

# CHAPTER 1100 – HIGHWAY TRAFFIC NOISE ABATEMENT

## Topic 1101 – General Requirements

### Index 1101.1 – Introduction

The abatement of highway traffic noise is a design consideration that is required by State and Federal Statutes and regulations and by Department policy. This chapter provides design standards relating to the location, height and length of noise barriers and includes discussion on alternative designs, maintenance and emergency access considerations and aesthetics of noise barriers. Procedures and policies on minimum attenuation, design goals, assessing noise impacts, noise abatement criteria levels, priorities, feasibility and reasonableness, and cost-effectiveness are contained in the Project Development Procedures Manual (produced by the Division of Design), the California Traffic Noise Analysis Protocol, and its companion publication, Technical Noise Supplement (both produced by the Division of Environmental Analysis).

### 1101.2 Objective

The objectives are: for new construction or reconstruction of highways, to limit the intrusion of highway noise into adjacent areas; on existing freeways to limit the noise intrusion to achievable levels within practical and financial limitations; and to limit the noise to the levels specified by statute for qualifying schools adjacent to freeways. To achieve these objectives the Department supports the following four approaches to alleviate traffic noise impacts:

- (1) *Reduction at the Source.* Reduction of traffic noise at the source is the most cost effective noise control strategy. Therefore, the Department encourages and supports design measures that reduce traffic noise impacts on adjacent roadside communities.

Designers are encouraged to consider mitigating traffic noise at the tire/pavement interface in order to minimize noise emanating from the highway. Quieter pavement strategies exist for flexible and rigid pavements on and off of structures. Refer to the Quiet Pavement Bulletin dated October 6, 2009 and the Pavement Program for more information. Low noise rumble strips are under development for reducing exterior roadside noise levels while maintaining or increasing interior vehicle noise and tactile feedback.

- (2) *Encouraging Compatible Adjacent Land Use.* The Department encourages local governments controlling development or land use near known highway locations to exercise their powers and responsibility to minimize the effect of highway vehicle noise through appropriate land use control. For example, cities and counties have the power to control development by the adoption of land use plans and zoning, subdivision, building and housing regulations.
- (3) *Noise Abatement.* The Department will attempt to locate, design, construct, and operate State highways to minimize the intrusion of traffic noise into adjacent areas. When this is not possible, noise impacts may be attenuated by the construction of noise barriers.

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Construction of noise barriers must result in at least a 5 decibel reduction of noise at the impacted receptors.

(4) *Noise Abatement by Others.* An increasing number of requests are being made to the Department by owners or developers to attenuate noise reaching adjacent properties for which the State's mitigation priority is low or nonexistent. The general policy is that all feasible steps must be taken in the design of the adjacent development to attenuate noise so as not to require encroachment on the State's right of way. The State shall assume no review authority or responsibility of any kind for the structural integrity or the effectiveness of the sound attenuation of walls constructed by others outside of the State's right of way. Where it is determined to be necessary to permit others to construct a noise barrier within the State's right of way, the general policy is that the design will meet geometric, structural, acoustic, and safety standards as established in this and other manuals and that the effects of the barrier on operation, maintenance and aesthetics of the highway will be more beneficial than detrimental.

### **1101.3 Terminology**

The terms "noise barrier" and "soundwall" are often used interchangeably. Technically, a "noise barrier" may be any feature which blocks, prevents or diminishes the transmission of noise. An earth berm could serve this purpose. A large building could serve as a noise barrier to shield receptors from the noise source. A dense growth of vegetation, if it were wide enough and dense enough, could be considered a noise barrier. Studies have shown, however, that adequate density would equate to a vegetative expanse of at least 100 feet. A "soundwall" is a particular type of noise barrier. It is a wall, which may be constructed of concrete panels, masonry blocks, wood boards or panels, or a variety of other materials.

### **1101.4 Procedures for Assessing Noise Impacts**

Highway traffic noise impacts are identified in the project noise study report and are listed in the environmental document. The procedures for assessing noise impacts for new highway construction or reconstruction projects, retrofit projects (Community Noise Abatement Program - HB311) along existing freeways, and School Noise Abatement Projects (HB312), are included in Title 23, United States Code of Federal Regulations Part 772, the California Traffic Noise Analysis Protocol, the Project Development Procedures Manual, and Section 216 of the Streets and Highways Code.

### **1101.5 Prioritizing Construction of Retrofit Noise Barriers**

Legal requirements and procedures for prioritizing the construction of noise attenuation barriers are provided in Section 215.5 of the Streets and Highway Code and in the California Traffic Noise Analysis Protocol.

## Topic 1102 – Design Criteria

### 1102.1 General

This section covers the noise barrier location, various design aspects such as height and length of noise barriers, alternative designs, maintenance considerations, and aesthetic considerations. Various types of Department standards and pre-approved alternative noise barrier designs are referenced. Noise barrier design procedures, from the acoustical standpoint, are included in the California Traffic Noise Analysis Protocol. Noise level criteria and guidelines on noise reduction can be found in the California Traffic Noise Analysis Protocol and the Project Development Procedures Manual.

### 1102.2 Noise Barrier Location

- (1) *Lateral Clearances.* **Minimum lateral clearance to noise barriers shall be as provided in Topic 309.1, Horizontal Clearances, of this manual, but shall not be less than 10 feet.** Lateral clearances greater than the minimums should be used whenever feasible. Where terrain permits, the most desirable location for a noise barrier from a safety perspective is just inside the right of way or, alternatively, 30 feet or more from the traveled way.

**When lateral clearance is 15 feet or less, the noise barrier shall be placed on a safety shape concrete barrier.** Guardrail or safety shape barrier protection should be considered when the noise barrier is located between 15 feet and 30 feet from the edge of traveled way.

When the noise barrier is placed closer than 16 feet from the traveled way, Traffic Operations should be consulted early in the design. Signs (overhead and ground mounted) and other poles and standards for lighting, Transportation Management items, call boxes, etc. should be detailed for mounting on the wall, incorporated into the wall foundation and possibly recessed into the surface of the wall.

- (2) *Sight Distance Requirements.* The stopping sight distance is of prime importance for noise barriers located on the edge of shoulder along the inside of a curve. Horizontal clearances which reduce the stopping sight distance should be avoided. Noise barriers within gore areas should begin or end at least 200 feet from the theoretical curb nose location.
- (3) *Ultimate Location.* Noise barriers should be constructed at the ultimate location – at the appropriate height and upon the proper foundation – for the facility as discussed in the Project Development Procedures Manual and the California Traffic Noise Analysis Protocol.

### 1102.3 Noise Barrier Height and Position

- (1) *Minimum Height.* Noise barriers should have a minimum height of 6 feet (measured from the top of the barrier to the top of the foundation).
- (2) *Maximum Height.* Noise barriers should not exceed 14 feet in height (measured from the pavement surface at the face of the safety-shape barrier) when located 15 feet or less from the edge of the traveled way, and should not exceed 16 feet in height above the ground line when located more than 15 feet from the traveled way.
- (3) *Truck Exhaust Intercept.* Current FHWA noise barrier design procedures result in noise barrier heights which often do not intercept noise emitted from the exhaust stack of trucks. For design purposes, the noise barrier should intercept the line of sight from the exhaust stack of a truck to the receptor. The truck stack height is assumed to be 11.5 feet above the

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pavement. The receptor is assumed to be 5 feet above the ground and located 5 feet from the living unit nearest the roadway. If this location is not representative of potential outdoor activities, then another appropriate location should be justified in the noise study report.

- (4) *Multi-story Development.* The noise barrier should not be designed to shield more than the first story of multi-story residences unless it provides a minimum reduction of 5 decibels for a substantial number of residences at a reasonable increase in cost. If the noise barrier is extended in height to provide attenuation beyond the first story, attenuation should effectively reduce noise by at least 5 decibels at the receptors precipitating the increase in height.
- (5) *Parallel Noise Barriers.* Frequently, noise barriers are constructed to shield noise receivers on both sides of a highway. These are referred to as parallel barriers. If the barrier surfaces are hard, relatively smooth, and nonporous, such as concrete or masonry surfaces, the barriers can reflect noise back and forth between the barriers, decreasing their effectiveness. As a result of research performed by the Department and others, reflective parallel barriers should have a width-to-height ratio (W:H) of at least 10:1 to avoid the risk of perceptible reduction in performance of both noise barriers. The width is the distance between the two barriers, and the height is the average height of both barriers with reference to the roadway elevation. For example, two parallel barriers, one 10 feet, the other 14 feet high, should be separated by at least 120 feet to avoid a noticeable degradation in performance. A perceptible, or noticeable decrease in performance is defined as a reduction of 3 decibels or more in noise attenuation.
- (6) *Potential Reflection.* Reflected noise may be an issue for elevated receptors on the opposite side of the roadway. Paving to the base of the noise barrier can create a 'hard' surface and in combination with a soundwall can form a concave shape which might focus sound energy on an opposite roadside community. When possible, keep the finish grade to the base of the noise barrier composed of less-reflective 'soft' material such as uncompacted dirt or ground vegetation. Parallel barriers (discussed above) may also raise reflected noise concerns. Traffic variation and metrological influences make noise measurements at large distances imprecise, while extensive noise studies in the past are inconclusive at finding any distinguishable or discernable change in acoustics due to reflection only. To address concerns and/or complaints regarding reflected noise, a number of absorptive noise barrier systems have been pre-approved for use both on and off of structures. The list of pre-approved absorptive noise barrier systems is available on the Division of Engineering Services Authorized Materials List at: <http://www.dot.ca.gov/aml/>.

## 1102.4 Noise Barrier Length

- (1) *General.* Careful attention should be given to the length of a noise barrier to assure that it provides adequate attenuation for the end dwelling. The California Traffic Noise Analysis Protocol provides guidance on determining how far beyond the end dwelling a noise barrier should be extended. When appropriate, consideration should be given to terminating the noise barrier with a section of the barrier perpendicular to the freeway. This could reduce the overall barrier length, but may require an easement or acquisition from the property owner to permit construction of the noise barrier off the right of way.
- (2) *Gap Closures.* In some cases, short gaps may exist between areas qualifying for a noise barrier. The closure of these gaps should be considered on a project by project basis and be justified in the project report.
- (3) *Local Street Connections.* At on- and off-ramp connections to local streets, the Department's responsibility for noise abatement should be limited to areas where the traffic noise level from the State highway is the predominant noise source.

- (4) *Barrier Overlaps.* When the noise barrier has overlapping sections, such as when concealing an access opening, the walls must be overlapped a minimum of 2.5 to 3 times the offset distance in order to maintain the integrity of the sound attenuation.

## 1102.5 Alternative Noise Barrier Designs

- (1) *General.* Every noise barrier that is constructed as a part of new highway construction or reconstruction, or along freeways as a part of the Community and School Noise Abatement Programs, requires at least two alternative designs included in the bid package. Bridge Reference Specifications 51-561(51SWAL), located on the Division of Engineering Services (DES) website provides the means to include alternative soundwall systems in the bid package. The contract plans should include masonry block as the state design and at least one of the approved soundwall systems listed in the Specification 51-56 (51SWAL). An aesthetic features sheet should be included in the plans for both the masonry block soundwall and for each of the alternatives selected.

The masonry block soundwall sheets (B15-1 to B15-15) can be found in the Standard Plans.

Other design alternatives may be considered provided they meet the structural and noise attenuation criteria. Questions regarding the approval status of various designs or products should be directed to the Division of Design, Office of Innovative Design and Delivery.

Project Files for each noise barrier project should include the justification and background for the design type or the options allowed on each project.

- (2) *Design Procedures.* As a minimum, the soundwall plans are to show each of the following:

- Horizontal alignment
- Wall profile made up of a top of Soundwall line and a Top of Footing/Concrete, Barrier/Retaining Wall line
- Applicable standard soundwall detail sheets
- Pile spacing
- Footing steps
- Locations of expansion joints
- Access gates
- Aesthetic features sheet

The following guidance should also be used:

- If the profile grade of the soundwall exceeds six (6) percent, the Top of the Soundwall line should be stepped.
- If the soundwall is on a footing and the Top of Soundwall line is stepped, the Top of Footing line should also be stepped.
- If the Top of Soundwall line is parallel to the profile grade, the Top of Footing line should be parallel to the profile grade of the soundwall.
- If the soundwall is on a concrete barrier, the Top of Concrete Barrier line must be constant height above the profile grade and the Bottom of Concrete Barrier line should be shown on the plans.

If the soundwall is on a Retaining Wall, the Top of Retaining Wall line or the Bottom of Footing line and Retaining Wall height should be shown on the plans.

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- The original ground (OG) line and any known utilities should be shown on the Soundwall Plan sheets.

(3) *Pay Quantities.* Soundwalls are to be measured by the square foot between the elevation lines shown on the plans and the length of the wall. Soundwall footings are to be paid as minor concrete and concrete barriers are to be paid for as concrete barrier (modified). Piles are to be paid for separately to facilitate minor changes in the field.

Refer to the Standard Special Provisions for more information on measurement and pay quantities.

When calculating costs for determining “reasonableness,” all pay quantities associated with the proposed soundwalls should be included in the analysis. Refer to the California Traffic Noise Analysis Protocol for a discussion on this topic.

(4) *Working Drawings.* Working Drawings are no longer required for state designed masonry block soundwalls in view of the fact that all the information necessary to construct the wall should be shown in the contract plans. The Special Provisions for Alternative Soundwall systems should require the successful bidder to submit four (4) sets of drawings for initial review and between six (6) and twelve (12) additional sets, as requested by the Engineer, for final approval and use during construction. Refer to Bridge Reference Specification 51-561(51SWAL) for more information.

(5) *Preliminary Site Data.* In using the "Top of Soundwall/Bottom of Concrete Barrier" line concept, it is important that the preliminary site data be as complete as possible. To eliminate or minimize construction change orders the following guidance is provided:

- Provide accurate ground line profiles.
- Select only standard or pre-approved design alternative soundwall types.
- Provide adequate information based on foundation investigation.
- Locate overhead and underground utilities.
- Review drainage and show any modifications on the plans.
- Determine and specify architectural treatment.
- Determine the need for special design, and coordinate with the Office of Structures Design during the early stages of design.

## 1102.6 Noise Barrier Aesthetics

(1) *General.* A landscaped earth berm or a combination wall and berm tend to minimize the apparent noise barrier height and are an aesthetically acceptable alternative among noise barrier options; however, these alternatives are not always suitable for many sites due to limited space.

Some additional cost to enhance the aesthetic quality of the noise barrier is usually warranted. Early community involvement toward proposing aesthetic treatment improvements on noise barriers is recommended to accommodate contextual considerations. However, accountability for designs that significantly increase the cost of the noise barrier should be a topic for discussion early in the design process.

Soundwalls should not be designed with abrupt beginnings or ends. Generally, the ends of the soundwall should be tapered or stepped if the height of the soundwall exceeds 6 feet. See Standard Plans for further details. Consult the District Landscape Architect regarding the design of tapers or stepped ends, aesthetic treatment, highway planting and landscaping adjacent to noise barriers. Refer to DIB 88 for additional information.

- (2) *Aesthetic Treatment.* Standard aesthetic treatments have been developed by the DES Office of Structure Design for the various alternative materials.

When treatment that is not a standard aesthetic treatment is proposed for noise barriers, contact the District Landscape Architect for selection of the most appropriate treatment. The District Traffic Engineer or designee should be consulted in these instances to ensure that the treatment of choice satisfies all safety requirements.

- (3) *Planting Near Noise Barriers.* The use of plants in conjunction with noise barriers can help to combat graffiti and promote public acceptance of the noise barrier. When landscaping is to be placed adjacent to the soundwall, which will eventually screen a substantial portion of the wall, only minimal aesthetic treatment is justified. Coordinate with District Maintenance when planting near or on noise barriers.

See Index 904.7 and the Project Development Procedures Manual for additional information.

- (4) *Transparent Barriers.* Noise barriers may impact viewsheds where consideration of transparent barriers may be warranted. A list of pre-qualified transparent barrier systems is available on the Authorized Materials List at: <http://www.dot.ca.gov/aml/>.

## 1102.7 Maintenance Consideration in Noise Barrier Design

- (1) *General.* Noise barriers placed within the area between the shoulder and right of way line complicate the ongoing maintenance operations. When there is a substantial distance behind the noise barriers and in front of the right of way line, special consideration is required. If the adjoining land is occupied with streets, roads, parks, or other large parcels, an effort should be made during the right of way negotiations to have the abutting property owners maintain the area. In this case, the chain link fence at the right of way line would not be required. Maintenance by others may not be practical if a number of small individual properties abut the noise barrier.
- (2) *Access Requirements.* Access to the back side of the noise barrier must be provided if the area is to be maintained by the Department. In subdivided areas, access can be via local streets, when available. If access is not available via local streets, access gates or openings are essential at intervals along the noise barrier. Access may be provided via offsets in the barrier. Offset barriers must be overlapped a minimum of 2.5 to 3 times the offset distance in order to maintain the integrity of the sound attenuation of the main barrier. Location of the access openings must be coordinated with the District maintenance office.
- (3) *Noise Barrier Material.* The alternative materials selected for the noise barrier should be appropriate for the environment in which it is placed. For walls that are located at or near the edge of shoulder, the portion of the noise barrier located above the safety-shape concrete barrier should be capable of withstanding the force of an occasional vehicle which may ride up above the top of the safety barrier.

## 1102.8 Emergency Access Considerations in Noise Barrier Design

- (1) *General.* In addition to access gates being constructed in noise barriers to satisfy the Department's maintenance needs, they may also be constructed to provide a means to access the freeway in the event of a catastrophic event which makes the freeway impassable for emergency vehicles. These gates are not intended to be used as an alternate means of emergency access to adjacent neighborhoods. Access to those areas should be planned and provided from the local street system. Small openings may also be provided in the noise barrier which would allow a fire hose to be passed through it. Local

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emergency response agencies should be contacted early in the design process to determine the need for emergency access gates and fire hose openings.

- (2) *Emergency Access Gate Requirements.* Access gates in noise barriers should be kept to a minimum and should be at least 1,000 feet apart. Locations of access should be coordinated with the District Maintenance office. Only one opening should be provided at locations where there is a need for access openings to serve both the emergency response agency and the Department's maintenance forces. Gates should be designed to comply with the soundwall details developed by the Office of Structures Design.
- (3) *Fire Hose Access Openings.* When there is no other means of providing fire protection to the freeway, small openings for fire hoses may be provided. Fire hose access should be located as close as possible to the fire hydrants on the local street system. Where possible, fire hose access should be combined with emergency or maintenance access openings. The Office of Structures Design should be requested to design fire hose access openings.

### **1102.9 Drainage Openings in Noise Barrier**

Drainage through noise barriers is sometimes required for various site conditions. Depending on the size and spacing, small, unshielded openings at ground level can be provided in the barriers to allow drainage and not adversely impact the noise attenuation of the barrier. The following sizes of unshielded openings at ground level are allowed for this purpose:

- (a) Openings of 8" x 8" or smaller, if the openings are spaced at least 10 feet on center.
- (b) Openings of 8" x 16" or smaller, if the openings are spaced at least 20 feet on center, and the noise receiver is at least 10 feet from the nearest opening.

The location and size of the drainage openings need to be designed based on the hydraulics of the area. The design should take into consideration possible erosion problems that may occur at the drainage openings.

Where drainage requirements dictate openings that do not conform to the above limitations, shielding of the opening will be necessary to uphold the noise attenuation of the barrier. The shielding designed must consider the hydraulic characteristics of the site. When shielding is determined to be necessary, consultation with the District Hydraulics Unit and the District Traffic Safety Engineer or designee is recommended, as well as the Division of Environmental Analysis.