

ARR/C/3071.01b Rev A

26th August 2025

Northern Trust

Reassessment of noise impact of proposed Phase II
commercial/industrial units at Sandbrook Park, OL11
1LQ, with regards to a recent change of layout.

Prepared for :-

Northern Trust
Lynton House
Ackhurst Business Park
Foxhole Road
Chorley
PR7 1NY

Prepared by :-

Andrew Raymond

CONTENTS

1.0 SUMMARY

2.0 INTRODUCTION

3.0 ASSESSMENT STANDARDS

- 3.1 NPPF, NPSE and NPPG
- 3.2 BS 8233
- 3.3 BS 4142
- 3.4 Local Authority

4.0 GUIDE TO MODELLING

- 4.1 General
- 4.2 Proposed Industrial Units

5.0 SURVEY DETAILS

- 5.1 Site times and Personnel
- 5.2 Instrumentation
- 5.3 Measurement Positions
- 5.4 Survey Conditions

6.0 RESULTS AND DISCUSSIONS

- 6.1 Existing Noise Levels
- 6.2 Impact of Industrial Units
- 6.3 Assessments
- 6.4 Mitigation
- 6.5 Discussion of Uncertainty

7.0 CONCLUSIONS/RECOMMENDATIONS

Appendix 1: Definition of Acoustic Terms

Appendix 2: Measurement and Calculation Details

1.0 **SUMMARY**

The general noise climate was dominated at all times by the noise from surrounding traffic which remained constant and quite steady throughout. There was also noise from surrounding industrial units off site and some intermittent noise from building work from the nearby residential areas.

The proposed industrial units have all been modelled with assumed activity levels likely to represent a somewhat extreme worst case, including cars and HGVs, internal noise break-out and mechanical equipment. They have also been modelled with loading and unloading activity as well. Note that the modelling is an updated version of the one issued in February 2024, revised with all up-to-date changes.

The overall impact is slightly reduced, mainly due to the access road no longer (potentially) bringing vehicles along the southeast boundary. With a significantly reduced fence width, the noisiest position in terms of proposed industrial impact is 46 dB L_{Aeq} daytime which is the same as the original assessment and below the quietest 15 minute period of existing daytime background sound level of 48 dB L_{A90} . This would rate under BS 4142 as *“low impact depending on the context”*. Even with no fence at all, the predicted levels are no higher than the background levels.

The context is an established commercial area on the edge of a residential area. The predicted noise is dominated by far by vehicle movements which is similar in context to the noise which already exists. We would suggest that the impact will be low, with or without boundary fencing.

Although we cannot know at this stage what sort of businesses will occupy the units, the levels of activity assumed are somewhat extreme and clearly unlikely.



A R Raymond



P J Durell

2.0 INTRODUCTION

The original report, dated 29th February 2024 was based on the previous layout. Since then the development has been approved based on a slightly updated layout, which give slightly lower predicted levels at the nearby houses. ADC was asked to carry out a reassessment of the changes and the original extensive boundary fence.

This report begins by summarising assessment standards (some of which have changed slightly, although only in terms of paragraph numbering) and, where appropriate, discusses alternative interpretations.

The impact is discussed along with a review of the original mitigation.

3.0 ASSESSMENT STANDARDS

This section is modified with minor updates (mainly paragraph numbering in NPPF, etc).

3.1 NPPF, NPSE and NPPG

The National Planning Policy Framework (NPPF), the Noise Policy Statement for England (NPSE) and the National Planning Practice Guidance (NPPG) provide nothing in the way of quantitative criteria but instead provide general policy aims and statements and some guidance on how certain situations can be interpreted.

The NPPF's main statement on noise is to be found in paragraph 198:-

198. Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:
- a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life⁷²;
 - b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and
 - c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.

Paragraph 200 is also relevant:-

200. Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed.

The NPPF refers to the NPSE which sets out the following aims:-

1. *avoid significant adverse impacts on health and quality of life;*
2. *mitigate and minimise adverse impacts on health and quality of life;*
and
3. *where possible, contribute to the improvement of health and quality of life.*

It also introduces the concepts of:

- *NOEL – No Observed Effect Level. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.*
- *LOAEL – Lowest Observed Adverse Effect Level. This is the level above which adverse effects on health and quality of life can be detected.*
- *SOAEL – Significant Observed Adverse Effect Level. This is the level above which significant adverse effects on health and quality of life occur.*

SOAEL is clearly something the policy seeks to avoid in aim 1. Aim 2 represents situations between SOAEL and LOAEL, and seeks to minimise and mitigate the effects.

The NPPG section on noise adds some further detail, much of it reproducing the NPPF and NPSE, but some useful qualitative guidance is provided Noise Exposure Hierarchy, as follows:-

Response	Examples of outcomes	Increasing effect level	Action
No Observed Effect Level			
Not present	No Effect	No Observed Effect	No specific measures required
No Observed Adverse Effect Level			
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

It also makes the point that the subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation, including the level of the noise in absolute terms and how it might compare with the underlying background noise, the impulsiveness or intermittence pattern of the noise, its spectral content, and the time of day. It discusses in very general terms the issues to consider when introducing noise sources to existing noise sensitive area, new residential development in areas affected by existing noise sources (most of which have their own specific guidance, such as BS 4142, BS 8233, etc.) and the potential impact on wildlife.

3.2 BS8233 and WHO

BS 8233 was updated in March 2014. Its guidance is primarily intended for new buildings, but the criteria are routinely referred to for putting general noise climates into context.

The criteria in Table 4 of BS 8233 are based on WHO guidance and give the desirable criteria for indoor ambient noise levels for dwellings as follows:-

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Room	35 dB $L_{Aeq, 16 \text{ hour}}$	-
Dining	Dining Room	40 dB $L_{Aeq, 16 \text{ hour}}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq, 16 \text{ hour}}$	30 dB $L_{Aeq, 8 \text{ hour}}$

The standard does not explicitly state criteria for bedroom noise in terms of dB L_{Amax} but the WHO Guidelines for Community Noise (or similar) are widely used with a recommendation that the noise inside bedrooms should not typically exceed 45 dB L_{Amax} , for instance no more than 10 to 15 times a night.

BS 8233 goes on to state that, where necessary, the criteria can be relaxed by up to 5 dB and still achieve reasonable conditions.

Note that the standard accepts the widely used rule of thumb that, for a partly open window, the levels just outside will be 15dB higher than those just inside. Other more recent research suggests a difference of 13 dB. The latter brings us to an external equivalent of the above table, as follows:-

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Room	48 dB $L_{Aeq, 16 \text{ hour}}$	-
Dining	Dining Room	53 dB $L_{Aeq, 16 \text{ hour}}$	-
Sleeping (daytime resting)	Bedroom	48 dB $L_{Aeq, 16 \text{ hour}}$	43 dB $L_{Aeq, 8 \text{ hour}}$

Garden area criteria are 50 dB L_{Aeq} and 55 dB L_{Aeq} being considered desirable and reasonable respectively.

3.3 BS 4142

BS 4142 was updated in November 2014. The standard is very complicated but, basically, it describes methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

- sound from industrial and manufacturing processes
- sound from fixed installations which comprise mechanical and electrical plant and equipment
- sound from the loading and unloading of goods and materials at industrial and/or commercial premises

- d) sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

The methods described in this British Standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

Characteristics and Context

Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, we need to add a character correction to the specific sound level to obtain the rating level.

These features can include tonality, impulsivity and intermittency with corrections typically ranging potentially from 0dB to 9 dB. Corrections at the higher end would represent characteristics which are highly perceptible in the context of the ambient noise as a whole. Corrections at the lower end would represent characteristics which are just perceptible in the presence of the ambient noise as a whole,

The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs. An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context.

Assessment

We obtain an *initial estimate* of the impact of the specific sound by subtracting the measured background sound level from the rating level and considering the following.

- a) Typically, the greater this difference, the greater the magnitude of the impact.
- b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an

indication of the specific sound source having a low impact, depending on the context.

Where the initial estimate of the impact needs to be modified due to the context, pertinent factors need to be taken into consideration, including the following.

1) The absolute level of sound.

For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low.

Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.

Where residual sound levels are very high, the residual sound might itself result in adverse impacts or significant adverse impacts, and the margin by which the rating level exceeds the background might simply be an indication of the extent to which the specific sound source is likely to make those impacts worse.

2) The character and level of the residual sound compared to the character and level of the specific sound.

We need to consider whether it would be beneficial to compare the frequency spectrum and temporal variation of the specific sound with that of the ambient or residual sound, to assess the degree to which the specific sound source is likely to be distinguishable and will represent an incongruous sound by comparison to the acoustic environment that would occur in the absence of the specific sound. Any sound parameters, sampling periods and averaging time periods used to undertake character comparisons should reflect the way in which sound of an industrial and/or commercial nature is likely to be perceived and how people react to it.

3) The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions.

3.4 Local Authority

The development has been approved based on our previous assessment. We have used this as a guide as to what are likely to be similarly acceptable levels in this assessment.

4.0 **GUIDE TO MODELLING**

This section is unchanged from the original report.

We have used our CadnaA modelling software which calculates noise propagation based on the processes of *ISO 9613 : Acoustics – Attenuation of sound during propagation outdoors*. Obviously, modelling software is reliant on the inputs and assumptions. The key ones are:-

4.1 General

1. The ground is mainly reflective (coefficient of 0.1 assumed).
2. Calculations are based on two orders of reflections.
3. The proposed site building and the surrounding buildings are assumed to be mainly reflective (0.5 dB loss on reflection assumed).
4. The fencing and walls around the existing and proposed sites are assumed to be mainly reflective (again 0.5 dB loss on reflection assumed).
5. The surrounding trees and vegetation will provide a small degree of absorption but this has been neglected.

4.2 Proposed Industrial Units

1. We do not know what type of uses each unit will be put but they are likely to comprise a combination of visiting cars and deliveries, activities within the units breaking out through walls and roof, and external mechanical equipment.
2. Vehicle movements are based on a series of 20 to 25 m segments which include a vehicle pulling forwards from a standstill, accelerating to 20 km/hr, and slowing to a stop. The source of the noise data was from our own database, measured at 10 m from the drive-past centre over hard ground. Each segment takes about 12 seconds. The figures are almost identical to a steady 40 to 50 km/hr drive past and so cover the steady and stop/start scenarios. Within the model, the source data is entered as a Sound Power Level per meter and calibrated to give the exact measured level at 10 m from a 25 m long line source. The actual line source entered can then be any length with the same Sound Power per meter. We then enter adjustments for the duration of the source data and for the number of vehicles per hour.

Vans, Rigs and HGVs are approximately 5 dB, 10 dB and 12 dB louder respectively at these speeds and are entered as separate sources taking largely the same routes but some slight differences (eg. car parks for cars and turning circles for HGVs).

The derivation of these adjustments is shown in Appendix 2.

3. Noise within the industrial units is pessimistically assumed to be 85 dB L_{Aeq} at worker positions. For an 8 hour day, anything above this would require action to reduce operator exposure and so it should represent a pessimistic assumption, especially given that it is assumed to take place continuously in all units. We have

pessimistically estimated that this will be equivalent to a level of 80 dB L_{Aeq} across all internal surfaces of the walls and roofs. We have assumed that the building envelopes are typical industrial cladding such as Kingspan KS100 RW.

4. Source data for potential mechanical equipment is taken from data sheets for Mitsubishi air con and inverter external units, published data is well known and easily accessible. As typical examples, all units have been given a Mitsubishi PUHZ-ZRP71VHA.

5.0 SURVEY DETAILS

This section is unchanged from the original report

5.1 Site times and Personnel

The measurements were carried out by Mark Pimlett of ADC Acoustics.

Measurements were carried out during the following times and dates

13th February 2024.

07:00 to 09:00 to represent the potential start of operating hours.

14th February 2024.

17:00 to 19:00 to represent the potential end of operating hours.

15th February 2024.

11:15 to 13:15 to represent a non -rush hour time of day.

These periods are likely to cover the quietest and/or most sensitive times of the proposed operating hours and are used to assess the impact of the industrial units on existing residential properties.

5.2 Instrumentation

Instrumentation used was a Rion NL-52. This is a Class I sound level meter which holds a current calibration certificate and which was field-calibrated as necessary with no drift noted. The meter was set up to measure 15 minute samples in terms of dB L_{eq} , dB L_{max} and dB L_{90} in overall A-weighted terms, and in octave bands across the frequency range. See Definition of Acoustic Terms in Appendix 1.

5.3 Measurement Positions

The main measurement positions were as shown on the following plan with the yellow star.



The position was chosen to represent the existing residential buildings to the northwest. The microphone was approximately 1.3 m above the ground.

5.4 Survey Conditions

Weather conditions were as follows :-

Rain	:	none, damp roads
Cloud	:	100%
Temperature	:	5 to 15 Celsius
Wind	:	less than 1 m/s, from the south to south west

The general noise climate appeared to be normal and representative.

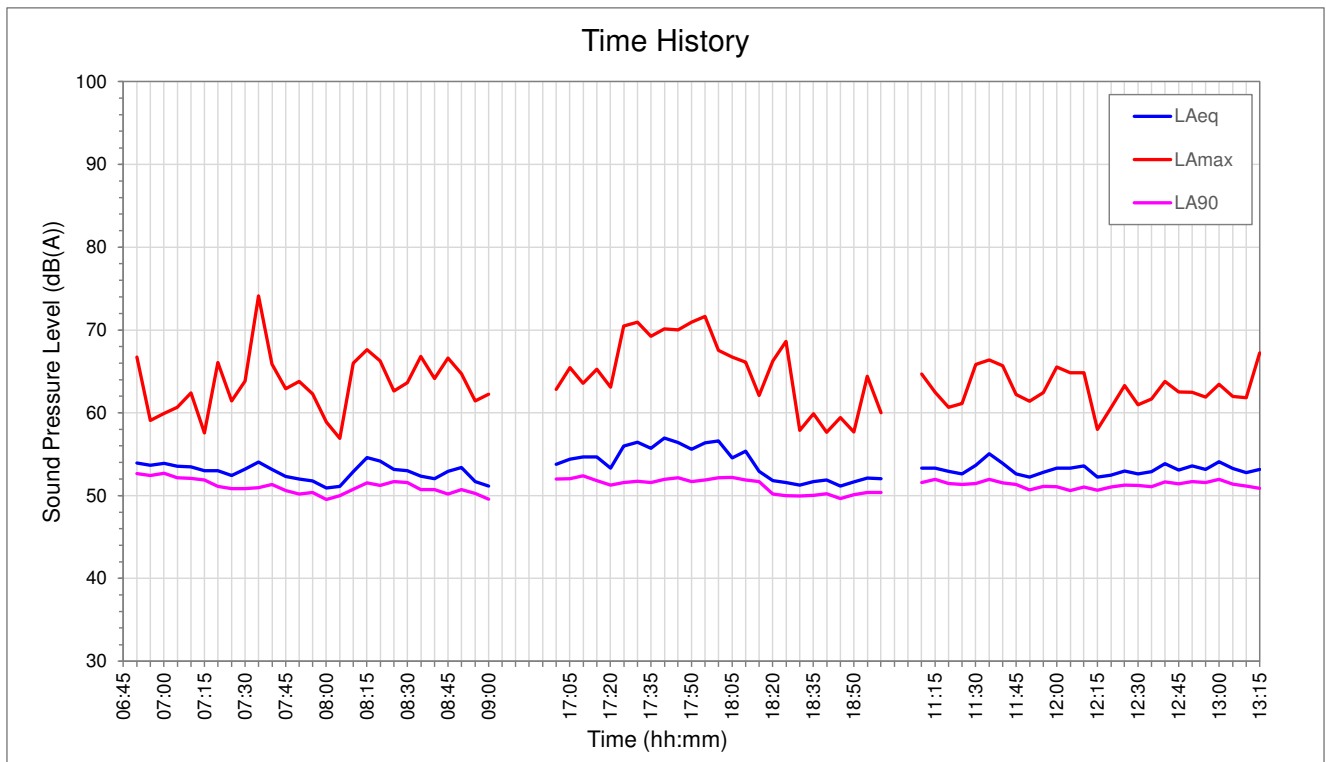
6.0 RESULTS AND DISCUSSIONS

The opening paragraphs and section 6.1 are unchanged from the original report. Section 6.2 and onwards are based on the current layout and therefore slightly modified.

The general noise climate was dominated at all times by the noise from surrounding traffic which remained constant and quite steady throughout. There was also noise from surrounding industrial units off site and some intermittent noise from building work from the nearby residential areas.

6.1 Existing Noise Levels

Full details are given in Appendix 2. In summary, the results are presented graphically, with overall figures shown below



We have used the lowest 15 minute period across all measurement periods in the assessments. BS 4142 does not require us to use the lowest periods but it is a means mitigating against potential uncertainty of varying conditions, for instance on different days of the week. The levels for these periods are as follows:-

Time Period	Index	dB(A)
Lowest 15 Minute Period	Leq	51
	Lmax	60
	L90	50

In terms of the underlying background levels these are represented by the dB(A) L₉₀ index, or the dB LA₉₀ index.

6.2 Impact of Industrial Units

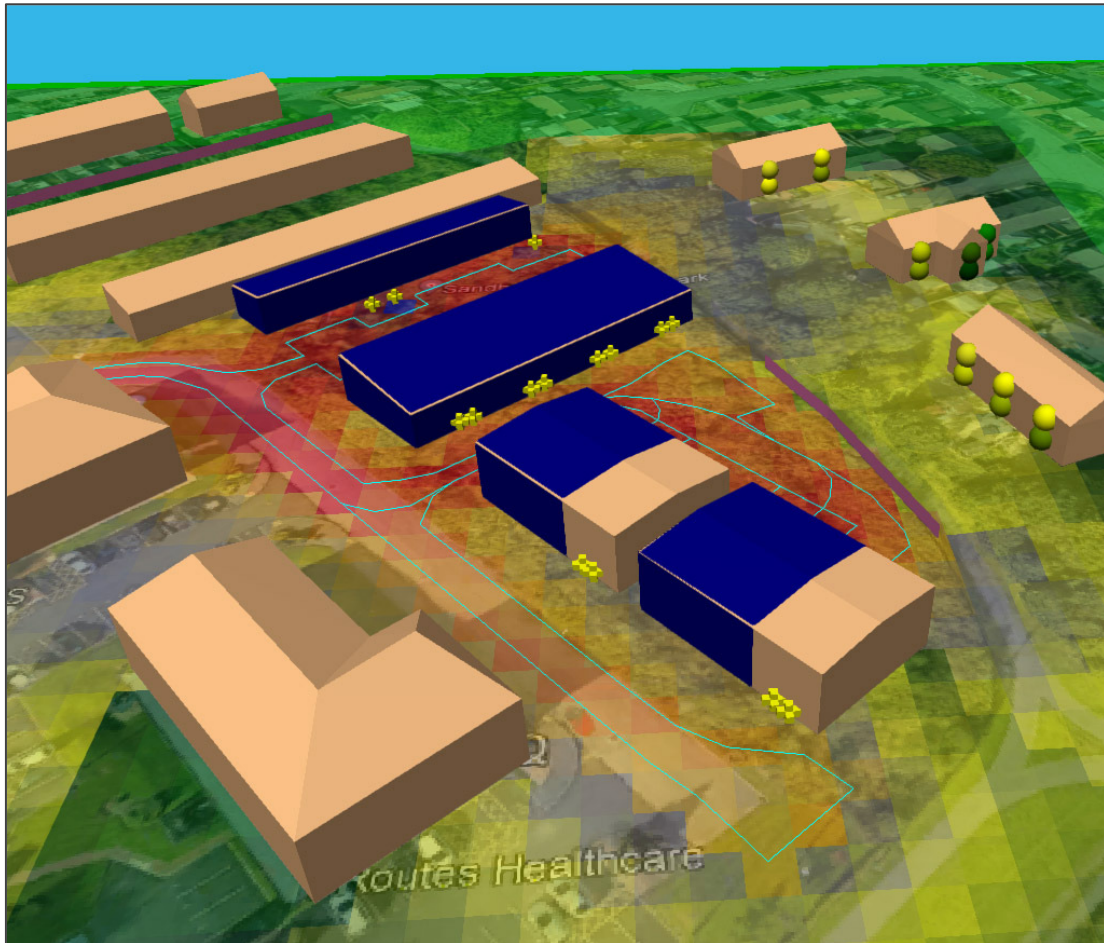
The CadnaA software was used to model the potential impact of the units as described in Section 4.



Note that:-

- The beige shapes are surrounding buildings and the application site building in its proposed form.
- Vehicle routes are the pale blue lines
- The yellow crosses are point sources (mechanical equipment, and loading/unloading activity)
- The internal noise break-out from the roofs is entered as area sources and shown as dark blue hatched area. The break-out from the walls is entered as vertical area sources. These are just thin blue lines in plan view and are easier to see in the 3D view below.
- The magenta lines are 1.8 m fences.
- The coloured numbers are the noise levels at the residential facades. Note that the software is set up to present the noisiest floor level.
- Note that the noise contours are shown for guidance as to how the noise propagates. The contours are at a height of 1.5 m.

The following 3D view should help to visualise the modelling:-



Exactly as before, the model is based on all units operating throughout the day including 8 cars and 4 vans, as well as 2 HGVs (1 large articulated HGV and 1 large rigid lorry) per hour, ie. each and every hour of the day. In effect we all assume that all vehicles follow the route all the way around the site, visiting all units.

Deliveries are assumed to take place at each unit for about 15 minutes per hour throughout the day. Or looking at it another way this could be 30 minutes to half of the units, etc. But, either way, it is for each and every hour.

The all units of are each assumed to have two external condenser units each which operate continuously.

Thes above fencing extents were chosen to match the predicted levels of the original assessment. The image below is the same model but with no boundary fencing. Note that there is presumably garden fencing but this has been ignored.



6.3 Assessments

We emphasise again that the above modelling is based on somewhat extreme assumptions of noisy internal activity, mechanical equipment, vehicle movements and deliveries, all running throughout the day. So, summarising the BS 4142 assessments at the noisiest residential locations to the northwest, we have:-

	<i>With Barrier</i>	<i>No Barrier</i>
Specific Sound Level	46 dB L _{Aeq}	48 dB L _{Aeq}
Feature Corrections ¹		
tonality	0 dB	0 dB
impulsivity	0 dB	0 dB
intermittency	0 dB	0 dB
other	0 dB	0 dB
Rating Level	46 dB L _{Ar}	48 dB L _{Ar}
Background Sound Level	48 dB L _{A90}	48 dB L _{A90}
Rating Level Excess re. Background	-4 dB	-2 dB

In both cases, these are below what BS 4142 rates as “*low impact depending on the context*”.

The context is an established commercial area on the edge of a residential area. The predicted noise is dominated by far by vehicle movements which is similar in character to the noise which already exists. We would suggest that the impact will be very low.

Although we cannot know at this stage what sort of businesses will occupy the units, the levels of activity assumed are somewhat extreme and clearly unlikely.

6.4 Mitigation

The above modelling shows a shortened section of 1.8 m high barrier along the NW boundary approximately as show in the first model image. This is not presented as a recommendation per se, but as a representation of what would be needed to match the originally predicted levels. Under any other circumstances, we would be recommending no fence, based on all the assumptions discussed throughout.

If a fence is to be used, then it should be noted that it is only relied upon to reduce the noise but around 2 dB. Theoretically, a barrier which is required to provide a 10 dB reduction only needs a density of 3 kg/m² which would be equivalent to around 6 mm thick timber. Of course such a fence would be far thicker than this for structural purposes. The important point is that there are no gaps, including allowance for shrinkage and warping. An overlapping 12 to 18 mm fence would be a typical example of a simple acoustic fence.

¹ We cannot know the exact nature of the proposed uses, but the predicted levels are dominated by the impact of vehicle movements, which are obviously unlikely to be tonal or impulsive. They will be intermittent at source but, at the receiver position, the intermittency is extremely unlikely to be “*readily distinctive against the residual acoustic environment*”, as BS 4142 describes it. Regarding other site activity, some fairly extreme worst case assumptions have been used and the predicted levels are well below background levels the noise is likely to be barely audible at the receiver positions. For these reasons no character corrections apply.

6.5 Discussion of Uncertainty

BS 4142 requires us to

“Consider the level of uncertainty in the data and associated calculations. Where the level of uncertainty could affect the conclusion, take reasonably practicable steps to reduce the level of uncertainty”.

The measurements of Background/Residual Sound were taken at times regarded as representing what are likely to be the worst case (quietest) time of the day or night. We have no reason to believe that the conditions were anything other than representative of normal conditions. BS 4142 does not state what would be a representative background noise but there is certainly no suggestion that it should be lowest and practices vary widely. However, in order to allow for the possibility of variation in levels, we have used the lowest 1 hour period for daytime, evening and night time.

Source data is likely to be highly variable but we have used what is likely to be somewhat extreme worst case assumptions. They are in any case examples only and will be subject to what kind of business occupies the units.

Calculations are based on the processes of *ISO 9613 : Acoustics – Attenuation of sound during propagation outdoors*. We know of no concerns within our industry as to the basic reliability of these methods and it is cited in BS 4142 as *“a validated method of calculating sound levels”*. The CadnaA software uses this standard and the input assumptions err on the side of caution and are stated in Section 4.

Varying meteorological conditions are unlikely to have a significant impact on results as the distances involved are small.

7.0 CONCLUSIONS/RECOMMENDATIONS

The proposed industrial units have all been modelled with assumed activity levels likely to represent a somewhat extreme worst case, including cars and HGVs, internal noise break-out and mechanical equipment. They have also been modelled with loading and unloading activity as well. Note that the modelling is an updated version of the one issued in February 2024, revised with all up-to-date changes.

The overall impact is slightly reduced, mainly due to the access road no longer (potentially) bringing vehicles along the southeast boundary. With a significantly reduced fence width, the noisiest position in terms of proposed industrial impact is 46 dB L_{Aeq} daytime which is the same as the original assessment and below the quietest 15 minute period of existing daytime background sound level of 48 dB L_{A90}. This would rate under BS 4142 as *“low impact depending on the context”*. Even with no fence at all, the predicted levels are no higher than the background levels.

The context is an established commercial area on the edge of a residential area. The predicted noise is dominated by far by vehicle

movements which is similar in context to the noise which already exists. We would suggest that the impact will be low, with or without boundary fencing.

Although we cannot know at this stage what sort of businesses will occupy the units, the levels of activity assumed are somewhat extreme and clearly unlikely.

Our only recommendation is that you submit this report to planners. We would also encourage Officers to contact us directly with any queries.

Appendix 1

Definition of Acoustic Terms

The Decibel

The decibel is the basic unit of noise measurement and is denoted dB. Technically, it is a means of expressing the difference in noise level between the measured noise and a standard level of noise. Most often the threshold of human hearing is used as the standard reference but it really should be stated. The threshold of human hearing is a sound pressure of 20 μ Pa or a sound power of 1pW.

A sound pressure level or SPL should be expressed in dB(re. 20 μ Pa). A sound power level or SWL should be expressed in dB(re. 1pW). If the reference levels are omitted, it will often (but not always) be safe to assume that they are referenced to the threshold of human hearing.

A-Weighting and dB(A)

The human hearing system responds differently to different frequencies. The A-weighting system takes account of this by emphasising mid and high frequencies more than low frequencies to give an overall level. An A-Weighted noise level, therefore, reflects the way normal, healthy hearing would perceive the overall level of the noise. The basic unit is dB(A), although other systems of expressing an A-weighted levels are discussed below.

Other weighting systems, such as C-Weighting, denoted dB(C), reflect the human hearing system's response at higher noise levels.

NR and NC Levels

NR curves and NC curves are a series of curves representing noise levels across the frequency range. A given noise climate has an NR level or NC level if it equals a point on the curve at any frequency. They are particularly, although by no means exclusively, used as a means of specifying noise limits in an indoor environment, for instance from mechanical services or traffic noise break-in from the outside. They are typically expressed as NR or NC followed by a number, e.g. NR40, NC55, etc.

Equivalent Continuous Sound Level, L_{eq}

This can be simplistically described as a way of expressing the average noise level.

The unit is dB L_{eq} . For A-weighted levels the unit is dB(A) L_{eq} or, in more modern units, dB L_{Aeq} .

Maximum Level, $L_{\max}$

This is the maximum level reached (usually for a fraction of a second) in the measurement period.

The unit is dB $L_{\max}$. For A-weighted levels the unit is dB(A) $L_{\max}$ or, in more modern units, dB $L_{A\max}$.

Statistical (Percentile) Levels, L_n

During a measurement of fluctuating noise, it is often useful to establish the levels exceeded for a percentage of the time. L_n is the index representing the level exceeded for $n\%$ of the measurement period.

The unit is dB L_n . For A-weighted levels, the unit is dB(A) L_n or, in more modern units, dB L_{An} .

Common examples are as follows :-

dB L_{A90} is the A-weighted level exceeded for 90% of the time and is often used to describe the underlying background noise.

dB L_{A50} is the A-weighted level exceeded for 50% of the time. Mathematically, it is the median, another kind of average.

dB L_{A10} is the A-weighted level exceeded for 10% of the time and has traditionally been used to describe the intermittent highs in the noise climate such as passing cars or aircraft.

Frequency Analysis

Here the audible frequency range is divided up into bands and the noise level is expressed in each frequency band from low pitches to high pitches.

Octave Band analysis is where the frequency range is divided into 8 bands from 63 Hz to 8kHz, or sometimes into 10 bands from 31.5 Hz to 16kHz.

1/3 Octave Band analysis provides more detailed subdivision into 24 bands from 50 Hz to 10kHz, or sometimes into 30 bands from 20Hz to 20kHz.

Narrow Band analysis takes this further with the possibility of many thousands of bands, possibly only 1Hz wide, or even less.

In all types of frequency analysis, the level in each band can be expressed in terms of L_{eq} , $L_{\max}$, L_n , etc. as defined above.

Sound Insulation

Sound insulation is best expressed across the frequency range in octave bands or third octave bands. Often, however, in known environments such as domestic sound insulation and speech privacy, it is simpler to express the sound insulation as a single figure. A higher value means better sound insulation.

The most common ways are dB D_{nTw} , dB R_w and dB_(mean 100-3150Hz). The first two are ways of expressing average sound insulation, weighted to account for speech frequencies. The third is simply an un-weighted mean value.

The Building Regulations Approved Document E (ADE) routinely refer to $D_{nTw} + C_{tr}$. The C_{tr} term is a negative number which is used to modify the D_{nTw} value for the insulation properties at lower frequencies.

ADE also uses the L_{nTw} index for impact sound transmission. It is a measure of the level of noise in the room below a room in which a standard tapping machine is being used. It represents the impact sound transfer such as footfall noise, scraping chairs, washing machines, etc. A lower value means better insulation.

Reverberation Time

The most common measure of Reverberation Time is, effectively the time taken for sound from a steady source to decay by 60 dB after it has been abruptly cut off. In practice it is often difficult to measure a 60 dB decay and so decays of 30 dB, 20 dB, or even 10 dB are often used and adjusted pro rata, although the exact measure is not quite the same.

Reverberation Time is generally expressed as RT in seconds. We may, if we are being precise, add subscripts 60, 30, etc to show whether the basis of the measure is 60 dB decay, 30 dB decay, etc. E.g. the $RT_{60} = 0.52s$, the $RT_{30} = 0.49s$, etc.

RT can be expressed in octave bands or 1/3 octave bands across the frequency range, or at central frequencies such as 500 Hz or 1kHz.

Appendix 2

Measurement and Calculation Details

<i>Time Period</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
06:50	Leq	54	57	51	45	51	52	41	40	34
	Lmax	67	66	57	52	55	54	57	63	62
	L90	53	54	49	44	51	51	39	24	14
06:55	Leq	54	57	52	45	51	51	41	39	30
	Lmax	59	62	61	54	55	54	48	52	46
	L90	52	55	50	43	50	50	39	23	14
07:00	Leq	54	57	52	45	51	52	41	37	29
	Lmax	60	74	61	52	55	54	54	51	44
	L90	53	54	50	43	50	51	39	22	15
07:05	Leq	54	56	51	45	51	51	41	38	29
	Lmax	61	68	61	54	55	54	56	50	45
	L90	52	54	49	43	50	50	38	21	14
07:10	Leq	53	57	51	46	51	51	41	38	32
	Lmax	62	64	57	56	56	57	58	51	50
	L90	52	55	50	43	50	50	38	21	14
07:15	Leq	53	57	51	44	51	51	39	37	29
	Lmax	58	62	56	48	53	53	44	51	46
	L90	52	55	50	43	50	50	38	20	14
07:20	Leq	53	57	52	47	50	51	41	35	28
	Lmax	66	64	63	58	58	60	62	58	50
	L90	51	54	49	43	49	49	37	20	14
07:25	Leq	52	57	51	45	50	50	39	40	34
	Lmax	61	66	56	55	54	54	54	56	51
	L90	51	55	49	43	48	49	36	22	14
07:30	Leq	53	57	51	44	49	50	39	46	41
	Lmax	64	67	59	50	53	53	50	60	59
	L90	51	55	49	42	48	49	37	23	15
07:35	Leq	54	57	51	44	50	51	41	46	42
	Lmax	74	70	64	52	61	72	65	64	60
	L90	51	55	49	43	49	49	37	23	15
07:40	Leq	53	58	52	46	50	50	39	43	40
	Lmax	66	68	65	58	59	56	50	62	61
	L90	51	55	50	43	49	49	37	25	15
07:45	Leq	52	57	52	45	50	50	38	40	36
	Lmax	63	67	58	53	61	54	51	57	55
	L90	51	55	50	43	48	49	36	26	16
07:50	Leq	52	59	52	45	49	49	40	42	35
	Lmax	64	69	62	54	55	60	57	56	52
	L90	50	55	50	43	48	48	36	27	16
07:55	Leq	52	60	52	45	48	49	40	39	34
	Lmax	62	71	65	56	51	52	50	58	56
	L90	50	57	50	43	48	48	38	31	20
08:00	Leq	51	58	51	46	49	48	38	34	26
	Lmax	59	67	57	55	57	56	46	45	43
	L90	50	55	50	42	47	47	36	24	15
08:05	Leq	51	58	51	45	49	49	38	30	29
	Lmax	57	69	61	54	52	51	47	42	52
	L90	50	55	49	43	48	48	36	23	15
08:10	Leq	53	58	51	45	50	49	39	45	41
	Lmax	66	69	61	55	59	55	50	63	59
	L90	51	55	50	43	49	49	37	24	16
08:15	Leq	55	59	53	49	51	50	42	48	44
	Lmax	68	68	61	59	54	62	61	61	59
	L90	52	56	51	44	50	49	38	23	15
08:20	Leq	54	60	54	50	50	50	41	47	43
	Lmax	66	76	67	67	57	55	50	62	61
	L90	51	55	50	43	48	49	38	24	16
08:25	Leq	53	58	52	45	50	51	40	40	36
	Lmax	63	72	65	61	54	55	48	58	55
	L90	52	55	50	43	49	50	39	23	15
08:30	Leq	53	58	52	45	50	51	40	42	36
	Lmax	64	75	60	51	53	54	57	59	55
	L90	52	55	50	43	49	50	38	22	15
08:35	Leq	52	58	52	45	49	50	43	36	29
	Lmax	67	69	60	53	54	61	64	50	48
	L90	51	55	50	43	48	49	38	25	17
08:40	Leq	52	57	52	47	50	50	40	33	29
	Lmax	64	67	63	60	60	55	58	58	50
	L90	51	55	50	43	48	49	38	24	15
08:45	Leq	53	60	52	47	49	49	40	46	42
	Lmax	67	79	61	58	53	52	59	62	62
	L90	50	55	50	43	48	48	38	25	16
08:50	Leq	53	58	52	46	49	50	41	46	42
	Lmax	65	65	58	60	56	53	51	61	60
	L90	51	55	50	43	48	49	38	26	17
08:55	Leq	52	57	53	44	49	49	40	34	30
	Lmax	61	67	60	51	52	55	55	54	54
	L90	50	55	50	42	48	48	38	25	15
09:00	Leq	51	56	51	44	48	49	40	32	30
	Lmax	62	65	57	52	54	55	58	53	47
	L90	50	54	50	42	47	47	37	22	15

Time Period	Index	dB(A)	63	125	250	500	1k	2k	4k	8k
17:00	Leq	54	58	54	46	49	51	42	43	38
	Lmax	63	69	65	55	53	55	51	59	55
	L90	52	55	51	44	48	50	41	25	15
17:05	Leq	54	59	54	47	50	52	44	44	40
	Lmax	65	75	63	55	60	56	52	61	60
	L90	52	55	51	43	48	50	41	25	15
17:10	Leq	55	59	53	46	49	52	44	46	40
	Lmax	64	71	63	55	53	56	51	60	58
	L90	52	56	51	44	48	51	42	27	16
17:15	Leq	55	60	54	47	49	51	44	47	41
	Lmax	65	76	66	61	54	58	55	61	57
	L90	52	55	51	44	48	50	42	28	16
17:20	Leq	53	57	52	46	49	51	43	42	35
	Lmax	63	65	60	55	58	55	51	59	53
	L90	51	55	50	44	48	49	40	25	15
17:25	Leq	56	61	58	53	52	52	48	43	38
	Lmax	70	75	74	69	67	63	65	58	52
	L90	52	55	51	43	48	50	41	26	16
17:30	Leq	56	62	60	55	52	52	48	44	38
	Lmax	71	75	74	69	68	66	64	58	53
	L90	52	56	51	43	48	50	41	29	19
17:35	Leq	56	62	59	55	51	52	44	46	42
	Lmax	69	75	72	67	64	61	57	64	62
	L90	52	55	51	43	47	50	41	26	16
17:40	Leq	57	57	51	45	49	52	44	53	48
	Lmax	70	72	58	56	53	63	56	67	63
	L90	52	54	49	43	48	50	41	29	18
17:45	Leq	56	59	55	50	51	52	45	50	47
	Lmax	70	74	73	65	63	60	56	66	63
	L90	52	54	49	43	48	51	41	27	17
17:50	Leq	56	60	58	54	52	52	46	39	33
	Lmax	71	76	77	72	68	65	63	56	51
	L90	52	54	49	43	48	50	40	24	15
17:55	Leq	56	61	58	54	53	53	47	44	36
	Lmax	72	74	72	71	69	65	65	60	53
	L90	52	55	50	44	48	50	40	26	18
18:00	Leq	57	60	57	54	53	54	47	40	33
	Lmax	68	74	70	67	64	62	60	55	49
	L90	52	54	50	44	48	50	41	24	15
18:05	Leq	55	58	55	50	51	52	44	36	29
	Lmax	67	73	71	68	62	61	59	54	47
	L90	52	54	50	43	48	51	41	23	14
18:10	Leq	55	60	57	53	51	53	46	38	32
	Lmax	66	75	72	67	63	60	57	54	47
	L90	52	55	50	43	48	50	40	23	14
18:15	Leq	53	57	53	46	49	51	42	30	27
	Lmax	62	68	62	61	58	58	54	52	46
	L90	52	55	50	42	48	50	40	22	14
18:20	Leq	52	56	51	44	46	50	41	34	35
	Lmax	66	71	60	55	55	57	57	59	64
	L90	50	53	49	43	45	49	40	23	16
18:25	Leq	52	55	51	45	47	50	41	37	33
	Lmax	69	65	60	59	58	58	58	65	61
	L90	50	53	49	43	45	48	39	23	16
18:30	Leq	51	55	51	45	46	49	41	31	26
	Lmax	58	65	58	59	53	53	50	46	39
	L90	50	53	49	43	45	48	40	26	20
18:35	Leq	52	55	51	45	47	50	41	27	22
	Lmax	60	68	62	61	56	57	49	39	36
	L90	50	53	49	43	45	48	39	24	18
18:40	Leq	52	56	51	44	47	50	41	26	20
	Lmax	58	65	57	55	52	55	48	40	38
	L90	50	53	49	43	46	49	39	23	15
18:45	Leq	51	55	51	44	46	49	41	28	27
	Lmax	59	61	59	60	56	53	51	47	49
	L90	50	53	48	42	44	48	39	22	14
18:50	Leq	52	55	51	45	47	50	42	29	23
	Lmax	58	63	62	56	55	53	49	43	38
	L90	50	53	49	42	45	48	40	23	15
18:55	Leq	52	56	51	44	47	50	43	35	30
	Lmax	64	64	59	53	51	58	61	55	51
	L90	50	53	49	42	45	49	40	27	22
19:00	Leq	52	56	51	45	47	50	42	31	26
	Lmax	60	65	60	56	53	57	54	47	43
	L90	50	53	49	43	45	49	40	25	19

<i>Time Period</i>	<i>Index</i>	<i>dB(A)</i>	<i>63</i>	<i>125</i>	<i>250</i>	<i>500</i>	<i>1k</i>	<i>2k</i>	<i>4k</i>	<i>8k</i>
11:10	Leq	53	59	53	48	50	51	42	42	35
	Lmax	65	71	62	60	55	54	49	62	56
	L90	52	56	51	45	48	50	40	27	16
11:15	Leq	53	59	54	49	50	51	42	38	32
	Lmax	62	71	68	61	57	54	49	53	59
	L90	52	56	52	46	49	50	41	28	19
11:20	Leq	53	58	53	47	49	51	43	37	28
	Lmax	61	72	61	57	53	54	55	52	44
	L90	51	56	51	45	48	49	40	27	17
11:25	Leq	53	59	53	47	49	51	42	31	23
	Lmax	61	75	64	57	55	58	53	50	44
	L90	51	55	51	45	48	49	40	26	16
11:30	Leq	54	58	53	47	49	51	42	45	38
	Lmax	66	79	65	55	60	55	52	62	57
	L90	51	55	51	45	48	50	40	27	17
11:35	Leq	55	59	53	48	50	51	42	49	43
	Lmax	66	70	62	58	55	55	50	64	60
	L90	52	56	51	45	48	50	41	28	18
11:40	Leq	54	60	54	49	50	51	43	44	38
	Lmax	66	76	66	62	59	55	56	61	57
	L90	52	57	51	45	48	50	41	27	17
11:45	Leq	53	60	54	48	49	50	42	30	25
	Lmax	62	77	68	65	55	57	54	42	43
	L90	51	56	51	45	48	49	40	27	16
11:50	Leq	52	60	53	49	48	50	41	33	25
	Lmax	61	72	61	63	53	54	50	57	47
	L90	51	56	51	46	47	49	40	26	16
11:55	Leq	53	59	54	48	48	50	41	40	34
	Lmax	62	75	65	58	52	55	52	57	55
	L90	51	56	51	45	47	49	40	26	17
12:00	Leq	53	58	52	47	48	50	41	45	38
	Lmax	66	65	62	55	55	60	51	62	57
	L90	51	55	51	45	47	49	40	26	17
12:05	Leq	53	57	52	46	48	50	42	45	40
	Lmax	65	70	58	58	53	54	51	62	58
	L90	51	55	50	44	47	49	40	26	16
12:10	Leq	54	57	52	46	48	50	42	46	41
	Lmax	65	66	64	55	53	55	52	62	57
	L90	51	55	50	44	47	49	40	28	18
12:15	Leq	52	58	52	46	48	50	41	30	22
	Lmax	58	71	60	55	53	55	49	44	44
	L90	51	55	50	44	47	49	40	26	16
12:20	Leq	52	58	52	46	48	50	43	34	24
	Lmax	61	70	60	55	52	54	57	50	39
	L90	51	55	50	44	47	49	40	27	17
12:25	Leq	53	58	53	48	50	51	42	32	22
	Lmax	63	68	59	58	64	56	55	47	37
	L90	51	56	51	45	47	49	41	28	17
12:30	Leq	53	58	53	47	49	50	42	36	27
	Lmax	61	68	60	54	53	56	55	53	43
	L90	51	56	51	45	47	49	40	28	17
12:35	Leq	53	58	53	46	48	50	42	42	33
	Lmax	62	71	60	53	52	54	51	58	51
	L90	51	56	51	45	47	49	40	29	18
12:40	Leq	54	59	53	48	49	51	45	44	38
	Lmax	64	75	60	56	55	55	56	58	57
	L90	52	56	51	46	48	50	41	30	19
12:45	Leq	53	59	53	47	49	51	42	41	34
	Lmax	63	73	61	54	53	55	55	58	52
	L90	51	56	51	45	48	49	41	28	17
12:50	Leq	54	59	54	50	50	51	42	41	34
	Lmax	62	75	71	62	59	55	47	55	51
	L90	52	56	50	45	47	50	41	28	17
12:55	Leq	53	59	54	49	49	51	42	35	34
	Lmax	62	68	59	59	53	55	56	54	53
	L90	52	56	52	46	48	50	41	28	17
13:00	Leq	54	59	54	50	49	51	43	44	41
	Lmax	63	76	67	62	55	54	53	58	56
	L90	52	56	51	46	48	50	41	29	19
13:05	Leq	53	58	53	48	49	51	42	42	39
	Lmax	62	66	58	57	53	56	51	57	56
	L90	51	56	51	46	47	49	40	27	17
13:10	Leq	53	60	53	47	48	50	42	40	34
	Lmax	62	71	66	59	54	54	50	57	54
	L90	51	56	51	45	47	49	40	27	16
13:15	Leq	53	59	55	54	49	50	41	32	30
	Lmax	67	67	66	71	60	58	60	58	57
	L90	51	56	51	45	47	49	39	26	16

Time Period	Index	dB(A)	63	125	250	500	1k	2k	4k	8k
Lowest 15 Minute Period	Leq	51	59	51	45	49	49	39	36	31
	Lmax	60	70	62	55	54	53	48	54	53
	L90	50	56	50	43	47	48	37	28	17

Source Data

Continuous Source Inputs

Description	Index	dB(A)	63	125	250	500	1k	2k	4k	8k
Car Drive Past	Leq	53	70	53	53	50	46	43	39	34
25m/12s long - pull away, pass at 10m, and stop	Lmax	57	73	60	59	53	50	47	44	38
LGV (eg. Van) Drive Past	Leq	58	75	58	58	55	51	48	44	39
25m/12s long - pull away, pass at 10m, and stop	Lmax	62	78	65	64	58	55	52	49	43
OGV1 (eg. Rigid Lorry) Drive Past	Leq	63	80	63	63	60	56	53	49	44
25m/12s long - pull away, pass at 10m, and stop	Lmax	67	83	70	69	63	60	57	54	48
OGV2 (eg. Articulated HGV) Drive Past	Leq	65	82	65	65	62	58	55	51	46
25m/12s long - pull away, pass at 10m, and stop	Lmax	69	85	72	71	65	62	59	56	50
Mitsubishi PUHZ-ZRP71VHA source sound power	Leq	58	62	63	61	55	52	47	41	37
Loading/Unloading Activity sound power	Leq	85	87	80	74	78	83	75	66	58
Light Industrial over internal surface	Leq	80	54	61	65	65	67	73	76	75

Vehicle Corrections

Length of Vehicle Source Segment 25 m
 Duration of Vehicle Segment 12 s
 Correction for the Duration of a Segment -25 dB

Description	Day	Eve	Night
Number of Cars per hour	8	0	0
Correction for number of Cars (dB)	9	n/a	n/a
Overall Correction for Cars (dB)	-16	n/a	n/a
Number of LGVs per hour	4	0	0
Correction for number of LGVs (dB)	6	n/a	n/a
Overall Correction for LGVs (dB)	-19	n/a	n/a
Overall Correction for Cars and LGVs (dB)	-12	n/a	n/a
Number of OGV1s per hour	1	0	0
Correction for number of OGV1s (dB)	0	n/a	n/a
Overall Correction for OGV1s (dB)	-25	n/a	n/a
Number of OGV2s per hour	1	0	0
Correction for number of OGV2s (dB)	0	n/a	n/a
Overall Correction for OGV2s (dB)	-25	n/a	n/a
Overall Correction for All OGVs (dB)	-21	n/a	n/a