New Hampshire DOT Department of Transportation

Noise Barrier Programs

How Does NHDOT Address Highway Traffic Noise?

Noise can be a concern for residents living near highways across New Hampshire. This document is intended to inform local officials and the public about highway noise, the responsibilities of the New Hampshire Department of Transportation (NHDOT), and the measures that municipalities can take to reduce traffic noise in their communities. Reducing highway traffic noise is a shared responsibility between Federal, State and Local governments. The Federal Highway Administration (FHWA) and the NHDOT encourage local governments to practice noise-compatible land use planning near highways.

Noise Compatible Planning eliminates or reduces the undesirable effects of highway traffic noise by encouraging thoughtful consideration of the relationship between land use and highways. Municipalities have the authority to regulate land development by either prohibiting the development of noise-sensitive land uses adjacent to highways or establishing requirements for developers to plan, design, and construct developments using methods that minimize noise impacts.

Noise Compatible Planning eliminates or reduces the undesirable effects of highway traffic noise

Local zoning and siting boards can control the development of new land uses adjacent to highways including the type, location, orientation, layout, and density of developments. Each of these tools can greatly minimize the impacts of highway traffic noise, as described in detail in this document. Planning developments effectively for noise can improve the quality of life for the citizens of New Hampshire.

The **NHDOT Highway Traffic Noise Policy** describes the Department's approach to implementing FHWA regulations for reducing the effects of highway noise in communities. The policy addresses noise abatement as part of **Type I** highway improvement projects and the recently introduced **Type II Noise Barrier Program** which provides the opportunity for abatement to be considered for communities adjacent to existing highways where no highway improvements are programmed.

Together, the implementation of noise compatible planning by municipalities and the Department's Type I and Type II Noise Policies can minimize the effects of highway noise in New Hampshire.

This document includes the following information related to highway noise:

- Highway Noise Concepts
- Overview of NHDOT Highway Noise Policies
- Noise Abatement Criteria and Assessments
- Type II Program Municipal Requirements
- Highway Noise Levels and Distance to Impact
- Noise-Compatibility Planning Approaches

Highway Noise Concepts

Noise is defined as unwanted sound. The ability for humans to hear different sounds depends on their frequency (whether a sound is low or high pitched). To account for this, environmental sounds are measured as A-weighted sound level decibels (denoted "dBA") which applies a weighting that is based on human hearing.

Highway noise levels fluctuate from moment to moment. Highway noise is evaluated according to the equivalent hourly sound level (Leq), which is a single value that represents the same acoustic energy as the time-varying noise level over an hour.

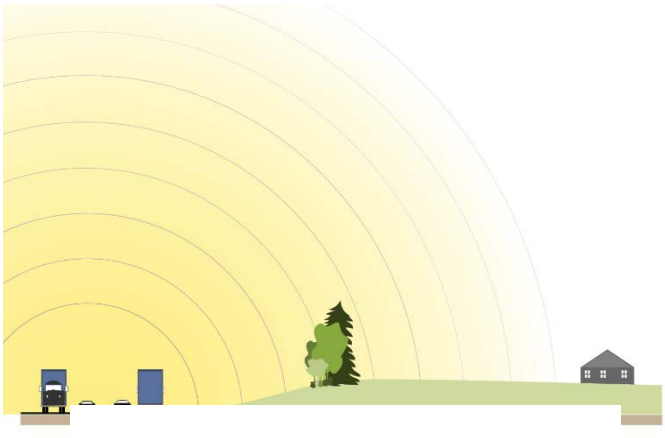
Typical sound levels that people experience range from about 20 to 100 dBA. For example, quiet rural areas at night may be as quiet as 25 dBA while urban areas during the day can reach 80 dBA.

Outdoor Sound Levels	Sound Level dB(A)	Indoor Sound Levels
	110	Rock Band at 5 m
Jet Over Flight at 300 m	105	
	100	Inside New York Subway Train
Gas Lawn Mower at 1 m	95	
	90	Food Blender at 1 m
Diesel Truck at 15 m	85	
Noisy Urban Area—Daytime	80	Garbage Disposal at 1 m
	75	Shouting at 1 m
Gas Lawn Mower at 30 m	70	Vacuum Cleaner at 3 m
Suburban Commercial Area	65	Normal Speech at 1 m
	60	
Quiet Urban Area—Daytime	55	Quiet Conversation at 1 m
	50	Dishwasher Next Room
Quiet Urban Area—Nighttime	45	
	40	Empty Theater or Library
Quiet Suburb—Nighttime	35	
	30	Quiet Bedroom at Night
Quiet Rural Area—Nighttime	25	Empty Concert Hall
Rustling Leaves	20	
	15	Broadcast and Recording Studios
	10	
	5	
Reference Pressure Level	0	Threshold of Hearing

Range of Typical Sound Levels

Sound levels are reduced the farther away you are from the source. Sound is further attenuated when there are intervening objects such as terrain, buildings or noise barriers.

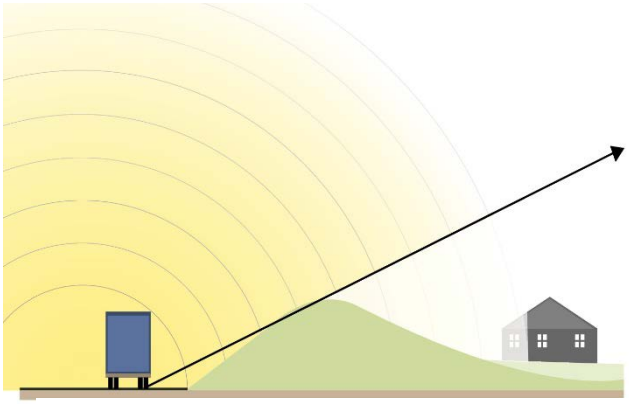
When there are soft ground types such as grass, fields, or snow between the highway and noise-sensitive locations, highway noise typically attenuates 4 to 5 decibels for each doubling of distance. For example, if highway noise is 60 dBA (Leq) at a distance of 100 feet from the highway, at 200 feet from the highway the noise level would typically be 55 dBA without intervening objects.



Sound Attenuates with Distance

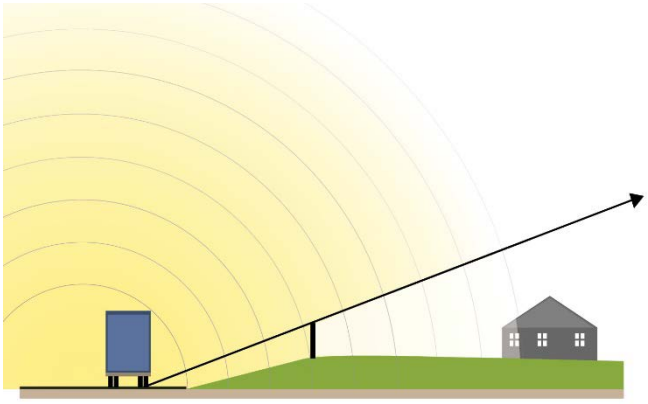
In the presence of intervening objects such as berms, buildings, or barriers, highway noise can be reduced further when these features break the line-of-sight between the highway and the noise-sensitive receptors.

For noise barriers to be effective, they must be constructed of a material with enough mass and with limited air gaps to minimize noise transmitting through the material. **An earthen berm or a highway noise barrier can typically reduce noise by 5 to 15 decibels depending on the geometry of the highway and the noise receptor.**



Intervening Terrain Reduces Noise

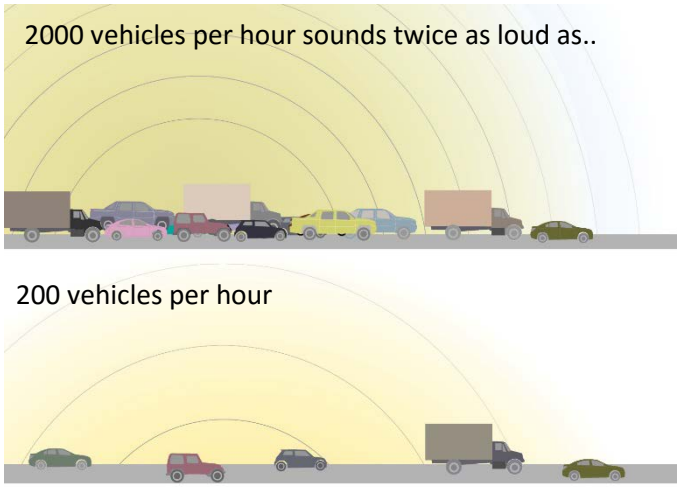
Vegetation including trees can decrease highway noise if it is tall enough, wide enough, dense enough, and would exist throughout the year. A 200-foot width of dense vegetation can reduce noise by 10 decibels, which cuts the loudness of traffic noise in half. Vegetation less than 100 feet wide is typically ineffective at reducing noise. **Therefore, it is usually not feasible to plant enough vegetation along a highway to achieve sufficient noise** reductions and the FHWA does not consider planting vegetation to be an effective noise abatement measure. The planting of trees and shrubs typically provides only psychological benefits and may be provided for visual, privacy, or aesthetic treatment, but not noise abatement.



Noise Barriers Reduce Noise

The primary sources of traffic noise are the interaction of vehicle tires with the pavement, vehicle exhaust, and vehicle engines. There are many factors that affect the amplitude of noise generated by highway traffic such as the volume of traffic, speeds and the percentage of different vehicles including cars, trucks, buses, and motorcycles. Trucks and buses generate more noise than automobiles.

When traffic volumes double, highway noise increases by 3 dB which is considered a barely perceptible change in noise. When traffic volumes increase by a factor of five, highway noise levels increase by 7 dB. When traffic volumes increase by a factor of 10, highway noise levels increase by 10 dB, which is considered to be twice as loud.



How Traffic Volume Affects Noise

Overview of Highway Noise Policies

FHWA regulation 23 CFR 772 describes the requirements that state highway agencies need to follow to evaluate highway traffic noise and include abatement for projects using Federal-aid highway funds or otherwise requiring FHWA approval. The NHDOT Noise Policy[1] describes the methods to identify noise-sensitive receptors, measure and predict highway noise levels, assess noise impact and evaluate potential abatement measures for both Type I and Type II highway projects. The Noise Policy also describes how the Department should provide outreach and coordination with local officials.

A Type II Project is an evaluation of potential noise abatement on an existing Tier 1 highway where no highway improvements are programmed

Noise assessments are required for Type I and Type II highway projects. A **Type I** project is any proposed highway project which requires the construction of highway on new location, the substantial physical alteration of an existing highway, the addition of one or more through traffic lanes, the addition of an auxiliary lane (except for turn lanes), the addition or relocation of interchange lanes or ramps, the restriping of existing pavement to create a new through lane, or the addition of a new or substantial alteration of a weigh station, rest stop, ride-share lot or toll plaza.

A **Type II** project is a proposed project for noise abatement on an existing Tier 1 highway where no highway improvements are programmed and where no prior determination about a Type I or II abatement measure has been made.

What Types of Land Use are Sensitive to Noise?

Highway noise is assessed at receptors separated into seven different Activity Categories as defined by FHWA. Noise is assessed at exterior locations of frequent human use except for all categories except Activity Category D which addresses interior noise levels for certain institutional properties. As shown in the Table 1, noise-sensitive land uses include residential, institutional and recreational properties.

[1] "Policy and Procedural Guidelines for the Assessment and Abatement of Highway Traffic Noise for Type I & Type II Highway Projects", New Hampshire Department of Transportation, Approved November 30, 2016.

Noise Abatement Criteria

Noise abatement criteria are intended to reduce human annoyance and speech interference from highway noise and are defined by the Department to minimize effects in exterior areas of frequent human use. The Noise Abatement Criteria (NAC) and respective activity categories defined by FHWA are shown in the table below. The Department defines a **Noise Impact** to occur when the NAC are approached within 1 decibel, are exceeded, or when sound levels are anticipated to increase by more than 15 decibels over the existing worst-case hourly noise level.

Table 1. FHWA Land Use Activity Categories and Noise Abatement Criteria

Land Use Activity Category	Loudest-Hour Noise Level (Leq)	Description of Activity Category
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 purposes.
B	67 (Exterior)	Residential.
C	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, Section 4(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	72 (Exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in Categories 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 warehouses.
G	--	Undeveloped lands that are not permitted.

Noise abatement is considered when noise levels approach or exceed the Noise Abatement Criteria (NAC) or when noise increases by 15 dB or more over existing levels

Highway noise is assessed for the loudest-hour, which is typically during the peak morning or afternoon period unless there is congestion causing slower travel speeds. For Type I projects, noise levels are evaluated for the design-year, which is typically 20 years in the future. For Type II projects, only the existing noise levels are evaluated.

The 15-decibel increase criterion only applies to Type I highway projects and usually is only a factor for highways in a new location.

Highway Noise Assessments

The process for assessing highway noise involves conducting noise measurements at several representative locations throughout a project area and developing a FHWA Traffic Noise Model (TNM) to predict noise levels at all receptors. The TNM includes the geometry of the highway, terrain and receptor locations, the presence of intervening objects such as buildings, different types of ground conditions that can affect sound propagation, and traffic information including volumes, speeds, and the percentages of different types of vehicles.

Noise Measurement

The accuracy of the TNM is validated within 3 decibels using field noise measurements and simultaneous traffic counts at select representative receptor locations.

Highway noise levels are then assessed according to the NAC to determine if abatement needs to be considered. If noise levels "approach or exceed" the NAC, abatement must be considered. Noise abatement may include measures such as traffic management measures, alteration of horizontal and vertical highway alignment for Type I projects, acquisition of land as a buffer zone to avoid incompatible land use, construction of noise barriers or berms, and building sound insulation of certain institutional properties.

Typical Highway Noise Barrier

Noise Abatement Measures

Effective control of highway traffic noise requires a three-pronged approached. Noise emissions of individual vehicles is regulated by the United States Environmental Protection Agency. Mitigation measures like exhaust mufflers are employed to reduce noise at the source. Noise reduction for highway improvement projects is the responsibility of the Department. Noise Compatible Planning is the responsibility of the municipality.

The Department considers several different noise abatement measures for Type I projects to mitigate the effects of highway noise.

Noise abatement measures that are commonly assessed for Type I projects include:

- *Traffic Management Measurements* are measures that calm traffic and reduce roadway noise. Lowering the speed limit of a roadway or restricting truck activity may be used to reduce the noise emissions of a roadway. These measures are not often used because they are typically unfeasible or may be counterproductive to the purpose of the project.
- *Alteration of the Roadway Alignment* involves shifting the roadway, either horizontally or vertically, to increase the propagation distance or take advantage of intervening terrain. This method is typically only used if the project is early in design and if space constraints allow for such action.
- *Acquisition of Property to Maintain a Buffer Zone* requires the Department to acquire land and maintain it to increase the propagation distance to receptors. This option is typically not favorable.
- *Noise Insulation of Public Use or Non-Profit Institutional Structures* occurs when a NAC Category D receptor is impacted and exterior mitigation is not suitable to reduce sound levels. The Department may offer funds to insulate NAC Category D receptors to reduce interior noise levels.
- *Construction of Noise Barriers or Berms* is the most commonly implemented noise abatement measure. Where space constraints allow, berms are a favorable mitigation measure due to their low-cost and aesthetically pleasing look. Noise barriers are installed when the distance between the edge of roadway and right of way does not allow for sufficiently tall berms.

Currently, FHWA does not allow for "quiet pavements" to mitigate noise impacts. Maintenance costs and decreased long-term effectiveness are prohibitive to their installation. Additionally, vegetative stands are not typically used as noise abatement measures as they are acoustically ineffective unless they are sizeable and have a dense underbrush. Vegetative stands have been shown to provide visual screening which is often favorably viewed by residents.

Highway Noise Earthen Berm

Feasible and Reasonable Abatement

The **feasibility** of an abatement measure addresses the safety, engineering constructability, and acoustical effectiveness. Every effort should be made to design a barrier that attains 10 decibels or greater of insertion loss at first row receptors. A barrier is not considered feasible if it cannot obtain 5 decibels of insertion loss for at least one impacted receptor. For stability reasons, the structural portions of a barrier should not be taller than 25 feet and is not considered if any portion of the barrier would need to be taller than 25 feet to obtain a minimum insertion loss of 7 decibels. Additional consideration should be given to the design of barrier in terms of safety factors such as maintaining a clear recovery zone, adequate sight distance and fire/emergency vehicle access. Other environmental impacts such as those to historic properties, park lands and wetlands should be considered in determining whether a barrier is feasible.

Noise barriers or berms must be evaluated to determine if they are feasible and reasonable to be constructed. This evaluation addresses the safety, constructability, cost-effectiveness, acoustical effectiveness and viewpoints of benefited receptors of abatement measures

The **reasonableness** of an abatement measure balances the fiscal responsibility of the Department with the design of the abatement measure. Reasonableness is divided into three components: cost-effectiveness, obtaining the noise reduction goal, and soliciting the views of benefited receptors.

- *Cost-Effectiveness* of an abatement measure is determined quantitatively on a dimensional basis by dividing the total protective surface area of the abatement alternative by the number of receptors it is benefitting (that is providing 5 decibels of insertion loss). If this number is less than the Department's Effectiveness Criterion (EC) the measure complies with the effectiveness component of reasonableness. The EC is set at a base of 1,500 square feet per benefitted receptor. **For Type I project's the EC is reduced depending on the percentage of properties permitted for development after November 30, 2017 and is increased by 200 square feet per benefitted receptor if the municipality has implemented noise compatibility planning.** The municipality must demonstrate to the Department (through the submittal of a written request) that it has enacted planning and development regulations which require avoidance, minimization or mitigation of exterior highway traffic noise impacts associated with new noise sensitive development adjacent to state highways. These regulations must have been in effect continuously for at least one year prior to the date of public knowledge.[2] The following section describes typical approaches to noise compatible planning.

[2] The inclusion of this positive adjustment factor is intended to address New Hampshire HB 1629 of the Laws of 2014 by allowing for an increase in the effectiveness criterion.

The **Type I Barrier Effectiveness Criterion** is increased by 200 square feet per benefited receptor if the municipality has demonstrated to the Department they have enacted Noise Compatible Planning measures.

Table 2 Effectiveness Criterion Adjustments for Type I Barriers

Properties permitted for development after November 28, 1995	Adjustment factor to base EC
1-25%	-100 s.f.
26-50%	-200 s.f.
51-75%	-300 s.f.
76-100%	-400 s.f.

- *Noise Reduction Goal* – Every effort should be made during noise barrier design to attain a 10-decibel or greater insertion loss (sound attenuation) at first row receptors and by providing at least 7 decibels of insertion loss for at least 1 benefitted receptor.
- *Views of the Benefitted Receptors* must be solicited and in favor of the abatement measure for it to be deemed reasonable. This process is further detailed in the Views of Benefited Receptors section of the Department's Noise Policy.

Obtaining the Views of Benefitted Receptors

FHWA requires that the views of impacted residents be considered when reaching a decision on the resonableness of an abatement measure chosen to reduce roadway noise. FHWA allows the Department to decide the methods used for obtaining the viewpoints of benefitted receptors and weighing their input to determine the resonableness of an abatement measure. As outlined in the Noise Policy, a two step process is followed for Type I barriers. The first step involves determining if objections against a noise barrier are expressed by the public during a Project's general public outreach. Should objections be stated or should the barrier be a Type II barrier, a more detailed solicitation for public opinions is required.

Public Meeting Presentation

Initial Solicitation for Type I Barriers

The potential impacts of a Type I highway project must be assessed for a multitude of environmental resource areas, including noise. Through the National Environmental Policy Act (NEPA) documentation required of a project, viewpoints from the entire project community, including benefited receptors, are solicited for all aspects of the project, including noise impacts and abatement. If no objections to the proposed noise abatement are found at this level of public involvement, then the viewpoints of benefitted receptors are considered obtained and a noise barrier would be deemed reasonable. If objections are found, further solicitation is required.

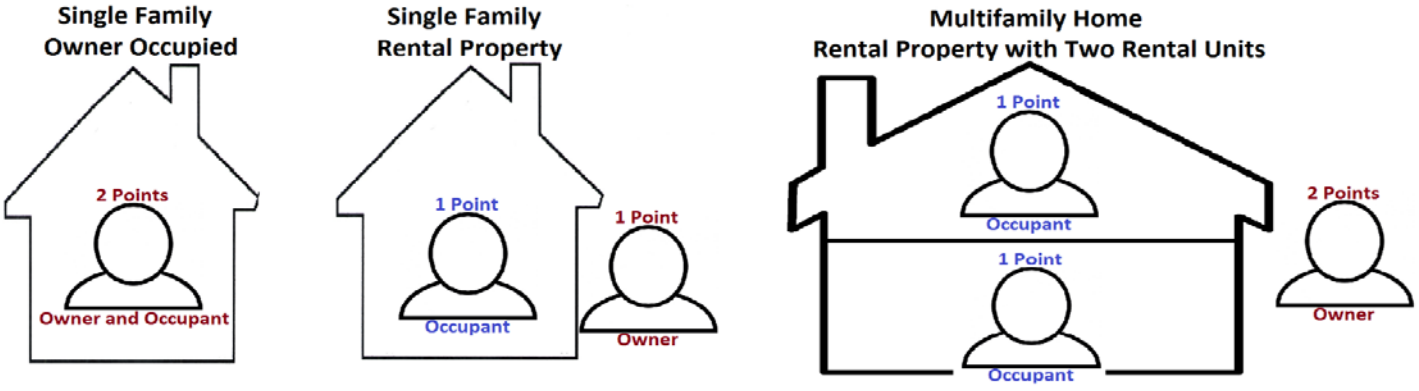
Further Type I Solicitation or Type II Solicitation

Further solicitation of public viewpoints is required for any Type I barrier with objections and for all Type II barriers. This second solicitation involves a vote by all receptors that would be benefitted by the proposed abatement measurement as determined by the noise analysis.

The votes of the benefited receptors for the proposed abatement measure are typically solicited by mail or public meeting. These votes are weighted by assigning points to them. One point is given to the vote of the owner of a benefitted receptor. One point is given the vote of the occupant of the benefitted receptor. One owner and one occupancy point is given for each dwelling unit at the benefitted receptor. At least 51% of the total possible points must be in support of an abatement alternative for it to be considered reasonable.

At least 51% of the total possible points must be in support of an abatement alternative for it to be considered reasonable.

For instance, if a single-family home is owned and occupied by the same person, that vote is given two points. If a single-family home is a rental property, the owner's vote counts as one point and the occupant's vote counts as one point. If the benefitted receptor has multiple dwelling units, the vote of each rental unit counts as one point and the vote of the owner is given a point for each rental unit at the receptor. This concept is illustrated below.



Viewpoint Voting Point System

Type II Noise Barrier Program Municipality Requirements

Municipal Eligibility Requirements

Type II Noise Barriers are only considered within municipalities that meet certain requirements. These municipal requirements include:

- Enacting noise-compatible planning regulations or ordinances,
- Committing to matching 20% of the total project costs (including engineering and construction costs) prior to commencing design,
- Obtaining and providing the Department with written support of the preferred abatement measure from at least 51% of the receptors, and
- Submitting a written request to the Department demonstrating that highway noise compatible planning regulations have been enacted.

Municipalities must enact planning and development regulations which require avoidance, minimization or mitigation of highway noise associated with new developments adjacent to state highways to be eligible for the Type II program.

Type II Program Implementation

All municipalities wishing to participate in the Type II program must engage with the Department to show eligibility. Upon acceptance into the program, the Department will initiate a noise study for all Tier 1 roadways in the municipality to determine any Type II abatement opportunities. Tier 1 highways include interstates, turnpikes and other similarly designed multi-lane, divided highways that provide statewide travel and carry high traffic volumes at increased speeds. Each feasible and reasonable abatement measurement will be added to the Department's Type II Noise Abatement Priority List. The priority of the construction of barriers will be ranked by the dimensional effectiveness of the barrier. Programming for the design and construction of Type II barriers will be based upon the availability of funds for the projects.

Type II Barrier Eligibility Criteria

Once a municipality is accepted into the Type II Program, potential Type II Barrier areas are assessed to determine if the initial eligibility criteria are met. These criteria are:

› The Type II abatement measure shall only be considered along existing Tier 1 highways.

› The Type II abatement measure shall not be considered along any section of roadway for which a Type I eligible project is programed within the Department's 10-year Transportation Improvement Plan.

- The Type II noise abatement measures shall not be considered in areas where such measures were previously determined not to be feasible and reasonable for a Type I or Type II project, regardless of any subsequent development.
- At least one benefitting receptor must have been permitted for development prior to either the original system opening date of the adjacent Tier 1 highway or prior to November 28, 1995.
- The Type II abatement measure shall not necessitate any permanent modification to the alignment of an existing roadway.
- Any temporary or permanent right-of-way needs necessary for the construction of a Type II abatement measure, including those necessary for maintenance access and utility relocation, must be donated to the Department prior to the commencement of final design.

If these eligibility criteria are met, the potential Type II Barrier areas will be considered in a Department-funded noise barrier evaluation.

Type II Noise Barrier Effectiveness Criterion

The Department's Noise Policy includes several Eligibility Criteria and Municipal Participation Requirements for the construction of a Type II noise barrier. The analysis conducted for a Type II noise abatement measure is similar to the process described above for a Type I project. A Type II abatement measure is subject to the same feasibility and reasonableness evaluation as a Type I abatement measure, except the adjustment factors to the Effectiveness Criterion are different. For a Type II noise abatement measure, the EC is lowered based on the percentage of properties permitted for development on or after November 28, 1995 and increased for the percentage of properties permitted for development prior to the original system opening date.

Table 3 Effectiveness Criterion Adjustments for Type II Barriers

Properties permitted for development on or after November 28, 1995	Adjustment factor to base EC	Properties permitted for development prior to original system opening date	Adjustment factor to base EC
1-25%	-100 s.f.	1-25%	+100 s.f.
26-50%	-200 s.f.	26-50%	+200 s.f.
51-75%	-300 s.f.	51-75%	+300 s.f.
76-100%	-400 s.f.	76-100%	+400 s.f.

Noise Barrier Design

Noise barriers are designed for acoustical effectiveness. The process for designing noise barriers includes both acoustical and structural engineers working in tandem to provide a structurally sound and acoustically effective barrier. Noise barriers are optimized in the TNM model to provide benefit to receptors without designing inappropriately excessive barriers in terms of length and height. Barriers must meet the feasibility and reasonableness criteria of the Noise Policy including the EC adjustments that are specific to the Type II Noise Abatement Program.

Typical Noise Barrier Design and Construction Costs

If the eligibility criteria are met and a feasible and reasonable noise mitigation measure is found, the cost of the noise abatement measure must be estimated so that the municipality and the Department can allocate funds. The local municipality must commit to providing a 20% match of the total project costs (including both engineering and construction costs) prior to the commencement of design.

A municipality must provide 20% of the total construction and design costs of a Type II noise barrier.

Typical NHDOT Noise Barrier Costs

The Department has constructed 45 berms and barriers across the state since 1977. The barriers are primarily made of wood, but the Department has also used pre-cast concrete and opaque plastic panels. The costs of noise barriers are often standardized on a dollar per square foot basis so that different factors can be compared for cost-effectiveness. The cost of noise barriers can vary widely depending on multiple factors. Some of the major factors are:

- *Construction Material* – Barrier costs will differ by the type of material used for the panels and posts. Typically, wood barriers have lower initial costs than precast concrete or acrylic barriers. However, maintenance costs and life expectancy will also vary by material. Regular maintenance is important for some construction materials to preserve the acoustical integrity of the barrier.
- *Mounting Type* – How a barrier is mounted will affect the cost of the barrier. If barrier must span a structure (typically a bridge or retaining wall), the unit cost of the barrier will increase. Barriers on structure involve more complicated mounting designs and may require retrofits to the existing structure to support the additional weight and wind load that accompanies a noise barrier. Structure mounted barriers have been estimated to cost approximately four times the cost of ground mounted barriers.[3]

[3] Alcala, Noel. "Noise Barrier Materials, Design, and Costs" Presented at the *Traffic Noise Practitioners Summit*. October 21-22, 2015.

› *Surface Texture* – The surfaces of a barrier's panels may be reflective or absorptive. Reflective surfaces will reflect sound waves while absorptive surfaces are designed to reduce these reflections. An absorptive surface may be warranted when a barrier is located across the highway from sensitive receptors or when there are parallel barriers. The need for an absorptive surface must be weighed against the additional cost, typically ranging from $7 to $11 per square foot.[4]

A review of the costs of the Department's constructed noise barriers has provided the following estimated construction unit costs depending on the construction material of the barrier. Currently, all wooden and plastic opaque barriers in the state have reflective surfaces, while all precast concrete barriers have absorptive surfaces. The unit costs in the table include material and construction costs. Design costs of noise barriers have been estimated at approximately 7% to 10% of the total construction costs.[3] Both design and construction costs should be considered when estimating the cost of a noise barrier.

Table 4 Noise Barrier Construction Costs in New Hampshire

Noise Barrier Material	Material and Construction Unit Cost (2017 $/sf)
Wood	$24
Precast Concrete	$37
Plastic Opaque	$45

Source: FHWA, New Hampshire Noise Barrier Inventory. December 31, 2016.
Costs averaged for constructed New Hampshire barriers by construction material and adjusted for inflation.

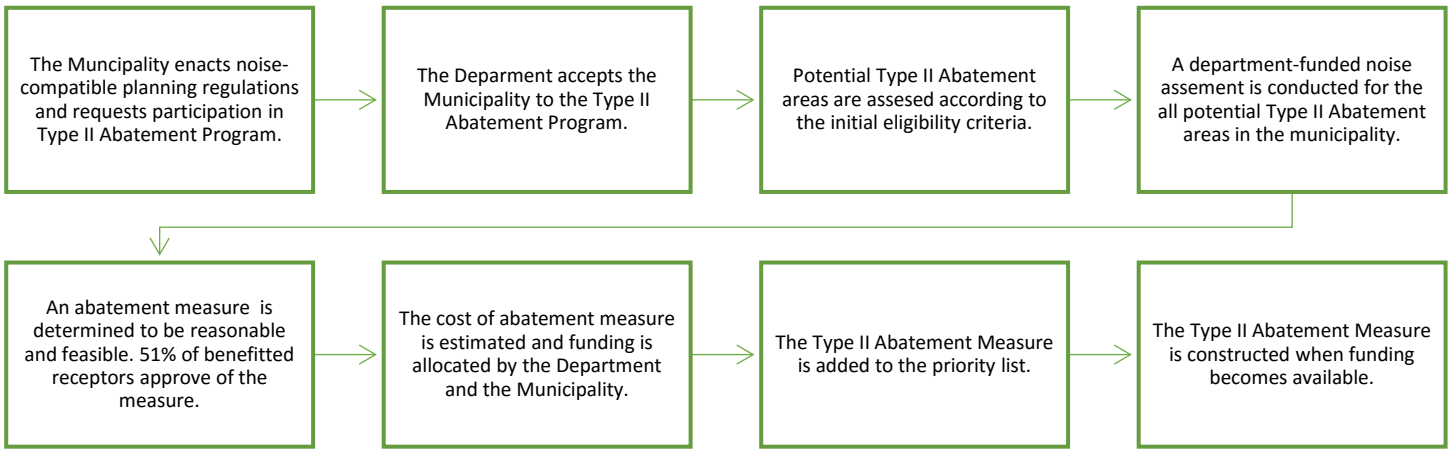
Reliance on Available State Funding

The design and construction of Type II Noise Abatement Measures on the Type II Priority List relies upon funding allocated by the State in the Department's 10-Year Transportation Improvement Plan. If the State does not provide funding for Type II Noise Abatement Measures then design and construction of the abatement measures will cease, irrespective of a municipality's funding commitments to a project.

[4] "Noise Barrier Design Handbook" Federal Highway Administration. August 2, 2000.

Type II Barrier Prioritization

Once the eligibility criteria are met, a feasible and reasonable noise mitigation measure is found, and the funding has been allocated, the Type II Noise Abatement Measure is placed on the Type II Priority List. The Type II Noise Abatement Priority List is a list of feasible and reasonable Type II Noise Abatement Measures in the state. The list is prioritized in the order of the square foot per benefitted receptor Effectiveness calculation developed to determine Reasonableness. Design and construction of Type II Barriers on the Priority List will be undertaken in the order of priority, upon the availability of funds in the Department's 10-Year Transportation Improvement Plan.



Type II Noise Barrier Program Flowchart

General Indicators of Type II Noise Barrier Eligibility

Local officials and residents can look for a few general indicators that a neighborhood or area may qualify for a Type II noise barrier. Generally, neighborhoods that meet the Feasibility and Reasonableness criteria have densely located homes that are close to a Tier 1 highway. These neighborhoods often have relatively flat terrain with few features that would shield the residents from roadway noise. The neighborhoods must have at least one home that existed prior to November 28, 1995 and are along a stretch of Tier 1 highway that has not and will not be a part of a Type I project.

Dense Residential Neighborhood near a Tier 1 Highway

Highway Noise Levels and Distances to Noise Impact

Understanding how much noise highways generate and how far away from the highway noise levels approach or exceed the NAC is critical to implementing noise-compatible planning. Based on a statewide analysis of traffic conditions on Tier 1 highways including traffic volumes, speeds, and percentages of different vehicle types, the distance to approaching the NAC has been determined for each Activity Category. The loudest-hour volumes of traffic on Tier 1 highways generally range from 2,000 to 10,000 vehicles per hour. The distances in the table below are from the edge of the pavement and provide a slightly conservative estimate of the extent of potential impact. These results assume that the terrain is relatively flat which usually represents the worst-case noise exposure and the most effective noise barrier condition.

It is important for local officials to understand how these distances relate to their municipality so they can create informed ordinances that effectively reduce roadway noise by employing setback requirements and overlay districts without inappropriately overburdening developers.

Local officials may also reference existing highway noise studies conducted for Type I highway project in their municipality for additional information to estimate highway noise levels. Note that areas that have been included in Type 1 noise study are not eligible for Type II noise abatement measures, but can still benefit from noise compatible planning.

Table 5 Typical Distances from Highway where Noise Abatement is Considered

Peak Hour Roadway Volume (Vehicles/Hour)	Distance to Noise Abatement Criteria from Roadway Edge (feet)				
	Activity Category A	Activity Category B	Activity Category C	Activity Category D	Activity Category E
2,000	650	250	250	150	150
4,000	925	300	300	200	200
6,000	1025	350	350	250	250
8,000	1150	425	425	275	275
10,000	1450	500	500	350	350

Activity Category A includes lands on which serenity and quiet are of extraordinary significance.
Activity Category B includes exterior residential land uses with frequent human use.
Activity Category C includes exterior institutional locations such as schools, libraries, hospitals, places of worship, amphitheaters, cemeteries, sport and recreation areas and trails.
Activity Category D includes interior institutional locations such as schools, libraries, hospitals, places of worship, TV and radio studios, and auditoriums. An outdoor-to-indoor sound attenuation of 20 dBA is assumed for these receptors equating to an exterior criterion of 72 dBA.
Activity Category E includes exterior land uses such as hotels, offices, and restaurants with frequent human use.

Noise-Compatible Planning: How Can Municipalities Reduce Traffic Noise Impacts?

Noise Compatible Planning eliminates or reduces the undesirable effects of highway traffic noise by encouraging less noise sensitive land uses next to highways, promoting the use of open space, and using special building construction techniques and site layout to minimize noise impacts. These measures will help to address potential future highway noise before problems and complaints occur.

Besides lowering highway traffic noise, Noise Compatible planning has many other benefits including:

- Increasing a citizen's quality of life;
- Reducing noise complaints due to highways;
- Saving costs on potential noise barriers or other mitigation measures and using these saved costs on other roadway improvements; and
- Increasing Property Values.

Challenges with implementing Noise Compatible Planning include:

- Administrative costs to implement the regulations and zoning requirements through ordinances;
- Additional costs to land owners and developers who must abide by stricter regulations; and
- Potential inter-agency and inter-ordinance conflicts among zoning and development codes.

Generally, local officials can implement Noise Compatible Planning through Physical Responses and Policy Strategies. These measures are often prescribed in a municipality's zoning ordinance, subdivision ordinance or land development review. Individual municipalities will have their own procedures to pass the ordinances required to include these measures in their regulations and review processes.

Noise Compatible Land Uses

One of the most common and effective measures in Noise Compatible Planning involves zoning the parcels adjacent to a highway for noise compatible land uses on the municipality's official zoning map. This may include industrial uses or commercial uses without areas of frequent human use.

Noise compatible land uses are those uses where highway traffic noise may be less intrusive to the purpose of land use and would be unlikely to cause annoyance amongst a parcel's occupants. These land uses typically fall under NAC Category F and partially under NAC Category E of the Department's Noise Policy. Common examples of Category F land uses that are appropriate for zoning adjacent to highways are agriculture, forest, industrial, utilities, or warehousing. While Category E land uses are more acceptable to be in proximity to highways than Category A, B, C, or D, certain types of commercial uses are not preferred. Retail and Intensive Commercial uses generally benefit from easy access to highways to better serve the users of these lands and are considered noise compatible land

uses. Hotels, restaurants and offices are more sensitive Category E land uses that may not be appropriate for land adjacent to highways.

Noise sensitive land uses such as residences, hospitals, nursing homes, day care centers, schools, places of worship, libraries, hotels, and auditoriums should be avoided near highways. If unavoidable, zoning maps and ordinances should carefully consider the placement of these land uses in relation to roadways. The Physical Responses and Policy Strategies, outlined below, should be employed when a noise sensitive land use is allowed near a highway.

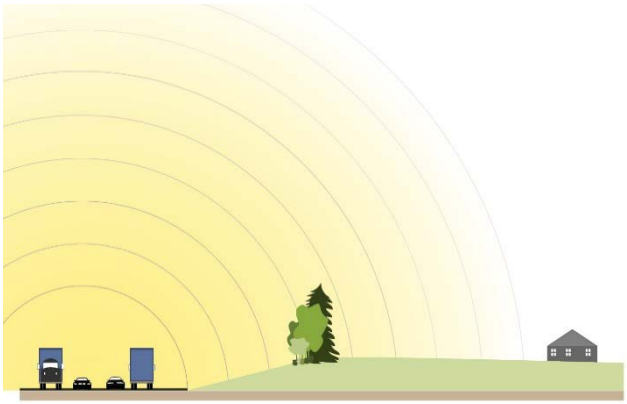
Noise Control in the Physical Environment

The physical environment between a sensitive land use and the highway affects the way highway noise travels and is heard by a receptor. The following physical conditions can reduce highway noise.

Open Space and Setbacks (Increasing Distance)

Increasing the distance between a highway and a neighborhood will decrease the noise levels in the community. This increased distance is often achieved by requiring and maintaining open space between the roadway and homes. Requiring a certain "setback" is most common way to maintain this open space. Setbacks mandate the locations of a building façade and reduce the impact of traffic noise by requiring a distance that is sufficient to reduce noise below the abatement criteria.

The effectiveness of open space and setbacks can be bolstered by the type of ground cover used. It is preferable to use soft ground types such as lawn or field grass in these spaces to further reduce traffic noise when compared to hard ground surfaces such pavement used for a parking lot. Examples of successful open space uses typically involve recreational uses such as walking or bike paths that provide a public good in addition to reducing traffic noise.



Noise Buffer Zone to Minimize Noise Impact

Topography, Berms and Barriers

Traffic noise is affected by terrain, whether hilly or flat. Land developers should take advantage of existing topography to block the line of sight between roadways and receptors. Where hills or berms exist, noise sensitive uses should be constructed behind this topography to provide some shielding.

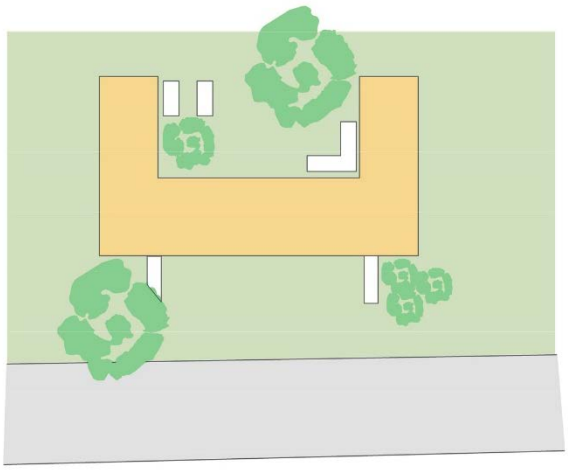
Developers may consider the construction of a noise berm or barrier along the property line facing a highway. Berms can be an excellent solution for putting excess fill obtained from site construction to good use and can be relatively inexpensive. Berms provide the dual functionality of noise reduction and aesthetically pleasing visual screening. Where berms are not feasible, a developer may consider the installation of a noise barrier. A noise barrier should be made from a material with sufficient density to decrease sound transmission through the barrier and should have limited gaps in the surface. Noise berms and barriers should be sufficiently tall to block the line of sight to the highway. Berms and Barriers taller than this will provide better attenuation of highway noise. Depending on

the site layout, a developer-constructed noise berm or barrier may be limited by the amount of land available on the property. Receptors near the ends of the property may not receive sufficient noise attenuation from a berm or barrier that is shortened due to property limits.

Acoustical Site Planning

Acoustical site planning can be employed to effectively layout buildings of a development to reduce noise at outdoor areas of frequent human use such as patios, pools, or balconies.

Less sensitive uses such as landscaping and vegetation should be placed between the roadway and sensitive receptors. Common examples of non-sensitive structures in a residential development include garages, clubhouses, or maintenance sheds. This concept is especially important in mixed-use developments. When laying out a mixed-use development, retail and commercial structures should be placed nearest to the highway to provide shielding to the residential structures. If a building is composed of both retail and residential uses, it is recommended that the residential uses be located on the upper floors and stepped-back from the retail façade facing the roadway.



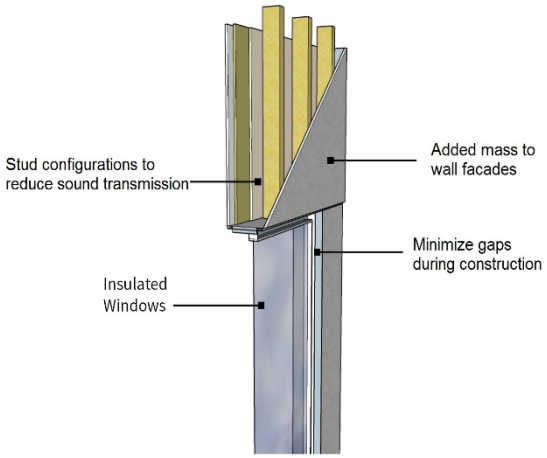
Shielding Outdoor Areas of Frequent Use with Building Structure

Locating and Orienting Sensitive Uses

Planning to reduce noise impact can even occur in the layout of rooms within a building. Bedrooms and rooms that necessitate lower sound levels should be located in the structure away from the roadway. Rooms where quiet is not a priority should be placed closer to the roadway within the structure. This way intervening walls and rooms can further dampen traffic noise. Outside, areas of frequent human use (such as pools or patios) should be located so that the home is between the roadway and the area. Structures will provide shielding and reduce traffic noise in the outside area.

Architectural Building Designs

Municipalities can encourage certain construction techniques that will reduce noise in interior spaces. Developers should minimize the number of windows on the façade facing the roadway, as walls typically provide more insertion loss than windows. The facades facing the roadway should be constructed with more insulation in the walls and using insulated windows with a higher “Outdoor to Indoor Transmission Classification” so that noise transmission through this façade is reduced. Houses can also benefit from the use of solid doors and noise dampeners on air intakes.



Noise Control Ordinances

Noise control can be achieved through municipal regulations such as zoning, subdivision, and land development ordinances. Regulating new developments is a powerful tool to reduce highway traffic noise. Zoning strategies should first and foremost attempt to increase the number of noise compatible land uses adjacent to highways. Where noise sensitive land uses are unavoidable, policy strategies may be used to implement noise control by controlling physical parameters or by setting zoning requirements that aid in reducing traffic noise.

Overlay Districts

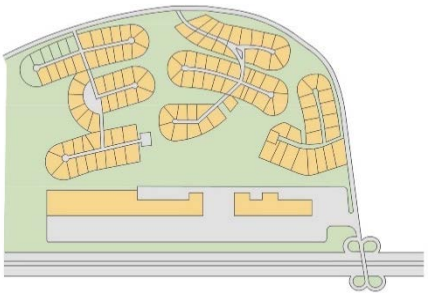
Local officials can create Overlay Districts in their zoning codes to increase the stringency of zoning regulations beyond the typical requirements for a land use. Overlay Districts should be geographically located so as to cover the parcels adjacent to a highway of concern that are within the distances to approaching the NAC. Requirements of the Overlay District should be established in the zoning ordinance, such that developments on parcels within the district must comply with additional setbacks, construction requirements, noise buffers, or other measures.

Performance Standards

A community may consider the use of performance-based zoning for lands adjacent to highways. Under a performance zoning policy, measurable standards are set and developments are assessed as to how well they meet these performance standards. Generally, specific land uses are not required on the parcel so long as the performance standards are obtained. Performance standards may indirectly require developers to implement noise control through physical parameters.

Clustering

Clustering sensitive receptors allows a developer to group residences at a location on a parcel that increases the distance between the roadway and the development. If the residences are clustered, the developer is encouraged to create open space or modify other physical elements in the area left between the cluster and the roadway. Clustering may require density characteristics to be relaxed for the parcel.



Clustering residences away from a highway with non-sensitive commercial uses intervening

Open space placed between a highway and a clustered residential development

Acquisition of Land Near Roadways

Municipalities may purchase or be gifted land near a roadway. Such land would be kept vacant to provide distance between the roadway and potential receivers.

FHWA Regulation Compliance

In accordance with FHWA Regulation 23 CFR 772.17, NHDOT is required to have a statewide outreach program in association with the Type II Noise Barrier Program and the use of the date of development of noise-sensitive receptors as a factor in determining the reasonableness of Type I noise abatement measures.

This document fulfills statewide outreach program requirements to inform local officials and the public about 1) noise compatible planning concepts, 2) estimates of future design-year noise levels at various distances from the highway and at what distance noise levels approach the NAC, 3) that federal funds are not available out of the Highway Trust Fund to construct Type II noise barriers if such barriers were not part of a project approved by FHWA prior to November 28, 1995, 4) that federal funds are available for Type II noise barriers along lands that were developed or under substantial construction prior to construction of the highway, and 5) that FHWA will not approve noise abatement measures for locations that such measures were previously determined not to be feasible and reasonable for a Type I project.

References

› NHDOT Noise Policy, 2016

https://www.nh.gov/dot/org/projectdevelopment/environment/units/program-management/documents/2016NHDOTTypeIandIINoisePolicy.pdf

› FHWA, Entering the Quiet Zone

https://www.fhwa.dot.gov/Environment/noise/noise_compatible_planning/federal_approach/land_use/quietzone.pdf

› FHWA, The Audible Landscape

https://www.fhwa.dot.gov/Environment/noise/noise_compatible_planning/federal_approach/audible_landscape/audible_landscape.pdf