North Carolina
Department of Transportation

Traffic Noise Analysis
And Abatement Manual

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

TRAFFIC NOISE ANALYSIS AND ABATEMENT MANUAL

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Some of the most invasive sources of noise in our lives are those associated with transportation. Traffic can be a dominant source of noise in our environments. Traffic noise is a problem of continuing and increasing public concern. Reaction to traffic-generated noise is a result of the responses to both physiological and psychological factors that vary from person to person.

The Federal-Aid Highway Act of 1970 mandated that the Federal Highway Administration (FHWA) develop noise standards for the mitigation of highway traffic noise. FHWA prepared guidelines and standards for the mitigation of highway traffic noise in the planning and design of federally funded highway projects. These standards comprise Title 23 of the United States Code of Federal Regulations Part 772 – *Procedures for Abatement of Highway Traffic Noise and Construction Noise* (23 CFR 772, July 2011). The document "Highway Traffic Noise: Analysis and Abatement Guidance" (July 2010) provides FHWA guidance for the analysis and abatement of highway traffic noise in accordance with 23 CFR 772. These guidelines call for each state highway agency to develop their own set of guidelines that satisfy the requirements of 23 CFR 772. The North Carolina Department of Transportation (NCDOT) revised its Traffic Noise Abatement Policy to comply with these federal requirements; this policy became effective on July 13, 2011.

The purpose of this guidance manual is to assist NCDOT employees, consultants, local governments, and developers with the evaluation of traffic and construction noise and the development of appropriate noise reduction measures. The information in this manual is intended to supplement 23 CFR 772, the NCDOT Traffic Noise Abatement Policy, FHWA's Highway Traffic Noise: Analysis and Abatement Guidance, and other FHWA guidance materials related to traffic noise analyses and the design of feasible and reasonable noise abatement measures.

2.0 DEFINITIONS

General definitions can be found in 23 CFR 772, which is included as Appendix B in this document. The following definitions include those that are not part of 23 CFR 772, but are particularly useful in areas for which guidance is herein provided.

A-Weighted Sound Level: A sound level filtered with the "A-weighted" frequency-weighing curve in which the magnitudes of low- and high-frequencies within the 20 Hz to 20,000 Hz audible range are penalized, increasing the relative significance of the 1,000 Hz to 6,000 Hz frequency range to which human hearing is typically most sensitive. It is the most widely used weighting system for assessing environmental noise, including highway traffic noise and is denoted by the abbreviation dB(A).

Ambient Noise: The combination of all noise sources that occur, typically described for a specific environment, location, and/or period of time.

Approach Criteria: One (1) dB(A) below the Federal Noise Abatement Criteria (NAC) for the land use activity categories A through G. A receptor is considered impacted if the predicted hourly equivalent traffic noise level meets or exceeds the approach criteria value. The Approach Criteria value is one of two criteria that define noise impacts, the other being a substantial increase in predicted noise levels.

Benefited Receptors: All receptors, both impacted and non-impacted, that receive a noise level reduction of 5 dB(A) or more through placement of a noise abatement measure.

Categorical Exclusion (CE): **A** category of actions which do not individually or cumulatively have a significant effect on the human environment and for which neither an environmental assessment or an environmental impact statement is required. The term usually refers to the environmental document that supports this action.

Date of Public Knowledge: The date of approval of the final environmental document, e.g., Categorical Exclusion (CE), State or Federal Finding of No Significant Impact (FONSI) or State or Federal Record of Decision (ROD).

Daytime Hours (Day): The hours of the day between 7:00 a.m. and 7:00 p.m.

Decibel (dB): The logarithmic unit for measuring the ratio of a physical quantity relative to a specified or implied reference level. For sound, the decibel is ten times the logarithm of the ratio of sound pressure levels to a reference pressure of 20 micro-Pascals (20 μPa). For traffic noise measurements, decibels are most commonly reported in terms of the A-weighing frequency scale, which applies penalties to frequencies to which human hearing is not typically sensitive (reference "A-Weighted Sound Level", above).

Design Noise Report (DNR): A detailed study of potential traffic noise impact mitigation measures. The Design Noise report typically follows the recommendation of a Traffic Noise Analysis that traffic noise impacts exist, and that mitigation measures are preliminarily deemed to meet feasibility and reasonableness criteria. A Design Noise Report may be prepared without a Traffic Noise Analysis if project criteria indicate a high likelihood that mitigation measures will meet feasibility and reasonableness criteria.

Design Year: The future year used to estimate the probable traffic volume for which a highway is designed. Design year is typically 20 years beyond the completion year of project construction.

Environmental Assessment (EA): An Environmental Assessment is a public document that serves to briefly provide sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI), to aid an agency's compliance with the National Environmental Policy Act when no environmental impact statement is necessary, and to facilitate preparation of an EIS when one is necessary.

Environmental Impact Statement (EIS): An Environmental Impact Statement is required for major actions that significantly affect the quality of the human environment. An EIS is a full-disclosure document that details the process through which a transportation project was developed, includes consideration of a range of reasonable alternatives, analyzes the potential impacts resulting from these alternatives, and demonstrates compliance with other applicable environmental laws and executive orders.

Evening Hours (Evening): The hours of the day between 7:00 p.m. and 10:00 p.m.

Finding of No Significant Impact (FONSI): When applicable, the conclusive determination after completion of the Environmental Assessment process that a highway project will not create any significant environmental impacts. The term usually refers to the environmental document that supports this action.

Holiday: Any weekend day or weekday recognized by the Federal and/or State Government as a non-working day.

Impacted Receptor: A receptor for which the predicted hourly equivalent traffic noise level meets or exceeds the approach criteria value and/or the predicted future hourly equivalent traffic noise level exceeds the existing ambient noise level by 10 to 15 dB(A), based upon a sliding scale as defined in Table 9.3.

Insertion Loss: The reduction of traffic noise levels, in dB(A), that directly results from installation of a noise reduction measure. Insertion Loss only pertains to the reduction in traffic noise levels, and is not synonymous with Noise Level Reduction (NLR), which also accounts for non-traffic noise sources.

L_{eq}: The equivalent steady-state sound level, which in a defined period of time contains the same amount of acoustic energy as a time-varying sound level during the same period of time.

$L_{eq(h)}$: The equivalent sound level for a one-hour period of time.

NEPA (National Environmental Policy Act): Federal legislation that establishes environmental policy for the nation. It provides an interdisciplinary framework to ensure that decision-makers adequately take environmental factors into account.

Nighttime Hours (Night): The hours of the day between 10:00 p.m. and 7:00 a.m.

Noise: Any unwanted sound.

Noise Abatement: Type of attenuation, such as an earthen berm or solid-mass wall, used to reduce traffic noise levels.

Noise Abatement Criteria (NAC*):* FHWA has determined noise levels for various activities or land uses which represent the upper limit of acceptable traffic noise level conditions, which are found in 23 CFR 772. These regulations do not require meeting the abatement criteria in every instance; rather, they require highway agencies make every feasible and reasonable effort to provide noise mitigation when the criteria are approached or exceeded. Compliance with the noise regulations is a prerequisite for the granting of Federal-aid highway funds for construction or reconstruction of a highway (refer to table 9.2). Along with Substantial Noise Increase, defined below, one of two criteria to determine noise impacts created by a proposed highway project.

Noise Contour: A linear representation of equal noise levels, similar to elevation contour lines on a topographic map.

Noise Level Reduction (NLR): The reduction in noise levels accounting for all known noise sources and attenuating measures. For traffic noise analyses, NLR is the assessment of barrier insertion loss, IL, screened against measured or otherwise quantified noise sources. For example, if a barrier adjacent to a proposed highway on new alignment was predicted to reduce loudest-hour equivalent traffic noise levels at an impacted receptor from

66 dB(A) to 54 dB(A), the Insertion Loss would be 12 dB(A). However, if the measured existing ambient noise level at the receptor was 57 dB(A), then the *actual* reduction in loudest-hour equivalent noise levels would be 66 dB(A) – 57 dB(A), or 9 dB(A). Because barriers can only reduce *traffic* noise levels, NLR is the appropriate metric by which to quantify predicted barrier effectiveness.

Noise Reduction Design Goal: The minimum-required predicted noise level reduction resulting from design of a traffic noise abatement measure. The NCDOT noise reduction design goal is 7 dB(A), and must be achieved for at least one benefited receptor for the abatement measure to meet NCDOT reasonableness criteria.

Noise Sensitive Area (NSA): A geographically limited area in which noise sensitive land uses exist that are, or may be exposed to, similar noise sources.

Optimized Barrier: A sound barrier design with a horizontal alignment and vertical (top) profile based upon an appropriate TNM model, that is designed to 1) provide the greatest amount of traffic noise level reduction per barrier quantity (noise wall area or earth berm volume), 2) provide noise level reduction benefits to as many predicted impacted receptors as possible, 3) meet applicable feasibility and reasonableness criteria and 4) includes all other pertinent engineering considerations such as, but not limited to, line-of-sight, visual impacts, social impacts and with-barrier noise levels.

Peak Hour Traffic: Highest hourly traffic volume in a 24-hour period, not to be confused with the worst (loudest) noise hour traffic.

Property Owner: An entity that holds legal ownership of land or other real property.

Record of Decision (ROD): The final step in the EIS process, where by the Federal Government issues final approval of the environmental documentation.

Sound Level Meter (SLM): An instrument used to measure sound levels, as specified by ANSI S1.4-1983. A Type-I or Type II sound level meter must be used to obtain all sound level data for NCDOT traffic noise analyses and/or design noise reports.

Special Land Use: Defined by FHWA as Noise Abatement Category "C" land uses, special land uses include, but are not limited to schools, churches, parks and recreational areas, golf courses, tennis courts, sports stadiums, and similar facilities.

Substantial Noise Increase: Along with the NAC, defined above, one of two criteria to determine noise impacts created by a proposed highway project. A receptor is considered impacted if the predicted future hourly equivalent traffic noise level exceeds the existing ambient noise level by 10 to 15 dB(A), based upon a sliding scale as defined in Table 9.3.

Traffic Noise Analysis (TNA): A preliminary investigation and report of existing/base year and predicted build-condition design year ambient and traffic noise levels, predicted traffic noise impacts, and assessment of mitigation measure(s) feasibility and reasonableness. This analysis is typically performed during project development for incorporation into the project NEPA document.

Traffic Noise Model (TNM): The computer modeling program created by FHWA used to predict hourly equivalent traffic noise levels. The most current version of TNM shall be used on all federal- and state-funded highway projects in North Carolina for which traffic noise analysis is required.

Traffic Noise Impacts: Receptors for which loudest hourly equivalent noise levels approach or exceed the NAC values or for which design year build condition loudest-hourly equivalent noise levels create a substantial increase over existing loudest-hourly equivalent noise levels.

Type I Project: Type I Projects include

(a) The construction of a highway on new location; or,

(b) The physical alteration of an existing highway where there is either:

(i) Substantial Horizontal Alteration. A project that halves the distance between the traffic noise source and the closest receptor between the existing condition to the future build condition; or,

(ii) Substantial Vertical Alteration. A project that removes shielding, exposing the line-of-sight between the receptor and the traffic noise source. This occurs when either the highway vertical alignment is altered, or when the intervening topography between the highway traffic noise source and receptor is altered,

(c) The addition of a through-traffic lane(s). This includes the addition of a through-traffic lane that functions as a HOV lane, High-Occupancy Toll (HOT) lane, bus lane, or truck climbing lane; or,

(d) The addition of an auxiliary lane, except for when the auxiliary lane is a turn lane; or,

(e) The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange; or,

(f) Restriping existing pavement for the purpose of adding a through-traffic lane or an auxiliary lane; or,

(g) The addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot or toll plaza.

(h) If a project is determined to be a Type I project under this definition then the entire project area as defined in the environmental document is a Type I project.

Type II Project: A Federal or Federal-aid highway project for noise abatement on an existing highway. For a Type II project to be eligible for Federal-aid funding, the highway agency must develop and implement a Type II program in accordance with 23 CFR 772.7(e).

Type III Project: A Federal or Federal-aid highway project that does not meet the classifications of a Type I or Type II project. Type III projects do not require a noise analysis.

Weekday: Excluding holidays, the days of the week between Monday and Friday, inclusive.

Weekend: Excluding holidays, the days of the week including Saturday and Sunday.

Worst Noise Hour: The hour within a day in which the highest magnitude hourly equivalent sound level occurs. The worst traffic noise hour typically occurs when traffic is flowing freely at a high volume relative to the peak traffic hour volume, with a high percentage of trucks.

3.0 TRAFFIC NOISE FUNDAMENTALS

Sound is created when an object moves – the rustling of leaves as the wind blows, the air passing through our vocal chords, the almost invisible movement of stereo speakers. The movements cause vibrations of the molecules in air to move in waves like ripples on water. When the vibrations reach our ears; we hear them.

Noise is unwanted or irritating sound. It is emitted from many sources including airplanes, factories, railroads, commercial businesses, and highway vehicles. Steady-state highway traffic noise is predominantly a composite of noises from engine exhaust, drive train, and tire-roadway interaction.

The magnitude of sound (and noise) is typically described by the logarithm of the ratio of the sound pressure to a reference sound pressure, which is usually twenty micro-Pascals (20μPa). Since the range of sound pressure ratios varies greatly – over many orders of magnitude, a base-10 logarithmic scale is used to express sound levels in dimensionless units of decibels (dB). The commonly accepted limits of human hearing to detect magnitudes of sound are between the threshold of hearing at 0 decibels and the threshold of pain at 140 decibels.

Sound frequencies are represented in units of Hertz (Hz), which correspond to the number of vibrations per second of a given tone. A cumulative 'sound level' is equivalent to ten times the base-10 logarithm of the ratio of the sum of the sound pressures of all frequencies to the reference sound pressure. To simplify the mathematical process of determining sound levels, sound frequencies are grouped into ranges, or 'bands', each typically representing either one 'octave' or '1/3 octave' of the sound frequency spectrum. Since the cumulative sound level is a representation of the total sound pressure (energy), cumulative sound levels are then calculated by adding all the sound pressure levels of each band, and multiplying the logarithm of the ratio of the result and the reference sound pressure level (e.g., 20 μPa) by ten.

The commonly accepted limits of human hearing to detect sound frequencies are between 20 Hz and 20,000 Hz, and human hearing is most sensitive to the frequencies between 1,000 Hz – 6,000 Hz. Although people are generally not as sensitive to lower-frequency sounds as they are to higher frequencies, most people lose the ability to hear high-frequency sounds as they age. To accommodate varying receptor sensitivities, frequency sound levels are commonly adjusted, or 'filtered', before being logarithmically added and reported as a single 'sound level' magnitude of that filtering scale.

The A-weighted decibel filtering scale applies numerical adjustments to sound frequencies to emphasize the frequencies at which human hearing is sensitive, and to minimize the frequencies to which human hearing is not as sensitive (refer to Table 3.1).

Table 3.1: Comparison: Flat vs. A-Weighted Frequency Scaling

Octave-Band Center Frequency (Hz)	A-Weighted Adjustment[1]	Sample Frequency Sound Levels (Flat)	Sample Frequency Sound Levels (A-Weighted)
31	-39.53	90.00	50.47
63	-26.22	80.00	53.78
125	-16.19	70.00	53.81
250	-8.68	65.00	56.32
500	-3.25	60.00	56.75
1000	0.00	60.00	60.00
2000	+1.20	60.00	61.20
4000	+0.96	55.00	55.96
8000	-1.14	50.00	48.86
16000	-6.7	45.00	38.30
Overall Sound Levels:		**90.48 dB[2]**	**66.32 dB(A)[2]**

1. Based on the ISO 226:2003 standard for normal equal-loudness contours, the A-weighted decibel network filtering scale is defined for a frequency, f, by the equation: $20 \times \log_{10} (A(f)/A\ (1000))$, where $A(f) = [12{,}200^2 \times f^4]/[(f^2 + 20.6^2) \times (f^2 + 12{,}200^2) \times (f^2 + 107.7^2)^{0.5} \times (f^2 + 737.9^2)^{0.5}]$.
2. Although the energy in the flat sound source would create an *actual* sound level = 90.48 dB, it would be *perceived* as a sound level of 66.32 dB(A) by human hearing due to the decreased sensitivity of human hearing to lower sound frequencies.

The A-weighted scale is commonly used in highway traffic noise studies because the typical frequency spectrum of traffic noise includes sounds at frequencies that are both higher and

lower than to which human hearing is most sensitive (1,000 Hz to 6,000 Hz). Several examples of noise levels, expressed in dB(A), are listed in Table 3.2. A review of Table 3.2 indicates that most individuals are exposed to fairly high noise levels from many sources on a regular basis.

Table 3.2: Common Indoor and Outdoor Noise Levels

Common Outdoor Noise Levels	Noise Level (dB(A))	Common Indoor Noise Levels
	110	Rock Band
Jet Flyover at 1,000 feet	100	Inside Subway Train (NY)
Gas Lawn Mower at 3 feet		
Diesel Truck at 50 feet	90	Food Blender at 3 feet
Noisy Urban Daytime	80	Garbage Disposal at 3 feet
Gas Lawn Mower at 100 feet	70	Vacuum Cleaner at 10 feet
Commercial Area		Normal Speech at 3 feet
	60	
		Large Business Office
Quiet Urban Daytime	50	Dishwasher Next Room
Quiet Urban Nighttime	40	Small Theater, Large Conference Room (Background)
Quiet Suburban Nighttime		Library
	30	
Quiet Rural Nighttime		Bedroom at Night, Concert Hall (Background)
	20	
		Broadcast and Recording Studio
	10	
	0	Threshold of Hearing

Adapted from Guide on Evaluation and Attenuation of Traffic Noise, American Association of State Highway and Transportation Officials (AASHTO). 1974 (revised 1993).

The degree of disturbance or annoyance from exposure to unwanted sound – noise – depends upon three factors:

1. The amount, nature, and duration of the intruding noise
2. The relationship between the intruding noise and the existing (ambient) sound environment; and
3. The situation in which the disturbing noise is heard

In considering the first of these factors, it is important to note that individuals have varying sensitivity to noise. Loud noises bother some people more than other people, and some individuals become increasingly upset if an unwanted noise persists. The time patterns of noise also enter into perception as to whether or not a noise is offensive. For example, noises that occur during nighttime (sleeping) hours are usually considered to be more offensive than the same noises in the daytime.

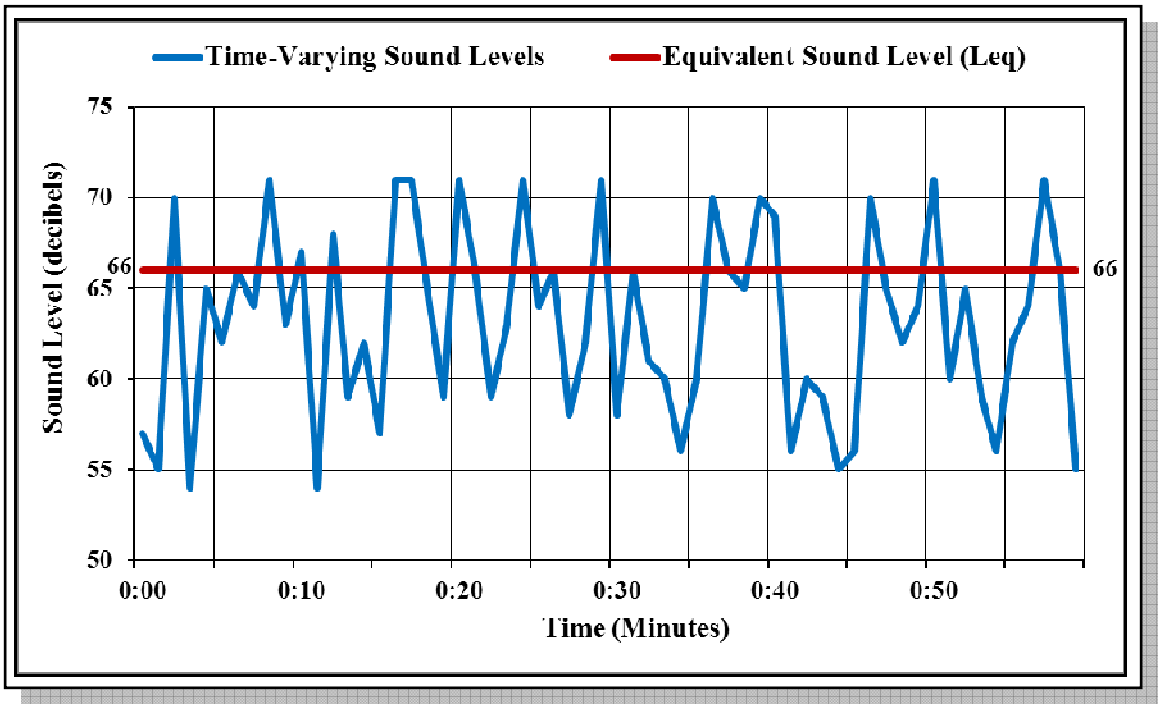
With regard to the second factor, individuals tend to judge the annoyance of an unwanted noise in terms of its relationship to noise from other sources (background noise). A car horn blowing at night when background noise levels are low would generally be more objectionable than one blowing in the afternoon when background noise levels are typically higher. The response to noise stimulus is analogous to the response to turning on an interior light. During the daytime an illuminated bulb simply adds to the ambient light, but when eyes are conditioned to the dark of night, a suddenly illuminated bulb can be temporarily blinding.

The third factor – situational noise – is related to the interference of noise with activities of individuals. In a 60 dB(A) environment such as is commonly found in a large business office, normal conversation would be possible, while sleep might be difficult. Loud noises may easily interrupt activities that require a quiet setting for greater mental concentration or rest; however, the same loud noises may not interrupt activities requiring less mental focus or tranquility.

Over time, individuals tend to accept the noises that intrude into their lives, e.g. regularly scheduled trains or subways in a city, particularly if the noises occur at predicted intervals and are expected. Attempts have been made to regulate many types of noises including airplane noise, factory noise, railroad noise, and highway noise. In relation to highway traffic noise, methods of analysis and control have developed rapidly over the past few years.

In addition to noise varying in frequency, noise intensity fluctuates with time. The L_{eq}, or equivalent sound level, is the equivalent steady-state sound level which in a stated period of time contains the same acoustic energy as a time-varying sound level during the same period. This noise descriptor has gained wide acceptance as a good representation of the aforementioned three factors. With regard to traffic noise, fluctuating sound levels of traffic noise are represented in terms of L_{eq}, the steady, or 'equivalent', noise level with the same energy.

Figure 3.1: Time-Varying Sound Levels vs. Equivalent Sound Level (Leq)



Because decibels are logarithmic representations of large ratios, they cannot be added arithmetically. A chart for approximate decibel addition is shown in Table 3.3. A doubling of the noise source produces a 3 dB(A) increase. For example, two trucks producing 90 dB each will combine to produce 93 dB, not 180 dB. Also, doubling the traffic volume from 400 vehicles per hour (vph) to 800 vph would create a 3 dB(A) noise level increase if the traffic speed remained constant.

Table 3.3: Rules for Combining Sound Levels by "Decibel Addition"

For noise levels known or desired to an accuracy of +/- 1 decibel:

When two decibel values differ by	Add the following amount to the higher value
0 or 1 dB(A)	3 dB(A)
2 or 3 dB(A)	2 dB(A)
4 or 9 dB(A)	1 dB(A)
10 dB(A) or more	0 dB(A)

As referenced in Table 3.4, variations of three dB(A) or less are commonly considered "barely perceptible" to normal human hearing. A five decibel (5 dB(A)) change is more readily noticeable. An increase or decrease of 10 dB(A) in the sound pressure level is typically perceived as a doubling or halving of the sound level intensity. For example, a sound at 70 dB(A) will sound twice as loud as a sound at 60 dB(A).

Sound intensity decreases in proportion to distance from the source. Sound levels from a point source will decrease by 6 dB(A) or more for each doubling of distance away from the point of origin because the sound energy dissipates in the shape of a sphere. Sound levels from a line source such as vehicle traffic on a highway will decrease by 3 dB(A) or more for each doubling of distance away from the line of origin because the sound energy dissipates in the shape of a cylinder. Empirical evidence has shown that highway traffic noise levels decrease at varying rates, converging at approximately a 4.5 dB(A) reduction per doubling of distance from the highway, depending upon several attenuating factors including

distance, intervening ground hardness/softness, structures, forestation, ground elevations, source-to-receptor spatial relationships, weather, and other factors.

Table 3.4: Relationships Between Changes in Sound Levels, Loudness, and Acoustic Energy

Sound Level Change	Change in Loudness[1,2]	Relative Change in Acoustic Energy[3]
+30 dB(A)	Eight Times as Loud	1,000
+20 dB(A)	Four Times as Loud	100
+10 dB(A)	Twice as Loud	10
+5 dB(A)	Readily Perceptible	~3
+3 dB(A)	Barely Perceptible	2
0 dB(A)	**No Change**	**0**
-3 dB(A)	Barely Perceptible	1 / 2
-5 dB(A)	Readily Perceptible	~1 / 3
-10 dB(A)	Half as Loud	1 / 10
-20 dB(A)	1/4 as Loud	1 / 100
-30 dB(A)	1/8 as Loud	1 / 1000

1. Loudness pertains only to the perceived magnitude of a sound or sounds. Loudness does not describe the tonal qualities of one or more sounds. Two sounds can have the same sound level magnitudes, and can sound "just as loud", and be distinguishable because of differing tones (frequencies).
2. Relative to the loudness of an initial sound level. E.g., the loudness of a 63 dB(A) sound would be barely perceptible from the loudness of a 60 dB(A) sound. An 80 dB(A) sound would generally be perceived as four times as loud as a 60 dB(A) sound.
3. Relative to the acoustic energy of an initial sound level. E.g., a sound level of 63 dB(A) has twice the acoustic energy as an initial sound level of 60 dB(A). A sound level of 80 dB(A) has 100 times the acoustic energy as 60 dB(A).

For the purpose of highway traffic noise analyses, motor vehicles fall into one of five categories: (1) automobiles - vehicles with two axles and four wheels, (2) medium trucks - vehicles with two axles and six wheels, (3) heavy trucks - vehicles with three or more axles, (4) buses – vehicles suited for transport of nine or more passengers, and (5) motorcycles – open-cockpit vehicles with two or three wheels. The emission levels of all three vehicle types increase as a function of the logarithm of their speed.

The level of highway traffic noise depends on three things: (1) the volume of the traffic, (2) the percentages of the different types of vehicles in the volume of traffic, and (3) the speed of the traffic. Generally, the loudness of traffic noise is increased by heavier traffic volumes, with higher percentages of trucks, traveling at higher speeds. Vehicle noise is predominantly a combination of undesirable sound emissions from engines, exhausts, and tire/pavement interaction. Traffic noise is also dependent upon other factors such as roadway geometry (e.g. inclines and/or declines), defective equipment, and vehicle operation.

4.0 LEGISLATION, REGULATIONS AND ORDINANCES

Effective control of the undesirable effects of highway traffic noise requires that land use near highways be controlled, quieter vehicles be manufactured, and consideration of traffic noise impacts and mitigation occur on qualifying highway projects.

The first component of effective highway traffic noise control is for local governments to plan and implement noise-sensitive land use planning. The second requirement for the effective control of the undesirable effects of highway traffic noise is source control. The final component is the responsibility of Federal, State, and local governments to identify and, when feasible and reasonable, mitigate traffic noise impacts as part of individual projects.

4.1 Land Use Planning and Control

The FHWA and NCDOT have no authority to regulate land use planning or the land development process. The FHWA and other Federal agencies encourage State and local governments to practice land use planning and control in the vicinity of highways. The FHWA advocates that local governments use their power to regulate land development in such a way that noise-sensitive land uses are either prohibited from being located adjacent to a highway, or that the developments are planned, designed, and constructed in such a way that traffic noise impacts are minimized. NCDOT will provide assistance to local jurisdictions in the development of local noise controls, when requested. NCDOT will advocate the planning, design and construction of noise-compatible development and encourage its practice among planners, building officials, developers and others.

4.2 Source Control

The Environmental Protection Agency (EPA) coordinated all federal noise control activities through its Office of Noise Abatement and Control. However, in 1981, the EPA concluded that noise issues were best handled at the State or local government level. As a result, the EPA phased out the office's funding in 1982 as part of a shift in federal noise control policy to transfer the primary responsibility of regulating noise to state and local governments. The Noise Control Act of 1972 and the Quiet Communities Act of 1978 were not rescinded by Congress and remain in effect today, although essentially unfunded.

The Federal Motor Carrier Safety Administration has adopted regulations under Chapter 49 Code of Federal Regulations Section 325 – *Compliance with Interstate Motor Carrier Noise Emission Standards 49 (CFR 325)*. Section 325.7 defines allowable noise levels for motor carriers governed by the regulations.

4.3 Highway Project Noise Abatement

The National Environmental Policy Act (NEPA) of 1969 provides broad authority and responsibility for evaluating and mitigating adverse environmental effects including highway traffic noise. NEPA directs the Federal government to use all practical means and measures to promote the general welfare and foster a healthy environment.

The Federal-Aid Highway Act of 1970 mandates that FHWA develop noise standards for mitigating highway traffic noise. The FHWA regulations for mitigation of highway traffic noise in the planning and design of federally aided highways are contained in 23 CFR 772 – *Procedures for Abatement of Highway Traffic Noise and Construction Noise*. These regulations require specific actions by transportation agencies during the planning and design of highway projects. Agencies must identify traffic noise impacts, examine all potential mitigation measures for every impact, incorporate feasible and reasonable noise mitigation measures into the highway project plans and coordinate with local officials to

provide helpful information on noise-compatible land use planning and control. The regulations further require that state and/or local governments define acceptable criteria for determination of traffic noise impacts for different types of land uses and human activities and that every feasible and reasonable effort be made to provide noise mitigation when traffic noise impacts are identified. Compliance with the noise regulations is a prerequisite for the granting of Federal-aid highway funds for construction or reconstruction of a highway.

In developing the Noise Abatement Criteria (NAC), FHWA considered several factors, such as hearing impairment; annoyance, sleep, task interference; and interference with speech communication. However, the NAC are noise levels predominantly associated with interference of speech communication, and are a compromise between noise levels that are desirable and those that are achievable.

5.0 APPLICABILITY

The applicability and the definitions of a Type I, Type II, and Type III can be found in Title 23 Code of Federal Regulations Section 772 (see Appendix B of this document). The NCDOT Traffic Noise Abatement Policy and this manual were developed in accordance with 23 CFR 772.

The effective date of applicability and its relationship to NEPA documents is as follows:

- A noise analysis conforming to the new policy is required for all NEPA documents (CEs, EAs, FONSIs, DEISs, FEISs and RODs) signed on or after July 13, 2011.

- A revised noise analysis conforming to the new policy is not required for Programmatic CE's (Types I, II(A) & II(B)) signed before July 13, 2011 since consultations are not required.

- A revised noise analysis conforming to the new policy is not required for full CE's (Type III(C)) signed before July 13, 2011, but for which consultation occurs on or after July 13, 2011, when the consultation confirms the CE classification is still valid. A revised noise analysis conforming to the new policy is required when the consultation results in a decision to prepare either an EA or EIS.

- A revised noise analysis conforming to the new policy is not required for FONSIs signed before July 13, 2011, but for which consultation (or reevaluation) occurs on or after July 13, 2011, as long as the consultation (or reevaluation) confirms the FONSI finding is valid.

- Results of a revised noise analysis conforming to the new policy are not a valid reason to reevaluate a ROD signed before July 13, 2011.

- All other situations will be determined on a case-by-case basis in coordination with FHWA.

Additionally, and in accordance with applicability requirements found in the 2011 NCDOT Traffic Noise Abatement Policy, projects with environmental documents signed before July 13, 2011 that are to be let for construction after July 13, 2011 shall be reviewed to determine whether the current policy's criteria impacts the feasibility and reasonableness of abatement measures examined during the project's most recent analysis. For all reviews performed to comply with this requirement, ***the original date of public knowledge shall remain unchanged***. Any traffic noise abatement measure found feasible and reasonable in the original analysis shall not be eliminated in cases where the review determines that the measure is not feasible and reasonable under the 2011 policy.

5.1 Type I Projects

The NCDOT Noise Abatement Policy and this manual will be utilized for all Type I Projects that are either Federal- or State-funded.

5.2 Type II Projects

NCDOT does not participate in Type II projects for noise abatement constructed on an existing highway.

5.3 Type III Projects

Type III projects do not meet the classification of either a Type I or Type II project. Type III projects do not require a noise analysis.

Projects described in 23 CFR 771.117(c) and (d) are Type III projects (see Appendix D of this document), with some exceptions as noted below, for which FHWA has determined the project clearly meets the definition of a Type I project.

- 771.117(c)(6) The installation of noise barriers or alterations to existing publicly owned buildings to provide for noise reduction.
- 771.117(c)(12) Improvements to existing rest areas and truck weigh stations.
- 771.117(c)(13) Ridesharing activities
- 771.117 (d)(1) Modernization of a highway by resurfacing, restoration, rehabilitation, reconstruction, adding shoulders, or **adding auxiliary lanes** (e.g., parking, weaving, turning, climbing).
- 771.117 (d)(3) Bridge rehabilitation, reconstruction or replacement or **the construction of grade separation to replace existing at-grade railroad crossings**.
- 771.117 (d)(5) Construction of new truck weigh stations or rest areas.

Construction of new Rideshare lots under 771.117(c)(13) represents a new noise source and may require a noise analysis similar to an analysis conducted for rest areas. Section 772.5 classifies auxiliary lanes as Type I except for turn lanes. The bolded text in 771.117(d)(3) indicates that construction of a grade separation to replace existing at-grade railroad crossings may result in a significant change in the vertical alignment of an existing roadway. In some cases, the grade separation project results in an overall benefit to the noise environment due to reduced requirements to sound train horns at grade separated crossings. Highway agencies may consider this benefit in the noise analysis.

Sometimes, unusual projects fall outside the standard definition of a Type I project. Generally, if a project results in a new noise source, the highway agency should consider a noise analysis for the project. The regulation does not preclude highway agencies from performing a noise analysis for a project that does not strictly meet the Type I or Type II criteria, but may result in a new noise source.

6.0 DATE OF PUBLIC KNOWLEDGE

The "Date of Public Knowledge" of the location and potential noise impacts of a proposed highway project will be the approval date of the final environmental document, e.g., Categorical Exclusion (CE), State or Federal Finding of No Significant Impact (FONSI) or State or Federal Record of Decision (ROD).

After this date, the federal and state governments are no longer responsible for providing noise abatement measures for new development within the noise impact area of the proposed highway project. The criteria (e.g., trigger date) for determining when undeveloped land is "permitted" for development will be the approval of a building permit for an individual lot or site. **Approval of a development plat or any other development plan does not meet the Date of Public Knowledge criteria.**

It is the responsibility of local governments and private landowners to ensure that noise-compatible designs are used for development permitted after the Date of Public Knowledge.

7.0 PREVENTING TRAFFIC NOISE IMPACTS

NCDOT advocates noise-compatible land use and development. To support this position, NCDOT will maintain the following processes to discourage future development that may create traffic noise impacts.

7.1 Public Information

During the development stage of a proposed highway project, area residents and local officials will be kept informed about the project. Appropriate public outreach activities will provide information as well as to gather comments, opinions, and concerns from the public and local officials. General and project-specific traffic noise information will be available at all meetings, workshops, and hearings (refer to section 13.1).

As applicable, both NCDOT and private consulting firm traffic noise professionals will attend all highway project-related meetings at which traffic noise may be discussed.

7.2 Public Documents

NCDOT environmental documents shall identify the following prior to CE approval or issuance of a FONSI or ROD:

- Noise abatement measures that are preliminarily determined to be feasible and reasonable;
- Noise impacts for which no abatement measures are preliminarily determined to be feasible and reasonable;
- Locations where noise impacts are predicted to occur, locations where noise abatement is preliminarily determined to be feasible and reasonable, and locations

for which no abatement measures are preliminarily determined to be feasible and reasonable; and

- Whether it is “likely” or “unlikely” that noise abatement measures will be installed for each noise sensitive area identified, regardless of whether the abatement measure is determined to be feasible and reasonable. The term "likely" does not constitute a firm commitment.

7.3 Public Hearings and Meetings

A detailed traffic noise analysis will be conducted for the detailed study alternatives based upon preliminary project design. The results of this analysis will be included in the project environmental document. Predicted noise sensitive areas, if any, will be shown for all alternatives on the Design Public Hearing map and/or will be defined in the environmental document. The recommended location(s) of any noise abatement measures found to be preliminarily feasible and reasonable in preliminary traffic noise analyses will not be shown on the Design Public Hearing map. The location(s) and design of such measures may change due to changes in the noise environment, the project design, and/or to findings in the detailed Design Noise Report prepared during final project design. The intent of not showing proposed noise abatement locations on Corridor/Design Public Hearing Maps is to minimize public confusion should the measures be modified or eliminated during final design and preparation of the Design Noise Report. Traffic Noise & Air Quality Group personnel and/or its consultants will attend public meetings, hearings and workshops, to the extent possible, to provide assistance with questions regarding traffic noise.

7.4 Final Determination

The final decision on the installation of traffic noise abatement measures shall be made upon completion of the project final design and the public involvement process. This decision will be based upon the feasibility and reasonableness criteria established in the NCDOT

Traffic Noise Abatement Policy, upon the opinions of benefited property owners and residents, and upon FHWA approval.

7.5 Coordination With Local Officials

NCDOT will provide all traffic noise analyses to local government officials presiding over the jurisdiction in which highway projects are proposed, including the municipal mayor or manager, and the county manager. This delivery will be completed as early in the project development process as possible to discourage future development that may be incompatible with predicted future traffic noise levels. Specifically, environmental documents, preliminary traffic noise analyses, and design noise reports will contain information identifying areas that may be impacted by traffic noise, noise level contour information, the best estimation of future noise levels in the vicinity of the project, and other appropriate highway project design information. If requested, NCDOT will assist local officials with coordination and distribution of this information to residents, property owners, and developers.

When requested, NCDOT will provide assistance to local jurisdictions in the development of noise controls. NCDOT strongly advocates the planning, design, and construction of noise-compatible development and encourages its practice among planners, building officials, developers, and others.

All noise-sensitive areas will be presented and discussed at the Design Public Hearing and Design Public Meetings.

8.0 PRELIMINARY TRAFFIC NOISE ANALYSIS

The North Carolina Department of Transportation performs and contracts several types of traffic noise analyses, including Traffic Noise Analyses, Design Noise Reports, and non-project-specific technical reports. Depending upon the type of traffic noise analysis and previously completed efforts, preliminary and/or detailed traffic noise analyses may be necessary. Communication is the key to producing accurate and comprehensive final results. The NCDOT Traffic Noise and Air Quality Group encourages collaboration and supports traffic noise analysis efforts not only at project initiation and after project completion, but also throughout the duration of each project.

8.1 NCDOT Traffic Noise Analyst Required Qualifications

Only qualified personnel can perform highway traffic noise analyses for NCDOT. Qualified personnel must have successfully completed formal training in the area of Highway Noise Analysis and the use of the FHWA-approved Traffic Noise Model (TNM) software through a qualified provider recognized by FHWA.

Qualified personnel must have demonstrated experience in conducting noise analysis studies for highway transportation projects and must have exhibited a working knowledge of procedures outlined in FHWA Report Number FHWA-PD-96-046, "Measurement of Highway-Related Noise," and Title 23 CFR Part 772. All persons performing noise analyses must also be proficient with the use of the most currently approved version of FHWA Traffic Noise Model (TNM) software, and be able to support their analyses with expert testimony if required.

Alternatively, NCDOT shall reserve the right to qualify personnel based upon involvement in the development and/or instruction of noise models and/or training courses, or other relevant experience.

The above qualifications must be met by all persons providing quality assurance functions for NCDOT traffic noise analyses.

Persons who perform a traffic noise analysis may not also provide quality assurance for the same project.

8.2 Noise Level Rounding Convention

With the exception of TNM model validation (refer to section 8.5), all noise levels shall be rounded to the nearest whole decibel prior to manipulation for traffic noise impact assessment and insertion loss/noise level reduction calculations. Unless explicitly requested otherwise, all noise levels shall be stated in units of whole decibels in all NCDOT traffic noise analyses and design noise reports.

8.3 Traffic Noise Analysis Initiation

Commencement of a traffic noise analysis or design noise report by a consulting firm shall be preceded by a project initiation meeting between NCDOT Traffic Noise and Air Quality staff and the traffic noise analyst (consultant, municipality, etc.) performing the work. This meeting will identify and define the specific tasks required.

Critical information necessary to initiate a traffic noise analysis on a proposed highway project includes the proposed project description, preliminary project design, appropriate scalable mapping, existing and future traffic data, anticipated design speeds, right-of-way width, and scope of project (widening, improvement, new location, etc). The planned

roadway access (uncontrolled, partially controlled, fully controlled access) must be known to appropriately determine feasibility of potential mitigation options.

Other design information is normally required, such as the proposed typical section with paved shoulders and lane configurations, to approximate traffic noise propagation. The existing and future traffic diagrams with traffic information (percentages and types of trucks, design hour volumes, and directional distribution) are essential in creating project segments and determining existing and future noise levels. Project mapping must be dated, scaled, and clearly display a north arrow and all detailed study alternatives. Mapping shall be at an appropriate scale to clearly show all project elements needed to appropriately document traffic noise levels, impacts, and mitigation.

8.4 Traffic Calculations and Segmentation

Traffic forecasts are essential in initiating the traffic noise modeling process. These forecasts ideally include the Annual Average Daily Traffic (AADT), Design Hour Volume (DHV), average daily truck volume percentages for Tandem Tractor & Semi-Trailer (TTST), average daily truck volume percentages for Duals (trucks with more than 4 wheels but not a TTST), and directional percentage split in the peak hour volume.

The traffic characteristics that yield the loudest hourly predicted traffic noise levels shall be used for the assessment of existing, design-year build-, and design-year no-build conditions (if applicable). The worst traffic noise conditions shall be evaluated as the lesser of the DHV percentage of the AADT or the roadway vehicle capacity Level of Service “C” (LOS C) operating at the design speed. TTST and dual truck volumes shall be assessed at the predicted average daily volume percentages (note: average daily truck volume percentages are no longer to be divided in half for calculating the ‘worst hour’ traffic noise levels).

Example: TNM Traffic Volume Calculation – Directional Split w/LOS C Cap:

AADT = 100,000, DHV = 9%

Classified Vehicle Distribution = 4% Duals, 5% TTST (91% Automobiles)

Roadway = Interstate, 3-Lane Directional Segment

Directional Split = 65% (Peak Direction) / 35% (Non-Peak Direction)

Peak Direction DHV = (100,000 VPD) x (9% DHV) x (65% Directional Volume) = 5,850 VPH

Non-Peak Direction DHV = (100,000 VPD) x (9% DHV) x (35% Directional Volume) = 3,150 VPH

LOS C Cap = (1,548 VPH/lane) x (3 lanes) = 4,644 VPH

Peak Directional DHV = 4,644 VPH (*lesser* of 5,850 or 4,644)

Non-Peak Directional DHV = 3,150 VPH (*lesser* of 3,150 or 4,644)

Peak Direction Autos = 4,644 VPH x 91% = **4,226** VPH

Peak Direction Medium Trucks = 4,644 VPH x 4% = **186** VPH

Peak Direction Heavy Trucks = 4,644 VPH x 5% = **232** VPH

Non-Peak Direction Autos = 3,150 VPH x 91% = **2,867** VPH

Non-Peak Direction Medium Trucks = 3,150 VPH x 4% = **126** VPH

Non-Peak Direction Heavy Trucks = 3,150 VPH x 5% = **158** VPH

(Note: Calculated classified vehicle volumes must be distributed appropriately throughout the modeled TNM roadway elements. E.g., if truck travel is prohibited on the inside (fast) lane of a section of 4-lane interstate, then the number of trucks should be distributed only on the TNM roadway elements representing the three outer (slower) lanes.)

Example: TNM Traffic Volume Calculation – 50% / 50% Directional Split w/LOS C Cap:

AADT = 100,000, DHV = 9%

Classified Vehicle Distribution = 4% Duals, 5% TTST (91% Automobiles)

Roadway = Interstate, 3-Lane Directional Segment

Directional Split = 50%/50%

Directional DHV = (100,000 VPD) x (9% DHV) x (50% Directional Volume) = 4,500 VPH

LOS C Cap = (1,548 VPH / lane) x (3 lanes) = 4,644 VPH

Directional DHV = 4,500 VPH (*lesser* of 4,500 or 4,644)

Directional Autos = 4,500 VPH x 91% = **4,095** VPH

Directional Medium Trucks = 4,500 VPH x 4% = **180** VPH

Directional Heavy Trucks = 4,500 VPH x 5% = **225** VPH

(Note: Calculated classified vehicle volumes must be distributed appropriately throughout the modeled TNM roadway elements. E.g., if truck travel is prohibited on the inside (fast) lane of a section of 4-lane interstate, then the number of trucks should be distributed only on the TNM roadway elements representing the three outer (slower) lanes.)

8.5 Field Work and Ambient Noise Monitoring

The primary purpose of field work is to measure existing ambient noise levels, ascertain other pertinent information in the vicinity of the project, and to serve as the foundation for the creation of a validated TNM model. Existing ambient noise measurements are obtained to quantify the existing acoustic environment and to provide a basis for assessing potential impacts due to predicted project traffic noise level increases.

8.5.1 Receptor Identification

In the general vicinity of a project, all potential noise-sensitive land uses, as defined by FHWA NAC criteria, shall be identified as traffic noise receptors. 23 CFR 772.11(d)(4) stipulates that no spatial limits exist for which traffic noise analysis must be completed. *All traffic noise impacts must be determined.* Identification of additional receptors may be necessary if the preliminarily identified receptors do not define the outer limits or distances from roadway(s) for which traffic noise impacts are predicted to occur.

8.5.2 Ambient Sound Level Data Collection

Ambient noise level data is obtained to quantify the existing acoustic environment, to provide a basis for assessing the existing loudest-hour traffic noise levels, to define noise levels in the areas for which traffic and/or construction noise may create an impact or impacts, and to define noise levels in the areas for which traffic and/or construction noise does not create an impact or impacts.

- Ambient noise monitoring locations shall be selected to provide a suitable foundation for accurately predicting existing and design-year traffic noise levels at identified receptor locations.
- A TNM model can be validated only as far from the existing roadway noise source(s) as the farthest existing noise monitoring location. Collection of existing noise monitoring data at distances beyond the probable limits of traffic noise impact occurrence is encouraged.
- Collection of existing noise monitoring data for the purposes of evaluating traffic noise levels, and for the formation of a validated TNM model, will require at least two receptor locations that will represent sound level attenuation with increased distance(s) from the roadway (e.g., at the property lot-line, at the representative structure, at a far-field receptor location beyond the likely limits of

traffic noise impacts). Focus should be placed upon locating noise meters for ambient noise monitoring data collection at discernible *sites*, rather than at nominal distances from the subject roadway (e.g., placing a noise meter at a utility pole included in the location survey data will provide a more readily identifiable location than attempting to place the noise meter at exactly 200 feet from the proposed edge of pavement).

- Noise monitoring data should not be obtained at locations that are not, or will not, be representative of potential noise sensitive land uses (e.g., collection of ambient noise monitoring data within the existing right-of-way of a proposed interstate highway widening project).

Figure 8.1: Ambient Noise Monitoring Locations:

Figure 8.1 Notes:

1) The noise meters shown in the background and foreground of Figure 8.1 represent the 2nd and 3rd row receptors, respectively, in the array. The 1st-row receptor was located near the roadway beyond the forested area in the background of the figure.

2) Collecting ambient noise monitoring data at far-field locations (distant from existing or proposed roadway alignments) is necessary to ensure TNM model validation beyond the possible limits of traffic noise impacts.
3) Noise meters used for ambient noise monitoring data collection should be placed at logical sites, since measuring distances from existing or proposed roadway alignments to the far-field locations necessary to create a correctly validated TNM model will be difficult, if not impossible.
4) The 2nd row receptor was placed at a slope break line conspicuous in the elevation contour data.
5) The 3rd row receptor was placed at a survey stake marking the corner of a residential lot, also clearly identified in the electronic survey data.

- ANSI S1.4-1983, TYPE I or TYPE II logging sound level meters shall be used to collect existing ambient noise level data. All meters must be calibrated by an appropriately accredited laboratory within 2 years of use on any project. All meters shall be field-calibrated at the beginning of every noise monitoring session and when batteries are changed (e.g. during a long-term noise monitoring session).
- Sound level meters shall be set to the "slow" response setting for traffic noise monitoring.
- Sound level meters shall be set to the "fast" response setting for construction noise monitoring.
- If possible, sound level meters shall be set to capture the L_{eq}, L_{max}, L_{10}, and L_{90} sound level metrics. Minimally, noise meters shall capture L_{eq} and L_{max}.
- 'Short-term' ambient noise level data collection monitoring sessions shall have a minimum duration of 20 minutes. Short-term ambient noise monitoring in rural areas, or in the vicinity of low traffic-volume roadways may require longer measurement periods (e.g., 60 minutes or more) to attain desirable statistical accuracy.
- One or more long-term ambient noise level data collection sessions of up to 24-hours, and encompassing at least the typical or known loudest traffic noise hours

of the day (e.g. 5:00 a.m. – 8:00 p.m. to capture both morning and evening rush hour traffic noise emissions) may be required if information is not available to extrapolate the loudest traffic-hour of the day from short-term ambient data, or in other situations, as applicable and approved by NCDOT.

- Noise monitoring data shall be obtained in increments of not more than one minute (i.e. a 20-minute short-term noise monitoring session shall be comprised of at least 20 data points; a 24-hour long-term noise monitoring session shall be comprised of at least 1,440 data points).
- An event log shall be created for all attended/manned noise monitoring sessions. The event log does not need to be included in the report; however, it shall be available as a reference to document the existing noise environment, justify 'despiking' of aberrant noise events from data sets, defend TNM model validation, etc.
- Sound level meters shall never be turned off during a noise monitoring session as a means to eliminate the effects of aberrant noise events (traffic or otherwise). When appropriate, justified, and documented in an event log, removing affected data points from the noise monitoring data set, or 'despiking', is encouraged.
- Traffic counts shall be made in accordance with the five vehicle classification types employed by the TNM model. Corresponding to the 13 FHWA vehicle classifications, the TNM model defines vehicles as "Autos" (FHWA vehicle classifications 2 & 3), "Medium Trucks" (FHWA vehicle classification 5), "Heavy Trucks" (FHWA vehicle classifications 6 through 13), "Buses" (FHWA vehicle classification 4), and "Motorcycles" (FHWA vehicle classification 1). All two-axle, four wheel vehicles – including pickups – shall be counted as "Autos." Only two-axle, six-wheel trucks (e.g. school buses, delivery trucks, and small box trucks) shall be counted as "Medium Trucks." All other trucks shall be counted as "Heavy Trucks."

8.6 TNM Model Validation

Title 23 CFR 772.11(d)(2) requires that the analysis of traffic noise impacts, for projects on new or existing alignments, validate predicted noise levels through comparison between measured and predicted levels. A TNM model is considered 'validated' if it is a reasonable representation of the existing noise sensitive area and/or project area, *and* the TNM-predicted noise levels are within the acceptable tolerance of the noise level data obtained in the field at *all* project noise monitoring locations. Arbitrary TNM models shall not be considered for TNM validation. Acceptable TNM models represent actual existing conditions of the project study area. Refer to Section 8.7 for guidance on TNM modeling.

Although the FHWA-accepted tolerance for TNM model validation is ±3.0 dB(A), the NCDOT goal for TNM model validation is ±1.7 dB(A). The basis for the more stringent NCDOT TNM model validation tolerance is that a ±1.75 dB(A) change in noise levels represents a ±50% change in noise level energy, which is half of the ±100% change in noise level energy defined by a ±3.0 dB(A) change in noise levels. Since TNM calculates predicted traffic noise levels to the nearest 0.1 dB(A), the minimum acceptable TNM model validation tolerance within ±1.75 dB(A) is ±1.7 dB(A). All reasonable effort must be employed to achieve this validation goal. An explanation must be reported for NCDOT consideration in the case of each modeled noise monitoring location that does not attain this goal. Refer to table 12.4 for an example of TNM model validation reporting, including explanations for receptors that did not conform to the ±1.7 dB(A) validation goal. Refer to section 8.6 for appropriate TNM modeling techniques and guidance references.

8.7 TNM Modeling

The FHWA Traffic Noise Model (FHWA TNM v2.5 or later, Report No. FHWA-PD-96-010) is the only approved tool for predicting traffic noise levels, for assessing traffic noise impacts, and for determining abatement measure effectiveness. Although the Reference Energy Mean Emission Level (REMEL) data and the predictive algorithm of the TNM

software is FHWA approved, subjective applications of the TNM model are not universally acceptable or appropriate. All traffic noise analyses, traffic noise level assessments, and assessments of potential mitigation effectiveness shall be performed by means of appropriate application of the TNM modeling software. Refer to *Traffic Noise Model: Frequently Asked Questions (FAQs)*: http://www.fhwa.dot.gov/environment/noise/traffic_noise_model/tnm_faqs/faq00.cfm).

All efforts must be made to appropriately represent the project study area(s) for the purpose of accurately assessing existing and design year traffic noise levels and identifying all traffic noise impacts. Acoustically-relevant features including, but not limited to, existing roadways, elevation contour changes, structures, areas of dense forestation, and all receptor locations should be modeled. If sufficient data is not available in customary formats such as electronic drawing files, external resources should be examined (e.g. web-accessible county GIS data). Detailed modeling – even for preliminary traffic noise analyses – is critical to limiting inaccurate results and misleading recommendations, and to optimizing the overall efficiency of the expenditure of resources in maintaining compliance with the requirements of 23 CFR 772. The "Run Identification" input shall be complete and accurate for all TNM models created in conjunction with NCDOT TNAs and DNRs.

Collaboration with NCDOT Traffic Noise and Air Quality Group staff is encouraged for the resolution of anomalous TNM results and/or complex modeling scenarios such as interchanges with flyover ramps, overpasses, barriers on structures, retaining walls, median barriers, superelevated highways, etc.

8.7.1 Roadway Elements

TNM roadway elements should be modeled in accordance with the latest version of the FHWA Traffic Noise Model (TNM) Release Notes, and FHWA TNM FAQs

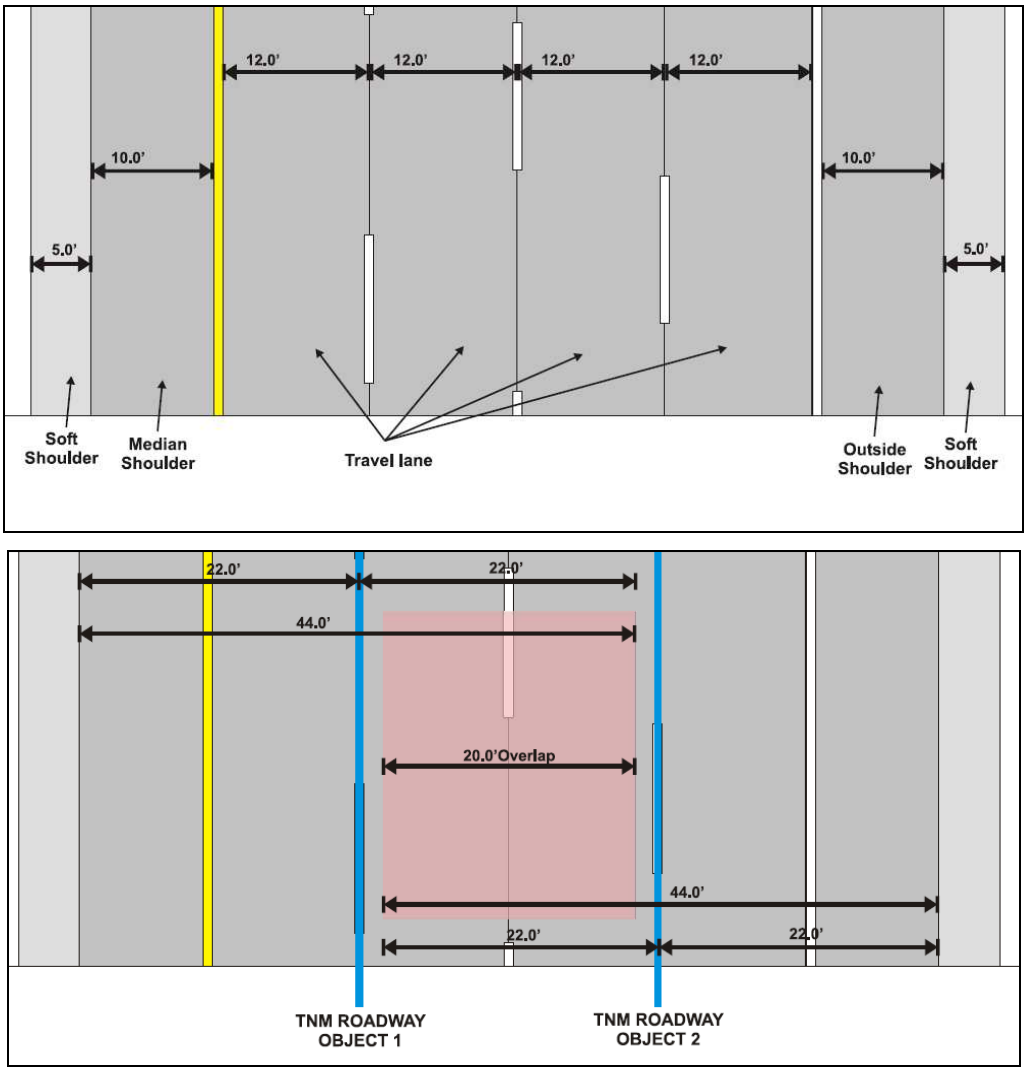
(http://www.fhwa.dot.gov/environment/noise/traffic_noise_model/tnm_faqs/faq06.cfm#miroadways1), which state or imply that:

- Roadway elements should not represent more than 2 travel lanes.
- Average pavement type must be used for prediction of all noise levels unless NCDOT obtains FHWA approval to use a different pavement type.
- Roadway widths should be set to ensure overlapping between adjacent roadway elements, and so that no horizontal gaps occur. Avoid exactly matching the edges of roadways.
- Roadway segment horizontal coordinates should be selected so that the modeled traffic is at the horizontal center of the actual travel lane(s), (e.g., to model the 4-lane northbound direction of an interstate highway with 12-foot wide travel lanes and 10-foot wide inside and outside shoulders, an acceptable methodology would be to model one 44-foot wide roadway element at the center of lanes 1-2 and another 44-foot wide roadway element at the center of lanes 3-4. The result will be a cumulative width = 68-feet (10-foot shoulder + four x 12-foot travel lanes + 10-foot shoulder), with a 20-foot overlap. Refer to figure 8.2).
- When possible, local roadways – particularly local streets within noise-sensitive neighborhoods – should be modeled for all projects.
- Unless specific final design data is available, TNM roadways should be modeled as flat and at-grade, such that all modeled lanes of a roadway section are modeled at the same elevation. (Note that "flat" applies to the roadway section; it means that super-elevations should not be modeled into the TNM roadway elements. The term "at-grade" applies to the roadway profile; it means that roadway grade elevations should be modeled into the TNM roadway elements. Furthermore, if a roadway is in a cut- or fill-section, then the appropriate terrain line(s) must be included in the TNM model.)
- If a barrier is to be assessed adjacent to the roadway at the edge of pavement, model the nearest shoulder as a pavement ground zone (not as a roadway element).

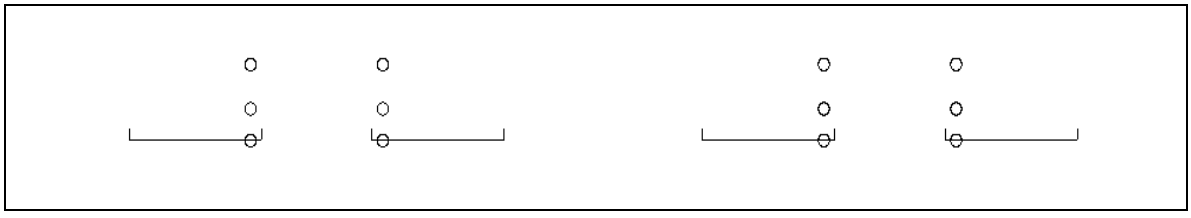
Figure 8.2: Modeling 4-Lane Interstate Roadways

(Two TNM Roadway Elements Per Direction)

Plan View – (Roadway Elements Shown in Blue)



TNM "Skew – Section" View



- Roadway segment lengths should be established to accurately represent horizontal and vertical changes in the roadway alignment. NCDOT encourages modeling TNM roadway element vertices at increments of no more than two (2) survey stations (English units). Standard NCDOT survey stations are in increments of 100 feet.
- Roadway vertical coordinates should be established to a resolution of at least 0.5-feet in the vertical direction. A greater degree of resolution in the vertical plane is acceptable, but not necessary.
- Roadway elements on structure should be appropriately bordered with applicable traffic barriers. Shielding for traffic barrier segments for roadways on structure must be correctly designated for applicable roadway segments.
- TNM traffic control devices should be designated as appropriate for ramps and intersections (particularly for on-ramps adjacent to the modeled study area).
- There is no "off-ramp" control device feature in TNM (TNM does not have a function to model true deceleration, and inputting a speed constraint that is higher than the travel speed does not cause a reduction in traffic noise levels consistent with deceleration). For first-row receptors for which ramp traffic is the primary noise source, the difference between 65 miles per hour and 35 miles per hour can be as much as 6 dB(A).

For a receptor located 200 feet horizontally distant from the centerline of a single lane ramp, with an unimpeded view, and with 1,000 vehicles per hour (2% medium trucks, 3% heavy trucks), the TNM-predicted traffic noise level at 65 miles per hour is 62 dB(A). At 35 miles per hour, the TNM-predicted traffic noise level is 56 dB(A).

Although the TNM modeling functionality will not exactly replicate emission levels and frequency spectra, NCDOT recommends modeling off-ramp deceleration by reducing vehicle speeds throughout the modeled off-ramp

roadway segments. For cases in which off-ramp traffic is the dominant noise source, employing this practice will produce more accurate results than otherwise. For cases in which off-ramp traffic is not the dominant noise source, then the effects of reducing vehicle speeds for the modeled off-ramp roadway segments will be relatively inconsequential.

8.7.2 Receptors

TNM receptors should be modeled at area(s) of frequent human use, which is defined as a specific location of outdoor activity (e.g. swimming pool, athletic field, etc.), or the corner of the representative structure (e.g. house, church, school) nearest to the primary roadway noise source.

- A representative receptor should be modeled at every noise-sensitive location (e.g. if a noise study area consists of ten residences, then ten receptors should be included in the TNM model).
- TNM receptors should be set to the default height of 4.92 feet above ground level, or 4.92 feet above the floor level for multi-story areas of frequent human use (e.g. if the 4^{th} - story balcony of an apartment building is 30-feet above the adjacent ground level, then the representative receptor height should be 30 + 4.92 = 34.92-feet. (refer to figure 8.3)).
- Although each TNM receptor location defines the ground elevation at a specific point, TNM does not interpolate a ground line between two or more receptors. Do not model TNM receptors with the assumption that TNM will accurately assume ground elevations (refer to section 8.6.3).
- More than one receptor may be necessary for larger parcels of land, potential noise-sensitive land uses represented by more than one equivalent residence (refer to section 11.3), and/or parcels for which more than one project roadway noise source may be acoustically significant. For sound barrier design, representation of impacted schools, churches, parks, etc., with a nodal-, or grid-

type array of receptors is encouraged (refer to figure 8.3). This will be discussed on a project-specific basis during the project initiation meeting.

Figure 8.3: Modeling Multi-Story Areas Of Frequent Human Use (Two Horizontal Locations of 4-Story Balconies)

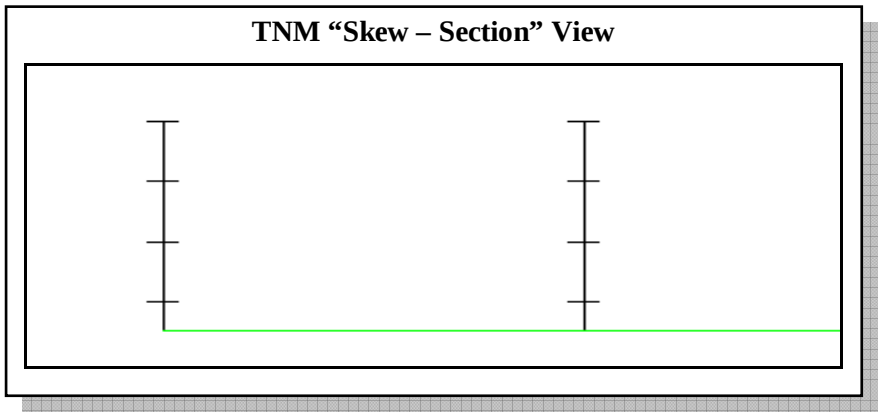
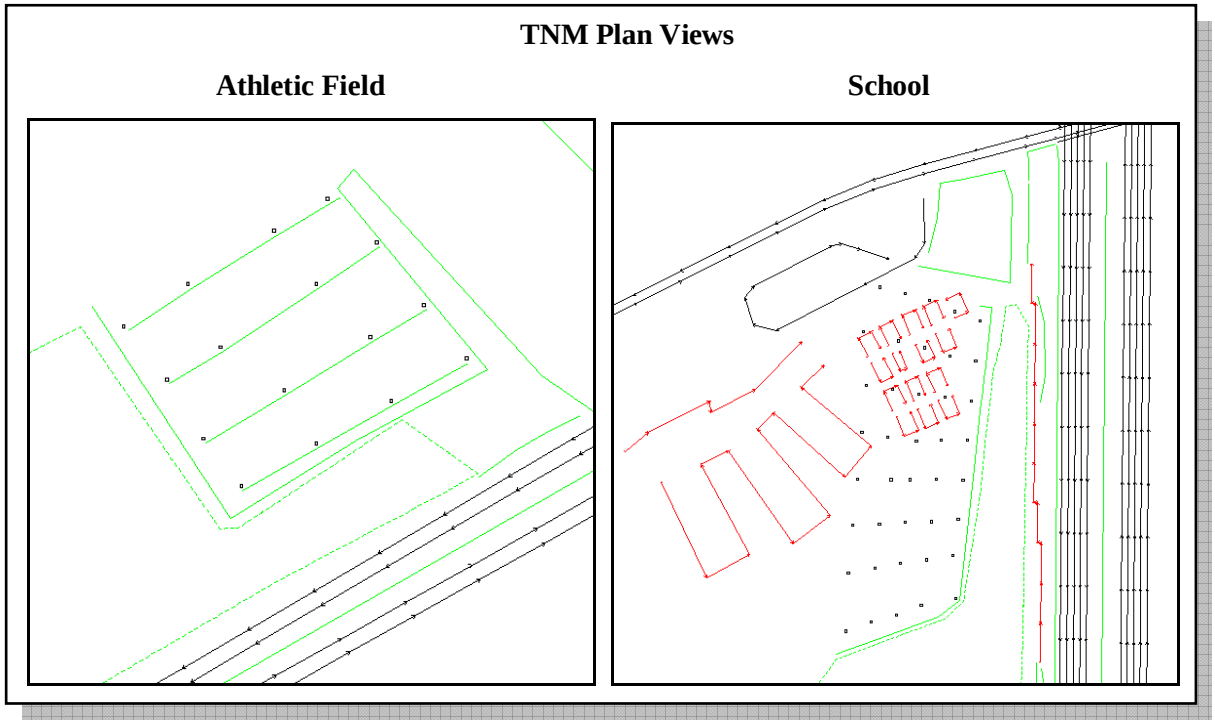


Figure 8.4: Nodal-Array Receptor Modeling on Large Parcels (Schools, Parks, Athletic Fields, etc.)



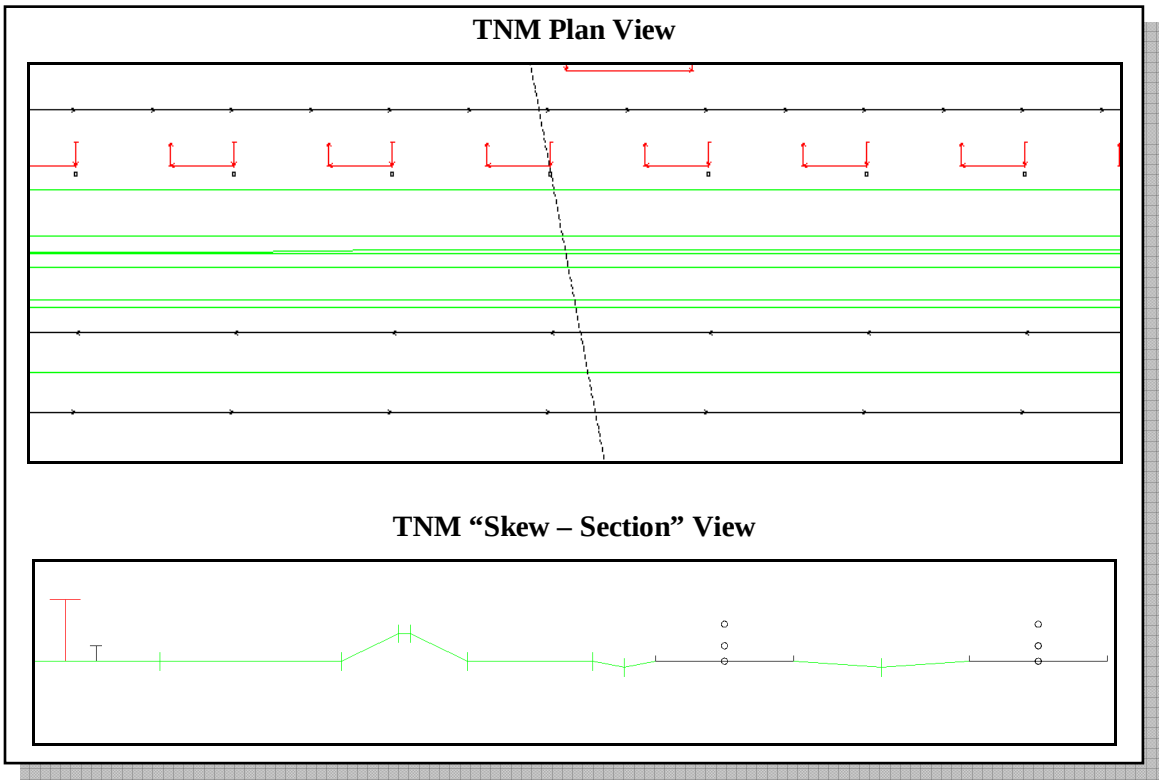
8.7.3 Terrain Lines

TNM terrain lines shall be modeled as necessary to represent acoustically significant elevation changes between the most-distant roadway edge of pavement (EOP) and the most-distant receptor(s). TNM terrain lines should be modeled in accordance with the latest version of FHWA TNM Release Notes, and FHWA TNM Frequently Asked Questions (http://www.fhwa.dot.gov/environment/noise/traffic_noise_model/tnm_faqs/faq07.cfm#miterlines1).

- All roadway median and shoulder ditches should be modeled.
- All defining grade changes such as top-of-cut sections and bottom-of-fill sections should be modeled (i.e. model any intervening C/F line(s) between roadway(s) and receptors).
- When possible, terrain lines should be modeled generally parallel to the primary roadway (terrain lines modeled at skewed or perpendicular angles to the roadway can result in anomalous TNM-predicted sound levels).
- Modeling the right-of-way line(s), cut-lines, and fill-lines as terrain lines is highly recommended.
- Since a sound barrier defines the ground elevations along its horizontal alignment in the TNM model, potential sound barrier horizontal alignments should be modeled as terrain lines (or as zero-height barriers) to limit discrepancies between predicted without-barrier and with-barrier traffic noise levels.
- Terrain line vertices should be added where terrain lines are modeled in close proximity to receptors so that the terrain line does not create anomalous vertical elevation changes in the source-to-receiver path(s).
- Terrain lines should be modeled just outside the horizontal limits of roadways on structure, so as to define the depressed ground elevation under the structure. Otherwise, TNM will interpret the ground elevation as the roadway elevation, even though the roadway is “on structure.”

- Terrain lines should be modeled at the top and bottom of retaining walls, with a minimal horizontal distance between the two, so that TNM perceives the surface between the top and bottom of the retaining wall to be nearly vertical.
- Since TNM does not interpolate ground elevations between the point locations of two or more receptors, a terrain line should be modeled just in front of any row or array of receptors, parallel to the roadway(s).
- Terrain lines should not be directly copied into TNM from exported design exchange formatted (.dxf) elements because the large number of vertices (points) in the .dxf elements will dramatically increase the number of calculations necessary to complete the running of the TNM model. Rather than converting .dxf elements into TNM terrain lines, create TNM terrain lines by snapping as few vertices as possible to appropriately represent the terrain feature.

Figure 8.5: Terrain Line Modeling (General)
(Median Ditch, Shoulder Ditch, Community Berm)



8.7.4 Sound Barriers

TNM sound barriers should be modeled as the basis for potential sound barrier design (refer to section 10). A moderate level of TNM sound barrier modeling input requires minimal time and effort; however, it is critical to making appropriate and technically accurate recommendations. Common consequences of coarse TNM sound barrier element input considerations are unnecessarily large barriers (length and / or segment heights), aesthetically unpleasing barriers (jagged, notched, and / or undulating top-of-barrier vertical profiles), recommendations to build inappropriately justified barriers, and recommendations to not build barriers when justifiable.

NOTE:

STARTING WITH A DETAILED INPUT SOUND BARRIER

=

ACCURATE ANALYSIS

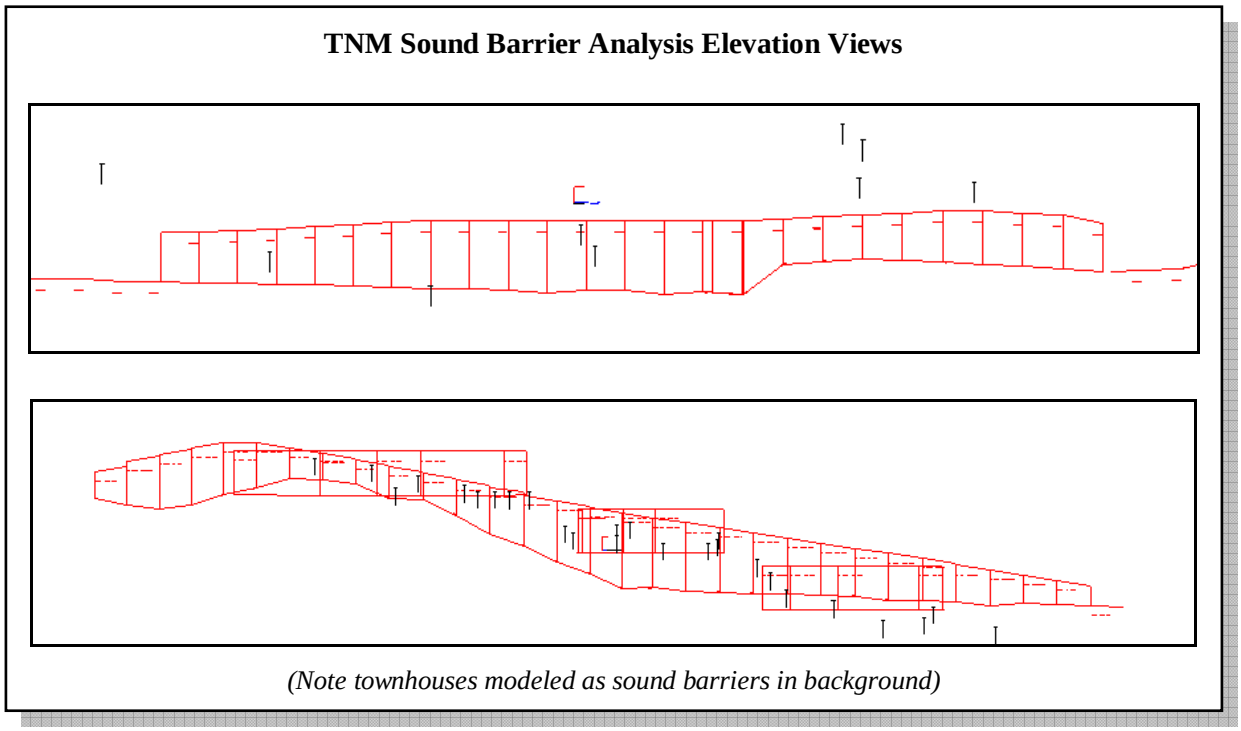
&

OPTIMAL DESIGN

- Optimization of a single sound barrier horizontal alignment is not sufficient justification to recommend that specific sound barrier for construction. Identification of one predicted preliminarily feasible and reasonable sound barrier will be satisfactory for Traffic Noise Analyses to justify the recommendation for further study. However, all potentially optimal feasible and reasonable sound barrier horizontal alignments should be evaluated as part of Design Noise Reports.
- Sound barriers should be modeled as equally spaced segments of logical lengths of 120-feet or less (60-foot foot segments are optimal to coincide with multiples of 10-foot, 12-foot, and 15-foot constructed panel lengths). The resolution of modeled sound barriers in the horizontal plane is equally important as the resolution in the vertical plane.
- Baseline, or input sound barriers should be modeled with a level top, with a consistent top-of-barrier grade, or with a convex top-of-barrier vertical profile. Focus should be placed upon consistent top-of-barrier elevations and uniform barrier segment elevation changes without notches, undulations, or concavities in the overall top-of-barrier profile.

- Beginning sound barrier analyses with a sound barrier top-of-barrier input profile that is generally a vertical projection of the roadway profile is highly recommended.
- Modeling barriers and/or barrier segments with nominal heights (e.g. 14.0 feet, 16.0 feet, 18.0 feet, etc.) should be avoided unless the barrier is immediately adjacent to the roadway edge of pavement.
- Modeling sound barriers with specific segment heights to achieve nominal top-of-barrier segment elevations is highly recommended (e.g. if a barrier segment has a ground elevation of 320.63 feet, model the segment height at 24.37 feet for a nominal top-of-barrier segment elevation of 325.00 feet).
- Final optimization of sound barrier vertical profiles should be performed to a resolution of 1.0-foot segment perturbations.
- Final recommended sound barrier top of wall profile segments should have consistent vertical grades.

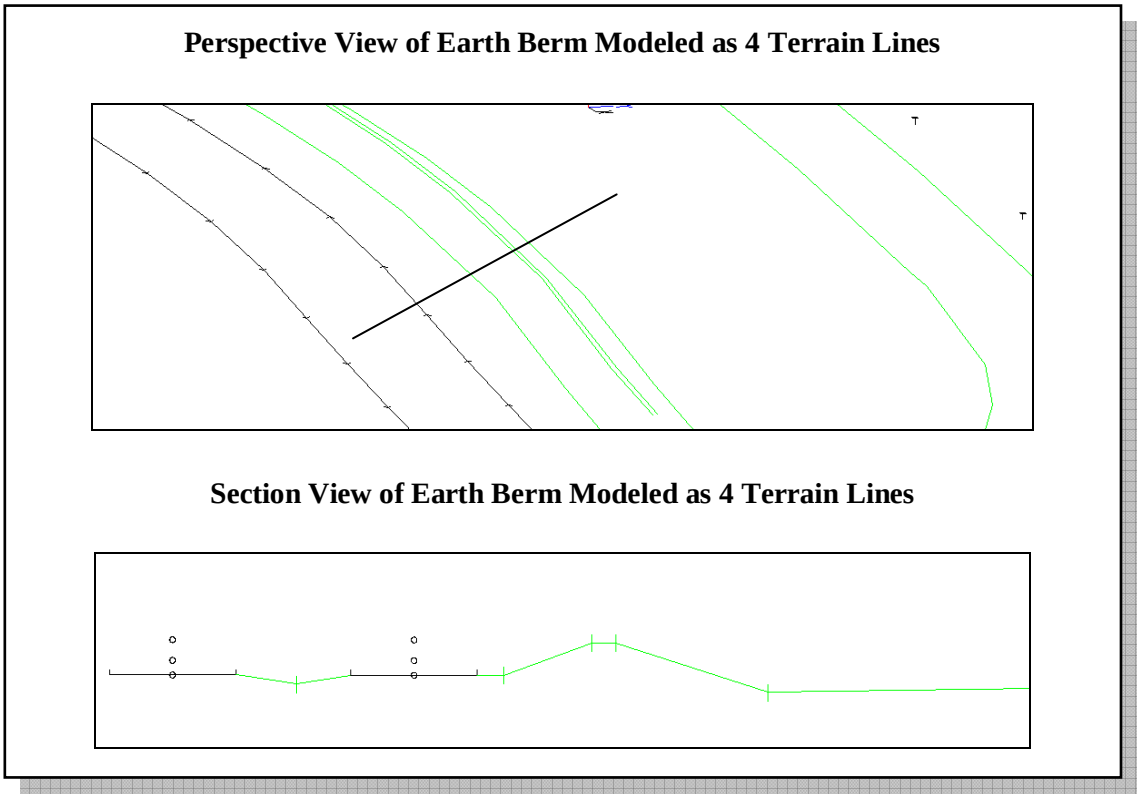
Figure 8.6: Final Recommended Sound Barrier Top of Wall Profiles



(Note townhouses modeled as sound barriers in background)

- Elevated roadway sections should be modeled with traffic barriers, as applicable. Shielding for traffic barrier segments for roadways on structure must be correctly designated for applicable roadway segments.
- Acoustically significant structures should be modeled as individual barriers and not grouped together into building rows. Apartment buildings, commercial buildings, townhouse clusters, and individual residences should be modeled separately. (Note: TNM assesses traffic noise attenuation from barriers with zero perturbations in the "without barrier" condition).
- Prior to recommendation in a Design Noise Report, the acoustic effectiveness of earth berm sound barriers shall be proven in a TNM model(s). Earth berm sound barriers shall be modeled as four terrain line TNM elements: bottom of berm (roadway side), top of berm (roadway side), top of berm (receptor side), and bottom of berm (receptor side).

Figure 8.7: Modeling TNM Earth Berm Sound Barriers



8.7.5 Tree Zones

TNM tree zones should be modeled to represent existing and/or proposed forested areas as necessary to accurately predict traffic noise levels.

- Sound level attenuation is commonly considered to be 5 dB(A) for an area of dense forestation 200 feet thick. Since TNM assesses traffic noise at angles of $\pm 80^{o}$ from perpendicular to the roadway, TNM tree zones should be modeled if the perpendicular width of the densely forested area is ≥35 feet (35 feet ÷ cosine (80^{o}) = 200 feet).
- Although the widely-accepted criteria for sound attenuation is that an area of dense forestation must be 200-feet thick for it to reduce noise levels by ~5 decibels, inclusion of much thinner TNM tree zones has been shown to appreciably affect TNM-predicted traffic noise levels. Inclusion of *actual* forested areas less than 35 feet wide into TNM models will be considered acceptable if all other features have been modeled (e.g. terrain lines, structures, ground zones, etc.) *and* the modeled tree zone appreciably improves the predictive accuracy of the validation model.

8.7.6 Ground Zones

TNM ground zones should be modeled to represent existing and/or proposed areas of acoustically significant ground surface conditions, including transitions between two or more different types of surfaces, and the representation of oddly-shaped hard or reflective surface areas such as parking lots, highway exit ramp gore areas, paved medians, and bodies of water, etc.

8.7.7 Building Rows

The use of TNM building rows should be limited to the following conditions:

- If more than one large building or structure exists in close proximity to the roadway and the first-row receptors are far away from the roadway.
- If the representation of buildings or structures as a modeled building row element improves the accuracy of the validated TNM model relative to modeling the buildings or structures as separate sound barrier elements, or not modeling the buildings or structures at all.

8.8 Predicted Noise Levels and Traffic Noise Level Contours

All predicted existing and future noise levels will be generated by validated TNM models (refer to section 8.5). Interpolation between two or more receptors, and/or extrapolation outside of two or more modeled receptors will not be an acceptable means of estimating, assuming, or predicting traffic noise levels at noise-sensitive receptors.

Per 23 CFR 772.7(9)(c), noise level contours may be used for project alternative screening or for land use planning to comply with 23 CFR 772.17; however, noise level contours shall not be used for determination of highway traffic noise impacts. Determination of noise level contours shall be made by screening the build-condition TNM models of the actual project for receptor locations at which the requisite contour noise levels are predicted to occur. Utilization of arbitrary TNM models, not representative of the actual project, is not an acceptable methodology to assess project traffic noise level contours.

NOTE:

NOISE LEVEL CONTOURS MAY NOT BE USED TO DETERMINE IMPACTS FOR ANY NCDOT TRAFFIC NOISE ANALYSES.

9.0 PROJECT NOISE IMPACT ASSESSMENT

Highway noise impacts generally occur as either traffic noise impacts and/or construction noise impacts. When traffic noise and construction noise impacts are identified, mitigation must be assessed, and if possible, implemented.

9.1 Traffic Noise Impacts

Traffic noise impacts occur when the predicted traffic noise levels either approach or exceed the FHWA noise abatement criteria, and/or when the predicted traffic noise levels substantially exceed the existing noise levels. Noise mitigation shall be considered for all traffic noise impacts. A sample summary table for the identification of traffic noise impacts along the project is shown below.

Table 9.1: Traffic Noise Impact Summary

DESCRIPTION	IMPACTED RECEPTORS APPROACHING OR EXCEEDING FHWA NAC							SUBSTANTIAL NOISE LEVEL INCREASE[1]	IMPACTS DUE TO BOTH CRITERIA[2]	TOTAL TRAFFIC NOISE IMPACTS
	A	B	C	D	E	F	G			
NSA 1	0	25	0	0	0	0	0	11	11	25
NSA 2	0	19	0	0	0	0	0	0	0	19
NSA 3	0	10	0	0	0	0	0	17	10	17
TOTALS	0	54	0	0	0	0	0	28	21	61

1. Predicted "substantial increase" traffic noise level impact per NCDOT Traffic Noise Abatement Policy
2. Predicted traffic noise level impacts due to approaching or exceeding Noise Abatement Criteria *and* "substantial increase" in Design Year build-condition noise levels.

Table 9.2 lists the Noise Abatement Criteria (NAC) land use activity categories, and the noise levels that, when approached, constitute an impact. NCDOT defines "approach" as reaching one decibel less than the applicable NAC Leq(h) values below.

Table 9.2: Noise Abatement Criteria
Hourly Equivalent A-Weighted Sound Level (decibels (dB(A))

Activity Category	Activity Criteria[1] $L_{eq(h)}$ [2]	Evaluation Location	Activity Description
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B [3]	67	Exterior	Residential
C [3]	67	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, daycare centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section4(f) sites, schools, television studios, trails, and trail crossings
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios
E [3]	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F
F	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G	--	--	Undeveloped lands that are not permitted

1 The $L_{eq(h)}$ Activity Criteria values are for impact determination only, and are not design standards for noise abatement measures.
2 The equivalent steady-state sound level which, in a stated period of time, contains the same acoustic energy as the time-varying sound level during the same time period, with $L_{eq(h)}$ being the hourly value of L_{eq}.
3 Includes undeveloped lands permitted for this activity category.

Table 9.3 documents the NCDOT criteria for traffic noise impacts created when predicted design year loudest hourly equivalent noise levels 'substantially' increase over existing loudest hourly equivalent noise levels.

Table 9.3: NCDOT Substantial Increase Criteria

Existing $L_{eq(h)}$	Substantial Increase
≤ 50 dB(A)	≥ 15 dB(A)
51 dB(A)	≥ 14 dB(A)
52 dB(A)	≥ 13 dB(A)
53 dB(A)	≥ 12 dB(A)
54 dB(A)	≥ 11 dB(A)
≥ 55 dB(A)	≥ 10 dB(A)

9.2 Construction Noise Impacts

Per 23 CFR 772.19, NCDOT shall perform the following tasks to assess, and if possible, minimize the impacts of construction noise for all Type I projects:

(a) Identify land uses or activities that may be affected by noise from construction of the project within the traffic noise technical report.

(b) Determine the measures that are needed in the plans and specifications to minimize or eliminate adverse construction noise impacts to the community. This determination shall consider the benefits achieved and the overall social, economic, and environmental effects and costs of the abatement measures.

(c) Consider construction techniques and scheduling to reduce construction noise impacts to nearby receptors and incorporate the needed abatement measures in the project plans and specifications.

NOTE:

PROJECT-SPECIFIC CONSTRUCTION NOISE ASSESSMENT IS A REQUIRED TASK FOR ALL NCDOT TRAFFIC NOISE ANALYSES.

The assessment of highway construction noise impacts and potential mitigation options is not an arbitrary or superfluous task. It is a requirement of 23 CFR 772, and shall be completed in a comprehensive manner for all Type I projects. Refer to Table 9.4 for typical construction equipment noise level emissions. Common factors of project construction noise that should be addressed as part of all traffic noise analyses include, but are not limited to:

- Proximity of project construction activities to noise sensitive areas
- Schedule of project construction activities in the context of localized land use(s), both in terms of the hour(s) of the day (e.g. daytime, evening, nighttime), and in terms of the number and type(s) of days, weeks or months specific activities might occur (e.g. weekday, weekend, holiday, season, etc.).
- Likelihood of any severe construction noise emissions, particularly from impact-type equipment, that might occur in the vicinity of noise sensitive areas.

The following text is a general example of acceptable construction noise impact evaluation and mitigation assessment documentation. It should not be considered "boilerplate" or universally acceptable for all traffic noise analyses. To fulfill the requirement of 23 CFR 772.19, the evaluation of construction noise impacts and assessment of construction noise mitigation shall be performed on a project-by-project basis.

Example: Construction Noise Sample Text:

"The predominant construction activities associated with this project are expected to be earth removal, hauling, grading, and paving. Temporary and localized construction noise impacts will likely occur as a result of these activities. During

daytime hours, the predicted effects of these impacts will be temporary speech interference for passers-by and those individuals living or working near the project. During evening and nighttime hours, steady-state construction noise emissions such as from paving operations will be audible, and may cause impacts to activities such as sleep. Sporadic evening and nighttime construction equipment noise emissions such as from backup alarms, lift gate closures ("slamming" of dump truck gates), etc., will be perceived as distinctly louder than the steady-state acoustic environment, and will likely cause impacts to the general peace and usage of noise-sensitive areas – particularly residences, hospitals, and hotels.

Extremely loud construction noise activities such as usage of pile-drivers and impact-hammers (jack hammer, hoe-ram) will cause temporary, sporadic, and acute construction noise impacts in isolated areas.

Generally, low-cost and easy-to-implement construction noise control measures should be incorporated into the project plans and specifications (e.g. work-hour limits, equipment exhaust muffler requirements, haul-road locations, elimination of "tail gate banging", ambient-sensitive backup alarms, construction noise complaint mechanisms, and consistent and transparent community communication and rapport).

While discrete construction noise level prediction is difficult for a particular receiver or group of receivers, it can be assessed in a general capacity with respect to distance from known or likely project activities. For this project, earth removal, grading, hauling, and paving is anticipated to occur in the near vicinity of three residential neighborhoods, two schools, and one commercial area (shopping center). Additionally, impact hammer and pile-driving activities are anticipated to occur in the near vicinity of one school as part of the removal and replacement of the "US 1234 – SR 5678" interchange. Although construction noise impact mitigation should not place an undue burden upon the financial cost of the project or the

project construction schedule, pursuant to the requirements of 23 CFR 772.19, it is the recommendation of this traffic noise analysis that:

- *Earth removal, grading, hauling, and paving activities in the vicinity of the three residential neighborhoods (provide neighborhood names and project station limits, if known) should be limited to weekday daytime hours.*
- *Earth removal, grading, hauling, and paving activities in the vicinity of the two schools (provide names of schools and project station limits, if known) should be performed during evening and nighttime hours, or any hours during weekends and/or holidays.* (Note: Address appropriate construction activity scheduling recommendations per project-specific noise sensitive land uses in this section).
- *If meeting the project schedule requires that earth removal, grading, hauling and/or paving must occur during nighttime hours in the vicinity of one or more of the three nearby residential neighborhoods (provide neighborhood names and project station limits, if known), the Contractor shall notify NCDOT as soon as possible. In such instance(s), all reasonable attempts shall be made to notify and to make appropriate arrangements for the mitigation of the predicted construction noise impacts upon the affected property owners and residents.*
- *If construction noise activities must occur during context-sensitive hours in the vicinity of noise-sensitive areas, discrete construction noise abatement measures including, but not limited to portable noise barriers and other equipment-quieting devices shall be considered.*

For additional information on construction noise, please refer to the FHWA Construction Noise Handbook (FHWA-HEP-06-015) and the Roadway Construction Noise Model (RCNM), available online at:
http://www.fhwa.dot.gov/environment/noise/cnstr_ns.htm."

Table 9.4: Construction Equipment Typical Noise Level Emissions[1]

Equipment	Noise Level Emissions (dB(A)) at 50 Feet From Equipment[2]
	70 80 90 100
Pile Driver[3]	
Jack Hammer	
Tractor	
Road Grader	
Backhoe	
Truck	
Paver	
Pneumatic Wrench	
Crane	
Concrete Mixer	
Compressor	
Front-End Loader	
Generator	
Saws	
Roller (Compactor)	

1. Adapted from *Noise Construction Equipment and Operations, Building Equipment, and Home Appliances*. U.S. Environmental Protection Agency. Washington D.C. 1971.
2. Cited noise level ranges are typical for the respective equipment. For "point sources" such as the construction equipment listed above, noise levels generally dissipate at a rate of -6 dB(A) for every doubling of distance. For example, if the noise level from a pile driver at a distance of 50 feet = 100 decibels (dB(A)), then at 400 feet, it will generally be 82 decibels (dB(A)) or less.
3. Due to project safety and potential construction noise concerns, pile driving activities are typically limited to daytime hours.

10. SOUND BARRIER DESIGN GUIDELINES

The following are generally-accepted sound barrier design considerations:

- Sound barriers should not be designed with any segment heights greater than 25 feet above the proposed ground line, without explicit NCDOT approval (note that barrier segment height refers to the height of all horizontal locations throughout the segment – not just at the segment termini).
- Sound barriers should be designed with linear or convex top-of-wall or top-of-berm vertical profiles. Design focus should be placed upon top-of-wall segment or top-of berm profile *elevations*, not *heights*. Jagged undulations, notches, and concavities in the top-of-wall or top-of-berm vertical profiles allow traffic noise to more easily reach noise-sensitive receptors – reducing the overall effectiveness and efficiency of the sound barrier.
- Sound barrier termini should extend beyond the last benefited receptor by four times the perpendicular distance from the last benefited receptor to the barrier. Sound barrier recommendations that do not meet this design guideline shall require NCDOT approval prior to report finalization.
- Sound barriers must not be considered where they create a safety hazard, such as blocking safe vehicle line-of-sight distances.
- Combining the barrier with natural terrain features and structures (e.g., berms and retaining walls), particularly at the barrier termini, can reduce required barrier length and/or area.
- Grade cut-fill transitions do not universally require sound barrier horizontal alignment shift to/from the edge of pavement to/from the right of way limits. Optimal sound barrier designs utilize the most cost-effective application of all roadway design elements (e.g., grading, drainage, etc.) resulting in the greatest reduction in traffic noise.
- Sound barriers function by extending the sound transmission path length. The most efficient sound barriers are horizontally located near the roadway or near the most-severely impacted receptors (e.g., 1st-row receptors). The predominant

sound barrier horizontal alignment should not be equidistant to the roadway and the most severely impacted receptors.

- The barrier location should take advantage of local terrain conditions to benefit from higher elevations; however, a higher barrier elevation does not always result in greater traffic noise attenuation. Priority should be given to overall sound barrier performance.
- Default TNM sound barrier analysis orthogonal views can be misleading with respect to the representation of sound barrier top-of-wall profiles. All recommended sound barriers must be supported by TNM-predicted noise levels; however, the NCDOT Traffic Noise and Air Quality Group encourages the use of spreadsheets and/or other computational tools outside of TNM model(s) as an intermediate step to derive the basis for the assessment and of acoustically efficient and cost-effective – optimal – sound barriers (refer to figure 10.1).

Figure 10.1: Use of a Spreadsheet for Sound Barrier Profile Optimization

		TNM		Optimized		RECOMMENDED		
STA	Length	Top El.	% Grade	Top El.	% Grade	Input Ht	Area	Length
392+00.00	49.26	649.20	3.3%	650	4.1%	12.8	664	49
392+50.00	49.32	650.85	5.4%	652	4.1%	14.15	731	49
393+00.00	52.33	653.50	2.4%	654	1.9%	15.5	831	52
393+50.00	52.26	654.75	2.4%	655	1.9%	16.25	869	52
011+00.00	50.91	656.00	1.2%	656	2.0%	17	901	51
011+50.00	50.69	656.60	-0.8%	657	0.0%	18.4	943	51
012+00.00	98.83	656.20	-0.2%	657	-1.0%	18.8	1,818	99
013+00.00	101.42	656.00	0.0%	656	0.0%	18	1,876	101
014+00.00	99.89	656.00	-1.0%	656	-1.0%	19	1,898	100
015+00.00	99.72	655.00	0.1%	655	0.0%	19	1,940	100
016+00.00	100.61	655.10	-2.4%	655	-2.0%	19.9	2,022	101
017+00.00	98.73	652.70	-3.3%	653	-3.0%	20.3	2,019	99
018+00.00	98.80	649.40	-3.7%	650	-3.0%	20.6	2,070	99
019+00.00	101.01	645.70	-1.9%	647	-3.0%	21.3	2,096	101
020+00.00	100.16	643.80	-2.3%	644	-3.0%	20.2	1,938	100

Note: The "Optimized % Grade" changes represent a more consistently convex shape – a more "optimal" top-of-wall-profile – than the "TNM % Grade" changes.

- Optimal sound barrier designs break the line-of-sight between receptors and the roadway noise source. Use the TNM line-of-sight check tool to confirm that sound barriers break the line-of-sight for all benefited receptors. Breaking line-of-sight to all roadway traffic noise sources for all benefited receptors is desirable; however, it is not an absolute requirement for barrier design.
- NCDOT does not generally construct maintenance openings in sound barriers. For instances in which special project conditions necessitate sound barrier maintenance openings, they will be considered on a case-by-case basis. It is much more preferable to provide doorways or other closable openings at locations where through-barrier access is desirable. For such approved cases, maintenance gaps shall be flanked by overlapping barrier sections at least four times the gap width in length (i.e., for a 10-foot wide gap, the sound barrier should have panels that overlap at least 40-feet), the sound barrier top profile elevation(s) shall be maintained on both sides of the opening, and the overlapping panels shall be oriented as parallel to the roadway as possible to minimize the potential for roadway traffic noise reflections.
- Consideration should be given to the effects of sound barriers and the construction of sound barriers on sunlight and shadows (e.g. if a residential neighborhood faces a proposed highway to the south, but will be buffered by a wide tract of dense forestation, the potential sound barrier design should consider the negative effects of tree removal – removing the natural cooling and shading against the sun - for the construction of the sound barrier).
- Sound barrier design should consider and provide access to fire hydrants as necessary, as coordinated with the appropriate jurisdictional entity.
- Sound barrier vertical profile segment elevations shall be clearly marked on the appropriate design plan sheet(s).
- A parallel barrier analysis shall be performed for all instances in which sound barriers are considered or recommended on opposing sides of a roadway.
- Absorptive materials or treatments shall be considered for sound barriers that are predicted to reflect noise into noise sensitive areas.

- Although the reasonableness design goal is a 7 dB(A) reduction for at least one first-row impact, preference will be given to feasible and reasonable barrier designs that reduce with-barrier noise levels below NAC criteria, reduce with-barrier noise level increases below substantial increase impact limits, and/or facilitate similar with-barrier noise levels throughout the noise sensitive area.

11.0 FEASIBILITY AND REASONABLENESS

Title 23 CFR 772.139(d) requires the examination and evaluation of feasible and reasonable noise abatement measures for reducing the noise impacts.

11.1 Feasibility

Determination of feasibility is the combination of acoustical and engineering factors considered in the evaluation of a noise abatement measure. The following factors apply to the determination of feasibility:

- Any receptor that receives a minimum noise level reduction of five dB(A) due to noise abatement measures shall be considered a benefited receptor. Noise reduction of five dB(A) must be achieved for at least one impacted receptor.
- Engineering feasibility of the noise abatement measure(s) shall consider adverse impacts created by or upon property access, drainage, topography, utilities, safety, and maintenance requirements.
- The effects of secondary traffic noise (e.g., non-project traffic noise) and non-traffic noise sources on attainable Noise Level Reduction shall be considered when developing effective noise mitigation measures.

Although projects with full control of access are typically optimal for the design of traffic noise abatement measures, sound barriers occasionally meet feasibility requirements on uncontrolled access and partial control of access roadway facilities. A comprehensive examination of possible traffic noise abatement measures shall be conducted for the benefit of all predicted traffic noise impacts – regardless of project roadway access.

NOTE:

JUST BECAUSE IT'S NOT AN INTERSTATE DOESN'T MEAN IT CAN'T GET A SOUND BARRIER.

11.2 Reasonableness

Determination of reasonableness includes the combination of social, economic, and environmental factors considered in the evaluation of a noise abatement measure. Per NCDOT Traffic Noise Abatement Policy, sound barrier reasonableness determination is based upon the following three factors:

(a) Viewpoints of the property owners and residents of all benefited receptors shall be solicited. One owner ballot and one resident ballot shall be solicited for each benefited receptor. Points per ballot shall be distributed in the following weighted manner:

- 3 points/ballot for benefited front row property owners
- 1 point/ballot for all other benefited property owners
- 1 point/ballot vote for all residents

Consideration of the noise abatement measure will continue unless a simple majority of all distributed points are returned that indicates the balloted voters do not want the abatement measure.

(b) The maximum allowable base quantity of noise walls and/or earthen berms per benefited receptor shall not exceed 2,500 ft^2 and 7,000 yd^3, respectively. Additionally, an incremental increase of 35 ft^2 for noise walls and 100 yd^3 for earthen berms shall be added to the base quantity per the average increase in dB(A) between existing and predicted exterior noise levels of all impacted receptors within each noise sensitive area, which is defined as a geographically limited area in which noise sensitive land uses exist that are, or may be exposed to, similar noise sources. A base dollar value of $37,500 plus an incremental increase of $525 (as defined above) shall be used to determine reasonableness of buffer zones and noise insulation.

Example: TNM-Optimized Noise Abatement Measure Meets Reasonableness Criteria:

Design square footage of proposed noise abatement measure = 24,000 ft^2
Number of benefited receptors = 12
V = 24,000 ÷ 12 = 2,000 ft^2
Projected level of 72 dB(A) – Existing level of 69 dB(A) = I = 3 dB(A)
Allowable square footage = 2,500 ft^2 + 35 ft^2 (3) = 2,605 ft^2 > 2,000 ft^2, therefore, the noise abatement measure **is reasonable.**

Example: TNM-Optimized Noise Abatement Measure Does Not Meet Reasonableness Criteria:

Design square footage of proposed noise abatement measure = 26,000 ft^2
Number of benefited receptors = 8
V= 26,000 ÷ 8 = 3,250 ft^2
Projected level of 70 dB(A) - Existing level of 65 dB(A) = I =5dB(A)
Allowable square footage = 2,500 ft^2 + 35 ft^2 (5) = 2,675 ft^2 < 3,250 ft^2, therefore, the noise mitigation measure **is not reasonable**.

(c) A noise reduction design goal of at least 7 dB(A) must be evaluated for all front row receptors. At least one benefited front row receptor must achieve the noise reduction design goal of 7 dB(A) to indicate the noise abatement measure effectively reduces traffic noise.

11.3 Equivalent Receptors/Other Land Uses

Representation of several types of land uses as more than one receptor is appropriate in some cases. These receptors typically include active sports areas, playgrounds, schools, pre-school and daycare facilities; churches, hospitals, retirement homes; parks, trails,

campgrounds, cemeteries, and other exterior areas of frequent human use for the land uses found in the NAC activity category 'C'. A grid- or nodal-type array of receptors shall be used to accurately assess the extent to which larger-area receptors and/or locations represented by more than one equivalent receptor are impacted (refer to section 8.6.2). Noise mitigation shall be considered for all modeled receptor locations within the grid- or nodal-type array for which impacts are predicted. NCDOT must approve both the equivalent receptor calculations and the locations of the equivalent number of receptors throughout the grid- or nodal-type array.

To determine the effectiveness of the noise wall, an equivalent number of residents is determined by using the formula:

Equivalent # Residences = # Occupants ÷ (# People/Residence) x Usage

Where:

Occupants = # People (Students, Visitors, etc.).

3 = Average # of People/Residence (North Carolina Rounded Average)

Usage = # of Daily Hours Used ÷ 24 Hours Per Day x Days Used Per Year ÷ Days Per Year (or Days Used Per Week ÷ Days Per Week)

For the calculation of equivalent residences for schools:

- The number of students shall be assessed as the greater of school capacity or existing enrollment.
- The "Daily Hours Used" shall be the number of hours for which the school is in operation on a typical instruction day. NCDOT assesses the hours of operation as being from one hour before the opening bell until two hours after the closing bell of each full-length school day.

Example: Equivalent Residences at a School:

For a school with 500 students, and a bell schedule between 8:00 a.m. and 3:00 p.m., the Equivalent # of Residences would be calculated as:

500 students ÷ 3 x ((1 + 7 + 2) Daily Hours Used ÷ 24 Hours Per Day x 180 Instructional Days Per Year ÷ 365 Days Per Year) = 34 Equivalent Residences

Example: Equivalent Residences at a Day Care Facility:

For a day care with 200 children that operates between 7:00 a.m. and 7:00 p.m. on Mondays through Fridays, the Equivalent # of Residences would be calculated as:

200 children ÷ 3 x ((12) Daily Hours Used ÷ 24 Hours Per Day x 5 Operating Days Per Week ÷ 7 Total Days Per Week) = 24 Equivalent Residences

Example: Equivalent Residences at a Park:

For a park operating year-round during the hours of sunlight for which the average daily patronage is 100 visitors, the Equivalent # of Residences would be calculated as:

100 people ÷ 3 x ((12) Average Daily Hours of Sunlight ÷ 24 Hours Per Day) = 17 Equivalent Residences

11.4 Common Noise Environment Cost Averaging

NCDOT will utilize cost averaging among all noise sensitive areas within the same Activity Category in Table 9.2 that are exposed to similar noise sources and levels; traffic volumes, traffic mix, and speed; and topographic features (common noise environment) if:

(1) No single common noise environment exceeds two times the base quantity reasonableness criteria (e.g., two times 2,500 square feet, or two times 7,000 cubic yards); and,

(2) Collectively, all common noise environments being averaged do not exceed the base quantity reasonableness criteria.

NCDOT shall approve the limits of Common Noise Environments prior to assessment of sound barrier reasonableness based upon the Cost Averaging criteria.

11.5 Sound Barrier Feasibility and Reasonableness Worksheet

The NCDOT Traffic Noise and Air Quality Group has developed a worksheet to assist with the assessment of sound barrier feasibility and reasonableness (see Appendix C). A completed worksheet is required to accompany each individual noise abatement measure investigated.

12.0 REPORTING

Although consistency in reporting and report formatting is desirable, NCDOT does not intend to dictate the exact content and formatting of all traffic noise analyses and design noise reports. All NCDOT traffic noise analyses should be written in a manner necessary to adequately and appropriately document the relevant noise conditions (traffic and otherwise), the assessment of traffic noise impacts and construction noise impacts, the analysis of all potential traffic noise abatement measures (including analyses of measures that do not meet feasibility and/or reasonableness criteria), all recommendations for mitigation, and other information pertinent to traffic noise in the context of the subject project(s).

With the exception of TNM model validation (refer to section 8.6), all noise levels shall be rounded to the nearest whole decibel prior to manipulation for traffic noise impact assessment and insertion loss/noise level reduction calculations. Unless explicitly requested otherwise, all noise levels shall be stated in units of whole decibels in all NCDOT traffic noise analyses and design noise reports. All noise level descriptors such as metric, time, and spatial references (e.g., $L_{eq(1\text{-}hr)}$) shall be included as appropriate. NCDOT shall consider the qualification of one or more noise level descriptors for the ease of reporting. For example, "L_{eq}" may be qualified to represent "$L_{eq(1\text{-}hr)}$" throughout an entire report.

The guidance provided in this section is intended to be comprehensive; however, specific features of individual projects will dictate the requirements of each traffic noise analysis and/or design noise report that must be fulfilled to satisfy 23 CFR 772.

12.1 Executive Summary

The Executive Summary should contain the following information:

- General project description
- Date of Public Knowledge (if known)

- The number, type, and general location of any predicted traffic noise impacts
- The location of any recommended noise barriers
- The general, summarized conclusion/recommendation

12.2 Table of Contents

The Table of Contents shall contain the following information:

- Section and subsection numbers, titles, and pages
- Appendix titles
- List of Tables, with table numbers, titles, and pages
- List of Figures, with figure numbers, titles, and pages

12.3 Project Location and Description

The Project Location and Description should expand upon the general description found in the Executive Summary.

- Detailed project description, including the project location, TIP number, design year, date of data collection and weather conditions during field work
- Description of existing land uses (and proposed land uses, if known)

12.4 Procedure

The procedure by which the noise analysis is completed is dependent upon the type of analysis (e.g., traffic noise analysis, or design noise report), the type of project (e.g., widening, new highway construction), and the relevance of any previous traffic noise analyses to the presently known project conditions (i.e., has the project changed appreciably

since any previous traffic noise analyses were performed?). Generally, the Procedure should include:

- Citation of all previous traffic noise analyses for the project
- Equipment, duration, and start/stop times for ambient noise level data collection
- General descriptions of the: TNM model validation(s), TNM modeling processes, traffic noise impact assessment, and TNM mitigation assessments
- Description of the construction noise impact assessment methodology

12.5 Characteristics of Noise

An informative description of the characteristics of noise shall be included in all NCDOT traffic noise analyses and design noise reports.

12.6 Noise Abatement Criteria

An informative description of applicable Federal and State criteria and policy for the assessment of traffic and construction noise impacts and impact mitigation measures shall be included in all NCDOT traffic noise analyses and design noise reports.

12.7 Ambient Noise Levels

An informative description of the ambient noise level data obtained as part of the field work shall be included in all NCDOT traffic noise analyses and design noise reports. At a minimum, the description of ambient noise levels shall include the following information:

- A general definition of ambient noise

- A general description of the ambient noise environment(s) in the vicinity of the project, including dominant and otherwise significant sources of existing noise
- The number, general descriptions, and photographs of the locations of ambient noise level data collection
- The range and general discussion of the noise levels obtained in the ambient monitoring data
- A reference to the appendix citing the hourly-equivalent ambient noise levels, $L_{eq(h)}$, obtained and/or predicted for all receptors in the vicinity of the project

12.8 Procedure for Predicting Future Noise Levels

An informative description of the comparative assessment and/or TNM analysis process shall be included in all NCDOT traffic noise analyses and design noise reports. Also, the procedure for predicting future noise levels shall describe the level of project design upon which the analysis is based (e.g. functional project plans, preliminary project plans, etc.).

12.9 Traffic Noise Impacts and Noise Level Contours

A general and project-specific description of traffic noise impacts and predicted traffic noise level contours shall be included in all NCDOT traffic noise analyses and design noise reports.

Predicted traffic noise level contours shall be cited in terms of distance from the roadway centerline for 71 dB(A) and 66 dB(A) – the noise levels at which exterior traffic noise level impacts definitively occur for NAC “B”, “C”, and “E” land uses. The basis for noise level contour prediction shall be TNM-predicted noise levels at one or more representative

receptors from one or more validated TNM model(s) of the actual project. Arbitrary or "flat and level" TNM models shall not be used to predict traffic noise level contours.

The general traffic noise impact description shall include the definitions of NAC "approach" and "substantial increase" traffic noise impacts. The project-specific traffic noise impact description shall include the number and type of impacts (refer to table 9.1).

12.10 Potential Traffic Noise Abatement Measures

As part of all NCDOT traffic noise analyses and design noise reports, a comprehensive discussion of potential traffic noise abatement measures shall be provided, including, but not limited to, discussion of the following:

- Highway alignment selection
- Traffic system management measures
- Buffer zones
- Vegetation
- Proper use of land controls
- Building insulation
- Noise barriers

All traffic noise abatement measure assessments shall be described in detail, including the measures that do not meet feasibility and reasonableness criteria.

12.11 Construction Noise

All NCDOT traffic noise analyses and design noise reports shall include a general discussion of construction noise, as well as a comprehensive discussion of the project-specific construction noise impact and mitigation assessment (refer to section 9.2).

12.12 Conclusion

A definitive conclusion shall be made as part of all NCDOT traffic noise analyses and design noise reports. The conclusion should cite the project name (including TIP number), the process/procedure by which traffic noise levels and/or impacts were assessed (e.g. ambient noise monitoring, TNM modeling, etc.), and make a recommendation regarding noise abatement (e.g. further study, recommendation of abatement measures, no further action, etc.). The recommendation should state whether it is "likely" or "unlikely" that noise abatement measures will be installed for each noise sensitive area identified. "Likely" does not mean a firm commitment. The final decision on the installation of the abatement measures shall be made upon completion of the project design, the public involvement process, concurrence with the NCDOT Policy, and FHWA approval.

12.13 References

A list of applicable references shall be included as part of all NCDOT traffic noise analyses and design noise reports.

12.14 Project Mapping

Project mapping shall include a representation of the entire project (study area) on one image, and detailed small-scale images as necessary to appropriately document receptor locations, traffic noise levels, impacts, and mitigation. All project maps shall include a title block, a legend (as applicable), properly oriented north arrow, draftsperson's name, and map creation date.

- Project Map: aerial photogrammetry or other appropriate base mapping of the entire project, defined by a logical scale or denoted as being not to scale.

- Detailed Study Area Maps: aerial photogrammetry showing the project and all noise receptors on one or more images, defined by a consistent logical scale based upon receptor density. All receptors located within proposed right of way limits, predicted traffic noise impacted receptors, predicted impacted and benefited receptors, and predicted non-impacted benefited receptors shall be clearly distinguished in the detailed study area maps.

12.15 Appendices

The Appendices of all NCDOT traffic noise analyses and design noise reports contain the detailed assessment of monitored noise levels, traffic noise model validation, predicted noise levels, noise level impacts, traffic noise model sound barrier analyses, mitigation recommendation(s), and other significant information including, but not limited to:

- Ambient Noise Level Monitoring: Information defining the time, duration, receptor number, land uses, hourly-equivalent sound levels, weather data, sound level meters (identified by meter manufacturer, model number, and serial number) shall be provided for each ambient noise level monitoring receptor location. Laboratory calibration certificates shall be included. Tables 12.1 and 12.2 are provided as a general reference; however, additional information may be required to describe the ambient noise level monitoring data on a project-specific basis.

Table 12.1: Project Ambient Hourly-Equivalent Sound Levels, $L_{eq(h)}$[1]					
Setup	**Receptor**	**Land Use**	**Roadway Noise Source(s)[2]**	**Start/Stop Time**	**$L_{eq(h)}$ (dB(A))**
1	1.1	Residential	US 29	8:50 – 9:10	73
	1.2	Residential	US 29		57
	1.3	Residential	US 29		47
2	2.1	Residential	US 29	9:50 – 10:10	51
	2.2	Residential	US 29		54
3	3.1	Residential	US 29	10:30 – 10:50	69
	3.2	Residential	US 29		66
	3.3	Residential	US 29		65
4	4.1	School	US 29	11:20 – 11:40	57
	4.2	School	US 29		64
	4.3	School	US 29		57

1. In accordance with FHWA guidance and accepted industry standards, hourly equivalent sound levels, $L_{eq(h)}$, were extrapolated from short-term data collection monitoring sessions, and are expressed in units of A-weighted decibels (dB(A)) rounded to the nearest whole number.
2. For each Setup, noise meters were located at logical locations for the assessment of existing highway traffic noise.

Table 12.2: Project Noise Monitoring Sessions Weather Data[1]							
Setup	**Temp. (^oF)**	**Dew Point (^oF)**	**Pressure (in)**	**Wind Dir.**	**Wind Speed (mph)**	**Relative Humidity**	**Precip. (in)**
1	69	53	30.19	E	5.8	57%	0.00
2	72	51	30.20	SE	9.2	48%	0.00
3	75	55	30.20	SE	6.9	50%	0.00
4	78	57	30.21	ESE	4.6	51%	0.00

1. Source: Weather Underground (http://www.wunderground.com) for the local weather station.

- Hourly Equivalent Traffic Noise Level Tables: information defining all noise-sensitive receptors, noise-sensitive land use (NAC category), number of dwelling units (equivalent receptors), property address, and predicted loudest-hourly equivalent noise levels (refer to table 12.3).

Table 12.3: Noise Sensitive Receptors and Hourly Equivalent Noise Levels

Receptors					Predicted Noise Levels, $L_{eq(h)}$ (dB(A))		
ID#	**Use**	**NAC**	**D.U.s**	**Address**	**Ex.**	**No-Build**	□
R-1	Res.	B	1	3205 Sunbright Ln	60	**67**	7
R-2	Res.	B	1	3207 Sunbright Ln	60	**67**	7
R-3	Res.	B	1	3209 Sunbright Ln	59	**66**	7
R-4	Res.	B	1	3211 Sunbright Ln	60	**66**	6
R-520B	School	C	16	11755 Cleveland Rd	56	58	2
R-520C	School	C	16	11755 Cleveland Rd	52	54	2
R-520D	School	C	16	11755 Cleveland Rd	51	52	1
R-520E	School	C	16	11755 Cleveland Rd	52	54	2
R-520F	School	C	16	11755 Cleveland Rd	51	52	1
Predicted "No-Build" Alternative Design Year 2035 Traffic Noise Impacts:[3,4]						4[1]	0[2]

1. Predicted traffic noise level impact due to approaching or exceeding NAC.
2. Predicted "substantial increase" traffic noise level impact.
3. The number of predicted impacts is not duplicated if receptors are predicted to be impacted by more than one criterion (e.g. if a receptor is impacted by NAC "C" and NAC "D", it is counted as only one impact).
4. Total number of predicted traffic noise impacts under the No-Build alignment alternative = 4.

- Traffic Noise Models: information pertaining to the input and implementation of all FHWA Traffic Noise Model (TNM) runs for the purpose of assessing project-related traffic noise levels. At a minimum, this information should include a general description of all modeled TNM elements (roadways, receptors, terrain lines, etc.), the validation process and accuracy (refer to table 12.4), and a description of the modeling iterations by which traffic noise levels were assessed. All TNM models associated with the traffic noise analysis/design noise report must be included in electronic format as part of each draft and final report submission. NCDOT requires approval of the TNM validation model(s) prior to completion of the draft report(s).

Table 12.4: TNM Validation Table

Monitoring Location	Measured $L_{eq(h)}$ dB(A)[1]	TNM-Predicted $L_{eq(h)}$ dB(A)[1]	Validation Delta (Pred. – Meas.)[1]
M-1.1	62.1	62.2	+0.1
M-1.2	62.4	63.2	+0.8
M-1.3	61.8	61.9	+0.1
M-2.1	83.1	80.2	-2.9[2]
M-2.2	70.9	72.0	+1.1
M-2.3	64.2	63.3	-0.9
M-3.1	67.1	66.9	-0.2
M-3.2	61.9	62.4	+0.5
M-3.3	55.4	51.9	-3.5[3]

1. Hourly equivalent noise levels, $L_{eq(h)}$, are expressed to the nearest one-tenth decibels to ensure that TNM-predicted noise levels validate to within ±1.7 dB(A) of measured noise levels without the benefits of rounding.
2. The 1st-row noise monitoring location M-2.1 is approximately 50' E of the existing roadway, and is not indicative of a noise-sensitive land use in the vicinity of the project.
3. The 3rd-row noise monitoring location M-3.3 is approximately 400' SE of the adjacent ramp, and it is approximately 50' higher in elevation. Ramp vehicle traffic was audible during the short-term monitoring session; however, local community non-traffic-related noise sources (e.g. air conditioning units) were perceived to be dominant. Given that the 1st- and 2nd-row receptors M-3.1 and M-3.2 validated to a high degree of tolerance to the monitored noise levels (-0.2 and +0.5 dB(A), respectively), and that the TNM-predicted noise levels at M-3.3 are *lower* than the field-monitored noise levels, traffic noise is considered to be an insignificant component of loudest-hour noise levels at the M-3.3 location.

- Noise Barrier Analyses: as applicable, a generalized or detailed summary of the assessment of noise barrier reasonableness for traffic noise analyses and design noise reports. This may be provided in text or tabular form; however, it should include mapping of the noise sensitive area and barrier location(s), the logical description (e.g. neighborhood and/or local street name(s)), noise barrier length, number of impacts, number of benefits, the maximum allowable base quantity per benefit, and the base quantity per benefit of the abatement measure (noise wall and/or earthen berm). Noise barrier analyses should be provided for all optimized barriers – including optimized barriers that do not meet feasibility and reasonableness criteria.

- Recommended Noise Barrier Envelope Drawings: Scale plan and profile drawings consistent with NCDOT CADD standards shall be provided for all barriers recommended in Design Noise Reports. Although one or both noise wall and/or earth berm termini or other significant barrier points may be defined in reference to the alignment and project survey stationing of the adjacent roadway, all recommended noise walls and/or earth berms shall have distinct horizontal alignments (e.g. "-NW-A-") and stationing. The envelope drawings should also include a logical description of noise barrier segment top elevations, either by wall segment numbers or wall segment lengths.

- Predicted Traffic Volumes: the base year, predicted design year no-build, and predicted design year build-condition traffic volume diagrams for all detailed study alternatives. Base year traffic volumes shall be assessed as the greater of base year Design Hour Volumes (DHV) or traffic counted in the field during ambient noise level monitoring.

- North Carolina Department of Transportation Traffic Noise Abatement Policy: a copy of the policy should be included in each report.

13 PUBLIC INVOLVEMENT

13.1 Communication and Public Hearings

Communication with the community regarding noise impacts and possible noise abatement shall occur early in the project development process and continue beyond the project public hearing. NCDOT will communicate with citizens to present information on the nature of highway traffic noise, and discuss the types and effects of noise abatement measures that may be considered. The concerns of the community shall be a major consideration in reaching a decision on the abatement measures to be provided. As needed, public outreach may include smaller-scale meetings with individual communities and neighborhoods, as well as project-wide workshops and hearings. Educational materials pertaining to traffic noise will be presented and distributed at public meetings.

NCDOT shall provide clear and concise explanations in all communications and interactions with the public and local governments.

Upon approval of final environmental documents (CE, FONSI, ROD), NCDOT shall provide written notice of the Date of Public Knowledge, transmitted via certified mail, to all relevant local governments. This notice shall include applicable specific language from NCDOT Traffic Noise Abatement Policy regarding the responsibility of local governments and private landowners to provide traffic noise abatement for development permitted after the Date of Public Knowledge.

13.2 Noise Abatement Measure Voting Process

The viewpoints of the benefited receptors shall be solicited after completion of Design Noise Reports. Each benefited resident will get one vote. Each benefited owner will also get one vote (i.e., an owner who resides at a predicted benefited property will be able to cast two votes). Owners of predicted first-row benefits will receive an additional two votes. All

noise mitigation measures recommended in the Design Noise Report shall be constructed unless a simple majority of opposing votes are received in a timely manner. All benefited residents and property owners shall have a period of fifteen (15) to thirty (30) days to cast their votes to NCDOT.

- 3 points/ballot for benefited front row property owners
- 1 point/ballot for all other benefited property owners
- 1 point/ballot vote for all residents

14 MISCELLANEOUS

14.1 Noise Abatement Measure Standards

To provide standard structural design criteria for the preparation of noise barrier plans and specifications, the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Bridges and Structures developed "Guide Specifications for Structural Design of Sound Barriers", which was published in 1989 and amended in 1992 and 2002. These specifications allow for more consistency and less conservatism in barrier design. FHWA encourages highway agencies to apply realistic noise barrier structural design practices and to avoid overly conservative design procedures, especially those related to wind load criteria. Also, the AASTHO Green Book is recommended for site design requirements. Finally, noise barrier material types should be selected based on economics, effectiveness, and visual impacts.

14.2 Federal Participation

The cost of noise abatement measures may be included in the cost of federal-aid participating projects with the federal share being the same as that for the system on which the project is located when:

(a) Traffic noise impacts have been identified, and

(b) Abatement measures have been determined to be feasible and reasonable.

14.3 Third Party Participation

(a) Third party funding of noise abatement measures cannot be used to facilitate sound barrier reasonableness. Third party funding can be provided only by

public entities, and can only be used to pay for additional features such as landscaping and aesthetic treatments for noise barriers that meet reasonableness criteria.

(b) If an entity (e.g., a local government) requests the use of materials that are more costly than those typically provided by NCDOT, the requesting entity must assume 100% of the actual additional construction cost.

(c) If an entity (e.g., local government) insists on the provision of a noise abatement measure deemed not reasonable by NCDOT, an abatement measure may be installed provided that the entity assumes 100% of the cost. These costs include, but are not limited to: preliminary engineering, actual construction costs, and maintenance. In such cases, NCDOT's noise barrier material, design, and construction specifications must still be met. In such cases, NCDOT will assume 0% of the present or future liability associated with the construction, maintenance, and ownership of the abatement measure. Furthermore, the requesting entity will hold NCDOT harmless.

(d) For (b) and (c) above, a settlement agreement shall be signed before design begins, and payment shall be made to NCDOT before construction begins.

14.4 Aesthetics

NCDOT has initiated a program for the improvement of sound barrier aesthetics. Good engineering judgment shall be applied toward context-sensitive sound barrier design until the program is formally implemented.

14.5 Noise Compatible Land Use

NCDOT will develop information pertaining to noise compatible land use. This information will be distributed to local municipalities and will be available to the public at meetings, workshops, and public hearings. Refer to the FHWA guidance on noise compatible planning, available on line at:
http://www.fhwa.dot.gov/environment/noise/noise_compatible_planning/

14.6 Constructability

NCDOT shall develop a comprehensive approach to traffic noise analysis and mitigation design that considers the constructability of recommended abatement measures. Solutions to project-specific constructability issues shall be explored to fulfill the assessed need for mitigation.

APPENDIX A

NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

TRAFFIC NOISE ABATEMENT POLICY

JULY 13, 2011

NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

TRAFFIC NOISE ABATEMENT POLICY

Effective Date: July 13, 2011

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Drew Joyner, PE…….Human Environment Unit
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INTRODUCTION

This document contains the North Carolina Department of Transportation (hereinafter NCDOT) policy on highway traffic noise and construction noise and describes the implementation of the requirements of the Federal Highway Administration (hereinafter FHWA) Noise Standard at 23 Code of Federal Regulations (CFR) Part 772 as they relate to federal and state funded highway construction in North Carolina. This policy was developed by the NCDOT and reviewed and approved by the FHWA.

The North Carolina Department of Transportation Traffic Noise Analysis and Abatement Guidance Manual and 23 CFR 772 are intended to be companion documents to this policy.

PURPOSE

This policy describes the NCDOT process that is used in determining traffic noise impacts and abatement measures and the equitable and cost-effective expenditure of public funds for traffic noise abatement. Where the FHWA has given highway agencies flexibility in implementing the 23 CFR 772 standards, this policy describes the NCDOT approach to implementation.

APPLICABILITY

This policy applies to all "Type I" federal, state or federal-aid highway projects in the State of North Carolina, including federal projects that are administered by local public agencies. NCDOT does not participate in nor fund Type II (retrofit) projects along existing state transportation facilities. Noise analyses are not required for Type III projects. Each of these project types are defined below. This policy shall be applied uniformly and consistently to all Type I federal projects throughout the state.

Type I Project

(a) The construction of a highway on new location; or,

(b) The physical alteration of an existing highway where there is either:
   (i) Substantial Horizontal Alteration. A project that halves the distance between the traffic noise source and the closest receptor between the existing condition to the future build condition; or,
   (ii) Substantial Vertical Alteration. A project that removes shielding, therefore exposing the line-of-sight between the receptor and the traffic noise source. This is done by either altering the vertical alignment of the highway or by altering the topography between the highway traffic noise source and the receptor; or,

(c) The addition of a through-traffic lane(s). This includes the addition of a through-traffic lane that functions as a HOV lane, High-Occupancy Toll (HOT) lane, bus lane, or truck climbing lane; or,

(d) The addition of an auxiliary lane, except for when the auxiliary lane is a turn lane; or,

(e) The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange; or,

(f) Restriping existing pavement for the purpose of adding a through-traffic lane or an auxiliary lane; or,

(g) The addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot or toll plaza.

(h) If a project is determined to be a Type I project under this definition then the entire project area as defined in the environmental document is a Type I project.

Type II Project.

A Federal or Federal-aid highway project for noise abatement on an existing highway. For a Type II project to be eligible for Federal-aid funding, the highway agency must develop and implement a Type II program in accordance with section 772.7(e).

Type III Project

A Federal or Federal-aid highway project that does not meet the classifications of a Type I or Type II project. Type III projects do not require a noise analysis.

The highway traffic noise prediction requirements, noise analyses, noise abatement criteria, and requirements for informing local officials in 23 CFR 772 and this policy constitute the noise standards mandated by 23 U.S.C. 109(1). All highway projects which are developed in conformance with this policy shall be deemed to be in accordance with the FHWA noise standards.

Projects let for construction on or after July 13, 2011 shall be reviewed under the criteria of this policy; however, the original date of public knowledge shall remain unchanged.

DATE OF PUBLIC KNOWLEDGE

The Date of Public Knowledge of the location and potential noise impacts of a proposed highway project is the approval date of the final environmental document, e.g., Categorical Exclusion (CE), State or Federal Finding of No Significant Impact (FONSI) or State or Federal Record of Decision (ROD).

After this date, the federal and state governments are no longer responsible for providing noise abatement measures for new development within the noise impact area of the proposed highway project. It is the responsibility of local governments and private landowners to ensure that noise-compatible designs are used for development permitted after the Date of Public Knowledge.

This policy applies only to developed land and to undeveloped land for which development is permitted before the project Date of Public Knowledge. The criteria (trigger date) for determining when undeveloped land is permitted for development is the approval date of a building permit for an individual lot or site.

TRAFFIC NOISE PREDICTION

All traffic noise analyses performed by or for NCDOT must utilize the most current version of the FHWA Traffic Noise Model (TNM®) or any other model determined by the FHWA to be consistent with the methodology of the TNM® model, pursuant to 23 CFR 772.9.

Average pavement type shall be used in the FHWA TNM® for future noise level prediction.

Noise contour lines may be used for project alternative screening or for land use planning, but shall not be used for determining highway traffic noise impacts.

Traffic characteristics that would yield the loudest hourly equivalent traffic noise levels for the design year shall be used in predicting noise levels and assessing noise impacts.

Traffic noise prediction must adhere to all methodologies detailed in the NCDOT Traffic Noise Analysis and Abatement Guidance Manual.

NOISE IMPACT DETERMINATION

Traffic noise abatement for NCDOT highway projects is warranted and must be considered when traffic noise impacts are created by either of the following two conditions:

(a) The predicted traffic noise levels for the Design Year approach (reach one decibel less than) or exceed the Noise Abatement Criteria (NAC) contained in 23 CFR 772 and in Table 1, found on page 4 of this policy, OR

(b) The predicted traffic noise levels for the Design Year substantially exceed existing noise levels as defined in Table 2, found on page 5 of this policy.

A receptor is a discrete or representative location of a noise sensitive area(s) for any of the land uses listed in Table 1. For multifamily dwellings, each residence shall be counted as one receptor when determining impacted and benefited receptors.

Primary consideration shall be given to exterior areas where frequent human use occurs in the determination of traffic noise impacts.

A traffic noise analysis shall be completed for each project alternative under detailed study and for each Activity Category listed in Table 1 that is present in the study area.

Table 1

Noise Abatement Criteria

Hourly Equivalent A-Weighted Sound Level (decibels (dB(A))

Activity Category	Activity Criteria[1] Leq(h)[2]	Evaluation Location	Activity Description
A	57	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B [3]	67	Exterior	Residential
C [3]	67	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, daycare centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section4(f) sites, schools, television studios, trails, and trail crossings
D	52	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios
E [3]	72	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F
F	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G	--	--	Undeveloped lands that are not permitted

[1] The Leq(h) Activity Criteria values are for impact determination only, and are not design standards for noise abatement measures.

[2] The equivalent steady-state sound level which in a stated period of time contains the same acoustic energy as the time-varying sound level during the same time period, with Leq(h) being the hourly value of Leq.

[3] Includes undeveloped lands permitted for this activity category.

Table 2	
Substantial Noise Level Increase Hourly Equivalent A-Weighted Sound Level (decibels (dB(A))	
Existing Noise Level[1] (Leq(h))	**Predicted Design Year Noise Level Increase[2] (Leq(h))**
50 or less	15 or more
51	14 or more
52	13 or more
53	12 or more
54	11 or more
55 or more	10 or more

[1] Loudest hourly equivalent noise level from the combination of natural and mechanical sources and human activity usually present in a particular area.
[2] Predicted hourly equivalent Design Year traffic noise level minus existing noise level.

ANALYSIS OF NOISE ABATEMENT MEASURES

When traffic noise impacts are identified and noise abatement is warranted, noise abatement measures shall be considered and evaluated for feasibility and reasonableness. All of the following conditions must be met in order for noise abatement to be justified and incorporated into project design, as applicable. Failure to achieve any single element of feasibility or reasonableness will result in the noise abatement measure being deemed not feasible or not reasonable, whichever applies.

Feasibility

The combination of acoustical and engineering factors considered in the evaluation of a noise abatement measure.

(a) Any receptor that receives a minimum noise level reduction of five dB(A) due to noise abatement measures shall be considered a benefited receptor. Noise reduction of five dB(A) must be achieved for at least one impacted receptor.

(b) Engineering feasibility of the noise abatement measure(s) shall consider adverse impacts created by or upon property access, drainage, topography, utilities, safety, and maintenance requirements.

Reasonableness

The combination of social, economic, and environmental factors considered in the evaluation of a noise abatement measure.

(b) Viewpoints of the property owners and residents of all benefited receptors shall be solicited. One owner ballot and one resident ballot shall be solicited for each benefited receptor. Points per ballot shall be distributed in the following weighted manner:

- 3 points/ballot for benefited front row property owners
- 1 point/ballot for all other benefited property owners
- 1 point/ballot vote for all residents

Consideration of the noise abatement measure will continue unless a simple majority of all distributed points are returned that indicates the balloted voters do not want the abatement measure.

(c) The maximum allowable base quantity of noise walls and/or earthen berms per benefited receptor shall not exceed 2,500 ft^2 and 7,000 yd^3, respectively. Additionally, an incremental increase of 35 ft^2 for noise walls and 100 yd^3 for earthen berms shall be added to the base quantity per the average increase in dB(A) between existing and predicted exterior noise levels of all impacted receptors within each noise sensitive area, which is defined as a group of receptors that are exposed to similar noise sources. A base dollar value of $37,500 plus an incremental increase of $525 (as defined above) shall be used to determine reasonableness of buffer zones and noise insulation.

(c) A noise reduction design goal of at least 7 dB(A) must be evaluated for all front row receptors. At least one benefited front row receptor must achieve the noise reduction design goal of 7 dB(A) to indicate the noise abatement measure effectively reduces traffic noise.

Other Considerations

Prior to CE approval or issuance of a FONSI or ROD, NCDOT shall identify in environmental documents:

(a) Noise abatement measures that are feasible and reasonable,

(c) Noise impacts for which no abatement appears to be feasible and reasonable;

(c) Locations where noise impacts will occur, where noise abatement is feasible and reasonable, and the locations that have no feasible and reasonable abatement.

(d) Whether it is “likely” or “unlikely” that noise abatement measures will be installed for each noise sensitive area identified. "Likely" does not mean a firm commitment. The final decision on the installation of the abatement measures shall be made upon completion of the project design, the public involvement process, concurrence with the NCDOT Policy, and FHWA approval.

Acceptable Noise Abatement Measures

The following noise abatement measures may be considered for incorporation into a project to reduce traffic noise impacts.

(a) Construction of noise barriers

(b) Traffic management measures

(c) Alteration of horizontal and vertical alignments

(d) Establishment of buffer zones

(e) Noise insulation of Activity Category D land use facilities listed in Table 1 on Page 4 of this policy.

Third Party Participation

(a) Third party funding of noise abatement measures cannot be used to make up the difference between the reasonable base quantity allowance and the actual quantity of noise abatement. Third party funding is allowed only by public entities, and can only be used to pay for additional features such as landscaping and aesthetic treatments for noise barriers that meet cost-effectiveness criteria.

(b) Traditional highway construction resources pay for required noise abatement measures. Should a local government request that materials be used that are more costly than those proposed by NCDOT, the requesting entity must assume 100% of the actual additional construction cost.

(c) If a local government insists on the provision of a noise abatement measure deemed not reasonable by NCDOT, an abatement measure may be installed provided the local government assumes 100% of the costs and obtains an encroachment permit from NCDOT to perform the work. These costs include, but are not limited to, preliminary engineering, actual construction and maintenance. In addition, local governments must ensure that NCDOT's material, design and construction specifications are met. The local government must also assume 100% of the liability associated with the measure and hold harmless the NCDOT.

(d) For (b) and (c) above, the settlement agreement shall be signed before third party noise abatement design begins and payment shall be made to NCDOT before project construction begins.

Quantity Averaging

NCDOT will utilize abatement measure quantity averaging among all noise sensitive areas within the same Activity Category in Table 1 that are exposed to a common noise environment, i.e., similar noise sources and levels, traffic volumes, traffic mix, speed and topographic features, if:

(a) No single common noise environment exceeds two times the base quantity reasonableness criteria (2500 sf); and,

(b) Collectively, all common noise environments being averaged do not exceed the base quantity reasonableness criteria.

PUBLIC INVOLVEMENT

Communication with the community regarding noise impacts and possible noise abatement shall occur at the start of the noise study process and continue throughout the development of the project. NCDOT will communicate with citizens to present information on the nature of highway traffic noise and discuss the effects of noise abatement measures in attenuating traffic noise and the types of noise abatement measures that may be considered. The concerns of the community shall be a major consideration in reaching a decision on the abatement measures to be provided.

COORDINATION WITH LOCAL OFFICIALS

NCDOT will provide all traffic noise analyses to local government officials within whose jurisdiction a highway project is proposed as early in the project planning process as possible to protect future development from becoming incompatible with traffic noise levels. Specifically, environmental documents and design noise reports will contain information identifying areas that may be impacted by traffic noise, predicted noise level contour information, the best estimation of future noise levels for developed and undeveloped lands or properties in the immediate vicinity of the project and other appropriate design information. If requested, NCDOT will assist local officials with coordination and distribution of this information to residents, property owners and developers. NCDOT will provide assistance to local jurisdictions in the development of local noise controls, when requested. NCDOT will advocate the planning, design and construction of noise-compatible development and encourage its practice among planners, building officials, developers and others.

All noise-sensitive areas and any known noise abatement measures will be presented and discussed at the Design Public Hearing and Design Public Meetings.

CONSTRUCTION NOISE

To minimize the impacts of construction noise on the public, NCDOT shall:

(a) Identify land uses or activities that may be affected by noise from construction of the project.

(b) Determine the measures that are needed in the plans and specifications to minimize or eliminate adverse construction noise impacts to the community. This determination shall consider the benefits achieved and the overall adverse social, economic, and environmental effects and costs of the abatement measures.

(c) Consider construction techniques and scheduling to reduce construction noise impacts to nearby receptors and incorporate the needed abatement measures in the project plans and specifications.

FEDERAL PARTICIPATION

The costs of noise abatement measures may be included in federal-aid participating project costs with the federal share being the same as that for the system on which the project is located when:

(a) Traffic noise impacts have been identified; and

(b) Abatement measures have been determined to be feasible and reasonable pursuant to 23 CFR 772 and this policy.

REVIEW OF POLICY

This policy shall be reviewed by the NCDOT Board of Transportation at least every five years.

APPENDIX B

TITLE 23

CODE OF FEDERAL REGULATIONS

PART 772

PROCEDURES FOR ABATEMENT OF HIGHWAY TRAFFIC NOISE AND CONSTRUCTION NOISE

JULY 13, 2011

PART 772-PROCEDURES FOR ABATEMENT OF HIGHWAY TRAFFIC NOISE AND CONSTRUCTION NOISE

Sec.

Authority: 23 U.S.C. 109(h) and (i); 42 U.S.C. 4331, 4332; sec. 339(b), Pub. L. 104-59, 109 Stat. 568, 605; 49 CFR 1.48(b).

§ 772.1 Purpose.

To provide procedures for noise studies and noise abatement measures to help protect the public's health, welfare and livability, to supply noise abatement criteria, and to establish requirements for information to be given to local officials for use in the planning and design of highways approved pursuant to title 23 U.S.C.

§ 772.3 Noise Standards.

The highway traffic noise prediction requirements, noise analyses, noise abatement criteria, and requirements for informing local officials in this regulation constitute the noise standards mandated by 23 U.S.C. 109(1). All highway projects which are developed in conformance with this regulation shall be deemed to be in accordance with the FHWA noise standards.

§ 772.5 Definitions.

Benefited Receptor. The recipient of an abatement measure that receives a noise reduction at or above the minimum threshold of 5 dB(A), but not to exceed the highway agency's reasonableness design goal.

Common Noise Environment. A group of receptors within the same Activity Category in Table 1 that are exposed to similar noise sources and levels; traffic volumes, traffic mix, and speed; and topographic features. Generally, common noise environments occur between two secondary noise sources, such as interchanges, intersections, cross-roads.

Date of Public Knowledge. The date of approval of the Categorical Exclusion (CE), the Finding of No Significant Impact (FONSI), or the Record of Decision (ROD), as defined in 23 CFR 771.

Design Year. The future year used to estimate the probable traffic volume for which a highway is designed.

Existing Noise Levels. The worst noise hour resulting from the combination of natural and mechanical sources and human activity usually present in a particular area.

Feasibility. The combination of acoustical and engineering factors considered in the evaluation of a noise abatement measure.

Impacted Receptor. The recipient that has a traffic noise impact.
L10. The sound level that is exceeded 10 percent of the time (the 90th percentile) for the period under consideration, with L10(h) being the hourly value of L10.

Leq. The equivalent steady-state sound level which in a stated period of time contains the same acoustic energy as the time-varying sound level during the same time period, with Leq(h) being the hourly value of Leq.

Multifamily Dwelling. A residential structure containing more than one residence. Each residence in a multifamily dwelling shall be counted as one receptor when determining impacted and benefited receptors.

Noise Barrier. A physical obstruction that is constructed between the highway noise source and the noise sensitive receptor(s) that lowers the noise level, including stand alone noise walls, noise berms (earth or other material), and combination berm/wall systems.

Noise Reduction Design Goal. The optimum desired dB(A) noise reduction determined from calculating the difference between future build noise levels with abatement, to future build noise levels without abatement. The noise reduction design goal shall be at least 7 dB(A), but not more than 10 dB(A).

Permitted. A definite commitment to develop land with an approved specific design of land use activities as evidenced by the issuance of a building permit.

Property Owner. An individual or group of individuals that holds a title, deed, or other legal documentation of ownership of a property or a residence.

Reasonableness. The combination of social, economic, and environmental factors considered in the evaluation of a noise abatement measure.

Receptor. A discrete or representative location of a noise sensitive area(s), for any of the land uses listed in Table 1.

Residence. A dwelling unit. Either a single family residence or each dwelling unit in a multifamily dwelling.

Statement of Likelihood. A statement provided in the environmental clearance document based on the feasibility and reasonableness analysis completed at the time the environmental document is being approved.
Substantial Construction. The granting of a building permit, prior to right-of-way acquisition or construction approval for the highway.

Substantial noise increase. One of two types of highway traffic noise impacts. For a Type I project, an increase in noise levels of 5 to 15 dB(A) in the design year over the existing noise level.

Traffic Noise Impacts. Design year build condition noise levels that approach or exceed the NAC listed in Table 1 for the future build condition; or design year build condition noise levels that create a substantial noise increase over existing noise levels.

Type I Project.
(1) The construction of a highway on new location; or,
(2) The physical alteration of an existing highway where there is either:

(i) Substantial Horizontal Alteration. A project that halves the distance between the traffic noise source and the closest receptor between the existing condition to the future build condition; or,

(ii) Substantial Vertical Alteration. A project that removes shielding therefore exposing the line-of-sight between the receptor and the traffic noise source. This is done by either altering the vertical alignment of the highway or by altering the topography between the highway traffic noise source and the receptor; or,

(3) The addition of a through-traffic lane(s). This includes the addition of a through-traffic lane that functions as a HOV lane, High-Occupancy Toll (HOT) lane, bus lane, or truck climbing lane; or,
(4) The addition of an auxiliary lane, except for when the auxiliary lane is a turn lane; or,
(5) The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange; or,
(6) Restriping existing pavement for the purpose of adding a through-traffic lane or an auxiliary lane; or,
(7) The addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot or toll plaza.
(8) If a project is determined to be a Type I project under this definition then the entire project area as defined in the environmental document is a Type I project.

Type II Project. A Federal or Federal-aid highway project for noise abatement on an existing highway. For a Type II project to be eligible for Federal-aid funding, the highway agency must develop and implement a Type II program in accordance with section 772.7(e).

Type III Project. A Federal or Federal-aid highway project that does not meet the classifications of a Type I or Type II project. Type III projects do not require a noise analysis.

§ 772.7 Applicability.
(a) This regulation applies to all Federal or Federal-aid Highway Projects authorized under title 23, United States Code. Therefore, this regulation applies to any highway project or multimodal project that:

(1) Requires FHWA approval regardless of funding sources, or
(2) Is funded with Federal-aid highway funds.

(b) In order to obtain FHWA approval, the highway agency shall develop noise policies in conformance with this regulation and shall apply these policies uniformly and consistently statewide.
(c) This regulation applies to all Type I projects unless the regulation specifically indicates that a section only applies to Type II or Type III projects.
(d) The development and implementation of Type II projects are not mandatory requirements of section 109(i) of title 23, United States Code.

(e) If a highway agency chooses to participate in a Type II program, the highway agency shall develop a priority system, based on a variety of factors, to rank the projects in the program. This priority system shall be submitted to and approved by FHWA before the highway agency is allowed to use Federal-aid funds for a project in the program. The highway agency shall re-analyze the priority system on a regular interval, not to exceed 5 years.
(f) For a Type III project, a highway agency is not required to complete a noise analysis or consider abatement measures.

§ 772.9 Traffic noise prediction.
(a) Any analysis required by this subpart must use the FHWA Traffic Noise Model (TNM), which is described in "FHWA Traffic Noise Model" Report No. FHWA–PD–96–010, including Revision No. 1, dated April 14, 2004, or any other model determined by the FHWA to be consistent with the methodology of the FHWA TNM. These publications are incorporated by reference in accordance with section 552(a) of title 5, U.S.C. and part 51 of title 1, CFR, and are on file at the National Archives and Record Administration (NARA). For information on the availability of this material at NARA, call (202) 741–6030 or go to http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html. These documents are available for copying and inspection at the Federal Highway Administration, 1200 New Jersey Avenue, SE, Washington, DC 20590, as provided in part 7 of title 49, CFR. These documents are also available on the FHWA's Traffic Noise Model Web site at the following URL: http://www.fhwa.dot.gov/environment/noise/index.htm.
(b) Average pavement type shall be used in the FHWA TNM for future noise level prediction unless a highway agency substantiates the use of a different pavement type for approval by the FHWA.
(c) Noise contour lines may be used for project alternative screening or for land use planning to comply with § 772.17, but shall not be used for determining highway traffic noise impacts.
(d) In predicting noise levels and assessing noise impacts, traffic characteristics that would yield the worst traffic noise impact for the design year shall be used.

§ 772.11 Analysis of traffic noise impacts.
(a) The highway agency shall determine and analyze expected traffic noise impacts.
(1) For projects on new alignments, determine traffic noise impacts by field measurements.
(2) For projects on existing alignments, predict existing and design year traffic noise impacts.
(b) In determining traffic noise impacts, a highway agency shall give primary consideration to exterior areas where frequent human use occurs
(c) A traffic noise analysis shall be completed for:
(1) Each alternative under detailed study;
(2) Each Activity Category of the NAC listed in Table 1 that is present in the study area;
(i) Activity Category A. This activity category includes the exterior impact criteria for lands on which serenity and quiet are of extraordinary significance and serve an important public need, and where the preservation of those qualities is essential for the area to continue to serve its intended purpose. Highway agencies shall submit justifications to the FHWA on a case-by-case basis for approval of an Activity Category A designation.
(ii) Activity Category B. This activity category includes the exterior impact criteria for single-family and multifamily residences.
(iii) Activity Category C. This activity category includes the exterior impact criteria for a variety of land use facilities. Each highway agency shall adopt a standard

practice for analyzing these land use facilities that is consistent and uniformly applied statewide.

(iv) Activity Category D. This activity category includes the interior impact criteria for certain land use facilities listed in Activity Category C that may have interior uses. A highway agency shall conduct an indoor analysis after a determination is made that exterior abatement measures will not be feasible and reasonable. An indoor analysis shall only be done after exhausting all outdoor analysis options. In situations where no exterior activities are to be affected by the traffic noise, or where the exterior activities are far from or physically shielded from the roadway in a manner that prevents an impact on exterior activities, the highway agency shall use Activity Category D as the basis of determining noise impacts. Each highway agency shall adopt a standard practice for analyzing these land use facilities that is consistent and uniformly applied statewide.

(v) Activity Category E. This activity category includes the exterior impact criteria for developed lands that are less sensitive to highway noise. Each highway agency shall adopt a standard practice for analyzing these land use facilities that is consistent and uniformly applied statewide.

(vi) Activity Category F. This activity category includes developed lands that are not sensitive to highway traffic noise. There is no impact criteria for the land use facilities in this activity category and no analysis of noise impacts is required.

(vii) Activity Category G. This activity includes undeveloped lands.

(A) A highway agency shall determine if undeveloped land is permitted for development. The milestone and its associated date for acknowledging when undeveloped land is considered permitted shall be the date of issuance of a building permit by the local jurisdiction or by the appropriate governing entity.

(B) If undeveloped land is determined to be permitted, then the highway agency shall assign the land to the appropriate Activity Category and analyze it in the same manner as developed lands in that Activity Category.

(C) If undeveloped land is not permitted for development by the date of public knowledge, the highway agency shall determine noise levels in accordance with 772.17(a) and document the results in the project's environmental clearance documents and noise analysis documents. Federal participation in noise abatement measures will not be considered for lands that are not permitted by the date of public knowledge.

(d) The analysis of traffic noise impacts shall include:

(1) Identification of existing activities, developed lands, and undeveloped lands, which may be affected by noise from the highway;

(2) For projects on new or existing alignments, validate predicted noise level through comparison between measured and predicted levels;

(3) Measurement of noise levels. Use an ANSI Type I or Type II integrating sound level meter;

(4) Identification of project limits to determine all traffic noise impacts for the design year for the build alternative. For Type II projects, traffic noise impacts shall be determined from current year conditions;

(e) Highway agencies shall establish an approach level to be used when determining a traffic noise impact. The approach level shall be at least 1 dB(A) less than the Noise Abatement Criteria for Activity Categories A to E listed in Table 1;

(f) Highway agencies shall define substantial noise increase between 5 dB(A) to 15 dB(A) over existing noise levels. The substantial noise increase criterion is independent of the absolute noise level.
(g) A highway agency proposing to use Federal-aid highway funds for a Type II project shall perform a noise analysis in accordance with §772.11 of this part in order to provide information needed to make the determination required by §772.13(a) of this part.

§ 772.13 Analysis of noise abatement.
(a) When traffic noise impacts are identified, noise abatement shall be considered and evaluated for feasibility and reasonableness. The highway agency shall determine and analyze alternative noise abatement measures to abate identified impacts by giving weight to the benefits and costs of abatement and the overall social, economic, and environmental effects by using feasible and reasonable noise abatement measures for decision-making.
(b) In abating traffic noise impacts, a highway agency shall give primary consideration to exterior areas where frequent human use occurs.
(c) If a noise impact is identified, a highway agency shall consider abatement measures. The abatement measures listed in §772.15(c) of this chapter are eligible for Federal funding.

(1) At a minimum, the highway agency shall consider noise abatement in the form of a noise barrier.

(2) If a highway agency chooses to use absorptive treatments as a functional enhancement, the highway agency shall adopt a standard practice for using absorptive treatment that is consistent and uniformly applied statewide.

(d) Examination and evaluation of feasible and reasonable noise abatement measures for reducing the traffic noise impacts. Each highway agency, with FHWA approval, shall develop feasibility and reasonableness factors.

(1) Feasibility:

(i) Achievement of at least a 5 dB(A) highway traffic noise reduction at impacted receptors. The highway agency shall define, and receive FHWA approval for, the number of receptors that must achieve this reduction for the noise abatement measure to be acoustically feasible and explain the basis for this determination; and

(ii) Determination that it is possible to design and construct the noise abatement measure. Factors to consider are safety, barrier height, topography, drainage, utilities, and maintenance of the abatement measure, maintenance access to adjacent properties, and access to adjacent properties (i.e. arterial widening projects).

(2) Reasonableness:

(i) Consideration of the viewpoints of the property owners and residents of the benefited receptors. The highway agency shall solicit the viewpoints of all of the benefited receptors and obtain enough responses to document a decision on either desiring or not desiring the noise abatement measure. The highway agency shall define, and receive FHWA approval for, the number of receptors that are needed to constitute a decision and explain the basis for this determination.

(ii) Cost effectiveness of the highway traffic noise abatement measures. Each highway agency shall determine, and receive FHWA approval for, the allowable cost of abatement by determining a baseline cost reasonableness value. This determination may include the actual construction cost of noise abatement, cost per square foot of abatement, the maximum square footage of abatement/benefited receptor and either the cost/benefited receptor or cost/benefited receptor/dB(A) reduction. The highway agency shall re-analyze the allowable cost for abatement on a regular interval, not to exceed 5 years. A highway agency has the option of justifying, for FHWA approval,

different cost allowances for a particular geographic area(s) within the State, however, the highway agency must use the same cost reasonableness/construction cost ratio statewide.

(iii) Noise reduction design goals for highway traffic noise abatement measures. When noise abatement measure(s) are being considered, a highway agency shall achieve a noise reduction design goal. The highway agency shall define, and receive FHWA approval for, the design goal of at least 7 dB(A) but not more than 10 dB(A), and shall define the number of benefited receptors that must achieve this design goal and explain the basis for this determination.

(iv) The reasonableness factors listed in §772.13(d)(5)(i), (ii) and (iii), must collectively be achieved in order for a noise abatement measure to be deemed reasonable. Failure to achieve §772.13(d)(5)(i), (ii) or (iii), will result in the noise abatement measure being deemed not reasonable.

(v) In addition to the required reasonableness factors listed in §§772.13(d)(5)(i), (ii) and (iii), a highway agency has the option to also include the following reasonableness factors: date of development, length of time receivers have been exposed to highway traffic noise impacts, exposure to higher absolute highway traffic noise levels, changes between existing and future build conditions, percentage of mixed zoning development, and use of noise compatible planning concepts by the local government. No single optional reasonableness factor can be used to determine reasonableness.

(e) Assessment of Benefited Receptors. Each highway agency shall define the threshold for the noise reduction which determines a benefited receptor as at or above the 5 dB(A), but not to exceed the highway agency's reasonableness design goal.

(f) Abatement Measure Reporting: Each highway agency shall maintain an inventory of all constructed noise abatement measures. The inventory shall include the following parameters: type of abatement; cost (overall cost, unit cost per/sq. ft.); average height; length; area; location (State, county, city, route); year of construction; average insertion loss/noise reduction as reported by the model in the noise analysis; NAC category(s) protected; material(s) used (precast concrete, berm, block, cast in place concrete, brick, metal, wood, fiberglass, combination, plastic (transparent, opaque, other); features (absorptive, reflective, surface texture); foundation (ground mounted, on structure); project type (Type I, Type II, and optional project types such as State funded, county funded, tollway/turnpike funded, other, unknown). The FHWA will collect this information, in accordance with OMB's Information Collection requirements.

(g) Before adoption of a CE, FONSI, or ROD, the highway agency shall identify:

(1) Noise abatement measures which are feasible and reasonable, and which are likely to be incorporated in the project; and

(2) Noise impacts for which no noise abatement measures are feasible and reasonable.

(3) Documentation of highway traffic noise abatement: The environmental document shall identify locations where noise impacts are predicted to occur, where noise abatement is feasible and reasonable, and locations with impacts that have no feasible or reasonable noise abatement alternative. For environmental clearance, this analysis shall be completed to the extent that design information on the alterative(s) under study in the environmental document is available at the time the environmental clearance document is completed. A statement of likelihood shall be included in the environmental document since feasibility and reasonableness determinations may change due to changes in project design after approval of the environmental document. The statement of likelihood shall include the preliminary location and physical description of noise abatement measures determined feasible and reasonable in the preliminary analysis. The statement of likelihood shall also indicate that

final recommendations on the construction of an abatement measure(s) is determined during the completion of the project's final design and the public involvement processes.

(h) The FHWA will not approve project plans and specifications unless feasible and reasonable noise abatement measures are incorporated into the plans and specifications to reduce the noise impact on existing activities, developed lands, or undeveloped lands for which development is permitted.

(i) For design-build projects, the preliminary technical noise study shall document all considered and proposed noise abatement measures for inclusion in the NEPA document. Final design of design-build noise abatement measures shall be based on the preliminary noise abatement design developed in the technical noise analysis. Noise abatement measures shall be considered, developed, and constructed in accordance with this standard and in conformance with the provisions of 40 CFR 1506.5(c) and 23 CFR 636.109.

(j) Third party funding is not allowed on a Federal or Federal-aid Type I or Type II project if the noise abatement measure would require the additional funding from the third party to be considered feasible and/or reasonable. Third party funding is acceptable on a Federal or Federal-aid highway Type I or Type II project to make functional enhancements, such as absorptive treatment and access doors or aesthetic enhancements, to a noise abatement measure already determined feasible and reasonable.

(k) On a Type I or Type II projects, a highway agency has the option to cost average noise abatement among benefited receptors within common noise environments if no single common noise environment exceeds two times the highway agency's cost reasonableness criteria and collectively all common noise environments being averaged do not exceed the highway agency's cost reasonableness criteria.

§ 772.15 Federal participation.

(a) Type I and Type II projects. Federal funds may be used for noise abatement measures when:

(1) Traffic noise impacts have been identified; and

(2) Abatement measures have been determined to be feasible and reasonable pursuant to §772.13(d) of this chapter.

(b) For Type II projects.

(1) No funds made available out of the Highway Trust Fund may be used to construct Type II noise barriers, as defined by this regulation, if such noise barriers were not part of a project approved by the FHWA before the November 28, 1995.

(2) Federal funds are available for Type II noise barriers along lands that were developed or were under substantial construction before approval of the acquisition of the rights-of-ways for, or construction of, the existing highway.

(3) FHWA will not approve noise abatement measures for locations where such measures were previously determined not to be feasible and reasonable for a Type I project.

(c) Noise Abatement Measures. The following noise abatement measures may be considered for incorporation into a Type I or Type II project to reduce traffic noise impacts. The costs of such measures may be included in Federal-aid participating project costs with the Federal share being the same as that for the system on which the project is located.

(1) Construction of noise barriers, including acquisition of property rights, either within or outside the highway right-of-way. Landscaping is not a viable noise abatement measure.

(2) Traffic management measures including, but not limited to, traffic control devices and signing for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, modified speed limits, and exclusive lane designations.

(3) Alteration of horizontal and vertical alignments.

(4) Acquisition of real property or interests therein (predominantly unimproved property) to serve as a buffer zone to preempt development which would be adversely impacted by traffic noise. This measure may be included in Type I projects only.
(5) Noise insulation of Activity Category D land use facilities listed in Table 1. Post-installation maintenance and operational costs for noise insulation are not eligible for Federal-aid funding.

§ 772.17 Information for local officials.

(a) To minimize future traffic noise impacts on currently undeveloped lands of Type I projects, a highway agency shall inform local officials within whose jurisdiction the highway project is located of:

(1) Noise compatible planning concepts;
(2) The best estimation of the future design year noise levels at various distances from the edge of the nearest travel lane of the highway improvement where the future noise levels meet the highway agency's definition of "approach" for undeveloped lands or properties within the project limits. At a minimum, identify the distance to the exterior noise abatement criteria in Table 1;
(3) Non-eligibility for Federal-aid participation for a Type II project as described in §772.15(b).

(b) If a highway agency chooses to participate in a Type II noise program or to use the date of development as one of the factors in determining the reasonableness of a Type I noise abatement measure, the highway agency shall have a statewide outreach program to inform local officials and the public of the items in §772.17(a)(1)-(3).

§772.19 Construction noise.

For all Type I and II projects, a highway agency shall:
(a) Identify land uses or activities that may be affected by noise from construction of the project. The identification is to be performed during the project development studies.
(b)Determine the measures that are needed in the plans and specifications to minimize or eliminate adverse construction noise impacts to the community. This determination shall include a weighing of the benefits achieved and the overall adverse social, economic, and environmental effects and costs of the abatement measures.
(c) Incorporate the needed abatement measures in the plans and specifications.

Table 1 to Part 772—Noise Abatement Criteria

Hourly A-Weighted Sound Level (decibels (dB(A))[1]

Activity Category	Activity Criteria[2] Leq(h)	L10(h)	Evaluation Location	Activity Description
A	57	60	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[3]	67	70	Exterior	Residential
C[3]	67	70	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, daycare centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreation areas, Section4(f) sites, schools, television studios, trails, and trail crossings
D	52	55	Interior	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios
E[3]	72	75	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F
F	-	-	-	Agriculture, airports, bus yards, emergency services, industrial, logging maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G	-	-	-	Undeveloped lands that are not permitted

[1] Either Leq(h) or L10(h) (but not both) may be used on a project.
[2] The Leq(h) or L10(h) Activity Criteria values are for impact determination only, and are not design standards for noise abatement measures.
[3] Includes undeveloped lands permitted for this activity category

APPENDIX C

NCDOT

SOUND BARRIER

FEASIBILITY AND REASONABLENESS

WORKSHEET

NCDOT SOUND BARRIER
FEASIBILITY and REASONABLENESS
WORKSHEET

PROJECT - _____ TIP # - _____

LOCATION - _____ COUNTY(IES) - _____

IMPACTS - _____ # BENEFITS - _____ NAC: (CIRCLE ALL THAT APPLY) A B C D E F G

A. FEASIBILITY:

1 Can a 5-dB(A) reduction in traffic noise levels be achieved for at least one impacted receptor? _____ YES _____ NO

2 Does topography negatively affect the proposed abatement measure? _____ YES _____ NO

3 Does the abatement measure negatively affect property access, drainage, safety and maintenance requirements? _____ YES _____ NO

4 Is there control of access in the vicinity of the proposed abatement measure? _____ YES _____ NO

B. REASONABLENESS:

1 Can a 7-dB(A) reduction in traffic noise levels be achieved for at least one impacted front row receptor? _____ YES _____ NO

2 Is the design criteria per benefited receptor of _____ (CIRCLE ONE) sq.ft./cu.yd less than the maximum allowable design criteria per benefited receptor of _____ YES _____ NO _____ (CIRCLE ONE) sq.ft. / cu.yd.?

C. NOISE ABATEMENT DECISION:

1 Is the noise mitigation feasible? _____ YES _____ NO

2 Is the noise mitigation reasonable? _____ YES _____ NO

3 Is the noise mitigation likely? _____ YES _____ NO

4 Have the owners' and residents' viewpoints been solicited? _____ YES _____ NO

5 Is the noise mitigation recommended for construction? _____ YES _____ NO

D. OPTIONAL REASONABLENESS CONSIDERATION:

1 Was optional averaging noise abatement allowance within a common noise environment used for consideration of barrier reasonableness? _____ YES _____ NO

2 If the answer to D.1 is YES, the design criteria per benefited receptor for each individual barrier within the common noise environment before averaging are:

Bar No. _____ _____ (CIRCLE ONE) sq.ft./cu.yd Bar No. _____ _____ (CIRCLE ONE) sq.ft./cu.yd

Bar No. _____ _____ sq.ft./cu.yd Bar No. _____ _____ sq.ft./cu.yd

3 If the answer to D.1 is YES, is the design criteria per benefited receptor for each individual barrier less than or equal to twice the maximum allowable design criteria per benefited receptor of _____ (CIRCLE ONE) sq.ft./cu.yd _____ YES _____ NO

Form Completed By: _____ Date: _____

In Consultation With: _____ Date: _____

APPENDIX D

TITLE 23

CODE OF FEDERAL REGULATIONS

PART 771.117

CATEGORICAL EXCLUSIONS

§771.117 Categorical exclusions

a. Categorical exclusions (CEs) are actions which meet the definition contained in 40 CFR 1508.4, and, based on past experience with similar actions, do not involve significnt environmental impacts. They are actions which: do not induce significant impacts to planned growth or land use for the area; do not require the relocation of significant numbers of people; do not have a significant impact on any natural, cultural, recreational, historic or other resource; do not involve significant air, noise, or water quality impacts; do not have significant impacts on travel patterns; or do not otherwise, either individually or cumulatively, have any significant environmental impacts.

b. Any action which normally would be classified as a CE but could involve unusual circumstances will require the Administration, in cooperation with the applicant, to conduct appropriate environmental studies to determine if the CE classification is proper. Such unusual circumstances include:

    1. Significant environmental impacts;
    2. Substantial controversy on environmental grounds;
    3. Significant impact on properties protected by section 4(f) of the DOT Act or section 106 of the National Historic Preservation Act; or
    4. Inconsistencies with any Federal, State, or local law, requirement or administrative determination relating to the environmental aspects of the action.

c. The following actions meet the criteria for CEs in the CEQ regulation (section 1508.4) and §771.117(a) of this regulation and normally do not require any further NEPA approvals by the Administration:

    1. Activities which do not involve or lead directly to construction, such as planning and technical studies; grants for training and research programs; research activities as defined in 23 U.S.C. 307; approval of a unified work program and any findings required in the planning process pursuant to 23 U.S.C. 134; approval of statewide programs under 23 CFR part 630; approval of project concepts under 23 CFR part 476; engineering to define the elements of a proposed action or alternatives so that social, economic, and environmental effects can be assessed; and Federal-aid system revisions which establish classes of highways on the Federal-aid highway system.
    2. Approval of utility installations along or across a transportation facility.
    3. Construction of bicycle and pedestrian lanes, paths, and facilities.
    4. Activities included in the State's *highway safety plan* under 23 U.S.C. 402.
    5. Transfer of Federal lands pursuant to 23 U.S.C. 317 when the subsequent action is not an FHWA action.
    6. The installation of noise barriers or alterations to existing publicly owned buildings to provide for noise reduction.
    7. Landscaping.

8. Installation of fencing, signs, pavement markings, small passenger shelters, traffic signals, and railroad warning devices where no substantial land acquisition or traffic disruption will occur.
9. Emergency repairs under 23 U.S.C. 125.
10. Acquisition of scenic easements.
11. Determination of payback under 23 CFR part 480 for property previously acquired with Federal-aid participation.
12. Improvements to existing rest areas and truck weigh stations.
13. Ridesharing activities.
14. Bus and rail car rehabilitation.
15. Alterations to facilities or vehicles in order to make them accessible for elderly and handicapped persons.
16. Program administration, technical assistance activities, and operating assistance to transit authorities to continue existing service or increase service to meet routine changes in demand.
17. The purchase of vehicles by the applicant where the use of these vehicles can be accommodated by existing facilities or by new facilities which themselves are within a CE.
18. Track and railbed maintenance and improvements when carried out within the existing right-of-way.
19. Purchase and installation of operating or maintenance equipment to be located within the transit facility and with no significant impacts off the site.
20. Promulgation of rules, regulations, and directives.

d. Additional actions which meet the criteria for a CE in the CEQ regulations (40 CFR 1508.4) and paragraph (a) of this section may be designated as CEs only after Administration approval. The applicant shall submit documentation which demonstrates that the specific conditions or criteria for these CEs are satisfied and that significant environmental effects will not result. Examples of such actions include but are not limited to:

1. Modernization of a highway by resurfacing, restoration, rehabilitation, reconstruction, adding shoulders, or adding auxiliary lanes (e.g., parking, weaving, turning, climbing).
2. Highway safety or traffic operations improvement projects including the installation of ramp metering control devices and lighting.
3. Bridge rehabilitation, reconstruction or replacement or the construction of grade separation to replace existing at-grade railroad crossings.
4. Transportation corridor fringe parking facilities.
5. Construction of new truck weigh stations or rest areas.
6. Approvals for disposal of excess right-of-way or for joint or limited use of right-of-way, where the proposed use does not have significant adverse impacts.
7. Approvals for changes in access control.
8. Construction of new bus storage and maintenance facilities in areas used predominantly for industrial or transportation purposes where such construction is

not inconsistent with existing zoning and located on or near a street with adequate capacity to handle anticipated bus and support vehicle traffic.

9. Rehabilitation or reconstruction of existing rail and bus buildings and ancillary facilities where only minor amounts of additional land are required and there is not a substantial increase in the number of users.
10. Construction of bus transfer facilities (an open area consisting of passenger shelters, boarding areas, kiosks and related street improvements) when located in a commercial area or other high activity center in which there is adequate street capacity for projected bus traffic.
11. Construction of rail storage and maintenance facilities in areas used predominantly for industrial or transportation purposes where such construction is not inconsistent with existing zoning and where there is no significant noise impact on the surrounding community.
12. Acquisition of land for hardship or protective purposes; advance land acquisition loans under section 3(b) of the UMT Act. [3] Hardship and protective buying will be permitted only for a particular parcel or a limited number of parcels. These types of land acquisition quality for a CE only where the acquisition will not limit the evaluation of alternatives, including shifts in alignment for planned construction projects, which may be required in the NEPA process. No project development on such land may proceed until the NEPA process has been completed.

[3]Hardship acquisition is early acquisition of property by the applicant at the property owner's request to alleviate particular hardship to the owner, in contrast to others, because of an inability to sell his property. This is justified when the property owner can document on the basis of health, safety or financial reasons that remaining in the property poses an undue hardship compared to others.

Protective acquisition is done to prevent imminent development of a parcel which is needed for a proposed transportation corridor or site. Documentation must clearly demonstrate that development of the land would preclude future transportation use and that such development is imminent. Advance acquisition is not permitted for the sole purpose of reducing the cost of property for a proposed project.

e. Where a pattern emerges of granting CE status for a particular type of action, the Administration will initiate rulemaking proposing to add this type of action to the list of categorical exclusions in paragraph (c) or (d) of this section, as appropriate.

[52 FR 32660, Aug. 28, 1987; 53 FR 11066, Apr. 5, 1988]