EXPRESSWAY NOISE AND APARTMENT TENANT RESPONSE

John Hitchcock and Alan Waterhouse, Department of Urban and Regional Planning, University of Toronto

A questionnaire was distributed to tenants living in apartments within 1,200 ft (365.7 m) of an expressway in metropolitan Toronto to determine what aspects of the expressway affected them, positively or negatively, and how important these aspects were, relative to other factors affecting their residential satisfaction. Tenants indicated that travel convenience was the main advantage of the expressway and that disturbance from noise was the main disadvantage. Analysis of moving intentions indicates that the disadvantage of noise outweighs the advantage of travel convenience for those tenants whose apartments have direct exposure to the expressway. As in other research findings, there is no single demographic group that is particularly sensitive to expressway noise, and analysis of moving intentions by rent level indicates that rent reductions do not seem to compensate for noise disturbance. Rental level and occupancy policy thus are not seen as mechanisms for reducing the environmental impact of expressway noise. Minimum setback distances from the expressway and use of apartments with single-loaded corridors so that living units face away from the expressway are suggested as appropriate means of protection from hazards of expressway noise.

•AN important development that has emerged from transportation planning recently is the effort to take into account the effects that new traffic systems may have on the amenities and environmental quality of adjacent areas. Most of the associated research of this kind to date concerns the impact that heavily traveled routes have on the residential areas and scenic landscapes through which they pass (1, 2, 3). These studies deal with residential development and emphasize levels of disturbance to single-family dwellings, possibly in the belief that such environments are most vulnerable to disruption by large new traffic systems (1, 4, 5). One does not have to attend many public meetings concerning expressway routes to encounter the belief, expressed by both homeowners and officials, that apartments should be used to buffer single-family areas from the environmental impact of expressways.

It is commonly believed by planners and city officials that homeowners are more zealous than apartment tenants in seeking to influence local government to protect low-density residential areas. There is also evidence to suggest that those who live in single-family dwellings, whether as owner or tenant, are more likely than those living in apartments to take an active interest in the local community (6). This does not necessarily mean, however, that apartment tenants are less sensitive to their physical surroundings.

This issue becomes increasingly important because, at least in Toronto, which is the laboratory for this study, there seems to be a trend toward locating substantial numbers of apartments adjacent to the expressway system (7). So far there has been little attempt to determine the general nature of the advantages and disadvantages of this pattern. This study represents one effort to obtain a clearer idea of the costs and benefits of locating apartments close to expressways, as seen by the apartment tenants themselves. The purpose of the study was threefold:

1. To determine which of a number of possible attributes or factors associated with expressways had positive or negative impact on residential satisfaction of the tenants,
2. To assess how important these expressway impacts were relative to other kinds

of factors that affected tenants' general satisfaction with their places of residence, and
3. To determine the implications these findings might have for land use policies affecting apartment location and design.

The survey, the nature of the sample of apartment tenants, and the findings are described in the following sections.

SURVEY

Ideally, a project intent on eliciting response to the presence of an expressway under conditions of varying exposure would take into account all types of exposure conditions in choosing a survey sample. Thus, building setback, elevation and orientation relative to the expressway, apartment floor level, presence and effectiveness of screening, and other obstacles would be important factors to consider. However, the scope of this project has limited the exposure characteristics used to choose the initial building sample to two conditions, namely, building setback and orientation. Buildings have been excluded where extensive site screening, other neighboring structures, or extreme changes in level might contaminate these relatively clear-cut conditions of exposure. A third factor, floor level, was used in selecting apartments for questionnaire distribution.

Figure 1 shows the setback and orientation criteria used in selecting buildings. There are three setback zones: near [0 to 150 ft (0 to 45.7 m)], medium [151 to 500 ft (46 to 152.4 m)], and far [501 to 1,200 ft (152.7 to 365.7 m)]. There are two possible building orientations: perpendicular and parallel to the expressway alignment. Finally, building faces are either unscreened or screened, depending on whether there is direct line of sight exposure to the expressway. All screened apartments are located on the blind side of buildings and have a parallel orientation.

Access to Expressway

Setback, orientation, and floor level are indicators of an apartment's location and exposure relative to the expressway. By themselves, however, these measures do not indicate proximity to an expressway access ramp. Only in some cases is this distance positively correlated with setback distance. In particular, buildings that are physically close to the expressway right-of-way do not necessarily have better accessibility to the expressway than those that are more distant. Three sets of driving distances to the nearest ramp were used in defining the relative accessibility of buildings in the sample: high, 0 to 1,999 ft (0 to 609.2 m); medium, 2,000 to 4,999 ft (609.6 to 1523.6 m); and low, 5,000 ft (1524 m) or more.

Determining Building Face Sample

Attempts were then made to select an adequate sample of buildings that had faces representing all of the 27 possible combinations of setback, orientation, and accessibility and that had no intervening obstacles between the apartment building and the expressway. There were only 37 buildings of the 512 available that satisfactorily met these criteria, and this number was further eroded when it was not possible to obtain permission to enter some buildings for purposes of the survey. Ultimately, the sample contained 23 buildings representing 20 of the possible 27 combinations.

Respondents within the buildings were chosen by a predetermined nonrandom sample procedure designed to ensure that various floor levels and positions along building faces were represented in the sample. Of the 1,000 questionnaires distributed, 795 returns were received, for an overall response rate of nearly 80 percent.

FINDINGS

The questionnaire attempted to determine which of a number of possible factors associated with the expressway were important to the apartment tenants. Analysis of the results showed that the two major factors were traffic noise and travel convenience.

Location within the expressway corridor does have serious disadvantages for the residents; almost 60 percent of the sample reported being disturbed or severely disturbed by noise. For tenants living along unscreened building faces, disturbance increased systematically as proximity to the expressway increased. Of the tenants living in the buildings in the far setback positions, almost 50 percent reported that they were disturbed by noise. This proportion increased to 75 percent for those living in the near setback positions. These relationships are given in Table 1 for tenants living along unscreened and screened building faces. Reports of disturbance from noise, although appreciable, are substantially lower along screened building faces and do not indicate a clear-cut relationship to distance from the expressway.

There is evidence of substantial disturbance from expressway noise, and it is appropriate to ask whether living in an apartment in the expressway corridor provides any compensating travel advantages that might offset the disadvantage of noise and to try and determine what proportion of the sample derives travel benefits from the expressway. Over 33 percent of the sample used the expressway for less than one-quarter of all vehicular trips, and 14.1 percent indicated no expressway use at all.

Proportion of Vehicular Trips on Expressway	Responses (percent)	Proportion of Vehicular Trips on Expressway	Responses (percent)
0	14.1	1/2	9.5
<1/4	23.4	2/3	8.3
1/4	8.4	3/4	13.1
1/3	4.2	All or almost all	19.0

It seems reasonable to conclude that there is a significant minority of tenants living in the expressway corridor for whom the expressway is of limited benefit.

One should also find out whether those who do use the expressway extensively (for more than one-half of their trips) are less likely to report disturbance from noise than those who do not use it extensively. Those who do use the expressway are less likely to report disturbance although we cannot be certain whether the lower level of disturbance among expressway users stems from a reduced perception of disturbance or from a greater reluctance to report disturbance (Table 2). In either case, the results suggest that expressway users in some manner take account of travel convenience in reporting disturbance from noise. The corollary to this, however, is that the reported noise problem for those making less extensive use of the expressway is more severe than would appear from the overall figures given in Table 1.

Although the data seem quite clear in pointing to a high level of noise disturbance for apartment tenants in the expressway corridor, it is useful to ascertain how important this disturbance is in their general assessment of residential satisfaction. The survey included a question concerning moving intentions of residents when their leases were up. The possible responses were yes, considering it but no definite plans, and no. Although moving is not per se an indicator of dissatisfaction, differences in the proportion planning to move may reasonably be considered as a rough indicator of relative satisfaction with the residential environment. Use of this indicator enables the researcher to get some sense of the degree of importance that the respondents attribute to the advantages of travel convenience and the disadvantages of noise relative to other factors influencing their evaluations of their living environment.

Along unscreened faces (Table 3), there is a definite and consistent relationship between noise disturbance and moving intentions in all three setback categories. Moving

Figure 1. Exposure classifications.

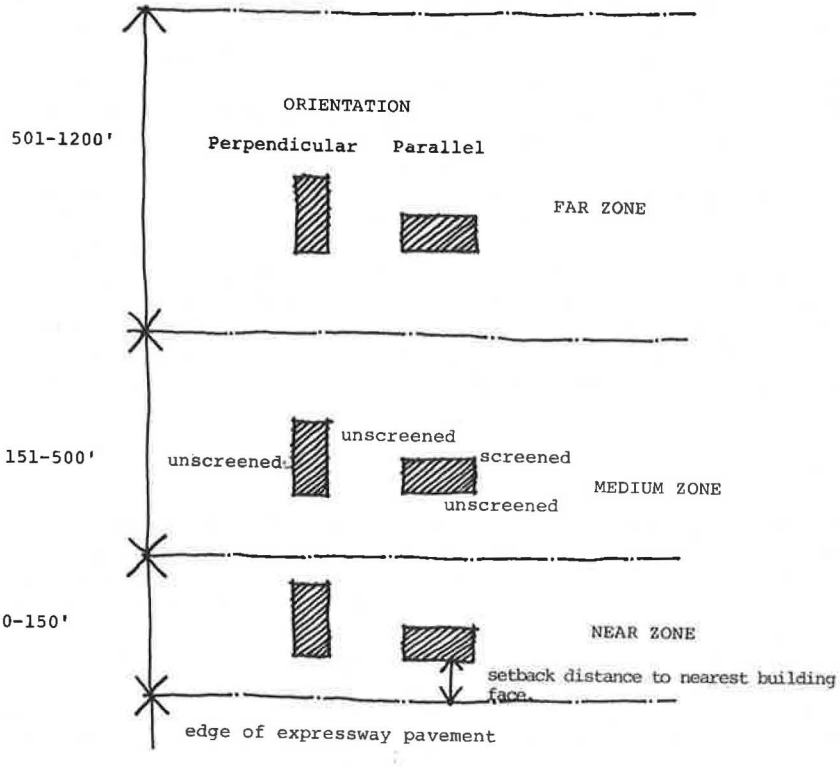

Table 1. Percentage of residents disturbed by noise related to building setback.

Setback	Severely Disturbed	Disturbed	Not Disturbed
Screened face			
Near	25.9	13.6	60.5
Medium	26.3	28.9	44.7
Far	14.3	23.4	62.3
Avg	21.4	20.4	58.2
Unscreened face			
Near	46.6	29.3	24.1
Medium	40.5	30.8	28.6
Far	20.8	27.6	51.6
Avg	35.9	29.2	34.9

Table 2. Percentage of residents disturbed or very disturbed by noise related to building setback and expressway use.

Setback	Expressway Use Low[a]	High[b]	Setback	Expressway Use Low[a]	High[b]
Screened face			Unscreened face		
Near	48.5	30.3	Near	82.1	71.2
Medium	61.1	50.0	Medium	78.7	62.8
Far	40.4	23.1	Far	49.1	46.7

[a] < ½ of all vehicular trips. [b] > ½ of all vehicular trips.

intentions are somewhat reduced in the near setback category as use is increased, but this does not hold in the other two setback categories. An interesting reversal of this general pattern occurs along screened faces (Table 3), where there is no consistent relationship between noise disturbance and moving intentions. However, there appears to be a definite relationship between expressway use and moving intentions: In the near and medium setback positions, the percentage of residents planning to move decreases as expressway use increases. In the far setback position, the percentage of residents planning to move increases markedly as expressway use increases.

Evidently, on the screened side of buildings, whatever respondents may have said about noise disturbance does not appear to be the overriding factor in their general assessment of the residential environment. One can speculate that these respondents may have sensed that, even though they personally were disturbed by noise, the level of noise they were exposed to was not that different from many other places in the city. In this case, moving would be less likely to be seen as a solution. Along unscreened building faces, however, it would certainly appear not only that noise is an important factor but also that it outweighs any advantage that may accrue from expressway use.

POLICY GUIDELINES

Based on the extent of the noise problem and its relative importance to respondents, we attempted to determine what the survey suggested in the way of policy recommendations. First, the survey suggests there has been a self-selection process whereby extensive expressway users have located themselves close to the expressway (Table 4). However, as we have seen, for those living in unscreened apartments, expressway noise is more important than expressway use, and this implies that, even for expressway users, a location near the expressway may not be advantageous. There is additional evidence that those making extensive use of the expressway have tended to choose locations close to the expressway, even though this has not necessarily enhanced their accessibility to an expressway ramp (Table 5); i.e., apparently some expressway users have made apartment location decisions on the basis of presumed travel convenience without considering the noise hazard or the real accessibility that their choice of location provides. Thus, although one could say that expressway users demand locations close to the expressway, it would be hard to argue that apartments in such locations are justified because of that demand, unless real (as opposed to apparent) accessibility is particularly good. Even here the costs may outweigh the benefits. Certainly, apartments close to an expressway hold no advantage for those not making extensive use of it. On the whole, although there may be some reasons for placing apartments close to expressways, the advantage for expressway users does not appear to be one of them.

Second, the survey lends no support to the notion that some groups defined in demographic or social terms are less sensitive to noise than others. Based on apartment location and presence or absence of screening, there is no social or demographic category that consistently has the highest proportion of respondents disturbed by noise (7). This is consistent with other research findings on this subject (8). (Lining the expressways with bachelor flats will not do.)

Third, the survey lends no support to the idea of providing lower rent accommodation near the expressway so that reduced rent can balance out the environmental disadvantage. Building managers were requested to provide us with average rentals for various sizes of apartments in their buildings. The data for two-bedroom units were used since they were most nearly complete. It was evident from these data that building rentals tended to be lower as proximity to the expressway increased; this suggests that the market had taken some account of expressway effects. However, there is no indication that the level of rents charged provides compensation for adverse environmental influences (Table 6). In low-rent buildings, the relationship between noise disturbance and moving intentions is stronger than in high-rent buildings for those tenants living along unscreened building faces. As before, for tenants living on the screened side of buildings there is no consistent relationship between noise and moving intentions.

It would appear, then, that the only approach to ameliorating this particular environ-

Table 3. Percentage of residents within setback categories who plan to move related to noise disturbance and expressway noise.

Setback	Disturbed by Noise	Not Disturbed by Noise	Low Expressway Use	High Expressway Use
Screened face				
Near	26.7	24.5	32.3	20.9
Medium	28.6	29.4	44.4	21.1
Far	13.8	6.5	4.2	20.2
Unscreened face				
Near	44.0	25.6	44.2	36.4
Medium	37.3	24.5	30.4	36.3
Far	28.3	18.4	21.2	22.4

Table 4. Number of residents by setback who use expressway.

	Expressway Use			Expressway Use	
Setback	Low	High	Setback	Low	High
Unscreened faces			Screened faces		
Near	77	107	Near	31	43
Medium	79	91	Medium	18	19
Far	113	76	Far	48	25

Table 5. Percentage of residents who use expressway extensively related to setback and accessibility.

	Accessibility		
Setback	High	Medium	Low
Near	68.0	64.4	45.5
Medium	52.4	56.8	47.4
Far	39.2	—	39.1

Table 6. Percentage of residents who plan to move related to rent and disturbance from noise.

Rent	Not Disturbed by Noise	Disturbed by Noise	Rent	Not Disturbed by Noise	Disturbed by Noise
Unscreened faces			Screened faces		
Low[a]	28.8	47.1	Low[a]	20.0	21.4
High[b]	17.1	29.5	High[b]	11.3	18.8

[a] < $180/month for two-bedroom unit. [b] > $180/month for two-bedroom unit.

Table 7. Percentage of residents disturbed by noise related to setback and building orientation.

Setback	Orientation	Severely Disturbed	Disturbed	Not Disturbed
Near	Unscreened parallel	54.5	22.7	22.7
	Unscreened perpendicular	35.8	38.3	25.9
	Screened parallel	25.9	13.6	60.5
Medium	Unscreened parallel	37.0	40.7	22.2
	Unscreened perpendicular	41.1	29.1	29.7
	Screened parallel	26.3	28.9	44.7
Far	Unscreened parallel	20.6	27.7	51.6
	Unscreened perpendicular	21.6	27.0	51.4
	Screened parallel	14.3	23.4	62.3

Table 8. Percentage of residents disturbed by noise related to setback and floor level.

Setback	Floors 1 to 6	Floors 7 to 12	Floors 13 to 26
Screened face			
Near	56.8	23.8	26.1
Medium	31.3	68.8	83.3
Far	41.9	37.0	31.6
Unscreened face			
Near	76.4	68.9	82.5
Medium	70.7	73.0	70.0
Far	43.8	43.5	65.9

mental hazard lies in land use and design controls. In this area, the survey provides some evidence that can assist in forming guidelines.

1. Unscreened building faces were divided into two types: those parallel with and those perpendicular to the expressway. Perpendicular orientation provided no consistent advantage in terms of noise reduction over the parallel orientation (Table 7). Since buildings oriented parallel to an expressway have one screened face, they are strongly preferred.
2. There appears to be no consistent reduction in disturbance from noise as the height of apartments above ground is increased (Table 8). Building taller apartments, therefore, does not appear to offer any guarantee that the proportion of tenants experiencing noise disturbance will be reduced.
3. Screening by a building is evidently an effective device for reducing noise disturbance. The level of disturbance reported by tenants living along screened faces in the nearest setback position is comparable with that reported by tenants in unscreened apartments that are furthest removed from the expressway (Table 1).

In view of these observations, we suggest the following design principles:

1. In built-up areas, no buildings with apartments that have a direct view of the expressway should be built within 500 ft (152.4 m) of an expressway.
2. Buildings located closer to an expressway than 500 ft (152.4 m) should only be permitted if they have single-loaded corridors and no living units on the exposed face.
3. Preferably, the nearest zone [0 to 180 ft (0 to 54.8 m)] should contain no residential structures at all.
4. Where expressways extend through land outside built-up areas, residential structures should, where possible, be at least 1,200 ft (365.8 m) from an expressway.

ACKNOWLEDGMENTS

Valuable assistance was received from the Metropolitan Toronto Planning Board and the Urban Development Institute. Our research was funded by the University of Toronto-York University Joint Program in Transportation and by the Humanities and Social Science Committee of the University of Toronto.

REFERENCES

1. A. Voorhees. The Computation of Highway Economic Impacts. Council of Planning Librarians, Monticello, Ill., Bibliography 67, 1969.
2. Transportation and Community Values. Special Rept. 105, 1969, 178 pp.
3. Motorway, Noise and Dwellings. Building Research Station, Digest 135, Nov. 1971.
4. A. Voorhees. Noise in Urban and Suburban Areas. U.S. Department of Housing and Urban Development, 1969.
5. W. J. Galloway, W. E. Clark, and J. S. Kerrick. Highway Noise: Measurement, Simulation, and Mixed Reactions. NCHRP Rept. 78, 1969.
6. M. Janowitz. The Community Press in an Urban Setting: The Social Elements of Urbanism. Univ. of Chicago Press, 2nd Ed., 1967.
7. J. Hitchcock and A. Waterhouse. The Impact of Expressways on Adjacent Apartments. Univ. of Toronto and York Univ. Joint Program in Transportation, Research Rept. 10, Feb. 1973, pp. 8-13; 113-114.
8. P. N. Borsky. The Use of Social Surveys for Measuring Community Responses to Noise Environments. In Transportation Noise: A Symposium on Acceptability Criteria (J. Chalupnik, ed.), Univ. of Washington Press, 1970, pp. 219-227.

SPONSORSHIP OF THIS RECORD

GROUP 1—TRANSPORTATION SYSTEMS PLANNING AND ADMINISTRATION
Charles V. Wootan, Texas A&M University, chairman

ENVIRONMENTAL QUALITY AND CONSERVATION OF RESOURCES SECTION
William L. Garrison, University of California, Berkeley, chairman

Committee on Transportation Environmental Review Process
James E. Clark III, District of Columbia Department of Highways and Traffic, chairman
Joseph F. Canny, John J. Collins, Jr., Robert J. Datel, James G. Deane, Michael Lash, William P. McKenna, E. Grover Rivers, John J. McC. Ryan, John B. Schnell

Stephen E. Blake and Kenneth E. Cook, Transportation Research Board staff

The organizational units and the chairmen and members are as of December 31, 1974.