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For LGSS Property Services
Property Development
Northamptonshire & Cambridgeshire
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Baseline Sound Survey and M&E Plant Assessment
William Knibb Centre, Kettering

Date 03 October 2016
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WBM

WBM (the trading name of The Walker Beak Mason Partnership) is an established independent acoustic consultancy specialising in architectural & building acoustics, environmental noise, planning issues and expert work. WBM is a member of the Association of Noise Consultants and is also a Corporate Member of the Institute of Environmental Management & Assessment. The consultants are Members or Fellows of the Institute of Acoustics.
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1 Introduction

WBM has been commissioned by LGSS Property Services to provide acoustic advice for the refurbishment of specific areas of the William Knibb Centre, Montagu Street, Kettering, NN16 8AE. Part of this work includes carrying out baseline noise surveys to assist with a planning application in relation to external M&E plant. The proposed location for the plant is the ground floor south facing façade of the existing 3 storey office building, adjacent the car park, accessed off Alfred Street.

The location for the plant is behind a boundary brick wall and the plant is expected to operate during normal office hours.

This report sets out the results of baseline sound monitoring undertaken in July and September 2016, proposed plant noise limits and an assessment of the proposed external M&E plant.

To aid comprehension, a glossary of acoustic terms is presented in Appendix A.

2 Assessment Methodology

The various relevant noise guidance documents used in this assessment are detailed below.

2.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF) was published in March 2012 with immediate effect and sets out the Government’s planning policies for England. At the heart of the National Planning Policy Framework is a presumption in favour of sustainable development.

The NPPF revoked and replaced a number of Planning Policy Statements (PPS), Planning Policy Guidance (PPG) and other guidance documents, including Planning Policy Guidance 24: Planning and Noise.

With regard to noise there are various aims, including that noise from a new development should avoid giving rise to significant adverse impacts on health and quality of life, and that other adverse impacts should be mitigated and reduced to a minimum including through the use of conditions.
Section 11 of the NPPF (Conserving and enhancing the natural environment) refers specifically to noise in the following paragraphs:

“109. The planning system should contribute to and enhance the natural and local environment by…preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability...”

“123. 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 (subject to the provisions of the Environmental Protection Act 1990 and other relevant law); and
- identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.”

2.2 British Standard 4142

British Standard (BS) 4142:2014 "Methods for rating and assessing industrial and commercial sound" describes methods for assessing the likely effects of sound on premises used for residential purposes. It includes the assessment of sound from industrial and manufacturing processes, M&E plant and equipment, loading and unloading of goods and materials, and mobile plant/vehicles on the site. It can be used to assess sound from proposed, new, modified or additional industrial/commercial sources, at existing or new premises used for residential purposes.

The standard describes methods to measure and determine ambient, background and residual sound levels, and the rating levels of industrial/commercial sound. This latest edition of BS 4142 also requires consideration of the level of uncertainty in the data and associated calculations.
BS 4142 is not intended to be used for the derivation or assessment of internal sound levels, or for the assessment of non-industrial/commercial sources such as recreational activities, motorsport, music and entertainment, shooting grounds, construction and demolition, domestic animals, people, and public address systems for speech.

Ambient sound is defined in BS 4142 as "totally encompassing sound in a given situation at a given time, usually composed of sound from many sources near and far". It comprises the residual sound and the specific sound when present.

Residual sound is defined in BS 4142 as "ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound". The background sound level is the $L_{A90,T}$ of the residual sound level, and is the underlying level of sound. Measurements of background sound level should be undertaken at the assessment location where possible or at a comparable location. The measurement time interval should be sufficient to obtain a representative value (normally not less than 15 minutes) and the monitoring duration should reflect the range of background sound levels across the assessment period. The background sound level used for the assessment should be representative of the period being assessed.

The specific sound level is the $L_{Aeq,Tr}$ of the sound source being assessed over the reference time interval, $T_r$. BS 4142 advises that $T_r$ should be 1 hour during the day and 15 minutes at night.

The rating level is the specific sound level plus any adjustment for the characteristics of the sound (tone, impulse, intermittent or other acoustic feature). The standard describes subjective and objective methods to establish the appropriate adjustment. The adjustments for the different features and assessment methods are summarised in Table 2.1.

Where tonal and impulsive characters are present in the specific sound within the same reference period then these two corrections can both be taken into account. If one feature is dominant, it might be appropriate to apply a single correction.

The rating level is equal to the specific sound level if there are no features present.
Table 2.1: Summary of Potential Acoustic Feature Adjustments

<table>
<thead>
<tr>
<th>Acoustic Feature</th>
<th>Adjustment for Acoustic Feature</th>
<th>Subjective Methods</th>
<th>Objective Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonality</td>
<td>+2 dB if just perceptible</td>
<td>Third Octave Analysis</td>
<td>Narrow Band Analysis</td>
</tr>
<tr>
<td></td>
<td>+4 dB if clearly perceptible</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>+6 dB if highly perceptible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impulsivity</td>
<td>+3 dB if just perceptible</td>
<td>Sliding scale of 0 to +6 dB depending on audibility of tone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+6 dB if clearly perceptible</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>+9 dB if highly perceptible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermittency</td>
<td>+3 dB if intermittency is readily distinctive</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>+3 dB if neither tonal nor impulsive, but otherwise readily distinctive</td>
<td>n/a</td>
<td></td>
</tr>
</tbody>
</table>

The level of impact is assessed by comparing the rating level of the specific sound source with the background sound level. Typically, the greater the difference, the greater the magnitude of the impact depending on the context. Other factors that may require consideration include the absolute level of sound, the character and level of the residual sound compared to the specific sound, and the sensitivity of the receptor and scope for mitigation.

When the rating level is above the background sound level, a difference of around +5 dB is likely to indicate an adverse impact and a difference of around +10 dB or more is likely to indicate a significant adverse impact, depending on the context.

The lower the rating level with respect to the background sound level, the less likely it is that the specific sound source will have an 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.

2.3 British Standard 8233

British Standard (BS) 8233: 2014 “Guidance on sound insulation and noise reduction for buildings” gives recommendations for the control of noise in and around buildings, and suggests indoor ambient noise levels for dwellings from noise sources without a specific character (“anonymous noise”).
For dwellings, the main considerations are the acoustic effects on sleep in bedrooms, and resting, listening and communicating in other rooms. The suggested levels in dwellings due to steady external noise, such as road traffic, mechanical services or continuously running plant, are presented below in Table 2.2 (based on Table 4 of BS 8233: 2014).

Table 2.2: Summary of BS8233:2014 Levels for Dwellings

<table>
<thead>
<tr>
<th>Activity</th>
<th>Location</th>
<th>Indoor ambient noise levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Daytime</strong> 07:00 to 23:00 hours</td>
</tr>
<tr>
<td>Resting</td>
<td>Living room</td>
<td>35 dB L_{Aeq,16hour}</td>
</tr>
<tr>
<td>Dining</td>
<td>Dining room/area</td>
<td>40 dB L_{Aeq,16hour}</td>
</tr>
<tr>
<td>Sleeping / daytime resting</td>
<td>Bedroom</td>
<td>35 dB L_{Aeq,16hour}</td>
</tr>
</tbody>
</table>

BS 8233: 2014 notes the following:

- The suggested levels are based on existing guidelines issued by the World Health Organisation and assume normal diurnal fluctuations in external noise. In cases where local conditions do not follow a typical diurnal pattern, an appropriate alternative time period, e.g. 1 hour, may be used but the level should be selected to ensure consistency with the recommended values tabulated above.

- Regular individual events, e.g. aircraft or trains, can cause sleep disturbance. Guideline values may be required in terms of a single event level (SEL) or maximum value (L_{Amax,i}) depending on the character and number of events per night.

- If relying on closed windows to meet the guideline values, there needs to be an appropriate, alternative means of ventilation that does not compromise the façade insulation or the resulting internal noise level.

- Where development is considered necessary or desirable, the internal levels tabulated above may be relaxed by up to 5 dB and reasonable internal conditions still be achieved.

As well as indoor ambient noise limits, BS 8233 also provides design criteria for noise outside dwellings.
BS 8233: 2014 also provides guidance on acoustic criteria and noise levels appropriate for other various types of space that have different functions, including office spaces. Table 2.3 below summaries the relevant criteria (based on Tables 2 and 6 of BS 8233: 2014).

Table 2.3: Summary of BS8233:2014 Typical Noise Levels for Offices

<table>
<thead>
<tr>
<th>Activity / Objective</th>
<th>Location / Typical Situation</th>
<th>Design range dB $L_{Aeq,T}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study and work requiring concentration</td>
<td>Staff/meeting room, training room</td>
<td>35 - 45</td>
</tr>
<tr>
<td></td>
<td>Executive office</td>
<td>35 - 40</td>
</tr>
<tr>
<td>Typical noise levels for acoustic privacy in shared spaces</td>
<td>Open plan office</td>
<td>45 - 50</td>
</tr>
</tbody>
</table>

2.4 Local Authority

WBM contacted the Environmental Protection Team at Kettering Borough Council on 7 July 2016 regarding current policy on noise. Rachel Fields (Team Leader) in Environmental Protection advised that the council has no specific written policy on noise, but would normally work on the basis that plant noise limits for the noise sensitive residential locations should be set at between 3-5 dB below the representative baseline background sound levels. Any application would be considered on its merits in terms of what limits should apply.

In a further discussion with the Environmental Protection Team Leader on 11 July 2016, WBM proposed that plant noise limits for non-residential buildings would be for the internal noise levels to be based upon the guidance contained within BS 8233:2014. This was considered acceptable.

Therefore, plant noise limits at dwellings are proposed to be at or lower than 5 dB below the representative baseline background sound level, $L_{A90,T}$, measured at the nearest noise sensitive receptors to the plant and, for the non-residential receptors, plant noise should not exceed the design internal ambient noise level guidance contained within BS 8233:2014.
3 Site Description

The William Knibb Centre is a Northamptonshire County Council building located on Montagu Street, Kettering, NN16 8AE. WBM understand that the buildings accommodate a Centre for Young Adults, child protection and other offices, along with a Complementary Education Centre (Academy).

The site is bounded by Montagu Street to the north and Alfred Street to the south and there is a mix of commercial, retail and residential buildings nearby. Refer to site location map in Appendix B.

The child protection offices in the existing red brick building and the offices within the 3 storey office block are to be refurbished and will have new external plant. The plant is understood to operate during normal office daytime periods only, but may be called upon during frost conditions to provide low level heating. The proposed location for the plant is the ground floor south facing façade of the existing 3 storey office building, adjacent the car park, accessed off Alfred Street.

The nearest noise sensitive receptors to the plant will be the existing 3 storey office building, the academy building and the nearest dwellings on Alfred Street, these being house numbers 20 and 22.

4 Measurement Methodology

LGSS has advised WBM that the M&E plant is intended to operate during normal office hours in the daytime period only. However, as the plant may be called upon during frost conditions to provide low level heating it may occasionally need to operate during the evening and night-time on any day if required in very cold weather. In addition, during cold weather the plant may need to come on just prior to 07:00 hours in order to bring the building up to temperature.

Therefore survey measurements have been undertaken to cover daytime, evening and night-time periods including weekends.
4.1 Measurement Description

Sample Measurements

Baseline sound surveys were undertaken during the daytime on Wednesday 6 July 2016, between the hours of 13:00 and 14:30pm, and on Thursday 15 September 2016, between 12:15 and 12:50pm in the vicinity of the William Knibb Centre and at the nearest dwellings on Alfred Street.

Sample 15 minute measurements were undertaken at the locations A to C as shown in the site location plan in Appendix B and described in Table 4.1 below. All of the sound level meter locations were in the free field.

Location A has been used to represent the nearest noise sensitive dwellings to the proposed plant compound. Locations B and C represent the nearest non-residential uses.

Table 4.1: Description of Measurement Locations

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>In line with front façade of 20/22 Alfred Street in centre of path.</td>
</tr>
<tr>
<td>B</td>
<td>In car park in line with façade of 3 storey offices, approximately 3.5m to east.</td>
</tr>
<tr>
<td>C</td>
<td>In car park in front of brick single storey office building, approximately 4.5m to south.</td>
</tr>
</tbody>
</table>

The survey details are presented in Appendix C.

Data Logging Measurements

In addition to sample measurements, a data logging sound level meter was installed on the south facing façade of the William Knibb Centre facing the nearest dwellings and Location A. The microphone was mounted at first floor level out of a window and was located at approximately 1m from the façade using a bespoke A-frame support.

The noise climate in the area was monitored for a period of over 5 days between Thursday 15 September 2016 and Tuesday 20 September 2016. This location is shown on the plan in Appendix B and it is noted that this was the only possible location for the install due to window types elsewhere. The location is considered to be slightly screened in comparison to Location A.

The survey details are presented in Appendix D.
4.2 Results

The detailed results from the attended survey are presented in Appendix E and for the installed monitoring equipment in Appendix F. For the latter the data is presented as a graph and as a table of 15 minutes measurements.

Sample Measurements

The detailed survey results are presented in Appendix E and a summary of the survey results is presented below in Table 4.2, as a range of values for $L_{A_{\text{max,f}}}$ noise levels, logarithmic averages for $L_{A_{\text{eq,T}}}$ levels and arithmetic averages for the other parameters.

<table>
<thead>
<tr>
<th>Location</th>
<th>$L_{A_{\text{eq,15mins}}}$</th>
<th>$L_{A_{\text{max,f}}}$</th>
<th>$L_{A_{10,15mins}}$</th>
<th>$L_{A_{90,15mins}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>53</td>
<td>67-85</td>
<td>53</td>
<td>40 (40)</td>
</tr>
<tr>
<td>B</td>
<td>45</td>
<td>62-65</td>
<td>47</td>
<td>39 (38)</td>
</tr>
<tr>
<td>C</td>
<td>47</td>
<td>61-72</td>
<td>49</td>
<td>37 (36)</td>
</tr>
</tbody>
</table>

* Average level shown with lowest $L_{A_{90,15mins}}$ in brackets

The noise climate was generally controlled by road traffic on Montagu Street and Victoria Street, with intermittent road traffic on Alfred Street. In addition car park activity in the William Knibb Centre car park and at nearby houses contributed to the ambient noise levels. Detailed observations are shown in Appendix E.

Data Logging Measurements

The detailed survey results are presented in Appendix F and a summary of the survey results is presented below in Table 4.3, excluding any 15 minute samples where wind speeds were above 5m/s and/or rain occurred.

The average levels are shown for each day and each daytime period (07:00-19:00 hours), evening period (19:00-23:00 hours) and night-time period (23:00-07:00 hours).

For the installed equipment the location was a façade location. As can be seen from Table 4.2 and Table 4.3 the daytime free field dwelling location average is 2 dB less than the daytime façade average.
Table 4.3: Averaged Noise Sound for Installed Meter

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Façade Sound Level dB $L_{A90,15\text{mins}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Daytime</td>
</tr>
<tr>
<td>15/09/2016</td>
<td>Thursday</td>
<td>42</td>
</tr>
<tr>
<td>16/09/2016</td>
<td>Friday</td>
<td>45</td>
</tr>
<tr>
<td>17/09/2016</td>
<td>Saturday</td>
<td>40</td>
</tr>
<tr>
<td>18/09/2016</td>
<td>Sunday</td>
<td>39</td>
</tr>
<tr>
<td>19/09/2016</td>
<td>Monday</td>
<td>42</td>
</tr>
<tr>
<td>20/09/2016</td>
<td>Tuesday</td>
<td>43</td>
</tr>
<tr>
<td>Averages</td>
<td></td>
<td>42</td>
</tr>
</tbody>
</table>

The difference in the same sample free field measurement undertaken at 12:15 hours on Thursday 15 September 2016 at Location A (Appendix C) and the installed meter sample measurement (Appendix F) at the same time was 3 dB $L_{A90,15\text{mins}}$. The difference between the façade and free field levels is taken to be 2 dB on average.

5 Proposed M&E Plant Noise Limits

As stated above, the M&E plant is intended to operate during normal office hours in the daytime period only, but may need to operate during the evening and night-time on any day for frost protection in very cold weather.

It is expected that the Local Authority requirements discussed with Environmental Protection and described in Section 2.4 will apply. The following plant noise limits are therefore proposed.

Note that all M&E plant noise limits should be confirmed to the M&E consultant / contractor for use in their design considerations.

5.1 Nearest Noise Sensitive Dwellings

It is proposed that the plant noise limits for the nearest residential dwellings on Alfred Street should be 5 dB below the representative baseline background sound level for each period as shown in Table 5.1 below. These are shown as façade levels as only façade measurements were carried out in the evening and night-time periods.
This is the specific sound level, $L_{Aeq,Tr}$, for the plant which is assessed over the reference time period, $Tr$. BS 4142: 2014 advises that $Tr$ should be 1 hour during the daytime and 15 minutes during the night-time.

Table 5.1: Proposed Façade Plant Noise Limits at Residential Receptors on Alfred Street

<table>
<thead>
<tr>
<th>Location</th>
<th>$dB\ L_{A90,T}$</th>
<th>Plant Noise Limit Rating Level, $dB\ L_{Ar,15mins\ façade}$&lt;sup&gt;1,2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daytime</td>
<td>42</td>
<td>37</td>
</tr>
<tr>
<td>Evening</td>
<td>39</td>
<td>34</td>
</tr>
<tr>
<td>Night-time</td>
<td>33</td>
<td>28</td>
</tr>
</tbody>
</table>

<sup>1</sup> As per BS 4142, the time period for daytime (07:00-23:00 hours) is 1 hour and for night-time (23:00-07:00 hours) is 15 minutes.

<sup>2</sup> The design noise level of the plant ($L_{Aeq,T}$) may need to be lower than this level if the plant is likely to generate any acoustic characteristics at the nearest noise sensitive receptors as set out in BS 4142 (Sections 2.2).

In accordance with BS 4142 and as described in Section 2.2, should any installed and operating plant have any specific characteristics (such as tone, impulse, intermittent or other acoustic feature) audible at the nearest noise sensitive receptors, then a penalty adjustment for the characteristics of the sound will be applied. Therefore, the plant should be designed and installed so as to avoid such characteristics being audible at the nearest residential receptors.

5.2 **Nearest Noise Sensitive Offices & Academy**

It is proposed that the plant noise limits for the nearest office receptors is based on meeting internal noise levels set out in guidance within BS 8233:2014.

The nearest offices are on the south facing façade of the 3 storey office block. The plant is proposed to be at ground floor level and it is understood from the client’s architects, Stenton Obhi Architects (SO<sup>5</sup>) that the ground and first floor windows will be sealed and non-openable. The second floor windows are proposed to be openable.

The internal ambient noise levels for open plan offices and cellular offices are shown in Section 2.4. BS 8233:2014 indicates the following internal design ranges, $L_{Aeq,T}$:

- **Executive office:** 35-40 dBA
- **Staff/meeting room, training room:** 35-45 dBA
- **Open plan office:** 45-50 dBA
The offices are indicated in the architectural layouts drawings as a flexible meeting space at ground floor and small open plan spaces at first and second floor. WBM has assessed the plant noise break-in requirement to be 35 dBA to allow for all uses and other external noise sources.

For the ground and first floor levels the windows can be designed and selected to achieve the above limits. For the second floor level, assuming open windows and a typical 10 dB open window attenuation, the external free field noise level due to plant should be no more than 45 dB $L_{Aeq,1\text{hour}}$.

The same limit will apply to the child protection offices although these are 30m further away and screened from the proposed plant location by the 3 storey building.

**Academy Building**

It is proposed that the plant noise limits for the nearby Complementary Education Academy should be based on the upper internal noise limit for secondary school classrooms in BB93 (February 2015).

This would be 35dB $L_{Aeq,30\text{mins}}$, and, allowing for open window attenuation, the plant noise limit outside the nearest academy windows should therefore be no more than 45 dB $L_{Aeq,1\text{hour}}$.

In summary the following plant noise limits in Table 5.2 are proposed for the offices and academy building and should be confirmed to the M&E Designers.

**Table 5.2: Proposed Free Field Plant Noise Limits for Offices & Academy**

<table>
<thead>
<tr>
<th>Location</th>
<th>Basis of Limits</th>
<th>Plant Noise Limit dB $L_{Aeq,1\text{hour}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second floor offices &amp; nearest Academy windows (Survey Location B)</td>
<td>Limit based upon internal level of 35 dBA (BS8233) and open windows.</td>
<td>45</td>
</tr>
<tr>
<td>Ground &amp; First floor office windows (Survey Location B)</td>
<td>Limit based upon internal level of 35 dBA (BS8233) and sealed window acoustic performance. (1)</td>
<td></td>
</tr>
<tr>
<td>Ground floor offices (Child Protection) (Survey Location C)</td>
<td>Limit based upon internal level of 35 dBA (BS8233) and open windows.</td>
<td>45</td>
</tr>
</tbody>
</table>

(1) The required window performance will need to be assessed based upon the internal noise level of 35 dBA. For example a façade (window and wall) overall performance of 25dB sound reduction outside to inside may mean that the cumulative noise level from all plant could not exceed 60 dBA $L_{Aeq,1\text{hour}}$. 


6 Evaluation and Analysis of Plant Noise Data

Figure 1 below shows the location of the compound area for the proposed external plant. The compound is approximately 5.5m x 2.5m and is currently proposed to have a hit and miss fence, assumed to be at least 1.7m high. The north side of the compound is the building facade.

The south boundary, towards the dwellings, is a brick wall, which is about 1.65m above the ground level of the compound area. Note that the ground level on the street side of the wall is lower than the ground level in the compound by up to 0.5m, based on the site plan levels.

Figure 1: Proposed Plant Compound Location
6.1 Plant Details

WBM understands that the external plant is to comprise 2 No Mitsubishi Electric Co Heat Recovery Units, one EP-900 unit and one EP400 unit or equivalent type units. The height of the units is 1.71m above local ground level, higher if the units are to be elevated off the ground.

The units generate noise from the body of the plant through valve action, refrigeration flow and internal pressure changes under normal operation. This could be mainly at a lower level. At high level the discharge fans are the main noise source. The manufacturer’s noise level data supplied to WBM only give the overall noise levels due to both these sources when operating on standard or low noise mode.

The manufacturer’s measured noise levels for each unit are shown in Table 6.1 for both ‘standard’ and ‘low noise’ operation. As well as having a low noise mode these units are proposed to be fitted with bespoke ‘Acoustic Kits’ comprising a top attenuator pod and vertical attenuators on 3 sides. The units are manufactured by Ambient Acoustics Limited (www.ambientacoustics.co.uk) and provide the attenuation levels indicated in Table 6.1, resulting in the plant noise levels shown.

Table 6.1: Manufacturer’s Plant Noise Data & Attenuated Noise Levels

<table>
<thead>
<tr>
<th>Heat Recovery Unit</th>
<th>Freq (Hz)</th>
<th>Octave Band Sound Pressure Level, dB Lp (at 1m height and 1m distance on a flat reflecting plane)</th>
<th>Overall dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>63</td>
<td>125</td>
<td>250</td>
</tr>
<tr>
<td>PURY-EP900YSLM-A1</td>
<td>Standard</td>
<td>76</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>Low noise</td>
<td>68</td>
<td>64</td>
</tr>
<tr>
<td>PURY-EP400YLM-A1</td>
<td>Standard</td>
<td>73</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>Low noise</td>
<td>65</td>
<td>61</td>
</tr>
<tr>
<td>Full acoustic kit reduction (dB)</td>
<td>-3</td>
<td>-5</td>
<td>-6</td>
</tr>
</tbody>
</table>

Plant noise levels with acoustic kits

<table>
<thead>
<tr>
<th>Heat Recovery Unit</th>
<th>Freq (Hz)</th>
<th>Octave Band Sound Pressure Level, dB Lp (at 1m height and 1m distance on a flat reflecting plane)</th>
<th>Overall dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>63</td>
<td>125</td>
<td>250</td>
</tr>
<tr>
<td>PURY-EP900YSLM-A1</td>
<td>Standard</td>
<td>73</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Low noise</td>
<td>65</td>
<td>59</td>
</tr>
<tr>
<td>PURY-EP400YLM-A1</td>
<td>Standard</td>
<td>70</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>Low noise</td>
<td>62</td>
<td>56</td>
</tr>
</tbody>
</table>
6.2 Calculated Plant Noise Levels

WBM has used the data in Table 6.1, based on the Acoustic Kits being incorporated with the design, to calculate the noise break-out from the plant. In addition the following is allowed for in the calculations:

1. The ground and wall reflecting surfaces are fully reflective and a hemispherical propagation constant applies.

2. The hit and miss fence proposed is assumed to be no more than 1.7m high. However, such a fence has regular openings and would provide limited screening.

3. From the SO² proposed site plan drawing No PL/NCC002/301/D, the site level in the area of the proposed compound is 91.83m and on the pavement in the same area is 91.31m. The boundary brickwork wall height is 93.48m. Therefore the wall height above the plant compound floor level is about 1.65m high and above the pavement level is about 2.15m. The heat recovery unit, with an allowance for support feet, is 1.75m high, plus the acoustic kit of 0.3m takes the overall source height to 2.05m. There is therefore only a small degree of screening provided by the wall, mainly to the body of the units.

4. There is no screening of plant to the first and second floor office windows.

5. The screening of the plant at the child protection office location will be at least 10 dBA and up to 15 dBA. Therefore 12 dB has been allowed in the calculation.

6. It is assumed for the purposes of calculations that the centre of the PURY-EP900YSLM-A1 unit will be 1m away from the boundary wall and that the PURY-EP400YLM-A1 unit will be about 2.3m away from the boundary wall. This is understood to be feasible according to the M&E designers, TPES LLP.

7. The final selection and size of the units may change during the detailed design development; however the alternative plant selected is to have similar plant noise levels or lower levels.

8. The units will need to run during the evening / night-time to provide frost protection and reduce the warm up period prior to building occupation. TPES intend to design the systems to cater for this such that these units will only run in low noise mode during these periods. This has been allowed for in the calculations.
The expected free field plant noise level at each noise sensitive receptor location, with the acoustic kits fitted, has been determined for both low noise and standard heat recovery unit operation for both the daytime and night-time periods. Provided that the night-time limits can be met, the evening limits will also be achieved.

Note that WBM has calculated the free field noise level for the specific plant sources for comparison with the proposed free field noise limits. Hence for the installed meter façade levels these have been adjusted, as indicated in Section 4.2 by -2dB, so that all levels presented are free field for comparison with calculated free field noise limits.

**Daytime ‘Standard’ Operation**

The results of calculations for the daytime are shown in Tables 6.2, below.

**Table 6.2(a): Calculated Plant Noise Level for 900 units ‘Standard’ Daytime Mode**

<table>
<thead>
<tr>
<th>Noise Sensitive Location</th>
<th>Plant Dist (m)</th>
<th>Plant Noise at 1m (dB)</th>
<th>Wall Refl’n (dB)</th>
<th>Dist Atten. (dB)</th>
<th>Screening Atten. (dB)</th>
<th>Calculated Plant Noise (dB L_{Aeq,T})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academy window</td>
<td>10</td>
<td>58</td>
<td>+3</td>
<td>- 20</td>
<td>-0</td>
<td>41</td>
</tr>
<tr>
<td>Ground office</td>
<td>3.25</td>
<td>58</td>
<td>+3</td>
<td>- 10</td>
<td>0</td>
<td>51</td>
</tr>
<tr>
<td>First floor office</td>
<td>4.5</td>
<td>58</td>
<td>+3</td>
<td>- 13</td>
<td>0</td>
<td>48</td>
</tr>
<tr>
<td>Second floor office</td>
<td>7.5</td>
<td>58</td>
<td>+3</td>
<td>- 18</td>
<td>0</td>
<td>43</td>
</tr>
<tr>
<td>Residential</td>
<td>14.75</td>
<td>58</td>
<td>+6</td>
<td>- 23</td>
<td>- 2</td>
<td>39</td>
</tr>
<tr>
<td>Child Protection offices</td>
<td>34</td>
<td>58</td>
<td>+3</td>
<td>- 31</td>
<td>- 12</td>
<td>18</td>
</tr>
</tbody>
</table>

**Table 6.2(b): Calculated Plant Noise Level for 400 units ‘Standard’ Daytime Mode**

<table>
<thead>
<tr>
<th>Noise Sensitive Location</th>
<th>Plant Dist (m)</th>
<th>Plant Noise at 1m (dB)</th>
<th>Wall Refl’n (dB)</th>
<th>Dist Atten. (dB)</th>
<th>Screening Atten. (dB)</th>
<th>Calculated Plant Noise (dB L_{Aeq,T})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academy window</td>
<td>8</td>
<td>55</td>
<td>+3</td>
<td>-18</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>Ground office</td>
<td>2</td>
<td>55</td>
<td>+3</td>
<td>-6</td>
<td>0</td>
<td>52</td>
</tr>
<tr>
<td>First floor office</td>
<td>3.75</td>
<td>55</td>
<td>+3</td>
<td>-11</td>
<td>0</td>
<td>47</td>
</tr>
<tr>
<td>Second floor office</td>
<td>6.75</td>
<td>55</td>
<td>+3</td>
<td>-17</td>
<td>0</td>
<td>41</td>
</tr>
<tr>
<td>Residential</td>
<td>16</td>
<td>55</td>
<td>+6</td>
<td>-24</td>
<td>3</td>
<td>34</td>
</tr>
<tr>
<td>Child Protection offices</td>
<td>36</td>
<td>55</td>
<td>+3</td>
<td>-31</td>
<td>12</td>
<td>15</td>
</tr>
</tbody>
</table>
Table 6.2(c): Calculated Total Plant Noise Level ‘Standard’ Daytime Mode

<table>
<thead>
<tr>
<th>Noise Sensitive Location</th>
<th>Calculated Plant Noise (dB L_{Aeq,T})</th>
<th>Plant Total Noise Level at d (dB L_{Aeq,T})</th>
<th>Daytime Plant Noise Limit (dB L_{Aeq,T})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>‘900’ Unit</td>
<td>‘400’ Unit</td>
<td></td>
</tr>
<tr>
<td>Academy window</td>
<td>41</td>
<td>40</td>
<td>44</td>
</tr>
<tr>
<td>Ground office</td>
<td>51</td>
<td>52</td>
<td>55</td>
</tr>
<tr>
<td>First floor office</td>
<td>48</td>
<td>47</td>
<td>51</td>
</tr>
<tr>
<td>Second floor office</td>
<td>43</td>
<td>41</td>
<td>45</td>
</tr>
<tr>
<td>Residential</td>
<td>39</td>
<td>34</td>
<td>40</td>
</tr>
<tr>
<td>Child Protection offices</td>
<td>18</td>
<td>15</td>
<td>20</td>
</tr>
</tbody>
</table>

(1) The required window performance will need to be assessed based upon an internal noise level of 35 dBA.
(2) The measured level is a façade level but this is adjusted here, as indicated in Section 4.2 by -2dB, so that all levels presented are free field for comparison with free field noise limits.

As can be seen from Table 6.3(c) the plant noise levels at the nearest academy window and the second floor offices should just be achievable. The plant noise level at the child protection offices is readily achieved. However, the plant noise level at the nearest residential could be up to 5dB above the proposed plant noise limit and further mitigation will be necessary.

Evening and Night-time ‘Low noise’ Operation

The evening and night-time operations are only relevant to the residential buildings and the calculation results for the evening and night-time ‘low noise’ operation is shown in Table 6.3, below.

Table 6.3(a): Calculated Plant Noise Level for 900 units ‘low noise’ Evening/Night-time Mode

<table>
<thead>
<tr>
<th>Noise Sensitive Location</th>
<th>Plant Dist (m)</th>
<th>Plant Noise at 1m (dB)</th>
<th>Wall Refi’n (dB)</th>
<th>Dist Atten. (dB)</th>
<th>Screening Atten. (dB)</th>
<th>Calculated Plant Noise (dB L_{Aeq,T})</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘900’ Unit</td>
<td>14.75</td>
<td>48</td>
<td>+6</td>
<td>- 23</td>
<td>- 1</td>
<td>30</td>
</tr>
<tr>
<td>‘400’ Unit</td>
<td>16</td>
<td>45</td>
<td>+6</td>
<td>-24</td>
<td>1</td>
<td>26</td>
</tr>
</tbody>
</table>

Table 6.3(b): Total Plant Noise Level ‘low noise’ Evening/Night-time Mode

<table>
<thead>
<tr>
<th>Noise Sensitive Location</th>
<th>Calculated Plant Noise (dB L_{Aeq,T})</th>
<th>Plant Total Noise Level at d (dB L_{Aeq,T})</th>
<th>Night-time Plant Noise Limit (dB L_{Aeq,T})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>‘900’ Unit</td>
<td>‘400’ Unit</td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>30</td>
<td>26</td>
<td>31</td>
</tr>
</tbody>
</table>

(1) The measured level is a façade level but this is adjusted here, as indicated in Section 4.2 by -2dB, so that all levels presented are free field for comparison with calculated free field levels.
For the evening and night-time use the units should be on ‘low noise’ operating mode. The plant noise is only relevant for the residential units as the offices and academy will not be in use. The evening plant noise limit from Table 5.1 is 34 dB $L_{Aeq,15min}$ and this will be achieved by plant operating on ‘low noise’ operating mode.

However, as can be seen from Table 6.3 the plant level could be up to 5dB above the proposed plant noise limit for night-time operation and further mitigation will be necessary.

6.3 Ground & First Floor Office Receptor Windows

For the ground and first floor offices the sealed window systems are to be selected to control the plant noise break-in. These windows (and wall) should be capable of reducing the external noise level of 55 dB $L_{Aeq,T}$ and 51 dB $L_{Aeq,T}$, respectively to 35 dB $L_{Aeq,T}$ inside the offices.

WBM has used the plant noise spectrum data to determine the acoustic performance of the curtain walling system that would be required to achieve the above internal noise levels due to the proposed M&E plant.

For this it is assumed that the office internal reverberation time would be around 1 second, which is appropriate for such spaces.

Note that the whole curtain walling system, including spandrel panels within the system, will need to be of the same performance as the glazing, unless internal wall systems behind are designed to provide further sound insulation. The curtain walling has been scaled off the elevations as 3.6m wide and assumed full room height (assumed to be 2.7m). WBM should be advised if these dimensions are incorrect.

To achieve the required internal noise levels due to the external plant, the acoustic performance of the curtain walling system (frame, glazing and spandrel panels) for the ground floor level should be at least a good thermal double glazed unit having an acoustic performance of at least 32 dB $R_w$ and 29 dB $R_{tr}$.

For the first floor level the curtain walling system (frame, glazing and spandrel panels) should be at least a good thermal double glazed unit having an acoustic performance of at least 30 dB $R_w$ and 27 dB $R_{tr}$
The curtain walling system to be installed should be checked and confirmed as suitable once specific plant data and locations have been confirmed and the manufacturer’s test data for the curtain wall system should be requested for confirmation of performance.

Academy Building

The plant noise levels at the adjacent academy building are indicated to be just acceptable. However, it is recommended that the hit and miss fence to the west side of the compound towards the academy building is a solid construction with a surface mass of at least 12 kg/m².

6.4 Residential Receptor Plant Mitigation

As indicated in Section 6.2, although the plant neat recovery units will be fitted with bespoke ‘Acoustic Kits’, further mitigation will be required to the plant in order achieve the plant noise limits at the residential dwellings on Alfred Street during both standard daytime operation and low noise night-time operation. Note that evening low noise operation will meet the proposed plant noise limits.

The practical option for reducing the plant noise level further is two fold:

a) Reduce reflection from the south facing wall of the building towards residential dwellings by having a localised absorbent lining on the wall area;

b) Increasing the height of the screening to the compound.

Reduction in Reflections

To reduce reflections from the wall we would recommend covering the wall area of the building, within the façade compound with a weatherproof absorptive material. The area should be from around 0.5m above the ground level to a level in line with the top of the screen. Again this should be reviewed when the final plant locations are known.

Some potential acoustic linings with an acoustically absorbent material to reduce reflections are:

- Quietstone (50mm panel with 25mm gap): (http://www.quietstone.co.uk/product/quietstone-light/)
- Custom Audio Designs Ltd also do the Acoustison-50:
  (http://www.customaudiodesigns.co.uk/acoustison-perforated-steel-acoustic-absorbers.htm)
- Allaway Acoustic, Enclosure Panel Model EP50/UF
  (www.allawayacoustics.co.uk/pdfs/enclosures/E040C-EP50UF.pdf)

**Increased Screening**

The increase in screen height is required to satisfy both daytime and night-time operation of plant. However, it is the night-time operation that will determine the required minimum height of the screen.

The increase in height needs to be at least 0.8m and this can be achieved by a vertical screen addition to the wall or it may be a screen which is angled back towards the building designed to give the same level of screening to the residential receptors.

The screen will need to run down the sides of the compound also for about 1m on the east side and approximately 2m on the west side, subject to confirmation of the final plant locations.

**Academy Building**

As indicated in Section 6.3, it is recommended that the hit and miss fence to the west side of the compound towards the academy building is also a solid construction with a surface mass of at least 12 kg/m².

It is expected that with the above mitigation recommendations the plant (with the proposed Acoustic Kits) should be able to achieve the proposed plant noise limits set out in this report.

7 **Summary and Conclusions**

WBM was commissioned by LGSS Property Services to provide acoustic advice for the refurbishment of specific areas of the William Knibb Centre, Montagu Street, Kettering, NN16 8AE. Part of this work includes carrying out baseline sound surveys during daytime, evening and night-time periods to assist with a planning application in relation to external M&E Plant.
The plant is to be located externally at ground floor level next to the south facing façade of the existing 3 storey office building and adjacent the William Knibb Centre car park, accessed off Alfred Street. The plant is to be housed in a compound with the office building to the south, hit and miss fencing to the east and west, and a boundary brick wall to the north.

The plant is expected to operate in its ‘standard’ mode of operation during normal office hours only, but during the evening and night-time it could operate in a ‘low noise’ mode to heat the building during frost conditions and building pre-heat periods.

This report sets out the results of the surveys undertaken on 6 July 2016 and 15 to 20 September 2016 and proposes appropriate plant noise limits for the operation of the plant.

The proposed plant has been assessed in terms of meeting these noise limits. The findings of this assessment are that for the daytime mode of operation the plant noise limits at the commercial office buildings and at the academy should be achieved.

In terms of the nearest residential dwellings, the findings of this assessment are that under daytime ‘standard’ operating mode and under night-time ‘low noise’ operating mode, the noise break-out from the M&E plant may exceed the plant noise limits by 5dBA. However, with the incorporation of absorbent lining to the plant area and an increase in screen height of 0.8m the plant noise limits should be achieved.

Guidance on the lining and improvement in screening is set out in this report, which is subject to confirmation when the final plant selection is made.

Richard Lyons  
BEng PhD CEng MIOA MCIBSE  
Partner  
(This document has been generated electronically and therefore bears no signature)
Appendix A – Glossary of Acoustic Terms

General Noise and Acoustics

The following section describes some of the parameters that are used to quantify noise.

Decibels dB

Noise levels are measured in decibels. The decibel is the logarithmic ratio of the sound pressure to a reference pressure (2x10⁻⁵ Pascals). The decibel scale gives a reasonable approximation to the human perception of relative loudness. In terms of human hearing, audible sounds range from the threshold of hearing (0 dB) to the threshold of pain (140 dB).

A-weighted Decibels dB(A)

The ‘A’-weighting filter emulates human hearing response for low levels of sound. The filter network is incorporated electronically into sound level meters. Sound pressure levels measured using an ‘A’-weighting filter have units of dB(A) which is a single figure value to represent the overall noise level for the entire frequency range.

A change of 3 dB(A) is the smallest change in noise level that is perceptible under normal listening conditions. A change of 10 dB(A) corresponds to a doubling or halving of loudness of the sound. The background noise level in a quiet bedroom may be around 20–30 dB(A); normal speech conversation around 60 dB(A) at 1 m; noise from a very busy road around 70-80 dB(A) at 10m; the level near a pneumatic drill around 100 dB(A).

Façade Noise Level

Façade noise measurements are those undertaken near to reflective surfaces such as walls, usually at a distance of 1m from the surface. Façade noise levels at 1m from a reflective surface are normally around 3 dB greater than those obtained under freefield conditions.

Freefield Noise Level

Freefield noise measurements are those undertaken away from any reflective surfaces other than the ground.

Frequency Hz

The frequency of a noise is the number of pressure variations per second, and relates to the “pitch” of the sound. Hertz (Hz) is the unit of frequency and is the same as cycles per second. Normal, healthy human hearing can detect sounds from around 20 Hz to 20 kHz.

Octave and Third-Octave Bands

Two frequencies are said to be an octave apart if the frequency of one is twice the frequency of the other. The octave bandwidth increases as the centre frequency increases. Each bandwidth is 70% of the band centre frequency.

Two frequencies are said to be a third-octave apart if the frequency of one is 1.26 times the other. The third octave bandwidth is 23% of the band centre frequency.

There are recognised octave band and third octave band centre frequencies. The octave or third-octave band sound pressure level is determined from the energy of the sound which falls within the boundaries of that particular octave of third octave band.

Equivalent Continuous Sound Pressure Level $L_{Aeq,T}$

The ‘A’-weighted equivalent continuous sound pressure level $L_{Aeq,T}$, is a notional steady level which has the same acoustic energy as the actual fluctuating noise over the same time period T. The $L_{Aeq,T}$ Unit is dominated by higher noise levels, for example, the $L_{Aeq,T}$ average of two equal time periods at, for example, 70 dB(A) and 50 dB(A) is not 60 dB(A) but 67 dB(A).

The $L_{Aeq}$ is the chosen unit of BS 7445-1:2003 “Description and Measurement of Environmental noise”.

Maximum Sound Pressure Level $L_{Amax}$

The $L_{Amax}$ value describes the overall maximum ‘A’-weighted sound pressure level over the measurement interval. Maximum levels are measured with either a fast or slow time weighted, denoted as $L_{Amax,f}$ or $L_{Amax,s}$ respectively.

Noise Rating NR

The noise rating level is a single figure index obtained from an octave band analysis of a noise. The NR level is obtained by comparing the octave band sound pressure levels to a set of reference curves and the highest NR curve that is intersected by the sound pressure levels gives the NR level.

Sound Exposure Level $L_{AE}$ or SEL

The sound exposure level is a notional level which contains the same acoustic energy in 1 second as a varying ‘A’-weighted noise level over a given period of time. It is normally used to quantify short duration noise events such as aircraft flyover or train passes.

Statistical Parameters $L_N$

In order to cover the time variability aspects, noise can be analysed into various statistical parameters, i.e. the sound level which is exceeded for N% of the time. The most commonly used are the $L_{A90,T}$, $L_{A90,T}$ and the $L_{A90,T}$.

$L_{A01,T}$ is the ‘A’-weighted level exceeded for 1% of the time interval T and is often used to gives an indication of the upper maximum level of a fluctuating noise signal.

$L_{A10,T}$ is the ‘A’-weighted level exceeded for 10% of the time interval T and is often used to describe road traffic noise. It gives an indication of the upper level of a fluctuating noise signal. For high volumes of continuous traffic, the $L_{A10,T}$ unit is typically 2–3 dB(A) above the $L_{Aeq,T}$ value over the same period.

$L_{A90,T}$ is the ‘A’-weighted level exceeded for 90% of the time interval T, and is often used to describe the underlying background noise level.
Appendix B – Site Location Map & Survey Locations

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>In line with front façade of 20/22 Alfred Street in centre of path.</td>
</tr>
<tr>
<td>B</td>
<td>In car park in line with façade of 3 storey offices, approximately 3.5m to east.</td>
</tr>
<tr>
<td>C</td>
<td>In car park in front of brick single storey office building, approximately 4.5m to south.</td>
</tr>
</tbody>
</table>
Appendix C – Attended Sample Survey Details

Date and Locations of Survey

Wednesday, 6 July 2016, 13:00 – 14:30 hours
Thursday, 15 September 2016, 12:15 – 14:50 hours

Noise measurements were undertaken in the vicinity of the William Knibb Centre at locations A to C on 6 July 2016 and A and B on 15 September 2016, as shown in Appendix B.

Survey carried out by

Dr Richard Lyons

Weather Conditions

Wednesday, 6 July 2016: Dry, ~40% cloud cover; sunny; warm 16-18 °C; winds westerly 2-3m/s.
Thursday, 15 September 2016: Dry, ~10% cloud cover; warm ~20 °C; still wind conditions.

Instrumentation used (Serial Number)

<table>
<thead>
<tr>
<th>Date</th>
<th>Meter</th>
<th>Location</th>
<th>Start Cal</th>
<th>End Cal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wednesday, 6 July 2016</td>
<td>Meter 1</td>
<td>B &amp; A (13:39 hrs)</td>
<td>113.8 dB(A)</td>
<td>113.7 dB(A)</td>
</tr>
<tr>
<td></td>
<td>Meter 2</td>
<td>C &amp; A (13:02 &amp; 14:14 hrs)</td>
<td>113.8 dB(A)</td>
<td>113.7 dB(A)</td>
</tr>
<tr>
<td>Thursday, 15 September 2016</td>
<td>Meter 2</td>
<td>A &amp; B</td>
<td>113.9 dB(A)</td>
<td>113.9 dB(A)</td>
</tr>
</tbody>
</table>

Calibration

The sensitivity of each meter was verified on site immediately before and after the survey. The measured calibration levels were as follows:

The meters and calibrators are tested monthly against a Brüel and Kjær Pistonphone, type 4220 (serial number 375806) and a Norsonic Calibrator, type 1253 (serial number 22906) with UKAS approved laboratory certificate of calibration. In addition, the meters and calibrators undergo traceable calibration at an external laboratory every two years.

Survey Details

Attended sample measurements of 15 minute duration were taken at locations A to C, as indicated in Appendix B. The microphone was at a height of between 1.2 and 1.5 metres above local ground level, in a free field location and representative of the nearby dwellings/commercial buildings.

Windshields were used throughout. Detailed observations of the sources of sound at each location are given in Appendix D.
Appendix D – Installed Equipment Survey Details

Date and Locations of Survey

A data logging sound level meter was installed to monitor sound levels in 15 minute samples from 12:00 hours on 15 September 2016 until 15:30 hours on 20 September 2016.

The external microphone was located on south facing façade of the William Knibb Centre at first floor level facing the nearest dwellings and Location A as shown in Appendix B.

Survey carried out by

Dr Richard Lyons

Weather Conditions

The weather conditions during installation were notes as dry, around 10% cloud cover and warm, ~20 °C; with low wind. Weather for other periods are hourly averages taken from Kettering historic weather records (www.timeanddate.com).

<table>
<thead>
<tr>
<th>Day &amp; Date</th>
<th>Period</th>
<th>Temp (°C)</th>
<th>Wind Speed (m/s)*</th>
<th>Direction</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thursday 15 September</td>
<td>Daytime</td>
<td>18-24</td>
<td>3.5-4.5</td>
<td>N/NE</td>
<td>Dry, hazy</td>
</tr>
<tr>
<td>2016</td>
<td>Evening</td>
<td>17-24</td>
<td>1.5-4.0</td>
<td>N/NE</td>
<td>Dry, hazy</td>
</tr>
<tr>
<td></td>
<td>Night-time</td>
<td>15-17</td>
<td>0.5-6.0</td>
<td>S-N</td>
<td>Dry, little cloud</td>
</tr>
<tr>
<td>Friday 16 September</td>
<td>Daytime</td>
<td>13-17</td>
<td>4.5-9.0</td>
<td>N/NW</td>
<td>Some rain showers as indicated in</td>
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<tr>
<td>2016</td>
<td>Evening</td>
<td>14-16</td>
<td>5.0-7.5</td>
<td>N/NW</td>
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</tr>
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<td>Night-time</td>
<td>13-14</td>
<td>6.0-8.0</td>
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<td>Saturday 17 September</td>
<td>Daytime</td>
<td>13-15</td>
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<tr>
<td>2016</td>
<td>Evening</td>
<td>14</td>
<td>3.0-4.0</td>
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<td>Dry, overcast</td>
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<tr>
<td></td>
<td>Night-time</td>
<td>11-13</td>
<td>1.0-4.5</td>
<td>W-N</td>
<td>Dry, some cloud</td>
</tr>
<tr>
<td>Sunday 18 September</td>
<td>Daytime</td>
<td>12-18</td>
<td>0.5-3.5</td>
<td>SW-N</td>
<td>Dry, sunny spells</td>
</tr>
<tr>
<td>2016</td>
<td>Evening</td>
<td>13-17</td>
<td>2.5-4.5</td>
<td>W</td>
<td>Dry, overcast</td>
</tr>
<tr>
<td></td>
<td>Night-time</td>
<td>13-15</td>
<td>2.5-4.0</td>
<td>W/NW</td>
<td>Dry, passing clouds</td>
</tr>
<tr>
<td>Monday 19 September</td>
<td>Daytime</td>
<td>14-16</td>
<td>1.0-6.0</td>
<td>W-N</td>
<td>Dry &amp; sunny, light rain spells as</td>
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<tr>
<td>2016</td>
<td>Evening</td>
<td>14</td>
<td>3.0-3.5</td>
<td>N</td>
<td>indicated in Appendix F</td>
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<tr>
<td></td>
<td>Night-time</td>
<td>12-14</td>
<td>1.0-4.0</td>
<td>N/NW</td>
<td>Light cloud with light rain spell</td>
</tr>
<tr>
<td></td>
<td>Evening</td>
<td>12-17</td>
<td>1.0-3.5</td>
<td>N/NW</td>
<td>as indicated in Appendix F</td>
</tr>
<tr>
<td>Tuesday 20 September</td>
<td>Daytime</td>
<td>12-17</td>
<td>1.0-3.5</td>
<td>N/NW</td>
<td>Mainly dry, cloudy, light rain</td>
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<tr>
<td>2016</td>
<td>Evening</td>
<td>12-17</td>
<td>1.0-3.5</td>
<td>N/NW</td>
<td>spell as indicated in Appendix F</td>
</tr>
</tbody>
</table>

* Wind speeds are at 10m and at ground level in suburban areas will be lower

Instrumentation and Calibration

The instrumentation used (including serial numbers in brackets) is tabulated below. The sensitivity of the meters was verified on site immediately before and after the survey using the field calibrator. The measured calibration levels were as follows:

<table>
<thead>
<tr>
<th>Install Location</th>
<th>Instrumentation (Serial Number)</th>
<th>Start Cal</th>
<th>End Cal</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Rion NL-52 Sound Level Meter (420715)</td>
<td>94.0 dB(A)</td>
<td>93.9 dB(A)</td>
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<tr>
<td></td>
<td>Rion NC-74 Calibrator (34425556)</td>
<td></td>
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</tr>
</tbody>
</table>
The meters and calibrators are tested monthly against a Brüel and Kjaer Pistonphone, type 4220 (serial number 375806) and a Norsonic Calibrator, type 1253 (serial number 22906) with UKAS approved laboratory certificate of calibration. In addition, the meters and calibrators undergo traceable calibration at an external laboratory every two years.

**Survey Details**

A data logging sound level meter was installed on an external A-frame on the south facing façade of the William Knibb Centre facing the nearest dwellings and Location A as shown in Appendix B. The microphone was mounted at first floor level out of a window and was located at approximately 1m from the façade.

15 minute sample façade measurements were recorded at the install location and a Rion WS-15 weatherproof windshields was used throughout.

**Observations**

At installation the following was noted: Intermittent road traffic on Alfred Street; passers-by talking and on phones; limited activity in Academy playground; activity in car park; distant aircraft movements; distant road traffic on Victoria Street and Montagu Street; distant siren; birdsong and distant reversing bleepers.

At collection the following was noted: distant road traffic on Victoria Street and Montagu Street; activity in car park; intermittent road traffic on Alfred Street; passers-by talking.
Appendix E – Sample Survey Results

Day & date: Wednesday 6 July 2016

Weather: Dry, around 40% cloud cover; sunny; warm 16-18 °C; winds westerly 2-3m/s.

<table>
<thead>
<tr>
<th>Location</th>
<th>Start Time (hh:mm)</th>
<th>Results dB free field (T = 15 minutes)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( L_{Aeq,T} )</td>
<td>( L_{Amax,f} )</td>
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<tr>
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<td>46</td>
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</tr>
<tr>
<td>A</td>
<td>13:02</td>
<td>49</td>
<td>67</td>
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<td>B</td>
<td>13:15</td>
<td>42</td>
<td>57</td>
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<tr>
<td>C</td>
<td>13:20</td>
<td>45</td>
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<tr>
<td>C</td>
<td>13:35</td>
<td>48</td>
<td>72</td>
</tr>
<tr>
<td>A</td>
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<td>C</td>
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<tr>
<td>B</td>
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</tr>
<tr>
<td>A</td>
<td>14:14</td>
<td>50</td>
<td>70</td>
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</table>
Appendix E (Continued)

**Day & date:** Thursday 15 September 2016

**Weather:** Dry, ~10% cloud cover; warm ~20 °C; still wind conditions.

<table>
<thead>
<tr>
<th>Location</th>
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<th>Results dB free field (T = 15 minutes)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12:15</td>
<td>$L_{A_{eq},T}$ 55, $L_{A_{max},T}$ 85, $L_{A_{10},T}$ 51, $L_{A_{90},T}$ 40</td>
<td>Distant Road Traffic (RT) on Montagu Street &amp; Victoria Street; intermittent RT on Alfred Street; passers-by; activity at academy playground; car movement behind dwellings; noisy van on Alfred Street; Activity at car park; distant aircraft movement.</td>
</tr>
<tr>
<td>B</td>
<td>12:33</td>
<td>$L_{A_{eq},T}$ 44, $L_{A_{max},T}$ 62, $L_{A_{10},T}$ 46, $L_{A_{90},T}$ 38</td>
<td>Distant RT on Montagu Street &amp; Victoria Street; Intermittent RT on Alfred Street; distant reversing bleepers; distant sirensx2; voices of passers-by; distant aircraft movement.</td>
</tr>
</tbody>
</table>
Installed Equipment (Facade Location) 15 to 20 September 2016
Appendix F (Continued)

Note that in the table below W = wind speeds were above 5 m/s and R = rainfall recorded. Data with W or R in last column has been left out of any analysis. All data is façade measured levels.

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<th>dB $L_{Amax,f}$</th>
<th>dB $L_{A10,15mins}$</th>
<th>dB $L_{A90,15mins}$</th>
<th>Wind/Rain</th>
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