



Review of Noise Impact Assessment

Proposed Sand and Gravel Quarry at Wasperton Farm, Barford

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Project	Wasperton Quarry, Barford
Client	Barford Residents Association

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A	18/08/2023	First issue
B	08/09/2023	Client comments addressed
B2	15/09/2023	Minor amendments

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Summary

Evolved Acoustics Ltd has undertaken a review of the noise matters associated with a planning application for a new sand and gravel quarry south of Barford in Warwickshire.

Following a review of the assumptions used in the applicant's noise assessment, several examples have been identified where actual source sound levels of the plant in use may be higher than those adopted in the noise predictions. In other cases, insufficient information is provided to justify the use of certain source data and model assumptions, leading to uncertainty in the assessment and the potential that predicted noise levels have been underestimated.

Except for the proposed 3m and 5m earth bunds, the applicant's submission contains minimal detailed commitment to best practices on noise control despite the requirements of the Government's Planning Practice Guidance on Minerals.

Based on the current proposals, there is a significant concern that noise from the quarry will not be monitored and reported in transparent manner. It is understood that the planning consent for Wolston Quarry, operated by Smiths Concrete, allows the operator to report on its noise monitoring only when they themselves have identified a breach of a noise limit, with no mechanism for scrutiny except if the Local Authority request copies of noise monitoring records. A recent Freedom of Information enquiry indicated that no noise monitoring report for Smiths Concrete's Wolston Quarry has ever been requested by Warwickshire County Council.

Considering the above, a much greater level of accountability should be placed upon the quarry operator through the provision of a robust noise monitoring regime should the quarry be granted planning permission. Recommendations for such a scheme have been put forward in this report.

The table below summarises the items reviewed from the applicant's submission along with a non-exhaustive list of comments on each item. Full details can be found in the report body.

Item	Comment on Applicant's Noise Submission
<i>Processing Plant</i>	Origin of Sound Power Level requires justification along with use of 4m source height.
<i>Dump Trucks</i>	Sound Power Level potentially underestimated. Low frequency noise from engines potentially overlooked.
<i>Infill Tipping</i>	Origin of Sound Power Level and basis for on-time correction require justification.



Item	Comment on Applicant's Noise Submission
<i>Ground Effects and Barriers</i>	<p>Full barrier calculations not provided; unclear whether low-frequency content of sound source has been accounted for in barrier calculation.</p> <p>Unclear whether assessment considers first-floor windows of receptors (likely to affect predicted noise levels).</p> <p>Uncertainty over whether prevailing wind conditions in Barford have been considered in acoustic model (potential to increase noise levels above those predicted in the NIA).</p>
<i>Proposed Noise Limits</i>	<p>Lower background readings obtained for some receptors compared to those in the NIA, lower noise limits suggested for these receptors.</p>
<i>Non-standard receptors</i>	<p>No assessment of non-standard receptors carried out in applicant's submission.</p>
<i>Noise Control Measures</i>	<p>Minimal commitment to adopt best practices on noise control. Additional measures put forward for consideration.</p>
<i>Monitoring</i>	<p>No commitment to monitoring provided. Concerns amongst residents as to accountability of the operator based on existing quarry operations.</p>
<i>Ecological Receptors</i>	<p>No assessment carried out in applicant's submission.</p>
<i>Vibration Assessment</i>	<p>No assessment carried out in applicant's submission.</p>



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1. Introduction

1.1 Scope

1.1.1 Evolved Acoustics Ltd was commissioned by Barford Residents Association to undertake an independent review of the noise aspects of a planning application for a new sand and gravel quarry at Wasperton Farm, south of Barford in Warwickshire.

1.1.2 The scope of this study includes:

- A review of the Noise Impact Assessment (NIA) submitted in support of the application.
- Contemporary baseline sound monitoring in the vicinity of the quarry site for comparison against the baseline levels presented in the NIA.
- Identification of any additional potential noise and vibration effects not considered in the applicant's submission.

1.2 Personnel

1.2.1 This study has been undertaken by Tim Hegan who is a corporate member of the Institute of Acoustics (MIOA). He has completed Institute of Acoustics Diploma in Acoustics and Noise Control and has 7 years' experience as an acoustic consultant working on a noise and vibration impact assessments across a variety of sectors.

2. Contemporary Baseline Sound Monitoring

- 2.1.1 An attended baseline sound survey was undertaken on Monday 31st July and Wednesday 2nd August 2023. The purpose of the monitoring was to gain observations of the sound climate in the vicinity of the quarry site and to compare measured background sound levels against those reported in the NIA.
- 2.1.2 Attended sound measurements were undertaken at positions representing two major receptor groups in the vicinity of the site. Position A-P1 was located the South of Barford and position A-P2 represented Wasperton Village.
- 2.1.3 The monitoring positions A-P1 and A-P2 are marked on the figure below.

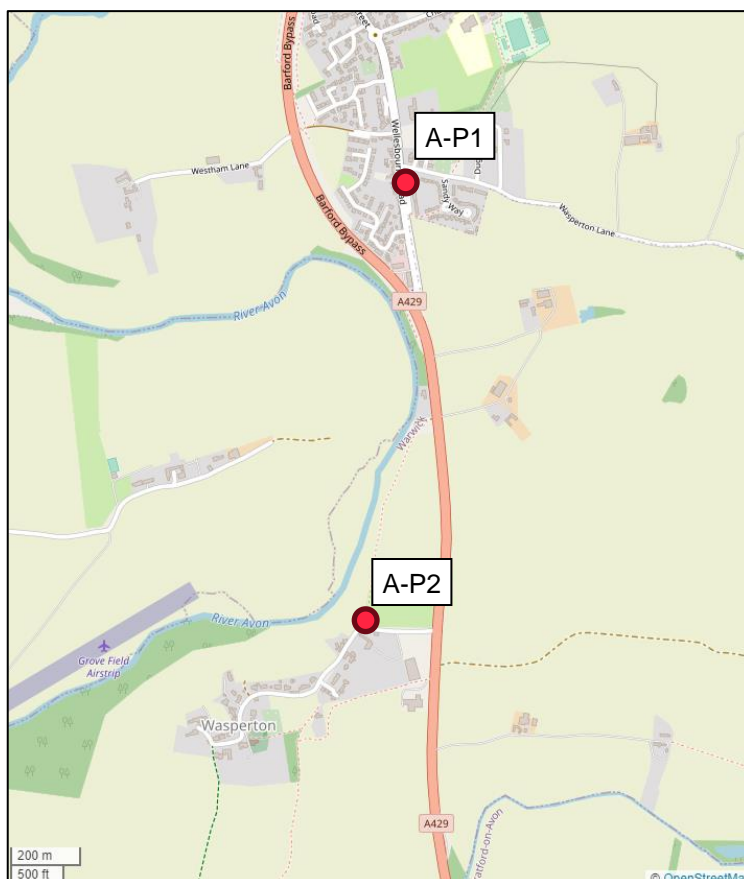


Figure 2.1: Sound Monitoring Locations

- 2.1.4 The sound level meter (SLM) was configured to measure ambient ($L_{Aeq,15min}$), background ($L_{A90,15min}$) and maximum (L_{AFmax}) sound levels.



2.2 Equipment and Calibration

2.2.1 All sound measurements were undertaken using a Rion NL-31 SLM with Serial Number 00410242, rated Class 1. The SLM holds a certificate of laboratory calibration dated within the last year.

2.2.2 Calibration checks were performed on the SLM at the beginning and end of the tests using a Castle dBCal GA611 acoustic calibrator. The calibration checks indicated that no significant drift occurred throughout the measurements.

2.2.3 The SLM was placed on a tripod approximately 1.4m above local ground with a windscreen protecting the microphone.

2.3 Weather Conditions

2.3.1 Weather conditions were satisfactory for outdoor noise monitoring. On Monday 31st July the temperature was around 17 °C. There were light south-westerly winds of up to 4 ms⁻¹ and the humidity was approximately 85%. On Wednesday 2nd August the temperature was around 16 °C. There were very light south-westerly winds of up to 1.5 ms⁻¹ and the humidity was approximately 70%.

3. Sound Survey Results

3.1 Attended Background Sound Survey Results

3.1.1 The results of the attended survey undertaken on Monday 31st July and Wednesday 2nd August 2023 are shown in Table 3.1 below. The results are grouped according to the monitoring position.

TABLE 3.1: ATTENDED BACKGROUND SOUND SURVEY RESULTS

Position	Date	Start Time	Duration T (mins)	Measured Sound Levels, dB ^[A]		
				Maximum L _{AFmax}	Ambient L _{Aeq,T}	Background L _{A90,T}
A-P1	31-Jul-23	09:15	15	68	48	42
	02-Aug-23	12:30	15	61	46	41
	Average^[B]			65	47	41
A-P2	31-Jul-23	10:15	15	60	41	37
	02-Aug-23	12:00	15	55	44	39
	02-Aug-23	13:00	15	59	42	37
	Average^[B]			58	42	38

Notes:

[A] free-field sound levels dB re 2x10⁻⁵ Pa

[B] logarithmic average of L_{Aeq,T} levels / arithmetic average of L_{Amax} and L_{A90,T} levels.

3.1.2 Observations made during the survey confirmed that the sound climate in the vicinity of the site is governed by a mixture of natural sounds and road traffic.

3.1.3 At position A-P1 in the south of Barford, the primary road traffic source governing the background (L_{A90,T}) levels is the A429, along with infrequent cars passing by on local roads. Birdsong is a significant contributor to the character of the ambient sound.

3.1.4 At position A-P2 in Wasperton Village, road traffic from the A429 is less prominent, potentially due to the topography. Natural sounds such as birdsong, insects and gentle rustling of foliage are contributors to the sound climate in the village.

4. Review of Noise Impact Assessment (NIA)

4.1.1 The primary document reviewed as part of this study is the Noise Impact Assessment undertaken by WBM Acoustics Consultants (Ref 5184) dated 11th January 2022 [1]. The document includes the results of baseline sound monitoring undertaken in the vicinity of the site in September 2021, proposed noise limits for quarry activities and predicted noise levels of these activities.

4.1.2 Mineral extraction activities are covered by the Government's Planning Practice Guidance on Minerals which includes a section on noise emissions which was last updated in March 2014 [2].

4.2 Site Description

4.2.1 In Chapter 2 of the NIA, the proposed quarry site is stated as being approximately 300m to the east of Wasperton and 600m to the south-east of Barford. Whilst it is acknowledged that these are approximate values based on a single point in the centre of each area, it should be noted that according to our measurements the closest dwellings in the villages of Wasperton and Barford are some 220m and 350m from the proposed quarry boundary respectively.

4.3 Temporary Operations

4.3.1 The duration of the temporary operations should be clarified to provide assurance to residents as to how long these potentially louder and more disturbing activities will last, noting that the Minerals Planning Guidance precludes the use of the higher 70 dB $L_{Aeq,1hr}$ noise limits for operations exceeding 8 weeks.

4.4 Input Assumptions

Processing Plant

4.4.1 The origin of the assumed Sound Power Level of the Processing Plant is not stated in the NIA other than it is from the Consultant's internal library of noise data. Given that this item

of plant will potentially be in the line-of-sight of receptors, further information should be provided to demonstrate that the Processing Plant used to obtain noise readings is representative of the scale and power of the plant that is to be installed at Wasperton Quarry. For very large items of plant such as these, measurements need to be undertaken at a range of distances to estimate the Sound Power Level to a sufficient degree of accuracy otherwise it is not appropriate to apply a point-source distance correction.

- 4.4.2 It is understood that the overall height of the processing plant is around 9m and the plant appears to consist of a number of potential noise sources. The height of the noise emission in the acoustic model in the NIA has been set at 4m. Justification should be provided as to this assumption, especially given that the acoustic model with its bund heights of 5m effectively assumes that the noise emission will be fully screened from receptors.

Dump Trucks

- 4.4.3 One of the primary sources of noise from the proposed mineral extraction operation is potentially the dump trucks making frequent trips around the site. A Sound Power Level of 105 dB L_{WA} has been adopted in the NIA based on a measurement from the Consultant's internal library of noise data. Certain sources suggest that the noise level of a dump truck is likely to be higher. For example, Table Ref D.6.53 of BS 5228-1 [3] refers to a 309 kW dump truck having a Sound Power Level of 109 dB L_{WA} . Furthermore, an informational video on Smiths Concrete's website [4] shows material being loaded into a Volvo Articulated Hauler. The manufacturer of this vehicle quotes Sound Power Levels ranging between 110 and 113 dB L_{WA} [5] for its current range of articulated dumpers depending on size / power.
- 4.4.4 Given that dump trucks are potentially a substantial noise source and the historical sound levels of this type of plant appear to vary significantly, it is suggested that further



information is provided on the origin of the Sound Power level adopted for this source in the NIA and, if necessary, additional justification for its use.

Infill Tipping

4.4.5 Within the NIA all plant items are stated as having an 100% on-time over the reference time interval of 1-hour to adopt a cautious approach in the calculations, with the exception of the infill tipping activity. This activity is stated as having a 10% on-time (only 6 minutes in a 1 hour period) which reduces its contribution in the overall noise calculation by 10 dB compared to 100% on-time. Clarification is sought over the basis for this assumption, given that it could make a material difference to the predicted noise levels.

4.4.6 A Sound Power Level of 107 dB has been adopted for the infill tipping activity. Table Ref D.3.60 of BS 5228-1 refers to a higher Sound Power Level of 110 dB L_{WA} . Use of the lower of the two values in the NIA should be justified.

4.5 Model Assumptions

4.5.1 The noise prediction example presented in Appendix H of the NIA has been replicated and we have been able to calculate matching outputs based on the assumptions used, except for the barrier attenuation calculations. This is not to suggest the barrier calculations are erroneous, but that the level of detail presented is insufficient to allow cross-checking to be carried out.

Ground Effects & Barriers

4.5.2 The noise predictions in the NIA follow the BS 5228-1 methodology adopting either soft ground attenuation effects or barrier effects but not both, in line with the recommendations in the standard.

- 4.5.3 In the example calculation provided, noise levels of mineral extraction activities are calculated at distances of between 55 and 410m depending on the distance of the activity from the receptor.
- 4.5.4 BS 5228-1 advises that noise predictions made at distances over 300m must be treated with caution due to the increasing importance of meteorological effects, especially where a soft-ground correction factor has been applied.
- 4.5.5 We understand that an analysis of wind conditions from a weather station at Wellesbourne Airfield (2 miles south of Wasperton Farm) [6] suggests that there is a strong prevailing south-westerly wind in this location and a potential funnelling effect of wind toward Barford due to the topography. Clarification is sought on whether any downwind correction has been applied in the acoustic model in the NIA, and if not, whether the actual noise levels are likely to be higher than those predicted under the typical wind conditions for the site.
- 4.5.6 It is suggested that the Consultant should assess any potential uncertainty that this introduces into the calculations and whether this influences the assessment outcomes.
- 4.5.7 Barrier attenuation corrections have been calculated in the NIA using the well-established Maekawa calculation based on path-difference. The barriers included in the model are the 3m and 5m high bunds which are to be constructed around certain parts of the quarry site.
- 4.5.8 Sound barriers offer significantly reduced attenuation at lower frequencies compared to higher frequencies because of diffraction effects. It is unclear whether the Maekawa calculation has first been performed individually in each octave frequency band to then generate an overall reduction, or whether the calculation is based on a single frequency band. Given that there is likely to be a significant low-frequency component to the sound from the quarry, for example from dumper and excavator engines, clarification is sought on this point. If the barrier attenuation has been calculated on a single frequency above



this suggests that the effects would have been overestimated, depending on the frequency. The difference in barrier attenuation is potentially up to 5 dB or more when comparing high vs low frequencies, depending on the barrier geometry.

4.5.9 There is a degree of ambiguity around the receiver height adopted in the noise predictions. For reference, the receiver height in the example calculation is stated to be 48.5m AOD however it is unclear whether this is the height of the local ground, ground-floor window or upper floor window.

4.5.10 Most of the receptors in the vicinity of the quarry are two-storey dwellings however there is a row of receptors on Wellesbourne Road that are three storeys high and the closest dwelling to the quarry in Wasperton Village also appears to be three storeys high.

4.5.11 If the path-difference calculations are based on the ground-floor window of the receptors, this needs to be clarified as it could affect the assessment outcomes. Barriers are usually less effective at upper receptor floors, potentially leading to higher noise levels at non-ground floor receiver positions than anticipated in the NIA. Based on experience of noise assessments for open sites, it is common practice to account for upper floors of each dwelling, often presenting the worst-case level for the overall assessment. We note also that it is becoming increasingly common to work from home offices which may be located on any floor.

4.6 Proposed Noise Limits

4.6.1 The proposed noise limits for routine operations in the NIA ($L_{Aeq,1hr}$) have been specified on the basis of 10 dB above the background noise level ($L_{A90,T}$) or 55 dB, whichever is the lower.

4.6.2 A background level ($L_{A90,15min}$) of 45 dB has been adopted for the receptor denoted 1a Wellesbourne Road whilst a level of 41 dB has been adopted for the receptor representing Wasperton Village.

4.6.3 The results of the contemporary baseline sound readings obtained in July / August 2023 suggest that lower background noise levels could occur at these locations (41 dB and 38 dB $L_{A90,15min}$ at Wellesbourne Road and Wasperton Village respectively). Whilst it is acknowledged that these readings were taken over a limited survey duration, it is recommended that a cautious approach is taken by basing the noise limits on these lower readings for the receptors in these locations.

4.7 Non-Standard Receptors

4.7.1 An AirBnB type business is operated at Glebe Farm, one of the closest receptors to the proposed quarry boundary, where there are two 'shepherd huts' available for private bookings. Given that one of the key selling points of the huts is the tranquil, rural surroundings, and the façade sound insulation of the huts is likely to be lower than that of a normal house, a more specific assessment is advisable. Such an assessment should consider the potential for the level and character of noise from the proposed quarry to have an adverse impact on the viability of the business and identify any specific control measures necessary to reduce any impact, if identified.

4.8 Proposed Mitigation Measures

4.8.1 In respect of noise mitigation the Government's PPG on minerals states:

"Proposals for the control or mitigation of noise emissions should:

- *consider the main characteristics of the production process and its environs, including the location of noise-sensitive properties and sensitive environmental sites;*
- *assess the existing acoustic environment around the site of the proposed operations, including background noise levels at nearby noise-sensitive properties;*

- *estimate the likely future noise from the development and its impact on the neighbourhood of the proposed operations;*
- *identify proposals to minimise, mitigate or remove noise emissions at source;*
- *monitor the resulting noise to check compliance with any proposed or imposed conditions.”*

4.8.2 The NIA relies heavily on the 3m and 5m high earth bunds as mitigation and is light on other noise control measures for routine operations other than the use of modern maintained plant. Whilst the predicted noise levels are within the specified limits, it is our view that this does not override the need to demonstrate best practices on noise control.

4.8.3 Examples of additional noise mitigation measures can be found in the March 2021 ANC Publication on Construction Noise [7]. Whilst the publication is focussed on construction noise and Section 61 (Control of Pollution Act) consents, much of the guidance is relevant to minerals extraction operations, including the following noise control examples:

- keeping internal haul routes well maintained to minimise impulsive noise and vibration from vehicles running over discontinuities in the running surfaces.
- fitting rubber linings to chutes, hoppers and dumper vehicles to reduce impact noise from material transfer.
- minimising drop heights of materials.
- carrying out regular inspections of mitigation measures (or BPM audits) to ensure compliance with noise and vibration commitments.
- providing regular briefings for all site-based personnel so that noise and vibration issues are understood and that generic and site-specific mitigation measures are explained and adhered to.

- phasing of materials deliveries to be controlled on a 'just in time' basis to minimise noise and congestion on roads around the site.
- carrying out noise monitoring.

4.8.4 It is stated in the NIA that noise emissions from mineral workings do not usually contain a distinguishable tone. This is potentially misleading as, based on experience, low-frequency noise from dumper and excavator engines can contain a distinct tonal component which can be audible at considerable distances. Furthermore, reversing alarms of vehicles can be tonal in nature. It is recommended that a scoping assessment of tonal noise sources is carried out to determine any specific mitigation measures for these sources (such as the use of broadband reversing alarms).

4.8.5 Once all practical noise mitigation measures have been evaluated, the assessment of potential noise impacts in the NIA should be revisited. Where a potential for unacceptable noise impacts has been identified which cannot be mitigated through practical noise control measures, reduced working hours for any particularly noisy activities should also be considered.

4.9 Noise Monitoring & Conditions

Need for Monitoring

4.9.1 The Government's PPG Guidance states that proposals for the control or mitigation of noise emissions should: "*monitor the resulting noise to check compliance with any proposed or imposed conditions*".

4.9.2 It is understood that the planning consent for Wolston Quarry, an existing quarry operated by Smiths Concrete, allows the operator to report on its noise monitoring only when they have identified a breach of a noise limit. This raises a potential conflict of interest and prevents any scrutiny of the noise monitoring data by the public and the Local Authority

from. WCC are able to request copies of noise reports, however we understand that a response from WCC to a Freedom of Information (FOI) request [8] submitted on behalf of the resident's associated indicated that no noise monitoring report by Wolston Quarry has ever been requested by WCC.

- 4.9.3 Should the quarry at Wasperton be granted planning permission, a greater level of accountability should be placed upon the quarry operator; protocols which rely on the operator 'marking its own homework' should be treated with caution. Given the statement in the NIA that the main uncertainty lies in whether the proposed activities will give rise to the calculated noise level at the receiver locations, it is reasonable to suggest that a proper monitoring scheme is necessary.

Recommended Condition on Monitoring

- 4.9.4 The following suggested condition on noise monitoring and reporting has been developed based on ANC Guidance, BS 5228-1 and experience of practices adopted on other open sites:

A scheme of noise monitoring shall be undertaken for the following reasons:

- *To check actual site noise levels against those predicted in the assessment.*
- *Ensuring compliance with the agreed noise limits.*
- *For the investigation of any complaints.*
- *Checking that best practices are being employed on-site and any proposed mitigation measures are functioning as intended.*
- *To prevent gradual increases in site noise levels over time.*

The above shall be achieved through a combination of continuous unattended semi-permanent monitoring stations and the deployment of specialists to undertake short-term attended sample measurements and on-site audits.

The fixed unattended monitoring shall include at least one semi-permanent position and shall utilise a remote noise monitoring device able to continuously log noise levels and to provide alerts when noise levels exceed the specified limits. The monitor should be installed in a location where predicted quarry noise levels are sufficiently above residual levels, to minimise false triggers. It may be necessary to change the location of the fixed monitor depending on the phase of works. If the monitor is to be placed in a location not directly representative of an individual off-site receptor, noise predictions shall be made at the actual monitoring position and shall be used to determine appropriate alert triggers with the overall aim of complying with off-site noise limits.

In the event of an exceedance of the specified limit, or in response to complaints, the operator shall investigate the cause of the exceedance or complaint and, where appropriate, take reasonable steps to mitigate the noise. Reasons should be recorded where the exceedance or complaint is deemed not attributable to the quarry.

Attended monitoring should be undertaken at an early stage of the main works to verify the site noise levels against the noise predictions and to investigate exceedances or complaints where there is a requirement for specialist investigation.

Any personnel undertaking noise and vibration monitoring shall be able to demonstrate their competency for the task, either through membership of a professional organisation, or practical experience.

All monitoring shall be carried out in accordance with Annex G of BS 5228-1.

Noise monitoring reports shall be submitted to the Local Authority in intervals of no greater than three months, to include:

- *Continuous unattended noise monitoring data including a summary of noise levels for each day and list of exceedances.*
- *Explanations for any gaps in the continuous noise monitoring data.*
- *List of exceedances / trigger alerts and action(s) undertaken.*
- *Details and results of attended monitoring undertaken (as per the information to be recorded in BS 5228-1 Annex G).*

4.10 Other Effects

Ecological Receptors



- 4.10.1 Advice published on the Government's website indicates that noise, additional lighting and vibration can harm badgers [9]. To our knowledge, no specific noise or vibration mitigation measures aimed at protecting ecological receptors have been included in either the NIA or in the applicant's Ecological Impact Assessment [10], the latter of which suggests that three badger setts have been identified. Whilst there are existing sources of anthropogenic noise in the vicinity of the quarry, including road traffic noise from the A429, addition of the quarry machinery could introduce impulsive sounds with a potential to cause startling effects which would not otherwise be generated by a steady flow of road traffic.
- 4.10.2 Bats are another ecological receptor with a potential to be affected by noise [11]. It is requested that the applicant confirms whether any noise risk assessment or scoping has been done to determine whether a more detailed assessment of noise on bats, badgers and other ecological receptors is required.

Vibration

- 4.10.3 The applicant should confirm whether any vibration risk assessment or scoping exercise has been carried out to justify the exclusion of a more detailed vibration assessment in the NIA.

5. Conclusions and Recommendations

- 5.1.1 A review of the noise aspects of a planning submission for a new sand and gravel quarry has been undertaken on behalf of Barford Residents Association.
- 5.1.2 It is recommended that justification is provided for a number of the key plant Sound Power Levels adopted in the noise calculations of the Noise Impact Assessment (NIA). In some cases, insufficient information is provided to determine whether the library sound data used is suitably representative of the scale and power of the plant that is to be employed at Wasperton Quarry. In other cases, alternative sources such as BS 5228-1 indicate that noise levels of plant are potentially higher than those adopted in the noise predictions.
- 5.1.3 There is a level of ambiguity around the assumptions used to calculate the barrier attenuation of the proposed 3m and 5m earth bunds in the NIA. In particular, it is not reported whether calculations are made at ground-floor or upper floor windows of receptors. This has a potential to materially affect the assessment's conclusions.
- 5.1.4 The results of a contemporary baseline sound survey indicate that background sound levels ($L_{A90,15min}$) may be lower at times than those reported in the NIA. Lower noise limits are therefore recommended for certain receptors to ensure a suitably cautious approach.
- 5.1.5 It is understood that no specific noise or vibration assessment has been undertaken in relation to non-standard receptors (for example the Holiday Lets at Glebe Farm), nor ecological receptors such as badgers which are known to be harmed by noise and vibration. The noise risks associated with these receptors should be considered to determine whether any further specific mitigation measures are required.
- 5.1.6 Whilst the NIA does contain a limited number of mitigation measures, there are additional best practices that should be employed to control noise. A list of potential additional measures has been put forward based on relevant industry guidance.



- 5.1.7 It is recommended that a scheme of monitoring should be proposed by the applicant in order to: ensure transparency in the reporting of noise emissions from the site; to check that the agreed site noise limits are being adhered to; to prevent gradual increases in noise emissions over the lifetime of the quarry; and to assess whether the proposed noise mitigation measures are effective and whether working practices need to be modified. A recommended monitoring scheme has been put forward in this report.
- 5.1.8 Overall, insufficient detail in the NIA indicates a potential for underestimation of the predicted noise levels at receptors, and further commitments on mitigation and monitoring are recommended to ensure that noise will be reduced to a minimum in accordance with the PPG Guidance on Minerals.

6. References

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