THE ENVIRONMENTAL NOISE EXPOSURE OF SCHOOLS AROUND HEATHROW

Gaël Vilatarsana

Msc **2004**

The Environmental Noise Exposure of Schools around Heathrow

by

Gaël Vilatarsana

A thesis submitted in partial fulfilment of the requirements for a Master of Science degree in Environmental and Architectural Acoustics at South Bank University

January 2004

School of Engineering , Systems and Design
South Bank University, Borough Road, London, SE1 OAA, UK

ABSTRACT

The noise exposure of 35 schools in Hounslow, near Heathrow Airport, has been investigated to determine the effects of noise on schoolchildren. A noise survey was conducted and 5 minute sample measurement were recorded at each school. A subjective assessment of the noise climate was also carried out. The results indicated the schools are chronically exposed to noise levels which are extreme in environmental noise. 91% of the schools investigated have external noise levels that exceed World Health Organisation guidelines for playgrounds. 74% of the schools have external noise levels that regularly exceed 80dB(A). Noise inside the classroom was also found to be considerably above current legislation and the classroom speech intelligibilty was compromised in most schools even with shut windows. The effects on children were evaluated by correlating the Key Stage 1 Standardised Asssessment Tests results with the noise levels. Correlations were adjusted to remove the effects of social background and language spoken and showed a strong relationship between aircraft noise and Reading scores. The detrimental effects of aircraft noise appeared to be from its high number of peak noise levels. These results were found to be in line with the findings of previous major study on the effects of noise on children's performance at school.

ACKNOWLEDGEMENTS

I would like to say thank you to Pr Bridget Shield of South Bank University for the advices and support. I would like to thank Hounslow Council for providing the school data.

CONTENTS

INTRODUCTION

Silence please! We can all remember our schoolteacher repeating these two words over and over. But the teacher's effort to obtain some quietness from their audience to create an environment conducive to concentration and listening may be in vain when noise from aircraft flyovers create interference every two to three minutes. This situation is the day to day reality of most of the schools in Hounslow due to the proximity of Heathrow International, the busiest airport in Europe.

This study aims at evaluating the noise climate surrounding schools in Hounslow and to analyse its effects on children. Indeed, how much and in what way are the school children affected by chronic noise exposure? Does the noise reduce the standards of education they receive? Are the noise levels high enough to affect their academic results?

This dissertation is based on a large field investigation of noise levels and subjective assessment of the noise climate at 35 schools along with a review of the current knowledge on the effects of noise on children. The study considers all type of noise exposure and try to identify which has the most detrimental effects. A cross-comparison with similar study in other London Boroughs is also carried out. Internal noise levels are estimated and compared against current guidelines and legislation and noise levels are assessed against criteria speech intelligibilty criteria.

Finally to determine whether a dose-response relationship exists between noise levels and academic achievements of children, the noise levels are correlated with standardised assessment tests with adjustements to remove social and languages effects.

Chapter 1

The effects of noise

1.0 INTRODUCTION

Human response to noise can have direct physiological effects and indirect effects which may or may not be health related.

The direct effects on the human body are rare in environmental noise exposure as the levels above which physiological effects occur are rarely reached. Indeed, physiological effects occur with sounds reaching peak overpressures of a fraction of one bar within a few milliseconds such as noise caused by explosions, gunfire or impulsive industrial processes. The effects can be direct physical disruption of the eardrum or other part of the ear, which in turn leads to a loss of auditory nerve sensitivity and can result in temporary or permanent reduction in hearing capacity. These physiological effects are also known to occur with long term exposure to high noise levels.

According to the World Health Organisation (WHO) document on 'Community Noise' [1], there is no identifiable risk of hearing damage, i.e. physiological effects, in noise levels of less than 75dB $L_{Aeq,8h}$. A research survey carried out by the Building Research Establishment [2] in 1990, indicated that 60% of the population of England and Wales were exposed to community noise levels outside their houses of between 50

and 60dB $L_{Aeq,16h}$ (equivalent to an exposure of 53 to 63dB $L_{eq,8h}$) and that the proportion exposed to outside noise levels exceeding 70dB $L_{Aeq,16h}$ (equivalent to 73dB $L_{eq,8h}$) was around 2%.

On this basis it is reasonable to assume that community noise does not typically exceed the threshold levels above which risk of hearing damage can occur. Thus, environmental noise exposure has no direct physiological effect on the human body.

While the physiological effects of noise are well known but rare, the indirect effects of lower but chronic noise exposure levels have been the subject of many research studies and debate in the world of acoustics and psychology. There is evidence that excessive exposure to noise leads to long-term annoyance, increase stress, interferes with activity and reduces performance.

The most common negative effect of noise is its interference with communication. The following section describes the relation between noise and speech interference. In section 2, interference with activity and performance is considered. A review of the literature on the effects of noise on children has been conducted and is presented in section 3 and the chapter concludes by a review of the current guideline and legislation documents in the United Kingdom associated with noise effects.

1.1 NOISE AND SPEECH INTERFERENCE

Speech intelligibility is defined as the proportion of words or sentences which are correctly understood. External noise in the presence of reverberent sound field can create interference in speech and reduce its intelligibility. In an environment where communication is a prime activity such as in schools the noise exposure has inevitably an effect on the listener's capacity to understand what is being said. In the case of environmental noise exposure the level of interference with speech communication depends principally on the level of external noise, the level of speech and the distance between speaker and listener.

Table 1.1 below, extracted from BS8233[3], indicates the maximum level of background noise to ensure adequate speech intelligibility.

Distance from speaker to listener (m)	Normal voice	Raised voice
1	57	62
2	51	56
4	45	50
8	39	44

Table 1.1 : Maximum steady noise in dB(A) for reliable speech communication

For example we can observe from Table 1.1 that in a classroom, if the teacher speaks with a raised voice and the furthest pupil is 8 m away, then a maximum noise level of 44 dB(A) is required to avoid interference which would compromise intelligibility of speech.

1.2 INTERFERENCE WITH ACTIVITY

Noise clearly causes direct interference with any form of activity that involves speech communication as shown in section 1.1 above. But noise also inteferes with activity which requires task performance. If the activity involves auditory signals, obviously any noise interference masking the signal will creates a disturbance to the activity and may reduce performance.

It is more difficult to evaluate the interference when the activity does not involve an auditory signal. In general, noise acts as a distracting stimulus and therefore would tend to affect more mental activities than physical ones. Research on this subject has shown averse effects. Basically, all performance, whether mental or motor can be affected by noise and the effect is increased as the task becomes more complex and as the duration or the intensity of the noise increases. Glass and Singer [5] carried out experiments in 1972 which identified a higher number of mistakes in mental tasks with intermittent noise stimuli when compared with the tasks conducted in the absence of noise. Furthermore, noise interferes with concentration and relaxation, but not all types of noise have the same effects. Research carried out by Hygge[4] in 1993 showed the effects of different type of noise sources (aircraft, road traffic and speech). The experiments revealed that aircraft and speech created the strongest interference with concentration.

BS 8233[3], the current British Standard in the United Kingdom for noise insulation in buildings, provides some recommended internal ambient noise levels for different levels of activity.

Criterion	Typical situation	Design range $L_{Aeq,T}$ in dB
Reasonable industrial working conditions	Heavy engineering	70 – 80
	Light engineering	65 – 75
Reasonable speech or telephone communications	Cafeteria	50 – 55
	Corridor	45 – 55
Reasonable conditions for study and work requiring concentration	Library, office	40 – 50
	Meeting room	35 – 40
Reasonable listening conditions	Classroom	35 – 40
	Lecture theatre	30 – 35
Reasonable resting/sleeping conditions	Living rooms	30 – 40
	Bedrooms	30 – 35

Table 1.2 : Ambient noise levels and activity

It can be noted from Table 1.2 that generally lower ambient noise levels are recommended for cognitive or intellectual tasks. This would indicate that intellectual tasks have a lower tolerance to noise compared to physical ones.

1.3 THE EFFECTS OF NOISE ON CHILDREN - LITERATURE REVIEW

Activity and communication are essential features in the development of a child. If in a school, learning activities and teaching are interfered with by chronic noise exposure then inevitably the child development will be affected. However, as the concept of noise exposure being detrimental to a child's learning is easy to understand, it has proved difficult to quantify the effects. Most of what we know on the effects on chronic noise exposure on children is from field research and laboratory studies. The section provides a chronological summary of the main publications on the effects of noise exposure on children since 1968.

Michelson[6] in 1968 was probably the first to try to establish a relationship between noise exposure and school children's performance. His work examined the effect of noise exposure on mathematical ability, but the results of his study showed there were no significant effects.

Cohen et al[7] in 1973 demonstrated that noise exposure affects language-based tasks of school children and particularly their reading ability.

Crook and Langdon[8] in 1974 considered the effects of external noise on schools. Their study revealed that teachers in schools around Heathrow airport had different behaviour patterns than other teachers mainly because aircraft noise was a major source of interference with their speech.

Bronzaft and McCarthy[9] in 1975 compared the reading scores of two groups of school children. The first group was located in classroom adjacent to a railway line, the other group was in a classroom which was not affected by train noise. The study found that lower reading scores were obtained from children exposed to the railway noise. The study also discovered that the effects of noise varied with age, with older school children's reading ability being more affected.

Maser et al[10] in 1978 found that noise exposure had a detrimental effect on school children's ability in Mathematics.

Cohen et al[11] in 1980 conducted the first major airport study. Aircraft noise exposure was associated with poor long term memory, reading comprehension and reduced motivation. The study was the first to identify that chronic exposure as opposed to acute exposure was associated with reduced academic performances of children.

Cohen et al[12] in 1981 were the first to observe a relationship between environmental noise exposure levels and standardised school tests. Their study demonstrated the long term effect of noise exposure by proving that children reading ability was still affected after exposure had stopped.

Bronzaft[13] in 1981 followed up her 1975 study (Bronzaft and McCarthy[9]) by re-testing both groups of children after noise abatement measures had been implemented and railway noise was reduced by 6-8 dB inside the classroom. The results of reading tests showed similar scores in both groups.

Lukas et al[14] in 1981 produced a noise abatement program and established criteria for road traffic noise intrusion in schools in California. The study established the detrimental effect of road traffic noise exposure and reading ability of school children.

Green et al[15] in 1982 conducted the most comprehensive airport study to date by correlating school achievement tests of 362 schools with noise levels. They demonstrated a dose-response relationship between

school children's test results and noise levels by observing that the percentage reading below grade level increased as noise level increased. The study also corroborated the Bronzaft and McCarthy[9] study which proved that older school children are more affected by chronic noise exposure than younger ones.

Hetu et al[16] in 1990 conducted a wide review of literature and researches on the negative effects of chronic environmental noise exposure on school children's reading ability. They found that background levels which interfered with speech were a significant handicap in learning how to read.

Hygge[4] in 1993 carried out a series of experiments in classrooms by testing long term recall and recognition of 12-14 years old children when separately exposed to 66 dB(A) of aircraft, road traffic and train noise. The experiment allowed Hygge to conclude that aircraft and road traffic noise affected long term recall but train noise had no siginificant effect.

Sanz et al[17] in 1993 considered in his study primary and secondary schools which were exposed to road traffic noise levels of around 70 dB(A). They found that children's exposure to noise reduced children capacity of concentration.

Berglund and Lindvall[18] in 1995 conducted a study that in turn would provide criteria for establishing the World Health Organisation guidelines on community noise. Their study confirmed previous findings that noise exposure appears to affect children more as they become older.

Haines and Stansfeld[19] in 1996 and again in 1997 conducted noise measurements inside primary schools around Heathrow airport at the time of testing of children. The test results were adjusted for age, social deprivation, and main language spoken. Results showed higher noise exposure was related to lower mental health, lower cognitive performance and higher stress response.

Hygge and Evans[20] in 1997 conducted a major study on the Munich Airport. This study is particularly interesting as the relocation of the airport gave the opportunity to test children before and during exposure to noise and vice-versa. A total of 326 children took part in data collection before and after the switch over of airports. Long-term memory and reading were impaired in the children at the new airport and improved in the formerly noise exposed children at the old airport. Overall, Hygge and Evans have highlighted in this study the negative effects of chronic environmental noise exposure on reading ability and long term memory. The nature of this study was also able to demonstrate that the effects of chronic exposure are reversible after long periods.

Evans and Maxwell[21] in 1997 showed that the detrimental effects of noise on school children's reading abilities is more apparent in situations of chronic exposure.

Mackenzie[22] in 2000 looked at the effect of background noise level on children's academic performance. The study showed that excessive background noise level affects word intelligibility in classrooms.

Haines and Stansfeld[23] in 2001 conducted a multilevel modelling of the effects of aircraft noise on performance tests in schools around Heathrow. The study established a dose-response function between Heathrow airport noise contours and reading and mathematics tests. This study is explained further in Chapter 2.

Shield and Dockrell[24] in 2001 observed in their study a relationship between external/internal noise levels and SATs results based on a field survey in three London boroughs. The research showed stronger correlation between internal noise levels and test results. This study took into account for the first time the combined environmental noise sources that can be heard in classrooms and provided the latest evidence of the detrimental effect of environment noise exposure on child development. This study is also detailed further in Chapter 2.

1.6 GUIDELINES AND LEGISLATION

In 2003 the Department for Skills and Education published Building Bulletin 93 'Acoustic design for schools'[25], also called BB93. In terms of acoustics it replaced Building Bulletin 87 'Environmental Design Criteria for Schools'[26], also called BB87. BB93 provides design guidelines for internal noise levels, airborne and impact sound insulation, reverberation times and speech intelligibility criteria in educational buildings. New schools are required to comply with BB93 to meet the requirements of Approved Document E edition 2003 of the Building Regulations 2000.

The World Health Organisation (WHO) has produced a guidance document 'Guidelines for Community Noise'[1] which is used as a reference document to eveluate the impacts of community noise. In this

document the aspects of noise in relation to interference with speech communication, mental-health and performance effects are considered. The effects on performance are particularly relevant to a school environment. The WHO states that there have been few if any detailed studies of noise on human productivity in real-life situations. According to WHO noise acts as a distracting stimulus which causes interference with many kinds of tasks. It states “mental activities involving vigilance, information gathering, and analytical processes appear to be particularly sensitive to noise”.

BS 8233:1999, ‘Noise insulation in Buildings – Code of Practice’ [3] is a widely used standard for the design for noise control in buildings. It provides some recommended internal noise levels in relation to the activity as explained in section 1.2.

The speech inteligibilty criteria relevant to a school environment from the various guidelines and legislative documents described above are compared in Table 1.3 below:

Reference document		Date	$L_{Aeq,T}$ for good speech intelligibility
WHO	Guidelines for community Noise	1995	$L_{Aeq,T}$ 45 dB indoor
BB87	Environmental design criteria guidelines in educational buildings	1997	$L_{Aeq,1h}$ 40 dB in classrooms
BS 8233	Sound Insulation in Buildings - Code of Practice	1999	$L_{Aeq,T}$ 40 dB indoor
BB93	Acoustic Design for Schools	2003	$L_{Aeq,30\ min}$ 35 dB in classrooms

Table 1.3 : Comparison of ambient noise level for speech intelligibility criteria

1.7 CONCLUSION

In the community, the environmental noise essentially affects speech communication. In general, activities which involves mental tasks have reduced capabilities when exposed to noise. Certain noise sources such as aircraft would appear to have more effects than others. The effects of noise on children's performance have been subject to a large number of studies and the combined findings could be summarised as follows:

- Chronic noise exposure affects reading ability, long-term memory, reading comprehension and capacity of concentration.
- The effects of noise vary with age. Academic performance of older children are more affected by noise than that of younger children.
- There is a dose-response relationship between noise exposure and academic achievements. Indeed, performance reduces as the exposure increases.
- Noise effects are long-term and can continue even after exposure has stopped, however, the effects can be reversed.
- Different effects for different type of noise sources have been found. Aircraft and road traffic noise have the most detrimental effects.

Over the years, as the detrimental effects of noise exposure became more and more documented and understood, guideline documents reduced their recommended noise levels in situations where speech communication was a prime activity (such as in schools). Legislation

changed toward more stringent criteria with the latest example being the 35dB $L_{Aeq,30min}$ requirement of BB93 for noise levels in classrooms.

Chapter 2

Case studies

2.0 INTRODUCTION

This chapter presents three case studies, which investigate the effects of environmental noise exposure on children.

Case Study 1 is titled “Traffic noise annoyance in schoolchildren: dose-response functions from field and experimental studies in the Alpine area of Tyrol” [27] and was carried out by P Lercher, M Meis and W Kofler. This study considers the adverse effects of road traffic noise on children’s general well being.

Case Study 2 is titled “Multilevel modelling of aircraft noise on performance tests in schools around Heathrow Airport London” [23] and was conducted by M Haines, S Stansfeld and J Head. This laboratory study was carried out in 2001 and correlates the Heathrow airport noise contours with schoolchildren SATs results.

Case Study 3 is titled “The effects of noise on the attainment and cognitive performance of primary scholl children” [24] and was carried out in 2002 by B Shield and J Dockrell. This study considers the effects of different type of noises on children academic performance by varying the type of noise source and considering various acoustic parameters and investigates the children ‘s perception of noise and annoyance.

2.1 CASER STUDY 1

Traffic noise annoyance in schoolchildren: dose-response functions from field and experimental studies in the Alpine area of Tyrol. [27]

This study was presented at the “Noise Pollution : Health Effects on Children” conference held in Berlin on 5-7th October 2002.

The study collected data from two surveys conducted in the Inn valley east of Innsbrcuk, Austria. A large representative sample (N=1280) from 26 local schools provided the field data and a sub sample (N=125) from this larger sample was additionally tested in a mobile sound attenuated laboratory.

The quality of living environment was assessed by a four-graded response scale. Children filled in the questionnaire in the classroom under standardised guidance of trained supervisors. Information on socio-demographic data, housing, children’s activities and health were obtained in parallel from a self administered mother’s questionnaire. Main sources of noise exposure were a central freeway with a network of main roads linking the smaller villages and a railway line with many heavy goods trains which operates also throughout the night time.

Noise exposure was assessed by modelling and calibration, through measurements from 31 sites according to Austrian guidelines. Based on both data sources approximate day-night levels were calculated for each respondent for each noise source to ease comparison with typical dose-response data. Exposure and questionnaire were then individually linked via a geographic information system.

The results showed that in the representative study a larger percentage of children was annoyed by car traffic than by rail traffic noise. However, safety concerns towards road traffic ranked higher than disturbance by noise. The dose-response curve from the larger study revealed stronger annoyance from road noise at lower levels (<50 dB(A)), while responses towards rail traffic rose sharply above 55 dB(A) and overtook the reported annoyance by road traffic noise. Among the modifying factors satisfaction with the social environment had the strongest impact, while housing factors played a role in a road noise exposure situation mainly.

The laboratory sample showed an identical annoyance response at the lowest (50 dB(A)) and the highest (80 dB(A)) exposure level with higher responses for rail traffic in between 60 and 70 dB(A).

The outcome of this study is that rail exposure during the night can lead to an overall loss of the rail bonus above 50 dB(A) while safety concerns toward road traffic dominate daytime annoyance over noise annoyance. The study gave an indication that the variations in the annoyance response due to the living context is more pronounced in children. This may reflect the greater dependence of the child on an optimal environment for its development.

2.2 CASE STUDY 2

Multilevel modelling of aircraft noise on performance tests in schools around Heathrow Airport London[23]

The aim of the study was to examine the effects of chronic exposure to aircraft noise on children's performance. 1996 and 1997 results of National Standardised Scores (SATs) in Mathematics, Science and English of 11,000 children in year 6 from 123 schools around Heathrow airport were considered. Aircraft noise exposure data from the 1994 Civil Aviation Authority aircraft noise contour maps were used. Noise data from the $L_{eq,16hour}$ contour maps were grouped in eight noise exposure levels. Schools were assigned into one of the eight aircraft noise exposure levels depending on their location and a cross sectional study was carried out. Multilevel modelling was selected for the statistical analysis as it produces correct standard errors and significance tests. Variables at school level and pupil level can be included in the same model. The variables included in the analysis were:

School Level factor:

- Aircraft noise exposure
- Percentage of pupils eligible for a free school meal
- Percentage of pupils statement with special needs
- Percentage of pupils with English as a second language
- Type of school

Pupil Level factor:

- English performance score
- English sub-tests (spelling, handwriting, creative writing, reading)
- Mathematics performance score

- Sex
- Year of testing
- Date of birth

The results showed that in general, the higher the noise exposure category the higher were the percentages of pupils:

- Eligible for free school meals
- with English as a second language

Results showed the relation between English scores and noise exposure is statistically significant for unadjusted data. When the type of school, year of testing and sex are included, the association is no longer significant. When taking into account the percentage of children eligible for free school meals the relation remained non-significant.

It was found that noise exposure affects performance on the reading tests more than any other subtests (spelling, handwriting, creative handwriting). Indeed, performance in reading drops by 0.42 of a mark as noise exposure level bands increase. These relations were also lost after adjustment for free school meals. Results in Mathematics proved to have a stronger relation with noise levels. As noise levels increase by contour band, performance drops by 0.73 of a mark. Here again the association could not be maintained after adjustment for free school meals. Relations between Science results and noise levels were not found to be statistically significant. The outcome from the study was that chronic exposure to aircraft noise was associated with school performance in reading and mathematics in a dose-response function, but that this association is influenced by socio-economic factors. The association with reading more than other tasks in English

suggest that noise exposure affects language-based tasks as opposed to cognitive tasks. Mathematics could be interpreted as a language with its own terms and symbols, this may explain its performance and noise exposure in a similar way to Reading in English.

However, this study associated two factors that may not have a link in time. Indeed, the study assumed the noise exposure the day of the tests was equal to the noise contours. Were they representative of the real noise exposure to the children? Were any of these schools exposed to road traffic and railway noise more chronically than aircraft?

2.3 CASE STUDY 3

The effects of noise on the attainment and cognitive performance of primary scholl children" [24]

The study started with a large noise survey inside and outside 142 schools in the London Boroughs of Islington, Haringey and Lambeth. The aim was to investigate the effects of noise on the attainments and cognitive performance of school children. The noise data were compared to a questionnaire on children's and teacher's perceptions of the school noise climate and correlated to the scores in SATs for individual schools.

Five minute samples of external noise levels at 53 schools were measured. The environmental noise parameters $L_{Aeq,5min}$, $L_{A10,5min}$, $L_{A90,5min}$, $L_{A99,5min}$, $L_{Amax,5min}$ and $L_{Amin,5min}$ were recorded using a A-weighted scale at each site. Measurements were carried out outside the noisisest façade, at the kerbside of the nearest road. Measurement locations were 4m from the facades, where this was not possible

meaurement were corrected to this standard position. Types of noise sources heard during the survey were recorded and are shown in Figure 2.1 below.

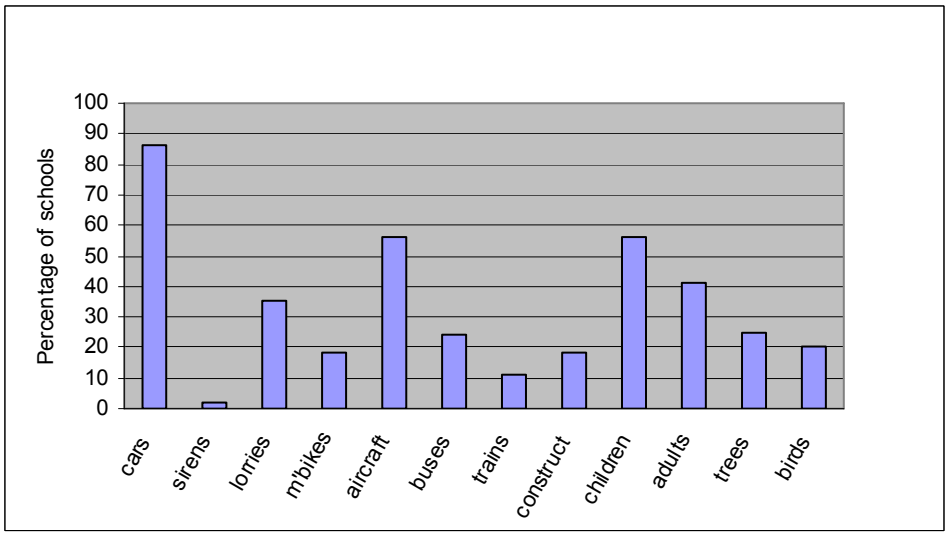


Figure 2.1. Noise sources outside primary schools

The study found that most London primary schools are exposed to high levels of external noise, mainly caused by road traffic. 65% of the schools were exposed to levels in excess of the World Health Organisation guidelines for noise outside schools, and 86% were exposed to road traffic noise.

In a second part, noise levels inside classrooms were measured, but were dominated by the noise of the children themselves and depended on the teaching activity. External noise interfered with the noise of the children's activity only during quiet activities such as reading.

The questionnaire survey of over 2000 children aged 7 and 11 showed awareness of external noise such as noise from cars and lorries, and that children were annoyed by some particular noises. Awareness of noise was found to be higher with older children but annoyance appeared to affect more the younger ones. The most annoying noises sources were trains, motorbikes, lorries and sirens.

Current guidelines and standards relating to speech intelligibility are based upon adult perceptions. This questionnaire survey was the first large scale survey to investigate children's perceptions of noise, and their own views on ease of listening in the classroom. The results indicated that children of 7 are aware of noise and its effects on their ability to hear, and have definite ideas about acceptable and unacceptable types of noise.

The project also investigated the way in which noise affects children's academic performance at school. SATs results for each of the schools measured were compared with both internal and external noise levels. Significant negative relationships were found between noise levels and SATs scores. Indeed average scores reduced as noise exposure increased. The results highlighted that, for external noise, it was particular noise events such as sirens or lorries passing that had the most effect. Background noise level in a classroom was also significantly related to the test scores. The study was able to demonstrate that 11 year old children were more affected than 7 year old ones. The scatter graphs below shows the relationship between external $L_{Amax,5min}$ levels and Key Stage 2 scores (11years old) in Figure 2.2 and the background noise levels in the classroom against Reading scores in Figure 2.3.

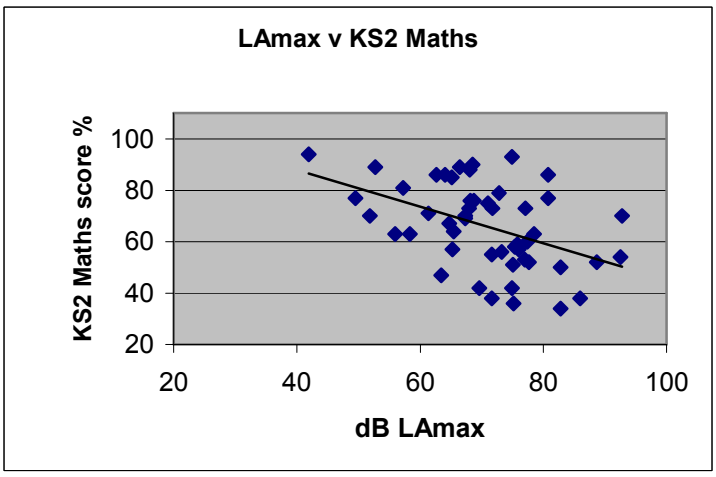


Figure 2.2 Relationship between maximum external noise and Mathematics scores

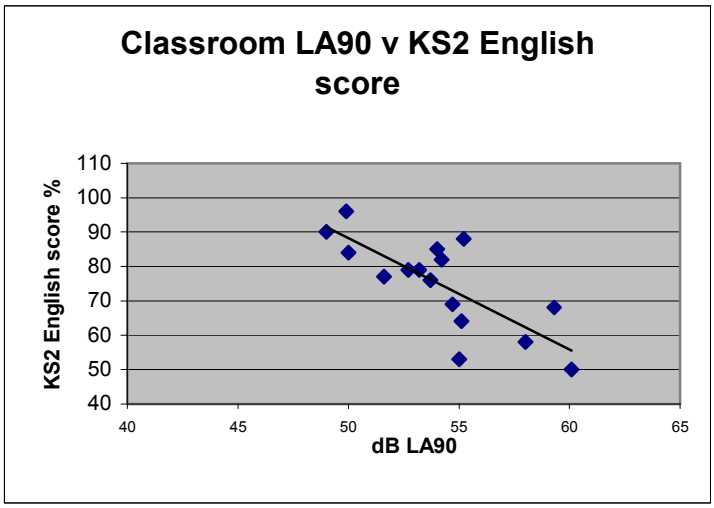


Figure 2.3 Relationship between background classroom noise and English scores

Significant relationship between noise and SATs were still found after data were adjusted to remove the affects of social deprivation and language spoken at home. This was done using the percentages of free school meals given and percentages of children having English as a second language for each school.

Furthermore, the study involved testing the children in the classroom using different noise climate. Figure 2.4 below shows the results of reading capacity in a quiet environment , then with just children's babble and with babble and external noise sources (buses, trains)

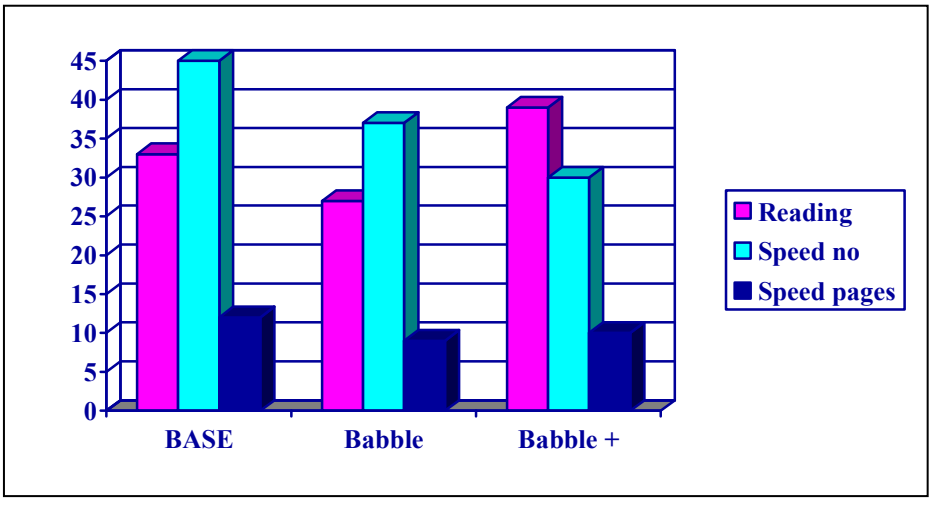


Figure 2.4 : Experimental testing results in different noise conditions

The results showed that classroom babble affected principally reading and spelling whereas non-verbal tasks involving speed of processing were worst affected in the babble plus environmental noise condition.

Overall the study was able to demonstrate that classrooms are affected by external and internal noise and that it has a detrimental effect upon children's academic performance at school. Children are annoyed by the noise and often realise noise affects what they can hear from the teacher. The effects are more significant with older children. Interfering noise events as opposed to constant masking noise appear to have more detrimental effects, especially on reading ability.

2.4 CONCLUSION

Case Study 1 showed stronger annoyance on children from road traffic noise compared to railway noise in general, but with higher noise levels train noise annoyance overcome road traffic and generally annoyance response due to the living context is more pronounced in children.

Case Study 2 showed that noise exposure affects performance on Reading and Mathematics tests in a dose-response relationship. But this association could not be demonstrated once correlations were adjusted for social deprivation.

Case Study 3 showed that children are aware of their noise environment and that specific noise events from outside as well as background noise in classroom affect their ability to perform in tests, with Reading and Mathematics being the most affected subjects.

Chapter 3

Data Collection, Measurement Procedure and Validations

3.0 INTRODUCTION

The survey was conducted in Hounslow outside 36 schools. Appendix 1 shows a map of the area highlighting the schools under investigation. All schools were located on the Eastern side of the Borough. The area under investigation was affected by the flightpaths from and to Heathrow Airport as shown in Figure 3.1 below.

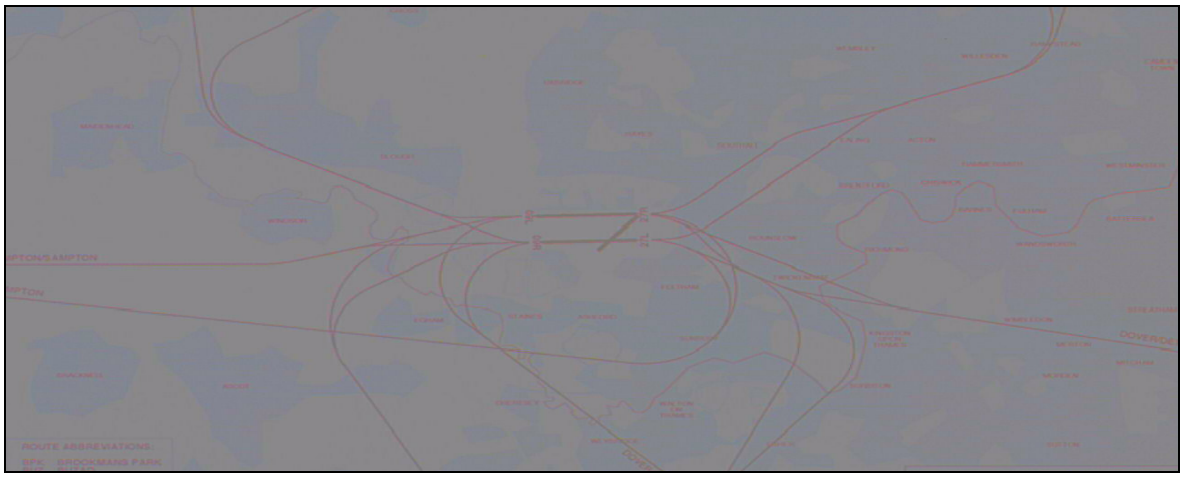


Figure 3.1: 1999 Heathrow Airport flightpaths[28]

In this chapter details of the measurement survey are provided and the data collection method explained. To allow a full assessment to be made, objective and

subjective measurements of the noise climate were recorded on a data sheet at each school.

All measurements were conducted outside the school's premises. Where possible the measurement position was 4m from the façade the most exposed to road traffic. This is to permit comparison of the results with another study in other London Boroughs. When this was not possible a distance correction was applied to the measurement and is explained in Section 3.3. Finally, comparison against published airport noise contours is carried out to provide confidence that the measurement period is representative of the daily noise exposure.

3.1 THE SURVEY

The survey was conducted between the 10th and 21st March 2003. All measurements were conducted during teaching hours. A five minutes sample measurement was taken at each school. The A-weighted acoustic parameters recorded are defined below.

$L_{Aeq,5min}$: Continuous Equivalent Noise Level in dB(A) of a time varying noise is a single figure noise level which over the period of time under consideration contains the same amount of A-weighted sound energy as the time varying noise over the same period of time.

$L_{90,5minutes}$: Sound level in dB(A) that is exceeded for 90% of the measurement time. This parameter is generally used to give an indication of the background noise level.

$L_{10,5minutes}$: Sound level in dB(A) that is exceeded for 10% of the

measuremt time. This parameter is generally used for road traffic noise measurements

$L_{max,5minutes}$: Maximum root mean square A-weighted sound pressure level occurring within the specified period of time.

$L_{min,5minutes}$: Minimum root mean square A-weighted sound pressure level occurring within the specified period of time.

Weather conditions and measurement positions were recorded on the data sheets. A summary of the measurement conditions particular to each school is provided in Table 3.1.

A calibrated hand held sound level meter Type Bruel & Kjaer 2236 was used in all measurements. The sound level meter was held at a height of 1.3m above local ground level.

The survey also included a subjective assessment of the noise climate at the schools by identifying the noise sources. In all cases the prevailing noise sources were aircraft noise and/or road traffic noise. A subjective interpretation of the loudness of the road traffic or planes flying over was noted.

School	Date	Time	Weather	Wind	Distance From meas. position to road in metres	Distance from road to school building in metres
Alexandra Ju.	11-Mar-03	9:51	Cloudy	Moderate	2	60
Spring Grove Prim.	11-Mar-03	10:12	Cloudy	Moderate	50	80
Hounslow Town Prim.	11-Mar-03	10:30	Cloudy	Moderate	2	20
Chatsworth Ju.	11-Mar-03	10:44	Cloudy	Moderate	2	10
Chatsworth I&N	11-Mar-03	10:44	Cloudy	Moderate	2	50
Orchad I&N	11-Mar-03	11:15	Rainy	Moderate	80	100
Grove Road Prim.	11-Mar-03	11:28	Cloudy	Moderate	2	20
St Mark's Catholic	11-Mar-03	13:46	Rainy	Moderate	2	60
St Mickael's & St Martin's	11-Mar-03	14:02	Rainy	Moderate	2	20
Hounslow Heath Ju.	11-Mar-03	14:22	Cloudy	Moderate	60	80
Hounslow Heath I&N	11-Mar-03	14:22	Cloudy	Moderate	2	10
Andrew Ewing Prim.	14-Mar-03	9:40	Sunny	Mild	5	55
Sparrow Farm I&N	14-Mar-03	10:55	Sunny	Mild	200	0
Sparrow Farm Ju.	14-Mar-03	10:38	Sunny	Mild	200	250
Cardinal Road I&N	14-Mar-03	11:17	Sunny	Mild	2	17
Bedfont Ju.	14-Mar-03	11:31	Sunny	Mild	5	15
Wellington Prim.	11-Mar-03	14:37	Cloudy	Moderate	5	35
Southville I&N	14-Mar-03	13:46	Sunny	Mild	2	30
Southville Ju.	14-Mar-03	13:46	Sunny	Mild	2	50
Cranford I&N	14-Mar-03	14:17	Sunny	Mild	5	55
Marjory Kinnon	14-Mar-03	14:42	Sunny	Mild	5	35
Springwell Ju.	19-Mar-03	10:03	Sunny	none	2	50
Springwell I&N	19-Mar-03	10:03	Sunny	none	2	45
Forge Lane Prim.	19-Mar-03	10:32	Sunny	none	700	700
Feltham Hill Ju.	19-Mar-03	11:05	Sunny	none	2	20
Isleworth Town Prim.	19-Mar-03	11:45	Sunny	none	2	50
Oriel Prim.	19-Mar-03	13:56	Sunny	none	15	65
Ivybridge Prim.	19-Mar-03	14:28	Sunny	none	100	100
Crane Park Prim.	20-Mar-03	10:35	Sunny	none	350	230
The Smallberry Green Prim.	20-Mar-03	10:57	Sunny	none	2	50
Victoria Ju.	20-Mar-03	11:18	Sunny	none	2	15
St Lawrence RC Prim.	20-Mar-03	11:43	Sunny	none	2	20
Belmont Prim.	20-Mar-03	13:49	Sunny	none	45	45
Grove Park Prim.	20-Mar-03	14:17	Sunny	none	2	80
St Mary's RC Prim.	20-Mar-03	14:50	Sunny	none	10	30

Table 3.1 : Survey details and environmental conditions

3.2 DATA SHEETS

The 'Data Sheet' is a one sided A4 page form, which was filled in at each measurement location. They were found to be a useful tool as they provided a single page summaries of all the parameters and information relating to the school, the measurements and the subjective assessment. A sample data sheet is shown in Figure 3.2 below. The 35 completed data sheets are shown in Appendix 3.

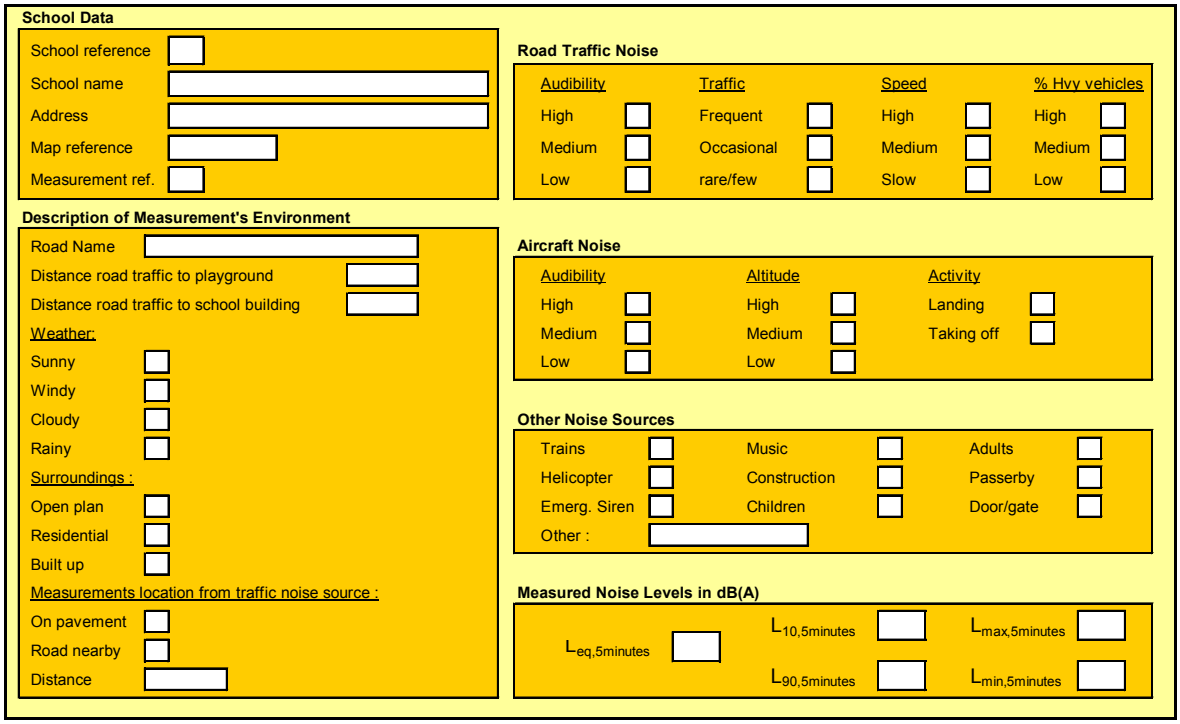


Figure 3.2 : Sample Data Sheet

Each data sheet is divided into 6 sections as described below:

3.2.1 School Data

This section provides the name and address of the school and gives a reference number to the school and the measurement. It also provides a map reference allowing location of the school on an 'A to Z map'.

3.2.2 Description of Measurement's Environment

This section relates to the survey itself. It allows the recording of all the parameters that differ from one measurement to the other so that a correction may be applied if necessary to allow proper comparison. Distances between road traffic to the nearest classroom and playground are noted. It includes a note of the weather conditions and whether the surroundings are open or urban. It also records the distance from the measurement position to the prevailing road traffic noise source.

3.2.3 Road Traffic Noise

This section contains a subjective assessment of the road traffic noise. It was used to determine whether road traffic was the prevailing noise source for the school. Parameters such as audibility, frequency of traffic, vehicle speeds and percentage of heavy vehicles were categorised as 'low', 'medium' or 'high'.

3.2.4 Aircraft Noise

In a similar manner to the road traffic, the parameters affecting aircraft noise were recorded subjectively. Audibility and altitude of the planes flying over during the measurement were recorded as 'low', 'medium', 'high'. It was also noted wether the plane was landing or taking off.

3.2.5 Other Noises

This section allowed a record of noise sources other than road traffic and aircraft which were present during the measurements. These are usually more intermittent

and occasional noise sources such as emergency siren, helicopter, construction noise, etc.

3.2.6 Measured Noise Levels

Finally this section shows the noise level parameters recorded. These are the continuous equivalent noise level ($L_{Aeq,5min}$), percentile levels ($L_{A0,5min}$) and ($L_{A10,5min}$), maximum noise level ($L_{max,5min}$) and minimum noise level ($L_{min,5min}$). Definition of these parameters is given in Section 3.1.

3.3 RESULTS OF MEASUREMENTS

The measured noise levels are summarised in Table 3.2.

3.4 CORRECTIONS

Where measurements were taken more than four metres from the noisiest school façade a correction is applied. This correction is necessary to enable comparison with the results of the Shield and Dockrell[24] study.

The data sheets indicates that in all situations either road traffic or aircraft noise was the dominant source. The aircraft noise component is not dependent on the measurement position because in all cases the distance between the measurement position and the plane is greater than the distance between the measurement and the school building. Therefore no distance corrections need to be applied to the aircraft noise contribution.

School Name	$L_{Aeq,5min}$	$L_{A90,5min}$	$L_{A10,5min}$	$L_{Amax,5min}$	$L_{Amin,5min}$
Alexandra Junior School	67	50	72	85	46
Andrew Ewing Primary	77	60	81	90	53
Bedfont Junior	73	60	78	86	55
Belmont Primary School	63	49	68	79	45
Cardinal Road Infant and Nursery	69	60	73	85	56
Chatsworth Infant and Nursery School	61	49	64	81	46
Chatsworth Juniors School	61	49	64	81	46
Crane Park Primary School	64	48	69	81	42
Cranford Junior	68	54	72	83	51
Feltham Hill Juniors	70	61	73	83	59
Forge Lane Primary School	64	41	62	83	38
Grove Park Primary School	51	44	54	70	36
Grove Road Primary School	62	49	64	84	44
Hounslow Heath Infant and Nursery	69	54	73	86	49
Hounslow Heath Junior	63	48	66	85	44
Hounslow Town Primary School	63	51	68	77	48
Isleworth Town Primary School	74	62	77	90	57
Ivybridge Primary School	54	45	57	68	42
Marjory Kinnon School	75	64	78	83	51
Orchad Junior School	57	50	59	73	47
Oriel Primary School	69	59	73	82	55
Southville Infant and Nursery	69	56	73	91	51
Southville Juniors	69	56	73	91	51
Sparrow Farm Infant and Nursery	81	53	79	108	44
Sparrow Farm Juniors	68	55	72	90	48
Spring Grove Primary School	64	51	68	84	48
Springwell Infant and Nursery	72	61	77	83	45
Springwell Junior School	73	63	77	84	55
St Lawrence RC Primary	63	55	67	78	51
St Mark's Catholic School	72	61	76	86	57
St Mary's RC Primary School	76	66	76	81	57
St Michael's & St Martin's School	67	59	69	83	53
The Smallberry Green Primary School	55	47	59	65	43
Victoria Juniors	63	55	67	78	51
Wellington Primary	72	59	76	83	53

Table 3.2 : Measured noise levels

In contrast, most of the measurements were carried out on the road pavement and the distances to the school building were greater than to the road. The correction method is as follows:

- Estimate each noise contribution (aircraft and road traffic).

  It was assumed that each audibility category represented a 5 dB difference in noise levels. This was based on the fact that a 'High' audibility sounded twice as loud as the 'Low' audibility. Because doubling loudness corresponds to a 10 dB increase, the 5 dB difference between 'Low', 'Medium' and 'High' was considered as the most suitable approximation.

- Correct road traffic noise component to a distance of 4 m from school building

- Combine back together components to obtain a total noise level 4 m from school's façade.

3.4.1 Estimation of Road and Air Noise Contribution

From the subjective assessment on the data sheets, we found there are five possibilities:

- If aircraft and road traffic have the same level of audibility their noise levels are estimated to be equal and therefore are each 3 dB lower than the measured noise levels.

- If road traffic audibility is ‘High’ and aircraft audibility ‘Medium’, then the road traffic noise component is estimated to be 1 dB lower than the measured noise level and the aircraft noise component 6 dB lower (5+1) than the measured noise level.

  For example: If road traffic audibility is ‘High’, Aircraft audibility is ‘Medium’ and the measured $L_{Aeq,5min}$ is 60 dB, then the road traffic component is estimated to be 59 dB and the aircraft component 54dB. This is explained from the theory of adding decibels. Whereby, when the difference in decibels between two noise sources is 5 dB, the combined noise level is 1 dB higher than the greater of the two components.

- If road traffic audibility is ‘High’ and aircraft audibility ‘Low’, then the road traffic noise component is estimated to be 10 dB greater than the aircraft component. When two noise levels to be added have a difference of 10 dB or more the lower noise level has a negligable contribution to the total noise level. Hence, the road traffic noise level component is estimated to be equal to the measured noise level.

- Similarly, if aircraft audibility is ‘High’ and road traffic audibility ‘Medium’, then the aircraft noise component is estimated to be 1 dB lower than the measured noise level and the aircraft noise component 6 dB lower (5+1) than the measured noise level.

- Similarly again, if aircraft audibility is ‘High’ and road traffic audibility ‘Low’, then the aircraft noise component is estimated to be 10 dB greater than the road traffic component. The road traffic noise component is therefore estimated to be 10 dB below the measured noise level and the aircraft noise equal to the measured noise level.

The estimation calculations are carried out for each school and are shown in Table 3.3. Table 3.3 hence provides separate estimation of the road and aircraft noise levels.

3.4.2 Correction to Road Traffic Noise

Now that the contribution of each noise source has been estimated, the distance correction is applied to road traffic noise levels.

Firstly, an estimation of the noise at 1 m from the source is made with equation (1).

(1) $L_1 = L_2 + 10 \log (d)$

where : L_1 Road traffic noise level at 1m from the road in dB(A)

L_2 Road traffic noise contribution at measurement position in dB(A)

d Distance from measurement position to 1 m from road traffic noise source in metres.

Secondly, the distance correction to 4m from the school's building façade is made with equation (2)

(2) $L_3 = L_1 - 10 \log (D-4)$

where : L_3 Road traffic noise contribution at 4 m from facade in dB(A)

School Name	$L_{Aeq,5min}$	Audibility		Estimated $L_{Aeq,5min}$	
		Road	Aircraft	Road traffic	Aircraft
Alexandra Junior School	67	L	H	57	67
Andrew Ewing Primary	77	H	H	74	74
Bedfont Junior	73	H	H	70	70
Belmont Primary School	63	M	L	62	57
Cardinal Road Infant and Nursery	69	H	M	68	63
Chatsworth Infant and Nursery School	61	L	H	51	61
Chatsworth Juniors School	61	L	H	51	61
Crane Park Primary School	64	L	H	54	64
Cranford Junior	68	M	H	62	67
Feltham Hill Juniors	70	H	H	67	67
Forge Lane Primary School	64	L	H	54	64
Grove Park Primary School	51	M	M	48	48
Grove Road Primary School	62	H	H	59	59
Hounslow Heath Infant and Nursery	69	H	H	66	66
Hounslow Heath Junior	63	M	H	57	62
Hounslow Town Primary School	63	L	H	53	63
Isleworth Town Primary School	74	H	H	71	71
Ivybridge Primary School	54	L	M	48	53
M arjory Kinnon School	75	H	H	72	72
Orchad Junior School	57	M	H	51	56
Oriel Primary School	69	H	H	66	66
Southville Infant and Nursery	69	M	H	63	68
Southville Juniors	69	M	H	63	68
Sparrow Farm Infant and Nursery	81	L	H	71	81
Sparrow Farm Juniors	68	L	H	58	68
Spring Grove Primary School	64	M	H	58	63
Springwell Infant and Nursery	72	M	H	66	71
Springwell Junior School	73	H	H	70	70
St Lawrence RC Primary	63	M	M	60	60
St Mark's Catholic School	72	H	H	69	69
St Mary's RC Primary School	76	H	L	76	66
St Michael's & St Martin's School	67	H	H	64	64
The Smallberry Green Primary School	55	L	M	49	54
Victoria Juniors	63	M	M	60	60
Wellington Primary	72	H	H	69	69

Table 3.3 : Air and road traffic contribution to noise levels

L_1 Road traffic noise levl at 1 m from the road in dB(A)

D Distance from road traffic noise at 1 m to building façade in metres.

By subsitution of (1) into (2) we obtain a total correction equation (3)

(3) $L_3 = L_2 + 10 \log [d/(D-4)]$

Where : L_2 Road traffic noise contribution at measurement position in dB(A).

L_3 Road traffic noise contribution at 4 m from facade in dB(A).

D Distance from road traffic noise at 1 m to building façade in metres.

d Distance from measurement position to 1 m from road traffic noise source in metres.

Equation (3) is applied to the road traffic noise component and the corrected noise levels are shown in the 4th column of Table 3.4.

3.4.3 Combined noise levels 4m from school's facade

Now the correction to the road traffic noise component has been determined, the two sources noise levels are added logarithmitically as shown in equation (4).

(4) $L_{corrected\ facade} = 10 \log (10^{L3/10} + 10^{Laircraft/10})$

Where : $L_{corrected\ facade}$ Corrected measured noise level 4m from façade in dB(A)

$L_{aircraft}$ Aircraft noise level contribution in dB(A)

L_3 Road traffic noise contribution at 4m from facade in dB(A)

This correction is only applied to the continuous equivalent noise levels. The estimated total noise levels 4 m from the school's facade are shown in the last column in Table 3.4 and are from now called the corrected noise levels. Figure 3.3 below shows the effect of distance correction on the measured noise levels in a graph.

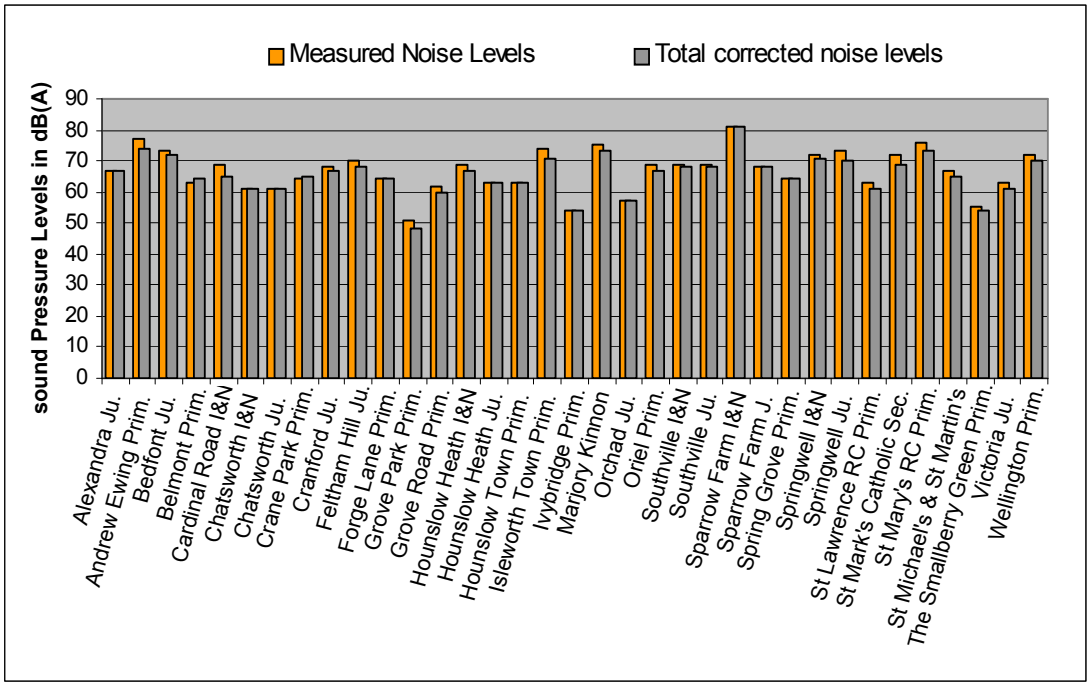


Figure 3.3: Measured and corrected noise levels

Figure 3.3 shows that corrected noise levels are very similar to the measured noise levels. This indicates the distance correction for the road traffic had small effect on the noise levels and therefore the aircraft noise is the prevailing noise source at most schools.

School Name	Estimated road traffic noise levels contribution to measured noise levels in dB(A)	Distance from meas. Position to road in metres	Distance from road to school's façade in metres	Estimated road traffic noise levels contribution 4m from façade in dB(A)	Estimated aircraft noise levels contribution to measured noise levels in dB(A)	**Total corrected noise levels 4m from school's façade in dB(A)**
Alexandra Ju.	57	2	60	43	67	**67**
Andrew Ewing Prim.	74	5	55	64	74	**74**
Bedfont Ju.	70	5	15	67	70	**72**
Belmont Prim.	62	45	45	62	57	**64**
Cardinal Road I&N	68	2	17	60	63	**65**
Chatsworth I&N	51	2	50	37	61	**61**
Chatsworth Ju.	51	2	10	46	61	**61**
Crane Park Prim.	54	350	230	56	64	**65**
Cranford Ju.	62	5	55	52	67	**67**
Feltham Hill Ju.	67	2	20	58	67	**68**
Forge Lane Prim.	54	700	700	54	64	**64**
Grove Park Prim.	48	2	80	32	48	**48**
Grove Road Prim.	59	2	20	50	59	**60**
Hounslow Heath I&N	66	2	10	61	66	**67**
Hounslow Heath Ju.	57	60	80	56	62	**63**
Hounslow Town Prim.	53	2	20	44	63	**63**
Isleworth Town Prim.	71	2	50	57	71	**71**
Ivybridge Prim.	48	100	100	48	53	**54**
Marjory Kinnon	72	5	35	64	72	**73**
Orchad Ju.	51	80	100	50	56	**57**
Oriel Prim.	66	15	65	60	66	**67**
Southville I&N	63	2	30	52	68	**68**
Southville Ju.	63	2	50	49	68	**68**
Sparrow Farm I&N	71	200	200	71	81	**81**
Sparrow Farm J.	58	200	250	57	68	**68**
Spring Grove Prim.	58	50	80	56	63	**64**
Springwell I&N	66	2	45	53	71	**71**
Springwell Ju.	70	2	50	56	70	**70**
St Lawrence RC Prim.	60	2	20	51	60	**61**
St Mark's Catholic Sec.	69	2	60	55	69	**69**
St Mary's RC Prim.	76	10	30	72	66	**73**
St Michael's & St Martin's	64	2	20	55	64	**65**
The Smallberry Green Prim.	49	2	50	35	54	**54**
Victoria Ju.	60	2	15	53	60	**61**
Wellington Prim.	69	5	35	61	69	**70**

Table 3.4 Corrected noise levels 4 m from facade

3.5 DATA VALIDATION

From Figure 3.3 it was deduced that the aircraft noise is predominantly responsible for the overall noise climate, but to ascertain that the 5 minutes sample measurements are representative of the daily noise climate surrounding the school, an assessment against published noise data has been conducted. The 1999 Heathrow $L_{Aeq,16h}$ Noise Contours[27] shown in Figure 3.4 below have been used to compare the corrected noise levels with the predicted $L_{eq,16h}$ at each school from the contours. A map indicating the school locations and the 57, 63 and 69 dB $L_{Aeq,16h}$ contour is shown in Appendix 1.

Figure 3.4 : 1999 $L_{eq,16h}$ Noise Contours from Heathrow Airport [28]

Depending on their locations the schools have been placed in 4 categories: below 57 dB $L_{Aeq,16h}$, between 57 and 63 dB $L_{Aeq,16hr}$, between 63 and 69 dB $L_{Aeq,16h}$ and above 69 dB $L_{Aeq,16h}$. Table 3.5 below shows the number of schools that are located within each noise contours categories and the arithmetic average of the corrected

$L_{Aeq,5min}$ and the arithmetic average $L_{Aeq,5min}$ aircraft noise components for these schools.

	$L_{Aeq,16h}$ contour ranges in dB			
	Less than 57	57 - 63	63 - 69	Greater than 69
Number of schools	2	11	12	10
Average of corrected $L_{Aeq,5min}$	55	63	66	69
Average of $L_{Aeq,5min}$ aircraft noise conponents	53	63	66	68

Table 3.5 : Measured noise levels and noise contours

The averaged noise levels from the survey falls adequately winthin the noise contour ranges. Hence, this comparison between predicted noise contours and corrected survey data gives confidence that the $L_{Aeq,5min}$ is representative of the typical daytime noise exposure.

3.5 CONCLUSION

In this chapter, the results of the survey have been presented and the data collection methodology explained. The results have been standardised to a reference measurement position of 4 m from the school's façade to allow comparison of the results with the Shield and Dockrell [24] study. Finally a comparison with the published 1999 Heathrow Airport noise contours [28] have provided confidence that the results of the survey provide typical daily noise level samples.

Chapter 4

Noise levels analysis

4.0 INTRODUCTION

In Chapter 3, measurements have been corrected to a reference position of 4m from the school's façade. This chapter presents a statistical analysis of the resulting noise levels and compares them with similar measurements carried out in Islington, Haringey and Lambeth.

4.1 STATISTICAL ANALYSIS

To give an overview of the noise climate surrounding the schools under investigation, Table 4.1 below provides values appelle a few commonly used statistical parameters for each measured noise parameter.

Statistical Parameter	Corrected	Measured			
	$L_{Aeq,5min}$	$L_{A90,5min}$	$L_{A10,5min}$	$L_{Amax,5min}$	$L_{Amin,5min}$
Minimum	48	41	54	65	36
Maximum	74	66	81	91	59
Artihmetic Mean	65	54	70	82	49
Median	66	55	72	83	50
Mode	67	49	73	83	51
Standard deviation	5.9	6.4	6.6	6.1	5.7

Table 4.1 : Statistical summary of noise levels

The measurements of Sparrow Farm Infant & Nursery have been excluded from the analysis. Indeed, the measurement took place when the Concorde took off from Heathrow. Noise levels measured at that location were 81 dB $L_{Aeq,5min}$ and 108 dB $L_{Amax,5min}$. Noise levels from the Concorde are significantly higher than any other

type of commercial aircraft and will no longer occur due to the withdrawal of this type of aircraft. Hence, due to the untypical nature of the noise event, this measurement was excluded from the statistical analysis.

The minimum and maximum parameters provides respectively the lowest and the highest sample noise levels of the survey. For example, the maximum $L_{Aeq,5min}$ predicted 4 m from the school's building is 74dB

Table 4.1 shows that on average (arithmetic mean) noise levels outside schools under investigations are 65 dB $L_{Aeq,5min}$. The average background noise level is given by the $L_{A90,5min}$ paramaters and is 54 dB.

The mode indicates the most frequently occuring noise level. The most frequently occuring $L_{Amax,5min}$ is 83 dB and the most frequent $L_{Amin,5min}$ is 51 dB.

The standard deviation gives a measure of the dispersion of the frequency distribution of the noise levels. Table 4.1 shows similar standard deviations of approximately 6 for all noise parameters.

Overall the small difference between the mean, median and mode values provides an indication of the consistency in the measurements and repetitive pattern of the noise levels suggests that the distribution of the measurement is approximately normal.

Graphs showing the frequency distribution of each noise parameter in relation to the number of schools are shown in Figures 4.1 to 4.5.

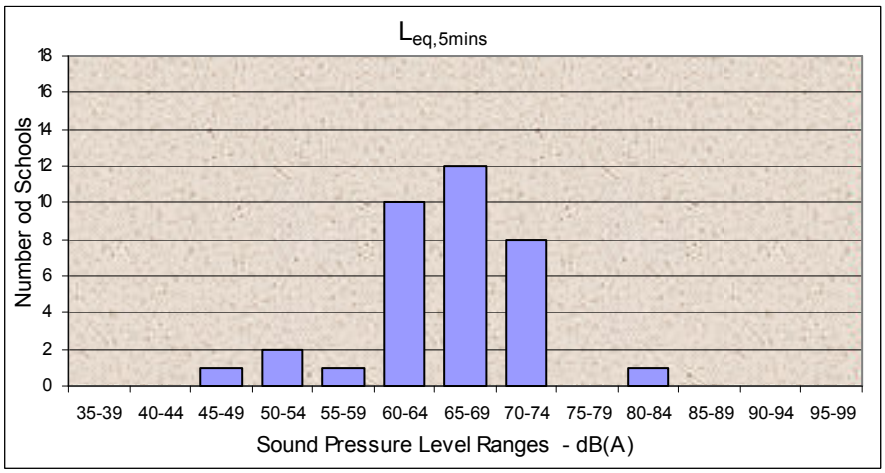


Figure 4.1 : $L_{Aeq,5min}$ distribution

The World Health Organisation [1] recommends that noise levels in a school's playground shall not exceed 55 dB $L_{Aeq,t}$. This figure is also mentioned in the new Building Bulletin 93 [25] as a 55 dB $L_{Aeq,30min}$ to encourage teachers to practice outdoor teaching with acceptable conditions for speech communication. In Hounslow, outdoor teaching is not a suitable teaching method due to the noise exposure. Indeed, Figure 4.1 indicates that 91% of the schools under investigation have outdoor noise levels above 55 dB(A). Furthermore 60% of the school's outdoor environment receives noise that is only deemed to be reasonable for industrial working conditions according to British Standard BS8233 [3], that is above 65 dB $L_{Aeq,t}$ (see Table 1.2).

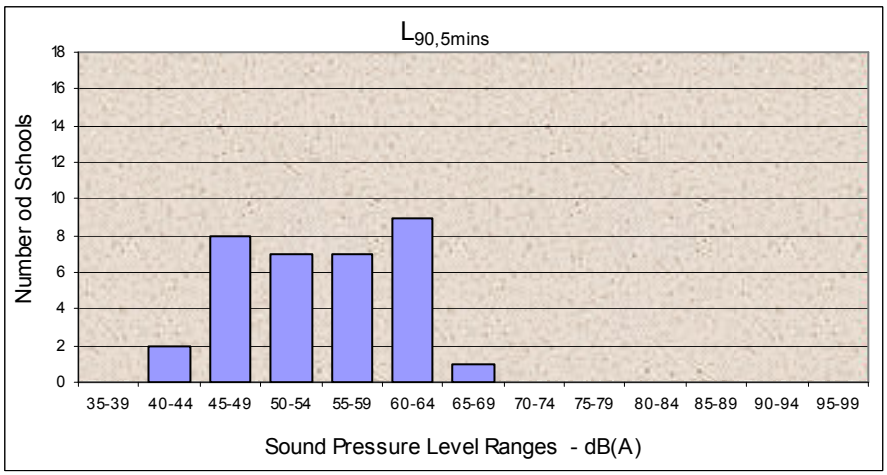


Figure 4.2 : $L_{A90,5min}$ distribution

The $L_{90,t}$ parameter is commonly used to provide an indication of the background noise climate. It represents the noise levels that are exceeded for 90% of the

measurement period. As seen in Table 1.1, 50 dB(A) is the maximum recommended background noise level for reliable speech communication with a raised voice at a distance of 4 m. Figure 4.2 indicates that in 69% of the schools investigated, a raised voice would not be sufficient for outdoor intelligible speech communication when 4 m apart outside. It also indicates that in approximately 10 schools reliable speech communcation is not possible with a raised voice when 1 m apart (that is above 62 dB $L_{A90,5min}$). In this situation the noise levels clearly reduce the range of outdoor activity for children.

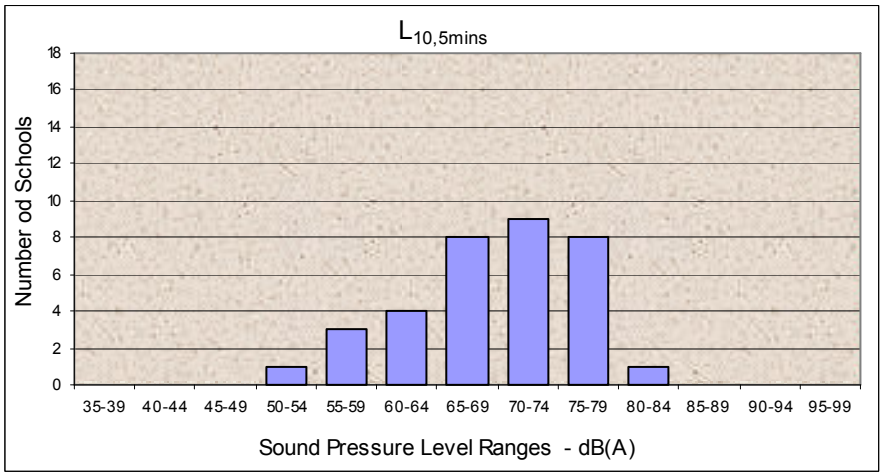


Figure 4.3 : $L_{A10,5min}$ distribution

The $L_{A10,t}$ parameter is commonly used in road traffic measurements. It represents the noise levels that are exceeded for 10% of the measurement period. Figure 4.3 shows that three quarters of the schools are exposed to $L_{A10,5min}$ greater than 65 dB.

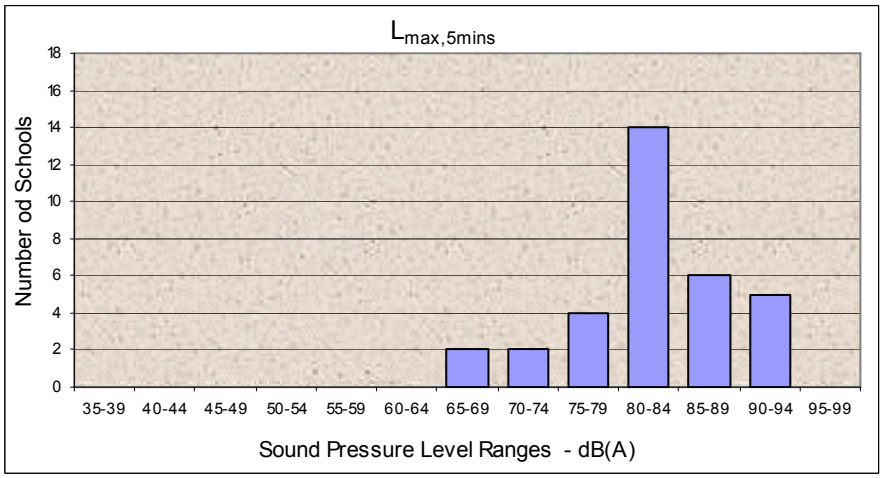


Figure 4.4 : $L_{Amax,5min}$ distribution

Figure 4.4 shows the distribution of the $L_{max,5minutes.}$ It indicates that 26 out of the 35 schools surveyed, i.e. 74%, had a noise event of at least 80 dB(A) during the 5 minutes measurement period. As the survey was carried out at different times of the day for each school and obviously at different locations, it is statistically probable that outside noise levels very regularly exceed 80 dB(A). the $L_{max,t}$ parameters gives the maximun noise level recorded in the measurement period. Although it is likely to represent a short noise event, the levels reached for these noise events were above 90 dB(A) at five schools.

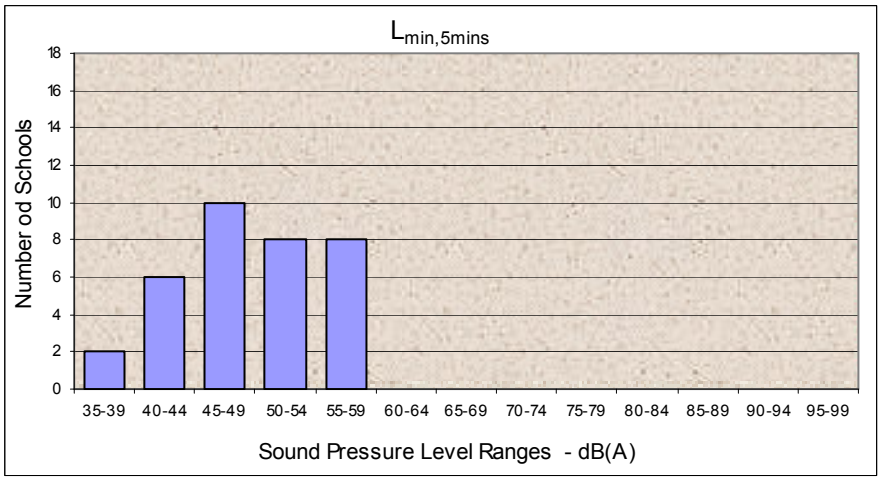


Figure 4.5 : $L_{Amin,5min}$ distribution

The $L_{Amin,t}$ represents the minimum noise level measured during the sample period. This parameter is less common in environmental noise assessments as it is not used in guidelines and standards. However, in this instance it provides interesting information. Indeed, on the basis that the 5 minutes measurement period is typical and can be extrapolated to the whole teaching hours. Figure 4.5 indicates that at no time noise levels are below 55 dB(A) at 20% of the schools under investigations.

Finally, Table 3.3 (refer to Chapter 3) provided a summary of the subjective assessment of road traffic and aircraft audibility at the measurement locations. As many as 31 schools had a high level of audibility from road or air traffic. This

observation and the noise levels distribution shown in Figure 4.1 to 4.5 shows that the schools investigated in Hounslow are chronically exposed to levels of noise which are exceptionally high.

This study has demonstrated, using objective and subjective parameters that schools in Hounslow are exposed to noise levels which are chronic and extreme in environmental noise exposure. But are these noise levels typical of all urban schools? Are these noise levels unique to airport surroundings? The next section compares the noise levels with similar surveys carried out in other London Boroughs.

4.2 COMPARISON WITH OTHER BOROUGHS

Shield and Dockrell [24] measured noise levels outside schools in Islington, Haringey and Lambeth at a distance of 4m from the facade. Their results are compared to the Hounslow schools noise levels in Table 4.2 below.

Parameter / Borough	$L_{Aeq,5min}$		$L_{A90,5min}$		$L_{A10,5min}$		$L_{Amax,5min}$		$L_{Amin,5min}$	
	Mean	STDV	Mean	STDV	Mean	STDV	Mean	STDV	Mean	STDV
Haringey	57	8.8	49	7.7	59	9	71	10.5	46	7.5
Islington	56	9.4	47	9.3	58	9.9	68	17	41	12.4
Lambeth	59	7.4	50	8.2	61	7.7	72	9	47	8.3
Hounslow	65	5.9	55	6.4	70	6.6	82	6.1	49	5.7

Table 4.2 : Mean and Standard Deviation comparison with other London Bouroughs

Standard deviations are noticeably lower in Hounslow when compared to Haringey, Lambeth or Islington. Indeed, the landing and taking off of planes on the runaway is continuously taking place at constant small intervals making the noise events more repetitive and more predictable than road traffic noise which is of a more intermittent character and which prevails in central London. Figure 4.6 below shows the noise levels graphically.

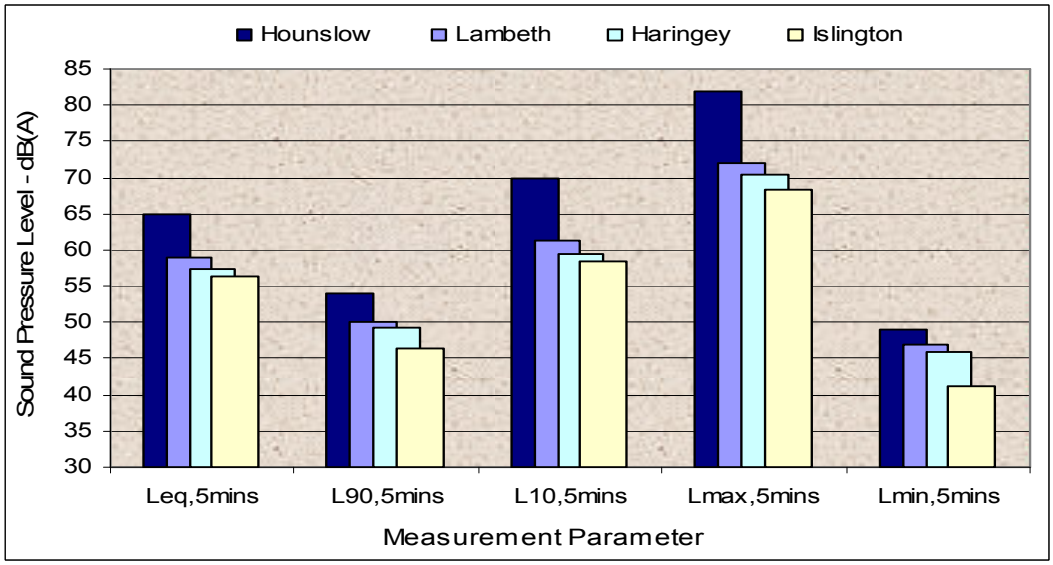


Figure 4.6 : Comparison of mean noise levels

The comparison of the results with other boroughs shows that on average schools in Hounslow are exposed to higher noise levels. The greatest difference appears in the $L_{A10,5min}$ and $L_{Amax,5min}$. This is likely to be due to aircraft flyovers.

4.3 CONCLUSION

The analysis of the results has shown that schools in Hounslow are chronically exposed to high noise levels. In most cases, these noise levels do not permit outdoor teaching to take place due to the level of interference that road traffic or aircraft flyovers creates.

Noise levels exceed WHO recommendation of 55 dB $L_{Aeq,t}$ in school playground in 91% of the schools investigated. Furthermore 74% of the schools are exposed to noise events that regularly exceed 80 dB(A).

Schools in Hounslow are exposed to noise levels distinctly higher than in other London Boroughs, and with higher peaks.

Chapter 5

Estimation and review of internal noise levels

5.0 INTRODUCTION

This chapter intends to make an estimation of the noise levels received in the classrooms. Based on the corrected noise levels at 4m from the façade and classrooms with open windows the noise levels predicted are compared to current and superseded guideline and legislative documents used in the design of schools.

In the second part an assessment is made of the voice level that teachers would need to maintain adequate speech intelligibility.

5.1 INTERNAL NOISE LEVELS

To predict the noise levels received from road and air traffic inside the classroms a number of assumptions is required. Indeed, for practical reasons, access into the school's premises was not possible during the survey. Hence, assumptions regarding the layout of the buildings, means of ventilations of the classrooms and reverberant effects inside the classrooms have to be made.

The assumptions are summarised as below:

- Façades at which noise levels have been predicted are those of classrooms
- Classrooms keep windows partially open for ventilation.
- Classroom reverberation times do not affect significantly intrusive noise
- There is no façade effect.

BS8233[3] estimates that any type of window in a façade when partially open has a weighted sound reduction index between 10 and 15 dB. Based upon the assumptions made above, the sound reduction index of the partially open window is considered to be equivalent to the total inside/outside level difference. Hence, the internal noise levels are estimated to be in the order of 10 dB below the external noise levels.

5.2 COMPARISON WITH BUILDING BULLETIN 87 & 93

As described in Chapter 1, Building Bulletin 93[25] (BB93) was published in July 2003 to replace Building Bulletin 87 [26] (BB87). These two documents propose internal noise levels in classrooms. BB87 which was published in 1997 recommended a maximum $L_{Aeq,t}$ of 40dB for indoor teaching spaces. BB93 has a more stringent requirement of 35 dB $L_{Aeq,30min}$. Table 5.1 compares the estimated internal noise levels (corrected external $L_{Aeq,5min}$ minus 10 dB) with the internal ambient noise criteria for classrooms of BB87 and BB93. A graphic representation of Table 5.1 is shown in Figure 5.1.

School Name	Corrected external noise levels in dB(A)	Estimated internal noise level in dB(A)	Excess from BB87 Criteria in dB(A)	Excess from BB93 Criteria in dB(A)
Alexandra Ju.	67	57	17	22
Andrew Ewing Prim.	74	64	24	29
Bedfont Ju.	72	62	22	27
Belmont Prim.	64	54	14	19
Cardinal Road I&N	65	55	15	20
Chatsworth I&N	61	51	11	16
Chatsworth Ju.	61	51	11	16
Crane Park Prim.	65	55	15	20
Cranford Ju.	67	57	17	22
Feltham Hill Ju.	68	58	18	23
Forge Lane Prim.	64	54	14	19
Grove Park Prim.	48	38	-2	3
Grove Road Prim.	60	50	10	15
Hounslow Heath I&N	67	57	17	22
Hounslow Heath Ju.	63	53	13	18
Hounslow Town Prim.	63	53	13	18
Isleworth Town Prim.	71	61	21	26
Ivybridge Prim.	54	44	4	9
Marjory Kinnon	73	63	23	28
Orchad Ju.	57	47	7	12
Oriel Prim.	67	57	17	22
Southville I&N	68	58	18	23
Southville Ju.	68	58	18	23
Sparrow Farm I&N	81	71	31	36
Sparrow Farm J.	68	58	18	23
Spring Grove Prim.	64	54	14	19
Springwell I&N	71	61	21	26
Springwell Ju.	70	60	20	25
St Lawrence RC Prim.	61	51	11	16
St Mark's Catholic Sec.	69	59	19	24
St Mary's RC Prim.	73	63	23	28
St Michael's & St Martin's	65	55	15	20
The Smallberry Green Prim.	54	44	4	9
Victoria Ju.	61	51	11	16
Wellington Prim.	70	60	20	25

Table 5.1 : Estimated internal noise levels

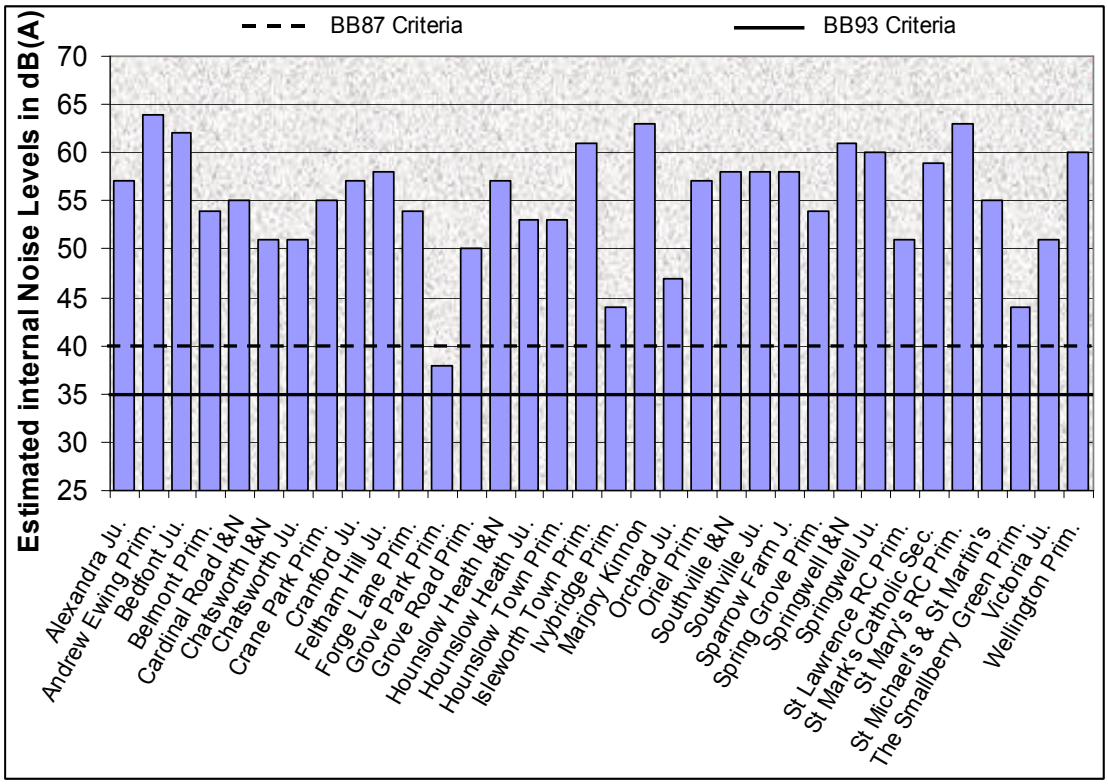


Figure 5.1 : Internal noise levels

None of the schools would comply with the BB93 criterion for internal ambient noise level in classrooms and only one would comply with the more relaxed criterion of BB87. Furthermore Table 5.1 indicates that 88% have internal ambient noise levels which exceed the BB93 criterion by more than 10 dB and 57% by 20 dB or more.

It is common sense to assume that in situations of such high noise exposure, the teacher would compromise temporarily the ventilation and would shut the windows. However, single pane windows would only provide approximately a 30 dB attenuation. (we assume for the purpose of this example a window area of $1m^2$ and a negligable room effect). This would still leave 63% of the schools with ambient internal noise levels exceeding the BB93 criteria and more than a quarter with internal noise levels exceeding BB93 criterion by more than 5 dB.

With such high internal noise levels, it would be interesting to estimate how much effort the teacher would require to ensure his/her voice can be intelligible to the pupils.

5.3 SPEECH INTERFERENCE

Table 5.2 below shows the maximum steady noise level in dB(A) to ensure reliable speech communication at a distance of 4m.

	Normal voice	Raised voice	Loud voice	Shouting
Steady noise level	45	50	55	60

Table 5.2: noise levels and reliable speech intelligibility when 4 m apart.

The estimated internal noise levels with open windows have been associated in Table 5.3 below with noise levels of Table 5.2 to determine the number of schools for each level of voice that would be required to ensure adequate speech intelligibility for a pupil seated 4 m from the teacher.

Ambient internal noise level	Number of schools	Voice Level required by teacher
Below 45 dB(A)	3	Normal
Between 45 and 49 dB(A)	1	Normal to Raised
Between 50 and 54 dB(A)	10	Raised to Loud
Between 55 and 59 dB(A)	11	Loud to Shouting
60dB(A) and above	8	Shouting

Table 5.3 : Schools and teacher's voice level

Table 5.3 shows that in the majority of the schools surveyed teachers require voice levels from loud to shouting to ensure their speech is intelligible throughout the classroom when windows are open.

5.4 CONCLUSION

In this chapter, the corrected external noise levels have been used to estimate noise heard in the classrooms. A number of assumptions have been made to allow these estimations to be made and the values calculated altough approximate can be considered as representative.

When compared to the documents used in the design of new schools, internal noise levels with open windows were found to be in most schools considerably above the performance standards of recent legislative document (BB93) but also above older guidelines documents (BB87). Calculations also showed that internal noise levels still exceeded performance standards siginificantly even with closed windows.

Finally, a review of the voice levels required by the teachers to overcome the interference created by external noise was estimated. It was found that in only 3 out of 35 schools teachers could use a normal voice level and be intelligible throughout the classroom. For the remaining schools the voice levels required varied from raised to shouting.

Chapter 6

Correlation of noise levels with SATs results

6.0 INTRODUCTION

This chapter presents the results of correlation calculations between the noise levels from the survey and the results of Standardised Assessment Tests (SATs). These correlations were carried out to determine whether or not there is a quantifiable relationship between noise exposure and academic performance of school children. SATs results of 2003 Key Stage 1 (KS1) Tests, which corresponds to 7 years old children, were obtained from Hounslow Council and are shown in Appendix 4. These results are the average tests results in Reading/Comprehension, Writing and Mathematics for the schools.

Unfortunately not all 2003 test results were available at the time and when compared with the number of school surveyed, overall, correlations between KS1 tests and measured noise levels were possible for 27 schools in the Borough. The analysis encompasses a total of 1539 pupils. Each school had an average of 57 pupils tested at KS1.

The academic results are influenced by a number of factors. It is known for example that social and economic status of the family from which a child comes will have

great impact on its academic results. Higgs et al [29] have demonstrated for example that children issued from a socially deprived background achieve in general, lower results compared to less deprived children. Furthermore children from families where English is not the first language will score lower results in reading and comprehension as they are disadvantaged when compared to children who have been spoken to in English since they were born.

To ensure a reliable relationship can be established between noise exposure and academic results it is necessary to remove the effects of these factors.

To this effect, the number of free schools meals (FSM) per schools has been used as a parameter which allows to scale the social deprivation. Indeed percentage of free school meals has been proven to be a reliable indicator of social deprivation in a study carried out by Williamson et al [30].

The percentage of free school meals given and the percentage of children having English as a second language (ESL) have also been obtained from Hounslow Council and are shown in Appendix 5.

Hence, in this chapter simple and partial correlation coefficients have been calculated between each of the noise levels shown below and the KS1 tests results for Reading/Comprehension, Writing and Mathematics.

Noise Levels Correlated:

- Measured $L_{Aeq,5min}$
- Corrected $L_{Aeq,5min}$
- Road Traffic $L_{Aeq,5min}$

- Aircraft $L_{Aeq,5min}$
- Measured $L_{A90,5min}$
- Measured $L_{A10,5min}$
- Measured $L_{Amax,5min}$
- Measured $L_{Amin,5min}$

Partial correlation allows to establish the relationship between two sets of data and removing the effects of a third one. Hence partial correlation was used to remove the effects of social deprivation and language spoken by using the FSM and ESL data.

Scatter graphs using noise levels on the (X) axis and SATs scores on the (Y) axis are presented with a trend line to visualise the relationship between the two parameters.

6.1 CORRELATIONS WITH $L_{AEQ,5MIN}$

Table 6.1 below shows the correlation coefficients with measured and corrected overall noise levles, road traffic and aircraft noise levels.

	Measured			Corrected			Aircraft			Road Traffic		
Correction	None	FSM	ESL	None	FSM	ESL	None	FSM	ESL	None	FSM	ESL
Reading	-0.08	-0.27	-0.09	-0.13	-0.33	-0.14	-0.25	-0.40	-0.25	0.05	-0.05	0.04
Writing	0.09	-0.13	0.12	0.05	-0.18	0.07	-0.05	-0.22	-0.04	0.15	0.03	0.21
Mathematics	0.04	-0.13	0.03	-0.01	-0.18	-0.02	-0.16	-0.29	-0.16	0.16	0.07	0.14

Table 6.1 : Correlation coefficients with $L_{Aeq,5min}$

The strongest correlations appears when the effect of social deprivation are removed (partial correlations with the FSM data held constant). For the type of noise, the strongest correlation occurs with aircraft noise. Indeed , aircraft noise

obtains coefficients of -0.40 in reading, -0.22 in writing and -0.29 in mathematics. The second strongest correlations appear between the corrected $L_{Aeq,5min}$ (which is indeed the external noise level at 4m from the school's façade). Reading and comprehension appear to be more affected by noise than Writing or Mathematics. These results show a strong relationship between aircraft noise and children's performance at school. This finding is a very interesting as it conforms with the results of Cohen et al[7] in 1973, Hetu et al [16] in 1990, the Munich Airport study of Hygge and Evans [20] in 1997, the Evans and Maxwell [21] study in 1997 and The Shield and Dockrell [24] study in 2002 with regard to reduced reading ability when exposed to noise.

Also, aircraft noise as opposed to other forms of environmental noise exposure has been particularly associated with lower cognitive performance of children by:

- Cohen et al in 1980 [11]
- Green et al in 1982 [15]
- Hygge in 1993 [4]
- Haines and Stansfeld in 1996 [19]
- Hygge and Evans in 1997 [20]
- Haines and Stansfeld in 2001 [23]

Figures 6.1, 6.2 and 6.3 below shows the scatter graphs of the aircraft noise against SATs scores in Reading, Writing and Mathematics.

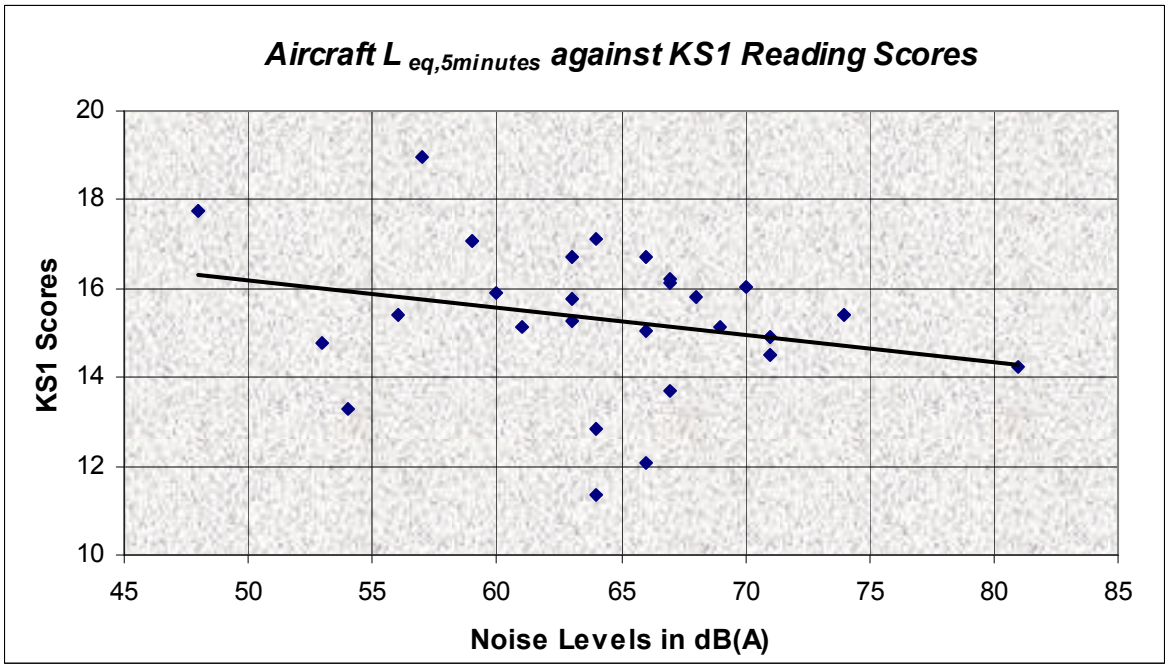


Figure 6.1 Aircraft Noise Levels against KS1 Reading Scores

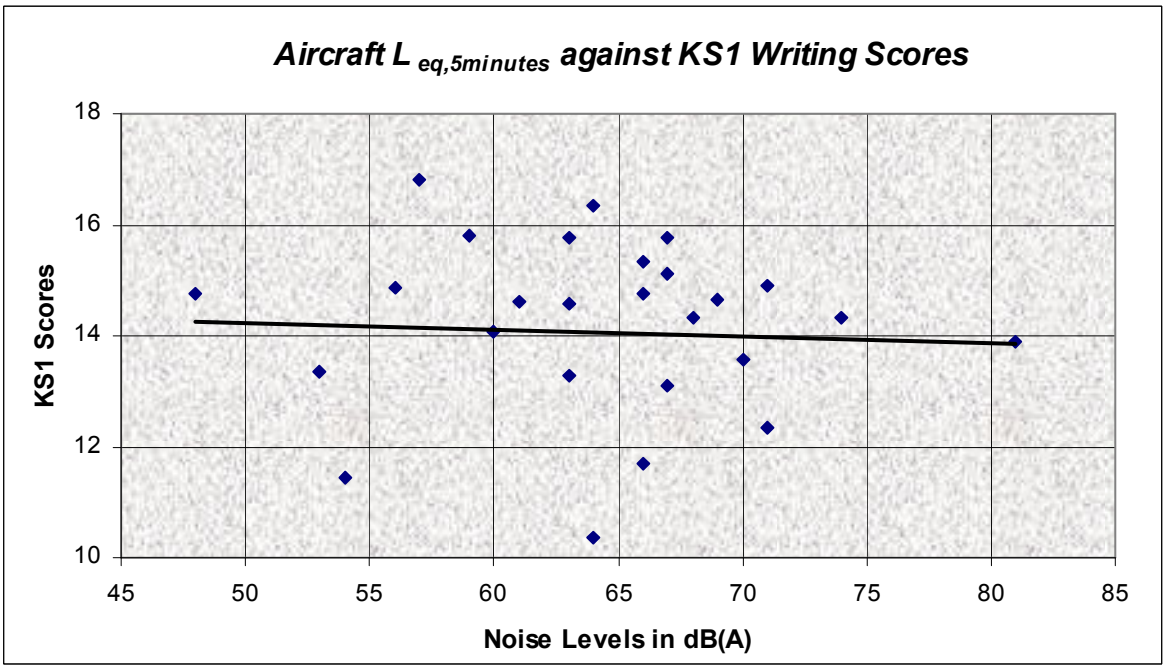


Figure 6.2 Aircraft Noise Levels against KS1 Writing Scores

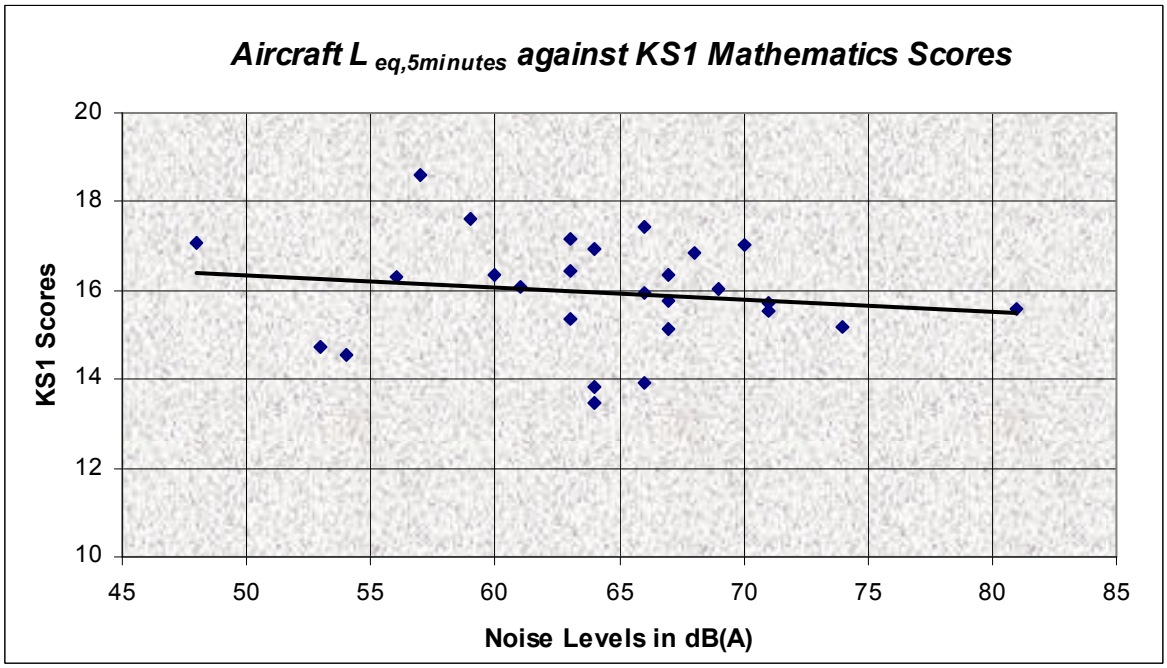


Figure 6.3 Aircraft Noise Levels against KS1 Mathematic Scores

Table 5.1 indicates a poor correlation between SATs scores and road traffic noise. This observation contradicts the results of the studies carried out by Lukas et al [14] in 1981, Hygge [4] in 1993, Sanz et al [17] in 1993 and Shield and Dockrell [24] in 2002. This can be explained by looking at the range of road traffic noise levels the schools are exposed to. It can be observed on Figure 5.4 that the range of noise exposure varies greatly from 32 dB $L_{Aeq,5min}$ to 72 dB $L_{Aeq,5min}$, whereas the aircraft noise exposure range from 47 dB $L_{Aeq,5min}$ to 81 dB $L_{Aeq,5min}$ 47. Furthermore, the arithmetic average of aircraft noise is 10 dB(A) greater than the arithmetic average of road traffic noise. Hence, as the exposure to road traffic is lower, the results of correlation are less conclusive, which does not mean the relationship does not exist, but that it can not be demonstrated in this study.

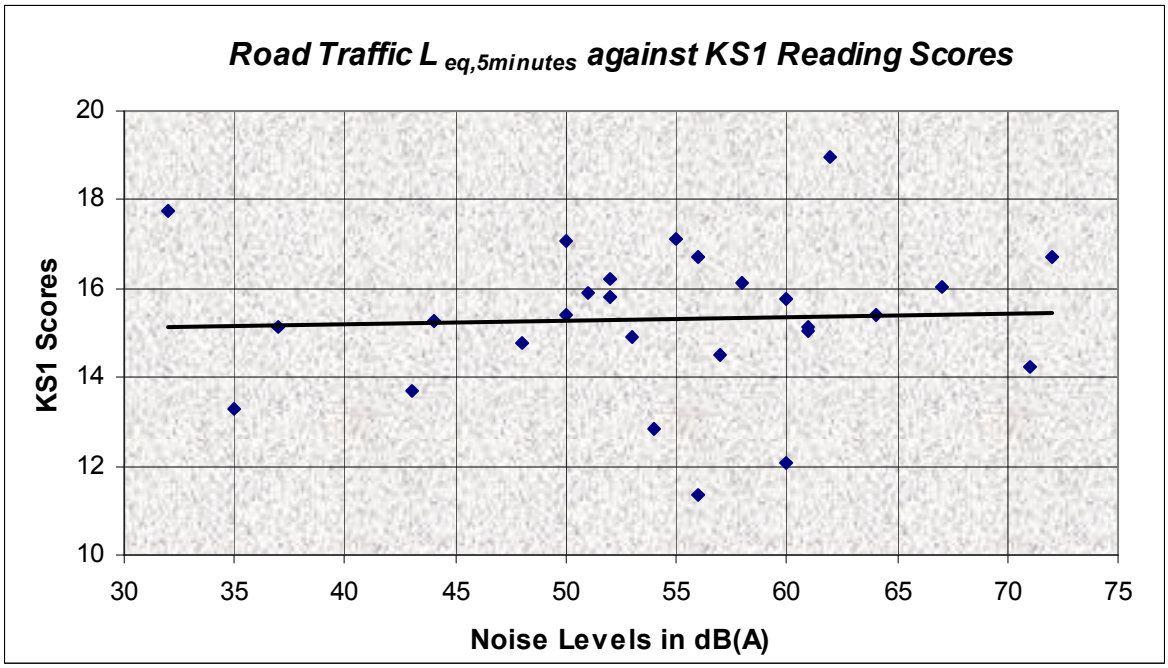


Figure 6.4 : Road traffic noise levels against Reading Scores

6.2 CORRELATIONS WITH OTHER ACOUSTIC PARAMETERS

The continuous equivalent noise levels showed good correlation with the SATs scores. However, the influence of other parameters is investigated below. Table 6.2 shows the correlations coefficients for Reading, Writing and Mathematics with minimum, maximal and percentile acoustic parameters:

	Lmax			L10			L90			Lmin		
Correction	None	FSM	ESL	None	FSM	ESL	None	FSM	ESL	None	FSM	ESL
Reading	-0.07	-0.22	-0.07	-0.07	-0.23	-0.07	0.15	-0.03	0.15	0.14	0.04	0.14
Writing	0.09	-0.09	0.12	0.10	-0.08	0.12	0.31	0.10	0.33	0.28	0.16	0.32
Mathematics	0.06	-0.07	0.05	0.06	-0.08	0.06	0.26	0.11	0.26	0.24	0.15	0.23

Table 6.2 : Correlation coefficients with common acoustic parameters

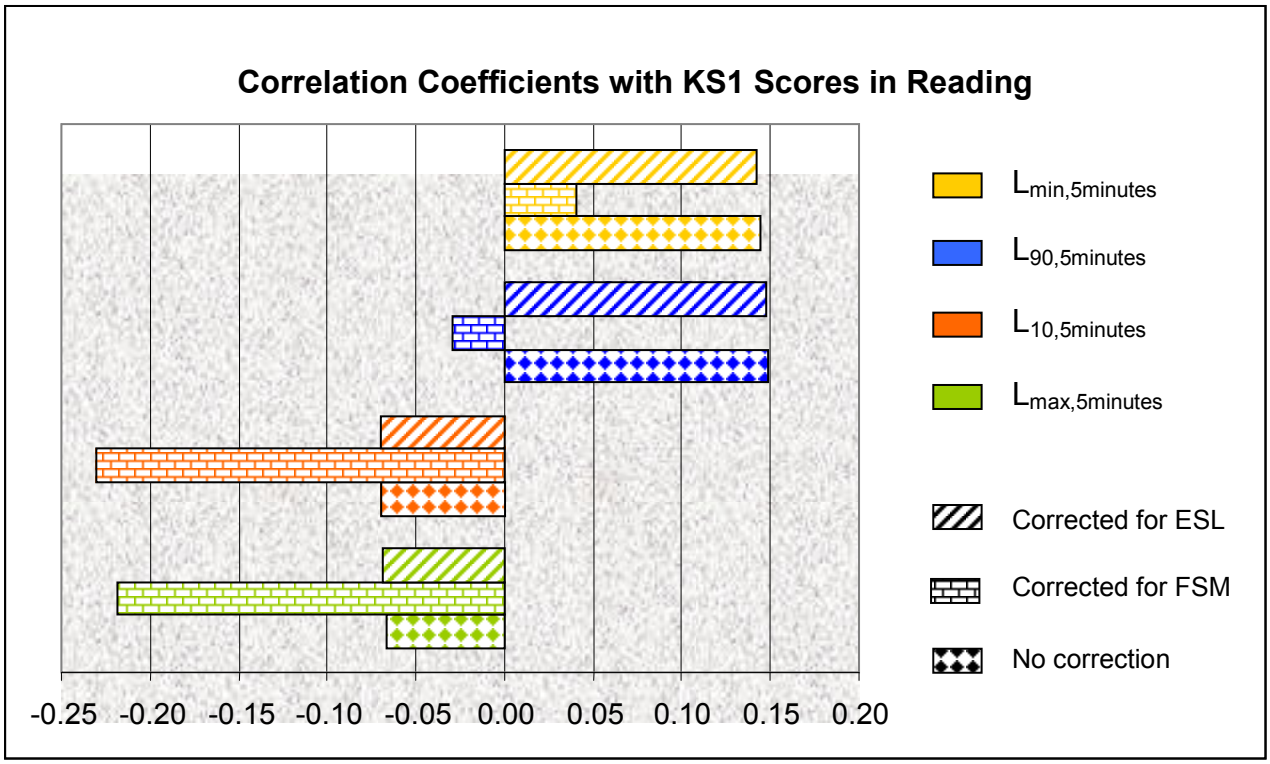


Figure 6.5: Correlation coefficients with KS1 Reading Scores

The strongest correlation appears with the highest noise levels, i.e. The $L_{Amax,5min}$ and The $L_{A10,5min}$. The $L_{A10,5min}$ has a correlation coefficient with Reading scores of –0.23 when the effects of social background are removed. Indeed the highest noise levels are more likely to be the noise levels heard in the classroom and create interference with activities. The $L_{A90,5min}$ which is a representation of the background noise levels are likely to be different to the background noise levels heard in the classrooms. Hence a lower correlation is found.

The $L_{A10,5min}$ are representative of the noise levels from an aircraft flying over. Hence finding a stronger correlation with the $L_{A10,5min}$ is consistent with the previous findings that aircraft noise is the most associated with SATs results.

Figure 6.6 to 6.11 below shows the scatter graphs of the $L_{A10,5min\ and}$ and $L_{Amax,5min}$ against scores in Reading, Writing and Mathematics.

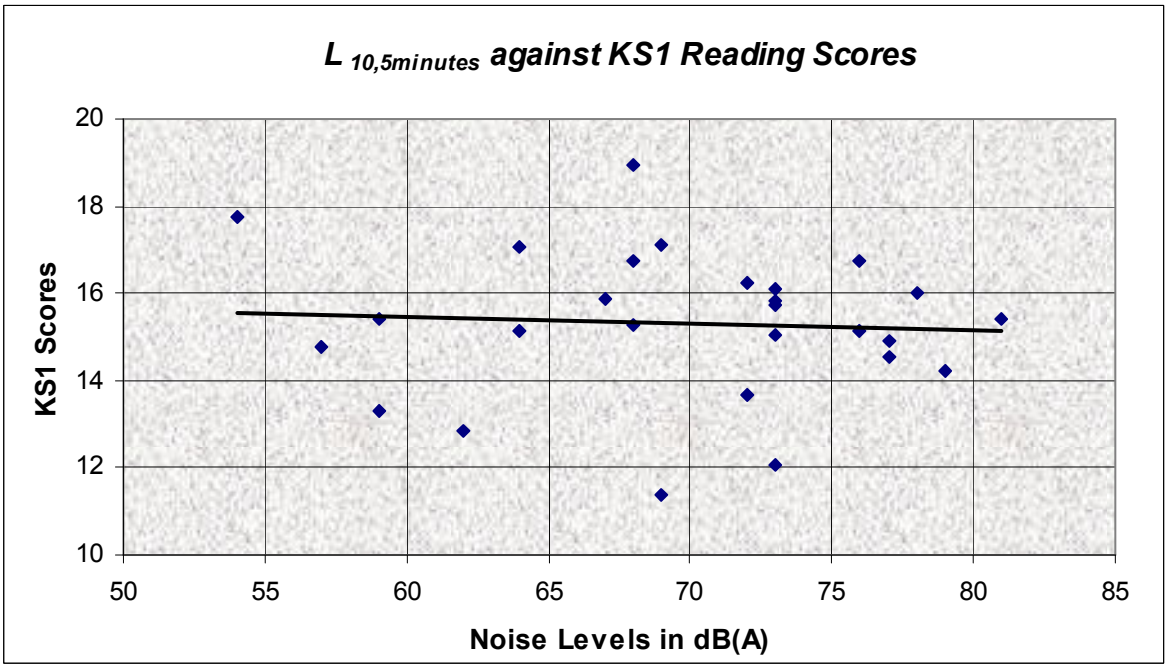


Figure 6.6 : $L_{A10,5min}$ against KS1 Reading Scores

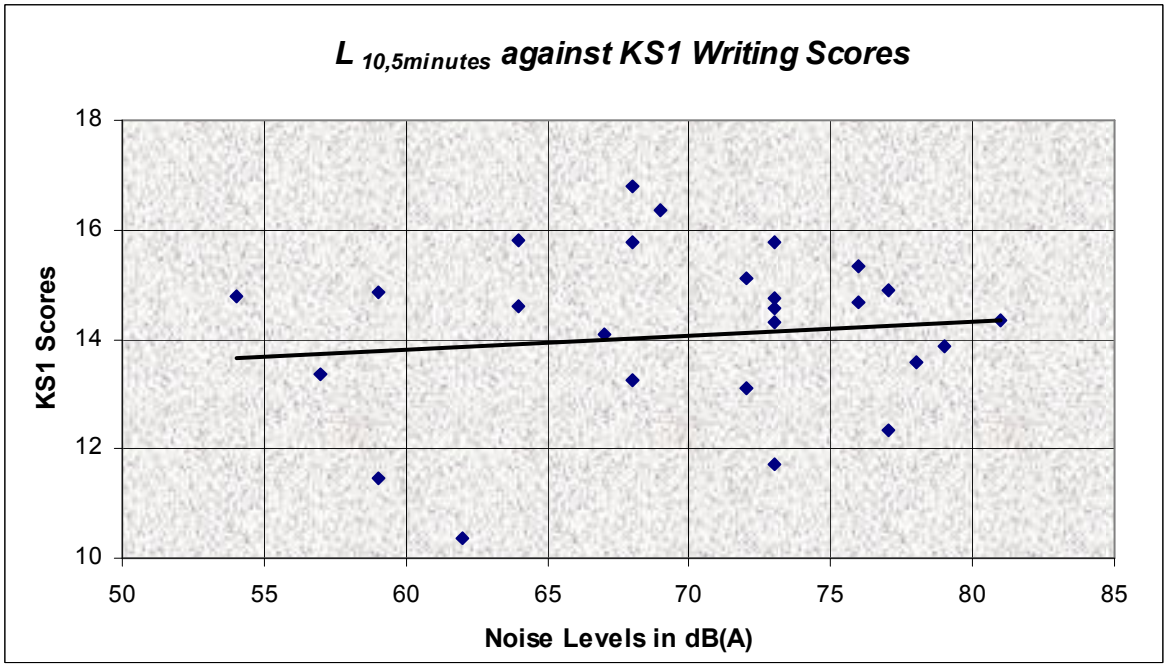


Figure 6.7 : $L_{A10,5min}$ against KS1 Writing Scores

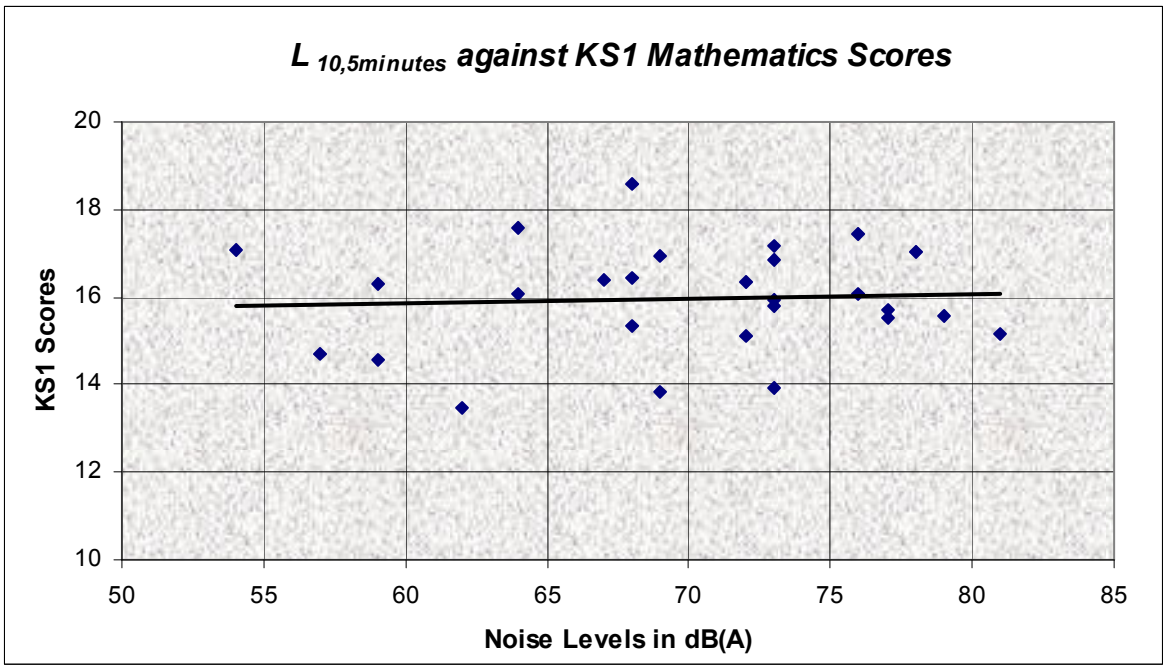


Figure 6.8 : $L_{A10,5min}$ against KS1 Mathematics Scores

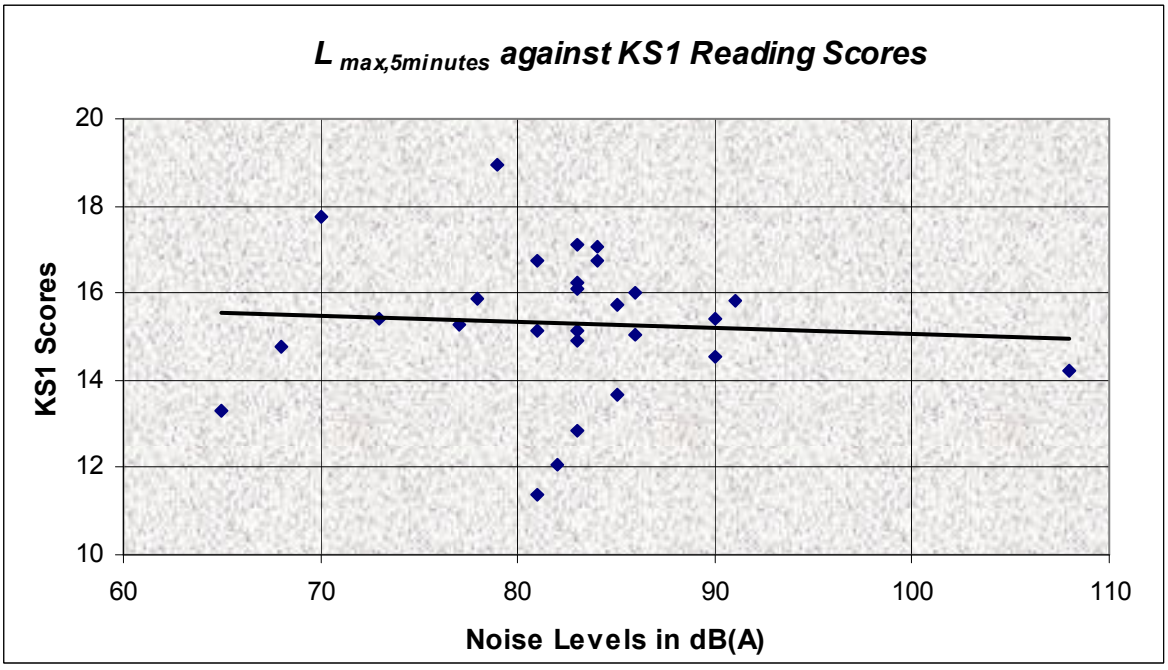


Figure 6.9 : $L_{Amax,5min}$ against KS1 Reading Scores

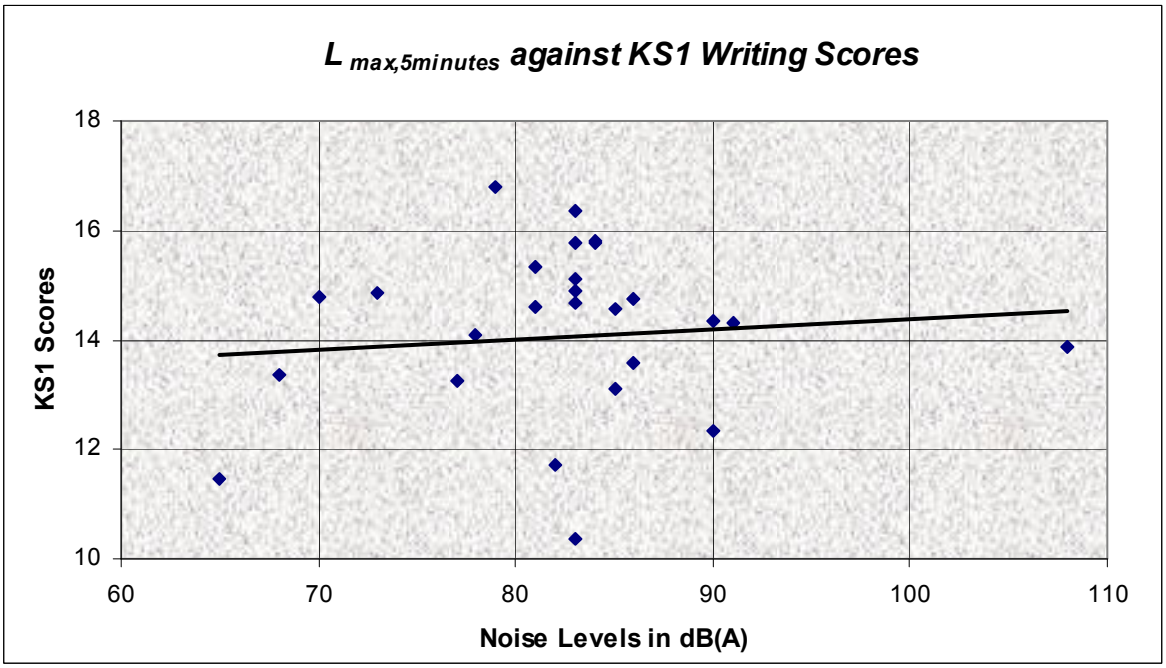


Figure 6.10 : $L_{Amax,5min}$ against KS1 Writing Scores

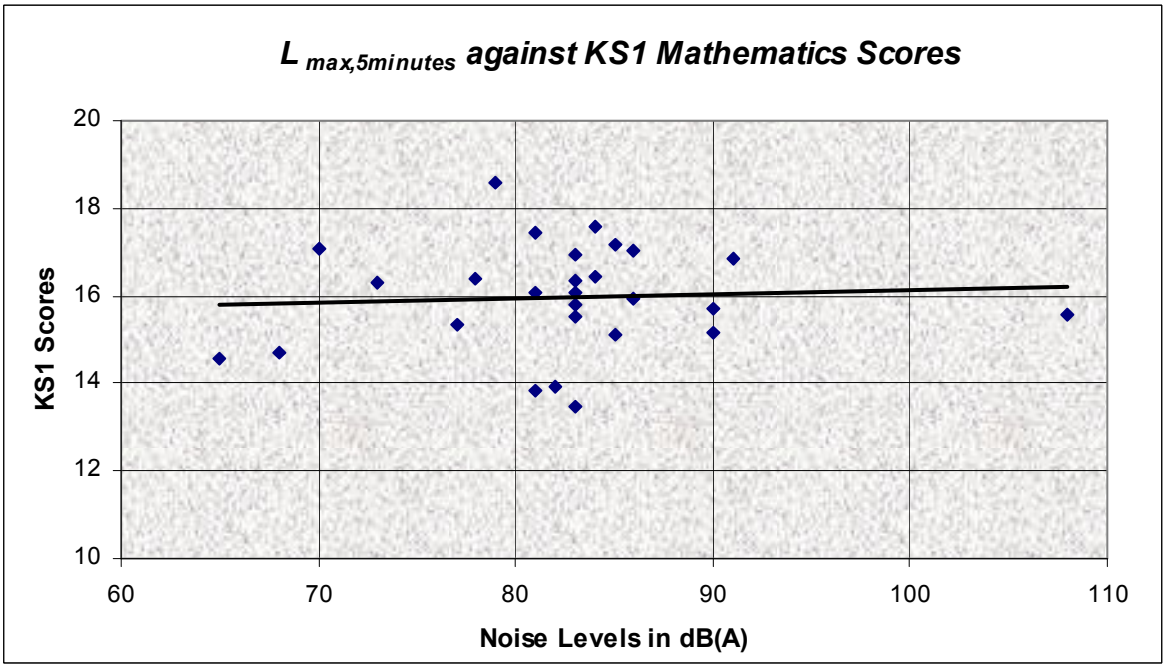


Figure 6.11 : $L_{Amax,5min}$ against KS1 Mathematics Scores

6.3 CONCLUSION

Partial correlations of noise levels with Reading, Writing and Mathematic scores of KS1 tests results showed that the continuous equivalent noise levels of aircraft noise are more detrimental to children's academic performance than any other noise source or acoustic parameter investigated. The relationship becomes even more significant when the data are corrected for social deprivation. In all cases the SATs tests the more affected were reading and comprehension. The effects of aircraft noise exposure were identified as a strong detrimental factor of children academic performance in six major studies in the past. This study hence provides confidence and further evidence of this observation.

Furthermore, the correlations showed that environmental noise exposure impairs reading capacity of children. This observation was also the results of six major studies carried out in the past.

The $L_{Amax,5min}$ and $L_{A10,5min}$ acoustic parameters also appear to be a factor influencing the academic results in Reading essentially. The Shield and Dockrell study [24] which also investigated the effects of several acoustic parameters also found that $L_{Amax,t}$ had a strong relationship but with Mathematics. This would tend to indicate that children are more affected by repetitive noise event which create a real but short term interference rather than by more constant steady noise levels.

CONCLUSION

Following a review of the knowledge on the effects of noise on chidlren, long term detrimental effects due to chronic exposure have been identified. These effects are in most cases the reduced ability to read and concentrate. The effects are long terms but revesible and they increase with age. They also have been found to be more acute when exposed to aircraft and road traffic noise than any other type of environmental noise.

Two major studies Haines and stansfeld [23] and Shield and Dockrell [24] have furthermore proved the dose-repsonse relationship between the noise and academic performance with lower academic results when exposed to more noise even when social and languages effects were removed.

From the subjective assessment, distinction betweeen aircraft and road traffic noise was possible. The analysis of the measured noise levels revealed that a large number of schools in Hounslow are exposed to high levels of noise such that outdoor teaching is not possible in most schools. 91% of schools are subject to external noise levels in excess of WHO guidelines with 60% exceeding the criterion (55 dB $L_{Aeq,t}$) by more than 10 dB. Three quarter of the schools are exposed to noise levels that regularly exceeds 80 dB(A). Noise levels in Hounslow largely exceed the ones measured in other London Boroughs and with higher peaks.

To consider how much the external noise levels can be heard in the classrooms a number of assumptions had to be made, however, the calculated values showed that noise levels exceeded considerably current legislation (legislation not applicable

to existing schools but used as a reference). In 19 schools, teachers would need a voice level from loud to shouting to ensure adequate intelligibility.

At this point of the study, it was clear that school's activity was largely handicaped due to noise, so an investigation into the consequences of this chronic exposure was carried out to find out if the same effects, as highlighted by previous studies , would be repeated in this case. Hence, the SATs results in Reading, Writing and Mathematics were correlated with each school noise levels. The results were not surprising. Indeed, in line with findings of other researches, strong relationship was found between noise levels and children academic achievements and in particular between Reading and Aircraft noise. It did appear that the nature of aircraft noise (i.e high noise for approximately 20 seconds during flyover then quiet for approximately 100 seconds, etc) had the most detrimental effects

This study contains a number of limitations. Indeed, it would have been beneficial to consider the layout of the classrooms, the building construction and its age as these are essential parameters affecting the sound insulation from intrusive noise. The correlation with SATs rely on the results of one set of tests and the conditions of the tests have not been taken into accounts. Indeed if the tests had taken place in a different classroom, may be less epxosed to noise the results may have been different.

Finally, this study could be investigated further in different ways. For example the character of the noise from aircraft and road traffic could be considered by looking at the octave band spectra. Also the effects of where the children live may be considered. For example, if aircraft noise affects the sleep of the children, are they not likely

to preform less well during the day?

REFERENCES

[1] Berglund B and Lindvall T, 'Community Noise'. WHO Environmental Health Criteria document, World Health Organisation, 1995.

[2] Sargent JW and Fothergill LC, 'The noise climate around our homes', BRE Information Pape IP21/93, Building Research establishment, 1993.

[3] BS 8233 'Sound insulation and noise reduction for buildings – Code of practice', British Standards Institution, HMSO, 1999

[4] Hygge S, 'Classroom experiments on the effects of aircraft, traffic and verbal noise on long term recall and recognition in children aged 12-14 years'. Proceedings of 6th International Congress on Noise as a Public Health Problem, 531-534, Nice, 1993.

[5] Glass and Singer,1972 (see refs in WHO)

[6] Michelson W, 'Ecological thought and its application to school functioning'. 14th Annual Eastern Research Institute of the Association for supervision and Curriculum Development. New York, 1968.

[7] Cohen S et al, 'Apartment noise, auditory discrimination and reading ability in children'. Journal of Experimental Social Psychology 9, 407 – 422, 1973.

[8] Crook MA and Langdon FJ, 'The effects of aircraft noise in schools around London airport'. Journal of Sound and vibration 3, 221-232, 1974.

[9] Bronzaft AL and McCarthy DP, 'The effects of elevated train noise on reading ability'. Environment and Behaviour 7, 517-527, 1975.

[10] Maser AL et al, 'Effects of intrusive sound on classroom behaviour: Data from a successful lawsuit'. Paper presented at Western Psychological Association. San Francisco, 22 April 1978.

[11] Cohen S et al, 'Physiological, motivational and cognitive effects of aircraft noise on children: moving from the laboratory to the field. American Psychologist 35, 231 – 243, 1980.

[12] Cohen S et al, 'Aircraft noise and children, longitudinal and cross sectional evidence on adaptation to noise and the effectiveness of noise abatement'. Journal of Personality and Social Psychology 40, 331-345, 1981.

[13] Bronzaft AL, 'The effect of noise abatement program on reading ability', Journal of Environmental Psychology 1, 215 – 222, 1981

[14] Lukas JS et al, ' Report of a study on the effects of freeway noise on academic achievement of elementary schoolchildren and a recommendation for a criterion level for a school noise abatement program'. Department of Health Services, California, 1981.

[15] Green KB et al, ‘Effects of aircraft noise on reading ability of school-age children’. Archives of Environmental Health 37, 24-31, 1982.

[16] Hetu R et al, ‘Problems of noise in school settings: a review of literature and the results of an exploratory study’. Journal of Speech, Language Pathology and Audiology 14 (3),31-38, 1990.

[17] Sanz S et al, ‘Road traffic noise around schools: a risk for pupil’s performance?’ International Archives of Occupational and Environmental Health 65, 205 – 207,1993.

[18] Berglund B and Lindvall T, ‘Community noise’. Research commissioned by World Health Organisation. Archives of the Centre for sensory research 2(1), Stockholm, 1995.

[19] Haines MM and Stansfeld SA, ‘The schools environment and health study – Pilot study report on tests conducted between March and July 1996’. Report for Terminal five public enquiry presented at the FICAN Symposium, San Diego, 16th February 2000.

[20] Hygge S, Evans GW et al, ‘The Munich Airport noise study: cognitive effects on children from before to after the change over of airports’. Proceedings of Internoise 96, 2189 – 2192, Liverpool, 1996.

[21] Evans G and Maxwell L, ‘Chronic noise exposure and reading deficits: the mediating effects of language acquisition. Environment and Behaviour 29, 638 – 656, 1997.

[22] Mackenzie DJ, ‘Noise Sources and levels in UK schools’. Proceedings of International symposium on Noise Control and Acoustics for Educational Buildings, Turkish Acoustical Society, 96 – 97, Istanbul, 2000.

[23] Haines M, Stansfeld S et al, ‘Multilevel modelling of aircraft noise on performance tests in schools around Heathrow Airport London’, Journal of Epidiomal Community Health, 56:39-144, UK, 2002.

[24] Shield BM and Dockrell JE, ‘The effects of noise on children at school: a review. J. Building Acoustics 10(2), 97-116, 2003

[25] Building Bulletin 93 ‘Acoustic Design of Schools’, DfES, TSO, 2003

[26] Building Bulletin 87 ‘Guidelines for Environmental Design in Schools’ DfEE, TSO, 1997

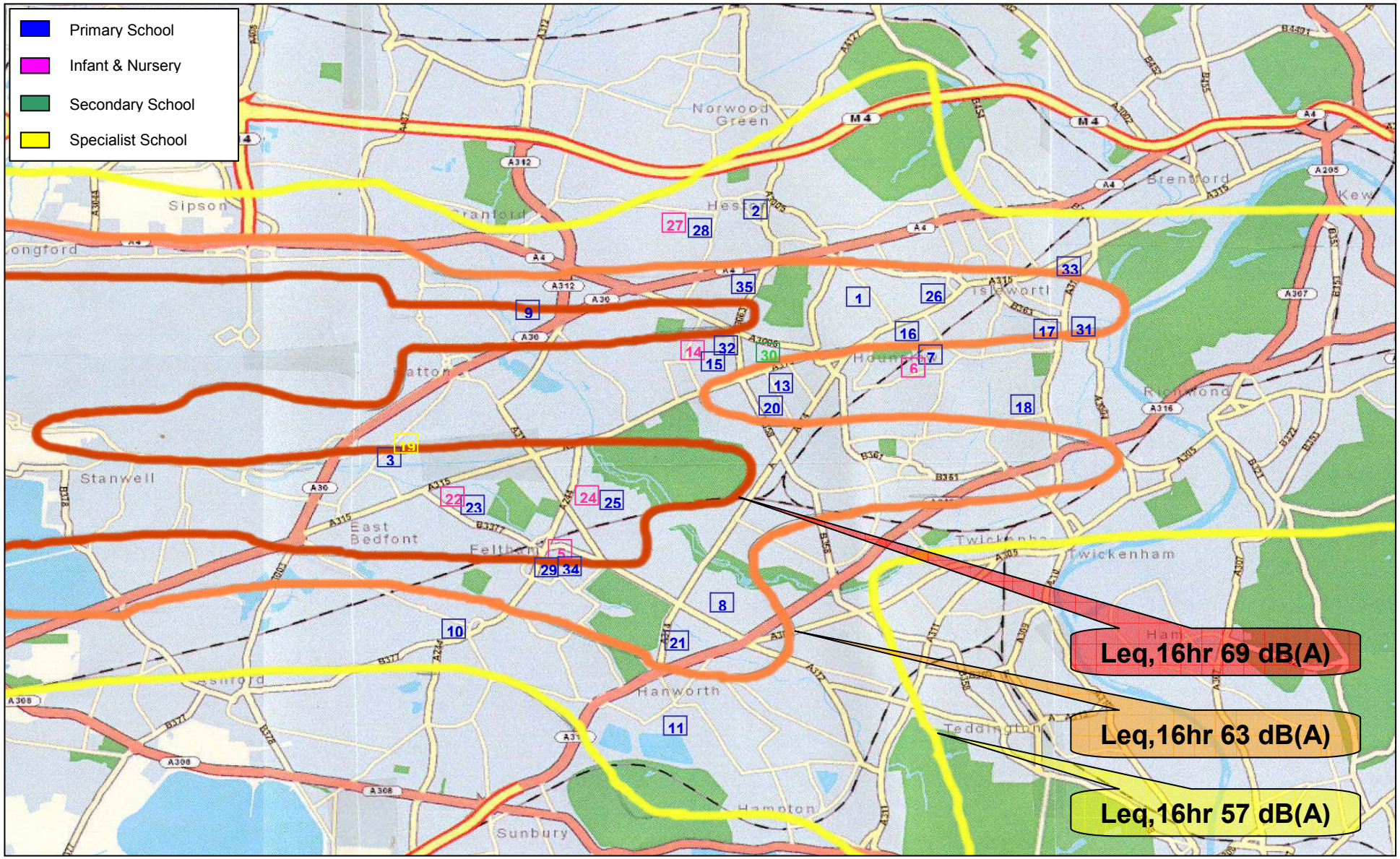
[27] Lercher P, Meis M and Kofler W, ‘Traffic noise annoyance in school children: dose-response functions from field and experimental studies in the Alpine area of Tyrol’, Proceedings of ‘Noise Pollution : Health effects on children’, Berlin, 2002.

[28] Monkman DJ, Edmond LE, Rhode DP, White S, ‘Noise exposure Contours for Heathrow Airport 1999’, ERCD Report, Department for Environment, Transport and Regions, 2001.

[29] Higgs G, Bellin W and Farrell S, ‘Educational attainments ans social disadvantage: contextualising school league tables’. Regional studies 31, 775-799, UK, 1997

[30] Williamson W and Byrne DD, ‘Educational disadvantage in an urban setting’ in Herbert DT, Smith DM, eds Social problems and the city. Oxford University Press, Oxford, 1977.

APPENDIX 1 – MAP SHOWING SCHOOL LOCATIONS AND 1999 NOISE CONTOURS



APPENDIX 2 – NOTATIONS AND TERMINOLOGY

Aircraft Noise levels

Contribution of the noise levels due to Aircraft flyovers only.

BB93

Building Bulletin 93 (see reference [25])

BB87

Building Bulletin 87 (see reference [26])

Correlation (and Partial Correlation)

The correlation is the measure of relationship between two setsof data. A partial correlation is a correlation where the effect of a third set of data are removed .

Corrected Noise Levels

External noise levels corrected to a distance of 4m from school's building façade

dB(A)

The decibel is the unit used to quantify sound pressure levels. The 'A' is a weighting correction term applied to the frequency range in order to mimic the sensitivity of the human ear to noise.

ESL

Percentage of pupils with English as a second language

FSM

Percentage of pupils eligible for free school meals

KS1

Key Stage 1 (7 years old children)

APPENDIX 2 – NOTATIONS AND TERMINOLOGY (CONTINUED)

KS2

Key Stage 2 (11 years old children)

$L_{eq,T}$

Continuous equivalent noise level (refer to paragraph 3.1 for definition)

$L_{max,T}$

Maxmium noise level (refer to paragraph 3.1 for definition)

$L_{min,T}$

Minimum noise level (refer to paragraph 3.1 for definition)

$L_{X,T}$

Percentile noise level (refer to paragraph 3.1 for definition)

Mean

The Mean is the arithmetic average of a set of data

Measured Noise Levels

Noise levels as measured with the Sound Level Meter

Median

The median is the value in the middle of a set of data.

Mode

The Mode of a set of data is the most frequently occurring value

Road traffic Noise Levels

Contribution of the noise levels due to road traffic.

SATs

National Standard Assessment Tests in school in England and Wales

APPENDIX 2 – NOTATIONS AND TERMINOLOGY (CONTINUED)

Sound Pressure Level

The sound pressure level is the sound pressure measured on a decibel scale with a reference sound pressure of $20x10^{-6}$ Pa. All noise levels are sound pressure levels.

Sound Reduction Index

Measure of the airborne insulating properties in dB.

Standard Deviation

The standard deviation gives a measure of the dispersion of the frequency distribution of a set of data.

WHO

World Health Organisation

APPENDIX 3 –SCHOOL DATA SHEET 1

School Data

School reference	1
School name	Alexandra Junior School
Address	Denbigh Road, Hounslow
Map reference	97 2F
Measurement ref.	1

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent		High		High	
Medium		Occasional		Medium		Medium	
Low	x	rare/few	x	Slow	x	Low	x

Description of Measurement's Environment

Road Name	Alexandra Gardens
Distance road traffic to playground	40m
Distance road traffic to school building	60m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium	x	Taking off	
Low		Low			

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	x
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	67	$L_{10,5minutes}$	72	$L_{max,5minutes}$	85
		$L_{90,5minutes}$	50	$L_{min,5minutes}$	46

APPENDIX 3 –SCHOOL DATA SHEET 2

School Data

School reference	2
School name	Andrew Ewing Primary
Address	Westbrook Road, Hounslow
Map reference	78 D7
Measurement ref.	12

Description of Measurement's Environment

Road Name	Upper Sutton Lane
Distance road traffic to playground	55m
Distance road traffic to school building	55m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	

Surroundings :

Open plan	x
Residential	
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	5m

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent		High		High	
Medium		Occasional	x	Medium	x	Medium	
Low		rare/few		Slow		Low	x

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium		Taking off	
Low		Low	x		

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	77	$L_{10,5minutes}$	72	$L_{max,5minutes}$	85
		$L_{90,5minutes}$	60	$L_{min,5minutes}$	46

APPENDIX 3 –SCHOOL DATA SHEET 3

School Data

School reference	3
School name	Bedfont Junior
Address	Hatton Road, East Bedfont
Map reference	95 6G
Measurement ref.	19

Description of Measurement's Environment

Road Name	Hatton Road
Distance road traffic to playground	2m
Distance road traffic to school building	15m

Weather:

Sunny	x
Windy	x
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	5m

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent		High	x	High	
Medium		Occasional	x	Medium		Medium	x
Low		rare/few		Slow		Low	

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium		Taking off	x
Low		Low	x		

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	73	$L_{10,5minutes}$	78	$L_{max,5minutes}$	86
		$L_{90,5minutes}$	60	$L_{min,5minutes}$	55

APPENDIX 3 –SCHOOL DATA SHEET 4

School Data

School reference	4
School name	Belmont Primary School
Address	Belmont Road
Map reference	81 4K
Measurement ref.	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent		High		High	
Medium	x	Occasional	x	Medium		Medium	
Low		rare/few		Slow	x	Low	x

Description of Measurement's Environment

Road Name	Belmont Road
Distance road traffic to playground	50m
Distance road traffic to school building	45m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	
Road nearby	x
Distance	45m

Aircraft Noise

Audibility		Altitude		Activity	
High		High	x	Landing	
Medium		Medium		Taking off	
Low	x	Low			

Other Noise Sources

Trains	x	Music		Adults	
Helicopter		Construction		Passerby	x
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	63	$L_{10,5minutes}$	68	$L_{max,5minutes}$	79
		$L_{90,5minutes}$	49	$L_{min,5minutes}$	45

APPENDIX 3 –SCHOOL DATA SHEET 5

School Data

School reference	5
School name	Cardinal Road Infant and Nursery
Address	Cardinal road, Feltham
Map reference	113 1K
Measurement ref.	16

Description of Measurement's Environment

Road Name	Hanworth Road
Distance road traffic to playground	50m
Distance road traffic to school building	17m

Weather:

Sunny	x
Windy	x
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent	x	High		High	
Medium		Occasional		Medium	x	Medium	x
Low		rare/few		Slow		Low	

Aircraft Noise

Audibility		Altitude		Activity	
High		High		Landing	
Medium	x	Medium	x	Taking off	x
Low		Low			

Other Noise Sources

Trains	x	Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	69	$L_{10,5minutes}$	73	$L_{max,5minutes}$	85
		$L_{90,5minutes}$	60	$L_{min,5minutes}$	56

APPENDIX 3 –SCHOOL DATA SHEET 6

School Data

School reference	6
School name	Chatsworth Infant and Nursery School
Address	Heath Road, Hounslow
Map reference	97 4G
Measurement ref.	4

Description of Measurement's Environment

Road Name	Heath Road
Distance road traffic to playground	30m
Distance road traffic to school building	50m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent		High		High	
Medium		Occasional		Medium		Medium	
Low	x	rare/few	x	Slow	x	Low	x

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium	x	Taking off	
Low		Low			

Other Noise Sources

Trains	x	Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children	x	Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	61	$L_{10,5minutes}$	64	$L_{max,5minutes}$	81
		$L_{90,5minutes}$	49	$L_{min,5minutes}$	46

APPENDIX 3 –SCHOOL DATA SHEET 7

School Data

School reference	7
School name	Chatsworth Juniors School
Address	Heath Road, Hounslow
Map reference	97 4G
Measurement ref.	4

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent		High		High	
Medium		Occasional		Medium		Medium	
Low	x	rare/few	x	Slow	x	Low	x

Description of Measurement's Environment

Road Name	Heath Road
Distance road traffic to playground	20m
Distance road traffic to school building	10m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium	x	Taking off	
Low		Low			

Other Noise Sources

Trains	x	Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children	x	Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	61	$L_{10,5minutes}$	64	$L_{max,5minutes}$	81
		$L_{90,5minutes}$	49	$L_{min,5minutes}$	46

APPENDIX 3 –SCHOOL DATA SHEET 8

School Data

School reference	8
School name	Crane Park Primary School
Address	Norman Avenue, Hanworth, TW13 5LN
Map reference	114 2D
Measurement ref.	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent		High		High	
Medium		Occasional		Medium		Medium	
Low	x	rare/few	x	Slow	x	Low	x

Description of Measurement's Environment

Road Name	Norman Avenue
Distance road traffic to playground	250m
Distance road traffic to school building	230m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	350m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium	x	Taking off	x
Low		Low			

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	x
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	64	$L_{10,5minutes}$	69	$L_{max,5minutes}$	81
		$L_{90,5minutes}$	48	$L_{min,5minutes}$	42

APPENDIX 3 –SCHOOL DATA SHEET 9

School Data

School reference	9
School name	Cranford Junior
Address	Berkerley Avenue
Map reference	95 2K
Measurement ref.	18

Description of Measurement's Environment

Road Name	Bekerley Avenue
Distance road traffic to playground	50m
Distance road traffic to school building	55m

Weather:

Sunny	x
Windy	x
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	5m

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent		High		High	
Medium	x	Occasional		Medium		Medium	
Low		rare/few	x	Slow	x	Low	x

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium		Taking off	x
Low		Low	x		

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	x
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	68	$L_{10,5minutes}$	72	$L_{max,5minutes}$	83
		$L_{90,5minutes}$	54	$L_{min,5minutes}$	51

APPENDIX 3 –SCHOOL DATA SHEET 10

School Data

School reference	10
School name	Feltham Hill Juniors
Address	Ashford Road, Feltham, TW13 4QP
Map reference	113 3H
Measurement ref.	

Description of Measurement's Environment

Road Name	Ashford Road
Distance road traffic to playground	40m
Distance road traffic to school building	20m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	x
Residential	
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent	x	High		High	
Medium		Occasional		Medium	x	Medium	x
Low		rare/few		Slow		Low	

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium	x	Taking off	x
Low		Low			

Other Noise Sources

Trains		Music		Adults	x
Helicopter		Construction		Passerby	x
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	70	$L_{10,5minutes}$	73	$L_{max,5minutes}$	83
		$L_{90,5minutes}$	61	$L_{min,5minutes}$	59

APPENDIX 3 –SCHOOL DATA SHEET 11

School Data

School reference	11
School name	Forge Lane Primary School
Address	Forge Lane, Hanworth, TW13 6UN
Map reference	114 5C
Measurement ref.	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent	x	High	x	High	x
Medium		Occasional		Medium		Medium	
Low	x	rare/few		Slow		Low	

Description of Measurement's Environment

Road Name	Forge Lane
Distance road traffic to playground	700m
Distance road traffic to school building	700m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	x
Residential	
Built up	

Measurements location from traffic noise source :

On pavement	
Road nearby	x
Distance	680m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium	x	Taking off	x
Low		Low			

Other Noise Sources

Trains		Music		Adults	x
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	64	$L_{10,5minutes}$	62	$L_{max,5minutes}$	83
		$L_{90,5minutes}$	41	$L_{min,5minutes}$	38

APPENDIX 3 –SCHOOL DATA SHEET 12

School Data

School reference	12
School name	Grove Park Primary School
Address	Nightingale Close, Chiswick, TW3 3QQ
Map reference	
Measurement ref.	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent		High		High	
Medium	x	Occasional		Medium		Medium	
Low		rare/few	x	Slow	x	Low	x

Description of Measurement's Environment

Road Name	Park Road
Distance road traffic to playground	50m
Distance road traffic to school building	80m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High		High		Landing	x
Medium	x	Medium	x	Taking off	
Low		Low			

Other Noise Sources

Trains	x	Music		Adults	x
Helicopter		Construction		Passerby	x
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	51	$L_{10,5minutes}$	54	$L_{max,5minutes}$	70
		$L_{90,5minutes}$	44	$L_{min,5minutes}$	36

APPENDIX 3 –SCHOOL DATA SHEET 13

School Data

School reference	13
School name	Grove Road Primary School
Address	Cromwel Road, Hounslow
Map reference	96 4E
Measurement ref.	6

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent		High		High	
Medium		Occasional	x	Medium	x	Medium	
Low		rare/few		Slow		Low	x

Description of Measurement's Environment

Road Name	Cromwell Road
Distance road traffic to playground	10m
Distance road traffic to school building	20m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium		Taking off	
Low		Low	x		

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children	x	Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	62	$L_{10,5minutes}$	64	$L_{max,5minutes}$	84
		$L_{90,5minutes}$	49	$L_{min,5minutes}$	44

APPENDIX 3 –SCHOOL DATA SHEET 14

School Data

School reference	14
School name	Hounslow Heath Infant and Nursery
Address	Martindale Road, Hounslow
Map reference	96 3C
Measurement ref.	10

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent		High		High	
Medium		Occasional	x	Medium	x	Medium	
Low		rare/few		Slow		Low	x

Description of Measurement's Environment

Road Name	Martindale Road
Distance road traffic to playground	50m
Distance road traffic to school building	10m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium	x	Taking off	
Low		Low			

Other Noise Sources

Trains		Music		Adults	x
Helicopter		Construction		Passerby	x
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	69	$L_{10,5minutes}$	73	$L_{max,5minutes}$	86
		$L_{90,5minutes}$	54	$L_{min,5minutes}$	49

APPENDIX 3 –SCHOOL DATA SHEET 15

School Data

School reference	15
School name	Hounslow Heath Junior
Address	Selwyn Close, Hounslow
Map reference	96 3C
Measurement ref.	9

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent		High		High	
Medium	x	Occasional		Medium		Medium	
Low		rare/few	x	Slow	x	Low	x

Description of Measurement's Environment

Road Name	Selwyn Close
Distance road traffic to playground	120m
Distance road traffic to school building	80m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	

Surroundings :

Open plan	x
Residential	
Built up	

Measurements location from traffic noise source :

On pavement	
Road nearby	x
Distance	60m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium	x	Taking off	
Low		Low			

Other Noise Sources

Trains		Music		Adults	x
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	63	$L_{10,5minutes}$	66	$L_{max,5minutes}$	85
		$L_{90,5minutes}$	48	$L_{min,5minutes}$	44

APPENDIX 3 –SCHOOL DATA SHEET 16

School Data

School reference	16
School name	Hounslow Town Primary School
Address	Pears Road, Hounslow
Map reference	97 3G
Measurement ref.	3

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent		High		High	
Medium		Occasional		Medium	x	Medium	
Low	x	rare/few	x	Slow		Low	x

Description of Measurement's Environment

Road Name	Pears Road
Distance road traffic to playground	40m
Distance road traffic to school building	20m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium	x	Taking off	
Low		Low			

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	x
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	63	$L_{10,5minutes}$	68	$L_{max,5minutes}$	77
		$L_{90,5minutes}$	51	$L_{min,5minutes}$	48

APPENDIX 3 –SCHOOL DATA SHEET 17

School Data

School reference	17
School name	Isleworth Town Primary School
Address	Twickenham Road, Isleworth, TW7 6AB
Map reference	97 3K
Measurement ref.	

Description of Measurement's Environment

Road Name	Twickenham Road
Distance road traffic to playground	20m
Distance road traffic to school building	50m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent	x	High		High	x
Medium		Occasional		Medium	x	Medium	
Low		rare/few		Slow		Low	

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium	x	Taking off	x
Low		Low			

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	74	$L_{10,5minutes}$	77	$L_{max,5minutes}$	90
		$L_{90,5minutes}$	62	$L_{min,5minutes}$	57

APPENDIX 3 –SCHOOL DATA SHEET 18

School Data

School reference	18
School name	Ivybridge Primary School
Address	Summerwood Road
Map reference	97 6K
Measurement ref.	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent	x	High		High	
Medium		Occasional		Medium	x	Medium	x
Low	x	rare/few		Slow		Low	

Description of Measurement's Environment

Road Name	Summerwood Road
Distance road traffic to playground	100m
Distance road traffic to school building	100m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	
Road nearby	x
Distance	100m

Aircraft Noise

Audibility		Altitude		Activity	
High		High		Landing	
Medium	x	Medium	x	Taking off	x
Low		Low			

Other Noise Sources

Trains		Music		Adults	x
Helicopter		Construction	x	Passerby	
Emerg. Siren		Children	x	Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	54	$L_{10,5minutes}$	57	$L_{max,5minutes}$	68
		$L_{90,5minutes}$	45	$L_{min,5minutes}$	42

APPENDIX 3 –SCHOOL DATA SHEET 19

School Data

School reference	19
School name	Marjory Kinnon School
Address	Hatton Road
Map reference	95 5G
Measurement ref.	19

Description of Measurement's Environment

Road Name	Hatton Road
Distance road traffic to playground	5m
Distance road traffic to school building	35m

Weather:

Sunny	x
Windy	x
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	5m

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent	x	High	x	High	
Medium		Occasional		Medium		Medium	x
Low		rare/few		Slow		Low	

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium		Taking off	x
Low		Low	x		

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :	Extract Fans				

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	75	$L_{10,5minutes}$	78	$L_{max,5minutes}$	83
		$L_{90,5minutes}$	64	$L_{min,5minutes}$	51

APPENDIX 3 –SCHOOL DATA SHEET 20

School Data

School reference	20
School name	Orchad Junior School
Address	Orchad Road, Housnlow
Map reference	96 5E
Measurement ref.	5

Description of Measurement's Environment

Road Name	Orchad Road
Distance road traffic to playground	100m
Distance road traffic to school building	100m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	x

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	
Road nearby	x
Distance	80m

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent	x	High	x	High	x
Medium	x	Occasional		Medium		Medium	
Low		rare/few		Slow		Low	

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium		Taking off	
Low		Low	x		

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	x
Emerg. Siren		Children	x	Door/gate	x
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	57	$L_{10,5minutes}$	59	$L_{max,5minutes}$	73
		$L_{90,5minutes}$	50	$L_{min,5minutes}$	47

APPENDIX 3 –SCHOOL DATA SHEET 21

School Data

School reference	21
School name	Oriel Primary School
Address	Hounslow Road, Hanworth, TW13 6QQ
Map reference	114 3C
Measurement ref.	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent	x	High		High	
Medium		Occasional		Medium	x	Medium	x
Low		rare/few		Slow		Low	

Description of Measurement's Environment

Road Name	Hounslow Road
Distance road traffic to playground	95m
Distance road traffic to school building	65m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	x
Residential	
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	15m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium	x	Taking off	x
Low		Low			

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	69	$L_{10,5minutes}$	73	$L_{max,5minutes}$	82
		$L_{90,5minutes}$	59	$L_{min,5minutes}$	55

APPENDIX 3 –SCHOOL DATA SHEET 22

School Data

School reference	22
School name	Southville Infant and Nursery
Address	Bedfont Lane, Feltham
Map reference	95 7H
Measurement ref.	21

Description of Measurement's Environment

Road Name	Bedfont Lane
Distance road traffic to playground	40m
Distance road traffic to school building	30m

Weather:

Sunny	x
Windy	x
Cloudy	
Rainy	

Surroundings :

Open plan	x
Residential	
Built up	

Measurements location from traffic noise source :

On pavement	
Road nearby	x
Distance	2m

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent	x	High		High	
Medium	x	Occasional		Medium	x	Medium	x
Low		rare/few		Slow		Low	

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium	x	Taking off	x
Low		Low			

Other Noise Sources

Trains		Music		Adults	x
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	69	$L_{10,5minutes}$	73	$L_{max,5minutes}$	91
		$L_{90,5minutes}$	56	$L_{min,5minutes}$	51

APPENDIX 3 –SCHOOL DATA SHEET 23

School Data

School reference	23
School name	Southville Juniors
Address	Bedfont Lane, Feltham
Map reference	95 7H
Measurement ref.	21

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent	x	High		High	
Medium	x	Occasional		Medium	x	Medium	x
Low		rare/few		Slow		Low	

Description of Measurement's Environment

Road Name	Bedfont Lane
Distance road traffic to playground	45m
Distance road traffic to school building	50m

Weather:

Sunny	x
Windy	x
Cloudy	
Rainy	

Surroundings :

Open plan	x
Residential	
Built up	

Measurements location from traffic noise source :

On pavement	
Road nearby	x
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium	x	Taking off	x
Low		Low			

Other Noise Sources

Trains		Music		Adults	x
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	69	$L_{10,5minutes}$	73	$L_{max,5minutes}$	91
		$L_{90,5minutes}$	56	$L_{min,5minutes}$	51

APPENDIX 3 –SCHOOL DATA SHEET 24

School Data

School reference	24
School name	Sparrow Farm Infant and Nursery
Address	Denham Road, Feltham
Map reference	96 7A
Measurement ref.	15

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent	x	High		High	
Medium		Occasional		Medium	x	Medium	x
Low	x	rare/few		Slow		Low	

Description of Measurement's Environment

Road Name	Denham Road
Distance road traffic to playground	200m
Distance road traffic to school building	200m

Weather:

Sunny	x
Windy	x
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	
Road nearby	x
Distance	200m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium	x	Taking off	x
Low		Low			

Other Noise Sources

Trains	x	Music		Adults	x
Helicopter		Construction	x	Passerby	
Emerg. Siren		Children	x	Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	81	$L_{10,5minutes}$	79	$L_{max,5minutes}$	108
		$L_{90,5minutes}$	53	$L_{min,5minutes}$	44

APPENDIX 3 –SCHOOL DATA SHEET 25

School Data

School reference	25
School name	Sparrow Farm Juniors
Address	Sparrow Farm Drive
Map reference	96 7A
Measurement ref.	14

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent	x	High		High	
Medium		Occasional		Medium	x	Medium	x
Low	x	rare/few		Slow		Low	

Description of Measurement's Environment

Road Name	Denham Road
Distance from playground	200m
Distance from school buildings	250m

Weather:

Sunny	x
Windy	x
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	
Road nearby	x
Distance	200m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium	x	Taking off	x
Low		Low			

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction	x	Passerby	x
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	68	$L_{10,5minutes}$	72	$L_{max,5minutes}$	90
		$L_{90,5minutes}$	55	$L_{min,5minutes}$	48

APPENDIX 3 –SCHOOL DATA SHEET 26

School Data

School reference	26
School name	Spring Grove Primary School
Address	Star Road
Map reference	97 2H
Measurement ref.	2

Description of Measurement's Environment

Road Name	Star Road
Distance road traffic to playground	60m
Distance road traffic to school building	80m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	
Road nearby	x
Distance	50m

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent	x	High		High	x
Medium	x	Occasional		Medium	x	Medium	
Low		rare/few		Slow		Low	

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium	x	Taking off	
Low		Low			

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction	x	Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	64	$L_{10,5minutes}$	68	$L_{max,5minutes}$	84
		$L_{90,5minutes}$	51	$L_{min,5minutes}$	48

APPENDIX 3 –SCHOOL DATA SHEET 27

School Data

School reference	27
School name	Springwell Infant and Nursery
Address	Speart Lane
Map reference	78 7C
Measurement ref.	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent		High		High	
Medium	x	Occasional		Medium	x	Medium	
Low		rare/few	x	Slow		Low	x

Description of Measurement's Environment

Road Name	Speart Lane
Distance road traffic to playground	45m
Distance road traffic to school building	45m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium		Taking off	x
Low		Low	x		

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	72	$L_{10,5minutes}$	77	$L_{max,5minutes}$	83
		$L_{90,5minutes}$	61	$L_{min,5minutes}$	45

APPENDIX 3 –SCHOOL DATA SHEET 28

School Data

School reference	28
School name	Springwell Junior School
Address	Vicarage Farm Road
Map reference	78 7C
Measurement ref.	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent	x	High		High	
Medium		Occasional		Medium	x	Medium	x
Low		rare/few		Slow		Low	

Description of Measurement's Environment

Road Name	Vicarage Farm Road
Distance road traffic to playground	30m
Distance road traffic to school building	50m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	
Medium		Medium		Taking off	x
Low		Low	x		

Other Noise Sources

Trains		Music		Adults	x
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	73	$L_{10,5minutes}$	77	$L_{max,5minutes}$	84
		$L_{90,5minutes}$	63	$L_{min,5minutes}$	55

APPENDIX 3 –SCHOOL DATA SHEET 29

School Data

School reference	29
School name	St Lawrence RC Primary
Address	Victoria Road, Feltham, TW13 4AQ
Map reference	113 2K
Measurement ref.	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent		High		High	
Medium	x	Occasional	x	Medium		Medium	
Low		rare/few		Slow	x	Low	x

Description of Measurement's Environment

Road Name	Victoria Road
Distance road traffic to playground	5m
Distance road traffic to school building	20m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High		High	x	Landing	
Medium	x	Medium		Taking off	x
Low		Low			

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren	x	Children	x	Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	63	$L_{10,5minutes}$	67	$L_{max,5minutes}$	78
		$L_{90,5minutes}$	55	$L_{min,5minutes}$	51

APPENDIX 3 –SCHOOL DATA SHEET 30

School Data

School reference	30	SECONDARY
School name	St Mark's Catholic School	
Address	Bath Road, Hounslow	
Map reference	96 3D	
Measurement ref.	7	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent	x	High	x	High	x
Medium		Occasional		Medium		Medium	
Low		rare/few		Slow		Low	

Description of Measurement's Environment

Road Name	Bath Road
Distance road traffic to playground	60m
Distance road traffic to school building	60m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	x

Surroundings :

Open plan	x
Residential	
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium		Taking off	
Low		Low	x		

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	72	$L_{10,5minutes}$	76	$L_{max,5minutes}$	86
		$L_{90,5minutes}$	61	$L_{min,5minutes}$	57

APPENDIX 3 –SCHOOL DATA SHEET 31

School Data

School reference	31
School name	St Mary's RC Primary School
Address	Duke Road, Chiswick, TW4 2DF
Map reference	82 6A
Measurement ref.	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent	x	High	x	High	x
Medium		Occasional		Medium		Medium	
Low		rare/few		Slow		Low	

Description of Measurement's Environment

Road Name	A4
Distance road traffic to playground	15m
Distance road traffic to school building	30m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	10m

Aircraft Noise

Audibility		Altitude		Activity	
High		High	x	Landing	
Medium		Medium		Taking off	
Low	x	Low			

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	76	$L_{10,5minutes}$	76	$L_{max,5minutes}$	81
		$L_{90,5minutes}$	66	$L_{min,5minutes}$	57

APPENDIX 3 –SCHOOL DATA SHEET 32

School Data

School reference	32
School name	St Michael's & St Martin's School
Address	Belgrave Road, hounslow
Map reference	96 3D
Measurement ref.	8

Description of Measurement's Environment

Road Name	Wellington Road
Distance road traffic to playground	10m
Distance road traffic to school building	20m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	x

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent	x	High		High	
Medium		Occasional		Medium	x	Medium	x
Low		rare/few		Slow		Low	

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium	x	Taking off	
Low		Low			

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	67	$L_{10,5minutes}$	69	$L_{max,5minutes}$	83
		$L_{90,5minutes}$	59	$L_{min,5minutes}$	53

APPENDIX 3 –SCHOOL DATA SHEET 33

School Data

School reference	33
School name	The Smallberry Green Primary School
Address	Turnpike Way, Isleworth, TW7 5BF
Map reference	98 1A
Measurement ref.	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent	x	High		High	x
Medium		Occasional		Medium	x	Medium	
Low	x	rare/few		Slow		Low	

Description of Measurement's Environment

Road Name	London Road
Distance road traffic to playground	50m
Distance road traffic to school building	50m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	
Road nearby	x
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High		High	x	Landing	
Medium	x	Medium		Taking off	x
Low		Low			

Other Noise Sources

Trains		Music		Adults	x
Helicopter		Construction		Passerby	
Emerg. Siren		Children	x	Door/gate	
Other :	Carwash				

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	55	$L_{10,5minutes}$	59	$L_{max,5minutes}$	65
		$L_{90,5minutes}$	47	$L_{min,5minutes}$	43

APPENDIX 3 –SCHOOL DATA SHEET 34

School Data

School reference	34
School name	Victoria Juniors
Address	Victoria Road, Feltham, TW13 4AQ
Map reference	113 2K
Measurement ref.	

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High		Frequent		High		High	
Medium	x	Occasional	x	Medium		Medium	
Low		rare/few		Slow	x	Low	x

Description of Measurement's Environment

Road Name	Victoria Road
Distance road traffic to playground	25m
Distance road traffic to school building	15m

Weather:

Sunny	x
Windy	
Cloudy	
Rainy	

Surroundings :

Open plan	
Residential	x
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	2m

Aircraft Noise

Audibility		Altitude		Activity	
High		High	x	Landing	
Medium	x	Medium		Taking off	x
Low		Low			

Other Noise Sources

Trains		Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren	x	Children	x	Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	63	$L_{10,5minutes}$	67	$L_{max,5minutes}$	78
		$L_{90,5minutes}$	55	$L_{min,5minutes}$	51

APPENDIX 3 –SCHOOL DATA SHEET 35

School Data

School reference	35
School name	Wellington Primary
Address	Sutton Lane, Hounslow
Map reference	96 2D
Measurement ref.	11

Road Traffic Noise

Audibility		Traffic		Speed		% Hvy vehicles	
High	x	Frequent	x	High	x	High	
Medium		Occasional		Medium		Medium	x
Low		rare/few		Slow		Low	

Description of Measurement's Environment

Road Name	Sutton Lane
Distance road traffic to playground	10m
Distance road traffic to school building	35m

Weather:

Sunny	
Windy	x
Cloudy	x
Rainy	

Surroundings :

Open plan	x
Residential	
Built up	

Measurements location from traffic noise source :

On pavement	x
Road nearby	
Distance	5m

Aircraft Noise

Audibility		Altitude		Activity	
High	x	High		Landing	x
Medium		Medium		Taking off	
Low		Low	x		

Other Noise Sources

Trains	x	Music		Adults	
Helicopter		Construction		Passerby	
Emerg. Siren		Children		Door/gate	
Other :					

Measured Noise Levels in dB(A)

$L_{eq,5minutes}$	72	$L_{10,5minutes}$	76	$L_{max,5minutes}$	83
		$L_{90,5minutes}$	59	$L_{min,5minutes}$	53

APPENDIX 4 – SCHOOLS AVERAGE KS1 SCORES

School Reference	School	2003 Key Stage 1 Scores		
		READING/ COMPREHENSION	WRITING	MATHEMATICS
1	Alexandra J	13.7	13.1	15.1
2	Andrew Ewing JI	15.4	14.3	15.2
3	Bedfont J	16.0	13.6	17.0
4	Belmont JI	19.0	16.8	18.6
5	Cardinal Road I	15.8	14.6	17.2
6	Chatsworth I	15.2	14.6	16.1
8	Crane Park	11.4	9.6	13.8
9	Cranford J	16.2	15.1	16.4
10	Feltham Hill J	16.1	15.8	15.8
11	Forge Lane Primary	12.8	10.3	13.5
12	Grove Park JI	17.8	14.8	17.1
13	Grove Road JI	17.1	15.8	17.6
14	Hounslow Heath I	15.0	14.8	15.9
16	Hounslow Town JI	15.3	13.3	15.3
17	Isleworth Town JI	14.5	12.3	15.7
18	Ivybridge JI	14.8	13.3	14.7
20	Orchard J	15.4	14.9	16.3
21	Oriel JI	12.1	11.7	13.9
22	Southville I	15.8	14.3	16.9
24	Sparrow Farm I	14.2	13.9	15.6
26	Spring Grove JI	16.7	15.8	16.4
27	Springwell I	14.9	14.9	15.5
29	St Lawrence RC JI	15.9	14.1	16.4
31	St Mary's RC JI (Chis)	16.7	15.3	17.4
32	St Michael/Martin RC JI	17.1	16.3	16.9
33	Smallberry Green JI	13.3	11.4	14.6
35	Wellington JI	15.2	14.7	16.1

APPENDIX 5 – FSM AND ESL DATA

Reference	School	Percentage of free school meals	Percentage of children with English as a second language
1	Alexandra J	20%	81%
2	Andrew Ewing JI	23%	65%
3	Bedfont J	24%	17%
4	Belmont JI	13%	25%
5	Cardinal Road I	40%	22%
6	Chatsworth I	13%	56%
8	Crane Park	44%	33%
9	Cranford J	26%	76%
10	Feltham Hill J	21%	7%
11	Forge Lane Primary	25%	16%
12	Grove Park JI	23%	18%
13	Grove Road JI	28%	77%
14	Hounslow Heath I	28%	75%
16	Hounslow Town JI	23%	59%
17	Isleworth Town JI	22%	25%
18	Ivybridge JI	54%	59%
20	Orchard J	24%	81%
21	Oriel JI	33%	21%
22	Southville I	35%	17%
24	Sparrow Farm I	19%	23%
26	Spring Grove JI	11%	45%
27	Springwell I	11%	91%
29	St Lawrence RC JI	14%	50%
31	St Mary's RC JI (Chis)	8%	25%
32	St Michael/Martin RC JI	13%	40%
33	Smallberry Green JI	39%	44%
35	Wellington JI	23%	55%