

# Acoustic assessment of a proposed residential development at Unit 4, Hawthorn Road, Littlehampton

**Report Reference: 180801-R001B**

**Date: September 2018**

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**Client:** Envision Contracting Limited

**Report Reference:** 180801-R001B

| <b>Revision:</b> | <b>Revision Date:</b> | <b>Author:</b>             |
|------------------|-----------------------|----------------------------|
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## 0. SUMMARY

- ACA Acoustics Limited have been commissioned to assess external noise intrusion to a proposed new residential development at Unit 4, Hawthorn Road, Littlehampton. The assessment is required to support an application for prior approval.
- A sound level survey has been carried out between 9<sup>th</sup> – 16<sup>th</sup> August 2018.
- The existing property is to offices. A prior approval application is to be submitted to Arun District Council for the change of use to residential properties. Existing ambient sound levels incident on the southern façade of the development are comprised primarily of traffic on the A259. To the East of the property loading and compactor noise is audible at periods during the day. To the north of the site levels from commercial units are inaudible, and to the east of the site levels from occasional use of the Morrisons loading bay is audible at times during the week.
- An assessment of noise from commercial and industrial noise to relevant facades of the development has been undertaken in accordance with procedures set out in BS 4142:2014.
- The initial BS 4142:2014 assessment result indicates that without suitable mitigation measures, noise from commercial equipment is likely to have a significant adverse impact to future residents of the development. In accordance with guidance in the Standard, the context of the assessment must be considered, including potential benefit of façade sound insulation.
- An outline scheme for sound insulation of the building envelope has been developed such that internal sound levels during the daytime to the south and northern facades of the property do not exceed LAeq 35dB within living rooms and bedrooms, and do not exceed LAeq 26 dB to the East, and LAeq 22dB to the western façade. During the night time levels should not exceed LAeq 30dB and LAFmax 45dB within bedrooms.
- Levels to the Eastern and Western facade apartments are lower than the corresponding recommended guideline limits set out in BS 8233:2014 to account for sound emissions from commercial and industrial sources as being potentially more disturbing than sound from anonymous sources such as traffic. Details of the sound insulation scheme are provided within this report.
- It is the author's opinion that, provided the installed sound insulation scheme complies with the recommended specification set out in this report, internal sound levels within the new residential units should not be detrimental to the amenity of future occupants and no further noise mitigation measures shall be necessary. The site is therefore considered suitable for residential development.
- This update to the report includes minor amendments as requested by the client.

## 1. INTRODUCTION

ACA Acoustics Limited has been commissioned to carry out a survey and assessment of external sound levels at the site of a proposed residential development at Unit 4, Hawthorn Road, Littlehampton.

The objective of the assessment is to determine the impact that existing noise sources would have on the proposed new development in accordance with national planning policies and other relevant British Standards and guidance documents. This report presents results of the sound level survey and assessment.

## 2. ACOUSTIC CRITERIA

The proposed noise measurement and assessment methodology is based on ACA Acoustics' experience of undertaking noise assessments for similar developments.

A review of the relevant parts of each of the routinely used planning guidance documents and British Standards is provided below.

### 2.1 National Planning Policy Framework (NPPF) and Noise Policy Statement for England (NPSE)

The National Planning Policy Framework (referred to as NPPF) was published by the Department for Communities and Local Government in July 2018.

The NPPF sets out the Governments' planning policies for England and provides guidance on how these are expected to be applied, providing a framework within which Local Authorities can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.

Paragraph 170 of the NPPF states that;

*"planning policies and decisions should contribute to and enhance the natural and local environment by ... preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability".*

It also talks specifically about noise and states that *"Planning policies and decisions should aim to:*

- *Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;*
- *Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions;*
- *Recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and*
- *Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational amenity value for this reason."*

Paragraph 180 also talks specifically about noise and states that;

*"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:*

- *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 quality of life.*
- *Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.”*

In March 2010, the Department for Environment, Food and Rural Affairs (Defra) issued Noise Policy Statement for England (referred to as NPSE). This sets out the Government’s long-term policy aims that are intended to be considered by Local Planning Authorities when developing their own Local Policies relating to noise. Stated aims of NPSE are;

*“Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy of sustainable development:*

- *Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life; and*
- *Where possible, contribute to the improvement of health and quality of life.”*

Paragraphs 2.19 to 2.24 clarify the above aims, referring to established concepts from toxicology; NOEL (No Observed Effect Level) and LOAEL (Lowest Observed Adverse Effect Level). It also introduces a new concept relating to “significant adverse” of SOAEL (Significant Observed Adverse Effect Level), however stating that;

*“it is not possible to have a single objective noise-based measure that describes SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times”.*

The second aim of the NPSE refers to the situation where the impact lies somewhere between LOAEL and SOAEL. It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also considering the guiding principles of sustainable development, as set out in the NPPF. As neither the NPPF or NPSE includes any numerical criteria, it is necessary to consider guidance provided in other documents to determine suitable limits that would define the LOAEL on an individual basis.

## 2.2 Planning Practise Guidance – Noise (PPG-N)

Related to the NPPF and NPSE, The Department for Communities and Local Government has published additional guidance and clarifications within the Planning Practice Guidance – Noise (PPG-N), available at <http://planningguidance.planningportal.gov.uk/blog/guidance/noise/noise-guidance/>.

Paragraph 003 of the PPG advises that ‘*Local planning authorities’ plan-making and decision taking should take account of the acoustic environment and in doing so consider:*

- *Whether or not a significant adverse effect is occurring or likely to occur;*
- *Whether or not an adverse effect is occurring or likely to occur; and*
- *Whether or not a good standard of amenity can be achieved.*

*In line with the Explanatory Note of the Noise Policy Statement for England, this would include identifying whether the overall effect of the noise exposure ... is, or would be, above or below the significant observed adverse effect level and the lowest observed adverse effect level for the given situation.’*

This guidance is very similar to that set out in the NPPF and NPSE, however, Paragraph 005 of the PPG-N provides outline guidance on the definition of ‘*significant adverse effect*’ and ‘*adverse effect*’. Copy of the table provided within Paragraph 005 is provided on the following page.

| Perception                   | Examples of Outcomes                                                                                                                                                                                                                                                                                                                                                                                       | Increasing Effect Level    | Action                           |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------------------------------|
| Not noticeable               | No effect                                                                                                                                                                                                                                                                                                                                                                                                  | No Observed Effect         | No specific measures required    |
| Noticeable and not intrusive | Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life                                                                                                                                                                                                    | No Observed Adverse Effect | No specific measures required    |
|                              | Lowest Observed Adverse Effect Level                                                                                                                                                                                                                                                                                                                                                                       |                            |                                  |
| Noticeable and intrusive     | Noise can be heard and causes small changes in behaviour and/or attitude, 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 perceived change in the quality of life | Observed Adverse Effect    | Mitigate and reduce to a minimum |
|                              | Significant Observed Adverse Effect Level                                                                                                                                                                                                                                                                                                                                                                  |                            |                                  |

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                     |         |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|---------|
| Noticeable and disruptive      | The noise causes a material change in behaviour and/or attitude, 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 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   |
| Noticeable and very disruptive | Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory                                                                                                                                                                           | Unacceptable Adverse Effect         | Prevent |

Table 1: Likely average response to noise exposure

Although this provides description of definitions for the LOAEL and SOAEL, as with the NPPF and NPSE there are no numerical values provided.

### 2.3 British Standard 8233:2014

The introduction to BS 8233:2014 *Guidance on sound insulation and noise reduction for buildings* advises that *'this guide suggests criteria, such as suitable sleeping/resting conditions, and proposes noise levels that normally satisfy these criteria'*.

Guidance limits for internal sound levels within living rooms, dining rooms and bedrooms are shown in Table 4 of BS 8233:2014. However, accompanying text in Section 7.7.1 advises that *'this subclause applies to external noise ... without a specific character... noise has a specific character if it contains features such as a distinguishable discrete and continuous tone, is irregular enough to attract attention, or has strong low-frequency content, in which case lower noise limits might be appropriate'*.

In this instance the to the eastern façade, impulsive noise from goods loading can be heard within the morrisons loading bay, and so a penalty of -9dB is proposed to the BS 8233:2014 criteria. To the western façade, impulsive and tonal noise from goods loading and the compactor can be heard, and so a penalty of -13dB is proposed to the BS 8233:2014 criteria. Although these are more onerous than the guidance of the acoustic feature corrections as set out in BS 4142:2014 (discussed below) it is considered that this will ensure the amenity of new residential occupants is not impacted.

This ensures that noise from the industrial and commercial sources to inside the proposed new dwellings will be low and should not be detrimental to the amenity of potential future occupants. Recommended suitable criteria are shown in Table 2 below. Compliance with these values would ensure sound levels within the new development are below the Lowest Observed Adverse Effect Level, as defined in the Planning Practice Guidance - Noise, and therefore comply with current national planning guidance.

| Location        | Activity                  | Location         | 07:00 – 23:00   | 23:00 – 07:00  |
|-----------------|---------------------------|------------------|-----------------|----------------|
| Western Facade  | <b>Resting</b>            | Living Room      | 22dB LAeq, 16hr | -              |
|                 | <b>Dining</b>             | Dining Room/Area | 22dB LAeq, 16hr | -              |
|                 | <b>Sleeping (daytime)</b> | Bedroom          | 22dB LAeq, 16hr | 30dB LAeq, 8hr |
| Northern Facade | <b>Resting</b>            | Living Room      | 22dB LAeq, 16hr | -              |
|                 | <b>Dining</b>             | Dining Room/Area | 22dB LAeq, 16hr | -              |
|                 | <b>Sleeping (daytime)</b> | Bedroom          | 22dB LAeq, 16hr | 30dB LAeq, 8hr |
| Eastern Facade  | <b>Resting</b>            | Living Room      | 26dB LAeq, 16hr | -              |
|                 | <b>Dining</b>             | Dining Room/Area | 26dB LAeq, 16hr | -              |
|                 | <b>Sleeping (daytime)</b> | Bedroom          | 26dB LAeq, 16hr | 30dB LAeq, 8hr |
| Southern Facade | <b>Resting</b>            | Living Room      | 22dB LAeq, 16hr | -              |
|                 | <b>Dining</b>             | Dining Room/Area | 22dB LAeq, 16hr | -              |
|                 | <b>Sleeping (daytime)</b> | Bedroom          | 22dB LAeq, 16hr | 30dB LAeq, 8hr |

Table 2: BS 8233:2014 indoor ambient sound levels for dwellings, corrected to account for adverse acoustic characteristics

## 2.4 World Health Organisation (WHO)

The World Health Organisation's guidance "*Community Noise 1999*" recommends a limit of Leq 30dBA for bedrooms at night as preventing sleep disturbance to vulnerable people. The WHO guidance also states that "*for a good sleep, it is believed that indoor sound pressure levels should not exceed 45dB LAFmax more than 10-15 times per night*".

The levels advised in The World Health Organisation's guidance correlate very well with those in BS 8233 described above.

## 2.5 British Standard 4142:2014

The scope of BS 4142:2014 advises that *“this British Standard describes methods for rating and assessing sound of an industrial and/or commercial nature ... 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”*. BS 4142:2014 is considered appropriate for this application, to consider the acoustic impacts where any industrial or commercial noise sources significantly contribute to the acoustic climate in the area.

The assessment method of BS 4142:2014 corrects the specific sound level from the source under investigation to account for characteristics that could make the sound more obtrusive to obtain a rating level. This rating level is compared against the prevailing background noise outside the noise-sensitive property. Section 11 of BS 4142:2014 provides a commentary of the assessment result and advises that:

- a) *The greater the difference between the rating level and the background sound level, the greater the magnitude of the impact;*
- b) *A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context;*
- c) *A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context;*
- d) *The lower the rating level is 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.*

It is important to note however, that this initial assessment conclusion is dependent on the context of the assessment, which may materially alter the assessment result.

### 3. REVIEW OF SITE LOCATION & DEVELOPMENT PROPOSALS

The application for prior approval includes the change of use of ground floor units of Unit 4, Hawthorn Road, Littlehampton, to residential properties. Existing units are to offices.

The front of the property faces onto the A259, with rear windows overlooking the courtyard behind the property, and overlooking the rear wall of industrial units. Levels to both the front and rear are dominated by traffic noise, with activity such as forklifts operating and goods being loaded within industrial units to the north of the property subjectively not audible while the author was on site, and following confirmation that this commercial activity was ongoing.

To the Western façade activity from goods loading and the compactor in operation was audible, at the façade of the development site, and to the eastern façade, levels from the loading of a morrisons lorry were witnessed.

Levels from this commercial activity are understood to occur only between the hours of 8am – 9pm, and as such do not affect measured night time levels.

A layout drawing showing the proposed location of the new development has been provided by the client and is shown below in Figure 1.

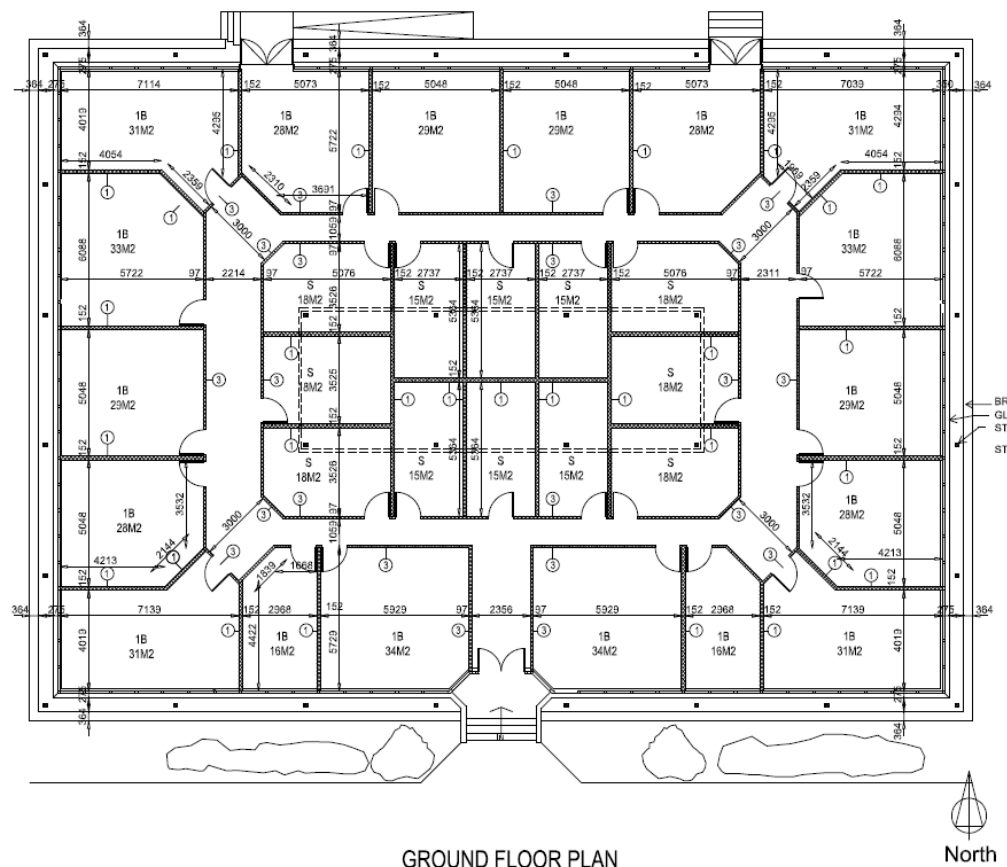


Figure 1: Proposed development

#### 4. SOUND LEVEL SURVEY

To assess the impact of existing noise sources, a sound level survey was conducted at the development site to determine levels incident on the proposed residential units.

The site was considered secure and therefore an unmanned survey was carried out between 09<sup>th</sup> August – 16<sup>th</sup> August 2018. Levels were measured to the front of the property, along with spot measurements taken around the site. The weather included dry and calm periods during the survey.

Manned measurements were also undertaken of the loading and compactor in use to the west of the site, along with loading of a morrisons lorry to the east of the site, and use of the commercial units with forklifts in activity to the north of the unit.

Sound level measurements were recorded in consecutive 15-minute samples of overall LAFmax, LAeq and LA90 values along with other statistical indices.

The following equipment was used during the survey; the sound level meter was calibrated before the survey and checked after with no change noted.

| Equipment                                                                                                              | Serial Number | Calibration Certificate |
|------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------|
| Rion sound level meter type NL31 Class 1 complete with weatherproof and lockable outdoor environmental kit             | 00431030      | 1512668                 |
| NTi Audio sound level meter type XL2 Class 1 complete with weatherproof and lockable outdoor environmental kit         | A2A-06294-E0  | 160915                  |
| NTi Audio calibrator type CAL200 94/114dB. Compliant to IEC 60942-1:2003 (Calibrated to a reference traceable to NIST) | 11441         | 42940-11441-CAL200      |

Table 3: Equipment used

Summary of the daytime and night time sound level survey results are shown in tabular form in Table 4 below and graphical form in Figures 2 and 3 on the following page.

| Description                                                                                             | Daytime<br>(07:00 – 23:00)<br>LAeq | Night Time<br>(23:00 – 07:00)<br>LAeq | Night Time<br>(23:00 – 07:00)<br>Typical LAFmax |
|---------------------------------------------------------------------------------------------------------|------------------------------------|---------------------------------------|-------------------------------------------------|
| Overlooking the front of the development between 09 <sup>th</sup> August – 16 <sup>th</sup> August 2018 | 57dB                               | 52dB                                  | 71dB                                            |

Table 4: Summary sound level survey results

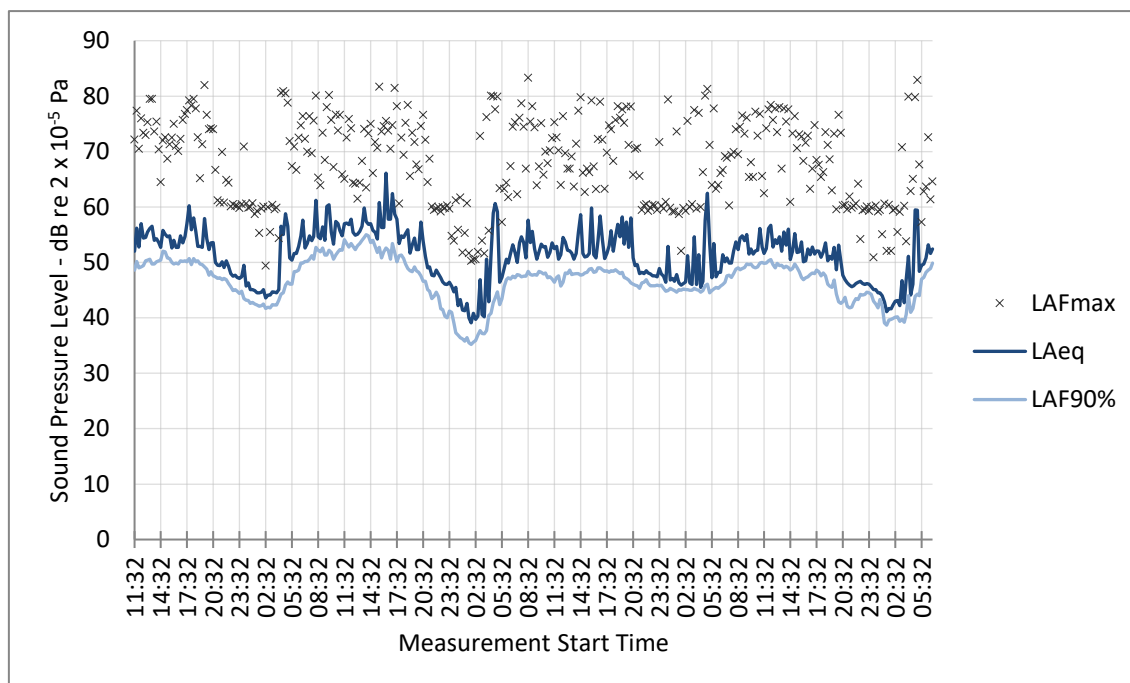


Figure 2: Sound level survey results to the front façade

## 5. ASSESSMENT OF INDUSTRIAL AND COMMERCIAL NOISE

Measured sound levels to the eastern and western facades of the development include contribution of noise from industrial sources. Results of the manned sound level survey have been used to assess this commercial noise source in accordance with BS 4142:2014.

Assessment of the measured sound level of commercial noise to the western façade of the proposed development is provided in Table 5 below and to the eastern façade in Table 6.

| Description                                        | Assessment of Western Facade                          | Relevant Clause | Commentary                                                                                                                                                                                                            |
|----------------------------------------------------|-------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ambient sound level at the western façade          | LAeq 72dB                                             | 7.3.2           | Measured level with loading and compactor in operation at 1m from the façade of the proposed development                                                                                                              |
| Existing residual level                            | LAeq 54dB                                             | 7.3.3           | The residual sound level was measured with the industrial sources not operating                                                                                                                                       |
| On time correction                                 | $10 \times \log\left(\frac{90}{3600}\right)$<br>= -13 |                 | The loading and compactor occurs for around 3 minutes at a time, occurring not more than once in an hour.                                                                                                             |
| Specific level                                     | LAeq 59dB                                             |                 | Logarithmic subtraction of residual level from ambient level                                                                                                                                                          |
| Background sound level                             | LA90 48dB                                             | 8.1             | Background sound level measured around 02:30 when equipment switches off.                                                                                                                                             |
| Acoustic feature correction                        | +13dB                                                 | 9.2             | The source levels were witnessed as being tonal and impulsive. Therefore, in accordance with Section 9.2, a +9 dB correction is applied for impulsive characteristics, and +3dB is applied for tonal characteristics. |
| Rating level                                       | LAr 72dB                                              | 9.2             |                                                                                                                                                                                                                       |
| Excess of rating level over background sound level | <b>24dB</b>                                           | <b>11</b>       | <b>Assessment indicates likelihood of significant adverse impact</b>                                                                                                                                                  |

Table 5: BS 4142:2014 Assessment of Western Facade

| Description                                        | Assessment of Eastern Facade                        | Relevant Clause | Commentary                                                                                                                                                   |
|----------------------------------------------------|-----------------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ambient sound level at the Eastern façade          | LAeq 59dB                                           | 7.3.2           | Measured level with loading in operation at 1m from the façade of the proposed development                                                                   |
| Existing residual level                            | LAeq 56dB                                           | 7.3.3           | The residual sound level was measured with the industrial sources not operating                                                                              |
| On time correction                                 | $10 \times \log\left(\frac{3600}{3600}\right) = -0$ |                 | The loading occurs for around a full hour.                                                                                                                   |
| Specific level                                     | LAeq 57dB                                           |                 | Logarithmic subtraction of residual level from ambient level                                                                                                 |
| Background sound level                             | LA90 51dB                                           | 8.1             | Background sound level measured when loading not in operation.                                                                                               |
| Acoustic feature correction                        | +9dB                                                | 9.2             | The source levels were witnessed as being impulsive. Therefore, in accordance with Section 9.2, a +9 dB correction is applied for impulsive characteristics. |
| Rating level                                       | LAr 66dB                                            | 9.2             |                                                                                                                                                              |
| Excess of rating level over background sound level | <b>15dB</b>                                         | <b>11</b>       | <b>Assessment indicates likelihood of significant adverse impact</b>                                                                                         |

Table 6: BS 4142:2014 Assessment of Eastern Facade

BS 4142:2014 requires an assessment to consider the context of a development, rather than simply adhere to numerical figures. The context of the assessment is the development of new residential properties to an area of existing commercial units. The likelihood of adverse impact is reduced in this context, compared to the reverse situation of bringing a new noise-generating use to an existing residential dwelling. However, 24dB and 15dB is a significant excess of rating level over

background level and indicates that without further mitigation measures there is potential for adverse impact.

Section 11 of BS 4142:2014 discusses potential aspects which may alter the initial assessment result and advises that:

*“where the initial estimate of the impact needs to be modified due to the context, take all pertinent factors into consideration, including the following ... the sensitivity of the receptor and whether dwellings ... will incorporate design measures that secure good internal and/or outdoor acoustic conditions, such as:*

- i) Façade insulation treatment;*
- ii) Ventilation and/or cooling that will reduce the need to have windows open so as to provide rapid or purge ventilation”.*

This confirms that designing the sound insulation performance of façade elements to achieve appropriate internal sound levels mitigates the adverse impact, particularly where the scheme includes mechanical ventilation such that residents can achieve both background and rapid ventilation rates without needing to open windows.

To control potential for disturbance, ACA Acoustics propose that the guideline internal sound level criteria of BS 8233:2014 is corrected by the value of the acoustic feature correction shown in Table 5 and 6 above. This should adequately protect the amenity of future residents and alters the context of the BS 4142:2014 assessment such that there would be a low likelihood of adverse impact.

## 6. ASSESSMENT OF FAÇADE SOUND INSULATION

A scheme for sound insulation is necessary to ensure sound levels inside rooms of the new residential apartments are reasonable and comply with the requirements of BS 8233:2014 and World Health Organisation guidelines.

A computer model has been set up using the measured sound levels incident on the façade of the houses along with expected performance of the façade elements. The computer model is based on the calculation procedures outlined in BS EN ISO 12354-3:2000 and BS 8233:2014.

Finalised drawings showing precise room layouts within the apartments were not available, and so a nominal dimension of 3mx5m has been used for the livingrooms, and 2.5m x 5 meters has been used for the bedrooms.

Confirmation of the acoustic performance of the building envelope elements used in the calculation model is provided below. *Consideration of non-acoustic aspects including, but not limited to, Building Regulations Approved Documents and structural calculations are outside the scope of ACA Acoustics Limited and should be considered by others accordingly.*

| Description  | R <sub>w</sub><br>(dB) | R <sub>w</sub> +<br>C' <sub>tr</sub><br>(dB) | Typical Construction                                                                                        |
|--------------|------------------------|----------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Façade Walls | 52                     | 48                                           | Brick – Cavity – Block construction with 75mm cavity.                                                       |
| Windows      | 42                     | 39                                           | High performance acoustic double-glazing with a-symmetric panes such as Schuco's 10-12-8 AWS 65 or similar. |
| Roof         | 53                     | 44                                           | Corrugated steel on z purlin, resilient bar beneath, 100mm insulation in cavity, 2 layers 15mm Soundbloc    |
| Ventilators  | -                      | -                                            | Mechanical ventilation such as MVHR or similar.                                                             |

*Table 7: Acoustic performance specification for facade elements*

Note that the constructions provided are typical and slight variations on the specification would be acceptable, so long as the installed construction achieved the specified sound insulation performance. The specification provided for glazed elements is for the window/door as a complete unit, including frames and seals, and it is recommended the successful glazing supplier confirm their unit supplied will comply with the specified performance.

Copy of acoustic calculations for noise intrusion into sample rooms is provided in Appendix A. Summary results are confirmed in Table 8 on the following page and demonstrate that intrusive

sound levels within rooms of the proposed residential units will comply with criteria proposed in Section 2 of this report.

| Plot / Room                           | Description       | Calculated Internal Sound Level | Criteria |
|---------------------------------------|-------------------|---------------------------------|----------|
| Typical Livingroom to Western Facade  | Daytime LAeq      | 22dB                            | ≤ 22dB   |
|                                       | Night Time LAeq   | -                               | -        |
|                                       | Night Time LAFmax | -                               | -        |
| Typical Bedroom to Western Facade     | Night Time LAeq   | 17dB                            | ≤ 30dB   |
|                                       | Night Time LAFmax | 34dB                            | ≤ 45dB   |
| Typical Livingroom to Northern Facade | Daytime LAeq      | 17dB                            | ≤ 22dB   |
|                                       | Night Time LAeq   | -                               | -        |
|                                       | Night Time LAFmax | -                               | -        |
| Typical Bedroom to Northern Facade    | Night Time LAeq   | 17dB                            | ≤ 30dB   |
|                                       | Night Time LAFmax | 34dB                            | ≤ 45dB   |
| Typical Livingroom to Eastern Facade  | Daytime LAeq      | 20dB                            | ≤ 26dB   |
|                                       | Night Time LAeq   | -                               | -        |
|                                       | Night Time LAFmax | -                               | -        |
| Typical Bedroom to Western Facade     | Night Time LAeq   | 17dB                            | ≤ 30dB   |
|                                       | Night Time LAFmax | 34dB                            | ≤ 45dB   |
| Typical Livingroom to Southern Facade | Daytime LAeq      | 20dB                            | ≤ 35dB   |
|                                       | Night Time LAeq   | -                               | -        |
|                                       | Night Time LAFmax | -                               | -        |
| Typical Bedroom to Western Facade     | Night Time LAeq   | 17dB                            | ≤ 30dB   |
|                                       | Night Time LAFmax | 34dB                            | ≤ 45dB   |

Table 8: Summary internal sound levels within sample habitable rooms

To ensure noise from external sources is not detrimental to the amenity of future occupants, it will be necessary to incorporate an acoustic ventilation scheme into the design such that residents can achieve adequate ventilation without necessarily needing to open windows. Suitable systems must also incorporate summer bypass mode to minimise the potential for overheating during warmer periods.

It is recommended that a mechanical ventilation system such as MVHR or equivalent is provided to habitable rooms of the proposed development. Suppliers including Titan or Envirovent would be able to offer suitable ventilation systems for residential purposes. It is important that any self-noise (i.e. noise from the fans) and external noise intrusion through the ducted system must not cause internal sound levels to exceed the design requirements.

## 7. CONCLUSION

An application is to be submitted to the Local Planning Authority for the conversion of new residential dwellings to Unit 4, Hawthorn Road, Littlehampton.

ACA Acoustics have undertaken background sound level surveys in the vicinity along with subjective listening and clarification of the acoustic environment. Noise from nearby mechanical services equipment was audible, and therefore an assessment has been carried out in accordance with BS 4142:2014. The initial assessment result indicates potential for adverse impact, however a high-performance scheme for façade sound insulation is proposed, such that suitable internal sound levels are achieved and there is therefore a low likelihood of adverse impact to future residents.

As such, no further acoustics assessment is required to comply with the requirements outlined in section 2 of this report, and the author considers that the site is suitable for residential development.

## APPENDIX A

### Acoustic Calculations



## Unit 4 Hawthorn Road

### Reference

Typical Western Livingroom Daytime LAeq

### Description

### Target Sound Level

-

### Max Sound Level

22dB(A)

### Calculated Sound Level

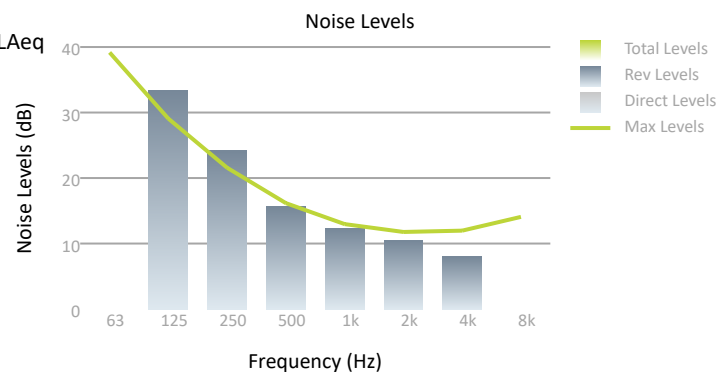
22dB(A)

### Calculated Tmf T60 (s)

0.48

### Volume (m<sup>3</sup>)

39



### Calculated Internal Sound Levels

| Reference | Quantity | Noise Levels (dB) |     |     |     |    |    |    |    |
|-----------|----------|-------------------|-----|-----|-----|----|----|----|----|
|           |          | 63                | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Leq,ff    | 1        | -                 | 33  | 24  | 16  | 12 | 10 | 8  | -  |

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## Calculation Sheet

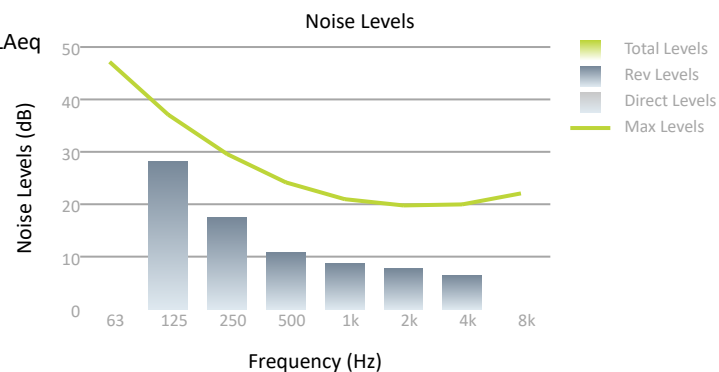
## Typical Western Livingroom Daytime LAeq

|                                                                                             |      | Octave Band Centre Frequency (Hz) |       |       |       |       |       |       |            |
|---------------------------------------------------------------------------------------------|------|-----------------------------------|-------|-------|-------|-------|-------|-------|------------|
|                                                                                             |      | 63                                | 125   | 250   | 500   | 1k    | 2k    | 4k    | 8k         |
| <b>Sound Level at Facade</b>                                                                |      |                                   |       |       |       |       |       |       |            |
| Source dBA                                                                                  | 59.0 |                                   |       |       |       |       |       |       |            |
| <b>Octave Band Frequencies</b>                                                              |      |                                   |       |       |       |       |       |       |            |
| Leq,ff                                                                                      |      | 63.0                              | 61.0  | 57.0  | 55.0  | 55.0  | 51.0  | 46.0  | 40.0 Row A |
| <b>Facade Wall Element</b>                                                                  |      |                                   |       |       |       |       |       |       |            |
|                                                                                             |      | -46.4                             | -49.4 | -53.4 | -53.4 | -62.4 | -66.4 | -68.4 | -73.4      |
| <b>Facade Glazed Element</b>                                                                |      |                                   |       |       |       |       |       |       |            |
|                                                                                             |      | -                                 | -39.0 | -39.0 | -47.0 | -51.0 | -50.0 | -55.0 | -          |
| <b>Facade Roof Element</b>                                                                  |      |                                   |       |       |       |       |       |       |            |
|                                                                                             |      | -17.8                             | -32.8 | -46.8 | -56.8 | -63.8 | -56.8 | -58.8 | -          |
| <b>Arithmetic Subtract</b>                                                                  |      |                                   |       |       |       |       |       |       |            |
| Result                                                                                      |      | 42.2                              | 25.2  | 7.2   | -4.8  | -11.8 | -8.8  | -15.8 | - Row E    |
|                                                                                             |      | -3.0                              | -3.0  | -3.0  | -3.0  | -3.0  | -3.0  | -3.0  | -          |
| <b>Cumulative Lp</b>                                                                        |      |                                   |       |       |       |       |       |       |            |
| Result                                                                                      |      | -                                 | 27.0  | 18.6  | 10.0  | 6.8   | 5.3   | 3.3   | -          |
| <b>ISO 12354-3 Lfs Correction</b>                                                           |      |                                   |       |       |       |       |       |       |            |
|                                                                                             |      | -                                 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | -          |
| <b>Room Corrections</b>                                                                     |      |                                   |       |       |       |       |       |       |            |
|                                                                                             |      | -                                 | 6.4   | 5.6   | 5.6   | 5.6   | 5.1   | 4.6   | -          |
| <b>Internal Receiver Noise</b>                                                              |      |                                   |       |       |       |       |       |       |            |
| Internal Receiver Noise - Typical Western Livingroom Daytime LAeq Reverberant Field, LPrev: |      |                                   |       |       |       |       |       |       |            |
|                                                                                             |      | -                                 | 33.4  | 24.2  | 15.6  | 12.3  | 10.5  | 8.0   | -          |



## Unit 4 Hawthorn Road

|                          |                                        |
|--------------------------|----------------------------------------|
| Reference                | Typical Western Bedroom Nighttime LAeq |
| Description              |                                        |
| Target Sound Level       | -                                      |
| Max Sound Level          | 30dB(A)                                |
| Calculated Sound Level   | 17dB(A)                                |
| Calculated Tmf T60 (s)   | 0.4                                    |
| Volume (m <sup>3</sup> ) | 32.5                                   |



### Calculated Internal Sound Levels

| Reference | Quantity | Noise Levels (dB) |     |     |     |    |    |    |    |
|-----------|----------|-------------------|-----|-----|-----|----|----|----|----|
|           |          | 63                | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Leq, ff   | 1        | -                 | 28  | 17  | 11  | 9  | 8  | 6  | -  |

## Calculation Sheet

## Typical Western Bedroom Nighttime LAeq

|                                                                                                         |      | Octave Band Centre Frequency (Hz) |       |       |       |       |       |       |       |
|---------------------------------------------------------------------------------------------------------|------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                                                                                                         |      | 63                                | 125   | 250   | 500   | 1k    | 2k    | 4k    | 8k    |
| <b>Sound Level at Facade (Leq)</b>                                                                      |      |                                   |       |       |       |       |       |       |       |
| Source dBA                                                                                              | 52.0 |                                   |       |       |       |       |       |       |       |
| <b>Octave Band Frequencies</b>                                                                          |      |                                   |       |       |       |       |       |       |       |
| Leq,ff                                                                                                  |      | 56.0                              | 54.0  | 50.0  | 48.0  | 48.0  | 44.0  | 39.0  | 33.0  |
| Row A                                                                                                   |      |                                   |       |       |       |       |       |       |       |
| <b>Facade Wall Element</b>                                                                              |      |                                   |       |       |       |       |       |       |       |
|                                                                                                         |      | -46.4                             | -49.4 | -53.4 | -53.4 | -62.4 | -66.4 | -68.4 | -73.4 |
| <b>Facade Glazed Element</b>                                                                            |      |                                   |       |       |       |       |       |       |       |
|                                                                                                         |      | -                                 | -39.0 | -39.0 | -47.0 | -51.0 | -50.0 | -55.0 | -     |
| <b>Facade Roof Element</b>                                                                              |      |                                   |       |       |       |       |       |       |       |
|                                                                                                         |      | -17.8                             | -32.8 | -46.8 | -56.8 | -63.8 | -56.8 | -58.8 | -     |
| <b>Cumulative Lp</b>                                                                                    |      |                                   |       |       |       |       |       |       |       |
| Result                                                                                                  |      | -                                 | 22.2  | 12.3  | 5.6   | 4.1   | 3.6   | 3.1   | -     |
| <b>ISO 12354-3 Lfs Correction</b>                                                                       |      |                                   |       |       |       |       |       |       |       |
|                                                                                                         |      | -                                 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | -     |
| <b>Room Corrections</b>                                                                                 |      |                                   |       |       |       |       |       |       |       |
|                                                                                                         |      | -                                 | 6.0   | 5.1   | 5.1   | 4.6   | 4.0   | 3.4   | -     |
| <b>Internal Receiver Noise</b>                                                                          |      |                                   |       |       |       |       |       |       |       |
| Internal Receiver Noise - Typical Western Bedroom Nighttime LAeq Reverberant Field, L <sub>Prev</sub> : |      |                                   |       |       |       |       |       |       |       |
|                                                                                                         |      | -                                 | 28.2  | 17.4  | 10.8  | 8.7   | 7.7   | 6.5   | -     |



## Unit 4 Hawthorn Road

### Reference

Typical Western Bedroom Nighttime LAfmax

### Description

Target Sound Level

-

Max Sound Level

45dB(A)

Calculated Sound Level

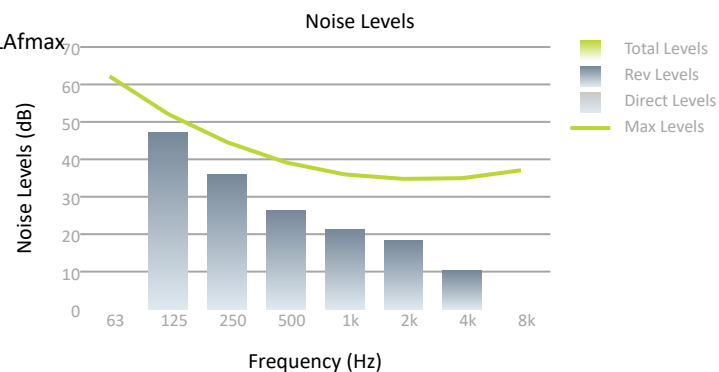
34dB(A)

Calculated Tmf T60 (s)

0.4

Volume (m<sup>3</sup>)

32.5



### Calculated Internal Sound Levels

| Reference | Quantity | Noise Levels (dB) |     |     |     |    |    |    |    |
|-----------|----------|-------------------|-----|-----|-----|----|----|----|----|
|           |          | 63                | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Lmax, ff  | 1        | -                 | 47  | 36  | 26  | 21 | 18 | 10 | -  |

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## Calculation Sheet

## Typical Western Bedroom Nighttime LAfmax

|                                                                                              |      | Octave Band Centre Frequency (Hz) |       |       |       |       |       |       |       |
|----------------------------------------------------------------------------------------------|------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                                                                                              |      | 63                                | 125   | 250   | 500   | 1k    | 2k    | 4k    | 8k    |
| <b>Sound Level at Facade (Lmax)</b>                                                          |      |                                   |       |       |       |       |       |       |       |
| Source dBA                                                                                   | 71.0 |                                   |       |       |       |       |       |       |       |
| <b>Octave Band Frequencies</b>                                                               |      |                                   |       |       |       |       |       |       |       |
| Leq,ff                                                                                       |      | 75.0                              | 73.0  | 69.0  | 67.0  | 67.0  | 63.0  | 58.0  | 52.0  |
|                                                                                              |      | Row A                             |       |       |       |       |       |       |       |
| <b>Facade Wall Element</b>                                                                   |      |                                   |       |       |       |       |       |       |       |
|                                                                                              |      | -46.4                             | -49.4 | -53.4 | -53.4 | -62.4 | -66.4 | -68.4 | -73.4 |
| <b>Facade Glazed Element</b>                                                                 |      |                                   |       |       |       |       |       |       |       |
|                                                                                              |      | -                                 | -39.0 | -39.0 | -47.0 | -51.0 | -50.0 | -55.0 | -     |
| <b>Facade Roof Element</b>                                                                   |      |                                   |       |       |       |       |       |       |       |
|                                                                                              |      | -17.8                             | -32.8 | -46.8 | -56.8 | -63.8 | -56.8 | -58.8 | -     |
| <b>Cumulative Lp</b>                                                                         |      |                                   |       |       |       |       |       |       |       |
| Result                                                                                       |      | -                                 | 41.2  | 30.8  | 21.3  | 16.7  | 14.2  | 6.9   | -     |
| <b>ISO 12354-3 Lfs Correction</b>                                                            |      |                                   |       |       |       |       |       |       |       |
|                                                                                              |      | -                                 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | -     |
| <b>Room Corrections</b>                                                                      |      |                                   |       |       |       |       |       |       |       |
|                                                                                              |      | -                                 | 6.0   | 5.1   | 5.1   | 4.6   | 4.0   | 3.4   | -     |
| <b>Internal Receiver Noise</b>                                                               |      |                                   |       |       |       |       |       |       |       |
| Internal Receiver Noise - Typical Western Bedroom Nighttime LAfmax Reverberant Field, LPrev: |      | -                                 | 47.2  | 35.9  | 26.4  | 21.3  | 18.2  | 10.3  | -     |



## Unit 4 Hawthorn Road

### Reference

Typical Northern Livingroom Daytime LAeq

### Description

Target Sound Level

-

Max Sound Level

35dB(A)

Calculated Sound Level

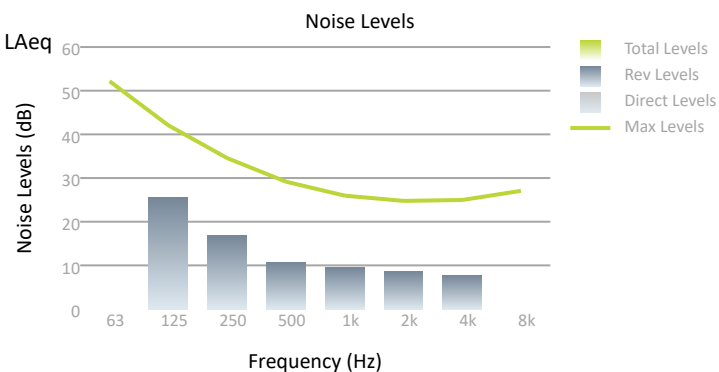
17dB(A)

Calculated Tmf T60 (s)

0.48

Volume (m<sup>3</sup>)

39



### Calculated Internal Sound Levels

| Reference | Quantity | Noise Levels (dB) |     |     |     |    |    |    |    |
|-----------|----------|-------------------|-----|-----|-----|----|----|----|----|
|           |          | 63                | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Leq,ff    | 1        | -                 | 25  | 17  | 11  | 9  | 9  | 8  | -  |

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## Calculation Sheet

## Typical Northern Livingroom Daytime LAeq

|                                                                    |      | Octave Band Centre Frequency (Hz) |       |       |       |       |       |       |       |
|--------------------------------------------------------------------|------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                                                                    |      | 63                                | 125   | 250   | 500   | 1k    | 2k    | 4k    | 8k    |
| <b>Sound Level at Facade</b>                                       |      |                                   |       |       |       |       |       |       |       |
| Source dBA                                                         | 51.0 |                                   |       |       |       |       |       |       |       |
| <b>Octave Band Frequencies</b>                                     |      |                                   |       |       |       |       |       |       |       |
| Leq,ff                                                             |      | 55.0                              | 53.0  | 49.0  | 47.0  | 47.0  | 43.0  | 38.0  | 32.0  |
| Row A                                                              |      |                                   |       |       |       |       |       |       |       |
| <b>Facade Wall Element</b>                                         |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -46.4                             | -49.4 | -53.4 | -53.4 | -62.4 | -66.4 | -68.4 | -73.4 |
| <b>Facade Glazed Element</b>                                       |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -                                 | -39.0 | -39.0 | -47.0 | -51.0 | -50.0 | -55.0 | -     |
| <b>Facade Roof Element</b>                                         |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -17.8                             | -32.8 | -46.8 | -56.8 | -63.8 | -56.8 | -58.8 | -     |
| <b>Arithmetic Subtract</b>                                         |      |                                   |       |       |       |       |       |       |       |
| Result                                                             |      | 34.2                              | 17.2  | -0.8  | -12.8 | -19.8 | -16.8 | -23.8 | -     |
|                                                                    |      | -3.0                              | -3.0  | -3.0  | -3.0  | -3.0  | -3.0  | -3.0  | -     |
| <b>Cumulative Lp</b>                                               |      |                                   |       |       |       |       |       |       |       |
| Result                                                             |      | -                                 | 19.1  | 11.2  | 5.1   | 3.9   | 3.5   | 3.1   | -     |
| <b>ISO 12354-3 Lfs Correction</b>                                  |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -                                 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | -     |
| <b>Room Corrections</b>                                            |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -                                 | 6.4   | 5.6   | 5.6   | 5.6   | 5.1   | 4.6   | -     |
| <b>Internal Receiver Noise</b>                                     |      |                                   |       |       |       |       |       |       |       |
| Internal Receiver Noise - Typical Northern Livingroom Daytime LAeq |      |                                   |       |       |       |       |       |       |       |
| Reverberant Field, LPrev:                                          |      | -                                 | 25.5  | 16.8  | 10.7  | 9.5   | 8.6   | 7.7   | -     |



## Unit 4 Hawthorn Road

### Reference

Typical Northern Bedroom Nighttime LAeq

### Description

Target Sound Level

-

Max Sound Level

30dB(A)

Calculated Sound Level

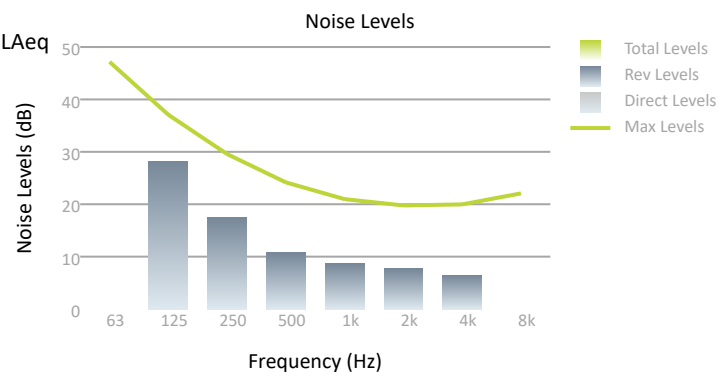
17dB(A)

Calculated Tmf T60 (s)

0.4

Volume (m<sup>3</sup>)

32.5



### Calculated Internal Sound Levels

| Reference | Quantity | Noise Levels (dB) |     |     |     |    |    |    |    |
|-----------|----------|-------------------|-----|-----|-----|----|----|----|----|
|           |          | 63                | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Leq, ff   | 1        | -                 | 28  | 17  | 11  | 9  | 8  | 6  | -  |

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Calculation Sheet

Typical Northern Bedroom Nighttime LAeq

|                                                                                             |      | Octave Band Centre Frequency (Hz) |       |       |       |       |       |       |       |
|---------------------------------------------------------------------------------------------|------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                                                                                             |      | 63                                | 125   | 250   | 500   | 1k    | 2k    | 4k    | 8k    |
| <b>Sound Level at Facade (Leq)</b>                                                          |      |                                   |       |       |       |       |       |       |       |
| Source dBA                                                                                  | 52.0 |                                   |       |       |       |       |       |       |       |
| <b>Octave Band Frequencies</b>                                                              |      |                                   |       |       |       |       |       |       |       |
| Leq,ff                                                                                      |      | 56.0                              | 54.0  | 50.0  | 48.0  | 48.0  | 44.0  | 39.0  | 33.0  |
| Row A                                                                                       |      |                                   |       |       |       |       |       |       |       |
| <b>Facade Wall Element</b>                                                                  |      |                                   |       |       |       |       |       |       |       |
|                                                                                             |      | -46.4                             | -49.4 | -53.4 | -53.4 | -62.4 | -66.4 | -68.4 | -73.4 |
| <b>Facade Glazed Element</b>                                                                |      |                                   |       |       |       |       |       |       |       |
|                                                                                             |      | -                                 | -39.0 | -39.0 | -47.0 | -51.0 | -50.0 | -55.0 | -     |
| <b>Facade Roof Element</b>                                                                  |      |                                   |       |       |       |       |       |       |       |
|                                                                                             |      | -17.8                             | -32.8 | -46.8 | -56.8 | -63.8 | -56.8 | -58.8 | -     |
| <b>Cumulative Lp</b>                                                                        |      |                                   |       |       |       |       |       |       |       |
| Result                                                                                      |      | -                                 | 22.2  | 12.3  | 5.6   | 4.1   | 3.6   | 3.1   | -     |
| <b>ISO 12354-3 Lfs Correction</b>                                                           |      |                                   |       |       |       |       |       |       |       |
|                                                                                             |      | -                                 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | -     |
| <b>Room Corrections</b>                                                                     |      |                                   |       |       |       |       |       |       |       |
|                                                                                             |      | -                                 | 6.0   | 5.1   | 5.1   | 4.6   | 4.0   | 3.4   | -     |
| <b>Internal Receiver Noise</b>                                                              |      |                                   |       |       |       |       |       |       |       |
| Internal Receiver Noise - Typical Northern Bedroom Nighttime LAeq Reverberant Field, LPrev: |      |                                   |       |       |       |       |       |       |       |
|                                                                                             |      | -                                 | 28.2  | 17.4  | 10.8  | 8.7   | 7.7   | 6.5   | -     |



## Unit 4 Hawthorn Road

### Reference

Typical Northern Bedroom Nighttime LAFmax

### Description

Target Sound Level

-

Max Sound Level

45dB(A)

Calculated Sound Level

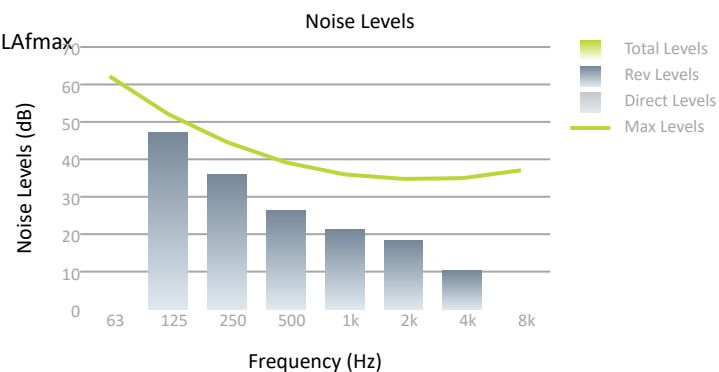
34dB(A)

Calculated Tmf T60 (s)

0.4

Volume (m<sup>3</sup>)

32.5



### Calculated Internal Sound Levels

| Reference | Quantity | Noise Levels (dB) |     |     |     |    |    |    |    |
|-----------|----------|-------------------|-----|-----|-----|----|----|----|----|
|           |          | 63                | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Lmax, ff  | 1        | -                 | 47  | 36  | 26  | 21 | 18 | 10 | -  |

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Calculation Sheet

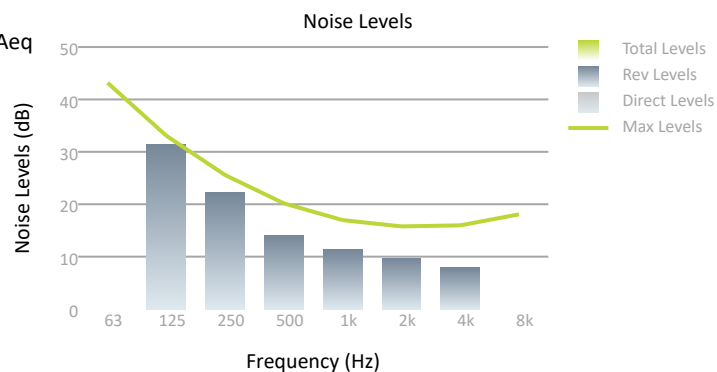
Typical Northern Bedroom Nighttime LAfmax

|                                                                                               |      | Octave Band Centre Frequency (Hz) |       |       |       |       |       |       |       |
|-----------------------------------------------------------------------------------------------|------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                                                                                               |      | 63                                | 125   | 250   | 500   | 1k    | 2k    | 4k    | 8k    |
| <b>Sound Level at Facade (Lmax)</b>                                                           |      |                                   |       |       |       |       |       |       |       |
| Source dBA                                                                                    | 71.0 |                                   |       |       |       |       |       |       |       |
| <b>Octave Band Frequencies</b>                                                                |      |                                   |       |       |       |       |       |       |       |
| Leq,ff                                                                                        |      | 75.0                              | 73.0  | 69.0  | 67.0  | 67.0  | 63.0  | 58.0  | 52.0  |
| Row A                                                                                         |      |                                   |       |       |       |       |       |       |       |
| <b>Facade Wall Element</b>                                                                    |      |                                   |       |       |       |       |       |       |       |
|                                                                                               |      | -46.4                             | -49.4 | -53.4 | -53.4 | -62.4 | -66.4 | -68.4 | -73.4 |
| <b>Facade Glazed Element</b>                                                                  |      |                                   |       |       |       |       |       |       |       |
|                                                                                               |      | -                                 | -39.0 | -39.0 | -47.0 | -51.0 | -50.0 | -55.0 | -     |
| <b>Facade Roof Element</b>                                                                    |      |                                   |       |       |       |       |       |       |       |
|                                                                                               |      | -17.8                             | -32.8 | -46.8 | -56.8 | -63.8 | -56.8 | -58.8 | -     |
| <b>Cumulative Lp</b>                                                                          |      |                                   |       |       |       |       |       |       |       |
| Result                                                                                        |      | -                                 | 41.2  | 30.8  | 21.3  | 16.7  | 14.2  | 6.9   | -     |
| <b>ISO 12354-3 Lfs Correction</b>                                                             |      |                                   |       |       |       |       |       |       |       |
|                                                                                               |      | -                                 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | -     |
| <b>Room Corrections</b>                                                                       |      |                                   |       |       |       |       |       |       |       |
|                                                                                               |      | -                                 | 6.0   | 5.1   | 5.1   | 4.6   | 4.0   | 3.4   | -     |
| <b>Internal Receiver Noise</b>                                                                |      |                                   |       |       |       |       |       |       |       |
| Internal Receiver Noise - Typical Northern Bedroom Nighttime LAfmax Reverberant Field, LPrev: |      |                                   |       |       |       |       |       |       |       |
|                                                                                               |      | -                                 | 47.2  | 35.9  | 26.4  | 21.3  | 18.2  | 10.3  | -     |



## Unit 4 Hawthorn Road

|                          |                                         |
|--------------------------|-----------------------------------------|
| Reference                | Typical Eastern Livingroom Daytime LAeq |
| Description              |                                         |
| Target Sound Level       | -                                       |
| Max Sound Level          | 26dB(A)                                 |
| Calculated Sound Level   | 20dB(A)                                 |
| Calculated Tmf T60 (s)   | 0.48                                    |
| Volume (m <sup>3</sup> ) | 39                                      |



### Calculated Internal Sound Levels

| Reference | Quantity | Noise Levels (dB) |     |     |     |    |    |    |    |
|-----------|----------|-------------------|-----|-----|-----|----|----|----|----|
|           |          | 63                | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Leq,ff    | 1        | -                 | 31  | 22  | 14  | 11 | 10 | 8  | -  |

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## Calculation Sheet

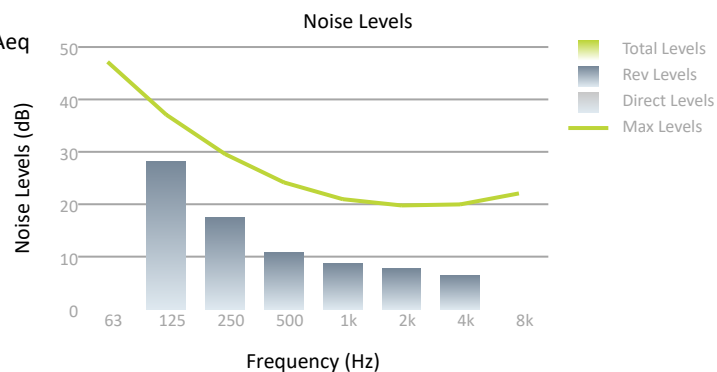
## Typical Eastern Livingroom Daytime LAeq

|                                                                                             |      | Octave Band Centre Frequency (Hz) |       |       |       |       |       |       |       |
|---------------------------------------------------------------------------------------------|------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                                                                                             |      | 63                                | 125   | 250   | 500   | 1k    | 2k    | 4k    | 8k    |
| <b>Sound Level at Facade</b>                                                                |      |                                   |       |       |       |       |       |       |       |
| Source dBA                                                                                  | 57.0 |                                   |       |       |       |       |       |       |       |
| <b>Octave Band Frequencies</b>                                                              |      |                                   |       |       |       |       |       |       |       |
| Leq,ff                                                                                      |      | 61.0                              | 59.0  | 55.0  | 53.0  | 53.0  | 49.0  | 44.0  | 38.0  |
| <b>Row A</b>                                                                                |      |                                   |       |       |       |       |       |       |       |
| <b>Facade Wall Element</b>                                                                  |      |                                   |       |       |       |       |       |       |       |
|                                                                                             |      | -46.4                             | -49.4 | -53.4 | -53.4 | -62.4 | -66.4 | -68.4 | -73.4 |
| <b>Facade Glazed Element</b>                                                                |      |                                   |       |       |       |       |       |       |       |
|                                                                                             |      | -                                 | -39.0 | -39.0 | -47.0 | -51.0 | -50.0 | -55.0 | -     |
| <b>Facade Roof Element</b>                                                                  |      |                                   |       |       |       |       |       |       |       |
|                                                                                             |      | -17.8                             | -32.8 | -46.8 | -56.8 | -63.8 | -56.8 | -58.8 | -     |
| <b>Arithmetic Subtract</b>                                                                  |      |                                   |       |       |       |       |       |       |       |
| Result                                                                                      |      | 40.2                              | 23.2  | 5.2   | -6.8  | -13.8 | -10.8 | -17.8 | -     |
|                                                                                             |      | -3.0                              | -3.0  | -3.0  | -3.0  | -3.0  | -3.0  | -3.0  | -     |
| <b>Row E</b>                                                                                |      |                                   |       |       |       |       |       |       |       |
| <b>Cumulative Lp</b>                                                                        |      |                                   |       |       |       |       |       |       |       |
| Result                                                                                      |      | -                                 | 25.0  | 16.6  | 8.5   | 5.7   | 4.6   | 3.2   | -     |
| <b>ISO 12354-3 Lfs Correction</b>                                                           |      |                                   |       |       |       |       |       |       |       |
|                                                                                             |      | -                                 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | -     |
| <b>Room Corrections</b>                                                                     |      |                                   |       |       |       |       |       |       |       |
|                                                                                             |      | -                                 | 6.4   | 5.6   | 5.6   | 5.6   | 5.1   | 4.6   | -     |
| <b>Internal Receiver Noise</b>                                                              |      |                                   |       |       |       |       |       |       |       |
| Internal Receiver Noise - Typical Eastern Livingroom Daytime LAeq Reverberant Field, LPrev: |      | -                                 | 31.4  | 22.2  | 14.1  | 11.3  | 9.7   | 7.8   | -     |



## Unit 4 Hawthorn Road

|                        |                                        |
|------------------------|----------------------------------------|
| Reference              | Typical Eastern Bedroom Nighttime LAeq |
| Description            |                                        |
| Target Sound Level     | -                                      |
| Max Sound Level        | 30dB(A)                                |
| Calculated Sound Level | 17dB(A)                                |
| Calculated Tmf T60 (s) | 0.4                                    |
| Volume (m³)            | 32.5                                   |



### Calculated Internal Sound Levels

| Reference | Quantity | Noise Levels (dB) |     |     |     |    |    |    |    |
|-----------|----------|-------------------|-----|-----|-----|----|----|----|----|
|           |          | 63                | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Leq, ff   | 1        | -                 | 28  | 17  | 11  | 9  | 8  | 6  | -  |

## Calculation Sheet

## Typical Eastern Bedroom Nighttime LAeq

|                                                                                                         |      | Octave Band Centre Frequency (Hz) |       |       |       |       |       |       |       |
|---------------------------------------------------------------------------------------------------------|------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                                                                                                         |      | 63                                | 125   | 250   | 500   | 1k    | 2k    | 4k    | 8k    |
| <b>Sound Level at Facade (Leq)</b>                                                                      |      |                                   |       |       |       |       |       |       |       |
| Source dBA                                                                                              | 52.0 |                                   |       |       |       |       |       |       |       |
| <b>Octave Band Frequencies</b>                                                                          |      |                                   |       |       |       |       |       |       |       |
| Leq,ff                                                                                                  |      | 56.0                              | 54.0  | 50.0  | 48.0  | 48.0  | 44.0  | 39.0  | 33.0  |
| Row A                                                                                                   |      |                                   |       |       |       |       |       |       |       |
| <b>Facade Wall Element</b>                                                                              |      |                                   |       |       |       |       |       |       |       |
|                                                                                                         |      | -46.4                             | -49.4 | -53.4 | -53.4 | -62.4 | -66.4 | -68.4 | -73.4 |
| <b>Facade Glazed Element</b>                                                                            |      |                                   |       |       |       |       |       |       |       |
|                                                                                                         |      | -                                 | -39.0 | -39.0 | -47.0 | -51.0 | -50.0 | -55.0 | -     |
| <b>Facade Roof Element</b>                                                                              |      |                                   |       |       |       |       |       |       |       |
|                                                                                                         |      | -17.8                             | -32.8 | -46.8 | -56.8 | -63.8 | -56.8 | -58.8 | -     |
| <b>Cumulative Lp</b>                                                                                    |      |                                   |       |       |       |       |       |       |       |
| Result                                                                                                  |      | -                                 | 22.2  | 12.3  | 5.6   | 4.1   | 3.6   | 3.1   | -     |
| <b>ISO 12354-3 Lfs Correction</b>                                                                       |      |                                   |       |       |       |       |       |       |       |
|                                                                                                         |      | -                                 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | -     |
| <b>Room Corrections</b>                                                                                 |      |                                   |       |       |       |       |       |       |       |
|                                                                                                         |      | -                                 | 6.0   | 5.1   | 5.1   | 4.6   | 4.0   | 3.4   | -     |
| <b>Internal Receiver Noise</b>                                                                          |      |                                   |       |       |       |       |       |       |       |
| Internal Receiver Noise - Typical Eastern Bedroom Nighttime LAeq Reverberant Field, L <sub>Prev</sub> : |      |                                   |       |       |       |       |       |       |       |
|                                                                                                         |      | -                                 | 28.2  | 17.4  | 10.8  | 8.7   | 7.7   | 6.5   | -     |



## Unit 4 Hawthorn Road

### Reference

Typical Eastern Bedroom Nighttime LAFmax

### Description

Target Sound Level

-

Max Sound Level

45dB(A)

Calculated Sound Level

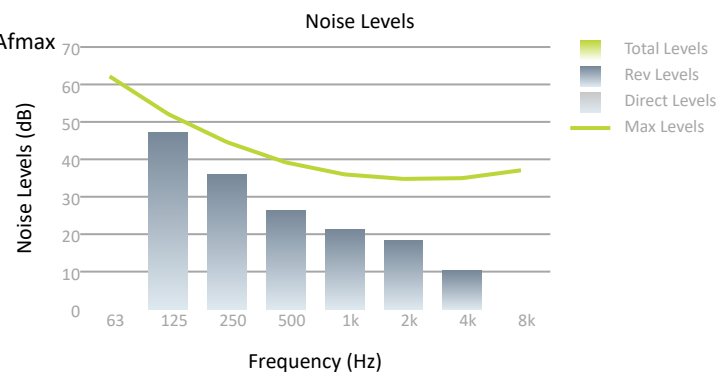
34dB(A)

Calculated Tmf T60 (s)

0.4

Volume (m<sup>3</sup>)

32.5



### Calculated Internal Sound Levels

| Reference | Quantity | Noise Levels (dB) |     |     |     |    |    |    |    |
|-----------|----------|-------------------|-----|-----|-----|----|----|----|----|
|           |          | 63                | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Lmax, ff  | 1        | -                 | 47  | 36  | 26  | 21 | 18 | 10 | -  |

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Calculation Sheet

Typical Eastern Bedroom Nighttime LAfmax

|                                                                    |      | Octave Band Centre Frequency (Hz) |       |       |       |       |       |       |       |
|--------------------------------------------------------------------|------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                                                                    |      | 63                                | 125   | 250   | 500   | 1k    | 2k    | 4k    | 8k    |
| <b>Sound Level at Facade (Lmax)</b>                                |      |                                   |       |       |       |       |       |       |       |
| Source dBA                                                         | 71.0 |                                   |       |       |       |       |       |       |       |
| <b>Octave Band Frequencies</b>                                     |      |                                   |       |       |       |       |       |       |       |
| Leq,ff                                                             |      | 75.0                              | 73.0  | 69.0  | 67.0  | 67.0  | 63.0  | 58.0  | 52.0  |
| Row A                                                              |      |                                   |       |       |       |       |       |       |       |
| <b>Facade Wall Element</b>                                         |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -46.4                             | -49.4 | -53.4 | -53.4 | -62.4 | -66.4 | -68.4 | -73.4 |
| <b>Facade Glazed Element</b>                                       |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -                                 | -39.0 | -39.0 | -47.0 | -51.0 | -50.0 | -55.0 | -     |
| <b>Facade Roof Element</b>                                         |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -17.8                             | -32.8 | -46.8 | -56.8 | -63.8 | -56.8 | -58.8 | -     |
| <b>Cumulative Lp</b>                                               |      |                                   |       |       |       |       |       |       |       |
| Result                                                             |      | -                                 | 41.2  | 30.8  | 21.3  | 16.7  | 14.2  | 6.9   | -     |
| <b>ISO 12354-3 Lfs Correction</b>                                  |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -                                 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | -     |
| <b>Room Corrections</b>                                            |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -                                 | 6.0   | 5.1   | 5.1   | 4.6   | 4.0   | 3.4   | -     |
| <b>Internal Receiver Noise</b>                                     |      |                                   |       |       |       |       |       |       |       |
| Internal Receiver Noise - Typical Eastern Bedroom Nighttime LAfmax |      |                                   |       |       |       |       |       |       |       |
| Reverberant Field, L <sub>Prev</sub> :                             |      | -                                 | 47.2  | 35.9  | 26.4  | 21.3  | 18.2  | 10.3  | -     |



## Unit 4 Hawthorn Road

### Reference

Typical Southern Livingroom Daytime LAeq

### Description

Target Sound Level

-

Max Sound Level

35dB(A)

Calculated Sound Level

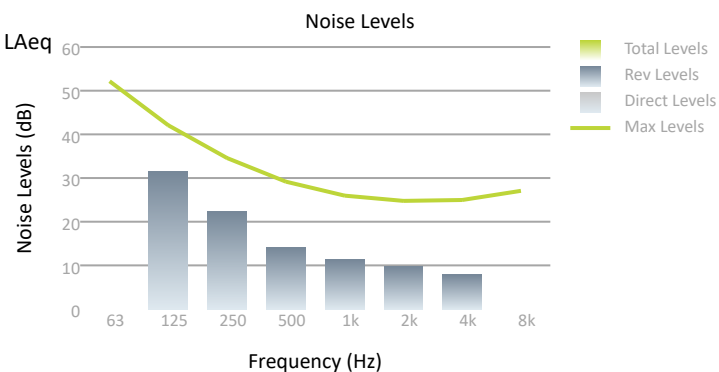
20dB(A)

Calculated Tmf T60 (s)

0.48

Volume (m<sup>3</sup>)

39



### Calculated Internal Sound Levels

| Reference | Quantity | Noise Levels (dB) |     |     |     |    |    |    |    |
|-----------|----------|-------------------|-----|-----|-----|----|----|----|----|
|           |          | 63                | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Leq,ff    | 1        | -                 | 31  | 22  | 14  | 11 | 10 | 8  | -  |

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## Calculation Sheet

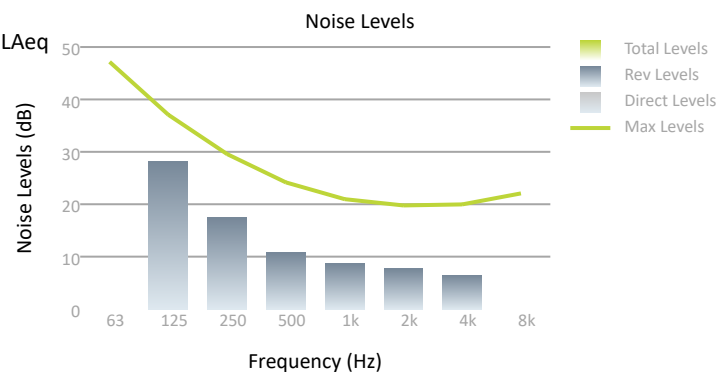
## Typical Southern Livingroom Daytime LAeq

|                                                                    |      | Octave Band Centre Frequency (Hz) |       |       |       |       |       |       |       |
|--------------------------------------------------------------------|------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                                                                    |      | 63                                | 125   | 250   | 500   | 1k    | 2k    | 4k    | 8k    |
| <b>Sound Level at Facade</b>                                       |      |                                   |       |       |       |       |       |       |       |
| Source dBA                                                         | 57.0 |                                   |       |       |       |       |       |       |       |
| <b>Octave Band Frequencies</b>                                     |      |                                   |       |       |       |       |       |       |       |
| Leq,ff                                                             |      | 61.0                              | 59.0  | 55.0  | 53.0  | 53.0  | 49.0  | 44.0  | 38.0  |
| <b>Row A</b>                                                       |      |                                   |       |       |       |       |       |       |       |
| <b>Facade Wall Element</b>                                         |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -46.4                             | -49.4 | -53.4 | -53.4 | -62.4 | -66.4 | -68.4 | -73.4 |
| <b>Facade Glazed Element</b>                                       |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -                                 | -39.0 | -39.0 | -47.0 | -51.0 | -50.0 | -55.0 | -     |
| <b>Facade Roof Element</b>                                         |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -17.8                             | -32.8 | -46.8 | -56.8 | -63.8 | -56.8 | -58.8 | -     |
| <b>Arithmetic Subtract</b>                                         |      |                                   |       |       |       |       |       |       |       |
| Result                                                             |      | 40.2                              | 23.2  | 5.2   | -6.8  | -13.8 | -10.8 | -17.8 | -     |
|                                                                    |      | -3.0                              | -3.0  | -3.0  | -3.0  | -3.0  | -3.0  | -3.0  | -     |
| <b>Row E</b>                                                       |      |                                   |       |       |       |       |       |       |       |
| <b>Cumulative Lp</b>                                               |      |                                   |       |       |       |       |       |       |       |
| Result                                                             |      | -                                 | 25.0  | 16.6  | 8.5   | 5.7   | 4.6   | 3.2   | -     |
| <b>ISO 12354-3 Lfs Correction</b>                                  |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -                                 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | -     |
| <b>Room Corrections</b>                                            |      |                                   |       |       |       |       |       |       |       |
|                                                                    |      | -                                 | 6.4   | 5.6   | 5.6   | 5.6   | 5.1   | 4.6   | -     |
| <b>Internal Receiver Noise</b>                                     |      |                                   |       |       |       |       |       |       |       |
| Internal Receiver Noise - Typical Southern Livingroom Daytime LAeq |      |                                   |       |       |       |       |       |       |       |
| Reverberant Field, LPrev:                                          |      | -                                 | 31.4  | 22.2  | 14.1  | 11.3  | 9.7   | 7.8   | -     |



## Unit 4 Hawthorn Road

|                        |                                         |
|------------------------|-----------------------------------------|
| Reference              | Typical Southern Bedroom Nighttime LAeq |
| Description            |                                         |
| Target Sound Level     | -                                       |
| Max Sound Level        | 30dB(A)                                 |
| Calculated Sound Level | 17dB(A)                                 |
| Calculated Tmf T60 (s) | 0.4                                     |
| Volume (m³)            | 32.5                                    |



### Calculated Internal Sound Levels

| Reference | Quantity | Noise Levels (dB) |     |     |     |    |    |    |    |
|-----------|----------|-------------------|-----|-----|-----|----|----|----|----|
|           |          | 63                | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Leq, ff   | 1        | -                 | 28  | 17  | 11  | 9  | 8  | 6  | -  |

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Calculation Sheet

Typical Southern Bedroom Nighttime LAeq

|                                                                   |      | Octave Band Centre Frequency (Hz) |       |       |       |       |       |       |       |
|-------------------------------------------------------------------|------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|
|                                                                   |      | 63                                | 125   | 250   | 500   | 1k    | 2k    | 4k    | 8k    |
| <b>Sound Level at Facade (Leq)</b>                                |      |                                   |       |       |       |       |       |       |       |
| Source dBA                                                        | 52.0 |                                   |       |       |       |       |       |       |       |
| <b>Octave Band Frequencies</b>                                    |      |                                   |       |       |       |       |       |       |       |
| Leq,ff                                                            |      | 56.0                              | 54.0  | 50.0  | 48.0  | 48.0  | 44.0  | 39.0  | 33.0  |
| Row A                                                             |      |                                   |       |       |       |       |       |       |       |
| <b>Facade Wall Element</b>                                        |      |                                   |       |       |       |       |       |       |       |
|                                                                   |      | -46.4                             | -49.4 | -53.4 | -53.4 | -62.4 | -66.4 | -68.4 | -73.4 |
| <b>Facade Glazed Element</b>                                      |      |                                   |       |       |       |       |       |       |       |
|                                                                   |      | -                                 | -39.0 | -39.0 | -47.0 | -51.0 | -50.0 | -55.0 | -     |
| <b>Facade Roof Element</b>                                        |      |                                   |       |       |       |       |       |       |       |
|                                                                   |      | -17.8                             | -32.8 | -46.8 | -56.8 | -63.8 | -56.8 | -58.8 | -     |
| <b>Cumulative Lp</b>                                              |      |                                   |       |       |       |       |       |       |       |
| Result                                                            |      | -                                 | 22.2  | 12.3  | 5.6   | 4.1   | 3.6   | 3.1   | -     |
| <b>ISO 12354-3 Lfs Correction</b>                                 |      |                                   |       |       |       |       |       |       |       |
|                                                                   |      | -                                 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | -     |
| <b>Room Corrections</b>                                           |      |                                   |       |       |       |       |       |       |       |
|                                                                   |      | -                                 | 6.0   | 5.1   | 5.1   | 4.6   | 4.0   | 3.4   | -     |
| <b>Internal Receiver Noise</b>                                    |      |                                   |       |       |       |       |       |       |       |
| Internal Receiver Noise - Typical Southern Bedroom Nighttime LAeq |      |                                   |       |       |       |       |       |       |       |
| Reverberant Field, LPrev:                                         |      | -                                 | 28.2  | 17.4  | 10.8  | 8.7   | 7.7   | 6.5   | -     |



## Unit 4 Hawthorn Road

### Reference

Typical Southern Bedroom Nighttime LAFmax

### Description

Target Sound Level

-

Max Sound Level

45dB(A)

Calculated Sound Level

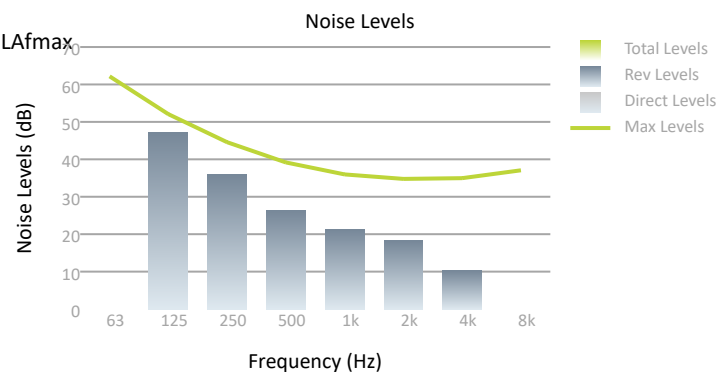
34dB(A)

Calculated Tmf T60 (s)

0.4

Volume (m<sup>3</sup>)

32.5



### Calculated Internal Sound Levels

| Reference | Quantity | Noise Levels (dB) |     |     |     |    |    |    |    |
|-----------|----------|-------------------|-----|-----|-----|----|----|----|----|
|           |          | 63                | 125 | 250 | 500 | 1k | 2k | 4k | 8k |
| Lmax, ff  | 1        | -                 | 47  | 36  | 26  | 21 | 18 | 10 | -  |

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Calculation Sheet

Typical Southern Bedroom Nighttime LAfmax

|                                                                                               |      | Octave Band Centre Frequency (Hz) |       |       |       |       |       |       |            |
|-----------------------------------------------------------------------------------------------|------|-----------------------------------|-------|-------|-------|-------|-------|-------|------------|
|                                                                                               |      | 63                                | 125   | 250   | 500   | 1k    | 2k    | 4k    | 8k         |
| <b>Sound Level at Facade (Lmax)</b>                                                           |      |                                   |       |       |       |       |       |       |            |
| Source dBA                                                                                    | 71.0 |                                   |       |       |       |       |       |       |            |
| <b>Octave Band Frequencies</b>                                                                |      |                                   |       |       |       |       |       |       |            |
| Leq,ff                                                                                        |      | 75.0                              | 73.0  | 69.0  | 67.0  | 67.0  | 63.0  | 58.0  | 52.0 Row A |
| <b>Facade Wall Element</b>                                                                    |      |                                   |       |       |       |       |       |       |            |
|                                                                                               |      | -46.4                             | -49.4 | -53.4 | -53.4 | -62.4 | -66.4 | -68.4 | -73.4      |
| <b>Facade Glazed Element</b>                                                                  |      |                                   |       |       |       |       |       |       |            |
|                                                                                               |      | -                                 | -39.0 | -39.0 | -47.0 | -51.0 | -50.0 | -55.0 | -          |
| <b>Facade Roof Element</b>                                                                    |      |                                   |       |       |       |       |       |       |            |
|                                                                                               |      | -17.8                             | -32.8 | -46.8 | -56.8 | -63.8 | -56.8 | -58.8 | -          |
| <b>Cumulative Lp</b>                                                                          |      |                                   |       |       |       |       |       |       |            |
| Result                                                                                        |      | -                                 | 41.2  | 30.8  | 21.3  | 16.7  | 14.2  | 6.9   | -          |
| <b>ISO 12354-3 Lfs Correction</b>                                                             |      |                                   |       |       |       |       |       |       |            |
|                                                                                               |      | -                                 | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | -          |
| <b>Room Corrections</b>                                                                       |      |                                   |       |       |       |       |       |       |            |
|                                                                                               |      | -                                 | 6.0   | 5.1   | 5.1   | 4.6   | 4.0   | 3.4   | -          |
| <b>Internal Receiver Noise</b>                                                                |      |                                   |       |       |       |       |       |       |            |
| Internal Receiver Noise - Typical Southern Bedroom Nighttime LAfmax Reverberant Field, LPrev: |      |                                   |       |       |       |       |       |       |            |
|                                                                                               |      | -                                 | 47.2  | 35.9  | 26.4  | 21.3  | 18.2  | 10.3  | -          |