

Chapter 32

Sound Barrier Walls

32.1	General Requirements	32-1
32.2	Noise Study Report Addendum.....	32-3
32.3	Noise Abatement Criteria	32-4
32.4	Public Involvement	32-8
32.5	Final Noise Abatement Commitments	32-9
32.6	Design of Sound Barrier Walls	32-10
32.7	Geotechnical Investigation	32-12
32.8	Preparation of Control Drawings	32-13
32.9	Detail Drawings	32-14

Tables

Table 32.1	Noise Abatement Criteria	32-7
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Chapter 32

32.1 General Requirements

Chapter 23 of the Code of Federal Regulations Part 772 (23 CFR 772) entitled "Procedures for Abatement of Highway Traffic Noise and Construction Noise" contains the federal regulations for the assessment of traffic noise impacts and abatement on federal aid projects. Chapter 335.17 of the Florida Statutes requires the use of 23 CFR 772 for traffic noise impact assessment on highway projects, regardless of funding. **Policy No. 000-360-005, Noise Abatement** contains the policy for abatement of traffic noise on Department projects. The requirements for assessing the noise impacts and abatement commitments are detailed in **Part 2, Chapter 17 of the Project Development and Environmental Manual (PD&E Manual) (Topic No. 650-000-001)**. The initial evaluation of noise impacts is made during the Project Development and Environmental (PD&E) study. Any preliminary commitments to provide reasonable and feasible noise abatement measures on a project are included in the environmental document. The environmental documents and any subsequent re-evaluations shall be reviewed to determine any noise abatement commitments, and the contingencies on which the commitments were based.

Noise abatement commitments made during the PD&E phase are subject to change due to refinements during final design. Designers must consider final roadway grades and horizontal alignments, land use changes, as well as ground elevation at sound barrier locations. Noise wall commitments identified during the PD&E study need to be reassessed against these final roadway features. The typical PD&E study assumptions are appropriate for feasibility decisions but the final design must utilize location specific data that reflects proposed vertical and horizontal locations of the travel lanes and noise wall. The noise wall professional shall provide the top of wall elevation for both minimum and desirable insertion reductions as described below. The designer shall coordinate with the noise specialist in the District Environmental Management Office to ensure proper analysis and public involvement occurs during final design.

If no noise abatement commitments exist in the environmental document or any subsequent environmental reevaluations, no further effort is required during final design. However, it may still be necessary to evaluate construction noise and vibration impacts and develop any special provisions to be included in the plans.

Upon review of the environmental documents the designer or noise specialist should identify the noise receptors considered during the noise impact assessment performed

in PD&E. Noise receptors resulting from development completed after the approval date of the environmental documents should not be considered as the Department is not responsible for providing noise abatement at these sites. A detailed noise impact design reassessment should be conducted for the following:

1. Locations of sound barrier commitments
2. Receptor sites where roadway geometric refinements are likely to increase noise impacts

An addendum to the Noise Study Report prepared by the District Environmental Management Office during Final Design will document the reassessment of noise abatement commitments.

32.2 Noise Study Report Addendum

The primary effort related to the reassessment of noise abatement commitments is the preparation of an addendum to the Noise Study Report (NSR). The reassessment shall be based on the final roadway geometry and the proposed noise abatement design, including sound barrier type, location, dimensions and estimated costs. For consistency, the Final Design reassessment should be conducted using the same computer noise model that was used for the original assessment and documented in the NSR.

Noise abatement measures are generally considered when noise levels at a receptor(s) approach or exceed the abatement criteria or substantially exceed existing noise levels. The noise abatement criteria is listed in **Table 32.1**. Noise abatement is generally only considered for Activity Categories 'A' and 'B'; however, the specific project noise abatement commitments will be documented in the original NSR. A substantial noise increase shall be 15 dBA.

32.3 Noise Abatement Criteria

The insertion loss is the level of noise reduction as a result of abatement. The desirable insertion loss is 10 dBA or more; however, the minimum insertion loss should be 5 dBA for an impacted receiver for abatement to be considered feasible. If a sound barrier can meet the desired insertion loss for a cost of \$35,000 or less per benefited receiver site, the barrier is considered cost reasonable. The statewide average unit cost (per square foot) and the upper limit of the cost per benefited receiver to be used in determining cost reasonableness is established by the Environmental Management Office. As of the printing of this update the unit cost is \$25 per ft² for ground mounted sound barriers and the upper limit of the cost per benefited receiver is \$35,000. The PD&E manual should be referenced for the latest unit cost update. Additional costs such as required additional right of way, special drainage features, special bridge support and special foundations associated with the installation of a sound barrier should be included if appropriate. If these special features increase the cost per benefited receiver above \$35,000, the decision whether or not to provide a barrier must be made in consultation with the District Environmental Management Office and FHWA. Any decision to eliminate a sound barrier from consideration based on the additional cost of special features will require clear demonstration that the need for such special features are associated only with the sound barrier and cannot be mitigated by other considerations.

If a minimum of 5 dBA insertion loss cannot be achieved at a receiver, that receiver is not benefited; therefore, it cannot be considered in the cost effective calculation to determine the reasonableness of that barrier. The noise specialist should investigate the scenarios required to meet the noise abatement criteria carefully by adjusting the length and/or height of the barrier to achieve the desirable insertion loss of 10 dBA at \$35,000 or less per benefited receiver particularly where design changes or the consideration of special features require cost or abatement level reanalysis.

Section 32.5, Design of Sound Barrier Walls, provides structural design criteria and procedures, and horizontal clearance requirements. Under normal conditions sound barriers shall not exceed the following heights:

1. For sound barriers at the right of way line or outside the clear zone use a maximum height of 22 feet.
2. For sound barriers on bridge and wall structures use a maximum height of 8 feet.
3. For sound barriers at the shoulder point, mounted on embankments only, use a maximum height of 14 feet.

Use of wall heights greater than these shall require a Design Variation. Justification for a variation should include, as a minimum, a description of site conditions requiring the increased height and a comparison to the standard height of both insertion loss and cost per benefited receiver.

The designer should provide analytical results to the Department project manager evaluating wall heights necessary to achieve minimum, desired and optimum insertion loss. The optimum wall height should be most cost effective in consideration of noise reduction benefits per unit cost of the wall. An evaluation matrix is suited to this type of comparative analysis. The evaluation matrix should consider an appropriate range of sound barrier wall configurations (height, length and roadway offset) that provide the desirable insertion loss (10 dBA) per impacted receiver and the minimum insertion loss (5 dBA) per impacted receiver. The number of benefited receivers should be identified and the cost per benefited receiver calculated for each configuration evaluated. If a sound barrier configuration can provide the desirable insertion loss (10 dBA) at a reasonable cost (less than \$35,000 per benefited receiver), then it should be provided. If this is not achievable, the designer should select a sound barrier wall configuration that optimizes insertion loss per impacted receiver and cost per benefited receiver. The designer should always provide a recommendation with the evaluation. The designer should also coordinate with the District Structures Design Office to ensure that the sound barrier wall design meets appropriate structural design standards and that construction is feasible and achievable.

The height of the sound barrier is measured from the ground elevation to the top of the wall. Tall sound barriers are seldom necessary at the top of roadway embankments or berms since the elevation of the embankment contributes to the effective height of the barrier. In addition, changes in the vertical grade of the top of the barrier should be gradual and abrupt changes in barrier heights should be avoided. Often natural ground elevations at the base of the wall fluctuate, even in flat terrain. Therefore, the designer should provide plan details that make clear to the contractor the final wall top elevations, foundation step locations and post spacing.

When an otherwise continuous wall is broken resulting in a horizontal separation between the walls, it is often necessary to overlap the walls to reduce insertion loss degradation. Applications of this occur when the mainline wall is located at the right of way line, but must be moved to the shoulder point at a bridge location. This may also occur at interchanges when transitioning from the mainline to a ramp. The overlap distance of noise walls is generally equal to four times the separation; however, an analysis by the noise specialist is necessary to determine the optimum overlap. The need or effectiveness of a noise wall in the infield area of an interchange should be reviewed as well during final design. The attenuation of ramp traffic may provide

adequate insertion loss when considering the intersecting roadway's noise contribution. Maintenance access and clear zone must be considered when selecting wall termini details.

Other noise abatement techniques that may be considered to supplement or replace sound barrier walls are:

1. Traffic management measures (e.g. traffic control devices and signing for prohibition of certain type vehicles, time use restrictions for certain type vehicles, modified speed limits, and exclusive lane designations);
2. Alignment modifications;
3. Acquisition of property rights for construction of noise barriers by donation, purchase or condemnation;
4. Acquisition of the balance of a noise-sensitive property from which there is a taking, if acquisition is less expensive than other methods;
5. Acquisition of right of way for landscaping adjacent to noise barriers and for buffer zones.

Table 32.1 Noise Abatement Criteria
 [Hourly A-Weighted Sound Level-decibels (dBA)]

Activity Category	Abatement Level (in L_{Aeq})		Description of Activity Category
	FHWA	FDOT	
A	57	56 (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	67	66 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, RV parks, day care centers and hospitals.
C	72	71 (Exterior)	Developed lands, properties, or activities not included in Categories A and B above.
D			Undeveloped lands.
E	52	51 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

32.4 Public Involvement

The identification and design of noise abatement measures during the project design phase will require additional public involvement efforts and will be especially important in the establishment of sound barrier wall design features such as wall texture. Public coordination is often necessary to finalize wall locations, heights and aesthetic features, especially if there are substantial changes to prior commitments. These changes may be the result of any of the considerations noted in **Section 17-4.6.1** of the **PD&E Manual**. Coordination with the District Public Involvement or Community Liaison Coordinator in obtaining additional input during the final design of the sound barrier wall is required.

When a barrier is warranted, informed judgment must be used to establish whether a numerical majority of the benefited receivers are in favor of the construction of the barrier. If they are not in favor, the Department may choose not to build it. If agreement cannot be reached by a neighborhood on the use of noise barriers, the decision to provide them or not will rest solely with the Department. Noise walls located on arterial roadways can potentially impact access. The ability to construct an effective noise wall(s) can depend on an individual property owner(s) willingness to sign a right of way indenture allowing access to be cut off or modified. For these type projects it is general practice to obtain a written statement from each affected property owner demonstrating support for the noise wall. If an adjacent property owner(s) declines to sign the indenture the noise specialist shall re-evaluate the effectiveness of noise abatement on the project segment considering alternate noise wall layouts. If insertion loss criteria cannot be met the noise specialist shall document such in the NSR Addendum.

32.5 Final Noise Abatement Commitments

During the final design phase, the noise abatement locations, sound barrier types, lengths and heights will be determined. The final noise abatement commitments must be documented in the environmental reevaluation prior to construction advertisement. The required data collection, analysis and documentation detailed in **Part 2, Chapter 17 of the Project Development and Environmental Manual** will be documented in the NSR addendum. It should also contain a description of the methodology for selecting final sound barrier wall dimensions including any evaluation matrix(s) used.

A copy of the NSR addendum, a summary of proposed sound barrier walls and a summary of the public involvement regarding noise abatement that took place during the design effort will be provided to the District Environmental Management Office. The environmental management staff will ensure that the final noise abatement commitments are reflected in the reevaluation of the environmental document and will obtain concurrence from FHWA.

32.6 Design of Sound Barrier Walls

Except as specified below, **AASHTO's Guide Specifications for Structural Design of Sound Barriers** and the Department's **Structures Design Guidelines** shall be used for the structural design; however, the designer shall also refer to the **Department Specifications, Section 534**, the **5200 Series** of the **Design Standards**, and the Structures Design Office's **Sound Barrier Evaluation Criteria** for specifications and general design requirements, the **Structures Manual, Volume 3** for guidance in the preparation of the drawings and the **Structures Detailing Manual** for conformance in detailing.

All sound barrier walls in the State of Florida shall be designed for a minimum wind velocity of 110 mph. If the sound barriers are not located on other structures, the wind pressures shown in **Table 1-2.1.2.C (Exposure B2)** of the referenced **AASHTO Guide Specifications** shall be used. If the sound barriers are located on bridge structures, retaining walls, or traffic barriers, the wind pressures shown in **Table 1-2.1.2.D (Exposure C)** of the referenced **AASHTO Guide Specifications** shall be used. For sound barriers located on embankments and structures, the height zone shall be determined by using the elevation of adjoining ground as being the approximate elevation of the original ground surface prior to embankment construction.

For panels, the maximum deflection due to service wind load shall not exceed the lesser of $1/180^{\text{th}}$ of the post spacing or $1\frac{1}{2}$ inch (deflection measured relative to posts). For posts or top of barrier, the maximum deflection due to service wind load shall not exceed the lesser of $1/50^{\text{th}}$ of the wall height or 5 inches for sound walls on deep foundations or 3 inches for sound walls founded on shallow foundations, and measured from the following:

1. Sound barriers on deep foundations: the deflection shall be measured relative to the point of fixity in the soil. The lateral displacement at the base of the wall shall not exceed 1 inch.
2. Sound barriers on shallow foundations: the deflection shall be measured relative to the base of the wall system.

More restrictive panel and wall deflection limits may be required based on the specific wall system utilized.

Unless approved by the Department, the maximum post spacing for noise wall panels shall not exceed 20'-0".

On flush shoulder roadways, sound barriers shall be located outside the clear zone unless shielded, and as close as practical to the right of way line. On urban curbed roadways, sound barriers shall be a minimum of 4 feet back of the face of curb. However, additional setbacks may be required to meet minimum sidewalk requirements. Sound barriers may be combined with traffic railings on a common foundation if the combination meets the crash test requirements of NCHRP 350 Test Level 4 criteria.

Besides the structural integrity of the sound barrier wall, the structural engineer should also be concerned with aesthetics, maintainability, constructability, cost and durability.

Sound barrier walls should not be located on bridge structures where feasible alternative locations exist. Sound barrier walls on bridge structures cause an unproportionate increase in bridge cost because of strengthening of the deck overhang and exterior girder. In addition, sound barriers on bridges interfere with normal maintenance inspection access and detract from the aesthetic quality of the structure. Where feasible alternative locations do not exist and sound barrier walls must be located on bridges or retaining walls, they shall not be taller than 8 ft. unless specifically approved in writing by the State Structures Design Engineer. See ***Design Standards, Index Nos. 5210 and 5212*** for acceptable crash tested 8 ft. bridge and retaining wall mounted sound walls.

On bridges or on the top of retaining walls, where the sound barrier does not meet crash test requirements of NCHRP 350, Test Level 4, sound barriers shall be placed a minimum of 5 feet beyond the gutter line of a FDOT approved standard bridge railing, and the noise wall shall be limited to 8 feet in height unless authorized by the State Structures Design Engineer due to reasons stated in the previous paragraph. Sound barriers may be combined with the traffic railing as long as the structural system meets the crash test requirements of NCHRP 350, Test Level 4 criteria.

Normally, the design should proceed as required hereinafter.

32.7 Geotechnical Investigation

Once the wall location, alignments, height and minimum thickness are determined, the soil exploration should be undertaken. The geotechnical engineer should follow the Department's *Soils and Foundations Handbook* for exploration.

32.8 Preparation of Control Drawings

The initial set of drawings to be prepared by the EOR is referred to as Control Drawings. By preparation of these drawings, the EOR shall provide all control parameters such as alignments, limits, notes, etc., and shall provide all the information which is common to all wall types including but not necessarily limited to:

1. Wall alignments (horizontal and vertical)
2. Wall limits (beginning and ending)
3. Location of all existing utilities (overhead and/or underground in the vicinity of the proposed wall)
4. Location of fire-access openings
5. Location of drainage openings
6. Sound barrier graphics details
7. General Notes
8. "Report of Core Borings" (Soil Information Data)
9. Quantities (wall area as described below for payment purposes only; the itemized quantities such as concrete volume, etc., shall be provided in the specific drawings)
10. All other information that may be construed to be of general nature
11. NOTE: The wall area for bidding purposes shall be the area bounded by the wall limits (beginning and ending), the top of the wall, and the bottom of the lowest panel between posts. This is the vertical surface area that can be seen on an elevation view plus the portion of the lowest panel which is buried.

32.9 Detail Drawings

The EOR shall prepare Detail Drawings showing the specific details required for the implementation of the selected wall type. All wall components such as: foundations, posts, panels, etc. shall be fully detailed for construction. All walls shall include a standard or conventional (non-proprietary) design. The FDOT Structures Sitemenu CADD cell tables shall be included in the plans depicting which proprietary wall designs are compliant with project specific requirements. These drawings shall provide the specific information as shown in the applicable drawings (see the ***Design Standards***).

Likewise, if proprietary designs are to be implemented, then the proprietary sound barrier wall drawings shall provide the specific information.

Manufacturers of proprietary sound barrier wall products shall have their products approved by the Department using the Sound Barrier acceptance Criteria and included in the Qualified Products List (QPL). The designer or project manager shall establish the project requirements for sound barriers including commitments made during the PD&E phase or during the design phase public involvement. Project requirements may include color, textures, graphics, post spacing (10 feet or 20 feet), absorptive vs. reflective surface, flush vs. recessed panels, etc. The project requirements shall be listed in the plans.

The designer should refer to options outlined in the ***Structures Detailing Manual, Chapter 15***.

In addition to the Department's standard concrete noise barrier design, the plans shall list proprietary noise barrier products that meet the project requirements and are listed in the QPL. Characteristics and details of each approved proprietary noise barrier product included in the QPL are listed in the Structures Design Office's web page.