-0.6	-1.1	-0.5	-0.5	-0.9	-0.6	-0.2
80	-4	-1.8	-2.2	-3.8	-2.2	-1.7	-3.5	-1.9	-1.5	-2.5	-1.9	-0.6
90	-6.5	-3.3	-3.2	-5.9	-3.6	-2.2	-4.9	-2.9	-1.9	-3.3	-2.5	-0.8
96	-9.3	-5.4	-3.9	-7.4	-4.8	-2.6	-5.8	-3.6	-2.2	-3.7	-2.9	-0.8
98	-10.4	-6.4	-4.1	-7.9	-5.3	-2.7	-6.1	-3.9	-2.2	-3.8	-3	-0.8
100	-11.5	-7.3	-4.2	-8.4	-5.7	-2.7	-6.4	-4.1	-2.3	-4	-3.1	-0.9

Alternative 2 from Draft EA: Preferred Alternative												
Vehicle Spacing	*Urban*					***Ambient Level***			*Urban (55 dB(A))*			
Speed (km/h)	**0**			**10**			**20**			**30**		
Number of Vehicles	50			50			50			50		
Y Receiver (meters)	15			15			15			15		
Vehicle Length (meters)	5			5			5			5		
Vehicle Gap (meters)	0			5.3			10.5			15.8		
SPL Conventional (No Ambient) (dB[A])	54.2			59.3			66.1			69.7		
SPL Quiet (No Ambient) (dB[A])	0.1			49.4			59.5			65.7		
SPL Quiet Plus Added Sound (No Ambient) (dB[A])	49.5			56.4			63.8			68.9		
Percentage EV/HV	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**	**Alt. 1 vs. Zero EV/ HVs**	**Alt. 2 vs. Alt. 1**	**Alt. 2 vs. Zero EV/ HVs**
2	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	-0.1	0	0	-0.1	-0.1	0
20	0	0	0	-0.1	0	0	-0.1	-0.1	-0.1	-0.2	-0.1	0
50	-0.2	-0.1	-0.1	-0.3	-0.1	-0.1	-0.5	-0.2	-0.3	-0.6	-0.4	-0.2
80	-0.5	-0.2	-0.3	-0.7	-0.3	-0.4	-1.5	-0.7	-0.7	-1.5	-1.1	-0.4
90	-0.7	-0.2	-0.4	-0.9	-0.5	-0.5	-1.9	-1	-0.9	-1.9	-1.4	-0.5
96	-0.8	-0.3	-0.5	-1.1	-0.5	-0.5	-2.1	-1.1	-1	-2.1	-1.5	-0.5
98	-0.8	-0.3	-0.5	-1.1	-0.5	-0.6	-2.2	-1.2	-1	-2.1	-1.6	-0.5
100	-0.8	-0.3	-0.5	-1.1	-0.5	-0.6	-2.3	-1.2	-1.1	-2.2	-1.6	-0.6

APPENDIX G – Public Comments

Scoping Commenters

All scoping commenters from Docket # NHTSA-2011-0100 are listed below. Not all commenters are necessarily represented in this document since this document addresses only the subset of comments that are related to this Environmental Assessment.

Document Number	Commenter Name	Commenter Organization
NHTSA-2011-0100-0002	Anonymous	N/A
NHTSA-2011-0100-0003	Barbara Jackson	Georgia State Clearinghouse
NHTSA-2011-0100-0004	Eric Danial Vollnogel	N/A
NHTSA-2011-0100-0005	Steve Holmer	N/A
NHTSA-2011-0100-0006	Georgianna Porter	NIH
NHTSA-2011-0100-0007	Michael M. Johnsen	N/A
NHTSA-2011-0100-0008	James Roger Lackore	Oshkosh Corporation
NHTSA-2011-0100-0009	Christi Noem	N/A
NHTSA-2011-0100-0010	Michael M Johnsen	N/A
NHTSA-2011-0100-0011	Timothy Mellon	SAE International
NHTSA-2011-0100-0012	Teresa O. Thomas	Poarch Band Of Creek Indians
NHTSA-2011-0100-0013	Daniel V Ryan	Mazda North American Operations
NHTSA-2011-0100-0014	Frank J Diertl	Mercedes-Benz USA, LLC
NHTSA-2011-0100-0015	Kiminori Orikasa	Hino Motors, Ltd.
NHTSA-2011-0100-0016	Gary Valasek	N/A
NHTSA-2011-0100-0017	N/A	Ford Motor Company
NHTSA-2011-0100-0018	Michael M Johnsen	N/A
NHTSA-2011-0100-0019	Eileen Marie Colleran	Arizona Department of Transportation
NHTSA-2011-0100-0020	Jan Urbahn	BMW of North America, LLC
NHTSA-2011-0100-0021	Tomoya Tohnai	Denso International America, Inc.
NHTSA-2011-0100-0022	N/A	Japanese Automobile Standards Internationalization Center
NHTSA-2011-0100-0023	Michael Cammisa	Association of Global Automakers, Inc.
NHTSA-2011-0100-0024	Tim L. LaFon	Volvo Truck North America
NHTSA-2011-0100-0025	Juan Ramos-Garcia	UNECE Transport Division
NHTSA-2011-0100-0026	Steven Kenner	Automotive Safety Office, Ford Motor Company
NHTSA-2011-0100-0027	Juan Ramos-Garcia	UNECE Transport Division
NHTSA-2011-0100-0028	Pamela P. Amette	Motorcycle Industry Council, Inc.
NHTSA-2011-0100-0029	Alex Cardinali	Nissan North America, Inc.
NHTSA-2011-0100-0030	Scott Schmidt	Alliance of Automobile Manufacturers
NHTSA-2011-0100-0031	Les D. Blomberg	Noise Pollution Clearinghosue
NHTSA-2011-0100-0032	N/A	Association for the Blind and Visually Impaired-Goodwill
NHTSA-2011-0100-0033	Richard Y. Woo	Maryland Department of Transportation
NHTSA-2011-0100-0034	Lauren McLarney	National Federation of the Blind
NHTSA-2011-0100-0035	Lelaina Marin	National Park Service
NHTSA-2011-0100-0036	James C Chen	Tesla Motors, Inc.
NHTSA-2011-0100-0037	Jay Joseph	American Honda Motor Co., Inc.
NHTSA-2011-0100-0038	Jay Joseph	American Honda Motor Co., Inc.

Draft EA Commenters

All Draft EA commenters from Docket # NHTSA-2011-0100 and NHTSA-2011-0148 are listed below. Not all commenters are necessarily represented in this document since this document addresses only the subset of comments that are related to the Draft Environmental Assessment.

Document Number	Commenter Name	Commenter Organization
NHTSA-2011-0148-0058	Daniel Y	N/A
NHTSA-2011-0148-0059	Craig Leonard	N/A
NHTSA-2011-0148-0061	Robert Brown	N/A
NHTSA-2011-0148-0076	D Engel	N/A
NHTSA-2011-0148-0079	Naor Wallach	N/A
NHTSA-2011-0148-0082	Darell Dickey	N/A
NHTSA-2011-0148-0083	Walter Greene	N/A
NHTSA-2011-0148-0085	Christopher Bocast	N/A
NHTSA-2011-0148-0097	Paul Larson	N/A
NHTSA-2011-0148-0121	Brad D.	N/A
NHTSA-2011-0148-0126	Anonymous N/A	N/A
NHTSA-2011-0148-0129	Jim Adams	N/A
NHTSA-2011-0148-0131	Mary McFadden	N/A
NHTSA-2011-0148-0144	Pedro Tavares	N/A
NHTSA-2011-0148-0154	David Condie	N/A
NHTSA-2011-0148-0155	Steve Smith	N/A
NHTSA-2011-0148-0157	Christopher Kozlowski	N/A
NHTSA-2011-0148-0167	Ryan Harper	N/A
NHTSA-2011-0148-0171	Stephen Barton	N/A
NHTSA-2011-0148-0172	Tim Hamill	N/A
NHTSA-2011-0148-0181	Ravi Rajagopalan	N/A
NHTSA-2011-0148-0182	Douglas George	N/A
NHTSA-2011-0148-0187	Steve N/A	N/A
NHTSA-2011-0148-0189	Rodney Brandt	N/A
NHTSA-2011-0148-0191	Richard Pavlicek	N/A
NHTSA-2011-0148-0192	Bonnie Norman	N/A
NHTSA-2011-0148-0193	Ken O'Neal	N/A
NHTSA-2011-0148-0247	Tomoya Tohnai	DENSO International America, Inc.
NHTSA-2011-0148-0251	Scott Schmidt	Alliance of Automobile Manufacturers and Global Automakers
NHTSA-2011-0148-0256	Les Blomberg	Noise Pollution Clearinghouse
NHTSA-2011-0148-0277	Michael Perel	N/A
NHTSA-2011-0148-0280	Giuseppe Casella	European Union

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