The economic and social effects of main road traffic noise in Sydney

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THE ECONOMIC AND SOCIAL EFFECTS OF MAIN ROAD TRAFFIC NOISE IN SYDNEY

by

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This thesis contains no work which has been presented for a higher degree at any other University or institution.

C. Robyn Bradley.

TABLE OF CONTENTS

Page

Page

LIST OF TABLES

LIST OF FIGURES

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ABSTRACT

The aim of this thesis is to investigate the economic and social impacts of main road traffic noise through an investigation of residential house prices in Sydney during the period 1968-1980 and by means of household questionnaires.

A survey-control area comparison technique which utilises study areas abutting main roads and control streets sufficiently distant from main roads not to be affected by them, is used to examine differences in mean annual house prices and long-run growth trends of house prices in nine study areas. The relative importance of main road traffic noise in main roads and control streets was identified by multiple regression analysis, and a household questionnaire enabled investigation of the effects on residential populations of exposure to main road traffic noise.

The general conclusions of this study are that main road externalities contributed to differences in mean house prices between main roads and control streets during the periods 1968-69, 1973-74 and 1977-80, and to the significant difference in the growth trends of house prices in main roads and control streets. Main road traffic noise is a significant but minor determinant of house prices, accounting for three per cent of the variation in house prices on main roads and just one per cent on control streets.

The majority of main road residents find main road traffic noise disagreeable, and actions designed to reduce the immediate impact of noise provided the best indicator of annoyance. Residential characteristics and indicators of activity interruption are not useful identifiers of those residents who are more sensitive to main road traffic noise.

CHAPTER ONE

INTRODUCTION

One of the main features of the concentration of population in the major cities of Australia in recent decades have been an increasing volume of road traffic. Although part of this increased traffic volume has been accommodated on new or improved roadways, in most cases it has been fed into the existing road network. In both situations one of the most notable aspects associated with increased traffic have been the adverse environmental effects such as noise and air pollution, visual pollution and increased danger or inconvenience to pedestrians and roadusers.

Much attention by academics and the general public has been focused on the adverse environmental effects of new, or proposed new transport facilities but underlying most new projects is a belief in the accompanying advantages such as decreased travel time and congestion, and increased accessibility. The introduction of new transport facilities have been shown to affect property and land values in two opposing manners (MSJ Keys Young Planners, 1974). It is reasonable to assume that increased traffic volume on an existing road network will also initiate the same effects, to a greater or lesser degree. Firstly, property values may experience a general increase as a result of one or more of the following factors:

(a) an increase in accessibility to central city locations such as the central business district, or major industrial zones;

(b) displacement of residential land may lead to increased demand pressures on remaining land; and

(c) a change in the relative supply of and demand for land may lead to an increase in value of newly accessible land.

Secondly, property values may experience a decline due to either:

(a) the nuisance aspects of the transport facility which may result in undesirable residential environments; or

(b) spatial redistribution of demand may result in value declines in areas left at a disadvantage.

Maclennan (1977) states that analyses of house prices have been undertaken for four purposes:

1. to statistically explain the apparent "determinants" of house prices in static, cross-section, usually aggregative studies;
2. to statistically determine the relative importance of various elements such as environmental or internal characteristics in the house price regression equation, or to demonstrate how this equation varies over racial or income groups;
3. to derive demand functions for housing; or
4. to test, indirectly, alternative theories of residential location.

This thesis falls into the second of Maclennan's four categories. It is intended to investigate the effects which main road traffic noise has had on residential house prices in selected areas of Sydney during the period 1968 to 1980. A survey-control area comparison technique which involves utilising study areas near or abutting the transportation facility and control areas sufficiently distant not to be affected by it (Graybeal and Gifford, 1974) will be used to indicate whether house price differentials are apparent in either the short run (one year time span) or long run period (1968-1980). This technique will be supplemented by multiple regression analysis which has the unique advantage of identifying the relative importance of individual variables on land values (Graybeal and Gifford, 1974). In this instance the relative importance of main road traffic noise to residential house prices will be investigated using multiple regression analysis. Further investigation will be concerned to determine the social effects of exposure to main road traffic noise on the residential population of the study areas.

1.1 LITERATURE REVIEW

The literature relating to this study can be divided into four categories:

1. those studies dealing with the determination of residential property or land values;
2. those studies dealing with the effects which environmental disturbances have on people;
3. those studies dealing with the impacts which transport facilities and their environmental disturbances have on residential property values; and
4. Australian studies dealing with transportation impact on residential property values.

1.1.1 Determinants of residential property values

Alonso (1960) saw the determination of property values as the outcome of competitive bidding by individuals seeking "to balance the costs and bother of commuting against the advantages of cheaper land with increasing distance from the centre of the city and the satisfaction of more space for living". Each individual is seen to have a set of bid price curves which represents "the set of prices for land the individual could pay at various distances while deriving a constant level of satisfaction" (Alonso, 1964).

Later studies saw property values as the market expression of the combined value of the set of attributes embodied in a particular property. Brigham's (1965) study of land values in Los Angeles County used the following model:

$$V_i = F(P_i, A_i, T_i, U_i, H_i)$$

which expressed land value (V) of the ith site as a function of that site's accessibility to economic activities (P), its amenity (A), its topography (T), its present and future use (U), and certain historical factors that affect its utilisation (H). These determinants of land value were approximated by using proxy variables which, particularly in the case of the amenity variable were difficult to measure and varied with the area in question. Brigham found that land values related negatively with distance from the central business district and the nearest freeway, and positively with employment opportunity. Neighbourhood amenity was most important in the area where deviations in mean income was greatest, while the topography variable generated a negative sign indicating low land values in very hilly areas.

Crecine, Davis and Jackson (1967) attempted to establish the effects of certain neighbourhood externalities upon the value of single family dwellings. They used the Brigham model of land values as the basis for their work, holding all independent variables constant except the "amenity" variable. Their derived model expressed the value of the dwelling as a constant plus influences from zoning and non-zoning externalities, a time trend and a stochastic disturbance. Analysis of housing data of ten Census Tracts in Pittsburg failed to support the idea that external diseconomies abound in the urban property market and suggested that independence is a characteristic of that market.

Treloar (1966) divided the factors which might be expected to influence the price of residential land into four categories: demand for residential land, supply of vacant residential lots, speculation and differences in the quality of housing stock. However, most of the recent work in the determinants of land or house prices have concentrated on those factors which are demand induced, including quality of housing stock (Ball, 1973; Wilkinson, 1973; Wilkinson and Archer, 1976; Richardson, Vipond and Furbey, 1974). Ball (1973) provides a description of several papers and their results, including the Brigham paper referred to earlier. Only two of the eleven papers Ball considers had coefficients of determination (R^2) less than 70 per cent, indicating that the remainder were successful in explaining the determinants of house prices in each of their studies. Two of the studies referred to by Ball, those by Wabe, and Ridker and Henning were able to achieve R^2 values of 0.90 or better.

Wabe's (Ball, 1973) study was conducted in the London Metropolitan Region using data at the borough level, a division similar to the Australian L.G.A. The variables included in a regression analysis he performed were: cost and journey time by commuter train to the relevant London rail terminal, social class, population density and proximity to green belts, house age, floor area and possession of central heating and a garage. These variables were all significant at the five per cent level and resulted in an R^2 of 0.90. However, these results must be tempered by the fact that many of the variables are highly correlated. Wabe's use of grouped house prices rather than individual data also tends to influence the R^2 value.

Ridker and Henning (Ball, 1973) were similarly successful and achieved an R^2 of 0.94 in a study of house prices in St Louis. Once again the use of grouped data would tend to inflate the R^2 value, but in this case an attempt was made to solve the problem of collinearity between variables using a process of residualisation. That is, a new variable was obtained by finding the computed value from a regression of one variable against the variable with which it is highly correlated and subtracting that computed value from the actual value of the variable under question. The variables used in this study were similar to those of Wabe and included travel time to the central business district, accessibility to a main highway, the number of rooms, while an air pollution index, percentage of recently built homes, housing density, school quality, a socio-economic index, population density, percentage of non-white and average weekly income were the environmental variables.

A different approach to the explanation of the price structure of dwellings and to assessment of the effect of environmental attributes on the structure of house prices was provided by Wilkinson's (1973) study of house prices in Leeds. Factor analysis was used to determine the combination of variables which influence the average house price. The scores of four factors: locality, internal and external amenities of dwellings, and space and structure, when regressed against house prices explained eighty per cent of the variation in house prices. Wilkinson suggested that the sensitivity of house prices to change would alter the composition of factors by adding or subtracting variables, or in more extreme cases such as the building of an urban motorway would result in the addition or subtraction of a factor.

In a later piece of work Wilkinson and Archer (1976) attempted to measure long-term changes in house prices in the English towns of Halifax and Doncaster, using a hedonic approach which involves using a regression technique to generate quality adjusted price indexes. Regression equations were calculated for twelve time periods between 1900 and 1970 using the dwelling type, age of dwelling, presence of a garage and internal or external toilet as the dependent variables. The predictive value of these equations was generally low, with only four of the twelve equations being significant at the 95 per cent level on an F-test. These results are not unexpected when the number and range of variables considered in other studies, including the previous study by Wilkinson (1973) are considered.

A more all-embracing study was that by Richardson, Vipond and Furbey (1974), who attempted to determine house prices in Edinburgh in 1966 in terms of four models. The first was a locationally insensitive housing characteristics model (R^2 = 0.44), the second was a spatial model (R^2 = 0.52), the third was an accessibility model (R^2 = 0.57) and the fourth an environmental model (R^2 = 0.60). Comparisons of the results of each of these models suggested that no one model was superior, and unless tests of the behaviour of individual home buyers supported one particular model, the future attempts to explain house prices should use a combination of the four models. Further analysis revealed a "reduced predictive model" which was a combination of variables from each of the original models, and yielded an R^2 of 0.60 with all six variables being significant at the 99 per cent level. These variables included distance from the central business district, car ownership, house type, rooms per person and two variables indicating direction from the city centre.

It is evident from the previous studies that no particular group, or combination of factors, will always be significant in explaining house prices in particular cities. These studies indicate that house prices are the result of an interplay between many factors, and that these factors will act with varying effect in different locations.

1.1.2 The social effects of environmental disturbance

Recent research (Griffiths and Langdon, 1968; Appleyard and Lintell, 1972; Sando and Batty, 1974; Langdon, 1976a, 1976b; Taylor and Hall, 1977; Taylor, Gertler and Hall, 1979; Wyatt and Bookman, 1981) suggests that as traffic volume and traffic noise increases, dissatisfaction felt by residents increases.

Griffiths and Langdon's (1968) study of twelve sites in north-west London showed that if the Traffic Noise Index and the distance from the road at which the measure was made are known then it is possible to predict levels of residents' dissatisfaction. They also discovered that as dissatisfaction from traffic effects increases, the possibility of leaving windows open while sleeping decreases and the need to close windows while engaging in various domestic activities increases. The more dissatisfied respondents also reported more disturbance of the children's and their own sleep, and a preference for living further from the roadside.

A study of three streets differing in traffic volumes in San Francisco discovered that danger from traffic, traffic noise, vibration, fumes, soot and trash were considered to be the most stressful aspects of neighbourhood environment (Appleyard and Lintell, 1972). The heavily trafficked street was considered to be unsafe by residents, and a greater number of these residents reported being troubled by noise and vibration than did residents from the moderately and lightly trafficked streets.

A similar study undertaken by Troy (1973) in Melbourne attempted to explain people's attitude to their environment in terms of their dwellings, physical environment and their social environment. Residents in the four suburbs of North Melbourne, St Kilda, Strathmore and Clayton were generally highly satisfied with their dwellings, social environment and general convenience, especially to shops, work, schools and public transport. However, residents were less satisfied with the physical environment; pedestrian safety, traffic noise and traffic congestion were regarded as unsatisfactory in all suburbs except Strathmore where aircraft noise was unsatisfactory.

Pedestrian danger was the factor causing greatest concern to respondents in a national survey of householders in England which attempted to ascertain how the public was affected by road traffic both in their homes and in their immediate locality (Sando and Batty, 1974). One in eight people had spontaneously mentioned traffic noise as something they disliked about their area, although 51 per cent of respondents felt that traffic delays were more serious than disturbances from noise or fumes. Of eight noise sources, road traffic was considered to be the biggest nuisance by 23 per cent of people, and this disturbance became more acute as traffic flow increased.

These abovementioned studies suggest that residents are dissatisfied with road traffic and its associated environmental disturbances in their neighbourhoods. Researchers have recently been investigating the nature and strength of community response to these environmental disturbances, especially the response to road traffic noise. In particular, a number of studies have been undertaken using data collected in Southern Ontario in Canada by Hall and Taylor and their associates to ascertain the nature of community response to traffic noise. Taylor and Hall (1977) found that attitudes toward noise are relatively uniform across social status groups, but that the higher status groups reported being more disturbed by noise and were more willing to make complaints. The people who reported being more disturbed were mostly those who had lived longest in each neighbourhood, and were those who spent longer periods at home. These results directly contradict those found in Melbourne (Wyatt and Bookman, 1981) where it is reported that after ten years' residence people change their negative attitude to one of affection for their neighbourhood, although they were reported to be worried about falling house values, vibration and the difficulty of external conversations, factors they attributed to traffic.

A related study (Hall, Taylor and Birnie, 1977) found a strong relationship between traffic noise values and the percentage of residents rating neighbourhood noise as highly disturbing, the percentage reporting any form of speech interference and the percentage carrying out complaint activity, with the correlation coefficient being 0.80 or greater in each case. Hall, Birnie and Taylor (1978a) also reported that speech interference and high levels of disturbance are similar as a function of sound levels, and suggested that noise reduction at high sound levels is more beneficial than an identical reduction at lower noise levels.

Gamble, Sauerlander and Langley (1974) noted that the degree of annoyance from highway noise in four North American communities was not related to income, age and sex. They reported a positive relationship between annoyance and the extent to which residents felt their property values had been adversely effected by noise and found that frequent highway users were less annoyed by noise, dust and odours than were infrequent highway users.

Community response to road traffic noise is not limited to feelings of annoyance or dissatisfaction. Physical manifestations of residents' response may include actions designed to decrease traffic noise such as closing windows or erecting walls or barriers or they may include health problems such as hearing difficulties. Taylor, Gertler and Hall (1979) found that the link between the impacts which traffic noise has on residents and their attitude to that noise is not a simple cause and effect relationship, and that health effects were more strongly related to attitude than were activity interference variables. It was also discovered that complaint activity was a poor index of annoyance and that immediate actions designed to reduce the impact of noise provided a better index of annoyance.

An investigation of aged people living in housing commission units in Brisbane (Burden and Damm, 1979) indicated that residents in noisy sites experience more chronic illnesses, higher incidence of argumentativeness, moodiness and depression, and they tend to visit their doctors more than residents in quiet sites. These residents also gave reports suggesting that they sleep less well, feel worse on rising, experience more life stress and enjoy less life satisfaction than residents in the quiet sites. Langdon and Buller (1977) revealed that the proportion of residents attributing sleep disturbance to traffic noise increases significantly with noise level, with only thirty per cent of the population at the noisiest sites being able to sleep undisturbed with windows open in summer conditions.

The Canadian series of investigations also questioned whether the response to the same noise level is similar when different types of shielding or barriers are present. Hall, Birnie and Taylor (1979) found that all forms of shielding appear equally effective with respect to a large range of responses to road traffic noise, but there are significant differences in the effectiveness of different kinds of shielding with relation to the attitude of people to the overall noise in their neighbourhoods. Housing type and tenure arrangements do not significantly affect awareness of road traffic noise (Taylor, Birnie and Hall, 1978b), although when tenure was relaxed, the residents in multiple-family dwellings were in general more adversely affected by traffic noise with townhouse residents reporting more adverse effects than apartment dwellings. Apartment dwellers report increasing disturbance as proximity to expressways increase (Hitchcock and Waterhouse, 1979) although reports of disturbance were substantially lower in buildings with screened faces than in unscreened buildings.

British investigations of community response to road traffic noise focused on attempts to predict dissatisfaction scores from noise levels, and on attempts to value the worth of peace and quiet to residents.

Correlations between median dissatisfaction scores and noise levels and traffic volumes in the Greater London area are highly significant, although dissatisfaction scores tended to be higher in non-freely flowing traffic than in freely flowing traffic conditions (Langdon, 1976a, 1976b). This result was reinforced by residential evaluation of the worth of peace and quiet, where under the most favourable conditions in areas of free-flowing traffic regression techniques yielded near zero evaluations rising to 25 pence per week, while in congested conditions the formula predicted 10 pence per week at the most favoured sites and rose to a maximum of 50 pence per week (Langdon, 1968). Although factors such as occupational class and household income have not been found to significantly effect scores of annoyance, demographic factors such as age and household income were important determinants of monetary evaluation of peace and quiet. This result is also supported by Harris (1979) who showed that a one per cent change in income will lead to a change in the weekly evaluation of around 0.3 per cent. These studies suggest that in areas where the environmental disturbances associated with road traffic noise are excessive people will be adversely affected by these disturbances. Therefore, it is reasonable to suggest that in areas where these disturbances are excessive that people will value such areas less highly and, hence, house values will be lower and will increase at slower rates than less affected areas.

1.1.3 The impact of transport associated disturbances on property values

To support the contentions in the previous paragraph, the third section of the literature deals with transport facilities and the effects which their adverse environmental disturbances have had on residential property prices. These studies are divided into two broad groups, those which look at actual changes in the nature or distribution of transport facilities (Adkins, 1959; Bardwell and Merry, 1960; Pearce and Nash, 1973; Koutsopoulos, 1977), and those which look at established road transport facilities (Gamble, Sauerlander and Langley, 1974; Langley, 1976a, 1976b; Hall, Breston and Taylor, 1977; Taylor, Breston and Hall, 1982).

The earliest of the reported studies dealing with changes in transport facilities are combined in a paper which compares changes in land values and sales prices along newly constructed expressways in three major cities in Texas (Adkins, 1959). In each of the cities, Houston, Dallas and San Antonio, the percentage increase in land values attributed to the freeway exceeded the percentage increase in sales prices, and in each city the increase was appreciably greater in those zones abutting the expressways. In Houston, for example, between 1939-41 and 1954-56, the sales prices for abutting properties increased by 334 per cent, and land values increased by 464 per cent. During the same period, sales prices for the zone immediately adjacent to the abutting properties decreased by 9 per cent and land prices increased by only 39 per cent.

A similar study of land values in Colorado of seven communities which had been bypassed by a newly constructed highway indicated that for the areas where there had previously been no highway, that the relationship between sales prices and acre-miles (a variable combining distance from a community and the size of the land parcel) changed from a random distribution to an inverse relationship (Bardwell and Merry, 1960). This result suggests that the properties abutting the highway had gained a locational advantage over other properties.

A different type of transport facility was examined in Denver, where the aim of the study was to ascertain the impact of a newly introduced mass transit system on property values (Koutsopoulos, 1977). This study began by looking at the land rent gradient which relates distance from the CBD to land rent or value, and suggested that there is a second gradient, the mass transit gradient, which reflects transportation impacts. Using regression analysis, two separate results were encountered; the bus routes serving the newly developed northwest and southwest areas showed a significant impact on prices, while those serving the older east and northeast areas had an insignificant impact on prices.

Other studies have approached the subject differently, for example a cost-benefit analysis was used to assess the impact of an urban motorway in Southampton (Pearce and Nash, 1973). However, this study does not confine itself to effects on property values but attempts to consider the impact on the whole community. After considering such factors as the actual cost of building the motorway, the cost of acquiring land, the cost of housing displaced persons, disruption to residents during construction and benefits including travel time savings and network benefits, the authors reached the conclusion that the benefits from construction of the motorway were marginal. Furthermore, the study revealed that the motorway was biased against lower income groups, with the benefits accruing to wealthier out-of-town residents.

The previous studies of newly introduced road transport facilities have indicated that the prices or values of abutting properties can safely be expected to increase relative to other properties as a result of increased locational advantages. The next group of studies investigate the impact of previously existing transport facilities on property values.

The first study to be considered was undertaken in Ontario in an attempt to analyse the impact of road traffic noise on house prices (Hall, Breston and Taylor, 1977). Six sites were selected, each consisting of parallel rows of housing, one abutting the major road and the other removed from the major road, serving as a control for the abutting properties. Sales of properties between 1975 and 1977 were recorded, and analysis of variance was used to determine if the sale prices of the parallel rows of housing were significantly different. On the basis of results of the analysis of variance, the sites were analysed in two subsets, the first consisting of those sites where there was a significant difference in prices and where the daytime index of traffic noise was 73 decibels or greater. The second subset consisted of those sites where the price difference was not significant, and the daytime index of traffic noise was 70 decibels or less. A multiple regression analysis which incorporated as independent variables the number of bedrooms, the presence of a swimming pool, the year and the daytime index of traffic noise, indicated that for the noisy sites, noise was valued at just over $700 per decibel, while for the quieter sites noise was not significant in explaining house prices.

A second study of the impact of road traffic noise on house prices in southern Ontario between January 1972 and June 1978 divided the study sites on the basis of traffic conditions, the first set of sites being near arterial roads which experience stop-go traffic conditions and the second sites being near expressways which experience uninterrupted traffic flow (Taylor, Breston and Hall, 1982). Regression analysis indicated that at the arterial sites where traffic noise was in excess of 65 dBA the regression coefficient revealed a depressive effect of $217 per decibel when sales price was used as the dependent variable, and $254 per decibel when the price difference between the average selling price of a site and the sale price of individual homes was used as the dependent variable. Only with the price difference as the dependent variable, and at traffic noise levels at or above 70 dBA does noise become significant at the expressway sites, resulting in a depressing effect of $312 per decibel. When differences in noise levels and selling prices between expressways and arterial sites is accounted for, the apparent difference in the effect which traffic noise has on house prices is negated.

A similar study carried out in 1971-72 for the United States towns of Bogota, North Springfield, Rosedale and Towson (Gamble et al., 1974) found that noise pollution was significant in explaining variation in property prices in all four communities, and that there was an average loss of $2,050 per property abutting the highway. Noise was valued at an average of $82 per decibel, ranging from $646 in Bogota and $60 in Rosedale. The study goes a step further, and estimates that the owners of properties abutting highways experience a net gain resulting from a gain in accessibility associated with location on the main roads. However, an in-depth study of North Springfield revealed that the increase in value of abutting properties was less than the increase in value of non-abutting properties, largely due to the adverse effects of the highway.

Another two studies of the impact of the Washington Beltway in North Springfield supports the results obtained by Gamble et al. (Langley, 1976a, 1976b). Gamble found that in 1970 the abutting properties sold for an average of $1,518 less than non-abutting properties. Similarly, in 1970 Langley (1976a) found a difference of $1,650 and in 1972 the difference was $1,652.

Therefore, the research into the effects of road transport facilities on house prices suggests two broad responses. Firstly, that house prices tend to increase as a response to increased locational advantages, and secondly, that the adverse effects of noise and air pollution associated with these facilities have a depressive effect on house prices, although

Gamble, Sauerlander and Langley (1974) were able to show that this depressing effect did not override the locational advantages.

Studies of airport facilities would tend to reinforce the above findings (Crowley, 1973; Holsman and Aleksandric, 1977). A study of the Toronto International Airport (Crowley, 1973) found that in the years immediately after substantial airport changes, 1956-58, 1960-62, and 1967-69, that land values in the airport area, Milton, decreased both absolutely and relatively compared to control areas.

The same response to airport changes was established in Sydney (Holsman and Aleksandric, 1977). In the long-run period the airport affected areas, Botany and Rockdale, showed a faster rate of increase than the control areas. The airport affected areas also exhibited the short-run response to airport changes as indicated in Toronto, that is, that following substantial changes in aircraft technology or airport extensions there were periods in which house prices declined absolutely and relatively, 1962-63 and 1968-69. However, the long-run evidence suggests that after these short-run periods of change, prices increased to approximately their previously established long-run trend.

1.1.4 Relevant Australian studies of transport impact

Other than Holsman and Aleksandric's abovementioned work, Australian studies of the impact of transport facilities on house prices have been particularly scarce (Abelson, 1977; McCalden and Jarvie, 1977; Holsman and Paparoulas, 1982). Abelson (1977) used multiple regression analysis to isolate the effects of aircraft and road traffic noise in Marrickville and Rockdale in Sydney in 1972-73. At Marrickville road traffic noise was found to have a 5.6 per cent depressing influence on house prices and aircraft noise of 30-40 NEF had a 6 per cent depressing influence. At

Rockdale, however, traffic noise had no effect on house prices, while aircraft noise of 30-40 NEF had a 10 per cent depressing influence on house prices.

A more recent study (Holsman and Paparoulas, 1982) has examined the effect which the Eastern Suburbs Railway has had on the price of residential cottages and terraces in the Sydney suburb of Edgecliff. House sales data for the period 1972 to 1981 were used to investigate the short-run and long-run differences in price movements in Edgecliff and a control area, South Paddington. The study identified a statistically significant difference in the long-run growth rate of prices in Edgecliff and South Paddington, with the growth rate in Edgecliff being notably faster since 1976, the year the commitment to the railway's completion was given. Indeed, from a situation in 1977 when Edgecliff's residential prices were $5,907 below those in South Paddington, in 1981 they were $12,880 higher. The study also divided Edgecliff into three sub-regions in an attempt to identify the effect of distance from the railway and operational noise. In the sub-region of Edgecliff affected by the above-ground section of the railway, the movement in property prices since the railway's opening shows two years of relative decline. A questionnaire survey of Edgecliff revealed a significant relationship between a household's use of the railway and its perception of economic benefit or loss, with all of those not using the railway and perceiving no economic benefit residing near the above-ground section of the railway. Noise was shown to have a statistically significant impact on property prices in the area, and it was concluded that in the residential areas affected by the operational noise of the railway that the environmental impact outweighed the accessibility benefits.

A study in Newcastle aimed to summarise the social and economic impact of bulk haulage, particularly coal haulage, on urban communities

(McCalden and Jarvie, 1977). One of the economic factors included in the study was the relationship between house devaluation and increased traffic volume. The streets used for study were Northcott Drive, which became a major road for local and through traffic in the 1960s, and Carolyn and Terrence Streets, which were used as control streets. Analysis of house sales for the period 1962-73 revealed that the average annual compound growth rates in property values was 5.54 per cent for Northcott Drive and 6.62 per cent for Carolyn and Terrence Streets. This result was reinforced by adjusting house values to 1967 dollars to obtain an average annual increase in the value of houses in Northcott Drive of $116 and of $223 in Carolyn and Terrence Streets. These results suggest that increased traffic volumes and associated disturbance have a depressive effect on house values.

The studies of environmental disturbances associated with increased traffic volumes and aircraft noise in Australia indicate that these factors exert a depressing effect on property prices in areas directly affected by the disturbances.

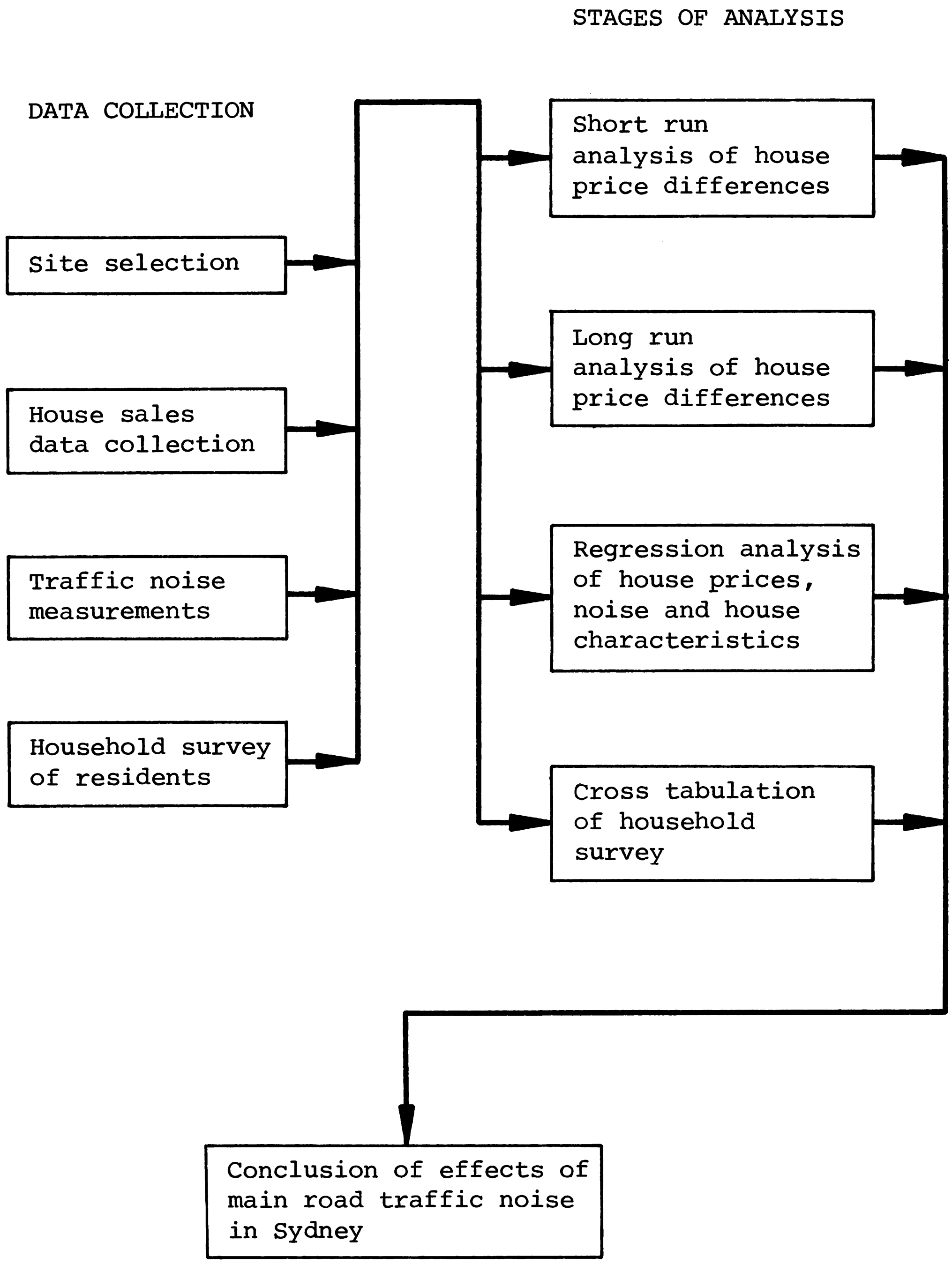
CHAPTER TWO

METHODOLOGY

On the basis of the findings derived from the literature survey presented in Chapter One, a four stage methodology was developed to investigate the effects of main road traffic noise on house prices in the Sydney Metropolitan Area. These four stages, which are diagrammatically represented in Figure 2.1, include:

1. A short-run analysis of house sales prices to indicate any years during the study period (1968-1980) when property prices on main roads were significantly different from those on streets parallel to the main roads.
2. A long-run analysis of house price movements to establish whether there are any differences in the movements, or rates of increase of house sales prices on main roads and on parallel streets over the study period.
3. Regression analyses to investigate the extent to which road traffic noise affects house sales prices. This is the first time that main road traffic noise is included in the analysis.
4. A survey of residents in the sites under study and of associated residential characteristics to indicate whether residents exposed to main road traffic noise exhibit any responses or residential characteristics which are different to those of residents not exposed to main road traffic noise.[1]

FIGURE 2.1 Outline of methodology



Before each of these stages is considered in some detail it is appropriate to outline the procedures used to collect the data necessary for this study, including site selection and the means of measuring traffic noise.

2.1 SITE SELECTION

The study relies on a survey-control area comparison approach (Graybeal and Gifford, 1968) in that it includes a comparison of house prices in areas abutting main roads with those in control areas of adjacent parallel roads. The main aim of incorporating the survey-control area comparison technique is the belief that it allows an externality impact, such as main road traffic noise on property prices to be distinguished from the general trends in the wider property market which are represented by the price movements in the adjacent control streets. In so doing, economic fluctuations in the study area due to inflation, migration or growth are controlled. Graybeal and Gifford (1968) cautioned, however, that the main difficulties of this approach involve selecting control areas representative of the study areas in all aspects except proximity to the transportation facility, in this case the main road, and secondly to hold constant all variables other than the change in the transportation facility, that is, all variables in respect of housing type, zoning and location other than road traffic noise.

In an attempt to obtain reliable control streets for comparisons with main roads identified as possible survey sites for this study, a number of criteria were formulated which both main roads and control streets had to satisfy.

(i) The predominant land use on both survey and control streets is residential, of basically similar housing stock (single storey, free-standing dwellings in most cases). This requirement reduces the chance of any differences in house prices being a reflection of differences in type of housing stock.

(ii) The roads selected for study should be straight and level, providing for uniform sound characteristics within any one road or street.

(iii) Road traffic noise should be the major source of noise at each site and the noise levels on the main roads and their respective control streets should be different.

These conditions necessitated that all control streets were parallel to the main road under study. An investigation of all main roads in the Sydney Metropolitan Area (as defined by the N.S.W. Department of Main Roads) in which suitable sections of road and control streets could be identified for study revealed just nine suitable locations. Even then, it proved difficult to fully control all of the abovementioned factors at each site. There was a smattering of retailing land use along several of the main roads, and at two sites, occasional noise from aircraft movement was noted. Additionally, the grade of three of the main roads is not level along the whole length of road identified for the study.

The sites used for the study are given in Table 2.1 and their location is shown in Figure 2.2.

2.2 HOUSE SALES DATA

House sales data for the period January 1968 to June 1980 inclusive were obtained from the respective Local Government Valuation Books. Data were recorded on both the sale price of each dwelling sold during the study period and the date of the sale.

Difficulties were encountered in the Local Government Area of South

TABLE 2.1 Sites used for study

Site Number	Local Government Area	Main Road	Parallel Streets
1	Ku-Ring-Gai	Bobbin Head Road	Bannockburn Road Fairlawn Avenue Reely Street Warrangi Street
2	Willoughby	Eastern Valley Way	Covelee Circuit Fourth Avenue Raeburn Avenue
3	Lane Cove	Epping Road	Finlayson Street Garling Street
4	Concord	Concord Road	Burke Street Cumming Avenue Mackenzie Street Tenterfield Street
5	Drummoyne	Lyons Road	Bowman Street Clare Crescent Lea Avenue Lenore Street
6	Woollahra	Old South Head Road	Kings Road
7	South Sydney	Gardeners Road	Tweedmouth Avenue
8	Kogarah	Princes Highway	Garden Street John Street Lobb Crescent Wyuna Street
9	Kogarah	King Georges Road	Dudley Street Mabel Street Neibro Avenue The Mall

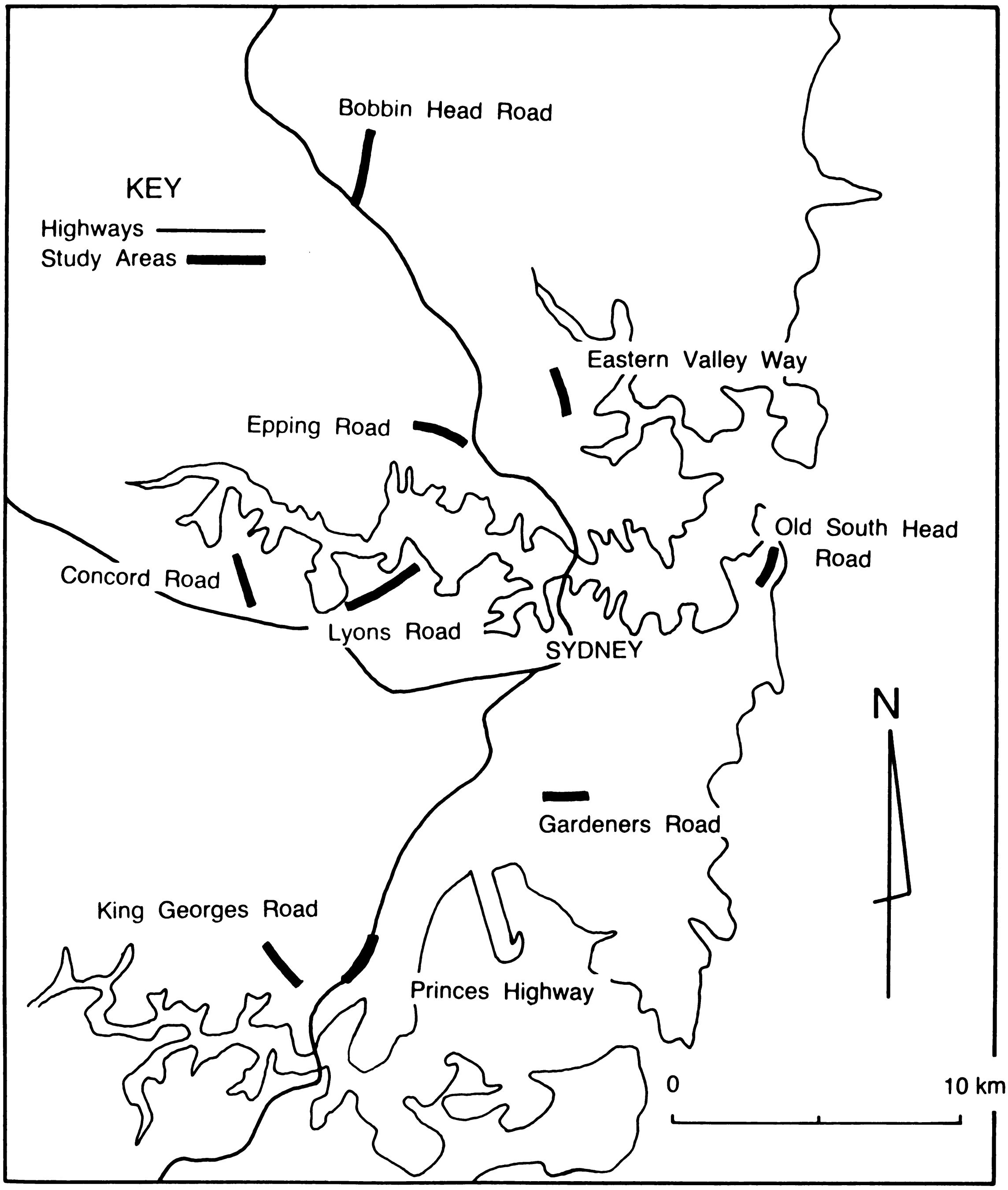


Figure 2.2 Study sites.

Sydney where data were only available from 1974 to 1980, and in Drummoyne, where the data for 1968 were unavailable. Nevertheless, both these sites were retained for study.

A total of 1,306 transactions were recorded, and a breakdown of the number of sales by year and site is provided in Table 2.2. As can be seen from Table 2.2, the data set is by no means ideal. Two main road sites (Number 6, Old South Head Road, and Number 7, Gardeners Road) have few transactions in total and a number of sites have very few observations in particular years. An inevitability of this unavoidable problem is that for some sites, and in some years, the results of the short-run analysis should be treated with caution. In the two sites mentioned previously, numbers 6 and 7, both the short-run and long-run analysis are affected by small sample sizes. The most complete data sets come from Bobbin Head Road, Ku-ring-gai; Lyons Road, Drummoyne and King Georges Road, Kogarah. As there are nine sets of parallel streets in the study, and therefore many more houses in total in the control streets compared with those in the main roads, it is interesting to note that there is not a great difference between the number of houses sold in the two sample sets. It would appear that relatively more houses are sold per year on main roads than on parallel streets. This in itself may reflect a dissatisfaction with living on main roads by many people.

2.3 THE HOUSEHOLD SURVEY OF RESIDENTS

During the months of November and December 1980 a household questionnaire was distributed to householders in each of the nine sites. In all 1,003 questionnaires were distributed to householders who had purchased their homes during the period of study.[2] A total of 368 surveys were returned, giving a response rate of 36.7 per cent which is highly respectable for this type of survey. Moser and Kalton (1975) suggest that

TABLE 2.2 Number of house sales for each site 1968-1980

	Year													
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Total
A. MAIN ROADS														
Site No.														
1	12	10	6	9	13	12	6	6	14	11	7	8	4	118
2	3	9	6	6	1	9	1	6	10	2	3	6		62
3	4	3	3	3	3	4	3	3	1	7	3	6	3	46
4		2		7	5	7	4	3	3	8	3	5		47
5		14	17	12	13	13	4	4	6	14	14	18		129
6		1	1		3	3	2	2		3	3	4		22
7							6		6	4	2	8	2	28
8	5	4	6	6	3	6	5	3	2	5	3	2	1	51
9	3	15	4	6	7	12	7	3	5	15	7	7	2	93
														596
B. PARALLEL STREETS														
Site No.														
1	9	13	5	9	8	9	9	8	10	10	7	10	3	110
2	3	12	8	10	8	15	3	12	8	4	8	12	3	106
3	2	6	8	4	5	8	9	6	1	5	4	13	3	74
4	1	6	7	10	7	3	3	10	3	10	13	12		85
5		8	15	10	7	11	8	7	7	9	13	16	3	114
6	4	3	4	6	2	4	4	3	2	4	5	3		44
7							4	5	6	8	3	4	2	32
8		2	3	3	2	5	2	5	7	2	5	8	2	46
9	2	5	4	7	10	11	6	10	17	10	9	6	2	99
														710
Total Sales														1,306

strenuous efforts are needed to bring the response rate for mail questionnaires to around 30 or 40 per cent. The questionnaire which was pilot tested was designed to be answered by the respondent at his leisure, and then mailed back to the researcher. In order to increase the rate of response the questionnaires were delivered personally to each householder, or if the householder was not at home, left in his letterbox.[3] One of the main points in favour of the mail questionnaire (in this case the questionnaire was returned by mail) is that the problem of non-contacts is avoided (Moser and Kalton, 1975). Each householder received an introductory letter, a set of instructions, a questionnaire and a stamped pre-addressed envelope for return of the questionnaire. A sample of the questionnaire is provided in Appendix A.

The questionnaire was divided into four parts, each of which was designed to solicit information to be used in separate sections of the analysis. The breakdown of the questionnaire is described below.

Part One looks at the householder's decision to buy his house. The questions serve three main purposes:

1. to discover which variables were important in the decision to buy the house, and the relative importance of those variables;
2. to discover which variables the householder dislikes about the neighbourhood at present, and the relative importance of those variables; and
3. to indicate the length of residence of the householder and any plans he may have for moving in the future.

The underlying purpose of this part of the questionnaire is to allow the householder to indicate either that "quiet" was an important variable in his decision to buy his house, or that main road traffic noise is one of the variables disliked about the neighbourhood at the present time.

Part Two deals specifically with main road traffic noise, its effects on the householder and his responses to that noise. The content of the questions fall into five groups which are described below.

1. Any noises which are noticed by the householder and their relative importance. Main road traffic noise is only included as part of a list of possible noises at this stage.
2. The times during a week when main road traffic noise is noticed by the householder. This is the first time that main road traffic noise is revealed as the focus of the questionnaire.
3. The extent to which main road traffic noise has intervened in the lifestyle of the householder. Three types of indicators are used for this purpose; interference with household activities, possible medical complaints and fears caused by the proximity of main road traffic.
4. Householder responses to interference caused by main road traffic noise have also been categorised into three types; short- and long-term responses as well as complaint activity.
5. A rating, by the householder, of "annoyance" or "disturbance" from main road traffic noise.

Part Three of the questionnaire looks at the respondent himself. The information requested includes the age, sex and occupation of the respondent as well as the amount of time spent at home each week and the mode of transport by which each member of the household gets to work. This information will be used to account for discrepancies between complaint activity and disturbance from main road traffic noise.

Part Four contains questions about the physical attributes of the house. Information is requested about the location, age and structure of the house, the number and type of rooms as well as any items included in the grounds of the property. Two further questions asking for details of any renovations will be used to gain an understanding of what the house was like at the time of purchase.

The analysis of the data obtained from the household questionnaire covers three major topics.

1. An investigation of both those variables which were an important factor in the householder's decision to buy his house, and of those variables which are presently disliked by the householder. This is effectively a neighbourhood evaluation by the residents.
2. An investigation of the householders' response to main road traffic noise (MRTN) is divided into three sections:
   (a) an investigation of the relationship between the impacts which MRTN has had on the residents, and their expressed attitude to MRTN;
   (b) an investigation of the relationship between the actions taken by residents in response to MRTN and their expressed attitude to MRTN; and
   (c) an investigation of the relationship between a set of intervening variables (i.e. variables which might be expected to influence the residents' attitude to MRTN) and the residents' expressed attitude to MRTN.
3. An investigation of complaint activity in order to determine whether there is a direct link between attitude to MRTN and complaint actions, or whether other factors have an influential pull.

These three sections of the analysis will be undertaken in light of a model of human response to noise environments as presented by Borsky (1970). Borsky says that sounds become unwanted noise when they intrude or interfere with human activity or living conditions. It is an underlying assumption of the present study that sounds from traffic using Main Roads in the Sydney Metropolitan Area are indeed unwanted noise, and it is therefore necessary to investigate whether this noise does in fact interfere with human activity and living conditions in the areas included in the study.

Borksy's model of human response to noise is divided into four stages (see Fig. 2.3). However, Borsky acknowledges that this is a simplified model and that other factors may be important in acceptance of, or hostility towards some noises. These factors include:

(a) Feelings about the necessity or preventability of the noise;

(b) Feelings about the importance of the noise source and the value of its primary functions;

(c) The extent to which there are other things disliked in the neighbourhood;

(d) Belief in the effect of noise on general health; and

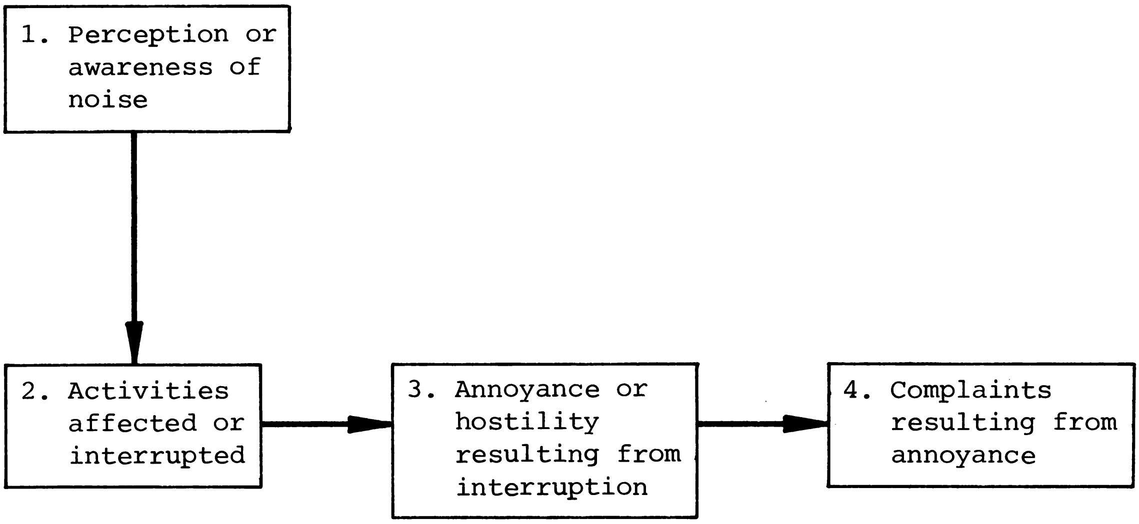
(e) The extent to which fear is associated with the noise.

These abovementioned factors will be referred to as "intervening variables" and it is believed that they should be included in any model intended to explain or account for response to noise.

Another set of intervening variables has been suggested by McKennel (1970) in his attempt to explain the link between noise exposure and complaint activity. These variables appear to be chiefly socio-economic in nature and should also be included in any modifications of the Borsky model.

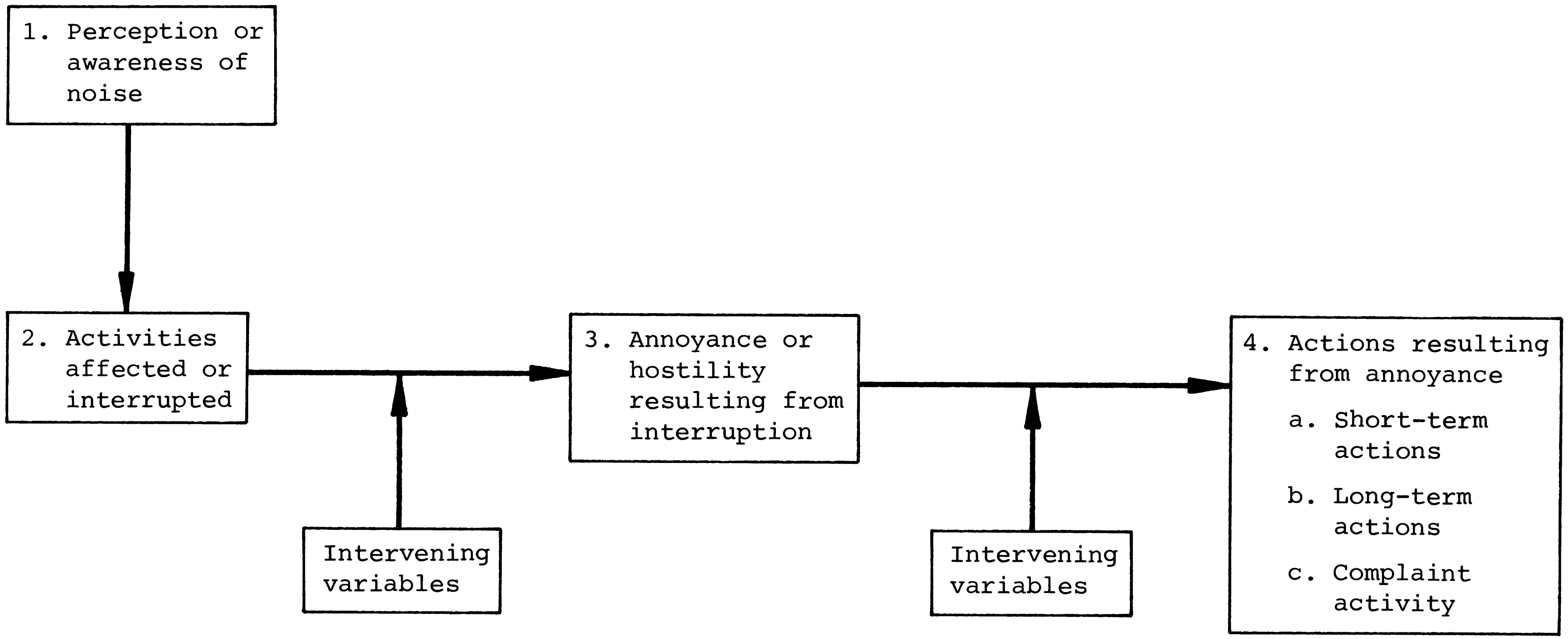
With reference to the original model, it appears that two sets of "intervening variables" should be added in order to increase its explanatory power with respect to the extent that it is an accurate picture of human response to noise (Fig. 2.4). One other modification seems necessary if all aspects of human response are to be covered, and this involves expanding the fourth stage of Borsky's model to include not only complaint activity, but also short-term and long-term actions taken by humans in a

FIGURE 2.3 Borsky model of human response to noise



Source: Borsky, P.N. (1970). The use of Social Surveys for measuring community responses to noise environments, in Chalupnik, J.D. Transportation Noises, A symposium on Acceptability Criteria.

FIGURE 2.4 Modified model of human response to noise



noisy environment.

In order to identify the model of human response to noise with the present study, Figure 2.5 includes a full list of all the variables which will be included at each stage of analysis in the problem of residential response to a main road traffic noise environment in the Sydney Metropolitan Area.

2.4 TRAFFIC NOISE MEASUREMENTS

Between June and August 1980, measurements of road traffic noise were undertaken at all nine study sites. A series of measurements was recorded on the main road at each site and on one of the parallel streets. In two cases (Site 1, Bobbin Head Road and Site 9, King Georges Road) measurements were recorded on two control streets due to differences in distance of parallel streets from the main road and due to differences in elevation of the control streets.

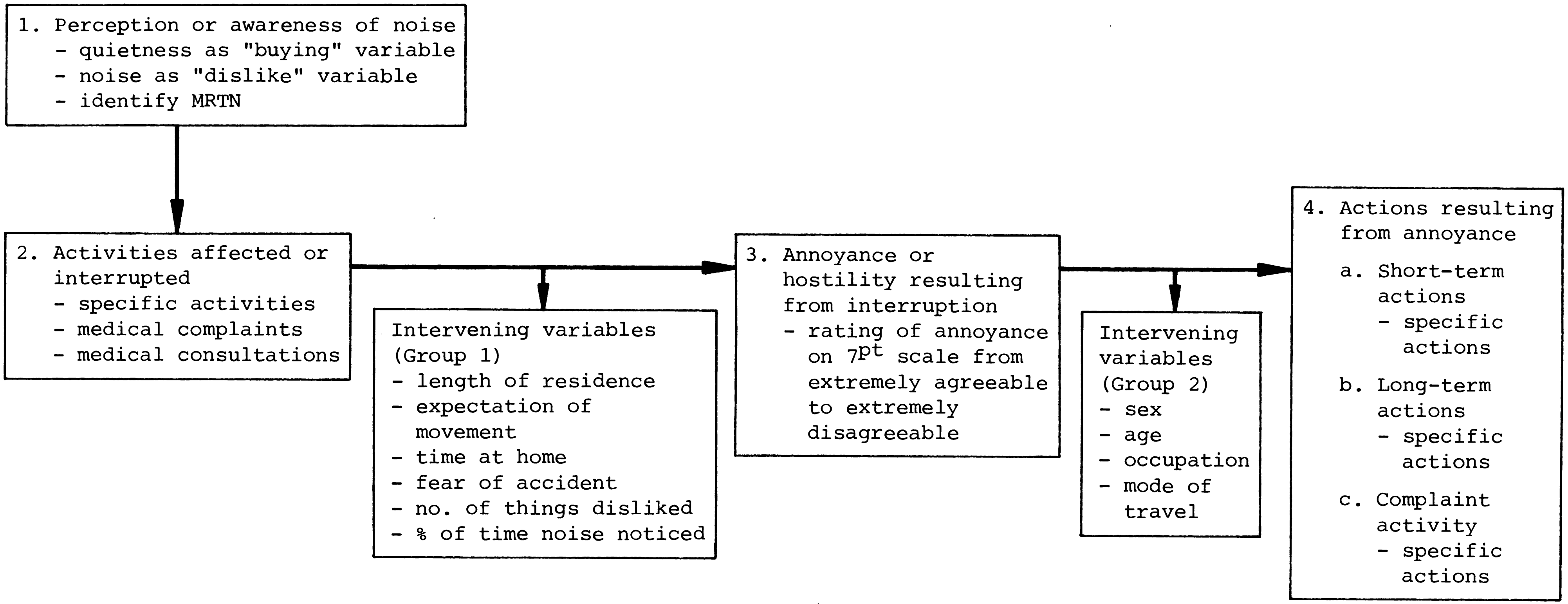
The noise measurements were undertaken and supervised by staff working under Professor Anita Lawrence of the Graduate School of the Built Environment at the University of New South Wales using that School's Mobile Acoustic Research Unit. At each of the nine study areas measurement of road traffic noise was made at sites which satisfied the following requirements (Burgess, 1977).

(i) The site was far enough from intersections or traffic lights so that most vehicles in the traffic stream had reached a steady stream. The traffic was considered to be freely flowing under urban conditions.

(ii) The road surface and covering were not atypical for an urban area.

(iii) Minimum disturbance from people using the footpath.

FIGURE 2.5 Model of residential response to main road traffic noise



(iv) Access was available for the transporting vehicle and equipment.

Recording sessions were conducted on weekdays between the daylight hours of ten o'clock and three o'clock. This avoided peak hour traffic and represents an attempt to record the traffic flow during the major portion of the day.

At each site a detailed site diagram was compiled before measurement began and usual sound measurement procedures were followed. Site diagrams included the following information: road width, the number of traffic lanes, nature and width of footpaths and verges, the distance to house facades and the position of the microphone. A diagram for Site 8, Princes Highway, is contained in Appendix B. In addition, wind speed and relative humidity levels were recorded. To facilitate measurement, the Bruel and Kjaer Type 2203 Sound Level Meter was located nine metres from the centre line of the nearest line of traffic flow and the stand was adjusted so that the microphone was always 1.2 metres above the ground.

A traffic count was undertaken during each recording session. Both the number and category of vehicles was recorded by two people located on each side of the road concerned. The vehicle categories used were: motor cycles, cars, light commercial vehicles, medium vehicles (dual tyres on rear axle), heavy vehicles (more than two axles) and buses.

Each recording session was commenced by a countdown to synchronise traffic count and noise measurements. Recordings were undertaken for ten minute intervals. The data obtained in the field were then processed by an established computer program - in so doing, the following noise metrics were obtained: L_{eq} and the estimated statistical levels of L_5, L_{10}, L_{50}, L_{90} and L_{95}. L_{eq}, equivalent energy level, which has the advantage that all noise events are included in the measurement (Lawrence, 1976) and L_{10}, the level exceeded for ten per cent of the time (Lawrence and Burgess, 1978) were used throughout the study. The noise levels derived for each site are given in Table 2.3.

TABLE 2.3 Average noise levels at sites

Site Number	Main Roads		Parallel Streets	
	L_{eq}	L_{10}	L_{eq}	L_{10}
1	62.01	63.52	61.49 51.59	65.12 50.38
2	69.57	73.26	54.52	51.91
3	74.48	78.12	56.94	58.20
4	75.05	78.45	57.01	57.70
5	73.83	76.77	60.60	57.59
6	67.50	70.95	50.92	48.23
7	69.88	73.44	50.78	50.64
8	73.22	76.46	51.68	50.97
9	73.68	77.63	56.05 51.68	55.99 53.67

2.5 THE SHORT-RUN ANALYSIS PROCEDURE

To investigate the hypothesis that the mean sales price of houses located on a main road is significantly different to that of houses located on parallel control streets, an appropriate "t" test was used (Hammond and McCullagh, 1977, p.164). The form of the "t" test used was:

$$t = \frac{y_1 - y_2}{\text{s.e. } (y_1 - y_2)}$$

where $y_1 - y_2$ = difference between the mean property sales price for a main road and its control street,

and s.e. $(y_1 - y_2)$ = standard error of the difference.

This "t" statistic was used for each year for each site. In an attempt to synthesise any common trends which may appear in the analysis of data for the nine sites, a further set of tests were performed on the mean sales prices of houses in all main roads and in all parallel streets.

To assist the explanation of occurrences of significant differences in mean sales prices at infrequent time periods, the percentage change in mean sales prices between each year was calculated, and also the difference in the percentage change between the two sets of streets. Such procedure provides a measure of absolute change of sales prices within any one street. These data may also point to groups of years in which house prices reflected surges in traffic volumes and associated noise, a phenomenon which has been found in airport affected areas (Holsman and Aleksandric, 1977; and Crowley, 1973).

2.6 THE LONG-RUN ANALYSIS PROCEDURE

The determination of the long-run general trends of the property markets on the main roads and on the control streets was achieved by a series of regression analyses, all using property values as the dependent variable, and time as the independent variable. Three different forms of the model were used as it was discovered that no single form of the model was universally successful in describing the movement of house prices in all study sites. All three models used the above variables, or transformations of those variables. The first model is linear (1), and the second a quadratic function (2) (Chou, 1969):

$$P = a + bt \qquad \ldots (1)$$

$$P = a + bt + ct^2 \qquad \ldots (2)$$

where P = house sales price

t = time, being 1 for 1968 and 13 for 1980

b = linear time trend coefficient

c = quadratic time trend coefficient

a = constant

The third form of the model suggests that the growth rate of prices may be constant (Nie, et al., 1975).

$$P = a(1 + g)^{t}e \qquad \text{... (3)}$$

where a = constant, representing price in year 0

g = growth rate

e = error term

Equation (3) can be linearised using a Logarithmic transformation thus,

$$L_N P = L_N a + (L_N [1 + g]) t + L_N e \qquad \text{... (4)}$$

The error term is treated as multiplicative, thus having a distribution which fluctuates around one in Equation (3), and in its transformed form (Eq. 4), has a distribution which fluctuates around zero. The only difference between Equations (1) and (4), is that in the former, a linear growth rate is considered and in the latter, an exponential growth rate.

Each of the abovementioned analyses of long-run movements of house prices were performed separately for data for both the main road and the parallel streets at each site. To determine whether the rate of growth of house prices was significantly different in noise affected streets and parallel streets, the "F" ratio used was computed for each set of trend areas (Johnston, 1960).

The "F" ratio used was of the form

$$F = \frac{Q_3/K}{Q_2/(m + n - 2K)}$$

where K = the number of parameters in the original equation

n, m = the number of observations in the two equations

Q_1 = the sum of squared residuals for the growth curve with $n + m$ observations

Q_2 = the total of the two sums of squared residuals for n and m observations

$Q_3 = Q_1 + Q_2$

2.7 MULTIPLE REGRESSION ANALYSIS OF EFFECT OF MAIN ROAD TRAFFIC NOISE ON HOUSE PRICES

This section of the analysis is not concerned with actual differences in house sales prices, but with establishing the effect which main road traffic noise has had on property prices on the main roads and on parallel streets both absolutely, and in comparison with other independent variables which are considered to be property price determining factors. The short- and long-run analyses of house prices is intended to demonstrate differences between house prices in main roads and control streets, and thereby indicate the broad influence of main road externalities. This stage of analysis specifically evaluates the role that main road traffic noise plays in house prices on main roads and control streets. It needs to be stressed that the aim of this section is not to totally account for the movement of property prices, as that is a far more embracing exercise, but to identify the role of noise. Therefore, no distance measurements to particular urban facilities were included.

In order to investigate the relationship between house price and noise, a multiple regression analysis was performed. A stepwise regression procedure was used to test the following model (Nie, et al., 1975).

$$P = c + x_1T + x_2A + x_3R + x_4N$$

where P = house sale price on main road or parallel street

T = year of the sale

A = age of the house

R = number of rooms in the house

N = measure of traffic noise (either L_{10} or L_{eq})

c = constant

$x_1 - x_4$ = regression coefficients

The model uses similar variables to those discovered to be of general significance in related studies. The stepwise procedure enters variables into the regression equation one variable at a time and in their order of importance in reducing the variance of P. This ordering is indicated by the partial correlation coefficients listed in the program output. At each stage or step of the procedure R^2 (coefficients of determination) values are given, and the change of R^2 values and "t" values for the variables can be examined to see when the procedure should be stopped and all insignificant variables excluded. As with all multiple regression procedures, stepwise regression should only be employed when there is no sizeable collinearity between the variables. In this case all of the variables are independent of one another, other than the two noise measures.

In total, four models were run, two for main roads and two for parallel streets, in the first instance using the L_{eq} measurement for noise, and secondly, the L_{10} value.

The data on the number of rooms and the age of the property were obtained from responses to the household questionnaire.

The sample sizes used in the regression analyses are 153 in the case of the main roads data set, and 215 for parallel streets. These sample sizes were determined by the level of response to the questionnaire.

2.8 SURVEY ANALYSIS PROCEDURE

The fourth section of the analysis involves a discussion of the responses to the household questionnaires. Analysis of these data will be undertaken in two ways:

1. Frequency distributions will be used to demonstrate the basic characteristics exhibited by respondents, and to indicate the nature of noises which are noticed by residents, the impact those noises have on residents, reasons underlying residents' decisions to purchase their houses and those aspects of their immediate neighbourhood which people now dislike.
2. Contingency tables, which are tables showing the joint frequency distribution of any two variables, will be used to determine whether a significant relationship exists between residents' attitude to main road traffic noise and their location and with several other variables including the length of residence, the time spent at home each day, the noises noticed by residents, and the impact of these noises on residents. The chi-square test will be used to indicate the statistical significance of any relationships that may exist.

The chi-square test takes the following form. (Nie, et al., 1975):

$$\chi^2 = \Sigma \frac{(f_o - f_e)^2}{f_e}$$

where f_o = the observed frequency in each cell, and

f_e = the expected frequency in each cell.

f_e is calculated as follows:

$$f_e = \left(\frac{cr}{N}\right)$$

where c = frequency in the respective column

r = frequency in the respective row

N = total number of cases.

---

1. Only those residents who had moved house during the period 1968-1980 were surveyed. Longer-term residents were not included in the study, although they are more likely to have taken long term actions to reduce the impact of traffic noise.

2. The number of questionnaires distributed to householders was less than the number of property transactions during the years 1968-1980 because some properties had been sold more than once. In instances where the resident indicated that the property was rented, the questionnaires were not included in any analyses.

3. Householders were lead to believe that the sampling procedure was random in order to increase the response rate.

CHAPTER THREE

ANALYSIS OF HOUSE PRICE DIFFERENCES

Before addressing the hypothesis that main road traffic noise exerts an adverse effect on the price of houses abutting main roads, it is necessary first to determine whether differentials exist between house prices on main roads and control streets. The analysis of house price differences is carried out in two stages: a short-run analysis is used to indicate years during which house prices on main roads and control streets are different, and a long-run analysis to identify differences in the growth rate of house prices on main roads and control streets. In the event that differences in house prices and their rate of growth are established, the similarity of housing stock and other price determining factors at each site would indicate that these differences result from traffic externalities. Regression analysis is then necessary to investigate any house price differences.

3.1 SHORT-RUN HOUSE PRICE DIFFERENCES

In order to investigate the hypothesis that the mean sales prices of houses located on a main road are different to those of houses located on parallel streets, "t" tests were performed on the annual mean sales prices of houses at each site. The results of these analyses are given in Tables 3.1 to 3.9.

In an effort to relate house price changes to those which have occurred in the wider Sydney real estate market, discussion will also focus on annual changes in house prices at each site. Daly (1982) has indicated that during the study period 1968-1980, Sydney real estate prices went through two periods of increase (1968-1973 and 1979-1980) and a period of relative price decline (1974-77), with prices increasing most swiftly during the years 1972-1973. Trends for both main roads and control streets which either support or contrast with those of the wider property market will be discussed in this section.

3.1.1 Site 1: Bobbin Head Road

At Site 1 there are only three years when the mean sales price of houses in Bobbin Head Road was significantly below that of the streets parallel to Bobbin Head Road. These years were 1974, 1976 and 1978. Despite these significant differences in price there have also been three years when the mean price on the main road was higher than that for the parallel streets (1969, 1973 and 1980).

The fluctuating nature of the relationship between mean prices on the main road and the parallel streets can also be observed from the right hand side of Table 3.1, where annual percentage changes in mean property prices are given. Although it is difficult to observe any common patterns in the data for the two sets of streets, it would appear that in years of high property demand, such as 1973 and 1980, prices on the main road move upwards rapidly and variations between mean prices on the main road and parallel streets are minimal. Conversely, when demand subsides and buyers can exert more control over their choice, then greater variations between the main road property prices and those on parallel streets can be noticed (1974-75).

TABLE 3.1 Short-run analysis - Site 2: Bobbin Head Road

Year	Bobbin Head Road Mean Price $	Parallel Streets Mean Price $	"t"-statistic	Bobbin Head Road % change in price	Parallel Streets % change in price	difference in % points
1968	21,462.5	27,427.7	0.7092			
1969	30,295.0	28,211.5	0.3772	41.15	2.78	38.37
1970	28,891.6	27,560.0	0.1906	- 4.63	- 2.36	- 2.27
1971	26,672.2	26,567.3	0.0297	- 7.68	- 3.74	- 3.94
1972	34,007.6	34,156.2	0.0266	27.50	22.20	5.30
1973	43,645.8	41,972.2	0.5713	28.34	18.62	9.72
1974	44,416.6	65,005.5	1.5564*	1.76	35.43	-36.67
1975	54,991.6	70,906.2	1.0663	23.80	8.32	15.48
1976	48,032.1	60,290.0	1.7569**	-12.65	-17.61	4.96
1977	52,613.6	66,545.0	1.1944	9.54	9.40	0.14
1978	70,707.1	87,500.0	0.8904	34.39	23.95	10.44
1979	75,500.0	109,850.0	2.3215**	6.78	20.34	-13.56
1980	106,000.0	99,000.0	0.4319	40.39	-10.96	51.35

* significant at .10 probability level.
** significant at .50 probability level.

3.1.2 Site 2: Eastern Valley Way

Site 2 displays a more regular pattern of price movements than Site 1 (see Table 3.2). Apart from 1976, all years reveal a mean sales price for property on Eastern Valley Way which is less than that for the parallel streets. However, variations in prices between the two sets of streets are generally quite small (10 per cent in 1979) and it is therefore not surprising that it is only in 1971 that the difference is statistically significant. The prices in both Eastern Valley Way and the parallel streets experienced growth in the early boom (1968 to 1973), followed by a pronounced decline in 1974. This decline may be a reflection of the

TABLE 3.2 Short-run analysis - Site 2: Eastern Valley Way

Year	Eastern Valley Way Mean Price $	Parallel Streets Mean Price $	"t"-statistic	Eastern Valley Way % change in price	Parallel Streets % change in price	difference in % points
1968	16,916.6	17,850.0	0.4376			
1969	17,150.0	18,800.0	0.9069	1.38	5.32	- 4.06
1970	20,683.3	23,637.5	0.8012	20.60	25.73	- 6.47
1971	21,250.0	25,480.0	1.3701*	2.74	7.79	- 6.95
1972	27,500.0	32,575.0	**	29.41	27.84	1.57
1973	33,161.1	38,493.3	1.1391	20.58	18.16	2.42
1974	26,000.0	30,166.6	**	-21.59	-21.63	0.04
1975	43,941.6	47,491.6	0.5192	69.00	57.43	11.57
1976	40,920.0	39,650.0	0.3470	- 6.88	-16.51	9.63
1977	53,500.0	53,625.0	0.0151	30.74	35.25	- 5.49
1978	46,000.0	61,406.2	1.1258	-14.02	14.51	.49
1979	70,000.0	76,945.8	1.0379	52.17	25.30	26.87
1980	--	88,000.0	**		14.36	

* significant at .10 probability level.
** "t"-statistic not calculated because sample size is small.

general slump in housing prices in Sydney at that time, or it may reflect the quality of the small number of sales in 1974 (refer to Table 2.2). However, the strong appreciating growth in 1978 and 1979 on parallel streets was not quite matched by movements in prices on Eastern Valley Way but this variation was not determined to be statistically significant.

3.1.3 Site 3: Epping Road

The pattern of price movements for Epping Road (see Table 3.3) is somewhat similar to that of Bobbin Head Road in that there have been years when mean price differences have been significant (1973, 1979, 1980), and

TABLE 3.3 Short-run analysis - Site 3: Epping Road

Year	Epping Road Mean Price $	Parallel Streets Mean Price $	"t"-statistic	Epping Road % change in price	Parallel Streets % change in price	difference in % points
1969	17,916.6	22,775.0	0.8421			
1970	19,250.0	22,714.2	0.8484	7.44	- 0.06	7.50
1971	26,666.6	23,468.7	1.0085	38.53	3.32	35.21
1972	27,666.6	24,400.0	0.7149	3.75	3.97	- 0.22
1973	25,850.0	31,343.7	1.3897*	- 6.57	28.46	-35.03
1974	36,500.0	38,500.0	0.6188	41.19	22.83	18.36
1975	41,166.6	38,766.6	0.3449	12.78	0.69	12.09
1976	43,000.0	39,750.0	**	4.45	2.53	1.92
1977	39,214.2	44,780.0	0.9199	- 8.80	12.65	21.45
1978	45,000.0	50,125.0	0.9266	14.75	11.94	2.81
1979	52,408.3	69,100.0	3.9437***	16.46	37.85	-21.39
1980	70,391.6	84,250.0	1.7293*	34.31	21.92	12.39

* significant at .10 probability level.
** "t"-statistic not calculated because sample size is small.
*** significant at .01 probability level.

also a number of years (1971, 1972, 1975) when mean prices of property on Epping Road were higher than those on parallel streets. However, the years of significant difference are in those years of high demand which suggests that in the case of Epping Road, variations in price between main roads and parallel streets became accentuated rather than diminished. Prices of property on main roads may subsequently go through a catch up phase as appeared to be occurring in 1980.

3.1.4 Site 4: Concord Road

At Site 4 the mean sales prices of houses in Concord Road were not found to be significantly less than those in the parallel streets for any of the years under consideration. Indeed, the only statistically significant result is the higher mean price on Concord Road in 1969. For almost half of the years under review, mean prices on Concord Road exceeded those of the parallel streets. Nevertheless, at the end of the study period, a time of high demand, the upward movement of prices is far more noticeable on the parallel streets. The boom in Sydney real estate prices in 1979 did not appear to have hit Concord Road where prices virtually declined from their 1978 values.

TABLE 3.4 Short-run analysis - Site 4: Concord Road

	Concord Road	Parallel Streets		Concord Road	Parallel Streets	
Year	Mean Price $	Mean Price $	"t"-statistic	% change in price	% change in price	difference in % points
1968	--	28,000.0	*			
1969	20,027.0	16,366.6	2.5014**		-41.90	
1970	--	15,939.2	*		- 2.01	
1971	21,578.5	22,077.7	1.9875		38.51	
1972	19,300.0	21,810.7	1.1200	-10.56	- 1.21	- 9.35
1973	30,421.4	37,500.0	1.2639	57.62	71.93	-14.31
1974	34,987.5	25,900.0	1.2778	15.01	-30.93	45.94
1975	27,416.6	31,200.0	0.5689	-21.64	20.46	-42.10
1976	41,016.6	37,700.0	0.6507	49.60	20.83	28.77
1977	40,375.0	38,480.0	0.4805	- 1.56	2.07	- 3.63
1978	46,333.3	51,069.2	0.5086	14.76	32.72	-17.96
1979	45,960.0	53,583.3	0.8783	- 0.80	4.92	- 5.72

* "t"-statistic not calculated because sample size is small.
** significant at .05 probability level.

3.1.5 Site 5: Lyons Road

Lyons Road is similar to Concord Road in that six of the eleven years analysed displayed a mean sales price which was greater than that for the parallel streets. In three of those years (1969, 1970 and 1972) during a period of high demand in Sydney, these differences were discovered to be statistically significant. Generally, it would appear that little financial disadvantage has been forthcoming to residents of Lyons Road by living on the main road rather than the parallel streets.

TABLE 3.5 Short-run analysis - Site 5: Lyons Road

	Lyons Road	Parallel Streets		Lyons Road	Parallel Streets	
Year	Mean Price $	Mean Price $	"t"-statistic	% change in price	% change in price	difference in % points
1969	17,365.0	14,518.7	1.4287*			
1970	16,737.0	14,876.6	1.3177*	- 3.62	2.46	- 6.08
1971	16,667.0	20,549.0	2.0633**	- 0.42	38.13	-38.55
1972	23,119.2	19,325.0	1.4178*	38.71	- 5.96	44.67
1973	28,107.6	27,368.1	0.3217	21.58	41.62	-20.04
1974	32,387.5	31,585.7	0.2088	15.23	15.41	- 0.18
1975	29,000.0	31,064.2	0.9642	11.60	- 1.65	- 9.95
1976	33,366.6	36,021.4	0.5982	75.61	15.96	59.65
1977	37,717.8	42,138.8	1.2551	13.04	16.98	- 3.94
1978	43,925.0	41,626.9	0.5428	16.46	- 7.78	24.24
1979	49,272.2	49,981.2	0.1282	12.17	20.07	- 7.90
1980	--	79,833.3	***	-	59.72	

* significant at .10 probability level.
** significant at .05 probability level.
*** "t"-statistic not calculated because sample size is small.

3.1.6 Sites 6 and 7: Old South Head Road, Gardeners Road

Data on house sales were available for a smaller number of years at these sites, a point which must be borne in mind when making comparisons with other sites. Mean sales prices in Old South Head Road in four of the seven years were less than those in the parallel street, and in two years, 1972 and 1976, the differences were found to be statistically significant (see Table 3.6). The wildly fluctuating mean prices on both Old South Head Road and the parallel street not only in these two years but throughout the period is probably caused by the sale of a small number of highly desirable properties at very high prices in a very desirable locality. Houses located on the main road are well cushioned from road noise by physical aspect. Traffic volumes are also quite low compared with other sites in the study. Given the same sample size, not too much emphasis should be placed on the 92 per cent increase in prices in the parallel street between 1975 and 1976, nor to the fact that in 1979 the mean house price on Old South Head Road was $49,000 higher than for parallel streets. Variation between prices on main road and parallel street is more a function of individual properties than the greater level of access afforded by such sites.

The analysis of mean prices at Site 7 (see Table 3.7) gives similar results but for different reasons. Mean sales prices in Gardeners Road were less than those in the parallel street for only half of the years in the study period and only 1980 had a mean price which was found to be significantly below that of the parallel street. Indeed, prices on the main road were found to be significantly above those of the parallel street in two years of the study, 1976 and 1979. In addition to the problem of small sample size, a complicating factor in this area which has generally had the effect of maintaining an equivalence of property prices is that of ethnicity. The strong desire of Greek migrants to purchase property in a

TABLE 3.6 Short-run analysis - Site 6: Old South Head Road

Year	Old South Head Road Mean Price $	Parallel Street Mean Price $	"t"-statistic	Old South Head Road % change in price	Parallel Street % change in price	difference in % points
1972	58,416.6	135,000.0	1.8874*			
1973	71,333.3	74,562.5	0.1666	22.11	-44.76	66.87
1974	56,250.0	81,750.0	1.1378	-21.14	9.64	-30.78
1975	61,250.0	51,166.6	0.5663	8.89	-37.41	46.30
1976	--	98,500.0	****		92.50	
1977	105,666.6	71,625.0	1.2572		-27.28	
1978	52,833.3	122,800.0	6.2113***	-50.00	71.45	-121.45
1979	162,375.0	113,333.3	0.8398	207.33	- 7.709	215.04

TABLE 3.7 Short-run analysis - Site 7: Gardeners Road

Year	Gardeners Road Mean Price $	Parallel Street Mean Price $	"t"-statistic	Gardeners Road % change in price	Parallel Street % change in price	difference in % points
1974	36,533.3	40,937.5	0.6572			
1975	--	40,800.0	****		- 0.33	
1976	39,166.6	31,250.0	1.4533*		-23.40	
1977	44,875.0	44,937.5	0.0112	14.57	43.80	-29.23
1978	51,750.0	51,733.3	0.0036	15.32	15.12	0.20
1979	61,475.0	34,925.0	2.3930**	18.79	-32.49	51.28
1980	71,250.0	77,500.0	3.3211**	15.90	121.90	-106.00

* significant at .10 probability level.
** significant at .05 probability level.
*** significant at .01 probability level.
**** "t"-statistic not calculated because sample size is small.

region with an established Greek community has maintained the demand for, and the price of, property both on main roads and parallel streets. The decrease in house prices during 1974 to 1976 in the parallel street is a reflection of a general fall in housing demand.

3.1.7 Site 8: Princes Highway

At Site 8 the mean sales prices of properties abutting Princes Highway exceeded those in the parallel streets between 1969 and 1972 (see Table 3.8). In all other years, except 1977, the prices on the main road were less than those in the parallel streets with these differences being

TABLE 3.8 Short-run analysis - Site 8: Princes Highway

	Princes Highway	Parallel Streets		Princes Highway	Parallel Streets	
Year	Mean Price $	Mean Price $	"t"-statistic	% change in price	% change in price	difference in % points
1968	10,260.0	--	**			
1969	19,275.0	17,220.0	0.3256	87.86		
1970	20,562.5	18,683.3	0.8810	6.67	10.84	4.17
1971	19,552.8	18,500.0	0.1781	- 5.10	- 0.10	5.00
1972	21,900.0	20,750.0	0.3450	12.00	12.16	- 0.16
1973	26,191.6	29,470.0	1.1860	19.59	42.02	-22.43
1974	27,800.0	28,225.0	0.0863	6.14	- 4.22	10.36
1975	34,333.3	36,300.0	0.3181	23.50	28.61	- 5.11
1976	31,250.0	40,000.0	1.4887*	- 8.98	10.19	-19.17
1977	33,778.0	31,000.0	0.4488	8.09	-22.50	30.59
1978	41,666.6	42,000.0	0.0759	23.35	35.48	-12.13
1979	38,000.0	59,081.2	1.7781*	- 8.80	40.67	-49.47
1980	57,500.0	81,000.0	**			

* significant at .10 probability level.
** "t"-statistic not calculated because sample size is small.

statistically significant in 1976 and 1979. These two years experienced an absolute decline in prices on main roads. As with other sites, the property values on parallel streets noted a very substantial jump in 1979 whereas those on the main road actually suffered a decline.

3.1.8 Site 9: King Georges Road

The data for this site are the most supportive of any of the sites for the basic hypothesis of this study, namely that house prices on main roads are lower than on parallel streets. Every year of the study period reveals a situation in which the mean sales price of houses in King

TABLE 3.9 Short-run analysis - Site 9: King Georges Road

Year	King Georges Road Mean Price $	Parallel Streets Mean Price $	"t"-statistic	King Georges Road % change in price	Parallel Streets % change in price	difference in % points
1968	14,633.3	18,750.0	1.2314			
1969	15,586.6	17,914.0	0.8660	6.51	-37.69	44.20
1970	14,737.5	19,800.0	1.1082	- 5.45	10.53	-15.98
1971	23,241.6	24,478.5	0.3170	57.70	23.63	34.07
1972	19,886.0	23,519.5	1.0836	-14.44	- 3.92	10.52
1973	26,046.0	31,522.7	1.2527	30.98	34.03	- 3.05
1974	32,680.0	48,223.3	1.9979*	25.47	52.98	-27.51
1975	23,566.6	36,850.0	1.5951**	-27.89	-23.58	- 4.31
1976	30,240.0	35,044.1	1.3299**	28.31	- 4.90	33.21
1977	32,213.3	36,990.0	0.9243	6.53	5.55	0.98
1978	37,678.5	48,372.2	1.5428**	16.96	30.77	-13.81
1979	39,242.8	51,625.0	2.0279**	4.15	6.72	- 2.57
1980	40,000.0	115,750.0	2.7192**	1.93	124.21	-122.28

* significant at .05 probability level.
** significant at .10 probability level.

Georges Road were less than those in the parallel streets (see Table 3.9). Also, there were six years when these differences were statistically significant, 1974-76, and 1978-1980. In the earlier of these two periods prices on parallel streets were well ahead of prices on King Georges Road in 1974, but the difference was gradually pegged back until only a minor difference existed in 1977. In 1978 prices on parallel streets started to boom, but until 1980 the evidence of a renewed surge in prices on these parallel streets was not matched by price movements on King Georges Road.

3.1.9 All Main Roads - All Parallel Streets

The data for all main roads and all parallel streets were combined in an attempt to discover any common short-run trends in mean sales prices in the period 1968-1980 (see Table 3.10). It has to be admitted that this task was performed without any real confidence as short run movements in the nine sites appear to fluctuate quite markedly. However, when the data are combined, the results are again supportive of the basic hypothesis of the study, for in all years, the mean sales prices of houses on the main roads were less than those in the streets parallel to the main roads. Further support to the hypothesis that main road traffic noise would exhibit lower sales prices than those houses which are protected from that noise, is gained from the finding that in eight of the thirteen years under consideration differences in mean sales prices were found to be significantly different. There appears to be three distinct periods during which the prices were significantly different, 1968-69, 1973-74, and 1977-1980 (excluding 1979). 1971 does not appear to belong to any group.

A consideration of the percentage changes in prices on main roads and parallel streets given in Table 3.10 is supportive of statements made earlier in this section about movements in prices on the two sets of

TABLE 3.10 Short-run analysis - All Main Roads, All Parallel Streets

	All Main Roads	All Parallel Streets		All Main Roads	All Parallel Streets		
Year	Mean Price $	Mean Price $	"t"-statistic	% change in prices	% change in prices	difference in % points	difference in mean values (%)
1968	18,472.2	24,935.4	1.6046*				34.5
1969	19,769.5	22,848.0	1.6134*	7.02	- 8.37	15.39	15.7
1970	22,605.9	22,752.1	0.0479	14.35	- 0.42	14.77	0.04
1971	21,538.2	26,665.2	2.8413***	- 4.72	17.20	-21.92	24.2
1972	27,704.2	28,956.4	0.4979	28.63	8.59	20.04	4.3
1973	33,146.2	37,566.6	1.8628**	19.64	29.73	-10.09	13.6
1974	36,077.8	46,665.0	2.6861***	8.84	24.22	-15.38	29.1
1975	39,051.6	44,293.2	1.2691	8.24	- 5.08	13.32	13.3
1976	40,353.1	43,990.7	1.2642	3.33	- 0.68	4.01	9.0
1977	42,896.9	48,263.8	1.6094*	6.30	9.71	- 3.41	12.6
1978	48,281.1	61,316.4	2.6664***	12.55	27.04	-14.49	27.2
1979	61,674.2	68,471.5	1.2637	27.74	11.67	16.07	11.0
1980	76,514.5	93,440.4	1.7901*	24.06	36.47	-12.41	22.1

* significant at .10 probability level.
** significant at .05 probability level.
*** significant at .01 probability level.

streets. The residential land market goes through periods of boom and stabilisation. In times of high demand prices move upwards more rapidly for those properties in more desirable localities (on parallel streets as opposed to main roads). As the boom wanes, such properties cannot sustain their price superiority (Bobbin Head Road does not conform to this thesis) and main road properties catch up.

For the thirteen year period under review the average yearly difference in mean house prices of property located on all main roads and those of all the parallel streets is 16 per cent.

3.2 LONG-RUN DIFFERENCES IN HOUSE PRICES

The previous section identified that for a number of years in the study period there was a significant difference between house prices on main roads and parallel streets, particularly when the site samples were aggregated. On the basis of this finding it might be expected that in the long-run analysis of house price differences a similar finding of significant difference may be obtained. As stated earlier, three forms of a time series regression model were used, using sales price as the dependent variable and time of sale as the independent variable.

The results of the regression analyses are tabulated in Table 3.11. The table also includes a listing of "F" statistics which indicate whether the best fit equations for main road and parallel streets long-run price movements are significantly different from one another. A discussion of the results given in Table 3.11 also indicates which form of regression model best fits the movement of house prices at each site. The most appropriate model is identified by the R^2 value, or coefficient of determination, which indicates the proportion of variation in the dependent variable (price) which is explained (in the statistical sense) by the independent variable (time).

TABLE 3.11 Results of regression models: Long-run trend of prices

Independent variables	Dependent variables					
	Price				LN Price (Natural Logarithm)	
	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.
SITE 1	Bobbin Head Road	Parallel Streets	Bobbin Head Road	Parallel Streets	Bobbin Head Road	Parallel Streets
constant (a)	10,151.85	- 1,354.58	28,910.98	40,056.80	9.8369	9.7476
time (t)	5,062.47	8,299.67	- 2,235.60	- 7,720.99	.1084	.1375
time² (t^2)			523.14	1,138.88		
F-stat	8.26**		4.89**		12.99**	
R^2	.493	.205	.546	.245	.588	.608
SITE 2	Eastern Valley Way	Parallel Streets	Eastern Valley Way	Parallel Streets	Eastern Valley Way	Parallel Streets
a	5,116.66	3,807.41	15,524.78	18,268.56	9.4703	9.5744
t	4,350.21	5,317.70	324.18	266.24	.1279	.1298
t^2			291.04	342.68		
F-stat	11.80**		5.62**		9.06**	
R^2	.799	.661	.831	.688	.869	.731

** significantly different at .01 probability level.

Independent variables	Dependent variables					
	Price				LN Price (Natural Logarithm)	
	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.
SITE 3	Epping Road	Parallel Streets	Epping Road	Parallel Streets	Epping Road	Parallel Streets
a	10,672.88	3,844.71	22,476.52	25,151.56	9.6511	9.3678
t	3,668.58	4,855.26	- 994.83	- 2,247.26	.0988	.1421
t^2			296.23	463.31		
F-stat	12.82**		7.76**		5.27	
R^2	.583	.693	.732	.750	.667	.567
SITE 4	Concord Road	Parallel Streets	Concord Road	Parallel Streets	Concord Road	Parallel Streets
a	7,537.12	4,697.13	7,679.30	17,722.27	9.5088	9.4151
t	3,202.64	3,731.54	3,161.42	- 617.95	.1038	.1150
t^2			2.60	287.10		
F-stat	1.26		1.88		0.50	
R^2	.583	.568	.583	.590	.569	.678

** significantly different at .01 probability level.

Independent variables	Dependent variables					
	Price				LN Price (Natural Logarithm)	
	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.
SITE 5	Lyons Road	Parallel Streets	Lyons Road	Parallel Streets	Lyons Road	Parallel Streets
a	5,686.22	1,643.33	14,458.97	12,647.24	9.3557	9.2661
t	3,272.43	3,940.00	283.34	343.73	.1133	.1260
t^2			197.97	234.16		
F-stat	4.43		2.14		-2.04	
R^2	.698	.606	.698	.622	.699	.696
SITE 6	Old South Head Road	Parallel Street	Old South Head Road	Parallel Street	Old South Head Road	Parallel Street
a	9,724.67	29,557.15	93,199.71	34,401.59	10.4791	10.4207
t	8,844.18	6,617.37	-16,133.01	4,748.02	.0850	.0962
t^2			1,574.36	135.40		
F-stat	0.54		0.98		0.17	
R^2	.264	.315	.335	.316	.274	.371

Independent variables	Dependent variables					
	Price				LN Price (Natural Logarithm)	
	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.
SITE 7	Gardeners Road	Parallel Street	Gardeners Road	Parallel Street	Gardeners Road	Parallel Street
a	- 9,343.66	13,941.42	80,239.71	145,132.23	9.6455	10.0908
t	5,607.28	2,870.38	-12,603.63	-23,952.67	.1059	.0505
t^2			889.02	1,329.02		
F-stat	4.52*		1.72		3.56	
R^2	.508	.127	.546	.222	.443	.054
SITE 8	Princes Highway	Parallel Streets	Princes Highway	Parallel Streets	Princes Highway	Parallel Streets
a	13,569.92	- 2,555.37	14,489.51	18,236.40	9.4438	9.2460
t	2,214.27	4,675.42	1,853.52	- 1,567.12	.1023	.1358
t^2			26.34	389.83		
F-stat	9.75**		4.25*		3.57	
R^2	.214	.620	.214	.661	.472	.758

* statistically significant at .05 probability level.
** statistically significant at .01 probability level.

Independent variables	Dependent variables					
	Price				LN Price (Natural Logarithm)	
	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.	Regr. Coeff.
SITE 9	King Georges Road	Parallel Streets	King Georges Road	Parallel Streets	King Georges Road	Parallel Streets
a	10,277.79	10,159.55	9,887.38	31,405.64	9.4217	9.6650
t	2,299.13	3,338.83	2,443.90	- 3,666.72	.9521	.9159
t^2			- 10.18	475.45		
F-stat	20.06**		15.15**		18.22**	
R^2	.532	.282	.532	.341	.566	.337
ALL	All Main Roads	All Parallel Streets	All Main Roads	All Parallel Streets	All Main Roads	All Parallel Streets
a	7,961.34	6,312.53	19,392.18	28,668.14	9.5476	9.6422
t	3,868.11	5,029.62	- 226.07	- 2,750.49	.1097	.1148
t^2			281.07	526.90		
F-stat	24.67**		13.83**		35.94**	
R^2	.348	.187	.365	.206	.521	.445

** statistically significant at .01 probability level.

3.2.1 Site 1: Bobbin Head Road

In the case of Bobbin Head Road, the third form of the regression model, using the natural logarithm of price as the dependent variable, is a better predictor of long-run movements of house prices for both main roads and parallel streets than either the linear or quadratic regression equations. This model, referred to henceforth as the logarithmic equation, explains 59 per cent of the variation in the movement of house prices in Bobbin Head Road and 60 per cent of the variation in the streets parallel to Bobbin Head Road. Table 3.11 reveals that the long-run growth of house prices as represented by the logarithmic equations for Bobbin Head Road and the parallel streets are significantly different (identified by the "F" statistic). In other words, the long-run growth of house prices in Bobbin Head Road is significantly less than the growth rate of house prices in the parallel streets.

3.2.2 Site 2: Eastern Valley Way

The R^2 values for the three models indicate that at Site 2 the logarithmic equation provides a better explanation of the long-run movement of house sales prices than either the linear or quadratic equations. The independent variable explains a highly satisfactory 86 per cent of the variation in house prices in Eastern Valley Way and 73 per cent of the variation in the parallel streets. Again, the "F" test identified a significant difference between the two equations, and leads to the conclusion that there is significant difference between the long-run movement of house sales prices in Eastern Valley and the streets parallel to Eastern Valley Way, with the growth rate of house prices being less in Eastern Valley Way.

3.2.3 Site 3: Epping Road

At the third study site, the quadratic regression equation provides the best explanation of movement in house prices. The two independent variables in this equation accounted for 73 per cent of the variation in price movements in Epping Road and 75 per cent of that variation in the parallel streets. Once again the differences between the two quadratic equations were found to be statistically significant, indicating that the long-run movements of house prices on the two sets of streets are different. Prices in Epping Road show a slower growth rate than that of the parallel streets.

3.2.4 Site 4: Concord Road

In the case of the Concord Road site, no one form of the model successfully explains both the movement of house prices on the main road and on parallel streets, while the movement of house prices on Concord Road is explained equally well by the linear and quadratic equations. However, the regression equation which best explains the movement of house prices in the streets parallel to Concord Road is the logarithmic model which accounts for 67 per cent of the variation.

It makes little difference which form of the model is preferred as the equations' parameters for the two sets of streets are not found to be significantly different. In other words there is no significant difference between the long-run movement of house prices on Concord Road and on parallel streets.

3.2.5 Site 5: Lyons Road

At Site 5 the logarithmic equation once again provided the best explanation of variation in house price movements in both Lyons Road and the streets parallel to Lyons Road. The independent variable accounts for 69 per cent of the variation in price movements in Lyons Road and also 69 per cent of that variation in the parallel streets. The results of the "F" test reveals that there is no significant difference between the logarithmic equations or best fit models at this site, and therefore leads to the conclusion that there is no difference between the long-run movement of house prices in Lyons Road and the parallel streets.

3.2.6 Site 6: Old South Head Road

At Site 6 the equation which provided the best explanation of house price movements for the main road was not the same equation which provided that explanation for the parallel streets. This once again creates the situation where direct comparison of the equations is not possible. However, in no form of the model did the "F" statistic identify statistically significant differences between the equations for the two sets of streets. Hence, it is concluded that in the long-run the movement of house prices in Old South Head Road and parallel streets is not significantly different.

3.2.7 Site 7: Gardeners Road

In the case of Gardeners Road only limited data are available (since 1974). The quadratic model provides the best predictor of house price movements, accounting for 54 per cent of the variation in price movements in Gardeners Road but only 22 per cent of the variation in the parallel streets. This low level of explanation on parallel streets is probably caused by the more mixed nature of residential development in the area. However, the "F" test did not reveal any significant differences between the two equations.

It is interesting to note that at this site if the linear form of the model is used, the "F" statistic does identify a statistically significant difference between the long-run trends. However, because of the lower level of explanation afforded by this form of the model, not too much emphasis should be read into this finding.

3.2.8 Site 8: Princes Highway

Similar findings to the previous site are discovered in the case of the Princes Highway data anlysis. At this site the logarithmic form of the model provided the best explanation of price movements, accounting for 47 per cent of price movements on the Princes Highway and 75 per cent of the variation in the parallel streets. However, the hypothesis that there is no significant difference between the long-run price movements on the main roads and the parallel streets has to be accepted as the "F" statistic is insignificant.

Although the best form of the model does not register any significant statistical differences both the linear and quadratic model do identify a statistically significant difference between the trends in main roads and parallel streets. Again, the lower levels of explanation provided by these forms of the model preclude any definitive statements being made.

3.2.9 Site 9: King Georges Road

At the final study site the logarithmic equation provides the highest level of explanation of house price movements in King Georges Road, although it is only marginally more successful than the other two forms of the model. The quadratic form of the model is however marginally more successful in accounting for the movement of house prices on parallel streets. If the quadratic form of the model is considered to be the best predictor of price movements in both cases then the results of the "F" test reveals that the two equations are significantly different. Indeed, all three forms of the model indicate a statistically significant difference between the long-run movements in the two sets of streets. It may be concluded that in the long run the growth in house prices in King Georges Road is significantly less than that experienced in parallel streets.

3.2.10 Summary of long-run analysis of house price differences

The examination of the regression analyses for the nine sites has produced some interesting findings.

1. No single form of regression model explains or predicts the movement of house prices on either main roads or parallel streets. In other words, the long-run trends of house prices vary considerably across the city, which is as would be expected because of the differential effects of booms and slumps on parts of the housing market.
2. In most of the study sites one of the forms of the model explains the long-run movement of house prices to a satisfactory degree. Only in the cases of Old South Head Road, Gardeners Road and

Princes Highway do the R^2 values for the main roads not exceed 50 per cent ($R^2 < .50$). On the parallel streets the models fail to explain 50 per cent of the variation in prices of Old South Head Road, Gardeners Road and King Georges Road.

The low R^2 values at some sites, and in two cases for both main and parallel roads, indicates two possibilities: The first is that none of the time series models used in this study is an adequate representation of the movement of house prices in these areas. Other polynomial equations or perhaps a logistic function could possibly have been used. Secondly, in these areas, particularly local influences may have been at work which have encouraged prices to move substantially above or below the trends represented by the three functions. In Old South Head Road and its adjacent streets for example, property lots and the size of houses vary considerably. Whilst property is generally very highly priced, there are individual properties that could fetch $200,000 more at sale than other properties.

3. If only the results of the most successful model at each site is considered, then at four sites, Bobbin Head Road, Eastern Valley Way, Epping Road and King Georges Road, a statistically significant difference is observed in the long-run movement of house prices on main roads and parallel streets. At these four sites the movement of house prices on main roads and parallel streets have been diverging, with the latter obviously moving ahead at a faster rate.

   In the remaining five sites (Concord Road, Lyons Road, Old South Head Road, Gardeners Road and the Princes Highway) the best fit form of the model did not register significant differences between the long-run main road price movements and those on parallel streets. This suggests that at these sites the movement of house prices on main roads and parallel streets has been similar, and that despite the increase in road traffic during the study period, main road property prices do not seem to have fallen any further behind those of parallel streets than they were at the beginning of the study period. It is possible that in such areas any negative or depressive effect of road traffic noise on house prices may be compensated by increased accessibility factors.

3.2.11 All main roads and all parallel streets

In an effort to draw together any common trends that may exist in the data, the data were again combined into the two data sets of all main roads and all parallel streets and the three time series regression analyses were undertaken. The results of these analyses are also given in Table 3.11.

The R^2 values for all main roads and all parallel streets indicate that the logarithmic equation provides the best explanation of house price movements. This form of the model accounted for 52 per cent of the variation in price movements on all main roads and 44 per cent of the variation in all parallel streets. Diagrammatic representation of the regression equations for the two samples is given in Figure 3.1. Given the unsatisfactory levels of explanation of the models at three or four sites, the overall level of explanation of the best fit model for all main roads and parallel streets is not surprising. The "F" statistic identifies that the long-run trends in house prices on main roads and parallel streets is significantly different, therefore, the hypothesis that there is no significant difference in the movement of house prices on main roads and parallel streets must be rejected.

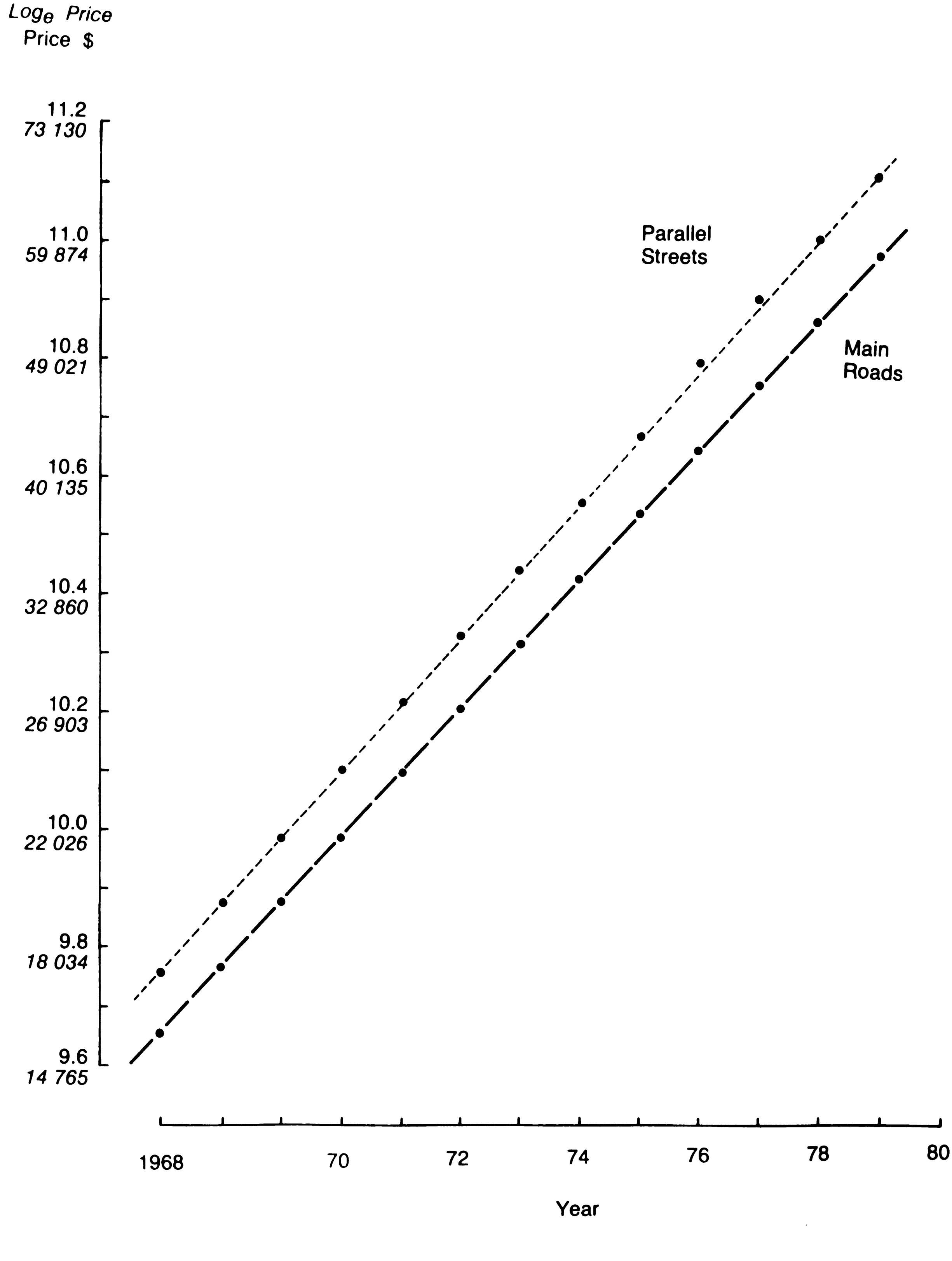


Figure 3.1 Long run trend of house prices.

CHAPTER FOUR

REGRESSION ANALYSES OF EFFECT OF MAIN ROAD TRAFFIC NOISE ON HOUSE PRICES

The previous two sections have identified that for selected sites and in particular years there is a statistically significant difference between main road property prices and those on parallel streets. Similarly, in the longer term for certain sites, the price movements on main roads and parallel streets have been significantly different. These short- and long-run significant differences between prices on main roads and parallel streets are also apparent when the data are combined into the two sets of all main roads and all parallel streets. The site selection procedure ensured that housing stock and other price determining factors such as distance to the city centre are similar on the main roads and control street at each site. The significant differences in mean house prices and in the growth rate of prices at many of the study sites can therefore be considered to be largely the result of traffic externality effects. This section attempts to investigate the effect which one particular traffic externality, main road traffic noise has on house prices on main roads and parallel streets. Stepwise regression analysis identifies the variation in house prices by relating price to main road traffic noise and a small number of independent variables which have been shown elsewhere (Wilkinson, 1973) to be significant price determining factors. For explanation of the model used and of the regression procedure, refer to Chapter 2.7.

The results of this exercise for all main roads and all parallel streets are given in Tables 4.1 and 4.2.

4.1 MAIN ROADS

In the case of the main roads data only 17 per cent of the variation in house prices is accounted for by the models as discussed in Chapter 2.7. The levels of explanation using either L_{10} or L_{eq} as the measure of noise are identical. This is not surprising as the L_{10} and L_{eq} values are highly correlated (Lawrence, 1974). The poor level of explanation (17 per cent) indicates that the four variables used to explore the relationship with property price are not successful indicators of the variation in property prices. Indeed, of the four independent variables only two are shown to be statistically significant. These two variables are the year of the property sale and the L_{10} or L_{eq} noise measurement. Of these two variables, the year of property sale is entered into the regression equation first and individually accounts for 14 per cent of the variation in house prices. When the noise variable is added into the equation, the level of explanation rises just three per cent. It can be seen, therefore, that although noise exerts a statistically significant effect on house prices, its impact in describing variations in house prices is quite minor.

By reference to the regression coefficients given in Table 4.1, the first form of the model (Equation 1 which used the L_{10} noise metric) indicates that the price of houses on main roads increased by $5,460 ($5,483 in Equation 2) for each unit increase in the year variable, that is, $5,460 per year. However, house prices decreased by $1,727 for every unit increase in noise ($1,381 using L_{eq}), that is,

TABLE 4.1 Results of stepwise regression analysis - all main roads

In order of entry into equation	Equation 1 (using L_{10} as noise measurement)		Equation 2 (using L_{eq} as noise measurement)	
Variables	Coefficient	Cumulative R^2	Coefficient	Cumulative R^2
Year	5460*	0.14	5483.5*	0.14
L_{10} or L_{eq}	- 1727.9**	0.17	- 1381.4**	0.17
Constant	121693.2**		101520.8**	

TABLE 4.2 Results of stepwise regression analysis - parallel streets

In order of entry into equation	Equation 1 (using L_{10} as noise measurement)		Equation 2 (using L_{eq} as noise measurement)	
Variables	Coefficient	Cumulative R^2	Coefficient	Cumulative R^2
Year	5062*	0.25	5057.1*	0.25
No. of Rooms	3364.7*	0.34	3318.0*	0.34
House Age	- 262.1*	0.37	- 249.8*	0.37
L_{10} or L_{eq}	- 499.9**	0.38	- 652.3**	0.38
Constant	17444.8		26069.3	

* statistically significant at .05 probability level.
** statistically significant at .10 probability level.

one decibel increase in the L_{10} value decreases house prices on main roads by $1,727. These results support those of Gamble et al. (1974) and Hall, Breston and Taylor (1977), although the size of the house price decrease is greater than those reported by either Gamble (an average of $82 per decibel) or Hall ($700 per decibel).

4.2 PARALLEL STREETS

The regression model was more successful in accounting for variations in property prices on parallel streets than on main roads (see Table 4.2). Again, it made little difference whether the L_{10} or L_{eq} measure of noise was used as 38 per cent of the variation in house prices was explained in both cases. In the analysis of property prices on parallel streets all four variables are shown to be statistically significant. As in the main roads analysis the year of the property sale is entered into the regression analysis first, and singularly accounts for 25 per cent of the variation in price. Unlike the main roads analysis, noise is not entered next into the equation. The number of rooms is entered as the second variable and the age of the property is entered as the third variable. These two variables which can be interpreted as indicators of house character, raise the level of explanation of the model to 37 per cent. The noise variable is the least significant of the four variables and adds just one per cent to the overall level of explanation of the model. In other words, noise can be regarded as a very minor determinant of house prices in the parallel streets under investigation, and is much less important than the characteristics of the property, such as its size or age.

The variable year increased the price of a house on parallel streets by $5,062 (or $5,057) for each unit increase (i.e. per year).

Each extra room in the property increased its price by \$3,365 (or \$3,318), whilst for each additional year of age of the property, price decreased by \$262 (or \$250). The latter regression coefficient suggests that households in Sydney are prepared to pay more for more modern homes.

Despite its lesser significance in this analysis, the impact of traffic noise is still shown to be important in monetary terms. Each additional decibel of noise depresses the price of property by \$500 using L_{10} as the noise measurement and \$652 using the L_{eq} measure. These values are obviously considerably less than the equivalent values obtained in the main roads analysis.

Although neither regression model is very successful in accounting for variations in property prices on main roads or parallel streets, the results presented here do serve the purpose for which the models were designed, that is, they do allow an appreciation of the effect which main road traffic noise has on house prices. It is obvious that to fully comprehend the movement of house prices on main roads and parallel streets, many more variables or determining factors would have to be included. This point applies particularly to the case of main road property price movements where property characteristics may be less important in determining price than access related variables.

Given the results of the earlier analytical sections where it was shown that, for numerous sites, there is no significant short or long term difference in house prices movements, the minor level of explanatory power of the noise increase in the two regression models may not be totally unexpected. Also, it would not be expected that traffic noise would be a major factor in accounting for house prices on parallel streets (though certainly it is a depressive factor). However, it was anticipated that traffic noise would be a greater determinant of price on main roads. That it is not, suggests that many residents trade off noise for increased accessibility or whatever. This suggestion is pursued in the next section of the analysis.

Therefore, it can be concluded that whilst traffic noise is shown to be a statistically significant determinant of property prices on both main roads and parallel streets, it is a factor of minor importance which at best accounts for just 3 per cent of property price variation.

CHAPTER FIVE

RESIDENTIAL RESPONSE TO MAIN ROAD TRAFFIC NOISE: ANALYSIS OF THE SURVEY QUESTIONNAIRE

In the previous chapters the short-run analysis of house price data revealed three periods during which prices on main roads were significantly less than those on control streets, and the long-run analysis indicated a significant difference between the growth rate of house prices on all main roads and all control streets. These differences in house prices were hypothesised to be the result of dissimilarities in road traffic externalities. Subsequent regression analysis revealed that main road traffic noise is a significant though minor determinant of house prices on both main roads and control streets, accounting for three per cent of variation in house prices on main roads and one per cent of variation on control streets. Consideration of these results suggests that residents in main roads and control streets may exhibit different responses or residential characteristics resulting from their unequal exposure to main road traffic noise. This chapter attempts to compare the response to main road traffic noise of residents in main roads and control streets using the Model of Residential Response to Main Road Traffic Noise outlined in Section 2.3 as the basis for explanation.

5.1 CHARACTERISTICS OF RESIDENTS

A total of 368 completed questionnaires were returned, 153 of these being from residents located on main roads and 215 being from residents located on control streets. The completed questionnaires were not evenly distributed among the nine study sites, but were heavily biased in favour of the three north shore sites (Bobbin Head Road, Eastern Valley Way and Epping Road), and to a lesser extent in favour of the Lyons Road and King Georges Road sites (see Table 5.1).

TABLE 5.1 Distribution of completed questionnaires

Survey Site	Main Road	Parallel Streets
Bobbin Head Road	42	61
Eastern Valley Way	23	33
Epping Road	17	26
Concord Road	11	18
Lyons Road	23	25
Old South Head Road	9	10
Gardeners Road	6	9
Princes Highway	8	8
King Georges Road	14	25
Total	153	215

Discussion in this chapter will be based on the two groups of main road and control street residents, and a summary of the personal characteristics is provided in Table 5.2. Male and female respondents within the main road group are approximately equal in number. However, within the control streets male respondents account for 58 per cent of responses while females account for only 42 per cent of responses. The age distribution of respondents is relatively similar within both groups, with the major differences occurring in the 18-25 year group which includes 10.5 per cent of main road respondents and only 6.1 per cent of control street respondents, and in the 26-40 year group where main road residents accounted for 44.4 per cent of respondents and control street residents for 48.8 per cent of respondents. The 41-65 and 65 plus age groups accounted for 38 per cent and 7 per cent of respondents on both main roads and control streets.

Occupational distribution within the two sample groups also proved to be similar, with the major differences occurring within the professional category, with 29 per cent of main road respondents classed as professional compared to 38 per cent of control street respondents. The length of residence of respondents varies up to 6 per cent within each category between the two groups of respondents. The major differences are that a greater percentage of residents on control streets have lived in their residences for 4-10 years (50.7 per cent against 42.5 per cent), and a larger percentage of main road residents have lived in their homes for more than ten years (18.9 per cent against 10.7 per cent). These figures provide little evidence of major differences in residential characteristics between main roads and control streets, or of a high turnover of property on main roads (caused possibly by traffic noise) and indeed, suggest that residents on main roads stay in their homes for more lengthy periods than do residents in control streets.

TABLE 5.2 Characteristics of sample populations

	Main Roads %	Parallel Streets %
<u>Sex</u>		
Male	52.3	58.4
Female	47.7	41.6
<u>Age</u>		
18-25 years	10.5	6.1
26-40	44.4	48.8
41-65	37.9	38.0
65 plus	7.2	7.0
<u>Occupation</u>		
Professional	28.8	37.7
Administrative	13.1	13.0
Clerical	9.8	5.6
Sales	9.8	9.3
Trades	12.4	15.3
Labourers	5.9	5.1
Domestic duties	11.8	8.4
Pensioners	3.9	3.7
Total	95.4	98.1
<u>Length of Residence</u>		
1 year or less	14.4	10.2
2-3 years	24.2	28.4
4-5	15.0	18.6
6-10	27.5	32.1
11-13	12.4	5.1
14 and above	6.5	5.6

5.2 NEIGHBOURHOOD EVALUATION

This section examines residents' perception of main road traffic noise in their neighbourhoods. Variables which were important in the householder's decision to purchase their homes, and the variables which they now dislike in their neighbourhoods will be used to gain an appreciation of whether "quiet" is equally regarded as a desirable neighbourhood attribute by both main road and control street residents, and whether they find main road traffic noise to be equally disturbing.

5.2.1 Decision to purchase home

Cost of the house and quality of house appear consistently as the major factors influencing people's decision to purchase their homes within both residential groups (see Table 5.3). The variables which indicate accessibility; distance from work, public transport and schools, are the next major group of variables, with over 20 per cent of residents in both groups indicating their importance. However, differences do occur in respect of the importance of a quiet neighbourhood, with 36.3 per cent of residents in control streets recording its importance compared with 18 per cent of residents from the main roads.

The variables which were ranked first in the householders' decision to purchase their homes were tested for differences in their importance to residents of main roads and control streets. However, in order to satisfy one of the requirements of the chi-square test, that no more than 20 per cent of the expected frequencies may be less than 5 (Hammond and McCullagh, 1974), those variables with small frequencies were combined, with the cost and quality of the house, and the quiet

TABLE 5.3 Factors in decision to purchase home (%)

Variables	1st ranking	2nd ranking	3rd ranking	Total mentioning factor *
MAIN ROADS				
Cost of house	45.8	19.6	5.2	70.6
Quiet neighbourhood	4.6	5.9	7.8	18.3
Distance from schools	3.3	5.9	9.2	18.4
Distance from work	5.9	7.8	15.0	28.7
Air quality	1.3	-	3.3	4.6
Distance from friends/ relatives	2.0	4.6	9.8	16.4
Quality of house	20.9	29.4	13.7	64.0
Distance from shops	0.7	5.2	9.2	15.1
Distance from recreational facilities	0.7	-	-	0.7
Distance from public transport	2.6	9.2	12.4	24.2
Distance from main roads	0.7	-	0.7	1.4
Other	3.3	1.4	2.0	6.7
PARALLEL STREETS				
Cost of house	43.7	23.3	7.0	74.0
Quiet neighbourhood	7.9	14.0	14.4	36.3
Distance from schools	1.4	5.6	14.0	21.0
Distance from work	7.9	6.5	13.5	27.9
Air quality	1.4	0.5	2.8	4.7
Distance from friends/ relatives	3.7	4.7	5.6	14.0
Quality of house	21.4	24.2	8.4	54.0
Distance from shops	0.5	3.3	8.8	12.6
Distance from recreational facilities	-	-	0.5	0.5
Distance from public transport	1.9	9.3	14.4	25.6
Distance from main roads	0.5	0.5	0.9	1.9
Other	4.2	1.0	1.0	6.3

* This is not a true percentage, but is a proportion of 300%.

neighbourhood variables being retained. The chi-square test failed to reveal any significant differences between the two groups of residents (chi-square = 2.41 with 5 degrees of freedom).

5.2.2 Factors disliked in neighbourhood

Reference to Table 5.4 reveals that within the main road group, the short distance from main roads was perceived as the major factor or aspect disliked by respondents, with 24 per cent of respondents ranking this as the most disliked neighbourhood quality. Several other factors indicate dislike of traffic related effects by respondents from main roads; air quality which can be regarded as a traffic externality effect was ranked first by 9.2 per cent of respondents, main road traffic noise was ranked first by 7.2 per cent and traffic itself by 1.3 per cent of respondents. The seeming unimportance of the variables main road traffic noise and traffic belies the significance which should be attributed to these results, firstly, neither of these variables were listed as an alternative in the questionnaire (see Appendix A), and as a consequence these were volunteered responses, and secondly, a comparison with responses from the parallel streets indicates a major difference in the percentage of respondents who identified these variables as things they disliked about their neighbourhood. The factor which recorded the greatest response (31.4 per cent) was neighbourhood noise, that is, the ambient or background noises. This high response indicates that some respondents probably included traffic noise as part of their interpretation of neighbourhood noise, a viewpoint supported by a comparison with the control street responses. Neighbourhood noise is basically similar in main roads and control streets at each site, yet only 11.6 per cent of control street respondents mentioned it as a negative neighbourhood factor.

A further point of interest from Table 5.4 is that only 18.9 per cent of main road respondents did not mention a factor that they disliked about their neighbourhood. Conversely, in the parallel streets, 60 per cent of respondents were unable to mention a neighbourhood factor they disliked. In other words, while over 80 per cent of main road respondents found something they disliked about their neighbourhood, less than half of control street respondents found something to dislike. In the control streets only two factors were registered by more than 10 per cent of respondents, these being distance from main roads and neighbourhood noise. However, within the main road group six factors were mentioned by more than 10 per cent of respondents, with four of these, distance from main roads, air quality, neighbourhood noise and industrial activity having a substantial main road traffic component within them.

It is not surprising then that the responses ranked first by residents in the two sample groups with regard to the factors that they dislike about their neighbourhood are significantly different (chi-square = 19.04 with 8 degrees of freedom and significant at 0.05 probability level). Distance from main roads, neighbourhood noise and main road traffic noise are the variables representing the major differences in response rates. These significant differences in factors which are largely representing traffic externalities suggests that there will be significant differences in the noises which residents in the two groups notice while they are at home, and consequently in their attitude to main road traffic noise.

TABLE 5.4 Factors disliked about neighbourhood (%)

Variables	1st ranking	2nd ranking	3rd ranking	Total mentioning factor*
MAIN ROADS				
Quality of house	3.9	4.6	0.7	9.2
Distance from shops	3.3	3.3	4.6	11.2
Distance from schools	1.3	1.3	2.0	4.6
Distance from work	3.3	6.5	1.3	11.1
Distance from main roads	24.8	2.0	2.0	28.8
Air quality	9.2	9.8	3.9	22.9
Neighbourhood noise	17.0	9.2	5.2	31.4
Distance from recreational facilities	2.6	2.6	3.3	8.5
Distance from public transport	-	1.3	2.6	3.9
Industrial activity	3.9	2.6	4.6	11.1
Main road traffic noise	7.2	2.6	-	9.8
Traffic	1.3	1.3	-	2.6
Other	3.3	3.4	2.1	8.8
No comment/No dislike	18.9	49.5	67.7	
PARALLEL STREETS				
Quality of house	3.3	2.3	0.5	6.1
Distance from shops	2.8	1.4	0.9	5.1
Distance from schools	0.9	0.9	1.9	3.7
Distance from work	3.7	3.7	2.8	10.2
Distance from main roads	4.2	3.3	1.4	8.9
Air quality	7.0	1.4	0.9	9.3
Neighbourhood noises	7.4	2.3	1.9	11.6
Distance from recreational facilities	2.3	2.8	-	5.1
Distance from public transport	2.3	2.3	1.9	6.5
Industrial activity	-	1.4	1.4	2.8
Main road traffic noise	1.4	-	-	1.4
Traffic	0.5	1.9	0.5	2.9
Other	4.2	1.0	-	5.2
No comment/No dislike	60.0	75.3	85.9	

* This is not a true percentage, but is a proportion of 300%.

5.2.3 Noises in the neighbourhood

62.8 per cent of respondents from main roads reported that main road traffic noise was the most noticeable neighbourhood noise compared with only 18 per cent from the parallel streets (see Table 5.5). The most noticeable noise in control streets was domestic noise (29.4 per cent) followed by local traffic noise (25.8 per cent). This result is not unexpected since one of the original assumptions of this study was that the parallel streets should be protected from the impact of main road traffic noise, and by implication would be unaffected by local traffic noise.

It is interesting to note that 27 per cent of main road respondents stated that local traffic noise was the most noticeable noise. This indicates perhaps that many of these respondents do not consider themselves to be resident on a main road, although only 4.3 per cent of respondents have indicated that belief in answer to a later question. The other interesting response from this table is the large number of people who mentioned aircraft noise as one of the three most noticeable noises. This response confirms an earlier statement concerning the problem of defining study sites where main road traffic noise is the major noise source.

A comparison of noises ranked most noticeable by residents in the two groups revealed a significant difference between responses for main roads and control streets (chi-square = 122.5 with 4 degrees of freedom and significant at 0.0001 probability level). This is as would be expected with main road traffic noise being most noticeable to main road residents, and aircraft noise and a combined variable domestic-garden noises (satisfying chi-square requirements) being considerably more noticeable to parallel street residents.

TABLE 5.5 Noise rankings by residents (%)

	MAIN ROADS				PARALLEL STREETS			
	1st ranking	2nd ranking	3rd ranking	* Total	1st ranking	2nd ranking	3rd ranking	* Total
Domestic noise	5.4	20.2	26.4	52.0	29.4	14.8	13.5	57.7
Local traffic noise	27.0	30.6	12.1	69.7	25.8	31.8	12.0	69.6
Aircraft noise	1.4	16.9	23.1	41.4	13.4	17.0	23.3	53.7
Garden noise	1.4	11.3	22.0	34.7	7.2	14.8	24.1	46.1
Main road traffic noise	62.8	16.9	7.7	87.4	18.0	15.3	15.5	48.8
Other	2.0	4.0	8.8	14.8	6.2	6.3	12.0	24.5

* This is not a true percentage, but is a proportion of 300%.

5.2.4 Attitude to main road traffic noise

Residential attitude to main road traffic noise reinforces the findings earlier in this section; the chi-square test revealed a significant difference between the attitude to main road traffic noise by the two groups of residents (chi-square = 88.1 with 6 degrees of freedom and significant at 0.0005 probability level). 84 per cent of main road respondents find main road traffic noise disagreeable to some degree compared with only 43.7 per cent of control street respondents (see Table 5.6). This latter result is however slightly higher than anticipated and may reflect experiences of main road traffic noise obtained while travelling, rather than residential experiences. The agreeable responses are reflective of residential exposure to main road traffic noise, accounting for less than 5 per cent of main road residents and 27.6 per cent of control street residents.[1]

TABLE 5.6 Attitude to main road traffic noise by locality

	Main Roads		Parallel Streets	
	Number	%	Number	%
Extremely agreeable	1	0.66	30	14.6
Moderately agreeable	6	4.0	24	11.6
Slightly agreeable	0	0	3	1.4
Neutral	18	12.0	57	27.6
Slightly disagreeable	33	21.8	55	26.7
Moderately disagreeable	62	41.0	27	13.1
Extremely disagreeable	32	21.2	8	3.9

[1] Because of the small agreeable response by main road residents, all remaining analyses where the attitude variable is used will include only the single category of "moderately agreeable".

5.3 ACTIVITIES AFFECTED OR INTERRUPTED BY MAIN ROAD TRAFFIC NOISE

Three types of indicators are used as gauges of the extent to which main road traffic noise interferes with the lifestyle of householders; interference with household activities, medical complaints caused by main road traffic noise and fears related to the proximity of main roads. The significant differences in noises noticed by residents, and in their attitudes to main road traffic noise suggest that differences would also be apparent between the indicators of lifestyle interference for main road and control street residents.

5.3.1 Interference with household activities

As Table 5.7 indicates almost all main road respondents experienced some activity interference caused by main road traffic noise, with only 19.6 per cent indicating no activity interference, whereas 69.3 per cent of control street respondents indicated no activity interference. However, a chi-square test failed to reveal any significant difference between the nature and order of interference in main roads and control streets (chi-square = 5.36 with 4 degrees of freedom).

The activity with which respondents reported most interference was sleeping, a factor registered by 33.3 per cent of main road respondents and 15.3 per cent of control street respondents. The second most disturbed activity was talking outside, being mentioned by 18.3 per cent of main road respondents and 7.9 per cent of control street respondents. The similarity in responses from main road and control street residents may be due in part to some confusion in the minds of control street residents between main road traffic noise and local traffic noise.

TABLE 5.7 Activity interference by main road traffic noise (%)

	MAIN ROADS				PARALLEL STREETS			
	1st ranking	2nd ranking	3rd ranking	Total*	1st ranking	2nd ranking	3rd ranking	Total*
Talk inside	5.2	6.5	5.9	17.6	0.5	1.9	1.4	3.8
Television viewing	13.1	11.1	6.5	30.7	2.3	0.5	2.3	5.1
Sleeping	33.3	12.4	9.2	54.9	15.3	2.8	1.9	20.0
Work inside	2.0	0.7	0.7	3.4	0.5	0.5	0.5	1.5
Talk outside	18.3	19.0	3.3	40.6	7.9	4.2	0.9	13.0
Telephone conversations	5.9	6.5	9.8	21.4	1.4	2.3	-	3.7
Work outside	2.0	9.8	8.5	20.3	2.8	2.8	1.9	7.5
Other	0.7	1.3	0.7	2.7	-	0.5	0.5	1.0
None	19.6	32.7	55.6		69.3	84.7	90.7	

* This is not a true percentage, but is a proportion of 300%.

5.3.2 Medical complaints

The incidence of medical complaints resulting from main road traffic noise is similar to that of activity interference, with residents of main roads reporting more medical complaints than those residents living in parallel streets. Table 5.8 reveals that a total of 147 medical complaints caused by main road traffic noise were listed by residents of main roads compared with 67 by residents from parallel streets. Again the chi-square test failed to reveal any significant differences in the nature or distribution of medical complaints between main road and control street residents (chi-square = 3.78 with 4 degrees of freedom). However, it is interesting to note that when specifically questioned about medical complaints less people claimed to be affected in their sleep patterns by main road traffic noise than was noted in Table 5.7 on activity interference. This difference is possibly due to problems of interpretation of the terms "interference" and "medical complaint". Although the difference is not surprising since the total number in Table 5.7 is a proportion of 300 percent and not 100 percent as in Table 5.8.

TABLE 5.8 Medical complaints by locality

	Main Roads		Parallel Streets	
	Number	%	Number	%
Headaches	17	11.1	5	2.3
Nervousness	15	9.8	10	4.7
Hearing difficulties	9	5.9	1	0.5
Irritability	28	18.3	13	6.0
Interrupted sleep	78	51.0	38	17.7
Total	147		67	

In order to gauge the seriousness of these medical complaints residents who had noted some health effect of main road traffic noise were asked if they had sought medical treatment. Twelve people or 7.8 per cent of households on main roads had sought medical assistance. Although this figure is small, it is regarded as a significant percentage. By contrast, only two people or 1.0 per cent of households on parallel streets suffered from main road traffic noise sufficiently to seek medical attention.

5.3.3 Fear of accidents

Residents on main roads display a greater fear of accidents due to the proximity of main roads than do control street residents, registering a total of 387 positive responses compared with 165 (see Table 5.9). Responses from the groups of residents differ significantly in both incidence and intensity (chi-square = 23.44 with 5 degrees of freedom and significant at 0.001 probability level). Only two variables, fear of pedestrian accidents to children and fear of road accidents to family were recorded by more than 10 per cent of control street residents, whereas all six alternatives were registered by more than 30 per cent of main road residents. Once again, the responses from control street respondents may be the result of general road traffic experiences rather than from proximity to the particular main road in their neighbourhoods.

5.3.4 Summary of activities affected by main road traffic noise

Neither activity interference nor medical complaints caused by main road traffic noise revealed any significant differences between the

TABLE 5.9 Fears caused by proximity to main roads

	Main Roads		Parallel Streets	
	Number	%	Number	%
Pedestrian accident self	51	33.3	35	16.3
Pedestrian accident child	73	47.7	53	24.7
Pedestrian accident pet	49	32.0	29	13.5
Access to home	77	50.3	19	8.8
Road accident family	81	52.9	46	21.4
Road accident self	56	36.6	29	13.5
Total	387		165	

responses from main road and control street residents. Significant differences in the response of the two residential groups did occur with respect to the variable fear of accidents, and consequently it appears that of the three variables only this one can help explain the significant difference in attitude to main road traffic noise between residents in main roads and control streets noted in Section 5.2.4.

5.4 ACTIONS RESULTING FROM ANNOYANCE BY MAIN ROAD TRAFFIC NOISE

Figure 2.5 lists three sets of actions which residents may undertake as a result of annoyance caused by main road traffic noise: short-term actions, long-term actions, and complaint activity. Each of these actions is able to decrease the impact which main road traffic noise has on residents.

5.4.1 Short-term actions

Collectively, the residents on main roads undertook 244 actions, or 1.6 actions per household, compared with 101 actions, or 0.47 actions per household on control streets (see Table 5.10). The significant differences between the two groups of residents are not surprising (chi-square = 14.92 with 4 degrees of freedom and significant at 0.01 probability level). Overall, people who live on main roads where traffic noise may be more or less constant would be expected to react more strongly than those on parallel streets where such noise may be intermittent, and possibly confused with local traffic noise. Households on main roads are more likely to respond to main road traffic noise by closing windows, turning up the television or radio, staying indoors or by waiting for the noise to stop. On the other hand, those residents living on control streets are more likely to close windows or, alternatively, wait for the noise to stop, which again suggests that the noise in these streets may be more intermittent in nature and is probably local traffic noise. It is interesting to note

TABLE 5.10 Short-term actions resulting from annoyance by main road traffic noise

	Main Roads		Parallel Streets	
	Number	%	Number	%
Close windows	101	41.4	43	42.6
Stay indoors	39	16.0	11	10.9
Turn up TV, radio	53	21.7	12	11.9
Wait for noise to stop	38	15.6	32	31.7
Other	13	5.2	3	2.9
Total	244		101	

that residents on main roads respond to main road traffic noise by undertaking a greater number of short-term actions than their counterparts on control streets, whose main responses are to close windows or wait for the noise to stop.

5.4.2 Long-term actions

The responses to the question on long-term actions which residents have undertaken to reduce the effect of traffic noise are summarised in Table 5.11. Again, those residents on main roads have reacted in greater number, though in this case, there is no significant difference in the pattern of responses (chi-square = 1.88 with 3 degrees of freedom). Both groups of residents displayed a preference for planting hedges or trees, most certainly the least cost option. Installing walls or fences was the next most popular method of reducing the impact of traffic noise for main road residents. Despite the effectiveness of double glazing in reducing noise, very few households had undertaken this option (4 in both main roads and control streets).

TABLE 5.11 Long-term actions resulting from annoyance by main road traffic noise

	Main Roads		Parallel Streets	
	Number	%	Number	%
Installed air conditioning or double glazing	12	7.8	8	3.8
Planted hedges or trees	53	34.6	31	14.5
Installed insulation	12	7.8	9	4.2
Installed walls or hedges	18	11.8	6	2.8

For 62 per cent of those residing on main roads, main road traffic noise has been sufficiently disturbing for some long-term action to be undertaken. This suggests that traffic noise finds another expression in cost, however marginal, in addition to that of influencing house prices.

5.4.3 Complaint activity

The third type of action which may result from annoyance caused by main road traffic noise is complaint activity. The two most common responses by both main road and control street residents were complaints to local councils and the signing of petitions (see Table 5.12). As anticipated, complaint activity by main road residents exceeded that of control street residents, although there is no significant variation in the pattern of responses. However, complaint activity within both groups has been limited, and is possibly due to lack of knowledge about the relevant authorities to whom one should complain.

TABLE 5.12 Complaint activity resulting from annoyance by main road traffic noise

	Main Roads		Parallel Streets	
Complaint to:	Number	%	Number	%
Council	17	11.1	14	6.5
Alderman	6	3.9	4	1.9
State politician	3	2.0	2	1.0
Government Department	5	3.3	3	1.5
Newspaper	2	1.3	2	1.0
Formed protest group	0	0	2	1.0
Signed petition	18	11.8	9	4.2
Federal politician	1	0.7	0	0
Joined protest group	4	2.4	0	0

5.4.4 Summary of actions to reduce impact of main road traffic noise

When the three possible actions of main road residents to main road traffic noise are considered, it can be concluded that the great majority of residents undertake some, or a number of, short-term actions to alleviate noise problems. A lesser percentage of residents have undertaken long-term actions to reduce noise, but the most common response has been to plant hedges or trees. A relatively small number of residents have attempted to improve their residential environment by making complaints about main road traffic noise to some public body. The cost of long-term solutions and the unlikelihood of achieving any positive response from complaint activity, appears to lead most residents into making short-term responses to cope with main road traffic noise.

5.5 RESIDENTIAL ATTITUDES TO MAIN ROAD TRAFFIC NOISE

The final investigation of the survey data represents an attempt to discover whether people who found main road traffic noise to be disagreeable exhibited any particular personal characteristics. Figure 2.5 contains a list of intervening variables, that is, variables which may be important in the acceptance of, or hostility toward, main road traffic noise. These will be used to identify factors accounting for any significant difference in attitude to main road traffic noise by main road and control street residents.

5.5.1 Attitude to main road traffic noise by sex

No significant differences were noted for the attitude to main road traffic noise between males and females, for either main roads (chi-square = 4.32 with 4 degrees of freedom) or control streets (chi-square = 3.08 with 4 degrees of freedom). However, of the main road residents, males find traffic noise more disagreeable than females, although the greatest response for both sexes is that main road traffic noise is moderately disagreeable (see Table 5.13). A similar result is evident in the control streets, with more males finding noise disagreeable than females, although the greatest response for males in this case is that traffic noise is either moderately agreeable or neutral, and slightly disagreeable for females. The males' greater sensitivity to noise may result from their less constant exposure to traffic noise, at least in comparison with some females who may be at home for greater periods in the day.

TABLE 5.13 Attitude to main road traffic noise by sex

	Males	%	Females	%
MAIN ROADS				
Moderately agreeable	2	2.5	6	8.5
Neutral	8	10.1	11	15.3
Slightly disagreeable	20	25.3	13	18.0
Moderately disagreeable	32	40.5	29	40.3
Extremely disagreeable	17	21.5	13	18.0
PARALLEL STREETS				
Moderately agreeable	34	28.8	22	25.9
Neutral	34	28.8	21	24.7
Slightly disagreeable	30	25.4	25	29.4
Moderately disagreeable	17	14.4	11	12.9
Extremely disagreeable	3	2.5	6	7.1

Reference to Table 5.14 indicates that there is no significant difference in attitude to main road traffic noise due to length of time spent at home (chi-square = 6.57 with 12 degrees of freedom). Almost 50 per cent of residents spend between 10-15 hours at home each weekday, and the majority of these find main road traffic noise disagreeable.

TABLE 5.14 Attitude to main road traffic noise by length of time at home on weekdays (hours)

	5-10	%	10-15	%	15-20	%	20-24	%
Moderately agreeable	6	20.7	31	18.0	18	16.2	7	18.9
Neutral	6	20.7	35	20.3	26	23.4	7	18.9
Slightly disagreeable	4	13.8	46	26.7	29	26.1	8	21.6
Moderately disagreeable	9	31.0	45	26.2	26	23.4	8	21.6
Extremely disagreeable	4	13.8	15	8.7	12	10.8	7	18.9

5.5.2 <u>Attitude to main road traffic noise by age</u>

Due to the large number of cells in Table 5.15 with less than 5 observations the chi-square test is not a satisfactory test of differences in attitude to main road traffic noise resulting from variations in age of residents. Instead, Kendall's Tau C is used to test the association between ordinal level variables (Nie et al., 1975). This test indicates no significant difference in attitudes to main road traffic noise among the four age groups residing on main roads (Tau C = .051, not significant). The most common response for all age groups is that main road traffic noise is moderately disagreeable, although compared to the other groups more residents (27.6 per cent) in the 41-65 age group found traffic noise to be extremely disagreeable.

Control street residents registered a statistically significant difference in attitude to main road traffic noise between the four age groups (Tau C = -.135, significant at .007 probability level). The most common responses vary by age group. Both the 18-25 and 41-65 age groups register the most common response to main road traffic as moderately agreeable while residents aged 26-40 find traffic noise slightly disagreeable. The 65 plus age group are most commonly neutral in their attitude to main road traffic noise.

TABLE 5.15 Attitude to main road traffic noise by age

	18-25 years	%	26-40 years	%	41-65 years	%	65 plus	%
MAIN ROADS								
Moderately agreeable	1	6.6	3	4.4	3	5.1	1	11.1
Neutral	1	6.6	9	13.2	7	12.0	2	22.2
Slightly disagreeable	4	25.0	18	26.4	11	19.0	0	0
Moderately disagreeable	9	56.2	26	38.2	21	36.2	5	55.5
Extremely disagreeable	1	6.6	12	17.6	16	27.6	1	11.1
PARALLEL STREETS								
Moderately agreeable	6	46.1	18	18.2	28	36.8	4	28.6
Neutral	2	15.4	27	27.3	18	23.7	8	57.1
Slightly disagreeable	2	15.4	30	30.4	20	26.3	2	14.3
Moderately disagreeable	3	23.1	19	19.2	6	7.9	0	0
Extremely disagreeable	0	0	5	5.0	4	5.3	0	0

5.5.3 Attitude to main road traffic noise by occupation

No significant differences in attitude to main road traffic noise among occupational groups were discovered on main roads. The most common response in all groups except trades was either moderately disagreeable or both moderately disagreeable and extremely disagreeable. The most common response for the trades occupational group was slightly disagreeable or neutral (see Table 5.16). There are some differences in attitude to main road traffic noise on control streets, a result indicated by the Lambda coefficient which reveals an increase of 10.2 per cent in prediction if occupation is known. The most common response to main road traffic noise among the professional, clerical and sales groups was slightly disagreeable, whereas the administration, labour and domestic/pension groups registered neutral as their most common response. The trades group is the only group to register moderately agreeable as the most common response to main road traffic noise.

5.5.4 Attitude to main road traffic noise by mode of transport for the journey to work

Residents' attitude to main road traffic noise may not reflect solely residential experiences of traffic noise, rather they may reflect non-residential impressions of traffic related externalities, hence the mode of transport by which residents complete the journey to work may influence attitudes to main road traffic noise.

Knowledge of the household head's mode of journey to work provides no improvement in the ability to predict attitude to main road traffic noise on main roads, and only marginally adds to the ability to predict attitude to traffic noise on control streets (Lambda = 4.6 per cent improvement). Reference to Table 5.17 reveals that regardless of mode of transport, the most common response to main road traffic noise among main road residents was moderately disagreeable. The most common response by car travellers on control streets was moderately agreeable,

TABLE 5.16 Attitude to main road traffic noise by occupation

	Professional		Administration		Clerical		Sales		Trades		Labour		Domestic and Pension	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
MAIN ROADS														
Moderately agreeable	0	0	1	5.0	2	13.3	0	0	3	15.8	1	11.7	1	4.5
Neutral	6	13.6	1	5.0	2	13.3	2	13.3	5	26.3	0	0	2	9.1
Slightly disagreeable	14	31.8	6	30.0	1	6.7	3	20.0	5	26.3	2	22.2	1	4.5
Moderately disagreeable	17	38.6	10	50.0	5	33.3	9	60.0	3	15.8	3	33.3	9	40.9
Extremely disagreeable	7	15.9	2	10.0	5	33.3	1	6.7	3	15.8	3	33.3	9	40.9
PARALLEL STREETS														
Moderately agreeable	21	26.2	7	26.9	1	9.1	6	30.9	9	31.0	2	18.2	9	37.5
Neutral	17	21.2	8	30.8	3	27.3	4	20.0	7	24.1	4	36.4	12	50.0
Slightly disagreeable	24	30.0	5	19.2	6	54.5	7	35.0	7	24.1	2	18.2	3	12.5
Moderately disagreeable	18	22.5	4	15.4	0	0	3	15.0	3	10.3	0	0	0	0
Extremely disagreeable	0	0	2	7.7	1	9.1	0	0	3	10.3	3	27.3	0	0

whereas those residents using a combination of modes found traffic noise to be slightly disagreeable. Bus travellers were equally divided between moderately agreeable and slightly disagreeable. The tendency of residents using non-private forms of transport to find traffic noise disagreeable may be a response to the relative inconvenience of these modes and other general traffic externalities, rather than purely a response to traffic noise.

TABLE 5.17 Attitude to main road traffic noise by mode of transport for the journey to work

	Car		Bus		Other combination	
	Number	%	Number	%	Number	%
MAIN ROADS						
Moderately agreeable	6	7.1	0	0	1	2.7
Neutral	10	11.8	1	9.1	6	16.6
Slightly disagreeable	22	25.9	2	18.2	8	22.2
Moderately disagreeable	32	37.6	6	54.5	14	38.8
Extremely disagreeable	15	17.6	2	18.2	7	19.4
PARALLEL STREETS						
Moderately agreeable	36	29.0	5	29.4	4	9.8
Neutral	30	24.2	4	23.5	14	34.1
Slightly disagreeable	31	25.0	5	29.4	17	41.5
Moderately disagreeable	22	17.7	2	11.8	4	9.8
Extremely disagreeable	5	4.0	1	5.9	2	4.9

5.5.5 Attitude to main road traffic noise by length of residence

No significant difference in attitude to main road traffic noise is evident among residents varying in length of residence on main roads (Tau C = -.017, not significant). The most common response in all groups is to find main road traffic noise moderately disagreeable, while more residents located on main roads for one year or less found traffic noise to be extremely disagreeable than did other groups (see Table 5.18).

Control street residents indicated a significant difference in attitude with respect to length of residence (Tau C = -.09, significant at .0488 probability level). New residents (one year or less) and older residents (6-10 and 11-13 years) find main road traffic noise moderately agreeable. Residents who have resided for 4-5 years and 14 plus years registered neutral as their most common response, while the most common response for 2-3 years is slightly disagreeable.

5.5.6 Summary of residential attitudes to main road traffic noise

None of the variables sex, age, occupation of household head, mode of journey to work or length of residence, were able to differentiate responses to main road traffic noise by main road residents. In almost all cases, the most common response to main road traffic noise was moderately disagreeable.

The variables age, occupation and length of residence, were able to differentiate between control street residents with respect to attitude to main road traffic noise. However, regardless of the predictive variable the most common response to traffic noise within each variable subgroup was usually slightly disagreeable or a more positive response.

TABLE 5.18 Attitude to main road traffic noise by length of residence (years)

	1 or less		2 - 3		4 - 5		6 - 10		11 - 13		14 plus	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
MAIN ROADS												
Moderately agreeable	1	4.8	2	5.4	0	0	4	9.5	0	0	1	10.0
Neutral	2	9.5	4	10.8	3	13.0	4	9.5	4	22.2	0	20.0
Slightly disagreeable	4	19.0	11	29.7	6	26.1	8	19.0	3	16.7	1	10.0
Moderately disagreeable	8	38.1	14	37.8	11	47.8	17	40.5	7	38.9	4	40.0
Extremely disagreeable	6	28.6	6	16.2	3	13.0	9	21.4	4	22.2	2	20.0
PARALLEL STREETS												
Moderately agreeable	8	40.0	13	22.0	7	19.4	20	29.4	5	45.5	3	30.0
Neutral	3	15.0	13	22.0	14	38.9	17	25.0	4	36.4	5	50.0
Slightly disagreeable	4	20.0	21	35.6	9	25.0	18	26.5	1	9.1	2	20.0
Moderately disagreeable	4	20.0	9	15.3	5	13.9	9	13.2	1	9.1	0	0
Extremely disagreeable	1	5.0	3	5.1	1	2.8	4	5.9	0	0	0	0

5.6 SUMMARY

Discussion of the results of the questionnaire will be related to the Model of Residential Response to Main Road Traffic Noise developed in Section 2.3. Analysis of the household questionnaire revealed that main road traffic noise was not one of the major factors which people dislike about their neighbourhoods, but when questioned further, main road residents did acknowledge main road traffic noise (and local traffic noise) as the noise which was most noticeable in their neighbourhood. Indeed, main road residents found main road traffic noise more disturbing than control street residents.

Investigation of the activities affected or interrupted by main road traffic noise revealed that although more main road residents reported interference than control street residents, there were no statistically significant differences between the incidence or intensity of the interference. Similarly, main road residents reported more medical complaints than control street residents, but again the differences were not statistically significant. However, while 7.8 per cent of main road respondents revealed that they had sought medical assistance, only 1.0 per cent of control street respondents had sought medical assistance.

Analysis of the actions which residents undertook to reduce the impact of main road traffic noise revealed the following points. Firstly, main road residents indicated that they undertook more actions aimed at reducing the impact of traffic noise than did control street residents, although the differences in long-term actions were not significantly different, and secondly, complaint activity by both residential groups is limited.

An attempt to explain differences in attitude to main road traffic noise used several of the intervening variables listed in the Model of Residential Response to Main Road Traffic Noise. Main road residents exhibited a greater anxiety about possible accidents due to the proximity of main road traffic. However, the most distinguishable characteristic of people who found main road traffic noise disagreeable is that they reside on main roads.

In summary, the Model of Residential Response to Main Road Traffic Noise does not adequately explain differences in attitude to main road traffic noise which are evident in this study of nine sites in Sydney.

CHAPTER SIX

CONCLUSION

This study provides an investigation of some of the economic and social impacts of main road traffic noise in Sydney during the period from 1968 to 1980. Economic evaluation of the effect of main roads on house prices was undertaken using a survey-control area comparison of mean house prices and long-run growth trends. Multiple regression analysis identified the contribution of main road traffic noise to house prices on main roads and control streets, and an assessment of the social consequences of main road traffic noise was facilitated by analysis of a questionnaire sent to home owners in each of the study areas. This conclusion presents a summary of the study's substantive findings, a discussion of methodological problems and suggestions for future research initiatives.

The major hypothesis of this study was that main road traffic noise would have a detrimental effect on house prices on main roads, such that both the annual mean sales prices and long-run growth rate of house prices on main roads would be less than those in parallel streets. However, it is not really possible to relate differences in house prices purely to main road traffic noise, and in practice any differences which do occur would be the result of a range of main road characteristics. A statistical technique such as regression analysis is needed to determine the specific contribution which main road traffic noise makes to house prices in main roads and control streets.

Investigation at each of the nine study sites revealed that differences in mean house prices are neither uniform in size nor timing, with only one site, King Georges Road, providing any real evidence in support of the major study hypothesis. This finding supports that of Hall, Breston and Taylor (1977) who were able to identify significant differences in mean house values in only two of six sites in their Canadian study. However, examination of the aggregate data sets (all main roads and all parallel streets) revealed three distinct periods when mean house prices on main roads were less than those in control streets. It is considered that these periods of house price differences (1968-69, 1973-74 and 1977-80) reflect changes in the Sydney real estate market rather than any transport induced shock such as those observed in studies of house prices in the vicinity of airports (Holsman and Aleksandric, 1977; Crowley, 1973).

During times of high demand house prices in the relatively attractive control streets increased more rapidly than those on the less desirable main roads. However, as demand declined prices in control streets were not able to maintain their superiority and house prices on main roads were able to catch up. The average yearly difference in mean house prices of property located on main roads and control streets is 16 per cent.

The findings which emerged from investigation of the long-run growth of house prices are similar to those of the investigation of mean house prices. Only four sites, Bobbin Head Road, Eastern Valley Way, Epping Road and King Georges Road, displayed statistically significant differences between the growth rate of house prices on main roads and parallel streets. House prices at these four sites, and for the aggregate data sets (all main roads and all parallel streets) have been diverging, with prices on control streets increasing at faster rates than those on main roads. A possible explanation for this variation in the growth rate of house prices is the increasing volume of traffic (and associated disturbances such as traffic noise) on main roads since the beginning of the study period.

Despite increases in traffic volume and associated disturbances the growth rates of house prices on main roads at the remaining five sites were not markedly different from those in the control streets. This lack of difference may be a reflection of similarities in the residential market at these sites, but in some cases it may also reflect problems with the data sets, particularly that of small sample sizes.

The relatively slower growth rate of house prices in the aggregate data set all main roads compared with that in all parallel streets seems to contradict the findings by Holsman and Paparoulas (1982) that the long growth rate of house prices in Edgecliff were faster than those in the control area of South Paddington. However, in contrast to the present study, Holsman and Paparoulas were investigating an area which had experienced a substantial change in relative accessibility to the central business district due to the introduction of the Eastern Suburbs Railway. McCalden and Jarvie's (1977) study of the impact of coal haulage in Newcastle is a better representation of the conditions of the present study. Their findings are similar, indicating that the rate of increase of property values is slower on major roads than on the control streets.

Analysis of both mean sales prices and of the long-run growth rate of house prices suggested the possibility that main road traffic noise may contribute differentially to house prices in main roads and control streets. Indeed, regression analysis revealed that main road traffic noise is a statistically significant, although minor, determinant of house prices in both main roads and control streets, accounting for just three per cent of the variation in main roads and one per cent in control streets.

The regression analysis approach allowed the derivation of the implicit price of traffic noise in the two street types. Main road traffic noise decreases the value of houses on main roads in Sydney by approximately $1,727 per decibel. Similar results were identified by Gamble et al. (1974), Langley (1976a), Hall, Breston and Taylor (1977) and Taylor, Breston and Hall (1982), although the value of noise per decibel is significantly higher in Sydney than in the other studies.

Consideration of the economic impact which main road traffic noise had on house prices on main roads and control streets in Sydney prompted the assumption that the social impacts resulting from traffic noise would also vary between the residential survey areas. Analysis of the survey questionnaire examined the hypothesis that main road residents are more sensitive to main road traffic noise than control street residents. It was felt that the increased sensitivity would result from greater interference with domestic activities and would result in a larger number of compensating actions by main road residents.

It seems that at the time of their house purchase, most residents considered themselves insensitive to traffic noise, with only 18.3 per cent of main road residents considering a quiet neighbourhood as an important factor in the purchase decision compared to 36.3 per cent of control street residents. The cost and quality of the house were of overwhelming importance in the decision to purchase a property to both main road and control street survey groups.

Further analysis indicated that more main road residents are sensitive to noise than control street residents. The two factors which main road residents disliked most about their neighbourhoods were neighbourhood noise (31.4 per cent) and the short distance from main roads (28.8 per cent). More significantly a large number of these residents volunteered that main road traffic noise (7.2 per cent) and main road traffic were factors they disliked, a finding which compares not unfavourably with Sando and Batty's (1974) figure of one in eight people spontaneously volunteering traffic noise as a factor they disliked. Similarly, whilst 60 per cent of control street residents were unable to name any factors which they disliked about their neighbourhood, only 18.9 per cent of main road residents followed suit. However, despite the fact that main road residents are more sensitive to main road traffic noise than control street residents, a greater percentage of main road residents had lived in their houses for longer periods than control street residents.

Main road traffic noise was the most noticeable noise in the residential area, a fact acknowledged by over 60 per cent of main road residents but only by 18 per cent of control street residents. In this instance the control street response is more representative of the findings reported by Sando and Batty (1974) that 23 per cent of residents in a national survey of England considered traffic noise to be the most disturbing noise in their neighbourhoods. In the present study 84 per cent of main road residents indicated that main road traffic noise was disagreeable compared with 42.2 per cent of control street residents. These findings from the neighbourhood evaluation section of the questionnaire are similar to the results of two studies undertaken in Melbourne. Troy (1973) indicated that while residents were dissatisfied with aspects of their physical environment such as traffic noise and traffic congestion, they were generally satisfied with other aspects of their neighbourhood, and similarly Wyatt and Bookman (1982) reported that although residents were dissatisfied with factors they attributed to traffic, the more long standing residents were happy with other aspects of their neighbourhood.

In spite of their expressed differences in sensitivity to main road traffic noise, the two residential groups did not relate any significant differences in either interruption of domestic activities or medical complaints resulting from the disturbance. 80.4 per cent of main road residents and 30.7 per cent of control street residents claimed some activity interruption and similarly main road residents reported a total of 147 medical complaints compared with 67 complaints for control street residents. Marked differences did occur in the number of respondents who had sought medical advice, with 7.8 per cent of main road residents and only 1.0 per cent of control residents taking this action. Burden and Damm (1979) in their Brisbane study produced results which suggest that in addition to seeing their doctors more often, residents in noisy sites, or in this case main roads, also suffer from stress problems resulting in argumentativeness, moodiness and depression.

Fear of accidents provided a better mirror than medical complaints or interruption of domestic activities of residents' sensitivity to main road traffic noise, with over 50 per cent of main road residents claiming problems with restricted car access to their houses or fear of road accidents involving their families or themselves and fear of pedestrian accidents involving their children. By comparison fear of pedestrian accidents involving children was the only variable identified by over 50 per cent of control street residents. This contrast in residential attitudes to accidents was also noted in San Francisco (Appleyard and Lintell, 1972) where residents considered that heavily trafficked streets were unsafe, and in England (Sando and Batty, 1974) the factor causing greatest concern to residents was pedestrian danger.

Generally the actions which residents took to reduce the impact of main road traffic noise did not differ significantly between main road and control street residents. Both residential groups displayed a preference for planting hedges or trees as a long-term measure, while the main complaint activities were lodging complaints to local councils or signing petitions. Relatively few main road residents actually resorted to complaint activity, which supports the contention of Taylor, Gertler and Hall (1979) that complaint activity is a poor indicator of annoyance. If Taylor and Hall's (1977) finding that higher status groups are more willing than other groups to make complaints is accepted, then differences in complaint activity should not be expected in this study since the two sample groups have essentially similar occupation distributions, a surrogate for social status.

Short-term actions differed significantly between the two sample groups, with main road residents performing a greater number of these actions which commonly included closing windows, increasing the volume of television or radio, or staying indoors, actions which are similar to those noted by Griffiths and Langdon (1968). These findings support the discovery by Taylor, Gertler and Hall (1979) that short-term actions are better indicators of annoyance than complaint activity.

No statistically significant differences in attitude to main road traffic noise among main road residents were noted by sex, age, occupation, mode of transport for the journey to work or length of residence. However, within the control street group significant differences in attitude were noted by age, occupation and length of residence. These results are partly supportive of Langdon's (1968) finding that annoyance is not related to occupation or income, and of Gamble et al.'s (1974) finding that neither sex, nor age are determinants of annoyance. However the latter study did indicate that people who were frequent highway users were more annoyed by noise, dust and odours than infrequent highway users, a result which is at variance with the lack of difference in attitude to main road traffic noise among users of different modes of transport for the journey to work in Sydney.

In summary, main road traffic noise exhibited a significant though minor effect on house prices in both main roads and control streets, and residents have indicated a difference in attitude to main road traffic noise which directly reflects distance from the main roads.

A number of points can be made about the methodology used in this study. The first is that the objective of this thesis was to examine the economic and social impact of main road traffic noise in Sydney, rather than to study the composite effects of main road externalities. However, even given the more limited aim of this study a number of weaknesses are evident in the methodology.

The study was confined to a small number of study sites, a factor resulting not from a desire to limit the study task, but from the observation that there were only nine suitable study sites across Sydney. Additionally, the distribution of these sites was relatively restricted, with no suitable sites observed in the Western Suburbs of Sydney. Of those sites finally chosen for study, some permitted only limited analysis due to the small number of property transactions. Other sites were influenced by intrusions from noises other than traffic noise, notably aircraft noise. Inevitably the variation in the number of property transactions at each of the sites meant that the results of the aggregate data analysis were generally biased in favour of the larger data sets, and, therefore, should be treated with caution.

However, it has been possible to demonstrate that both in the short- and long-run that house prices on main roads differ significantly from house prices on control streets. Such variations are accounted for by a range of main road characteristics, with the role of noise being significant but minor. The household questionnaire proved a valuable exercise in identifying the relative significance of noise as a minor factor in residents' decisions to buy their houses, and as a factor disliked about the neighbourhood. The questionnaire indicated a number of other main road characteristics which may account for variation in house prices: volume of traffic, distance to public transport, air quality, industrial traffic and differing accessibility to key local amenities.

The decision to use three models to represent the long-run trends of house prices proved a sound methodology. However, even these models were unable to account for differences in growth rates between main roads and control streets at five of the study sites, and more importantly were able to explain less than 50 per cent of the variation in growth rates for five of the data sets. Indeed the natural logarithmic model which was the best predictor of growth trends for the aggregate data set, all parallel streets, was able to account for only 45 per cent of variation in growth rates. This study demonstrated the need to be flexible in approaching any long-run investigation of house prices in any market as volatile as that of Sydney in recent years.

With regard to the model of Residential Response to Main Road Traffic Noise (Fig. 2.5), it appears that although main road traffic noise was one of the main factors disliked by main road residents, it is only a minor issue in most residents' day to day existence. The large number of main road residents who claimed to find main road traffic noise disagreeable, did not reflect that attitude, either when reporting the impact that noise had had on their activities or on their health, and similarly, they did not report carrying out a large number of actions designed to minimize the effect of that noise. It was not possible to differentiate between residents on the basis of factors which could be expected to explain their attitudes to main road traffic noise. The model of Residential Response to Main Road Traffic Noise was not successful in accounting for differences in the impact of traffic noise on residents, their response to that impact or their attitudes to main road traffic noise.

The household questionnaire suffered from a number of weaknesses. Differentiation between main road traffic noise, local traffic noise and neighbourhood noise was not sufficiently clear and some respondents were obviously confused. Use of a mail questionnaire increases the possibility that residents uninterested in the subject of the survey may exhibit higher than average rates of non-response. Both these weaknesses may have been overcome had the questionnaire been administered in person.

The current work could be extended in a number of ways. Firstly, a much broader investigation of the effects of main road traffic noise could be achieved if a range of traffic conditions were examined. These could include the freely flowing traffic conditions used in this study, non-freely flowing traffic conditions (Langdon, 1976a, 1976b; Taylor, Breston and Hall, 1982) and expressway conditions (Hitchcock and Waterhouse, 1982). In addition, a more comprehensive understanding of the attitudes of householders to main road traffic noise could be obtained by a survey of residents living in a greater number of areas than considered in the present study. It may also be possible to establish a critical noise level above which economic or social impacts are felt by a significant number of residents.

Secondly, an investigation of the composite effects of main road externalities could be achieved with the inclusion of a number of other main road characteristics. These factors could include air pollution indicators including dust and odours, distance to key local and regional facilities, number of accidents, traffic volume and mix and traffic related disturbances such as vibration of houses. Work of this nature would allow an appreciation of the relative importance of various main road characteristics in determining differences in house prices between main roads and parallel streets (or other main roads), and would widen the explanation of residents' attitudes to main road externalities.

Thirdly, a fuller appreciation of the contribution which main road characteristics make to variations in house prices across Sydney might result from the inclusion of a large number of price determining factors. These factors could include more housing attributes, and a number of indicators of main road externalities mentioned previously. Indeed, it may be constructive to investigate the effect which various main road characteristics have on prices of a number of house types and tenure arrangements. This would enable the identification of groups of residents who are affected adversely by main road externalities.

Finally, residential response to traffic noise and other main road characteristics should be investigated not as a composite response, but rather by comparison of different social, economic or regional groups. Additionally, a thorough investigation of medical complaints and stress resulting from exposure to main road traffic noise may be instructive.

This study has afforded many findings which may provide a useful input into policy and planning decisions. Three of these findings may be instructive to planners: firstly, many residents demonstrated a need to provide some type of shielding, such as hedges or fences to reduce the impact of main road traffic noise; secondly, main road traffic noise had a significant though minor depressive effect on house prices; and thirdly, a significant number of main road residents had sought medical complaints resulting from exposure to main road traffic noise. These findings could prove useful in a number of planning issues, including discussions of compensation for negative impacts associated with new or upgraded transport corridors, and for design standards of main roads and residential developments.

This study has shown that the economic and social impacts of main road traffic noise are variable across Sydney, and in certain locations there are considerable depressive price effects resulting from the combined externalities of main roads. An attempt was made to extend knowledge of socio-economic impacts of main road externalities, and it is obvious that the impacts of main road traffic noise in Sydney are similar to those experienced in Britain, Canada and the United States. Although this work has only scratched the surface of a broad research problem, it has established the economic variations resulting from main road externalities and the impact of main road traffic noise in both economic and social terms.

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APPENDIX A

THE SURVEY QUESTIONNAIRE

THE UNIVERSITY OF NEW SOUTH WALES

P.O. BOX 1 • KENSINGTON • NEW SOUTH WALES • AUSTRALIA • 2033
TELEX AA26054 • TELEGRAPH: UNITECH, SYDNEY • TELEPHONE 663 0351
EXTN. 3675

PLEASE QUOTE

School of Geography

Dear Resident

This questionnaire is intended to gain information on the way that environmental factors affect residents and their lifestyles within the Sydney Metropolitan Area. It is being distributed as part of a wider study being undertaken on transportation facilities in the School of Geography at the University of New South Wales.

The research is being carried out in nine different areas, which have been selected to provide a coverage of residential areas within Sydney. A random sampling technique has been used to choose a group of dwellings to which the questionnaire should be distributed.

The questionnaire should take between ten and fifteen minutes to complete. Please be assured that all replies will be treated with the strictest confidence and that all replies will be aggregated for analysis. This survey is completely anonymous and therefore please do not sign your name.

Your co-operation in answering this questionnaire is greatly appreciated. You are welcome to ring 662 3675 if you have any problems, or queries about the questionnaire.

Yours sincerely

Dr Andrew Holsman
Senior Lecturer

Robyn Bradley
Research Assistant

INSTRUCTIONS FOR QUESTIONNAIRE

Please follow these instructions when answering the questionnaire:

1. One adult, preferably an owner of the house, is requested to answer the questionnaire.

2. The questionnaire is divided into four (4) parts, please answer them in the order you find them.

3. If you do not wish to answer any question, leave it and go on to the next question.

4. If there is any question to which you cannot provide an answer, leave it blank and continue with the questionnaire.

5. Most of the questions require that you tick the appropriate answer(s), although there is room for additional answers or comments.

6. Once you have completed the questionnaire, please place it in the envelope provided and post it as soon as possible.

NEIGHBOURHOOD ENVIRONMENT QUESTIONNAIRE

PART ONE: THE DECISION TO BUY YOUR HOME

1. Which factors were important to you when you bought your house? (Rank using 1 for the most important, 2 for the next important and so on. Fill in as many boxes as needed.)

   Cost of house ☐
   Quiet neighbourhood ☐
   Distance from schools ☐
   Distance from work ☐
   Air quality ☐
   Distance from relatives or friends ☐
   Quality of house ☐
   Distance from shops ☐
   Distance from recreational facilities ☐
   Distance from public transport ☐
   Distance from main roads ☐

   Other (please specify) ....

2. Which things do you dislike about your neighbourhood? (Rank using 1 for the most disliked, 2 for the next most disliked and so on. Fill in as many boxes as needed.)

   Quality of house ☐
   Distance from shops ☐
   Distance from schools ☐
   Distance from work ☐
   Distance from main roads ☐
   Air quality ☐
   Disturbing neighbourhood activity (e.g. dogs, stereos) ☐
   Distance from recreational facilities ☐
   Distance from public transport ☐
   Industrial activity ☐

   Other (please specify) ....

3. How long have you lived in this house? ....

   ....

4. Are you intending to move in the next year? If so, please list your major reasons for moving.

   ....

   ....

PART TWO: NOISE IN YOUR NEIGHBOURHOOD

5. Which noises do you notice when you are at home? (Rank using 1 for the most noticeable, 2 for the second most noticeable and so on. Fill in as many boxes as needed.)

- Domestic noises (e.g. dogs) ☐
- Local traffic noise ☐
- Aircraft noise ☐
- Industrial noise ☐
- Garden machinery noises ☐
- Main road traffic noise ☐
- Railway noises ☐
- Institutional noise (e.g. schools, hospitals) ☐

Other (please specify) ....

6. Which days, and time of day do you notice main road traffic noise at home?

Time / Day	6.30am-9.30am	9.30am-11.30am	11.30am-2.30pm	2.30pm-4.30pm	4.30pm-7.30pm	7.30pm-10.30pm	10.30pm-6.30am
Weekdays							
Saturday							
Sunday							

Tick (√) those times and days when you notice main road traffic noise while you are at home.

IF THERE ARE NO TIMES WHEN YOU NOTICE MAIN ROAD TRAFFIC NOISE GO TO Q.14.

7. Does main road traffic noise interfere with any of the following activities? (Rank using 1 for the most interference, 2 for the next most interference and so on. Fill in as many boxes as needed.)

- Talking inside house ☐
- Watching television ☐
- Sleeping ☐
- Working inside house ☐
- Talking outside house ☐
- Telephone conversations ☐
- Eating ☐
- Working outside house ☐

Other (please specify) ....

8. When main road traffic noise disturbs you, which action(s) do you take? Please tick.

Close windows	☐	Turn up TV, radio etc.	☐
Stay indoors	☐	Wait for noise to stop	☐
Wear earplugs	☐	Turn on air-conditioning	☐

Other (please specify) ....

9. Have you taken any action(s) to avoid being generally disturbed by main road traffic noise? Please tick.

Installed air-conditioning	☐	Installed insulation	☐
Installed double glazing	☐	Installed walls or fences	☐
Planted trees or hedges	☐		

Other (please specify) ....

10. Has main road traffic noise caused <u>you</u>, or <u>any other members of your household</u>, to suffer any illnesses? Please tick.

Headaches	☐	Irritability or stress	☐
Nervousness	☐	Interrupted sleep	☐
Hearing difficulties	☐		

Other (please specify) ....

11. Please list those complaints caused by main road traffic noise, for which <u>you</u>, or <u>any other member of your household</u>, have sought medical treatment.

....

....

....

....

12. Which action(s) have you taken to complain about main road traffic noise? Please tick.

- Complaint to local council ☐
- Complaint to local politician ☐
- Complaint to State politician ☐
- Complaint to Federal politician ☐
- Complaint to Government Department ☐
- Letter to newspaper ☐
- Formed a protest group ☐
- Joined a protest group ☐
- Signed a petition ☐

Other (please specify) ....

13. Does the presence of a main road cause you to worry about the possibility of any of the following events? Please tick.

- Pedestrian accidents involving yourself ☐
- Pedestrian accidents involving your children ☐
- Pedestrian accidents involving your pets ☐
- Restricted access to your home by car ☐
- Road accidents involving your family ☐
- Road accidents involving yourself ☐

Other (please specify) ....

14. How do you rate main road traffic noise in your neighbourhood? Please tick.

- Extremely agreeable ☐
- Moderately agreeable ☐
- Slightly agreeable ☐
- Neutral ☐
- Slightly disturbing ☐
- Moderately disturbing ☐
- Extremely disturbing ☐

PART THREE: SOME QUESTIONS ABOUT YOURSELF

15. What is your sex? Please tick.

Male ☐ Female ☐

16. How old are you? Please tick.

18-25 years ☐ 26-40 years ☐

41-65 years ☐ 65 years or over ☐

17. What is your occupation? (What sort of work do you do?) If you are a housewife, what occupation does your husband have?

....

....

18. How do the wage-earners in your house travel to work?

Mode of Travel / Person	Walk	Car	Bus	Bus and Train	Other (please specify)
1					
2					
3					
4					
5					

Tick the column which best describes how each wage-earner gets to work each day (that is, their major form of transport.)

19. How many hours do you normally spend at home each day? (Please estimate for a 24 hour day and include sleeping time.)

Number of Hours / Day	0 - 5	5 - 10	10 - 15	15 - 20	20 - 24
Weekdays					
Saturday					
Sunday					

Tick the column which best describes how many hours you spend at home on each of the days listed.

PART FOUR: SOME QUESTIONS ABOUT YOUR HOME

20. Where is your house located? Please tick.

Main road ☐ Local street ☐

21. What is the best description of your house? Please tick.

Separate house ☐ Semi-detached house ☐

Terrace house ☐ Home-unit ☐

22. How old is your house? (If you are uncertain, please estimate.)

....

23. How many rooms are there in your house? (Write the number of each type of room.)

Bedroom(s) ☐ Permanently enclosed sleepout ☐

Bedsitting room ☐ Combined lounge/dining room ☐

Dining room ☐

Kitchen ☐ Lounge ☐

Family room ☐ Bathroom ☐

Business office ☐ Study ☐

Other (please specify) ....

24. How many of the following items are included in the grounds of your home? (Write the number of each item.)

Garage(s)	☐	Self-contained flat	☐
Laundry	☐	Carport	☐
Tennis court	☐	Workshop	☐
Rumpus room	☐	Swimming pool - above ground	☐
		- below ground	☐

Other (please specify) ....

25. What is the material of the outer walls of the house? Tick as many boxes as you need.)

Brick	☐	Brick veneer	☐
Stone	☐	Concrete, concrete block	☐
Timber	☐	Metal	☐
Fibro, asbestos	☐	Stucco	☐

Other (please specify) ....

26. What is the material of the roof of your house? (Tick as many boxes as you need.)

Tile	☐	Slate	☐
Tin	☐		

Other (please specify) ....

27. List any rooms or items in the grounds of your house which have been added since the time of purchase (e.g. extra bedroom, workshop).

....

....

28. List any general improvements (e.g. painting or landscaping) which have been made to your house since the time of purchase.

....

....

APPENDIX B

Site diagram of Princes Highway (Site 8)