CHAPTER TWO

MISCELLANEOUS DESIGN CRITERIA

GLARE SCREENS 2-1

Background: The following information is from "Evaluation of Glare Screens-Final Report, November 2, 1988," prepared by Ashley B. Vaughn.

A copy of this report is on file in the Roadway Design Library and in the Transportation Program Management Unit.

Additional information on glare screens mounted on guardrail can be found in the Roadway Standard Drawings, Std. No. 866.05.

I. Criteria for Use of Glare Screens

a. Glare screens should be considered in the median on multilane highways, in interchange areas, and where service roads are in close proximity to major arterials.

b. Opposing traffic with 20' or less of separation should be highly considered for using a glare screen.

c. Widths of 21' to 50' should be considered on a project by project basis and justified using the following criteria:

New Facilities
- Vertical and horizontal alignment
- Traffic volumes
- Field review of graded roadway

Existing Facilities
- Accident experience
  a. Day/night ratio of accidents
  b. Age of drivers in night accidents
  c. Unusual distribution by type of accident
- Day/night traffic volumes
- Public input
- Vertical and horizontal alignment
- Measure of glare (Use Pritchad Photometer)

d. Traffic separated by 50′ or more, will not need glare screens.

GLARE SCREENS (continued) 2-1

e. Normal height should be 50″ and up to 80″ in sag verticals.

f. Cutoff angle for opposing highlight glare for screens on tangent alignments is twenty degrees (20°). The cutoff angle for screens on horizontal curves should be twenty degrees (20°) plus degree of curvature.

II. Types of Glare Screens

a. Type I - A continuous screen that is essentially opaque to light from all angles.

b. Type II - A continuous screen of an open material that is opaque to light at angles to about 20 degrees and increasingly transparent beyond 20 degrees.

c. Type III - Individual elements positioned to block light at angles from 0 degrees to 20 degrees. Beyond 20 degrees visibility is clear between the elements.

The following types of glare screens are recommended:

Plants
Extended Concrete Barrier
½" Mesh Chain Link Fence (Vinyl Coating Optional)
Modular Guidance System

The State Roadway Design Engineer's approval will be required for any use of glare screen in areas other than interchanges or in areas in the 21′ to 50′ width. The submittal should include drawings and justifications.

CLIMBING LANES 2-2

A climbing lane is the response to the increasing amount of traffic delays and the number of serious crashes occurring on grades due to heavy loaded and slow moving vehicles.
Consideration should be done during the original construction planning stage and on Safety Improvement Projects.

Criteria for recommending and designing climbing lanes is outlined in A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (2011), ch. 3. and the Highway Capacity Manual, Chapter Three.

CLIMBING LANES (continued) 2-2

Report No. FHWA-IP-88-015 Grade Severity Rating System (GSRS) can be used to determine the maximum safe descent speeds for trucks according to weight and to determine the need for an auxiliary lane.

Additional information on climbing lanes can be found in the FHWA Report: "New Methods for Determining Requirements for Truck-Climbing Lanes" located in the Roadway Design Library and/or Transportation Program Management Unit Library.

The locations proposed by the Project Engineer shall be discussed with the Assistant State Roadway Design Engineer. Justification studies and cost estimates will be required when the Project Engineer proposes climbing lanes.

PEDESTRIAN OVERPASSES 2-3

Pedestrian overpasses should be included in the environmental document for the project. If the potential need for the overpass is determined during the design phase of the project, then a request and justification should be made to the Project Development and Environmental Analysis Branch. The design of pedestrian overpasses should be submitted to the Federal Highway Administration and/or the Structure Design Unit as a structure recommendation report using the A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (2011), CH. 4.

PEDESTRIAN UNDERPASSES 2-3A

Pedestrian underpasses should be considered where greenway facilities with pedestrian or bicycle use are existing or part of a planned system. Underpasses for greenways that are determined by using floodway maps and have not been designated as actual 'trails' can be constructed if the city or county supplements the cost.

APPALACHIAN NATIONAL SCENIC TRAIL 2-4

Projects conflicting with the Appalachian National Scenic Trail should be included in the environmental document and any mitigation should be resolved at the planning stage. Trail crossings of any project on new location will most likely require a grade separation.

TRUCK ESCAPE RAMPS 2-5

Truck escape ramps have generally been used on long mountain grades in rural areas. They should also be considered in urban areas on steep, short grades where high truck volumes are mixed with dense traffic and development. The urban areas have a higher probability of fatalities or property damage than the rural areas especially if a stop condition or turn occurs at the bottom of the grade.

It has also been suggested that an area should be provided at the top of the grade for truckers to check their brakes, read any information available about the upcoming grade and shift to the correct gear for the downgrade.

Justification for truck escape ramps (TERs) involve several considerations and have not been formalized into specific warrants or processes. The principal factor for a TER need is determined by runaway accident experience. Site conditions such as grade length, percent of grade, a combination of horizontal alignment, and end-of-grade conditions weigh about equally.

Average daily traffic and percent trucks count about the same as site conditions. Although available right of way and topography are factors in site selection, they are not factors in determining the need for a ramp.

The "Grade Severity Rating System (GSRS)" was developed to determine the maximum safe speed for vehicles of different weights. It can also be used to establish the need and location for truck escape ramps by calculating the brake temperatures at ½ mile intervals on a grade. A computer program is available with this report.

Also, available in the Roadway Design Unit library is a very informative Transportation Research Board publication:

"NCHRP Synthesis 178
Truck Escape Ramps
A Synthesis of Highway Practice"

Limited information is also available in " A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (2011), CH. 3. Additional research information is available in the Special Services Group, Transportation Program Management Unit.

BARRIERS FOR NOISE ABATEMENT 2-6

Type I Projects

A Type I project is defined as a proposed Federal, or Federal-aid highway project for the construction of a highway on new location or the physical alterations of an existing highway which significantly changes either the horizontal or vertical alignment, or increases the number of through-traffic lanes. For Type I projects, the consideration of noise abatement as a part of the highway construction project is mandatory if Federal-aid funds are to be used and if a traffic noise impart is expected to occur.

Type II Projects

The only purpose of a Type II project is to construct noise abatement along an existing roadway. NCDOT does not participate in retrofitting (Type II) projects.

Information for the Public and Local Officials:

In an effort to prevent future noise impacts on currently undeveloped lands, NCDOT will use the following criteria:

A. The "Date of Public Knowledge" of the locations of a proposed highway project will be the approval date of CE's, FONSI's, ROD's, or the Design Public Hearing, whichever comes later. After this date, the Federal/State governments are no longer responsible for providing noise abatement measures for new development for which building permits are issued within the noise impact area of the proposed highway project.
B. For development occurring after this public knowledge date, it is the responsibility of the local governing bodies to insure that noise compatible designs are utilized.
C. The date for determining when undeveloped land is "….planned, designed, and programmed…" for development will be the issuance of a building permit for an individual site.

During the project development stage of a proposed highway project, informational meetings, both formal and informal, will be conducted to solicit comments, opinions, and concerns from local officials and the public. A list of potentially affected areas and reasonable and feasible noise abatement measures will be developed by the Air and Noise Sections of the Project Development and Environmental Analysis Branch. These noise sensitive areas will be addressed in environmental documents prepared for the project.

BARRIERS FOR NOISE ABATEMENT (continued) 2-6

Likely noise abatement measures will be presented and discussed at the Design Public Hearing. Following public comment, a Final Noise Report will be prepared. Abatement design measures deemed reasonable, feasible, and cost effective by staff Engineers, will be incorporated into this report and presented at a final meeting. In this forum, the opinions of the impacted residents are once again solicited to make a final determination on the reasonableness and feasibility of noise abatement.

The Department of Transportation will furnish the results of all highway traffic noise analyses to local government officials within whose jurisdiction a proposed highway project is located. Specifically, environmental documents and design noise reports will contain noise contours and other pertinent design information. Local officials should coordinate and distribute this information to the local area affected. Following this procedure will encourage planners, developers, and affected communities to practice noise compatible development.

Sound and Noise

Sound is created when an object moves. This movement causes vibrations or waves in air molecules like ripples on water. When vibrations reach our ears, we hear sound. Sound is quantified by a meter, which measures units called decibels (dB). For highway traffic noise, an adjustment or weighting of the highway and low-pitched sounds is made to approximate the way that an average person hears sound. The adjusted sounds are called "A-weighted level" (dBA).

Noise is defined as unwanted or excessive sound. It is an undesirable by-product of our modern way of life. Noise descriptors such as Leq are used to describe the time-varying nature of noise. In noise abatement studies, Leq(h) or hourly equivalent sound level, is defined as the constant, average sound level, which over a period of time contains the same amount of sound energy as the varying levels of the traffic noise.

Noise Abatement / Impact Determination

In NCDOT highway projects, traffic noise abatement must be considered when either of the following two conditions exist.

BARRIERS FOR NOISE ABATEMENT (continued) 2-6

A. The predicted design year noise levels approach or exceed those values shown for the appropriate activity category of the FHWA Noise Abatement.

Please note: NCDOT has defined approach values as being 1 dBA less than those in the table and; the design year is 20 years after the start of construction.

B. The predicted design year noise levels substantially exceed existing noise level as defined below:

Existing (Leq(h)	Increase
≤ 50 dBA	> 15 dBA
> 50 dBA	≥ 10 dBA

Please note: Depending on the existing noise levels, NCDOT uses both a 10 dBA increase to define a substantial increase. This sliding scale allows a greater increase at a lower existing noise level before a substantial increase is defined. A 10 dBA increase is judged by most people as a doubling of the loudness of the sound; a 15 dBA increase represents more than a doubling of the loudness.

Since NCDOT has no Type II program, noise abatement will generally not be considered for heavy maintenance, rehabilitation projects and existing conditions.

Feasibility and Reasonableness

After a determination has been made to consider noise abatement under A&B above, several factors including benefits, cost of abatement, and overall social, economic, and environmental effects should be examined to determine both the feasibility and reasonableness of constructing a noise abatement device.

BARRIERS FOR NOISE ABATEMENT (continued) 2-6

A. Feasibility: Feasibility deals primarily with engineering considerations. The following items should be considered in order to determine feasibility.

1. Can a barrier be built given the topography of the location?
2. Can a minimum 5 dBA reduction, but preferably 8 dBA or more, be achieved for design receptors (first row receptors) given certain access, drainage, safety, or maintenance requirements?
3. Is other noise sources present in the area?
4. Can noise reduction (insertion loss) provided by the wall be a minimum 5 dBA, but preferably 8 dBA or more, for design receptors (first row receptors) ?
5. Unless special conditions exist and effective abatement can be provided, it is not considered feasible to provide noise abatement on non-controlled or partial access controlled facilities.

B. Reasonableness: Reasonableness is a more subjective criterion. It should show that common sense and good judgement were used in arriving at a decision. A determination of reasonableness should include the following:

1. Barrier Cost - the abatement measure should be cost effective. Cost effective is defined as $25,000 (construction cost) per effectively protected (5 dBA or more reduction) residence.
2. Barrier Height - The exposed height of a wall should not exceed a maximum of 25 feet.
3. Barrier Scale Relationship - It generally will not be reasonable to provide abatement unless the receptor is located a distance of four times the height of the wall or more from the proposed wall. Noise walls have a dominant visual effect on receptors in close proximity to the wall.
4. Difference Between Existing and Future Noise Levels - It generally will not be reasonable to provide abatement if the change in existing noise levels and design year noise levels are 3 dBA or less (a barely perceptible change).
5. Opinions of the Impacted Residents - There must be documented support of the benefited residents (those that receive a 5 dBA or more reduction by the construction of the abatement measure). These opinions are solicited at informal and formal meetings, depending on the scope of the project.

BARRIERS FOR NOISE ABATEMENT (continued) 2-6

6. Unless special conditions exist, it is not considered reasonable to provide noise abatement for impacted businesses or isolated receptors. Businesses generally prefer visibility from the transportation facility. Based on past project experience, it is considered unreasonable to provide abatement for isolated residences, due to the cost of abatement versus the benefits provided.

7. Unless special conditions exist and effective abatement can be provided, it is not considered reasonable to provide noise abatement on non-controlled or partial access controlled facilities.

8. The noise barrier will be located beyond the clear recovery zone or incorporated into safety devices.

9. In areas of impacted receptors where abatement measures have been considered, a vegetative barrier may be considered for aesthetic screening, even though an acoustical barrier is not justified.

The above listing is not intended to be all encompassing. Rather, it is intended to indicate some of the factors that should be considered in determining the reasonableness of proposed noise abatement measures.

It is the Policy of NCDOT that the type of material used in construction of these structures should be an engineering decision based on economics, effectiveness, and to a limited degree, visual impact. Visual impact considerations will assure the proposed barrier meets a basic aesthetic level and a basic durability level such that deterioration or excessive corrosion will not occur during the design life of the barrier.

It is also part of this Policy to have traditional highway resources pay for the required noise abatement. Should a local jurisdiction request that a material be used for the noise barrier that is more costly than that proposed by NCDOT, the requesting body must assume 100% of the additional cost.

If a local jurisdiction insists on the provision of a noise abatement measure deemed not reasonable by NCDOT, a noise barrier may be installed, provided the locality is willing to assume 100% of the cost of the abatement measure including but not limited to preliminary engineering, construction, maintenance, and that NCDOT's material, design and construction specifications are met.

BARRIERS FOR NOISE ABATEMENT (continued) 2-6

Additional information is available in the Transportation Program Management Unit. Information also can be found in the following publications:

1. "A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS" (2011), ch. 3 and ch. 4.

2. "Fundamentals and Abatement of Highway Traffic Noise" – Roadway Design Unit Library.

3. "Highway Traffic Noise in the United States: Problems and Response" – Roadway Design Unit Library.

CUL-DE-SACS 2-7

The Design Engineers should provide turn arounds on roads that are dead-ended. Cul-de-sacs should be provided if extensive right-of way costs are not required for their construction. Other type facilities should be considered in lieu of providing a simple barricade. For additional information on cul-de-sacs and dead-end streets, see A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS (2011), ch. 5. Also, see NCDOT "Subdivision Road Manual".

The cul-de-sacs shall be designed and discussed on the Preliminary Field Inspection. Usually when a street has to be dead-ended, the Division Engineer will be responsible for any administrative action required in closing the facility.

PLACEMENT OF CONTROL OF ACCESS FENCING BEHIND NOISE WALL 2-8

The Roadway Design Unit will coordinate with the Right of Way Branch and the Division Construction Engineer to determine the placement of the C/A fencing with respect to the location of noise walls.

The purpose of this guideline is to establish consistent placement of control of access fencing where noise walls are constructed. Generally, in roadway cut sections, the noise walls are set 5 feet inside the right of way and the C/A line. The 5-foot dimension is needed for construction working room. If the C/A fence is installed, this 5-foot spacing restricts maintenance/cleanup activities and duplicates the control of access function with both the wall and the fence. In roadway fill sections, the noise barrier is usually placed on the roadside shoulder, a significant distance from the R/W and C/A fence line. This configuration could result in an inaccessible area between the C/A fence and the wall. This policy addresses the options and recommendations for the wall and fence positions in these conditions. See Figure F-1 for reference.

Areas of New R/W Acquisition

In cut sections where new right of way is being purchased to contain the construction limits, the wall should be placed 5 foot inside the right of way and the control of access will be shown at the right of way line. In this case, the wall serves as a barrier and the control of access fence.

When the wall is in a fill section of the roadway shoulder, the normal C/A fence should be installed at the R/W line.

If an inaccessible area occurs between the wall on the shoulder and the C/A fence, maintenance access to this inaccessible area can be achieved via gaps or overlaps in the noise wall as it transitions from a cut to a fill section.

Areas of Construction within Existing R/W

On projects with the wall installation occurring in a roadway cut section inside the existing R/W (with an existing C/A fence), the wall is generally constructed 5 feet from this existing R/W line. Usually an existing fence is in place resulting in a confined strip, which is inaccessible for both NCDOT maintenance functions and the adjacent property

PLACEMENT OF CONTROL OF ACCESS FENCING
BEHIND NOISE WALLS (continued) 2-8

owners. The fence should be removed with the R/W line still labeled as the C/A limit. The wall will serve as the physical C/A barrier. With the fence removed, if the property owner wants to use the 5-foot area behind the wall, the Right of Way Branch can prepare an encroachment agreement. No improvements (structures, buildings, etc.) can be placed within the encroaching area by the adjacent property owners.

If an inaccessible area occurs between the wall on the shoulder and the C/A fence, maintenance access to this inaccessible area can be achieved via gaps or overlaps in the noise wall as it transitions from a cut to a fill section.

These situations should be discussed at the Preliminary Field Inspections by the Roadway Design staff and representatives from the Right of Way Branch and the Division Construction Engineer to determine the appropriate treatment on each project site.

FIGURE 1 **2–8**

F–1

PROPOSED PLACEMENT OF CONTROL ACCESS FENCING AT NOISE WALLS