9. NOISE AND VIBRATION

9.1 Introduction

9.1.1 Overview

Potential noise and vibration impacts may be divided into the following categories:

- Construction phase noise impacts on surrounding receptors.
- Construction phase vibration impacts on surrounding receptors.
- Operational phase noise impacts on surrounding receptors.
- Operational phase vibration impacts on surrounding receptors.

The construction phase will include the development of a quarantine area for imported material (soil/gravel/stone) at the facility. This will comprise of a concrete hardstand area and inspection/storage shed, located approximately 25 m to the northeast of the existing site office. The proposed inspection shed is approximately 800 m^2 in area and 15 m in elevation.

The operational phase of the proposed development will involve the import of fill material.

This chapter focuses on four primary noise and vibration impact categories: construction phase noise, construction phase vibration, operational phase noise and operational phase vibration

The completed project will involve the return of a former sand and gravel pit to agricultural use. Following completion of the development, the only activities carried out on-site will be agricultural. Such activities will not give rise to any noise or vibration emissions of significance, and any such emissions will be consistent with those arising throughout the surrounding area. Thus, the proposed development will not give rise to any post-operational noise or vibration impacts.

9.1.2 Methodology

Typical ambient noise levels across the local area were measured, and these were used to identify appropriate operational phase noise criteria. Plant required on-site was identified, and the noise emissions data was used to predict likely noise levels at surrounding receptors. Predicted levels were assessed in the context of identified criteria, and mitigation measures identified where required. Potential sources of operational phase vibration were identified, and impacts assessed by reference to commonly applied criteria. Construction phase noise and vibration impacts were also assessed.

9.1.3 Documents Consulted

The following documents were consulted during the preparation of this chapter:

- RI 8507: Structural Response and Damage Produced by Ground Vibration from Surface Mines Blasting (US Bureau Of Mines, 1980).
- British Standard BS 7385-2:1993 Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration (1993).
- Guidelines on Community Noise (World Health Organisation, 1999).
- Directive 2002/49/EC of the European Parliament and of the Council relating to the Assessment and Management of Environmental Noise (2002), transposed into Irish law by the European Communities (Environmental Noise) Regulations 2018 (SI No. 549/2018).

- Quarries and Ancillary Activities: Guidelines for Planning Authorities (Department of the Environment, Heritage & Local Government, 2004).
- Environmental Management Guidelines: Environmental Management in the Extractive Industry (Non-Scheduled Minerals) (Environmental Protection Agency, 2006).
- British Standard BS 6472-1:2008 Guide to Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz) – Part 1: Vibration Sources other than Blasting (2008).
- Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (National Roads Authority (Now Transport Infrastructure Ireland), 2014).
- British Standard BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise (2014).
- British Standard BS 5228-2:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration (2014).
- Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (National Roads Authority, 2014).
- Guidelines for Noise Impact Assessment (Institute of Environmental Management and Assessment, 2014).
- Draft Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (Environmental Protection Agency, 2015).
- NG4 Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (Environmental Protection Agency, 2016).
- Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (Environmental Protection Agency, 2017).
- Kildare County Development Plan 2017-2023 (Kildare County Council, 2017).
- Kildare County Council Third Noise Action Plan 2019-2023 (Kildare County Council, 2019).

A baseline noise survey was undertaken in accordance with International Standard ISO 1996-2:2017 Acoustics – Description, Measurement and Assessment of Environmental Noise, Part 2: Determination of Environmental Noise Levels (2017). Predictive modelling was carried out using International Standard ISO 9613-2:1996 Acoustics: Attenuation of Sound during Propagation Outdoors – Part 2 General Method of Calculation (1996).

9.1.4 Statement of Authority

The noise and vibration assessment was undertaken by Damian Brosnan, of Damian Brosnan Acoustics, who has over 20 years' experience in scoping and carrying out such impact assessments. His qualifications and experience are as follows:

- BSc (Honours) 1993 (University College Cork).
- Diploma in Acoustics & Noise Control 2009 (Institute of Acoustics).
- MSc (Distinction) in Applied Acoustics 2015 (University of Derby).
- Member of Institute of Acoustics (MIOA) & secretary of Irish branch.
- Founder member of Association of Acoustic Consultants of Ireland (AACI).
- Member of Engineers Ireland (MIEI).
- 1996-2001: Noise Officer with Cork County Council.
- 2001-2014: Partner with DixonBrosnan Environmental Consultants, specialising in EIA.
- 2015–Present: Principal at Damian Brosnan Acoustics.

9.2 Guidance and Criteria

9.2.1 Construction phase noise

There are no national mandatory noise limits relating to the construction phases of projects. In granting planning permission, a local authority may stipulate construction phase noise limits applicable to daytime, evening, night-time and weekend hours as appropriate. There are no national guidelines available regarding the selection of such limits. Many local authorities chose to apply a 65 dB $L_{Aeq\ T}$ limit.

The chief noise guidance document applied in Ireland and the UK in construction phase noise assessments is British Standard BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise (2014). Annex E of the document sets out several methods to draw up suitable noise criteria applicable to the construction phase of a project. The most appropriate method here is considered to be the 'ABC method', which provides for the selection of criteria based on existing ambient noise data. On the basis of noise data recorded in the vicinity of the study site, as discussed below, a daytime $L_{Aeq\ 1\ h}$ criterion of 65 dB is identified. This criterion is identical to that typically applied by local authorities, and is thus applied in this assessment. The $L_{Aeq\ 1\ h}$ parameter describes the total noise emissions from all construction sources occurring during any 1 h period, averaged over that hour.

BS 5228:2009+A1:2014 states that the 65 dB criterion is applicable to the periods Monday-Friday 0700-1900 h and Saturday 0700-1300 h. Construction operations are unlikely to be undertaken during evening or night-time hours, or on Sundays. This assessment therefore applies the 65 dB criterion in respect of all construction works.

The 65 dB criterion is considered applicable to surrounding receptors, in their immediate curtilage. In this regard, the Environmental Protection Agency document NG4 Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (2016) defines a noise sensitive locations as:

> *Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or area of high amenity which for its proper enjoyment requires absence of noise at nuisance levels.*

As construction projects tend to be relatively short, and as construction works areas are usually localised and mobile, the 65 dB limit is usually not subject to any additional criteria such as tone and impulse restrictions.

9.2.2 Construction phase vibration

As with noise, there are no national limits relating to groundborne vibration, and reference is usually made to guidance set out in British Standard BS 5228-2:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration (2014). Table 9-1 presents guidance included in the document with respect to human perception of peak particle velocity (PPV), the most commonly applied descriptor of groundborne vibration.

Table 9-1 Human perception of vibration, from BS 5228-2:2009+A1:2014

PPV	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.

PPV	Effect
0.3 mm/s	Vibration might be just perceptible in residential environments.
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10.0 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

During construction and demolition projects, reference is usually made to criteria relevant to buildings, in order to avoid potential cosmetic or structural damage. Guidance presented in the National Roads Authority (now Transport Infrastructure Ireland) document Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (2014) is seeing increasing application to non-road projects due to the absence of any other Irish guidance. NRA criteria, listed in Table 9-2, are informed by documents such as British Standard BS 7385-2:1993 Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration (1993). The criteria apply to the closest part of any relevant building or structure.

Table 9-2 Building vibration criteria, from NRA (2014)

Frequency	<10 Hz	10-50 Hz	>50 Hz
PPV (mm/s)	8	12.5	20

NRA limits set out above are considerably lower than criteria recommended by two respected international authorities, as presented in Table 9-3. The criteria presented are those below which cosmetic damage (hairline cracking, etc.) to buildings is unlikely to occur. Limits relating to structural damage are significantly higher.

Table 9-3 Recommended vibration limits

Structure	Lower frequencies	Higher frequencies	Source
Modern dwellings	<40 Hz: 19 mm/s	>40 Hz: 51 mm/s	1
Older dwellings	<40 Hz: 12.7 mm/s	>40 Hz: 51 mm/s	1
Industrial & heavy commercial	4-15 Hz: 50 mm/s	>15 Hz: 50 mm/s	2&3
Residential & light commercial	4-15 Hz: 15-20 mm/s	>15 Hz: 20-50 mm/s	2&3

Sources:

1 US Bureau Of Mines report RI 8507: Structural Response and Damage Produced by Ground Vibration from Surface Mines Blasting (1980).

2 BS 5228-2:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Vibration (2014).

3 BS 7385-02: 1993 Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Ground Borne vibration (1993).

9.2.3 Operational Noise Sources

No national noise or vibration guidance documents have been issued specifically with respect to quarry restoration. Given that quarry restoration represents a final stage of the quarrying process, and given that much of the plant used is similar, it is considered that guidance documents issued in relation to quarries are also appropriate to restoration projects such as that proposed by the applicant.

The most authoritative quarry guidance document available is Quarries and Ancillary Activities: Guidelines for Planning Authorities, issued in 2004 by the then Department of the Environment, Heritage & Local Government (DOEHLG). Although issued to provide guidance with respect to the 2005-2007 quarry registration process set out in Section 261 of the Planning & Development Act 2000, the DOEHLG document remains valid and in force, and continues to be used by local authorities in the assessment of quarry planning applications. The document draws on guidance presented in Environmental Protection Agency (EPA) report number MS-2000-M1, subsequently published in 2006, and titled Environmental Management Guidelines: Environmental Management in the Extractive Industry (Non-Scheduled Minerals).

The DOEHLG guidance and the related EPA document recommend a daytime $L_{Aeq\ 1\ h}$ limit of 55 dB. The documents additionally recommend that audible tonal and impulsive components be minimised. The limit is typically applied at offsite noise sensitive locations.

The proposed development will require a waste management licence from the EPA. In reviewing the licence application, the Agency will most likely have regard to their NG4 document, which includes a 55 dB criterion with respect to daytime noise levels, similar to that recommended by the DOEHLG. The criterion is again applicable to offsite receptors. The NG4 document defines daytime as 0700-1900 hours. The document does not specifically recommend a measurement interval.

From the foregoing, a 55 dB daytime $L_{Aeq\ 1\ h}$ limit is considered the most suitable criterion with respect to the operational phase of the proposed development, applicable externally at offsite receptors during daytime working hours. The criterion applies to all noise emissions expected from the proposed development.

The 55 dB $L_{Aeq\ 1\ h}$ criterion is identical to that which currently applies to the existing on-site quarry, as set out in Condition 17(a) of planning permission PL 09.226857 (Kildare County Council planning permission reference number 07/723) which states:

> *'During the operational phase of the proposed development, the noise level emanating from within the premises, as measured from the facing external elevation of any dwelling house in the surrounding area shall not exceed 55dB(A) LAeq (one hour) between 0800 hours and 1800 hours Monday to Friday and 0800 hours and 1400 hours on Saturday, and of 45dB(A) LAeq (15 minutes) at any other time.'*

The degree of noise impact may also be assessed by reference to the magnitude of increase. Table 9-4 sets out the scale applied in this report, drawn from guidance given in *Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports* (EPA, 2017) and *Guidelines for Noise Impact Assessment* (Institute of Environmental Management and Assessment, 2014). The criteria apply at offsite receptors.

Table 9-4 Assessment of impact by reference to increase over existing noise levels.

Increase	Impact	Effect
<2 dB	Imperceptible	Capable of measurement, but without significant consequences
2-4 dB	Not significant	Causes noticeable changes to soundscape, but without significant consequences

Increase	Impact	Effect
4-6 dB	Slight	Causes noticeable changes to soundscape without affecting its sensitivities
6-10 dB	Moderate	Alters soundscape in manner consistent with existing and emerging baseline trends
10-15 dB	Significant	Alters soundscape due to source character, magnitude, duration or intensity
15-20 dB	Very significant	Significantly alters soundscape due to source character, magnitude, duration or intensity
>20 dB	Profound	Obliterates soundscape

9.2.4 Operational Vibration Sources

Vibration criteria recommended in the DOEHLG document relate solely to blasting, and are therefore not applicable to the proposed development, where potential vibration sources will consist solely of plant movements. The most pertinent criteria here are considered to be those set out in British Standard BS 385-2:1993 *Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration* (1993), and which are also quoted in British Standard BS 5228-2:2009+A1:2014 *Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration* (2014).Table 9-5 and Figure 9-1 present peak particle velocity (PPV) criteria recommended in both standards with respect to transient vibration, below which cosmetic building damage (hairline cracking, etc.) is unlikely to occur. Limits relating to structural damage are significantly higher. Where vibration is continuous, and thus where building resonance effects may arise, both standards note that guide values may need to be reduced by 50 %. BS 7385-2:1993 and BS 5228-2:2009+A1:2014 state that the probability of building damage tends towards zero at a PPV level of 12.5 mm/s, and this is evident in Figure 9-1.

Table 9-5 Transient vibration guide values, from BS 7385-2:1993 & BS 5228-2:2009+A1:2014.

Structure	PPV guide value (mm/s)
Reinforced or framed structures Industrial & heavy commercial buildings	50 (line 1 in Figure X-1)
Unreinforced or light framed structures Residential or light commercial type buildings	15 (4 Hz); 20 (15 Hz); 50 (≥40 Hz) (line 2 in Figure 9-1)

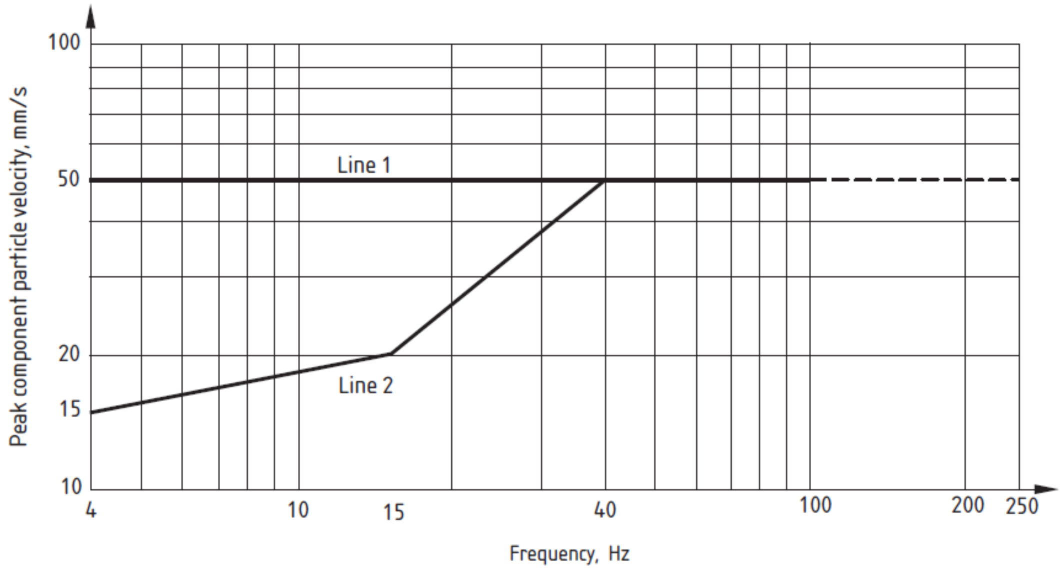

Figure 9-1 PPV guide values recommended by BS 7385-2:1993 & BS 5228-2:2009+A1:2014 with respect to transient vibration. Lines 1 and 2 refer to Table 9-5.

Criteria presented in Tables 9-1 and 9-2 above are also considered relevant to operational vibration.

9.2.5 World Health Organisation

Most environmental noise guidance documents issued across Europe ultimately derive limits from guidance issued by the World Health Organisation (WHO). The WHO document *Guidelines For Community Noise* (1999) sets out guideline values considered necessary to protect communities from environmental noise. With respect to residential settings, the document notes that an outdoor $L_{Aeq\ 16\ h}$ level of 55 dB is an indicator of serious annoyance during daytime and evening hours, with 50 dB being an indicator of moderate annoyance. The 55 dB criterion was first suggested by the WHO in their 1980 document Environmental Health Criteria 12.

Since 1980, the 55 dB criterion has become the de facto daytime limit applied by most Irish regulatory authorities to commercial and industrial operators. Although the WHO criterion applies to daytime periods of 16 hours, authorities typically specify shorter periods such as one hour.

The WHO's 55 dB recommendation most likely informed the 55 dB criterion included in the DOEHLG document discussed above. It follows that compliance with the DOEHLG criterion will be consistent with WHO guidance.

9.2.6 Kildare County Development Plan

The Kildare County Development Plan 2017-2023 (2017) includes the following objectives with respect to noise:

> ***Objective CPD RSO 3:*** *Implement the recommendations of the Kildare Noise Action Plan 2013-2018 to seek to reduce, where necessary, the harmful effects of traffic noise, through appropriate mitigation measures that meet the best environmental options not entailing excessive cost (BATNEEC).*
>
> ***Objective CDP PC 1:*** *Implement the provisions of EU and National Legislation on air, light and noise control and other relative legislative requirements, as appropriate, in conjunction with all relevant stakeholders.*

> ***Objective CDP PC 2:*** *Implement the relevant spatial planning recommendations and actions of the Kildare Noise Action Plan 2013-2018.*
>
> ***Objective CDP PC 6:*** *Enforce where applicable, the provisions of the Environmental Noise Regulations (2006).*
>
> ***Objective CDP PC 7:*** *Ensure that noise levels caused by new and existing developments throughout the county do not exceed normally accepted standards and that new developments shall incorporate measures to ensure compliance with the Environmental Noise Regulations 2006 and any subsequent revision of the Regulations.*
>
> ***Objective CDP PC 9:*** *Require activities likely to give rise to excessive noise to intall noise mitigation measures and monitors.*
>
> ***Objective CDP EN 4:*** *Facilitate the implementation of the Kildare Noise Action Plan 2013-2018 and Litter Management Plan 2016-2019 and any subsequent amendments during the period of this Plan.*

It is clear that the County Development Plan does not set out specific noise criteria, and instead refers to the local authority's Noise Action Plan. In this regard, the 2013-2018 Noise Action Plan referenced above has been superceded. The current plant is discussed below.

9.2.7 Kildare Noise Action Plan

The *Kildare County Council Third Noise Action Plan 2019-2023* (2019) describes a strategic plan based on noise mapping undertaken in 2017 ('round 3' mapping). Preparation of the plan is a requirement of *Directive 2002/49/EC of the European Parliament and of the Council relating to the Assessment and Management of Environmental Noise* (2002), transposed into Irish law by the European Communities (Environmental Noise) Regulations 2018 (SI No. 549/2018). The Directive requires preparation of noise plans for all roads with annual traffic volumes over 3 million vehicles (deemed 'major roads').

Regional route R448, which passes within 600 m of the proposed development site, is not classed as a major road at this location. The nearest major road is the M9 which runs within 2.5 km of the site. Noise mapping undertaken in relation to the M9 indicates that the area around the proposed development site lies outside the M9 zone of influence. It follows that the proposed development site is not located in an area which warrants consideration of mitigation of existing public road traffic noise.

With respect to the proposed development, Section 4.2.2 of the Noise Action Plan states:

> *'In the case of planning application by third parties for industrial or commercial developments close to residential areas, the Council would normally apply the following maximum limits that would apply to measurements taken in the vicinity of adjacent noise sensitive receptors:*
>
> *Daytime 55 dB (A) Leq*
>
> *Night-time 45 dB (A) Leq (or exceptionally 40 dB (A) Leq)*
>
> *Where an environmental impact assessment is required as part of the planning process, noise would normally be one of the impacts considered and noise limits imposed through the imposition of planning conditions. This would be decided on case by case basis.'*

The daytime 55 dB Leq criterion specified by the Noise Action Plan is identical to the criterion stipulated by the DOEHLG document, as discussed above. The criterion applied in this assessment is 55 dB $L_{Aeq\ 1\ h}$. Night-time operations are not proposed.

9.3 Baseline

9.3.1 Location and Land Use

The proposed development site consists of an existing sand and gravel pit 1500 m southeast of Ballitore village (Figure 9-2). Regional route R448 runs 600 m west of the site. The site is accessed from the R448 via route R747. From the latter, an access road 350 m in length terminates at the southwest corner of the pit. The pit directly adjoins agricultural land on most sides. The northern boundary adjoins a belt of scrub, beyond which lies agricultural land. The north western corner adjoins a mixture of scrub, historic workings, and settlement ponds. Agricultural land also lies beyond these. A number of overgrown soil and subsoil stockpiles are scattered around the perimeter of the pit.

Figure 9-2 Site location

The floor across the southern half of the sand and gravel pit is relatively level, and is occupied by stockpiles, a stationary washing plant, and ancillary infrastructure at the entrance (weighbridge, office, storage structures). The northern half of the pit is more variable in elevation, consisting of scattered excavation zones and settlement ponds.

The entire pit generally lies below the surrounding terrain. Around most of the perimeter, the pit floor lies approximately 10 m below surrounding fields. Height differences are more variable along the northern side, due to a combination of storage stockpiles outside the pit, and due to a natural fall in local topography to the northwest.

Outside the applicant's sand and gravel pit, the surrounding land use is agricultural in character. However, the soundscape is entirely dominated by road traffic noise, chiefly due to R448 traffic which is relatively level and straight at this location, resulting in elevated traffic speeds and open propagation. Other roads including the R747 see intermittent traffic throughout the day.

There are no commercial noise sources of note, outside of the applicant's pit. Point sources in the surrounding area include farmyards and small commercial operators. A quarry pit 750 m southeast of the applicant's site is outside audible range.

9.3.2 Receptors

There are no noise receptors on the proposed development site itself. The nearest receptors are as follows:

- Two dwellings lie immediately adjacent to the site access road, one of which lies adjacent to its junction with the R747. A number of one-off dwellings lie to the south and west of the junction.
- Portersize Cross lies 350 m south of the above junction. From the cross, a local secondary road runs northeast. A number of dwellings are situated along this road, the nearest of which lies 200 m from the pit perimeter.
- An access road off the local secondary road serves two dwellings 230 m and 300 m east of the pit.
- There are fewer receptors to the north and northeast. The nearest dwelling here lies 870 m north of the pit.
- A farmhouse to the northwest lies 500 m from the pit.

Receptors in the local area are shown in Figure 9-3. There are 19 detached dwellings within 500 m of the pit. The nearest settlements are Ballitore 1500m northwest of the pit, and Timolin to the southwest. Ribbon development at Timolin approaches to within 1200m of the site.

Figure 9-3 Surrounding receptors

All receptors in the surrounding area consist of dwellings. No other receptors such as creches, schools, care centres or nursing homes have been identified in proximity to the site.

9.3.3 Noise survey

A baseline noise survey was carried out at the proposed development site on 5th March 2020. Monitoring was carried out at four stations representing the nearest receptors. The stations are shown in Figure 9-4 and Plate 9-1, Plate 9-2, Plate 9-3, Plate 9-4 and described in Table 9-6. Survey methodology, equipment specifications and weather conditions are listed in Appendix 9-1. Recorded time history profiles are shown in Figure 9-5, Figure 9-6, Figure 9-7 and Figure 9-8. Noise data are presented in Appendix 9-2, and summarised in Table 9-7.

Figure 9-4 Baseline noise stations

Table 9-6 Noise stations.

Station	NGR	Reason for selection
N1	680625 695379	To represent dwelling further northwest
N2	680756 695059	To represent dwelling adjacent to access road
N3	681052 694976	To represent nearest dwelling to S of pit
N4	681547 695191	To represent dwellings SE of pit

Plate 9-1 N1, looking NW towards dwelling.

Plate 9-2 N2, looking SW towards dwelling.

Plate 9-3 N3 looking SE towards dwelling.

Plate 9-4 N4 looking NE towards dwelling.

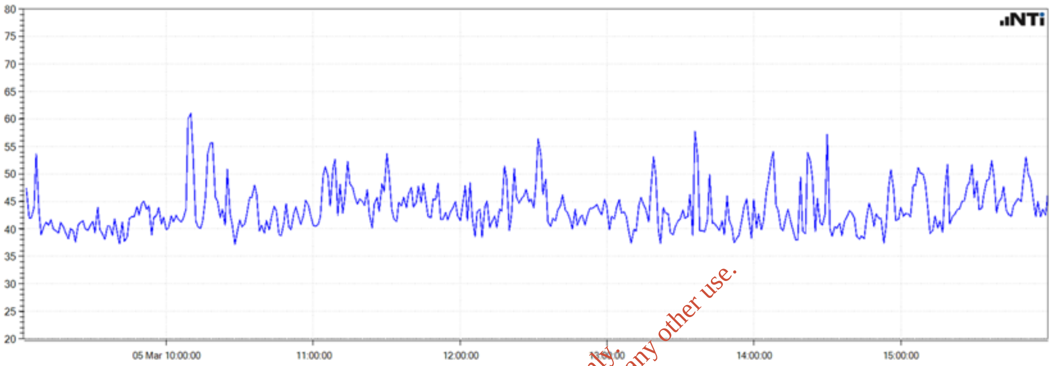

Figure 9-5 $L_{Aeq\ 1\ s}$ profile at N1.

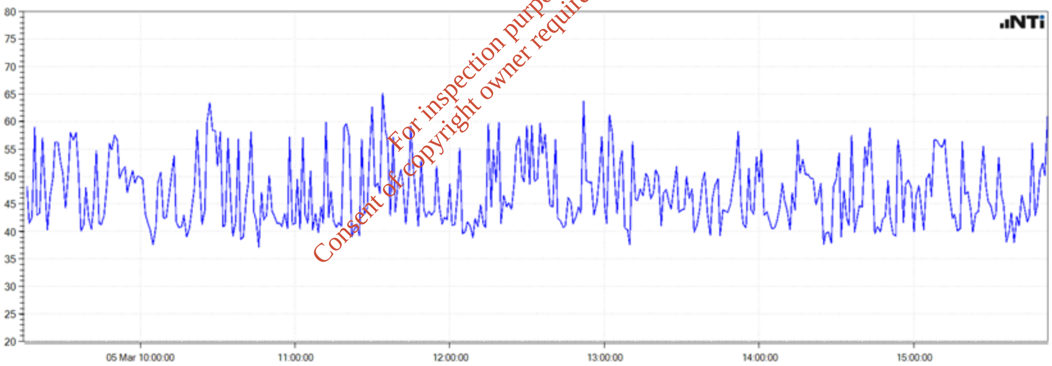

Figure 9-6 $L_{Aeq\ 1\ s}$ profile at N2.

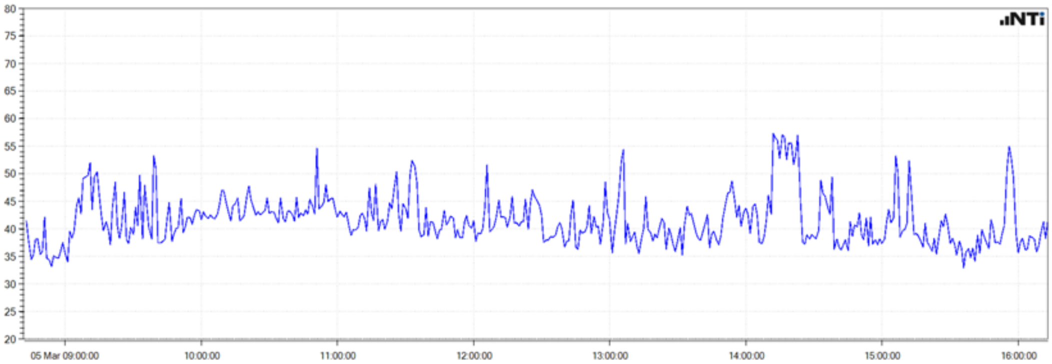

Figure 9-7 $L_{Aeq\ 1\ s}$ profile at N3.

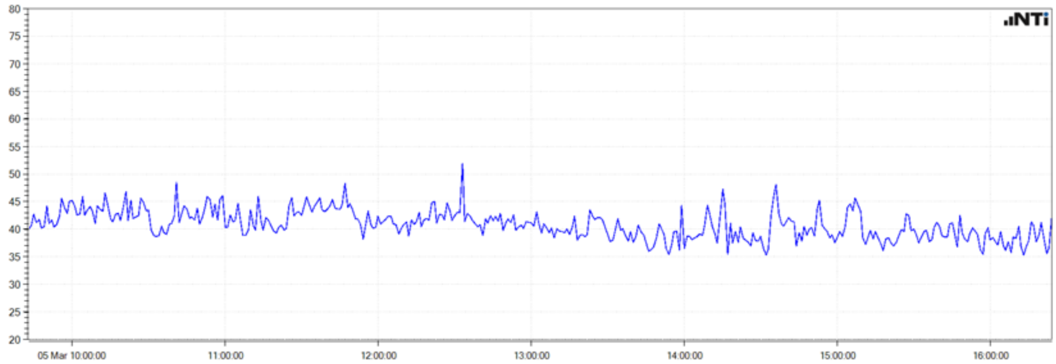

Figure 9-8 $L_{Aeq\ 1\ s}$ profile at N4.

Table 9-7 Noise data summary. Average is arithmetic.

Interval	Parameter	N1	N2	N3	N4
15 minutes	$L_{Aeq\ 15\ min}$ range	40-53	45-56	37-53	38-44
	$L_{Aeq\ 15\ min}$ average	45	51	43	41
	$L_{AF90\ 15\ min}$ range	37-41	37-40	33-41	34-42
	$L_{AF90\ 15\ min}$ average	38	38	36	38
1 hour	$L_{Aeq\ 1\ h}$ range	43-49	50-54	43-49	40-43
	$L_{Aeq\ 1\ h}$ average	46	52	45	42
	$L_{AF90\ 1\ h}$ range	37-39	37-38	34-40	35-39
	$L_{AF90\ 1\ h}$ average	38	38	36	37

The washing plant at the applicant's existing sand and gravel pit was operating throughout most of the survey period. Washing plant emissions are considered part of the existing soundscape, and thus the noise survey is representative of baseline conditions.

The dominant noise source at N1 and N2 throughout the survey was R448 traffic, with R747 traffic also audible at N2. Sporadic traffic on the access road to the existing pit dominated at N2 when present. Washing plant operations were not audible at N1 or N2.

Local and distant traffic dominated at N3 and N4 when the washing plant was shut down. When operating, washing plant emissions were continuously slightly audible at N3, and clearly audible at N4. $L_{AF90\ 15\ min}$ levels fell to 33 dB at these stations when the washing plant shut down.

9.3.4 Future Trends

EPA EIAR guidance recommends that a noise impact assessment should include a description of the likely evolution of the future receiving acoustic environment in the absence of the proposed development. The local noise environment is rural in character, with the chief background noise source being road traffic. Washing plant emissions are additionally audible at properties close to the southeast corner of the site.

In the medium and long term, traffic noise levels are likely to remain relatively constant across the study area. While a slight increase in R448 traffic may arise due to continued growth of settlements along the R448 corridor, any such increase may be partially offset by developments in tyre design, and by increasing use of stone mastic asphalt. Although engine noise emissions are expected to reduce in the future due to increasing take-up of electric vehicles, it is noted that traffic noise above 40-50 km/h arises chiefly from tyre noise.

The applicant's existing quarry is expected to cease operating in 2021 when the current planning permission expires. Noise emissions from the washing plant will therefore cease, resulting in a slight reduction in ambient noise levels at properties to the south and east of the pit. Truck movements on the access road will also terminate, and noise levels at the dwelling immediately adjacent to the access road will reduce.

9.3.5 Construction Phase Noise

Minor enabling works will be required, chiefly in relation to construction of a concrete hardstand area and inspection shed to the northeast of the existing site office. Noise emissions associated with these works will be minimal. Mobile plant required during the construction phase (trucks, tracked excavator and telescopic handler) will be similar to those operating on-site during the operational phase. Typical sound pressure levels associated with such plant are listed in Table 9-8, taken from *British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise* (2014).

Table 9-8 Expected construction plant. Levels at 10 m.

Plant	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Total L_{Aeq}
Tracked excavator (16 t)	78	70	72	68	67	66	73	65	76
Telescopic handler	85	79	69	67	64	62	56	47	71
Truck (driving)	73	78	78	78	74	73	68	66	80

Noise emissions from the proposed construction works were modelled using DGMR iNoise v2020.1 software. Input parameters were as follows:

- Model algorithm: *International Standard ISO 9613-2:1996 Acoustics: Attenuation of sound during propagation outdoors – Part 2 General method of calculation* (1996).
- Soft ground assumed throughout.
- Receiver height: 2 m (to assess external levels).
- Levels not rated for character.
- Plant output data taken from Table 9-8.
- 31.5 Hz levels (not provided in BS 5228) assumed to be same as 63 Hz levels.
- Plant on-times per hour: excavator (80 %), handler (20 %).
- Trucks following haul route from road entrance.

Predicted $L_{Aeq\ 1\ h}$ contours are shown in Figure 9-9. Predicted levels at all surrounding receptors during construction works will be lower than 45 dB, an thus considerably lower than the 65 dB criterion recommended by BS 5228-1:2009+A1:2014. It follows that construction phase noise impacts will be neutral, imperceptible and temporary.

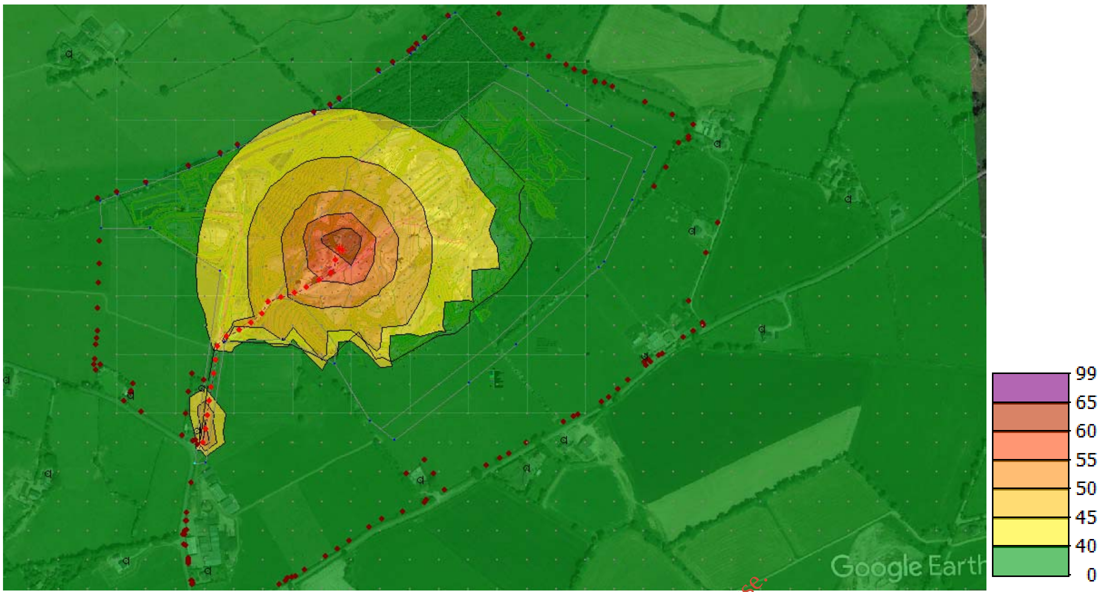

Figure 9-9 Predicted $L_{Aeq\ 1\ h}$ levels during construction phase.

9.3.6 Construction Phase Vibration

Significant vibrations are not expected from the types of equipment to be used, i.e. track machine and dumper. There will be no significant vibration associated with the construction phase.

9.3.6.1 Potential Pre-mitigation Effects

The expected construction phase vibration effects at the nearest receptor to the site are summarised as follows:

Neutral Quality, Imperceptible Temporary.

9.3.7 Operational Phase Noise

It is proposed to import inert soil, subsoil and stone to the site. The proposed finished topography will follow the surrounding terrain. The final profile will therefore rise towards the southern boundary, where the fill depth will be approximately 8 m. An existing mound near the site entrance will be graded.

The proposed activity will involve the import of fill material by trucks, and its distribution across the site. It is proposed to distribute fill in one layer, most likely in four lines running northwest to southeast. No processing activities such as crushing or grading are proposed. Plant required on-site will consist of the following:

- Fill will be imported by tipper truck, typically 8x4 and 10x4 rigid units, with some articulated trucks. Trucks will access the site from the R747 using the existing access road. Trucks will be weighed upon arrival at the site at the proposed on-site weighbridge. The material will be visually inspected and sampled if necessary. The vehicles will then travel to the tipping zone, tip its load, and immediately depart. The number of truck-loads imported each day will vary depending on demand. There may be concentrated events where up to 45 truck-loads may be imported per day (this is the upper maximum), followed by extended periods where no activity occurs.

- At intervals, tipped material will be pushed into position in the void space using a dozer. It is proposed to retain a dozer at the site throughout the project for this purpose. The dozer is likely be used for several hours each week. This may be concentrated in one event each week, or may be distributed across several shorter events.
- On occasion, a tracked excavator may be used on-site where circumstances require e.g. when levelling existing mounds, or when tying into surrounding levels. Although it is unlikely that the excavator and dozer will operate simultaneously, a worst case scenario of joint operation is applied in this assessment. Noise sources proposed on-site are listed in Table 9-9, along with corresponding noise output data taken from BS 5228-1:2009+A1:2014.

Table 9-9 Plant sound pressure levels (dB) at 10 m, from BS 5228-1:2009+A1:2014.

Source	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	$L_{Aeq\ T}$
Dozer 28 t	75	79	77	77	74	71	65	57	79
Excavator 25 t	95	84	79	73	70	68	64	57	77
8x4 tipper truck	73	78	78	78	74	73	68	66	80

Fill import and distribution will be confined to Monday-Friday 0700-1800 h and Saturday 0700-1400 h. The overall project is expected to last approximately 20 years. The proposed development will utilise existing infrastructure at the pit including welfare facilities. The activity will not result in an increase in public road traffic volumes and will represent a continuation of current sand and gravel pit activity.

At the end of the project, or at intervals during completion of interim phases, agricultural machinery will be used on-site for soil preparation and seeding. This activity will be entirely consistent with surrounding land use practices and is not considered further here.

9.3.7.1 Predicted Immissions

Noise levels likely to be received at surrounding receptors were calculated using DGMR iNoise v.2020 software. The following input parameters were applied:

- Algorithm: International Standard ISO 9613-2:1996 Acoustics: Attenuation of Sound during Propagation Outdoors – Part 2 General Method of Calculation (1996).
- Ground conditions: Soft, vegetated.
- Source data taken from Table 9-9.
- Receiver height: 2 m
- Dozer and excavator operating continuously.
- 10 trucks an hour travelling between gate and tipping zone.

The following scenarios were modelled:

- NW scenario 1: Dozer and excavator operating continuously near northwest corner, at pit floor level, with 10 truck movements per hour.
- NE scenario 1: Dozer and excavator operating continuously near northeast corner, at pit floor level, with 10 truck movements per hour.
- SW scenario 1: Dozer and excavator operating continuously near southwest corner, at pit floor level, with 10 truck movements per hour.
- SE scenario 1: Dozer and excavator operating continuously near southeast corner, at pit floor level, with 10 truck movements per hour.

- NW scenario 2: Dozer and excavator operating continuously near northwest corner, close to final ground level, with 10 truck movements per hour.
- NE scenario 2: Dozer and excavator operating continuously near northeast corner, close to final ground level, with 10 truck movements per hour.
- SW scenario 2: Dozer and excavator operating continuously near southwest corner, close to final ground level, with 10 truck movements per hour.
- SE scenario 2: Dozer and excavator operating continuously near southeast corner, close to final ground level, with 10 truck movements per hour.

Predicted $L_{Aeq\ 1\ h}$ levels are shown in Figure 9-10, Figure 9-11, Figure 9-12, Figure 9-13, Figure 9-14, Figure 9-15, Figure 9-16 and Figure 9-17 and presented in Table 9-10. The highest $L_{Aeq\ 1\ h}$ level received at any receptor will be 52 dB, arising at the dwellings adjacent to the access road due to truck movements.

Source data taken from BS 5228-1:2009+A1:2014 suggest that emissions will not be tonal. Noise surveys undertaken by Damian Brosnan Acoustics at other sites confirm that emissions are unlikely to be tonal. During such surveys, two potential sources of impulsive emissions have been detected previously: empty truck bodies rattling on access road potholes, and tailgate slap. Both sources may be readily addressed through mitigation.

Table 9-10 Received $L_{Aeq\ 1\ h}$ levels (dB).

Receptor	NW scenario	NE scenario	SW scenario	SE scenario	NW scenario	NE scenario	SW scenario	SE scenario
Operations elevation	Pit floor	Pit floor	Pit floor	Pit floor	Finished level	Finished level	Finished level	Finished level
Dwelling adjacent to access road	52	52	52	52	52	52	52	52
Dwelling adjacent to gate	52	52	52	52	52	52	52	52
Dwelling further W	43	42	43	41	43	42	43	41
Farmhouse S of gate	38	38	39	38	40	39	42	39
Nearest dwellings on road SE of site	3839	38-39	37-40	39-40	39-42	40-41	40-45	43-46
2 dwellings on cul de sac E of site	35-36	37-39	33-35	37-39	38-39	42	37-38	43-45
Dwelling NW of site	36	34	37	35	40	38	38	37

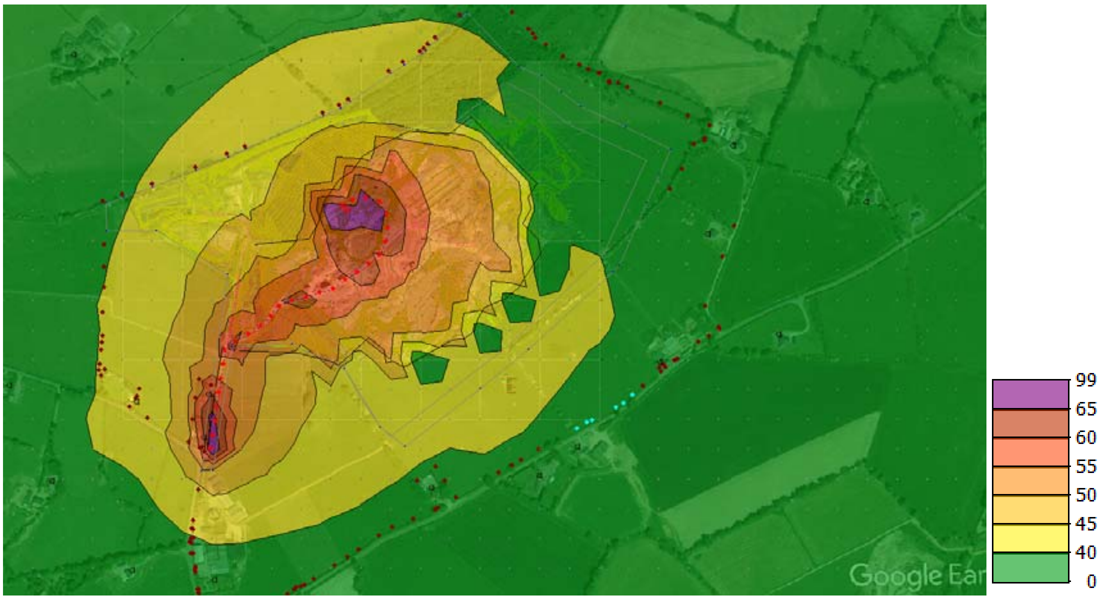

Figure 9-10 Predicted $L_{Aeq\ 1\ h}$ levels during NW operations at pit floor level.

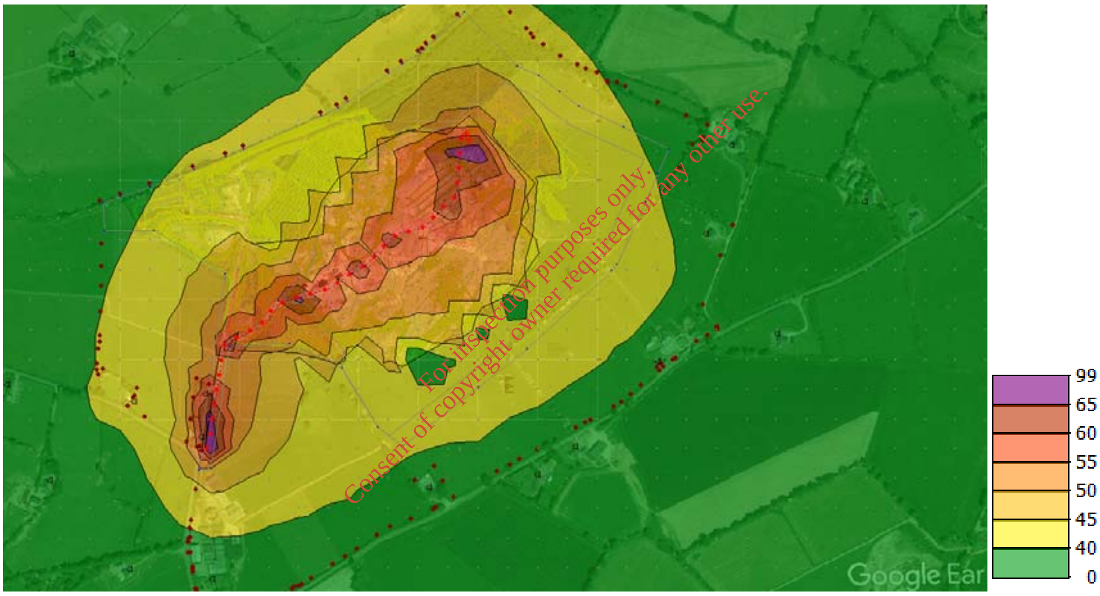

Figure 9-11 Predicted $L_{Aeq\ 1\ h}$ levels during NE operations at pit floor level.

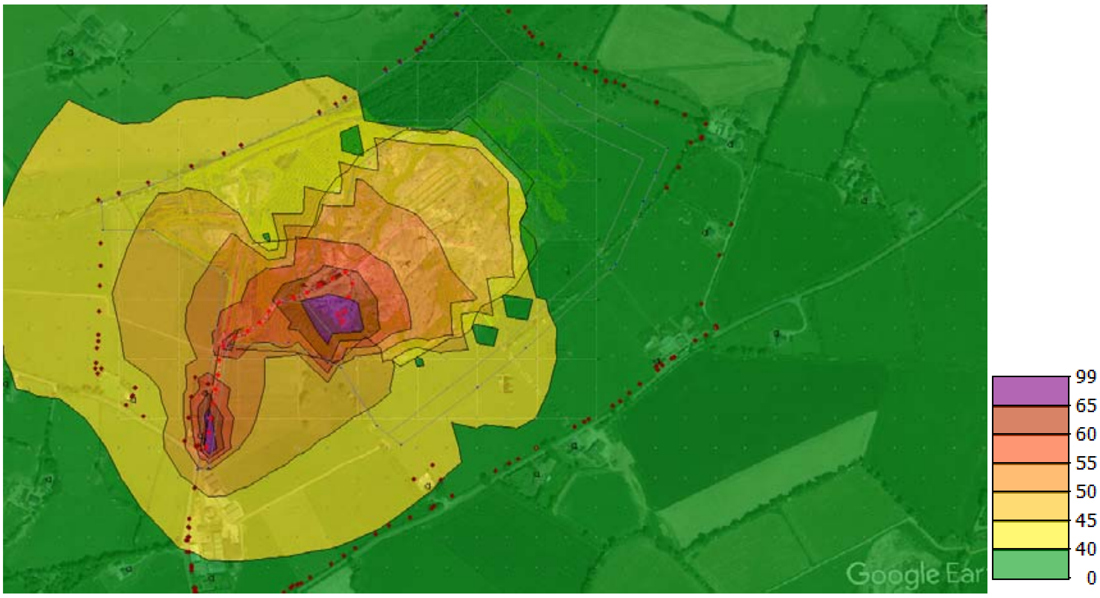

Figure 9-12 Predicted $L_{Aeq\ 1\ h}$ levels during SW operations at pit floor level.

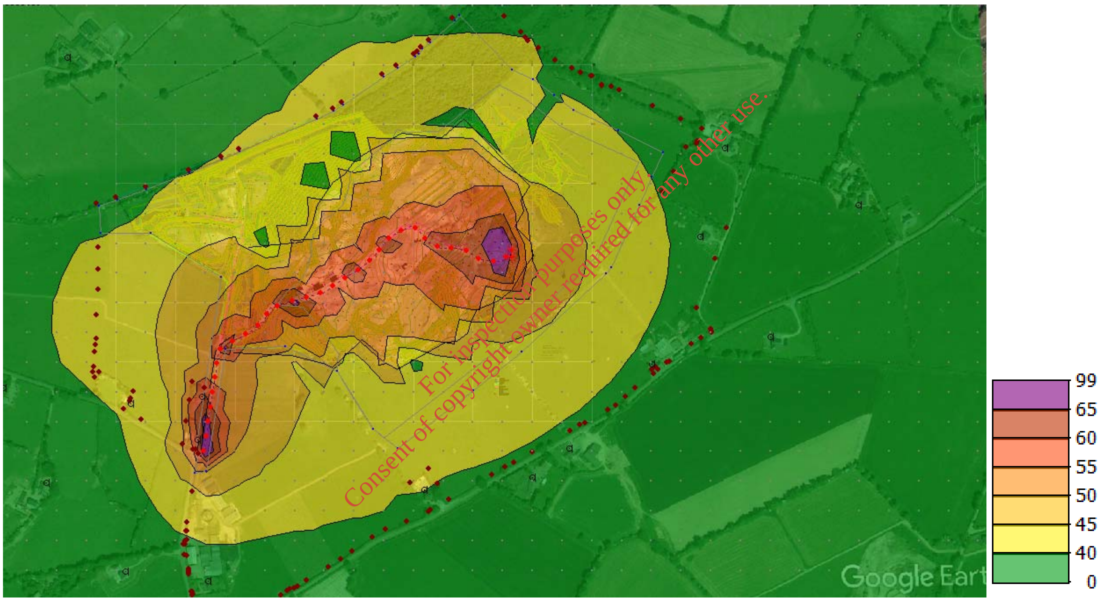

Figure 9-13 Predicted $L_{Aeq\ 1\ h}$ levels during SE operations at pit floor level.

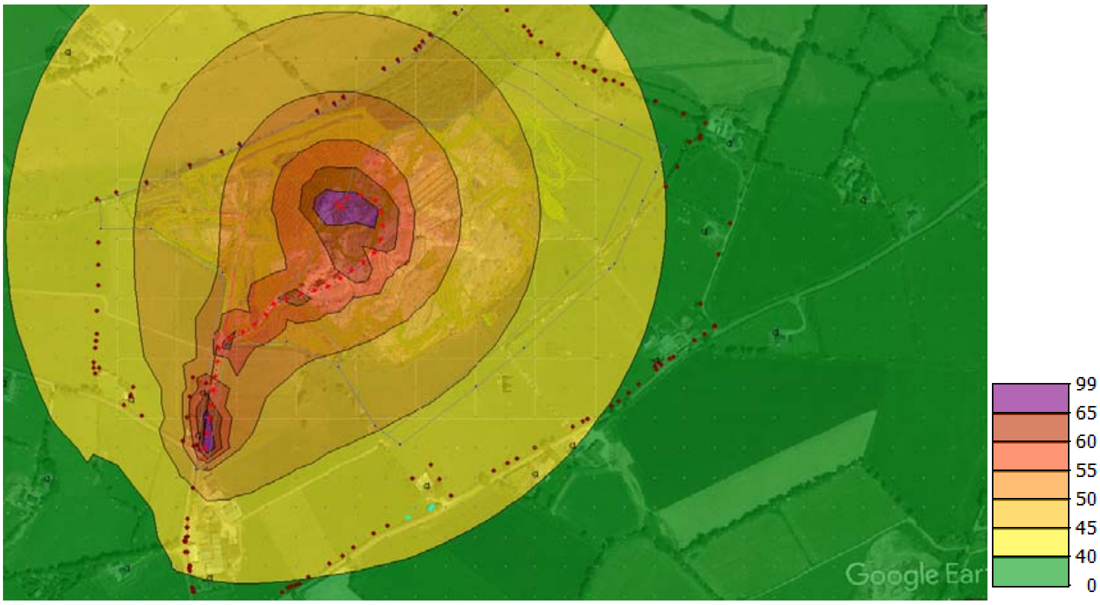

Figure 9-14 Predicted $L_{Aeq\ 1\ h}$ levels during NW operations at finished level.

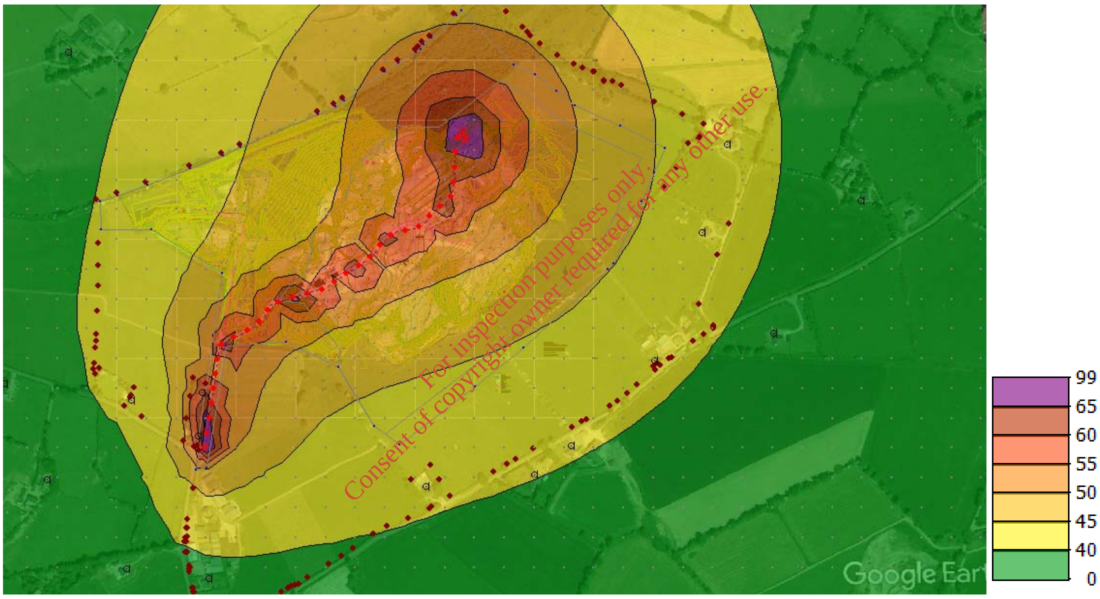

Figure 9-15 Predicted $L_{Aeq\ 1\ h}$ levels during NE operations at finished level.

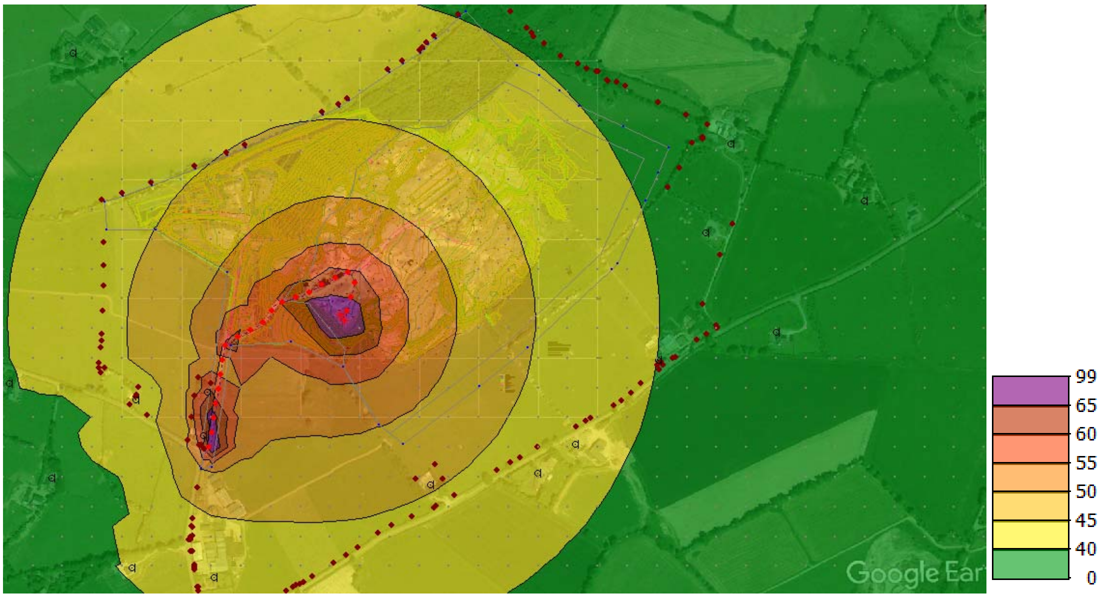

Figure 9-16 Predicted $L_{Aeq\ 1\ h}$ levels during SW operations at finished level.

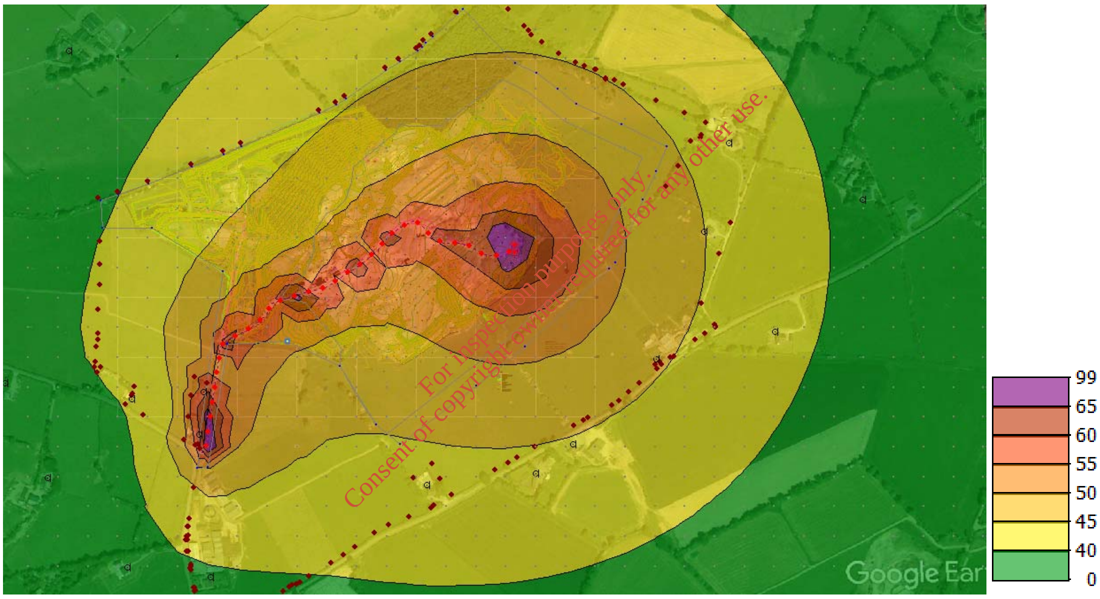

Figure 9-17 Predicted $L_{Aeq\ 1\ h}$ levels during SE operations at finished level.

9.3.8 Impacts

Predicted levels in Table 9-10 may be assessed in light of criteria identified above. At all receptors, $L_{Aeq\ 1\ h}$ levels throughout the project will be lower than the 55 dB daytime criterion. Apart from two dwellings adjacent to the site access road, $L_{Aeq\ 1\ h}$ levels at all dwellings will be lower than 45 dB, and indeed lower than 40 dB at most. Due to their proximity to the access road, the two dwellings identified will receive $L_{Aeq\ 1\ h}$ levels of 52 dB during the worst-case scenario i.e. ten truck movements per hour.

Impacts at the nearest properties may also be assessed by reference to existing baseline (Table 9-7) and criteria set out in Table 9-4. The assessment is presented in Table 9-11. As existing levels were measured while operations were underway at the pit, and because these emissions will cease, it is not appropriate to add predicted and baseline levels.

Table 9-11 Comparison of baseline and predicted $L_{Aeq\ 1\ h}$ levels at nearest receptors. Baseline levels taken from nearest representative position.

Receptor	Baseline	NW scenario	NE scenario	SW scenario	SE scenario	NW scenario	NE scenario	SW scenario	SE scenario
Operations elevation		Pit floor	Pit floor	Pit floor	Pit floor	Finished level	Finished level	Finished level	Finished level
Dwelling adjacent to access road	50-54	52	52	52	52	52	52	52	52
Dwelling adjacent to gate	50-54	52	52	52	52	52	52	52	52
Nearest dwellings on road SE of site	43-49	3839	38-39	37-40	39-40	39-42	40-41	40-45	43-46
2 dwellings on cul de sac E of site	40-43	35-36	37-39	33-35	37-39	38-39	42	37-38	43-45
Dwelling NW of site	43-49	36	34	37	35	40	38	38	37

At the dwellings adjacent to the access road, predicted levels are similar to those currently arising, representing a continuation of existing impacts. With one exception, predicted levels at all other receptors will be lower than baseline $L_{Aeq\ 1\ h}$ levels, which were dominated at most stations by road traffic noise. This will render site emissions inaudible or slightly audible at these receptors. The single exception here relates to two dwellings on the cul de sac to the east of the site, where operations at the finished level near the southeast corner may marginally exceed baseline noise levels.

9.3.8.1 Potential Pre-mitigation Effects

At almost all receptors, the significance of effects can be described as neutral, imperceptible and long term. At the dwellings adjacent to the access road, effects will represent a continuation of existing effects, and are therefore neutral, imperceptible and long term. Towards the end of the project, as the fill approaches surrounding ground level, operations at the southeast quadrant will give rise to slight negative effects when the dozer and excavator are in simultaneous use. Such activity is likely to occur rarely.

9.3.9 Operational Phase Vibration

The proposed development will not involve any processes which give rise to groundborne vibration. Thus activities such as piling and vibro-rolling will not be undertaken. Plant used on-site (tracked excavator, dozer and trucks) are not associated with groundborne vibration. BS 5228-2:2009+A1:2014 does not make any reference to vibration from such plant.

Experience with other facilities which use mobile plant indicates that PPV levels will remain below 1 mm/s even at positions within 50 m of plant. By reference to criteria listed above, it is evident that the proposed development is highly unlikely to give rise to perceptible groundborne vibration at any receptor. PPV levels on the development site itself will be markedly lower than building damage threshold levels, and it follows that the risk of damage to offsite buildings will be zero.

9.3.9.1 Potential Pre-mitigation Effects

Neutral quality, imperceptible and Long-term duration.

9.3.10 Population and Human Health

The assessment of impacts on human health is typically undertaken by reference to WHO guidance, which has been revised over the last four decades according as noise and health studies have been published. Current WHO guidance, discussed above, recommends an external 55 dB daytime criterion.

Received $L_{Aeq\ 1\ h}$ levels at all receptors will be lower than 55 dB. Levels will be lower than 45 dB at all receptors apart from two dwelling adjacent to the site access road. On this basis, it is considered that there will be no adverse noise impact on the local population or on human health.

9.4 Mitigation Measures

Received $L_{Aeq\ 1\ h}$ levels attributable to the proposed development will be lower than the daytime 55 dB criterion at all receptors. At two dwellings adjacent to the site access road, $L_{Aeq\ 1\ h}$ levels due to truck movements will be 52 dB during peak events. These levels are similar to those currently arising, associated with the existing sand and gravel pit. At all other receptors, $L_{Aeq\ 1\ h}$ levels will be less than 45 dB. At most of these, noise emissions from the site will be inaudible or slightly audible due to masking by road traffic noise. It follows that no specific mitigation measures are required. However, the applicant proposes to implement the following general mitigation measures:

- Plant used on-site will be maintained in accordance with manufacturer specifications. In particular, exhaust silencers will be maintained in a satisfactory condition.
- Communication through plant horns will be prohibited.
- Unnecessary revving of truck engines will be prohibited.

Specific mitigation is warranted with respect to potential impulsive emissions, and two measures are proposed here by the applicant:

- Site haul roads will be maintained in a satisfactory condition, and free from surface defects that may generate rattles in empty truck bodies.
- Tailgate slap during tipping events will be prevented by using rubber stops or powered tailgates.

Given the relatively low intensity of the project, it is not considered necessary to implement a noise or vibration monitoring programme following project commencement. Such a programme may be commissioned if required by conditions attached to any planning permission, waste permit or waste licence.

9.5 Summary of Effects

At two dwellings adjacent to the site access road, impacts will represent a continuation of existing impacts associated with the existing sand and gravel pit. No change will arise here, and thus effects will remain as at present.

At all other dwellings, the proposed development will give rise to neutral impacts and effects, increasing to slight negative at two dwellings served by the cul de sac to the east towards the end of the project when operations occur in the southeast part of the site. Emissions will be inaudible or barely audible at worst.

No cumulative impacts are predicted.

GLOSSARY

Ambient: Total noise environment at a location, including all sounds present.

A-weighting: Weighting or adjustment applied to sound level to approximate non-linear frequency response of human ear. Denoted by suffix A in parameters such as $L_{Aeq\ T}$, $L_{AF10\ T}$, etc.

Background level: A-weighted sound pressure level of residual noise exceeded for 90 % of time interval T. Denoted $L_{AF90\ T}$.

Broadband: Noise which contains roughly equal energy across frequency spectrum. Does not contain tones, and is generally less annoying than tonal noise.

Decibel (dB): Unit of noise measurement scale. Based on logarithmic scale so cannot be simply added or subtracted. 3 dB difference is smallest change perceptible to human ear. 10 dB difference is perceived as doubling or halving of sound level. Examples of decibel levels are as follows: 20 dB: very quiet room; 30-35 dB: night-time rural environment; 55-65 dB: conversation; 80 dB: busy pub; 100 dB: nightclub. Throughout this report noise levels are presented as decibels relative to 20 µPa.

Fast response: 0.125 seconds response time of sound level meter to changing noise levels. Denoted by suffix F in parameters such as $L_{AF10\ T}$, $L_{AF90\ T}$, etc.

Free field: Measurement position removed from acoustically reflective surfaces other than ground.

Frequency: Number of cycles per second of a sound or vibration wave. Low frequency noise may be perceived as hum, while whine represents higher frequency. Range of human hearing approaches 20-20,000 Hertz.

Hertz (Hz): Unit of frequency measurement.

Impulse: Noise which is of short duration, typically less than one second, sound pressure level of which is significantly higher than background.

Interval: Time period T over which noise parameters are measured at position. Denoted by T in $L_{Aeq\ T}$, $L_{AF90\ T}$, etc.

$L_{Aeq\ T}$: Equivalent continuous sound pressure level during interval T, effectively representing average A-weighted noise level of ambient noise environment.

$L_{AF10\ T}$: Sound pressure level exceeded for 10% of interval T, usually used to quantify traffic noise.

$L_{AF90\ T}$: Sound pressure level exceeded for 90% of interval T, usually used to quantify background noise. May also be used to describe noise level from continuous steady or almost-steady source, particularly where local noise environment fluctuates.

Noise sensitive location: Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or area of high amenity which for its proper enjoyment requires absence of noise at nuisance levels.

Octave band: Frequency spectrum may be divided into octave bands. Upper limit of each octave is twice lower limit.

Peak particle velocity (PPV): Rate of change of displacement of particles in solid medium due to vibration, measured as mm/s. Usually used to assess vibration in relation to activities such as blasting as correlates well with human perception of vibration and property damage.

Soundscape: Acoustic environment as perceived, experienced or understood by listeners, taking context into account.

Specific level: $L_{Aeq\ T}$ level produced by specific noise source under consideration during interval T, measured directly or by estimation or calculation.

Tone: Character of noise caused by dominance of one or more frequencies which may result in increased noise nuisance.

APPENDIX 9-1

SURVEY DETAILS

Project	
Microphone positions	Free field 1.5 m above ground level
Time	Thursday 05-03-20 0800-1700
Comment	Facility operating
Operator	Damian Brosnan BSc MSc MIOA MIEI
Standard	ISO 1996 (2016 & 2017) BS 4142 (2014)
Field calibrator	Bruel & Kjaer Type 4231 Serial 2342544 Laboratory verification 14.02.20 by Sonitus Systems

Weather	
Cloud cover	80-100 %
Precipitation	0 mm
Temperature	0 rising to 8 °C
Wind direction	SW
Wind speed	0-1 m/s
Wind measurement	Anemo anemometer 2 m above ground level at each station

Instrument 1	
Stations used	N4
Instrument	NTi XL2 ('xl1') IEC 61672-1:2013 Class 1
SLM serial	A2A-13658-E0
Microphone serial	A14735 + pre-amp 7066
Range	0-100 dB
Intervals	Logging at 1 s with audio Relevant intervals extracted
Time weighting	Fast
Frequency weighting	Broadband: A+C Spectrum: Z
Laboratory verification	14.02.20 by Sonitus Systems Compliance certificate available on request
Field calibration	05.03.20 0858 @ 44.0 mV/Pa
Post survey drift check	93.9 dB

Instrument 2	
Stations used	N2
Instrument	NTi XL2 ('xl2') IEC 61672-1:2013 Class 1
SLM serial	A2A-14337-E0
Microphone serial	A14972 + pre-amp 7266
Range	0-100 dB
Intervals	Logging at 1 s with audio Relevant intervals extracted
Time weighting	Fast
Frequency weighting	Broadband: A+C Spectrum: Z
Laboratory verification	14.02.20 by Sonitus Systems Compliance certificate available on request
Field calibration	05.03.20 0911 @ 43.7 mV/Pa
Post survey drift check	93.9 dB

Instrument 3	
Stations used	N1
Instrument	NTi XL2 ('xl3') IEC 61672-1:2013 Class 1
SLM serial	A2A-15392-E0
Microphone serial	A16340 + pre-amp 7956
Range	0-100 dB
Intervals	Logging at 1 s with audio Relevant intervals extracted
Time weighting	Fast
Frequency weighting	Broadband: A+C Spectrum: Z
Laboratory verification	14.02.20 by Sonitus Systems Compliance certificate available on request
Field calibration	05.03.20 0832 @ 42.0 mV/Pa
Post survey drift check	93.9 dB

Instrument 4	
Stations used	N3
Instrument	NTi XL2 (‘xl4’) IEC 61672-1:2013 Class 1
SLM serial	A2A-15429-E0
Microphone serial	A16329 + pre-amp 7945
Range	0-100 dB
Intervals	Logging at 1 s with audio Relevant intervals extracted
Time weighting	Fast
Frequency weighting	Broadband: A+C Spectrum: Z
Laboratory verification	14.02.20 by Sonitus Systems Compliance certificate available on request
Field calibration	05.03.20 0930 @ 40.1 mV/Pa
Post survey drift check	93.9 dB

Uncertainty	
Residual noise	u_i = 0.5 dB c_i = 1 dB where source dominates, >20 dB where source becomes masked c_iu_i range = 0.5 to >10 dB
Weather conditions	Levels representative of contemporaneous conditions only c_iu_i = 2 dB at wind vector + or x Otherwise c_iu_i >2 dB
Anemometer height	Not possible to measure wind speed at 10 m Anemometer height of 2 m may increase meteorological uncertainty
Precipitation	Precipitation = 0 mm during reported intervals c_iu_i = 0 dB
Operating conditions	Levels representative of contemporaneous operating conditions only c_iu_i <1 dB
Location	c_iu_i = 0 dB at free field positions c_iu_i = 0.4 dB at near field & reflective field positions
Instrument	IEC 61672-1 class 1 specifications u = 0.5 dB.
Combined	3 dB to >10 dB, depending on position Variation chiefly to meteorology & residual noise intrusion
Expanded	6 dB to >10 dB, 95 % coverage

Project	
Microphone positions	Free field 1.5 m above ground level
Time	Thursday 05-03-20 0800-1700
Comment	Facility operating
Operator	Damian Brosnan BSc MSc MIOA MIEI
Standard	ISO 1996 (2016 & 2017) BS 4142 (2014)
Field calibrator	Bruel & Kjaer Type 4231 Serial 2342544 Laboratory verification 14.02.20 by Sonitus Systems

Weather	
Cloud cover	80-100 %
Precipitation	0 mm
Temperature	0 rising to 8 °C
Wind direction	SW
Wind speed	0-1 m/s
Wind measurement	Anemo anemometer 2 m above ground level at each station

Instrument 1	
Stations used	N4
Instrument	NTi XL2 ('xl1') IEC 61672-1:2013 Class 1
SLM serial	A2A-13658-E0
Microphone serial	A14735 + pre-amp 7066
Range	0-100 dB
Intervals	Logging at 1 s with audio Relevant intervals extracted
Time weighting	Fast
Frequency weighting	Broadband: A+C Spectrum: Z
Laboratory verification	14.02.20 by Sonitus Systems Compliance certificate available on request
Field calibration	05.03.20 0858 @ 44.0 mV/Pa
Post survey drift check	93.9 dB

Instrument 2	
Stations used	N2
Instrument	NTi XL2 ('xl2') IEC 61672-1:2013 Class 1
SLM serial	A2A-14337-E0
Microphone serial	A14972 + pre-amp 7266
Range	0-100 dB
Intervals	Logging at 1 s with audio Relevant intervals extracted
Time weighting	Fast
Frequency weighting	Broadband: A+C Spectrum: Z
Laboratory verification	14.02.20 by Sonitus Systems Compliance certificate available on request
Field calibration	05.03.20 0911 @ 43.7 mV/Pa
Post survey drift check	93.9 dB

Instrument 3	
Stations used	N1
Instrument	NTi XL2 ('xl3') IEC 61672-1:2013 Class 1
SLM serial	A2A-15392-E0
Microphone serial	A16340 + pre-amp 7956
Range	0-100 dB
Intervals	Logging at 1 s with audio Relevant intervals extracted
Time weighting	Fast
Frequency weighting	Broadband: A+C Spectrum: Z
Laboratory verification	14.02.20 by Sonitus Systems Compliance certificate available on request
Field calibration	05.03.20 0832 @ 42.0 mV/Pa
Post survey drift check	93.9 dB

Instrument 4	
Stations used	N3
Instrument	NTi XL2 ('xl4') IEC 61672-1:2013 Class 1
SLM serial	A2A-15429-E0
Microphone serial	A16329 + pre-amp 7945
Range	0-100 dB
Intervals	Logging at 1 s with audio Relevant intervals extracted
Time weighting	Fast
Frequency weighting	Broadband: A+C Spectrum: Z
Laboratory verification	14.02.20 by Sonitus Systems Compliance certificate available on request
Field calibration	05.03.20 0930 @ 40.1 mV/Pa
Post survey drift check	93.9 dB

Uncertainty	
Residual noise	u_i = 0.5 dB c_i = 1 dB where source dominates, >20 dB where source becomes masked c_iu_i range = 0.5 to >10 dB
Weather conditions	Levels representative of contemporaneous conditions only c_iu_i = 2 dB at wind vector + or x Otherwise c_iu_i >2 dB
Anemometer height	Not possible to measure wind speed at 10 m Anemometer height of 2 m may increase meteorological uncertainty
Precipitation	Precipitation = 0 mm during reported intervals c_iu_i = 0 dB
Operating conditions	Levels representative of contemporaneous operating conditions only c_iu_i <1 dB
Location	c_iu_i = 0 dB at free field positions c_iu_i = 0.4 dB at near field & reflective field positions
Instrument	IEC 61672-1 class 1 specifications u = 0.5 dB.
Combined	3 dB to >10 dB, depending on position Variation chiefly to meteorology & residual noise intrusion
Expanded	6 dB to >10 dB, 95 % coverage

APPENDIX 9-2

BASELINE NOISE DATA

Station	Start Date and Time	$L_{Aeq\ 15\ min}$	$L_{AF10\ 15\ min}$	$L_{AF90\ 15\ min}$
N1	05/03/2020 09:15	40	42	37
N1	05/03/2020 09:30	40	42	37
N1	05/03/2020 09:45	43	45	38
N1	05/03/2020 10:00	53	46	37
N1	05/03/2020 10:15	49	49	37
N1	05/03/2020 10:30	44	46	37
N1	05/03/2020 10:45	42	46	37
N1	05/03/2020 11:00	49	52	38
N1	05/03/2020 11:15	47	51	38
N1	05/03/2020 11:30	46	48	39
N1	05/03/2020 11:45	44	46	38
N1	05/03/2020 12:00	44	46	38
N1	05/03/2020 12:15	47	48	39
N1	05/03/2020 12:30	48	50	38
N1	05/03/2020 12:45	43	46	39
N1	05/03/2020 13:00	43	45	37
N1	05/03/2020 13:15	45	45	37
N1	05/03/2020 13:30	49	46	37
N1	05/03/2020 13:45	42	44	37
N1	05/03/2020 14:00	47	47	37
N1	05/03/2020 14:15	49	45	37
N1	05/03/2020 14:30	41	43	37
N1	05/03/2020 14:45	45	46	38
N1	05/03/2020 15:00	47	49	38
N1	05/03/2020 15:15	47	48	40
N1	05/03/2020 15:30	47	49	40
N1	05/03/2020 15:45	47	47	41
N2	05/03/2020 09:15	53	56	38
N2	05/03/2020 09:30	52	56	38
N2	05/03/2020 09:45	53	57	39

N2	05/03/2020 10:00	47	49	37
N2	05/03/2020 10:15	56	59	38
N2	05/03/2020 10:30	52	48	37
N2	05/03/2020 10:45	48	45	38
N2	05/03/2020 11:00	51	47	38
N2	05/03/2020 11:15	55	50	37
N2	05/03/2020 11:30	56	57	40
N2	05/03/2020 11:45	47	48	39
N2	05/03/2020 12:00	50	46	37
N2	05/03/2020 12:15	54	54	38
N2	05/03/2020 12:30	54	56	39
N2	05/03/2020 12:45	54	52	40
N2	05/03/2020 13:00	53	51	38
N2	05/03/2020 13:15	48	50	38
N2	05/03/2020 13:30	47	49	38
N2	05/03/2020 13:45	50	49	37
N2	05/03/2020 14:00	49	48	39
N2	05/03/2020 14:15	49	53	37
N2	05/03/2020 14:30	52	52	38
N2	05/03/2020 14:45	49	47	37
N2	05/03/2020 15:00	53	54	37
N2	05/03/2020 15:15	49	50	37
N2	05/03/2020 15:30	45	47	37
N3	05/03/2020 08:45	37	38	33
N3	05/03/2020 09:00	47	52	34
N3	05/03/2020 09:15	42	43	37
N3	05/03/2020 09:30	46	47	37
N3	05/03/2020 09:45	42	44	38
N3	05/03/2020 10:00	44	46	39
N3	05/03/2020 10:15	44	47	40
N3	05/03/2020 10:30	43	45	40

N3	05/03/2020 10:45	47	48	41
N3	05/03/2020 11:00	42	45	38
N3	05/03/2020 11:15	45	46	38
N3	05/03/2020 11:30	46	44	37
N3	05/03/2020 11:45	41	44	37
N3	05/03/2020 12:00	44	45	37
N3	05/03/2020 12:15	44	44	37
N3	05/03/2020 12:30	40	42	36
N3	05/03/2020 12:45	42	43	36
N3	05/03/2020 13:00	46	44	36
N3	05/03/2020 13:15	40	43	36
N3	05/03/2020 13:30	41	42	36
N3	05/03/2020 13:45	44	48	36
N3	05/03/2020 14:00	51	56	36
N3	05/03/2020 14:15	53	59	36
N3	05/03/2020 14:30	44	48	35
N3	05/03/2020 14:45	40	41	35
N3	05/03/2020 15:00	46	46	35
N3	05/03/2020 15:15	39	42	34
N3	05/03/2020 15:30	37	39	33
N3	05/03/2020 15:45	47	46	34
N3	05/03/2020 16:00	38	41	35
N4	05/03/2020 09:45	43	45	39
N4	05/03/2020 10:00	44	46	40
N4	05/03/2020 10:15	44	46	40
N4	05/03/2020 10:30	42	44	38
N4	05/03/2020 10:45	44	45	40
N4	05/03/2020 11:00	42	44	38
N4	05/03/2020 11:15	42	45	38
N4	05/03/2020 11:30	44	47	42
N4	05/03/2020 11:45	43	45	39

N4	05/03/2020 12:00	41	43	39
N4	05/03/2020 12:15	43	45	40
N4	05/03/2020 12:30	44	44	39
N4	05/03/2020 12:45	41	43	39
N4	05/03/2020 13:00	40	42	38
N4	05/03/2020 13:15	41	44	38
N4	05/03/2020 13:30	39	42	37
N4	05/03/2020 13:45	39	41	35
N4	05/03/2020 14:00	41	43	37
N4	05/03/2020 14:15	39	41	36
N4	05/03/2020 14:30	42	45	35
N4	05/03/2020 14:45	41	42	37
N4	05/03/2020 15:00	42	44	34
N4	05/03/2020 15:15	39	42	36
N4	05/03/2020 15:30	40	42	36
N4	05/03/2020 15:45	39	42	35
N4	05/03/2020 16:00	38	40	35

Station	Start Date and Time	$L_{Aeq\ 1\ h}$	$L_{AF10\ 1\ h}$	$L_{AF90\ 1\ h}$
N1	05/03/2020 09:00	43	44	37
N1	05/03/2020 10:00	49	47	37
N1	05/03/2020 11:00	47	49	38
N1	05/03/2020 12:00	46	47	39
N1	05/03/2020 13:00	46	45	37
N1	05/03/2020 14:00	46	45	37
N1	05/03/2020 15:00	47	48	39
N2	05/03/2020 09:00	53	57	38
N2	05/03/2020 10:00	52	49	37
N2	05/03/2020 11:00	54	50	38
N2	05/03/2020 12:00	53	53	38

N2	05/03/2020 13:00	50	50	38
N2	05/03/2020 14:00	50	51	37
N2	05/03/2020 15:00	51	51	37
N3	05/03/2020 09:00	45	49	37
N3	05/03/2020 10:00	45	47	40
N3	05/03/2020 11:00	44	45	38
N3	05/03/2020 12:00	43	44	37
N3	05/03/2020 13:00	43	45	36
N3	05/03/2020 14:00	49	52	36
N3	05/03/2020 15:00	44	44	34
N4	05/03/2020 10:00	43	46	39
N4	05/03/2020 11:00	43	46	39
N4	05/03/2020 12:00	42	44	39
N4	05/03/2020 13:00	40	42	36
N4	05/03/2020 14:00	41	43	36
N4	05/03/2020 15:00	40	42	35