Kyoto energypark

Appendix D

Noise Assessment
Wilkinson Murray
(August 2008)

pamada

KYOTO ENERGY PARK, SCONE

NOISE ASSESSMENT

ACOUSTICS AND AIR

REPORT NO. 07038
VERSION C

WILKINSON MURRAY

KYOTO ENERGY PARK, SCONE

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AUGUST 2008

PREPARED FOR

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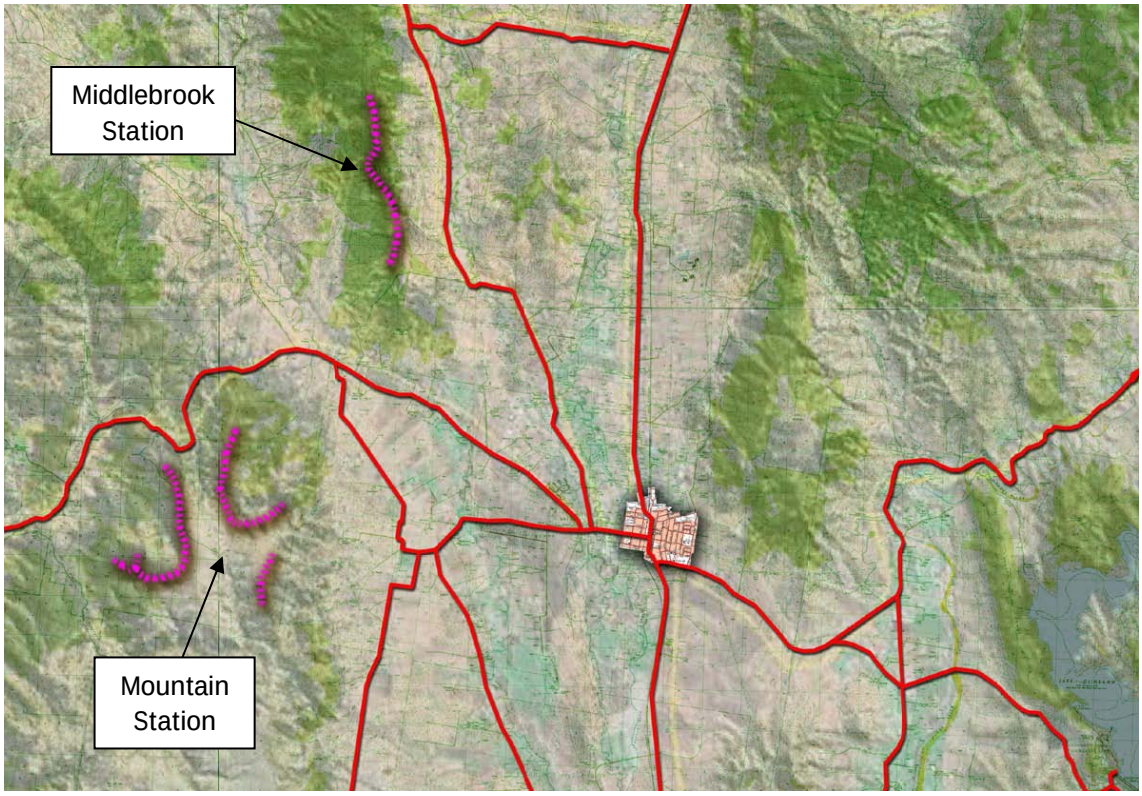
1 INTRODUCTION

Pamada Pty Ltd proposes to develop an Energy Park (an eco-generating power station that generates electricity from renewable sources such as the wind, water and the sun) near Scone in the Upper Hunter Valley. Wilkinson Murray has been asked to carry out a noise assessment of the Energy Park and in particular the 42 turbine wind farm component along the ridge line of The Great Dividing Range. The Kyoto Energy Park is proposed on two separate properties known as "Middlebrook Station" (11 turbines) and "Mountain Station" (31 turbines) to the west of Scone and east of Bunnan as shown in Figure 1-1. In addition, there are mini hydro and solar energy components, although the noise impact from these is considered to be minor and insignificant in comparison to the wind turbines.

Figure 1-1 General Area Plan showing Turbine Locations



The sites are currently used primarily for agricultural activities. Other activities located on site are as follows:

1.1 Middlebrook and Mountain Station

- Clifford Quarries Pty Ltd – existing gravel and road base quarry. No washing facilities, Plant is for dry processing only
- Sheep Grazing – existing over Middlebrook and Mountain stations
- Residencies/homestead – several homesteads located on Middlebrook station and leased to third party. Landowners homestead is referred to as Middlebrook Station, off Middlebrook road
- Grassed Private Airstrip –located adjacent to the Middlebrook Station homestead and used solely by the landowner. A second airstrip is located on Mt Moobi Plateau, Mountain Station
- Tourist accommodation – situated on Middlebrook property 'Middlebrook Station Tourist Accommodation' facilities. Tourists activities included shearing demonstrations, a functions hall, site tours and visits to Mt Moobi Plateau lookout (located on Mountain Station at location of proposed Visitors and Education Centre)
- Shearing Sheds - located at current entrance to Mountain Station off Bunnan Road

The project is situated on two separate landholdings of 2032ha and 2013ha in total area. Only a small fraction of the two landholdings will be used for the Kyoto Energy Park proposal. All existing grazing, agricultural, tourism, residential and private aviation uses will continue unaffected on the station properties. The grassed airstrip on Mt Moobi (Mountain Station) would be displaced by the inclusion of the Solar PV Plant. A more detailed location map showing the location of the Energy Park and surrounds is shown in Figures 3-1 and 3-2.

The following list of facilities includes all components of the Kyoto Energy Park:

- 1 x 3-10 MW Solar Photovoltaic (PV) Plant
- 1 x 1MW Closed loop hydro-electric Plant
- 42 x 2.0-3.0MW Wind Turbine Generators
- Installation of 33KV underground cables
- 1 x 100MVA 66/33kV site substation, switchyard and control room
- Construction of overhead 66,000 volt transmission line to connection point on grid network
- Construction of a 10m x 30m Maintenance building
- Construction of a Manager's residence
- Construction of a Visitor's and Education Centre
- 5 m wide access tracks and hardstand areas

The construction of the above components and facilities of the Energy Park will be completed in a single stage of approximately 20 months duration for all works.

The operational phase of the development is for a working life of 30 years based on typical lifecycle of wind turbine generators.

There are no specific guidelines relating to the noise assessment of wind farms prepared by the NSW Government. However, the guidelines for assessment of noise from industrial facilities are managed within the NSW Department of Environment & Climate Change (DECC) *Industrial Noise Policy (INP).* This policy provides useful information regarding the appropriate procedures for measurement and assessment of noise, particularly how to deal with meteorological conditions.

In addition, the DECC adopt the Government of South Australia (SA) approach which has guidelines specifically related to wind farm noise "Wind Farms Environmental Noise Guidelines" dated February 2003. Although there has been an update to the SA guidelines in December 2007, these have not been adopted by the DECC so are not addressed.

In addition, an Australian Standard (EV16) relating to wind farm noise is currently in its draft status and this document has also been considered in refining the noise assessment process.

The assessment of noise from wind farms requires more detailed consideration than other "industrial" noise since noise levels are a function of wind speed and direction. Given wind speeds are relatively high, some consideration is also given to the simultaneous increase in background noise levels when the wind farm is operating. This consideration is adopted in both the South Australian and Australian Standards.

There is also a requirement to consider the "Van den Berg effect" which relates to atmospheric stability differences during the day and night and effects on noise impact, particularly at night time. This assessment, in addition to following the procedure outlined in the guidelines has also split background noise level data collected and undertaken noise predictions into day and night time periods.

In addition to the noise generated by the proposed wind farm turbines, this assessment also considers the ancillary equipment associated with the Kyoto Energy Park including site substation, solar PV Plant and the closed loop mini-hydro facility.

Works external to the site include provision of overhead 66kV transmission line to a connection point on the national Electricity Grid, assumed to be to the south of Scone approximately 12km from Mountain Station.

Traffic generation during construction and operational phases of the project has been considered in relation to the NSW Department of Environment & Climate Change (DECC), *Environmental Criteria for Road Traffic Noise (ECRTN)*.

Construction noise is also addressed in accordance with requirements of the DECC *Environmental Noise Management Manual (ENMM)*.

2 PROPOSED TURBINE DETAILS

The proposed location of the wind turbines, elevation at the base and hub height are summarised in Table 2-1.

Table 2-1 Turbine Locations

Turbine No.	Site	Easting (MGA56)	Northing (MGA56)	Base RL	Hub Height (m)
1	Mountain	286224	6453348	595	105
2	Mountain	286402	6453127	590	105
3	Mountain	286478	6452751	540	105
4	Mountain	286519	6452178	590	105
5	Mountain	286572	6451894	605	105
6	Mountain	286626	6451623	600	105
7	Mountain	286680	6451371	600	105
8	Mountain	286812	6451147	610	105
9	Mountain	286448	6450691	540	105
10	Mountain	286238	6450474	550	105
11	Mountain	285816	6450526	545	105
12	Mountain	285503	6450795	580	105
13	Mountain	284850	6450926	520	105
14	Mountain	285457	6451110	520	105
15	Mountain	287781	6454157	580	105
16	Mountain	287677	6453681	580	105
17	Mountain	287609	6453404	600	105
18	Mountain	287631	6453118	630	105
19	Mountain	287533	6452826	620	105
20	Mountain	287752	6452556	630	105
21	Mountain	287794	6452227	620	105
22	Mountain	287691	6451888	580	105
23	Mountain	288029	6452006	585	105
24	Mountain	288473	6452152	540	105
25	Mountain	289076	6452496	580	105
26	Mountain	289049	6452173	570	105
27	Mountain	288481	6450063	620	105
28	Mountain	288481	6450372	620	105
29	Mountain	288570	6450660	620	105
30	Mountain	288740	6450912	620	105
31	Mountain	288871	6451094	620	105
32	Middlebrook	291744	6458695	380	105
33	Middlebrook	291995	6459234	390	105
34	Middlebrook	291886	6459881	430	105
35	Middlebrook	291789	6460220	470	105

Turbine No.	Site	Easting (MGA56)	Northing (MGA56)	Base RL	Hub Height (m)
36	Middlebrook	291571	6460556	520	105
37	Middlebrook	291073	6461007	560	105
38	Middlebrook	290602	6460957	540	105
39	Middlebrook	291383	6461298	590	105
40	Middlebrook	291458	6461645	600	105
41	Middlebrook	291360	6462019	590	105
42	Middlebrook	291306	6462464	600	105

The turbine that is proposed to be used (on which the noise assessment has been conducted) is the Suzlon Energy A/S S88-2.1 MW, V3 turbines which have a maximum sound power level of 104.3dBA. In accordance with IEC 61400-11, these turbines are not defined as tonal at rated power.

The noise level generation for this turbine at the integer wind speeds above cut-in (approximately 4m/s) are summarised in Table 2-2, based on manufacturer's data for the V3 blade.

Table 2-2 Turbine SWL with Wind Speed

Hub Height Wind Speed (m/s)	Sound Power Level (dBA)
4.2	100.4
5.6	101.5
7.0	102.4
8.4	103.0
9.7	103.7
11.1	104.3
12.5	103.6

Should other turbine manufacturers be considered (Vestas, GE or RePower) noise levels will not be higher than those modelled in this assessment. The typical octave band spectrum shape for the operation of the wind turbine is summarised in Table 2-3.

Table 2-3 Turbine Octave Band Spectrum

Octave Band Centre Frequency (Hz) (dB)							
63	125	250	500	1K	2K	4K	8K
86	98	103	102	99	97	91	78

3 SURROUNDING RESIDENTIAL RECEIVERS

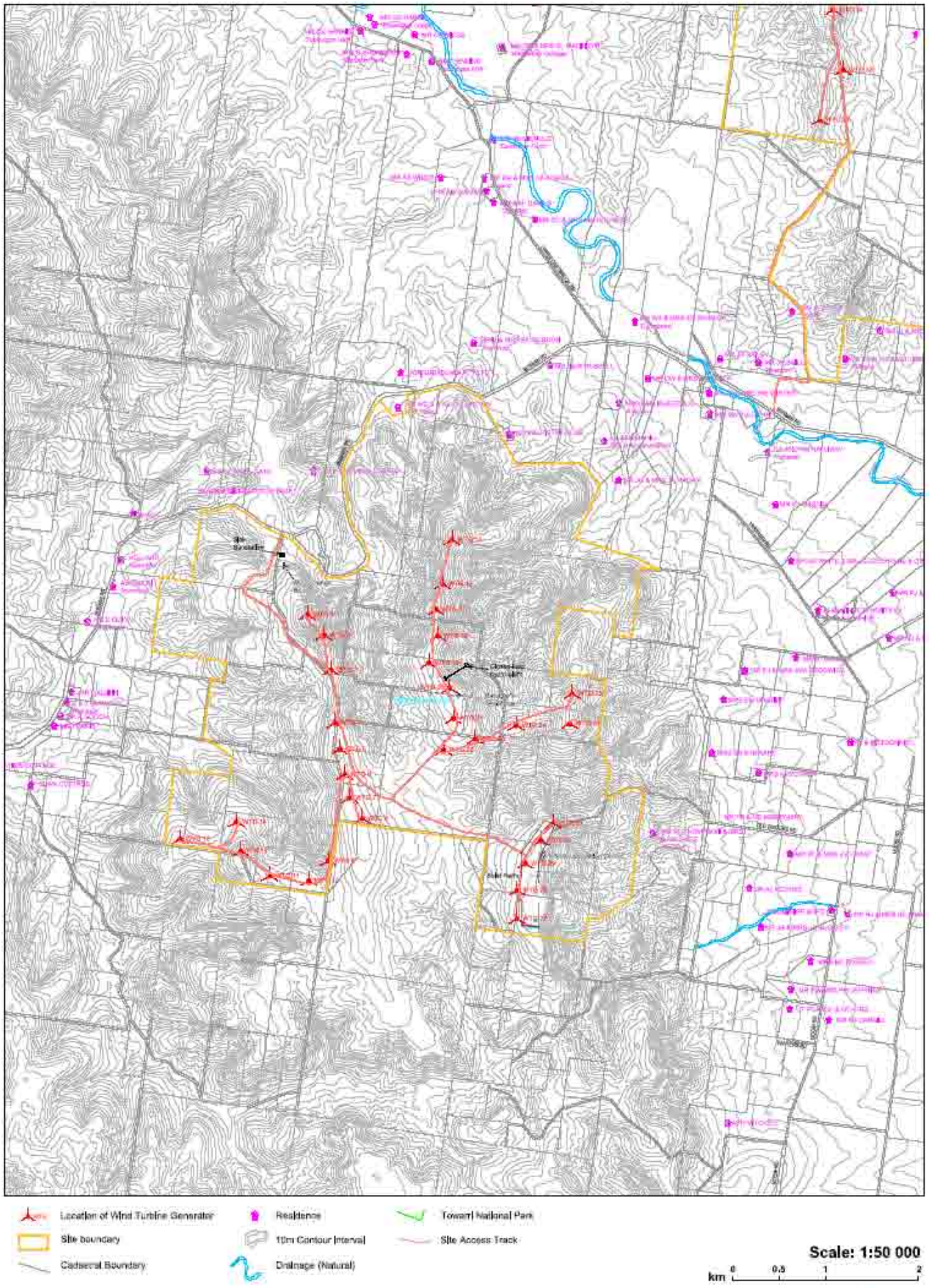
Based on a review by Pamada of local mapping, Council GIS data, aerial photographs and a fly over of the area a total of approximately 80 residences were identified within 4km of the turbines. These are identified on Figures 3-1 and 3-2 shown overleaf.

Of these residences eight belong to the landowner/s of the properties on which the wind farm is proposed to be developed. We understand that the noise level results from this report will be provided to the landowner such that they will be aware of the likely noise impacts and can make an informed decision as part of the landowner's agreement.

These are summarised as follows:

- Middlebrook Station
- Middlebrook Accommodation
- The Glen
- Old Middlebrook House
- Clairmont
- Dairy Cottage
- Benham
- White Cottage

Residences are located to the east, north and west of Mountain Station and all are more than 1km from the majority of turbines. Residences are located to the north, east, south and west of Middlebrook Station and are all more than 1km from the majority of turbines. Due to the elevation of the turbines on the various ridge lines the nearest turbines would be in line of sight to the residences.



KYOTO ENERGY PARK SCONE | **Figure 3-1 Surrounding Residences - Mountain Station** | pamada

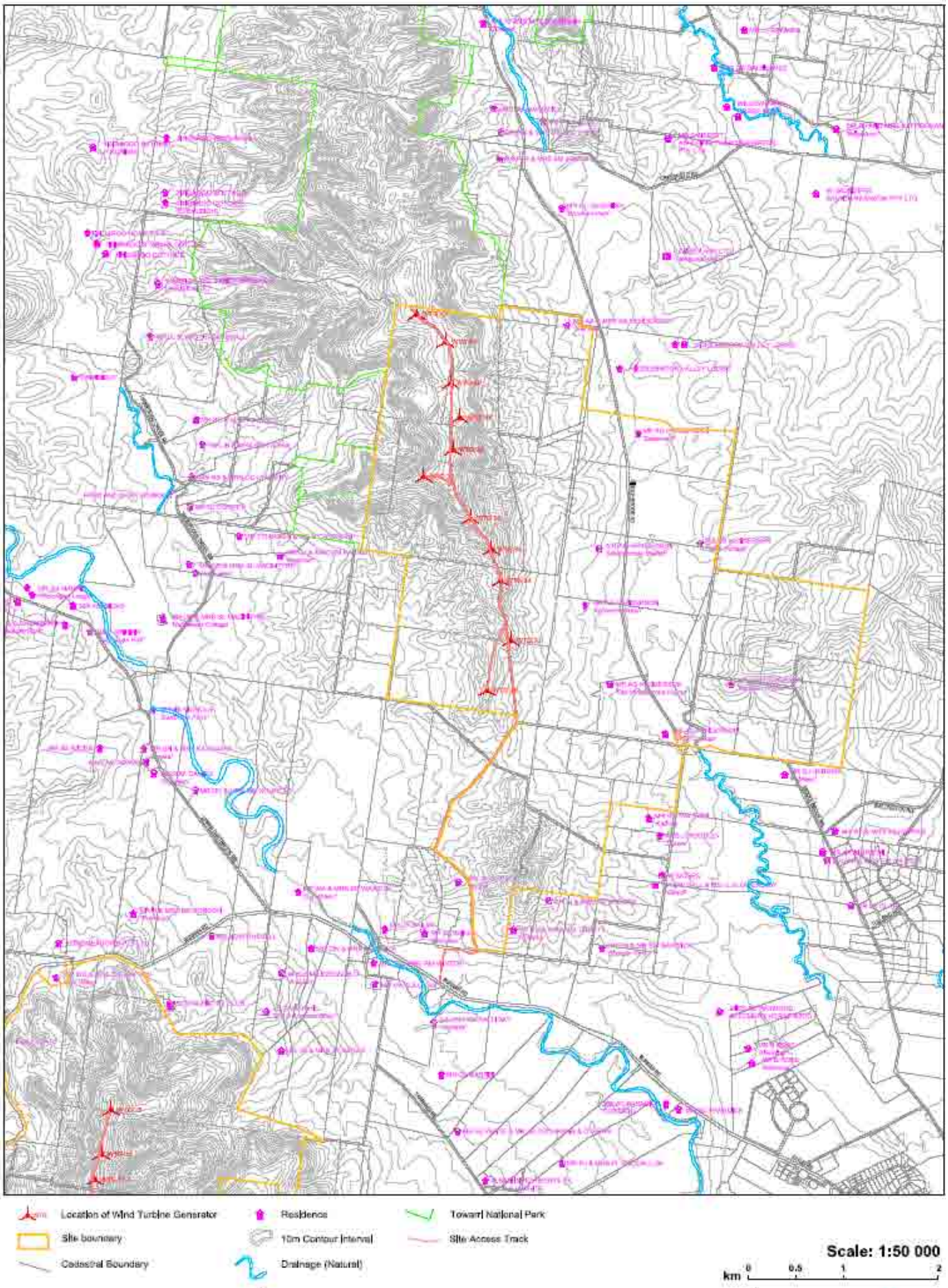


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Figure 3-2 Surrounding Residences - Middlebrook Station

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4 AMBIENT NOISE SURVEY

In order to assess the potential impacts from the wind farm it is essential to know the relationship between background noise levels at the residences and the wind speed at Hub Height (HH) at the proposed wind farm. There is a requirement to obtain background noise levels at a representative sample of surrounding residences. In addition data was obtained at two different times of year to confirm if there were significant differences between seasons.

Ten residential locations in total were chosen surrounding the Middlebrook Station and Mountain Station property boundaries to conduct background noise measurements and are summarised as follows: The SA Windfarm Guidelines suggest a distance of 20m from the residence should be used whilst the NSW INP adopts 30m. Irrespective of these nominated distances the purpose of measurements is to find the quietest location in the immediate environs of the residence which is removed from any extraneous noise such as air conditioning, swimming pool pumps and in the case of rural properties vegetation which may lead to elevated noise levels not representative of all areas near the residence. The distances from the residence are included in the description below and are consistent with the intention of the Guidelines or in some cases may have conservatively lower noise levels.

- Middlebrook Station (292923, 6460199). This is one of the Landowners properties located to the northeast from Mountain Station turbines and east from Middlebrook Station turbines. This is representative of properties along Middlebrook Road. The Turbines range from 1km to 12.2km from this residence. The logger was located next to a fence approximately 80m to the north of the residential house. The location for the logger was chosen to avoid extraneous noise from farm equipment. This site was used for both surveys.

- Peakhill (289943, 6450952). Located to the east from Mountain Station turbines and south / southwest from Middlebrook Station turbines. This is representative of properties along Yarrandi Road and Moobi Road. The Turbines range from 1km to 11.9km from this residence. The logger was located near a fence in the garden approximately 30m to the east of the residential house. This site was used for both surveys.

- Greylands (283906, 6453309). Located to the west / northwest from Mountain Station turbines and southwest from Middlebrook Station turbines. This is representative of properties along the Bunnan Road west of Sophia Creek Road. The Turbines range from 2.3km to 11.8km from this residence. The logger was located in the middle of a tennis court approximately 30m south of the residential house.

- Lot 6, Clifton Hills Estate (286283, 6454892). Located to the north / northwest from Mountain Station turbines and southwest from Middlebrook Station turbines. This is an exisiting property within the Clifton Hills Estate. The Turbines range from 1.7 km to 9.1km from this residence. The logger was located in an open yard approximately 20m to the north east of the residential house. Other lots marginally closer are vacant.

- The Valley (287198, 6455552). Located to the north from Mountain Station turbines and southwest from Middlebrook Station turbines. This is representative of properties along the Bunnan Road east of Sophia Creek Road and west of Upper Dartbrook Road. The Turbines range from 1.4km to 8km from this residence. The logger was located near a fence approximately 50m to the south west of the residential house.

- Jingerah (289562, 6460118). Located to the north / northeast from Mountain Station turbines and west from Middlebrook Station turbines. This is representative of properties

along Thompson Creek Road and Upper Dartbrook Road. The Turbines range from 1.3km to 10.3km from this residence. The logger was located within the properties garden approximately 30m to the west of the residential house.

- Dunvagen (288769, 6461579). Located to the north / northeast from Mountain Station turbines and west / northwest from Middlebrook Station turbines. This is representative of properties along Thompsons Creek Road. The Turbines range from 1.9km to 11.5km from this residence. The logger was located in a fenced off area approximately 30m south of the residential house.

- Middlebrook Road - Adams (291879, 6464441). Located to the northeast from Mountain Station turbines and north from Middlebrook Station turbines. This is representative of properties along Middlebrook Road. The Turbines range from 1.9km to 15.2km from this residence. The logger was located in an open field approximately 120m to the west of the residential house. The location for the logger was chosen to obtain background noise levels that would not be excessively affected by tree noise.

- Airdrie (291493, 6456537). Located to the northeast from Mountain Station turbines and south from Middlebrook Station turbines. This is representative of properties north of Bunnan Road, east of Yarrandi Road and west of Middlebrook Drive. The Turbines range from 2.1km to 8.7km from this residence. The logger was located in an open section of a paddock approximately 80m to the west of the residential house. The location for the logger was chosen to obtain background noise levels that would not be excessively affected by tree noise or farm equipment.

- Bunnan Road - Hagan (289498, 6454728). Located to the northeast from Mountain Station turbines and southwest from Middlebrook Station turbines. This is representative of properties south of Bunnan Road and east of Yarrandi Road. The Turbines range from 1.7km to 8.2km from this residence. The logger was located next to a fence in an open paddock approximately 80 to the north of the residential house.

Two of the locations from the first round (Peakhill and Middlebrook) were repeated in the second measurement campaign.

The noise measurements took place between Monday, 21 May and Wednesday, 6 June 2007 and between Thursday, 20 September and Thursday, 4 October 2007 (to obtain the 2000 data points required). During this monitoring period, wind data was also obtained from the onsite masts and wind measurements were also conducted at one of the logger locations (Airdrie during the first round and Peakhill during the second round).

In accordance with the requirements of the wind farm guidelines the wind data was extrapolated (by Garrad Hassan using site wind shear coefficients) from heights of 35m, 45m and 65m to the hub height of 105m.

4.1 Noise Measurement Procedure

The noise monitoring equipment used for these measurements consisted of environmental noise loggers set to A-weighted, fast response, continuously monitoring over 10 minute sampling periods. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift occurred.

The logger determines L_{A1}, L_{A10}, L_{A90} and L_{Aeq} levels of the ambient noise. L_{A1}, L_{A10} and L_{A90} are the levels exceeded for 1%, 10% and 90% of the sample time respectively (see Appendix A for definitions). The L_{A1} is indicative of maximum noise levels due to individual noise events such as the occasional passby of a heavy vehicle. This is used for the assessment of sleep disturbance. The L_{A90} level is normally taken as the background noise level during the relevant period.

ARL Type 215 environmental noise loggers were used at all sites. These were fitted with the standard 90mm wind shields supplied by ARL (we believe these are manufactured by Rion). ARL state that the performance of these windshields is equivalent to the Bruel & Kjaer 90mm windshield where wind noise data on the microphone is available.

4.2 Noise Measurement Results

A graphical representation of the wind data plotted against time is shown for each of the receivers in Appendix B. Photos of the measurement sites are shown in Appendix C. The SA Wind farm Guidelines state they require approximately 2,000 samples. We confirm that the minimum number of samples collected ranged from 1,907 to 2,005 at the 10 receivers. This is considered to be sufficient data in order to plot the regression curves required by the SA Guideline. As required by the SA Guideline Figures 4-1 to 4-10 show the 24 hour background noise data plotted against hub height wind speed.

The data clearly shows the typical relationship between background noise levels and wind speed at all residences. With respect to rain, we have confirmed that there was only 6.0mm of rain during the 1st round of measurements and on this basis, no data was excluded.

A second order polynomial was considered the best fit to the data sets and these are shown on each graph. For more detailed assessment the data was also split into daytime/evening 7.00am to 10.00pm and night time 10.00pm to 7.00am periods.

The data in the first two figures (Figure 4-1 and Figure 4-2) can be used to see that there is little overall difference between the two sets of data points for the different seasons and the regression curves plotted.

Figure 4-1 Wind Speed vs. Background Noise Levels– Middlebrook

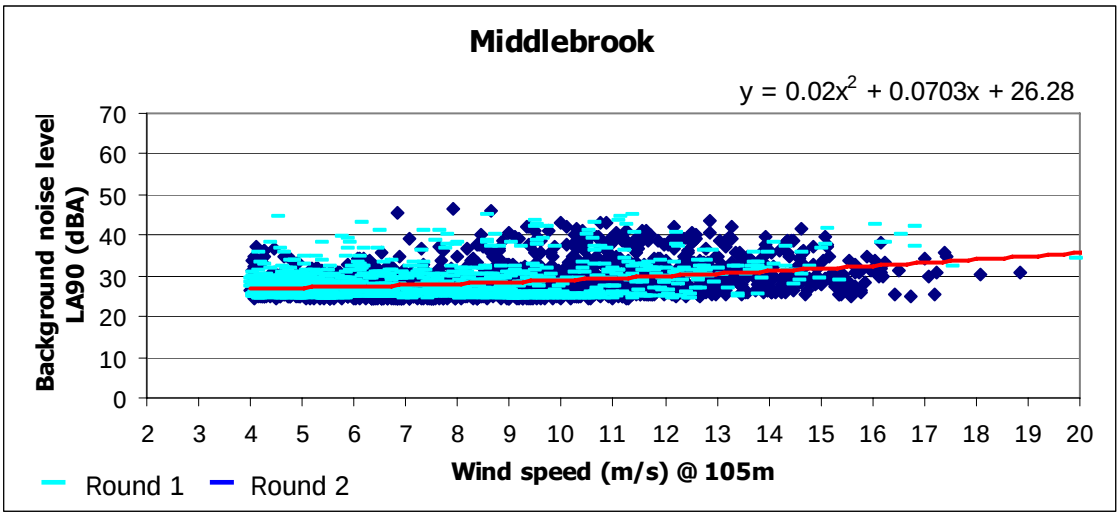


Figure 4-2 Wind Speed vs. Background Noise Levels– Peakhill

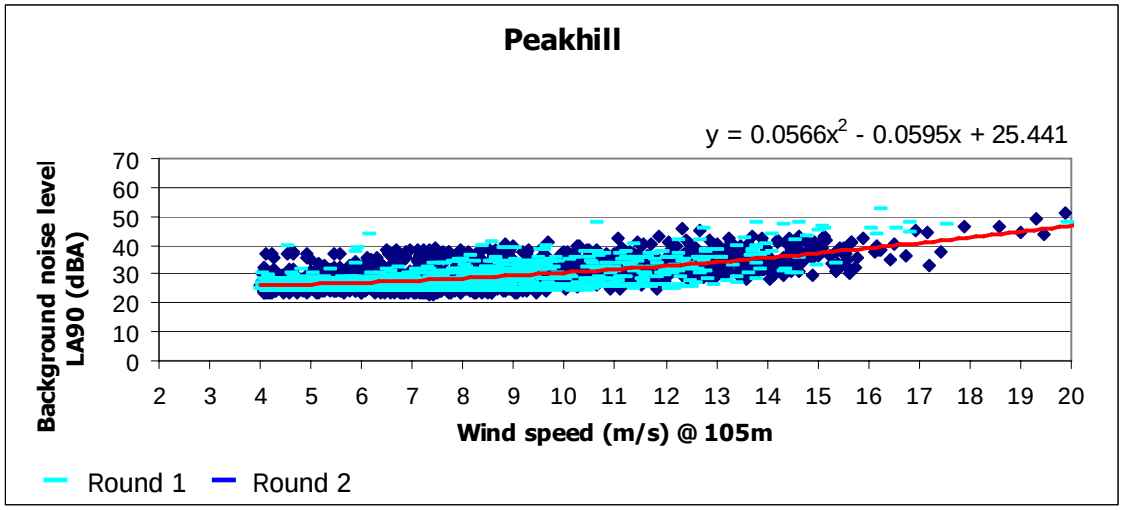


Figure 4-3 Wind Speed vs. Background Noise Levels– Greylands

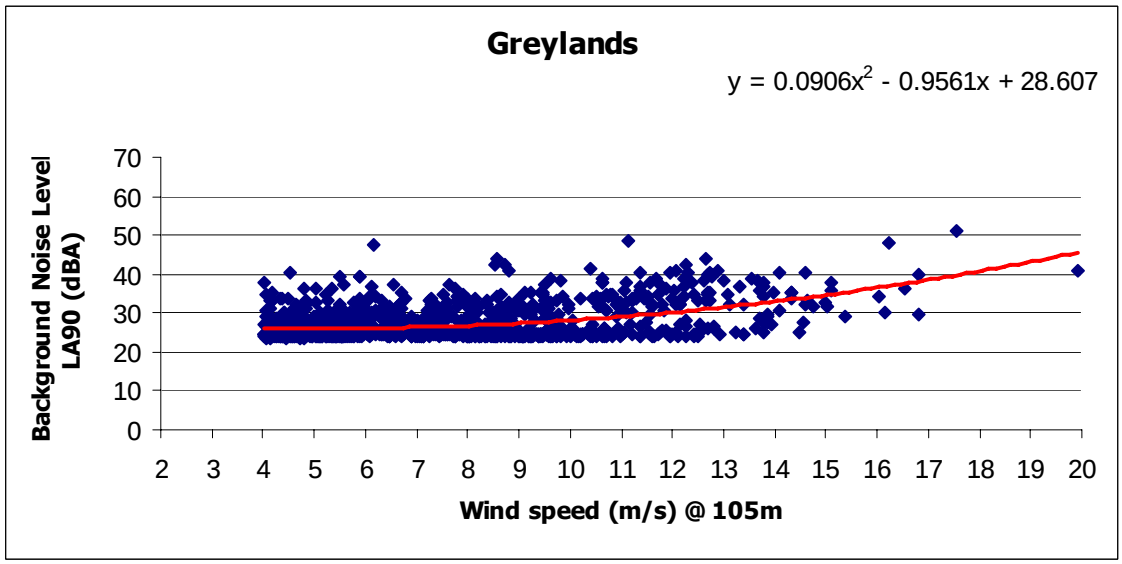


Figure 4-4 Wind Speed vs. Background Noise Levels– Clifton Hills Estate Lot 6

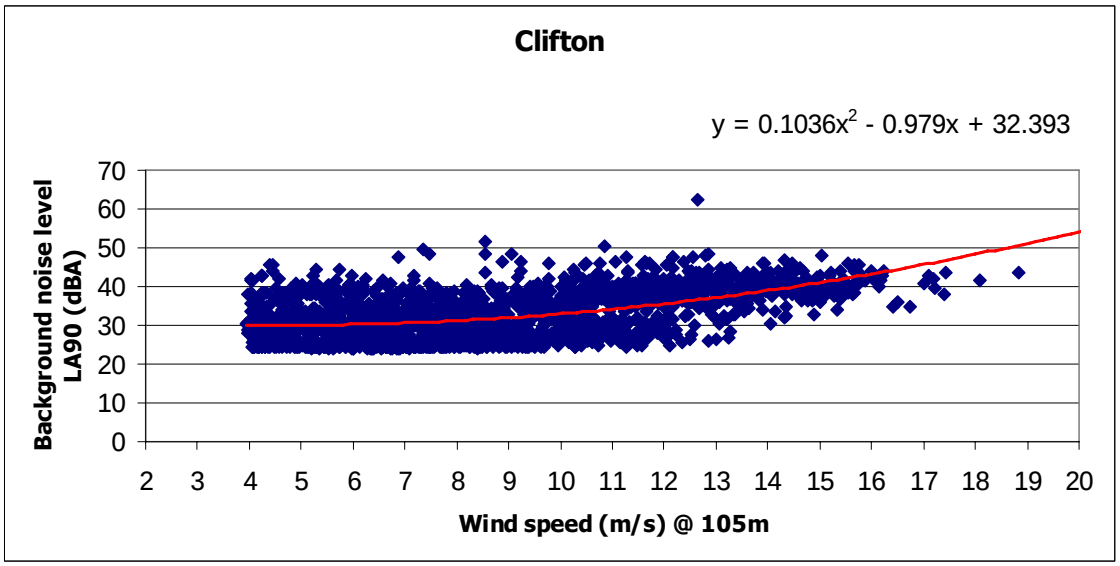


Figure 4-5 Wind Speed vs. Background Noise Levels– The Valley

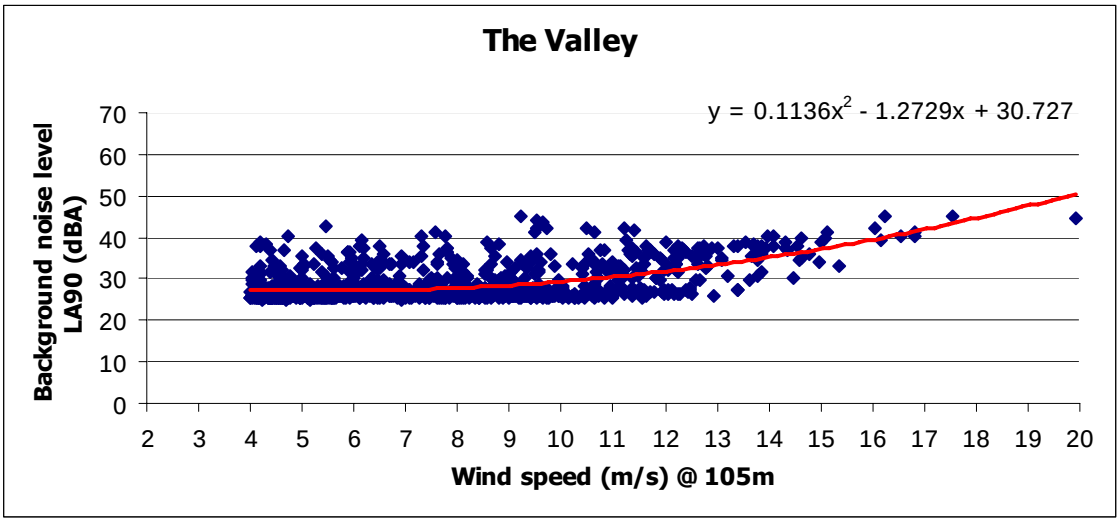


Figure 4-6 Wind Speed vs. Background Noise Levels- Jingerah

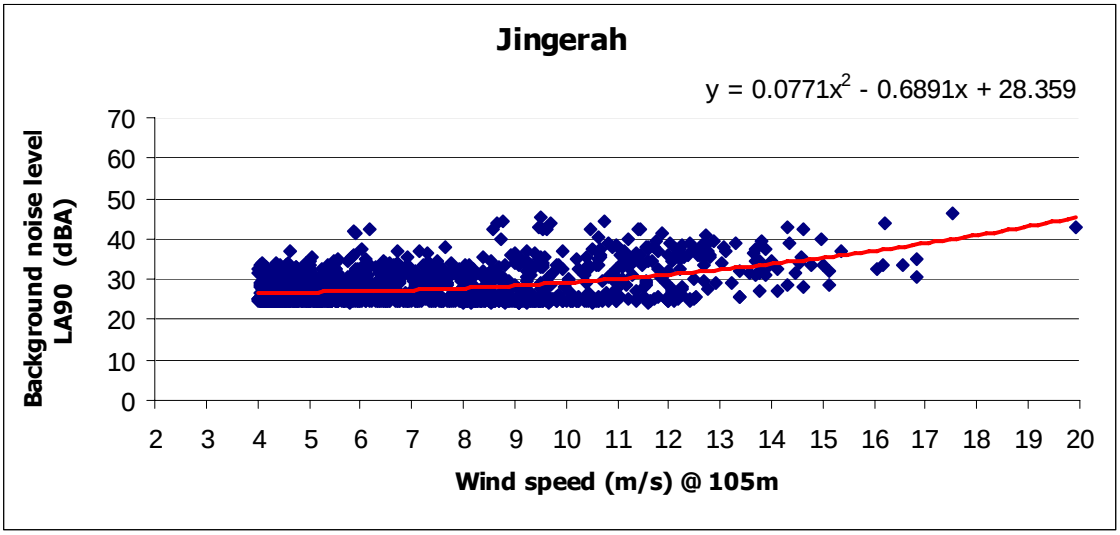


Figure 4-7 Wind Speed vs. Background Noise Levels– Dunvagen

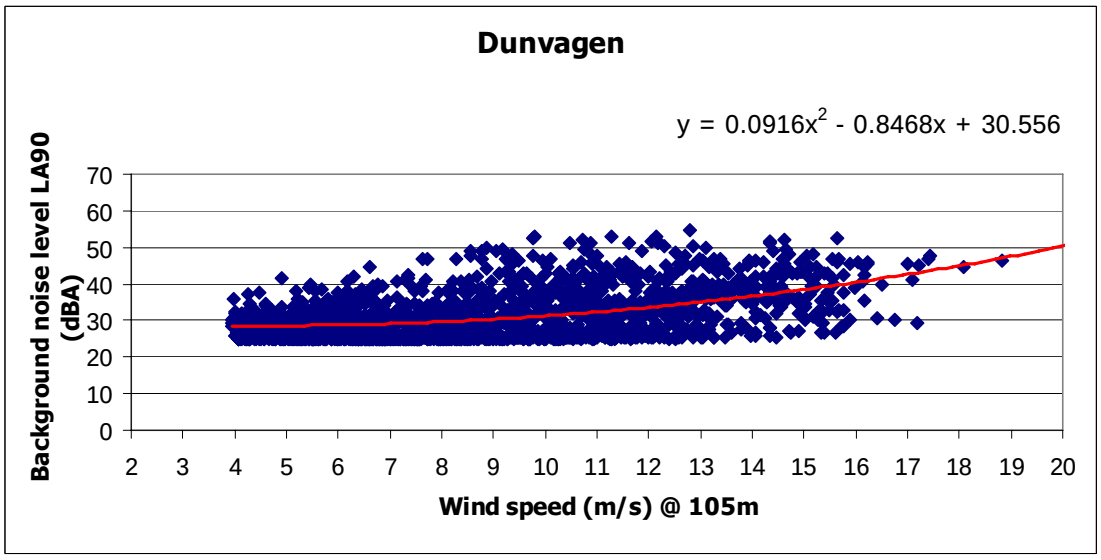


Figure 4-8 Wind Speed vs. Background Noise Levels– Adams

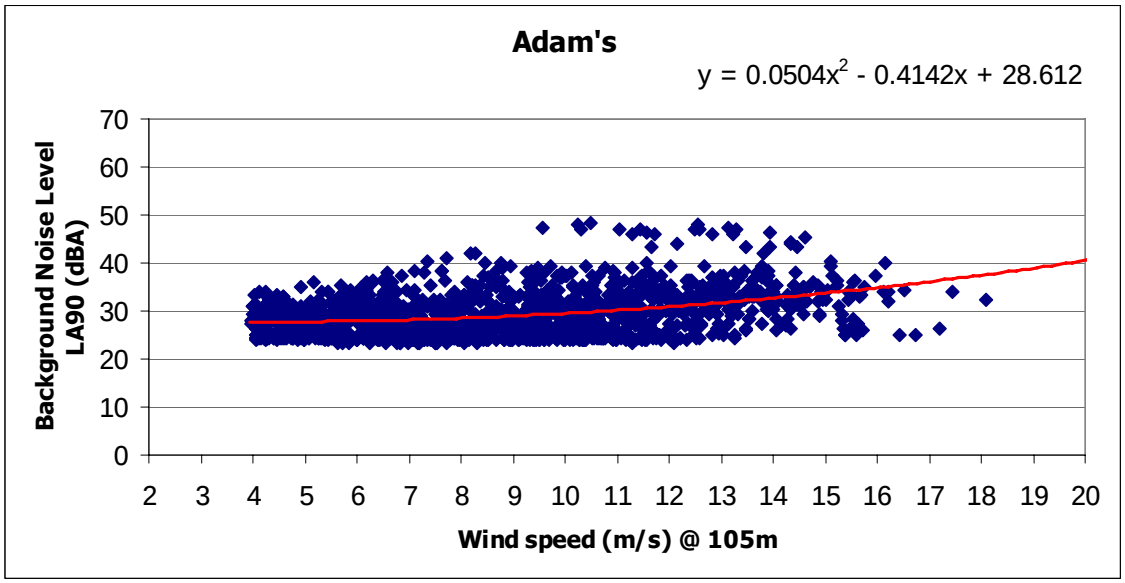


Figure 4-9 Wind Speed vs. Background Noise Levels– Airdrie

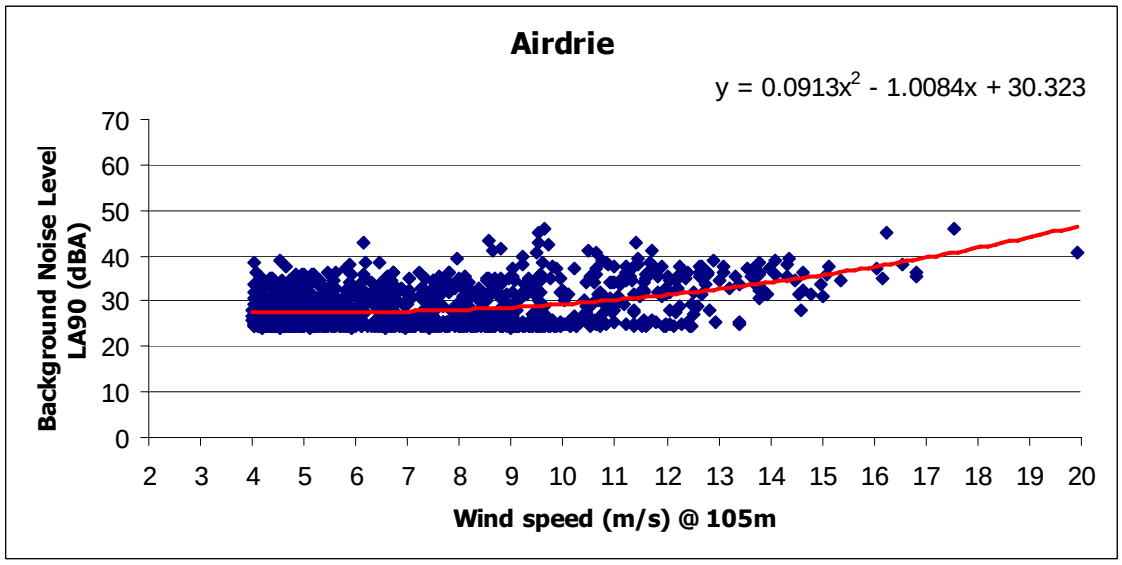
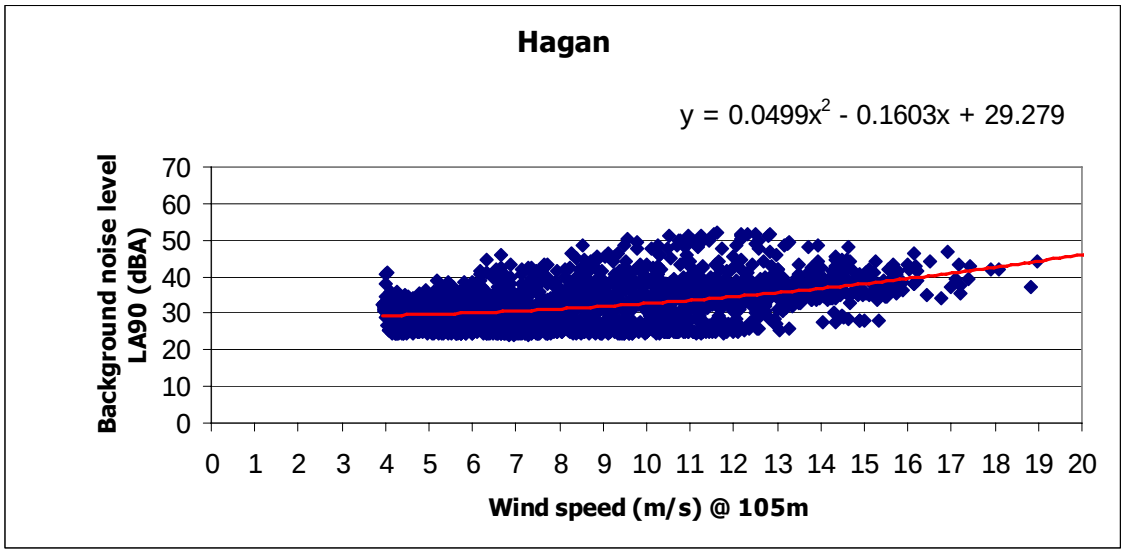


Figure 4-10 Wind Speed vs. Background Noise Levels– Hagan



The data has been split into 24 hour and night time and a summary of this data is provided in Table 4-1 and Table 4-2

Table 4-1 Background Noise Levels (Rounded) versus Wind Speed – Daytime

HH Wind speed (m/s)	Rounded Background Noise Level (dBA)									
	Middlebrook	Peakhill	Greylands	Clifton Hills	The Valley	Jingerah	Dunvagen	Adams	Airdrie	Hagan
4	28	27	27	31	28	28	30	29	29	27
5	28	28	27	32	28	28	30	29	29	27
6	28	28	27	32	28	28	31	30	29	27
7	29	29	27	33	28	28	31	30	29	27
8	29	30	28	33	29	29	32	30	30	27
9	30	31	28	34	29	30	33	31	30	27
10	30	32	29	35	30	30	34	31	31	27
11	31	33	30	36	31	31	35	32	32	28
12	31	34	31	37	33	33	36	32	33	28
13	31	35	32	38	34	34	37	33	34	28
14	32	36	33	39	36	36	39	34	35	29
15	32	38	35	40	38	38	40	35	37	29
16	33	39	36	42	41	40	42	35	39	30
17	33	40	38	43	43	42	44	36	41	30
18	34	42	39	45	46	44	46	37	43	31
19	35	44	41	46	49	47	48	38	46	32
20	35	45	43	48	52	50	50	39	48	33

Table 4-2 Background Noise Levels (Rounded) versus Wind Speed - Nighttime

HH Wind speed (m/s)	Rounded Background Noise Level (dBA)									
	Middlebrook	Peakhill	Greylands	Clifton Hills	The Valley	Jingerah	Dunvagen	Adams	Airdrie	Hagan
4	26	26	25	28	26	25	28	26	25	29
5	26	26	25	28	26	25	27	26	25	28
6	26	26	25	27	26	25	27	26	25	27
7	26	26	25	27	26	26	26	26	25	27
8	27	27	25	27	27	26	26	26	26	27
9	27	27	26	28	27	27	26	26	27	27
10	27	28	27	29	28	27	27	26	27	28
11	28	30	28	30	29	28	27	26	28	28
12	28	31	29	31	31	29	27	27	30	29
13	29	33	30	33	32	31	28	27	31	30
14	29	35	32	36	34	32	29	27	33	32
15	30	37	34	39	36	33	30	28	34	34
16	30	39	36	42	39	35	31	28	36	36
17	31	41	39	45	41	37	32	29	39	38
18	32	44	42	49	44	39	34	30	41	41
19	33	47	45	53	47	41	36	30	44	44
20	34	50	48	57	51	43	37	31	46	47

The graphical raw data for the daytime and night time periods are shown separately in Appendix D. For most receivers there is little difference (2dBA or less) between the 24 hour data and the nightime data, such that it is not considered necessary to differentiate. However at 4 receivers (Clifton Hills, Dunvagen, Adams and Hagan) the differences are more significant, such that criteria have been based on the nighttime data.

4.3 Wind Measurement Results

The ratio of the wind speed at 1.5m at the background noise logging location to the wind speed at 65m at the turbines indicated the following average over the 2 week monitoring periods.

- Peakhill 0.18
- Airdrie 0.28

It should be noted however that the 65m data is a 10minute average whereas the 1.5m data is only an instantaneous speed every 10 minutes, however for the number of data points is considered to be representative. This data indicates at times wind speeds at the residential receivers can be low even though the turbines would be operating.

5 OPERATIONAL NOISE LEVEL CRITERIA

5.1 Wind Farm

This assessment has considered the Draft Australian Standard for Wind Farms, the 2003 South Australian "Wind Farms Environmental Noise Guidelines" adopted by the DECC, the Van Den Berg effect and also the general requirements for noise assessment included within the DECC *INP.*

The SA Wind Farm Guidelines state:

> *The predicted equivalent noise level ($L_{Aeq,10}$), adjusted for tonality in accordance with these guidelines, should not exceed:*
>
> - *35dBA; or*
> - *the background noise level ($L_{A90,10}$) by more than 5dBA*
>
> *whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG.*
>
> *The background noise should be as determined by the data collection and regression analysis procedure recommended under these guidelines."*

Based on the background noise levels measured at the ten residential receivers and the regression analysis described in Section 4, the criteria at each of the residences as a function of integer HH wind speed at the proposed wind farm site is summarised in Table 5-1.

For those receivers under a Landowner agreement there are two approaches which have previously been considered.

The first is to assess the noise levels against World Health Organisation (WHO) recommendations which suggest 45dBA as a maximum level outside bedroom windows. This also refers to achieving 30dBA inside (presumably with windows open).

Because the wind farm noise levels and background noise levels are so dependent on wind speed and direction the single figure criterion does not correlate well with the background plus 5 approach used for non landowners. We consider it is reasonable to allow an additional 5dBA tolerance i.e. a level not exceeding 40dBA or background noise by more than 10dBA. This would apply at the Middlebrook properties.

Table 5-1 Noise Level Criteria (Rounded) versus HH Wind Speed

HH Wind speed (m/s)	Noise Level Criterion (dBA)									
	Middlebrook	Peakhill	Greylands	Clifton Hills	The Valley	Jingerah	Dunvagen	Adams	Airdrie	Hagan
4	35	35	35	35	35	35	35	35	35	35
5	35	35	35	35	35	35	35	35	35	35
6	35	35	35	35	35	35	35	35	35	35
7	35	35	35	35	35	35	35	35	35	35
8	35	35	35	35	35	35	35	35	35	35
9	35	36	35	35	35	35	35	35	35	35
10	35	37	35	35	35	35	35	35	36	35
11	36	38	35	35	36	36	35	35	37	35
12	36	39	36	36	38	38	35	35	38	35
13	36	40	37	38	39	39	35	35	39	35
14	37	41	38	41	41	41	35	35	40	37
15	37	43	40	44	43	43	35	35	42	39
16	38	44	41	47	46	45	36	35	44	41
17	38	45	43	50	48	47	37	35	46	43
18	39	47	44	54	51	49	39	35	48	46
19	40	49	46	58	54	52	41	35	51	49
20	40	50	48	62	57	55	42	36	53	52

5.2 Mini Hydro, Solar PV and Ancillary Items

The operation of these items need to be considered in accordance with the INP and at the same time ensure the cumulative noise from wind farm noise does measurably increase under worst case conditions.

For this project a noise level contribution of 25dBA under isothermal conditions is considered appropriate for each of these components as this would not measurably add to the noise from the wind turbines, and in most cases would be less than the background noise level and would most likely be inaudible. Under adverse conditions noise levels would unlikely exceed 30dBA and would not measurably add to the noise of the wind farm under those conditions.

In the case of the substation, which will have a low frequency hum, it is recommended that it is designed to meet 20dBA.

None of these sources are believed to generate short term high level noise, such that sleep disturbance is likely to be an issue, such that compliance with the project specific criteria nominated above for these items would ensure achievement of sleep disturbance criterion of 45dBA (30dBA + 15dBA).

6 PREDICTED WIND FARM NOISE LEVELS

The prediction and assessment of noise from the wind farm needs to address the following parameters:

- The Sound Power Level (SWL) of the turbine varies with wind speed and wind speed at hub height is dependent on the wind shear characteristics (atmospheric stability) of the site and may differ between day and night time.
- The background noise level (and therefore the criterion) varies with wind speed and may also vary between daytime and night time.
- The propagation of noise varies with wind speed and direction.

6.1 Van den Berg Effect

Some of these wind speed vs noise level relationships are the issues considered by Van den Berg. Fundamentally Van den Berg was concerned about the possibility that there is sufficient wind energy at hub height to drive the turbines, whilst wind speeds at the residences in the lower lying areas surrounding the ridge are much lower. This potentially results in background noise levels being much lower than the best fit regression of the all the background noise data at night time.

Previously this aspect was considered an issue where all wind data was related to a 10mAGL. Background noise levels were required to be plotted against wind speed at 10mAGL. In addition, historically the manufacturer's turbine SWL data was based on an assumed wind shear between 10m and HH at the turbine test site, whilst measurements were undertaken. If wind shear differences both between day and night and the wind farm site and turbine test site were not properly understood, noise levels could be under predicted under certain conditions because it is possible that higher wind speeds (therefore greater turbine SWL) exist at actual HH in relation to the HH wind speed estimated from 10m AGL using a wind shear coefficient.

More recent turbine SWL data is now provided based on HH wind speeds, eliminating this uncertainty.

Van den Berg is also concerned about the potential for modulation in turbulent noise levels from the blades which can occur if the wind speed across the blades at the top of the swept path is sufficiently different to the wind speed at the bottom. This is more likely to also occur at night where the atmosphere can be more stable with a steeper wind speed gradient above the ground. Modulation can be exacerbated if two turbines experience this modulation and are in phase at a particular residence.

At the Kyoto Energy Park site, wind speed and direction has been measured since January 2007 on a mast with data collected at three heights (30m, 45m and 65m). Data sets do not exist for all three heights for the complete period. Sufficient data has been collected from these heights to determine the wind shear with height and to look at this data for the different months and between daytime and night time.

A summary of this data is shown in Appendix E which concludes that the wind shear at night time is steeper than during the daytime and some months it is steeper than others. However in all cases the range of ratios (speedup) between HH 105m wind speed and 65m wind data is between 4-14%, with an average across all data of 7-8%.

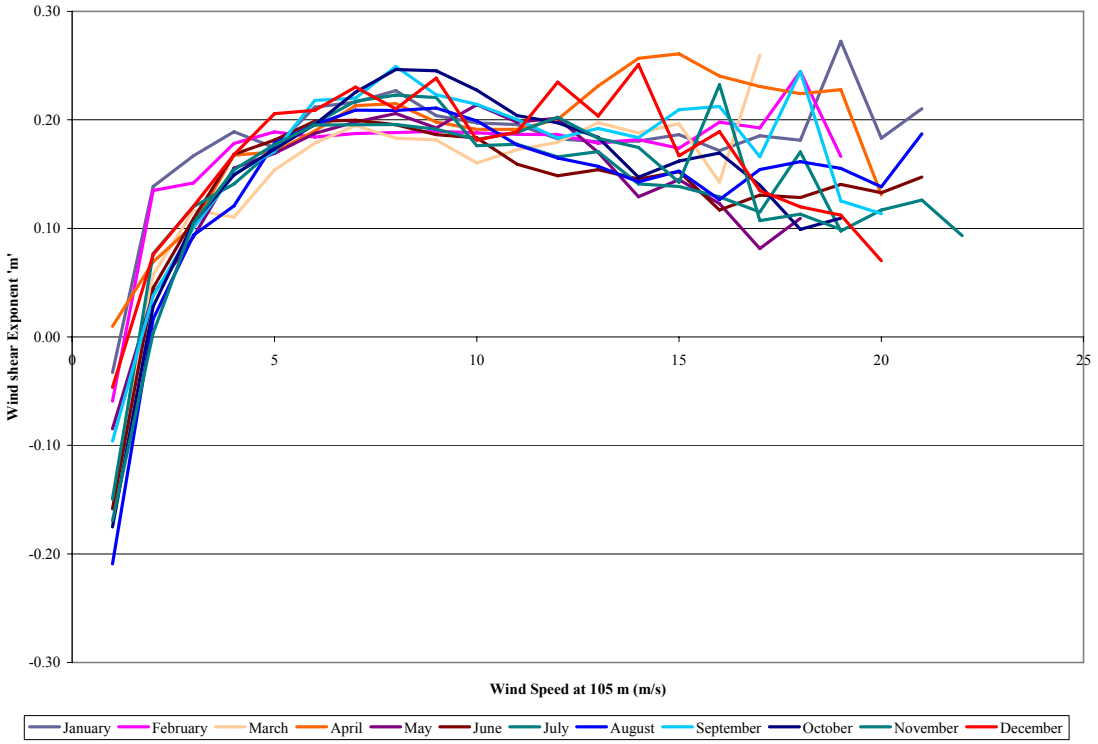
Considering the background noise level at this site are typically less than 30dBA up to HH wind speeds of 10m/s, at these speeds there is a relatively small change in SWL with an increase in

wind speed by a further 7%. We do not consider this change is significant enough to alter the conclusions of this noise assessment and this aspect of the "Van den Berg" effect are included within the current assessment..

In relation to modulation, we understand that if the wind shear (m) is less than 0.2, then Van den Berg considers the atmosphere would be unstable enough that modulation is unlikely to be considered a significant enough feature of the proposed windfarm to warrant consideration. Wind shear data (refer Appendix E) indicates that average values of m is higher at night than at daytime and at night time it falls between approximately 0.15 and 0.24 between hub height speeds of approximately 4-10m/s This falls into the neutral to slightly stable range, such that some degree of modulation may occur at times.

The data has also been presented on a monthly basis, which shows only a small difference between seasons. This is summarised below in Figure 6-1

Figure 6-1 Windshear versus windspeed for each Calendar Month



It will be necessary to review the likelihood of modulation, once the windfarm is operational and require commitments from the windfarm operator to "control" turbines to eliminate high degrees of modulation under certain atmospheric conditions.

The effect of temperature inversions on the propagation of noise also needs to be considered in the assessment. Inversions can cause an increase in noise level from ground-level sources because sound energy that would otherwise be directed upward is "bent" back down to earth. However, this effect is much less prominent if the source is located above the inversion layer, due to the effect of "bending" both above and below the layer. In this case it is likely that if

turbines are rotating, they would be above the inversion layer, as within an inversion layer wind speeds are typically restricted to "drainage flow" of a few metres per second. Hence, it is not considered necessary to include the effect of temperature inversions in calculating noise levels from wind turbines.

6.2 Preliminary Wind Farm Noise Assessment

A Wind Farm noise prediction model known as "WindFarmer" was used to predict noise levels at preliminary stages of the project. This site modelling was performed by Garrad Hassan to determine gross noise and used by Pamada in their initial site selection process. This software uses the ISO9613 algorithms which assume a hard ground and a 2dB/km attenuation with distance. The noise level contours from this model are shown for both sites in Appendix E.

These contours indicate noise levels would not exceed 35dBA at most of the (non landowner) residences and would only exceed 40dBA at a few locations. Assuming the criteria varies above 35dBA, the proposed wind farm would therefore generally comply with the criteria, although some exceedances were likely.

This noise model does not specifically deal with the propagation of noise under different meteorological conditions and therefore the noise model may not effectively compensate for downwind propagation, although it is considered to be conservative enough to accommodate a typical worst case scenario.

6.3 Detailed Noise Assessment

As discussed in the South Australia Guidelines, prediction of noise should consider the effects of air absorption, ground effects and particularly downwind propagation of noise which can enhance noise levels significantly, particularly over large distances.

For this purpose, a noise model was also generated using the ENM software. However it should be noted ENM was not specifically developed to address wind farms and the meteorological conditions in which they normally operate, but is an industry accepted model for assessing environmental noise.

A more detailed analysis was conducted by calculating the noise levels from all turbines at the 38 closest receivers over a range of meteorological conditions which exist by predicting noise for integer HH wind speeds (4-20m/s) in the eight segments of the compass.

A technical note from RTA Technology (the developers of ENM software) provides advice on the appropriate adjustments to wind speed for the prediction of noise using ENM from elevated sources. Although the hub height of the turbines is 105m, we have conservatively adopted a lower propagation height to undertake the noise assessment. The technical note requires a conversion factor of 0.27 from the wind speed at Hub Height to the "ENM assumed" wind speed (at 10m) for an elevated source.

Table 6-1 below summarises the ENM assumed wind speeds.

Table 6-1 Wind Speed at HH versus ENM assumed Wind Speed (10mAGL)

Wind Speed (m/s)	ENM Assumed Wind Speed (m/s)
4	1.088
5	1.36
6	1.632
7	1.904
8	2.176
9	2.448
10	2.72
11	2.992
12	3.264
13	3.536
14	3.808
15	4.08
16	4.352
17	4.624
18	4.896
19	5.168
20	5.44

For the full range of predicted noise levels for each wind speed and direction, based on the proportion of times those conditions exist, the median noise level and the noise level exceeded for 10% of the time is shown in Table 6-2.

Table 6-2 Predicted Median and 10th percentile Exceedance Noise Levels

	Median Noise Level (dBA)									
	Middlebrook	Peakhill	Greylands	Lot 6 Clifton Hills	The Valley	Jingerah	Dunvagen	Adams	Airdrie	Hagan
Median	32	31	23	28	26	24	22	24	21	26
10%	38	38	31	35	33	30	29	28	25	31

This shows at the potentially most affected residences, where background noise monitoring was undertaken that the lowest noise level limit of 35dBA is achieved by the 10th percentile noise level at all non landowner residences with the exception of Peakhill, where the median value is 31dBA and the 10th percentile level is 38dBA.

At Middlebrook the 10th percentile level is less than the 45dBA WHO guideline.

Graphs showing the predicted worst case noise levels versus the background noise level and the relevant 24 hour criteria or nighttime criteria (where these are significantly lower) are shown in Appendix F.

The full range of predicted noise levels at integer wind speeds (for upwind and downwind scenarios) at the 10 nominated receivers are shown in Table 6-3 . The predicted noise levels are rounded to the nearest dB.

Table 6-3 Range of Predicted Noise Levels versus HH Wind Speed

HH Wind speed (m/s)	Range of Noise Levels (dBA)																			
	Middlebrook		Peakhill		Greylands		Lot 6 Clifton Hills		The Valley		Jingerah		Dunvagen		Adams		Airdrie		Hagan	
	Mn	Mx	Mn	Mx	Mn	Mx	Mn	Mx	Mn	Mx	Mn	Mx	Mn	Mx	Mn	Mx	Mn	Mx	Mn	Mx
4	30	36	28	35	21	30	26	33	23	31	22	31	16	28	18	28	20	26	19	30
5	30	37	28	37	21	31	25	34	23	32	22	32	16	29	18	29	19	27	18	32
6	30	38	29	38	21	32	25	36	23	34	22	33	17	30	18	31	20	28	19	33
7	30	39	29	39	21	33	25	37	23	35	23	34	17	31	18	32	20	29	19	34
8	30	40	29	40	21	34	23	38	22	36	23	35	17	32	18	33	20	30	20	35
9	31	41	29	42	22	35	23	39	22	37	23	36	17	34	17	34	20	31	20	36
10	31	42	29	43	22	36	24	40	22	38	23	37	18	35	15	35	20	32	20	37
11	31	43	29	44	22	37	24	41	22	39	23	38	18	35	14	36	21	33	21	38
12	31	43	28	44	21	37	23	41	22	39	22	38	17	36	13	36	20	33	21	38
13	30	44	27	44	21	37	23	41	21	40	22	38	17	36	11	36	20	34	21	39
14	30	44	26	45	20	38	23	42	21	40	22	39	17	37	10	37	20	34	21	39
15	30	45	25	45	20	38	22	42	21	41	22	39	17	37	9	37	20	35	21	40
16	30	45	25	46	20	39	22	43	21	41	21	40	17	38	8	38	20	35	21	40
17	29	46	25	46	20	39	22	43	20	42	21	40	16	38	7	39	20	36	21	41
18	29	46	24	47	19	40	22	44	20	42	20	41	16	39	7	39	20	36	21	41
19	29	47	24	47	19	40	22	44	20	43	20	41	16	39	6	40	20	37	21	42
20	29	47	22	48	19	41	21	45	20	43	20	42	16	40	6	40	20	37	21	42

On the basis that noise levels above 35dBA are predicted at these 10 receivers which range from 1km to 2.3km from the nearest turbines at some wind speeds, it was necessary to predict noise levels at residences further away in each direction which was up to 38 receivers surrounding the wind farm at up to approximately 3.2km from the nearest turbine. The ranges of noise levels at all these residences are shown in Appendix G.

7 ASSESSMENT OF POTENTIAL WIND TURBINE NOISE IMPACTS

7.1 Non Landowner

This assessment has shown that the noise levels from the proposed Suzlon (SWL 104.3dB) turbines are predicted to meet the noise criteria specified in this report at all but three of the "non Landowner" residences at all times. Potential noise impacts from the proposed turbines are therefore considered to be negligible at these receivers.

For the receivers where some exceedances have been predicted we have reviewed the wind data to determine the proportion of time these exceedances may exist, by number of dBA, by time of day and by season summarised in Table 7-1.

Table 7-1 Non Landowner Residences - Proportion of Time Exceedances Occur

Location	Day / Night	Season	Exceedance of Criteria – 35 or background + 5 (dBA)					
			0-1dBA	1-2dBA	2-3dBA	3-4dBA	4-5dBA	Total
Peakhill	Day	Autumn	13%	5%				18%
		Spring	14%	6%				20%
		Summer	5%	2%				7%
		Winter	21%	10%				31%
	Night	Autumn	7%	3%	6%	4%	1%	21%
		Spring	8%	3%	5%	4%	1%	21%
		Summer	2%	0%	1%	1%	<1%	5%
		Winter	10%	5%	11%	9%	4%	39%
Lot 6 Clifton Hill	Night	Autumn	3%	1%				4%
		Spring	5%	3%				8%
		Summer	9%	4%				13%
		Winter	3%	1%				4%
Mastin	Night	Autumn	1%					1%
		Spring	1%					1%
		Summer	<1%					<1%
		Winter	4%					4%

At Mastin, the degree of exceedances is mostly less than 1%, when analysed by season and by time of day and is certainly less than 1% over the whole year. At Lot 6 Clifton Hills estate the exceedances occur at night time and vary between 4-13% depending on season. At yet to be developed Lots (the closest is Lot 8) the predicted noise levels are less than 1dBA higher.

The most affected residence is Peakhill where exceedances occur at both day and night time and are predicted to occur up to 31% of time during the winter night times. At this time of year it is likely windows would be closed.

Although the noise predictions are based on the best available information from the manufacturers regarding the turbine source noise levels and also a review of environmental noise modelling algorithms, there is a need to understand the "engineering accuracy" of the noise prediction and measurement process.

It is recognised that all measurement and prediction processes have a certain degree of accuracy / tolerance and predictions are undertaken on this basis and the results presented. However, the accuracy of noise source data would normally be expected to be in the region of ± 1-2dBA. The wind turbine manufacturer has confirmed that the noise levels provided in the technical report are guaranteed noise levels, which they expect should not be exceeded. On this basis the accuracy is likely to be ± 1dBA.

In addition, the known accuracy of modelling in relation to long term noise monitoring is probably in the region of ± 1-2dBA for distances of several hundred metres but would be greater ± 2-3dBA for distances in the order of 2km which exist at this proposed wind farm site.

7.1.1 Mitigation and Monitoring

While it is considered that a conservative approach has been adopted in this noise assessment in terms of a number of assumptions that have been made, it is possible that the tolerances discussed above, plus any tolerances in the compliance measurements could result in exceedance of the noise limits, whilst the proponent has installed equipment exactly as described and assessed.

Given these tolerances (source data and distances involved), we consider it is relevant to note that the proposed turbines can be software controlled to operate at reduced noise levels during the critical part (with respect to noise) of the wind speed operating range. The reduction in noise levels (should compliance testing show it would be necessary) would be up to 3dBA in this part of the range between cut in and rated power and would reduce the proportion of time that exceedances would occur.

It would also be possible to control the closest turbines to Peakhill under those wind speeds and directions which result in exceedances. All turbines have a remotely monitored met station installed on top of the nacelle for independent control. Control procedures including ramping down turbines during offending wind conditions could be incorporated into a Noise Management Plan for the site.

This identification of those conditions would be either by comprehensive testing over the first year to determine the range of wind speeds and directions likely to result in exceedances, such that these sets of conditions can be "programmed in". Alternatively real time noise monitoring at the most affected residences could provide continuous feedback which a SCADA or similar control package could manage the turbine settings in relation to power generation and noise.

7.2 Landowner

Pamada currently has a Landowner Agreement to enable work to be undertaken on wind speed monitoring and other investigations related to the proposed Kyoto Energy Park. An agreement has been reached between the Landowner and Pamada in relation to noise on landowner properties within Middlebrook Station. The two parties, have signed a letter which refers to the noise level predictions for Landowner residences. The letter states that Landowner is aware of the predicted noise level impacts and accepts them. A final copy of the letter will be forwarded to DECC once signed by all parties.

A similar assessment to the one discussed above has also been compiled for the Landowner residences, although this allows for the 5dBA higher criterion of background + 10dBA.

Table 7-2 Landowner Residences - Proportion of Time Exceedances Occur

Location	Day / Night	Season	Exceedance of Criteria – 40 or background + 10 (dBA)					
			0-1	1-2	2-3	3-4	4-5	Total
Middlebrook Station	Night	Autumn	1%	<1%				1%
		Spring	1%	1%				2%
		Summer	<1%	<1%				1%
		Winter	4%	2%				6%
Middlebrook Accommodation	Night	Autumn	3%	1%				4%
		Spring	3%	1%				4%
		Summer	1%	<1%				1%
		Winter	9%	4%				13%

This only shows exceedances at night time for less than 5% of the time, with the exception of winter nights when the exceedances are as high as 13%. During these colder months it is more likely residents would be inside with windows closed.

7.3 Ancillary Wind Farm Equipment

The major noise sources associated with a wind farm is the turbines due to both their sound power level and their elevation. However there are other minor noise sources associated with small transformers at the base of each turbine and the sub station including transformers and switching gear.

Project specific criteria for these minor items have been established for isothermal “neutral” meteorological conditions on the basis that, in conjunction with noise from the turbines the proportion of time that adverse conditions would exist and overall noise levels are measurably increased as a result of cumulative noise would be significantly less than the 30% of time in any season as required by the INP. Calculations presented below therefore only consider the isothermal situation.

7.3.1 Site Substation and Turbine Transformers

These items of equipment also generate increasing noise as a function of increasing electrical power which is a function of increasing wind speed.

The proposed wind farm will require outdoor transformers located adjacent to the sub station which is located on the access road from Bunnan Road in the north-west corner of Mountain Station at an RL of approximately 465m. This location is more than 1.3km from any existing residence and over 1km from Lot 6 Clifton Hills estate.

Under full load the combined sound power level from all the ancillary equipment at the sub station is estimated (from AS2374-6 Power Transformer Noise Levels) as less than 100dBA. The transformers at each turbine are less than 80dBA. On this basis the additional noise from the ancillary equipment compared with the turbines operating at their maximum sound level would result in no predicted or measurable increase in the noise levels presented in this report.

The contribution from this noise at the closest residences, under neutral meteorological conditions, predicted using The RTA Technology Environmental Noise Modelling software ENM is 22dBA. At all other receivers the noise level is less than 10dBA.

It is recommended that at the northern / eastern edge of the substation area that sufficient space is available to provide 4m high bunding, to provide additional shielding in the direction of Clifton Hills Estate.

7.4 Solar PV Plant

Various technologies are being considered for the Solar photovoltaic plant, including fixed, single axes, duel-axes or heliostat type arrangements. The noise generation comes from the numerous (up to 1000) small ac motors used to manoeuvre the panels to track the sun. The SWL of each motor is in the order of 65dBA and these are spread out on the top of the ridge beneath turbines 27, 28 and 29 assumed at a height of 3m above ground level. The closest residence is Peakhill, approximately 1.3km from the closest part of the solar array.

Even if we assumed the array as 3 point sources at the closest location, the total SWL for up to 1000 motors operating at the same time is only 95dBA which is approximately 10 dBA less than a single turbine. Prediction of noise from cumulative solar trackers under neutral conditions is less than 10dBA at Peakhill and less than 5dBA at all other receivers. The equipment is therefore expected to be inaudible. At Peakhill the noise sources are expected to be shielded based on the topographic information provided.

7.5 Closed Loop Mini Hydro

A Closed-loop mini hydro plant (1MW) is proposed to provide a power generation source that can be fed into the grid system supplementing local electricity peak output periods. Given certain circumstances, such as at night, low wind, or very high electricity pricing, the water can be released using gravity to drive turbines and create electricity.

The system is simple in nature, header tanks are filled with water. Additional top up water is collected from rooftops during rainfall, diverted and stored in the tanks located at a high point. Potential energy is converted to electricity when water in the header tank is discharged under gravity through a series of connecting pipes to bottom tanks located at the lowest point of the system. Water is discharged through 5 200kW synchronous mini-hydro water turbine

generators to generate electricity which is reticulated to a step up transformer and pole mounted switching-station located adjacent to the top header tanks. From here electricity would be fed into the site substation via underground cable. Using surplus electricity generated from other devices on the site, water can be pumped up at slow efficient rates to the top holding tanks.

Each of the 5 mini-hydro turbines will be housed in an enclosure at RL530 on the eastern side of the ridge between turbines 19 & 20 about 500m from the manager's residence. The nearest residences are over 2.5km away further to the east and north east.

In order to meet the criteria of 25dBA at the nearest residences, the effective SWL radiating from the turbine enclosure, needs to be controlled to less than 120dBA. A simple shed construction would be considered sufficient to achieve this noise level.

8 CONSTRUCTION NOISE ASSESSMENT

This section of the report deals with on site and off site construction noise. Additional traffic noise on the surrounding road network during construction is discussed in Chapter 9.

Construction is expected to occur over a 20 month period in a single stage for all works. Construction would occur between 7.00am and 6.00pm Monday to Friday and between 7.00am and 1.00pm on Saturday.

Construction activities would be phased with different activities being carried out at different locations across the site, so only a few locations will be worked on at any one time. Delivery of turbine components would be scheduled so that they can be directly installed at each location, however provision has been made for intermediate storage on site in the laydown area. The down are area is to be located adjacent to the site depot near the entrance to the Mountain Station site.

In addition to onsite construction, there is also the requirement to connect the Energy Park into the National Electricity Grid. This requires the construction of either a 66kV or 132kV overhead power line from the Mountain Station site substation to the electrical connection point. The final option for electrical connection has not been finalised but considers connection to either Scone 66/33kV zone substation, Mitchell Line Feeder at Dartbrook or Muswellbrook STS.

Given the large distances from the Energy Park to the residences vibration from construction would not be perceptible and is not addressed further in this report.

8.1 Construction Noise Level Goals

The assessment of construction is dependent on the duration of construction in the vicinity of the potentially affected residential receiver. The DECC in their *Environmental Noise Control Manual (ENCM)* suggest the following noise control guidelines.

The following time restrictions apply:

- Monday – Friday 7.00am – 6.00pm
- Saturday 7.00am – 1.00pm if inaudible at residential premises, otherwise 8.00am – 1.00pm

The following noise level restrictions apply to non landowner residences:

- Construction periods of less than four weeks. The L_{A10} level in any 15 minute period must not exceed the background L_{A90} level by more than 20dBA.
- Construction periods of between four and 26 weeks. The L_{A10} level in any 15 minute period must not exceed background L_{A90} level by more than 10dBA.

At Landowner residences, criteria for temporary construction noise would not normally apply

The construction period is greater than 26 weeks, and although not stated in the Manual, it is normally adopted that background + 5dBA would apply, therefore the following goals apply based on the measured background noise levels between 7.00am and 6.00pm. It should be noted that in accordance with DECC policy, where the background noise is measured as less than 30dBA, it is normal to adopt 30dBA.

Table 8-1 Background Noise levels and Construction Noise Criteria – On Site

	Middlebrook	Peakhill	Greylands	Clifton Hills	The Valley	Jingerah	Dunvagen	Adams	Airdrie	Hagan
RBL	27	27	26	30	27	27	30	29	27	31
Criteria	NA	35	35	35	35	35	35	35	35	36

8.2 Proposed Construction Activities

The proposed Energy Park would require the following construction activities:

- site establishment;
- site preparation;
- upgrade of existing tracks and construction of new tracks;
- construction of turbine foundations;
- construction of cable trenches alongside access tracks and laying of cables in trenches;
- construction of substation/facilities/visitors building;
- construction of overhead transmission lines;
- construction of turbines;
- construction of mini hydro plant
- construction of solar PV and
- site restoration following commissioning.

8.3 Predicted On Site Construction Noise Levels

The activities described above can be broadly split into three main construction phases, representative of the noisiest activities:

- Earthworks
- Foundation works
- Superstructure (Turbines/Substation/transmission lines/Mini-Hydro/Solar-PV/Buildings) erection.

The following construction plant items and associated maximum sound pressure levels at 7m are summarised as follows:

- Front End Loader 88dBA
- Dozer 88dBA
- Grader 85dBA
- Excavator 84dBA
- Multi-tyred tractor 86dBA
- Hydraulic Hammer 98dBA
- Tip Truck 83dBA
- Concrete Trucks 83dBA
- Concrete Vibrator 80dBA
- Concrete Pump 84dBA
- Batching Plant 85dBA
- Mobile Crane 85dBA

- Semi-trailers 87dBA
- Powered Hand Tools 88dBA
- Welding Machine 80dBA
- Air Compressor 75dBA

Based on a typical operating scenario for the various construction equipment the following source L_{A10} sound pressure levels at 7m for each phase of work are summarised as follows:

- Earthworks 87dBA (SWL = 112)
- Foundation 85dBA (SWL = 110)
- Superstructure 85dBA (SWL = 110)

Based on attenuation due to distance to the residences from the turbines the following L_{A10} noise levels are predicted at the nearest residences from the various activities on the closest turbines on the site to each residence.

Table 8-2 Predicted Construction L_{A10} Noise Levels

Location	Earthworks (dBA)	Foundation (dBA)	Superstructure (dBA)	Criteria (dBA)
Middlebrook	38	36	36	35
Peakhill	21	19	19	35
Greylands	29	27	27	35
Lot 6 Clifton Hills	34	32	32	35
The Valley	23	21	21	35
Jingerah	29	27	27	35
Dunvagen	28	26	26	35
Adams	30	28	28	35
Airdrie	26	24	24	35
Hagan	23	21	21	36

The predicted construction noise levels comfortably meet the criteria from the various activities during the construction phase at all the non landowner residences. Even allowing for cumulative impacts associated with the simultaneous operation of foundation works at one turbine while another is being erected would still result in overall noise levels of less than 35dBA, which is within the criteria.

8.4 Predicted Off Site Construction Noise Levels

There is a requirement to provide an overhead power line connection into the national Electricity Grid. The preferred option has not been determined at this stage. From a construction noise perspective there is a requirement to provide power poles along the alignment, requiring works in the same location for only a few days to provide foundations and erect the power pole and hang the transmission lines. These mostly follow existing road alignments.

This will require use of small excavation plant such as a mini excavator and bobcat, a small concrete pour for foundations and a crane and cherry picker to mount the pole and undertake the electrical fixing.

Noise levels are predicted to exceed criteria for a few days at residences within 200m of the alignment.

9 TRAFFIC NOISE ASSESSMENT

This section of the report presents the appropriate DECC noise level goals for "new developments which generate additional traffic on public roads" and assesses the potential impact.

The *Environmental Criteria for Road Traffic Noise (ECRTN)* sets out criteria for assessment of noise from vehicles on public roads. These are used for assessment of the impact of additional vehicles using the surrounding road network.

The *ECRTN* sets out noise criteria for 'arterial', 'sub-arterial', 'local roads' and 'collector roads'. Bunnan Road would be considered as a collector road. Criteria for "land use developments with potential to create additional traffic" are as follows:

- Collector Roads
  - Daytime (7.00am-10.00pm) $L_{Aeq,1hr}$ = 60dBA
  - Night Time (10.00pm-7.00am) $L_{Aeq,1hr}$ = 55dBA

Where existing daytime levels exceed 58dBA $L_{Aeq,1hr}$ or the night time levels exceed 53dBA $L_{Aeq,1hr}$, the development should not increase existing levels by more than 2dBA. This criterion is to be met at a time ten years after the opening of the development.

Whilst these criteria do not normally apply to temporary traffic changes during construction noise they can be used as a guideline to assess potential noise impact.

9.1 Operational Phase

Existing tourist accommodation is located at Middlebrook Station Accommodation, off Middlebrook Rd. Accommodation is currently accessed by large buses visiting the site and individual tourists. Averages of 2 large bus trips per week currently visit the Middlebrook Station Accommodation site. Existing tourist activities on both sites include round trips to Mountain Station and Mt Moobi lookout using a modified 4WD bus run by the landowner. It is envisaged that these tourism activities will continue along the same route and merge with tourism potential for the Visitors and Education Centre.

There would be very few regular daily traffic movements associated with the facility, once operational. Provision has been made to construct a Visitor's and Education Centre on Mt Moobi Plateau, Mountain Station. Intermittent traffic generated from visits to the site from educational groups such as local schools, TAFE students, University or tourist groups would be expected during the daytime. These activities are expected to be in buses (individually or in groups) with an estimate of 3-4 bus trips per week included in the traffic estimate. Facilities at the Centre include a small gravel carpark, display area and entrance foyer, a conference room, Indigenous heritage displays, a large viewing platform (i.e. balcony) and general amenities.

On this intermittent basis negligible impact would be expected.

9.2 Construction Phase

Traffic volumes during the construction period are only temporary and are likely to generally be relatively low, although there may be short periods with higher numbers during concrete pours.

It is expected there would be an average of 9 heavy vehicle movements per day (18 movements) between Scone and the site along Bunnan Road. On peak days during deliveries prior to concrete pours this could increase to 20 heavy vehicles i.e. 40 movements.

During establishment of the on site access tracks which will require road base, there will be additional heavy vehicle movements along the short section of Bunnan Road between the access road to Middlebrook Stations and Mountain Station, since trucks will be coming from the existing quarry on the Middlebrook Station site. This will occur for an estimated period of 2 months duration.

The closest residences to Bunnan Road / Satur Road are on the western fringes of Scone and to the south of the airport where set backs are typically 20-25m and the speed limit is 60km/hr, however at an average of 2 heavy vehicle movements per hour and up to 4 heavy vehicle movements per hour the predicted noise level is less than 60dBA.

For the section of Bunnan Road between the entrance to Middlebrook and Mountain Stations given residential setbacks are relatively large (greater than 150m) at a speed of up to 100km.hr the predicted traffic noise during construction would be less than 60dBA and impacts are considered minor.

Figure 9-1 Road Base Haulage Indicating Large Residential Set Backs

10 CONCLUSION

This report assesses the potential noise impact associated with the proposed operation of the Kyoto Energy Park, near Scone.

The proposal includes a 42 turbine wind farm across two sites (Mountain Station (31 turbines and Middlebrook Station (11 turbines), plus associated substation. In addition the proposal includes a closed loop mini hydro and solar pv plant. These ancillary components generate insignificant noise in comparison to the turbines, although the provision of sufficient space at the substation should be allowed to provide bunding around the north east corner in the direction of the Clifton Hills estate.

An informed agreement will be signed with the landowner in regard to the associated properties on Middlebrook Station.

The predicted noise levels has considered the prevailing meteorological conditions, change in Sound Power Level of the turbine as wind speed increases and downwind propagation to the surrounding receivers from elevated noise sources.

This assessment has shown that there are only three non landowner residences where criteria are potentially exceeded and of these 3 residences, exceedances at 1 are considered to be negligible as they would occur less than 1% of the time.

At Lot 6 Clifton Hills estate exceedances are predicted at night time only (are up to 2dBA) and up to 13% of the night time in summer. This is considered marginal. At slightly closer yet to be developed Lots noise levels are predicted to be less than 1dBA higher.

At one existing residence (Peakhill) the exceedances are considered more significant and mitigation in the form of sector management to the nearest five or six turbines would need to be instigated to ensure the 10 percentile noise levels did not exceed the criterion. This aspect will need to be addressed in the Environmental Management Plan for the proposed development.

Noise monitoring will be required, particularly over the first few years of operation to determine compliance and provide feedback into the site EMP regarding the need for turbine noise control under certain wind conditions through turbine management software. This may comprise both attended and permanent noise monitoring systems capable of identifying the contribution of noise from the site.

Construction noise from on site activities is predicted to meet NSW Department of Environment & Climate Change (DECC) criteria given the relatively large distances to the nearest residences. Construction noise associated with the overhead power line connection to the National Electricity Grid will result in some impacts where construction of power poles occurs within 200m of residences. A Construction Noise Management Plan will need to address these minor issues when more construction details are available, however in addition to ensuring the use of modern well maintained plant, it is likely that informing the community of impending works will be the major component.

Traffic noise during operation is expected to be negligible, although there is the possibility of occasional educational visits (for example by school groups) by bus to the Visitor Centre. This would only generate a few heavy vehicle movements.

During construction phase there is predicted to be up to 40 movements per day along Bunnan / Satur Road and a higher number of movements (up to 60) along the short section of road between the Middlebrook and Mountain Station access roads. Due to either the low number of hourly movements or the large residential set backs the $L_{Aeq,1hr}$ noise levels are predicted as less than 60dBA. This would comply with the requirements of the *Environmental Criteria for Road Traffic Noise (ECRTN)*, even though they would not generally apply to construction phase traffic noise.

Note

All materials specified by Wilkinson Murray Pty Limited have been selected solely on the basis of acoustic performance. Any other properties of these materials, such as fire rating, chemical properties etc. should be checked with the suppliers or other specialised bodies for fitness for a given purpose.

Quality Assurance

We are committed to and have implemented AS/NZS ISO 9001:2000 "Quality Management Systems – Requirements". This management system has been externally certified and Licence No. QEC 13457 has been issued.

AAAC

This firm is a member firm of the Association of Australian Acoustical Consultants and the work here reported has been carried out in accordance with the terms of that membership.

Version	Status	Date	Prepared by	Checked by
A	Draft	9 May 2008	Neil Gross	John Wassermann
B	Draft	13 August 2008	Neil Gross	John Wassermann
C	Final	16 April 2009	Neil Gross	John Wassermann

APPENDIX A

GLOSSARY OF ACOUSTIC TERMS

GLOSSARY

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph overleaf, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

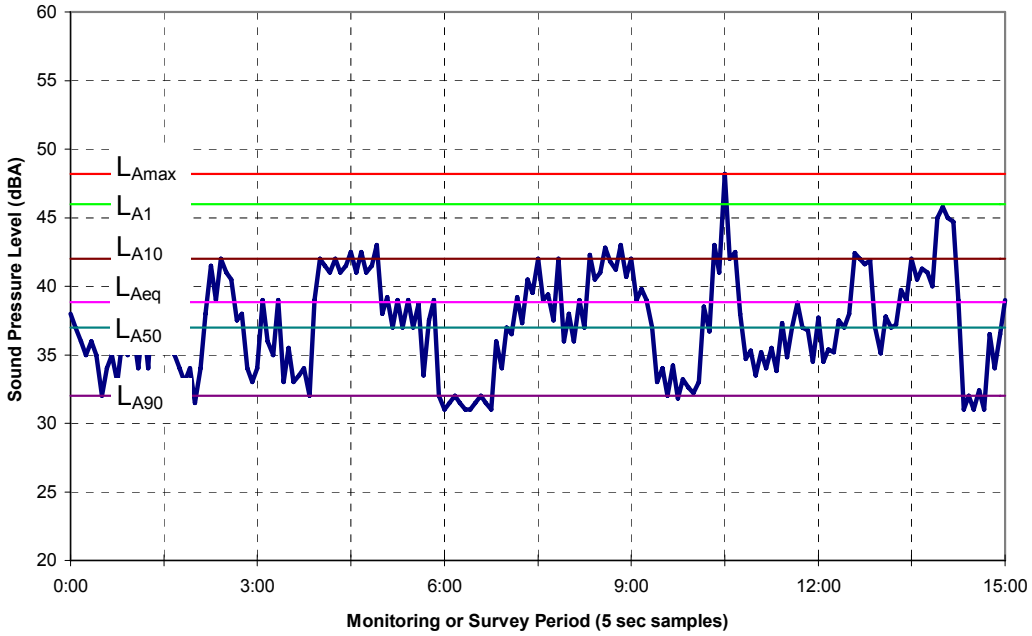
L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

L_{A50} – The L_{A50} level is the noise level which is exceeded for 50% of the sample period. During the sample period, the noise level is below the L_{A50} level for 50% of the time.

L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10^{th} percentile (lowest 10^{th} percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.


60
55
50
45
40
35
30
25
20
Sound Pressure Level (dBA)
LAmax
LA1
LA10
LAeq
LA50
LA90
0:00
3:00
6:00
9:00
12:00
15:00
Monitoring or Survey Period (5 sec samples)

APPENDIX B

BACKGROUND NOISE MEASUREMENT RESULTS

Middlebrook Station – Round 1

Location: Middlebrook Station

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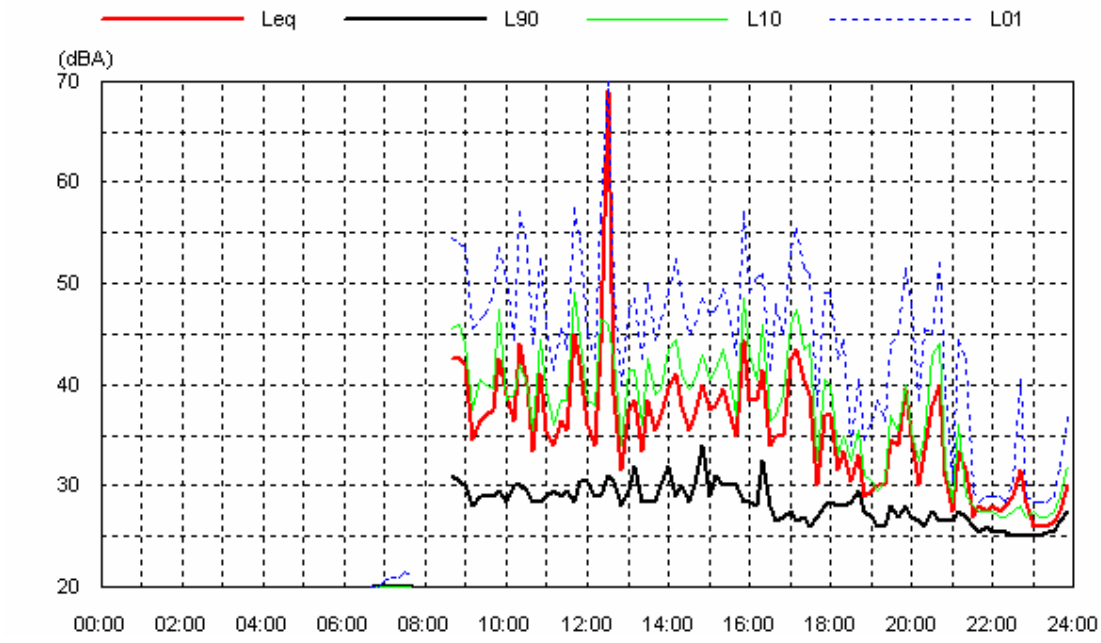

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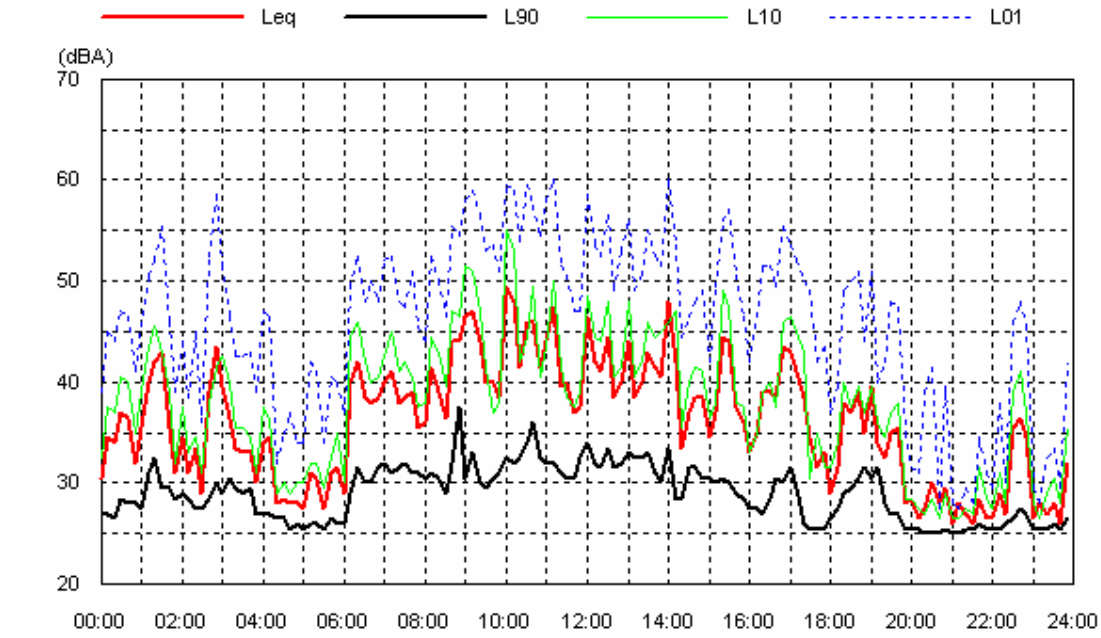

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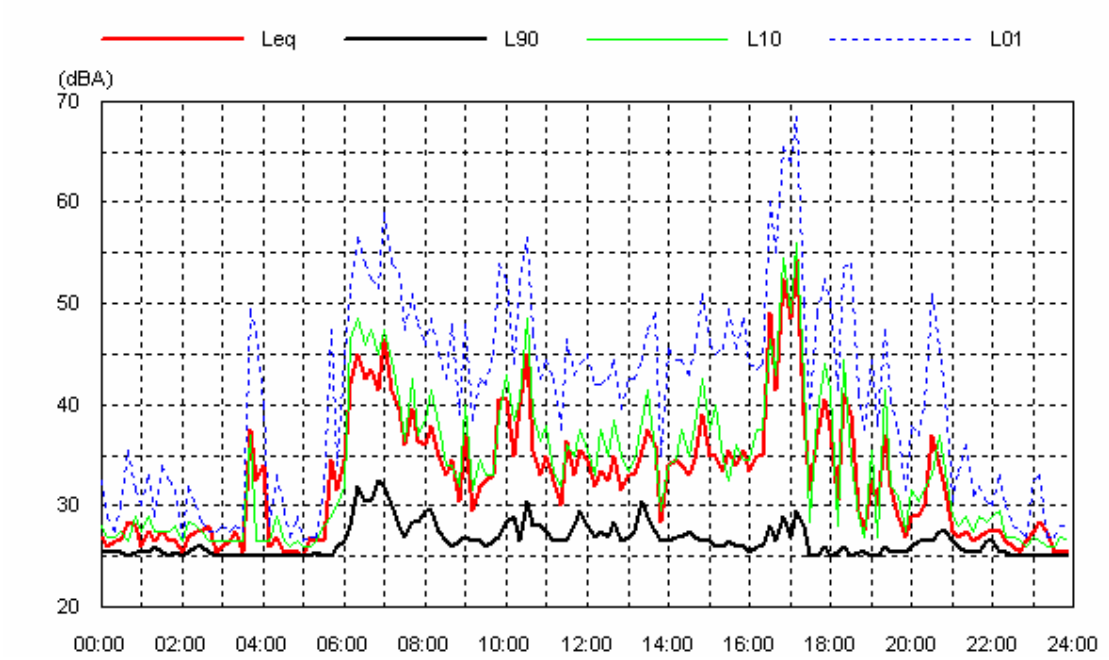

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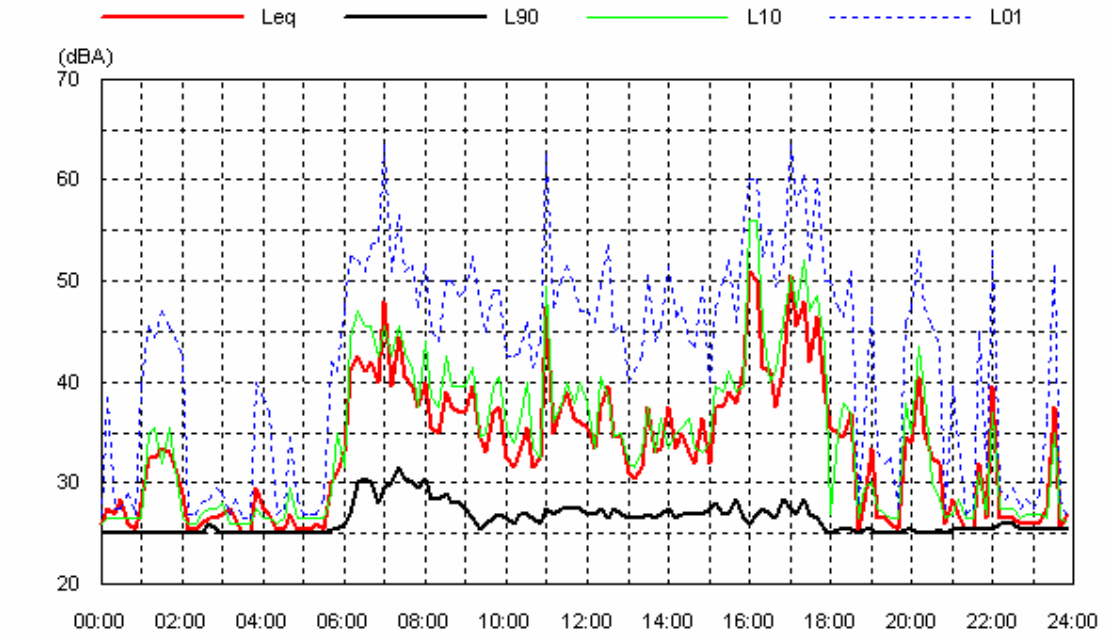

Location: Middlebrook Station

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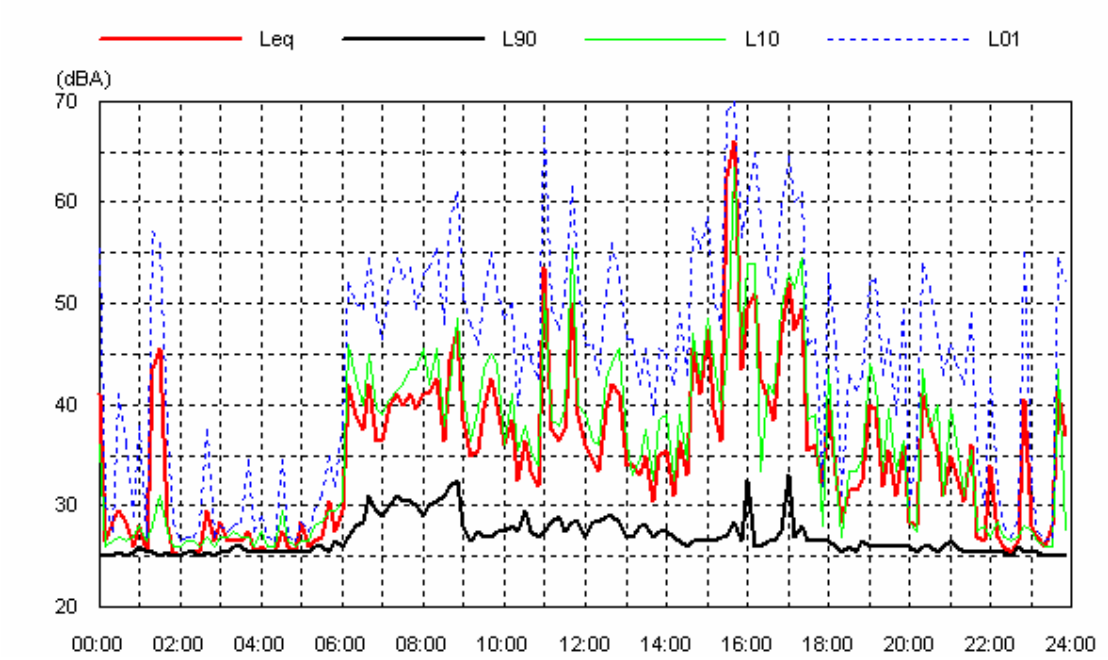

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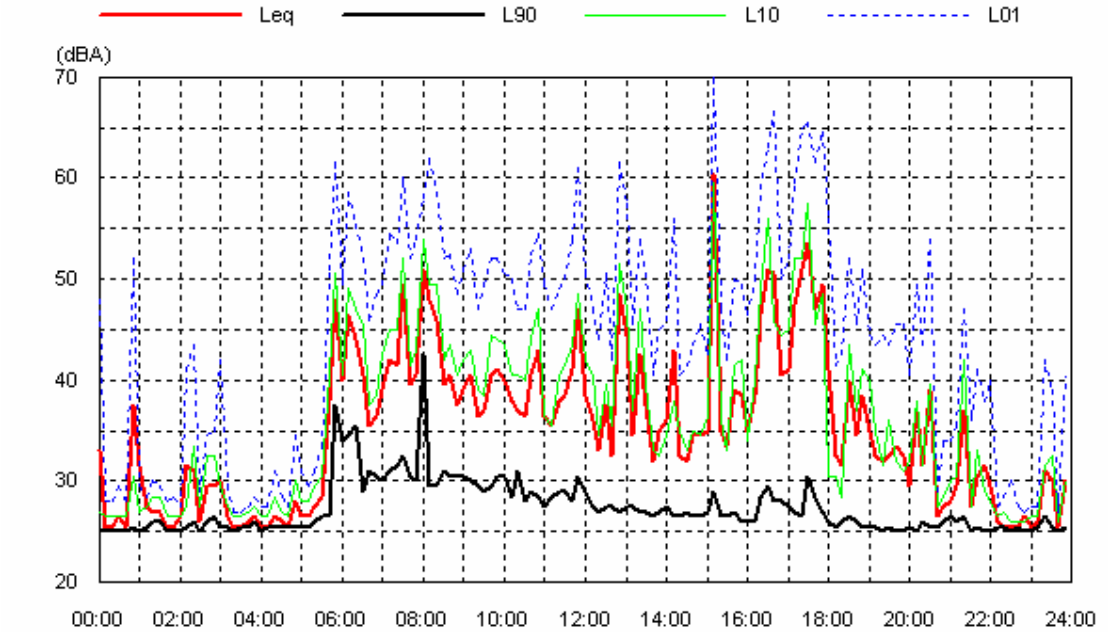

Location: Middlebrook Station

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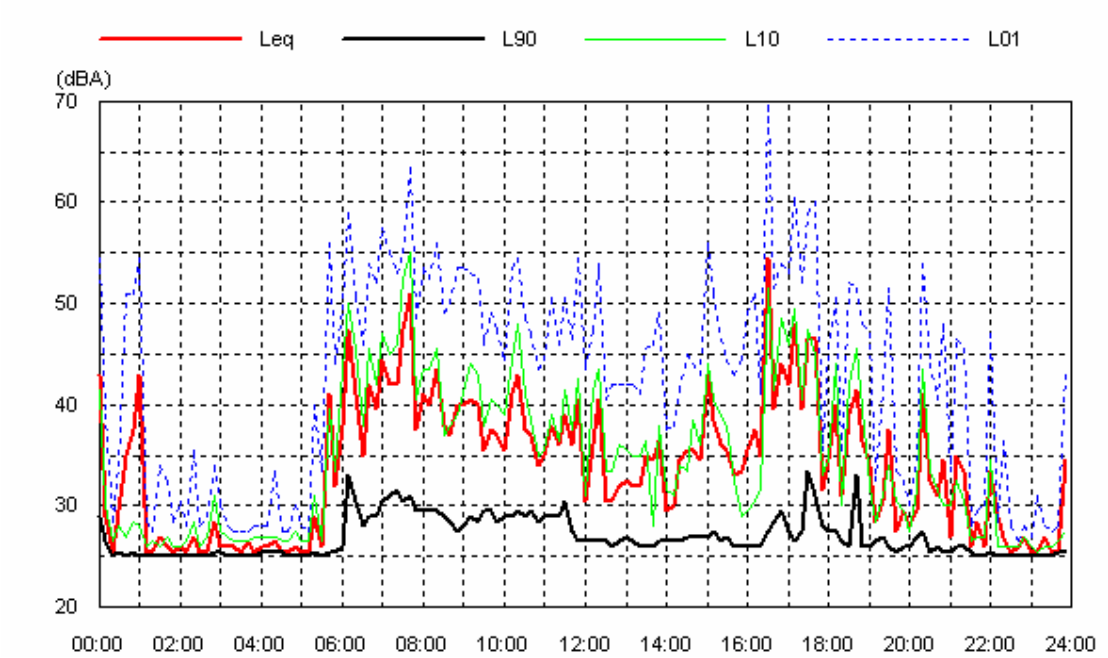

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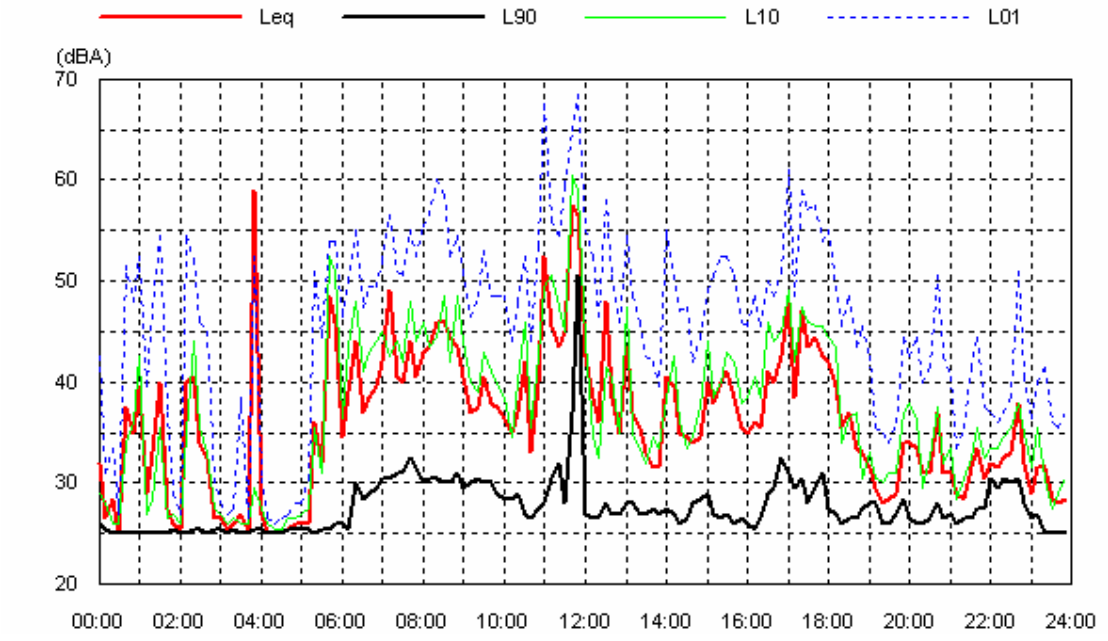

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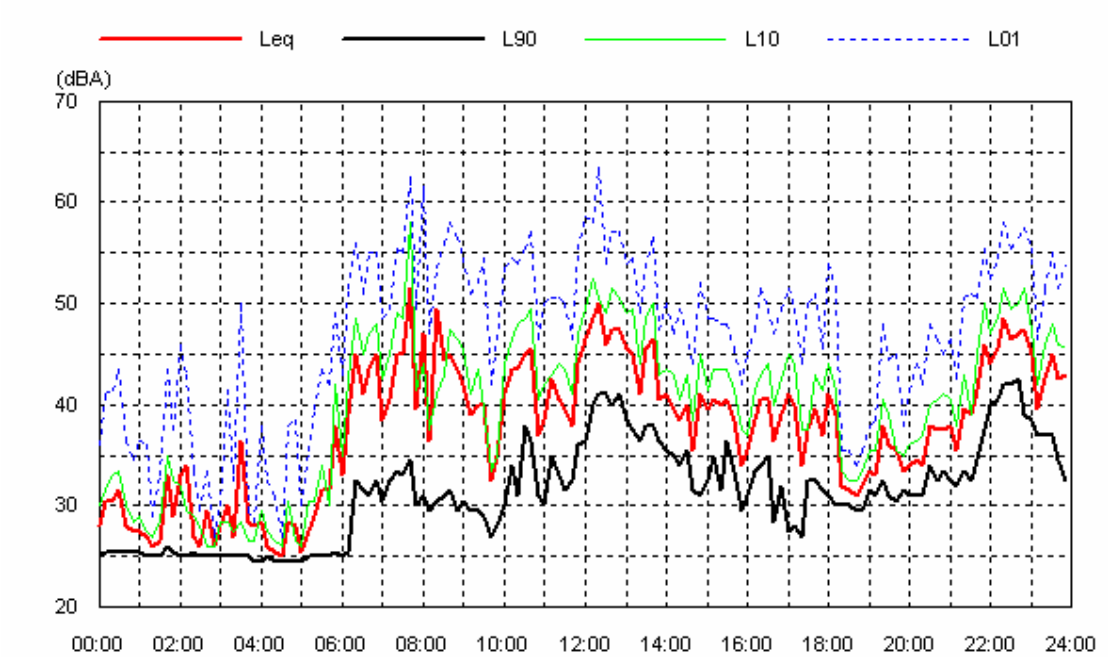

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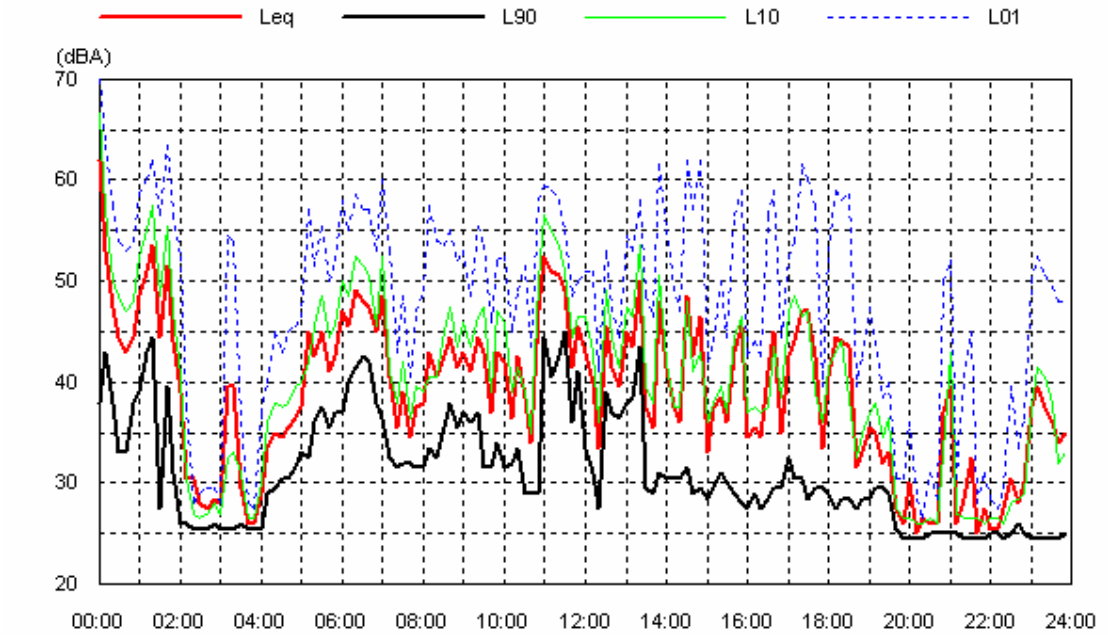

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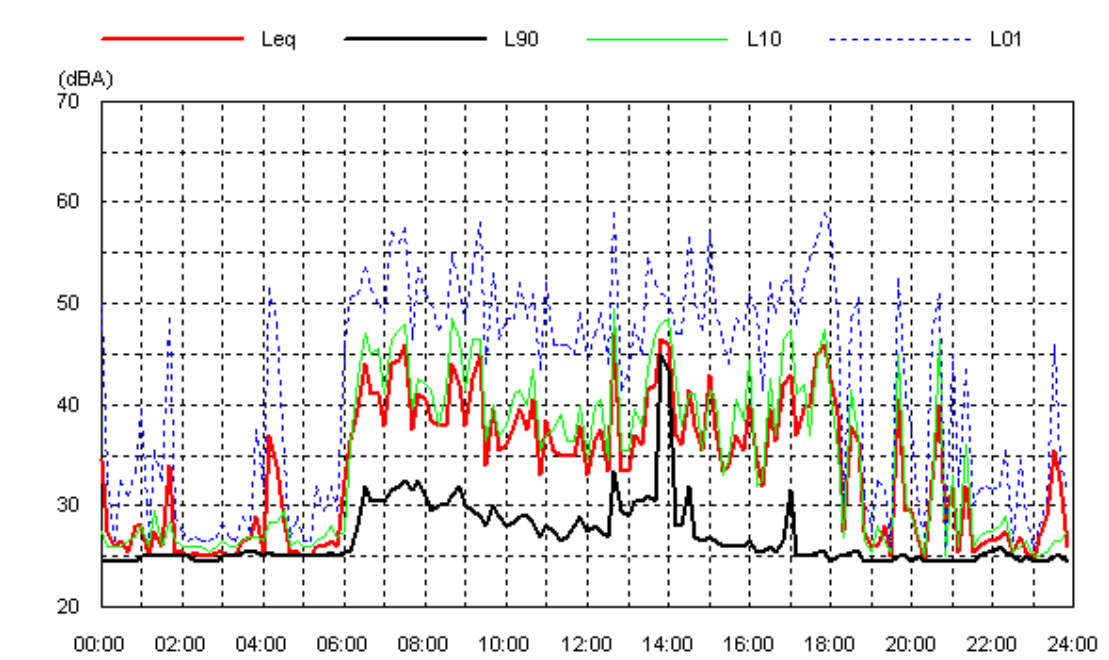

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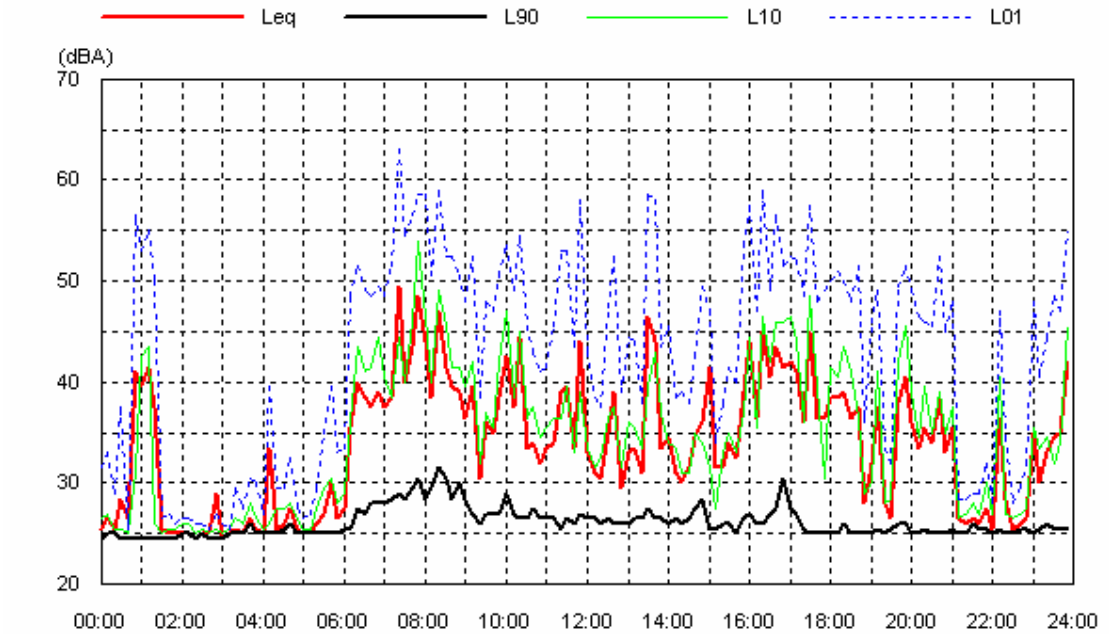

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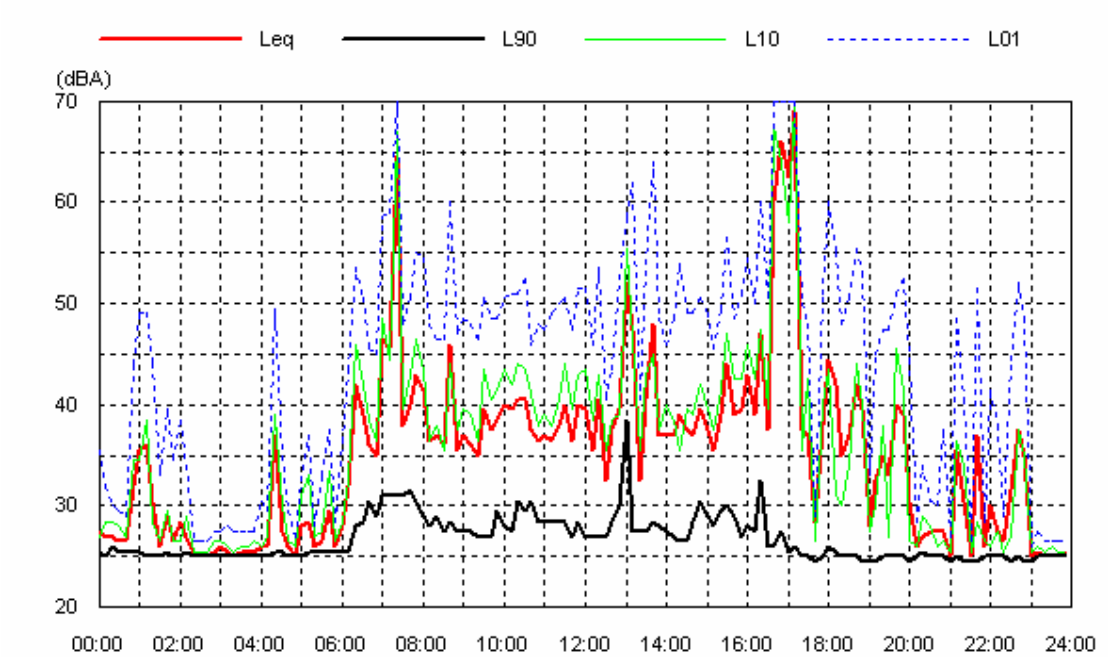

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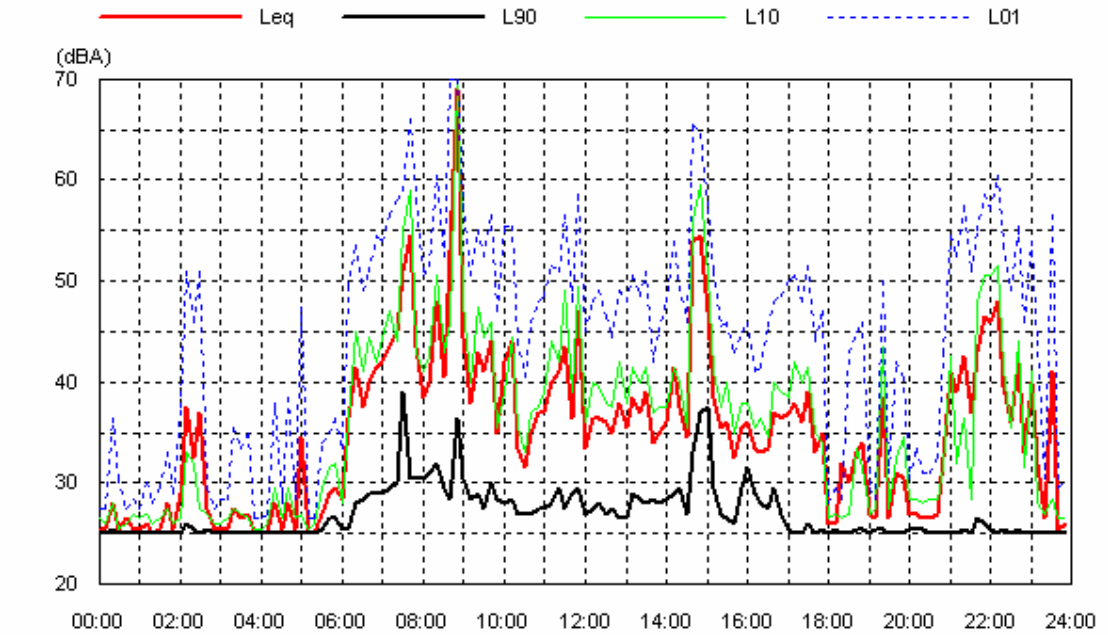

Location: Middlebrook Station

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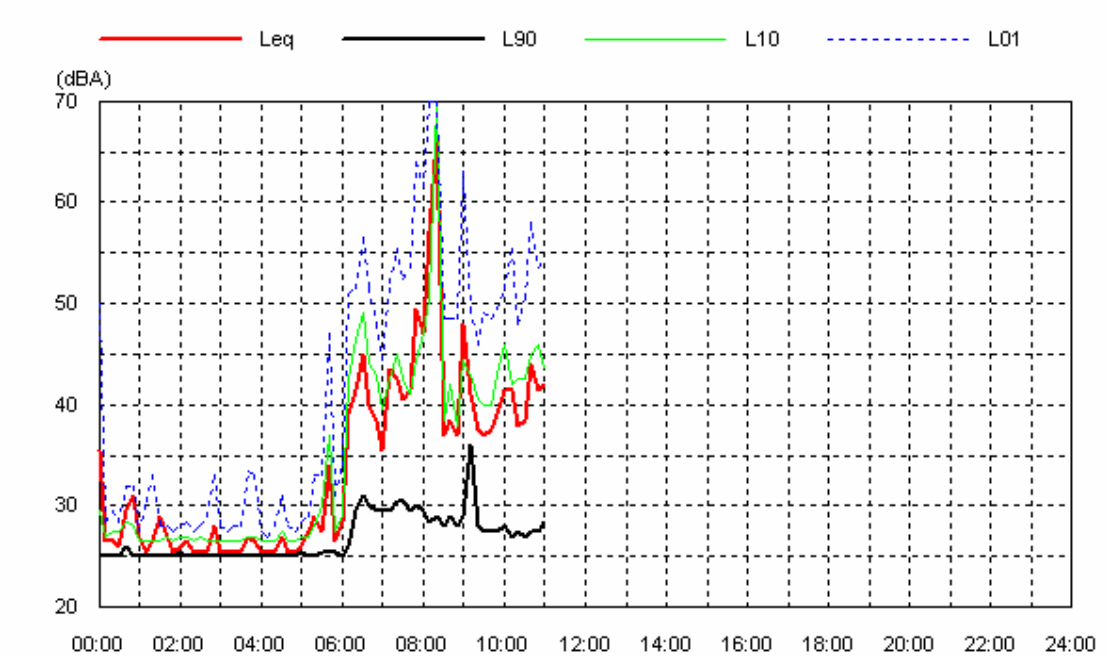

Middlebrook Station – Round 2

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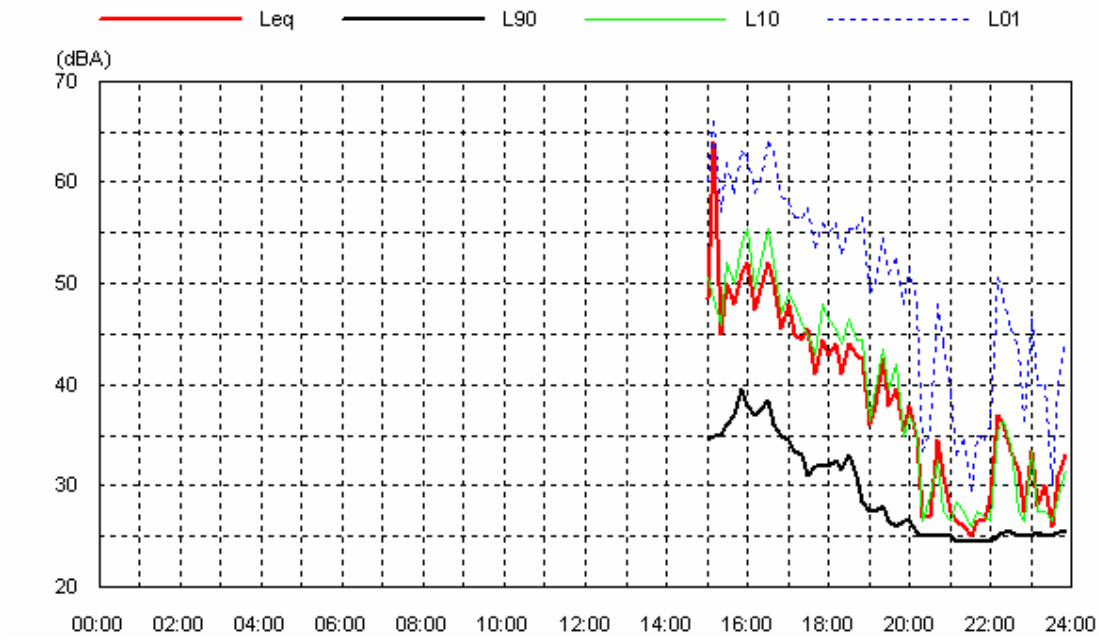

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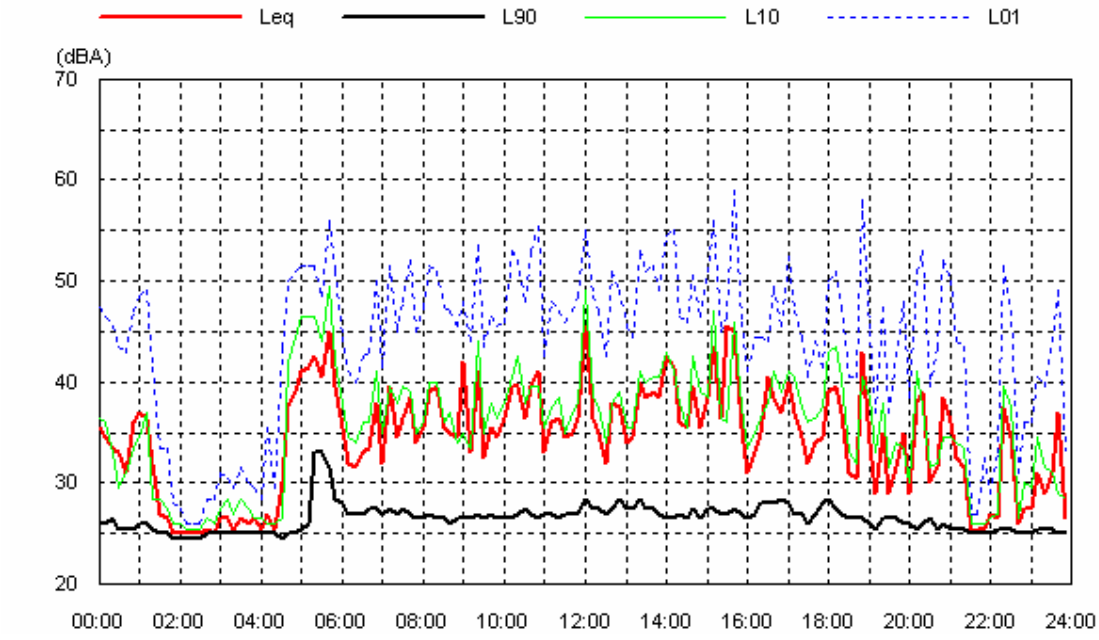

Location: MiddleBrook2

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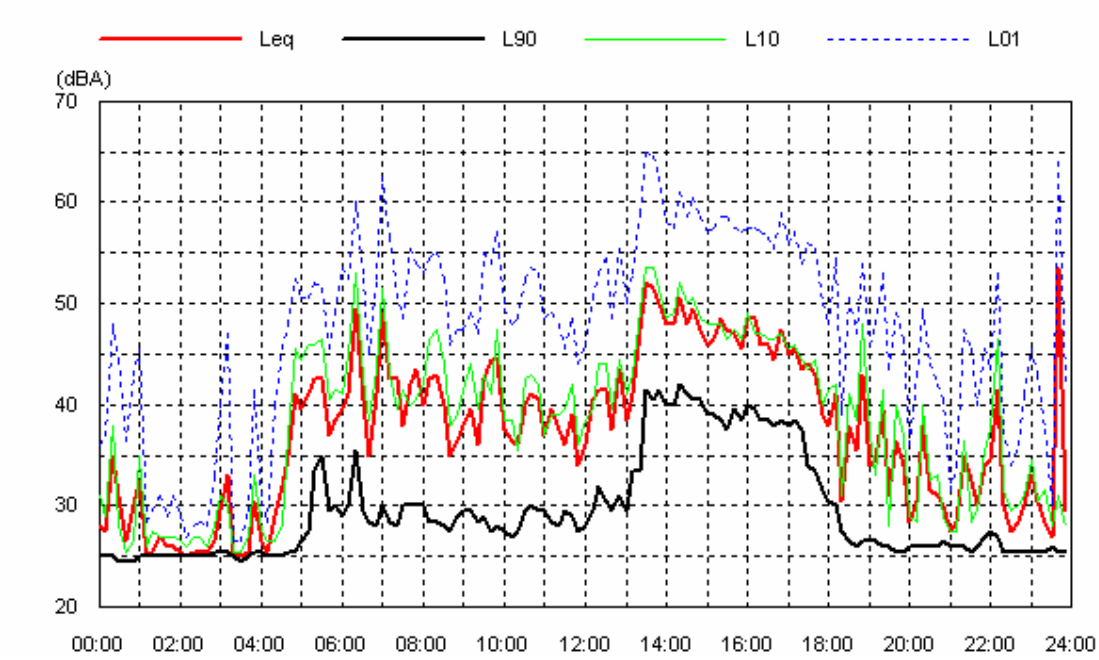

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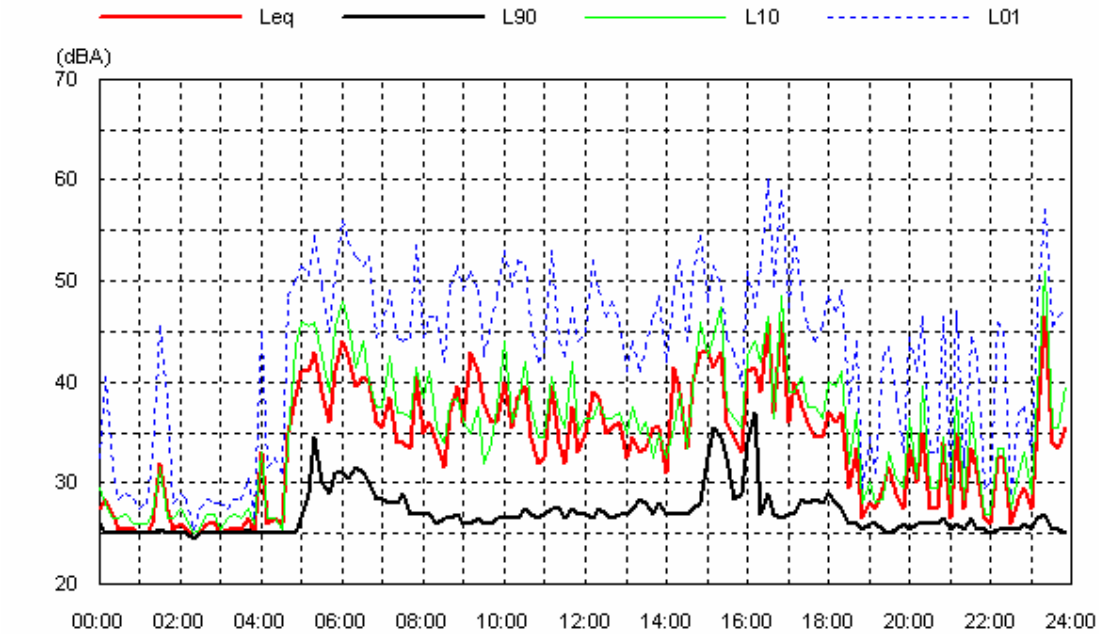

Location: MiddleBrook2

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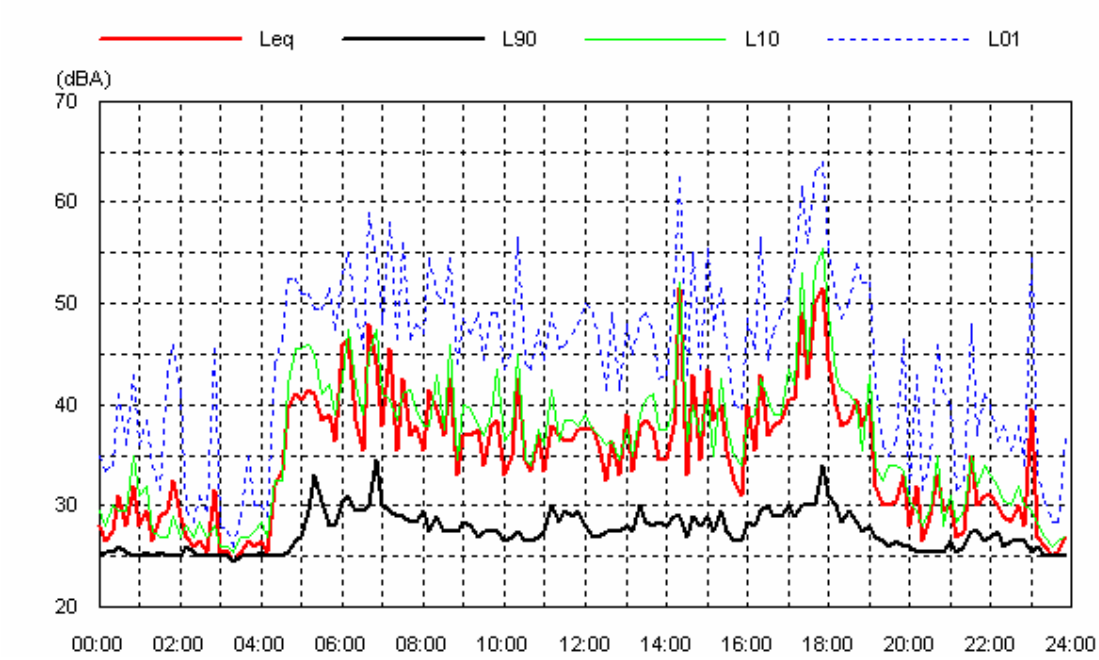

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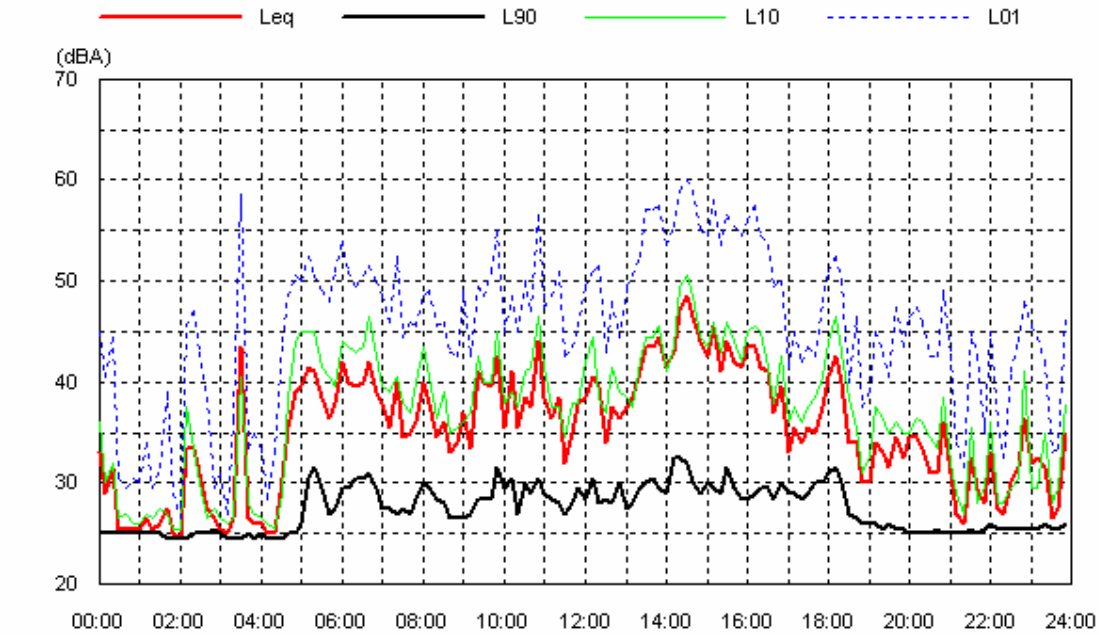

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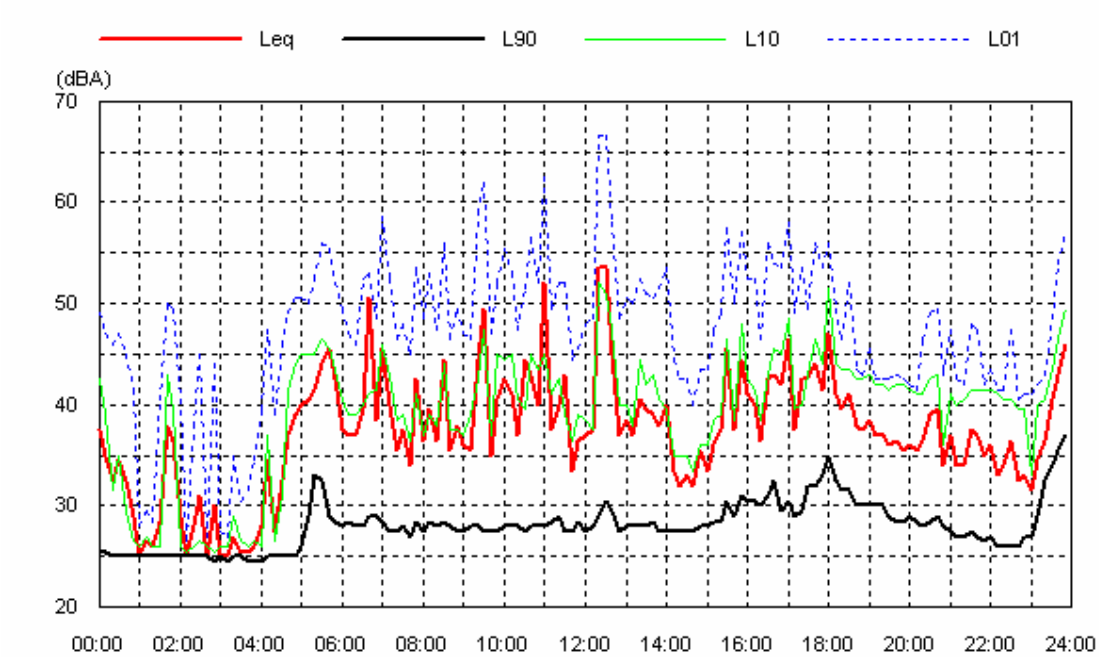

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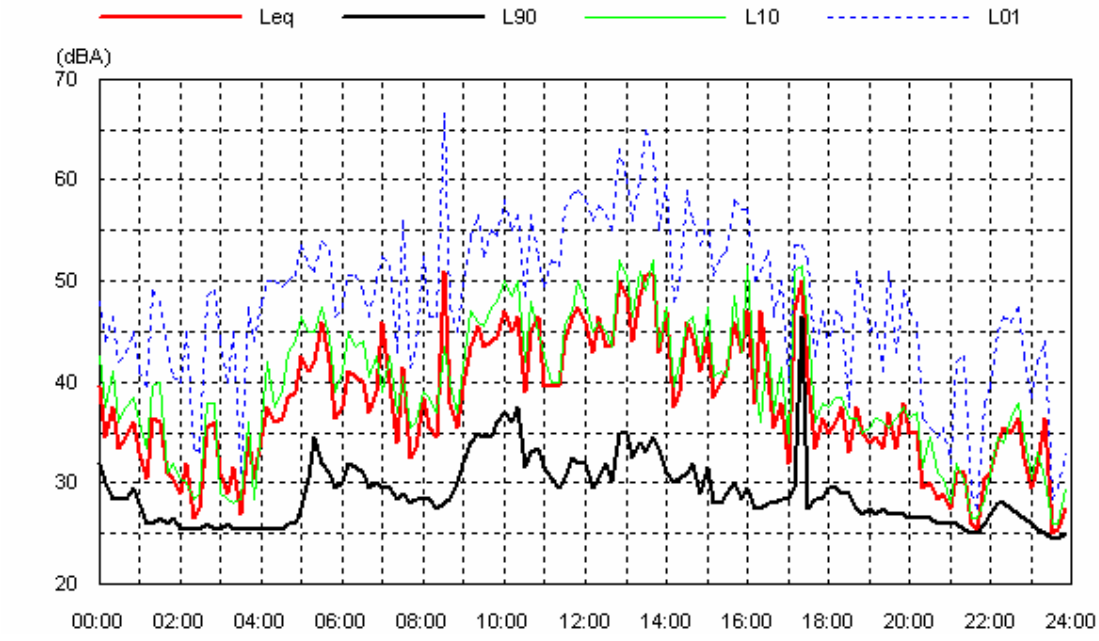

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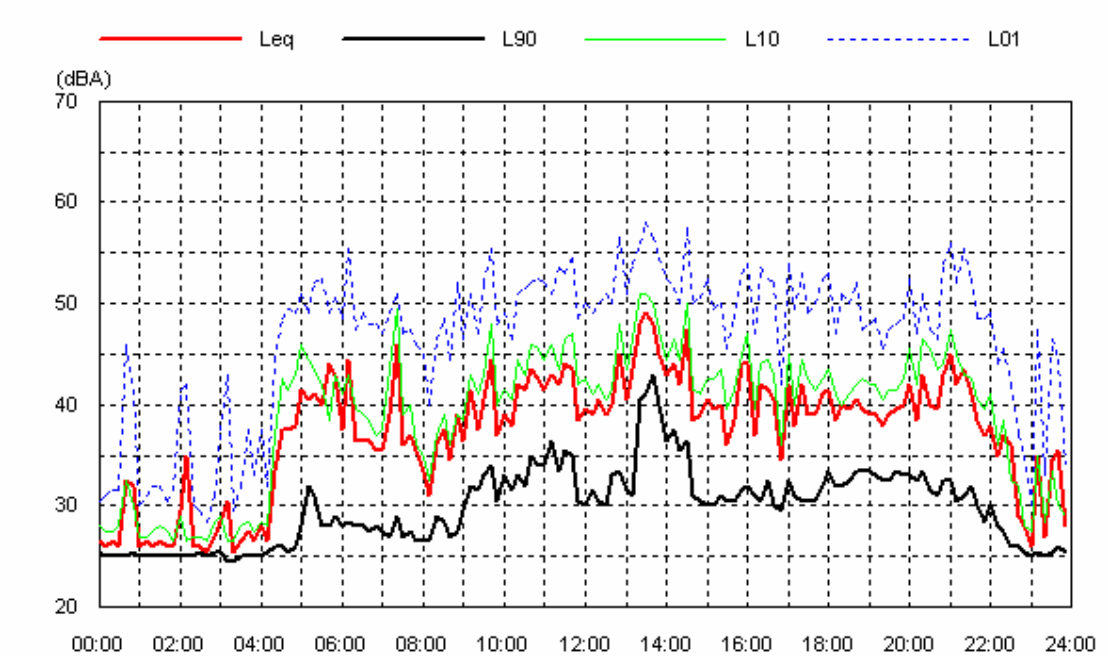

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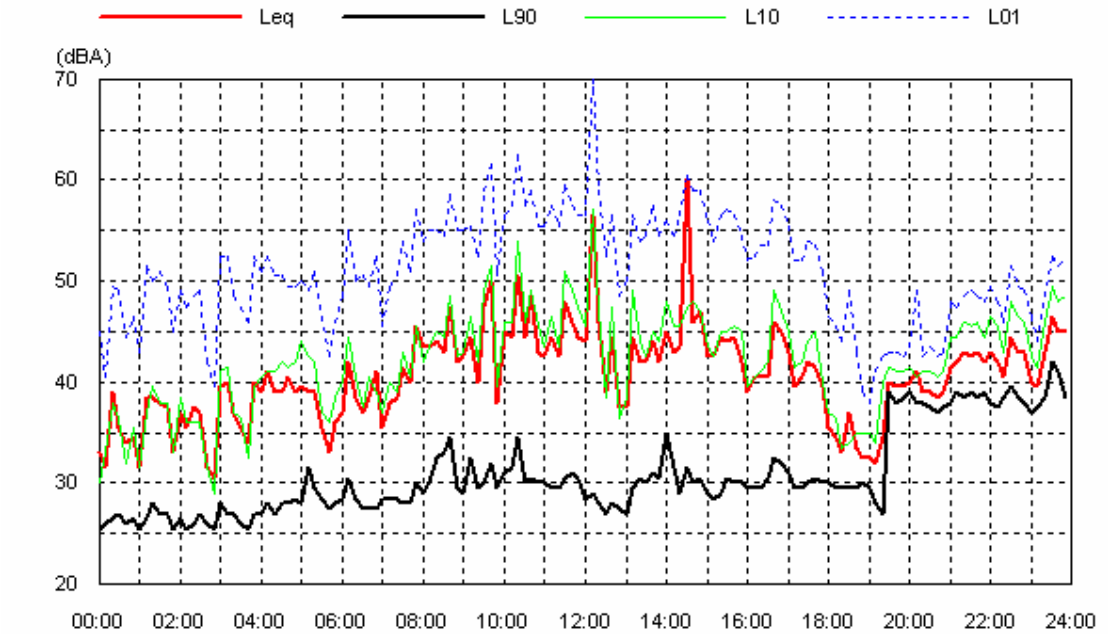

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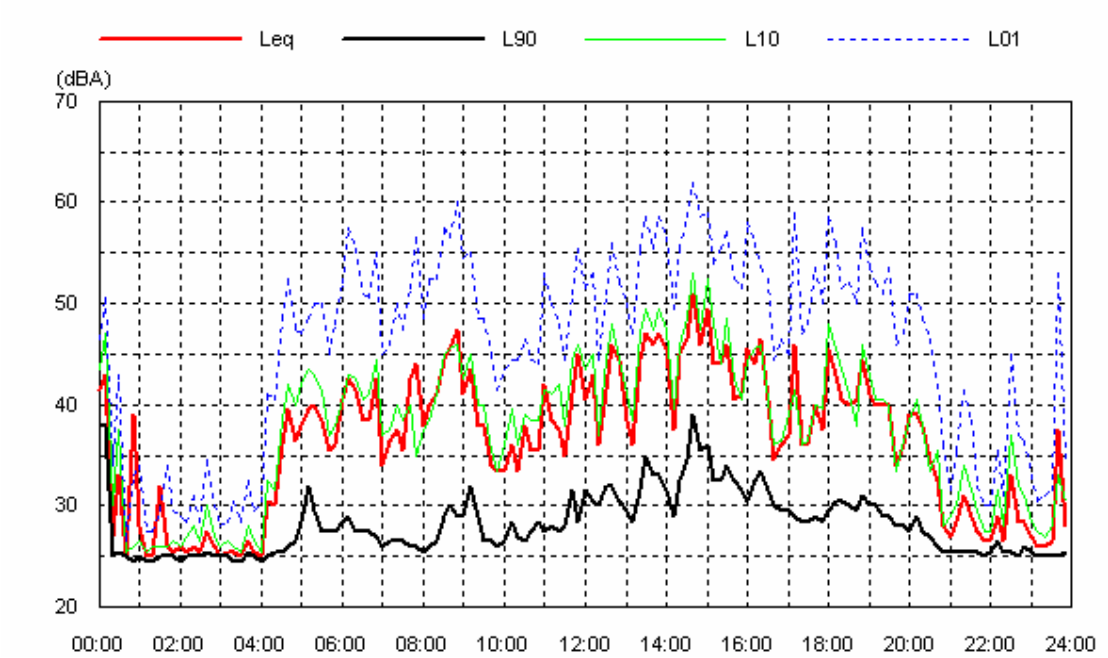

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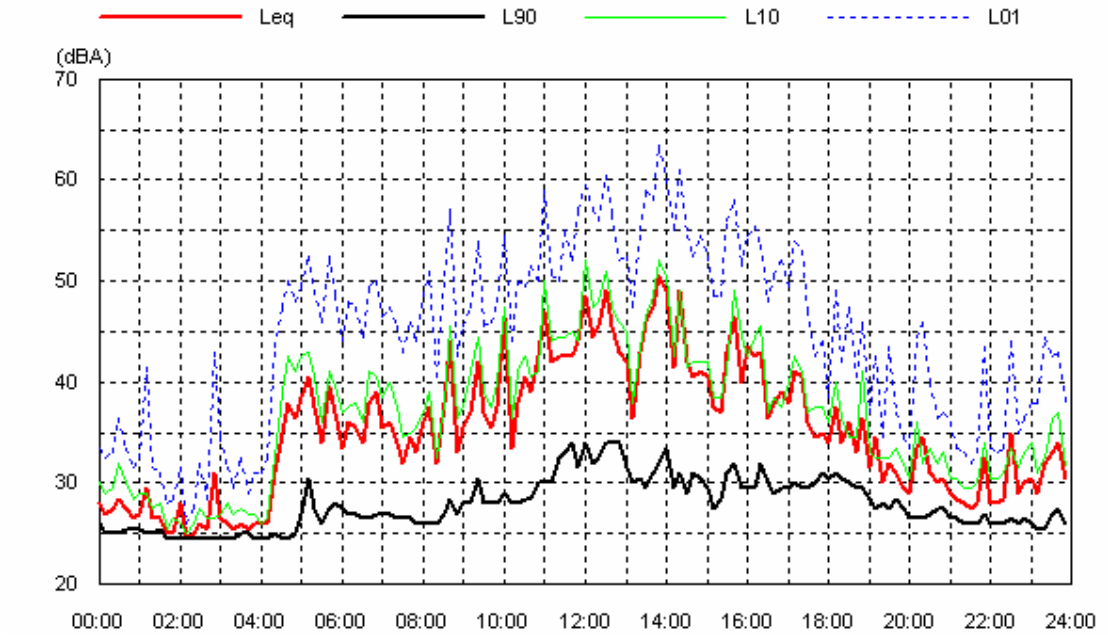

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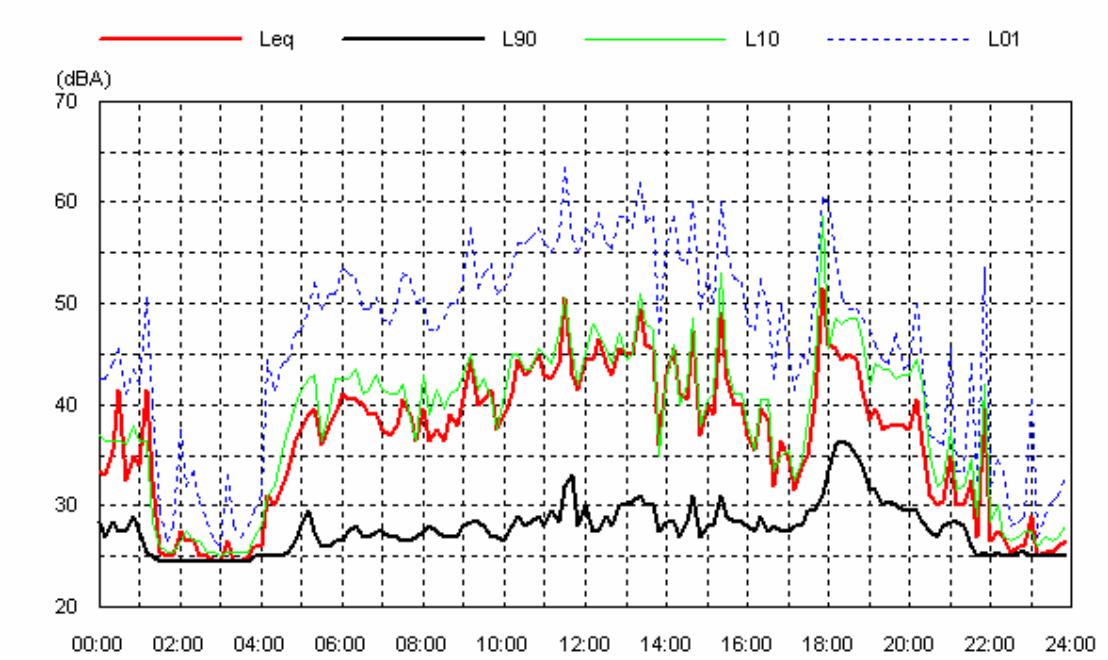

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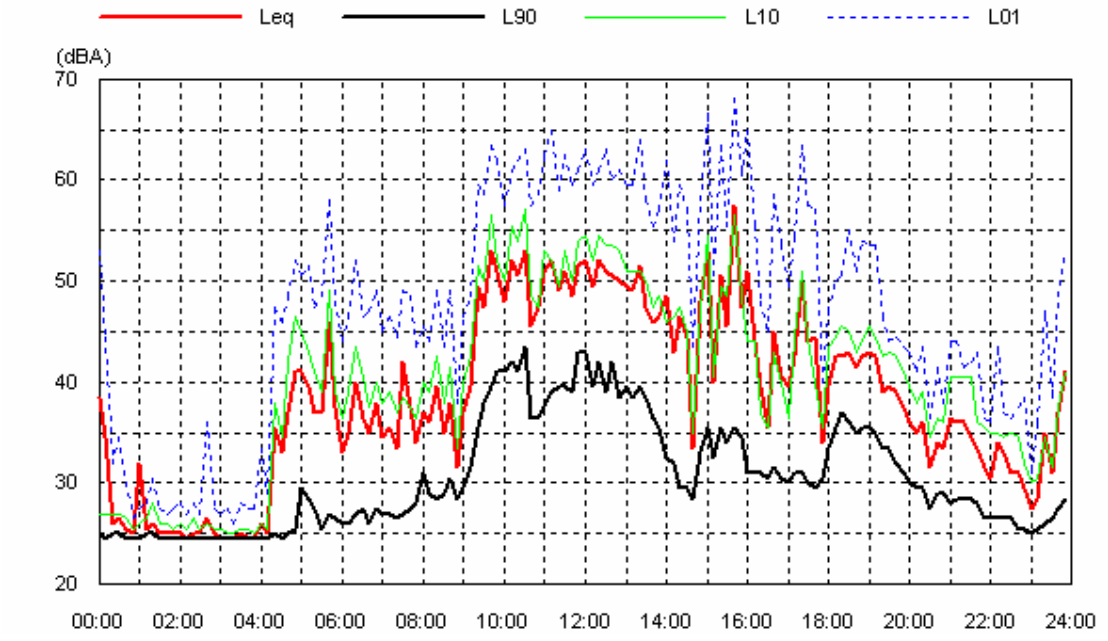

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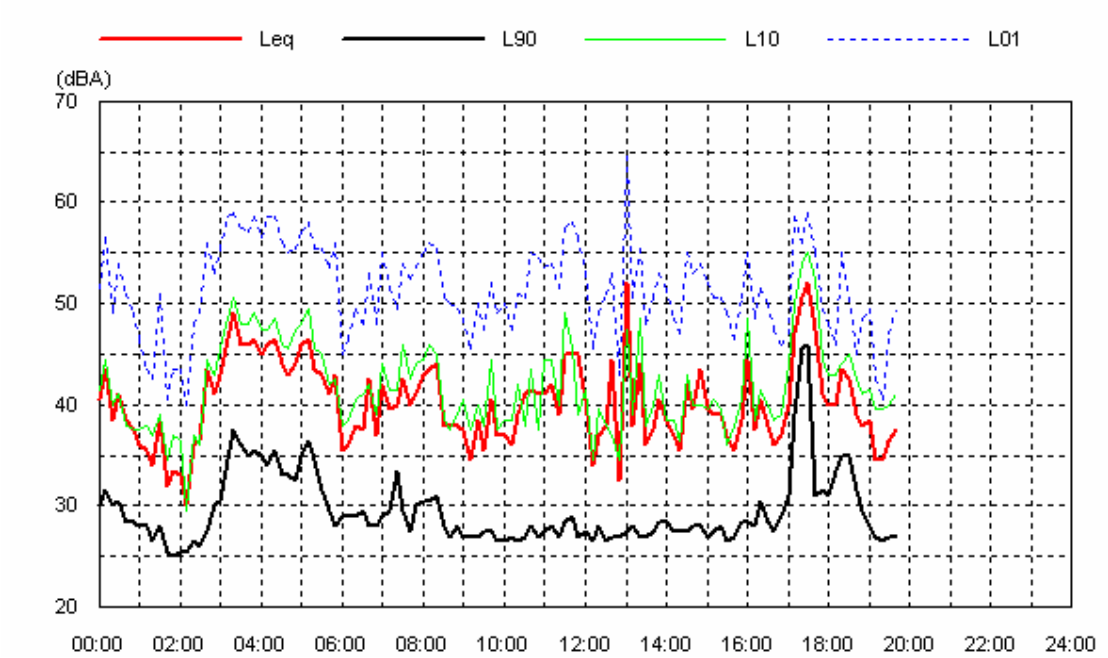

Peakhill – Round 1

Location: Peakhill

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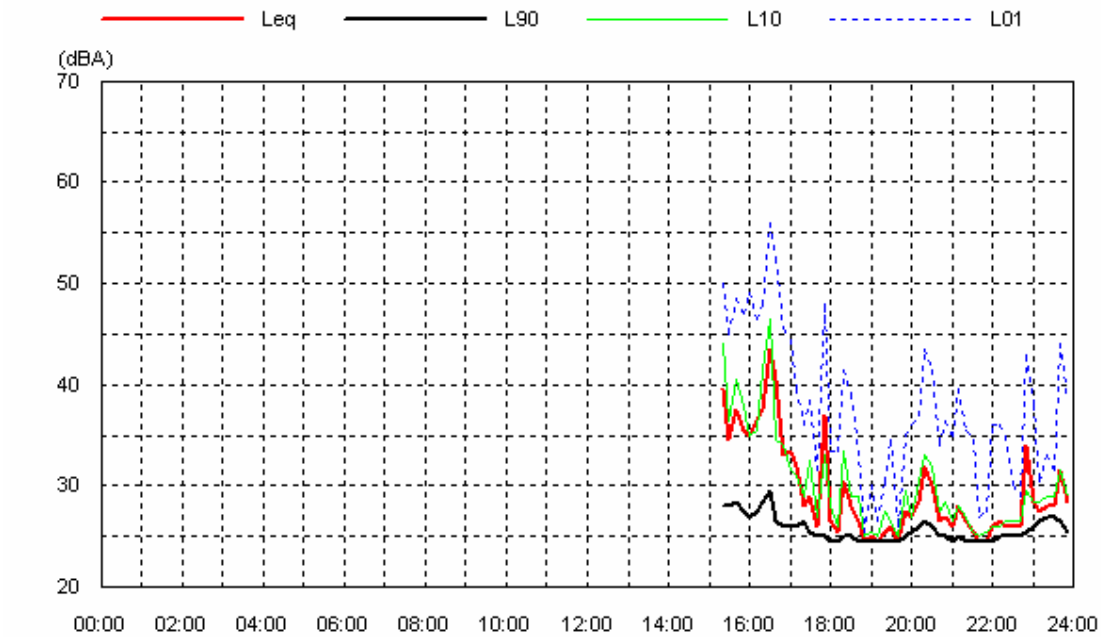

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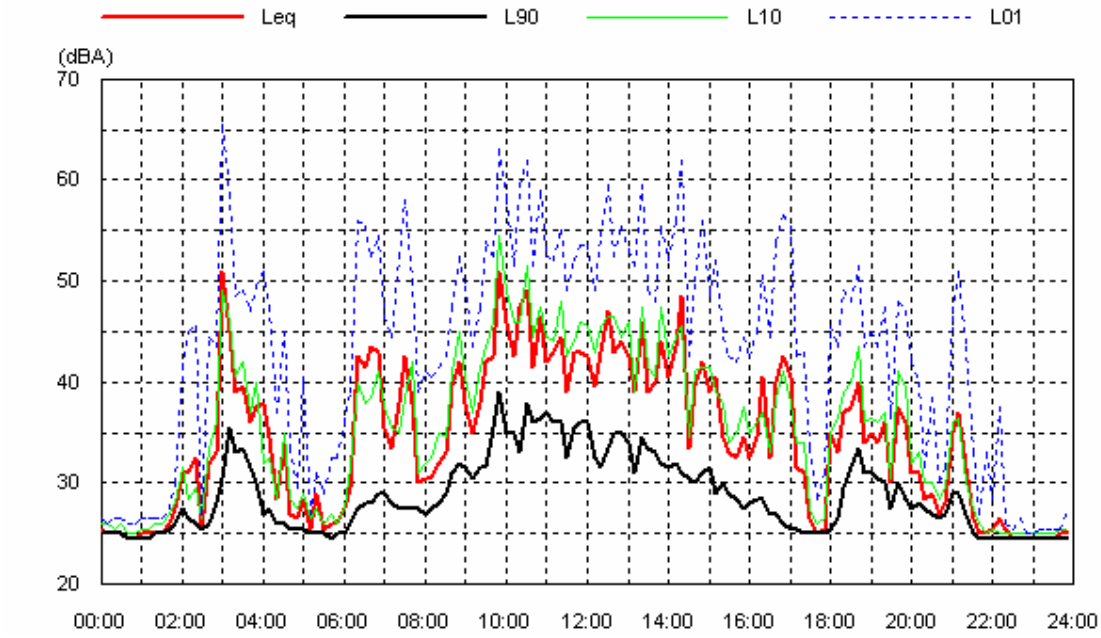

Location: Peakhill

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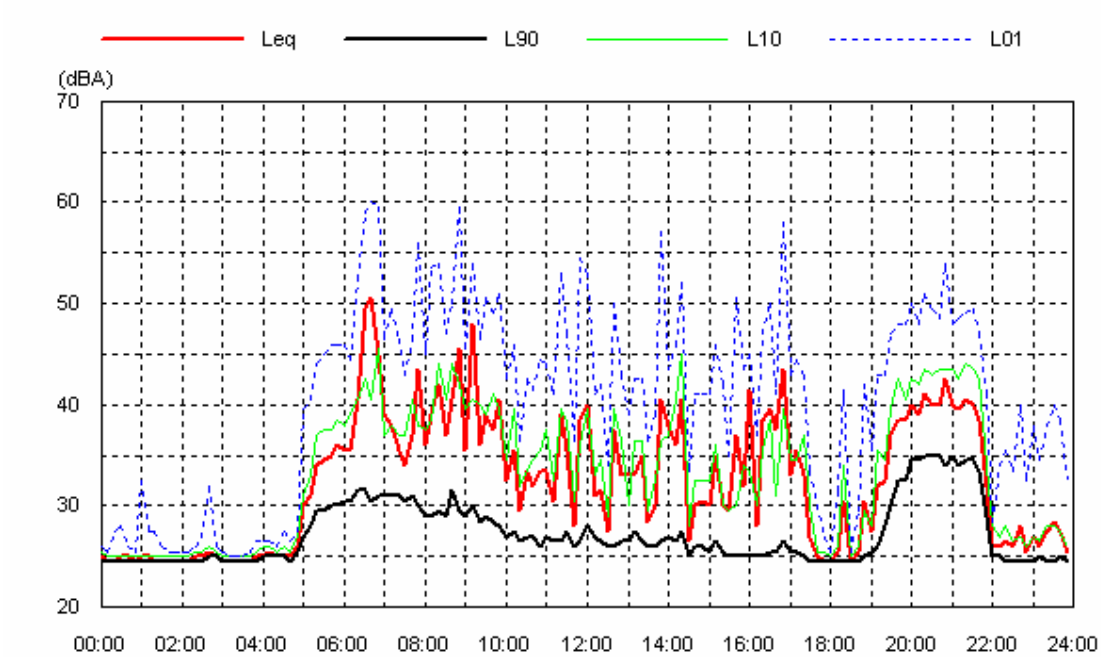

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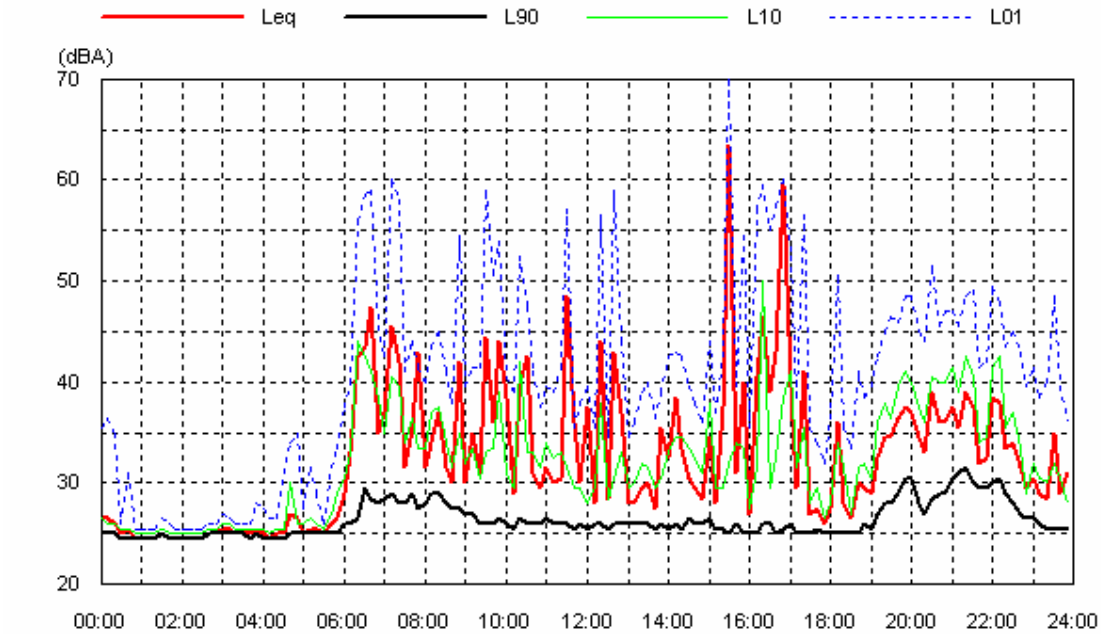

Location: Peakhill

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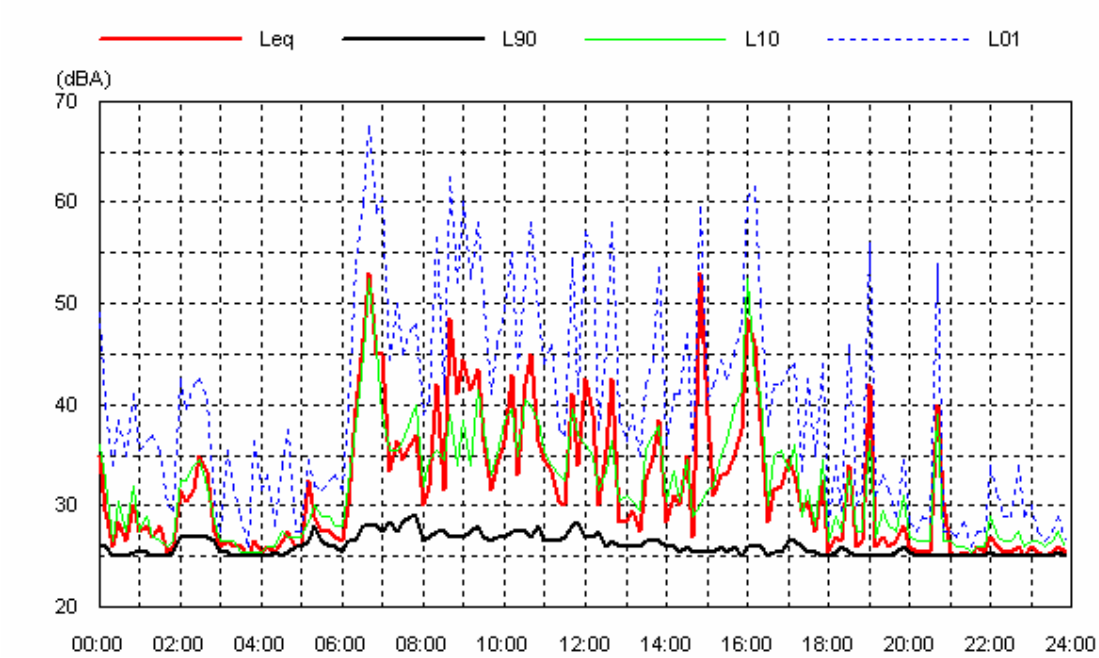
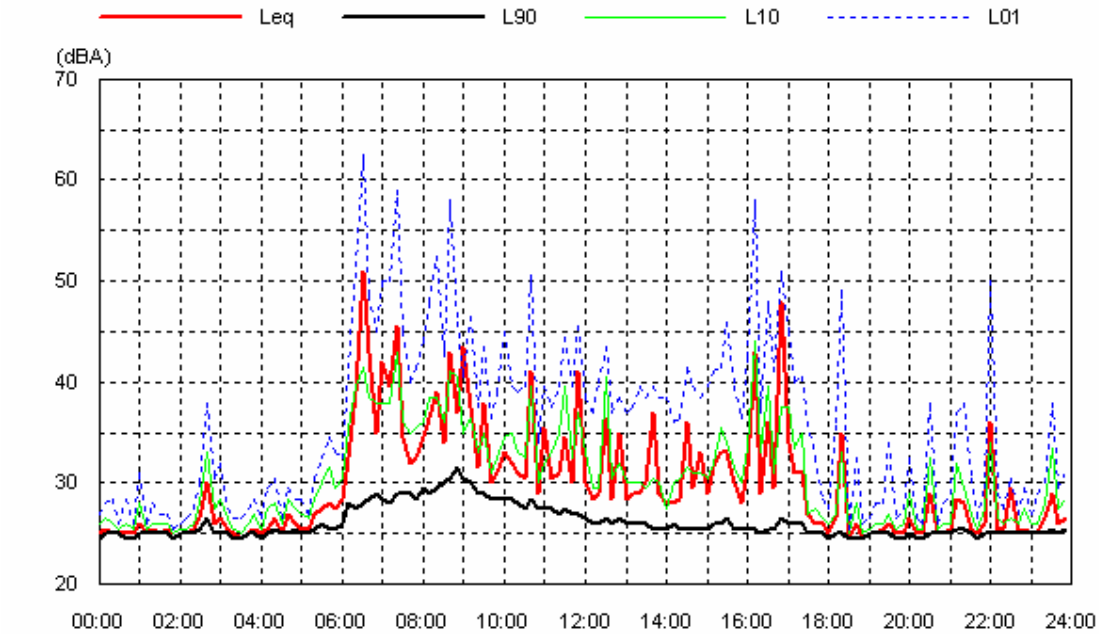
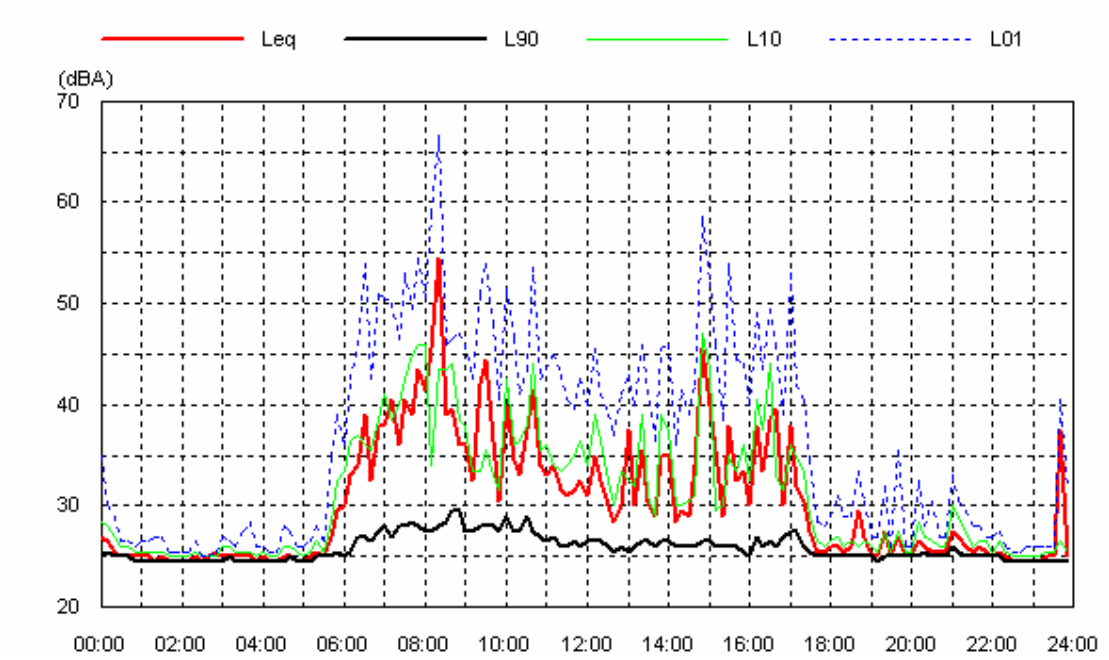


Sat 26 May 07

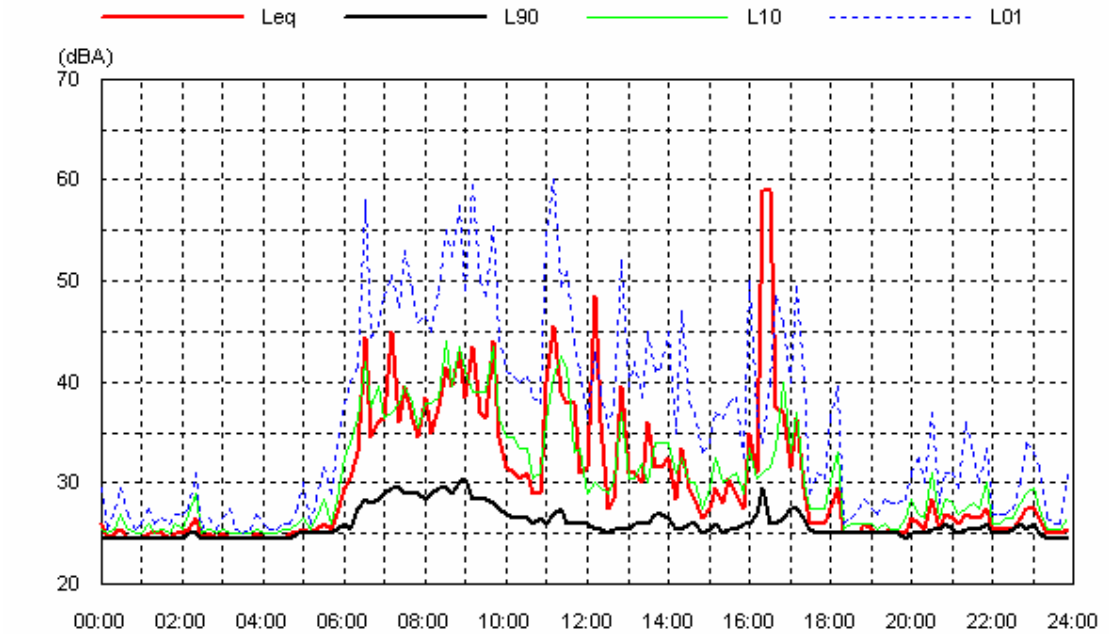


Location: Peakhill

Sun 27 May 07

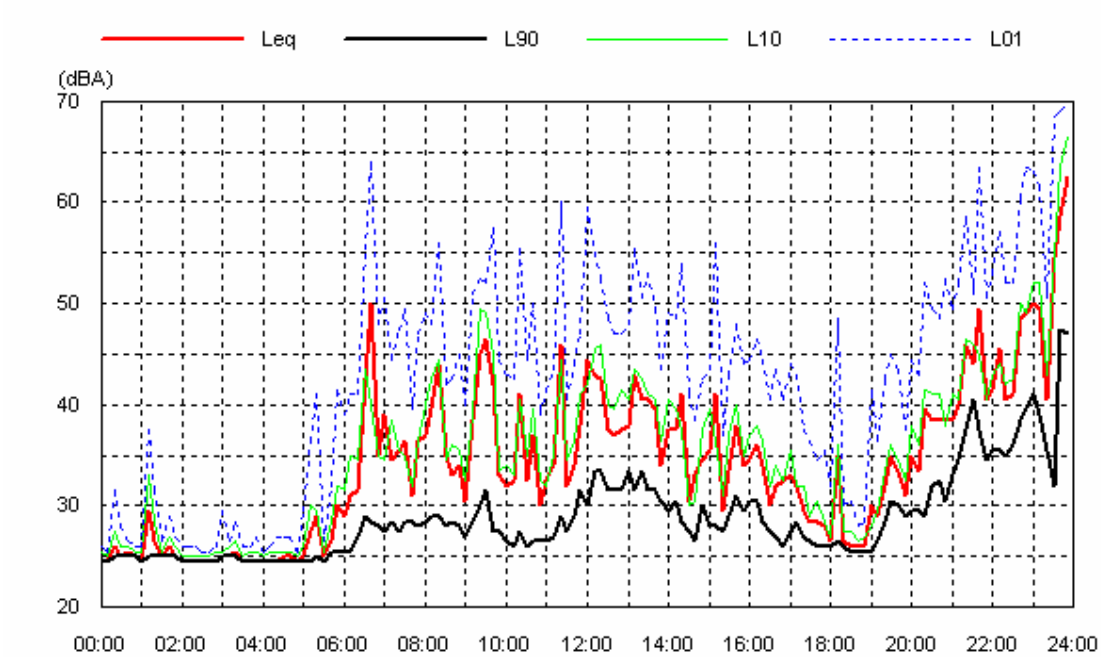


Mon 28 May 07

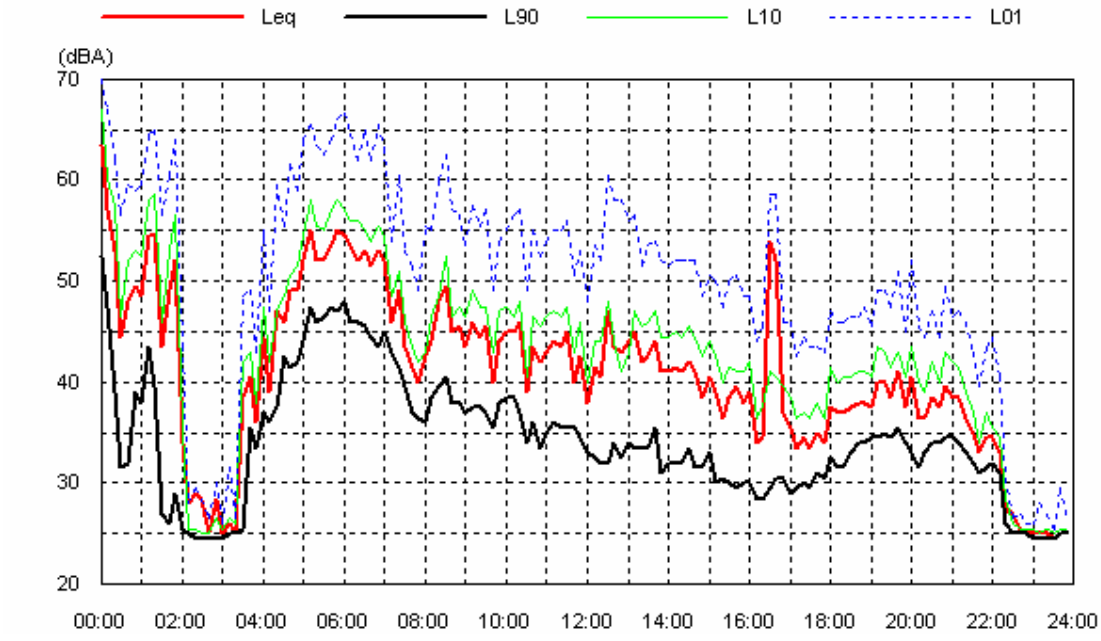


Location: Peakhill

Tue 29 May 07

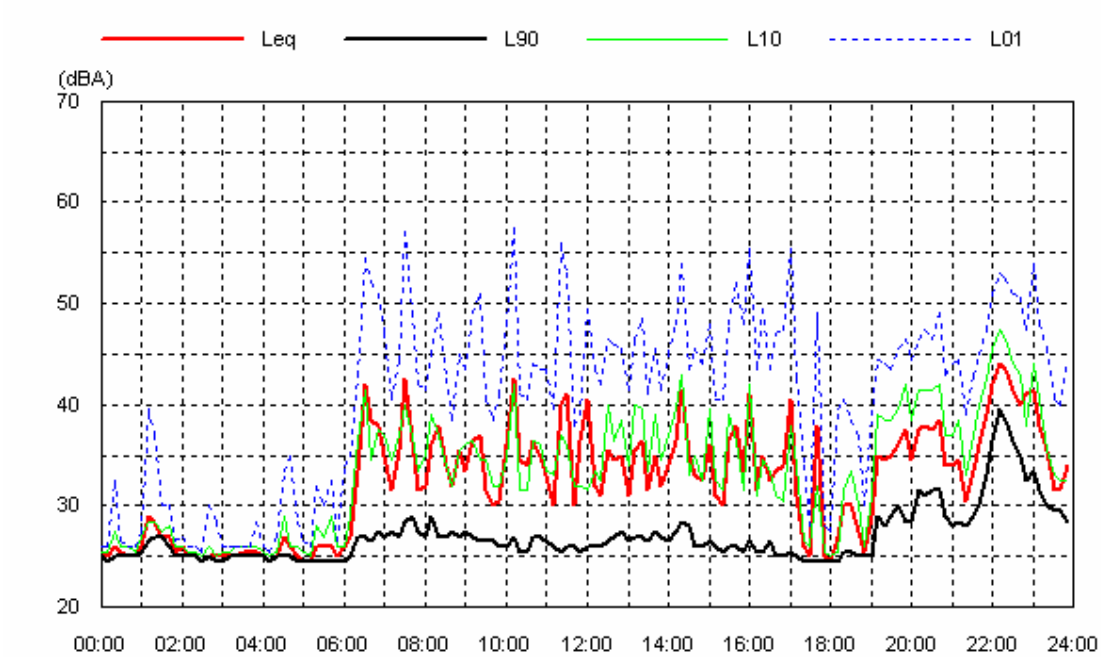


Wed 30 May 07

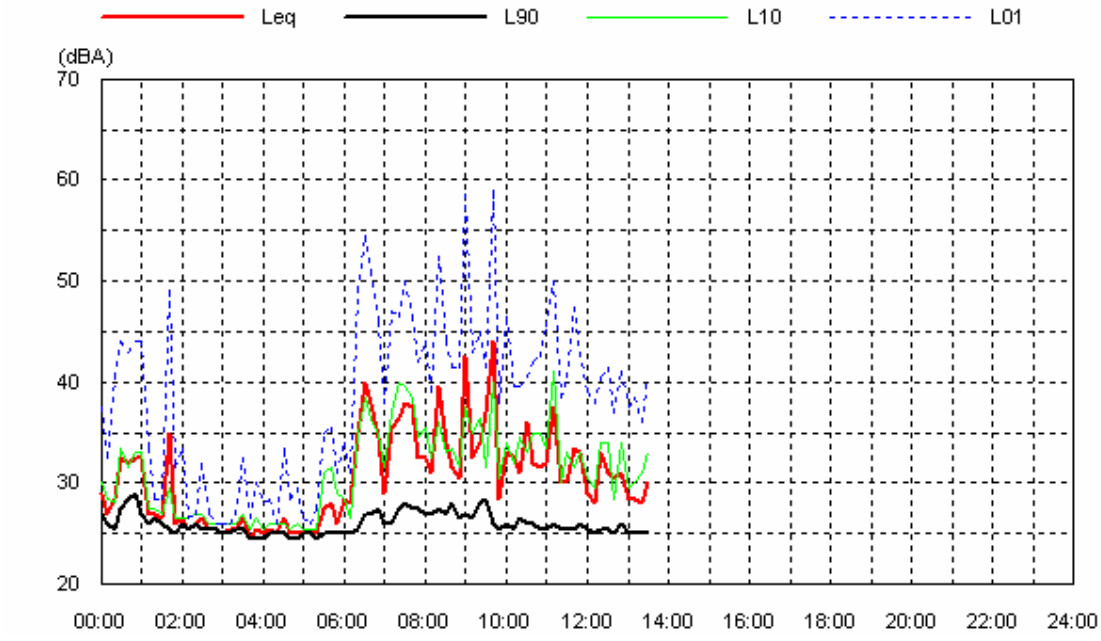


Location: Peakhill

Thu 31 May 07



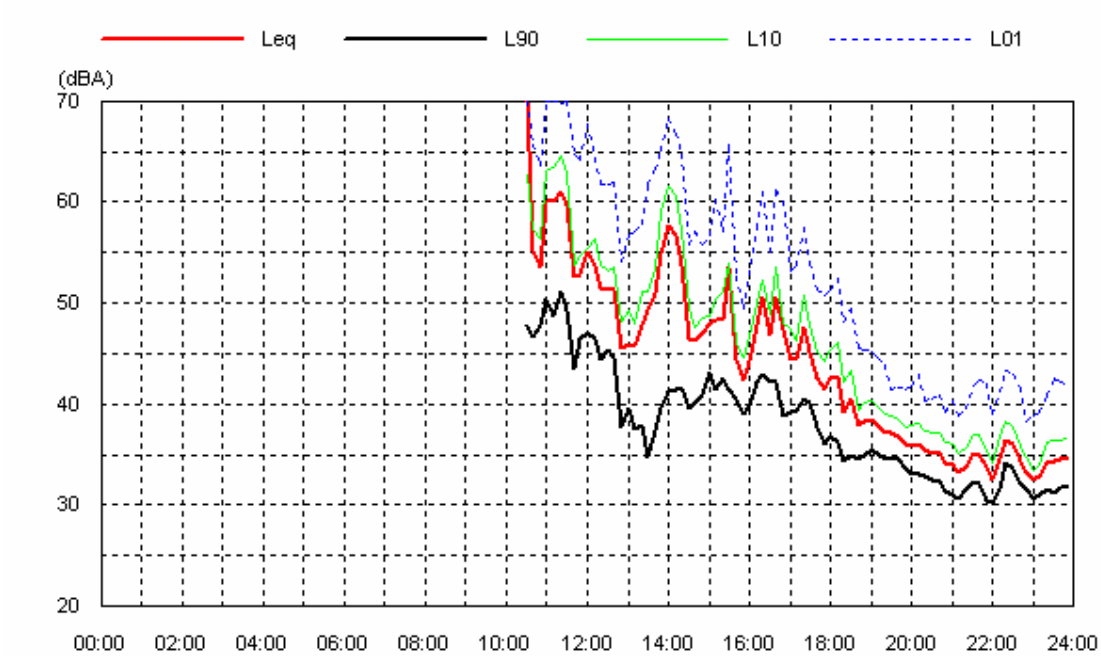
Fri 01 Jun 07



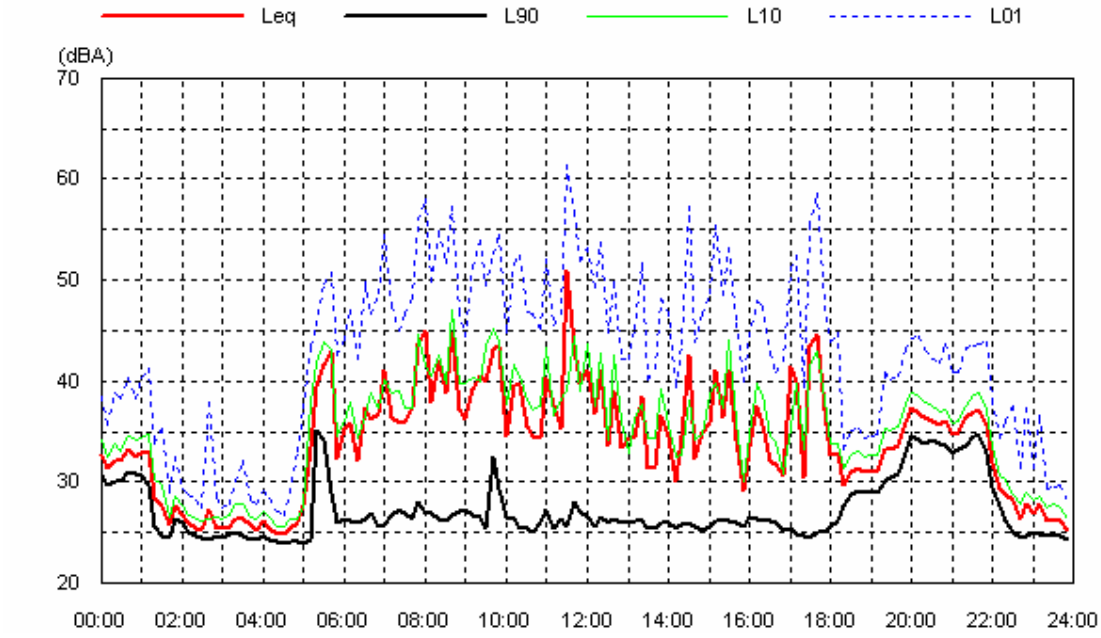
Peakhill – Round 2

Location: Peakhill2

Thu 20 Sep 07

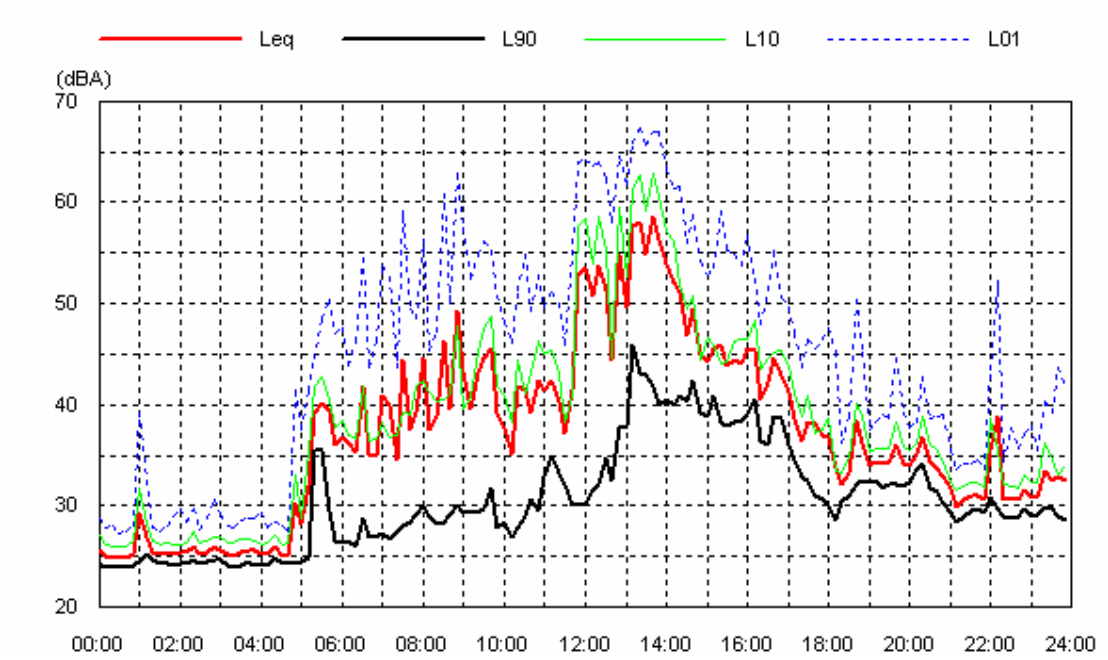


Fri 21 Sep 07

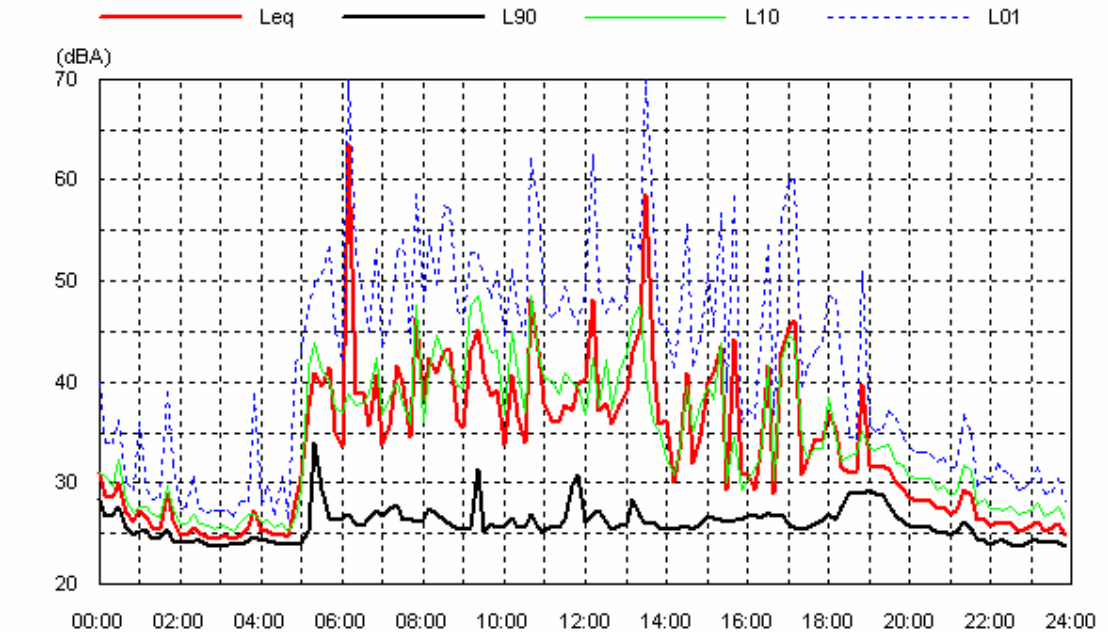


Location: Peakhill2

Sat 22 Sep 07

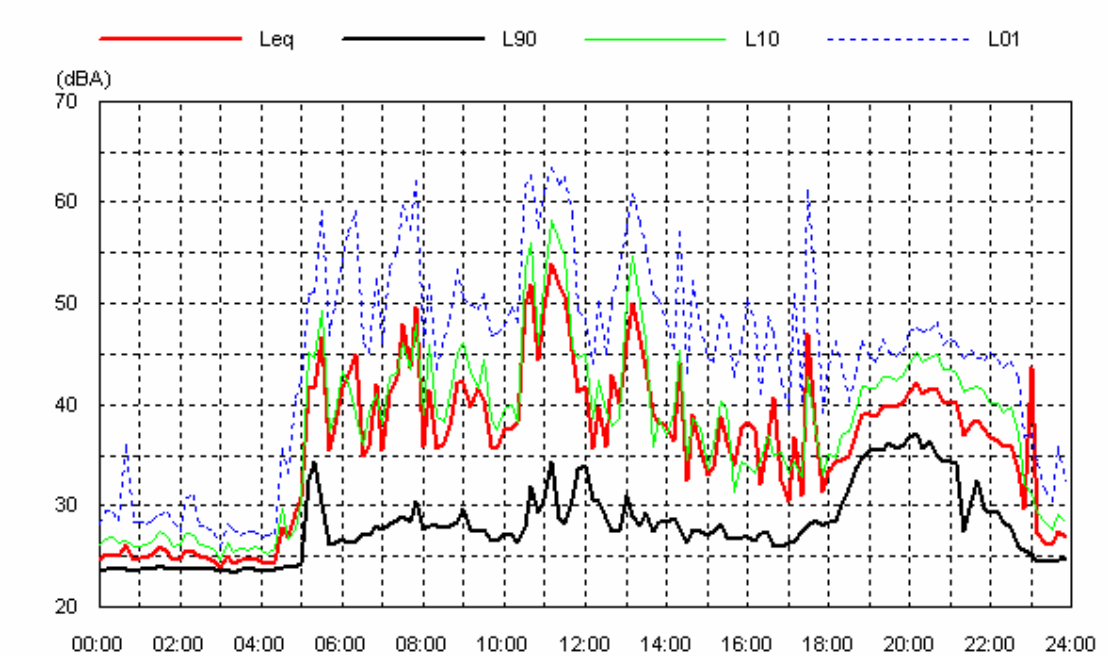


Sun 23 Sep 07

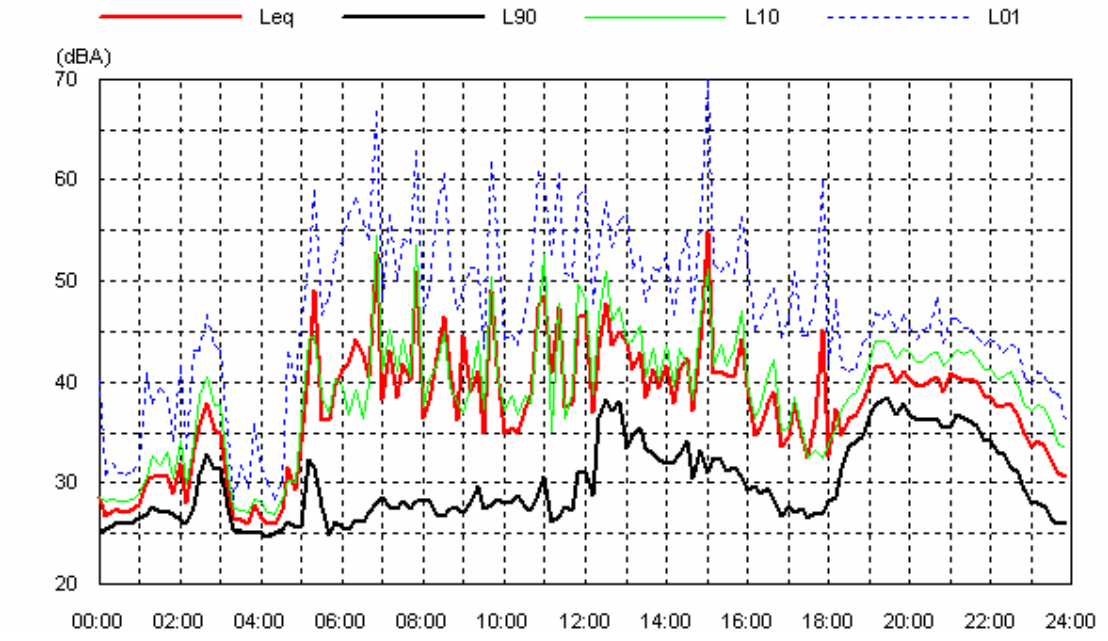


Location: Peakhill2

Mon 24 Sep 07

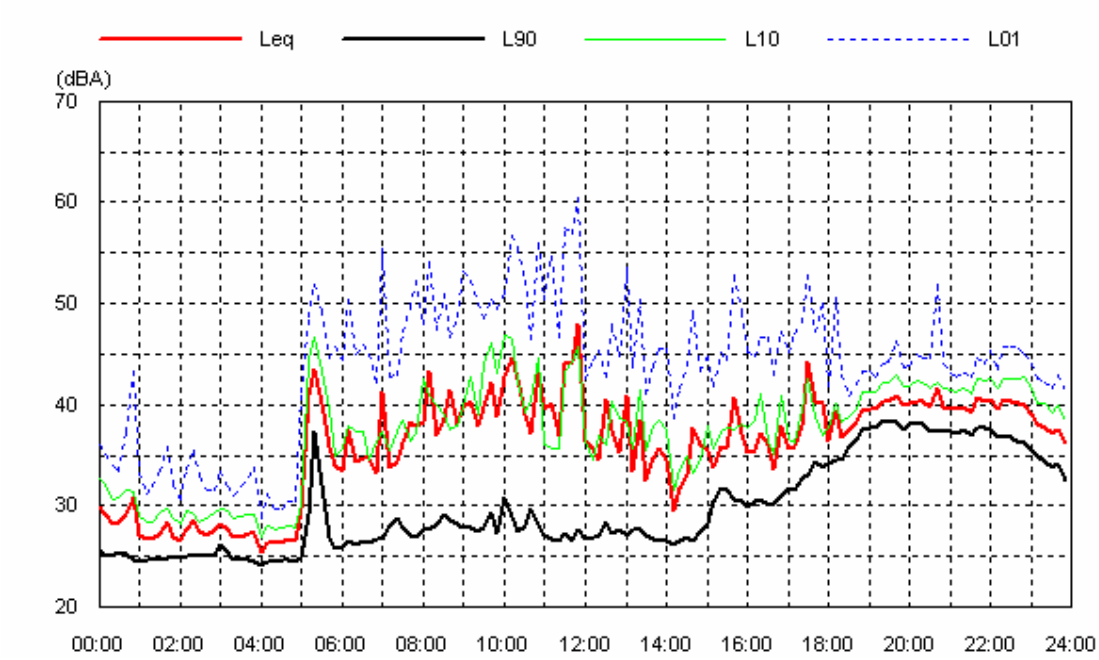


Tue 25 Sep 07

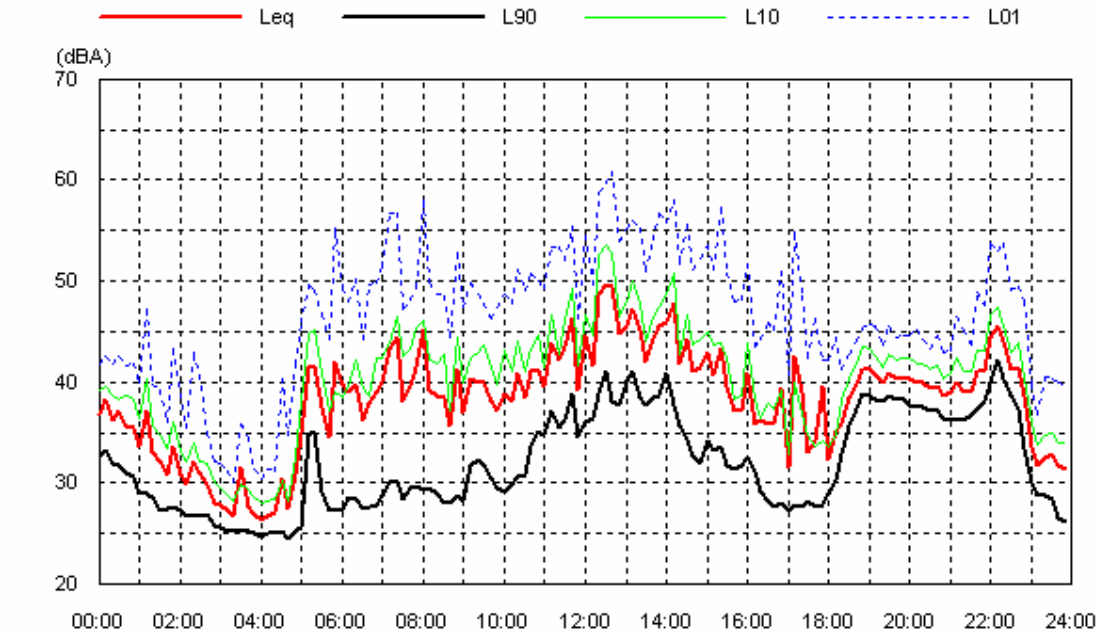


Location: Peakhill2

Wed 26 Sep 07

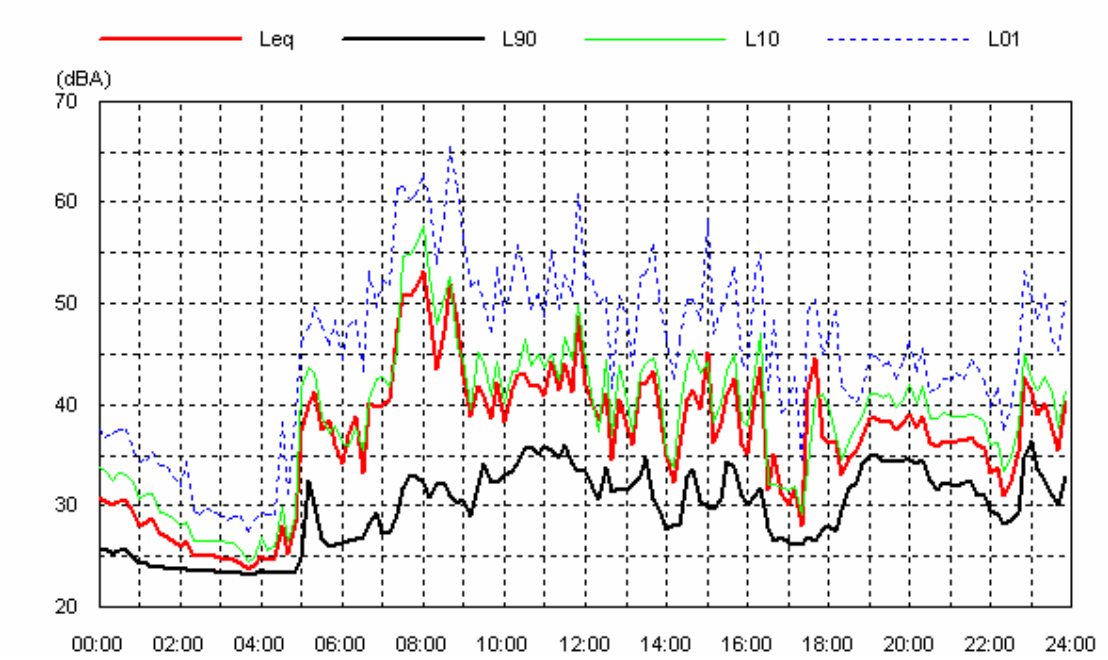


Thu 27 Sep 07

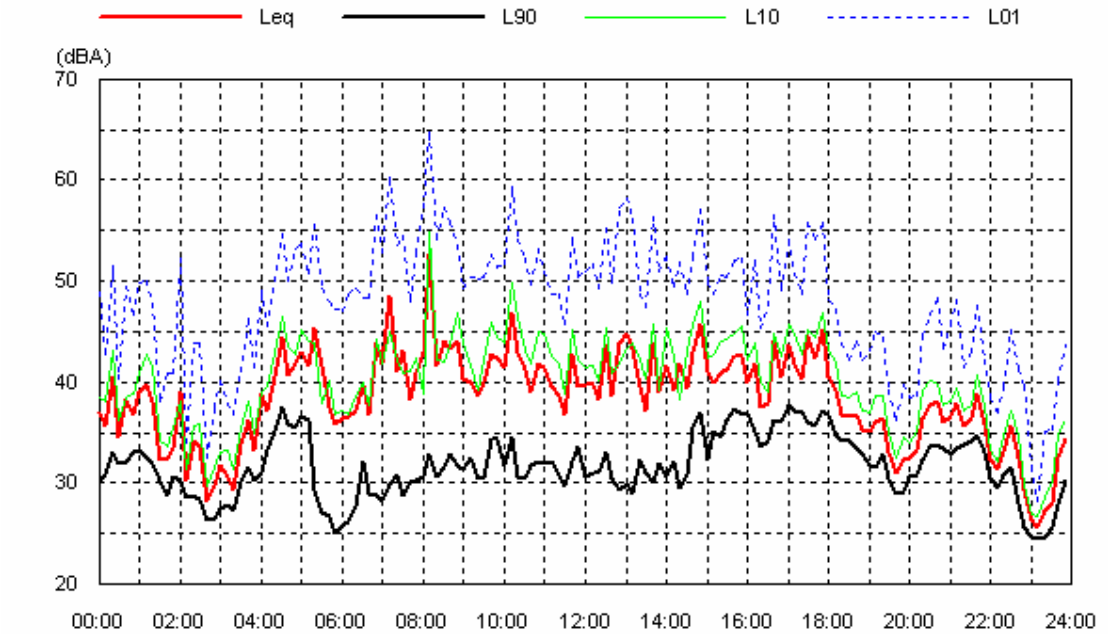


Location: Peakhill2

Fri 28 Sep 07

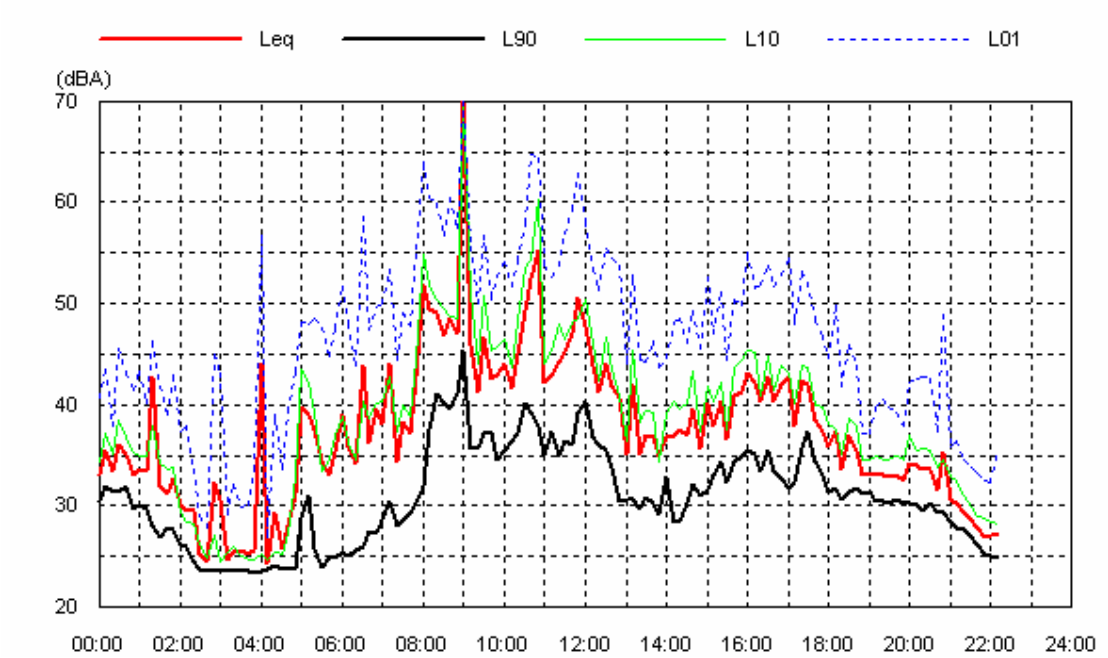


Sat 29 Sep 07



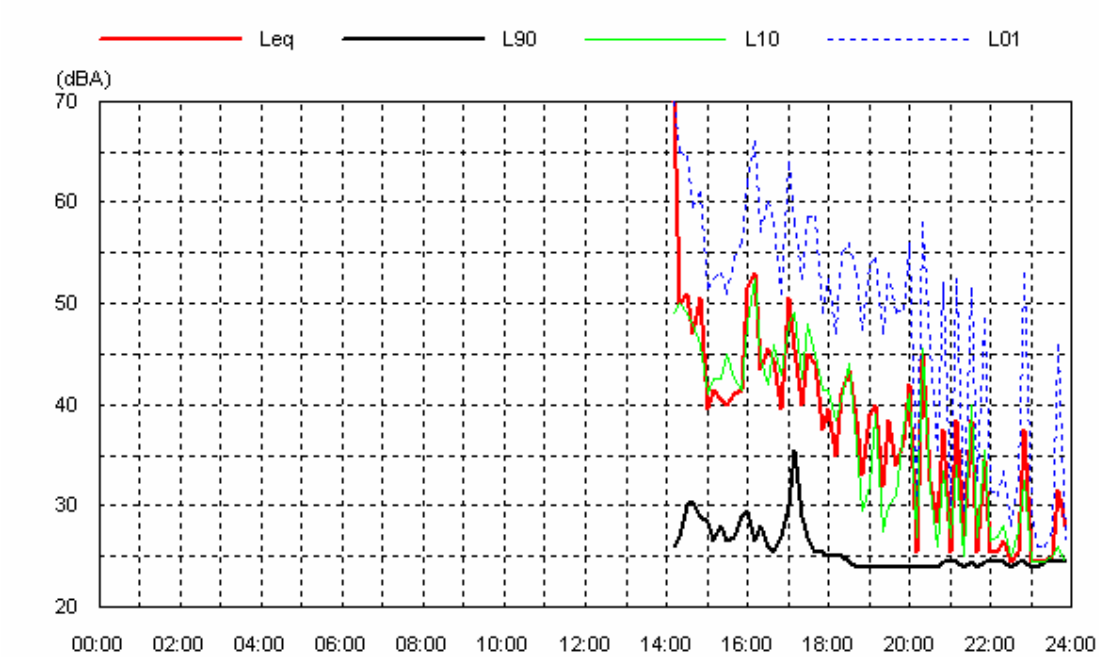
Location: Peakhill2

Sun 30 Sep 07

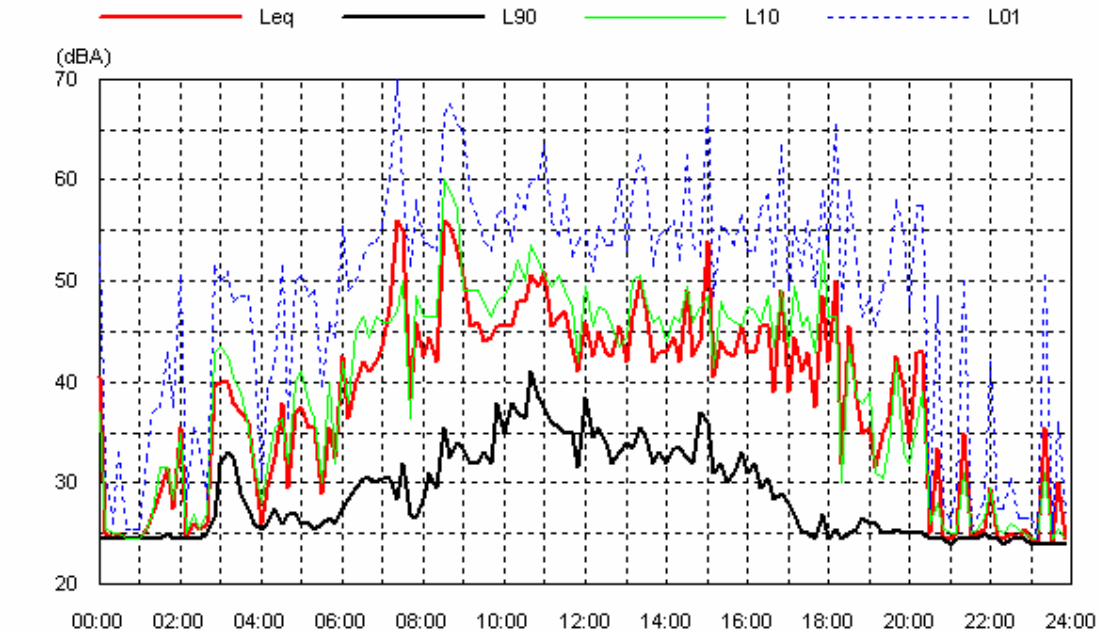


Location: Greyland

Mon 21 May 07

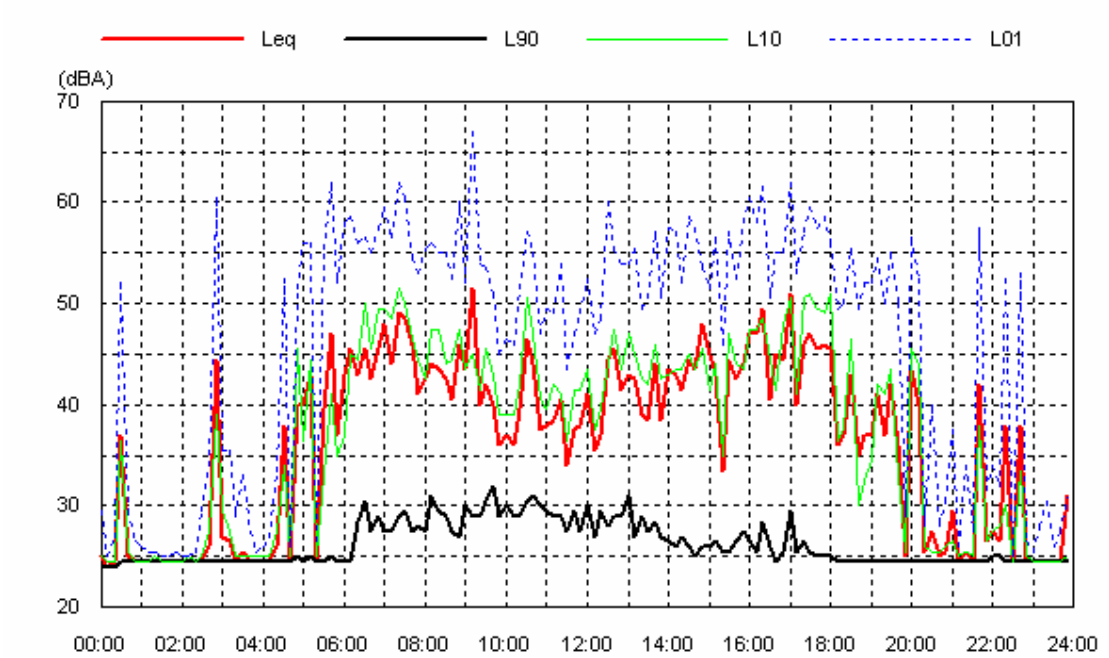


Tue 22 May 07

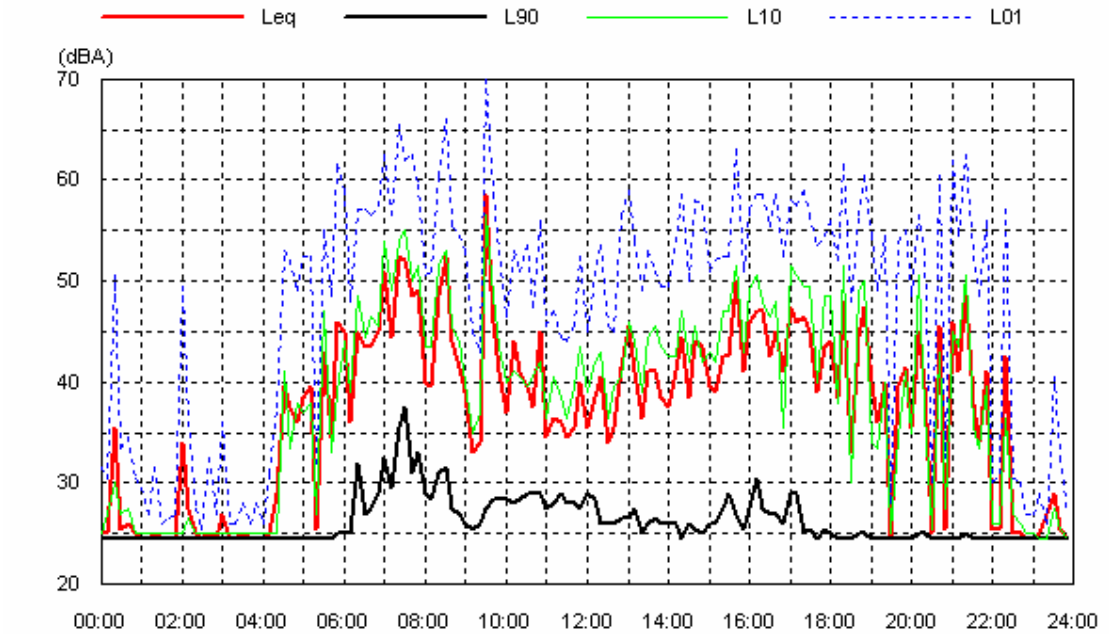


Location: Greyland

Wed 23 May 07

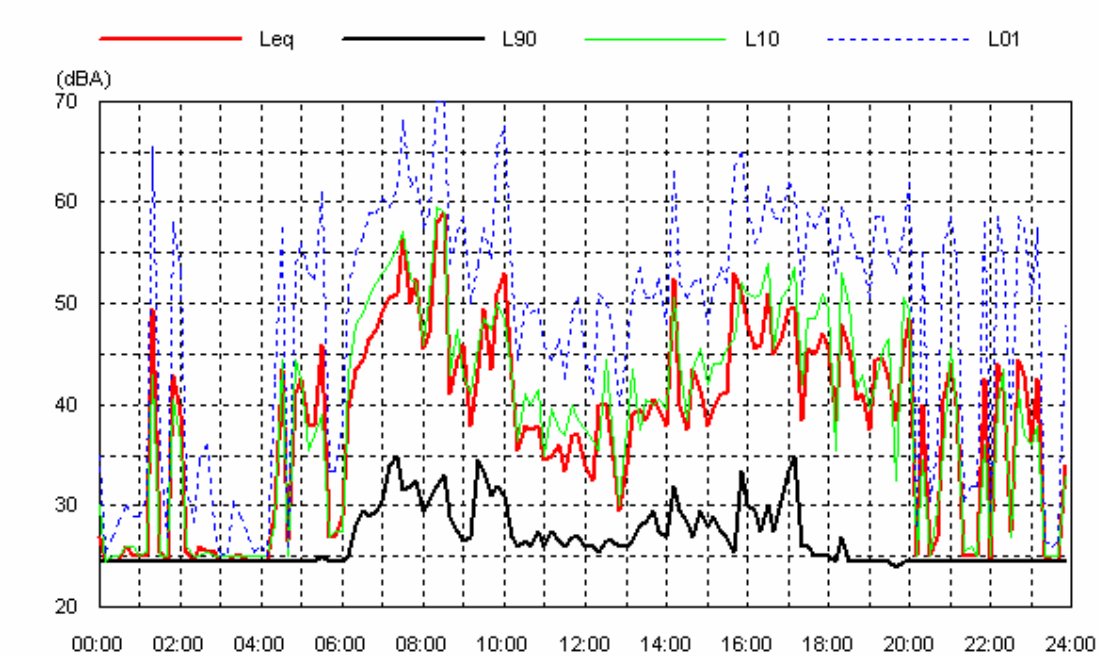


Thu 24 May 07

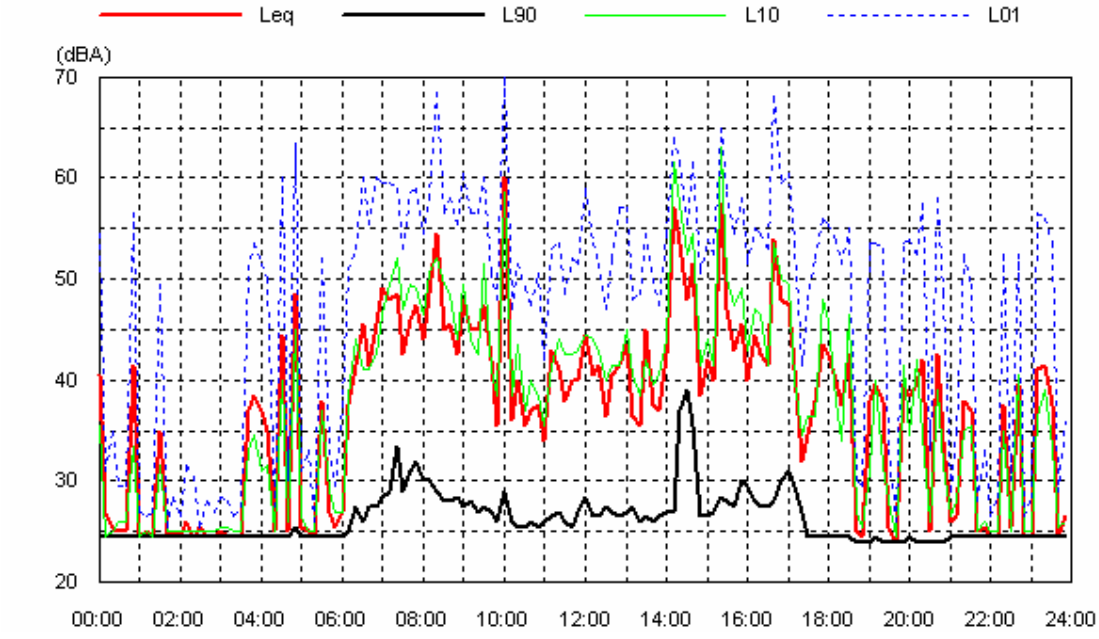


Location: Greyland

Fri 25 May 07

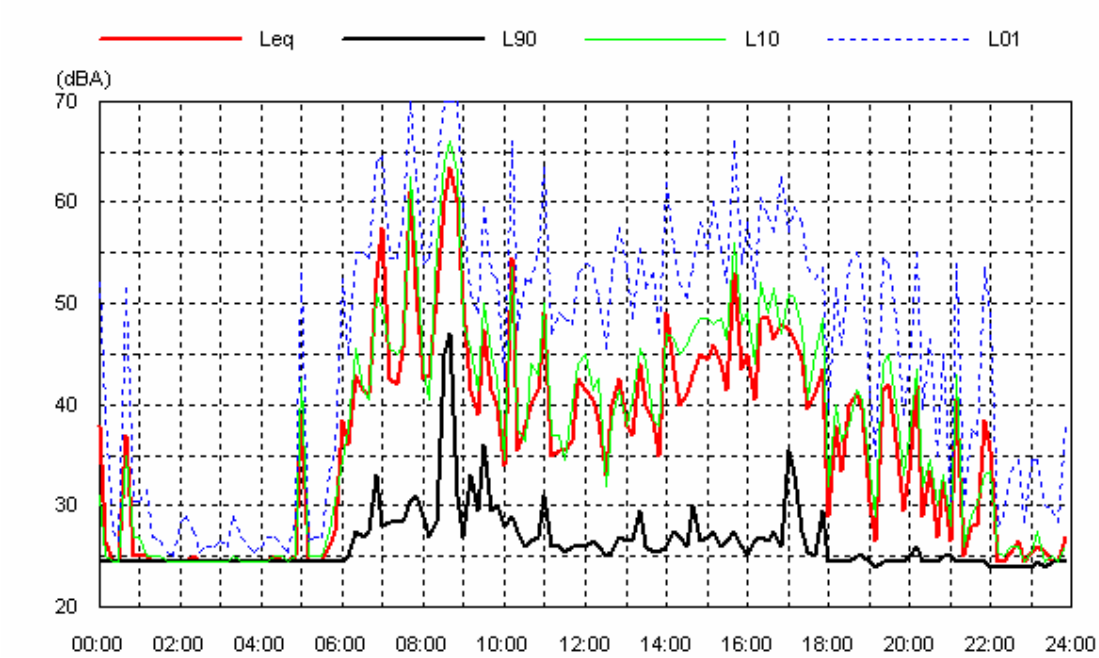


Sat 26 May 07

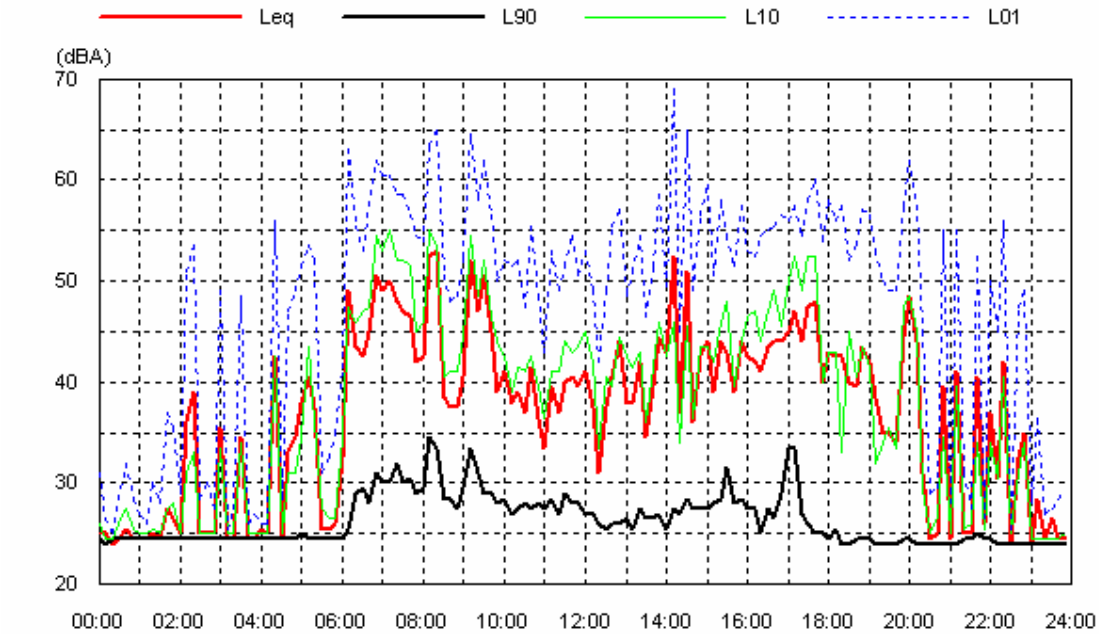


Location: Greyland

Sun 27 May 07

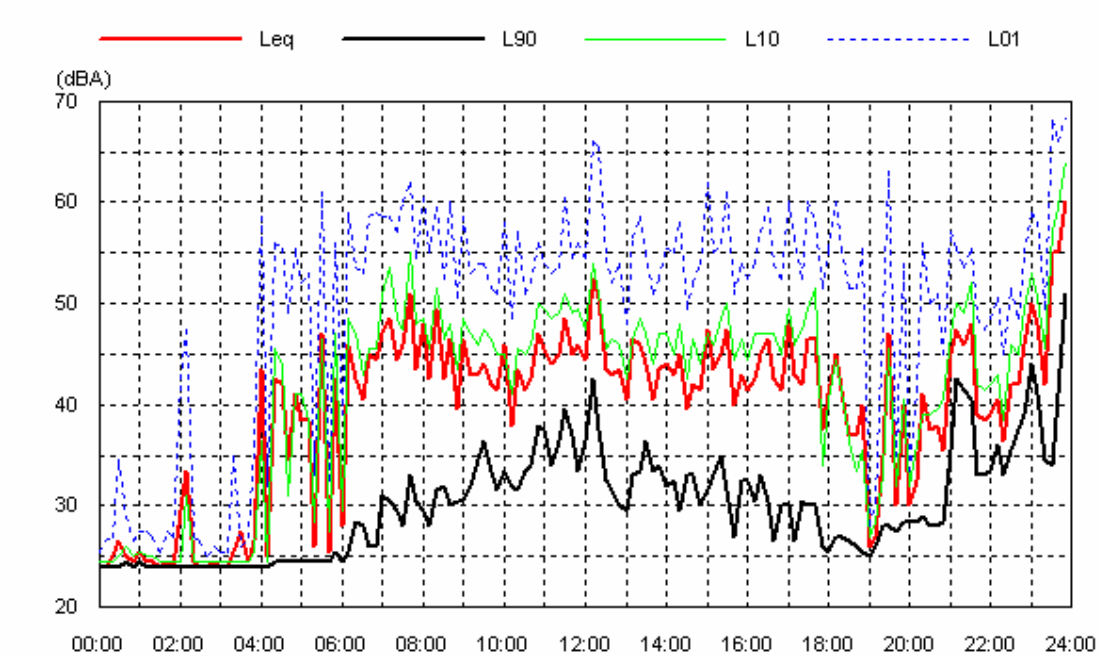


Mon 28 May 07

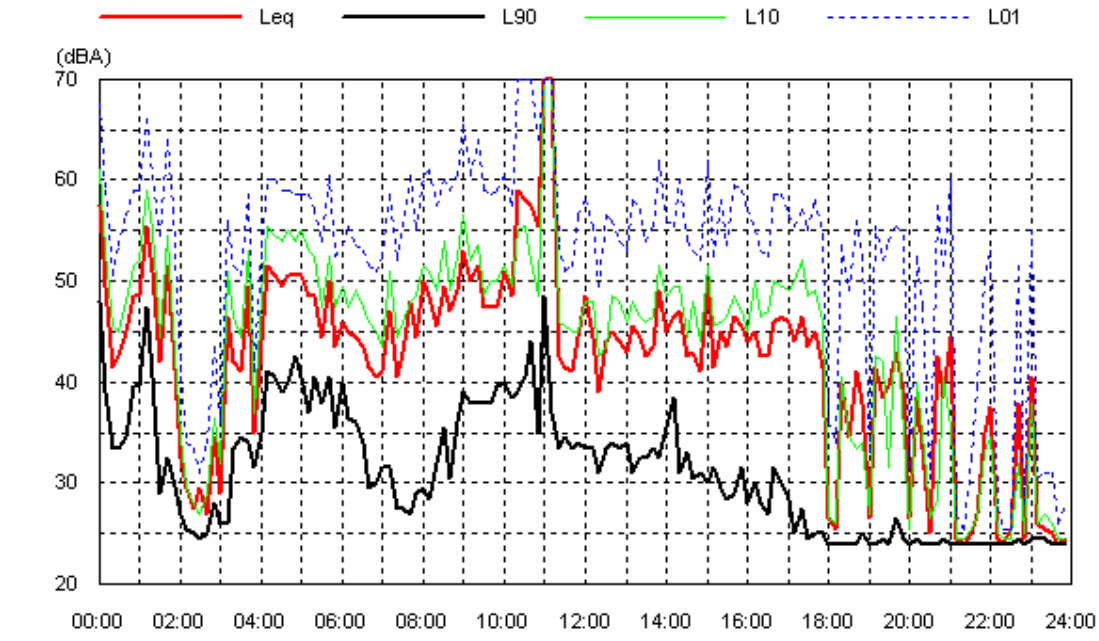


Location: Greyland

Tue 29 May 07

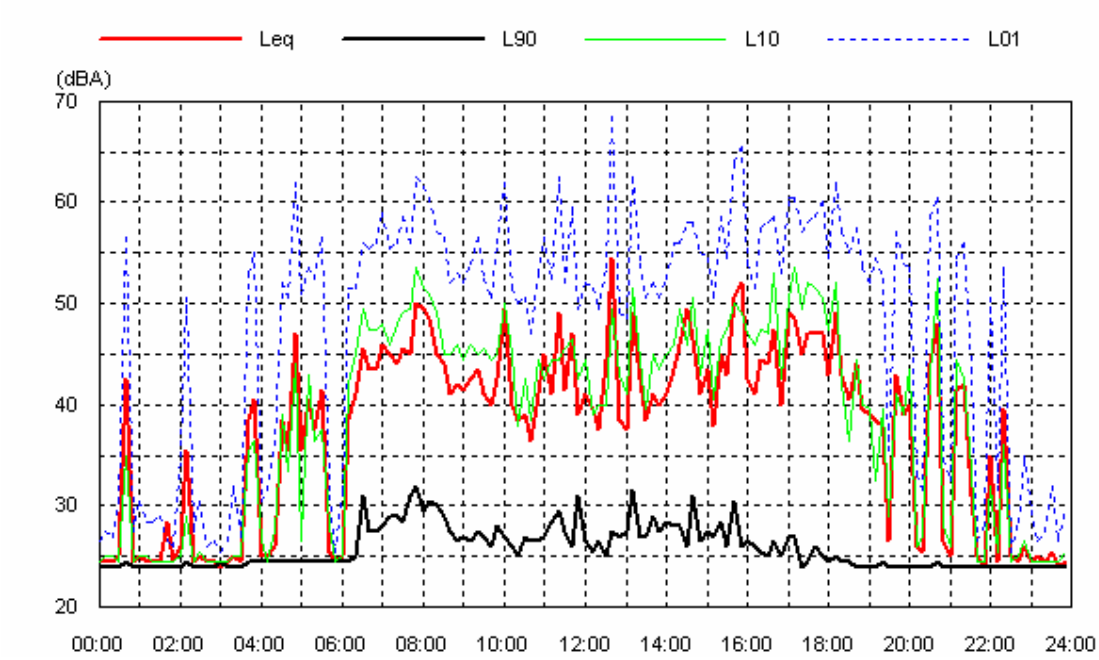


Wed 30 May 07

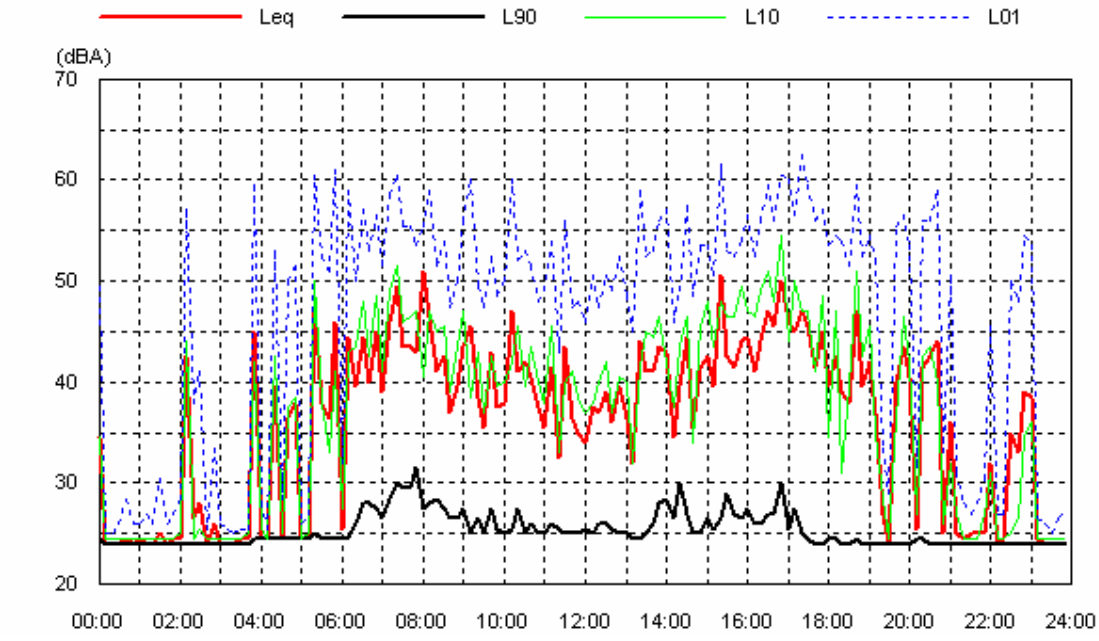


Location: Greyland

Thu 31 May 07

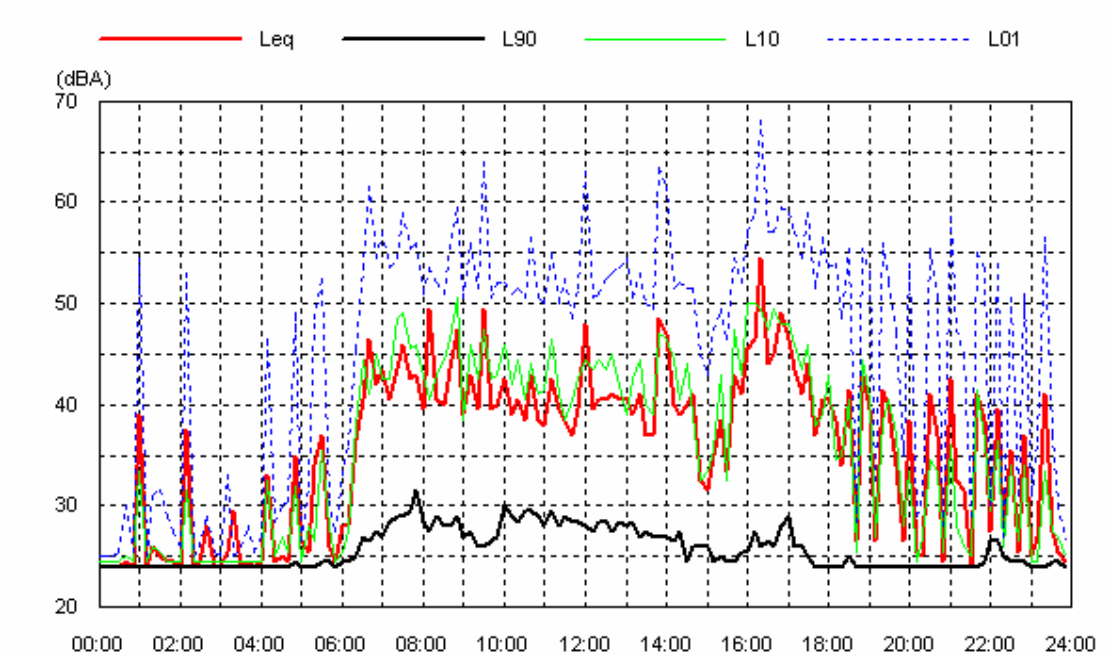


Fri 01 Jun 07

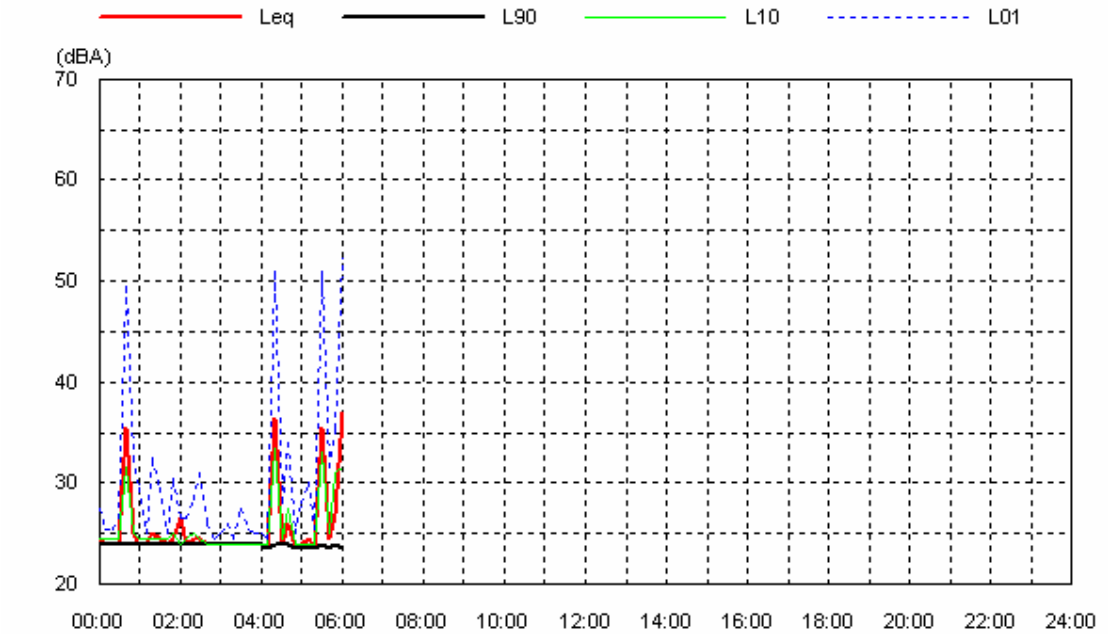


Location: Greyland

Sat 02 Jun 07

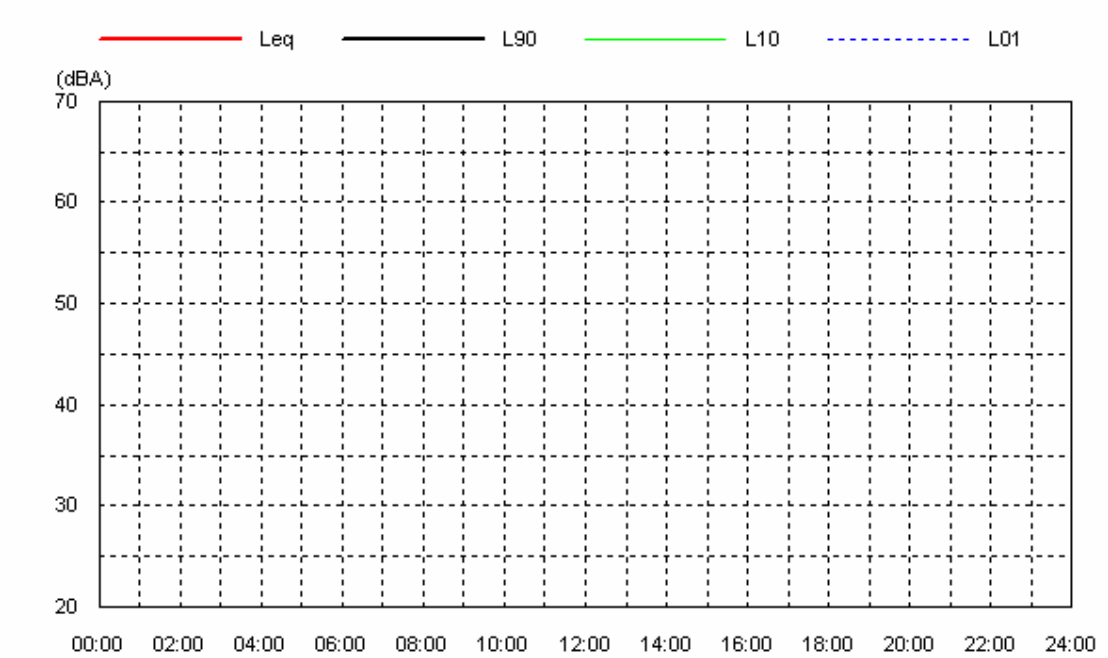


Sun 03 Jun 07



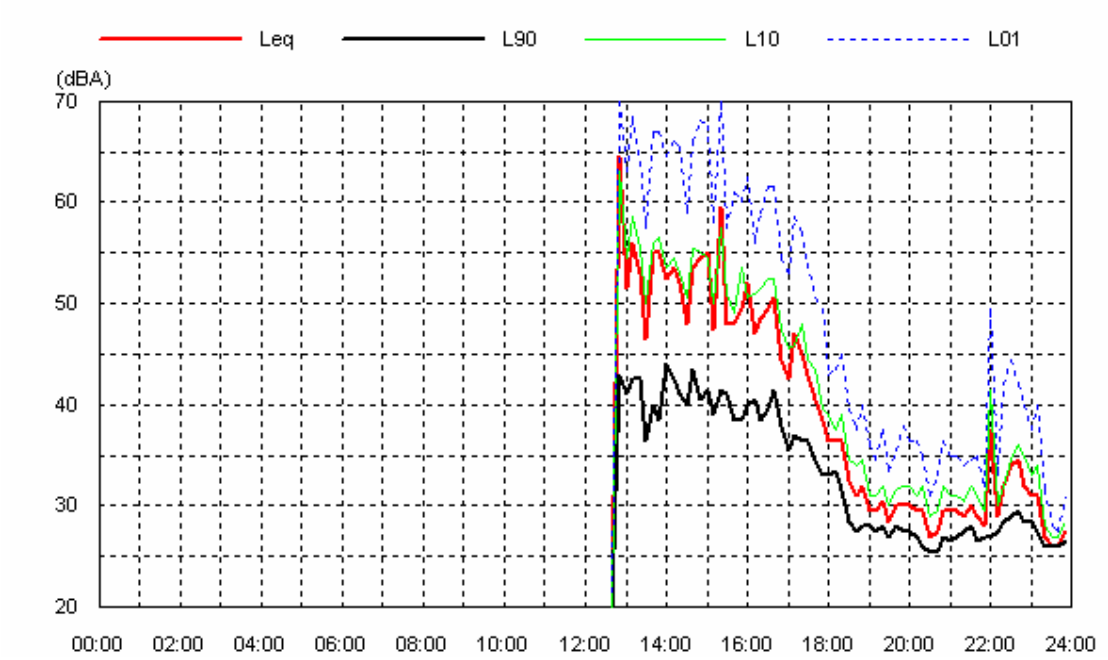
Location: Greyland

Fri 08 Jun 07

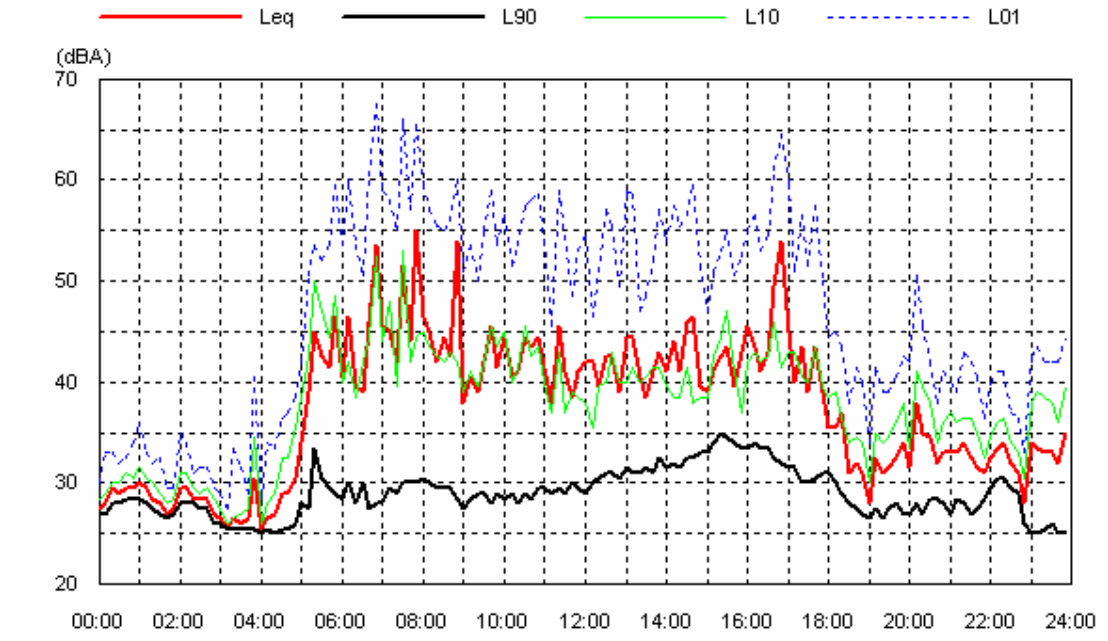


Location: Clifton2

Thu 20 Sep 07

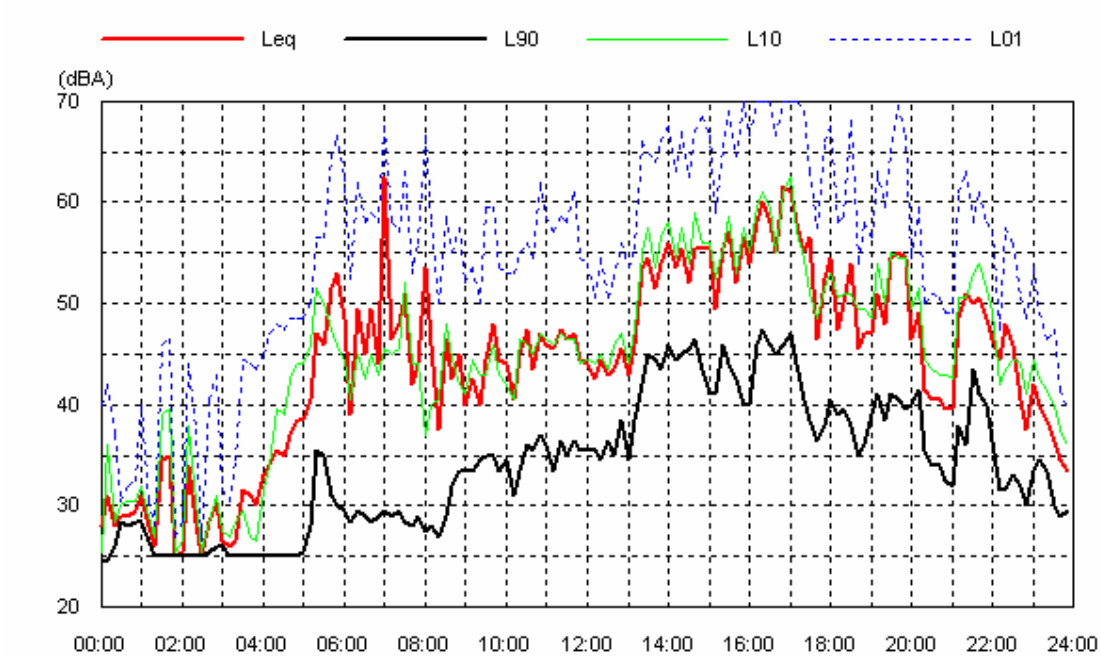


Fri 21 Sep 07

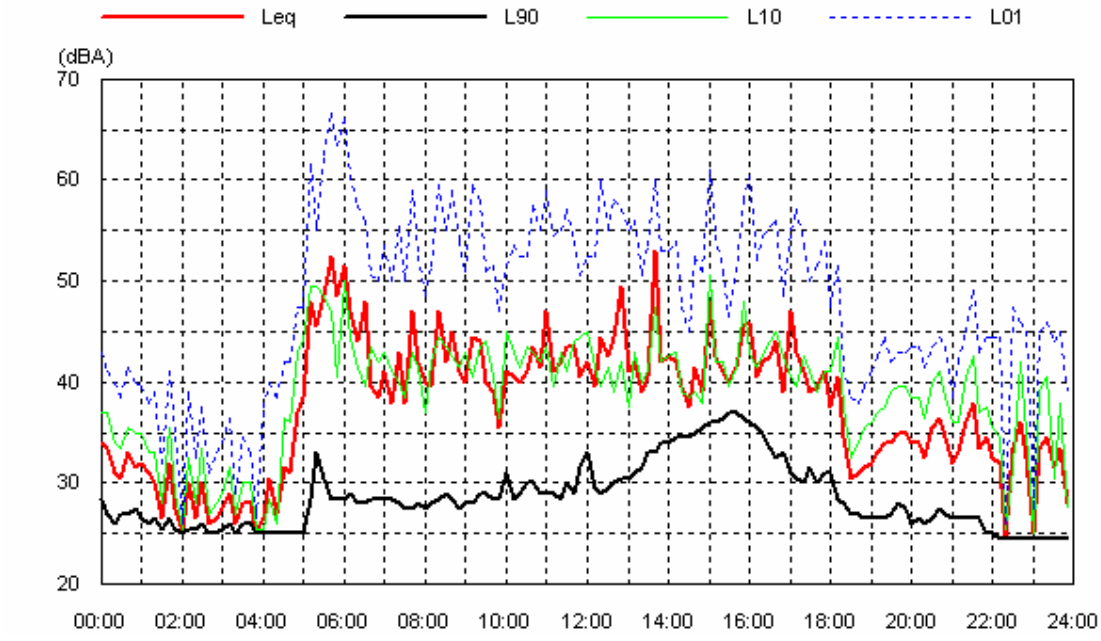


Location: Clifton2

Sat 22 Sep 07

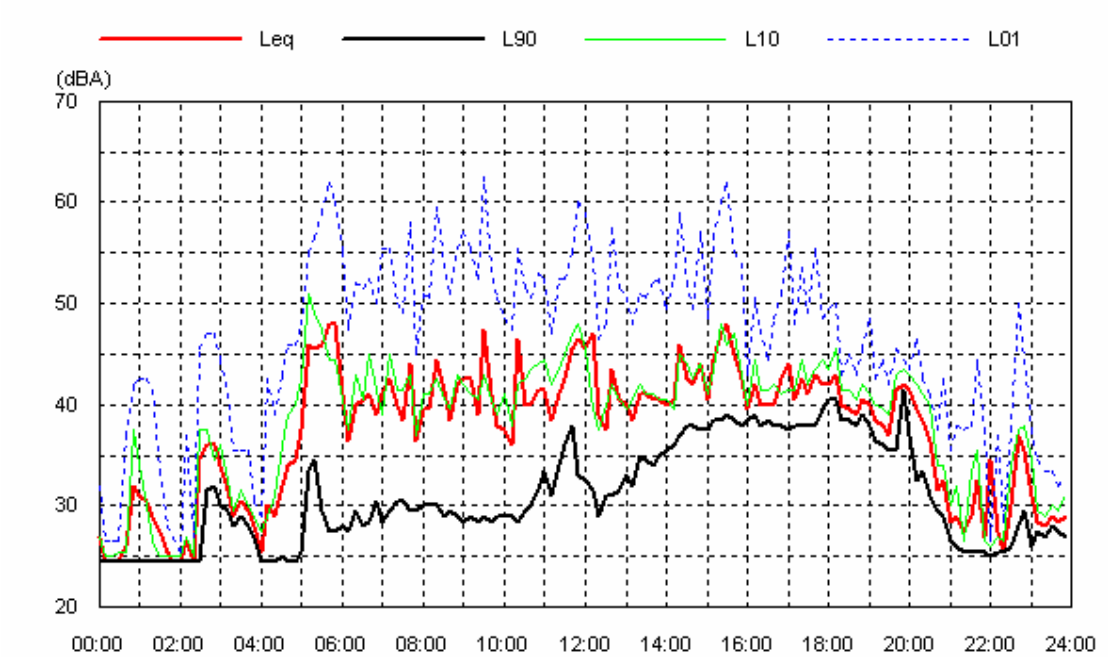


Sun 23 Sep 07

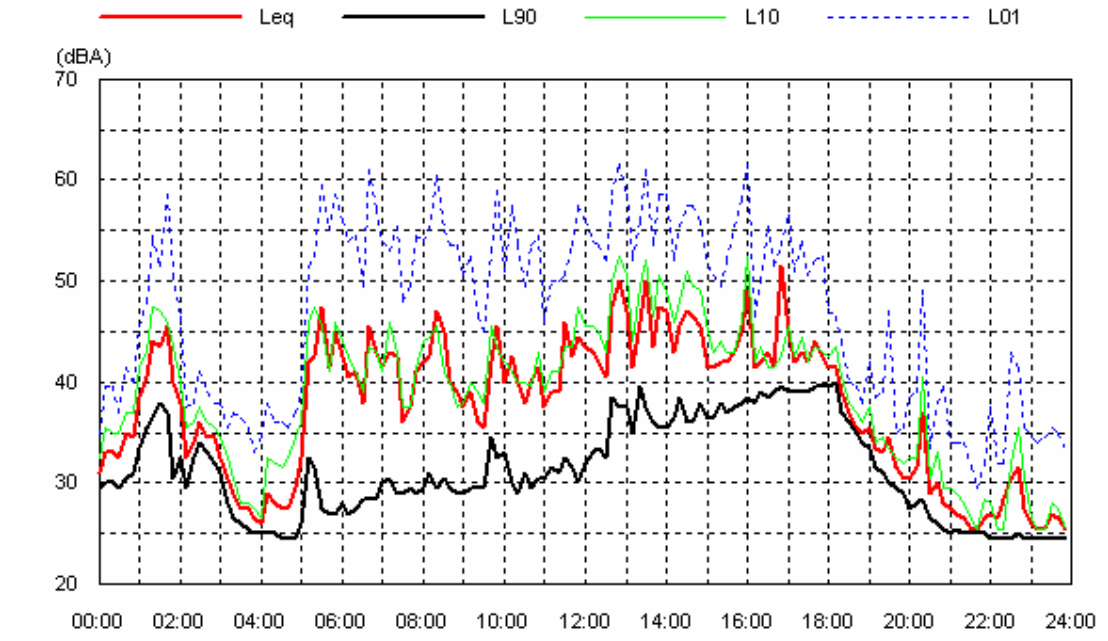


Location: Clifton2

Mon 24 Sep 07

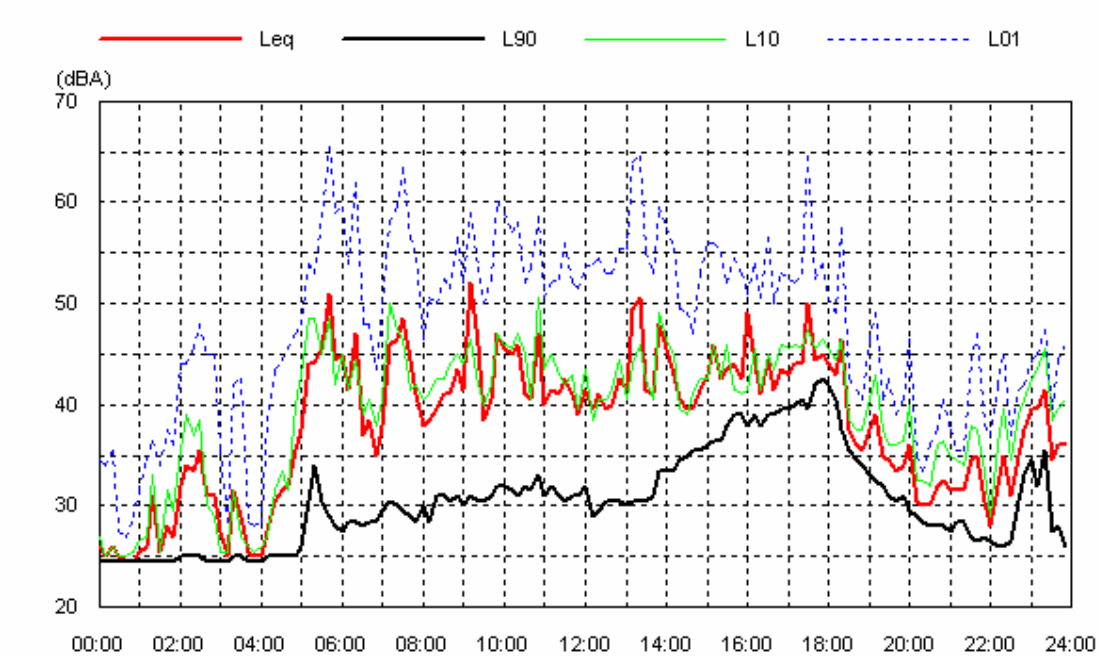


Tue 25 Sep 07

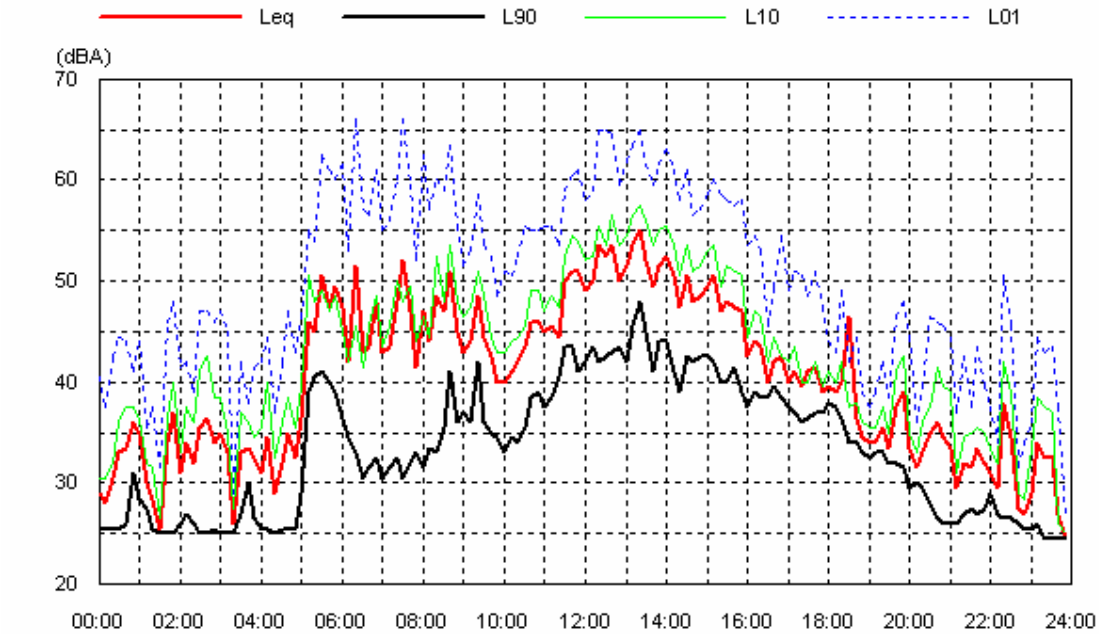


Location: Clifton2

Wed 26 Sep 07

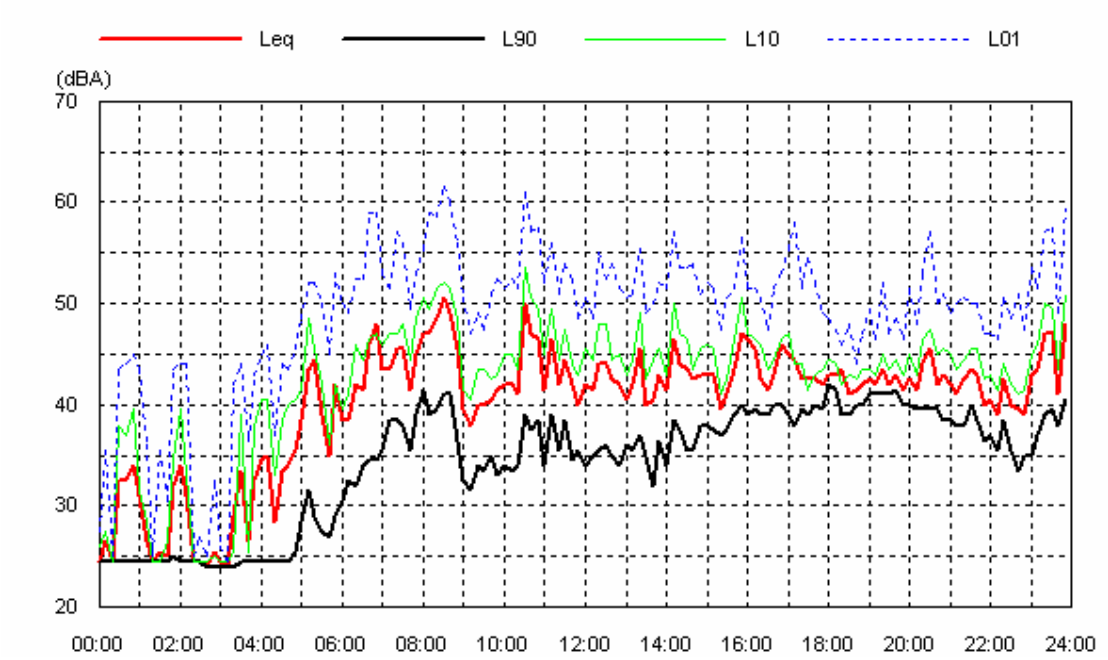


Thu 27 Sep 07

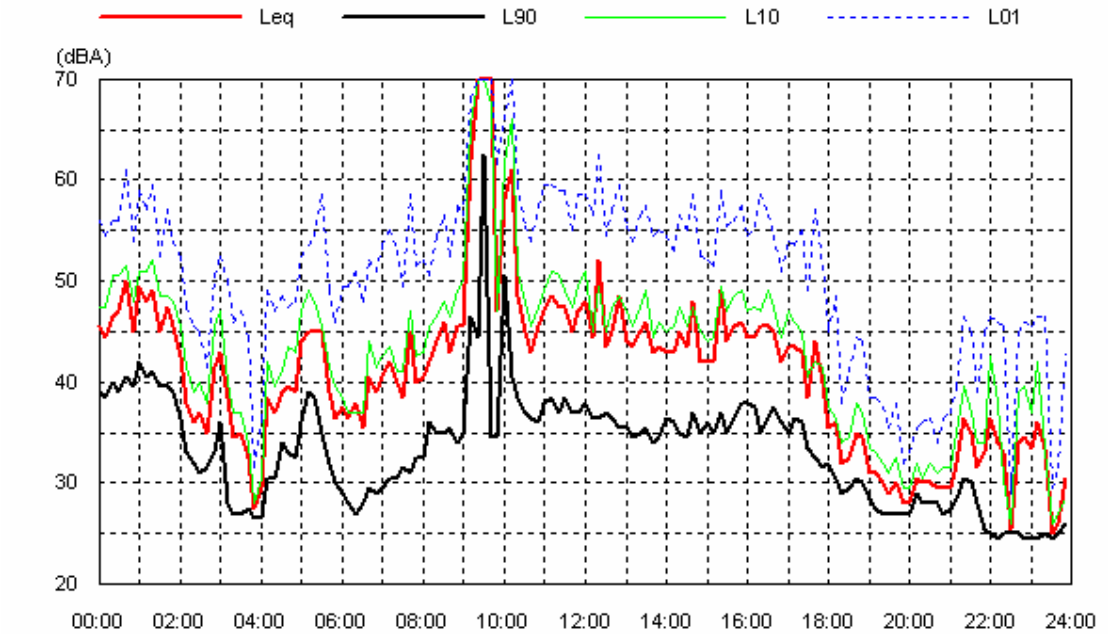


Location: Clifton2

Fri 28 Sep 07

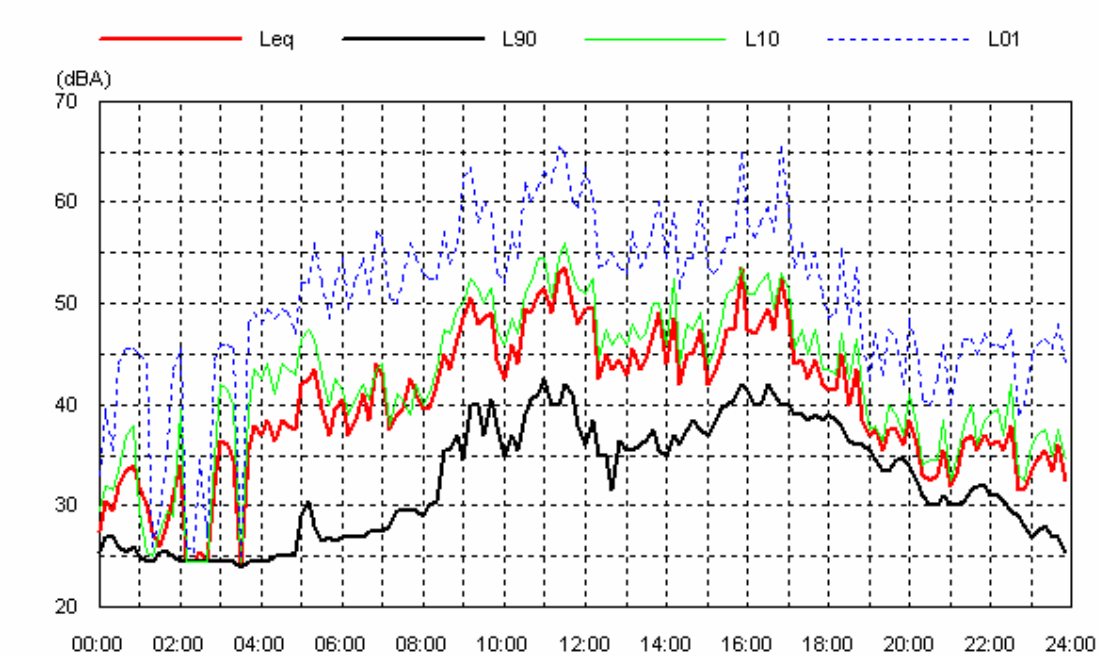


Sat 29 Sep 07

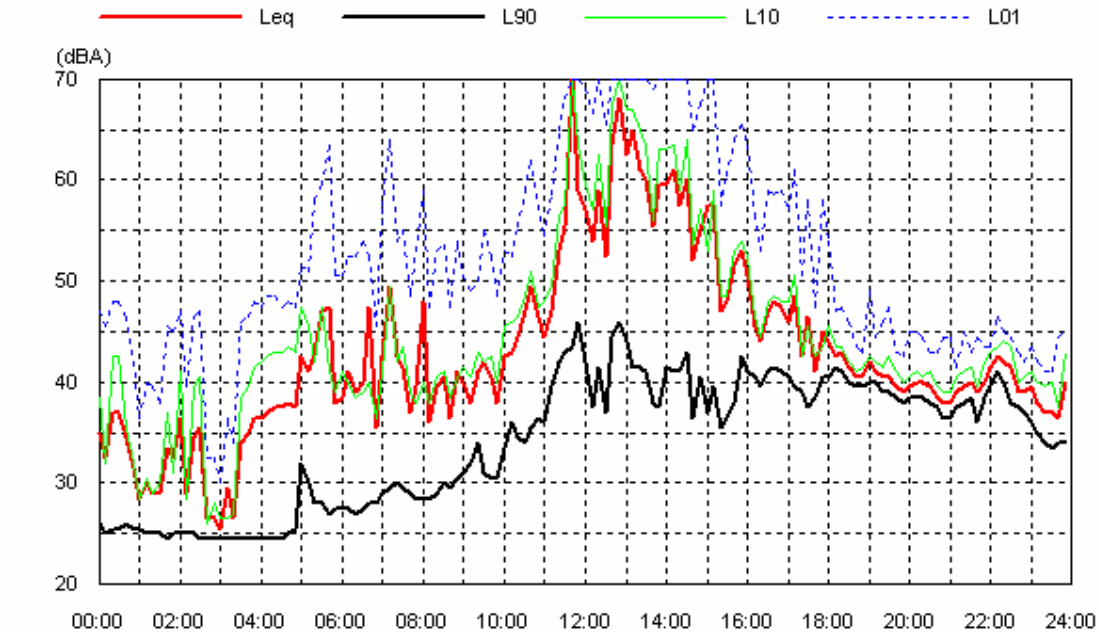


Location: Clifton2

Sun 30 Sep 07

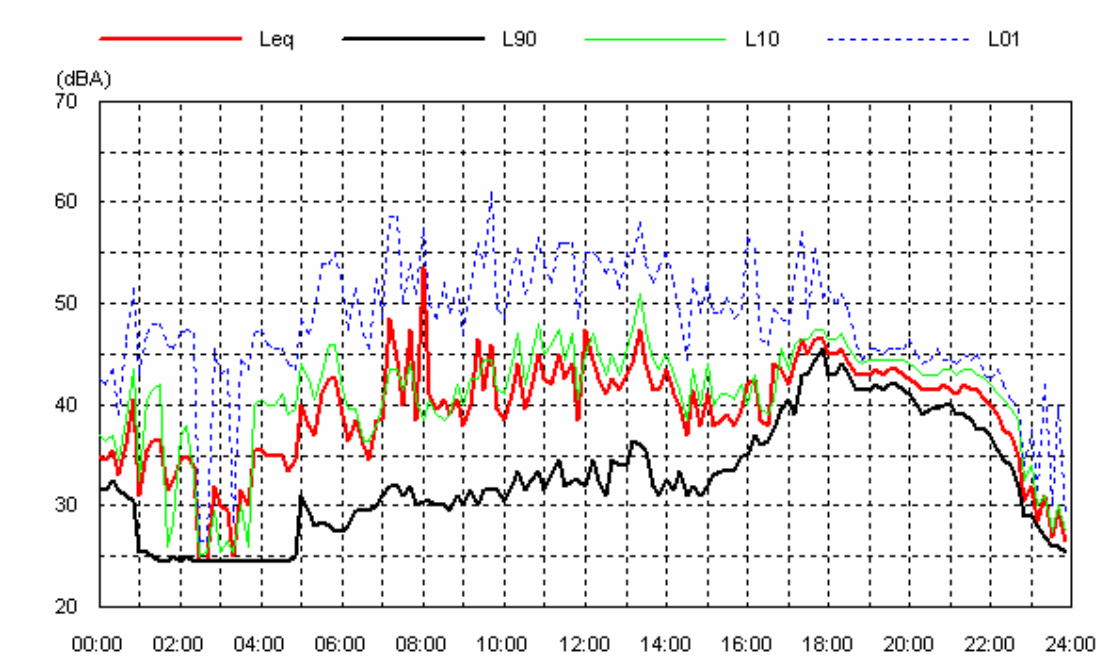


Mon 01 Oct 07

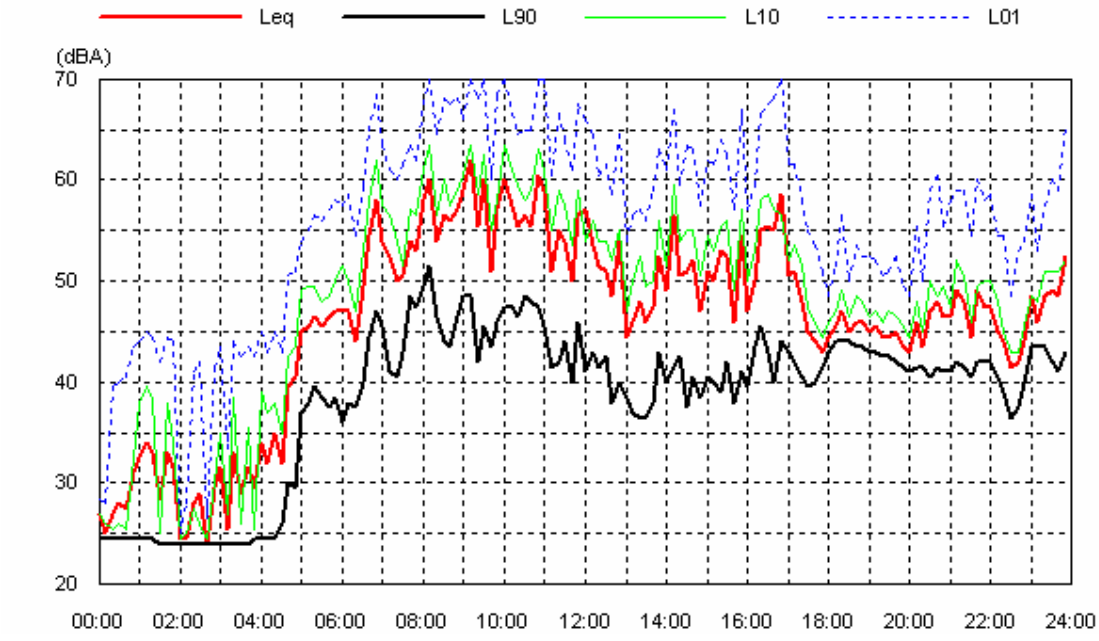


Location: Clifton2

Tue 02 Oct 07

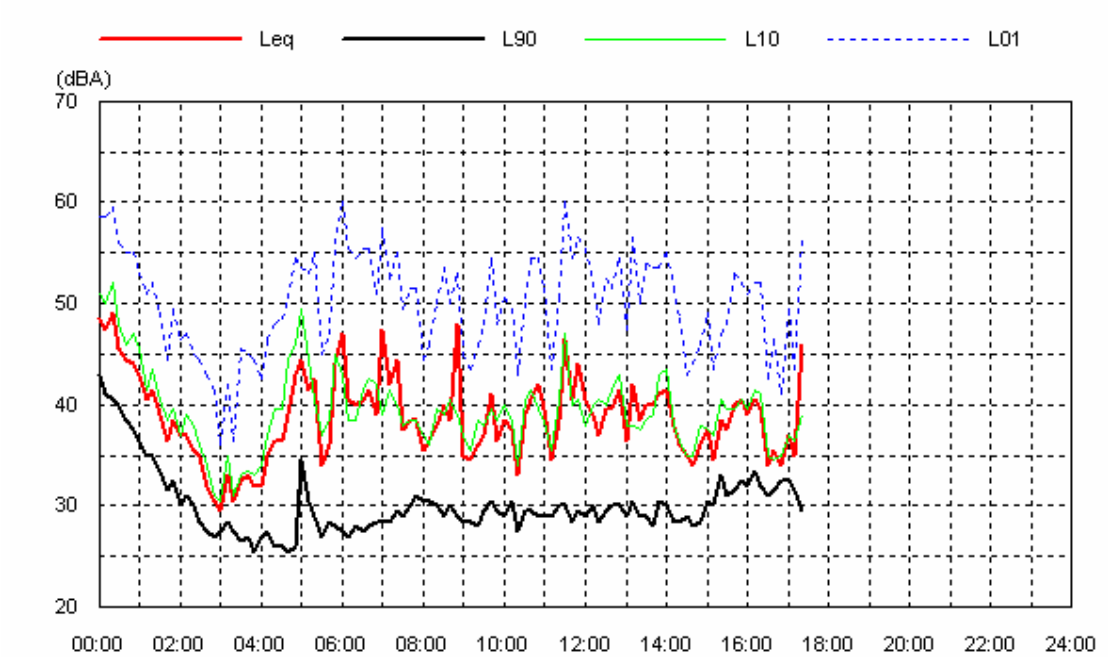


Wed 03 Oct 07



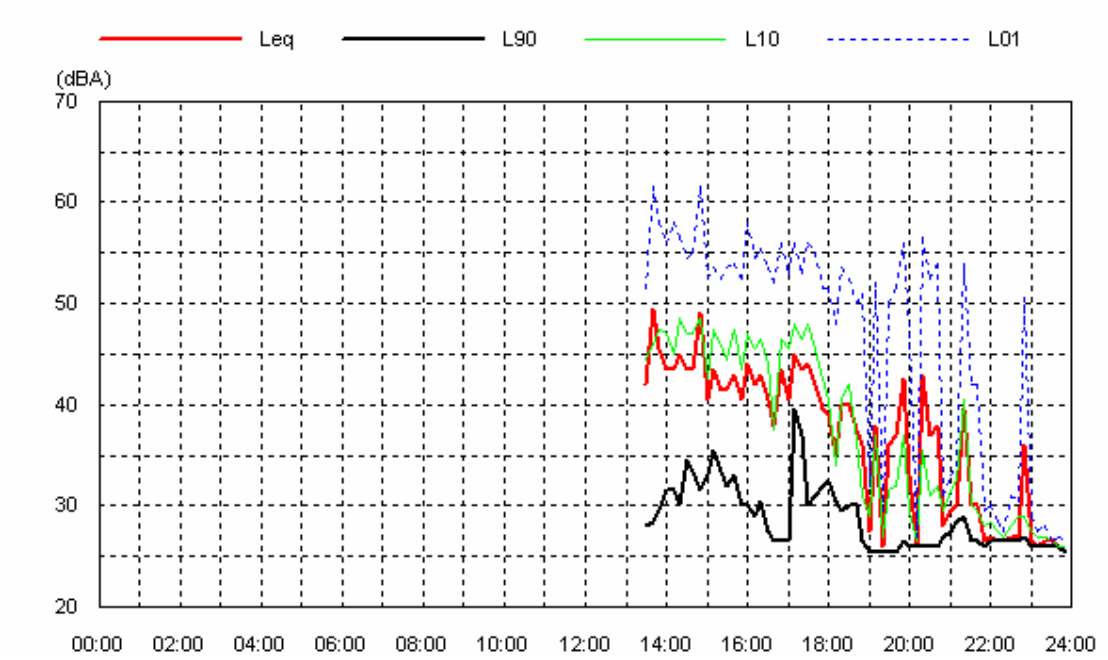
Location: Clifton2

Thu 04 Oct 07

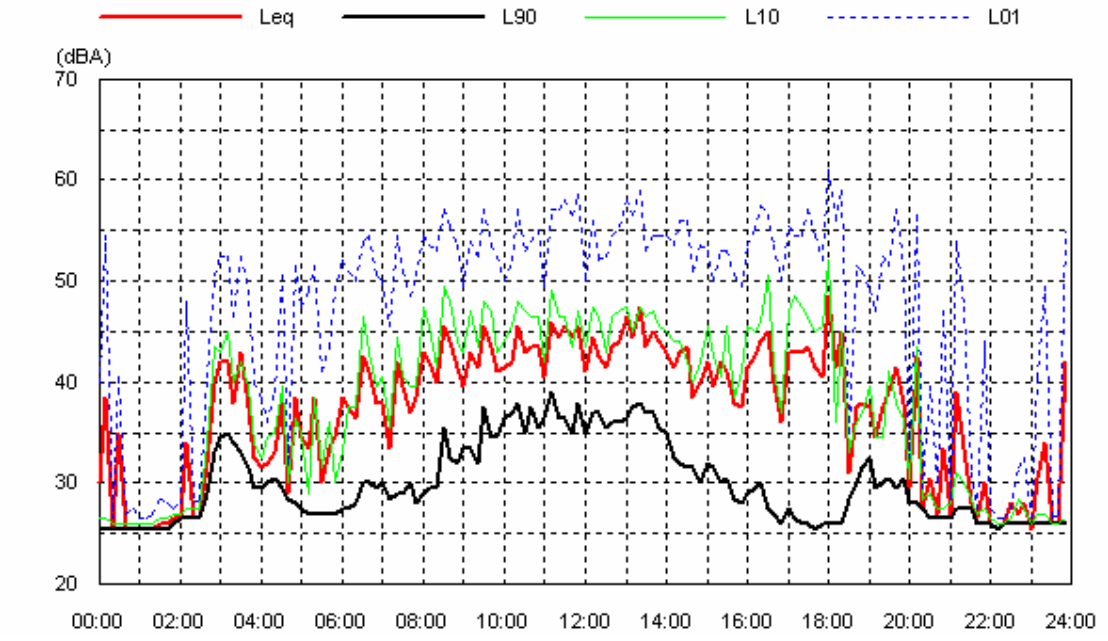


Location: The Valley

Mon 21 May 07

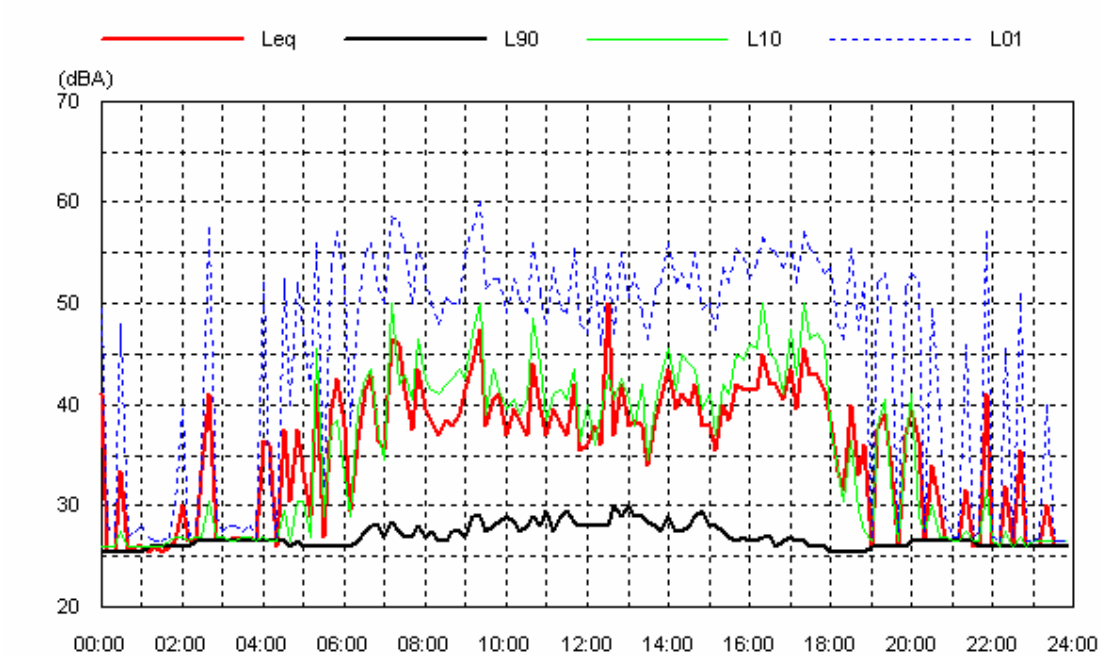


Tue 22 May 07

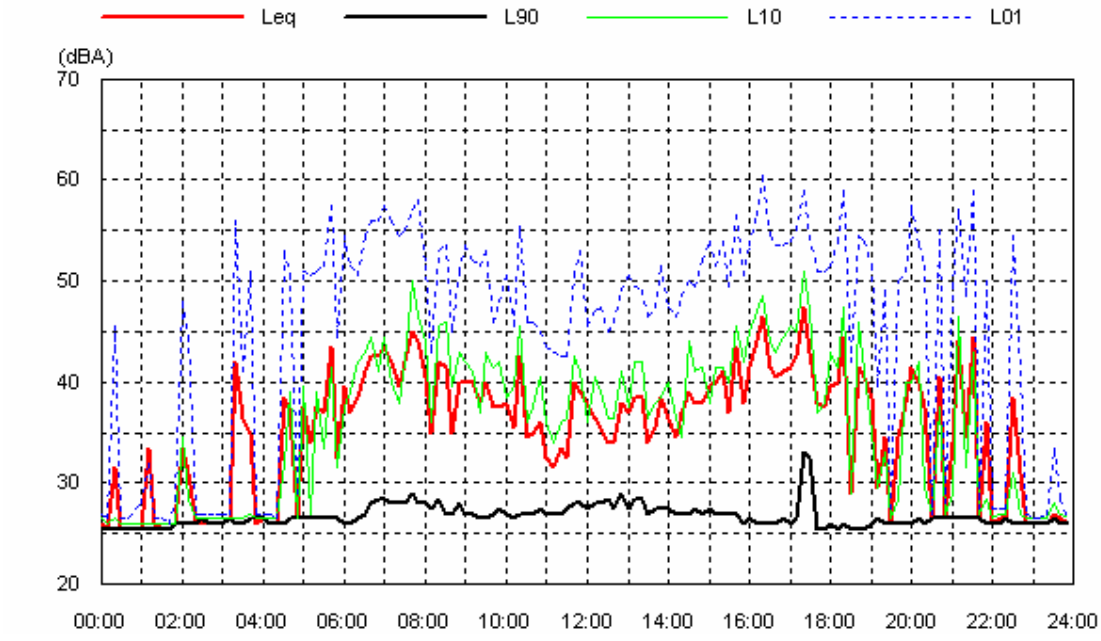


Location: The Valley

Wed 23 May 07

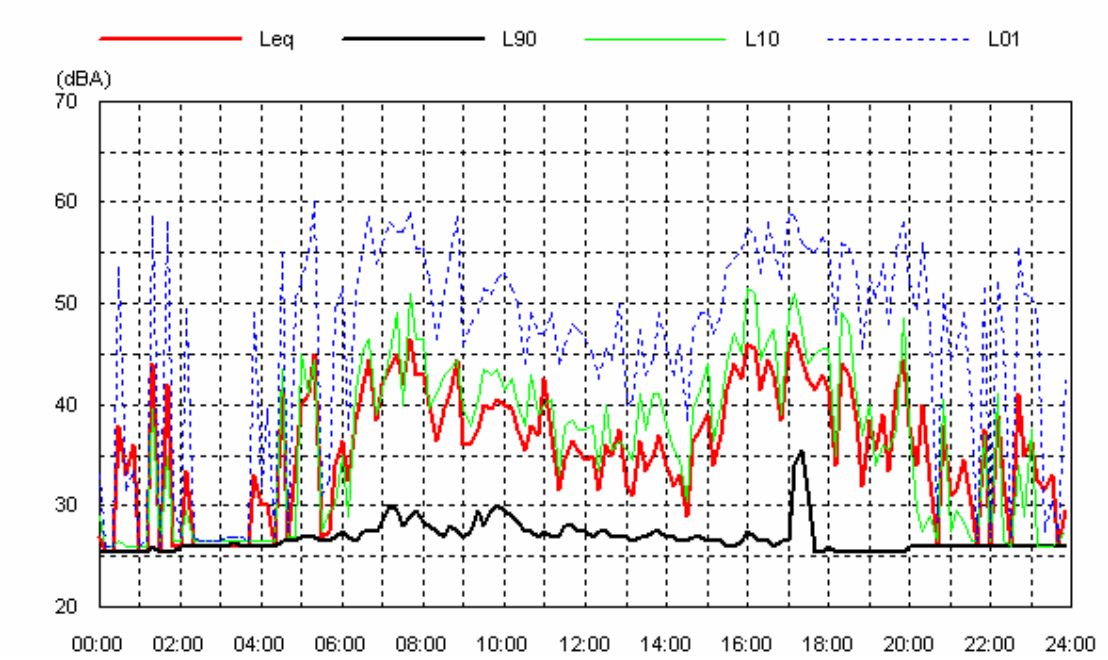


Thu 24 May 07

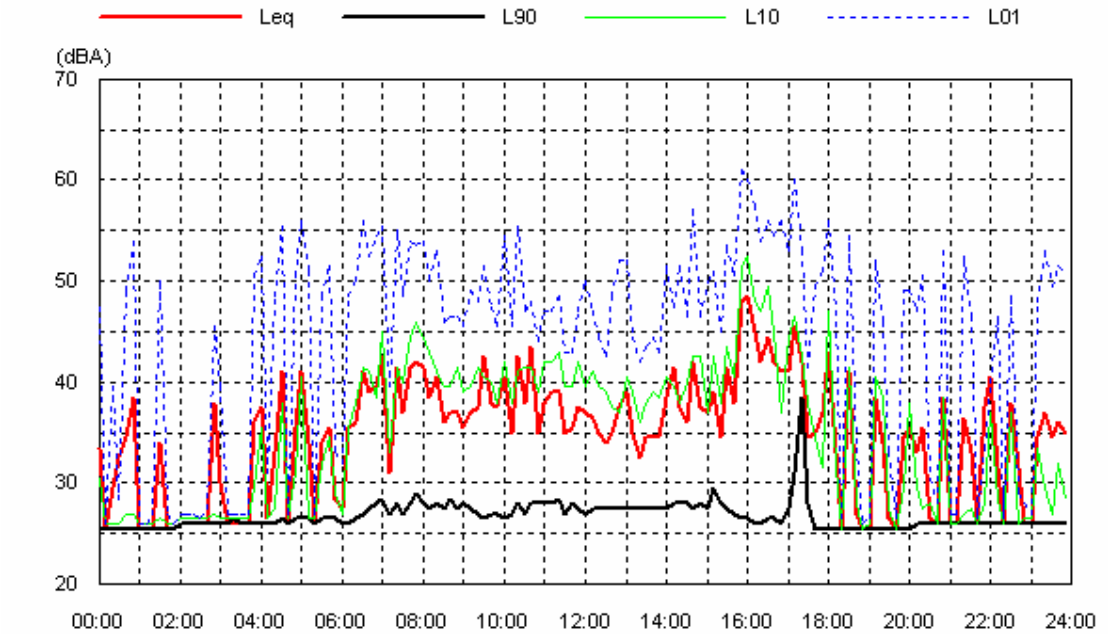


Location: The Valley

Fri 25 May 07

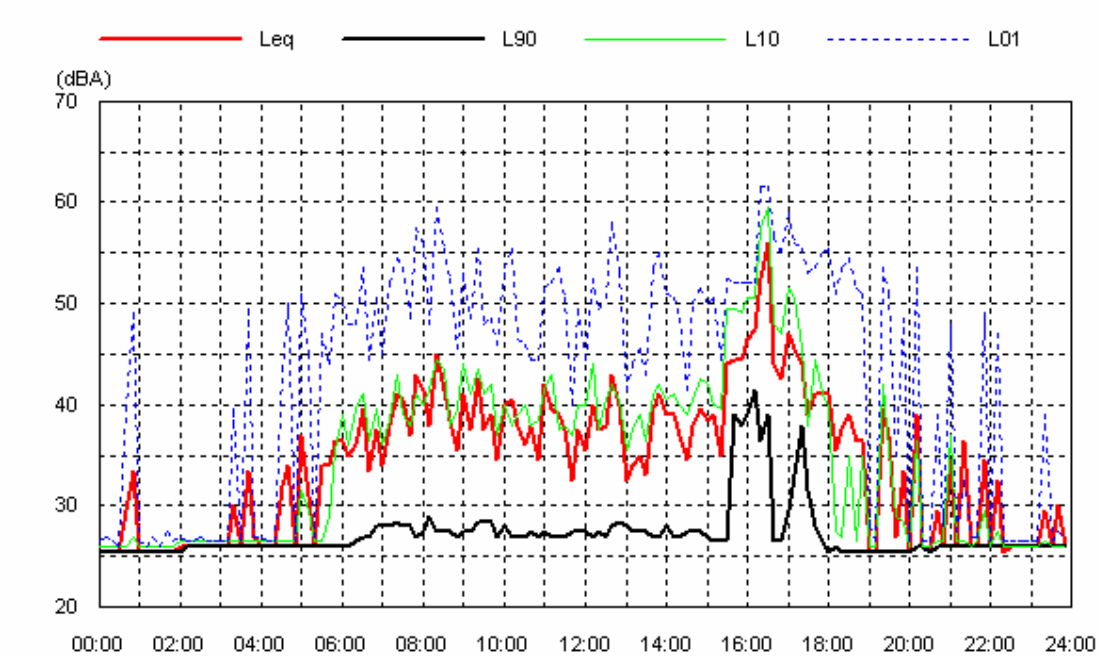


Sat 26 May 07

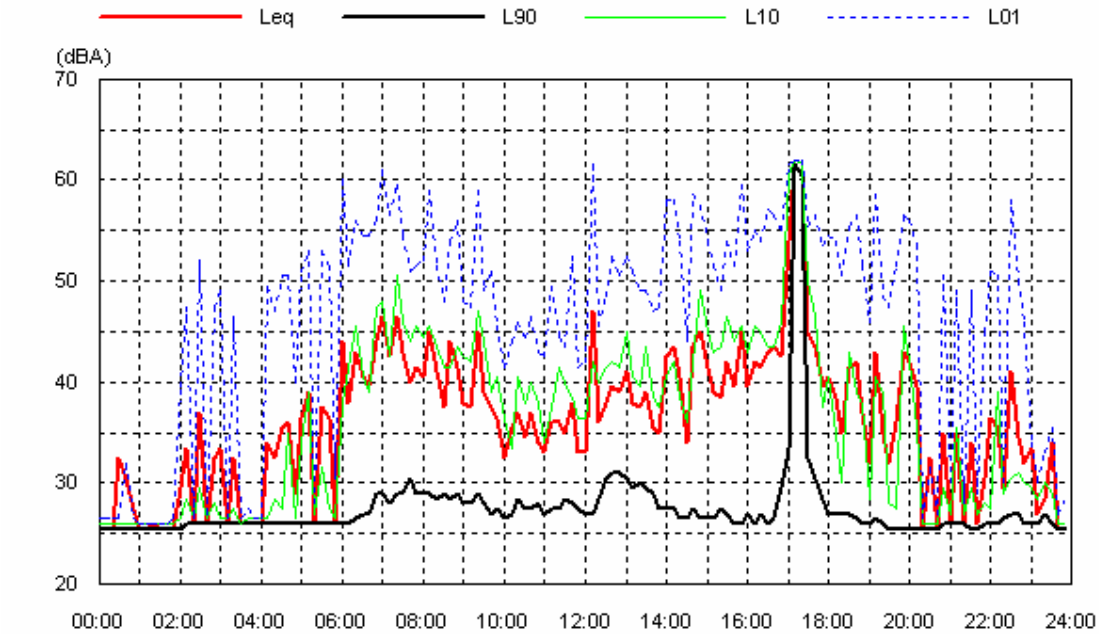


Location: The Valley

Sun 27 May 07

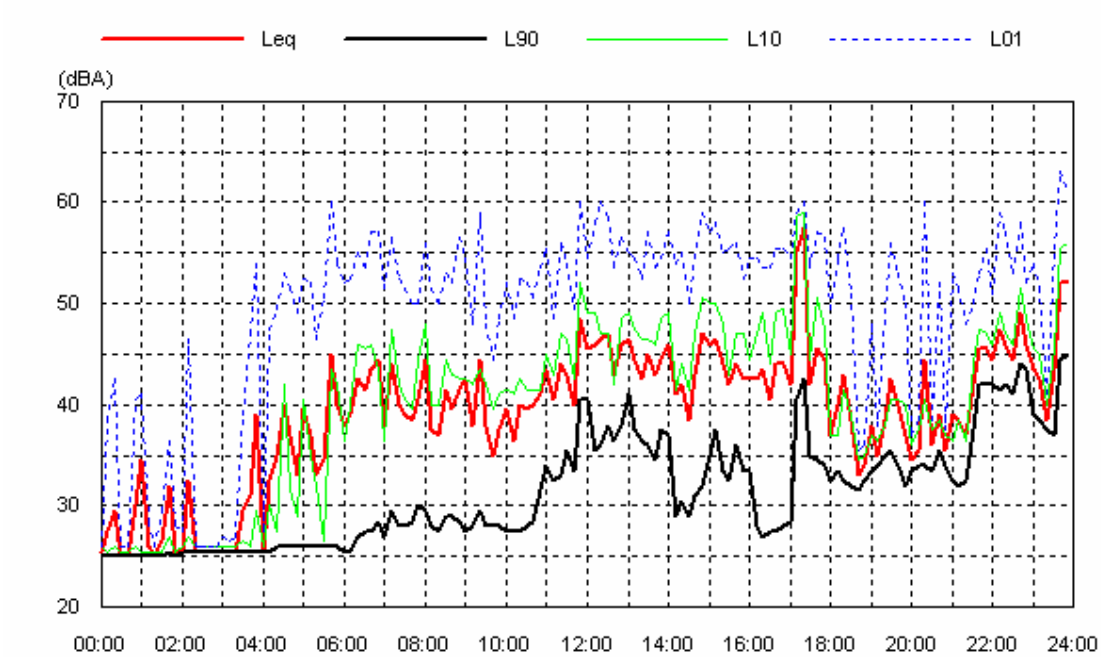


Mon 28 May 07

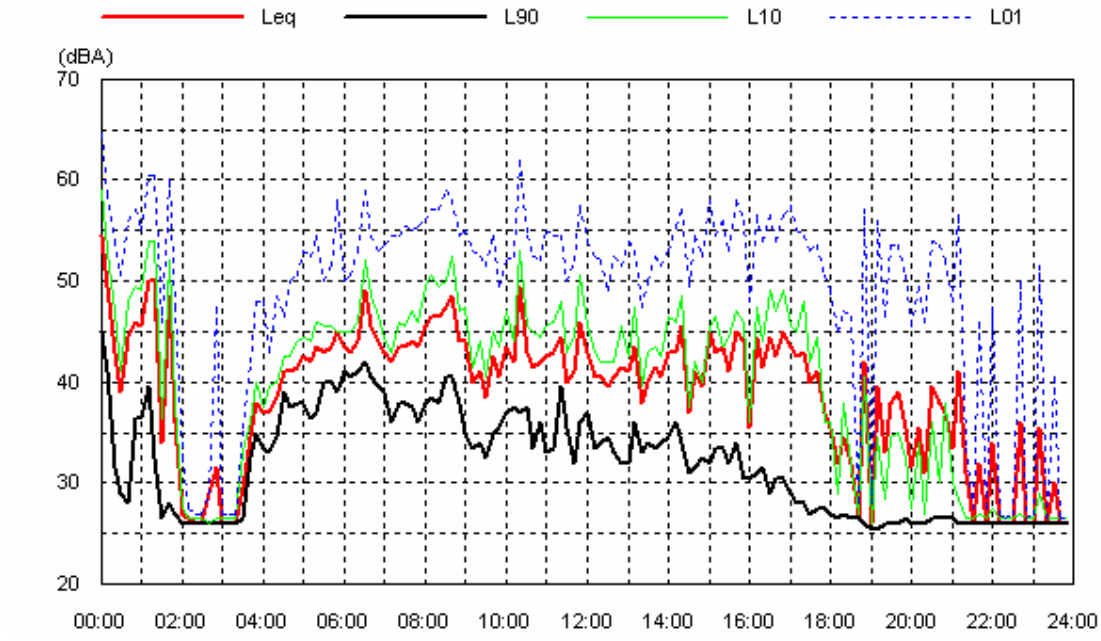


Location: The Valley

Tue 29 May 07

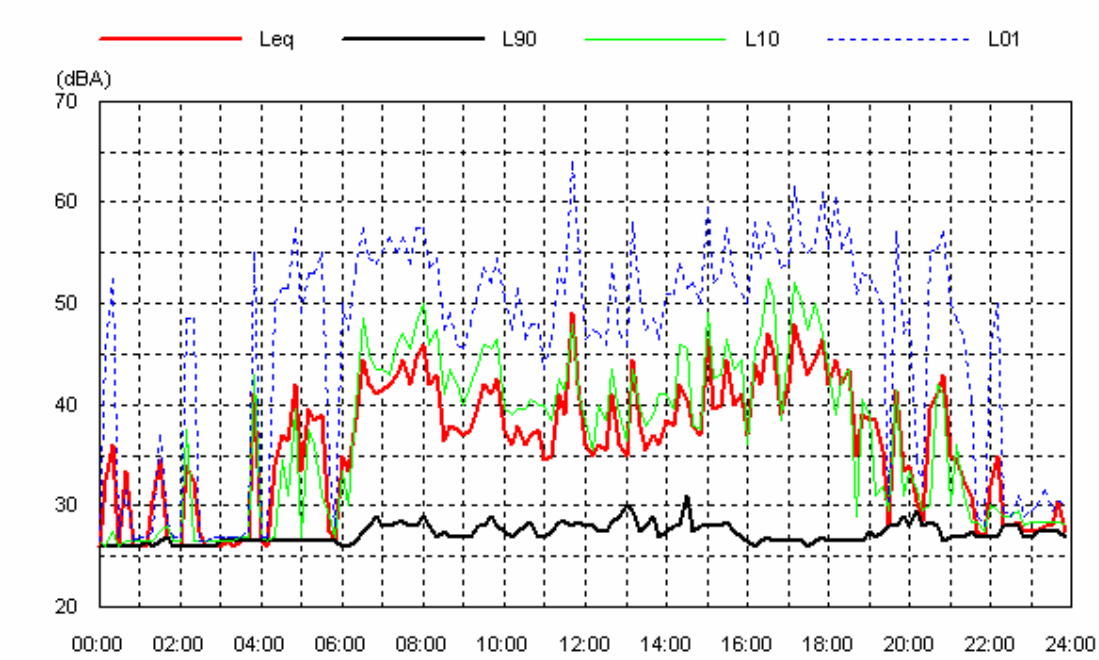


Wed 30 May 07

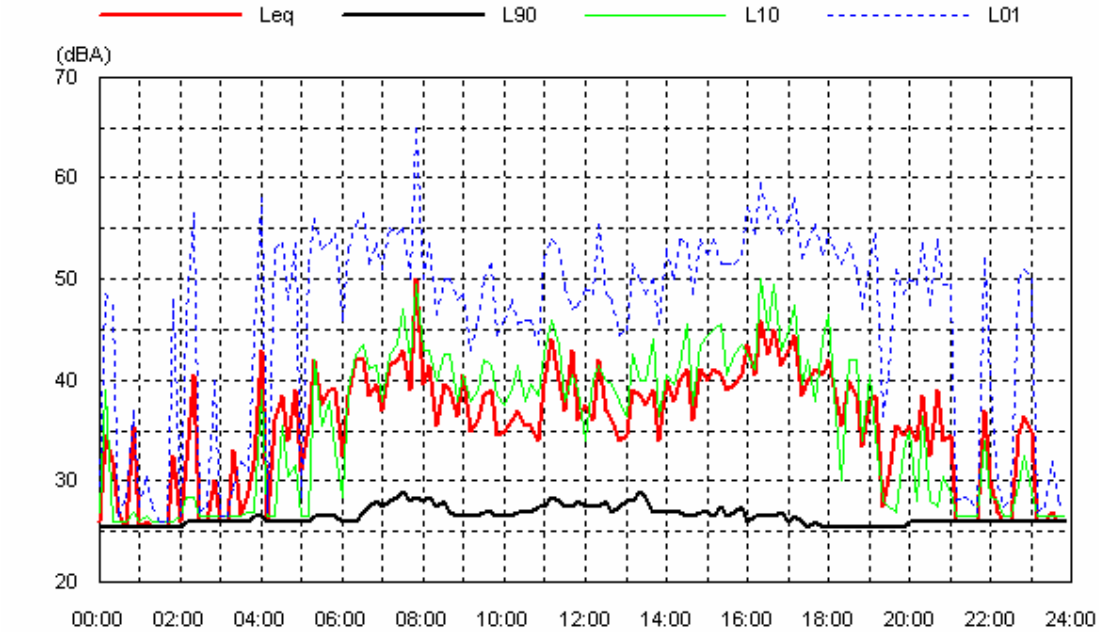


Location: The Valley

Thu 31 May 07

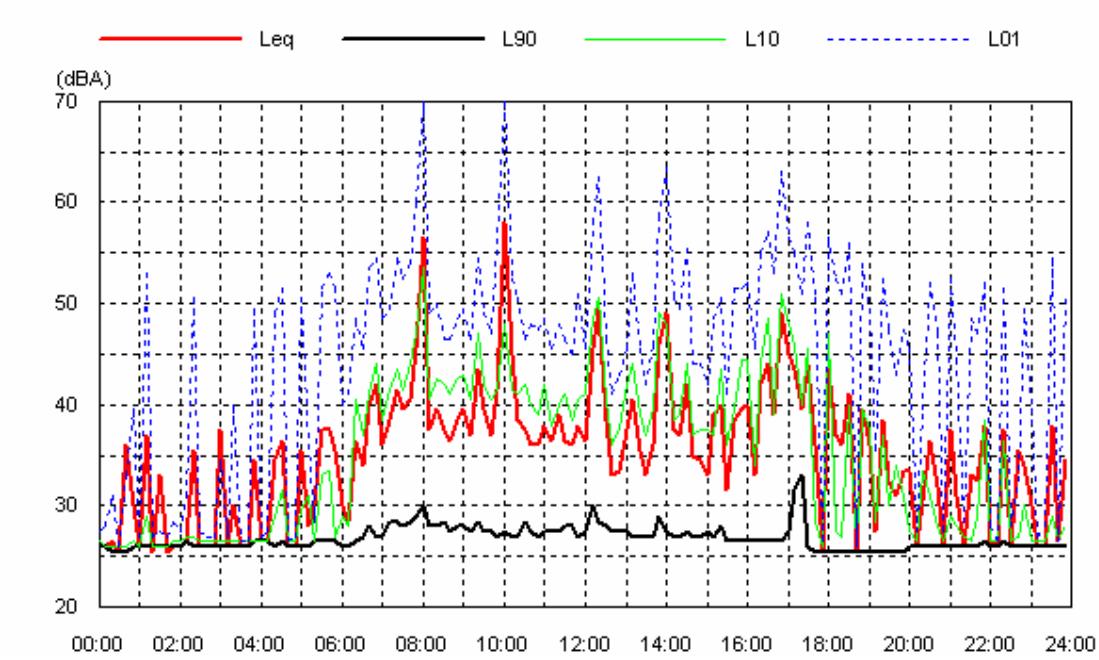


Fri 01 Jun 07

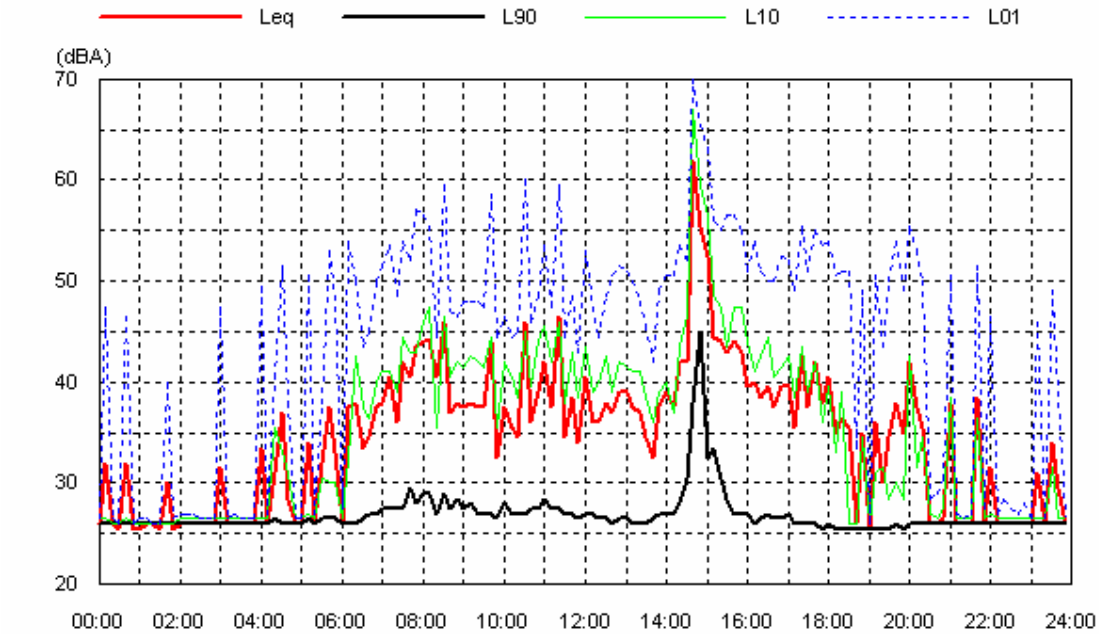


Location: The Valley

Sat 02 Jun 07

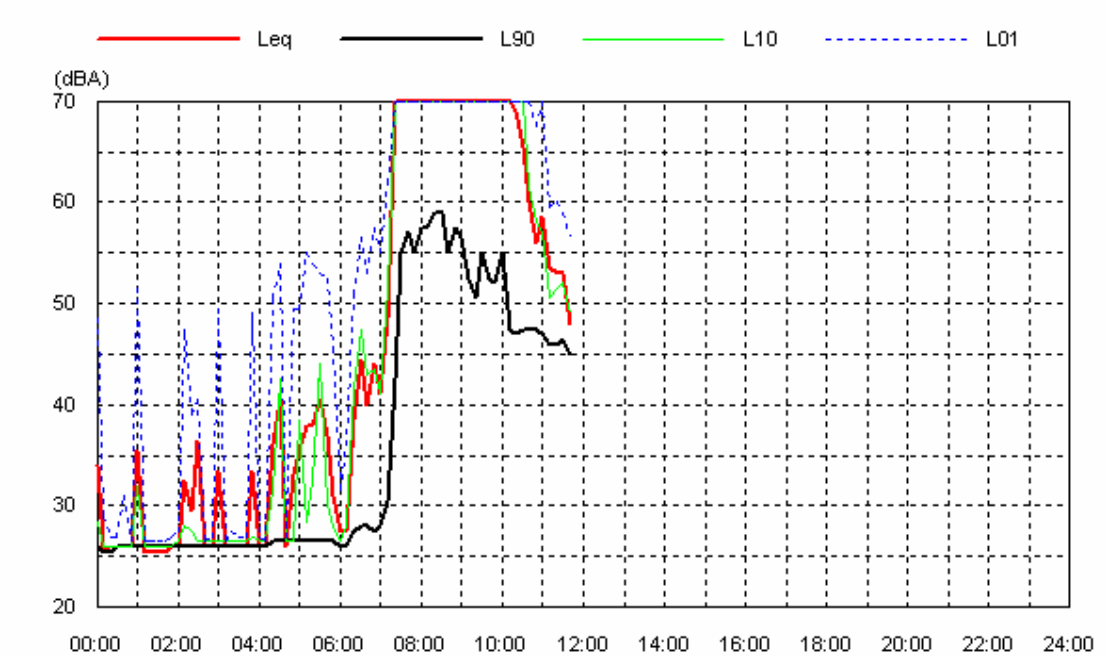


Sun 03 Jun 07



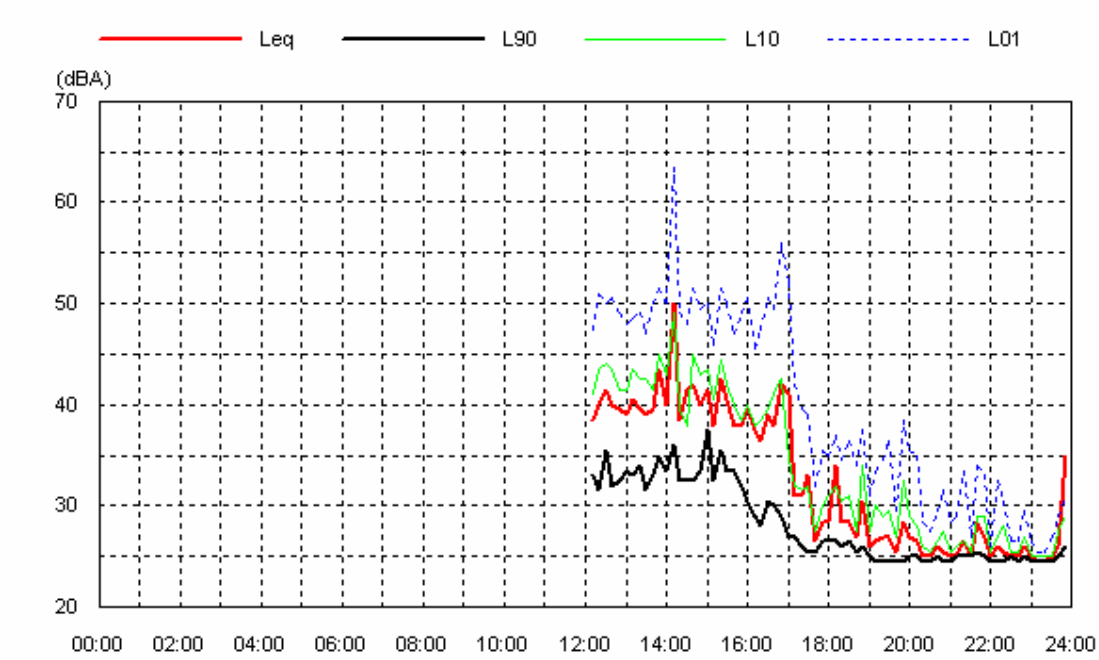
Location: The Valley

Mon 04 Jun 07

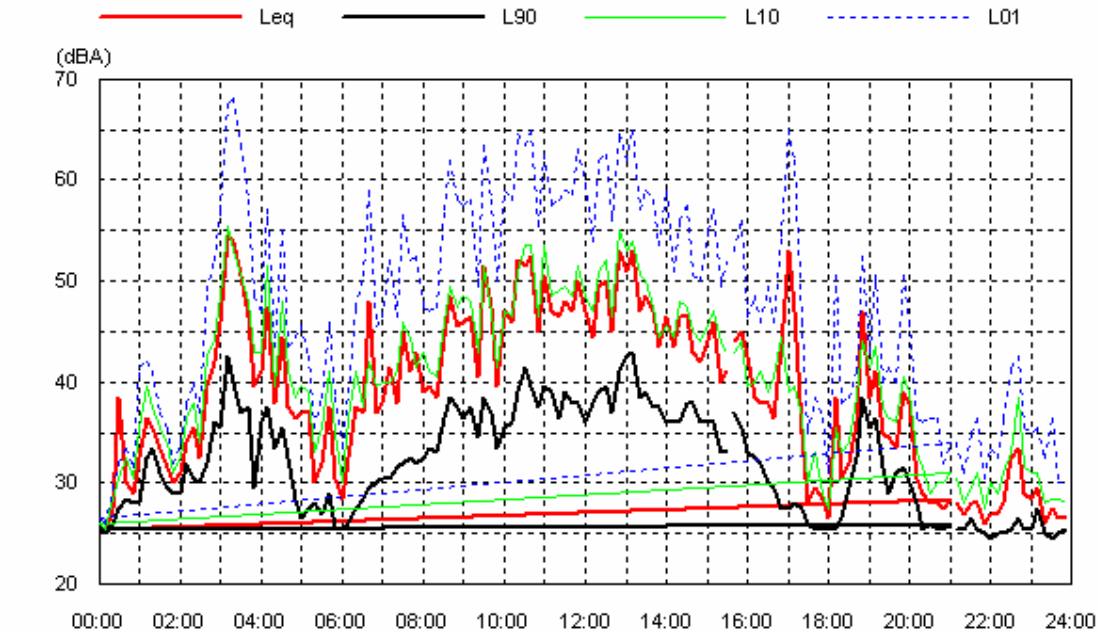


Location: Jingerah

Mon 21 May 07

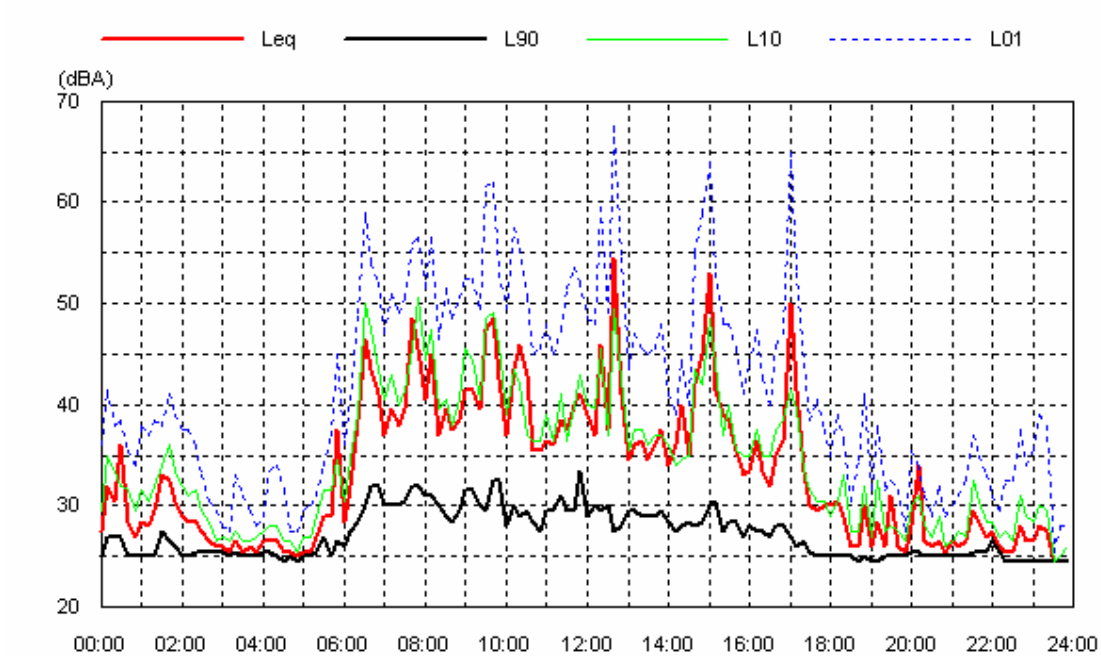


Tue 22 May 07

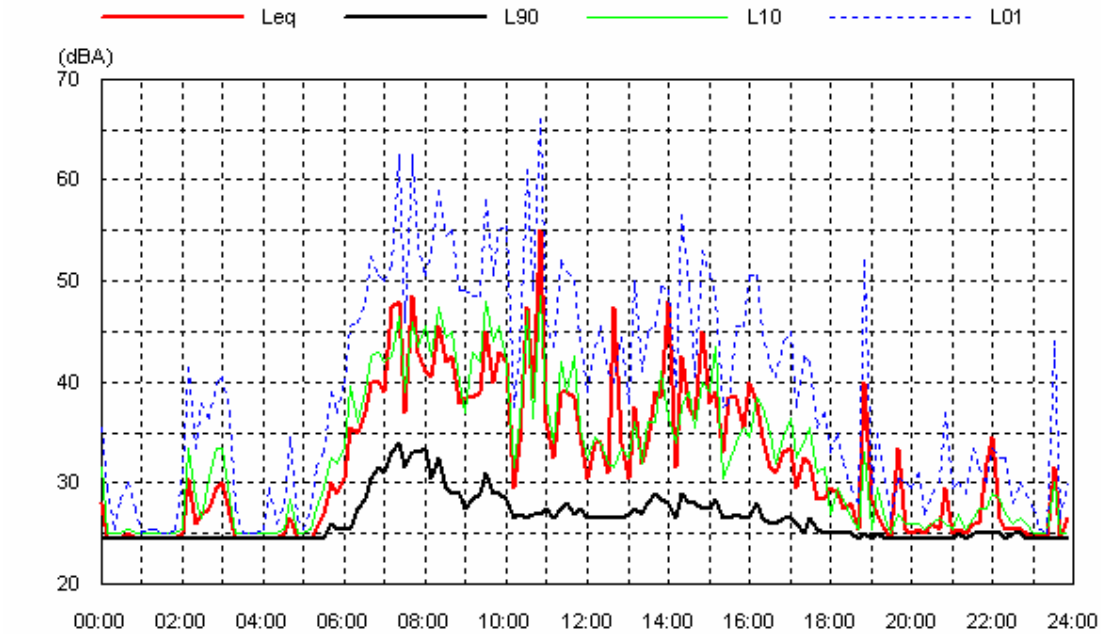


Location: Jingerah

Wed 23 May 07

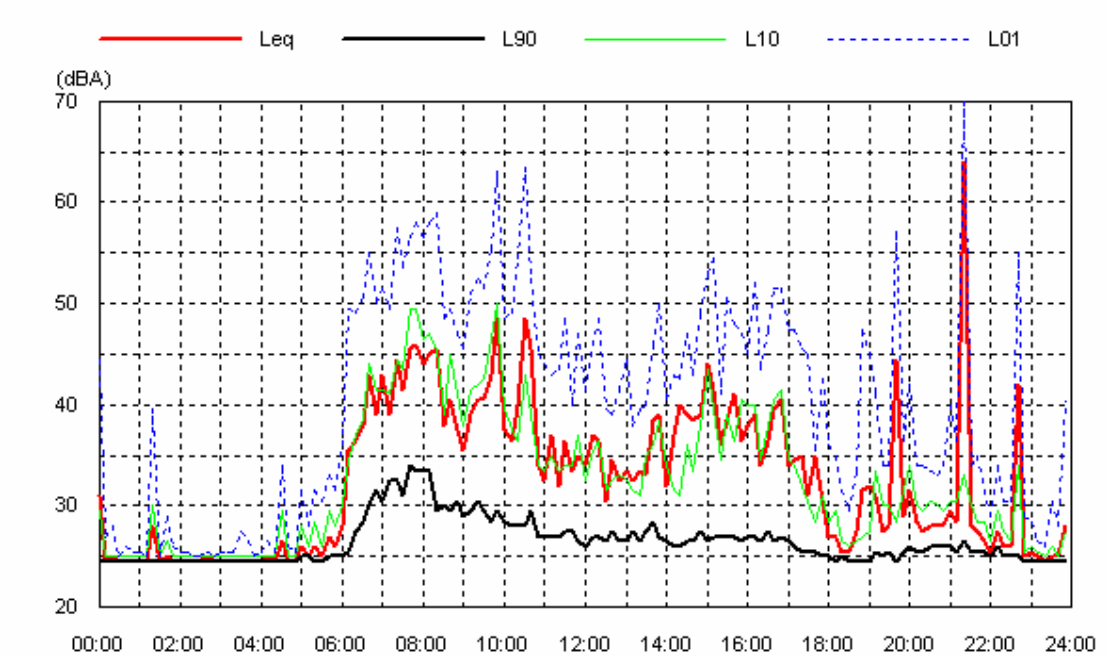


Thu 24 May 07

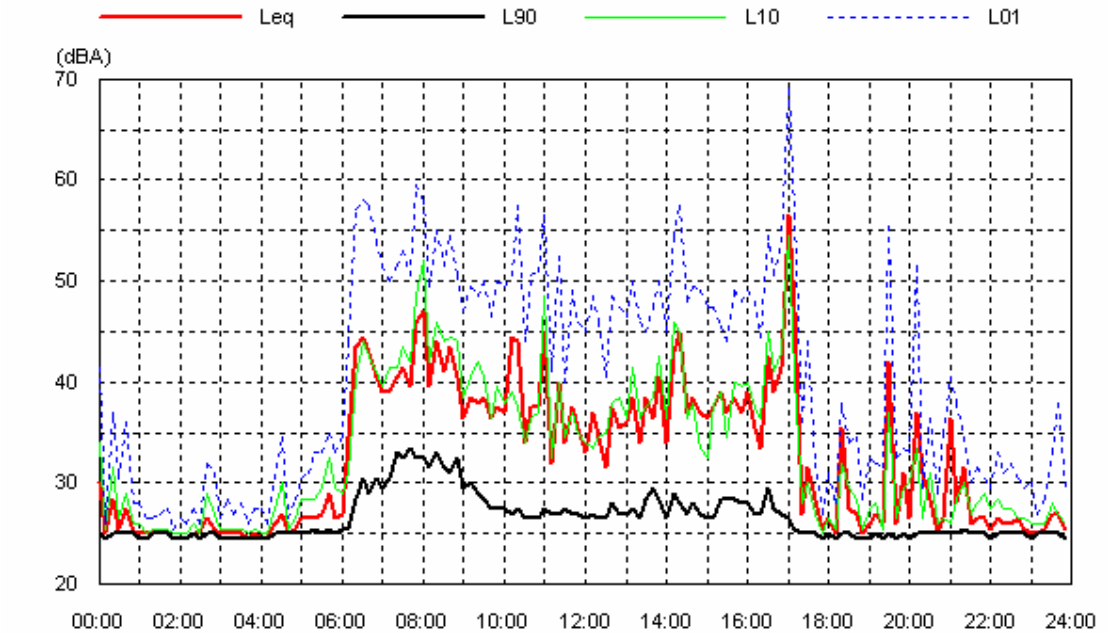


Location: Jingerah

Fri 25 May 07

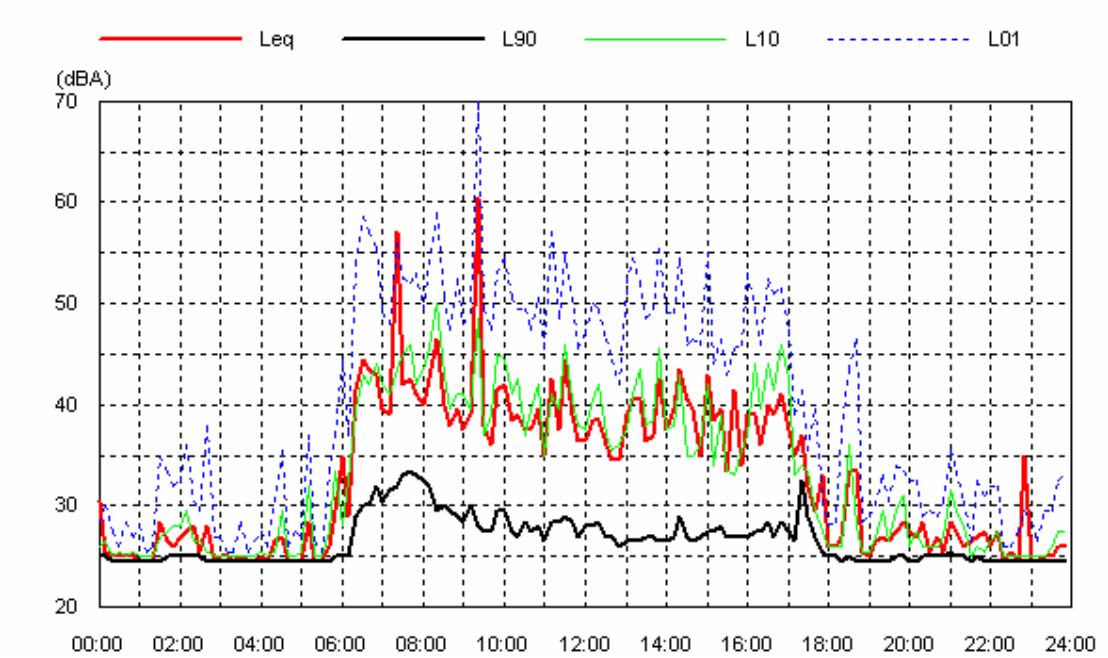


Sat 26 May 07

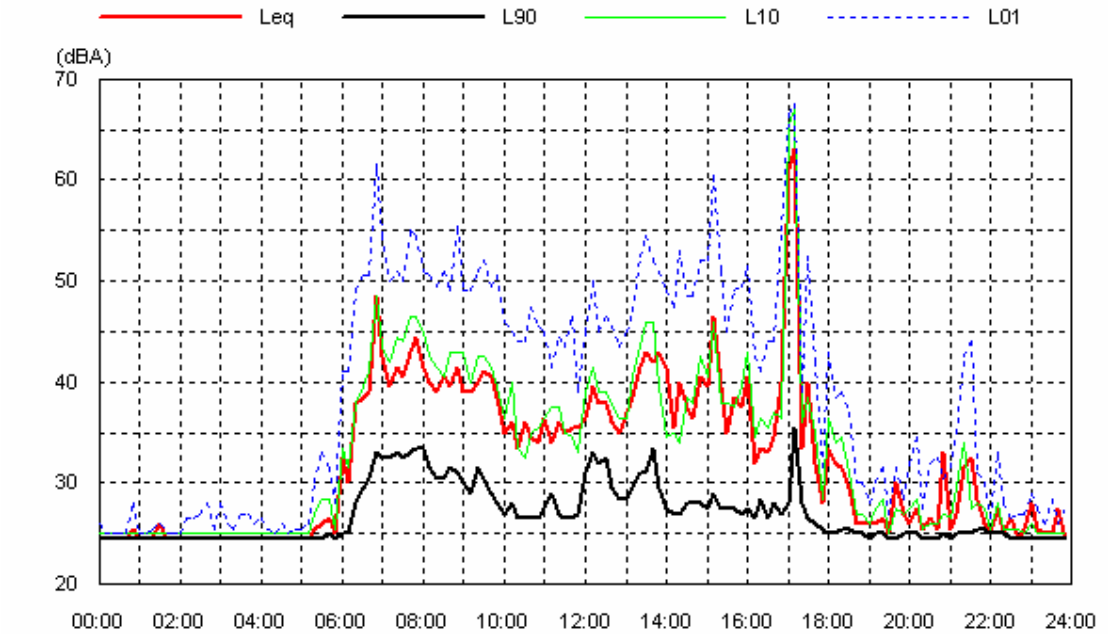


Location: Jingerah

Sun 27 May 07

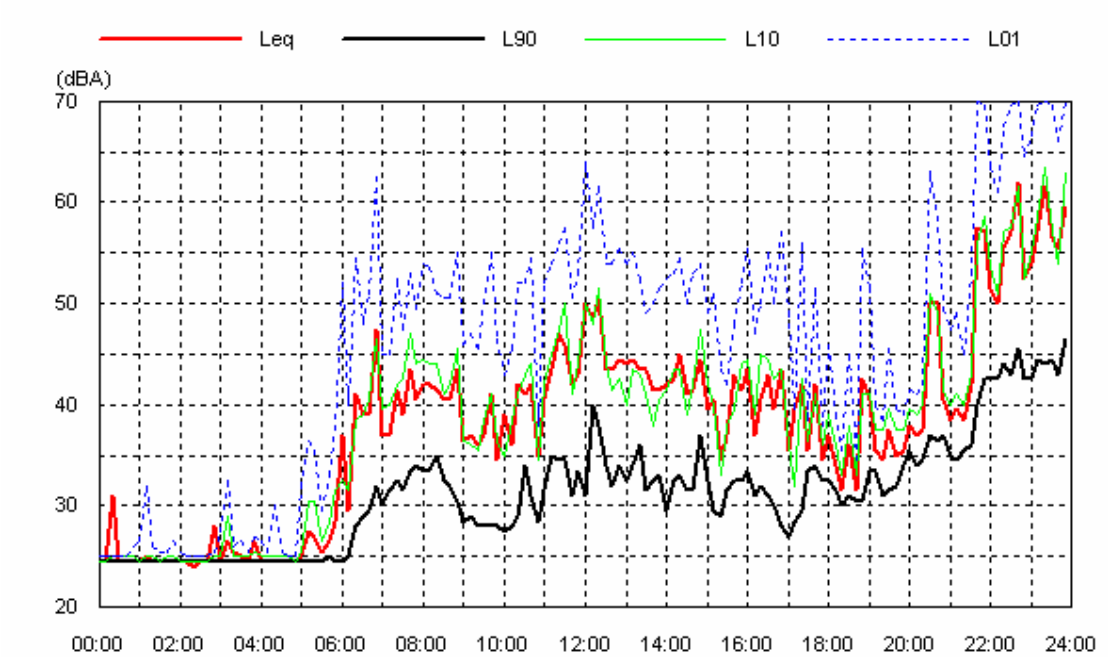


Mon 28 May 07

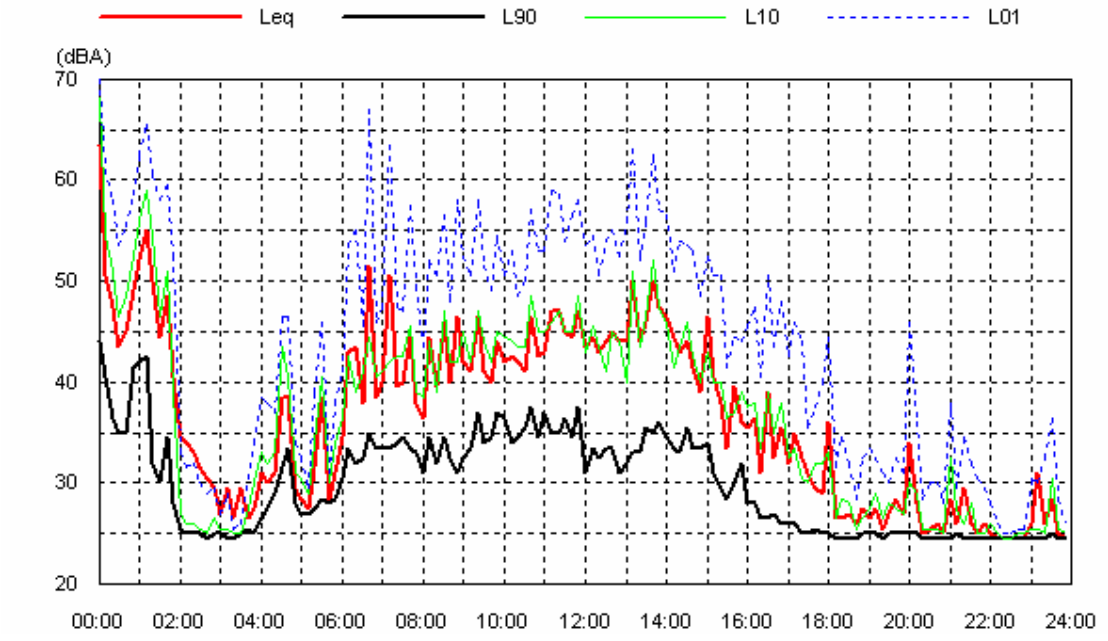


Location: Jingerah

Tue 29 May 07

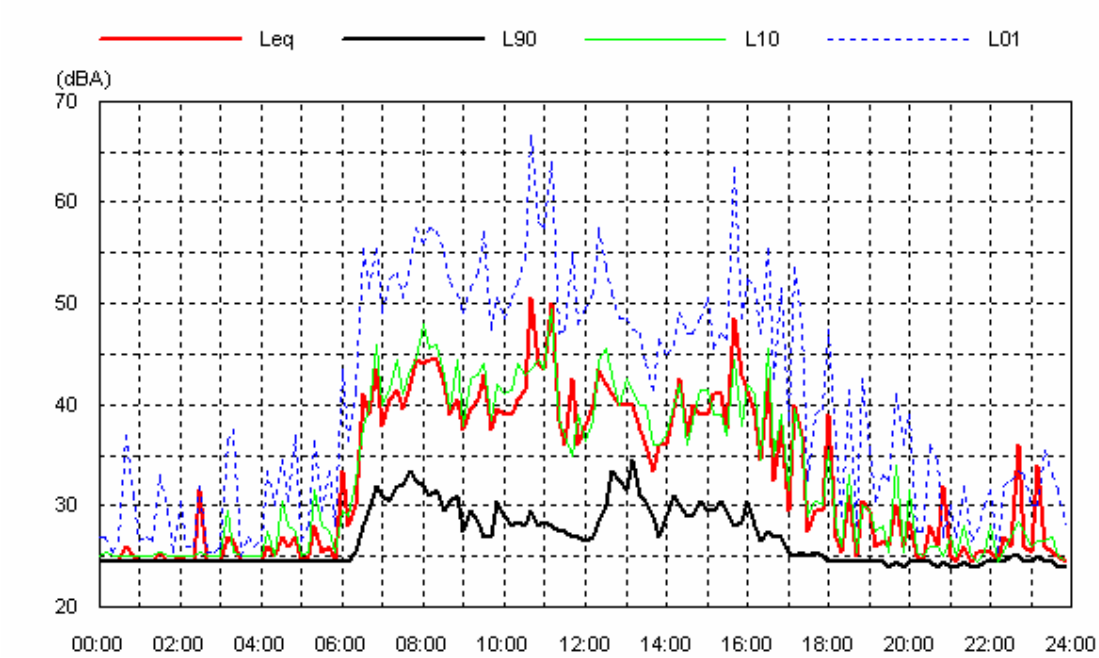


Wed 30 May 07

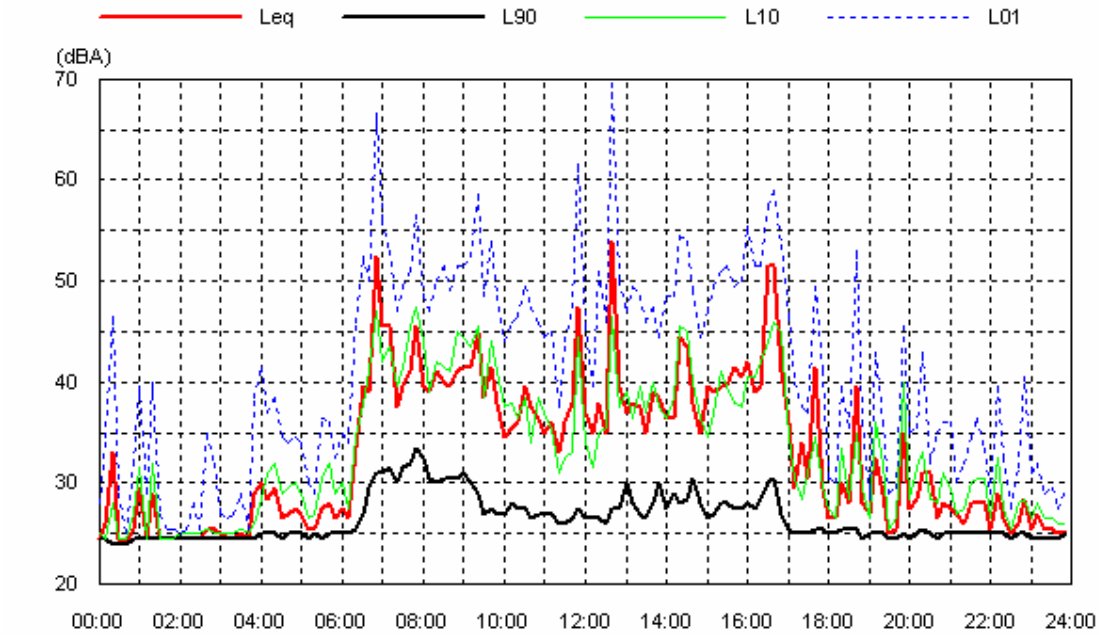


Location: Jingerah

Thu 31 May 07

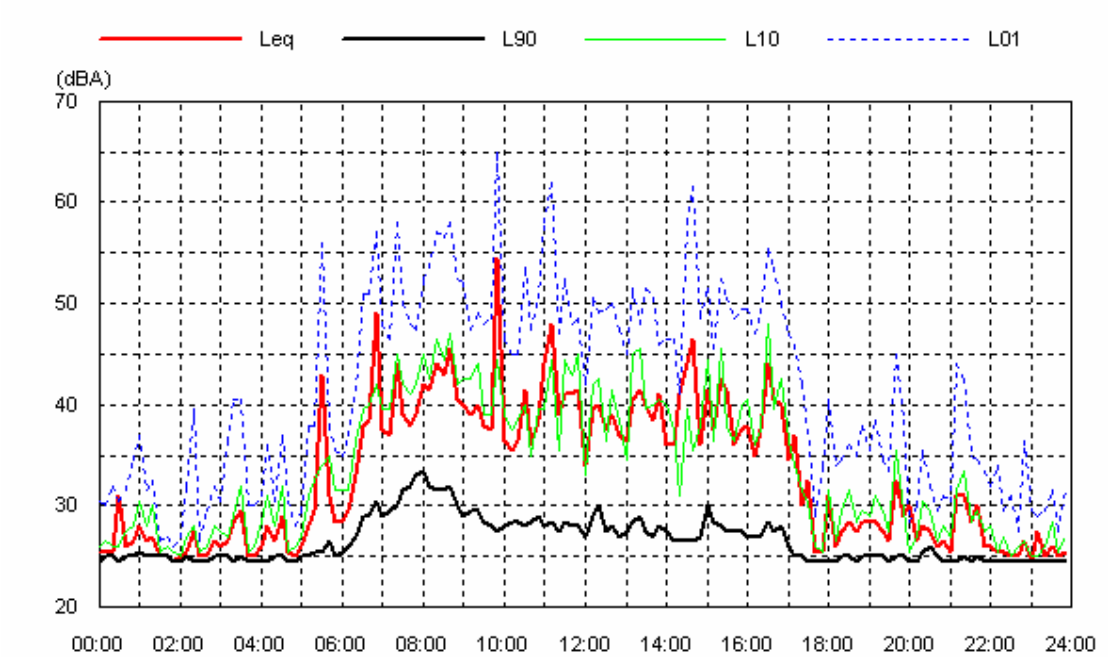


Fri 01 Jun 07

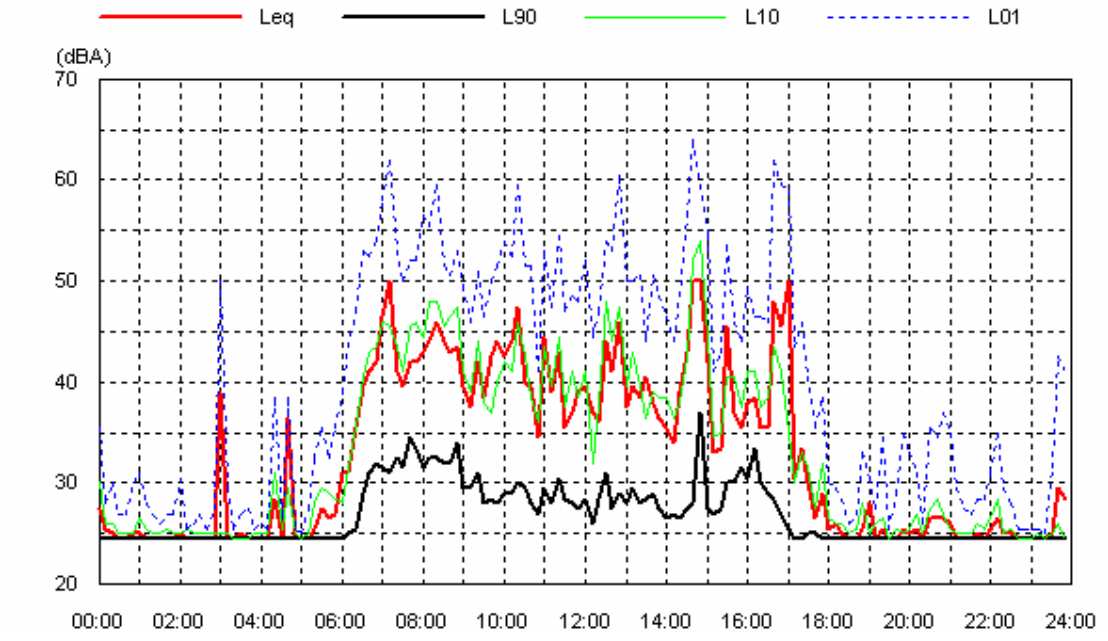


Location: Jingerah

Sat 02 Jun 07

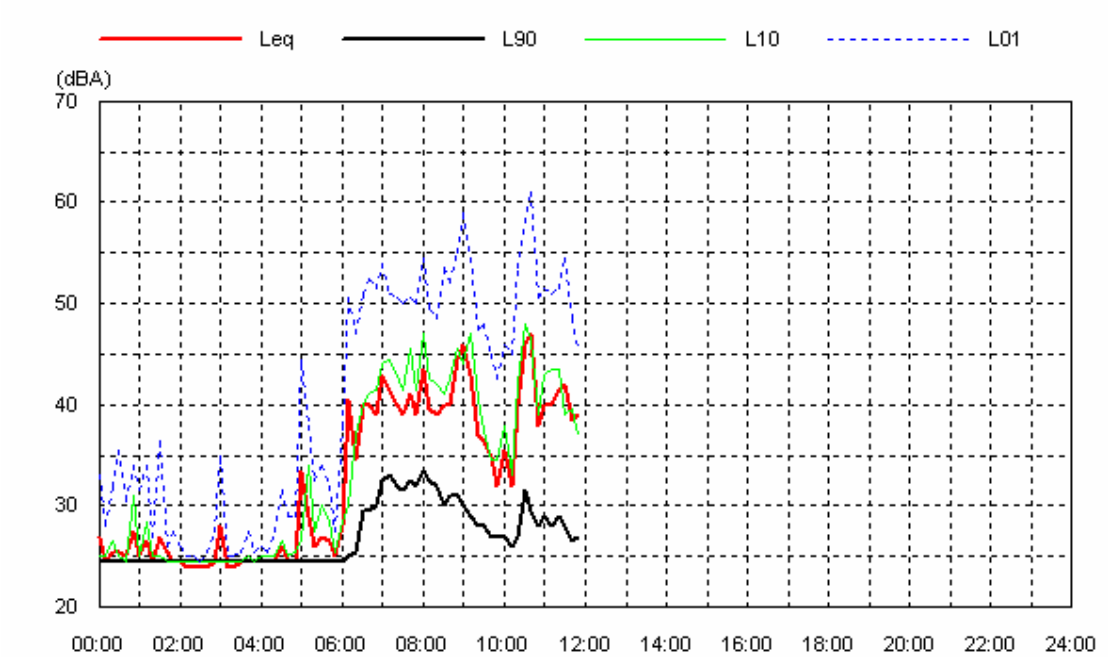


Sun 03 Jun 07



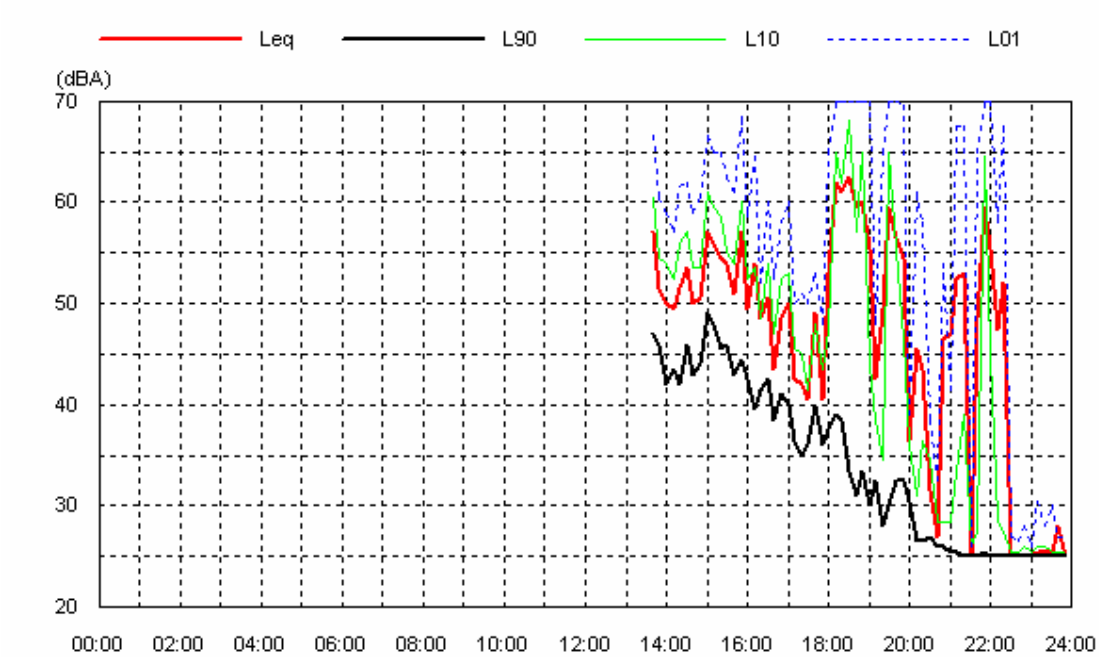
Location: Jingerah

Mon 04 Jun 07

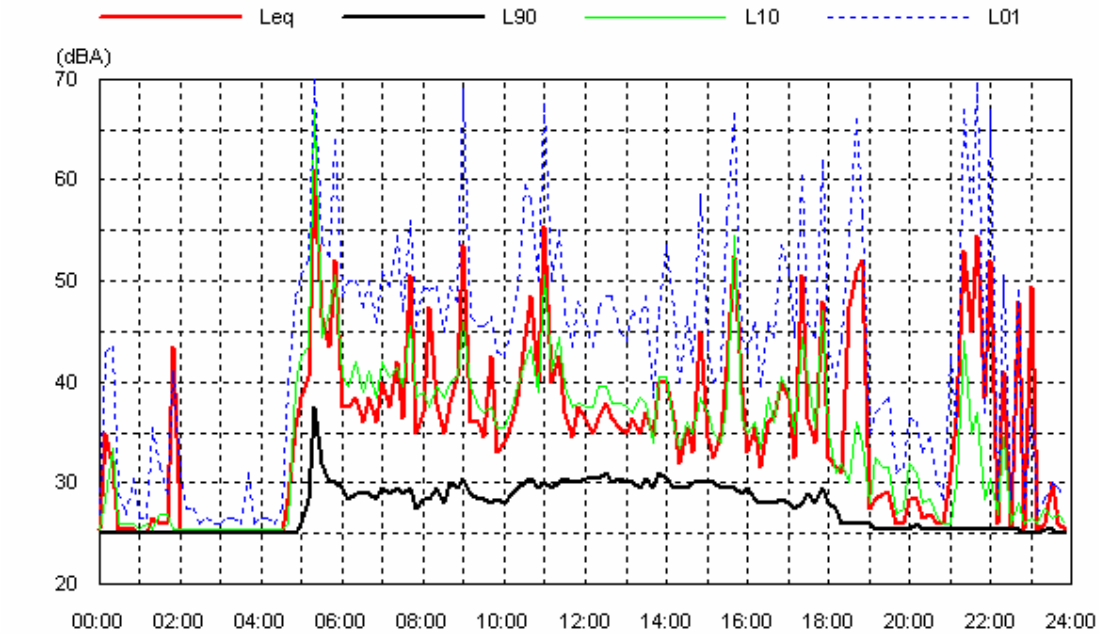


Location: Dunvagen2

Thu 20 Sep 07

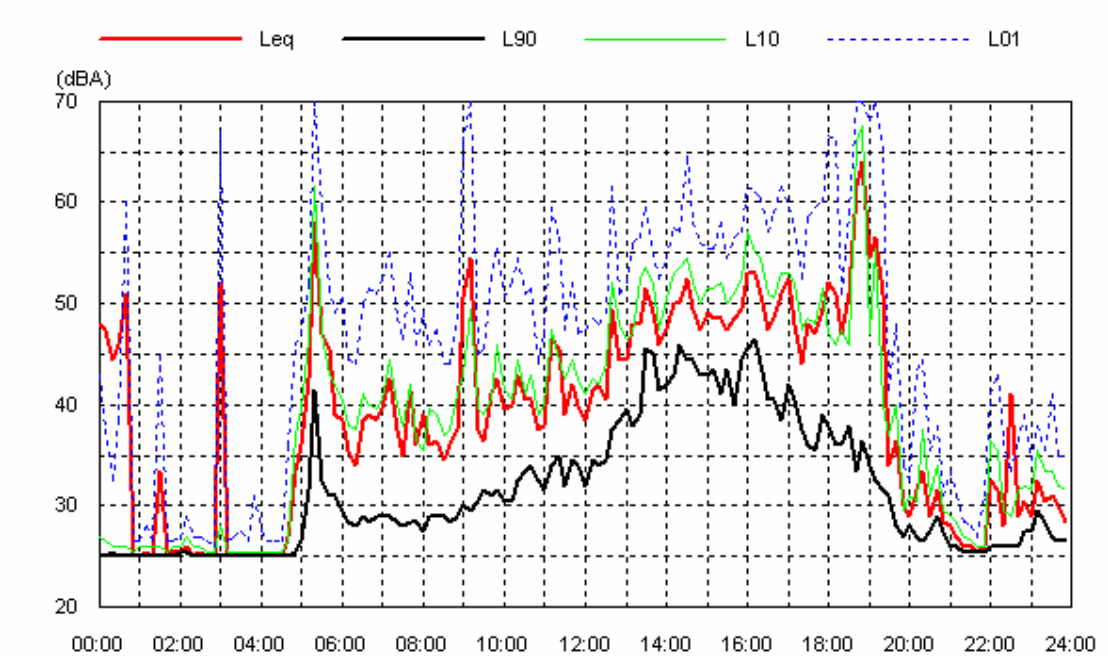


Fri 21 Sep 07

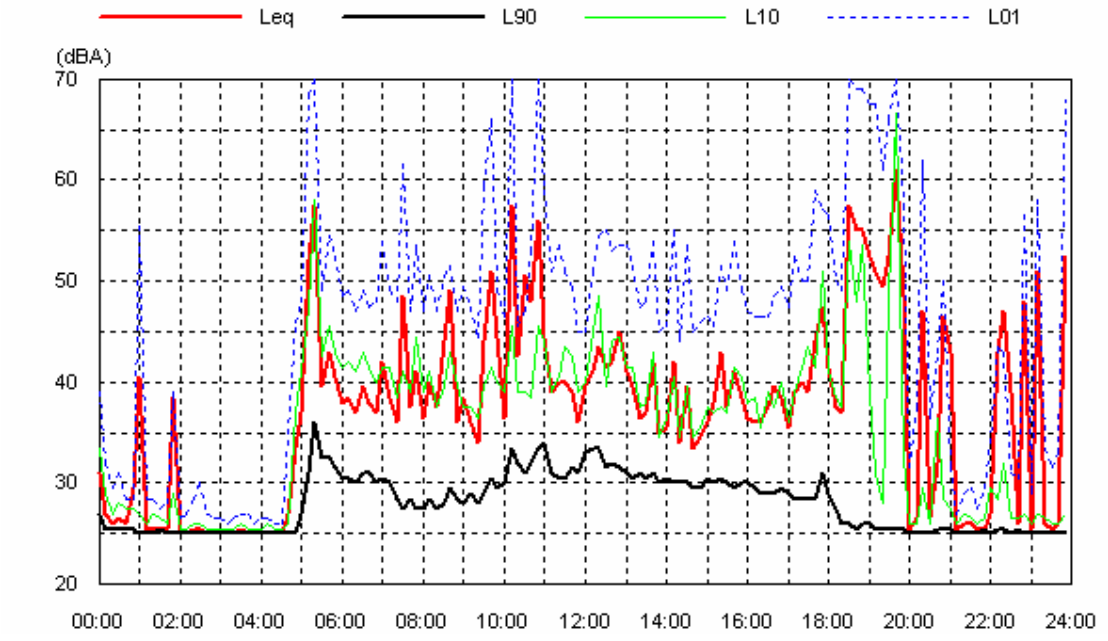


Location: Dunvagen2

Sat 22 Sep 07

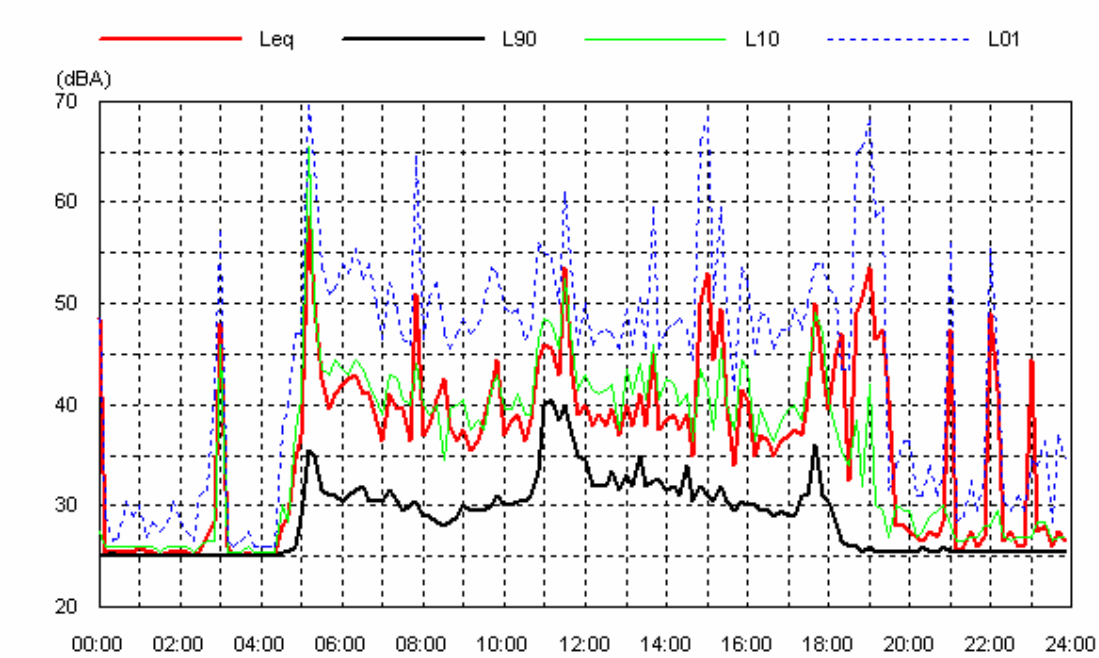


Sun 23 Sep 07

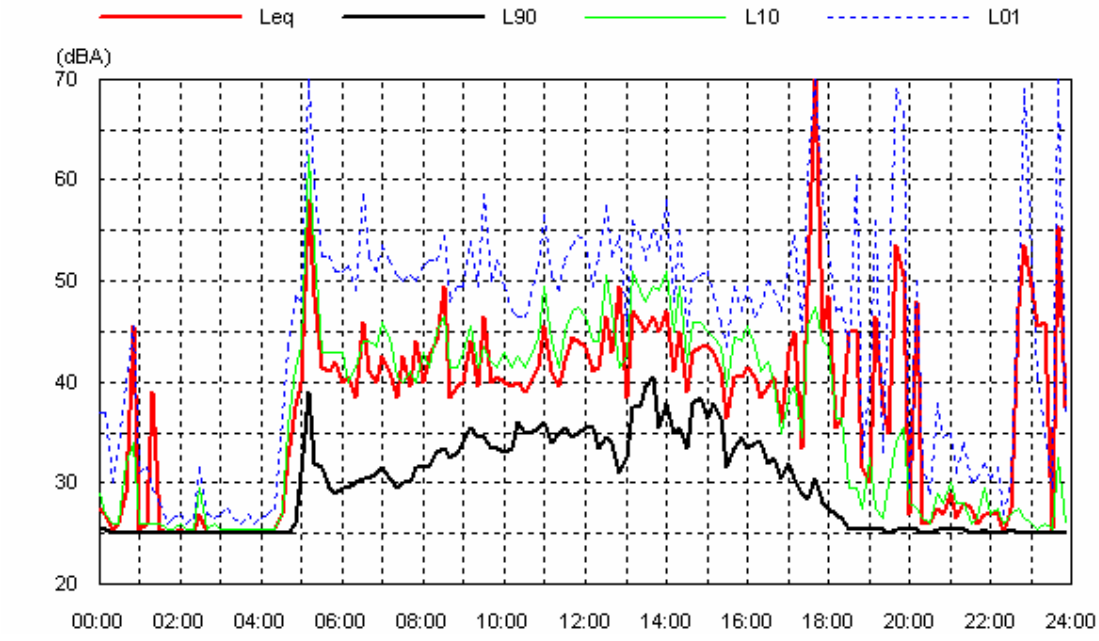


Location: Dunvagen2

Mon 24 Sep 07

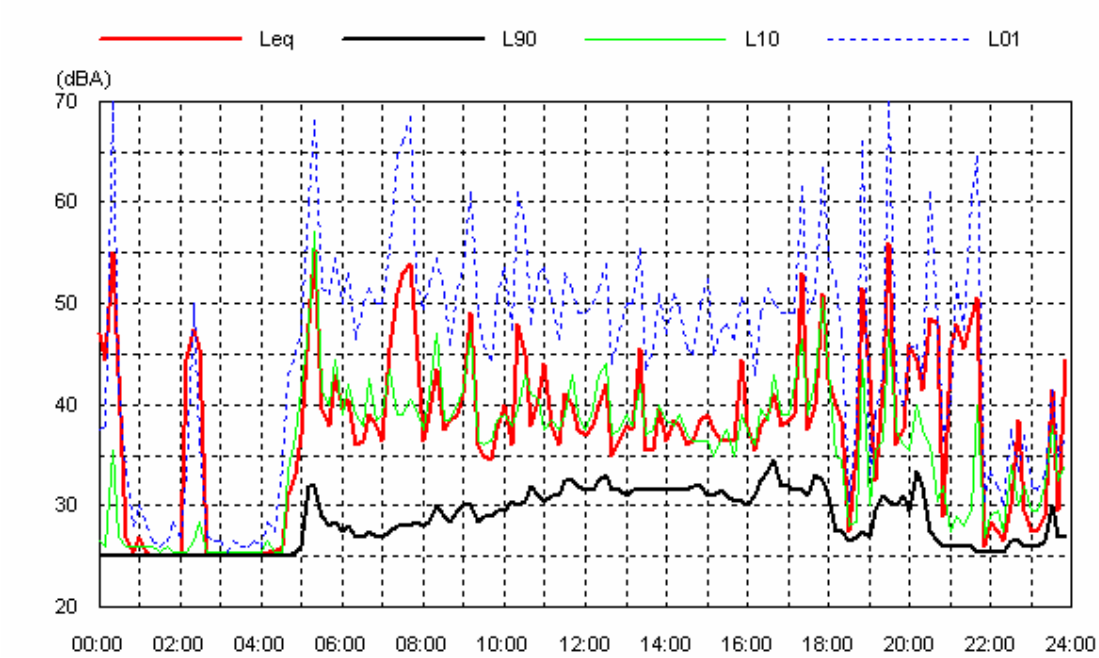


Tue 25 Sep 07

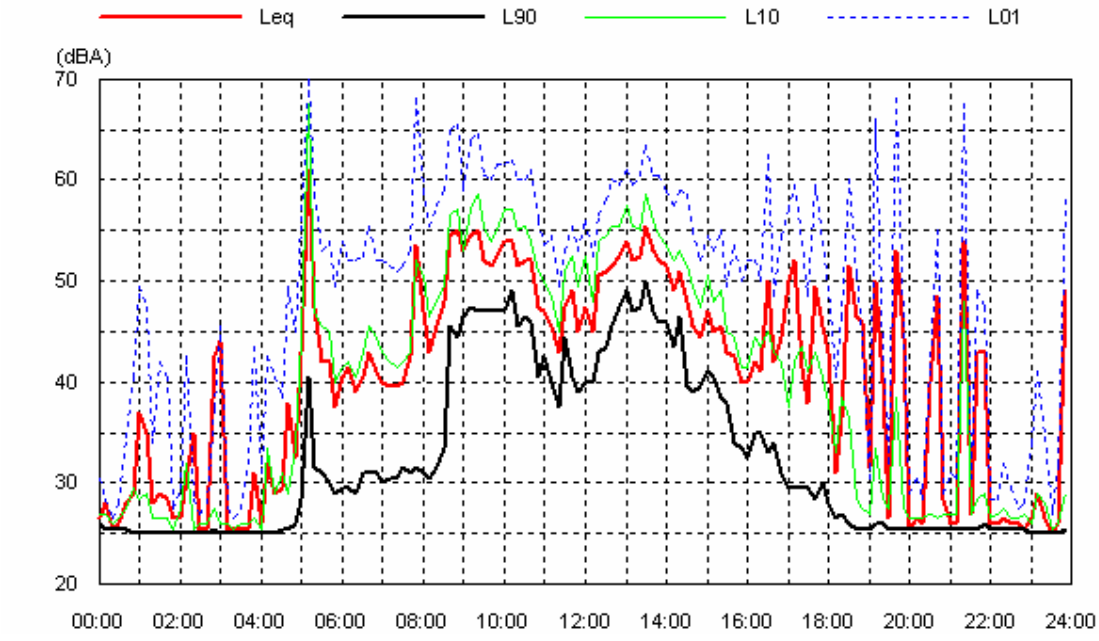


Location: Dunvagen2

Wed 26 Sep 07

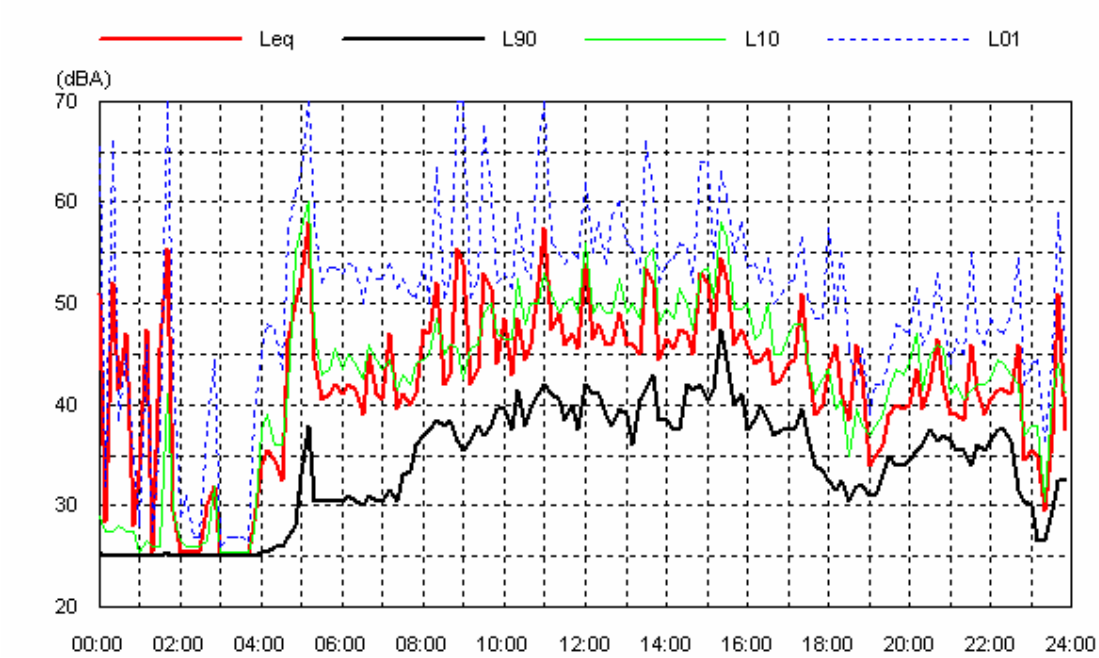


Thu 27 Sep 07

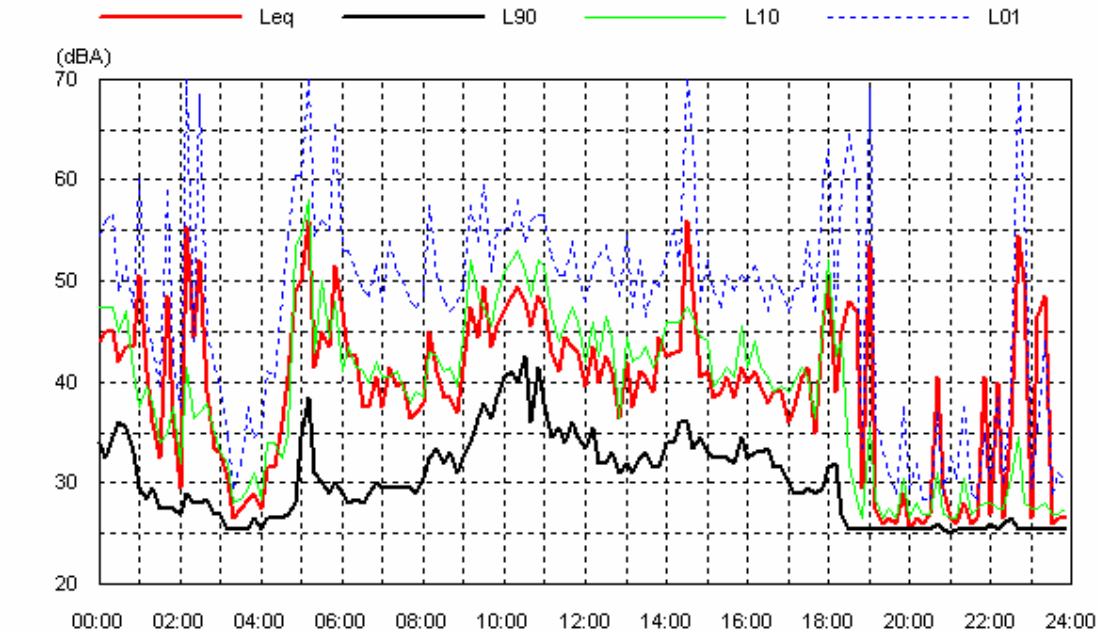


Location: Dunvagen2

Fri 28 Sep 07

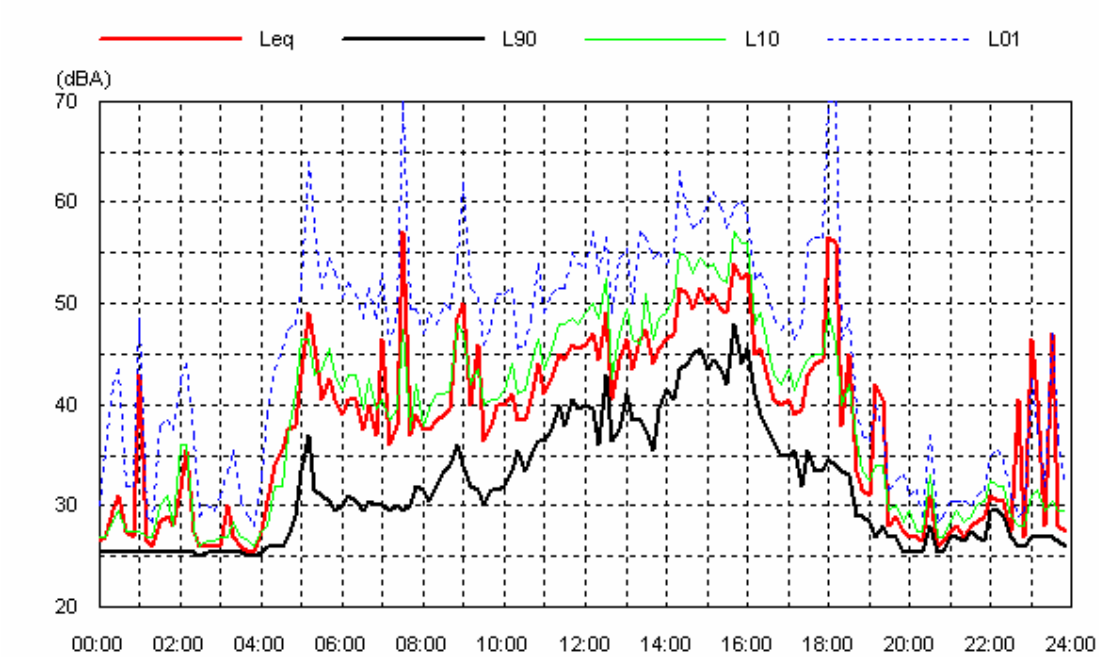


Sat 29 Sep 07

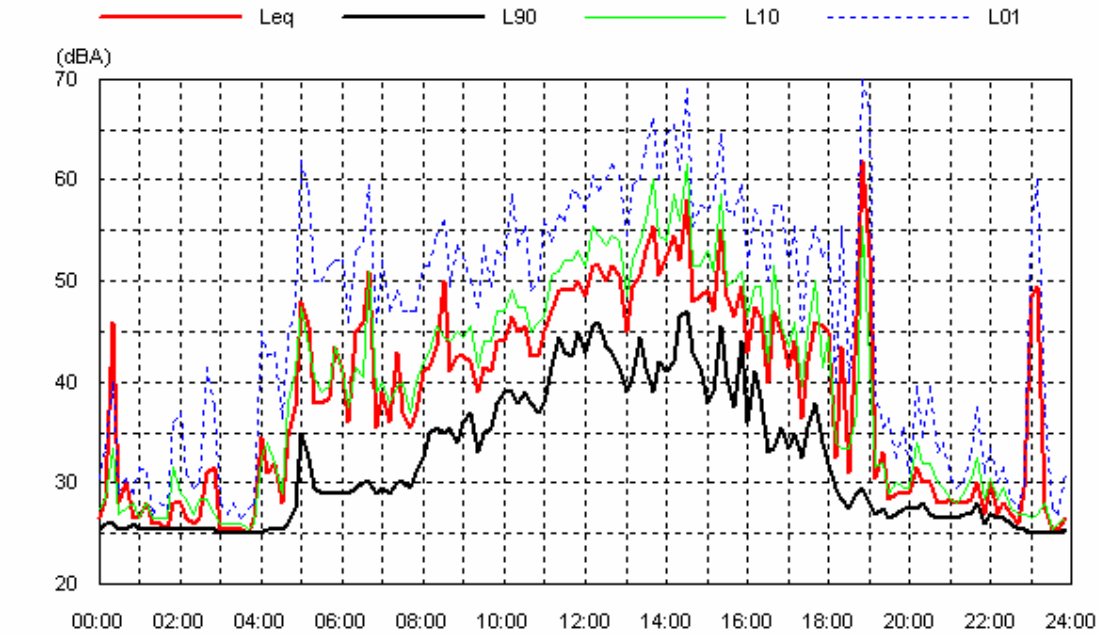


Location: Dunvagen2

Sun 30 Sep 07

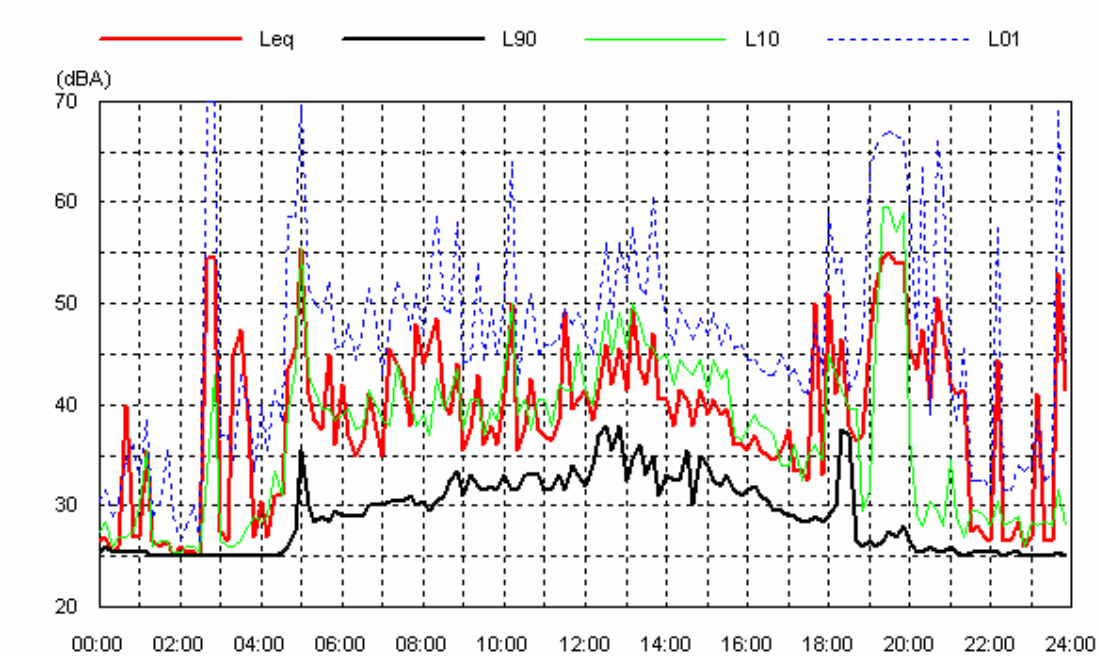


Mon 01 Oct 07

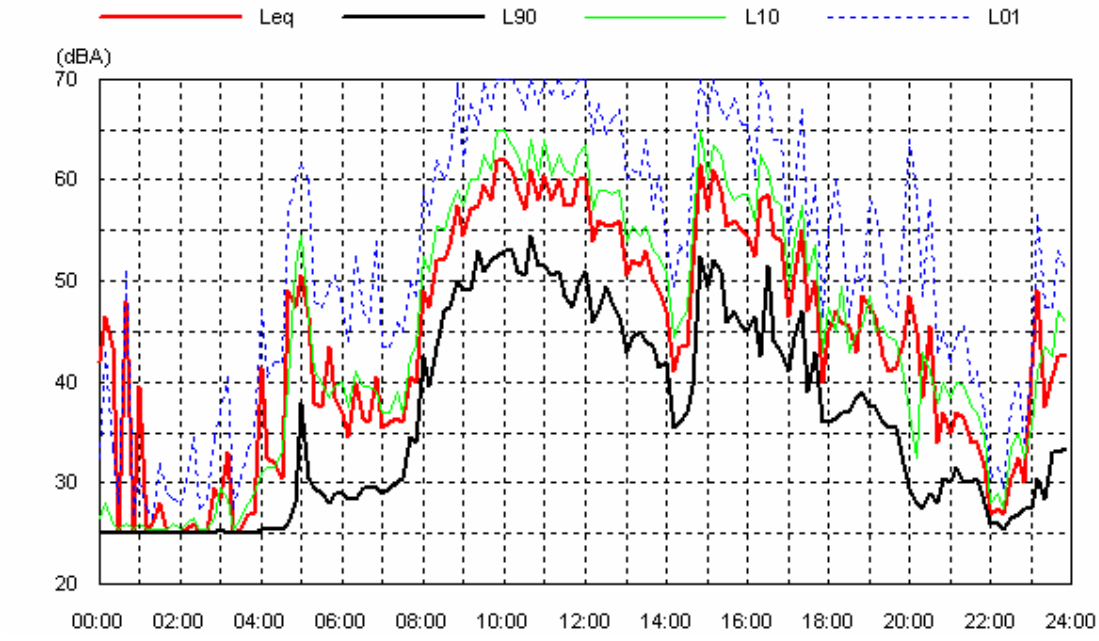


Location: Dunvagen2

Tue 02 Oct 07

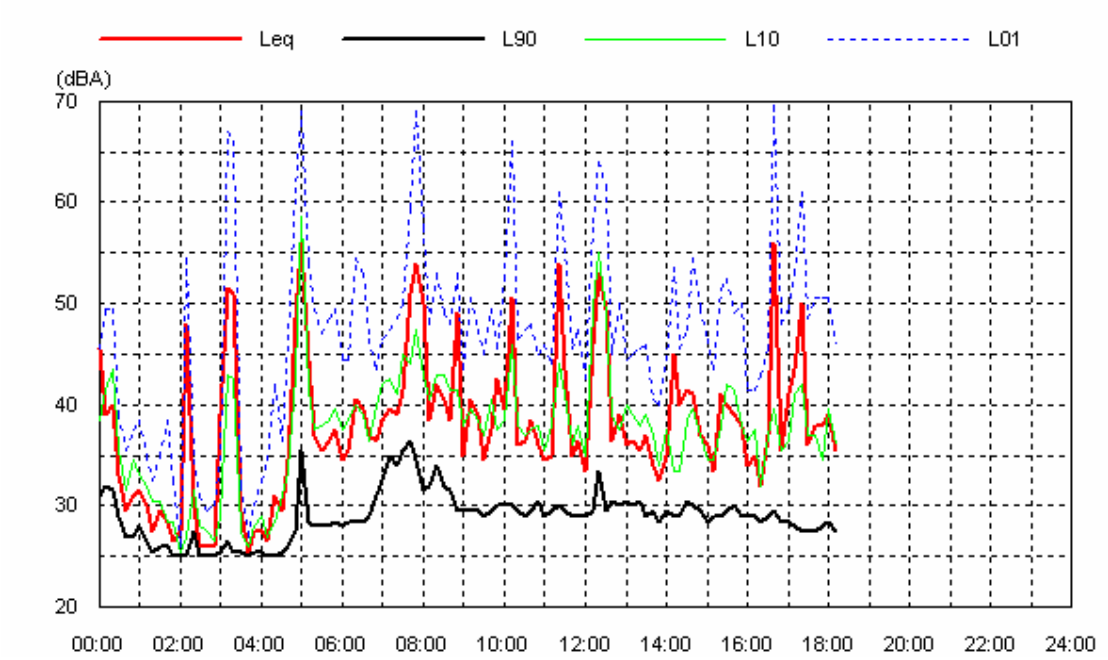


Wed 03 Oct 07



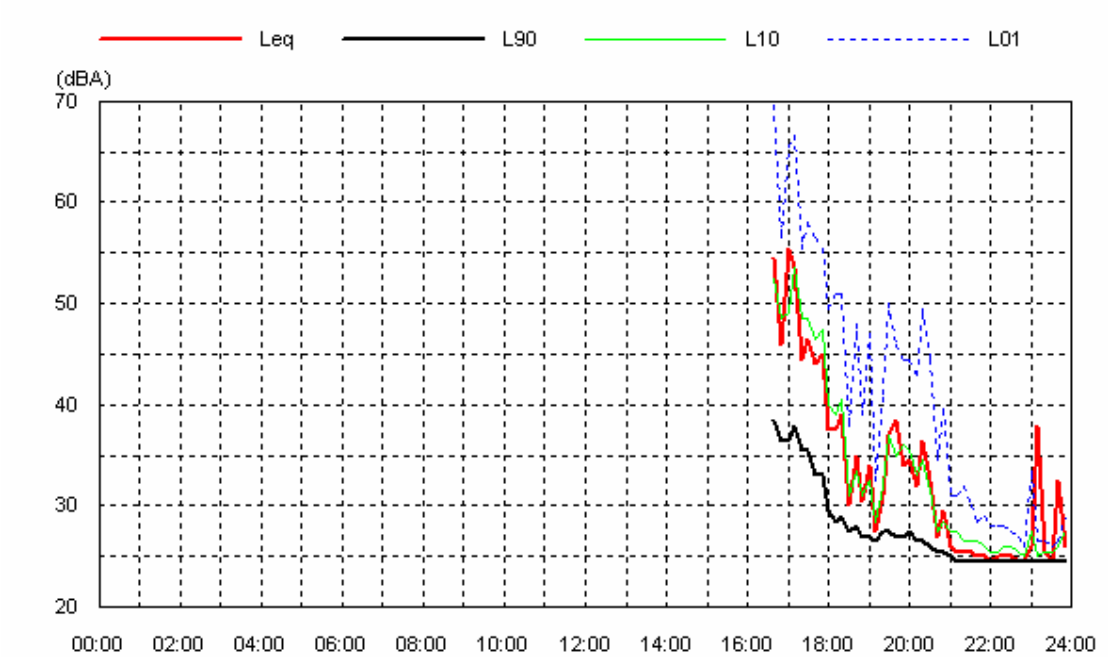
Location: Dunvagen2

Thu 04 Oct 07

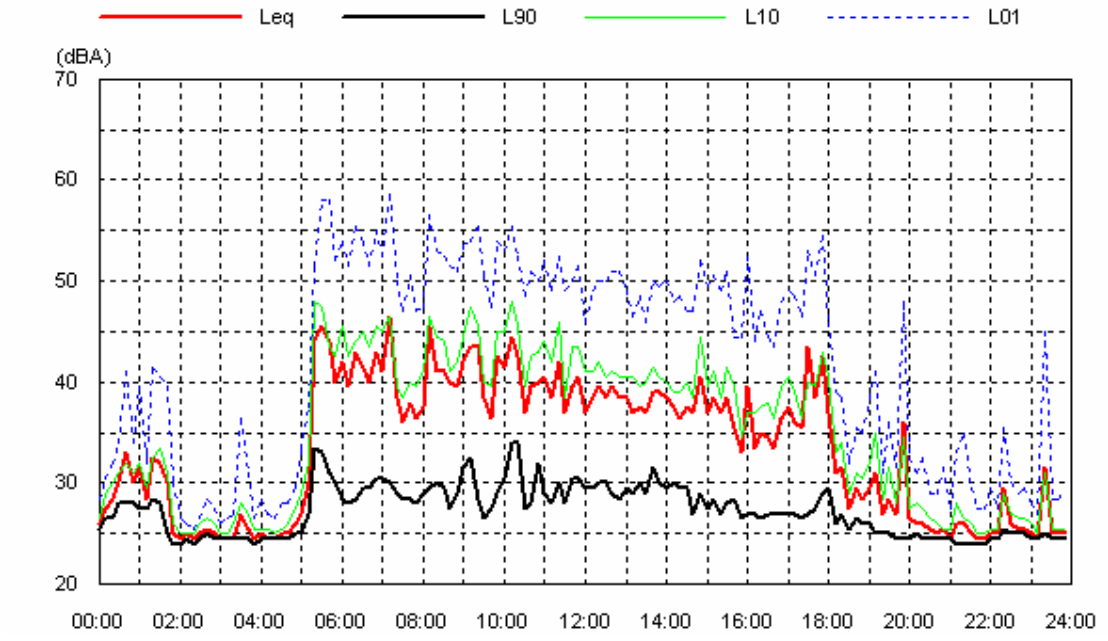


Location: Adams2

Thu 20 Sep 07

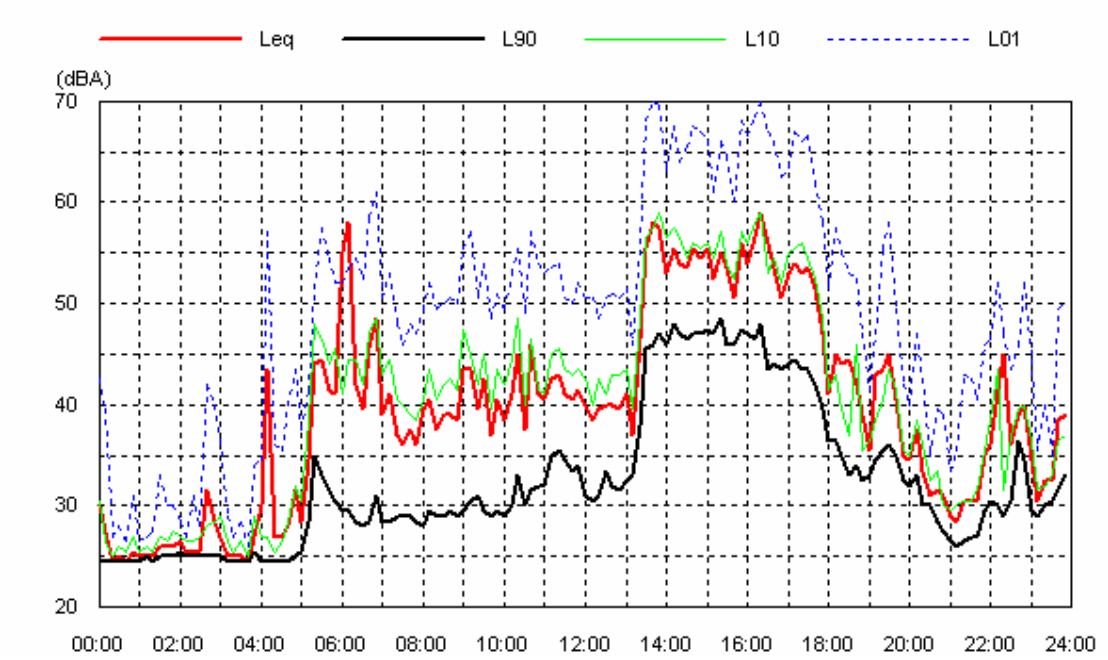


Fri 21 Sep 07

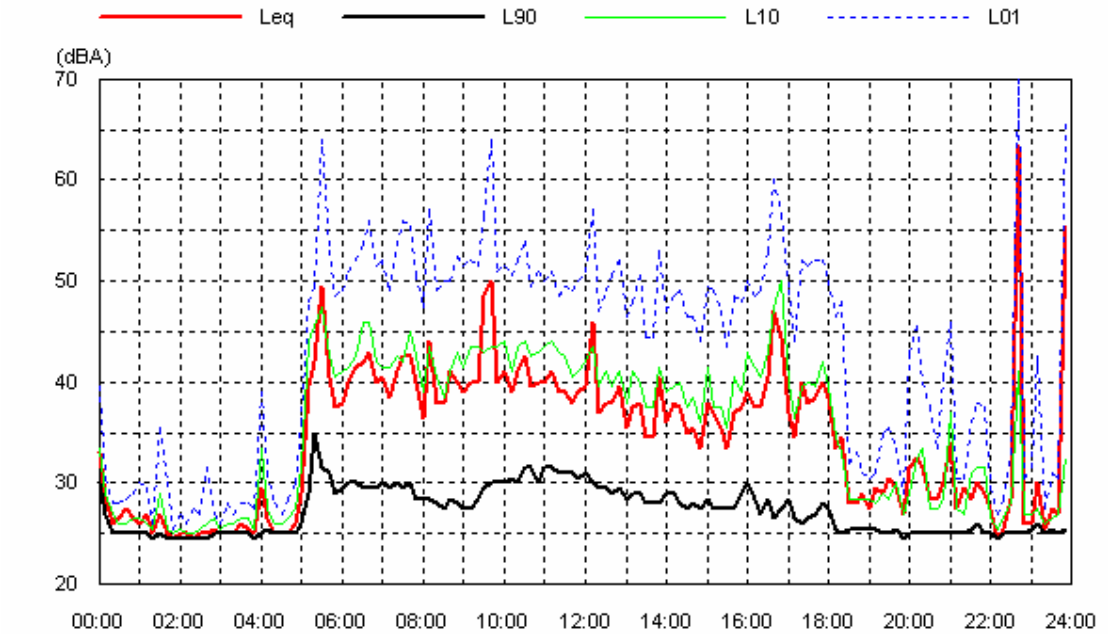


Location: Adams2

Sat 22 Sep 07

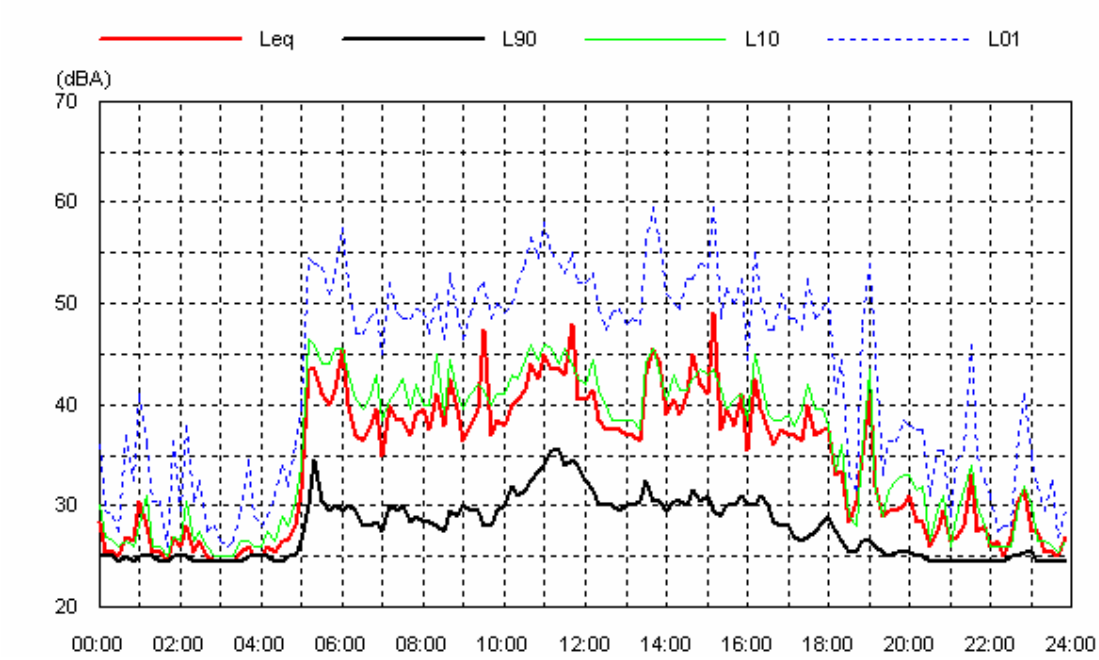


Sun 23 Sep 07

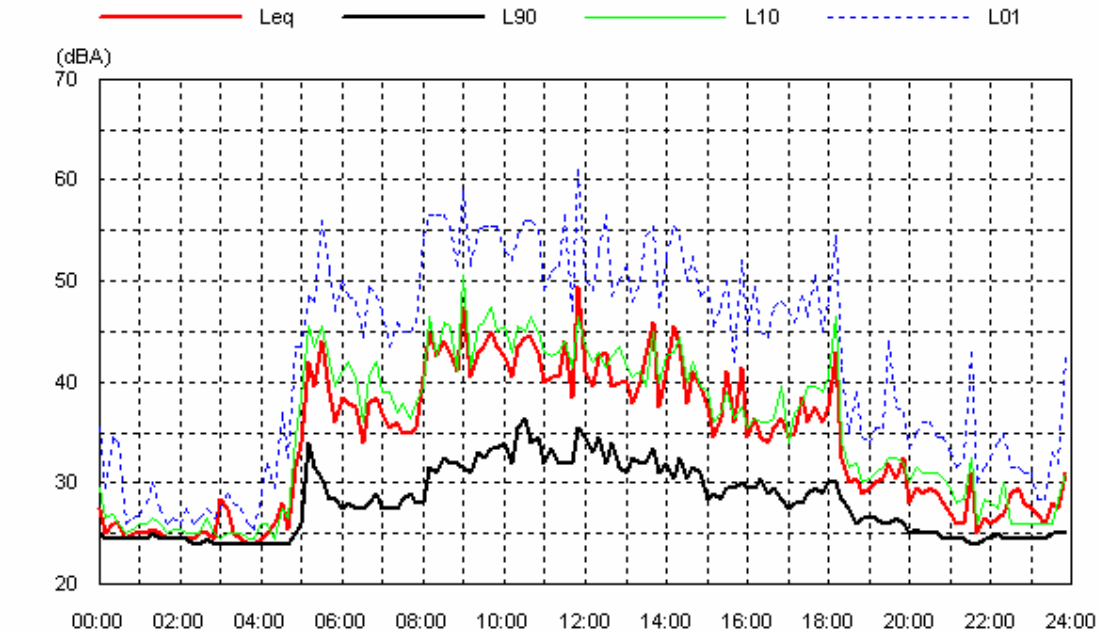


Location: Adams2

Mon 24 Sep 07

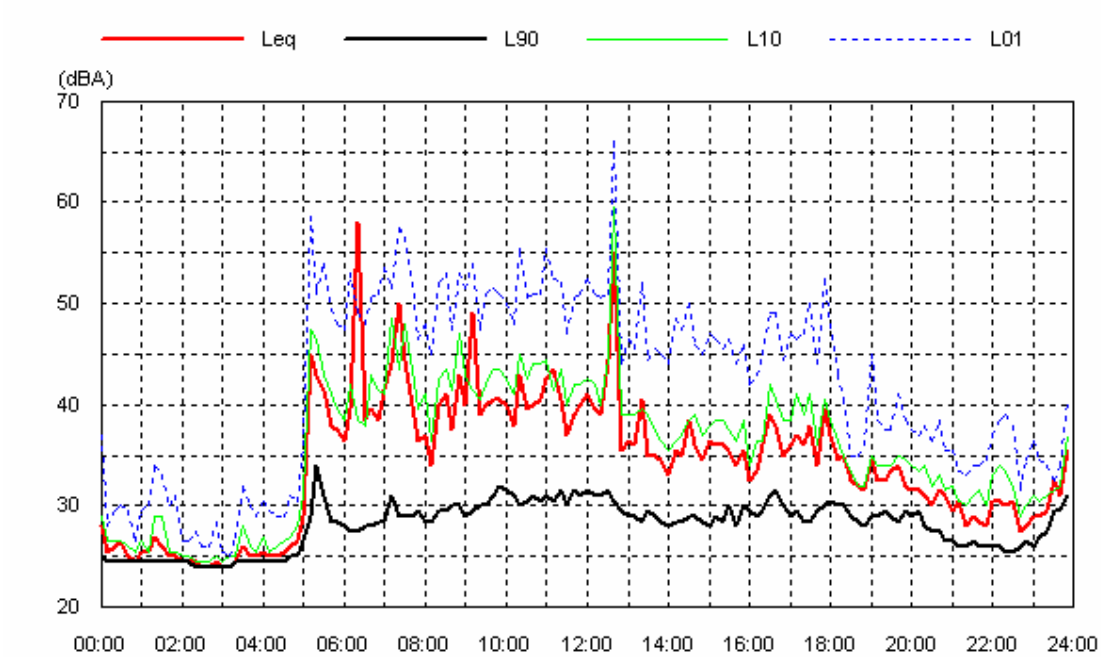


Tue 25 Sep 07

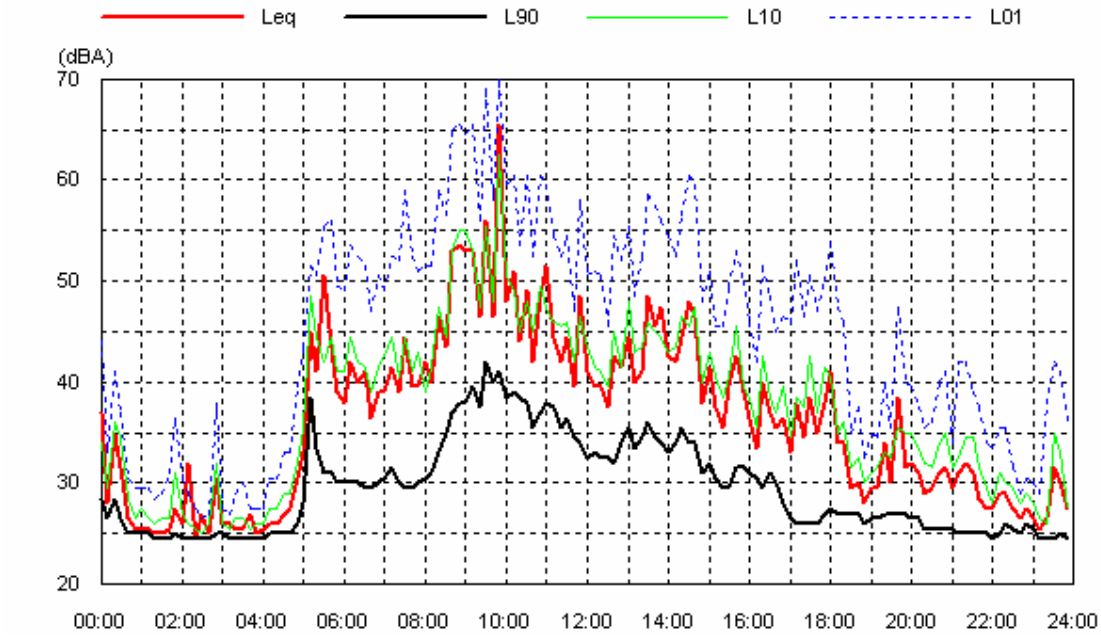


Location: Adams2

Wed 26 Sep 07

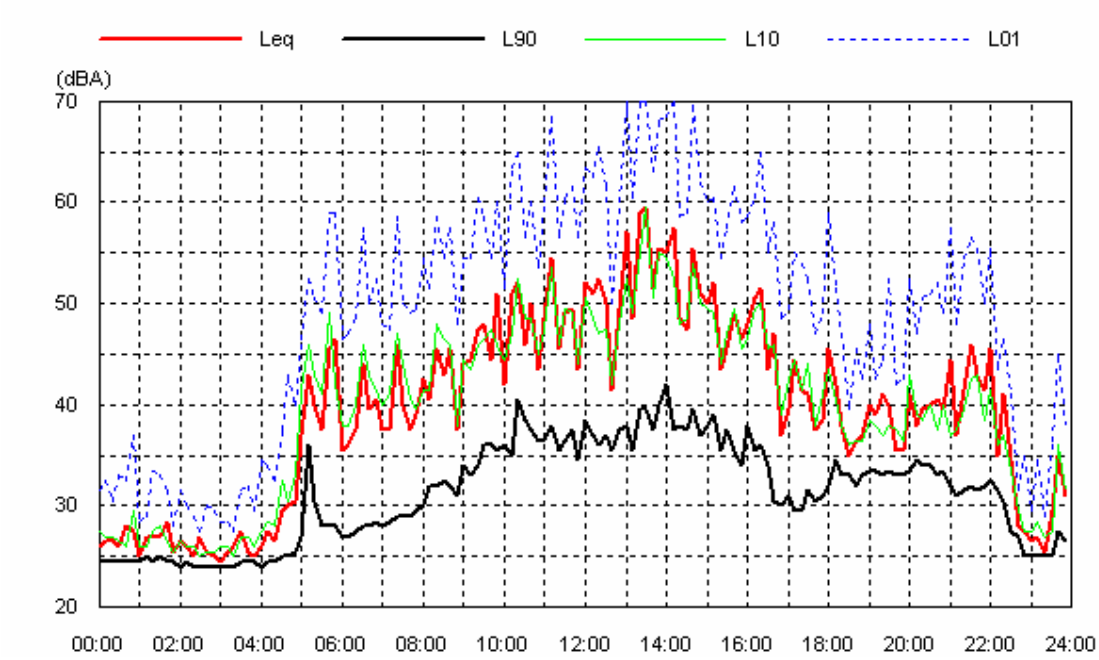


Thu 27 Sep 07

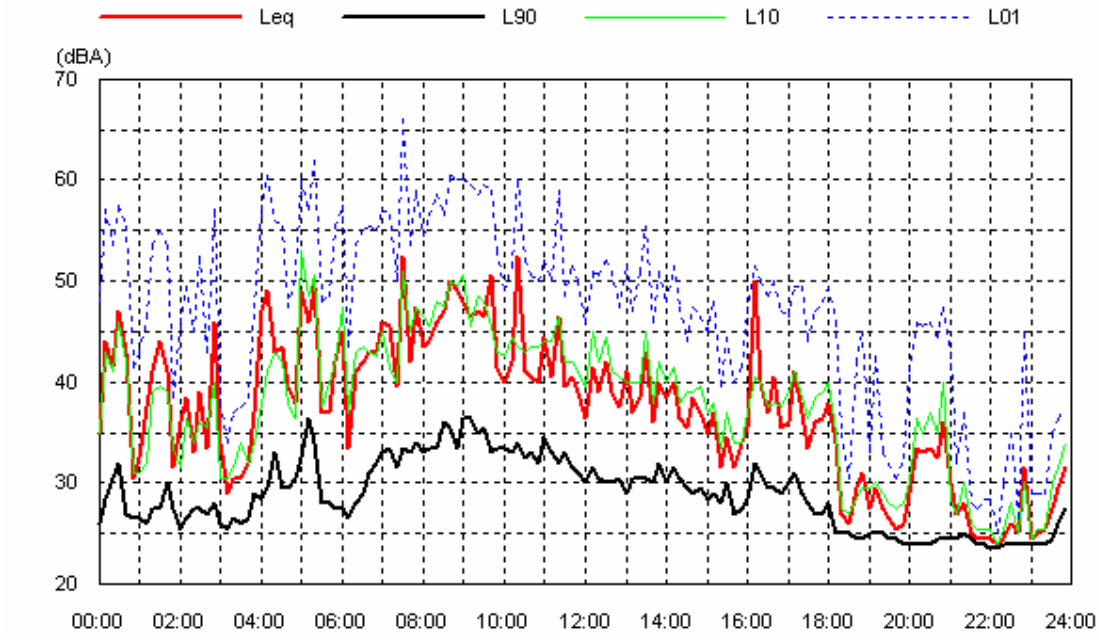


Location: Adams2

Fri 28 Sep 07

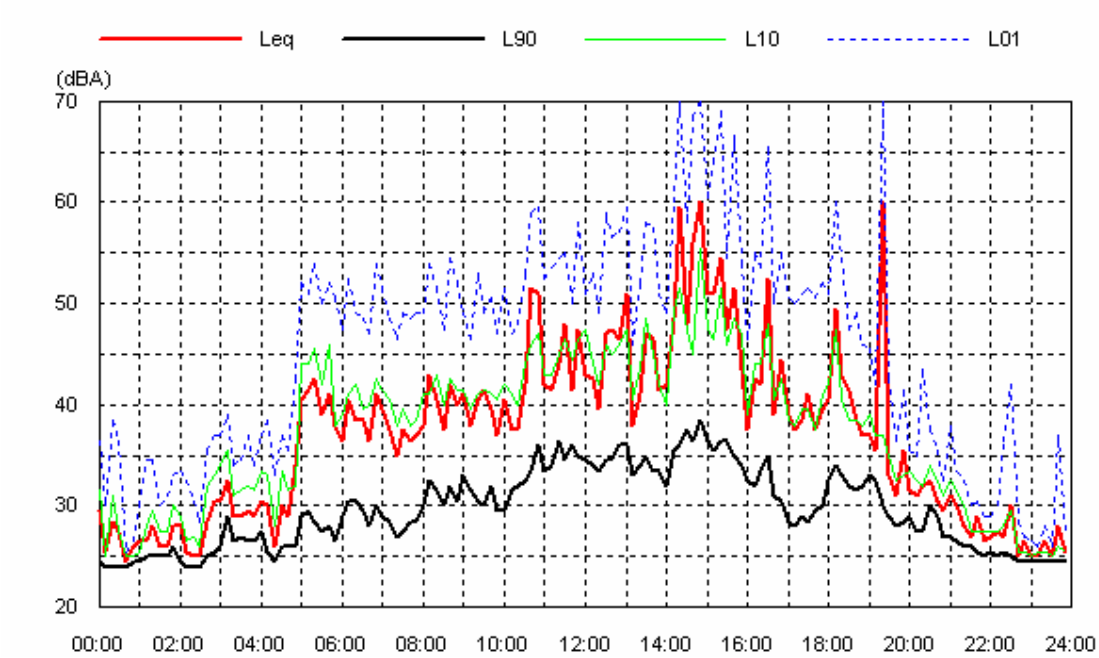


Sat 29 Sep 07

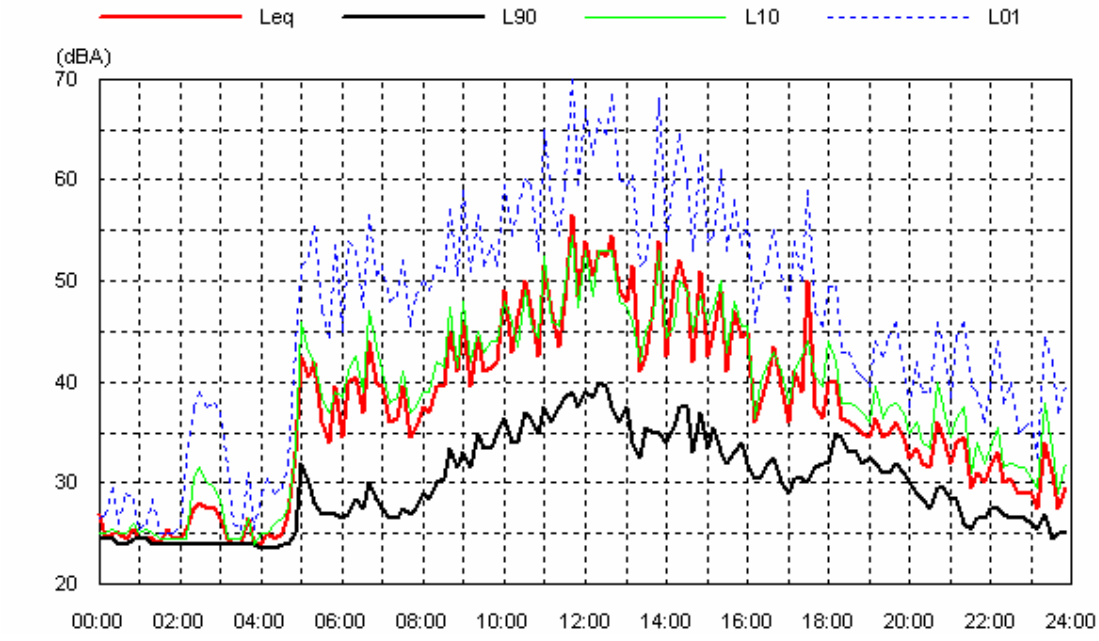


Location: Adams2

Sun 30 Sep 07

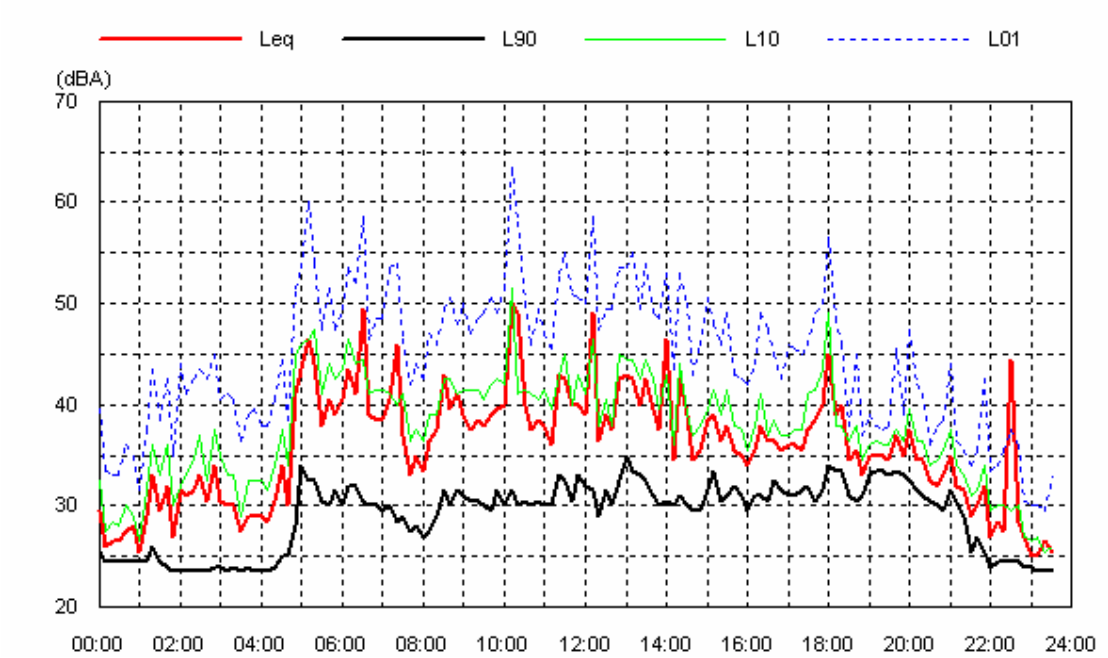


Mon 01 Oct 07



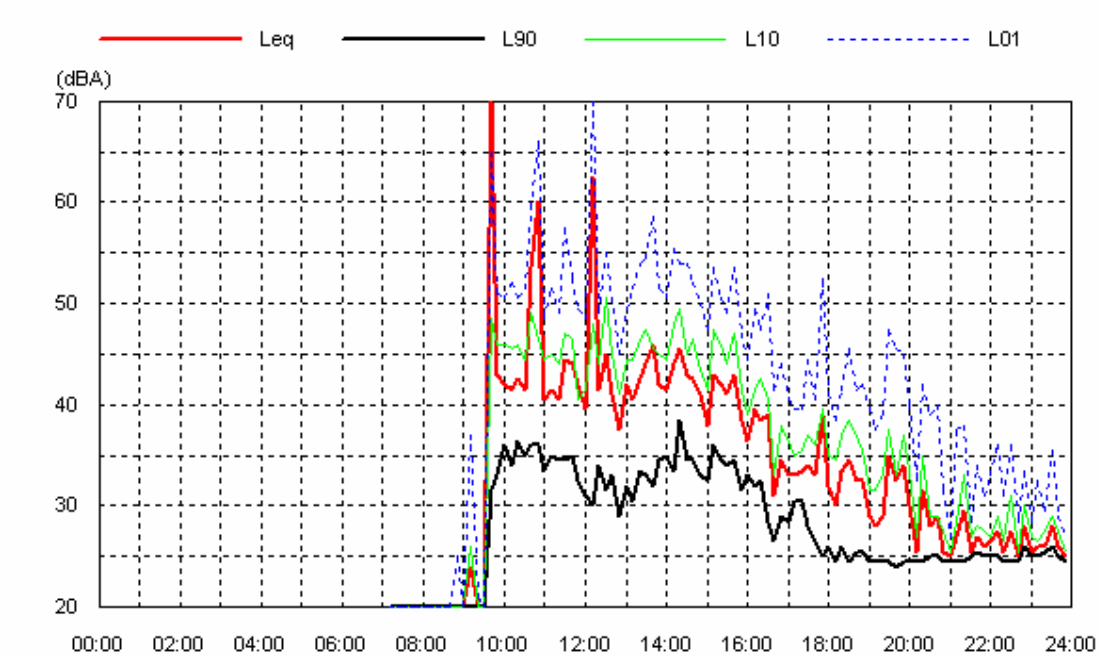
Location: Adams2

Tue 02 Oct 07

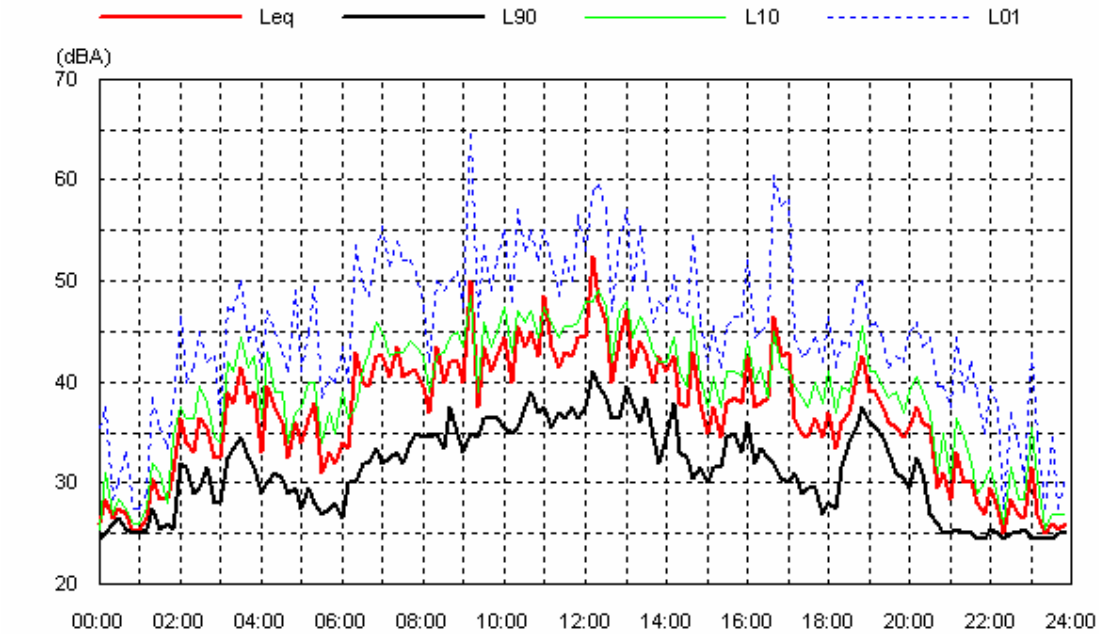


Location: Airdrie

Mon 21 May 07

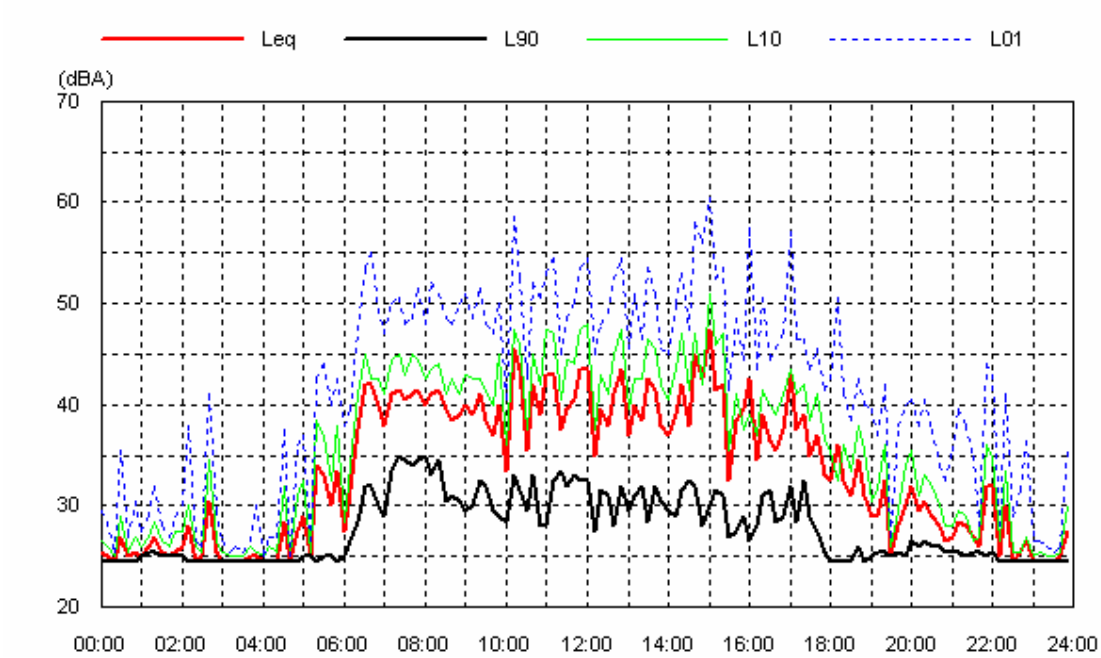


Tue 22 May 07

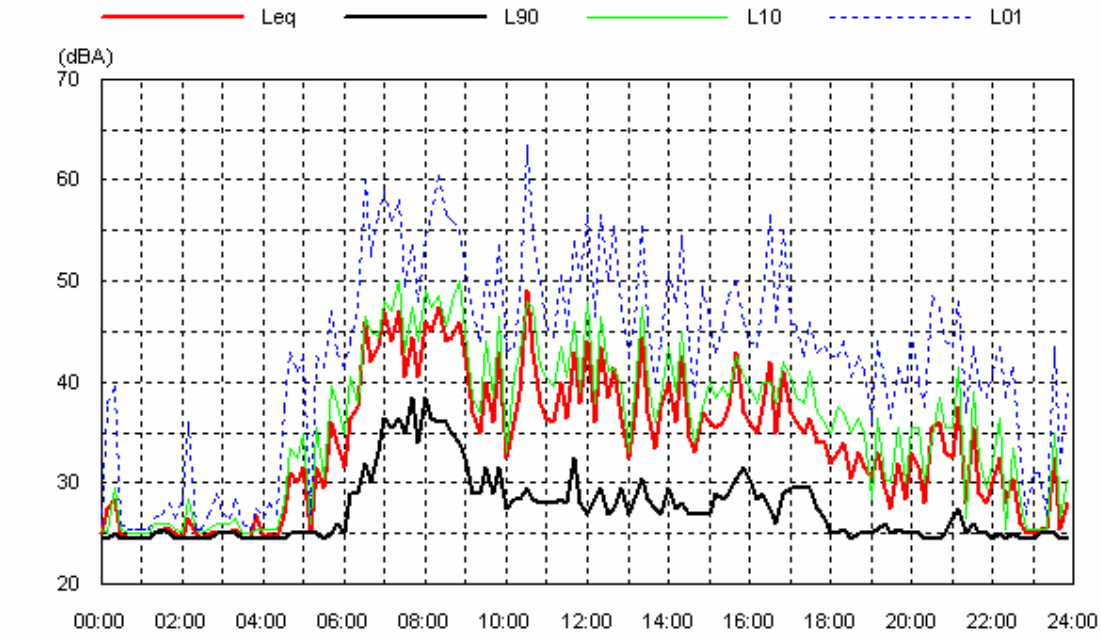


Location: Airdrie

Wed 23 May 07

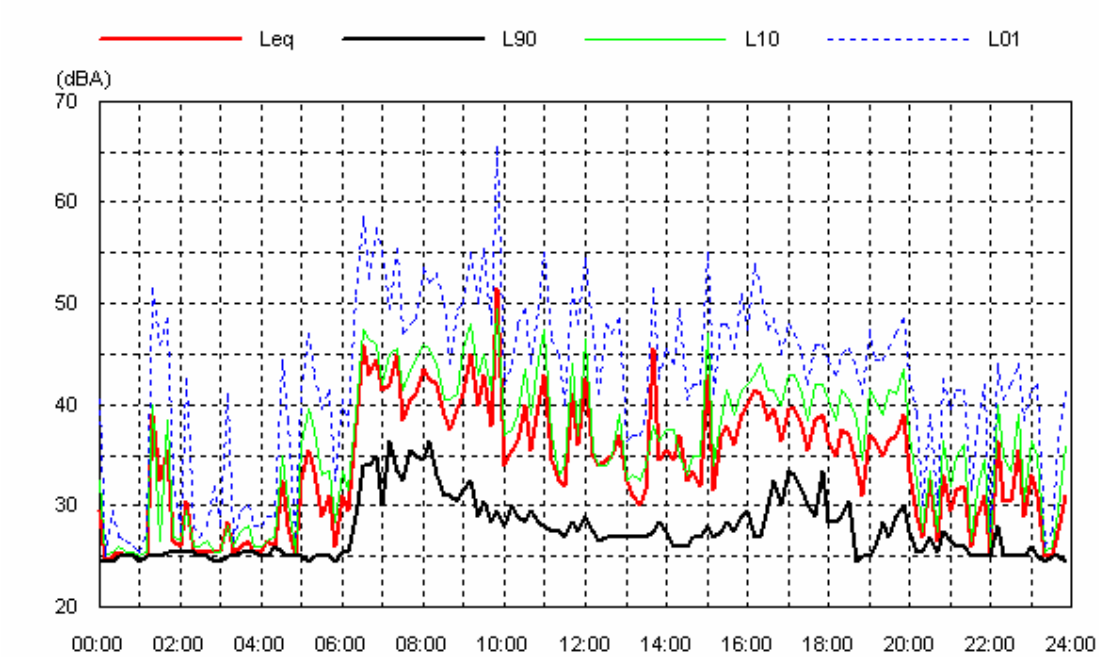


Thu 24 May 07

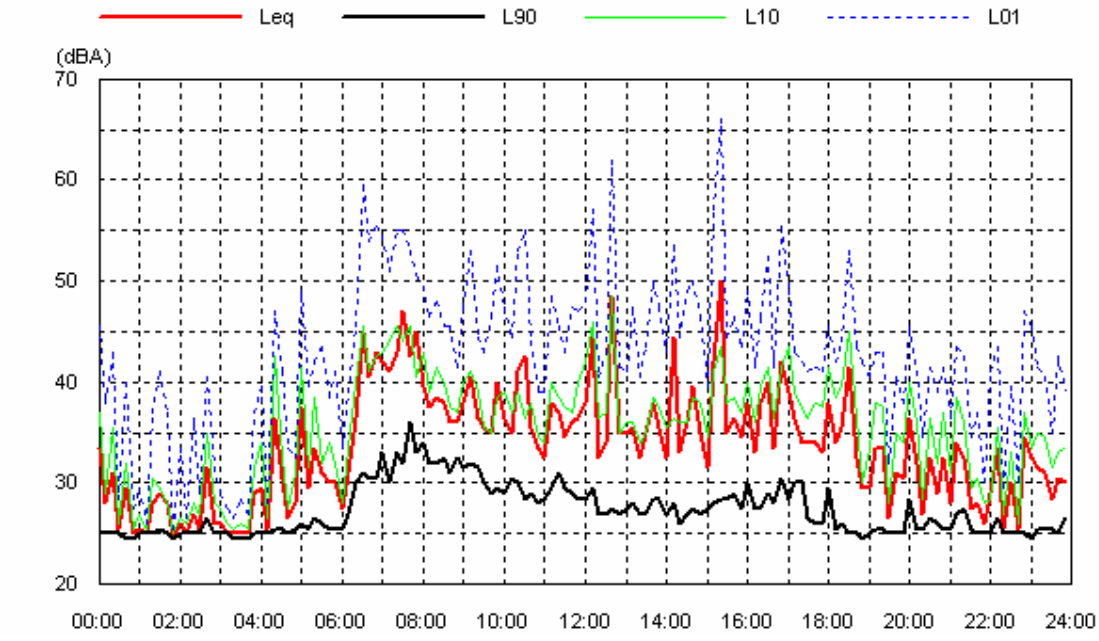


Location: Airdrie

Fri 25 May 07

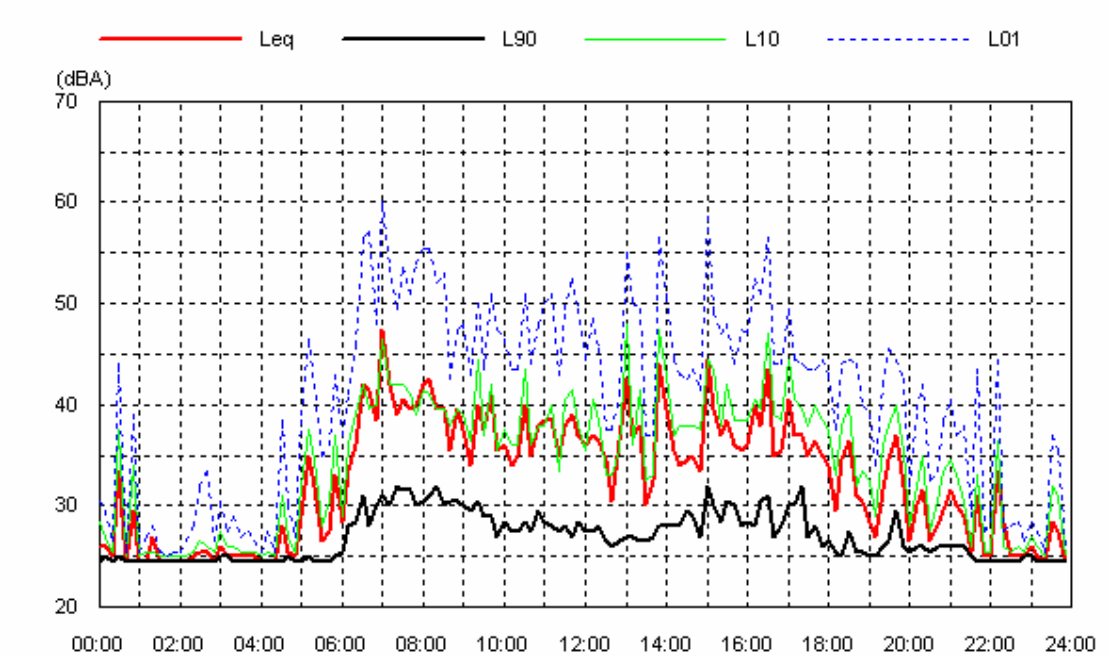


Sat 26 May 07

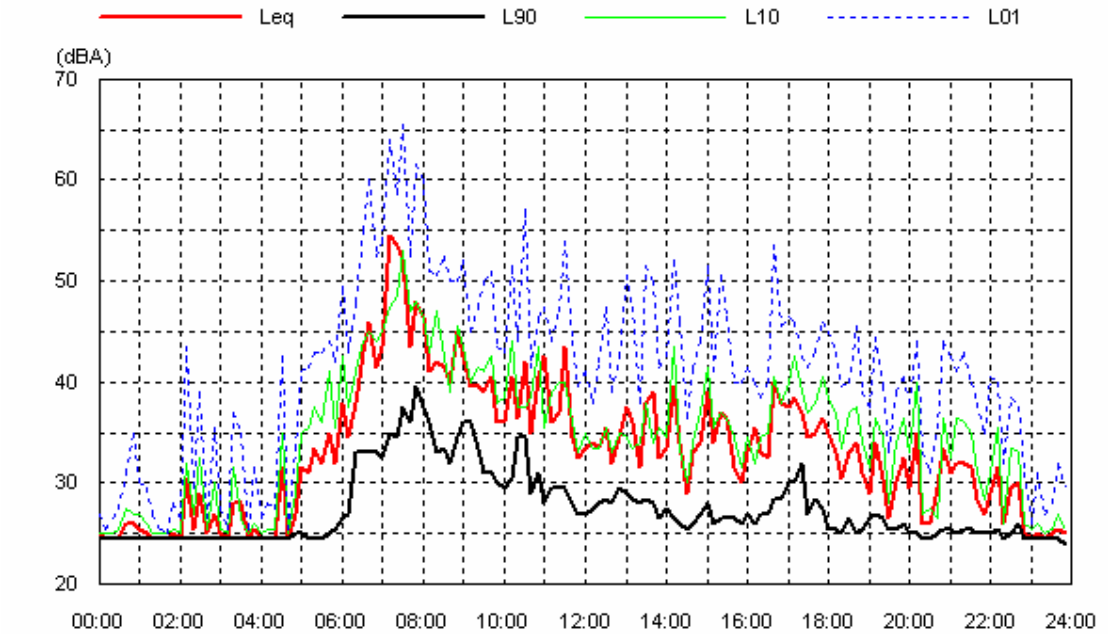


Location: Airdrie

Sun 27 May 07

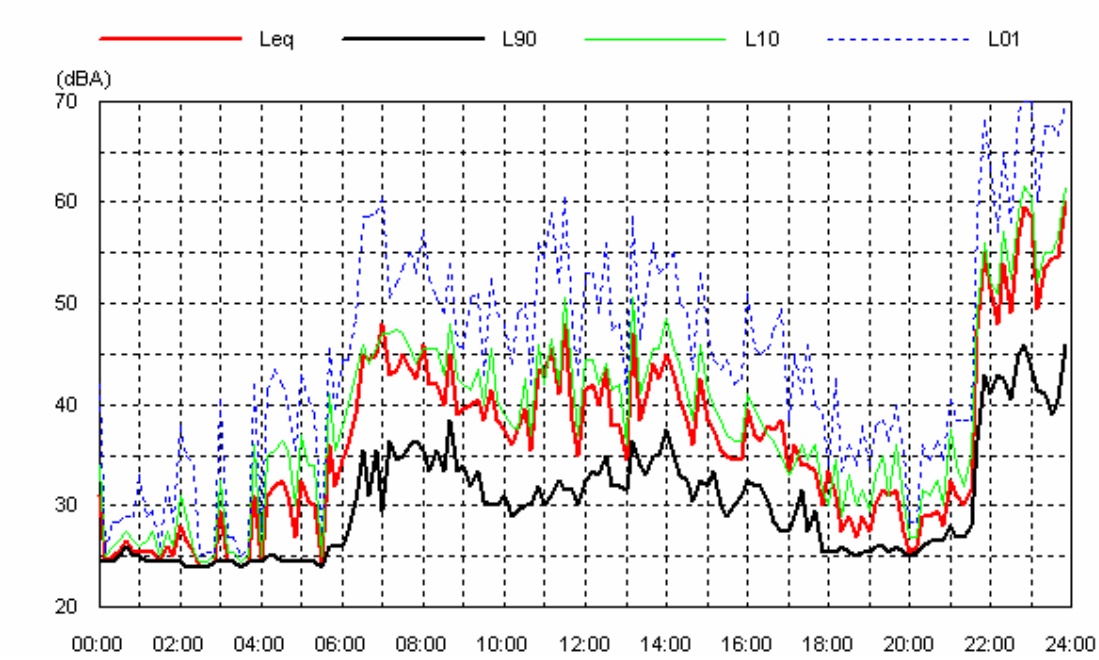


Mon 28 May 07

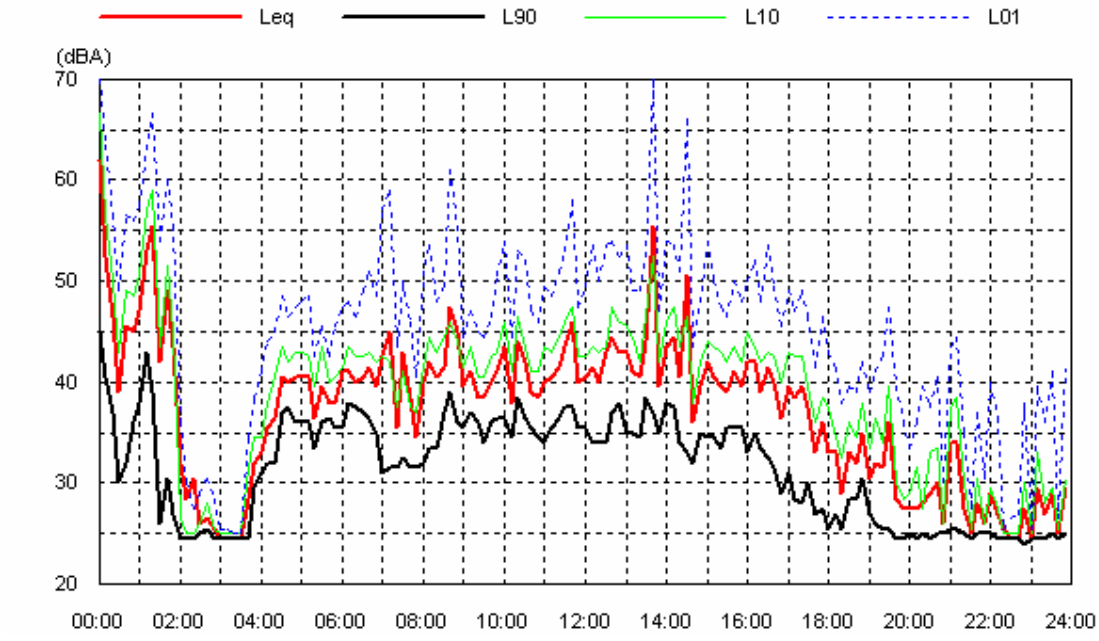


Location: Airdrie

Tue 29 May 07

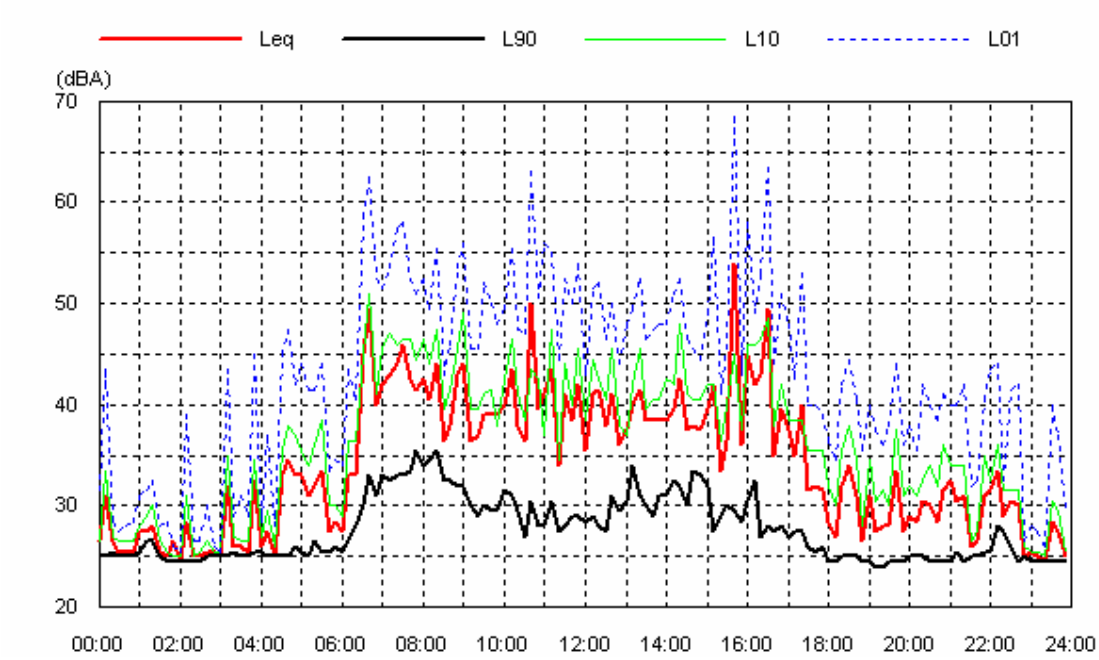


Wed 30 May 07

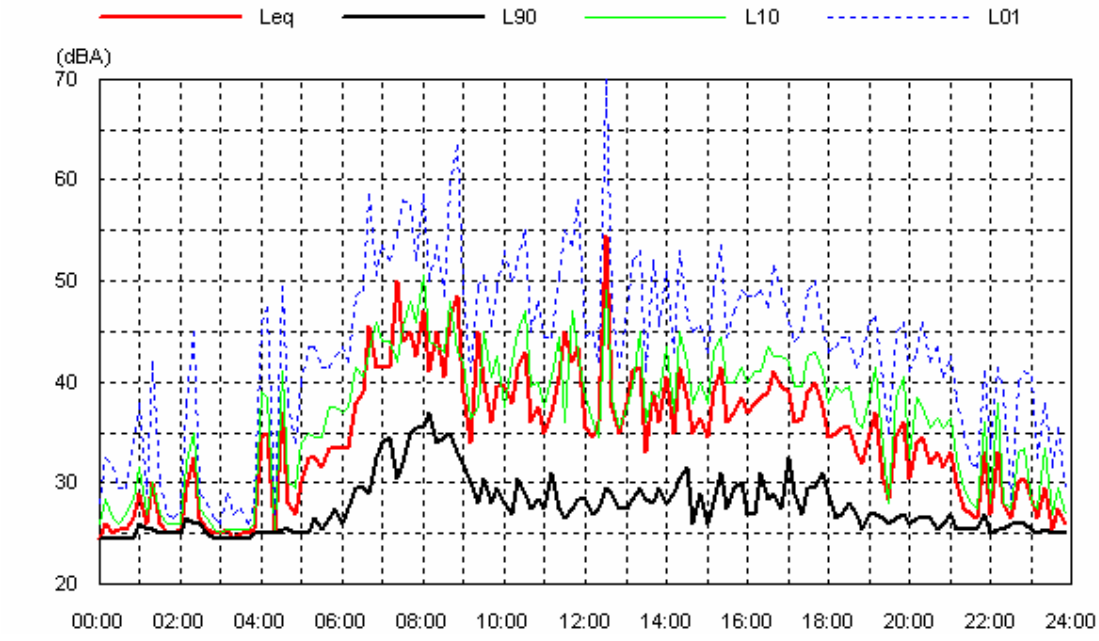


Location: Airdrie

Thu 31 May 07

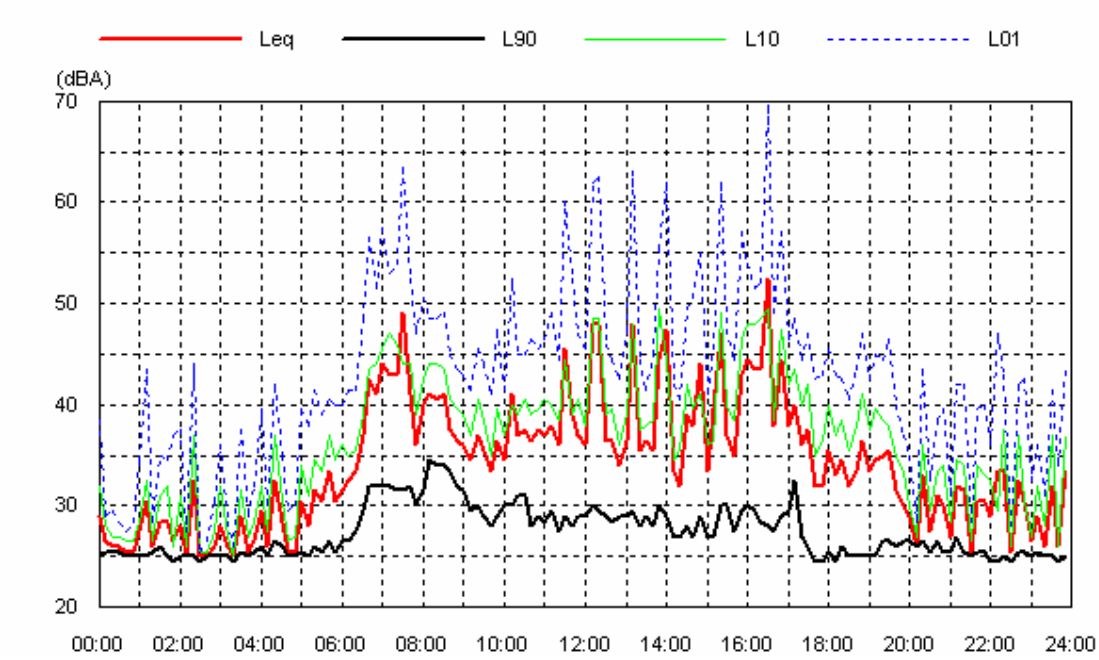


Fri 01 Jun 07

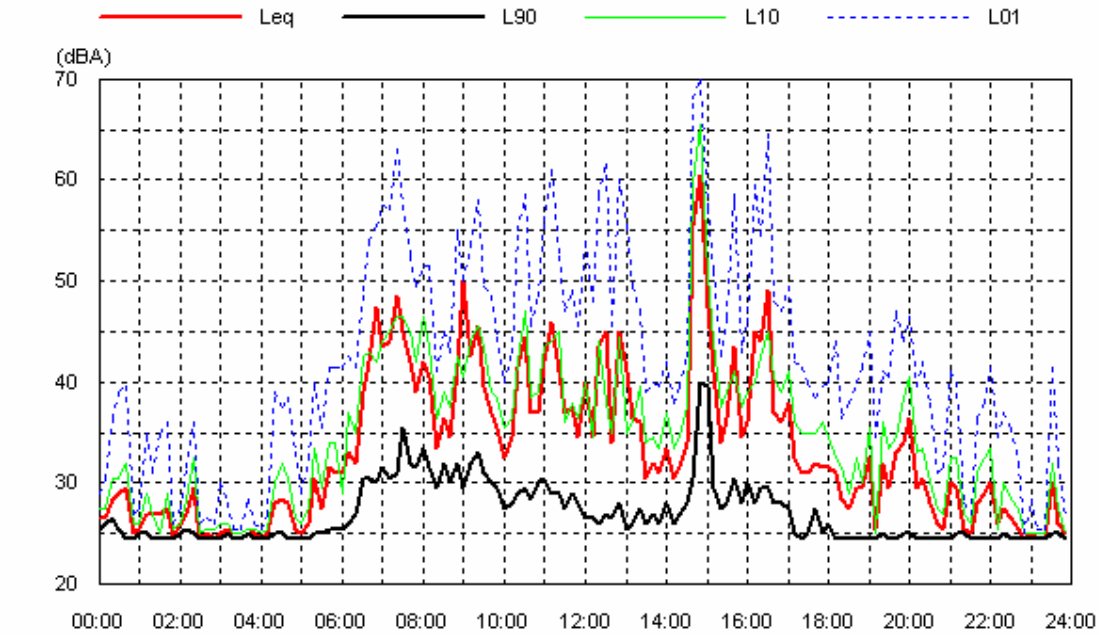


Location: Airdrie

Sat 02 Jun 07

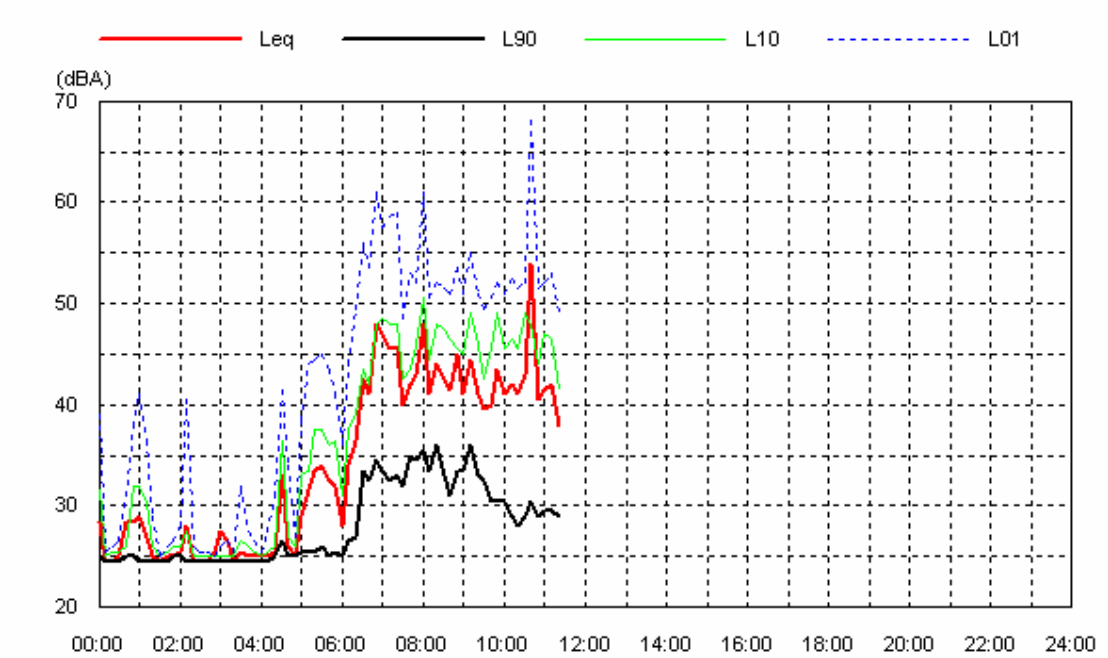


Sun 03 Jun 07



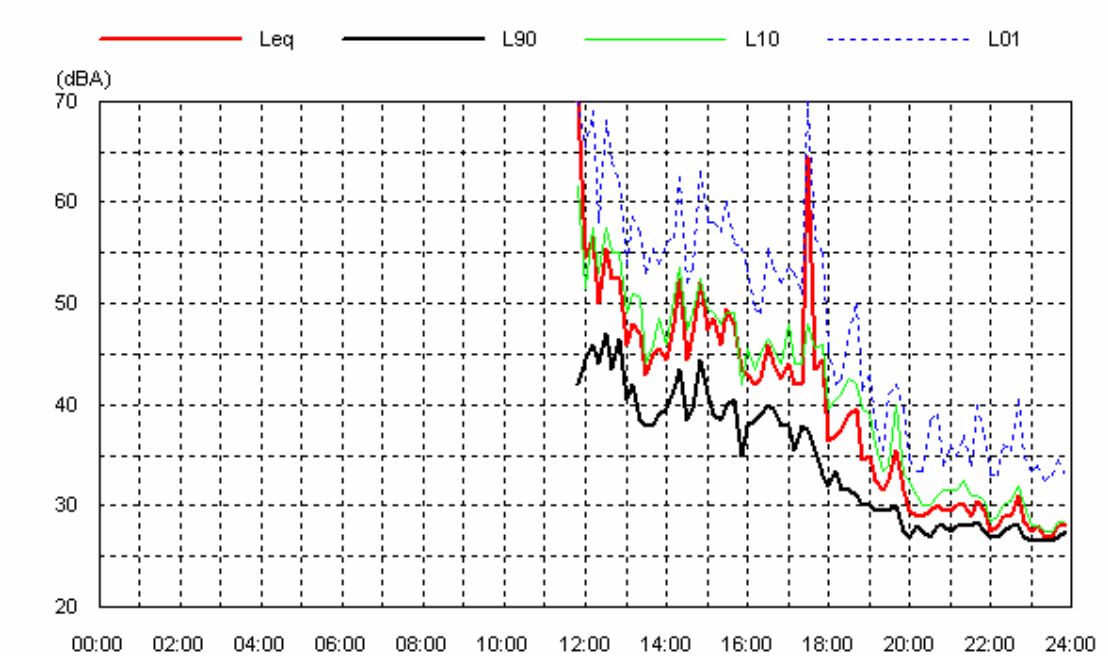
Location: Airdrie

Mon 04 Jun 07

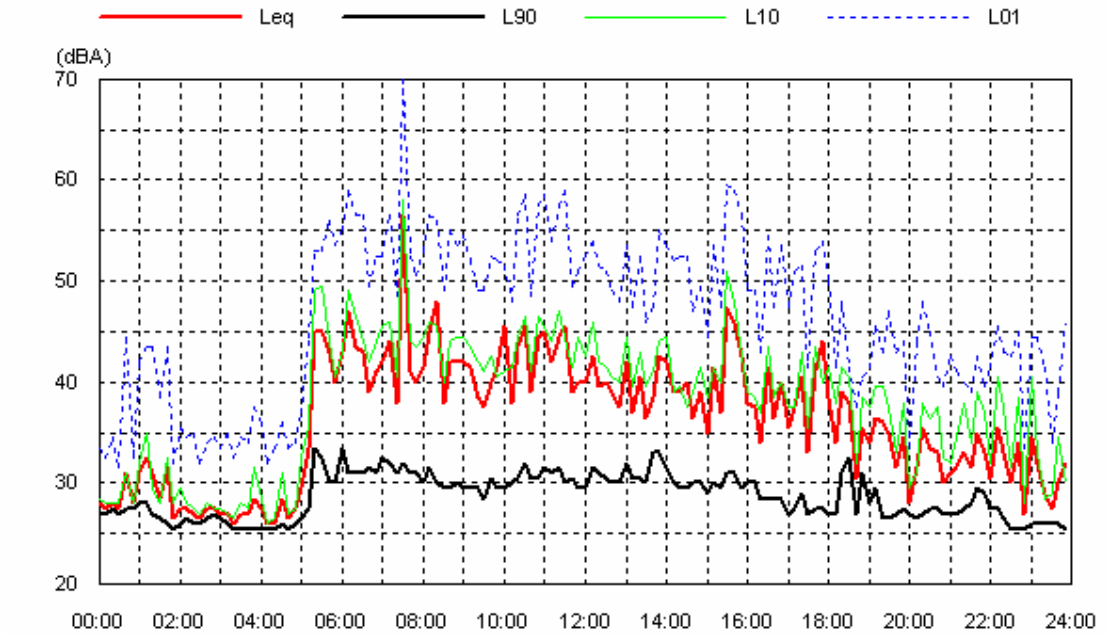


Location: Hagan2

Thu 20 Sep 07

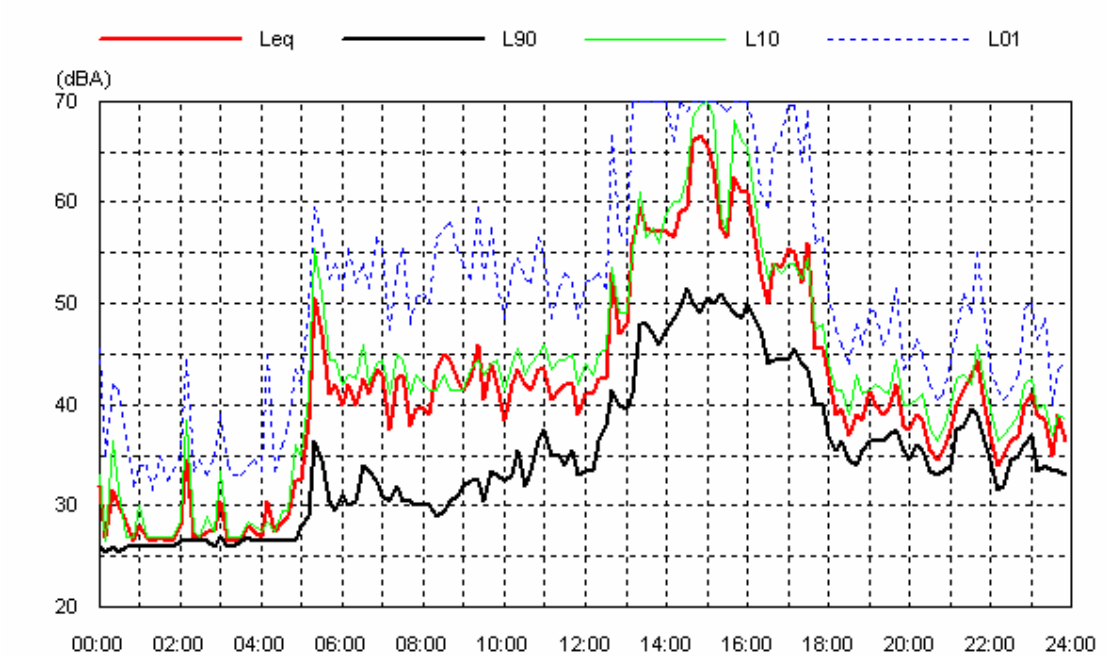


Fri 21 Sep 07

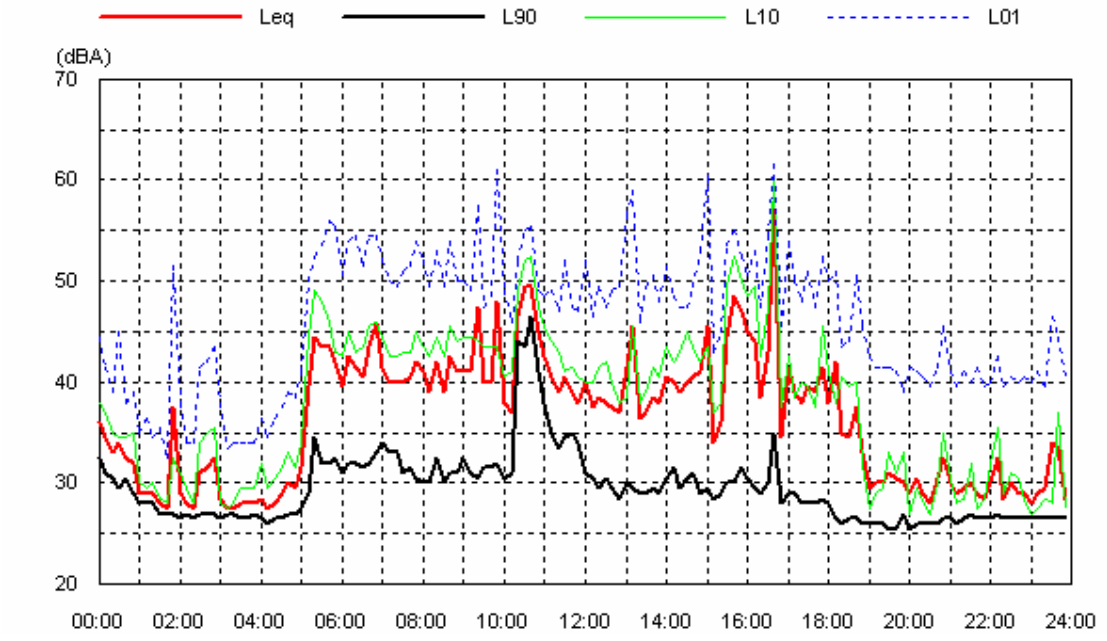


Location: Hagan2

Sat 22 Sep 07

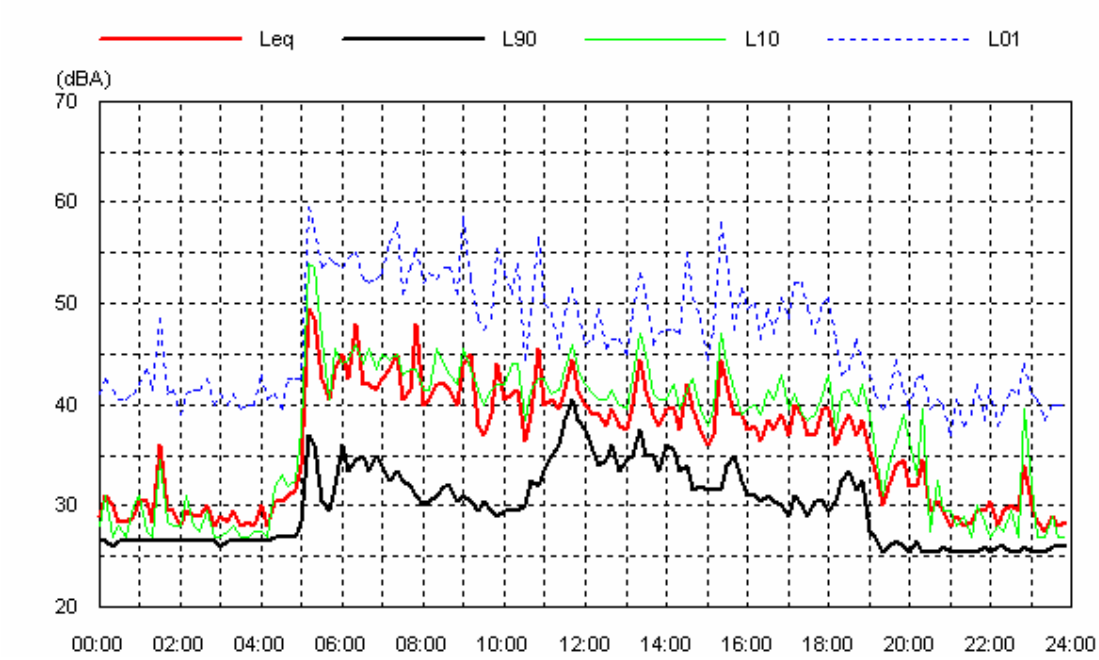


Sun 23 Sep 07

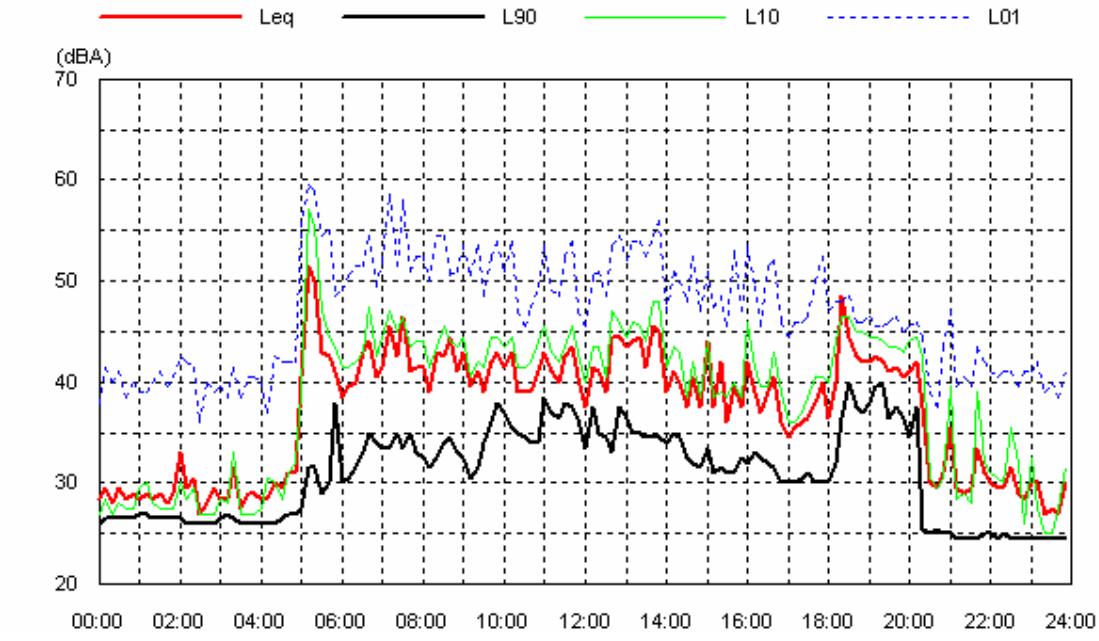


Location: Hagan2

Mon 24 Sep 07

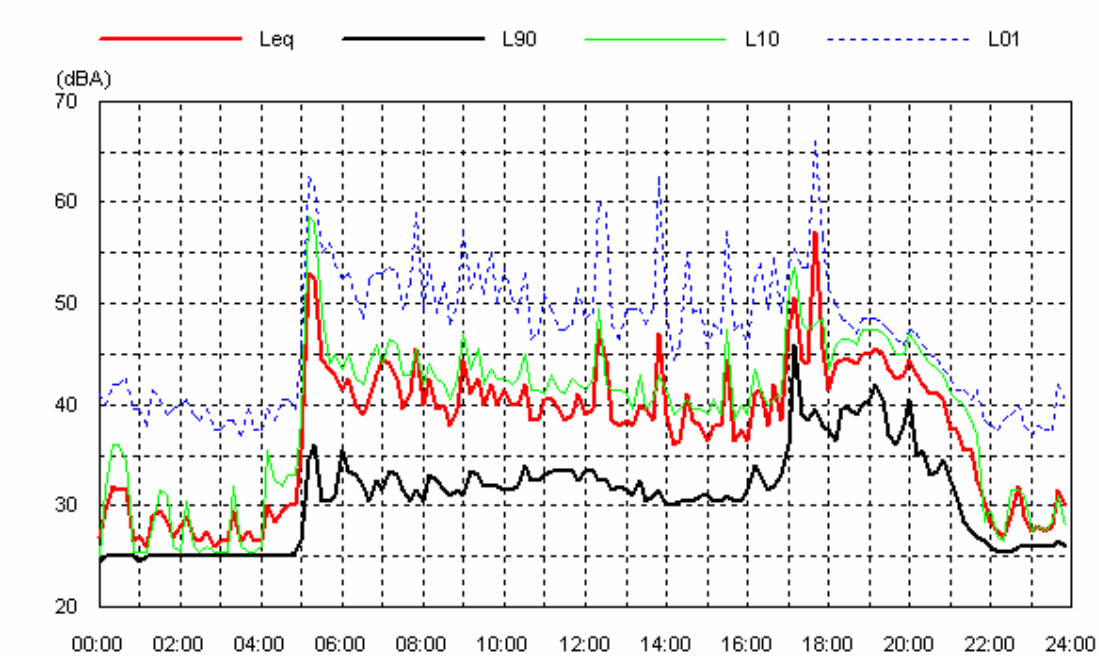


Tue 25 Sep 07

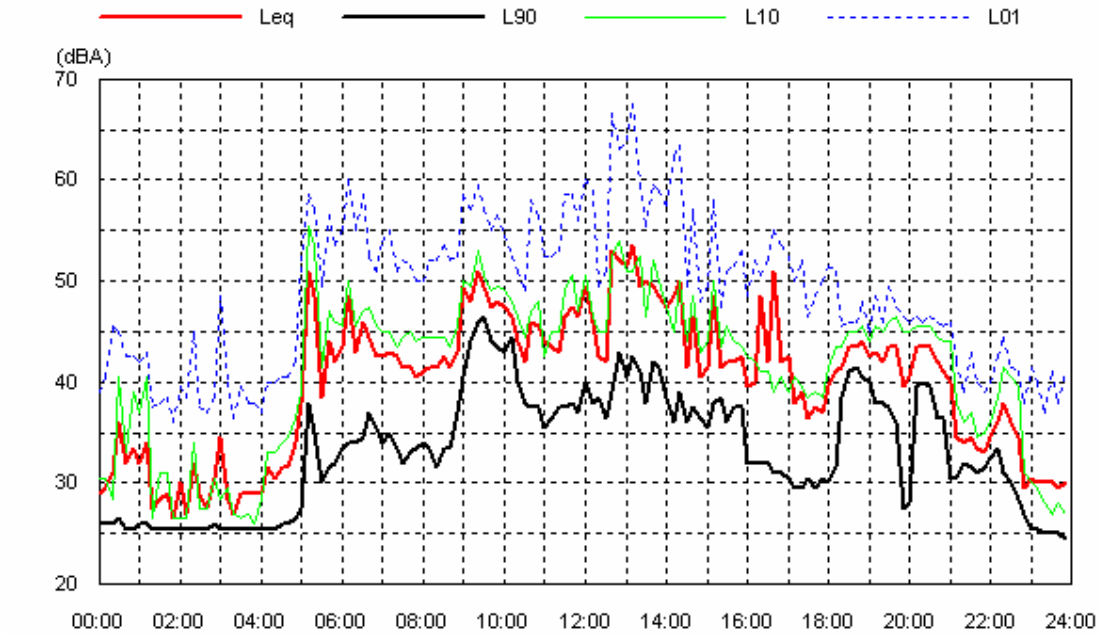


Location: Hagan2

Wed 26 Sep 07

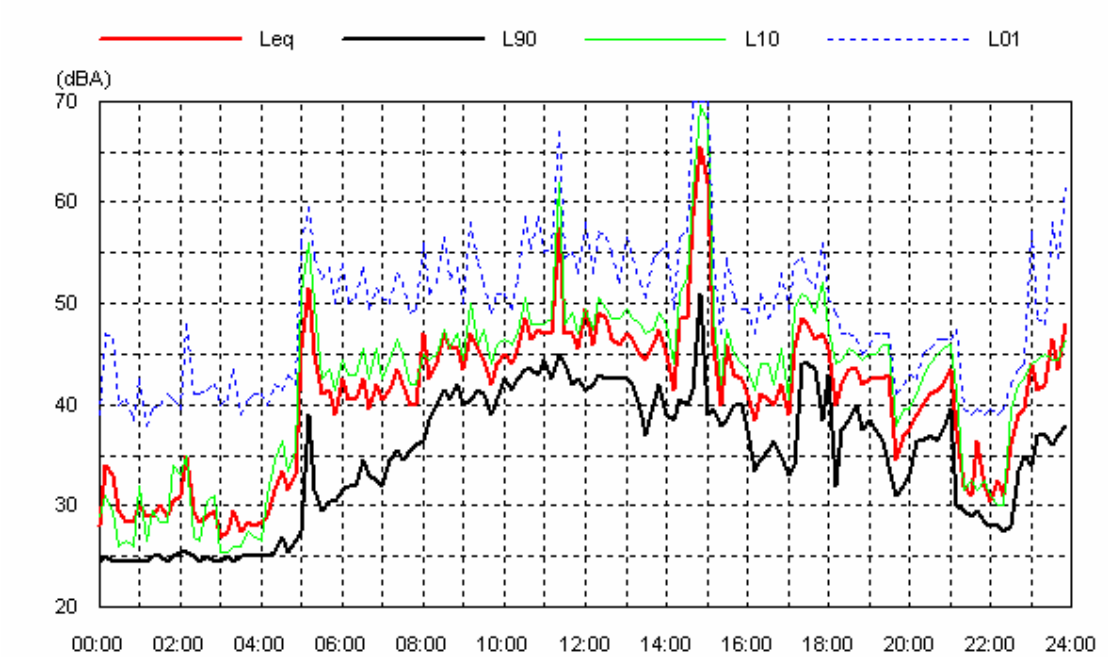


Thu 27 Sep 07

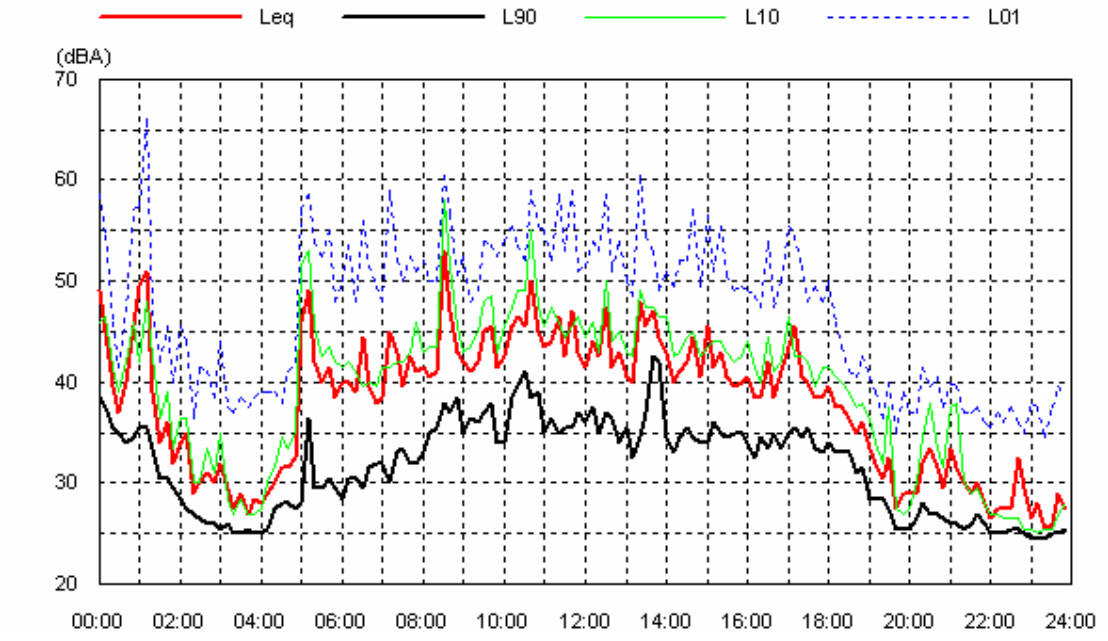


Location: Hagan2

Fri 28 Sep 07

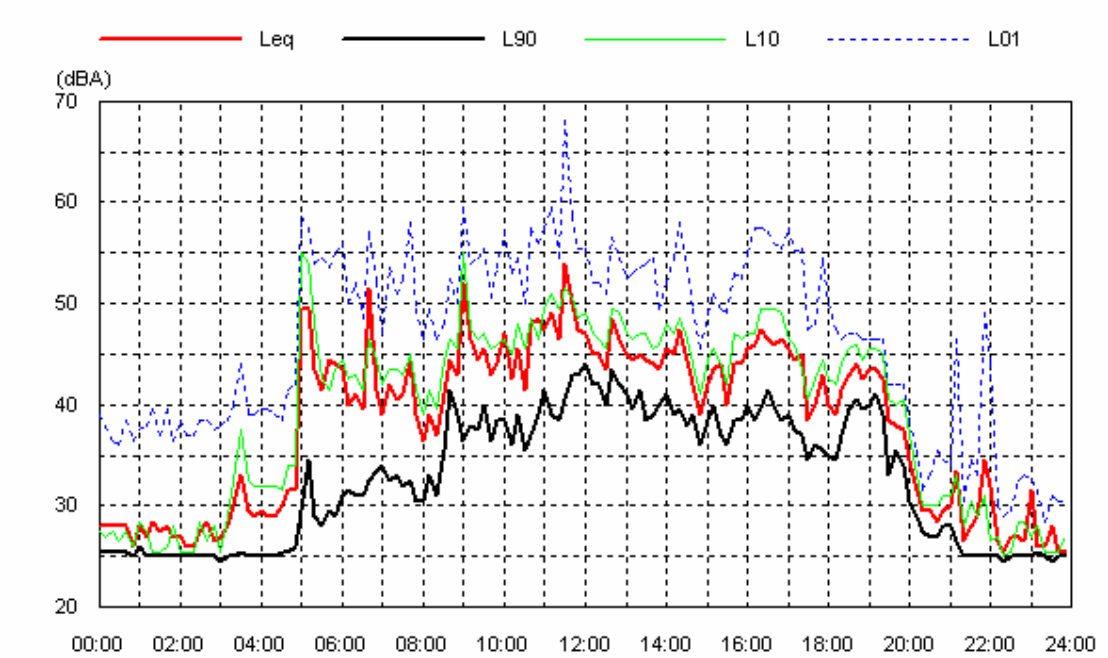


Sat 29 Sep 07

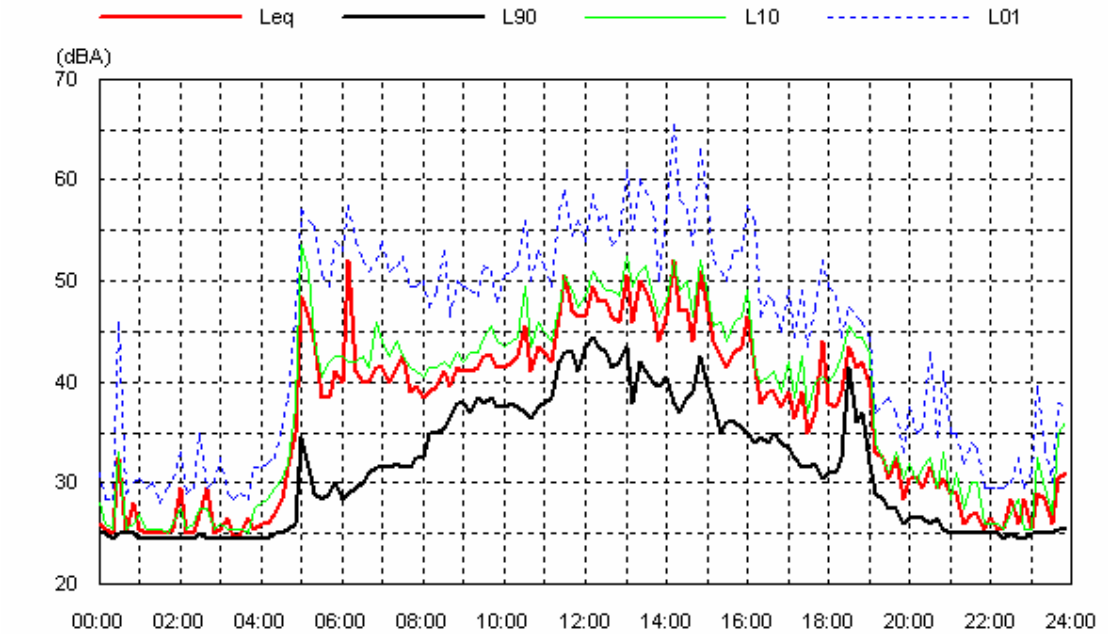


Location: Hagan2

Sun 30 Sep 07

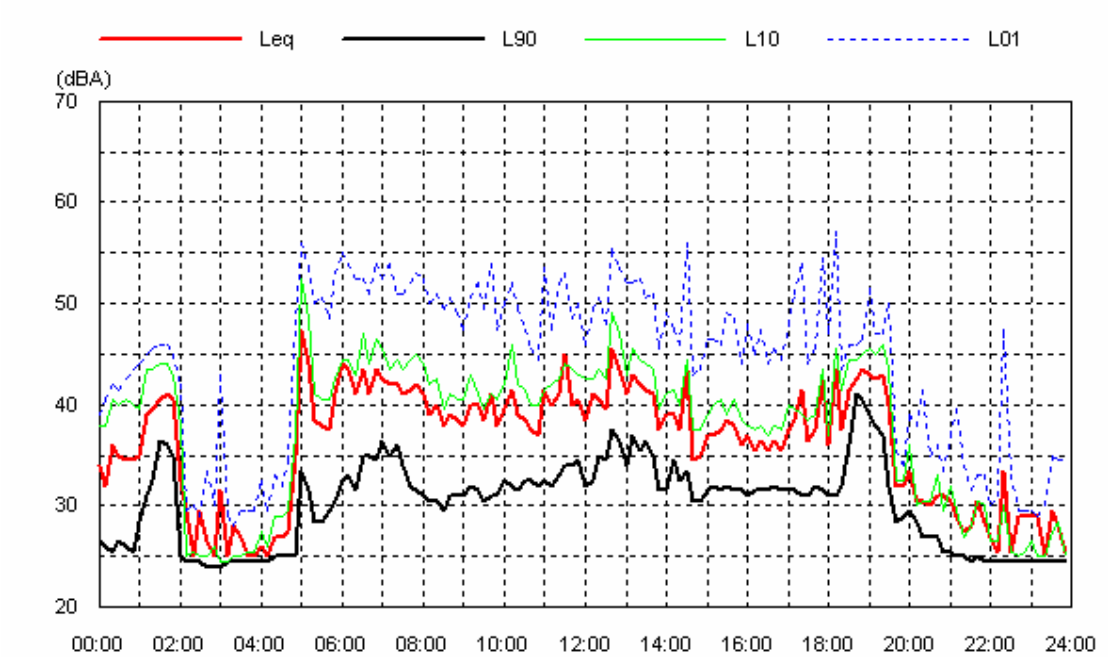


Mon 01 Oct 07

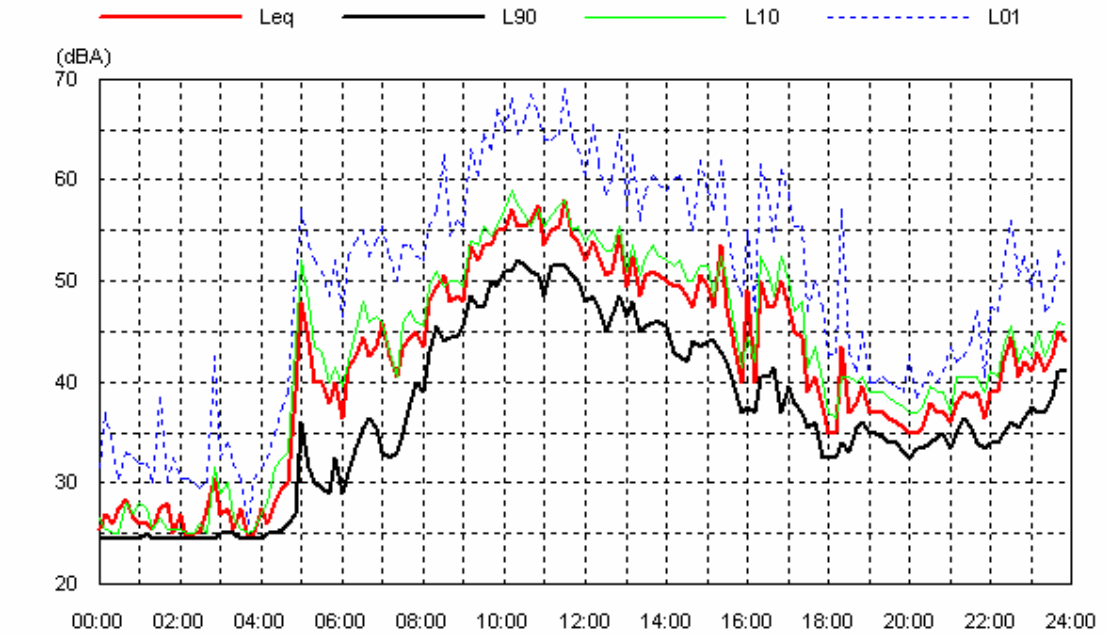


Location: Hagan2

Tue 02 Oct 07

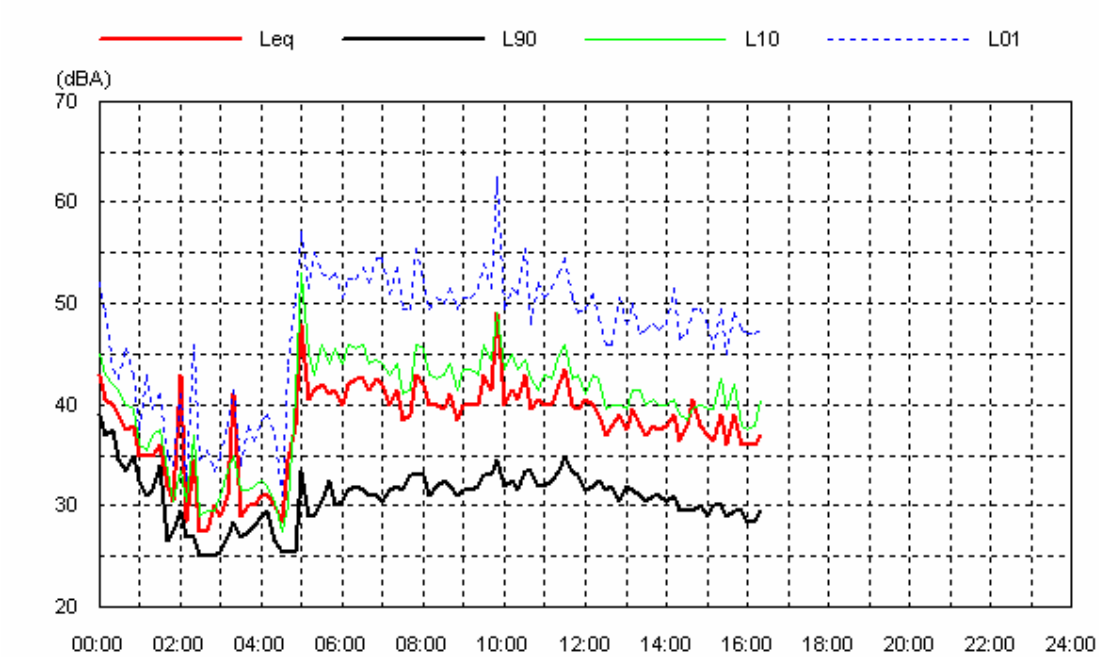


Wed 03 Oct 07



Location: Hagan2

Thu 04 Oct 07



APPENDIX C

BACKGROUND MEASUREMENT LOCATION PHOTOS

Middlebrook Station Residence

Peakhill Residence

Greylands Residence

Clifton Hills Estate Lot 6 Residence

The Valley Residence

Jingerah Residence

Dunvagen Residence

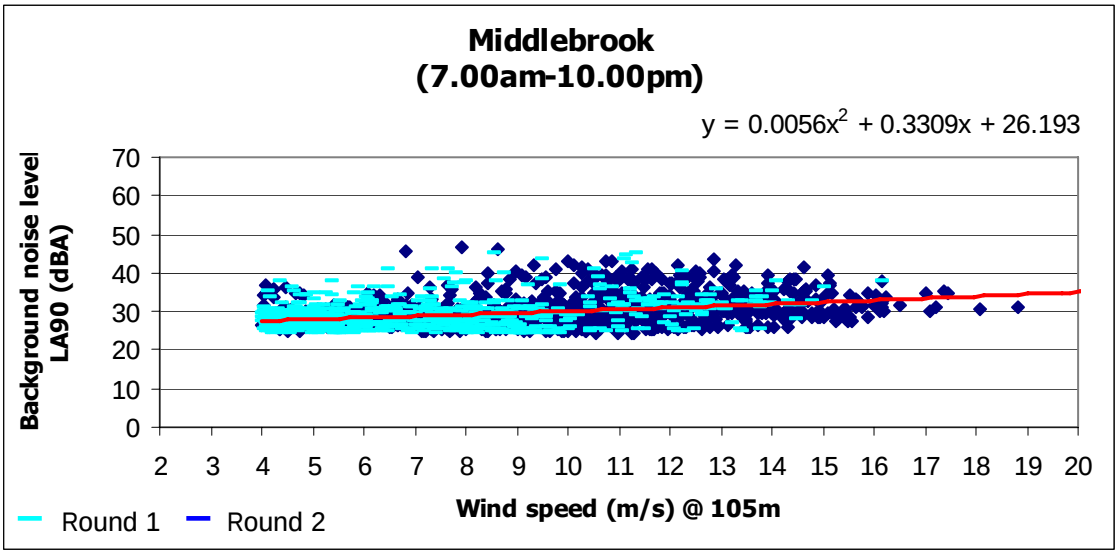
Adam's Residence

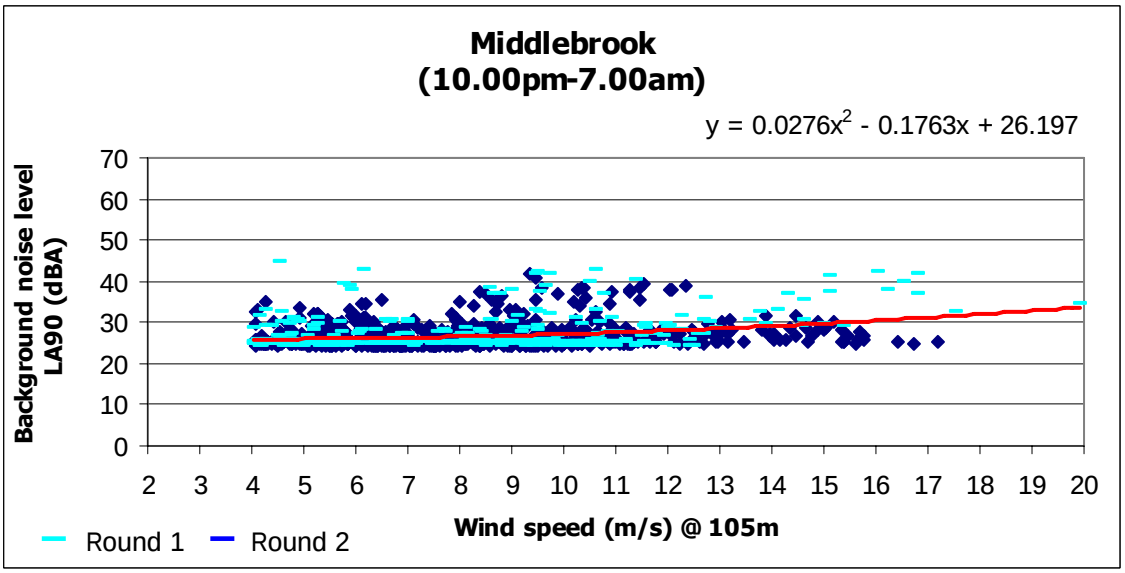
Airdrie Residence

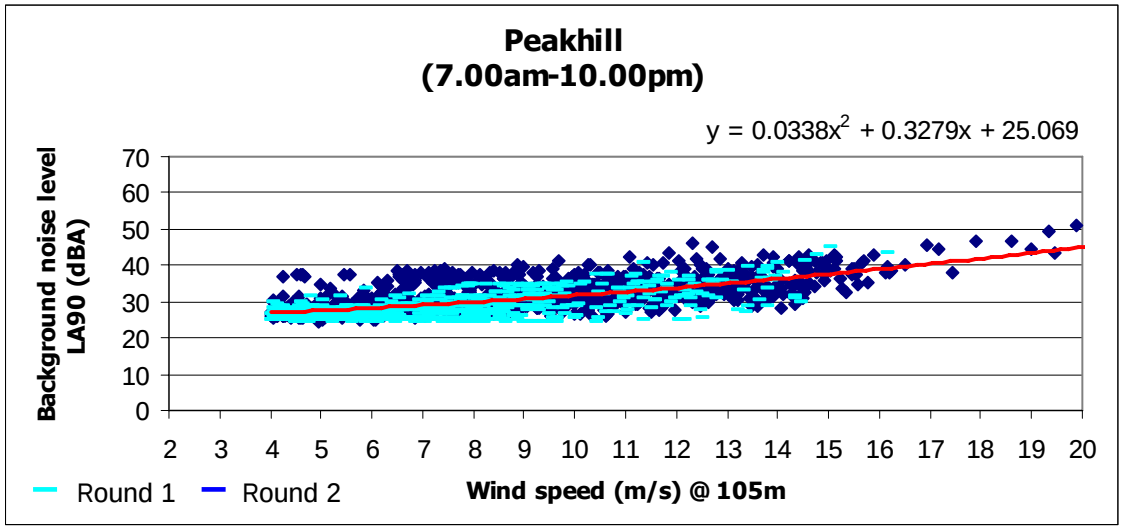
Hagan Residence

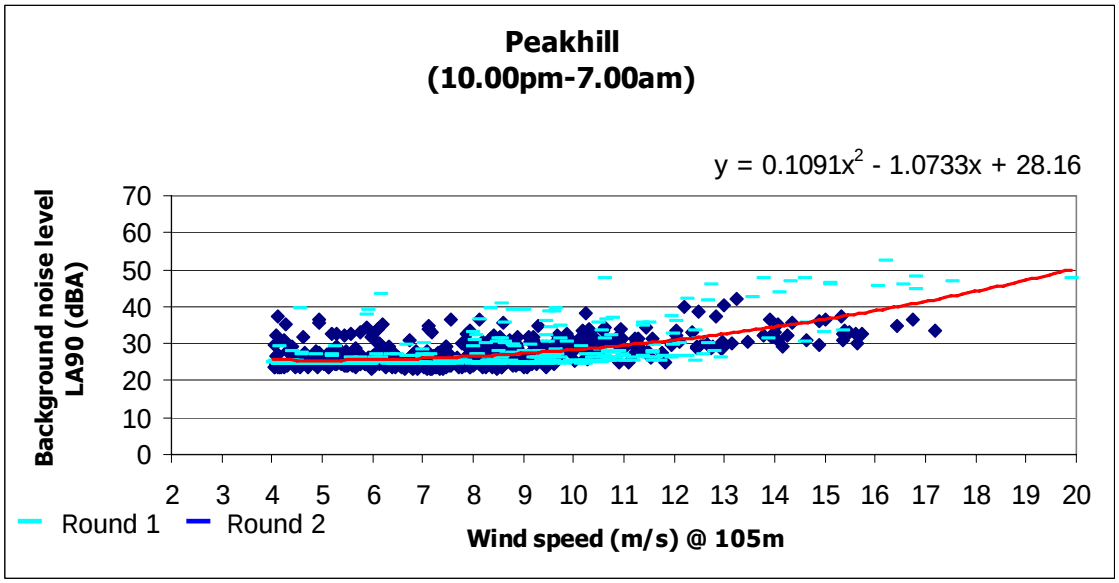
APPENDIX D

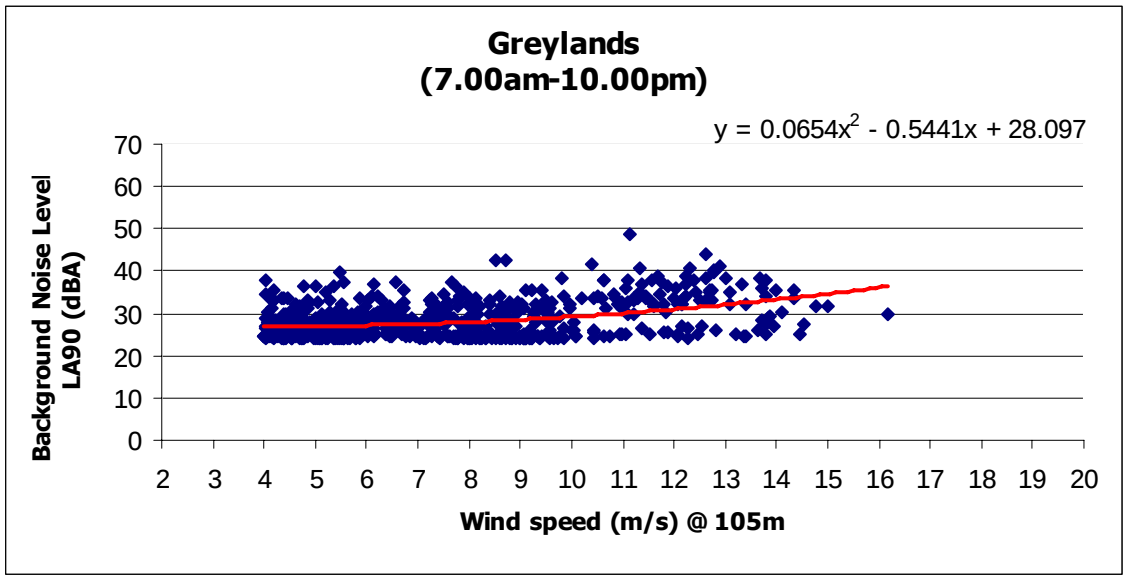
GRAPHS OF BACKGROUND NOISE VS WIND SPEED

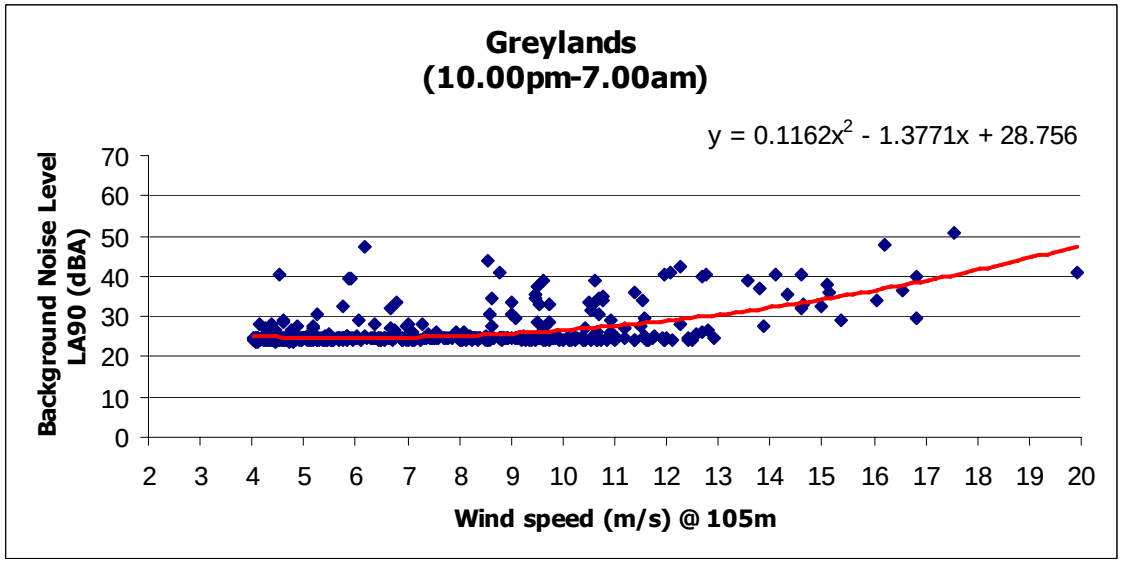

Middlebrook
(7.00am-10.00pm)
y = 0.0056x2 + 0.3309x + 26.193
Background noise level LA90 (dBA)
70
60
50
40
30
20
10
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m
Round 1
Round 2

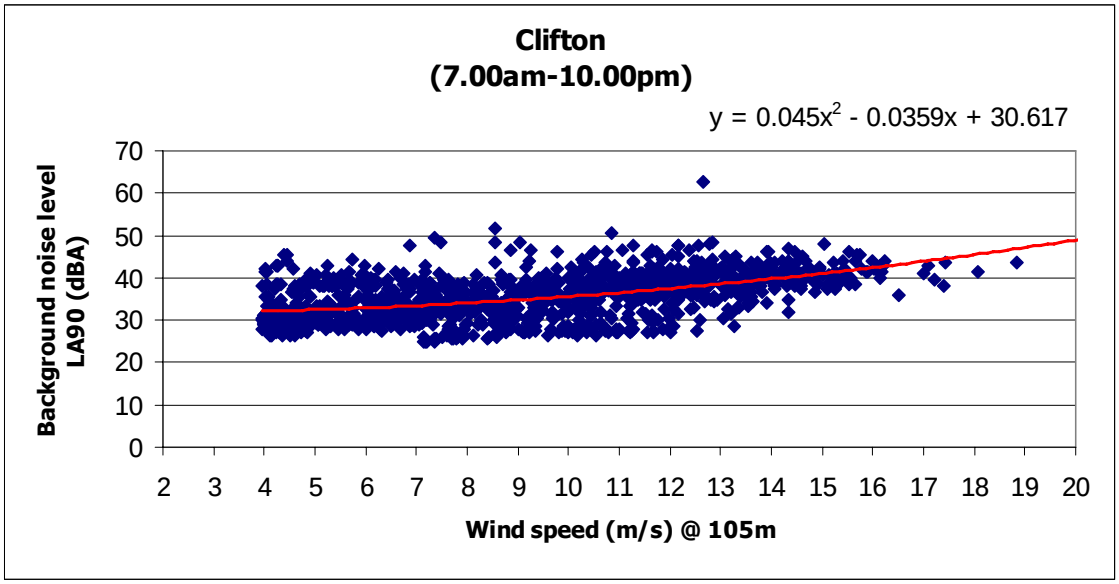

Middlebrook
(10.00pm-7.00am)
y = 0.0276x2 - 0.1763x + 26.197
Background noise level LA90 (dBA)
70
60
50
40
30
20
10
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m
Round 1
Round 2

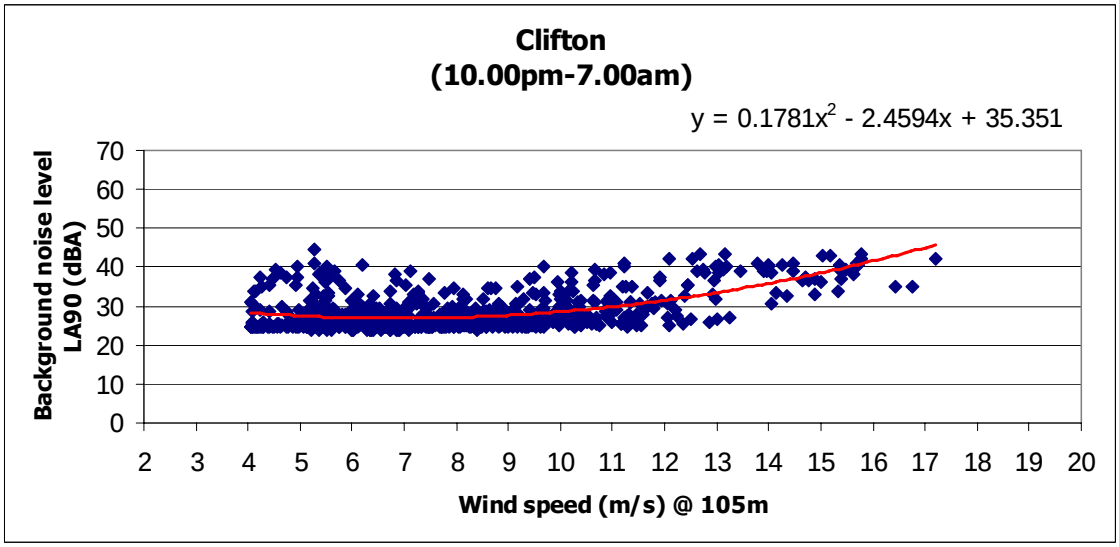

Peakhill
(7.00am-10.00pm)
y = 0.0338x2 + 0.3279x + 25.069
Background noise level LA90 (dBA)
70
60
50
40
30
20
10
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Round 1
Round 2
Wind speed (m/s) @ 105m

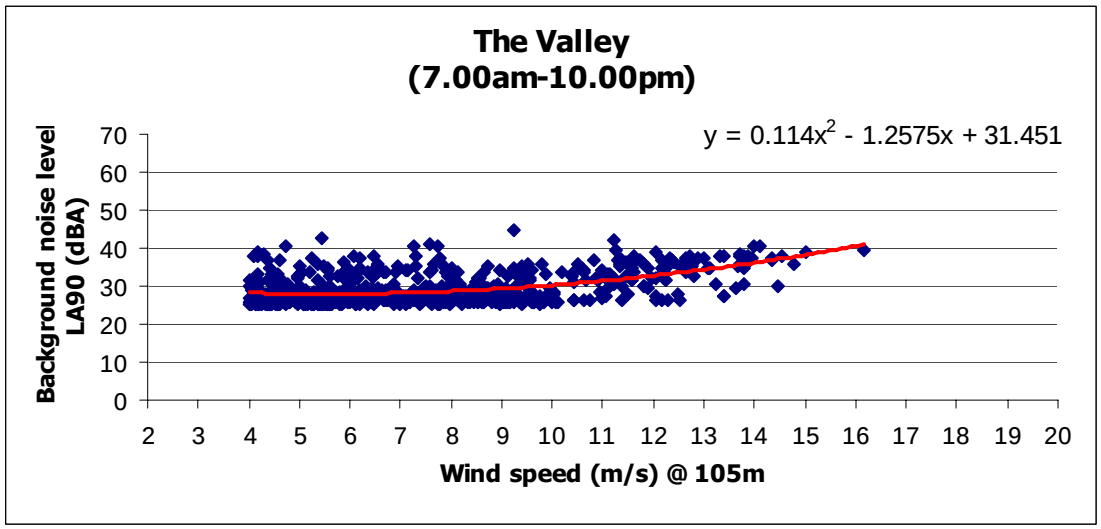

Peakhill
(10.00pm-7.00am)
y = 0.1091x2 - 1.0733x + 28.16
Background noise level LA90 (dBA)
70
60
50
40
30
20
10
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Round 1
Round 2
Wind speed (m/s) @ 105m

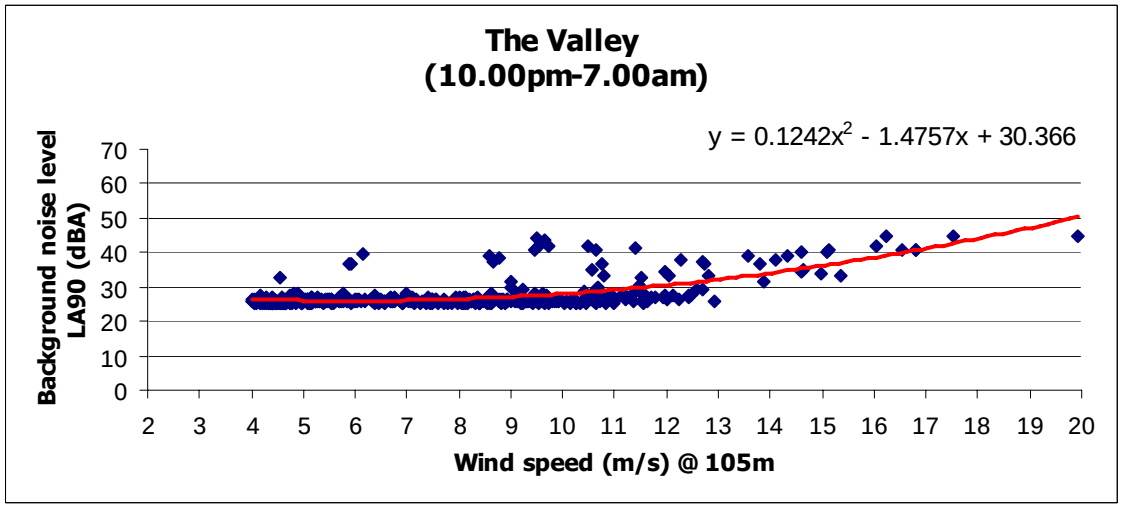

Greylands
(7.00am-10.00pm)
y = 0.0654x2 - 0.5441x + 28.097
Background Noise Level LA90 (dBA)
70
60
50
40
30
20
10
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

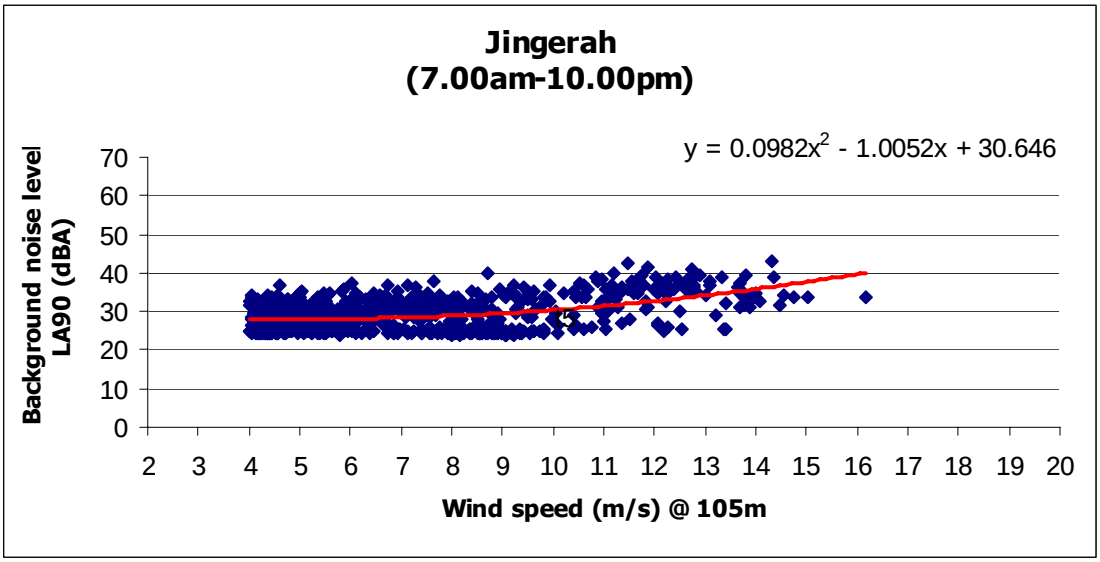

Greylands
(10.00pm-7.00am)
y = 0.1162x2 - 1.3771x + 28.756
Background Noise Level LA90 (dBA)
70
60
50
40
30
20
10
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

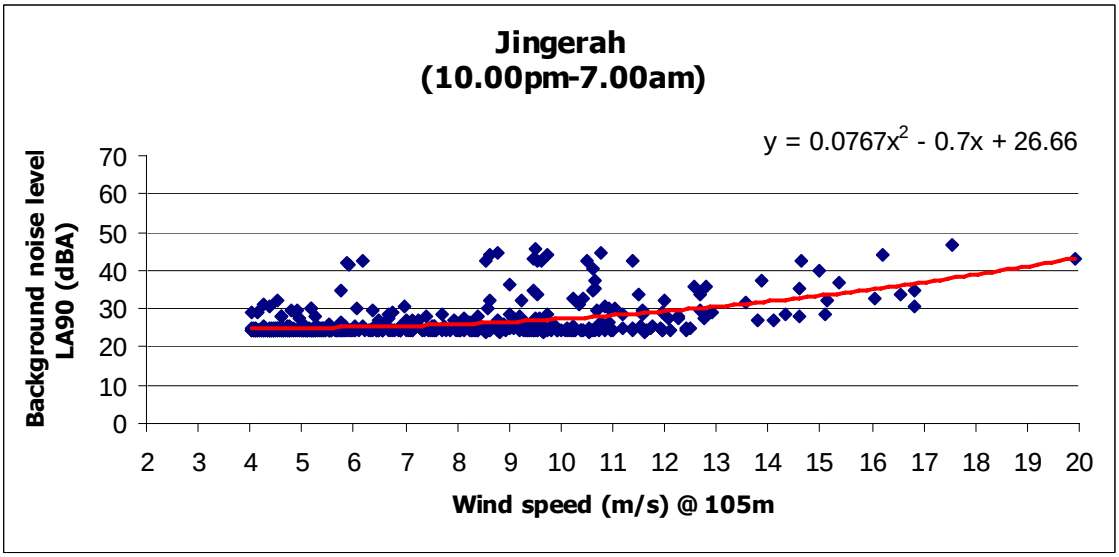

Clifton
(7.00am-10.00pm)
y = 0.045x2 - 0.0359x + 30.617
Background noise level LA90 (dBA)
70
60
50
40
30
20
10
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

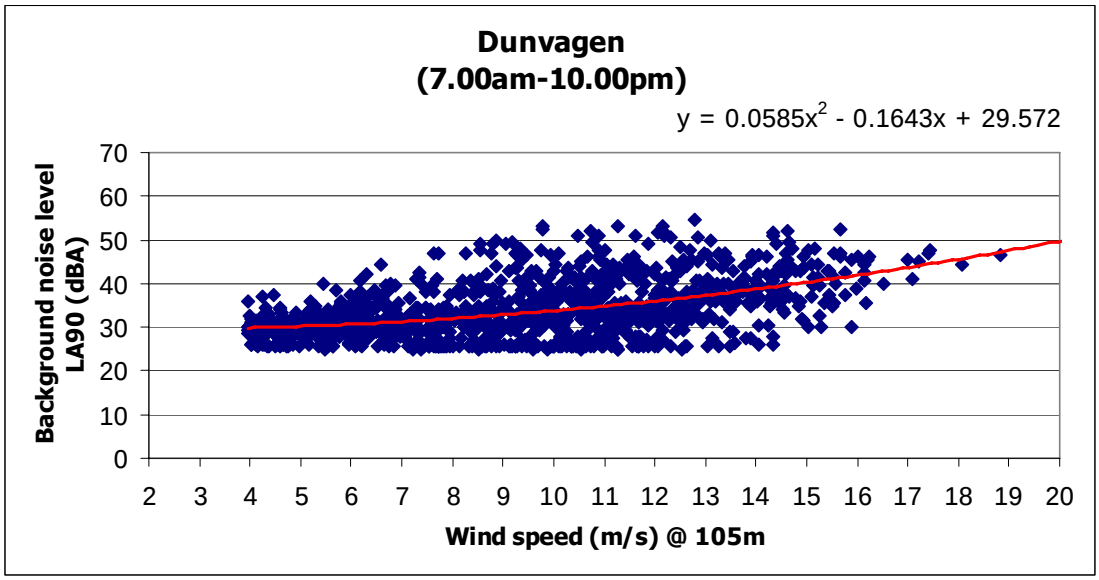

Clifton
(10.00pm-7.00am)
y = 0.1781x2 - 2.4594x + 35.351
Background noise level LA90 (dBA)
70
60
50
40
30
20
10
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

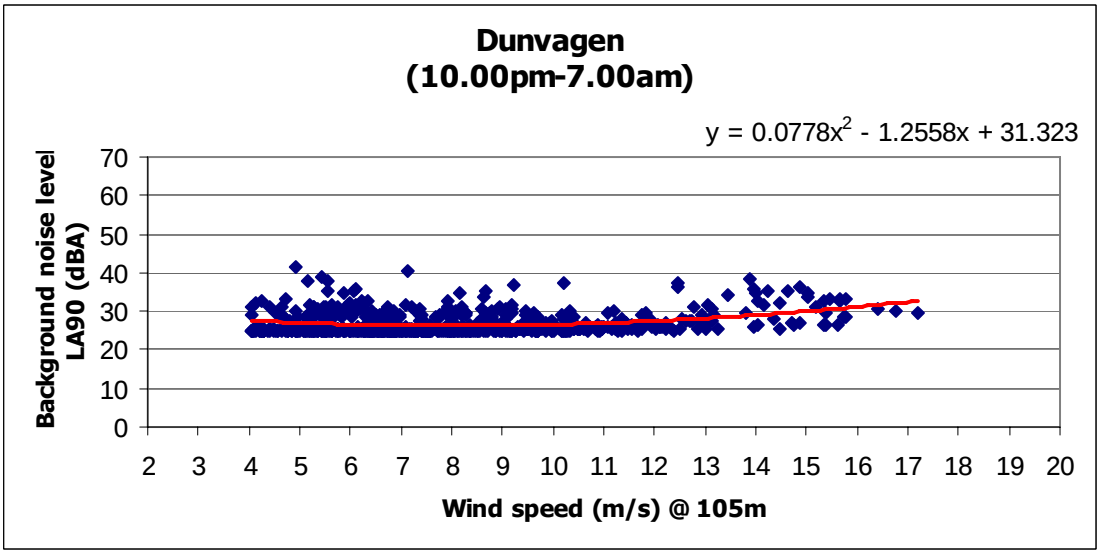

The Valley
(7.00am-10.00pm)
y = 0.114x2 - 1.2575x + 31.451
Background noise level LA90 (dBA)
0
10
20
30
40
50
60
70
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

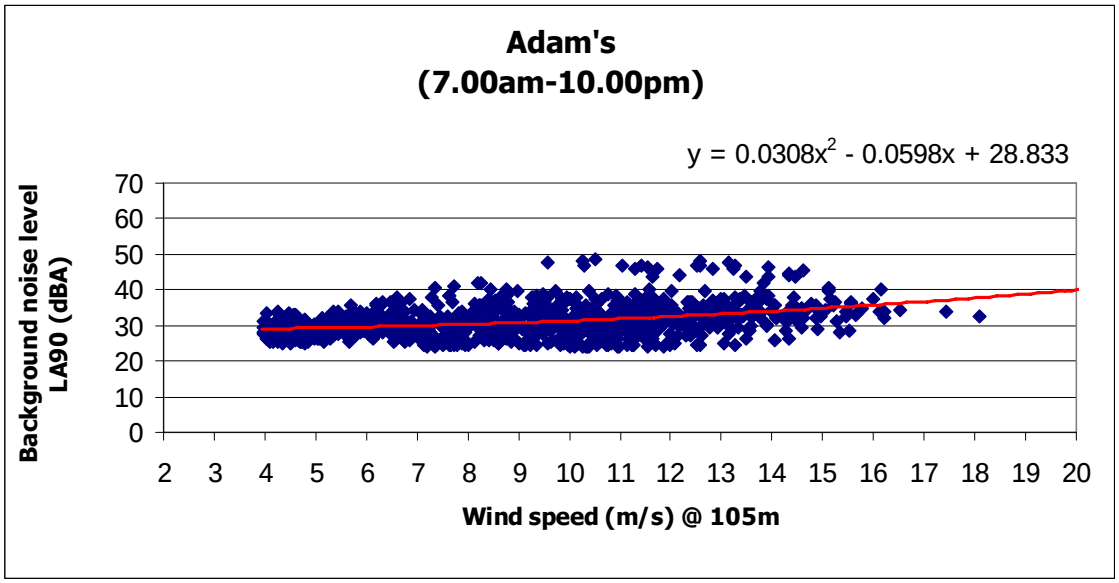

The Valley
(10.00pm-7.00am)
y = 0.1242x2 - 1.4757x + 30.366
Background noise level LA90 (dBA)
0
10
20
30
40
50
60
70
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

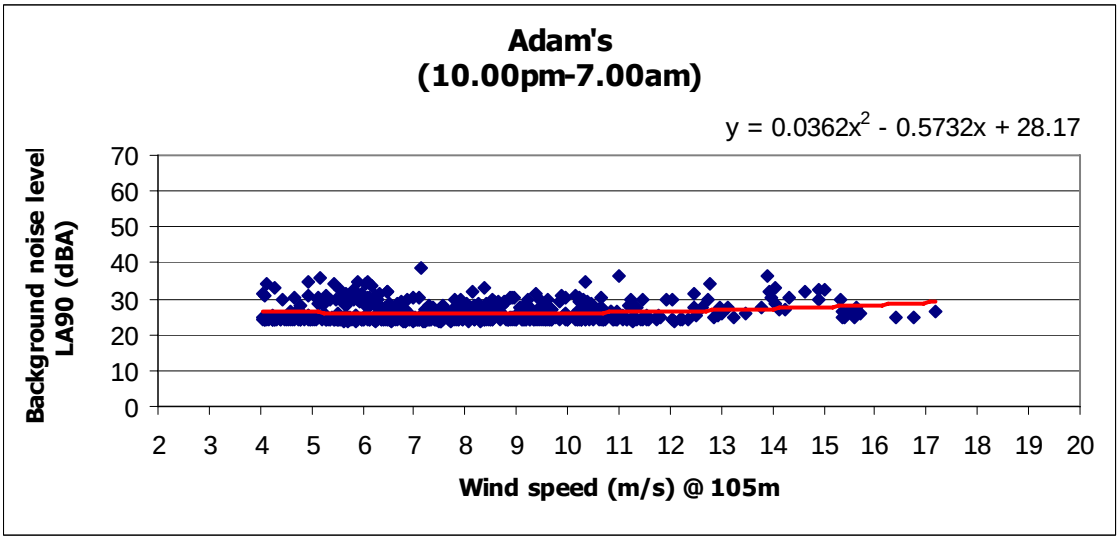

Jingerah
(7.00am-10.00pm)
y = 0.0982x2 - 1.0052x + 30.646
Background noise level LA90 (dBA)
0
10
20
30
40
50
60
70
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

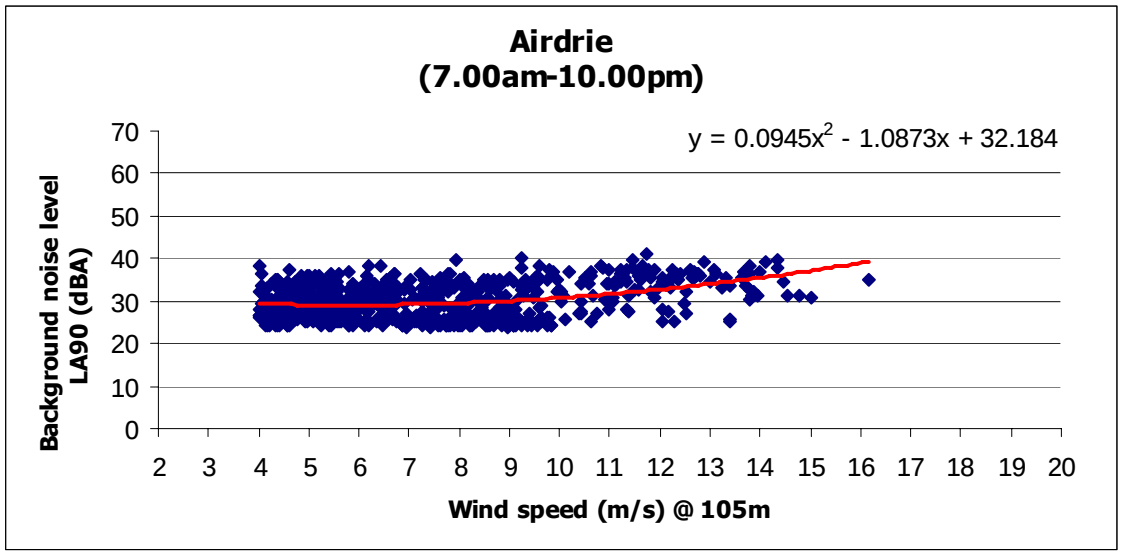

Jingerah
(10.00pm-7.00am)
y = 0.0767x2 - 0.7x + 26.66
Background noise level LA90 (dBA)
0
10
20
30
40
50
60
70
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

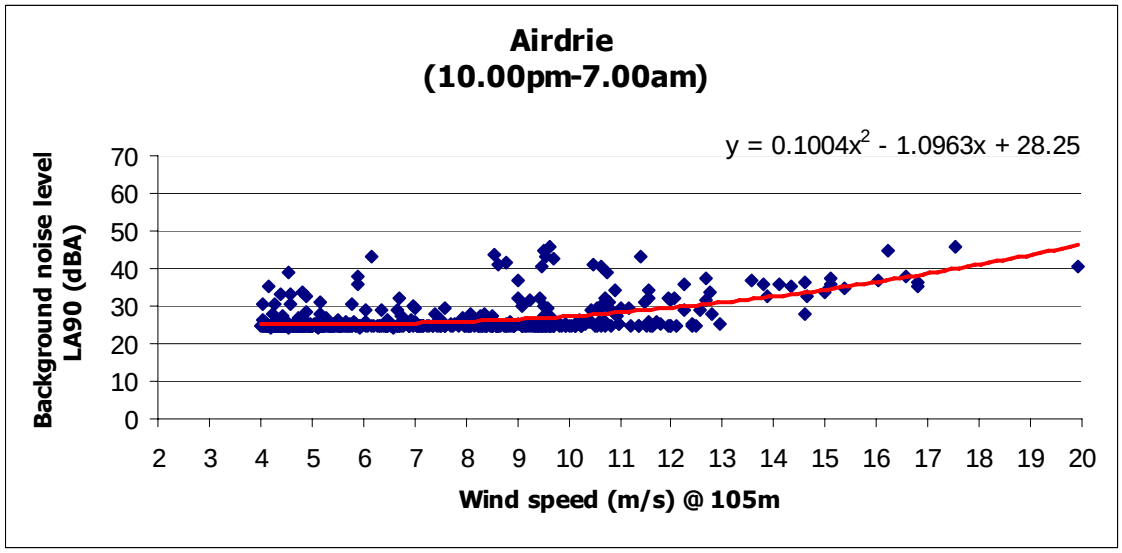

Dunvagen
(7.00am-10.00pm)
y = 0.0585x2 - 0.1643x + 29.572
Background noise level LA90 (dBA)
0
10
20
30
40
50
60
70
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

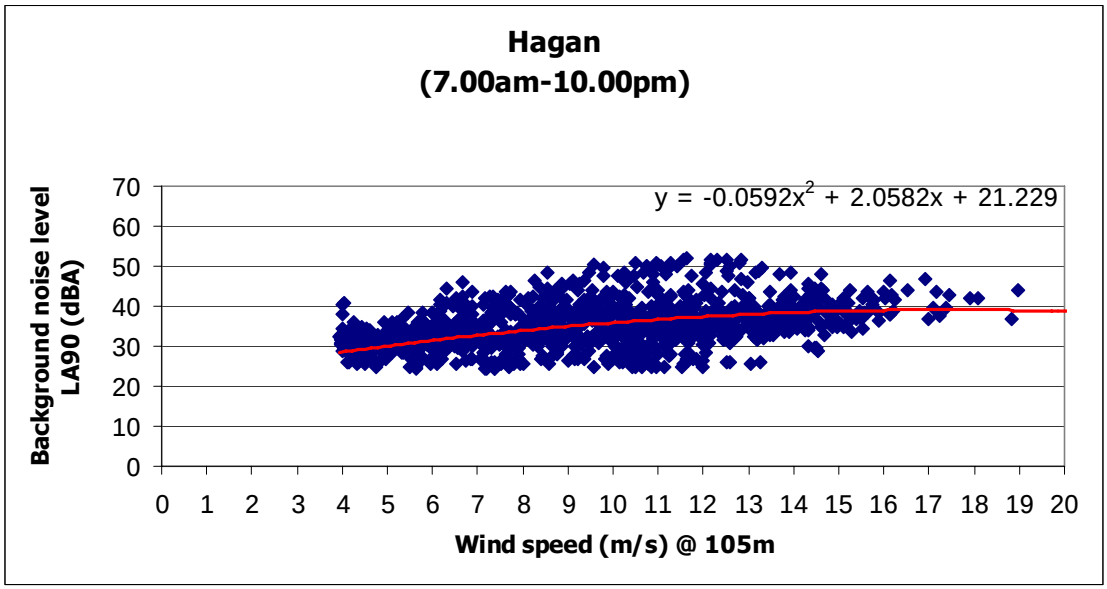

Dunvagen
(10.00pm-7.00am)
y = 0.0778x2 - 1.2558x + 31.323
Background noise level LA90 (dBA)
0
10
20
30
40
50
60
70
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

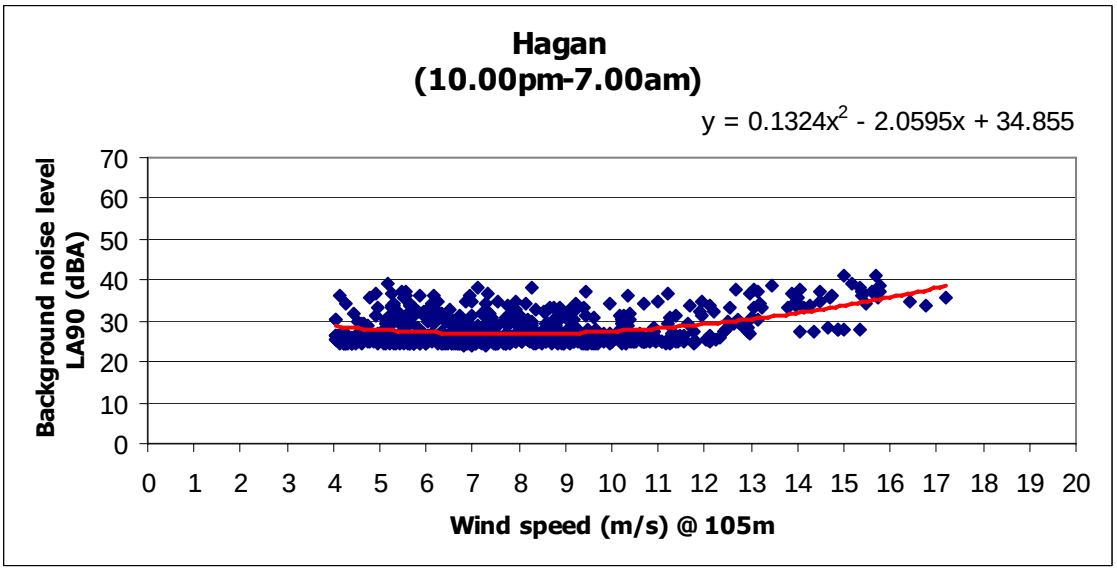

Adam's
(7.00am-10.00pm)
y = 0.0308x2 - 0.0598x + 28.833
Background noise level LA90 (dBA)
70
60
50
40
30
20
10
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m


Adam's
(10.00pm-7.00am)
y = 0.0362x2 - 0.5732x + 28.17
Background noise level LA90 (dBA)
70
60
50
40
30
20
10
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m


Airdrie
(7.00am-10.00pm)
y = 0.0945x2 - 1.0873x + 32.184
Background noise level LA90 (dBA)
70
60
50
40
30
20
10
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

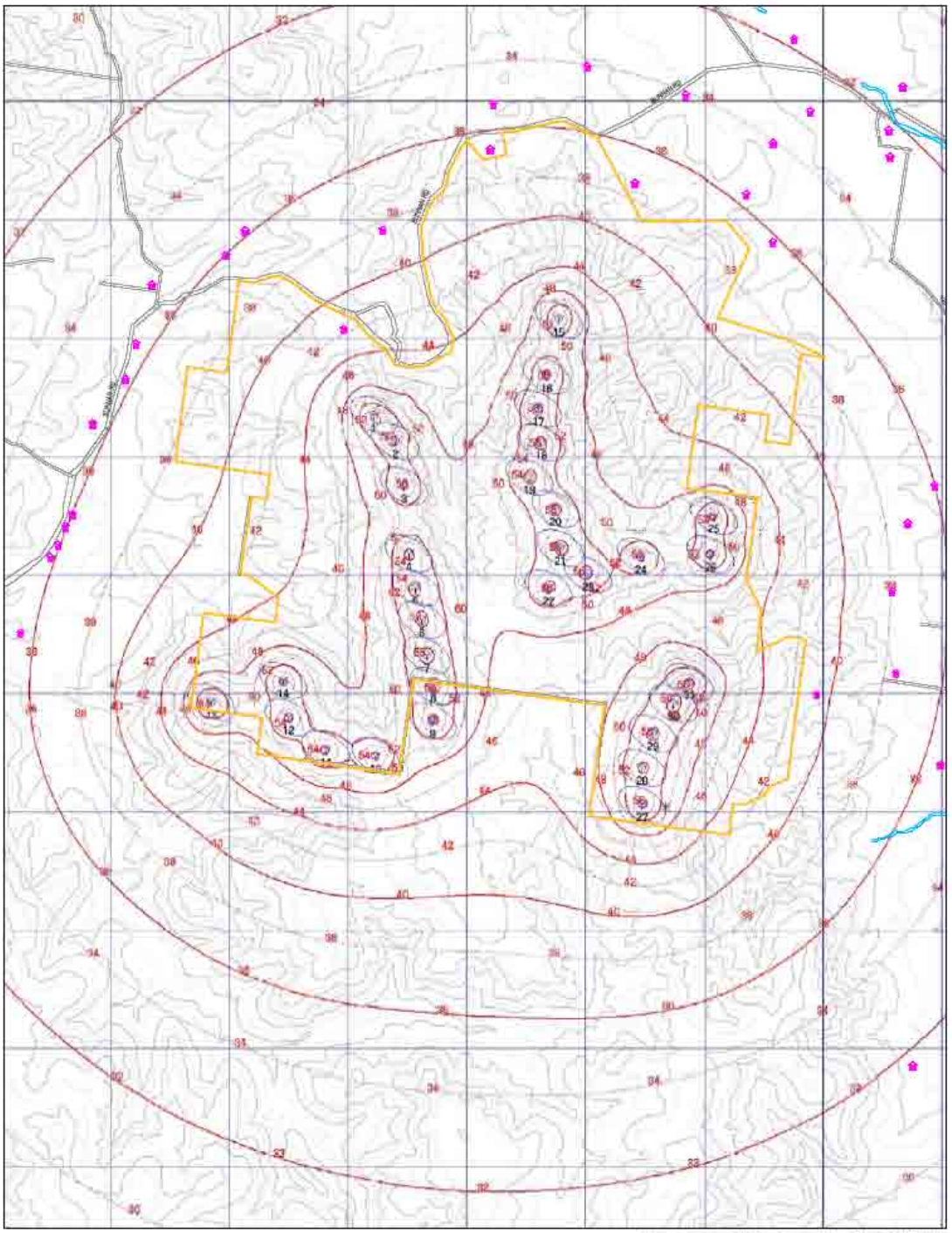

Airdrie
(10.00pm-7.00am)
y = 0.1004x2 - 1.0963x + 28.25
Background noise level LA90 (dBA)
70
60
50
40
30
20
10
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m


Hagan
(7.00am-10.00pm)
y = -0.0592x2 + 2.0582x + 21.229
Background noise level LA90 (dBA)
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

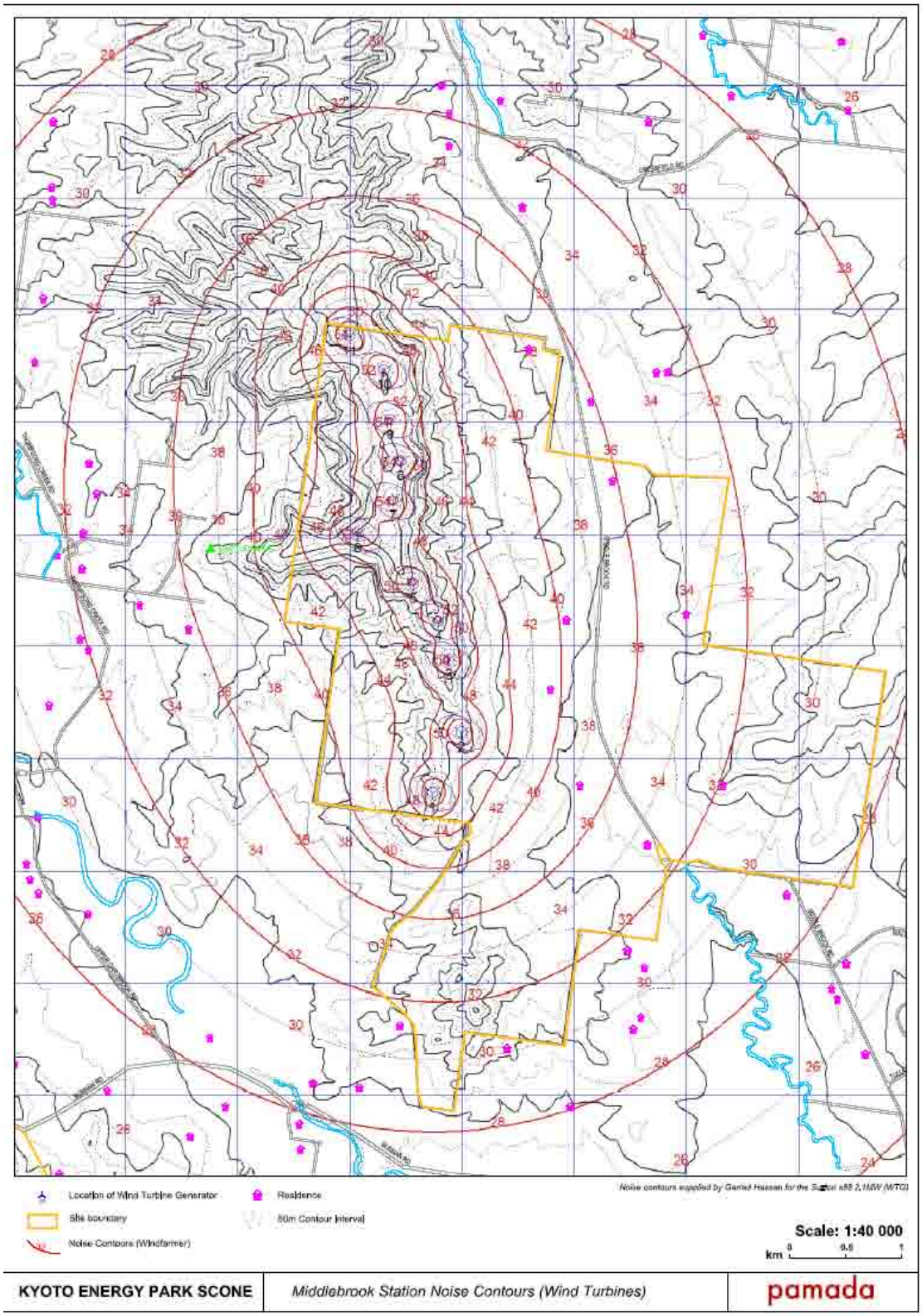

Hagan
(10.00pm-7.00am)
y = 0.1324x2 - 2.0595x + 34.855
Background noise level LA90 (dBA)
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wind speed (m/s) @ 105m

APPENDIX E

GARRAD HASSAN WIND/NOISE CONTOUR ASSESSMENT



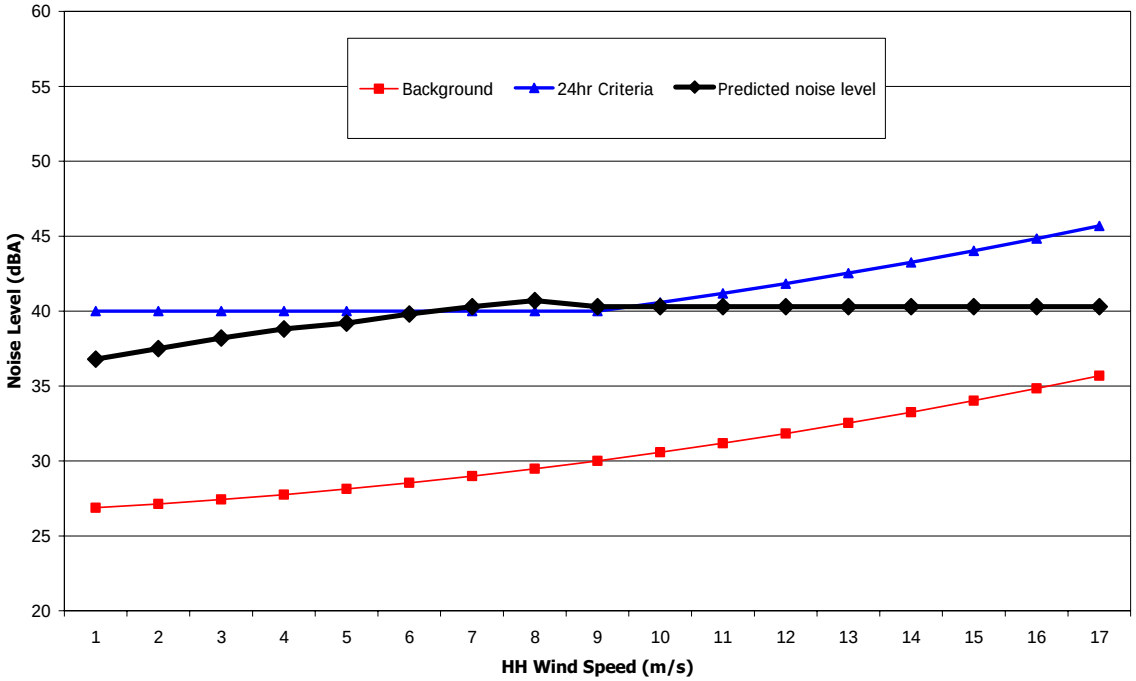
KYOTO ENERGY PARK SCONE	*Mountain Station Noise Contours (Wind Turbines)*	pamada


Location of Wind Turbine Generator
Site boundary
Noise Contours (Windfarmer)
Residence
10m Contour Interval
Scale: 1:40 000
km
0
0.5
1
KYOTO ENERGY PARK SCONE
Middlebrook Station Noise Contours (Wind Turbines)
pamada

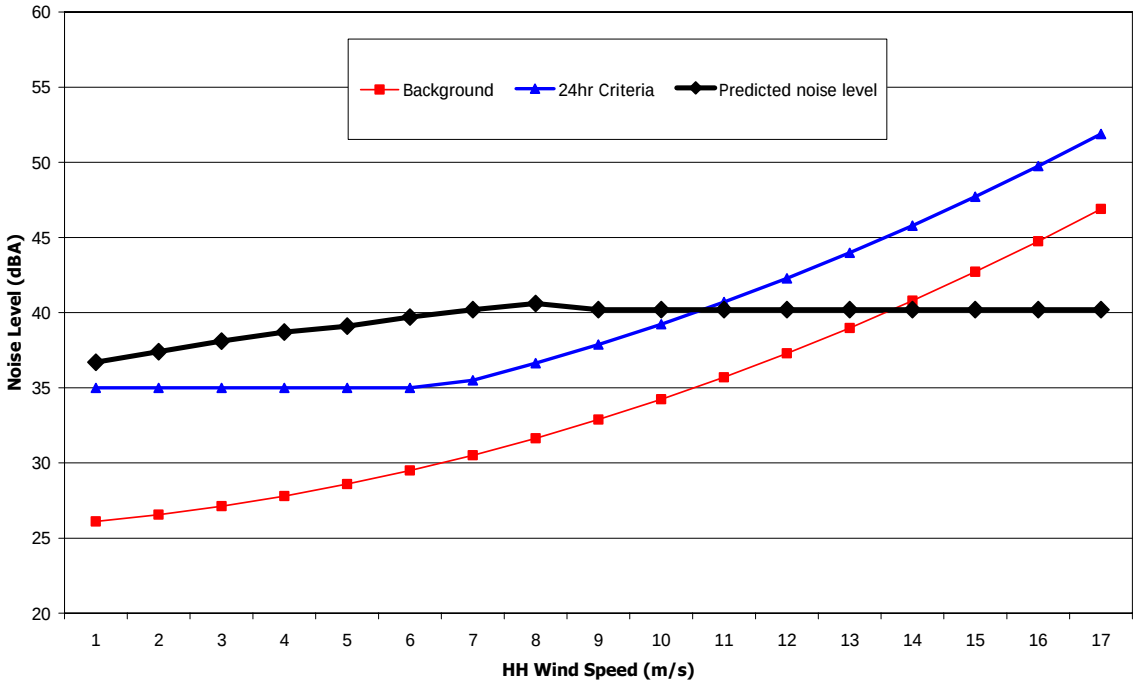
APPENDIX F

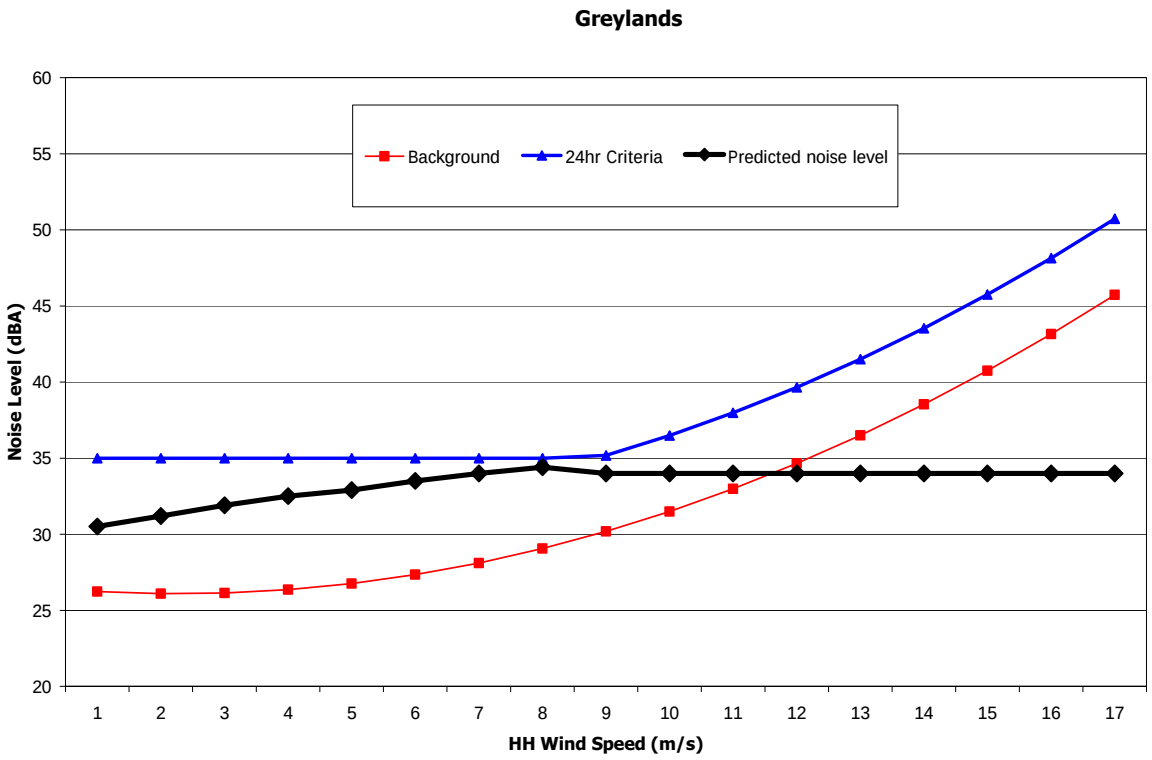
PREDICTED NOISE LEVEL VS CRITERIA

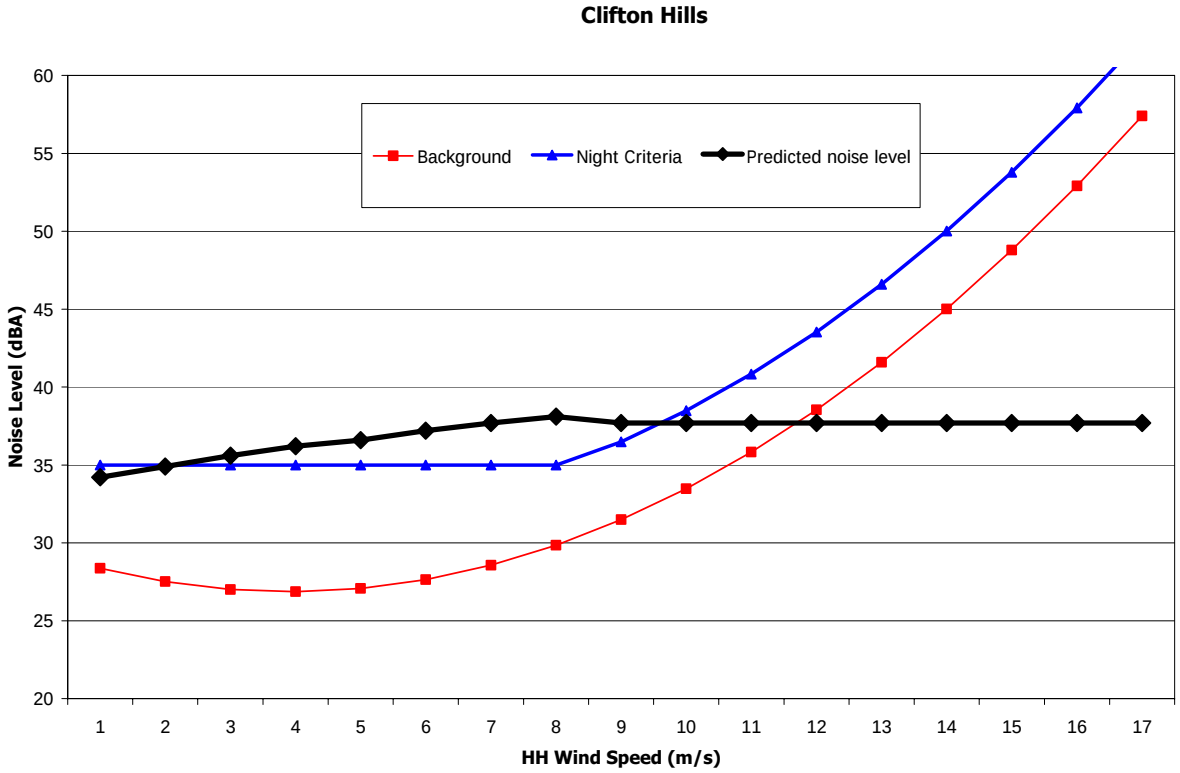
Middlebrook Station



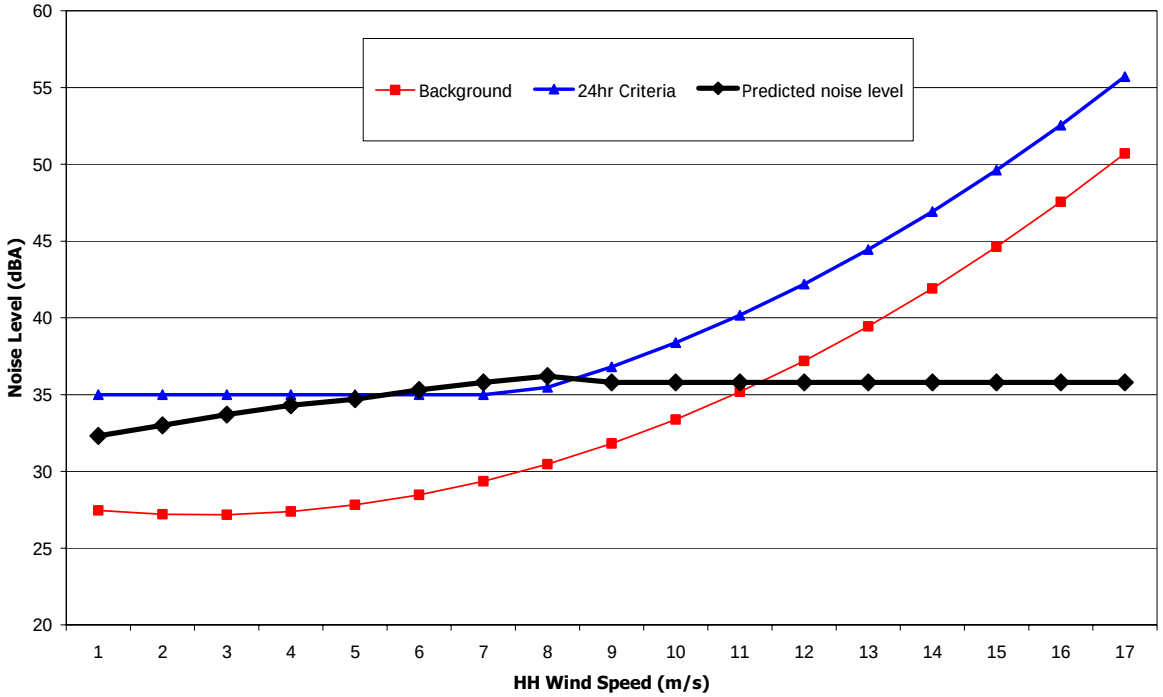
Peakhill



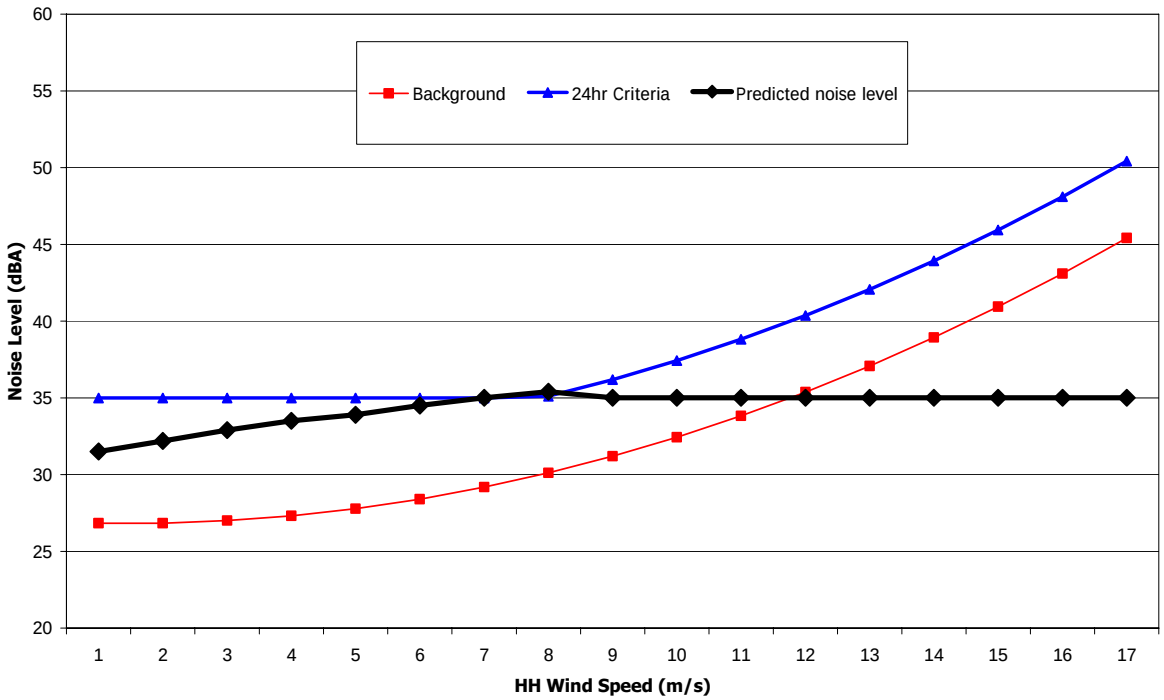

Greylands
Background
24hr Criteria
Predicted noise level
Noise Level (dBA)
HH Wind Speed (m/s)
60
55
50
45
40
35
30
25
20
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17


Clifton Hills
Background
Night Criteria
Predicted noise level
Noise Level (dBA)
HH Wind Speed (m/s)
60
55
50
45
40
35
30
25
20
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

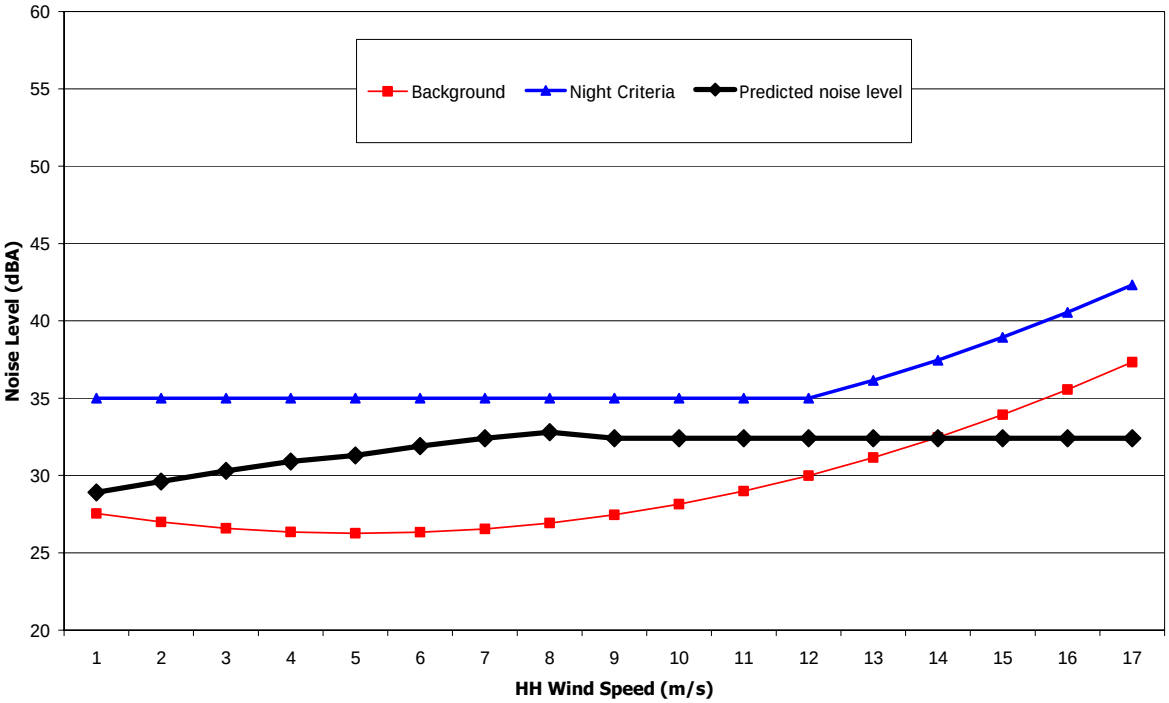
The Valley



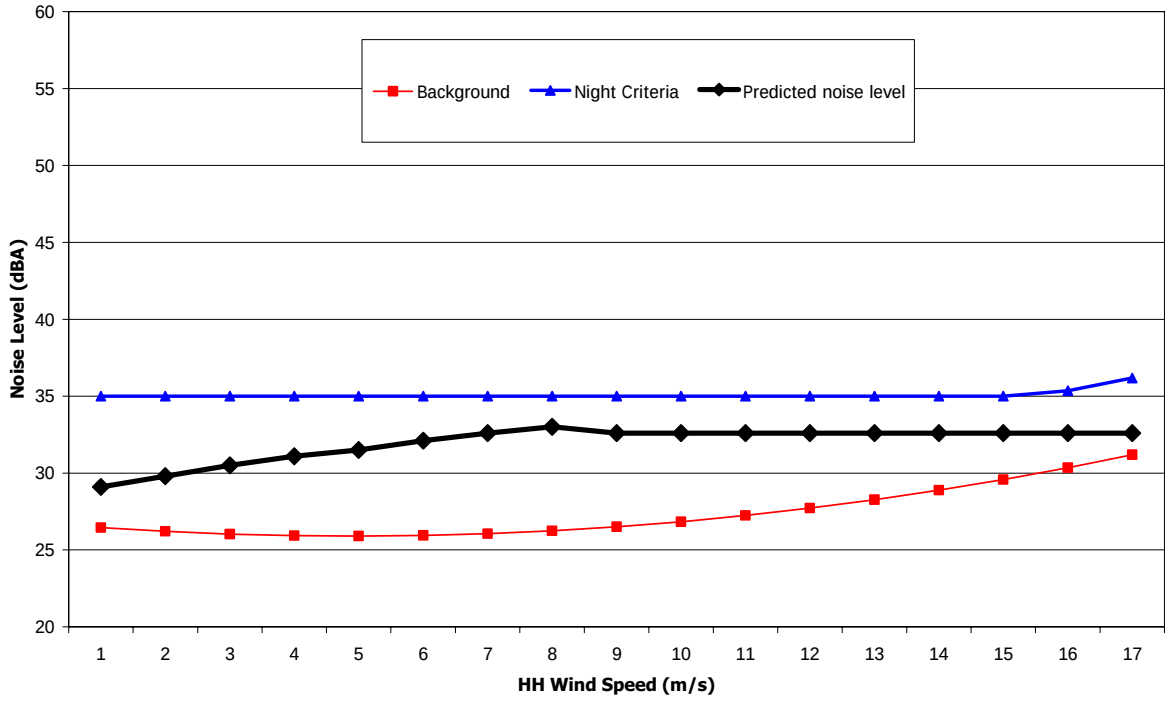
Jingerah



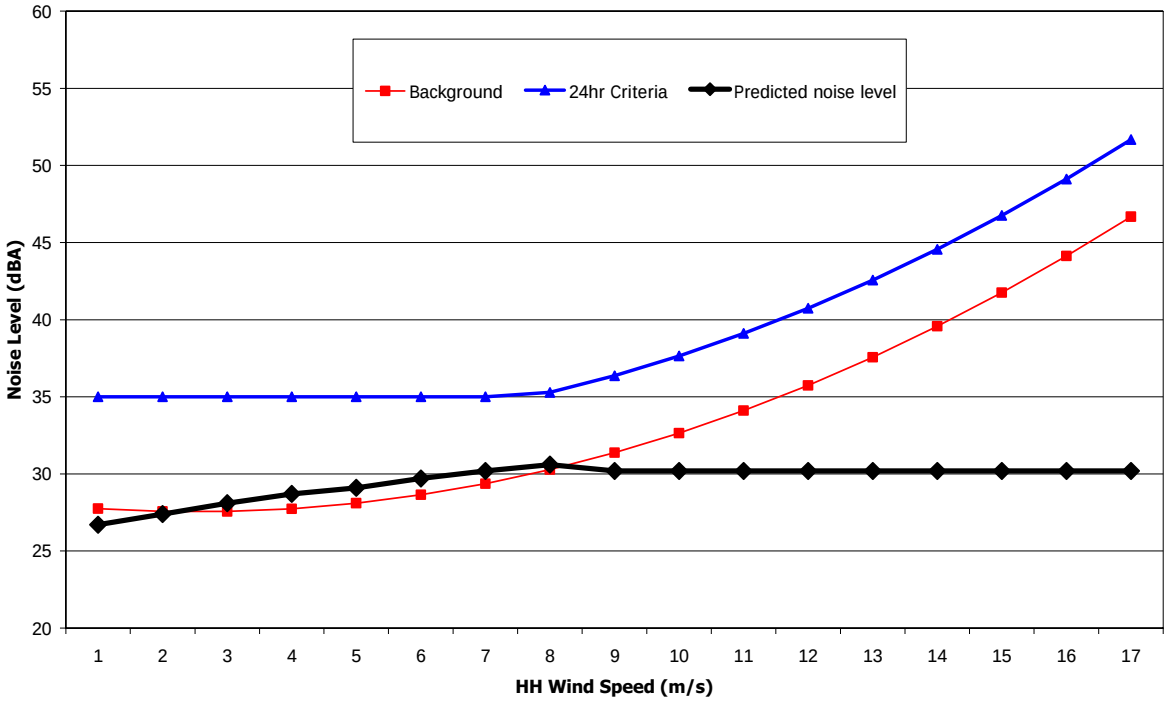
Dunvagen



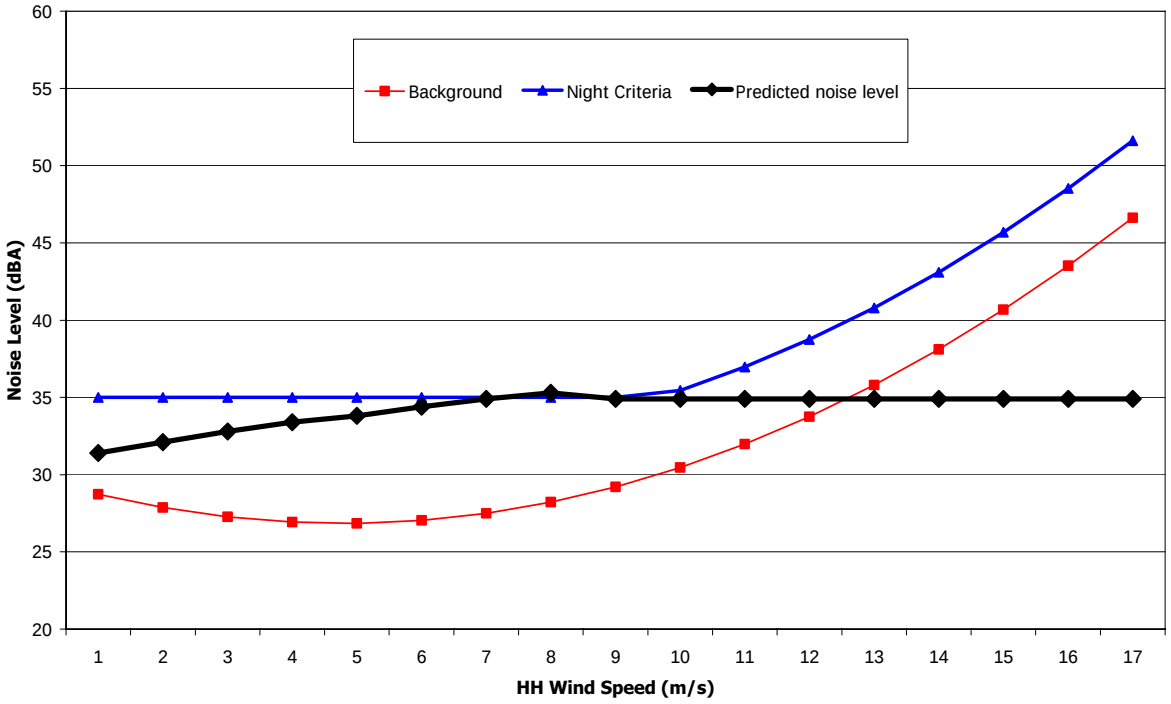
Adams



Airdrie



Hagan



APPENDIX G

RANGE OF PREDICTED NOISE LEVELS

Location	Min / Max	Range of Predicted Noise Levels dBA at Hub Height Wind Speed (m/s)																
		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
House2 South Nioka	Min	20.5	20.9	20.6	20.9	19.6	19.7	19.9	19.7	19.0	18.8	18.5	18.3	18.1	17.8	17.6	17.4	17.2
	Max	29.8	30.9	32.1	33.2	34.1	35.2	36.2	37.1	37.2	37.7	38.2	38.7	39.2	39.7	40.1	40.6	41.1
Greylands	Min	21.2	20.6	20.8	21.0	21.2	21.5	21.7	21.9	21.2	20.5	20.3	20.0	19.8	19.5	19.3	19.1	18.9
	Max	29.5	30.7	31.9	32.9	33.8	34.9	35.9	36.8	36.9	37.4	37.9	38.4	38.8	39.3	39.8	40.3	40.8
Lot 6 Clifton Hills Estate	Min	25.6	25.4	25.1	25.3	23.2	23.4	23.7	23.8	23.1	22.9	22.6	22.4	22.0	21.8	21.7	21.5	21.3
	Max	33.3	34.5	35.6	36.7	37.6	38.7	39.7	40.6	40.7	41.2	41.7	42.2	42.7	43.2	43.7	44.2	44.6
The Valley	Min	22.7	22.7	23.1	22.7	22.1	22.0	22.0	22.1	21.5	21.2	21.0	20.8	20.6	20.4	20.2	20.0	19.8
	Max	31.3	32.5	33.7	34.9	35.8	36.9	38.0	38.9	39.1	39.6	40.1	40.7	41.2	41.7	42.3	42.8	43.3
Airdrie	Min	19.8	19.2	19.9	19.5	19.5	19.9	20.3	20.7	20.2	20.2	20.2	20.2	20.0	20.0	19.9	19.9	19.9
	Max	25.9	27.0	28.1	29.0	29.9	31.0	32.0	32.9	33.1	33.6	34.2	34.7	35.2	35.8	36.3	36.8	37.4
Peakhill	Min	28.3	28.5	28.8	29.1	28.7	28.6	28.7	28.6	27.8	27.3	26.0	25.3	24.9	24.6	24.3	24.0	21.6
	Max	35.3	36.7	38.1	39.4	40.4	41.5	42.6	43.6	43.7	44.2	44.7	45.2	45.7	46.2	46.7	47.2	47.7
Old Middlebrook House	Min	26.9	27.4	27.8	28.1	28.2	28.6	28.8	29.0	28.3	28.0	27.8	27.5	27.3	27.1	26.9	26.7	26.5
	Max	33.2	34.4	35.6	36.7	37.7	38.8	39.8	40.7	40.8	41.3	41.8	42.4	42.9	43.4	43.9	44.4	44.9
Middlebrook Station	Min	29.5	29.8	30.0	30.3	30.4	30.7	31.0	31.1	30.5	30.2	30.0	29.8	29.5	29.3	29.1	28.8	28.6
	Max	35.8	37.0	38.2	39.2	40.1	41.2	42.3	43.2	43.3	43.8	44.3	44.8	45.3	45.8	46.3	46.8	47.2
Jingerah	Min	22.0	22.3	22.4	22.6	22.7	23.1	23.4	23.0	22.3	22.1	21.9	21.6	21.4	20.9	20.3	19.7	19.5
	Max	30.5	31.7	32.9	33.9	34.8	35.9	36.9	37.8	37.9	38.4	38.9	39.4	39.8	40.3	40.8	41.3	41.8
Adams	Min	17.5	17.6	17.8	17.9	17.6	16.5	14.5	14.1	12.8	11.4	9.9	8.7	7.7	7.1	6.8	6.4	6.1
	Max	28.0	29.3	30.5	31.6	32.6	33.7	34.7	35.7	35.8	36.3	36.9	37.4	37.9	38.5	39.0	39.5	40.0
Hagan	Min	19.2	18.4	18.9	19.3	19.5	20.0	20.4	20.8	20.5	20.6	20.7	20.6	20.8	21.1	21.2	21.1	21.0
	Max	30.4	31.6	32.8	33.9	34.9	36.0	37.1	38.0	38.2	38.7	39.3	39.8	40.3	40.9	41.4	41.9	42.4
Dunvagen	Min	15.6	16.0	16.5	16.8	17.0	17.4	17.7	17.9	17.3	17.1	16.9	16.8	16.6	16.4	16.3	16.1	16.0
	Max	27.9	29.1	30.3	31.4	32.3	33.5	34.5	35.4	35.6	36.1	36.6	37.1	37.7	38.2	38.7	39.2	39.7
Jeffries	Min	13.2	13.6	14.0	14.3	14.4	14.7	14.9	15.0	14.4	14.1	13.9	13.6	13.4	13.1	12.9	12.6	12.4
	Max	25.5	26.7	27.9	29.0	29.9	31.0	32.0	32.9	33.1	33.6	34.1	34.6	35.2	35.7	36.2	36.7	37.2

Location	Min / Max	Range of Predicted Noise Levels dBA at Hub Height Wind Speed (m/s)																
		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
AJ McPhee	Min	19.3	17.6	16.8	10.3	9.1	9.3	9.5	9.6	8.9	8.6	8.3	8.1	7.8	7.5	7.3	7.0	6.8
	Max	29.5	30.7	31.9	33.0	33.9	35.0	36.0	36.9	37.1	37.6	38.1	38.6	39.1	39.6	40.1	40.6	41.1
Mitchell	Min	3.4	3.7	4.0	4.3	4.3	4.6	4.8	4.9	4.2	3.9	3.6	3.3	3.0	2.7	2.5	2.2	2.0
	Max	23.6	25.0	26.3	27.5	28.4	29.6	30.7	31.6	31.7	32.3	32.8	33.3	33.8	34.4	34.9	35.4	35.9
Stewart	Min	23.9	24.4	24.9	25.3	25.5	25.9	25.9	26.2	25.7	25.7	25.7	25.7	25.7	25.7	25.6	25.6	25.5
	Max	30.0	31.2	32.4	33.5	34.5	35.6	36.6	37.6	37.7	38.3	38.8	39.3	39.9	40.4	40.9	41.4	42.0
Mastin	Min	22.0	22.1	22.3	22.6	22.6	17.4	14.4	14.6	14.0	13.9	13.7	13.6	13.5	13.3	13.2	13.1	13.0
	Max	31.8	33.1	34.3	35.4	36.4	37.5	38.5	39.5	39.6	40.1	40.7	41.2	41.7	42.2	42.7	43.3	43.8
Camal Hill	Min	19.1	17.3	17.9	18.5	18.9	19.6	20.2	20.3	20.1	20.3	20.5	20.8	21.2	21.3	21.3	20.8	20.7
	Max	29.5	30.7	32.0	33.2	34.1	35.2	36.3	37.2	37.3	37.9	38.4	38.9	39.5	40.0	40.5	41.0	41.5
Black and Millgate	Min	7.4	6.9	6.6	6.4	6.2	6.5	6.8	6.9	6.2	5.9	5.7	5.4	5.2	5.0	4.8	4.6	4.5
	Max	29.9	31.1	32.4	33.5	34.4	35.6	36.6	37.6	37.7	38.2	38.8	39.3	39.9	40.4	40.9	41.4	41.9
Holland Allambie	Min	17.6	16.3	16.6	16.9	17.0	17.3	17.5	17.6	16.9	16.7	16.4	16.2	15.9	15.7	15.5	15.2	15.0
	Max	29.5	30.7	31.9	33.0	33.9	35.0	36.0	36.9	37.0	37.5	38.1	38.6	39.1	39.6	40.1	40.6	41.1
Inverness	Min	20.3	20.4	20.7	20.6	19.9	19.9	19.8	19.9	19.3	19.0	18.8	18.6	18.3	18.1	17.9	17.6	17.4
	Max	29.4	30.5	31.7	32.8	33.7	34.8	35.8	36.7	36.8	37.3	37.8	38.3	38.8	39.3	39.8	40.3	40.8
Quinn / Van Wees	Min	22.2	22.5	22.8	22.7	22.8	23.1	22.3	22.3	21.5	21.2	21.0	20.6	20.1	19.9	19.6	19.3	18.8
	Max	30.0	31.2	32.4	33.4	34.3	35.4	36.4	37.3	37.4	37.9	38.4	38.9	39.4	39.9	40.4	40.8	41.3
Cuan Cottage	Min	21.4	21.2	21.6	21.9	22.0	22.3	22.5	22.6	21.9	21.7	21.4	21.1	20.7	20.2	19.8	19.5	19.2
	Max	29.8	31.0	32.2	33.3	34.3	35.4	36.4	37.3	37.5	38.0	38.5	39.1	39.6	40.1	40.6	41.1	41.6
Brooks	Min	7.9	8.2	8.5	8.8	8.9	9.1	9.3	9.4	8.7	8.5	8.3	8.0	7.8	7.6	7.4	7.2	7.0
	Max	24.9	26.0	27.1	28.1	28.9	30.0	31.0	32.0	32.1	32.6	33.2	33.7	34.2	34.8	35.3	35.8	36.4
Lawes	Min	18.5	18.6	19.0	19.3	19.4	19.8	20.0	20.2	19.6	19.3	19.1	18.5	17.7	17.5	17.4	17.2	17.0
	Max	27.6	28.8	30.0	31.1	32.0	33.1	34.2	35.1	35.2	35.7	36.2	36.8	37.3	37.8	38.3	38.8	39.3
Marshall - N	Min	13.2	13.4	13.6	13.8	13.9	14.3	14.1	12.6	11.7	11.6	11.5	11.4	10.1	8.5	7.4	6.9	6.7
	Max	24.1	25.3	26.5	27.6	28.5	29.7	30.7	31.6	31.8	32.3	32.9	33.4	34.0	34.5	35.0	35.5	36.1

Location	Min / Max	Range of Predicted Noise Levels dBA at Hub Height Wind Speed (m/s)																
		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Marshall W&S	Min	8.9	7.8	7.9	8.2	8.3	8.6	8.8	8.9	8.2	8.0	7.7	7.4	7.1	6.9	6.6	6.4	6.1
	Max	24.0	25.2	26.3	27.4	28.3	29.4	30.4	31.3	31.4	31.9	32.4	32.9	33.4	33.9	34.4	34.9	35.4
Henderson The Glen	Min	26.8	27.2	27.6	27.9	28.0	28.3	28.6	28.7	27.7	27.4	27.2	26.9	26.7	26.5	26.3	26.0	25.8
	Max	33.6	34.8	36.0	37.1	38.0	39.1	40.1	41.0	41.1	41.6	42.2	42.7	43.2	43.7	44.2	44.6	45.1
Brooklyn Park	Min	20.3	20.7	17.4	17.0	17.1	17.5	17.7	17.8	17.2	16.9	16.7	16.4	16.2	15.9	15.7	15.5	15.2
	Max	28.9	30.1	31.4	32.5	33.5	34.6	35.7	36.6	36.8	37.3	37.9	38.4	38.9	39.5	40.0	40.5	41.0
Middlebrook Valley Lodge	Min	24.9	25.2	25.7	25.4	24.8	24.6	24.7	24.8	24.2	23.2	22.4	22.2	22.0	21.7	21.5	21.3	21.1
	Max	31.2	32.4	33.5	34.6	35.5	36.6	37.6	38.5	38.6	39.1	39.6	40.1	40.6	41.1	41.6	42.1	42.5
Henderson - Clairmont	Min	25.0	24.9	25.2	25.6	25.2	25.4	25.5	25.7	25.0	24.4	24.1	23.8	23.6	23.4	23.2	22.2	22.0
	Max	31.3	32.5	33.7	34.7	35.6	36.7	37.7	38.6	38.7	39.2	39.7	40.2	40.7	41.2	41.7	42.2	42.7
Henderson - Dairy Cottage	Min	21.5	21.2	21.6	21.9	22.0	22.3	22.6	22.7	22.0	21.8	21.5	21.3	21.0	20.8	20.6	20.3	20.1
	Max	28.9	30.1	31.3	32.4	33.3	34.4	35.4	36.3	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.1	40.5
Henderson - Accommodation	Min	30.5	30.9	31.3	31.6	31.7	32.0	32.3	32.4	31.7	31.5	31.2	31.0	30.8	30.5	30.3	30.1	29.9
	Max	36.5	37.6	38.8	39.9	40.8	41.8	42.8	43.7	43.8	44.3	44.8	45.3	45.7	46.2	46.7	47.2	47.6
Henderson - Benham	Min	16.3	16.7	17.1	17.4	17.5	17.8	18.1	18.2	17.5	17.3	17.0	16.8	16.5	16.3	16.1	15.8	15.6
	Max	25.8	26.9	28.1	29.2	30.0	31.1	32.1	33.0	33.1	33.6	34.1	34.6	35.1	35.6	36.0	36.5	37.0
Henderson - White Cottage	Min	21.2	21.6	22.0	22.3	22.4	22.8	23.0	23.1	22.5	22.2	21.9	21.0	20.5	19.9	19.4	19.2	19.0
	Max	27.8	29.0	30.2	31.3	32.2	33.4	34.4	35.3	35.4	35.9	36.5	37.0	37.5	38.0	38.5	39.0	39.5
Fairfield	Min	15.3	14.9	15.3	15.6	15.8	16.1	16.3	16.5	15.8	15.1	14.9	14.6	14.2	13.9	13.7	13.5	13.2
	Max	22.2	23.4	24.5	25.6	26.5	27.6	28.6	29.5	29.6	30.1	30.6	31.2	31.7	32.2	32.7	33.2	33.7
Kalinda	Min	18.5	16.2	16.5	16.8	17.0	17.3	17.6	17.8	17.2	16.9	16.8	16.6	16.4	16.2	16.1	15.9	15.7
	Max	25.8	27.0	28.2	29.3	30.2	31.4	32.4	33.3	33.5	34.0	34.5	35.1	35.6	36.1	36.7	37.2	37.7
Hall Towarn	Min	14.1	14.3	14.6	14.9	14.9	15.3	15.6	15.8	15.3	14.9	14.7	14.6	14.4	14.2	14.1	13.9	13.8
	Max	22.9	24.0	25.2	26.2	27.1	28.2	29.1	30.0	30.1	30.6	31.1	31.6	32.1	32.6	33.1	33.6	34.1