Gatwick Airport Northern Runway Project

The Applicant's Response to Actions - ISH 5: Aviation Noise

Book 10

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APFP Regulations 5(2)(a) **Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009**

Table of Contents

1 Introduction

1.1 Introduction

1.1.1 This document provides the Applicant's response to the actions arising from Issue Specific Hearing (ISH) 5: Aviation Noise [EV10-005]. The actions relevant to the Applicant are as follows:

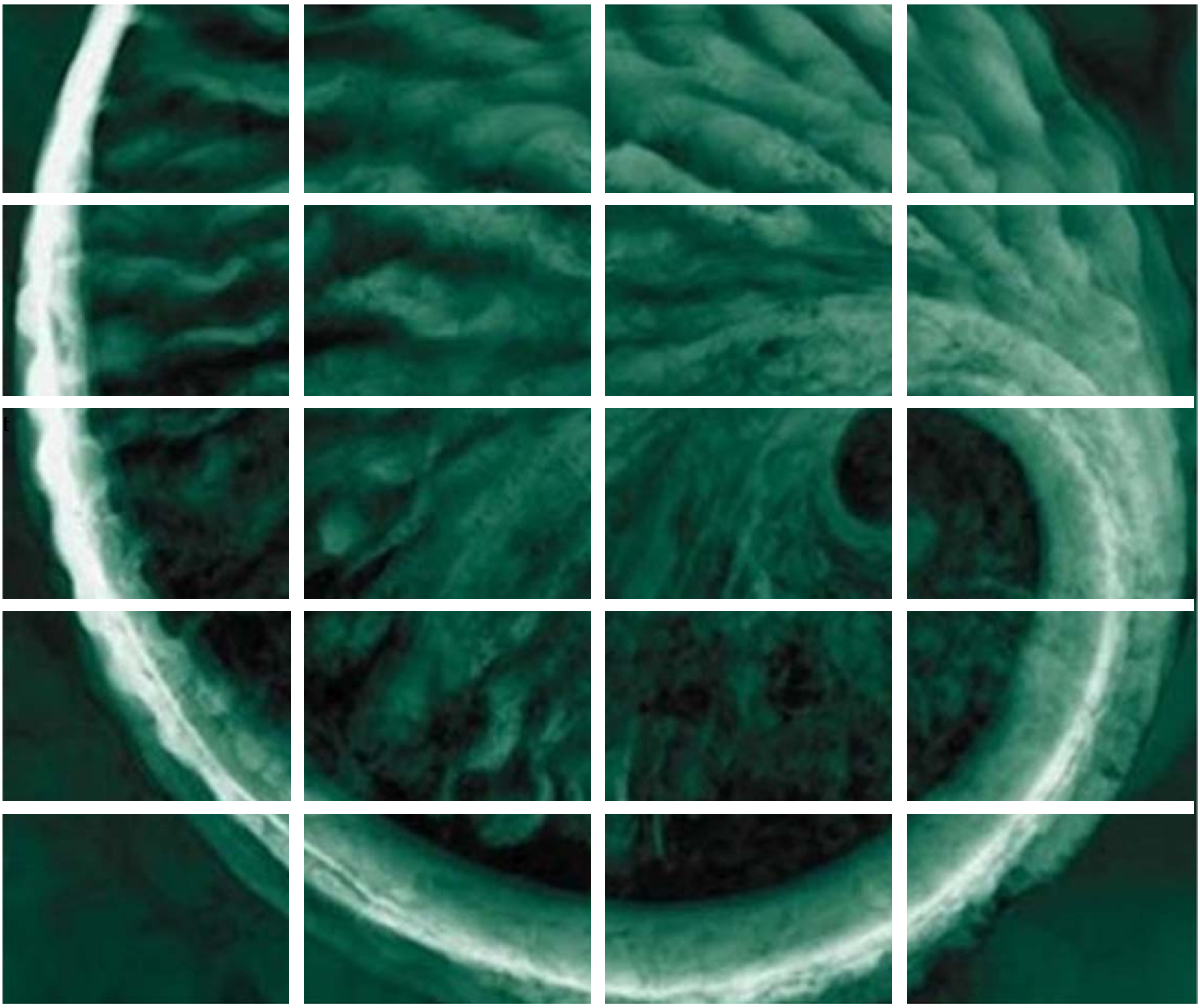
Action No.	Action	Deadline
1	Outline differences, if any, between where an aircraft is under the scope of the Air Navigation Order and where it is not.	Deadline 2
2	To submit the 2018 ambient noise study undertaken by the Applicant in support of its position on impact thresholds.	Deadline 1
3	To consider nighttime sound levels at specific school raised by Cllr Lockwood, Lingfield Parish.	Deadline 2
4	Joint Local Authorities To set out concerns regarding modelling at Deadline 1 separately or within Local Impact Report.	Deadline 1
5	CAGNE to set out the detail of what it feels is missing from the noise assessment, as stated.	Deadline 2
6	Applicant to respond to the points of detail raised at the hearing by Interested Parties in its written submissions.	Deadline 2
7	Applicant to provide an updated annex of how the noise insulation scheme will be implemented.	Deadline 2

1.1.2 The below sections provide the Applicant's response for Action 2. For actions which require a more detailed response, a reference to the appropriate document is included. All other actions will be responded to at the deadline stipulated in EV10-005.

2 Action Point 2

2.1.1 The ExA has requested a copy of the 2018 ambient air noise study undertaken by the Applicant. The Applicant has appended the Gatwick Airport: Ambient Air Study to this document at Appendix A.

Appendix A: Gatwick Airport: Ambient Air Noise Study



Gatwick Airport: Ambient Noise Study

December 2018

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229057\2018\2 SCM

Gatwick Airport Ltd.

December 2018

For and on behalf of
Environmental Resources Management

Approved by: Steve Mitchell

Signed: [redacted]

Position: Partner

Date: 21 December 2018

CONTENTS

1 INTRODUCTION

1.1 BACKGROUND AND SCOPE

NMB Information paper NMB/11 IP29 Developing Metrics for Gatwick Growth and Noise, GAL Update 22 June 2018, provides an account of the work GAL has been carrying out with the Community Noise Groups (CNG) to identify appropriate noise metrics to report impacts fully and clearly. The need to consider the influence of ambient (non-aircraft) noise was identified and the latter part of that paper set out a plan for that work. Appendix 1 reproduces NMB/11 IP29 for reference.

It has been suggested that people in rural areas where ambient noise is low are affected by aircraft noise more so than people in areas where ambient noise levels are higher. This study considers this by continuing the work reported in NMB/11 IP29 in three areas, as follows:

- A literature review of relevant research;
- further consideration of ambient noise levels around Gatwick; and
- further analysis of the Survey of Noise Attitudes 2014: Aircraft (SoNA) study.

Following this introduction, the remainder of the report is structured as follows:

Section 2 Literature Review
Section 3 Ambient Noise around Gatwick
Section 4 Further SoNA Analysis
Section 5 Discussion
Section 6 Conclusions

Appendix 1 Developing Metrics for Gatwick Growth and Noise, NMB11/IP29
Appendix 2 Literature Review
Appendix 3 Ambient Noise Survey Report

1.2 STAKEHOLDER CONSULTATION

NMB/11 IP29 (see Appendix 1) noted the importance of engaging with stakeholders including the following:

- CNG's technical advisors To70;
- Department for Transport (DfT) (in particular future consultations);
- local authority health practitioners, including;
    - Crawley borough council (BC);
    - Reigate and Banstead BC; and
    - Mid-Sussex district council (DC).

We have also consulted the CAA's Environmental Research and Consultancy Department (ERCD) as mentioned below.

Accordingly, a Methodology Paper was circulated to these parties for comment. We also sent it to local authority health practitioners in the other local authorities who cover the area around Gatwick most affected by noise (within the Leq 51dB contour), as follows:

- Mole Valley DC;
- Tandridge DC;
- Sevenoaks DC; and
- Horsham DC.

No authorities were able to provide ambient noise data. The key responses which have informed the study are as follows:

> (i) Urban areas have pockets of quiet, and buildings have quiet facades away from noisy roads. The details of specific dwelling/plot layout will of course affect whether an individual is annoyed/disturbed. However, when looking for trends in overall population responses (as used in strategic noise assessments of the type we need to do) these may blur any trends. However, there might still be some trend.
>
> (ii) There is a distinction between the effect of ambient noise on sleep disturbing from aircraft noise events at night, and general annoyance by day. At least one paper makes the point that adding more aircraft noise to an already noisy area could just increase annoyance more than might be expected.

2 LITERATURE REVIEW

2.1 APPROACH

A review has been carried out of literature reporting on how background or ambient noise influences the effects of aircraft noise. The CAA ERCD were helpful in providing some suggestions of papers to review, and To70 similarly contributed relevant papers to consider. The scope of this study involved, therefore the sampling of the most relevant and recent papers. Not all of the references that these papers themselves provide have been reviewed, and it is possible that other published research remains which could be relevant which has not been identified.

The following are the main papers reviewed in addition to SoNA which is covered in some detail in Section 3 of this report. Appendix 2 presents the relevant findings of each and the following section summarises the key findings.

1. CAP1588 Aircraft Noise and Annoyance: Recent Findings, UK CAA, February 2018.
2. Ambient Noise, To70, Netherlands, 2016.
3. Reaction to environmental noise in an ambient noise context in residential areas, Fields JM, Journal of Acoustic Society of America 104(4) October 1998.
4. Effect of Background Levels on Community Response to Aircraft Noise, SM Taylor, FL Hall, SE Bernie, McMaster University, Ontario, Canada, 1980.
5. Effect of Background Levels on Community Annoyance from Aircraft Noise, C Lim, Seoul National University, Korea, Journal of Acoustical Society of America 123(2) 2008.
6. Effect of Background Levels on Community Annoyance from Aircraft Noise, C Lim, Seoul National University, Korea, Journal of Acoustical Society of America 123(2) 2008.
7. Relatie vliegverkeergeluid en geluidhinder rondom vliegveld Eindhoven Blootstelling - respons relatie RIVM Briefrapport 2015-0108 O.R.P. Breugelmans et al. 2015
8. Current Issues in Aviation Noise Management: A Non-Acoustic Factors Perspective. Diana Sánchez, Jack Naumann, Nicole Porter and Andy Knowles, 2015

2.2 SUMMARY OF KEY FINDINGS

Reference 1 identifies a large-scale USA study as being underway at 20 airports aiming to produce an annoyance response relationship. The search for a single annoyance curve implies ambient noise levels are not under consideration. However, the study will compute modelled noise exposure level at respondent's locations so the underlying data may be useful if it becomes available in the future.

Reference 3 comprised a very large study in the United States (c57,000 people) and concluded that ambient noise has little effect on any specific type of noise impact (referred to as the "target noise" below and which could be aircraft noise):

Although there is considerable variation from survey to survey, the best direct estimate is that a 20dB increase in ambient noise exposure (95% confidence interval of 15-50dB) has no more impact that approximately a 1 dB decrease in the target noise exposure.

Acoustic perception theory, well developed from laboratory studies, shows that the perception of one sound can be inhibited by the presence of another. The reference 3 study found, however, that this does not occur in residential environments. The study went on to suggest three possible reasons why this form of perception inhibition may be unimportant in residential environments.

- First, ambient noise fluctuates so the target noise may be clearly discernible in the lower ambient noise moments so that the subject can form a view on the overall level of the target noise.

- Second, it may be that high levels of ambient noise may cause sensitization to more noise.

- Third, research has shown that inside buildings total ambient noise judgements are dominated by internal noise sources from members of the household.

The first bullet point above is addressed in Section 3 where we look in more detail at the interplay of ambient noise and aircraft noise at a selection of sites around Gatwick.

Reference 4 refers to a survey of 673 interviews in 56 residential areas around Toronto airport across a range of aircraft noise levels with 24 hours ambient noise levels measured at each. The response variables considered included annoyance, activity interference, and complaints. The study concluded:

The results of various statistical analysis show that the effect of background noise level is generally not significant.

The Korean study (Reference 6) found the opposite to References 3 and 4. Surveys were carried out at 20 sites around two airports with 753 respondents. The results indicated that annoyance responses in low background noise regions are much higher than those in high background noise regions, even though aircraft noise levels are the same. From this it was concluded that background noise level is one of the important factors on the estimation of annoyance from aircraft noise exposure.

However, in our review of this paper we have noted that the report authors' mention that very different types of housing were prevalent at each of the survey sites. One group of respondents lived in ferro-concrete apartments in Seoul, while the other group, the residential population lived in detached brick built houses amongst rice fields and farmed land.

The reason for the disparity in results between the two airports could relate to the very different types of housing at each, with the homes in the rice fields providing less noise insulation than modern apartment blocks. Or, in the wider context of considering non-acoustic factors, it may be that the city dwellers were less annoyed by noise for reasons other than the level of ambient noise, e.g. because they mostly do not have outside associated space with their homes.

The Dutch study (Reference 7) showed different annoyance response relationships between residents affected by noise from Schiphol and Eindhoven airports. Again, the areas affected are quite different and again it is not clear if the difference correlates directly with ambient noise level or other factors.

The paper on non-acoustical factors (reference 8) noted that the variation in different studies point to at best one third of the variance in annoyance responses being explained by acoustic characteristics and another third by non-acoustic factors (the remaining third remains unexplained, and could in part be attributed to measurement errors and subjective ratings of annoyance).

The CAA's SoNA report (section 7) also considered non-acoustic factors, and provided a list of some of these:

- Length of residence
- Self-reported noise sensitivity rating
- Expectation of possibility of hearing noise from the airport prior to moving to their current home
- Expectations on experiencing more or less noise next summer
- Age
- Socio-economic status
- Presence of double-glazing

2.3 CONCLUSION

This focused review of the literature on the influence of ambient noise on the effects of aircraft noise has found no consensus, with some studies showing no effect and others notable effects.

The studies varied in size and provided information on effects at population level as opposed to individuals. Where studies have reported higher annoyance responses in rural areas than in urban areas this review has identified that whilst ambient noise levels may be generally lower in the rural areas other acoustic and non-acoustic factors are present. It may be that there are correlations between non-acoustical factors and ambient noise which do not significantly affect overall "population level" response to noise but are nonetheless significant to individuals.

We discuss these issues further in later sections following the review of the ambient noise results and their correlation with the SoNA study.

3 AMBIENT NOISE AROUND GATWICK

3.1 INTRODUCTION

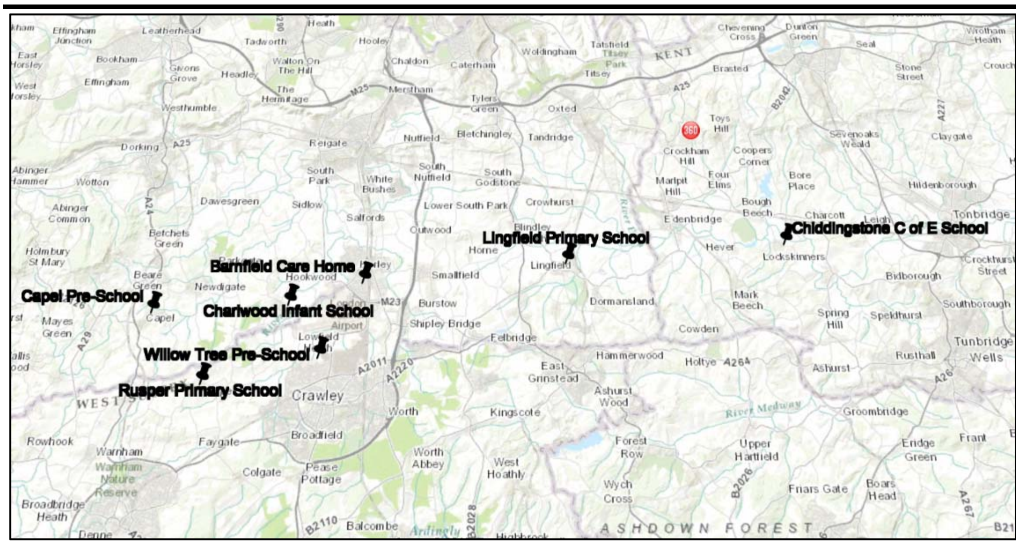
This section aims to provide a detailed picture of ambient noise levels in various locations that are affected by noise from the airport. It describes a series of sample noise surveys that were carried out, and then reports the recorded levels in a variety of ways that may be helpful when considering how aircraft noise events relate to ambient noise. It then discusses how ambient noise levels tend to be distributed around houses and a noise model is used to show the extent to which road traffic noise levels reduce away from the front facades which usually face on to roads.

3.2 AMBIENT NOISE SURVEYS

In order to gain a better understanding of ambient noise levels, 7 brief daytime noise surveys were carried out on 25th September 2018. The measurement locations were chosen to obtain examples of ambient noise representative of a variety of communities that are affected by noise, not all communities. They are mostly near schools, in the heart of communities, and on all sides of the airport as follows, and as shown in the figure below:

1. Rusper Primary School
2. Charlwood Village Infant School
3. Lingfield Primary School
4. Chiddingstone Church of England School
5. Capel Pre School
6. Willow Tree Pre-school, Ifield
7. Barnfield Care Home, Horley

Figure 3.1 Representative Community Noise Survey Locations

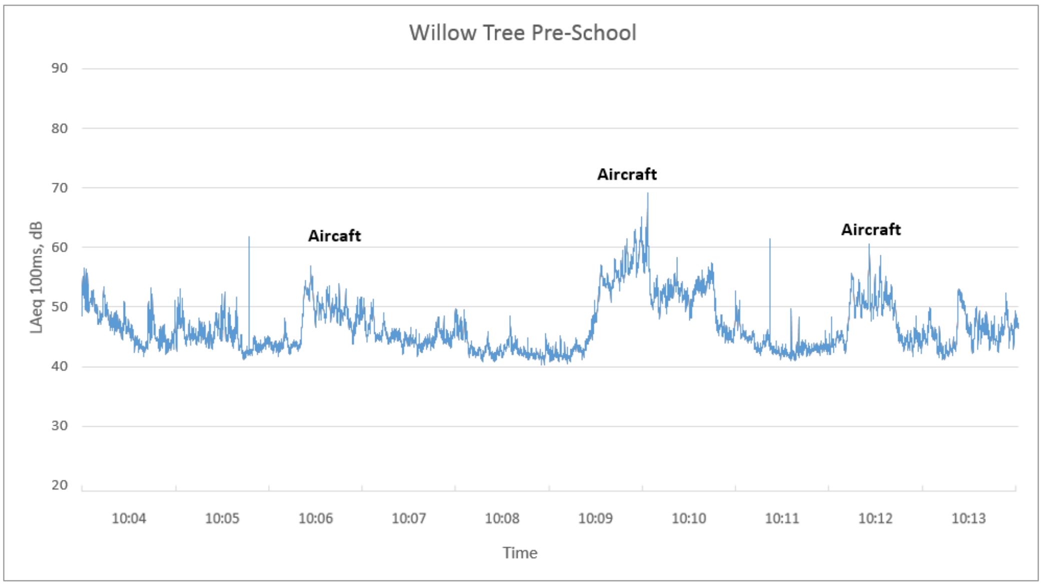


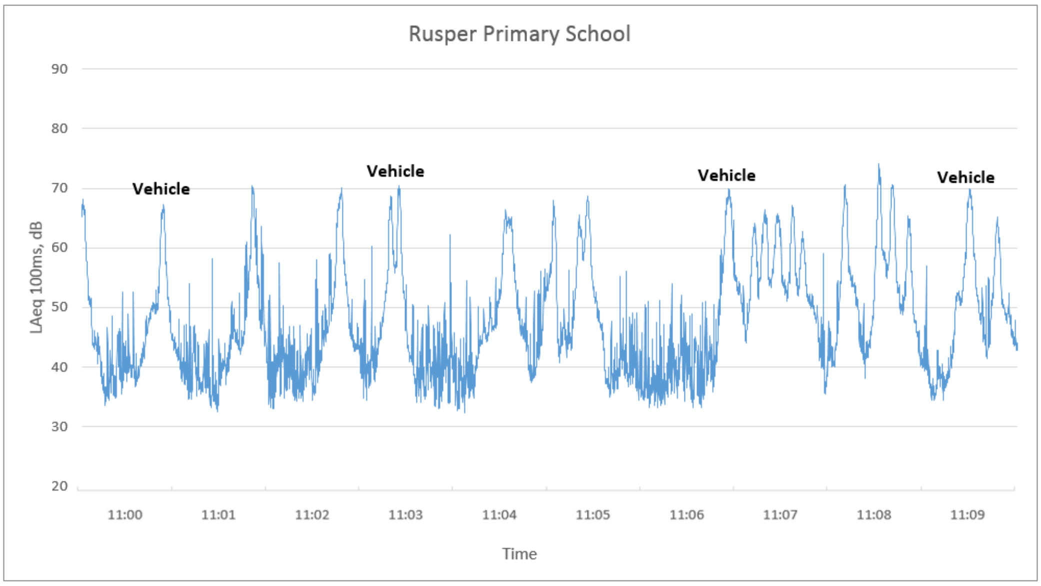
The purpose of these surveys was not to measure aircraft noise, but to measure other noise (ambient noise). So, in analysing the surveys results aircraft noise events were deleted from the data to derive a "baseline without aircraft" ambient noise level. The full survey procedures and results are provided in Appendix 3, and summarised as follows.

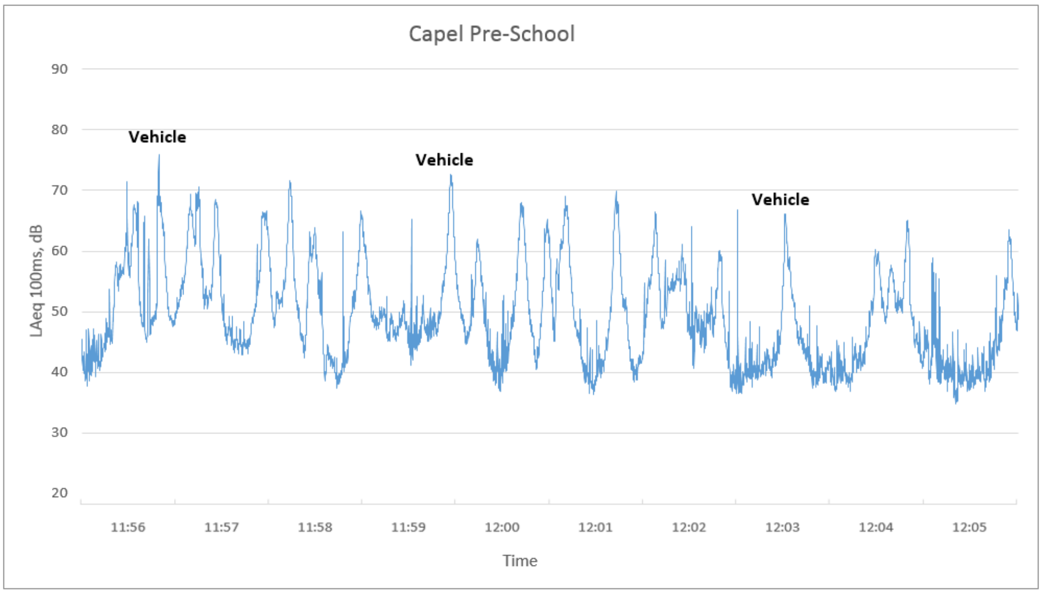
The weather was fine on the survey day with light winds. The runway direction changed from easterlies operations in the morning to westerlies in the afternoon.

The 7 figures below give time history plots of noise levels over 10 minute samples taken within the survey at each site. The surveys took place set back from the road roughly by the distance to the front facade of the buildings identified. Less usual noise sources (such as children playing at break time) were avoided for the analysis and illustrations. Onto each figure we have annotated some of the most obvious peaks in the noise levels (although not all vehicles or aircraft are identified).

Figure 3.2 Noise Time History Plots






Capel Pre-School
90
80
70
60
50
40
30
20
LAeq 100ms, dB
Vehicle
Vehicle
Vehicle
11:56
11:57
11:58
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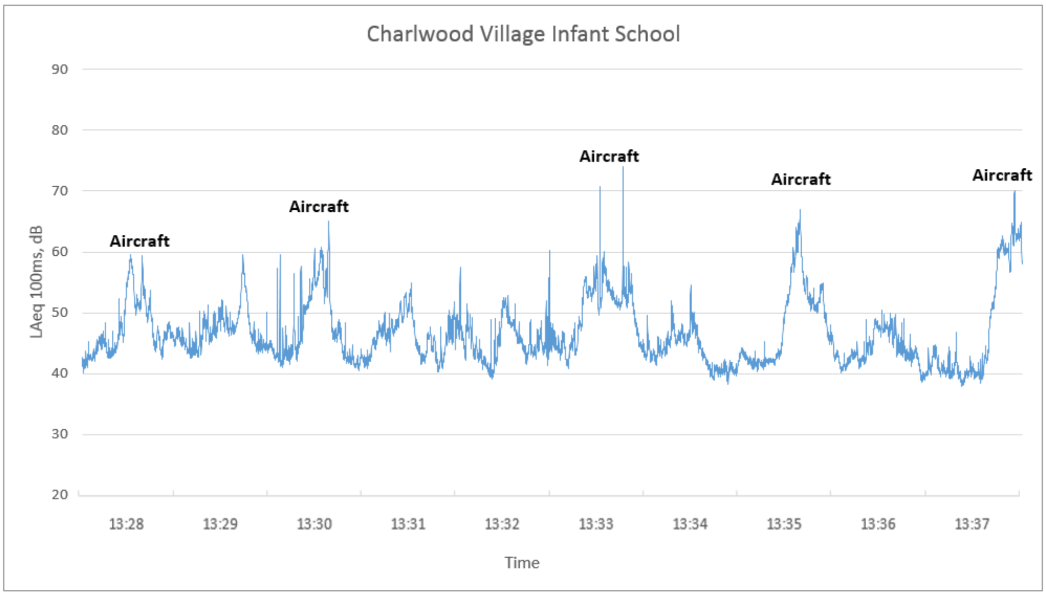
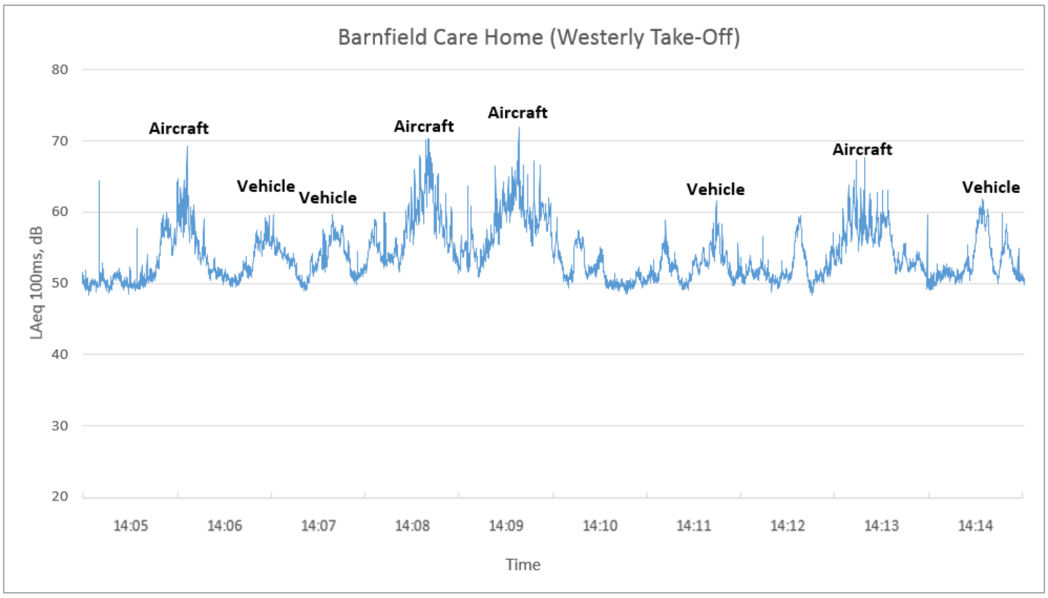
12:03
12:04
12:05
Time


Charlwood Village Infant School
90
80
70
60
50
40
30
20
LAeq 100ms, dB
Aircraft
Aircraft
Aircraft
Aircraft
Aircraft
13:28
13:29
13:30
13:31
13:32
13:33
13:34
13:35
13:36
13:37
Time


Barnfield Care Home (Westerly Take-Off)
80
70
60
50
40
30
20
LAeq 100ms, dB
Aircraft
Vehicle
Vehicle
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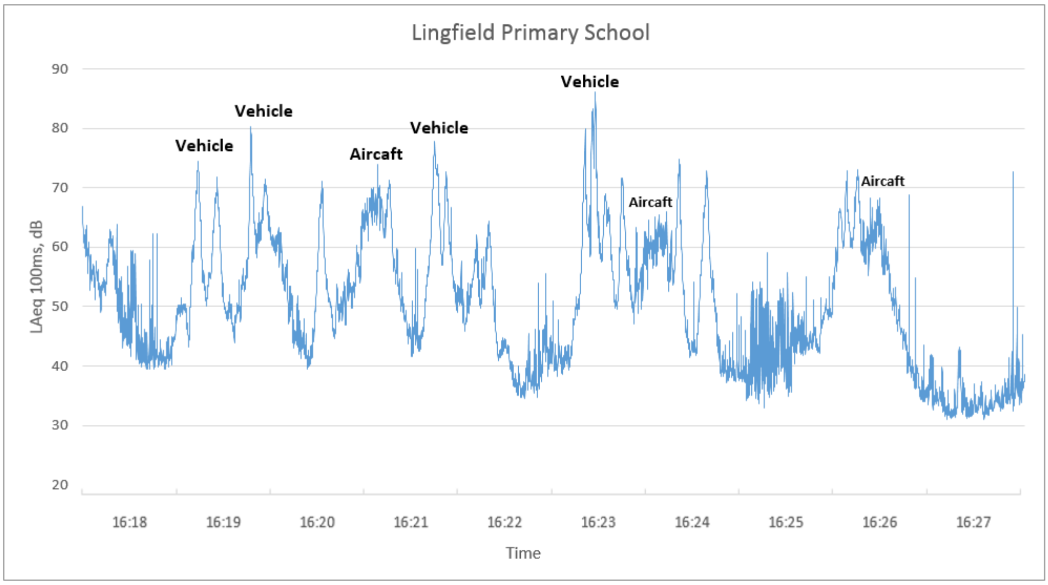
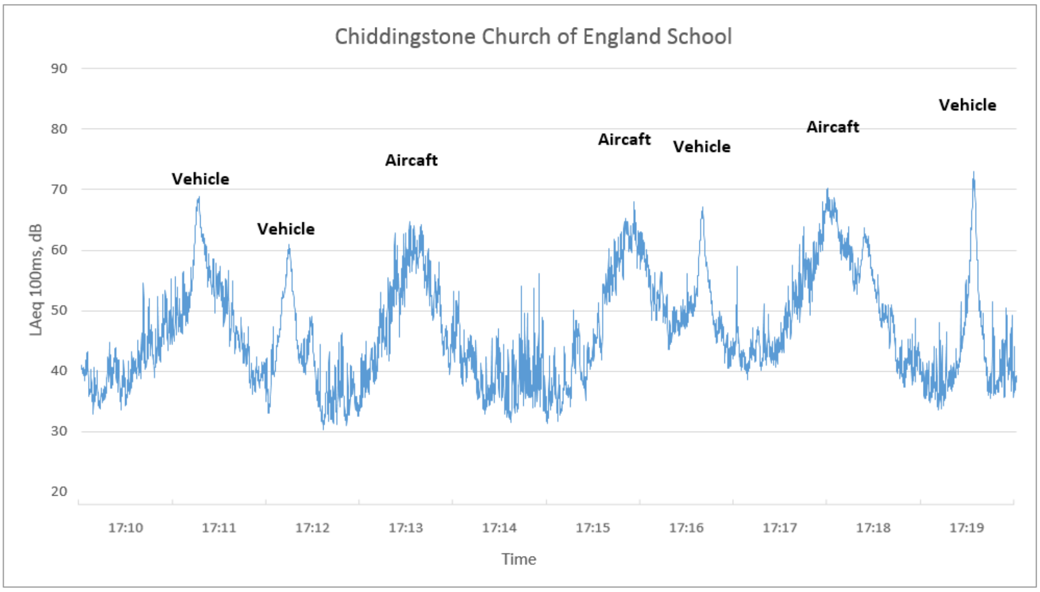
Time





The following table summarises these results numerically.

Table 3.1 Ambient [(1)] Noise Level – Freefield, front of building, daytime, 30 minutes dB(A)

Location	**Ambient [(1)]** $L_{eq, 30\ minutes}$	**Ambient [(1)]** $L_{max\ 30\ minutes}$	**Aircraft (arrivals)** $L_{max\ 30\ minutes}$	**Comment**
1. Rusper Primary School	58	68-74	(42-48)*	Aircraft arrivals from West just discernible. Fast local road
2. Charlwood Village Infant School	47	50-60	60-75	Arrivals from West. Dead end road, little traffic.
3. Lingfield Primary School	60	70-86	65-73	Arrivals from East. Local road.
4. Chiddingstone C of E School	53	52-72	55-70	Arrivals from East. Local road low traffic flow
5. Capel Pre School	57	64-74	(47-55)*	Arrivals from West just discernible. Fast local road.
6. Willow Tree Pre-school, Ifield	47	50-55	60-69	Arrivals from West. No local road.
7. Barnfield Care Home, Horley	55	58-62	68-72	Departures to East.
1) Excluding aircraft noise				

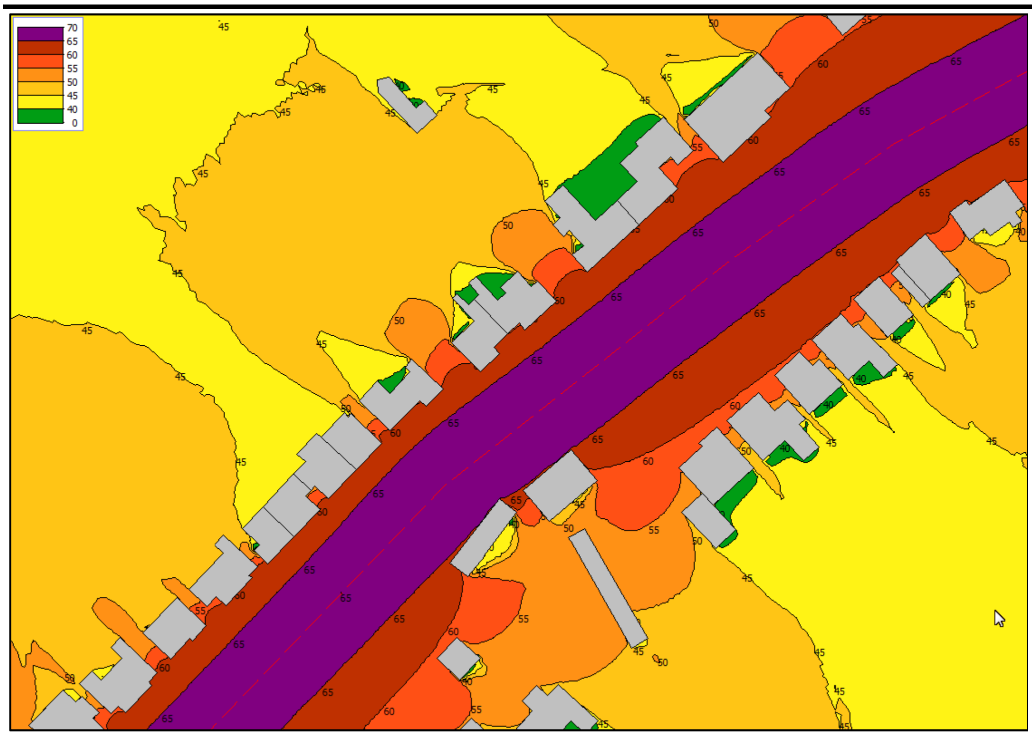
*Rusper and Capel are not overflown by arrivals and would experience higher levels from departing aircraft that were not measured.

The Rusper and Capel survey locations are located far enough from the arrivals flight path for aircraft noise not to be the dominant noise source at the time of the survey. The Barnfield Care home at Horley was subject to easterly departures noise at the time of the survey. At the remaining survey locations Lmax levels from ambient noise sources ranged considerably and where they are located on roads, traffic noise is comparable or higher than most aircraft noise events at the measurement locations near the fronts of building.

3.3 AMBIENT NOISE AROUND HOUSES

When we discuss noise levels in the community, we rarely specify where we mean, yet noise levels vary considerably even with small distances. The figure below shows the modelled propagation of road traffic noise around houses facing a road.

Figure 3.3 Road Traffic Noise Propagation



It can be seen that in most cases road traffic noise levels at or near the rear façade and garden are around 20dB lower than at the front façade. In some case, for example terraced houses, the difference may be larger, in others smaller. Noise from a railway shows a similar pattern.

Aircraft noise levels are likely to be much more similar on all sides of a house, and are the same for a direct overflight. So, if we are to compare levels of aircraft noise with ambient noise it is important to identify which façade of the house or garden we are considering.

Levels of road traffic noise are typically quoted at front facades to present the worst case noise exposure. There has been research on the value of a 'quiet façade' in determining if the occupants of a house have an acceptable noise environment. Many people use rear bedrooms for sleeping, and rear gardens for relaxing, whereas in contrast, front gardens are rarely used for this purpose.

Given that aircraft noise levels are usually similar on the front and rear of a house, it is probably sensible to use the rear façade location to compare the impacts of aircraft noise and ambient noise. So, using a 20dB reduction as an approximate rule of thumb, we can deduce the very approximate general ambient noise levels presented in Table 3.2 near the rear facades of houses adjacent to the roads that pass the 7 schools (or care home) where the ambient noise surveys were carried out, as discussed above.

Table 3.2 Ambient Noise Level – Estimate at Rear of Nearby Residential Building, Daytime, 30 minutes dB(A)

Location	Estimated Ambient noise at rear facade Lmax 30 minutes	Aircraft (arrivals) $L_{max\ 30\ minutes}$	Comment
1. Rusper Primary School	48-54	(42-48)*	Rusper is not overflown by arrivals and would experience higher levels from departing aircraft that were not measurable on the survey day owing to the direction of operations at the time of measurement.
2. Charlwood Village Infant School	50-60*	60-75	
3. Lingfield Primary School	50-66	65-73	
4. Chiddingstone C of E School	32-52	60-70	
5. Capel Pre School	44-54	(52-55)*	
6. Willow Tree Pre-school, Ifield	50-55*	55-69	
7.Barnfield Care Home, Horley	38-42	68-72	

*No correction is required from the front to rear of buildings in this case because there was no dominant local road noise source.

With the exception of Rusper and Capel, which were not so affected by arrivals noise, at all survey locations the aircraft Lmax levels are substantially above estimated ambient noise Lmax levels near the rear of houses.

This study has only surveyed 7 locations, all within the airport's Leq 51dB noise contour. It is likely, however, that similar relationships between peak noise levels from overflying aircraft and ambient road traffic noise would be found elsewhere. Aircraft noise events are therefore likely to be clearly discernible near the rear facades of the majority of houses within similar distances from the airport and its flightpaths ie within the Leq 51dB contour.

Whilst the extent to which aircraft noise levels exceed ambient noise will generally be higher in cases nearer the airport and in cases where ambient noise level is lower, this survey suggests that in typical situations, and where overflight occurs, aircraft will be clearly discernible near to rear facades of houses. So, whilst ambient noise may to some extent mask aircraft noise at front facades it is less likely to do so near rear facades, within the Leq 51dB contour, regardless of whether a property is in a rural or urban location.

During the surveys, noise was measured over short time periods, during the day only, and no attempt was made to consider how the orientation and other features of particular properties could create different results in some cases. Nor has this study considered locations further afield where aircraft noise levels are lower.

4 SONA FURTHER ANALYSIS

4.1 INTRODUCTION

The Survey of Noise Attitudes 2014: Aircraft, (SoNA) study included nearly 2,000 social surveys of indivual's reponses to aircraft noise around 9 UK airports. The SoNA social surveys were carried out to the exacting requirements of ISO (2003) Acoustics – Assessment of Noise Annoyance by means of social and socio-acoustic surveys ISO 15666:2003. In additional to asking questions about noise annoyance the social surveys asked many other questions giving a great deal of context. Consequently the results, (which DfT have made available) are a rich source of further research into reactions to aircraft noise.

SoNA correlated respondents' answers to levels of aircraft noise. It did not measure ambient noise nor comment on it. This section looks further into the SoNA results including estimating ambient noise levels around Gatwick and investigating if the underlying SoNA data shows any link between ambient noise level and aircraft noise annoyance.

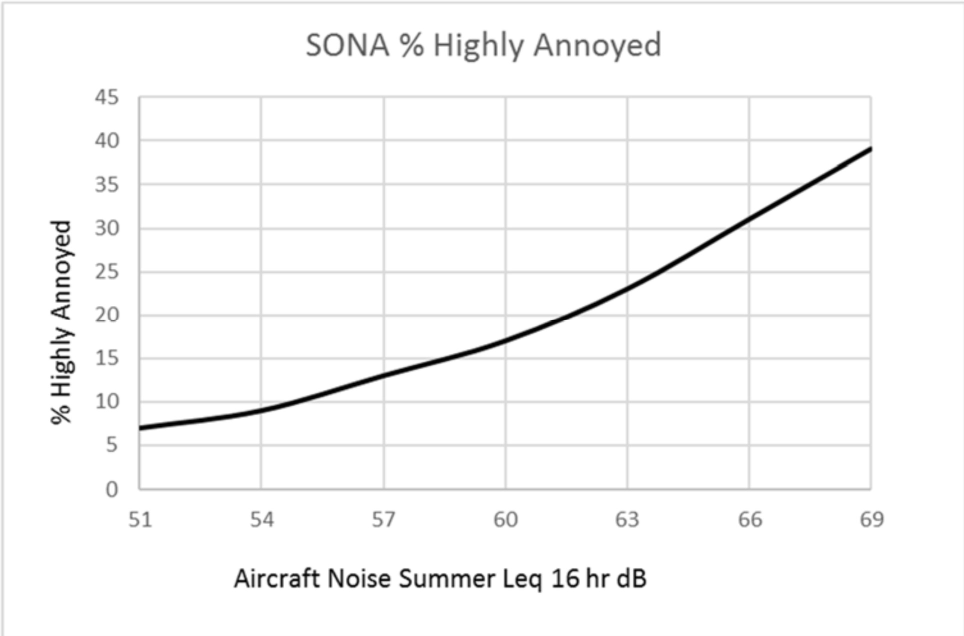
4.2 METHODOLOGY

Of the 2,000 SoNA survey locations there are approximately 450 with missing postcodes, which cannot be studied. To check if this missing sample produced any sample bias their approximate locations (by postcode section eg TN3) were mapped. The 450 locations constitute 137 unique postcode sectors (represented by the red dots on the map below). These 137 locations are fairly evenly spread across the SoNA dataset, suggesting no sample bias implied by their omission.

Figure 4.1 SoNA Missing Postcodes

The surveys were undertaken to exacting standards and looked into many aspects of people's response to aircraft noise. The study eventually drew various firm conclusions including a new dose response relationship for aircraft noise and community annoyance. This relationship is shown in Figure 4.2.

Figure 4.2 Annoyance Dose Response



For example, at an aircraft noise level of Leq 16 hr 51dB, SoNA concluded that on average 7% of a community are highly annoyed by aircraft noise. This conclusion formed the basis of the Lowest Observable Adverse Effect Level (LOAEL) adopted by government in 2017. Whilst the study looked at numerous factors that could influence a person's reaction to noise it did not consider the effect of other noise, or ambient noise, at that persons home. In this regard the dose response is an average of responses in all ambient noise conditions.

To investigate this proposition we assigned an approximate ambient noise level to each of the 184 SoNA survey locations around Gatwick, using the method described below, and analysed the responses for different ambient noise conditions.

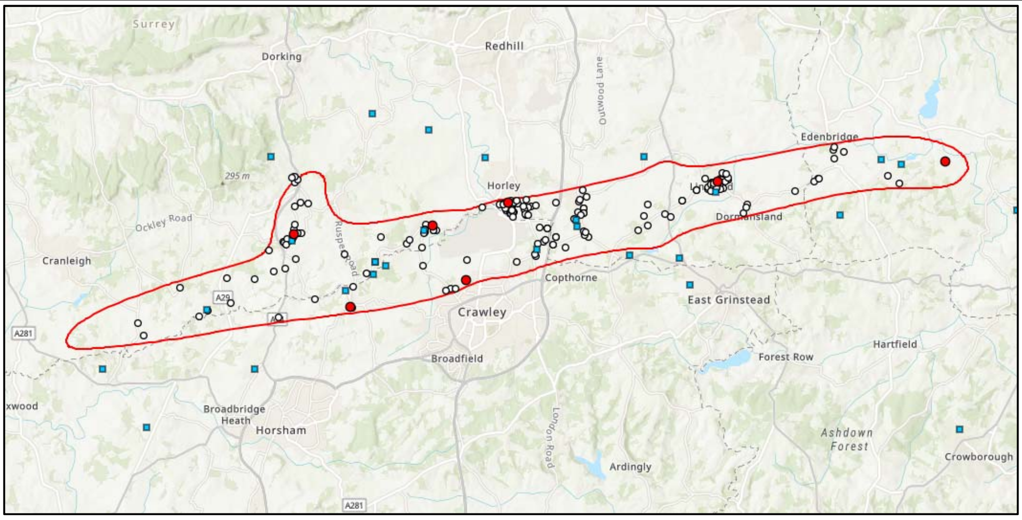
Ambient noise levels were not measured during the SoNA survey, although as described later, the survey site is given one of a number of descriptive categories from "rural" to "town". The process is not straightforward and inevitably involves some level of approximation.

Three sources of ambient noise data were used:

1. Defra strategic noise mapping for roads and railways;
2. Gatwick Noise and Track Keeping (NTK) Data; and
3. Ambient Noise Surveys at 7 Community Representative Locations (as reported in Section 3).

These data were imported into an interactive Geographic Information System (GIS), so that the relationship of each SoNA survey point to local noise sources (primarily roads) could also be seen. See Figure 4.3.

Figure 4.3 Ambient Noise Data and SoNA Survey Sites



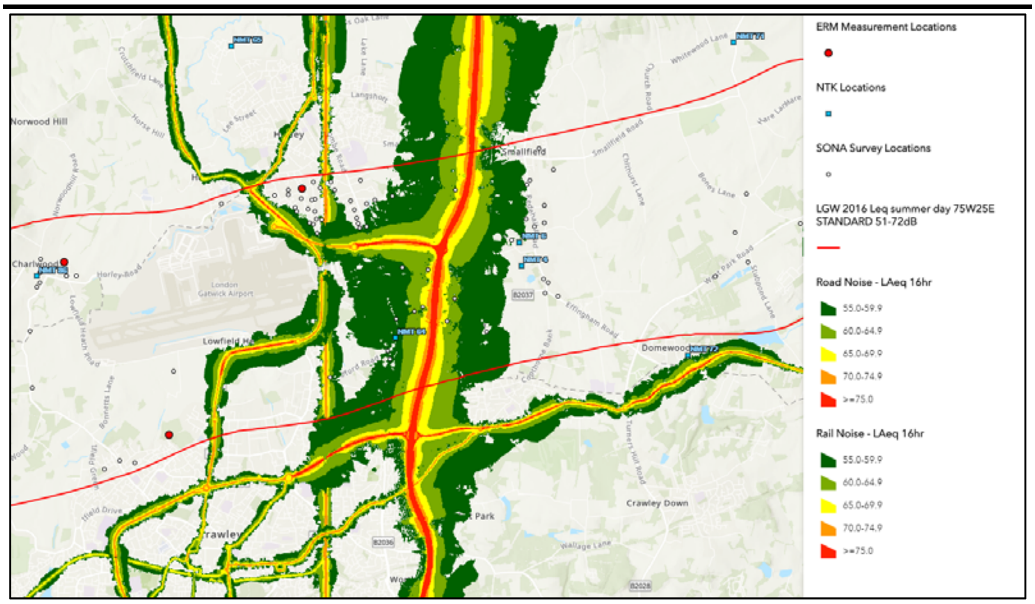
Key:

- o SoNA Survey point
- • (red) Ambient Noise Survey Site
- • (blue) - NTK Site

The SoNA survey locations have been mapped approximately from their postcodes. The centre of the postcode polygon has been used. In most cases the postcode represents several houses, leading to an unavoidable approximation when assigning an ambient noise level to each SoNA site.

A sample of the Defra strategic road and railway noise mapping data near Gatwick Airport is shown in Figure 4.4.

Figure 4.4 Defra Strategic Noise Mapping (road and railway)



It can be seen that the strategic noise mapping covers only a small proportion of the SoNA survey locations around Gatwick, but it does show areas which are likely to have some of the highest ambient noise. In these, the daytime noise level ranges from Leq 16 hr 55 to 75dB.

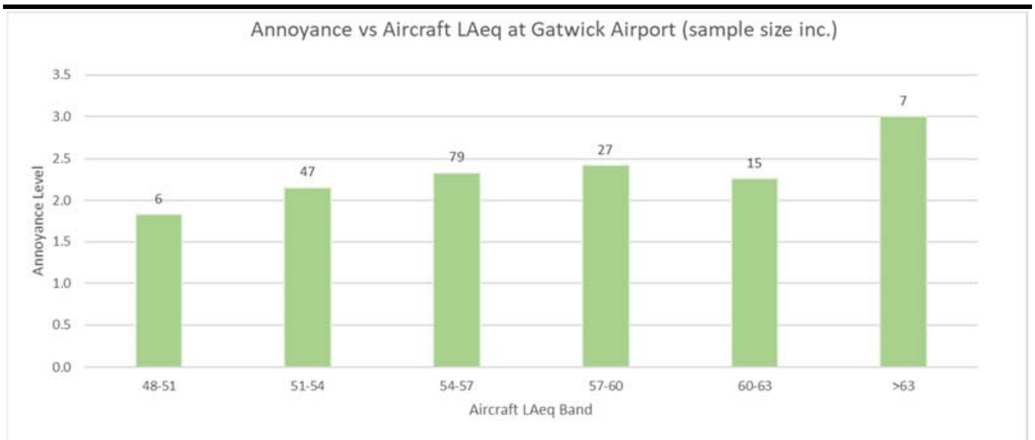
Data was provided by GAL from the records held of the 32 portable and fixed noise monitors that have been deployed in the area. The locations for which data was available are shown in Figure 4.3. They tend to be located away from main roads and buildings so are useful at indicating the lower ambient noise levels in these types of areas.

From these datasets estimates of ambient free-field daytime Leq levels for the front façade of houses were assigned to each SoNA survey site in 5dB bands from 45 to 65dB.

4.3 RESULTS

The results are firstly summarised in the following figures which show the SoNA annoyance scores on the scale of 1-5, for the 6 ranges of aircraft noise (Leq, 16 hour 51-63dB). The survey sample size is annotated in each case, and in some cases is small.

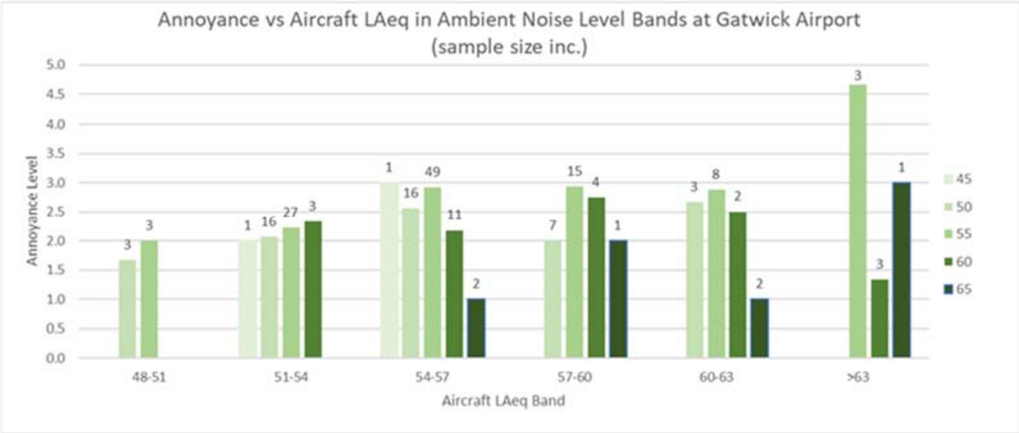
Figure 4.5 SoNA Further Annoyance Analysis



Considering the general trend in annoyance from low to high aircraft noise (left to right) a small upward trend can be seen, showing how annoyance increases slightly with aircraft noise level above Leq 51dB. This is as expected.

In the following figure the same data is shown but with the samples in each band of aircraft noise split into 5 approximate ambient noise ranges (Leq day 45-65dB). The survey sample size is annotated in each case, and in many cases is very small.

Figure 4.6 SoNA Further Annoyance Analysis



Looking at the trend in annoyance for different levels of ambient noise within a given aircraft noise band, no repeated upward or downward trend is evident. However, for the most part, the sample sizes are very small.

The highest level of annoyance in any case is 4.6, for an aircraft noise level > Leq 63dB with a low mid-range ambient noise level (55dB). These are likely to be locations near the airport and the data points show they are not near main roads. However, given that there are only 3 surveys in this category, it would be wrong to attach any significance to this, owing to the very small sample size.

There are low sample sizes (or none) in many other cases leading to uncertainty in this analysis. However, there is no trend in the available data, giving no indication of a link between ambient noise and aircraft noise annoyance in the SoNA data around Gatwick.

There are of course other limitations is this analysis as well as the limited sample size of 184 surveys. Ambient noise levels were estimated rather than measured, exact survey locations have been unavailable due to privacy restrictions, etc. It may be that a more detailed analysis, or further analysis of more SoNA data would reveal a more conclusive result. But there is no indication from the analysis completed to date of a link between ambient noise and aircraft noise annoyance around Gatwick.

5 DISCUSSION

Figure 2 of NMB11/IP29 (see Appendix 1 below) indicated that for the full SoNA dataset there appeared to be a slightly higher level of annoyance in rural areas than in other areas, at the same level of aircraft noise. This study has investigated if this is the case for the Gatwick area and in particular if a higher level of annoyance from aircraft noise in rural areas can be directly attributed to lower levels of ambient noise. It did not find any conclusive evidence that this was the case.

The fact that a relationship between ambient noise and aircraft noise disturbance was not found could be due to limitations in the survey size, the precision and scope, the range of aircraft noise levels studied (above Leq 51dB) etc, but at this time there is no better source of data.

Such a relationship could also be obscured because there are areas of low ambient noise in urban areas as well as in rural areas.

It could be that we found no relationship between levels of annoyance and level of ambient noise because there are other non-acoustic factors that are more influential in determining annoyance from aircraft noise than the level of ambient noise. The literature review provides some insight in to this.

Various non-acoustic and confounding factors are discussed in the literature and it may be that these combine. For example, we know that sensitivity to noise various considerably between individuals.

The literature suggests that non-acoustic factors can account for a large part of an individual's response to aircraft noise, possibly a greater part than the level of aircraft noise itself. There are many non-acoustic factors and most relate to attitudes and individuals' characteristics. Some of these non-acoustic factors are more relevant to the question of rural noise impact. One postulation could be that people who are more sensitive to noise choose to live in rural locations because they tend to be quieter. In this scenario, where a person who is already more sensitive to noise than the general population is affected by aircraft noise, and considers that they shouldn't be, individual annoyance could be higher. This may go some way to explaining the evidence as it is from the re-analysis of the SoNA data (see again Figure 2, Appendix 1).

Thus, under this scenario, the people reporting higher levels of annoyance in more rural areas may:

- have chosen to live in rural areas to avoid noise;
- have higher expectations for their environment;
- have less favourable attitudes to the airport because they perceive that their local community and economy receive less benefit from it;
- prefer to be connected to the outside and have windows open;
- own and use outside space more;
- perceive the noise as unnecessary, due to choice of flightpaths which they feel could be elsewhere; and

- be more sensitive to noise than the wider population.

The last point, when combined with other non-acoustic factors that are specific to rural settings, may provide some level of explanation for the slightly higher levels of annoyance in rural populations across the SoNA dataset as a whole. There is however, no conclusive evidence of the effect of these or other non-acoustics factors nor metrics to quantify them.

6 CONCLUSIONS

It has been suggested that people living in rural areas are affected by aircraft noise more so than people in urban areas and that this is because rural areas have lower levels of ambient noise levels. Community Noise Groups (CNGs) have suggested that because of this aircraft noise metrics should consider the extent to which aircraft noise is above ambient noise.

This study has investigated if there is a link between ambient noise and aircraft noise impact through four main areas of work:

1. Completing a focused literature review of available research on this topic.
2. Measuring ambient noise levels at 7 community representative locations and provided an analysis comparing aircraft noise levels with ambient noise levels at the front and the rear of houses in these areas.
3. Carrying out further analysis of social survey data available from the SoNA study for 184 households within the Leq 51dB aircraft noise contour around Gatwick.
4. Consulting local authorities and the CNG technical advisors to seek their input.

The main conclusions are as follows.

(1) The literature review found conflicting reports, some linking ambient noise to aircraft noise annoyance and some not.

In those studies which did show a link there was also evidence of confounding factors, eg the types of homes in which the residents lived and the comparative operational circumstances at the airports concerned. The literature indicates that it is likely that non-acoustic factors are influential.

(2) Peaks in aircraft noise can be similar to peaks in road traffic noise at the fronts of houses, but are generally above ambient noise at the rear of properties in rural as well as urban areas.

The ambient noise surveys provided a good picture of the relative levels of road traffic noise and aircraft noise, albeit in a small number of locations, within the Leq 51dB aircraft noise contour. At the fronts of houses, the Lmax levels of aircraft are sometimes lower than the Lmax levels from road traffic, but when calculated near to the rear of houses, aircraft noise levels in locations overflown are above ambient noise Lmax levels. This analysis demonstrated that that aircraft will usually be clearly discernible near to rear facades of any house, whether that house is located on an urban or rural road.

(3) The further analysis of the SoNA data around Gatwick showed no clear relationship between ambient noise and aircraft noise disturbance.

Ambient noise data was collated from available Defra strategic road traffic noise mapping, from 32 Noise and Track Keeping survey sites used around Gatwick in recent years and by completing surveys of ambient noise at 7 community locations referred to above. Using this, it was possible to estimate approximate levels of ambient noise at the 184 locations around Gatwick where the SoNA study had carried out social surveys of aircraft noise effects in 2014. This allowed a further analysis to be completed of the relationship that the SoNA study found between community annoyance and aircraft noise level but considering the level of ambient noise at each site.

The further analysis of the SoNA social survey dataset within the Leq 51dB contour shows no clear relationship between ambient noise and aircraft noise disturbance. Consequently it is not possible to incorporate a measure of ambient noise into metrics for assessing aircraft noise impacts.

APPENDIX 1

Developing Metrics for Gatwick Growth and Noise, Update (22 June 2018) NMB11/IP29

1 Introduction and review of activities to date

This paper provides an update on the work undertaken thus far to develop a Plan for Gatwick Growth and Noise in support of our objective to achieve sustainable growth of aviation at Gatwick.

In April 2018 GAL produced paper NMB/10 IP08 *"Developing a Plan for Gatwick Growth and Noise"*. GAL then met two CNG representatives on 3rd May 2018 to discuss the CNG's *"Gatwick Noise Metrics Discussion Paper*" (22 March 2018). GAL's detailed response to this paper is attached as Appendix 1.

GAL then met six CNG representatives on 21 May to discuss Government policy, and work to consider "growth and noise" metrics. Notes of that meeting have been circulated to those present and will be sent to the NMB when finalised.

This paper now sets out next steps in building from the analyses undertaken by Gatwick and the CNGs, and trying to understand what noise metrics can be developed.

2 Developing Noise Metrics

The CNG's Noise Metrics Discussion paper put forward that '*reduced to its simplest level, the impact of noise can be seen as a function of three key variables:*

1. Noise intensity
2. Frequency of the noise impact
3. Level of ambient noise'

We believe the first two of these are already measured in the current suite of Leq, N60, N65 and N70 aircraft noise metrics. Ambient noise (ie non-aircraft noise) is not as clearly accounted for, but it is the case that the annoyance thresholds produced by the Government's Survey of Noise Attitudes study (SoNA), are in effect, the response averaged over all ambient noise levels in the survey.

We have reviewed the report produced by To70 Aviation titled *Ambient Noise* in 2016. This was commissioned by the Gatwick Area Conservation Campaign (GACC) and indicates that areas of low ambient noise are likely to have higher rates of annoyance not just because aircraft noise is more obtrusive, but also because people tend to choose to live in rural areas because they value quietness more. The To70 report suggests using a 'total people annoyed' metric for community noise impact, especially when considering airport development or airspace change. To support this, it quotes differences between rural and urban areas in Holland, and then postulates that '*the local difference between ambient noise levels should always be taken into account when calculating annoyance. This would require a local dose-response relationship for each airport when annoyance is modelled*.' However, the To70 report does not set out any methodology for how to go about establishing the local dose-response relationship, and as we discuss later below, this could be technically difficult to achieve.

We have looked at the SoNA social survey data to investigate whether ambient noise correlates with aircraft noise annoyance. Figures 1 and 2 summarise the results. In the first case, the 200 SoNA survey locations around Gatwick were considered and ranked crudely with either high, medium of quiet ambient noise by referring to Defra strategic road noise mapping (Figure 1). The result (although with small sample sizes) indicates that areas with quiet ambient noise levels were 1 point (on a scale of 0-5) more annoyed than those with high ambient road traffic noise.

Figure 1 Arrivals Review Imm15 Report (March 2018) Section 12.5.5 Figure 12.8

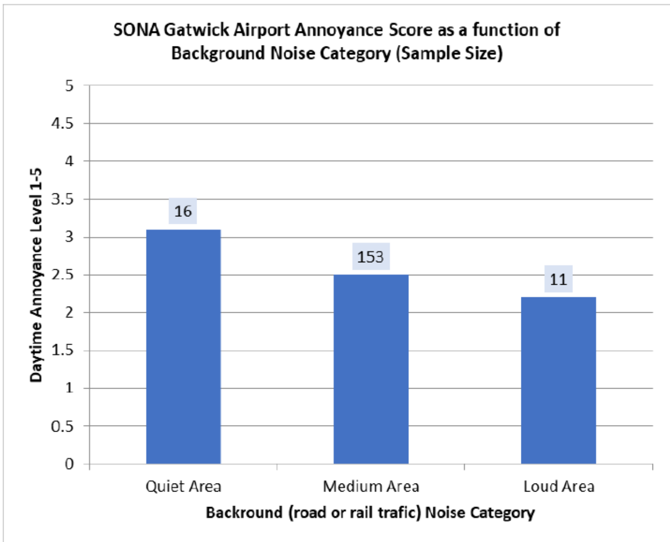
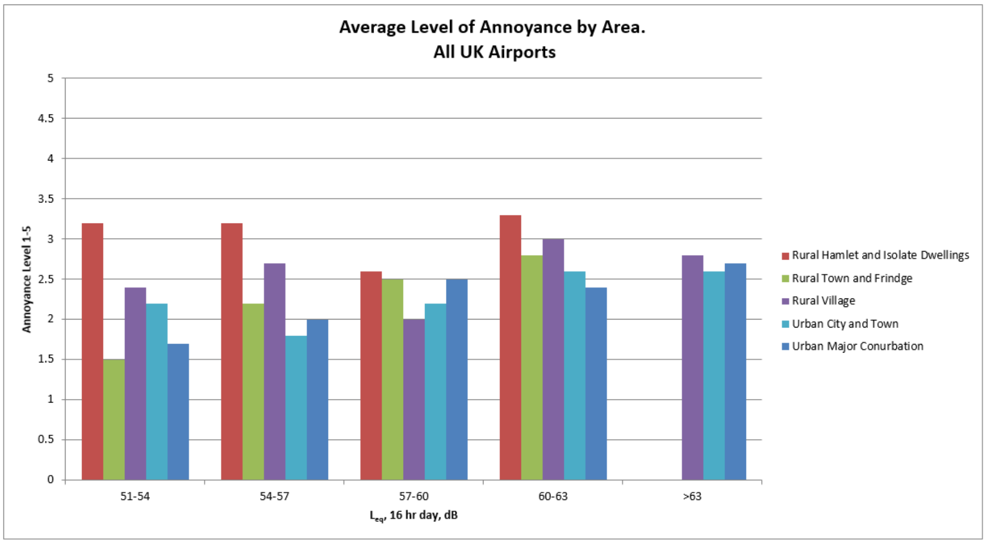


Figure 12-8 Daytime annoyance for different areas. Annoyance levels are arithmetically averaged across each of the areas and plotted next to one another, separating day and night.

In the second case, we reviewed the entire SoNA survey dataset (which comprises 2000 survey locations), and noted that each location was given one of five Ordnance Survey area classifications, from "rural hamlet", to "major urban conurbation". In this analysis, we are applying a value judgement that a rural hamlet is more likely to have lower ambient noise than a built up area – this may not be entirely robust as discussed later. This caveat notwithstanding, we reviewed the data for each of the 5 area categories separately to see if there was any correlation between annoyance response and area categorisation (Figure 2).

Figure 2 Variation of SoNA Annoyance Response Function with Survey Area Classification

1 LEVEL OF ANNOYANCE AROUND UK AIRPORTS BY SURVEY LOCATION CLASSIFICATION (2,000 LOCATIONS)



There is no clear trend, but there is some evidence that the drop off in annoyance response, as the air noise level reduces, is less obvious in rural areas than in urban areas.

This result is of interest, but the results still need to be treated with caution. Defra noise mapping shows that urban areas away from transport corridors can experience low background noise, and equally that areas which would be classified as “rural” experience higher background noise if located, for instance, close to a trunk road. Moreover, at the scale of individual houses, ambient noise can be very site specific as discussed further in section 3 below.

Finally, we should remark that the SoNA noise/annoyance dose response relationship is, and the response relationships used on webTAG are, in effect, the response averaged over all ambient noise levels in the survey. Further work is thus proposed to develop our understanding of the whether there is a link between ambient noise and annoyance, and this is included in the workplan below, along with work proposed to develop noise metrics and growth metrics for Gatwick.

3 Workplan

GAL will continue to engage with CNGs on noise metrics, and will also consider views of other stakeholders, including the CNG’s technical advisors To70, and DfT (in particular future consultations). We also believe the views of local authority health practitioners have a role to play because they may have both technical knowledge of noise effects and local knowledge. Three local authority officers have engaged with the NMB (Crawley BC, Reigate and Banstead BC and Mid-Sussex DC) and GAL will seek their further input.

Between July and September of 2018, we will look further into the SoNA survey data to see if better indicators of ambient noise can be found, with which to correlate annoyance from aircraft noise. We will carry out a literature review of the effects of ambient noise on aircraft noise annoyance, in particular if there are studies considering lower levels of aircraft noise than the SoNA report (which focused on noise levels above the daytime LOAEL of LAeq 51dB). We will also consult ERCD on any work they may be carrying out on the same topic.

We will discuss our findings with the CNGs and consult them on a set of noise metrics that our research has revealed. We will then report back to the NMB with a set of metrics suitable for the various noise assessments required to manage noise at the airport, including those discussed in our previous NMB paper on growth and noise, NMB10/IP08.

GAL is preparing a Master Plan which will lay out the airport's proposals for growth up to at least 2028. This will include forecasts in the growth of air traffic movements and an assessment of the associated noise (and other) impacts from that growth. The research work proposed above to establish appropriate noise metrics for Gatwick will feed into our Master Plan work programme, so that when the Master Plan is published later in the year all the noise modelling will have been done using the necessary noise metric so that we can report the impacts fully. We will provide a briefing session to the NMB on the results of that assessment, so that noise impacts associated with the air traffic growth forecast in the Master Plan can be fully understood.

APPENDIX 2

Aircraft Noise Metrics and Ambient Noise – Focused Literature Review

CAP1588 Aircraft Noise and Annoyance: Recent Findings, UK CAA, February 2018

A Swiss study authored by Wundderli et al (2016) examined a noise metric called Intermittency Ratio (IR) that reflects the eventfulness of the noise for possible use alongside Leq. The intention was for the metric to take into account the frequency distribution of events and their emergence from background.

The study looked into whether IR could actually contribute to the explanation of noise annoyance and self-reported sleep disturbance. The preliminary results suggested that the de-correlation of the IR from LAeq in the survey sample studies worked relatively well with road traffic noise but less well with railway and aircraft noise, which is surprising given the intermittent nature of aircraft noise. IR was not strongly associated with self-reported perception of intermittency, and does not seem to increase or decrease self-reported annoyance or sleep disturbance responses.

It was suggested that the situations with high IR, such as an aircraft overflights, have more and longer noise-free intervals, but also more obvious single events, which could trigger physiological responses at night. The authors suggest a possibility for future epidemiological studies on long-term health effects and sleep disturbances may be to consider the use of IR as a supplementary tool to help explain variance.

In the USA a new Civil Aircraft noise annoyance study is underway, involving 20 airports being surveyed simultaneously during one year. The aim is to produce a cumulative national civil airport annoyance curve from responses to postal surveys. So far as we are aware the search for a single annoyance curve implies ambient noise levels are not under consideration.

Ambient Noise, To70, Netherlands, 2016

This report was commissioned by the Gatwick Area Conservation Campaign (GACC) and indicates that areas of low ambient noise are likely to have higher rates of annoyance not just because aircraft noise is more obtrusive, but also because people tend to choose to live in rural areas because they value quietness more. The To70 report suggests using a 'total people annoyed' metric for community noise impact, especially when considering airport development or airspace change. To support this, it quotes differences between rural and urban areas in Holland, and then postulates that 'the local difference between ambient noise levels should always be taken into account when calculating annoyance. This would require a local dose-response relationship for each airport when annoyance is modelled.' However, the To70 report does not set out any methodology for how to go about establishing the local dose-response relationship, and this could be technically difficult to achieve.

Reaction to environmental noise in an ambient noise context in residential areas, Fields JM, Journal of Acoustic Society of America 104(4) October 1998.

The study noted that laboratory studies find that the perception of loudness of audible tones is reduced by the presence of another ambient noise. As a corollary, it has long been assumed that in residential settings annoyance with one audible noise (eg aircraft) will be reduced in the presence of another noise (eg road traffic). The research tested this assumption by reviewing reactions of various types of 'target noise' in the presence of ambient noise. 57,000 interview responses to 35 noise sources in 20 social surveys were reanalysed and 12,000 responses to 13 social surveys were reviewed. Target noise sources studied included aircraft, road traffic, railway and impulse noise.

They concluded:

Although there is considerable variation from survey to survey, the best direct estimate is that a 20dB increase in ambient noise exposure (95% confidence interval of 15-50dB) has not more impact that approximately a 1 dB decrease in the target noise exposure.

Acoustic perception theory, well developed from laboratory studies, shows that the perception of one sound can be inhibited by the presence of another. This showed this is not the case in residential environments and the study went on to suggest three possible reasons why this form of perception inhibition may be unimportant in residential environments.

First, ambient noise fluctuates so the target noise may be clearly discernible in the lower ambient noise moments so that subject can form a view on the overall level of the target noise.

Second, it may be that a high levels of ambient noise may in fact cause sensitization to more noise.

Third, research has shown that inside buildings total ambient noise judgements are dominated by internal noise sources from members of the household.

This last point would not apply to residents perceiving aircraft noise outside, so there may be a need to consider the response of these residents who only hear noise inside their home (eg flats) separately from residents who have and use outside space, age gardens, balconies etc. Weather could affect the use of such space implying the effects could vary with seasons.

Effect of Background Levels on Community Response to Aircraft Noise, SM Taylor, FL Hall, SE Bernie, McMaster University, Ontario, Canada, 1980.

This study involved a survey of 673 interviews in 56 residential areas around Toronto airport across a range of aircraft noise levels (NEF <25 to >35) with 24 hours ambient noise levels measured at each. The response variables considered included annoyance, activity interference, and complaints. The study concluded:

The results of various statistical analysis show that the effect of background noise level is generally not significant.

Effect of Background Levels on Community Annoyance from Aircraft Noise, C Lim, Seoul National University, Korea, Journal of Acoustical Society of America 123(2) 2008.

The study reviewed other research, noting that much research had been done in laboratories finding the familiar sound inhibiting effect of background noise. It noted that real world acoustical situations are different and went on to survey 753 residents in 20 sites around two airports, Gimpo and Gimhae in Korea. The study concluded:

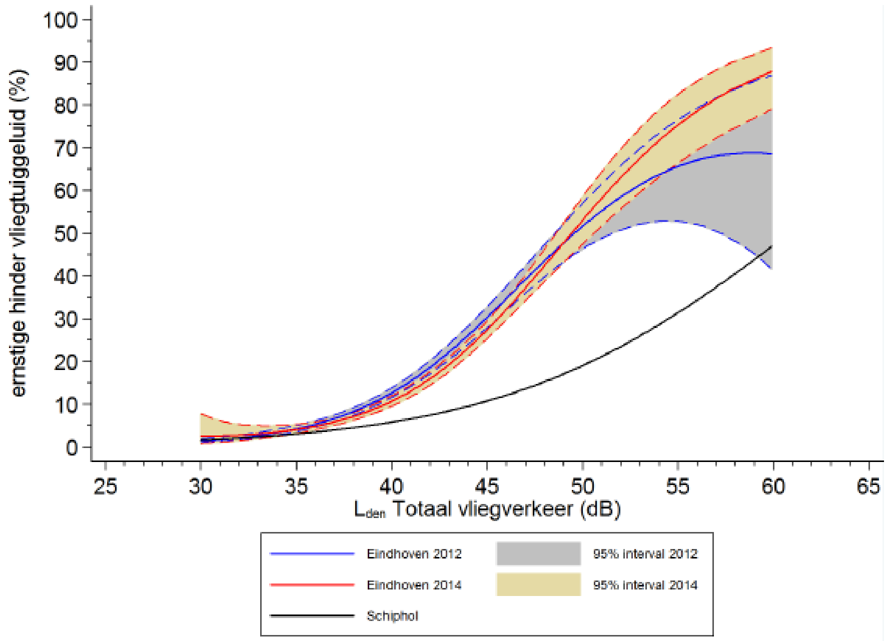
The results show that annoyance responses in low background noise regions are much higher than those in high background noise regions, even though aircraft noise levels are the same. It can be concluded that background noise level is one of the important factors on the estimation of annoyance from aircraft noise exposure.

The researchers noted areas around Gimpo airport are mostly urban locate near by Seoul, while those near Gimhae airport are mostly rural areas with rice fields. The researchers do not comment on the different residential groups further.

Gimpo is on the West side of Seoul which has a residential population of 10 million people, the majority of whom live in ferroconcrete apartments located on busy urban roads. Gimhau airport is located 300km south of Seoul to the south of Gimhau a city with a population of 500,000 people. The residential population in this area live in houses amongst rice fields and farmed land. The researchers do not attempt to isolate observed difference in annoyance from the differences in the residents sampled. It seems likely that the group around Gimhau are more aware of aircraft noise because they spend more time outside and this may account for at least some of the observed difference in annoyance.

Relatie vliegverkeergeluid en geluidhinder rondom vliegveld Eindhoven
Blootstelling - respons relatie RIVM Briefrapport 2015-0108 O.R.P. Breugelmans et al. 2015

This report, provided by To70 in Dutch, includes the following figure showing the % highly annoyed as derived from two equivalent social surveys in the communities around Schiphol and Eindhoven airports in Holland.



Figuur 6: Blootstelling respons relaties van het verwachte percentage ernstig gehinderden bij blootstelling aan vliegverkeersgeluid (Lden totaal) rond Vliegveld Eindhoven

Figure 6: Dose response relation of the expected percentage of highly annoyed exposed to aircraft noise around Eindhoven Airport

The graph shows a lower annoyance response at Schiphol than at Eindhoven, particularly at higher noise levels. Eindhoven was a military airport which now has fast growing numbers of commercial flights. This may explain the higher and increasing annoyance response than at Schiphol. Other non-acoustic factors that may account for the difference, in addition to the much more stable noise situation at Schiphol, include the fact that Schiphol has an established and advanced noise mitigation programme in terms of land use planning and noise insulation from 58 dBA Lden. Eindhoven is in a more rural location, so residents will in general experience lower ambient noise levels, but these other non-acoustic factors could equally explain the difference in annoyance response to Schiphol.

Current Issues In Aviation Noise Management: A Non-Acoustic Factors Perspective. Diana Sánchez, Jack Naumann, Nicole Porter and Andy Knowles, 2015

Recent studies have indicated a considerable increase in annoyance judgments over the last 20 years, for a given noise level. Two issues may help to explain this trend:

(1) Energy based noise descriptors cannot accurately reflect actual community response to noise. Acoustic metrics measure the physical amount of noise; they do not measure actual community response to noise. Traditional longer term LAeq or Lden metrics cannot fully explain variations in annoyance ratings.

(2) Human response to noise is very complex and varies between people and places. The extent of the response is influenced by many elements, besides those that are purely acoustic in nature, such as personal, attitudinal and social factors. The relationship between noise exposure and a potential effect is neither simple, nor linear as commonly presented. Figure 1 below, shows that noise exposure itself is

only one of multiple factors that feed various paths by which people react to noise exposure.

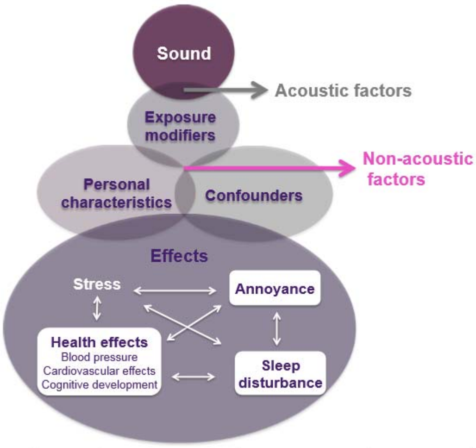


Figure 1. Multiple pathways between sound exposure and response (Source: Anderson Acoustics).

Factors explaining annoyance

It is widely accepted that the annoyance reactions of people exposed to aircraft noise depends on factors beyond noise energy, spectrum and its temporal variation. Different studies point in the direction that at best one third of the variance in annoyance responses can be explained by acoustic characteristics and another third by non-acoustic factors. The rest remains unexplained, and could in part be attributed to measurement errors and subjective ratings of annoyance.

Non-acoustic factors can be broadly categorised into personal, social factors, and situational factors:

1. Personal: linked to an individual and are stable over time. These include noise sensitivity, the capacity to cope with noise, the satisfaction with noise insulation programmes, fear of accidents or harmful effects from aircraft noise, and some demographics variables.

2. Social: related to opinions and evaluations shared by a group of people. For example, trust in authorities, perception of being fairly treated by the airport and, the general expectations from residents are the factors that most influence annoyance responses.

3. Situational: referring to characteristics of the context in which a noise event occurs. These include noise insulation measures, whereabouts of the individuals, and background noise levels as a result of the degree of urbanisation of the area. Temporal factors, such as time of day and day of week are also considered.

The paper goes on to describe various non-acoustic factors and suggests which are likely to most influence annoyance and which are most readily modifiable, summarised in the following figure:

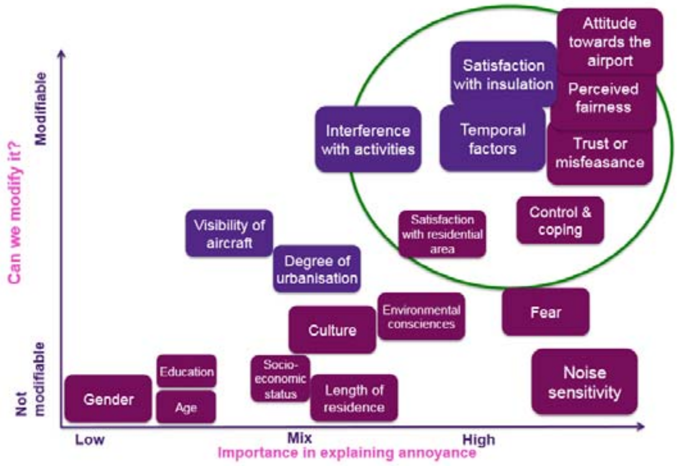


Figure 2. The importance of non-acoustic factors in explaining annoyance and the rating of ability to modify these factors. [Source: Anderson Acoustics]

The paper briefly discusses the top-ranking non-acoustic factors and how they relate to airport noise management. For example:

Attitude towards airport: Recent research indicates that attitude towards the airport has the biggest influence on an annoyance response; fear and negative attitudes could contribute more to aircraft noise annoyance than Lden [noise level]. Some of the most common attitudes include the belief that airports are important for the economy, concerns raised due to the negative effects of noise on health, the expectation that the noise situation will worsen, and the environmental awareness.

Fairness: When considering fairness it is necessary to compare the situation of an individual or community with that of a reference person or community. However, rather than judging fairness based upon an outcome, it is possible to evaluate fairness in terms of the circumstances by which an outcome was reached. This concept is referred to as procedural fairness and can be vital in shaping the attitude of a community in the vicinity of an airport to the relevant authorities.

Trust or misfeasance: This refers to the degree to which a person thinks that airports or authorities act in proper manner and do everything they can to reduce noise and improve the resident's situation. Clear, simple and effective communication has been shown to improve trust with the community

Control and coping: Stress or annoyance caused by aircraft noise can be viewed as an imbalance between the perceived threat or harm caused by the noise and the potential coping resources that are available. This leads to the idea that even in the case of high noise levels, little or no annoyance will occur if there are sufficient coping mechanisms in place. The strategy to deal with the threat can be direct, by reducing the impact of the noise source, or indirect via an understanding of how the noise will vary over time. It should also be noted that the degree of perceived control is not only affected by an individual's confidence in their own abilities to cope with noise but also the belief that the appropriate authorities are being pro-active in pursuing noise reduction measures.

The literature indicates that these high ranking non-acoustical factors have the greatest influence on how annoyed an individual is at a given noise exposure. The SoNA study investigated some of these factors, and for example found that a person is 30-50% more likely to be annoyed by noise if the fear the airport is likely to be noisier next year compared to a person who does not.

These non-acoustic factors are also those that are effected by how the airport communicates with residents affected by noise. This suggests that by improving those communities, with the whole community that is affected by noise, an airport can substantially reduce noise annoyance and its implications.

All of these factors imply that reducing noise level is only one way of addressing community annoyance and reaction to aircraft noise. It remains an important part of noise management, and it is also clear that reporting noise and noise reduction clearly gains trust and reduces annoyance, so using appropriate metrics that are readily understood and trusted in itself also contributes to reducing annoyance.

APPENDIX 3

AMBIENT NOISE SURVEY REPORT

1 Background and Objectives

A noise survey was carried out on the 25th of September 2018 in seven communities around Gatwick Airport. Surveying sites were chosen to represent the centres of the communities. Six out of seven survey sites were located next to the early age schools and one next to a care home.

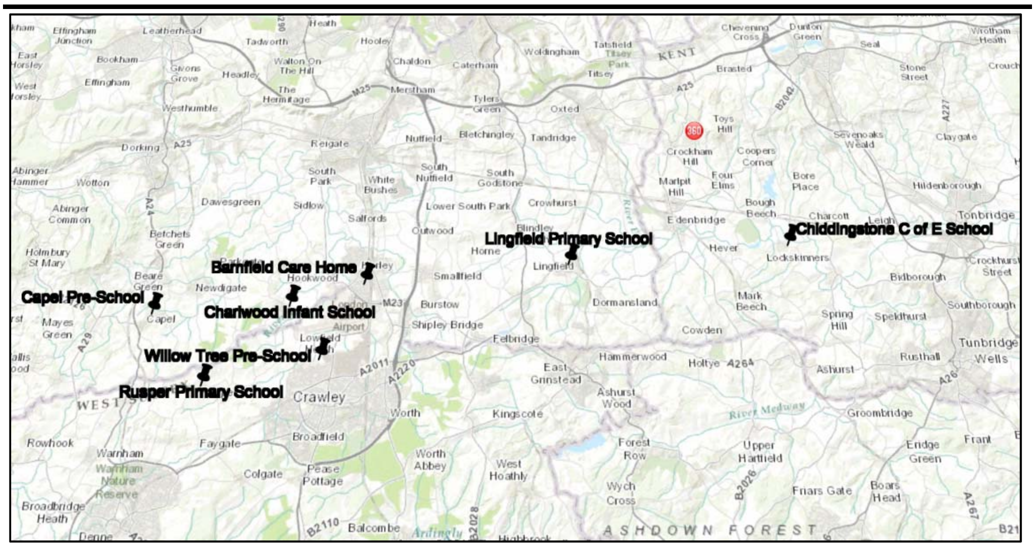
The aim of the surveys was to measure the daytime noise levels and identify the main sources of ambient noise in the communities excluding contributions from aircraft. This was achieved by taking 30 minute measurement samples at each site and removing time periods when arriving / departing aircraft noise was recorded.

2 Methodology

The seven sites surveyed are as follows, and are located as shown in Figure 1.

1. Willow Tree Pre-School, Ifield, Crawley, RH11 7NX
2. Rusper Primary School, RH12 4PR
3. Capel Pre-school, RH5 5JZ
4. Charlwood Village Infant School, RH6 0DA
5. Barnfield Care Home, Upfield, Horley, RH6 7LA
6. Lingfield Primary School, RH7 6HA
7. Chiddingstone C of E School, TN8 7AH

Figure 1 Ambient Noise Survey Locations



Further mapping of each survey site and photographs of each monitoring location are provided in Appendix A.

Surveys were carried out using a B&K 2250L Class 1 sound level meter positioned on a tripod 1.5m above the ground, far enough from the nearest façade to avoid significant reflected noise.

Times when airborne aircraft noise was audible were noted and used to calculate the ambient noise level without aircraft.

The weather was sunny with no clouds and no wind in the first three sites and a slight wind in the remaining four.

Aircraft were operating in an easterly direction during the surveys at sites one to 4 and then changed to westerly for sites 5 to 7. Noting that the objective of the surveys was to measure ambient noise, not aircraft noise, it was not necessary to change the survey plan.

3 Results

The table below gives a description of each survey location, the noise sources observed, the measured noise levels (Leq, L90 and Lmax), the calculated ambient noise levels without aircraft (Leq), and measurements of the main sources of ambient Lmax levels.

Table 3.1 Survey Description and Noise Level Statistics

Community Representative Location	*Site Descriptions and Noise Sources*	*Measured Total Noise levels dB*	*Calculated Ambient Noise (Excluding-aircraft)*	*Sources of Ambient Noise peaks, LAFMax*
1 Willow Tree Pre-School, Ifield, Crawley,	Willow Tree Pre-School is located on the north side of Crawley in Langley Green, about 1.5km from the extended runway centre line. The school is located next to the cricket/football field and is well away from any major roads. Aircraft at low altitude and on the ground were clearly audible. During the survey from 9:57 to 10:27, ambient noise consisted of occasional birds singing, children shouting, people talking, lawn mowing and a delivery van reversing, gates being opened/closed.	LAeq – 53 LA90 – 42 LAFmax – 71	LAeq – 47dB	Lawn Mover 60dB Lawn Mover 70dB
2 Rusper Primary School	Rusper Primary School is located in the village of Rusper, about 1.6km from the extended runway centre line, 5km from the airport. The school is next to the village hall set about 4m from Horsham Road which is a minor road, but during our survey from 1100-1130 was used by vehicles passing the school typically 2 or 3 times every a minute. The noise environment at the front of the school was dominated by road traffic noise, with aircraft on westerly approach to Gatwick just audible.	LAeq – 58 LA90 – 37 LAFmax – 76	LAeq – 58dB	Passing Car 69dB Passing Truck 76dB Passing Car 68dB

Community Representative Location	***Site Descriptions and Noise Sources***	***Measured Total Noise levels dB***	***Calculated Ambient Noise (Excluding-aircraft)***	***Sources of Ambient Noise peaks, LAFMax***
3 Capel Pre-school	Capel Pre-School is located in Capel village and is about 2.6 km away from the extended runway centreline, 7km from the airport. The school is located next to the small, but busy main road. During the survey between 11:56 and 12:26 vehicles were passing by the school about every 15 seconds. Ambient noise consisted of people talking, birds singing, construction works happening at school and cars driving past. Vehicles were the dominant noise source. However, westerly landing aircraft were audible as well.	LAeq – 57 LA90 – 41 LAFmax – 79	LAeq – 57dB	
4 Charlwood Village Infant School	Charlwood Village Infant School is located in the village of Charlwood and is about 1.4km away from the extended runway centre line. The school is next to a very small road. During the survey between 12:57 and 13:38 only a few cars were driven past. The noise environment was dominated by school children playing outside. Once they were inside, noise from westerly landing aircraft became dominant.	LAeq – 52 LA90 – 41 LAFmax – 72	LAeq – 47dB	
5 Barnfield Care Home, Upfield, Horley	Barnfield Care Home is located in the town of Horley and is about 1.7km from the extended runway centre line. The Care Home is on the Upfield, next to the roundabout. During the survey between 14:05 and 14:35 vehicles passed about 4-5 times per minute. Although the vehicle movements were noisy, aircraft taking off to the East and on-ground aircraft noise was prominant. In the middle of the survey, runway operations changed direction, so that aircraft approached from the east. This reduced airborne aircraft noise due to the low vertical landing profile. The noise environment also included rustling leaves and bird singing.	LAeq – 56 LA90 – 51 LAFmax – 71	LAeq – 55dB (1)	Passing Car 44dB Passing Car 58dB Passing Truck 65dB
6 Lingfield Primary School,	Lingfield Primary School is in the village of Lingfield and is located on a small village road, about 0.5km from the extended runway centre line, 10km from the airport. The noise environment at the school was dominated by the vehicles driving past, which, at the time of the survey between 15:58 and 16:28 was about 3-4 per minute. Easterly approaching aircraft were clearly audible and contributed to the overall noise level. Other background noise sources included rustling leaves and people talking.	LAeq – 62 LA90 – 39 LAFmax – 86	LAeq – 60dB	Passing Car 70dB Passing Car 70dB Passing Bus 83dB Passing Car 68dB Passing Motorbike 81dB

Community Representative Location	*Site Descriptions and Noise Sources*	*Measured Total Noise levels dB*	*Calculated Ambient Noise (Excluding-aircraft)*	*Sources of Ambient Noise peaks, LAFMax*
7 Chiddingstone C of E School	Chiddingstone Church of England School is located in the village of Chiddingstone and is about 0.9km away from the extended runway centre line, 22km from the airport. The school is based next to the Chiddingstone Road, where during the survey between 16:59 and 17:29 about one vehicle per minute passed by. The noise environment was dominated by road noise, however, easterly approaching airplanes were clearly audible as well. The noise environment also included birds singing, children shouting at school and noises from the village.	LAeq – 55 LA90 – 36 LAFmax – 74	LAeq – 53dB	Starting Car 73dB Passing Car 69dB Passing Car 65dB Passing Car 72dB

1 – Note ground noise from aircraft and the airport has not been removed.

The second table gives the range of aircraft LAmax noise levels measured during the survey, noting the direction of the aircraft in each case.

Table 3.2 Noise Level and Aircraft LAFmax

Community Representative Location	*Range of Aircraft LAFmax, Arrivals From The West*	*Range of Aircraft LAFmax, Arrivals From The East*
1 Willow Tree Pre-School, Ifield, Crawley	60, 61, 69	
2 Rusper Primary School	48dB, 45dB, 42dB	
3 Capel Pre-school	47dB, 52dB, 51dB, 55dB, 53dB	
4 Charlwood Village Infant School	75dB, 60dB, 55dB, 63dB, 58dB, 62dB	
5 Barnfield Care Home, Upfield, Horley	68dB, 67dB, 68, 72dB	62dB, 65dB
6 Lingfield Primary School		70dB, 67dB, 70dB, 66dB, 68dB, 73dB, 63dB, 65dB
7 Chiddingstone C of E School		56dB, 58dB, 62dB, 66dB, 69dB, 55dB, 61, 70dB

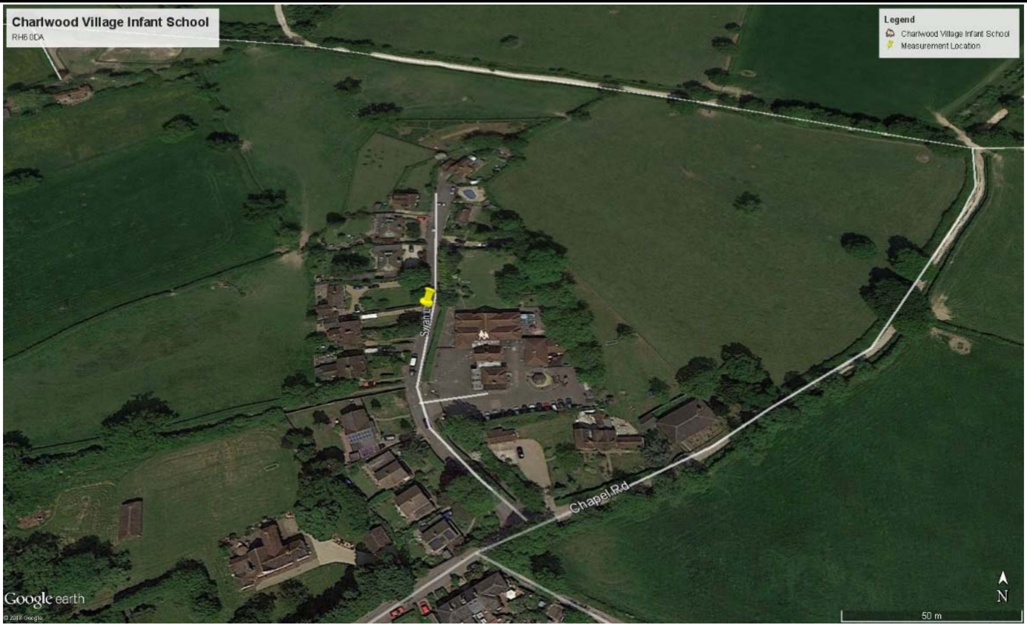
Appendix A
Noise Survey Location Maps and Photographs

Measurement Location 1 Willow Tree Pre-School, Ifield, Crawley

Measurement Location 2, Rusper Primary School

Measurement Location 3, Capel Pre-School

Measurement Location 4, Charlwood Infant School



Measurement Location 5, Barnfield Care Home, Horley

Measurement Location 6, Lingfield Primary School

Measurement Location 7, Chiddingstone C of E School