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ALTERNATIVE NOISE BARRIER APPROVALS

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Alternative Noise Barrier Approvals

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16. Abstract
Current Illinois Department of Transportation (IDOT) policies specify that noise barriers can be constructed of earth, masonry, concrete, and composite materials. These IDOT policies specify that alternative noise barriers with specialty items and materials must meet a number of criteria such as minimum transmission loss, noise reduction coefficient, crash testing requirements, and material degradation. This report presents the findings of a research project funded by the Illinois Center for Transportation (ICT) to accurately describe and document this approval procedure to streamline and expedite the approval process of alternative noise barriers. The objectives of this project were to (1) Perform a comprehensive analysis to study the current IDOT alternative noise barrier approval procedure; (2) Conduct a survey to gather and analyze feedback from other state Departments of Transportation (DOTs) on their experiences in approving and utilizing alternative noise barriers; and (3) Develop recommendations that provide guidance to IDOT on expediting the approval process of alternative noise barriers.

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Members of the Technical Review Panel were the following:

- Scott Stitt, IDOT (Chair)
- Sam Mead, IDOT
- Tim Peters, IDOT
- Janis Piland, FHWA
- Laura Shanley, IDOT
- Filiberto Sotelo, IDOT
- Joseph Vespa, IDOT

EXECUTIVE SUMMARY

Current Illinois Department of Transportation (IDOT) policies specify that noise barriers can be constructed of earth, masonry, concrete, and composite materials. IDOT policies also specify that alternative noise barriers with specialty items and materials must meet a number of criteria such as minimum transmission loss, noise reduction coefficient, crash testing requirements, and material degradation. To accurately describe and document this approval procedure, a research project funded by the Illinois Center for Transportation (ICT) was conducted to streamline and expedite the approval process of alternative noise barriers. This report presents the findings of this research project. The objectives of this project were as follows:

- Perform a comprehensive analysis to study the current IDOT alternative noise barrier approval procedure. This analysis was executed in three steps that focused on (1) Performing a comprehensive review of all Federal laws and IDOT policies related to noise barriers; (2) Conducting interviews with IDOT officials and developing a flow chart and a step-by-step procedure to concisely describe current IDOT practices and policies for approving alternative noise barriers; and (3) Compiling a list of recommendations from interviewed officials that can be used to streamline and expedite the approval procedure.
- Conduct a survey to gather and analyze feedback from other state Departments of Transportation (DOTs) on their experiences in approving and utilizing alternative noise barriers. The survey was designed to collect data on (1) Noise barrier policies and approval criteria; (2) Timeline for reviewing and approving noise barriers, and approved noise barrier systems; (3) Performance of noise barrier materials; (4) Problems encountered with different noise barrier materials; and (5) Recommendations for expediting noise barrier approvals.
- Develop recommendations that provide guidance to IDOT on expediting alternative noise barrier approvals. These recommendations can be used by IDOT to update and/or expand related IDOT practices, policies, specifications, and standards.

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CHAPTER 1: INTRODUCTION

1.1 PROBLEM STATEMENT

Current Illinois Department of Transportation (IDOT) policies specify that noise barriers can be constructed of earth, masonry, concrete, and composite materials. IDOT policies specify that alternative noise barriers with specialty items and materials that have not been preapproved and covered by ASTM, AASHTO, or other IDOT specifications must have prior approval of the Illinois Highway Development Council (IHDC). Approval by the IHDC is dependent on meeting a number of criteria such as minimum transmission loss, noise reduction coefficient, crash testing requirements, and material degradation. This approval procedure needs to be accurately described and documented to streamline and expedite the approval process of alternative noise barriers.

1.2 RESEARCH OBJECTIVES AND METHODOLOGY

The main goal of this research project was to study, identify, and recommend the most effective and timely procedure and policy that can be used by IDOT for the approval of alternative noise barriers. To accomplish this goal, the research objectives of these project were:

1. Perform a comprehensive review of current IDOT policies and practices for alternative noise barrier approvals and develop a concise report describing these policies and practices.
2. Conduct a survey of other state DOTs to collect and analyze their pertinent policies and procedures.
3. Develop recommendations for IDOT policy based on the findings of the aforementioned two tasks.

1.2.1 Proposed Techniques and Methodology

The research team accomplished the project objectives by adopting a rigorous research methodology. The methodology breaks down the research work into three major tasks (see Figure 1) that are described in more detail in the following chapters and appendices.

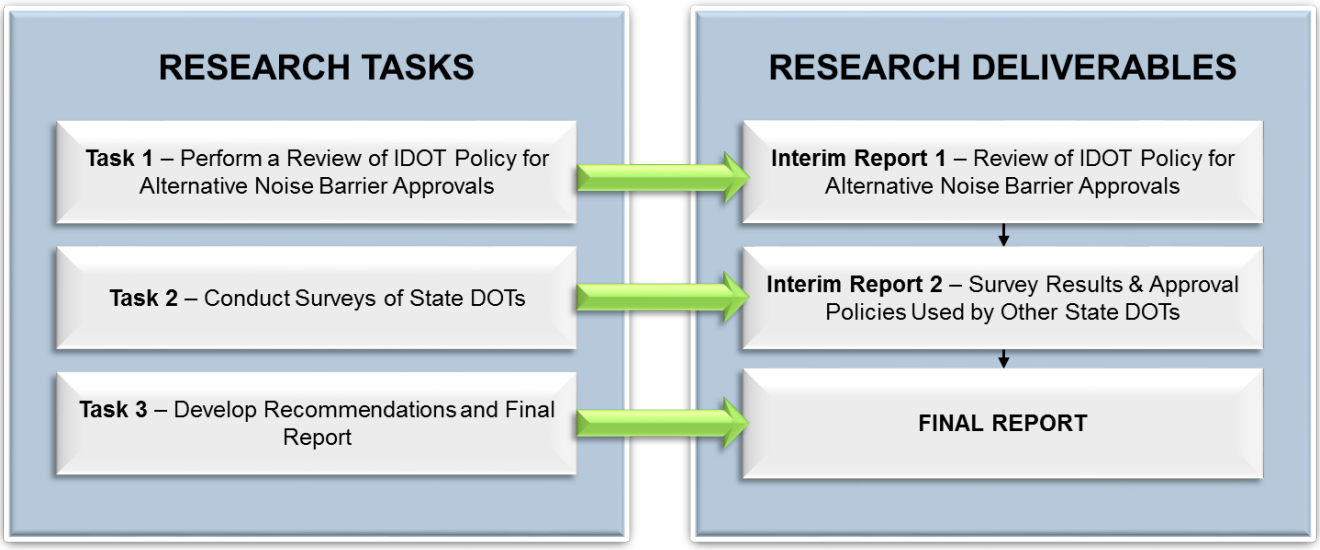

Figure 1. Research tasks and deliverables.

CHAPTER 2: REVIEW OF IDOT PRACTICES AND POLICIES FOR ALTERNATIVE NOISE BARRIER APPROVALS

This chapter describes the conducted analysis to study the alternative noise barrier approval procedure. This analysis was executed in three steps that focused on (1) Performing a comprehensive review of all federal laws and IDOT policies related to noise barriers; (2) Conducting interviews with IDOT officials and developing a flow chart and a step-by-step procedure to concisely describe current IDOT practices and policies for approving alternative noise barriers; and (3) Compiling a list of recommendations based on interviews and practices, that can be used to streamline and expedite the approval procedure. These three steps and their outcomes are described in the following sections of this chapter.

2.1 FEDERAL LAWS AND IDOT POLICIES FOR NOISE BARRIERS

This chapter provides a concise review of federal laws, regulations, and guidelines as well as IDOT policies that govern noise barrier approvals in Illinois. They collectively specify the requirements for analyzing traffic noise, noise abatement criteria, noise wall material effectiveness, and the funding of noise barrier walls. The conducted review in this chapter is organized into four sections that focus on (1) Related federal laws; (2) Federal regulations; (3) Federal guidance; and (4) IDOT policies.

2.1.1 Federal Laws

This section focuses on three Federal laws that collectively govern noise barriers, including federal-aid highways (23 U.S.C. 109), National Environmental Policy Act (NEPA) (42U.S.C. 4321 et seq.), and the Noise Control Act of 1972 (42 U.S.C. 4901 et seq.).

2.1.1.1 FEDERAL-AID HIGHWAYS (23 U.S.C. § 109(h) and (i))

One of the federal laws that governs highway noise barriers is included in Chapter 1 of Title 23 of the United States Code that is titled “Federal-Aid Highways” (23 U.S.C. § 109). Section 109 subpart (h) of Title 23 (23 U.S.C. § 109(h)) mandates the development of federal guidelines to assure that possible adverse economic, social, and environmental effects relating to any proposed project on any Federal-aid system have been fully considered in developing such project. This ensures that the final decisions of a project are made in the best overall public interest taking into consideration the need for fast, safe and efficient transportation, public services, and the costs of eliminating or minimizing adverse effects such as (1) Air, noise, and water pollution; (2) Destruction or disruption of man-made and natural resources, aesthetic values, community cohesion and the availability of public facilities and services; (3) Adverse employment effects, and tax and property value losses; (4) Injurious displacement of people, businesses and farms; and (5) Disruption of desirable community and regional growth (23 U.S.C. § 109(h)). Similarly, section 109 subpart (i) of Title 23 mandates the development of standards for controlling highway noise levels on federally funded highway projects (23 U.S.C. § 109(i)).

2.1.1.2 NATIONAL ENVIRONMENTAL POLICY ACT (42 U.S.C. § 4321 et seq.)

Another federal law relevant to highway noise is the National Environmental Policy Act (NEPA) (42U.S.C. 4321 et seq.). It established a broad framework for protecting our environment, which

includes both the natural and human environment. NEPA contains (1) A declaration of national environmental policies and goals; (2) The requirement for federal agencies to incorporate environmental considerations into planning and decision-making through a systematic interdisciplinary approach; and (3) The establishment of the Council on Environmental Quality to oversee NEPA implementation.

2.1.1.3 NOISE CONTROL ACT OF 1972 (42 U.S.C. § 4901 et seq.)

The third federal law that governs highway noise barriers is included in Chapter 65 of Title 42 of the United States Code that is titled "Noise Control" (42 U.S.C. 4901 et seq.). This federal law is commonly known as the Noise Control Act of 1972 and it is organized into 18 sections. The purpose of this law is to establish a means for effective coordination of federal research and activities in noise control, to authorize the establishment of federal noise emission standards for products distributed in commerce, and to provide information to the public on the noise emission and noise reduction characteristics of such products as noted in section 4901(b). Also, Section 4903(b) of Title 42 states in part "that each department engaged in any activity resulting, or which may result, in the emission of noise, shall comply with Federal, State, interstate, and local requirements respecting control and abatement of environmental noise" (42 U.S.C. 4901(b)).

2.1.2 Federal Regulations

Part 772 of Title 23 of the Code of Federal Regulations titled "Procedures for Abatement of Highway Traffic Noise and Construction Noise" (23 CFR § 772) establishes standards for abatement of highway traffic noise. This federal regulation provides procedures for noise studies and noise abatement measures to help protect the public health and welfare, to establish noise abatement criteria, and to establish requirements for information to be given to local officials for use in the planning and design of highways (23 CFR § 772.1). This federal regulation is organized into ten sections describing (1) The purpose of the statute; (2) Noise standards; (3) Definitions related to highway traffic noise evaluation; (4) Applicability of this regulation; (5) Traffic noise prediction; (6) Analysis of traffic noise impacts; (7) Analysis of noise abatement; (8) Eligibility requirements for federal funding, (9) Information for local officials, and (10) Construction noise. The Appendix contains Noise Abatement Criteria, which represent the upper limit of acceptable highway traffic noise for different types of land uses and human activities (23 CFR § 772.1 et seq).

2.1.3 Federal Guidelines

The federal guidelines that governs highway noise barriers are included in the Federal Highway Administration (FHWA) guidance that is titled "Highway Traffic Noise: Analysis and Abatement Guidance", December 2011. This document provides FHWA guidance for applying 23 CFR 772 in the analysis and abatement of highway traffic noise. Each section of 23 CFR 772 is discussed in detail, includes explanations, interpretations, and specific guidance for its implementation. The FHWA guidance also contains seven appendices that describe the (1) Noise analysis process; (2) Noise reporting; (3) Noise abatement measures; (4) Feasibility and reasonableness; (5) Type II program examples; (6) Determination of reasonable abatement cost; and (7) Highway traffic-induced vibration (FHWA 2011).

2.1.4 IDOT Policies Governing Noise Walls

This section focuses on IDOT policies that are directly related to highway noise wall approvals. These policies are described in two IDOT manuals: (1) Bureau of Design and Environment Manual, and (2) Highway Traffic Noise Assessment Manual.

2.1.4.1 BUREAU OF DESIGN AND ENVIRONMENT (BDE) MANUAL

The Bureau of Design and Environment (BDE) Manual provides IDOT personnel with procedures and practices for the development of roadway projects (IDOT 2018a). Chapter 26 of the BDE Manual, titled "Special Environmental Analyses", includes subchapter 26-6 titled "Noise Analyses" which describes the policies and procedures for conducting noise studies and noise abatement. The policies in subchapter 26-6 are organized into ten sections that focus on (1) Criteria and procedures; (2) Complimentary technical manual information; (3) Legal authority; (4) Federal and state policy; (5) Procedures for conducting a noise analysis; (6) Noise abatement wall materials; (7) Requirements for coordinating with local counties and municipalities; (8) Steps for addressing construction noise; (9) Required NEPA documentation, and (10) Validity of noise assessments (IDOT 2018a).

The aforementioned sixth section in subchapter 26-6, titled "Noise Wall Abatement Materials," is organized into five subsections that describe the (a) Physical requirements; (b) Acoustical specifications; (c) Aesthetic specifications; (d) Absorptive material considerations; and (e) Noise abatement wall maintenance. The main criteria for approving noise walls in Illinois are described in the first four subsections of section 26-6.06. The first of these four subsections is 26-6.06(a) and it focuses on the physical requirements of noise walls. It states in part that noise walls "will be constructed with a design life of 35 or more years, will be aesthetically pleasing, consistent with any neighboring design themes, easily maintained, and replaceable, if damaged; and, its material must be suitable for safe recycling." The second subsection, 26-6.06(b), focuses on the acoustical specifications of noise walls and it states in part that "noise wall materials must achieve sound Transmission Loss (TL) equal to or greater than 20 dB in all one-third octave bands from 100 hertz to 5,000 hertz, inclusive." The third subsection, 26-6.06(c), focuses on the aesthetic considerations and it states in part that "funding for aesthetics is assessed per individual project, and may require local (municipal or county) funding, based on FHWA and IDOT discretion." The fourth subsection, 26-6.06(d), focuses on absorptive material considerations and it states in part that "a noise abatement wall surface will qualify as "absorptive" provided that it achieves a composite Noise Reduction Coefficient (NRC) of at least 0.80 if on the roadway side of the wall, and a composite NRC of at least 0.65 if on the side of the wall away from the roadway" (IDOT 2018a).

2.1.4.2 IDOT HIGHWAY TRAFFIC NOISE ASSESSMENT MANUAL

The IDOT Highway Traffic Noise Assessment Manual, also known as the 'IDOT Noise Manual', was developed as a companion document to the noise policy presented in Chapter 26 of the aforementioned BDE Manual. It provides technical information and procedures that IDOT uses when performing highway traffic noise analyses in the State of Illinois (IDOT 2017a). This manual includes six sections that focus on (1) Noise fundamentals; (2) Noise regulations; (3) Traffic noise analysis; (4) Traffic noise abatement evaluation; (5) Construction noise; and (6) Traffic noise reporting. The

procedures presented in this manual are based on the FHWA "Highway Traffic Noise: Analysis Abatement Guidance", December 2011 previously discussed in Section 2.3 of this report.

The IDOT Noise Manual provides specific noise barrier material options unlike the previously discussed BDE Manual (section 26-6.06). Section 4.2.2 of the IDOT Noise Manual states that "Noise barriers in Illinois have been constructed of earth, masonry, concrete, and composite materials. Alternative noise barrier materials and/or designs may be considered by IDOT and FHWA Illinois Division on a case-by-case basis. Any proposed alternative noise barrier must meet IDOT specifications, notably the transmission loss specification" (IDOT 2017b). It should be noted that the aforementioned BDE manual section 26-6.06 did not describe specific material types, only noting their design life, aesthetics, maintainability, and recyclability (IDOT 2018a).

2.2 INTERVIEWS WITH IDOT OFFICIALS

This chapter describes the conducted analysis to study the IDOT alternative noise barrier approval process. This analysis was performed in three steps that focused on: (1) Identifying IDOT bureaus, offices, and officials who are involved in the approval of alternative noise barriers; (2) Conducting interviews with the identified IDOT officials in the first step to gather and analyze all IDOT practices and policies that govern the approval of alternative noise barriers; and (3) Developing a flowchart that concisely describes the IDOT alternative noise barrier approval process. These three steps and their outcomes are discussed in the following sections of this chapter.

2.2.1 Identifying IDOT Officials Experienced With Noise Barrier Approvals

In order to identify the IDOT bureaus, offices, and officials that need to be interviewed in this task, the research team obtained feedback and guidance from the Technical Review Panel (TRP). The TRP provided a list of 15 IDOT officials and two noise wall consultants, as shown in Table 1. In addition, the TRP provided contact information for each of the identified IDOT personnel who have experience with noise barriers. The IDOT personnel and consultants who were interviewed in this study and their associated bureau/office are listed in in Table 1.

Table 1. Interviewed IDOT Personnel and Consultants

Bureau/Office	Name	Type of Interview
Central Bureau of Materials & IHDC	Joseph Vespa	In Person
Central Bureau of Materials & IHDC	Michael Brownlee	In Person
Central Bureau of Materials	Hani Alnamer	In Person
Central Bureau of Materials	Allan Ma	In Person
Central Bureau of Local Roads and Streets & IHDC	Tim Peters	In Person
Bureau of Bridges and Structures	Kevin Riechers	In Person
Bureau of Bridges and Structures	Mark Shaffer	In Person
Bureau of Bridges and Structures	Mark Thomson	In Person
Bureau of Bridges and Structures	James Klein	Via Telephone
Bureau of Safety Programs and Engineering	Filiberto Sotelo	Via Telephone
Huff & Huff/GZA	Timothy Kelly	In Person
Huff & Huff/GZA	Jamie Tunnell Bents	Via Teleconference
District 1 – Local Roads	Chris Holt	Via Telephone
District 1 – Maintenance	Sarah Wilson	Via Telephone
District 1 – Maintenance	Jim Stumpner	Via Telephone
District 8 – Materials	Thomas Weck	Via Telephone
District 8 – Program Development	Jennifer Hunt	Via Telephone

2.2.2 Conducting Interviews

The research team scheduled meetings to interview each of the IDOT officials listed in Table 1. These meetings were conducted from December 5, 2017 to December 14, 2017. Interviewed personnel were asked to invite any employees with related experience on the alternative noise barrier approval process. The following sections provide a concise description of the interview procedure and its findings on the alternative noise barrier approval process.

2.2.2.1 CENTRAL BUREAU OF MATERIALS

The IDOT Central Bureau of Materials (CBM) is responsible for establishing policies and procedures that provide quality assurance of materials on Illinois highway projects. CBM operates under the policies and procedures set forth by the 'Manual of Test Procedures for Materials'. The conducted interview with the Central Bureau of Materials officials was held on December 5, 2017 from 2:00 pm to 5:30 pm, at the IDOT Central Bureau of Materials (CBM) office in Springfield, IL. The IDOT officials who participated in this interview were Joseph Vespa, Michael Brownlee, Hani Alnamer, and Allan Ma.

In this interview, the IDOT CBM officials described their involvement in approving alternative noise barriers for general use in Illinois. The IDOT officials detailed the alternative noise barrier approval process along with specific tasks and estimated range of durations for these tasks. If a product is rejected for any reason during the approval process, CBM notifies the alternative noise barrier manufacturer. The manufacturer has the option to revise and resubmit but must start the entire approval process again. CBM receives and reviews the independent lab testing results submitted by alternative noise barrier manufacturers. Alternative noise barriers are defined as any noise barrier that currently does not have an IDOT specification. The main criteria that CBM considers when reviewing alternative noise barriers are transmission loss (TL) of the material and noise reduction coefficient

(NRC) to determine reflective/absorptive classification. Upon completion of CBM review, CBM distributes the manufacturer submitted information to the IDOT Bureau of Design and Environment, the Bureau of Bridges and Structures, and the Bureau of Safety Programs and Engineering. After the completion of the review from these three bureaus, CBM creates an assessment report that is presented to the Illinois Highway Development Council (IHDC). Two interviewed IDOT CBM officials are also members of the Illinois Highway Development Council. Their collected feedback on the IHDC review procedures are discussed in section 3.2.5 of this report.

CBM does not normally review noise walls for specific projects. There are very rare cases where a noise barrier was requested to be used on a specific project while undergoing CBM review. In this case, CBM accelerated the review process to accommodate the Bureau of Local Roads and Streets and the community requesting that specific noise wall. This request was made possible through an Experimental Feature (EF) request (IDOT 2018b). An Experimental Feature is defined as a material, process, method, equipment item, traffic operational device, or other feature which: (1) Has not yet been sufficiently tested under actual field and operational conditions to merit acceptance without reservations in normal highway construction; or (2) Has been accepted, but needs to be compared with alternative acceptable features to determine relative merits and cost effectiveness. One or both of these criteria serve as the basis for whether or not the Experimental Feature is justified for inclusion into a specific IDOT project, and whether or not the Experimental Feature can gain FHWA approval for project specific use. For an experimental feature to be authorized or approved for inclusion in a project, an Experimental Features Work Plan must be prepared for approval by the Central Bureau of Materials (IDOT 2018b). Upon completion of this EF field trial, CBM will present an assessment report with a recommendation on the noise wall to the IHDC.

Additional findings from this interview on the noise wall approval procedure are combined and synthesized with those collected from the other interviewed IDOT officials and consultants, in order to provide a concise description of the current practices and policies used by IDOT for the approval of alternative noise barriers. The additional findings are discussed in Section 2.3 of this report.

2.2.2.2 CENTRAL BUREAU OF LOCAL ROADS AND STREETS

The Central Bureau of Local Roads and Streets (CBLRS) operates under the policies and procedures set forth by the 'Bureau of Local Roads and Streets Manual'. Local roads are classified as roads that are non-state highways and non-interstate highways. These roadways typically have significantly lower volume than highways and normally do not meet the criteria for noise impacts and abatement. Each IDOT district also has a local roads bureau that works with CBLRS. The conducted interview with the CBLRS official was held on December 5, 2017 from 11:00 am to 12:30 pm, at the IDOT central office in Springfield, IL. The IDOT official who participated in this interview was Tim Peters.

The Central Bureau of Local Roads and Streets (CBLRS) is not directly involved in the evaluation and approval process of alternative noise barriers for general use. However, the CBLRS can be involved in the review and approval of noise barriers for use on a specific project. In this case, the IDOT official reported that a noise analysis would be conducted on a local road if the proposed project includes a new alignment, increase of lanes, or another change that has the potential to significantly increase the volume of traffic. If this conducted noise analysis warrants the installation of a new noise barrier on

that specific project, and noise abatement is determined to be feasible and reasonable, construction of a noise barrier should be included as part of the roadway construction project. In this case, the district Bureau of Local Roads and Streets needs to solicit the viewpoint from benefited receptors to verify that a noise barrier is desired to abate the noise caused by the increased traffic volume. Upon receiving a favorable response to installing the noise barrier, the district utilizes a noise consultant to identify noise barrier options. The noise consultant works with the district and the community to determine specific details of the noise barrier (size, style, length, color, pattern, etc.). After these details are approved by all parties, the IDOT designer includes these specifications into the highway contract before letting.

If the noise barrier is being funded by state funds, motor fuel tax or other local funds, the district does not require approval from the central office as long as all the IDOT policies and procedures are being met. A local roads noise barrier can be federally funded through the Experimental Feature (EF) exclusion, where the noise wall can be any type or manufacturer (including sole source) as long as the project meets certain requirements (as discussed in the previous subsection 3.2.1).

2.2.2.3 BUREAU OF BRIDGES AND STRUCTURES

The Bureau of Bridges and Structures (BBS) is responsible for developing the structural design policies, specifications, and standards for IDOT. These policies and practices are maintained in the IDOT CADD Manual, IDOT Bridge Manual, structural sections of the IDOT Standard Specs, IDOT Culvert Manual, and IDOT Prestressed Concrete Manual (IDOT 2010). The BBS reviews the structural design plans, special provisions, shop drawings and construction submittals from the contractor for conformance with structural IDOT policies. The conducted interview with the Bureau of Bridges and Structures officials was held on December 14, 2017 from 9:00 am to 10:30 am, at the IDOT central office in Springfield, IL. The IDOT officials who participated in this interview were Kevin Riechers, Mark Shaffer, and Mark Thomson. Another interview with BBS official James Klein was held earlier on December 6, 2017 from 10:45 am to 11:00 am.

The Bureau of Bridges & Structures (BBS) approves noise barriers for general statewide use and reviews noise barriers on a project by project basis; specifically the design of structural components, connections, and drilled shaft diameters and depth. If a Special Provision exists for the use of noise barriers, the BBS will review the specific barrier design for conformance with IDOT structural specifications.

The scope of review by BBS depends on the type of noise barriers and whether it is ground mounted or structure mounted. For ground mounted noise barriers, the IDOT officials reported that BBS only reviews their foundation designs which can be completed in approximately 90 days. For structure mounted noise barriers, the BBS reviews all structure elements of the noise barrier system and that review can take significantly longer time that can extend up to two years. Structure mounted noise barrier designs must meet the criteria set in the American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications, and the vehicle loads from the AASHTO Manual for Assessing Safety Hardware (MASH 2016). If crash testing of the noise barrier is required, the review process can take up to two years. The interviewed officials reported that IDOT currently participates as pool funded members with two sites

in the US that perform crash testing. The BBS reported that crash testing is not purely quantitative and it often considers additional impacts such as shattering of material, toppling of the wall, deformation of noise panel, destruction of noise barrier system, and the response of the vehicle. This lengthy review and approval process makes the use of structure mounted noise walls undesirable. Additionally, IDOT officials reported that structure mounted noise barriers create potential safety hazards to motorists and other occupants in adjacent buildings.

IDOT officials reported that acrylic noise walls have grown in popularity over the past few years because they are the only noise wall system that has been crash tested and passed MASH 2016 criteria. IDOT currently has a special provision written for an Experimental Feature installed in 2017 that allows the use of acrylic noise barriers for a specific project. Each time an acrylic noise wall is proposed for a specific project, BBS edits the aforementioned IDOT special provision to address the specific needs of the new project. The BBS officials reported that it generally takes a minimum of five iterations of a project specific specification to become an IDOT special provision.

The interviewed officials reported that the design, construction, and maintenance of noise barrier systems are performed by different IDOT bureaus. They reported that the BBS reviews and approves the design, the Bureau of Construction manages the installation, and the Bureau of Maintenance performs post-construction maintenance. BBS does not inspect the structural integrity of the noise barrier system after construction unless specifically requested by the district. This inspection request can occur following a vehicular crash which may compromise the integrity of the noise wall. An inspection request can also occur if the noise wall foundation is exposed due to heavy erosion.

2.2.2.4 BUREAU OF SAFETY PROGRAMS AND ENGINEERING

The Bureau of Safety Programs and Engineering (BSPE) is responsible for providing IDOT with coordinated and focused engineering safety efforts for both state and local roadways. The BSPE develops, maintains, and implements (a) The Illinois Strategic Highway Safety Plan; (b) Roadway safety policies regarding roadside hardware; (c) Work zone traffic policies and requirements; (d) The Highway Safety Improvement Program; and (e) Training policies and procedures to enhance safety on Illinois roadways. Furthermore, the BSPE analyzes trends in fatal and serious injury crashes to provide data driven recommendations and strategies (IDOT 2010). The conducted interview with the BSPE official was held via telephone on December 4, 2017 from 3:00 pm to 3:30 pm. The IDOT official who participated in this interview was Filiberto Sotelo.

In this interview, the IDOT official stated that BSPE is the main resource for districts on general road hardware. BSPE reviews the manufacturer supplied safety information such as drawings, specifications, videos, and crash data. The safety information submitted by manufacturers must follow the procedures as described in the National Cooperative Highway Research Program Report 350 titled “Recommended Procedures for the Safety Performance Evaluation of Highway Features” (Ross Jr. et al. 1993) or Manual for Assessing Safety Hardware (MASH 2016). For noise walls, this testing procedure includes a number of motor vehicle crashes taken at speeds ranging from 50 to 60 mph at varying angles of impact (Ross Jr. et al. 1993). The BSPE reviews this safety information and makes a recommendation to reject, accept as is, or accept as field trial. This recommendation is included in the CBM assessment report and presented to the IHDC.

2.2.2.5 ILLINOIS HIGHWAY DEVELOPMENT COUNCIL

The Illinois Highway Development Council (IHDC) is an interdisciplinary council of approximately 16 IDOT officials that meets two to three times per year to review and give proper consideration to proposals from manufacturers, producers and others promoting new items for highway use (IHDC 2017). The IDOT officials who participated in this interview were Joseph Vespa and Michael Brownlee from CBM, and Tim Peters from CBLRS.

The IHDC provides the Chief Engineer of IDOT with competent advice on the value of new products, materials, and procedures that are offered or developed for use in the highway field (IHDC 2017). These new products are initially reviewed by four IDOT bureaus, namely the CBM, BBS, BSPE and BDE. Based upon the input from these bureaus, CBM creates an assessment report that is presented to the IHDC. After reviewing the assessment reports of these new materials, products and procedures, the IHDC can recommend to accept for immediate adoption, reject, or recommend for trial usage for further evaluation (IHDC 2017). According to IDOT officials, it is rare that the IHDC recommends to immediately adopt the use of a new product in IDOT projects. In recent years, products receiving a positive response from the IHDC have been recommended for field trials. The final approval or rejection of these new products will depend on the outcome of the completed field trials. For example, it is possible for a noise wall product to initially pass the reviews of CBM, BBS, BSPE and BDE and be approved for field trials by the IHDC, but be rejected by the IHDC after conclusion of the field trial, due to constructability, maintenance, or performance in other locations.

2.2.2.6 HUFF & HUFF/GZA

Huff & Huff/GZA (H&H) provides statewide noise consulting, environmental compliance services, and noise policy development for IDOT. The conducted interview with Huff & Huff/GZA was held on December 8, 2017 from 1:00pm to 2:30pm at the Huff & Huff/GZA office in Oak Brook, IL. The Huff & Huff/GZA officials who participated in this interview were Timothy Kelly and Jamie Tunnell Bents.

H&H personnel reported that they are not involved in the approval process for alternative noise barrier materials. The majority of H&H responsibilities are in conducting noise analyses as part of the Phase I environmental process. There are a few exceptions when H&H consulting services are required past Phase I. The solicitation of viewpoints from benefited receptors on their desire for a noise abatement barrier are normally required at the end of Phase I. However, in some cases the local community is reluctant to vote on whether or not they want a noise abatement barrier because no designs have been provided. This delays the solicitation of viewpoints into Phase II Design, instead of receiving them during the Phase I. This delay in the solicitation of viewpoints was experienced on the Eisenhower Expressway project (Interstate 290) near Oak Park in Cook County. H&H personnel reported that the public had concerns over the aesthetics of the noise barriers. Only half the residents of Oak Park voted in favor of noise barriers, mainly due to aesthetic concerns. The public was reluctant to vote on a noise barrier without knowing what it would look like. Additionally, the public wanted multiple options of noise barrier patterns to choose from. H&H personnel reported that Will County currently has five different styles of noise barrier patterns that are regularly used in an effort to minimize public concerns over their aesthetics.

H&H utilizes the FHWA Noise Model also known as Traffic Noise Model (TNM) to conduct the noise analyses of the impacted receptors. This noise model assists with determining the geometric design of the noise barriers including the barrier height, length, distance from noise source, and distance from receptors. The size and orientation of the barrier determines the estimated cost of the noise barrier.

H&H personnel reported that the complexity of a noise analysis and Environmental Impact Statement (EIS) are directly related to the complexity of the proposed project. H&H personnel reported that the absolute minimum duration for the noise analysis portion of the EIS can be six months.

2.2.2.7 DISTRICT INTERVIEWS

As part of the list of contacts to be interviewed, the TRP included five IDOT district contacts from four district bureaus. Through the discussions with these five IDOT officials, it was determined that the approval of alternative noise barriers are not conducted at the district level, but rather by the aforementioned IDOT bureaus and IHDC. The discussions with these IDOT district officials are grouped in the following four subsections.

2.2.2.7.1 District 1 – Bureau of Local Roads and Streets

The conducted interview with District 1 Bureau of Local Roads and Streets (BLRS) official was held via telephone on December 6, 2017 from 10:00 am to 10:15 am. The IDOT official who participated in this interview was Chris Holt.

In this interview, the IDOT official stated that District 1 BLRS is not involved in the review and approval of noise barriers. Additionally, the IDOT official reported that it is rare that noise barriers are installed on local roads in District 1. A vinyl noise barrier was installed on Eola Road in Aurora, IL in 2017 as part of an experimental feature.

2.2.2.7.2 District 1 – Bureau of Maintenance

The Bureau of Maintenance in District 1 is responsible for coordinating and implementing all activities for the preservation, maintenance, and roadside development of the State highway system in the district (IDOT 2017c). The conducted interview with the District 1 Bureau of Maintenance officials was held via telephone on December 6, 2017 from 11:45 am to 12:00 pm. The IDOT officials who participated in this interview were Sarah Wilson and Jim Stumpner.

In this interview, the IDOT officials stated that District 1 Bureau of Maintenance is not involved in the review and approval of noise barriers. The main involvement that the Bureau of Maintenance has with noise barriers is the repair and replacement of damaged noise barriers and the removal of graffiti. It should be noted that noise barriers damaged by weather or motor vehicle crashes are immediately repaired and/or temporarily secured by District 1 Bureau of Maintenance to ensure public safety, and then may be replaced at a later time when there is a need for the replacement of multiple noise barrier panels. For graffiti removal, District 1 Bureau of Maintenance will either power wash or paint over graffiti on noise barriers. Consideration of how this power washing or paint may affect the transmission loss or noise reduction of the noise barrier are not taken into account.

2.2.2.7.3 District 8 – Bureau of Materials

The conducted interview with the District 8 Bureau of Materials official was held via telephone on December 8, 2017 from 8:15 am to 8:45 am. The IDOT official who participated in this interview was Thomas Weck.

In this interview, the IDOT official stated that District 8 Bureau of Materials is not involved in the review and approval of noise barriers. District 8 Bureau of Materials performs quality assurance and quality control for noise barriers during the construction phase to verify that the noise wall materials meet the design specifications.

2.2.2.7.4 District 8 – Bureau of Program Development

The conducted interview with the District 8 Bureau of Program Development official was held via telephone on December 11, 2017 from 10:30 am to 10:45 am. The IDOT official who participated in this interview was Jennifer Hunt.

In this interview, the IDOT official stated that District 8 Program Development is not involved in the review and approval of noise barriers. District 8 Program Development works with the noise consultant Huff and Huff/GZA during Phase 1 to determine if a noise barrier is required for a specific project. Additionally, District 8 Program Development does not review or approve the types of noise barriers that can be installed.

2.3 IDOT PROCEDURES FOR APPROVING ALTERNATIVE NOISE BARRIERS

Based on the findings of the aforementioned review of related policies and the conducted interviews of IDOT officials, a flow chart and a step-by-step procedure were developed to concisely describe current IDOT practices and policies for approving alternative noise barriers. The developed flowchart provides a graphical representation of the sequence of approval activities/steps and their estimated range of durations, as shown in Figure 16 in Chapter 4. The identified approval activities/steps in this flowchart are described in more details in Table 34 in Chapter 4.

2.4 RECOMMENDATIONS TO STREAMLINE THE ALTERNATIVE NOISE BARRIER APPROVAL PROCESS

This chapter summarizes the provided recommendations by the interviewed IDOT officials and consultants to streamline the alternative noise barrier approval process. These recommendations have been organized into three sections that match the first three development phases of IDOT highway projects: (1) Phase I Preliminary Engineering; (2) Phase II Design; and (3) Phase III Construction (IDOT 2018a). The main reason for this organization is that all the aforementioned noise wall approval activities/steps are performed during these three phases.

2.4.1 Phase I Preliminary Engineering Recommendations

The IDOT noise consultant Huff & Huff/GZA (H&H) provided the following suggestion on streamlining the alternative noise barrier process during the preliminary engineering phase. Public outreach is normally conducted at the end of Phase I by soliciting viewpoints from the benefited receptors. During

this time, benefited receptors vote on their desire for implementation of the noise barrier, but many of them are reluctant to vote without knowing the aesthetics options of the noise barrier. Noise barrier aesthetic options are completed by the IDOT designer at the end of Phase II, after the benefited receptors have agreed on the implementation of a noise barrier. H&H suggested that preliminary public outreach should be incorporated into Phase I to assess the public viewpoints and their willingness to implement the proposed noise barrier. This allows further participation in Phase II so the public is not surprised by the available options. Additionally, introducing the IDOT designer into the late stages of Phase I provides a continuous point of contact and could help alleviate public concerns with the implementation and aesthetics of the proposed noise barrier.

2.4.2 Phase II Design Recommendations

The interviewed IDOT Bureau of Bridges and Structures officials recommended providing an IDOT preapproved list of noise barriers to contractors during letting. A preapproved list would reduce the delays and costs related to the contractor requesting unapproved noise wall systems.

Maintaining a list of IDOT preapproved noise barriers may also assist with timely manufacturer submissions. For example, if a manufacturer discovers that their product is not on the IDOT preapproved list, the manufacturer would be more inclined to seek early IDOT approval before project design is finalized. In the absence of this list, the Central Bureau of Materials (CBM) reported that manufacturers often submit their product for review after the completion of project design. This submission is too late for proper consideration for this specific project. For example, if an IDOT highway contract that includes a noise wall is let in Fall 2017 for a Spring 2018 project start, several manufacturers seeking consideration will submit their products to CBM in late 2017. This late submission does not provide IDOT enough time to review and approve the noise wall for this specific project because noise walls must be approved prior to the final project design.

2.4.3 Phase III Construction Recommendations

The officials from the Bureau of Bridges & Structures (BBS) provided the following recommendations on streamlining the IDOT noise barrier process during the construction phase. The BBS officials reported that a number of contractors have introduced value engineering (VE) based design changes to structure mounted noise barriers in Phase III. These changes lead to cost savings and often require changing the noise barrier material from reflective to absorptive or vice versa. This change in material affects the height of the wall and can drastically affect the design of the structure and its connections and accordingly it can cause a delay in the completion of the project. BBS recommends that the selection of a reflective or absorptive wall be finalized in the design phase (Phase II) and should not be allowed to change in a VE proposal (Phase III). These proposals can drastically change the design of noise barriers, which impacts the design of the structure and causes unnecessary delays and costs. The BBS officials request that unnecessary extensive design changes proposed by contractors for noise walls be rejected or limited in Phase III.

CHAPTER 3: SURVEYS OF STATE DOTS

This chapter presents the findings of an online survey that was conducted to gather and analyze feedback from state DOT officials on their experiences in approving and utilizing alternative noise barriers. The survey was designed to collect data on (1) Noise barrier policies and approval criteria; (2) Timeline for reviewing and approving noise barriers, and approved noise barrier systems; (3) Performance of noise barrier materials; (4) Problems encountered with different noise barrier materials; (5) Recommendations for expediting noise barrier approvals; and (6) Additional feedback.

The survey was developed following the best practices provided by the American Association for Public Opinion Research (AAPOR 2018). The survey was developed in collaboration with the Technical Review Panel of this project and was designed to take less than 15 minutes to complete. As shown in Table 2, the survey included 29 questions that were grouped into six sections that focus on (1) Background of survey respondents; (2) Noise barrier policies and criteria; (3) Approved noise barriers and timeline for review; (4) Noise barrier performance and challenges; (5) Recommendations for expediting noise barrier approvals; and (6) Additional feedback. The survey was developed using an online surveying website (SurveyMonkey, https://www.surveymonkey.com/) to facilitate distribution, and collection of survey data. A list of contacts for state DOT officials was compiled by the Technical Review Panel and a link of the online survey was then e-mailed to each of the identified contacts. The full survey for state DOT officials is presented in Appendix A.

Table 2. Organization of State DOT Survey Questions

Section	Question
S1. Background information	Q1. What is your name?
	Q2. What state do you represent?
	Q3. What is your current job title?
S2. State noise barrier policies and criteria	Q4. List your state DOT specific policies and procedures (DOT manual/flowchart/other) for noise barriers approvals.
	Q5. What is the minimum requirements for Transmission Loss (TL) that your state uses to approve noise barriers?
	Q6. What is the minimum requirements for Noise Reduction Coefficient (NRC) (Roadway Side) that your state uses to approve noise barriers?
	Q7. What is the minimum requirements for Noise Reduction Coefficient (NRC) (Away Side) that your state uses to approve noise barriers?
	Q8. What is the maximum cost per benefited receptor that your state uses to approve noise barriers?
	Q9. What is the maximum cost per mile that your state uses to approve noise barriers?
	Q10. What is the required safety criteria that your state uses to approve noise barriers?
	Q11. Describe any additional criteria that your state uses to approve noise barriers.
S3. Timeline and approved noise barriers	Q12. Estimate the duration (in months) for review and approval of noise barriers from manufacturer submission to approval in your state
	Q13. Select from the checklist, the noise barriers that were approved by your state DOT (full checklist in Appendix A)
S4. Noise barrier performance and challenges	Q14. Compare the performance (on a scale from 1 to 5) of acrylic noise barriers to precast concrete noise barriers in your state in each of the listed criteria. (Construction Time, Cost, Durability, Aesthetics, Maintenance, Other)
	Q15. Compare the performance (on a scale from 1 to 5) of metallic noise barriers to precast concrete noise barriers in your state in each of the listed criteria. (Construction Time, Cost, Durability, Aesthetics, Maintenance, Other)
	Q16. Compare the performance (on a scale from 1 to 5) of vinyl noise barriers to precast concrete noise barriers in your state.
	Q17. Compare the performance (on a scale from 1 to 5) of other noise barrier materials to precast concrete noise barriers in your state.
	Q18. Rank the level of encountered challenges (on a scale from 1 to 5) of utilizing acrylic noise barriers in your state in each of the listed areas. (Material Degradation, Construction Difficulties, Maintenance/Repair Difficulties, Visual Impairment to Drivers, Other)
	Q19. Rank the level of encountered challenges (on a scale from 1 to 5) of utilizing metallic noise barriers in your state in each of the listed areas. (Material Degradation, Construction Difficulties, Maintenance/Repair Difficulties, Visual Impairment to Drivers, Other)
	Q20. Rank the level of encountered challenges (on a scale from 1 to 5) of utilizing vinyl noise barriers in your state in each of the listed areas. (Material Degradation, Construction Difficulties, Maintenance/Repair Difficulties, Visual Impairment to Drivers, Other)
	Q21. Rank the level of encountered challenges (on a scale from 1 to 5) of utilizing other noise barrier materials in your state in each of the listed areas. (Material Degradation, Construction Difficulties, Maintenance/Repair Difficulties, Visual Impairment to Drivers, Other)
S5. Recommendations for expediting noise barrier approvals	Q22. When does your state conduct public outreach to assess desire for implementation of noise barrier?
	Q23. Does your state regularly request new noise barrier products from manufacturers to review?
	Q24. Does your state provide a preapproved list of noise barriers to contractors during letting/bidding?
	Q25. Does your state allow value engineering changes by contractors to structure mounted noise barriers after letting/bidding (which may significantly alter the design of the structure)?
	Q26. Has your state made any changes to expedite or streamline the review and approval process of noise barriers in your state?
S6. Additional feedback	Q27. Please provide any additional comments regarding your state noise barrier approval process.
	Q28. Would you be willing to provide more information, if needed?
	Q29. Are you interested in receiving the main findings of this survey upon completion?

A total of 32 complete responses were received from state DOT officials. The 32 responses represents 30 different states as two responses were received from both New Jersey and Tennessee. An individual response was received from Arkansas, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Iowa, Idaho, Indiana, Kansas, Kentucky, Louisiana, Missouri, Montana, North Carolina, North Dakota, Nebraska, New Hampshire, Nevada, New York, Ohio, Oregon, South Carolina, Virginia, Washington, Wisconsin, and West Virginia. Table 3 summarizes the number of completed responses from each participating state DOT.

Table 3. Number of State DOT Responses

State	Number of Responses	State	Number of Responses
Arkansas	1	North Carolina	1
Colorado	1	North Dakota	1
Connecticut	1	Nebraska	1
Delaware	1	New Hampshire	1
Florida	1	New Jersey	2
Georgia	1	Nevada	1
Hawaii	1	New York	1
Iowa	1	Ohio	1
Idaho	1	Oregon	1
Indiana	1	South Carolina	1
Kansas	1	Tennessee	2
Kentucky	1	Virginia	1
Louisiana	1	Washington	1
Missouri	1	Wisconsin	1
Montana	1	West Virginia	1
		Total	32

The analysis of the survey responses is summarized in the following six sections that focused on: (1) State DOT noise barrier policies and approval criteria; (2) Approved noise barriers and timeline for review; (3) Noise barrier performance; (4) Encountered challenges; (5) Recommendations for expediting noise barrier approvals; and (6) Additional feedback and comments.

3.1 STATE DOT NOISE BARRIER POLICIES AND APPROVAL CRITERIA

The state DOT officials were asked to identify the noise abatement policies, procedures, and criteria used for reviewing and approving noise barriers in their states. The collected feedback on their state DOT noise abatement policies, procedures, and criteria is analyzed and grouped into eight categories: (1) Noise abatement policies and procedures; (2) Minimum Transmission Loss; (3) Minimum Noise Reduction Coefficient on the roadway side; (4) Minimum Noise Reduction Coefficient on the away side; (5) Maximum cost per benefitted receptor; (6) Maximum cost per mile; (7) Safety criteria; and (8) Additional criteria.

3.1.1 Noise Abatement Policies and Procedures

All 32 respondents reported that their state DOT has noise policies and procedures and they can be accessed using the hyperlink listed in Table 4.

Table 4. State DOT Noise Policies and Procedures

State	Name of state DOT policies and procedures (hyperlink available)
Arkansas	Policy on Highway Traffic Noise Abatement (ArDOT 2018)
Colorado	CDOT Noise Analysis and Abatement Guidelines (CDOT 2018)
Connecticut	Connecticut DOT Highway Traffic Noise Abatement Policy (ConnDOT 2018)
Delaware	Transportation Noise Policy (DelDOT 2018)
Florida	Project Development and Environment Manual (Highway Traffic Noise) (FDOT 2018)
Georgia	Environmental Procedures Manual (GDOT 2018)
Hawaii	Highway Noise Policy and Abatement Guidelines (HIDOT 2018)
Iowa	Noise Wall Design Process (IowaDOT 2018)
Idaho	IDT Traffic Noise Analysis and Abatement Policy and Procedures (IDT 2018)
Indiana	Indiana DOT Traffic Noise Analysis Procedure (INDOT 2018)
Kansas	Kansas DOT Highway Traffic Noise Analysis and Abatement Policy and Procedures (KDOT 2018)
Kentucky	Kentucky Transportation Cabinet Noise Analysis and Abatement Policy (KYTC 2018)
Louisiana	Qualification Procedure for Noise Reduction Systems (LaDOTD 2018)
Missouri	Engineering Policy Guide (MoDOT 2018)
Montana	MDT Traffic Noise Analysis & Abatement Policy (MDT 2018)
North Carolina	NCDOT 2016 Traffic Noise Policy (NCDOT 2018a)
	NCDOT 2016 Traffic Noise Manual (NCDOT 2018b)
North Dakota	Noise Policy and Guidance (NDDOT 2018)
Nebraska	Nebraska Noise Analysis and Abatement Policy (NEDOT 2018)
New Hampshire	Policy and Procedural Guidelines for the Assessment and Abatement of Highway Traffic Noise for Type I & II Highway Projects (NHDOT 2018)
New Jersey	Traffic Noise Management Policy and Noise Wall Design Guidelines (NJDOT 2018)
Nevada	Traffic and Construction Noise Analysis and Abatement Policy (NVDOT 2018)
New York	Noise Analysis Policy and Procedures (NYSDOT 2018)
Ohio	ODOT Highway Traffic Noise Analysis Manual (ODOT 2018a)
Oregon	ODOT Noise Manual (ODOT 2018b)
South Carolina	SCDOT Traffic Noise Abatement Policy (SCDOT 2018)
Tennessee	Policy on Highway Traffic Noise Abatement (TDOT 2018)
Virginia	VDOT Highway Traffic Noise Impact Analysis Guidance Manual (VDOT 2018)
Washington	WSDOT 2011 Traffic Noise Policy and Procedures (WSDOT 2018)
Wisconsin	Facilities Development Manual - Chapter 23 Noise (WisDOT 2018)
West Virginia	Design Directive 253 - Noise Policy (WVDOT 2018)

3.1.2 Transmission Loss

State DOT officials were asked to identify the minimum Transmission Loss (TL) requirements for the approval of noise barriers in their states. TL is defined by IDOT as the reduction in sound transmitted through the noise barrier material measured in decibels (dB) (IDOT 2017a). A total of 25 respondents from 24 different states reported their minimum TL requirements or their 'noise reduction design goal', as shown in Table 5. Noise reduction design goal is defined by IDOT as the optimum desired noise reduction determined by calculating the difference between noise levels without abatement and with abatement, measured in adjusted decibels (dBA) (IDOT 2017a). In addition to the reported values to this question in the survey, the online DOT noise policies provided by survey respondents in Table 4 were analyzed to identify the TL and noise reduction design goal utilized by each state participating in this survey, as shown in Table 5.

Table 5. Minimum Transmission Loss and Noise Reduction Design Goals Reported by State DOTs

State	Reported Survey Values		Online DOT Noise Policy	
	Transmission	Noise Reduction	Transmission	Noise Reduction Design Goal
Arkansas	30	-	-	-
Colorado	N/A	-	-	7 dBA for 1 receptor
Connecticut	N/A	-	-	7 dBA for 2/3 of receptors
Delaware	-	-	-	9 dBA for 25% of receptors
Florida	-	-	-	7 dBA for 1 receptor
Georgia	20	-	22	7 dBA for 1 receptor
Hawaii	-	5 dB for	-	7 dBA for 75% front-row receptors
Iowa	-	-	-	8 dBA
Idaho	-	minimum of 5 dBA	-	7 dBA for 1 receptor
Indiana	20	-	20	7 dBA for 50% first row receptors
Kentucky	-	7 dB	-	7 dBA of 50% front-row receptors
Montana	-	7 dBA	-	7dBA for 60% first-row receptors
North	-	10 dB	-	10 dBA for 80% first row receptors
Nebraska	-	-	-	7 dBA for 40% front row receptors
New	-	-	-	7 dBA for 1 receptor
New Jersey	20	-	-	7 dBA for 50% first row of residences
New York	-	-	-	7 dBA for 50% of receptors
Ohio	22	-	22	7 dBA for 1 receptor
Oregon	-	-	-	7 dBA for 1 receptor
Tennessee	30	-	20	7 dBA for 60% of first-row receptors
Virginia	23	-	23	7 dBA for 1 receptor
Washington	-	7 dB for 1 one home	20	7 dBA for 1 receptor
Wisconsin	20	-	20	9 dBA for 1 receptor
West	-	-	-	7 dBA for 10% receptors

The survey results illustrate that five states reported a minimum transmission loss of 20 dB, two states reported a minimum TL of 22 dB, one state reported a minimum TL of 23 dB, and one state reported a minimum TL of 30 dB, as summarized in Table 6 and Figure 2. The remaining 17 states that participated in the survey reported that they did not have a specified TL requirement. The lack of TL requirements in these 17 states was confirmed by analyzing their online DOT noise policies, which also confirmed that they utilize a noise reduction design goal requirement that ranges from 7 dBA to 10 dBA, as shown in Table 7 and Figure 3.

Table 6. Minimum Transmission Loss Reported by State DOTs

Minimum Transmission Loss	States	Number of States	Percentage of Responses
20 dB	Indiana, Tennessee, Washington, Wisconsin	5	55.6%
22 dB	Georgia, Ohio	2	22.2%
23 dB	Virginia	1	11.1%
30 dB	Arkansas	1	11.1%
Total		**9**	**100.0%**

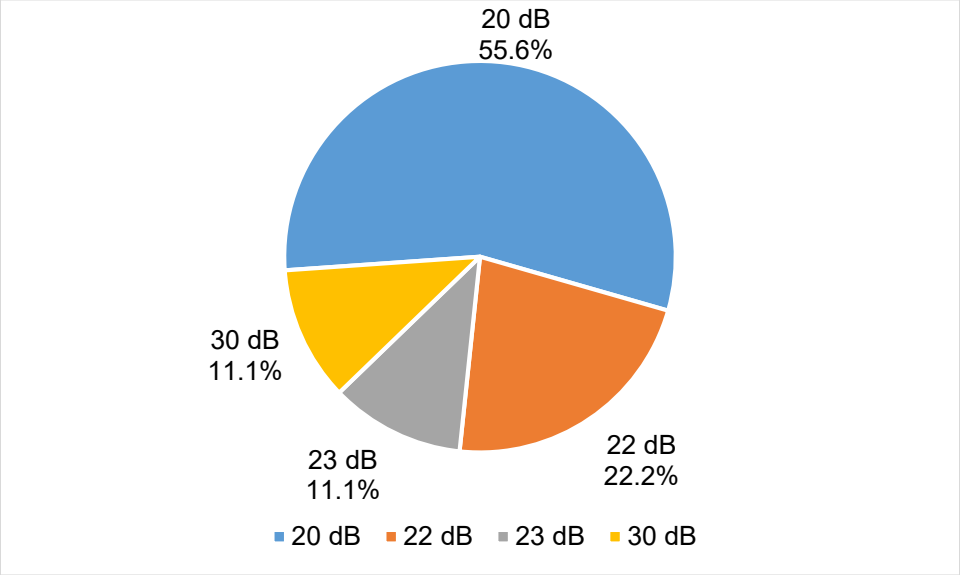

Figure 2. Minimum transmission loss for noise barriers reported by state DOTs.

Table 7. Minimum Noise Reduction Design Goal for Noise Barriers Reported by State DOTs

Minimum Noise Reduction Design Goal	States	Number of States	Percentage of Responses
7 dBA	Colorado, Connecticut, Florida, Georgia, Hawaii, Idaho, Indiana, Kentucky, Montana, Nebraska, New Hampshire, New Jersey, New York, Ohio, Oregon, Tennessee, Virginia, Washington, West Virginia	19	82.6%
8 dBA	Iowa	1	4.3%
9 dBA	Delaware, Wisconsin	2	8.7%
10 dBA	North Dakota	1	4.3%
Total		**23**	**100.0%**

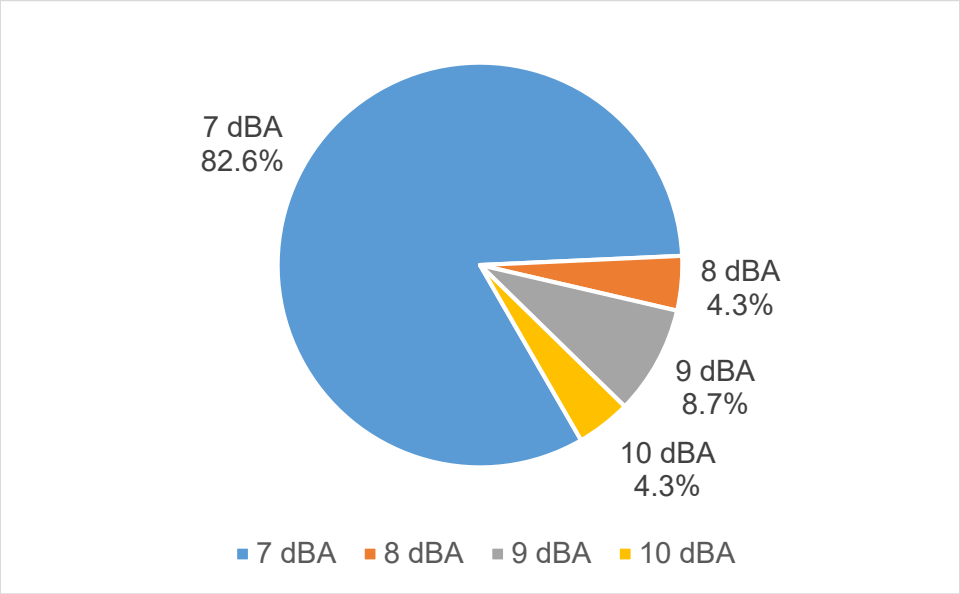

Figure 3. Noise reduction design goal for noise barriers reported by state DOTs.

3.1.3 Noise Reduction Coefficient – Roadway Side

A total of 25 respondents from 24 different states reported their minimum Noise Reduction Coefficient (NRC) on the roadway side for the approval of absorptive noise barriers in their states. The number of states reporting each of the minimum roadway side NRCs and their percentages are summarized in Table 8 and Figure 4. The survey results illustrate that twelve states did not specify a minimum roadway side NRC, six states reported a minimum roadway side NRC of 0.7, and six more reported a minimum NRC of 0.8, as shown in Table 8 and Figure 4.

Table 8. Minimum Roadway Side Noise Reduction Coefficient (NRC) Reported by State DOTs

Minimum Roadway Side Noise Reduction Coefficient (NRC)	States	Number of States	Percentage
0.70	Arkansas, Colorado, Indiana, Ohio, Tennessee, Virginia	6	25.0%
0.80	Georgia, Louisiana, New Jersey, Tennessee, Washington, Wisconsin	6	25.0%
Not Applicable	Connecticut, Delaware, Florida, Hawaii, Iowa, Idaho, Kentucky, Nebraska, New Hampshire, New York, Oregon, West Virginia	12	50.0%
Total		**24**	**100.0%**

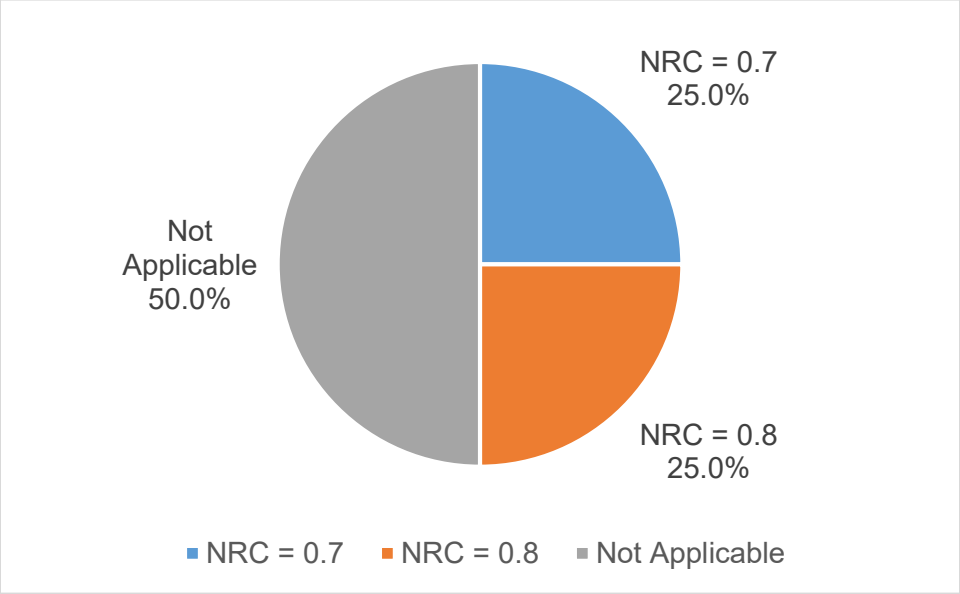

Figure 4. Minimum roadway side noise reduction coefficient (NRC) for absorptive walls.

3.1.4 Noise Reduction Coefficient – Away Side

Survey respondents were asked to identify the minimum Noise Reduction Coefficient (NRC) on the away side of the wall for the approval of absorptive noise barriers in their states. The number of responses and percentages of each response are organized in Table 9 and Figure 5. The survey results illustrate that 18 states did not specify a minimum away side NRC for approving absorptive noise barriers; one state each reported a minimum away side NRC of 0.6, 0.7, and 0.8, as shown in Table 9 and Figure 5.

Table 9. Minimum Away Side Noise Reduction Coefficient (NRC) Reported by State DOTs

Minimum Away Side Noise Reduction Coefficient (NRC)	States	Number of States	Percentage
0.60	New Jersey	1	4.8%
0.70	Indiana	1	4.8%
0.80	Washington	1	4.8%
Not Applicable	Arkansas, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Iowa, Idaho, Kentucky, Nebraska, New Hampshire, New York, Ohio, Oregon, Tennessee, Virginia, West Virginia	18	85.7%
Total		**21**	**100.0%**

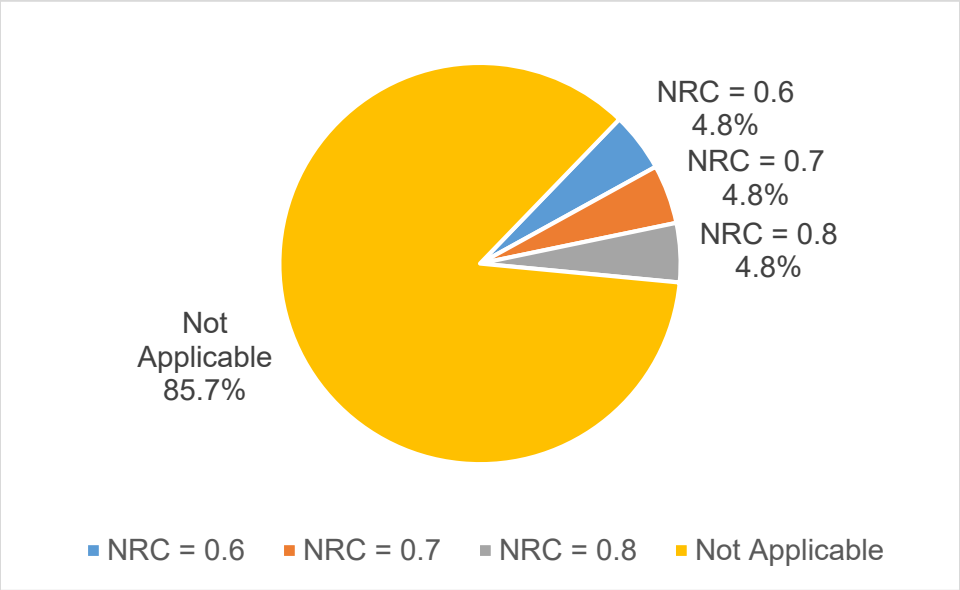

Figure 5. Minimum away side noise reduction coefficient (NRC) for absorptive walls.

3.1.5 Cost per Benefited Receptor

DOT officials were asked to identify their specified maximum cost per benefited receptor for noise barriers. The cost per benefited receptor was reported by 20 states to range from $24,000 to $60,000, as shown in Table 10. Eight other states reported that they use 'Other' criteria for analyzing noise barriers including six states that utilize 'wall area per benefitted receptor' and two states that use 'cost per decibel per benefited receptor', as shown in Table 10.

Table 10. Maximum Cost per Benefited Receptor Reported by State DOTs

State	Maximum Cost per Benefitted Receptor	Number of States
North Dakota	$24,000.00	1
Idaho	$24,250.00	1
Delaware	$25,000.00	1
Indiana, Kansas, South Carolina, West Virginia	$30,000.00	4
Kentucky, Ohio, Oregon	$35,000.00	3
Arkansas	$36,000.00	1
Nebraska,	$40,000.00	1
Florida, Iowa	$42,000.00	2
Wisconsin	$47,000.00	1
New Jersey, Nevada	$50,000.00	2
Connecticut, Georgia	$55,000.00	2
Hawaii	$60,000.00	1
New York	Other - $80,000 per berm or noise insulation, 2,000 sf per benefited receptors per wall	1
New Hampshire, North Carolina	Other - 1,500 sf per benefited receptor	2
Virginia	Other - 1,600 sf per benefitted receptor	1
Tennessee	Other - 2,400 sf per benefited receptor	1
Montana	Other - $6,300 per dB per benefited receptor	1
Colorado	Other - $6,800 per dB per benefited receptor	1
Washington	Other - Cost per benefited receiver based on increasing future noise levels (no maximum)	1
	Total	**28**

3.1.6 Cost per Mile

Survey respondents were asked to identify the maximum cost per mile for the approval of noise barriers, as shown in Table 11. The survey results indicate that the reported maximum cost per mile ranges from $1,000,000 to $3,200,000. Furthermore, two states reported that they do not have a specified maximum cost per mile, and 16 states indicated that they do not consider cost per mile as criteria when analyzing noise barriers. These 16 states use either 'cost per benefited receptor', 'area

per benefited receptor', or 'cost per decibel per benefited receptor', as discussed in the previous section 2.1.5.

Table 11. Maximum Cost per Mile Reported by State DOTs

State	Maximum Cost per Mile	Number of States
New Jersey	$1,000,000.00	1
Ohio	$2,000,000.00	1
Florida	$2,217,600.00	1
Oregon	$3,200,000.00	1
North Carolina, West Virginia	No maximum	2
North Dakota, Idaho, Delaware, Indiana, Kentucky, Arkansas, Iowa, New Jersey, Connecticut, Georgia, Hawaii	Other – Cost per receptor (See Table 10)	11
Colorado	Other – Cost per dB per benefited receptor (See Table 10)	1
New York	Other – Cost per berm or noise insulation (See Table 10)	1
New Hampshire, Virginia, Tennessee	Other – Area per benefited receptor (See Table 10)	2
Washington	Other – Cost per benefited receptor based on future noise levels (See Table 10)	1
Total		**23**

3.1.7 Safety Criteria

State DOT officials were asked to identify the safety criteria that their state utilizes to approve noise barriers. The respondents were provided four options (a) Manual for Assessing Safety Hardware (MASH 2016); (b) American Association of State Highway and Transportation Officials Load and Resistance Factor Design (AASHTO 2017); (c) Recommended Procedures for Safety Performance Evaluation of Highway Features (NCHRP 350) (Ross Jr. et al. 1993); and (d) other. A total of 22 states reported their utilized safety criteria for the approval of noise barriers in their states, as shown in Table 12.

Table 12. Safety Criteria Utilized for the Approval of Noise Barriers Reported by State DOTs

State	Safety Criteria	Number of States
Georgia, Hawaii, Iowa, North Carolina, Oregon, Washington, West Virginia	MASH 2016	7
Arkansas, Georgia, Hawaii, Idaho, Nebraska, New Jersey, New York, Ohio, Oregon, South Carolina, Tennessee, Wisconsin, West Virginia	AASHTO LRFD	14
Florida, Hawaii, Nebraska, Washington, West Virginia	NCHRP 350	5
Indiana, North Carolina, Virginia	Other – Additional safety devices	3
Connecticut, North Dakota, Ohio	Other – State specific criteria	3
Georgia, Kentucky	Other – AASHTO Green Book and Roadside Design Guide	2

3.1.8 Additional Criteria

Survey respondents were asked to list any additional criteria that their state uses to approve noise barriers. Thirty state DOT officials reported their utilized additional criteria for the approval of noise barriers in four categories (a) Constructability; (b) Feasibility; (c) Aesthetics; and (d) Other, as shown in Table 12, Table 13, Table 14, and Table 15, respectively.

Table 12. Constructability Criteria for the Approval of Noise Barriers Reported by State DOTs

Constructability Criteria		Number of States
Maximum wall height	20 feet	1
	20 feet; 12 feet if constructed on shoulder	1
	24 feet	1
	25 feet	2
Topography, access and utility requirements		1
Consultation with DOT design personnel		1
Terrain changes, utilities, safety, bridges, overpasses		1
Topography, drainage, safety, barrier height, utilities, and access/maintenance needs		1
AASHTO Green Book, Roadside Design Guide and MUTCD		1
Noise barrier must achieve a reduction design goal of 7 dBA		1
Engineering driveways, utilities, hydro, safety, maintenance		1
Utility and geotechnical issues		1
Topography, safety, drainage, utilities, maintenance, access		1
Height limit on bridges		1
Must be pre-certified noise barrier system		1
Project specific evaluation		2
Yes (did not elaborate)		4
Total		**22**

Table 13. Feasibility Criteria for the Approval of Noise Barriers Reported by State DOTs

Feasibility Criteria		Number of States
Minimum noise reduction	5 dBA for 2/3 impacted receptors. Consultation with DOT design personnel	1
	5 dBA for 4/5 of first-row receptors and 2/3 of all impacted receptors	1
	5 dBA for at least one receptor	2
	5 dBA for at least two receptors	1
	5 dBA for majority (greater than 50%) of the first row homes	1
	5 dBA for majority (greater than 50%) of impacted receptors	3
	5 dBA for three front row receptors	1
	5 dBA reduction	2
	7 dBA reduction	1
	9 dBA for 1/4 of benefited receptors.	1
Maximum cost of $70/sf for reflective and $90/sf for absorptive noise walls		1
Must meet acoustic and engineering considerations		1
Must meet AASHTO Green Book site distance requirements		1
Yes (did not elaborate)		5
Total		**22**

Table 14. Aesthetics Criteria for the Approval of Noise Barriers Reported by State DOTs

Aesthetics Criteria	Number of States
Architectural treatments must not increase cost of barrier by more than 5%	1
Barrier distance from residences should be at least four times its height	1
Consultation with DOT design personnel	1
DOT pre-approved options of noise barrier designs	4
Project specific criteria	1
Yes (did not elaborate)	4
Total	**12**

Table 15. Other Criteria for the Approval of Noise Barriers Reported by State DOTs

Other Criteria		Number of States
Minimum of	50% of benefited receptors must agree to noise abatement	1
	60% of benefited receptors must agree to noise abatement	2
	80% of front-row receptors must agree to noise abatement	1
Consultation with DOT design personnel		2
Cannot exceed original estimated cost		1
Cost-effectiveness - Future development dates, future noise levels, noise increase due to the project, noise compatibility planning		1
Must not exceed area per benefited receptor		1
Total		**9**

3.2 REVIEW TIMELINE AND APPROVED NOISE BARRIERS

This section analyzes the collected feedback from DOT officials on their (1) Estimated duration for the review and approval of noise barriers; and (2) Approved list of noise barriers.

3.2.1 Duration for Review and Approval of Noise Barriers

State DOTs were asked to estimate the duration for reviewing and approving noise barriers from manufacturer submission to final DOT approval. The survey respondents were asked to provide their estimated duration for noise barriers not requiring crash testing (see Table 16) and for noise barriers that require crash testing, as shown in Table 17.

Table 16. Duration for Review and Approval of Noise Barriers when Crash Testing is Not Required

Duration	Number of States	Percentage
1 month	1	5.3%
6 months	3	15.8%
12 months	2	10.5%
Unknown	13	68.4%
Total	**19**	**100.0%**

Table 17. Duration for Review and Approval of Noise Barriers when Crash Testing is Required

Duration	Number of States	Percentage
12 months	1	7.1%
18 months	2	14.3%
Unknown	11	78.6%
Total	**14**	**100.0%**

The survey results illustrate that the more than 65% of the DOT officials could not provide an estimated duration for the review and approval of noise barriers when crash testing is not required. For other cases that require crash testing, over 75% of state DOTs could not provide an estimated duration for the review and approval of noise barriers. The other states reported that the estimated duration for the approval of noise barriers ranges from 1 to 12 months and 12 to 18 months for non-crash tested walls and crash tested walls, respectively. This indicates that crash testing noise barriers increases their approval time by at least six months, as shown in Table 16 and Table 17.

3.2.2 Approved Noise Barriers

Survey respondents were asked to identify the noise barrier systems that have been approved by their state DOTs. Each state DOT official was provided a list of 33 noise barrier systems, with an additional option to write in a noise barrier that was not on the list. The list also included options for indicating if the noise barrier was approved as an absorptive wall or a reflective wall. Feedback was collected from 32 states on their approved noise barrier systems, as shown in Table 18.

Table 18. Number of States Approving Different Noise Wall Systems

Manufacturer – Noise Wall System	Absorptive	Reflective
ACH - USG Ultrasound Sight & Sound Screen Panel	0	0
- Acoustax	2	1
Barrier Stone - Concrete Masonry Wall 6.0"	0	2
Barrier Stone - Concrete Masonry Wall 7.825"	2	4
Carsonite - Barrier Wall w/Agg Facing	0	1
Carsonite - Barrier Wall w/Perforated Metal Facing	0	0
Carsonite - Unfaced Highway Sound Barrier	0	1
Carsonite - H-way Sound Barrier w/ Extruded Cover-Strip Facing	0	0
Carsonite - Barrier Wall w/ Snap-on Plastic Cover Strips	0	0
Carsonite - Quietwall filled	0	0
Carsonite - Quietwall unfilled	0	0
Centria - Eco Sound Barrier	0	3
CSI - Soundtrap	0	0
CSI - Soundsorb	2	1
CYRO - Paraglass RFP	0	1
CYRO - Paraglass TL4	0	1
CYRO (Evonic) - ACRYLITE Soundstop TL4	1	8
EAS - Silent Screen	0	0
Reinforced Earth - Durisol	3	2
New Frontier Industries - Everquiet	0	0
Faddis - AcoustaCrete 3.0", 2.5"	2	3
Faddis - AcoustaCrete 3.0"	4	3
I-Rock (Curb Appeal) - I-Rock (Smart-tie) - Recycled Plastic	0	0
MBCI -	0	0
Sound Fighter Systems - LSE Noise Barrier Systems	2	1
Soundscape - Soundscape -unfilled	0	0
Soundscape - Soundscape -unfilled-uv	0	0
Soundscape - Soundscape -filled-uv	0	0
Harder, Luckey, & Hargrave - Tuf-Barrier	0	0
Harder, Luckey, & Hargrave - Silent Protector	0	0
Harder, Luckey, & Hargrave - Silent Protector Plus	0	0
PEC - Whisperwall	2	1
Vinyl Fence Wholesalers - Simtek Fence (Polyethylene Noise Reduction Fence)	0	0
Other _____	12	

Thirty-two DOT officials reported the use of nine absorptive noise walls and thirteen reflective noise walls, as shown in Table 18. Twelve state DOTs reported an additional 31 approved noise wall products (see Table 19). It should be noted that the additional list does not indicate if the noise barrier was approved for absorptive or reflective use.

Table 19. Additional List of Approved Noise Barriers Reported by State DOTs

AcoustaAL (By Faddis)	Mack Concrete Panels.
Acoustashield (by Carsonite)	Mack Industries, Inc. - Whisper Wall Sound Absorbing Noise Wall System
Armtec LP - Durisol Precast Noise Barrier System	Mack Industries, Of Michigan Inc. - Jbm75 Noise Barrier Wall
ArtUSA Noise Control Products - ArtVinyl Reflective Barrier Wall	Mack Industries, Of Pennsylvania Inc. - Jbm75 Noise Barrier Wall
Carsonite Composites - 12" AcoustaShield Unfilled	Nwb Llc For Isolated Replacement Panels.
Carsonite Composites - 6" AcoustaShield Filled	Precast Solutions, Inc. (Dba Cgm) - Jbm75 Noise Barrier Wall
Carsonite Composites - 6" AcoustaShield Unfilled	Prestress Engineering Corp. - Jbm75 Noise Barrier Wall
Coastal Precast Systems - Whisper-Wall	Prestress Engineering Corp. - Whisper Wall Sound Absorbing Noise Wall System
Concorde Wall Systems - Dry Stack Interlocking Block Sound Barrier System	Prestress Engineering Corp. - Whisper Wall Sound Absorbing Noise Wall System
Corbin Fiberglass Panels.	Sanders Pre-Cast Concrete System Co. - Envirosound
Crest Products Concrete, Inc. - JBM75 Noise Barrier Wall	Sanders Pre-Cast Concrete System Co., Inc - Silent Sound System
Durisol - Durisol Wall System	Sound Fighter Systems LLC - SonaGuard Noise Barrier System
Evonik Cyro LLC - Acrylite Soundstop GS CC Acrylic Sheet	The Reinforced Earth Company - FanWall
Evonik Cyro LLC - Acrylite Soundstop Ready Fit Panels	Total Precast Solutions, Llc - Whisper Wall Sound Absorbing Noise Wall System
Faddis Concrete Products – Acoustacrete	Utility Concrete Products, Llc - Jbm75 Noise Barrier Wall
Fay Block Materials - AB Fence System by Allan Block	

3.3 NOISE BARRIER PERFORMANCE

Survey respondents were asked to compare the performance of alternative noise barrier materials (acrylic, metallic, vinyl, and other) to precast concrete barriers in five different criteria: construction time, cost, durability, aesthetics, and maintenance. A total of 28 state DOT officials provided their performance comparison for this question using a five-point scale: significantly worse, slightly worse, similar performance, slightly better, and significantly better. A weighted average performance for each wall in all five criteria was calculated using a numerical scale that ranges from 1 to 5, where 1 represents “significantly worse” and 5 represents “significantly better” than precast concrete noise barriers. This comparative performance analysis is conducted for four categories of noise barrier materials: (1) acrylic; (2) metallic; (3) vinyl; and (4) other.

3.3.1 Performance of Acrylic Noise Barriers

The performance of acrylic noise barriers compared to precast concrete noise barriers in each of the aforementioned five criteria was reported by four state DOTs, as shown in Table 20 and Figure 6. The survey results illustrate that acrylic noise barriers were reported to provide a similar performance to precast concrete noise barriers in construction time, aesthetics, and maintenance. However, acrylic noise barriers perform slightly worse than precast concrete noise barriers in cost and durability. Additionally, it should be noted that 23 state DOT officials reported that they do not use acrylic noise walls. Three of these state DOTs reported that they have acrylic noise walls either currently under construction or scheduled in the near future.

Table 20. Performance Level of Acrylic vs Precast Concrete Noise Barriers

Performance Criteria	5 Significantly Better	4 Slightly Better	3 Similar Performance	2 Slightly Worse	1 Significantly Worse	Weighted Average
Construction Time	0	0	4	0	0	3.00
Cost	0	0	0	3	0	2.00
Durability	0	0	2	1	0	2.67
Aesthetics	0	1	3	0	0	3.25
Maintenance	0	0	4	0	0	3.00

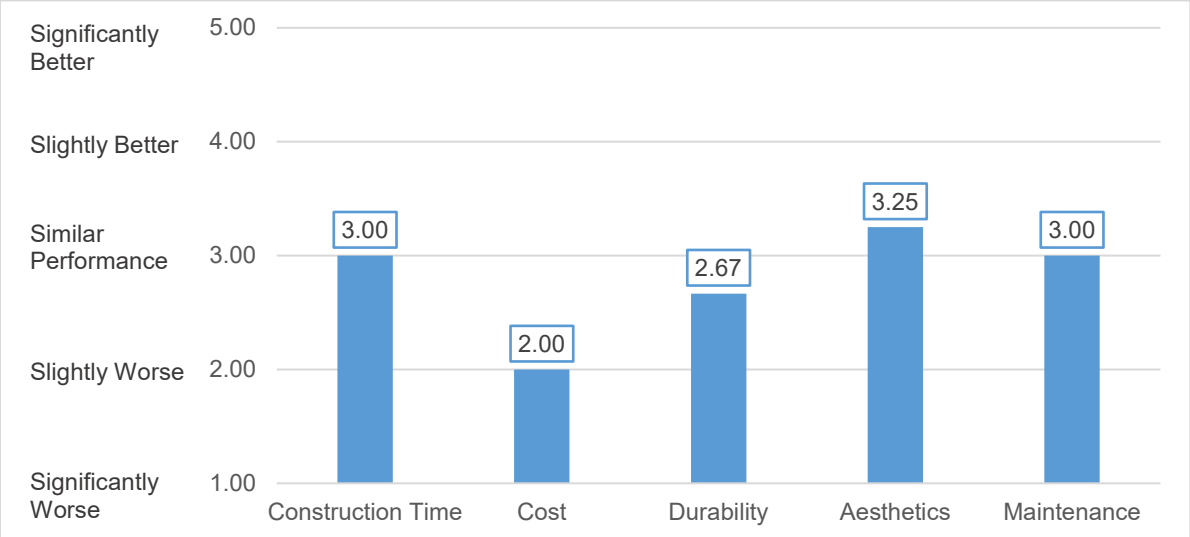

Figure 6. Average performance of acrylic noise barriers compared to precast concrete walls.

3.3.2 Performance of Metallic Noise Barriers

Nine state DOT officials provided performance scores comparing metallic noise barriers to precast concrete noise barriers in each of the aforementioned five criteria, as shown in Table 21 and Figure 7. The survey results indicate that metallic noise barriers were reported to perform slightly worse in all criteria compared to precast concrete noise barriers. Furthermore, 19 states reported that they do not, or no longer use metallic noise barriers.

Table 21. Performance Level of Metallic vs Precast Concrete Noise Barriers

Performance Criteria	5 Significantly Better	4 Slightly Better	3 Similar Performance	2 Slightly Worse	1 Significantly Worse	Weighted Average
Construction Time	0	0	5	1	1	2.57
Cost	0	1	3	2	1	2.57
Durability	0	0	3	1	5	1.78
Aesthetics	0	0	2	1	6	1.56
Maintenance	0	0	4	1	4	2.00

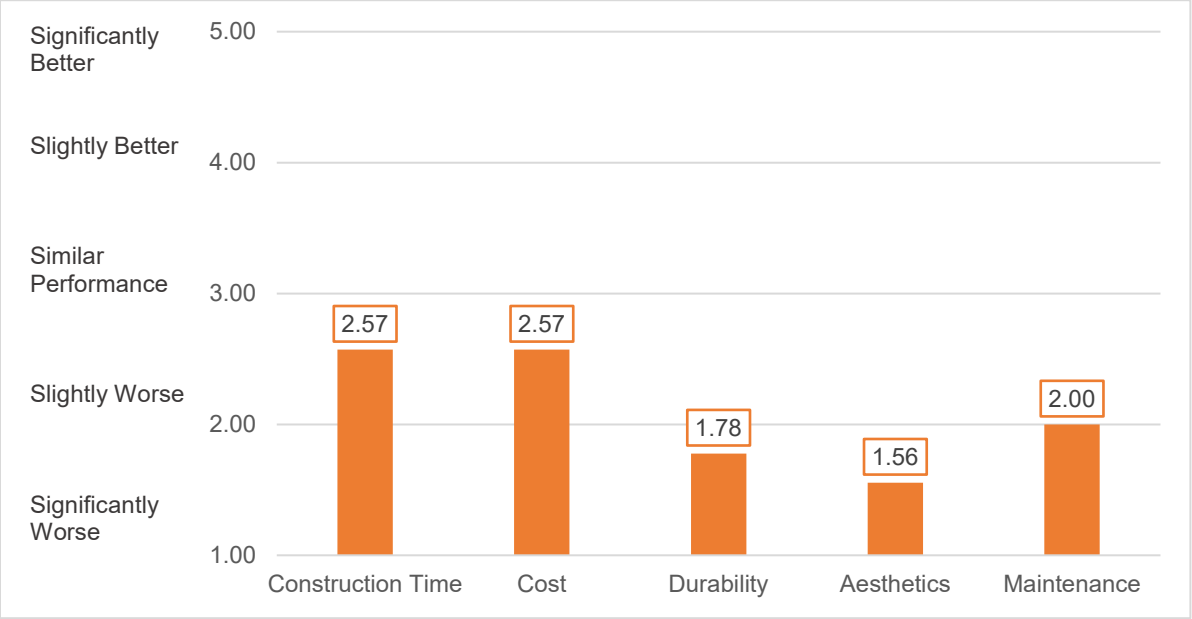

Figure 7. Average performance of metallic noise barriers compared to precast concrete walls.

3.3.3 Performance of Vinyl Noise Barriers

The performance of vinyl noise barriers compared to precast concrete noise barriers in each of the aforementioned five criteria was provided by four state DOTs, as shown in Table 22 and Figure 8. The survey results illustrate that vinyl noise barriers are reported to perform slightly better than precast concrete noise barriers in construction time. However, vinyl noise barriers performed slightly worse than precast concrete in cost, durability, aesthetics, and maintenance. It should be noted that 23 states reported that they do not use vinyl noise walls, while another state reported that they do not have sufficient data on vinyl noise barriers.

Table 22. Performance Level of Vinyl vs Precast Concrete Noise Barriers

Performance Criteria	5 Significantly Better	4 Slightly Better	3 Similar Performance	2 Slightly Worse	1 Significantly Worse	Weighted Average
Construction Time	2	1	0	0	1	3.75
Cost	0	1	2	0	1	2.75
Durability	0	0	3	0	1	2.50
Aesthetics	0	0	3	0	1	2.50
Maintenance	0	1	2	0	1	2.75

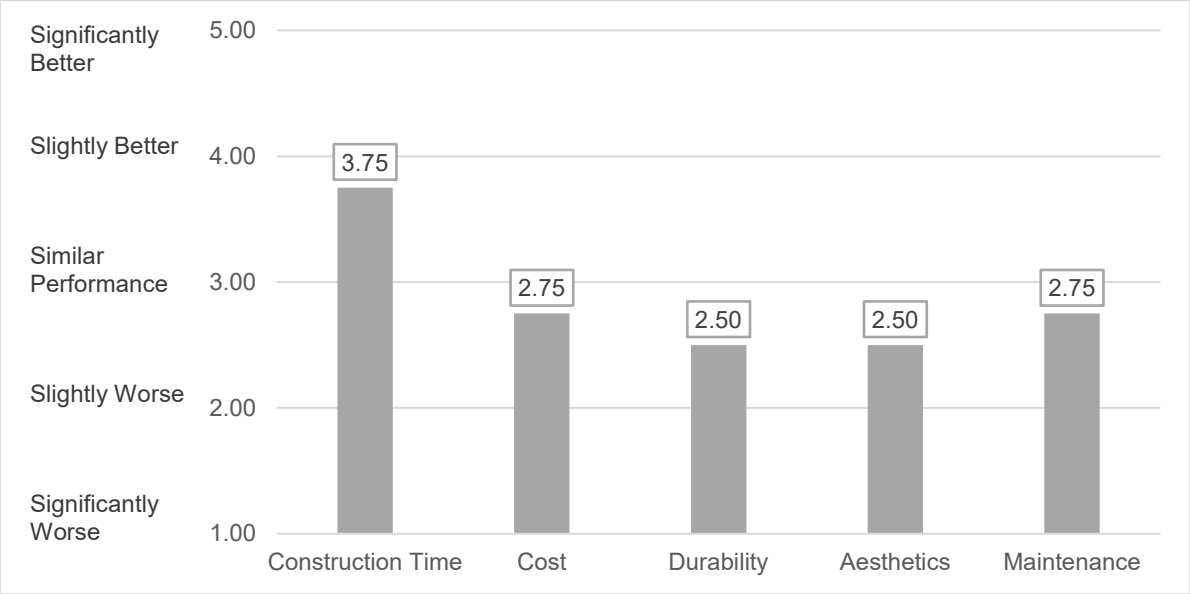

Figure 8. Average performance of vinyl noise barriers compared to precast concrete walls.

3.3.4 Performance of Other Noise Barriers

Two state DOT officials provided performance scores comparing other noise barrier materials to precast concrete noise barriers in the aforementioned five criteria, as shown in Table 23 and Figure 9. One state DOT reported that earth berms perform significantly better than precast concrete noise barriers in cost, durability, aesthetics, and maintenance. However, earth berms performed slightly worse than precast concrete in construction time. Additionally, one DOT official reported that fiberglass noise walls performed similarly or slightly better than precast concrete in construction time, cost, durability and maintenance. However, fiberglass noise walls performed slightly worse than precast concrete in aesthetics.

Table 23. Performance Level of Other Noise Barriers vs Precast Concrete

Performance Category	Other Noise Barrier Material	
	Earth Berm	Fiberglass
Construction Time	2 Slightly Worse	4 Slightly Better
Cost	5 Significantly Better	3 Similar Performance
Durability	5 Significantly Better	4 Slightly Better
Aesthetics	5 Significantly Better	2 Slightly Worse
Maintenance	5 Significantly Better	4 Slightly Better

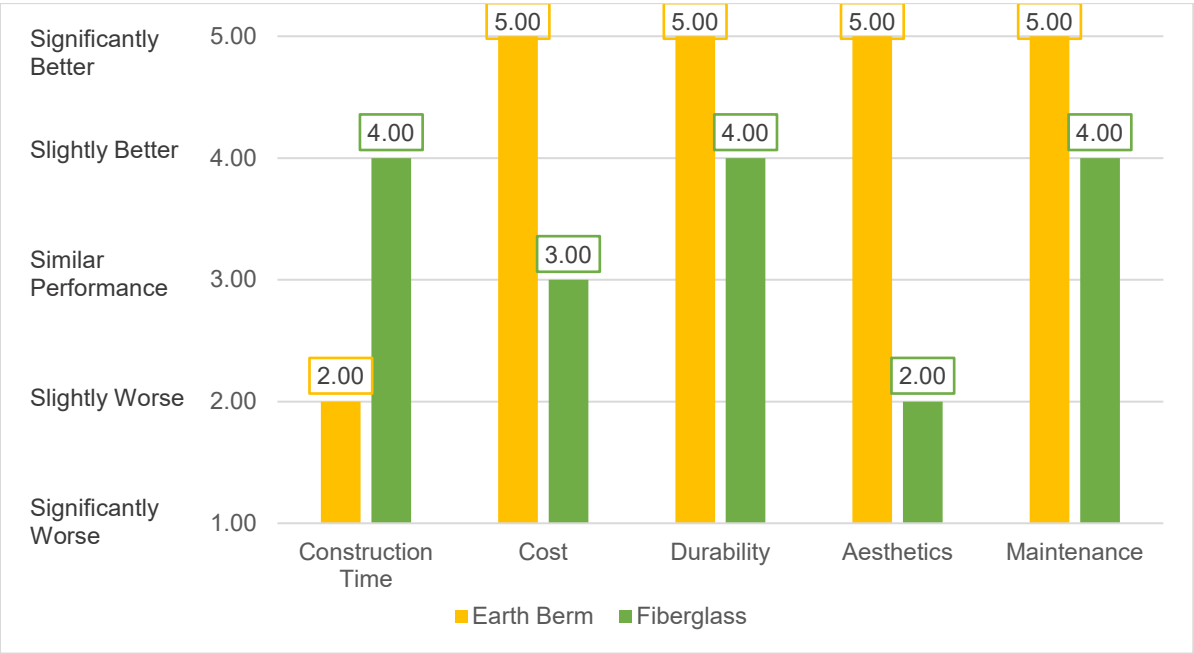

Figure 9. Average performance of other noise barriers compared to precast concrete walls.

3.3.5 Performance Comparison of Noise Barriers Materials

A comparison of the performance of all noise barrier materials reported by participating state DOTs is shown in Figure 10. It should be noted that the performance levels for earth berm and fiberglass noise barriers were reported by only one state DOT while the remaining noise barriers are an average of at least four state DOTs. The results illustrate that (1) precast concrete noise barriers were reported to provide better than or similar performance than acrylic and metallic walls in terms of construction time, cost, durability, and maintenance; (2) vinyl noise barriers were reported to provide slightly better performance than precast concrete walls in terms of construction time; and (3) earth berm noise barriers were reported to perform significantly better than precast concrete walls in cost, durability, aesthetics, and maintenance.

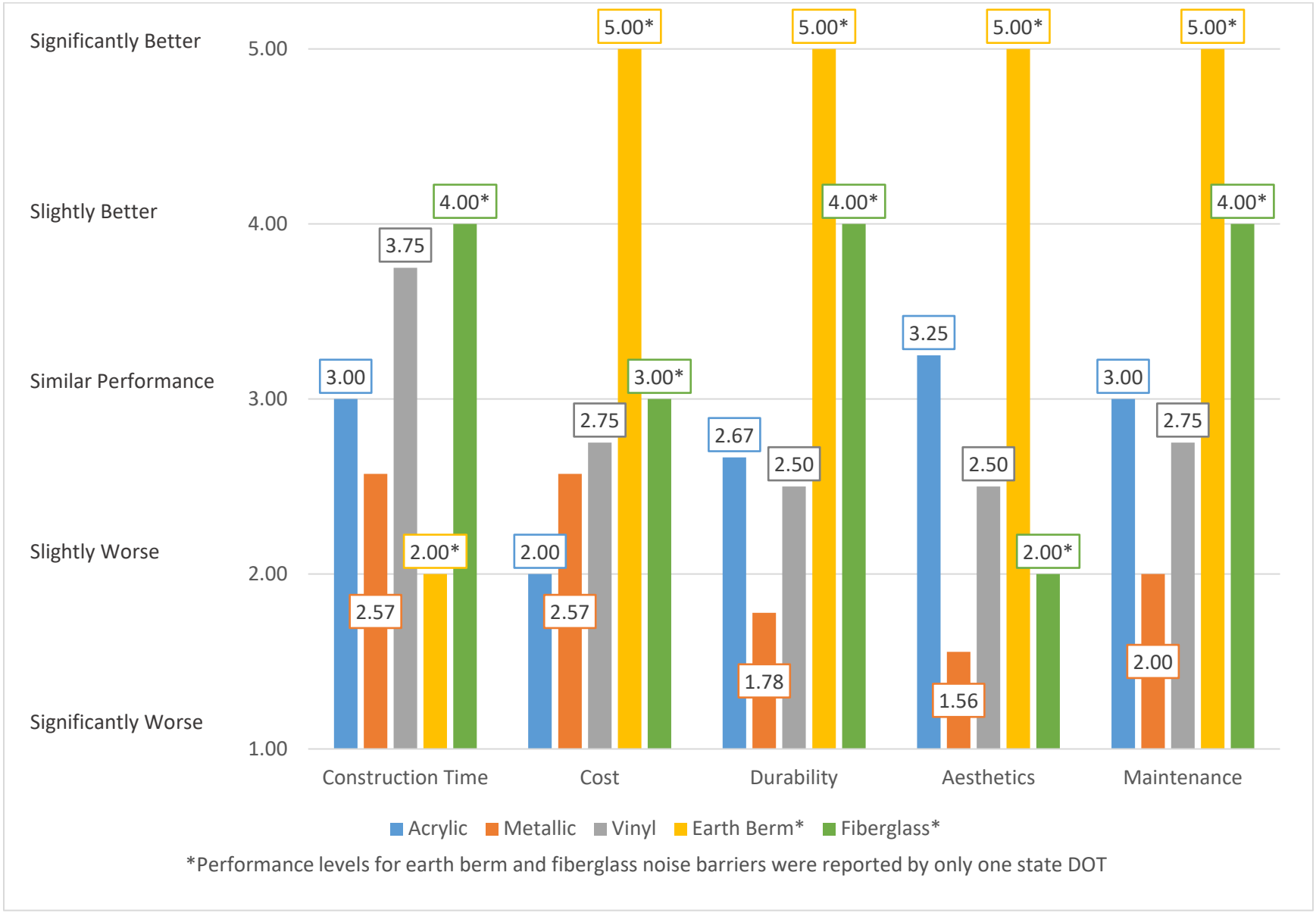

Figure 10. Performance of noise barrier materials.

3.4 PROBLEMS AND CHALLENGES EXPERIENCED

Survey respondents were asked to rank the level of encountered challenges of utilizing different types of noise barrier materials (acrylic, metallic, and vinyl) in five categories: material degradation, construction difficulties, maintenance difficulties, visual impairment to drivers, and other. A total of 26 state DOT officials reported their level of encountered challenges, using a five-point scale: none, slight, moderate, high, and very high. A weighted average for each category was calculated using a numerical scale that ranges from 1 to 5, where 1 represents "no challenges" and 5 represents "very highly challenging". The level of encountered challenges and their weighted averages are analyzed for the following three types of noise barrier materials: (1) acrylic; (2) metallic; and (3) vinyl.

3.4.1 Acrylic Noise Barrier Challenges

The encountered challenges of utilizing acrylic noise barriers in each of the five criteria was reported by six state DOTs, as shown in Table 24 and Figure 11. The survey results illustrate few reported problems utilizing acrylic noise barriers. The average reported problems in four categories was slight, or slight-to-none. One DOT official reported 'Very High' encountered problems for the 'other' category which they detailed acrylic barriers having a very high cost.

Table 24. Encountered Challenges with Acrylic Noise Barriers Reported by State DOTs

Encountered Challenges	1 None	2 Slight	3 Moderate	4 High	5 Very High	Weighted Average
Material Degradation	4	2	0	0	0	1.33
Construction Difficulties	4	1	1	0	0	1.50
Maintenance Difficulties	3	2	0	0	1	2.00
Visual Impairment to Drivers	2	3	0	0	0	1.60
Other – Cost	0	0	0	0	1	5.00

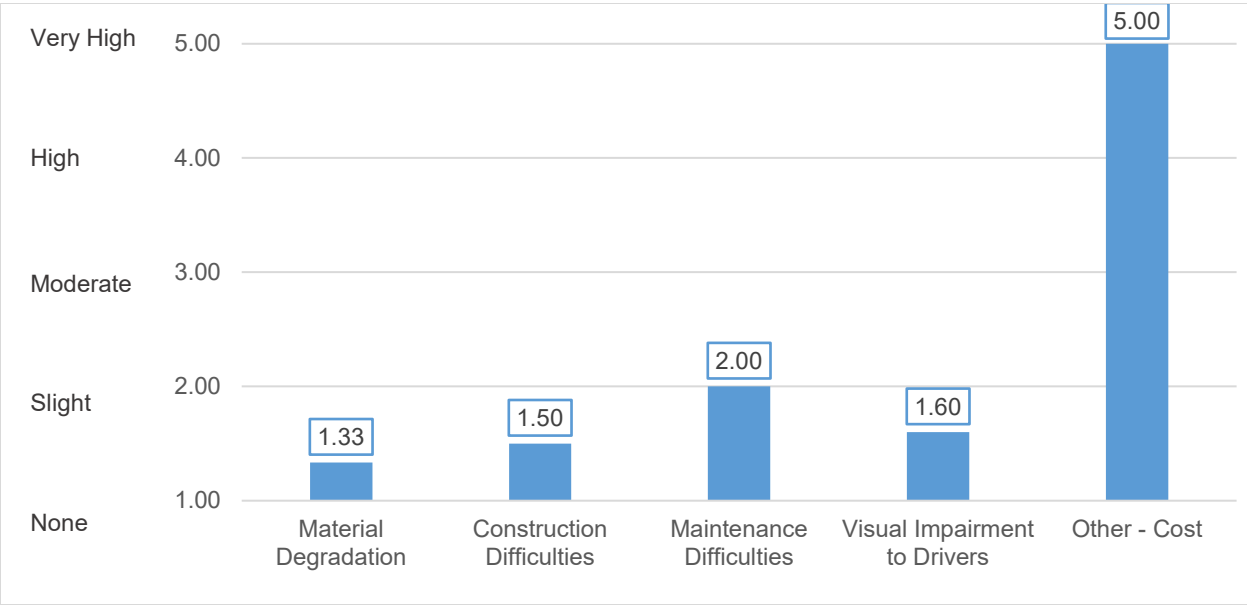

Figure 11. Reported challenges of utilizing acrylic noise barriers.

3.4.2 Metallic Noise Barrier Challenges

Six state DOT officials reported their encountered level of challenges utilizing metallic noise barriers in the aforementioned five categories, as shown in Table 25 and Figure 12. The survey results show that the weighted averages for reported challenges by state DOTs for metallic noise barriers were slight or slight-to-none in all categories. Two state DOT officials reported 'high' and 'very high' for maintenance difficulties and one DOT official noted that replacing metal noise barriers on bridges is very challenging.

Table 25. Encountered Challenges with Metallic Noise Barriers Reported by State DOTs

Encountered Challenges	1 None	2 Slight	3 Moderate	4 High	5 Very High	Weighted Average
Material Degradation	2	1	1	1	0	2.20
Construction Difficulties	4	1	0	0	0	1.20
Maintenance Difficulties	3	1	0	1	1	2.33
Visual Impairment to Drivers	5	0	0	0	0	1.00

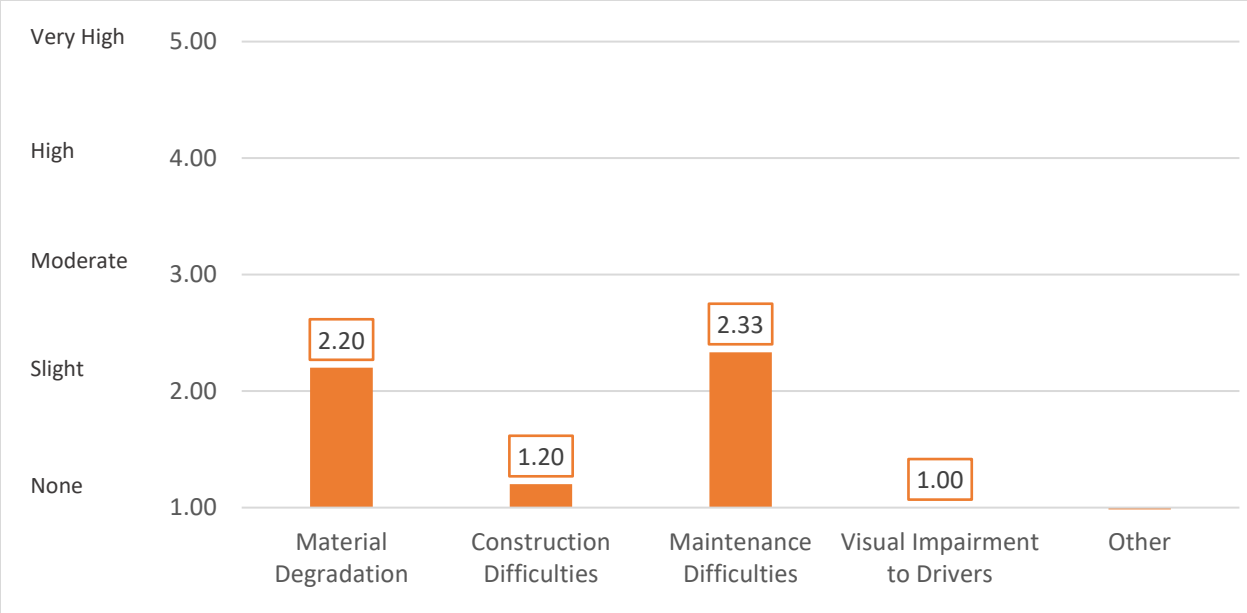

Figure 12. Reported challenges of utilizing metallic noise barriers.

3.4.3 Vinyl Noise Barrier Challenges

The encountered challenges of utilizing vinyl noise barriers in the aforementioned five categories was provided by five state DOTs, as shown in Table 26 and Figure 13. The survey results illustrate very few reported problems utilizing vinyl noise barriers, as they were reported to have the fewest problems among surveyed DOT officials, receiving 14 reported values of 'no problems', as shown in Table 26 and Figure 13.

Table 26. Encountered Challenges with Vinyl Noise Barriers Reported by State DOTs

Encountered Challenges	1 None	2 Slight	3 Moderate	4 High	5 Very High	Weighted Average
Material Degradation	3	1	1	0	0	1.60
Construction Difficulties	3	1	0	0	0	1.25
Maintenance Difficulties	4	0	0	0	0	1.00
Visual Impairment to Drivers	4	0	0	0	0	1.00
Other	0	0	0	0	0	0.00

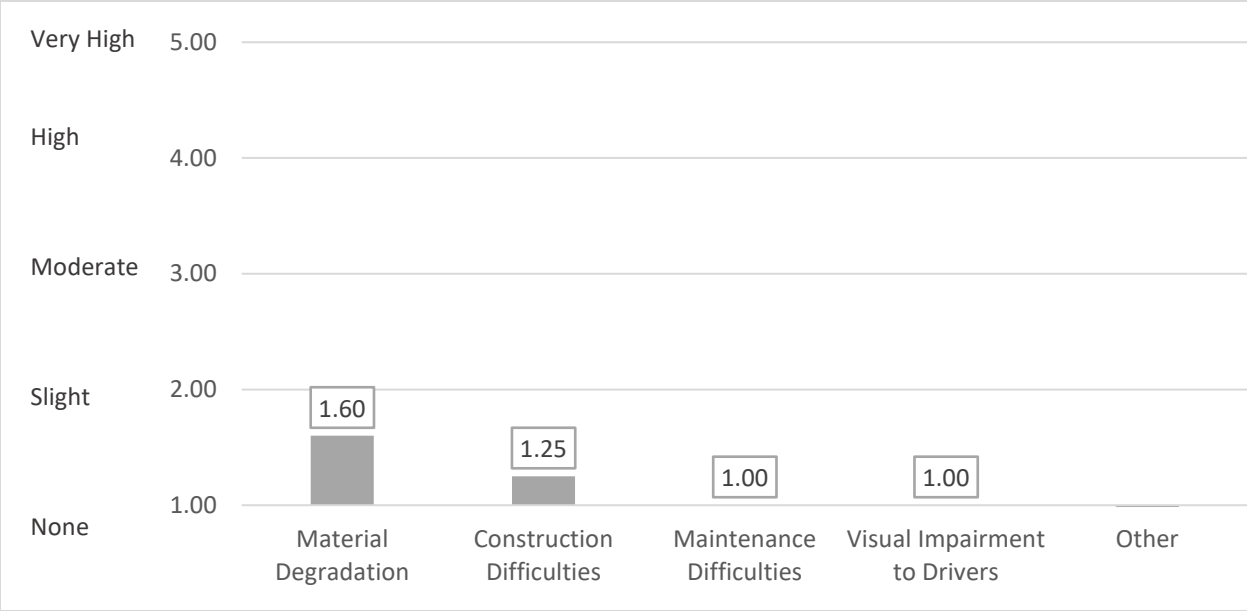

Figure 13. Reported challenges of utilizing vinyl noise barriers.

3.4.4 Comparison of Challenges of Noise Barrier Materials

The encountered challenges of all noise barrier materials reported by participating state DOTs are shown in Figure 14.

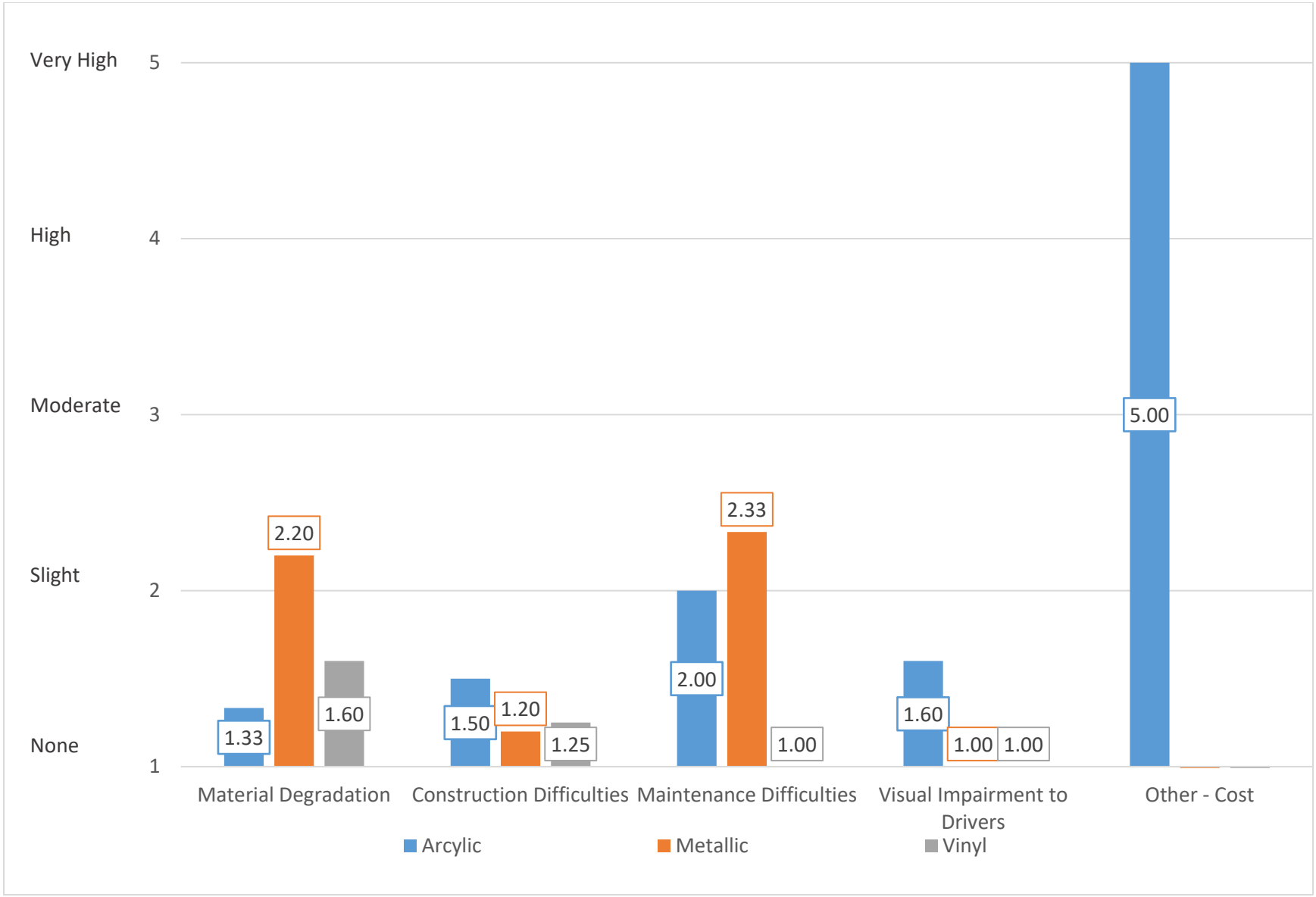

Figure 14. Level of encountered challenges for different noise barrier materials.

3.5 RECOMMENDATIONS FOR EXPEDITING NOISE BARRIER APPROVALS

This section analyzes the collected feedback from state DOT officials on their practices to expedite noise barrier approvals. Survey respondents were asked five questions that were designed to identify their practices for (1) Timing of conducting public outreach; (2) Soliciting new noise barrier products; (3) Distributing a list of preapproved noise barriers to contractors during bidding/letting; (4) Allowing value engineering after bidding/letting; and (5) Streamlining the noise barrier approval process.

3.5.1 Public Outreach Schedule

Survey respondents were asked to identify the project phase that their state conducts public outreach to assess desire to implement a noise barrier. The respondents were provided three options (a) During preliminary engineering/NEPA; (2) During design; and (3) Other. The number of responses and percentages of each response are summarized in Table 27 and Figure 15. The survey results illustrate that 60.0% of state DOTs conduct public outreach during preliminary engineering/NEPA; 20.0% during design; and 20.0% during other phases.

Table 27. Timing of Public Outreach Reported by State DOTs

When does your state conduct public outreach?	Number of States	Percentage
During Preliminary Engineering/NEPA	18	60.0%
During Design	6	20.0%
Other	6	20.0%
Total	**30**	**100%**

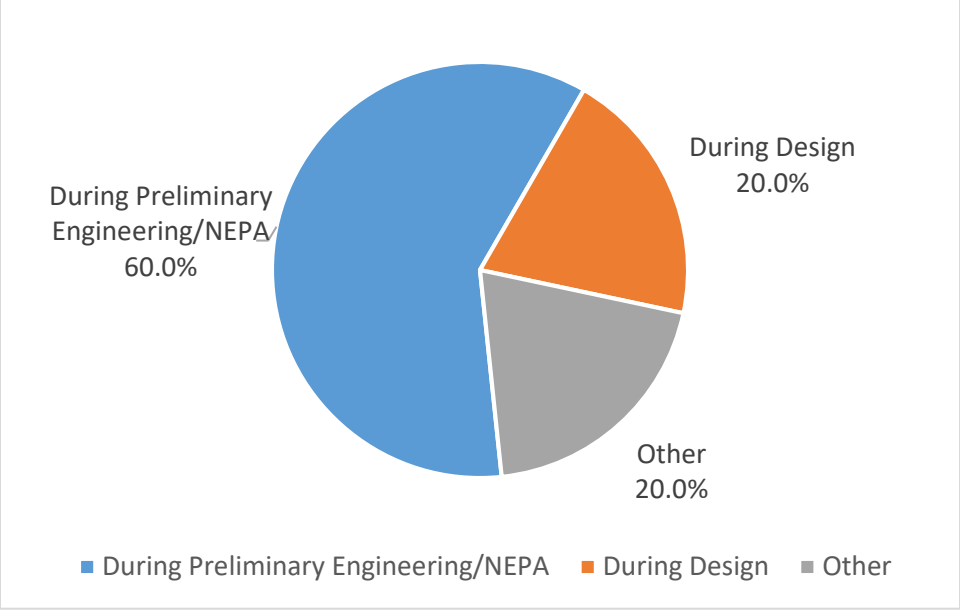

Figure 15. Timing of public outreach reported by state DOTs.

3.5.2 Request New Noise Barrier Products

State DOTs were asked if they regularly request new noise barrier products from manufacturers, as shown in Table 28. The survey results show that 28 state DOTs do not request new noise barrier products from manufacturers. Of the two states that regularly request new products, one state makes requests quarterly, and the other state reported that they make requests as needed by the regions.

Table 28. Request of New Noise Barrier Products Reported by State DOTs

Request New Noise Barriers	Number of States	Percentage
Yes	2	6.7%
No	28	93.3%
Total	**30**	**100%**

3.5.3 List of DOT Preapproved Noise Barriers

Survey respondents were asked if they provide a preapproved list of noise barriers to contractors during letting/bidding. As shown in Table 29, the majority of state DOTs (67.9%) reported that they do not provide a preapproved list of noise barriers to contractors during letting/bidding.

Table 29. Supplied Preapproved List of Noise Barriers Reported by State DOTs

Preapproved List of Noise Barriers	Number of States	Percentage
Yes	9	32.1%
No	19	67.9%
Total	**28**	**100%**

3.5.4 Value Engineering of Noise Barriers

State DOTs officials were asked if they allow value engineering (VE) changes to structure mounted noise barriers after letting/bidding. As shown in Table 30, 17 states do not allow value engineering after letting/bidding, while eight states do allow VE changes.

Table 30. Value Engineering of Noise Barriers After Letting/Bidding Reported by State DOTs

Allow Value Engineering After Letting/Bidding	Number of States	Percentage
Yes	8	32.0%
No	17	68.0%
Total	**25**	**100%**

3.5.5 Expediting Review and Approval of Noise Barriers

Survey respondents were asked if their state has made any changes to expedite or streamline the review and approval process of noise barriers. The number of responses and percentages of each response are summarized in Table 31. The survey results indicate that eight states have not made any changes to expedite noise barrier approvals, six states have made changes, and four states responded 'not applicable'. Five of the six states listed their practices for streamlining the approval process as (1) Using a noise report template; (2) Consulting with DOT design personnel; (3) Changing the design-build process; (4) Utilizing a screening process for impact identification and possible abatement, and (5) Using pre-certified noise barrier systems.

Table 31. Expediting/Streamlining Noise Barrier Approvals Reported by State DOTs

Streamline Noise Barrier Approvals	Number of States	Percentage
Yes	6	33.3%
No	8	44.4%
N/A	4	22.2%
Total	**18**	**100%**

3.6 ADDITIONAL FEEDBACK AND COMMENTS

At the end of the survey, respondents were asked to (1) Provide any additional feedback; and (2) Indicate if they wish to receive the main findings of this survey.

3.6.1 Additional Feedback

State DOT officials were asked to provide any additional comments regarding their state noise barrier approval process. Seven states provided additional comments, as shown in Table 32. The additional comments provided by the survey respondents include practices that are currently used by IDOT or have been suggested by IDOT officials. For example, one DOT official reported that they maintain an online list of approved noise barrier systems, which was recommended by IDOT Bureau of Bridges and Structures and IDOT Central Bureau of Materials in Chapter 2. Another DOT official reported that they have a multi-division noise barrier approval process, similar to the IDOT/IHDC review.

Table 32. Additional Feedback Reported by State DOTs

State DOT Comments
DOT maintains a list of all approved noise barrier systems online so everyone including contractors has access to this information.
DOT noise barrier approval includes several divisions within the agency including acoustics, bridge/structural, landscape, architectural, and maintenance. All must approve unconditionally to fully approve a product.
Routinely uses standard concrete barrier design (or approved concrete product that meets structural criteria in our design standards). Years ago, the DOT issued a procedure approving other noise barrier products. The procedure was later withdrawn because no manufacturers could compete with the price of concrete barriers in Florida.
DOT requires the use of the same pressure treated wood panel, concrete post and drilled shaft noise barrier design for all ground mounted noise barriers. Alternative materials are only allowed for structure mounted noise barriers.
Require anti-graffiti coating in policies.
We do not build many noise walls in this state.
Currently do not use noise barriers. Existing noise policy will soon be updated.

3.6.2 Request of Survey Findings

Respondents were also asked if they are interested in receiving the main findings of this survey, as shown in Table 33. The survey results show that 89.3% of state DOT respondents are interested in receiving the main findings of the collected data on noise barrier approvals.

Table 33. Requested Survey Results

Interested in Findings	Number of States	Percentage
Yes	25	89.3%
No	3	10.7%
Total	**28**	**100.0%**

CHAPTER 4: RECOMMENDATIONS AND FUTURE RESEARCH

4.1 RECOMMENDATIONS

This chapter provides four recommendations that can be used by IDOT to expedite the approvals of alternative noise barriers. These recommendations were developed based on the main findings of the research tasks, and they can be used to update and/or expand related IDOT practices, policies, specifications, and standards. The four developed recommendations are discussed in the following subsections.

4.1.1 Recommendation 1

Existing IDOT policies should include the "IDOT Flowchart for Approving Alternative Noise Barriers" and "IDOT procedures for Approving Alternative Noise Barriers" that are summarized in Figure 16 and Table 34, respectively. These updated flowchart and procedures were developed to concisely and clearly describe IDOT practices and policies for approving alternative noise barriers based on the findings of the aforementioned review of related policies and the conducted interviews of IDOT officials that were earlier described in Chapter 2. This flowchart represents IDOT approval procedures for alternative noise barriers for general use statewide and does not represent the approval procedure of noise barriers for specific projects. The flowchart provides a graphical representation of the sequence of approval activities/steps and their estimated range of durations, as shown in Figure 16 and described in more details in Table 34. It should be noted that the developed flowchart and its list of approval activities were designed to conform to the format and style of network diagrams used in the BDE Manual to facilitate their future integration into IDOT policies.

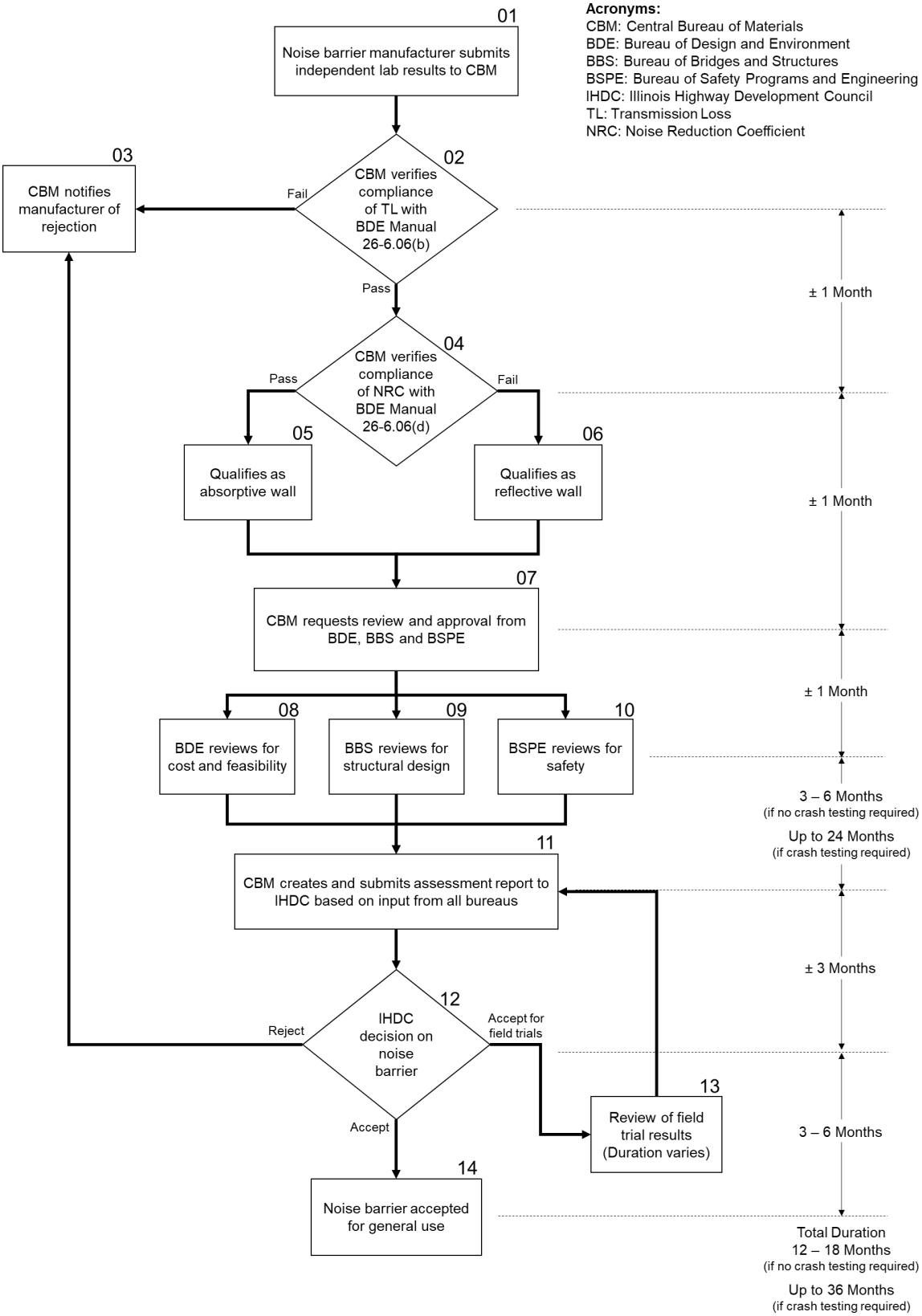

Figure 16. IDOT flowchart for approving alternative noise barriers.

Table 34. IDOT Procedures for Approving Alternative Noise Barriers

Activity No.	Description	Duration
Activity No. 1:	Noise wall manufacturer submits independent lab results to IDOT Central Bureau of Materials (CBM).	N/A
Activity No. 2:	CBM verifies that the reported Transmission Loss (TL) in the independent lab results complies with the requirements in BDE Manual subsection 26-6.06(a) that states “noise wall materials must achieve sound Transmission Loss (TL) equal to or greater than 20 dB in all one-third octave bands from 100 hertz to 5,000 hertz, inclusive” (IDOT 2018a).	±1 Month
Activity No. 3:	CBM notifies alternative noise wall manufacturer of rejection.	N/A
Activity No. 4:	CBM classifies the wall as absorptive or reflective based on its reported Noise Reduction Coefficient (NRC) in the independent lab results based on the requirements in BDE Manual subsection 26-6.06(d) that states “a noise abatement wall surface will qualify as “absorptive” provided that it achieves a composite Noise Reduction Coefficient (NRC) of at least 0.80 if on the roadway side of the wall, and a composite NRC of at least 0.65 if on the side of the wall away from the roadway” (IDOT 2018a).	±1 Month
Activity No. 5:	Alternative noise wall qualifies as absorptive wall.	N/A
Activity No. 6:	Alternative noise wall qualifies as reflective wall. Noise reduction coefficient below 0.80 on the roadway side of the wall or 0.65 on the wall away from the roadway indicates that the noise wall does not qualify as absorptive and can only be considered for use as a reflective wall.	N/A
Activity No. 7:	CBM requests review and approval from Bureau of Design and Environment (BDE), Bureau of Bridges and Structures (BBS), and Bureau of Safety Programs and Engineering (BSPE).	±1 Month
Activity No. 8:	BDE analyzes the cost and feasibility of the noise wall.	±6 Months
Activity No. 9:	BBS reviews the design of the noise wall including its structural components, connections, drilled shaft diameters and depth to ensure that they meet the requirements of IDOT specifications. The scope of review by BBS depends on the type of noise wall and whether it is ground mounted or structure mounted.	3 – 6 Months (if no crash testing required) Up to 24 Months (if crash testing required)
Activity No. 10:	BSPE reviews manufacturer supplied safety information such as drawings, specifications, videos, and crash data to ensure that the noise wall meets NCHRP 350 or MASH 2016 requirements.	3 – 24 Months
Activity No. 11:	CBM creates and submits an assessment report to Illinois Highway Development Council (IHDC) based on input from all bureaus.	±3 Months
Activity No. 12:	IHDC reviews assessment report and decides to accept, reject, or recommend for field trials.	3 – 6 Months
Activity No. 13:	Conduct field trials of noise wall and submit their results to CBM, BDE, BBS and BSPE for additional review and approval.	Duration varies
Activity No. 14	Alternative noise wall accepted for general use in Illinois.	Total Duration: 12 – 18 Months (if no crash testing required) Up to 36 Months (if crash testing required)

4.1.2 Recommendation 2

IDOT should maintain a list of 'approved noise barriers' that can be accessed on the IDOT website and/or supplied with bid documents for contracts that have noise barriers. This recommendation is developed based on the findings of both the conducted interviews with IDOT officials and the survey results. Interviewed IDOT officials recommended distributing a list of approved noise barriers (see Chapter 2.4.2), and over 30% of state DOT survey respondents reported that they provide a list of preapproved noise barriers to contractors during letting/bidding (see Chapter 3.5.4).

4.1.3 Recommendation 3

IDOT review procedures should prohibit contractor-introduced value engineering changes to all noise barriers after bidding/letting subject to review and approval from IDOT BDE and FHWA. These contractor-introduced value engineering changes often require changing the noise barrier material from reflective to absorptive or vice versa. This change in material affects the height of the wall and can drastically affect the design of the structure, its connections, and accordingly it can cause a delay in the completion of the project. Additionally, any changes to the noise barrier material can experience further delays due to additional public involvement. This recommendation is developed based on the findings of both the conducted interviews with IDOT officials and the survey results. Interviewed IDOT officials recommended that contractor-proposed unnecessary extensive design changes for noise walls be rejected or limited after bidding/letting (see Chapter 2.4.3), and 68% of state DOT survey respondents reported that they do not allow value engineering after bidding/letting (see Chapter 3.5.4).

4.1.4 Recommendation 4

IDOT should explore the technical and financial feasibility to establish an experimental test site or make an arrangement with an existing testing facility to evaluate the performance and durability of noise barriers that have been approved for field trials by the IHDC. Interviewed IDOT officials indicated that approved alternative noise barrier systems must wait until they are selected as a field trial for a project that requires a noise wall. Conducting field trials at an experimental test site avoids the need to wait for an appropriate project that can be used to evaluate the performance of the noise barrier. Additionally, if a noise barrier sample fails to satisfy the performance or durability requirements at the experimental test site, the required cost and time to demolish a limited length (e.g. 100 feet) of the tested wall sample are significantly less than those required to replace a failed full-length wall in an actual project.

4.2 FUTURE RESEARCH

During the course of this study, the research team identified a number of promising research areas that need further in-depth analysis and investigation. Building on the accomplishments in this project, the research team foresees an opportunity to continue studying and improving the approval of noise barriers by focusing on one or more of the following research areas.

4.2.1 Research Area 1: Improving the Selection of Project-Specific Noise Barrier Materials

4.2.1.1 Problem Statement

During the review of alternative noise barrier approval procedures, the research team observed that there was a lack of a practical and effective procedure for selecting the most suitable noise barrier material for specific projects. This selection often varies from one project to another, as it is dependent on the specific project conditions and its required performance criteria including: (1) Construction time; (2) Cost; (3) Durability; (4) Aesthetics; (5) Maintenance; (6) Construction difficulties; and (7) Visual impairment to drivers. These criteria need to be individually weighted to fit the specific requirements of each project. Accordingly, there is a pressing need for a practical and effective procedure for optimizing the selection of noise barrier materials that is capable of optimizing the collective performance in all these project-specific criteria. This can lead to the selection of optimal noise barriers for each IDOT specific project that reduces construction time, minimizes cost, increases life cycle, enhances aesthetics and public acceptance, improves maintainability, provides better constructability, and reduces levels of visual impairments to drivers.

4.2.1.2 Objective and Scope of Proposed Research

The objectives of this proposed research are to (1) Quantify and analyze the performance criteria of each noise barrier material; and (2) Develop a practical and effective decision support system (DSS) to select the optimal noise barrier material for a specific project that meets the IDOT criteria and satisfies the public. The proposed research will enable IDOT and other DOT agencies to (a) Reduce delays related to public concerns of noise barrier materials; and (b) Optimize the selection of alternative noise barriers.

4.2.1.3 Expected Outcome

The deliverables of this proposed research will enable IDOT to (1) Quantify the performance of each noise barrier material; (2) Identify the optimal noise barrier material for each project; (3) Reduce construction time; (4) Minimize cost; (5) Increase life cycle; (6) Enhance aesthetics and public acceptance; (7) Improve maintainability; (8) Provide better constructability; and (9) Reduce levels of visual impairments to drivers.

4.2.2 Research Area 2: Developing an Approval Procedure and Flowchart for Project Specific Use

4.2.2.1 Problem Statement

IDOT officials reported that project specific approvals, specifically for products under the Experimental Feature exclusion are reviewed and approved differently than noise barriers approved for general use. Accordingly, there is a need to accurately identify the review and approval procedures for project specific use to provide a complete analysis of both project specific and general use approvals.

4.2.2.2 Objective and Scope of Proposed Research

The objectives of this proposed research are to (1) Identify and analyze the approval procedures required for project specific alternative noise barriers; and (2) Develop a flowchart and procedure that details the individual approvals steps. The proposed research will enable IDOT to (a) Reduce delays associated with manufacturers submitting alternative noise barriers for approval under the incorrect use (general/project specific); and (b) Accurately document the project specific approval process.

4.2.2.3 Expected Outcome

The deliverables of this proposed research will enable IDOT to (1) Provide manufacturers information on the project specific approval procedures of alternative noise barriers; and (2) Identify the approval steps and estimated duration for each stage.

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APPENDIX A: STATE DOT SURVEY FORM

NOISE BARRIER APPROVALS

Introduction and Basic Information

The Illinois Department of Transportation is sponsoring an ongoing research project to study the approval practices of noise barriers. This online survey is designed to take less than 15 minutes to complete. Your valuable feedback will assist in evaluating the current approval processes used by State DOTs in an effort to streamline these approvals for highway projects. We would appreciate if you completed the survey by June 1st, 2018.

The research team will be glad to share the findings of this survey with you upon completion.

If you have any questions or comments, please contact the Principle Investigator (PI) of this research project:

Khaled El-Rayes, Professor

Department of Civil and Environmental Engineering

University of Illinois at Urbana-Champaign

E-mail: elrayes@illinois.edu

Thank you in advance for your time.

What is your name? (Optional) _____

What state do you represent? (Required) _____

What is your current job title? (Optional) _____

STATE NOISE BARRIER POLICIES AND CRITERIA

1. Please list your state DOT specific policies and procedures (DOT manual/flowchart) for noise barriers approvals

   _____

   _____

   a. Please provide link to policy/procedure if possible _____

2. Please select from the list below the criteria that your state uses to approve noise barriers and their acceptable limits

	⩾20db	⩾25db	⩾30db	⩾35db	Other
(a) Transmission Loss (TL)	☐	☐	☐	☐	☐_____

	⩾0.80	⩾0.85	⩾0.90	⩾0.95	Other
(b1) Noise Reduction Coefficient (NRC) (Roadway Side)	☐	☐	☐	☐	☐_____

	⩾0.60	⩾0.65	⩾0.70	⩾0.75	Other
(b2) Noise Reduction Coefficient (NRC) (Away Side)	☐	☐	☐	☐	☐_____

	$20,000	$25,000	$30,000	$35,000	Other
(c1) Cost (per benefited receptor)	☐	☐	☐	☐	☐_____

	$1,000,000	$2,000,000	$2,500,000	$3,000,000	Other
(c2) Cost (per mile)	☐	☐	☐	☐	☐_____

	MASH 2016	AASHTO LRFD	Other
(d) Safety	☐	☐	☐_____

(e) Additional criteria	Please specify requirements, if any
Constructability	
Feasibility	
Aesthetics	
Other _____	

TIMELINE AND APPROVED NOISE BARRIERS

3. Please estimate the duration (in months) for review and approval of noise barriers in your state (from manufacturer submission to approval).
    a. If crash testing is not required _____
    b. If crash testing is required _____

4. Please select from the checklist below noise barriers that were approved by your state DOT.

Manufacturer – Noise Wall Product	Absorptive	Reflective
ACH - USG Ultrasound Sight & Sound Screen Panel	☐	☐
- Acoustax	☐	☐
Barrier Stone - Concrete Masonry Wall 6.0"	☐	☐
Barrier Stone - Concrete Masonry Wall 7.825"	☐	☐
Carsonite - Barrier Wall w/Agg Facing	☐	☐
Carsonite - Barrier Wall w/Perforated Metal Facing	☐	☐
Carsonite - Unfaced Highway Sound Barrier	☐	☐
Carsonite - H-way Sound Barrier w/ Extruded Cover-Strip Facing	☐	☐
Carsonite - Barrier Wall w/ Snap-on Plastic Cover Strips	☐	☐
Carsonite - Quietwall filled	☐	☐
Carsonite - Quietwall unfilled	☐	☐
Centria - Eco Sound Barrier	☐	☐
CSI - Soundtrap	☐	☐
CSI - Soundsorb	☐	☐
CYRO - Paraglass RFP	☐	☐
CYRO - Paraglass TL4	☐	☐
CYRO (Evonic) - ACRYLITE Soundstop TL4	☐	☐
EAS - Silent Screen	☐	☐
Reinforced Earth - Durisol	☐	☐
New Frontier Industries - Everquiet	☐	☐
Faddis - AcoustaCrete 3.0", 2.5"	☐	☐
Faddis - AcoustaCrete 3.0"	☐	☐
I-Rock (Curb Appeal) - I-Rock (Smart-tie) - Recycled Plastic	☐	☐
MBCI -	☐	☐
Sound Fighter Systems - LSE Noise Barrier Systems	☐	☐

Soundscape - Soundscape -unfilled	☐	☐
Soundscape - Soundscape -unfilled-uv	☐	☐
Soundscape - Soundscape -filled-uv	☐	☐
Harder, Luckey, & Hargrave - Tuf-Barrier	☐	☐
Harder, Luckey, & Hargrave - Silent Protector	☐	☐
Harder, Luckey, & Hargrave - Silent Protector Plus	☐	☐
PEC - Whisperwall	☐	☐
Vinyl Fence Wholesalers - Simtek Fence (Polyethylene Noise Reduction Fence)	☐	☐
Other _____	☐	☐

NOISE BARRIER EFFECTIVENESS AND CHALLENGES

5. Please compare the performance of non-precast concrete noise barriers (acrylic, metallic, vinyl, etc.) in your state to precast concrete noise barriers in each of the listed criteria
   (1 Significantly Worse, 2 Slightly Worse, 3 Similar Performance, 4 Slightly Better, and 5 Significantly Better)

Performance Criteria Compared to Precast Concrete Noise Barriers	1 Significantly Worse	2 Slightly Worse	3 Similar Performance	4 Slightly Better	5 Significantly Better
Construction Time	☐	☐	☐	☐	☐
Cost	☐	☐	☐	☐	☐
Durability	☐	☐	☐	☐	☐
Aesthetics	☐	☐	☐	☐	☐
Maintenance					
Others, please specify _____	☐	☐	☐	☐	☐

6. Please rank the level of encountered challenges of utilizing non-precast concrete noise barriers in your state in each of the listed areas
   (1 None, 2 Slight, 3 Moderate, 4 High, 5 Very High)

Encountered Problems of Noise Barriers	1 None	2 Slight	3 Moderate	4 High	5 Very High
Material Degradation	☐	☐	☐	☐	☐
Construction Difficulties	☐	☐	☐	☐	☐
Maintenance/Repair Difficulties	☐	☐	☐	☐	☐
Visual Impairment (reflection/glare) to Drivers	☐	☐	☐	☐	☐
Others, please specify _____	☐	☐	☐	☐	☐

RECOMMENDATIONS FOR EXPEDITING NOISE BARRIER APPROVALS

7. When does your state conduct public outreach to assess desire for implementation of noise barrier?
   ( ) During Preliminary Engineering/NEPA
   ( ) During Design
   ( ) Other _____

8. Does your state regularly request new noise barrier products from manufacturers to review? (Y/N)
   ( ) If yes, how often? (Yearly, bi-yearly, monthly, other) _____
   ( ) No

9. Does your state provide a preapproved list of noise barriers to contractors during letting/bidding?
   ( ) Yes
   ( ) No

10. Does your state allow value engineering changes by contractors to structure mounted noise barriers after letting/bidding (which may significantly alter the design of the structure)?
    ( ) Yes
    ( ) No

11. Has your state made any changes to expedite or streamline the review and approval process of noise barriers in your state?
    _____
    _____

Feedback

12. Please provide any additional comments regarding the noise barrier approval process

    _____

    _____

13. Would you be willing to provide more information, if needed?

    ( ) Yes (Please provide e-mail address) _____

    ( ) No

14. Are you interested in receiving the main findings of this survey upon completion?

    ( ) Yes (Please provide e-mail address) _____

    ( ) No


Illinois Department
of Transportation


ILLINOIS