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LeBreton Flats Development Evaluation 1

Sound Barriers for Windows

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Canada

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Minister

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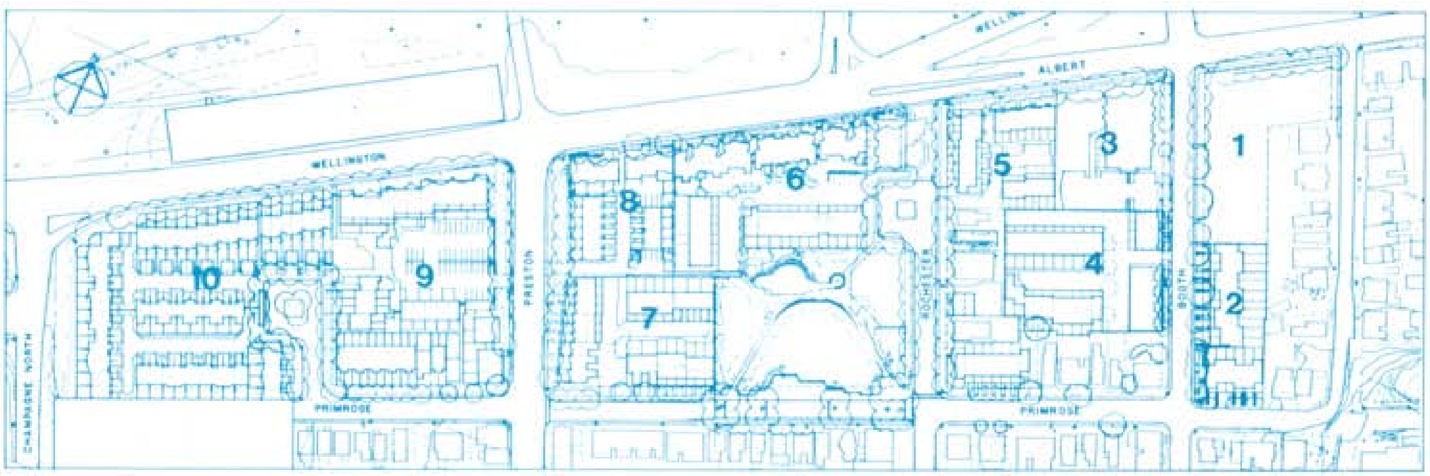
Preface

The LeBreton Flats residential community is located in downtown Ottawa, within view of the Ottawa River, just 1 km west of Parliament Hill. Phase I, consisting of 425 housing units, has been developed by Canada Mortgage and Housing Corporation as an exemplary inner-city community. This development adjoins an existing residential neighbourhood on the south and borders Wellington Street, a major traffic artery, on the north. Within its ten development subdivisions, new approaches to construction, to energy conservation and to overcoming environmental constraints have been tried; the results are now under evaluation.

This pamphlet on the use of sound barriers for windows designed to reduce noise indoors from traffic outside, is one in a series describing experiments undertaken at LeBreton Flats. New approaches to energy conservation, snow control, storm-water management and recreation facility design are among the subjects discussed in the series.

Each pamphlet will identify a specific problem or need encountered in the LeBreton Flats development, describe its experimental solution in terms of concept, design and performance and offer suggestions for improving the design and adapting it to other sites and conditions.



LeBreton Flats, Ottawa

Map showing the ten housing projects which make up phase I of the development.

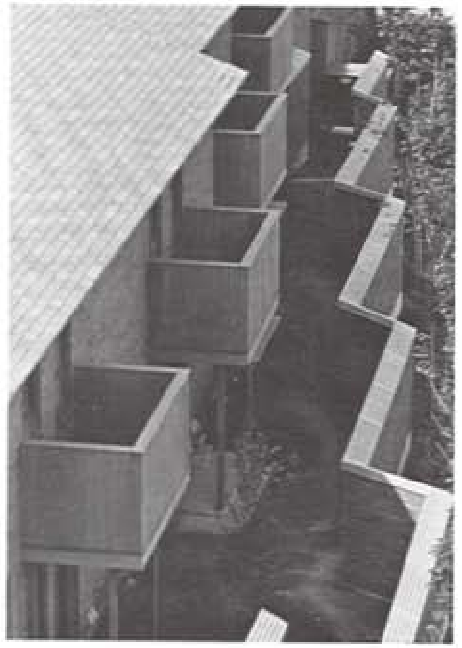
Identifying the problem

Phase I of the LeBreton Flats residential community was designed to provide medium-density, ground-oriented housing and recreational park facilities for a wide range of households.

The townhouses sponsored by the Centretown Citizens (Ottawa) Corporation are located only 3–7 m from Wellington Street, a major traffic artery, in order to make maximum use of the area available for development. Traffic noise from cars, buses and trucks is aggravated by a signal light opposite the townhouses that changes the frequency and level of noise as vehicles slow down, stop and accelerate.

To minimize this noise inside residences, the LeBreton planners used traffic-noise barriers — a brick wall that attenuates traffic noise on the ground floor level, and sound barriers on the upper storeys.

This pamphlet describes how traffic noise can be reduced in upper floor spaces by building low-cost sound barriers around windows.



At LeBreton, a barrier wall and sound barriers on windows were used for traffic noise attenuation.

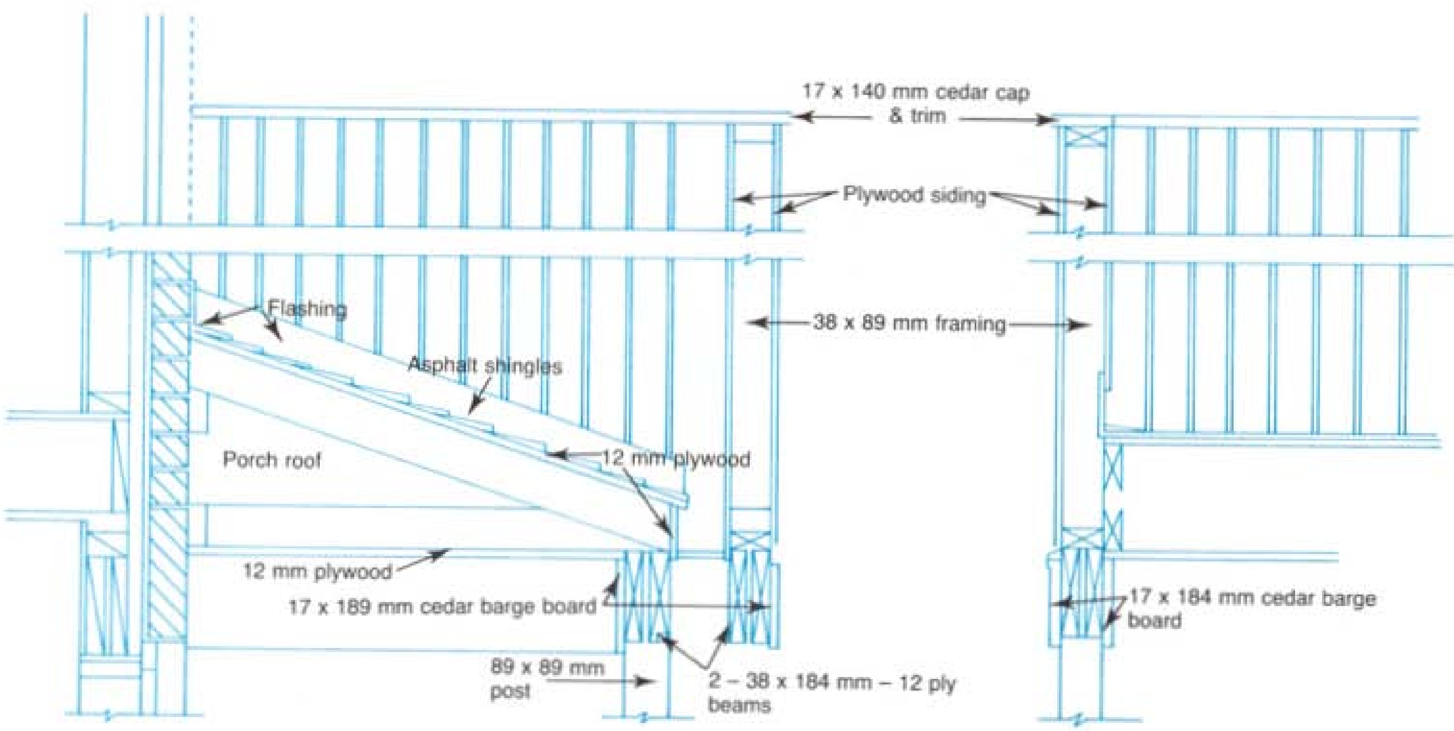


Figure 1.

Construction details of window sound barrier in combination with entrance awning at LeBreton

The window sound barrier

The LeBreton window sound barrier was designed by Urban Aerodynamics of Ottawa, based on a model study of the barrier and traffic noise at the site.

The barrier is box shaped, with three solid sides and a floor. Each box encloses either a single awning window or two windows, and its floor forms a roof awning for the entrance. This places constraints on the size of barrier that affects its noise-reducing capacity.

The sound barriers at LeBreton are built of 12 mm thick plywood nailed over a frame of 89 × 89 mm posts. The dimensions of the single window and two-window barrier boxes are as follows:

	single	two-window
height	1600	1600
width	1300	2600
projection (extension from wall) (mm)	1200	1200
construction costs in 1981	$527.00	$697.00

Installing the barriers around bedroom windows facing traffic reduced noise levels by up to 10 dB. Attenuations of up to 15 dB can be attained by modifying their construction details (see Appendix).

The National Research Council of Canada tested the barrier's effectiveness by measuring bedroom noise levels both with the awning window at its normal extension (200 mm opening between sill and sash) and when propped completely open. (All noise readings are weighted averages.)

Incident noise level outside barrier	67.7 dB
Difference in noise level inside	23 dB
Attenuation attributed to window	13 dB
Noise reduction provided by barrier	10 dB

With the window open during summer, the barrier reduces the traffic noise level in the bedroom to 44.7 dB, which is 9.7 dB above the CMHC minimum standard for bedrooms — 35 dB (See *Road and Rail Noise: Effects on Housing*, NHA 5156). At night-time, when traffic noise is of most concern, the level is usually about 4 dB lower than the 24-hour average. Therefore, the readings at night-time would probably be 40.7 dB, which is within 5.7 dB of the CMHC standard. Additional attenuation can be provided by modifying the sound barrier, using the information presented below.

The window barrier and the roof awning for the entrance were designed as an integrated unit.

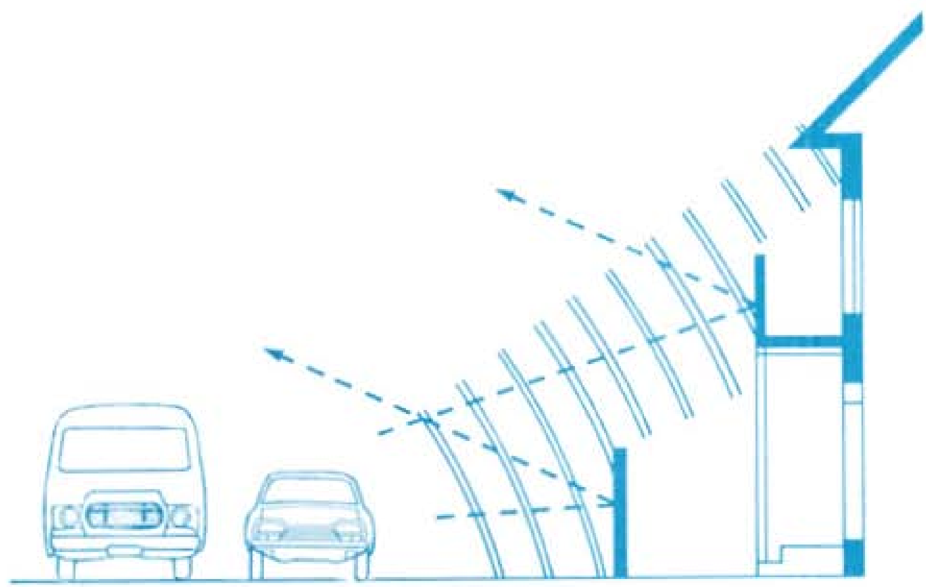


Figure 2.

The use of sound barriers to attenuate traffic noise inside the dwelling

Principles of window barrier design

Sound waves travel in all directions from the noise source. When the waves strike the surface of an obstruction, such as a fence, some of the sound energy is absorbed, some is bounced off or reflected back toward the source, and the remainder passes through or bends around the barrier. To shield against noise, a barrier must reduce the sound energy coming through and around it.

The distance from the noise source, the contours of the site and the layout of surrounding buildings affect how much direct noise and reflected sound reaches the area that requires noise protection. The traffic noise level in multi-storey buildings, for example, is usually most acute at the top floors, partly because fences, hills and low structures only block sound waves up to their own height.

The effectiveness of a traffic noise barrier depends on its geometric shape, its material, and the proximity and shape of buildings and other reflecting surfaces. The height and length of the barrier determine how much noise passes over or around it. Overhangs or other surfaces on adjacent buildings may reflect sound into the area sheltered by the barrier, thus reducing its effectiveness.

Noise barrier dimensions

To reduce traffic noise, the LeBreton window barrier must interrupt the line of sight from the openable (bottom) part of the window to the vehicles on the roadway; this is one factor in determining the height of its front and sides. Because the barrier reduces visibility and ventilation through the bottom portion of the window, it is preferable to keep it as low as possible; this can be done by widening the floor of the box, so that its front wall is farther from the window. The barrier must, however, enclose the full width of the window.

The dimensions of the barrier are determined by the following factors:

- the required noise reduction
- the horizontal distance from the window wall to the noise source
- the vertical distance of the window sill from the noise source: this is usually the height of the window sill above ground, unless the traffic noise comes from an overpass, elevated highway, or bridge, or is generated predominantly by trucks with above-cab exhaust pipes
- the desired height of barrier: this can vary as long as the requirements described above are met.

The charts and step-by-step explanation in the Appendix can be used to calculate the dimensions of window barriers for noise attenuations of 8 to 15 dB.

Design considerations

The window sound barrier can be installed in both new buildings and existing homes. It is effective at any building height but is recommended for windows above the ground floor: noise attenuation at street level can be provided more economically by a wall-type barrier, which also provides privacy and child safety.

The LeBreton noise barrier partially blocks the view and restricts ventilation through the window; therefore, achieving a balance between these factors and its sound attenuation capacity is a major design consideration.

For optimum noise reduction the openable area of windows should be kept as small as possible. Awning windows are recommended in preference to casements or sliding windows, because the swing-out portion helps to deflect sound waves passing over the top of the barrier.

The underside of any projection over the barrier box, such as an eave, awning or balcony, must be insulated with sound-absorptive material in order to prevent noise from becoming trapped within the box. To provide maximum noise attenuation, the barrier box can be lined with acoustic tiles or fibreglass batts that absorb sound. Fibreglass must be protected from the weather by a covering that allows sound to reach the absorptive layer. Pegboard or perforated metal facing satisfy this requirement and can be painted to improve their appearance.

The barrier's drainage outlet should be small and indirect in order to prevent sound from travelling through the drain opening. A trough and standpipe system was used at LeBreton.

The barrier box can be constructed from conventional building materials with good weathering properties — wood, brick, siding, or stucco. Appearance, maintenance requirements and cost are the main reasons for choosing one or another material.

The barrier can be attractively incorporated into a building's facade, and used to emphasize the vertical lines of a high-rise complex, or simply painted to add colour to a drab residential building.

Barriers on windows can be designed as part of the façade.

Alternative applications

Since the problem of traffic noise is most acute in the top floors of buildings, the principles used in the design of sound barriers for windows can be applied to high-rise apartment balconies. The sides of the balcony can double as sound barriers if they are high enough and meet safety standards, but this requires that the balcony structure be strengthened. The floor of the balcony above can be lined with sound-absorptive material. The door to the balcony should be kept as small as possible in keeping with general principles of sound attenuation.

For further reading:

Road and Rail Noise: Effects on Housing.
Ottawa: Canada Mortgage and Housing Corporation, 1981. (NHA 5156)

May, Daryl N. "Freeway Noise and Highrise Balconies", *Journal of the Acoustical Society of America*, Vol LXV, No. 3, March 1979.

For more information, contact:

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Appendix

The calculation of window barrier dimensions (step-by-step explanation)

See Figure 3

		Example
Vertical distance of window sill above noise source, (H)	—	2.4 m
Horizontal distance from window wall to noise source, (D)	—	6.1 m
Preferred height of barrier sides above window sill, (V)	—	0.6 m
Noise attenuaton required (A)	—	12 dB
Maximum acceptable projection of box, (P)	—	1.2 m

Using the charts in Figure 3, the value of P is calculated. If P exceeds the maximum, the height of the barrier should be increased, and the value of P recalculated.

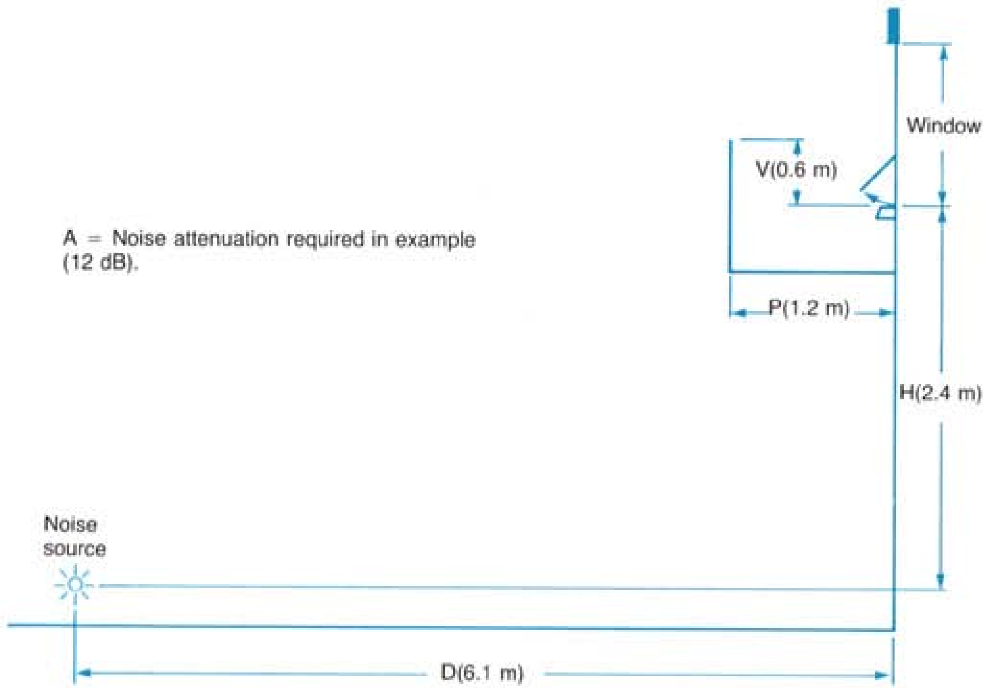

Figure 3.

Graphic example of measurements required to calculate noise attenuation (see Calculation Charts in Figure 4)

See Figure 4

Using the values of D, H, V and A (as defined above and graphically illustrated in Figure 3) proceed as follows:

1. Calculate the ratio H/D — (in Example, 2.4 m/6.1 m = 0.4 dB)
2. On the horizontal axis of Chart 1, Figure 4, find the value V and trace a vertical line to the curve marked with the ratio of H/D calculated in step 1. This is point 'a'.
3. Trace a horizontal straight line from 'a' to intersect the attenuation axis, point 'b'.
4. Connect 'b' with a straight line to the origin of chart 2.
5. Locate the attenuation value A, (12 dB) on the attenuation axis of chart 1.
6. Draw a line from value A to the vertical axis of chart 2 parallel to the connecting line between 'b' and the origin (step 4). This is point 'c'.
7. On chart 2, find the straight line marked with the ratio H/D (0.4 dB) determined in step 1. Draw a line parallel to it, starting from point 'c' (step 6) until it intersects the curve of value V. (If it fails to cut the curve, see note below.) This is point 'd'.
8. From 'd' drop a vertical line down to the horizontal axis to find the required value of P (0.49 m). Maximum acceptable value of P = 1.2 m.

Note: If the line drawn in step 7 falls below the curve of selected value of V, the size of the barrier will reduce noise more than the required amount. The selected value can then be reduced.
Similarly, if the line drawn in step 7 is above the curve of V, the barrier cannot provide the required attenuation with the selected value of V and V must be increased.

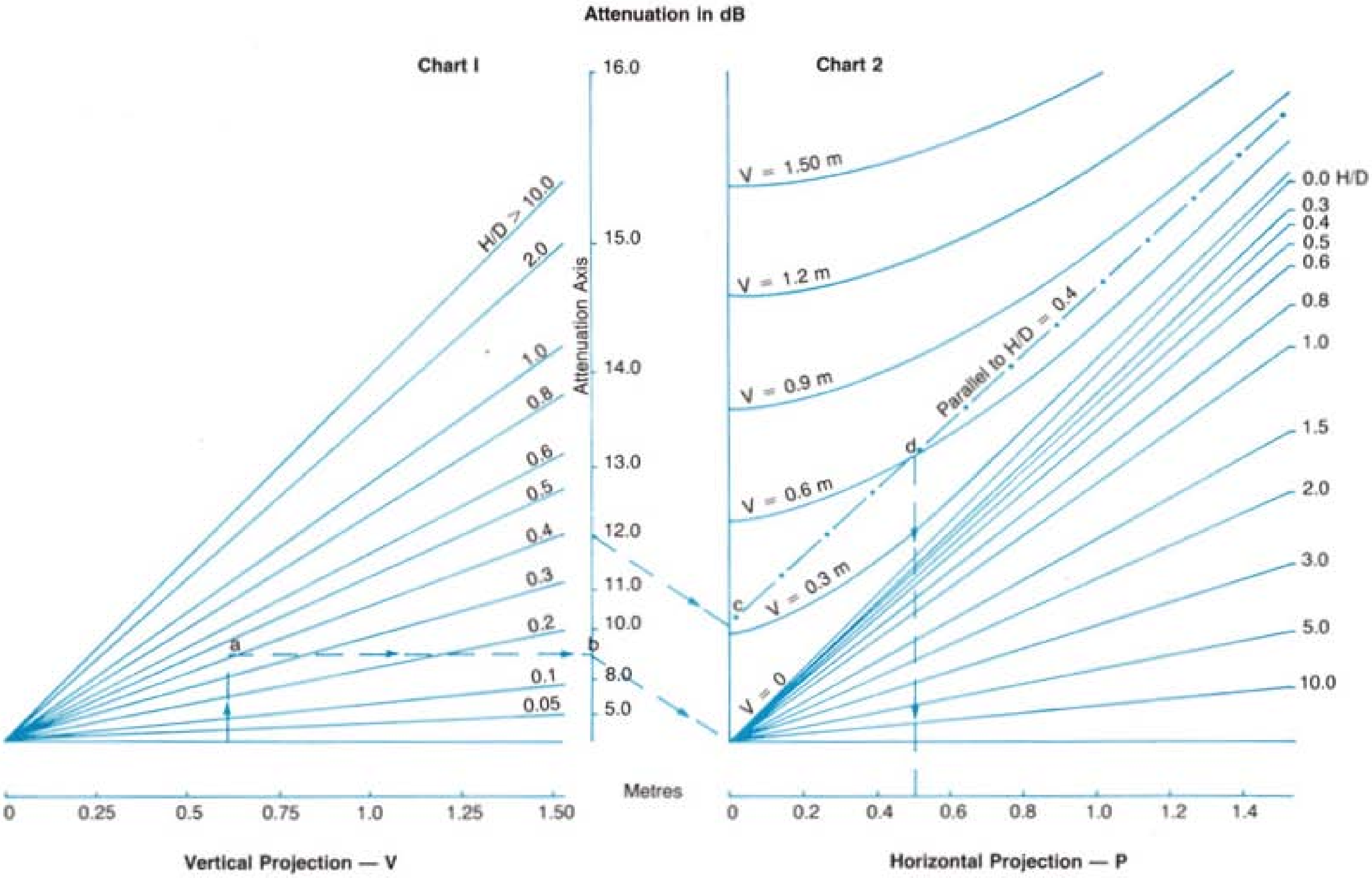

Figure 4.

Charts for calculating noise attenuation ratios