EFFECTS OF A ROAD CLOSURE ON RESIDENTS' RESPONSES TO TRAFFIC NOISE

by

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EFFECTS OF A ROAD CLOSURE

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ABSTRACT

The purpose of this study is to investigate the effect of a change in road traffic conditions on individual response to traffic noise. The partial closure of King Street in the summer of 1977 and the subsequent re-routing of traffic provided an excellent opportunity to examine this problem. This analysis uses questionnaire data collected at three sites before and during the closure. Research focusses upon changes in five sets of responses: awareness of traffic noise, annoyance, activity interference, health effects and actions taken with respect to noise. The effects of personal characteristics on changes in response are also examined. In general, changes in response were slight. Awareness of traffic noise increased at two of the three sites, and annoyance at only one. There were no significant changes in any of the other responses. Weak relationships were found between two personal characteristics - age and income - and changes in response. Several reasons for the lack of change in response are postulated including the small change in noise levels, the temporary nature of the change and the publicity campaign prior to the road closure.

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CHAPTER I

INTRODUCTION

1.1 Purpose and Objectives

One important question in noise research concerns the relationship between changing traffic conditions and individuals' reaction to that change. Answers to questions in this area have important implications for residential planning and noise control policy. Residents' reaction to changing traffic conditions has to be investigated before we can judge the potential effectiveness of noise control strategies such as: reducing traffic volume in residential areas or constructing acoustical barriers.

Existing studies shed little light on the effect of changing traffic conditions on response to noise. Several studies have examined the relationship between noise level and various indicators of the health and welfare of the exposed population (Galloway and Jones, 1972; Goldstein, 1977; Griffiths and Langdon, 1968). These studies are restricted to the relationship between traffic noise level and community response at one point in time.

The results of these studies imply that the magnitude of human response varies proportionately with the degree of noise exposure. The same may not apply to reactions to noise levels which change over time. That this may not be the case is suggested by a recent study by Fidell

and others (1980). Therefore, the relationship between noise level and response at the individual or aggregate level based on cross-sectional studies does not necessarily correspond to the relationship between response and changing noise levels as determined through longitudinal analysis.

The main purpose of this research is to determine if there are any differences in responses of the same residents toward traffic noise when there is a change in traffic conditions.

The partial closure of King Street in Hamilton, Ontario provided an ideal situation for empirically testing individuals' reactions to change in traffic noise levels. From June to October, 1977, King Street (see Fig. 1.1) the most important west bound route in Hamilton, Ontario had three of four lanes closed for major construction. During the period of construction, all road transportation vehicles were re-routed, except for buses and local commercial traffic. This meant that traffic volume on alternate streets increased leading to changed road traffic conditions. In this paper residents' reactions to road traffic noise on three of the alternative streets are discussed.

The focus of this study was to examine changes in noise responses in relation to changing traffic conditions. In view of this, data collection was in three phases for periods before, during and after construction on King Street. For each site a randomly selected sample of residents were personally interviewed to determine residents' responses to changing traffic conditions. In this report residents' reactions to road traffic noise for phases one and two on three of the alternative streets are discussed.

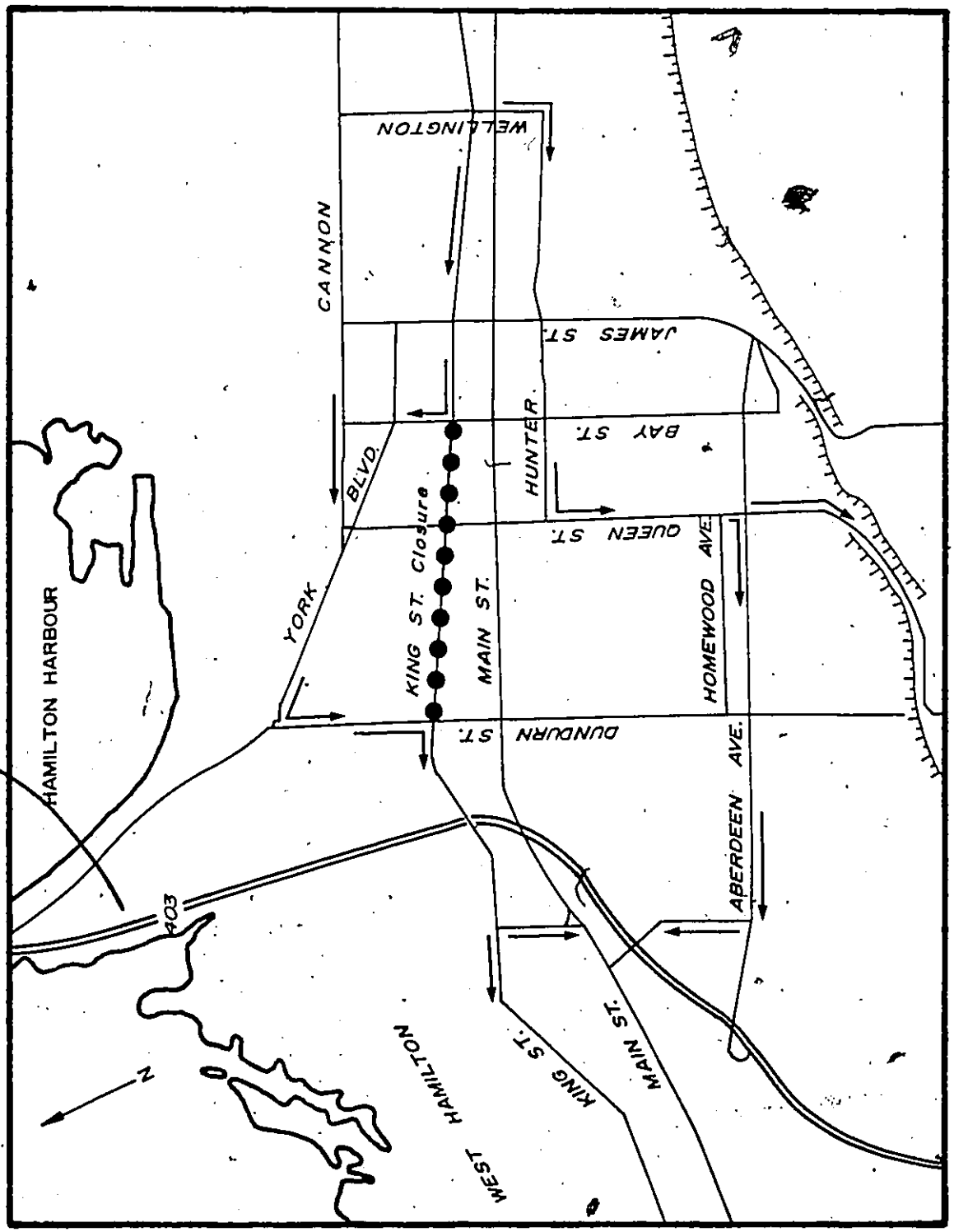


Figure 1.1
Designated Detour Routes

This paper has two objectives. The first is to examine the relationships between a change in traffic conditions and residents' reactions. The second objective is to determine whether responses to changing road traffic conditions relate to personal characteristics of the respondents.

1.2 Structure of the Paper

This paper is organized in five parts.

The literature review found in chapter two presents the findings of studies which have assessed community response to noise. The major physiological, psychological and behavioural effects of noise are discussed. Research looking at factors affecting response to traffic noise is also reviewed.

In pursuing the objectives outlined in the introduction, the research design and hypotheses are presented in chapter three. Chapter four presents an analysis of the relationships between individuals' responses and changing traffic conditions. The final chapter summarizes the findings and possible implications of this study.

CHAPTER II

INDIVIDUAL RESPONSE TO ROAD TRAFFIC NOISE

The literature concerning the adverse effects of noise in residential communities deals with the measurement of response in various ways: attitudes, such as annoyance; activities interferred with; and actions taken such as complaints. Likewise the level of analysis and the impact of time on response to traffic noise has been measured in numerous ways. The empirical studies will be discussed using a typology based on level of analysis and time frame. From this discussion it becomes apparent there are several areas that remain to be investigated. These form the basis for the King Street study.

2.1 Classification of Noise Research Studies

Previous studies of community response to traffic noise can be categorized in terms of two main criteria: time frame and level of analysis. With respect to the first, there is a distinction between cross-sectional and longitudinal studies and with respect to the second, between individual and aggregate level analyses. (Table 2.1)

2.1.1 Cross-sectional Studies

Most studies to date have been cross-sectional and aggregate. They have focussed on response to noise at one point in time for a particular community or group of people as a whole. The problems that have been addressed concern effects on the physical and mental

Table 2.1

Typology of Road Traffic Noise Studies

Level of Analysis	Time Frame: Cross-Sectional	Time Frame: Longitudinal
Individual	eg. Langdon, 1976	eg. Fidell et al, 1980 Orlich, 1979
Aggregate	eg. Schultz, 1977 Hall and Taylor 1977	

well being of humans as well as other indirect effects as annoyance, interference with communication and other activities, loss of value and utility of property. In general, as the sound pressure level increases the effects spread from attitudinal to behavioural and ultimately physiological effects. In the case of traffic noise, most of the effects fall into the category of nuisance - attitudes and feelings of annoyance.

The focus of research in studies of response to road traffic noise has been to determine the relationship between the average noise level measured at residential sites and some measure of the average or median response, the latter usually measured according to subjective ratings of annoyance. Langdon (1976), for example, showed that correlations between noise levels (L_{10},L_{50},L_{90}) and median disatisfaction, measured on a seven-point semantic differential scale, were high enough to yield useful predictions of nuisance. However, the correlation between the measured noise and individuals' subjective response was insignificant.

Investigations by Hall and Taylor (1977) showed regression equations have the ability to predict subjective response to road traffic noise. Results from the equations considering six noise measures (day-time L_{eq}, L_{10} and L_{50}; night-time L_{eq} and L_{10}; and L_{dn}) showed there is an increase of approximately 2¼ in the percentage of the population at all disturbed for every decibel increase in noise level and of approximately 2 3/4 in the percentage volunteering noise as a problem.

The recent synthesis by Schultz (1977) attempts to summarize the main findings of eighteen existing cross-sectional

aggregate studies. Using regression analysis he has defined a noise-response curve which is currently regarded as the best summary of the relationship between noise level (measured as Ldn) and aggregate response (measured as percent highly annoyed). The results of eleven of these surveys show a remarkable consistency, as shown in Fig. 2.1.

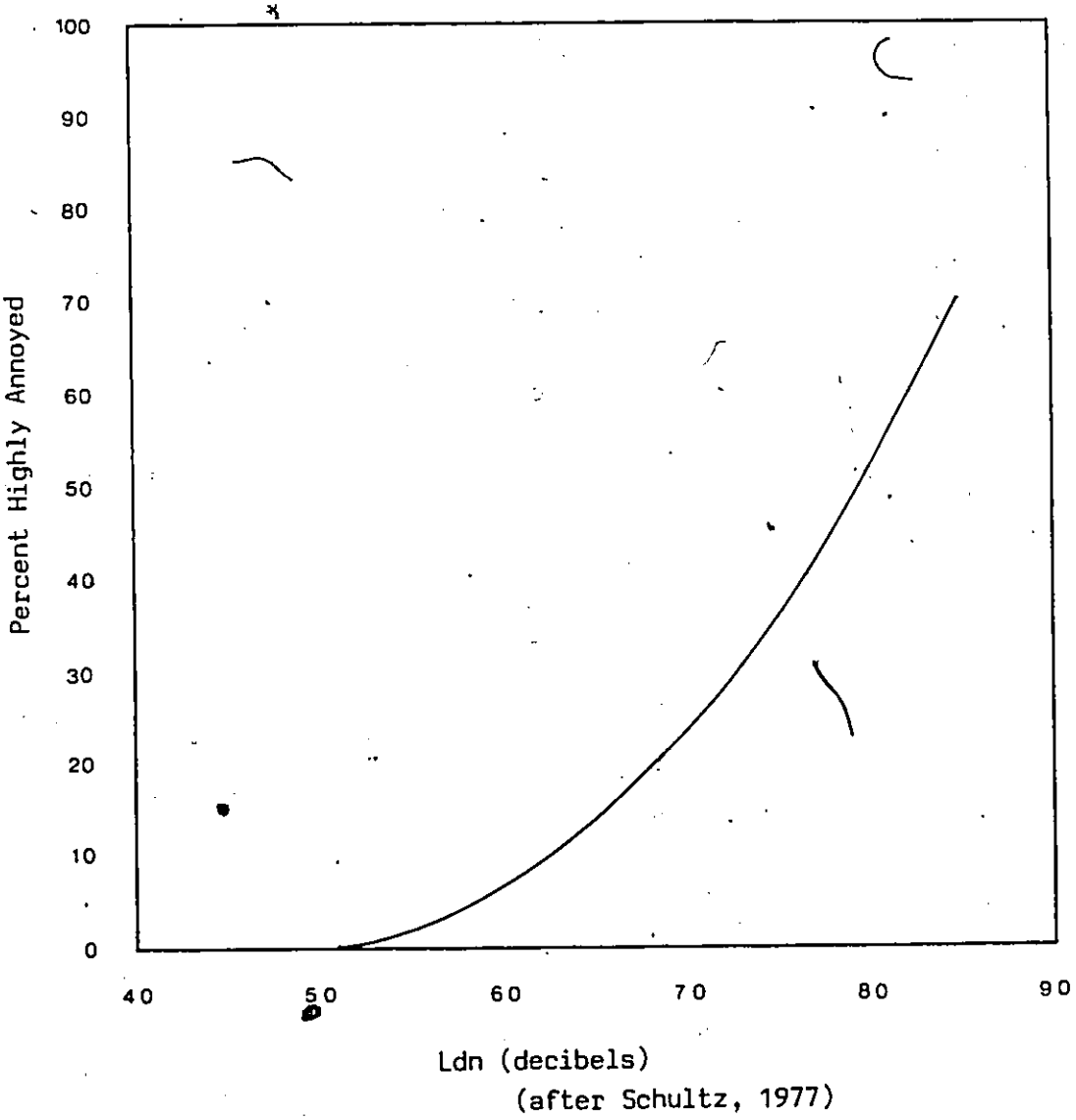
These same studies have also found that the strength of this relationship is significantly reduced when individual responses are related to noise levels. The marked reduction in correlation between aggregate and individual level analysis suggests that there are intervening factors affecting individual response to noise exposure. Recognizing this, some cross-sectional studies have examined the relationship between various intervening variables and individuals' reactions to road traffic noise. (Glass and Singer, 1972; Langdon and Buller, 1977; Rossall et al., 1977; Taylor and Hall, 1977).

The study by Bolt, Beranek and Newman (1971) revealed that annoyance due to traffic noise was not exclusively a function of the noise level. Noise annoyance from road traffic correlated positively with age. Younger residents, in the 20-30 year old age category, reported most annoyance. The authors found that for equivalent noise levels, those more highly annoyed respondents tended to have higher incomes, more prestigious jobs and to be more highly educated.

The effect of differences in life style is to increase the dispersion of annoyance scores for any community or site. Aubree, taking time spent at home as a surrogate measure of life style, showed

Figure 2.1

Synthesis Curve from Eleven "Clustering" Surveys



a significant difference in annoyance for Paris residents according to time spent at home (Alexandre, et al., 1975). Respondents who spent little time at home tended to be more annoyed than those who were at home all day.

Hall and Taylor (1977) examined the effects of personal and situational variables on response to road traffic noise, using data collected at residential sites in Southern Ontario. Contrary to the findings of the previous study, their results reveal that people spending less time at home tend to be less disturbed by traffic noise. Regarding the effect of length of residence, the results indicate a positive relationship: the longer the people had lived at a particular site the more disturbing they tended to rate the noise. A general lack of relationship was found between noise response and the sex, age and socio-economic composition of residential areas. Considering the situational factors included in the analysis, the results show several significant differences in the noise ratings of people at shielded and unshielded sites. Noise response was not found to differ significantly depending on whether residents had air conditioned homes.

In summary, results of aggregate studies show a significant relationship between road traffic noise level and response. However, the existing results of individual level analysis indicate a weak relationship with noise level. Furthermore, the effects of intervening factors, particularly socio-economic variables on individual response to traffic noise have been investigated, but

there are some inconsistencies in the results. Overall, the findings of cross-sectional studies fail to show how responses of the same group change with a change in noise conditions.

2.1.2 Longitudinal Studies

A few studies have been conducted to provide an understanding of the role of time on response to noise (Fidell et al., 1980; Orlich, 1979). The research conducted by Fidell et al. (1980) examined community sensitivity to changes in exposure conditions in terms of annoyance associated with changes in aircraft noise. Interviewing was conducted in four stages in conjunction with the changes in noise exposure: one immediately before the first change in noise exposure and three others. The first set of interviews preceded runway closure by 18 days. The second, third and fourth rounds followed runway closure by 11, 54, and 82 days. Noise levels were monitored during the week preceding each round of interviews in four neighbourhoods. Questions asked during each phase of interviewing obtained information concerning the major environmental problem in the neighbourhood, annoyance due to street traffic and aircraft noise in the preceding year. Responses to the question about annoyance due to aircraft noise in the week preceding the interview provided the clearest indication of sensitivity to physical exposure parameters (p.8). The results overall reflect the direction and magnitude of changes in exposure. This study, though primarily concerned with aircraft noise, notes the effect of time on community reaction following major changes in noise exposure. It does not provide information on the extent to which changing noise levels relate

to daily activities or physiological well-being of individuals. Nor is response to changing noise exposure related to socio-economic characteristics of the respondents.

In another study, residents were interviewed to determine attitudes toward nearby noise barriers, immediately following construction and subsequently a year later. (Orlich, 1979). The study looked at the effect of acoustical barriers on noise levels and on the value of abutting property. Also the opinions of abutting property owners on the effectiveness and desirability of acoustical barriers was examined. Results revealed that the perceived effectiveness is less than the anticipated effectiveness. A partial explanation of these findings may be that the residents became accustomed to the quieter environment in the period after completion of the barrier. Because of this adjustment, the residents are more sensitive to the traffic noise level prior to barrier construction. Again, as in the previous study, no attempt was made to examine the relationship between response variables and personal characteristics of the respondents.

2.2 Implications for the King Street Study

Three main findings emerge from these results. Firstly, the longitudinal studies show that annoyance is significantly related to changing noise exposure. Secondly, the results show that the link between changing noise level and response is by no means simple, indicating that intervening factors play an important role in determining annoyance. The effects of personal characteristics on reactions

to changes have not been investigated. Thirdly, existing research does not address the reactions to changing road traffic conditions, except indirectly as in the case of the few barrier studies. From the cross-sectional studies it may be possible to infer the effect of changing noise level on annoyance, for example, by generalizing the Schultz synthesis curve to the longitudinal situation. However, the validity of such a generalization could only be assessed by a longitudinal study.

Therefore, the question which remains and which the King Street study examines is how stable are levels of response over time? For example, referring to Fig. 2.1, if twenty-five percent of the respondents are highly annoyed by traffic noise at 75 decibels and we have seventy percent highly annoyed at 85 decibels, then can we infer that if at one site there is an increase/decrease in noise of 10 decibels that will produce a corresponding increase/decrease of forty-five percent of the respondents highly annoyed?

CHAPTER III

RESEARCH DESIGN

In this chapter, the conceptual framework forming the basis of this study is presented. Hypotheses are formulated to test the relationships proposed in the model. The sample design and data collection procedures are described.

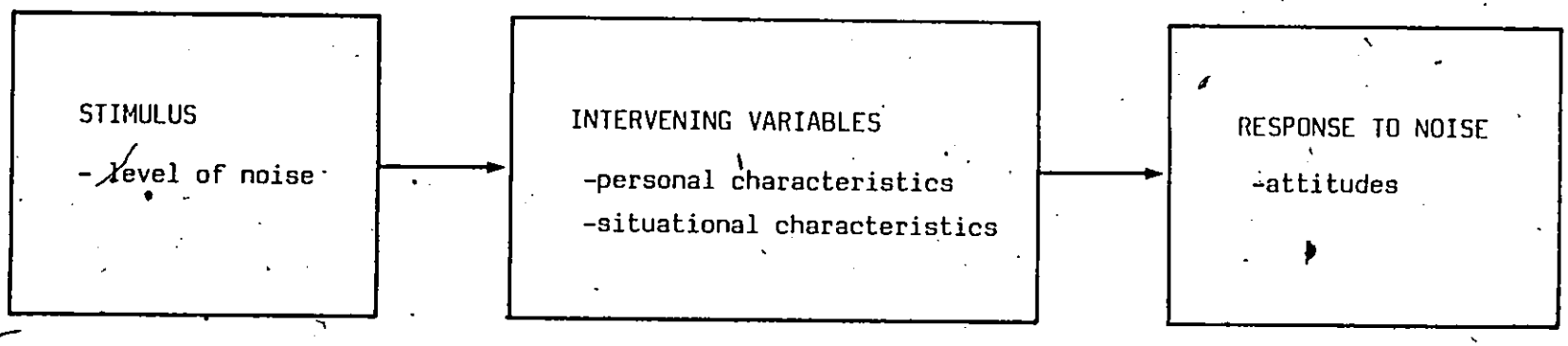
3.1 Conceptual Model

Exposure to road traffic noise has direct impacts, such as activity interference or health effects, which in turn influence a person's attitudes toward the noise. The attitudes influence subsequent actions in response to the noise. These casual links are influenced by a number of factors, such as socio-economic status, but they delineate the basic pattern of noise effects, and therefore are useful for the investigation and analysis of reactions to noise.

An individual's reactions to road traffic noise are not a simple cause and effect relationship between noise exposure and response. It is necessary to understand the effect of intervening variables to assess the validity of using aggregate relationships to predict response in particular sites (Taylor and Hall,1977). These intervening variables can be various personal or situational factors such as the individual's demographic characteristics, length of residence or the hours spent at home (Fig 3.1).

Figure 3.1

The Role of Intervening Variables



Evidence to support this conceptual model is found in studies by Bolt, Beranek and Newman (1971), Griffiths and Langdon (1968), Taylor and Hall (1977).

This conceptual model formed the basis of this analysis, building on the idea of stages of reaction to noise. However it has been formulated more specifically for investigating individuals' reactions to change in traffic conditions and the factors affecting response to change in traffic conditions (Fig 3.2).

Briefly, change in traffic conditions is seen to affect in some way the individuals' life-style. This impact, then, can be associated with awareness level, attitudes towards the change, and effects of the change such as activity interference and the actions of the individual in response to the changed traffic conditions. The model further assumes that reactions are not a simple and direct reflection of change in traffic conditions. This link is complicated by the intervention of various factors particularly socio-economic variables.

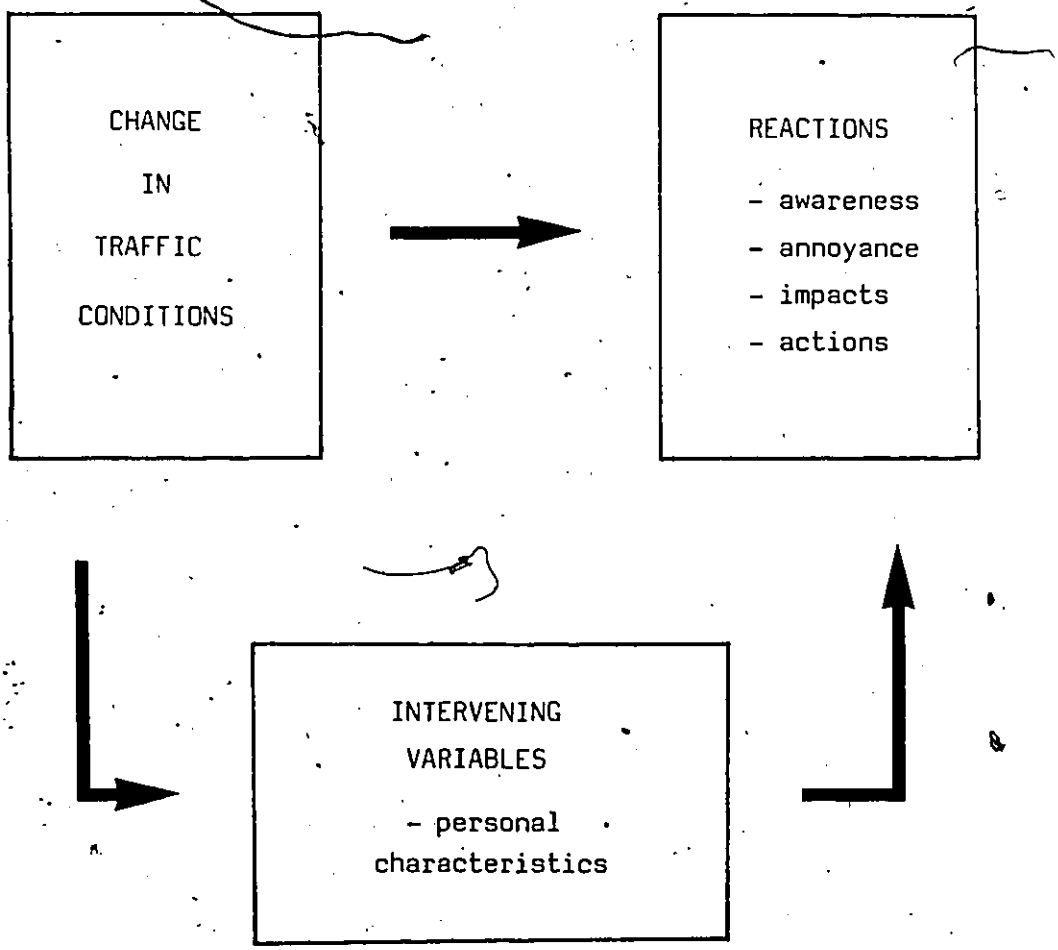
On the basis of the traffic noise studies presented in the preceeding chapter and the model outlined, a number of hypotheses may be formulated, corresponding to the objectives outlined in the introduction.

3.2 Hypotheses

The following hypotheses are proposed for testing using data collected during the partial closure of King Street.

Figure 3.2

Conceptual Model of Reactions to Change in Traffic Conditions



1. The initial hypothesis is that a sudden increase in traffic volume will produce a significant increase in residents' awareness of noise levels.
2. The second hypothesis deals with specific effects of noise. That is: a sudden increase in traffic volume will produce an increased percentage of respondents reporting annoyance, interruption of activities, and perceived health effects.
3. The final hypothesis concerns factors which mediate individual response; that is: the reported change in response to traffic conditions is significantly related to socio-demographic variables, specifically: sex, age, education, occupation, income, hours spent at home (weekday and weekend), type of occupancy, and length of residence.

Note that in all three hypotheses, the change in traffic conditions is assumed to result in increased noise levels.

3.3 Description of Study Area

The closure of King Street provided the opportunity to conduct a longitudinal study to examine the effects of changed traffic conditions and residents.

On June 27th, 1977, westbound vehicular travel along King Street from Bay to Dundurn was restricted to local traffic, buses and emergency vehicles. The remaining traffic was rerouted from the affected area by two detour routes located parallel to King Street (Fig 1.1). York and Aberdeen were chosen as detour routes

so that traffic previously using King could be diverted with a minimum of delay from the construction zone. The construction work required to install a new sewage system together with a road resurfacing resulted in the closure of three of the four lanes on King Street for approximately four months.

3.4 Data Collection

The complete study consisted of three phases of data collection. Phase 1 was conducted in early June, 1977, shortly before King Street was closed to all vehicular traffic. Phase 2 was carried out in late July and early August, 1977, approximately six weeks after the closure of King Street. Phase 3 began in late October, 1977, approximately three weeks after King Street had been re-opened to all traffic. Data collection involved personal interviews and physical measures of noise levels for each phase.

Three sites were selected for this study. Dundurn and Aberdeen Streets were selected because residents on these streets were subjected to the higher volumes of road traffic detoured during the closure of King Street. The third site, Homewood, functioned as a control site. This is because it was not designated as a detour route. Therefore, assuming all other conditions being equal, responses of Homewood residents in the three phases should not vary significantly. Figure 3.3 indicates each site in relationship to the King Street closure. A brief description of each site, giving its location relative to King Street and maps showing site location

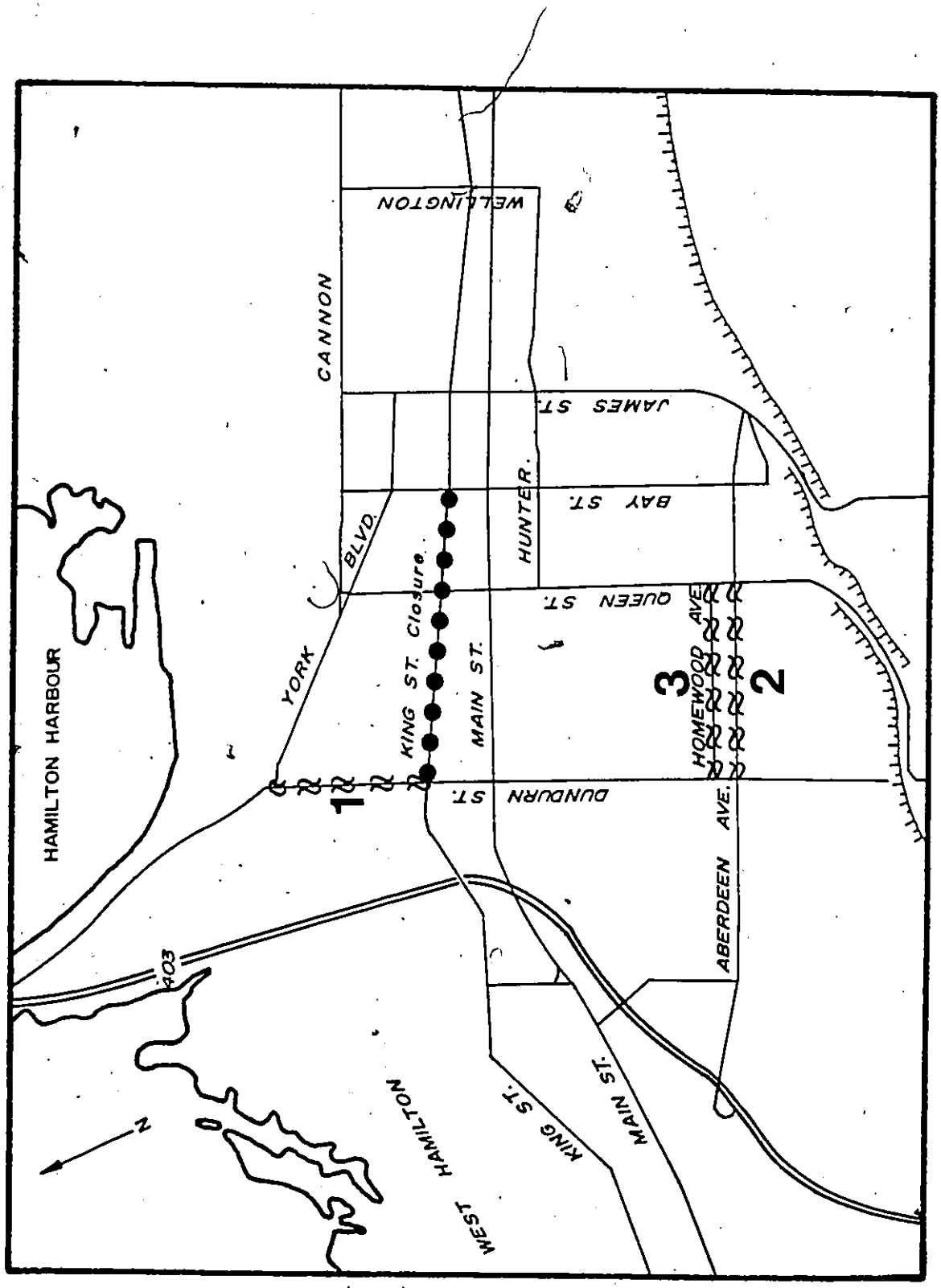


Figure 3.3
Survey Sites

and the residents that were interviewed are found in Appendix A.

The objective was to obtain twenty personal interviews at each site for Phase 1. During Phase 2, an effort was made to again interview the same respondents randomly selected in Phase 1, plus twenty additional personal interviews at each site. In Phase 3, the respondents from Phases 1 and 2 were reinterviewed and another twenty households were interviewed for the first time. By having a repeat and new sample for each phase comparisons of responses can be made between the groups for each phase. The purpose of having a repeat sample was to control for variations in the personal characteristics of the respondents between phases. A new sample was selected to provide a check on response bias due to the reinterviewing of the repeat sample. The interview completions by site and phase are summarized in Table 3.1.

Considering that traffic conditions changed for only a short time period, the objective of this study is to investigate residents' awareness of the change and its reported effects. For this reason, analysis focusses on responses to the initial change, that is between Phases 1 and 2. Therefore, results are reported for Phases 1 and 2 only.

3.5 Questionnaire Design and Administration

The questionnaire for this study was modelled on a questionnaire used in earlier studies (Hall et al. 1975, 1976). It was designed to determine various aspects of residents' attitudes and behavioural responses to road traffic noise. A comprehensive set of

Table 3.1

Interviews Completed According To Site and Phase

SITES	PHASE		
	1	2	
		Repeat	New
Dundurn	N = 20	N = 19	N = 19
Aberdeen	N = 20	N = 19	N = 20
Homewood	N = 20	N = 15	N = 20

questions provided information related to the awareness of road traffic noise, reported levels of disturbance, perceived effects of traffic noise and actions taken to reduce the unwanted effects of noise. Information under these headings was obtained corresponding to each hypothesis.

Hypothesis one required respondents to answer questions concerning perceived problems in their neighbourhood, awareness of noise, noise sources and changing traffic conditions. Attention has been focussed on the respondents' awareness of and attitudes toward the changing traffic noise between Phases 1 and 2, and reported levels of disturbances from general neighbourhood noise, main road traffic noise and noise from motorcycles, cars, trucks and buses.

Hypothesis two explores individual response to disturbing noise. Questions were designed to find out what activities were involved when noise disturbance ocurred, what perceived effects the noise had on the respondent and the members of their family and what, if any, protest actions or home adaptations the respondent had undertaken in reaction to the noise.

In order to test hypothesis three questions were asked relating to demographic and socio-economic variables (sex, age, education, occupation, income). Also, questions related to other variables relevant to noise response were included. These concern type of occupancy and length of residence, average time spent at

home and outside on a weekday and on the weekend.

The same questionnaire was used for all new respondents in each phase of the study. For repeat respondents introductory questions (1,2,3c, 3d), personal and observational questions were omitted. For Phase 2 and 3 some of the questions were rewritten slightly to elicit responses to the noise conditions in the week prior to the interview. This ensured that responses reflected reaction to the noise conditions existing during the appropriate phase of the construction. A copy of the questionnaire is included in Appendix B.

In addition to the questionnaire designed to assess subjective response to traffic, actual measurements of noise levels were taken at each site to validate the assumed relationship between traffic conditions and noise levels. However, due to equipment malfunction these measurements are incomplete and are not used in this analysis.

CHAPTER IV

ANALYSIS OF RESPONSE TO CHANGING TRAFFIC CONDITIONS

This chapter begins with a description of the effects of of the King Street construction on traffic conditions. The results are then reported in three sections correscponding to the hypotheses described in the previous chapter.

4.1 Effects of King Street Construction on Traffic Conditions

Basic to this study are the traffic conditions before and during the King Street closure. It was essential to assess the impact of the closure on traffic conditions on Dundurn (site one) and Aberdeen (site two) Streets which were detour routes. As previously mentioned the attempt to monitor 24 hour noise levels at each site was unsuccessful due to the malfunctioning of the noise monitor. However, a study by Filip and Allen (1979) identifies and describes the traffic volume shifts before, during and after construction on King Street.

Automatic traffic counts were conducted at the following intersections (1) York and Dundurn; (2) Dundurn and King; and (3) Aberdeen and Longwood Streets (Refer to Fig 4.1). In addition, fifteen-minute manual traffic counts were conducted to determine the daily variation in 3:00 - 6:00 pm traffic volumes. No am peak was assessed since eastbound traffic predominates at that time.

Results revealed daily traffic volume on York and Aberdeen

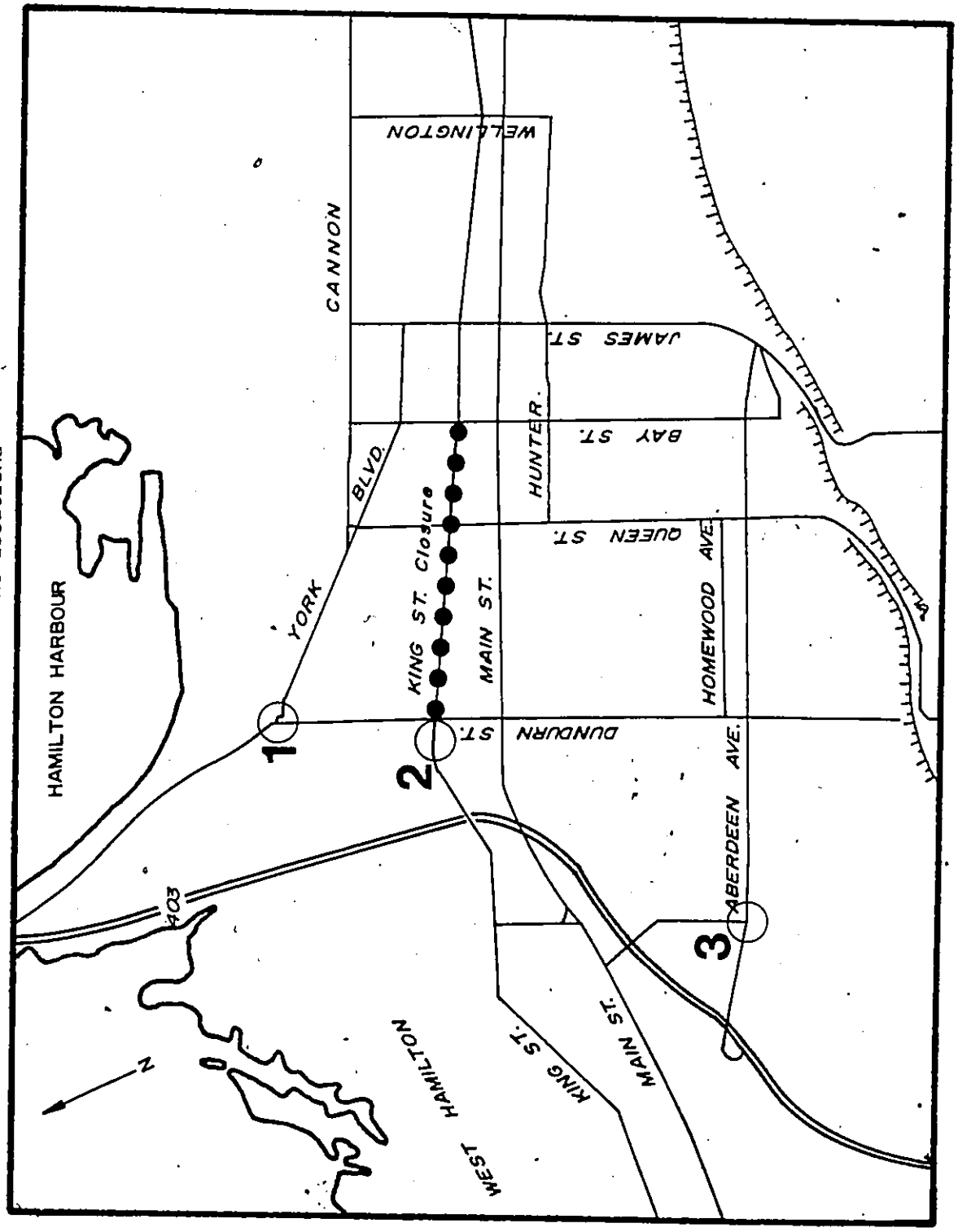


Figure 4.1
Traffic Count Locations

increased overall and fluctuated rather erractically during the construction period (Figures 6,8 on pgs. 13,15). Both AM and PM peak periods could be identified. Vehicle infiltration appeared as a side-effect in both residential streets close to the worksite and at critical intersections located on detour routes.

This study also provided an assessment of travel speed on four routes during the PM peak for various days of the week. Results for Route 1 which included Dundurn (shown in Fig.28, pg. 43) revealed that the average speed was about 28 km/hr before closure, but fell to 20 km/hr during closure, representing a 28% reduction of the average overall travel speed. For Route 3, Aberdeen, (shown in Fig.30, pg.45) there was no information for before closure but during closure the average overall travel speed was computed as 28 km/hr and after closure, overall travel speed increased to 32 km/hr.

This study showed that it is difficult to predict the roadways likely to be used and the magnitude of the vehicle influx into the residential zones as a result of such a road closure. Results indicated that both volume and speed altered significantly during the closure which can be directly related to changing noise exposure. These changes in traffic conditions almost certainly led to increases in noise levels although in the absence of noise date, the magnitude of any increase is unknown.

4.2 Effects of Changed Traffic Conditions on Responses

Since exposure to road traffic noise is different for each site, the analysis and results have been reported according to site. The statistical tests performed to examine subjective response to changes in noise levels were between groups of respondents in relation to phase and sample (Table 4.1).

Different forms of analysis are employed to determine the relationships between changing conditions and residents' awareness, attitudes, impacts and actions. The variables included in the analysis possess nominal, ordinal or ratio properties (Table 4.2). To test relationships between two nominal variables, chi-square statistics were performed. The Mann-Whitney U test was applied in cases where one variable was nominal and the other was ordinal. The degree of relationship between two ordinal variables was measured using Spearman rho (denoted r_s). In cases where one variable was nominal and the other was ratio, the student's t test was applied.

The analysis divides into three sections. First, the changes in residents' awareness of road traffic noise between Phase 1 and 2 are examined. Second, specific effects of changing traffic conditions on annoyance, activity interference, health and complaints are examined. The third deals with the demographic and socio-economic factors affecting changes in response.

4.2.1 Effects on Awareness

To determine changes in reported awareness and disturbance of traffic noise between Phase 1 and Phase 2, each respondent was

Table 4.1

Tests of Differences in Subjective Response to Change in Traffic Conditions

GROUP COMPARISONS FOR EACH SITE

R1	vs	R2
R1	vs	R21
R21	vs	R22

KEY: R1 = respondents from Phase 1

R2 = repeat and new respondents from Phase 2

R21 = repeat respondents from Phase 2

R22 = new respondents from Phase 2

Table 4:2

Measurement Scales for Variable in Tests of Differences between Phases 1 and 2

VARIABLE	MEASUREMENT SCALE
Dependent Variables	
Awareness of noise	nominal
Attitudes toward noise	ordinal
Noise impacts	nominal
Complaint actions	nominal
Independent Variables	
Sex	nominal
Age	ratio
Education	ordinal
Occupation	ordinal
Income	ordinal
Sensitivity	ordinal
Time at home	ratio
Length of residence	ratio

asked what sounds he/she noticed when at home during the last week. Responses were noted as being either volunteered or elicited. If road traffic was a sound mentioned, further questioning determined if it was road traffic in general or particular types of vehicles, for example cars or trucks. A card listing common sounds was also shown to all respondents to determine if particular sounds were noticed, besides those already reported.

The frequency of mention of traffic noise and noise from specific traffic sources was compared between Phase 1 and Phase 2 to determine the residents' awareness of changing traffic conditions. Few significant differences emerge for the number of times road traffic, motorcycles, cars, trucks and buses were mentioned between the phases and subgroups of the sample. Table 4.3 shows that seven of the forty-five relationships examined are significant beyond the 95 percent confidence level (based on the probability of the chi-square statistics).

Looking at the significant results, the frequency of mention of road traffic and cars on Dundurn reveals the impact of the change in traffic conditions in Phase 2. In Phase 1, 75% (15) of the respondents were aware of the road traffic, whereas in Phase 2, the percentage aware increased to 89% (34) of whom 53% (18) were the same persons interviewed in Phase 1. Noise from cars was mentioned by 26% (10) of the respondents on Dundurn in Phase 2. In comparison to Phase 1, none of the respondents mentioned cars.

As expected, the results obtained for Dundurn confirm a sign-

Table 4.3

Significant Changes[1] in Awareness of Noise

Between Phases 1 and 2

Noise Source	Dundurn		
	Phases 1 & 2	Phases 11 & 21	Phases 21 & 22
Road Traffic	7.58 *	10.13 **	
Cars	6.36 *	7.46 **	

Aberdeen
No Significant Results

Noise Source	Homewood		
	Phase 1 & 2	Phase 11 & 21	Phase 21 & 22
Road Traffic	8.25 **	6.55 *	6.07 *

1 Figures reported are chi square statistics

* Significant at .05 level

** Significant at .01 level

ificant relationship between changed traffic conditions and increase in residents' awareness of noise from traffic. The fact that the overall increase in traffic volumes in Phase 2 was primarily due to an increase in cars (Filip & Allen, 1979, pg.67) explains why other specific noise sources besides cars were not observed to change in Phase 2.

The lack of any significant results for Aberdeen fail to support the hypothesis. However, Aberdeen was operating as an optional detour route, as a result there was less of an increase in traffic columes (Filip and Allen, 1979). Therefore the lack of a significant difference in awareness is not inconsistent. It is also possible that residents on Aberdeen were expecting the vehicle intrusion derived from the closure and seemed to have accepted it. The reverse is also possible - that drivers did not always use designated detour routes and filtered through the residential streets located between King and Aberdeen or even Mohawk Road since it is a westbound arterial and was used by drivers who were avoiding the corridor (Filip and Allen, 1979).

The above explanation could also be a reason for the significant finding for Homewood (Table 4.3). Homewood was not a designated detour route but could have been used by drivers to avoid middle block congestion and traffic signals. However this does not explain the significant differences in response between Phase 21 and 22 for Homewood. It is possible that residents interviewed

in the repeat sample were sensitized to noise by the initial survey and therefore, more aware of even the small increase in traffic using their street.

Generally these results do not provide strong evidence to support the hypothesis that a sudden increase in traffic flow will produce a significant increase in residents' awareness of noise levels. Possible explanations for obtaining such results are:

(1) residents were made aware of the temporary increase in traffic due to the short term closure of King Street and felt noise levels were insignificant and not worthwhile reporting;

(2) it is possible that residents were not aware of the increase in noise levels because Aberdeen and Dundurn are normally busy streets and therefore the changes in traffic conditions due to the King Street closure were not especially noticeable;

(3) or it is possible the change in noise levels was not significantly different between Phase 1 and Phase 2, even though the volume of traffic increased in Phase 2. Unfortunately in the absence of noise data this explanation is speculative.

4.2.2 Effects on Annoyance, Activity Interference, Health and Complaints

This segment of analysis looks at changes in reported impacts and attitudes between Phase 1 and 2. Effects are assessed primarily with reference to reported levels of disturbance due to overall neighbourhood noise, main road traffic noise in general, and/or specific traffic sources - motorcycles, cars, trucks, or buses. Measures of disturbance were obtained using a ten point numeric scale ranging from 0 (not at all disturbed) to 10 (unbearably disturbed). Respondents were permitted to report non-integer disturbance scores (eg. 2.5) if they wished. The four measures of

annoyance based on this scale correspond to the overall rating of disturbance, the rating when inside the home, the rating outside on the exposed side of the building and the rating when outside on the shielded side of the building.

The effects of changed traffic conditions between the two phases on reported disturbance were analysed on the basis of difference of means tests. Twenty-three different disturbance measures formed the dependent variables for the analysis (Table 4.4). In total 117 tests were performed. Of these only 6 were significant (Table 4.5), which could be expected to occur by chance alone. The general lack of significant results indicates that in most cases there was no reported increase in annoyance in Phase 2. These results are not unreasonable considering the minimal increase in residents' awareness of noise levels between Phase 1 and 2 as previously reported.

The only significant differences in the mean disturbance levels were for Dundurn on the overall neighbourhood and road traffic noise ratings (Table 4.5). The direction of the difference for all six significant tests is consistent with the research hypothesis that an increase in traffic flow will produce a higher level of annoyance.

Tests revealed no significant results for either Aberdeen or Homewood. These results are not surprising considering responses to changed traffic conditions in Phase 2 generally did not show a significant increase in awareness of noise. Therefore it is unlikely

Table 4.4

Disturbance Scales Used in the Analysis

Neighbourhood noise	-	overall rating
Neighbourhood noise	-	inside rating
Neighbourhood noise	-	outside rating
Main road traffic noise	-	overall rating
Main road traffic noise	-	inside rating
Main road traffic noise	-	outside exposed rating
Main road traffic noise	-	outside shielded rating
Truck noise	-	overall rating
Truck noise	-	inside rating
Truck noise	-	outside exposed rating
Truck noise	-	outside shielded rating
Car noise	-	overall rating
Car noise	-	inside rating
Car noise	-	outside exposed rating
Car noise	-	outside shielded rating
Motorcycle noise	-	overall rating
Motorcycle noise	-	inside rating
Motorcycle noise	-	outside exposed rating
Motorcycle noise	-	outside shielded rating
Bus noise	-	overall rating
Bus noise	-	inside rating
Bus noise	-	outside exposed rating
Bus noise	-	outside shielded rating

Table 4.5

Significant Changes[1] in Disturbance Reported From Overall Neighbourhood and Road Traffic Noise

DUNDURN				
Disturbance Scale	Phase	N	Mean	T Value
NEIGHBOURHOOD NOISE				
Overall	1	8	3.6	1.24*
	2	28	6.8	
Inside	1	8	2.4	1.84*
	2	23	5.0	
Outside	1	8	3.3	1.28*
	2	23	6.8	
ROAD TRAFFIC NOISE				
Overall	1	11	5.8	1.77*
	2	29	7.5	
Inside	1	11	3.5	1.13*
	2	29	6.0	
Outside: Side	1	11	6.7	-2.24
	2	29	8.6	
Inside: Shielded Side	1	11	2.5	1.18*
	2	29	6.0	

1 Figures reported are Student's t statistics

* Significant at .05 level
** Significant at .01 level

that residents on Aberdeen or Homewood would report a higher level of annoyance.

Each respondent who reported being disturbed by one or more road traffic source was asked which, if any, activities were interfered with and what, if any, health effects any members of the household had experienced as a result of the noise (Table 4.6). Chi-square tests were performed to see if the frequency of activity interference, and health effects differed from Phase 1 to Phase 2. All results for each site were insignificant.

Information was obtained from each respondent disturbed by traffic noise sources to determine what, if any, actions had been taken to reduce the noise impact between Phase 1 and 2 (Table 4.6). Analysis revealed that in Phase 1 only four of the respondents had reported taking any action. In Phase 2 the percentage of respondents who took any kind of action to reduce unwanted noise increased to twelve. Overall, most frequently reported action against road traffic noise was filing a complaint with a government official or politician.

Although slight, there is evidence that the effects of traffic noise did change between Phase 1 and Phase 2. The level of disturbance reported and the number of respondents who reported disturbance on Dundurn from neighbourhood noise and road traffic noise increased significantly in Phase 2 from Phase 1. However the change in traffic noise conditions did not result in a significant increase in the reported activity interference, health effects or actions taken.

Table 4.6

Variables Included in the Analysis

Impacts	Actions
ACTIVITY INTERFERENCE	
Sleeping	Complaining
Relaxing Inside	Closing Windows
Relaxing Outside	Staying Inside
Conversing Inside	Turning on/up T.V.
Conversing Outside	Any Immediate Action
Working Inside	
Working Outside	
Watching T.V.	
Speaking on the Phone	
Eating	
HEALTH EFFECTS	
Hearing Loss	
Nervousness	
Irritability	
Increased Tension	
Headaches	
Sleep Interruption	
Being Kept Awake	
Any Sleep Disturbance	

Overall, the findings could be explained by:

(1) Dundurn residents were probably more directly affected by the changed traffic conditions, and

(2) the temporary change in traffic conditions was too short a period to affect the activities and health of residents.

4.3 Factors Affecting Changes in Response

Response to a sudden change in traffic conditions is compounded by the effects of several intervening variables. Reactions to traffic noise as a function of increased traffic flow varied among residents in the three sites. Other data collected in the questionnaire survey permitted an examination of personal factors which are plausible explanations of these differences. These factors are: sex, age, education, occupation, income, hours spent at home (weekday and weekend), type of occupancy, and length of residence. The relevance of these factors was assessed by testing the relationships between them and reported change in disturbance levels with respect to the following noise sources: (1) overall neighbourhood, (2) road traffic, (3) cars, and (4) trucks. In addition, response to noise was evaluated for various locations around the house, as discussed and shown in Table 4.4. Difference of means tests (T-test) and correlation analysis (Spearman Rho) were performed to evaluate whether the various personal factors had any significant influence on response to the specific noise sources, in the specific locations.

Results indicate that only two personal variables produced any mediating influence on response. Specifically, significant results emerged for income and age.

Income was significantly correlated with the change in disturbance ratings of road traffic noise for both Dundurn and Homewood (Table 4.7). The relationship between income and change in response was positive. People with a higher income tended to report a greater increase in disturbance level between Phase 1 and 2 on both Dundurn and Homewood.

Age was also correlated with change in the disturbance rating of car noise for Dundurn (Table 4.8). The correlation was positive, indicating that older respondents in general reported a greater increase in disturbance between the phases.

No significant correlations were found between other personal characteristics and changes in response between Phases 1 and 2. One possible explanation for this finding is that age and income have the greatest variance at the sites where significant results were obtained. Significant results are primarily for Dundurn because this is where the greatest change in annoyance occurred.

Overall the results show that a sudden change in traffic conditions for a short time period has a negligible effect on residents' awareness, and annoyance due to road traffic. The only significant results were obtained from Dundurn which had the greatest change in traffic conditions. Again the effects of personal characteristics

Table 4.7

Significant Relationships[1] Between Income and Change in Disturbance

DISTURBANCE SCALE	INCOME		
Road Traffic Noise	Dundurn N=19	Aberdeen N=19	Homewood N=15
Overall	rho=.502*	No Signi-ficant Results	rho=.505
Inside	rho=.545*		rho=.475
Outside (exposed)	rho=.326		rho=.511*
Outside (shielded)	rho=.243		rho=.505

1 Figures reported are Spearman rho

* Significant at .05 level

Table 4.8

Significant Relationships[1] Between Age and Change in Disturbance

DISTURBANCE SCALE	AGE		
Car Noise	Dundurn N=19	Aberdeen N=19	Homewood N=19
Overall	rho=.453*	No Significant Results	No Significant Results
Inside	rho=.508*		
Outside (exposed)	rho=.428		
Outside (shielded)	rho=.493*		

1 Figures reported are Spearman rho

* Significant at .05 level

on changes in disturbance are mainly for Dundurn, where annoyance was shown to differ between Phase 1 and 2. Even so, only age and income are related to annoyance changes.

CHAPTER V

SUMMARY AND CONCLUSIONS

The main objectives of this study have been firstly, to investigate changes in individual response in relation to changing traffic conditions, and secondly, to determine whether changes in response are related to personal characteristics. Hypotheses were designed to reflect the study objectives. The purpose of this chapter is to summarize the preceeding chapters; to evaluate the results of analysis; and to suggest directions for further research stemming from the present study.

5.1 Summary

It was pointed out in the literature review that existing noise studies have generally not investigated the stability of individual responses over time. Also, they failed to examine residents' awareness and reaction to changes in noise levels resulting from changes in traffic conditions. Furthermore, the findings of studies examining factors which mediate individual response to traffic noise are inconsistent.

The closure of King Street provided the opportunity for an empirical study to determine the effects of short-term changes in traffic conditions on response to noise. This study reports the findings of the analysis conducted to determine how residents at three sites, Dundurn, Aberdeen, and Homewood were affected by road

traffic noise before and during the closure of King Street.

Due to the closure, the traffic volume increased and the average overall travel speed decreased significantly on both Dundurn and Aberdeen. These factors in combination almost certainly led to an increase in traffic noise levels.

The analysis was conducted in two parts. The first part analyzed the effects of changed traffic conditions on reported awareness, annoyance, activity interference, health and complaints. The second part of the analysis considered the relationships between response to changed traffic conditions and personal characteristics. The analysis was based on the conceptual model presented in chapter two.

Few significant differences emerged between responses in Phase 1 and 2. For both Dundurn and Aberdeen there was an increase in the number of respondents who reported awareness of noise from road traffic in Phase 2. Also, on Dundurn more residents reported an awareness of car noise. Although significant results were few, there is evidence to support the first hypothesis that a sudden increase in traffic volume will produce a significant increase in residents' awareness of noise levels. Considering that traffic conditions changed for a short time and residents at all three sites were subject to road traffic noise prior to the closure, the overall lack of strong evidence to support this hypothesis is not surprising.

Very few significant differences were found between Phases 1

and 2 in reported annoyance, activity interference, health effects and actions taken with respect to noise. The only significant differences were in the mean disturbance levels for Dundurn on the overall neighbourhood and road traffic noise ratings. The results therefore only weakly support the second hypothesis that an increase in traffic volume produces a higher level of annoyance. No significant results were shown for Aberdeen or Homewood. These findings are consistent with the minimal increase in residents' awareness of noise levels between Phase 1 and 2.

Results of correlations between personal characteristics and changes in responses between Phases 1 and 2 revealed very weak relationships. This finding is inevitable given the minimal changes in response revealed by the other analyses. Age and income were the only variables related to changes in response to noise. The significant results were again limited to Dundurn. They show that increases in annoyance were greatest for older residents and for those with higher incomes.

5.2 Conclusions

Universal conclusions should not be drawn from results of this study. It should be kept in mind that the situation surrounding the King Street closure was relatively unique. Changes in traffic conditions between Phases 1 and 2 created by the closure were only for a short time. Considering that time acts as a modifier on residents' perception of prior noise levels, the short time increases the probab-

ility of finding a change in response because habituation effects and memory loss would be negligible. However, no substantially significant differences emerged in responses between Phases 1 and 2. Overall, then, these results suggest that there is minimal change in response to traffic noise when a temporary change in traffic conditions occurs.

These results can be explained by three very plausible factors. The first is the possibility that there was a small change in noise levels between Phases 1 and 2 as a result of changes in traffic conditions. The second is that the change in conditions was for too short a period to notice or report. The third is that the residents were well informed of the closure and its effects.

With respect to the first of these three factors, the absence of accurate physical noise measurements for both phases raises the question as to what degree the noise levels changed. If the change was relatively small it would explain why significant differences in responses did not emerge between Phases 1 and 2.

Given that conditions changed for only a short time, it is highly possible residents felt that any effects of the change were very minor and perhaps not worth reporting. Therefore, any effects due to changes in traffic conditions are directly related to the degree of change, whether the change is temporary or permanent.

The third plausible explanation of the study findings is that a well informed public is less likely to have negative attitudes and

reactions to noise occurring from changes in traffic conditions. The importance and value of having an informed public is suggested by the results. Prior to the closure, announcements were made through the media. Reports were published in the local newspaper identifying detour routes, describing the state of the construction work, and expected termination date. These measures were probably an effective means of reducing or preventing negative responses and reactions due to the change in traffic conditions during the closure.

The results of this study can be related to both cross-sectional and longitudinal research. They provide preliminary evidence of how response to noise changes with increase in noise. Assuming that the change in traffic noise levels due to the closure was minor the small changes in response generally support the results of cross-sectional studies (eg. Schultz, 1977). It may be therefore, that response to change in noise over time in one location can be predicted using results of cross-sectional studies.

This general conclusion, however, is only tenative. Several additional factors need to be considered in further research. Studies focussing on the effects of the permanence of change in noise levels, the magnitude of change in noise, and variation in neighbourhood situational factors all need to be considered before final conclusions can be drawn about the correspondence between the results of cross-sectional and longitudinal studies of the noise - response relationship.

APPENDIX A

SITE DESCRIPTIONS

SITE DESCRIPTIONS

SITE 1: DUNDURN

LOCATION: ON DUNDURN STREET BETWEEN YORK AND KING STREETS
N → S

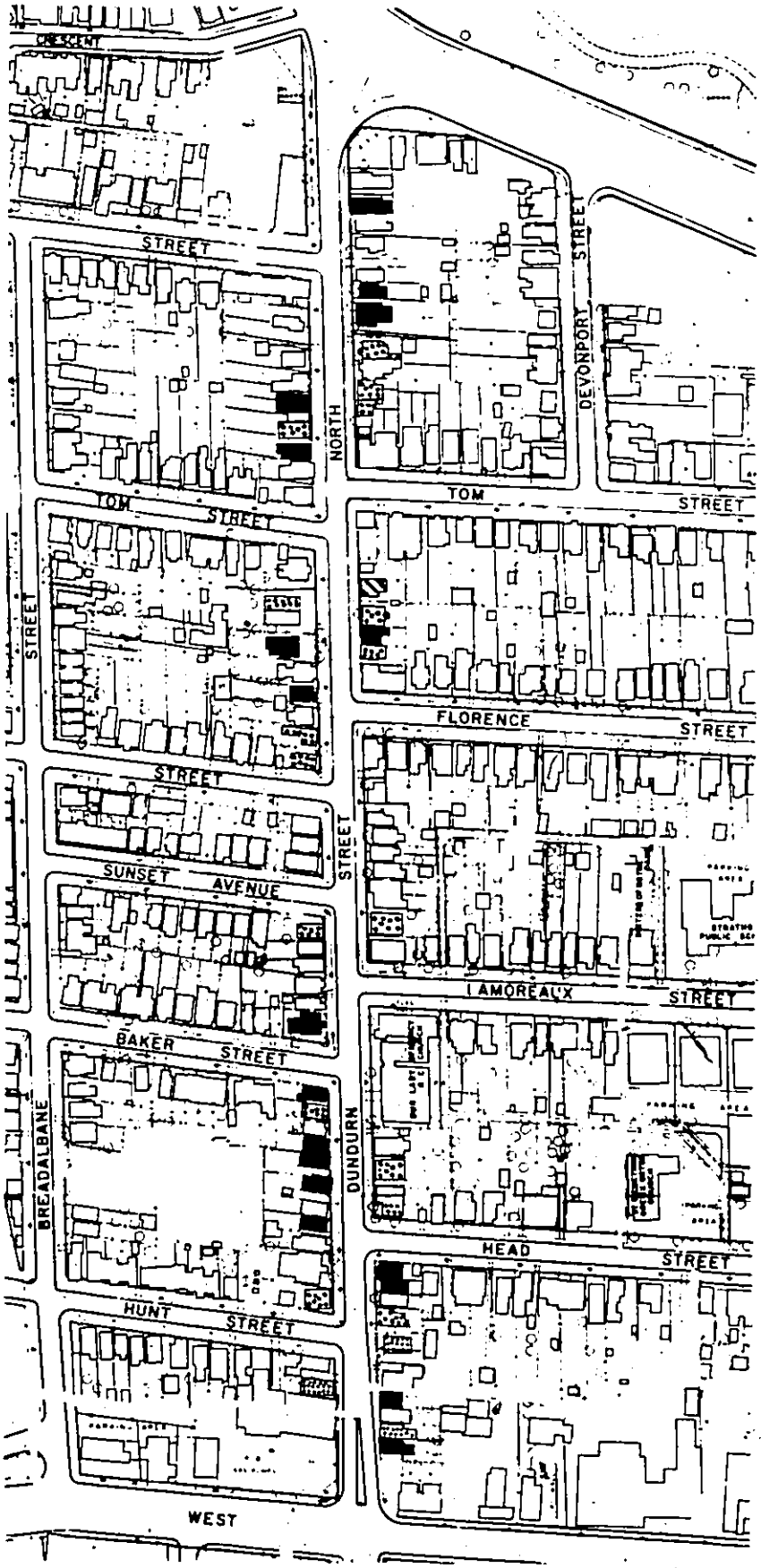
SITE 2: ABERDEEN

LOCATION: ON ABERDEEN AVENUE BETWEEN QUEEN AND DUNDURN STREETS
E → W

SITE 3: HOMEWOOD

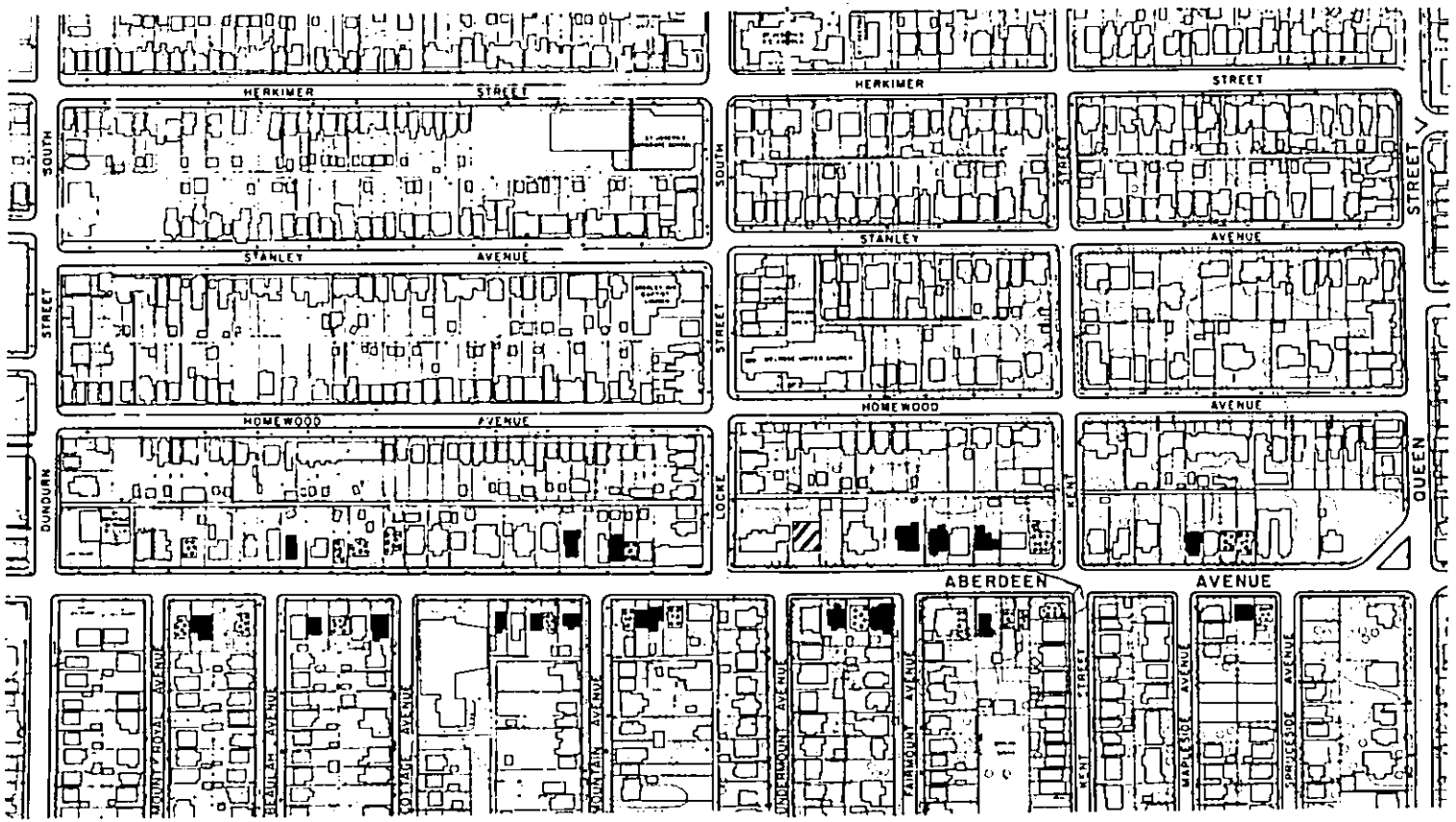
LOCATION: ON HOMEWOOD AVENUE BETWEEN QUEEN AND DUNDURN STREETS
E → W

Sample households for Dundurn



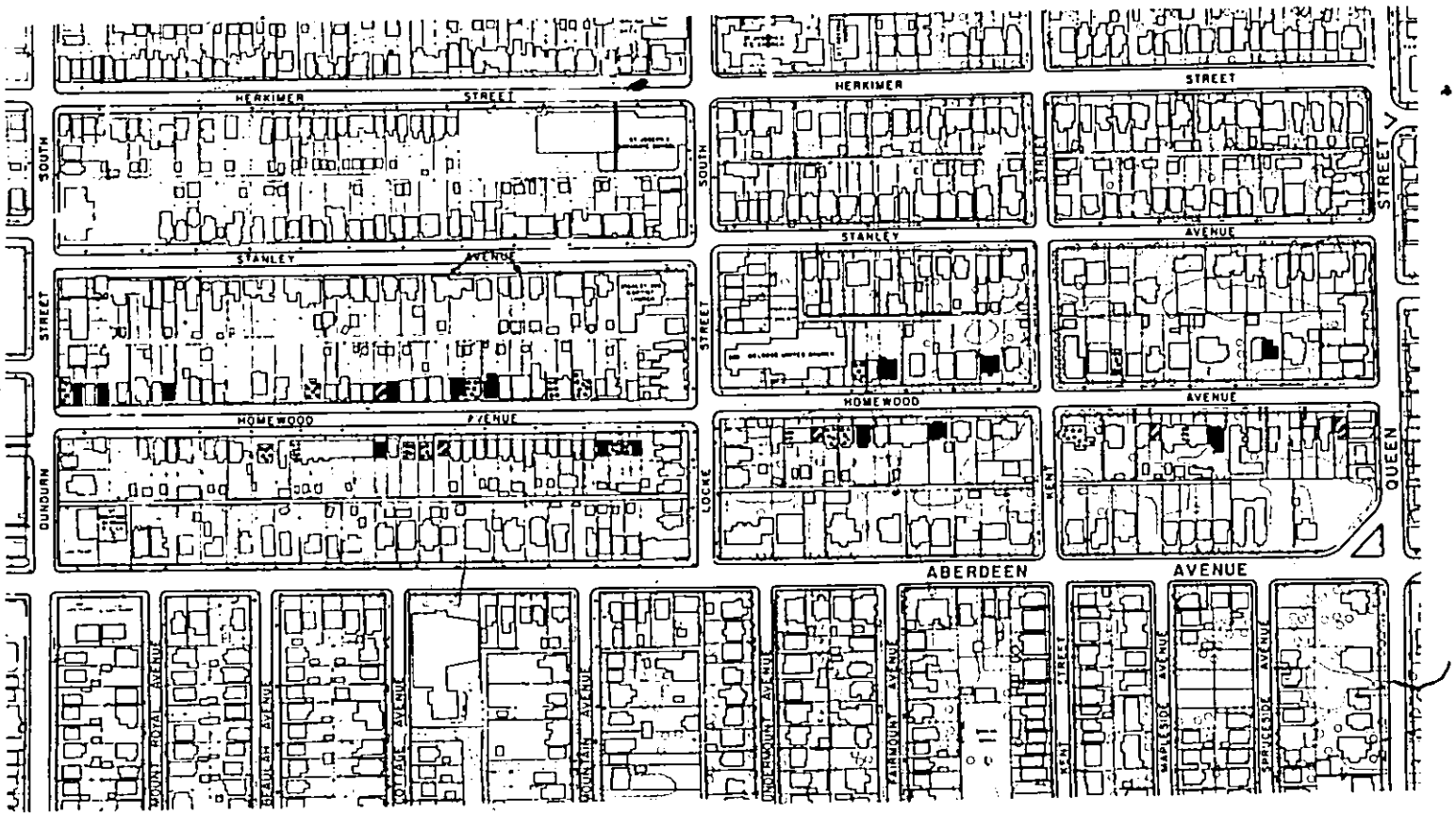
SAMPLE 1: ▨ SAMPLE 1 REPEAT: ■ SAMPLE 2: ⊡

Sample Households for Aberdeen



SAMPLE 1: ▨ SAMPLE 1 REPEAT: ■ SAMPLE 2: ⊡

Sample Households for Homewood



SAMPLE 1: ▨ SAMPLE 1 REPEAT: ■ SAMPLE 2: ⊞

APPENDIX B

THE QUESTIONNAIRE

SITE_____

ADDRESS_____

PHASE_____

SAMPLE_____

INTERVIEWER_____

NEIGHBOURHOOD ATTITUDE SURVEY

McMASTER UNIVERSITY

TRANSPORTATION RESEARCH GROUP

CALL	DATE	TIME	RESPONSE
1	_____	____	_____
2	_____	____	_____
3	_____	____	_____

INTRODUCTION: Hello, I'm from the Geography Department at McMaster and I'm interviewing people to find out what they think about this area. Could you spare me about 5 minutes? Thanks very much.

1. What are the important things you like about living in this neighbourhood?

2. What are the important things you don't like about living in this neighbourhood.

Item	Like V (1)	Like E (2)	Don't Like V (1)	Don't Like E (2)
Schools				
Shopping				
Open Space				
Recreational Facs.				
Bus Service				
Proximity to Work				
Noise				
Quietness				
Air Quality				
Landscaping				
Cost of Housing				
Quality of Housing				
Neighbours				
Safety for Children				
Crime				
Maintenance				
Privacy				
Parking				
Other (specify)				

For 1 and 2 check all non-volunteered items using card. Here are some other things that have been mentioned, are any of them important to you?

Transition: You have mentioned noise; I'd like to ask you a little more about that. (or) One of the items we're particularly interested in is noise and I'd like to ask you about that.

3

3. a. During the last week what sounds have you noticed while at home?

b. How would you rate each of the sounds you have mentioned?

Hand respondent the card listing the intensity scale:

1. *Extremely agreeable*
2. *Considerably agreeable*
3. *Moderately agreeable*
4. *Slightly agreeable*
5. *Neutral*
6. *Slightly disturbing*
7. *Moderately disturbing*
8. *Considerably disturbing*
9. *Extremely disturbing*

c. Here is a list of common sounds (you have already mentioned some). Do you ever particularly notice any of these (any of the others)?

d. *Repeat* b *for elicited noises.*

e. *(If children/other people, garden machinery, and road traffic noise not previously mentioned).* Although you haven't mentioned (source(s)) I would like to know how you rate the sound from (source(s)) during the last week.

f. *For each noise with an intensity rating between 6 and 9.*

You mentioned that _____ (source) was disturbing. How often did it disturb you during the last week?

Hand respondent the card listing the categories:

1. *Less than once a day*
2. *Once or twice a day*
3. *Several times a day*
4. *Almost continuously*

	Source	V 1	E 2	F 3	Intens. (1-9)	Freq. (1-4)	Over.	Intensity IN	OUT	OEX	OSH
(01)	Children/other people										
(02)	Handyman tools										
(03)	Air conditioner										
(04)	Domestic pets										
(05)	Garden Machinery										
(06)	TV/radio/records										
(07)	Musical instruments										
(08)	Road Traffic Noise										
(09)	Motorcycles										
(10)	Cars										
(11)	Trucks										
(12)	Buses										
(13)	Mini-bikes										
(14)	Trains										
(15)	Aircraft										
(16)	Industrial Noise										
(17)	Construction Noise										
(18)	Institutional Noise										
(19)	Mechanical or Plumbing noise										
(20)	Other (specify)										

4. Considering noise from all sources (egs. industry, traffic, people) how would you rate the noise in this neighbourhood during the last week?

(1) Extremely agreeable ____

(2) Considerably agreeable ____

(3) Moderately agreeable ____

(4) Slightly agreeable ____

(5) Neutral ____

(6) Slightly disturbing ____

(7) Moderately disturbing ____

(8) Considerably disturbing ____

(9) Extremely disturbing ____

5. (If one or more road traffic source mentioned are disturbing) We would like to obtain an additional rating for the traffic noise sources which you indicated are disturbing.

   a. Please indicate the level of disturbance caused by the noise source by rating your disturbance on a scale of 0 to 10, where 0 indicates not at all disturbed, and 10 indicates unbearably disturbed. Please put your rating in the first box, marked overall.

   b. We would like to know if your disturbance varies depending on where you are. Please show your level of disturbance when you are indoors by placing the appropriate number in the box marked inside.

      Now please indicate in the appropriate boxes your disturbance when you are outside on the side of the building which is exposed to the traffic noise, and then on the shielded side.

      Repeat a *and* b *for each road traffic source rated 6 to 9.*

   c. *Ask* c *only if neighbourhood rating on question* 4 *was disturbing.*

      We would like to obtain a similar rating to describe your level of disturbance from the general neighbourhood noise. Please indicate your disturbance in the first box of the set marked neighbourhood. Now please indicate your disturbance when you are inside and outside of your residence.

      Neighbourhood rating: *Overall* _____

      Inside _____

      Outside _____

Transitional statement: The next several questions relate to those noises which you previously mentioned are disturbing.

6. What days and times during the last week were you disturbed most?

Sources	no difference, or			
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

7. Are there any activities which these noises interrupted during the last week?

Volunteered answers only.

Source	Sleeping	Relaxing In	Relaxing Out	Conversing In	Conversing Out	Working In	Working Out	T.V.	Telephone Convers.	Eating
_____	___	___	___	___	___	___	___	___	___	___
_____	___	___	___	___	___	___	___	___	___	___
_____	___	___	___	___	___	___	___	___	___	___
_____	___	___	___	___	___	___	___	___	___	___

Blank = 1, check = 2.

8. When you were disturbed by (source) during the last week did you: *read list.*

	Sources			
	_____	_____	_____	_____
Close your window	___	___	___	___
Use air conditioning	___	___	___	___
Stay indoors	___	___	___	___
Turn on/up TV/radio/records	___	___	___	___
Wear earplugs	___	___	___	___
Contact noise source	___	___	___	___
Wait for noise to stop	___	___	___	___

Blank = 1, check = 2.

9. Have you ever taken any other actions in response to the noise sources?

yes

no

(If yes) What did you do and when?

Source	Action	Date
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

10. What effects on you and your family have these noises had during the last week? *Read list.*

Source	Nervousness	Irritability	Headaches	Interrupt Sleep	Kept Awake
_____	____	____	____	____	____
_____	____	____	____	____	____
_____	____	____	____	____	____
_____	____	____	____	____	____

Blank = 1, check = 2.

11. *(Ask in phases 2 and 3 only)* How would you rate the noise in this neighbourhood during the past week compared with two months ago? *Read first five on list.*

(1) Much quieter ____

(2) Somewhat quieter ____

(3) About the same ____

(4) Somewhat noisier ____

(5) Much noisier ____

(6) Cannot answer or don't know ____

In order to understand more about how people assess their environment, we would appreciate the following information about yourself. This information will be used only in looking at groups of people, we will not be using it on an individual level. If there are any questions you would prefer not to answer, please say so. Your answers to the other questions will still be appreciated.

1. Sex (1) Male ____ (2) Female ____

2. Please write down your age. _____ years.

3. What level of education have you completed?

(1) Some public school ____

(2) Public school graduation ____

(3) Some high school ____

(4) High school graduation ____

(5) Some university or college ____

(6) University or college graduation ____

(7) Post-graduate work ____

4. What is your main occupation? _____

5. What is the occupation of the head of the household? _____

6. Please indicate which range most closely describes the income before taxes of this household in the past year?

(1) Less than $5,000	____	(5) $20,000 - $25,000	____
(2) $ 5,000 - $10,000	____	(6) $25,000 - $30,000	____
(3) $10,000 - $15,000	____	(7) More than $30,000	____
(4) $15,000 - $20,000	____		

7. How many hours do you normally spend at home each day?

	(1) less than [illegible]	(2) 10-15	(3) 15-20	(4) more than 20
Weekdays	____	____	____	____
Weekends	____	____	____	____

8. Do you rent or own your residence?

(1) Rent ____

(2) Own ____

9. How long have you lived in this house/apartment? _____ (months)

10. Would you be willing to have a noise monitor on your property for a day some time during the next two weeks?

____ yes

____ no

Time _____

Phone _____

10

OBSERVATIONAL DATA

1. Building construction:

   a. Number of stories in building ____

   b. Building material:

      (1) Brick ____

      (2) Frame ____

      (3) Stucco ____

      (4) Asbestos panels ____

      (5) Other (specify) ____

      Type of windows:

      (1) Single pane ____

      (2) Double glazing ____

   c. Air conditioning:

      (1) Central ____

      (2) Window unit ____

      (3) None ____

      (4) Don't know ____

2. Buffer features with reference to major noise source: *blank = 1, check = 2.*

   Shrubs ____

   Trees ____

   Hedge ____

   Wall/Solid fence ____

3. Type of dwelling unit:

   (1) Apartment ____

   (2) Flat ____

   (3) Row/Townhouse ____

   (4) Semi-detached ____

   (5) Detached ____

4. If an apartment or flat, which floor? ____

5. Date _____ (day/month) _____ day _____ month

6. Hour of day _____

0	to	10
not at all disturbed		unbearably disturbed

Site No. ________

Respondent ______

Interviewer No.___

Source: ____________________

Overall	Inside	Outdoors	Exposed side of building	Shielded side of building

Source: ____________________

Overall	Inside	Outdoors	Exposed side of building	Shielded side of building

Source: ____________________

Overall	Inside	Outdoors	Exposed side of building	Shielded side of building

Source: ____________________

Overall	Inside	Outdoors	Exposed side of building	Shielded side of building

Source: NEIGHBOURHOOD

Overall	Inside	Outdoors

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