ArupAcoustics

University of York

Heslington East Campus

Details of Noise Modelling and Noise Survey

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Contents

Figures

Appendices

Executive Summary

Arup Acoustics has been instructed to carry out a noise measurement survey at the proposed site of the Heslington East Campus in order to inform the acoustic design of the development and in support of detailed planning.

This report describes a noise survey carried out to determine the existing noise levels around the proposed development site.

Details of a noise mapping exercise have also been included in the report. The model has been created in order to predict noise levels across the entire development site to inform the detailed design of Cluster 1 and to aid any future work packages conducted by Arup or others. The model was calibrated using the noise survey measurements and traffic data.

1 Introduction

Arup Acoustics has been instructed to carry out a noise measurement survey at the proposed site of the Heslington East Campus in order to inform the acoustic design of the development and in support of detailed planning.

This report describes a noise survey carried out to determine the existing noise levels around the proposed development site and a noise mapping exercise carried out to assist the design for Cluster 1 and for any future work packages, conducted by Arup or others.

The measured noise survey data has been collected for the following purposes:

a) To determine representative daytime and night-time background (L_{A90}) noise levels at the nearest residential receptors in order to inform design of mechanical fixed plant within the development in order to facilitate the discharge of planning condition #22.

b) To determine daytime and night-time baseline noise levels at specified nearby noise receptors to help inform the assessment of construction noise and facilitate compliance with planning condition #21.

c) To determine the daytime and night-time ambient noise levels at the façade locations of the proposed buildings in order to inform ventilation strategy & possible façade build-up design.

d) To produce an accurate calibrated noise map to aid all aspects of detailed acoustic design for Cluster 1 and any future work packages, conducted by Arup or others.

Appendix A of this acoustic report provides a description of the acoustic terminology used in this report.

Appendix B provides details of the environmental noise survey.

2 The Proposed Development

The proposed development is adjacent to the village of Heslington to the south east of York. The site is bounded to the North by Hull Road (A1079), to the east by the A64, to the south by Low Lane (with the A64 beyond), to the west by School Lane and to the northwest by Field Lane. A site plan is presented in Figure 1.

2.1 Noise Sensitive Receivers

Noise sensitive receptors include the residential properties on The Crescent and School Lane (West) and Field Lane (Northwest). A school is also located on School Lane.

There are predominantly commercial premises to the North on Hull Road. The remainder of land uses are currently agricultural in nature.

The proposed development also introduces noise sensitive receptors, including teaching spaces as well as residential student accommodation. Notably the TFTV building will be particularly sensitive to noise.

2.2 Potential Noise Sources within the Development

Sources of potential noise include those from fixed plant associated with the development affecting nearby existing residential dwellings and residential dwellings within the development. This potential impact is recognised by the planning conditions imposed (Condition #22). Consideration also needs to be given to non residential intra-development impacts such as fixed plant affecting the TFTV building or other teaching spaces within the development.

Construction noise is a temporary but not insignificant impact. This potential impact is recognised by the planning conditions imposed (Condition #21). Consequently measurements of noise due to existing sources affecting the development have been carried out in order to quantify existing baseline noise levels.

2.3 Existing Noise Sources Affecting the Development

The main noise impact on the development will result from existing ambient noise levels (Road traffic noise) upon the development. This impact is not conditioned but needs be addressed within the design, especially for specialist low tolerance spaces such as the TFTV facilities. There is also a potential noise impact arising from overlying aircraft and gas powered bird scaring devices located in adjacent agricultural fields

3 Baseline Environmental Noise Survey

3.1 Site and Conditions

The primary source of noise affecting the development site is road traffic noise from the distant A64. The A64 is a busy road and in the absence of any other major noise sources clearly dominates the noise climate for the majority of the site.

Field lane to the north of the site is a moderately trafficked road which only dominates the noise climate at locations in close proximity to the road. Whilst Hull Road (A1079) is quite busy, it contributes little to the noise in the main body of the site due to the shielding effect afforded by the intervening topography.

3.2 Traffic Flows

Average weekday traffic flows are described in Table 1 below.*

<table>
<tr><th rowspan="2">Road</th><th colspan="2">Day Time (07:00 - 23:00)</th><th colspan="2">Night Time (23:00 - 07:00)</th><th rowspan="2">Source</th></tr>
<tr><th>Average</th><th>Peak hour</th><th>Average</th><th>Peak hour</th></tr>
<tr><td>A64 Annualised Average</td><td>2509</td><td>4024
(17:00 – 18:00)</td><td>266</td><td>1067
(06:00 – 07:00)</td><td rowspan="3">WSP (2006)</td></tr>
<tr><td>A64
Peak Month (July)</td><td>2725</td><td>4288
(17:00 – 18:00)</td><td>300</td><td>1192
(06:00 – 07:00)</td></tr>
<tr><td>A64
(December)</td><td>2274</td><td>3391
(17:00 – 18:00)</td><td>235</td><td>900
(06:00 – 07:00)</td></tr>
<tr><td>Field Lane</td><td>-</td><td>560</td><td>-</td><td>-</td><td rowspan="2">Faber Maunsell (2003)</td></tr>
<tr><td>Hull Road</td><td>-</td><td>2157</td><td>-</td><td>-</td></tr>
</table>

Table 1 Traffic Flow Figures

* “Average weekday traffic flows" are an average of the weekday traffic flows and consequently exclude data for Saturday and Sunday. Average weekly flows a little lower hence the adopted data provides a slight worst case.

Traffic flow data for December is provided as this relates to the period during which the noise measurement survey was conducted. This period has the second lowest average traffic flows with January having the lowest traffic flows, albeit only slightly less than December. The summer months have the highest traffic flows, which is consistent with holiday traffic to and from the coast.

For the purposes of establishing background (L_{A90}) noise levels in order to inform design of mechanical fixed plant within the development (Condition #22), the noise levels measured in December represent a 'worst case' as they were measured during one of the quietest months.

Conversely, for the purposes of establishing Ambient (L_{Aeq}) noise levels in order to inform ventilation strategy & possible façade build-up design, the noise levels measured in December need to be scaled up to provide an indication of Annualised Average noise levels or "Peak Month" noise levels.

3.3 Effect Of Road Traffic Flow On Noise Levels

In terms of L_{Aeq} and L_{A10} parameters, road traffic noise can be linked to a number of physical attributes of a particular road and traffic flow. The 'Calculation of Road traffic Noise' (CRTN) describes a procedure for calculating noise from road traffic in order to determine entitlement under the Noise Insulation Regulations. They also provide useful guidance for more general applications such as environmental appraisal, highway design and land use planning.

The document describes the interrelationship of number of mechanisms which affect noise levels, the main ones of which are described below:

- Source terms - Traffic flow, Traffic speed, Percentage of heavy goods vehicles (HGV), Road gradient and Road surface
- Propagation effects - Distance correction, Ground absorption and Barrier correction.

All other factors being broadly equal (as is the case for the proposed development site) and assuming identical weather conditions, differences in traffic flow and percentage of HGV's can be used to determine differences in measured noise level.

3.4 Noise Correction Factors for Traffic Flow

Calculations have been conducted according to Calculation of Road Traffic Noise document (Charts 3 and 4) and the following corrections (Table 2) have been developed in order to convert the noise levels from average flow to peak hour flows and between day and night periods. These corrections have been reviewed against the measured noise levels and compare very favourably.

Month	**Period**	**Descriptor**	**Correction Factors, dB**	
			Day time	**Night time**
Peak Month (July)	Day	$L_{Aeq,1h\ peak}$	**+1**	+10
		$L_{Aeq,16h}$	**-**	+9
	Night	$L_{Aeq,1h\ peak}$	-3	**+6**
		$L_{Aeq,8h}$	-9	**-**

Table 2 Correction factors for different noise indices relative to each other

3.5 Noise Survey

The noise measurements were undertaken during the period of the 11th – 13th December 2007. Details of equipment, weather and personnel are described in Appendix B1. The measurement positions are shown in Figure 1.

The unattended monitoring equipment was set to measure at 5 minute intervals throughout the day and night period. For attended measurements, during the day time 15 minute measurements periods were adopted. During the night time 3 consecutive 5 minute measurements were conducted.

The clocks on all sound level meters were synchronised.

3.6 Survey Results

Full survey results are given in Appendix B2 of this report.

In terms of L_{Aeq} and L_{A10} parameters noise levels throughout the site during both the day and night are dictated by road traffic noise on adjacent roads.

During the day the background (L_{A90}) noise levels were dictated by distant road traffic noise. During the night the background levels were predominantly dictated by distant road traffic noise however some of the lower values are likely to have resulted from distant industrial noise which was audible during quieter periods.

In terms of L_{Amax} levels, gas powered bird scarers in adjacent fields were occasionally audible during the day time. These events were intermittent but not exceptionally loud (74 dB(A)). In addition high flying aircraft were occasionally audible with one event where a military jets aircraft resulted in elevated levels (77dB(A)).

The measured noise levels have been used to calibrate the noise map, which is described in detail in the following section of this report. The noise maps can be used for the detailed acoustic design for Cluster 1 and any future work packages, conducted by Arup or others.

The measured noise levels can also be used for various elements of design work throughout the development project.

4 Noise Map

4.1 SoundPLAN Software

SoundPLAN is a three dimensional graphics oriented program. It produces colour plots and tabulations of the input data and results.

Combining noise prediction methods for the different types of environmental noise sources with topographical data, it is possible to map the noise climate over a large geographical area.

Mapping therefore enables the evaluation of large scale existing situations, and the prediction of potential noise levels where new noise sources are to be introduced, or more importantly in this case, where new buildings (which provide shielding) and changes to the land are to be introduced into an existing environment.

A completed noise map can be used to provide noise levels at number of locations and heights and quickly evaluate changes to site massing.

4.2 Methodology

The noise climate around the site has been modelled based upon L_{Aeq} noise levels calculated from the average weekday (Monday to Friday) traffic flow, for the peak month for the year (July) in 2006.

Calculations indicate that the noise level for the peak July period is 1.0 - 1.1 dB(A) higher than levels for the month of December and 0.3 – 0.5 dB(A) higher than for annualised average traffic flows.

The noise map was calibrated to measured survey data and corrected for traffic flow and percentage of heavy goods vehicles as necessary. These noise levels were used as input data for the noise modelling and in order to convert the noise levels in the model to other indices Table 2 above has been developed.

It should be noted that the noise model is based upon road traffic flows and does not include noise from possible future pedestrians within the development or other extraneous noise sources.

4.3 Results

The calibrated noise maps for Average Weekday daytime and night time traffic flows are shown in Figure 2 to 5.

The site has been modelled both as an empty site with no buildings or obstructions and also with the proposed Cluster 1 buildings in place.

The noise map showing Cluster 1 has been based upon the latest design drawings (HE (1) MODEL A 14-08-07 received from BDP on 5th October 2007) in order to demonstrate the implications of site massing upon site noise levels.

Any subsequent changes to site massing can be incorporated within the model relatively quickly to provide revised noise levels as necessary.

The site drawing includes a proposed man-made lake to the south of Cluster 1. As sound propagates better across water than soft ground, this would affect the noise levels on-site. The proposed lake has therefore been included in the noise maps.

5 Conclusions

This report describes a noise measurement survey carried out to determine the existing noise levels around the proposed development site at Heslington East.

This has been conducted in order to inform the design of future on-site buildings and in support of detailed planning.

Details of a noise mapping exercise have also been included in the report. The model has been created in order to predict noise levels across the entire development site to inform the detailed design of Cluster 1 and to aid any future work packages conducted by Arup or others. The model was calibrated using the noise survey measurements and traffic data.

FIGURES

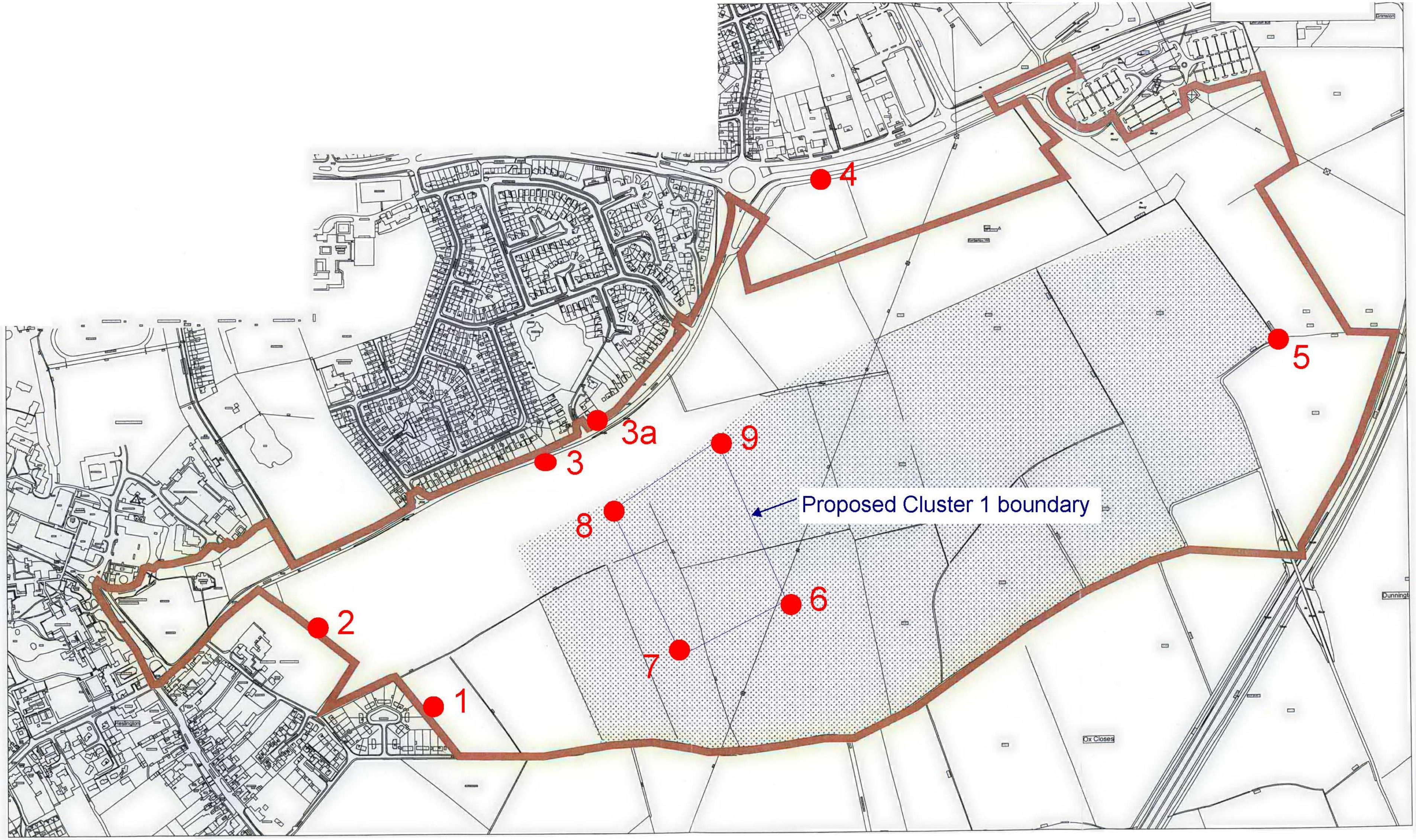

Figure 1 Site Plan and Measurements Locations

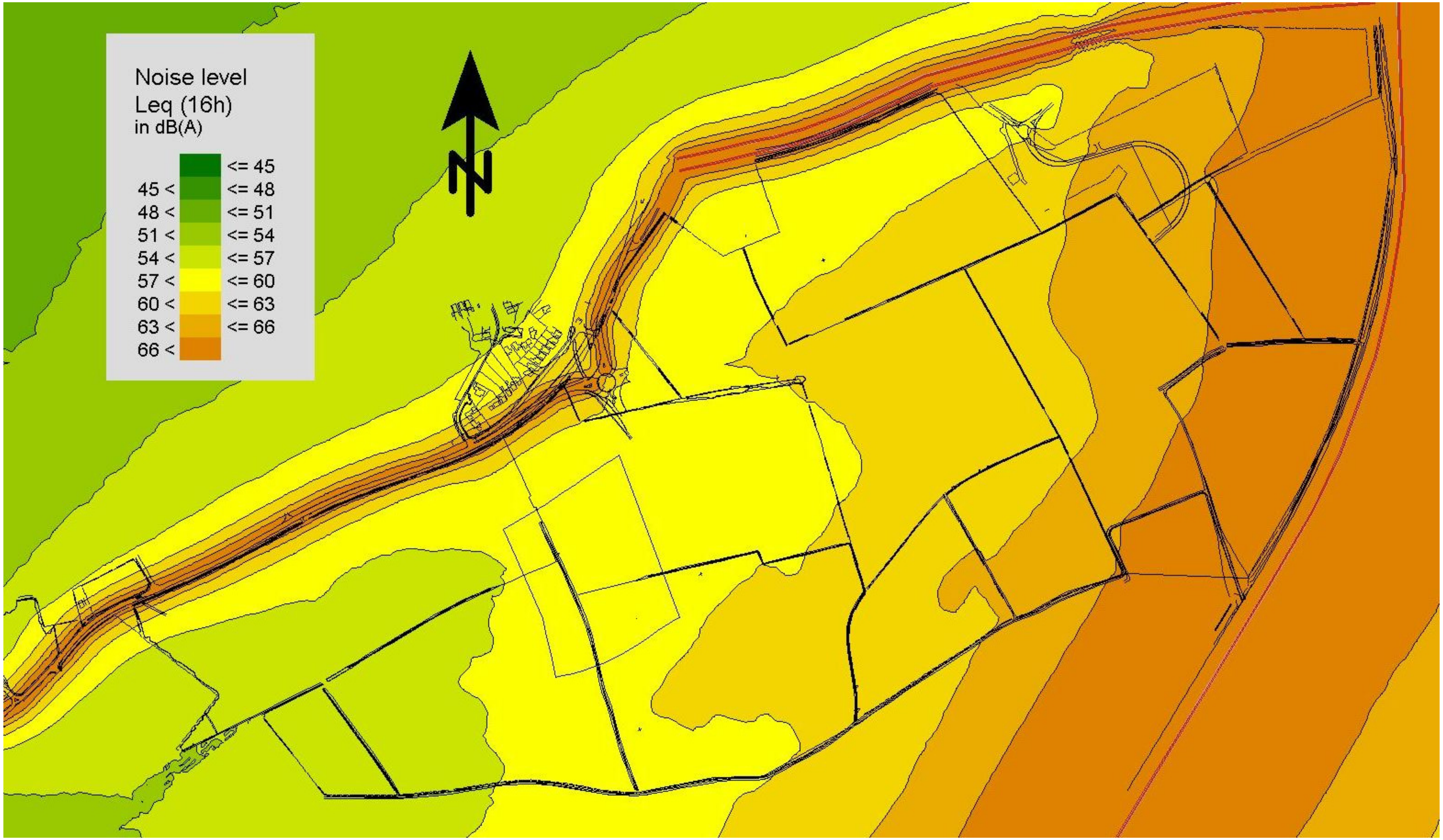

Figure 2 July Weekday, Day time Noise Map (empty site), $L_{Aeq,16h}$ (dB)

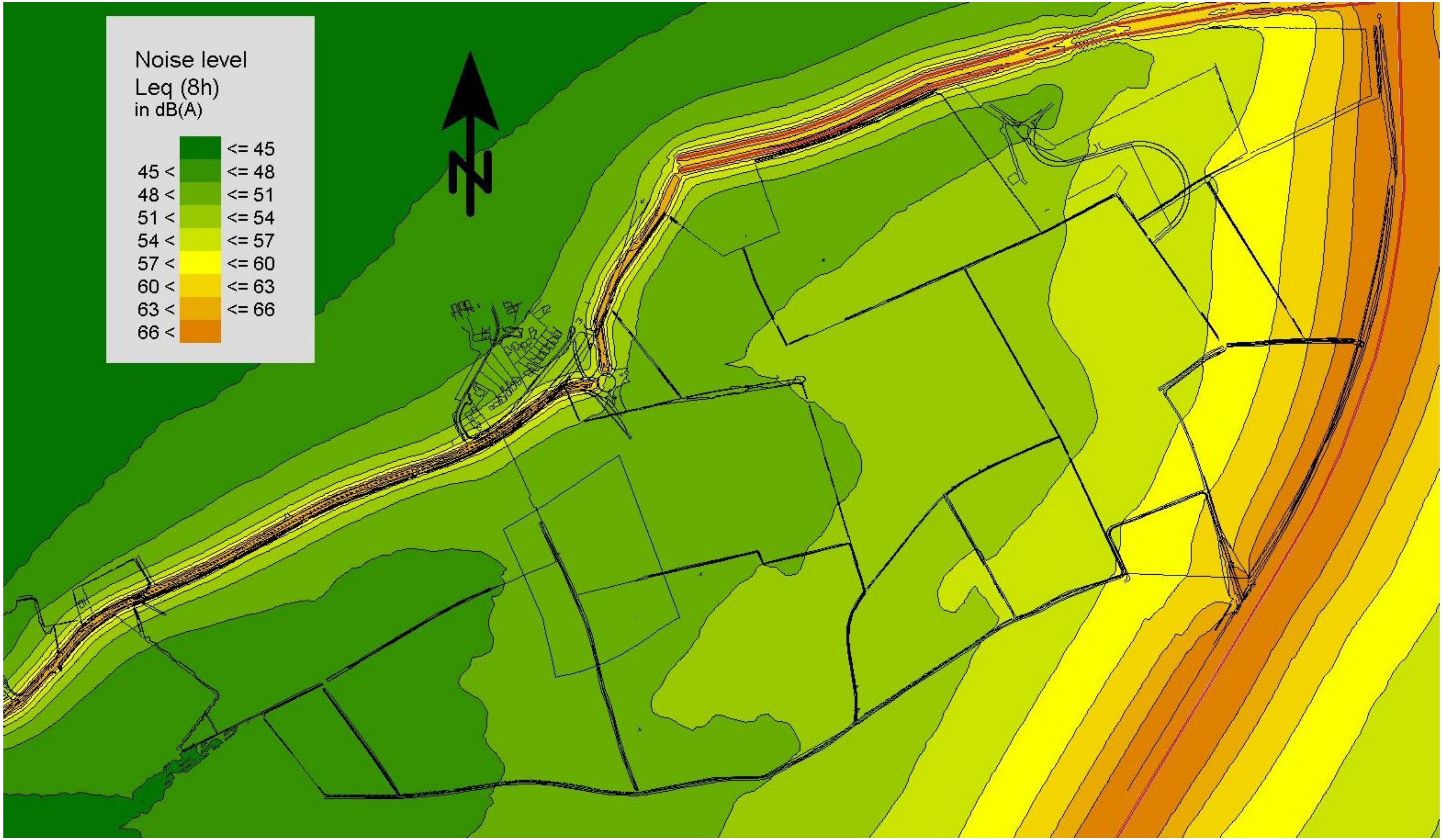

Figure 3 July Weekday, Night time Noise Map (empty site), $L_{Aeq,8h}$ (dB)

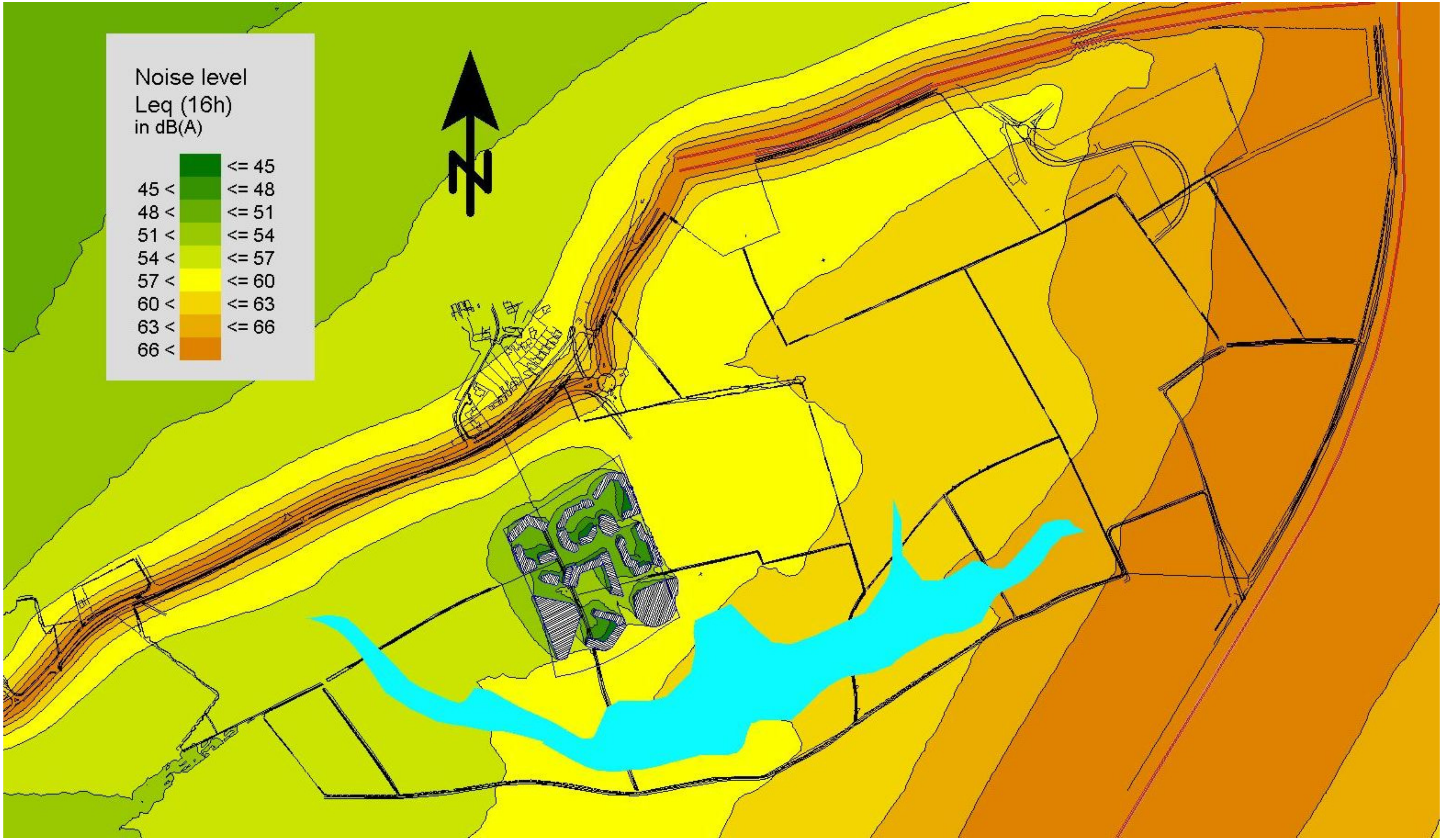

Figure 4 July Weekday, Day time Noise Map (Cluster 1), $L_{Aeq,16h}$ (dB)

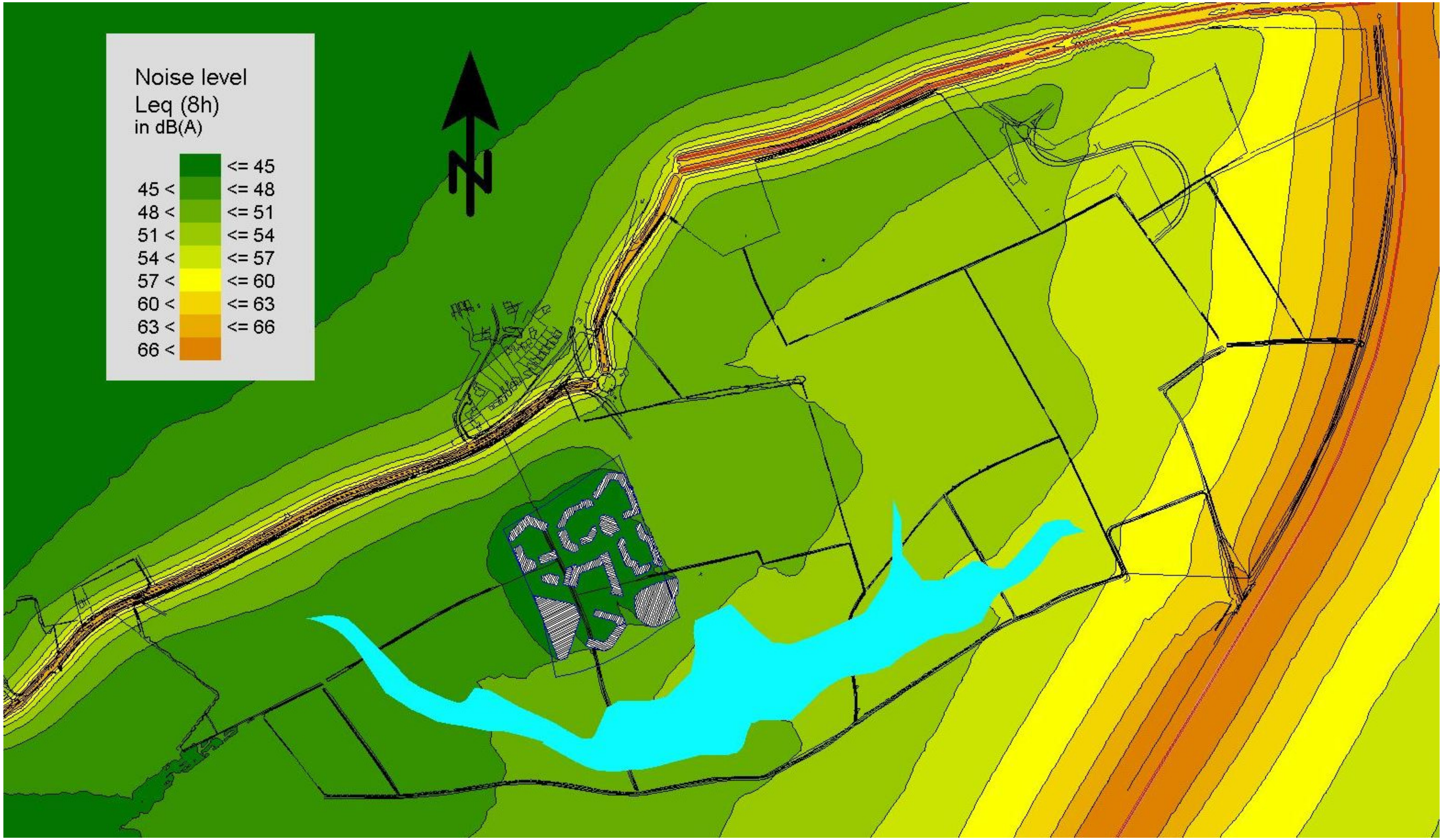

Figure 5 July Weekday, Night time Noise Map (Cluster 1), $L_{Aeq,8h}$ (dB)

Appendix A

Acoustic Terminology

Decibel

The ratio of sound pressures which we can hear is a ratio of 1:10^6 (one:one million). For convenience, therefore, a logarithmic measurement scale is used. The resulting parameter is called the 'sound pressure level' (L_p) and the associated measurement unit is the decibel (dB). As the decibel is a logarithmic ratio, the laws of logarithmic addition and subtraction apply.

dB(A)

The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dB(A). An A-weighting network can be built into a sound level measuring instrument such that sound levels in dB(A) can be read directly from a meter. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. It is worth noting that an increase or decrease of approximately 10dB corresponds to a subjective doubling or halving of the loudness of a noise, and a change of 2 to 3dB is subjectively barely perceptible.

Equivalent Continuous Sound Level

Another index for assessment for overall noise exposure is the equivalent continuous sound level, L_{eq}. This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual time-varying sound over the same period. Hence fluctuating levels can be described in terms of a single figure level.

Frequency

The rate of repetition of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the Hertz (Hz), which is identical to cycles per second. A thousand hertz is often denoted kHz, eg 2kHz = 2000Hz. Human hearing ranges approximately from 20Hz to 20kHz. For design purposes, the octave bands between 63Hz to 8kHz are generally used. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For more detailed analysis, each octave band may be split into three one-third octave bands or in some cases, narrow frequency bands.

Statistical Noise Levels

For levels of noise that vary widely with time, for example road traffic noise, it is necessary to employ an index which allows for this variation. The L_{10}, the level exceeded for ten per cent of the time period under consideration, has been adopted in this country for the assessment of road traffic noise. The L_{90}, the level exceeded for ninety per cent of the time, has been adopted to represent the background noise level. The L_1, the level exceeded for one per cent of the time, is representative of the maximum levels recorded during the sample period. A weighted statistical noise levels are denoted L_{A10}, dBL_{A90} etc. The reference time period (T) is normally included, eg $dBL_{A10, 5min}$ or $dBL_{A90, 8hr}$.

Maximum Noise Levels

The maximum noise level identified during a measurement period. Experimented data has shown that the human ear does not generally register the full loudness of transient sound events of less than 125 ms. Fast time weighting has an exponential time constant of 125 ms which reflects the ear's response. The maximum level measured with fast time weighting is denoted as $L_{AMax, F}$. Slow time weighting (S) with an exponential time constant of 1s is used to allow more accurate estimation of the average sound level on a visual display

Appendix B

Environmental Noise Survey Details

B1 Survey Details

Attended noise surveys were performed as follows:

- Between approximately 13:40hrs and 17:45hrs on 11 December 2007;
- 02:40hrs and 05:20hrs on 12 December 2007;
- 11:25hrs and 19:10hrs on 12 December 2007; and
- 02:50hrs and 05:25hrs on 13 December 2007

by Will Martin and Peter Mumford of Arup Acoustics.

B1.1 Survey Methodology

B1.1.1 Attended Survey

The sound level meter was set to record noise levels over 15-minute periods during the day time and 3 x 5 min periods during the night time. The meter was set to automatically store the L_{Aeq}, L_{A1}, L_{A10}, L_{A90} and $L_{Amax,F}$ indices. Measurements were made with a fast (0.125s) time constant.

The measurements were made under free-field conditions at all locations and the measurement microphone was mounted using a tripod approximately 1.2m – 1.5m above ground level.

B1.1.2 Unattended Survey

The sound level meter was set to record noise levels over 5-minute periods throughout the entire survey duration. The meter was set to automatically store the L_{Aeq}, L_{A1}, L_{A10}, L_{A90} and $L_{Amax,F}$ indices. Measurements were made with a fast (0.125s) time constant.

The measurements were made under free-field conditions and the measurement microphone was mounted using a tripod approximately 1.2m above ground level.

The surveys were carried out according to relevant advice on noise measurement given in BS 4142 and other relevant standards.

B1.2 Measurement Equipment

Measurements were carried out using equipment as detailed in Tables B1 to B3. The sound level meter and microphone are Type 1, conforming to BS EN 61672-1: 2003. The calibration of the sound level meter, pre-amplifier and microphone chains were checked before and after use, to confirm that there was no significant drift in meter response at the calibrator frequency and level. All Arup Acoustics' sound level meters are annually calibrated and this calibration is traceable to international standards.

Equipment	Manufacturer	Type number	Serial number
Precision grade sound level meter	Brüel & Kjær	2260	SN 2576748
½" diameter pre-polarised condenser microphone	Brüel & Kjær	4189	SN 2595438
Type 1 sound pressure level calibrator	Brüel & Kjær	4231	SN 2594520

Table B1 Measurement Instrumentation (Kit D)

Equipment	Manufacturer	Type number	Serial number
Precision grade sound level meter	Brüel & Kjær	2238	SN 2447768
½" diameter pre-polarised condenser microphone	Brüel & Kjær	4188	SN 2427576
Type 1 sound pressure level calibrator	Brüel & Kjær	4231	SN 2466120

Table B2 Measurement Instrumentation (Kit B)

Equipment	Manufacturer	Type number	Serial number
Precision grade sound level meter	CEL	490	SN 074212
½" diameter pre-polarised condenser microphone	CEL	250	SN 5832
Pre-amplifier	CEL	495	SN 000162
Type 1 sound pressure level calibrator	CEL	110/1	SN 074411

Table B3 Measurement Instrumentation (Kit C)

B1.3 Measurement Positions

The noise measurement locations and survey methodology was agreed in writing in advance with representatives of York City Council. The adopted measurement locations are described in Table B4 below.

Measurement Position	Location	Unattended continuous logging	Short term attended measurements
1	Western boundary of site adjacent to "The Crescent"	24 hour	-
2	Western boundary of site adjacent to school's outside play area	10 hour (08:00 – 18:00)	-
3	The northern boundary of the site adjacent to Field Lane (6 metres from the kerb)	24 hour	-
3a	The northern boundary of the site adjacent to Field Lane / Badgers Wood Close (9 metres from the kerb)		✓
4	Northern site perimeter adjacent to Hull Road (7 metres from the kerb)		✓
5	End of Low Lane nr A64	24 hour	-
6	SE corner of Cluster 1		✓
7	SW corner of Cluster 1		✓
8	NW corner of Cluster 1		✓
9	NE corner of Cluster 1		✓

Table B4 Noise Measurement Locations

B1.4 Weather

Meteorological conditions during the noise survey period were dry and cold with negligible wind speed (<<5ms^{-1}). During the day it was sunny but cold.

B2 Measurement Results

B2.1 Attended Measurements

Tables B5 to B8 give the measured results of the attended noise survey, with data provided in chronological order. Measurement locations are as shown in Figure 1. All values are presented as free-field sound pressure levels.

Meas. position	Start	End	Duration	L_{Aeq}	L_{A90}	L_{A10}	L_{A1}	$L_{Amax,F}$	Notes
8	13:40	13:55	15	60.8	47.4	63.8	67.0	75.6	Some distant excavators for final 10 minutes affected measurements
4	14:40	14:55	15	68.0	58.4	71.8	74.8	77.5	Hull Road traffic dominant (approx 1680 vehicles per hour)
5	15:35	15:50	15	64.8	63.0	66.2	67.2	68.6	A64 dominant (approx 3048 vehicles per hour)
6	16:10	16:25	15	58.0	56.0	59.6	60.6	62.1	A64 dominant
9	16:40	16:55	15	56.9	54.4	59.2	61.2	62.5	A64 dominant
8	17:05	17:20	15	57.5	56.0	58.4	60.4	61.6	A64 and Field Lane
7	17:30	17:46	15	58.2	56.0	59.4	60.2	61.5	A64 dominant

Table B5 Daytime noise level measurement results (dB), 11 December 2007

Meas. position	Start	End	Duration	L_{Aeq}	L_{A90}	L_{A10}	L_{A1}	$L_{Amax,F}$	Notes
6	02:40	02:45	05	44.6	33.8	47.8	50.4	53.4	A64 & distant industrial noise
	02:45	02:50		42.7	32.4	46.6	50.6	53.4	
	02:50	02:55		43.8	32.2	47.6	52.0	55.1	
9	03:10	03:15	05	46.9	39.4	49.4	52.6	55.6	A64 & distant industrial noise
	03:15	03:20		44.7	34.8	48.4	50.8	53.4	
	03:20	03:25		46.0	37.2	48.6	52.4	56.9	
8	03:35	03:40	05	42.1	33.8	45.2	49.0	52.4	A64 & distant industrial noise
	03:40	03:45		40.9	33.6	44.4	48.2	51.3	
	03:45	03:50		43.2	36.8	46.6	49.6	51.7	
7	04:00	04:05	05	47.6	43.8	49.6	52.4	57.7	A64 & distant industrial noise
	04:05	04:10		48.7	45.4	51.0	53.6	56.2	
	04:10	04:15		47.7	43.4	50.4	53.0	54.9	
4	04:35	04:40	05	58.5	43.2	58.4	71.6	75.1	Hull Rd, birdsong, A64, fixed plant
	04:40	04:45		53.9	41.4	55.2	67.8	71.7	Hull Rd, birdsong, A64, fixed plant (approx 96 vehicles per hour)
	04:45	04:58		46.6	41.4	49.0	50.8	53.0	Distant A64 and plant noise (Traffic on Hull Road paused out)
3a	05:05	05:10	05	48.1	43.4	50.4	53.0	68.0	Field Lane no cars, distant A64
	05:10	05:15		47.2	44.6	48.8	50.8	52.4	Field Lane no cars distant A64,
	05:15	05:20		54.6	45.6	50.4	66.0	76.0	Field Lane 1 car, distant A64

Table B6 Night-time noise level measurement results (dB), 12 December 2007

Meas. position	Start	End	Duration	L_{Aeq}	L_{A90}	L_{A10}	L_{A1}	$L_{Amax,F}$	Notes
4	11:25	11:40	15	67.3	57.0	71.4	74.2	76.8	Hull Road dominant (approx 1608 vehicles per hour)
3a	11:50	12:05	15	69.7	59.6	73.4	77.6	86.2	Field Lane dominates (62-66 SPL from excavators) (approx 588 vehicles per hour)
8	13:00	13:05	05	56.9	55.6	57.8	58.6	59.6	A64 & some distant excavator noise for first 30 seconds
	13:05	13:10		56.0	54.6	56.8	57.8	59.3	A64 dominant
7	13:20	13:25	05	56.8	55.4	57.8	58.8	60.1	A64 dominant
	13:25	13:30		57.0	55.6	57.8	59.0	61.3	
6	16:40	16:55	15	59.9	58.6	60.6	61.6	65.0	A64 dominant (approx 3864 vehicles per hour)
9	17:05	17:20	15	59.0	57.6	60.0	60.8	75.1	A64 dominant
8	17:30	17:47	15	57.9	56.8	58.8	59.6	63.0	A64 dominant (approx 3600 vehicles per hour) Military aircraft paused out
7	17:55	18:11	15	58.4	57.0	59.4	60.4	61.9	A64 dominant
3a	18:25	18:40	15	68.5	57.0	73.0	76.6	83.7	Field Lane dominates (54 SPL from A64 alone) (approx 408 vehicles per hour)
4	18:55	19:12	15	66.9	58.0	70.4	74.4	81.6	Hull Road dominant

Table B7 Daytime noise level measurement results (dB), 12 December 2007

Meas. position	Start	End	Duration	L_{Aeq}	L_{A90}	L_{A10}	L_{A1}	$L_{Amax,F}$	Notes
6	02:50	02:56	05	47.5	37.4	50.2	55.2	65.3	A64 & distant industrial noise
	02:56	03:01		44.6	32.2	48.2	51.6	56.7	
	03:01	03:06		47.5	39.8	50.8	53.6	57.0	
9	03:20	03:35	15	44.4	33.4	48.2	51.2	55.8	A64 & distant industrial noise
8	03:45	04:00	15	41.4	36.4	44.4	47.8	51.7	A64 & distant industrial noise
7	04:10	04:15	05	45.9	40.6	48.6	52.4	58.9	A64 & distant industrial noise
	04:15	04:20		46.8	43.2	48.8	51.8	66.9	
	04:20	04:25		47.2	40.6	50.6	53.6	62.6	
4	04:40	04:45	05	59.9	41.6	58.2	72.2	79.1	Hull Rd, A64, plant
	04:45	04:50		54.6	41.8	57.0	67.0	72.0	Hull Rd, A64, plant (approx 84 vehicles per hour)
	04:50	05:00		46.3	42.0	48.2	53.4	58.1	Distant A64 and plant noise (Traffic on Hull Road paused out)
3a	05:10	05:15	05	48.5	45.0	50.6	52.8	55.1	Field Lane no cars
	05:15	05:20		51.7	43.2	48.4	67.2	70.8	Field Lane 1 car
	05:20	05:25		55.1	44.8	53.6	69.2	72.3	Field Lane 3 cars

Table B8 Night-time noise level measurement results (dB), 13 December 2007

B2.2 Unattended Measurements

Tables B9 to B12 give the measured results of the un-attended noise survey and are also shown in Figures 6 to 9. Measurement locations are as shown in Figure 1. All values are presented as free-field sound pressure levels. All results have been rounded to the nearest whole dB, with 0.5 being rounded up.

Start	End	L_{Aeq}	L_{A90}	L_{A10}	$L_{Amax,F}$
07:00	08:00	55	52-55	54-57	66
08:00	09:00	57	54-57	56-59	82
09:00	10:00	56	52-56	57-58	88
10:00	11:00	54	50-53	54-56	73
11:00	12:00	54	50-53	53-55	85
12:00	13:00	50	45-50	47-56	74
13:00	14:00	48	41-47	43-54	74*
14:00	15:00	54	43-52	45-66	81
15:00	16:00	53	51-53	53-57	79
16:00	17:00	55	50-55	52-60	79
17:00	18:00	57	52-58	55-62	75
18:00	19:00	51	49-51	51-54	59
19:00	20:00	49	46-50	49-52	54
20:00	21:00	47	43-46	47-51	60
21:00	22:00	47	41-46	47-50	55
22:00	23:00	47	41-46	46-51	58
53.3 dB $L_{Aeq,16h}$					
23:00	00:00	47	37-45	46-54	57
00:00	01:00	46	29-44	44-51	64
01:00	02:00	42	28-37	42-49	54
02:00	03:00	40	24-38	36-46	56
03:00	04:00	41	24-35	42-48	55
04:00	05:00	44	33-41	45-49	55
05:00	06:00	46	38-45	46-49	54
06:00	07:00	50	44-51	48-54	56
45.6 dB $L_{Aeq,8h}$					

Table B9 Summary of noise logger measurement results (dB) for Position 1, 11 - 12 December 2007, Kit B

* L_{Amax} noise level attributed to distant bird scarer.

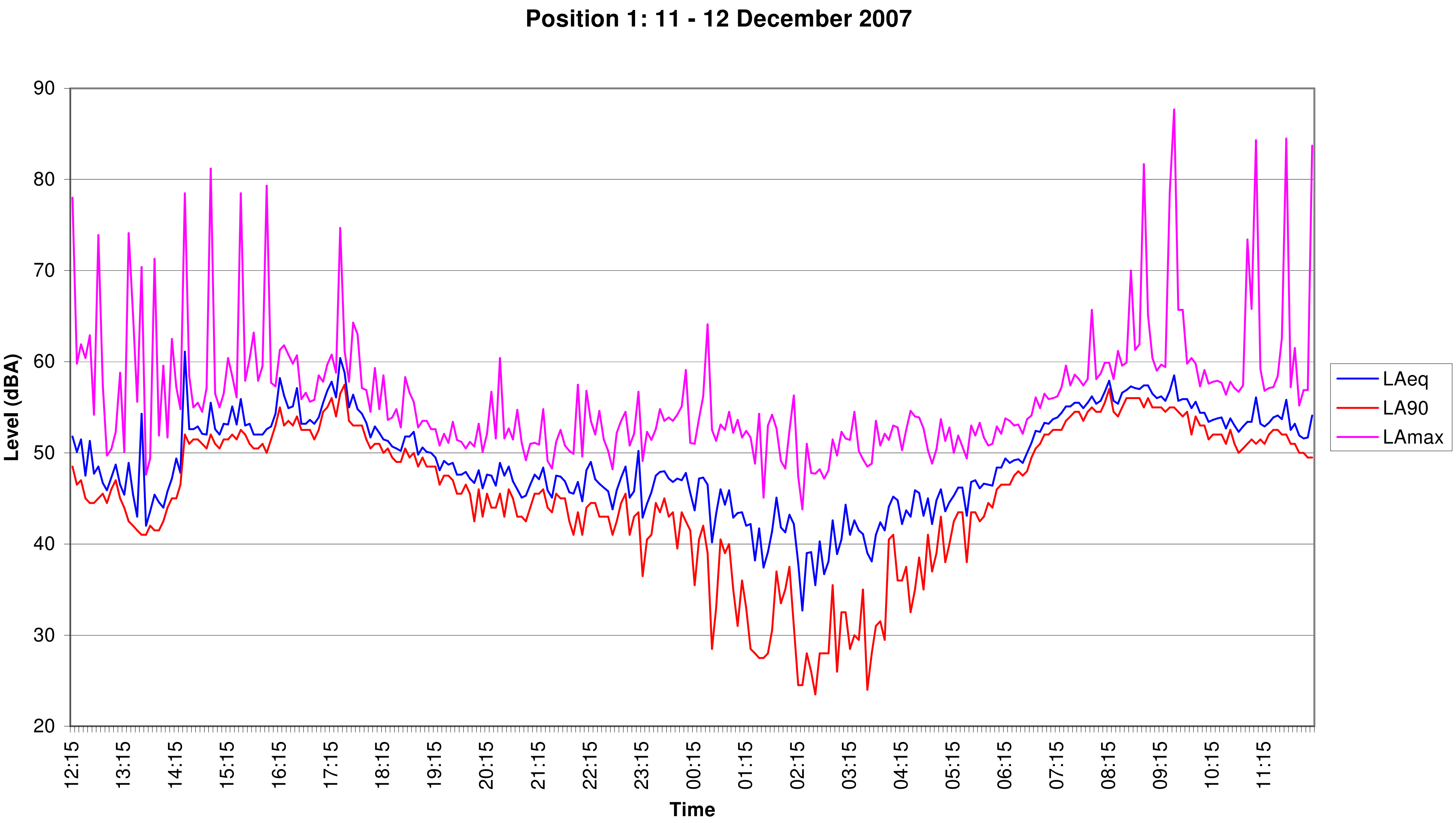

Figure 6 Summary of noise logger measurement results (dB) for Position 1

Start	End	L_{Aeq}	L_{A90}	L_{A10}	$L_{Amax,F}$
07:00	08:00	56	52-55	54-56	85
08:00	09:00	56	54-56	56-58	76
09:00	10:00	55	53-54	55-57	76
10:00	11:00	55	53-54	55-58	69
11:00	12:00	53	51-53	53-56	76
12:00	13:00	55	52-53	55-59	81
13:00	14:00	54	51-54	53-56	76
14:00	15:00	55	52-54	54-57	78
15:00	16:00	55	53-54	55-57	76
16:00	17:00	55	53-55	55-57	75
17:00	18:00	57	54-55	56-61	76*
18:00	19:00	54	52-54	54-56	63
19:00	20:00	52	49-52	52-54	68
20:00	21:00	49	47-49	49-52	59
21:00	22:00	48	45-48	48-52	59
22:00	23:00	47	44-47	47-50	60
		54.1 dB $L_{Aeq,16h}$			
23:00	00:00	45	39-44	45-50	61
00:00	01:00	42	35-41	40-46	57
01:00	02:00	41	36-40	39-44	54
02:00	03:00	41	35-39	40-46	55
03:00	04:00	41	34-41	41-46	52
04:00	05:00	43	37-42	43-47	58
05:00	06:00	46	41-46	45-50	56
06:00	07:00	50	45-52	49-53	56
		45.0 dB $L_{Aeq,8h}$			

Table B10 Summary of noise logger measurement results (dB) for Position 2, 12 – 13 December 2007, Kit B

L_{Amax} noise level attributed to high flying military aircraft

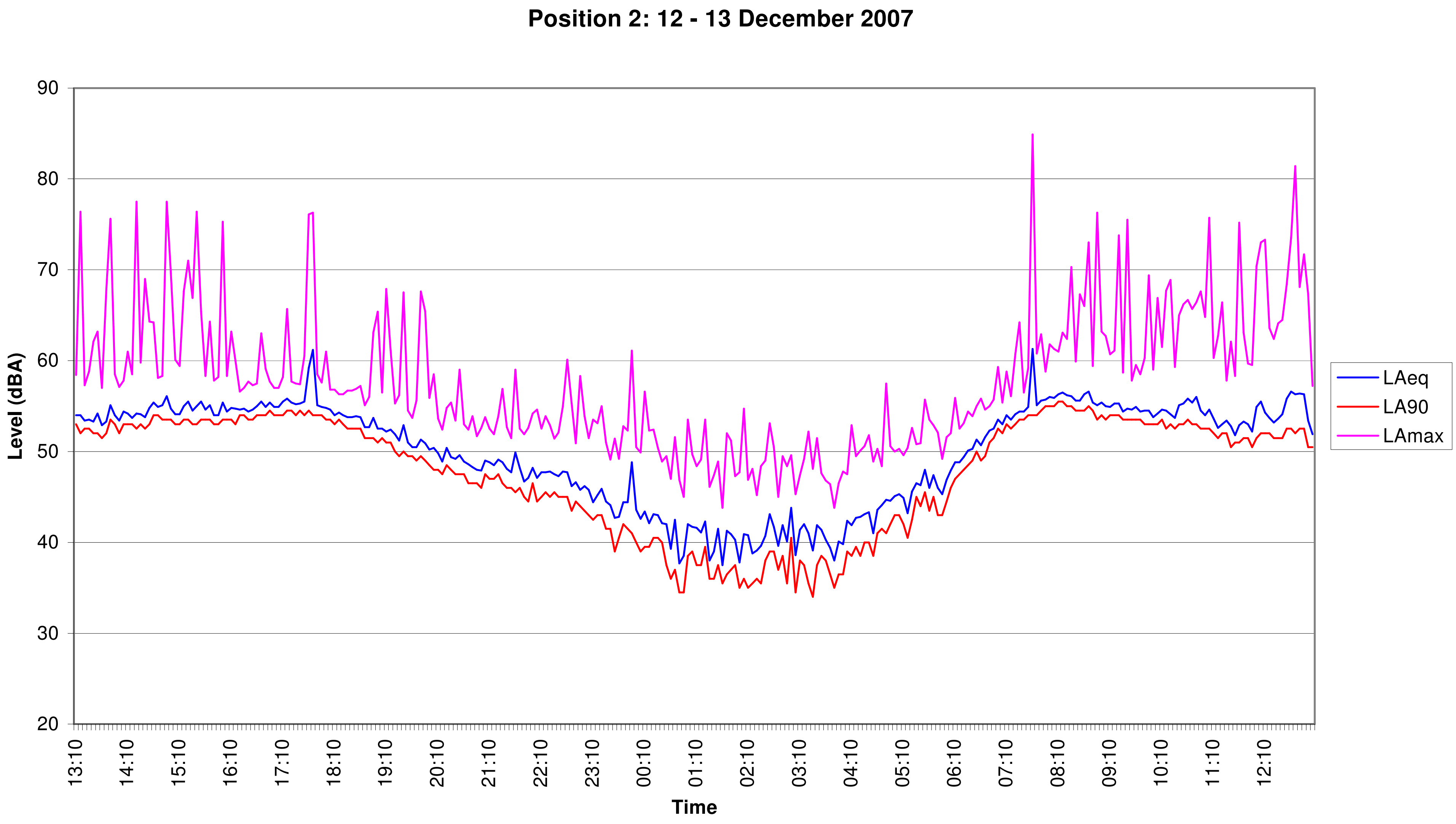

Figure 7 Summary of noise logger measurement results (dB) for Position 2

Start	End	L_{Aeq}	L_{A90}	L_{A10}	L_{A1}	$L_{Amax,F}$
07:00	08:00	66	55-60	68-72	72-76	80
08:00	09:00	68	60-65	67-72	72-76	81
09:00	10:00	67	60-62	65-72	71-77	85
10:00	11:00	66	56-60	70-72	73-78	83
11:00	12:00	67	59-62	70-72	73-79	86
12:00	13:00	67	57-63	71-73	73-76	82
13:00	14:00	67	56-60	70-72	73-76	83
14:00	15:00	67	59-62	68-72	71-77	82
15:00	16:00	68	59-63	71-73	74-77	81
16:00	17:00	68	55-61	71-73	74-75	84
17:00	18:00	68	57-62	72-72	74-75	84
18:00	19:00	66	53-59	70-72	73-77	80
19:00	20:00	65	50-56	69-71	73-76	78
20:00	21:00	63	47-50	59-69	69-76	87
21:00	22:00	62	46-50	63-70	71-74	78
22:00	23:00	60	45-49	58-66	71-73	87
			66.4 dB $L_{Aeq,16h}$			
23:00	00:00	59	43-48	50-64	53-79	88
00:00	01:00	56	41-46	47-58	52-71	88
01:00	02:00	48	40-43	45-51	47-67	73
02:00	03:00	50	40-43	45-49	49-69	76
03:00	04:00	49	39-43	45-52	48-72	81
04:00	05:00	49	42-46	47-51	49-69	76
05:00	06:00	55	43-48	49-60	50-72	80
06:00	07:00	61	48-54	55-68	70-75	86
			55.7 dB $L_{Aeq,8h}$			

Table B11 Summary of noise logger measurement results (dB) for Position 3, 11 – 12 December 2007, Kit C

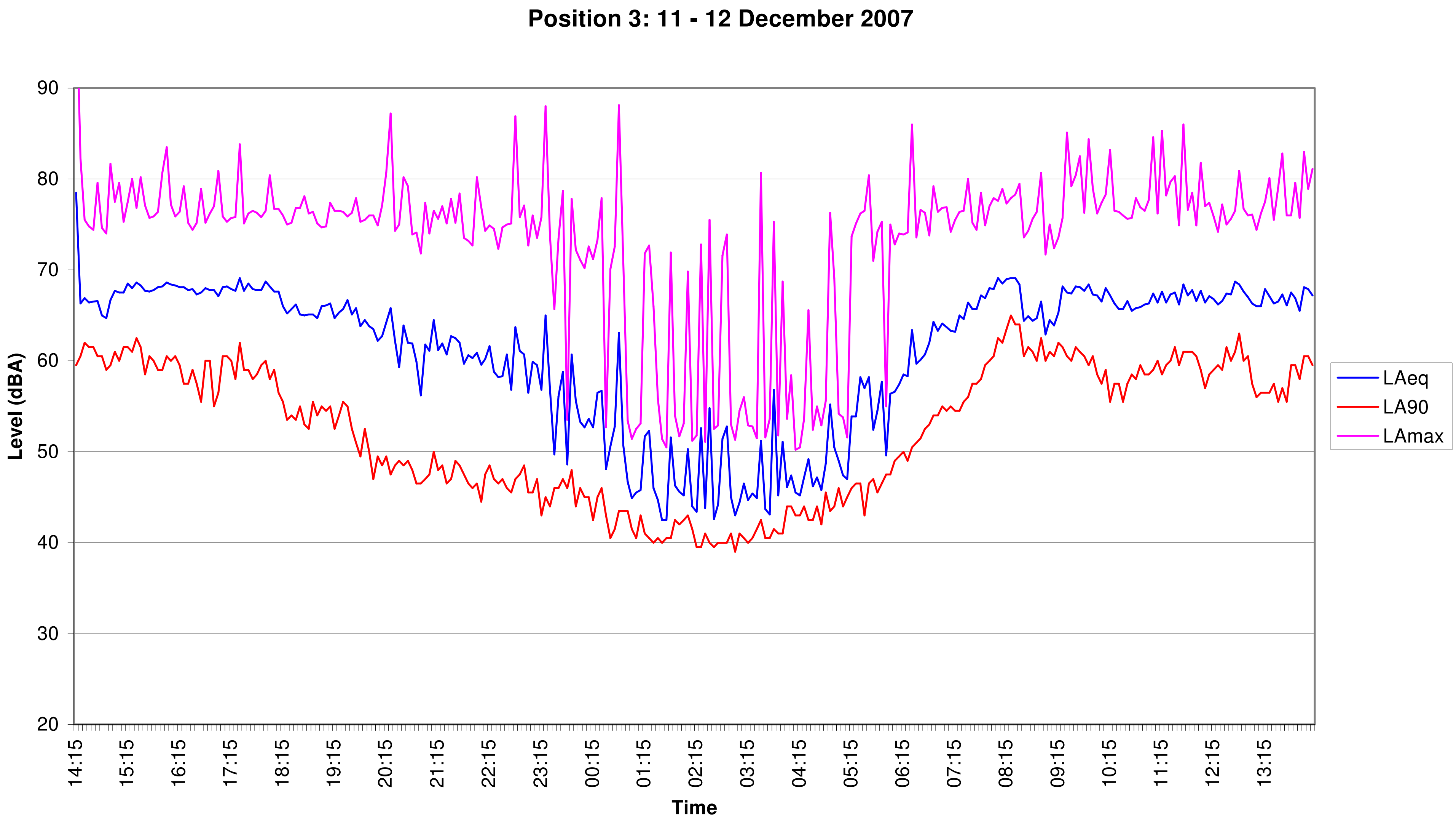

Figure 8 Summary of noise logger measurement results (dB) for Position 3

Start	End	L_{Aeq}	L_{A90}	L_{A10}	L_{A1}	$L_{Amax,F}$
07:00	08:00	68	65-68	68-70	69-72	76
08:00	09:00	68	66-68	69-70	70-71	72
09:00	10:00	66	62-67	65-69	66-70	71
10:00	11:00	63	61-64	64-66	65-67	68
11:00	12:00	64	60-63	64-66	65-67	70
12:00	13:00	64	61-64	64-67	66-69	70
13:00	14:00	64	62-64	65-67	66-68	69
14:00	15:00	66	64-66	66-68	67-73	82
15:00	16:00	67	65-66	68-69	69-70	71
16:00	17:00	68	66-67	69-70	70-71	72
17:00	18:00	68	66-67	69-70	69-74	77*
18:00	19:00	66	64-66	67-69	68-70	71
19:00	20:00	65	62-64	66-67	67-68	70
20:00	21:00	64	58-62	64-67	65-68	70
21:00	22:00	62	56-61	63-66	65-67	68
22:00	23:00	61	52-59	62-64	64-66	67
65.8 dB $L_{Aeq,16h}$						
23:00	00:00	59	48-56	58-64	60-66	67
00:00	01:00	54	31-50	50-61	53-65	66
01:00	02:00	53	33-48	52-60	57-63	66
02:00	03:00	53	32-44	53-60	56-64	65
03:00	04:00	54	32-42	55-62	58-64	65
04:00	05:00	56	38-50	57-62	59-64	66
05:00	06:00	60	42-57	59-64	61-66	67
06:00	07:00	64	59-64	65-68	66-69	70
58.6 dB $L_{Aeq,8h}$						

Table B12 Summary of noise logger measurement results (dB) for Position 5, 12 – 13 December 2007, Kit C

* L_{Amax} noise level attributed to high flying military aircraft

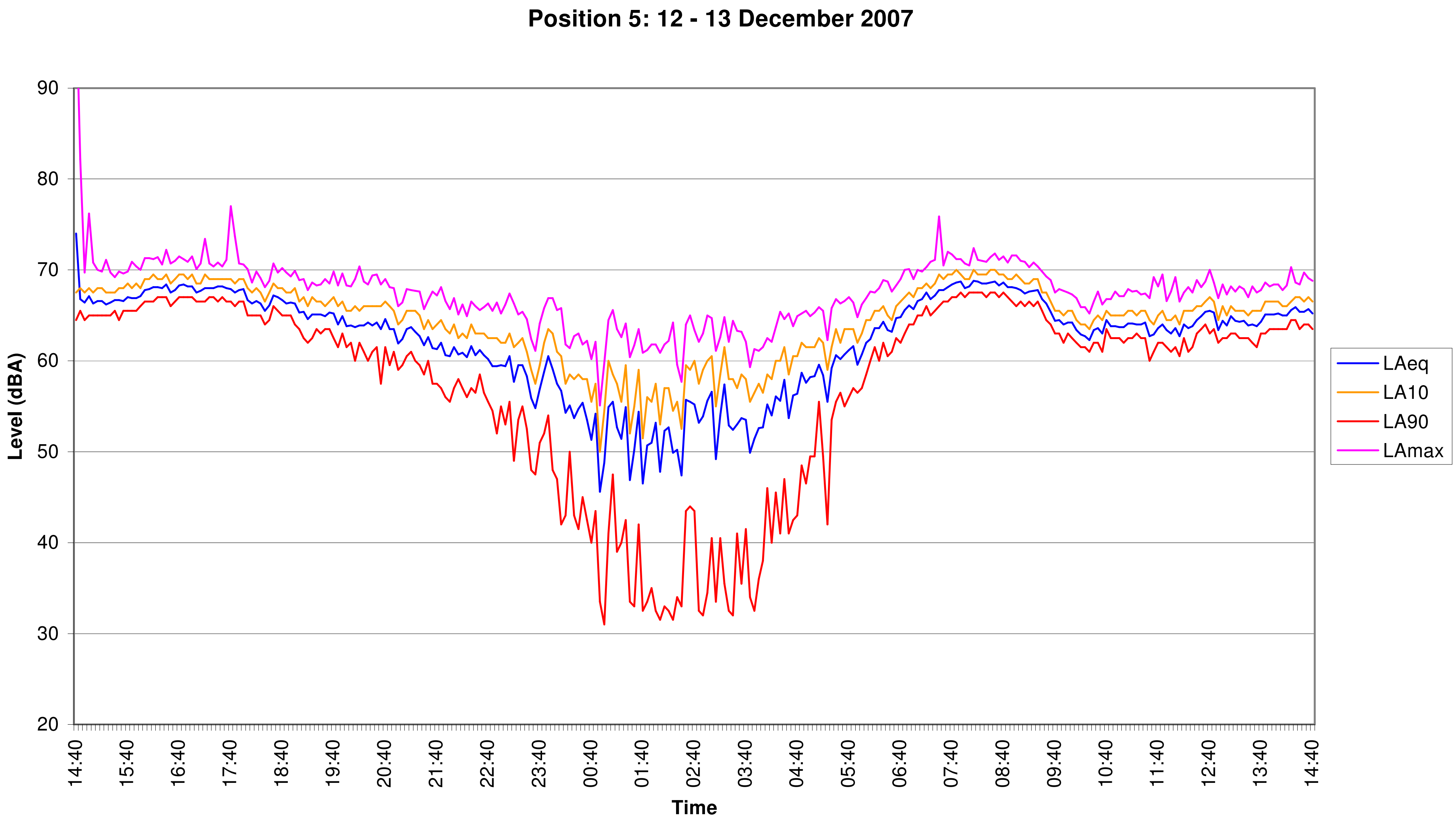

Figure 9 Summary of noise logger measurement results (dB) for Position 5

B3 Noise Map Results

Scenario		Empty site including Lake		Cluster 1 including Lake	
Period		Day	Night	Day	Night
Parameter		$L_{Aeq,16h}$	$L_{Aeq,8h}$	$L_{Aeq,16h}$	$L_{Aeq,8h}$
Meas. position	Location				
6	SE corner of Cluster 1	61.3	52.3	61.2	52.2
7	SW corner of Cluster 1	59.7	50.7	59.5	50.5
8	NW corner of Cluster 1	59.3	50.3	56.5	47.5
9	NE corner of Cluster 1	60.2	51.2	59.1	50.1

Table B13 July Weekday Predicted Results (dB) at 7m above ground (free-field)