APPENDIX D

Using the Barrier Reflections Screening Tool

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CONTENTS

CHAPTER D-1

Intended Use

The accompanying Barrier Reflections Screening Tool quickly estimates the expected increase in traffic noise due to reflections from a barrier on the opposite side of the road. This tool focuses on a single variable to estimate the barrier-reflected noise effect at receptors opposite a noise barrier: path-length difference (comparing the path length for direct sound and for barrier-reflected sound). The tool uses this variable to conservatively estimate the increase in traffic noise based on the geometrical spreading of sound from a line source. The results can be used to determine areas where detailed evaluation of reflected noise and abatement options should be considered.

Analysts should carefully define inputs, and results should be considered within the context of each individual scenario to ensure that values are relevant. For instance, the increase in noise levels from barrier reflections may not contribute to the overall sound level if background noise levels at the receptor are dominated by a source other than traffic on the highway being evaluated. This may be the case if local roads or other noise sources are 10 dB greater than the traffic noise. It is also recognized that variables other than path length difference, such as meteorological or ground effects, contribute to the barrier reflections effect. Depending on the amount of those contributions, estimates for other variables may need to be combined with the path-length screening tool to refine results.

CHAPTER D-2

Instructions for Use

Two versions of the tool (separated by tabs in the spreadsheet file) are provided, and they accept different input types. To estimate the barrier reflections effects, use the “based on distances” tab if the direct path length is known, and the “based on coordinates” tab if XYZ coordinate locations of the source, receptor, and barrier are known. It is recommended to use the centerline of all traffic lanes as the traffic noise source location. This will provide an approximation of the barrier reflection contribution for all lanes of traffic. For typical highways, this will be the center of the median; however, depending on the number of lanes in each direction and inside shoulder widths, the centerline may shift closer to the receptor or barrier. Barrier reflection effects can be estimated for individual traffic lanes by choosing that lane as a source location.

In both versions of the tool, cells shaded blue require a user input, cells shaded yellow allow for optional user input, and the cell shaded green provides the result. The dynamic graph in each tab provides a bird’s-eye view of the setup and can be used to visually verify that input values match expectations.

Optional input allows for including shielding effects for both the direct and reflected sound levels. User-estimated shielding can be entered if there are features in the site geometry that potentially block or partially block the line of sight from the source to receptor or barrier to receptor. Such features could include the edge of pavement for a cut roadway, edge of an elevated roadway, or safety barriers with heights greater than a standard 32-inch safety barrier.

Optional input also allows for determining the effect of barrier reflections for traffic upstream or downstream. Some receptors do not have a noise barrier directly across the highway; however, they may experience effects from upstream or downstream noise barriers. In such cases, a source offset can be applied to evaluate the effect of those barriers. Care should be taken when considering an offset. In cases with a large offset, the direct path noise at the point of closest approach to the receptor (the zero offset location) may be higher than the offset direct path noise plus the reflected increase. In such cases, although the barrier is causing an increase in sound levels from the offset position, the sound increase at the receptor due to all sources (including the zero offset location) may be negligible.

CHAPTER D-3

Validation of Estimates

For NCHRP Project 25-44 Phase 1, the project team conducted field measurements in California (SR-71), Maryland (MD-5), Tennessee (I-24 & Briley Parkway), and Illinois (I-90). For Phase 2, the project team conducted field measurements in Ohio at three sites: I-75, I-70, and I-270. Detailed information about the measurements can be found in Appendix E, which is available for download from the *NCHRP Research Report 886* web page at www.trb.org. The analysis found the measured barrier effect (comparing sites with and without a barrier) for each location. For validating the screening tool, the tool results are compared to both A-weighted and unweighted measured results. The unweighted results provide a conservative estimate of the barrier reflection effects (generally slightly greater effect than for A-weighted results). For locations where two microphones were placed the same distance from the barrier, the selected range came from the microphone with the higher elevation. Since the influence from ground effects are not considered in the screening tool, the higher microphone provides for a more accurate comparison.

The estimated effect (from the screening tool) is presented in Figure 1, shown as circles. The estimated effect is compared to the range of measured barrier reflection effects, both unweighted (diamonds) and A-weighted (squares). The distances listed for each site represent the perpendicular distance from the traffic centerline to the receivers.

Three of the measured locations (I-24, Briley Parkway, and I-75) included a median barrier of a height higher than a typical safety barrier. In these cases, it was assumed that the barrier provided no direct path shielding (either from the source to the receptor or the source to the noise barrier) because reflections off the median barrier from the near lanes of travel can be considered roughly equivalent to the direct path noise from the far lanes from cases without a barrier. However, the taller barrier does provide some shielding of the reflected noise, so a shielding amount of 2 dB was included in the screening tool estimates for these sites.

For site I-270, a slightly modified version of the screening tool was used to estimate the effect of reflections from the homes behind the microphone locations. The effect was applied to the measured data to compare it to screening tool estimates.

An additional plot is shown in Figure 2 to illustrate the relationship of the maximum measured barrier reflections effect as a function of reflected path length, which appears to be a key parameter in the magnitude of the effect. Several parameters were examined, and this parameter helps to differentiate absorptive barrier sites.

Key observations of the validation analysis results in Figure 1 and Figure 2 are as follows:

- All the estimated values fall within or slightly above the top of the measured value ranges. This indicates that the screening tool provides a conservative estimate of the barrier-reflected effect and is appropriate for use in screening for potential adverse effects due to a noise barrier on the opposite side of a highway.
- The barrier effect appears to be dominated by path lengths. Any trends related to barrier absorption are likely masked. It could be expected that the screening tool would over-estimate

the barrier effect for absorptive barriers (sites I-75, I-70, and I-270), but since the absorptive barrier sites all had geometries with fairly large propagation distances for the reflected path, that expectation is not realized.

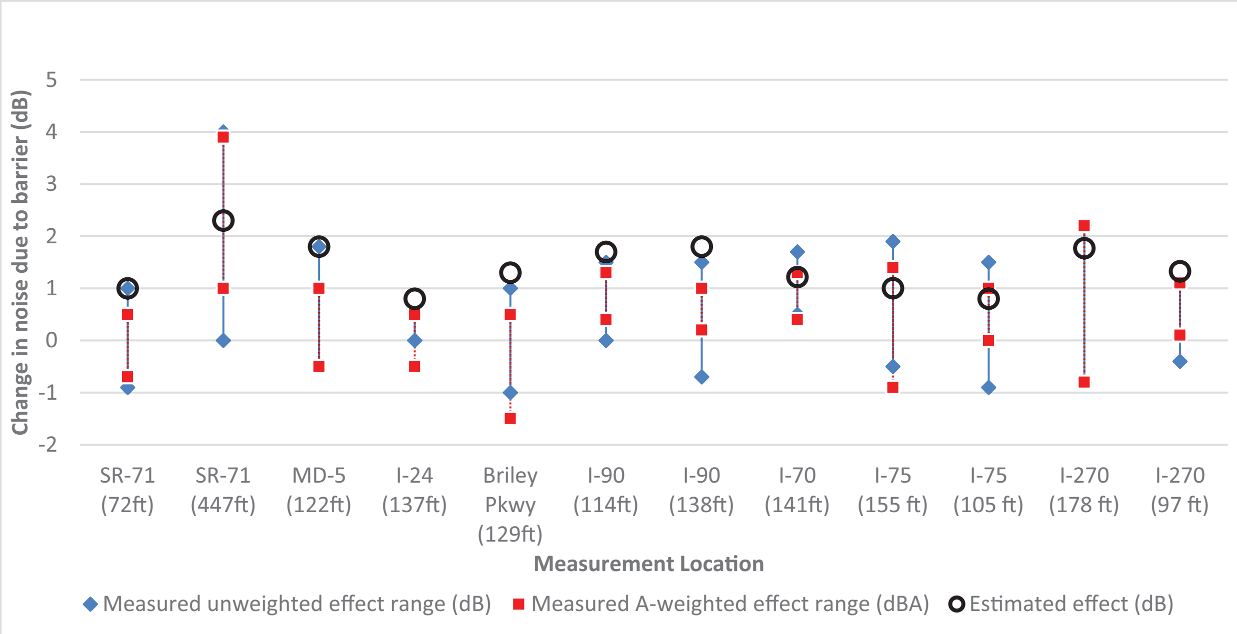

Figure 1. Estimated barrier effect compared to unweighted and A-weighted results.

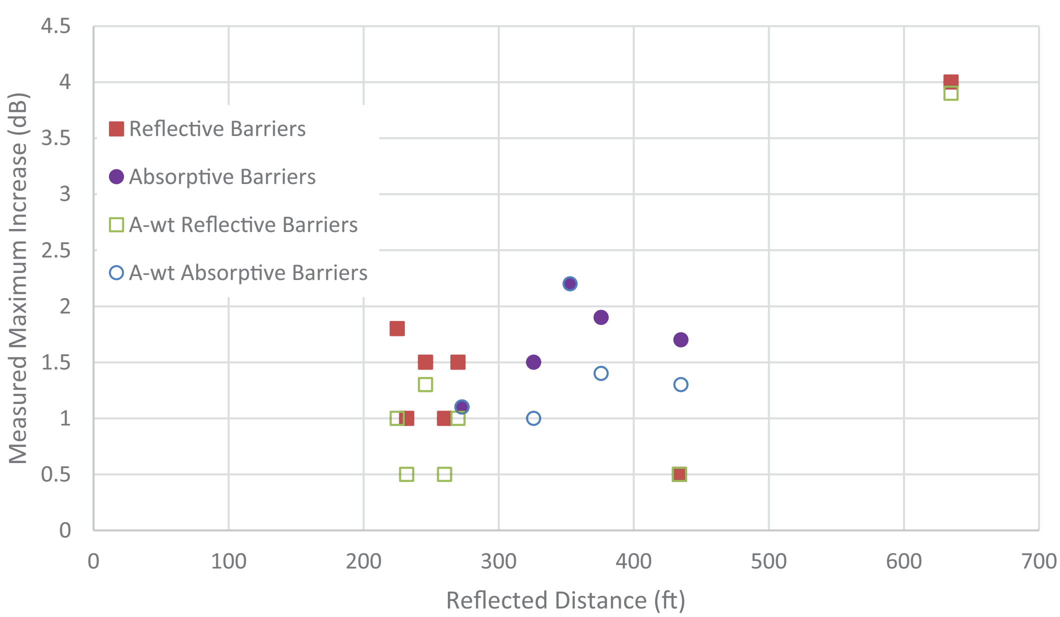

Figure 2. Maximum measured barrier effect compared to reflected path length.