Suburban Noise Control with Plant Materials and Solid Barriers

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ABSTRACT.—Studies were conducted in suburban settings with specially designed noise screens consisting of combinations of plant materials and solid barriers. The amount of reduction in sound level due to the presence of the plant materials and barriers is reported. Observations and conclusions for the measured phenomenae are offered, as well as tentative recommendations for the use of plant materials and solid barriers as noise screens.

YOUR $50,000 HOME IN THE SUBURBS may be the object of an invasion more insidious than termites, and fully as damaging. The culprit is noise, especially traffic noise; and although it will not structurally damage your house, it will cause value depreciation and discomfort for you. The recent expansion of our national highway systems, and the upgrading of arterial streets within the city, have caused widespread traffic-noise problems at residential properties. Blame for the problem rests with governmental bodies at all levels, and with real-estate developers and the general public in its demand for rapid automobile access and movement. Rather than attempting to fix the responsibility, however, our objective is to help reduce the suburban traffic-noise problem, using combinations of plant materials and solid barriers.

THE ALTERNATIVES

Preliminary planning that includes noise considerations, adequate zoning, and setbacks offers the greatest assurance of a relatively noise-free suburban environment. Where the noise problem already exists, however, means are available for reducing noise to an acceptable level.

Ideally, noise is controlled by reducing the source level. Lowered speed limits, relocated truck routes, and improved engine muffling can be helpful. An alternative solution is to create some sort of barrier between the noise source and the property to be protected. In the Twin Cities, for instance, wooden walls up to 16 feet tall have been built along Interstate Highways 35 and 94. Although not esthetically pleasing, they have effectively reduced traffic noise, and the response from property owners has been generally favorable.

Land forms consisting of earthen dikes, also known as acoustical berms, have shown promise. Roadside developments, strategically placed to take advantage of natural hills and other topographic features, reflect good planning to reduce noise from passing traffic.

Trees, shrubs, grass, and other plant materials can significantly reduce certain noises; and where conditions favor their use, no other means may be required.

HOW MUCH REDUCTION IS NEEDED

The amount of reduction in noise (attenuation) needed is determined by the level at the source and by requirements at the receiver. Source noise emitted by a large truck often exceeds 100 decibels (dBA) within a few feet of the vehicle. Requirements at the receiver vary considerably, depending on personal sensitivity, but most observers think that noise levels exceeding 70 dBA are objectionable for outdoor daytime activities, especially if conversation is to be maintained. (A reduction of 10 dBA means noise is cut about in half.) We favor levels in the 60- to 65-dBA range for daylight hours, and 50 to 55 dBA for evening hours, when background sounds are quieter. Our experience indicates that the majority of persons living adjacent to a 35-mile-per-hour arterial street do not object to noise levels in the 60- to 65-dBA range in their backyards.

To further illustrate the amount of reduction needed, consider a hypothetical situation in which the noise level of a large truck is 90 dBA at a point 10 meters from the center of the traffic lane. We would like to reduce the noise level to an acceptable 65 dBA at 30 meters from the same point. Some reduction occurs naturally with distance. Assuming a point source and spherical divergence, we would find the level at 30 meters to be about 80 dBA. The remaining 15-dBA reduction would have to come from some form of barrier interposed between source and receiver. However, neither a belt of tall dense trees, nor a solid wall of reasonable height, nor any combination of the two, will provide sufficient attenuation. Thus this situation represents a condition that can be remedied only by source-level reduction. It would therefore seem that heavy truck traffic, at its present high noise-emission level, should be excluded from suburban residential areas.

Consider a second illustration in which the noise level of an automobile is 75 dBA at a point 10 meters from the center of the traffic lane. The level at 30 meters is then only 65 dBA, which is acceptable to many persons for daytime outofdoor environments, although unsatisfactory for evening hours. We need only to reduce the level by as much as 5 to 10 dBA to provide a satisfactory acoustical environment in this case.

HOW MUCH REDUCTION IS POSSIBLE

With the means considered — plant materials and solid barriers — the amount of reduction possible depends largely on the height of the structure and the density and extent of the plant materials. Plant materials, by themselves, are capable of reducing noise levels as much as 8 dBA, and occasionally more. A tall masonry wall or earthen dike is capable of reducing noise levels by 15 dBA, when properly placed. However, practical considerations such as local ordinances, expense, and appearance rarely permit the construction of a solid barrier of sufficient height (12 to 20 feet) in residential areas.

Our earlier studies in rural areas, where we used combinations of 12-foot-high solid earthen dikes and large dense trees, showed that reductions of 12 to 18 dBA are possible. Results of current experiments in suburban areas are not yet complete, but it appears that combinations of lower solid barriers and moderate-size plantings are also effective.

SITE SELECTION AND PROCEDURE

Ten residential properties in an upper-middle-class neighborhood were selected for study. Backyards of the properties faced a heavily traveled arterial street with a 35-mile-per-hour speed limit. Screen plantings and ground-surface configurations varied considerably from site to site. Three sites that illustrate the most significant features, for noise-control purposes, are described here (figs. 1, 2, and 3).

A sound-level meter was used to measure the noise of a vehicle as it passed by a test site, and a second meter was used to measure noise from the same vehicle as it passed by an open (control) area immediately thereafter. The difference in the two readings (attenuation) represented the amount of reduction that could be attributed to trees and shrubs, solid barriers, and ground-profile effect.

Figure 1.—Site 105 as viewed from the street. Low, dense, cotoneaster shrubs were backed by tall ponderosa pines.

The procedure was repeated at distances of 5, 10, 15, and 20 meters from the curb.

A special site, with relatively young trees on University of Nebraska property, was also selected to provide additional flexibility and control for the experiments. Here a power lawnmower was used as a noise source, and both microphone and source positions were varied. A concrete block wall (figs. 4 and 5), the height of which could be changed by adding courses, was also used in combination with the trees. One segment of the wall was placed in an open area, and an identical segment was placed within the tree belt.

Sound levels were measured by using three different barrier treatments and a control. In one case trees alone were located between the noise source and receiver; in a second case the wall alone was used; in the third both trees and wall were used. Source and receiver distances from the wall were varied from 5 to 20 meters. Readings were taken at various positions to determine the effects of wall, trees, and distance in reducing noise levels.

Figure 2.—Site 108 as viewed from the street: medium-height plantings, a woven board fence, and a downward-sloping ground profile from street to residence.

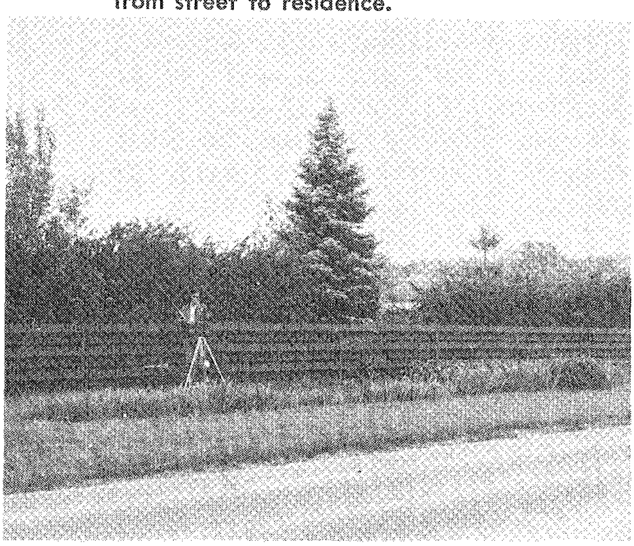


Figure 3.—Site 107 as viewed from the street: tall evergreens hide a 3- to 6-foot brick wall, and an upward-sloping ground profile from street to residence.

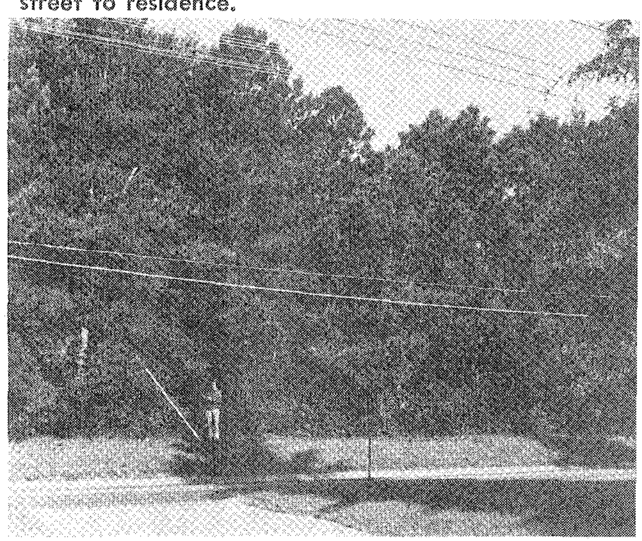
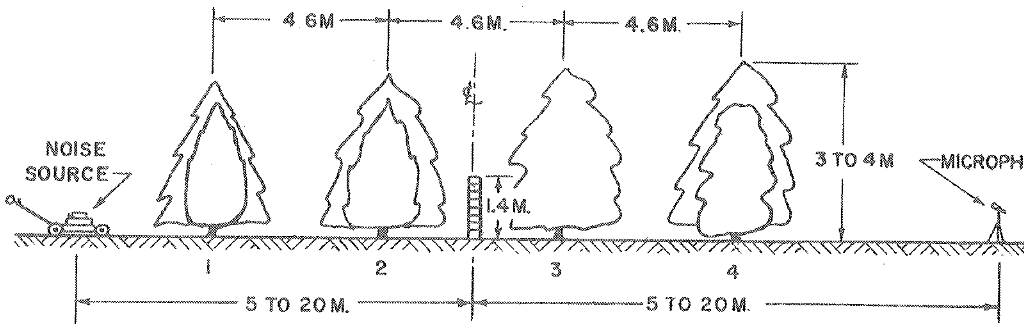


Figure 4.—Site III: Schematic diagram of wall within belts of trees.

SITE 5

PLATTSMOUTH BELT AND WALL



ROW NO	NAME OF TREE
1	AUSTRIAN PINE ALTERNATED WITH ROCKY MT. JUNIPER
2	PONDEROSA PINE ALTERNATED WITH EASTERN REDCEDAR
3	SCOTCH PINE
4	AUSTRIAN PINE ALTERNATED WITH ORIENTAL ARBORVITAE

(TREE SPACING IN ALL ROWS – 2 M.)

Figure 5.—Site III: top, the sound-barrier wall; bottom, the belts of trees.

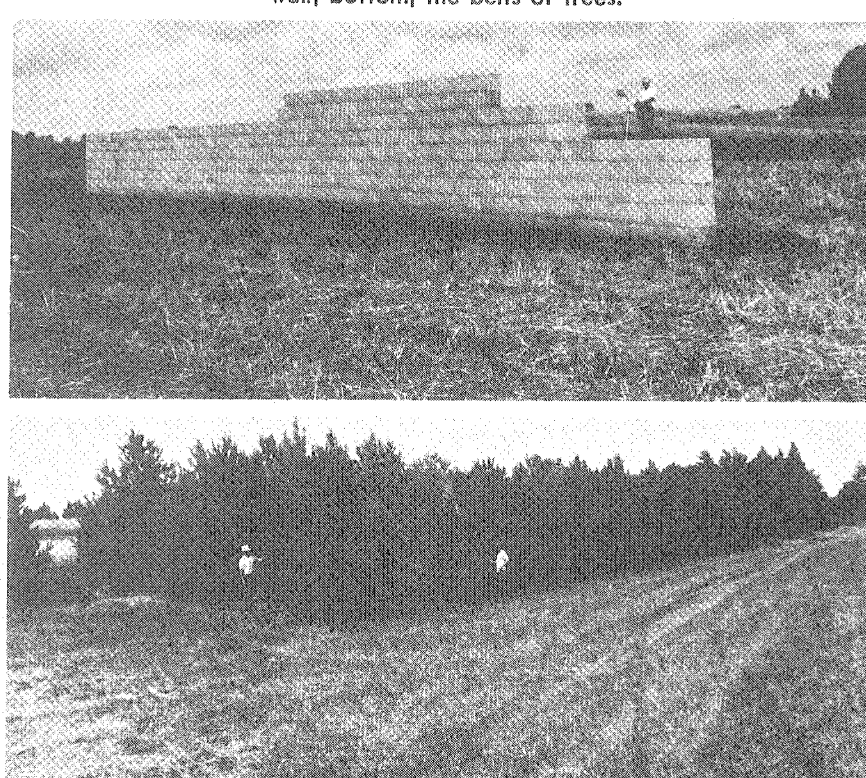


Figure 6.—Site 105: profile of site, noise level, and attenuation.

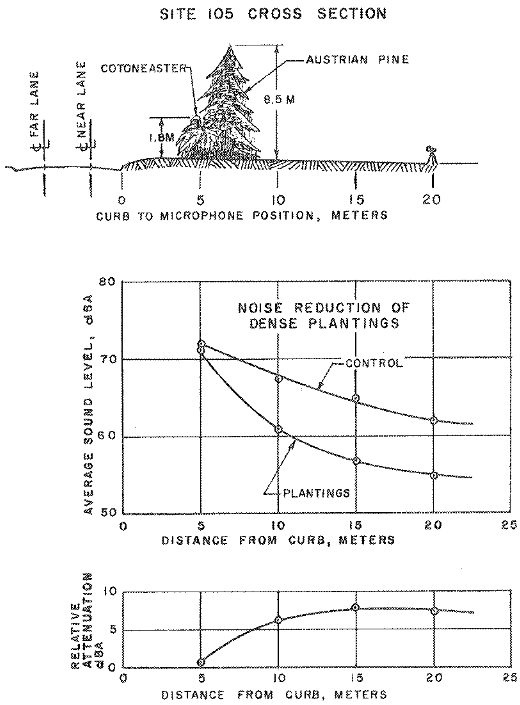


Figure 8.—Site 107: profile of site, noise level, and attenuation.

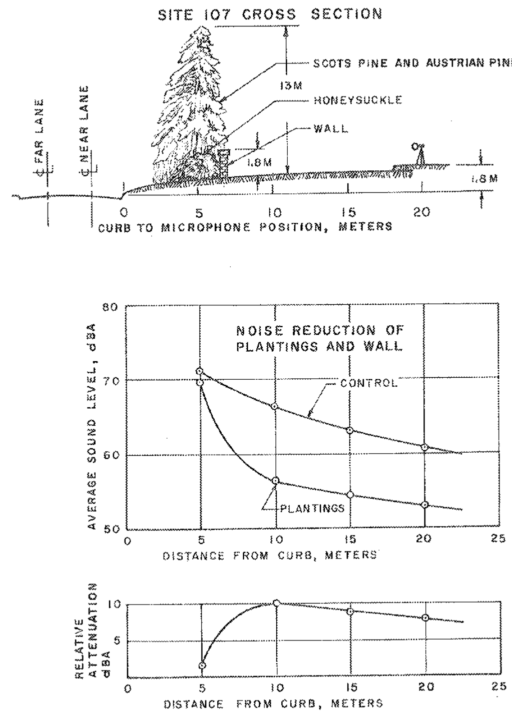
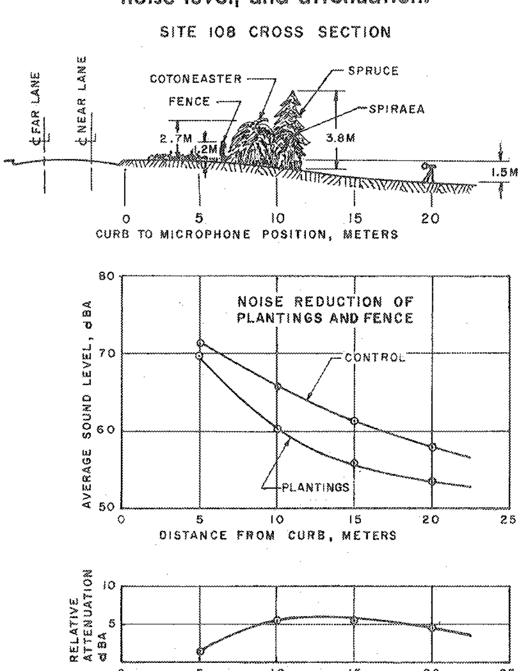


Figure 7.—Site 108: profile of site, noise level, and attenuation.



RESULTS OF EXPERIMENTS

Suburban Sites

Noise reduction characteristics of the three sites are shown graphically in figures 6, 7, and 8. Curves are positioned directly below the schematic cross-section drawings so the points denoting sound level and attenuation line up with the corresponding microphone positions. All readings are in dBA units.

Tree-Farm Site

Variation of sound level with distance and attenuation for the different surface treatments is shown in figure 9. The full height (1.6 meter) wall and the 10-meter wall-to-microphone distance were used in this instance.

The effect of different wall placements —between source and receiver—on the

Figure 9.—Sound level and attenuation with different surfaces.

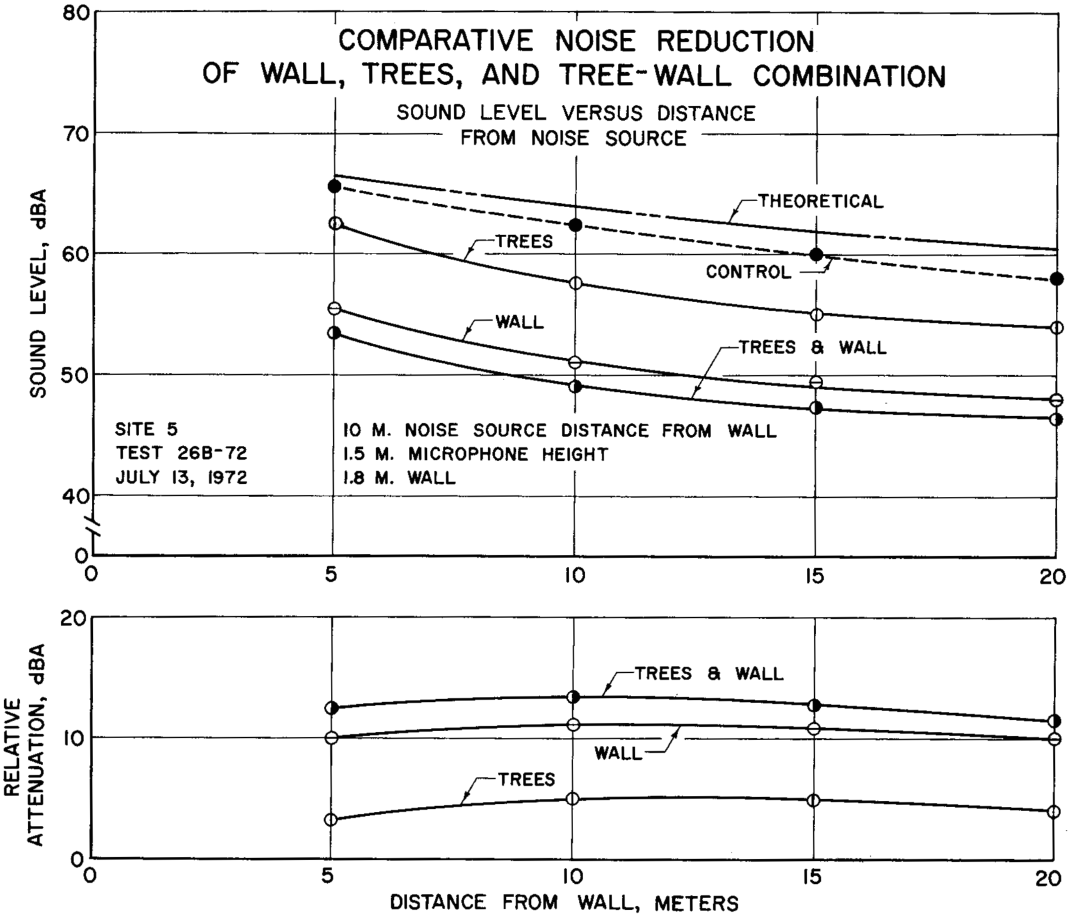


Figure 10.—Effect of wall placement.

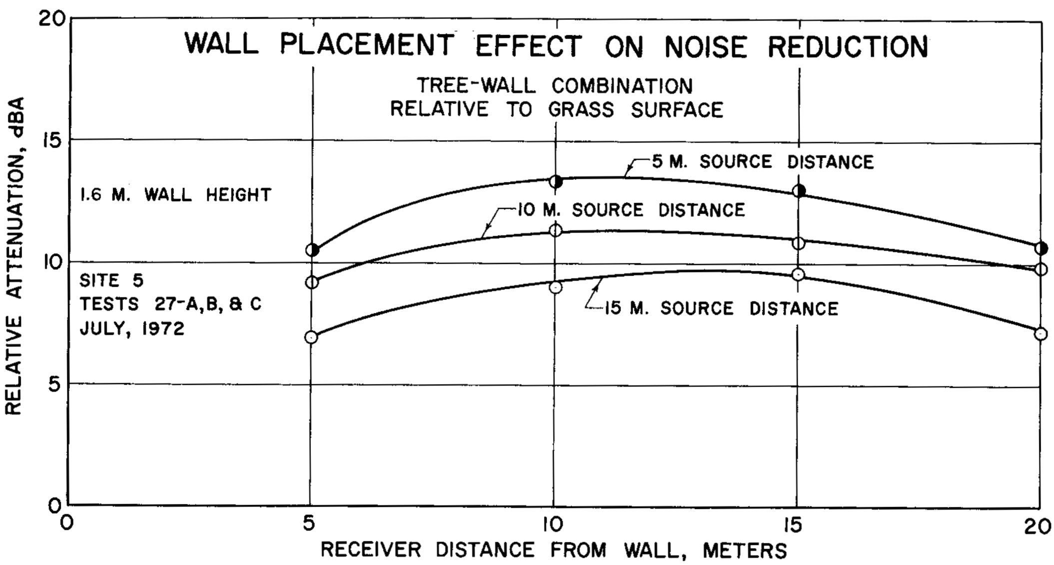
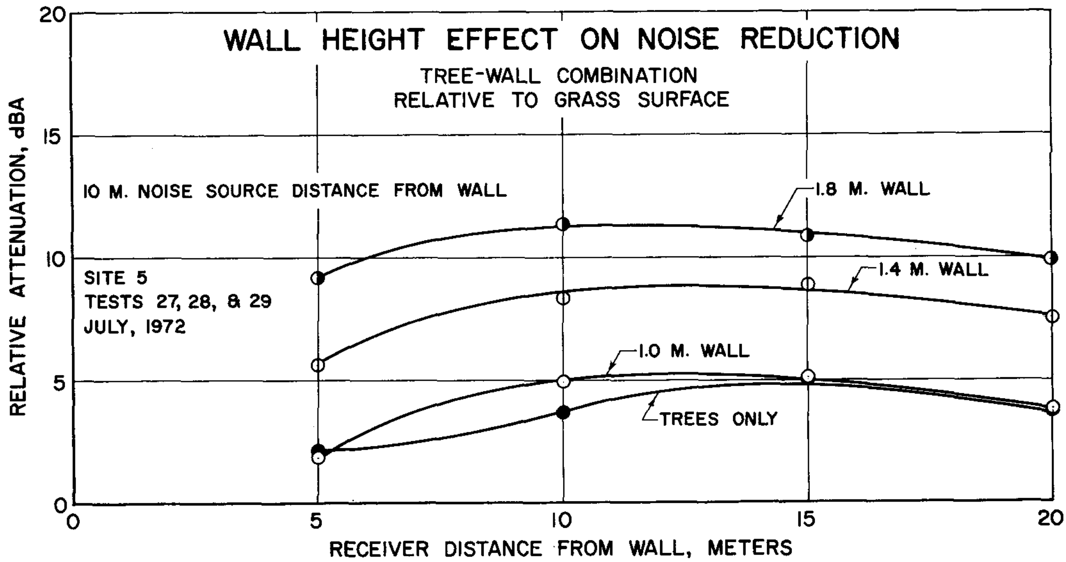


Figure 11.—Effect of wall height.



attenuation obtainable is shown in figure 10.

The effect of walls of different height combined with trees is illustrated in figure 11. A trees-only curve has been included for comparison.

OBSERVATIONS AND CONCLUSIONS

Results of the current series of suburban experiments are not fully analyzed at this time, and further experiments under controlled conditions are scheduled for next summer. Although our conclusions must be somewhat tentative, the general pattern of results is consistent and reliable.

At some of the sites, it appears that existing natural barriers, combined with additional plantings and some form of a low solid barrier, are adequate for the control of traffic noise from 35-mile-per-hour automobiles (figs. 6, 7, and 8). For similar suburban sites, continuous plantings of dense shrubs backed up by taller trees, as in the case of site 5 (figs. 1 and 6) are capable of providing sufficient protection from automobile and light truck traffic noise.

Where individuals are more sensitive to noise, or where the residence is rather close to the traffic lane, additional protection in the form of a higher solid barrier, such as an earthen dike, solid masonry wall, or tight wooden fence may be necessary.

It also appears that there is no practical means for reducing noise from large trucks to a level acceptable in suburban areas. The source itself must be brought under control.

RECOMMENDATIONS

1. To reduce noise from suburban automobiles and light trucks to an acceptable level where the residence is at least 25 meters from the centerline of the roadway, plant one or two continuous rows of dense shrubs as close to the curb as possible, and one or two continuous rows of dense trees behind the shrubs. One or both plantings should be of evergreens for year-round protection.
2. Where immediate relief from traffic noise is desired, erect an earthen dike, masonry wall, or solid wooden fence. The height should be sufficient to screen the noise source from view at the location to be protected. Landscaping should be included to provide

additional protection, when the trees become larger, and to decrease the reflection from the hard wall surface back across the street.

3. Where the residence is less than about 20 meters from the centerline of the roadway, both trees and a solid barrier are necessary.