

Venta Acoustics

## Report VA1832.170922.R2

Concrete Mouldings, Littlehampton

### Noise Survey Report

10 October 2017

Concrete Mouldings  
Hobbs New Farm  
Grevatts Lane  
Climping  
Littlehampton  
West Sussex  
BN17 5RE

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## Attachments

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| VA1832/TH1 - TH3 | Environmental Noise Time Histories |
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## 1. Introduction

Concrete Mouldings propose to relocate their concrete moulding facility from its current site on Hobbs New Farm, to a plot on Rudfield Industrial Estate.

Following a planning application for industrial use at the site, Arun District Council have requested a survey of the noise emissions from the concrete moulding operation. Venta Acoustics has been appointed by Concrete Mouldings to undertake a survey of the noise emissions from their operation on Hobbs New Farm.

The concrete moulding operation has a defined process that repeats on a daily basis with little variation.

Automated and attended survey measurements were undertaken at the current operation over a full working day to capture noise emissions of each stage of the production process.

## 2. Site Description

The current Concrete Mouldings facility on Hobbs New Farm operates out of an agricultural barn and containers on the surrounding land, with in a location surrounding by fields. There are residential dwellings 280m to the south-east, 200m to the north-west and 270m to the north-east.

The locality is relatively quiet with the A259 500m to the north being the primary source controlling background noise levels. No complaints of noise from the Concrete Mouldings facility have been reported in this setting.

The proposed new site is located on the north-east side of Rudfield Industrial Estate. A single dwelling is located some 50m to the east of this plot on Church Ln. Rudfield Industrial Estate includes South Coast Skips, a waste material recycling plant.

The production Concrete Mouldings facility currently operates between 07:00hours and 17:00hours Monday – Friday. It is intended to continue operating within these hours.

## 3. Typical Operation

Operations are generally undertaken by two operatives, with a manager providing supervision and undertaking office work. Most activities are done by hand with two forklift trucks, a Caterpillar 35 and a Daewoo. Other machinery on site includes a concrete mixer, air compressors (operated for no more than 30 minutes throughout the day) and a clipper to cut steel bar (operated for approximately 30 minutes per day within the barn).

The standard operations that take place on a daily basis can be grouped into the following broad procedures:

**Preparation**

- Starting forklift trucks
- Load sand and stone into the concrete mixer hopper bin (with forklift)

**Empty Moulds**

- Mostly by hand. Larger products lifted out of moulds by chain on the forklifts.
- Move product into the yard areas for stacking (with forklifts)

**Clean Moulds and Reset for Days Production**

- Scrape dried concrete off moulds
- Set moulds to correct sizes
- Spray moulds with mould release oil (use of compressor)
- Cut re-bar to required length for days production

**Fill Moulds**

- Fill cement hopper (empty bags of cement by hand)
- Check mixing machine screw and belts and start
- Place tray onto forklift
- Fill tray with concrete
- Drive concrete to moulds and fill (either by bucket or directly from the tray into the moulds)

**Clean up**

- Stop mixer, wash down and close up
- Clean off forklift
- Arrange product in yard for orders to be collected the following day
- Return all equipment and lock up.

## **Deliveries / Collections**

Deliveries and collections occur infrequently throughout the day. These may be by car, van or lorry. Product is loaded by hand or by forklift truck. There is large variation in the numbers of deliveries and collections, but it is very unusual for more than two in an hour.

## **4. Noise Survey**

A noise survey was carried out at Concrete Mouldings between 07:00hours and 16:00 hours on Wednesday 31<sup>st</sup> May 2017. The weather during the survey was dry and warm with light winds.

Sample measurements were undertaken with a hand-held meter of each activity at representative distanced. Notes were made of the acoustic character of the sound.

In addition, continuous measurements were undertaken by sound level meters at a distance of 100m to the east and west of the facility. These were complemented by continuous synchronised measurements at a point next to the barn to show levels of activity at the facility.

The following equipment was used in the course of the survey:

| Manufacturer                            | Model Type   | Serial No               | Calibration        |         |
|-----------------------------------------|--------------|-------------------------|--------------------|---------|
|                                         |              |                         | Certificate No.    | Date    |
| NTi Class 1 Integrating SLM             | XL2          | A2A-11586-E0            | 42530-A2A-11586-E0 | 9/6/16  |
| Svantek Class 1 Integrating SLM         | 958A         | 59177                   | None provided      | 10/1/17 |
| Convergence Instruments MEMs Microphone | Noise Sentry | CNHeBVUaU9W fgjFSy+D5tD | None provided      | -       |
| Convergence Instruments MEMs Microphone | Noise Sentry | CIP+r106U1WV ijtQa4JRnD | None provided      | -       |
| Larson Davis calibrator                 | CAL200       | 13069                   | 42530-13069        | 9/6/16  |

**Table 4.1 – Equipment used for the survey**

The MEMs microphone is solid state sound level meter which would equate to a type 2 meter, but due to the test standard procedure, cannot be given formal certification as the microphone cannot be tested to failure as it has no diaphragm. These were used to complement the measurements taken with Type 1 sound level meters (hand held measurements and 100m to the west).

To provide an indicative assessment at the new location, a brief survey of the noise levels at a position representative of the nearest residential dwelling was undertaken between 11:20 hours and 11:50 hours.

The calibration of the sound level meters was verified before and after use with no significant calibration drift observed.

## **5. Noise Measurement Results**

The following is a summary of the hand held measurements taken on site:

| Activity                                                                                         | Measurement Distance (m) | Measured level (L <sub>Aeq</sub> ) | Notes                                                  |
|--------------------------------------------------------------------------------------------------|--------------------------|------------------------------------|--------------------------------------------------------|
| <b>Preparation</b>                                                                               |                          |                                    |                                                        |
| Forklifts starting and driving past                                                              | 2                        | 72dB                               | Some squeaking of suspension                           |
| Filling bin with sand                                                                            | 7                        | 68dB                               | Mostly engine noise                                    |
| Filling bin with gravel                                                                          | 7                        | 68dB                               |                                                        |
| Removing shovel off forklift                                                                     | 7                        | 69dB                               | Mostly engine noise. Slightly impulsive                |
| <b>Empty Moulds</b>                                                                              |                          |                                    |                                                        |
| Forklift moving moulds out of barn                                                               | 5                        | 72dB                               |                                                        |
| Emptying mould by hand in yard                                                                   | 7                        | 51dB                               | Some dull thudding whilst loosening mould by hand      |
| Lifting base plates out of mould with a chain on forklift (in yard)                              | 10                       | 64dB                               |                                                        |
| Forklift lifting product out of moulds in barn (measurement directly in front of open barn door) | 20                       | 57dB                               |                                                        |
| Forklift moving product                                                                          | 25                       | 52 dB                              |                                                        |
| Wrapping product on pallet in plastic wrap                                                       | 10                       | 68dB                               | Screech of plastic pulling off roll                    |
| <b>Clean Moulds and Reset for Days Production</b>                                                |                          |                                    |                                                        |
| Cleaning and resetting moulds (measured in barn)                                                 | 10                       | 60dB                               | Scraping dry concrete off moulds. Occasional hammering |
| Spraying release oil on moulds (in barn – measured outside)                                      | 20                       | 50dB                               | Compressor running                                     |
| Spraying release oil on moulds – in yard                                                         | 10                       | 61dB                               |                                                        |
| Dragging steel re-bar (measured in barn)                                                         | 3                        | 69dB                               |                                                        |
| Cropping Metal (measured in barn)                                                                | 5                        | 80dB                               | Impulsive                                              |
| Cropping Metal (measured outside of barn)                                                        | 20                       | 39dB                               | Slight impulsive sound                                 |
| <b>Fill Moulds</b>                                                                               |                          |                                    |                                                        |
| Load cement into hopper by hand                                                                  | 9                        | 56dB                               | Dull thudding                                          |
| Turn Mixer on                                                                                    | 5                        | 61dB                               | Slightly tonal                                         |
| Mixer running                                                                                    | 50                       | 39dB                               | Almost inaudible                                       |
| Mixer pouring concrete into sled                                                                 | 15                       | 57dB                               |                                                        |
| Pouring concrete into moulds by bucket                                                           | 20                       | 52dB                               | Some knocking to settle concrete                       |
| Pouring concrete into moulds from sled                                                           | 20                       | 55dB                               | Scrapping                                              |
| Filling moulds in container                                                                      | 10                       | 53dB                               |                                                        |
| Forklift manoeuvring                                                                             | 15                       | 60dB                               |                                                        |
| <b>Clean up</b>                                                                                  |                          |                                    |                                                        |
| Concrete mixer screw with no concrete                                                            | 10                       | 58dB                               |                                                        |
| Washing down sled                                                                                | 10                       | 57dB                               |                                                        |
| Spray down forklift                                                                              | 10                       | 44dB                               |                                                        |
| Closing lid on mixer                                                                             | 10                       | 59dB                               |                                                        |
| Forklift moving product                                                                          | 15                       | 66dB                               |                                                        |
| <b>Deliveries / Collections</b>                                                                  |                          |                                    |                                                        |
| Lorry manoeuvring                                                                                | Library data, 8m         | 73dB                               |                                                        |
| Lorry loading/ unloading                                                                         | Library data, 5m         | 61dB                               |                                                        |

Table 5.1 – Noise data of operations

The automated measurements at 100m are shown as time-history plots on the attached charts VA1832/TH1-2. Due to the low noise levels from Concrete Mouldings at these locations, the measurements are dominated almost entirely by birdsong and overhead aircraft and show little correlation to Concrete Mould activities. VA1832/TH3 shows the trace of the monitor next to the yard, confirming activity at the yard. All three time histories share the same time axis and have been labelled to indicate approximate times of the different activities.

During the indicative measurement undertaken at Rudfield Industrial Estate, noise from the industrial estate dominated the measurements. The minimum background noise level measured was  $L_{A90}$  52dB with an ambient noise level of  $L_{Aeq}$  57dB.

## 6. Predicted Source Levels at 30m

As requested by Arun District Council, this section considered the noise levels of all activities calculated to a distance of 30m (the distance from the boundary of the proposed new yard to the nearest dwelling). This assumes that all activity takes place on this boundary. In reality, most activity is going to be centred around the building towards the centre of the site, at a distance of approximately 50m from the dwellings. The boundary area is likely to be used for storage with forklifts only occasionally moving towards the boundary when goods are being placed in storage or retrieved. Additionally, the storage containers and concrete mouldings along the boundary would likely provide some degree of acoustic screening of the site to the dwellings, which has not been taken into account in the following calculations. This assessment therefore provides a very pessimistic and hence robust indication of the impact on the dwellings.

Table 6.1 shows the measured source levels are corrected to a distance of 30m. Where the measurements were of activities in the barn measured at 20m directly in front of the open doors, a correction has been allowed for directivity.

The levels are corrected to a typical 1-hour assessment period and have been given acoustic character corrections, as described in BS4142: 2014 *Methods for rating and assessing industrial and commercial sound*. The penalties have been awarded based upon the subjective method and observations of the processes.

| Activity                                                            | Predicted level at 30m (LAeq) | Typical on-time (mins/hr) | Level corrected to 1 hour LAeq | Suggested BS4142 Character Corrections |
|---------------------------------------------------------------------|-------------------------------|---------------------------|--------------------------------|----------------------------------------|
| <b>Preparation (approx. 1hr)</b>                                    |                               |                           |                                |                                        |
| Forklifts starting and driving past                                 | 48                            | 2                         | 34                             | Intermittency +3                       |
| Filling bin with sand                                               | 55                            | 8                         | 47                             | Other Character +3                     |
| Filling bin with gravel                                             | 55                            | 8                         | 47                             | Other Character +3                     |
| Removing shovel off forklift                                        | 56                            | 2                         | 42                             | Impulsivity +3                         |
| <b>Empty Moulds (approx. 1hr)</b>                                   |                               |                           |                                |                                        |
| Forklift moving moulds out of barn                                  | 56                            | 10                        | 49                             | Other Character +3                     |
| Emptying mould by hand in yard                                      | 38                            | 60                        | 38                             |                                        |
| Lifting base plates out of mould with a chain on forklift (in yard) | 54                            | 10                        | 47                             |                                        |
| Forklift lifting product out of moulds (in barn)                    | 46                            | 60                        | 46                             |                                        |
| Forklift moving product                                             | 50                            | 20                        | 46                             | Other Character +3                     |
| Wrapping product on pallet in plastic wrap                          | 58                            | 3                         | 45                             | Other Character +3                     |
| <b>Clean Moulds and Reset for Days Production (approx. 2hr)</b>     |                               |                           |                                |                                        |
| Cleaning and resetting moulds (measured in barn)                    | 43                            | 60                        | 43                             | Impulsivity +3                         |
| Spraying release oil on moulds (in barn – measured outside)         | 39                            | 10                        | 32                             | Intermittency +3                       |
| Spraying release oil on moulds – in yard                            | 51                            | 5                         | 41                             | Intermittency +3                       |
| Dragging steel re-bar (in barn)                                     | 49                            | 10                        | 41                             | Other Character +3                     |
| Cropping Metal                                                      | 35                            | 20                        | 31                             | Impulsivity +6                         |
| <b>Fill Moulds (approx. 3hr)</b>                                    |                               |                           |                                |                                        |
| Load cement into hopper by hand                                     | 46                            | 10                        | 38                             |                                        |
| Turn Mixer on                                                       | 45                            | 1                         | 28                             |                                        |
| Mixer running                                                       | 43                            | 60                        | 43                             | Tonality +4                            |
| Mixer pouring concrete into sled                                    | 51                            | 5                         | 40                             | Intermittency +3                       |
| Pouring concrete into moulds by bucket                              | 41                            | 55                        | 41                             |                                        |
| Pouring concrete into moulds from sled                              | 44                            | 55                        | 44                             |                                        |
| Filling moulds in container                                         | 43                            | 45                        | 42                             |                                        |
| Forklift manoeuvring                                                | 54                            | 15                        | 48                             | Other Character +3                     |
| <b>Clean up (approx. 1hr)</b>                                       |                               |                           |                                |                                        |
| Concrete mixer screw with no concrete                               | 48                            | 30                        | 45                             | Tonality +4                            |
| Washing down sled                                                   | 47                            | 5                         | 37                             | Intermittency +3                       |
| Spray down forklift                                                 | 34                            | 5                         | 24                             | Intermittency +3                       |
| Closing lid on mixer                                                | 49                            | 2                         | 35                             |                                        |
| Forklift moving product                                             | 60                            | 60                        | 60                             | Other Character +3                     |
| <b>Deliveries / Collections (occasionally throughout the day)</b>   |                               |                           |                                |                                        |
| Lorry manoeuvring                                                   | 62                            | 5                         | 51                             | Intermittency +3                       |
| Lorry loading/ unloading                                            | 45                            | 10                        | 38                             | Intermittency +3                       |

Table 6.1 – Noise data of operations

The following table provides a summary BS4142 assessment of the different processes during a typical day, as calculated at the nearest residential receiver. These assume all activities take place on the boundary of the site nearest the dwellings. In practice, most activities will be towards the centre of the site, with some at the nearer and some at the further boundary. A reduction of 3-6dB from these levels is expected when the location of works is considered.

| Works Stage                | Cumulative level | Penalty | Rating level | Relative to Background (52dB) | Notional Impact                      |
|----------------------------|------------------|---------|--------------|-------------------------------|--------------------------------------|
| Preparation (1hr)          | 50dB             | 3dB     | 53dB         | +1dB                          | Tending towards low impact           |
| Emptying Moulds (1hr)      | 54dB             | 3dB     | 57dB         | +6dB                          | Marginal impact                      |
| Clean Moulds & Reset (2hr) | 47dB             | 3dB     | 50dB         | -2dB                          | Low impact                           |
| Fill Moulds (3hr)          | 52dB             | 4dB     | 56dB         | +4dB                          | Marginal impact                      |
| Clean up (1hr)             | 60dB             | 3dB     | 63dB         | +9dB                          | Tending towards a significant impact |
| Deliveries / Collections   | 51dB             | 3dB     | 54dB         | +2dB                          | Tending towards low impact           |

**Table 6.2 – Summary BS4142 Assessment**

As discussed with Fiona Fitzgerald of Arun District Council, the calculated levels are combined into a single rating level for a typical working day by expanding the normal reference time period of 1 hour, as stipulated by BS4142, to include all the individual activities across an 8 hour day. The result is as follows:

| Works Stage        | Cumulative level | Penalty | Rating level | Relative to Background (52dB) | Notional Impact |
|--------------------|------------------|---------|--------------|-------------------------------|-----------------|
| Typical 8 hour day | 53dB             | 4dB     | 57dB         | +5dB                          | Marginal impact |

**Table 6.3 – Combined rating level of all activities over a full day**

## 7. Discussion

The greatest risk of noise impact is from the forklifts manoeuvring. The majority of other activities are of a very limited duration or are relatively quiet. This is supported by observations on site where most activities were barely audible at a distance from the site, despite the relatively low local background noise levels.

The background noise levels at the proposed new site are relatively high, being measured as 52dB(A) during the indicative measurements.

Assuming all activities take place on the boundary nearest the adjacent dwellings, the impact of the proposed activities vary from no significant impact to a significant impact depending on context. However, if the likely distribution of noise sources across the site is considered, the impact is likely to be marginal, due to forklifts, or lower for all activities.

The cumulative impact of works over a normal day, including the robust assumption that all works take place on the boundary of the site nearest the receptor, indicates a marginal impact may be expected, depending on the context of the site.

In the context of the site, on the edge of a busy industrial estate, Concrete Mouldings would not be introducing new types of sound to the locality and would not change the acoustic environment. All activities would be quieter than the existing industrial noise present at the adjacent dwelling.

Given the inconspicuous nature of most activities that take place on a daily basis, it is not expected that Concrete Mouldings would have a significant adverse impact in the context of an existing industrial estate.

## 8. Mitigation

Most activities are already undertaken within the barn, and are proposed to continue to be undertaken within a factory building or containers at the new site. This is effective in limiting noise propagation to surrounds.

The primary exception is the use of forklifts which necessarily move around the yard, albeit generally over limited distances and for brief periods of time (with the exception of arranging product around the yard). Maintaining the forklifts in a good state of repair to minimise rattles and squeaking suspension would reduce the potential for the forklifts to draw attention and so reduce the potential noise impact.

## 9. Conclusion

Venta Acoustics have been appointed by Concrete Mouldings to undertake a survey of noise levels generated by the processes involved in their operation.

Measurements of noise emissions were undertaken at various distanced of the numerous processes that take place on a daily basis.

In general, most processes are discrete, with few examples of 'traditional' industrial noise characteristics, such as hammering, grinding, etc, observed. The greatest noise source was identified to be the two forklifts that operate for brief periods throughout the day.

Calculations of the noise emissions to 30m have been undertaken and acoustic character corrections, as described in BS4142:2014, have been suggested.

An indicative assessment of the likely noise impact of the operation in the context of a proposed new site on an industrial estate has been provided. This suggests that the operation would generally have a low impact on the surroundings, with moderate or occasional significant impacts occurring in the worst case scenarios. However, in the context of the site, the proposals are not expected to cause a significant loss of amenity to the neighbouring dwellings.

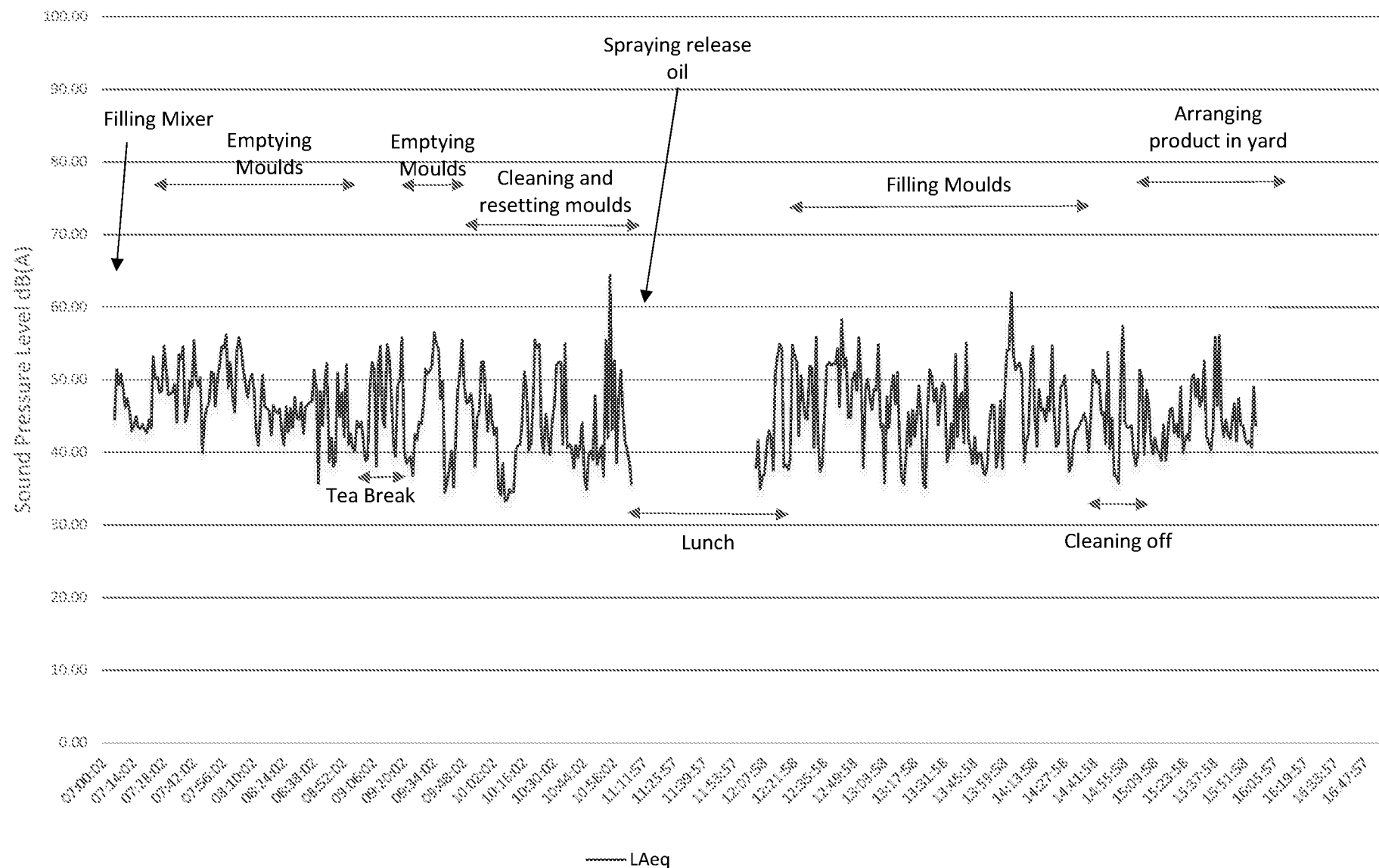
**Steven Liddell MIOA**



Concrete Moulding, Littlehampton  
 Environmental Noise Time History: 1  
 Location 1 - 100m West



Figure VA1832/TH1



Concrete Moulding, Littlehampton  
 Environmental Noise Time History: 2  
 Location 2 - 100m East

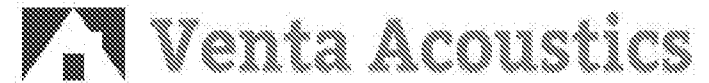
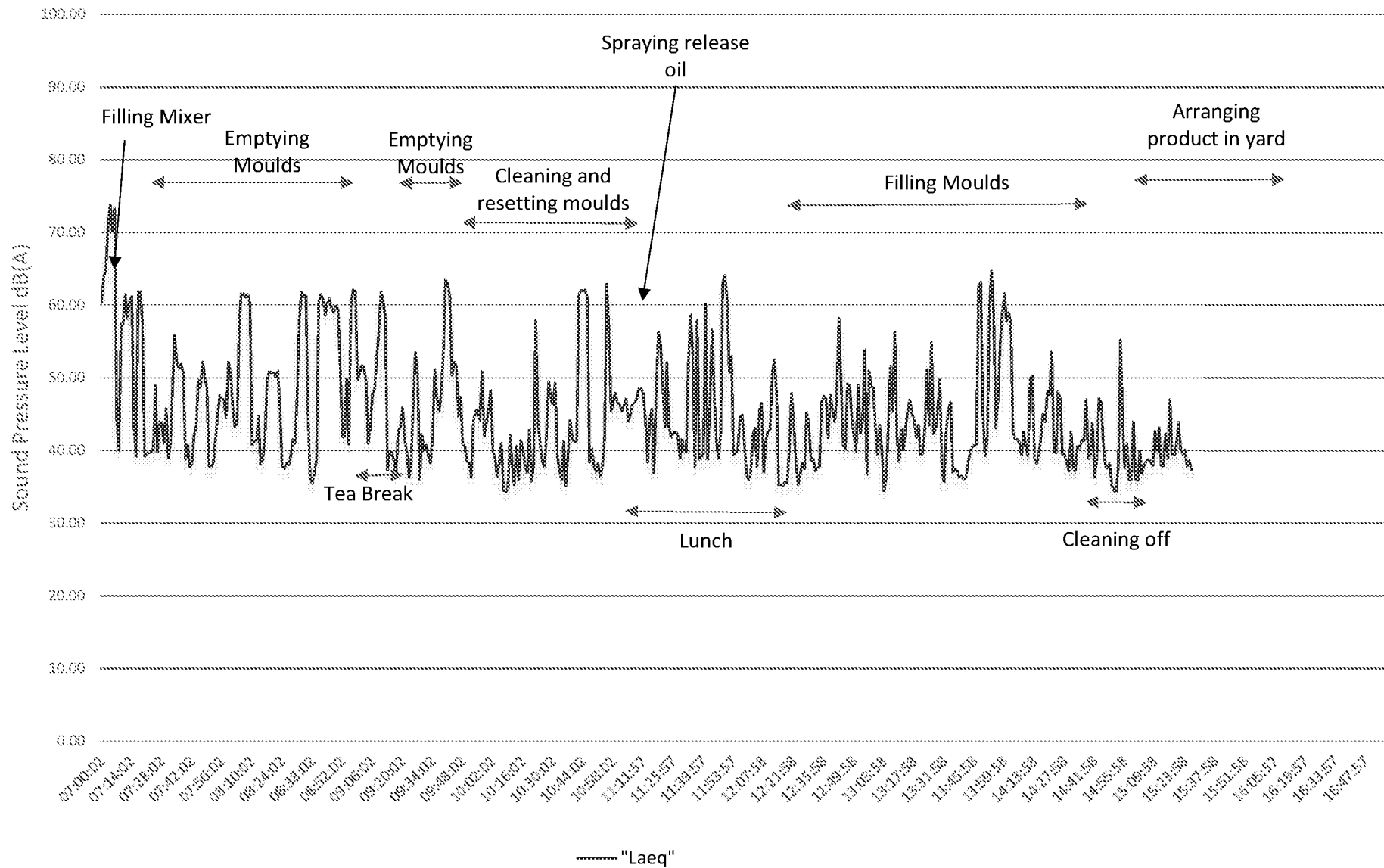


Figure VA1832/TH2



Concrete Moulding, Littlehampton  
 Environmental Noise Time History: 3  
 Location 3 - Yard

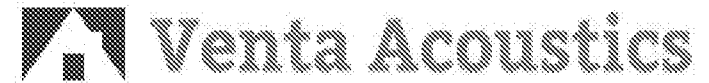
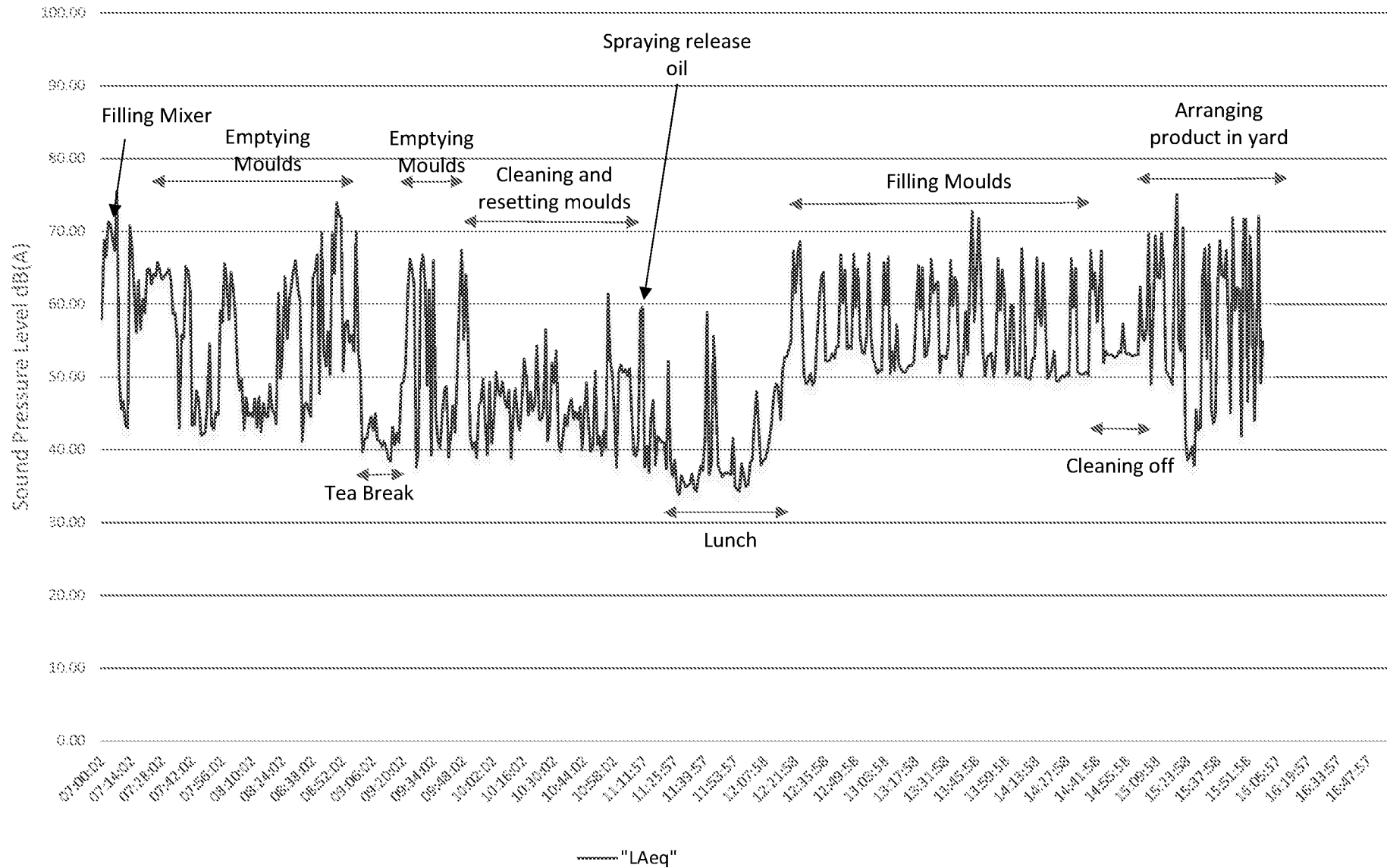


Figure VA1832/TH3



# APPENDIX A

## Acoustic Terminology & Human Response to Broadband Sound

### 1.1 Acoustic Terminology

The human impact of sounds is dependent upon many complex interrelated factors such as 'loudness', its frequency (or pitch) and variation in level. In order to have some objective measure of the annoyance, scales have been derived to allow for these subjective factors.

|                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Sound</b>                                           | Vibrations propagating through a medium (air, water, etc.) that are detectable by the auditory system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Noise</b>                                           | Sound that is unwanted by or disturbing to the perceiver.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Frequency</b>                                       | The rate per second of vibration constituting a wave, measured in Hertz (Hz), where 1Hz = 1 vibration cycle per second. The human hearing can generally detect sound having frequencies in the range 20Hz to 20kHz. Frequency corresponds to the perception of 'pitch', with low frequencies producing low 'notes' and higher frequencies producing high 'notes'.                                                                                                                                                                                                                                               |
| <b>dB(A):</b>                                          | Human hearing is more susceptible to mid-frequency sounds than those at high and low frequencies. To take account of this in measurements and predictions, the 'A' weighting scale is used so that the level of sound corresponds roughly to the level as it is typically discerned by humans. The measured or calculated 'A' weighted sound level is designated as dB(A) or $L_A$ .<br><br>A notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the actual, fluctuating sound measured over that period (e.g. 8 hour, 1 hour, etc).        |
| <b><math>L_{eq}</math> :</b>                           | The concept of $L_{eq}$ (equivalent continuous sound level) has primarily been used in assessing noise from industry, although its use is becoming more widespread in defining many other types of sounds, such as from amplified music and environmental sources such as aircraft and construction. Because $L_{eq}$ is effectively a summation of a number of events, it does not in itself limit the magnitude of any individual event, and this is frequently used in conjunction with an absolute sound limit.                                                                                             |
| <b><math>L_{10}</math> &amp; <math>L_{90}</math> :</b> | Statistical $L_n$ indices are used to describe the level and the degree of fluctuation of non-steady sound. The term refers to the level exceeded for n% of the time. Hence, $L_{10}$ is the level exceeded for 10% of the time and as such can be regarded as a typical maximum level. Similarly, $L_{90}$ is the typical minimum level and is often used to describe background noise.<br><br>It is common practice to use the $L_{10}$ index to describe noise from traffic as, being a high average, it takes into account the increased annoyance that results from the non-steady nature of traffic flow. |
| <b><math>L_{max}</math> :</b>                          | The maximum sound pressure level recorded over a given period. $L_{max}$ is sometimes used in assessing environmental noise, where occasional loud events occur which might not be adequately represented by a time-averaged $L_{eq}$ value.                                                                                                                                                                                                                                                                                                                                                                    |

### 1.2 Octave Band Frequencies

In order to determine the way in which the energy of sound is distributed across the frequency range, the International Standards Organisation has agreed on "preferred" bands of frequency for sound measurement and analysis. The widest and most commonly used band for frequency measurement and analysis is the Octave Band. In these bands, the upper frequency limit is twice the lower frequency limit, with the band being described by its "centre frequency" which is the average (geometric mean) of the upper and lower limits, e.g. 250 Hz octave band extends from 176 Hz to 353 Hz. The most commonly used octave bands are:

|                                 |    |     |     |     |      |      |      |      |
|---------------------------------|----|-----|-----|-----|------|------|------|------|
| Octave Band Centre Frequency Hz | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---------------------------------|----|-----|-----|-----|------|------|------|------|

## Acoustic Terminology & Human Response to Broadband Sound

### 1.3 Human Perception of Broadband Noise

Because of the logarithmic nature of the decibel scale, it should be borne in mind that sound levels in dB(A) do not have a simple linear relationship. For example, 100dB(A) sound level is not twice as loud as 50dB(A). It has been found experimentally that changes in the average level of fluctuating sound, such as from traffic, need to be of the order of 3dB before becoming definitely perceptible to the human ear. Data from other experiments have indicated that a change in sound level of 10dB is perceived by the average listener as a doubling or halving of loudness. Using this information, a guide to the subjective interpretation of changes in environmental sound level can be given.

| Change in Sound Level<br>dB | Subjective Impression                             | Human Response   |
|-----------------------------|---------------------------------------------------|------------------|
| 0 to 2                      | Imperceptible change in loudness                  | Marginal         |
| 3 to 5                      | Perceptible change in loudness                    | Noticeable       |
| 6 to 10                     | Up to a doubling or halving of loudness           | Significant      |
| 11 to 15                    | More than a doubling or halving of loudness       | Substantial      |
| 16 to 20                    | Up to a quadrupling or quartering of loudness     | Substantial      |
| 21 or more                  | More than a quadrupling or quartering of loudness | Very Substantial |

### 1.4 Earth Bunds and Barriers - Effective Screen Height

When considering the reduction in sound level of a source provided by a barrier, it is necessary to establish the "effective screen height". For example if a tall barrier exists between a sound source and a listener, with the barrier close to the listener, the listener will perceive the sound as being louder if he climbs up a ladder (and is closer to the top of the barrier) than if he were standing at ground level. Equally if he sat on the ground the sound would seem quieter than if he were standing. This is explained by the fact that the "effective screen height" is changing with the three cases above. In general, the greater the effective screen height, the greater the perceived reduction in sound level.

Similarly, the attenuation provided by a barrier will be greater where it is aligned close to either the source or the listener than where the barrier is midway between the two.